



REPORT

Annual Coal Combustion Residuals Groundwater Monitoring and Corrective Action Report – 2019

Nebraska Public Power District, Gerald Gentleman Station

Submitted to:

Nebraska Public Power District

Gerald Gentleman Station, 6089 South Highway 25, Sutherland, Nebraska, 69165

Submitted by:

Golder Associates Inc.

7245 West Alaska Drive, Suite 200, Lakewood, Colorado 80226

+1 303 980-0540

1777981

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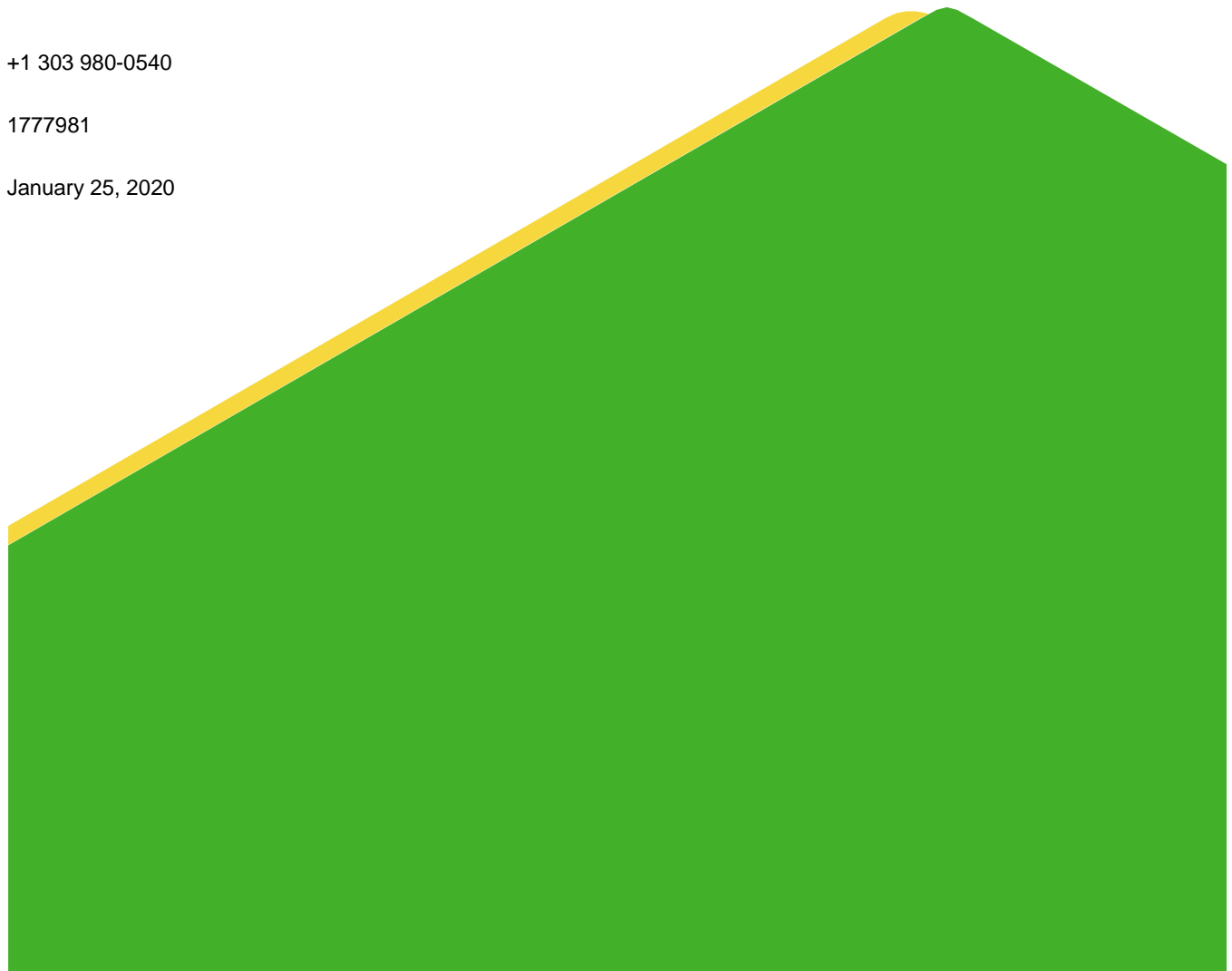


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Figure 1: June 2019 Groundwater Contours

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APPENDIX A

Alternative Source Demonstration – Q4 2018 Detection Monitoring Event

APPENDIX B

Alternative Source Demonstration – Q2 2019 Detection Monitoring Event

1.0 REPORT SUMMARY

This report presents the results from groundwater monitoring events that occurred at Nebraska Public Power District's Gerald Gentleman Station in 2019. The facility entered 2019 under a detection monitoring program. The following items of statistical significance were identified in 2019:

■ Potential Exceedances

■ Q2 2019

- APMW-6 (Downgradient) – Fluoride
- APMW-10 (Downgradient) – Calcium
- APMW-10 (Downgradient) – Sulfate
- APMW-12 (Downgradient) – Boron Elevated CUSUM
- APMW-13 (Downgradient) – Chloride Elevated CUSUM
- APMW-19 (Downgradient) – Calcium
- APMW-19 (Downgradient) – Sulfate Elevated CUSUM

■ Q4 2019

- No potential exceedances were found.

■ False-Positives

- The following potential exceedances identified during the Q4 2018 detection monitoring event were found to be false-positives through confirmatory re-sampling during the Q2 2019 detection monitoring event:

- APMW-13 (Downgradient) – Field pH

- The following potential exceedances identified during the Q2 2019 detection monitoring event were found to be false-positives through confirmatory re-sampling during the Q4 2019 detection monitoring event:

- APMW-6 (Downgradient) – Fluoride
- APMW-10 (Downgradient) – Calcium
- APMW-10 (Downgradient) – Sulfate
- APMW-12 (Downgradient) – Boron Elevated CUSUM
- APMW-13 (Downgradient) – Chloride Elevated CUSUM

■ Verified Statistically Significant Increases (SSI)

- The following potential exceedances identified during the Q4 2018 detection monitoring event were found to be verified SSIs through confirmatory re-sampling during the Q2 2019 detection monitoring event:
 - APMW-19 (Downgradient) – Chloride
 - APMW-19 (Downgradient) – Fluoride
- The following potential exceedances identified during the Q2 2019 detection monitoring event were found to be verified SSIs through confirmatory re-sampling during the Q4 2019 detection monitoring event:
 - APMW-19 (Downgradient) – Calcium
 - APMW-19 (Downgradient) – Chloride
 - APMW-19 (Downgradient) – Sulfate

Due to the verified SSIs identified in both Q4 2018 and Q2 2019, alternative source demonstrations (ASD) were conducted, with alternative sources identified. The ASDs have been included as Appendix A and Appendix B within this document. ASDs for calcium and sulfate at APMW-19 will be attempted prior to entering assessment monitoring. The facility will remain in detection monitoring pending the results of the alternative source demonstration.

As described in the Groundwater Monitoring System Certification (Golder 2017a) and the Groundwater Monitoring Statistical Methods Certification (Golder 2017b), the groundwater monitoring and analytical procedures meet the general requirements of the CCR rule, and modifications to the monitoring network and sampling program are not recommended at this time.

2.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this report describing the 2019 groundwater sampling and comparative statistical analysis for Nebraska Public Power District's (NPPD) Gerald Gentleman Station (GGS) in Sutherland, Nebraska. This report was written to meet the requirements of the Coal Combustion Residuals (CCR) rule's sections on groundwater monitoring and corrective action, 40 CFR 257.90 to 257.98.

2.1 Facility Information

GGS is located approximately 5 miles south of Sutherland, Nebraska, and 1.2 miles south of Sutherland Reservoir. The ash pits at GGS are situated in the NW ¼, NE ½, Section 30 of Township 13N, Range 33W, in Lincoln County, Nebraska. NPPD began operating GGS in 1979 as a coal-fired electrical generation facility. GGS is both owned and operated by NPPD. The plant, which is capable of generating 1,365 MW of power, uses a low-sulfur coal from Wyoming's Power River Basin. The active CCR landfill at the site contains fly ash and bottom ash.

2.2 Purpose

The CCR rule established specific requirements for reporting of groundwater monitoring and corrective action in 40 CFR 257.90. In accordance with part (e) of §257.90, no later than January 31, 2018, and annually thereafter, owners or operators of CCR units must prepare an annual groundwater monitoring and corrective action report.

3.0 GROUNDWATER MONITORING NETWORK PROGRAM STATUS

The groundwater monitoring network for the active CCR landfill at GGS consists of 14 monitoring wells, as shown in Figure 1. The four upgradient monitoring wells are APMW-5, APMW-15, APMW-16A, and APMW-17. The ten downgradient monitoring wells are APMW-4, APMW-6, APMW-8A, APMW-10, APMW-11, APMW-12, APMW-13, APMW-14, APMW-18, and APMW-19.

