Annual Groundwater Monitoring Report

Appalachian Power Company

John E. Amos Plant

Fly Ash Pond CCR Management Unit

Winfield, West Virginia

January 2022

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Abbreviations:

ASD – Alternate Source Demonstration
CCR – Coal Combustion Residual
GWPS – Groundwater Protection Standard
SSI – Statistically Significant Increase
SSL – Statistically Significant Level
AMFAP – Amos Fly Ash Pond

I. Overview

This *Annual Groundwater Monitoring and Corrective Action Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Appalachian Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), John E. Amos Power Plant. The USEPA's CCR rules require that the initial Annual Groundwater Monitoring and Corrective Action Report for inactive surface impoundments be posted to the operating record no later than August 1, 2019 and then annually, thereafter. This Annual Groundwater Monitoring and Corrective Action Report covers all activities required by the CCR Rule for all of 2021.

In general, the following activities were completed:

- The Amos Fly Ash Pond (AMFAP) CCR unit began 2021 in detection monitoring and remained in detection monitoring throughout all of 2021.
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units.
- The Statistical Analysis Plan for AMFAP that was developed in accordance with the CCR Rule requirements initially in April 2019 was revised in January 2021 and subsequently posted to the operating record and publically available website.
- Statistically significant increases (SSI's) were observed during the November 2020 detection monitoring event. The monitoring well locations and potential SSI parameters were re-sampled in January 2021 in accordance with the statistical analysis plan. Statistical analysis for this detection monitoring event was completed in February 2021. The re-sampling event confirmed SSI's for the following:
    - MW-5: Calcium and sulfate
    - MW-6: Fluoride
    - MW-7: Fluoride
    - MW-1804A: Chloride and sulfate

  An alternative source demonstration (ASD) for the above parameters and well locations was successfully completed in May 2021.
- SSI's were observed during the May 2021 detection monitoring event. The monitoring well locations and potential SSI parameters were re-sampled in July 2021 in accordance with the statistical analysis plan. Statistical analysis for this detection monitoring event was completed in August 2021. The following were concluded to be confirmed SSI's:
    - MW-5: Sulfate
    - MW-6: Fluoride

An ASD for the above parameters and well locations was successfully completed in November 2021.

- A detection monitoring sampling event occurred in November 2021. The statistical analysis for this event is not yet complete. Upon completion of statistical analysis, if potential SSI's are identified, a resampling event will occur. If any SSI's are confirmed, an ASD will be performed. If the ASD is unsuccessful, the AMFAP will transition into the assessment monitoring program under the CCR Rule.
- In December 2021, the background levels for Appendix III parameters were recalculated using the Statistical Analysis Plan for the AMFAP. These updated upper prediction limits will be used to determine if SSI's exist for the November 2021 sampling event.
- Statistics related reports completed in 2021 are included in **Attachment 2**.
- Alternative source demonstrations completed in 2021 are included in **Attachment 3**.

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers.
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs (**Appendix 1**).
- Results of the required statistical analysis of groundwater monitoring results (**Appendix 2**).
- Discussion of any alternative source demonstrations completed, if applicable (**Appendix 3**).
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations, if applicable (Appendix 4). This is not applicable to this report.
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened, if applicable (Appendix 5). This is not applicable to this report.
- Other information required to be included in the annual report such as an alternate monitoring frequency or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

Figure 1 depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers. The groundwater monitoring network has been determined to adequately monitor upgradient, downgradient, and background areas adjacent to the Fly Ash Pond, as detailed in the *Groundwater Monitoring System Design and Construction Certification* that was placed on the AEP CCR public internet site on May 1, 2019. The groundwater quality monitoring network includes the following:

- Five upgradient or sidegradient monitoring wells: MW-1807A, MW-1807B, MW-1808A, MW-1809A, and MW-1810A.
- Ten downgradient monitoring wells: MW-1, MW-2, MW-5, MW-6, MW-7, MW-8, MW-9, MW-1801A, MW-1804A, and MW-1806A.

MW-1807B is screened in the Clarksburg shale to provide background groundwater quality in a deeper secondary groundwater-bearing zone that is hydraulically connected to the uppermost aquifer. Since this monitoring well is not located within the uppermost aquifer but in a deeper groundwater bearing zone, it is shown only on the site figure and not included in the groundwater flow direction maps.

Legend
- Upgradient Sampling Location
- Downgradient Sampling Location
- Fly Ash Pond

Notes
- Monitoring well coordinates and site features provided by AEP.

Site Layout
Fly Ash Pond

AEP Amos Generating Plant
Winfield, West Virginia

Geosyntec consultants

Columbus, Ohio | 2019/07/30

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Amos\2018\AEP-Amos_FAP_Site_Layout.mxd. ARevezzo. 7/30/2019. CHA8423.

III. Monitoring Wells Installed or Decommissioned

No monitoring wells were installed or decommissioned in 2021.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction Calculations and Discussion

Appendix 1 contains the groundwater quality data collected since initiating CCR background sampling through results received in 2021. **Appendix 1** also contains the groundwater velocity and residence time determinations for each completed sampling event, to date. Static water elevation data from each monitoring event are used to develop potentiometric maps and determine the groundwater flow direction for each respective sampling event.

V. Groundwater Quality Data Statistical Analysis

Statistical analysis of the November 2020 detection monitoring samples was completed in February 2021. The following SSI's were confirmed in the February 2021 *Evaluation of Detection Monitoring Data at Amos Plant's Fly Ash Pond* memorandum (**Appendix 2**):

- MW-5: Calcium and sulfate
- MW-6: Fluoride
- MW-7: Fluoride
- MW-1804A: Chloride and sulfate

A successful alternative source demonstration was completed for these confirmed SSI's. That demonstration is discussed in the next section of this report.

Statistical analysis of the May 2021 detection monitoring samples was completed in August 2021. The following SSI's were documented in the August 2021 *Evaluation of Detection Monitoring Data at Amos Plant's Fly Ash Pond* memorandum (**Appendix 2**):

- MW-5: Sulfate
- MW-6: Fluoride

A successful alternative source demonstration was completed for these confirmed SSI's. That demonstration is discussed in the next section of this report.

The November 2021 detection monitoring samples received do not indicate potential SSI's, however statistical analysis is ongoing and will be completed in early 2022. If potential SSI's are identified, a resampling event will occur. If any SSI's are confirmed, an ASD will be attempted. If successful, the AMFAP will remain in detection monitoring. However, if unsuccessful, the AMFAP will transition into assessment monitoring.

Additionally, the AMFAP Statistical Analysis Plan (SAP) and background levels were both updated in 2021. The revised SAP that is posted to the AEP publically available CCR website was updated in January 2021. The revised SAP is included in **Appendix 2** and includes a record of revisions. The upper prediction limits were recalculated in December 2021 with updated background levels. The AMFAP Statistical Analysis Summary – Background Update Calculations report is also included in **Appendix 2**.

VI. Alternative Source Demonstration

An alternative source demonstration (ASD) relative to the Appendix III SSI's confirmed for the November 2020 detection monitoring event was successfully completed in May 2021. The demonstration concluded that groundwater quality and the Appendix III indicator parameter SSI's identified in the statistical evaluation is attributable to an alternative source. The successful ASD is attached in **Appendix 3**.

An ASD relative to the Appendix III SSI's confirmed for the May 2021 detection monitoring event was successfully completed in November 2021. The demonstration concluded that groundwater quality and the Appendix III indicator parameters SSI's identified in the statistical evaluation is attributable to an alternative. The successful ASD is attached in **Appendix 3**.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

As of this annual groundwater report date there has been no transition between detection monitoring and assessment monitoring. Detection monitoring will continue throughout 2022 pending the results of the aforementioned statistical analysis regarding the November 2021 detection monitoring event. If the statistical analysis confirms any SSIs, an ASD will be performed if applicable. The sampling frequency of twice per year will be maintained for the Appendix III parameters upon a successful alternative source demonstration. If necessary, a transition to the assessment monitoring program will occur.

Regarding defining an alternate monitoring frequency, the groundwater velocity and monitoring well production is high enough at this facility that no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

All required information has been included in this annual groundwater monitoring report.

IX. Description of Any Problems Encountered in 2021 and Actions Taken

No significant problems were encountered. The low flow sampling effort went smoothly and the schedule was met to support the 2021 annual groundwater report preparation.

X. A Projection of Key Activities for 2022

Key activities for the upcoming year include:

- Complete the statistical evaluation of the November 2021 detection monitoring results and subsequent verification sampling, looking for any confirmed statistically significant increases.
- Perform an ASD, if necessary, for the November 2021 detection monitoring event if any SSI's are confirmed. If the ASD if necessary and is unsuccessful, the CCR unit will transition into assessment monitoring. If it is successful or no SSI's are confirmed, the CCR unit will continue detection monitoring on a semi-annual basis.
- Respond to any new data received in light of what the CCR rule requires.
- Preparation of the 2022 annual groundwater report.

APPENDIX 1

Tables follow, showing a summary of the number of samples collected per monitoring well and the groundwater monitoring data collected, the groundwater velocity, and the direction of groundwater flow. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary: MW-1
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/24/2018	Background	0.182	2.83	11.7	0.42	8.2	30.6	473
8/28/2018	Background	0.135	2.80	11.3	0.45	8.5	31.6	435
10/3/2018	Background	0.138	2.95	11.1	0.40	8.3	30.8	457
10/22/2018	Background	0.180	2.36	11.4	0.42	8.3	30.7	434
11/13/2018	Background	0.209	3.03	11.5	0.45	8.0	32.2	444
12/19/2018	Background	0.117	2.71	10.7	0.43	8.1	30.9	428
1/23/2019	Background	0.115	2.29	14.6	0.41	8.2	55.9	453
2/19/2019	Background	0.126	2.36	10.9	0.44	8.5	31.3	457
3/12/2019	Detection	0.110	2.60	11.0	0.43	8.2	31.6	458
11/8/2019	Detection	0.114	2.38	11.2	0.42	8.2	33.7	461
5/13/2020	Detection	0.122	2.74	11.2	0.42	8.2	33.6	457
11/2/2020	Detection	0.097	2.70	10.5	0.48	8.4	33.6	434
5/5/2021	Detection	0.111	2.65	11.0	0.51	8.3	32.9	448
7/21/2021	Detection	--	--	--	0.49	8.1	--	--
11/10/2021	Detection	0.109	2.31	11.0	0.48	8.2	31.5	440

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	pCi/L	mg/L	μg/L	mg/L	μg/L	μg/L	μg/L	μg/L
7/24/2018	Background	0.02 J1	7.65	52.9	< 0.004 U1	0.008 J1	0.075	0.031	1.086	0.42	0.041	0.012	< 0.002 U1	1.94	< 0.03 U1	0.03 J1
8/28/2018	Background	0.02 J1	7.90	49.5	< 0.004 U1	< 0.005 U1	0.092	0.039	0.261	0.45	0.047	0.009	< 0.002 U1	1.48	< 0.03 U1	0.01 J1
10/3/2018	Background	< 0.02 U1	7.98	51.5	< 0.02 U1	< 0.01 U1	0.1 J1	0.03 J1	1.782	0.40	0.02 J1	< 0.009 U1	< 0.002 U1	1 J1	< 0.03 U1	< 0.1 U1
10/22/2018	Background	< 0.02 U1	6.84	44.7	< 0.02 U1	< 0.01 U1	0.1 J1	0.05 J1	0.608	0.42	0.07 J1	< 0.009 U1	< 0.002 U1	1 J1	< 0.03 U1	< 0.1 U1
11/13/2018	Background	< 0.02 U1	8.04	51.9	< 0.02 U1	< 0.01 U1	0.583	0.03 J1	0.4563	0.45	0.06 J1	< 0.009 U1	< 0.002 U1	1 J1	< 0.03 U1	< 0.1 U1
12/19/2018	Background	0.03 J1	7.65	48.6	< 0.02 U1	< 0.01 U1	0.08 J1	0.03 J1	0.3156	0.43	0.02 J1	0.02 J1	< 0.002 U1	1 J1	< 0.03 U1	< 0.1 U1
1/23/2019	Background	0.06 J1	7.64	43.7	< 0.02 U1	< 0.01 U1	0.09 J1	0.03 J1	0.688	0.41	0.03 J1	< 0.009 U1	< 0.002 U1	1 J1	< 0.03 U1	< 0.1 U1
2/19/2019	Background	0.05 J1	7.83	44.7	< 0.02 U1	< 0.01 U1	0.1 J1	0.03 J1	0.00538	0.44	0.111	0.01 J1	< 0.002 U1	1 J1	0.05 J1	< 0.1 U1

Notes:
μg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-2
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/27/2018	Background	0.259	4.24	471	3.08	8.4	2.4	1,260
8/29/2018	Background	0.249	3.98	443	2.99	8.6	17.4	1,310
10/4/2018	Background	0.256	4.31	435	2.99	8.5	14.8	1,280
10/23/2018	Background	0.262	3.95	438	3.08	8.5	7.4	1,250
11/15/2018	Background	0.328	4.07	469	3.30	8.5	13.5	1,250
12/19/2018	Background	0.225	3.81	430	3.03	8.5	6.4	1,250
1/23/2019	Background	0.318	3.67	441	3.00	8.2	6.4	1,310
2/20/2019	Background	0.237	3.95	447	3.06	8.7	2.3	1,310
3/13/2019	Detection	0.230	3.98	441	3.02	8.7	1.8	1,300
11/12/2019	Detection	0.265	4.77	426	2.73	8.5	20.1	1,340
2/11/2020	Detection	--	4.31	--	--	8.3	--	--
5/12/2020	Detection	0.214	4.35	443	2.91	8.6	6 J1	1,340
11/2/2020	Detection	0.194	4.13	435	3.24	8.6	6.6	1,310
5/5/2021	Detection	0.230	4.07	480	3.24	8.4	13.1	1,310
11/11/2021	Detection	0.212	4.54	451	3.26	8.4	9.9	1,310

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-2
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/27/2018	Background	0.06	1.68	202	0.008 J1	0.02 J1	0.312	0.102	1.354	3.08	0.406	0.019	< 0.002 U1	27.2	0.04 J1	0.02 J1
8/29/2018	Background	0.02 J1	1.62	178	< 0.004 U1	< 0.005 U1	0.129	0.034	1.7	2.99	0.033	0.023	< 0.002 U1	34.5	< 0.03 U1	0.02 J1
10/4/2018	Background	< 0.02 U1	1.76	192	< 0.02 U1	< 0.01 U1	0.2 J1	0.05 J1	1.288	2.99	0.1 J1	< 0.009 U1	< 0.002 U1	30.8	< 0.03 U1	< 0.1 U1
10/23/2018	Background	< 0.02 U1	1.24	181	< 0.02 U1	< 0.01 U1	0.2 J1	0.055	0.594	3.08	0.214	0.03 J1	< 0.002 U1	26.1	< 0.03 U1	< 0.1 U1
11/15/2018	Background	< 0.02 U1	1.66	185	< 0.02 U1	< 0.01 U1	0.2 J1	0.04 J1	0.953	3.30	0.110	0.02 J1	< 0.002 U1	29.2	< 0.03 U1	< 0.1 U1
12/19/2018	Background	0.03 J1	1.33	182	< 0.02 U1	0.03 J1	0.967	0.04 J1	1.058	3.03	0.290	0.02 J1	< 0.002 U1	25.5	< 0.03 U1	< 0.1 U1
1/23/2019	Background	< 0.02 U1	1.55	178	< 0.02 U1	< 0.01 U1	0.382	0.050	0.725	3.00	0.166	0.01 J1	< 0.002 U1	29.2	0.04 J1	< 0.1 U1
2/20/2019	Background	< 0.1 U1	1.35	169	< 0.1 U1	< 0.05 U1	< 0.2 U1	< 0.1 U1	0.2747	3.06	< 0.1 U1	0.02 J1	< 0.002 U1	21.9	< 0.2 U1	< 0.5 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-5
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/24/2018	Background	0.252	6.75	793	3.32	8.1	0.2	1,890
8/29/2018	Background	0.240	6.71	780	3.33	8.2	0.2	1,880
10/3/2018	Background	0.276	7.03	776	3.33	8.1	0.1 J1	1,860
10/24/2018	Background	0.249	7.09	811	3.44	8.1	< 0.06 U1	1,840
11/13/2018	Background	0.264	6.79	832	3.63	8.0	0.1 J1	1,880
12/19/2018	Background	0.221	6.48	783	3.43	7.9	< 0.06 U1	1,890
1/23/2019	Background	0.323	5.98	782	3.36	8.1	< 0.06 U1	1,910
2/19/2019	Background	0.239	6.79	793	3.38	8.2	< 0.06 U1	1,920
3/13/2019	Detection	0.229	6.85	804	3.44	8.0	0.08 J1	1,930
11/8/2019	Detection	0.182	21.0	663	3.04	8.0	32.0	1,840
2/11/2020	Detection	--	11.3	713	--	7.8	18.6	--
5/11/2020	Detection	0.211	9.85	746	2.97	7.9	11.0	1,820
7/7/2020	Detection	--	8.77	--	--	8.1	22.8	--
10/27/2020	Detection	0.207	9.50	729	3.24	8.2	25.1	1,770
1/7/2021	Detection	--	9.31	--	--	8.1	14.6	--
5/5/2021	Detection	0.203	7.23	773	3.31	8.1	13.7	1,750
7/21/2021	Detection	--	--	--	--	8.0	45.9	--
11/11/2021	Detection	0.207	11.0	707	3.21	7.9	17.8	1,720

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-5
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/24/2018	Background	0.06	4.89	356	0.004 J1	0.006 J1	0.152	0.046	1.37	3.32	0.222	0.032	< 0.002 U1	36.5	< 0.03 U1	0.05 J1
8/29/2018	Background	0.18	5.08	359	< 0.004 U1	0.01 J1	0.278	0.085	1.805	3.33	0.284	0.030	< 0.002 U1	38.4	< 0.03 U1	0.02 J1
10/3/2018	Background	< 0.02 U1	4.86	373	< 0.02 U1	< 0.01 U1	0.626	0.053	1.63	3.33	0.03 J1	< 0.009 U1	< 0.002 U1	35.7	< 0.03 U1	< 0.1 U1
10/24/2018	Background	0.02 J1	4.34	363	< 0.02 U1	< 0.01 U1	0.219	0.516	0.731	3.44	0.06 J1	0.03 J1	< 0.002 U1	35.1	0.04 J1	< 0.1 U1
11/13/2018	Background	< 0.02 U1	4.37	353	< 0.02 U1	< 0.01 U1	0.1 J1	0.04 J1	1.824	3.63	0.03 J1	0.02 J1	< 0.002 U1	34.7	< 0.03 U1	< 0.1 U1
12/19/2018	Background	< 0.02 U1	4.39	364	< 0.02 U1	< 0.01 U1	0.07 J1	0.04 J1	1.514	3.43	< 0.02 U1	0.03 J1	< 0.002 U1	34.8	< 0.03 U1	< 0.1 U1
1/23/2019	Background	< 0.04 U1	4.35	351	< 0.04 U1	< 0.02 U1	0.532	< 0.04 U1	1.052	3.36	< 0.04 U1	0.02 J1	< 0.002 U1	35.0	< 0.06 U1	< 0.2 U1
2/19/2019	Background	< 0.06 U1	5.25	349	< 0.06 U1	< 0.03 U1	0.2 J1	< 0.06 U1	1.454	3.38	< 0.06 U1	0.034	< 0.002 U1	33.6	< 0.09 U1	< 0.3 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-6
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/24/2018	Background	0.120	61.0	19.3	0.22	6.9	44.4	392
8/28/2018	Background	0.096	59.7	19.4	0.24	6.9	44.6	398
10/3/2018	Background	0.125	60.7	18.9	0.21	6.8	43.4	402
10/24/2018	Background	0.1 J1	61.5	18.4	0.23	6.9	42.0	400
11/13/2018	Background	0.111	64.9	19.8	0.24	6.7	44.6	390
12/19/2018	Background	0.07 J1	55.8	17.7	0.23	6.7	41.7	376
1/23/2019	Background	0.08 J1	54.1	17.8	0.22	6.6	41.3	411
2/19/2019	Background	0.09 J1	55.8	17.3	0.24	7.0	40.4	406
3/12/2019	Detection	0.08 J1	57.9	17.4	0.23	6.9	39.8	390
11/8/2019	Detection	0.079	56.6	17.2	0.24	6.9	41.7	368
5/11/2020	Detection	0.088	55.8	15.9	0.25	7.0	32.6	416
10/27/2020	Detection	0.089	53.4	16.5	0.28	7.1	38.6	384
1/7/2021	Detection	--	--	--	0.30	7.1	--	--
5/6/2021	Detection	0.074	49.7	15.4	0.32	6.9	35.8	400
7/21/2021	Detection	--	--	--	0.27	6.8	--	--
11/11/2021	Detection	0.078	52.5 M1, P3	16.0	0.28	6.8	36.6	370

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.
M1: The associated matrix spike (MS) or matrix spike duplicate (MSD) recovery was outside acceptance limits.
P3: The precision on the matrix spike duplicate (MSD) was above acceptance limits.

Table 1 - Groundwater Data Summary: MW-6
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/24/2018	Background	0.01 J1	1.81	536	0.009 J1	0.01 J1	0.094	0.242	2.73	0.22	0.02 J1	0.012	< 0.002 U1	0.58	< 0.03 U1	0.03 J1
8/28/2018	Background	0.02 J1	1.82	527	0.008 J1	0.02	0.663	0.323	2.439	0.24	0.167	0.009	< 0.002 U1	0.60	< 0.03 U1	0.02 J1
10/3/2018	Background	< 0.02 U1	1.91	523	< 0.02 U1	0.01 J1	0.09 J1	0.260	4.59	0.21	< 0.02 U1	< 0.009 U1	< 0.002 U1	0.5 J1	< 0.03 U1	< 0.1 U1
10/24/2018	Background	< 0.02 U1	1.72	494	0.03 J1	< 0.01 U1	0.07 J1	0.258	2.202	0.23	0.03 J1	0.01 J1	< 0.002 U1	0.6 J1	< 0.03 U1	< 0.1 U1
11/13/2018	Background	< 0.02 U1	2.12	524	< 0.02 U1	< 0.01 U1	0.08 J1	0.233	2.325	0.24	0.03 J1	< 0.009 U1	< 0.002 U1	0.7 J1	< 0.03 U1	< 0.1 U1
12/19/2018	Background	< 0.02 U1	1.88	510	< 0.02 U1	0.01 J1	0.06 J1	0.234	2.53	0.23	0.02 J1	0.01 J1	< 0.002 U1	0.7 J1	< 0.03 U1	< 0.1 U1
1/23/2019	Background	0.04 J1	1.89	486	< 0.02 U1	< 0.01 U1	0.04 J1	0.220	1.82	0.22	< 0.02 U1	< 0.009 U1	< 0.002 U1	0.6 J1	< 0.03 U1	< 0.1 U1
2/19/2019	Background	< 0.02 U1	1.53	482	< 0.02 U1	< 0.01 U1	0.277	0.219	2.136	0.24	< 0.02 U1	0.02 J1	< 0.002 U1	0.6 J1	0.04 J1	< 0.1 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-7
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/26/2018	Background	0.087	1.33	5.41	0.27	8.5	32.0	368
8/29/2018	Background	0.112	1.29	5.32	0.27	8.8	31.5	387
10/3/2018	Background	0.156	1.44	5.23	0.26	8.8	31.8	376
10/24/2018	Background	0.09 J1	1.40	5.37	0.27	8.8	31.7	344
11/13/2018	Background	0.192	1.49	5.65	0.29	8.4	33.2	379
12/17/2018	Background	0.1 J1	1.24	5.29	0.27	8.6	32.0	387
1/23/2019	Background	0.127	1.41	5.18	0.25	8.4	32.0	389
2/18/2019	Background	0.06 J1	1.37	5.39	0.26	9.0	32.1	401
3/12/2019	Detection	0.06 J1	1.47	5.49	0.27	8.9	32.5	385
11/11/2019	Detection	0.066	2.18	5.36	0.25	8.7	32.3	390
2/11/2020	Detection	--	1.39	--	--	8.5	--	--
5/11/2020	Detection	0.067	1.59	5.30	0.27	8.4	23.6	395
10/28/2020	Detection	0.065	1.81	5.34	0.31	8.9	31.2	387
1/6/2021	Detection	--	1.53	--	0.31	9.0	--	--
5/12/2021	Detection	0.055	1.46	5.45	0.30	8.8	31.1	401
11/10/2021	Detection	0.058	1.57	5.50	0.27	8.6	29.9	390

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-7
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	pCi/L	mg/L	μg/L	mg/L	μg/L	μg/L	μg/L	μg/L
7/26/2018	Background	0.04 J1	5.31	34.0	< 0.004 U1	0.01 J1	0.082	0.038	1.958	0.27	0.211	0.009	< 0.002 U1	1.12	< 0.03 U1	0.01 J1
8/29/2018	Background	0.05 J1	5.51	32.3	< 0.004 U1	0.01 J1	0.190	0.023	0.745	0.27	0.121	0.010	< 0.002 U1	1.06	< 0.03 U1	0.02 J1
10/3/2018	Background	0.07 J1	5.65	33.9	< 0.02 U1	< 0.01 U1	0.07 J1	< 0.02 U1	2.391	0.26	0.111	< 0.009 U1	< 0.002 U1	1 J1	0.03 J1	< 0.1 U1
10/24/2018	Background	0.18	5.13	37.0	< 0.02 U1	0.02 J1	0.296	0.134	0.1126	0.27	0.476	< 0.009 U1	< 0.002 U1	1 J1	0.05 J1	< 0.1 U1
11/13/2018	Background	0.12	5.24	32.7	< 0.02 U1	< 0.01 U1	0.1 J1	0.03 J1	0.9538	0.29	0.146	< 0.009 U1	< 0.002 U1	1 J1	< 0.03 U1	< 0.1 U1
12/17/2018	Background	0.06 J1	5.21	33.5	< 0.02 U1	< 0.01 U1	0.1 J1	< 0.02 U1	1.236	0.27	0.1 J1	< 0.009 U1	< 0.002 U1	1 J1	0.04 J1	< 0.1 U1
1/23/2019	Background	0.44	5.86	36.8	< 0.02 U1	0.02 J1	0.221	0.068	0.558	0.25	0.420	< 0.009 U1	< 0.002 U1	1 J1	0.05 J1	< 0.1 U1
2/18/2019	Background	0.27	5.33	34.3	0.03 J1	0.02 J1	0.1 J1	0.057	0.543	0.26	0.230	0.01 J1	< 0.002 U1	1 J1	< 0.03 U1	< 0.1 U1

Notes:
μg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-8
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/26/2018	Background	0.233	2.15	--	--	--	--	--
8/2/2018	Background	--	--	105	2.70	8.2	21.6	690
8/30/2018	Background	0.225	1.99	109	2.66	8.9	24.2	727
10/3/2018	Background	0.259	2.74	108	2.58	7.9	31.6	729
10/23/2018	Background	0.278	2.32	108	2.74	8.5	26.3	717
11/13/2018	Background	0.254	2.46	116	2.93	8.2	27.2	711
12/19/2018	Background	0.224	2.28	110	2.78	8.5	26.4	696
1/23/2019	Background	0.213	2.39	111	2.62	8.1	30.1	739
2/20/2019	Background	0.195	2.49	111	2.87	9.2	26.4	740
3/12/2019	Detection	0.192	2.32	110	2.87	8.5	27.4	716
11/8/2019	Detection	0.197	1.98	109	2.97	8.3	22.5	717
5/12/2020	Detection	0.191	1.83	108	2.73	7.3	19.9	720
10/26/2020	Detection	0.215	8.47	508	3.07	8.4	37.4	1,400
1/7/2021	Detection	--	2.46	107	--	8.2	18.3	729
5/7/2021	Detection	0.180	2.19	109	2.99	8.5	20.2	711
11/10/2021	Detection	0.191	2.28	107	2.97	8.6	15.8	700

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-8
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/26/2018	Background	0.04 J1	3.02	63.7	0.005 J1	< 0.005 U1	0.114	0.210	1.5625	--	0.237	0.013	< 0.002 U1	11.7	0.05 J1	0.02 J1
8/2/2018	Background	--	--	--	--	--	--	--	--	2.70	--	--	--	--	--	--
8/30/2018	Background	0.85	5.71	58.2	0.049	0.05	1.89	1.69	0.655	2.66	2.78	0.012	0.004 J1	20.6	0.2	0.076
10/3/2018	Background	0.20	5.18	86.2	< 0.02 U1	0.02 J1	0.2 J1	0.270	3.981	2.58	0.427	< 0.009 U1	< 0.002 U1	8.76	0.08 J1	< 0.1 U1
10/23/2018	Background	0.15	4.26	70.9	< 0.02 U1	< 0.01 U1	0.229	0.284	0.294	2.74	0.491	0.02 J1	< 0.002 U1	10.2	0.08 J1	< 0.1 U1
11/13/2018	Background	0.14	3.49	71.5	< 0.02 U1	< 0.01 U1	0.2 J1	0.253	0.691	2.93	0.352	< 0.009 U1	< 0.002 U1	7.64	0.08 J1	< 0.1 U1
12/19/2018	Background	0.26	2.91	73.3	< 0.02 U1	< 0.01 U1	0.264	0.231	0.956	2.78	0.357	0.02 J1	< 0.002 U1	6.93	0.1 J1	< 0.1 U1
1/23/2019	Background	0.27	3.49	76.8	< 0.02 U1	< 0.01 U1	0.463	0.513	0.3857	2.62	0.990	< 0.009 U1	< 0.002 U1	11.0	0.09 J1	< 0.1 U1
2/20/2019	Background	0.4 J1	2.41	71.9	< 0.1 U1	< 0.05 U1	0.4 J1	0.538	0.736	2.87	0.770	0.009 J1	< 0.002 U1	8 J1	0.4 J1	< 0.5 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-9
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/26/2018	Background	0.157	1.03	--	--	--	--	--
8/2/2018	Background	--	--	7.22	0.87	8.3	12.9	421
8/30/2018	Background	0.128	1.04	7.21	0.86	8.0	12.2	468
10/2/2018	Background	0.145	1.44	7.60	0.83	7.1	12.6	513
10/23/2018	Background	0.141	1.07	7.26	0.87	9.3	12.8	460
11/13/2018	Background	0.166	1.24	7.29	0.91	9.1	11.9	449
12/19/2018	Background	--	--	--	--	9.2	--	--
12/20/2018	Background	0.114	1.03	7.11	0.84	--	15.7	435
1/22/2019	Background	--	--	--	--	9.7	--	--
1/23/2019	Background	0.134	1.01	7.45	0.77	--	20.1	484
2/19/2019	Background	--	--	--	--	9.2	--	--
2/20/2019	Background	0.128	1.26	7.70	0.84	--	28.5	505
3/12/2019	Detection	0.122	1.18	7.50	0.91	9.0	24.0	463
11/8/2019	Detection	0.133	1.02	7.72	0.83	8.8	19.1	440
5/13/2020	Detection	0.122	0.959	7.27	0.82	9.0	12.0	459
10/28/2020	Detection	--	--	--	--	7.1	--	--
10/29/2020	Detection	0.128	1.44	6.93	0.90	--	11.1	459
5/5/2021	Detection	--	--	--	--	9.0	--	--
5/6/2021	Detection	0.109	1.01	7.08	0.92	--	14.4	448
11/11/2021	Detection	0.122	1.11	7.26	0.91	8.8	14.5	450

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.
Due to limited groundwater volume, pH values for some sampling events were collected the day prior to collection of analytical samples.

Table 1 - Groundwater Data Summary: MW-9
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/26/2018	Background	0.21	5.23	46.8	0.004 J1	0.01 J1	0.218	1.00	0.912	--	1.12	0.010	< 0.002 U1	7.31	0.06 J1	0.060
8/2/2018	Background	--	--	--	--	--	--	--	--	0.87	--	--	--	--	--	--
8/30/2018	Background	0.91	5.87	46.8	0.02 J1	0.35	1.17	2.15	1.162	0.86	5.23	0.010	0.012	6.28	0.2	0.209
10/2/2018	Background	0.59	7.04	66.0	0.192	0.07	4.52	3.70	0.543	0.83	8.66	0.009 J1	0.016	6.07	0.9	0.4 J1
10/23/2018	Background	1.28	4.58	45.4	0.08 J1	0.02 J1	1.90	1.39	0.658	0.87	2.68	0.01 J1	0.008	5.93	0.4	0.3 J1
11/13/2018	Background	0.35	5.83	51.1	0.115	0.02 J1	2.54	1.92	0.635	0.91	3.44	< 0.009 U1	0.004 J1	6.06	0.6	0.2 J1
12/20/2018	Background	0.33	4.47	35.8	< 0.02 U1	0.10	0.725	0.393	0.847	0.84	1.03	< 0.009 U1	0.010	6.51	0.4	0.1 J1
1/23/2019	Background	1.08	5.84	44.6	0.09 J1	0.03 J1	2.46	1.43	1.464	0.77	2.45	< 0.009 U1	0.009	6.49	0.5	0.2 J1
2/20/2019	Background	0.4 J1	5.45	41.5	< 0.1 U1	< 0.05 U1	0.7 J1	0.349	0.2514	0.84	0.955	0.01 J1	0.006	6 J1	0.3 J1	< 0.5 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1801A
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/24/2018	Background	0.274	62.5	9.64	0.1 J1	7.6	49.4	372
8/29/2018	Background	0.288	64.0	10.8	0.11	7.4	54.8	420
10/2/2018	Background	0.137	61.0	7.48	0.1 J1	7.4	46.7	356
10/24/2018	Background	0.105	63.1	8.14	0.1 J1	7.5	41.8	357
11/14/2018	Background	0.236	65.4	9.86	0.1 J1	7.3	49.3	386
12/19/2018	Background	0.289	62.8	9.08	0.12	7.3	45.5	361
1/24/2019	Background	0.168	53.4	9.18	0.14	6.3	46.3	365
2/20/2019	Background	0.09 J1	53.3	8.96	0.13	8.0	40.0	343
3/12/2019	Detection	0.09 J1	51.2	9.40	0.16	7.5	41.7	306
11/11/2019	Detection	0.229	61.6	9.76	0.12	7.4	45.3	385
5/13/2020	Detection	0.105	52.6	9.93	0.13	7.6	34.6	353
11/4/2020	Detection	0.244	62.4	8.84	0.12	7.3	41.5	385
5/6/2021	Detection	0.090	56.4	6.75	0.12	7.1	30.5	304
11/8/2021	Detection	0.162	58.1	8.81	0.15	7.3	36.8	360

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1801A
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/24/2018	Background	0.13	0.36	54.4	< 0.004 U1	0.01 J1	0.113	0.194	0.602	0.1 J1	0.042	0.009	< 0.002 U1	4.97	0.09 J1	0.04 J1
8/29/2018	Background	0.05 J1	0.57	56.5	< 0.004 U1	< 0.005 U1	0.143	0.260	1.222	0.11	0.024	0.007	< 0.002 U1	3.07	0.05 J1	0.04 J1
10/2/2018	Background	0.14	0.82	47.1	< 0.02 U1	< 0.01 U1	0.09 J1	0.422	0.254	0.1 J1	0.04 J1	0.02 J1	< 0.002 U1	4.79	0.1 J1	< 0.1 U1
10/24/2018	Background	0.06 J1	0.72	51.3	< 0.02 U1	< 0.01 U1	0.08 J1	0.380	0.654	0.1 J1	0.02 J1	0.009 J1	< 0.002 U1	2.08	0.2 J1	< 0.1 U1
11/14/2018	Background	0.08 J1	1.01	51.3	< 0.02 U1	0.03 J1	0.08 J1	0.414	0.6902	0.1 J1	0.05 J1	< 0.009 U1	< 0.002 U1	2.34	0.1 J1	< 0.1 U1
12/19/2018	Background	0.04 J1	1.11	56.0	< 0.02 U1	0.02 J1	0.1 J1	0.349	0.836	0.12	0.03 J1	0.01 J1	< 0.002 U1	2.77	0.09 J1	< 0.1 U1
1/24/2019	Background	0.06 J1	1.57	55.3	< 0.02 U1	< 0.01 U1	0.07 J1	0.326	0.595	0.14	< 0.02 U1	< 0.009 U1	< 0.002 U1	2.22	0.1 J1	< 0.1 U1
2/20/2019	Background	0.09 J1	1.52	56.6	< 0.02 U1	< 0.01 U1	0.1 J1	0.290	0.588	0.13	< 0.02 U1	< 0.009 U1	< 0.002 U1	3.57	0.2 J1	< 0.1 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1804A
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/27/2018	Background	0.672	28.1	--	--	--	--	--
8/1/2018	Background	--	--	3.87	0.70	7.4	35.2	423
8/28/2018	Background	0.779	15.9	5.27	0.84	8.3	44.7	452
10/2/2018	Background	0.629	38.8	3.63	0.61	7.9	35.7	458
10/23/2018	Background	0.675	12.9	4.79	0.78	7.6	36.9	452
11/13/2018	Background	0.846	8.90	5.32	0.91	7.8	46.0	498
12/19/2018	Background	0.772	10.1	4.51	0.78	7.9	40.1	433
1/24/2019	Background	0.673	12.1	3.14	0.71	7.4	32.3	414
2/20/2019	Background	0.611	7.43	3.29	0.89	8.0	33.8	461
3/12/2019	Detection	0.568	10.2	3.55	0.85	7.9	34.0	411
11/11/2019	Detection	0.730	6.77	11.2	0.64	8.0	85.4	582
2/12/2020	Detection	--	--	9.59	--	7.8	69.0	--
5/14/2020	Detection	0.739	4.51	6.20	0.85	8.1	51.4	484
11/2/2020	Detection	0.549	4.70	7.12	0.86	8.0	57.0	517
1/6/2021	Detection	--	--	9.72	--	8.2	69.3	--
5/6/2021	Detection	0.565	3.98	10.6	0.97	8.1	57.3	533
7/20/2021	Detection	--	--	6.22	--	7.8	47.3	--
11/8/2021	Detection	0.628	5.35	9.80	0.84	8.0	61.1	550

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1804A
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/27/2018	Background	0.54	2.48	245	0.008 J1	< 0.005 U1	0.185	0.458	1.814	--	0.445	0.018	< 0.002 U1	136	1.8	0.069
8/1/2018	Background	--	--	--	--	--	--	--	--	0.70	--	--	--	--	--	--
8/28/2018	Background	0.15	3.59	204	< 0.004 U1	< 0.005 U1	0.304	0.314	1.559	0.84	0.031	0.015	< 0.002 U1	136	0.2	0.05 J1
10/2/2018	Background	0.53	2.35	390	< 0.02 U1	< 0.01 U1	0.1 J1	0.693	1.664	0.61	0.05 J1	0.032	< 0.002 U1	111	3.1	< 0.1 U1
10/23/2018	Background	0.18	3.36	131	< 0.02 U1	< 0.01 U1	0.1 J1	0.137	0.444	0.78	0.114	0.01 J1	< 0.002 U1	116	0.7	< 0.1 U1
11/13/2018	Background	0.09 J1	4.16	135	< 0.02 U1	< 0.01 U1	0.2 J1	0.160	0.523	0.91	0.133	0.02 J1	< 0.002 U1	129	0.2	< 0.1 U1
12/19/2018	Background	0.13	4.00	169	< 0.02 U1	< 0.01 U1	0.1 J1	0.176	1.089	0.78	0.111	0.01 J1	< 0.002 U1	130	0.5	< 0.1 U1
1/24/2019	Background	0.30	3.32	183	< 0.02 U1	< 0.01 U1	0.2 J1	0.137	1.424	0.71	0.140	< 0.009 U1	< 0.002 U1	110	1.7	< 0.1 U1
2/20/2019	Background	0.19	4.48	116	< 0.02 U1	< 0.01 U1	0.2 J1	0.096	0.894	0.89	0.219	< 0.009 U1	< 0.002 U1	115	0.6	< 0.1 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1806A
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/27/2018	Background	0.164	12.9	--	--	--	--	--
8/1/2018	Background	--	--	17.7	0.56	7.6	48.4	426
8/29/2018	Background	0.162	12.0	16.2	0.55	8.0	45.6	445
10/2/2018	Background	0.150	5.81	7.21	0.80	8.5	36.2	435
10/23/2018	Background	0.158	7.43	8.62	0.77	8.4	40.8	423
11/13/2018	Background	0.213	7.51	8.15	0.85	8.1	40.1	442
12/19/2018	Background	0.162	5.14	5.29	0.85	8.5	30.9	409
1/24/2019	Background	0.168	12.2	11.7	0.59	8.1	48.1	445
2/18/2019	Background	0.133	5.67	6.24	0.81	8.6	33.0	460
3/12/2019	Detection	0.130	4.98	5.51	0.83	8.8	32.9	430
11/12/2019	Detection	0.156	13.5	11.1	0.48	7.9	42.8	423
5/15/2020	Detection	0.127	2.32	8.45	0.86	8.8	35.2	456
10/29/2020	Detection	0.153	7.38	10.2	0.85	8.7	49.7	480
5/6/2021	Detection	0.123	2.01	8.82	0.95	9.0	33.8	449
11/10/2021	Detection	0.127	2.31	10.5	0.91	8.9	34.5	450

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1806A
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/27/2018	Background	1.16	2.65	163	0.01 J1	0.01 J1	0.416	0.240	0.998	--	0.368	0.012	< 0.002 U1	17.0	0.1	0.03 J1
8/1/2018	Background	--	--	--	--	--	--	--	--	0.56	--	--	--	--	--	--
8/29/2018	Background	0.89	3.29	148	< 0.004 U1	0.008 J1	1.54	0.161	1.533	0.55	0.154	0.010	< 0.002 U1	14.2	0.09 J1	0.02 J1
10/2/2018	Background	0.28	5.30	65.4	< 0.02 U1	< 0.01 U1	0.1 J1	0.080	0.9	0.80	0.158	0.02 J1	< 0.002 U1	7.73	0.07 J1	< 0.1 U1
10/23/2018	Background	0.19	5.16	88.3	< 0.02 U1	< 0.01 U1	0.252	0.152	0.469	0.77	0.195	0.02 J1	< 0.002 U1	6.66	0.07 J1	< 0.1 U1
11/13/2018	Background	0.11	5.91	98.7	< 0.02 U1	< 0.01 U1	0.1 J1	0.163	0.3442	0.85	0.137	< 0.009 U1	< 0.002 U1	7.44	0.05 J1	< 0.1 U1
12/19/2018	Background	0.17	5.65	65.6	< 0.02 U1	< 0.01 U1	0.1 J1	0.071	0.8606	0.85	0.122	< 0.009 U1	< 0.002 U1	6.02	0.06 J1	< 0.1 U1
1/24/2019	Background	0.15	3.97	168	< 0.02 U1	< 0.01 U1	0.08 J1	0.159	1.164	0.59	0.06 J1	0.02 J1	< 0.002 U1	5.62	0.04 J1	< 0.1 U1
2/18/2019	Background	0.1 J1	4.21	78.8	< 0.02 U1	< 0.01 U1	0.2 J1	0.050	0.419	0.81	0.110	0.01 J1	< 0.002 U1	4.74	0.03 J1	< 0.1 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1807A
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/26/2018	Background	0.170	146	9.57	0.21	7.5	334	929
8/28/2018	Background	0.137	136	11.8	0.21	6.9	356	953
10/4/2018	Background	0.129	166	12.5	0.16	6.7	367	985
10/24/2018	Background	0.199	144	10.3	0.20	6.9	308	838
11/14/2018	Background	0.175	155	10.5	0.21	6.8	326	904
12/20/2018	Background	0.208	151	9.68	0.19	7.2	315	931
1/25/2019	Background	0.183	156	11.3	0.15	8.2	361	876
2/21/2019	Background	0.08 J1	150	12.0	0.14	7.2	396	1,050
3/14/2019	Detection	0.09 J1	160	11.1	0.15	6.7	363	1,020
11/11/2019	Detection	0.074	173	11.9	0.13	6.9	392	1,070
5/12/2020	Detection	0.088	159	10.8	0.12	6.7	358	1,040
10/28/2020	Detection	0.069	170	12.4	0.13	7.0	392	1,020
5/6/2021	Detection	0.082	153	10.2	0.17	6.8	328	936
11/11/2021	Detection	0.106	166	9.90	0.15	6.9	336	960

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1807A
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/26/2018	Background	0.13	0.99	32.6	0.006 J1	0.02	0.098	0.629	1.366	0.21	0.046	0.020	< 0.002 U1	1.65	0.3	0.03 J1
8/28/2018	Background	0.87	1.13	32.6	0.005 J1	0.06	0.253	0.565	1.507	0.21	0.300	0.018	0.002 J1	9.07	0.6	0.054
10/4/2018	Background	0.14	1.10	30.1	< 0.02 U1	0.05 J1	0.205	0.918	1.127	0.16	0.142	< 0.009 U1	< 0.002 U1	11.1	0.2 J1	< 0.1 U1
10/24/2018	Background	0.18	0.84	27.8	< 0.02 U1	0.03 J1	0.2 J1	0.579	0.38891	0.20	0.105	0.02 J1	< 0.002 U1	2 J1	0.2 J1	< 0.1 U1
11/14/2018	Background	0.17	0.96	28.8	< 0.02 U1	0.03 J1	0.09 J1	0.614	0.985	0.21	0.09 J1	0.01 J1	< 0.002 U1	2 J1	0.2	< 0.1 U1
12/20/2018	Background	0.17	0.94	29.5	< 0.02 U1	0.03 J1	0.403	0.616	1.016	0.19	0.251	0.02 J1	< 0.002 U1	1 J1	0.3	< 0.1 U1
1/25/2019	Background	0.12	0.92	27.4	< 0.02 U1	0.03 J1	0.1 J1	0.733	1.269	0.15	0.126	0.030	< 0.002 U1	1 J1	0.1 J1	< 0.1 U1
2/21/2019	Background	0.08 J1	0.82	24.1	< 0.02 U1	0.03 J1	0.1 J1	0.811	0.735	0.14	0.118	0.01 J1	< 0.002 U1	0.6 J1	0.1 J1	< 0.1 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1807B
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/26/2018	Background	0.195	8.76	8.46	0.75	8.3	218	732
8/28/2018	Background	0.178	8.39	10.8	1.13	8.1	219	706
10/5/2018	Background	0.201	9.21	9.94	1.01	7.9	219	752
10/24/2018	Background	0.176	8.92	7.93	0.81	8.3	220	735
11/14/2018	Background	0.211	8.87	8.52	0.91	7.7	230	732
12/20/2018	Background	0.164	11.6	9.88	1.16	8.2	230	738
1/25/2019	Background	0.277	9.33	7.68	0.79	6.9	227	742
2/21/2019	Background	0.168	11.0	9.53	1.06	8.4	238	791
3/14/2019	Detection	0.163	12.7	10.8	1.19	7.9	249	793
11/11/2019	Detection	0.189	12.7	13.3	1.40	8.0	247	807
5/13/2020	Detection	0.170	8.70	10.5	1.13	7.7	224	783
11/2/2020	Detection	0.079	168	10.9	0.18	6.7	343	1,020
5/11/2021	Detection	0.182	8.93	12.3	1.46	7.8	193	787
11/11/2021	Detection	0.189	9.21	14.7	1.78	8.0	179	780

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1807B
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/26/2018	Background	0.27	1.93	49.6	0.049	0.01 J1	1.40	0.525	0.719	0.75	0.756	0.021	< 0.002 U1	4.22	0.3	0.03 J1
8/28/2018	Background	0.23	1.94	56.3	< 0.004 U1	< 0.005 U1	0.134	0.046	1.31	1.13	0.035	0.010	< 0.002 U1	23.9	0.08 J1	0.01 J1
10/5/2018	Background	0.15	1.70	59.6	0.03 J1	< 0.01 U1	0.263	0.179	2.079	1.01	0.310	< 0.009 U1	< 0.002 U1	12.5	0.2 J1	< 0.1 U1
10/24/2018	Background	0.25	1.26	42.3	< 0.02 U1	< 0.01 U1	0.381	0.139	0.305	0.81	0.203	0.02 J1	< 0.002 U1	5.59	0.07 J1	< 0.1 U1
11/14/2018	Background	0.16	1.28	41.4	< 0.02 U1	< 0.01 U1	0.247	0.073	0.348	0.91	0.08 J1	0.02 J1	< 0.002 U1	5.62	0.05 J1	< 0.1 U1
12/20/2018	Background	0.43	1.75	73.7	< 0.02 U1	< 0.01 U1	0.335	0.114	0.2672	1.16	0.145	0.02 J1	< 0.002 U1	13.5	0.1 J1	< 0.1 U1
1/25/2019	Background	0.09 J1	1.23	43.0	< 0.02 U1	< 0.01 U1	0.08 J1	0.05 J1	1.003	0.79	0.04 J1	0.02 J1	< 0.002 U1	4.21	0.06 J1	< 0.1 U1
2/21/2019	Background	0.35	1.48	66.9	< 0.02 U1	< 0.01 U1	0.1 J1	0.051	0.291	1.06	0.04 J1	< 0.009 U1	< 0.002 U1	9.27	0.08 J1	< 0.1 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1808A
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/25/2018	Background	0.182	40.4	19.6	0.52	7.7	184	734
8/28/2018	Background	0.142	38.5	19.4	0.57	7.6	227	740
10/4/2018	Background	0.135	38.6	16.7	0.41	7.4	216	790
10/24/2018	Background	0.103	41.5	17.1	0.55	7.7	126	614
11/13/2018	Background	0.152	40.2	18.4	0.51	7.4	210	770
12/20/2018	Background	0.172	40.3	21.6	0.47	7.6	242	834
1/25/2019	Background	0.173	47.4	18.3	0.40	6.1	231	840
2/21/2019	Background	0.122	39.4	17.4	0.40	7.2	213	821
3/14/2019	Detection	0.112	62.9	20.9	0.33	7.7	290	912
11/11/2019	Detection	0.131	29.3	17.1	0.45	7.6	235	887
5/13/2020	Detection	0.124	69.6	23.3	0.29	7.0	321	1,010
11/3/2020	Detection	0.119	54.3	25.6	0.44	7.2	300	1,050
5/7/2021	Detection	0.152	28.7	25.0	0.53	7.2	276	1,070
11/11/2021	Detection	0.126	50.1	19.4	0.48	7.1	221	840

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1808A
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/25/2018	Background	0.29	2.47	86.2	0.299	0.007 J1	0.831	0.544	1.892	0.52	2.28	0.024	0.006	6.46	0.5	0.04 J1
8/28/2018	Background	0.14	5.34	105	0.251	0.01 J1	1.25	0.821	4.96	0.57	2.06	0.025	0.005 J1	11.7	0.4	0.083
10/4/2018	Background	0.14	2.84	78.1	0.05 J1	< 0.01 U1	0.500	0.231	2.082	0.41	0.392	< 0.009 U1	< 0.002 U1	4.56	0.07 J1	< 0.1 U1
10/24/2018	Background	0.03 J1	1.86	86.2	0.05 J1	< 0.01 U1	0.443	0.117	1.04	0.55	0.397	0.02 J1	< 0.002 U1	3.06	0.07 J1	< 0.1 U1
11/13/2018	Background	0.04 J1	3.83	74.1	0.03 J1	< 0.01 U1	0.381	0.160	0.47	0.51	0.245	0.02 J1	0.002 J1	2.75	0.05 J1	< 0.1 U1
12/20/2018	Background	0.05 J1	4.37	71.0	0.04 J1	< 0.01 U1	0.293	0.119	1.048	0.47	0.227	0.03 J1	0.003 J1	2 J1	0.08 J1	< 0.1 U1
1/25/2019	Background	0.06 J1	2.27	80.3	0.102	< 0.01 U1	0.415	0.149	2.76	0.40	0.717	0.035	< 0.002 U1	1 J1	0.2 J1	< 0.1 U1
2/21/2019	Background	0.02 J1	1.99	78.9	0.05 J1	< 0.01 U1	0.213	0.076	0.535	0.40	0.316	0.01 J1	< 0.002 U1	1 J1	0.09 J1	< 0.1 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1809A
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/26/2018	Background	0.085	173	26.1	0.16	7.2	386	1,020
8/28/2018	Background	0.091	179	28.8	0.17	7.1	386	1,020
10/3/2018	Background	0.09 J1	191	26.8	0.14	7.1	388	1,070
10/23/2018	Background	0.114	181	26.6	0.14	7.1	390	1,050
11/14/2018	Background	0.09 J1	188	28.4	0.16	7.2	403	1,050
12/19/2018	Background	0.06 J1	182	27.7	0.15	7.0	384	1,040
1/25/2019	Background	0.08 J1	188	28.1	0.14	5.1	390	1,080
2/20/2019	Background	0.08 J1	184	30.2	0.14	7.2	403	1,080
3/12/2019	Detection	0.05 J1	189	31.0	0.14	7.2	396	1,090
11/8/2019	Detection	0.096	195	37.6	0.15	7.0	393	1,110
5/13/2020	Detection	0.081	179	34.9	0.11	7.3	400	1,100
11/5/2020	Detection	0.055	196	33.8	0.13	6.9	391	1,100
5/6/2021	Detection	0.062	182	34.8	0.14	7.1	384	1,090
11/11/2021	Detection	0.063	195	36.6	0.11	7.0	391	1,090

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1809A
Amos - FAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/26/2018	Background	0.05	2.30	60.2	0.004 J1	< 0.005 U1	0.119	0.555	1.561	0.16	0.035	0.020	< 0.002 U1	7.18	0.04 J1	0.01 J1
8/28/2018	Background	0.03 J1	2.83	67.3	0.004 J1	< 0.005 U1	0.200	0.754	1.193	0.17	0.01 J1	0.024	< 0.002 U1	3.01	0.06 J1	0.02 J1
10/3/2018	Background	0.03 J1	2.87	61.4	< 0.02 U1	< 0.01 U1	0.1 J1	0.533	4.22	0.14	< 0.02 U1	< 0.009 U1	< 0.002 U1	2.27	0.05 J1	< 0.1 U1
10/23/2018	Background	< 0.02 U1	2.59	53.0	< 0.02 U1	< 0.01 U1	0.09 J1	0.424	1.501	0.14	< 0.02 U1	0.043	< 0.002 U1	2 J1	0.03 J1	< 0.1 U1
11/14/2018	Background	< 0.02 U1	3.10	58.0	< 0.02 U1	< 0.01 U1	0.08 J1	0.447	1.717	0.16	< 0.02 U1	0.01 J1	< 0.002 U1	2 J1	< 0.03 U1	< 0.1 U1
12/19/2018	Background	< 0.02 U1	3.51	63.4	< 0.02 U1	< 0.01 U1	0.212	0.504	1.417	0.15	< 0.02 U1	0.032	< 0.002 U1	2.88	< 0.03 U1	< 0.1 U1
1/25/2019	Background	< 0.02 U1	3.39	57.2	< 0.02 U1	< 0.01 U1	0.06 J1	0.375	2.99	0.14	< 0.02 U1	0.046	< 0.002 U1	2 J1	< 0.03 U1	< 0.1 U1
2/20/2019	Background	< 0.1 U1	4.57	64.5	< 0.1 U1	< 0.05 U1	< 0.2 U1	0.559	1.56	0.14	< 0.1 U1	0.038	< 0.002 U1	2 J1	< 0.2 U1	< 0.5 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1810A
Amos - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
7/26/2018	Background	0.220	23.0	--	--	--	--	--
8/2/2018	Background	--	--	23.4	0.93	7.4	170	565
8/27/2018	Background	0.271	25.9	21.6	0.93	7.5	129	525
10/3/2018	Background	0.245	28.0	19.0	0.89	7.3	114	542
10/24/2018	Background	0.211	23.7	18.6	0.86	7.7	93.1	473
11/13/2018	Background	0.238	30.2	19.5	1.04	7.3	160	544
12/20/2018	Background	0.210	30.1	17.0	0.98	7.1	160	548
1/23/2019	Background	0.319	24.8	16.3	0.90	7.5	112	494
2/20/2019	Background	0.245	32.3	15.4	1.01	7.4	170	580
3/12/2019	Detection	0.228	30.5	15.4	1.00	7.3	153	548
11/8/2019	Detection	0.249	44.5	15.2	0.94	7.1	256	692
5/12/2020	Detection	0.226	67.5	17.2	0.78	7.4	379	993
11/3/2020	Detection	0.194	53.7	15.8	0.91	7.0	341	802
5/6/2021	Detection	0.207	64.0	17.3	0.87	7.2	373	935
11/11/2021	Detection	0.230	59.3	15.4	0.83	7.2	283	770

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag.
In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit.
In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 1 - Groundwater Data Summary: MW-1810A
Amos - FAP
Appendix IV Constituents

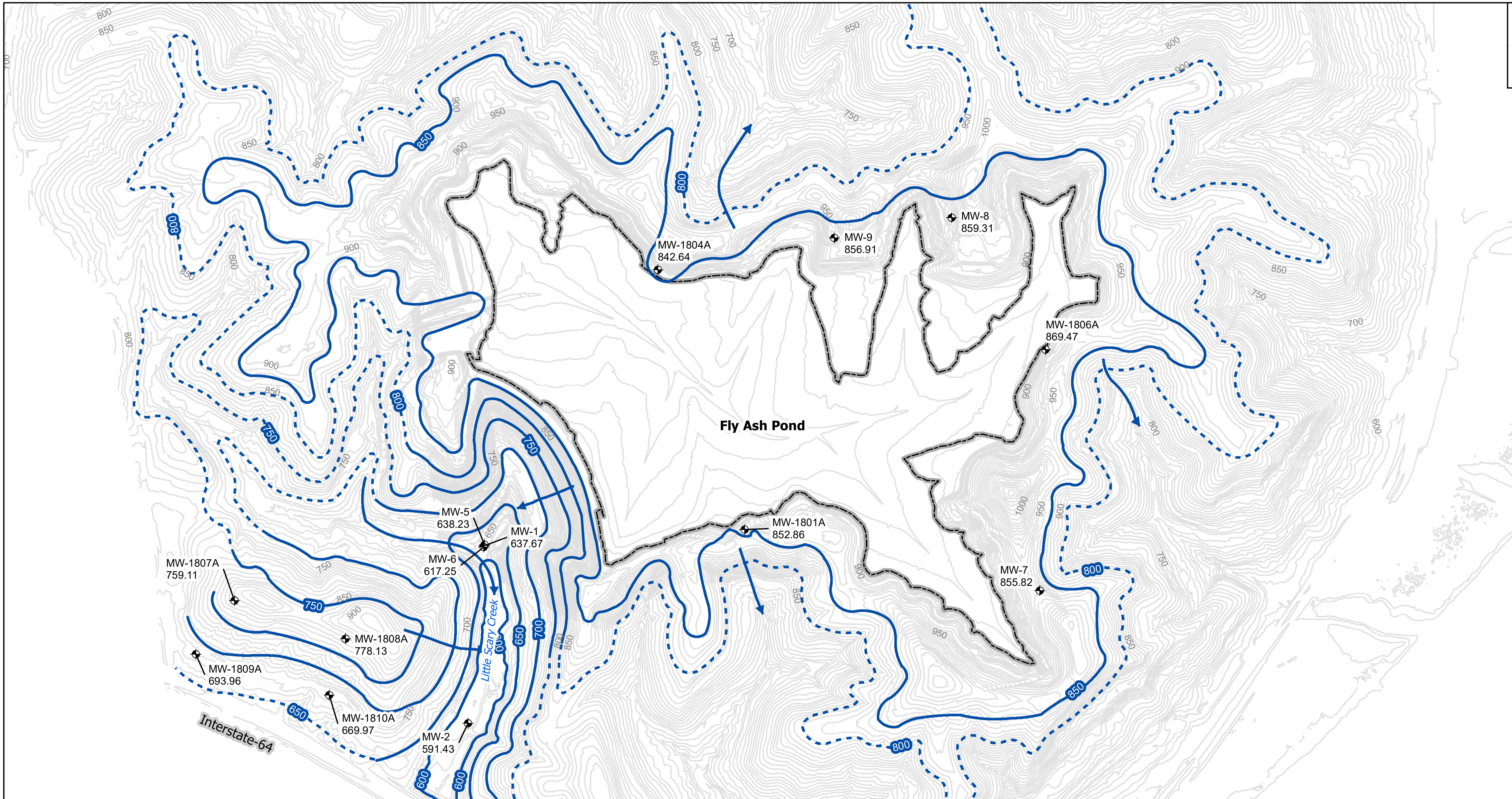
Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
7/26/2018	Background	0.13	0.88	124	0.009 J1	< 0.005 U1	0.442	0.150	0.382	--	0.149	0.018	< 0.002 U1	9.26	0.06 J1	0.051
8/2/2018	Background	--	--	--	--	--	--	--	--	0.93	--	--	--	--	--	--
8/27/2018	Background	0.10	0.51	83.4	< 0.004 U1	< 0.005 U1	0.229	0.048	0.842	0.93	0.057	0.015	< 0.002 U1	8.52	0.04 J1	0.02 J1
10/3/2018	Background	0.11	0.49	83.0	< 0.02 U1	< 0.01 U1	0.2 J1	0.03 J1	1.218	0.89	0.09 J1	< 0.009 U1	< 0.002 U1	7.06	0.05 J1	< 0.1 U1
10/24/2018	Background	0.07 J1	0.54	88.5	< 0.02 U1	< 0.01 U1	0.1 J1	0.02 J1	0.992	0.86	0.03 J1	0.02 J1	< 0.002 U1	6.28	0.04 J1	< 0.1 U1
11/13/2018	Background	0.09 J1	0.40	83.5	< 0.02 U1	< 0.01 U1	0.1 J1	0.02 J1	0.24	1.04	0.04 J1	< 0.009 U1	< 0.002 U1	6.03	0.03 J1	< 0.1 U1
12/20/2018	Background	0.08 J1	0.43	87.9	< 0.02 U1	< 0.01 U1	0.1 J1	0.03 J1	0.5648	0.98	0.05 J1	0.02 J1	< 0.002 U1	5.24	0.03 J1	< 0.1 U1
1/23/2019	Background	0.07 J1	0.45	84.2	< 0.02 U1	< 0.01 U1	0.08 J1	0.02 J1	0.768	0.90	0.03 J1	0.01 J1	< 0.002 U1	5.94	0.03 J1	< 0.1 U1
2/20/2019	Background	< 0.1 U1	0.4 J1	87.8	< 0.1 U1	< 0.05 U1	0.3 J1	< 0.1 U1	0.65	1.01	0.1 J1	0.02 J1	< 0.002 U1	4 J1	< 0.2 U1	< 0.5 U1

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
<: Non-detect value. Analytes which were not detected are shown as less than the method detection limit (MDL) followed by a 'U1' flag. In analytical data prior to 5/18/2021, U1 flags were reported as U in the analytical report.
- -: Not analyzed
J1: Concentration estimated. Analyte was detected between the method detection limit and the reporting limit. In analytical data prior to 5/18/2021, J1 flags were reported as J in the analytical report.

Table 2: Residence Time Calculation Summary
Amos Fly Ash Pond

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2020-01[3] Groundwater Velocity (ft/year)	2020-01[3] Groundwater Residence Time (days)	2020-05 Groundwater Velocity (ft/year)	2020-05 Groundwater Residence Time (days)	2020-07[3] Groundwater Velocity (ft/year)	2020-07[3] Groundwater Residence Time (days)	2021-11 Groundwater Velocity (ft/year)	2021-11 Groundwater Residence Time (days)
Fly Ash Pond	MW-1801A[1]	2.0	36.7	1.7	37.9	1.6	36.4	1.7	35.8	1.7
	MW-1804A[1]	2.0	16.3	3.7	16.2	3.8	15.9	3.8	15.7	3.9
	MW-1806A[1]	2.0	10.9	5.6	13.0	4.7	10.9	5.6	9.2	6.6
	MW-1807A[2]	2.0	7.5	8.1	10.2	6.0	9.4	6.5	7.5	8.1
	MW-1808A[2]	2.0	35.2	1.7	37.7	1.6	38.9	1.6	32.0	1.9
	MW-1809A[2]	2.0	10.8	5.6	10.3	5.9	12.2	5.0	13.9	4.4
	MW-1810A[2]	2.0	35.2	1.7	34.9	1.7	37.7	1.6	38.6	1.6
	MW-1 [1]	2.0	17.8	3.4	16.8	3.6	19.3	3.1	19.3	3.2
	MW-2 [1]	2.0	112	0.5	112	0.5	112	0.5	112	0.5
	MW-5 [1]	2.0	45.0	1.4	16.1	3.8	31.6	1.9	31.2	2.0
	MW-6 [1]	2.0	12.4	4.9	31.1	2.0	12.6	4.8	12.6	4.8
	MW-7 [1]	2.0	6.7	9.1	12.6	4.8	9.0	6.7	3.6	17.0
	MW-8 [1]	2.0	8.7	7.0	11.3	5.4	13.7	4.5	10.0	6.1
	MW-9 [1]	2.0	7.7	7.9	9.8	6.2	9.7	6.3	6.2	9.8

Notes:
[1] - Upgradient/Sidegradient Well
[2] - Downgradient Well
[3] - Two-of-two verification sampling



Legend

- Groundwater Monitoring Well
- Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)
- Fly Ash Pond

Notes

- Monitoring well coordinates and water level data (collected on May 3, 2021) provided by AEP.
- Potentiometric surface contour interval is 50 feet.
- Topography basemap from AEP Drawing No. 13-30705-0 (topographic contour interval: 10 feet).
- Site features based on information available in the Fly Ash Pond CCR Groundwater Monitoring Well Network Evaluation - Amos Plant report (Arcadis, 2019) provided by AEP.
- Groundwater elevation units are in feet above mean sea level.

700 350 0 700
Feet

Potentioetric Surface Map - Uppermost Aquifer
May 2021

AEP Amos Generating Plant - Fly Ash Pond
Winfield, West Virginia

Geosyntec consultants

Columbus, Ohio | 2021/06/22

Figure
2

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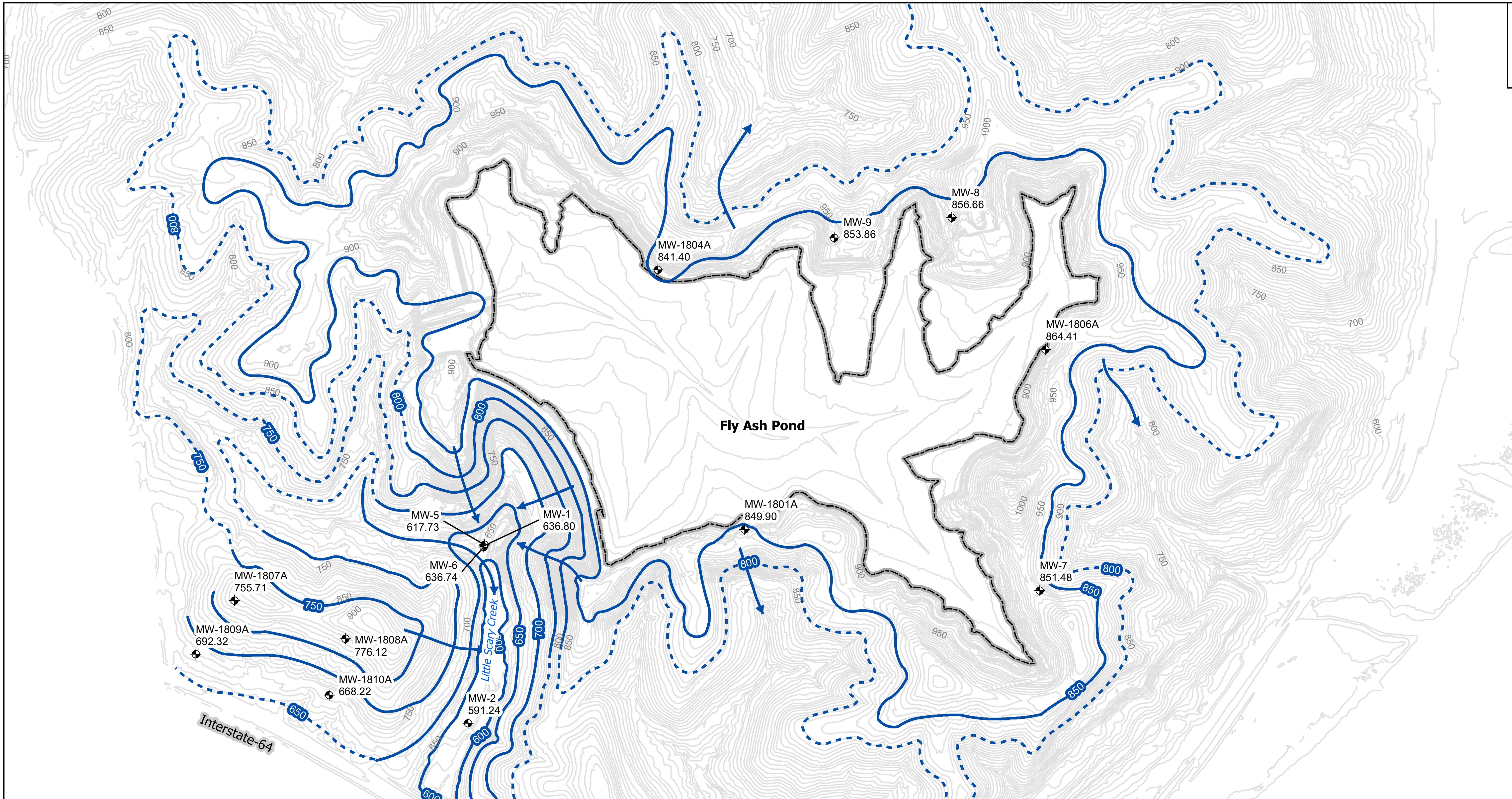

Legend

- Groundwater Monitoring Well
- Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)
- Fly Ash Pond

Notes

- Monitoring well coordinates and water level data (collected on November 1 - 2, 2021) provided by AEP.
- Potentiometric surface contour interval is 50 feet.
- Topography basemap from AEP Drawing No. 13-30705-0 (topographic contour interval: 10 feet).
- Site features based on information available in the Fly Ash Pond CCR Groundwater Monitoring Well Network Evaluation - Amos Plant report (Arcadis, 2019) provided by AEP.
- Groundwater elevation units are in feet above mean sea level.

700 350 0 700
Feet

Potentioetric Surface Map - Uppermost Aquifer
November 2021

AEP Amos Generating Plant - Fly Ash Pond
Winfield, West Virginia

Geosyntec
consultants

Columbus, Ohio | 2022/01/19

Figure
3

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APPENDIX 2

The statistical analysis reports completed in 2021 follow.

STATISTICAL ANALYSIS PLAN

APPALACHIAN POWER COMPANY

JOHN AMOS PLANT

FLY ASH POND

Prepared in compliance with USEPA's Coal Combustion Residuals Rule, 40 CFR 257.93

APPALACHIAN POWER

An AEP Company

Revision 0: April 2019

Revision 1: January 2021

STATISTICAL ANALYSIS PLAN

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane, Suite 103
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and

Kirk M. Cameron, Ph.D.
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CHA8500

January 2021
Revision 1

TABLE OF CONTENTS

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LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

Annual Report	Annual Groundwater Monitoring and Corrective Action Report
ANOVA	analysis of variance
CCR	coal combustion residuals
CFR	Code of Federal Regulations
GWPS	groundwater protection standard
LCL	lower confidence limit
MCL	maximum contaminant level
OLS	ordinary least-squares
ORP	oxidation-reduction potential
PQL	practical quantitation limit
QC	quality control
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
ROS	regression on order statistics
SAP	Statistical Analysis Plan
SSI	statistically significant increase
SSL	statistically significant level
SWFPR	site-wide false positive rate
UCL	upper confidence limit
Unified Guidance	*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009)
UPL	upper prediction limit
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit

SECTION 1

INTRODUCTION

In April 2015, the United States Environmental Protection Agency (USEPA) issued new regulations regarding the disposal of coal combustion residuals (CCR) in certain landfills and impoundments under 40 CFR 257, Subpart D, referred to as the "CCR rules." Facilities regulated under the CCR rules are required to develop and sample a groundwater monitoring well network to evaluate if landfilled CCR materials are impacting downgradient groundwater quality. As part of the evaluation, the analytical data collected during the sampling events must undergo statistical analysis to identify statistically significant increases (SSIs) in analyte concentrations above background levels. A description of acceptable statistical programs is provided in USEPA's document *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009), which is commonly referred to as the "Unified Guidance".

The CCR rules are not prescriptive regarding what statistical analyses should be selected so that groundwater data are interpreted in a consistent manner and the results meet certification requirements. Geosyntec Consultants, Inc. (Geosyntec) prepared this Statistical Analysis Plan (SAP) on behalf of American Electric Power (AEP) to develop a logic process regarding the appropriate statistical analysis of groundwater data collected in compliance with the CCR rules. The SAP will provide a narrative description of the statistical approach and methods used in accordance with the CCR rule reporting requirements [40 CFR 257.93(f)(6)].

This SAP describes statistical procedures to be used to establish background conditions, implement detection monitoring, implement assessment monitoring (as needed), and implement corrective action monitoring (as needed).

Procedures for collecting, preserving, and shipping groundwater samples are not included in this SAP. It is assumed that samples are collected and handled in accordance with AEP's draft *Groundwater Sampling and Analysis Plan* (AEP, 2016) and the requirements of 40 CFR 257.93 *et seq.*

SECTION 2

ANALYSES FOR REVIEWING AND PREPARING DATA

2.1 Physical Independence

Most statistical analyses require separate sampling events to be statistically independent. Statistical independence of groundwater samples is most likely to be realized when the samples are collected at time intervals that are sufficiently far apart that the samples are not from the same volume of groundwater. In such cases, the samples of groundwater are considered physically independent. To ensure physical independence, the minimum time between sampling events must be longer than the residence time of groundwater that would be collected in the monitoring well. The minimum time interval between sampling events (t_{min}) can be determined by calculating the groundwater velocity, as follows:

$$v = \frac{Ki}{n} \quad (1)$$

$$t_{min} = \frac{v}{D} \quad (2)$$

where:

$v =$	groundwater velocity
$K =$	hydraulic conductivity
$i =$	hydraulic gradient
$n =$	effective porosity
$t_{min} =$	minimum time interval between sampling events
$D =$	well bore volume (i.e., diameter of well and surrounding filter pack)

2.2 Testing for Normality

Many statistical analyses assume that the sample data are normally distributed. If such an analysis is used, the assumption of normality can be tested using the Shapiro-Wilk test (for sample sizes up to 50) or the Shapiro-Francía test (for sample sizes greater than 50). Normality can also be tested by less computationally intensive means such as graphing data on a probability plot. If the data appear not to be normally distributed (e.g., they are skewed in some fashion), then data may be transformed mathematically such that the transformed data do follow a normal distribution (e.g., lognormal distributions, Box-Cox transformations). Alternatively, a non-parametric test (i.e., a test that does not assume a particular distribution of the data) may be used. However, since non-parametric tests generally require large datasets to maintain an adequately low site-wide false positive rate (SWFPR), transforming the data is preferred.

2.3 Testing for Outliers

Outliers are extreme data points that may represent an anomaly or error. Data sets should be visually inspected for outliers using time series and/or box-and-whisker plots. While they are valuable as screening tools, visual methods are not foolproof. For example, if data are skewed according to a lognormal distribution, the boxplot screening may identify more outliers than actually exist. Typically, goodness-of-fit testing must be done on the non-outlier portion of the data to determine at what scale to test the possible outliers.

Potential outliers should be evaluated for potential sources of error (e.g., in transcription or calculation) or evidence that the data point is not representative (e.g., by examining quality control [QC] data, groundwater geochemistry, sampling procedures, etc.). Errors should be corrected prior to further statistical analysis, and data points that are flagged as non-representative should not be used in the statistical analysis. In addition, data points can be considered extreme outliers if they meet one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (3)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (4)$$

where:

$x_i =$	individual data point
$\tilde{x}_{0.25} =$	first quartile
$\tilde{x}_{0.75} =$	third quartile
$IQR =$	the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

Extreme outliers may be excluded from the statistical analysis based on professional judgment. Goodness-of-fit testing may be needed to corroborate the classification of data points as extreme outliers. Flagged data and extreme outliers should still be maintained in the database and should be reevaluated as new data are collected.

2.4 Handling Duplicate or Replicate Data

Duplicate or replicate samples are often collected for QC purposes. Averaging the parent sample and duplicate sample results may give a more accurate representation of the constituent concentration at the time, but doing so would reduce the sample variability. Since many statistical tests assume that data are homoscedastic (i.e., the population variance does not change across samples), this technique is not recommended. Unless there is reason to suspect that either the parent sample or the duplicate sample is more representative of site groundwater, one of the samples should be selected at random and that value should be used in the subsequent statistical analysis. However, it should be reported when parent sample and duplicate sample results are different from a decision-making perspective, e.g., when the duplicate sample exceeds the groundwater protection standard (GWPS) but the parent sample does not.

2.5 Handling Non-Detect Data

If non-detect data are infrequent (less than 15%), half of the reporting limit (RL) can be used in place of these data without significantly altering the results of a statistical test. The RL may be either the laboratory practical quantification limit (PQL) or an established project limit which is less than the maximum contaminant level (MCL) or CCR rule-specified screening level for constituents that do not have an MCL. If non-detect data are more frequent, parametric methods that explicitly consider non-detects or non-parametric methods insensitive to the presence of non-detect data should be used. Where available, estimated results less than the RL (i.e., "J-flagged" data) should be used, and these data should be considered detections for the purposes of statistical analysis.

2.6 Deseasonalizing Data

Most statistical tests assume that data are independent and identically distributed. Datasets with seasonal or cyclic patterns violate this assumption. If seasonal trends are not corrected, the variance of the data will be overestimated, lessening the statistical power of the test. False positives may also be identified for elevated results that are caused by seasonal variation instead of a release.

At the same time, deseasonalizing data inherently assumes that the seasonal pattern will continue into the future, so care should be taken when correcting for seasonality. There should be a physical explanation for the seasonal pattern, and the seasonal pattern should be observed for at least three cycles before deseasonalizing data.

To evaluate whether a seasonal pattern exists, data should first be visually inspected on a time series plot. Observing parallel or antiparallel patterns for the same constituent across multiple wells or for multiple constituents within a single well provides greater assurance of a seasonal pattern and may be used to infer a physical explanation.

If a seasonal pattern is observed, the dataset should undergo a statistical test for seasonality before deseasonalizing the data. First, results are categorized into seasons based on the observed seasonal pattern and the frequency of sampling (e.g., summer or winter; dry season or wet season; first, second, third, or fourth quarter; etc.). Then, the Kruskal-Wallis test can be applied to the various seasonal datasets to test whether the different seasons are statistically significantly different from one another.

To deseasonalize the data, a seasonal mean should be calculated for each season based on the categorization for the dataset, and a grand mean (i.e., the overall mean of all data) should be calculated. Each result should then be corrected based on the difference between the grand mean and the seasonal mean for that result's season. Similar to transforming apparently non-normal data, statistics should be calculated based on the deseasonalized data.

SECTION 3

DETECTION MONITORING

3.1 Establishing Background

By April 17, 2019, eight independent background samples should be collected from each monitoring well in the CCR unit groundwater monitoring system as part of the initial monitoring period [40 CFR 257.94(b)]. Background wells do not necessarily need to be hydraulically upgradient of the CCR unit, but they must not be affected by a release from the CCR unit [40 CFR 257.91(a)(1)]. The sampling frequency should be such that samples are physically independent, as described in **Section 2.1**. Samples should be analyzed for the Appendix III and Appendix IV constituents listed in **Table 1**.

Once analytical data are received, summary statistics (e.g., mean and variance) should be calculated for the background datasets. Initially, analysis should be done independently for each constituent at each well. As part of our protocol in such situations, time series plots and box plots will be prepared along with the summary statistics. The Kaplan-Meier method or robust regression on order statistics (ROS) can be used to compute summary statistics when there are large fractions (i.e., 15% to 50%) of non-detects; these methods are discussed below. If more than 50% of the data are non-detect, then summary statistics cannot be reliably calculated. Procedures for evaluating future data against these background datasets are described in **Section 3.2.1** (for detection monitoring) and **Section 4.1.1** (for assessment monitoring and corrective action monitoring).

Background data will be evaluated for statistically significant temporal trends using (a) ordinary least-squares (OLS) linear regression with a *t*-test ($\alpha = 0.01$) on the slope and/or (b) the non-parametric Theil-Sen slope estimator with Mann-Kendall trend test ($\alpha = 0.05$, or 0.01 for larger datasets). Non-detect data are replaced with half the RL for these analyses. The OLS linear regression or Theil-Sen slope estimator will be used to estimate the rate of change (increasing, no change, or decreasing) over time for each constituent at each well. The *t*-test or Mann-Kendall statistic will be used to determine whether a trend is statistically significant. OLS linear regression should only be used when at most 15% of the data are non-detect, when regression residuals are normally distributed, and when the variance from the regression line does not change over time. The Theil-Sen/Mann-Kendall analysis requires at least five observations for meaningful results; at least eight observations are recommended. Note that a statistically significant increasing trend in background data (or a statistically significant decreasing trend in pH) could indicate an existing release from the CCR unit or another source, and further investigation may be needed to determine the source of this trend.

Background data will also be evaluated for statistically significant seasonal patterns and, if present, will be deseasonalized using the procedure described in **Section 2.6**.

If the trend analysis does not indicate a statistically significant trend, the proposed background data will be tested for normality using one of the methods outlined in **Section 2.2**. When data follow a normal or transformed-normal distribution (e.g. lognormal or other Box-Cox transformation), parametric methods are applied. If fewer than 15% of the data are non-detect, non-detect data may be replaced with half the RL and the mean and variance can be calculated normally. If 15% to 50% of the data are non-detect, two methods – the Kaplan-Meier method or Robust ROS method – can be used to determine the sample mean and variance. Kaplan-Meier should not be used if all non-detect data have the same RL or if the maximum detected value is less than the highest RL of the non-detect data. When data do not follow a normal or transformed-normal distribution, or when more than 50% of the data are non-detect, nonparametric methods may be used.

Once the sample mean and variance are calculated for each constituent at each well (assuming no significant trends over time), the data from background wells should be compared for each constituent. The purpose of this exercise is to test for significant spatial variation and to decide between interwell and intrawell approaches. First, the equality of variance across background wells should be tested visually using box-and-whisker plots and/or analytically using Levene's test ($\alpha = 0.01$). If the variances appear equal, then one-way, parametric analysis of variance (ANOVA) should be conducted across background wells ($\alpha = 0.05$). If there are no statistically significant differences among the background wells, then interwell comparisons may be appropriate to evaluate SSIs.

If ANOVA indicates statistically significant differences among background wells, then spatial variability can be concluded. As with temporal trends, the existence of spatial variability could indicate an existing release from the CCR unit or another source, and further investigation may be needed to determine the source of this variability. If the spatial variability is not caused by a release from the CCR unit, then intrawell comparisons would be appropriate to evaluate SSIs.

3.2 Evaluating Statistically Significant Increases (SSIs)

After the initial eight rounds of background sampling, groundwater sampling and analysis should be conducted on a semiannual basis. The statistical evaluation of each groundwater monitoring event must be completed within 90 days of receiving the analytical results from the laboratory [40 CFR 257.93(h)(2)].

The CCR rules only require analysis of the Appendix III constituents; however, analyzing additional constituents should be considered. Turbidity, dissolved oxygen, and oxidation-reduction potential (ORP), should be measured in the field in addition to pH. Other geochemical parameters, such as alkalinity, magnesium, potassium, sodium, iron, and manganese, should also be analyzed in the laboratory periodically (e.g., once every one to four years). Both the field and laboratory geochemical parameters can help identify the cause of any apparent change in groundwater quality. Additionally, analyzing for the Appendix IV constituents periodically should be considered to ensure the background dataset for these constituents is complete and current should assessment monitoring be needed. Statistical analyses should still be limited to the Appendix III constituents to help meet the dual goals of a SWFPR less than 10% per year and an adequate statistical power.

The CCR rules specifically list four methods acceptable for statistical analysis: ANOVA, tolerance intervals, prediction intervals, and control charts [40 CFR 257.93(f)]. Of these, the Unified Guidance recommends prediction limits combined with retesting for maintaining a low SWFPR while providing high statistical power (USEPA, 2009). Control charts are also acceptable as long as parametric methods can be used (i.e., the data or transformed data are normally distributed and the frequency of non-detects is at most 50%), as there is no nonparametric counterpart to the control chart. ANOVA is not recommended as the CCR rules mandate a minimum Type I error (α) of 0.05, at which it would be difficult to maintain an annual SWFPR less than 10%.

Prediction intervals and control charts can be used for both interwell and intrawell comparisons. For interwell comparisons, the pooled data from background monitoring wells should be used for the background dataset; for intrawell comparisons, the background dataset should be a subset of historical data at each monitoring well. (See **Section 3.4** below for procedures for updating background datasets.) Interwell comparisons are preferable, but they should only be used when there are no trends and no statistically significant population differences among background wells; otherwise, a significant test result may only indicate natural spatial variability instead of an SSI.

For prediction intervals, the upper prediction limit (UPL) is calculated according to the following formula:

$$\text{UPL} = \bar{x} + ks \quad (5)$$

where:

$\bar{x} =$	mean concentration of the background dataset
$s =$	standard deviation of the background dataset
$k =$	multiplier based on the characteristics of the site and the statistical test

Values for k are chosen to maintain an SWFPR less than 10% and depend on the following: (1) number of wells, (2) number of constituents being evaluated, (3) size of the background dataset, (4) retesting regime, and (5) whether intrawell or interwell comparisons are being used. Values for k are listed in Tables 19-1, 19-2, 19-10, and 19-11 in Appendix D of the Unified Guidance (USEPA, 2009). If the k value that precisely matches site conditions does not appear in these tables, it can be estimated using the provided values by linear interpolation.

A one-of-two or one-of-three testing regime should be employed; i.e., if at least one sample in a series of two or three (respectively) does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, if the initial result does not exceed the UPL, then no resampling is needed. If the initial result does exceed the UPL, then a resample should be collected prior to the next regularly scheduled sampling event at the monitoring well(s) and for the constituent(s) exceeding the UPL. Additional geochemical parameters, such as alkalinity, magnesium, potassium, sodium, iron, and manganese, should also be analyzed during resampling to help identify the source of the apparent increase. Enough time should elapse between the initial sample and each resample so that the samples are physically independent (**Section 2.1**). If both the initial result and the subsequent resample(s) exceed the UPL, then an SSI can be concluded.

Choosing between a one-of-two and a one-of-three testing regime should be done before conducting the statistical analysis, as the UPL calculation depends on the resampling regime selected. The choice should depend on site conditions and the size of the background dataset. First, if three physically independent samples cannot be collected in a six-month period, then a one-of-two testing regime should be used. A one-of-two testing regime may also be considered (a) if the background dataset has at least 16 data points or (b) if the CCR unit's monitoring well network has nine or fewer downgradient monitoring wells and a background dataset of at least 8 data points. Otherwise, a one-of-three testing regime should be employed to achieve an acceptably high statistical power and an acceptably low SWFPR.

If two physically independent samples cannot be collected in a six-month period, then a reduced monitoring frequency may be warranted. In this case, a demonstration must be made documenting the need for – and effectiveness of – a reduced monitoring frequency. This demonstration must be certified by a qualified professional engineer, and monitoring must still be done on at least an annual basis [40 CFR 257.94(d)].

The above procedure can be used wherever a mean and variance can be calculated for background data, including datasets that are transformed-normal and datasets where the mean and variance are calculated using the Kaplan-Meier or Robust ROS method. (Note that if data are transformed-normal, prediction intervals or control limits should first be calculated for the transformed data and then be transformed back into concentration terms.) Methods for determining prediction intervals where more than half of the background data are non-detect, where background data are neither normal nor transformed-normal, or where statistically significant trends or seasonal patterns exist are described below.

Different analyses can and should be used for different constituents and different monitoring wells within a CCR unit depending on the background data. For instance, if background wells have similar chloride data but different pH data, then interwell comparisons may be considered for chloride analysis and intrawell comparisons may be considered for pH analysis. If boron data are stable above the RL at MW-1 and mostly non-detect at MW-2, then it would be appropriate to use parametric prediction limits at MW-1 and non-parametric prediction limits at MW-2.

3.2.1 Most Background Data Are Non-Detect

If at least half of the data are non-detect, non-parametric prediction intervals with retesting should be used. In this method, the UPL is set either at the highest or at the second-highest concentration observed in the background dataset. A sufficiently large background dataset is paramount for this procedure to achieve an acceptably low SWFPR. To this end, the Kruskal-Wallis test should be performed on all background monitoring wells where at least 50% of the data for the constituent are non-detect to evaluate spatial variability. If the Kruskal-Wallis test indicates that there is no significant spatial variability among background wells, then the data from the background wells should be pooled to form a larger background dataset and thus to run an interwell test.

The choice between a one-of-two and a one-of-three testing regime should be based on the same criteria used for parametric testing, as described in **Section 3.2**. Choosing between using the highest or second-highest observed concentration as the UPL should depend in part on the size of the background dataset and the number of monitoring wells around the CCR unit. Assuming a one-of-three testing regime is used, the highest observed concentration should be used when the background dataset has fewer than 32 data points and the monitoring network has twelve or fewer wells. If there are at least thirteen wells, the highest observed concentration should be used when the background dataset has fewer than 48 data points. The second-highest observed concentration may be used for larger datasets.

If a one-of-two testing regime must be used due to aquifer conditions, then the highest observed concentration should be used (a) when the background dataset has fewer than 64 data points if there are fifteen or fewer wells or (b) when the background dataset has fewer than 88 data points if there are at least sixteen wells. The second-highest observed concentration may be used for larger data sets.

3.2.2 All Background Data Are Non-Detect

If all of the background data are non-detect, then the Double Quantification Rule should be used. According to this rule, if a sample and verification resample both exceed the PQL, then an SSI can be concluded. This can be thought of as setting the UPL at the PQL with a one-of-two testing regime. The possibility of false positives from this rule does not count against the calculated SWFPR because the false positive risk is small when all previous background data have been non-detect.

3.2.3 Background Data Are neither Normal nor Transformed-Normal

If background data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, then non-parametric prediction intervals with retesting should be used. In this method, the UPL is set either at the highest or at the second-highest concentration observed in the background dataset. A sufficiently large background dataset is paramount for this procedure to achieve an acceptably low SWFPR. To this end, the Kruskal-Wallis test should be performed on all background monitoring wells where at least 50% of the data for the constituent are non-detect to evaluate spatial variability. If the Kruskal-Wallis test indicates that there is no significant spatial variability among background wells, then the data from the background wells should be pooled to form a larger background dataset and thus to run an interwell test.

The choice between a one-of-two and a one-of-three testing regime should be based on the same criteria used for parametric testing, as described in **Section 3.2**. The choice between using the highest or second-highest observed concentration as the UPL should be based on the same considerations described in **Section 3.2.1**.

3.2.4 A Significant Temporal Trend Exists

True temporal trends in background data (i.e., absent a release from the facility or another source) are considered unlikely. Thus, a truncated dataset that does not exhibit a statistically significant trend may be used. In these cases, UPLs would be calculated as described in the previous sections.

Alternatively, if there is a significant temporal trend in the background data that is not attributable to a release, prediction limits can be constructed around a trend line. A trend line can be constructed parametrically using OLS linear regression. OLS linear regression should only be used when at most 15% of the data are non-detect, when regression residuals are normally distributed, and when the variance from the regression line does not change over time. If OLS linear regression is used, the UPL can be calculated according to the following equation:

$$\text{UPL} = \widehat{x_0} + t_{1-\alpha,n-2} * s_e * \sqrt{1 + \frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1)s_t^2}} \quad (6)$$

where:

$\widehat{x_0} =$	regression-line estimate of the mean concentration at time t_0
$t_{1-\alpha,n-2} =$	one-tailed *t*-value at a confidence of 1 – α and n – 2 degrees of freedom
$s_e =$	standard error of the regression line
$n =$	number of samples in the background dataset
$t_0 =$	date the groundwater sample being compared to the UPL was collected
$\bar{t} =$	mean of the sampling dates in the background dataset
$s_t =$	standard deviation of the sampling dates in the background dataset

The choice between a one-of-two and a one-of-three testing regime should be based on the same criteria used when there is no significant trend, as described in **Section 3.2**. The choice of α depends on the retesting regime and the number of wells within the monitoring network. If a one-of-two testing regime is employed, an α = 0.02 is recommended if there are eighteen or fewer wells and an α = 0.01 is recommended if there are at least nineteen wells within the monitoring network. If a one-of-three testing regime is employed, an α = 0.05 should be used.

3.2.5 A Significant Seasonal Pattern Exists

If a statistically significant seasonal pattern exists and if there is a physical explanation for the seasonality, the background data should be deseasonalized using the procedure described in **Section 2.6**. The background UPL should be calculated based on the deseasonalized data. Results should then be deseasonalized by subtracting the difference between the seasonal mean and the grand mean before comparing results to the UPL.

3.3 Responding to an Identified SSI

If the statistical evaluation indicates that an SSI is present, the data should be evaluated to assess whether the SSI is caused by a release from the CCR unit. If it can be shown that the SSI resulted from a release from another source, from an error in sampling or analysis, or from natural variability, then a demonstration of this must be made in writing and certified by a qualified professional engineer within 90 days of completing the statistical evaluation [40 CFR 257.94(e)(2)]. (The statistical evaluation itself must be completed within 90 days of receiving the analytical data from the laboratory.) If this demonstration is not made within 90 days of completing the statistical evaluation, then the site must begin assessment monitoring [40 CFR 257.94(e)(1)].

3.4 Updating Background

As recommended in the Unified Guidance, background values should be updated every four to eight measurements, assuming no confirmed SSI is identified (USEPA, 2009). (See **Section 4.4** for procedures for updating background if an SSI has been identified.) A Student's *t*-test or the nonparametric Mann-Whitney test (also known as the Wilcoxon rank-sum test) should be conducted to compare the set of new data points against the existing background dataset, as appropriate. An $\alpha = 0.05$ is recommended given the relatively small size of the datasets, particularly if background is updated every four measurements and particularly if the nonparametric Mann-Whitney test is used. However, an α as low as 0.01 may be used if the existing background dataset is sufficiently large (i.e., contains at least five data points) or if Student's *t*-test is used.

If the *t*-test or Mann-Whitney test does not indicate significant differences, the new data should be combined with the existing background data to calculate an updated UPL. Increasing the size of the background dataset will increase the power of subsequent statistical tests.

If the *t*-test or Mann-Whitney test indicates a statistically significant difference between the two populations, then the data should not be combined with the existing background data until further review determines the cause of the difference. If the differences appear to be caused by a release, then the previous background dataset should continue to be used. Absent evidence of a release, the new dataset should be considered more representative of present-day groundwater conditions and used for background. Note that the *t*-test or Mann-Whitney test is used to compare new data to the existing background dataset for the purposes of updating background. The tests are not used to determine whether an SSI is present or whether a release has occurred.

Periodically, spatial variability among background wells may be assessed to determine whether using an interwell or intrawell comparison is appropriate on a constituent-by-constituent basis, as outlined in **Section 3.1**.

SECTION 4

ASSESSMENT MONITORING

A CCR unit must begin assessment monitoring if an SSI is identified and is not attributed to some cause besides a release from the CCR unit. Assessment monitoring must begin within 90 days of identifying the SSI. During this 90-day period, the monitoring well network must be sampled for all Appendix IV constituents [40 CFR 257.95(b)]. Within 90 days of obtaining the results from this sampling event, all of the CCR unit wells must be sampled for all Appendix III constituents and those Appendix IV constituents that were detected during the initial assessment monitoring event [40 CFR 257.95(d)(1)].

After these initial assessment monitoring events, the CCR unit wells must be sampled for all Appendix III constituents and previously detected Appendix IV constituents on a semiannual basis [40 CFR 257.95(d)(1)]. Additionally, the CCR unit wells must be sampled for all Appendix IV constituents on an annual basis [40 CFR 257.95(b)].

As with detection monitoring, if physically independent samples cannot be collected on a semiannual basis, then a reduced monitoring frequency may be warranted. A demonstration must be made documenting the need for – and effectiveness of – a reduced monitoring frequency. This demonstration must be certified by a qualified professional engineer, and monitoring must still be done on at least an annual basis [40 CFR 257.95(c)].

GWPSs must be established for each detected Appendix IV constituent. The GWPS shall be the greater of the background concentration and the MCL established by the USEPA for that constituent. There is no established MCL for cobalt, lead, lithium, and molybdenum. For these constituents, the CCR rules specify a screening level that can be used in place of the MCL. For these constituents, the GWPS shall be the greater of the background concentration and the CCR rule-specified screening level [40 CFR 257.95(h)]. An upper tolerance limit (UTL) with 95% confidence and 95% coverage is often used as the representative background concentration.

A single site-wide GWPS would be recommended for each constituent based on pooled background data, even if natural spatial variability exists. If background data are not pooled, background concentrations and consequently GWPSs would vary from well to well. One difficulty with this approach is that concentrations at one monitoring well may exceed the location-specific GWPS and still be below levels considered as natural background at other locations within the site. The pooled background is often more interpretable and less cumbersome for developing a single background-based GWPS per constituent.

To determine whether a move to corrective action is warranted, a confidence interval constructed on recent data at each compliance well should be compared to the site-wide GWPS. When the lower confidence limit (LCL) of this interval exceeds the GWPS, an assessment of corrective measures may be justified.

When corrective action is not warranted, to return from assessment monitoring to detection monitoring, the CCR rules specify that all Appendix III and IV constituents must be at or below background levels for two consecutive sampling events [40 CFR 257.95(e)]. Procedures for comparing results to background are described in **Section 4.2**.

4.1 Comparing Data to the GWPS

As stated in **Section 4**, the GWPS is set at the MCL (or CCR rule-specified screening level for cobalt, lead, lithium, and molybdenum) or a value based on background data, whichever is higher. The UTL calculated from the background dataset is often used as the background value.

Tolerance intervals are similar to prediction intervals. However, whereas prediction intervals represent a range where a future result is expected to lie, tolerance intervals represent a range where a proportion of the population is expected to lie. Tolerance intervals have both an associated coverage (i.e., the proportion of the population covered by the tolerance interval) and an associated confidence. A coverage of 95% ($\gamma = 0.95$) and a confidence of 95% ($\alpha = 0.05$) are typically used.

The UTL is calculated similarly to the UPL:

$$\mathrm{UTL} = \bar{x} + \tau s \quad (7)$$

Similar to the UPL calculation, $\bar{x}$ is the mean concentration and s is the standard deviation of the background dataset. However, in this case the multiplier τ is different from that of the UPL calculation and is a function of the chosen coverage and confidence and the size of the background dataset. Values of τ are tabulated in Table 17-3 in Appendix D of the Unified Guidance (USEPA, 2009). As with prediction limits, if the τ value that precisely matches site conditions does not appear in these tables, it can be estimated using the provided values by linear interpolation.

Once a GWPS is established, new data must be evaluated to determine whether they are statistically significantly higher than the GWPS. The statistical analyses listed in 40 CFR 257.93(f) are appropriate for comparing new data to a background dataset but are not appropriate for comparing new data to a fixed standard. For these cases, the Unified Guidance recommends using confidence intervals around the mean or median (USEPA, 2009).

Evaluations should be done for each detected Appendix IV constituent at each well. Data from different wells should not be pooled. When selecting which data to include in the recent dataset, time series plots of concentration data at each well should be created and visually inspected. Only data that exhibit the same behavior as recent data should be included. For instance, if the last eight arsenic results cluster around 9 μg/L and the previous eight results cluster around 4 μg/L, then only the eight most recent results should be used in the statistical analysis. Similarly, if chromium concentrations steadily increased over the last ten samples and were stable previously, then the statistical analysis should only use the ten most recent results and (since they are steadily increasing) should involve constructing a confidence interval around a trend line.

At the same time, datasets should also be sufficiently large to maintain statistical power. As many data points that exhibit the same behavior as recent data as possible should be included, including data collected prior to assessment monitoring (e.g., during the initial eight monitoring events). Ideally, datasets should have at least eight data points; in no case should a dataset have fewer than four data points.

If at least 50% of the recent dataset is non-detect, then a parametric confidence interval should not be used, and the procedure in **Section 4.1.1** should be followed.

New data will be evaluated for statistically significant temporal trends using (1) OLS linear regression with a *t*-test ($\alpha = 0.01$) on the slope and/or (2) the non-parametric Theil-Sen slope estimator with Mann-Kendall trend test ($\alpha = 0.05$, or 0.01 for larger datasets). Non-detect data are replaced with half the RL for these analyses. The OLS linear regression or Theil-Sen slope estimator will be used to estimate the rate of change (increasing, no change, or decreasing) over time for each constituent at each well. The *t*-test or Mann-Kendall statistic will be used to determine whether a trend is statistically significant. OLS linear regression should only be used when at most 15% of the data are non-detect, when regression residuals are normally distributed, and when the variance from the regression line does not change over time. The Theil-Sen/Mann-Kendall analysis requires at least five observations for meaningful results; at least eight observations are recommended. If a significant temporal trend exists, then a confidence interval around the trend line should be constructed as outlined in **Section 4.1.3**.

If the trend analysis does not indicate a statistically significant trend, then the mean and variance should be calculated. If fewer than 15% of the data are non-detect, then the non-detect data can be replaced with half the RL and the mean and variance can be calculated normally. Tolerance intervals are sensitive to the choice of population distribution. Normality should be confirmed using the Shapiro-Wilk (or Shapiro-Francía) test and/or probability plots, as described in **Section 2.2**. If data appear not to be normally distributed, data should be transformed so that the transformed data are normally distributed.

Two methods – the Kaplan-Meier or Robust ROS method – can be used to determine the sample mean and variance when 15% to 50% of the data are non-detect. Kaplan-Meier should not be used if all non-detect data have the same RL or if the maximum detected value is less than the highest RL of the non-detect data.

When most of the data are detections, data are normally distributed, and there is no significant temporal trend, the LCL is calculated according to the following equation:

$$\text{LCL} = \bar{x} - t_{1-\alpha,n-1} * \frac{s}{\sqrt{n}} \quad (8)$$

where:

$\bar{x} =$	mean concentration of the recent dataset
$t_{1-\alpha,n-1} =$	one-tailed t-value at a confidence of 1 – α and at n – 1 degrees of freedom
$s =$	standard deviation of the recent dataset
$n =$	number of samples in the recent dataset

The *t* value must be chosen in such a way to balance the competing goals of a low false-positive rate and a high statistical power. The Unified Guidance recommends that the statistical test have at least 80% power ($1 - \beta = 0.8$) when the underlying mean concentration is twice the MCL (USEPA, 2009). Values of the minimum α (from which *t* values can be determined) are tabulated for this criterion for various values of *n* in Table 22-2 in Appendix D of the Unified Guidance (USEPA, 2009). The selected α should be the maximum of the value in Table 22-2 and 0.01.

If data are transformed normal, the LCL should first be calculated for the transformed data and then be transformed back into concentration terms. Correction factors are available but are not expected to be required. Alternatively, a non-parametric LCL can be used, as described in **Section 4.1.2**.

If data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, then a non-parametric LCL should be used, as described in **Section 4.1.2**.

If the LCL exceeds the GWPS, then a statistically significant exceedance can be concluded. If this occurs, the owner/operator is required to take several actions, including potentially moving the facility to corrective action, as described in **Section 4.3**.

4.1.1 Most Data Are Non-Detect

If background data are mostly non-detect, non-parametric tolerance intervals should be used. In these cases, the UTL is set at either the highest or second-highest concentration observed in the background dataset. If all background data are non-detect, then the UTL would default to the RL. The highest or second-highest observed concentration (or RL) effectively becomes the GWPS when this value is greater than the MCL (or CCR rule-specified screening level for cobalt, lead, lithium, and molybdenum). However, if most background data are non-detect, then detected concentrations are likely less than the MCL (or CCR rule-specified screening level), and the GWPS will be set at the MCL (or CCR rule-specified screening level).

If recent data are mostly non-detect, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the LCL equal to one of the lower values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

However, if most of the recent data are non-detect, then the data point selected for the LCL will also be non-detect. If the RL is less than the GWPS, then no statistically significant exceedance has occurred.

GWPSs should only be determined for detected Appendix IV constituents [40 CFR 257.95(d)(2)]. If all the data for a constituent are non-detect, no statistical evaluation need be performed.

4.1.2 Data Are neither Normal nor Transformed-Normal

If background data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, then non-parametric tolerance intervals should be used. In these cases, the UTL is set at either the highest or second-highest concentration observed in the background dataset.

If recent data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the LCL equal to one of the lower values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

4.1.3 A Significant Temporal Trend Exists

If recent data show a significant temporal trend, then an LCL below the trend line can be calculated according to the following equation:

$$\text{LCL} = \widehat{x_0} - \sqrt{2s_e^2 * F_{1-2\alpha,2,n-2} * \left(\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1)s_t^2}\right)} \quad (9)$$

where:

$\widehat{x_0} =$ regression-line estimate of the mean concentration at time t_0
$s_e =$ standard error of the regression line
$F_{1-2\alpha,2,n-2} =$ upper (1 - 2α)th percentage point from an *F*-distribution with 2 and n – 2 degrees of freedom
$n =$ number of samples in the recent dataset
$t_0 =$ date of the most recent groundwater sample
$\bar{t} =$ mean of the sampling dates in the recent dataset
$s_t =$ standard deviation of the sampling dates in the recent dataset

Note that the LCL is a function of time; to assess current compliance, the date of the most recent sample should be used for t_0. If and only if the LCL is greater than the GWPS at this time, then a statistically significant exceedance can be concluded. This equation can also be used to assess when the LCL will exceed the GWPS (assuming the current trend continues).

The same α that would have been selected if there were no significant trend (as described in **Section 4.1**) should be used here to determine the proper *F* value.

If the Theil-Sen method is used to determine the trend line, a computationally intensive technique known as bootstrapping can be used to determine the LCL. This procedure is described in Section 21.3.2 of the Unified Guidance (USEPA, 2009).

4.1.4 A Significant Seasonal Pattern Exists

If a statistically significant seasonal pattern exists in the background data and if there is a physical explanation for the seasonality, the background data should be deseasonalized using the procedure described in **Section 2.6**. The background-based UTL should be calculated based on the deseasonalized data, and the GWPS should be set at the MCL (or CCR rule-specified screening level) or the background-based UTL, whichever is greater.

Similarly, if a statistically significant seasonal pattern exists in compliance well data and if there is a physical explanation for the seasonality, the compliance well data should be deseasonalized using the procedure described in **Section 2.6**. The LCL to be compared to the GWPS should be calculated based on the deseasonalized compliance well data.

4.2 Comparing Data to Background

Assessment monitoring data must be compared to the GWPS (the higher of the MCL, CCR rule-specified level, or background level) to assess whether corrective action is warranted at the CCR unit (i.e. the LCL exceeds the GWPS). Additionally, assessment monitoring data may be compared to background data to assess whether the CCR unit can move from assessment monitoring back to detection monitoring.

To return from assessment monitoring to detection monitoring, the CCR rules specify that all Appendix III and IV constituents must be at or below background levels for two consecutive sampling events [40 CFR 257.95(e)]. However, the analysis of all Appendix III and IV constituents is not required for every monitoring event. Therefore, all Appendix III and IV constituents should be collected during two consecutive sampling events on a periodic basis (e.g., every two to four years) and/or when statistical evaluation of assessment monitoring data suggests groundwater concentrations are at or below background levels.

A UTL can be used to represent "a reasonable maximum on likely background concentrations" for Appendix III and IV constituents (USEPA, 2009). As described previously, UTLs can be determined parametrically or non-parametrically. For the parametric intervals, the UTL is calculated according to Equation 7. Non-parametric UTLs can be determined by setting the UTL to the highest or second-highest measured background value. If all background data are non-detect, then non-detect results in compliance wells can be considered statistically similar to background. If a temporal trend in background data exists and is not attributable to a release, background data can be truncated so that no significant temporal trend is evident.

To determine whether Appendix III and IV constituents are at or below background levels, a confidence interval constructed on recent data at each compliance monitoring well should be compared to the background UTL for each constituent. When the upper confidence limit (UCL) is below the background UTL, then it can be concluded that concentrations are at or below background. If UCLs are less than background UTLs for every constituent at every monitoring well for two consecutive events, then the CCR unit may return to detection monitoring.

When most of the data are detections, data are normally distributed, and there is no significant temporal trend, the UCL is calculated according to the following equation:

$$\text{UCL} = \bar{x} + t_{1-\alpha,n-1} * \frac{s}{\sqrt{n}} \quad (10)$$

where:

$\bar{x} =$	mean concentration of the recent dataset
$t_{1-\alpha,n-1} =$	one-tailed *t*-value at a confidence of $1 - \alpha$ and at $n - 1$ degrees of freedom
$s =$	standard deviation of the recent dataset
$n =$	number of samples in the recent dataset

If recent data are mostly non-detect or are non-normal and cannot be transformed such that the transformed data follow a normal distribution, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the UCL equal to one of the higher values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

If recent data show a significant temporal trend, then a UCL above the trend line can be calculated according to the following equation:

$$\mathrm{UCL} = \widehat{x_0} + \sqrt{2s_e^2 * F_{1-2\alpha,2,n-2} * \left(\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1)s_t^2}\right)} \quad (11)$$

where:

$\widehat{x_0} =$ regression-line estimate of the mean concentration at time t_0
$s_e =$ standard error of the regression line
$F_{1-2\alpha,2,n-2} =$ upper (1 - 2α)th percentage point from an F-distribution with 2 and $n - 2$ degrees of freedom
$n =$ number of samples in the recent dataset
$t_0 =$ date of the most recent groundwater sample
$\bar{t} =$ mean of the sampling dates in the recent dataset
$s_t =$ standard deviation of the sampling dates in the recent dataset

In all cases, the choice of τ and α (for parametric UTLs and UCLs, respectively), the choice of the highest or second-highest data point (for non-parametric UTLs and UCLs), etc. should be made based on sound statistical judgment and site characteristics (e.g., size of datasets, number of monitoring wells, etc.).

4.3 Required Responses to the Results of the Statistical Evaluation

If the statistical evaluation demonstrates that the concentrations of all Appendix III and Appendix IV constituents are at or below background levels for two consecutive sampling events, then the CCR unit may return to detection monitoring [40 CFR 257.95(e)]. A notification that the CCR unit is returning to detection monitoring must be placed in the facility's operating record.

If the statistical evaluation demonstrates that some Appendix III or Appendix IV constituents are at concentrations above background levels but there are no statistically significant exceedances of GWPSs, then the CCR unit must remain in assessment monitoring [40 CFR 257.95(f)].

If the statistical evaluation demonstrates that an Appendix IV constituent is present at a statistically significant level (SSL) above its GWPS (i.e., if the LCL exceeds the GWPS), then the owner/operator must:

- Include a notification in the facility's operating record that identifies the constituents exceeding GWPSs [40 CFR 257.95(g)];
- Characterize the nature and extent of the release, including installing monitoring wells needed to delineate the plume, installing a monitoring well at the downgradient property boundary, quantifying the nature and the amount of the release, and sampling all wells for Appendix III and detected Appendix IV constituents [40 CFR 257.95(g)(1)];
- If the plume has migrated off-site, notify property owners overlying the plume [40 CFR 257.95(g)(2)]; and
- Either begin an assessment of corrective measures or demonstrate that the SSL is not due to a release from the CCR unit within 90 days of completing the statistical evaluation [40 CFR 257.95(g)(3)]. This demonstration must be made in writing and certified by a qualified professional engineer. The CCR rules require the previous three actions to be taken even if it can be demonstrated that the SSL is not due to a release from the CCR unit.

Reporting requirements for assessment monitoring are summarized in **Section 6.2**.

4.4 Updating Background

Care should be taken when updating background during assessment monitoring since, by definition, an SSI over background has already occurred. Data that appear to be affected by a release from the CCR unit should not be included in updated background datasets. However, it may be possible to update some background datasets (e.g., constituents not associated with a release, wells upgradient of the CCR unit, etc.). Formal updating of Appendix III constituents may be considered when there are at least four new points.

Data should be reviewed every four to eight measurements to assess the possibility of updating background datasets. Professional judgment should first be applied; any data that appear to be affected by a release should be excluded from the background update, even if there is no statistically significant difference between the new data and the existing background data.

For data that appear not to be affected by a release, a Student's *t*-test or Mann-Whitney test should be conducted to compare the set of new data points against the existing background dataset. If the *t*-test or Mann-Whitney test corroborates that there are no significant differences, the new data should be combined with the existing background data to create an updated and expanded background dataset. Increasing the size of the background dataset will increase the power of subsequent statistical tests.

If the *t*-test or Mann-Whitney test indicates a statistically significant difference between the two datasets, then it should be considered that the difference results from a release and the existing background dataset should continue to be used. If and only if there is evidence to suggest that the difference is not related to a release from the CCR unit, then the newer set of measurements should be used for background so that resulting statistical limits are representative of present-day groundwater quality conditions.

Periodically, spatial variability among background wells may be re-assessed to determine whether using an interwell or intrawell comparison is appropriate on a constituent-by-constituent basis, as outlined in **Section 3.1**.

SECTION 5

CORRECTIVE ACTION MONITORING

A CCR unit must begin an assessment of corrective measures if an SSL is identified and is not attributed to some cause other than a release from the CCR unit. The assessment of corrective measures must begin within 90 days of identifying the SSL [40 CFR 257.95(g)(3)]. Based on the results of the corrective measures assessment, a remedy must be selected as soon as feasible [40 CFR 257.97(a)]. A schedule for implementing and completing the remedial activities must be included in the remedy selection [40 CFR 257.97(d)]. The owner/operator must begin remedial activities within 90 days of selecting a remedy, and a corrective action groundwater monitoring program must be implemented based on the schedule established as part of the remedy selection [40 CFR 257.98(a)].

The corrective action monitoring program must:

- Meet the requirements of an assessment monitoring program [40 CFR 257.98(a)(1)(i)];
- Document the effectiveness of the remedy [40 CFR 257.98(a)(1)(ii)]; and
- Demonstrate compliance with the GWPS [40 CFR 257.98(a)(1)(iii)].

The statistical methods used in corrective action monitoring are similar to those used in assessment monitoring. For each detected Appendix IV constituent, a GWPS is set at the MCL (or CCR rule-specified screening level for cobalt, lead, lithium, and molybdenum) or a value based on background data, whichever is greater. A confidence interval is constructed based on recent data at each compliance well, and the confidence interval is compared to the site-wide GWPS. However, in assessment monitoring, the presumption is that a release has not occurred, and a release is concluded when average concentrations are higher than the GWPS (i.e., when the *lower* confidence limit [LCL] is *greater* than the GWPS). If a CCR unit is in corrective action monitoring, then evidence of a release has already been identified. Therefore, in corrective action monitoring, the presumption is that a release has occurred, and the conclusion that the remedy has successfully decreased concentrations below the GWPS is made when average concentrations are less than the GWPS (i.e., when the *upper* confidence limit [UCL] is *less* than the GWPS). (Note that this presumption only applies to well-constituent pairs where an SSL has previously been identified. Well-constituent pairs in assessment monitoring where an SSL has not been identified effectively remain in assessment monitoring until the entire unit returns to detection monitoring.)

A remedy is considered complete when, among other things, confidence intervals constructed for Appendix IV constituents for wells identified with SSLs have not exceeded the GWPS for three consecutive years [40 CFR 257.98(c)(2)]. In this instance, a return to assessment monitoring would be warranted.

Upon completion of the remedy, the owner/operator must prepare a notification stating that the remedy is complete. The notification must be certified by a qualified professional engineer or approved by the State Director or USEPA and placed in the operating record [40 CFR 257.98(e)]. Otherwise, the owner/operator should follow the reporting requirements for assessment monitoring, as summarized in **Section 6.2**.

5.1 Comparing Data to the GWPS

As stated in **Section 5**, the GWPS is set at the MCL (or CCR rule-specified screening level for cobalt, lead, lithium, and molybdenum) or a value based on background data, whichever is greater. The UTL calculated from the background dataset is often used as the background value. The UTL is calculated as described in **Section 4.1**. Methods for updating background are described in **Section 4.4**.

For well-constituent pairs in corrective action monitoring, new data must be evaluated to determine whether they are statistically significantly lower than the GWPS. The statistical analyses listed in 40 CFR 257.93(f) are appropriate for comparing new data to a background dataset but are not appropriate for comparing new data to a fixed standard. For these cases, the Unified Guidance recommends using confidence intervals around the mean or median (USEPA, 2009).

When selecting which data to include in the recent dataset, time series plots of concentration data at each well should be created and visually inspected. Only data that exhibit the same behavior as recent data should be included. For instance, if the last eight arsenic results cluster around 9 µg/L and the previous eight results cluster around 4 µg/L, then only the eight most recent results should be used in the statistical analysis. Similarly, if chromium concentrations steadily increased over the last ten samples and were stable previously, then the statistical analysis should only use the ten most recent results and (since they are steadily increasing) should involve constructing a confidence interval around a trend line.

At the same time, datasets should also be sufficiently large to maintain statistical power. As many data points that exhibit the same behavior as recent data as possible should be included, including data collected prior to assessment monitoring (e.g., during the initial eight monitoring events). Ideally, datasets should have at least eight data points; in no case should a dataset have fewer than four data points.

If at least 50% of the recent dataset is non-detect, then a parametric confidence interval should not be used, and the procedure in **Section 5.1.1** should be followed.

New data will be evaluated for statistically significant temporal trends using (1) OLS linear regression with a *t*-test ($\alpha = 0.01$) on the slope and/or (2) the non-parametric Theil-Sen slope estimator with Mann-Kendall trend test ($\alpha = 0.05$, or 0.01 for larger datasets). Non-detect data are replaced with half the RL for these analyses. The OLS linear regression or Theil-Sen slope estimator will be used to estimate the rate of change (increasing, no change, or decreasing) over time for each constituent at each well. The *t*-test or Mann-Kendall statistic will be used to determine whether a trend is statistically significant. OLS linear regression should only be used when at most 15% of the data are non-detect, when regression residuals are normally distributed, and when the variance from the regression line does not change over time. The Theil-Sen/Mann-Kendall analysis requires at least five observations for meaningful results; at least eight observations are recommended. If a significant temporal trend exists, then a confidence interval around the trend line should be constructed as outlined in **Section 5.1.3**.

If the trend analysis does not indicate a statistically significant trend, then the mean and variance should be calculated. If fewer than 15% of the data are non-detect, then the non-detect data can be replaced with half the RL and the mean and variance can be calculated normally. Tolerance intervals are sensitive to the choice of population distribution. Normality should be confirmed using the Shapiro-Wilk (or Shapiro-Francía) test and/or probability plots, as described in **Section 2.2**. If data appear not to be normally distributed, data should be transformed so that the transformed data are normally distributed.

Two methods – the Kaplan-Meier or Robust ROS method – can be used to determine the sample mean and variance when 15% to 50% of the data are non-detect. Kaplan-Meier should not be used if all non-detect data have the same RL or if the maximum detected value is less than the highest RL of the non-detect data.

When most of the data are detections, data are normally distributed, and there is no significant temporal trend, the UCL is calculated according to the following equation:

$$\mathrm{UCL} = \bar{x} + t_{1-\alpha,n-1} * \frac{s}{\sqrt{n}} \quad (10)$$

where:

$\bar{x} =$	mean concentration of the recent dataset
$t_{1-\alpha,n-1} =$	one-tailed *t*-value at a confidence of 1 – α and at n – 1 degrees of freedom
$s =$	standard deviation of the recent dataset
$n =$	number of samples in the recent dataset

The *t* value must be chosen in such a way to balance the competing goals of a low false-positive rate and a high statistical power. The Unified Guidance recommends that the statistical test have at least 80% power ($1 - \beta = 0.8$) when the underlying mean concentration is twice the MCL (USEPA, 2009). Values of the minimum α (from which *t* values can be determined) are tabulated for this criterion for various values of *n* in Table 22-2 in Appendix D of the Unified Guidance (USEPA, 2009). The selected α should be the maximum of the value in Table 22-2 and 0.01.

If data are transformed normal, the UCL should first be calculated for the transformed data and then be transformed back into concentration terms. Correction factors are available but are not expected to be required. Alternatively, a non-parametric LCL can be used, as described in **Section 5.1.2**.

If data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, then a non-parametric LCL should be used, as described in **Section 5.1.2**.

5.1.1 Most Data are Non-Detect

If recent data are mostly non-detect, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the UCL equal to one of the higher values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

5.1.2 Data Are neither Normal nor Transformed-Normal

If recent data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the UCL equal to one of the higher values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

5.1.3 A Significant Temporal Trend Exists

If recent data show a significant temporal trend, then a UCL above the trend line can be calculated according to the following equation:

$$\mathrm{UCL} = \widehat{x_0} + \sqrt{2s_e^2 * F_{1-2\alpha,2,n-2} * \left(\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1)s_t^2}\right)} \quad (11)$$

where:

$\widehat{x_0} =$ regression-line estimate of the mean concentration at time t_0
$s_e =$ standard error of the regression line
$F_{1-2\alpha,2,n-2} =$ upper (1 - 2α)th percentage point from an *F*-distribution with 2 and *n* – 2 degrees of freedom
$n =$ number of samples in the recent dataset
$t_0 =$ date of the most recent groundwater sample
$\bar{t} =$ mean of the sampling dates in the recent dataset
$s_t =$ standard deviation of the sampling dates in the recent dataset

Note that the UCL is a function of time; to assess current compliance, the date of the most recent sample should be used for t_0. If and only if the UCL is less than the GWPS at this time, then it can be concluded that the remedy has successfully decreased concentrations below the GWPS. This equation can also be used to assess when the UCL will decrease below the GWPS (assuming the current trend continues).

The same α that would have been selected if there were no significant trend (as described in **Section 5.1**) should be used here to determine the proper *F* value.

If the Theil-Sen method is used to determine the trend line, a computationally intensive technique known as bootstrapping can be used to determine the UCL. This procedure is described in Section 21.3.2 of the Unified Guidance (USEPA, 2009).

5.1.4 A Significant Seasonal Pattern Exists

If a statistically significant seasonal pattern exists in compliance well data and if there is a physical explanation for the seasonality, the compliance well data should be deseasonalized using the procedure described in **Section 2.6**. The UCL to be compared to the GWPS should be calculated based on the deseasonalized compliance well data.

SECTION 6

REPORTING REQUIREMENTS

The CCR rule specifies reporting requirements throughout the monitoring process. Throughout the process, the required documentation is required to be posted both to the site's operating record and to a public internet set for review. As required by 40 CFR 257.93(f)(6), the chosen statistical methods described within this SAP are certified by a qualified professional engineer as appropriate for groundwater evaluation (**Section 7**).

By August 1, 2019, all existing facilities must submit an initial Annual Groundwater Monitoring and Corrective Action Report (Annual Report) [40 CFR 257.90(e)]. The Annual Report should be prepared and posted to both the site operating record and the public internet site. A notification should be sent to the State Director (and/or appropriate tribal authority) once the Annual Report is available.

The Annual Report should document site status, summarize key actions taken, describe problems encountered and their resolutions, and project key actions to be taken for the following year. The Annual Report should also include:

- A figure showing the CCR unit and the monitoring well network [40 CFR 257.90(e)(1)];
- An identification of monitoring wells installed or abandoned during the preceding year and the rationale for doing so [40 CFR 257.90(e)(2)];
- A summary of groundwater samples collected, which wells were sampled, what dates the samples were collected, and whether the samples were collected for detection monitoring, assessment monitoring, or corrective action monitoring [40 CFR 257.90(e)(3)]; and
- A discussion of any transition between monitoring programs (i.e., detection monitoring vs. assessment monitoring vs. corrective action monitoring) [40 CFR 257.90(e)(4)].

If appropriate, the Annual Report should detail a demonstration for an alternative groundwater sampling frequency. If no SSIs are identified during each sampling event, an updated Annual Report should be submitted yearly. If SSIs are identified, additional reporting requirements are summarized below.

6.1 Detection Monitoring

If SSIs are identified, the facility should demonstrate within 90 days of the detection, where possible, that SSIs over background are not due to a release from the facility, along with a certification by a qualified professional engineer that the information is accurate. If the SSIs over background are attributed to a release from the facility, the facility should prepare and place on the operating record within 90 days a notification stating that an assessment monitoring program has been established [40 CFR 257.94(e)(3)].

6.2 Assessment Monitoring

If an assessment monitoring program is in place, the Annual Report must also include [40 CFR 257.95(d)(3)]:

- Analytical results for Appendix III and detected Appendix IV constituents,
- Background concentrations for all Appendix III and Appendix IV constituents, and
- GWPSs established for detected Appendix IV constituents.

The semiannual analytical results for Appendix III and detected Appendix IV constituents must also be posted to the facility's operating record within 90 days of receipt [40 CFR 257.95(d)(1)].

If a constituent is detected at an SSL above its GWPS, a notification must be reported to the site's operating record. Additionally, the facility must notify any person who owns or resides on land that directly overlies any part of an off-site contaminant plume and record the notifications in the facility's operating record. Within 90 days, the facility must either initiate an assessment of corrective measures or demonstrate that the SSL is not due to a release from the CCR unit. The demonstration must be supported by a report certified by a qualified professional engineer [40 CFR 257.95(g)].

If statistics are performed by mid-May 2019 for the first compliance event, one or more resamples would normally be collected and re-analyzed within 90 days. By the end of August 2019, the initial exceedance will be either confirmed or determined to be a false positive. If it is confirmed, then assessment monitoring must be initiated within 90 days, which would fall at the same time as the next regular semi-annual event. In that case, the semi-annual event (September/October timeframe) would be for both assessment and detection monitoring (if assessment monitoring was initiated).

If the facility determines it may return to detection monitoring, the facility should issue a notification to the operating record and public site within 30 days.

6.3 Corrective Action Monitoring

If a corrective action monitoring program is in place, it must meet the requirements of an assessment monitoring program [40 CFR 257.98(a)(1)(i)]. Thus, the reporting requirements for corrective action monitoring will be similar to assessment monitoring, as described in **Section 6.2**. Upon completion of the remedy, the facility must prepare a notification that the remedy has been completed. The notification must be certified by a qualified professional engineer or approved by the State Director or USEPA and placed in the operating record [40 CFR 257.98(e)]

SECTION 7

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

By means of this certification, I certify that I am a qualified professional engineer as defined in 40 CFR 257.53, that I have reviewed this SAP, and that the statistical methods described therein are appropriate and meet the requirements of 40 CFR 257.93.

DAVID ANTHONY MILLER

Printed Name of Qualified Professional Engineer

DAVID ANTHONY MILLER
REGISTERED
22663
STATE OF
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PROFESSIONAL ENGINEER

David Anthony Miller

Signature

22663	WEST VIRGINIA	01.22.2021
Registration No.	Registration State	Date

SECTION 8

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Table 1

Monitored Constituents Under the CCR Rules

Appendix III to 40 CFR 257 – Constituents for Detection Monitoring

Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)

Appendix IV to 40 CFR 257 – Constituents for Assessment Monitoring

Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 combined

APPENDIX A

RECORD OF REVISIONS

Revision 1 (January 2021)

- Added statistical procedures used to implement corrective action monitoring (Section 5) and reporting requirements for corrective action monitoring (Section 6.3).
- Added references to CCR rule-specified screening levels for constituents that do not have an MCL (i.e., cobalt, lead, lithium, and molybdenum) in Sections 2.5, 4, 4.1, and 5.1.
- Removed text from Section 4 regarding a potential assessment monitoring approach for constituents that do not have an MCL because the CCR rule was revised to specify screening levels for these constituents.
- Added statistical procedures used to evaluate whether a seasonal pattern exists and to deseasonalize data (Sections 2.6, 3.2.5, 4.1.4, and 5.1.4).
- Specified that the Mann-Kendall trend test can use an α of 0.01 for sufficiently large datasets (Sections 3.1, 4.1, and 5.1).
- Removed references to control limits in Section 3.2 because prediction limits are generally being used to conduct detection monitoring.
- Removed references to using trend tests to evaluate SSIs at the end of Section 3.2 because prediction limits are generally being used to conduct detection monitoring.
- Clarified that non-parametric limits should be used when data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution (Sections 3.2.3, 4.1.2, and 5.1.2).
- Referred to the Wilcoxon rank-sum/Mann-Whitney test as the Mann-Whitney test to match the statistical output from Sanitas (Sections 3.4 and 4.4).
- Clarified that a background dataset that contains at least five data points is sufficiently large to use an α as low as 0.01 to conduct the Mann-Whitney test as part of a background update, in line with recommendations in the Unified Guidance (Section 3.4).
- Clarified the procedure to be used if the Mann-Whitney test indicates a statistically significant difference between existing background data and newer data (Sections 3.4 and 4.4).

