Robert Singletary
Executive Director

OKLAHOMA
Environmental
Quality

Kevin Stitt
Governor

June 27, 2024

Ms. Rebecca Jones, P.G.
American Electric Power
502 North Allen Avenue
Shreveport, LA 71101

Re: Alternate Source Demonstration for Barium, Fluoride and Lithium Exceedances –Bottom Ash
        Pond
        Public Service Company of Oklahoma - Northeastern Power Station, Rogers County
        Solid Waste Permit No. none

Dear Ms. Jones:

The Oklahoma Department of Environmental Quality received the Alternate Source Demonstration
(ASD) dated May 16, 2024. The ASD was submitted by American Electric Power (AEP) Public
Service Company of Oklahoma – Northeastern Power Station (PSO-NES) for the Bottom Ash Pond
(BAP). During the October 10, 2023 sampling event, potential statistically significant levels (SSLs)
were identified for lithium, barium, and fluoride in SP-10. The Lower Confidence Levels (LCL) for
lithium (0.238 mg/L), barium (4.20 mg/L), and fluoride (5.59 mg/L) exceeded their respective
Groundwater Protection Standards (GWPS) of 0.163 mg/L for lithium, 2.77 mg/L for barium, and
4.39 mg/L for fluoride. The detected 2023 concentrations for each constituent (0.235 mg/L, 6.01
mg/L, and 6.3 mg/L for lithium, barium, and fluoride, respectively) also exceeded their respective
GWPSs.

On October 29, 2019, DEQ approved the revised ASD for lithium detected in monitoring well SP-10
for the BAP. The 2019 ASD proposed that naturally occurring lithium in the shale lenses was the
source of the potential SSL. On June 4, 2021, DEQ approved an ASD for fluoride exceedances
detected in SP-10 for the BAP. The 2021 ASD also proposed that naturally occurring fluoride in the
shale lenses was the source of the potential SSL.

On September 20, 2022, DEQ approved the ASD for barium, lithium, and fluoride exceedances
detected in SP-10. The 2022 ASD proposed that naturally occurring barium in the shale lenses was
the source of the potential SSL. The 2022 ASD approval stated it is applicable for lithium, fluoride,
and barium exceedances of the GWPS in SP-10 if conditions do not change.

The lithium and fluoride concentrations in SP-10 from the October 2023 sampling event are consistent
with previous results and continue to show no statistically positive trends. However, the time-series
plot and Mann-Kendall analysis of the reported barium concentration over time, indicate a statistically
significant increasing trend.

AEP provided additional evidence to demonstrate conditions have not changed and the BAP is not
the source of the potential SSLs. The Piper Diagram continues to show that the SP-10 samples are
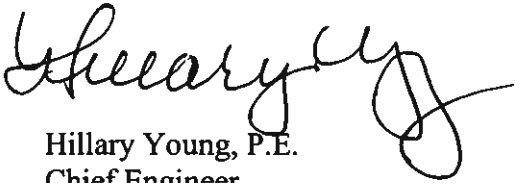chemically distinct from the BAP surface water, pore water, and sediment samples. The geochemistry

at SP-10 does not change significantly over time in a manner indicative of a release from the BAP. The October 2023 SP-10 sample concentration of barium was detected at 6.01 mg/L, far greater than the 2019 samples of the leachate from bottom ash, surface water in the BAP, and pore water beneath the BAP, detected at 0.352 mg/L, 0.315 mg/L, and 0.083 mg/L, respectively.

AEP may refer to the ASD approval and continue assessment monitoring for the BAP in accordance with Oklahoma Administrative Code (OAC) 252:517-9-6(g)(3)(B). If exceedances of GWPSs are determined in other monitoring wells, AEP is required to submit a separate ASD for constituents in those monitoring wells if applicable.
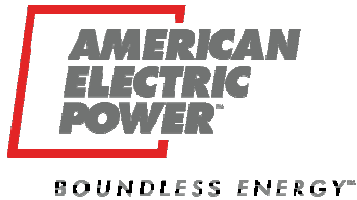
The ASD for barium, fluoride, and lithium exceedances in SP-10 is accepted as submitted. If you have any questions, please contact Kaylee Daneshmand at (405) 702-5196 or at Kaylee.daneshmand@deq.ok.gov.

Sincerely,

Hillary Young, P.E.
Chief Engineer
Land Protection Division

HY/kd

May 17, 2024

Via electronic mail

Ms. Kaylee Daneshmand
Oklahoma Department of Environmental Quality (ODEQ)
707 North Robinson, P.O. Box 1677
Oklahoma City, OK 73101-1677

Re: Alternate Source Demonstration (ASD)
        Bottom Ash Pond (BAP)
        Public Service Company of Oklahoma (PSO) - Northeastern Power Station (NPS)
        Roger County
        Solid Waste Permit No. Pending

Dear Ms. Daneshmand,

AEP/PSO received ODEQ's correspondence dated February 22, 2024, in which ODEQ accepted the ASD for the lithium, fluoride, and barium detected in SP-10 during the October 4, 2023, sampling event. ODEQ indicated that if lithium, fluoride, and barium continue to exceed the groundwater protection standards (GWPS) in the future and conditions have not changed, NPS may refer to the October 24, 2019, ASD approval for lithium, June 4, 2021, ASD approval for fluoride, and to the March 9, 2023, ASD approval for barium and continue assessment monitoring for the BAP in accordance with OAC 252:517-9-6(g)(3)(B).

On February 20, 2024, the statistical evaluation of the second semi-annual 2023 assessment monitoring event (October 10, 2023) for the BAP was certified and in that statistical evaluation report, potential SSLs were identified for lithium, fluoride, and barium at SP-10.

The statistical findings are summarized as follows:

The Lower Confidence Level (LCL) for lithium (0.238 mg/L) exceeded the GWPS (a calculated Upper Tolerance Limit (UTL)) of 0.163 mg/L at SP-10. The actual detected lithium concentration in SP-10 was 0.235 mg/l.

The LCL for fluoride (5.59 mg/L) exceeded the GWPS (UTL of 4.39 mg/L) was exceeded as at SP-10. The actual detected fluoride concentration in SP-10 was 6.3 mg/L.

The LCL for barium (4.20 mg/L) exceeded the GWPS (UTL of 2.77 mg/L) was exceeded as at SP-10. The actual detected barium concentration in SP-10 was 6.01 mg/L.

Attached are the alternative source demonstrations for your review outlining the lines of evidence that these exceedances are the result of natural variations occurring in the groundwater at SP-10 and that the conditions at the BAP have not changed.

Please do not hesitate to contact me if you have any questions or would like to discuss. I can be reached by email at: rdjones2@aep.com or by phone at: (737) 330-3725.

Sincerely,

Rebecca D. Jones, P.G.

AEP, Environmental Specialist

Attachments

Geosyntec consultants

Memorandum

Date: May 16, 2024

To: Rebecca Jones, American Electric Power (AEP)

From: Beth Gross, PhD, PE (OK) and Allison Kreinberg, Geosyntec

Subject: Alternative Source Demonstration Update
                 Northeastern Power Station Bottom Ash Pond
                 Oologah, Rogers County, Oklahoma

The Bottom Ash Pond (BAP) is a regulated coal combustion residual (CCR) management unit at the Northeastern Power Station (NPS) in Oologah, Oklahoma. A semiannual assessment monitoring event was completed at the BAP on October 10, 2023, in accordance with the assessment monitoring requirements of Oklahoma Administrative Code (OAC) 252:517-9-6. Analysis of the October 2023 data identified statistically significant levels (SSLs) above the groundwater protection standards (GWPSs) for lithium, fluoride, and barium at SP-10 (Attachment B). The following SSLs were identified at the Northeastern BAP:

- The lower confidence limit (LCL) for lithium exceeded the GWPS of 0.163 milligrams per liter (mg/L) at SP-10 (0.238 mg/L).

- The LCL for fluoride exceeded the GWPS of 4.39 mg/L at SP-10 (5.59 mg/L).

- The LCL for barium exceeded the GWPS of 2.77 mg/L at SP-10 (4.20 mg/L).

Key analytical results for samples collected from the BAP and from SP-10 are provided in **Table 1**. As described in previous alternative source demonstrations (ASDs) (Geosyntec 2019, Geosyntec 2021a, Geosyntec 2021b, Geosyntec 2021c, Geosyntec 2022, Geosyntec 2023a, Geosyntec 2023b, Geosyntec 2023c), concentrations of lithium, fluoride, and barium in the BAP water (including pore water) and BAP sediments that are lower than concentrations observed at SP-10 suggest that the BAP is not the source of these exceedances. These previous ASDs demonstrate that the release of lithium from the clay minerals in the shale lens located at 46 feet below ground surface in the screened interval of SP-10 is the likely source of lithium in groundwater at that location. Analytical results suggest that naturally occurring barium and fluoride are also associated with the shale lenses and are contributing to aqueous barium and fluoride concentrations at SP-10.

The Oklahoma Department of Environmental Quality (DEQ) previously noted in a letter to the NPS dated June 4, 2021, that "[i]f lithium and fluoride continue to exceed their relative GWPS in the future and conditions have not changed, NPS may refer to the October 29, 2019 ASD approval

for lithium and this [June 4, 2021] approval for fluoride and continue assessment monitoring for the BAP in accordance with OAC 252:517-6(g)(3)(B)" (DEQ 2021). DEQ provided a similar letter to the NPS dated September 20, 2022, that indicated that the July 14, 2022 ASD "is applicable for the barium exceedance in SP-10 of the GWPS if conditions do not change. AEP may refer to the ASD approval for barium and continue assessment monitoring for the BAP in accordance with OAC 252:517-9-6(g)(3)(B)" (DEQ 2022). This ASD update presents an evaluation of the BAP for changing conditions that may affect previously approved ASDs for lithium, fluoride, and barium exceedances at SP-10.

The sample collected from the October 2023 monitoring event at SP-10 contained a lithium concentration of 0.235 mg/L, fluoride concentration of 6.3 mg/L, and barium concentration of 6.01 mg/L. The lithium concentration (**Figure 1**) and fluoride concentration (**Figure 2**) are consistent with previous results collected during the assessment monitoring period and continue to show no statistically significant positive trends. This is an indication that conditions have not changed substantially since the preceding ASD was submitted (Geosyntec 2023c), and the arguments presented in the previous ASDs are still valid. Therefore, the lithium and fluoride concentrations at SP-10 during the October 2023 assessment monitoring event are not attributed to a release from the BAP.

A time series plot of the barium concentrations at SP-10 and a Mann-Kendall statistical analysis of the reported barium results over time are shown in **Figure 3**. The analysis determined that barium concentrations at SP-10 display a statistically significant increasing trend. However, based on a Piper diagram showing select events where the full suite of major cations and anions were sampled (**Figure 4**), the geochemistry at monitoring well SP-10 does not change over time in a manner indicative of a release from the BAP. The October 2023 sample is displayed on the plot as the purple diamond. **Figure 4** demonstrates that the geochemistry of SP-10 has remained consistent over the past several years, indicating that groundwater condition at SP-10 is geochemically stable.

The information above, as well as the information presented in previous ASDs (Geosyntec 2019, Geosyntec 2021a, Geosyntec 2021b, Geosyntec 2021c, Geosyntec 2022, Geosyntec 2023a, Geosyntec 2023b, Geosyntec 2023c), continues to support the position that barium, fluoride, and lithium concentrations are a result of natural variation in the underlying lithology, including the presence of shale lenses containing barium, fluoride, and lithium within the screened interval at SP-10. Therefore, no further action is warranted, and the BAP will remain in the assessment monitoring program. Certification of this ASD memorandum by a qualified professional engineer is in Attachment A.

******

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REFERENCES

DEQ. 2021. Alternate Source Demonstration for Fluoride and Lithium Exceedance – Bottom Ash Pond, Public Service Company of Oklahoma Northeastern Power Station, Rogers County. Oklahoma Department of Environmental Quality. June 4.

DEQ. 2022. Alternative Source Demonstration for Barium, Fluoride, and Lithium Exceedances – Bottom Ash Pond, Public Service Company of Oklahoma - Northeastern Power Station, Rogers County. Oklahoma Department of Environmental Quality. September 20.

Geosyntec. 2019. Alternative Source Demonstration. Bottom Ash Pond – Northeastern Power Station, Oologah, Oklahoma. Geosyntec Consultants. April.

Geosyntec. 2021a. Alternative Source Demonstration. Bottom Ash Pond – Northeastern Power Station, Oologah, Oklahoma. Geosyntec Consultants. January.

Geosyntec. 2021b. Alternative Source Demonstration. Bottom Ash Pond – Northeastern Power Station, Oologah, Oklahoma. Geosyntec Consultants. May.

Geosyntec. 2021c. Alternative Source Demonstration. Bottom Ash Pond – Northeastern Power Station, Oologah, Oklahoma. Geosyntec Consultants. October.

Geosyntec. 2022. Alternative Source Demonstration. Bottom Ash Pond – Northeastern Power Station, Oologah, Oklahoma. Geosyntec Consultants. July.

Geosyntec. 2023a. Alternative Source Demonstration. Bottom Ash Pond – Northeastern Power Station, Oologah, Oklahoma. Geosyntec Consultants. January.

Geosyntec. 2023b. Alternative Source Demonstration. Bottom Ash Pond – Northeastern Power Station, Oologah, Oklahoma. Geosyntec Consultants. May.

Geosyntec. 2023c. Alternative Source Demonstration. Bottom Ash Pond – Northeastern Power Station, Oologah, Oklahoma. Geosyntec Consultants. December.

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TABLES

Table 1. Summary of Key Analytical Data
Alternative Source Demonstration Update Memorandum
Northeastern Power Station Bottom Ash Pond, Oologah, Oklahoma

Sample	Sample Date	Lithium Concentration (mg/L)	Fluoride Concentration (mg/L)	Barium Concentration (mg/L)
SPLP Leachate of Bottom Ash	7/10/2019	0.001	0.458	0.352
	8/25/2022	< 0.5	NA	0.22
BAP Surface Water	2/5/2019	0.00874	0.37	0.315
BAP Pore Water	7/10/2019	0.003	< 0.83	0.083
SP-10 October 2023 Result	10/10/2023	0.235	6.3	6.01

Notes:

1. Nondetect results are shown as less than the reporting limit.

BAP: Bottom Ash Pond

mg/L: milligram per liter

NA: not analyzed

SPLP: synthetic precipitation leaching procedure

FIGURES
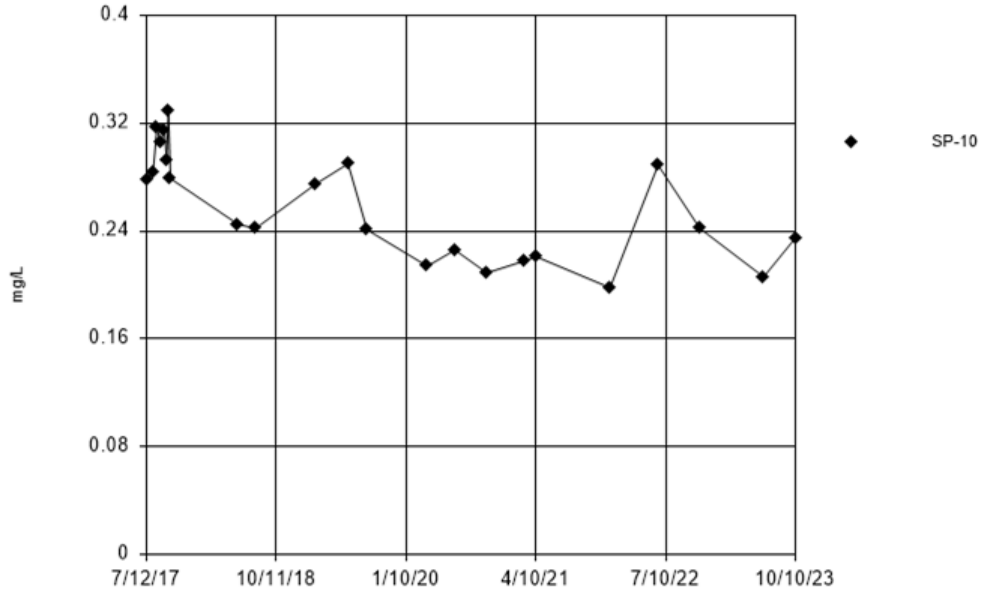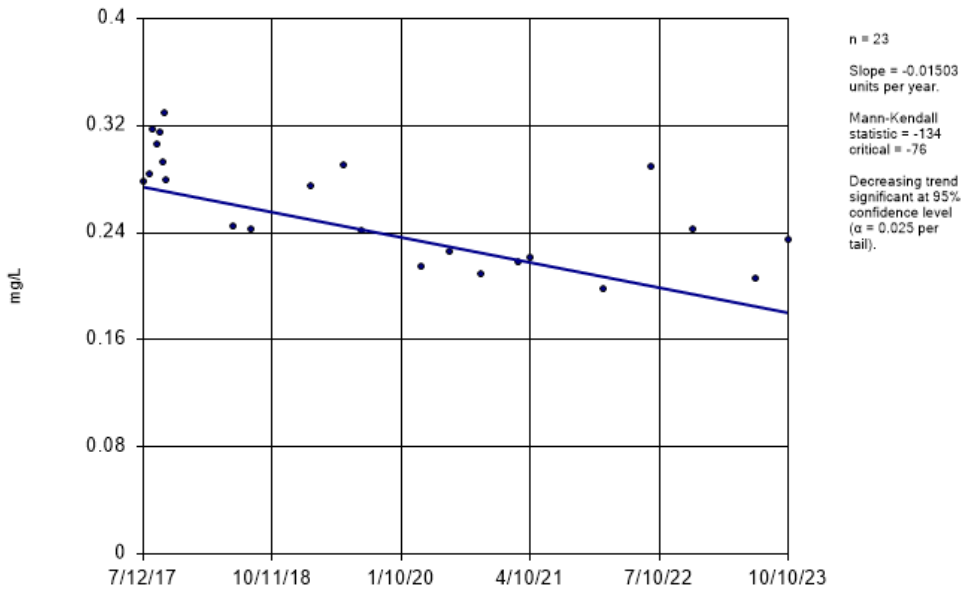
Notes: Lithium results from monitoring well SP-10 are displayed on the plots.

AEP: American Electric Power
mg/L: milligrams per liter

Lithium Time Series and Trend Test: SP-10
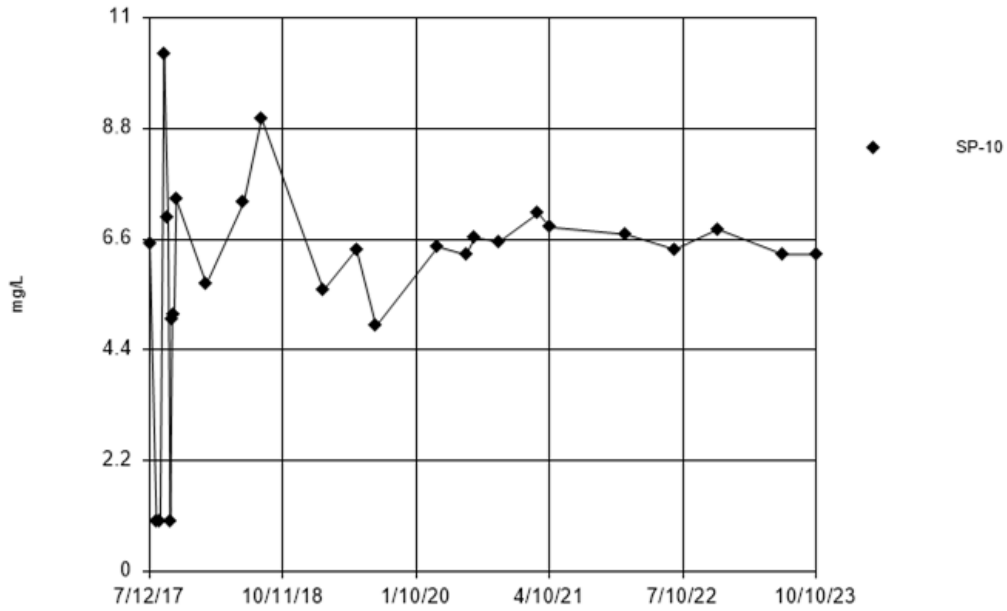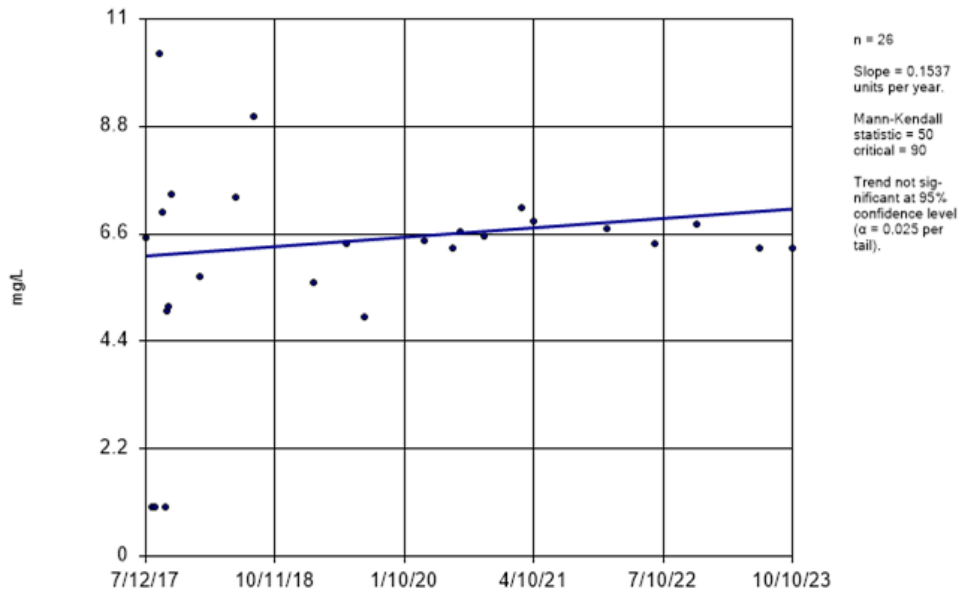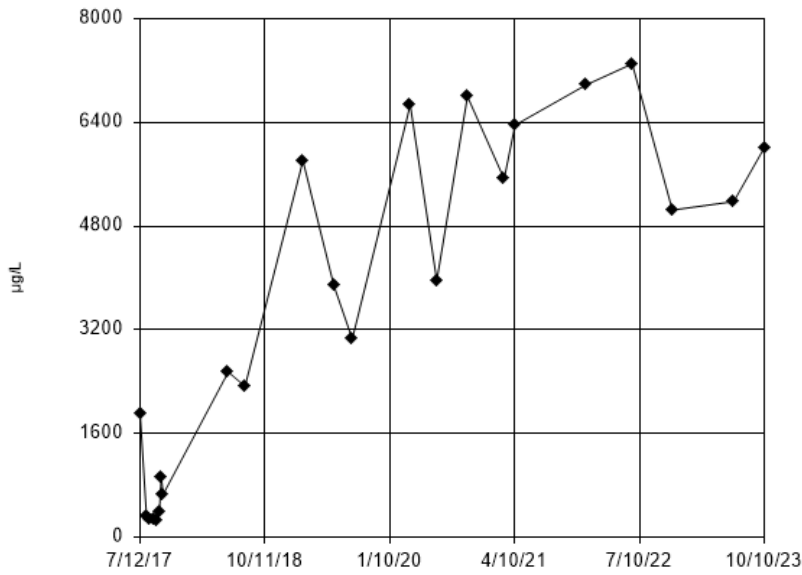Northeastern Bottom Ash Pond

Geosyntec▷ consultants

AMERICAN ELECTRIC POWER

Figure **1**

Columbus, Ohio   May, 2024

Fluoride Time Series and Trend Test: SP-10
Northeastern Bottom Ash Pond

Notes: Fluoride results from monitoring well SP-10 are displayed on the plots.

AEP: American Electric Power
mg/L: milligrams per liter

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consultants

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Figure
2
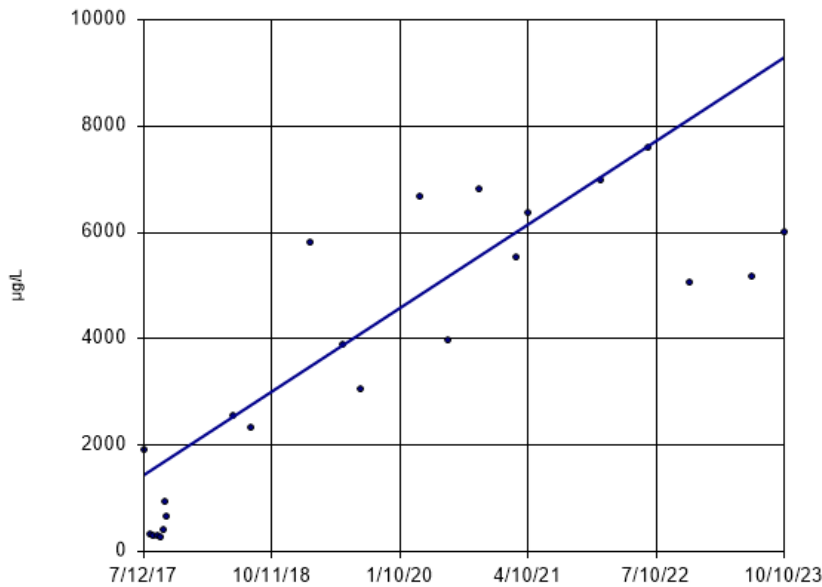
Columbus, Ohio   May, 2024

Time Series

Constituent: Barium   Analysis Run 3/22/2024 4:42 PM

Sen's Slope Estimator

SP-10

n = 23

Slope = 1256 units per year.

Mann-Kendall statistic = 165 critical = 76

Increasing trend significant at 95% confidence level (α = 0.025 per tail).

Constituent: Barium   Analysis Run 3/22/2024 5:05 PM

Notes: Barium results from monitoring well SP-10 are displayed on the plots.

AEP: American Electric Power
ug/L: micrograms per liter

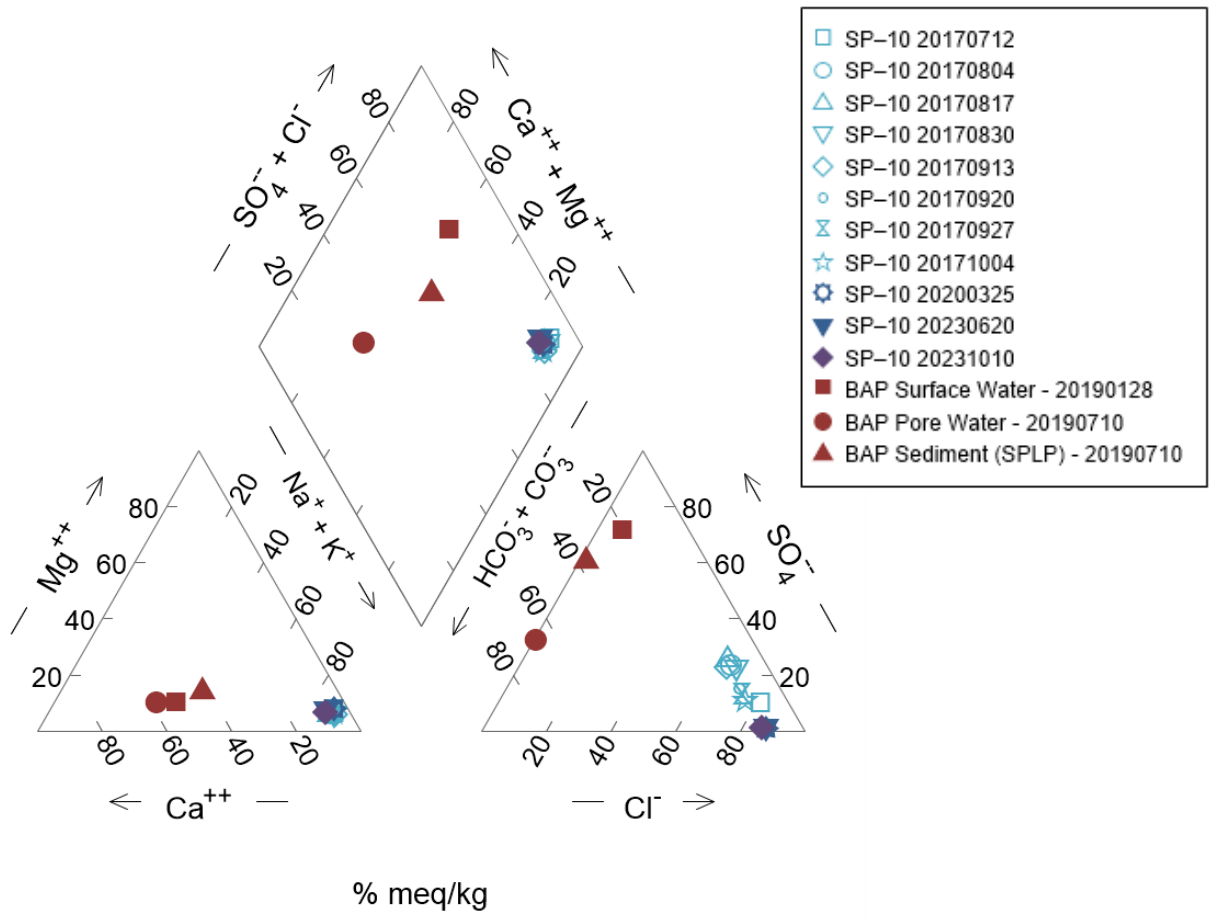**Barium Time Series and Trend Test: SP-10**
Northeastern Bottom Ash Pond

Geosyntec consultants

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Columbus, Ohio   May, 2024

Figure
3

% meq/kg

Legend:
- □ SP–10 20170712
- ○ SP–10 20170804
- △ SP–10 20170817
- ▽ SP–10 20170830
- ◇ SP–10 20170913
- ∘ SP–10 20170920
- ⨯ SP–10 20170927
- ☆ SP–10 20171004
- ✿ SP–10 20200325
- ▼ SP–10 20230620
- ◆ SP–10 20231010
- ■ BAP Surface Water - 20190128
- ● BAP Pore Water - 20190710
- ▲ BAP Sediment (SPLP) - 20190710

Notes:
SPLP – Synthetic Precipitation Leaching Procedure.

% meq/kg – percent milliequivalents per kilogram

Piper Diagram – SP-10 and BAP Samples
Northeastern Bottom Ash Pond

Geosyntec▷ consultants

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Figure **4**

Columbus, Ohio   May 2024

ATTACHMENT A

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Bottom Ash Pond CCR management area at the Northeastern Power Station and that the requirements of OAC 252:517-9-6(g)(3)(B) have been met.