3.1 Completed Key Actions in 2019

The following key actions were completed in 2019:

- The 2018 annual CCR groundwater monitoring and corrective action report was completed and placed within the operating record and on the publicly accessible CCR website (Golder 2019).
- An ASD was conducted for the verified statistically significant increase (SSI) for fluoride at APMW-19 identified in Q4 2018, with an alternative source identified.
- Detection monitoring samples were collected in June and November 2019 and analyzed for the Appendix III constituent list associated with the CCR rule for the program wells.
- An ASD was conducted for the verified SSI for chloride at APMW-19 identified in Q2 2019, with an alternative source identified.
- Comparative statistical analysis was completed for the Quarter 2 (Q2) 2019 and Quarter 4 (Q4) 2019 detection monitoring events, collected in June and November 2019, respectively.
- Additional groundwater quality samples were collected in support of the Q2 2019 ASD. Samples from wells APMW-4, APMW-5, APMW-8A, APMW-12, APMW-14, APMW-17, APMW-18, and APMW-19 were collected and analyzed for the Appendix III parameters, arsenic, barium, molybdenum, selenium, and major anions/cations on February 20, 2019.
- Samples collected from APMW-4 and APMW-5 during the semi-annual sampling events were also analyzed for Appendix IV constituents to reach the eight samples necessary to establish baseline (these wells were only sampled six times during the eight baseline sampling events due to insufficient water in the wells).
- Baseline statistical analysis was conducted for APMW-4 and APMW-5, following collection of sufficient samples for establishing statistical baseline.

3.2 Installation and Decommissioning of Monitoring Wells

No monitoring wells were installed or decommissioned at GGS in 2019.

3.3 Problems and Resolutions

No problems were encountered in 2019.

3.4 Proposed Key Activities for 2020

The following key activities are expected to be completed in 2020:

- Detection monitoring sampling events and associated comparative statistical analysis are planned to occur in Q2 and Q4 of 2020.
- An ASD will be evaluated to determine whether the SSIs for calcium and sulfate at APMW-19 are the result of impacts due to the active CCR facility. If the ASD is successful, the report will be included with the 2021 annual groundwater report. If the ASD is unsuccessful, NPPD will establish an assessment monitoring program for the facility.

4.0 GROUNDWATER MONITORING ANALYTICAL PROGRAM STATUS

Analytical activities associated with the groundwater monitoring program are described below.

4.1 Samples Collected

GGs staff collected detection monitoring samples from the four upgradient and ten downgradient monitoring wells in June and November 2019. Specific dates for each sample are provided on Tables 1 through 14.

4.1.1 Groundwater Elevation and Flow Rate

Groundwater elevations were measured in each well during each sampling event prior to purging. Elevation measurements can be found in Tables 1 through 14 for each location. Groundwater elevations and interpolated groundwater contours are shown on Figure 1 for the June 2019 (Q2 2019) detection monitoring sampling event. Groundwater elevations and interpolated groundwater contours are shown on Figure 2 for the November 2019 (Q4 2019) detection monitoring sampling event.

The groundwater flow rate across the facility was estimated with the equation $V_s = k \times i / n_e$, where:

- V_s is the groundwater flow rate, in feet per day (ft/day)
- k is the hydraulic conductivity, estimated from slug testing results from system wells, in ft/day
- i is the hydraulic gradient, calculated based on groundwater elevations for each monitoring event, in feet per foot (ft/ft)
- n_e is the effective porosity, estimated to be 0.25 for site soils

Hydraulic conductivity values at the site range from 0.14 to 19 ft/day, based on slug test data reported in *Design and Construction of a Groundwater Monitoring Network, Final Report*, issued in September 1991 by Woodward-Clyde Consultants. According to the 1991 report, a hydraulic conductivity value of 0.14 ft/day represents the Ogallala Formation silts. Values of 16 and 19 ft/day were reported for Ogallala Formation sands. Both 0.14 and 19 ft/day have been used to estimate a range of hydraulic conductivities. The effective porosity estimate above is based on typical values for sands and silts, as presented in *Applied Hydrogeology* (Fetter 1994).

Based on the range of site values for hydraulic conductivity and the estimated effective porosity, the average groundwater flow rate for June 2019 was estimated between 2.6×10^{-4} and 3.7×10^{-2} ft/day. The average groundwater flow rate for November 2019 was estimated between 2.7×10^{-4} and 3.7×10^{-2} ft/day.

4.2 Monitoring Data (Analytical Results)

Analytical results for the CCR rule Appendix III detection monitoring events in June and November 2019 are shown in Tables 1 through 14.

Additionally, Appendix IV results for APMW-4 and APMW-5 were collected in November 2019 to aid in establishing baseline for those wells. Analytical results for those analyses are included in the associated tables for APMW-4 and APMW-5.

4.3 Comparative Statistical Analysis

The comparative statistical analysis is summarized below with the results presented in Tables 15 through 28. A full description of the steps taken for the comparative statistical analysis can be found in the Groundwater Monitoring Statistical Methods Certification (Golder 2017a).

4.3.1 Definitions

The following definitions are used in discussion of the comparative statistical analysis:

- Elevated CUSUM – An elevated CUSUM occurs when the CUSUM is greater than the Shewhart-CUSUM limit established by the baseline statistical analysis, but the analytical result does not exceed the Shewhart-CUSUM limit. An elevated CUSUM is an indication that concentrations are gradually increasing and that analytical results may exceed the Shewhart-CUSUM limit in the future. For elevated CUSUMs in the case of two-tailed analysis (namely, pH), the calculated CUSUM value may also be below the lower Shewhart-CUSUM limit established by the baseline statistical analysis.
- Potential Exceedance – is defined as an initial elevated CUSUM or an initial analytical result that exceeds the Shewhart-CUSUM limit or non-parametric statistical limit established by the baseline statistical analysis. Confirmatory resampling will determine if the potential exceedance is a false-positive or a verified statistically significant increase (SSI). Non-detect results that exceed either the Shewhart-CUSUM limit or the non-parametric statistical limit are not considered unverified SSIs.
- False-positive – is defined as an analytical result that exceeds the statistical limit that can clearly be attributed to laboratory error or changes in analytical precision or is invalidated through confirmatory re-sampling. False-positives are not used in calculation of any subsequent CUSUMs.
- Confirmatory re-sampling – is designated as the next scheduled sampling event.
- Verified SSI – is interpreted as two consecutive exceedances (the original sample and the confirmatory re-sample, or two consecutive elevated CUSUMs) for the same constituent at the same well.

4.3.2 Potential Exceedances

The following potential exceedances were identified during the Q2 2019 detection monitoring event:

- APMW-6 (Downgradient) – Fluoride
- APMW-10 (Downgradient) – Calcium
- APMW-10 (Downgradient) – Sulfate
- APMW-12 (Downgradient) – Boron Elevated CUSUM

- APMW-13 (Downgradient) – Chloride Elevated CUSUM
- APMW-19 (Downgradient) – Calcium
- APMW-19 (Downgradient) – Sulfate Elevated CUSUM

Confirmatory re-sampling for these constituents occurred during the Q4 2019 detection monitoring sampling event, with results discussed below.

No potential exceedances were identified during the Q4 2019 detection monitoring event.

4.3.3 False-Positives

The following false-positives were identified during the Q2 2019 detection monitoring event:

- APMW-13 (Downgradient), Field pH: The potential exceedance for Field pH at APMW-13 identified during the Q4 2018 detection monitoring event (Golder 2019) was shown to be a false-positive through confirmatory re-sampling during the Q2 2019 detection monitoring event.

The following potential exceedances identified during the Q2 2019 detection monitoring event were found to be false-positives through confirmatory re-sampling during the Q4 2019 detection monitoring event:

- APMW-6 (Downgradient) – Fluoride
- APMW-10 (Downgradient) – Calcium
- APMW-10 (Downgradient) – Sulfate
- APMW-12 (Downgradient) – Boron Elevated CUSUM
- APMW-13 (Downgradient) – Chloride Elevated CUSUM

4.3.4 Verified SSIs

The following verified SSIs were identified during the Q2 2019 detection monitoring event:

- APMW-19 (Downgradient) – Chloride
- APMW-19 (Downgradient) – Fluoride (ongoing from Q4 2018)

Successful ASDs for these parameters are included as Appendix A (for fluoride) and Appendix B (for chloride).