- Clarified that spatial variability among background wells may be assessed periodically as part of a background update because spatial variability is evaluated when background values are initially established (Sections 3.4 and 4.4).

- Clarified that UPLs are used to establish background values for Appendix III constituents and UTLs are used to establish background values for Appendix IV constituents (Section 4.2).

- Added statistical procedures to determine when Appendix III and Appendix IV concentrations are at or below background to evaluate whether units in assessment monitoring may return to detection monitoring (Section 4.2).

- Generally replaced "parameter" with "constituent".

- Added references to the Unified Guidance and the CCR rule throughout the document.

- Made minor grammatical and stylistic changes throughout the document.

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Memorandum

Date: February 5, 2021

To: David Miller (AEP)

Copies to: Ben Kepchar (AEP)

From: Allison Kreinberg (Geosyntec)

Subject: Evaluation of Detection Monitoring Data at Amos Plant's Fly Ash Pond (FAP)

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257 Subpart D, "CCR rule"), the second semi-annual detection monitoring event of 2020 at the Fly Ash Pond (FAP), an existing CCR unit at the Amos Power Plant located in Winfield, West Virginia, was completed on October 27-29 and November 2-4, 2020. Based on the results, verification sampling was completed on January 6-7, 2021.

Eight background monitoring events were conducted at the Amos FAP prior to this detection monitoring event, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. Lower prediction limits (LPLs) were also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated July 15, 2019 and revised on March 3, 2020.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is concluded only if both samples in a series of two exceed the UPL (or are below the LPL for pH). In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are compared in Table 1 and noted exceedances are described in the list below.

- Calcium concentrations exceeded the intrawell UPL of 7.79 mg/L in both the initial (9.50 mg/L) and second (9.31 mg/L) samples collected at MW-5. Therefore, an SSI over background is concluded for calcium at MW-5.

- Chloride concentrations exceeded the intrawell UPL of 6.93 mg/L in both the initial (7.12 mg/L) and second (9.72 mg/L) samples collected at MW-1804A. Therefore, an SSI over background is concluded for chloride at MW-1804A.

- Fluoride concentrations exceeded the intrawell UPL of 0.264 mg/L in both the initial (0.28 mg/L) and second (0.30 mg/L) samples collected at MW-6 and the intrawell UPL of 0.304 mg/L in both the initial (0.31 mg/L) and second (0.31 mg/L) samples collected at MW-7. Therefore, SSIs over background are concluded for fluoride at MW-6 and MW-7.

- Sulfate concentrations exceeded the intrawell UPL of 0.20 mg/L in both the initial (25.1 mg/L) and second (14.6 mg/L) samples collected at MW-5 and intrawell UPL of 53.9 mg/L in both the initial (57.0 mg/L) and second (69.3 mg/L) samples collected at MW-1804A. Therefore, SSIs over background are concluded for sulfate at MW-5 and MW-1804A.

In response to the exceedances noted above, the Amos FAP CCR unit will either transition to assessment monitoring or an alternative source demonstration (ASD) for calcium, chloride, fluoride, and sulfate will be conducted in accordance with 40 CFR 257.94(e)(2). If the ASD is successful, the Amos FAP will remain in detection monitoring.

The statistical analysis was conducted within 90 days of completion of sampling and analysis in accordance with 40 CFR 257.93(h)(2). A certification of these statistics by a qualified professional engineer is provided in Attachment A.

Table 1: Detection Monitoring Data Evalation
Amos Plant - Fly Ash Pond

Analyte	Unit	Description	MW-1	MW-2	MW-5		MW-6		MW-7		MW-8		MW-9	MW-1801A	MW-1804A		MW-1806A
			11/2/2020	11/2/2020	10/27/2020	1/7/2021	10/27/2020	1/7/2021	10/28/2020	1/6/2021	10/26/2020	1/7/2021	10/29/2020	11/4/2020	11/3/2020	1/6/2021	10/29/2020
Boron	mg/L	Intrawell Background Value (UPL)	0.261	0.382	0.355		0.159		0.248		0.320		0.192	0.459	0.965		0.235
		Analytical Result	0.097	0.194	0.207	--	0.089	--	0.065	--	0.215	--	0.128	0.244	0.549	--	0.153
Calcium	mg/L	Intrawell Background Value (UPL)	3.58	4.66	7.79		70.6		1.63		3.06		1.63	75.4	51.2		18.8
		Analytical Result	2.70	4.13	**9.50**	**9.31**	53.4	--	**1.81**	1.53	**8.47**	2.46	1.44	62.4	4.70	--	7.38
Chloride	mg/L	Intrawell Background Value (UPL)	14.6	495	853		21.4		5.80		120		8.00	12.4	6.93		24.6
		Analytical Result	10.5	435	729	--	16.5	--	5.34	--	**508**	107	6.93	8.84	**7.12**	**9.72**	10.2
Fluoride	mg/L	Intrawell Background Value (UPL)	0.485	3.39	3.72		0.264		0.304		3.11		0.976	0.162	1.10		1.14
		Analytical Result	0.48	3.24	3.24	--	**0.28**	**0.30**	**0.31**	**0.31**	3.07	--	0.90	0.12	0.86	--	0.85
pH	SU	Intrawell Background Value (UPL)	8.8	8.9	8.4		7.3		9.3		9.8		11.4	8.8	8.8		9.3
		Intrawell Background Value (LPL)	7.7	8.0	7.8		6.3		8.0		7.0		6.1	5.9	6.8		7.2
		Analytical Result	8.4	8.6	8.2	--	7.1	--	8.9	--	8.4	--	7.1	7.3	8.0	--	8.7
Sulfate	mg/L	Intrawell Background Value (UPL)	55.9	26.7	0.200		48.0		33.6		36.5		36.2	61.2	53.9		61.4
		Analytical Result	33.6	6.6	**25.1**	**14.6**	38.6	--	31.2	--	**37.4**	18.3	11.1	41.5	**57.0**	**69.3**	49.7
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	536	1,410	1,980		424		458		798		640	518	599		485
		Analytical Result	434	1,310	1,770	--	384	--	387	--	**1,400**	729	459	385	517	--	480

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the July 15, 2019 *Statistical Analysis Summary* report (revised March 3, 2020), is appropriate for evaluating the groundwater monitoring data for the Amos FAP CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER REGISTERED 22663 STATE OF WEST VIRGINIA PROFESSIONAL ENGINEER

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

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Memorandum

Date: August 30, 2021

To: David Miller (AEP)

Copies to: Ben Kepchar (AEP)

From: Allison Kreinberg (Geosyntec)

Subject: Evaluation of Detection Monitoring Data at Amos Plant's Fly Ash Pond (FAP)

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257 Subpart D, "CCR rule"), the first semi-annual detection monitoring event of 2021 at the Fly Ash Pond (FAP), an existing inactive CCR unit at the Amos Power Plant located in Winfield, West Virginia, was completed on May 5-12, 2021. Based on the results, verification sampling was completed on July 20-21, 2021.

Eight background monitoring events were conducted at the Amos FAP prior to this detection monitoring event, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. Lower prediction limits (LPLs) were also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated July 15, 2019 and revised on March 3, 2020.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is concluded only if both samples in a series of two exceed the UPL (or are below the LPL for pH). In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are compared in Table 1 and noted exceedances are described in the list below.

- Fluoride concentrations exceeded the intrawell UPL of 0.26 mg/L in both the initial (0.32 mg/L) and second (0.27 mg/L) samples collected at MW-6. Therefore, an SSI over background is concluded for fluoride at MW-6.

- Sulfate concentrations exceeded the intrawell UPL of 0.20 mg/L in both the initial (13.7 mg/L) and second (45.9 mg/L) samples collected at MW-5. Therefore, an SSI over background is concluded for sulfate at MW-5.

In response to the exceedances noted above, the Amos FAP CCR unit will either transition to assessment monitoring or an alternative source demonstration (ASD) for fluoride and sulfate will be conducted in accordance with 40 CFR 257.94(e)(2). If the ASD is successful, the Amos FAP will remain in detection monitoring.

The statistical analysis was conducted within 90 days of completion of sampling and analysis in accordance with 40 CFR 257.93(h)(2). A certification of these statistics by a qualified professional engineer is provided in Attachment A.

Table 1: Detection Monitoring Data Evalation
Amos Plant - Fly Ash Pond

Analyte	Unit	Description	MW-1		MW-2	MW-5		MW-6		MW-7	MW-8	MW-9	MW-1801A	MW-1804A		MW-1806A
			5/5/2021	7/21/2021	5/5/2021	5/5/2021	7/21/2021	5/6/2021	7/21/2021	5/12/2021	5/7/2021	5/6/2021	5/6/2021	5/6/2021	7/20/2021	5/6/2021
Boron	mg/L	Intrawell Background Value (UPL)	0.261		0.382	0.355		0.159		0.248	0.320	0.192	0.459	0.965		0.235
		Analytical Result	0.111	--	0.230	0.203	--	0.074	--	0.055	0.180	0.109	0.090	0.565	--	0.123
Calcium	mg/L	Intrawell Background Value (UPL)	3.58		4.66	7.79		70.6		1.63	3.06	1.63	75.4	51.2		18.8
		Analytical Result	2.65	--	4.07	7.23	--	49.7	--	1.46	2.19	1.01	56.4	3.98	--	2.01
Chloride	mg/L	Intrawell Background Value (UPL)	14.6		495	853		21.4		5.80	120	8.00	12.4	6.93		24.6
		Analytical Result	11.0	--	480	773	--	15.4	--	5.45	109	7.08	6.75	**10.6**	6.22	8.82
Fluoride	mg/L	Intrawell Background Value (UPL)	0.49		3.39	3.72		0.26		0.304	3.11	0.976	0.162	1.10		1.14
		Analytical Result	**0.51**	0.49	3.24	3.31	--	**0.32**	**0.27**	0.30	2.99	0.92	0.12	0.97	--	0.95
pH	SU	Intrawell Background Value (UPL)	8.8		8.9	8.4		7.3		9.3	9.8	11.4	8.8	8.8		9.3
		Intrawell Background Value (LPL)	7.7		8.0	7.8		6.3		8.0	7.0	6.1	5.9	6.8		7.2
		Analytical Result	8.3	--	8.4	8.1	--	6.9	--	8.8	8.5	9.0	7.1	8.1	--	9.0
Sulfate	mg/L	Intrawell Background Value (UPL)	55.9		26.7	0.200		48.0		33.6	36.5	36.2	61.2	53.9		61.4
		Analytical Result	32.9	--	13.1	**13.7**	**45.9**	35.8	--	31.1	20.2	14.4	30.5	**57.3**	47.3	33.8
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	536		1,410	1,980		424		458	798	640	518	599		485
		Analytical Result	448	--	1,310	1,750	--	400	--	401	711	448	304	533	--	449

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by a Qualified Professional Engineer

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the July 15, 2019 *Statistical Analysis Summary* report (revised March 3, 2020), is appropriate for evaluating the groundwater monitoring data for the Amos FAP CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER REGISTERED 22663 STATE OF WEST VIRGINIA PROFESSIONAL ENGINEER

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

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STATISTICAL ANALYSIS SUMMARY-
Background Update Calculations
Fly Ash Pond –
John E. Amos Plant
Winfield, West Virginia

Submitted to

AMERICAN ELECTRIC POWER

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December 28, 2021
CHA8500

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LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Value
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
FAP	Fly Ash Pond
LFB	Laboratory Fortified Blanks
LPL	Lower Prediction Limit
LRB	Laboratory Reagent Blanks
NELAP	National Environmental Laboratory Accreditation Program
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257 Subpart D, "CCR rule"), groundwater monitoring has been conducted at the Fly Ash Pond (FAP), an inactive CCR unit at the John E. Amos Power Plant located in Winfield, West Virginia. Recent groundwater monitoring results were incorporated into the FAP background dataset as appropriate and the site-specific background values were re-established for use in future detection monitoring events.

Eight monitoring events were completed prior to February 2019 to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. Since then, five semiannual detection monitoring events were conducted between March 2019 and July 2021. Data from these five events, including both initial and verification results, were evaluated for inclusion in the background dataset. 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 the usability of the data.

The detection monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. The compliance data were reviewed for outliers, with seven values removed prior to updating upper prediction limits (UPLs) for each Appendix III parameter to represent background values.

Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

FLY ASH POND EVALUATION

2.1 Previous Background Calculations

Eight background monitoring events were completed from July 2018 through February 2019 to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. The data were reviewed for outliers and trends prior to calculating upper prediction limits (UPLs) for each Appendix III parameter. Lower prediction limits (LPLs) were also established for pH. Analysis of variance (ANOVA) was conducted during the initial background screening to assist in identifying if intrawell tests are the most appropriate statistical approach for assessing Appendix III parameters. ANOVA indicated significant variation among the five background wells for all Appendix III parameters. Based on this statistical screening, intrawell methods were recommended for calcium, pH, and sulfate and interwell methods were recommended for boron, chloride, fluoride, and total dissolved solids (TDS). However, a review of site geochemistry identified differences in groundwater composition between upgradient and downgradient wells due to natural variation. Thus, intrawell prediction limits were selected for all parameters with a one-of-two resampling plan. The statistical analyses to establish background levels are detailed in the March 2020 *Statistical Analysis Summary* report (Geosyntec, 2020a).

2.2 Data Validation & QA/QC

Five semiannual detection monitoring events have been conducted at the FAP since the background dataset was originally established. If the initial results for each detection monitoring event identified possible exceedances, verification sampling was completed on an individual well/parameter basis. Thus, a minimum of five samples were collected from each compliance well since background was established. A summary of data collected during these detection monitoring events is provided in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

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.9.6.21g statistics software. The export was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.3 Statistical Analysis

The data used to conduct the statistical analyses described below are summarized in Table 1. Statistical analyses for the FAP were conducted in accordance with the October 2020 *Statistical Analysis Plan* (Geosyntec, 2020b). The complete statistical analysis results are included in Attachment B.

Time series plots of Appendix III parameters are included in Attachment B and were used to evaluate concentrations over time and to provide an initial screening of suspected outliers and trends. Box plots were also compiled to provide visual representation of variations between wells and within individual wells (Attachment B).

2.3.1 Outlier Evaluation

Potential outliers were evaluated using Tukey's outlier test; i.e., data points were considered potential outliers if they met one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (1)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (2)$$

where:

$x_i =$ individual data point
$\tilde{x}_{0.25} =$ first quartile
$\tilde{x}_{0.75} =$ third quartile
$IQR =$ the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

Data that were evaluated as potential outliers are summarized in Attachment B. Tukey's outlier test and visual inspection indicated several potential outliers. Next, the data were reviewed to identify possible sources of errors or discrepancies, including data recording errors, unusual sampling conditions, laboratory quality, or inconsistent sample turbidity. After further review, seven results were removed from the dataset, including:

- The calcium concentrations of 168 mg/L at MW-1807B from November 3, 2020, and 8.47 mg/L at MW-8 from October 26, 2020;
- The chloride concentration of 508 mg/L at MW-8 from October 26, 2020;
- The pH value of 5.12 at MW-1809A from January 25, 2019;
- The sulfate concentration of 55.9 mg/L at MW-1 from January 23, 2019; and

- The TDS values of 1,020 mg/L at MW-1807B on November 3, 2020 and 1,400 mg/L at MW-8 from October 26, 2020.

Flagged data and outliers will be reevaluated as new data are collected.

2.3.2 Establishment of Updated Background Dataset

Intrawell tests compare compliance data from a single well to background data within the same well and are most appropriate when 1) upgradient wells exhibit spatial variation; 2) when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; or 3) when downgradient water quality is not impacted compared to upgradient water quality for the same parameter. Periodic updating of background statistical limits is necessary as natural systems continuously change due to physical changes to the environment. For intrawell analyses, data for all wells and parameters are re-evaluated when a minimum of four new data points are available. These four (or more) new data points are used to determine if earlier concentrations are representative of present-day groundwater quality.

Mann-Whitney (Wilcoxon rank-sum) tests were used to compare the medians of historical data (July 2018 – February 2019) to the new compliance samples (March 2019 – July 2021). Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset would have continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. Significant differences were found between the two groups for the following upgradient well/parameter pairs:

- An increase was found for calcium at MW-1810A;
- Increases were found for chloride at MW-1707B and MW-1809A; and,
- An increase was found for sulfate at MW-1808A; and,
- An increase was found for TDS at MW-1808A.

During this background update, the datasets for all upgradient wells were updated because these data represent naturally occurring groundwater quality and are not impacted by a release.

Significant differences were found between the two groups for the following downgradient well/parameter pairs:

- A decrease was found for boron at MW-5;
- An increase was found for calcium at MW-5;
- An increase was found for chloride at MW-1804A, and a decrease was found for chloride at MW-6;
- An increase was found for fluoride at MW-6; and,
- Increases were found for sulfate at MW-1804A and MW-5, and a decrease was found for sulfate at MW-6.

For downgradient well/parameter pairs with statistically significant differences in medians, if at least one of the results in the newer data was similar to historical data or the results had similar patterns as those in upgradient wells, the background dataset was updated to include the newer data. Similar patterns between upgradient and downgradient monitoring wells indicate that the groundwater quality may be naturally changing unrelated to the site. Therefore, the construction of intrawell prediction limits at these wells used all historical data through July 2021. Exceptions to this included chloride and sulfate in MW-1804A and sulfate in MW-5, in which a significant increase was found between the medians of the historical and compliance datasets. Alternative source demonstrations (ASDs) conducted in June 2020 and December 2020 by EHS Support LLC (EHS) indicated that the increases in sulfate and chloride concentrations were likely due to both natural variability and lower purge rates of more recent samples compared to historical samples (EHS, 2020a and 2020b). Because the higher concentrations were not attributed to a release from the FAP and the current results are more representative of present-day conditions, the background datasets for these well/parameter pairs were truncated to the eight most recent data.

During the next background update, data from all wells and parameters will be re-evaluated to determine whether the more historical data are no longer representative of present-day groundwater quality.

2.3.3 Updated Prediction Limits

After the revised background set was established, a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., “J-flagged” data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one-half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment B.

Except as noted in Section 2.3.2, intrawell UPLs were updated using all the historical data through July 2021 to represent background values. Intrawell LPLs were also generated for pH. The updated prediction limits are summarized in Table 2.

The intrawell UPLs and LPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL and the pH result is greater than or equal to the LPL, then it can be concluded that an SSI has not occurred. In practice, where the initial result does not exceed the UPL and the pH result is greater than or equal to the LPL, 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.

2.4 Conclusions

Five detection monitoring events were completed in accordance with the CCR Rule. The laboratory and field data from these events were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. Mann-Whitney tests were completed to evaluate whether data from the detection monitoring events could be added to the existing background dataset. Where appropriate, the background datasets were updated, and UPLs and LPLs were recalculated. Intrawell tests using a one-of-two retesting procedure were selected and updated for all Appendix III parameters

SECTION 3

REFERENCES

EHS Support LLC. 2020a. Alternative Source Demonstration Report for Calcium, Chloride and Sulfate - John E. Amos Plant Fly Ash Pond, Winfield, West Virginia. June 2020.

EHS Support LLC. 2020b. Addendum Report to Alternative Source Demonstration Report for Calcium and Sulfate - John E. Amos Plant Fly Ash Pond, Winfield, West Virginia. November 2020.

Geosyntec Consultants, 2020a. Statistical Analysis Summary. Fly Ash Pond – John E. Amos Plant. March 2020.

Geosyntec Consultants. 2020b. Statistical Analysis Plan. October 2020.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March.

TABLES

Table 1: Groundwater Data Summary
Amos Plant - Fly Ash Pond

Parameter	Unit	MW-1						MW-2					
		3/12/2019	11/8/2019	5/13/2020	11/2/2020	5/5/2021	7/21/2021	3/13/2019	11/12/2019	2/11/2020	5/12/2020	11/2/2020	5/5/2021
		2019-D1	2019-D2	2020-D1	2020-D2	2021-D1	2021-D1-R1	2019-D1	2019-D2	2019-D2-R1	2020-D1	2020-D2	2021-D1
Boron	mg/L	0.110	0.114	0.122	0.097	0.111	-	0.230	0.265	-	0.214	0.194	0.230
Calcium	mg/L	2.60	2.38	2.74	2.70	2.65	-	3.98	4.77	4.31	4.35	4.13	4.07
Chloride	mg/L	11.0	11.2	11.2	10.5	11.0		441	426	-	443	435	480
Fluoride	mg/L	0.43	0.42	0.42	0.48	0.51	0.49	3.02	2.73	-	2.91	3.24	3.24
Sulfate	mg/L	31.6	33.7	33.6	33.6	32.9	-	1.8	20.1	-	6 J	6.6	13.1
Total Dissolved Solids	mg/L	458	461	457	434	448	-	1,300	1,340	-	1,340	1,310	1,310
pH	SU	8.2	8.2	8.2	8.4	8.3	8.1	8.7	8.5	8.3	8.6	8.6	8.4

Parameter	Unit	MW-5									MW-6						
		3/13/2019	11/8/2019	2/11/2020	5/11/2020	7/7/2020	10/27/2020	1/7/2021	5/5/2021	7/21/2021	3/12/2019	11/8/2019	5/11/2020	10/27/2020	1/7/2021	5/6/2021	7/21/2021
		2019-D1	2019-D2	2019-D2-R1	2020-D1	2020-D1-R1	2020-D2	2020-D2-R1	2021-D1	2021-D1-R1	2019-D1	2019-D2	2020-D1	2020-D2	2020-D2-R1	2021-D1	2021-D1-R1
Boron	mg/L	0.229	0.182	-	0.211	-	0.207	-	0.203	-	0.08 J	0.079	0.088	0.089	-	0.074	-
Calcium	mg/L	6.85	21.0	11.3	9.85	8.77	9.50	9.31	7.23	-	57.9	56.6	55.8	53.4	-	49.7	-
Chloride	mg/L	804	663	713	746	-	729	-	773	-	17.4	17.2	15.9	16.5	-	15.4	-
Fluoride	mg/L	3.44	3.04	-	2.97	-	3.24	-	3.31	-	0.23	0.24	0.25	0.28	0.30	0.32	0.27
Sulfate	mg/L	0.08 J	32.0	18.6	11.0	22.8	25.1	14.6	13.7	45.9	39.8	41.7	32.6	38.6	-	35.8	-
Total Dissolved Solids	mg/L	1,930	1,840	-	1,820	-	1,770	-	1,750	-	390	368	416	384	-	400	-
pH	SU	8.0	8.0	7.8	7.9	8.1	8.2	8.1	8.1	8.0	6.9	6.9	7.0	7.1	7.1	6.9	6.8

Parameter	Unit	MW-7							MW-8					
		3/12/2019	11/11/2019	2/11/2020	5/11/2020	10/28/2020	1/6/2021	5/12/2021	3/12/2019	11/8/2019	5/12/2020	10/26/2020	1/7/2021	5/7/2021
		2019-D1	2019-D2	2019-D2-R1	2020-D1	2020-D2	2020-D2-R1	2021-D1	2019-D1	2019-D2	2020-D1	2020-D2	2020-D2-R1	2021-D1
Boron	mg/L	0.06 J	0.066	-	0.067	0.065	-	0.055	0.192	0.197	0.191	0.215	-	0.180
Calcium	mg/L	1.47	2.18	1.39	1.59	1.81	1.53	1.46	2.32	1.98	1.83	8.47	2.46	2.19
Chloride	mg/L	5.49	5.36	-	5.30	5.34	-	5.45	110	109	108	508	107	109
Fluoride	mg/L	0.27	0.25	-	0.27	0.31	0.31	0.30	2.87	2.97	2.73	3.07	-	2.99
Sulfate	mg/L	32.5	32.3	-	23.6	31.2	-	31.1	27.4	22.5	19.9	37.4	18.3	20.2
Total Dissolved Solids	mg/L	385	390	-	395	387	-	401	716	717	720	1,400	729	711
pH	SU	8.9	8.7	8.5	8.4	8.9	9.0	8.8	8.5	8.3	7.3	8.4	8.2	8.5

Parameter	Unit	MW-9					MW-1801A				
		3/12/2019	11/8/2019	5/13/2020	10/29/2020	5/6/2021	3/12/2019	11/11/2019	5/13/2020	11/4/2020	5/6/2021
		2019-D1	2019-D2	2020-D1	2020-D2	2021-D1	2019-D1	2019-D2	2020-D1	2020-D2	2021-D1
Boron	mg/L	0.122	0.133	0.122	0.128	0.109	0.09 J	0.229	0.105	0.244	0.090
Calcium	mg/L	1.18	1.02	0.959	1.44	1.01	51.2	61.6	52.6	62.4	56.4
Chloride	mg/L	7.50	7.72	7.27	6.93	7.08	9.40	9.76	9.93	8.84	6.75
Fluoride	mg/L	0.91	0.83	0.82	0.90	0.92	0.16	0.12	0.13	0.12	0.12
Sulfate	mg/L	24.0	19.1	12.0	11.1	14.4	41.7	45.3	34.6	41.5	30.5
Total Dissolved Solids	mg/L	463	440	459	459	448	306	385	353	385	304
pH	SU	9.0	8.8	9.0	7.1	9.0	7.5	7.4	7.6	7.3	7.1

Notes:
mg/L: milligrams per liter
SU: standard unit
U: Parameter was not present in concentrations above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
--: Not Measured
D1: First semi-annual detection monitoring event of the year
D2: Second semi-annual detection monitoring event of the year
R1: First verification event associated with detection monitoring round

Table 1: Groundwater Data Summary
Amos Plant - Fly Ash Pond

Parameter	Unit	MW-1804A								MW-1806A				
		3/12/2019	11/11/2019	2/12/2020	5/14/2020	11/3/2020	1/6/2021	5/6/2021	7/20/2021	3/12/2019	11/12/2019	5/15/2020	10/29/2020	5/6/2021
		2019-D1	2019-D2	2019-D2-R1	2020-D1	2020-D2	2020-D2-R1	2021-D1	2021-D1-R1	2019-D1	2019-D2	2020-D1	2020-D2	2021-D1
Boron	mg/L	0.568	0.730	-	0.739	0.549	-	0.565	-	0.130	0.156	0.127	0.153	0.123
Calcium	mg/L	10.2	6.77	-	4.51	4.70	-	3.98	-	4.98	13.5	2.32	7.38	2.01
Chloride	mg/L	3.55	11.2	9.59	6.20	7.12	9.72	10.6	6.22	5.51	11.1	8.45	10.2	8.82
Fluoride	mg/L	0.85	0.64	-	0.85	0.86	-	0.97	-	0.83	0.48	0.86	0.85	0.95
Sulfate	mg/L	34.0	85.4	69.0	51.4	57.0	69.3	57.3	47.3	32.9	42.8	35.2	49.7	33.8
Total Dissolved Solids	mg/L	411	582	-	484	517	-	533	-	430	423	456	480	449
pH	SU	7.9	8.0	7.8	8.1	8.0	8.2	8.1	7.8	8.8	7.9	8.8	8.7	9.0

Parameter	Unit	MW-1807A					MW-1807B					MW-1808A				
		3/14/2019	11/11/2019	5/12/2020	10/28/2020	5/6/2021	3/14/2019	11/11/2019	5/13/2020	11/3/2020	5/11/2021	3/14/2019	11/11/2019	5/13/2020	11/3/2020	5/7/2021
		2019-D1	2019-D2	2020-D1	2020-D2	2021-D1	2019-D1	2019-D2	2020-D1	2020-D2	2021-D1	2019-D1	2019-D2	2020-D1	2020-D2	2021-D1
Boron	mg/L	0.09 J	0.074	0.088	0.069	0.082	0.163	0.189	0.170	0.079	0.182	0.112	0.131	0.124	0.119	0.152
Calcium	mg/L	160	173	159	170	153	12.7	12.7	8.70	168	8.93	62.9	29.3	69.6	54.3	28.7
Chloride	mg/L	11.1	11.9	10.8	12.4	10.2	10.8	13.3	10.5	10.9	12.3	20.9	17.1	23.3	25.6	25.0
Fluoride	mg/L	0.15	0.13	0.12	0.13	0.17	1.19	1.40	1.13	0.18	1.46	0.33	0.45	0.29	0.44	0.53
Sulfate	mg/L	363	392	358	392	328	249	247	224	343	193	290	235	321	300	276
Total Dissolved Solids	mg/L	1,020	1,070	1,040	1,020	936	793	807	783	1,020	787	912	887	1,010	1,050	1,070
pH	SU	6.7	6.9	6.7	7.0	6.8	7.9	8.0	7.7	6.7	7.8	7.7	7.6	7.0	7.2	7.2

Parameter	Unit	MW-1809A					MW-1810A				
		3/12/2019	11/8/2019	5/13/2020	11/3/2020	5/6/2021	3/12/2019	11/8/2019	5/12/2020	11/3/2020	5/6/2021
		2019-D1	2019-D2	2020-D1	2020-D2	2021-D1	2019-D1	2019-D2	2020-D1	2020-D2	2021-D1
Boron	mg/L	0.05 J	0.096	0.081	0.055	0.062	0.228	0.249	0.226	0.194	0.207
Calcium	mg/L	189	195	179	196	182	30.5	44.5	67.5	53.7	64.0
Chloride	mg/L	31.0	37.6	34.9	33.8	34.8	15.4	15.2	17.2	15.8	17.3
Fluoride	mg/L	0.14	0.15	0.11	0.13	0.14	1.00	0.94	0.78	0.91	0.87
Sulfate	mg/L	396	393	400	391	384	153	256	379	341	373
Total Dissolved Solids	mg/L	1,090	1,110	1,100	1,100	1,090	548	692	993	802	935
pH	SU	7.2	7.0	7.3	6.9	7.1	7.3	7.1	7.4	7.0	7.2

Notes:
mg/L: milligrams per liter
SU: standard unit
U: Parameter was not present in concentrations above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
--: Not Measured
D1: First semi-annual detection monitoring event of the year
D2: Second semi-annual detection monitoring event of the year
R1: First verification event associated with detection monitoring round

Table 2: Background Level Summary
Amos Plant - Fly Ash Pond

Analyte	**Unit**	**Description**	MW-1	MW-2	MW-5	MW-6	MW-7	MW-8	MW-9	MW-1801A	MW-1804A	MW-1806A
Boron	mg/L	Intrawell Background Value (UPL)	0.153	0.348	0.331	0.137	0.146	0.296	0.174	0.388	0.912	0.214
Calcium	mg/L	Intrawell Background Value (UPL)	3.25	4.79	21.0	67.8	2.08	2.91	1.55	72.0	19.2	17.5
Chloride	mg/L	Intrawell Background Value (UPL)	14.6	489	880	21.2	5.67	116	7.95	11.8	16.4	19.3
Fluoride	mg/L	Intrawell Background Value (UPL)	0.521	3.43	3.76	0.324	0.325	3.20	0.970	0.165	1.07	1.13
pH	SU	Intrawell Background Value (UPL)	8.6	8.9	8.3	7.2	9.2	9.4	10.7	8.3	8.5	9.4
		Intrawell Background Value (LPL)	7.9	8.1	7.8	6.5	8.2	7.2	6.6	6.4	7.3	7.3
Sulfate	mg/L	Intrawell Background Value (UPL)	35.1	24.4	59.1	49.8	33.2	38.5	30.9	59.9	108	56.7
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	483	1,380	2,000	429	422	756	529	442	600	488

<u>Notes</u>
UPL: Upper prediction limit
LPL: Lower prediction limit

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Amos Fly Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER REGISTERED 22663 STATE OF WEST VIRGINIA PROFESSIONAL ENGINEER

22663
License Number

WEST VIRGINIA
Licensing State

12.28.21
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS CONSULTING

September 29, 2021

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Amos Fly Ash Pond (FAP)
Background Update - 2021

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the background update of statistical limits for groundwater data at American Electric Power Company's Amos Fly Ash Pond (FAP). The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals (CCR) from Electric Utilities (CCR Rule, 2015) as well as with the United States Environmental Protection Agency (USEPA) Unified Guidance (2009).

Sampling began for the CCR program in 2018, and 8 background samples have been collected at each of the groundwater monitoring wells. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient Wells:** FAP-MW-1807A, FAP-MW-1807B, FAP-MW-1808A, FAP-MW-1809A, and FAP-MW-1810A
- **Downgradient Wells:** FAP-MW-1, FAP-MW-2, FAP-MW-5, FAP-MW-6, FAP-MW-7, FAP-MW-8, FAP-MW-9, FAP-MW-1801A, FAP-MW-1804A, and FAP-MW-1806A

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis was prepared according to the 2019 screening evaluation provided by Groundwater Stats Consulting, and reviewed and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance. The background update discussed in this report was reviewed by Dr. Jim Loftis, Civil & Environmental

Engineering professor emeritus at Colorado State University, Senior Advisor to Groundwater Stats Consulting.

The following Appendix III constituents were evaluated for updating prediction limits: Appendix III parameters – boron, calcium, chloride, fluoride, pH, sulfate, and TDS.

Time series plots for Appendix III constituents at all wells are provided for the purpose of screening data at these wells (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). 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.

During the initial background screening conducted in 2019, data at all wells were evaluated for the following: 1) outliers; 2) trends; 3) most appropriate statistical method for Appendix III parameters based on site characteristics of groundwater data upgradient of the facility; and 4) eligibility of downgradient wells when intrawell statistical methods are recommended. Power curves were provided and demonstrated that the selected statistical methods for Appendix III parameters comply with the USEPA Unified Guidance recommendations as discussed below.

Summary of Statistical Method

- Intrawell prediction limits, combined with a 1-of-2 resample plan for all Appendix III parameters.

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. 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. 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 in background, 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. 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. Below is a discussion of the background update included in this report. In the intrawell case, data for all wells and constituents are 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 some cases, the earlier portion of data are deselected prior to construction of limits in order to provide sensitive limits that will rapidly detect 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 Initial Background Screening - 2019

Outlier Evaluation

Time series plots were used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III constituents were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits. The reports were submitted with the screening. Additionally, any flagged values may be seen in a lighter font and disconnected symbol on the time series graphs, as well as in a lighter font on the accompanying data pages.

Seasonality

No seasonal patterns were observed on the time series plots for any of the detected data; therefore, no deseasonalizing adjustments were made to the data. When seasonal patterns are observed, data may be deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release.

Trends

While trends may be visually apparent, a quantification of the trend and its significance is needed. The Sen's Slope/Mann Kendall trend test was used to evaluate all data at each well to identify statistically significant increasing or decreasing trends. In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. This step serves to eliminate the trend and, thus, reduce variation in background. When statistically significant decreasing trends are present, earlier data are evaluated to determine whether earlier concentration levels are significantly different than current reported concentrations and will be deselected as necessary. When the historical records of data are truncated for the reasons above, a summary report will be provided to show the date ranges used in construction of the statistical limits.

The results of the trend analyses showed a statistically significant decreasing trend for chloride and an increasing trend for sulfate, both in upgradient wells. Both of these trends were relatively low in magnitude when compared to average concentrations within these wells. Additionally, the short background period of record makes it difficult to separate trends from normal year-to-year variation. Therefore, no adjustments were made to the data sets at that time.

Appendix III – Determination of Spatial Variation

The Analysis of Variance (ANOVA) was used to statistically evaluate differences in average concentrations among upgradient wells, which assists in identifying the most appropriate statistical approach. Interwell tests, which compare downgradient well data to statistical limits constructed from pooled upgradient well data, are appropriate when average concentrations are similar across upgradient wells. Intrawell tests, which compare compliance data from a single well to screened historical data within the same well, are appropriate when upgradient wells exhibit spatial variation; when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; and when downgradient water quality is unimpacted compared to upgradient water quality for the same parameter. The ANOVA identified variation among upgradient well data for all of the Appendix III parameters. A summary of these findings was submitted with the screening report.

Based on the statistical screening, intrawell methods were recommended for calcium, pH, and sulfate. Interwell methods were initially recommended for boron, chloride, fluoride, and TDS due to somewhat higher concentrations present in one or more downgradient wells compared to those reported in upgradient wells.

In cases where downgradient average concentrations are higher than observed concentrations upgradient for a given constituent and in cases of unexplained increasing trends in downgradient concentrations, an independent study and hydrogeological investigation is required to identify local geochemical conditions and expected groundwater quality for the region to conclusively validate an intrawell approach. The intrawell method assumes that practices at the site are not influencing background groundwater quality downgradient of the site. If background water quality has historically been affected by the facility, the intrawell limits will serve to detect changes from current, impacted conditions rather than to initially identify such impacts.

Supporting documentation provided by Geosyntec Consultants demonstrated that a review of the geochemistry at the site identified two distinct types of groundwater chemistry, differing between the upgradient and downgradient wells indicating that interwell methods would lead to either false positive results (identifying impacts when there are none) or false negative results (not identifying impacts to groundwater when present in downgradient wells). Therefore, intrawell prediction limits combined with a 1-of-2 resample plan were recommended for all Appendix III parameters.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result, and therefore, no further action is necessary.

Background Update – Fall 2021

Background data sets were evaluated during this analysis for the appropriateness of consolidating new measurements through May 2021 with screened historical data for construction of updated prediction limits. This process requires a minimum of four new measurements as mentioned above. Time series graphs and Tukey's outlier test were used to identify potential outliers. The Mann Whitney test for equality of medians was used to determine whether background data sets were eligible for updating with newer measurements as discussed below.

<u>Outlier Analysis</u>

Prior to constructing prediction limits, proposed background data through May 2021 were evaluated using Tukey's outlier test and visual screening to identify suspected outliers at all wells for boron, calcium, chloride, fluoride, pH, sulfate, and TDS (Figure C). Note that outliers may be identified in the historical data since Tukey's test is currently performed on a comparatively larger data set. When values are identified as outliers by Tukey's test, these measurements are typically flagged with "o" and excluded to reduce variation, better represent background conditions, and provide limits that are conservative from a regulatory perspective. In some cases, potential outliers that are identified by Tukey's test but are not greatly different from the rest of the data are not flagged.

Tukey's test identified several measurements as potential outliers. All values were flagged in the database and deselected prior to construction of statistical limits except for the following well/constituent pairs as the measurements were similar to remaining concentrations within the same well:

- Calcium: FAP-MW-7
- Chloride: FAP-MW-1
- Sulfate: FAP-MW-1807B (upgradient) and FAP-MW-7

For some well/constituent pairs, measurements not identified as significant by Tukey's test were flagged in the database to construct statistical limits that are conservative (i.e., lower) from a regulatory perspective. All flagged values are included on the Outlier Summary following this letter (Figure D). As mentioned above, 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.

<u>Mann-Whitney</u>

Since intrawell prediction limits are used for all wells and Appendix III constituents, the Mann-Whitney test is used to compare the previous background data for each well/constituent to newer data through May 2021. When no statistically significant difference in medians between the two groups is found at a 99% confidence level, the historical data may be updated with newer compliance data.

For boron, calcium, chloride, fluoride, pH, and sulfate the historical data through February 2019 were compared to compliance data through May 2021 at all wells except well FAP-MW-9 (Figure E). Background data sets for well FAP-MW-9 and for total dissolved solids at all wells utilized historical data through November 2018 during the previous background screening due to fewer available samples. Therefore, for these well/constituent pairs, the Mann-Whitney test compared the medians of historical data through November 2018 to more recent compliance data through May 2021 (Figure F).

Statistically significant differences (either an increase or decrease in median concentrations) were found between the two groups for the following well/constituent pairs:

Increase

- Calcium: FAP-MW-1810A (upgradient) and FAP-MW-5
- Chloride: FAP-MW-1807B, FAP-MW-1809A (both upgradient), and FAP-MW-1804A
- Fluoride: FAP-MW-6
- Sulfate: FAP-MW-1804A, FAP-MW-1808A (both upgradient), and FAP-MW-5
- TDS: FAP-MW-1808A (upgradient) and FAP-MW-7

Decrease

- Boron: FAP-MW-5
- Chloride: FAP-MW-6
- Sulfate: FAP-MW-6

Typically, when the test concludes that the medians of the two groups are statistically significantly different, particularly in the downgradient wells, the background data are not updated to include the newer data unless it can be reasonably justified that the change in concentrations reflects a naturally occurring shift unrelated to practices at the site. In studies such as the current one, in which at least one of the segments being compared is of short duration, the comparison is complicated by the fact that normal short-term variation may be mistaken for long-term change in medians.

At this time, all records at upgradient wells were updated since data from these wells represent naturally occurring groundwater quality unimpacted by the facility. Additionally, the shifts between historical and compliance data were generally small. An exception to this is calcium in upgradient well FAP-MW-1810A where the current median is considerably higher than the historical median. However, because the more recent 4 measurements are reflective of changing groundwater quality upgradient of the facility, these data were incorporated into background which resulted in a higher statistical limit. Similarly, there is an obvious, though not statistically significant, increase in sulfate at upgradient well FAP-MW-1810A which also resulted in a higher statistical limit. During the next background update, if reported observations remain stable at the current higher concentrations, the earlier portion of the record may be deselected and only the most recent 8 measurements will be used to construct the intrawell prediction limit.

Regarding downgradient well/constituent pairs with either statistically significant increases or decreases in medians, one or more of the newer measurements were similar to those observed historically or had similar patterns to those observed in upgradient wells. Therefore, these records were updated. Exceptions to this include chloride and sulfate in downgradient well FAP-MW-1804A and sulfate in downgradient well FAP-MW-5. The majority of the more recent concentrations are higher than those reported historically but remain well below those reported in upgradient wells. Therefore, these records were updated to use only the most recent 8 measurements to construct prediction limits since it is assumed current concentrations represent present-day groundwater quality rather than impacts from practices at the facility. A summary of the background date ranges used for these records follows this letter.

<u>Prediction Limits</u>

Updated intrawell prediction limits, combined with a 1-of-2 resample plan, were constructed for each well/constituent pair (Figure G). These limits will be updated in the future when at least 4 new compliance samples are available.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Amos Fly Ash Pond. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

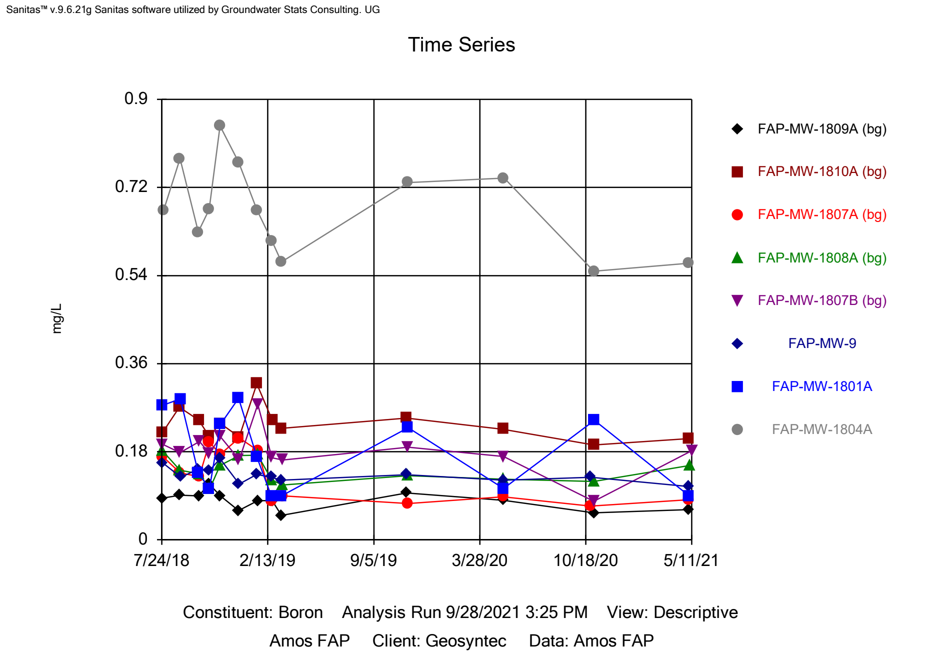
Date Ranges

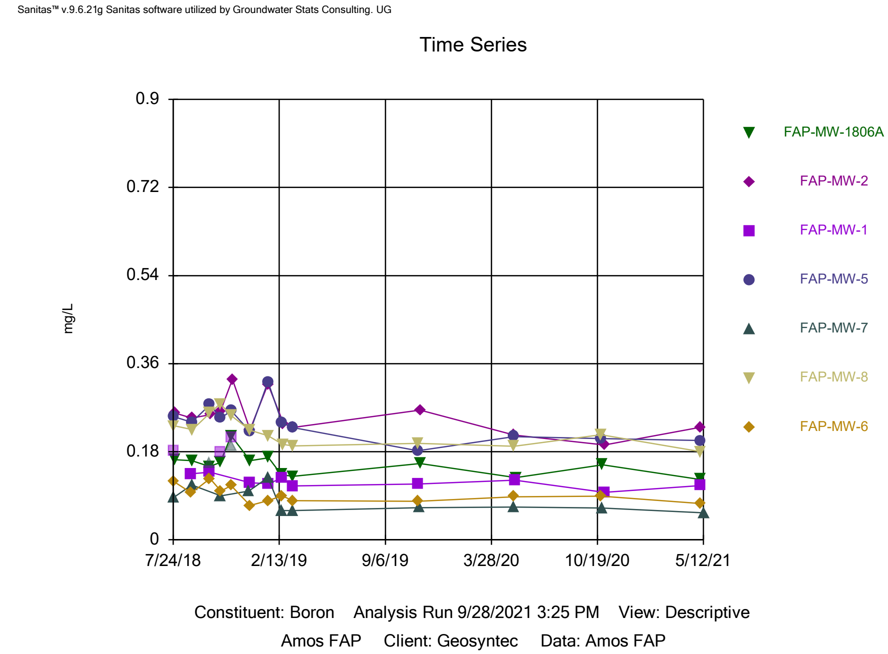
Date: 9/28/2021 3:24 PM

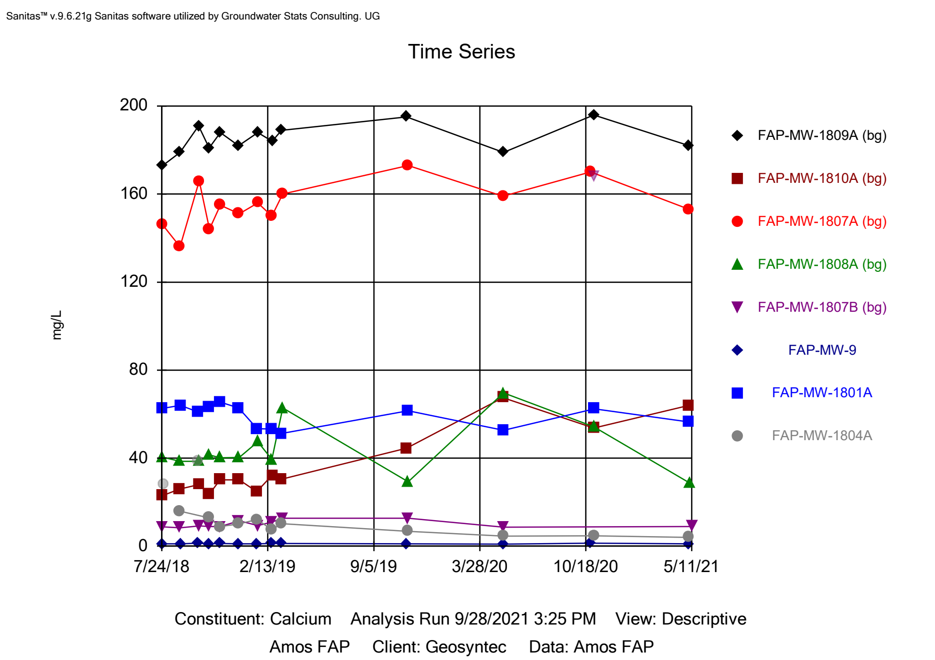
Amos FAP   Client: Geosyntec   Data: Amos FAP

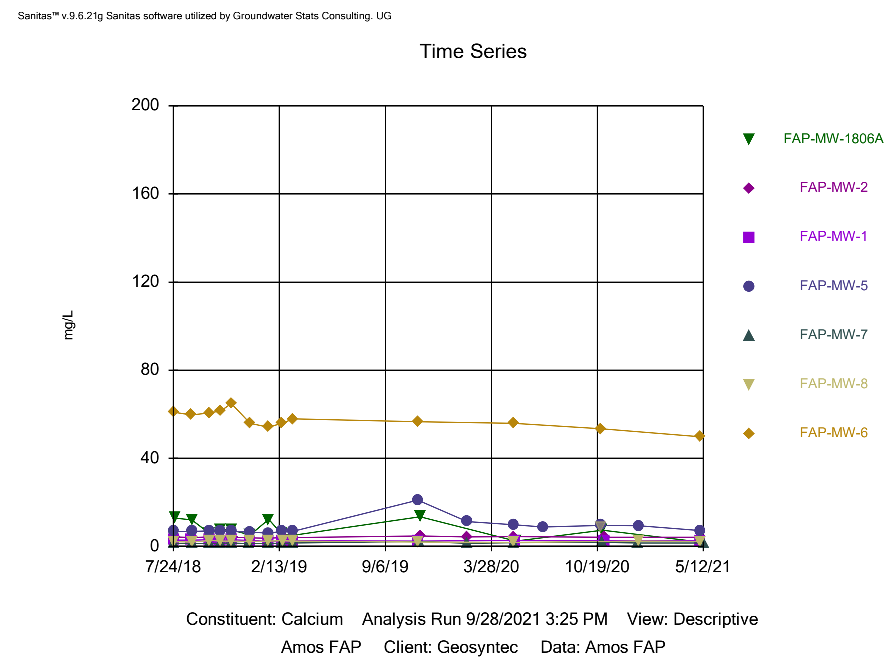
Chloride (mg/L)
- FAP-MW-1804A background:3/12/2019-7/20/2021

Sulfate (mg/L)
- FAP-MW-1804A background:3/12/2019-7/20/2021
- FAP-MW-5 background:11/8/2019-7/21/2021

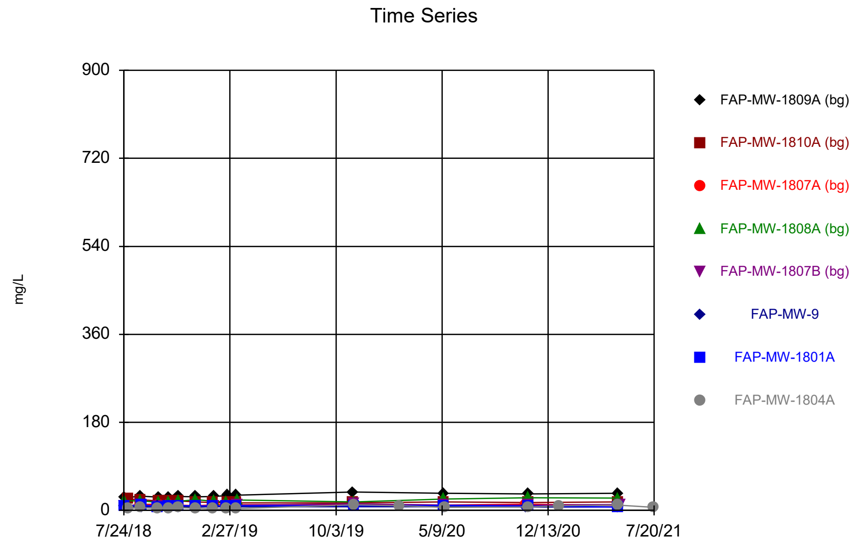

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Time Series
mg/L
0.9
0.72
0.54
0.36
0.18
0
7/24/18
2/13/19
9/5/19
3/28/20
10/18/20
5/11/21
FAP-MW-1809A (bg)
FAP-MW-1810A (bg)
FAP-MW-1807A (bg)
FAP-MW-1808A (bg)
FAP-MW-1807B (bg)
FAP-MW-9
FAP-MW-1801A
FAP-MW-1804A
Constituent: Boron Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Time Series
mg/L
0.9
0.72
0.54
0.36
0.18
0
7/24/18
2/13/19
9/6/19
3/28/20
10/19/20
5/12/21
FAP-MW-1806A
FAP-MW-2
FAP-MW-1
FAP-MW-5
FAP-MW-7
FAP-MW-8
FAP-MW-6
Constituent: Boron Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Time Series
mg/L
200
160
120
80
40
0
7/24/18
2/13/19
9/5/19
3/28/20
10/18/20
5/11/21
FAP-MW-1809A (bg)
FAP-MW-1810A (bg)
FAP-MW-1807A (bg)
FAP-MW-1808A (bg)
FAP-MW-1807B (bg)
FAP-MW-9
FAP-MW-1801A
FAP-MW-1804A
Constituent: Calcium Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

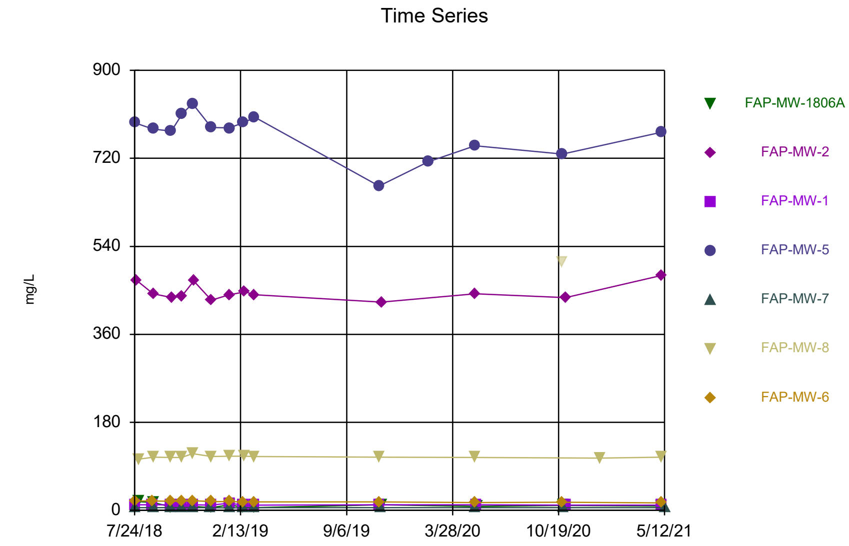

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Time Series
mg/L
200
160
120
80
40
0
7/24/18
2/13/19
9/6/19
3/28/20
10/19/20
5/12/21
FAP-MW-1806A
FAP-MW-2
FAP-MW-1
FAP-MW-5
FAP-MW-7
FAP-MW-8
FAP-MW-6
Constituent: Calcium Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



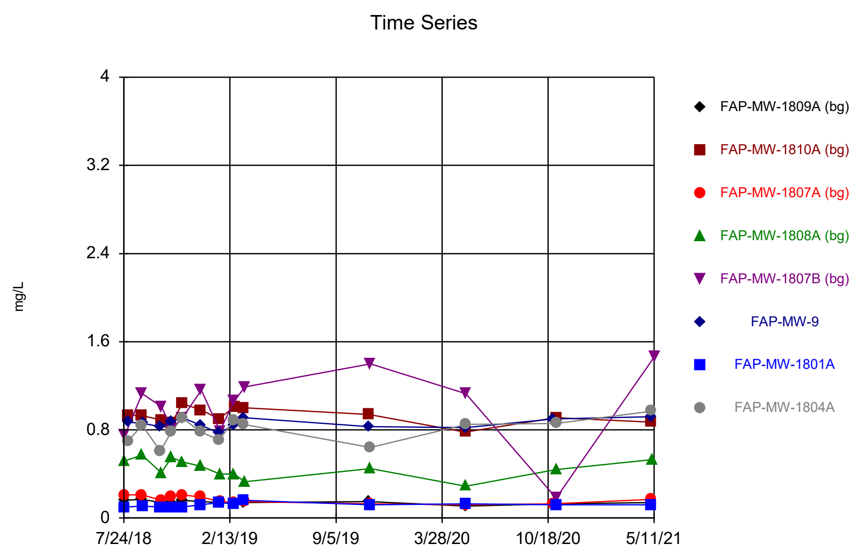
Constituent: Chloride Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Chloride Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



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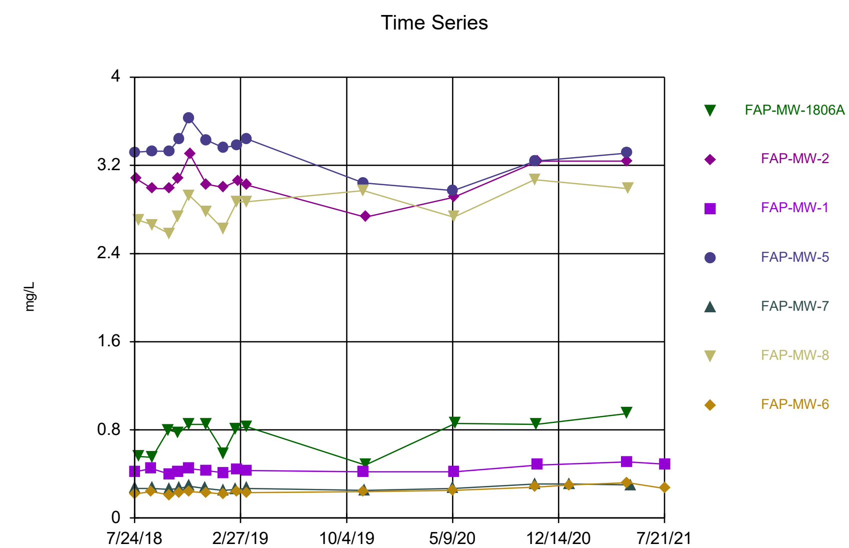
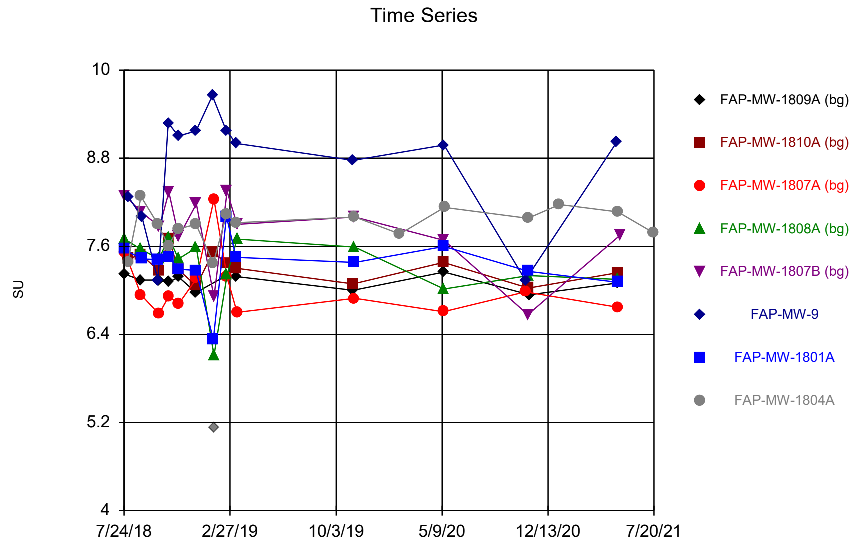
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



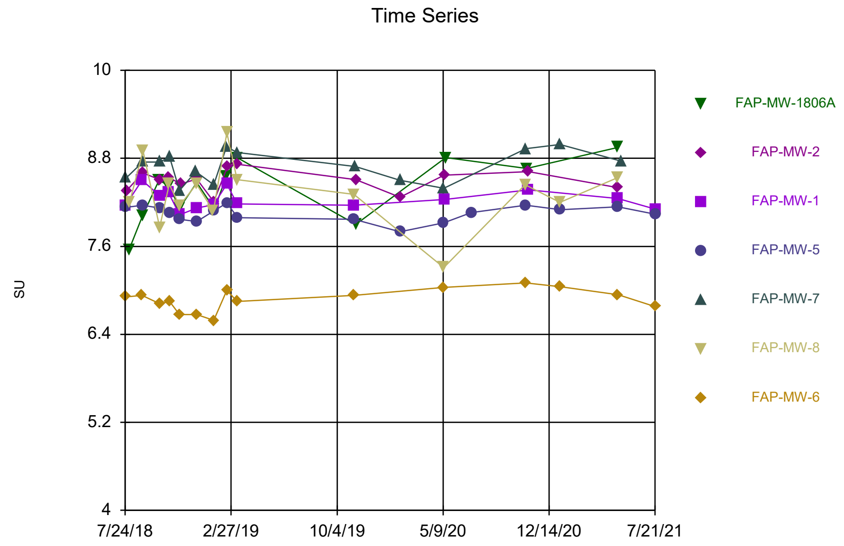
Constituent: Fluoride Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



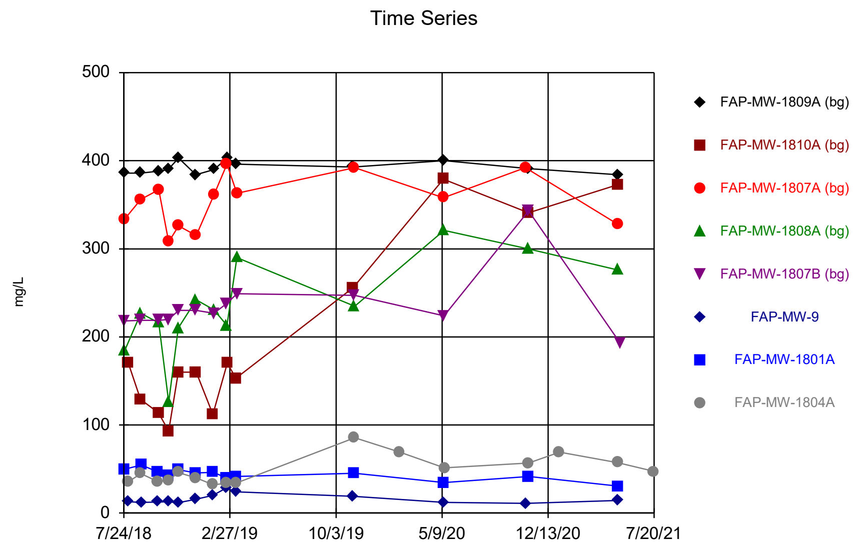
Constituent: pH Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



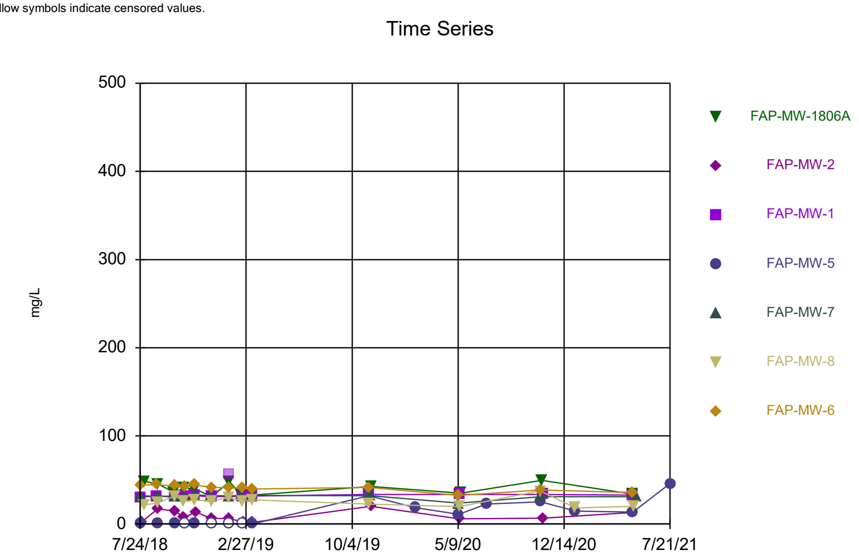
Constituent: pH Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Sulfate Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



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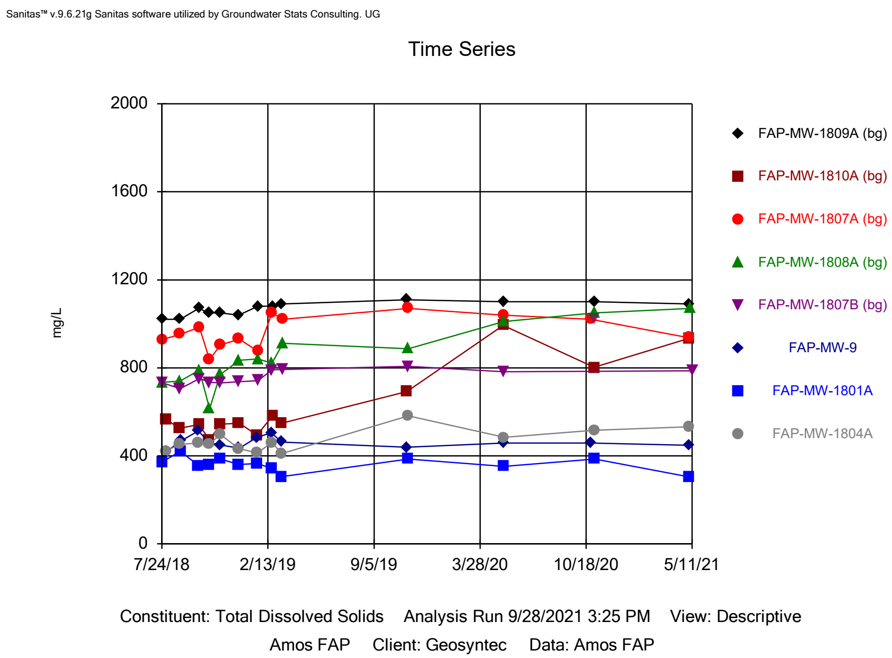
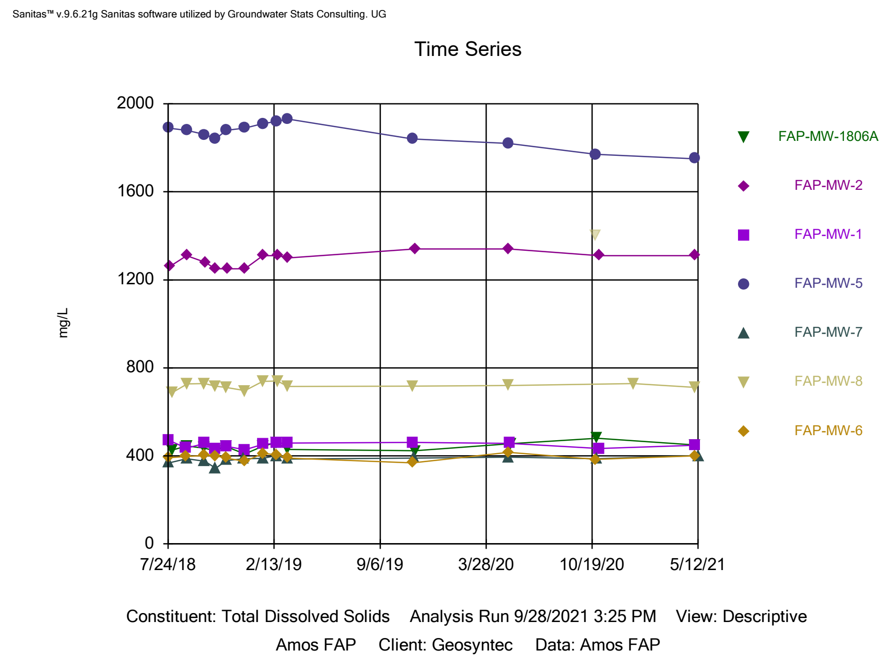
Amos FAP Client: Geosyntec Data: Amos FAP



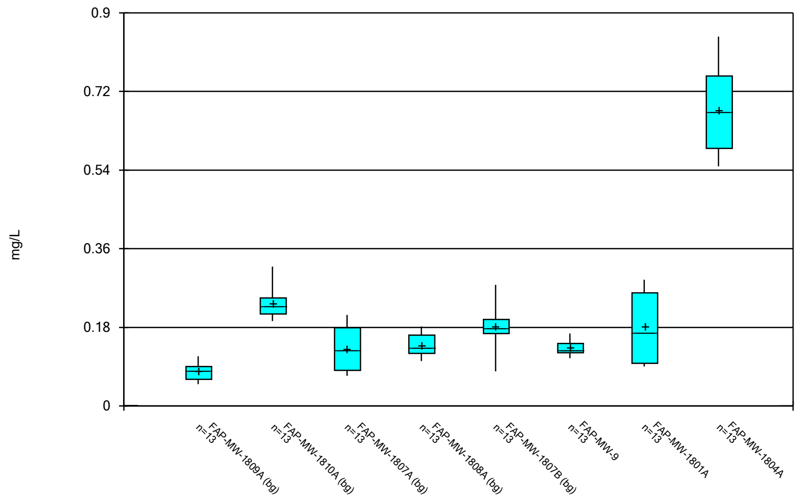
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Time Series
mg/L
2000
1600
1200
800
400
0
7/24/18
2/13/19
9/5/19
3/28/20
10/18/20
5/11/21
FAP-MW-1809A (bg)
FAP-MW-1810A (bg)
FAP-MW-1807A (bg)
FAP-MW-1808A (bg)
FAP-MW-1807B (bg)
FAP-MW-9
FAP-MW-1801A
FAP-MW-1804A
Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP



Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Time Series
mg/L
2000
1600
1200
800
400
0
7/24/18
2/13/19
9/6/19
3/28/20
10/19/20
5/12/21
FAP-MW-1806A
FAP-MW-2
FAP-MW-1
FAP-MW-5
FAP-MW-7
FAP-MW-8
FAP-MW-6
Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:25 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

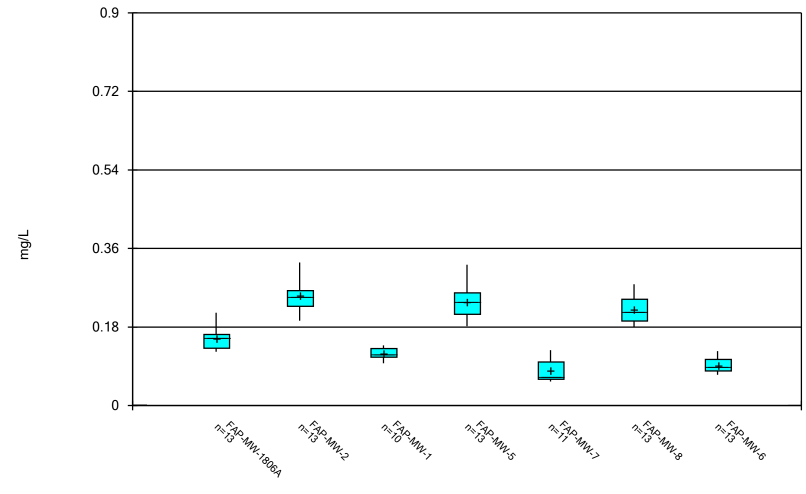
Box & Whiskers Plot



Constituent: Boron Analysis Run 9/28/2021 3:27 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Box & Whiskers Plot



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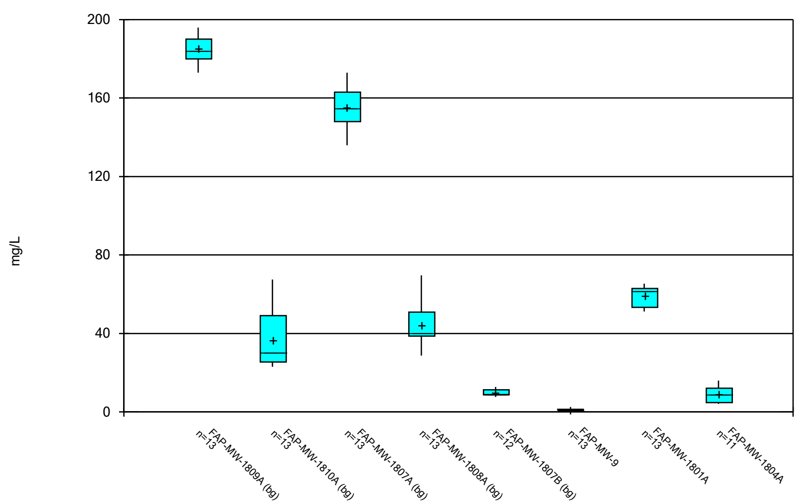
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Box & Whiskers Plot



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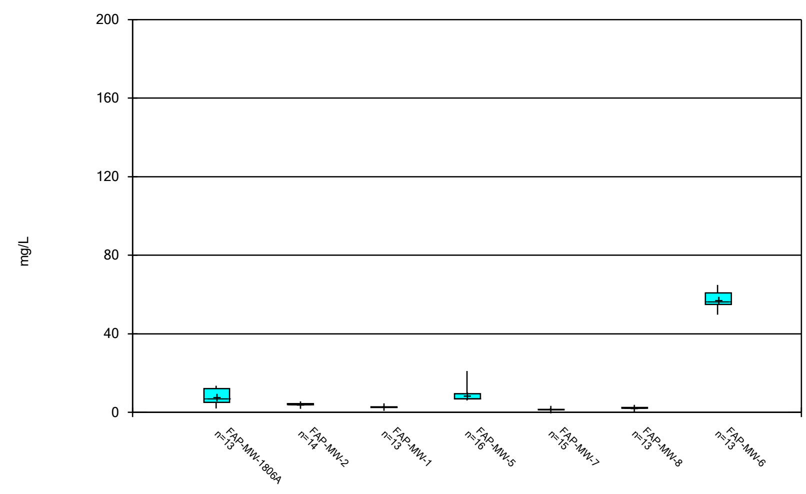
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Box & Whiskers Plot



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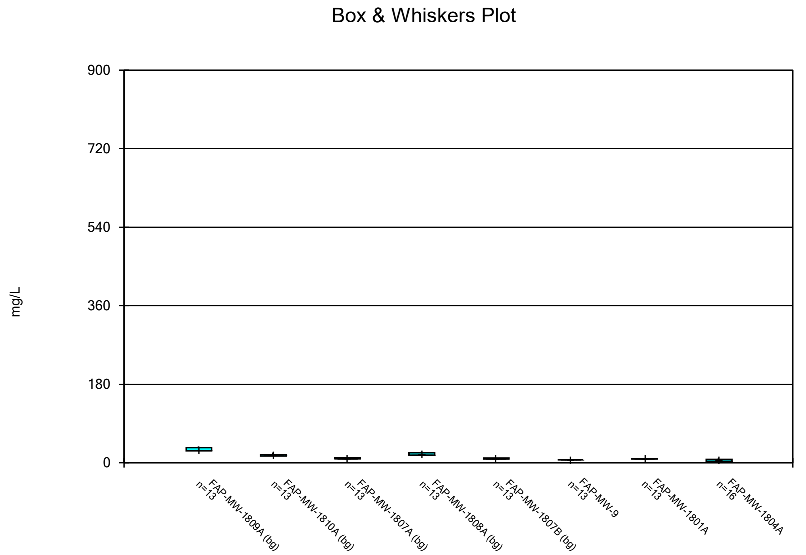
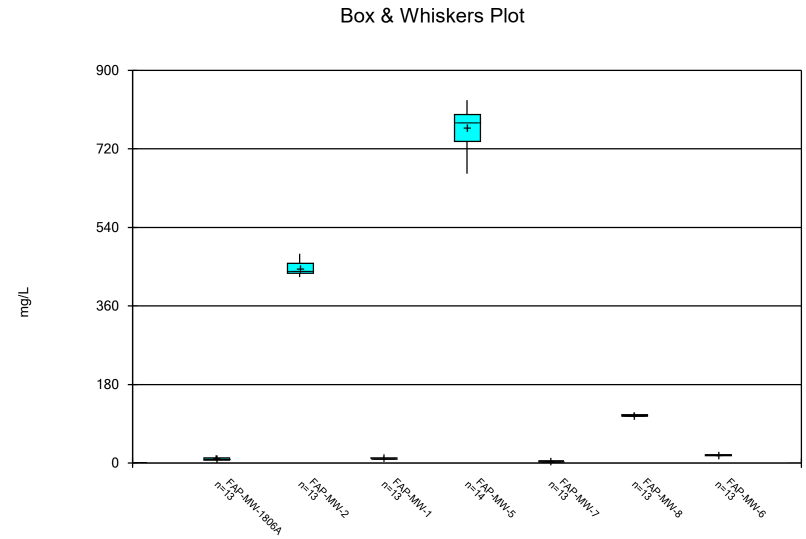
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



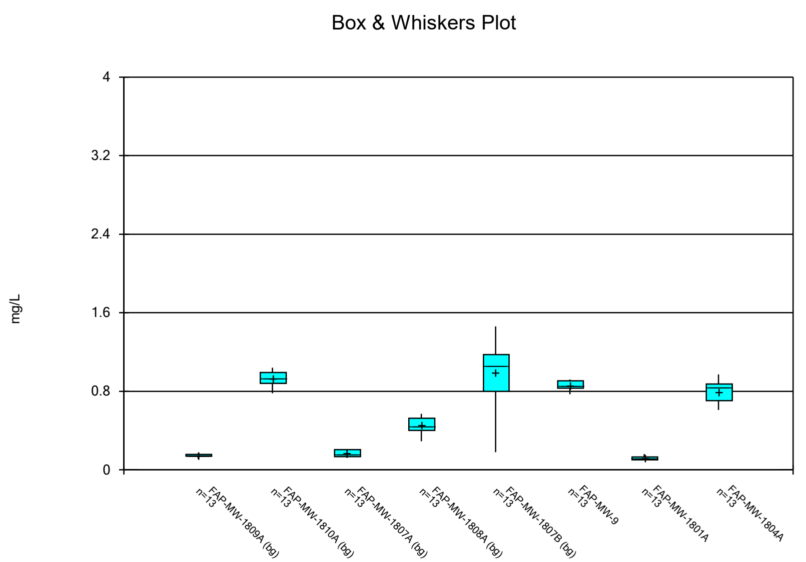
Constituent: Chloride Analysis Run 9/28/2021 3:27 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Chloride Analysis Run 9/28/2021 3:27 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



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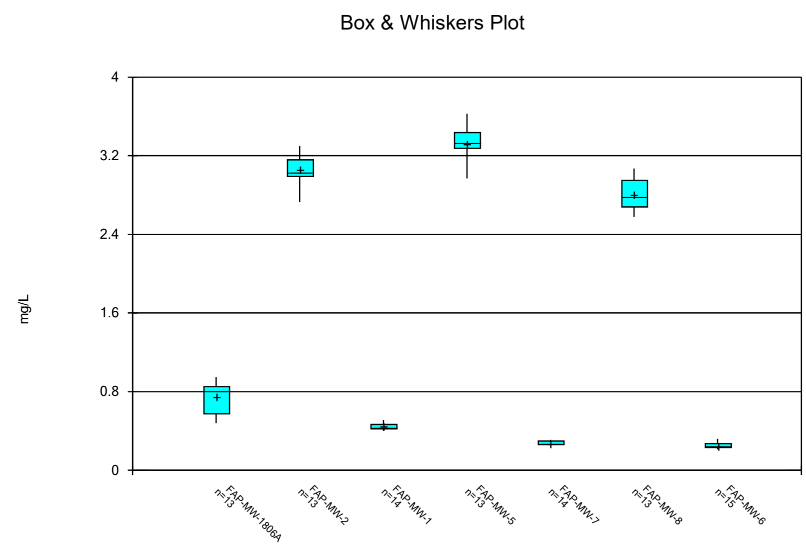
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



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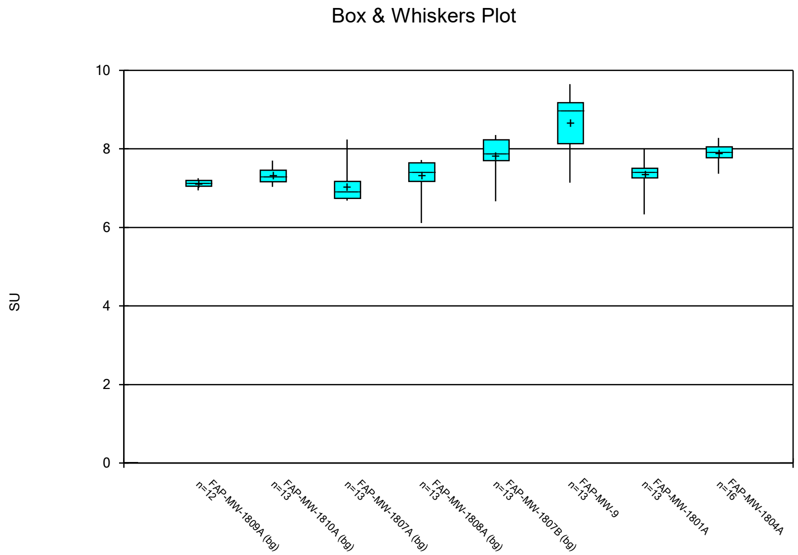
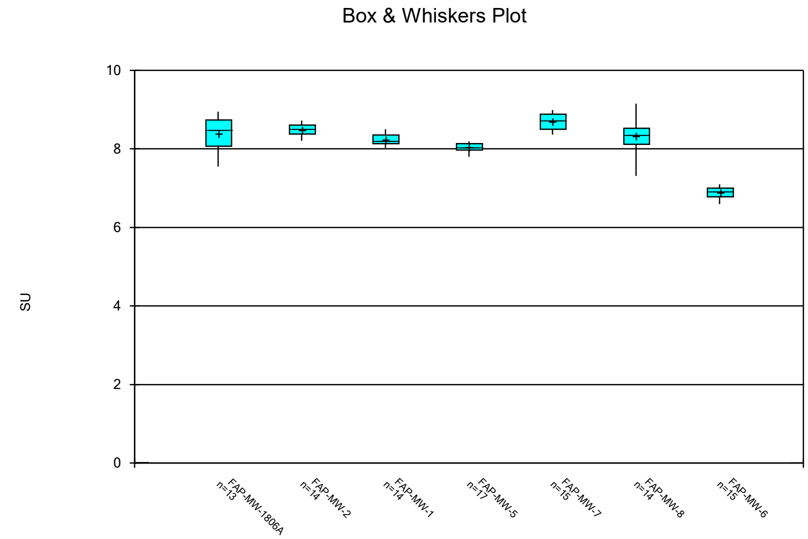
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: pH Analysis Run 9/28/2021 3:27 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



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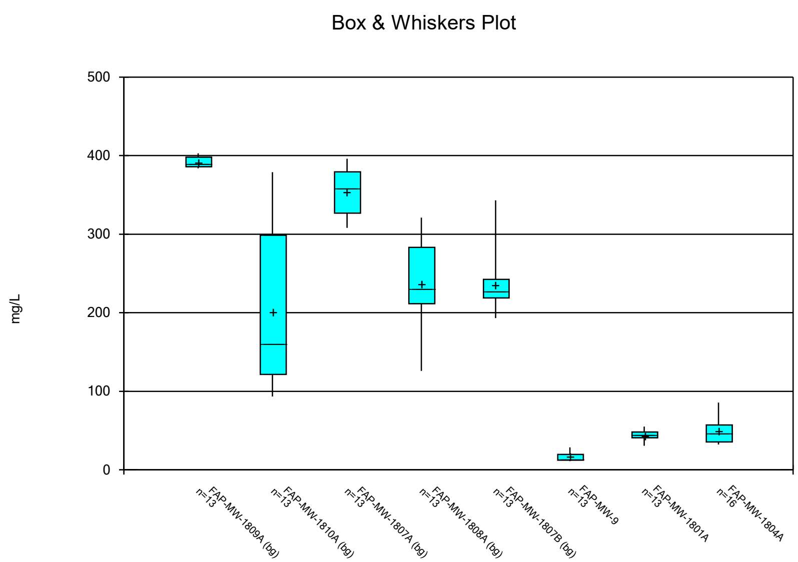
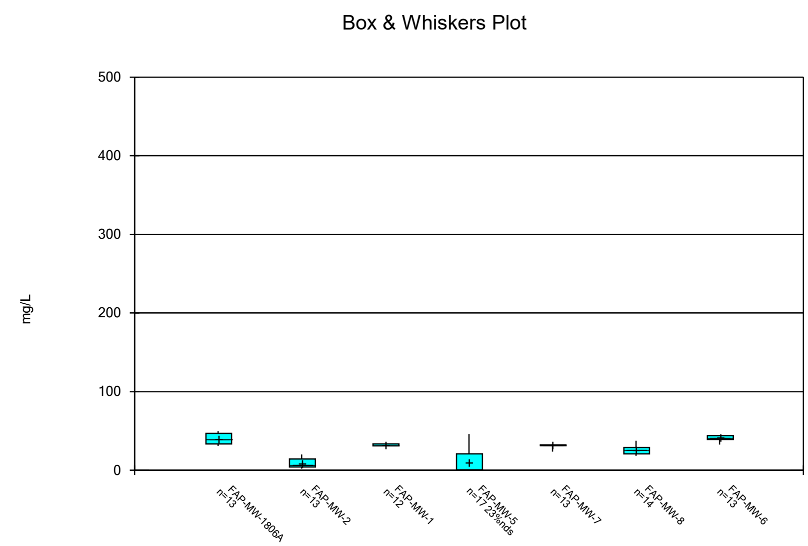
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Sulfate Analysis Run 9/28/2021 3:27 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



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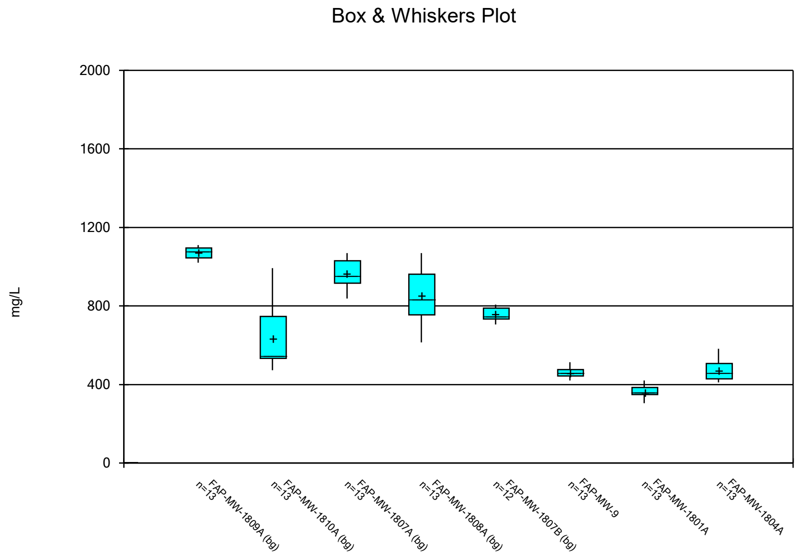
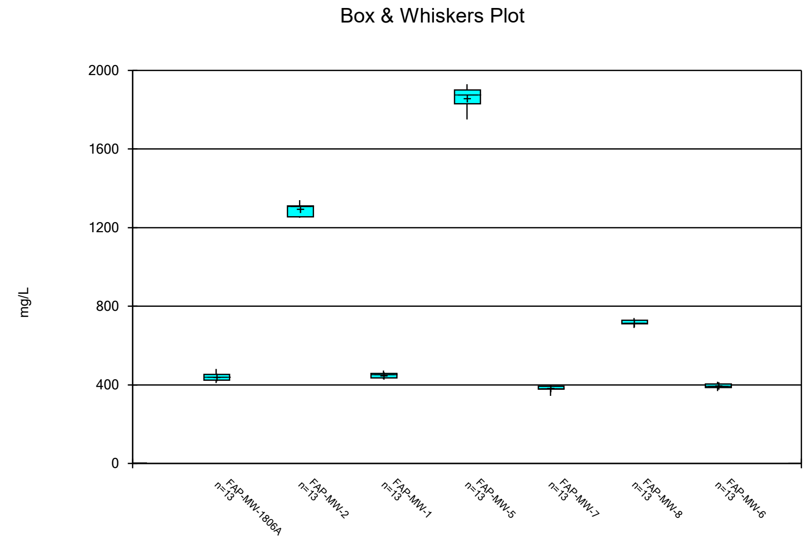
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:27 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:27 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Outlier Analysis - Significant Results

Amos FAP   Client: Geosyntec   Data: Amos FAP   Printed 9/28/2021, 3:32 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Calcium (mg/L)	**FAP-MW-1807B (bg)**	**Yes**	**168**	**NP**	**13**	**22.09**	**43.87**	**ln(x)**	**ShapiroWilk**
Calcium (mg/L)	**FAP-MW-7**	**Yes**	**2.18**	**NP**	**15**	**1.493**	**0.2331**	**ln(x)**	**ShapiroWilk**
Calcium (mg/L)	**FAP-MW-8**	**Yes**	**8.47**	**NP**	**14**	**2.719**	**1.672**	**ln(x)**	**ShapiroWilk**
Chloride (mg/L)	**FAP-MW-1**	**Yes**	**14.6**	**NP**	**13**	**11.39**	**1.016**	**ln(x)**	**ShapiroWilk**
Chloride (mg/L)	**FAP-MW-8**	**Yes**	**508**	**NP**	**14**	**137.8**	**106.6**	**ln(x)**	**ShapiroWilk**
pH (SU)	**FAP-MW-1809A (bg)**	**Yes**	**5.12**	**NP**	**13**	**6.966**	**0.5631**	**x^6**	**ShapiroWilk**
Sulfate (mg/L)	**FAP-MW-1807B (bg)**	**Yes**	**343**	**NP**	**13**	**235.2**	**35.4**	**ln(x)**	**ShapiroWilk**
Sulfate (mg/L)	**FAP-MW-1**	**Yes**	**55.9**	**NP**	**13**	**33.8**	**6.74**	**ln(x)**	**ShapiroWilk**
Sulfate (mg/L)	**FAP-MW-7**	**Yes**	**23.6**	**NP**	**13**	**31.31**	**2.38**	**x^6**	**ShapiroWilk**
Total Dissolved Solids (mg/L)	**FAP-MW-1807B (bg)**	**Yes**	**1020**	**NP**	**13**	**778.3**	**78.92**	**ln(x)**	**ShapiroWilk**
Total Dissolved Solids (mg/L)	**FAP-MW-8**	**Yes**	**1400**	**NP**	**14**	**767.3**	**182.7**	**ln(x)**	**ShapiroWilk**

Outlier Analysis - All Results

Amos FAP   Client: Geosyntec   Data: Amos FAP   Printed 9/28/2021, 3:32 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Boron (mg/L)	FAP-MW-1809A (bg)	No	n/a	NP	13	0.07954	0.01827	normal	ShapiroWilk
Boron (mg/L)	FAP-MW-1810A (bg)	No	n/a	NP	13	0.2356	0.03263	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-1807A (bg)	No	n/a	NP	13	0.1295	0.05192	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-1808A (bg)	No	n/a	NP	13	0.1399	0.02491	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-1807B (bg)	No	n/a	NP	13	0.181	0.04293	normal	ShapiroWilk
Boron (mg/L)	FAP-MW-9	No	n/a	NP	13	0.1328	0.01614	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-1801A	No	n/a	NP	13	0.1804	0.08142	normal	ShapiroWilk
Boron (mg/L)	FAP-MW-1804A	No	n/a	NP	13	0.6775	0.09226	sqrt(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-1806A	No	n/a	NP	13	0.1538	0.02354	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-2	No	n/a	NP	13	0.2513	0.03786	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-1	No	n/a	NP	13	0.1351	0.03389	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-5	No	n/a	NP	13	0.2382	0.03661	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-7	No	n/a	NP	13	0.09515	0.04196	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-8	No	n/a	NP	13	0.2197	0.02986	ln(x)	ShapiroWilk
Boron (mg/L)	FAP-MW-6	No	n/a	NP	13	0.09246	0.01733	ln(x)	ShapiroWilk
Calcium (mg/L)	FAP-MW-1809A (bg)	No	n/a	NP	13	185.2	6.719	ln(x)	ShapiroWilk
Calcium (mg/L)	FAP-MW-1810A (bg)	No	n/a	NP	13	36.78	15.49	ln(x)	ShapiroWilk
Calcium (mg/L)	FAP-MW-1807A (bg)	No	n/a	NP	13	155.3	10.48	sqrt(x)	ShapiroWilk
Calcium (mg/L)	FAP-MW-1808A (bg)	No	n/a	NP	13	43.93	11.93	ln(x)	ShapiroWilk
Calcium (mg/L)	**FAP-MW-1807B (bg)**	**Yes**	**168**	**NP**	**13**	**22.09**	**43.87**	**ln(x)**	**ShapiroWilk**
Calcium (mg/L)	FAP-MW-9	No	n/a	NP	13	1.133	0.1647	ln(x)	ShapiroWilk
Calcium (mg/L)	FAP-MW-1801A	No	n/a	NP	13	59.21	5.03	x^6	ShapiroWilk
Calcium (mg/L)	FAP-MW-1804A	No	n/a	NP	13	12.65	10.11	ln(x)	ShapiroWilk
Calcium (mg/L)	FAP-MW-1806A	No	n/a	NP	13	7.604	3.9	sqrt(x)	ShapiroWilk
Calcium (mg/L)	FAP-MW-2	No	n/a	NP	14	4.114	0.272	ln(x)	ShapiroWilk
Calcium (mg/L)	FAP-MW-1	No	n/a	NP	13	2.646	0.2374	x^3	ShapiroWilk
Calcium (mg/L)	FAP-MW-5	No	n/a	NP	16	8.589	3.638	ln(x)	ShapiroWilk
Calcium (mg/L)	**FAP-MW-7**	**Yes**	**2.18**	**NP**	**15**	**1.493**	**0.2331**	**ln(x)**	**ShapiroWilk**
Calcium (mg/L)	**FAP-MW-8**	**Yes**	**8.47**	**NP**	**14**	**2.719**	**1.672**	**ln(x)**	**ShapiroWilk**
Calcium (mg/L)	FAP-MW-6	No	n/a	NP	13	57.45	4.051	normal	ShapiroWilk
Chloride (mg/L)	FAP-MW-1809A (bg)	No	n/a	NP	13	30.37	3.746	ln(x)	ShapiroWilk
Chloride (mg/L)	FAP-MW-1810A (bg)	No	n/a	NP	13	17.82	2.526	ln(x)	ShapiroWilk
Chloride (mg/L)	FAP-MW-1807A (bg)	No	n/a	NP	13	11.08	0.9951	normal	ShapiroWilk
Chloride (mg/L)	FAP-MW-1808A (bg)	No	n/a	NP	13	20.03	3.042	ln(x)	ShapiroWilk
Chloride (mg/L)	FAP-MW-1807B (bg)	No	n/a	NP	13	10.04	1.657	ln(x)	ShapiroWilk
Chloride (mg/L)	FAP-MW-9	No	n/a	NP	13	7.334	0.2437	ln(x)	ShapiroWilk
Chloride (mg/L)	FAP-MW-1801A	No	n/a	NP	13	9.063	1.085	x^3	ShapiroWilk
Chloride (mg/L)	FAP-MW-1804A	No	n/a	NP	16	6.126	2.737	ln(x)	ShapiroWilk
Chloride (mg/L)	FAP-MW-1806A	No	n/a	NP	13	9.63	3.802	ln(x)	ShapiroWilk
Chloride (mg/L)	FAP-MW-2	No	n/a	NP	13	446.1	16.69	ln(x)	ShapiroWilk
Chloride (mg/L)	**FAP-MW-1**	**Yes**	**14.6**	**NP**	**13**	**11.39**	**1.016**	**ln(x)**	**ShapiroWilk**
Chloride (mg/L)	FAP-MW-5	No	n/a	NP	14	769.9	43.99	x^6	ShapiroWilk
Chloride (mg/L)	FAP-MW-7	No	n/a	NP	13	5.368	0.1196	ln(x)	ShapiroWilk
Chloride (mg/L)	**FAP-MW-8**	**Yes**	**508**	**NP**	**14**	**137.8**	**106.6**	**ln(x)**	**ShapiroWilk**
Chloride (mg/L)	FAP-MW-6	No	n/a	NP	13	17.77	1.36	x^2	ShapiroWilk
Fluoride (mg/L)	FAP-MW-1809A (bg)	No	n/a	NP	13	0.1438	0.01502	x^2	ShapiroWilk
Fluoride (mg/L)	FAP-MW-1810A (bg)	No	n/a	NP	13	0.9262	0.07054	x^2	ShapiroWilk
Fluoride (mg/L)	FAP-MW-1807A (bg)	No	n/a	NP	13	0.1669	0.03351	ln(x)	ShapiroWilk
Fluoride (mg/L)	FAP-MW-1808A (bg)	No	n/a	NP	13	0.4515	0.08484	x^2	ShapiroWilk
Fluoride (mg/L)	FAP-MW-1807B (bg)	No	n/a	NP	13	0.9985	0.3284	x^2	ShapiroWilk
Fluoride (mg/L)	FAP-MW-9	No	n/a	NP	13	0.8592	0.04349	x^3	ShapiroWilk
Fluoride (mg/L)	FAP-MW-1801A	No	n/a	NP	13	0.1192	0.01801	ln(x)	ShapiroWilk
Fluoride (mg/L)	FAP-MW-1804A	No	n/a	NP	13	0.7992	0.108	x^3	ShapiroWilk
Fluoride (mg/L)	FAP-MW-1806A	No	n/a	NP	13	0.75	0.1499	x^5	ShapiroWilk
Fluoride (mg/L)	FAP-MW-2	No	n/a	NP	13	3.052	0.1499	x^2	ShapiroWilk

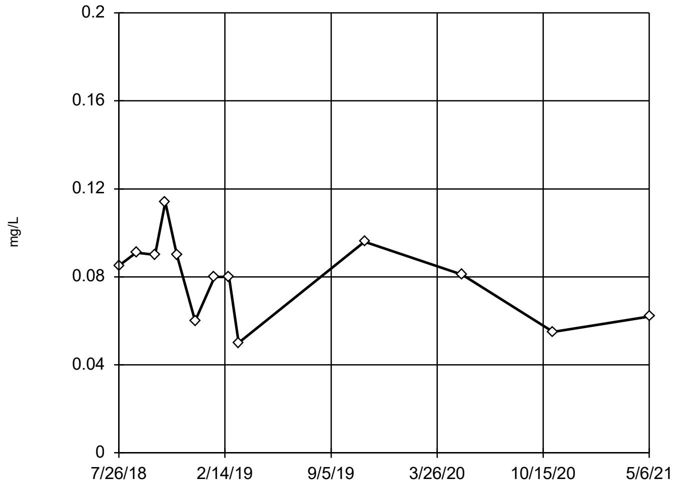
Outlier Analysis - All Results

Amos FAP Client: Geosyntec Data: Amos FAP Printed 9/28/2021, 3:32 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Fluoride (mg/L)	FAP-MW-1	No	n/a	NP	14	0.4407	0.03222	ln(x)	ShapiroWilk
Fluoride (mg/L)	FAP-MW-5	No	n/a	NP	13	3.325	0.1707	x^5	ShapiroWilk
Fluoride (mg/L)	FAP-MW-7	No	n/a	NP	14	0.275	0.0199	ln(x)	ShapiroWilk
Fluoride (mg/L)	FAP-MW-8	No	n/a	NP	13	2.808	0.1536	ln(x)	ShapiroWilk
Fluoride (mg/L)	FAP-MW-6	No	n/a	NP	15	0.248	0.03121	ln(x)	ShapiroWilk
pH (SU)	**FAP-MW-1809A (bg)**	**Yes**	**5.12**	**NP**	**13**	**6.966**	**0.5631**	**x^6**	**ShapiroWilk**
pH (SU)	FAP-MW-1810A (bg)	No	n/a	NP	13	7.32	0.193	ln(x)	ShapiroWilk
pH (SU)	FAP-MW-1807A (bg)	No	n/a	NP	13	7.038	0.4302	ln(x)	ShapiroWilk
pH (SU)	FAP-MW-1808A (bg)	No	n/a	NP	13	7.338	0.4355	x^6	ShapiroWilk
pH (SU)	FAP-MW-1807B (bg)	No	n/a	NP	13	7.826	0.5155	x^6	ShapiroWilk
pH (SU)	FAP-MW-9	No	n/a	NP	13	8.67	0.7991	x^6	ShapiroWilk
pH (SU)	FAP-MW-1801A	No	n/a	NP	13	7.351	0.3753	x^6	ShapiroWilk
pH (SU)	FAP-MW-1804A	No	n/a	NP	16	7.884	0.2567	x^6	ShapiroWilk
pH (SU)	FAP-MW-1806A	No	n/a	NP	13	8.375	0.4102	x^6	ShapiroWilk
pH (SU)	FAP-MW-2	No	n/a	NP	14	8.498	0.1481	x^6	ShapiroWilk
pH (SU)	FAP-MW-1	No	n/a	NP	14	8.239	0.1352	ln(x)	ShapiroWilk
pH (SU)	FAP-MW-5	No	n/a	NP	17	8.049	0.1045	x^6	ShapiroWilk
pH (SU)	FAP-MW-7	No	n/a	NP	15	8.691	0.2093	x^6	ShapiroWilk
pH (SU)	FAP-MW-8	No	n/a	NP	14	8.325	0.4389	x^3	ShapiroWilk
pH (SU)	FAP-MW-6	No	n/a	NP	15	6.875	0.1498	x^6	ShapiroWilk
Sulfate (mg/L)	FAP-MW-1809A (bg)	No	n/a	NP	13	391.8	6.756	ln(x)	ShapiroWilk
Sulfate (mg/L)	FAP-MW-1810A (bg)	No	n/a	NP	13	200.8	101.6	ln(x)	ShapiroWilk
Sulfate (mg/L)	FAP-MW-1807A (bg)	No	n/a	NP	13	353.5	29.53	ln(x)	ShapiroWilk
Sulfate (mg/L)	FAP-MW-1808A (bg)	No	n/a	NP	13	236.2	51.95	normal	ShapiroWilk
Sulfate (mg/L)	**FAP-MW-1807B (bg)**	**Yes**	**343**	**NP**	**13**	**235.2**	**35.4**	**ln(x)**	**ShapiroWilk**
Sulfate (mg/L)	FAP-MW-9	No	n/a	NP	13	15.95	5.416	ln(x)	ShapiroWilk
Sulfate (mg/L)	FAP-MW-1801A	No	n/a	NP	13	43.65	6.402	x^2	ShapiroWilk
Sulfate (mg/L)	FAP-MW-1804A	No	n/a	NP	16	48.46	15.55	ln(x)	ShapiroWilk
Sulfate (mg/L)	FAP-MW-1806A	No	n/a	NP	13	39.81	6.632	ln(x)	ShapiroWilk
Sulfate (mg/L)	FAP-MW-2	No	n/a	NP	13	9.092	6.024	sqrt(x)	ShapiroWilk
Sulfate (mg/L)	**FAP-MW-1**	**Yes**	**55.9**	**NP**	**13**	**33.8**	**6.74**	**ln(x)**	**ShapiroWilk**
Sulfate (mg/L)	FAP-MW-5	No	n/a	NP	17	10.89	13.99	sqrt(x)	ShapiroWilk
Sulfate (mg/L)	**FAP-MW-7**	**Yes**	**23.6**	**NP**	**13**	**31.31**	**2.38**	**x^6**	**ShapiroWilk**
Sulfate (mg/L)	FAP-MW-8	No	n/a	NP	14	25.68	5.155	ln(x)	ShapiroWilk
Sulfate (mg/L)	FAP-MW-6	No	n/a	NP	13	40.84	3.537	x^6	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-1809A (bg)	No	n/a	NP	13	1069	30.4	x^6	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-1810A (bg)	No	n/a	NP	13	633.9	170.2	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-1807A (bg)	No	n/a	NP	13	965.5	71.61	x^2	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-1808A (bg)	No	n/a	NP	13	851.7	132.8	x^(1/3)	ShapiroWilk
Total Dissolved Solids (mg/L)	**FAP-MW-1807B (bg)**	**Yes**	**1020**	**NP**	**13**	**778.3**	**78.92**	**ln(x)**	**ShapiroWilk**
Total Dissolved Solids (mg/L)	FAP-MW-9	No	n/a	NP	13	461.8	26.22	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-1801A	No	n/a	NP	13	361	31.75	x^3	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-1804A	No	n/a	NP	13	470.6	50.63	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-1806A	No	n/a	NP	13	440.2	18.82	ln(x)	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-2	No	n/a	NP	13	1294	32.54	x^6	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-1	No	n/a	NP	13	449.2	13.3	x^4	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-5	No	n/a	NP	13	1860	54.92	x^6	ShapiroWilk
Total Dissolved Solids (mg/L)	FAP-MW-7	No	n/a	NP	13	383.8	15.09	x^6	ShapiroWilk
Total Dissolved Solids (mg/L)	**FAP-MW-8**	**Yes**	**1400**	**NP**	**14**	**767.3**	**182.7**	**ln(x)**	**ShapiroWilk**
Total Dissolved Solids (mg/L)	FAP-MW-6	No	n/a	NP	13	394.8	13.53	x^6	ShapiroWilk

Tukey's Outlier Screening

FAP-MW-1809A (bg)



n = 13

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

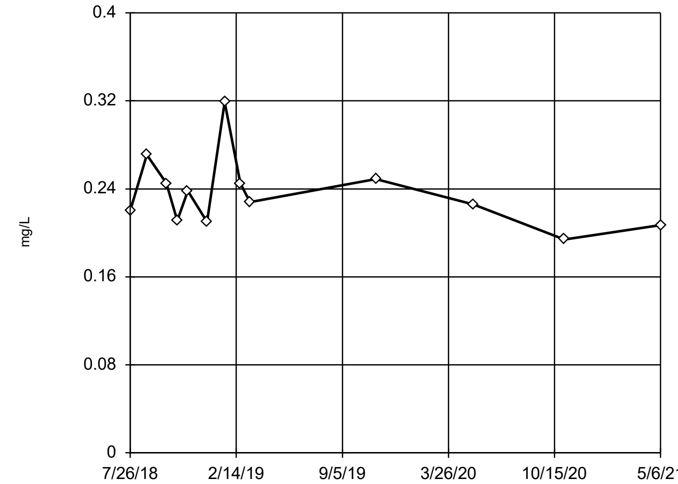
Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.179, low cutoff = -0.0275, based on IQR multiplier of 3.

Constituent: Boron   Analysis Run 9/28/2021 3:29 PM   View: Descriptive
Amos FAP   Client: Geosyntec   Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-1810A (bg)



n = 13

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

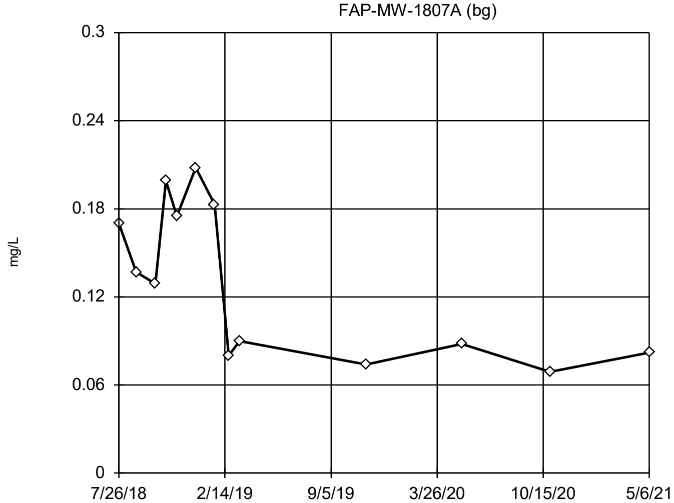
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.399, low cutoff = 0.1303, based on IQR multiplier of 3.

Constituent: Boron   Analysis Run 9/28/2021 3:29 PM   View: Descriptive
Amos FAP   Client: Geosyntec   Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-1807A (bg)



n = 13

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

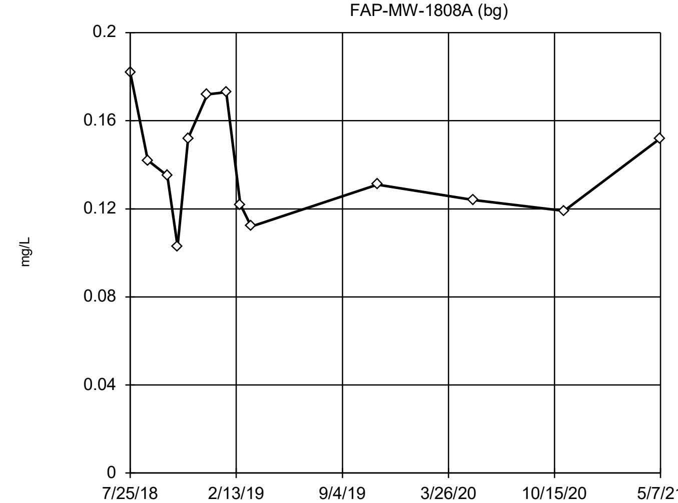
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.93, low cutoff = 0.007509, based on IQR multiplier of 3.

Constituent: Boron   Analysis Run 9/28/2021 3:29 PM   View: Descriptive
Amos FAP   Client: Geosyntec   Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-1808A (bg)



n = 13

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

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

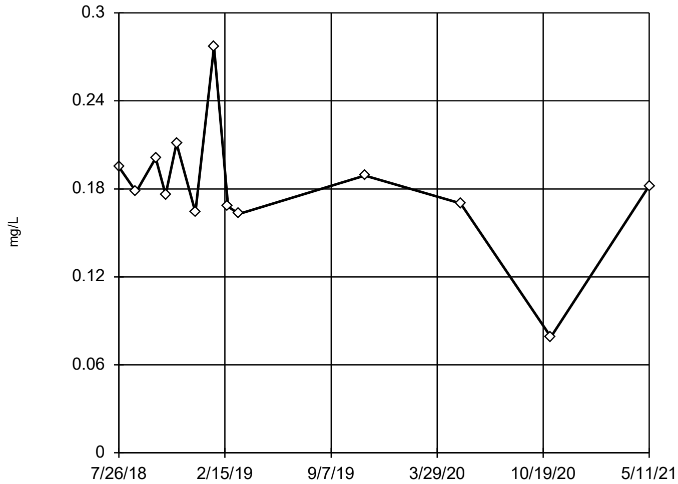
High cutoff = 0.3907, low cutoff = 0.04986, based on IQR multiplier of 3.

Constituent: Boron   Analysis Run 9/28/2021 3:29 PM   View: Descriptive
Amos FAP   Client: Geosyntec   Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1807B (bg)



n = 13

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

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

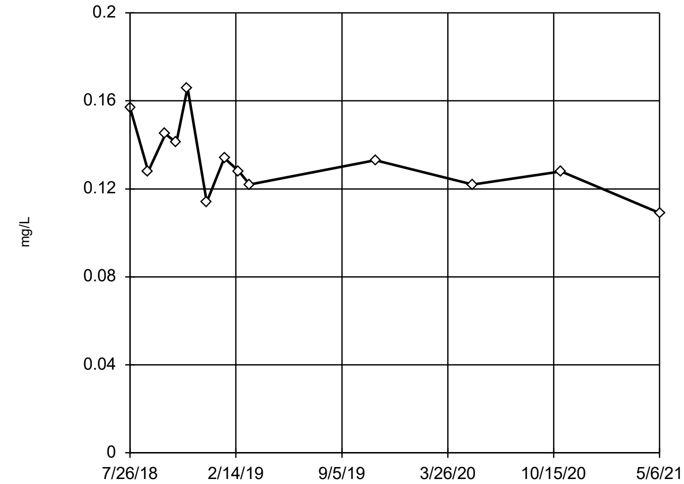
High cutoff = 0.294, low cutoff = 0.07, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-9



n = 13

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

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

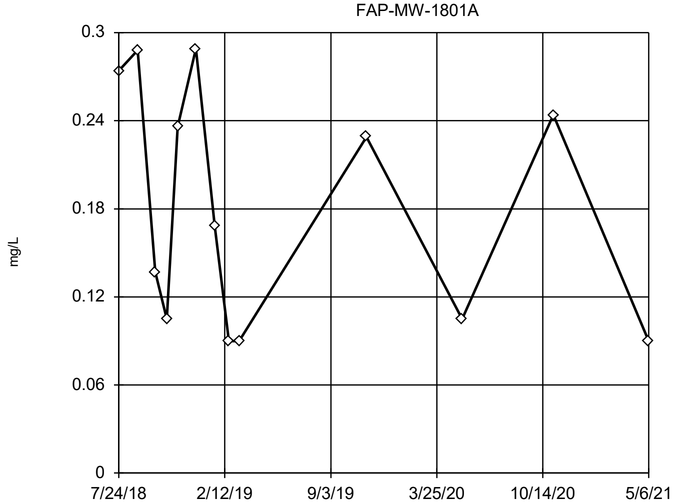
High cutoff = 0.2302, low cutoff = 0.07578, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1801A



n = 13

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

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

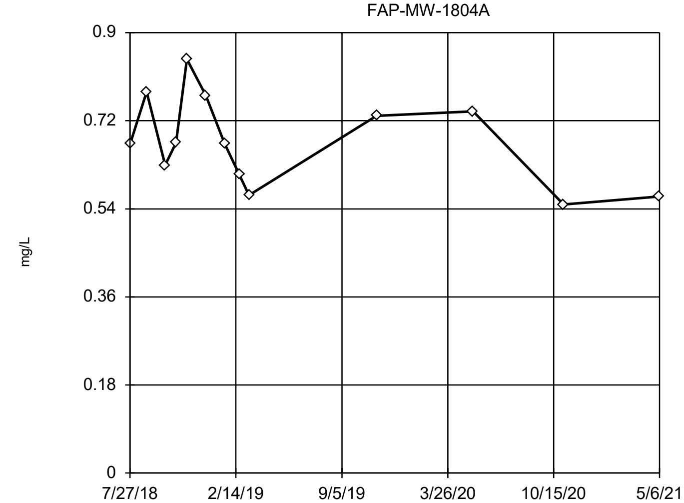
High cutoff = 0.7435, low cutoff = -0.387, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1804A



n = 13

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

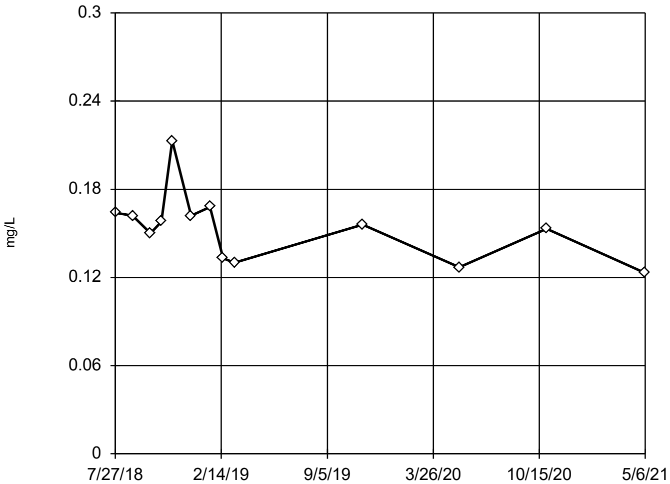
Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.377, low cutoff = 0.2146, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-1806A



n = 13

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

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

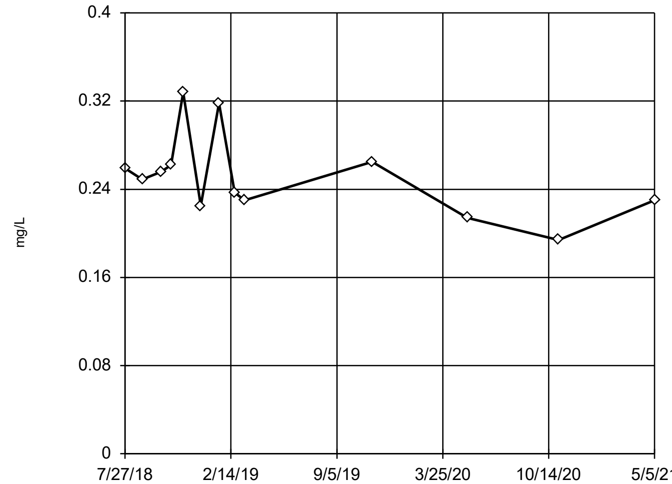
High cutoff = 0.3105, low cutoff = 0.06903, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-2



n = 13

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

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

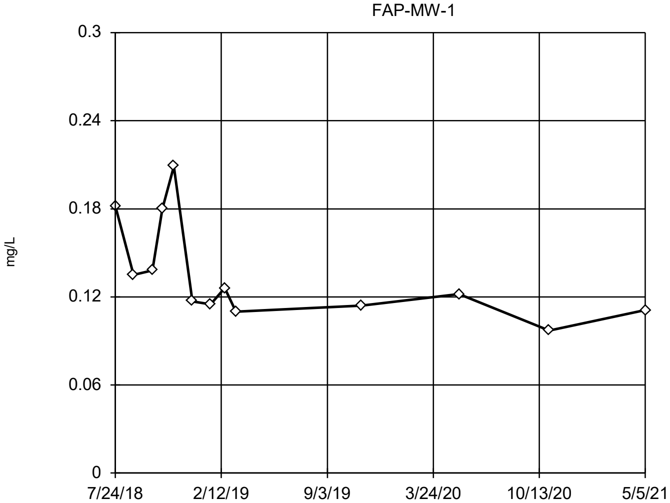
High cutoff = 0.4095, low cutoff = 0.1464, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1



n = 13

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

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

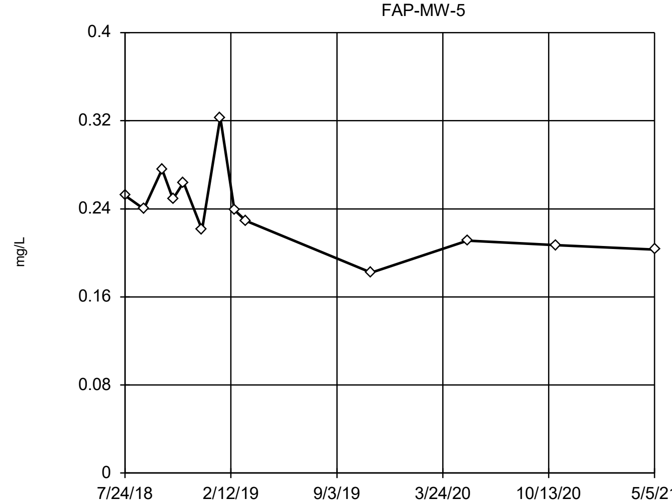
High cutoff = 0.4335, low cutoff = 0.0409, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-5



n = 13

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

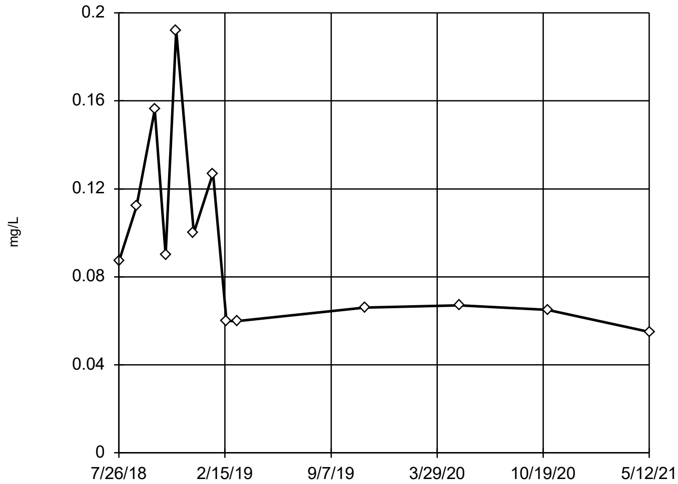
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.4849, low cutoff = 0.1112, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-7



n = 13

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

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

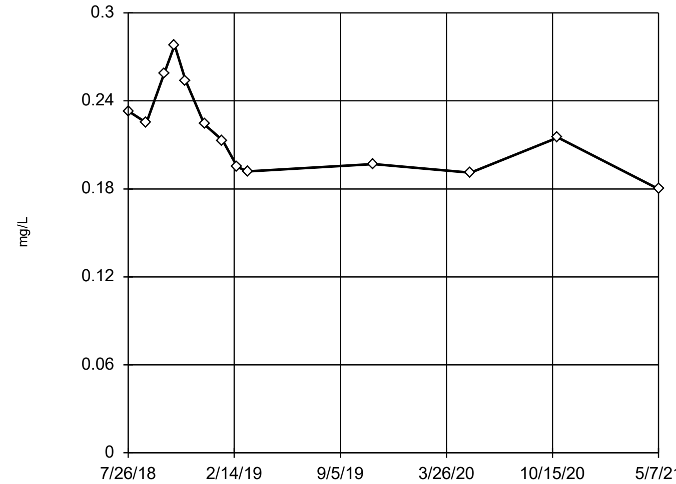
High cutoff = 0.8307, low cutoff = 0.008966, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-8



n = 13

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

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

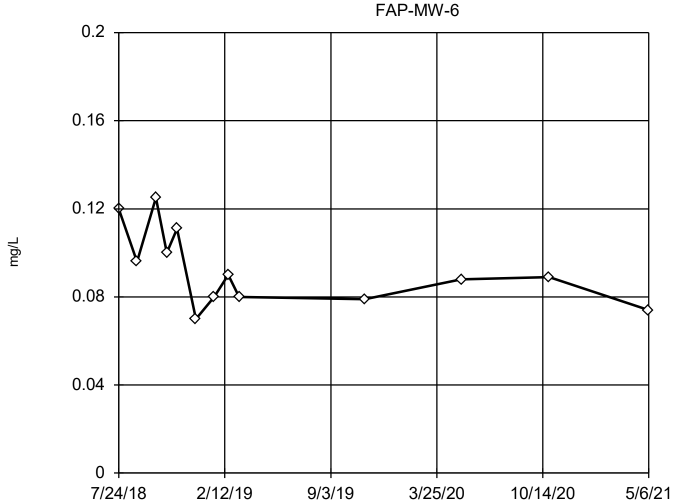
High cutoff = 0.4835, low cutoff = 0.09736, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-6



n = 13

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

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

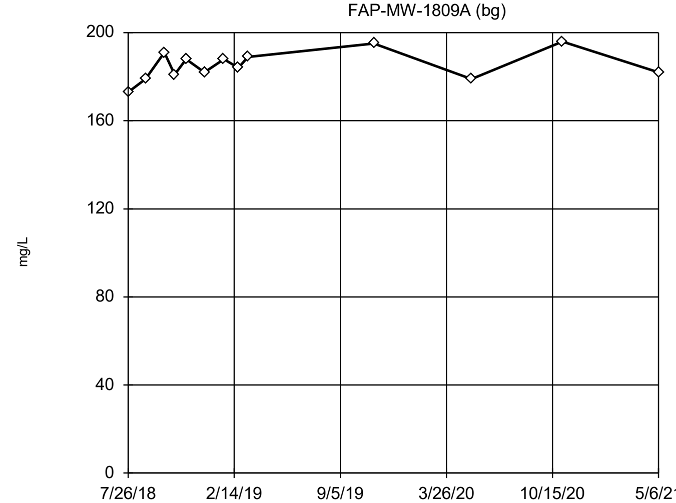
High cutoff = 0.2452, low cutoff = 0.03415, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1809A (bg)



n = 13

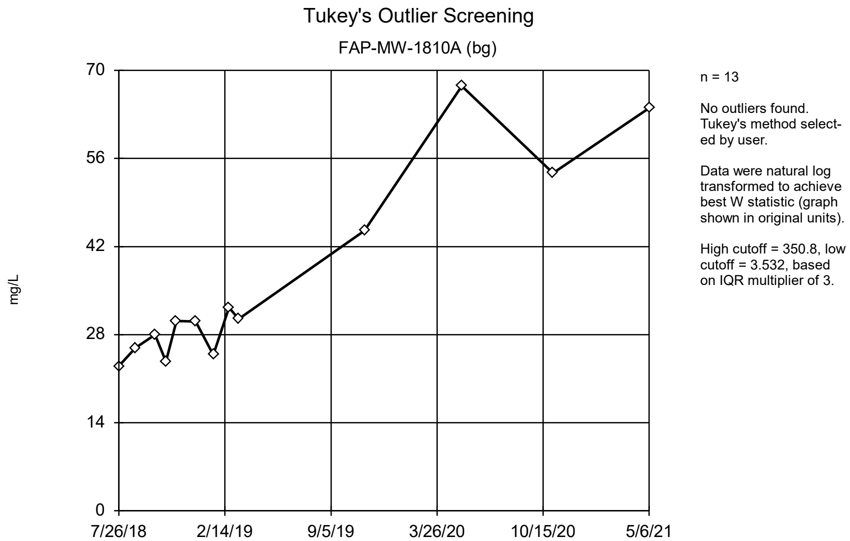
No outliers found. Tukey's method selected by user.

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

High cutoff = 223.5, low cutoff = 153, based on IQR multiplier of 3.