Beth Ann Gross
_____
Printed Name of Licensed Professional Engineer

Beth Ann Gross
_____
Signature

Geosyntec Consultants
2039 Centre Pointe Boulevard, Suite 103
Tallahassee, Florida 32308

Oklahoma Firm Certificate of
Authorization No. 1996
Exp. 6/30/2024

18167   Oklahoma   5/16/2024
_____   _____   _____
License Number   Licensing State   Date

* * * * *

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ATTACHMENT B

Assessment Statistics Summary

2023 Second Semiannual Event

STATISTICAL ANALYSIS SUMMARY, BOTTOM ASH POND – SECOND SEMIANNUAL EVENT 2023

Northeastern Power Station
Oologah, Oklahoma

Prepared for

American Electric Power
1 Riverside Plaza
Columbus, Ohio 43215-2372

Prepared by

Geosyntec Consultants, Inc.
500 West Wilson Bridge Road, Suite 250
Worthington, Ohio 43085

Project Number: CHA8500B

February 13, 2024

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ACRONYMS AND ABBREVIATIONS

ASD	alternative source demonstration
BAP	bottom ash pond
CCR	coal combustion residuals
GWPS	groundwater protection standard
LCL	lower confidence limit
LPL	lower prediction limit
mg/L	milligrams per liter
NPS	Northeastern Power Station
OAC	Oklahoma Administrative Code
ODEQ	Oklahoma Department of Environmental Quality
PQL	practical quantitation limit
QA/QC	quality assurance and quality control
SSI	statistically significant increase
SSL	statistically significant level
TDS	total dissolved solids
UPL	upper prediction limit

1. INTRODUCTION

In accordance with Oklahoma Department of Environmental Quality (ODEQ) requirements regarding the disposal of coal combustion residuals (CCRs) in landfills and surface impoundments (Oklahoma Administrative Code [OAC] 252:517), groundwater monitoring has been conducted at the Bottom Ash Pond (BAP), an existing CCR unit at the Northeastern Power Station (NPS) in Oologah, Oklahoma. Recent groundwater monitoring results were used to identify concentrations of Appendix B constituents that are above site-specific groundwater protection standards (GWPSs).

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, fluoride, total dissolved solids (TDS), and sulfate at the BAP. In addition, pH values below the lower prediction limit (LPL) resulted in SSIs below background as well. GWPSs were set in accordance with OAC 252:517-9-6(h) and a statistical evaluation of the assessment monitoring was conducted.

During 2023, a sampling event for both Appendix A parameters and Appendix B parameters, as required by OAC 252:517-9-6(d), was completed in June. During the June 2023 assessment monitoring event, statistically significant levels (SSLs) were observed for barium, fluoride, and lithium (Geosyntec 2023a). An alternative source demonstration (ASD) was successfully completed (Geosyntec 2023b). Therefore, the unit remained in assessment monitoring. One assessment monitoring event was conducted at the BAP in October 2023 in accordance with OAC 252:517-9-6(d). The results of the October 2023 assessment event are documented in this report.

Prior to conducting the statistical analyses, the groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact data usability.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. GWPSs were reestablished for the Appendix B parameters. Confidence intervals were calculated for Appendix B parameters at the compliance wells to assess whether SSLs of Appendix B parameters were present above the GWPS. SSLs were identified for barium, fluoride, and lithium. Therefore, either the unit will move to an assessment of corrective measures, or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

2. BOTTOM ASH POND EVALUATION

2.1 Data Validation and QA/QC

During the October 2023 assessment monitoring event, one set of samples was collected for analysis from each background and compliance well to meet the requirements of OAC 252:517-9-6(d)(1). Samples from the October 2023 sampling event were analyzed for all Appendix A and Appendix B parameters. A summary of data collected during this assessment monitoring event are presented in Table 1.

Chemical analysis was completed by a National Environmental Laboratory Accreditation Program–certified analytical laboratory. The laboratory completed analysis of quality assurance and quality control (QA/QC) samples such as laboratory reagent blanks, continuing calibration verification samples, and laboratory fortified blanks.

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.10.0.15 statistics software. The export file was checked against the analytical data for transcription errors and completeness.

2.2 Statistical Analysis

Statistical analyses for the BAP were conducted in accordance with the November 2021 *Statistical Analysis Plan* (Geosyntec 2021). Time series plots and results for all completed statistical tests are provided in Attachment B. The data obtained in October 2023 were screened for potential outliers. No outliers were identified for these events.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix B parameter in accordance with the Statistical Analysis Plan (Geosyntec 2021). The established GWPS was set to whichever was greater of the background concentration and the maximum contaminant level for each Appendix B parameter. To determine background concentrations, an upper tolerance limit was calculated using data that were pooled from the background wells collected during the background monitoring and assessment monitoring events. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for antimony, arsenic, cadmium, chromium, combined radium, and lead. Nonparametric tolerance limits were calculated for barium, beryllium, cobalt, fluoride, lithium, molybdenum, and selenium due to apparent nonnormal distributions, and for mercury and thallium due to a high nondetect frequency. Upper tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix B SSLs

A confidence interval was constructed for each Appendix B parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$). However, nonparametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the nondetect frequency was too high). Select datasets were truncated if significant serial correlation was observed among the background samples that were collected on

an approximately monthly basis in 2017. A list of the truncated well/constituent pairs used for calculation of the confidence limits is provided in Attachment B.

An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval was above the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Northeastern BAP:

- The LCL for barium was above the GWPS of 2.77 milligrams per liter (mg/L) at SP-10 (4.20 mg/L).

- The LCL for fluoride was above the GWPS of 4.39 mg/L at SP-10 (5.59 mg/L).

- The LCL for lithium was above the GWPS of 0.163 mg/L at SP-10 (0.238 mg/L).

ODEQ previously noted in a letter provided to the NPS that "[i]f lithium and fluoride continue to exceed their relative GWPS in the future and conditions have not changed, NPS may refer to the October 29, 2019 ASD approval for lithium and June 4, 2021 approval for fluoride and continue assessment monitoring at the BAP in accordance with OAC 252:517-6(g)(3)(B)" (ODEQ 2021). ODEQ provided a similar letter dated September 20, 2022 documenting ASD approval for a barium SSL at SP-10 which is applicable in the future if conditions do not change (ODEQ 2022). Thus, an ASD will be submitted to ODEQ demonstrating that conditions at the BAP remain unchanged so that the unit will continue assessment monitoring.

2.2.3 Establishment of Appendix A Prediction Limits

Upper prediction limits (UPLs) were previously established for all Appendix A parameters following the background monitoring period. Intrawell tests were used to evaluate potential SSIs for boron, chloride, fluoride, pH, sulfate, and TDS, and interwell tests were used to evaluate potential SSIs for calcium. Interwell and intrawell prediction limits are updated periodically during the assessment monitoring period as sufficient data become available.

For intrawell tests, insufficient data was available to compare against the existing background dataset, and so the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits were previously calculated using historical data through June 2022 (Geosyntec 2023c). The established intrawell prediction limits were used to evaluate potential SSIs for calcium.

Prediction limits for the interwell tests were recalculated using data collected during the 2023 assessment monitoring events. New background well data were tested for outliers before being added to the background data set. Background well data were also evaluated for statistically significant trends using the Sen's Slope/Mann-Kendall trend test, and the results are included in Attachment B.

After the revised background set was established, a parametric or nonparametric analysis was selected based on the distribution of the data and the frequency of nondetect data. Estimated results under the reporting limit (i.e., practical quantitation limit [PQL]) but above the method detection

limit—that is, "J-flagged" data—were considered detections and the estimated results were used in the statistical analyses. Nonparametric analyses were selected for data sets with at least 50% nondetect data or data sets that could not be normalized. Parametric analyses were selected for data sets (either transformed or untransformed) that passed the Shapiro-Wilk/Shapiro-Francía test for normality. The Kaplan-Meier nondetect adjustment was applied to data sets with between 15% and 50% nondetect data. For data sets with fewer than 15% nondetect data, nondetect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or nonparametric) and transformation (where applicable) for each background data set are shown in Attachment B.

Interwell UPLs were updated for boron, chloride, fluoride, pH, sulfate, and TDS and interwell LPLs were updated for pH using historical data through October 2023. Intrawell UPLs for calcium were previously updated using data through June 2022 to represent background values. The prediction limits are summarized in Table 3. The prediction limits were calculated for a one-of-two retesting procedure: If at least one sample in a series of two is not above the UPL (or, in the case of pH, is neither less than the LPL nor greater than the UPL), then it can be concluded that an SSI has not occurred. In practice, where the initial result does not exceed the UPL (or, in the case of pH, is neither less than the LPL nor greater than the UPL), a second sample will not be collected. The retesting procedures allow achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using intrawell prediction limits.

2.2.4 Evaluation of Potential Appendix A SSIs

While SSLs were identified, a review of the Appendix A results were also completed to assess whether concentrations of Appendix A parameters at the compliance wells were above background concentrations. Data collected during the October 2023 assessment monitoring event from each compliance well were compared to updated interwell and previously established intrawell prediction limits to assess whether the results are above background values (Table 3).

The following concentrations were above the UPLs:

- Boron concentrations were above the interwell UPL of 0.496 mg/L at SP-10 (0.879 mg/L).

- Chloride concentrations were above the interwell UPL of 874 mg/L at SP-10 (1,820 mg/L).

- Fluoride concentrations were above the interwell UPL of 4.39 mg/L at SP-10 (6.3 mg/L).

- Sulfate concentrations were above the interwell UPL of 83.0 mg/L at SP-1 (84.8 mg/L) and SP-11 (184 mg/L).

- TDS concentrations were above the interwell UPL of 1,940 mg/L at SP-10 (3,460 mg/L).

While the prediction limits were calculated for a one-of-two retesting procedure, SSIs were conservatively assumed if the October 2023 sample was above the UPL or below the LPL in the case of pH. Based on these results, concentrations of Appendix A constituents appear to be above background concentrations.

2.3 Conclusions

A semiannual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, and no QA/QC issues that impacted data usability were identified. A review of outliers identified no potential outliers in the October 2023 data. GWPSs were reestablished for the Appendix B parameters. A confidence interval was constructed at each compliance well for each Appendix B parameter; SSLs were concluded if the entire confidence interval was above the GWPS. SSLs were identified for barium, fluoride, and lithium. Appendix A parameters were compared to calculated prediction limits, with exceedances identified for boron, chloride, fluoride, sulfate, and TDS.

Based on this evaluation, the Northeastern BAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

3.   REFERENCES

Geosyntec. 2021. Statistical Analysis Plan – Northeastern Power Station. Geosyntec Consultants, Inc. November.

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Geosyntec. 2023b. Alternative Source Demonstration Update. Northeastern Power Station, Bottom Ash Pond, Oologah, Oklahoma. Geosyntec Consultants, Inc. December.

Geosyntec. 2023c. Statistical Analysis Summary – Bottom Ash Pond, Northeastern Power Station, Oologah, Oklahoma. Geosyntec Consultants, Inc. February.

ODEQ. 2021. Letter Transmittal – Alternative Source Demonstration for Fluoride and Lithium Exceedance – Bottom Ash Pond. Public Service Company of Oklahoma – Northeastern Power Station. Oklahoma Department of Environmental Quality. June.

ODEQ. 2022. Letter Transmittal – Alternative Source Demonstration for Barium, Fluoride, and Lithium Exceedance – Bottom Ash Pond. Public Service Company of Oklahoma – Northeastern Power Station. Oklahoma Department of Environmental Quality. September.

TABLES

Table 1. Groundwater Data Summary
Statistical Analysis Summary
Northeastern – Bottom Ash Pond

Parameter	Unit	SP-1 10/10/2023	SP-2 10/10/2023	SP-4 10/10/2023	SP-5R 10/10/2023	SP-10 10/10/2023	SP-11 10/10/2023
Antimony	µg/L	0.745	1.06	0.249	0.195	0.062 J1	0.075 J1
Arsenic	µg/L	0.65	0.82	0.84	15.8	0.65	3.61
Barium	µg/L	138	1,270	232	2,770	6,010	455
Beryllium	µg/L	0.053	0.086	0.036 J1	0.201	0.035 J1	0.027 J1
Boron	mg/L	0.159	0.210	0.339	0.228	0.879	0.354
Cadmium	µg/L	0.041	0.047	0.057	0.076	0.007 J1	0.031
Calcium	mg/L	102	151	90.9	107	93.0	79.1
Chloride	mg/L	45.1	699	450	964	1,820	79.4
Chromium	µg/L	0.47	0.62	0.59	2.64	0.36	0.90
Cobalt	µg/L	0.717	0.322	0.218	1.03	0.039	0.635
Combined Radium	pCi/L	3.06	8.06	3.23	24.78	21.79	2.91
Fluoride	mg/L	0.96	2.79	3.19	3.21	6.3	2.28
Lead	µg/L	0.17 J1	0.15 J1	0.38	2.52	0.08 J1	0.45
Lithium	mg/L	0.00819	0.0809	0.0554	0.123	0.235	0.0222
Mercury	µg/L	0.005 U1	0.005 U1	0.005 U1	0.005 U1	0.005 U1	0.005 U1
Molybdenum	µg/L	26.0	15.9	3.3	0.7	0.2 J1	0.9
Selenium	µg/L	11.8	3.63	0.30 J1	0.94	0.06 J1	0.23 J1
Sulfate	mg/L	84.8	20.2	81.4	2.6	19.2	184
Thallium	µg/L	0.11 J1	0.05 J1	0.02 J1	0.04 J1	0.2 U1	0.2 U1
Total Dissolved Solids	mg/L	470	1,470	1,160	1,830	3,460	880
pH	SU	7.42	7.6	7.62	7.32	7.73	7.24

Notes:

J1: Estimated value. Parameter was detected in concentrations below the reporting limit.

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U1: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.

µg/L: micrograms per liter

Table 2. Appendix B Groundwater Protection Standards
Statistical Analysis Summary
Northeastern Plant - Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL	GWPS
Antimony, Total (mg/L)	0.00600		0.00467	0.00600
Arsenic, Total (mg/L)	0.0100		0.0529	0.0529
Barium, Total (mg/L)	2.00		2.77	2.77
Beryllium, Total (mg/L)	0.00400		0.00212	0.00400
Cadmium, Total (mg/L)	0.00500		0.00022	0.00500
Chromium, Total (mg/L)	0.100		0.00373	0.100
Cobalt, Total (mg/L)	n/a	0.00600	0.0179	0.0179
Combined Radium, Total (pCi/L)	5.00		19.4	19.4
Fluoride, Total (mg/L)	4.00		4.39	4.39
Lead, Total (mg/L)	n/a	0.0150	0.0087	0.0150
Lithium, Total (mg/L)	n/a	0.0400	0.163	0.163
Mercury, Total (mg/L)	0.00200		0.0000300	0.00200
Molybdenum, Total (mg/L)	n/a	0.100	0.0100	0.100
Selenium, Total (mg/L)	0.0500		0.00499	0.0500
Thallium, Total (mg/L)	0.00200		0.00162	0.00200

Notes:

1. Calculated UTL (upper tolerance limit) represents site-specific background values.

2. Grey cells indicate the GWPS is based on the calculated UTL, which is higher than the MCL or CCR Rule-specified value.

CCR: coal combustion residuals

GWPS: groundwater protection standard

MCL: maximum contaminant level

mg/L: milligrams per liter

pCi/L: picocuries per liter

Table 3. Appendix A Data Summary
Statistical Analysis Summary
Northeastern – Bottom Ash Pond

Analyte	Unit	Description	SP-1 10/10/2023	SP-2 10/10/2023	SP-10 10/10/2023	SP-11 10/10/2023
Boron	mg/L	Interwell Background Value (UPL)	0.496			
		Analytical Result	0.159	0.210	**0.879**	0.354
Calcium	mg/L	Intrawell Background Value (UPL)	141	167	227	156
		Analytical Result	102	151	93.0	79.1
Chloride	mg/L	Interwell Background Value (UPL)	874			
		Analytical Result	45.1	699	**1,820**	79.4
Fluoride	mg/L	Interwell Background Value (UPL)	4.39			
		Analytical Result	0.96	2.79	**6.3**	2.28
pH	SU	Interwell Background Value (UPL)	9.1			
		Interwell Background Value (LPL)	7.0			
		Analytical Result	7.4	7.6	7.7	7.2
Sulfate	mg/L	Interwell Background Value (UPL)	83.0			
		Analytical Result	**84.8**	20.2	19.2	**184**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	1,940			
		Analytical Result	470	1,470	**3,460**	880

Notes:

1. Bold values exceed the background value.

2. Background values are shaded gray.

LPL: lower prediction limit

mg/L: milligrams per liter

SU: standard units

UPL: upper prediction limit

ATTACHMENT A
Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Northeastern BAP CCR management area and that the requirements of OAC 252:517-9-4(g) have been met.

David Anthony Miller
_____
Printed Name of Licensed Professional Engineer

David Anthony Miller
_____
Signature
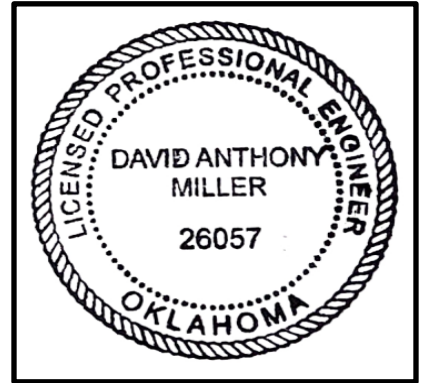
26057	Oklahoma	02.20.2024
License Number	Licensing State	Date

ATTACHMENT B
Statistical Analysis Output
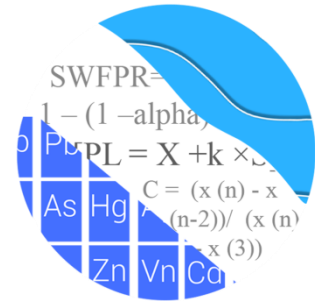
January 11, 2024

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
500 W. Wilson Bridge Road, Suite 250
Worthington, OH 43085

Re: Northeastern BAP (Bottom Ash Pond)
        Background Update & Assessment Monitoring Statistics – October 2023

Dear Ms. Kreinberg,

Groundwater Stats Consulting (GSC), formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis and background update of 2023 groundwater data for American Electric Power Inc.'s Northeastern BAP. The analysis complies with the Oklahoma Administrative Code (OAC) as well as with the United States Environmental Protection Agency (USEPA) Unified Guidance (2009).

Sampling began at the site for the OAC program in 2017. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- o **Upgradient wells:** SP-4 and SP-5R
- o **Downgradient wells:** SP-1, SP2, SP-10, and SP-11

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC. The analysis was reviewed by Kristina Rayner, Senior Statistician and Founder of Groundwater Stats Consulting.

The OAC program consists of the following constituents listed below. The terms "constituent" and "parameter" are interchangeable.

- **Appendix A** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS
- **Appendix B** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium

For all constituents, a substitution of the most recent reporting limit is used for non-detect data. For calculating intrawell prediction limits, the substitution is performed for individual wells and may differ across wells. This generally gives the most conservative limit in each case.

Time series plots for Appendix A and B parameters are provided for all wells and are used to evaluate concentrations over time as well as for the purpose of updating statistical limits (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). Values in background which have been flagged as outliers may be seen in a lighter font and as a disconnected symbol on the graph. A summary of these values follows this letter (Figure C). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells.

For regulatory comparison of current observations against statistical limits for Appendix A constituents, the annual site-wide false positive rate is based on the USEPA Unified Guidance (2009) recommendation of 10% (5% for each semi-annual sample event). Power curves were provided with the previous screening and demonstrated that the selected statistical method provides sufficient power to detect a change at any of the downgradient wells which complies with the USEPA Unified Guidance recommendation. The EPA suggests the selected statistical method should provide at least 55% power at 3 standard deviations or at least 80% power at 4 standard deviations. Power curves were based on the following:

Semi-Annual Sampling
1-of-2 resample plan
Constituents, c=7
Downgradient wells, w=4

Summary of Statistical Method – Appendix A Parameters

Based on the original background screening described in the 2017 screening report, the following statistical methods were selected for Appendix A parameters:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for calcium
2) Interwell prediction limits, combined with a 1-of-2 resample plan for boron, chloride, fluoride, pH, sulfate, and TDS

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are non-detects, a nonparametric test is utilized. While the annual false positive rate associated with parametric limits is fixed at 10% as recommended by the EPA Unified Guidance (2009), the false positive rate associated with nonparametric limits is not fixed and depends upon the available background sample size, number of future comparisons, and verification resample plan. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits as appropriate. Non-detects are handled as follows:

- No statistical analyses are required on wells and analytes containing 100% non-detects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% non-detects, simple substitution of one-half the reporting limit is utilized in the statistical analysis. The reporting limit utilized for non-detects is the most recent practical quantification limit (PQL) as reported by the laboratory.
- When data contain between 15-50% non-detects, the Kaplan-Meier non-detect adjustment is applied to the background data for parametric limits. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric prediction limits are used on data containing greater than 50% non-detects.

Natural systems continuously evolve due to physical changes made to the environment. Examples include capping a landfill, paving areas near a well, or lining a drainage channel to prevent erosion. Periodic updating of background statistical limits is necessary to accommodate these types of changes. In the intrawell case, data for all wells and constituents may be re-evaluated when a minimum of 4 new data points are available to determine whether earlier concentrations are representative of present-day groundwater

quality. In the interwell case, prediction limits may be updated with upgradient well data following each sampling event after careful screening for any new outliers. In some cases, deselecting the earlier portion of data may be necessary prior to construction of limits so that resulting statistical limits are conservative (lower) from a regulatory perspective and capable of rapidly detecting changes in groundwater quality. Even though the data are excluded from the calculation, the values will continue to be reported and shown in tables and graphs.

Summary of Appendix A Background Screening and Updates

December 2017 – Initial Background Screening

Interwell prediction limits combined with a 1-of-2 verification strategy were recommended for boron, chloride, fluoride, pH, sulfate and TDS; and intrawell prediction limits combined with a 1-of-2 verification strategy were recommended for calcium. All proposed background data were screened for outliers and trends during the background screening. The findings of those reports were submitted with that analysis. Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data may be screened for any newly suspected outliers or obvious trending patterns using time series plots. Intrawell prediction limits utilized the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data sets are evaluated for the purpose of updating statistical limits, as described below, using the Mann-Whitney test when at least four additional measurements are available.

January 2024 – Background Update Summary

During this analysis, Tukey's outlier test and visual screening were used to evaluate data through October 2023 at upgradient wells for boron, chloride, fluoride, pH, sulfate, and TDS, which are tested using interwell prediction limits (Figure C).

For any parameters which use intrawell prediction limits (calcium), values were not re-evaluated for new outliers as these records had insufficient samples for updating background limits during this evaluation period.

Note that during the previous update, the Rank Von Neumann serial correlation test was used to evaluate whether the measurements collected during 2017 represented independent samples, or whether serial correlation was present among the measurements. Significant serial correlation was identified for the calcium at SP-4 and sulfate both SP-4 and SP-5R; therefore, the records for these well/constituent pairs were

truncated to remove earlier measurements for construction of statistical limits using only more recent data that represent independent samples.

Outlier Analysis

Tukey's outlier test on pooled upgradient well data confirmed previously identified values for chloride, fluoride, and TDS, but no additional values were flagged. Any values identified by Tukey's but not flagged appeared representative of similar concentrations upgradient of the facility. Previously flagged outliers were confirmed by Tukey's test and visual screening, and no changes to values flagged in previous background updates occurred. As mentioned above, any flagged data are displayed in a lighter font and as a disconnected symbol on the time series reports, as well as in a lighter font on the accompanying data pages. A summary table of all flagged outliers follows this report (Figure C).

Intrawell - Prediction Limits

Intrawell prediction limits, combined with a 1-of-2 resample plan, are constructed using historical data through June 2022 for calcium at all wells. A summary table of the limits follows this report (Figure D). A list of well/constituent pairs using a truncated portion of their records follows this report (Date Ranges Table). No comparison of the October 2023 observation was performed in this analysis.

Interwell – Trend Test Evaluation

For parameters tested using interwell analyses (boron, chloride, fluoride, pH, sulfate, and TDS) the Sen's Slope/Mann-Kendall trend test was used on upgradient wells to determine whether concentrations are statistically increasing, decreasing or stable at the 99% confidence level (Figure E). Statistically significant trends were identified for the following upgradient well/constituent pairs:

Increasing:
- Chloride: SP-5R
- Sulfate: SP-4
- TDS: SP-5R

Decreasing:
- Boron: SP-4 and SP-5R

Although statistically significant trends were identified, no records were adjusted since the resulting statistical limits are representative of present-day groundwater quality conditions and truncating the records would lead to statistical limits that are less conservative (i.e., higher) from a regulatory perspective. All available data from upgradient wells were used to construct interwell prediction limits for all Appendix A parameters except calcium, which is tested using intrawell prediction limits. As more data are collected, all upgradient well data will be re-evaluated for possible deselection of earlier measurements if concentrations no longer represent present-day groundwater quality conditions.

<u>Interwell – Prediction Limits</u>

Interwell prediction limits, combined with a 1-of-2 resample plan, were updated using all available data from upgradient wells through October 2023 for boron, chloride, fluoride, pH, sulfate, and TDS (Figure F). Time series plots were included with the interwell prediction limit graphs to display concentrations at upgradient wells that were used to construct the statistical limits. No comparison of the October 2023 data was performed in this analysis.

Evaluation of Appendix B Parameters – October 2023 Event

Prior to evaluating Appendix B parameters, background data are screened through visual screening and Tukey's outlier test for potential outliers and extreme trending patterns that would lead to artificially elevated statistical limits.

As mentioned above, during the previous update, the Rank Von Neumann serial correlation test was used to evaluate whether the measurements collected during 2017 represented independent samples, or whether serial correlation was present among the measurements. The records that showed significant serial correlation were truncated to remove earlier measurements for construction of statistical limits using only more recent data that represent independent samples.

<u>Outlier Analysis</u>

For the current analysis, Tukey's outlier test on pooled upgradient well data identified outliers for fluoride, mercury, and selenium and confirmed previously flagged values. Several of the values identified by Tukey's test were either similar to concentrations upgradient of the facility or were lower than the respective Maximum Contaminant Level (MCL); therefore, the values were not flagged as outliers. Previously flagged outliers were

confirmed by Tukey's test or visual screening. A summary of previously flagged outliers follows this report (Figure C).

Additionally, downgradient well data through October 2023 were screened through visual screening using time series graphs. Since the downgradient well data are used to construct confidence intervals, a regulatory conservative approach is taken in that values that are marginally high relative to the rest of the data are retained unless there is particular justification for excluding them. No new outliers among downgradient wells were flagged during this analysis.

During previous updates, due to no variation in the data, Tukey's outlier test was not performed for cadmium and selenium in well SP-5R along with mercury and thallium in all wells. Among upgradient wells, high values for cadmium, lead, and selenium were identified by Tukey's outlier test. Only the highest values for cadmium and lead were flagged as outliers to maintain statistical limits that are conservative from a regulatory perspective. Substantially high values were identified at upgradient well SP-4 on 8/4/17 through visual screening and the highest values for arsenic, beryllium, cobalt, and mercury were flagged. This step results in upper tolerance limits that are conservative (lower) from a regulatory perspective.

Among downgradient wells, a high value for combined radium 226 + 228 in well SP-1 was flagged as an outlier along with the following values since they did not adequately represent the populations at their respective wells: chromium in well SP-10; combined radium 226 + 228 in well SP-11; lithium in well SP-1; and molybdenum in well SP-10. More recent concentrations for barium in downgradient well SP-10 were noted to be significantly higher than historical concentrations. Therefore, earlier concentrations were deselected prior to constructing confidence intervals in order to evaluate present-day groundwater concentrations of barium at this well. As mentioned above, a list of well/constituent pairs using a truncated portion of their records follows this report (Date Ranges Table).

Interwell Upper Tolerance Limits

Upper tolerance limits were used to calculate background limits from pooled upgradient well data through October 2023 for Appendix B parameters (Figure G). These limits are updated on an annual basis and will be updated again during the Fall 2024 sample event. Parametric tolerance limits are calculated, with a target of 95% confidence and 95% coverage, when data follow a normal or transformed-normal distribution. When data contained greater than 50% non-detects or did not follow a normal or transformed-normal distribution, non-parametric tolerance limits were constructed using the highest

background measurement. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples.

Groundwater Protection Standards

These background limits were compared to the Maximum Contaminant Levels (MCLs) and CCR Rule-Specified levels as shown in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure H).

Confidence Intervals

Confidence intervals were constructed on downgradient wells with data through October 2023 for each of the Appendix B parameters and then compared to the GWPS, i.e., the highest limit of the MCL, CCR Rule-Specified level, or background limit as discussed above (Figure I). These intervals were constructed as either parametric or nonparametric confidence intervals depending on the data distribution and percentage of non-detects. When data followed a normal or transformed-normal distribution, parametric confidence intervals were used for Appendix IV parameters. Nonparametric confidence intervals were constructed when data did not follow a normal or transformed-normal distribution or when there were greater than 50% non-detects. The lower confidence limit, which is constructed with 99% confidence for parametric confidence intervals, is compared to the GWPS prepared as described above. The confidence level associated with nonparametric confidence intervals is dependent upon the number samples available.

Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. Complete graphical results of the confidence intervals follow this letter. Exceedances were identified for the following well/constituent pairs:

- Barium: SP-10
- Fluoride: SP-10
- Lithium: SP-10

Trend Test Evaluation

When confidence interval exceedances are identified in downgradient wells, data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing, or stable at the 95% confidence level (Figure J). Utilizing the 95% confidence level for trend tests readily identifies

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significant trends and is more sensitive than the 99% confidence level without drastically increasing the false negative rate. Upgradient wells are included in the trend analyses for all parameters found to exceed their confidence intervals in downgradient wells. When similar patterns exist upgradient of the site, it is an indication of variability in groundwater which may be unrelated to practices at the site. Statistically significant trends were identified for the following well/constituent pairs:

Increasing:
- Barium: SP-5R (upgradient) and SP-10

Decreasing:
- Lithium: SP-4 and SP-5R (both upgradient) and SP-10

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Northeastern BAP. If you have any questions or comments, please feel free to contact us.