The following verified SSIs were identified during the Q4 2019 detection monitoring event:

- APMW-19 (Downgradient) – Calcium
- APMW-19 (Downgradient) – Sulfate Elevated CUSUM
- APMW-19 (Downgradient) – Chloride (ongoing from Q2 2019, previous ASD performed)

4.3.5 Trending Data

Statistical limits were unable to be established for sulfate at APMW-15 and calcium at APMW-18 due to statistically significant trends within the baseline period. The following approaches have been used to assess the statistical significance of these constituents:

- **APMW-15 (Upgradient), Sulfate:** As an upgradient location, the facility was determined not to be the source of the increasing sulfate trend at APMW-15. For comparative statistics, an alternative trend test, namely that described by EPRI (2015), was used. Both the complete data set and the most recent eight points were analyzed with Sen's Slope trend tests to determine if the data continue to show a statistically significant trend. Both data sets were found to exhibit a statistically significant trend. Linear trend lines were then made for both the baseline data and the complete data set, including the most recent data from Q2 2019 and Q4 2019, following both the Q2 2019 and Q4 2019 detection monitoring sampling events. The regression residuals for the linear trend lines were tested for normalcy and shown to be normal or transform-normal. The slopes of the two lines were then compared. In accordance with the EPRI guidance (EPRI 2015), as the trend line for each of the complete data sets (both the complete data set through Q2 2019 and the complete data set through Q4 2019) had a lower slope than that of the baseline data set, the Q2 2019 and Q4 2019 detection monitoring points are not considered statistically significant. Data for this well-constituent pair will continue to be reassessed following collection of further data to determine if the trend continues or if a non-trending baseline period can be established.
- **APMW-18 (Downgradient), Calcium:** For comparative statistics, an alternative trend test, namely that described by EPRI (2015), was used. Both the complete data set and the most recent eight points were analyzed with Sen's Slope trend tests to determine if the data continue to show a statistically significant trend. Both data sets were found to exhibit a statistically significant trend. Linear trend lines were then made for both the baseline data and the complete data set, including the most recent data from Q2 2019 and Q4 2019, following both the Q2 2019 and Q4 2019 detection monitoring sampling events. The regression residuals for the linear trend lines were tested for normalcy and shown to be normal or transform-normal. The slopes of the two lines were then compared. In accordance with the EPRI guidance (EPRI 2015), as the trend line for each of the complete data sets (both the complete data set through Q2 2019 and the complete data set through Q4 2019) had a lower slope than that of the baseline data set, the Q2 2019 and Q4 2019 detection monitoring points are not considered statistically significant. Data for this well-constituent pair will continue to be reassessed following collection of further data to determine if the trend continues or if a non-trending baseline period can be established.

4.4 Program Transitions

Beginning in Q4 2017, the groundwater monitoring program at GGS transitioned from the baseline period to detection monitoring. During the baseline period, eight independent samples from each well within the program were collected and analyzed for the constituents listed in Appendix III and Appendix IV of the rule prior to October 17, 2017, as specified in 40 CFR 257.94(b), with the previously noted exceptions of APMW-4 and APMW-5 due to lack of precipitation (Golder 2018).

4.4.1 Detection Monitoring

Samples for the detection monitoring program are collected on a semi-annual basis, beginning with the sample collected in November 2017. NPPD plans to collect semi-annual samples for the detection monitoring program in Q2 and Q4 2020.

4.4.2 Alternative Source Demonstrations

Resulting from the verified SSI for fluoride at APMW-19 during the Q4 2018 detection monitoring event, NPPD pursued an ASD. As specified in 40 CFR 257.94, NPPD had 90 days to complete the ASD following completion of comparative statistics or establish an assessment monitoring program. The successful ASD was completed on

April 19, 2019, and is included as Appendix A. As a result of the successful ASD outcome, NPPD remained in detection monitoring for the Q2 2019 sampling event.

Resulting from the verified SSI for chloride at APMW-19 during the Q2 2019 detection monitoring event, NPPD pursued an ASD. As specified in 40 CFR 257.94, NPPD had 90 days to complete the ASD following completion of comparative statistics for the detection monitoring event or establish an assessment monitoring program. The successful ASD was completed on December 25, 2019 and is included as Appendix B. As a result of the successful ASD outcome, NPPD remained in detection monitoring for the Q4 2019 sampling event.

Resulting from the verified SSIs for calcium and sulfate at APMW-19, NPPD will pursue an ASD. As specified in 40 CFR 257.94, NPPD has 90 days to complete the ASD. Pending completion of the successful ASD, NPPD will remain in detection monitoring.

4.4.3 Assessment Monitoring

The current groundwater monitoring program at GGS is not in Assessment Monitoring. Assessment monitoring has not been triggered as described in 40 CFR 257.95. If a successful ASD is not completed, GGS will enter Assessment Monitoring under the steps described in 40 CFR 257.95.

4.4.4 Corrective Measures and Assessment

The current groundwater monitoring program at GGS does not indicate the need for corrective measures. An assessment of corrective measures, as described in 40 CFR 257.96, has not been required. No ASDs for Appendix IV parameters have been made. No corrective actions are required at this time.

5.0 RECOMMENDATIONS AND CLOSING

This report presents the results from the Q2 2019 and Q4 2019 detection monitoring events of the CCR program, along with the associated comparative statistical analysis and successful ASDs for fluoride at APMW-19 during Q4 2018, and chloride at APMW-19 during Q2 2019. Pursuant to 40 CFR 257.94, NPPD will prepare an ASD to address the SSIs found for calcium and sulfate at APMW-19. Pending completion of the successful ASD, NPPD will remain in detection monitoring at GGS.

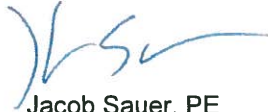
As described in the Groundwater Monitoring System Certification (Golder 2017b) and the Groundwater Monitoring Statistical Methods Certification (Golder 2017a), the groundwater monitoring and analytical procedures used in 2019 meet the general requirements of the CCR rule. Modifications to the monitoring network and sampling program are not recommended at this time.

Signature Page

Golder Associates Inc.



Erin L. Hunter, PhD, PE
Project Engineer



Jacob Sauer, PE
Senior Engineer

ELH/JJS/rjg

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6.0 REFERENCES

Electric Power Research Institute (EPRI). 2015. Groundwater Monitoring Guidance for the Coal Combustion Residuals Rule – 2015 Technical Report, November.

Fetter, Charles Willard. 1994. Applied Hydrogeology, 3rd Edition. Prentice-Hall.

Golder. 2017a. Groundwater Monitoring Statistical Methods Certification, Gerald Gentleman Station Ash Disposal Facility. Golder Associates Inc. October 10.

Golder. 2017b. Coal Combustion Residuals Landfill Groundwater Monitoring System Certification, Gerald Gentleman Station, Sutherland, Nebraska. Golder Associates Inc. October 10.

Golder. 2018. Annual Groundwater Report – 2017, Nebraska Public Power District – Gerald Gentleman Station. Golder Associates Inc. January 24.

Golder. 2019a. Annual Groundwater Report – 2018, Nebraska Public Power District – Gerald Gentleman Station. Golder Associates Inc. Published January 25. Tables Revised March 7.

Golder. 2019b. Alternative Source Demonstration, Nebraska Public Power District – Gerald Gentleman Station. Golder Associates Inc. Published April 19.

Golder. 2019c. Alternative Source Demonstration, Nebraska Public Power District – Gerald Gentleman Station. Golder Associates Inc. Published December 25.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. Office of Resource Conservation and Recovery, EPA-R-09-007. March.

United States Environmental Protection Agency (USEPA). 2015. Code of Federal Regulations Title 40 Part 257: Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities. April 17.

Woodward-Clyde Consultants. 1991. Design and Construction of a Groundwater Monitoring Network, Final Report. September.

Tables

Table 1. Data Summary Table - APMW-5

Analytes		6/11/2019	11/5/2019	2/20/2019	6/11/2019	11/5/2019
	Units	Additional Baseline		Additional ASD ³	Detection Monitoring ²	
Appendix III						
Boron, Total	mg/L	---	---	< 0.200	< 0.200	< 0.200
Calcium, Total	mg/L	---	---	56.8	95.0	71.4
Chloride	mg/L	---	---	16.7	38.1	23.2
Fluoride	mg/L	---	---	0.591	0.676	< 0.500
pH, Field	pH units	---	---	7.37	7.51	7.52
pH	pH units	---	---	7.7	7.8	
Sulfate	mg/L	---	---	46.9	76.9	57.5
Total Dissolved Solids	mg/L	---	---	360	450	338
Appendix IV						
Antimony, Total	mg/L	< 0.00100	< 0.00100	---	---	---
Arsenic, Total	mg/L	0.00430	0.00371	0.00512	---	---
Barium, Total	mg/L	0.359	0.231	0.299	---	---
Beryllium, Total	mg/L	< 0.00100	< 0.00100	---	---	---
Cadmium, Total	mg/L	< 0.000500	< 0.000100	---	---	---
Chromium, Total	mg/L	< 0.00500	< 0.00500	---	---	---
Cobalt, Total	mg/L	< 0.000500	< 0.000500	---	---	---
Fluoride	mg/L	0.676	< 0.500	---	---	---
Lead, Total	mg/L	< 0.000500	< 0.000500	---	---	---
Lithium, Total	mg/L	0.0272	0.0229	---	---	---
Mercury, Total	mg/L	< 0.000200	< 0.000200	---	---	---
Molybdenum, Total	mg/L	0.00646	0.00609	0.00774	---	---
Radium-226	pCi/L	---	---	---	---	---
Radium-228	pCi/L	---	---	---	---	---
Radium-226 + Radium-228	pCi/L	---	---	---	---	---
Selenium, Total	mg/L	0.0184	0.00993	0.0083	---	---
Thallium, Total	mg/L	< 0.00100	< 0.00100	---	---	---

Legend:

---. Not analyzed

ft amsl, feet above mean sea level

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. Samples were not collected on September 12, 2016, November 14, 2016, and November 7, 2017 due to a lack of water at APMW-5. A lack of precipitation was noted on-site during the third and fourth quarter of 2016 and fourth quarter of 2017.

2. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

3. Additional Alternative Source Demonstration data. No statistical analysis

Table 2. Data Summary Table - APMW-15

Analytes		6/11/2019	11/5/2019
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.200	< 0.200
Calcium, Total	mg/L	125	106
Chloride	mg/L	37.3	32.9
Fluoride	mg/L	0.649	<0.500
pH, Field	pH units	7.35	7.32
pH	pH units	7.6	7.6
Sulfate	mg/L	172	153
Total Dissolved Solids	mg/L	616	454
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

2. Appendix IV parameters analyzed during detection monitoring for informational purposes only. No statistical analysis performed.

Table 3. Data Summary Table - APMW-16A

Analytes		6/11/2019	11/5/2019
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.200	< 0.200
Calcium, Total	mg/L	168	105
Chloride	mg/L	93.8	25.3
Fluoride	mg/L	1.49	<0.500
pH, Field	pH units	7.22	7.52
pH	pH units	7.5	
Sulfate	mg/L	198	150
Total Dissolved Solids	mg/L	722	522
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 4. Data Summary Table - APMW-17

Analytes		2/20/2019	6/11/2019	11/5/2019
	Units	Additional ASD ²	Detection Monitoring ¹	
Appendix III				
Boron, Total	mg/L	< 0.200	< 0.200	< 0.200
Calcium, Total	mg/L	115	119	104
Chloride	mg/L	28.5	20.6	23.3
Fluoride	mg/L	0.186	< 0.500	<0.500
pH, Field	pH units	7.51	7.31	7.21
pH	pH units	7.4	7.6	
Sulfate	mg/L	108	111	109
Total Dissolved Solids	mg/L	770	496	430
Appendix IV				
Antimony, Total	mg/L	---	---	---
Arsenic, Total	mg/L	0.00246	---	---
Barium, Total	mg/L	0.077	---	---
Beryllium, Total	mg/L	0.186	---	---
Cadmium, Total	mg/L	---	---	---
Chromium, Total	mg/L	---	---	---
Cobalt, Total	mg/L	---	---	---
Fluoride	mg/L	---	---	---
Lead, Total	mg/L	---	---	---
Lithium, Total	mg/L	---	---	---
Mercury, Total	mg/L	---	---	---
Molybdenum, Total	mg/L	---	---	---
Radium-226	pCi/L	---	---	---
Radium-228	pCi/L	---	---	---
Radium-226 + Radium-228	pCi/L	---	---	---
Selenium, Total	mg/L	0.008	---	---
Thallium, Total	mg/L	---	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

2. Additional Alternative Source Demonstration data. No statistical analysis performed.

Table 5. Data Summary Table - APMW-4

Analytes		6/11/2019	11/5/2019	2/20/2019	6/11/2019	11/5/2019
	Units	Additional Baseline		Additional ASD ³	Detection Monitoring ²	
Appendix III						
Boron, Total	mg/L	---	---	< 0.200	< 0.200	< 0.200
Calcium, Total	mg/L	---	---	54.5	56.2	50.8
Chloride	mg/L	---	---	38.6	43.7	40.2
Fluoride	mg/L	---	---	0.231	0.859	<0.500
pH, Field	pH units	---	---	7.67	7.55	7.62
pH	pH units	---	---	7.6	7.9	7.9
Sulfate	mg/L	---	---	25.7	33.8	26.4
Total Dissolved Solids	mg/L	---	---	296	324	210
Appendix IV						
Antimony, Total	mg/L	< 0.00100	< 0.00100	---	---	---
Arsenic, Total	mg/L	0.00473	0.00431	0.00506	---	---
Barium, Total	mg/L	0.0916	0.0808	0.0933	---	---
Beryllium, Total	mg/L	< 0.00100	< 0.00100	---	---	---
Cadmium, Total	mg/L	< 0.000500	< 0.000500	---	---	---
Chromium, Total	mg/L	< 0.00500	< 0.00500	---	---	---
Cobalt, Total	mg/L	< 0.000500	< 0.000500	---	---	---
Fluoride	mg/L	0.859	<0.500	---	---	---
Lead, Total	mg/L	< 0.000500	< 0.000500	---	---	---
Lithium, Total	mg/L	0.0157	0.0156	---	---	---
Mercury, Total	mg/L	< 0.000200	< 0.000200	---	---	---
Molybdenum, Total	mg/L	0.00453	0.00512	0.0482	---	---
Radium-226	pCi/L	---	---	---	---	---
Radium-228	pCi/L	---	---	---	---	---
Radium-226 + Radium-228	pCi/L	---	---	---	---	---
Selenium, Total	mg/L	0.0148	0.014	0.0144	---	---
Thallium, Total	mg/L	< 0.00100	< 0.00100	---	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. Samples were not collected on September 12, 2016, November 14, 2016, and November 7, 2017 due to a lack of water at APMW-4. A lack of precipitation was noted on-site during the third and fourth quarter of 2016 and fourth quarter of 2017.

2. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

3. Additional Alternative Source Demonstration data. No statistical analysis performed.

Table 6. Data Summary Table - APMW-6

Analytes		6/11/2019	11/5/2019
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.200	< 0.200
Calcium, Total	mg/L	58.4	48.6
Chloride	mg/L	15.5	12
Fluoride	mg/L	0.713	<0.500
pH, Field	pH units	7.48	7.47
pH	pH units	7.8	7.7
Sulfate	mg/L	30.2	27.5
Total Dissolved Solids	mg/L	308	222
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 7. Data Summary Table - APMW-8A

Analytes		2/20/2019	6/11/2019	11/05-06/2019
	Units	Additional ASD ²	Detection Monitoring ¹	
Appendix III				
Boron, Total	mg/L	<0.200	< 0.200	< 0.200
Calcium, Total	mg/L	105	133	110
Chloride	mg/L	78.7	84.8	80.7
Fluoride	mg/L	0.127	< 0.500	0.221
pH, Field	pH units	7.6	7.21	7.23
pH	pH units	7.4	7.6	7.5
Sulfate	mg/L	119	135	118
Total Dissolved Solids	mg/L	564	572	536
Appendix IV				
Antimony, Total	mg/L	---	---	---
Arsenic, Total	mg/L	0.00345	---	---
Barium, Total	mg/L	0.133	---	---
Beryllium, Total	mg/L	---	---	---
Cadmium, Total	mg/L	---	---	---
Chromium, Total	mg/L	---	---	---
Cobalt, Total	mg/L	---	---	---
Fluoride	mg/L	---	---	---
Lead, Total	mg/L	---	---	---
Lithium, Total	mg/L	---	---	---
Mercury, Total	mg/L	---	---	---
Molybdenum, Total	mg/L	0.0109	---	---
Radium-226	pCi/L	---	---	---
Radium-228	pCi/L	---	---	---
Radium-226 + Radium-228	pCi/L	---	---	---
Selenium, Total	mg/L	0.0202	---	---
Thallium, Total	mg/L	---	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

2. Additional Alternative Source Demonstration data. No statistical analysis performed.

Table 8. Data Summary Table - APMW-10

Analytes		6/11/2019	11/5/2019
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	< 0.200	< 0.200
Calcium, Total	mg/L	113	62.5
Chloride	mg/L	49.8	43.7
Fluoride	mg/L	< 0.500	0.211
pH, Field	pH units	7.38	7.49
pH	pH units	7.8	7.7
Sulfate	mg/L	85.5	42.6
Total Dissolved Solids	mg/L	396	320
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 9. Data Summary Table - APMW-11

Analytes		6/11/2019	11/5/2019
	Units	Detection	Monitoring ¹
Appendix III			
Boron, Total	mg/L	< 0.200	< 0.200
Calcium, Total	mg/L	85.0	81.3
Chloride	mg/L	65.2	79.4
Fluoride	mg/L	0.552	0.258
pH, Field	pH units	7.34	---
pH	pH units	7.7	7.6
Sulfate	mg/L	44.1	36.7
Total Dissolved Solids	mg/L	388	368
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 10. Data Summary Table - APMW-12