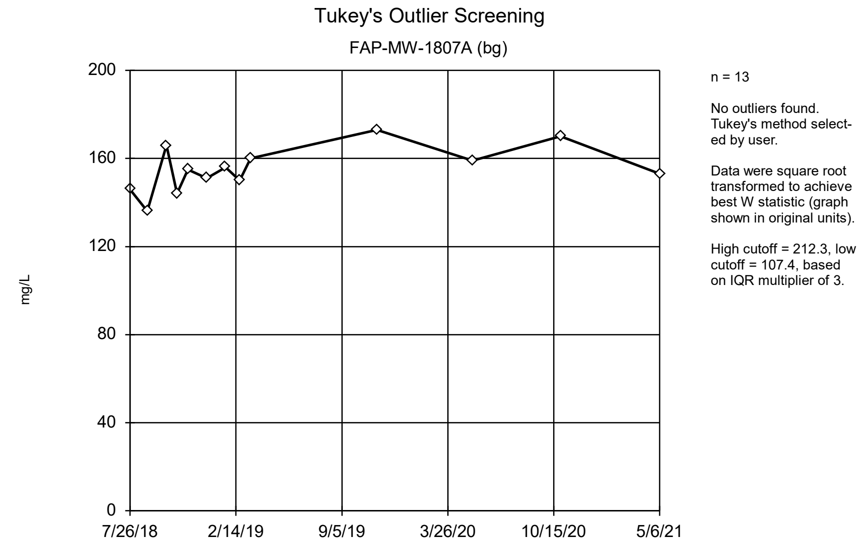
Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



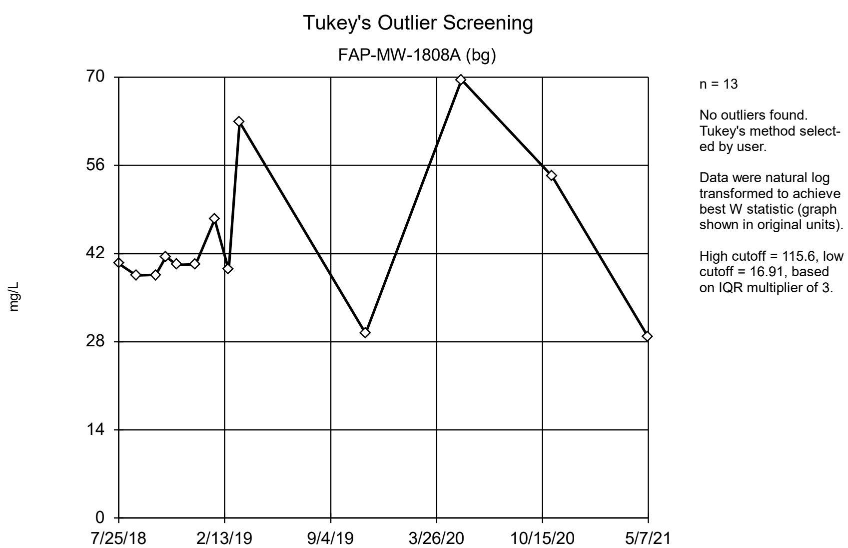
Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



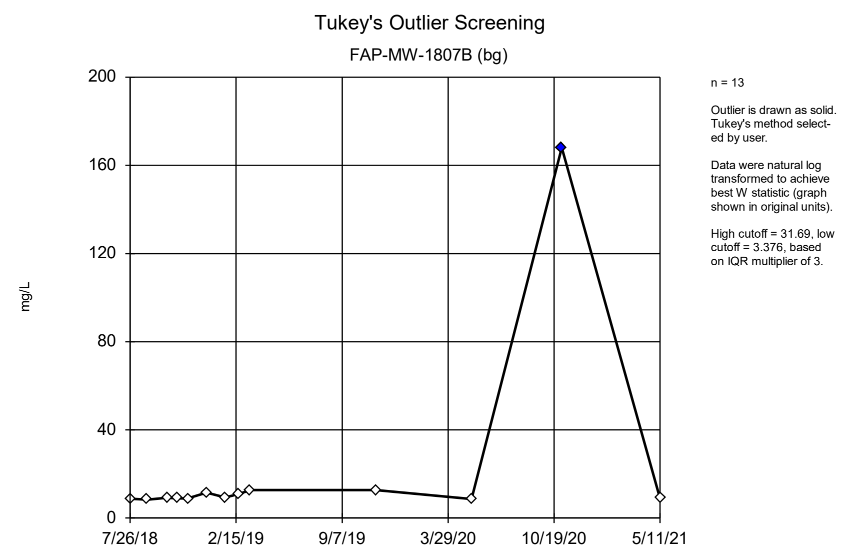
Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

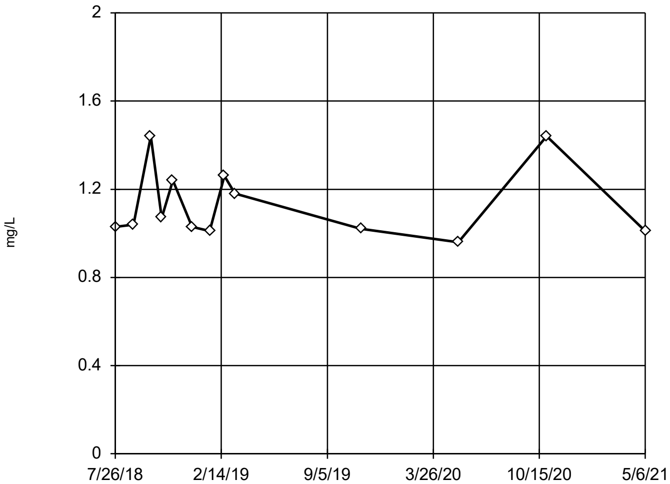


Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-9



n = 13

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

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

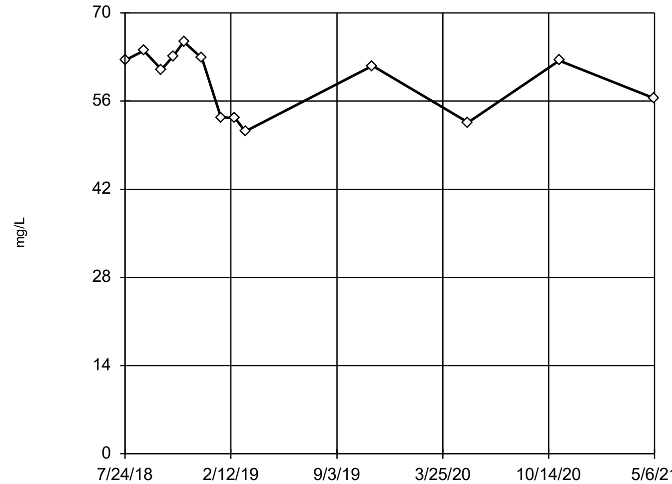
High cutoff = 2.335, low cutoff = 0.5434, based on IQR multiplier of 3.

Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1801A



n = 13

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

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

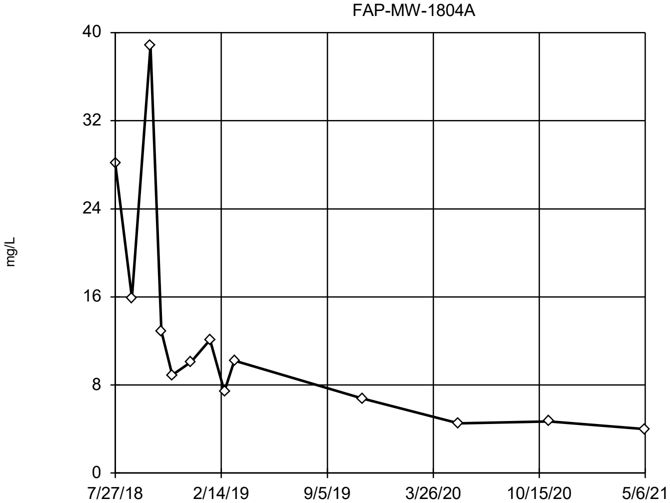
High cutoff = 75.12, low cutoff = -67.49, based on IQR multiplier of 3.

Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1804A



n = 13

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

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

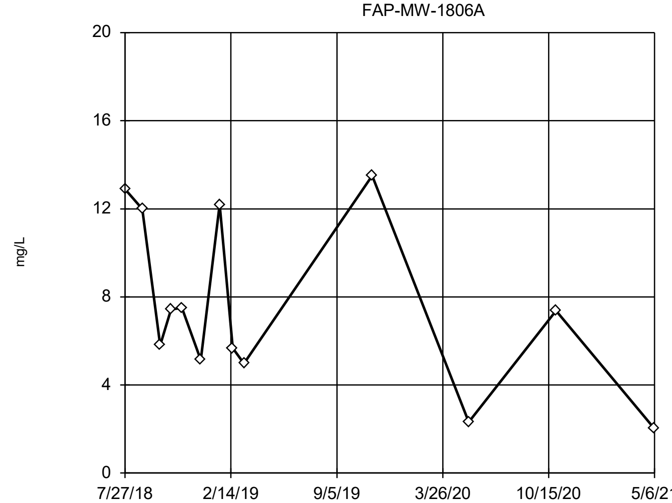
High cutoff = 234.4, low cutoff = 0.3447, based on IQR multiplier of 3.

Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1806A



n = 13

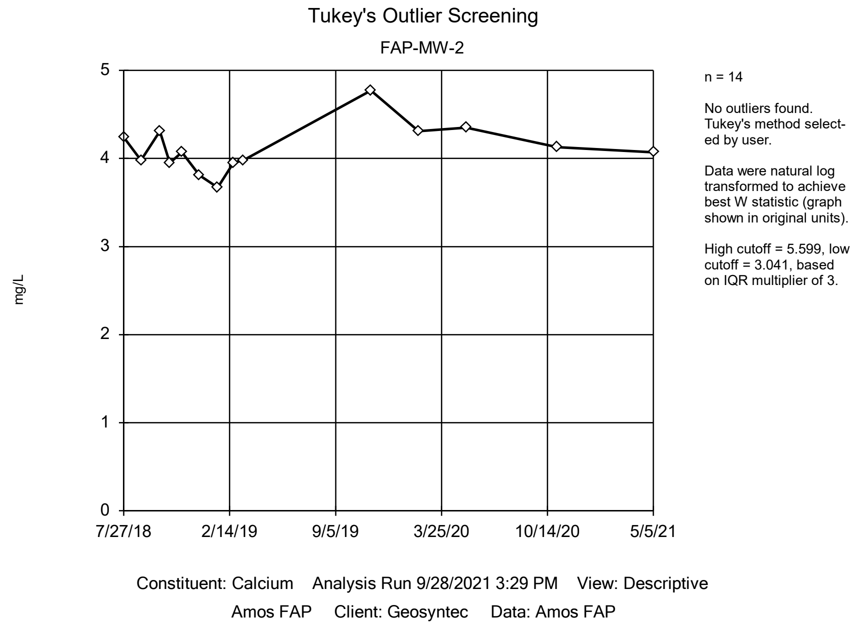
No outliers found. Tukey's method selected by user.

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

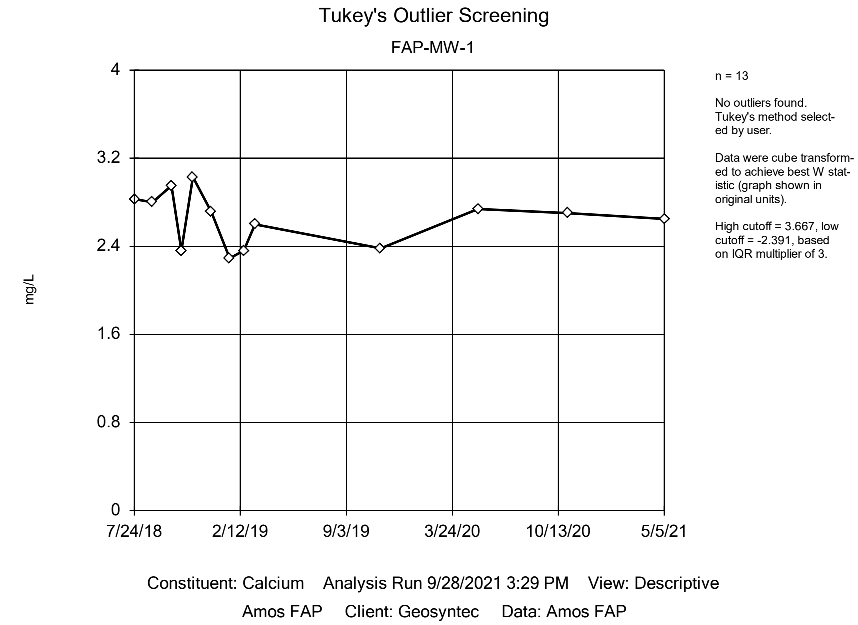
High cutoff = 51.35, low cutoff = -2.068, based on IQR multiplier of 3.

Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

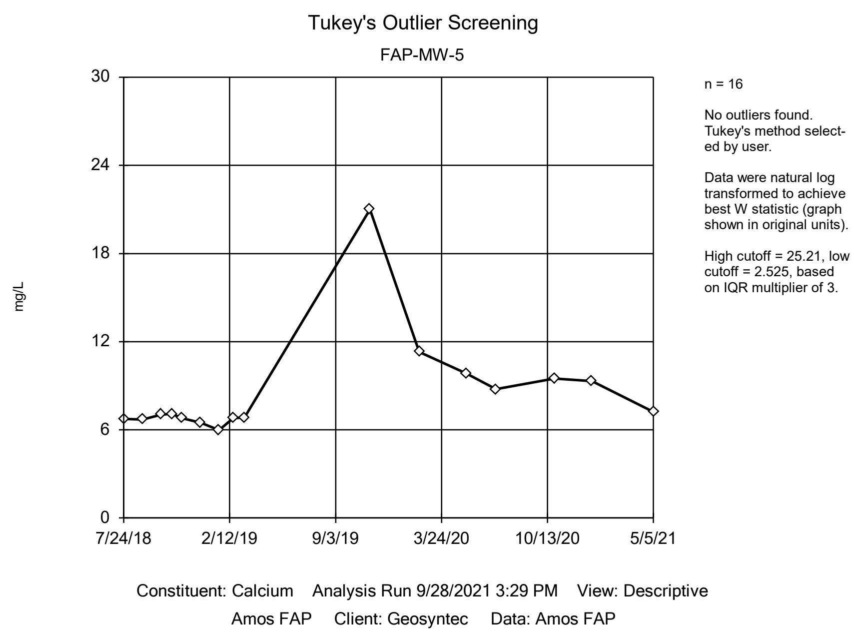
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



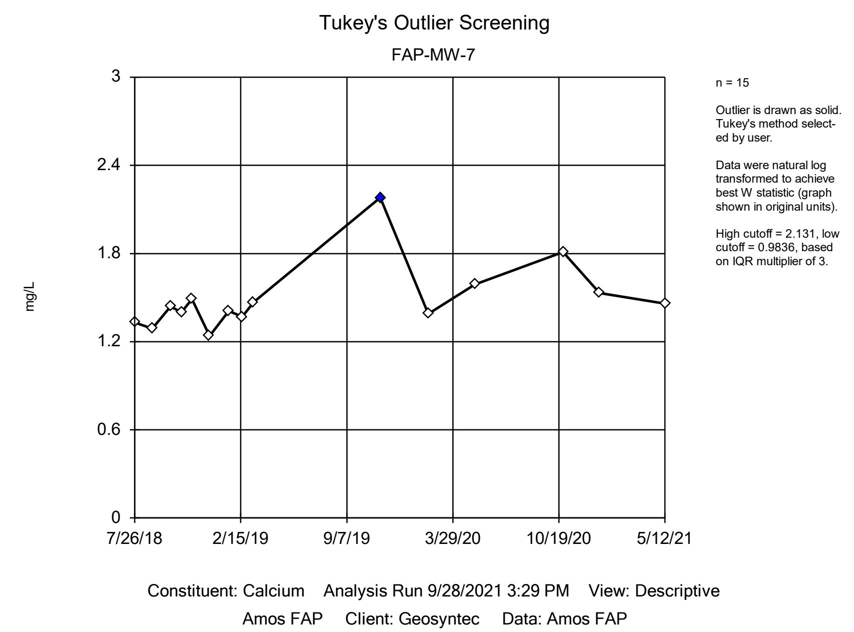
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

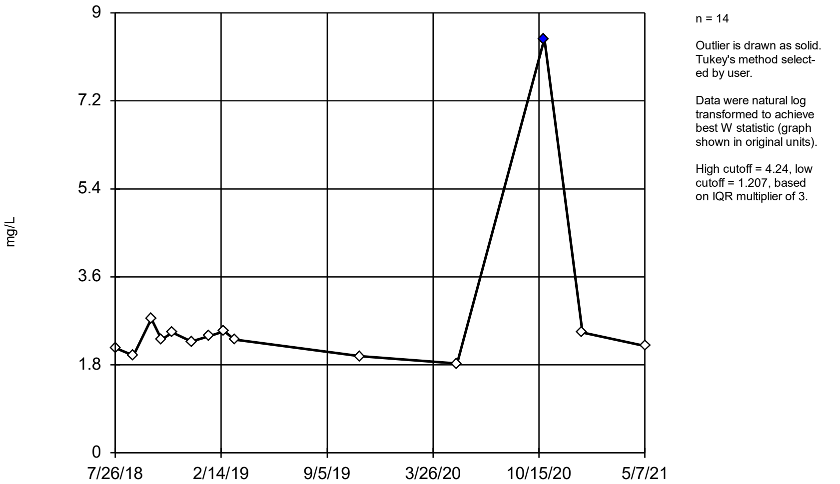


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Tukey's Outlier Screening

FAP-MW-8

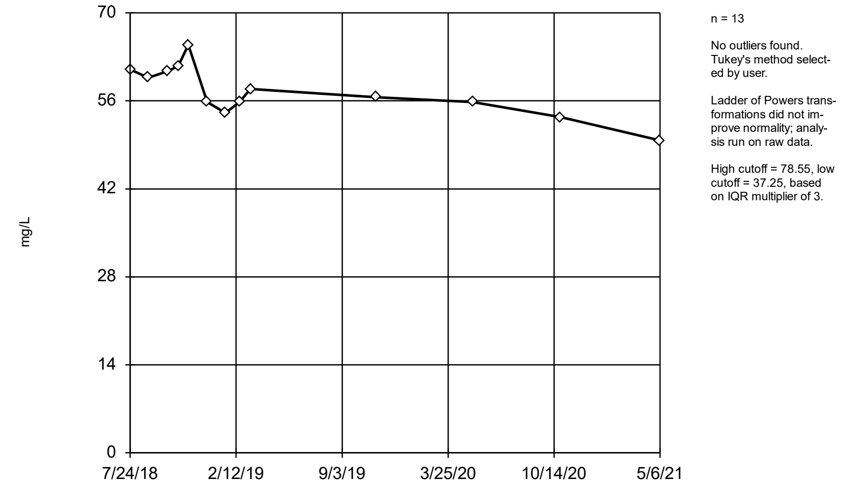


Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-6

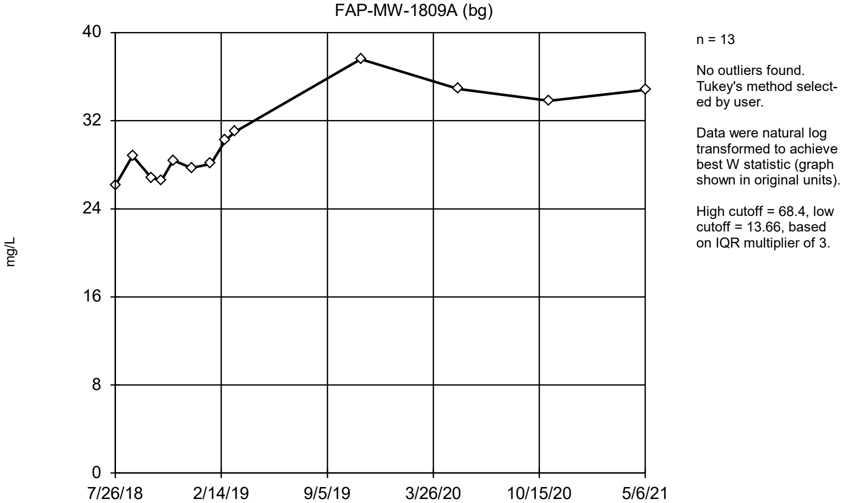


Constituent: Calcium Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1809A (bg)

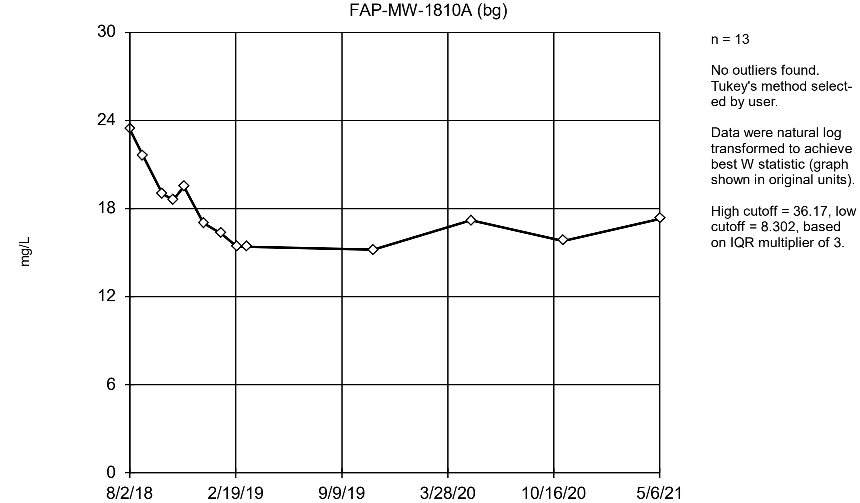


Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1810A (bg)

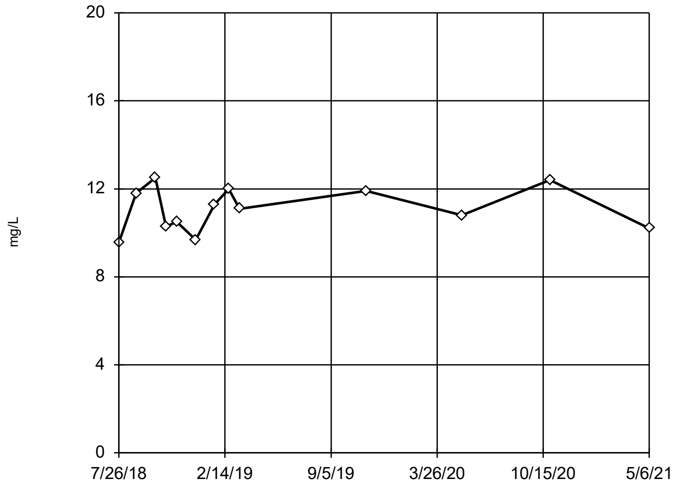


Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1807A (bg)



n = 13

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

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

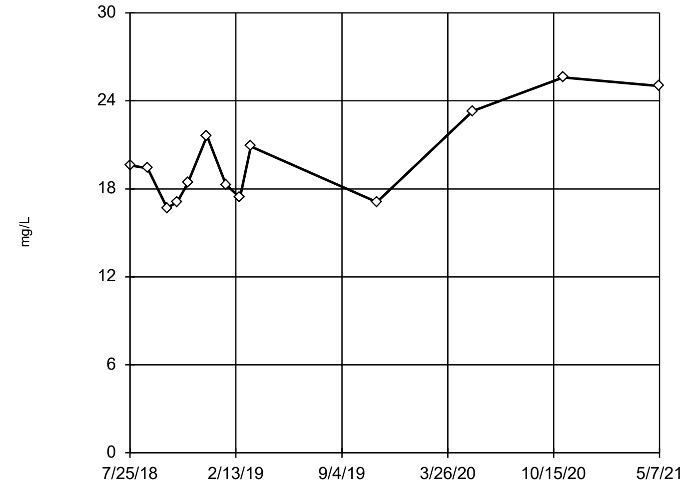
High cutoff = 17.05, low cutoff = 5.15, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1808A (bg)



n = 13

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

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

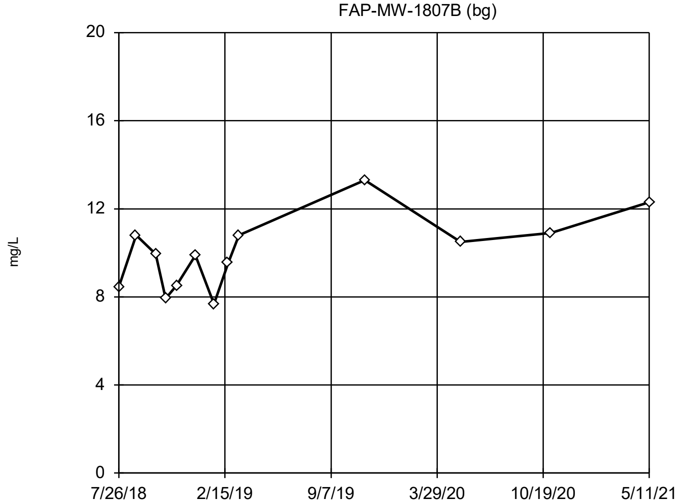
High cutoff = 49.35, low cutoff = 7.841, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1807B (bg)



n = 13

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

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

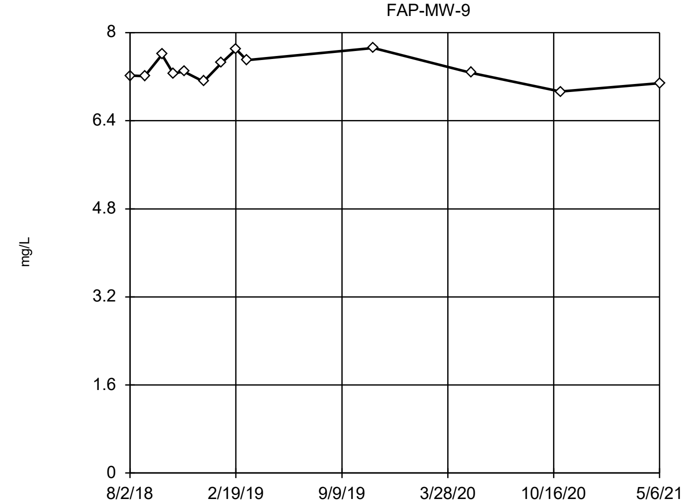
High cutoff = 22.65, low cutoff = 4.068, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-9



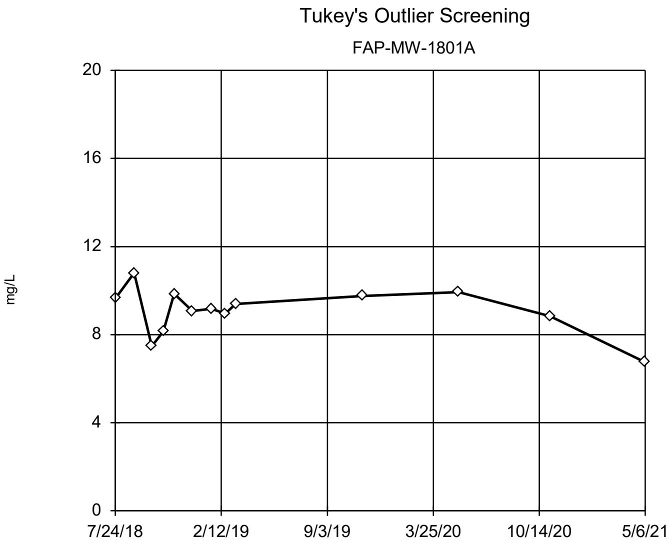
n = 13

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 = 8.852, low cutoff = 6.107, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP



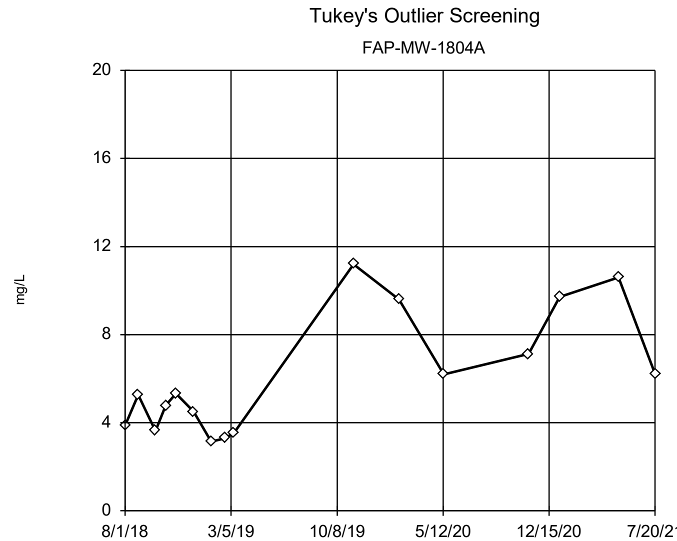
n = 13

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

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

High cutoff = 12.45, low cutoff = -7.193, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP



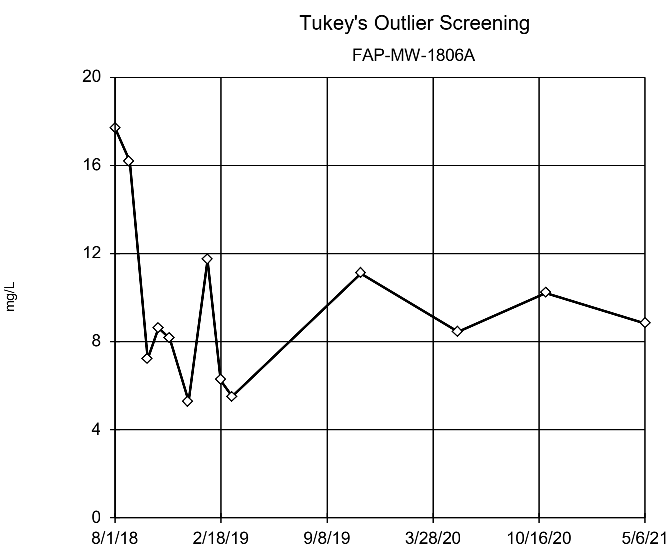
n = 16

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 = 88.55, low cutoff = 0.3498, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP



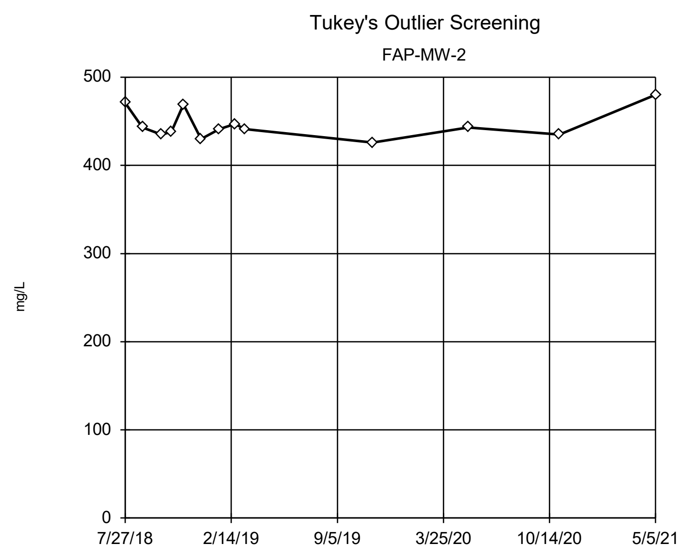
n = 13

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 = 55.89, low cutoff = 1.368, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP



n = 13

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

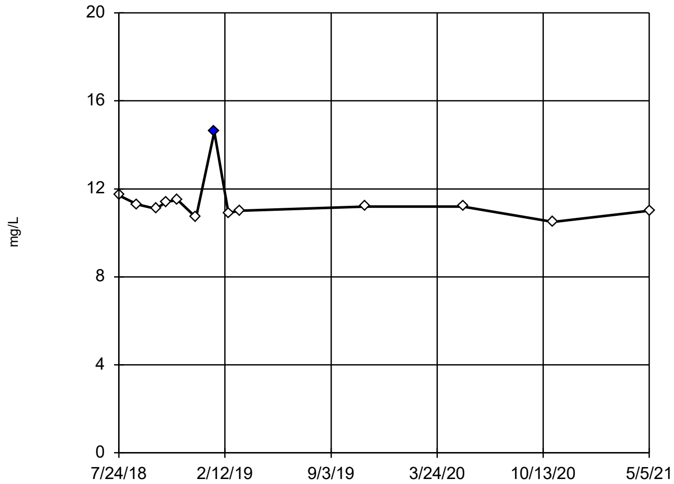
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 533.9, low cutoff = 373, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:29 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-1



n = 13

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

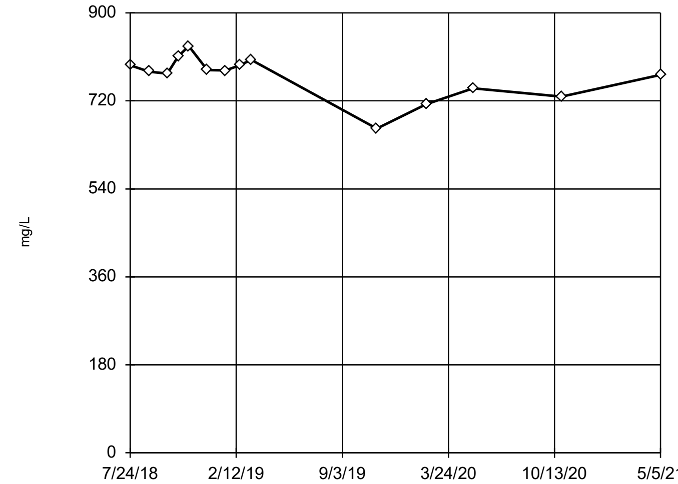
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 13.09, low cutoff = 9.577, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-5



n = 14

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

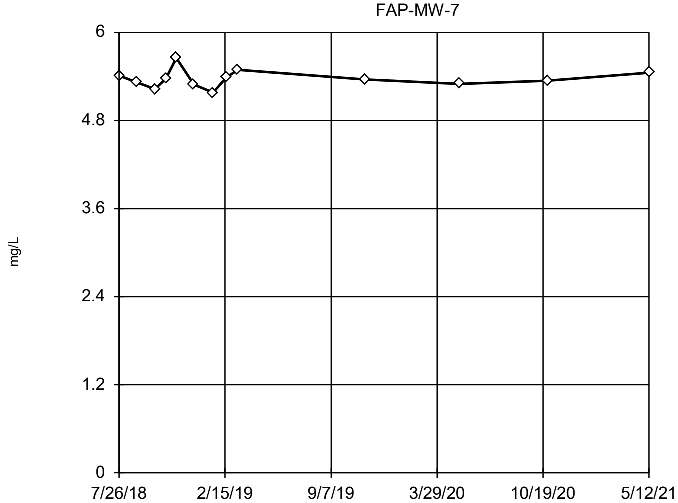
Data were x^6 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 906.2, low cutoff = -714.7, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-7



n = 13

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

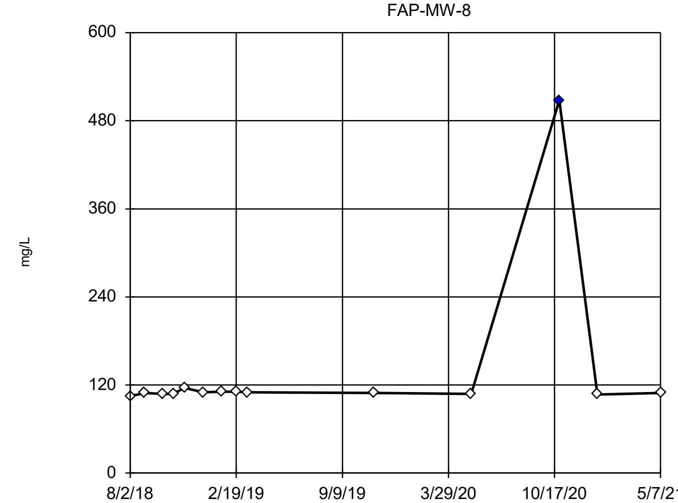
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.856, low cutoff = 4.91, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-8



n = 14

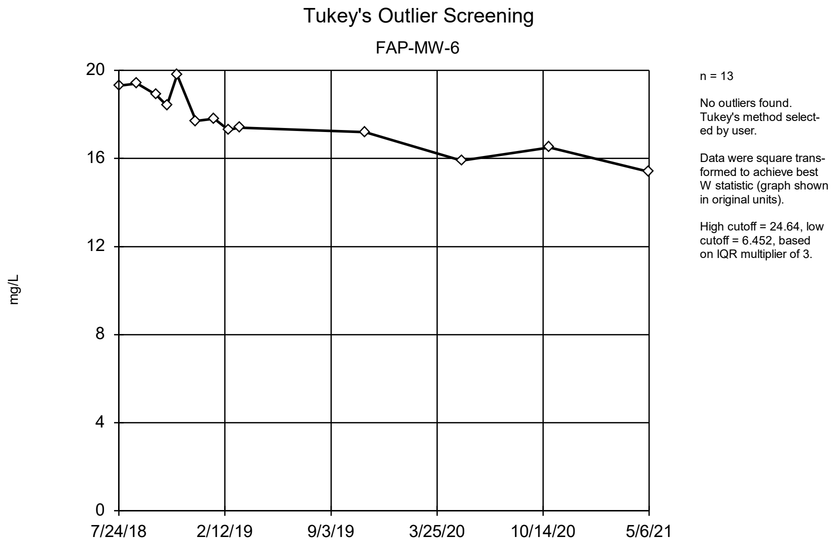
Outlier is drawn as solid. Tukey's method selected by user.

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

High cutoff = 120.5, low cutoff = 99.48, based on IQR multiplier of 3.

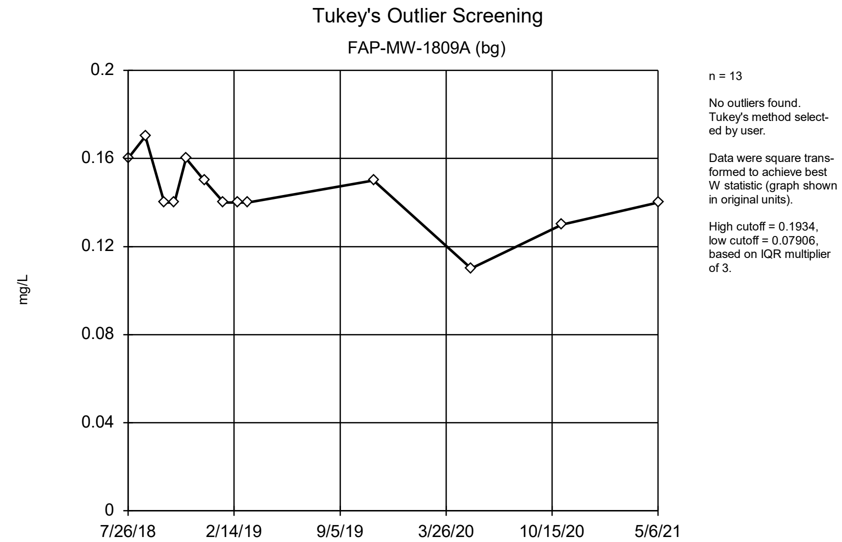
Constituent: Chloride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



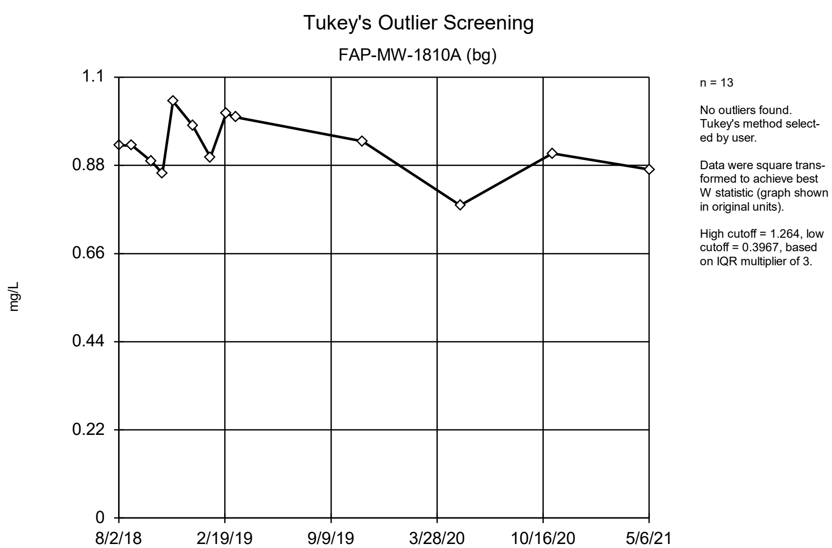
Constituent: Chloride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



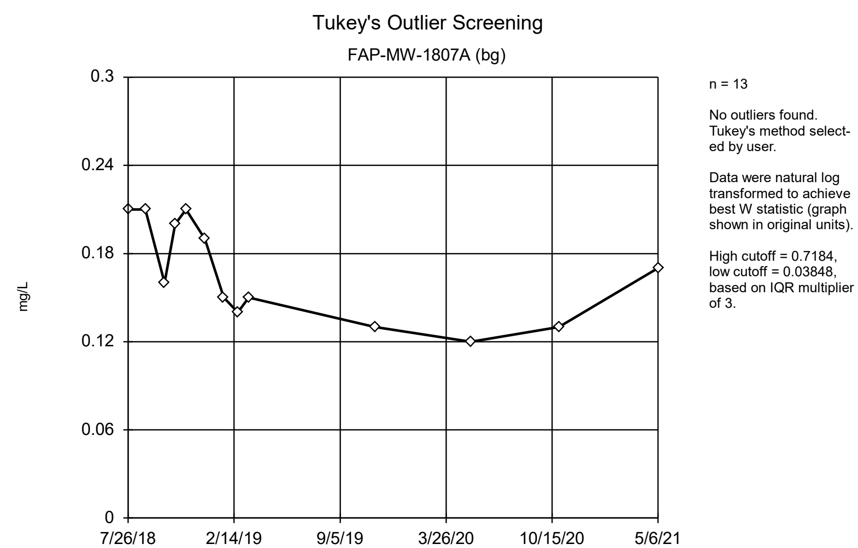
Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

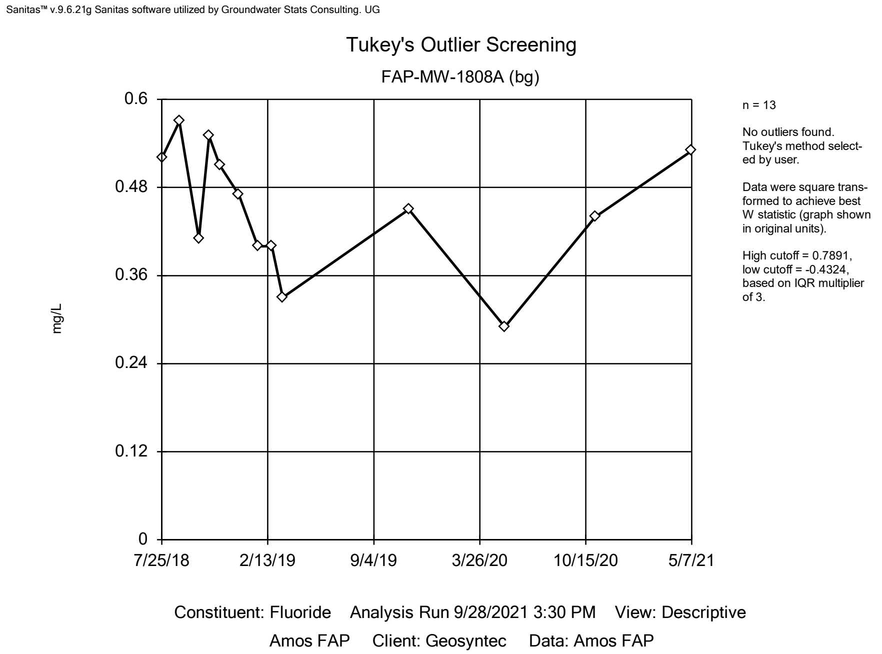


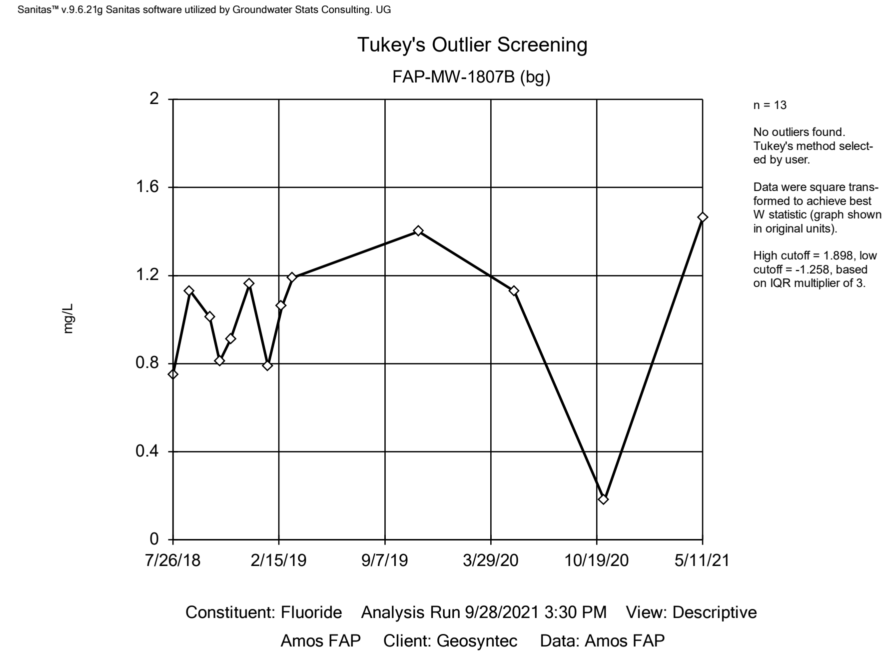
Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

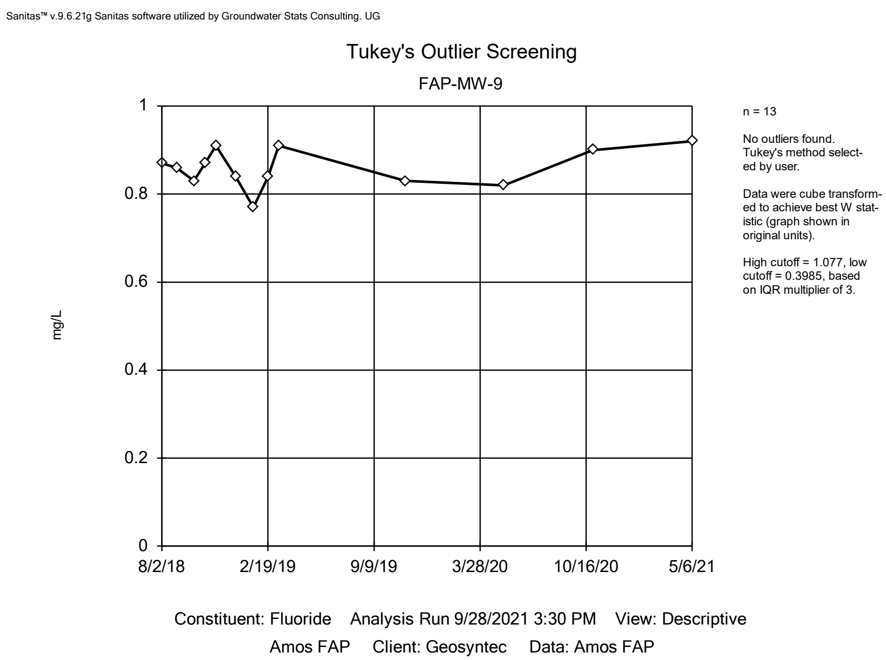
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

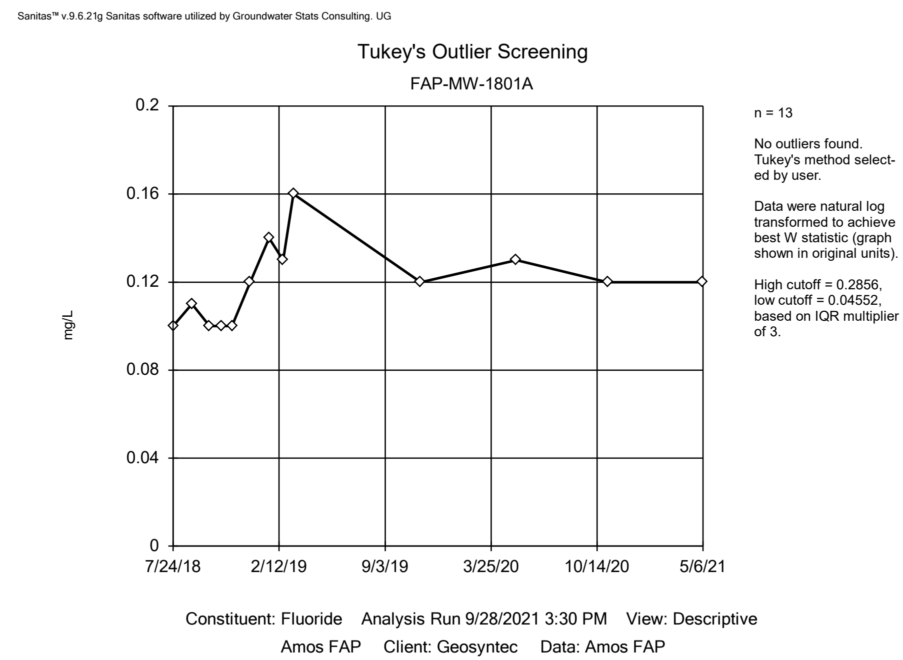


Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1808A (bg)
mg/L
0.6
0.48
0.36
0.24
0.12
0
7/25/18
2/13/19
9/4/19
3/26/20
10/15/20
5/7/21
n = 13
No outliers found. Tukey's method selected by user.
Data were square transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.7891, low cutoff = -0.4324, based on IQR multiplier of 3.
Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1807B (bg)
mg/L
2
1.6
1.2
0.8
0.4
0
7/26/18
2/15/19
9/7/19
3/29/20
10/19/20
5/11/21
n = 13
No outliers found. Tukey's method selected by user.
Data were square transformed to achieve best W statistic (graph shown in original units).
High cutoff = 1.898, low cutoff = -1.258, based on IQR multiplier of 3.
Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

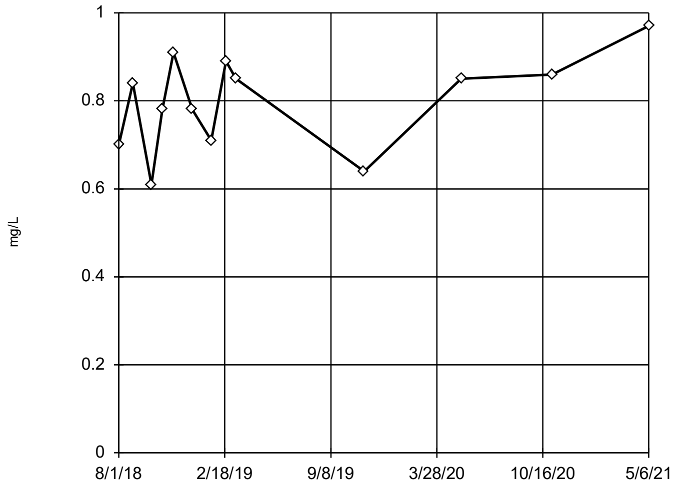

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-9
mg/L
1
0.8
0.6
0.4
0.2
0
8/2/18
2/19/19
9/9/19
3/28/20
10/16/20
5/6/21
n = 13
No outliers found. Tukey's method selected by user.
Data were cube transformed to achieve best W statistic (graph shown in original units).
High cutoff = 1.077, low cutoff = 0.3985, based on IQR multiplier of 3.
Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1801A
mg/L
0.2
0.16
0.12
0.08
0.04
0
7/24/18
2/12/19
9/3/19
3/25/20
10/14/20
5/6/21
n = 13
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 = 0.2856, low cutoff = 0.04552, based on IQR multiplier of 3.
Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1804A



n = 13

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

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

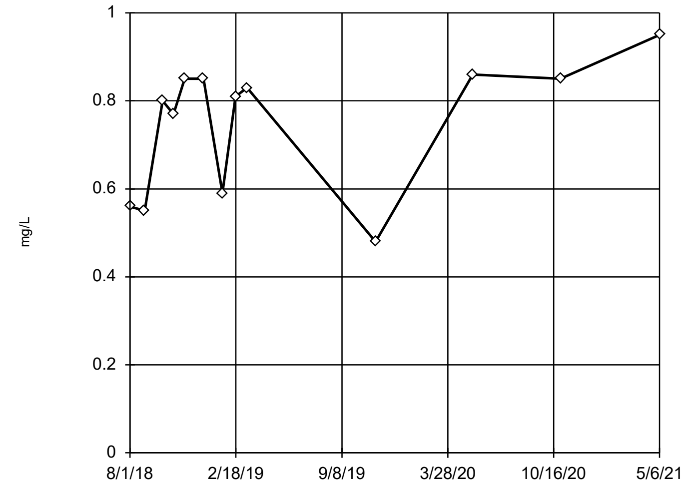
High cutoff = 1.177, low cutoff = -0.848, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1806A



n = 13

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

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

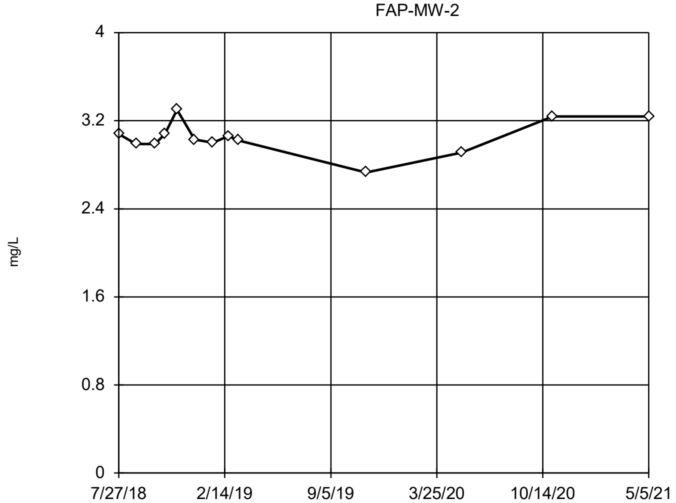
High cutoff = 1.096, low cutoff = -1.015, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-2



n = 13

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

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

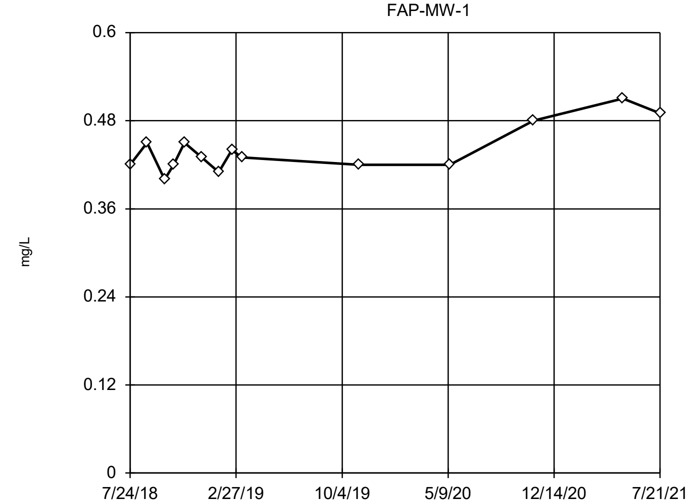
High cutoff = 3.626, low cutoff = 2.405, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1



n = 14

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

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

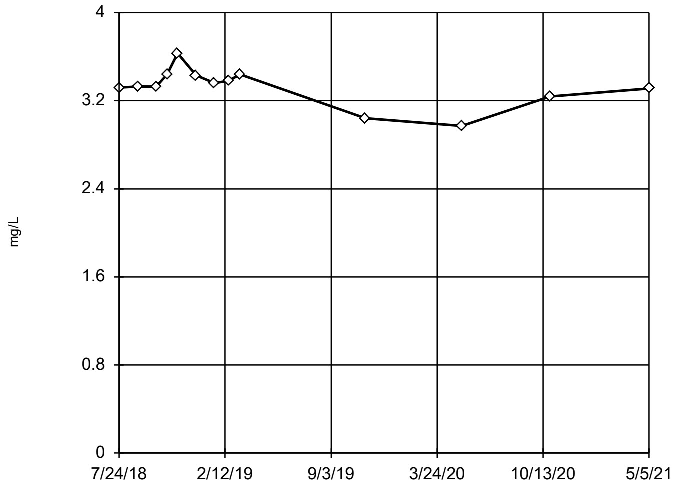
High cutoff = 0.6297, low cutoff = 0.31, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-5



n = 13

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

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

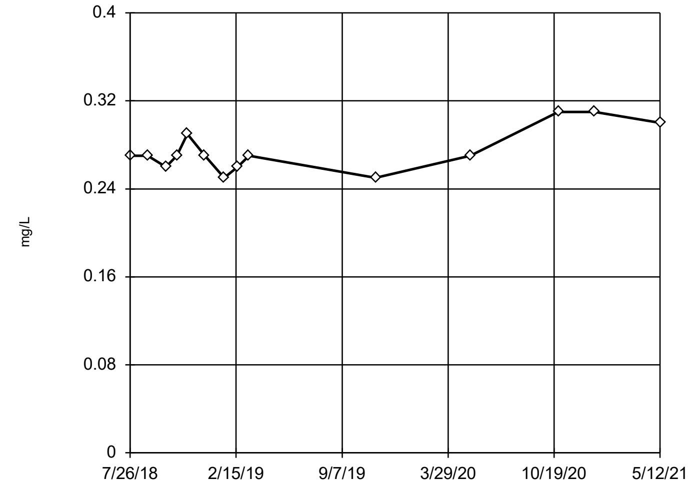
High cutoff = 3.789, low cutoff = 2.365, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-7



n = 14

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

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

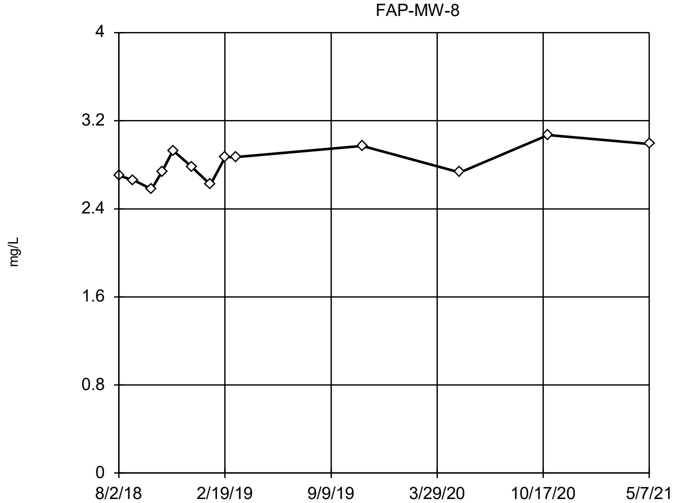
High cutoff = 0.4306, low cutoff = 0.1781, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-8



n = 13

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

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

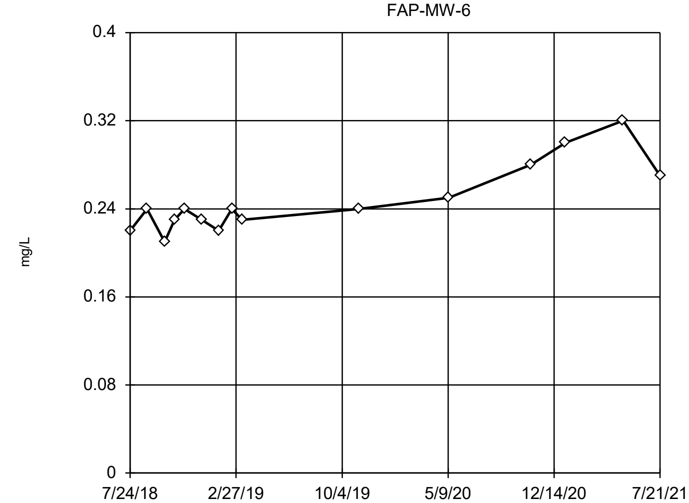
High cutoff = 3.934, low cutoff = 2.009, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-6



n = 15

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

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

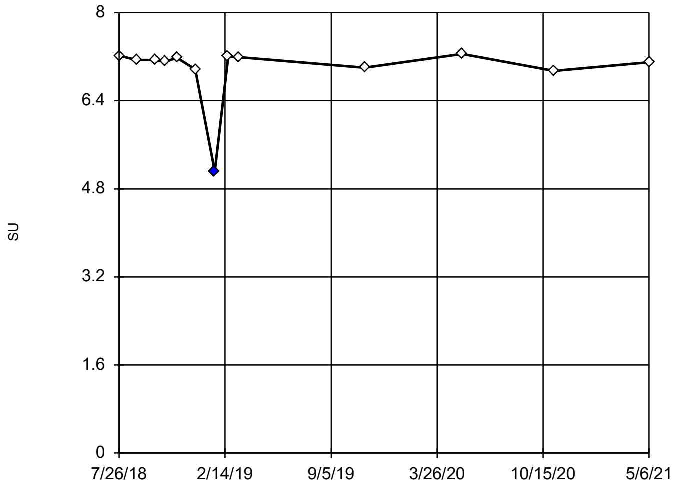
High cutoff = 0.4368, low cutoff = 0.1422, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1809A (bg)



n = 13

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

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

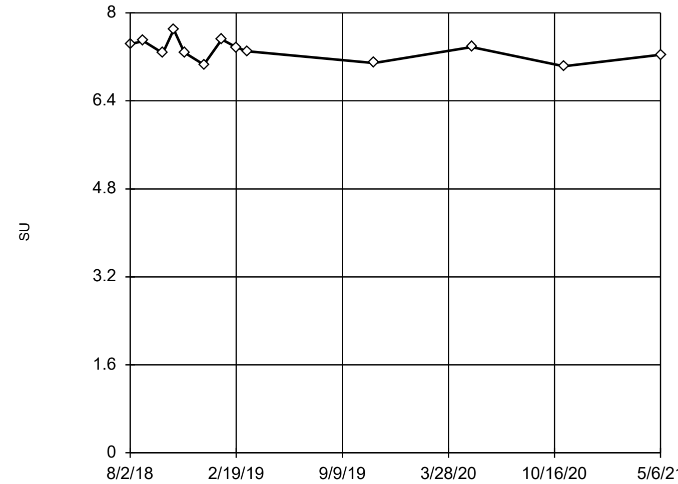
High cutoff = 7.688, low cutoff = 6.037, based on IQR multiplier of 3.

Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1810A (bg)



n = 13

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

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

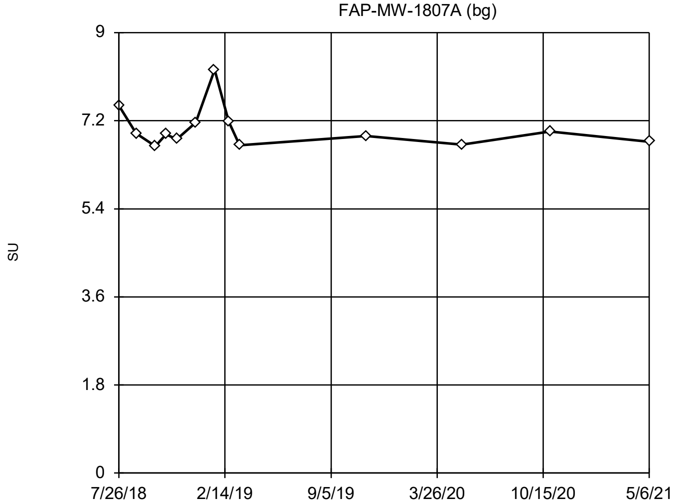
High cutoff = 8.421, low cutoff = 6.347, based on IQR multiplier of 3.

Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1807A (bg)



n = 13

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

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

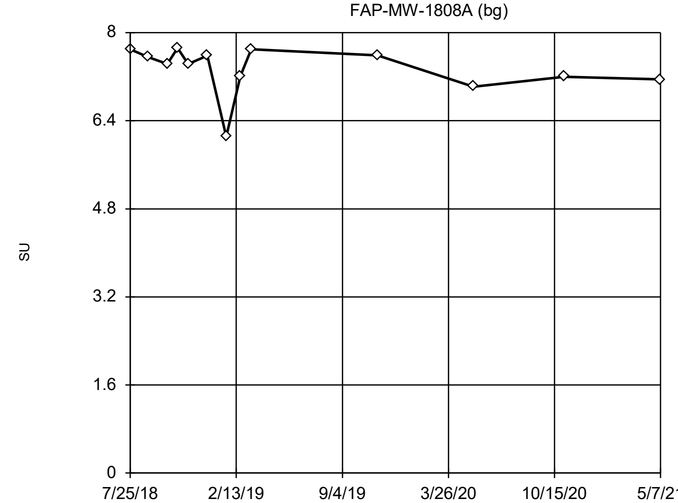
High cutoff = 8.632, low cutoff = 5.598, based on IQR multiplier of 3.

Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1808A (bg)



n = 13

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

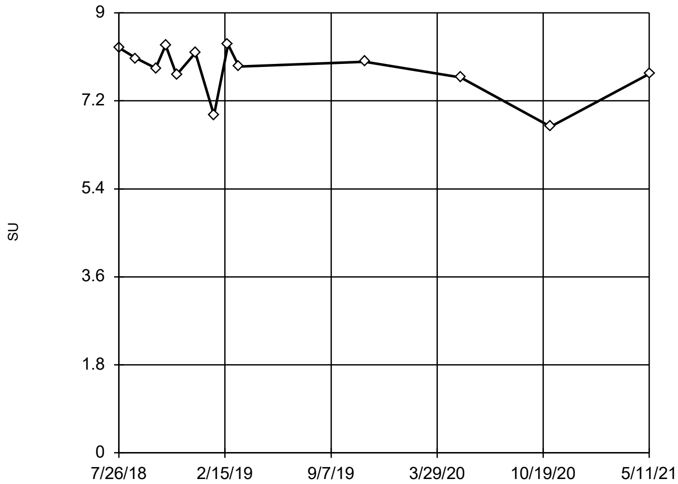
Data were x^6 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 8.547, low cutoff = -6.14, based on IQR multiplier of 3.

Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-1807B (bg)



n = 13

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

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

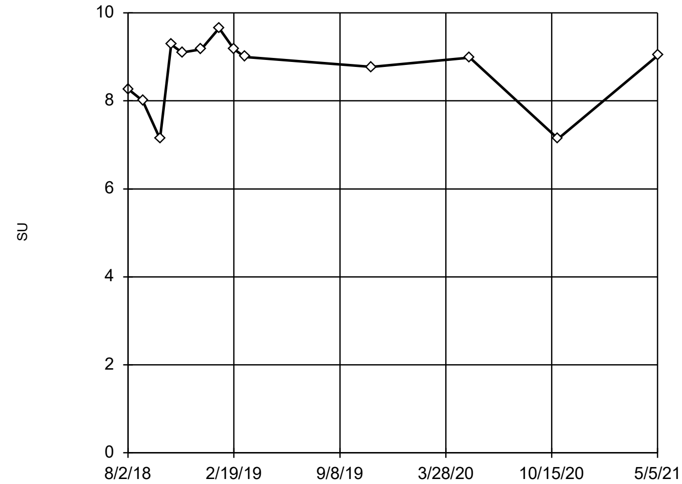
High cutoff = 9.236, low cutoff = -6.804, based on IQR multiplier of 3.

Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-9



n = 13

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

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

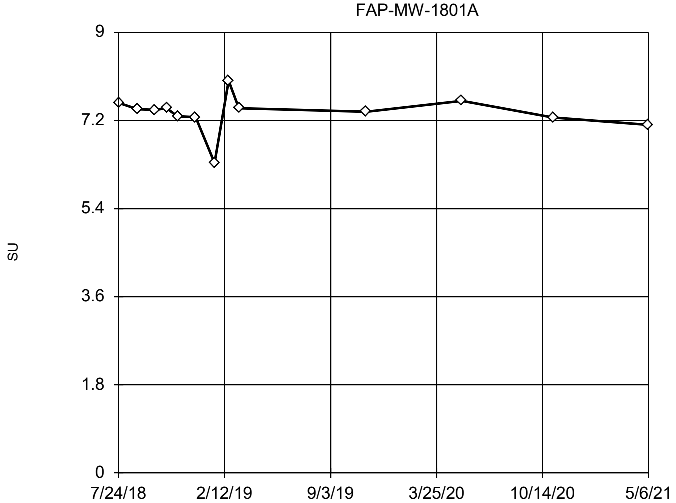
High cutoff = 10.71, low cutoff = -9.248, based on IQR multiplier of 3.

Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1801A



n = 13

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

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

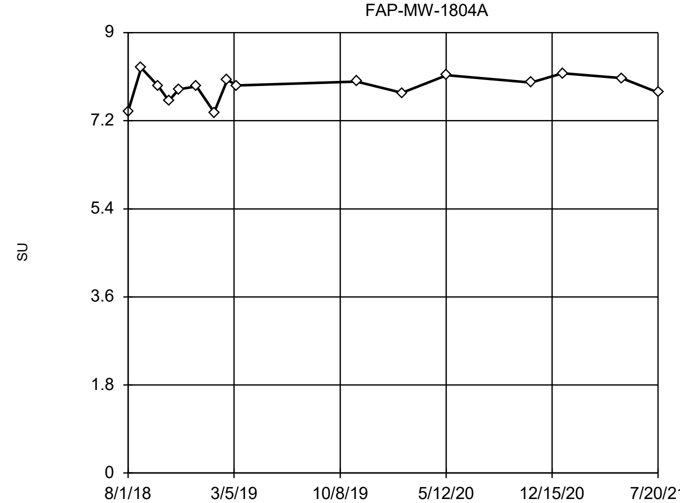
High cutoff = 8.06, low cutoff = 6.102, based on IQR multiplier of 3.

Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1804A



n = 16

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

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

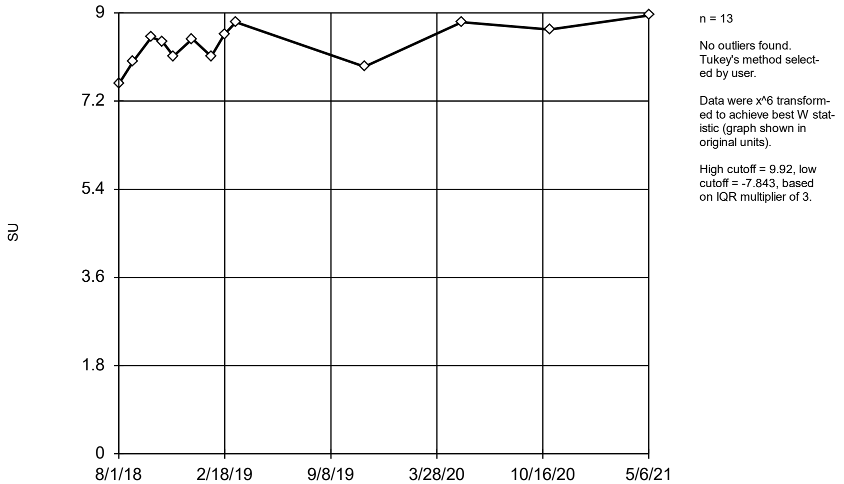
High cutoff = 8.674, low cutoff = 6.375, based on IQR multiplier of 3.

Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1806A

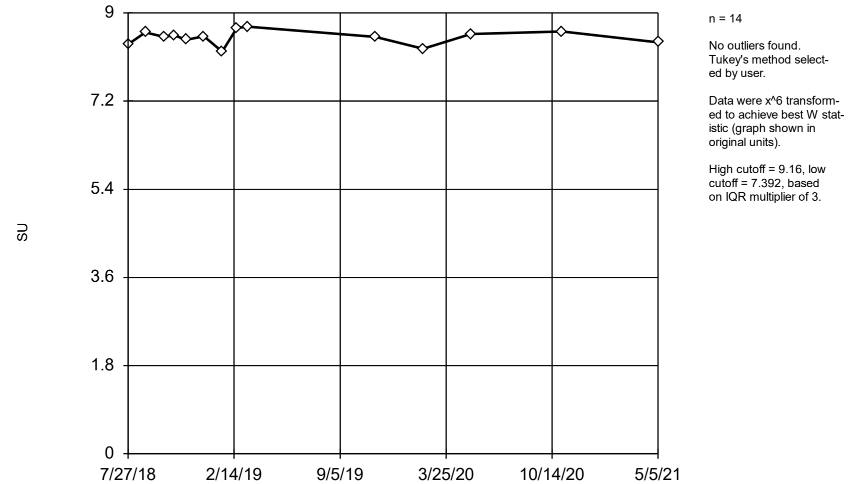


Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-2

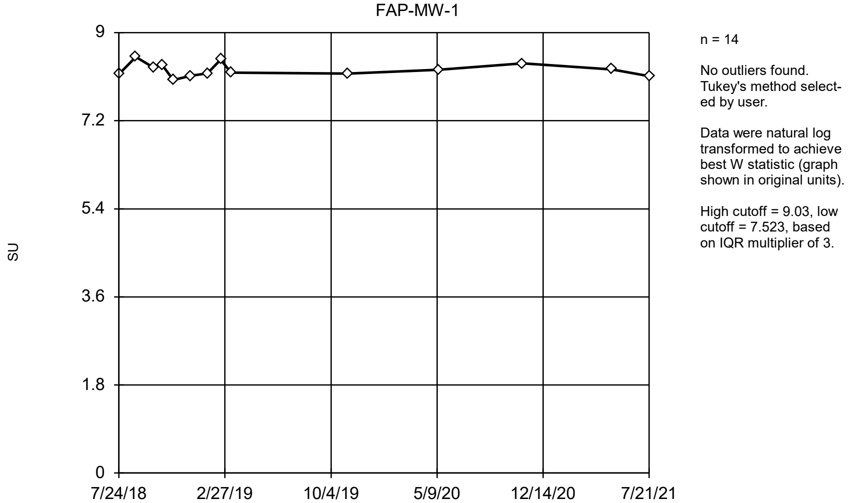


Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1

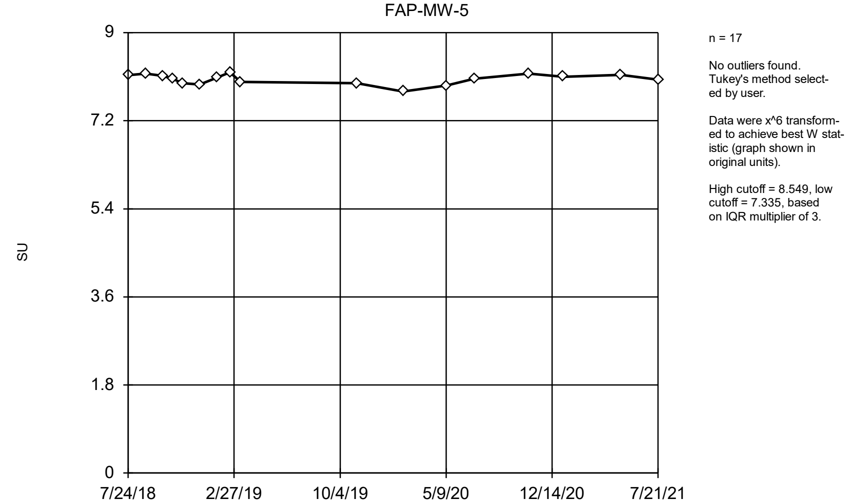


Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

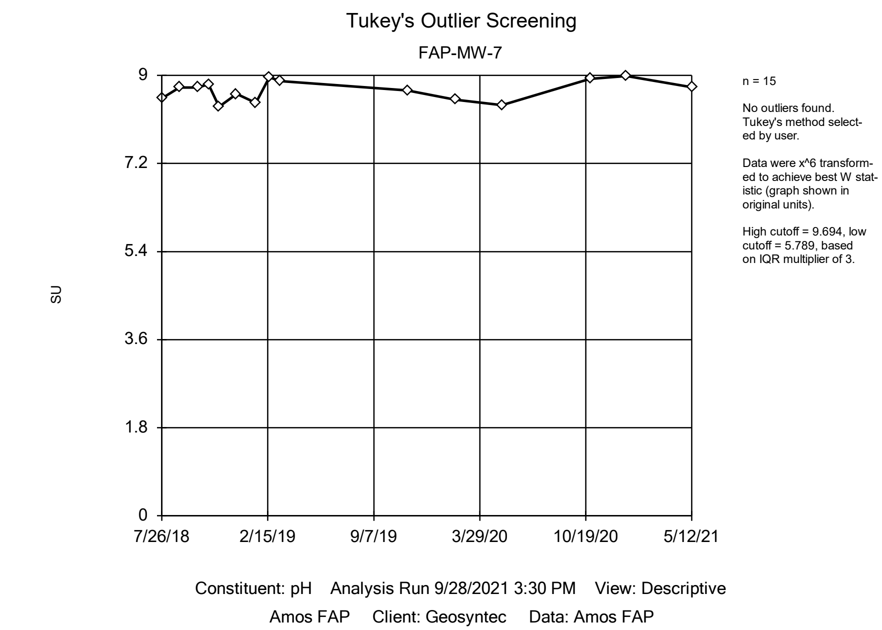
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

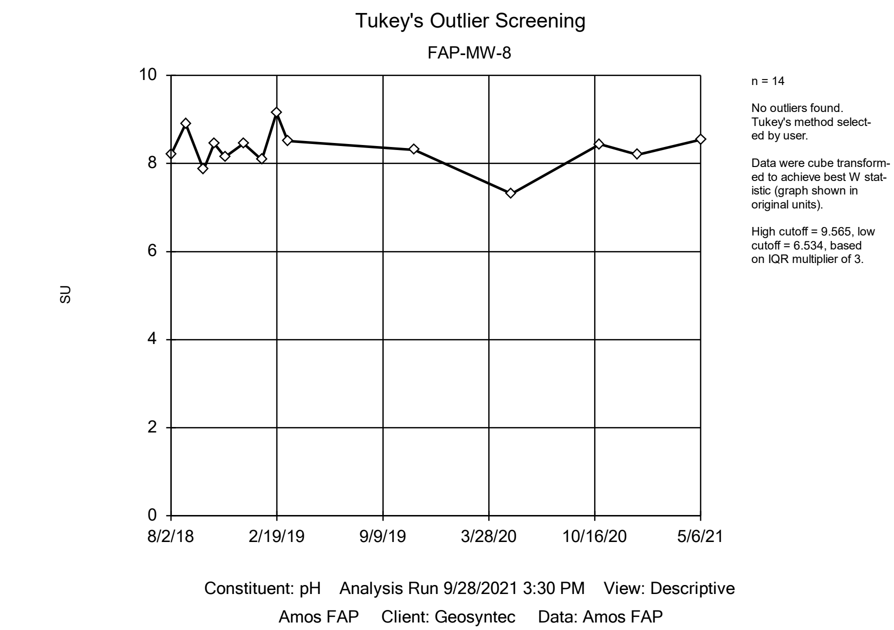
FAP-MW-5



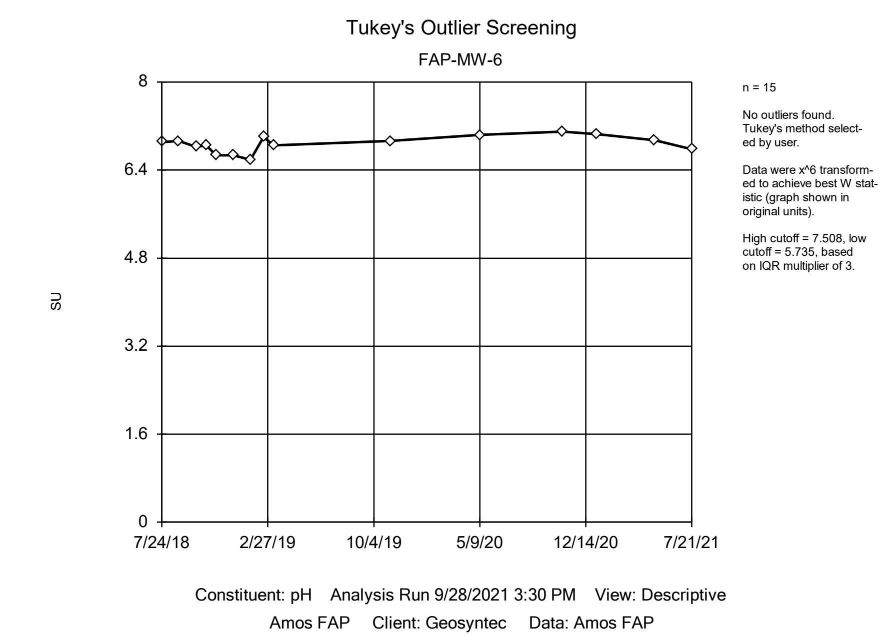
Constituent: pH Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP



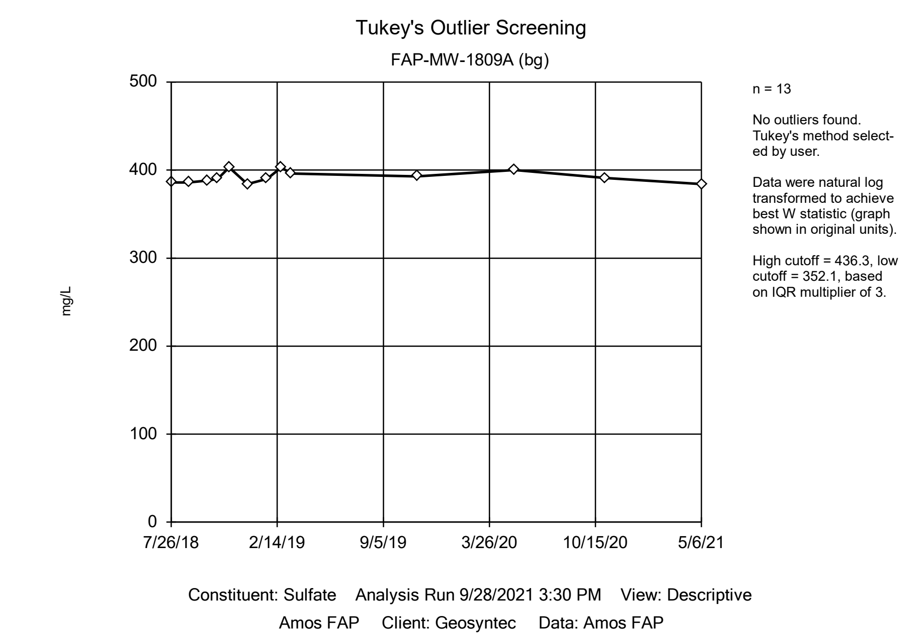
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

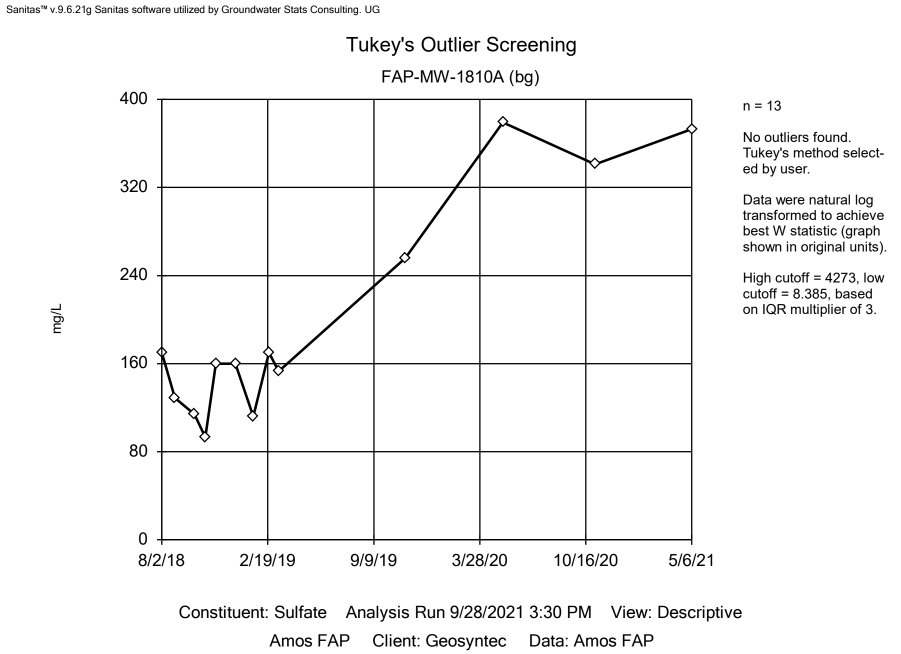


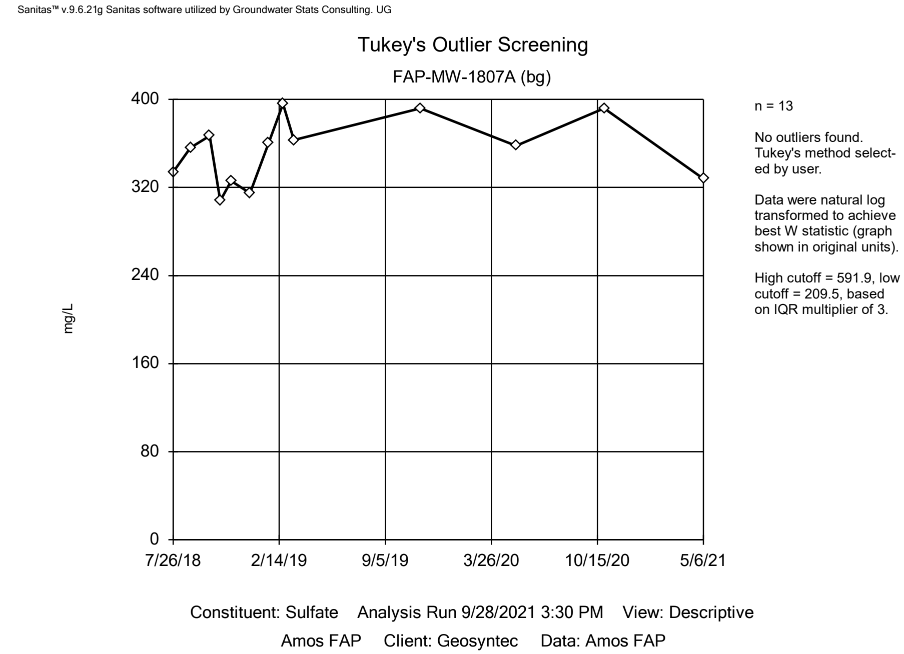
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

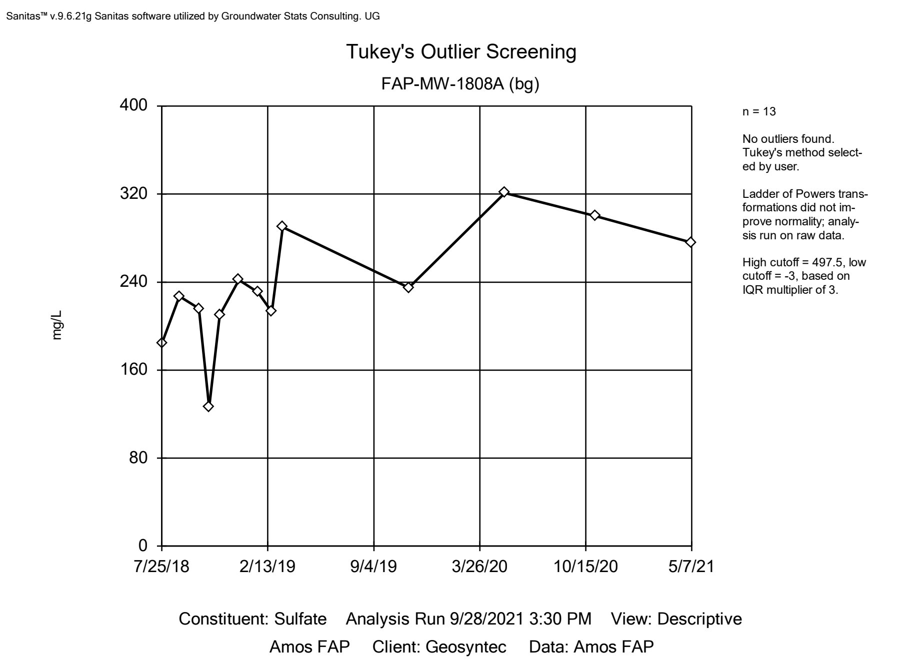


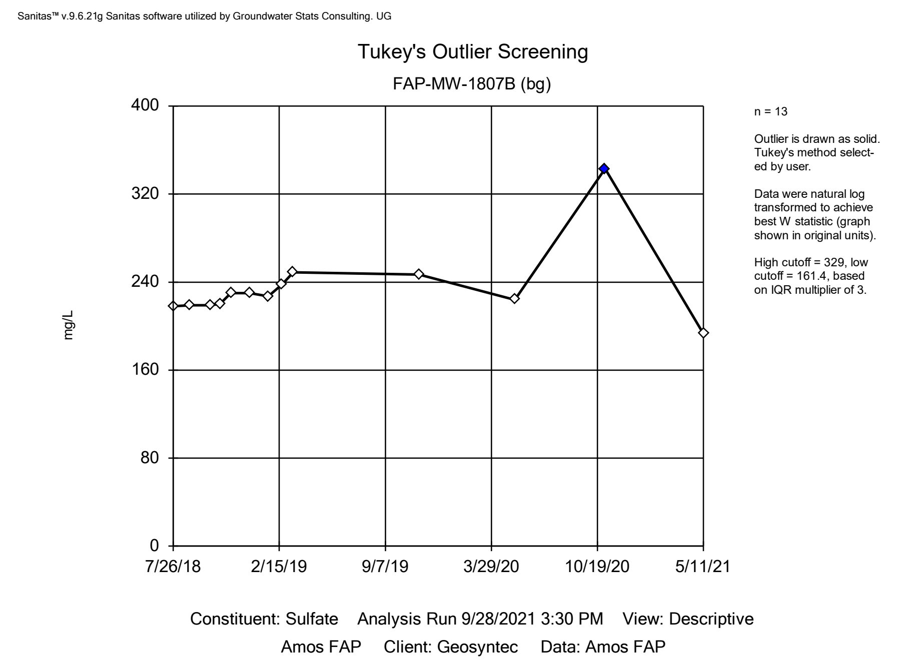
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



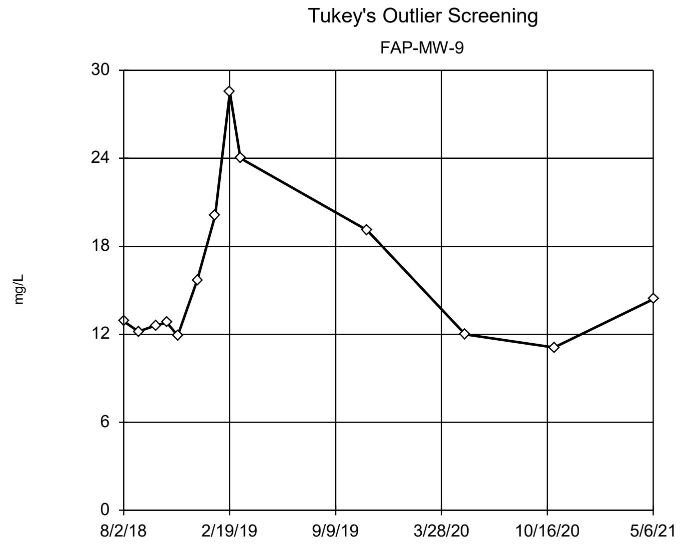

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1810A (bg)
400
320
240
160
80
0
mg/L
8/2/18
2/19/19
9/9/19
3/28/20
10/16/20
5/6/21
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 4273, low cutoff = 8.385, based on IQR multiplier of 3.
Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1807A (bg)
400
320
240
160
80
0
mg/L
7/26/18
2/14/19
9/5/19
3/26/20
10/15/20
5/6/21
n = 13
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 = 591.9, low cutoff = 209.5, based on IQR multiplier of 3.
Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1808A (bg)
400
320
240
160
80
0
mg/L
7/25/18
2/13/19
9/4/19
3/26/20
10/15/20
5/7/21
n = 13
No outliers found. Tukey's method selected by user.
Ladder of Powers transformations did not improve normality; analysis run on raw data.
High cutoff = 497.5, low cutoff = -3, based on IQR multiplier of 3.
Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1807B (bg)
400
320
240
160
80
0
mg/L
7/26/18
2/15/19
9/7/19
3/29/20
10/19/20
5/11/21
n = 13
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 = 329, low cutoff = 161.4, based on IQR multiplier of 3.
Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 13

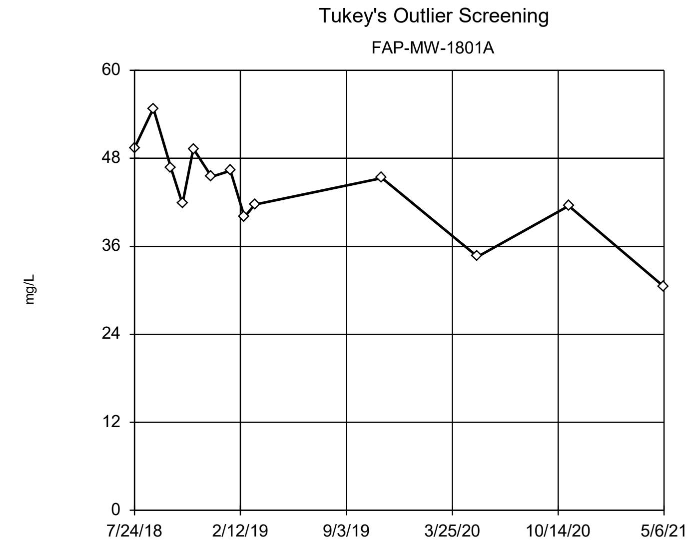
No outliers found. Tukey's method selected by user.

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

High cutoff = 83.2, low cutoff = 2.849, based on IQR multiplier of 3.

Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 13

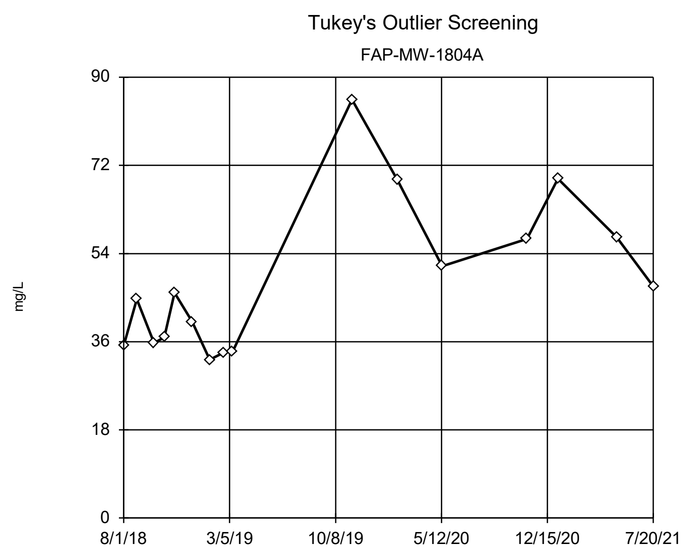
No outliers found. Tukey's method selected by user.

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

High cutoff = 65.11, low cutoff = -16.51, based on IQR multiplier of 3.

Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 16

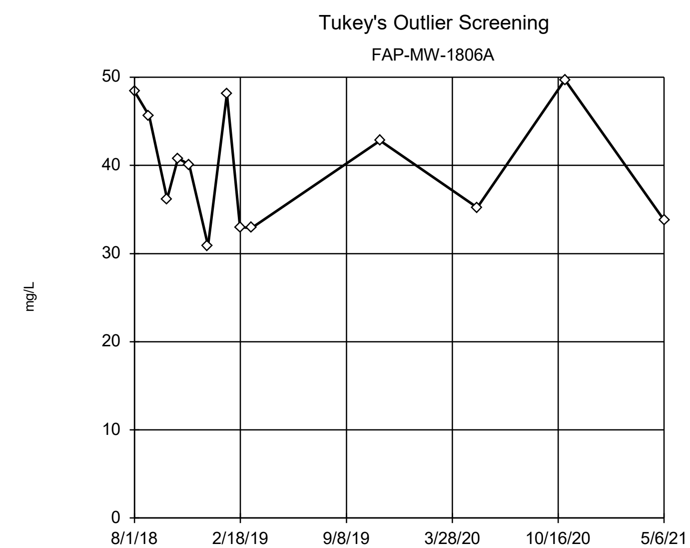
No outliers found. Tukey's method selected by user.

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

High cutoff = 239.5, low cutoff = 8.46, based on IQR multiplier of 3.

Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 13

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

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

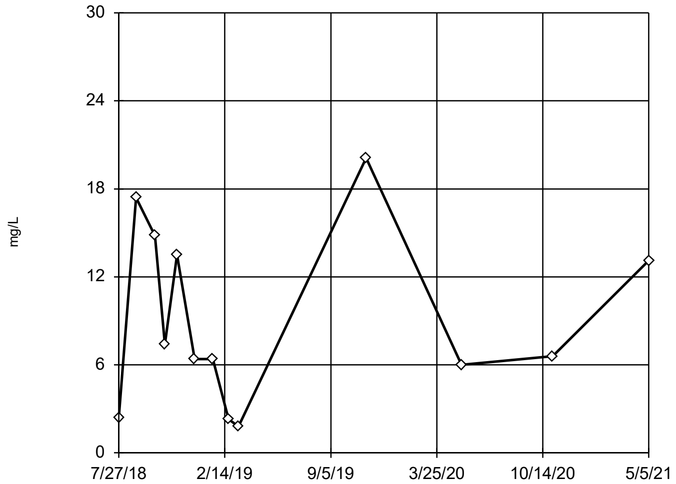
High cutoff = 129.1, low cutoff = 12.11, based on IQR multiplier of 3.

Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-2



n = 13

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

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

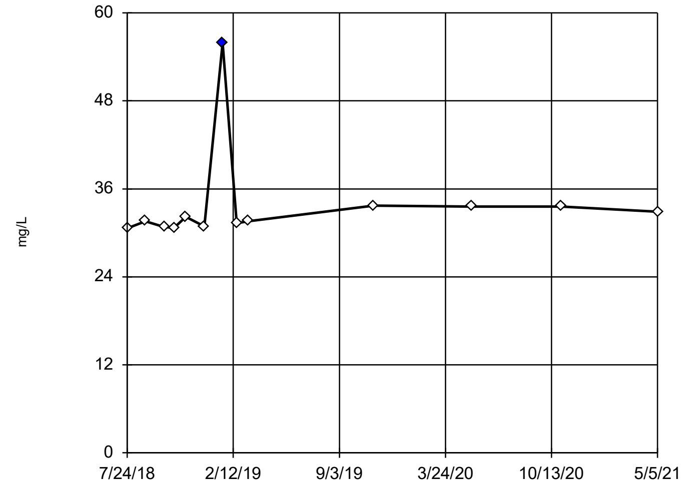
High cutoff = 81.8, low cutoff = -10.79, based on IQR multiplier of 3.

Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1



n = 13

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).

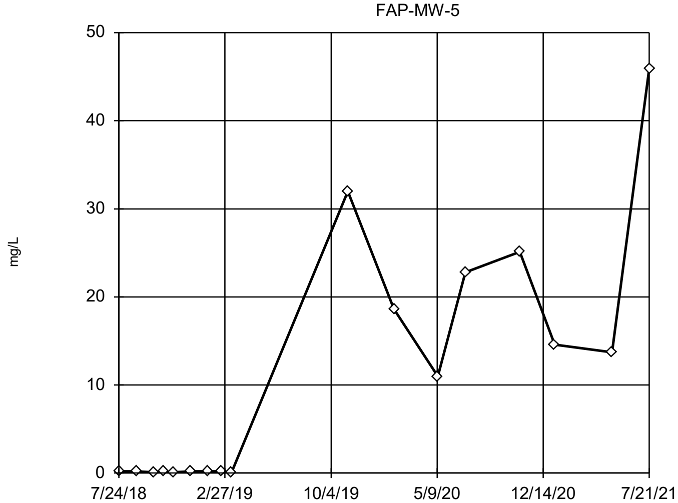
High cutoff = 43.41, low cutoff = 23.88, based on IQR multiplier of 3.

Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-5



n = 17

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

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

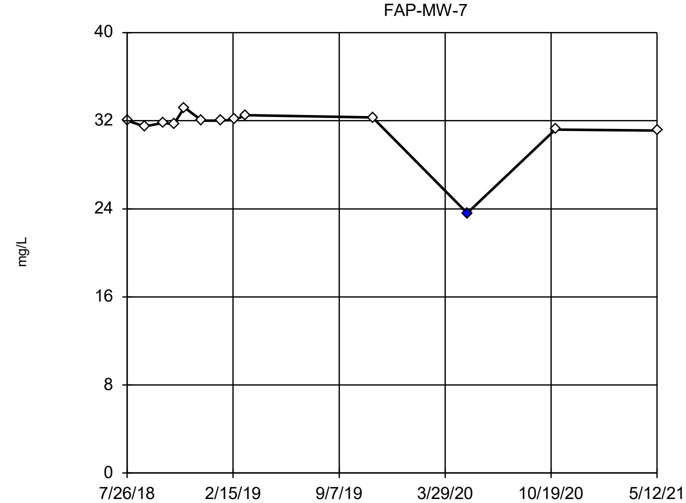
High cutoff = 283.4, low cutoff = -140.2, based on IQR multiplier of 3.

Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-7



n = 13

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

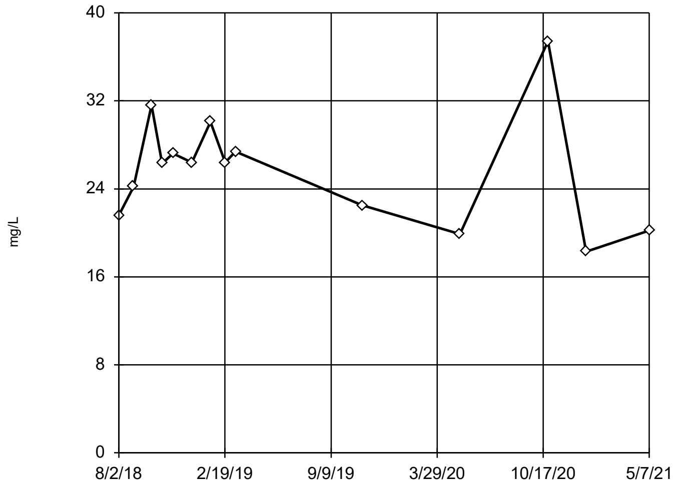
Data were x^6 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 34.24, low cutoff = 27.73, based on IQR multiplier of 3.

Constituent: Sulfate Analysis Run 9/28/2021 3:30 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Tukey's Outlier Screening

FAP-MW-8



n = 14

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

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

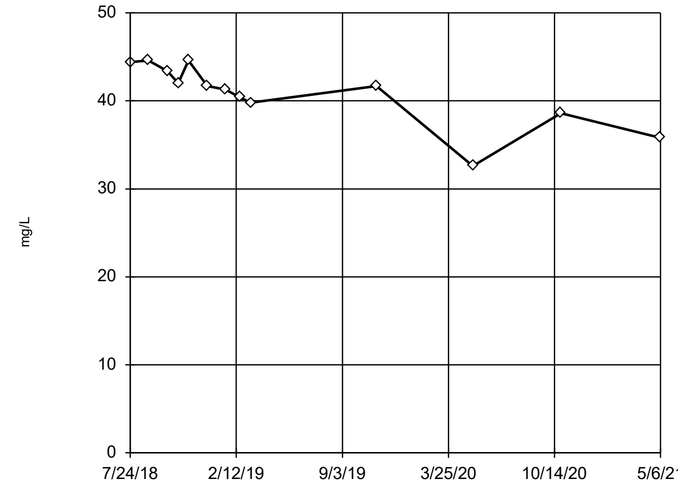
High cutoff = 74.63, low cutoff = 8.038, based on IQR multiplier of 3.

Constituent: Sulfate   Analysis Run 9/28/2021 3:31 PM   View: Descriptive
Amos FAP   Client: Geosyntec   Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-6



n = 13

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

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

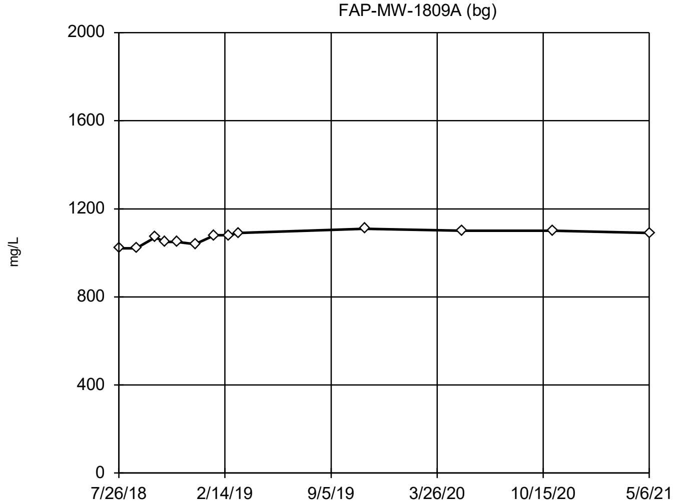
High cutoff = 51.08, low cutoff = -43.69, based on IQR multiplier of 3.

Constituent: Sulfate   Analysis Run 9/28/2021 3:31 PM   View: Descriptive
Amos FAP   Client: Geosyntec   Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1809A (bg)



n = 13

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

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

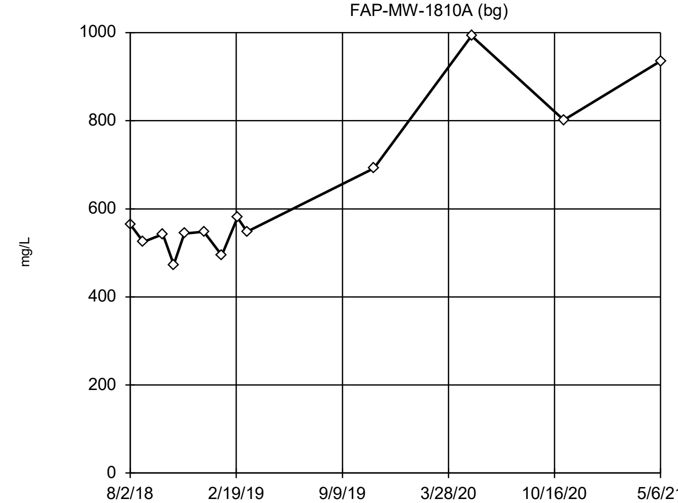
High cutoff = 1200, low cutoff = 579.4, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids   Analysis Run 9/28/2021 3:31 PM   View: Descriptive
Amos FAP   Client: Geosyntec   Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1810A (bg)



n = 13

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

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

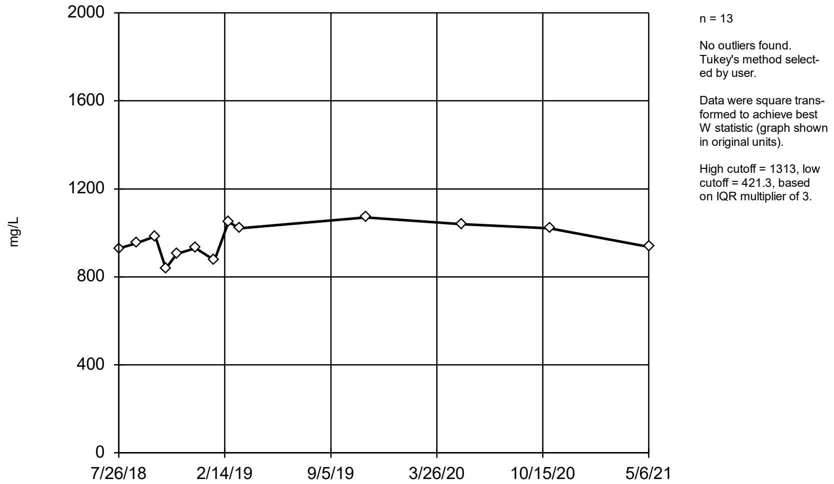
High cutoff = 2029, low cutoff = 195.8, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids   Analysis Run 9/28/2021 3:31 PM   View: Descriptive
Amos FAP   Client: Geosyntec   Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1807A (bg)

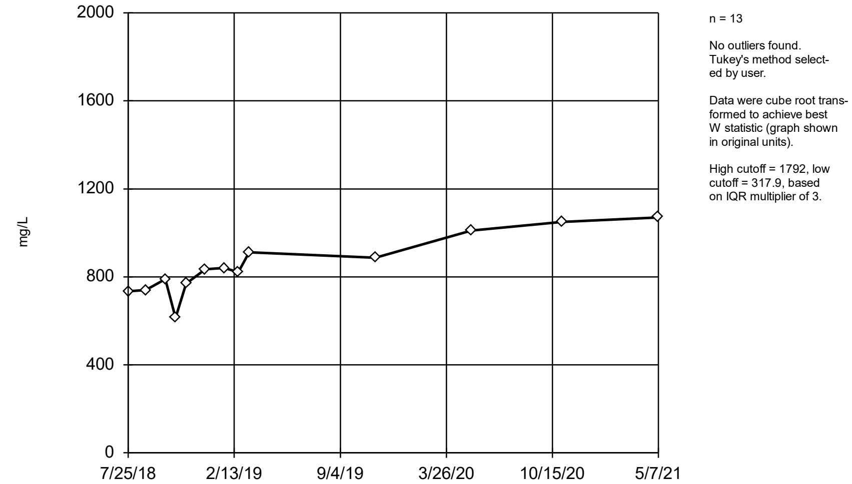


Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:31 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1808A (bg)

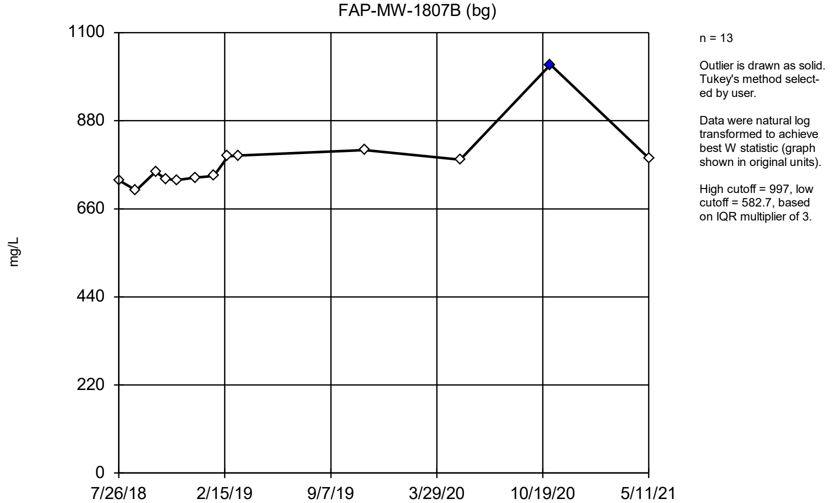


Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:31 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

FAP-MW-1807B (bg)

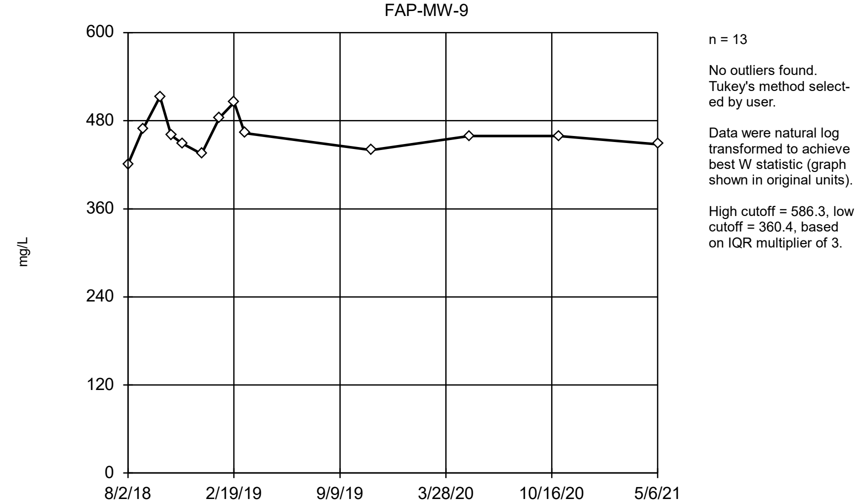


Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:31 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

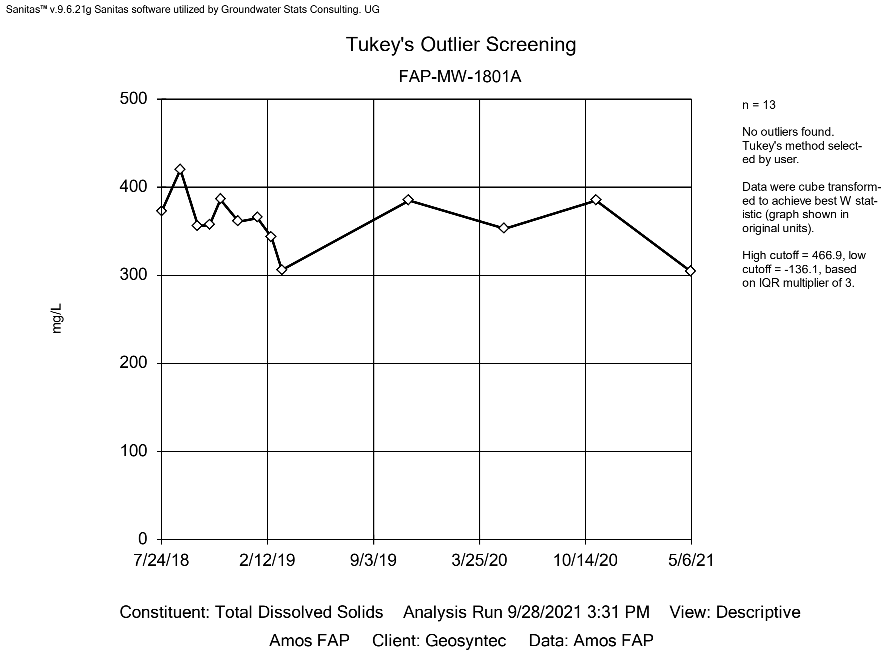
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

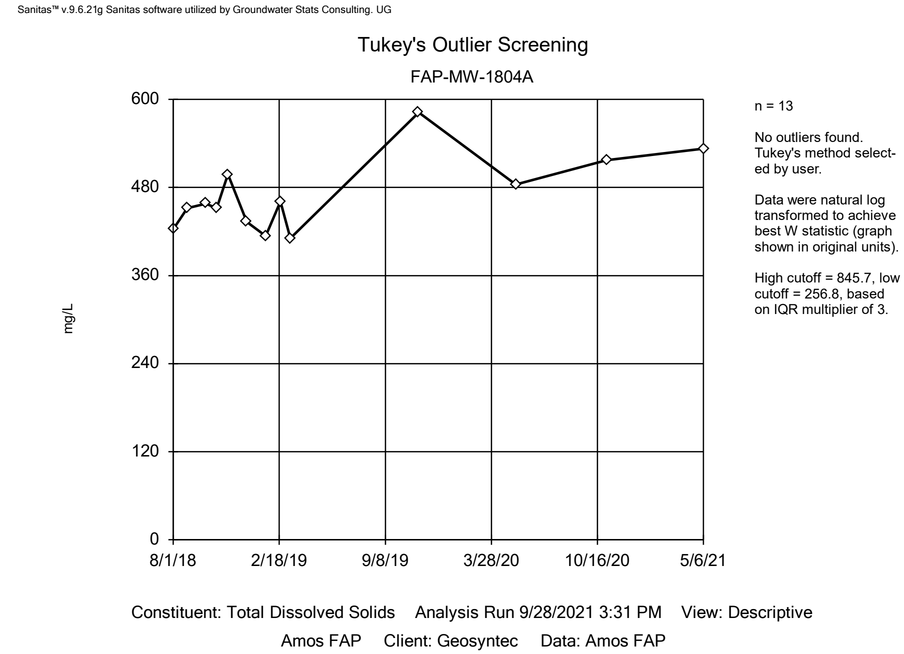
Tukey's Outlier Screening

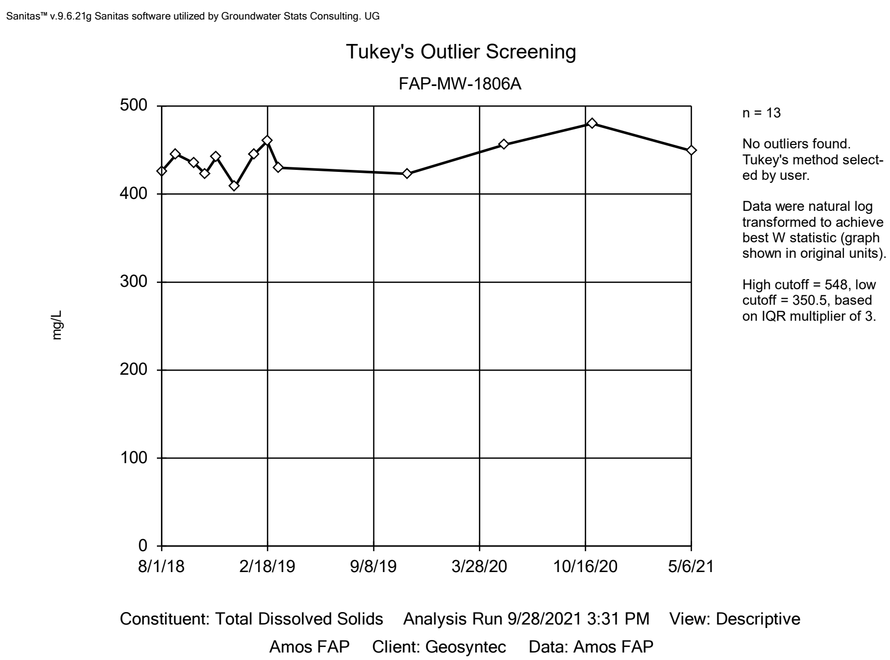
FAP-MW-9

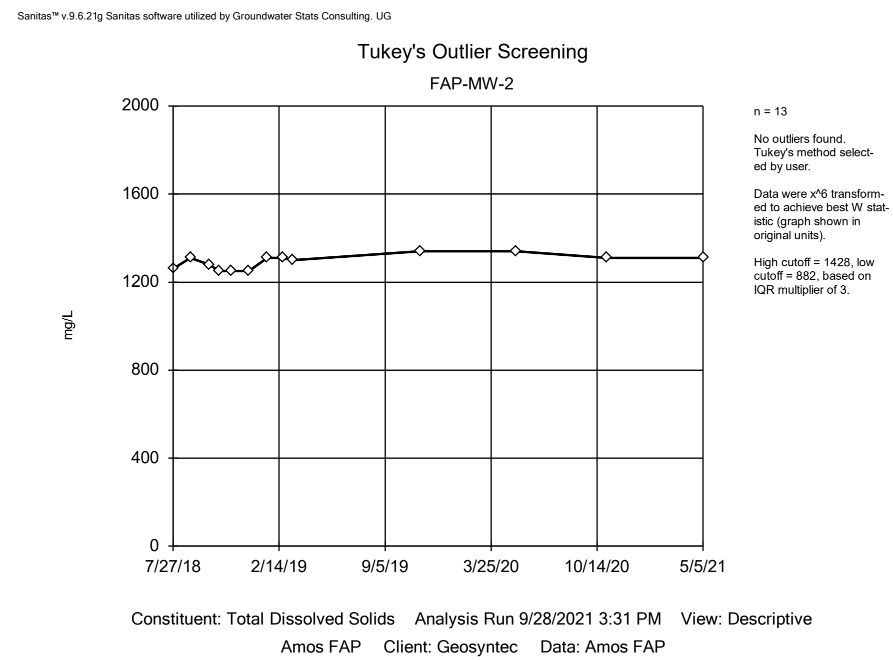


Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:31 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

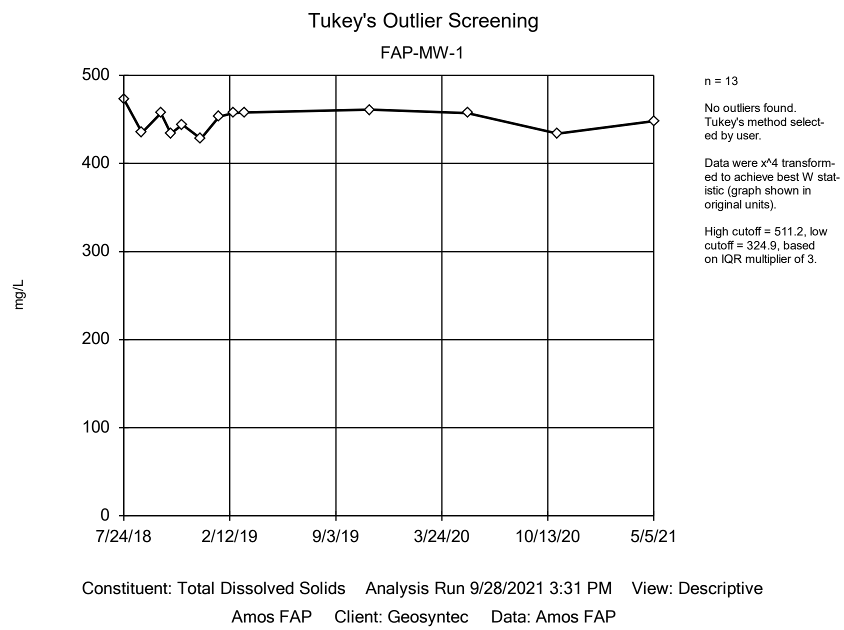

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1801A
mg/L
500
400
300
200
100
0
7/24/18
2/12/19
9/3/19
3/25/20
10/14/20
5/6/21
n = 13
No outliers found. Tukey's method selected by user.
Data were cube transformed to achieve best W statistic (graph shown in original units).
High cutoff = 466.9, low cutoff = -136.1, based on IQR multiplier of 3.
Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:31 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1804A
mg/L
600
480
360
240
120
0
8/1/18
2/18/19
9/8/19
3/28/20
10/16/20
5/6/21
n = 13
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 = 845.7, low cutoff = 256.8, based on IQR multiplier of 3.
Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:31 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

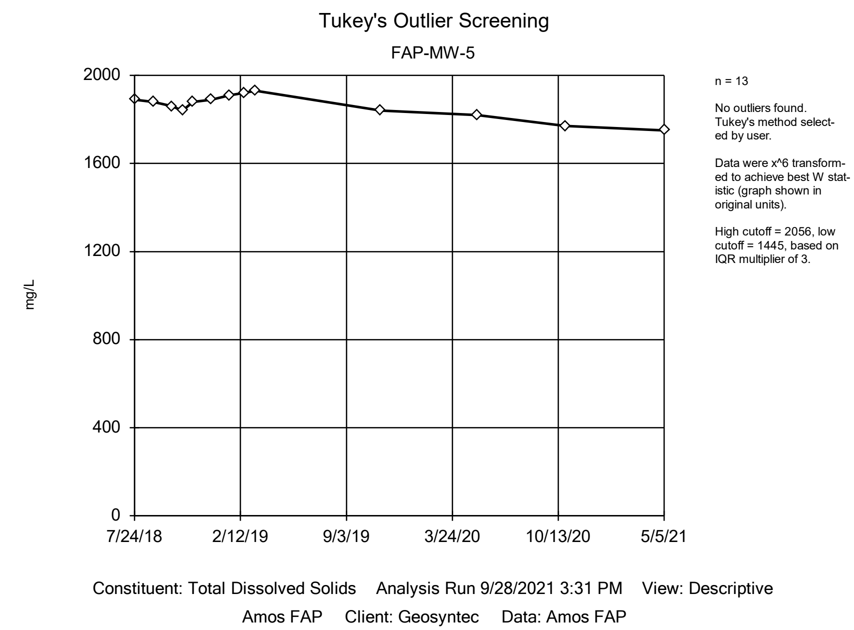

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-1806A
mg/L
500
400
300
200
100
0
8/1/18
2/18/19
9/8/19
3/28/20
10/16/20
5/6/21
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 548, low cutoff = 350.5, based on IQR multiplier of 3.
Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:31 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP


Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Tukey's Outlier Screening
FAP-MW-2
mg/L
2000
1600
1200
800
400
0
7/27/18
2/14/19
9/5/19
3/25/20
10/14/20
5/5/21
n = 13
No outliers found. Tukey's method selected by user.
Data were x^6 transformed to achieve best W statistic (graph shown in original units).
High cutoff = 1428, low cutoff = 882, based on IQR multiplier of 3.
Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:31 PM View: Descriptive
Amos FAP Client: Geosyntec Data: Amos FAP

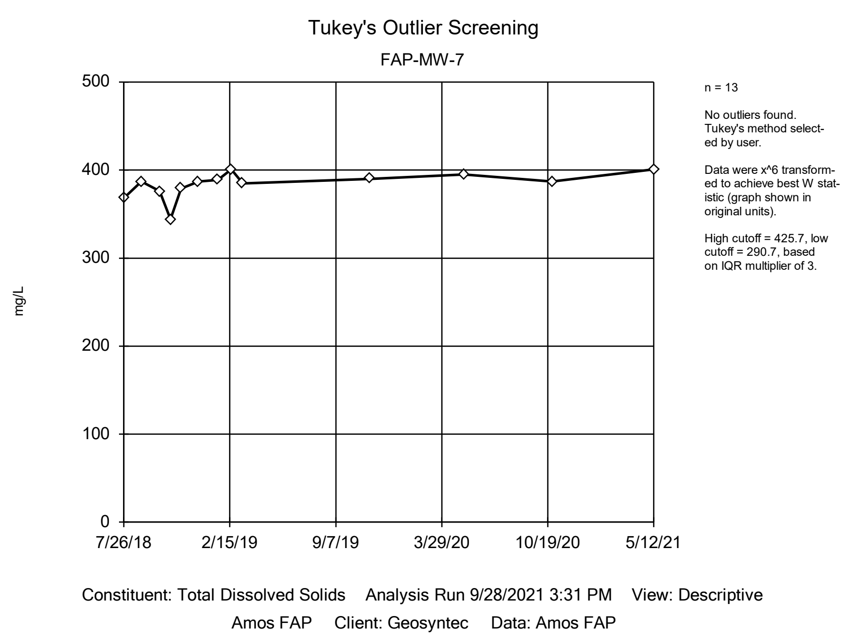
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



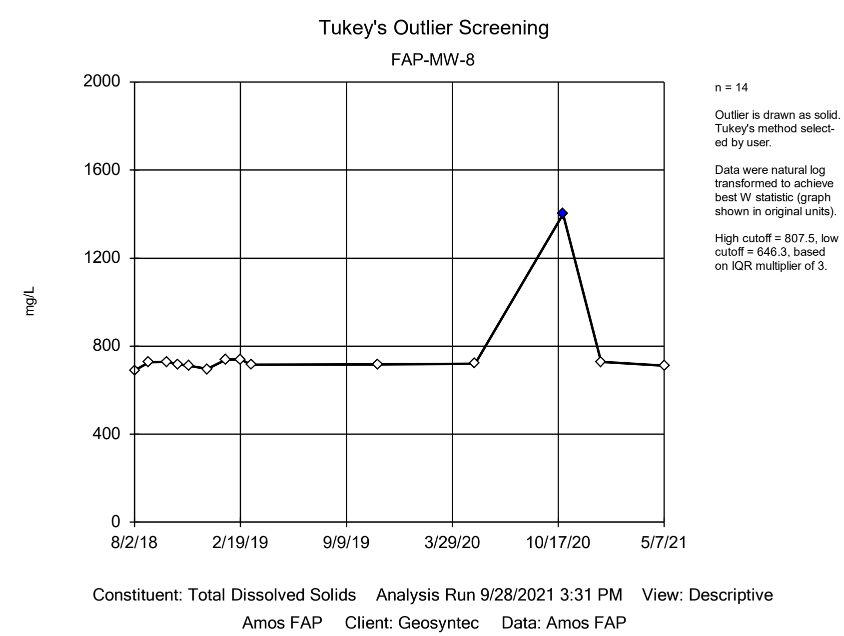
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



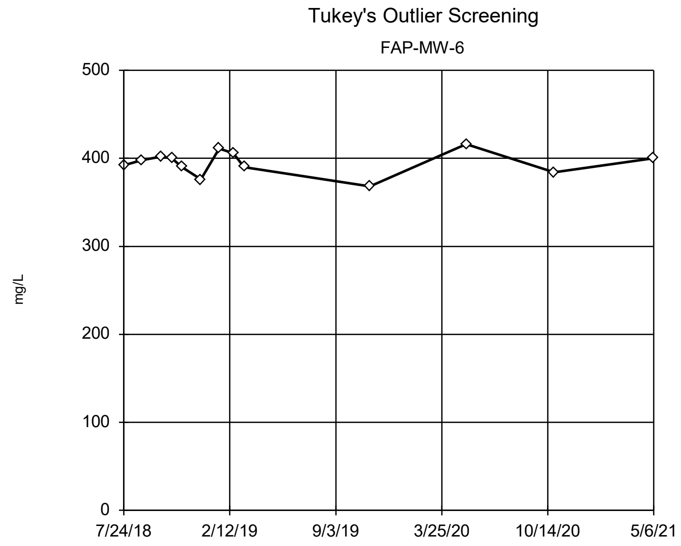
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 13

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

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 440.6, low cutoff = 271.6, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:31 PM View: Descriptive

Amos FAP Client: Geosyntec Data: Amos FAP

Outlier Summary

Amos FAP Client: Geosyntec Data: Amos FAP Printed 9/28/2021, 3:35 PM

	FAP-MW-1 Boron (mg/L)	FAP-MW-7 Boron (mg/L)	FAP-MW-1807B Calcium (mg/L)	FAP-MW-1804A Calcium (mg/L)	FAP-MW-8 Calcium (mg/L)	FAP-MW-8 Chloride (mg/L)	FAP-MW-1809A pH (SU)	FAP-MW-1 Sulfate (mg/L)	FAP-MW-1807B Total Dissolved Solids (mg/L)	FAP-MW-8 Total Dissolved Solids (mg/L)
7/24/2018	0.182 (o)									
7/27/2018				28.1 (o)						
10/2/2018				38.8 (o)						
10/3/2018		0.156 (o)								
10/22/2018	0.18 (o)									
11/13/2018	0.209 (o)	0.192 (o)								
1/23/2019								55.9 (o)		
1/25/2019							5.12 (o)			
10/26/2020					8.47 (o)	508 (o)				1400 (o)
11/3/2020			168 (o)						1020 (o)	