For Groundwater Stats Consulting,

Andrew T. Collins   Kristina L. Rayner
Project Manager   Senior Statistician

Date Ranges

Barium (mg/L)
> SP-10 overall:5/30/2018-10/10/2023
> SP-11 overall:5/30/2018-10/10/2023
> SP-4 overall:5/30/2018-10/10/2023

Cadmium (mg/L)
> SP-1 overall:5/30/2018-10/10/2023
> SP-10 overall:5/30/2018-10/10/2023
> SP-4 overall:5/30/2018-10/10/2023
> SP-5R overall:5/30/2018-10/10/2023

Calcium (mg/L)
> SP-11 background:7/30/2018-6/14/2022
> SP-4 overall:7/30/2018-6/14/2022

Chromium (mg/L)
> SP-4 overall:5/30/2018-10/10/2023

Lead (mg/L)
> SP-10 overall:5/30/2018-10/10/2023

Lithium (mg/L)
> SP-11 overall:5/30/2018-10/10/2023
> SP-4 overall:5/30/2018-10/10/2023

Molybdenum (mg/L)
> SP-2 overall:5/30/2018-10/10/2023

Selenium (mg/L)
> SP-2 overall:5/30/2018-10/10/2023
> SP-5R overall:5/30/2018-10/10/2023

Sulfate (mg/L)
> SP-4 overall:5/30/2018-10/10/2023
> SP-5R overall:5/30/2018-10/10/2023

Thallium (mg/L)
> overall:5/30/2018-10/10/2023

FIGURE A
Time Series

Time Series
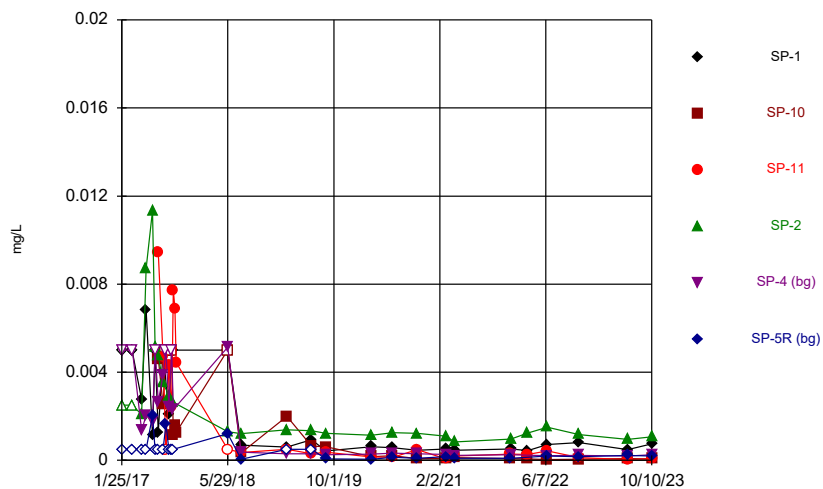
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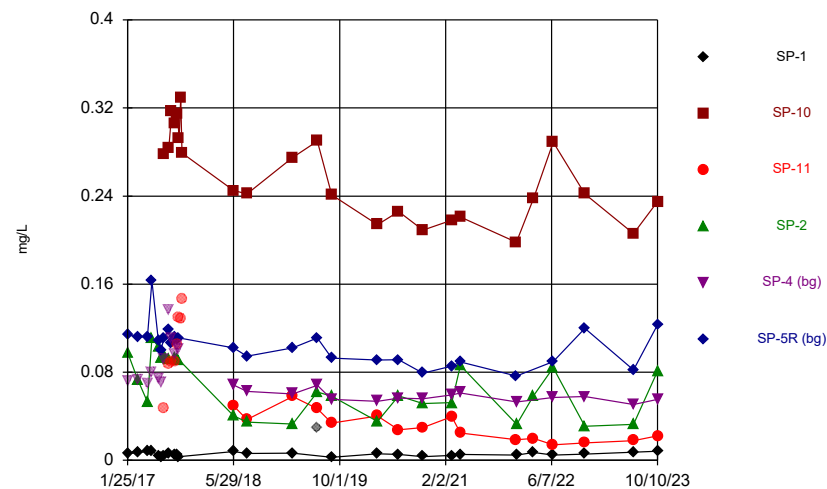Northeastern BAP   Data: Northeastern BAP
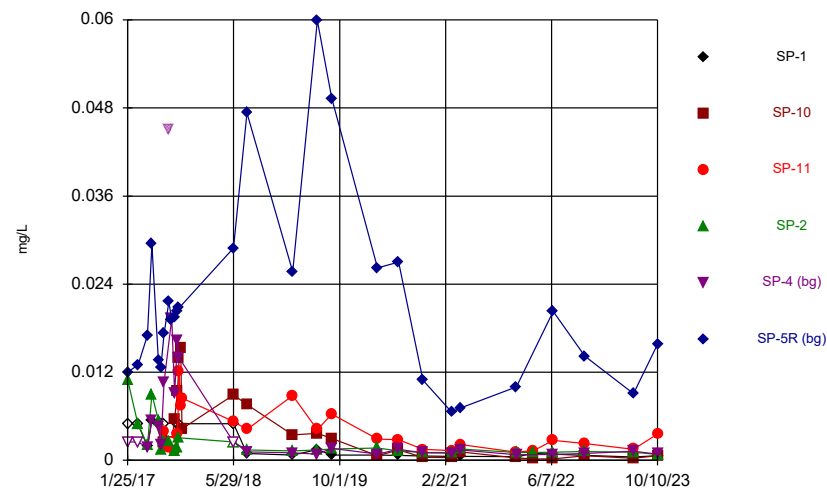
Time Series

Constituent: Arsenic   Analysis Run 1/10/2024 8:54 AM
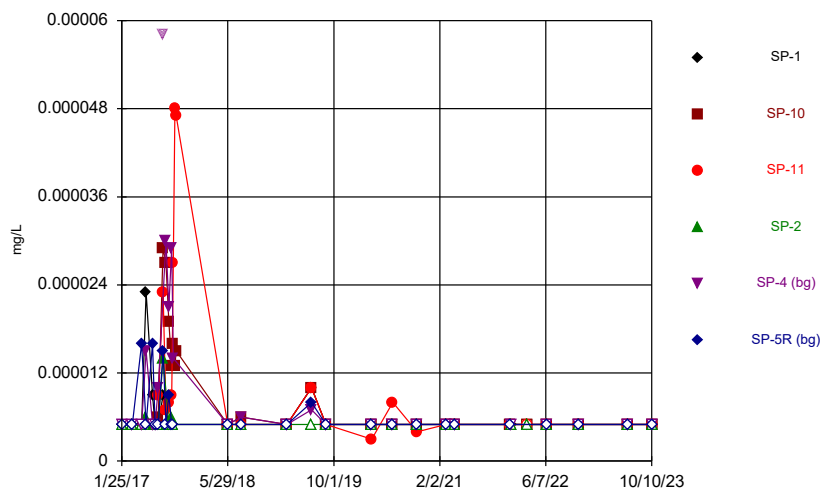
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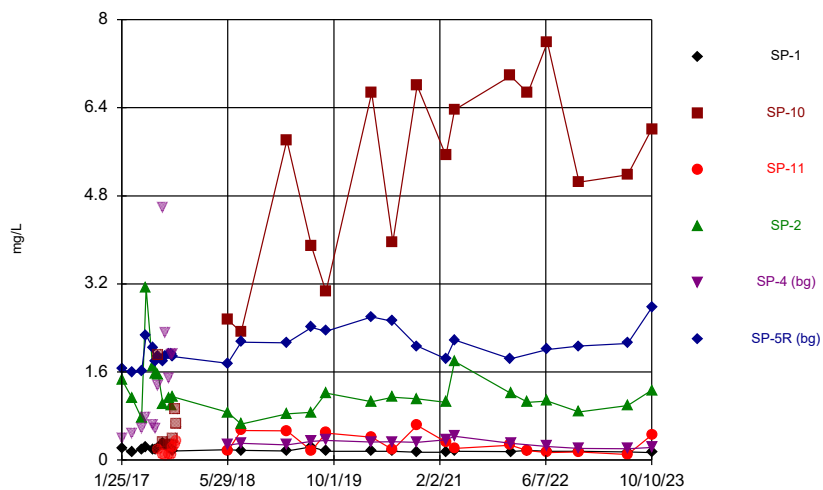
Time Series

Constituent: Barium   Analysis Run 1/10/2024 8:54 AM

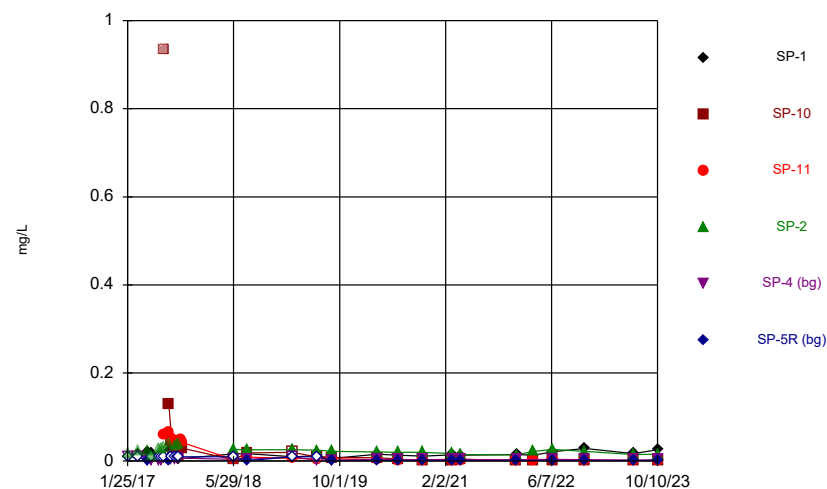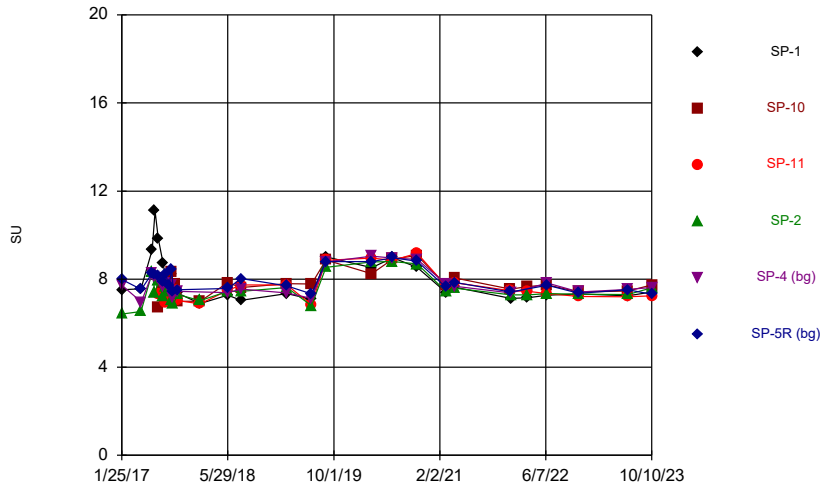Northeastern BAP   Data: Northeastern BAP
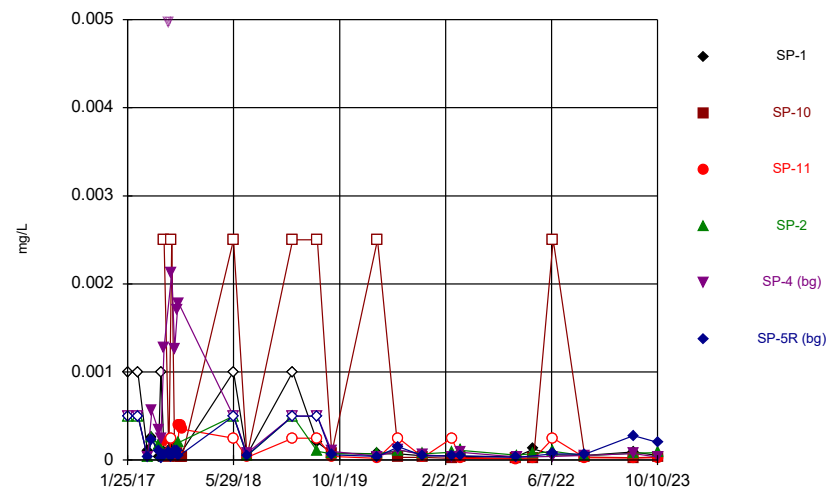
Time Series

Constituent: Beryllium   Analysis Run 1/10/2024 8:54 AM

Northeastern BAP   Data: Northeastern BAP
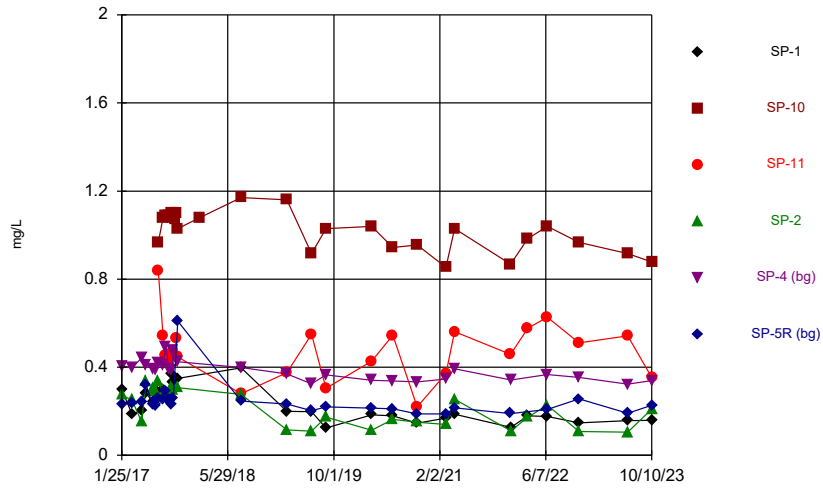
Time Series

Constituent: Boron   Analysis Run 1/10/2024 8:54 AM

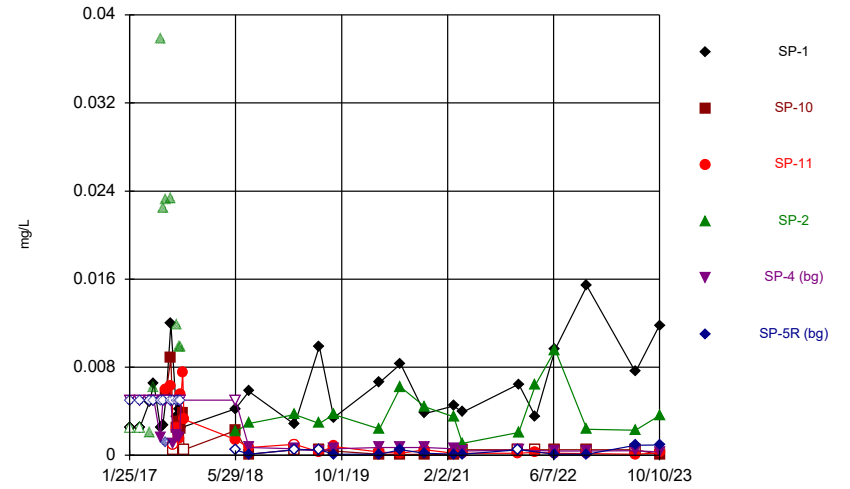Northeastern BAP   Data: Northeastern BAP
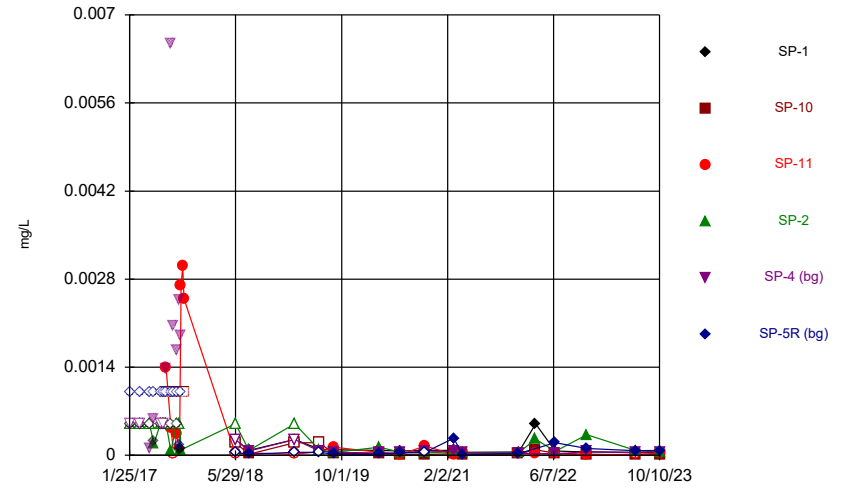
Time Series

Constituent: Cadmium   Analysis Run 1/10/2024 8:54 AM

Northeastern BAP   Data: Northeastern BAP
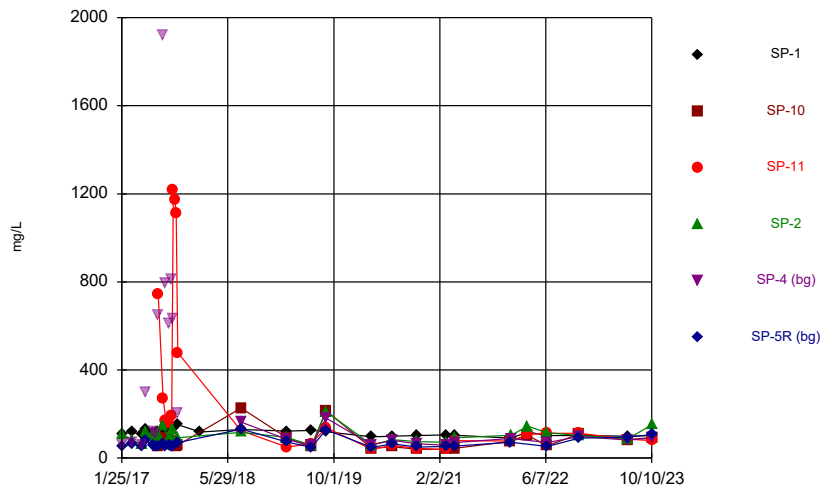
Time Series

Constituent: Calcium   Analysis Run 1/10/2024 8:54 AM

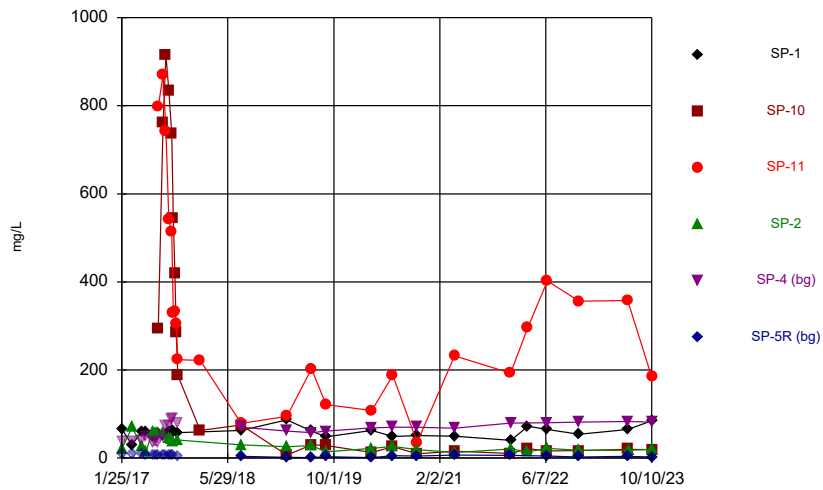Northeastern BAP   Data: Northeastern BAP
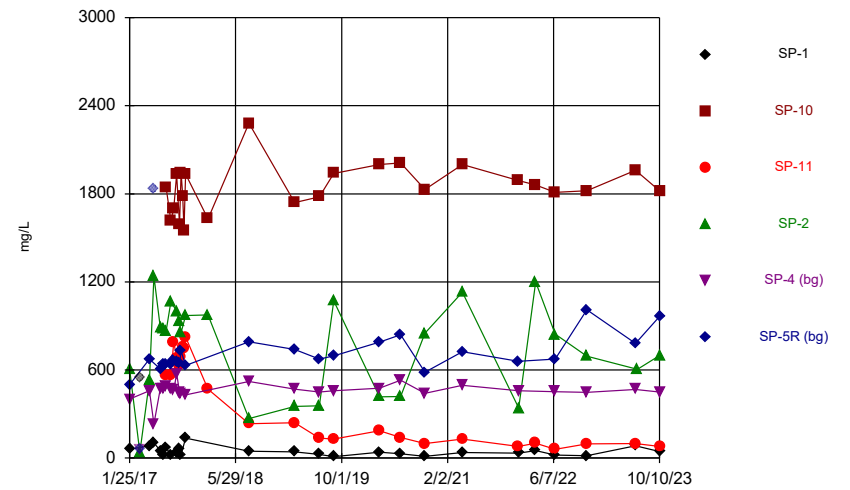
Time Series

Constituent: Chloride   Analysis Run 1/10/2024 8:54 AM

Northeastern BAP   Data: Northeastern BAP
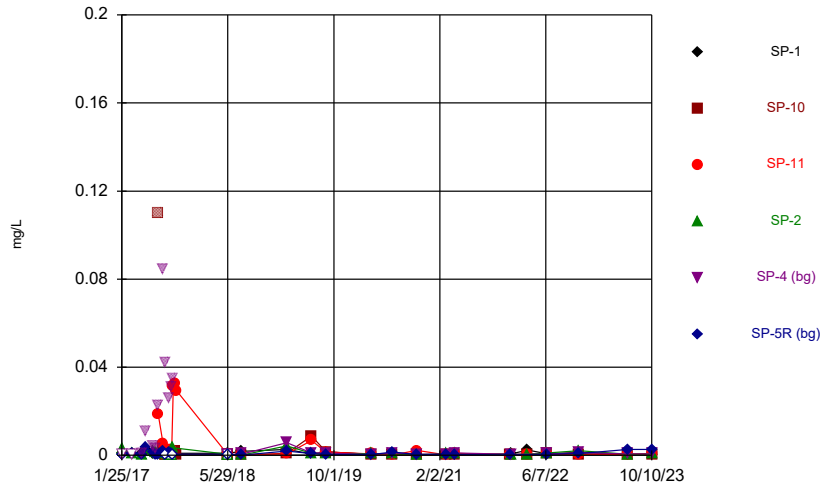
Time Series

Constituent: Chromium   Analysis Run 1/10/2024 8:54 AM
Northeastern BAP   Data: Northeastern BAP
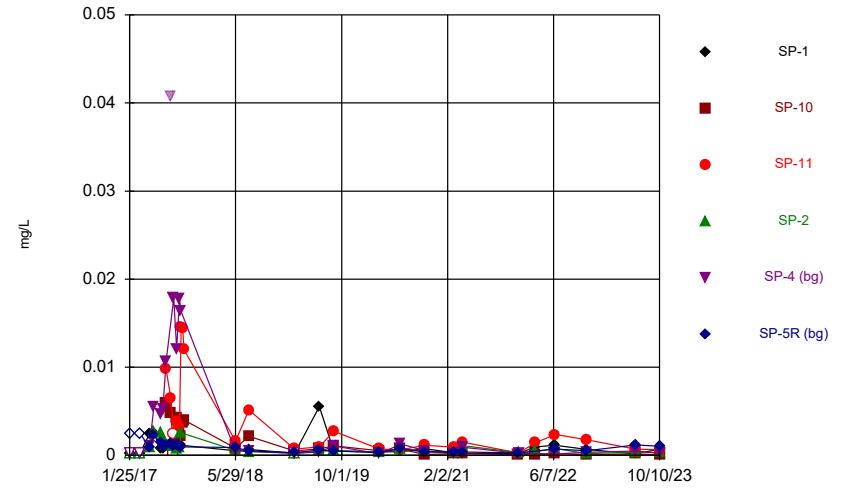
Time Series

Constituent: Cobalt   Analysis Run 1/10/2024 8:54 AM
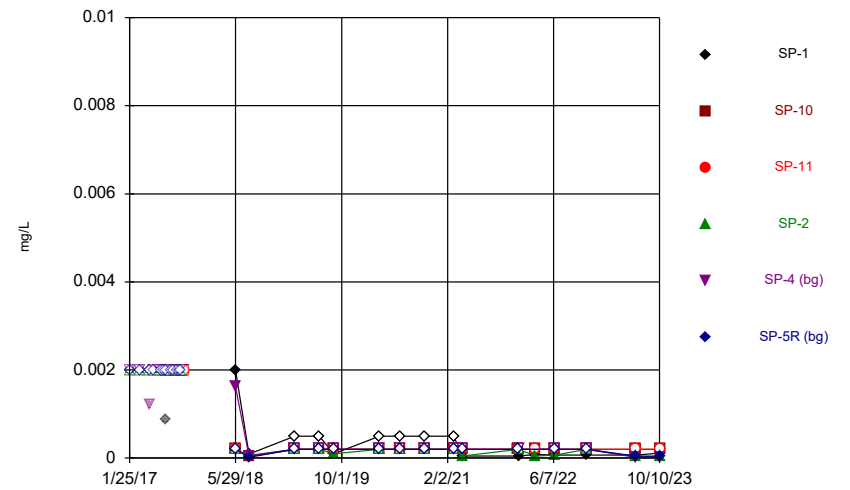Northeastern BAP   Data: Northeastern BAP
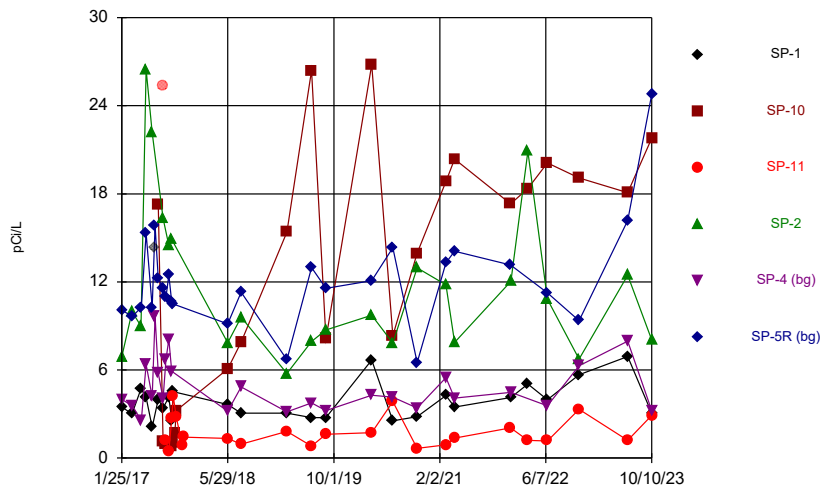
Time Series

Constituent: Combined Radium 226 + 228   Analysis Run 1/10/2024 8:54 AM
Northeastern BAP   Data: Northeastern BAP
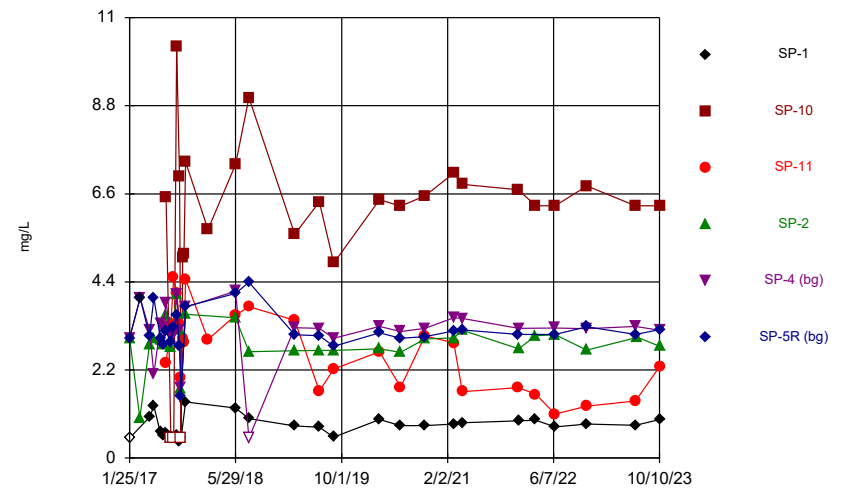
Time Series

Constituent: Fluoride   Analysis Run 1/10/2024 8:54 AM
Northeastern BAP   Data: Northeastern BAP
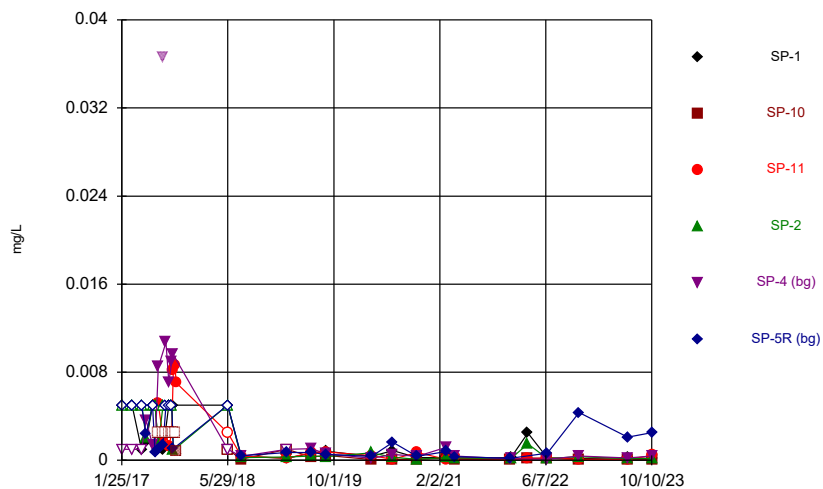
Time Series

Constituent: Lead   Analysis Run 1/10/2024 8:54 AM
Northeastern BAP   Data: Northeastern BAP

Time Series

Constituent: Lithium   Analysis Run 1/10/2024 8:54 AM
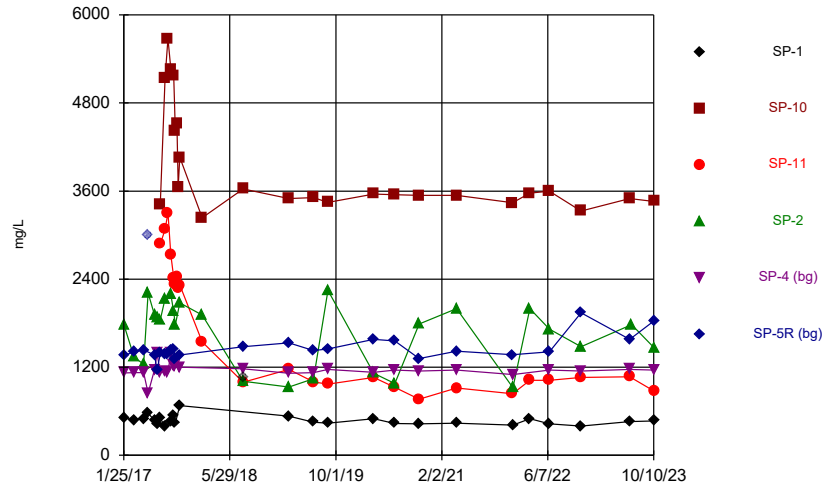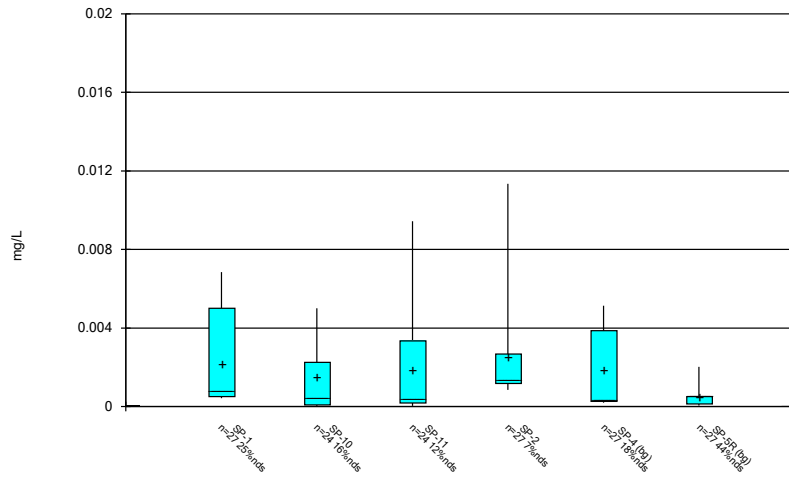Northeastern BAP   Data: Northeastern BAP