Analytes		2/20/2019	6/11/2019	11/6/2019
	Units	Additional ASD ²	Detection Monitoring ¹	
Water Elevation	ft amsl			
Appendix III				
Boron, Total	mg/L	0.331	0.341	0.260
Calcium, Total	mg/L	156	173	155
Chloride	mg/L	166	148	144
Fluoride	mg/L	<0.100	< 0.500	< 0.200
pH, Field	pH units	7.36	6.98	7.02
pH	pH units	7.2	7.4	7.3
Sulfate	mg/L	292	312	279
Total Dissolved Solids	mg/L	1100	1030	860
Appendix IV				
Antimony, Total	mg/L	0.00257	---	---
Arsenic, Total	mg/L	0.0528	---	---
Barium, Total	mg/L	---	---	---
Beryllium, Total	mg/L	---	---	---
Cadmium, Total	mg/L	---	---	---
Chromium, Total	mg/L	---	---	---
Cobalt, Total	mg/L	---	---	---
Fluoride	mg/L	---	---	---
Lead, Total	mg/L	---	---	---
Lithium, Total	mg/L	---	---	---
Mercury, Total	mg/L	---	---	---
Molybdenum, Total	mg/L	0.00216	---	---
Radium-226	pCi/L	---	---	---
Radium-228	pCi/L	---	---	---
Radium-226 + Radium-228	pCi/L	---	---	---
Selenium, Total	mg/L	0.0065	---	---
Thallium, Total	mg/L	---	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

2. Additional Alternative Source Demonstration data. No statistical analysis performed.

Table 11. Data Summary Table - APMW-13

Analytes		6/11/2019	11/6/2019
	Units	Detection Monitoring ¹	
Appendix III			
Boron, Total	mg/L	0.373	0.295
Calcium, Total	mg/L	169	140
Chloride	mg/L	156	126
Fluoride	mg/L	< 0.500	< 0.200
pH, Field	pH units	6.97	7.12
pH	pH units	7.4	7.3
Sulfate	mg/L	288	257
Total Dissolved Solids	mg/L	996	914
Appendix IV			
Antimony, Total	mg/L	---	---
Arsenic, Total	mg/L	---	---
Barium, Total	mg/L	---	---
Beryllium, Total	mg/L	---	---
Cadmium, Total	mg/L	---	---
Chromium, Total	mg/L	---	---
Cobalt, Total	mg/L	---	---
Fluoride	mg/L	---	---
Lead, Total	mg/L	---	---
Lithium, Total	mg/L	---	---
Mercury, Total	mg/L	---	---
Molybdenum, Total	mg/L	---	---
Radium-226	pCi/L	---	---
Radium-228	pCi/L	---	---
Radium-226 + Radium-228	pCi/L	---	---
Selenium, Total	mg/L	---	---
Thallium, Total	mg/L	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

Table 12. Data Summary Table - APMW-14

Analytes		2/20/2019	6/11/2019	11/6/2019
	Units	Additional ASD ²	Detection Monitoring ¹	
Appendix III				
Boron, Total	mg/L	0.354	0.317	0.259
Calcium, Total	mg/L	163	172	155
Chloride	mg/L	128	137	133
Fluoride	mg/L	0.123	< 0.500	< 0.200
pH, Field	pH units	7.4	7.01	7.12
pH	pH units	7.3	7.4	7.4
Sulfate	mg/L	213	222	201
Total Dissolved Solids	mg/L	948	936	854
Appendix IV				
Antimony, Total	mg/L	---	---	---
Arsenic, Total	mg/L	0.00278	---	---
Barium, Total	mg/L	0.0476	---	---
Beryllium, Total	mg/L	---	---	---
Cadmium, Total	mg/L	---	---	---
Chromium, Total	mg/L	---	---	---
Cobalt, Total	mg/L	---	---	---
Fluoride	mg/L	---	---	---
Lead, Total	mg/L	---	---	---
Lithium, Total	mg/L	---	---	---
Mercury, Total	mg/L	---	---	---
Molybdenum, Total	mg/L	0.00216	---	---
Radium-226	pCi/L	---	---	---
Radium-228	pCi/L	---	---	---
Radium-226 + Radium-228	pCi/L	---	---	---
Selenium, Total	mg/L	0.0055	---	---
Thallium, Total	mg/L	---	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

2. Additional Alternative Source Demonstration data. No statistical analysis performed.

Table 13. Data Summary Table - APMW-18

Analytes		2/20/2019	6/11/2019	11/5/2019
	Units	Additional ASD ²	Detection Monitoring ¹	
Appendix III				
Boron, Total	mg/L	<0.200	< 0.200	< 0.200
Calcium, Total	mg/L	70.2	88.8	78.4
Chloride	mg/L	36.3	38.0	85.7
Fluoride	mg/L	0.129	< 0.500	< 0.500
pH, Field	pH units	7.71	7.39	7.44
pH	pH units	7.5	7.7	7.7
Sulfate	mg/L	54.1	19.8	35.2
Total Dissolved Solids	mg/L	484	412	392
Appendix IV				
Antimony, Total	mg/L	---	---	---
Arsenic, Total	mg/L	0.00311	---	---
Barium, Total	mg/L	0.22	---	---
Beryllium, Total	mg/L	---	---	---
Cadmium, Total	mg/L	---	---	---
Chromium, Total	mg/L	---	---	---
Cobalt, Total	mg/L	---	---	---
Fluoride	mg/L	---	---	---
Lead, Total	mg/L	---	---	---
Lithium, Total	mg/L	---	---	---
Mercury, Total	mg/L	---	---	---
Molybdenum, Total	mg/L	0.00575	---	---
Radium-226	pCi/L	---	---	---
Radium-228	pCi/L	---	---	---
Radium-226 + Radium-228	pCi/L	---	---	---
Selenium, Total	mg/L	0.0075	---	---
Thallium, Total	mg/L	---	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

2. Additional Alternative Source Demonstration data. No statistical analysis performed.

Table 14. Data Summary Table - APMW-19

Analytes		2/20/2019	6/11/2019	11/5/2019
	Units	Additional ASD ²	Detection Monitoring ¹	
Appendix III				
Boron, Total	mg/L	< 0.200	< 0.200	< 0.200
Calcium, Total	mg/L	89.8	113	102
Chloride	mg/L	46.9	55.3	51.8
Fluoride	mg/L	0.158	0.552	0.232
pH, Field	pH units	7.59	7.33	7.44
pH	pH units	7.5	7.6	7.6
Sulfate	mg/L	100	135	130
Total Dissolved Solids	mg/L	528	518	502
Appendix IV				
Antimony, Total	mg/L	---	---	---
Arsenic, Total	mg/L	0.00379	---	---
Barium, Total	mg/L	0.149	---	---
Beryllium, Total	mg/L	---	---	---
Cadmium, Total	mg/L	---	---	---
Chromium, Total	mg/L	---	---	---
Cobalt, Total	mg/L	---	---	---
Fluoride	mg/L	---	---	---
Lead, Total	mg/L	---	---	---
Lithium, Total	mg/L	---	---	---
Mercury, Total	mg/L	---	---	---
Molybdenum, Total	mg/L	0.00418	---	---
Radium-226	pCi/L	---	---	---
Radium-228	pCi/L	---	---	---
Radium-226 + Radium-228	pCi/L	---	---	---
Selenium, Total	mg/L	0.0128	---	---
Thallium, Total	mg/L	---	---	---

Legend:

---. Not analyzed

mg/L, milligrams per liter

pCi/L, picocuries per liter

U, Result is less than the sample detection limit (varies by sample for radiological results).

NOTES:

1. As indicated by the CCR rule (40 CFR 257.94), the Detection Monitoring Program monitors all constituents found in Appendix III.

2. Additional Alternative Source Demonstration data. No statistical analysis performed.

Table 15: Comparative Statistics - APMW-5

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	120.2	95	84.16	Yes	71.4	73.28	Yes
Chloride	mg/L	NP-PL	86.86	38.1			23.2	---	Yes
Fluoride	mg/L	CUSUM	2.268	0.676			< 0.5	0.634	Yes
pH, Field	pH units	NP-PL	7.23, 9.71	7.51	---	Yes	7.52	---	Yes
Sulfate	mg/L	CUSUM	76.93	76.9			57.5	76.8	Yes
Total Dissolved Solids	mg/L	CUSUM	652.5	450	390.7	Yes	338	385.8	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 16: Comparative Statistics - APMW-15

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	136.8	125	122.2	Yes	106	117.5	Yes
Chloride	mg/L	CUSUM	40.71	37.3	35.75	Yes	32.9	33.75	Yes
Fluoride	mg/L	NP-PL	0.716	0.649	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	5.94, 8.42	7.35	7.18, 7.18	Yes	7.32	7.18, 7.18	Yes
Sulfate	mg/L	Trend	NA	172	---	---	153	---	---
Total Dissolved Solids	mg/L	CUSUM	859.4	616	613	Yes	454	613	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Trend: Trends were identified in the background period. See text for discussion of significance.

NA: No limit set due to increasing trend. Alternative statistical method used.