Mann-Whitney Summary- Significant Results

Amos FAP   Client: Geosyntec   Data: Amos FAP   Printed 9/28/2021, 3:39 PM

Constituent	Well	Calc.	0.01	Sig.	Method
Boron (mg/L)	**FAP-MW-5**	**-2.855**	**Yes**	**Yes**	**Mann-W**
Calcium (mg/L)	**FAP-MW-1810A (bg)**	**2.708**	**Yes**	**Yes**	**Mann-W**
Calcium (mg/L)	**FAP-MW-5**	**3.1**	**Yes**	**Yes**	**Mann-W**
Chloride (mg/L)	**FAP-MW-1809A (bg)**	**2.855**	**Yes**	**Yes**	**Mann-W**
Chloride (mg/L)	**FAP-MW-1807B (bg)**	**2.639**	**Yes**	**Yes**	**Mann-W**
Chloride (mg/L)	**FAP-MW-1804A**	**2.678**	**Yes**	**Yes**	**Mann-W**
Chloride (mg/L)	**FAP-MW-6**	**-2.855**	**Yes**	**Yes**	**Mann-W**
Fluoride (mg/L)	**FAP-MW-6**	**2.581**	**Yes**	**Yes**	**Mann-W**
Sulfate (mg/L)	**FAP-MW-1808A (bg)**	**2.708**	**Yes**	**Yes**	**Mann-W**
Sulfate (mg/L)	**FAP-MW-1804A**	**2.678**	**Yes**	**Yes**	**Mann-W**
Sulfate (mg/L)	**FAP-MW-5**	**2.666**	**Yes**	**Yes**	**Mann-W**
Sulfate (mg/L)	**FAP-MW-6**	**-2.642**	**Yes**	**Yes**	**Mann-W**

Mann-Whitney Summary - All Results

Amos FAP Client: Geosyntec Data: Amos FAP Printed 9/28/2021, 3:39 PM

Constituent	Well	Calc.	0.01	Sig.	Method
Boron (mg/L)	FAP-MW-1809A (bg)	-1.394	No	No	Mann-W
Boron (mg/L)	FAP-MW-1810A (bg)	-1.246	No	No	Mann-W
Boron (mg/L)	FAP-MW-1807A (bg)	-2.562	No	No	Mann-W
Boron (mg/L)	FAP-MW-1808A (bg)	-1.466	No	No	Mann-W
Boron (mg/L)	FAP-MW-1807B (bg)	-1.537	No	No	Mann-W
Boron (mg/L)	FAP-MW-1801A	-1.327	No	No	Mann-W
Boron (mg/L)	FAP-MW-1804A	-1.537	No	No	Mann-W
Boron (mg/L)	FAP-MW-1806A	-2.419	No	No	Mann-W
Boron (mg/L)	FAP-MW-2	-1.832	No	No	Mann-W
Boron (mg/L)	FAP-MW-1	-2.298	No	No	Mann-W
Boron (mg/L)	**FAP-MW-5**	**-2.855**	**Yes**	**Yes**	**Mann-W**
Boron (mg/L)	FAP-MW-7	-2.196	No	No	Mann-W
Boron (mg/L)	FAP-MW-8	-2.562	No	No	Mann-W
Boron (mg/L)	FAP-MW-6	-1.906	No	No	Mann-W
Calcium (mg/L)	FAP-MW-1809A (bg)	1.102	No	No	Mann-W
Calcium (mg/L)	**FAP-MW-1810A (bg)**	**2.708**	**Yes**	**Yes**	**Mann-W**
Calcium (mg/L)	FAP-MW-1807A (bg)	2.123	No	No	Mann-W
Calcium (mg/L)	FAP-MW-1808A (bg)	0.5123	No	No	Mann-W
Calcium (mg/L)	FAP-MW-1807B (bg)	0.7656	No	No	Mann-W
Calcium (mg/L)	FAP-MW-1801A	-1.83	No	No	Mann-W
Calcium (mg/L)	FAP-MW-1804A	-2.282	No	No	Mann-W
Calcium (mg/L)	FAP-MW-1806A	-1.391	No	No	Mann-W
Calcium (mg/L)	FAP-MW-2	1.945	No	No	Mann-W
Calcium (mg/L)	FAP-MW-1	-0.6596	No	No	Mann-W
Calcium (mg/L)	**FAP-MW-5**	**3.1**	**Yes**	**Yes**	**Mann-W**
Calcium (mg/L)	FAP-MW-7	2.488	No	No	Mann-W
Calcium (mg/L)	FAP-MW-8	-1.394	No	No	Mann-W
Calcium (mg/L)	FAP-MW-6	-1.84	No	No	Mann-W
Chloride (mg/L)	**FAP-MW-1809A (bg)**	**2.855**	**Yes**	**Yes**	**Mann-W**
Chloride (mg/L)	FAP-MW-1810A (bg)	-1.906	No	No	Mann-W
Chloride (mg/L)	FAP-MW-1807A (bg)	0.366	No	No	Mann-W
Chloride (mg/L)	FAP-MW-1808A (bg)	1.759	No	No	Mann-W
Chloride (mg/L)	**FAP-MW-1807B (bg)**	**2.639**	**Yes**	**Yes**	**Mann-W**
Chloride (mg/L)	FAP-MW-1801A	-0.07319	No	No	Mann-W
Chloride (mg/L)	**FAP-MW-1804A**	**2.678**	**Yes**	**Yes**	**Mann-W**
Chloride (mg/L)	FAP-MW-1806A	-0.07319	No	No	Mann-W
Chloride (mg/L)	FAP-MW-2	-0.441	No	No	Mann-W
Chloride (mg/L)	FAP-MW-1	-1.541	No	No	Mann-W
Chloride (mg/L)	FAP-MW-5	-2.391	No	No	Mann-W
Chloride (mg/L)	FAP-MW-7	0.6587	No	No	Mann-W
Chloride (mg/L)	FAP-MW-8	-0.8906	No	No	Mann-W
Chloride (mg/L)	**FAP-MW-6**	**-2.855**	**Yes**	**Yes**	**Mann-W**
Fluoride (mg/L)	FAP-MW-1809A (bg)	-1.853	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-1810A (bg)	-0.8062	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-1807A (bg)	-2.362	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-1808A (bg)	-1.246	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-1807B (bg)	1.466	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-1801A	1.583	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-1804A	0.9541	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-1806A	1.251	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-2	-0.5145	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-1	1.308	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-5	-2.055	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-7	1.349	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-8	2.052	No	No	Mann-W

Mann-Whitney Summary - All Results

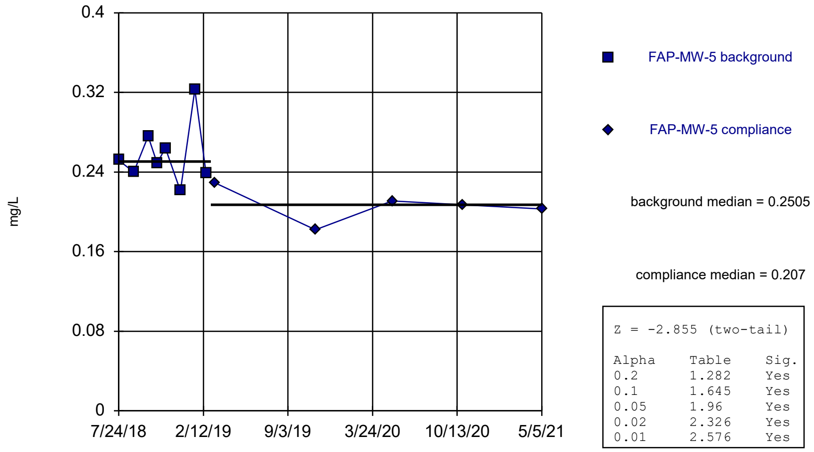
Amos FAP Client: Geosyntec Data: Amos FAP Printed 9/28/2021, 3:39 PM

Constituent	Well	Calc.	0.01	Sig.	Method
Fluoride (mg/L)	**FAP-MW-6**	**2.581**	**Yes**	**Yes**	**Mann-W**
pH (SU)	FAP-MW-1809A (bg)	-0.6507	No	No	Mann-W
pH (SU)	FAP-MW-1810A (bg)	-1.683	No	No	Mann-W
pH (SU)	FAP-MW-1807A (bg)	-1.683	No	No	Mann-W
pH (SU)	FAP-MW-1808A (bg)	-0.7339	No	No	Mann-W
pH (SU)	FAP-MW-1807B (bg)	-1.683	No	No	Mann-W
pH (SU)	FAP-MW-1801A	-0.4398	No	No	Mann-W
pH (SU)	FAP-MW-1804A	1.314	No	No	Mann-W
pH (SU)	FAP-MW-1806A	1.832	No	No	Mann-W
pH (SU)	FAP-MW-2	0.3877	No	No	Mann-W
pH (SU)	FAP-MW-1	-0.3227	No	No	Mann-W
pH (SU)	FAP-MW-5	-1.157	No	No	Mann-W
pH (SU)	FAP-MW-7	0.7529	No	No	Mann-W
pH (SU)	FAP-MW-8	-0.1294	No	No	Mann-W
pH (SU)	FAP-MW-6	1.915	No	No	Mann-W
Sulfate (mg/L)	FAP-MW-1809A (bg)	0.5888	No	No	Mann-W
Sulfate (mg/L)	FAP-MW-1810A (bg)	2.275	No	No	Mann-W
Sulfate (mg/L)	FAP-MW-1807A (bg)	1.099	No	No	Mann-W
Sulfate (mg/L)	**FAP-MW-1808A (bg)**	**2.708**	**Yes**	**Yes**	**Mann-W**
Sulfate (mg/L)	FAP-MW-1807B (bg)	1.101	No	No	Mann-W
Sulfate (mg/L)	FAP-MW-1801A	-2.415	No	No	Mann-W
Sulfate (mg/L)	**FAP-MW-1804A**	**2.678**	**Yes**	**Yes**	**Mann-W**
Sulfate (mg/L)	FAP-MW-1806A	-0.366	No	No	Mann-W
Sulfate (mg/L)	FAP-MW-2	-0.2199	No	No	Mann-W
Sulfate (mg/L)	FAP-MW-1	2.526	No	No	Mann-W
Sulfate (mg/L)	**FAP-MW-5**	**2.666**	**Yes**	**Yes**	**Mann-W**
Sulfate (mg/L)	FAP-MW-7	-0.9568	No	No	Mann-W
Sulfate (mg/L)	FAP-MW-8	-1.228	No	No	Mann-W
Sulfate (mg/L)	**FAP-MW-6**	**-2.642**	**Yes**	**Yes**	**Mann-W**

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

FAP-MW-5

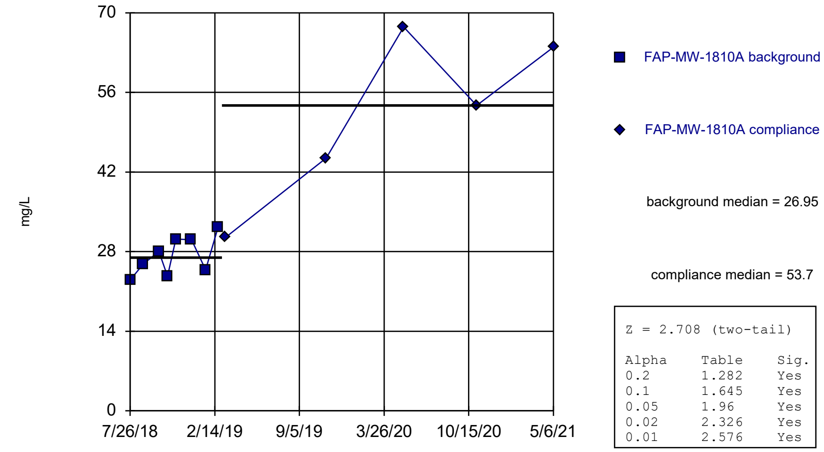


Constituent: Boron   Analysis Run 9/28/2021 3:37 PM   View: Mann Whitney
Amos FAP   Client: Geosyntec   Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

FAP-MW-1810A (bg)

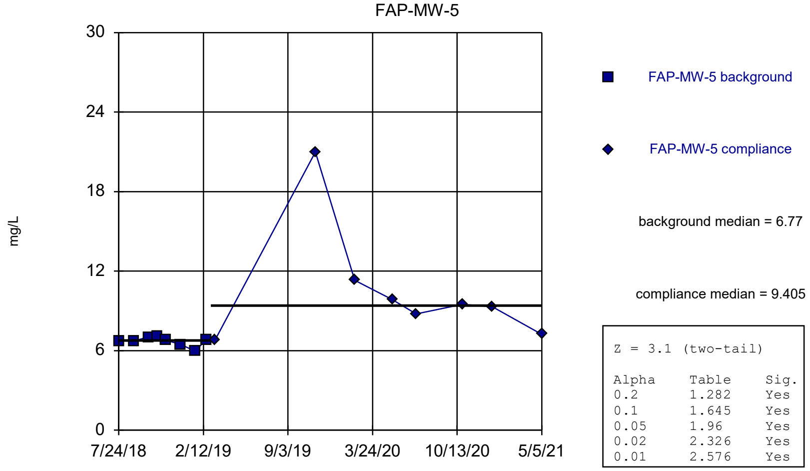


Constituent: Calcium   Analysis Run 9/28/2021 3:37 PM   View: Mann Whitney
Amos FAP   Client: Geosyntec   Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

FAP-MW-5

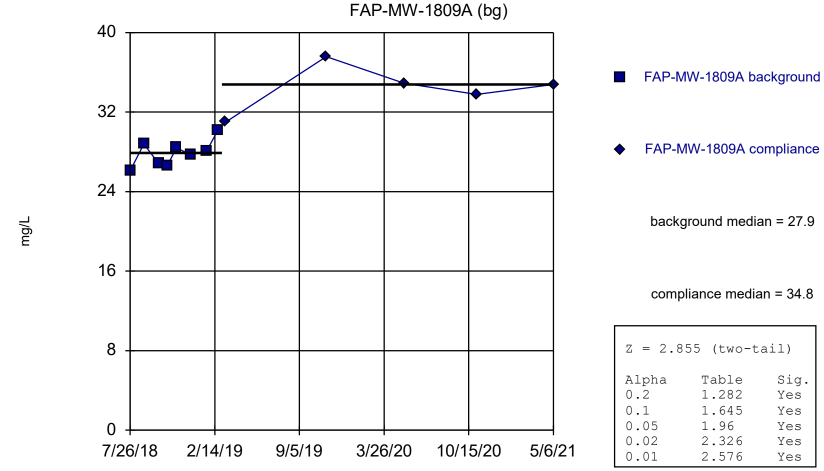


Constituent: Calcium   Analysis Run 9/28/2021 3:37 PM   View: Mann Whitney
Amos FAP   Client: Geosyntec   Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

FAP-MW-1809A (bg)

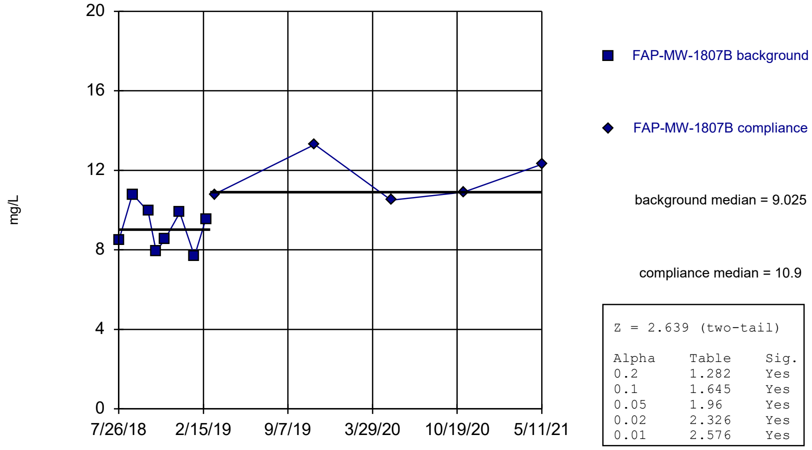


Constituent: Chloride   Analysis Run 9/28/2021 3:37 PM   View: Mann Whitney
Amos FAP   Client: Geosyntec   Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

FAP-MW-1807B (bg)

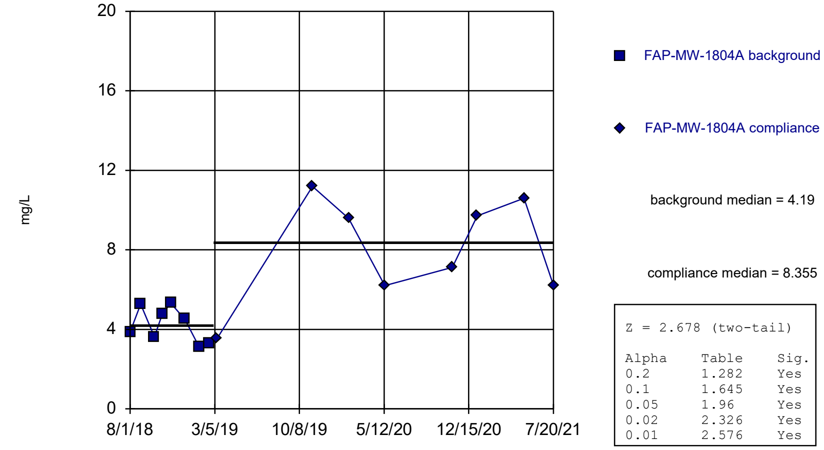


Constituent: Chloride Analysis Run 9/28/2021 3:37 PM View: Mann Whitney
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

FAP-MW-1804A

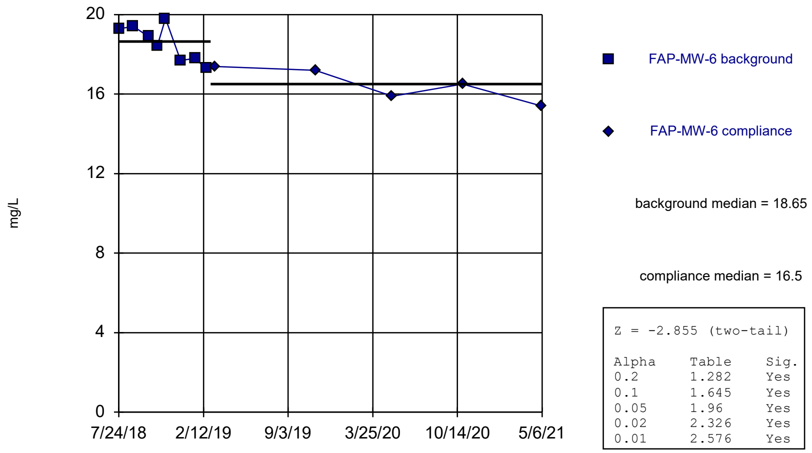


Constituent: Chloride Analysis Run 9/28/2021 3:37 PM View: Mann Whitney
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

FAP-MW-6

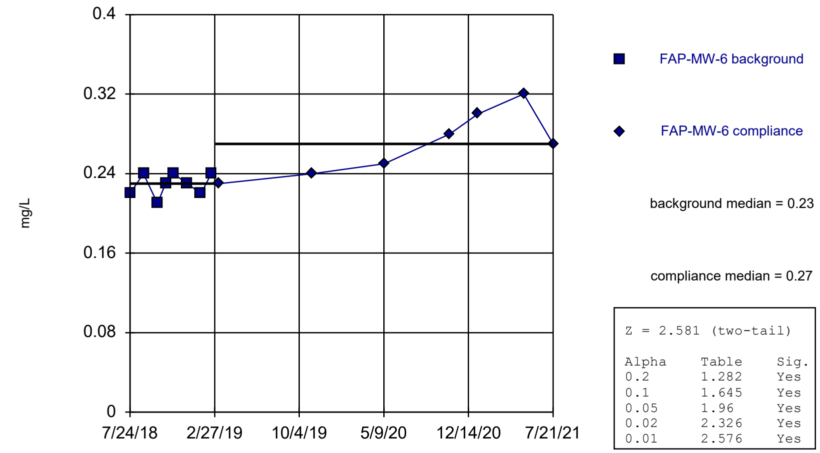


Constituent: Chloride Analysis Run 9/28/2021 3:37 PM View: Mann Whitney
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

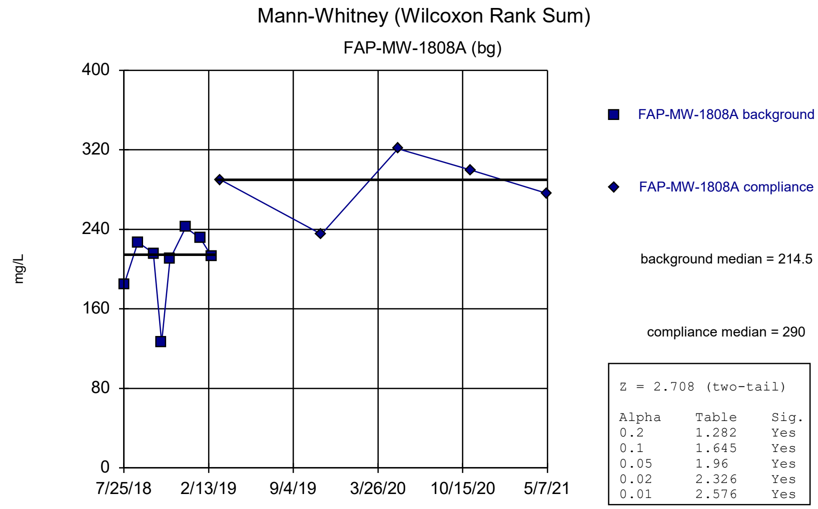
Mann-Whitney (Wilcoxon Rank Sum)

FAP-MW-6



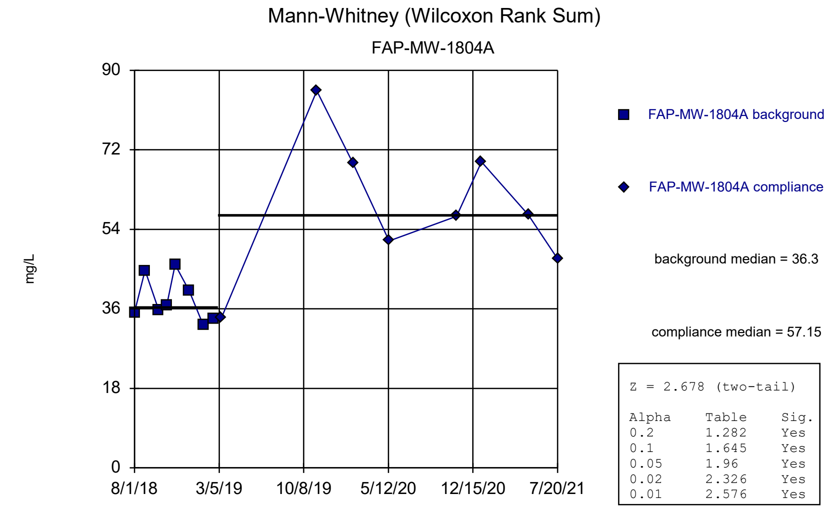
Constituent: Fluoride Analysis Run 9/28/2021 3:38 PM View: Mann Whitney
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



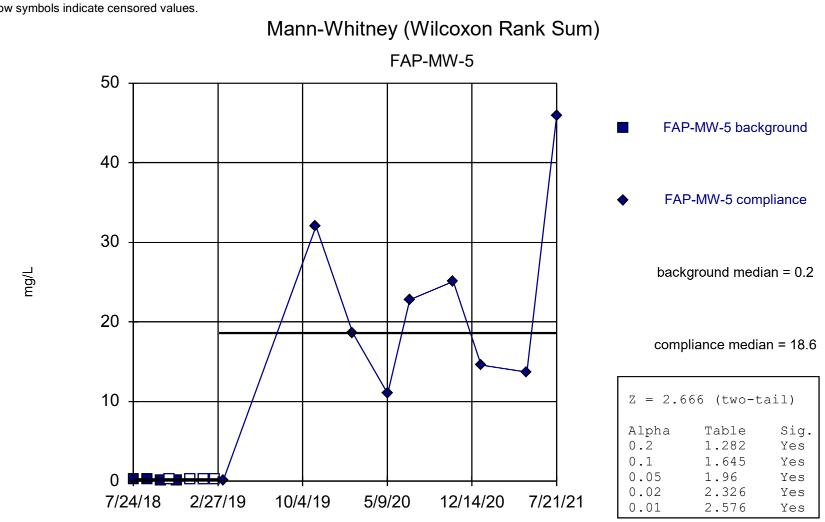
Constituent: Sulfate Analysis Run 9/28/2021 3:38 PM View: Mann Whitney
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



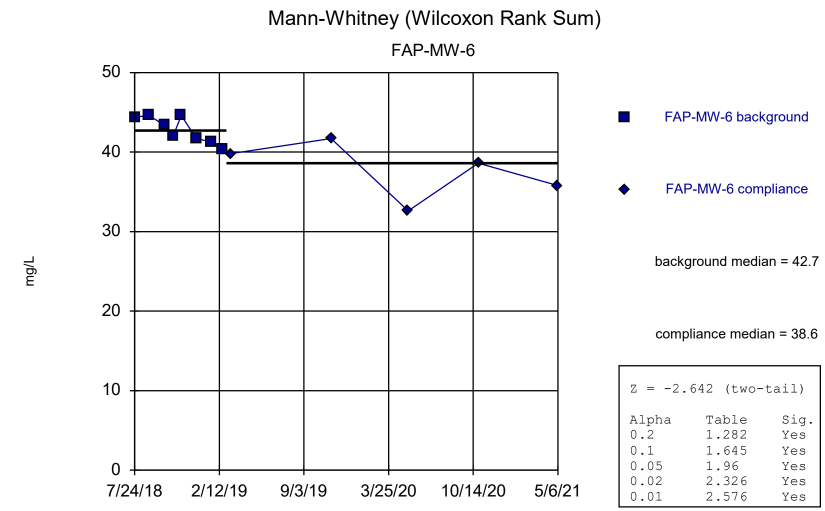
Constituent: Sulfate Analysis Run 9/28/2021 3:38 PM View: Mann Whitney
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Sulfate Analysis Run 9/28/2021 3:38 PM View: Mann Whitney
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Sulfate Analysis Run 9/28/2021 3:38 PM View: Mann Whitney
Amos FAP Client: Geosyntec Data: Amos FAP

Mann-Whitney Summary (TDS & FAP-MW-9) - Significant Results

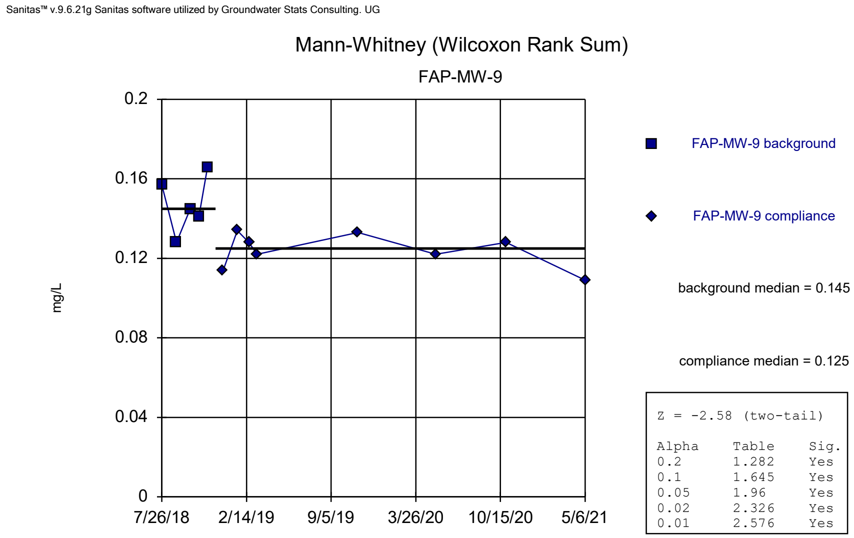
Amos FAP Client: Geosyntec Data: Amos FAP Printed 9/28/2021, 3:41 PM

Constituent	Well	Calc.	0.01	Sig.	Method
Boron (mg/L)	**FAP-MW-9**	**-2.58**	**Yes**	**Yes**	**Mann-W**
Total Dissolved Solids (mg/L)	**FAP-MW-1808A (bg)**	**2.855**	**Yes**	**Yes**	**Mann-W**
Total Dissolved Solids (mg/L)	**FAP-MW-7**	**2.58**	**Yes**	**Yes**	**Mann-W**

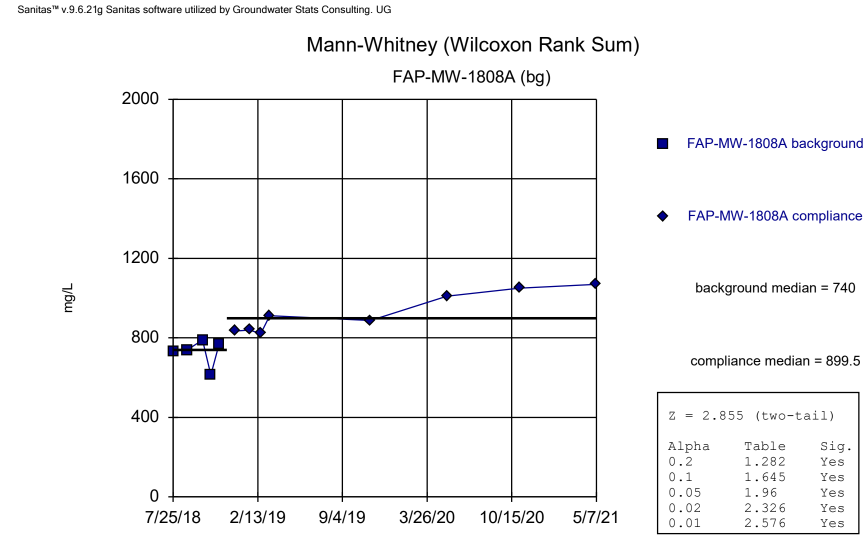
Mann-Whitney Summary (TDS & FAP-MW-9) - All Results

Amos FAP   Client: Geosyntec   Data: Amos FAP   Printed 9/28/2021, 3:41 PM

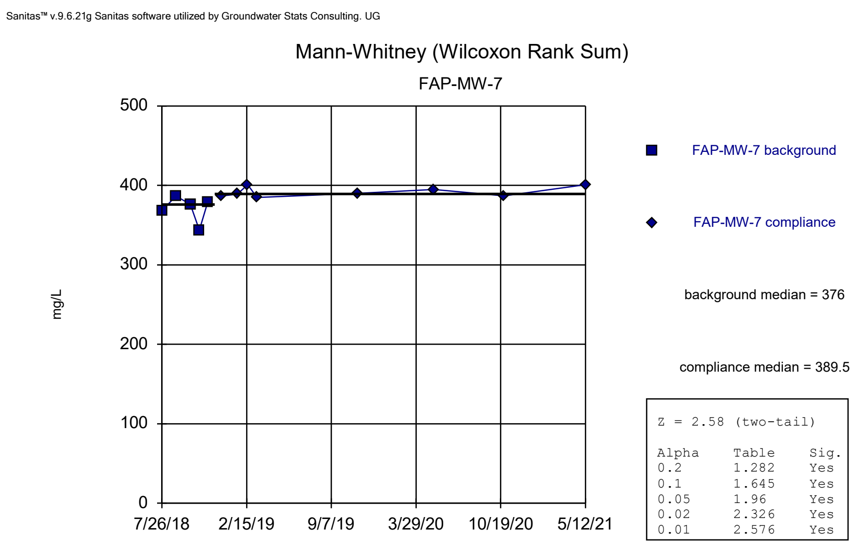
Constituent	Well	Calc.	0.01	Sig.	Method
Boron (mg/L)	**FAP-MW-9**	**-2.58**	**Yes**	**Yes**	**Mann-W**
Calcium (mg/L)	FAP-MW-9	-1.249	No	No	Mann-W
Chloride (mg/L)	FAP-MW-9	0.07319	No	No	Mann-W
Fluoride (mg/L)	FAP-MW-9	-0.6624	No	No	Mann-W
pH (SU)	FAP-MW-9	0.7329	No	No	Mann-W
Sulfate (mg/L)	FAP-MW-9	1.537	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-1809A (bg)	2.432	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-1810A (bg)	1.979	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-1807A (bg)	1.686	No	No	Mann-W
Total Dissolved Solids (mg/L)	**FAP-MW-1808A (bg)**	**2.855**	**Yes**	**Yes**	**Mann-W**
Total Dissolved Solids (mg/L)	FAP-MW-1807B (bg)	2.44	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-9	-0.3665	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-1801A	-1.539	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-1804A	0.5131	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-1806A	0.9541	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-2	1.896	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-1	0.1474	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-5	-0.0735	No	No	Mann-W
Total Dissolved Solids (mg/L)	**FAP-MW-7**	**2.58**	**Yes**	**Yes**	**Mann-W**
Total Dissolved Solids (mg/L)	FAP-MW-8	0.588	No	No	Mann-W
Total Dissolved Solids (mg/L)	FAP-MW-6	-0.2202	No	No	Mann-W



Constituent: Boron Analysis Run 9/28/2021 3:40 PM View: Mann Whitney MW-9 & TDS
Amos FAP Client: Geosyntec Data: Amos FAP



Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:40 PM View: Mann Whitney MW-9 & TDS
Amos FAP Client: Geosyntec Data: Amos FAP



Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:40 PM View: Mann Whitney MW-9 & TDS
Amos FAP Client: Geosyntec Data: Amos FAP

Intrawell Prediction Limits - All Results

Amos FAP   Client: Geosyntec   Data: Amos FAP   Printed 10/18/2021, 4:00 PM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron (mg/L)	FAP-MW-1809A	0.126	n/a	13	0.07954	0.01827	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-1810A	0.3187	n/a	13	0.2356	0.03263	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-1807A	0.2617	n/a	13	0.1295	0.05192	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-1808A	0.2033	n/a	13	0.1399	0.02491	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-1807B	0.2903	n/a	13	0.181	0.04293	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-9	0.1739	n/a	13	0.1328	0.01614	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-1801A	0.3877	n/a	13	0.1804	0.08142	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-1804A	0.9124	n/a	13	0.6775	0.09226	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-1806A	0.2137	n/a	13	0.1538	0.02354	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-2	0.3477	n/a	13	0.2513	0.03786	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-1	0.1526	n/a	10	0.1185	0.01223	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-5	0.3314	n/a	13	0.2382	0.03661	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-7	0.1456	n/a	11	0.08082	0.02406	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-8	0.2957	n/a	13	0.2197	0.02986	0	None	No	0.0007523	Param Intra 1 of 2
Boron (mg/L)	FAP-MW-6	0.1366	n/a	13	0.09246	0.01733	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-1809A	202.3	n/a	13	185.2	6.719	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-1810A	80.82	n/a	13	5.956	1.192	0	None	sqrt(x)	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-1807A	182	n/a	13	155.3	10.48	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-1808A	74.3	n/a	13	43.93	11.93	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-1807B	12.7	n/a	12	n/a	n/a	0	n/a	n/a	0.01077	NP Intra (normality) 1 of 2
Calcium (mg/L)	FAP-MW-9	1.552	n/a	13	1.133	0.1647	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-1801A	72.01	n/a	13	59.21	5.03	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-1804A	19.16	n/a	11	8.863	3.823	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-1806A	17.53	n/a	13	7.604	3.9	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-2	4.792	n/a	14	4.114	0.272	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-1	3.251	n/a	13	2.646	0.2374	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-5	21	n/a	16	n/a	n/a	0	n/a	n/a	0.006456	NP Intra (normality) 1 of 2
Calcium (mg/L)	FAP-MW-7	2.081	n/a	15	0.3912	0.1401	0	None	ln(x)	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-8	2.908	n/a	13	2.277	0.2479	0	None	No	0.0007523	Param Intra 1 of 2
Calcium (mg/L)	FAP-MW-6	67.77	n/a	13	57.45	4.051	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-1809A	39.91	n/a	13	30.37	3.746	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-1810A	24.25	n/a	13	17.82	2.526	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-1807A	13.61	n/a	13	11.08	0.9951	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-1808A	27.78	n/a	13	20.03	3.042	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-1807B	14.26	n/a	13	10.04	1.657	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-9	7.954	n/a	13	7.334	0.2437	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-1801A	11.82	n/a	13	9.063	1.085	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-1804A	16.35	n/a	8	8.025	2.658	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-1806A	19.31	n/a	13	9.63	3.802	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-2	488.6	n/a	13	446.1	16.69	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-1	14.6	n/a	13	n/a	n/a	0	n/a	n/a	0.009692	NP Intra (normality) 1 of 2
Chloride (mg/L)	FAP-MW-5	879.5	n/a	14	769.9	43.99	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-7	5.672	n/a	13	5.368	0.1196	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-8	115.9	n/a	13	109.3	2.594	0	None	No	0.0007523	Param Intra 1 of 2
Chloride (mg/L)	FAP-MW-6	21.23	n/a	13	17.77	1.36	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-1809A	0.1821	n/a	13	0.1438	0.01502	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-1810A	1.106	n/a	13	0.9262	0.07054	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-1807A	0.2522	n/a	13	0.1669	0.03351	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-1808A	0.6675	n/a	13	0.4515	0.08484	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-1807B	1.834	n/a	13	0.9985	0.3284	0	None	No	0.0007523	Param Intra 1 of 2

Intrawell Prediction Limits - All Results

Amos FAP Client: Geosyntec Data: Amos FAP Printed 10/18/2021, 4:00 PM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Fluoride (mg/L)	FAP-MW-9	0.9699	n/a	13	0.8592	0.04349	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-1801A	0.1651	n/a	13	0.1192	0.01801	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-1804A	1.074	n/a	13	0.7992	0.108	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-1806A	1.132	n/a	13	0.75	0.1499	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-2	3.433	n/a	13	3.052	0.1499	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-1	0.521	n/a	14	0.4407	0.03222	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-5	3.759	n/a	13	3.325	0.1707	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-7	0.3246	n/a	14	0.275	0.0199	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-8	3.199	n/a	13	2.808	0.1536	0	None	No	0.0007523	Param Intra 1 of 2
Fluoride (mg/L)	FAP-MW-6	0.3241	n/a	15	0.248	0.03121	0	None	No	0.0007523	Param Intra 1 of 2
pH (SU)	FAP-MW-1809A	7.383	6.857	12	7.12	0.1011	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-1810A	7.811	6.829	13	7.32	0.193	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-1807A	8.24	6.68	13	n/a	n/a	0	n/a	n/a	0.01938	NP Intra (normality) 1 of 2
pH (SU)	FAP-MW-1808A	8.249	6.184	13	398.9	63.83	0	None	x^3	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-1807B	9.138	6.514	13	7.826	0.5155	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-9	10.7	6.636	13	8.67	0.7991	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-1801A	8.306	6.395	13	7.351	0.3753	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-1804A	8.496	7.271	16	7.884	0.2567	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-1806A	9.42	7.331	13	8.375	0.4102	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-2	8.867	8.129	14	8.498	0.1481	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-1	8.576	7.902	14	8.239	0.1352	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-5	8.295	7.802	17	8.049	0.1045	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-7	9.202	8.181	15	8.691	0.2093	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-8	9.419	7.231	14	8.325	0.4389	0	None	No	0.0003761	Param Intra 1 of 2
pH (SU)	FAP-MW-6	7.241	6.51	15	6.875	0.1498	0	None	No	0.0003761	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-1809A	409	n/a	13	391.8	6.756	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-1810A	459.3	n/a	13	200.8	101.6	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-1807A	428.7	n/a	13	353.5	29.53	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-1808A	368.5	n/a	13	236.2	51.95	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-1807B	343	n/a	13	n/a	n/a	0	n/a	n/a	0.009692	NP Intra (normality) 1 of 2
Sulfate (mg/L)	FAP-MW-9	30.91	n/a	13	3.947	0.6337	0	None	sqrt(x)	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-1801A	59.94	n/a	13	43.65	6.402	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-1804A	108.1	n/a	8	58.84	15.72	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-1806A	56.69	n/a	13	39.81	6.632	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-2	24.43	n/a	13	9.092	6.024	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-1	35.09	n/a	12	31.96	1.204	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-5	59.08	n/a	8	22.96	11.53	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-7	33.2	n/a	13	n/a	n/a	0	n/a	n/a	0.009692	NP Intra (normality) 1 of 2
Sulfate (mg/L)	FAP-MW-8	38.53	n/a	14	25.68	5.155	0	None	No	0.0007523	Param Intra 1 of 2
Sulfate (mg/L)	FAP-MW-6	49.84	n/a	13	40.84	3.537	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-1809A	1147	n/a	13	1069	30.4	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-1810A	1109	n/a	13	8.534	0.7131	0	None	x^(1/3)	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-1807A	1148	n/a	13	965.5	71.61	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-1808A	1190	n/a	13	851.7	132.8	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-1807B	842	n/a	12	758.2	32.27	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-9	528.6	n/a	13	461.8	26.22	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-1801A	441.8	n/a	13	361	31.75	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-1804A	599.5	n/a	13	470.6	50.63	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-1806A	488.1	n/a	13	440.2	18.82	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-2	1377	n/a	13	1294	32.54	0	None	No	0.0007523	Param Intra 1 of 2

Intrawell Prediction Limits - All Results

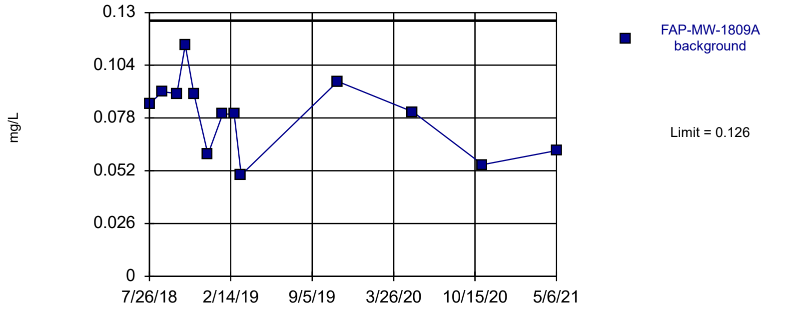
Amos FAP Client: Geosyntec Data: Amos FAP Printed 10/18/2021, 4:00 PM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Total Dissolved Solids (mg/L)	FAP-MW-1	483	n/a	13	449.2	13.3	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-5	2000	n/a	13	1860	54.92	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-7	422.2	n/a	13	383.8	15.09	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-8	756.2	n/a	13	718.6	14.77	0	None	No	0.0007523	Param Intra 1 of 2
Total Dissolved Solids (mg/L)	FAP-MW-6	429.3	n/a	13	394.8	13.53	0	None	No	0.0007523	Param Intra 1 of 2

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1809A (bg)



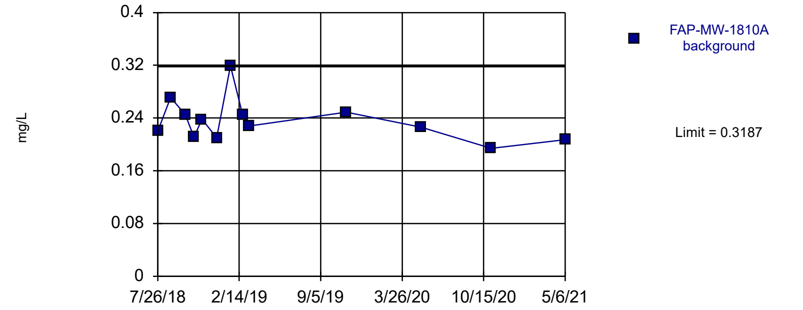
Background Data Summary: Mean=0.07954, Std. Dev.=0.01827, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.946, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1810A (bg)



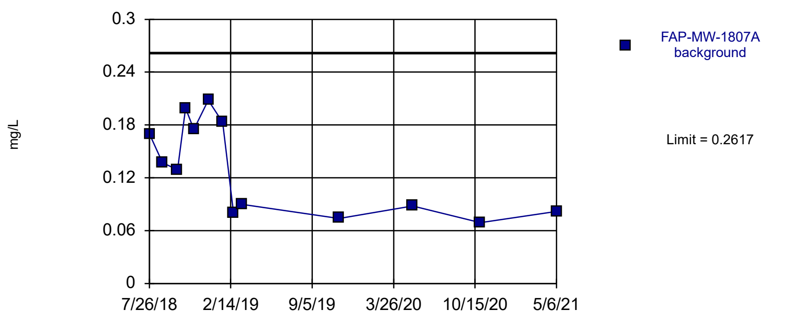
Background Data Summary: Mean=0.2356, Std. Dev.=0.03263, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8942, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807A (bg)



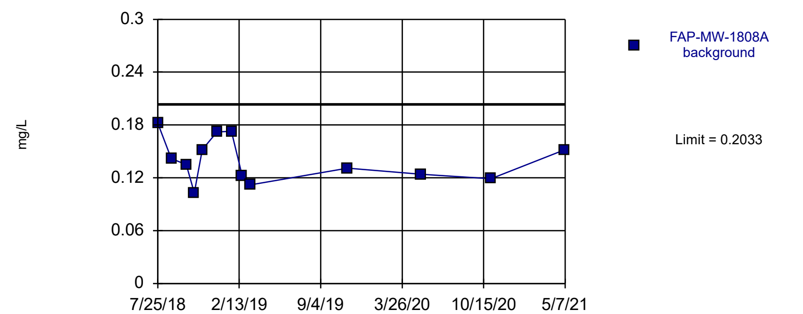
Background Data Summary: Mean=0.1295, Std. Dev.=0.05192, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8757, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1808A (bg)



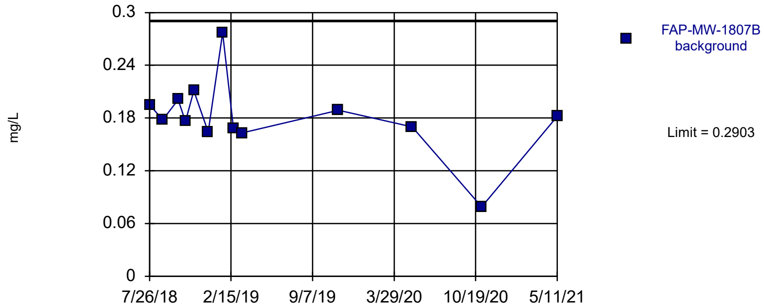
Background Data Summary: Mean=0.1399, Std. Dev.=0.02491, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9516, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807B (bg)



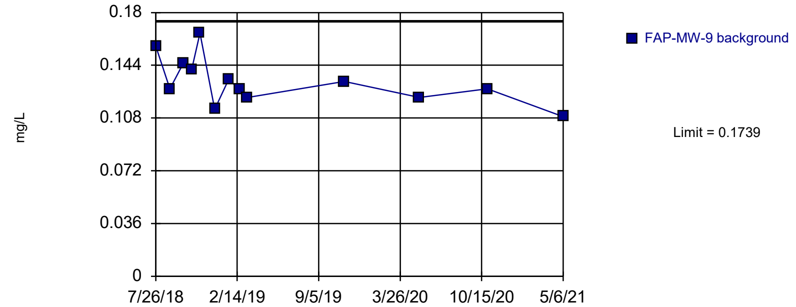
Background Data Summary: Mean=0.181, Std. Dev.=0.04293, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8612, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-9



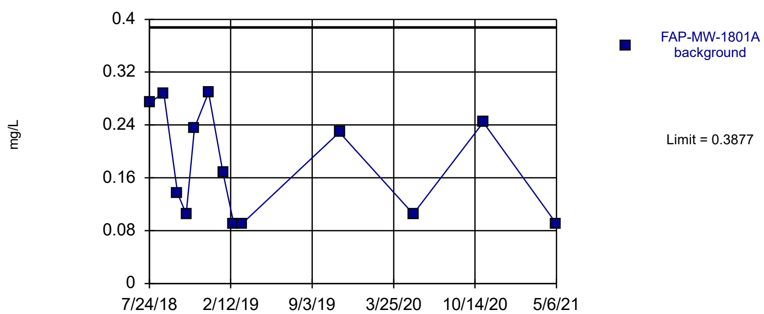
Background Data Summary: Mean=0.1328, Std. Dev.=0.01614, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9519, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1801A



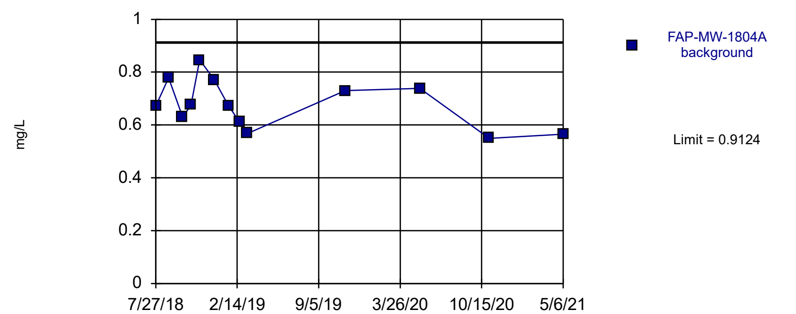
Background Data Summary: Mean=0.1804, Std. Dev.=0.08142, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8494, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

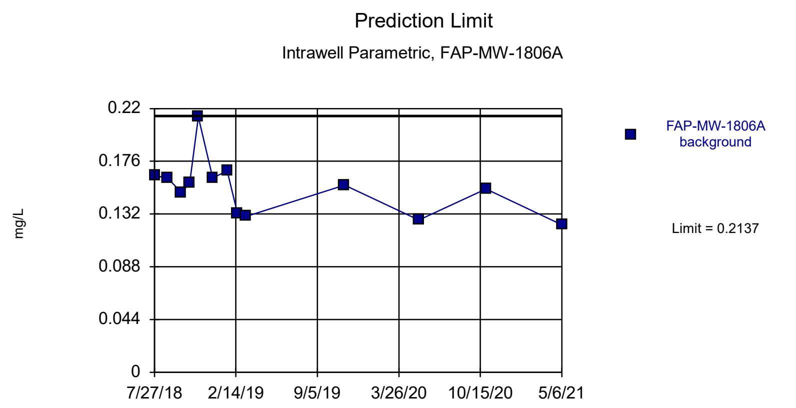
Intrawell Parametric, FAP-MW-1804A



Background Data Summary: Mean=0.6775, Std. Dev.=0.09226, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9568, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

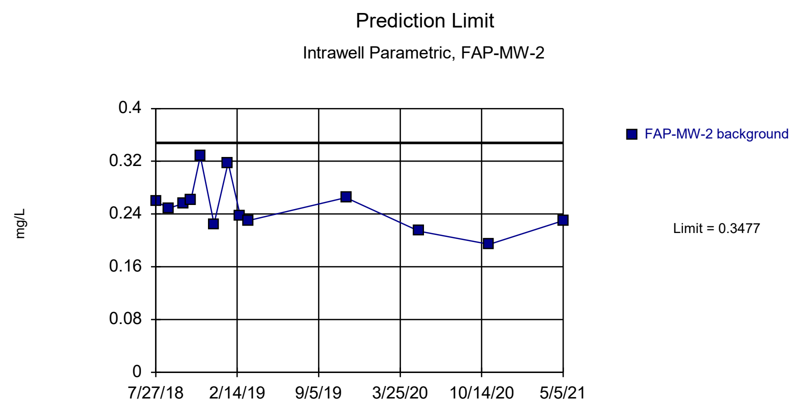
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Background Data Summary: Mean=0.1538, Std. Dev.=0.02354, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8826, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

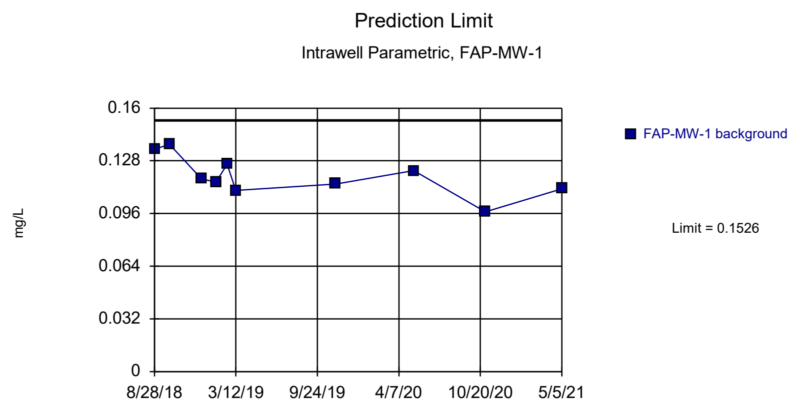
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Background Data Summary: Mean=0.2513, Std. Dev.=0.03786, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9189, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

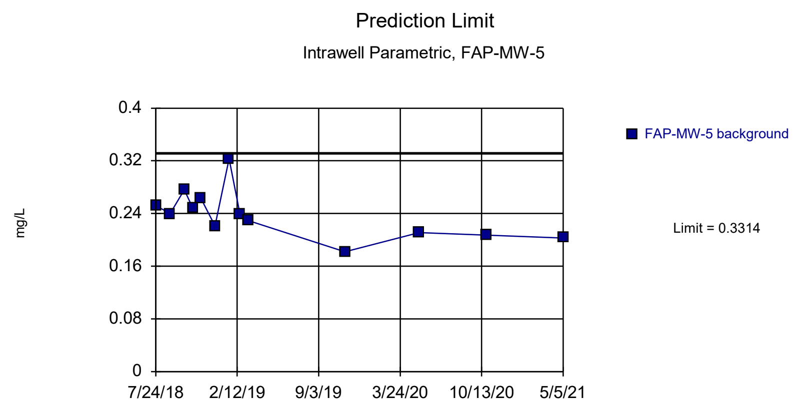
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Background Data Summary: Mean=0.1185, Std. Dev.=0.01223, n=10. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.964, critical = 0.781. Kappa = 2.789 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



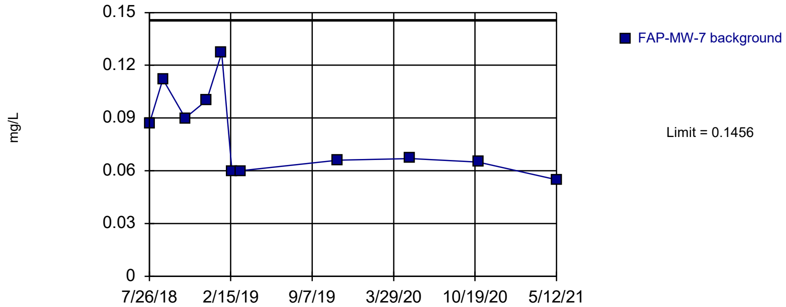
Background Data Summary: Mean=0.2382, Std. Dev.=0.03661, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9596, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-7



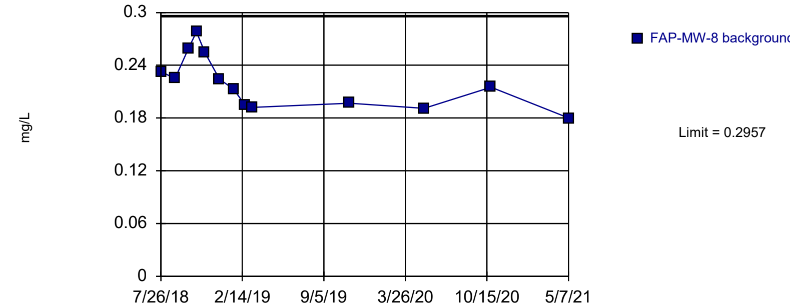
Background Data Summary: Mean=0.08082, Std. Dev.=0.02406, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8864, critical = 0.792. Kappa = 2.694 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-8



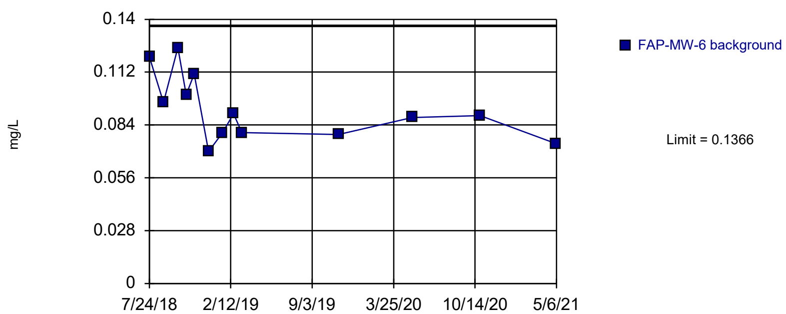
Background Data Summary: Mean=0.2197, Std. Dev.=0.02986, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9388, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-6



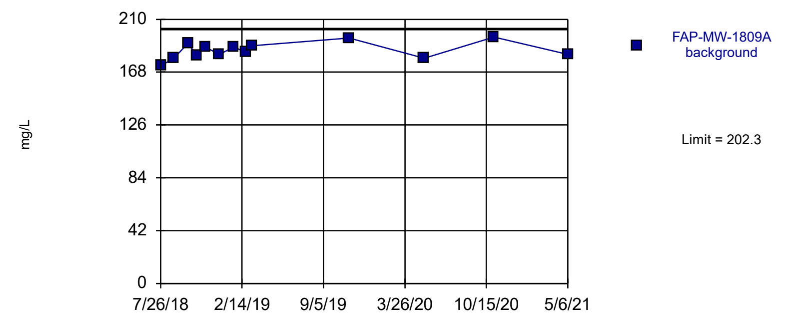
Background Data Summary: Mean=0.09246, Std. Dev.=0.01733, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9256, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Boron Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1809A (bg)

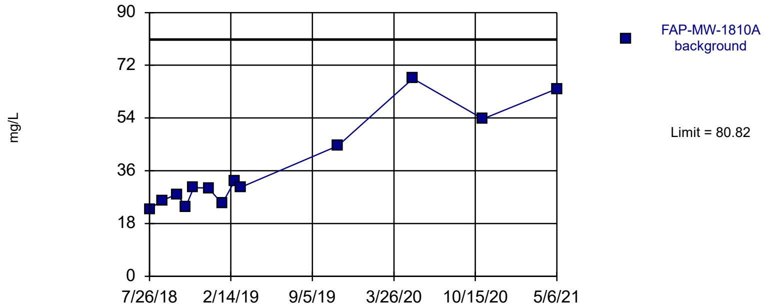


Background Data Summary: Mean=185.2, Std. Dev.=6.719, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9671, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Prediction Limit

Intrawell Parametric, FAP-MW-1810A (bg)



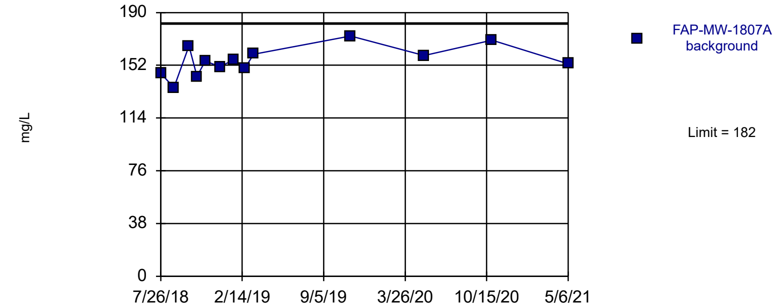
Background Data Summary (based on square root transformation): Mean=5.956, Std. Dev.=1.192, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8273, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:01 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807A (bg)



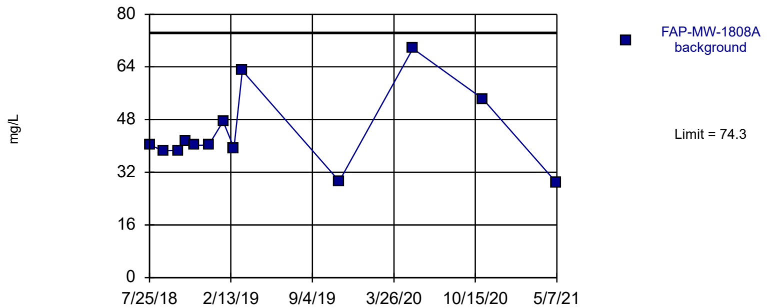
Background Data Summary: Mean=155.3, Std. Dev.=10.48, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9852, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1808A (bg)



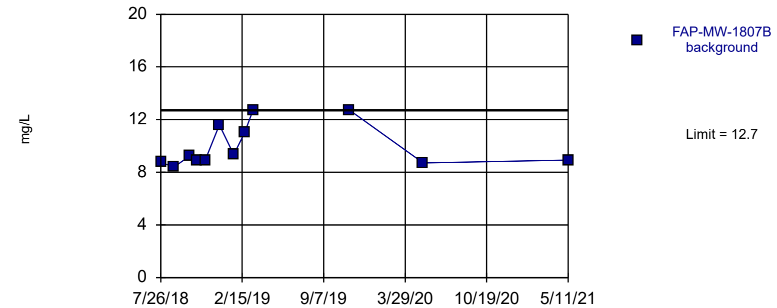
Background Data Summary: Mean=43.93, Std. Dev.=11.93, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8743, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, FAP-MW-1807B (bg)



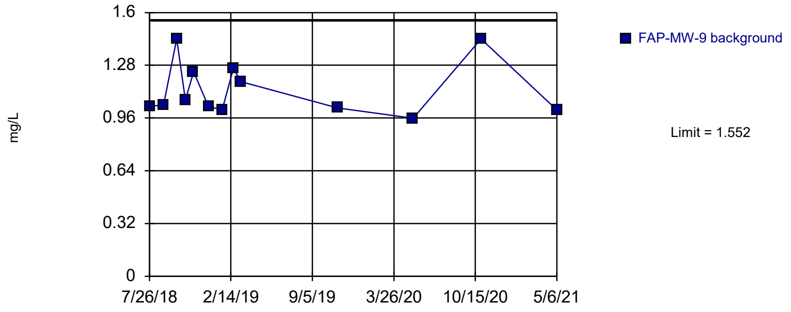
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 12 background values. Well-constituent pair annual alpha = 0.02143. Individual comparison alpha = 0.01077 (1 of 2). Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-9



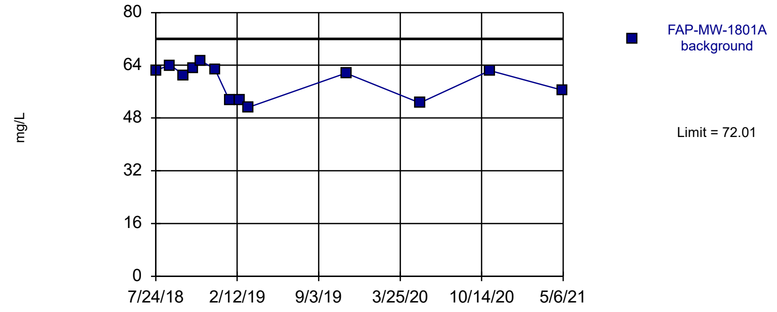
Background Data Summary: Mean=1.133, Std. Dev.=0.1647, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8221, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1801A



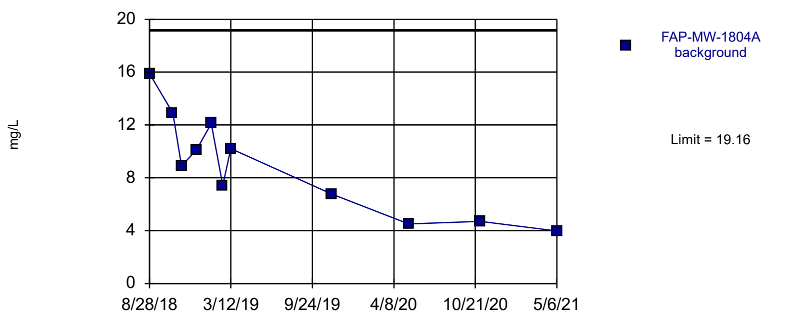
Background Data Summary: Mean=59.21, Std. Dev.=5.03, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8552, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1804A



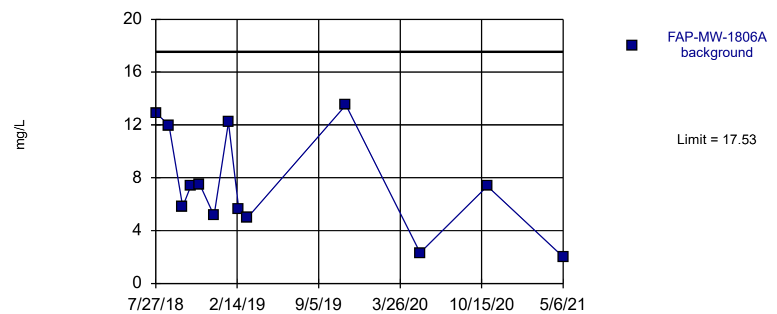
Background Data Summary: Mean=8.863, Std. Dev.=3.823, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9535, critical = 0.792. Kappa = 2.694 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1806A

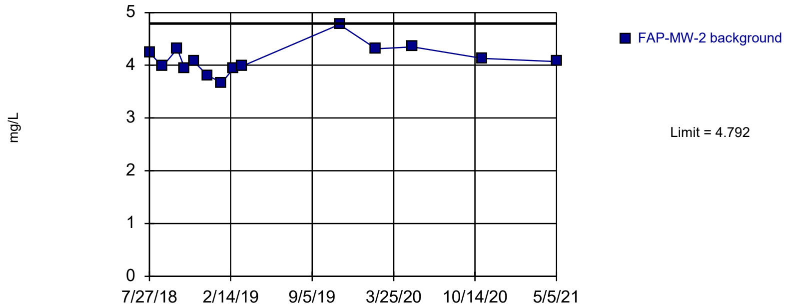


Background Data Summary: Mean=7.604, Std. Dev.=3.9, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9088, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Prediction Limit

Intrawell Parametric, FAP-MW-2



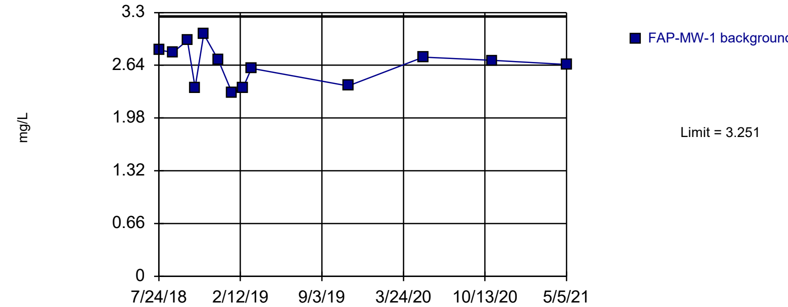
Background Data Summary: Mean=4.114, Std. Dev.=0.272, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9447, critical = 0.825. Kappa = 2.493 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1



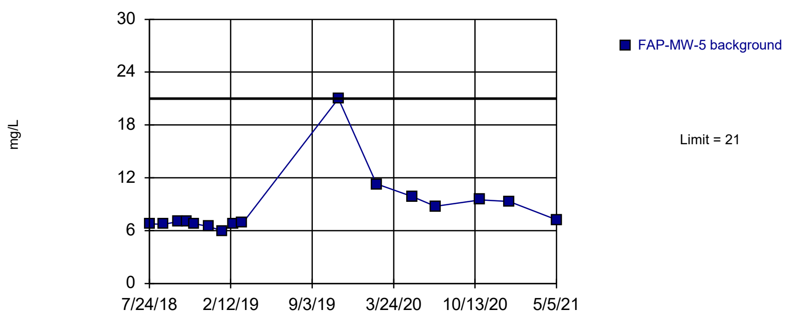
Background Data Summary: Mean=2.646, Std. Dev.=0.2374, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9376, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, FAP-MW-5



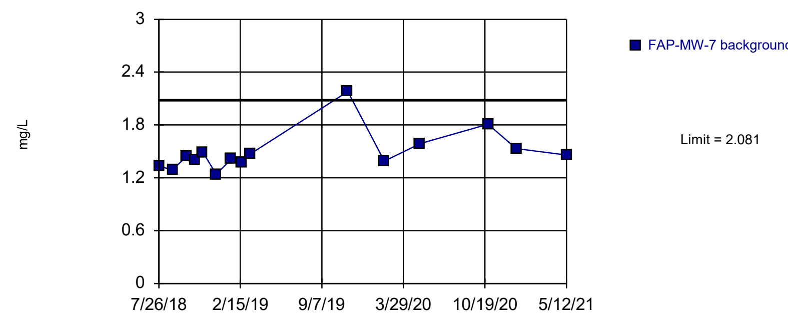
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 16 background values. Well-constituent pair annual alpha = 0.01287. Individual comparison alpha = 0.006456 (1 of 2). Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-7



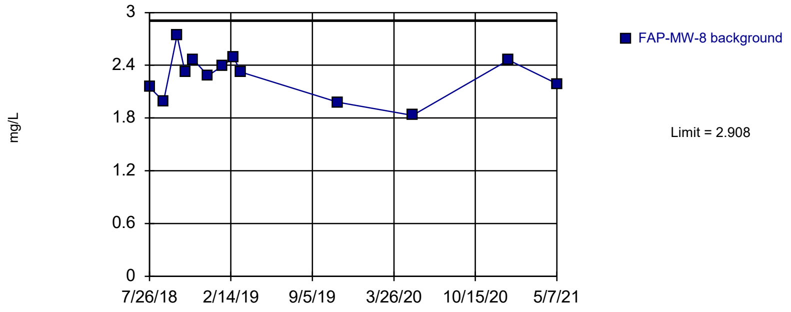
Background Data Summary (based on natural log transformation): Mean=0.3912, Std. Dev.=0.1401, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8494, critical = 0.835. Kappa = 2.439 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-8



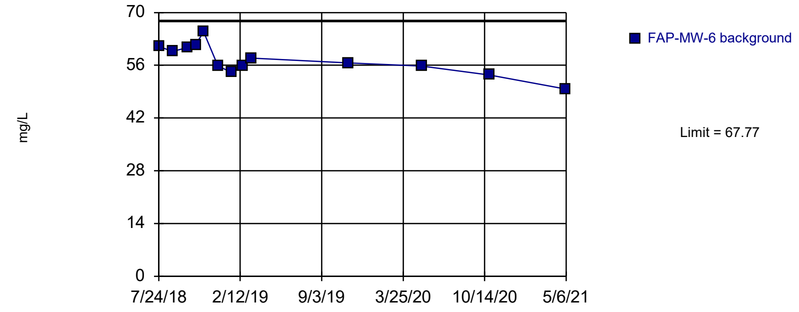
Background Data Summary: Mean=2.277, Std. Dev.=0.2479, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9746, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-6



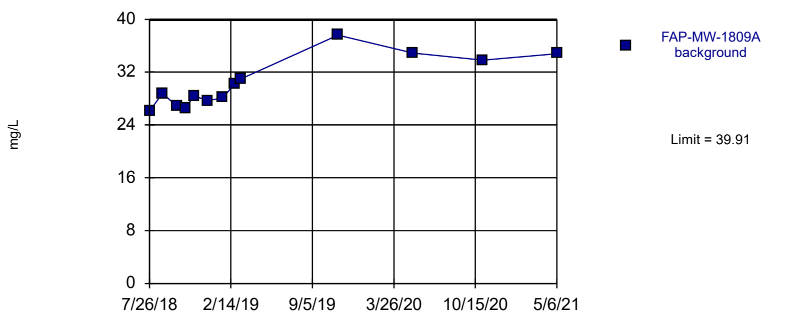
Background Data Summary: Mean=57.45, Std. Dev.=4.051, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9786, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Calcium Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1809A (bg)



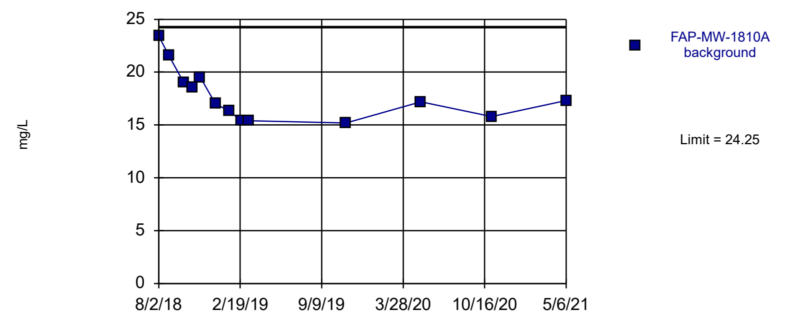
Background Data Summary: Mean=30.37, Std. Dev.=3.746, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8996, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1810A (bg)



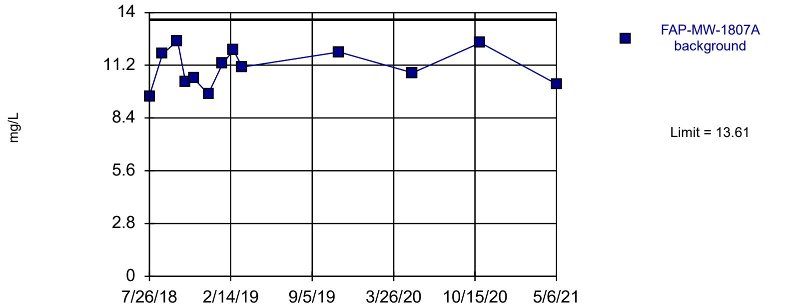
Background Data Summary: Mean=17.82, Std. Dev.=2.526, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8914, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807A (bg)



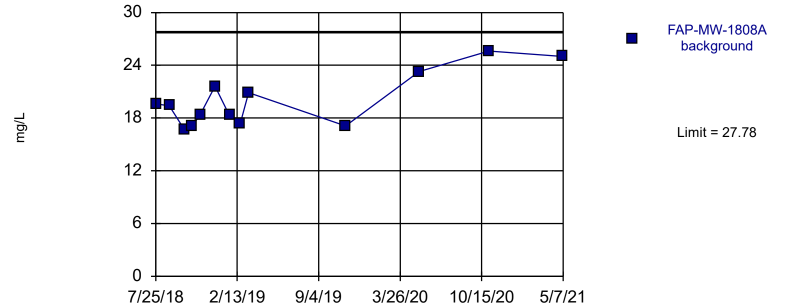
Background Data Summary: Mean=11.08, Std. Dev.=0.9951, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9454, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1808A (bg)



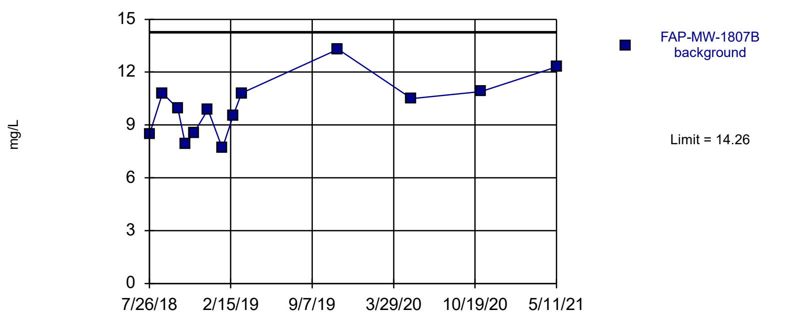
Background Data Summary: Mean=20.03, Std. Dev.=3.042, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8932, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807B (bg)



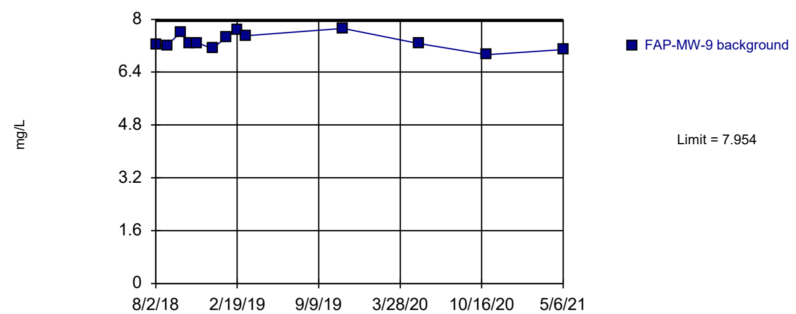
Background Data Summary: Mean=10.04, Std. Dev.=1.657, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9566, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-9



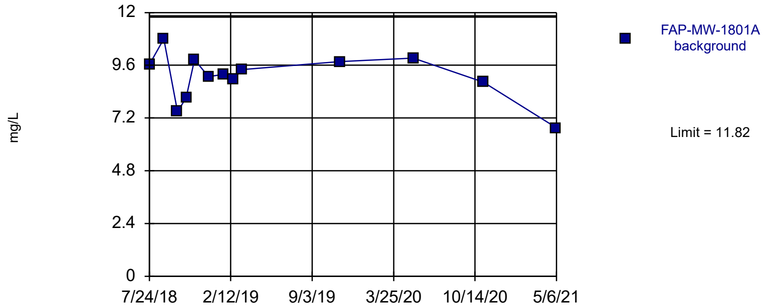
Background Data Summary: Mean=7.334, Std. Dev.=0.2437, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9532, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1801A



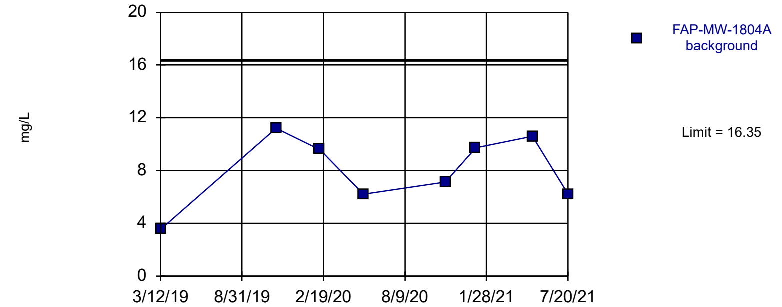
Background Data Summary: Mean=9.063, Std. Dev.=1.085, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9431, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1804A



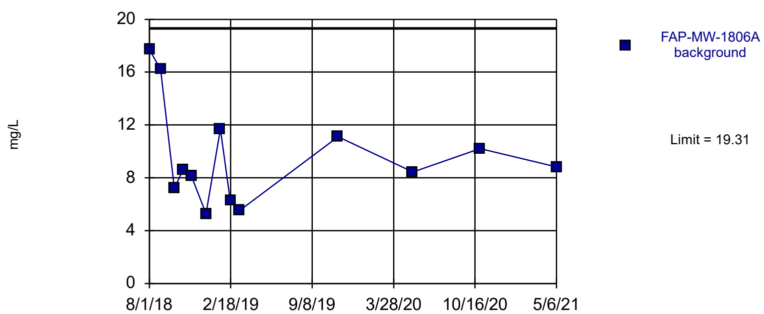
Background Data Summary: Mean=8.025, Std. Dev.=2.658, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9267, critical = 0.749. Kappa = 3.133 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1806A



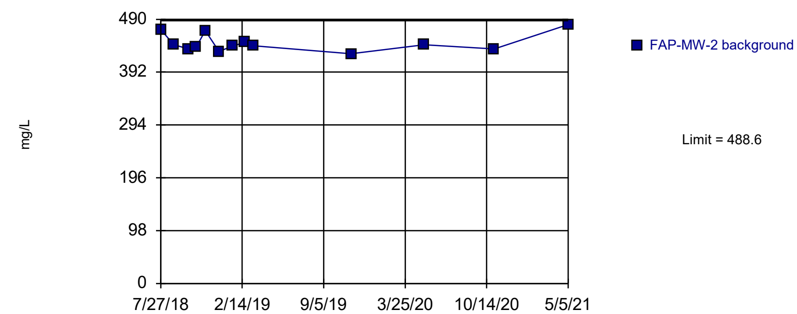
Background Data Summary: Mean=9.63, Std. Dev.=3.802, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8908, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-2



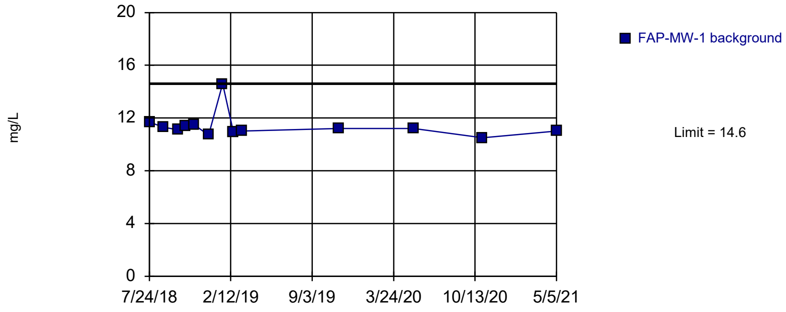
Background Data Summary: Mean=446.1, Std. Dev.=16.69, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.856, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, FAP-MW-1



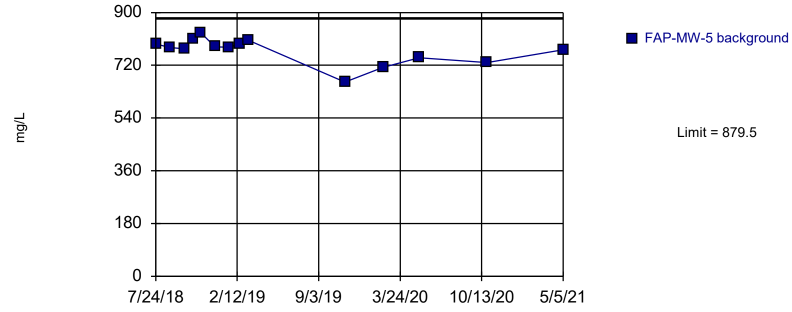
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 13 background values. Well-constituent pair annual alpha = 0.01929. Individual comparison alpha = 0.009692 (1 of 2). Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-5



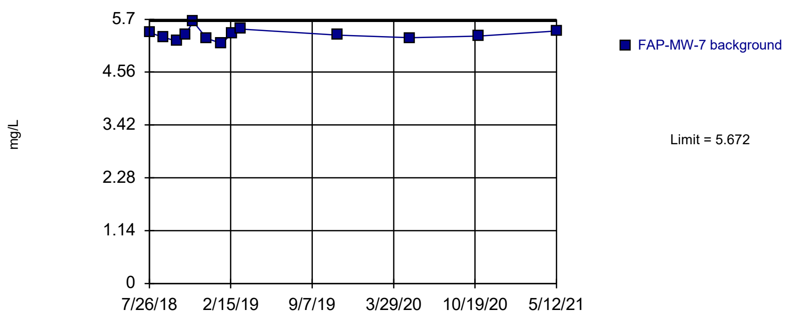
Background Data Summary: Mean=769.9, Std. Dev.=43.99, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9091, critical = 0.825. Kappa = 2.493 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-7



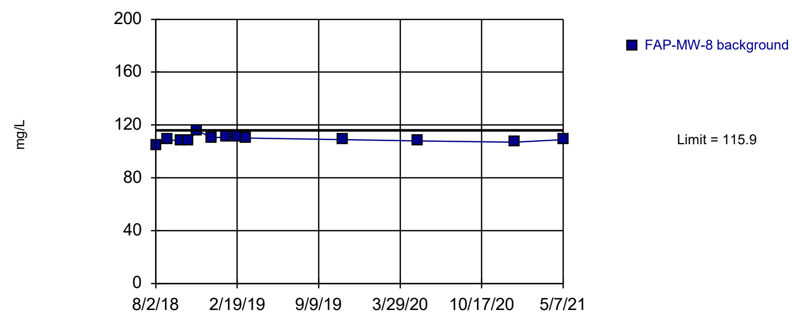
Background Data Summary: Mean=5.368, Std. Dev.=0.1196, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9557, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-8



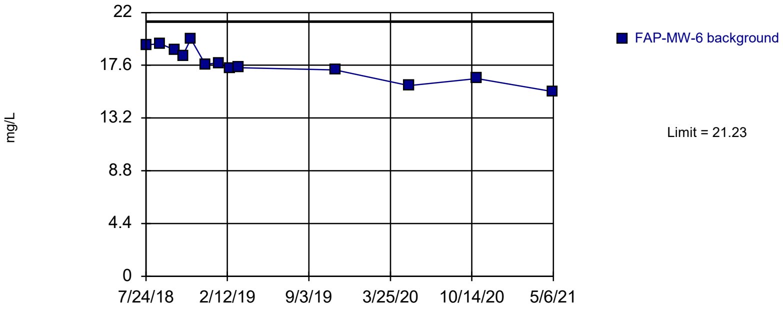
Background Data Summary: Mean=109.3, Std. Dev.=2.594, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8966, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-6



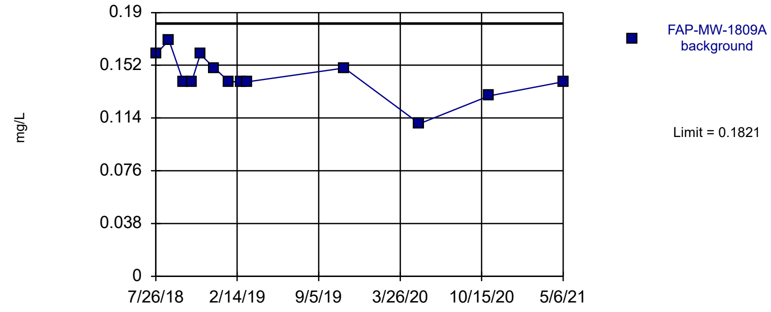
Background Data Summary: Mean=17.77, Std. Dev.=1.36, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9652, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Chloride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1809A (bg)



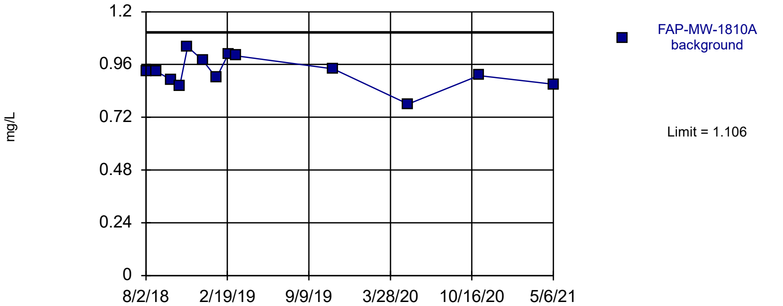
Background Data Summary: Mean=0.1438, Std. Dev.=0.01502, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9144, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1810A (bg)



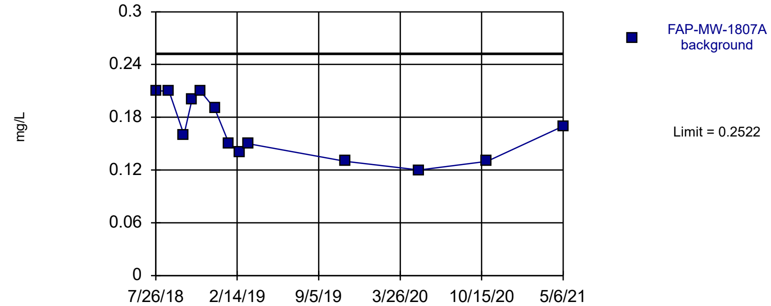
Background Data Summary: Mean=0.9262, Std. Dev.=0.07054, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.976, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807A (bg)



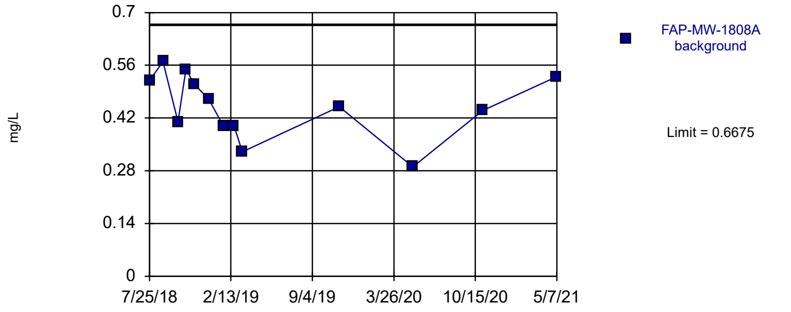
Background Data Summary: Mean=0.1669, Std. Dev.=0.03351, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8953, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1808A (bg)



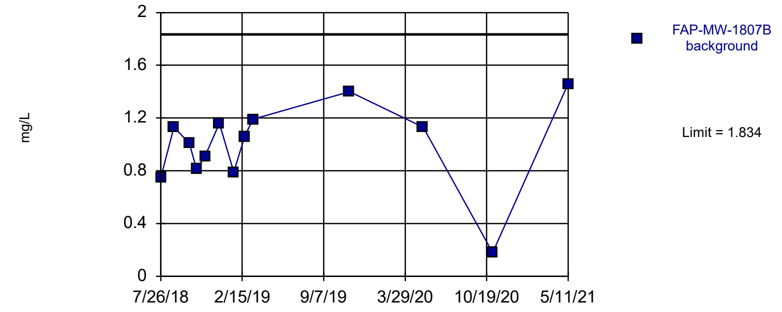
Background Data Summary: Mean=0.4515, Std. Dev.=0.08484, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.958, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807B (bg)



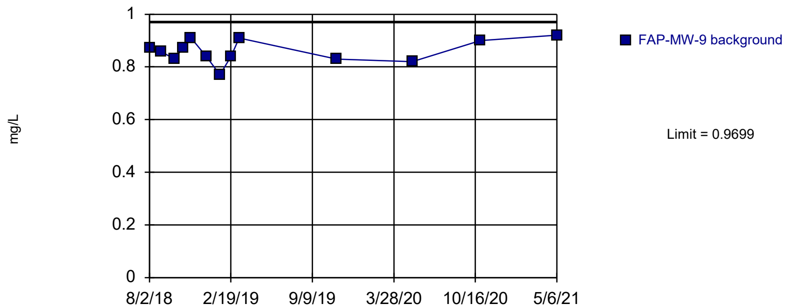
Background Data Summary: Mean=0.9985, Std. Dev.=0.3284, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9164, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-9



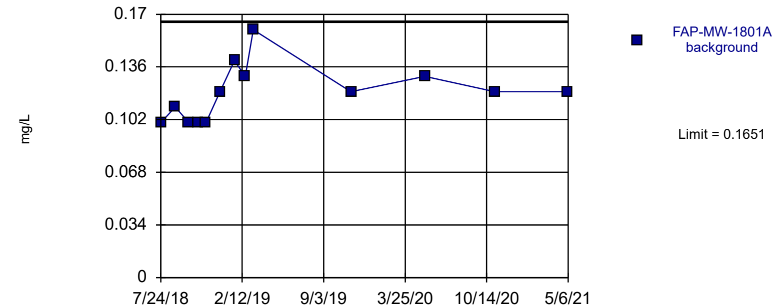
Background Data Summary: Mean=0.8592, Std. Dev.=0.04349, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9454, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1801A



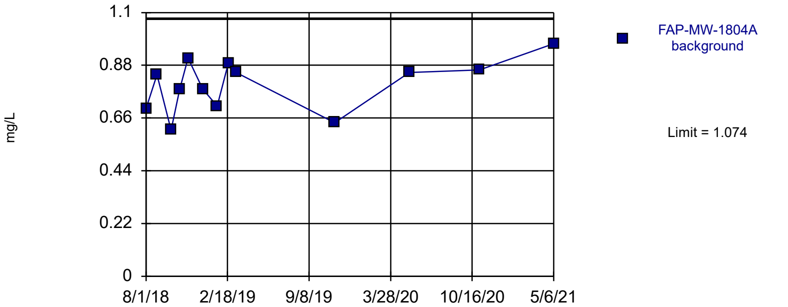
Background Data Summary: Mean=0.1192, Std. Dev.=0.01801, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8916, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1804A



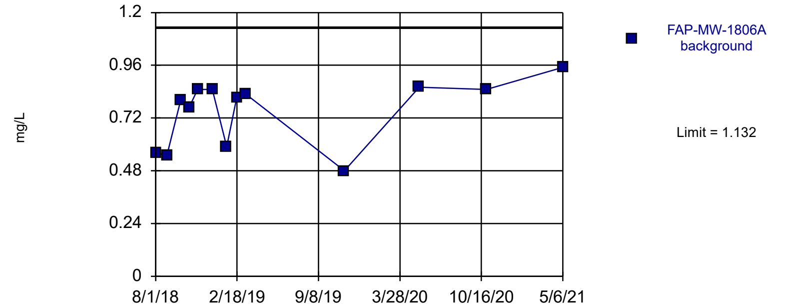
Background Data Summary: Mean=0.7992, Std. Dev.=0.108, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9555, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1806A



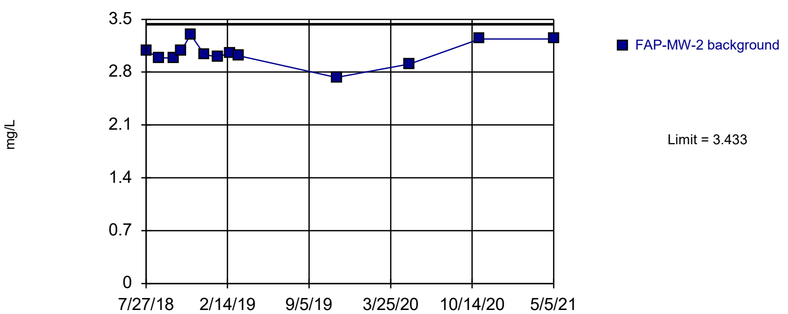
Background Data Summary: Mean=0.75, Std. Dev.=0.1499, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8535, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-2



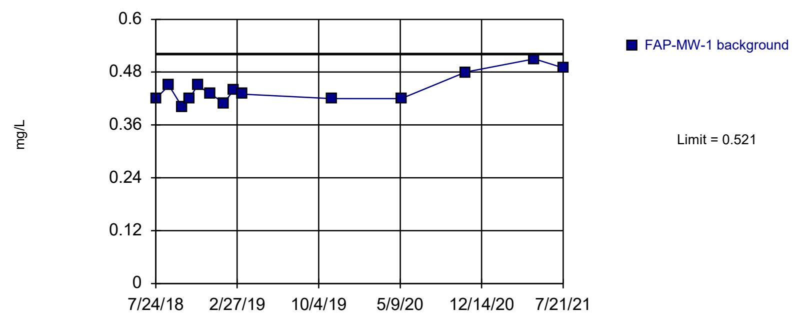
Background Data Summary: Mean=3.052, Std. Dev.=0.1499, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9341, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1



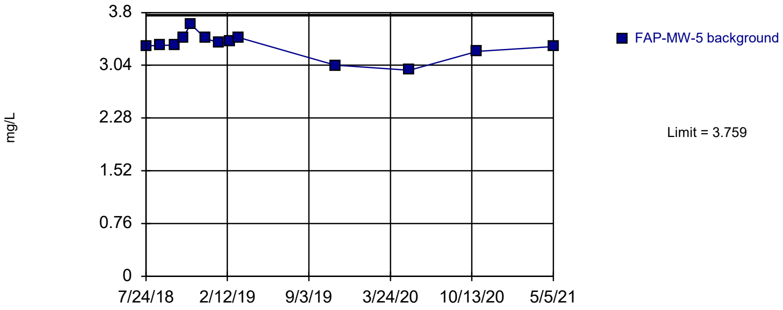
Background Data Summary: Mean=0.4407, Std. Dev.=0.03222, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.891, critical = 0.825. Kappa = 2.493 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-5



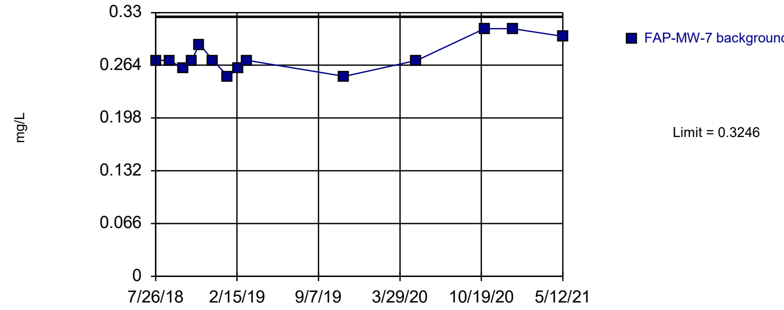
Background Data Summary: Mean=3.325, Std. Dev.=0.1707, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9089, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-7



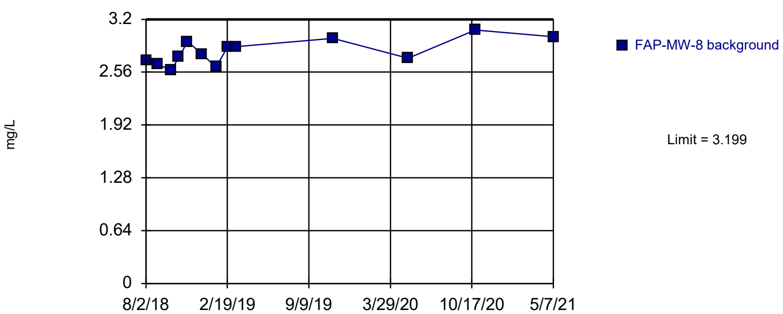
Background Data Summary: Mean=0.275, Std. Dev.=0.0199, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8628, critical = 0.825. Kappa = 2.493 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-8



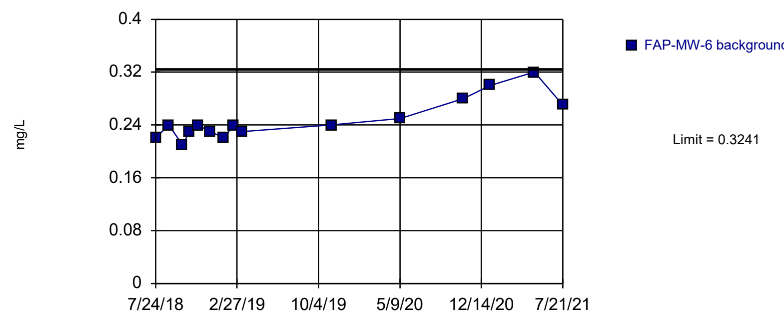
Background Data Summary: Mean=2.808, Std. Dev.=0.1536, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9631, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-6



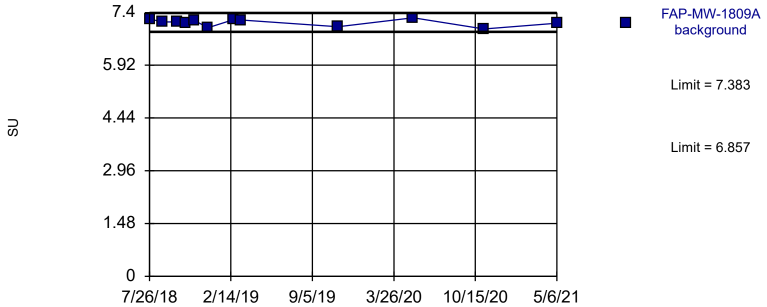
Background Data Summary: Mean=0.248, Std. Dev.=0.03121, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8737, critical = 0.835. Kappa = 2.439 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Fluoride Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1809A (bg)



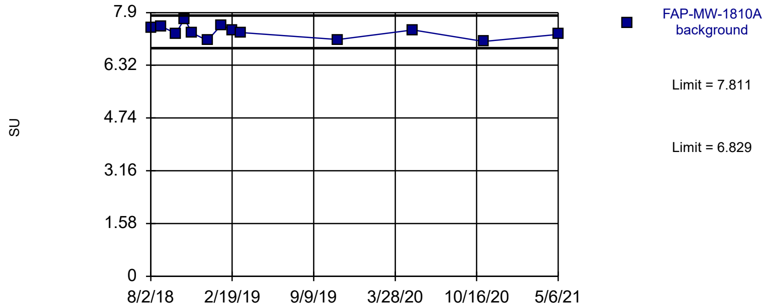
Background Data Summary: Mean=7.12, Std. Dev.=0.1011, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.914, critical = 0.805. Kappa = 2.599 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1810A (bg)



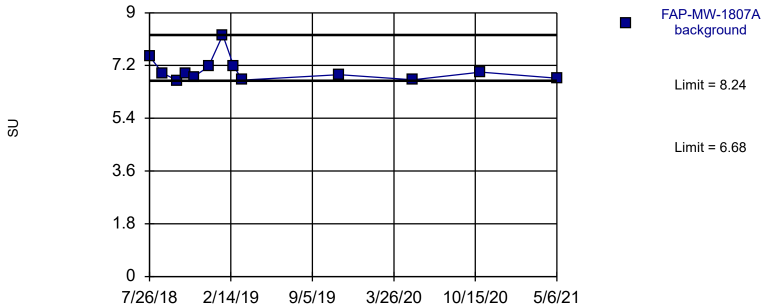
Background Data Summary: Mean=7.32, Std. Dev.=0.193, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9682, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, FAP-MW-1807A (bg)



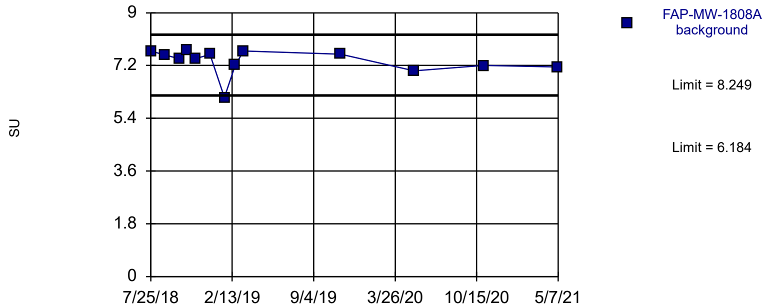
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limits are highest and lowest of 13 background values. Well-constituent pair annual alpha = 0.03858. Individual comparison alpha = 0.01938 (1 of 2). Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1808A (bg)



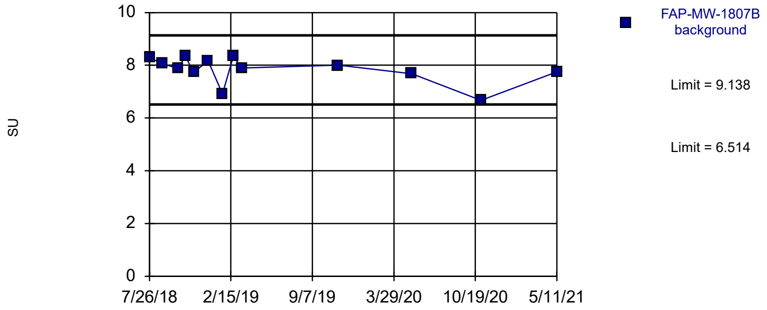
Background Data Summary (based on cube transformation): Mean=398.9, Std. Dev.=63.83, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8333, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807B (bg)



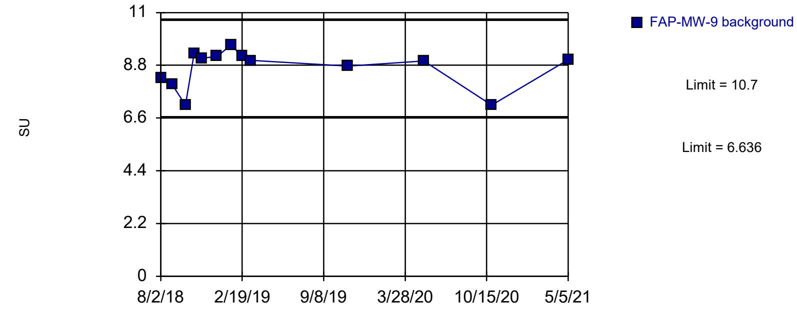
Background Data Summary: Mean=7.826, Std. Dev.=0.5155, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8455, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-9



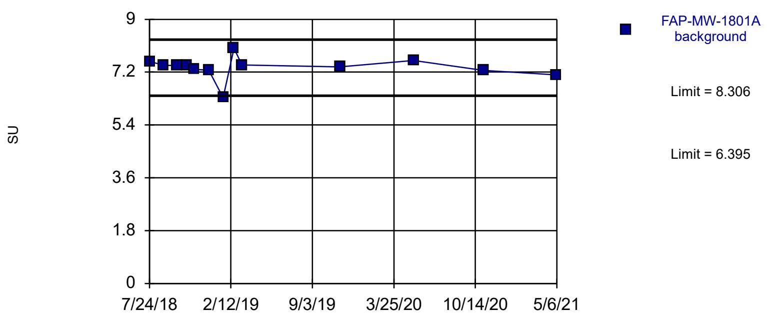
Background Data Summary: Mean=8.67, Std. Dev.=0.7991, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8379, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1801A



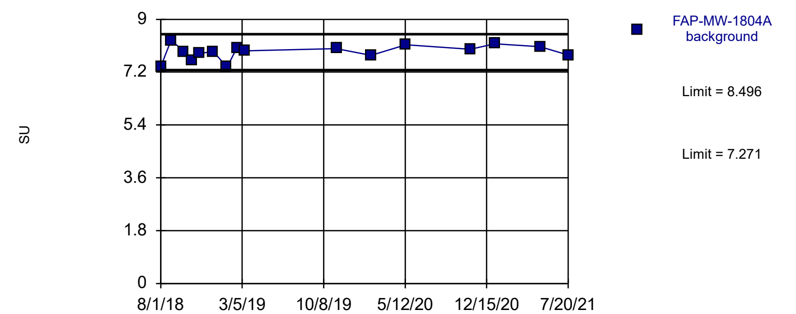
Background Data Summary: Mean=7.351, Std. Dev.=0.3753, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8329, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1804A

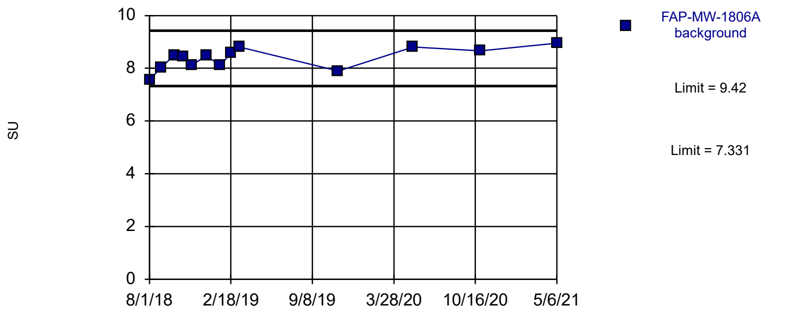


Background Data Summary: Mean=7.884, Std. Dev.=0.2567, n=16. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9388, critical = 0.844. Kappa = 2.386 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Prediction Limit

Intrawell Parametric, FAP-MW-1806A



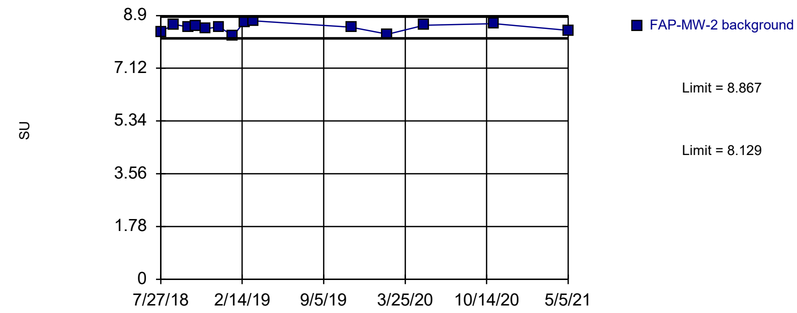
Background Data Summary: Mean=8.375, Std. Dev.=0.4102, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.957, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:02 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-2



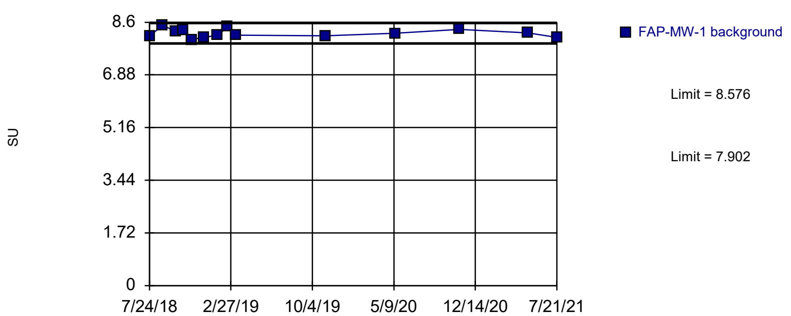
Background Data Summary: Mean=8.498, Std. Dev.=0.1481, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.965, critical = 0.825. Kappa = 2.493 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1



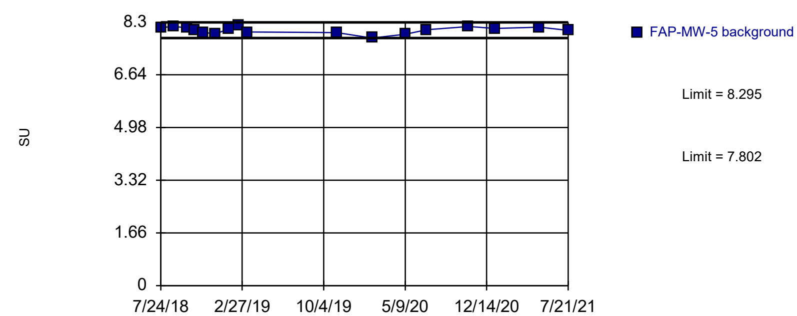
Background Data Summary: Mean=8.239, Std. Dev.=0.1352, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9569, critical = 0.825. Kappa = 2.493 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-5

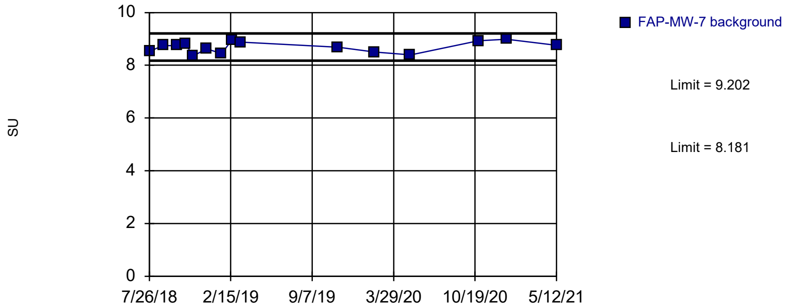


Background Data Summary: Mean=8.049, Std. Dev.=0.1045, n=17. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.851. Kappa = 2.358 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Prediction Limit

Intrawell Parametric, FAP-MW-7



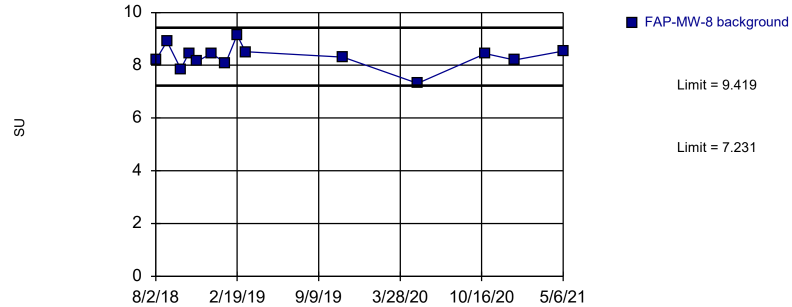
Background Data Summary: Mean=8.691, Std. Dev.=0.2093, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.943, critical = 0.835. Kappa = 2.439 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-8



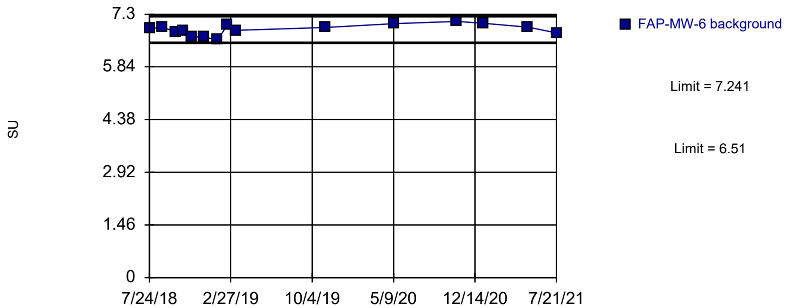
Background Data Summary: Mean=8.325, Std. Dev.=0.4389, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9488, critical = 0.825. Kappa = 2.493 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-6



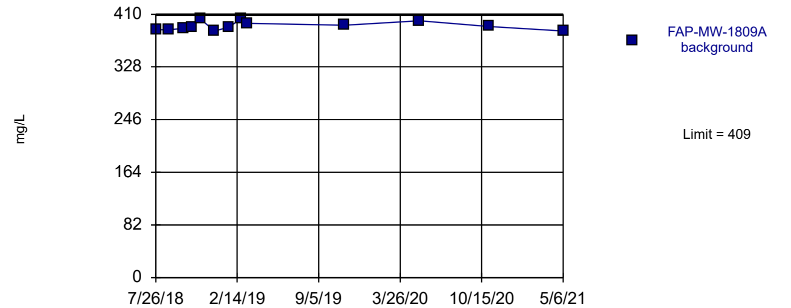
Background Data Summary: Mean=6.875, Std. Dev.=0.1498, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9581, critical = 0.835. Kappa = 2.439 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: pH Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1809A (bg)



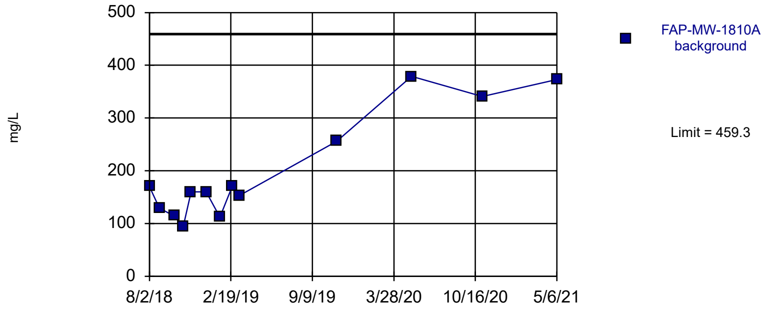
Background Data Summary: Mean=391.8, Std. Dev.=6.756, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8988, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1810A (bg)



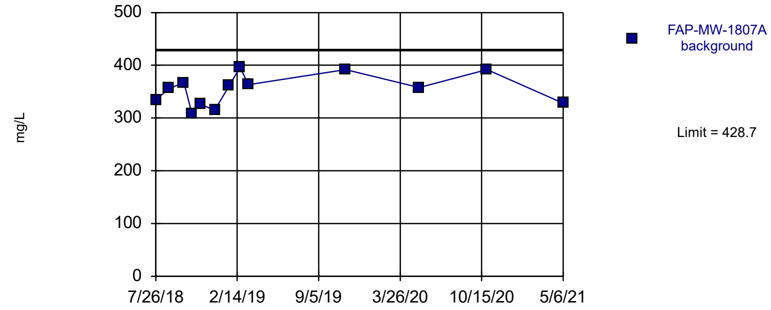
Background Data Summary: Mean=200.8, Std. Dev.=101.6, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8211, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807A (bg)



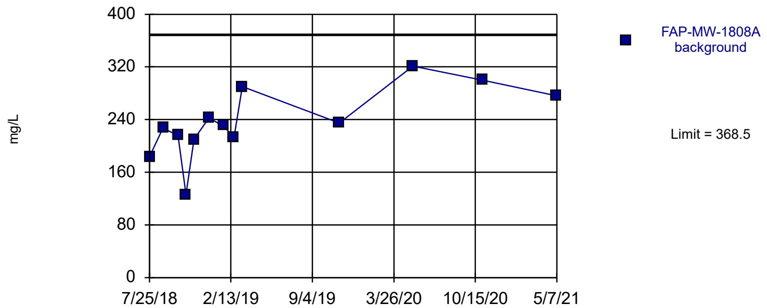
Background Data Summary: Mean=353.5, Std. Dev.=29.53, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9327, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1808A (bg)



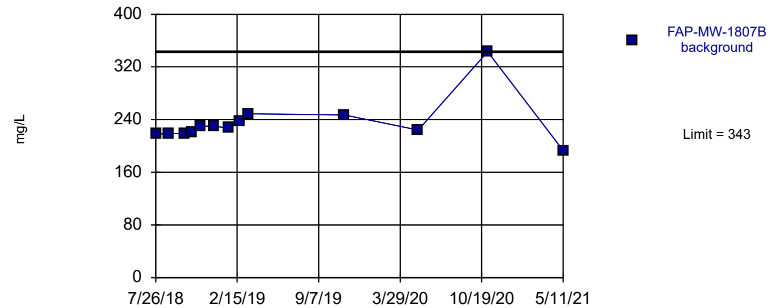
Background Data Summary: Mean=236.2, Std. Dev.=51.95, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9608, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, FAP-MW-1807B (bg)



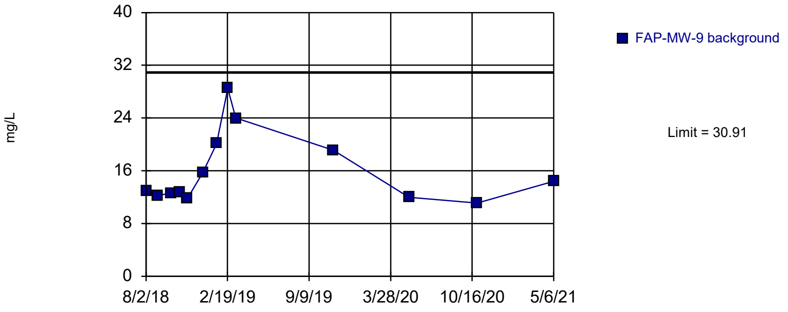
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 13 background values. Well-constituent pair annual alpha = 0.01929. Individual comparison alpha = 0.009692 (1 of 2). Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-9



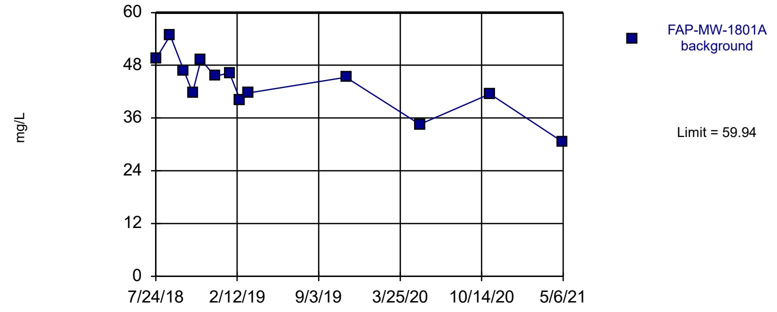
Background Data Summary (based on square root transformation): Mean=3.947, Std. Dev.=0.6337, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8384, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1801A



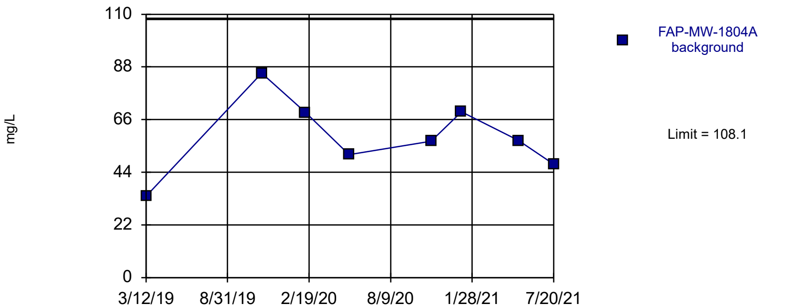
Background Data Summary: Mean=43.65, Std. Dev.=6.402, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9645, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1804A



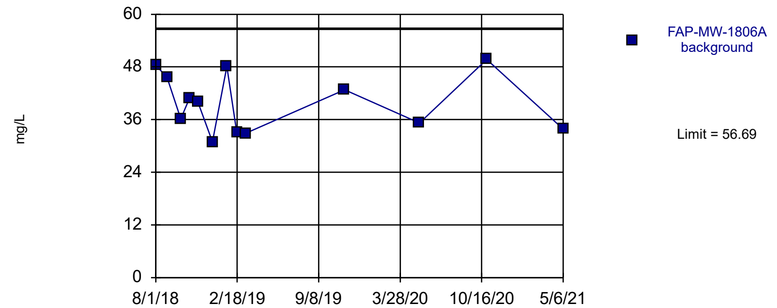
Background Data Summary: Mean=58.84, Std. Dev.=15.72, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9793, critical = 0.749. Kappa = 3.133 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1806A



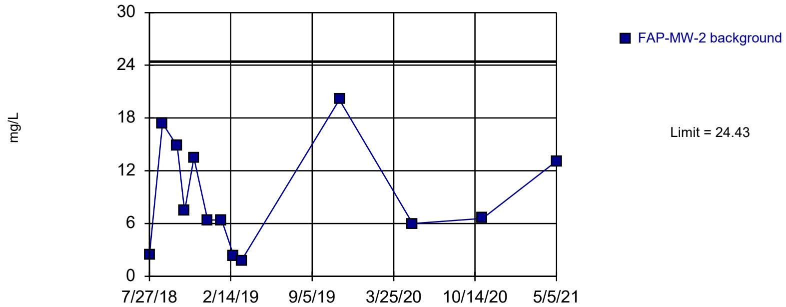
Background Data Summary: Mean=39.81, Std. Dev.=6.632, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9144, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-2



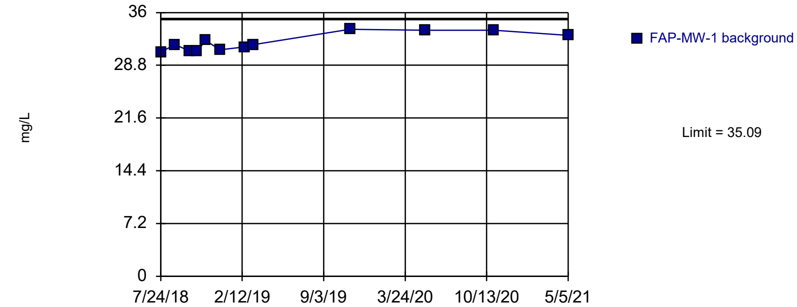
Background Data Summary: Mean=9.092, Std. Dev.=6.024, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9083, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1



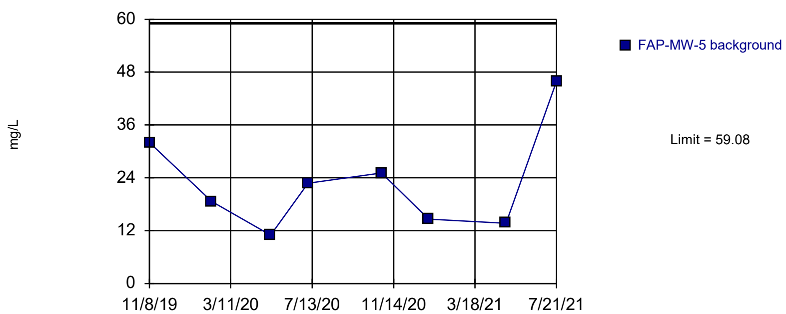
Background Data Summary: Mean=31.96, Std. Dev.=1.204, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8671, critical = 0.805. Kappa = 2.599 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-5



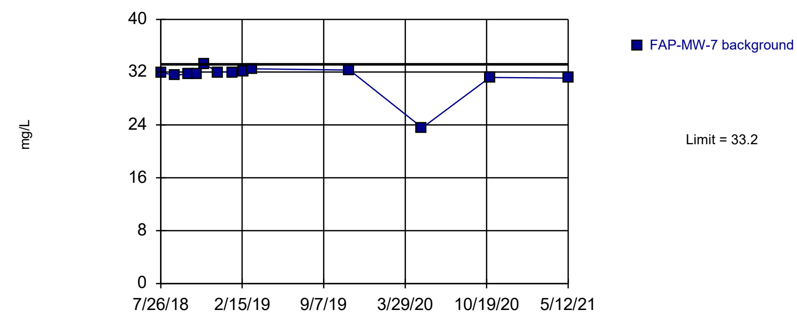
Background Data Summary: Mean=22.96, Std. Dev.=11.53, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9026, critical = 0.749. Kappa = 3.133 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, FAP-MW-7



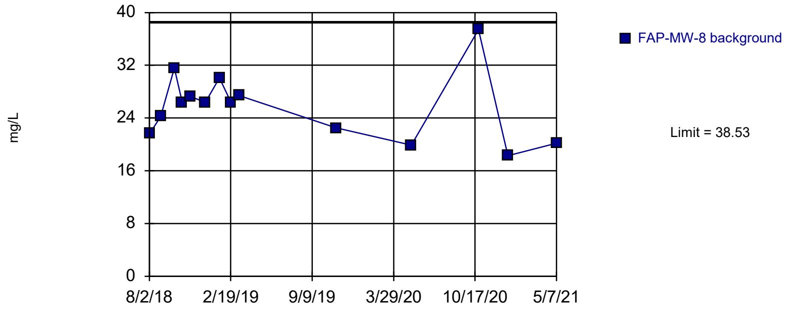
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 13 background values. Well-constituent pair annual alpha = 0.01929. Individual comparison alpha = 0.009692 (1 of 2). Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-8



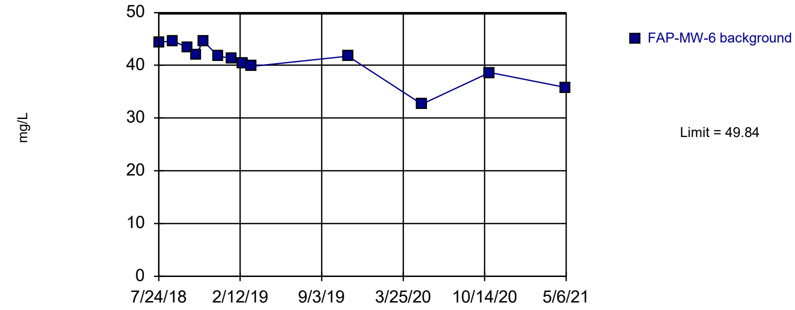
Background Data Summary: Mean=25.68, Std. Dev.=5.155, n=14. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9522, critical = 0.825. Kappa = 2.493 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-6



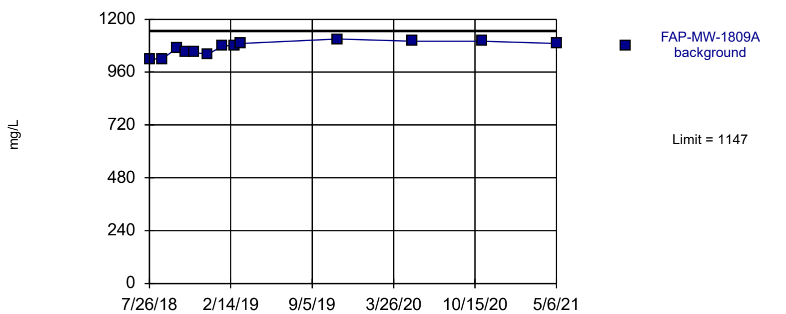
Background Data Summary: Mean=40.84, Std. Dev.=3.537, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8913, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Sulfate Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1809A (bg)



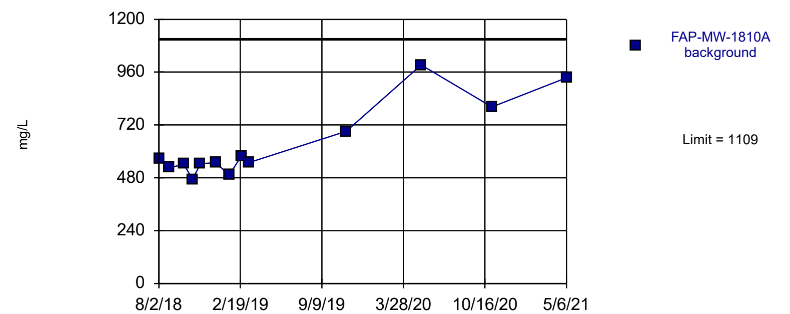
Background Data Summary: Mean=1069, Std. Dev.=30.4, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9208, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1810A (bg)



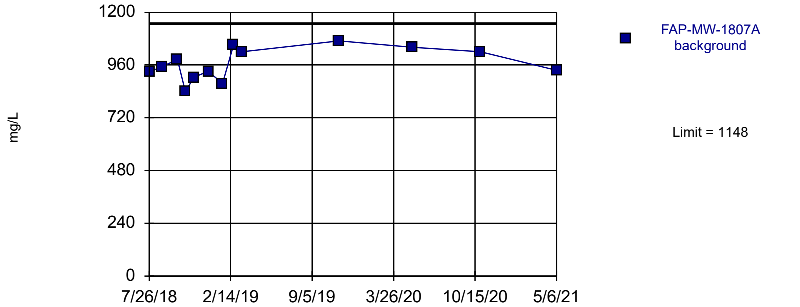
Background Data Summary (based on cube root transformation): Mean=8.534, Std. Dev.=0.7131, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8158, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807A (bg)



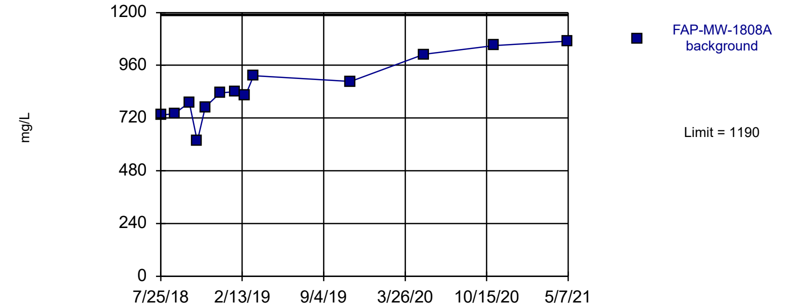
Background Data Summary: Mean=965.5, Std. Dev.=71.61, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9592, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1808A (bg)



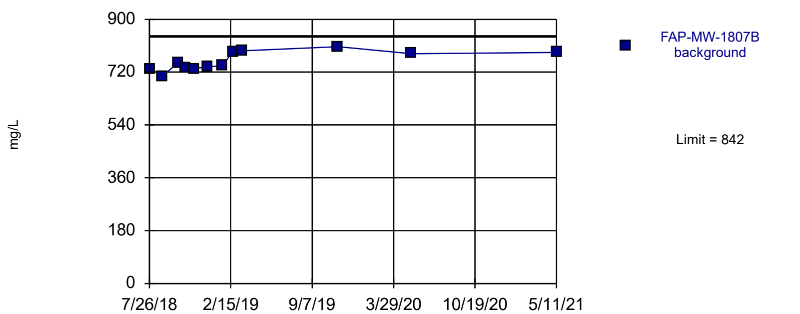
Background Data Summary: Mean=851.7, Std. Dev.=132.8, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.959, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1807B (bg)



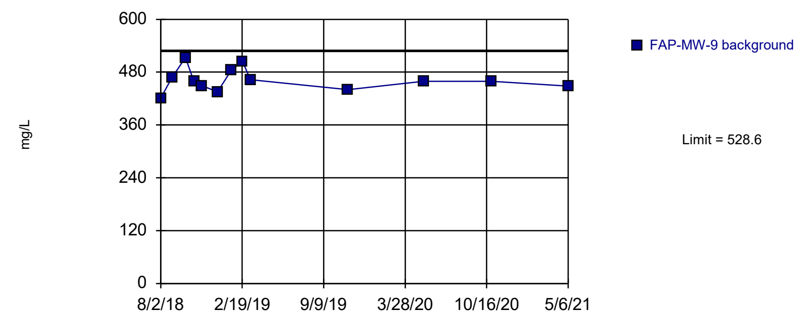
Background Data Summary: Mean=758.2, Std. Dev.=32.27, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9103, critical = 0.805. Kappa = 2.599 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-9



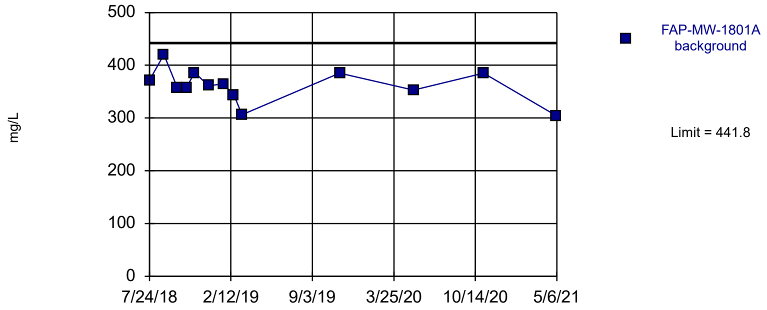
Background Data Summary: Mean=461.8, Std. Dev.=26.22, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9427, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1801A



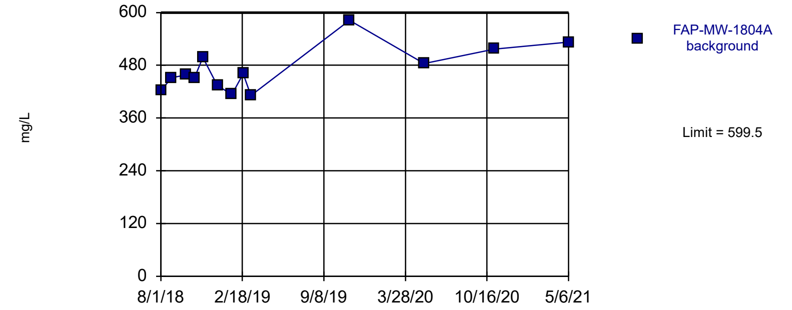
Background Data Summary: Mean=361, Std. Dev.=31.75, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9384, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1804A



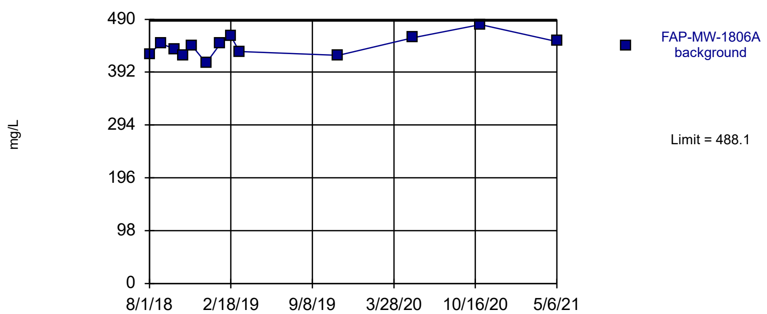
Background Data Summary: Mean=470.6, Std. Dev.=50.63, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9281, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1806A



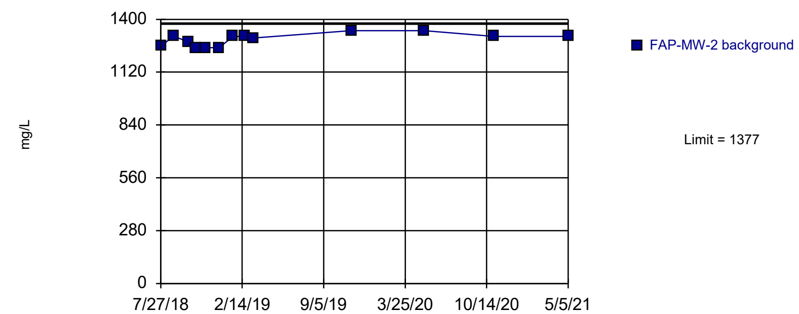
Background Data Summary: Mean=440.2, Std. Dev.=18.82, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9765, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-2



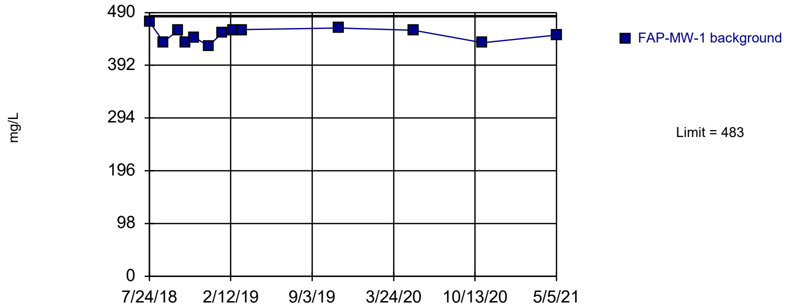
Background Data Summary: Mean=1294, Std. Dev.=32.54, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8676, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-1



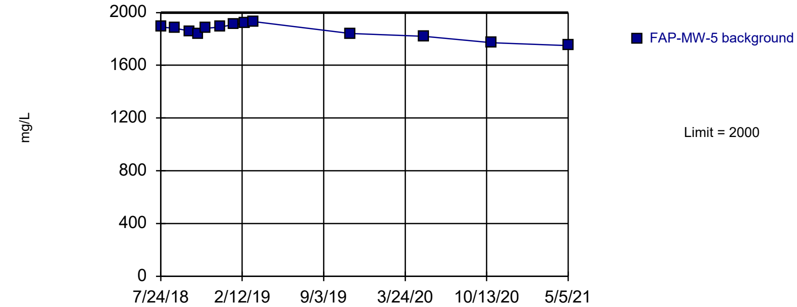
Background Data Summary: Mean=449.2, Std. Dev.=13.3, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9355, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-5



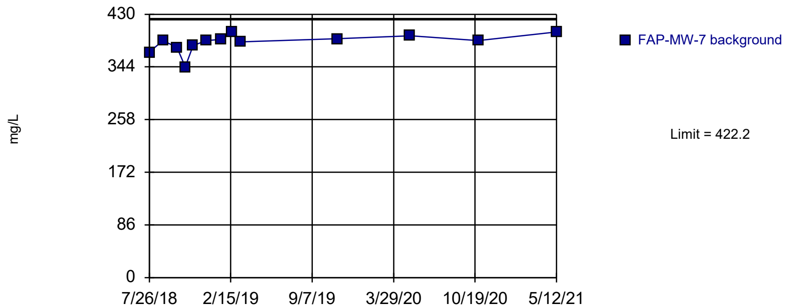
Background Data Summary: Mean=1860, Std. Dev.=54.92, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9267, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-7



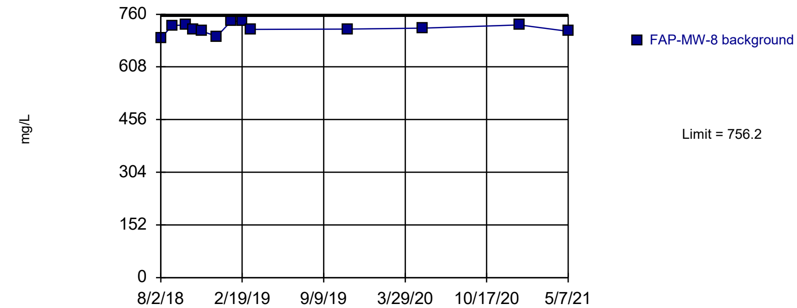
Background Data Summary: Mean=383.8, Std. Dev.=15.09, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.858, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, FAP-MW-8

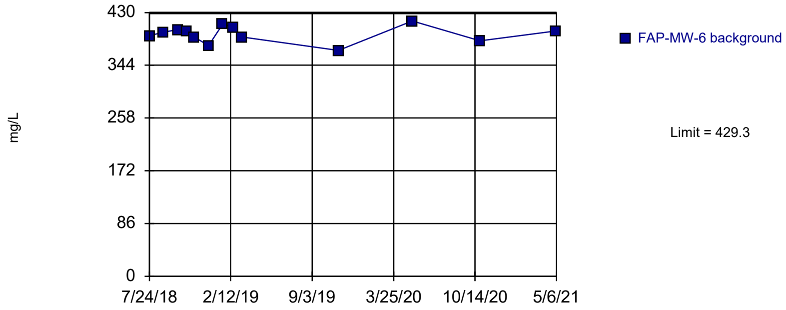


Background Data Summary: Mean=718.6, Std. Dev.=14.77, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9499, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell
Amos FAP Client: Geosyntec Data: Amos FAP

Prediction Limit

Intrawell Parametric, FAP-MW-6



Background Data Summary: Mean=394.8, Std. Dev.=13.53, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.974, critical = 0.814. Kappa = 2.546 (c=7, w=10, 1 of 2, event alpha = 0.05132). Report alpha = 0.0007523. Assumes 1 future value.