Time Series

Constituent: Mercury   Analysis Run 1/10/2024 8:54 AM
Northeastern BAP   Data: Northeastern BAP

Time Series

Constituent: Molybdenum   Analysis Run 1/10/2024 8:54 AM
Northeastern BAP   Data: Northeastern BAP

Time Series

Constituent: pH, field   Analysis Run 1/10/2024 8:54 AM
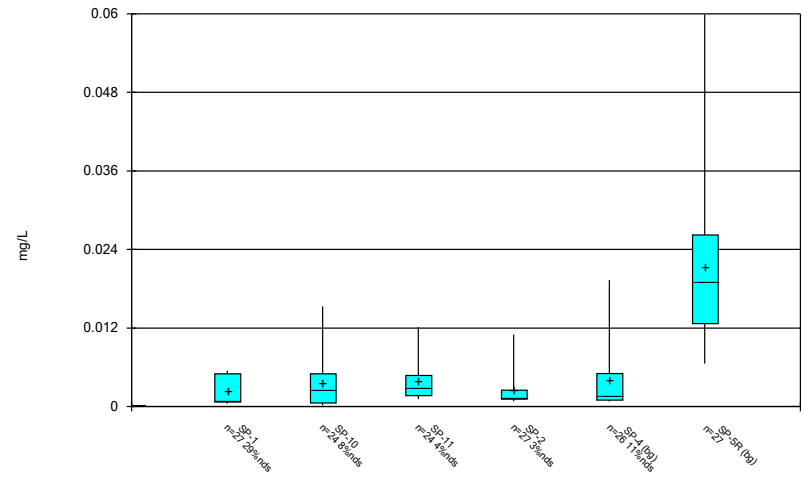
Northeastern BAP   Data: Northeastern BAP

Time Series

Constituent: Selenium   Analysis Run 1/10/2024 8:54 AM

Northeastern BAP   Data: Northeastern BAP

Time Series

Constituent: Sulfate   Analysis Run 1/10/2024 8:54 AM

Northeastern BAP   Data: Northeastern BAP

Time Series

Constituent: Thallium   Analysis Run 1/10/2024 8:54 AM

Northeastern BAP   Data: Northeastern BAP

Time Series

Constituent: Total Dissolved Solids [TDS]   Analysis Run 1/10/2024 8:54 AM

Northeastern BAP   Data: Northeastern BAP

FIGURE B
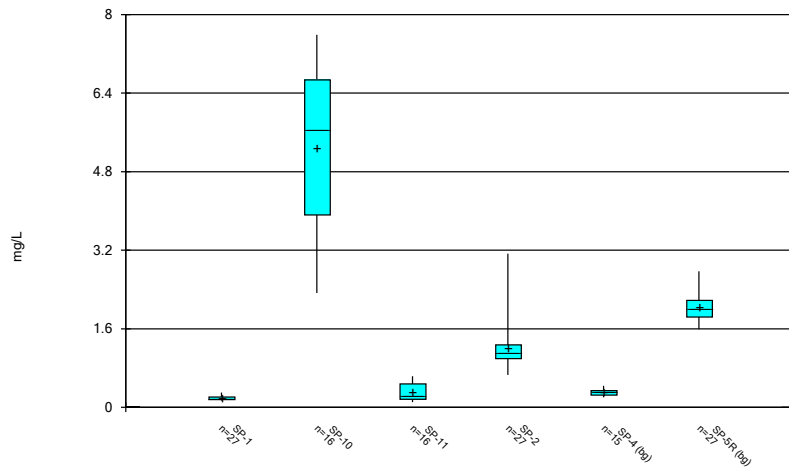# Box Plots

Box & Whiskers Plot

Constituent: Antimony   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP
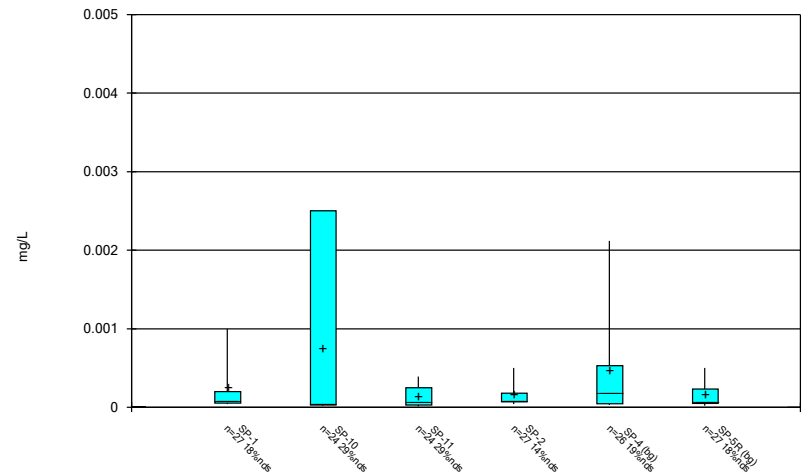
Box & Whiskers Plot

Constituent: Arsenic   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP
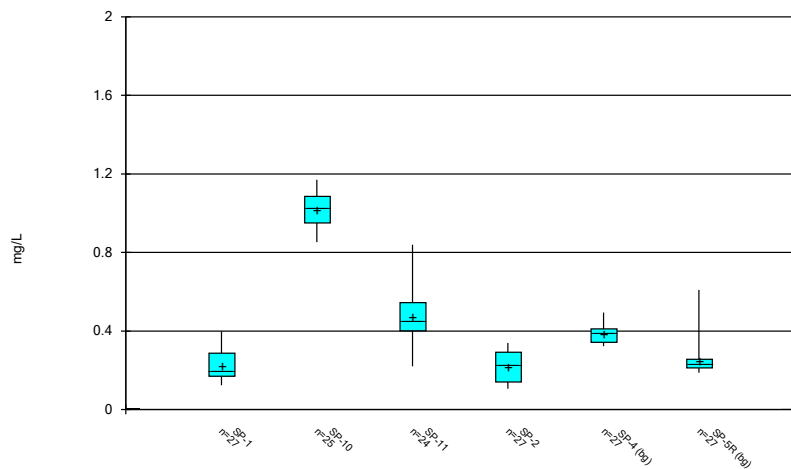
Box & Whiskers Plot

Constituent: Barium   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP
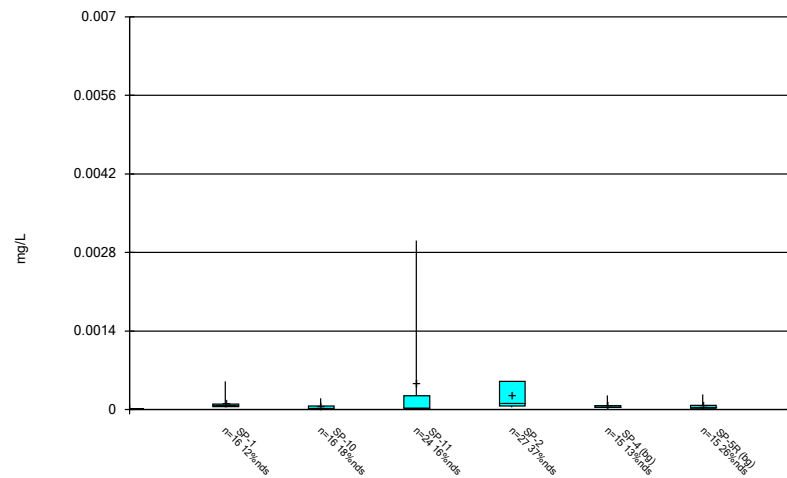
Box & Whiskers Plot

Constituent: Beryllium   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP
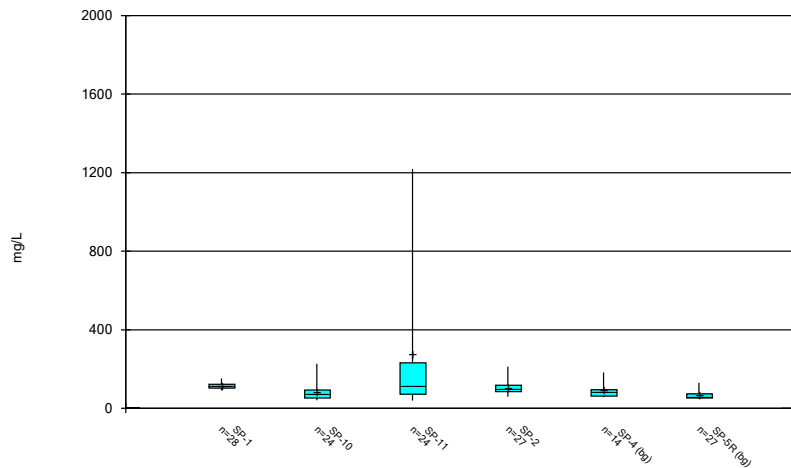
Box & Whiskers Plot

Constituent: Boron   Analysis Run 1/10/2024 9:00 AM
Northeastern BAP   Data: Northeastern BAP
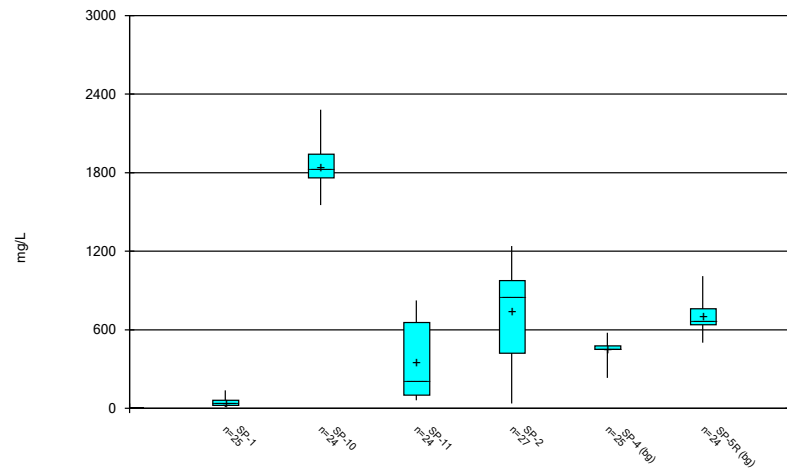
Box & Whiskers Plot

Constituent: Cadmium   Analysis Run 1/10/2024 9:00 AM
Northeastern BAP   Data: Northeastern BAP
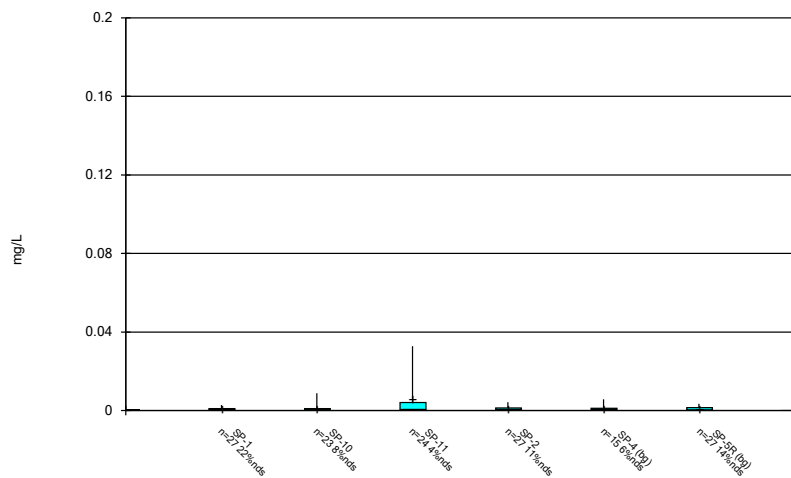
Box & Whiskers Plot

Constituent: Calcium   Analysis Run 1/10/2024 9:00 AM
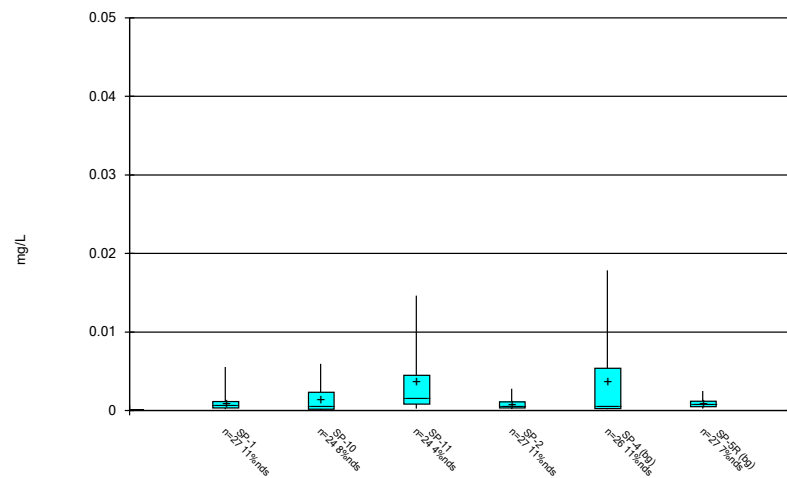Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Chloride   Analysis Run 1/10/2024 9:00 AM
Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Chromium   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Cobalt   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Combined Radium 226 + 228   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Fluoride   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Lead   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Lithium   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Mercury   Analysis Run 1/10/2024 9:00 AM

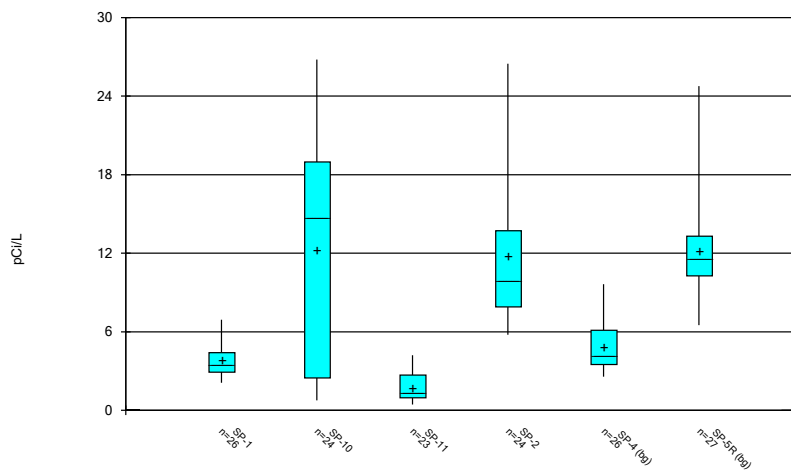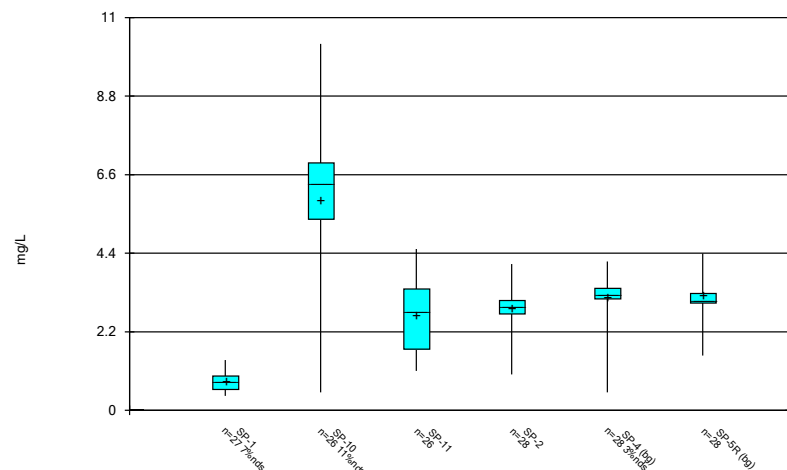Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Molybdenum   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: pH, field   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Selenium   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

Box & Whiskers Plot

Constituent: Sulfate   Analysis Run 1/10/2024 9:00 AM

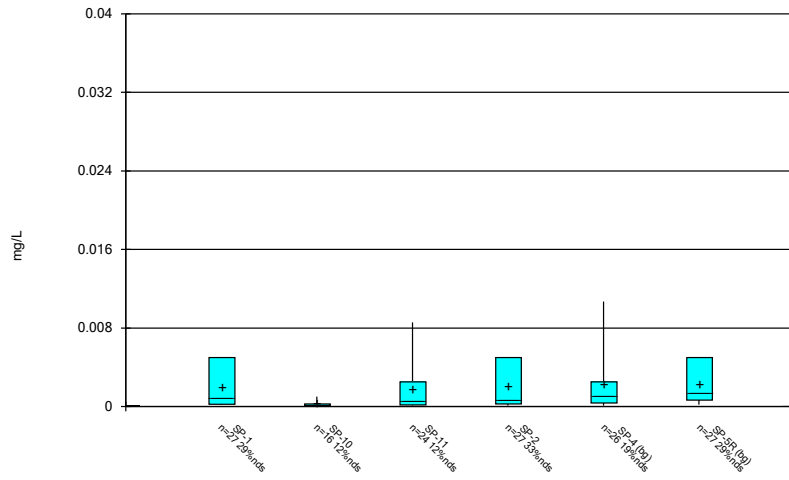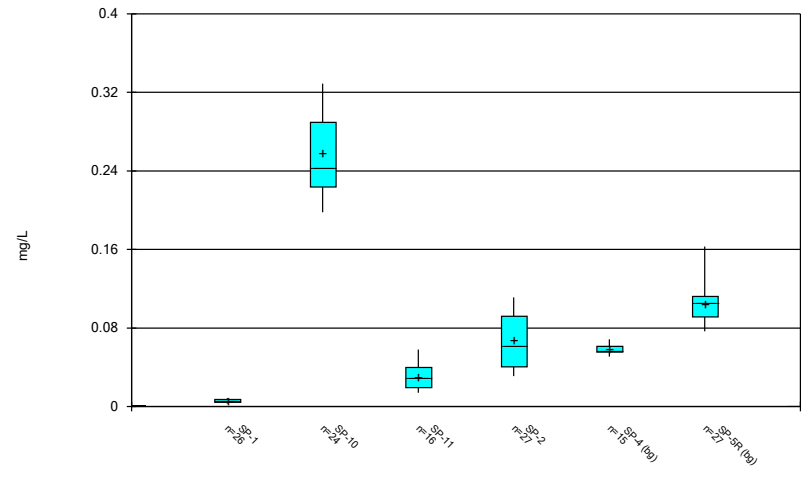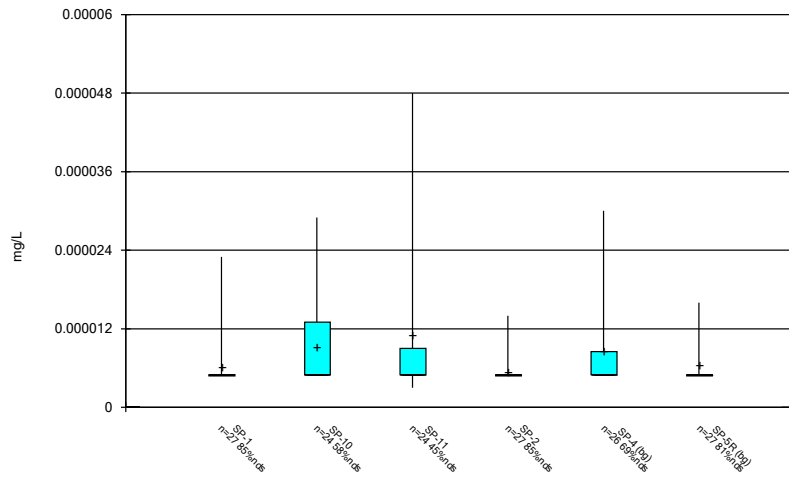Northeastern BAP   Data: Northeastern BAP
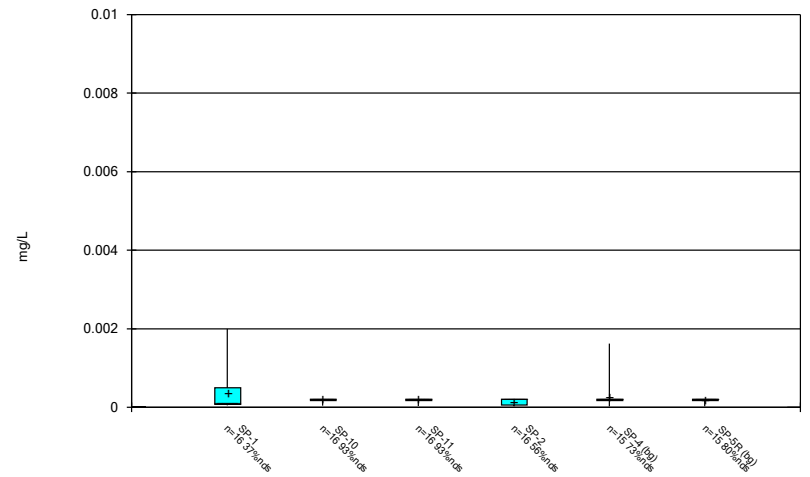
Box & Whiskers Plot

Constituent: Thallium   Analysis Run 1/10/2024 9:00 AM
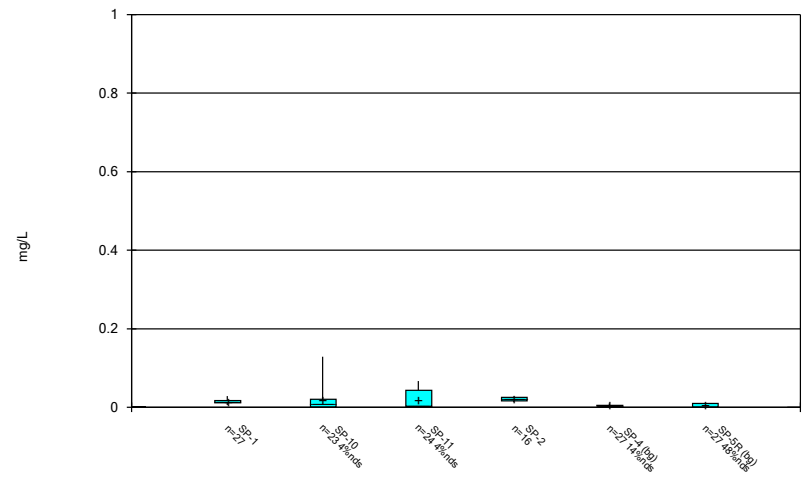
Northeastern BAP   Data: Northeastern BAP
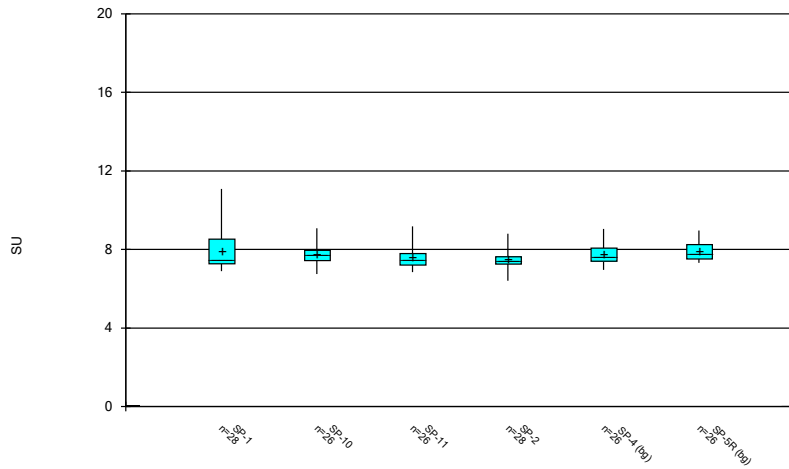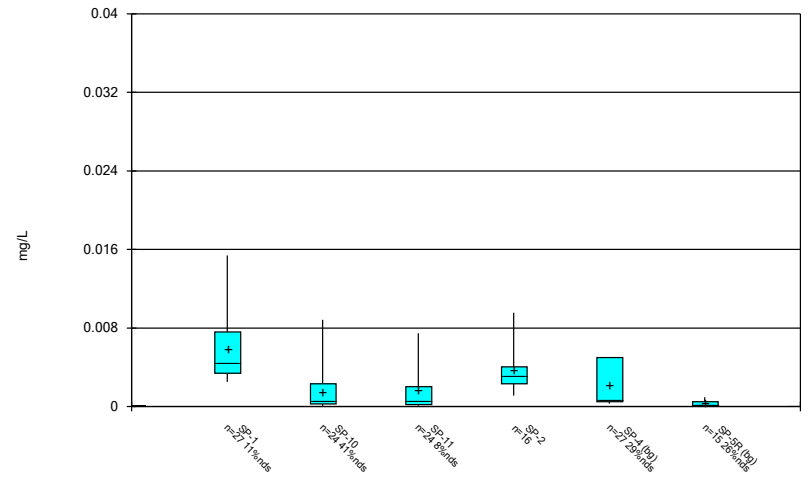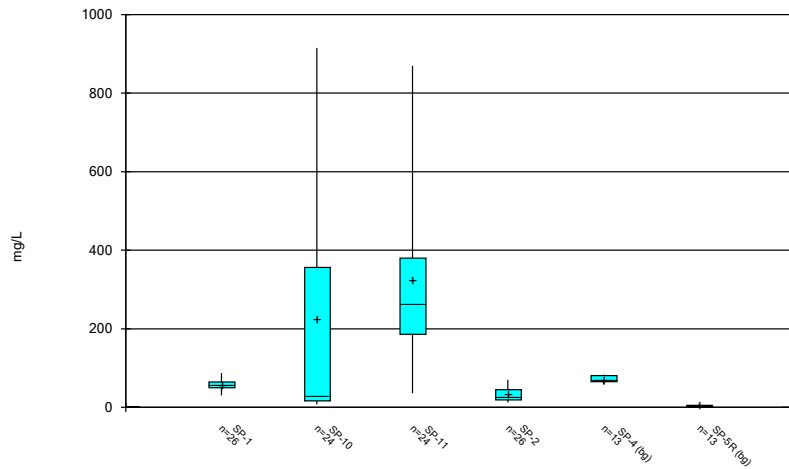
Box & Whiskers Plot
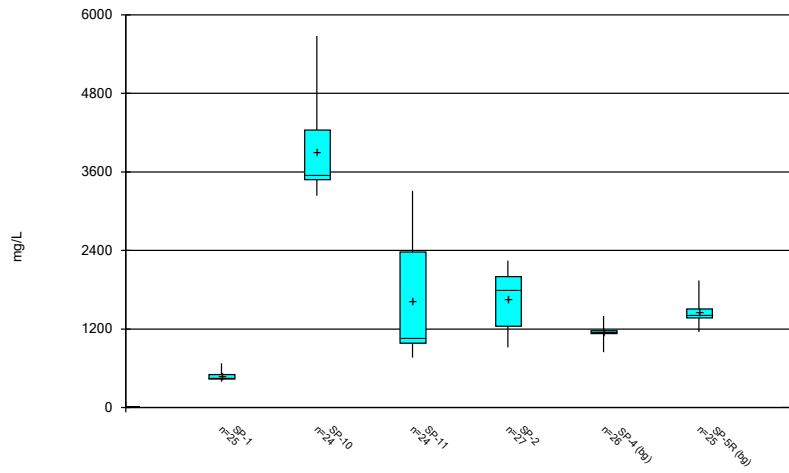
Constituent: Total Dissolved Solids [TDS]   Analysis Run 1/10/2024 9:00 AM

Northeastern BAP   Data: Northeastern BAP

FIGURE C

Outlier Summary and Tukey's Outlier Test

	SP-4 Arsenic (mg/L)	SP-4 Beryllium (mg/L)	SP-1 Chloride (mg/L)	SP-4 Chloride (mg/L)	SP-5R Chloride (mg/L)	SP-10 Chromium (mg/L)	SP-4 Cobalt (mg/L)	SP-1 Combined Radium 226 + 228 (pCi/L)	SP-11 Combined Radium 226 + 228 (pCi/L)	SP-1 Fluoride (mg/L)
3/13/2017			548 (o)							4 (o)
3/15/2017				52 (o)	62 (o)					
5/18/2017					1834 (o)					
6/27/2017								14.29 (o)		
7/13/2017						0.11 (o)				
8/4/2017	0.04498 (o)	0.00497 (o)					0.04069 (o)		25.367 (o)	
7/30/2018										
6/20/2019										

	SP-4 Lead (mg/L)	SP-1 Lithium (mg/L)	SP-4 Mercury (mg/L)	SP-10 Molybdenum (mg/L)	SP-1 Total Dissolved Solids [TDS] (mg/L)	SP-5R Total Dissolved Solids [TDS] (mg/L)
3/13/2017						
3/15/2017						
5/18/2017						3008 (o)
6/27/2017						
7/13/2017				0.934 (o)		
8/4/2017	0.03663 (o)		5.8E-05 (o)			
7/30/2018					1060 (o)	
6/20/2019		0.03 (J,o)				

Tukey's Outlier Test - Upgradient Wells - Significant Results

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Fluoride, total (mg/L)	AD-12,AD-18,AD-3	Yes	0.2565,0.213,0.02,0.02,0.02,0.02,0.02,0.02,0.01,0	NP	NaN	77	0.07116	0.04303	ln(x)	ShapiroFrancia
Mercury, total (mg/L)	AD-12,AD-18,AD-3	Yes	0.000084	NP	NaN	74	0.00001032	0.00001278	ln(x)	ShapiroFrancia