Table 17: Comparative Statistics - APMW-16A

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	219.9	168	149.3	Yes	105	135.6	Yes
Chloride	mg/L	CUSUM	151.6	93.8	73.03	Yes	25.3	58.14	Yes
Fluoride	mg/L	NP-PL	0.708	1.49	---	No	< 0.5	---	Yes
pH, Field	pH units	CUSUM	5.89, 8.10	7.22	7.00, 7.00	Yes	6.89	7.00, 7.00	Yes
Sulfate	mg/L	CUSUM	315.5	198	202.4	Yes	150	202.4	Yes
Total Dissolved Solids	mg/L	CUSUM	1190	722	748	Yes	522	748	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 18: Comparative Statistics - APMW-17

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	183.8	119	139.8	Yes	104	139.8	Yes
Chloride	mg/L	CUSUM	59.03	20.6	46.45	Yes	23.3	46.45	Yes
Fluoride	mg/L	NP-PL	1.07	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	5.88, 8.20	7.31	7.04, 7.10	Yes	7.21	7.04, 7.04	Yes
Sulfate	mg/L	CUSUM	189.4	111	156.4	Yes	109	156.4	Yes
Total Dissolved Solids	mg/L	CUSUM	828.2	496	643.5	Yes	430	643.5	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 19: Comparative Statistics - APMW-4

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	64.31	56.2	55.14	Yes	50.8	55.14	Yes
Chloride	mg/L	Trend	NA	43.7	---	---	40.2	---	---
Fluoride	mg/L	NP-PL	0.569	0.859	---	No	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.21, 9.02	7.55	7.62, 7.62	Yes	7.62	7.62, 7.62	Yes
Sulfate	mg/L	CUSUM	40.53	33.8	31.01	Yes	26.4	28	Yes
Total Dissolved Solids	mg/L	CUSUM	427.9	324	306.3	Yes	210	306.3	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

NA: Not analyzed due to lack of number of samples needed for establishing background.

NA: No limit set due to increasing trend. Alternative statistical method used.

Table 20: Comparative Statistics - APMW-6

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	60.17	58.4	56.95	Yes	48.6	53.45	Yes
Chloride	mg/L	CUSUM	20.4	15.5	13.15	Yes	12	12.98	Yes
Fluoride	mg/L	NP-PL	0.708	0.713	---	No	< 0.5	---	Yes
pH, Field	pH units	CUSUM	5.73, 9.08	7.48	7.40, 7.40	Yes	7.47	7.40, 7.40	Yes
Sulfate	mg/L	CUSUM	37.52	30.2	31.07	Yes	27.5	29.1	Yes
Total Dissolved Solids	mg/L	CUSUM	396.7	308	296	Yes	222	296	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 21: Comparative Statistics - APMW-8A

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	168.3	133	128	Yes	110	121.9	Yes
Chloride	mg/L	CUSUM	170.9	84.8	84.41	Yes	80.7	84.41	Yes
Fluoride	mg/L	NP-PL	13.7	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	5.34, 9.16	7.21	7.25, 7.25	Yes	7.23	7.25, 7.25	Yes
Sulfate	mg/L	CUSUM	226.6	135	148.6	Yes	118	157.1	Yes
Total Dissolved Solids	mg/L	CUSUM	900.7	572	546.8	Yes	536	546.8	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 22: Comparative Statistics - APMW-10

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	80.04	113	109.4	No	62.5	63.66	Yes
Chloride	mg/L	CUSUM	64.41	49.8	43.84	Yes	43.7	43.53	Yes
Fluoride	mg/L	NP-PL	3.78	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	5.54, 9.42	7.38	7.48, 7.48	Yes	7.49	7.48, 7.48	Yes
Sulfate	mg/L	CUSUM	76.58	85.5	78.54	No	42.6	45.29	Yes
Total Dissolved Solids	mg/L	CUSUM	502.2	396	365.3	Yes	320	364	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 23: Comparative Statistics - APMW-11

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	106.1	85	83.13	Yes	81.3	83.13	Yes
Chloride	mg/L	CUSUM	150.7	65.2	79.35	Yes	79.4	79.35	Yes
Fluoride	mg/L	NP-PL	6.96	0.552	---	Yes	< 0.5	---	Yes
pH, Field	pH units	NP-PL	7.2, 8.64	7.34	---	Yes	7.36	---	Yes
Sulfate	mg/L	CUSUM	68.35	44.1	54.72	Yes	36.7	53.41	Yes
Total Dissolved Solids	mg/L	CUSUM	614.3	388	452.8	Yes	368	452.8	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 24: Comparative Statistics - APMW-12

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/6/2019		
Boron, Total	mg/L	CUSUM	0.3428	0.341	0.3699	No	0.26	0.2889	Yes
Calcium, Total	mg/L	CUSUM	205.7	173	170	Yes	155	170	Yes
Chloride	mg/L	CUSUM	318.7	148	164.3	Yes	144	164.3	Yes
Fluoride	mg/L	NP-PL	21.3	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	NP-PL	6.77, 8.79	6.98	---	Yes	7.02	---	Yes
Sulfate	mg/L	CUSUM	399.7	312	299.1	Yes	279	299.1	Yes
Total Dissolved Solids	mg/L	CUSUM	1596	1030	1153	Yes	860	1153	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 25: Comparative Statistics - APMW-13

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/6/2019		
Boron, Total	mg/L	CUSUM	0.4771	0.373	0.3365	Yes	0.295	0.3129	Yes
Calcium, Total	mg/L	CUSUM	193.2	169	161.6	Yes	140	146.8	Yes
Chloride	mg/L	CUSUM	157.9	156	190.9	No	126	137.1	Yes
Fluoride	mg/L	NP-PL	8.25	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	NP-PL	6.81, 9.04	6.97	---	Yes	7.12	---	Yes
Sulfate	mg/L	CUSUM	365.5	288	284.3	Yes	257	260	Yes
Total Dissolved Solids	mg/L	CUSUM	1182	996	1030	Yes	914	1030	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 26: Comparative Statistics - APMW-14

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/6/2019		
Boron, Total	mg/L	CUSUM	0.3992	0.317	0.2847	Yes	0.259	0.2575	Yes
Calcium, Total	mg/L	CUSUM	194.8	172	163.9	Yes	155	158.5	Yes
Chloride	mg/L	CUSUM	223.3	137	134.1	Yes	133	134.1	Yes
Fluoride	mg/L	NP-PL	19.2	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	4.16, 10.82	7.01	7.49, 7.49	Yes	7.12	7.49, 7.49	Yes
Sulfate	mg/L	CUSUM	267.1	222	230.6	Yes	201	214.8	Yes
Total Dissolved Solids	mg/L	CUSUM	1335	936	954.3	Yes	854	954.3	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Table 27: Comparative Statistics - APMW-18

		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	Trend	NA	88.8	---	---	78.4	---	---
Chloride	mg/L	CUSUM	183.6	38	52.53	Yes	85.7	56.58	Yes
Fluoride	mg/L	NP-PL	1.74	< 0.500	---	Yes	< 0.500	---	Yes
pH, Field	pH units	CUSUM	6.08, 8.44	7.39	7.26, 7.26	Yes	7.44	7.26, 7.26	Yes
Sulfate	mg/L	CUSUM	185.4	19.8	39.03	Yes	35.2	39.03	Yes
Total Dissolved Solids	mg/L	CUSUM	737.1	412	413.5	Yes	392	413.5	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

CUSUM: Parametric Shewhart-CUSUM Control Chart

Trend: Trends were identified in the background period. See text for discussion of significance.

NA: No limit set due to increasing trend. Alternative statistical method used.