Constituent: Total Dissolved Solids Analysis Run 9/28/2021 3:03 PM View: PL's - Intrawell

Amos FAP Client: Geosyntec Data: Amos FAP

APPENDIX 3

The alternative source demonstrations completed in 2021 follow.

Addendum Report to Alternative Source Demonstration for Calcium, Chloride, Fluoride, and Sulfate

John E. Amos Plant Fly Ash Pond
Winfield, West Virginia

Prepared for:

American Electric Power

Prepared by:

EHS Support LLC and EnviroProbe Integrated Solutions, Inc.

May 2021

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Acronyms

amsl	above mean sea level
ASD	alternative source demonstration
bgs	below ground surface
Ca	calcium
$Ca-HCO_3$	calcium bicarbonate
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
IPL	intrawell prediction limit
JAFAP	John E. Amos Plant Fly Ash Pond
Mg	manganese
mg/L	milligrams per liter
Na	sodium
NaCl	sodium chloride
$Na-HCO_3$	sodium bicarbonate
SRF	stress relief fracturing
SSI	statistically significant increases
TDS	total dissolved solids
USEPA	United States Environmental Protection Agency

Certification by Qualified Professional Engineer

I certify that the alternative source demonstration (ASD) conducted and presented within this addendum report is appropriate for evaluating the groundwater monitoring data for the John E. Amos Plant Fly Ash Pond Coal Combustion Residual (CCR) management area associated with the John E. Amos Plant Power Plant located in Winfield. West Virginia. This ASD meets the requirements of the United States Environmental Protection Agency CCR Rule defined at 40 Code of Federal Regulations 257.94(e)(2).

Roderic E. Moore

Printed Name of Licensed Professional Enginee

Signature

RODERIC E. MOORE
REGISTERED
16390
STATE OF
WEST VIRGINIA
PROFESSIONAL ENGINEER

PE #016390

License Number

West Virginia

Licensing State

05/07/21

Date

1 Introduction

EHS Support LLC ("EHS Support") was retained by Appalachian Power Company, doing business as American Electric Power ("AEP") to conduct an alternative source demonstration (ASD) investigation for coal combustion residual (CCR) constituents at the John E. Amos Plant Fly Ash Pond (JAFAP) located in Putnam County, Winfield, West Virginia (**Appendix A**). The following is a timeline of ASDs completed for the JAFAP to date:

- Initial ASD investigation dated June 2020 was completed for November 2019 detection monitoring data which was validated during a February 2020 resampling event (EHS Support, 2020a).
- First addendum to the initial ASD investigation was completed for the May 2020 detection monitoring data which was validated during a July 2020 resampling event (EHS Support, 2020b).
- Current ASD investigation (second addendum) herein has been prepared for the November 2020 detection monitoring data and subsequent January 2021 confirmation sampling data and is provided as an addendum to the initial (June 2020) investigation and the November 2020 addendum.

EHS Support has teamed with EnviroProbe Integrated Solutions, Inc. of Nitro, West Virginia to complete this ASD investigation addendum per the requirements of the United States Environmental Protection Agency (USEPA) CCR Rule (40 Code of Federal Regulations [CFR] 257.94).

1.1 Objectives

The objective for this ASD investigation addendum is to assess groundwater monitoring data collected in compliance with the CCR Rule as allowed under paragraph 40 CFR 257.94(e)(2) of the CCR Rule. This part of the rule allows AEP to determine whether the source(s) for statistically significant increases (SSIs) reported from groundwater monitoring are associated with the CCR unit, or if the SSIs resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The focus of this JAFAP ASD investigation addendum is specifically on calcium and sulfate in MW-5, chloride and sulfate at MW-1804A, and fluoride in MW-6 and MW-7, the constituents that demonstrated SSIs during the October-November 2020 detection monitoring event and subsequent January 2021 confirmation sampling event. Following a possible SSI of total dissolved solids (TDS) in MW-8 in the October 2020 sample, a confirmation TDS sample was collected from MW-8 in January 2021. The confirmation sampling results did not indicate an SSI for TDS in MW-8, so it is not a subject of this ASD.

1.2 Lines of Evidence

This ASD investigation addendum for the JAFAP has been conducted to evaluate potential alternate sources or reasons for the SSIs of calcium and sulfate in MW-5, chloride and sulfate at MW-1804A, and fluoride in MW-6 and MW-7. A potential alternate source is evident, when based on the following lines of evidence:

- Lack of exceedances and increasing trends of primary indicators of CCR.
- JAFAP pore water concentrations are lower than those of the corresponding constituent observed in groundwater.
- Major ion chemistry does not indicate mixing between JAFAP water and groundwater.

For the purposes of this ASD investigation addendum, constituents were identified that would serve as a primary indicator for CCR leachate. A primary indicator must meet **both** of the following criteria:

- Constituent typically has high concentration in CCR leachate, relative to background, such that it is expected to have elevated concentration in the event of a release.
- Constituent is not reactive and has high mobility in groundwater such that it is expected to be at the leading edge of the plume, meaning that it will have elevated concentrations relative to background across the entire area of the plume.

As sulfate is a primary indicator for CCR leachate (Electric Power Research Institute [EPRI], 2012) it has been evaluated in this ASD investigation addendum. Other potential indicators that were evaluated in this ASD investigation addendum include calcium, chloride, and fluoride. Whereas fluoride is considered a potential indicator of CCR leachate (EPRI, 2017), calcium and chloride, are only considered to be potential indicators of CCR leachate if flue gas desulfurization (FGD) gypsum is intermixed with CCR (EPRI, 2012). As the Amos Plant is equipped with an FGD system, calcium and chloride are included as potential indicators in this ASD addendum. It is understood that JAFAP only received CCR (fly ash) from 1971 until 2010, and that FGD residual was disposed in a separate FGD landfill. Consequently, this ASD Addendum conservatively assesses calcium and chloride as potential indicators, with the understanding that there is low likelihood for an extensive contributing FGD source within the JAFAP. It is noteworthy that sulfate, calcium, fluoride, and chloride all have abundant natural sources in the site vicinity, specifically:

- Occurrence of sulfide-bearing coal seams, where sulfate is produced from sulfide oxidation (Siegel et al., 2015).
- Significant thicknesses of various limestone formations, which are a potential source of calcium (specifically, within the Conemaugh and Monongahela Groups, which form the ridges around and basement beneath the JAFAP [Cardwell et al, 1968]).
- Presence of connate brines as a source of halides (chloride and fluoride) (Mathes and Waldron, 1993; Sheets and Kozar, 2000).

2 Project Background

Details about the site location and history, geology, groundwater geochemistry, and monitoring well network details are provided in the *Alternative Source Demonstration Report for Calcium, Chloride, and Sulfate John E. Amos Plant Fly Ash Pond, Winfield, West Virginia* dated June 2020 (EHS Support, 2020a). Arcadis (2019) determined that the groundwater monitoring well network described above meets the requirements of 40 CFR §257.91, as it consists of a sufficient number of wells installed at the appropriate locations and depths to yield groundwater samples from the uppermost shallow aquifer that accurately represent the quality of background groundwater and groundwater passing the waste boundary of the JAFAP. Figures from the Fly Ash Pond CCR Groundwater Monitoring Well Network Evaluation report depicting the locations of the site, plant and CCR unit, JAFAP and wells are presented in **Appendix A** (Arcadis, 2019). Pertinent details to this ASD investigation addendum are summarized as follows.

Appalachian Plateau groundwater geochemistry, including the JAFAP site area in West Virginia, is established through several regional studies (Piper, 1933, Mathes and Waldron, 1993; Trap and Horn, 1997; Sheets and Kozar, 2000; Warner et al., 2012; Siegel et al., 2015). Groundwater recharge generally occurs on hill tops and circulates along hill slopes to shallow depths in Appalachian Plateau sedimentary bedrock aquifers. Saline (connate) water is frequently encountered beneath a thin (a few feet [ft]) transitional mixing zone with the overlying “fresh” (low TDS) water (Trapp and Horn, 1997; Siegel et al., 2015). The chemistry of groundwater in recharge areas on hilltops is characterized by low TDS calcium bicarbonate (Ca-HCO_3-type) water, that evolves to low TDS sodium bicarbonate (Na-HCO_3-type) groundwater as groundwater percolates down slopes owing to calcium (Ca) and manganese (Mg) ion exchange with sodium (Na) in Na-bearing clay minerals. Saline sodium chloride (NaCl-type) high TDS waters are naturally occurring connate brines that are found in “restricted flow zones” where recharge waters do not flush the host lithology. The NaCl-type water is further characterized by low to non-detectable sulfate, due to reducing conditions that promote sulfide as the predominant sulfur species (Siegel et al., 2015). The NaCl-type groundwater is also typically associated with elevated fluoride concentrations in West Virginia (Mathes and Waldron, 1993). The compositional evolution of these water types is shown on a Piper plot in **Figure 2-1** taken from Siegel et al. (2015).

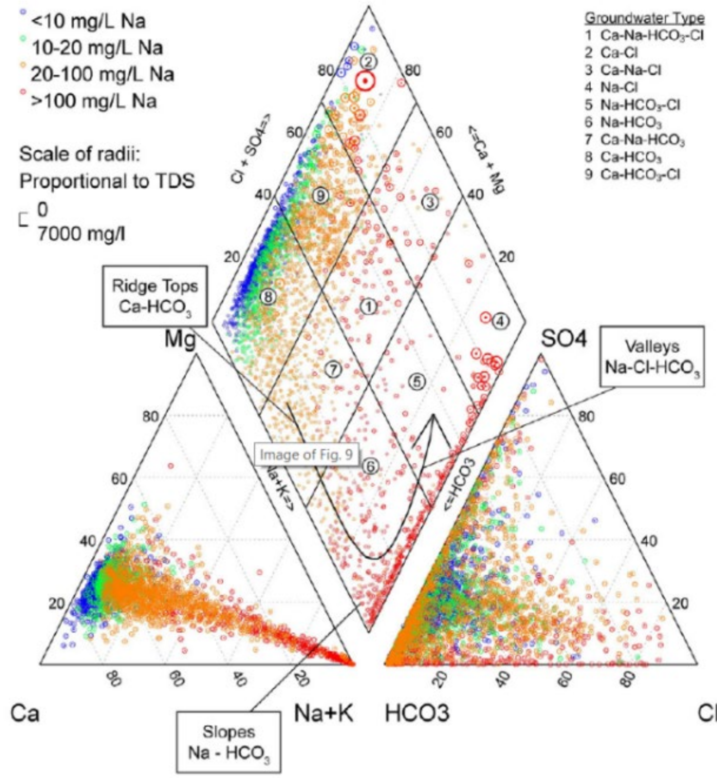


Figure 2-1 Generalized Groundwater Major Ion Chemistry within the Appalachian Plateau

(Siegel et al., 2015).

Regionally throughout the Appalachian Plateau, NaCl-type water is typically encountered at low elevations in valley centers at approximately 100 ft beneath the level of the nearest major stream (Trapp and Horn, 1997; Warner et al., 2012; Siegel et al., 2015). In West Virginia, NaCl-type groundwater is frequently encountered at even shallower depths beneath streams in valley bottoms owing to the overall lower topographic elevation and associated lower potential groundwater head available to depress underlying saline water (Siegel et al., 2015).

An additional control on regional groundwater chemistry is the occurrence of natural coal intervals and laminations within bedrock formations. Where coal occurs, aerobic groundwater leads to oxidation of sulfide minerals (principally the iron sulfide pyrite) in the coal, which leads to elevated concentrations of iron and sulfate in groundwater (Siegel et al., 2015).

2.1 Groundwater Monitoring Network

Details of the JAFAP monitoring network are presented in Fly Ash Pond CCR Groundwater Monitoring Well Network Evaluation report (Arcadis, 2019). Four of the monitoring wells (MW-1807A, MW-1808A, MW-1809A, and MW-1810A) are installed upgradient of the JAFAP to support background monitoring. Ten monitoring wells (MW-1, MW-2, MW-5, MW-6, MW-1801A, MW-1804A, MW-1806A, MW-7, MW-8, and MW-9) are located downgradient of the JAFAP and used for compliance monitoring.

The details of each groundwater monitoring location used for water quality sampling are summarized in **Table 1** and the location of the monitoring wells within the uppermost aquifer is shown on Figure 3 (Arcadis, 2019) in **Appendix A**.

2.2 ASD Investigation Monitoring Wells

Monitoring wells MW-5, MW-6, MW-7, and MW-1804A had constituents that showed SSIs in October and November 2020 groundwater monitoring data:

- MW-5 had SSIs of sulfate and calcium.
- MW-6 had an SSI of fluoride.
- MW-7 had an SSI of fluoride.
- MW-1804A had SSIs of sulfate and chloride.

Monitoring wells MW-5, MW-6, and MW-7 were sampled on October 27 and 28, 2020, and MW-1804 was sampled on November 2, 2020. These SSIs were confirmed by a verification sampling event in January 2021. The details of these monitoring wells are provided in the following sections to support the ASD investigation addendum.

2.2.1 MW-5

MW-5 is installed near the base of the incised valley of Little Scary Creek where the ground surface (648.03 ft above mean sea level [amsl]) and piezometric surface are within the Morgantown Sandstone and stratigraphically lower than the base of the JAFAP. In deepening stratigraphic succession, the 114.8-foot boring intercepted approximately 23 ft of predominantly clay unconsolidated deposits, 11 ft of Morgantown Sandstone, 69.5 ft of variably weathered Birmingham Shale (shale and clay shale), 7 ft of sandstone (interpreted as Grafton Sandstone) before terminating within approximately 4 ft of shale (see cross section A-A' [Arcadis, 2019] in **Appendix B** and MW-5 boring log in **Appendix C**). The MW-5 sand pack and screen extends over the Grafton Sandstone and includes several ft of the over- and under-lying shale. The following lines of evidence place MW-5 in the context of the groundwater monitoring network and indicate that groundwater in MW-5 includes a component of deep brine:

- MW-5 is located at the base of the Little Scary Creek stream valley and is screened at a lower elevation (546.43 to 537.03 ft amsl) than all other site wells.
- MW-5 screen is set at 101.6 to 111.0 ft below ground surface (bgs), which is approximately 100 ft lower in elevation than the adjacent Little Scary Creek bed, corresponding to the depth beneath Appalachian Plateau streams where NaCl-type connate water is typically encountered in the Appalachian Plateau.
- The screen for MW-5 is vertically lower and laterally distal to the base of the JAFAP. According to the stress relief fracturing (SRF) model, groundwater from the JAFAP would migrate through coal-bearing strata (specifically the Elk Lick Coal within Birmingham Shale) prior to entering the screened interval for MW-5 with concomitant geochemical effects on groundwater composition.
- TDS values for MW-5 historically exceed values in the JAFAP by nearly an order of magnitude (AEP, 2020). Additionally, sulfate is historically near or below the laboratory reporting limit in MW-5. The geochemistry of MW-5 historically corresponds with the composition of Appalachian Plateau NaCl-type connate water.
- The NaCl-type groundwater in MW-5 is distinct from the Na-HCO_3-type water typically encountered in site wells screened in the SRF at higher elevations and located on the hilltops

surrounding the site and is distinct from porewater in the JAFAP (EHS Support, 2020a). The exception is MW-2, the only site well that is also at the base of Little Scary Creek alluvial valley and is screened at a similar elevation (549.10 to 540.20) to MW-5.

- During packer testing, MW-5 did not accept flow with up to 100 pounds per square inch pressure (Arcadis, 2019), indicating the presence of low permeability units typical of those that are not regularly flushed with groundwater and that may host NaCl connate waters.
- Wells co-located with MW-5, MW-6 (screen = 619.00 to 614.00 ft amsl) and MW-1 (screen = 606.47 to 597.57 ft amsl), are screened at higher elevations and exhibit lower TDS and a $NaHCO_3$-type water, which is expected with the fresher shallower groundwater being present in these shallower wells versus the deeper connate (brine) groundwater. The screen and sand pack separations between MW-1 and MW-5 of approximately 12 feet are significant considering the brine/freshwater interface is typically on the order of one to two feet.

In summary, we do not see the expected effects on groundwater composition typically associated with CCR material in a fly ash pond (FAP), indicating JAFAP water has not reached MW-5. The groundwater composition at MW-5 is best described by natural causes.

2.2.2 MW-6

MW-6 is co-located with MW-1 and MW-5 near the base of the incised valley of Little Scary Creek where the ground surface (647.50 ft amsl) and piezometric surface are within the Morgantown Sandstone. In deepening stratigraphic succession, the 34.2-foot boring intercepted approximately 23 ft of predominantly clay unconsolidated deposits, 11 ft of Morgantown Sandstone, and 0.2 ft of shale (see cross section A-A’ [Arcadis, 2019] in **Appendix B** and MW-6 boring log in **Appendix C**). The MW-6 sand pack and screen extends over the Morgantown Sandstone. The following places MW-6 in the context of the groundwater monitoring network:

- MW-6 is screened from 619.00 to 614.00 ft amsl; above MW-5 (screened from 546.43 to 537.03 ft amsl) and MW-1 (screened from 606.47 to 597.57 ft amsl).
- MW-6 had the highest maximum pumping rate (3.8 gallons per minute) of all the JAFAP wells during hydraulic testing in 2018 and had the highest hydraulic conductivity at 37 feet per day (Arcadis, 2019).
- MW-6 is a Ca-HCO3-type water. As described in **Section 3.1** and **3.4**, the composition is gradually towards the composition of NaCl along the natural mixing line typical of Appalachian Plateau waters.
- Given Appalachian Plateau NaCl-type waters have naturally elevated fluoride concentrations (Mathes and Waldron, 1993), it is expected that the fluoride concertation will continue to increase in MW-6 as it follows this compositional trajectory.

2.2.3 MW-7

MW-7 is installed along the access road on the southeastern side of the JAFAP berm where the ground surface (953.00 ft amsl) and piezometric surface are stratigraphically within the Pittsburgh Sandstone/Conemaugh Shale members of the upper interval of the Conemaugh Formation. MW-7 is co-located with MW-3 and MW-4, the boring log for MW-4 was used to describe the subsurface material in MW-7 (**Appendix C**). In deepening stratigraphic succession, the 132.5 ft boring for MW-7 intercepted approximately 14 ft of overburden, 94 ft of interbedded limestone, sandstone, and shale (Pittsburgh

Sandstone/Conemaugh Shale), approximately 23.75 ft of upper Connellsville Sandstone, before terminating within approximately 0.75 ft of shale. The MW-7 sand pack and screen extends across the Conemaugh Shale and Upper Connellsville Sandstone (see boring log for MW-4 and well log for MW-7 in **Appendix C** and cross section B-B' [Arcadis, 2019] in **Appendix B**). The following places MW-7 in the context of the groundwater monitoring network:

- MW-7 is primarily screened over the Upper Connellsville Sandstone, similar to wells MW-8, MW-9, MW-1801A, MW-1804A, and MW-1806A (as presented in **Table 1**).
- Wells co-located with MW-7 (screen 823 to 843 ft msl) include MW-4 (screen = 714.10 to 705.20 ft amsl) and MW-3 (screen = 672.79 to 643.89 ft amsl).
- MW-6 is an Na-HCO_3-type water. As described in **Section 3.1.4**, the overall composition (particularly fluoride) remained remarkably stable during background assessment monitoring compared to other wells screened over similar formations (e.g., MW-1804A and MW-1806A). Consequently, relatively small natural compositional fluctuations will likely results in SSIs at MW-7 until extended monitoring provides adequate measurements to reflect natural variability in ground composition at this location.

2.2.4 MW-1804A

MW-1804A is installed on the inside edge of the northern JAFAP berm where the ground surface (858.53 ft amsl) and piezometric surface are stratigraphically within the Pittsburgh Sandstone/Conemaugh Shale members of the upper interval of the Conemaugh Formation. In deepening stratigraphic succession, the boring for MW-1804A intercepted approximately 14 ft of overburden, 16 ft of interbedded sandstone and shale (Pittsburgh Sandstone/Conemaugh Shale), approximately 15 ft of upper Connellsville Sandstone, before terminating within approximately 4 ft of shale. The MW-1804A sand pack and screen extends across the Conemaugh Shale, Upper Connellsville Sandstone, and an unnamed shale/siltstone unit (see boring log in **Appendix C** and cross section B-B' [Arcadis, 2019] in **Appendix B**). The following places MW-1804A in the context of the groundwater monitoring network:

- MW-1804A is primarily screened over the Upper Connellsville Sandstone, similar to wells MW-7, MW-8, MW-9, MW-1801A, and MW-1806A (as presented in **Table 1**).
- MW-1806A provides a convenient comparison for potential groundwater compositional variations in MW-1804A, as it is the only other site well with a sand pack that extends across the same combination of units (substantial interval of the Conemaugh Shale and the Upper Connellsville Sandstone and an unnamed shale/siltstone unit).

2.3 JAFAP Porewater Piezometer

AEP installed a multi-level port piezometer (STN-12-4) within the JAFAP to evaluate fly ash porewater. This multi-port piezometer has seven screened intervals, as detailed in the boring log (Stantec, 2012) provided in **Appendix C**.

Fly ash porewater was sampled during five events: September 28, 2017, December 11, 2017, November 16, 2018, March 12, 2019, November 11, 2019, May 11 through 14, 2020, and October 28 through 30, 2020. Water quality results for CCR constituents in the fly ash, with the geometric mean of each constituent over the seven interval ports, are presented in **Table 2**. These data will be used in this ASD investigation addendum to represent the JAFAP porewater when comparing to CCR constituent concentrations in the monitoring well network. It should be noted that based on the multi-port screen elevations, multi-port intervals 1 and 2, with a filter pack elevation range from 845.1 amsl to 821 amsl are the only intervals at higher elevations than the well screen and sand pack for MW-7 and MW-1804A.

2.4 Groundwater Monitoring

AEP has conducted groundwater monitoring of the uppermost aquifer to meet the requirements of the CCR Rules. These monitoring activities generally included the following activities:

- Collection of groundwater samples and analysis for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan* (AEP, 2019)
- Completion of validation tests for groundwater data, including tests for completeness, valid values, transcription errors, and consistent units.
- Establishment of background values for each Appendix III and Appendix IV constituent (eight sampling events conducted over a seven-month period between July 25, 2018 and February 18, 2019) (AEP, 2020)
- Evaluation of the groundwater data using a statistical process in accordance with 40 CFR 257.93, which was prepared and certified in April 2019 in AEP's *Statistical Analysis Plan* (Geosyntec, 2019), and posted to AEP's CCR website in May 2019. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance"; USEPA, 2009).
- Completion of the initial detection monitoring sampling event (March 2019), which resulted in no SSIs of Appendix III parameters.
- Completion of a second detection monitoring event (November 2019), which resulted in potential SSIs for Appendix III parameters in MW-2 (calcium), MW-5 (calcium and sulfate), MW-7 (calcium), and MW-1804A (chloride and sulfate).
- Completion of confirmation sampling (February 2020) for constituents identified as potentially exhibiting SSIs per AEP's *Statistical Methods Selection Certification* (Geosyntec, 2019), which confirmed SSIs for Appendix III parameters at MW-5 (calcium and sulfate) and MW-1804A (chloride and sulfate).
- An ASD investigation (between April and June 2020) for the JAFAP was conducted which confirmed potential alternate sources or reasons for the SSIs of calcium and sulfate in MW-5 and chloride and sulfate in MW-1804A (EHS Support, 2020a).
- Completion of a third detection monitoring event (May 2020), which resulted in potential SSIs for Appendix III parameters in MW-5 (calcium and sulfate).
- Completion of confirmation sampling (July 2020) for constituents identified as potentially exhibiting SSIs per AEP's *Statistical Methods Selection Certification* (Geosyntec, 2019), which confirmed SSIs for Appendix III parameters at MW-5 (calcium and sulfate).
- An ASD investigation (between August and November 2020) for the JAFAP was conducted which confirmed potential alternate sources or reasons for the SSIs of calcium and sulfate in MW-5 (EHS Support, 2020b).
- Completion of a fourth detection monitoring event (October – November 2020), which resulted in potential SSIs for Appendix III parameters in MW-5 (calcium and sulfate), MW-6 (fluoride), MW-7 (calcium and fluoride), MW-8 (calcium, chloride, sulfate, and TDS) and MW-1804A (chloride and sulfate).
- Completion of confirmation sampling (January 2021) for constituents identified as potentially exhibiting SSIs per AEP's *Statistical Analysis Plan* (Geosyntec, 2021), which confirmed SSIs for

Appendix III parameters at MW-5 (calcium and sulfate), MW-6 (fluoride), MW-7 (fluoride), and MW-1804A (chloride and sulfate).

A table summarizing monitoring data for key wells analyzed during this ASD investigation addendum, including the background sampling events through the October-November 2020 monitoring event and the January 2021 verification sampling event, is included in **Table 3**.

3 Alternative Source Demonstration Assessment

As identified in **Section 1.1**, SSIs in the concentration of calcium and sulfate in MW-5, fluoride in MW-6 and MW-7, and chloride and sulfate in MW-1804A have been reported for the October-November 2020/January 2021 detection monitoring events.

Per the CCR Rule at 40 CFR 257.94I(2), "The owner or operator may demonstrate that a source other than the CCR unit caused the SSI over background levels for a constituent or that the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting an SSI over background levels to include obtaining a certification from a qualified professional engineer verifying the accuracy of the information in the report."

EPRI (2017) guidelines for developing an ASD indicates potential causes that support the ASD may include, but are not limited to:

1. sampling causes (ASD Type I),
2. laboratory causes (ASD Type II),
3. statistical evaluation causes (ASD Type III),
4. natural variation causes (ASD Type IV), and/or
5. alternative sources (natural) (ASD Type V).

This ASD investigation addendum for the JAFAP is focused on assessing whether Type I, Type III, Type IV, and/or Type V causes identified in the initial ASD investigation (EHS Support, 2020a) could be the reason for SSIs for calcium and sulfate in MW-5, fluoride in MW-6 and MW-7, and chloride and sulfate in MW-1804A in the October-November 2020/January 2021 detection monitoring events**.**

EPRI (2012) describes three tiers of investigation for evaluation of water quality signatures to determine if elevated concentrations represent a release from a CCR facility. Conversely, these tools can also be used to evaluate whether or not sources other than CCR are contributing to groundwater quality degradation. The three tiers defined by EPRI (2012) are:

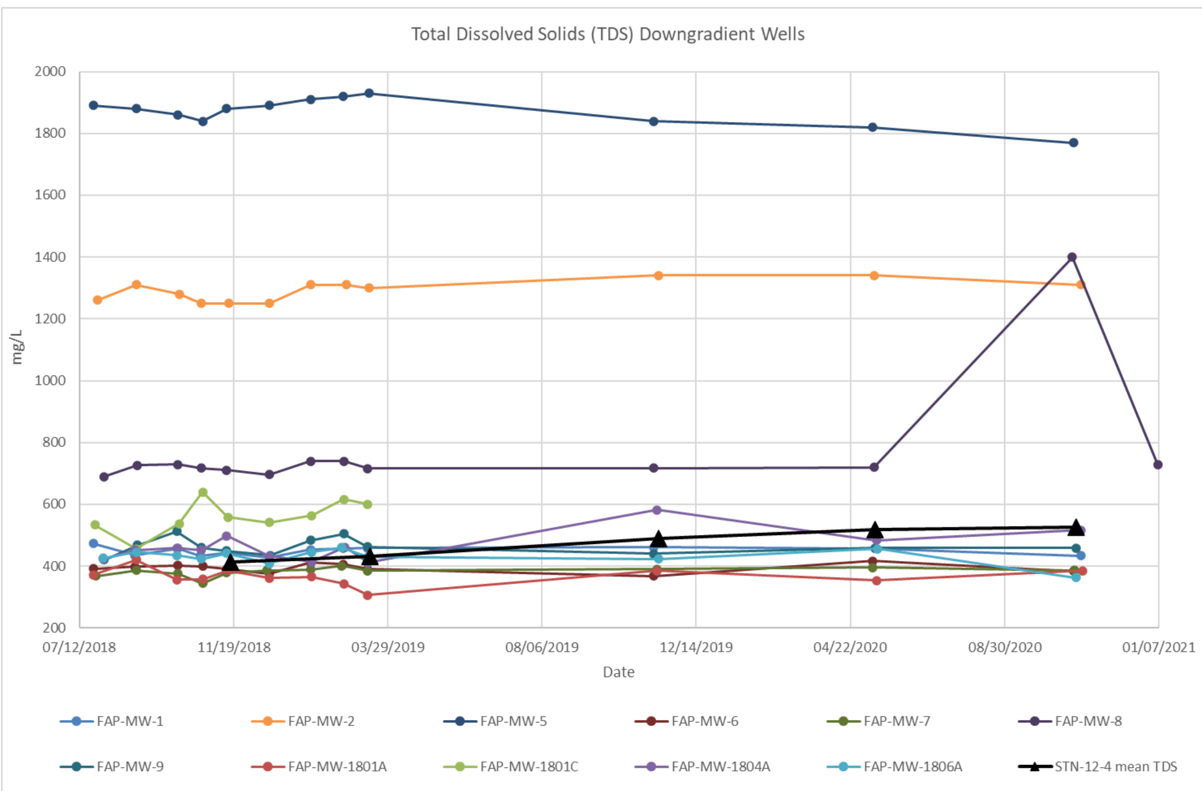
- Tier I: Trend Analysis and Statistics (**Section 3.1** and **Section 3.2**)
- Tier II: Advanced Geochemical Evaluation Methods (**Section 3.1**, **Section 3.3** and **3.4**)
- Tier III: Isotopic Analyses (not conducted as part of this ASD)

These assessments are presented in the following sections. Additionally, an analysis of potential variation due to sampling techniques (ASD Type I) is included in **Section 3.5** and statistical evaluations (ASD Type III) are included in **Section 3.6**.

3.1 Groundwater Data Analysis

3.1.1 Site Groundwater Sources

Total dissolved solids measurements provide a robust means to distinguish groundwater with a connate brine and/or low TDS precipitation source. Consistent with a brine origin, historical TDS in MW-2, MW-5 and MW-8 are notably elevated (almost by an order of magnitude in MW-5) compared to other site wells that produce sodium/calcium bicarbonate-type waters (**Figure 3-1**). TDS in most site wells is below about 600 to 650 milligrams per liter (mg/L), in comparison to a range of 174 to 840 mg/L (geometric mean 474 mg/L) for JAFAP porewater measured in all seven ports of STN-12-4 between September 2017 and May 2020. Clearly, the TDS data (coupled with historical boron, fluoride, and chloride systematics for these wells) rule out JAFAP porewater as the origin of the high TDS measurements in MW-2, MW-5 and MW-8. Whereas a connate brine component is expected to be the source of high TDS concentrations for MW-2 and MW-5 based on the location of the wells at the base of the Little Scary Creek valley and deep (>100 ft bgs) well screen/sand pack depths (**Section 2.3**), MW-8 is situated on a ridge with a sand pack/screen interval over a higher elevation (sand pack from 797 to 821.21 ft amsl in MW-8 compared to 534.20 to 560.50 and 535.93 and 557.03 ft amsl in MW-2 and MW-5, respectively; **Table 1**). As discussed by Siegel et al., (2015), connate brine is periodically encountered along ridgelines in formations with low throughput of groundwater in the Appalachian Plateau of West Virginia, thus, MW-8 also likely contains a brine component that is responsible for the elevated TDS in this well. Following a potential SSI of TDS in MW-8 in the October 2020 sample, a confirmation TDS sample was collected from MW-8 in January 2021. The confirmation sample indicated typical TDS levels in MW-8, thus, the sample is not the subject of this ASD. Notably, the potential SSI observed in MW-8 for the October 2020 sample fell within the range of other NaCl-type waters encountered at the site (MW-2, MW-5) and the result is attributed to a sampling anomaly or natural variation (**Figure 3-1**).



Note: MW-1801C has not been sampled since March 2019

Figure 3-1 Total Dissolved Solids in Downgradient Monitoring Wells

3.1.2 MW-5 Evaluation

A temporal plot for the primary indicator sulfate reported in groundwater monitoring well MW-5 is presented in **Figure 3-2**, and a temporal plot for the elevated potential indicator calcium is presented in **Figure 3-3**. Data for the geometric mean of JAFAP porewater (**Table 2**) is provided for comparison.

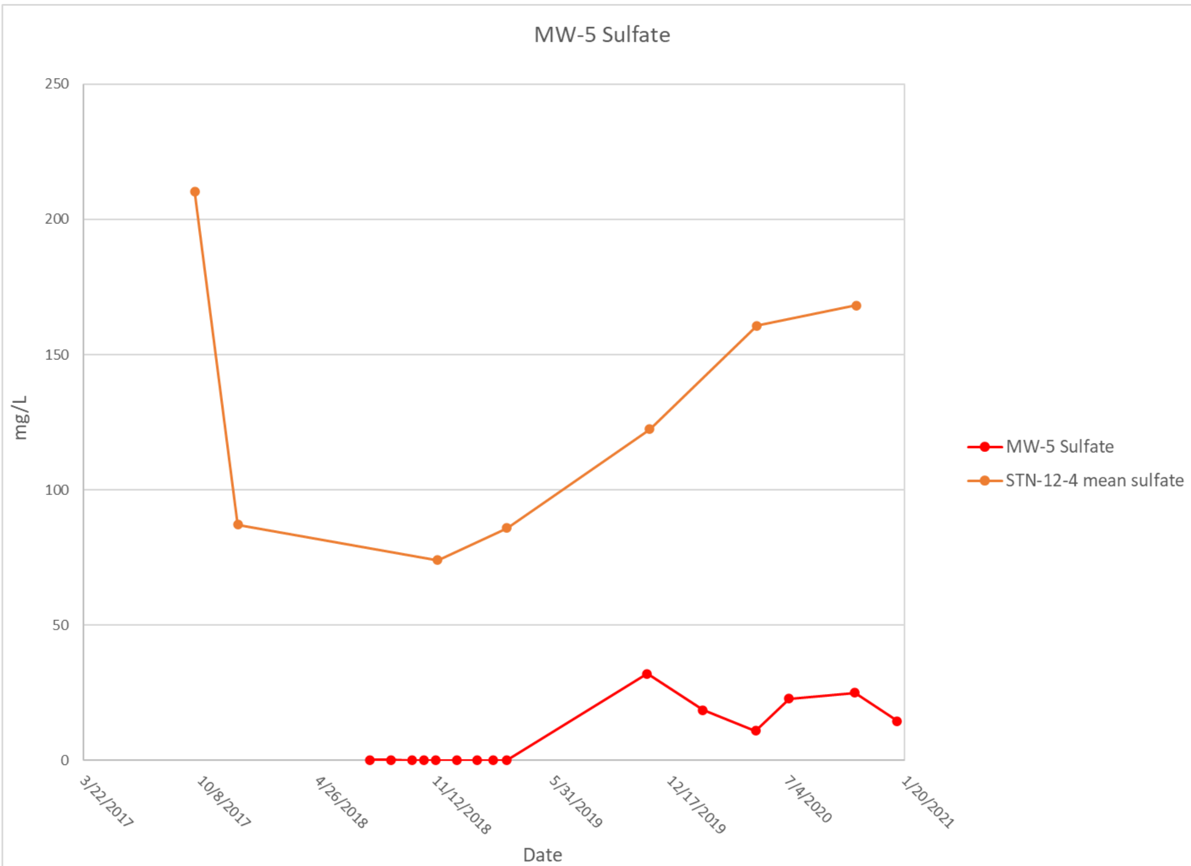


Figure 3-2 MW-5 Sulfate Concentrations

Sulfate concentrations in MW-5 remained relatively constant (geometric mean = 0.1 mg/L) until the November 2019 detection monitoring event. Sulfate concentrations measured in groundwater samples collected in November 2019 through November 2020 have been approximately two orders of magnitude higher (11 mg/L to 32 mg/L) than those reported historically. The sulfate concentrations measured in groundwater samples collected in the October 2020 detection monitoring and the January 2021 verification sampling events remained elevated at 25.1 mg/L and 14.6 mg/L, respectively. The sulfate concentrations in MW-5 groundwater have remained 100 times lower than the concentration reported in the JAFAP porewater. Sulfate is typically absent or at low concentrations in Appalachian Plateau connate brines due to overall reducing conditions that favor sulfide (Siegel et al., 2015). In contrast, sulfate is present at higher concentrations in oxygenated groundwater sourced from more recent precipitation, particularly following interaction with pyrite, which is documented in the Birmingham Shale and Grafton Sandstone rock matrix in the logs for MW-1802C, MW-1803C, MW-1805C; rock units that are within and directly overlying the sand pack interval for MW-5.

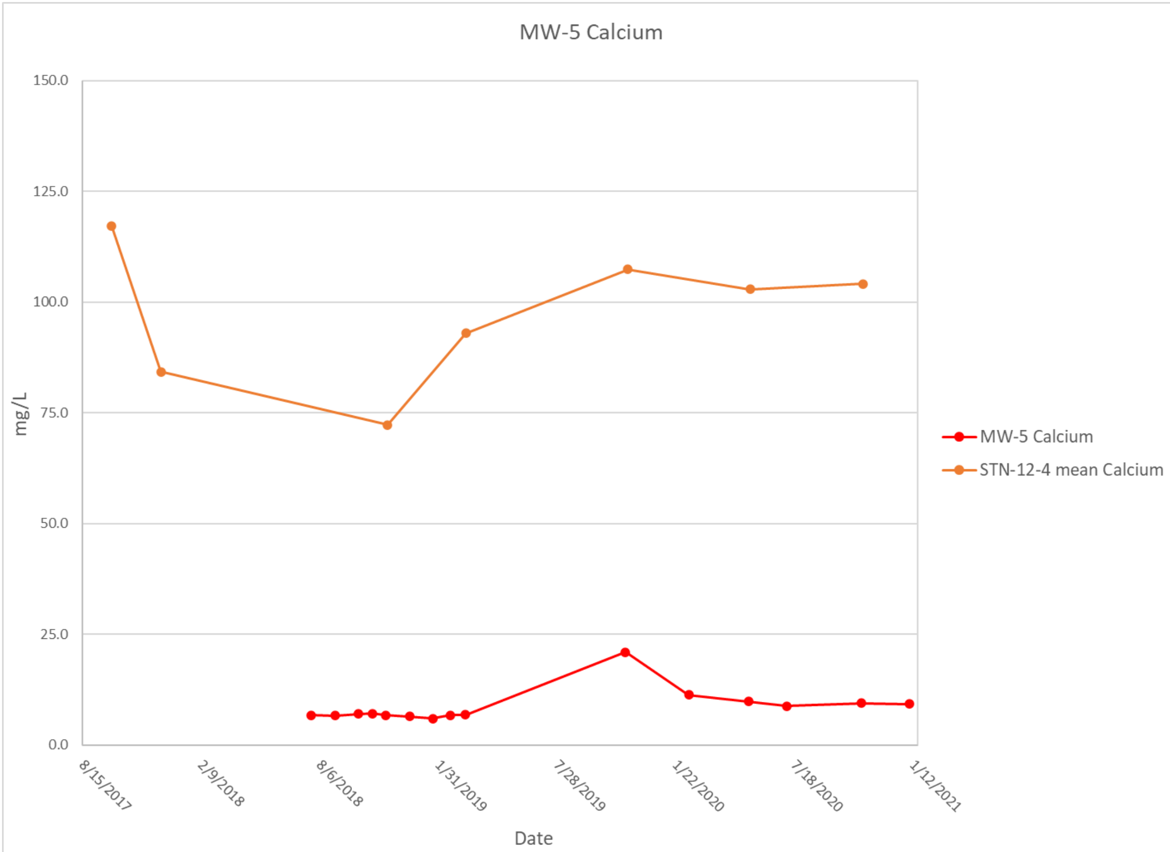


Figure 3-3 MW-5 Calcium Concentrations

Calcium concentrations in MW-5 remained relatively constant (geometric mean = 6.7 mg/L) until the November 2019 groundwater monitoring event. In November 2019 through November 2020, the calcium concentration of groundwater sampled from MW-5 ranged from 8.77 mg/L to 21 mg/L. The calcium concentrations measured in groundwater samples collected in the October 2020 detection monitoring and January 2021 verification sampling events (9.50 mg/L and 9.31 mg/L, respectively) are comparable to the post-November 2019 calcium concentrations. The range of calcium concentrations in MW-5 post-November 2019 have remained approximately 10 times lower than the concentrations reported in the JAFAP porewater (**Figure 3-3**). The relative sodium/calcium concentration ratios reported for groundwater from MW-5 in November 2019, May 2020, and October 2020 was lower than all previous sampling events (**Table 3-1**). The relative changes in calcium and sodium suggests mixing between different groundwater types with distinct sodium/calcium concentration ratios set through ion exchange reactions with distinctive rock types or secondary minerals within formations.

Table 3-1 MW-5 Relative Sodium and Calcium Concentrations

Date	Sodium (mg/L)	Calcium (mg/L)	Sodium/Calcium Ratio
7/24/2018	777	6.75	115
8/29/2018	714	6.71	106
10/3/2018	742	7.03	106

Date	Sodium (mg/L)	Calcium (mg/L)	Sodium/Calcium Ratio
10/24/2018	735	7.09	104
11/13/2018	586	6.79	86
12/19/2018	595	6.48	92
1/23/2019	599	5.98	100
2/19/2019	687	6.79	101
3/13/2019	660	6.85	96
11/8/2019	571	21	**27**
5/11/2020	694	9.85	**70**
10/27/2020	692	9.31	**73**

Note: bold ratios correspond to samples that had SSIs of calcium and/or sulfate
mg/L = milligrams per liter

The increase in dissolved calcium and sulfate may be attributed to a change in the proportion of mixing between sodium chloride and sodium/calcium bicarbonate water types; with the post-November 2019 results reflecting a higher proportion of more calcium and sulfate-rich, low TDS sodium bicarbonate water type. Groundwater in the vicinity of MW-5 is identified as a sodium chloride water type (further discussed in **Section 3.1.1**) and the elevation of the screened section of MW-5 is very close to the expected mixing interface between sodium bicarbonate and sodium chloride (connate brine) water types, as discussed in **Section 2**. External influences such as pumping rates or intense and extended rainfall events can perturb the transition between the connate aquifer and the overlying sodium bicarbonate aquifer.

Boron, another primary indicator, historically fluctuated in MW-5 between 0.22 mg/L to 0.32 mg/L, whereas the post-November 2019 boron concentrations have been notably lower between 0.18 mg/L and 0.22 mg/L (**Figure 3-4**). Boron is typically elevated in groundwater that has contacted aquifer rock for extended periods of time or that has experienced elevated temperatures; therefore, elevated boron in connate brine is expected. The observation of decreased boron during and post-November 2019 sampling in MW-5 supports dilution by a younger sodium bicarbonate water type.

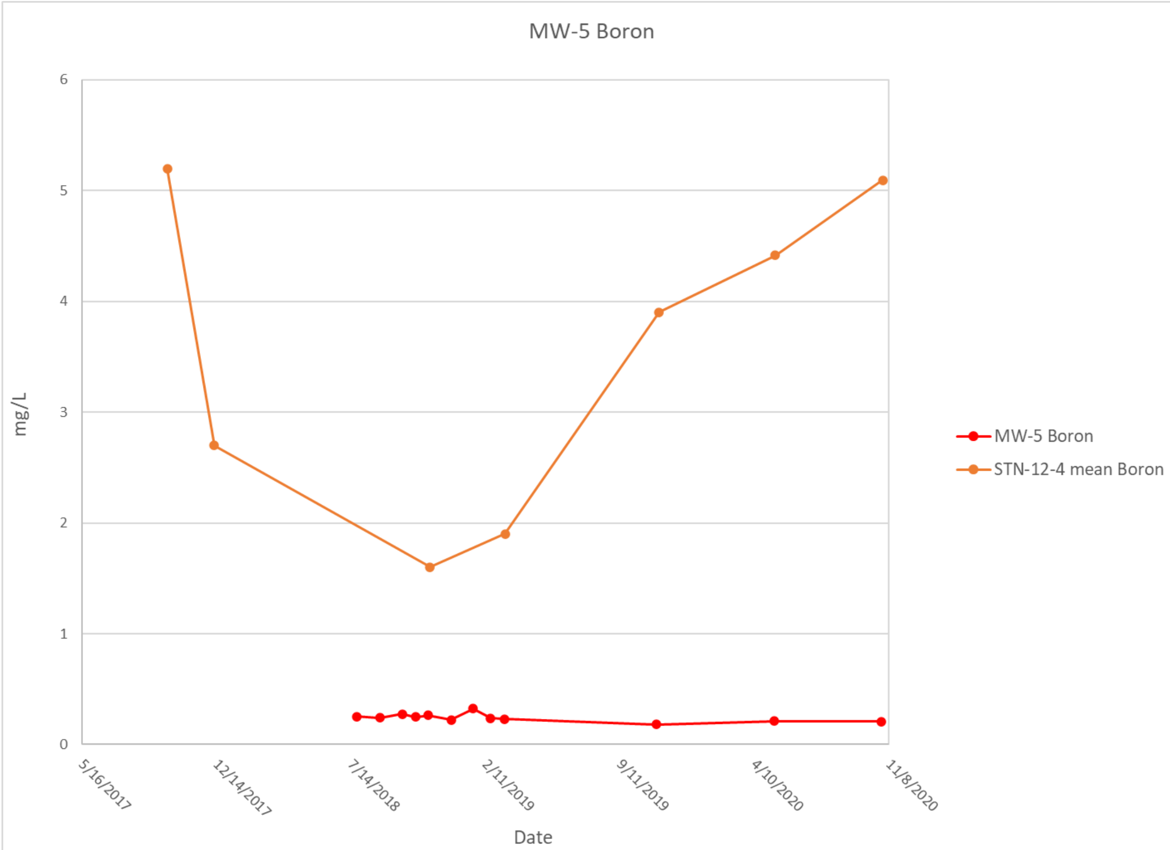


Figure 3-4 MW-5 Boron Concentrations

Temporal plots for potential indicators bromide, fluoride, molybdenum, potassium, and sodium reported in groundwater monitoring well MW-5 are provided in **Appendix D**, with geometrical mean data for the JAFAP porewater presented for comparison. Molybdenum and potassium are present in groundwater at concentrations below the concentrations within the JAFAP for MW-5. For MW-5, bromide, fluoride and sodium concentrations in groundwater are elevated in comparison to the JAFAP. These concentration variations between potential indicator parameters relative to the JAFAP water indicates a low likelihood of MW-5 groundwater being influenced by the JAFAP.

3.1.3 MW-6 Evaluation

A temporal plot for the primary indicator sulfate reported in groundwater monitoring well MW-6 is presented in **Figure 3-5**, and a temporal plot for the elevated ASD constituent fluoride is presented in **Figure 3-6**. Data for the geometrical mean of JAFAP porewater (**Table 2**) is provided for comparison.

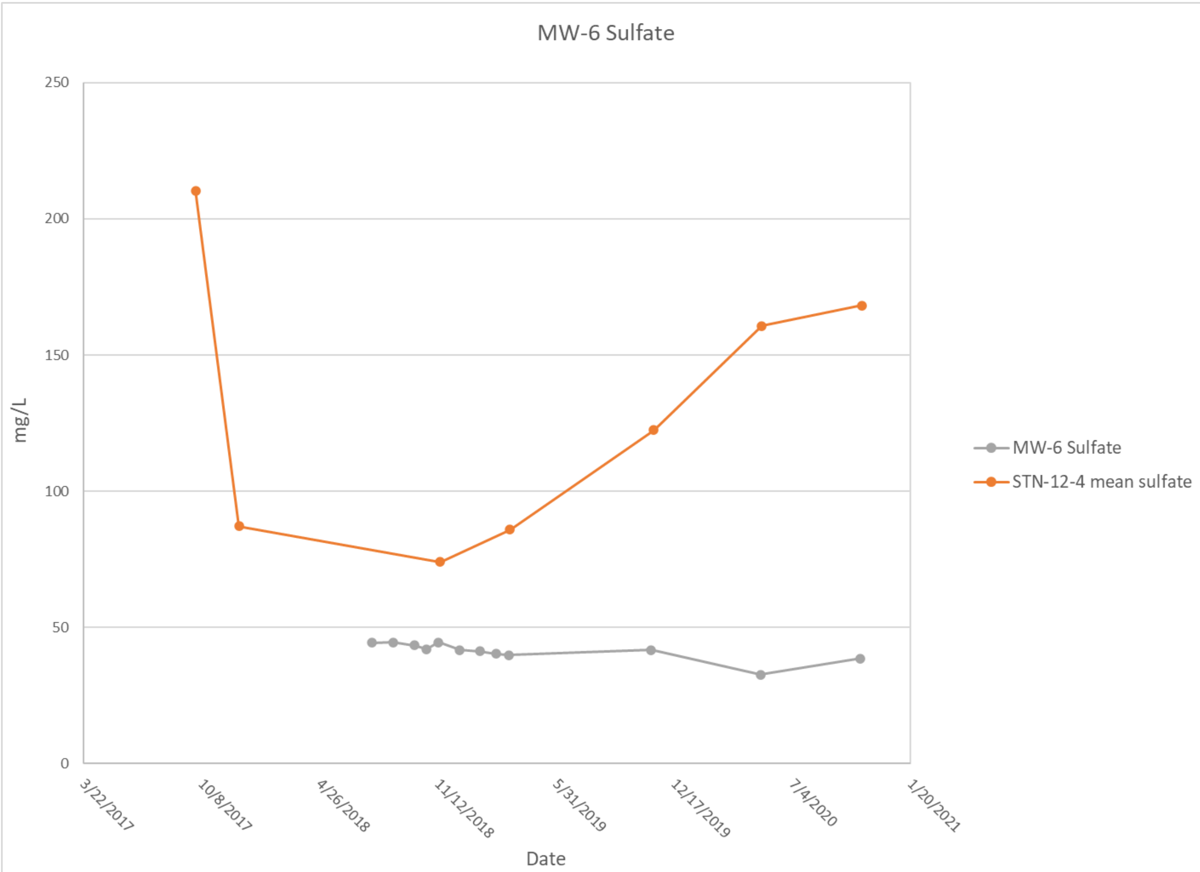


Figure 3-5 MW-6 Sulfate Concentrations

Sulfate concentrations in MW-6 have overall been decreasing since sampling began in July 2018, with the lowest concentration of 32.6 mg/L measured in the May 2020 sample. The sulfate concentration measured in the groundwater sample from October 2020 increased slightly to 38.6 mg/L, a value still below the range of concentrations measured during background sampling events (40.4 mg/L to 44.6 mg/L). MW-6 groundwater sulfate concentrations are 3 to 4 times lower than in the JAFAP porewater.

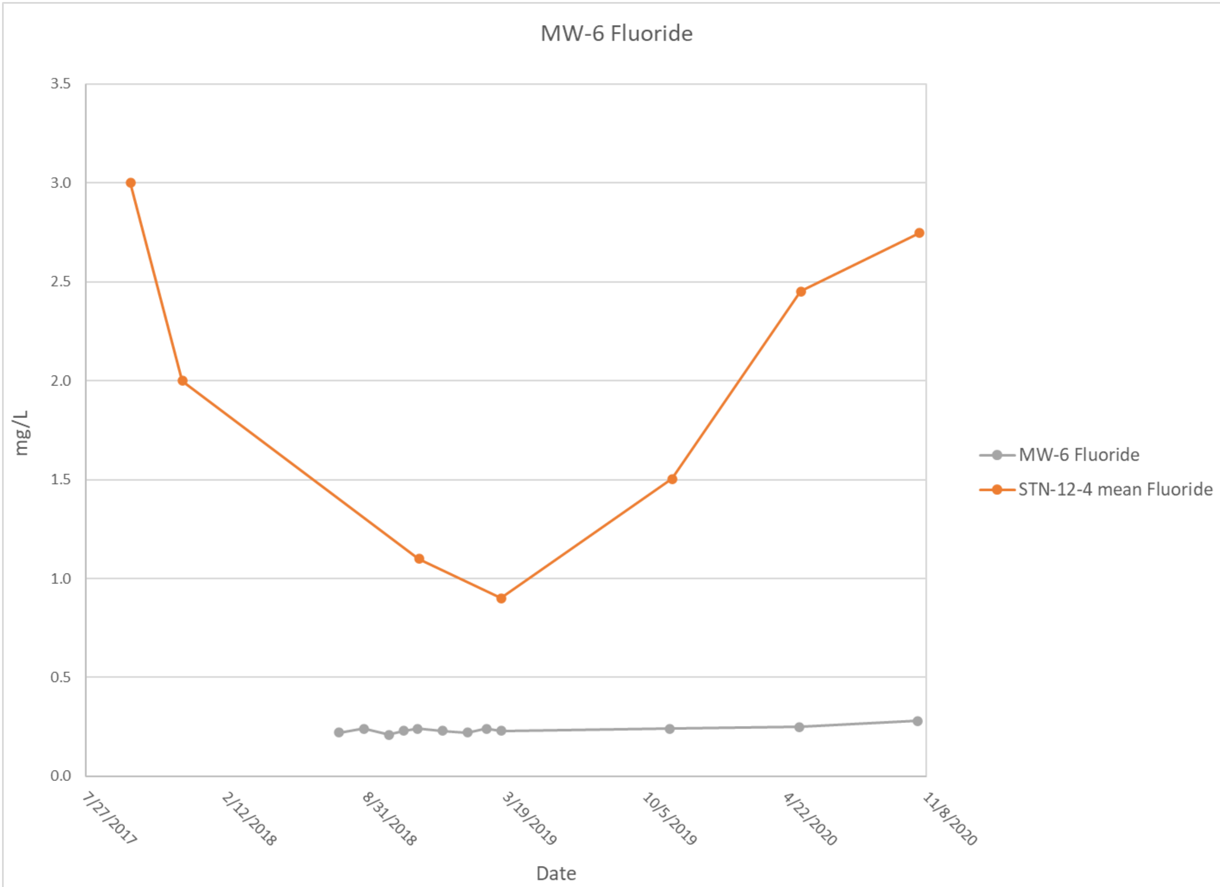


Figure 3-6 MW-6 Fluoride Concentrations

Fluoride concentrations in MW-6 have been steadily increasing since a concentration of 0.23 mg/L was measured in the first detection monitoring event sample collected on March 12, 2019 (**Figure 3-6** and **Table 3**). During background sampling, fluoride concentrations ranged from 0.22 mg/L to 0.24 mg/L. During the detection monitoring, fluoride has steadily increased from 0.23 mg/L to 0.30 mg/L in the January 2021 verification sample. Fluoride concentrations in MW-6 groundwater are up to 10 times lower than in the JAFAP porewater.

Boron, another primary indicator, ranged between 0.07 mg/L to 0.125 mg/L during background sampling (**Figure 3-7**). During the detection monitoring events, boron has ranged from 0.079 mg/L to 0.089 mg/L; an overall decrease in concentration.

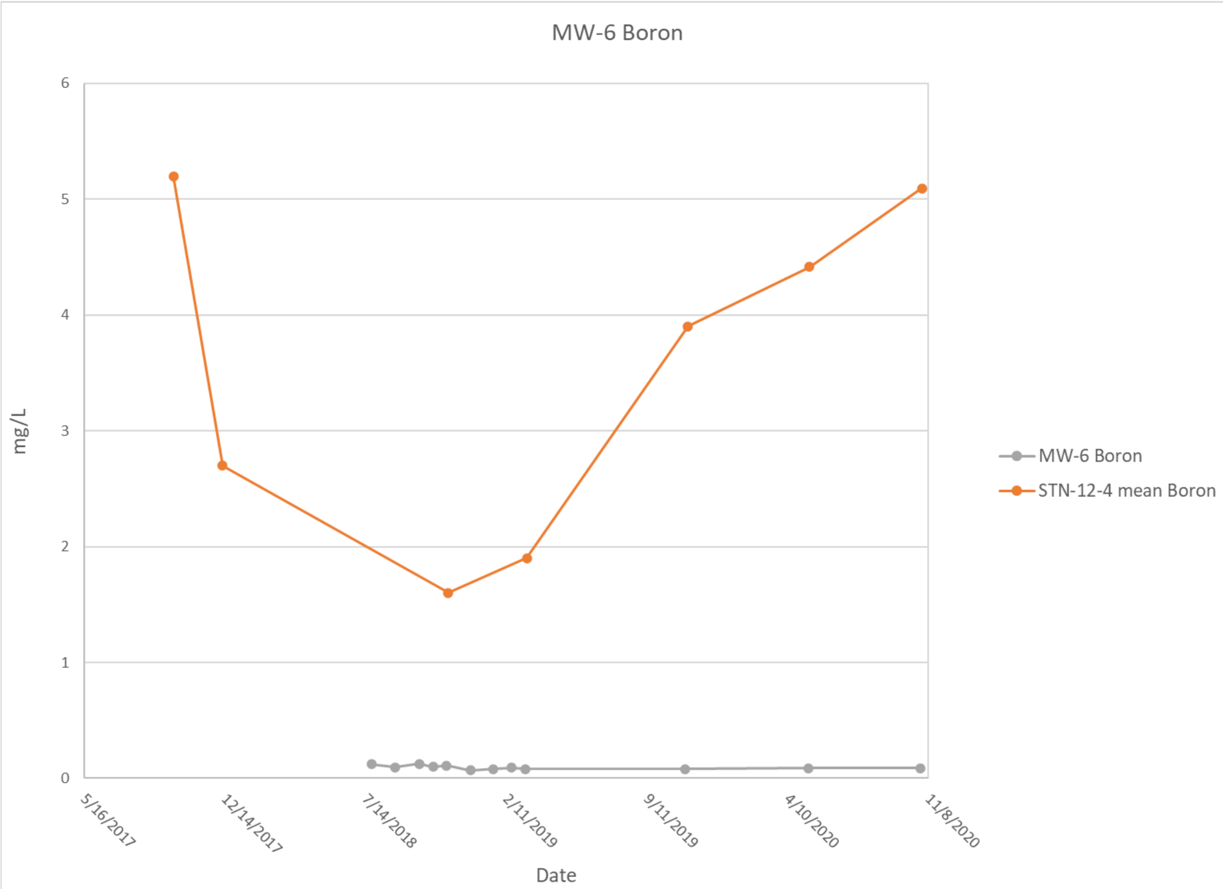


Figure 3-7 MW-6 Boron Concentrations

Temporal plots for potential indicators bromide, calcium, molybdenum, potassium, and sodium reported in groundwater monitoring well MW-6 are provided in **Appendix D**, with geometrical mean data for the JAFAP porewater presented for comparison. Bromide, calcium, and potassium are present in groundwater at concentrations below the concentrations within the JAFAP for MW-6. Molybdenum and sodium concentrations in MW-6 groundwater are elevated in comparison to the JAFAP. The plots indicate an overall decrease in calcium and increase in sodium; the opposite pattern as observed for MW-5.

The overall decreasing trend of the primary CCR leachate indicator sulfate in MW-6 supports an alternate source for the subtle change in chemistry since the establishment of background concentrations. Should CCR leachate be responsible, we would expect an increase in the primary indicators sulfate and boron, and potential indicator calcium. Instead, we see decrease in other key primary and secondary indicators. Indeed, this is the opposite pattern as observed for co-located but deeper screened MW-5. Whereas groundwater compositional changes at MW-5 reflect dilution of brine with low TDS water, compositional changes at MW-6 likely reflect an increasing proportion of intermixed brine. As discussed in **Section 2**, this conclusion is supported by the observation that sulfate is typically absent or at low concentrations in Appalachian Plateau connate brines, whereas fluoride is typically elevated. Conceivably, the brine/freshwater interface at the MW-5/MW-6 location has been perturbed, which has led to a more diffuse boundary. The cause is not definitively known but may be a combination of sampling-induced perturbations or changes in precipitation patterns.

3.1.4 MW-7 Evaluation

A temporal plot for the primary indicator sulfate reported in groundwater monitoring well MW-7 is presented in **Figure 3-8**, and a temporal plot for the elevated ASD constituent fluoride is presented in **Figure 3-9**. Data for the geometrical mean of JAFAP porewater (**Table 2**) is provided for comparison.

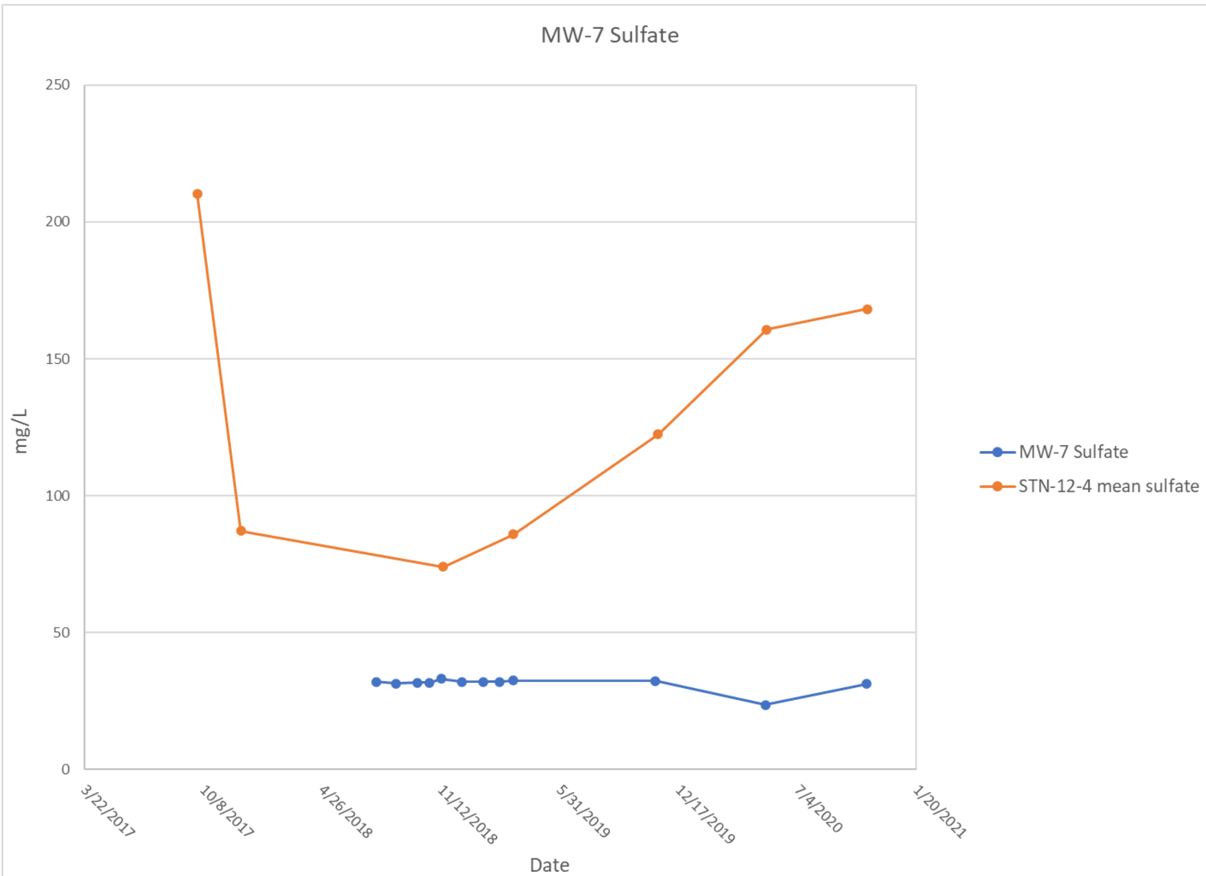


Figure 3-8 MW-7 Sulfate Concentrations

Sulfate concentrations in MW-7 have remained stable except for the May 2020 detection monitoring event when the concentration was at a historical low of 23.6 mg/L.

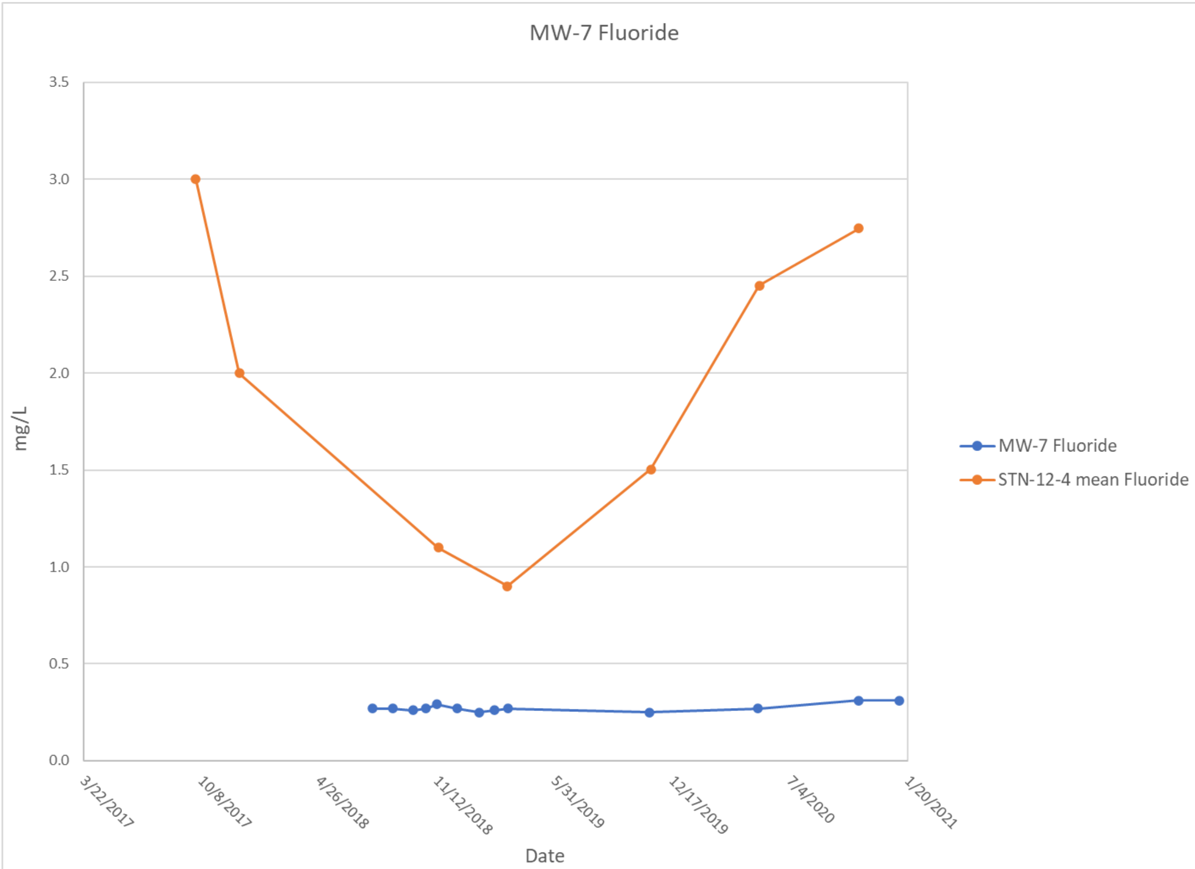


Figure 3-9 MW-7 Fluoride Concentrations

Fluoride concentrations in MW-7 groundwater samples have remained stable between 0.25 mg/L and 0.27 mg/L over the background monitoring and detection sampling events (**Figure 3-9**). The narrow range of fluoride concentrations measured during background sampling resulted in a comparatively low intrawell prediction limit (IPL) of 0.304 mg/L. The highest measured concentration of 0.31 mg/L was measured in samples taken during the October 2020 detection monitoring and January 2021 verification sampling events.

The laboratory estimates uncertainty (i.e. precision) of measurements above the reporting limit based on the standard deviation of laboratory control samples. The uncertainty for the MW-7 fluoride concentration provided by the laboratory is 0.31 mg/L ± 0.01 mg/L. Given the level of uncertainty, the result does not technically exceed the IPL.

Boron, another primary indicator, ranged between 0.06 mg/L and 0.192 mg/L during background monitoring events, and has remained between 0.60 mg/L and 0.067 mg/L during detection monitoring. Thus, boron concentrations have not increased and remained at the lower end of the range measured during background monitoring (**Figure 3-10**).

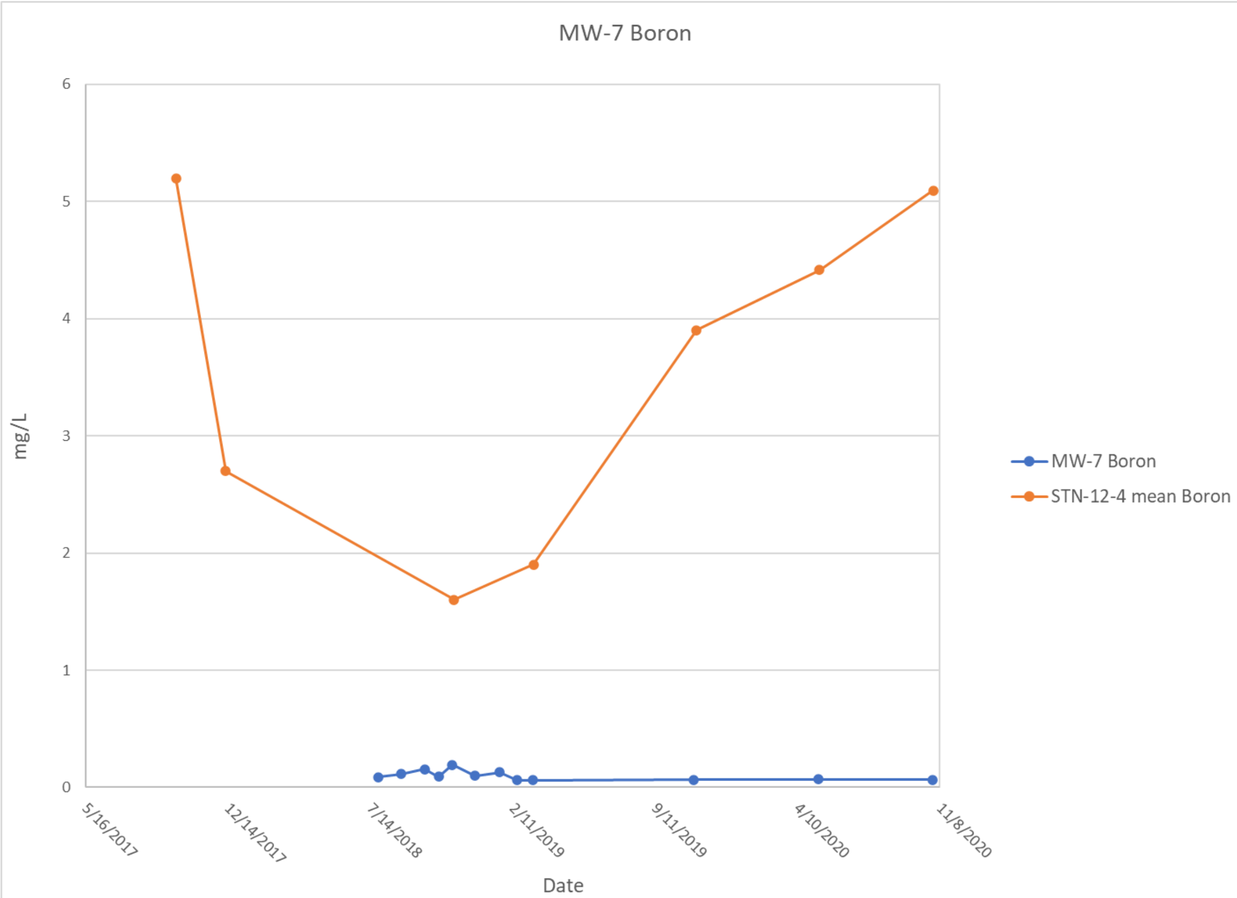


Figure 3-10 MW-7 Boron Concentrations

Temporal plots for potential indicators bromide, fluoride, molybdenum, potassium, and sodium reported in groundwater monitoring well MW-7 are provided in **Appendix D**, with geometrical mean data for the JAFAP porewater presented for comparison. Bromide, calcium, and potassium are present in groundwater at concentrations below the concentrations within the JAFAP for MW-7. Molybdenum and sodium concentrations in MW-7 groundwater are elevated in comparison to the JAFAP.

Given the uncertainty in fluoride concentration measurement, and the high natural variability of fluoride concentrations in groundwater in the JAFAP vicinity, coupled with the stability of primary indicators boron and sulfate, the MW-7 fluoride detections are not attributed CCR leachate constituents, and more likely reflect natural variation.

3.1.5 MW-1804A Evaluation

Temporal plots for the primary indicators sulfate and chloride in MW-1804A are provided in **Figure 3-11** and **Figure 3-12**, respectively. Data for the geometrical mean of JAFAP porewater (**Table 2**) is provided for comparison.

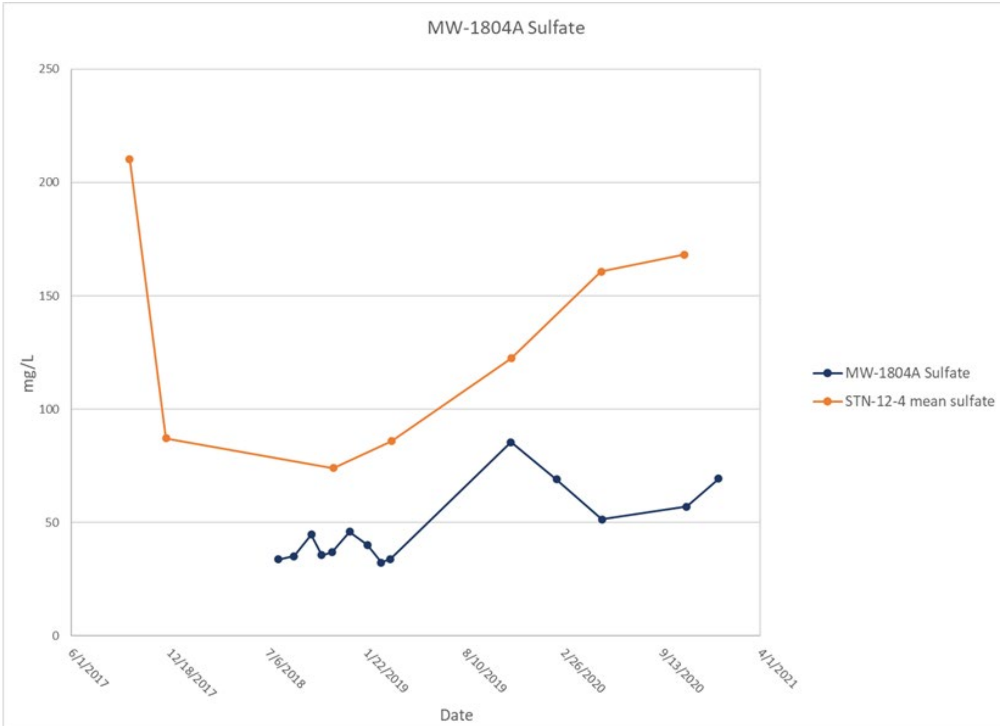


Figure 3-11 MW-1804A Sulfate Concentrations

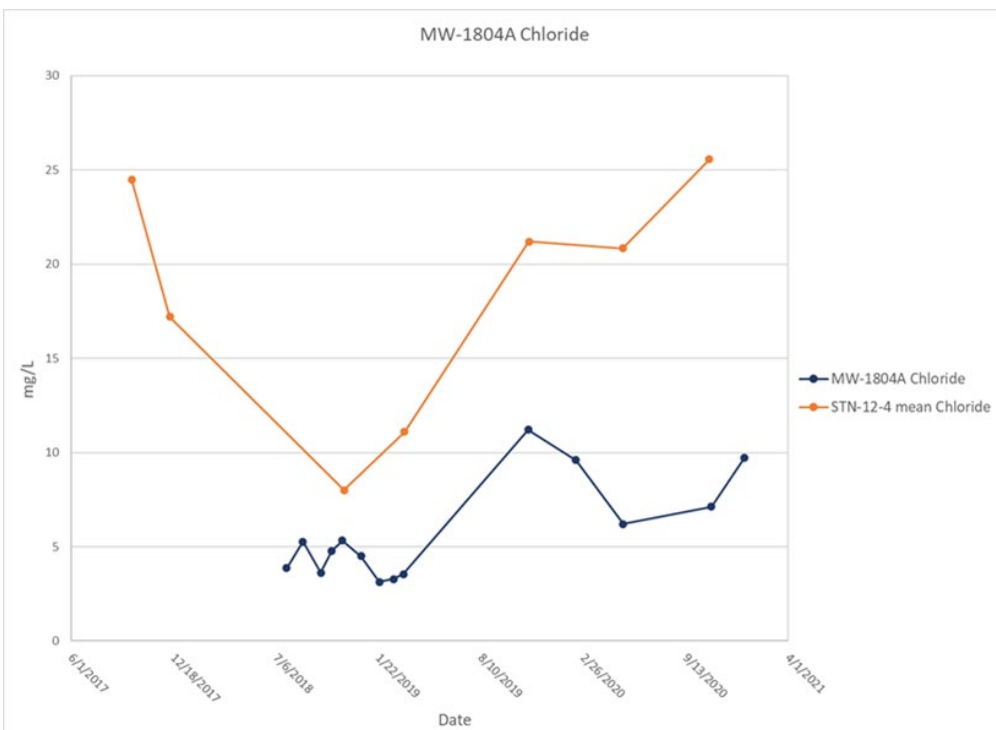


Figure 3-12 MW-1804A Chloride Concentrations

Sulfate and chloride concentrations in MW-1804A remained relatively stable during the eight events that established background concentrations and the initial detection monitoring event (July 2018 through March 2019): within the range 32.3 mg/L to 46 mg/L (geometric mean = 40.6 mg/L) for sulfate and 3.14 mg/L to 5.32 mg/L (geometric mean = 4.5 mg /L) for chloride. Following the first detection monitoring event (starting in November 2019), the range has been 51.4 mg/L to 85.4 mg/L for sulfate and 6.2 mg/L to 11.20 mg/L for chloride. The shift indicates a shift in environmental or field sampling conditions between background sampling and detection monitoring events.

Whereas sulfate may be attributed to oxidation of sulfides in coal-bearing intervals known to be present in the site vicinity (see **Section 2**), concentration changes in chloride, a conservative ion in groundwater, typically reflects evaporation, dilution, or mixing between distinct water types. Notably, the chloride concentrations in MW-1804A have historically been similar to concentrations in MW-1806A, the only other site well with a sand pack and screen that extends over the same three geologic formations (**Table 1**). This similarity provides an indication that variations in MW-1804A chloride are likely driven by conditions within the formation and/or variations in the recharge (precipitation) chemistry or flow path, and not migration of constituents from the JAFAP porewater. The apparent relationship between sulfate and chloride in MW-1804A and the JAFP pore water on **Figure 3-11** and **Figure 3-12**, reflects the fact that both locations are recharged by a common source (i.e. precipitation infiltration through ridge top formations), as opposed to migration of constituents from the JAFAP.

Other primary indicators such as boron report a stable concentration over time in MW-1804A, with a background concentration range of 0.611 mg/L to 0.846 mg/L (**Figure 3-13**). The subsequent detection monitoring results have ranged from 0.549 mg/L to 0.739 mg/L, generally lower than the range of background boron concentrations. Comparing the boron concentrations in MW-1804A groundwater to the upper section of the JAFAP (STN-12-4 Intervals 1 and 2), concentrations clearly diverge and do not track one another.

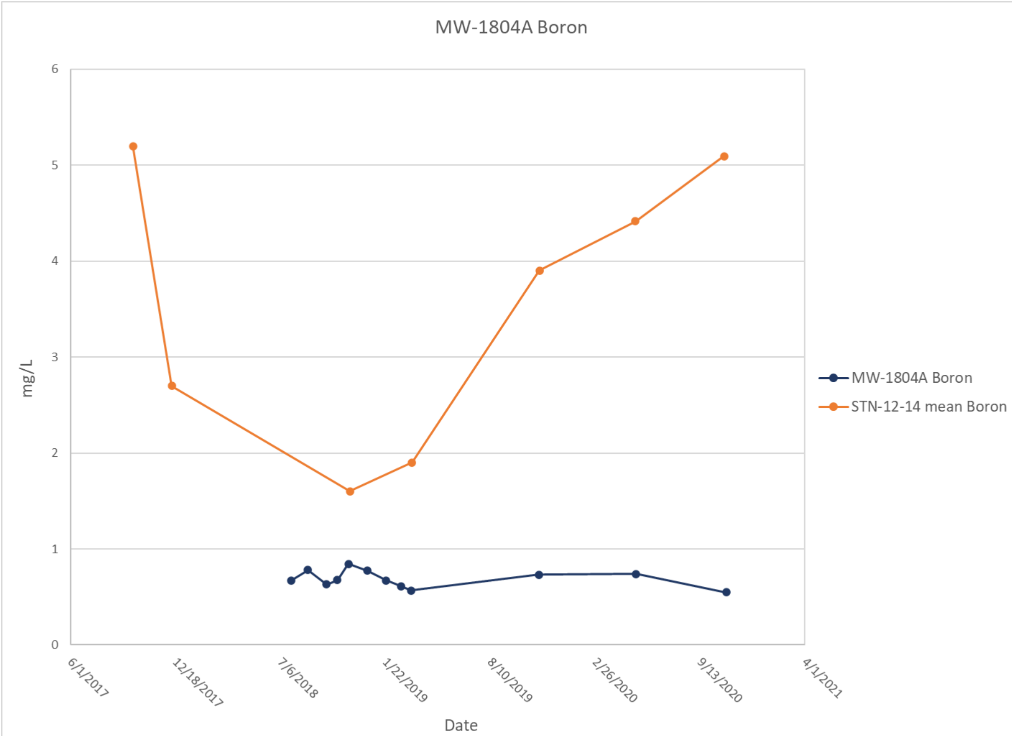


Figure 3-13 MW-1804A Boron Concentrations

Groundwater (**Table 3**) and upper JAFAP porewater data (**Table 4**) were compared for potential indicators bromide, fluoride, molybdenum (not analyzed in any detection monitoring events at MW-1804A), potassium, and sodium. Of these five potential indicators, molybdenum and sodium are the only indicators where concentrations are higher in MW-1804A groundwater than the upper JAFAP porewater (STN-12-4 Intervals 1 and 2), as shown in temporal plots in **Appendix D** (molybdenum data from the October 2018 background sampling event also had higher concentrations than JAFAP water at that time). These higher concentrations in groundwater indicate this groundwater is being affected by another source within the formation, and likely not being influenced by the JAFAP porewater.

3.2 Statistical Evaluation

3.2.1 Mann-Whitney Test

The statistical analysis plan for the site recommends that background values be updated every four to eight measurements, assuming no SSIs are identified (Geosyntec, 2021). The statistical analysis plan specifies a set of new data points may be compared against the existing background dataset using a nonparametric Mann-Whitney test (also known as the Wilcoxon rank-sum test) to determine if data belong to different populations. A significance level (α) = 0.05 is used in the test if there are less than 5 observations, and an α as low as 0.01 may be used if there are at least five data points. If the Mann-Whitney test indicates a statistically significant difference between the two populations, then the data should not be combined with the existing background data until further review determines the cause of the difference. If there is no evidence of CCR leachate release, the new dataset is considered more representative of present-day groundwater conditions and should be used to establish background concentrations.

The results of a Mann-Whitney test for samples/constituents with SSIs is provided on **Table 3-2**. All locations indicate a difference in the population of observations made before and after sampling practices changed (as described in **Section 3.5**), except for MW-7 which shows no difference. As described in **Section 3.1**, expanded on in **Section 3.3** and **Section 3.4**, and described by EHS Support (2020a, 2020b), SSIs are attributable to a combination of sampling practices, the presence of distinct water types, and natural variations in hydrological conditions. Therefore, background values presently used to identify SSIs do not adequately represent natural conditions and should be updated.

For the constituents that repeatedly show SSIs, there may be sufficient detection monitoring and verification sampling results presently available to make the background revisions, if the timing between samples meet the physical independence criteria outlined in the statistical analysis plan (Geosyntec, 2021). For all other locations, the background may be revised using data from the upcoming detection monitoring event, which would constitute the fourth set of measurements since sampling practices have been standardized.

Table 3-2 Wilcoxon – Mann-Whitney Statistics

Monitoring Well ID	Constituent	α used in nonparametric Mann-Whitney test	Comparison between July 2012 to March 2019 and November 2019 onward sampling results
MW-5	Calcium	0.05	A difference exists
MW-1804A	Chloride	0.05	A difference exists
MW-6	Fluoride	0.01	A difference exists
MW-7	Fluoride	0.01	No difference
MW-5	Sulfate	0.05	A difference exists
MW-1804A	Sulfate	0.05	A difference exists

3.2.2 Mann-Kendall Test

Mann-Kendall analysis was used to compare the temporal variation in concentrations of constituents with SSIs. Non-detect values were evaluated by using half the reported detection limit. The Mann-Kendall test was completed for two scenarios: 1) concentration data for constituents with SSIs over the entire 2018 through 2020 dataset (including background sampling, detection monitoring, and confirmation sampling event data), and 2) concentrations for constituents with SSIs for the November 2019 detection monitoring event and onward (including confirmation sampling event data) (**Table 3-3**). The second scenario was established because consistent sampling practices were implemented starting in November 2019 (see **Section 3.5**).

Table 3-3 Mann-Kendall Statistics

Monitoring Well ID	Constituent	Scenario 1 Trend 2018 - 2020	Scenario 2 Trend (November 2019 Onward)
MW-5	Calcium	Increasing	Decreasing
MW-1804A	Chloride	Probably Increasing	Stable
MW-6	Fluoride	Increasing	N/A – less than 5 measurements
MW-7	Fluoride	No Trend	N/A – less than 5 measurements
MW-5	Sulfate	Probably Increasing	Stable
MW-1804A	Sulfate	Increasing	Stable

N/A = Not Applicable

When the entire constituent concentration history (including background observations) is considered (Scenario 1):

- MW-5 has an increasing calcium and a probably increasing sulfate trend.
- MW-1804A has a probably increasing chloride and an increasing sulfate trend.
- MW-6 has an increasing trend in fluoride.
- MW-7 has no trend for fluoride.

As discussed in **Section 3.1.3**, the increasing fluoride trend in MW-6 corresponds with a decreasing trend in the primary CCR leachate indicator sulfate, implicating steadily increasing proportion of intermixed natural connate brine rather than CCR leachate affects. Consistent with historical sampling results described in **Section 3.1.4**, the lack of a fluoride concentration trend in MW-7 implies fluoride concentration variations are natural.

When the period over which consistent sampling practices were used (November 2019 – January 2021) is considered (Scenario 2):

- MW-5 calcium and sulfate concentrations are increasing and stable, respectively.
- MW-1804A chloride and sulfate concentrations are stable.

Scenario 2 could not be applied to fluoride detections in MW-6 and MW-7 as Mann-Kendall tests require a minimum of 5 observations for meaningful results (Geosyntec, 2021). In summary, the population of sampling results collected after sampling practices were standardized (see **Section 3.5**) indicate that groundwater geochemistry is stable in wells MW-5 and MW-1804A.

3.3 Ion Ratios and Conservative Ion Binary Plots

3.3.1 Ion Ratios

EPRI (2012) recommends the use of ion ratios to identify source waters, or to determine that an additional source water is being added along a flow path. The premise is that the concentration of two constituents in groundwater is maintained unless mixing with a water source that has different ion concentration ratios occurs. Care must be taken to select unreactive constituents (conservative ions) to support this analysis. Conservative ions are generally not volatile, largely do not participate in ion exchange or redox reactions, generally form minerals with high solubilities, and are not typically leached from or incorporated into reactive minerals along groundwater paths in appreciable concentrations. These characteristics result in preservation of conservative ion ratios through binary mixing, dilution, and evaporation processes. Sulfate should be assessed with caution using the conservative ion ratio approach, since sulfate is typically a conservative ion in oxygenated waters, however, oxidation of sulfide or reduction of sulfate on mixing between anoxic and oxygenated waters can shift the sulfate concentration substantially from an expected binary mixing result.

Ion ratios for key constituents in groundwater and JAFAP porewater samples from the November 2020 sampling round are provided in **Table 4**. Notably, the sulfate/chloride (SO_4/Cl) and iron/chloride (F/Cl) ratios for most groundwater samples are indistinguishable from JAFAP porewater; therefore, these SO_4/Cl and F/Cl ratios are not useful for distinguishing JAFAP porewater influence for the majority of locations in the monitoring network. The exception is for wells MW-5, MW-2 and MW-8, which have distinct SO_4/Cl and F/Cl ratios that likely reflect a connate brine component. In contrast, calcium/chloride (Ca/Cl) and boron/chloride (B/Cl) ion ratios are distinct for most groundwater and JAFAP porewater samples and provide useful indicators of mixing relationships between different water types. To better assess mixing relationships based on ion ratios, ion ratio plots were developed following the method and rationale described below.

Ion ratio plots were developed from historical and current data for MW-5 and co-located wells MW-6 and MW-1 (**Figure 3-14**). The ion ratio plots show the following:

- MW-5 (both historical and current sample data) shows a distinct ion composition compared to shallower co-located wells (MW-1 and MW-6) and JAFAP porewater.
- MW-6 is distinct from JAFAP porewater in terms of B/Cl and F/Cl.
- MW-5 and MW-6 maintain consistent ion ratios across all sampling events, implying that they are not shifted towards JAFAP porewater compositions.

The distinct composition of MW-5 supports an Appalachian Plateau connate brine origin. Indeed, the composition of MW-5 groundwater on these plots is sufficiently unique that no clear mixing relationship between the sampling results and other water sources is clear based on ion ratios. For this reason, absolute conservative ion concentrations (not ratios) are used to better assess mixing between MW-5 and alternative sources, as discussed below (**Section 3.3.2**).

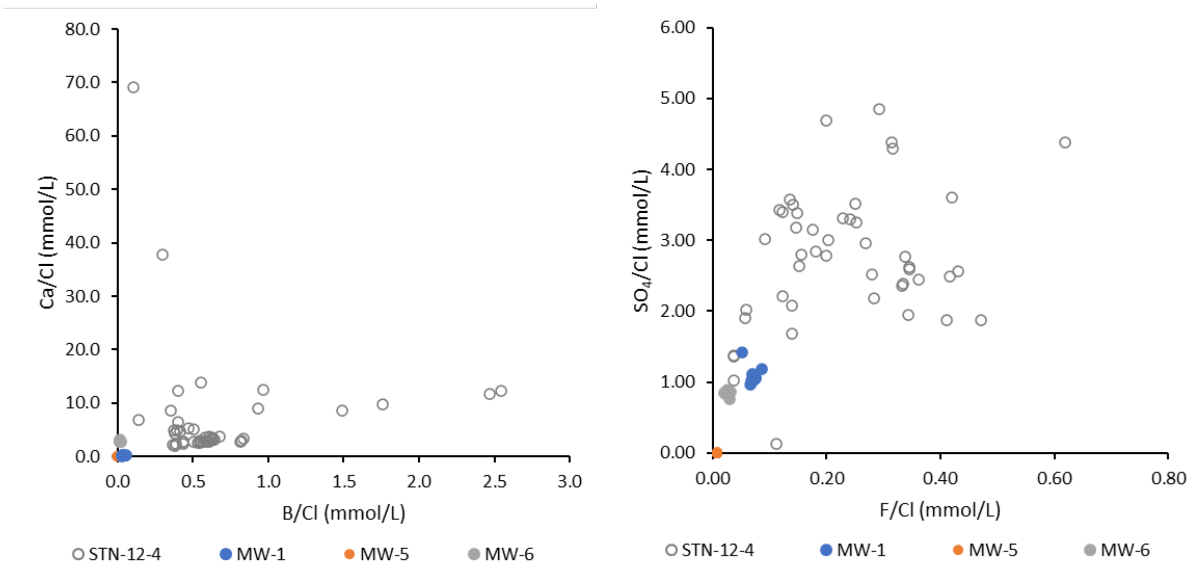


Figure 3-14 Ion Ratio Plots of Historical and Current Data from MW-1, MW-5, MW-6, and STN-12-4 JAFAP Porewater

Ion ratio plots were also developed from historical and current data for MW-7 and MW-1804A that had constituents with SSIs during the most recent detection monitoring event (**Figure 3-15**). Ion ratios for MW-1804A and MW-7 are both screened in the Upper Connellsville Sandstone, and are compared to MW-1806A which is screened in the same formation. The ion ratio plots show the following:

- The Ca/Cl versus B/Cl ion ratio plot for MW-1804A shows a compositional trend towards that of MW-1806A and MW-7.
- The MW-1804A, MW-1806A, and MW-7 SO_4/Cl versus F/Cl ion ratio plot is of limited use for distinguishing JAFAP porewater mixing, as there is substantial overlap between these ion ratios in Upper Connellsville Sandstone groundwater and JAFAP porewater.
- The MW-7 ion ratios span a range between MW-1804A and MW-1806A.

Overall, the plots suggest that SSIs of constituents in samples from MW-1804A are best attributed to groundwater compositional variations within the Upper Connellsville Sandstone unit rather than mixing with JAFAP porewater.

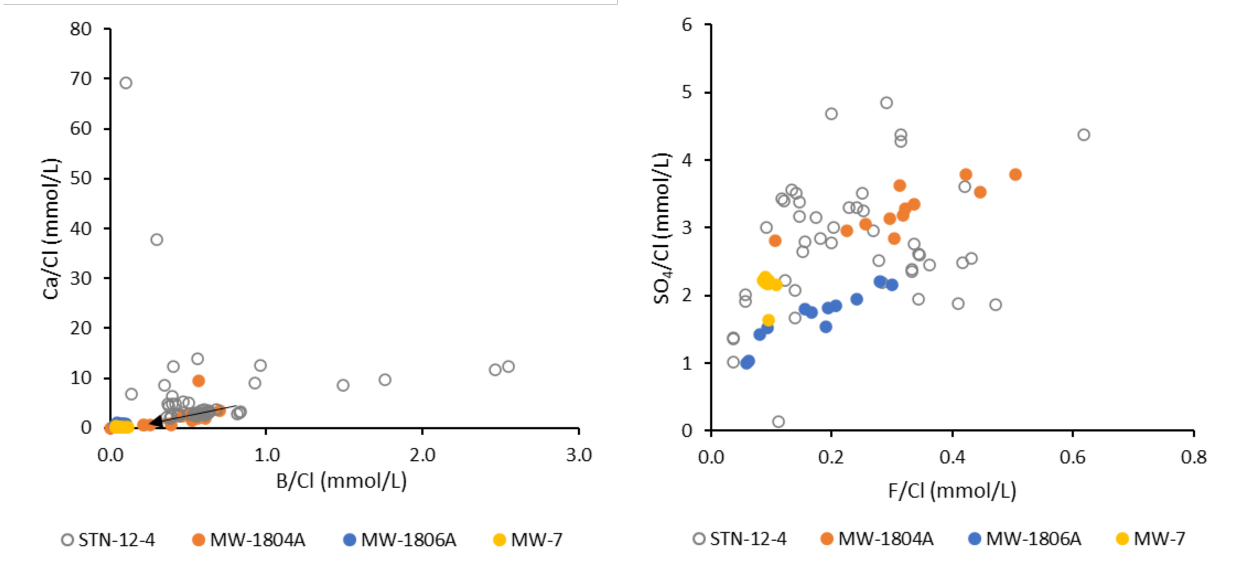


Figure 3-15 Ion Ratio Plots of Historic and Current Data from MW-7, MW-1804A, and MW-1806A, and STN-12-4 JAFAP Porewater

3.3.2 Conservative Ion binary plots

Binary plots of the molar concentrations of conservative ions in waters that have undergone binary mixing or dilution trace a straight line between the mixing endmembers, and the intermediate (resulting) water falls on the mixing line. Molal concentrations are preferred in this type of diagram as mineral precipitation effects are more readily apparent. Dissolved elements broadly considered as conservative for this purpose include the halides (e.g., chloride and fluoride) and boron.

Binary conservative ion plots (B-Cl, F-Cl, and B-F) were constructed for the historic data record starting in July 2018 for co-located wells MW-1, MW-5 and MW-6 (**Figure 3-16**). Historic data for JAFAP porewater from the seven ports in multi-level well STN-12-4 from September 2017 to present, were included on the charts as a possible mixing endmember.

For well MW-5, samples trace a mixing line toward $NaHCO_3$-type waters in the shallower co-located wells MW-1 and MW-6 for all conservative ion plots, and does not indicate mixing with JAFAP porewater (**Figure 3-16**). This relationship indicates that mixing between Appalachian Plateau NaCl-type connate water and overlying more dilute $NaHCO_3$-type water, and mixing with JAFAP porewater is not supported.

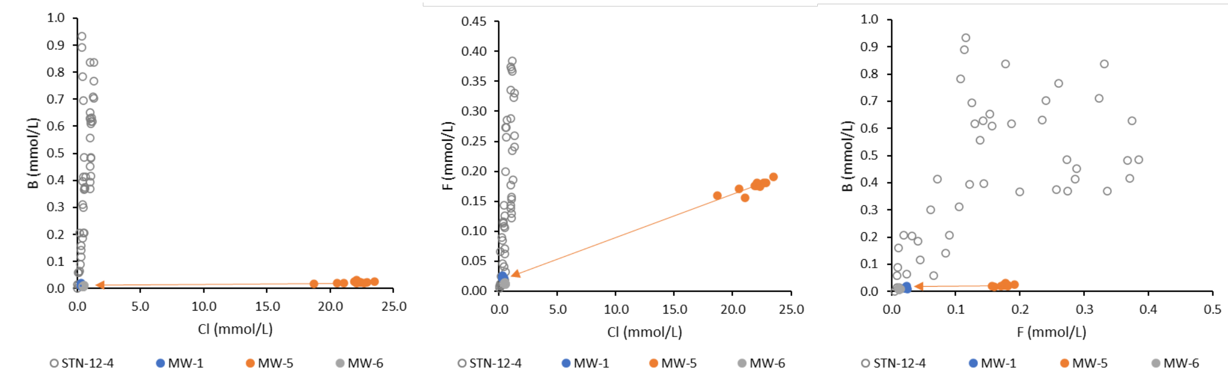


Figure 3-16 Conservative Ion Binary Plots for MW-5 and MW-6

Binary conservative ion plots (B-Cl, F-Cl, and B-F) were constructed for the historic data record starting in July 2018 for wells MW-1804A, MW-7, and MW-1806A, which are all screened in the Upper Connellsville Sandstone (**Figure 3-17**). The boron and chloride plot for MW-1804A shows that chloride increases with no concomitant increase in boron, whereas JAFAP porewater results shows a distinct increase in chloride with increasing boron concentration (**Figure 3-17**). The chloride and fluoride concentrations for MW-1804A also show increasing chloride with no concomitant increase in Fluoride; a trend also observed in groundwater samples from MW-1806A. The trend is distinct from the pathway expected for mixing between MW-1804A and JAFAP porewater. The boron and fluoride concentrations plotted against each other do not reveal any mixing relationships but do show the broad compositional similarity between groundwater in MW-1804A, MW-1806A and MW-7. The MW-7 composition appears stable with no apparent mixing relationship.

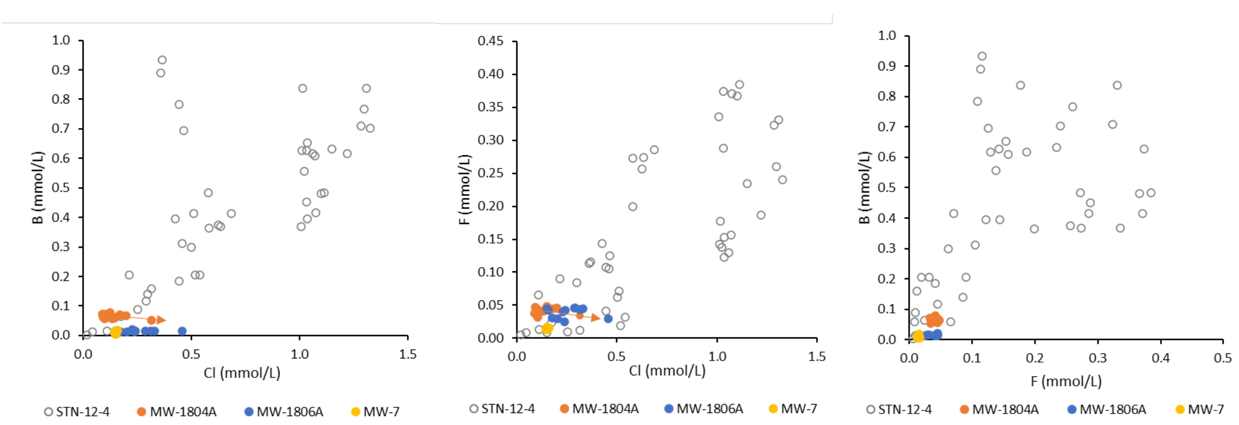


Figure 3-17 Conservative Ion Binary Plots for MW-1804A and MW-7

In summary, fluoride and boron concentrations plotted against chloride suggest mixing between different groundwater compositions within the Upper Connellsville Sandstone unit best explain the MW-1804A and MW-7 sample results from November 2020, and that mixing with JAFAP porewater is unlikely.

3.4 Tier II Evaluation - Geochemical Evaluation

A simple analysis of primary and potential indicator constituents (as performed in **Section 3.1**) may not provide the lines of evidence required for a robust ASD investigation. It is recognized that naturally occurring indicator constituents and upgradient sources may have an additional influence on groundwater quality. Spatially across a site, groundwater quality may be observed to change due to chemical interactions with the aquifer matrix. EPRI (2012) recommends more sophisticated methods that can be used for multiple parameters over multiple locations.

Piper plots are used to classify groundwater types based on the major ion ratios of calcium, magnesium, sodium (and potassium), alkalinity, chloride, and sulfate. They can be used to visually illustrate ion exchange and mixing between different water chemistries.

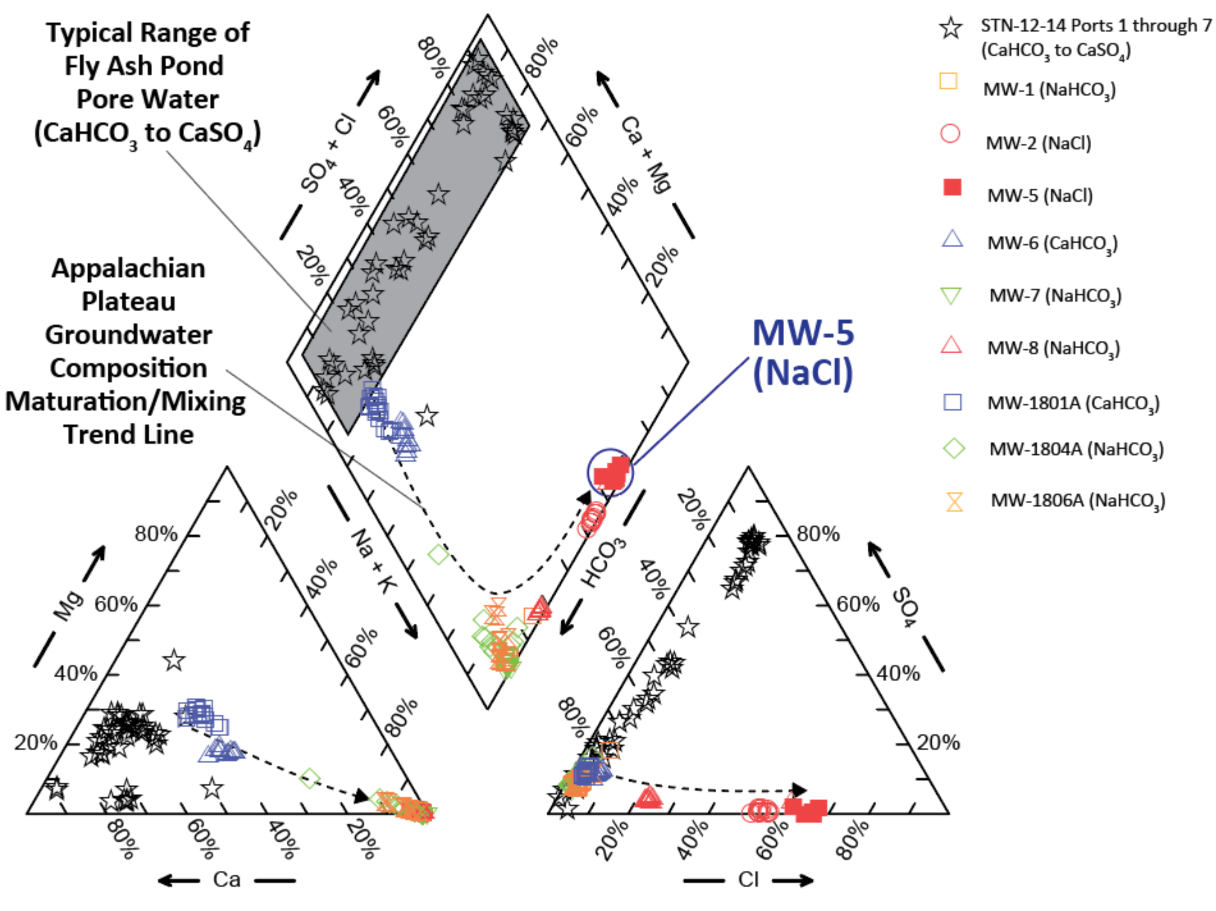


Figure 3-18 JAFAP and Groundwater Piper Plot (water types)

Not all site monitoring wells are shown.

Ash porewater and groundwater are represented by different water types. In **Figure 3-18** above, the water types related to the JAFAP porewater are dominated by calcium, bicarbonate, and sulfate. Groundwater samples from JAFAP groundwater monitoring wells trace the expected evolution trend expected for Appalachian Plateau groundwater, where dilute calcium bicarbonate ($Ca-HCO_3$-type) water evolves to sodium bicarbonate (Na-HCO_3-type) groundwater that may mix with NaCl-type connate brines (see **Section 2**).

Groundwater samples from MW-6 represent immature calcium bicarbonate-type waters, whereas MW-7 and MW-1804A represent more evolved sodium bicarbonate water types. Groundwater samples collected in the vicinity of MW-5 between July 2018 and November 2020 consistently report a sodium chloride water type. This water type is typically indicative of connate brines that are relict within the aquifer. This groundwater type is also consistent with the construction of well MW-5, which monitors a deeper section of the bedrock aquifer than other site wells (except MW-2) where a connate brine is expected to be encountered, as discussed in **Section 2**. Notably, no groundwater samples trend away from the expected groundwater maturation/mixing line and trend toward the calcium sulfate -type JAFAP porewater.

In summary, the geochemical evaluation indicates no evidence to support the presence of CCR constituents in groundwater sampled at any of the groundwater monitoring locations reviewed as indicated by **Figure 3-18**. Groundwater compositional changes are observed, but these changes are within the range expected in the hydrogeochemical framework for Appalachian Plateau bedrock groundwater. The magnitude of natural variation is not captured by the constituent concentrations that were collected over the seven-month period used to establish background concentrations.

Based on this evidence, it is considered that porewater from JAFAP is unlikely to be influencing the surrounding groundwater. Any compositional similarity between JAFAP pore water and the monitoring locations mentioned reflects the common recharge source and flow pathways for JAFAP pore water and local groundwater.

3.5 ASD Type I – Natural Variation due to Sampling Causes

EPRI (2012) describes sampling anomalies as a defensible cause for an SSI. Review of field documents indicates a notable change in the sampling technique at MW-5, MW-6, MW-7, and MW-1804A during the November 2019, through January 2021 sampling compared to the eight background monitoring events, in that the maximum purge rate in the detection monitoring events was between one half and one quarter the rate used historically during the background sampling events (**Figure 3-19** through **Figure 3-22**). Additionally, the total volume purged during the November 2019 through January 2021 sampling and verification events at MW-5, MW-6, MW-7, and MW-1804A was typically lower than all previous instances (**Figure 3-19** through **Figure 3-22**).

Sampling events used to establish benchmark values for evaluating SSIs were formulated through statistical analysis of the historical samples that were collected at higher purge rates and purge volumes. In the case of MW-5 (**Figure 3-19**), the excess pumping in the associated low-yield formation during SSI benchmark calibration sampling is expected to result in incursion of reducing, low sulfate, high TDS NaCl-type connate water into the well screen. Subsequent sampling at a lower purge rate and purge volume between November 2019 and January 2021 is expected to have minimized connate water incursion into the well and facilitated sampling of low TDS and sulfate bearing water with elevated calcium from above the connate water mixing interface.

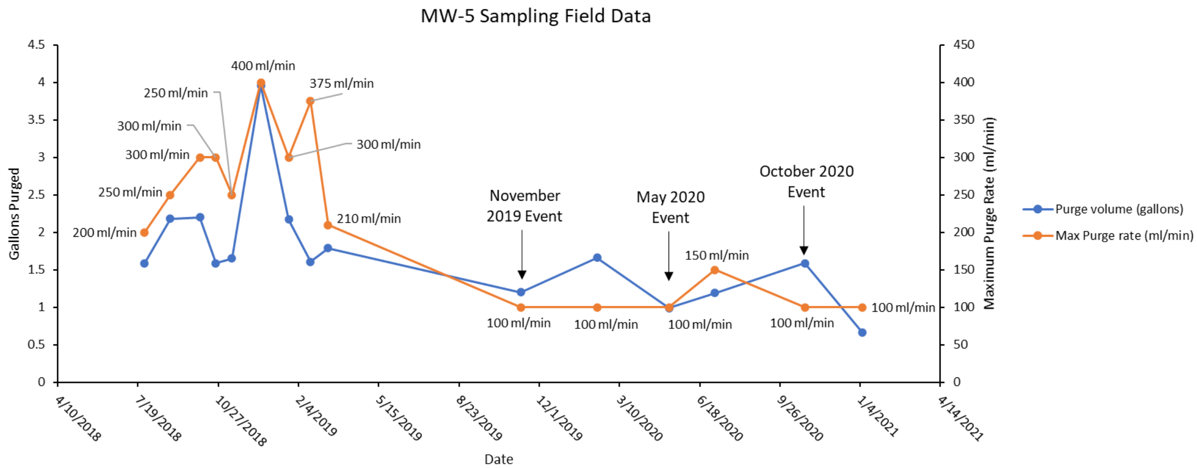


Figure 3-19 Historical Well Purge Rates and Volume Purged for MW-5

Similar to MW-5, lower purge rates and volumes at MW-6, MW-7, and MW-1804 during November 2019 through January 2021 sampling is expected to draw groundwater from portions of the formation not typically sampled during the background sampling events. The SSI exceedances in these monitoring wells can be attributed in part to a substantially lower purge rate and volume than used during background sampling to establish SSI benchmarks. In the case of MW-1804A (**Figure 3-20**), the screen and sand pack extend across the Conemaugh Shale, Upper Connellsville Sandstone, and an unnamed shale/siltstone unit, which conceivably has different groundwater geochemistry. Notably, MW-1806A is the only other site well with a sand pack that extends across the same combination of units and a substantial interval of the Conemaugh Shale as MW-1804A. Conceivably, differences in the purge rate during sampling affected the relative contributions of different water-bearing zones to the well, which resulted in groundwater geochemistry differences.

For MW-1804A, this is supported by the outcome of the Tier II geochemical evaluation (**Section 3.4**) that provides multiple lines of evidence to support the November 2019 MW-1804A groundwater sample has a simlar origin to groundwater sampled from other wells screened over simlar elevation ranges in the Conemaugh Shale/Upper Connellsville Sandstone, and that mixing with JAFAP porewater is not supported.

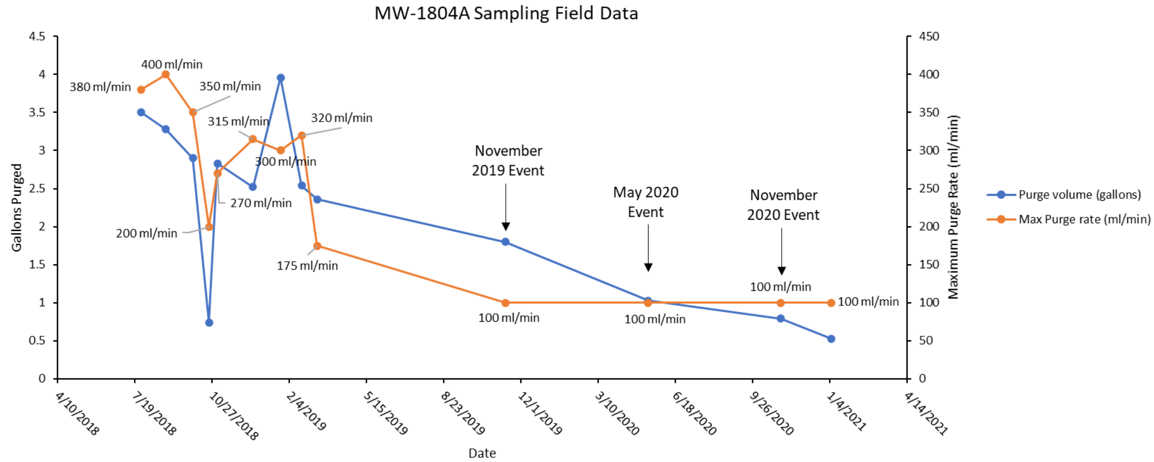


Figure 3-20 Historical Well Purge Rates and Volume Purged for MW-1804A

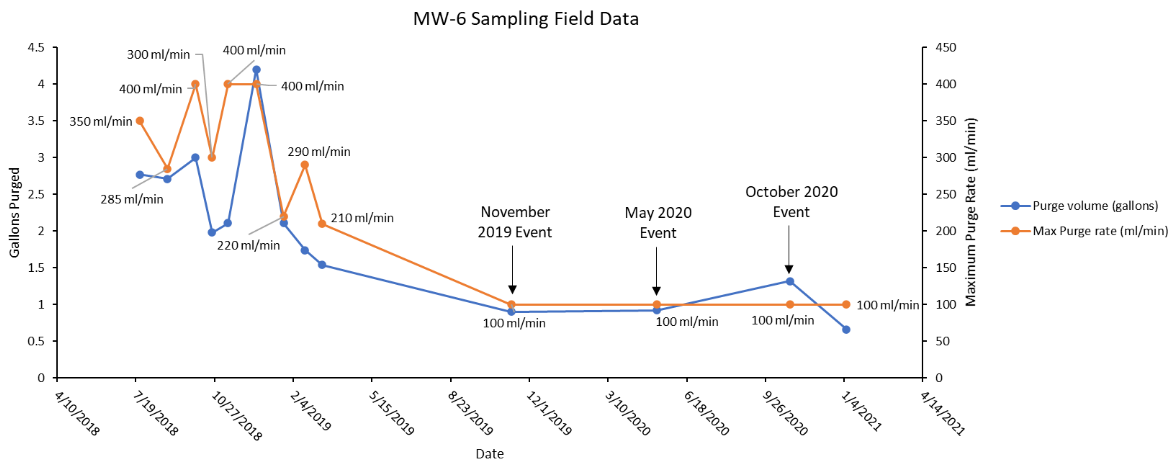


Figure 3-21 Historical Well Purge Rates and Volume Purged for MW-6

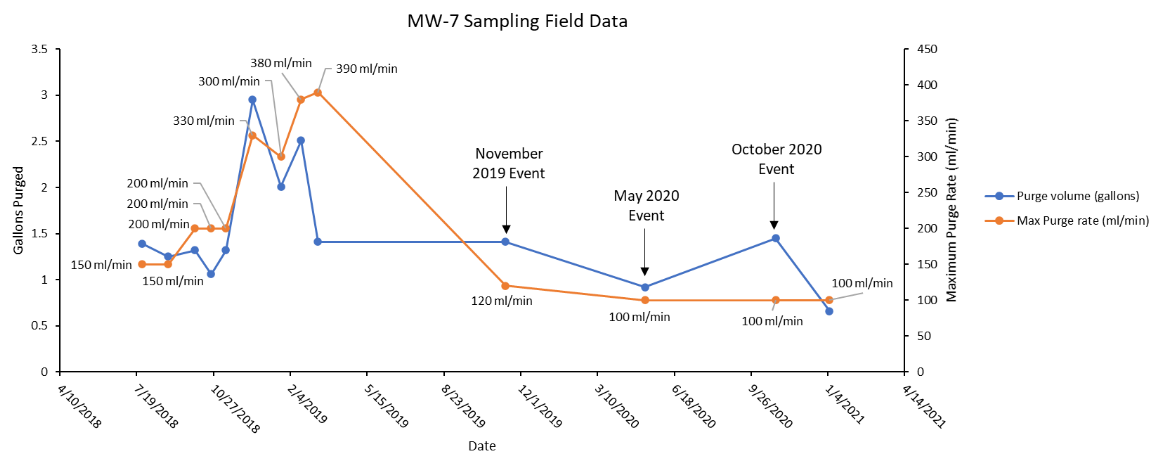


Figure 3-22 Historical Well Purge Rates and Volume Purged for MW-7

3.6 ASD Type III – Statistical Evaluation Causes

Samples to establish SSI benchmarks were obtained over a seven-month period between July 25, 2018 to February 18, 2019. For this reason, benchmark statistical calulations are qualified with “Insufficient data to test for seasonality: data were not deseasonalized” (AEP, 2020). Additionally, annual variations owing to high rainfall years (**Section 3.7**) are not accounted for, as detection monitoring began immediately following the establishment of SSI benchmarks. Therefore, periodic SSI exceedences related to seasonal and/or annual weather variations should be expected until a broader dataset is available that incorporates seasonal and annual weather patterns.