Tukey's Outlier Test - Upgradient Wells - All Results

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-12,AD-18,AD-3	n/a	n/a	NP	NaN	74	0.00008808	0.00002915	unknown	ShapiroFrancia
Arsenic, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	0.001202	0.0009703	x^(1/3)	ShapiroFrancia
Barium, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	0.06236	0.03367	sqrt(x)	ShapiroFrancia
Beryllium, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	0.0002513	0.0002456	ln(x)	ShapiroFrancia
Boron, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	77	0.03168	0.0186	x^(1/3)	ShapiroFrancia
Cadmium, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	0.00005845	0.00004507	ln(x)	ShapiroFrancia
Chloride, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	77	6.633	1.243	ln(x)	ShapiroFrancia
Chromium, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	0.000665	0.0006099	ln(x)	ShapiroFrancia
Cobalt, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	0.002448	0.002127	ln(x)	ShapiroFrancia
Combined Radium 226 + 228 (pCi/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	1.199	0.824	x^(1/3)	ShapiroFrancia
Fluoride, total (mg/L)	**AD-12,AD-18,AD-3**	**Yes**	**0.2565,0.213,0.02,0.02,0.02,0.02,0.02,0.02,0.01,0**	**NP**	**NaN**	**77**	**0.07116**	**0.04303**	**ln(x)**	**ShapiroFrancia**
Lead, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	0.0005609	0.0004228	ln(x)	ShapiroFrancia
Lithium, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	0.04176	0.1153	ln(x)	ShapiroFrancia
Mercury, total (mg/L)	**AD-12,AD-18,AD-3**	**Yes**	**0.000084**	**NP**	**NaN**	**74**	**0.00001032**	**0.00001278**	**ln(x)**	**ShapiroFrancia**
Molybdenum, total (mg/L)	AD-12,AD-18,AD-3	n/a	n/a	NP	NaN	74	0.0004969	0.0001231	unknown	ShapiroFrancia
Selenium, total (mg/L)	AD-12,AD-18,AD-3	No	n/a	NP	NaN	74	0.0005129	0.0006234	ln(x)	ShapiroFrancia
Thallium, total (mg/L)	AD-12,AD-18,AD-3	n/a	n/a	NP	NaN	74	0.0001988	0.0001558	unknown	ShapiroFrancia

Tukey's Outlier Screening, Pooled Background
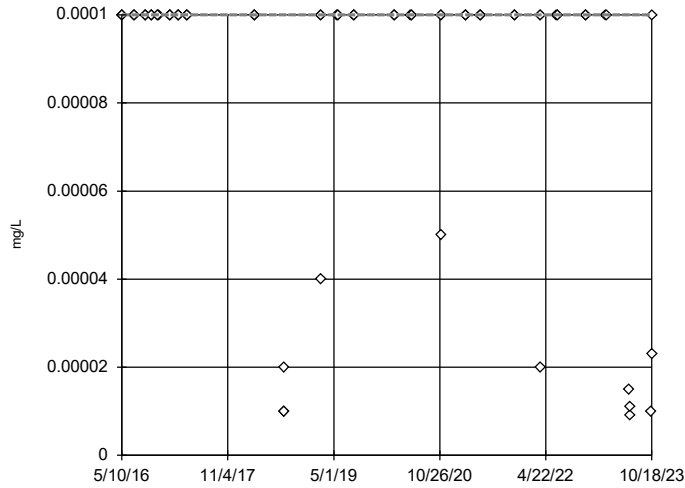
AD-12,AD-18,AD-3

mg/L

0.0001
0.00008
0.00006
0.00004
0.00002
0

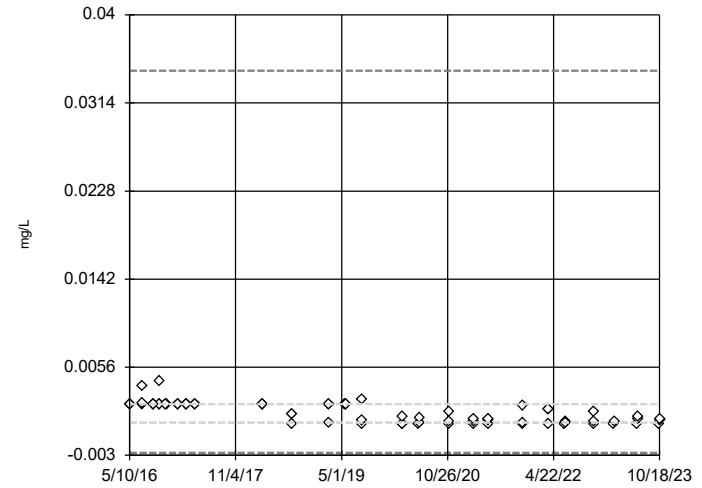5/10/16   11/4/17   5/1/19   10/26/20   4/22/22   10/18/23

n = 74

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test
Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

mg/L

0.04
0.0314
0.0228
0.0142
0.0056
-0.003

5/10/16   11/4/17   5/1/19   10/26/20   4/22/22   10/18/23

n = 74

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.03455, low cutoff = -0.00276, based on IQR multiplier of 3.

Constituent: Arsenic, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test
Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

mg/L

0.6
0.466
0.332
0.198
0.064
-0.07

5/10/16   11/4/17   5/1/19   10/26/20   4/22/22   10/18/23

n = 74

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.5016, low cutoff = -0.06134, based on IQR multiplier of 3.

Constituent: Barium, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test
Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

mg/L

0.002
0.0016
0.0012
0.0008
0.0004
0

5/10/16   11/4/17   5/1/19   10/26/20   4/22/22   10/18/23

n = 74

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.001665, low cutoff = 0.00001843, based on IQR multiplier of 3.

Constituent: Beryllium, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test
Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background
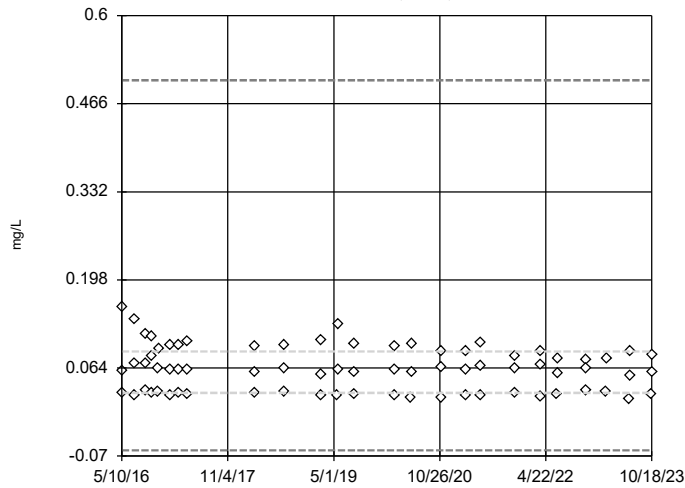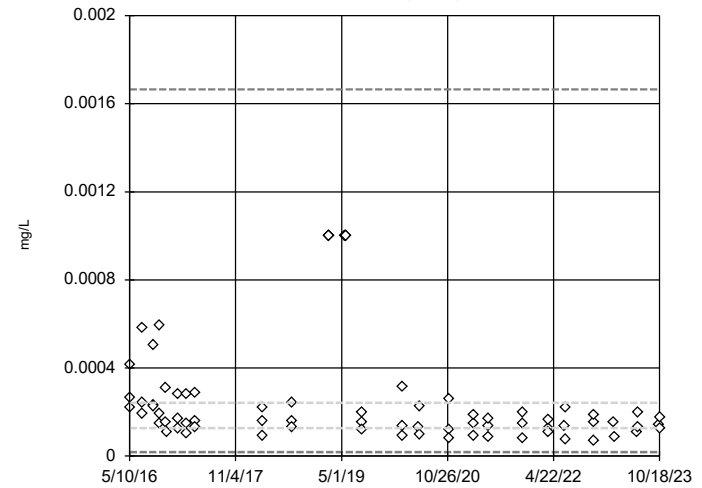
AD-12,AD-18,AD-3

n = 77

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.3353, low cutoff = -0.00057, based on IQR multiplier of 3.

Constituent: Boron, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test

Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

n = 74

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.06594, low cutoff = 1.7e-8, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test

Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background
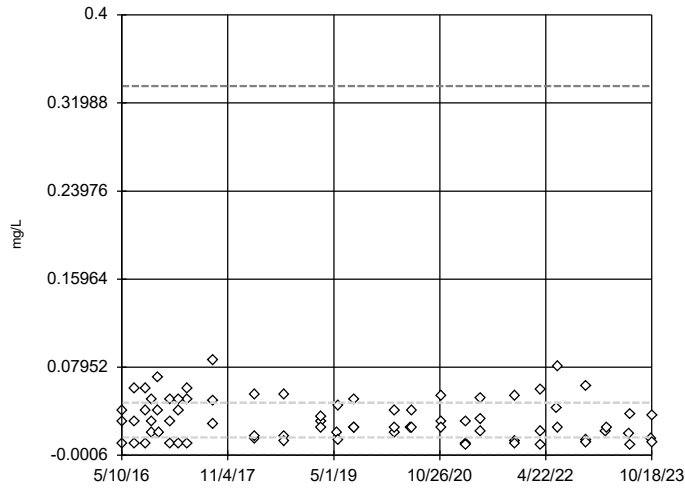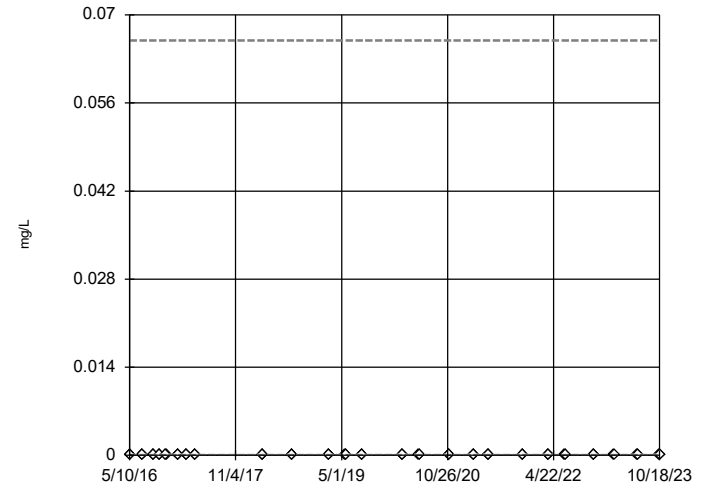
AD-12,AD-18,AD-3

n = 77

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 13.17, low cutoff = 3.312, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test

Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

n = 74

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.01379, low cutoff = 0.00001555, based on IQR multiplier of 3.

Constituent: Chromium, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test

Pirkey WBAP   Data: Pirkey WBAP

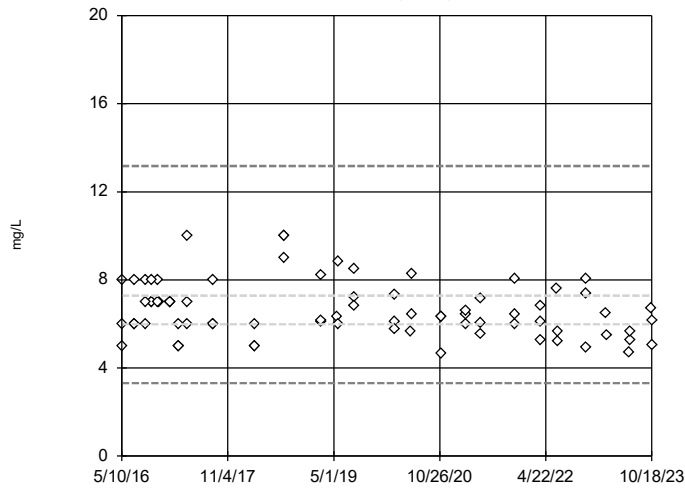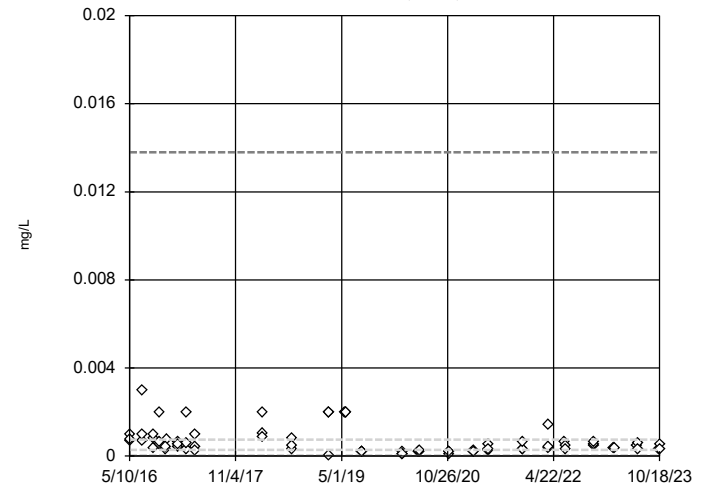## Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

n = 74

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.06273, low cutoff = 0.00005026, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test
Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

n = 74

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 7.582, low cutoff = 0.0002623, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test
Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

n = 77

Outliers are drawn as solid.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1452, low cutoff = 0.03093, based on IQR multiplier of 3.

Constituent: Fluoride, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test
Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background
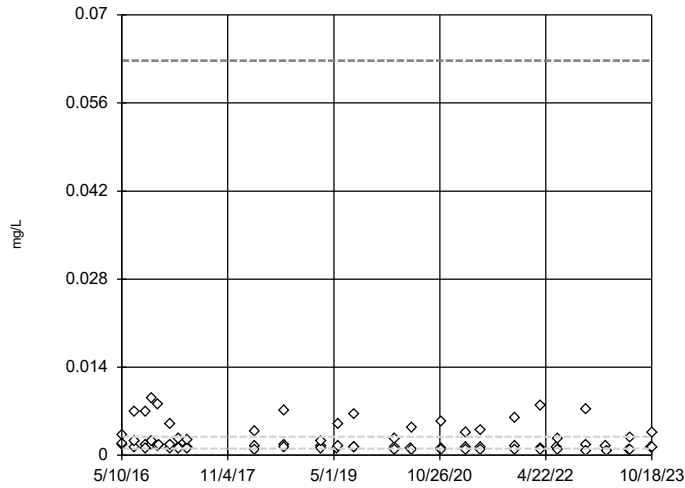
AD-12,AD-18,AD-3

n = 74

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1, low cutoff = 1.0e-7, based on IQR multiplier of 3.

Constituent: Lead, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test
Pirkey WBAP   Data: Pirkey WBAP

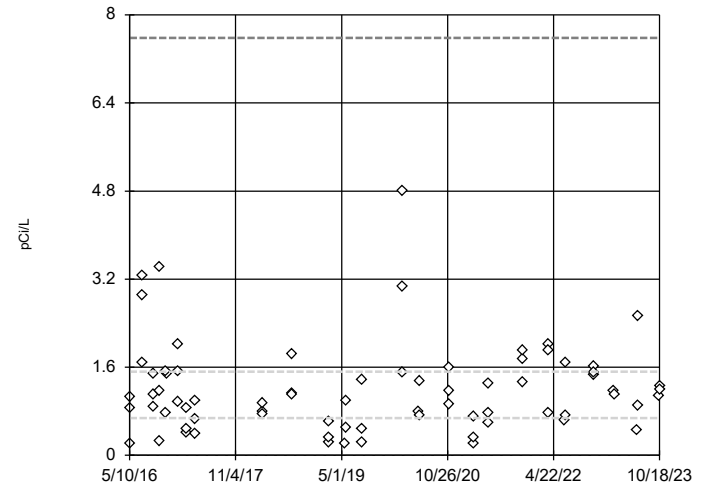## Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

n = 74

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.599, low cutoff = 0.00007568, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test

Pirkey WBAP   Data: Pirkey WBAP

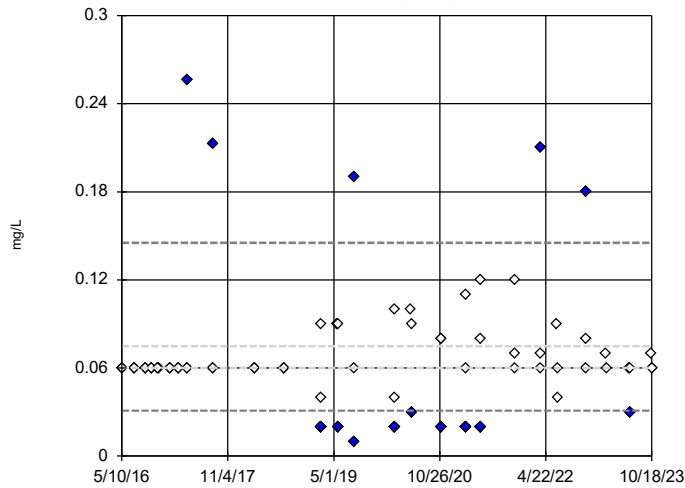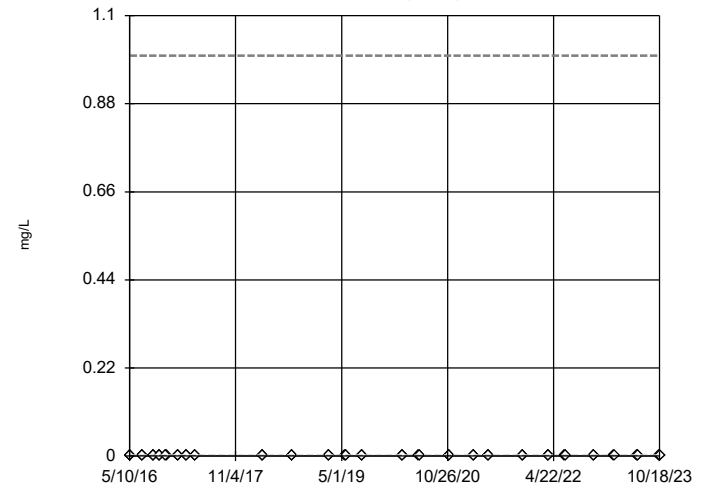## Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

n = 74

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.00007873, low cutoff = 6.3e-7, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test

Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

n = 74

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Molybdenum, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test

Pirkey WBAP   Data: Pirkey WBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3

n = 74
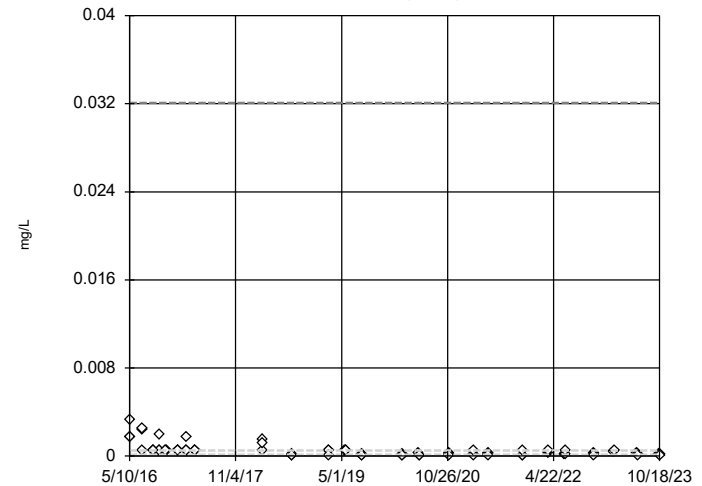
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.03208, low cutoff = 0.000001947, based on IQR multiplier of 3.

Constituent: Selenium, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test

Pirkey WBAP   Data: Pirkey WBAP

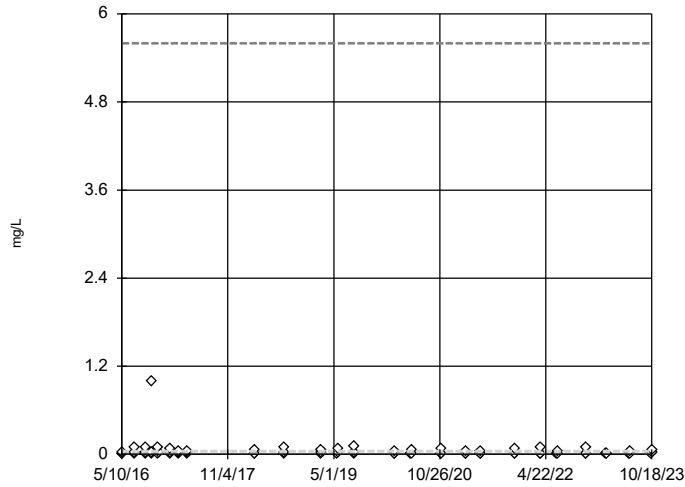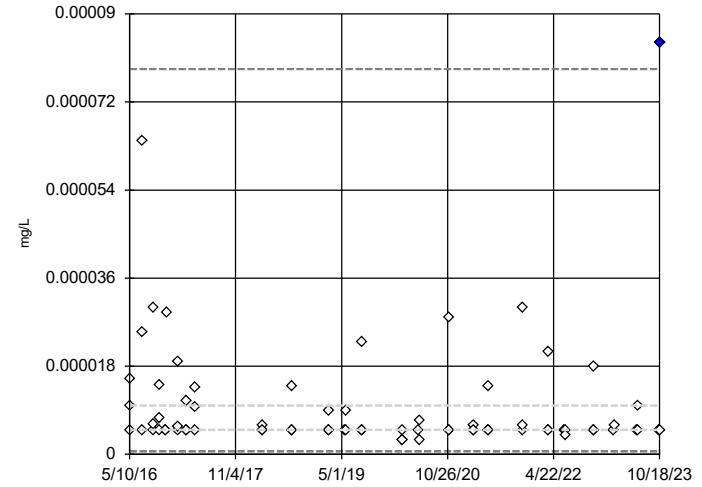## Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-3
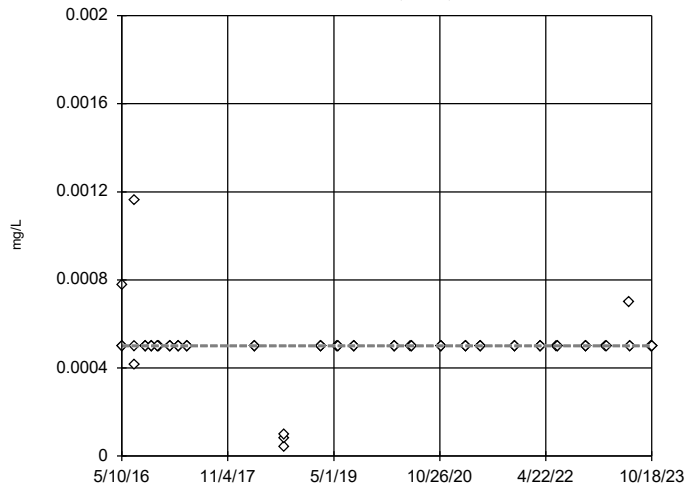
n = 74

No outliers found.
Tukey's method select-
ed by user.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Thallium, total   Analysis Run 1/4/2024 12:00 PM   View: Tukey's Outlier Test

Pirkey WBAP   Data: Pirkey WBAP

FIGURE D

Intrawell PLs

Intrawell Pediction Limits - All Results

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium (mg/L)	SP-1	141.3	n/a	n/a	1 future	n/a	25	115.9	13.21	0	None	No	0.00188	Param Intra 1 of 2
Calcium (mg/L)	SP-10	227	n/a	n/a	1 future	n/a	21	n/a	n/a	0	n/a	n/a	0.003999	NP Intra (normality) 1 of 2
Calcium (mg/L)	SP-11	155.9	n/a	n/a	1 future	n/a	12	78	34.89	0	None	No	0.00188	Param Intra 1 of 2
Calcium (mg/L)	SP-2	166.8	n/a	n/a	1 future	n/a	24	102.5	33.2	0	None	No	0.00188	Param Intra 1 of 2
Calcium (mg/L)	SP-4	182	n/a	n/a	1 future	n/a	11	n/a	n/a	0	n/a	n/a	0.01276	NP Intra (normality) 1 of 2
Calcium (mg/L)	SP-5R	131	n/a	n/a	1 future	n/a	24	n/a	n/a	0	n/a	n/a	0.003124	NP Intra (normality) 1 of 2

Prediction Limit

Intrawell Parametric, SP-1

■ SP-1 background

Limit = 141.3
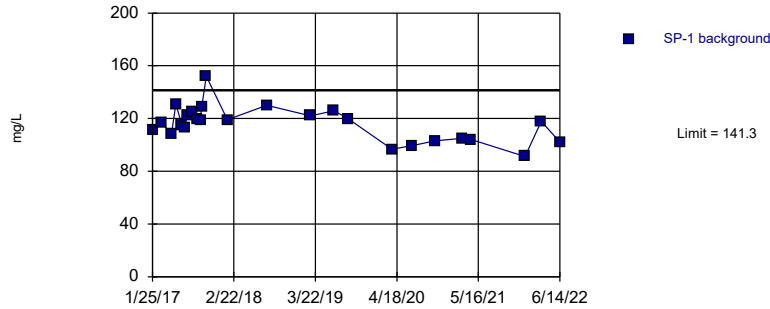
Background Data Summary: Mean=115.9, Std. Dev.=13.21, n=25.   Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9663, critical = 0.888.   Kappa = 1.924 (c=7, w=4, 1 of 2, event alpha = 0.05132). Report alpha = 0.00188. Assumes 1 future value.

Constituent: Calcium   Analysis Run 1/11/2024 12:01 PM   View: Intrawell

Northeastern BAP   Data: Northeastern BAP

Prediction Limit

Intrawell Non-parametric, SP-10
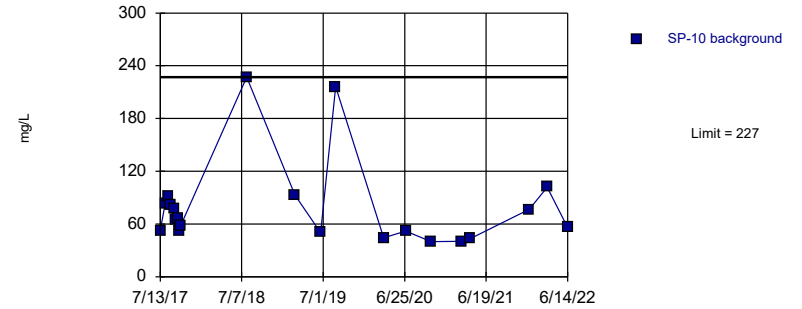
■ SP-10 background

Limit = 227

Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 21 background values. Well-constituent pair annual alpha = 0.007982. Individual comparison alpha = 0.003999 (1 of 2). Assumes 1 future value.

Constituent: Calcium   Analysis Run 1/11/2024 12:01 PM   View: Intrawell

Northeastern BAP   Data: Northeastern BAP

Prediction Limit

Intrawell Parametric, SP-11

■ SP-11 background

Limit = 155.9
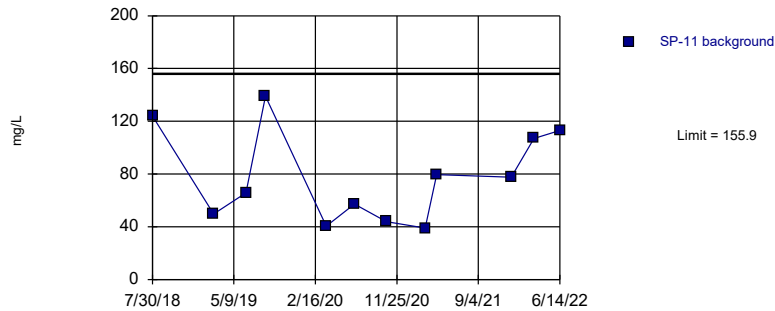
Background Data Summary: Mean=78, Std. Dev.=34.89, n=12.   Normality test: Shapiro Wilk @alpha = 0.05, calculated = 0.9081, critical = 0.859.   Kappa = 2.232 (c=7, w=4, 1 of 2, event alpha = 0.05132). Report alpha = 0.00188. Assumes 1 future value.

Constituent: Calcium   Analysis Run 1/11/2024 12:01 PM   View: Intrawell

Northeastern BAP   Data: Northeastern BAP

Prediction Limit

Intrawell Parametric, SP-2

■ SP-2 background

Limit = 166.8
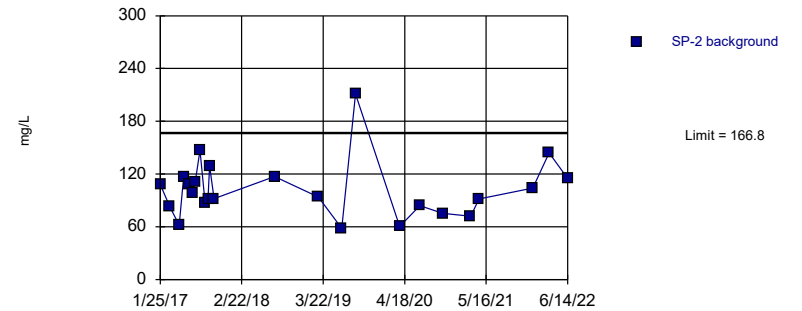
Background Data Summary: Mean=102.5, Std. Dev.=33.2, n=24.   Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8901, critical = 0.884.   Kappa = 1.937 (c=7, w=4, 1 of 2, event alpha = 0.05132). Report alpha = 0.00188. Assumes 1 future value.

Constituent: Calcium   Analysis Run 1/11/2024 12:01 PM   View: Intrawell

Northeastern BAP   Data: Northeastern BAP

Prediction Limit

Intrawell Non-parametric, SP-4 (bg)
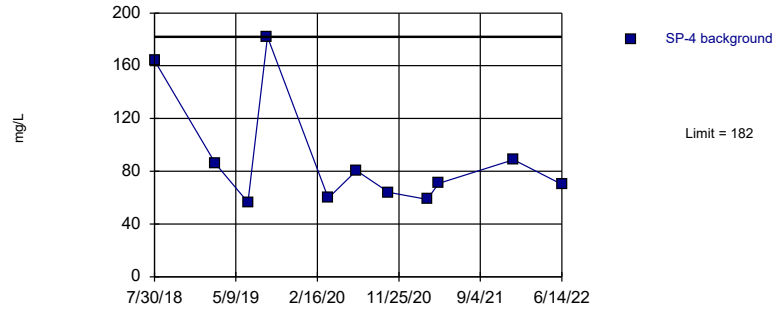
■ SP-4 background

Limit = 182

mg/L

200
160
120
80
40
0

7/30/18   5/9/19   2/16/20   11/25/20   9/4/21   6/14/22

Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.05 alpha level. Limit is highest of 11 background values. Well-constituent pair annual alpha = 0.02537. Individual comparison alpha = 0.01276 (1 of 2). Assumes 1 future value.

Constituent: Calcium   Analysis Run 1/11/2024 12:01 PM   View: Intrawell

Northeastern BAP   Data: Northeastern BAP

Prediction Limit

Intrawell Non-parametric, SP-5R (bg)
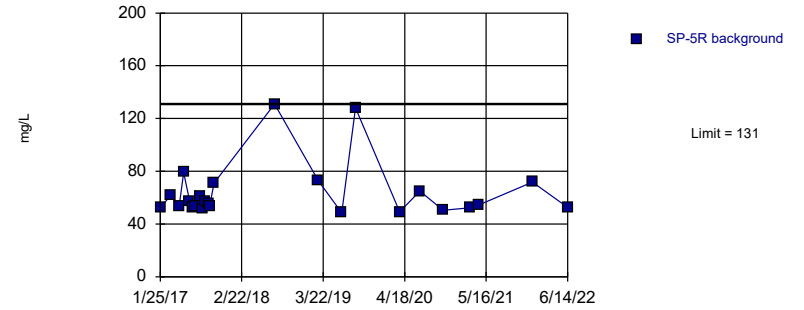
■ SP-5R background

Limit = 131

mg/L

200
160
120
80
40
0

1/25/17   2/22/18   3/22/19   4/18/20   5/16/21   6/14/22

Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 24 background values. Well-constituent pair annual alpha = 0.006238. Individual comparison alpha = 0.003124 (1 of 2). Assumes 1 future value.

Constituent: Calcium   Analysis Run 1/11/2024 12:01 PM   View: Intrawell

Northeastern BAP   Data: Northeastern BAP

FIGURE E

Upgradient Trend Tests

Trend Tests - Upgradient Wells - Significant Results

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Alpha	Method
Boron (mg/L)	SP-4 (bg)	-0.01357	-180	-124	Yes	27	0	n/a	0.01	NP
Boron (mg/L)	SP-5R (bg)	-0.00878	-138	-124	Yes	27	0	n/a	0.01	NP
Chloride (mg/L)	SP-5R (bg)	34.59	135	105	Yes	24	0	n/a	0.01	NP
Sulfate (mg/L)	SP-4 (bg)	4.952	54	43	Yes	13	0	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	SP-5R (bg)	37.61	115	111	Yes	25	0	n/a	0.01	NP

Trend Tests - Upgradient Wells - All Results

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Alpha	Method
Boron (mg/L)	**SP-4 (bg)**	**-0.01357**	**-180**	**-124**	**Yes**	**27**	**0**	**n/a**	**0.01**	**NP**
Boron (mg/L)	**SP-5R (bg)**	**-0.00878**	**-138**	**-124**	**Yes**	**27**	**0**	**n/a**	**0.01**	**NP**
Chloride (mg/L)	SP-4 (bg)	0	0	111	No	25	0	n/a	0.01	NP
Chloride (mg/L)	**SP-5R (bg)**	**34.59**	**135**	**105**	**Yes**	**24**	**0**	**n/a**	**0.01**	**NP**
Fluoride (mg/L)	SP-4 (bg)	0.005715	10	131	No	28	3.571	n/a	0.01	NP
Fluoride (mg/L)	SP-5R (bg)	0.007758	26	131	No	28	0	n/a	0.01	NP
Sulfate (mg/L)	**SP-4 (bg)**	**4.952**	**54**	**43**	**Yes**	**13**	**0**	**n/a**	**0.01**	**NP**
Sulfate (mg/L)	SP-5R (bg)	0.2705	6	43	No	13	0	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	SP-4 (bg)	2.056	27	118	No	26	0	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	**SP-5R (bg)**	**37.61**	**115**	**111**	**Yes**	**25**	**0**	**n/a**	**0.01**	**NP**

Sen's Slope Estimator

SP-4 (bg)

n = 27

Slope = -0.01357
units per year.

Mann-Kendall
statistic = -180
critical = -124

Decreasing trend
significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests

Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-5R (bg)

n = 27

Slope = -0.00878
units per year.

Mann-Kendall
statistic = -138
critical = -124

Decreasing trend
significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests

Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-4 (bg)

n = 25

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 111

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Chloride   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests

Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-5R (bg)

n = 24

Slope = 34.59
units per year.

Mann-Kendall
statistic = 135
critical = 105

Increasing trend
significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Chloride   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests

Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-4 (bg)

n = 28

Slope = 0.005715
units per year.

Mann-Kendall
statistic = 10
critical = 131

Trend not sig-
nificant at 99%
confidence level
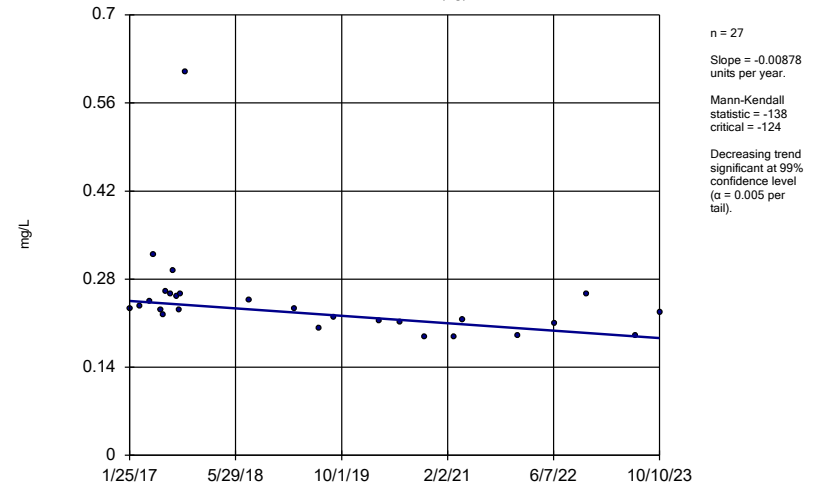(α = 0.005 per
tail).

mg/L

Constituent: Fluoride   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-5R (bg)

n = 28

Slope = 0.007758
units per year.

Mann-Kendall
statistic = 26
critical = 131

Trend not sig-
nificant at 99%
confidence level
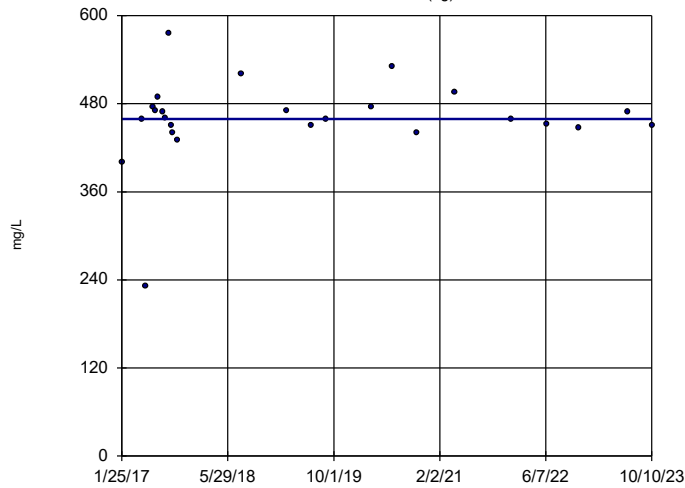(α = 0.005 per
tail).

mg/L

Constituent: Fluoride   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-4 (bg)

n = 13

Slope = 4.952
units per year.

Mann-Kendall
statistic = 54
critical = 43

Increasing trend
significant at 99%
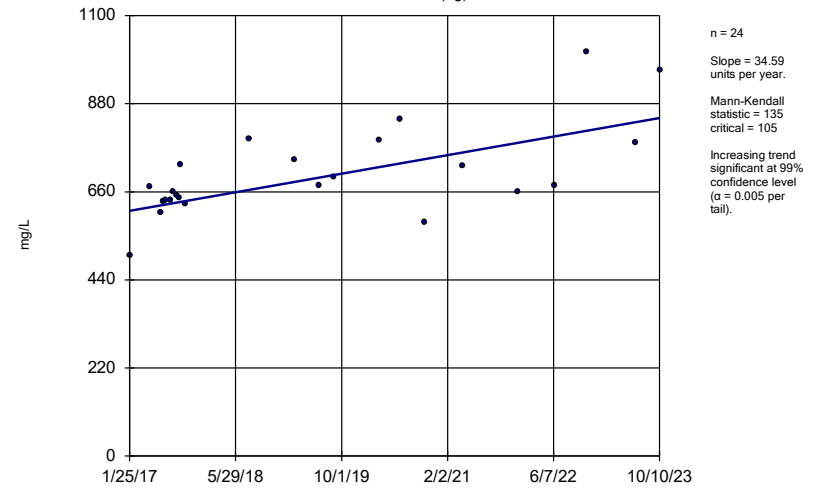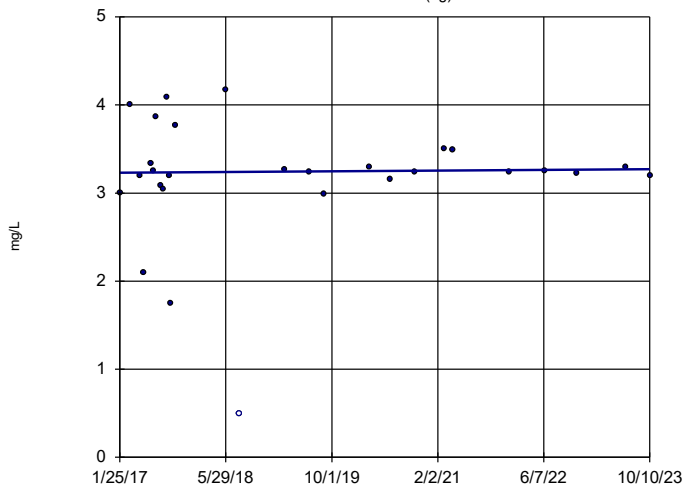confidence level
(α = 0.005 per
tail).

mg/L

Constituent: Sulfate   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-5R (bg)

n = 13

Slope = 0.2705
units per year.

Mann-Kendall
statistic = 6
critical = 43

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

mg/L

Constituent: Sulfate   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator
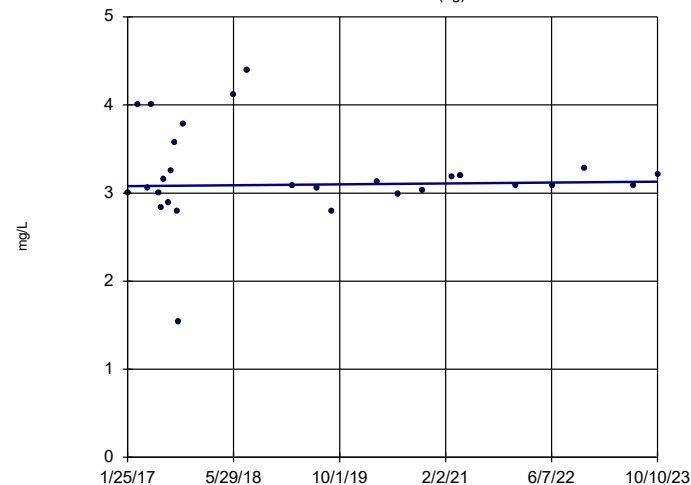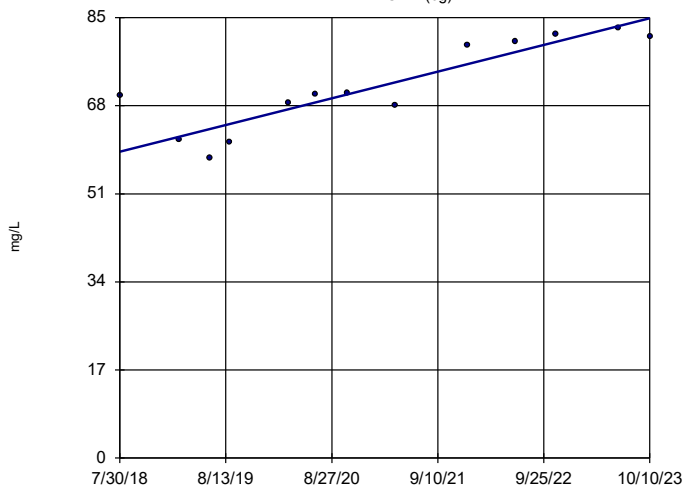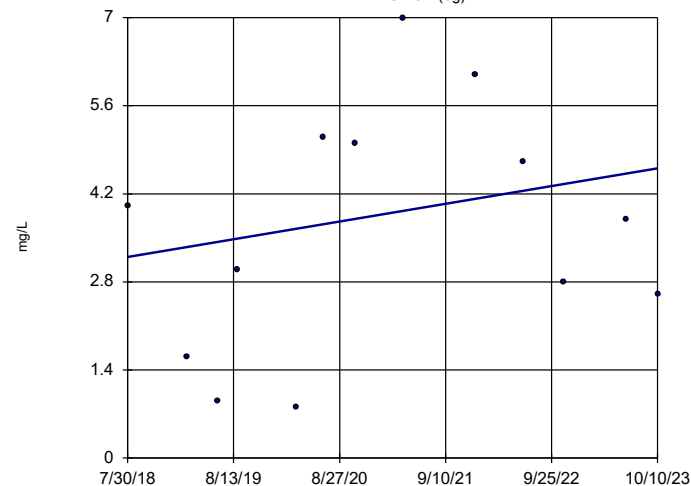
SP-4 (bg)

n = 26

Slope = 2.056
units per year.

Mann-Kendall
statistic = 27
critical = 118

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Total Dissolved Solids [TDS]   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-5R (bg)

n = 25

Slope = 37.61
units per year.

Mann-Kendall
statistic = 115
critical = 111

Increasing trend
significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Total Dissolved Solids [TDS]   Analysis Run 1/10/2024 10:55 AM   View: Trend Tests
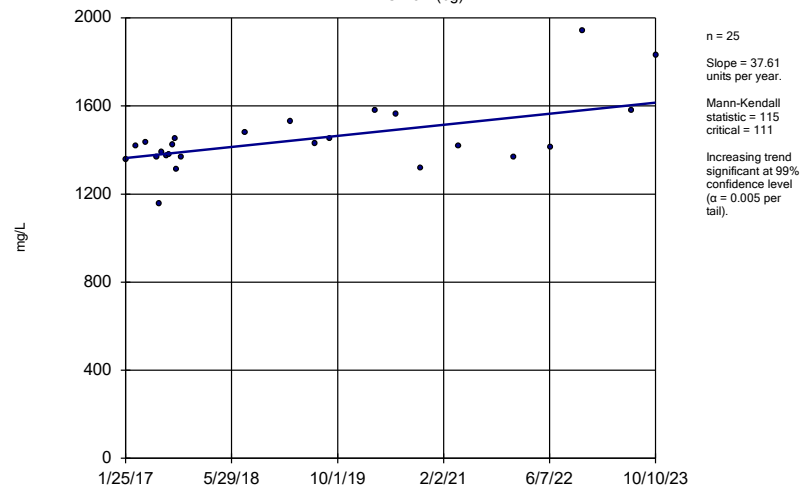Northeastern BAP   Data: Northeastern BAP

# FIGURE F

Interwell PLs

Interwell Pediction Limits - All Results

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron (mg/L)	n/a	0.4957	n/a	n/a	4 future	n/a	54	0.5554	0.08286	0	None	sqrt(x)	0.00188	Param Inter 1 of 2
Chloride (mg/L)	n/a	873.8	n/a	n/a	4 future	n/a	49	23.88	3.148	0	None	sqrt(x)	0.00188	Param Inter 1 of 2
Fluoride (mg/L)	n/a	4.39	n/a	n/a	4 future	n/a	56	n/a	n/a	1.786	n/a	n/a	0.0006126	NP Inter (normality) 1 of 2
pH, field (SU)	n/a	9.05	6.96	n/a	4 future	n/a	52	n/a	n/a	0	n/a	n/a	0.001402	NP Inter (normality) 1 of 2
Sulfate (mg/L)	n/a	83	n/a	n/a	4 future	n/a	26	n/a	n/a	0	n/a	n/a	0.00258	NP Inter (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	n/a	1940	n/a	n/a	4 future	n/a	51	n/a	n/a	0	n/a	n/a	0.0007231	NP Inter (normality) 1 of 2

Time Series
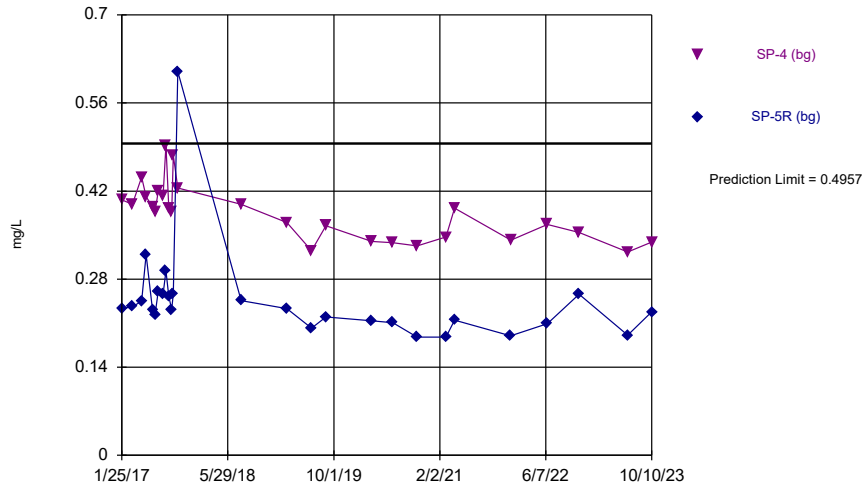
SP-4 (bg)

SP-5R (bg)

Prediction Limit = 0.4957

Constituent: Boron   Analysis Run 1/10/2024 11:57 AM   View: Interwell
Northeastern BAP   Data: Northeastern BAP

Time Series

SP-4 (bg)

SP-5R (bg)

Prediction Limit = 873.8

Constituent: Chloride   Analysis Run 1/10/2024 11:57 AM   View: Interwell
Northeastern BAP   Data: Northeastern BAP

Time Series

SP-4 (bg)

SP-5R (bg)

Prediction Limit = 4.39

Constituent: Fluoride   Analysis Run 1/10/2024 11:57 AM   View: Interwell
Northeastern BAP   Data: Northeastern BAP

Time Series

SP-4 (bg)

SP-5R (bg)

Prediction Limit = 9.05

Prediction Limit = 6.96
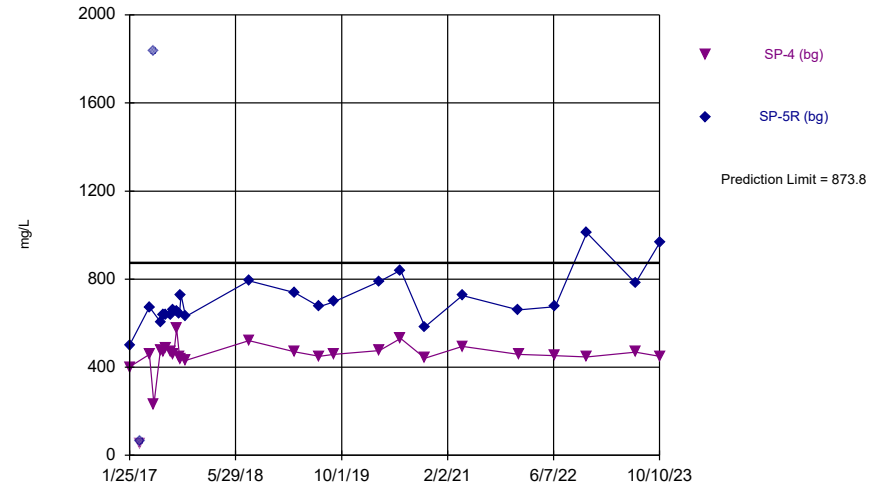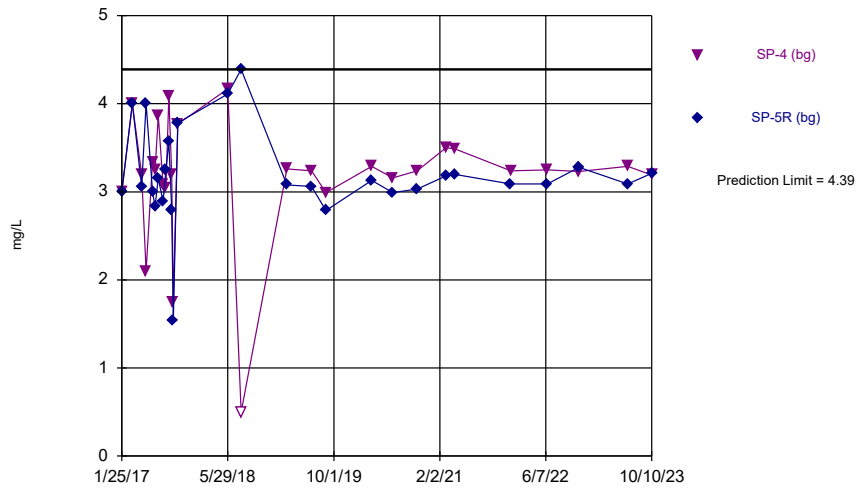
Constituent: pH, field   Analysis Run 1/10/2024 11:58 AM   View: Interwell
Northeastern BAP   Data: Northeastern BAP
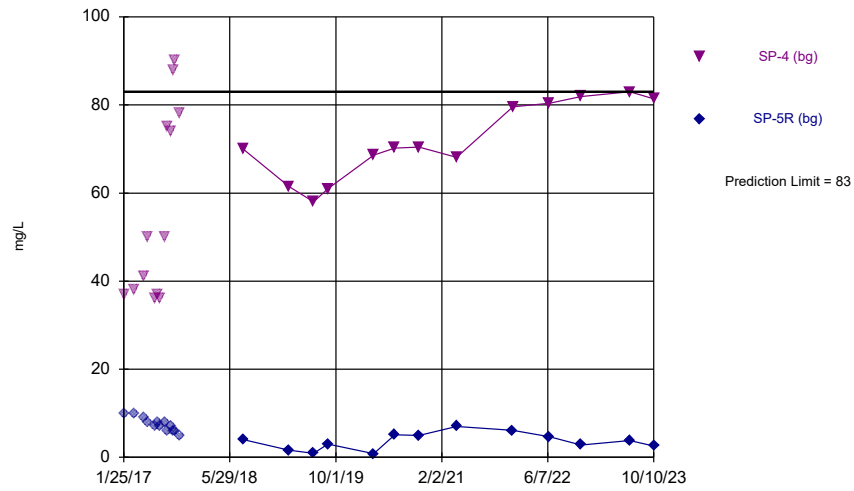
Time Series

SP-4 (bg)

SP-5R (bg)

Prediction Limit = 83

Constituent: Sulfate   Analysis Run 1/10/2024 12:02 PM   View: Interwell
Northeastern BAP   Data: Northeastern BAP

Time Series

SP-4 (bg)

SP-5R (bg)

Prediction Limit = 1940

Constituent: Total Dissolved Solids [TDS]   Analysis Run 1/10/2024 12:02 PM   View: Interwell
Northeastern BAP   Data: Northeastern BAP

Prediction Limit
Interwell Parametric

mg/L

Limit = 0.4957

10/9/23 — 10/10/23

Background Data Summary (based on square root transformation): Mean=0.5554, Std. Dev.=0.08286, n=54. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.949, critical = 0.939. Kappa = 1.794 (c=7, w=4, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.00188. Assumes 4 future values.

Constituent: Boron   Analysis Run 1/10/2024 10:56 AM   View: Interwell
Northeastern BAP   Data: Northeastern BAP

Prediction Limit
Interwell Parametric

mg/L

Limit = 873.8

10/9/23 — 10/10/23

Background Data Summary (based on square root transformation): Mean=23.88, Std. Dev.=3.148, n=49. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9416, critical = 0.929. Kappa = 1.805 (c=7, w=4, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.00188. Assumes 4 future values.

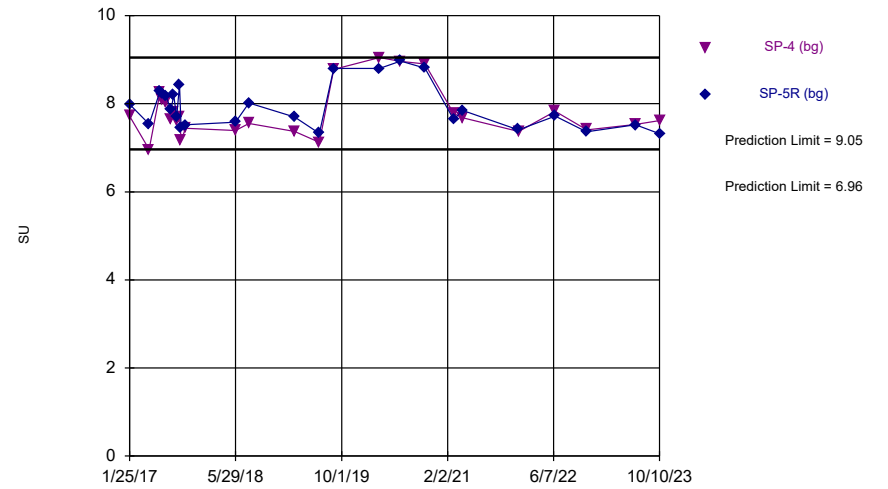Constituent: Chloride   Analysis Run 1/10/2024 10:56 AM   View: Interwell
Northeastern BAP   Data: Northeastern BAP

Prediction Limit
Interwell Non-parametric

mg/L

Limit = 4.39

10/9/23 — 10/10/23

Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 56 background values. 1.786% NDs. Annual per-constituent alpha = 0.004891. Individual comparison alpha = 0.0006126 (1 of 2). Assumes 4 future values.

Constituent: Fluoride   Analysis Run 1/10/2024 10:56 AM   View: Interwell
Northeastern BAP   Data: Northeastern BAP

Prediction Limit
Interwell Non-parametric

SU

Limit = 9.05

Limit = 6.96

10/9/23 — 10/10/23

Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limits are highest and lowest of 52 background values. Annual per-constituent alpha = 0.01119. Individual comparison alpha = 0.001402 (1 of 2). Assumes 4 future values.
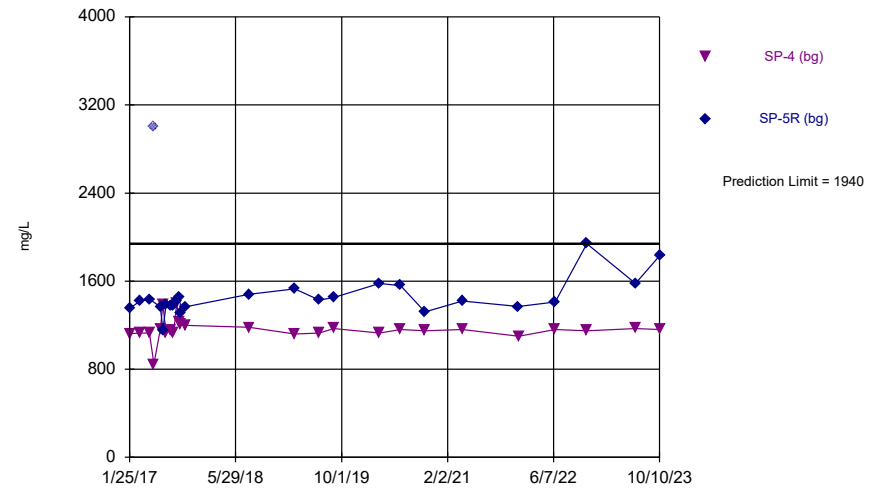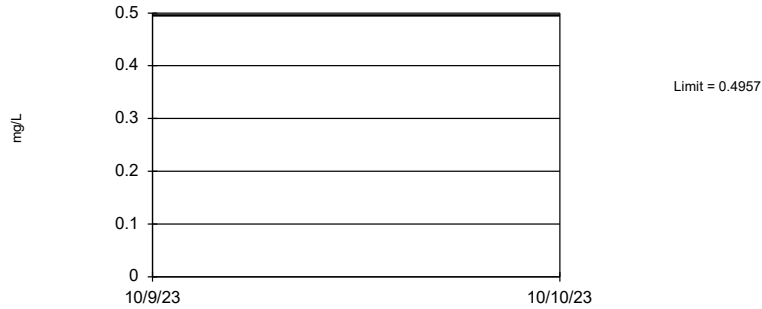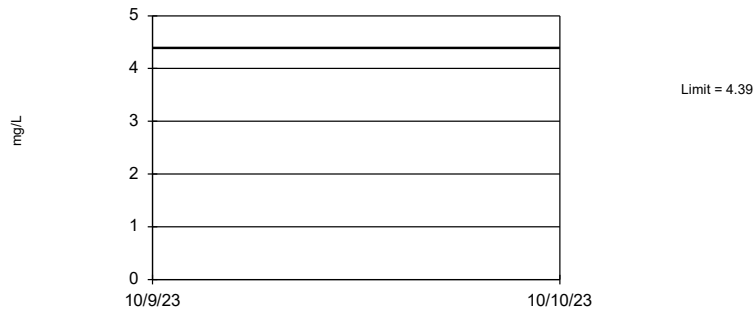
Constituent: pH, field   Analysis Run 1/10/2024 10:56 AM   View: Interwell
Northeastern BAP   Data: Northeastern BAP

Prediction Limit

Interwell Non-parametric

Limit = 83

Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. Annual per-constituent alpha = 0.02045. Individual comparison alpha = 0.00258 (1 of 2). Assumes 4 future values.