3.7 ASD Type IV – Natural Variation

Historical groundwater geochemistry data for MW-5 show that it is screened close to a mixing zone between low TDS and comparatively young recharge water and high TDS and comparatively ancient connate brine. Regionally, the mixing interface between these two disparate water types is known to be only a few feet thick. The two water types constitute two natural groundwater sources with distinct groundwater geochemistry that may periodically contribute water to the saturated zone within the MW-5 screen/sand pack zone. Given that SSI benchmarks were established over approximately a seven-month period, seasonality and longer timescale natural variations in the location of the mixing interface are unlikely captured in the benchmark dataset.

The highest annual rainfall ever recorded in West Virigina (67.05 inches) occurred in 2018 (NOAA, 2020), which coincides with the time period when 75 percent of the data to support the SSI benchmarks was collected. Historical water level records only extend back to the period where SSI benchmark data was collected for MW-1804A. In addition, the conceptual time-frame for recharge water to infiltrate to the MW-1804A screened zone is on the order of days to weeks (**Figure 3-23**), consistent with the expected response time between precipitation and sampling at MW-1804A during the high rainfall period. The anomalous rainfall is not expected to influence MW-5, as the conceptual time for recharge water to infiltrate the MW-5 screened zone is on the order of years to centuries (**Figure 3-24**). The November 2019 water level elevation (841.72 ft mean sea level) was the lowest measured to date. In comparison, the water level ranged between 842.01 and 846.00 ft during the earlier eight quarters of sampling used to establish SSI benchmarks, an elevation range that spans the overburden/bedrock interface (**Figure 3-24**). The water level measured in November 2019 was nearly 2.5 feet lower than the overburden/ bedrock interface and approached the top of a sandstone interbed within the Conemaugh Shale. Variable water level elevations in MW-1804A support potential changes in the relative contributions from different water-bearing zones to the November 2019 sample. Additionally, the lowest historical water level in November 2019 conceivably reflects relaxation of the water table back to typical levels with concomitant changes in groundwater geochemistry, thus, may be more reflective of typical conditions.

The same shift in water level across formations is not observed at other wells where SSIs of constituents were observed (**Figure 3-25** and **Figure 3-26**). This may explain why overall compositional variation in MW-7 is less than observed in MW-1804A and MW-1806A, as described in **Section 3**.

It is expected that a combination of a historically low water levels and a notably lower purge rate during the November 2019 sampling event contributed to concentrations outside the range used to establish

SSI benchmark exceedances. The variable concentrations in MW-1804A may be attributed to natural variations in the water chemistry at this location.

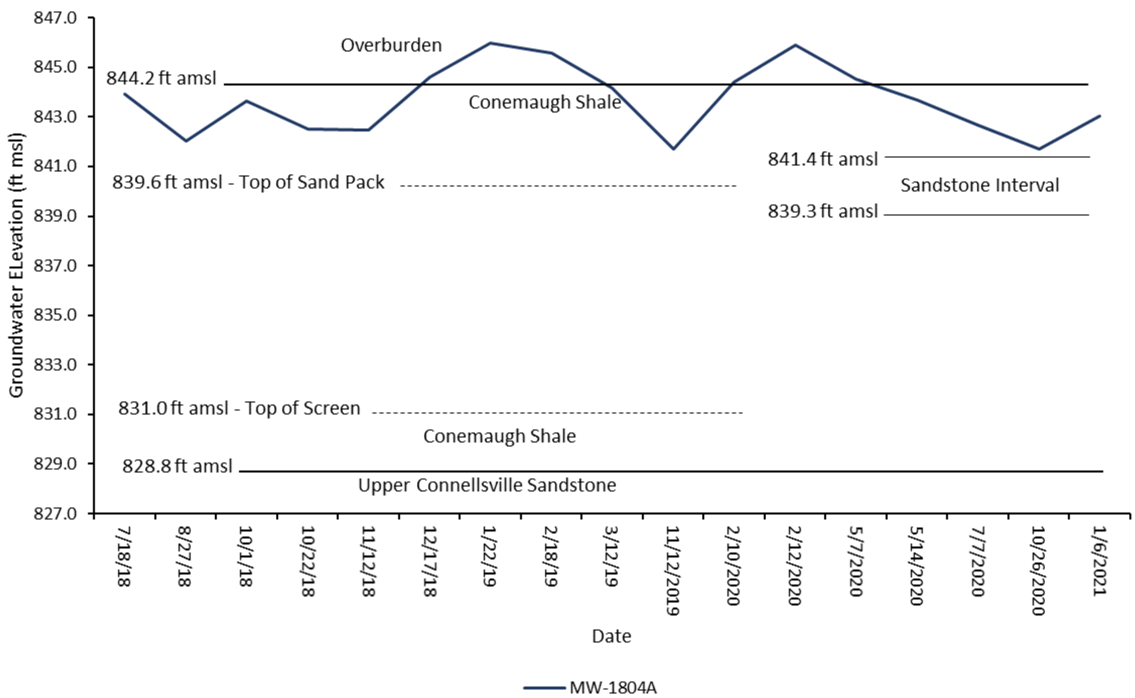


Figure 3-23 Hydrograph for MW-1804A Relative to Geological Observations Over the Screen Interval

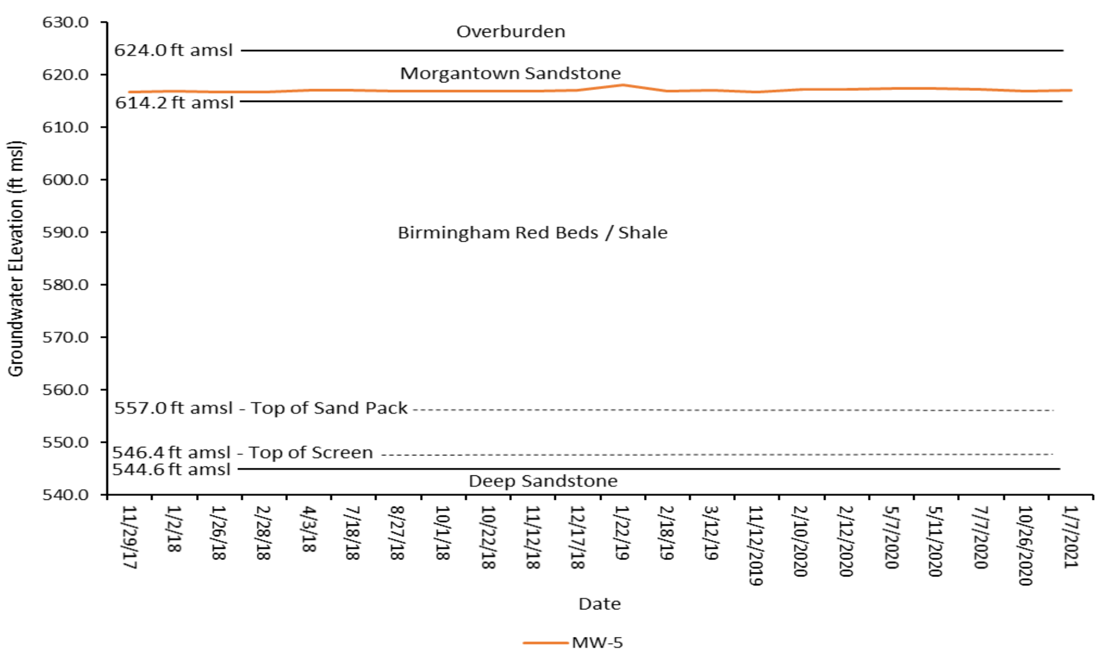


Figure 3-24 Hydrograph for MW-5 Relative to Geological Observations Over the Screen Interval

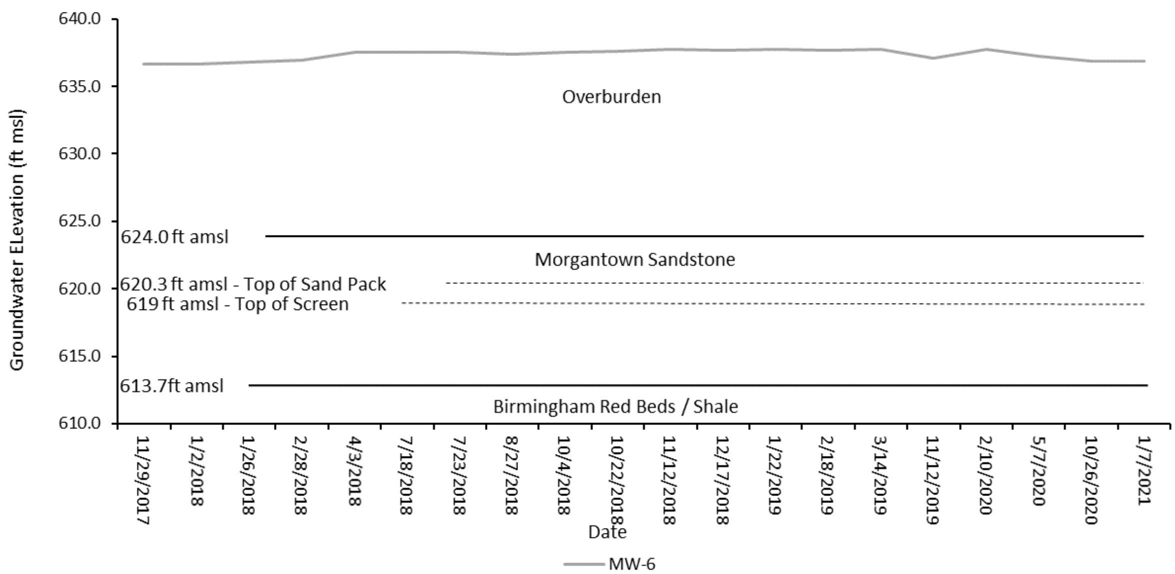


Figure 3-25 Hydrograph for MW-6 Relative to Geological Observations Over the Screen Interval

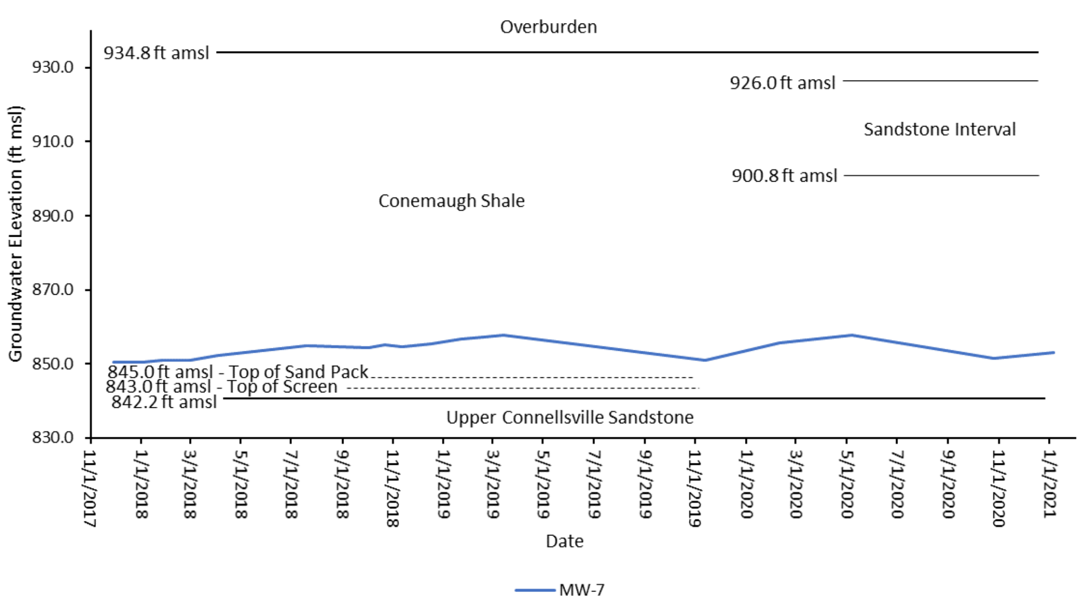


Figure 3-26 Hydrograph for MW-7 Relative to Geological Observations Over the Screen Interval

4 Summary and Conclusions

Table 4-1 highlights the potential causes of SSIs at MW-5, MW-6, MW-7, and MW-1804A during the October-November 2020 detection monitoring event that have been identified during this ASD investigation.

Table 4-1 Summary of Potential Causes Identified by ASD Investigation

Sampling Causes (ASD Type I)	Laboratory Causes (ASD Type II)	Statistical Evaluation Causes (ASD Type III)	Natural Variation (ASD Type IV)	Alternative Sources (ASD Type V- Natural and Anthropogenic)
• Sample mislabeling • Contamination • Change in technique • Excessive suspended solids or turbidity • Other sampling anomalies	• Analytical method • Calibration • Analytical technique • Contamination • Interference • Recording • Dilution errors • Digestion methods	• Lack of statistical independence • Outliers • Trends • Non-detect Processing • False positives • New background data	• Geology • Precipitation • Seasonality • Water level • Changes in pH an/or ORP • Biological activity • Time of travel	• See Appendix A, Tables A-3 and A-4 (EPRI, 2017)

Source: Table 6-1 Potential Causes for an SSI/SSL (EPRI, 2017).

Using the EPRI (2017) guidance for completing an ASD, the conclusions that are based on the lines of evidence presented and discussed within **Section 3** indicate that groundwater in the vicinity of the JAFAP is not being influenced by CCR constituents from the JAFAP. Concentrations of calcium and sulfate in MW-5, fluoride in MW-6 and MW-7, and chloride and sulfate in MW-1804 that led to SSIs in October-November 2020 are primarily caused by a change in the sampling procedure (ASD Type I – Sampling Causes), which led to a difference in where sampled water originated in the formation. Consequently, an ASD Type III – Statistical Evaluation Causes is the primary reason that SSIs of constituents have been observed in subsequent samples, as background concentrations are not representative of current groundwater conditions. Additional ASD causes include ASD Type IV Natural Variation Causes, and Type V – Alternatives Source (i.e. connate brine influence at MW-5 and MW-6). Lines of evidence for these ASD causes are detailed in **Table 4-2.**

Table 4-2 Evidence of ASD for SSIs at the John Amos Fly Ash Pond

MW-5 Evidence
MW-5: Calcium SSI
1. High purge rates and purge volumes during background sampling resulted in intrusion of sodium chloride water, setting an unrealistically low calcium SSI value for future comparison. 2. Mixing of shallower calcium-rich groundwater during detection monitoring sampling events occurred due to a substantially lower purge rate and volume, which led to the SSI as evidenced by: a. Calcium was 5.7 times lower in MW-5 than calcium in the shallower, co-located well MW-6. b. Shallow groundwater mixing is supported by Ca/Cl and B/Cl ratios in MW-5 similar to shallow groundwater and notably different than JAFAP porewater. c. Shallow groundwater mixing with brine is supported by conservative element (B, Cl, F) concentrations.
MW-5: Sulfate SSI
1. High purge rates and purge volumes during background sampling resulted in intrusion of sodium chloride water, with essentially no sulfate, setting an unrealistically low SSI value for future comparison (sulfate SSI benchmark is over 100 times lower than typical groundwater sulfate concentrations due to incursion of reducing, sulfide-bearing and sulfate-free brine). 2. Mixing of shallower sulfate-rich groundwater occurred during the detection monitoring sampling events due to substantially lower purge rates and volumes, as evidenced by: a. Sulfate in MW-5 was lower than in co-located and shallower wells MW-1 and MW-6. b. SO_4/Cl ratios were substantially lower than JAFAP porewater and closer to those in shallow groundwater wells. c. Piper plot relationships that show MW-5 is compositionally distinct from JAFAP porewater, and that there is no mixing relationship.
MW-6 Evidence
MW-6: Fluoride SSI
1. High purge rates and purge volumes during background sampling resulted in preferential sampling of more dilute water, setting an unrealistically low fluoride SSI value for future comparison. 2. Mixing of a brine component with higher fluoride concentration has gradually occurred due to a substantially lower purge rate and volume and/or natural variations in hydrology, which ultimately led to the SSI as evidenced by: a. The primary CCR leachate indicator sulfate has been steadily decreasing. b. The primary CCR leachate indicator boron has remained stable. c. There is no indication of a compositional shift toward JAFAP porewater composition as apparent on a Piper plot (**Figure 3-18**).

MW-7 Evidence
MW-7: Fluoride SSI
1. High purge rates and purge volumes, coupled with the rapid (seven-month) duration of sample collection during background sampling underrepresented the natural groundwater compositional variation. 2. Substantially lower purge rate and volume and/or natural variations in hydrology, which ultimately led to the SSI as evidenced by: a. The primary CCR leachate indicator sulfate has remained stable. b. The primary CCR leachate indicator boron has remained stable. c. There is no indication of a compositional shift toward Amos FAP porewater composition as apparent on a Piper plot (**Figure 3-18**). 3. The MW-7 fluoride result (0.31 mg/L) exceeded the intrawell prediction limit of 0.301 mg/L) by 0.006 mg/L, which is less than the analytical limits of precision (0.01 mg/L for MW-7) and should be considered an anomalous result.
MW-1804A Evidence
MW-1804A: Chloride SSI
1. The SSI exceedance can be attributed to a substantially lower purge rate and volume during detection monitoring sampling events than used during background sampling to establish SSI benchmarks. The screen and sand pack extends across the Conemaugh Shale, Upper Connellsville Sandstone, and an unnamed shale/siltstone unit, which conceivably have variable groundwater geochemistry. Variable groundwater chemistry in the different units is supported by the subtle geochemical differences in background data for other site wells screened over only one or two of these units. Conceivably, differences in the purge rate during detection monitoring sampling events affects the relative contributions of different water-bearing zones to the well, which results in groundwater geochemistry differences that were not accounted for during the background sampling events. 2. Data, obtained with the lower purge rate is likely due to natural groundwater variation within the screened formations and not the JAFAP, as evidenced by: a. Chloride in MW-1804A (7.12 mg/L) is lower than MW-1806A (8.45 mg/L), which is screened in the same formation and over a similar elevation range. b. Ca/Cl and B/Cl ratios indicate that chloride in MW-1804A cannot be attributed to mixing with JAFAP porewater. c. Mixing between historical MW-1804A groundwater with MW-1806A groundwater is supported by conservative element (B, Cl, F) concentrations. d. There is no indication of a compositional shift toward Amos FAP porewater composition as apparent on a Piper plot (**Figure 3-18**).
MW-1804A: Sulfate SSI
1. The SSI exceedance can be attributed to a substantially lower purge rate and volume during detection monitoring sampling events than used during background sampling to establish SSI benchmarks. 2. Data obtained with the lower purge rate, combined with a low groundwater table elevation, is likely due to natural variation within the Upper Connellsville Sandstone formation and not the JAFAP, as evidenced by: a. Ca/Cl and B/Cl ratios indicate samples from MW-1804A cannot be explained by mixing with JAFAP porewater and are best explained by natural variation within the Upper Connellsville Sandstone/SRF aquifer. b. Mixing between historical MW-1804A groundwater with groundwater of a composition similar to MW-1806A is supported by conservative element (B, Cl, F) concentrations.

MW-7 Evidence
3. Sulfate concentrations should be considered anomalous since increases in other elements that would suggest mixing with JAFAP porewater are not observed.

ASD = alternative source demonstration
B = boron
Ca = calcium
CCR = coal combustion residual
Cl = chloride
F = fluoride
FAP = fly ash pond
JAFAP = John E. Amos Plant Fly Ash Pond
mg/L = milligrams per liter
SO_4 = sulfate
SRF = stress relief fracturing
SSI = statistically significant increase

An ASD Type III – Statistical evaluation cause is a primary reason for SSIs that have occurred in subsequent detection monitoring events. SSI benchmarks were established over approximately a seven-month period preceding three quarters of detection monitoring. Subsequent detection monitoring events have currently spanned approximately 20 months since the first detection monitoring event in March 2019. The seven-month background period does not fully capture seasonal and annual weather variations, and recalculation of the background data is recommended to accurately reflect the natural variation in groundwater chemistry across the hydrogeologic units surrounding the JAFAP, as described in **Section 3.2**.

In addition to ASD Type I – Sampling Causes and ASD Type III – Statistical Evaluation Causes, the following potential contributing alternative sources were identified:

MW-5 and MW-6

- ASD Type V – Alternative sources (Natural). Historical groundwater geochemistry data for MW-5 show that it is screened close to a mixing zone between low TDS and comparatively young recharge water and high TDS and comparatively ancient connate brine. Regionally, the mixing interface between these two disparate water types is known to be only a few feet thick. The two water types constitute two natural groundwater sources with distinct groundwater geochemistry that may periodically contribute water to the saturated zone within the MW-5 screen/sand pack zone.
- MW-6 is co-located with MW-5 and screened at a higher elevation. An increasing proportion of brine represented by MW-5 has been observed overtime, likely due to a combination of sampling practices and natural hydrologic variations.

MW-1804A

- ASD Type IV – Natural Variation (precipitation and geology). The highest rainfall on record for West Virginia occurred during 2018, which coincides with the period where 75 percent of the values were obtained to establish SSI benchmarks and when water levels were first measured in MW-1804A.
  - Water levels in MW-1804A collected during establishment of SSI benchmarks spanned the overburden-bedrock interface.

- The lowest water level on record for MW-1804A occurred during November 2019 and was nearly 2.5 feet lower than the overburden/bedrock interface.
- Water quality variations associated with different water-bearing zones exposed to the saturated zone in MW-1804A conceivably contributed to differences in groundwater geochemistry during the November 2019 sampling event compared to the eight background events sampled during a seven-month period during the wettest year on record in West Virginia.

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Tables

Table 1 Screened Interval of Monitoring Wells

Well/ Boring	Hydraulic Location	Hydrolitho-stratigraphic Unit	Surface Elevation (ft amsl)	Screened Interval (ft amsl)	Sand Pack Interval (ft amsl)	Geologic Formation
MW-1807A	Upgradient/ Background	SRF	861.99	766.99 – 746.99	745.99 – 769.99	Unnamed clay shale/ Lower Connellsville SS
MW-1808A	Upgradient/ Background	SRF	857.55	733.73 – 748.35	746.55 – 776.55	Unnamed clay shale/ Lower Connellsville SS
MW-1809A	Upgradient/ Background	SRF	738.09	666.09 – 681.09	664.09 – 683.69	Clarksburg Shale
MW-1810A	Upgradient/ Background	SRF	735.26	655.26 – 675.26	653.26 – 681.26	Clarksburg Shale
MW-1	Downgradient	SRF	647.57	587.57 – 606.47	569.47 – 609.57	Birmingham Shale
MW-2	Downgradient	SRF	645.20	540.20 – 549.10	534.20 – 560.50	Birmingham Shale
MW-5	Downgradient	SRF	648.03	537.03 – 546.43	535.93 – 557.03	Birmingham Shale /Grafton SS
MW-6	Downgradient	SRF	647.50	614.00 – 619.00	613.30 – 620.30	Morgantown SS/ Birmingham Shale
MW-7	Downgradient	U/SRF	953.00	823.00 – 843.00	820.50 – 845.00	Conemaugh Shale/ Upper Connellsville SS
MW-8	Downgradient	U/SRF	963.01	800.01 – 819.01	797.01 – 821.21	Conemaugh Shale/ Upper Connellsville SS
MW-9	Downgradient	U/SRF	944.66	805.56 – 824.56	804.56 – 824.56	Conemaugh Shale/ Upper Connellsville SS
MW-1801A	Downgradient	U/SRF	901.12	826.12 – 846.12	824.12 – 849.12	Conemaugh Shale/ Upper Connellsville SS
MW-1804A	Downgradient	U/SRF	858.53	811.03 – 831.03	809.53 – 838.63	Conemaugh Shale/ Upper Connellsville SS/ Unnamed clay shale
MW-1806A	Downgradient	U/SRF	889.63	809.23 – 829.23	808.63 – 832.63	Conemaugh Shale/ Upper Connellsville SS/ Unnamed clay shale

amsl = above mean sea level
ft = feet
SRF = Stress Relief Fracture System
SS = Sandstone
U = Upper Connellsville Sandstone

Table 2
Multi-Port Piezometer STN-12-4 Water Quality Data
Fly Ash Pond Alternative Source Demonstration Investigation
AEP, John E. Amos Plant, Winfield, WV
May 2020

Multi-Port Interval	Sampling Date	Major Ions							Minor Ions				TDS	pH
		Bicarbonate Alkalinity (as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
1	9/29/2017	630	182	13	41.7	--	75.6	151	10.1	--	2.2	--	810	--
2	9/28/2017	181	84.9	15.8	23.1	--	10.2	129	2	--	0.78	--	394	--
3	9/28/2017	108	69.2	16.3	11.9	--	16.1	146	3.36	--	2	--	344	--
4	9/28/2017	187	103	24.3	25.3	--	23.5	164	4.48	--	5.43	--	458	--
5	9/28/2017	62	122	39.5	22.9	--	15.7	280	5.23	--	7.3	--	582	--
6	9/28/2017	44	134	35.9	3.59	--	38.5	341	6.79	--	2.71	--	612	--
7	9/28/2017	51	168	46.4	29.3	--	19.9	409	9.05	--	6.28	--	740	--
GeoMean	September 2017	118.1	117.1	24.5	18.3	--	23.1	210.3	5.2	--	3.0	--	539.2	--
1	12/12/2017	597	170	12.8	22.6	--	20.1	152	9.63	--	2.16	--	816	--
2	12/12/2017	122	30.7	3.98	19.9	--	12.6	1.4	0.169	--	0.24	--	174	--
3	12/12/2017	102	34.5	6.18	3.06	--	33.7	28.1	0.698	--	0.46	--	224	--
4	12/11/2017	185	91.9	22.5	25.1	--	16.2	156	3.98	--	5.2	--	446	--
5	12/11/2017	67.1	105	38.1	38.5	--	66.6	268	4.5	--	7.05	--	550	--
6	12/11/2017	50.6	122	36.3	6.36	--	6.01	351	6.02	--	2.62	--	608	--
7	12/11/2017	49.6	143	45.6	6.81	--	7.42	435	7.67	--	6.14	--	774	--
GeoMean	December 2017	112.7	84.3	17.2	12.8	--	17.0	87.1	2.7	--	2.0	--	448.9	--
1	11/15/2018	360	58.5	3.74	15.3	8.76	13.6	44.4	0.634	0.1	1.24	0.0375	406	7.57
2	11/14/2018	289	67.9	1.59	17.4	7.36	10.5	20.2	0.145	0.1	0.17	0.0158	320	7.32
3	11/15/2018	181	50	0.64	12.6	7.6	7.78	8.4	<0.02	0.1	0.1	0.00892	217	7.47
4[1]	11/15/2018	229	63.6	10.6	15.1	8.26	12.1	62.8	1.52	0.2	1.61	0.231	330	7.48
5	11/15/2018	80.4	86	35.8	17.9	6.34	10.6	229	3.98	0.508	6.38	1.62	440	7.65
6	11/15/2018	38.7	82.7	36.8	4.82	10.8	22.2	342	4.27	0.5	2.32	2.52	840	8.92
7	11/16/2018	55.8	115	40.8	19.3	7.83	16.1	332	6.83	0.502	4.45	3.17	600	8.01
GeoMean	November 2018	133.3	72.3	8.0	13.6	8.0	12.6	74.1	1.6	0.2	1.1	0.2	413.4	7.76
1	3/12/2019	392	107	7.59	26.8	8.47	39.9	74.1	2.23	0.1	1.71	0.0924	508	7.76
2	3/13/2019	281	73	5.24	19.1	5.43	13	27.1	0.643	<0.1	0.16	0.101	314	7.28
5	3/14/2019	213	75.3	10.3	19	4.67	13.6	78.2	1.25	<0.1	0.86	0.45	346	7.26
6	3/15/2019	47.4	127	37.6	3.98	11.2	37.8	346	6.67	0.548	2.46	2.5	628	9.52
GeoMean	March 2019	182.6	93.0	11.1	14.0	7.0	22.7	85.9	1.9	0.2	0.9	0.3	431.5	7.90

Table 2
Multi-Port Piezometer STN-12-4 Water Quality Data
Fly Ash Pond Alternative Source Demonstration Investigation
AEP, John E. Amos Plant, Winfield, WV
May 2020

Multi-Port Interval	Sampling Date	Major Ions							Minor Ions				TDS	pH
		Bicarbonate Alkalinity (as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
1	11/11/2019	627	173	15.8	36.8	10.4	70.8	141	8.47	0.311	2.05	0.146	816	7.55
2	11/11/2019	314	86.5	8.95	19.5	6.14	12	24.7	0.955	0.224	0.18	0.0714	361	7.25
3	11/11/2019	211	64.6	11.2	13.8	4.9	13.4	41.8	1.72	0.263	0.22	0.114	285	7.46
4	11/11/2019	201	83.4	20.6	20.5	6.01	20.4	109	3.95	0.423	3.79	0.551	391	7.68
5	11/11/2019	75.7	114	36.6	21.6	3.86	12.3	250	4.88	0.634	5.47	1.69	512	7.82
6	11/12/2019	47.7	132	36.8	3.7	10	42	337	7.05	0.584	2.91	2.68	632	9.26
7	11/12/2019	62	136	43.3	19.5	5.58	18.7	310	6.67	0.657	3.54	2.81	625	7.64
GeoMean	November 2019	151.9	107.4	21.2	16.4	6.3	21.7	122.5	3.9	0.4	1.5	0.5	488.5	7.79
1	5/11/2020	568	155	15.1	38.7	11.4	61.4	113	4.28	0.2	2.73	0.186	758	7.82
2	5/11/2020	281	101	18.4	27.6	6.89	11.9	67.6	2.23	0.297	0.36	0.202	457	7.24
3	5/13/2020	120	56.8	17.8	14.3	7.83	14.6	107	3.24	0.294	1.17	0.315	336	7.40
4	5/13/2020	192	75.9	22.2	23.2	6.22	18.8	113	4.06	0.336	4.88	0.543	368	7.67
5	5/13/2020	555	104	39	22.7	5.14	11	252	5.2	0.534	6.97	1.67	555	7.76
6	5/14/2020	46.1	123	38	4.32	11.9	40	327	6.58	0.455	2.98	2.49	624	9.34
7	5/14/2020	40.6	142	47.1	20.5	6.76	19.3	363	7.6	0.546	4.57	3.3	676	7.69
GeoMean	May 2020	168.3	103.0	25.8	18.4	7.7	20.8	160.7	4.4	0.4	2.5	0.7	518.2	7.82
1	10/28/2020	590	159	16.5	39.5	11.8	65.1	132	7.51	0.311	2.38	0.161	826	7.57
2	10/28/2020	264	94.5	19.2	26.3	6.43	10.7	105	2.22	0.421	0.6	0.125	479	7.35
3	10/28/2020	122	58.2	18.1	13.8	7.83	14.5	102	3.79	0.399	1.35	0.241	316	7.70
4	10/28/2020	201	77.1	20.5	23.3	5.82	18	104	4.28	0.42	5.18	0.582	404	7.96
5	10/29/2020	76.2	111	36.6	24.3	5.1	10.3	243	5.56	0.634	7.11	1.57	532	8.15
6	10/30/2020	44.6	122	36	4.15	11.8	37.1	308	7.14	0.584	3.37	2.28	615	9.32
7	10/30/2020	40.6	145	46	21	6.2	16.3	347	8.29	0.711	4.93	3.17	688	7.78
GeoMean	October 2020	126.8	104.1	25.6	18.4	7.5	19.7	168.3	5.1	0.5	2.7	0.6	527.5	7.95

Notes:
mg/L : milligrams per liter
s.u. : standard units
TDS : total dissolved solids
- - : not analyzed
< : value less than reporting limit
[1] pH reported in Interval 4 in November 2018 was recorded in error as 4.48 at time of sampling, pH prior to sampling was 7.42, this value was corrected to 7.48

Table 3
Monitoring Well Water Quality Data
Fly Ash Pond Alternative Source Demonstration Investigation
AEP, John E. Amos, Winfield, WV
May 2021

			Major Ions							Minor Ions					
Monitoring Well	Collection Date	Monitoring Program	Bicarbonate (Alkalinity as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum	TDS	pH
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
MW-1	7/24/2018	Background	382	2.83	11.7	0.466	1.75	159	30.6	0.182	0.106	0.42	0.00194	473	8.20
	8/28/2018	Background	371	2.80	11.3	0.502	1.63	168	31.6	0.135	0.121	0.45	0.00148	435	8.50
	10/3/2018	Background	385	2.95	11.1	0.456	1.4	172	30.8	0.138	0.1	0.40	0.001	457	8.30
	10/22/2018	Background	380	2.36	11.4	0.396	1.49	170	30.7	0.180	0.1	0.42	0.001	434	8.30
	11/13/2018	Background	388	3.03	11.5	0.424	2.27	159	32.2	0.209	0.1	0.45	0.001	444	8.00
	12/19/2018	Background	372	2.71	10.7	0.441	1.31	162	30.9	0.117	0.09	0.43	0.001	428	8.10
	1/23/2019	Background	242	2.29	14.6	0.404	1.41	148	55.9	0.115	0.04	0.41	0.001	453	8.20
	2/19/2019	Background	367	2.36	10.9	0.371	1.22	175	31.3	0.126	0.09	0.44	0.001	457	8.50
	MW-1 Intrawell Prediction Limit		- -	**3.58**	**14.6**	- -	- -	- -	**55.9**	**0.261**	- -	**0.485**	- -	**536**	**7.70**
	3/12/2019	Detection	390	2.60	11.0	0.383	1.14	170.0	31.6	0.110	0.080	0.43	- -	458	8.20
	11/8/2019	Detection	353	2.38	11.2	0.413	1.42	165.0	33.7	0.114	0.100	0.42	- -	461	8.20
	5/13/2020	Detection	335	2.74	11.2	0.410	1.38	163.0	33.6	0.122	0.070	0.42	- -	457	8.24
	11/2/2020	Detection	322	2.70	10.5	0.461	1.33	169.0	33.6	0.097	0.1 J	0.48	- -	434	8.37
MW-2	07/27/2018	Background	545	4.24	471	0.924	1.97	427	2.4	0.259	2.6	3.08	0.0272	1260	8.40
	08/29/2018	Background	547	3.98	443	0.891	3.05	426	17.4	0.249	2.49	2.99	0.0345	1310	8.60
	10/04/2018	Background	550	4.31	435	0.870	2.33	532	14.8	0.256	2.55	2.99	0.0308	1280	8.50
	10/23/2018	Background	561	3.95	438	0.866	2.47	516	7.4	0.262	2.41	3.08	0.0261	1250	8.50
	11/15/2018	Background	546	4.07	469	0.861	2.69	482	13.5	0.328	2.67	3.3	0.0292	1250	8.50
	12/19/2018	Background	551	3.81	430	0.822	2.03	443	6.4	0.225	2.34	3.03	0.0255	1250	8.50
	01/23/2019	Background	513	3.67	441	0.903	2.4	447	6.4	0.318	2.22	3	0.0292	1310	8.20
	02/22/2019	Background	568	3.95	447	0.855	2.02	461	2.3	0.237	2.26	3.06	0.0219	1310	8.70
	MW-2 Intrawell Prediction Limit		- -	**4.66**	**495**	- -	- -	- -	**26.7**	**0.382**	- -	**3.39**	- -	**1410**	**8.00**
	3/13/2019	Detection	605	3.98	441	0.826	1.86	470	1.8	2.300	2.38	3.02	0.0262	1300	8.70
	11/8/2019	Detection	543	4.77	426	1.08	2.91	481	20.1	0.265	2.39	2.73	- -	1340	8.51
	2/11/2020	Verification	- -	4.31	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
	5/12/2020	Detection	505	4.35	443	1.05	2.06	471	6.0	0.214	2.1	2.91	- -	1340	8.57
	11/2/2020	Detection	538	4.13	435	0.925	2.18	544	6.6	0.194	2.52	3.24	- -	1310	8.62
MW-5	7/24/2018	Background	599	6.75	793	1.60	3.04	777	0.2	0.252	4.69	3.32	0.0365	1890	8.10
	8/29/2018	Background	601	6.71	780	1.63	4.59	714	0.2	0.240	4.56	3.33	0.0384	1880	8.20
	10/3/2018	Background	581	7.03	776	1.56	3.37	742	0.1	0.276	4.67	3.33	0.0357	1860	8.10
	10/24/2018	Background	623	7.09	811	1.61	3.4	735	<0.06	0.249	4.63	3.44	0.0351	1840	8.10
	11/13/2018	Background	600	6.79	832	1.38	4.03	586	0.1	0.264	4.89	3.63	0.0347	1880	8.00
	12/19/2018	Background	609	6.48	783	1.53	3.02	595	<0.06	0.221	4.73	3.43	0.0348	1890	7.90
	1/23/2019	Background	619	5.98	782	1.60	3.8	599	<0.06	0.323	4.58	3.36	0.035	1910	8.10
	2/19/2019	Background	599	6.79	793	1.69	3.21	687	<0.06	0.239	4.58	3.38	0.0336	1920	8.20
	MW-5 Intrawell Prediction Limit		- -	**7.79**	**853**	- -	- -	- -	**0.20**	**0.355**	- -	**3.72**	- -	**1980**	**7.80**
	3/13/2019	Detection	609	6.85	804	1.60	2.78	660	0.08	0.229	4.69	3.44	- -	1930	8.00
	11/8/2019	Detection	588	21.00	663	2.61	6.61	571	32	0.182	4.36	3.04	- -	1840	7.97
	2/11/2020	Verification	- -	11.30	713	- -	- -	- -	18.6	- -	- -	- -	- -	- -	7.80
	5/11/2020	Detection	540	9.85	746	2.32	2.9	694	11	0.211	3.74	2.97	- -	1820	7.92
	7/7/2020	Verification	- -	8.77	- -	- -	- -	- -	22.8	- -	- -	- -	- -	- -	8.06
	10/27/2020	Detection	489	9.50	729	2.07	3.52	692	25.1	0.207	3.25	3.24	--	1770	8.16
	1/7/2021	Verification	- -	9.31	- -	- -	- -	- -	14.6	- -	- -	- -	- -	- -	8.10
MW-6	7/24/2018	Background	294	61.0	19.3	15.5	2.73	59	44.4	0.120	0.168	0.22	0.00058	392	6.90
	8/28/2018	Background	310	59.7	19.4	15.6	2.87	60.8	44.6	0.096	0.203	0.24	0.0006	398	6.90
	10/3/2018	Background	309	60.7	18.9	15.3	2.72	62.5	43.4	0.125	0.2	0.21	0.0005	402	6.80
	10/24/2018	Background	302	61.5	18.4	15.0	2.76	68.3	42.0	0.1	0.2	0.23	0.0006	400	6.90
	11/13/2018	Background	304	64.9	19.8	14.0	3.24	57.4	44.6	0.111	0.2	0.24	0.0007	390	6.70
	12/19/2018	Background	324	55.8	17.7	14.1	2.8	57.4	41.7	0.07	0.1	0.23	0.0007	376	6.70
	1/23/2019	Background	309	54.1	17.8	15.0	2.77	54.8	41.3	0.08	0.1	0.22	0.0006	411	6.60
	2/19/2019	Background	325	55.8	17.3	15.1	2.92	67.4	40.4	0.09	0.1	0.24	0.0006	406	7.00
	MW-6 Intrawell Prediction Limit		- -	**70.6**	**21.4**	- -	- -	- -	**48.0**	**0.159**	- -	**0.264**	- -	**424**	**6.30**
	3/12/2019	Detection	314	57.9	17.4	14.7	2.69	65.5	39.8	0.08	0.1	0.23	- -	390	6.90
	11/8/2019	Detection	308	56.6	17.2	15.3	2.84	66.1	41.7	0.079	0.201	0.24	- -	368	6.93

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			Major Ions							Minor Ions					
Monitoring Well	**Collection Date**	**Monitoring Program**	**Bicarbonate (Alkalinity as $CaCO_3$)**	**Calcium**	**Chloride**	**Magnesium**	**Potassium**	**Sodium**	**Sulfate**	**Boron**	**Bromide**	**Fluoride**	**Molybdenum**	**TDS**	**pH**
			mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**s.u.**
MW-6	5/11/2020	Detection	295	55.8	15.9	15.3	2.65	69.0	32.6	0.088	0.1	0.25	- -	416	7.04
MW-6	10/27/2020	Detection	274	53.4	16.5	14.5	2.91	64.8	38.6	0.089	- -	0.28	- -	384	7.10
MW-6	1/7/2021	Verification	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.30	- -	- -	7.05
MW-7	07/26/2018	Background	314	1.33	5.41	0.175	0.59	138	32	0.087	0.096	0.27	0.00112	368	8.53
MW-7	08/29/2018	Background	306	1.29	5.32	0.159	1.15	133	31.5	0.112	0.09	0.27	0.00106	387	8.75
MW-7	10/03/2018	Background	312	1.44	5.23	0.162	0.91	147	31.8	0.156	0.1	0.26	< 0.001	376	8.75
MW-7	10/24/2018	Background	309	1.4	5.37	0.203	0.94	154	31.7	0.09	0.1	0.27	< 0.001	344	8.82
MW-7	11/13/2018	Background	318	1.49	5.65	0.169	1.45	135	33.2	0.192	0.1	0.29	< 0.001	379	8.36
MW-7	12/17/2018	Background	323	1.24	5.29	0.173	0.73	155	32	0.1	0.09	0.27	< 0.001	387	8.62
MW-7	01/23/2019	Background	330	1.41	5.18	0.191	1.04	128	32	0.127	0.08	0.25	< 0.001	389	8.44
MW-7	02/18/2019	Background	325	1.37	5.39	0.181	0.78	154	32.1	0.06	0.09	0.26	< 0.001	401	8.96
MW-7	**MW-7 Intrawell Prediction Limit**		- -	**1.63**	**5.80**	- -	- -	- -	**33.6**	**0.248**	- -	**0.304**	- -	**458**	**8.00**
MW-7	3/13/2019	Detection	308	1.47	5.5	0.185	0.650	162	32.5	0.060	0.090	0.27	- -	385	8.88
MW-7	11/8/2019	Detection	295	2.18	5.4	1.54	1.760	139	32.3	0.066	0.100	0.25	- -	390	8.69
MW-7	2/11/2020	Verification	- -	1.39	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
MW-7	5/11/2020	Detection	284	1.59	5.3	0.286	0.7	143	23.6	0.067	0.08	0.27	- -	395	8.39
MW-7	10/28/2020	Detection	295	1.81	5.34	0.44	0.9	144	31.2	0.065	- -	0.31	- -	387	8.93
MW-7	1/6/2021	Verification	- -	1.53	- -	- -	- -	- -	- -	- -	- -	0.31	- -	- -	8.99
MW-8	7/26/2018	Background	518	2.15	- -	0.291	0.86	260	- -	0.233	0.504	- -	0.0117	- -	8.48
MW-8	8/2/2018	Background	494	- -	105	- -	- -	- -	21.6	- -	0.462	2.70	- -	690	8.20
MW-8	8/30/2018	Background	509	1.99	109	0.401	1.99	243	24.2	0.225	0.495	2.66	0.0206	727	8.90
MW-8	10/3/2018	Background	477	2.74	108	0.323	1.12	280	31.6	0.259	0.491	2.58	0.00876	729	7.86
MW-8	10/23/2018	Background	504	2.32	108	0.313	1.53	280	26.3	0.278	0.490	2.74	0.0102	717	8.45
MW-8	11/13/2018	Background	488	2.46	116	0.272	1.54	249	27.2	0.254	0.517	2.93	0.00764	711	8.15
MW-8	12/19/2018	Background	501	2.28	110	0.297	1.09	264	26.4	0.224	0.495	2.78	0.00693	696	8.45
MW-8	1/23/2019	Background	485	2.39	111	0.351	1.13	245	30.1	0.213	0.423	2.62	0.011	739	8.08
MW-8	2/20/2019	Background	492	2.49	111	0.307	0.88	270	26.4	0.195	0.471	2.87	0.008 J	740	9.15
MW-8	**MW-8 Intrawell Prediction Limit**		- -	**3.06**	**120**	- -	- -	- -	**36.5**	**0.320**	- -	**3.11**	- -	**798**	**7.00**
MW-8	3/12/2019	Detection	493	2.32	110	0.292	0.78	296	27.4	0.192	0.519	2.87	- -	716	8.49
MW-8	11/8/2019	Detection	484	1.98	109	0.30	1	263	22.5	0.197	0.6	2.97	- -	717	8.31
MW-8	5/12/2020	Detection	457	1.83	108	0.262	0.8	263	19.9	0.191	0.432	2.73	- -	720	7.31
MW-8	5/12/2020	Detection (Duplicate)	468	1.89	109	0.278	0.9	273	20.1	0.191	0.433	2.74	- -	715	7.31
MW-8	10/26/2020	Detection	457	8.47	508	1.65	2.84	510	37.4	0.215	2.7	3.07	- -	1400	8.44
MW-8	1/6/2021	Verification	- -	2.46	107	- -	- -	- -	18.3	- -	- -	- -	- -	729	8.20
MW-9	7/26/2018	Background	417	1.03	- -	0.172	0.64	171	- -	0.157	0.04 J	0.87	0.00731	- -	8.00
MW-9	8/2/2018	Background	394	- -	7.22	- -	- -	- -	12.9	- -	< 0.05	- -	- -	421	8.27
MW-9	8/30/2018	Background	416	1.04	7.21	0.214	0.93	165	12.2	0.128	0.04 J	0.86	0.00628	468	9.17
MW-9	10/2/2018	Background	427	1.44	7.6	0.851	1.26	178	12.6	0.145	0.04 J	0.83	0.00607	513	7.14
MW-9	10/23/2018	Background	409	1.07	7.26	0.463	0.96	180	12.8	0.141	0.04 J	0.87	0.00593	460	9.28
MW-9	11/13/2018	Background	415	1.24	7.29	0.55	1.21	161	11.9	0.166	0.04 J	0.91	0.00606	449	9.29
MW-9	12/20/2018	Background	398	1.03	7.11	0.183	0.76	176	15.7	0.114	< 0.04	0.84	0.00651	435	9.17
MW-9	1/23/2019	Background	407	1.01	7.45	0.441	1.09	159	20.1	0.134	< 0.04	0.77	0.00649	484	8.74
MW-9	2/20/2019	Background	405	1.26	7.70	0.211	0.69	185	28.5	0.128	< 0.04	0.84	0.006	505	9.59
MW-9	**MW-9 Intrawell Prediction Limit**		- -	**1.63**	**8.00**	- -	- -	- -	**36.2**	**0.192**	- -	**0.976**	- -	**640**	**6.10**
MW-9	3/12/2019	Detection	400	1.18	7.50	0.174	0.52	195	24	0.122	< 0.04	0.91	- -	463	9.40
MW-9	11/8/2019	Detection	389	1.02	7.72	0.168	0.6	179	19.1	0.133	0.10 J	0.83	- -	440	8.77
MW-9	5/13/2020	Detection	377	0.96	7.27	0.126	0.6	179	12	0.122	< 0.04	0.82	- -	459	8.98
MW-9	10/29/2020	Detection	373	1.44	6.93	1.47	1.6	190	11.1	0.128	< 0.04	0.9	- -	459	7.14
MW-1801A	7/24/2018	Background	312	62.5	9.64	24.9	2.39	38.6	49.4	0.274	0.09	0.10 J	0.00497	372	7.56
MW-1801A	8/29/2018	Background	339	64.0	10.8	27.4	2.54	46.1	54.8	0.288	0.109	0.11	0.00307	420	7.43
MW-1801A	10/2/2018	Background	294	61.0	7.48	23.0	2.2	39.6	46.7	0.137	<0.1	0.10 J	0.00479	356	7.42
MW-1801A	10/24/2018	Background	298	63.1	8.14	22.8	2.29	39.4	41.8	0.105	<0.1	0.10 J	0.00208	357	7.45

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May 2021

			Major Ions							Minor Ions					
Monitoring Well	Collection Date	Monitoring Program	Bicarbonate (Alkalinity as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum	TDS	pH
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
MW-1801A	11/14/2018	Background	332	65.4	9.86	25.8	2.26	45.8	49.3	0.236	<0.1	0.10 J	0.00234	386	7.29
	12/19/2018	Background	307	62.8	9.08	24.9	2.82	46	45.5	0.289	0.08	0.12	0.00277	361	7.27
	1/24/2019	Background	319	53.4	9.18	24.4	2.3	42.7	46.3	0.168	0.06	0.14	0.00222	365	6.33
	2/20/2019	Background	296	53.3	8.96	21.8	2.42	41	40	0.09	0.05	0.13	0.00357	343	8.01
	MW-1801A Intrawell Prediction Limit		- -	**75.4**	**12.40**	- -	- -	- -	**61.2**	**0.459**	- -	**0.16**	- -	**518**	**5.9**
	3/12/2019	Detection	291	51.2	9.40	19.7	2.05	52.5	41.7	0.090	0.05	0.16	- -	306	7.45
	3/12/2019	Detection (Duplicate)	300	52.1	9.18	20.0	2.07	52.6	40.8	0.090	0.05	0.15	- -	342	7.45
	11/11/2019	Detection	317	61.6	9.76	25.5	2.07	50.3	45.3	0.229	0.1	0.12	- -	385	7.38
	11/11/2019	Detection (Duplicate)	344	63.7	9.63	26.5	2.12	49.9	45.2	0.261	0.1	0.11	- -	387	7.38
	5/13/2020	Detection	288	52.6	9.93	20.7	2.55	43.4	34.6	0.105	0.05	0.13	- -	353	7.60
	5/13/2020	Detection (Duplicate)	290	52.8	10.30	20.7	2.56	49.8	34.4	0.086	0.05	0.15	- -	365	7.60
	11/4/2020	Detection	332	62.4	8.84	27.4	2.39	44.1	41.5	0.244	0.1 J	0.12	- -	385	7.26
	11/4/2020	Detection (Duplicate)	341	62.8	8.89	27.6	2.4	44.4	41.7	0.242	0.1	0.12	- -	401	7.26
MW-1804A	7/27/2018	Background	< 1	28.1	- -	7.61	2.45	113	- -	0.672	0.5	- -	0.136	- -	7.50
	8/1/2018	Background	367	- -	3.87	- -	- -	- -	35.2	- -	0.04	0.70	- -	423	7.39
	8/28/2018	Background	395	15.9	5.27	4.03	2.82	157	44.7	0.779	0.08	0.84	0.136	452	8.30
	10/2/2018	Background	377	38.8	3.63	10.00	3.18	118	35.7	0.629	0.04	0.61	0.111	458	7.90
	10/23/2018	Background	423	12.9	4.79	3.22	1.9	167	36.9	0.675	0.05	0.78	0.116	452	7.60
	11/13/2018	Background	425	8.9	5.32	1.72	1.58	187	46	0.846	0.06	0.91	0.129	498	7.80
	12/19/2018	Background	446	10.1	4.51	2.14	1.91	170	40.1	0.772	0.04	0.78	0.13	433	7.90
	1/24/2019	Background	367	12.1	3.14	3.09	1.86	146	32.3	0.673	0.04	0.71	0.11	414	7.40
	2/21/2019	Background	362	7.43	3.29	1.74	1.29	164	33.8	0.611	0.04	0.89	0.115	461	8.00
	MW-1804A Intrawell Prediction Limit		- -	**51.2**	**6.93**	- -	- -	- -	**53.9**	**0.965**	- -	**1.10**	- -	**599**	**6.80**
	3/12/2019	Detection	329	10.2	3.55	2.27	1.37	165.0	34.0	0.568	<0.04	0.85	- -	411	7.90
	11/11/2019	Detection	438	6.8	11.20	1.16	0.80	211.0	85.4	0.730	0.203	0.64	- -	582	8.00
	2/12/2020	Verification	- -	- -	9.59	- -	- -	- -	69	- -	- -	- -	- -	- -	7.77
	5/14/2020	Detection	357	4.51	6.2	0.767	1.13	180	51.4	0.739	0.04	0.85	- -	484	8.13
	11/2/2020	Detection	361	4.7	7.12	0.819	1.2	187	57	0.549	0.1	0.86	- -	517	7.98
	1/6/2021	Verification	- -	- -	9.72	- -	- -	- -	69.3	- -	- -	- -	- -	- -	8.17

Table 3
Monitoring Well Water Quality Data
Fly Ash Pond Alternative Source Demonstration Investigation
AEP, John E. Amos, Winfield, WV
May 2021

			Major Ions							Minor Ions				TDS	pH
Monitoring Well	Collection Date	Monitoring Program	Bicarbonate (Alkalinity as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
MW-1806A	7/27/2018	Background	328	12.9	- -	3.19	1.63	129	- -	0.164	0.07	- -	0.017	- -	7.84
	8/1/2018	Background	331	- -	17.7	- -	- -	- -	48.4	- -	0.06	0.56	- -	426	7.60
	8/29/2018	Background	333	12.0	16.2	2.9	2.01	139	45.6	0.162	0.063	0.55	0.0142	445	8.00
	10/2/2018	Background	380	5.81	7.21	1.3	1.31	160	36.2	0.15	0.04	0.80	0.00773	435	8.50
	10/23/2018	Background	363	7.43	8.62	1.72	1.3	158	40.8	0.158	0.04	0.77	0.00666	423	8.40
	11/13/2018	Background	371	7.51	8.15	1.67	1.32	159	40.1	0.213	0.04	0.85	0.00744	442	8.10
	12/19/2018	Background	369	5.14	5.29	1.12	1.2	161	30.9	0.162	0.04	0.85	0.00602	409	8.50
	1/24/2019	Background	360	12.2	11.7	2.89	2.17	153	48.1	0.168	0.05	0.59	0.00562	445	8.10
	2/18/2019	Background	351	5.67	6.24	1.3	1.14	159	33.0	0.133	0.04	0.81	0.00474	460	8.60
	MW-1806A Intrawell Prediction Limit		- -	**18.80**	**24.60**	- -	- -	- -	**61.4**	**0.235**	- -	**1.14**	- -	**485**	**7.20**
	3/12/2019	Detection	375	4.98	5.51	1.10	0.98	180.0	32.9	0.130	0.040	0.83	- -	430	8.80
	11/12/2019	Detection	351	13.50	11.10	3.26	1.78	149.0	42.8	0.156	0.100	0.48	- -	423	7.90
	5/15/2020	Detection	363	2.32	8.45	0.451	0.90	175.0	35.2	0.127	<0.04	0.86	- -	456	8.81
	10/29/2020	Detection	363	7.38	10.20	1.580	1.25	210.0	49.7	0.153	<0.04	0.85	--	480	8.66

Notes:
Intrawell Prediction Limits are "Lower" for pH and "Upper" for all other constituents (AEP, 2020)
- - : not analyzed
< - Non-detect value, less than the Method Detection Limit
J: analyte was positively identified, though the quantitation was below the Reporting Limit
mg/L : milligrams per liter
s.u. : standard units
TDS : total dissolved solids
AEP. 2020. Annual Groundwater Monitoring Report. Appalachian Power Company, John E. Amos Plant Fly Ash Pond CCR Management Unit, Winfield, West Virginia. January.

Table 4
Ion Ratios for Key Constituents in Groundwater
Fly Ash Pond Alternative Source Demonstration Investigation
AEP, John E. Amos Plant, Winfield, WV
May 2021

	Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	Sulfate	B/Cl *100	Ca/Cl	F/Cl *1000	SO_4/Cl *1000
			mg/L	mg/L	mg/L	mg/L	mg/L				
JAFAP Pore Water											
STN-12-4 Port 1	10/28/2020	Fly Ash	7.51	159	16.5	2.38	132	455	9.6	0.14	8,000
STN-12-4 Port 2	10/28/2020	Fly Ash	2.22	94.5	19.2	0.6	105	116	4.9	0.03	5,469
STN-12-4 Port 3	10/28/2020	Fly Ash	3.79	58.2	18.1	1.35	102	209	3.2	0.07	5,635
STN-12-4 Port 4	10/28/2020	Fly Ash	4.28	77.1	20.5	5.18	104	209	3.8	0.25	5,073
STN-12-4 Port 5	10/29/2020	Fly Ash	5.56	111	36.6	7.11	243	152	3.0	0.19	6,639
STN-12-4 Port 6	10/30/2020	Fly Ash	7.14	122	36	3.37	308	198	3.4	0.09	8,556
STN-12-4 Port 7	10/30/2020	Fly Ash	8.29	145	46	4.93	347	180	3.2	0.11	7,543
Benchmark SSI Exceedances											
MW-5	10/27/2020	Detection	0.207	**9.50**	729	3.24	**25.1**	0.3	0.01	0.004	34
MW-6	10/27/2020	Detection	0.089	53.4	16.5	**0.28**	38.6	5	3.2	0.02	2,339
MW-7	10/28/2020	Detection	0.065	**1.81**	5.3	**0.31**	31.2	12	0.3	0.06	5,843
MW-1804A	11/2/2020	Detection	0.549	4.70	**7.12**	0.86	**57.0**	77	0.7	0.12	8,006
Downgradient Wells											
MW-1	11/2/2020	Detection	0.097	2.70	10.5	0.48	33.6	9	0.3	0.05	3,200
MW-2	11/2/2020	Detection	0.194	4.13	435	3.24	6.6	0	0.01	0.01	15
MW-8	10/26/2020	Detection	0.215	8.47	508	3.07	37.4	0	0.02	0.01	74
MW-9	10/29/2020	Detection	0.128	1.44	6.93	0.90	11.1	18	0.2	0.13	1,602
MW-1801A	11/4/2020	Detection	0.244	62.4	8.84	0.12	41.5	28	7.1	0.01	4,695
MW-1806A	10/29/2020	Detection	0.153	7.38	10.20	0.85	49.7	15	0.7	0.08	4,873

Notes:

Bold values indicate SSI of a constituent

B/Cl : Boron/Chloride

Ca/Cl : Calcium/Chloride

F/Cl : Fluoride/Chloride

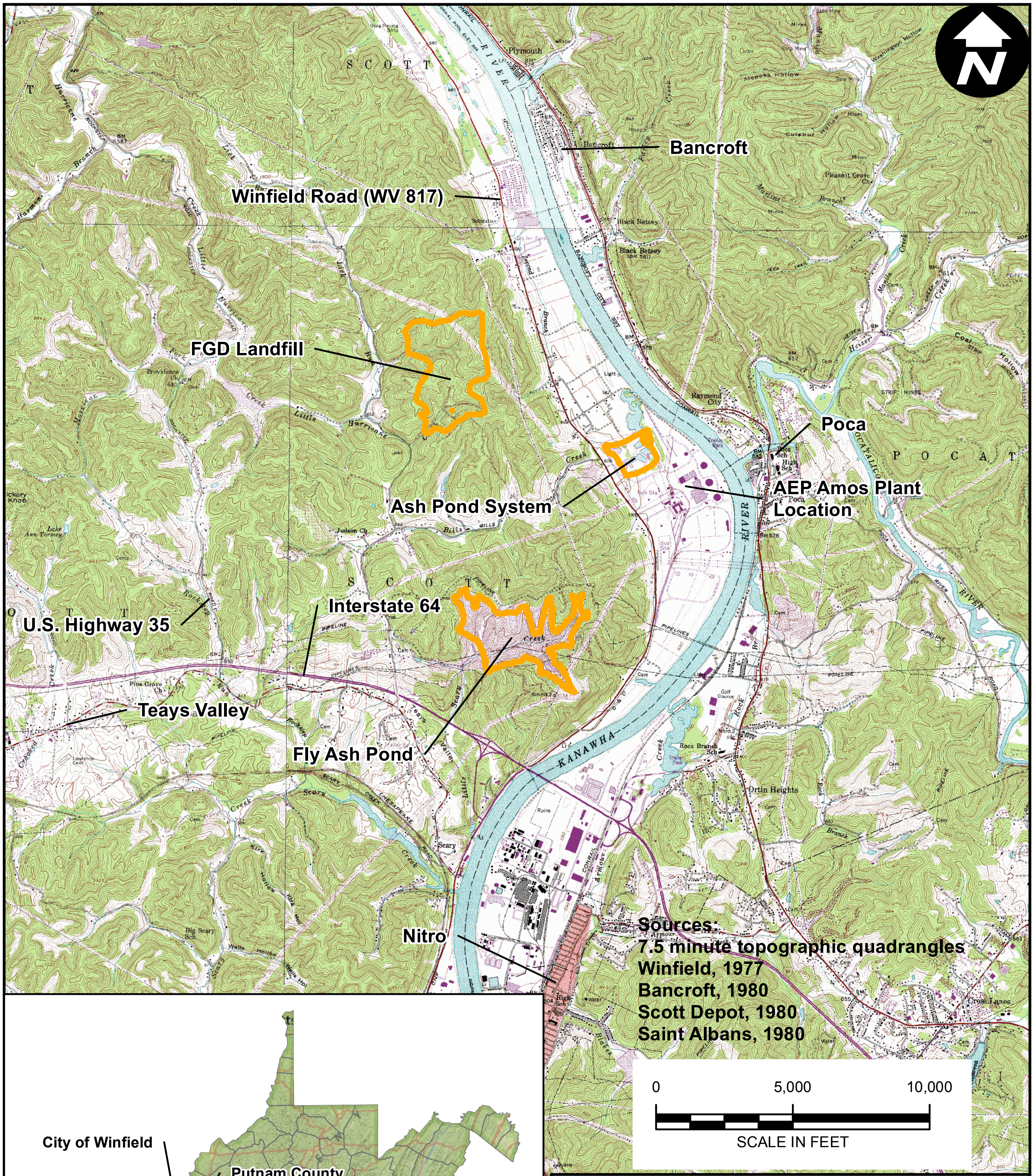
JAFAP: John E. Amos Plant Fly Ash Pond

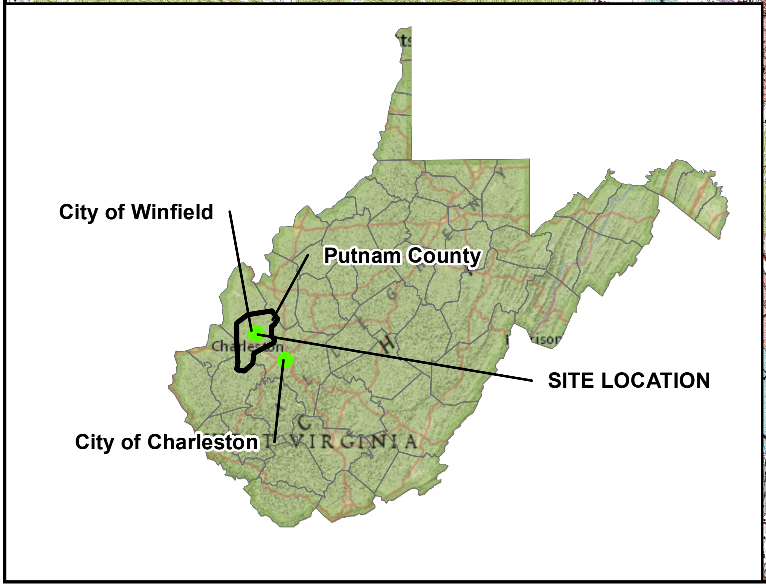
mg/L : milligrams per liter

SO_4/Cl : Sulfate/Chloride

SSI: statistically significant increase

Appendix A Site Maps





AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

SITE LOCATION MAP

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FIGURE
1

Document Path: Z:\GISProjects_ENV\AEP\Amos\mxd\Impoundment\Report\F1_ site map.mxd

LEGEND:

- Coal Combustion Residual (CCR) Unit
- Rivers and Streams
- Streamflow Direction

NOTES:
1. 2016 AERIAL IMAGERY OBTAINED FROM ESRI IMAGE SERVICE.
2. 2018 SITE SPECIFIC AERIAL IMAGERY OBTAINED FROM AEP.
3. WEST VIRGINIA 1983 STATE PLANAR COORDINATES

0 3,000 6,000 Feet
GRAPHIC SCALE

AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

PLANT AND CCR UNIT LOCATION MAP

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FIGURE 2

City: CITRIX Div/Group: IM/DV Created By: K.Ives Last Saved By: webb
OH015976.0009.00001 (Mountaineer Ash Pond)
Z:\GISProjects_ENV\AEP\Amos\mxd\ImpoundmentReport\F2_AmosRegionalMap.mxd 1/14/2019 9:27:48 AM

Well Identifiers
A – uppermost aquifer (Upper Connellsville sandstone/stress relief fracture system)
B – intermediate secondary groundwater-bearing zone (Clarksburg disconformity and fissile shale)
C – deep secondary groundwater-bearing zone (Morgantown sandstone – upper and basal disconformity contacts)

LEGEND:

- CCR Unit Boundary
- 2014 Soil and Rock Boring Location
- Oil & Gas Well
- 2008 Soil Boring and/or Rock Core
- Dewatering Well Converted to Piezometer
- Dewatering Well - Abandoned
- Downgradient Monitoring Well
- Upgradient or Background Monitoring Well
- 2012 Direct Push Boring with Cone Penetration Test (SCPTU)
- 2012 Direct Push Boring
- Piezometer
- 2012 Direct Push Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
- 2012 Direct Push Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Piezometer
- 2012 Soil Boring with Standard Penetration Tests and Rock Core
- Rivers and Streams
- Stream Flow Direction
- Access Road

NOTES:
1. 2018 aerial imagery obtained from AEP.
2. FAP monitor well, STN boring, B-1401, and B-1402 coordinate source: AEP Drawing No. 13-30702-1
3. FAP piezometer and 2008 soil boring coordinate source: AEP-provided boring logs
4. Oil and gas well coordinate source: WVDEP Oil and Gas Well Database
5. West Virginia 1983 State Planar Coordinates

0 600 1,200 Feet
GRAPHIC SCALE

AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

FLY ASH POND LAYOUT AND WELL LOCATIONS MAP

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FIGURE
3

City: Div/Group: Created By: Last Saved By: acarlone
Project (Project #)
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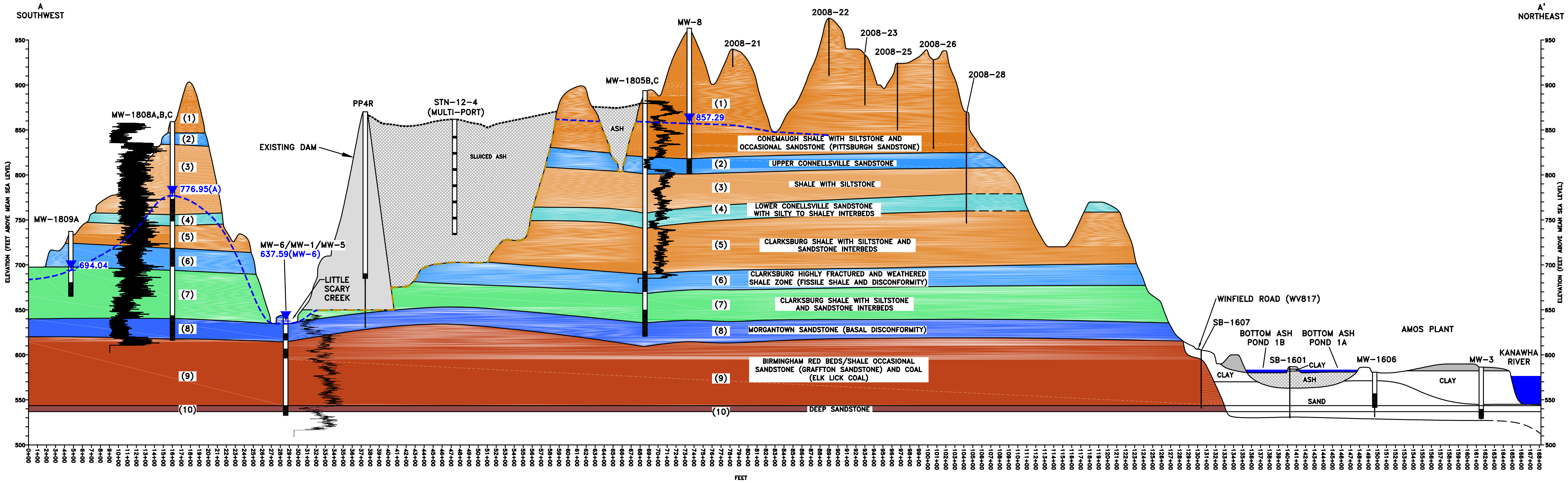
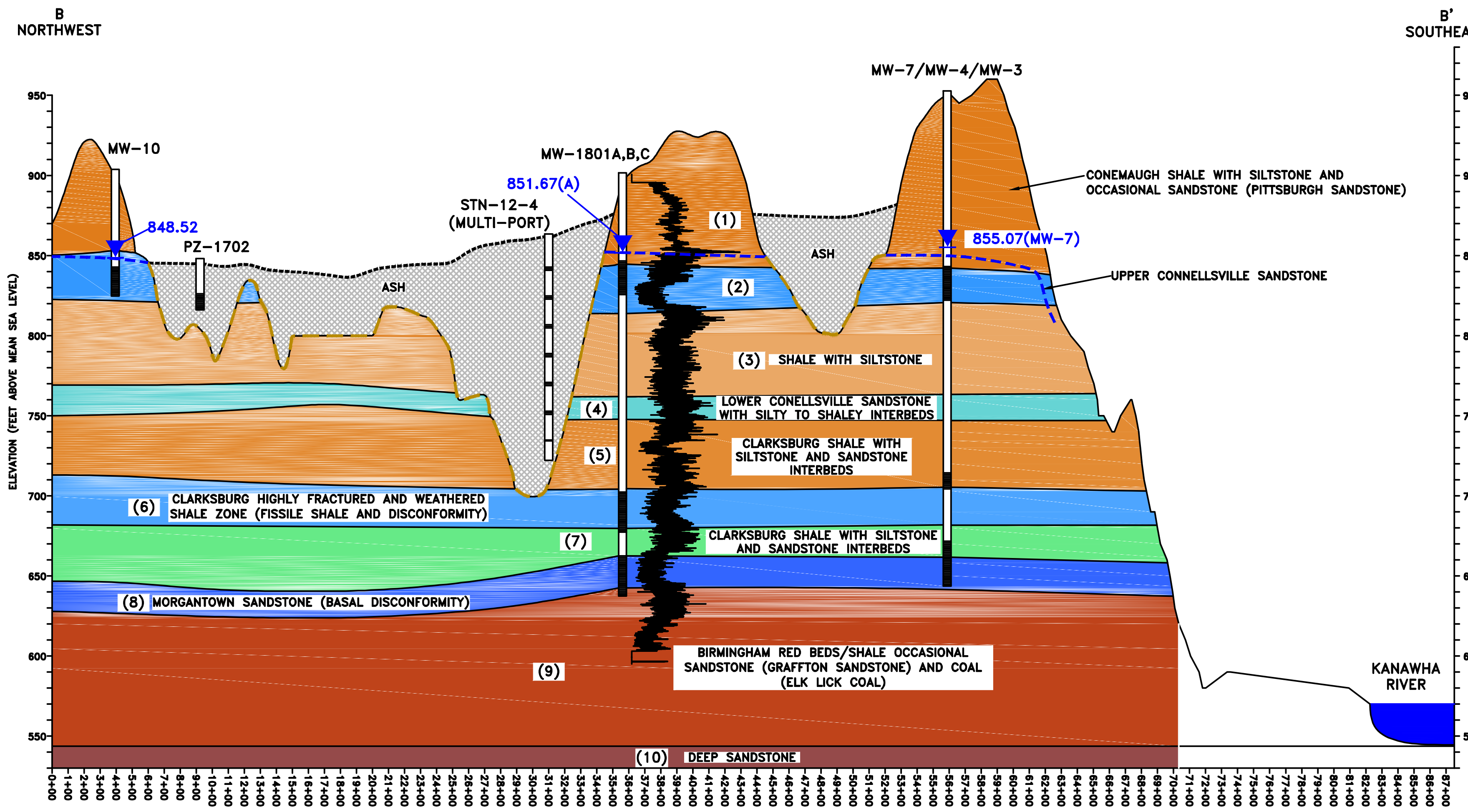
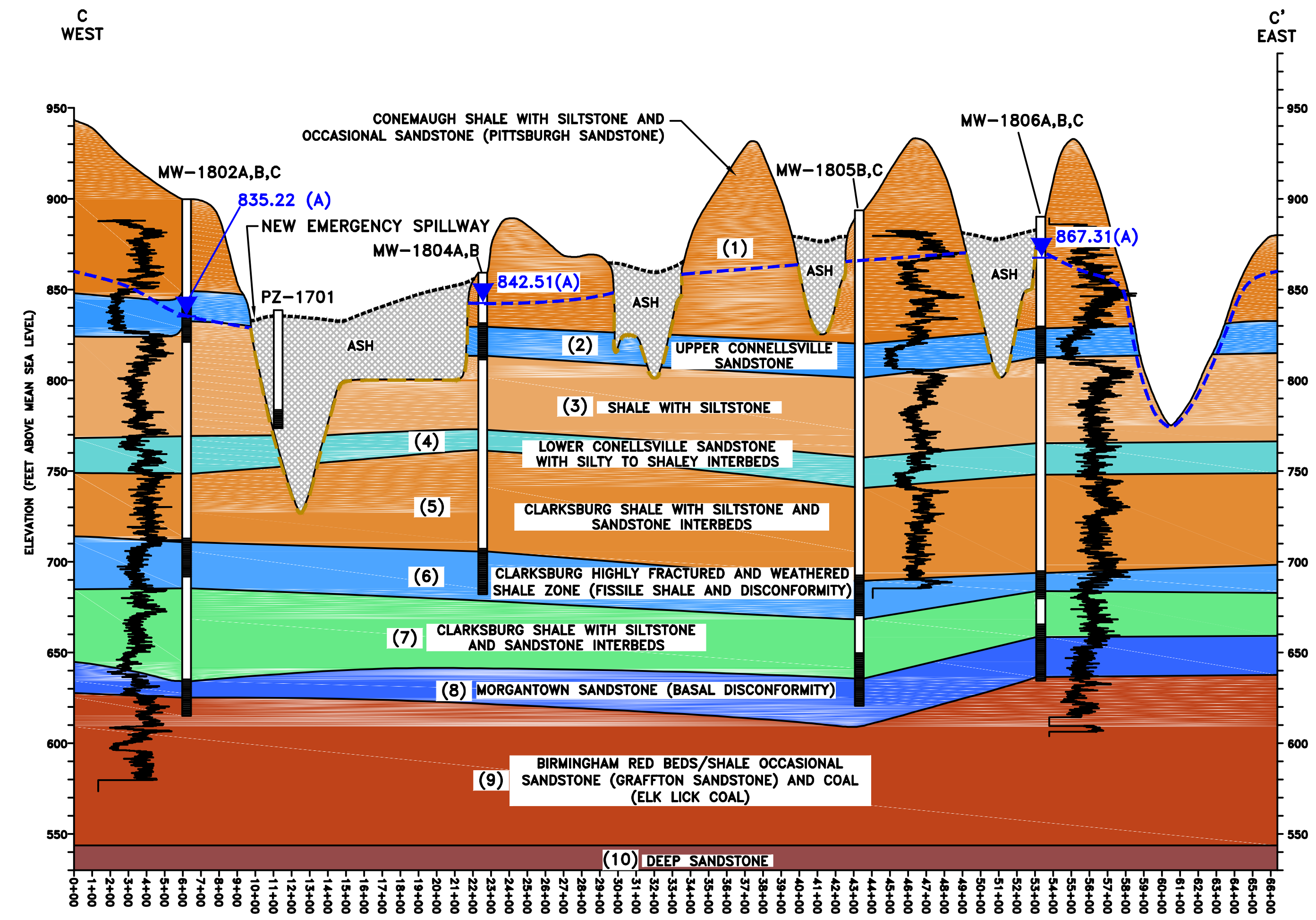
Appendix B Geologic Cross-Sections







LEGEND

MW-9 — WELL OR BORING IDENTIFICATION

— WELL
— WELL SCREEN
— BORING

CAP CONSTRUCTION (BOTTOM TO TOP):
- SUBGRADE PREPARATION (IN-PLACE FLY ASH AND ONSITE BORROW MATERIAL DEWATERING, EXCAVATING, GRADING)
- 40-MIL LINEAR LOW-DENSITY POLYETHYLENE (LLDPE) FLEXIBLE MEMBRANE LINER
- 8oz. GEOTEXTILE CUSHION LAYER
- 18 INCHES OF PROTECTIVE SOIL COVER LAYER
- 6 INCHES OF VEGETATIVE COVER LAYER
- DRAINAGE STRUCTURES
- SEEDING AND MULCHING

UPPERMOST AQUIFER (UPPER CONNELLSVILLE SANDSTONE AND SRF) MONITORING WELL WATER LEVEL OCTOBER 22, 2018

UPPERMOST AQUIFER (UPPER CONNELLSVILLE SANDSTONE AND SRF) POTENTIOMETRIC SURFACE

UPPERMOST AQUIFER (UPPER CONNELLSVILLE SANDSTONE AND SRF) TOP BELOW SATURATED ASH

NATURAL GAMMA LOG

0 100 200 300 COUNTS PER SECOND

(1) CONEMAUGH SHALE WITH SILTSTONE AND OCCASIONAL SANDSTONE (PITTSBURGH SANDSTONE)
(2) UPPER CONNELLSVILLE SANDSTONE
(3) SHALE WITH SILTSTONE
(4) LOWER CONELLSVILLE SANDSTONE WITH SILTY TO SHALEY INTERBEDS
(5) CLARKSBURG SHALE WITH SILTSTONE AND SANDSTONE INTERBEDS
(6) CLARKSBURG HIGHLY FRACTURED AND WEATHERED SHALE ZONE (FISSILE SHALE AND DISCONFORMITY)
(7) CLARKSBURG SHALE WITH SILTSTONE AND SANDSTONE INTERBEDS
(8) MORGANTOWN SANDSTONE (BASAL DISCONFORMITY)
(9) BIRMINGHAM RED BEDS/SHALE OCCASIONAL SANDSTONE (GRAFFTON SANDSTONE) AND COAL (ELK LICK COAL)
(10) DEEP SANDSTONE

VERTICAL SCALE: 1" = 100'
HORIZONTAL SCALE: 1" = 1000'

AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

CROSS SECTIONS A-A', B-B' AND C-C'

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FIGURE
6

CITY:(COLUMBUS, OHIO) DIV/GROUP:(ENV) DB:(R. SMITH) LD:(Opt) PIC:(Opt) PM:(T. FORTNER) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
C:\BIM\OneDrive - ARCADIS\BIM 360 Docs\AMERICAN ELECTRIC POWER\AEP AMOS FAP\2019\WV015976.0005\01-DWG\0001E\WV015976-0005-0001E-FAP-CS01.dwg LAYOUT: CS ALL SAVED: 2/1/2019 8:34 AM ACADVER: 21.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ACAD.CTB
PLOTTED: 2/1/2019 12:57 PM BY: SMITH, BOB
XREFS:

City: Div/Group: Created By: Last Saved By: akens
Project (Project #)
Z:\GISProjects_ENV\AEP\Amos\mxd\ImpoundmentReport\F5_Layout_CrossSectionLocationRevJan2019.mxd 3/29/2019 7:44:22 AM

LEGEND:

- CCR Unit Boundary
- Stormwater Pond
- 2014 Soil and Rock Boring Location
- Oil & Gas Well
- 2008 Soil Boring and/or Rock Core
- Dewatering Well Converted to Piezometer
- Dewatering Well - Abandoned
- Downgradient Monitoring Well
- Upgradient or Background Monitoring Well
- Monitoring wells for the Ash Pond CCR Unit
- 2012 Direct Push Boring with Cone Penetration Test (SCPTU)
- 2012 Direct Push Boring
- Piezometer
- 2012 Direct Push Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
- 2012 Direct Push Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Piezometer
- 2012 Soil Boring with Standard Penetration Tests and Rock Core
- Rivers and Streams
- Stream Flow Direction
- Access Road
- Cross Section Location

NOTES:

1. Topography from AEP dwg no. 13-30705-0 and 3dAMtopo_FAP11_aerial05.dgn. Contour Interval: 10 feet (2 feet within CCR unit boundary)
2. FAP monitor well, STN boring, B-1401, and B-1402 coordinate source: AEP Drawing No. 13-30702-1
3. FAP piezometer and 2008 soil boring coordinate source: AEP-provided boring logs
4. Oil and gas well coordinate source: WVDEP Oil and Gas Well Database
5. Amos Generating Plant monitor well, piezometer, and soil boring coordinate source: June 2016 AEP survey and EPRI, April 1999, Groundwater Quality at the John E. Amos Power Plant, Putnam County, West Virginia
6. West Virginia 1983 State Planar Coordinates
7. CSM = Conceptual Site Model

AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

CROSS SECTION LOCATION MAP

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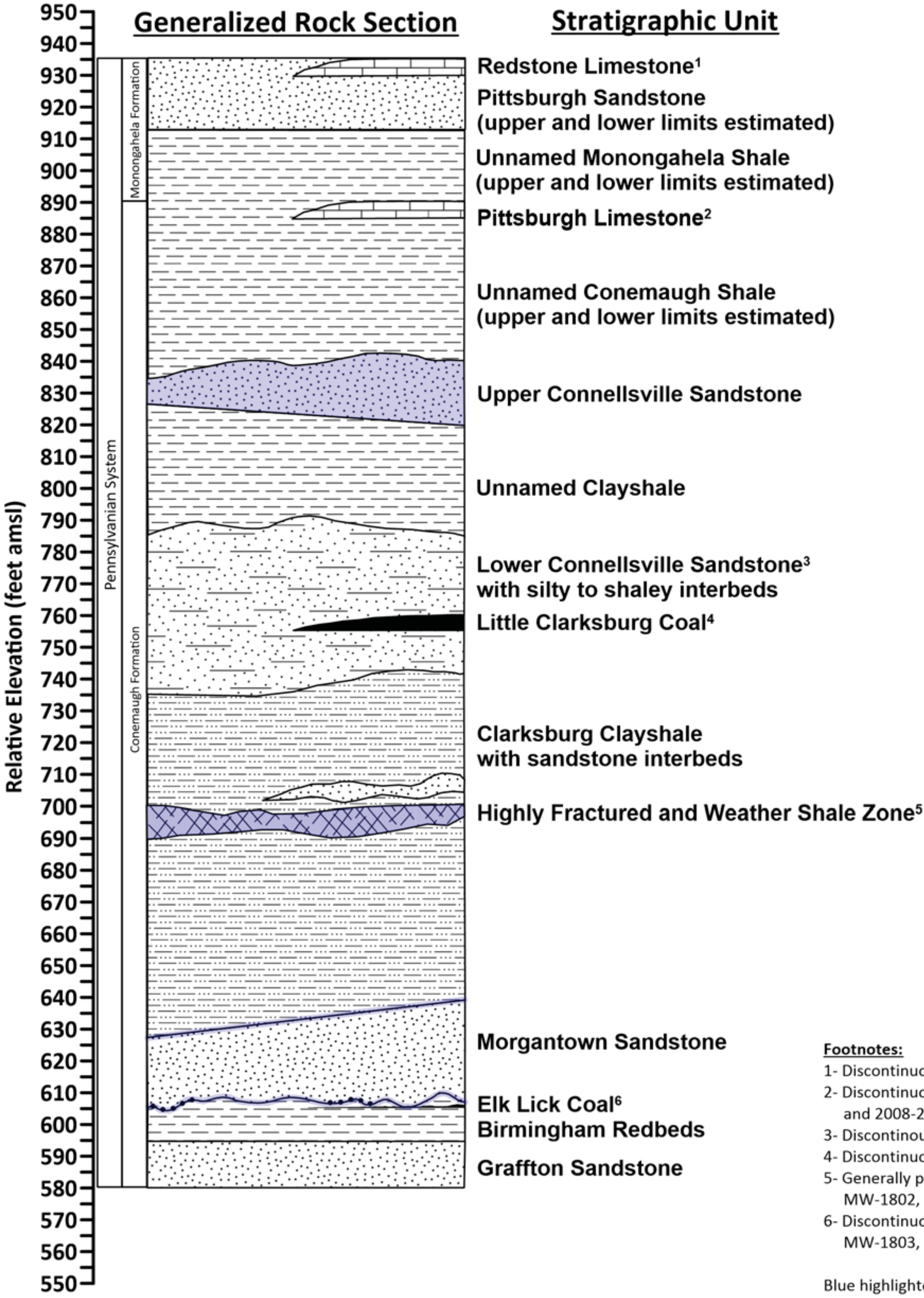
FIGURE
5



Footnotes:

1- Discontinuous - only present at boring MW-3
2- Discontinuous - only present at borings MW-3 and 2008-26
3- Discontinous - interbeds of sandstone
4- Discontinuous - only present at boring B-0608
5- Generally present at borings MW-1801, MW-1802, MW-1803, and MW-1805
6- Discontinuous and thin - present at MW-1802, MW-1803, MW-1805

Blue highlighted areas designate groundwater-bearing fracture zones

References:

- Site stratigraphic and geophysics from current data collection and historical reports.
- Cross, A.T and M.P. Shemel. 1956. *Geology and Economic Resources of the Ohio River Valley in West Virginia, Part I Geology.* West Virginia Geological Survey Volume XXII.
- Latimer, W.J., et al. 1911. *Jackson, Mason and Putnam Counties, Volume 1, County Reports and Maps*. Wheeling News Litho. Company.
- Orsborn, N.P. 2008. *Deposition and Structural Features of the Basal Morgantown Sandstone of the Casselman Formation (Pennsylvanian) of the Greater Pittsburgh Region*. MS Thesis.
- Reger, D.B., et al. 1918. *Barbour and Upshur Counties and Western Portion of Randolph, Volume 1, County Reports and Maps.* Wheeling News Litho. Company.

AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

GENERALIZED STRATIGRAPHIC COLUMN

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FIGURE
4

Appendix C Boring Logs

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER WV015976.0005

COMPANY American Electric Power

PROJECT Amos Fly Ash Pond

COORDINATES N 533,349.8 E 1,725,662.5

GROUND ELEVATION 858.5 SYSTEM NAD83/NAVD88

BORING NO. MW-1804A DATE 1/11/19 SHEET 1 OF 3

BORING START 5/21/18 BORING FINISH 5/23/18

PIEZOMETER TYPE NA WELL TYPE OW

HGT. RISER ABOVE GROUND 3.32 DIA 2"

DEPTH TO TOP OF WELL SCREEN 27.5 BOTTOM 47.5

WELL DEVELOPMENT Surge/Purge BACKFILL Bentonite Grout

FIELD PARTY Zachary Racer (AEP) RIG Direct Circulation - Wireline Core

Water Level, ft	▽ 17.9	▼	▼
TIME			
DATE	7/18/2018		

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
0	NR	0.0	14.3		0				CL ML	0-14.3': No recovery - Silty CLAY overburden.		0-27.50': Riser
							5					
												7-18.90': Bentonite Seal
							10					
1	RC	14.3	24.3		120	14	15			14.3-17.1': SHALE; weak field strength; GLEY 4/N (Dark Gray); fine-grained texture; thinly bedded; highly decomposed; moderately disintegrated, mottling; intensely fractured.		
										17.1-19.2': SANDSTONE; moderate to strong field strength; GLEY 6/N (Gray); fine-grained texture; thinly bedded; slightly decomposed; slightly fractured.	▽	
										19.2-26.5': SHALE; weak field strength; GLEY 4/N (Dark Gray); fine-grained texture; thinly		18.90-19.90': Secondary Sand

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
NA	6" x 3.25 HSA	
NA	9" x 6.25 HSA	
NA	HW CASING ADVANCER	4"
NA	NW CASING	3"
NA	SW CASING	6"
NA	AIR HAMMER	8"

Continued Next Page

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER A. Gillespie

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER **WV015976.0005**

COMPANY **American Electric Power**

PROJECT **Amos Fly Ash Pond**

BORING NO. **MW-1804A** DATE **1/11/19** SHEET **2** OF **3**

BORING START **5/21/18** BORING FINISH **5/23/18**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
1	RC	14.3	24.3		120	14				bedded; moderately decomposed; moderately disintegrated, iron staining in bedded intervals and vertical fractures; moderately fractured with iron-stained vertical fractures.		Pack (Global #6) 19.90-49': Primary Sand Pack (Global #5)
2	RC	24.3	34.3		120	7	25			26.5-29.7': Interbedded SHALE and SANDSTONE; moderate field strength; GLEY 4/N (Dark Gray); fine-grained texture; thinly bedded; slightly decomposed in some bedded intervals in the top 3' of the interval; slightly disintegrated; slightly to moderately fractured.		27.50-47.50': Slotted PVC (20-slot) Screen
							30			29.7-34.3': SANDSTONE; strong field strength; GLEY 6/N (Gray); fine-grained texture; thinly bedded; fresh; competent; unfractured.		
3	RC	34.3	44.3			NR	35			34.3-45.3': SANDSTONE; strong field strength; GLEY 6/N (Gray); fine-grained texture; thinly bedded; fresh; competent; unfractured.		
							40					
4	RC	44.4	54.4			NR	45					

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER **WV015976.0005**

COMPANY **American Electric Power**

PROJECT **Amos Fly Ash Pond**

BORING NO. **MW-1804A** DATE **1/11/19** SHEET **3** OF **3**

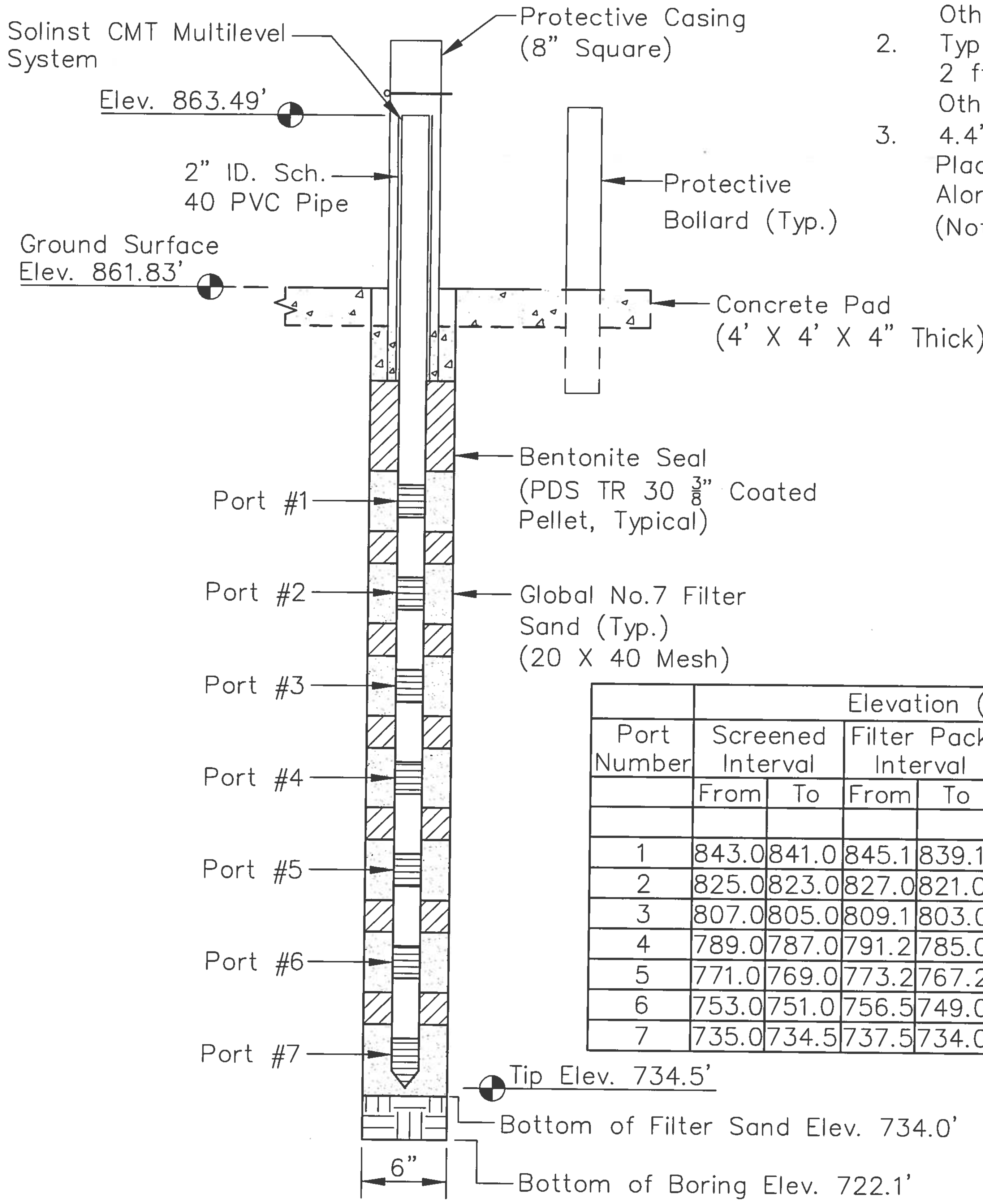
BORING START **5/21/18** BORING FINISH **5/23/18**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
4	RC	44.4	54.4			NR				45.3-49': SHALE; GLEY 4/N (Dark Gray); fine-grained texture; thinly bedded; moderately decomposed; slightly to moderately disintegrated, calcite layer from 46.8-46.9' bgs; moderately fractured.		
							50					
							55					
							60					
							65					
							70					

AEP - AEP.GDT - 1/11/19 13:55 - C:\USERS\LWOODS\DESKTOP\FOR NICOLE BORING LOGS GINT FILES\AEP MOUNTAINEER.GPJ

NOTES:

1. All Units Are in Feet Unless Noted Otherwise.
2. Typical Port Length is 2 ft. Unless Noted Otherwise.
3. 4.4" Dia. Centralizers Placed at 10ft. Spacing Along Well Tubing (Not Shown).



Port Number	Elevation (ft.) Screened Interval		Filter Pack Interval		Bentonite Seal Interval	
	From	To	From	To	From	To
					861.5	845.1
1	843.0	841.0	845.1	839.1	839.1	827.0
2	825.0	823.0	827.0	821.0	821.0	809.1
3	807.0	805.0	809.1	803.0	803.0	791.2
4	789.0	787.0	791.2	785.0	785.0	773.2
5	771.0	769.0	773.2	767.2	767.2	756.5
6	753.0	751.0	756.5	749.0	749.4	737.5
7	735.0	734.5	737.5	734.0		

PLOT DATE: 04/27/2012 USER: JENNINGS, MATTHEW
U:\1756\175661014\ENVIRONMENTAL\DRAWING\SHEET_FILES\MONITORING WELLS\STN-12-4-WELL-LOG.DWG

LOCATION:

Northing: 531,882.29
Easting: 1,726,127.18
Ground Elevation: 861.83'
Installation Date: 3/8/12
Horizontal Datum: NAD 83 WV. South
Vertical Datum: NAVD 88

PIEZOMETER DETAIL
AEP AMOS POWER PLANT, FLY ASH DAM COMPLEX
STN-12-4, WEST VIRGINIA WELL ID WV00054-0003-12

Stantec

Stantec Consulting Services Inc.
11687 Lebanon Rd.
Cincinnati, Ohio
45241-2012
513-842-8200
www.stantec.com

DRAWN BY	MSJ	DATE	4/25/12	REVISED	SHEET
CHECKED BY	JMM	PROJ. NO.	175661014	1.	3.
CHECKED BY	JSD	SCALE	NTS	2.	4.

1 OF 1

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER ________

COMPANY ________

PROJECT **EPRI GROUND WATER STUDY - AMOS**

COORDINATES **N 530,922.0 E 1,728,552.0**

GROUND ELEVATION **953.2** SYSTEM **STATE PLANE**

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **1** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

PIEZOMETER TYPE ________ WELL TYPE **OW**

HGT. RISER ABOVE GROUND **1.9** DIA **2.0**

DEPTH TO TOP OF WELL SCREEN **239.1** BOTTOM **248.0**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT**

FIELD PARTY **MCR-REL-TJH-REB** RIG **BK-81 CME-75**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
												AUGERED TO 2.0'
1	SPT	2.0	3.5	22-9-6	1.0					**LIGHT OLIVE-BROWN (5Y,5/6) SILTY FINE SAND**, ROCK FRAGMENTS, FELDSPAR, DRY		
							5					
2	SPT	7.0	7.8	28-50/4	.83					SAME, SHALE-LIKE, TRACE BLACK COAL SEAMS, DRY		
							10					
3	SPT	12.0	13.3	30-45-50/4	1.33					SAME		
1	NQ	14.2	20.8		6.5	56	15			**LIGHT OLIVE BROWN (5Y 5/6) CLAY SHALE**, WEATHERED, NUMEROUS FRACTURES, ABUNDANT FILLED FRACTURES.		RETURN WATER WENT FROM GREEN TO GRAY IN RUN #1.
										MEDIUM LIGHT GRAY (N6) LIMESTONE, LAMINATED, SLIGHTLY WEATHERED		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
X	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

Continued Next Page

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **D. BENNETT**

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **2** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
2	NQ	20.8	30.8		8.4	30				SAME EXCEPT WEATHERED AND FRACTURED		
										MODERATE BROWN (5YR4/4) CLAY SHALE, VERY WEATHERED, FRACTURED		
							25					
										MEDIUM LIGHT GRAY (N6) SANDSTONE, MEDIUM GRAINED, SLIGHTLY WEATHERED		
							30					
3	NQ	30.8	40.8		9.0	90				**MEDIUM LIGHT GRAY (N6) SANDSTONE**, MEDIUM TO COARSE GRAINED, LAMINATED, SLIGHTLY WEATHERED		
							35					
							40					
4	NQ	40.8	50.8		9.6	96				**MEDIUM GRAY (N5) COARSE SANDSTONE**, BLACK LAMINATIONS, SLIGHTLY WEATHERED		LOST WATER
							45					

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER ______

COMPANY ______

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **3** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							50					
5	NQ	50.8	60.8		10.0	64						STILL NO WATER RETURN
										MEDIUM GRAY (N5) CLAYSHALE, WEATHERED, FRACTURED		
										GRAYISH-RED (5R4/2) CLAY SHALE, WEATHERED, FRACTURED		
							55					
										MEDIUM GRAY (N5) CLAY SHALE, WEATHERED, FRACTURED		
										MEDIUM GRAY (N5) LIMESTONE		
							60			WEATHERED ZONE 60.5'-60.6 SHALEY 60.6'- 60.8'		
6	NQ	60.8	70.8		9.5	72				**MEDIUM GRAY (N5) SHALE**, SOME LAMINATIONS, SLIGHTLY WEATHERED		
							65					
										GRAYISH RED (5R4/2) CLAY SHALE, WEATHERED, SEDIMENT FILLED FRACTURES		SPORADIC GRAY WATER RETURN
							70					
7	NQ	70.8	80.8		10.0	91				**INTERBEDDED MEDIUM GRAY (N5) AND GRAYISH RED (5R4/2) SHALE**, SLIGHT TO		

Continued Next Page

JOB NUMBER ________

COMPANY ________

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **4** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										MODERATELY FRACTURED AND WEATHERED		
							75					
										MEDIUM GRAY (N5) SHALE, SLIGHTLY WEATHERED		
							80					
8	NQ	80.8	90.8		10.0	89						SPORADIC GRAY WATER RETURN
										MEDIUM GRAY (N5) SANDSTONE, MEDIUM TO COARSE GRAIN, SOME INTERBEDDED CALCITE, SLIGHTLY WEATHERED		
							85					
										MEDIUM GRAY (N5) SHALE, LAMINATED, SOFT, SLIGHT TO MODERATELY WEATHERED, FRACTURED		
							90					
9	NQ	90.8	100.8		10.0	80				**MEDIUM GRAY (N5) SHALE**, SOME LAMINATIONS, SLIGHTLY WEATHERED		SPORADIC WATER RETURN
							95					

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JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **5** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										GRAYISH RED (5Y4/2) SHALE, MODERATELY FRACTURED AND WEATHERED, SOFT		
10	NQ	100.8	110.8		9.9	89	100			SAME EXCEPT GRAYISH RED (5R5/2) AND MEDIUM GRAY (N5) SHALE, WEATHERED FROM 100.8 TO 101.2'		
										MEDIUM GRAY (N5) SHALE AND MEDIUM SANDSTONE, INTERBEDDED, LAMINATED, SLIGHTLY WEATHERED, SOME FRACTURES		
							105					
												SPORADIC WATER RETURN
11	NQ	110.8	120.8		10.0	95	110			**MEDIUM GRAY (N5) SANDSTONE**, MEDIUM TO COARSE GRAIN WITH INTERBEDDED SHALE, LAMINATED, SLIGHTLY WEATHERED		SPORADIC WATER RETURN
							115					
12	NQ	120.8	125.8		5.0	80	120			120.8 - 120.9 CLAY FILLED FRACTURE, YELLOWISH GRAY (5R7/2) 120.9 - 121.8' LIGHT OLIVE GRAY (5Y6/1) MEDIUM TO COARSE SANDSTONE, SLIGHTLY WEATHERED 121.8 - 122.2' MEDIUM DARK GRAY (N4) SHALE		RESUMED DRILLING 7-19-95 SPORADIC WATER RETURN

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **6** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							125			122.2 - 122.5' MEDIUM GRAY (N5) CLAY FILLED FRACTURE 122.5 - 124.7' MEDIUM DARK GRAY (N4) CLAY AND MEDIUM SANDSTONE INTERBEDDED, SLIGHT TO MEDIUM WEATHERED		
13	NQ	125.8	135.8		9.8	87				124.7 - 125.8 MEDIUM GRAY (N5) MEDIUM TO COARSE SANDSTONE, LAMINATIONS PRESENT 125.8 - 131.8 MEDIUM GRAY (N5) MEDIUM TO COARSE SANDSTONE, SOME LAMINATIONS, SLIGHTLY WEATHERED		SLIGHT WATER RETURN
							130			**MEDIUM DARK GRAY (N4) SHALE**, LAMINATED, SLIGHTLY WEATHERED 134.2 - 134.8' FRACTURED, WEATHERED		
14	NQ	135.8	145.8		9.9	90	135			**MEDIUM DARK GRAY (N4) TO DARK GRAY (N3) SHALE**, SLIGHT TO MODERATELY WEATHERED, LAMINATIONS PRESENT. 137.5 - 137.6' FRACTURED		
							140			140.5 - 142.2' FRACTURED		GOT GRAY WATER RETURN
15	NQ	145.8	155.8		9.7	76	145			**DARK GRAY (N3) TO DARK REDDISH BROWN (10R3/4) CLAY SHALE**, VERY WEATHERED, VERY SOFT **DARK GRAY (N3) TO DARK REDDISH BROWN (10R3/4) CLAY SHALE**, LAMINATIONS, SLIGHT TO MODERATELY WEATHERED.		

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JOB NUMBER ______

COMPANY ______

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **7** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										DARK REDDISH BROWN 10R3/4) AND GRAYISH GREEN (10Y4/2) CLAY SHALE, VERY SOFT, SLIGHTLY WEATHERED, SOME CALCITE PRESENT		
							155					
16	NQ	155.8	165.8		10.0	85				**DARK REDDISH BROWN 10R3/4 AND GRAYISH GREEN (10Y4/2) CLAY SHALE**, TRACE CALCITE, SOFT, MODERATELY FRACTURED AND WEATHERED		
							160			**MEDIUM DARK GRAY (N4) SHALE**, SOME CALCITE NODULES, SOME LAMINATIONS, SLIGHTLY WEATHERED		
							165					
17	NQ	165.8	170.8		5.0	80				**MEDIUM DARK GRAY (N4), DARK GRAY (N3) AND TRACE GRAYISH RED (10R4/2) SHALE AND FINE TO MEDIUM SANDSTONE**, INTERBEDDED, SLIGHTLY WEATHERED		
										GRAYISH BROWN (10R4/2) CLAY SHALE, MODERATELY FRACTURED AND WEATHERED.		
							170					
18	NQ	170.8	180.8		9.8	83						
							175					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **8** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										DARK GRAY (N3) SHALE, MODERATELY WEATHERED		
										GRAYISH RED (10R4/2) AND MODERATE OLIVE BROWN (5Y4/4) CLAY SHALE, SOME CALCITE VEINS, MODERATE WEATHERED AND FRACTURED.		
							180			**MEDIUM GRAY (N5) SHALE**, WITH INTERBEDDED FINE SANDSTONE, LITTLE WEATHERING		
19	NQ	180.8	190.8		10.0	91				180.5 - 190.8 SAME EXCEPT SOME CALCITE VEINS, SLIGHTLY WEATHERED		
							185					
							190					
20	NQ	190.8	200.8		9.9	82				**MEDIUM GRAY (N5) SHALE**		191.1 Top of seal.
							195					
										MEDIUM GRAY (N5) WITH DARK GRAY (N3) SEAMS OF SHALE AND CLAY SHALE, MODERATELY WEATHERED AND FRACTURED		197.3 Top of sand.
							200			200.1 - 200.4 MODERATELY BROWN (5YR 3/4)		
21	NQ	200.8	210.8		10.0	98				**MEDIUM BLUISH GRAY (5B5/1) SHALE**, CALCITE NODULES, SOME LAMINATIONS,		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION
AEP CIVIL ENGINEERING LABORATORY
LOG OF BORING

JOB NUMBER ______

COMPANY ______ BORING NO. **D=MW-04** DATE **8/27/07** SHEET **9** OF **13**

PROJECT **EPRI GROUND WATER STUDY - AMOS** BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										SLIGHT TO MODERATELY WEATHERED		
							205					
										MODERATE BROWN (5YR 3/4) CLAY SHALE, FRACTURES, SOFT		209.1 Top of screen.
							210					
22	NQ	210.8	220.8		9.95	94				**MEDIUM DARK GRAY (N4) AND MODERATE BROWN (5YR 3/4) INTERBEDDED SHALE**, SLIGHTLY WEATHERED, FRACTURED		
							215					
										MEDIUM GRAY (N5) FINE SANDSTONE, TRACE CALCITE PRESENT, SLIGHTLY WEATHERED		
							220					
23	NQ	220.8	230.8		10.0	95						
										MODERATE BROWN (5YR 3/4) CLAYEY SHALE, SLIGHTLY WEATHERED		
							225					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER ______

COMPANY ______

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										228.8 - 230.8 SAME EXCEPT WITH GRAYISH OLIVE (10Y 4/2), LAMINATIONS MODERATELY WEATHERED, FRACTURED		
24	NQ	230.8	240.8		10.0	91	230					
							235			**LIGHT BLUISH GRAY (5B 7/1) SHALE AND MEDIUM GRAIN SANDSTONE**, INTERBEDDED, SLIGHTLY WEATHERED		
25	NQ	240.8	250.8		10.0	80	240					
							245			**MEDIUM LIGHT GRAY (N6) SANDSTONE**, MEDIUM TO COARSE GRAIN, LAMINATED, CALCITE PRESENT, SLIGHTLY WEATHERED 241.8 - 242.7 SLIGHT TO MODERATE WEATHERING, FRACTURES		
										DARK GREENISH GRAY (5GY 4/1) AND MODERATE BROWN (5YR 3/4) CLAY SHALE, SOFT, MODERATELY WEATHERED, FRACTURED		248.0 Bottom of screen. 249.1 Bottom of sand.
26	NQ	250.8	259.8		9.0	38	250			250.8 - 259.8 SAME, EXCEPT SOFT TO VERY SOFT, WEATHERED, SEDIMENT FILLED FRACTURES 259.8 - 265.8 SAME, HIGHLY FRACTURED		

Continued Next Page

JOB NUMBER
COMPANY
PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **11** OF **13**
BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							255					257.0 Bottom of seal.
27	NQ	259.8	265.8		3.6	25	260					
							265					
28	NQ	265.8	269.0		1.45	11				265.8 - 269.0 SAME, HIGHLY FRACTURED, GRAYISH RED (10R 4/2) AND LIGHT OLIVE BROWN (5Y 5/6)		WATER LEVEL PRIOR TO START 7.1'
29	NQ	269.0	269.2		0	0				269.0 - 269.2 NO RECOVERY		PULLED RODS AND CORE BARREL OUT OF HOLE - BIT MISSING. RETREIVED BIT FULL INTACT.
30	NQ	269.2	271.3		.2	0	270			269.2 - 271.3 DARK YELLOWISH BROWN (10YR 4/2), WEATHERED		
31	NQ	271.3	275.5		4.2	60				**GRAYISH RED (10R 4/2) AND MODERATE OLIVE BROWN (5Y 5/6) CLAY SHALE**, SLIGHT TO MODERATELY WEATHERED, FRACTURED.		
							275					
32	NQ	275.5	282.8		7.3	96				**BROWNISH GRAY (5YR 4/1) INTERBEDDED WITH MEDIUM GRAY (N5) CLAY SHALE/SHALE**, TRACE CALCITE, MODERATELY WEATHERED, FRACTURED		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER ______

COMPANY ______

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **12** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										MEDIUM GRAY (N5) SHALE, LAMINATED		
33	NQ	282.8	290.5		7.6	99				**MEDIUM GRAY (N5) AND GRAYISH BROWN (5YR 2/2) SHALE**, INTERBEDDED WITH CLAYEY SHALE, TRACE CALCITE, LAMINATIONS, SLIGHTLY WEATHERED		
							285					
							290					
34	NQ	290.5	300.5		9.9	99				**MEDIUM GRAY (N5) FINE TO COARSE SANDSTONE**, INTERBEDDED WITH SHALE, LAMINATED, SLIGHT WEATHERING		
							295					
										298.2 - 300.5 SAME EXCEPT SHALE WITH MODERATE BROWN (5YR 4/4) AND GRAYISH BROWN (5YR 3/2), LAMINATIONS, SLIGHT WEATHERING		
							300					
35	NQ	300.5	310.5		9.45	90				**MEDIUM DARK GRAY (N4) SHALE**, SLIGHTLY WEATHERED		
										MEDIUM GRAY (N5) SANDSTONE, MEDIUM TO COARSE GRAIN, SLIGHTLY WEATHERED, TRACE CALCITE		
							305					
										305.6 - 305.7 WEATHERED, FRACTURED		

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JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-04** DATE **8/27/07** SHEET **13** OF **13**

BORING START **7/18/95** BORING FINISH **7/20/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							310			**MEDIUM DARK GRAY (N4) SHALE**, SLIGHTLY WEATHERED		
										BOTTOM OF BORING 310.5'		

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

COORDINATES **N 531,282.0 E 1,724,360.0**

GROUND ELEVATION **648.0** SYSTEM **STATE PLANE**

BORING NO. **D=MW-05** DATE **8/27/07** SHEET **1** OF **5**

BORING START **7/11/95** BORING FINISH **7/26/95**

PIEZOMETER TYPE WELL TYPE **OW**

HGT. RISER ABOVE GROUND **1.9** DIA **2.0**

DEPTH TO TOP OF WELL SCREEN **101.6** BOTTOM **111.0**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT**

FIELD PARTY **MCR-RLY=TJH-REB** RIG **BK-81 CME-75**

Water Level, ft	▽	▼	▼
TIME			
DATE			

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										AUGERED TO 2'		
1	SS	2.0	3.5	??-28-19	15"				GM	**GRAY ROCK FRAGMENTS, GRAVEL, SILT,** DRY, (FILL).		
									ML	**CLAYEY SILT AND GRAVEL**, MODERATE BROWN (5YR 3\4), Moist. AUGERED TO 7.0'		
							5					
2	SS	7.0	22.0	10-9-9	7.5"				ML	**CLAYEY SILT AND GRAVEL**, MODERATE BROWN (5YR 4\8) LIGHT BROWN (5YR 5\6 AND MODERATE BROWN (5YR 3\4), TRACE FELDSPAR, MOIST. AUGERED TO 12.0'		
							10					
3	SS	12.0	13.5	13-8-5	17"				ML	**SAME AS ABOVE**		
									CL	**SILTY CLAY**, PALE YELLOWISH BROWN (12YR 6\2) AND LIGHT OLIVE GRAY (5YR 5\2), LOW TO MEDIUM PLASTICITY, MOIST. AUGERED TO 17.0'		
							15					
4	SS	17.0	18.5	3-3-3	18"				SC	**CLAYEY-SILTY FINE SAND**, DUSKY YELLOWISH BROWN (10 YR 2\2),MOIST TO WET.		
										AUGERED TO 22.0'		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
X	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **D.BENNETT**

JOB NUMBER
COMPANY
PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-05** DATE **8/27/07** SHEET **2** OF **5**
BORING START **7/11/95** BORING FINISH **7/26/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
5	SS	22.0	23.2	7-7-50/3"	13"				SC	**SAME AS SAMPLE No. 4**		
									SW	**MEDIUM TO COARSE SAND**, LIGHT BLUISH GRAY (5B 7\1), MOIST.		
1	NQ	24.0	29.8		5.0	60				AUGERED TO 23.9' - AUGERED THROUGH OBSTRUCTION (ROCK?)		
							25			**MORGANTOWN SANDSTONE?**, GRAY. 24.0 - 25.0' Solid, light gray, (N-7) 25.0 - 26.0' Fractured, brown clay lined fractures, light gray (N-7). 26.0 - 27.0' Minimal fractures 27.0 - 27.7' Fractured, weathered, very fine dark gray (N-3) bedding. 27.7 - 29.8' Light gray (N-7) sandstone		25.0 Fracture = 8 26.0 Fracture = 3 26.5 Lost water 27.0 Fracture = 5
2	NQ	29.8	39.8		10.0	93	30			29.8 - 33.8' Light gray (N-7) sandstone		
										CLAY SHALE, MEDIUM GRAY (N4) MOIST, VERY SOFT.		
							35			**CLAY SHALE**, GRAYISH BROWN (5YR 3\2), MOIST, VERY SOFT.		35.2 Fracture = 3
										CLAY SHALE, LIGHT OLIVE GRAY (5Y 5\2) MEDIUM LIGHT GRAY (N6), SOFT, MODERATE WEATHERING.		36.3 Fracture = 3
										SHALE, MEDIUM BLUISH GRAY (5B 5\1), TRACE IRREGULAR BEDDING PLANES, SOFT.		37.3 Fracture = 2
3	NQ	39.8	49.8		9.8	67	40			**SAME AS ABOVE**		39.8 Fracture = 6
										SAME, WITH MODERATE BROWN (5YR 3\4) BEDDING PLANES, MEDIUM TO HIGHLY FRACTURED, MODERATE WEATHERING.		42.5 Fracture = 8
										SHALE, MEDIUM BLUISH GRAY 5Y 5\2), SLIGHT TO MODERATE WEATHERED		
							45			**CLAY SHALE**, PALE BROWN (5YR 5/2), TO DARK YELLOWISH BROWN (10YR 4/2) AND		44.6 numerous fractures.

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JOB NUMBER

COMPANY

BORING NO. **D=MW-05** DATE **8/27/07** SHEET **3** OF **5**

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING START **7/11/95** BORING FINISH **7/26/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										LIGHT OLIVE GRAY (5YR 4/2), SOFT, SOME IRREGULAR BEDDING PLANES		
4	NQ	49.8	56.5		4.7	54	50					
												51.0 Regained drill water
							55					
5	NQ	56.5	59.8		2.55	50				**SAME EXCEPT VERY SOFT**		56.5 Fracture = 7
6	NQ	59.8	67.3		7.5	96	60			**CLAYEY SILT**, DARK YELLOWISH BROWN (10yr 4\2), MOIST - WET		
										SAME, VERY WEATHERED, SOFT		
										CLAY SHALE, PALE BROWN (5YR 5\2), SLIGHTLY WEATHERED		
							65					
										SAME, SOME MODERATELY WEATHERED, SOFT		
7	NQ	67.3	69.8		2.5	40				**SAME**, VERY WEATHERED, VERY SOFT		
										SAME, MODERATELY WEATHERED, SOFT		68.0 Fracture = 5
										SHALE, MEDIUM GRAY (N5), SOFT.		
8	NQ	69.8	78.8		6.8	64	70			**SAME**		
										CLAY SHALE, PALE BROWN (YR 5\2) AND		71.6 Fracture = 12

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER ______

COMPANY ______

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-05** DATE **8/27/07** SHEET **4** OF **5**

BORING START **7/11/95** BORING FINISH **7/26/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										MEDIUM GRAY (N5), MODERATELY WEATHERED, SOFT.		
							75					
9	NQ	78.8	79.8		1.0	40				**SHALE**, PALE BROWN (5YR 5\2) AND LIGHT OLIVE GRAY (5Y 5\2), IRREGULAR BEDDING, WEATHERED, SOFT.		78.8 numerous fracture.
10	NQ	79.8	87.8		6.3	48	80			**SAME**, SOME SEDIMENT FILLED FRACTURES		
							85					86.0 Top of seal.
11	NQ	87.8	89.8		2.0	75				**SHALE**, GRAYISH OLIVE (10 YR 4\2) AND MODERATE BROWN (5YR 3\4), INTERBEDDED LAYERS, SOFT, SLIGHTLY WEATHERED.		
12	NQ	89.8	90.8		.75	0	90			**SAME**, EXCEPT WEATHERED		
13	NQ	90.8	99.8		9.0	100				**SHALE**, MEDIUM BLUISH GRAY (5B 5\1), WITH SOME INTERBEDDED BROWNISH GRAY (5YR 4\1) COLOR, SLIGHTLY WEATHERED, SOFT		91.0 Top sand.
							95					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-05** DATE **8/27/07** SHEET **5** OF **5**

BORING START **7/11/95** BORING FINISH **7/26/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
14	NQ	99.8	100.3		.25	0	100			**SAME**, EXCEPT WEATHERED		Lost water return on run #14.
15	NQ	100.3	109.8		9.5	95				**SHALE**, MEDIUM BLUISH GRAY 5B 5\1), SLIGHTLY WEATHERED, SOFT		101.6 Top of screen.
										SANDSTONE, MEDIUM BLUISH GRAY (5B 5\1), SLIGHTLY WEATHERED AT 104', SOFT.		
							105					
16	NQ	109.8	114.8		4.4	40	110			**SAME**, SOFT		
										SHALE, MEDIUM BLUISH GRAY (5B 5\1), SOFT.		111.0 Bottom of screen.
										SHALE, MEDIUM DARK GRAY, SOFT, WEATHERED, VERY FRACTURED.		112.0 Fracture = 7 112.1 Bottom of sand.
										CLAY SHALE, GRAYISH BROWN (5YB 3\2), WEATHERED, SOFT TO VERY SOFT, FRACTURED.		
										114.8 BOTTOM OF HOLE		114.7 Bottom of seal.

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER ______

COMPANY ______

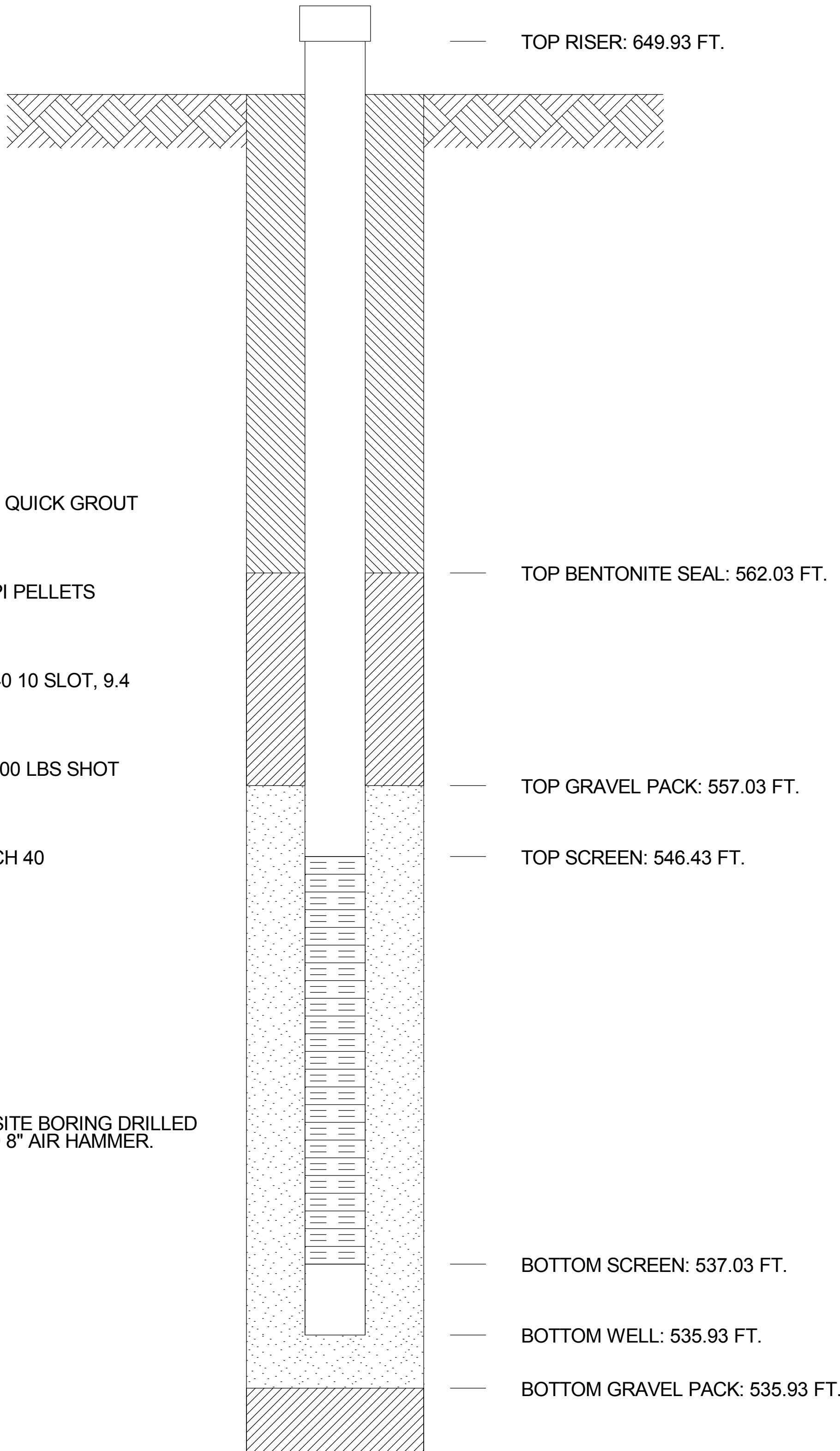
WELL No. **MW-5** BORING No. **D=MW-05** INSTALLED **7/26/95**

PROJECT **EPRI GROUND WATER STUDY - AMOS**

COORDINATES **N 531,282.0 E 1,724,360.0**

SYSTEM **STATE PLANE**

GROUND ELEVATION 648.03 FT.



GROUT SEAL: 600 GALLONS QUICK GROUT

BENTONITE SEAL: 100 LBS PI PELLETS

SCREEN: 2.0 dia., PVC SCH 40 10 SLOT, 9.4

GRAVEL PACK: 500 LBS #5 200 LBS SHOT

RISER PIPE: 2.0, dia., PVC SCH 40

SPACERS, DEPTH:

FLY ASH DAM CLUSTERED SITE BORING DRILLED USING 10" CASING AND 8" AIR HAMMER.

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

COORDINATES **N 531,266.0 E 1,724,352.0**

GROUND ELEVATION **647.5** SYSTEM **STATE PLANE**

BORING NO. **D=MW-06** DATE **8/27/07** SHEET **1** OF **5**

BORING START **8/20/95** BORING FINISH **8/21/95**

PIEZOMETER TYPE WELL TYPE **OW**

HGT. RISER ABOVE GROUND **1.95** DIA **2.0**

DEPTH TO TOP OF WELL SCREEN **28.5** BOTTOM **33.5**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT**

FIELD PARTY **TJH-REB** RIG **CME-75**

Water Level, ft	▽	▼	▼
TIME			
DATE			

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
									AUGERED TO 2'		
								GM	**GRAY ROCK FRAGMENTS, GRAVEL, SILT,** DRY, (FILL).		
								ML	**CLAYEY SILT AND GRAVEL**, MODERATE BROWN (5YR 3\4), Moist.		
									AUGERED TO 7.0'		
							5				
								ML	**CLAYEY SILT AND GRAVEL**, MODERATE BROWN (5YR 4\8) LIGHT BROWN (5YR 5\6 AND MODERATE BROWN (5YR 3\4), TRACE FELDSPAR, MOIST.		
									AUGERED TO 12.0'		
							10				
								ML	**SAME AS ABOVE**		
								CL	**SILTY CLAY**, PALE YELLOWISH BROWN (12YR 6\2) AND LIGHT OLIVE GRAY (5YR 5\2), LOW TO MEDIUM PLASTICITY, MOIST.		
									AUGERED TO 17.0'		
							15				
								SC	**CLAYEY-SILTY FINE SAND**, DUSKY YELLOWISH BROWN (10 YR 2\2),MOIST TO WET.		
									AUGERED TO 22.0'		

TYPE OF CASING USED

	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **D. BEMMETT**

JOB NUMBER ______

COMPANY ______

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-06** DATE **8/27/07** SHEET **2** OF **5**

BORING START **8/20/95** BORING FINISH **8/21/95**

DEPTH IN FEET	USCS	SOIL / ROCK IDENTIFICATION	DRILLER'S NOTES
	SC	**SAME AS SAMPLE No. 4**	22.5 Top of seal.
25	SW	**MEDIUM TO COARSE SAND**, LIGHT BLUISH GRAY (5B 7\1), MOIST. AUGERED TO 23.9' - AUGERED THROUGH OBSTRUCTION (ROCK?) **MORGANTOWN SANDSTONE?**, GRAY. 24.0 - 25.0' Solid, light gray, (N-7) 25.0 - 26.0' Fractured, brown clay lined fractures, light gray (N-7). 26.0 - 27.0' Minimal fractures 27.0 - 27.7' Fractured, weathered, very fine dark gray (N-3) bedding. 27.7 - 29.8' Light gray (N-7) sandstone	27.2 Top of sand. 28.5 Top of screen.
30		29.8 - 33.8' Light gray (N-7) sandstone	
35		**CLAY SHALE**, MEDIUM GRAY (N4) MOIST, VERY SOFT.	33.5 Bottom of screen. 34.2 Bottom of sand.
		CLAY SHALE, GRAYISH BROWN (5YR 3\2), MOIST, VERY SOFT.	
		CLAY SHALE, LIGHT OLIVE GRAY (5Y 5\2) MEDIUM LIGHT GRAY (N6), SOFT, MODERATE WEATHERING.	
		SHALE, MEDIUM BLUISH GRAY (5B 5\1), TRACE IRREGULAR BEDDING PLANES, SOFT.	
40		**SAME AS ABOVE**	
		SAME, WITH MODERATE BROWN (5YR 3\4) BEDDING PLANES, MEDIUM TO HIGHLY FRACTURED, MODERATE WEATHERING.	
		SHALE, MEDIUM BLUISH GRAY 5Y 5\2), SLIGHT TO MODERATE WEATHERED	
45		**CLAY SHALE**, PALE BROWN (5YR 5/2), TO DARK YELLOWISH BROWN (10YR 4/2) AND	

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-06** DATE **8/27/07** SHEET **3** OF **5**

BORING START **8/20/95** BORING FINISH **8/21/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										LIGHT OLIVE GRAY (5YR 4/2), SOFT, SOME IRREGULAR BEDDING PLANES		
							50					
							55					
										SAME EXCEPT VERY SOFT		
							60			**CLAYEY SILT**, DARK YELLOWISH BROWN (10yr 4\2), MOIST - WET		
										SAME, VERY WEATHERED, SOFT		
										CLAY SHALE, PALE BROWN (5YR 5\2), SLIGHTLY WEATHERED		
							65					
										SAME, SOME MODERATELY WEATHERED, SOFT		
										SAME, VERY WEATHERED, VERY SOFT		
										SAME, MODERATELY WEATHERED, SOFT		
										SHALE, MEDIUM GRAY (N5), SOFT.		
							70			**SAME**		
										CLAY SHALE, PALE BROWN (YR 5\2) AND		

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JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-06** DATE **8/27/07** SHEET **4** OF **5**

BORING START **8/20/95** BORING FINISH **8/21/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										MEDIUM GRAY (N5), MODERATELY WEATHERED, SOFT.		
							75					
										SHALE, PALE BROWN (5YR 5\2) AND LIGHT OLIVE GRAY (5Y 5\2), IRREGULAR BEDDING, WEATHERED, SOFT.		
							80			**SAME**, SOME SEDIMENT FILLED FRACTURES		
							85					
										SHALE, GRAYISH OLIVE (10 YR 4\2) AND MODERATE BROWN (5YR 3\4), INTERBEDDED LAYERS, SOFT, SLIGHTLY WEATHERED.		
							90			**SAME**, EXCEPT WEATHERED		
										SHALE, MEDIUM BLUISH GRAY (5B 5\1), WITH SOME INTERBEDDED BROWNISH GRAY (5YR 4\1) COLOR, SLIGHTLY WEATHERED, SOFT		
							95					

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JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-06** DATE **8/27/07** SHEET **5** OF **5**

BORING START **8/20/95** BORING FINISH **8/21/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							100			**SAME**, EXCEPT WEATHERED		
										SHALE, MEDIUM BLUISH GRAY 5B 5\1), SLIGHTLY WEATHERED, SOFT		
										SANDSTONE, MEDIUM BLUISH GRAY (5B 5\1), SLIGHTLY WEATHERED AT 104', SOFT.		
							105					
							110			**SAME**, SOFT		
										SHALE, MEDIUM BLUISH GRAY (5B 5\1), SOFT.		
										SHALE, MEDIUM DARK GRAY, SOFT, WEATHERED, VERY FRACTURED.		
										CLAY SHALE, GRAYISH BROWN (5YB 3\2), WEATHERED, SOFT TO VERY SOFT, FRACTURED.		
										114.8 BOTTOM OF HOLE		

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

COMPANY

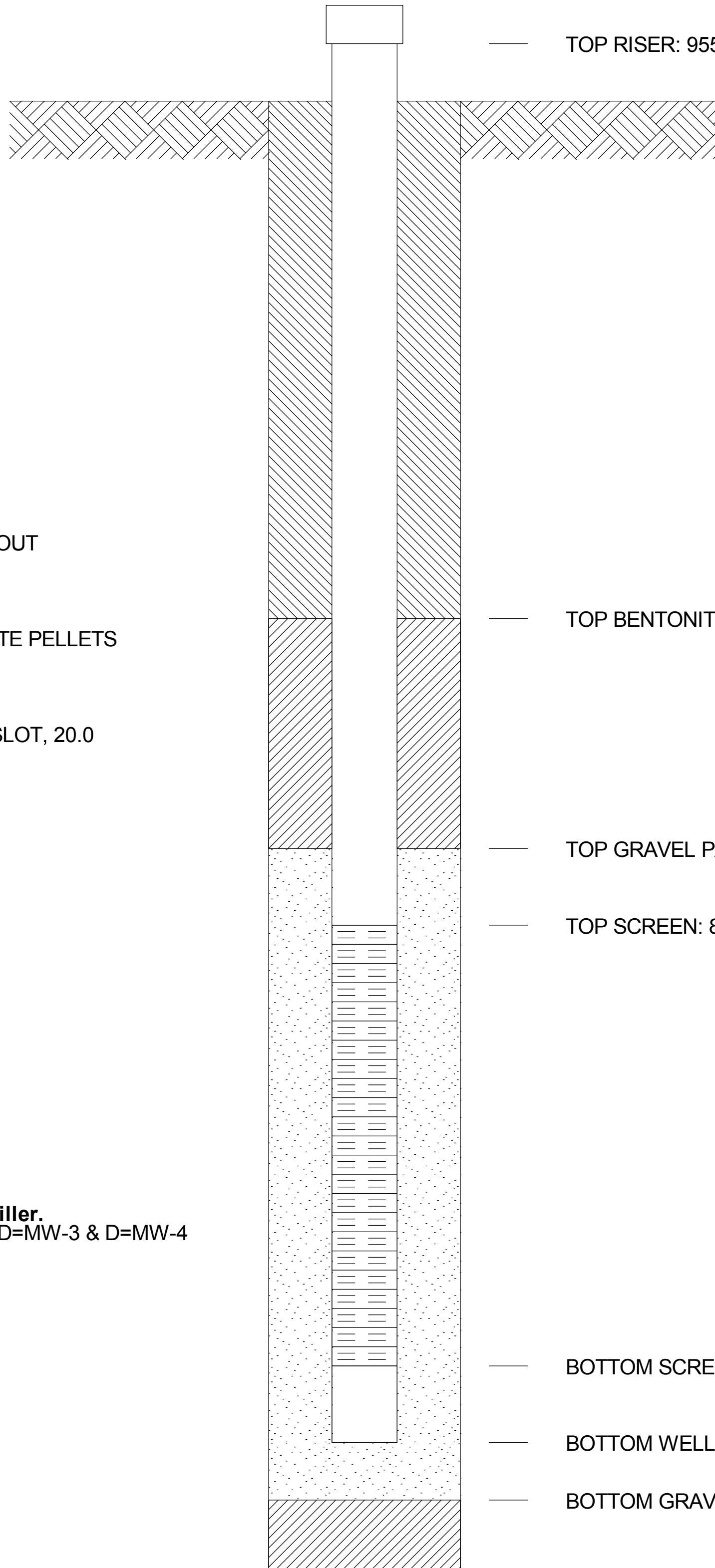
WELL No. **MW-7** BORING No. **D=MW-07** INSTALLED **3/26/96**

PROJECT **EPRI GROUND WATER STUDY - AMOS**

COORDINATES **N 530,938.0 E 1,788,533.0**

SYSTEM

GROUND ELEVATION 953.00 FT.



GROUT SEAL: VOLCLAY GROUT

BENTONITE SEAL: BENTONITE PELLETS

SCREEN: 2.0 dia., PVC .020 SLOT, 20.0

GRAVEL PACK: SAND

RISER PIPE: 2.0, dia., PVC

SPACERS, DEPTH:

Well installed by contract driller.
WELL IS CLUSTERED WITH D=MW-3 & D=MW-4

Used 4 centralizers
Top 3' - Sakcrete

GEOMCNST EPRI_AMOS.GPJ AEP.GDT 6/14/13

Appendix D Potential Indicator Temporal Plots

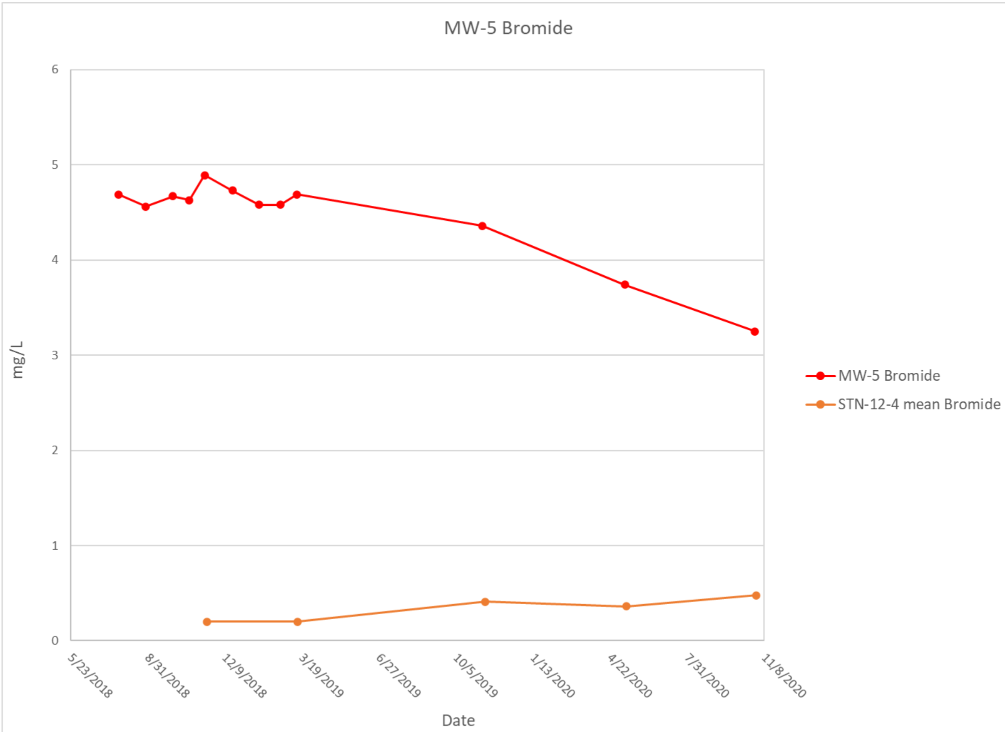


Figure D-1 MW-5 Bromide Concentrations

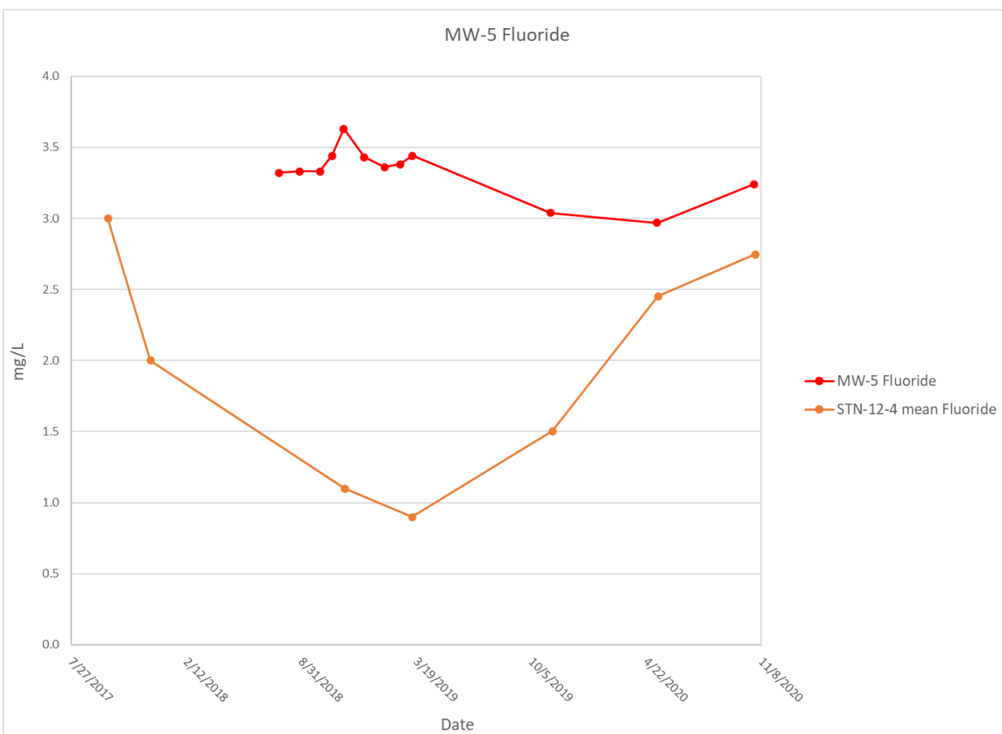


Figure D-2 MW-5 Fluoride Concentrations

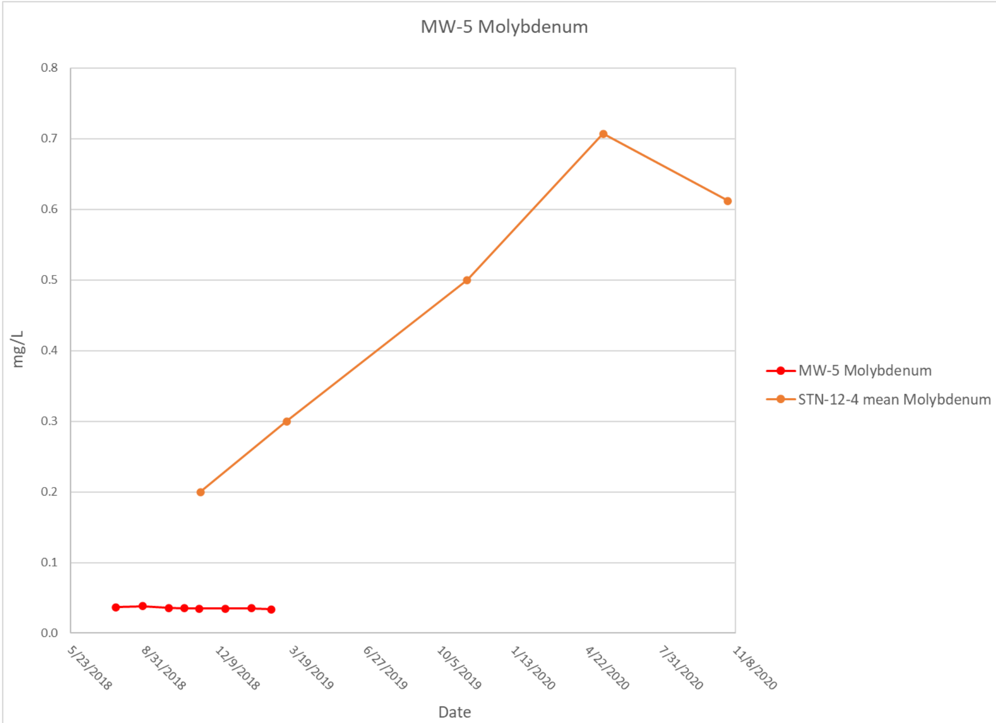


Figure D-3 MW-5 Molybdenum Concentrations

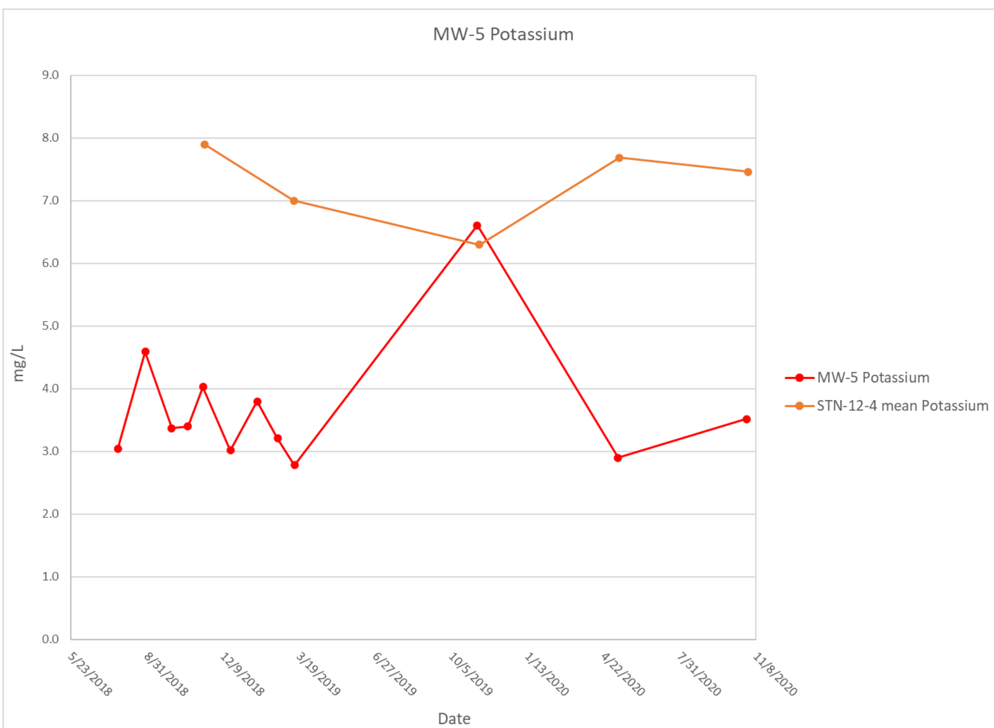


Figure D-4 MW-5 Potassium Concentrations

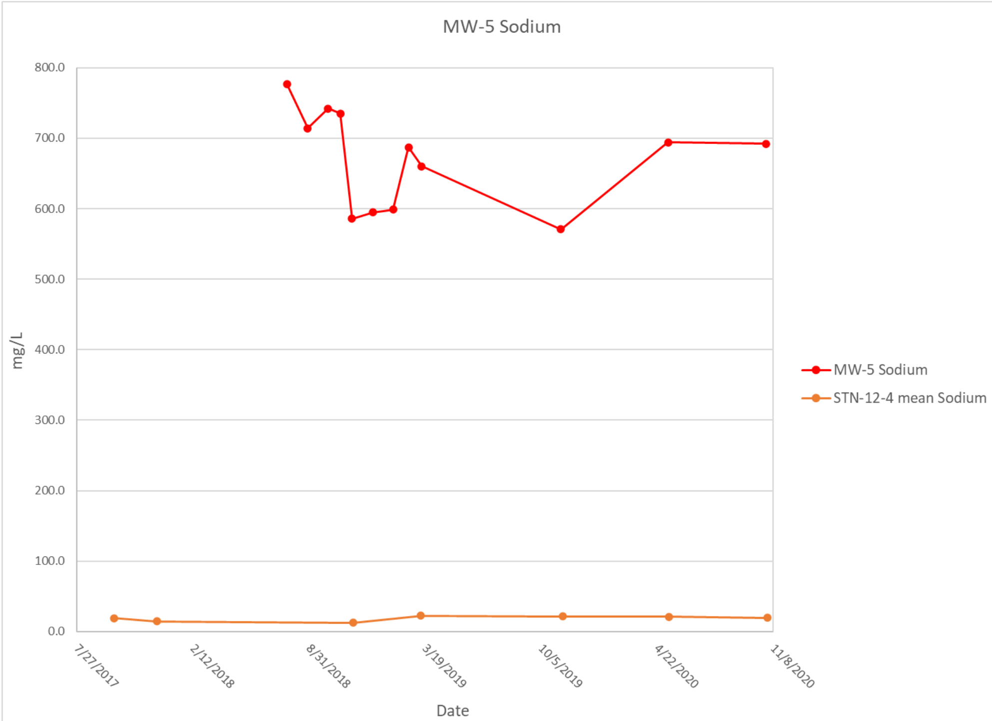


Figure D-5 MW-5 Sodium Concentrations

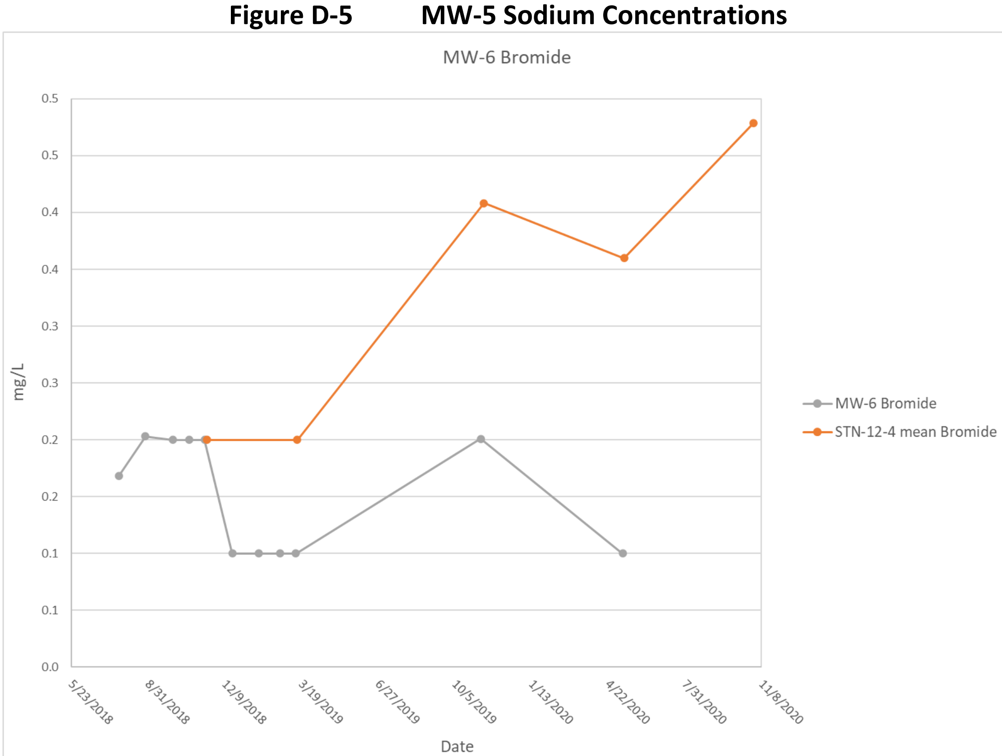


Figure D-6 MW-6 Bromide Concentrations

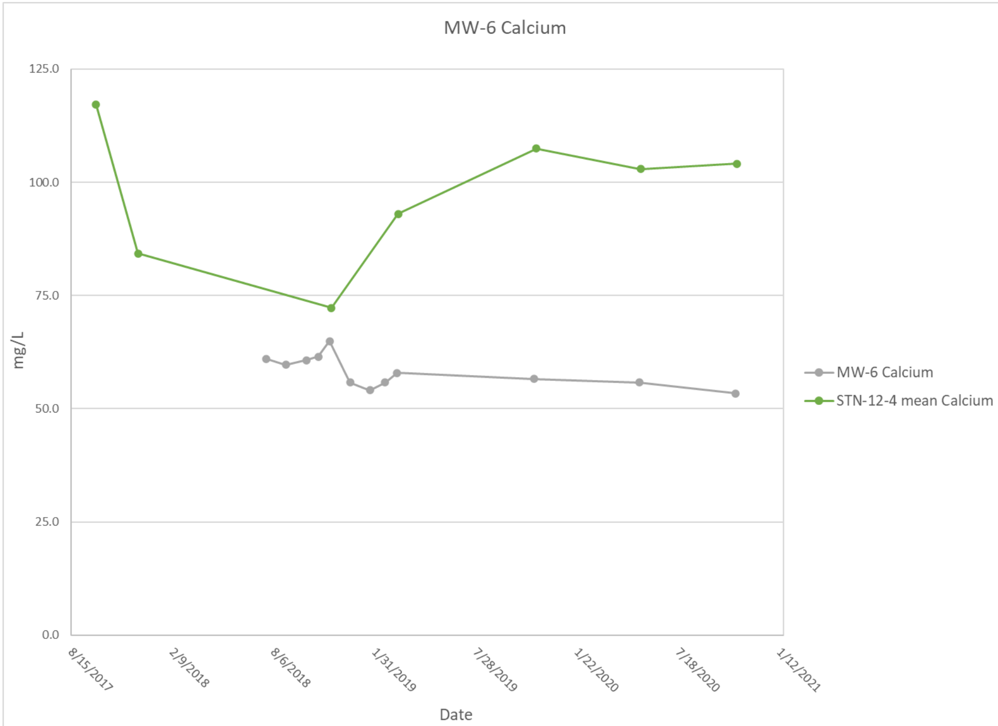


Figure D-7 MW-6 Calcium Concentrations

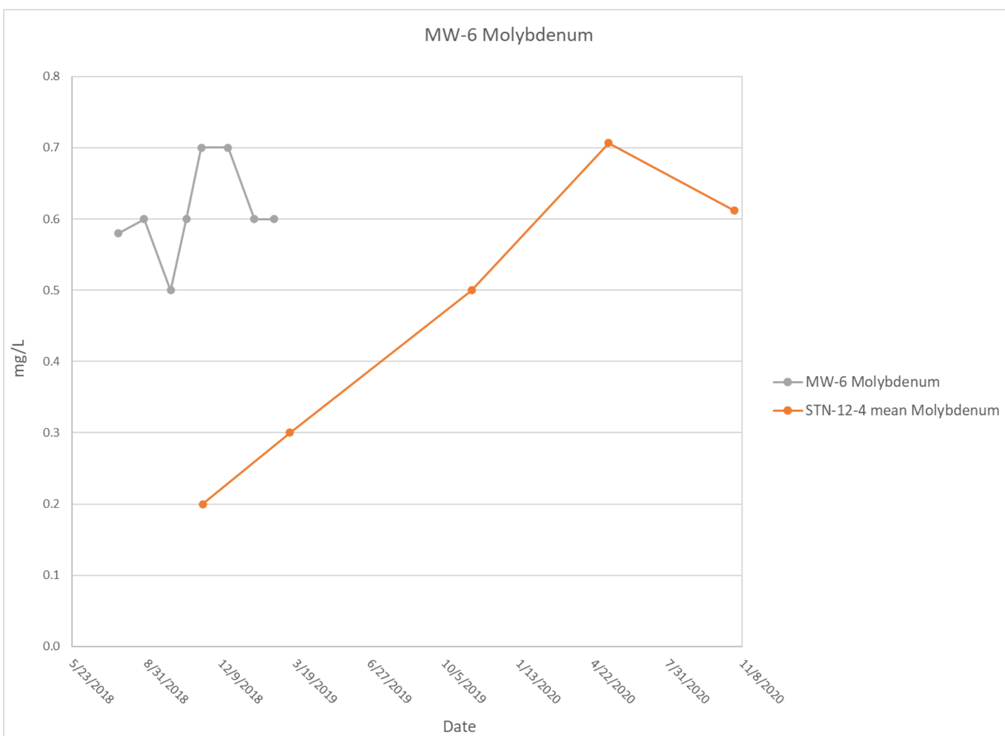


Figure D-8 MW-6 Molybdenum Concentrations

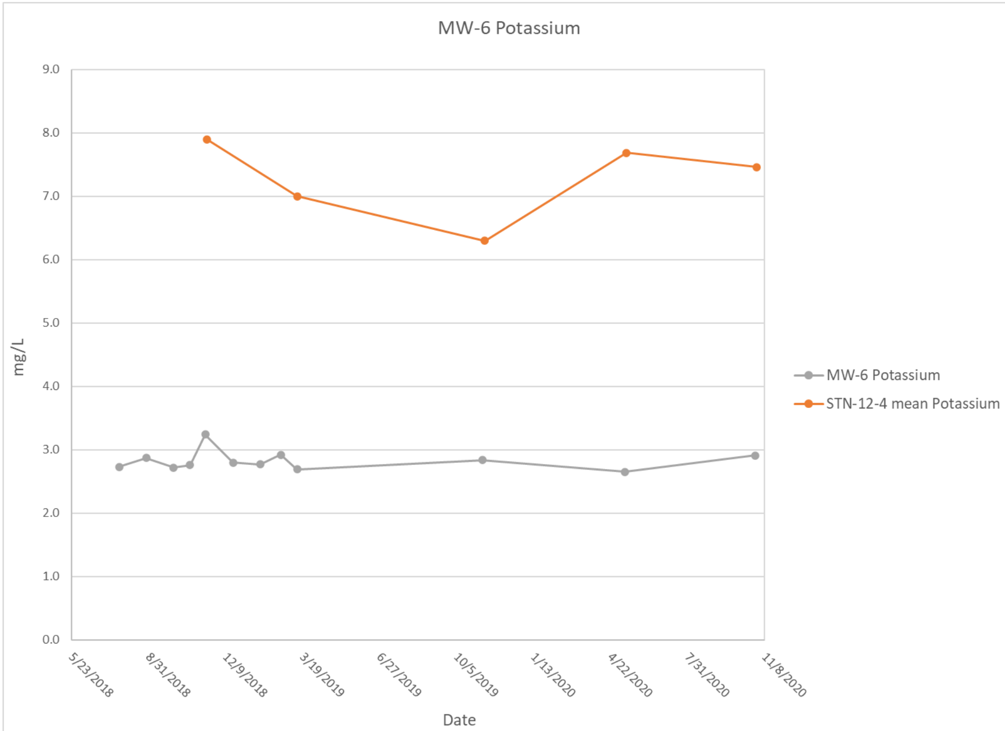


Figure D-9 MW-6 Potassium Concentrations

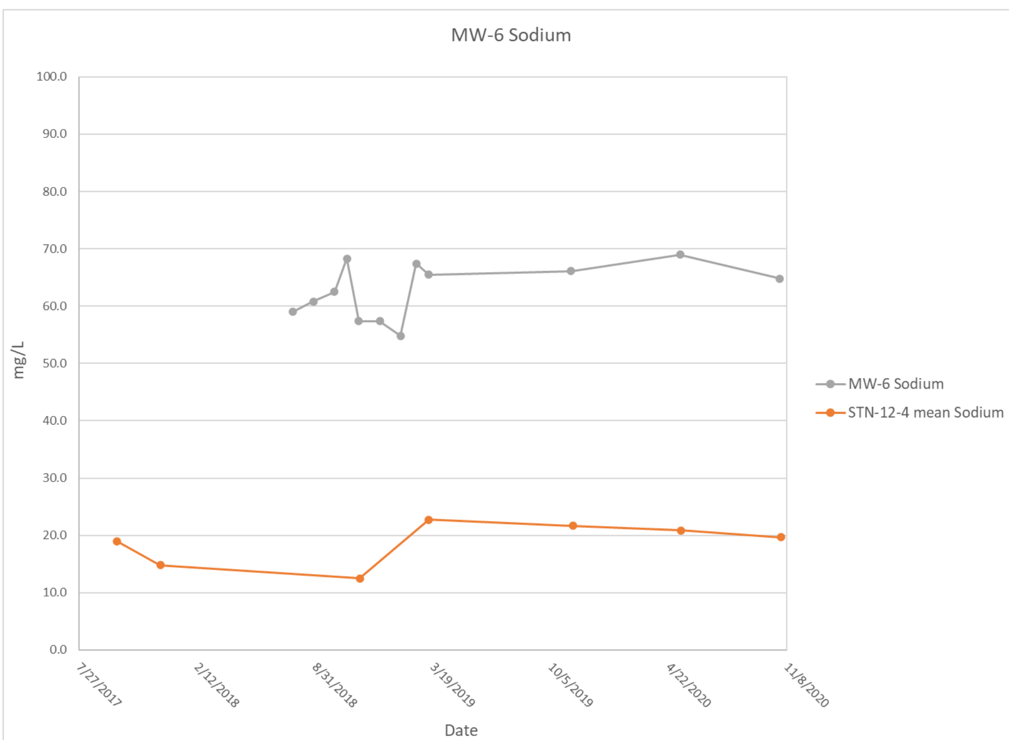


Figure D-10 MW-6 Sodium Concentrations

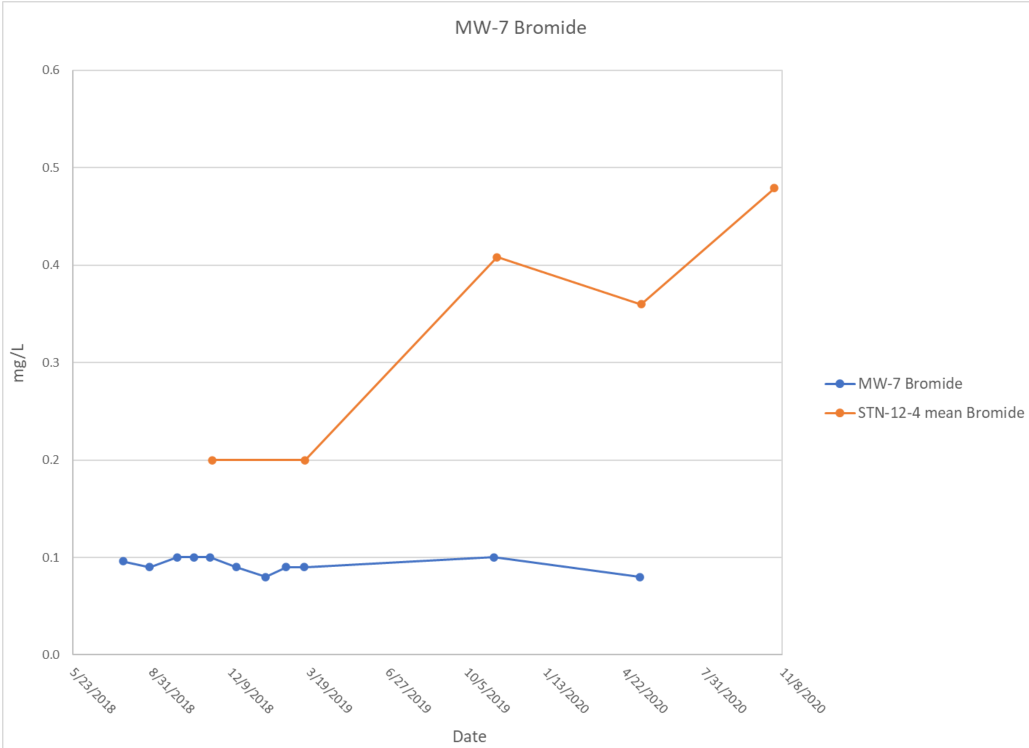


Figure D-11 MW-7 Bromide Concentrations

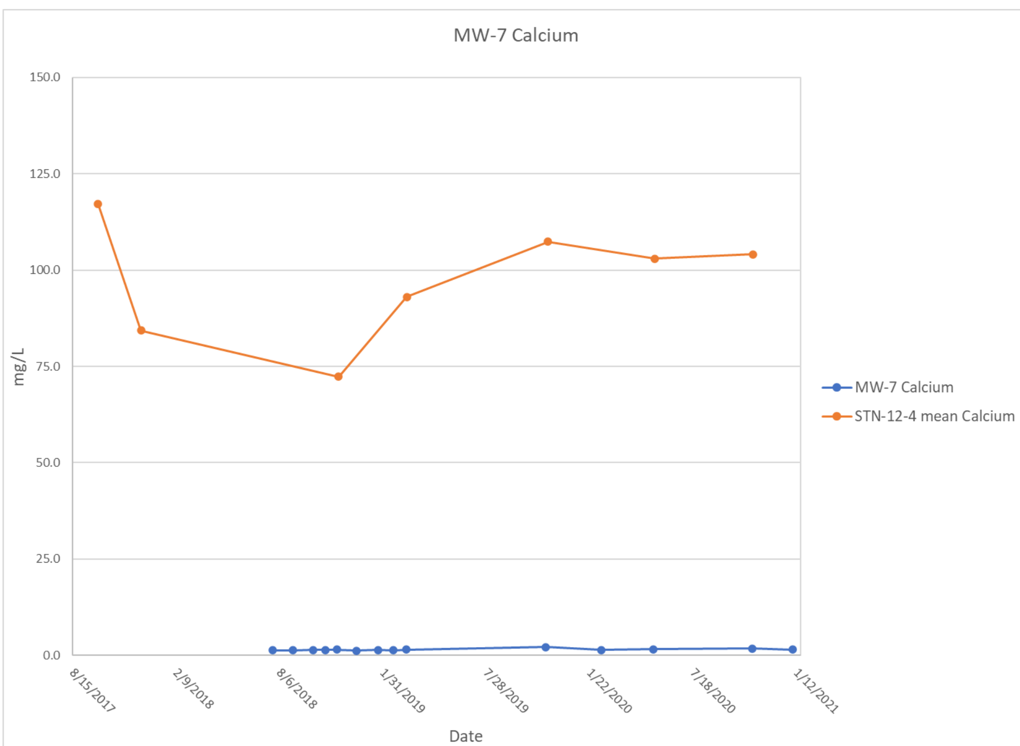


Figure D-12 MW-7 Calcium Concentrations

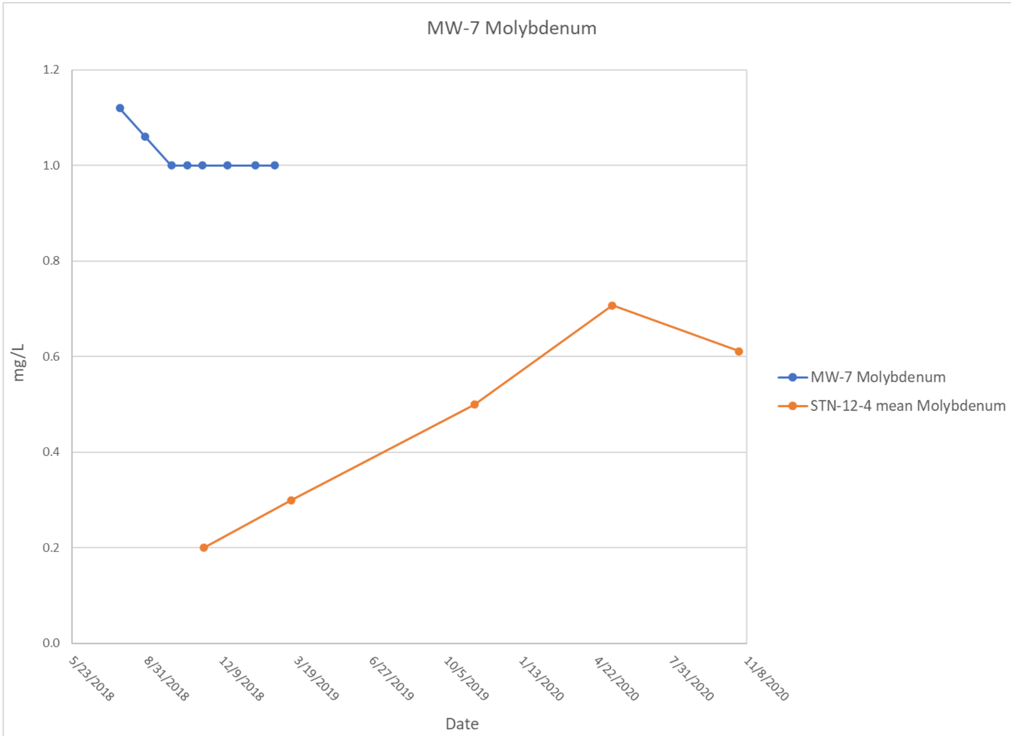


Figure D-13 MW-7 Molybdenum Concentrations

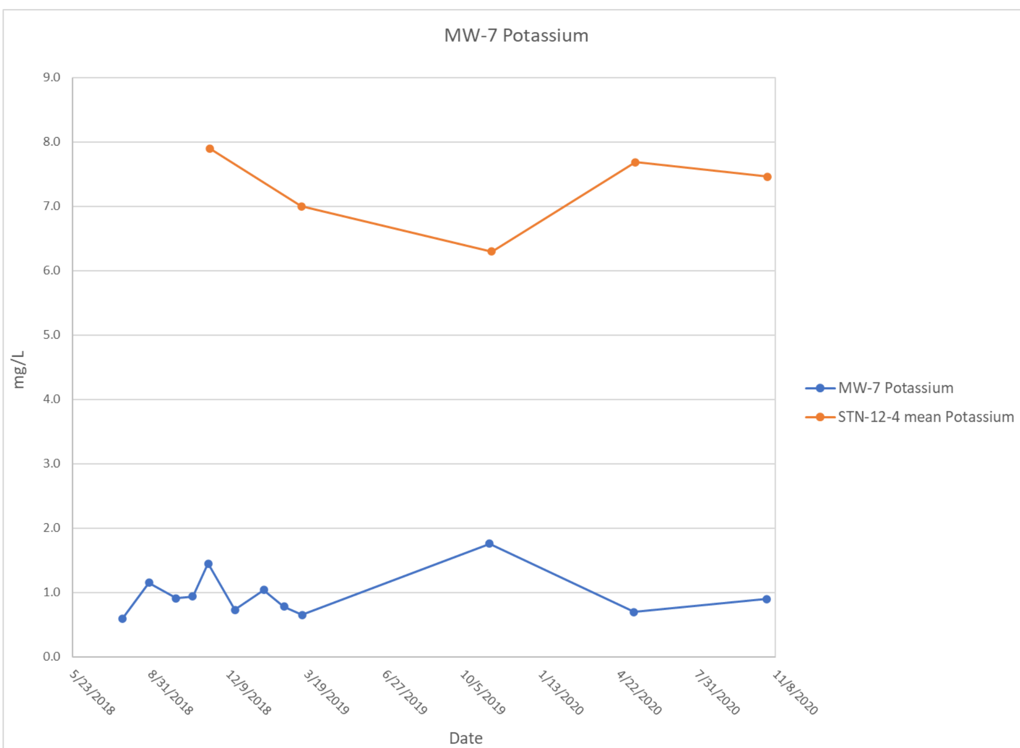


Figure D-14 MW-7 Potassium Concentrations

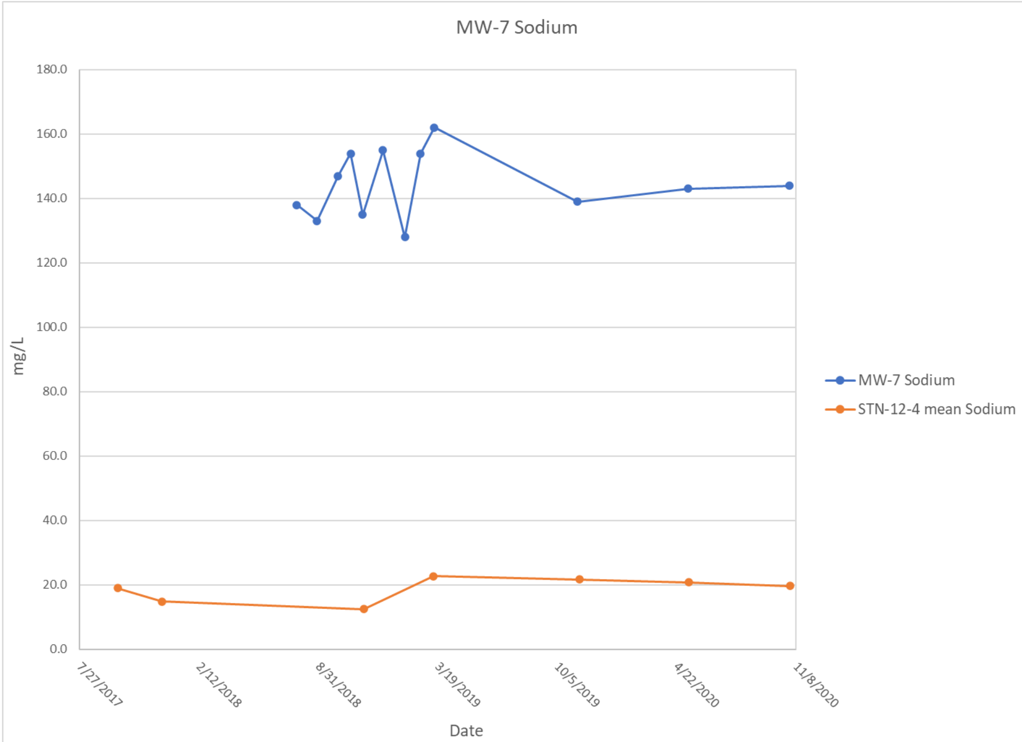


Figure D-15 MW-7 Sodium Concentrations

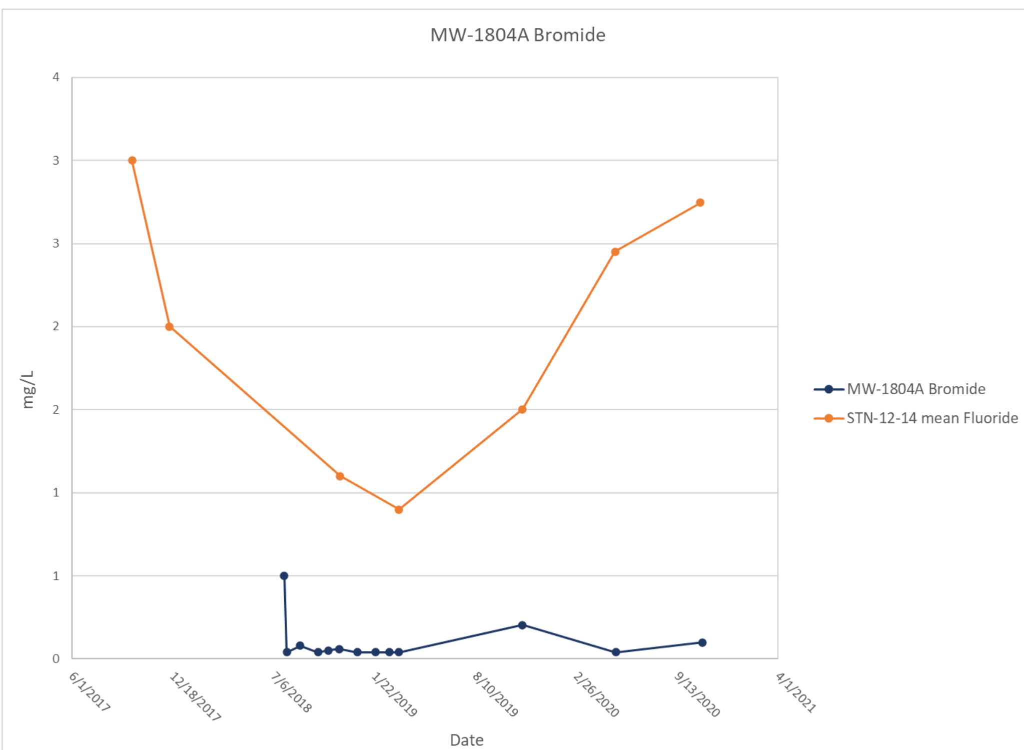


Figure D-16 MW-1804A Bromide Concentrations

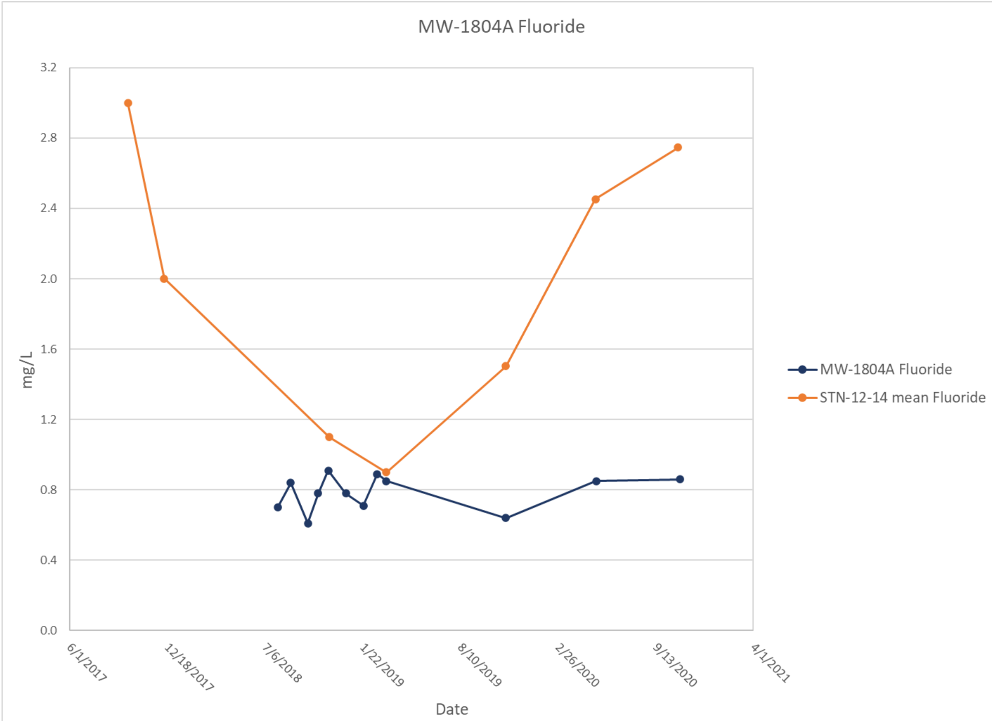


Figure D-17 MW-1804A Fluoride Concentrations

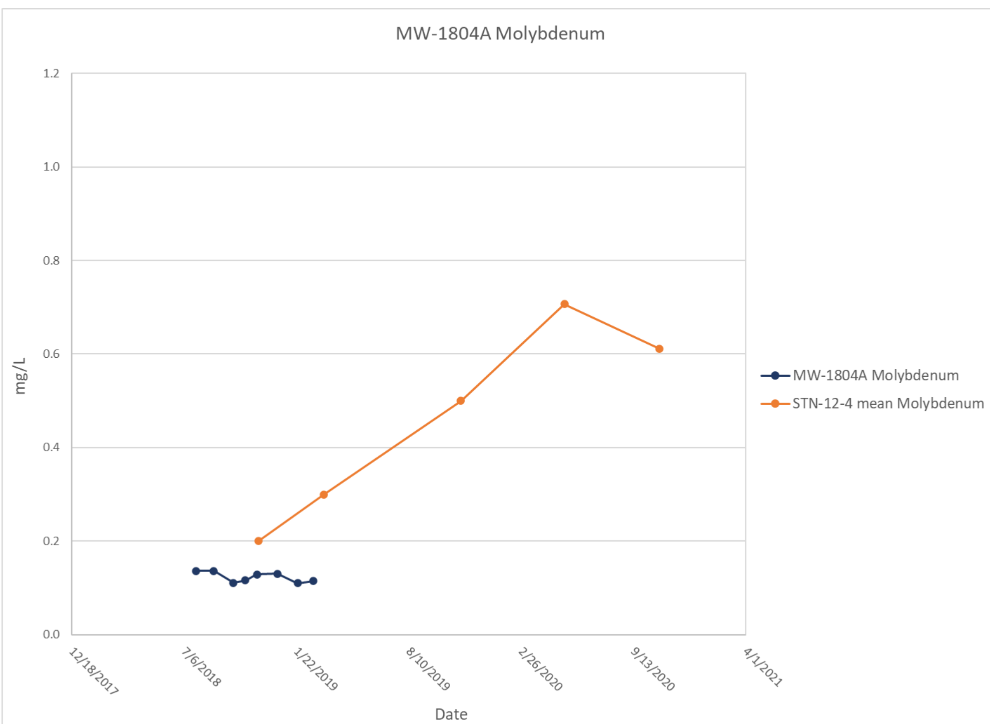


Figure D-18 MW-1804A Molybdenum Concentrations

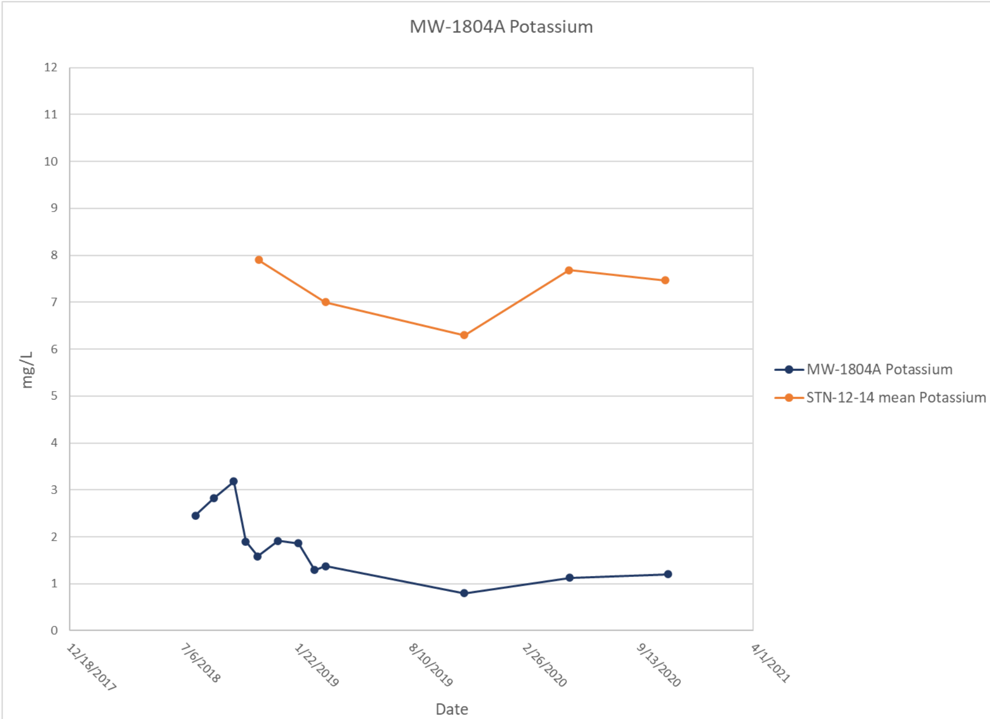


Figure D-19 MW-1804A Potassium Concentrations

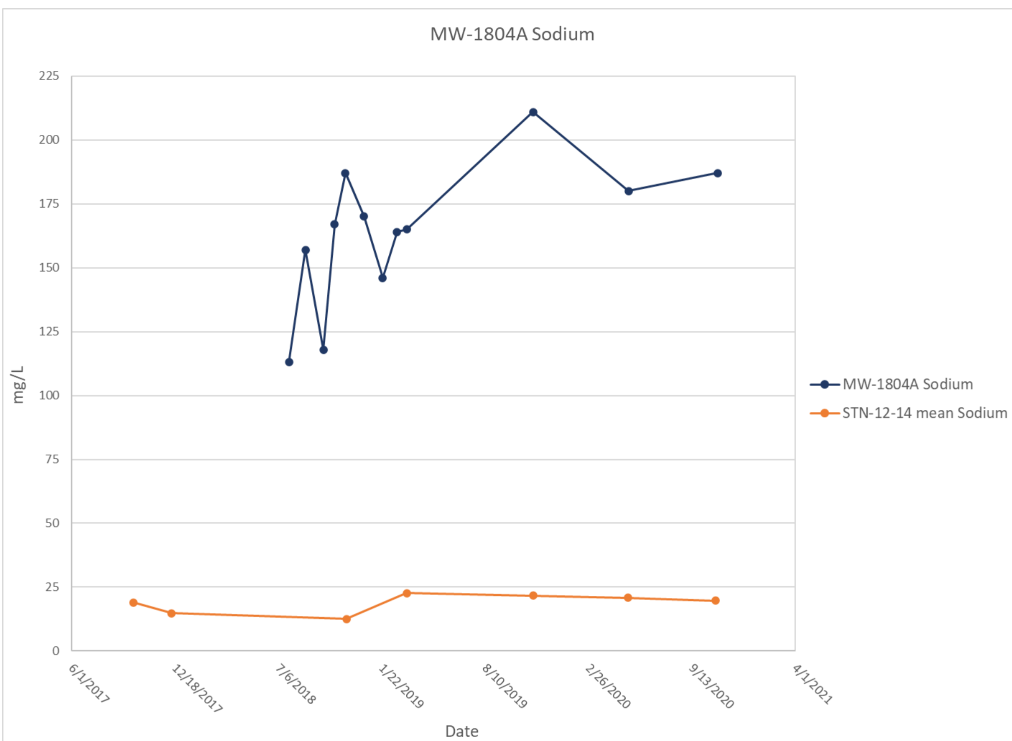


Figure D-20 MW-1804A Sodium Concentrations

Addendum Report to Alternative Source Demonstration for Fluoride and Sulfate

John E. Amos Plant Fly Ash Pond
Winfield, West Virginia

Prepared for:

American Electric Power

Prepared by:

EHS Support LLC and EnviroProbe Integrated Solutions, Inc.

November 2021

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Acronyms

α	significance level
AEP	American Electric Power
amsl	above mean sea level
ASD	alternative source demonstration
B	boron
bgs	below ground surface
Ca	calcium
$Ca\text{-}HCO_3$	calcium bicarbonate
CCR	coal combustion residual
CFR	Code of Federal Regulations
Cl	chloride
EPRI	Electric Power Research Institute
FGD	flue gas desulfurization
ft	foot or feet
JAFAP	John E. Amos Plant Fly Ash Pond
mg/L	milligrams per liter
Na	sodium
NaCl	sodium chloride
$Na\text{-}HCO_3$	sodium bicarbonate
ORP	oxidation-reduction potential
SO_4	sulfate
SRF	stress relief fracturing
SSI	statistically significant increase
SSL	statistically significant level
TDS	total dissolved solids
USEPA	United States Environmental Protection Agency

Certification by Qualified Professional Engineer

I certify that the alternative source demonstration (ASD) conducted and presented within this addendum report is appropriate for evaluating the groundwater monitoring data for the John E. Amos Plant Fly Ash Pond Coal Combustion Residual (CCR) management area associated with the John E. Amos Plant Power Plant located in Winfield, West Virginia. This ASD meets the requirements of the United States Environmental Protection Agency CCR Rule defined at 40 Code of Federal Regulations 257.94(e)(2).

Roderic E. Moore

Printed Name of Licensed Professional Engineer

Signature

RODERIC E. MOORE
REGISTERED
16390
STATE OF
WEST VIRGINIA
PROFESSIONAL ENGINEER

WV016390	West Virginia	11/24/2021
License Number	Licensing State	Date

1 Introduction

EHS Support LLC ("EHS Support") was retained by Appalachian Power Company, doing business as American Electric Power (AEP), to conduct an alternative source demonstration (ASD) investigation for coal combustion residual (CCR) constituents at the John E. Amos Plant Fly Ash Pond (JAFAP or "Site") located in Winfield, Putnam County, West Virginia (**Appendix A**). The following is a timeline of ASDs completed for the JAFAP to date:

- The initial ASD investigation, dated June 2020, was completed for November 2019 detection monitoring data which was validated during a February 2020 resampling event (EHS Support, 2020a).
- The first addendum to the initial ASD investigation was completed for the May 2020 detection monitoring data which was validated during a July 2020 resampling event (EHS Support, 2020b).
- A second addendum was completed for the November 2020 detection monitoring data which was validated during a January 2021 resampling event (EHS Support, 2021).
- The current ASD investigation is provided as a third addendum and has been prepared for the May 2021 detection monitoring data and subsequent July 2021 verification sampling data.

EHS Support has teamed with EnviroProbe Integrated Solutions, Inc. of Nitro, West Virginia to complete this ASD investigation addendum per the requirements of the United States Environmental Protection Agency (USEPA) CCR Rule (40 Code of Federal Regulations [CFR] 257.94).

1.1 Objectives

The objective for this ASD investigation addendum is to assess groundwater monitoring data collected in compliance with paragraph 40 CFR 257.94(e)(2) of the CCR Rule. This part of the rule allows AEP to determine whether the source(s) for statistically significant increases (SSIs) reported from groundwater monitoring are associated with the CCR unit, or if the SSIs resulted from an error in sampling, analysis, statistical evaluation, or a natural variation in groundwater quality. The focus of this JAFAP ASD investigation addendum is specifically on sulfate in MW-5 and fluoride in MW-6. These constituents demonstrated SSIs during the May 2021 detection monitoring event and subsequent July 2021 verification sampling event.

1.2 Lines of Evidence

This ASD investigation addendum for the JAFAP has been conducted to evaluate potential alternate sources, or reasons for the SSIs of sulfate in MW-5 and fluoride in MW-6. A potential alternate source is evident based on the following lines of evidence:

- There is a lack of exceedances and increasing trends of primary indicators of CCR.
- JAFAP pore water concentrations are lower than those of the corresponding constituents observed in groundwater.
- Major ion chemistry does not indicate mixing between JAFAP water and groundwater.

For the purposes of this ASD investigation addendum, constituents were identified that would serve as a primary indicator for CCR leachate. A primary indicator must meet **both** of the following criteria:

- Constituent typically has a high concentration in CCR leachate, relative to background, such that it is expected to have an elevated concentration in the event of a release.
- Constituent is not reactive and has high mobility in groundwater such that it is expected to be at the leading edge of the plume, meaning that it will have elevated concentrations relative to background across the entire area of the plume.

The nature of landfilled fly ash is a key factor in determining indicators for coal ash leachate. Boron and sulfate are listed as primary indicators of coal ash leachate (Electric Power Research Institute [EPRI], 2012 and 2017); therefore, these elements have been evaluated as primary indicators in this ASD investigation addendum. It is understood that JAFAP only received CCR (fly ash) from 1971 until 2010 and that flue gas desulfurization (FGD) gypsum residual was disposed of in a separate FGD landfill. Based on this Site history, the following potential indicators are assessed in this ASD investigation:

- Fluoride and bromide are considered potential indicators of CCR leachate and FGD gypsum (EPRI, 2017), therefore, these elements are included as potential indicators in this ASD.
- Sodium and potassium are listed as potential indicators for CCR leachate, but not FGD gypsum leachate; therefore, sodium and potassium are included as potential indicators in this ASD.
- Calcium and chloride are considered potential indicators of CCR leachate if FGD gypsum is intermixed with CCR (EPRI, 2012). As the Amos Plant is equipped with an FGD system, this ASD investigation conservatively assesses calcium and chloride as potential indicators due to past SSIs, with the understanding that there is a low likelihood for an extensive contributing FGD source within the JAFAP due to CCR being the primary landfilled material.

It is noteworthy that sulfate, calcium, fluoride, and chloride all have abundant natural sources in the Site vicinity, specifically the following:

- Occurrence of sulfide-bearing coal seams, where sulfate is produced from sulfide oxidation (Siegel et al., 2015)
- Significant thicknesses of various limestone formations, which are a potential source of calcium (specifically, within the Conemaugh and Monongahela Groups, which form the ridges around and the basement beneath the JAFAP [Cardwell et al, 1968])
- Presence of connate brines as a source of halides (chloride and fluoride) (Mathes and Waldron, 1993; Sheets and Kozar, 2000)

2 Project Background

Details about the Site location and history, geology, groundwater geochemistry, and monitoring well network are provided in the *Alternative Source Demonstration Report for Calcium, Chloride, and Sulfate John E. Amos Plant Fly Ash Pond, Winfield, West Virginia* (EHS Support, 2020a). Pertinent details from the *Fly Ash Pond CCR Groundwater Monitoring Well Network* Evaluation (Arcadis, 2019) to this ASD investigation addendum are summarized in this section. Figures from the 2019 report (Arcadis, 2019) depicting the Site boundaries, JAFAP location, and monitoring network are presented in **Appendix A**.

Appalachian Plateau groundwater geochemistry, including the JAFAP Site area in West Virginia, is established through several regional studies (Piper, 1933; Mathes and Waldron, 1993; Trapp and Horn, 1997; Sheets and Kozar, 2000; Warner et al., 2012; Siegel et al., 2015). Groundwater recharge generally occurs on hilltops and circulates along hill slopes to shallow depths in Appalachian Plateau sedimentary bedrock aquifers. Saline (connate) water is frequently encountered beneath a thin (a few feet [ft]) transitional mixing zone with overlying "fresh" water (i.e., water with low total dissolved solids [TDS]) (Trapp and Horn, 1997; Siegel et al., 2015).

The chemistry of groundwater in recharge areas on hilltops is characterized by low TDS calcium bicarbonate (Ca-HCO_3-type) water. This Ca-HCO_3-type water evolves to low TDS sodium bicarbonate (Na-HCO_3-type) groundwater as it percolates down slopes owing to calcium and magnesium ion exchange with sodium (Na) in Na-bearing clay minerals. High TDS sodium chloride (NaCl-type) groundwaters are naturally occurring connate brines that are found in "restricted flow zones" where recharge waters do not flush the host lithology. The NaCl-type water is further characterized by low to non-detectable sulfate, due to reducing conditions that promote sulfide as the predominant sulfur species (Siegel et al., 2015). The NaCl-type groundwater is also typically associated with elevated fluoride concentrations in West Virginia (Mathes and Waldron, 1993). The compositional evolution of these water types is shown on a Piper plot in **Figure 2-1** (Siegel et al., 2015)**.**

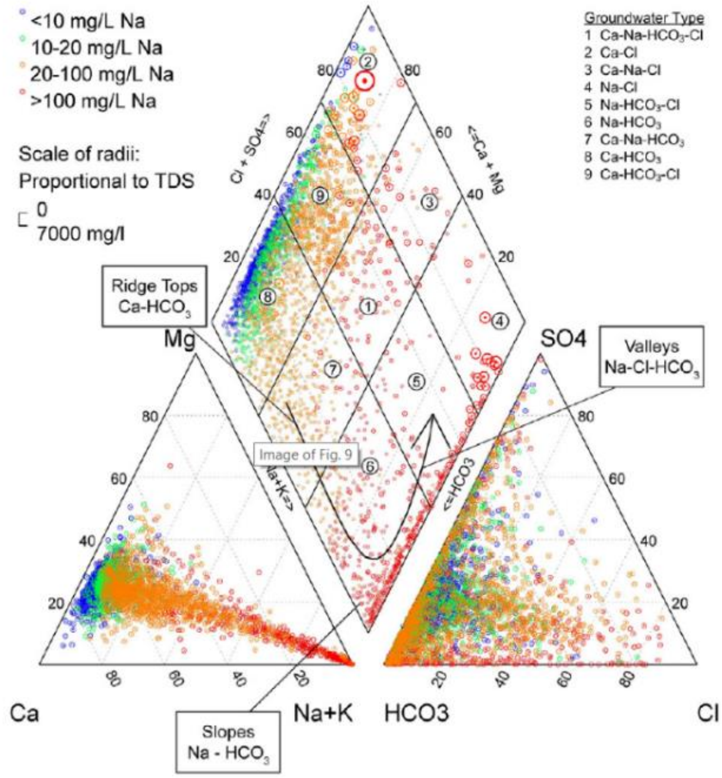

Figure 2-1 Generalized Groundwater Major Ion Chemistry within the Appalachian Plateau

Source: Siegel et al., 2015

Regionally throughout the Appalachian Plateau, NaCl-type water is typically encountered at low elevations in valley centers at approximately 100 feet beneath the level of the nearest major stream (Trapp and Horn, 1997; Warner et al., 2012; Siegel et al., 2015). In West Virginia, NaCl-type groundwater is frequently encountered at even shallower depths beneath streams in valley bottoms owing to the overall lower topographic elevation and associated lower potential groundwater head available to depress underlying saline water (Siegel et al., 2015).

An additional control on regional groundwater chemistry is the occurrence of natural coal intervals and laminations within bedrock formations. Where coal occurs, aerobic groundwater leads to oxidation of sulfide minerals in the coal (principally the iron sulfide pyrite), which leads to elevated concentrations of iron and sulfate in groundwater (Siegel et al., 2015).

2.1 Groundwater Monitoring Network

The *Fly Ash Pond CCR Groundwater Monitoring Well Network Evaluation* report (Arcadis, 2019) determined that the groundwater monitoring well network meets the requirements of 40 CFR §257.91, as it consists of a sufficient number of wells installed at the appropriate locations and depths to yield groundwater samples from the uppermost shallow aquifer that accurately represent the quality of background groundwater and groundwater passing the waste boundary of the JAFAP. The monitoring network includes the following:

- Four monitoring wells (MW-1807A, MW-1808A, MW-1809A, and MW-1810A) are installed upgradient of the JAFAP to support background monitoring.
- Ten monitoring wells (MW-1, MW-2, MW-5, MW-6, MW-7, MW-8, MW-9, MW-1801A, MW-1804A, and MW-1806A) are located downgradient of the JAFAP and used for compliance monitoring.

Additional details of the JAFAP monitoring network are presented in *Fly Ash Pond CCR Groundwater Monitoring Well Network Evaluation* report (Arcadis, 2019). The details of each groundwater monitoring location used for water quality sampling are summarized in **Table 1** and the location of the monitoring wells within the uppermost aquifer is shown in Figure 3 of Arcadis (2019), which is provided in **Appendix A**.

2.2 ASD Investigation Monitoring Wells

Groundwater from monitoring wells MW-1, MW-5, MW-6, and MW-1804A had constituents that showed potential SSIs in the May 2021 groundwater monitoring data:

- Fluoride in MW-1
- Sulfate and calcium in MW-5
- Fluoride in MW-6
- Sulfate and chloride in MW-1804A

The SSIs of sulfate in MW-5 and fluoride in MW-6 were confirmed by a verification sampling event in July 2021. The construction details of these monitoring wells are provided in Section 2.2.1 and Section 2.2.2 to support this ASD investigation addendum.

2.2.1 MW-5

MW-5 is installed near the base of the incised valley of Little Scary Creek. At this location, the ground surface (648.03 feet above mean sea level [ft amsl]) and piezometric surface are within the Morgantown Sandstone and are stratigraphically lower than the base of the JAFAP. In deepening stratigraphic succession, the 114.8-ft boring intercepted approximately 23 feet of predominantly clay unconsolidated deposits, 11 feet of Morgantown Sandstone, 69.5 feet of variably weathered Birmingham Shale (shale and clay shale), and 7 feet of sandstone (interpreted as Grafton Sandstone) before terminating within approximately 4 feet of shale (see cross-section A-A' [Arcadis, 2019] in **Appendix B** and MW-5 boring log in **Appendix C**). The MW-5 sand pack and screen extend over the Grafton Sandstone and include several feet of the overlying and underlying shale.

The following lines of evidence place MW-5 in the context of the groundwater monitoring network and indicate that groundwater in MW-5 includes a component of deep brine:

- MW-5 is located at the base of the Little Scary Creek stream valley and is screened at a lower elevation (546.43 to 537.03 ft amsl) than all other Site wells.
- MW-5 screen is set at 101.6 to 111.0 ft below ground surface (bgs), which is approximately 100 feet lower in elevation than the adjacent Little Scary Creek bed, corresponding to the depth beneath streams where NaCl-type connate water is typically encountered in the Appalachian Plateau.

- The screen for MW-5 is vertically lower and laterally distal to the base of the JAFAP. According to the stress relief fracturing (SRF) model, groundwater from the JAFAP would migrate through coal-bearing strata (specifically the Elk Lick Coal within Birmingham Shale) before entering the screened interval for MW-5, with concomitant geochemical effects on groundwater composition.
- The geochemistry of MW-5 historically corresponds with the composition of Appalachian Plateau NaCl-type connate water. TDS values for MW-5 historically exceeded values in the JAFAP by nearly an order of magnitude (AEP, 2021). Additionally, sulfate is historically near or below the laboratory reporting limit in MW-5.
- The NaCl-type groundwater in MW-5 is distinct from the Na-HCO_3-type water typically encountered in Site wells (screened in the SRF at higher elevations and located on the hilltops surrounding the Site) and is distinct from porewater in the JAFAP (EHS Support, 2020a). The exception is MW-2, the only Site well that is also at the base of Little Scary Creek alluvial valley and is screened at a similar elevation (549.10 to 540.20) to MW-5 (546.43 to 537.03 ft amsl).
- During packer testing, MW-5 did not accept flow with up to 100 pounds per square inch pressure (Arcadis, 2019), indicating the presence of low permeability units. This characteristic is typical of those units that are not regularly flushed with groundwater and that may host NaCl connate waters.
- Wells co-located with MW-5, MW-6 (screen = 619.00 to 614.00 ft amsl) and MW-1 (screen = 606.47 to 597.57 ft amsl), are screened at higher elevations and exhibit lower TDS and an $NaHCO_3$-type groundwater, characteristics that indicate fresher shallower groundwater is present in these shallower wells versus the deeper connate groundwater. The screen and sand pack separations between MW-1 and MW-5 of approximately 12 feet are significant considering the brine/freshwater interface is typically on the order of one to two feet.

In summary, the data indicates JAFAP water has not reached MW-5. The groundwater composition at MW-5 is best described by natural causes and does not exhibit the expected effects on groundwater composition typically associated with CCR material in a fly ash pond.

2.2.2 MW-6

MW-6 is co-located with MW-1 and MW-5 near the base of the incised valley of Little Scary Creek where the ground surface (647.50 ft amsl) and piezometric surface are within the Morgantown Sandstone. In deepening stratigraphic succession, the 34.2-ft boring intercepted approximately 23 feet of predominantly clay unconsolidated deposits, 11 feet of Morgantown Sandstone, and 0.2 feet of shale (see cross section A-A' [Arcadis, 2019] in **Appendix B** and MW-6 boring log in **Appendix C**). The MW-6 sand pack and screen extends over the Morgantown Sandstone.

The following lines of evidence place MW-6 in the context of the groundwater monitoring network:

- MW-6 is screened from 619.00 to 614.00 ft amsl; above MW-5 (screened from 546.43 to 537.03 ft amsl) and MW-1 (screened from 606.47 to 597.57 ft amsl).
- MW-6 had the highest maximum pumping rate of all the JAFAP wells during hydraulic testing in 2018 (3.8 gallons per minute) and had the highest hydraulic conductivity (37 feet per day) (Arcadis, 2019).
- MW-6 is a Ca-HCO_3-type water. As described in **Section 3.1** and **Section 3.4,** and consistent with published hydrogeochemical conceptual models for Appalachian Plateau waters, the

composition of MW-6 groundwater has progressively shifted along a natural mixing trajectory with NaCl-type waters observed in MW-5.
- Given that Appalachian Plateau NaCl-type waters have naturally elevated fluoride concentrations (Mathes and Waldron, 1993), it is expected that the fluoride concentration will continue to increase in MW-6 as long as the groundwater composition continues to shift along this natural mixing trajectory toward the composition of an NaCl-type water.

2.3 JAFAP Porewater Piezometer

AEP installed a multi-level port piezometer (STN-12-4) within the JAFAP to evaluate fly ash porewater. This multi-port piezometer has seven screened intervals, as detailed in the boring log (Stantec, 2012) provided in **Appendix C**.

Fly ash porewater was sampled during eight events: September 28, 2017; December 11, 2017; November 16, 2018; March 12, 2019; November 11, 2019; May 11 through 14, 2020; October 28 through 30, 2020; and May 10 through 11, 2021. Water quality results for CCR constituents in the fly ash, with the geometric mean of each constituent over the seven interval ports, are presented in **Table 2**. These data will be used in this ASD investigation addendum to represent the JAFAP porewater when comparing to CCR constituent concentrations in the monitoring well network.

2.4 Groundwater Monitoring

AEP has conducted groundwater monitoring of the uppermost aquifer to meet the requirements of the CCR Rules. These monitoring activities generally included the following activities:

- Collect groundwater samples and analyze for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan* (AEP, 2019).
- Complete validation tests for groundwater data, including tests for completeness, valid values, transcription errors, and consistent units.
- Establish background values for each Appendix III and Appendix IV constituent (eight sampling events conducted over a seven-month period between July 25, 2018 and February 18, 2019) (AEP, 2021).
- Evaluate the groundwater data using a statistical process in accordance with 40 CFR 257.93, which was prepared and certified in April 2019 in AEP's *Statistical Analysis Plan* (Geosyntec, 2019), and posted to AEP's CCR website in May 2019. The statistical process was guided by *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance"; USEPA, 2009).
- Complete the initial detection monitoring sampling event (March 2019), which resulted in no SSIs of Appendix III parameters.
- Complete a second detection monitoring event (November 2019), which resulted in potential SSIs for Appendix III parameters in MW-2 (calcium), MW-5 (calcium and sulfate), MW-7 (calcium), and MW-1804A (chloride and sulfate).
- Complete verification sampling (February 2020) for constituents identified as potentially exhibiting SSIs per AEP's *Statistical Analysis Plan* (Geosyntec, 2019), which confirmed SSIs for Appendix III parameters at MW-5 (calcium and sulfate) and MW-1804A (chloride and sulfate).

- An ASD investigation for the JAFAP was conducted (dated June 2020) which confirmed potential alternate sources or reasons for the SSIs of calcium and sulfate in MW-5 and chloride and sulfate in MW-1804A (EHS Support, 2020a).
- Complete a third detection monitoring event (May 2020), which resulted in potential SSIs for Appendix III parameters in MW-5 (calcium and sulfate).
- Complete verification sampling (July 2020) for constituents identified as potentially exhibiting SSIs per AEP's *Statistical Analysis Plan* (Geosyntec, 2019), which confirmed SSIs for Appendix III parameters at MW-5 (calcium and sulfate).
- An ASD investigation for the JAFAP was conducted (dated November 2020) which confirmed potential alternate sources or reasons for the SSIs of calcium and sulfate in MW-5 (EHS Support, 2020b).
- Complete a fourth detection monitoring event (October to November 2020), which resulted in potential SSIs for Appendix III parameters in MW-5 (calcium and sulfate), MW-6 (fluoride), MW-7 (calcium and fluoride), MW-8 (calcium, chloride, sulfate, and TDS) and MW-1804A (chloride and sulfate).
- Complete verification sampling (January 2021) for constituents identified as potentially exhibiting SSIs per AEP's *Statistical Analysis Plan* (Geosyntec, 2021), which confirmed SSIs for Appendix III parameters at MW-5 (calcium and sulfate), MW-6 (fluoride), MW-7 (fluoride), and MW-1804A (chloride and sulfate).
- An ASD investigation for the JAFAP was conducted (dated May 2021) which confirmed potential alternate sources or reasons for the SSIs of calcium and sulfate in MW-5, fluoride in MW-6 and MW-7, and chloride and sulfate in MW-1804A (EHS Support, 2021).
- Complete a fifth detection monitoring event (May 2021), which resulted in potential SSIs for Appendix III parameters in MW-1 (fluoride), MW-5 (sulfate), MW-6 (fluoride), and MW-1804A (chloride and sulfate).
- Complete verification sampling (July 2021) for constituents identified as potentially exhibiting SSIs per AEP's *Statistical Analysis Plan* (Geosyntec, 2021), which confirmed SSIs for Appendix III parameters at MW-5 (sulfate) and MW-6 (fluoride).

Table 3 summarizes the monitoring data for key wells analyzed during this ASD investigation addendum, including the background sampling events through the May 2021 monitoring event and the July 2021 verification sampling event.

3 Alternative Source Demonstration Assessment

As identified in **Section 1.1**, SSIs in the concentration of sulfate in MW-5 and fluoride in MW-6 have been reported for the May 2021 detection monitoring and July 2021 verification monitoring events. Per the CCR Rule at 40 CFR 257.94I(2), "The owner or operator may demonstrate that a source other than the CCR unit caused the SSI over background levels for a constituent or that the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting an SSI over background levels to include obtaining a certification from a qualified professional engineer verifying the accuracy of the information in the report."

EPRI (2017) guidelines for developing an ASD indicates potential causes that support the ASD may include, but are not limited to, the following:

1. Sampling causes (ASD Type I)
2. Laboratory causes (ASD Type II)
3. Statistical evaluation causes (ASD Type III)
4. Natural variation causes (ASD Type IV)
5. Alternative sources (natural) (ASD Type V)

This ASD investigation addendum for the JAFAP is focused on assessing whether Type I, Type III, Type IV, and/or Type V causes identified in the initial ASD investigation (EHS Support, 2020a) could be the reason for SSIs for sulfate in MW-5 and fluoride in MW-6.

EPRI (2012) describes three tiers of investigation for evaluation of water quality signatures to determine if elevated concentrations represent a release from a CCR facility. Conversely, these tools can also be used to evaluate whether sources other than CCR are contributing to groundwater quality degradation. The three tiers defined by EPRI (2012) are:

- Tier I: Trend Analysis and Statistics (**Section 3.1** and **Section 3.2**)
- Tier II: Advanced Geochemical Evaluation Methods (**Section 3.1**, **Section 3.3**, and **3.4**)
- Tier III: Isotopic Analyses (not conducted as part of this ASD)

3.1 Groundwater Data Analysis

An analysis of potential groundwater compositional changes due to ASD Types listed in **Section 3** and supplemental assessments (EPRI, 2012 and 2017) is presented below. Tier I and Tier II assessments are presented in **Section 3.1** through **Section 3.4**. The potential variation due to sampling techniques (ASD Type I) is included in **Section 3.5**, statistical evaluations (ASD Type III) are included in **Section 3.6**, and natural variation (Type IV) is included in **Section 3.7**.

3.1.1 Site Groundwater Sources

TDS measurements provide a robust means to distinguish groundwater with a connate brine and/or low TDS precipitation source. Consistent with a brine origin, historical TDS in MW-2, MW-5, and MW-8 are notably elevated (almost by an order of magnitude in MW-5) compared to other Site wells that produce sodium/calcium bicarbonate-type waters (**Figure 3-1**).

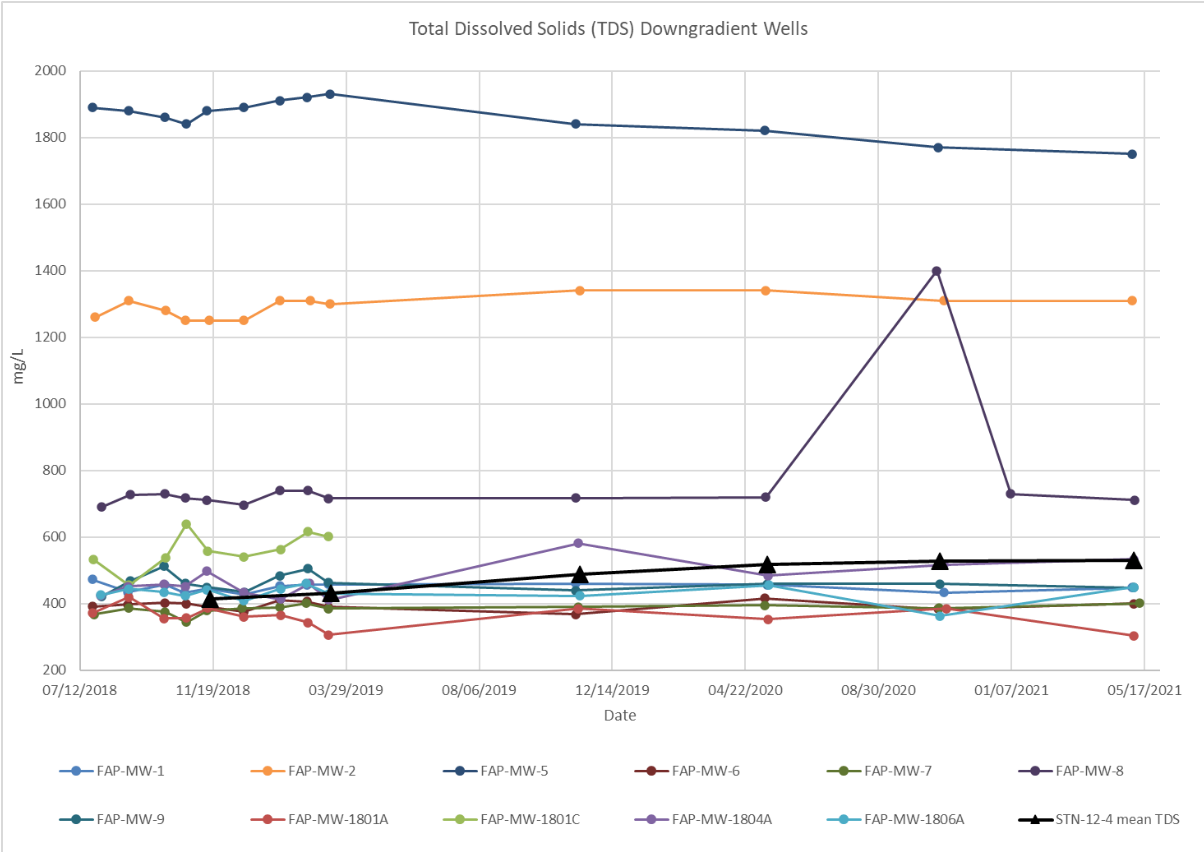

Figure 3-1 Total Dissolved Solids in Downgradient Monitoring Wells

Note: MW-1801C has not been sampled since March 2019

TDS in most Site wells is below 600 milligrams per liter (mg/L). In comparison, JAFAP porewater measurements for all seven ports of STN-12-4 ranged from 174 to 840 mg/L (geometric mean 474 mg/L) between September 2017 and May 2020. These TDS data rule out JAFAP porewater as the origin of the high TDS groundwater measured in MW-2, MW-5, and MW-8. The connate brine component is expected to be the source of high TDS concentrations for MW-5 based on the location of the wells at the base of the Little Scary Creek valley and deep (greater than 100 ft bgs) well screen and sand pack depth (**Section 2.2.1**).

3.1.2 MW-5 Evaluation

A temporal plot for the primary indicator sulfate reported in groundwater monitoring well MW-5 is presented in **Figure 3-2**, and a temporal plot for the elevated potential indicator calcium is presented in **Figure 3-3**. Data for the geometric mean of JAFAP porewater (**Table 2**) is provided for comparison.

Sulfate concentrations in MW-5 remained relatively constant (geometric mean = 0.1 mg/L) until the November 2019 detection monitoring event. Sulfate concentrations measured in groundwater samples collected in November 2019 through July 2021 have been approximately two orders of magnitude higher (between 11 mg/L and 46 mg/L) than those reported historically. Despite this increase, the sulfate concentrations in MW-5 groundwater have remained approximately an order of magnitude lower than the concentration reported in the JAFAP porewater and within the historical range of sulfate concentration values from monitoring wells that sample sodium/calcium bicarbonate waters as shown in **Table 3**.

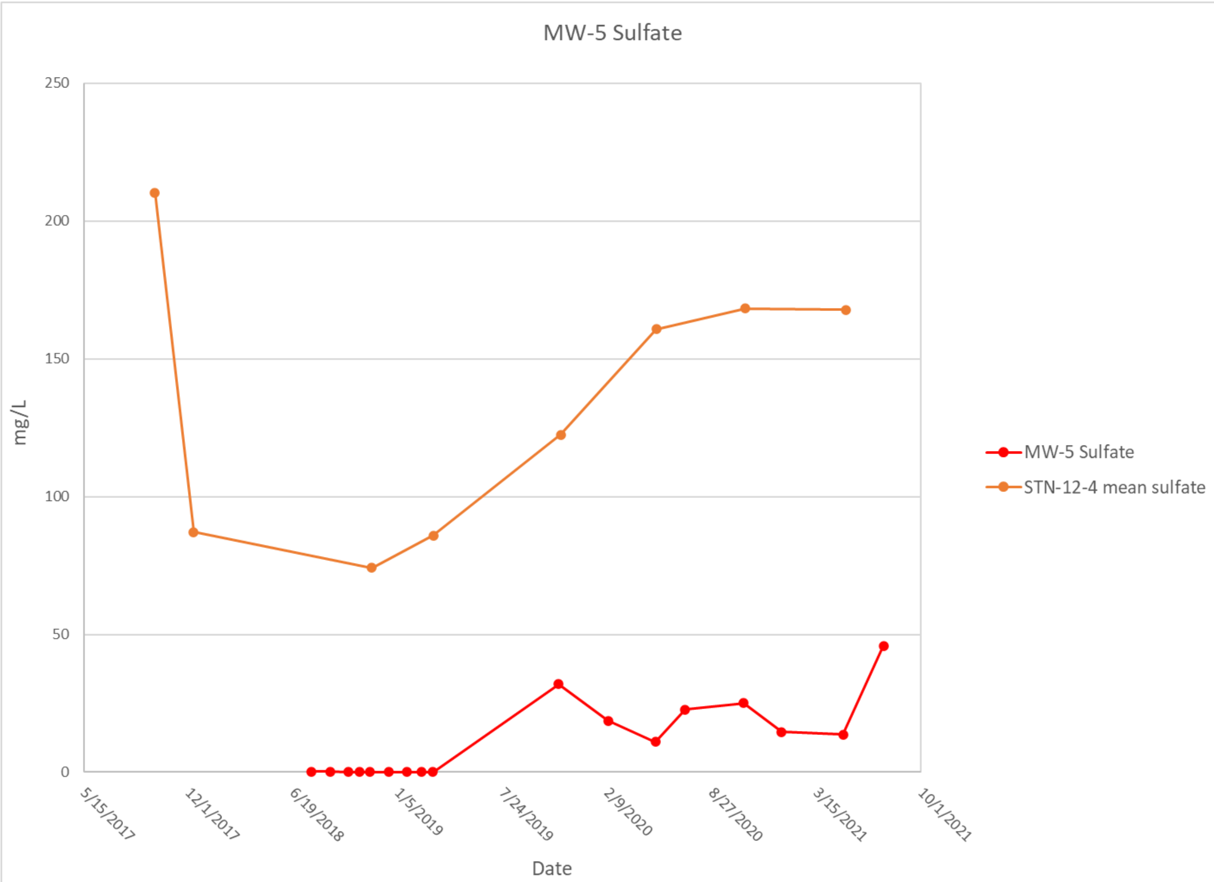

Figure 3-2 MW-5 Sulfate Concentrations

Sulfate is typically absent or at low concentrations in Appalachian Plateau connate brines due to overall reducing conditions that favor sulfide (Siegel et al., 2015). In contrast, sulfate is present at higher concentrations in oxygenated groundwater sourced from more recent precipitation, particularly following interaction with pyrite, which is documented in the Birmingham Shale and Grafton Sandstone rock matrix in the logs for MW-1802C, MW-1803C, MW-1805C (Arcadis, 2019). These rock units are within and directly overlying the sand pack interval for MW-5.

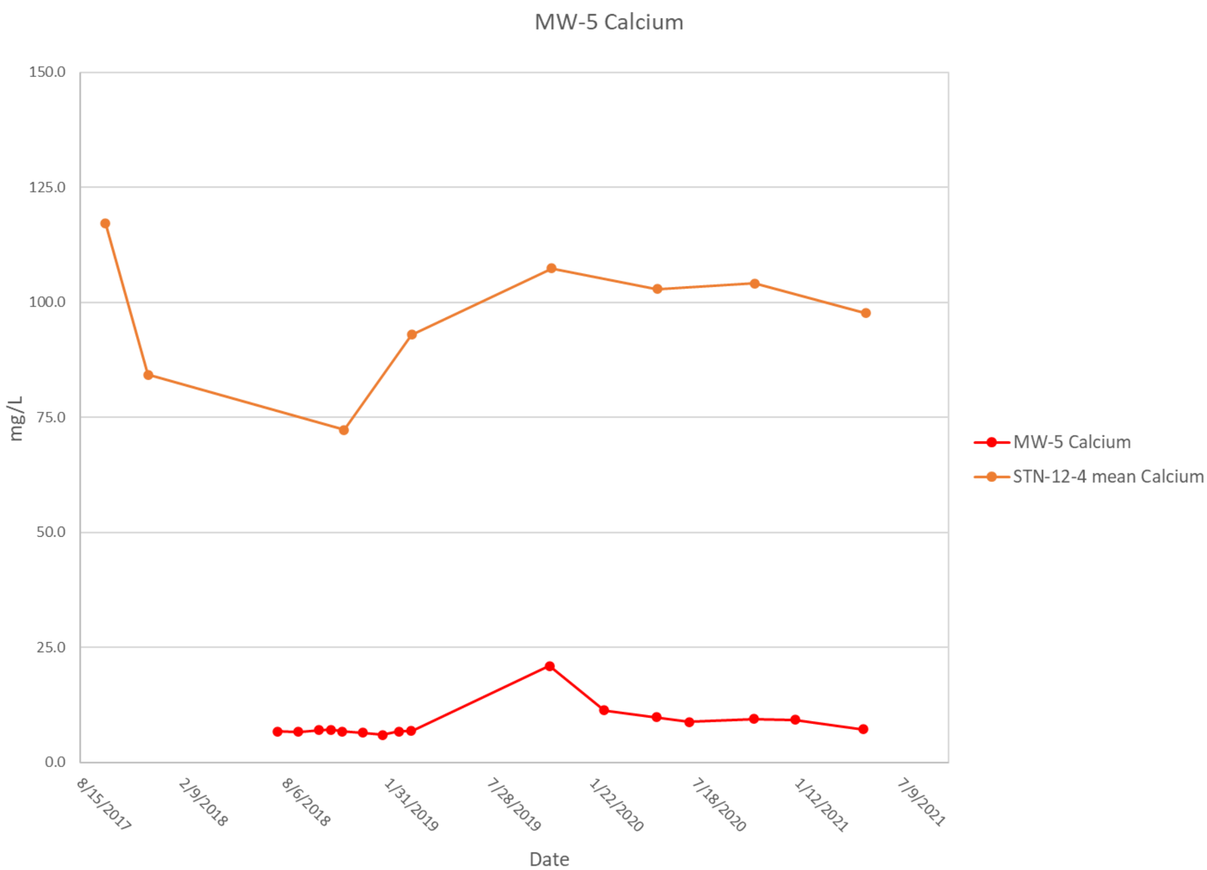

Figure 3-3 MW-5 Calcium Concentrations

Calcium concentrations in MW-5 remained relatively constant (geometric mean = 6.7 mg/L) until the November 2019 groundwater monitoring event. In November 2019, the calcium concentration of groundwater sampled from MW-5 was 21 mg/L. The subsequent calcium concentrations measured in groundwater samples collected between February 2020 and July 2021 ranged between 7.2 mg/L and 11.3 mg/L (geometric mean = 9.3 mg/L). The range of calcium concentrations in MW-5 post-November 2019 has remained approximately 10 times lower than the concentrations reported in the JAFAP porewater (**Figure 3-3**).

The relative sodium/calcium concentration ratios reported for groundwater from MW-5 in May and July 2021 remain lower than previous sampling events (**Table 3-1**). The relative changes in calcium and sodium suggest mixing between different groundwater types with distinct sodium/calcium concentration ratios set through ion exchange reactions with distinctive rock types or secondary minerals within formations.

Table 3-1 MW-5 Relative Sodium and Calcium Concentrations

Date	Sodium (mg/L)	Calcium (mg/L)	Sodium/Calcium Ratio
7/24/2018	777	6.75	115
8/29/2018	714	6.71	106
10/3/2018	742	7.03	106
10/24/2018	735	7.09	104
11/13/2018	586	6.79	86
12/19/2018	595	6.48	92
1/23/2019	599	5.98	100
2/19/2019	687	6.79	101
3/13/2019	660	6.85	96
11/8/2019	571	21	**27**
5/11/2020	694	9.85	**70**
10/27/2020	692	9.31	**74**
5/6/2021	528	7.23	**73**

Note: bold ratios correspond to samples that had statistically significant increases (SSIs) of calcium and/or sulfate.
mg/L = milligrams per liter

Groundwater in the vicinity of MW-5 is identified as a sodium chloride water type (**Section 2.2.1**) and the elevation of the screened section of MW-5 is very close to the expected mixing interface between sodium bicarbonate and sodium chloride (connate brine) water types (**Section 2**). The increase in dissolved calcium and sulfate may be attributed to a change in the proportion of mixing between sodium chloride and sodium/calcium bicarbonate water types; with the post-November 2019 results reflecting a higher proportion of more calcium and sulfate-rich, low TDS sodium bicarbonate water type. External influences such as pumping rates during sampling or intense and extended rainfall events can perturb the transition between the connate aquifer and the overlying sodium bicarbonate aquifer.

Boron, another primary indicator, historically fluctuated in MW-5 between 0.22 mg/L to 0.32 mg/L, whereas the post-November 2019 boron concentrations have been notably lower between 0.18 mg/L and 0.21 mg/L (**Figure 3-4**). Boron is typically elevated in groundwater that has contacted aquifer rock for extended periods of time or that has experienced elevated temperatures; therefore, elevated boron in connate brine is expected. The observation of decreased boron during and post-November 2019 sampling in MW-5 supports dilution by a younger sodium bicarbonate water type.

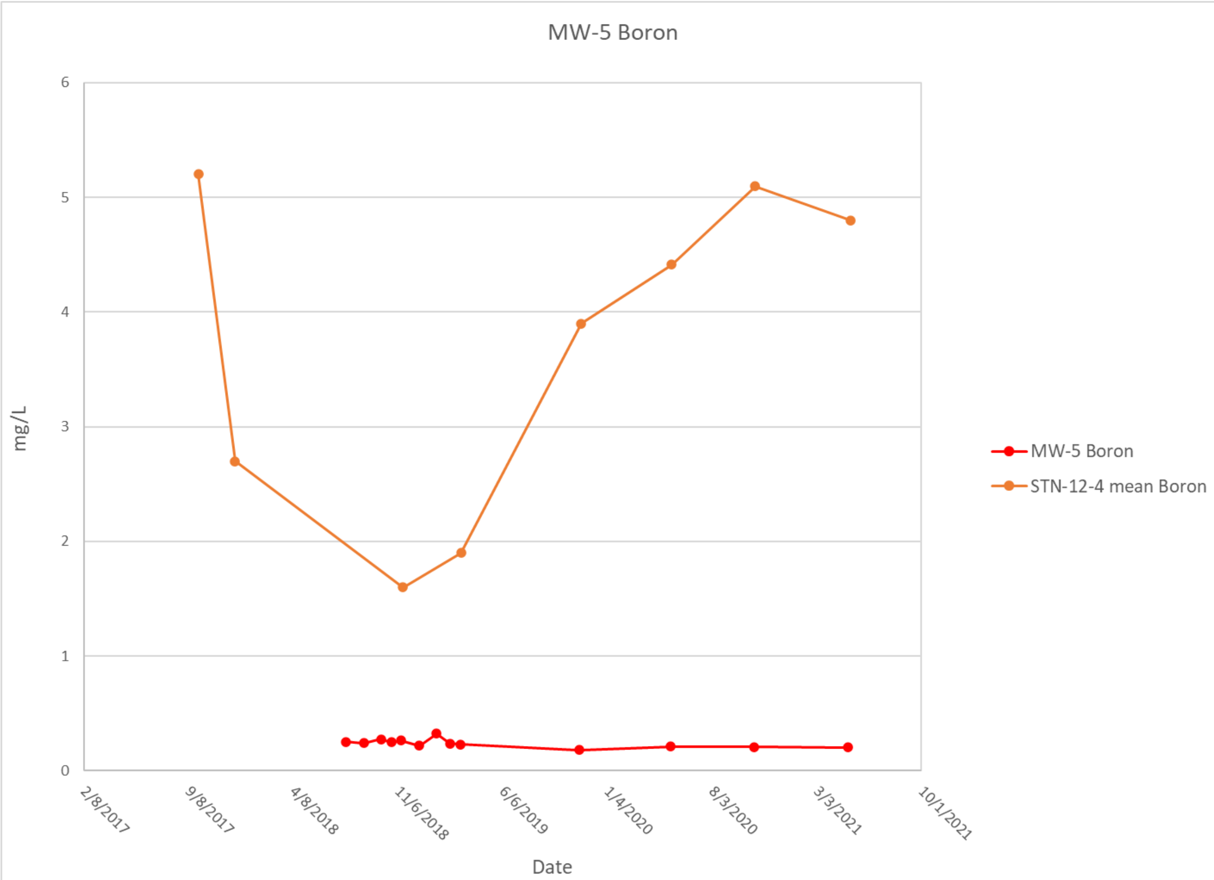

Figure 3-4 MW-5 Boron Concentrations

Temporal plots for potential indicators bromide, fluoride, potassium, and sodium reported in groundwater monitoring well MW-5 are provided in **Appendix D**, with geometrical mean data for the JAFAP porewater presented for comparison.

Potassium is typically present at lower concentrations in MW-5 groundwater compared to JAFAP porewater. Potassium concentrations have been generally declining with the lowest concentration measured during the most recent detection monitoring event in May 2021. Declining potassium concentrations with time provide a line of evidence that compositional changes to MW-5 groundwater are from mixing with low TDS groundwater as opposed to mixing with JAFAP porewater; mixing with JAFAP porewater should lead to higher potassium concentrations in MW-5 with time.

Bromide, fluoride, and sodium are present at higher concentrations in MW-5 groundwater compared to JAFAP porewater; therefore, there is a low likelihood that these components are sourced from the JAFAP. The generally declining concentrations of these elements with time are an additional line of evidence that periodic SSIs of constituents in MW-5 are the result of mixing between natural water types that have resulted in dilution of the Sodium Chloride-type groundwater.

3.1.3 MW-6 Evaluation

A temporal plot for the primary indicator sulfate reported in groundwater monitoring well MW-6 is presented in **Figure 3-5**, and a temporal plot for the elevated ASD constituent fluoride is presented in **Figure 3-6**. Data for the geometrical mean of JAFAP porewater (**Table 2**) is provided for comparison.

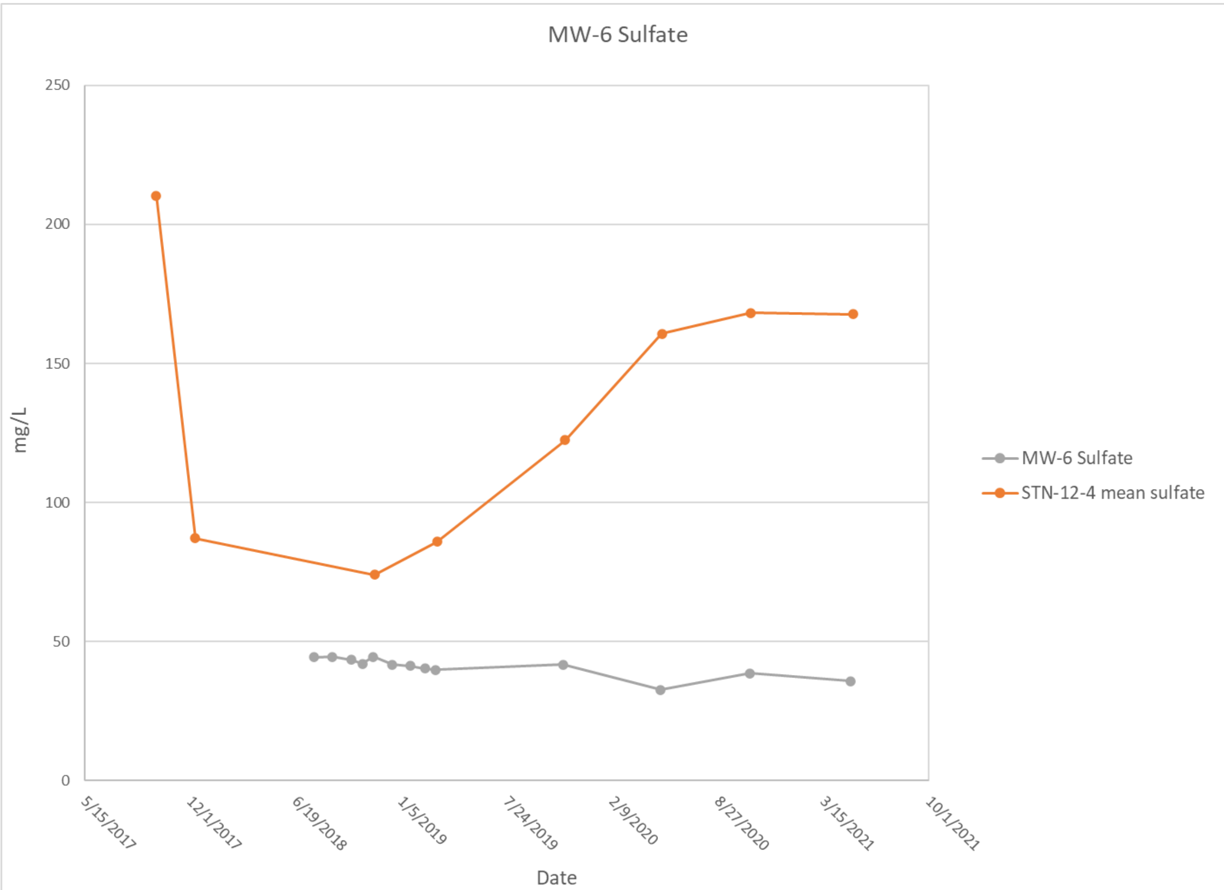

Figure 3-5 MW-6 Sulfate Concentrations

Sulfate concentrations in MW-6 have been decreasing overall since sampling began in July 2018, with the lowest concentration of 32.6 mg/L measured in the May 2020 sample. The sulfate concentration measured in the groundwater sample from May 2021 increased slightly to 35.8 mg/L, a value still below the range of concentrations measured during background sampling events (40.4 mg/L to 44.6 mg/L). MW-6 groundwater sulfate concentrations are 3 to 4 times lower than in the JAFAP porewater.

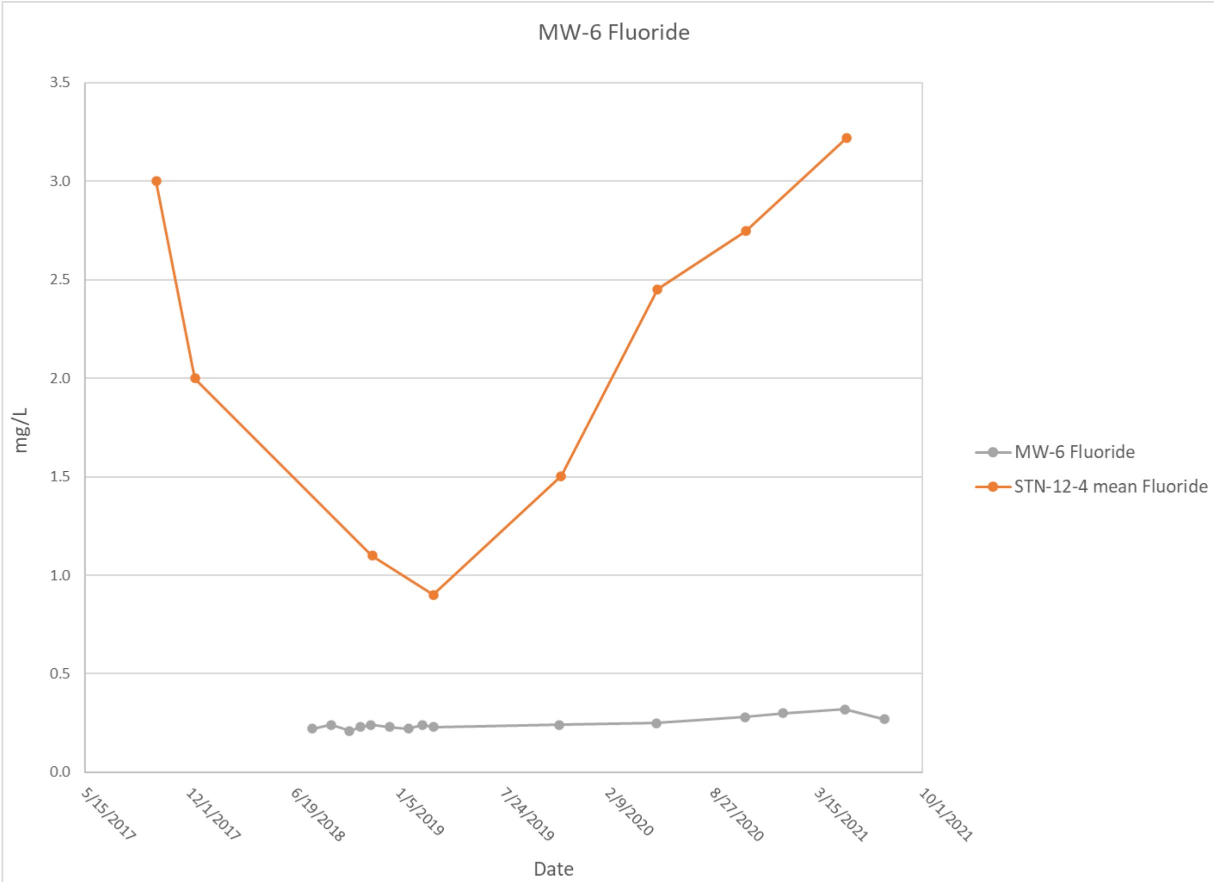

Figure 3-6 MW-6 Fluoride Concentrations

During background sampling, fluoride concentrations in MW-6 ranged from 0.22 mg/L to 0.24 mg/L. Fluoride had steadily increased from 0.23 mg/L to 0.32 mg/L during monitoring conducted between January 2019 and May 2021. During the July 2021 verification monitoring event, fluoride in MW-6 decreased to 0.27 mg/L. Fluoride concentrations in MW-6 groundwater are up to 10 times lower than in the JAFAP porewater.

Boron, another primary indicator, ranged between 0.07 mg/L and 0.125 mg/L during background sampling (**Figure 3-7**). During the detection monitoring events, boron has ranged from 0.074 mg/L to 0.089 mg/L; an overall decrease in concentration. Boron concentrations in MW-6 groundwater are up to 25 times lower than in the JAFAP porewater.

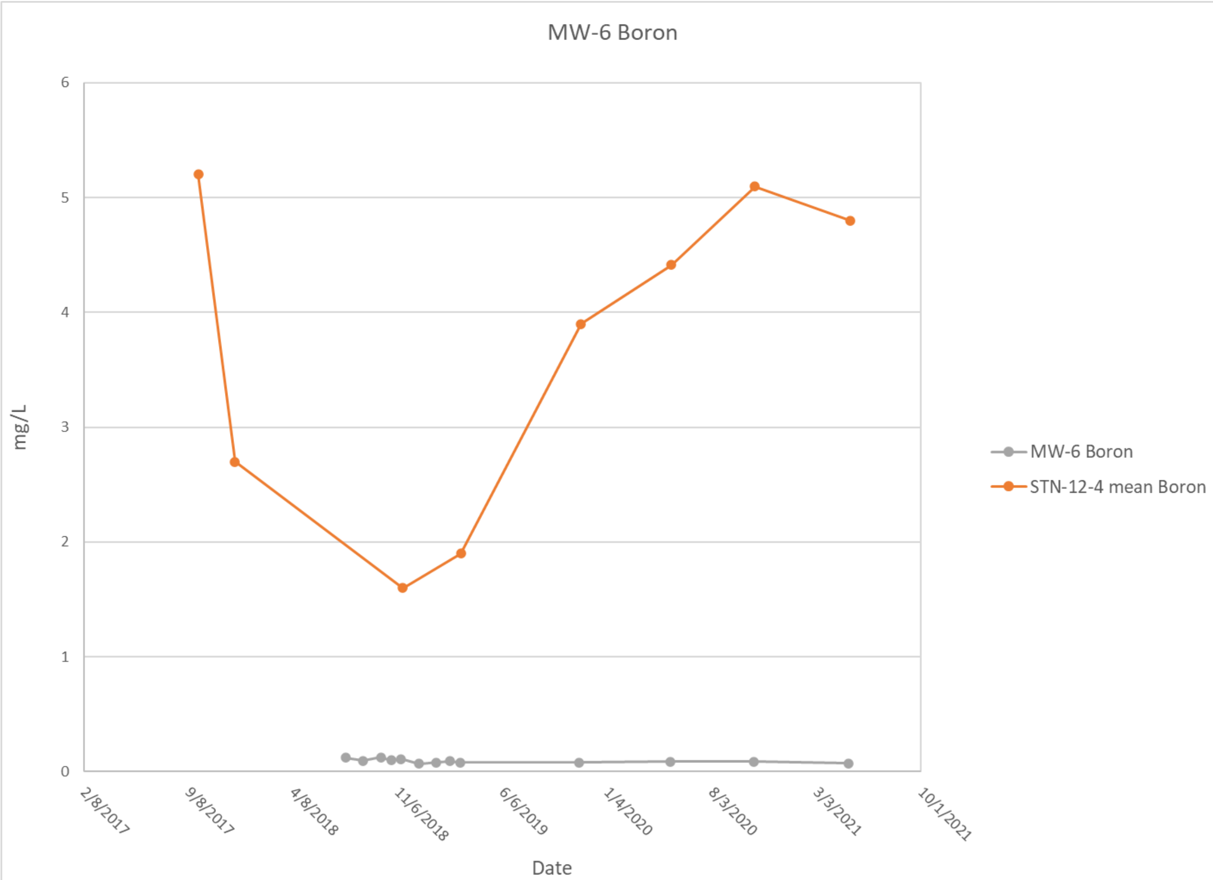

Figure 3-7 MW-6 Boron Concentrations

Temporal plots for potential indicators reported in groundwater monitoring well MW-6 are provided in **Appendix D**, with geometrical mean data for the JAFAP porewater presented for comparison. Bromide, calcium, and potassium are present in groundwater at concentrations below the concentrations within the JAFAP for MW-6. Sodium concentrations in MW-6 groundwater are elevated in comparison to the JAFAP. The plots indicate an overall decrease in calcium and increase in sodium; the opposite pattern as observed for MW-5. Potassium concentrations have remained steady, whereas bromide has frequently been below the detection limit.

The overall decreasing trend of the primary CCR leachate indicators sulfate and boron in MW-6 support an alternate source for the subtle change in fluoride concentrations since the establishment of background values. Should CCR leachate be responsible for the increase in fluoride, we would expect a concomitant increase in the primary indicators, sulfate and boron (**Figure 3-5** and **Figure 3-7**), and potential indicators calcium, sodium, bromine, and potassium (**Appendix D**). The increase in fluoride and sodium, coupled with a decrease in calcium and sulfate, suggests a shift in composition towards NaCl-type waters; the opposite effect as observed at co-located, more deeply screened well MW-5. Therefore, the compositional changes at MW-6 likely reflect an increasing proportion of intermixed brine.

As discussed in **Section 2**, this conclusion is supported by the observation that sulfate is typically absent or at low concentrations in Appalachian Plateau connate brines, whereas fluoride and sodium are elevated. Conceivably, the brine/freshwater interface at the MW-5/MW-6 location has been perturbed, which has led to a more diffuse boundary. The cause is not definitively known but may be a combination of sampling-induced perturbations or changes in precipitation patterns.

3.2 Statistical Evaluation

The *Statistical Analysis Plan* for the Site recommends that background values be updated every four to eight measurements, assuming no SSIs are identified (Geosyntec, 2021). The *Statistical Analysis Plan* specifies a set of new data points may be compared against the existing background dataset using a nonparametric Mann-Whitney test (also known as the Wilcoxon rank-sum test) to determine if data belong to different populations. In addition, Mann-Kendall analysis is used to compare the temporal variation in concentrations of constituents with SSIs.

3.2.1 Mann-Whitney Test

To complete a Mann-Whitney test, a significance level (α) equal to 0.05 is used in the test if there are fewer than five observations, and an α as low as 0.01 may be used if there are at least five data points. If the Mann-Whitney test indicates a statistically significant difference between the two populations, then the data should not be combined with the existing background data until further review determines the cause of the difference. If there is no evidence of CCR leachate release, the new dataset is considered more representative of present-day groundwater conditions and should be used to establish background concentrations.

The results of a Mann-Whitney test for samples/constituents with SSIs are provided in **Table 3-2**. All locations indicate a difference in the population of observations made before and after sampling practices changed (**Section 3.5**). As described in **Section 3.1** and EHS Support (2020a, 2020b, 2021), SSIs are attributable to a combination of sampling practices, the presence of distinct water types, and natural variations in hydrological conditions. Therefore, background values presently used to identify SSIs do not adequately represent natural conditions and should be updated.

Table 3-2 Wilcoxon – Mann-Whitney Statistics

Monitoring Well ID	Constituent	α used in nonparametric Mann-Whitney test	Comparison between July 2012 to March 2019 And November 2019 onward sampling results
MW-5	Sulfate	0.01	A difference exists
MW-6	Fluoride	0.01	A difference exists

α = significance level

For the constituents that repeatedly show SSIs, there may be sufficient detection monitoring and verification sampling results presently available to make the background revisions, if the timing between samples meets the physical independence criteria outlined in the *Statistical Analysis Plan* (Geosyntec, 2021). For all other locations, the background may be revised using data from the upcoming detection monitoring event, which would constitute the fourth set of measurements since sampling practices have been standardized.

3.2.2 Mann-Kendall Test

Mann-Kendall analysis was used to compare the temporal variation in concentrations of constituents with SSIs. Non-detect values were evaluated by using half the reported detection limit. The Mann-Kendall test was completed for two scenarios: Scenario 1) concentration data for constituents with SSIs over the entire 2018 through 2020 dataset (including background sampling, detection monitoring, and verification sampling event data), and Scenario 2) concentrations for constituents with SSIs for the November 2019 detection monitoring event and onward (including verification sampling event data) (**Table 3-3**). The second scenario was established because consistent sampling practices were implemented starting in November 2019 (**Section 3.5**).

Table 3-3 Mann-Kendall Statistics

Monitoring Well ID	Constituent	Scenario 1 Trend 2018 – 2020	Scenario 2 Trend (November 2019 Onward)
MW-5	Sulfate	Increasing	Stable
MW-6	Fluoride	Increasing	Increasing

When the entire constituent concentration history (including background observations) is considered (Scenario 1):

- MW-5 has an increasing sulfate trend.
- MW-6 has an increasing trend in fluoride.

As discussed in **Section 3.1.3**, the increasing fluoride trend in MW-6 corresponds with a decreasing trend in the primary CCR leachate indicator sulfate, implicating a steadily increasing proportion of intermixed natural connate brine rather than CCR leachate affects.

When the period over which consistent sampling practices were used (November 2019 – January 2021) is considered (Scenario 2):

- MW-5 sulfate concentrations are stable.
- MW-6 has an increasing trend in fluoride.

In summary, the population of sampling results collected after sampling practices were standardized (**Section 3.5**) indicates that groundwater geochemistry is stable in well MW-5. Groundwater geochemistry in MW-6 has not stabilized and continues to increase. Given that the primary indicator sulfate has been steadily decreasing, the change at MW-6 is likely a natural phenomenon. A periodic review of background values used for MW-6 is recommended until conditions stabilize.

3.3 Ion Ratios and Conservative Ion Binary Plots

EPRI (2012) recommends the use of ion ratios to identify source waters or to determine that an additional source water is being added along a flow path. Binary plots of the molar concentrations of conservative ions in waters that have undergone binary mixing or dilution trace a straight line between the mixing end-members, and the intermediate (resulting) water falls on the mixing line.

3.3.1 Ion Ratios

EPRI (2012) recommends the use of ion ratios to identify source waters or to determine that an additional source water is being added along a flow path. The premise is that the concentration of two constituents in groundwater is maintained unless mixing with a water source that has different ion concentration ratios occurs. Care must be taken to select unreactive constituents (conservative ions) to support this analysis. The characteristics for conservative ions are as follows:

- Generally not volatile
- Largely do not participate in ion exchange or redox reactions
- Generally form minerals with high solubilities
- Are not typically leached from or incorporated into reactive minerals along groundwater paths in appreciable concentrations

These conservative ion characteristics result in preservation of conservative ion ratios through binary mixing, dilution, and evaporation processes. Sulfate should be assessed with caution using the conservative ion ratio approach, since sulfate is typically a conservative ion in oxygenated waters; however, oxidation of sulfide or reduction of sulfate on mixing between anoxic and oxygenated waters can shift the sulfate concentration substantially from an expected binary mixing result.

Ion ratios for key constituents in groundwater and JAFAP porewater samples from the May 2021 sampling round are provided in **Table 4**. Notably, the sulfate/chloride (SO_4/Cl) and fluoride/chloride (F/Cl) ratios for most groundwater samples are indistinguishable from JAFAP porewater; therefore, these SO_4/Cl and F/Cl ratios are not useful for distinguishing JAFAP porewater influence for most locations in the monitoring network. The exception is for wells MW-5, MW-2, and MW-8, which have distinct SO_4/Cl and F/Cl ratios that likely reflect a connate brine component.

In contrast, calcium/chloride (Ca/Cl) and boron/chloride (B/Cl) ion ratios are distinct for most groundwater and JAFAP porewater samples and provide useful indicators of mixing relationships between different water types. To better assess mixing relationships based on ion ratios, ion ratio plots were developed based on the following method and rationale.

Ion ratio plots were developed from historical and current data for MW-5 and co-located wells MW-6 and MW-1 (**Figure 3-8**). The ion ratio plots show the following:

- MW-5 (both historical and current sample data) shows a distinct ion composition compared to shallower co-located wells (MW-1 and MW-6) and JAFAP porewater.
- MW-6 is distinct from JAFAP porewater in terms of B/Cl and F/Cl.
- MW-5 and MW-6 maintain consistent ion ratios across all sampling events, implying that they are not shifted towards JAFAP porewater compositions.

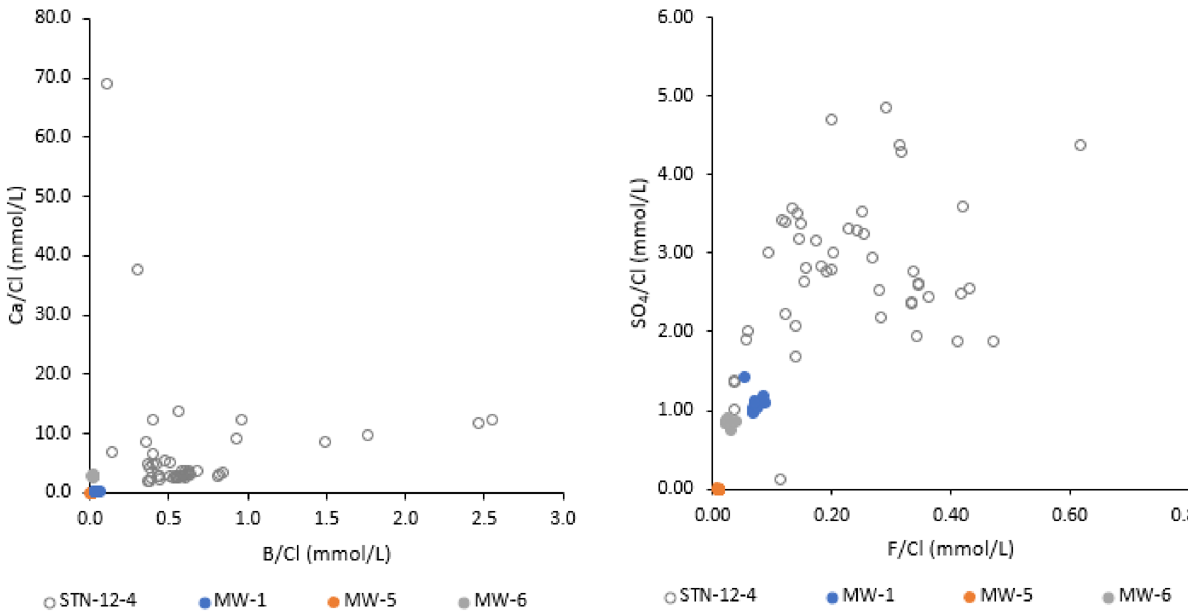

Figure 3-8 Ion Ratio Plots of Historical and Current Data from MW-1, MW-5, MW-6, and STN-12-4 JAFAP Porewater

The distinct composition of MW-5 supports an Appalachian Plateau connate brine origin. Indeed, the composition of MW-5 groundwater on these plots is sufficiently unique that no clear mixing relationship between the sampling results and other water sources is clear based on ion ratios. For this reason, absolute conservative ion concentrations (not ratios) are used to better assess mixing between MW-5 and alternative sources, as discussed in **Section 3.3.2**.

3.3.2 Conservative Ion Binary Plots

Binary plots of the molar concentrations of conservative ions in waters that have undergone binary mixing (or dilution) trace a straight line between the mixing end-members, and the intermediate (resulting) water falls on the mixing line. Molal concentrations are preferred in this type of diagram as mineral precipitation effects are more readily apparent. Dissolved elements broadly considered as conservative for this purpose include the halides (e.g., chloride and fluoride) and boron.

Binary conservative ion plots (B-Cl, F-Cl, and B-F) were constructed for the historic data record starting in July 2018 for co-located wells MW-1, MW-5, and MW-6 (**Figure 3-9**). Historic data for JAFAP porewater from the seven ports in multi-level well STN-12-4 from September 2017 to the present, were included on the charts as a possible mixing end-member.

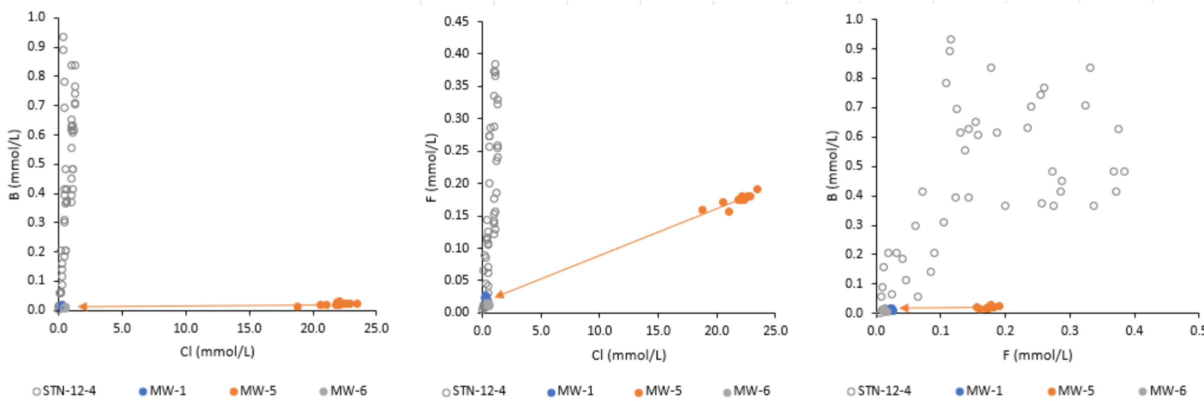

Figure 3-9 Conservative Ion Binary Plots for MW-5 and MW-6

For well MW-5, samples trace a mixing line toward $NaHCO_3$-type waters in the shallower co-located wells MW-1 and MW-6 for all conservative ion plots and do not indicate mixing with JAFAP porewater (**Figure 3-9**). This relationship indicates that mixing between Appalachian Plateau NaCl-type connate water and overlying more dilute $NaHCO_3$-type water, and mixing with JAFAP porewater is not supported.

3.4 Tier II Evaluation – Geochemical Evaluation

A simple analysis of primary and potential indicator constituents (**Section 3.1**) may not provide the lines of evidence required for a robust ASD investigation. It is recognized that naturally occurring indicator constituents and upgradient sources may have an additional influence on groundwater quality. Groundwater quality may be observed to change due to chemical interactions with the aquifer matrix spatially across a site. EPRI (2012) recommends more sophisticated methods that can be used for multiple parameters over multiple locations.

Piper plots are used to classify groundwater types based on the major ion ratios of calcium, magnesium, sodium (and potassium), alkalinity, chloride, and sulfate. They can be used to visually illustrate ion exchange and mixing between different water chemistries.

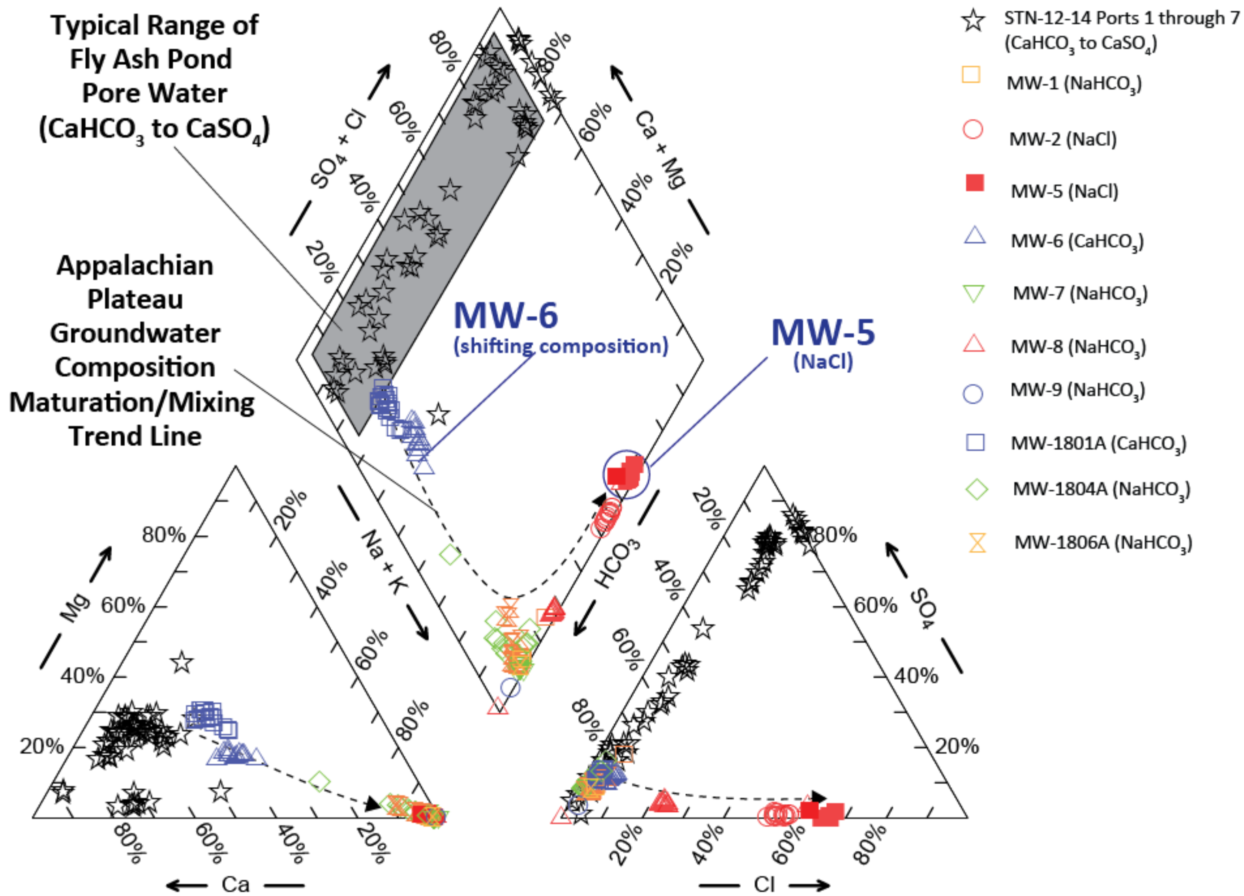

Figure 3-10 JAFAP and Groundwater Piper Plot (water types)

Note: Not all Site monitoring wells are shown.