Constituent: Sulfate   Analysis Run 1/10/2024 10:56 AM   View: Interwell
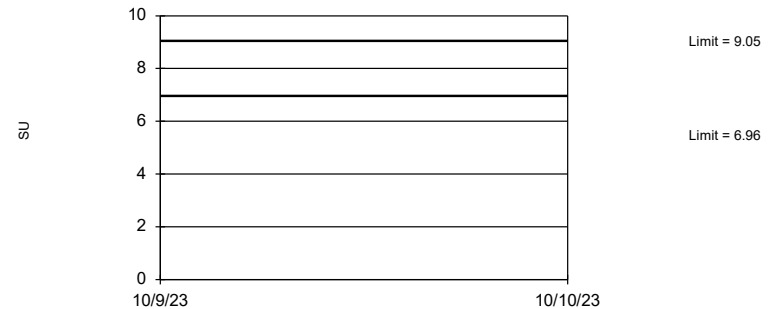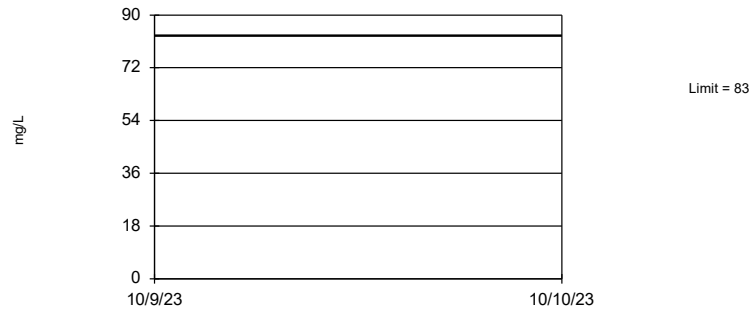
Northeastern BAP   Data: Northeastern BAP

Prediction Limit

Interwell Non-parametric

Limit = 1940
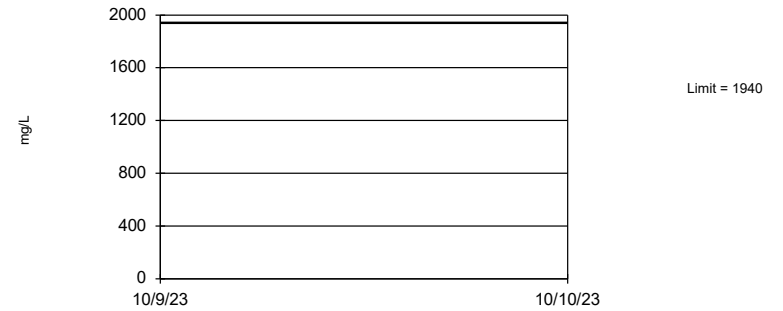
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 51 background values. Annual per-constituent alpha = 0.00577. Individual comparison alpha = 0.0007231 (1 of 2). Assumes 4 future values.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 1/10/2024 10:56 AM   View: Interwell

Northeastern BAP   Data: Northeastern BAP

FIGURE G

UTLs

Upper Tolerance Limits Summary Table

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony (mg/L)	0.004669	54	-8.028	1.303	31.48	Kaplan-Meier	ln(x)	0.05	Inter
Arsenic (mg/L)	0.0529	53	0.2046	0.08342	5.66	None	x^(1/3)	0.05	Inter
Barium (mg/L)	2.77	42	n/a	n/a	0	n/a	n/a	0.116	NP Inter(normality)
Beryllium (mg/L)	0.00212	53	n/a	n/a	18.87	n/a	n/a	0.06597	NP Inter(normality)
Cadmium (mg/L)	0.0002157	30	-10.33	0.8506	20	Kaplan-Meier	ln(x)	0.05	Inter
Chromium (mg/L)	0.003731	42	-7.265	0.7923	11.9	None	ln(x)	0.05	Inter
Cobalt (mg/L)	0.01786	53	n/a	n/a	9.434	n/a	n/a	0.06597	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	19.39	53	2.82	0.773	0	None	sqrt(x)	0.05	Inter
Fluoride (mg/L)	4.39	56	n/a	n/a	1.786	n/a	n/a	0.05656	NP Inter(normality)
Lead (mg/L)	0.008682	53	-7.11	1.154	24.53	Kaplan-Meier	ln(x)	0.05	Inter
Lithium (mg/L)	0.163	42	n/a	n/a	0	n/a	n/a	0.116	NP Inter(normality)
Mercury (mg/L)	0.00003	53	n/a	n/a	75.47	n/a	n/a	0.06597	NP Inter(NDs)
Molybdenum (mg/L)	0.01	54	n/a	n/a	31.48	n/a	n/a	0.06267	NP Inter(normality)
Selenium (mg/L)	0.00499	42	n/a	n/a	28.57	n/a	n/a	0.116	NP Inter(normality)
Thallium (mg/L)	0.00162	30	n/a	n/a	76.67	n/a	n/a	0.2146	NP Inter(NDs)

Tolerance Limit
Interwell Parametric
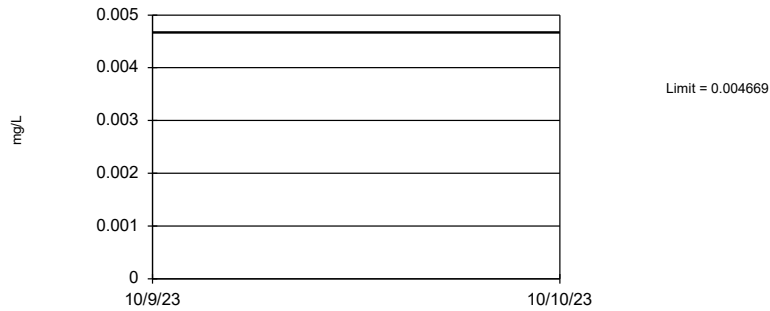
mg/L

Limit = 0.004669

95% coverage. Background Data Summary (based on natural log transformation) (after Kaplan-Meier Adjustment):
Mean=-8.028, Std. Dev.=1.303, n=54, 31.48% NDs. Normality test: Shapiro Francia @alpha = 0.01, calculated =
0.9524, critical = 0.939.   Report alpha = 0.05.

Constituent: Antimony   Analysis Run 1/10/2024 12:18 PM   View: UTLs
Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Parametric

mg/L

Limit = 0.0529

95% coverage. Background Data Summary (based on cube root transformation): Mean=0.2046, Std. Dev.=0.08342,
n=53, 5.66% NDs. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.9413, critical = 0.938.   Report
alpha = 0.05.

Constituent: Arsenic   Analysis Run 1/10/2024 12:18 PM   View: UTLs
Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Non-parametric

mg/L

Limit = 2.77
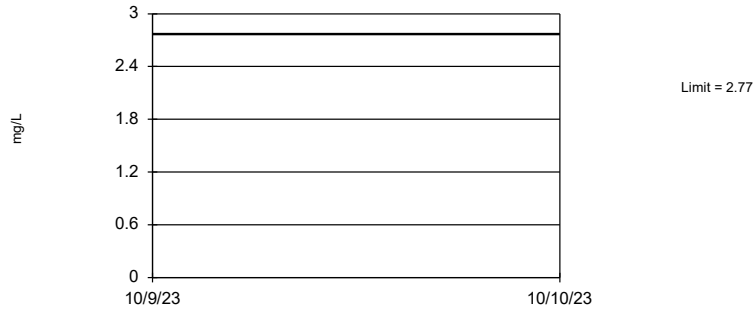
Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data
to be non-normal at the 0.01 alpha level. Limit is highest of 42 background values. 89.65% coverage at alpha=0.01;
93.16% coverage at alpha=0.05; 98.24% coverage at alpha=0.5. Report alpha = 0.116.

Constituent: Barium   Analysis Run 1/10/2024 12:18 PM   View: UTLs
Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Non-parametric

mg/L

Limit = 0.00212

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Francia normality test showed the
data to be non-normal at the 0.01 alpha level. Limit is highest of 53 background values. 18.87% NDs. 91.6%
coverage at alpha=0.01; 94.34% coverage at alpha=0.05; 98.63% coverage at alpha=0.5. Report alpha = 0.06597.

Constituent: Beryllium   Analysis Run 1/10/2024 12:18 PM   View: UTLs
Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Parametric

Limit = 0.0002157

y-axis: mg/L (0, 0.001, 0.002, 0.003, 0.004, 0.005)
x-axis: 10/9/23 — 10/10/23
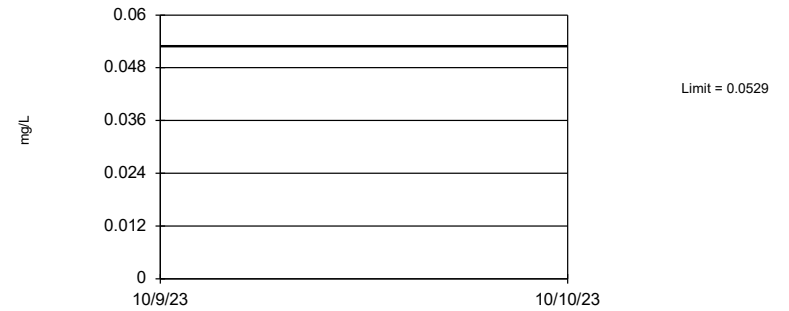
95% coverage. Background Data Summary (based on natural log transformation) (after Kaplan-Meier Adjustment): Mean=-10.33, Std. Dev.=0.8506, n=30, 20% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9423, critical = 0.9. Report alpha = 0.05.

Constituent: Cadmium   Analysis Run 1/10/2024 12:18 PM   View: UTLs
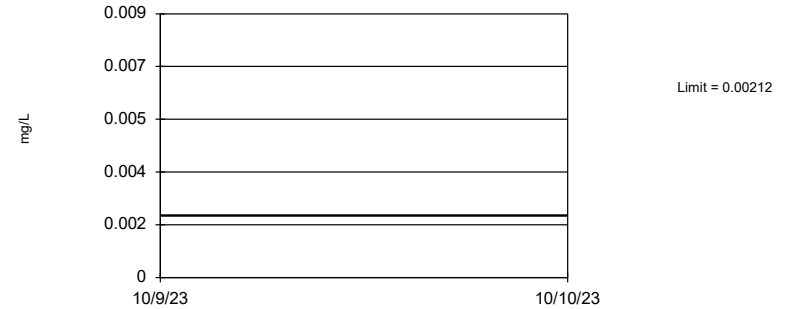Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Parametric

Limit = 0.003731

y-axis: mg/L (0, 0.001, 0.002, 0.003, 0.004)
x-axis: 10/9/23 — 10/10/23

95% coverage. Background Data Summary (based on natural log transformation): Mean=-7.265, Std. Dev.=0.7923, n=42, 11.9% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9556, critical = 0.922. Report alpha = 0.05.

Constituent: Chromium   Analysis Run 1/10/2024 12:18 PM   View: UTLs
Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Non-parametric

Limit = 0.01786

y-axis: mg/L (0, 0.004, 0.008, 0.012, 0.016, 0.02)
x-axis: 10/9/23 — 10/10/23

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 53 background values. 9.434% NDs. 91.6% coverage at alpha=0.01; 94.34% coverage at alpha=0.05; 98.63% coverage at alpha=0.5. Report alpha = 0.06597.

Constituent: Cobalt   Analysis Run 1/10/2024 12:18 PM   View: UTLs
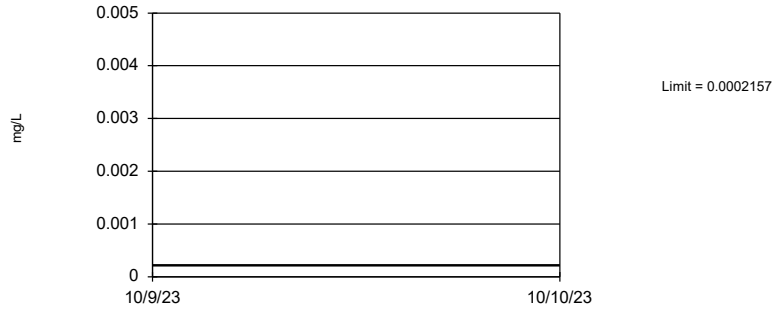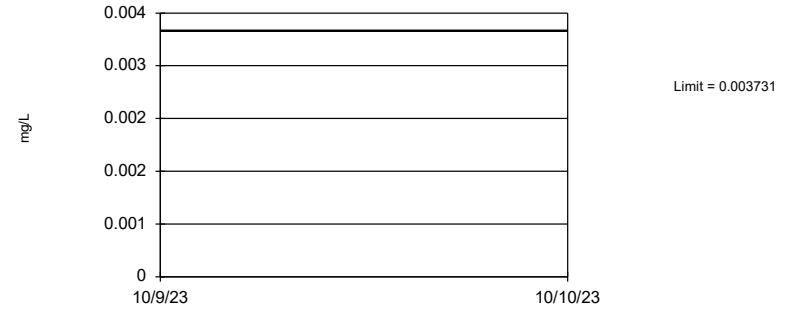Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Parametric

Limit = 19.39

y-axis: pCi/L (0, 4, 8, 12, 16, 20)
x-axis: 10/9/23 — 10/10/23

95% coverage. Background Data Summary (based on square root transformation): Mean=2.82, Std. Dev.=0.773, n=53. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.9513, critical = 0.938. Report alpha = 0.05.

Constituent: Combined Radium 226 + 228   Analysis Run 1/10/2024 12:18 PM   View: UTLs
Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Non-parametric

Limit = 4.39

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 56 background values. 1.786% NDs. 91.99% coverage at alpha=0.01; 94.73% coverage at alpha=0.05; 98.63% coverage at alpha=0.5. Report alpha = 0.05656.

Constituent: Fluoride   Analysis Run 1/10/2024 12:18 PM   View: UTLs
Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Parametric

Limit = 0.008682

95% coverage. Background Data Summary (based on natural log transformation) (after Kaplan-Meier Adjustment): Mean=-7.11, Std. Dev.=1.154, n=53, 24.53% NDs. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.9393, critical = 0.938. Report alpha = 0.05.

Constituent: Lead   Analysis Run 1/10/2024 12:18 PM   View: UTLs
Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Non-parametric

Limit = 0.163

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 42 background values. 89.65% coverage at alpha=0.01; 93.16% coverage at alpha=0.05; 98.24% coverage at alpha=0.5. Report alpha = 0.116.

Constituent: Lithium   Analysis Run 1/10/2024 12:18 PM   View: UTLs
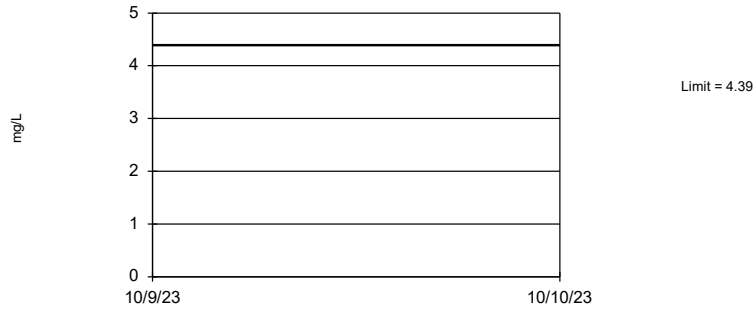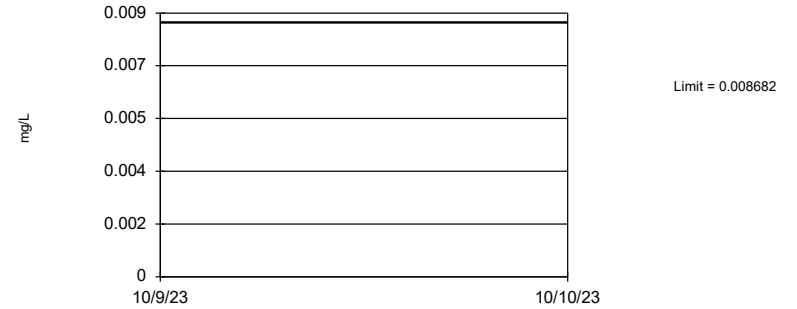Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Non-parametric

Limit = 0.00003

Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 50%. Limit is highest of 53 background values. 75.47% NDs. 91.6% coverage at alpha=0.01; 94.34% coverage at alpha=0.05; 98.63% coverage at alpha=0.5. Report alpha = 0.06597.

Constituent: Mercury   Analysis Run 1/10/2024 12:18 PM   View: UTLs
Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Non-parametric

mg/L

0.01
0.008
0.006
0.004
0.002
0

Limit = 0.01

10/9/23   10/10/23

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 54 background values. 31.48% NDs. 91.99% coverage at alpha=0.01; 94.73% coverage at alpha=0.05; 98.63% coverage at alpha=0.5. Report alpha = 0.06267.

Constituent: Molybdenum   Analysis Run 1/10/2024 12:18 PM   View: UTLs

Northeastern BAP   Data: Northeastern BAP

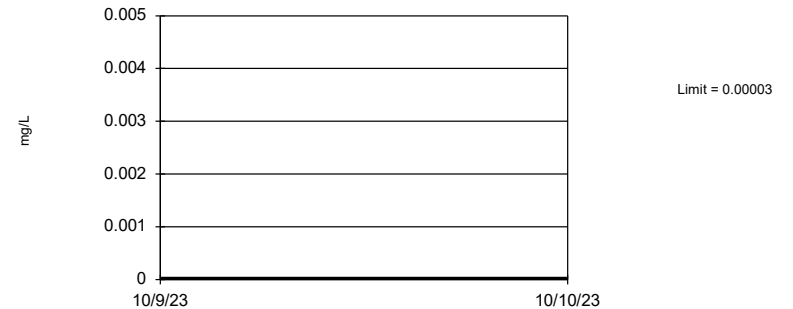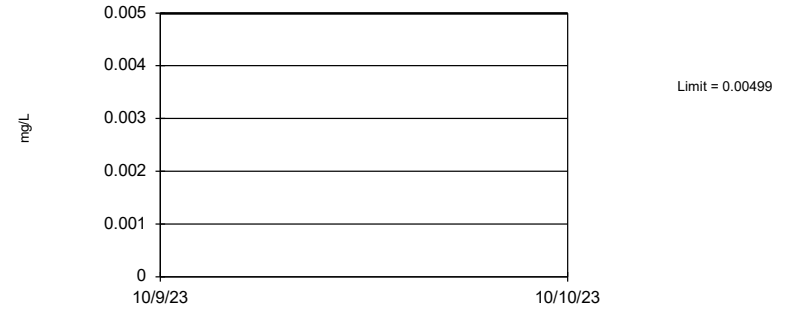## Tolerance Limit
Interwell Non-parametric

mg/L

0.005
0.004
0.003
0.002
0.001
0

Limit = 0.00499

10/9/23   10/10/23

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 42 background values. 28.57% NDs. 89.65% coverage at alpha=0.01; 93.16% coverage at alpha=0.05; 98.24% coverage at alpha=0.5. Report alpha = 0.116.

Constituent: Selenium   Analysis Run 1/10/2024 12:18 PM   View: UTLs

Northeastern BAP   Data: Northeastern BAP

Tolerance Limit
Interwell Non-parametric

mg/L

0.007
0.006
0.004
0.003
0.001
0

Limit = 0.00162

10/9/23   10/10/23

Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 50%. Limit is highest of 30 background values. 76.67% NDs. 85.74% coverage at alpha=0.01; 90.43% coverage at alpha=0.05; 97.85% coverage at alpha=0.5. Report alpha = 0.2146.

Constituent: Thallium   Analysis Run 1/10/2024 12:18 PM   View: UTLs

Northeastern BAP   Data: Northeastern BAP

FIGURE H
GWPS

NORTHEASTERN BAP GWPS				
Constituent Name	MCL	CCR- Rule Specified Level	Background Limit	GWPS
Antimony, Total (mg/L)	0.006		0.0047	0.006
Arsenic, Total (mg/L)	0.01		0.053	0.053
Barium, Total (mg/L)	2		2.77	2.77
Beryllium, Total (mg/L)	0.004		0.0021	0.004
Cadmium, Total (mg/L)	0.005		0.00022	0.005
Chromium, Total (mg/L)	0.1		0.037	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.018	0.018
Combined Radium, Total (pCi/L)	5		19.39	19.39
Fluoride, Total (mg/L)	4		4.39	4.39
Lead, Total (mg/L)	n/a	0.015	0.0087	0.015
Lithium, Total (mg/L)	n/a	0.04	0.16	0.16
Mercury, Total (mg/L)	0.002		0.00003	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.01	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.0016	0.002

*Grey cell indicates Background Limit is higher than MCL

*GWPS = Groundwater Protection Standard

*MCL = Maximum Contaminant Level

*CCR = Coal Combustion Residuals

FIGURE I

Confidence Intervals

Confidence Intervals - Significant Results

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Barium (mg/L)	SP-10	6.356	4.197	2.77	Yes	16	5.277	1.659	0	None	No	0.01	Param.
Fluoride (mg/L)	SP-10	6.84	5.59	4.39	Yes	26	5.91	2.283	11.54	None	No	0.01	NP (normality)
Lithium (mg/L)	SP-10	0.2779	0.2378	0.16	Yes	24	0.2579	0.03932	0	None	No	0.01	Param.

Confidence Intervals - All Results

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony (mg/L)	SP-1	0.00275	0.00058	0.006	No	27	0.002151	0.002126	25.93	None	No	0.01	NP (normality)
Antimony (mg/L)	SP-10	0.0005862	0.0001217	0.006	No	24	0.00149	0.00192	16.67	Kaplan-Meier	ln(x)	0.01	Param.
Antimony (mg/L)	SP-11	0.001275	0.0002399	0.006	No	24	0.00186	0.002804	12.5	None	ln(x)	0.01	Param.
Antimony (mg/L)	SP-2	0.00267	0.00117	0.006	No	27	0.002508	0.002468	7.407	None	No	0.01	NP (normality)
Arsenic (mg/L)	SP-1	0.005	0.00069	0.053	No	27	0.002287	0.002033	29.63	None	No	0.01	NP (normality)
Arsenic (mg/L)	SP-10	0.004677	0.001184	0.053	No	24	0.003704	0.00434	8.333	None	sqrt(x)	0.01	Param.
Arsenic (mg/L)	SP-11	0.004844	0.002311	0.053	No	24	0.003888	0.002871	4.167	None	sqrt(x)	0.01	Param.
Arsenic (mg/L)	SP-2	0.00251	0.00121	0.053	No	27	0.002458	0.002465	3.704	None	No	0.01	NP (normality)
Barium (mg/L)	SP-1	0.1974	0.1632	2.77	No	27	0.1816	0.03782	0	None	sqrt(x)	0.01	Param.
Barium (mg/L)	**SP-10**	**6.356**	**4.197**	**2.77**	**Yes**	**16**	**5.277**	**1.659**	**0**	**None**	**No**	**0.01**	**Param.**
Barium (mg/L)	SP-11	0.4053	0.1881	2.77	No	16	0.3092	0.1743	0	None	sqrt(x)	0.01	Param.
Barium (mg/L)	SP-2	1.329	0.9879	2.77	No	27	1.208	0.4734	0	None	ln(x)	0.01	Param.
Beryllium (mg/L)	SP-1	0.0002	0.000053	0.004	No	27	0.0002561	0.0003647	18.52	None	No	0.01	NP (normality)
Beryllium (mg/L)	SP-10	0.00008	0.00003	0.004	No	24	0.0007557	0.001143	29.17	None	No	0.01	NP (normality)
Beryllium (mg/L)	SP-11	0.00025	0.000027	0.004	No	24	0.0001486	0.0001327	29.17	None	No	0.01	NP (normality)
Beryllium (mg/L)	SP-2	0.00018	0.00007	0.004	No	27	0.0001571	0.0001535	14.81	None	No	0.01	NP (normality)
Cadmium (mg/L)	SP-1	0.0001	0.00005	0.005	No	16	0.0001183	0.0001206	12.5	None	No	0.01	NP (normality)
Cadmium (mg/L)	SP-10	0.000089	0.00001	0.005	No	16	0.00005725	0.00007341	18.75	None	No	0.01	NP (normality)
Cadmium (mg/L)	SP-11	0.00034	0.00002	0.005	No	24	0.000464	0.0009258	16.67	None	No	0.01	NP (normality)
Cadmium (mg/L)	SP-2	0.0005	0.00006	0.005	No	27	0.000248	0.0002072	37.04	None	No	0.01	NP (normality)
Chromium (mg/L)	SP-1	0.001069	0.0005249	0.1	No	27	0.0009884	0.0006701	22.22	Kaplan-Meier	sqrt(x)	0.01	Param.
Chromium (mg/L)	SP-10	0.0009388	0.0003229	0.1	No	23	0.001027	0.001791	8.696	None	ln(x)	0.01	Param.
Chromium (mg/L)	SP-11	0.00525	0.000379	0.1	No	24	0.005833	0.01052	4.167	None	No	0.01	NP (normality)
Chromium (mg/L)	SP-2	0.001364	0.0005761	0.1	No	27	0.001163	0.00108	11.11	None	x^(1/3)	0.01	Param.
Cobalt (mg/L)	SP-1	0.00116	0.0004813	0.018	No	27	0.001002	0.001103	11.11	None	x^(1/3)	0.01	Param.
Cobalt (mg/L)	SP-10	0.001849	0.0004051	0.018	No	24	0.001478	0.00178	8.333	None	sqrt(x)	0.01	Param.
Cobalt (mg/L)	SP-11	0.004362	0.001305	0.018	No	24	0.003752	0.004424	4.167	None	x^(1/3)	0.01	Param.
Cobalt (mg/L)	SP-2	0.0008877	0.0004265	0.018	No	27	0.0008354	0.0007414	11.11	None	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	SP-1	4.435	3.252	19.39	No	26	3.843	1.214	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	SP-10	16.72	7.758	19.39	No	24	12.24	8.786	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	SP-11	2.307	1.216	19.39	No	23	1.761	1.043	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	SP-2	13.79	8.953	19.39	No	24	11.72	5.264	0	None	sqrt(x)	0.01	Param.
Fluoride (mg/L)	SP-1	0.9355	0.6969	4.39	No	27	0.8162	0.2501	7.407	None	No	0.01	Param.
Fluoride (mg/L)	**SP-10**	**6.84**	**5.59**	**4.39**	**Yes**	**26**	**5.91**	**2.283**	**11.54**	**None**	**No**	**0.01**	**NP (normality)**
Fluoride (mg/L)	SP-11	3.145	2.183	4.39	No	26	2.664	0.9872	0	None	No	0.01	Param.
Fluoride (mg/L)	SP-2	3.159	2.692	4.39	No	28	2.883	0.5577	0	None	x^2	0.01	Param.
Lead (mg/L)	SP-1	0.00247	0.000254	0.015	No	27	0.001934	0.00209	29.63	None	No	0.01	NP (normality)
Lead (mg/L)	SP-10	0.0002921	0.00008559	0.015	No	16	0.0002569	0.0003088	12.5	None	ln(x)	0.01	Param.
Lead (mg/L)	SP-11	0.00144	0.0003009	0.015	No	24	0.001852	0.002644	12.5	None	ln(x)	0.01	Param.
Lead (mg/L)	SP-2	0.005	0.000245	0.015	No	27	0.002023	0.002192	33.33	None	No	0.01	NP (normality)
Lithium (mg/L)	SP-1	0.006385	0.004798	0.16	No	26	0.005591	0.001628	0	None	No	0.01	Param.
Lithium (mg/L)	**SP-10**	**0.2779**	**0.2378**	**0.16**	**Yes**	**24**	**0.2579**	**0.03932**	**0**	**None**	**No**	**0.01**	**Param.**
Lithium (mg/L)	SP-11	0.03961	0.02238	0.16	No	16	0.03099	0.01324	0	None	No	0.01	Param.
Lithium (mg/L)	SP-2	0.08005	0.05525	0.16	No	27	0.06765	0.02599	0	None	No	0.01	Param.
Mercury (mg/L)	SP-1	0.000009	0.000005	0.002	No	27	0.000006148	0.000003645	85.19	None	No	0.01	NP (NDs)
Mercury (mg/L)	SP-10	0.000013	0.000005	0.002	No	24	0.000009333	0.000007167	58.33	None	No	0.01	NP (NDs)
Mercury (mg/L)	SP-11	0.000009	0.000005	0.002	No	24	0.00001096	0.0000126	45.83	None	No	0.01	NP (normality)
Mercury (mg/L)	SP-2	0.000005	0.000005	0.002	No	27	0.000005407	0.000001738	85.19	None	No	0.01	NP (NDs)
Molybdenum (mg/L)	SP-1	0.01714	0.0117	0.1	No	27	0.01442	0.005699	0	None	No	0.01	Param.
Molybdenum (mg/L)	SP-10	0.01739	0.002637	0.1	No	23	0.01652	0.02775	4.348	None	x^(1/3)	0.01	Param.
Molybdenum (mg/L)	SP-11	0.04433	0.002	0.1	No	24	0.01864	0.02314	4.167	None	No	0.01	NP (normality)
Molybdenum (mg/L)	SP-2	0.02375	0.01788	0.1	No	16	0.02081	0.004511	0	None	No	0.01	Param.
Selenium (mg/L)	SP-1	0.006934	0.004029	0.05	No	27	0.005798	0.003409	11.11	None	sqrt(x)	0.01	Param.
Selenium (mg/L)	SP-10	0.0007629	0.0001231	0.05	No	24	0.001439	0.002133	41.67	Kaplan-Meier	ln(x)	0.01	Param.
Selenium (mg/L)	SP-11	0.0014	0.0003495	0.05	No	24	0.001675	0.002266	8.333	None	ln(x)	0.01	Param.
Selenium (mg/L)	SP-2	0.004796	0.002357	0.05	No	16	0.003707	0.002116	0	None	sqrt(x)	0.01	Param.
Thallium (mg/L)	SP-1	0.0005	0.00007	0.002	No	16	0.0003556	0.0004853	37.5	None	No	0.01	NP (normality)
Thallium (mg/L)	SP-10	0.0002	0.00004	0.002	No	16	0.00019	0.00004	93.75	None	No	0.01	NP (NDs)
Thallium (mg/L)	SP-11	0.0002	0.00003	0.002	No	16	0.0001894	0.0000425	93.75	None	No	0.01	NP (NDs)
Thallium (mg/L)	SP-2	0.0002	0.00005	0.002	No	16	0.0001381	0.00007378	56.25	None	No	0.01	NP (NDs)

Parametric and Non-Parametric (NP) Confidence Interval
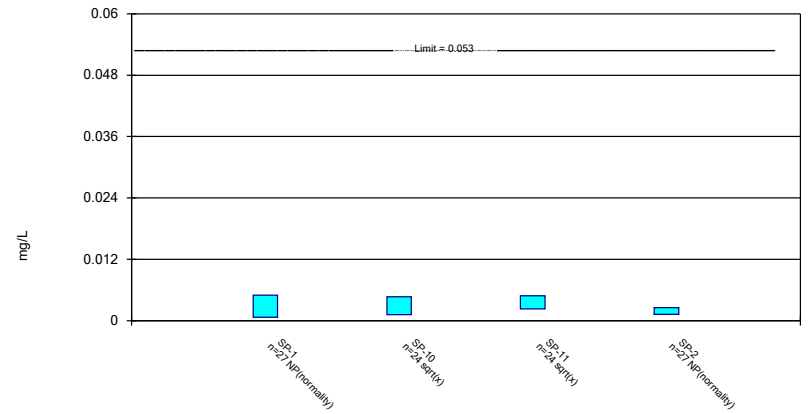
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.
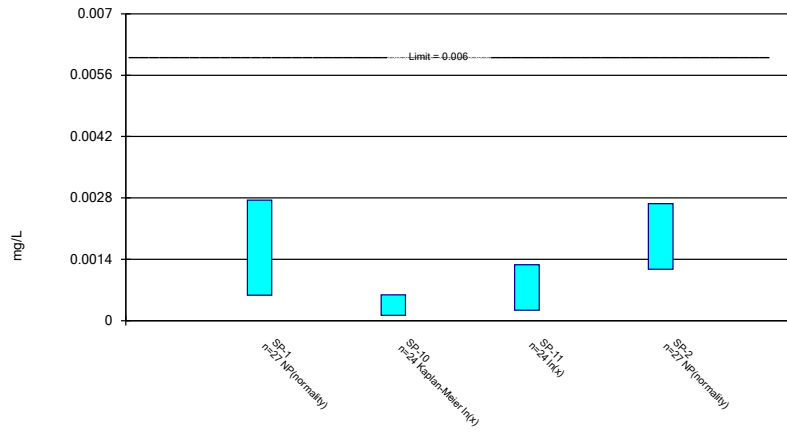
Constituent: Antimony   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