Fly ash porewater and groundwater are represented by different water types. In **Figure 3-10**, the water types related to the JAFAP porewater are dominated by calcium, bicarbonate, and sulfate. Groundwater samples from JAFAP groundwater monitoring wells trace the expected evolution trend expected for Appalachian Plateau groundwater, where dilute calcium bicarbonate (Ca-HCO_3-type) water evolves to sodium bicarbonate (Na-HCO_3-type) groundwater that may mix with NaCl-type connate brines (**Section 2**).

Groundwater samples from MW-6 represent immature calcium bicarbonate-type waters, whereas MW-7 and MW-1804A represent more evolved sodium bicarbonate water types. Groundwater samples collected in the vicinity of MW-5 between July 2018 and May 2021 consistently report a sodium chloride water type. This water type is typically indicative of connate brines that are relict within the aquifer. This groundwater type is also consistent with the construction of well MW-5, which monitors a deeper section of the bedrock aquifer than other Site wells (except MW-2) where a connate brine is expected to be encountered (**Section 2**). Notably, no groundwater samples trend away from the expected groundwater maturation/mixing line and trend toward the calcium sulfate-type JAFAP porewater.

In summary, the geochemical evaluation indicates no evidence to support the presence of CCR constituents in groundwater sampled at any of the groundwater monitoring locations reviewed as indicated by **Figure 3-10**. Groundwater compositional changes are observed, but these changes are within the range expected in the hydrogeochemical framework for Appalachian Plateau bedrock groundwater. The magnitude of natural variation is not captured by the constituent concentrations that were collected over the seven months used to establish background concentrations.

Based on this evidence, it is considered that porewater from JAFAP is unlikely to be influencing the surrounding groundwater. Any compositional similarity between JAFAP pore water and the monitoring locations mentioned reflects the common recharge source and flow pathways for JAFAP pore water and local groundwater.

3.5 ASD Type I – Natural Variation due to Sampling Causes

EPRI (2012) describes sampling anomalies as a defensible cause for an SSI. A review of field documents indicates a notable change in the sampling technique at MW-5 and MW-6 during the November 2019 through July 2021 sampling compared to the eight background monitoring events, the maximum purge rate in the detection monitoring events was between one-half and one-quarter the rate used historically during the background sampling events (**Figure 3-11** and **Figure 3-12**). Additionally, the total volume purged during the November 2019 through January 2021 sampling and verification events at MW-5 and MW-6 was typically lower than all previous instances (**Figure 3-11** and **Figure 3-12**).

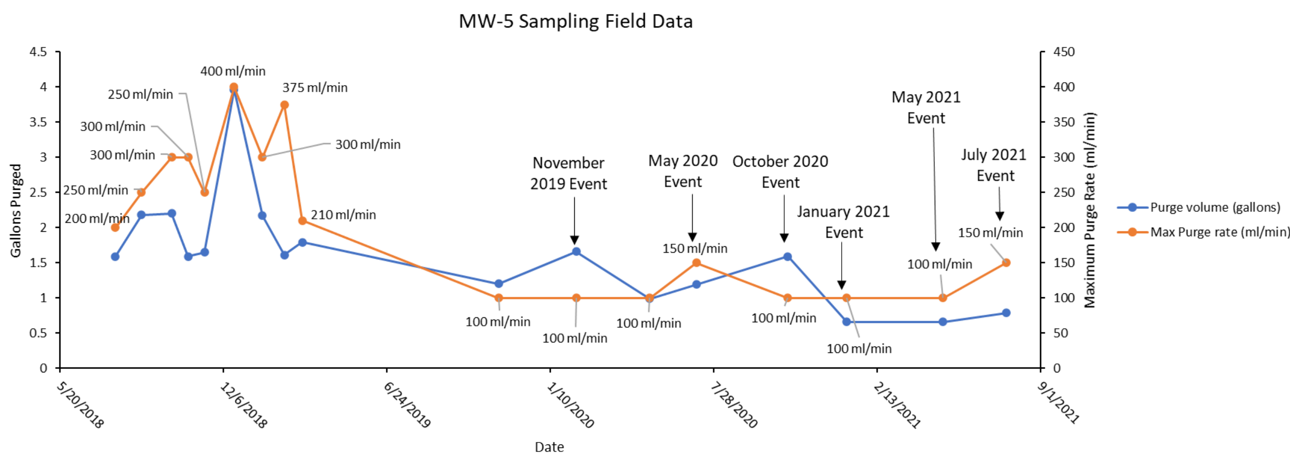

Figure 3-11 Historical Well Purge Rates and Volume Purged for MW-5

Sampling events used to establish benchmark values for evaluating SSIs were formulated through statistical analysis of the historical samples that were collected at higher purge rates and purge volumes. In the case of MW-5 (**Figure 3-11**), the excess pumping in the associated low-yield formation during SSI benchmark calibration sampling is expected to result in incursion of reducing, low sulfate, high TDS NaCl-type connate water into the well screen. Subsequent sampling at a lower purge rate and purge volume between November 2019 and January 2021 is expected to have minimized connate water incursion into the well and facilitated sampling of low TDS and sulfate bearing water with elevated calcium from above the connate water mixing interface.

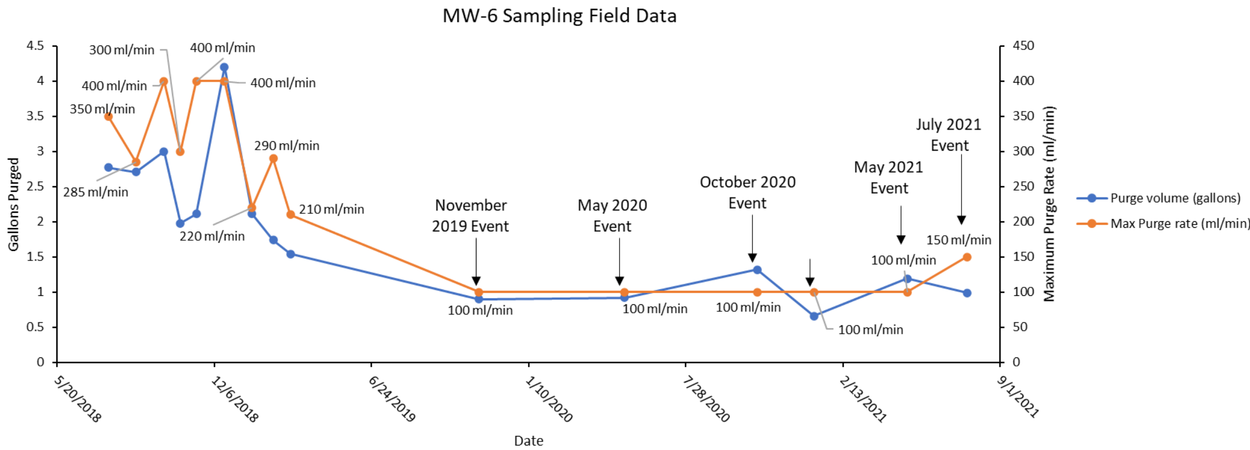

Figure 3-12 Historical Well Purge Rates and Volume Purged for MW-6

Similar to MW-5, lower purge rates and volumes at MW-6 during November 2019 through July 2021 sampling is expected to draw groundwater from portions of the formation not typically sampled during the background sampling events. The SSI exceedances in these monitoring wells can be attributed in part to a substantially lower purge rate and volume than used during background sampling to establish SSI benchmarks.

3.6 ASD Type III – Statistical Evaluation Causes

Samples to establish SSI benchmarks were obtained over seven months from July 25, 2018 to February 18, 2019. For this reason, benchmark statistical calculations are qualified with “Insufficient data to test for seasonality: data were not deseasonalized” (AEP, 2021). Additionally, annual variations owing to high rainfall years (**Section 3.7**) are not accounted for, as detection monitoring began immediately following the establishment of SSI benchmarks. Therefore, background values provide a representative timeframe to compare detection monitoring results against. It is recommended that background statistics be periodically updated to compensate.

3.7 ASD Type IV – Natural Variation

Historical groundwater geochemistry data for MW-5 show that it is screened close to a mixing zone between low TDS and comparatively young recharge water and high TDS and comparatively ancient connate brine. Regionally, the mixing interface between these two disparate water types is known to be only a few feet thick. The two water types constitute two natural groundwater sources with distinct groundwater geochemistry that may periodically contribute water to the saturated zone within the MW-5 screen/sand pack zone. Given that SSI benchmarks were established over approximately seven months, seasonality and longer timescale natural variations in the location of the mixing interface are unlikely captured in the benchmark dataset.

Similar to MW-5, historical data for co-located MW-6 show the groundwater composition is progressively shifting along the natural Appalachian Plateau groundwater geochemical evolution trend.

Natural variations in the groundwater flow system are increasingly contributing a component of deeper brine to the screened interval for MW-6.

4 Summary and Conclusions

Using the EPRI (2017) guidance for completing an ASD, the conclusions that are based on the lines of evidence presented and discussed within **Section 3** indicate that groundwater in the vicinity of the JAFAP is not being influenced by CCR constituents from the JAFAP. **Table 4-1** highlights the potential causes of SSIs at MW-5 and MW-6 during the May 2021 detection monitoring event that have been identified during this ASD investigation.

Table 4-1 Summary of Potential Causes Identified by ASD Investigation

Sampling Causes (ASD Type I)	Laboratory Causes (ASD Type II)	Statistical Evaluation Causes (ASD Type III)	Natural Variation (ASD Type IV)	Alternative Sources (ASD Type V- Natural and Anthropogenic)
• Sample mislabeling • Contamination • Change in technique • Excessive suspended solids or turbidity • Other sampling anomalies	• Analytical method • Calibration • Analytical technique • Contamination • Interference • Recording • Dilution errors • Digestion methods	• Lack of statistical independence • Outliers • Trends • Non-detect Processing • False positives • New background data	• Geology • Precipitation • Seasonality • Water level • Changes in pH and/or ORP • Biological activity • Time of travel	• See Appendix A, Tables A-3 and A-4 (EPRI, 2017)

ASD = Alternative source demonstration
ORP = oxidation-reduction potential
Source: Table 6-1 Potential Causes for a statistically significant increase / statistically significant level (SSI/SSL) (EPRI, 2017).
EPRI. 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. EPRI, Palo Alto, CA. 3002010920.

Concentrations of sulfate in MW-5 and fluoride in MW-6 that led to SSIs in May 2021 are primarily caused by a change in the sampling procedure (ASD Type I – Sampling Causes). The sampling procedure change between the baseline sampling and subsequent detection monitoring events led to a difference in where sampled water originated in the formation. Consequently, an ASD Type III – Statistical Evaluation Causes is the primary reason that SSIs of constituents have been observed in subsequent samples, as background concentrations are not representative of current groundwater conditions. Additional ASD causes include ASD Type IV Natural Variation Causes, and Type V – Alternatives Source (i.e., connate brine influence at MW-5 and MW-6). Lines of evidence for these ASD causes are detailed in **Table 4-2.**

Table 4-2 Evidence of ASD for SSIs at JAFAP

MW-5 Evidence
MW-5: Sulfate SSI
1. High purge rates and purge volumes during background sampling resulted in an intrusion of sodium chloride water, with essentially no sulfate, setting an unrealistically low SSI value for future comparison (sulfate SSI benchmark is over 100 times lower than typical groundwater sulfate concentrations due to incursion of reducing, sulfide-bearing and sulfate-free brine). 2. Mixing of shallower sulfate-rich groundwater occurred during the detection monitoring sampling events due to substantially lower purge rates and volumes, as evidenced by the following: a. Sulfate in MW-5 was lower than in co-located and shallower wells MW-1 and MW-6. b. SO_4/Cl ratios were substantially lower than JAFAP porewater and closer to those in shallow groundwater wells. c. Piper plot relationships show MW-5 is compositionally distinct from JAFAP porewater and there is no mixing relationship.
MW-6 Evidence
MW-6: Fluoride SSI
1. High purge rates and purge volumes during background sampling resulted in the preferential sampling of more dilute water, setting an unrealistically low fluoride SSI value for future comparison. 2. Mixing of a brine component with higher fluoride concentration has gradually occurred due to a substantially lower purge rate and volume and/or natural variations in hydrology, which ultimately led to the SSI as evidenced by the following: a. The primary CCR leachate indicator sulfate has been steadily decreasing. b. The primary CCR leachate indicator boron has remained stable. c. There is no indication of a compositional shift toward JAFAP porewater composition per the Piper plot (**Figure 3-10**).

ASD = alternative source demonstration
CCR = coal combustion residual
Cl = chloride
JAFAP = John E. Amos Plant Fly Ash Pond
SO_4 = sulfate
SSI = statistically significant increase

An ASD Type III – Statistical evaluation cause is a primary reason for SSIs that have occurred in subsequent detection monitoring events. SSI benchmarks were established over an approximately seven-month period preceding three-quarters of detection monitoring. Subsequent detection monitoring events have currently spanned approximately 20 months since the first detection monitoring event in March 2019. The seven-month background period does not fully capture seasonal and annual weather variations, and recalculation of the background data is recommended to accurately reflect the natural variation in groundwater chemistry across the hydrogeologic units surrounding the JAFAP (**Section 3.2**).

In addition to ASD Type I – Sampling Causes and ASD Type III – Statistical Evaluation Causes, the following potential contributing alternative sources were identified for MW-5 and MW-6:

- ASD Type V – Alternative sources (Natural). Historical groundwater geochemistry data for MW-5 show that it is screened close to a mixing zone between low TDS and comparatively young recharge water and high TDS and comparatively ancient connate brine. Regionally, the mixing interface between these two disparate water types is known to be only a few feet thick. The two water types constitute two natural groundwater sources with distinct groundwater geochemistry that may periodically contribute water to the saturated zone within the MW-5 screen/sand pack zone.
- MW-6 is co-located with MW-5 and screened at a higher elevation. An increasing proportion of brine represented by MW-5 has been observed over time, likely due to a combination of sampling practices and natural hydrologic variations.

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Tables

Table 1 Screened Interval of Monitoring Wells

Well/ Boring	Hydraulic Location	Hydrolitho-Stratigraphic Unit	Surface Elevation (ft amsl)	Screened Interval (ft amsl)	Sand Pack Interval (ft amsl)	Geologic Formation
MW-1807A	Upgradient/ Background	SRF	861.99	766.99 – 746.99	745.99 – 769.99	Unnamed clay shale/ Lower Connellsville SS
MW-1808A	Upgradient/ Background	SRF	857.55	733.73 – 748.35	746.55 – 776.55	Unnamed clay shale/ Lower Connellsville SS
MW-1809A	Upgradient/ Background	SRF	738.09	666.09 – 681.09	664.09 – 683.69	Clarksburg Shale
MW-1810A	Upgradient/ Background	SRF	735.26	655.26 – 675.26	653.26 – 681.26	Clarksburg Shale
MW-1	Downgradient	SRF	647.57	587.57 – 606.47	569.47 – 609.57	Birmingham Shale
MW-2	Downgradient	SRF	645.20	540.20 – 549.10	534.20 – 560.50	Birmingham Shale
MW-5	Downgradient	SRF	648.03	537.03 – 546.43	535.93 – 557.03	Birmingham Shale /Grafton SS
MW-6	Downgradient	SRF	647.50	614.00 – 619.00	613.30 – 620.30	Morgantown SS/ Birmingham Shale
MW-7	Downgradient	U/SRF	953.00	823.00 – 843.00	820.50 – 845.00	Conemaugh Shale/ Upper Connellsville SS
MW-8	Downgradient	U/SRF	963.01	800.01 – 819.01	797.01 – 821.21	Conemaugh Shale/ Upper Connellsville SS
MW-9	Downgradient	U/SRF	944.66	805.56 – 824.56	804.56 – 824.56	Conemaugh Shale/ Upper Connellsville SS
MW-1801A	Downgradient	U/SRF	901.12	826.12 – 846.12	824.12 – 849.12	Conemaugh Shale/ Upper Connellsville SS
MW-1804A	Downgradient	U/SRF	858.53	811.03 – 831.03	809.53 – 838.63	Conemaugh Shale/ Upper Connellsville SS/ Unnamed clay shale
MW-1806A	Downgradient	U/SRF	889.63	809.23 – 829.23	808.63 – 832.63	Conemaugh Shale/ Upper Connellsville SS/ Unnamed clay shale

Notes:
amsl = above mean sea level
ft = feet
SRF = Stress Relief Fracture System
SS = Sandstone
U = Upper Connellsville Sandstone

Table 2
Multi-Port Piezometer STN-12-4 Water Quality Data
Fly Ash Pond Alternative Source Demonstration Investigation
AEP, John E. Amos Plant, Winfield, WV
November 2021

Multi-Port Interval	Sampling Date	Major Ions							Minor Ions				TDS	pH
		Bicarbonate Alkalinity (as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
1	9/29/2017	630	182	13	41.7	--	75.6	151	10.1	--	2.2	--	810	--
2	9/28/2017	181	84.9	15.8	23.1	--	10.2	129	2	--	0.78	--	394	--
3	9/28/2017	108	69.2	16.3	11.9	--	16.1	146	3.36	--	2	--	344	--
4	9/28/2017	187	103	24.3	25.3	--	23.5	164	4.48	--	5.43	--	458	--
5	9/28/2017	62	122	39.5	22.9	--	15.7	280	5.23	--	7.3	--	582	--
6	9/28/2017	44	134	35.9	3.59	--	38.5	341	6.79	--	2.71	--	612	--
7	9/28/2017	51	168	46.4	29.3	--	19.9	409	9.05	--	6.28	--	740	--
GeoMean	September 2017	118.1	117.1	24.5	18.3	--	23.1	210.3	5.2	--	3.0	--	539.2	--
1	12/12/2017	597	170	12.8	22.6	--	20.1	152	9.63	--	2.16	--	816	--
2	12/12/2017	122	30.7	3.98	19.9	--	12.6	1.4	0.169	--	0.24	--	174	--
3	12/12/2017	102	34.5	6.18	3.06	--	33.7	28.1	0.698	--	0.46	--	224	--
4	12/11/2017	185	91.9	22.5	25.1	--	16.2	156	3.98	--	5.2	--	446	--
5	12/11/2017	67.1	105	38.1	38.5	--	66.6	268	4.5	--	7.05	--	550	--
6	12/11/2017	50.6	122	36.3	6.36	--	6.01	351	6.02	--	2.62	--	608	--
7	12/11/2017	49.6	143	45.6	6.81	--	7.42	435	7.67	--	6.14	--	774	--
GeoMean	December 2017	112.7	84.3	17.2	12.8	--	17.0	87.1	2.7	--	2.0	--	448.9	--
1	11/15/2018	360	58.5	3.74	15.3	8.76	13.6	44.4	0.634	0.1	1.24	0.0375	406	7.57
2	11/14/2018	289	67.9	1.59	17.4	7.36	10.5	20.2	0.145	0.1	0.17	0.0158	320	7.32
3	11/15/2018	181	50	0.64	12.6	7.6	7.78	8.4	<0.02	0.1	0.1	0.00892	217	7.47
4[1]	11/15/2018	229	63.6	10.6	15.1	8.26	12.1	62.8	1.52	0.2	1.61	0.231	330	7.48
5	11/15/2018	80.4	86	35.8	17.9	6.34	10.6	229	3.98	0.508	6.38	1.62	440	7.65
6	11/15/2018	38.7	82.7	36.8	4.82	10.8	22.2	342	4.27	0.5	2.32	2.52	840	8.92
7	11/16/2018	55.8	115	40.8	19.3	7.83	16.1	332	6.83	0.502	4.45	3.17	600	8.01
GeoMean	November 2018	133.3	72.3	8.0	13.6	8.0	12.6	74.1	1.6	0.2	1.1	0.2	413.4	7.76
1	3/12/2019	392	107	7.59	26.8	8.47	39.9	74.1	2.23	0.1	1.71	0.0924	508	7.76
2	3/13/2019	281	73	5.24	19.1	5.43	13	27.1	0.643	<0.1	0.16	0.101	314	7.28
5	3/14/2019	213	75.3	10.3	19	4.67	13.6	78.2	1.25	<0.1	0.86	0.45	346	7.26
6	3/15/2019	47.4	127	37.6	3.98	11.2	37.8	346	6.67	0.548	2.46	2.5	628	9.52
GeoMean	March 2019	182.6	93.0	11.1	14.0	7.0	22.7	85.9	1.9	0.2	0.9	0.3	431.5	7.90
1	11/11/2019	627	173	15.8	36.8	10.4	70.8	141	8.47	0.311	2.05	0.146	816	7.55
2	11/11/2019	314	86.5	8.95	19.5	6.14	12	24.7	0.955	0.224	0.18	0.0714	361	7.25
3	11/11/2019	211	64.6	11.2	13.8	4.9	13.4	41.8	1.72	0.263	0.22	0.114	285	7.46
4	11/11/2019	201	83.4	20.6	20.5	6.01	20.4	109	3.95	0.423	3.79	0.551	391	7.68
5	11/11/2019	75.7	114	36.6	21.6	3.86	12.3	250	4.88	0.634	5.47	1.69	512	7.82
6	11/12/2019	47.7	132	36.8	3.7	10	42	337	7.05	0.584	2.91	2.68	632	9.26
7	11/12/2019	62	136	43.3	19.5	5.58	18.7	310	6.67	0.657	3.54	2.81	625	7.64

Table 2
Multi-Port Piezometer STN-12-4 Water Quality Data
Fly Ash Pond Alternative Source Demonstration Investigation
AEP, John E. Amos Plant, Winfield, WV
November 2021

Multi-Port Interval	Sampling Date	Major Ions							Minor Ions				TDS	pH
		Bicarbonate Alkalinity (as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
GeoMean	November 2019	151.9	107.4	21.2	16.4	6.3	21.7	122.5	3.9	0.4	1.5	0.5	488.5	7.79
1	5/11/2020	568	155	15.1	38.7	11.4	61.4	113	4.28	0.2	2.73	0.186	758	7.82
2	5/11/2020	281	101	18.4	27.6	6.89	11.9	67.6	2.23	0.297	0.36	0.202	457	7.24
3	5/13/2020	120	56.8	17.8	14.3	7.83	14.6	107	3.24	0.294	1.17	0.315	336	7.40
4	5/13/2020	192	75.9	22.2	23.2	6.22	18.8	113	4.06	0.336	4.88	0.543	368	7.67
5	5/13/2020	555	104	39	22.7	5.14	11	252	5.2	0.534	6.97	1.67	555	7.76
6	5/14/2020	46.1	123	38	4.32	11.9	40	327	6.58	0.455	2.98	2.49	624	9.34
7	5/14/2020	40.6	142	47.1	20.5	6.76	19.3	363	7.6	0.546	4.57	3.3	676	7.69
GeoMean	May 2020	168.3	103.0	25.8	18.4	7.7	20.8	160.7	4.4	0.4	2.5	0.7	518.2	7.82
1	10/28/2020	590	159	16.5	39.5	11.8	65.1	132	7.51	0.311	2.38	0.161	826	7.57
2	10/28/2020	264	94.5	19.2	26.3	6.43	10.7	105	2.22	0.421	0.6	0.125	479	7.35
3	10/28/2020	122	58.2	18.1	13.8	7.83	14.5	102	3.79	0.399	1.35	0.241	316	7.70
4	10/28/2020	201	77.1	20.5	23.3	5.82	18	104	4.28	0.42	5.18	0.582	404	7.96
5	10/29/2020	76.2	111	36.6	24.3	5.1	10.3	243	5.56	0.634	7.11	1.57	532	8.15
6	10/30/2020	44.6	122	36	4.15	11.8	37.1	308	7.14	0.584	3.37	2.28	615	9.32
7	10/30/2020	40.6	145	46	21	6.2	16.3	347	8.29	0.711	4.93	3.17	688	7.78
GeoMean	October 2020	126.8	104.1	25.6	18.4	7.5	19.7	168.3	5.1	0.5	2.7	0.6	527.5	7.95
1	5/10/2021	557	136	16.9	37.3	12.2	67.2	114	3.95	0.25	2.91	0.189	751	7.45
2	5/10/2021	285	103	22.9	31	7.36	14.1	130	3.11	0.435	0.96	0.279	524	7.30
3	5/10/2021	119	58.1	19.4	15.5	8.57	18	115	4.05	0.386	2.04	0.408	341	7.83
4	5/10/2021	208	74.8	21	24.5	6.27	20.9	97.8	4.12	0.383	5.44	0.547	415	7.95
5	5/11/2021	116	99.6	35.5	21.9	5.01	12.5	208	5.12	0.562	7.24	1.49	508	8.20
6	5/11/2021	48.6	106	37.5	3.92	11.3	40.5	306	6.94	0.543	3.33	2.31	607	9.08
7	5/11/2021	41.9	132	47.2	19.3	6.09	18	353	8.03	0.657	4.85	3.20	687	7.87
GeoMean	May 2021	137.48	97.68	26.79	18.45	7.74	22.85	167.79	4.80	0.44	3.22	0.75	530.3	7.94

Notes:
mg/L = milligrams per liter
s.u. = standard units
TDS = total dissolved solids
- - = not analyzed
< = value less than reporting limit
[1] pH reported in Interval 4 in November 2018 was recorded in error as 4.48 at time of sampling, pH prior to sampling was 7.42, this value was corrected to 7.48.

Table 3
Monitoring Well Water Quality Data
Fly Ash Pond Alternative Source Demonstration Investigation
AEP, John E. Amos, Winfield, WV
November 2021

Monitoring Well	Collection Date	Monitoring Program	Major Ions							Minor Ions				TDS	pH
			Bicarbonate (Alkalinity as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
MW-1	7/24/2018	Background	382	2.83	11.7	0.466	1.75	159	30.6	0.182	0.106	0.42	0.00194	473	8.20
	8/28/2018	Background	371	2.80	11.3	0.502	1.63	168	31.6	0.135	0.121	0.45	0.00148	435	8.50
	10/3/2018	Background	385	2.95	11.1	0.456	1.4	172	30.8	0.138	0.1	0.40	0.001	457	8.30
	10/22/2018	Background	380	2.36	11.4	0.396	1.49	170	30.7	0.180	0.1	0.42	0.001	434	8.30
	11/13/2018	Background	388	3.03	11.5	0.424	2.27	159	32.2	0.209	0.1	0.45	0.001	444	8.00
	12/19/2018	Background	372	2.71	10.7	0.441	1.31	162	30.9	0.117	0.09	0.43	0.001	428	8.10
	1/23/2019	Background	242	2.29	14.6	0.404	1.41	148	55.9	0.115	0.04	0.41	0.001	453	8.20
	2/19/2019	Background	367	2.36	10.9	0.371	1.22	175	31.3	0.126	0.09	0.44	0.001	457	8.50
	MW-1 Intrawell Prediction Limit		- -	**3.58**	**14.6**	- -	- -	- -	**55.9**	**0.261**	- -	**0.485**	- -	**536**	**7.70**
	3/12/2019	Detection	390	2.60	11.0	0.383	1.14	170.0	31.6	0.110	0.080	0.43	- -	458	8.20
	11/8/2019	Detection	353	2.38	11.2	0.413	1.42	165.0	33.7	0.114	0.100	0.42	- -	461	8.20
	5/13/2020	Detection	335	2.74	11.2	0.410	1.38	163.0	33.6	0.122	0.070	0.42	- -	457	8.24
	11/2/2020	Detection	322	2.70	10.5	0.461	1.33	169.0	33.6	0.097	0.1 J	0.48	- -	434	8.37
	5/5/2021	Detection	336	2.65	11.0	0.448	1.25	166.0	32.9	0.111	0.08 J	0.51	- -	448	8.25
	7/21/2021	Verification	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.49	- -	- -	- -
MW-2	07/27/2018	Background	545	4.24	471	0.924	1.97	427	2.4	0.259	2.6	3.08	0.0272	1260	8.40
	08/29/2018	Background	547	3.98	443	0.891	3.05	426	17.4	0.249	2.49	2.99	0.0345	1310	8.60
	10/04/2018	Background	550	4.31	435	0.870	2.33	532	14.8	0.256	2.55	2.99	0.0308	1280	8.50
	10/23/2018	Background	561	3.95	438	0.866	2.47	516	7.4	0.262	2.41	3.08	0.0261	1250	8.50
	11/15/2018	Background	546	4.07	469	0.861	2.69	482	13.5	0.328	2.67	3.3	0.0292	1250	8.50
	12/19/2018	Background	551	3.81	430	0.822	2.03	443	6.4	0.225	2.34	3.03	0.0255	1250	8.50
	01/23/2019	Background	513	3.67	441	0.903	2.4	447	6.4	0.318	2.22	3	0.0292	1310	8.20
	02/22/2019	Background	568	3.95	447	0.855	2.02	461	2.3	0.237	2.26	3.06	0.0219	1310	8.70
	MW-2 Intrawell Prediction Limit		- -	**4.66**	**495**	- -	- -	- -	**26.7**	**0.382**	- -	**3.39**	- -	**1410**	**8.00**
	3/13/2019	Detection	605	3.98	441	0.826	1.86	470	1.8	2.300	2.38	3.02	0.0262	1300	8.70
	11/8/2019	Detection	543	4.77	426	1.08	2.91	481	20.1	0.265	2.39	2.73	- -	1340	8.51
	2/11/2020	Verification	- -	4.31	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
	5/12/2020	Detection	505	4.35	443	1.05	2.06	471	6.0	0.214	2.1	2.91	- -	1340	8.57
	11/2/2020	Detection	538	4.13	435	0.925	2.18	544	6.6	0.194	2.52	3.24	- -	1310	8.62
	5/5/2021	Detection	529	4.07	480	0.912	1.71	432	13.1	0.23	2.25	3.24	--	1310	8.40

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Monitoring Well	Collection Date	Monitoring Program	Major Ions							Minor Ions				TDS	pH
			Bicarbonate (Alkalinity as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
MW-5	7/24/2018	Background	599	6.75	793	1.60	3.04	777	0.2	0.252	4.69	3.32	0.0365	1890	8.10
	8/29/2018	Background	601	6.71	780	1.63	4.59	714	0.2	0.240	4.56	3.33	0.0384	1880	8.20
	10/3/2018	Background	581	7.03	776	1.56	3.37	742	0.1	0.276	4.67	3.33	0.0357	1860	8.10
	10/24/2018	Background	623	7.09	811	1.61	3.4	735	<0.06	0.249	4.63	3.44	0.0351	1840	8.10
	11/13/2018	Background	600	6.79	832	1.38	4.03	586	0.1	0.264	4.89	3.63	0.0347	1880	8.00
	12/19/2018	Background	609	6.48	783	1.53	3.02	595	<0.06	0.221	4.73	3.43	0.0348	1890	7.90
	1/23/2019	Background	619	5.98	782	1.60	3.8	599	<0.06	0.323	4.58	3.36	0.035	1910	8.10
	2/19/2019	Background	599	6.79	793	1.69	3.21	687	<0.06	0.239	4.58	3.38	0.0336	1920	8.20
	MW-5 Intrawell Prediction Limit		- -	**7.79**	**853**	- -	- -	- -	**0.20**	**0.355**	- -	**3.72**	- -	**1980**	**7.80**
	3/13/2019	Detection	609	6.85	804	1.60	2.78	660	0.08	0.229	4.69	3.44	- -	1930	8.00
	11/8/2019	Detection	588	21.00	663	2.61	6.61	571	32	0.182	4.36	3.04	- -	1840	7.97
	2/11/2020	Verification	- -	11.30	713	- -	- -	- -	18.6	- -	- -	- -	- -	- -	7.80
	5/11/2020	Detection	540	9.85	746	2.32	2.9	694	11	0.211	3.74	2.97	- -	1820	7.92
	7/7/2020	Verification	- -	8.77	- -	- -	- -	- -	22.8	- -	- -	- -	- -	- -	8.06
	10/27/2020	Detection	489	9.50	729	2.07	3.52	692	25.1	0.207	3.25	3.24	- -	1770	8.16
	1/7/2021	Verification	- -	9.31	- -	- -	- -	- -	14.6	- -	- -	- -	- -	- -	8.10
	5/5/2021	Detection	499	7.23	773	1.78	2.6	528	13.7	0.203	3.67	3.31	- -	1750	8.14
	7/21/2021	Verification	- -	- -	- -	- -	- -	- -	45.9	- -	- -	- -	- -	- -	- -
MW-6	7/24/2018	Background	294	61.0	19.3	15.5	2.73	59	44.4	0.120	0.168	0.22	0.00058	392	6.90
	8/28/2018	Background	310	59.7	19.4	15.6	2.87	60.8	44.6	0.096	0.203	0.24	0.0006	398	6.90
	10/3/2018	Background	309	60.7	18.9	15.3	2.72	62.5	43.4	0.125	0.2	0.21	0.0005	402	6.80
	10/24/2018	Background	302	61.5	18.4	15.0	2.76	68.3	42.0	0.1	0.2	0.23	0.0006	400	6.90
	11/13/2018	Background	304	64.9	19.8	14.0	3.24	57.4	44.6	0.111	0.2	0.24	0.0007	390	6.70
	12/19/2018	Background	324	55.8	17.7	14.1	2.8	57.4	41.7	0.07	0.1	0.23	0.0007	376	6.70
	1/23/2019	Background	309	54.1	17.8	15.0	2.77	54.8	41.3	0.08	0.1	0.22	0.0006	411	6.60
	2/19/2019	Background	325	55.8	17.3	15.1	2.92	67.4	40.4	0.09	0.1	0.24	0.0006	406	7.00
	MW-6 Intrawell Prediction Limit		- -	**70.6**	**21.4**	- -	- -	- -	**48.0**	**0.159**	- -	**0.264**	- -	**424**	**6.30**
	3/12/2019	Detection	314	57.9	17.4	14.7	2.69	65.5	39.8	0.08	0.1	0.23	- -	390	6.90
	11/8/2019	Detection	308	56.6	17.2	15.3	2.84	66.1	41.7	0.079	0.201	0.24	- -	368	6.93
	5/11/2020	Detection	295	55.8	15.9	15.3	2.65	69.0	32.6	0.088	0.1	0.25	- -	416	7.04
	10/27/2020	Detection	274	53.4	16.5	14.5	2.91	64.8	38.6	0.089	- -	0.28	- -	384	7.10
	1/7/2021	Verification	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.30	- -	- -	7.05
	5/6/2021	Detection	311	49.7	15.4	13.7	2.82	71.3	35.8	0.074	0.12	0.32	- -	400	6.94
	7/21/2021	Verification	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.27	- -	- -	- -

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Monitoring Well	Collection Date	Monitoring Program	Major Ions							Minor Ions				TDS	pH
			Bicarbonate (Alkalinity as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
MW-7	07/26/2018	Background	314	1.33	5.41	0.175	0.59	138	32	0.087	0.096	0.27	0.00112	368	8.53
	08/29/2018	Background	306	1.29	5.32	0.159	1.15	133	31.5	0.112	0.09	0.27	0.00106	387	8.75
	10/03/2018	Background	312	1.44	5.23	0.162	0.91	147	31.8	0.156	0.1	0.26	< 0.001	376	8.75
	10/24/2018	Background	309	1.4	5.37	0.203	0.94	154	31.7	0.09	0.1	0.27	< 0.001	344	8.82
	11/13/2018	Background	318	1.49	5.65	0.169	1.45	135	33.2	0.192	0.1	0.29	< 0.001	379	8.36
	12/17/2018	Background	323	1.24	5.29	0.173	0.73	155	32	0.1	0.09	0.27	< 0.001	387	8.62
	01/23/2019	Background	330	1.41	5.18	0.191	1.04	128	32	0.127	0.08	0.25	< 0.001	389	8.44
	02/18/2019	Background	325	1.37	5.39	0.181	0.78	154	32.1	0.06	0.09	0.26	< 0.001	401	8.96
	MW-7 Intrawell Prediction Limit		- -	**1.63**	**5.80**	- -	- -	- -	**33.6**	**0.248**	- -	**0.304**	- -	**458**	**8.00**
	3/13/2019	Detection	308	1.47	5.5	0.185	0.650	162	32.5	0.060	0.090	0.27	- -	385	8.88
	11/8/2019	Detection	295	2.18	5.4	1.54	1.760	139	32.3	0.066	0.100	0.25	- -	390	8.69
	2/11/2020	Verification	- -	1.39	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
	5/11/2020	Detection	284	1.59	5.3	0.286	0.7	143	23.6	0.067	0.08	0.27	- -	395	8.39
	10/28/2020	Detection	295	1.81	5.34	0.44	0.9	144	31.2	0.065	- -	0.31	- -	387	8.93
	1/6/2021	Verification	- -	1.53	- -	- -	- -	- -	- -	- -	- -	0.31	- -	- -	8.99
	5/12/2021	Detection	320	1.46	5.45	0.192	0.7 J	153	31.1	0.055	0.106	0.3	--	401	8.76
MW-8	7/26/2018	Background	518	2.15	- -	0.291	0.86	260	- -	0.233	0.504	- -	0.0117	- -	8.48
	8/2/2018	Background	494	- -	105	- -	- -	- -	21.6	- -	0.462	2.70	- -	690	8.20
	8/30/2018	Background	509	1.99	109	0.401	1.99	243	24.2	0.225	0.495	2.66	0.0206	727	8.90
	10/3/2018	Background	477	2.74	108	0.323	1.12	280	31.6	0.259	0.491	2.58	0.00876	729	7.86
	10/23/2018	Background	504	2.32	108	0.313	1.53	280	26.3	0.278	0.490	2.74	0.0102	717	8.45
	11/13/2018	Background	488	2.46	116	0.272	1.54	249	27.2	0.254	0.517	2.93	0.00764	711	8.15
	12/19/2018	Background	501	2.28	110	0.297	1.09	264	26.4	0.224	0.495	2.78	0.00693	696	8.45
	1/23/2019	Background	485	2.39	111	0.351	1.13	245	30.1	0.213	0.423	2.62	0.011	739	8.08
	2/20/2019	Background	492	2.49	111	0.307	0.88	270	26.4	0.195	0.471	2.87	0.008 J	740	9.15
	MW-8 Intrawell Prediction Limit		- -	**3.06**	**120**	- -	- -	- -	**36.5**	**0.320**	- -	**3.11**	- -	**798**	**7.00**
	3/12/2019	Detection	493	2.32	110	0.292	0.78	296	27.4	0.192	0.519	2.87	- -	716	8.49
	11/8/2019	Detection	484	1.98	109	0.30	1	263	22.5	0.197	0.6	2.97	- -	717	8.31
	5/12/2020	Detection	457	1.83	108	0.262	0.8	263	19.9	0.191	0.432	2.73	- -	720	7.31
	5/12/2020	Detection (Duplicate)	468	1.89	109	0.278	0.9	273	20.1	0.191	0.433	2.74	- -	715	7.31
	10/26/2020	Detection	457	8.47	508	1.65	2.84	510	37.4	0.215	2.7	3.07	- -	1400	8.44
	1/6/2021	Verification	- -	2.46	107	- -	- -	- -	18.3	- -	- -	- -	- -	729	8.20
	5/7/2021	Detection	451	2.19	109	0.312	0.9 J	275	20.2	0.18	0.501	2.99	--	711	8.54

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			Bicarbonate (Alkalinity as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
MW-9	7/26/2018	Background	417	1.03	- -	0.172	0.64	171	- -	0.157	0.04 J	0.87	0.00731	- -	8.00
MW-9	8/2/2018	Background	394	- -	7.22	- -	- -	- -	12.9	- -	< 0.05	- -	- -	421	8.27
MW-9	8/30/2018	Background	416	1.04	7.21	0.214	0.93	165	12.2	0.128	0.04 J	0.86	0.00628	468	9.17
MW-9	10/2/2018	Background	427	1.44	7.6	0.851	1.26	178	12.6	0.145	0.04 J	0.83	0.00607	513	7.14
MW-9	10/23/2018	Background	409	1.07	7.26	0.463	0.96	180	12.8	0.141	0.04 J	0.87	0.00593	460	9.28
MW-9	11/13/2018	Background	415	1.24	7.29	0.55	1.21	161	11.9	0.166	0.04 J	0.91	0.00606	449	9.29
MW-9	12/20/2018	Background	398	1.03	7.11	0.183	0.76	176	15.7	0.114	< 0.04	0.84	0.00651	435	9.17
MW-9	1/23/2019	Background	407	1.01	7.45	0.441	1.09	159	20.1	0.134	< 0.04	0.77	0.00649	484	8.74
MW-9	2/20/2019	Background	405	1.26	7.70	0.211	0.69	185	28.5	0.128	< 0.04	0.84	0.006	505	9.59
MW-9	**MW-9 Intrawell Prediction Limit**		- -	**1.63**	**8.00**	- -	- -	- -	**36.2**	**0.192**	- -	**0.976**	- -	**640**	**6.10**
MW-9	3/12/2019	Detection	400	1.18	7.50	0.174	0.52	195	24	0.122	< 0.04	0.91	- -	463	9.40
MW-9	11/8/2019	Detection	389	1.02	7.72	0.168	0.6	179	19.1	0.133	0.10 J	0.83	- -	440	8.77
MW-9	5/13/2020	Detection	377	0.96	7.27	0.126	0.6	179	12	0.122	< 0.04	0.82	- -	459	8.98
MW-9	10/29/2020	Detection	373	1.44	6.93	1.47	1.6	190	11.1	0.128	< 0.04	0.9	- -	459	7.14
MW-9	5/6/2021	Detection	391	1.01	7.09	0.154	0.6 J	174	14.4	0.109	0.03 J	0.92	--	448	9.03
MW-1801A	7/24/2018	Background	312	62.5	9.64	24.9	2.39	38.6	49.4	0.274	0.09	0.10 J	0.00497	372	7.56
MW-1801A	8/29/2018	Background	339	64.0	10.8	27.4	2.54	46.1	54.8	0.288	0.109	0.11	0.00307	420	7.43
MW-1801A	10/2/2018	Background	294	61.0	7.48	23.0	2.2	39.6	46.7	0.137	<0.1	0.10 J	0.00479	356	7.42
MW-1801A	10/24/2018	Background	298	63.1	8.14	22.8	2.29	39.4	41.8	0.105	<0.1	0.10 J	0.00208	357	7.45
MW-1801A	11/14/2018	Background	332	65.4	9.86	25.8	2.26	45.8	49.3	0.236	<0.1	0.10 J	0.00234	386	7.29
MW-1801A	12/19/2018	Background	307	62.8	9.08	24.9	2.82	46	45.5	0.289	0.08	0.12	0.00277	361	7.27
MW-1801A	1/24/2019	Background	319	53.4	9.18	24.4	2.3	42.7	46.3	0.168	0.06	0.14	0.00222	365	6.33
MW-1801A	2/20/2019	Background	296	53.3	8.96	21.8	2.42	41	40	0.09	0.05	0.13	0.00357	343	8.01
MW-1801A	**MW-1801A Intrawell Prediction Limit**		- -	**75.4**	**12.40**	- -	- -	- -	**61.2**	**0.459**	- -	**0.16**	- -	**518**	**5.9**
MW-1801A	3/12/2019	Detection	291	51.2	9.40	19.7	2.05	52.5	41.7	0.090	0.05	0.16	- -	306	7.45
MW-1801A	3/12/2019	Detection (Duplicate)	300	52.1	9.18	20.0	2.07	52.6	40.8	0.090	0.05	0.15	- -	342	7.45
MW-1801A	11/11/2019	Detection	317	61.6	9.76	25.5	2.07	50.3	45.3	0.229	0.1	0.12	- -	385	7.38
MW-1801A	11/11/2019	Detection (Duplicate)	344	63.7	9.63	26.5	2.12	49.9	45.2	0.261	0.1	0.11	- -	387	7.38
MW-1801A	5/13/2020	Detection	288	52.6	9.93	20.7	2.55	43.4	34.6	0.105	0.05	0.13	- -	353	7.60
MW-1801A	5/13/2020	Detection (Duplicate)	290	52.8	10.30	20.7	2.56	49.8	34.4	0.086	0.05	0.15	- -	365	7.60
MW-1801A	11/4/2020	Detection	332	62.4	8.84	27.4	2.39	44.1	41.5	0.244	0.1 J	0.12	- -	385	7.26
MW-1801A	11/4/2020	Detection (Duplicate)	341	62.8	8.89	27.6	2.4	44.4	41.7	0.242	0.1	0.12	- -	401	7.26
MW-1801A	5/6/2021	Detection	244	56.4	6.75	24.2	2.46	37.4	30.5	0.09	0.04 J	0.12	--	304	7.11
MW-1801A	5/6/2021	Detection (Duplicate)	252	53.9	6.99	23.1	2.35	36.2	31.1	0.09	0.04 J	0.13	--	314	7.11

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			Bicarbonate (Alkalinity as $CaCO_3$)	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	Boron	Bromide	Fluoride	Molybdenum		
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.
MW-1804A	7/27/2018	Background	< 1	28.1	- -	7.61	2.45	113	- -	0.672	0.5	- -	0.136	- -	7.50
	8/1/2018	Background	367	- -	3.87	- -	- -	- -	35.2	- -	0.04	0.70	- -	423	7.39
	8/28/2018	Background	395	15.9	5.27	4.03	2.82	157	44.7	0.779	0.08	0.84	0.136	452	8.30
	10/2/2018	Background	377	38.8	3.63	10.00	3.18	118	35.7	0.629	0.04	0.61	0.111	458	7.90
	10/23/2018	Background	423	12.9	4.79	3.22	1.9	167	36.9	0.675	0.05	0.78	0.116	452	7.60
	11/13/2018	Background	425	8.9	5.32	1.72	1.58	187	46	0.846	0.06	0.91	0.129	498	7.80
	12/19/2018	Background	446	10.1	4.51	2.14	1.91	170	40.1	0.772	0.04	0.78	0.13	433	7.90
	1/24/2019	Background	367	12.1	3.14	3.09	1.86	146	32.3	0.673	0.04	0.71	0.11	414	7.40
	2/21/2019	Background	362	7.43	3.29	1.74	1.29	164	33.8	0.611	0.04	0.89	0.115	461	8.00
	MW-1804A Intrawell Prediction Limit		- -	**51.2**	**6.93**	- -	- -	- -	**53.9**	**0.965**	- -	**1.10**	- -	**599**	**6.80**
	3/12/2019	Detection	329	10.2	3.55	2.27	1.37	165.0	34.0	0.568	<0.04	0.85	- -	411	7.90
	11/11/2019	Detection	438	6.8	11.20	1.16	0.80	211.0	85.4	0.730	0.203	0.64	- -	582	8.00
	2/12/2020	Verification	- -	- -	9.59	- -	- -	- -	69	- -	- -	- -	- -	- -	7.77
	5/14/2020	Detection	357	4.51	6.2	0.767	1.13	180	51.4	0.739	0.04	0.85	- -	484	8.13
	11/2/2020	Detection	361	4.7	7.12	0.819	1.2	187	57	0.549	0.1	0.86	- -	517	7.98
	1/6/2021	Verification	- -	- -	9.72	- -	- -	- -	69.3	- -	- -	- -	- -	- -	8.17
	5/6/2021	Detection	376	3.98	10.6	0.742	1.05	191	57.3	0.565	0.1 J	0.97	--	533	8.07
	7/20/2021	Verification	- -	- -	6.22	- -	- -	- -	47.3	- -	- -	- -	- -	- -	- -
MW-1806A	7/27/2018	Background	328	12.9	- -	3.19	1.63	129	- -	0.164	0.07	- -	0.017	- -	7.84
	8/1/2018	Background	331	- -	17.7	- -	- -	- -	48.4	- -	0.06	0.56	- -	426	7.60
	8/29/2018	Background	333	12.0	16.2	2.9	2.01	139	45.6	0.162	0.063	0.55	0.0142	445	8.00
	10/2/2018	Background	380	5.81	7.21	1.3	1.31	160	36.2	0.15	0.04	0.80	0.00773	435	8.50
	10/23/2018	Background	363	7.43	8.62	1.72	1.3	158	40.8	0.158	0.04	0.77	0.00666	423	8.40
	11/13/2018	Background	371	7.51	8.15	1.67	1.32	159	40.1	0.213	0.04	0.85	0.00744	442	8.10
	12/19/2018	Background	369	5.14	5.29	1.12	1.2	161	30.9	0.162	0.04	0.85	0.00602	409	8.50
	1/24/2019	Background	360	12.2	11.7	2.89	2.17	153	48.1	0.168	0.05	0.59	0.00562	445	8.10
	2/18/2019	Background	351	5.67	6.24	1.3	1.14	159	33.0	0.133	0.04	0.81	0.00474	460	8.60
	MW-1806A Intrawell Prediction Limit		- -	**18.80**	**24.60**	- -	- -	- -	**61.4**	**0.235**	- -	**1.14**	- -	**485**	**7.20**
	3/12/2019	Detection	375	4.98	5.51	1.10	0.98	180	32.9	0.130	0.040	0.83	- -	430	8.80
	11/12/2019	Detection	351	13.50	11.10	3.26	1.78	149	42.8	0.156	0.100	0.48	- -	423	7.90
	5/15/2020	Detection	363	2.32	8.45	0.451	0.90	175	35.2	0.127	<0.04	0.86	- -	456	8.81
	10/29/2020	Detection	363	7.38	10.20	1.580	1.25	210	49.7	0.153	<0.04	0.85	--	480	8.66
	5/6/2021	Detection	365	2.01	8.82	0.430	0.8 J	169	33.8	0.123	0.02 J	0.95	--	449	8.95

Notes:

Intrawell Prediction Limits are "Lower" for pH and "Upper" for all other constituents (AEP, 2020)

- - = not analyzed

< = Non-detect value, less than the Method Detection Limit

J = analyte was positively identified, though the quantitation was below the Reporting Limit

mg/L = milligrams per liter

s.u. = standard units

TDS = total dissolved solids

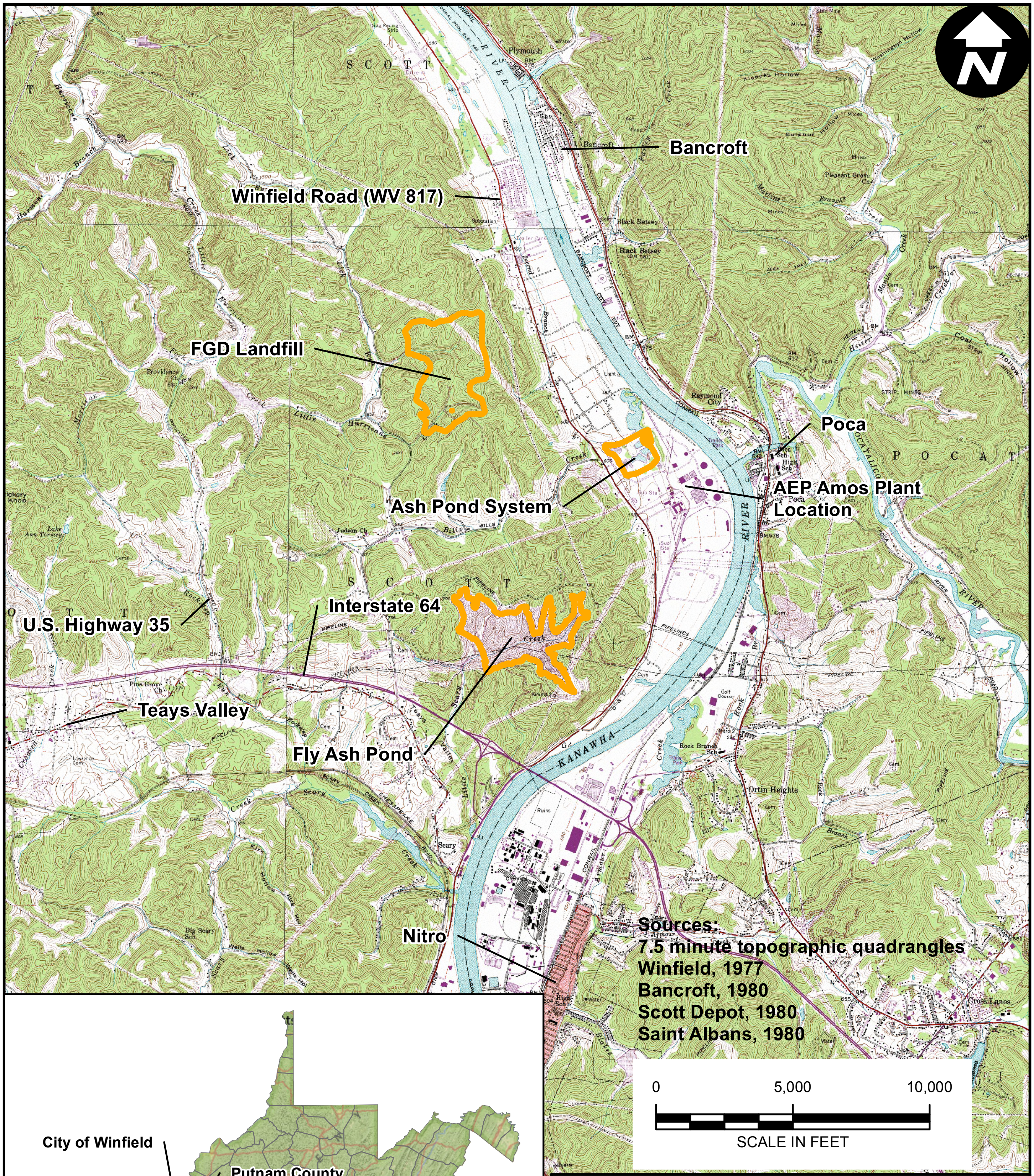
AEP. 2021. Annual Groundwater Monitoring Report. Appalachian Power Company, John E. Amos Plant Fly Ash Pond CCR Management Unit, Winfield, West Virginia. January.

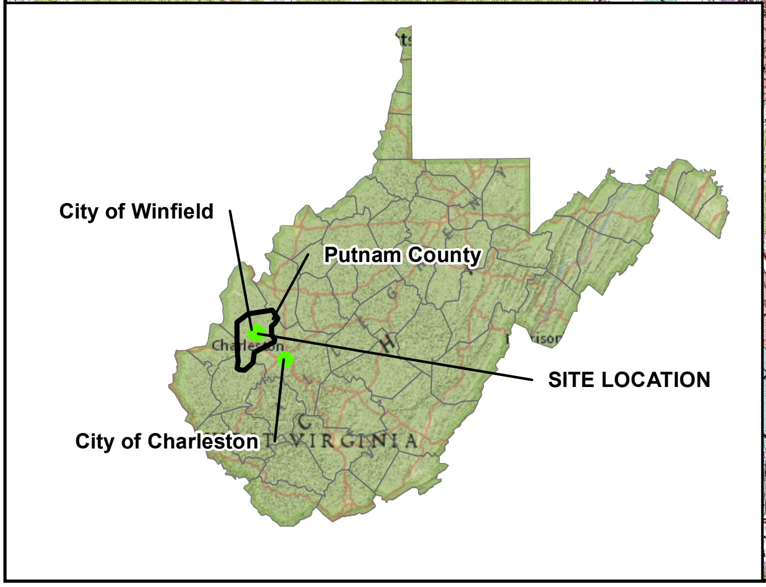
Table 4
Ion Ratios for Key Constituents in Groundwater
Fly Ash Pond Alternative Source Demonstration Investigation
AEP, John E. Amos Plant, Winfield, WV
November 2021

	Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	Sulfate	B/Cl *100	Ca/Cl	F/Cl *1000	SO_4/Cl *1000
			mg/L	mg/L	mg/L	mg/L	mg/L				
JAFAP Pore Water											
STN-12-4 Port 1	5/10/2021	Fly Ash	3.95	136	16.9	2.91	114	234	8.0	0.17	6,746
STN-12-4 Port 2	5/10/2021	Fly Ash	3.11	103	22.9	0.96	130	136	4.5	0.04	5,677
STN-12-4 Port 3	5/10/2021	Fly Ash	4.05	58.1	19.4	2.04	115	209	3.0	0.11	5,928
STN-12-4 Port 4	5/10/2021	Fly Ash	4.12	74.8	21	5.44	97.8	196	3.6	0.26	4,657
STN-12-4 Port 5	5/11/2021	Fly Ash	5.12	99.6	35.5	7.24	208	144	2.8	0.20	5,859
STN-12-4 Port 6	5/11/2021	Fly Ash	6.94	106	37.5	3.33	306	185	2.8	0.09	8,160
STN-12-4 Port 7	5/11/2021	Fly Ash	8.03	132	47.2	4.85	353	170	2.8	0.10	7,479
Benchmark SSI Exceedances											
MW-5	5/5/2021	Detection	0.203	7.23	773	3.31	**13.7**	0.3	0.01	0.004	18
MW-6	5/6/2021	Detection	0.074	49.7	15.4	**0.32**	35.8	5	3.2	0.02	2,325
Downgradient Wells											
MW-1	5/5/2021	Detection	0.111	2.65	11.0	0.51	32.9	10	0.2	0.05	2,991
MW-2	5/5/2021	Detection	0.230	4.07	480	3.24	13.1	0	0.01	0.01	27
MW-7	5/12/2021	Detection	0.055	**1.46**	5.5	**0.30**	31.1	10	0.3	0.06	5,706
MW-8	5/7/2021	Detection	0.18	2.19	109	2.99	20.2	2	0.02	0.03	185
MW-9	5/6/2021	Detection	0.109	1.01	7.08	0.92	14.4	15	0.1	0.13	2,034
MW-1801A	5/6/2021	Detection	0.090	56.4	6.75	0.12	30.5	13	8.4	0.02	4,519
MW-1804A	5/6/2021	Detection	0.565	3.98	**10.60**	0.97	**57.3**	53	0.4	0.09	5,406
MW-1806A	5/6/2021	Detection	0.123	2.01	8.82	0.95	33.8	14	0.2	0.11	3,832

Notes:
Bold values indicate SSI of a constituent
B/Cl = Boron/Chloride
Ca/Cl = Calcium/Chloride
F/Cl = Fluoride/Chloride
JAFAP= John E. Amos Plant Fly Ash Pond
mg/L = milligrams per liter
SO_4/Cl = Sulfate/Chloride
SSI= statistically significant increase

Appendix A Site Maps





AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

SITE LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

Document Path: Z:\GISProjects_ENV\AEP\Amos\mxd\Impoundment\Report\F1_ site map.mxd

LEGEND:

- Coal Combustion Residual (CCR) Unit
- Rivers and Streams
- Streamflow Direction

NOTES:
1. 2016 AERIAL IMAGERY OBTAINED FROM ESRI IMAGE SERVICE.
2. 2018 SITE SPECIFIC AERIAL IMAGERY OBTAINED FROM AEP.
3. WEST VIRGINIA 1983 STATE PLANAR COORDINATES

0 3,000 6,000 Feet
GRAPHIC SCALE

AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

PLANT AND CCR UNIT LOCATION MAP

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FIGURE
2

City: CITRIX Div/Group: IM/DV Created By: K.Ives Last Saved By: webb
OH015976.0009.00001 (Mountaineer Ash Pond)
Z:\GISProjects_ENV\AEP\Amos\mxd\ImpoundmentReport\F2_AmosRegionalMap.mxd 1/14/2019 9:27:48 AM

LEGEND:

- CCR Unit Boundary
- 2014 Soil and Rock Boring Location
- Oil & Gas Well
- 2008 Soil Boring and/or Rock Core
- Dewatering Well Converted to Piezometer
- Dewatering Well - Abandoned
- Downgradient Monitoring Well
- Upgradient or Background Monitoring Well
- 2012 Direct Push Boring with Cone Penetration Test (SCPTU)
- 2012 Direct Push Boring
- Piezometer
- 2012 Direct Push Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
- 2012 Direct Push Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Piezometer
- 2012 Soil Boring with Standard Penetration Tests and Rock Core
- Rivers and Streams
- Stream Flow Direction
- Access Road

NOTES:
1. 2018 aerial imagery obtained from AEP.
2. FAP monitor well, STN boring, B-1401, and B-1402 coordinate source: AEP Drawing No. 13-30702-1
3. FAP piezometer and 2008 soil boring coordinate source: AEP-provided boring logs
4. Oil and gas well coordinate source: WVDEP Oil and Gas Well Database
5. West Virginia 1983 State Planar Coordinates

0 600 1,200 Feet

GRAPHIC SCALE

AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

FLY ASH POND LAYOUT AND WELL LOCATIONS MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3

City: Div/Group: Created By: Last Saved By: acarlone
Project (Project #)
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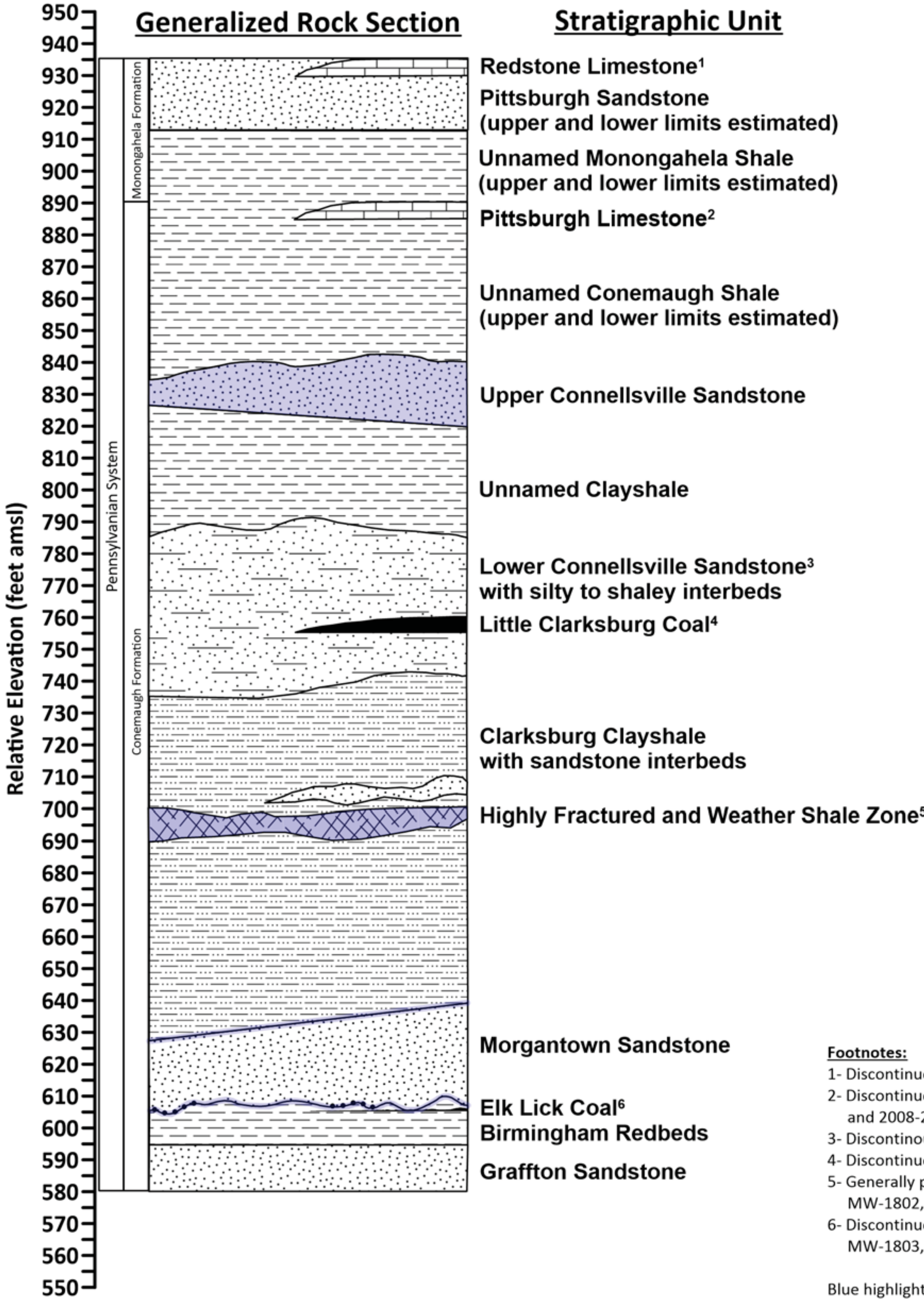
Appendix B Geologic Cross-Sections



Footnotes:

1- Discontinuous - only present at boring MW-3
2- Discontinuous - only present at borings MW-3 and 2008-26
3- Discontinous - interbeds of sandstone
4- Discontinuous - only present at boring B-0608
5- Generally present at borings MW-1801, MW-1802, MW-1803, and MW-1805
6- Discontinuous and thin - present at MW-1802, MW-1803, MW-1805

Blue highlighted areas designate groundwater-bearing fracture zones

References:

- Site stratigraphic and geophysics from current data collection and historical reports.
- Cross, A.T and M.P. Shemel. 1956. *Geology and Economic Resources of the Ohio River Valley in West Virginia, Part I Geology.* West Virginia Geological Survey Volume XXII.
- Latimer, W.J., et al. 1911. *Jackson, Mason and Putnam Counties, Volume 1, County Reports and Maps*. Wheeling News Litho. Company.
- Orsborn, N.P. 2008. *Deposition and Structural Features of the Basal Morgantown Sandstone of the Casselman Formation (Pennsylvanian) of the Greater Pittsburgh Region*. MS Thesis.
- Reger, D.B., et al. 1918. *Barbour and Upshur Counties and Western Portion of Randolph, Volume 1, County Reports and Maps.* Wheeling News Litho. Company.

AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

GENERALIZED STRATIGRAPHIC COLUMN

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FIGURE 4

LEGEND:

- CCR Unit Boundary
- Stormwater Pond
- 2014 Soil and Rock Boring Location
- Oil & Gas Well
- 2008 Soil Boring and/or Rock Core
- Dewatering Well Converted to Piezometer
- Dewatering Well - Abandoned
- Downgradient Monitoring Well
- Upgradient or Background Monitoring Well
- Monitoring wells for the Ash Pond CCR Unit
- 2012 Direct Push Boring with Cone Penetration Test (SCPTU)
- 2012 Direct Push Boring
- Piezometer
- 2012 Direct Push Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
- 2012 Direct Push Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Piezometer
- 2012 Soil Boring with Standard Penetration Tests and Rock Core
- Rivers and Streams
- Stream Flow Direction
- Access Road
- Cross Section Location

NOTES:

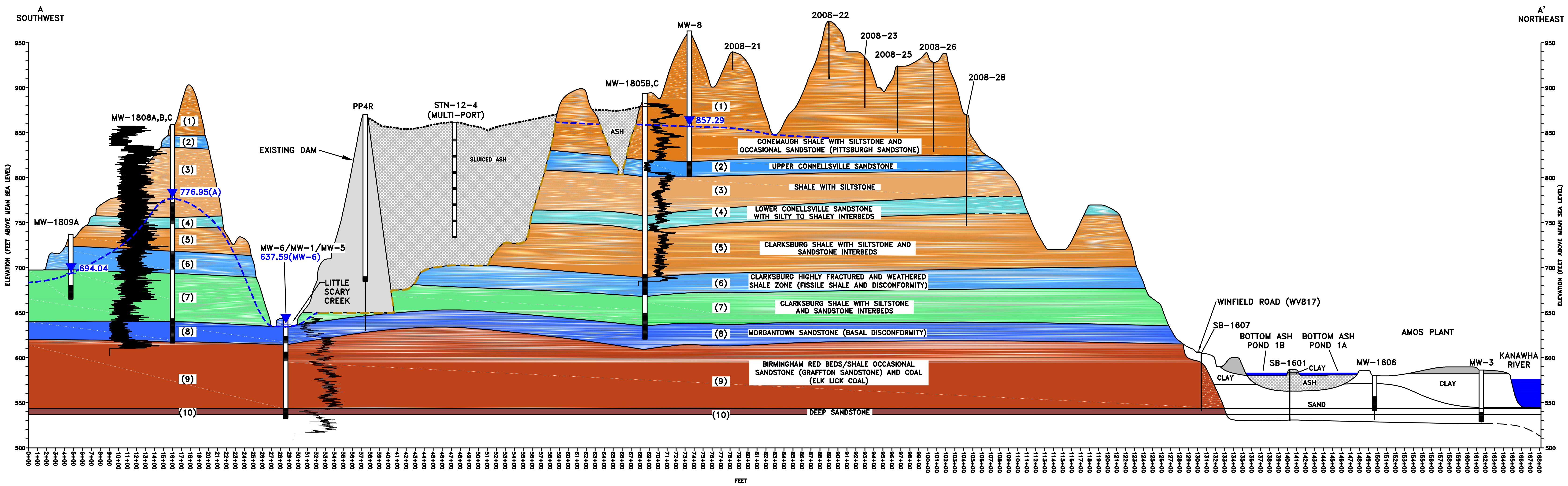
1. Topography from AEP dwg no. 13-30705-0 and 3dAMtopo_FAP11_aerial05.dgn. Contour Interval: 10 feet (2 feet within CCR unit boundary)
2. FAP monitor well, STN boring, B-1401, and B-1402 coordinate source: AEP Drawing No. 13-30702-1
3. FAP piezometer and 2008 soil boring coordinate source: AEP-provided boring logs
4. Oil and gas well coordinate source: WVDEP Oil and Gas Well Database
5. Amos Generating Plant monitor well, piezometer, and soil boring coordinate source: June 2016 AEP survey and EPRI, April 1999, Groundwater Quality at the John E. Amos Power Plant, Putnam County, West Virginia
6. West Virginia 1983 State Planar Coordinates
7. CSM = Conceptual Site Model

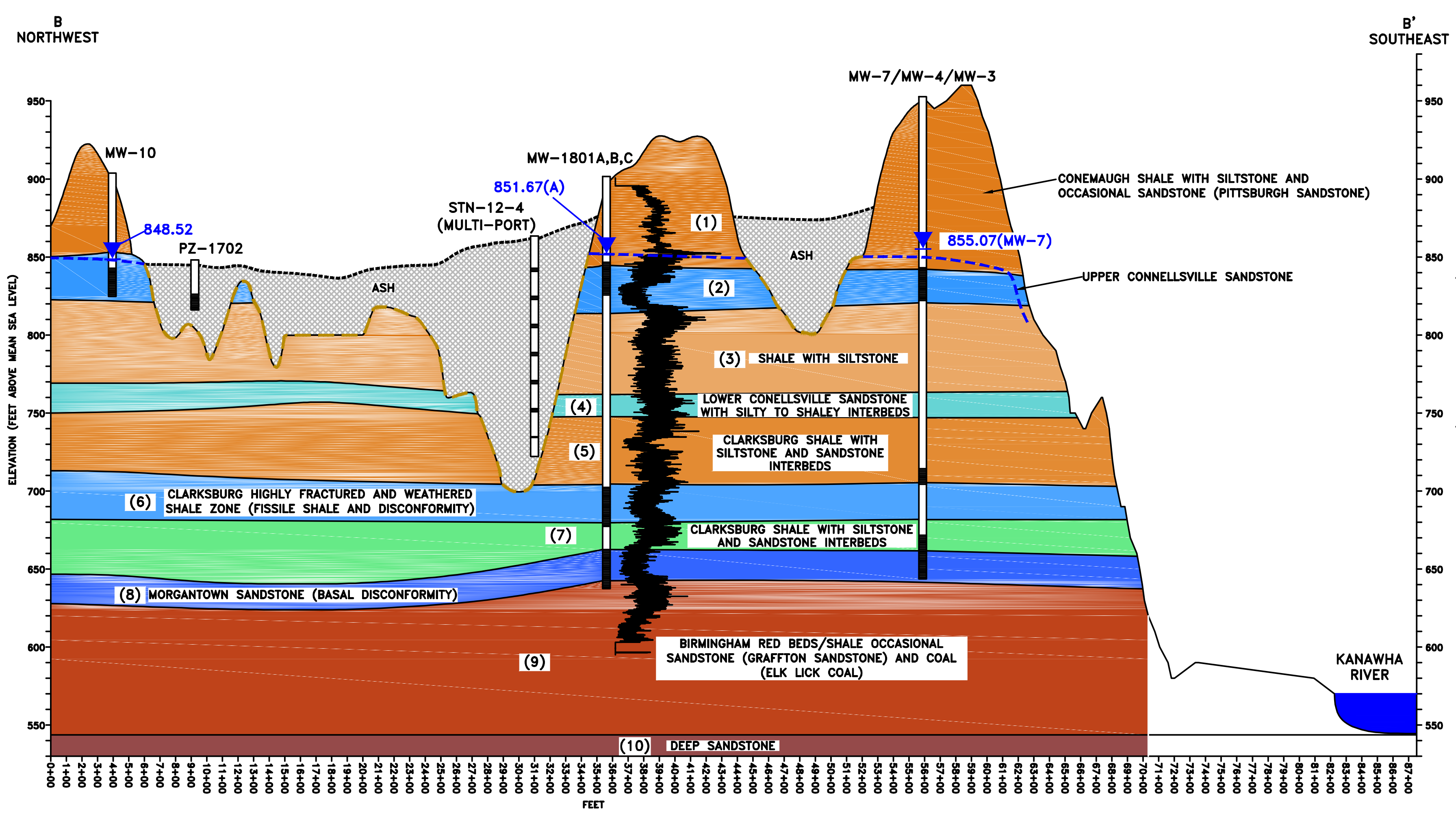
AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

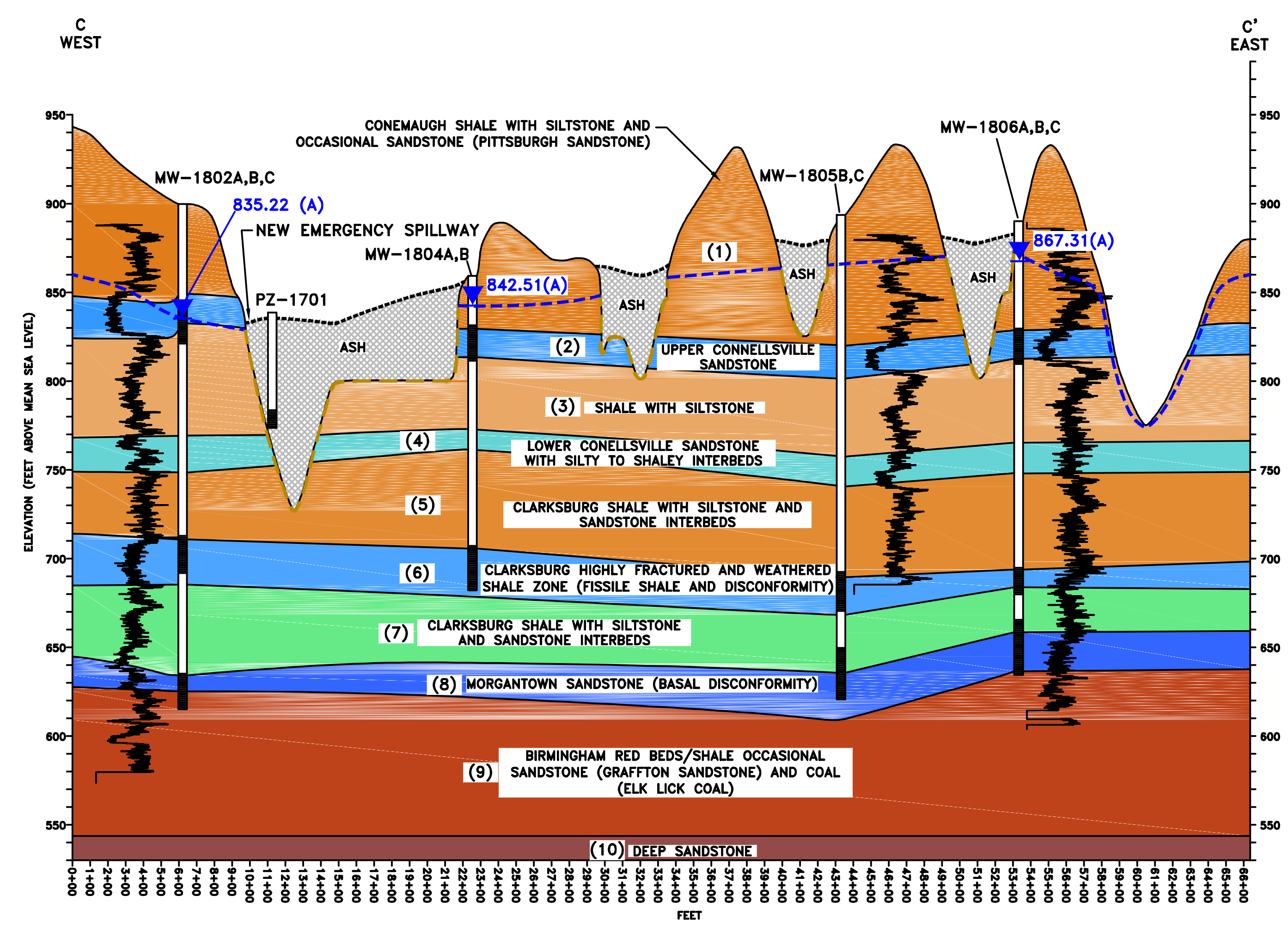
CROSS SECTION LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
5







LEGEND

MW-9 — WELL OR BORING IDENTIFICATION

WELL
WELL SCREEN
BORING

CAP CONSTRUCTION (BOTTOM TO TOP):
- SUBGRADE PREPARATION (IN-PLACE FLY ASH AND ONSITE BORROW MATERIAL DEWATERING, EXCAVATING, GRADING)
- 40-MIL LINEAR LOW-DENSITY POLYETHYLENE (LLDPE) FLEXIBLE MEMBRANE LINER
- 8oz. GEOTEXTILE CUSHION LAYER
- 18 INCHES OF PROTECTIVE SOIL COVER LAYER
- 6 INCHES OF VEGETATIVE COVER LAYER
- DRAINAGE STRUCTURES
- SEEDING AND MULCHING

UPPERMOST AQUIFER (UPPER CONNELLSVILLE SANDSTONE AND SRF) MONITORING WELL WATER LEVEL OCTOBER 22, 2018

UPPERMOST AQUIFER (UPPER CONNELLSVILLE SANDSTONE AND SRF) POTENTIOMETRIC SURFACE

UPPERMOST AQUIFER (UPPER CONNELLSVILLE SANDSTONE AND SRF) TOP BELOW SATURATED ASH

NATURAL GAMMA LOG

0 100 200 300 COUNTS PER SECOND

(1) CONEMAUGH SHALE WITH SILTSTONE AND OCCASIONAL SANDSTONE (PITTSBURGH SANDSTONE)
(2) UPPER CONNELLSVILLE SANDSTONE
(3) SHALE WITH SILTSTONE
(4) LOWER CONELLSVILLE SANDSTONE WITH SILTY TO SHALEY INTERBEDS
(5) CLARKSBURG SHALE WITH SILTSTONE AND SANDSTONE INTERBEDS
(6) CLARKSBURG HIGHLY FRACTURED AND WEATHERED SHALE ZONE (FISSILE SHALE AND DISCONFORMITY)
(7) CLARKSBURG SHALE WITH SILTSTONE AND SANDSTONE INTERBEDS
(8) MORGANTOWN SANDSTONE (BASAL DISCONFORMITY)
(9) BIRMINGHAM RED BEDS/SHALE OCCASIONAL SANDSTONE (GRAFFTON SANDSTONE) AND COAL (ELK LICK COAL)
(10) DEEP SANDSTONE

VERTICAL SCALE: 1" = 100'
HORIZONTAL SCALE: 1" = 1000'

AEP AMOS GENERATING PLANT - FLY ASH POND
WINFIELD ROAD
WINFIELD, WEST VIRGINIA

CROSS SECTIONS A-A', B-B' AND C-C'

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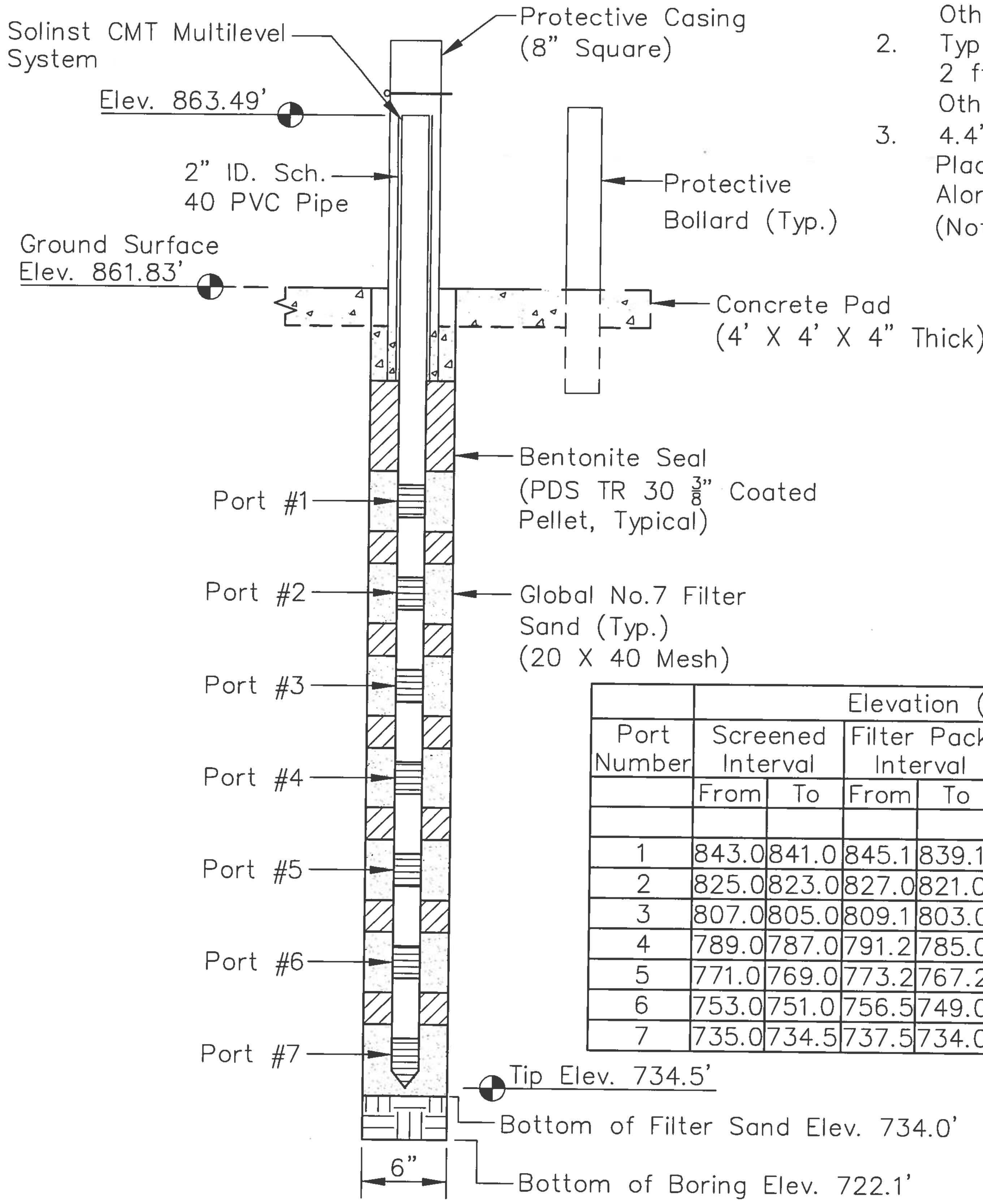
FIGURE
6

Appendix C Boring Logs



NOTES:

1. All Units Are in Feet Unless Noted Otherwise.
2. Typical Port Length is 2 ft. Unless Noted Otherwise.
3. 4.4" Dia. Centralizers Placed at 10ft. Spacing Along Well Tubing (Not Shown).

	Elevation (ft.)					
Port Number	Screened Interval		Filter Pack Interval		Bentonite Seal Interval	
	From	To	From	To	From	To
					861.5	845.1
1	843.0	841.0	845.1	839.1	839.1	827.0
2	825.0	823.0	827.0	821.0	821.0	809.1
3	807.0	805.0	809.1	803.0	803.0	791.2
4	789.0	787.0	791.2	785.0	785.0	773.2
5	771.0	769.0	773.2	767.2	767.2	756.5
6	753.0	751.0	756.5	749.0	749.4	737.5
7	735.0	734.5	737.5	734.0		

PLOT DATE: 04/27/2012 USER: JENNINGS, MATTHEW
U:\1756\175661014\ENVIRONMENTAL\DRAWING\SHEET_FILES\MONITORING WELLS\STN-12-4-WELL-LOG.DWG

LOCATION:

Northing: 531,882.29
Easting: 1,726,127.18
Ground Elevation: 861.83'
Installation Date: 3/8/12
Horizontal Datum: NAD 83 WV. South
Vertical Datum: NAVD 88

PIEZOMETER DETAIL
AEP AMOS POWER PLANT, FLY ASH DAM COMPLEX
STN-12-4, WEST VIRGINIA WELL ID WV00054-0003-12

Stantec

Stantec Consulting Services Inc.
11687 Lebanon Rd.
Cincinnati, Ohio
45241-2012
513-842-8200
www.stantec.com

DRAWN BY	MSJ	DATE	4/25/12	REVISED		SHEET
CHECKED BY	JMM	PROJ. NO.	175661014	1.	3.	1 OF 1
CHECKED BY	JSD	SCALE	NTS	2.	4.	

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

AEP

JOB NUMBER ______

COMPANY ______

PROJECT **EPRI GROUND WATER STUDY - AMOS**

COORDINATES **N 531,282.0 E 1,724,360.0**

GROUND ELEVATION **648.0** SYSTEM **STATE PLANE**

BORING NO. **D=MW-05** DATE **8/27/07** SHEET **1** OF **5**

BORING START **7/11/95** BORING FINISH **7/26/95**

PIEZOMETER TYPE ______ WELL TYPE **OW**

HGT. RISER ABOVE GROUND **1.9** DIA **2.0**

DEPTH TO TOP OF WELL SCREEN **101.6** BOTTOM **111.0**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT**

FIELD PARTY **MCR-RLY=TJH-REB** RIG **BK-81 CME-75**

Water Level, ft	▽	▼	▼
TIME			
DATE			

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										AUGERED TO 2'		
1	SS	2.0	3.5	??-28-19	15"				GM	**GRAY ROCK FRAGMENTS, GRAVEL, SILT,** DRY, (FILL).		
									ML	**CLAYEY SILT AND GRAVEL**, MODERATE BROWN (5YR 3\4), Moist. AUGERED TO 7.0'		
							5					
2	SS	7.0	22.0	10-9-9	7.5"				ML	**CLAYEY SILT AND GRAVEL**, MODERATE BROWN (5YR 4\8) LIGHT BROWN (5YR 5\6 AND MODERATE BROWN (5YR 3\4), TRACE FELDSPAR, MOIST. AUGERED TO 12.0'		
							10					
3	SS	12.0	13.5	13-8-5	17"				ML	**SAME AS ABOVE**		
									CL	**SILTY CLAY**, PALE YELLOWISH BROWN (12YR 6\2) AND LIGHT OLIVE GRAY (5YR 5\2), LOW TO MEDIUM PLASTICITY, MOIST. AUGERED TO 17.0'		
							15					
4	SS	17.0	18.5	3-3-3	18"				SC	**CLAYEY-SILTY FINE SAND**, DUSKY YELLOWISH BROWN (10 YR 2\2),MOIST TO WET.		
										AUGERED TO 22.0'		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
X	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

Continued Next Page

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **D.BENNETT**

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER ____________________

COMPANY ____________________

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-05** DATE **8/27/07**

BORING START **7/11/95** BORING FINISH **7/26/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	SAMPLE DEPTH IN FEET TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
5	SS	22.0	23.2	7-7-50/3"	13"				SC	**SAME AS SAMPLE No. 4**		
									SW	**MEDIUM TO COARSE SAND**, LIGHT BLUISH GRAY (5B 7\1), MOIST.		
1	NQ	24.0	29.8		5.0	60	25			AUGERED TO 23.9' - AUGERED THROUGH OBSTRUCTION (ROCK?) **MORGANTOWN SANDSTONE?**, GRAY. 24.0 - 25.0' Solid, light gray, (N-7) 25.0 - 26.0' Fractured, brown clay lined fractures, light gray (N-7). 26.0 - 27.0' Minimal fractures 27.0 - 27.7' Fractured, weathered, very fine dark gray (N-3) bedding. 27.7 - 29.8' Light gray (N-7) sandstone		25.0 Fracture = 8 26.0 Fracture = 3 26.5 Lost water 27.0 Fracture = 5
2	NQ	29.8	39.8		10.0	93	30			29.8 - 33.8' Light gray (N-7) sandstone		
										CLAY SHALE, MEDIUM GRAY (N4) MOIST, VERY SOFT.		
							35			**CLAY SHALE**, GRAYISH BROWN (5YR 3\2), MOIST, VERY SOFT.		35.2 Fracture = 3
										CLAY SHALE, LIGHT OLIVE GRAY (5Y 5\2) MEDIUM LIGHT GRAY (N6), SOFT, MODERATE WEATHERING.		36.3 Fracture = 3
										SHALE, MEDIUM BLUISH GRAY (5B 5\1), TRACE IRREGULAR BEDDING PLANES, SOFT.		37.3 Fracture = 2
3	NQ	39.8	49.8		9.8	67	40			**SAME AS ABOVE**		39.8 Fracture = 6
										SAME, WITH MODERATE BROWN (5YR 3\4) BEDDING PLANES, MEDIUM TO HIGHLY FRACTURED, MODERATE WEATHERING.		42.5 Fracture = 8
										SHALE, MEDIUM BLUISH GRAY 5Y 5\2), SLIGHT TO MODERATE WEATHERED		
							45			**CLAY SHALE**, PALE BROWN (5YR 5/2), TO DARK YELLOWISH BROWN (10YR 4/2) AND		44.6 numerous fractures.

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-05** DATE **8/27/07** SHEET **3** OF **5**

BORING START **7/11/95** BORING FINISH **7/26/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										LIGHT OLIVE GRAY (5YR 4/2), SOFT, SOME IRREGULAR BEDDING PLANES		
4	NQ	49.8	56.5		4.7	54	50					
												51.0 Regained drill water
							55					
5	NQ	56.5	59.8		2.55	50				**SAME EXCEPT VERY SOFT**		56.5 Fracture = 7
6	NQ	59.8	67.3		7.5	96	60			**CLAYEY SILT**, DARK YELLOWISH BROWN (10yr 4\2), MOIST - WET		
										SAME, VERY WEATHERED, SOFT		
										CLAY SHALE, PALE BROWN (5YR 5\2), SLIGHTLY WEATHERED		
							65					
										SAME, SOME MODERATELY WEATHERED, SOFT		
7	NQ	67.3	69.8		2.5	40				**SAME**, VERY WEATHERED, VERY SOFT		
										SAME, MODERATELY WEATHERED, SOFT		68.0 Fracture = 5
										SHALE, MEDIUM GRAY (N5), SOFT.		
8	NQ	69.8	78.8		6.8	64	70			**SAME**		
										CLAY SHALE, PALE BROWN (YR 5\2) AND		71.6 Fracture = 12

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

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PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-05** DATE **8/27/07** SHEET **4** OF **5**

BORING START **7/11/95** BORING FINISH **7/26/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										MEDIUM GRAY (N5), MODERATELY WEATHERED, SOFT.		
							75					
9	NQ	78.8	79.8		1.0	40				**SHALE**, PALE BROWN (5YR 5\2) AND LIGHT OLIVE GRAY (5Y 5\2), IRREGULAR BEDDING, WEATHERED, SOFT.		78.8 numerous fracture.
10	NQ	79.8	87.8		6.3	48	80			**SAME**, SOME SEDIMENT FILLED FRACTURES		
							85					
												86.0 Top of seal.
11	NQ	87.8	89.8		2.0	75				**SHALE**, GRAYISH OLIVE (10 YR 4\2) AND MODERATE BROWN (5YR 3\4), INTERBEDDED LAYERS, SOFT, SLIGHTLY WEATHERED.		
12	NQ	89.8	90.8		.75	0	90			**SAME**, EXCEPT WEATHERED		
13	NQ	90.8	99.8		9.0	100				**SHALE**, MEDIUM BLUISH GRAY (5B 5\1), WITH SOME INTERBEDDED BROWNISH GRAY (5YR 4\1) COLOR, SLIGHTLY WEATHERED, SOFT		91.0 Top sand.
							95					

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AEP CIVIL ENGINEERING LABORATORY
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COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-05** DATE **8/27/07** SHEET **5** OF **5**

BORING START **7/11/95** BORING FINISH **7/26/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
14	NQ	99.8	100.3		.25	0	100			**SAME**, EXCEPT WEATHERED		Lost water return on run #14.
15	NQ	100.3	109.8		9.5	95				**SHALE**, MEDIUM BLUISH GRAY 5B 5\1), SLIGHTLY WEATHERED, SOFT		101.6 Top of screen.
							105			**SANDSTONE**, MEDIUM BLUISH GRAY (5B 5\1), SLIGHTLY WEATHERED AT 104', SOFT.		
16	NQ	109.8	114.8		4.4	40	110			**SAME**, SOFT		
										SHALE, MEDIUM BLUISH GRAY (5B 5\1), SOFT.		111.0 Bottom of screen.
										SHALE, MEDIUM DARK GRAY, SOFT, WEATHERED, VERY FRACTURED.		112.0 Fracture = 7 112.1 Bottom of sand.
										CLAY SHALE, GRAYISH BROWN (5YB 3\2), WEATHERED, SOFT TO VERY SOFT, FRACTURED.		
										114.8 BOTTOM OF HOLE		114.7 Bottom of seal.

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER ______________________

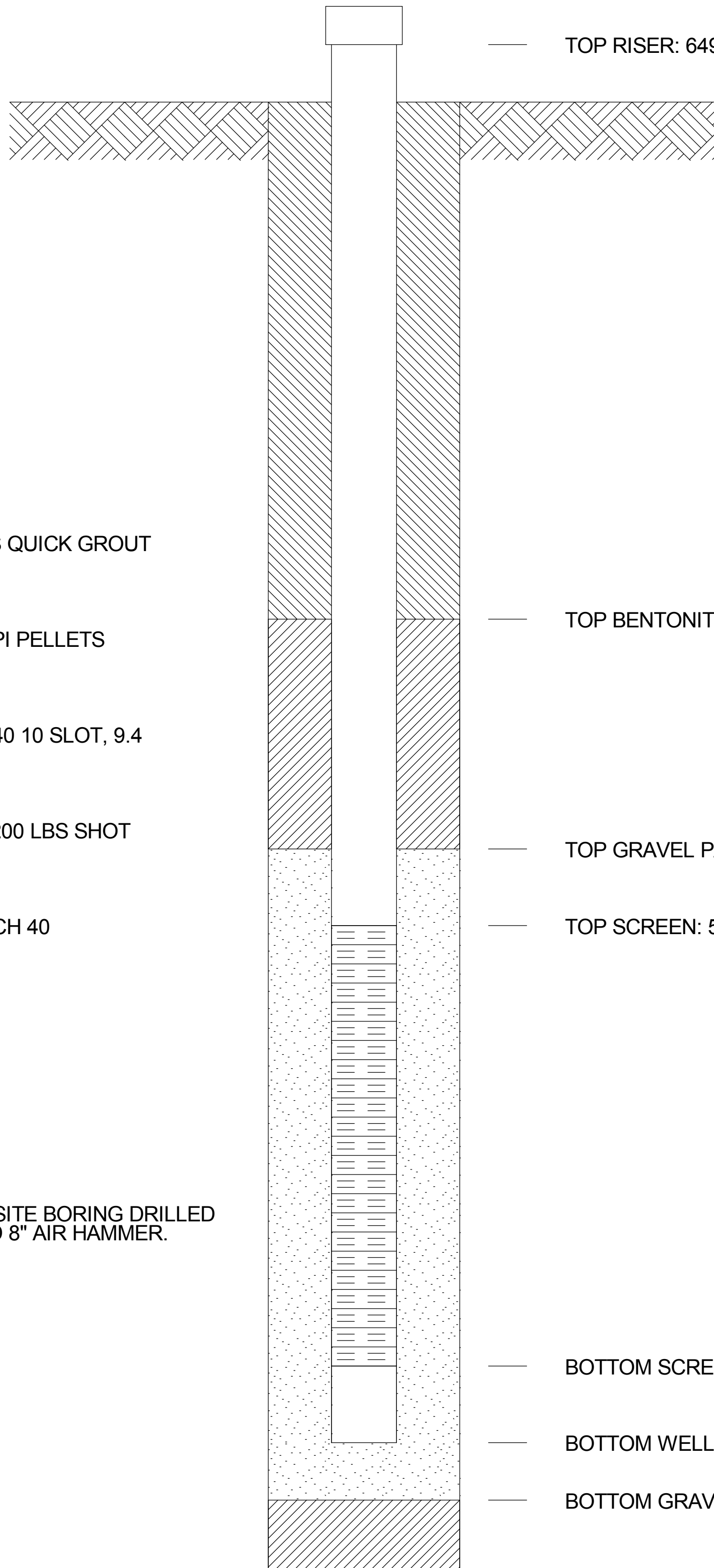
COMPANY ______________________ WELL No. **MW-5** BORING No. **D=MW-05** INSTALLED **7/26/95**

PROJECT **EPRI GROUND WATER STUDY - AMOS**

COORDINATES **N 531,282.0 E 1,724,360.0**

SYSTEM **STATE PLANE**

GROUND ELEVATION 648.03 FT.



GROUT SEAL: 600 GALLONS QUICK GROUT

BENTONITE SEAL: 100 LBS PI PELLETS

SCREEN: 2.0 dia., PVC SCH 40 10 SLOT, 9.4

GRAVEL PACK: 500 LBS #5 200 LBS SHOT

RISER PIPE: 2.0, dia., PVC SCH 40

SPACERS, DEPTH:

FLY ASH DAM CLUSTERED SITE BORING DRILLED USING 10" CASING AND 8" AIR HAMMER.

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

AEP

JOB NUMBER

COMPANY

PROJECT EPRI GROUND WATER STUDY - AMOS

COORDINATES N 531,266.0 E 1,724,352.0

GROUND ELEVATION 647.5 SYSTEM STATE PLANE

BORING NO. D=MW-06 DATE 8/27/07 SHEET 1 OF 5

BORING START 8/20/95 BORING FINISH 8/21/95

PIEZOMETER TYPE WELL TYPE OW

HGT. RISER ABOVE GROUND 1.95 DIA 2.0

DEPTH TO TOP OF WELL SCREEN 28.5 BOTTOM 33.5

WELL DEVELOPMENT YES BACKFILL QUICK GROUT

FIELD PARTY TJH-REB RIG CME-75

Water Level, ft	▽	▼	▼
TIME			
DATE			

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										AUGERED TO 2'		
									GM	**GRAY ROCK FRAGMENTS, GRAVEL, SILT,** DRY, (FILL).		
									ML	**CLAYEY SILT AND GRAVEL**, MODERATE BROWN (5YR 3\4), Moist. AUGERED TO 7.0'		
							5					
									ML	**CLAYEY SILT AND GRAVEL**, MODERATE BROWN (5YR 4\8) LIGHT BROWN (5YR 5\6 AND MODERATE BROWN (5YR 3\4), TRACE FELDSPAR, MOIST. AUGERED TO 12.0'		
							10					
									ML	**SAME AS ABOVE**		
									CL	**SILTY CLAY**, PALE YELLOWISH BROWN (12YR 6\2) AND LIGHT OLIVE GRAY (5YR 5\2), LOW TO MEDIUM PLASTICITY, MOIST. AUGERED TO 17.0'		
							15					
									SC	**CLAYEY-SILTY FINE SAND**, DUSKY YELLOWISH BROWN (10 YR 2\2),MOIST TO WET.		
										AUGERED TO 22.0'		

TYPE OF CASING USED

- NQ-2 ROCK CORE
- 6" x 3.25 HSA
- 9" x 6.25 HSA
- HW CASING ADVANCER 4"
- NW CASING 3"
- SW CASING 6"
- AIR HAMMER 8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER D. BEMMETT

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-06** DATE **8/27/07** SHEET **2** OF **5**

BORING START **8/20/95** BORING FINISH **8/21/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
									SC	**SAME AS SAMPLE No. 4**		22.5 Top of seal.
							25		SW	**MEDIUM TO COARSE SAND**, LIGHT BLUISH GRAY (5B 7\1), MOIST. AUGERED TO 23.9' - AUGERED THROUGH OBSTRUCTION (ROCK?) **MORGANTOWN SANDSTONE?**, GRAY. 24.0 - 25.0' Solid, light gray, (N-7) 25.0 - 26.0' Fractured, brown clay lined fractures, light gray (N-7). 26.0 - 27.0' Minimal fractures 27.0 - 27.7' Fractured, weathered, very fine dark gray (N-3) bedding. 27.7 - 29.8' Light gray (N-7) sandstone		27.2 Top of sand. 28.5 Top of screen.
							30			29.8 - 33.8' Light gray (N-7) sandstone		
										CLAY SHALE, MEDIUM GRAY (N4) MOIST, VERY SOFT.		33.5 Bottom of screen. 34.2 Bottom of sand.
							35			**CLAY SHALE**, GRAYISH BROWN (5YR 3\2), MOIST, VERY SOFT.		
										CLAY SHALE, LIGHT OLIVE GRAY (5Y 5\2) MEDIUM LIGHT GRAY (N6), SOFT, MODERATE WEATHERING. **SHALE**, MEDIUM BLUISH GRAY (5B 5\1), TRACE IRREGULAR BEDDING PLANES, SOFT.		
							40			**SAME AS ABOVE**		
										SAME, WITH MODERATE BROWN (5YR 3\4) BEDDING PLANES, MEDIUM TO HIGHLY FRACTURED, MODERATE WEATHERING.		
							45			**SHALE**, MEDIUM BLUISH GRAY 5Y 5\2), SLIGHT TO MODERATE WEATHERED **CLAY SHALE**, PALE BROWN (5YR 5/2), TO DARK YELLOWISH BROWN (10YR 4/2) AND		

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PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-06** DATE **8/27/07** SHEET **3** OF **5**

BORING START **8/20/95** BORING FINISH **8/21/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										LIGHT OLIVE GRAY (5YR 4/2), SOFT, SOME IRREGULAR BEDDING PLANES		
							50					
							55					
										SAME EXCEPT VERY SOFT		
							60			**CLAYEY SILT**, DARK YELLOWISH BROWN (10yr 4\2), MOIST - WET		
										SAME, VERY WEATHERED, SOFT		
										CLAY SHALE, PALE BROWN (5YR 5\2), SLIGHTLY WEATHERED		
							65					
										SAME, SOME MODERATELY WEATHERED, SOFT		
										SAME, VERY WEATHERED, VERY SOFT		
										SAME, MODERATELY WEATHERED, SOFT		
										SHALE, MEDIUM GRAY (N5), SOFT.		
							70			**SAME**		
										CLAY SHALE, PALE BROWN (YR 5\2) AND		

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JOB NUMBER

COMPANY

PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-06** DATE **8/27/07** SHEET **4** OF **5**

BORING START **8/20/95** BORING FINISH **8/21/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										MEDIUM GRAY (N5), MODERATELY WEATHERED, SOFT.		
							75					
										SHALE, PALE BROWN (5YR 5\2) AND LIGHT OLIVE GRAY (5Y 5\2), IRREGULAR BEDDING, WEATHERED, SOFT.		
							80			**SAME**, SOME SEDIMENT FILLED FRACTURES		
							85					
										SHALE, GRAYISH OLIVE (10 YR 4\2) AND MODERATE BROWN (5YR 3\4), INTERBEDDED LAYERS, SOFT, SLIGHTLY WEATHERED.		
							90			**SAME**, EXCEPT WEATHERED		
										SHALE, MEDIUM BLUISH GRAY (5B 5\1), WITH SOME INTERBEDDED BROWNISH GRAY (5YR 4\1) COLOR, SLIGHTLY WEATHERED, SOFT		
							95					

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PROJECT **EPRI GROUND WATER STUDY - AMOS**

BORING NO. **D=MW-06** DATE **8/27/07** SHEET **5** OF **5**

BORING START **8/20/95** BORING FINISH **8/21/95**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							100			**SAME**, EXCEPT WEATHERED		
										SHALE, MEDIUM BLUISH GRAY 5B 5\1), SLIGHTLY WEATHERED, SOFT		
										SANDSTONE, MEDIUM BLUISH GRAY (5B 5\1), SLIGHTLY WEATHERED AT 104', SOFT.		
							105					
							110			**SAME**, SOFT		
										SHALE, MEDIUM BLUISH GRAY (5B 5\1), SOFT.		
										SHALE, MEDIUM DARK GRAY, SOFT, WEATHERED, VERY FRACTURED.		
										CLAY SHALE, GRAYISH BROWN (5YB 3\2), WEATHERED, SOFT TO VERY SOFT, FRACTURED.		
										114.8 BOTTOM OF HOLE		

Appendix D Potential Indicator Temporal Plots

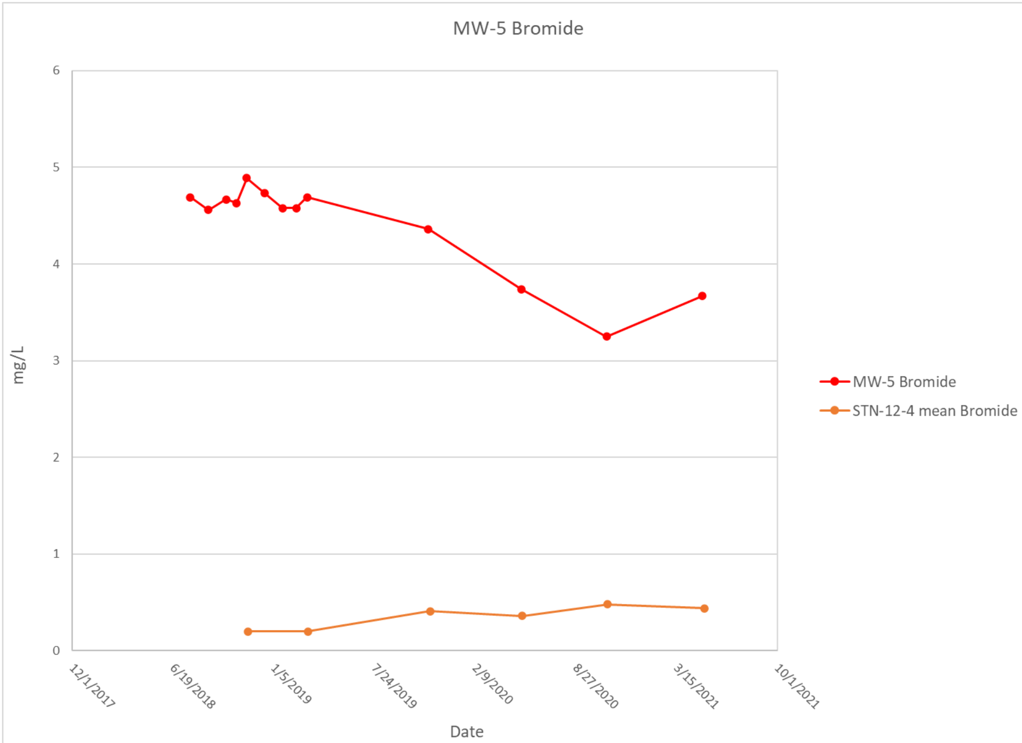

Figure D-1 MW-5 Bromide Concentrations

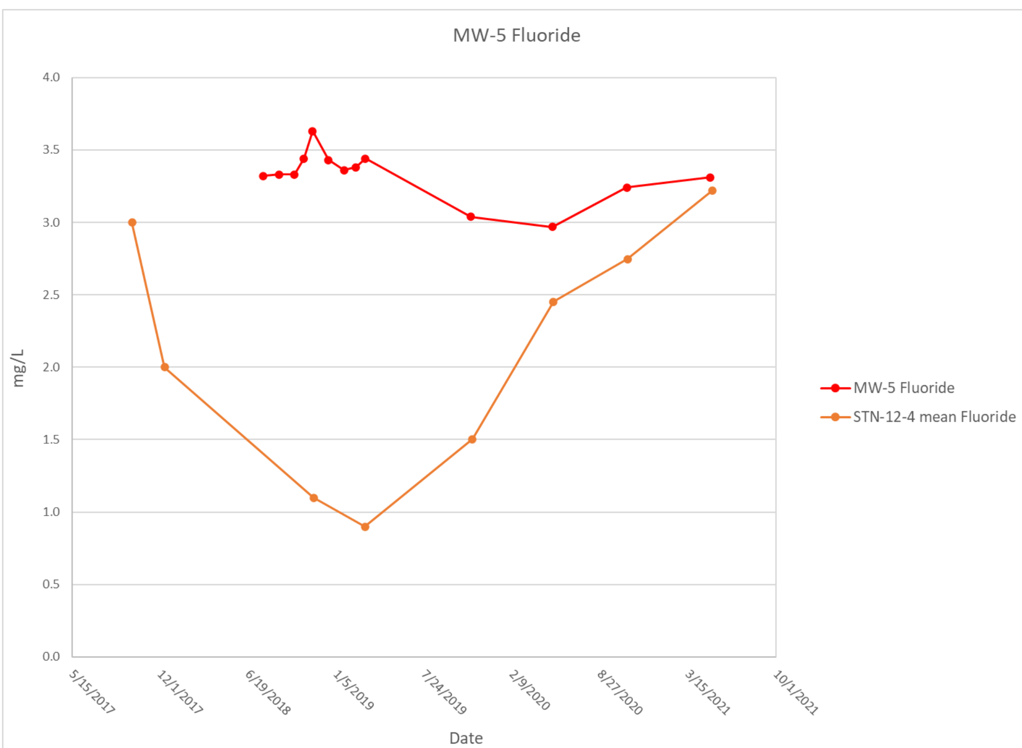

Figure D-2 MW-5 Fluoride Concentrations

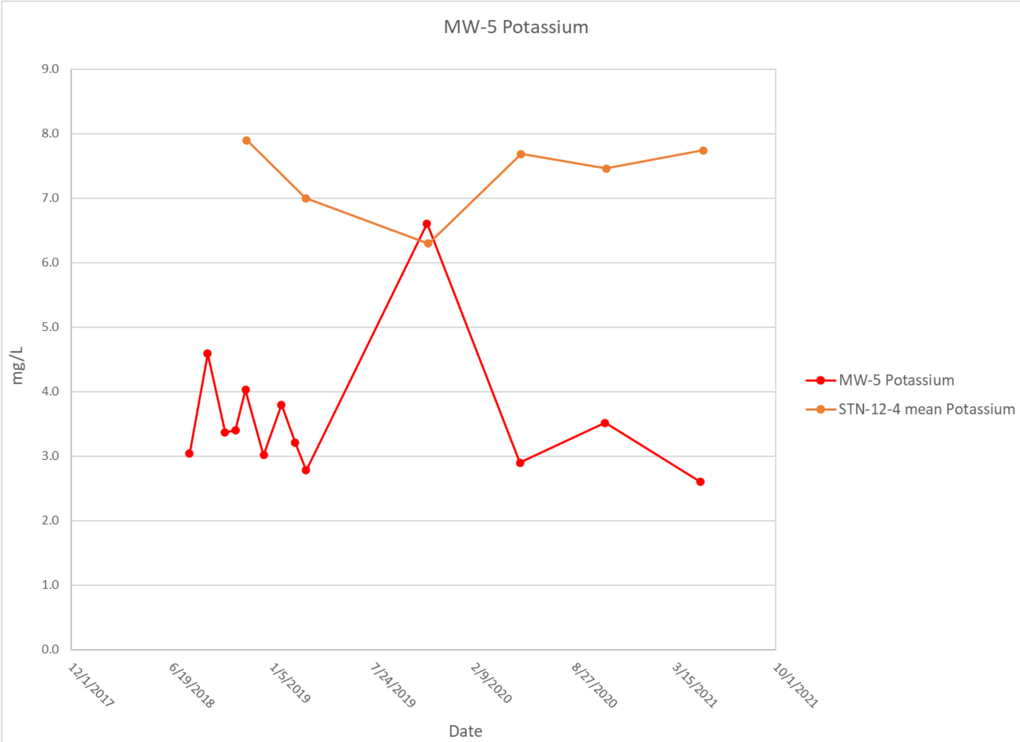

Figure D-3 MW-5 Potassium Concentrations

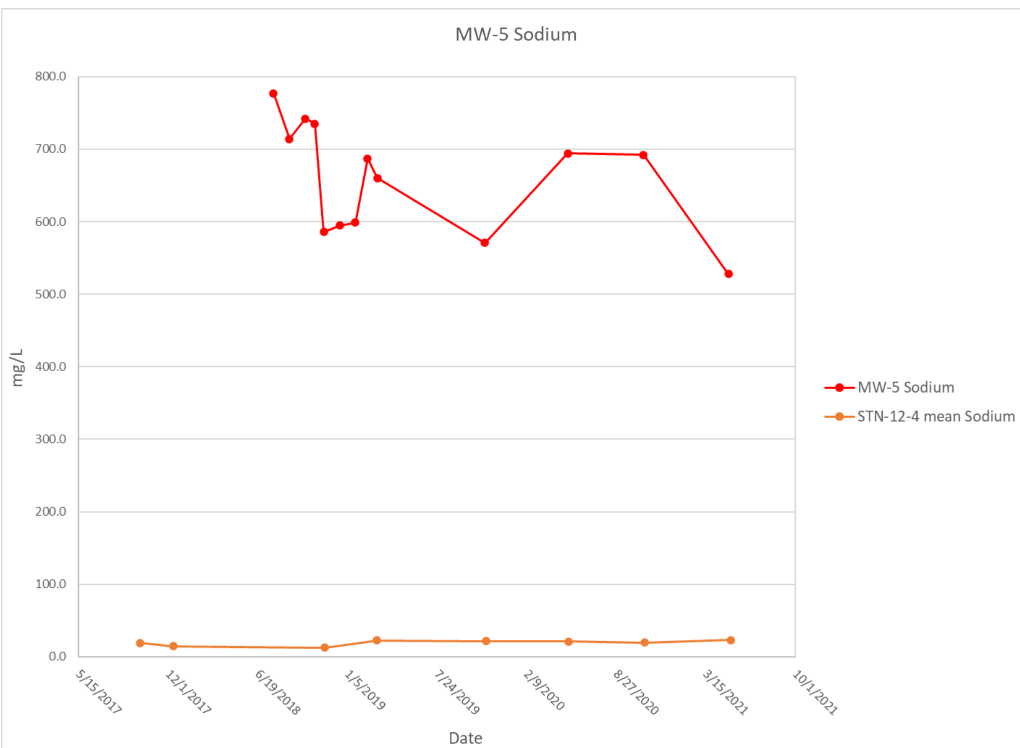

Figure D-4 MW-5 Sodium Concentrations

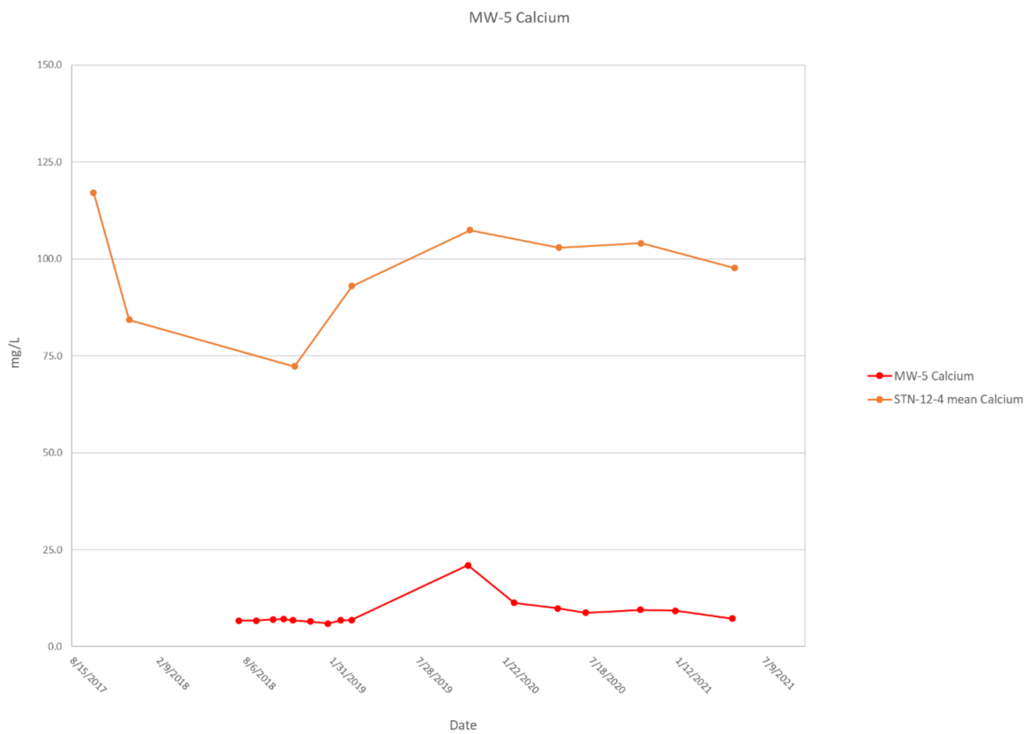

Figure D-5 MW-5 Calcium Concentrations

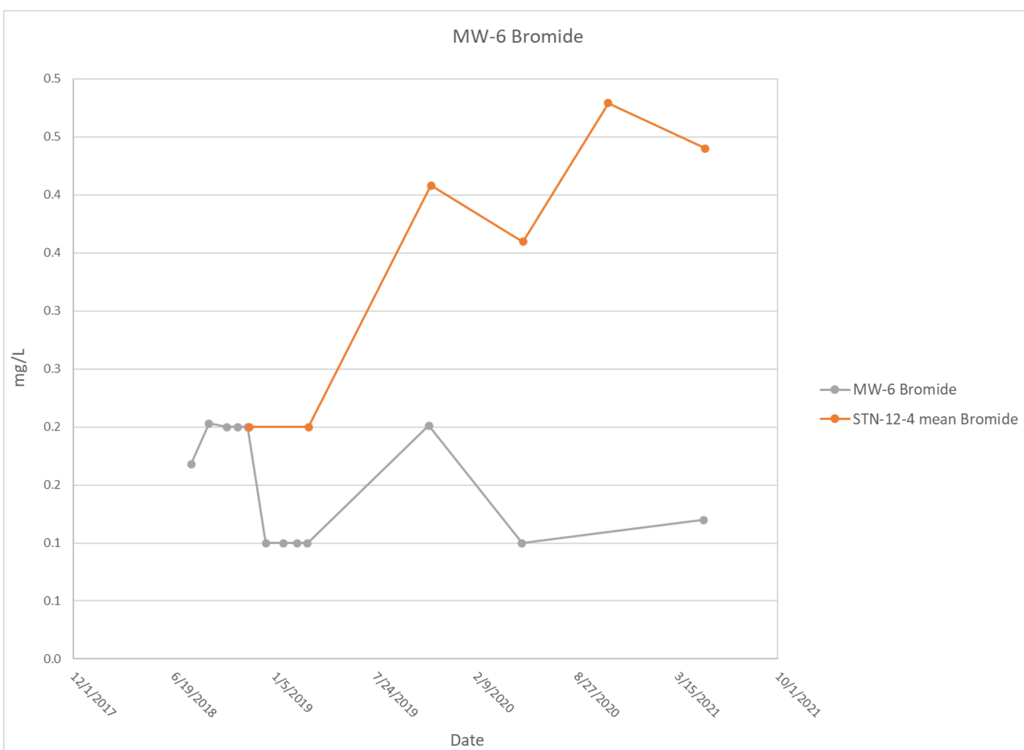

Figure D-6 MW-6 Bromide Concentrations

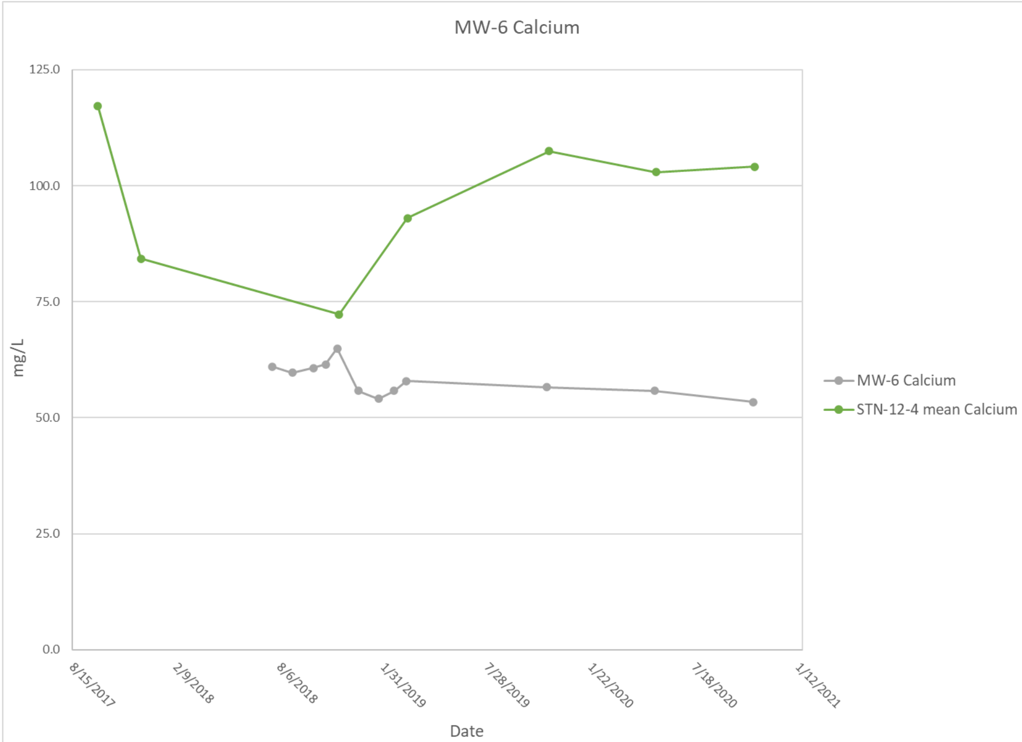

Figure D-7 MW-6 Calcium Concentrations

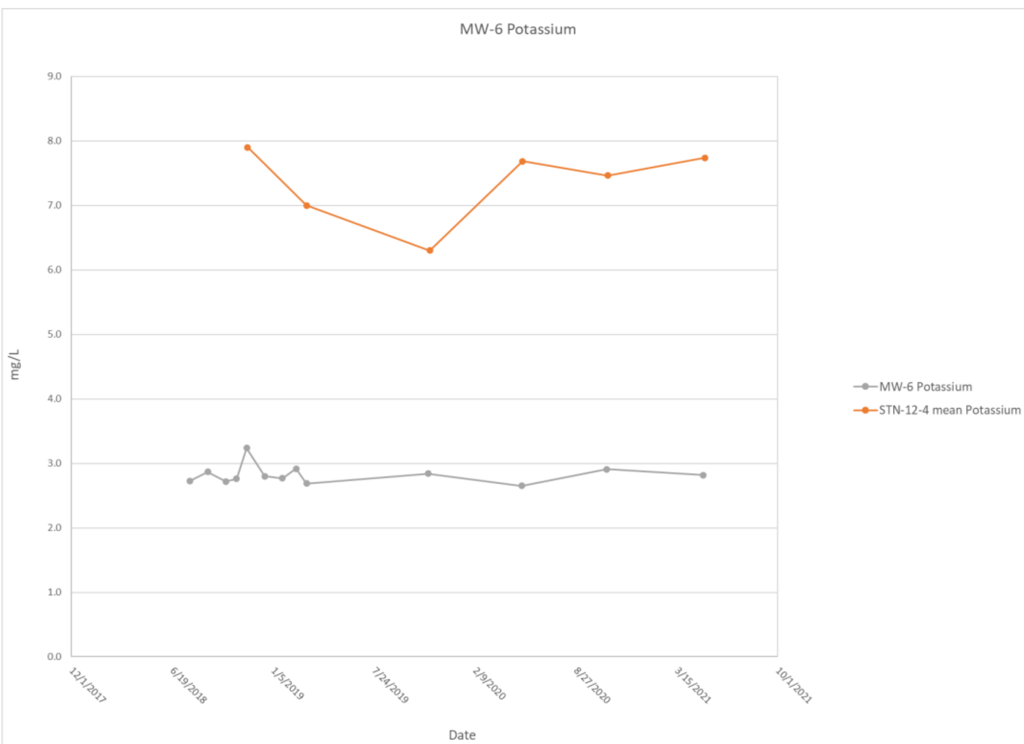

Figure D-8 MW-6 Potassium Concentrations

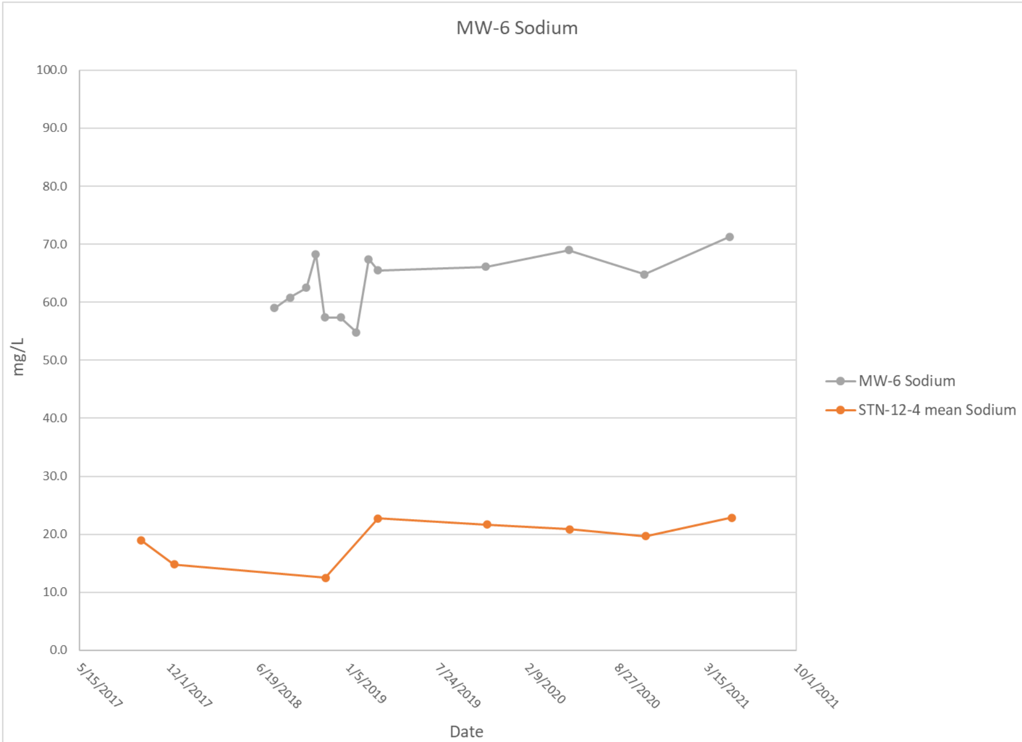

Figure D-9 MW-6 Sodium Concentrations

APPENDIX 4

Not applicable.

APPENDIX 5

Not applicable.