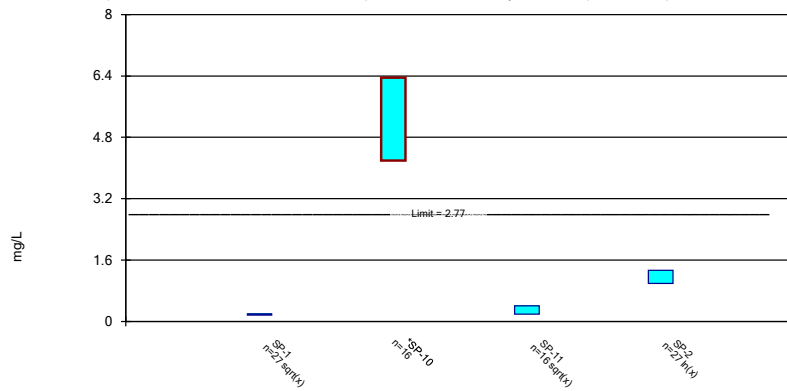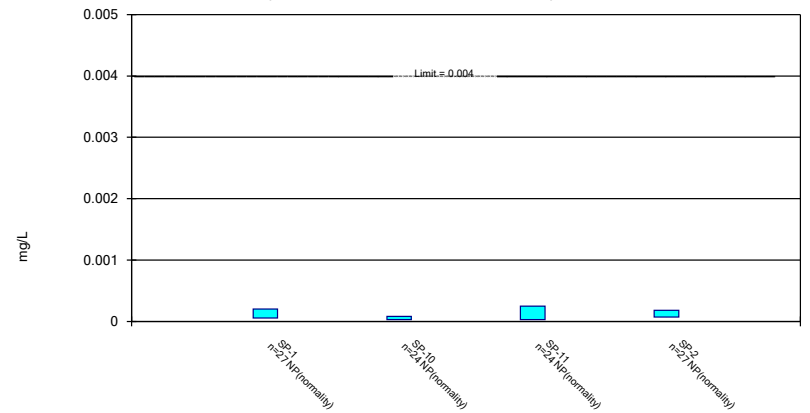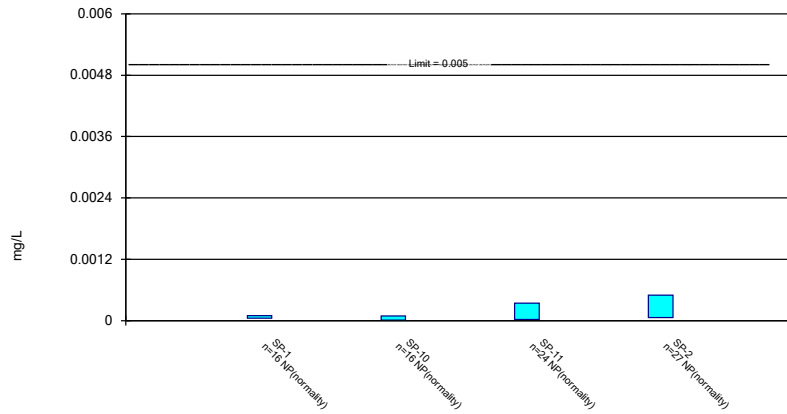## Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Arsenic   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Barium   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

Constituent: Beryllium   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP
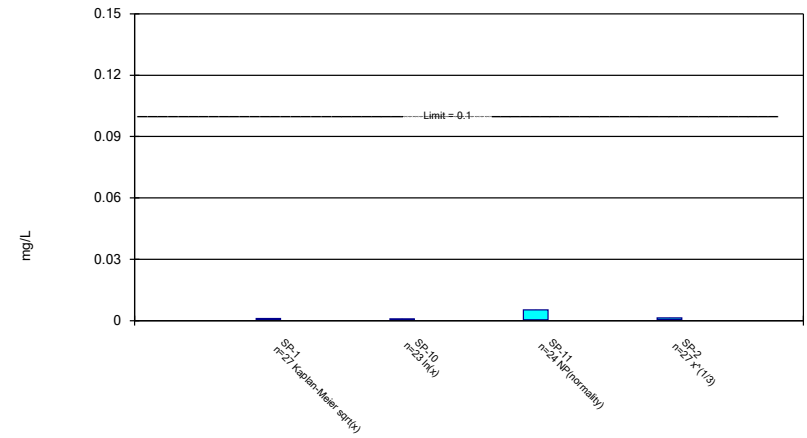
Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

Constituent: Cadmium   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

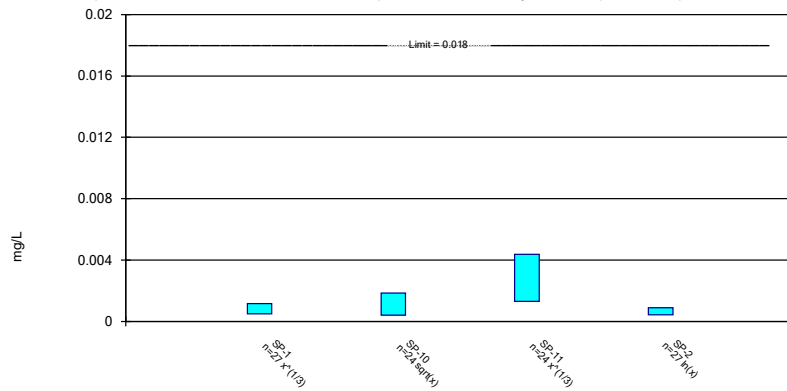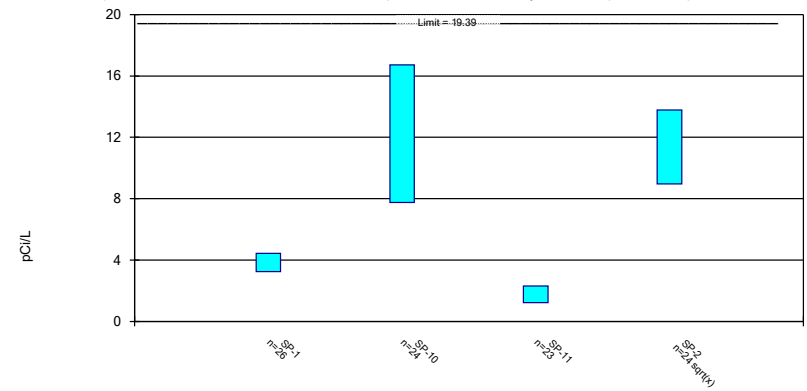## Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Chromium   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Cobalt   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP
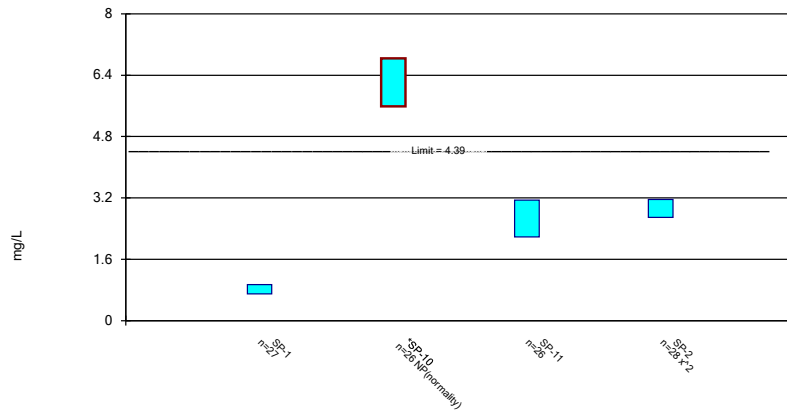
Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Combined Radium 226 + 228   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

Parametric and Non-Parametric (NP) Confidence Interval
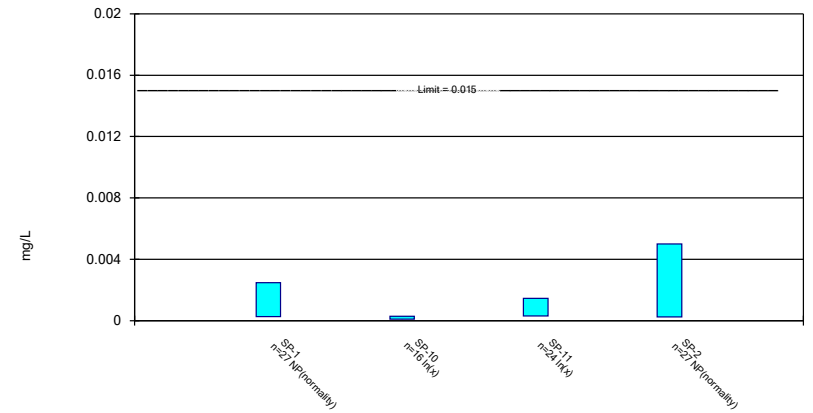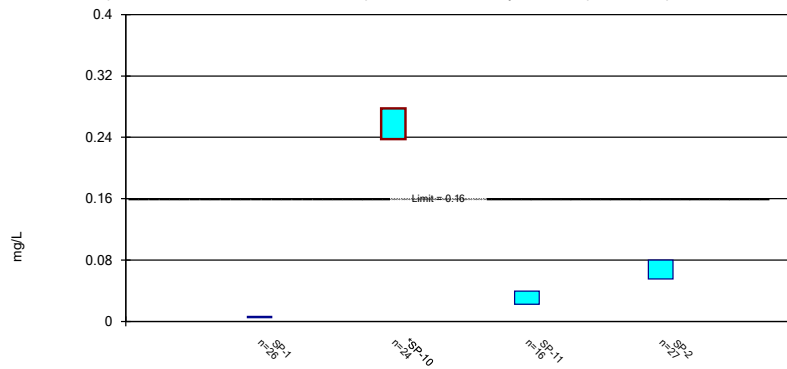
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Fluoride   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Lead   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

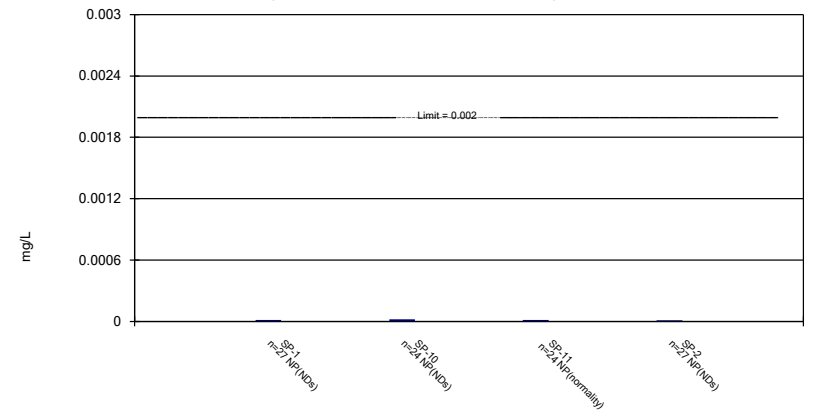## Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Lithium   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

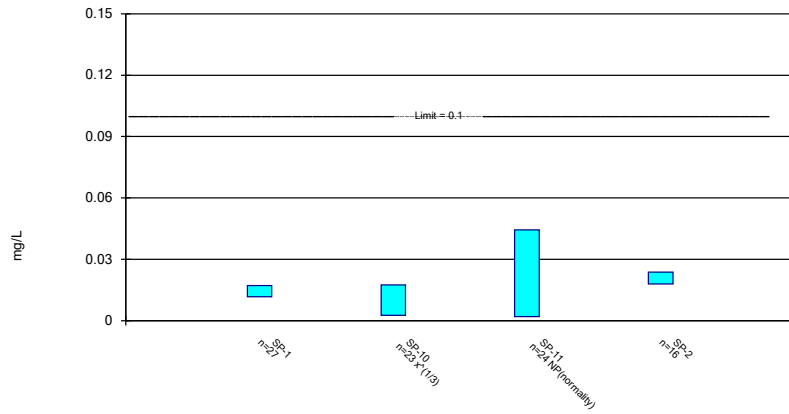## Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

Constituent: Mercury   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

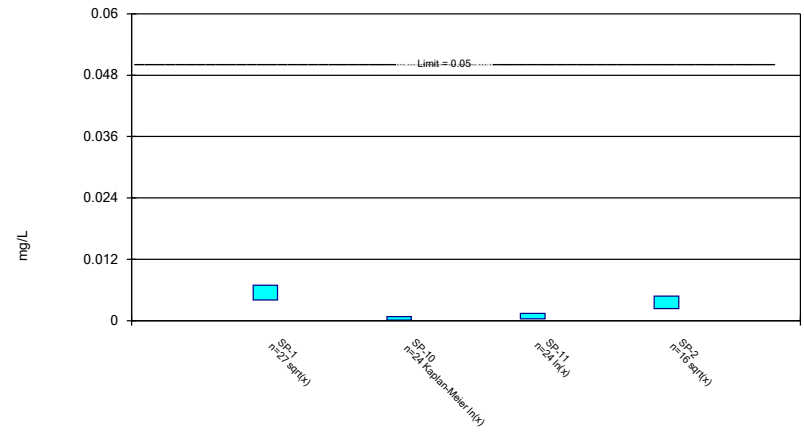## Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Molybdenum   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP
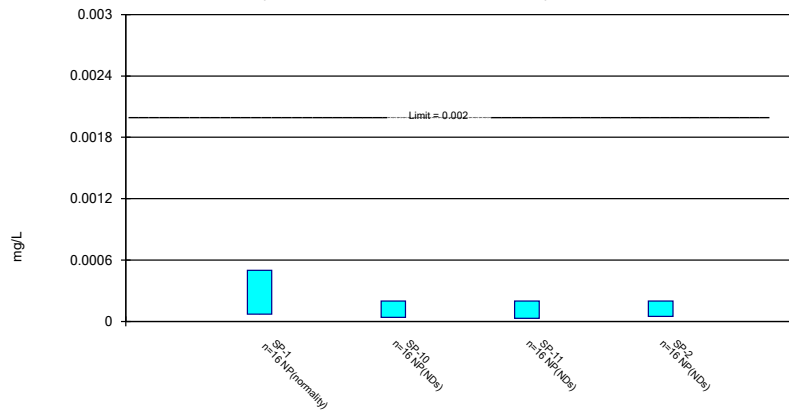
Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Selenium   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

Constituent: Thallium   Analysis Run 1/10/2024 12:16 PM   View: Confidence Intervals
Northeastern BAP   Data: Northeastern BAP

FIGURE J

Confidence Intervals – Trend Tests

Trend Tests - Confidence Interval Exceedances - Significant Results

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Alpha	Method
Barium (mg/L)	SP-10	0.5918	49	45	Yes	16	0	n/a	0.05	NP
Barium (mg/L)	SP-5R (bg)	0.08353	143	96	Yes	27	0	n/a	0.05	NP
Lithium (mg/L)	SP-10	-0.01416	-141	-81	Yes	24	0	n/a	0.05	NP
Lithium (mg/L)	SP-4 (bg)	-0.001794	-44	-41	Yes	15	0	n/a	0.05	NP
Lithium (mg/L)	SP-5R (bg)	-0.005489	-162	-96	Yes	27	0	n/a	0.05	NP

Trend Tests - Confidence Interval Exceedances - All Results

| Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Alpha	Method
Barium (mg/L)	**SP-10**	**0.5918**	**49**	**45**	**Yes**	**16**	**0**	**n/a**	**0.05**	**NP**
Barium (mg/L)	SP-4 (bg)	-0.01306	-23	-41	No	15	0	n/a	0.05	NP
Barium (mg/L)	**SP-5R (bg)**	**0.08353**	**143**	**96**	**Yes**	**27**	**0**	**n/a**	**0.05**	**NP**
Fluoride (mg/L)	SP-10	0.1218	42	90	No	26	11.54	n/a	0.05	NP
Fluoride (mg/L)	SP-4 (bg)	0.005715	10	101	No	28	3.571	n/a	0.05	NP
Fluoride (mg/L)	SP-5R (bg)	0.007758	26	101	No	28	0	n/a	0.05	NP
Lithium (mg/L)	**SP-10**	**-0.01416**	**-141**	**-81**	**Yes**	**24**	**0**	**n/a**	**0.05**	**NP**
Lithium (mg/L)	**SP-4 (bg)**	**-0.001794**	**-44**	**-41**	**Yes**	**15**	**0**	**n/a**	**0.05**	**NP**
Lithium (mg/L)	**SP-5R (bg)**	**-0.005489**	**-162**	**-96**	**Yes**	**27**	**0**	**n/a**	**0.05**	**NP**

Sen's Slope Estimator

SP-10
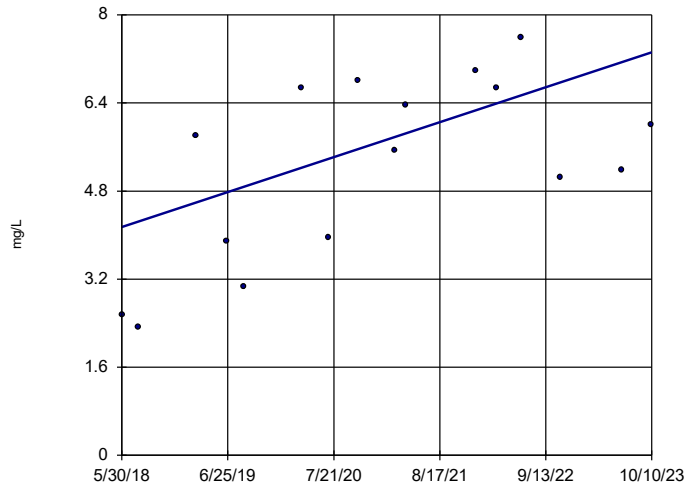
n = 16

Slope = 0.5918
units per year.

Mann-Kendall
statistic = 49
critical = 45

Increasing trend
significant at 95%
confidence level
(α = 0.025 per
tail).

mg/L

Constituent: Barium   Analysis Run 1/10/2024 12:21 PM   View: Trend Tests

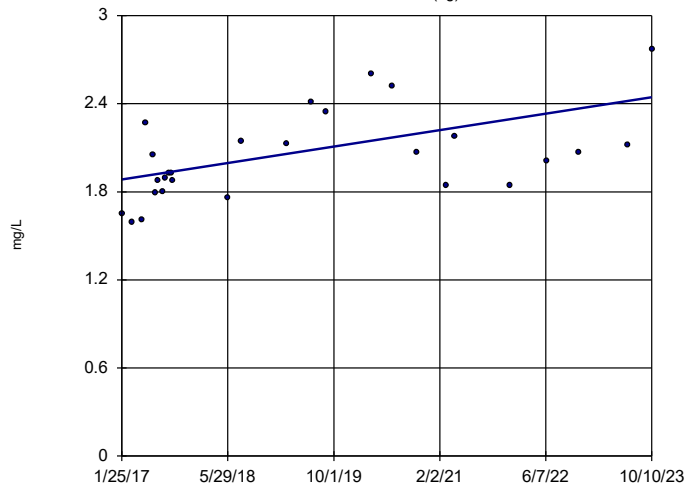Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-4 (bg)
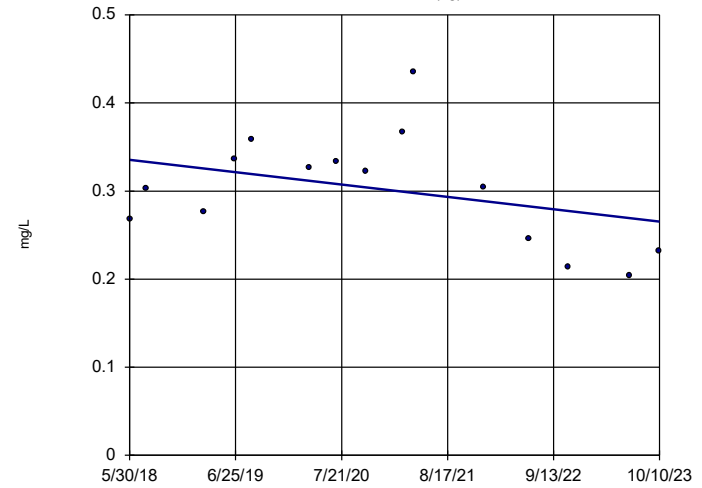
n = 15

Slope = -0.01306
units per year.

Mann-Kendall
statistic = -23
critical = -41

Trend not sig-
nificant at 95%
confidence level
(α = 0.025 per
tail).

mg/L

Constituent: Barium   Analysis Run 1/10/2024 12:21 PM   View: Trend Tests

Northeastern BAP   Data: Northeastern BAP
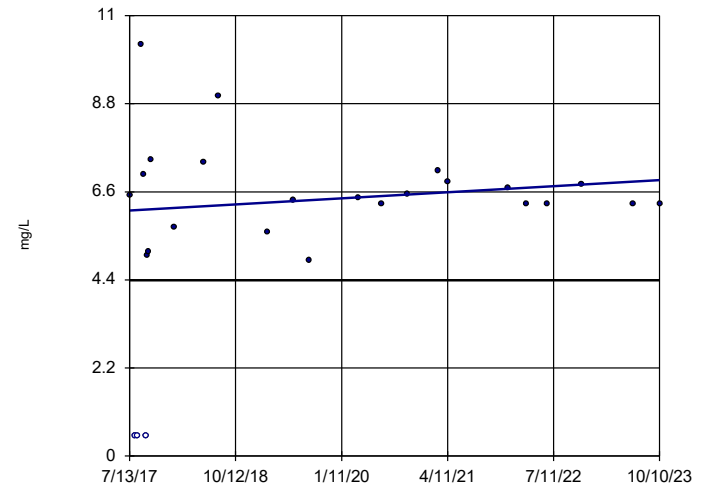
Sen's Slope Estimator

SP-5R (bg)

n = 27

Slope = 0.08353
units per year.

Mann-Kendall
statistic = 143
critical = 96

Increasing trend
significant at 95%
confidence level
(α = 0.025 per
tail).

mg/L

Constituent: Barium   Analysis Run 1/10/2024 12:21 PM   View: Trend Tests

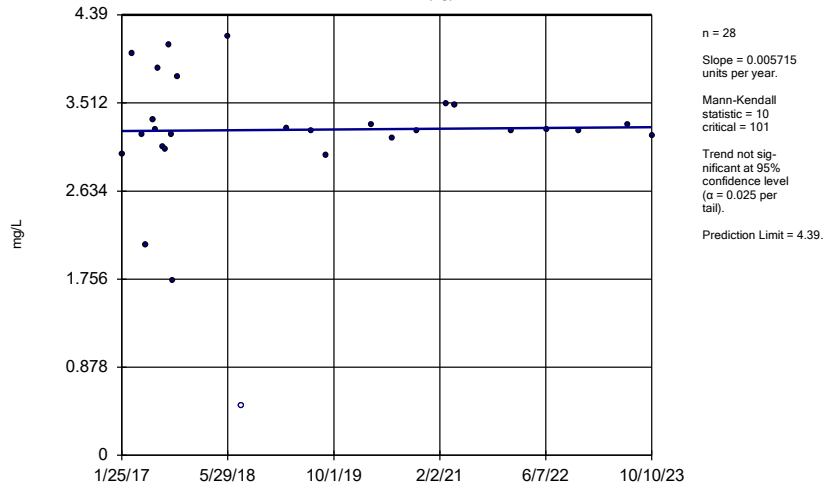Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-10

n = 26

Slope = 0.1218
units per year.

Mann-Kendall
statistic = 42
critical = 90

Trend not sig-
nificant at 95%
confidence level
(α = 0.025 per
tail).

Prediction Limit = 4.39.

mg/L

Constituent: Fluoride   Analysis Run 1/10/2024 12:21 PM   View: Trend Tests

Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-4 (bg)

n = 28

Slope = 0.005715 units per year.

Mann-Kendall statistic = 10 critical = 101

Trend not significant at 95% confidence level (α = 0.025 per tail).

Prediction Limit = 4.39.

Constituent: Fluoride   Analysis Run 1/10/2024 12:21 PM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-5R (bg)

n = 28

Slope = 0.007758 units per year.

Mann-Kendall statistic = 26 critical = 101

Trend not significant at 95% confidence level (α = 0.025 per tail).

Prediction Limit = 4.39.

Constituent: Fluoride   Analysis Run 1/10/2024 12:21 PM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP
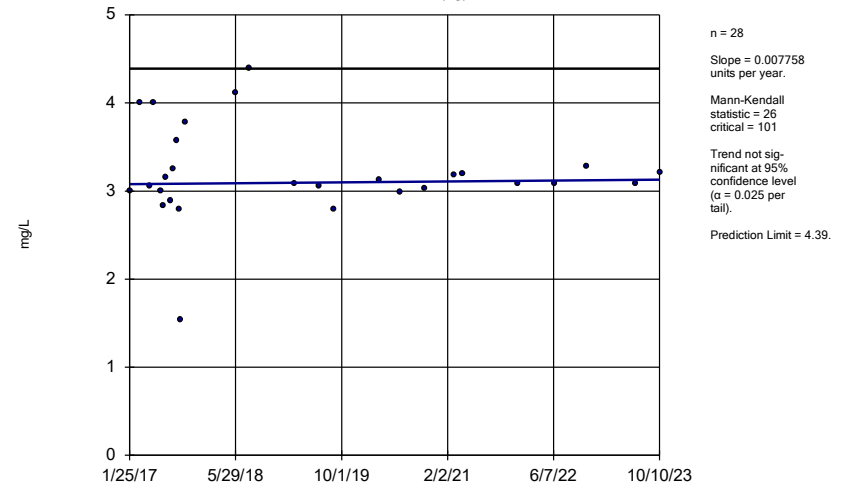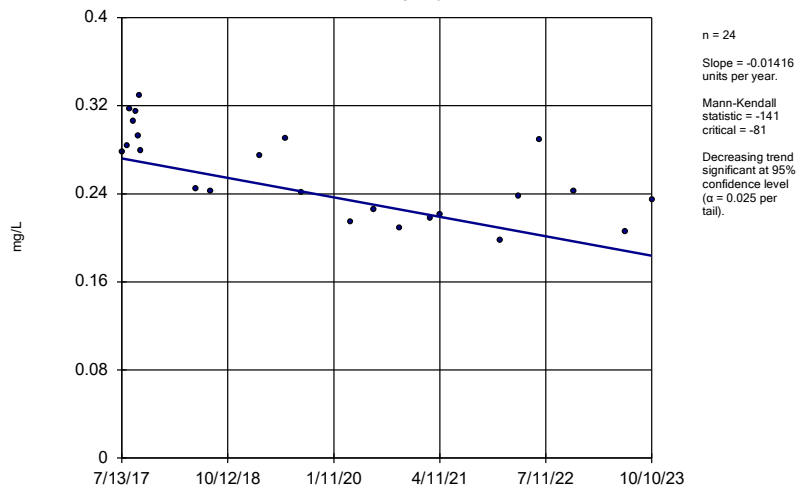
Sen's Slope Estimator

SP-10

n = 24

Slope = -0.01416 units per year.

Mann-Kendall statistic = -141 critical = -81

Decreasing trend significant at 95% confidence level (α = 0.025 per tail).
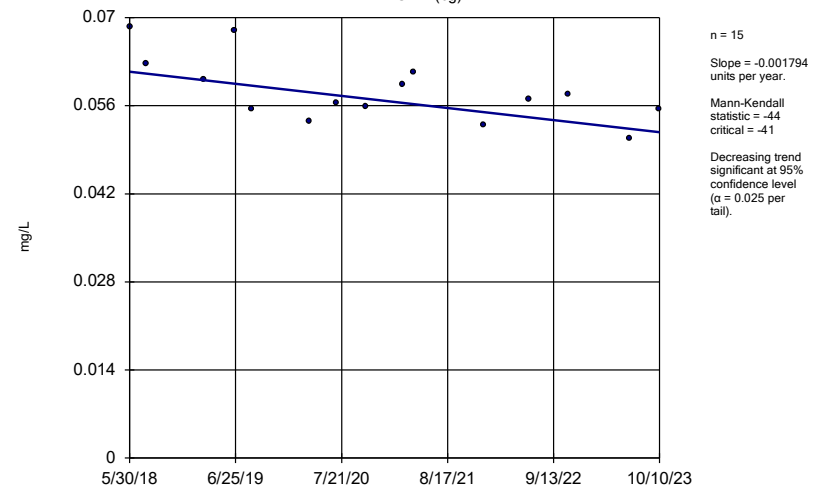
Constituent: Lithium   Analysis Run 1/10/2024 12:21 PM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-4 (bg)

n = 15

Slope = -0.001794 units per year.

Mann-Kendall statistic = -44 critical = -41

Decreasing trend significant at 95% confidence level (α = 0.025 per tail).
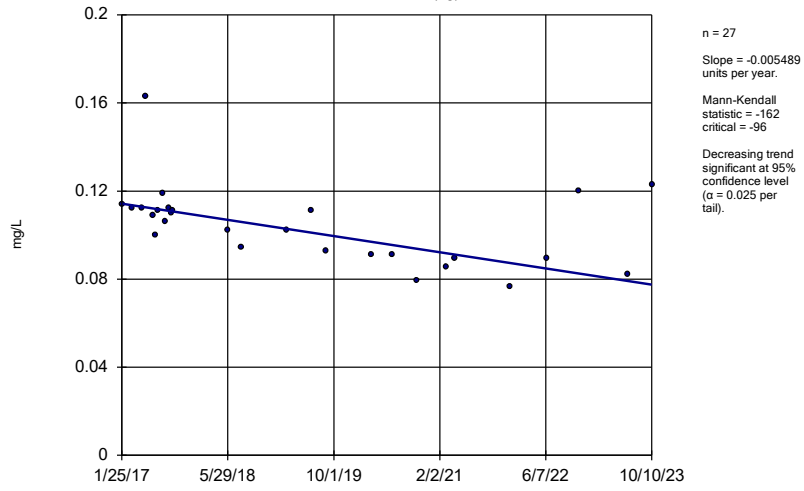
Constituent: Lithium   Analysis Run 1/10/2024 12:21 PM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP

Sen's Slope Estimator

SP-5R (bg)

n = 27

Slope = -0.005489
units per year.

Mann-Kendall
statistic = -162
critical = -96

Decreasing trend
significant at 95%
confidence level
(α = 0.025 per
tail).

Constituent: Lithium   Analysis Run 1/10/2024 12:21 PM   View: Trend Tests
Northeastern BAP   Data: Northeastern BAP