Table 28: Comparative Statistics - APMW-19

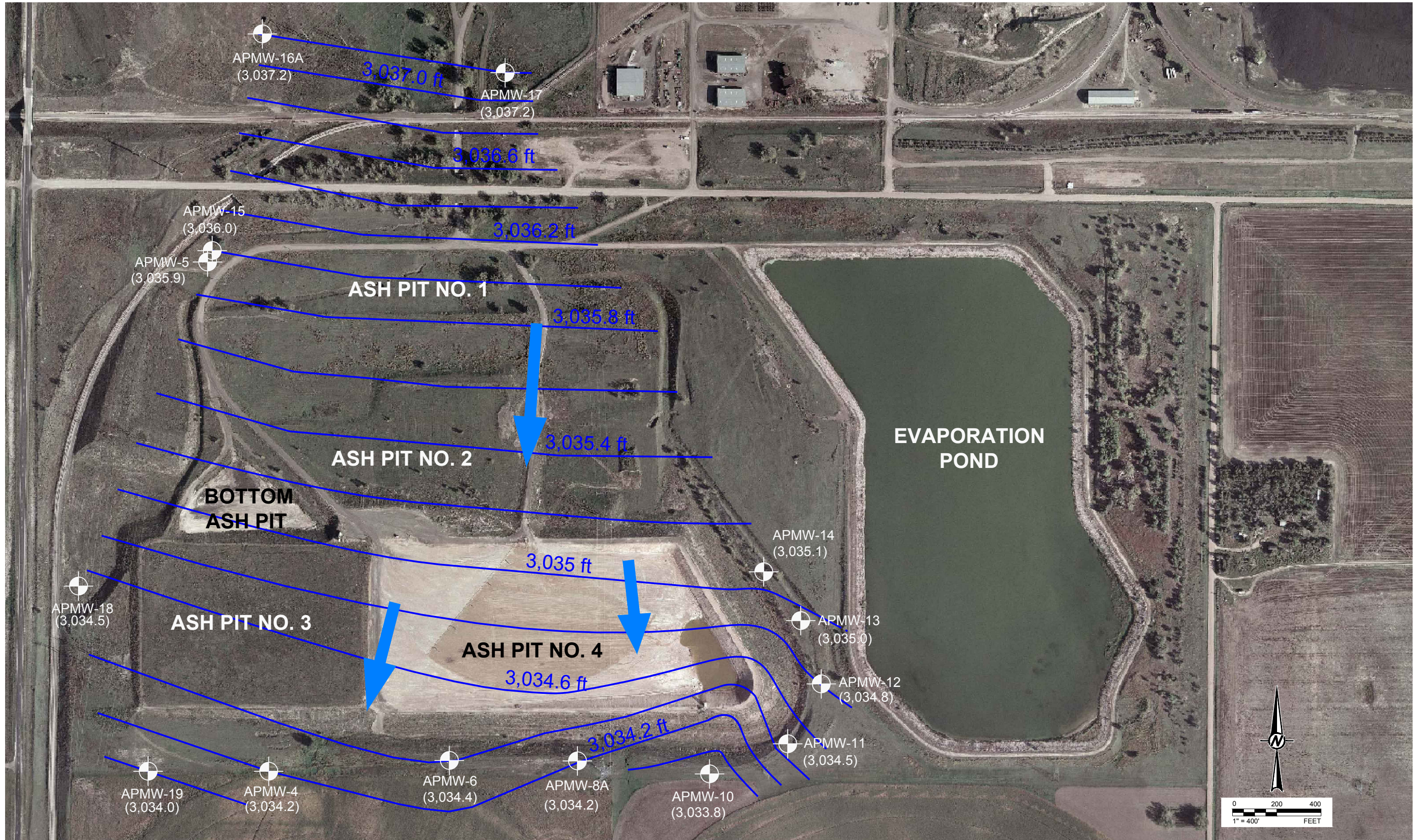
		Statistical Method	Statistical Limit	Detection Monitoring Result	CUSUM Value	Within Limit?	Detection Monitoring Result	CUSUM Value	Within Limit?
Appendix III Analytes	Units			6/11/2019			11/5/2019		
Boron, Total	mg/L	NP-PL	0.2	< 0.200	---	Yes	< 0.200	---	Yes
Calcium, Total	mg/L	CUSUM	104.4	113	115.8	No	102	122.7	No
Chloride	mg/L	CUSUM	49.12	55.3	61.43	No	51.8	67.87	No
Fluoride	mg/L	NP-PL	0.5	0.552	---	No	< 0.5	---	Yes
pH, Field	pH units	CUSUM	5.84, 8.64	7.33	7.24, 7.24	Yes	7.35	7.24, 7.24	Yes
Sulfate	mg/L	CUSUM	135.4	135	153.6	No	130	199.2	No
Total Dissolved Solids	mg/L	CUSUM	690.5	518	466.2	Yes	502	459.1	Yes

Notes:

NP-PL: Non-Parametric Prediction Limit

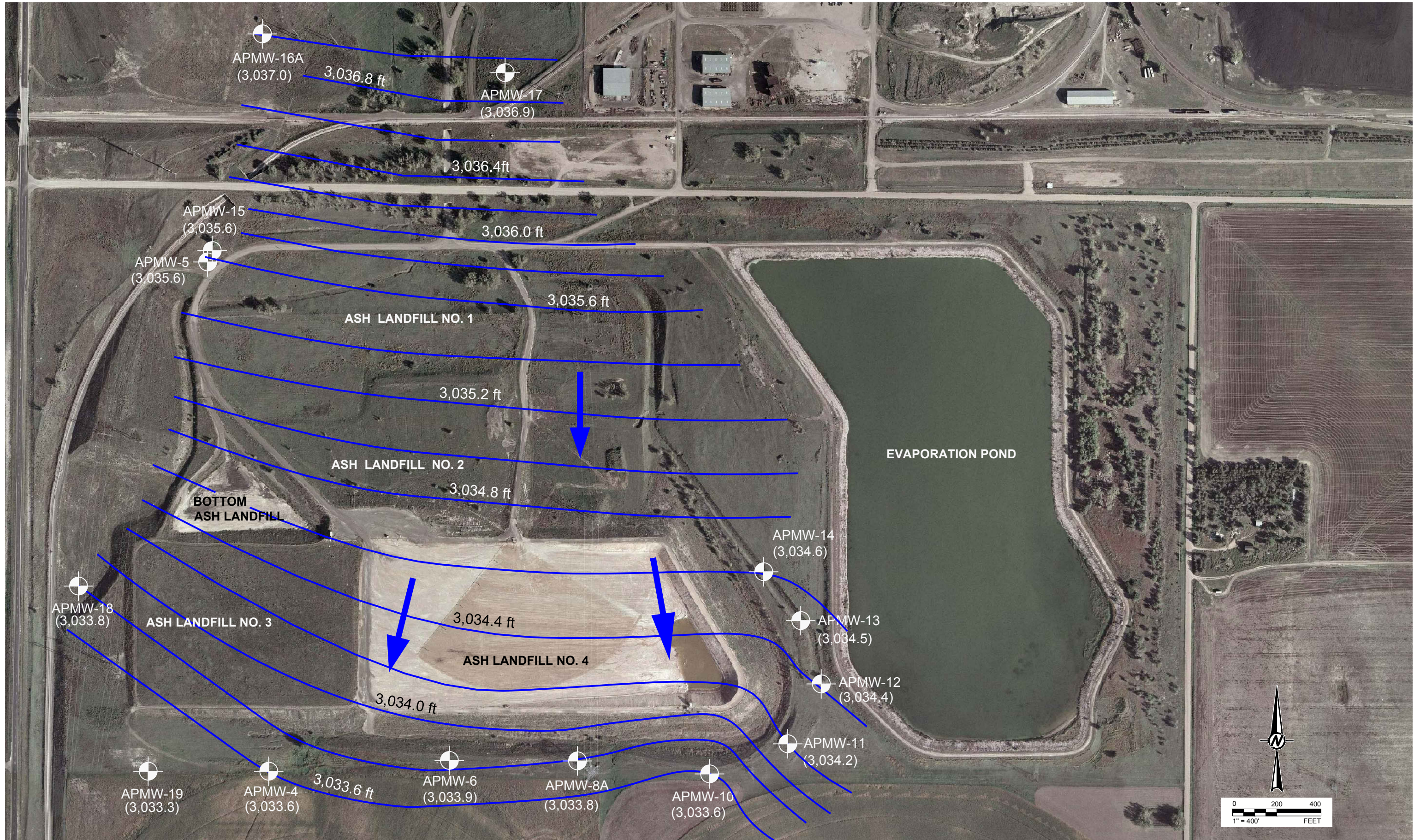
CUSUM: Parametric Shewhart-CUSUM Control Chart

Figures



NOTE
GROUNDWATER CONTOURS DEVELOPED FROM LEVELS MEASURED IN ACTIVE
MONITORING WELLS SHOWN.

NEBRASKA PUBLIC POWER DISTRICT
GERALD GENTLEMAN STATION
GROUNDWATER MONITORING WELL NETWORK
(JUNE 2019 GROUNDWATER CONTOURS)
FIGURE 1



APPENDIX A

**Alternative Source Demonstration –
Q4 2018 Detection Monitoring Event**



REPORT

Alternate Source Demonstration

Nebraska Public Power District: Gerald Gentleman Station

Submitted to:

Nebraska Public Power District

Gerald Gentleman Station, 6089 South Highway 25, Sutherland, Nebraska 69165

Submitted by:

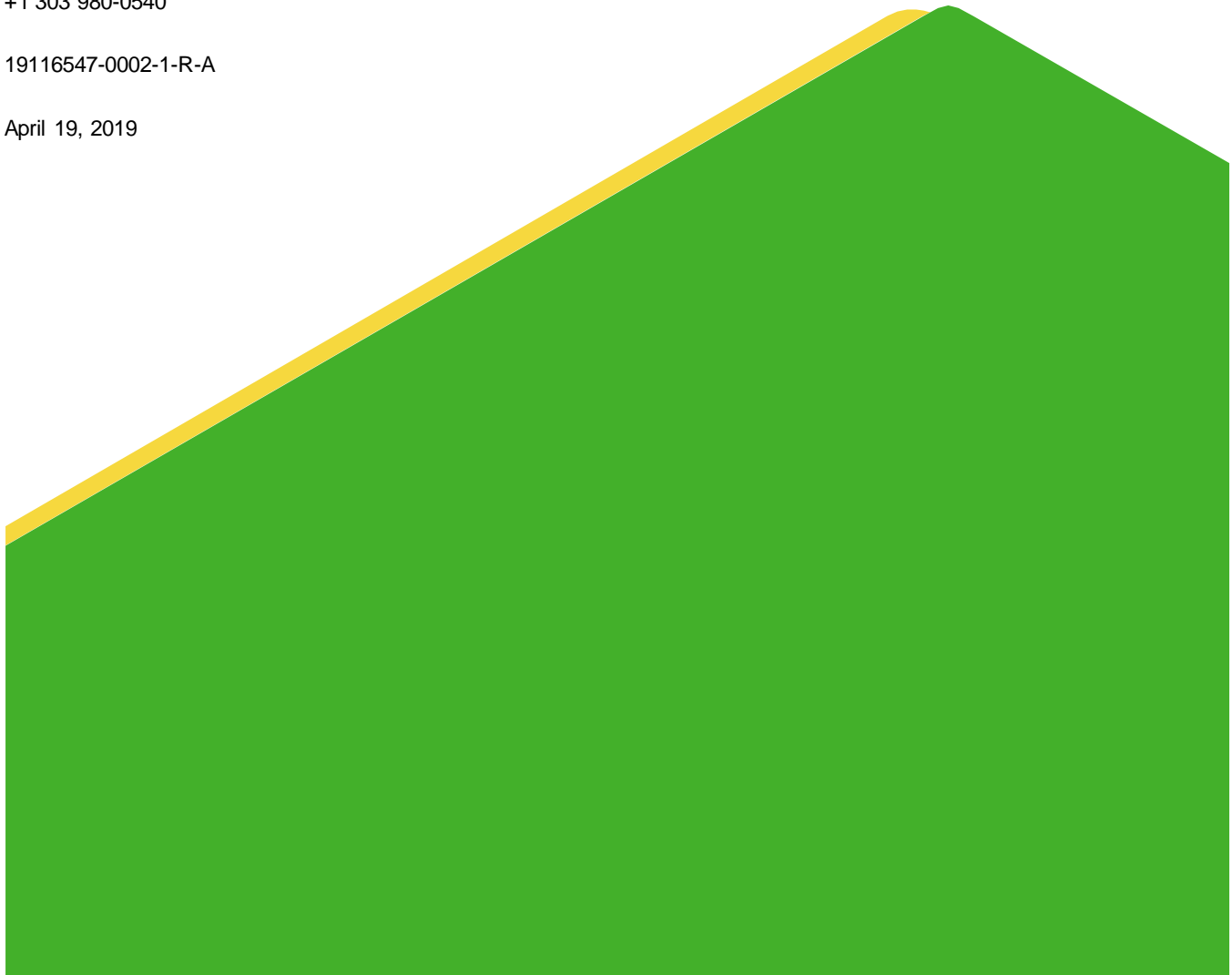
Golder Associates Inc.

44 Union Boulevard, Suite 300, Lakewood, Colorado 80228

+1 303 980-0540

19116547-0002-1-R-A

April 19, 2019



Distribution List

Nebraska Public Power District

Golder Associates Inc.

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FIGURES

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Figure 2: Groundwater Monitoring Well Water Levels

Figure 3: Piper Diagram of Groundwater and Potential Fluoride Sources

Figure 4: Ternary Diagram of Groundwater and Potential Fluoride Sources

Figure 5: Conceptual Site Model

APPENDICES**APPENDIX A**

Historical Concentrations of Appendix III Analytes and Selected Appendix IV Analytes

1.0 INTRODUCTION

On behalf of Nebraska Public Power District (NPPD), Golder Associates Inc. (Golder) performed a statistical evaluation of groundwater analytical results from the fourth quarter groundwater detection monitoring event of 2018 at Gerald Gentleman Station (GGS or Site) ash landfill (or CCR Unit), located at 6089 South Highway 25, Sutherland, Lincoln County, Nebraska (See Figure 1). The statistical evaluation was performed in accordance with applicable provisions of 40 Code of Federal Regulations (CFR) Part 257, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals (CCR) from Electric Utilities; Final Rule" (CCR Final Rule), as amended, and corresponding regulations under Nebraska Administrative Code (NAC) Title 132, Chapter 7 (Integrated Solid Waste Management Regulations, Groundwater Monitoring and Remedial Action).

Statistical analyses of the Appendix III detection monitoring data for fluoride in groundwater at the downgradient monitoring well APMW-19 indicated a potential exceedance of the non-parametric Upper Prediction Limit (UPL) in the Q2 2018 sampling results, which were subsequently verified as evidence of a statistically-significant increase (SSI) after the Q4 2018 event. Although determination of an SSI generally indicates that the groundwater monitoring program should transition from detection monitoring to assessment monitoring, 40 CFR §257.94(e)(2) allows the owner or operator (i.e., NPPD) 90 days from the date of determination (January 25, 2019) to demonstrate a source other than the CCR unit or another condition caused the potential SSI for fluoride at APMW-19.

Golder's initial review of the hydrological and geologic conditions at the Site indicated the potential for the SSI to have resulted from a source other than the CCR unit. To assess potential fluoride sources and the natural variability of fluoride concentrations in groundwater, NPPD collected and analyzed CCR source materials and groundwater samples. Based upon this assessment and in accordance with provisions of the CCR Final Rule, Golder prepared this Alternative Source Demonstration (ASD) for the CCR unit. This ASD includes an evaluation of geological, hydrogeological, and chemical information regarding ash and groundwater obtained from an ash boring and monitoring wells installed within and adjacent to the CCR Unit.

This ASD conforms to the requirements of 40 CFR §257.94(e)(2) and provides the basis for concluding that the apparent SSI is not a result of a release from the CCR Unit. The following sections provide a summary of the GGS CCR Unit, sampling procedures and analytical methods, analytical and geochemical assessment results, a Conceptual Site Model, and lines of evidence demonstrating an alternative source is responsible for the fluoride SSI.

2.0 BACKGROUND

2.1 Description of Waste Disposal Area

The ash landfill at GGS is located southwest of the plant's generation facility, in the northern one-half of Section 30, Township 13N, Range 33W. The ash disposal facility consists of Ash Landfill Nos. 1, 2, 3, and 4 and the bottom ash landfill. Ash Landfill Nos. 1 and 2 are closed, and Ash Landfill Nos. 3 and 4 are active (see Figure 1). The bottom ash landfill was closed in October 2018.

Fly ash is currently disposed at Ash Landfill No. 4 and in the east cell of Ash Landfill No. 3. The liner design at Ash Landfill No. 4 consists of 60-mil high density polyethylene (HDPE) geomembrane over compacted subgrade. Prior to geomembrane installation, the existing subgrade was scored to a depth of at least 6 inches and compacted to 95 percent of its maximum dry density (standard Proctor). Smooth HDPE geomembrane was placed on the bottom of the ash landfill and textured HDPE geomembrane was placed on the side slopes.

Construction quality assurance (CQA) for the geomembrane installation was performed by Golder Construction Services and completed on November 15, 1994. There is no Leachate Collection System (LCS) at Ash Landfill No. 4.

The original liner at Ash Landfill No. 3 consisted of 2 feet of soil compacted to 95 percent of the standard Proctor maximum dry density. The average permeability of the liner was 1.2×10^{-8} cm/sec. Ash Landfill No. 3 was previously closed in 1995 with 2.0 to 7.5 feet of soil cover. This cover was removed and the historically placed CCR was covered with a new liner in 2015. The new liner system at Ash Landfill No. 3 consists of a prepared subgrade overlain by a geosynthetic clay liner (GCL) and 60-mil linear low-density polyethylene (LLDPE) geomembrane. Ash Landfill No. 3 also has a 1-foot LCS sand layer that reports to two sumps. Construction of the new Ash Landfill No. 3 liner system was completed in November 2015.

To the east of the ash landfill, plant process water, such as boiler blowdown, is managed in a 50-acre evaporation pond, as shown in Figure 1. The bottom of the evaporation pond consists of re-compacted native soils.

2.2 Site Geology

The geologic sequence near the ash landfill was summarized by Woodward-Clyde in 1991. In the report, nine boreholes (APMW-1, APMW-2, APMW-3, APMW-4, APMW-5, EPMW-1, EPMW-2, EPMW-3, and EPMW-4) were used to characterize the site geology. The geologic sequence, from top to bottom, was described as follows:

- 4 to 5 feet of topsoil and/or fill
- 20 to 35 feet of eolian silty sands
- 8 to 10 feet of silty clay paleosol at the top of the Ogallala Formation
- 25 to 35 feet of Ogallala Formation silts
- Approximately 50 feet of Ogallala Formation sands or Ogallala Formation silts and clays, to the bottoms of the boreholes

The topsoil layer consists of stiff, dark brown, low to medium plasticity silty clay directly overlying the eolian silts and sands. Thickness of topsoil ranges from 0 to 4 feet. The fill material consists of stiff, dark brown, low plasticity sandy silty clay with trace gravel and other debris. Fill thickness ranges from 0 to 5 feet.

The eolian silts and sands (Quaternary Period) consist of loose to medium dense, tan, very fine-grained, well-rounded, and well-sorted sandy silts and silty sands. The thickness of this unit ranges from 17 feet (APMW-5) to 34 feet (EPMW-2). Materials with a bimodal texture (two distinct grain sizes) are present in the lower part of this unit. The eolian silts and sands are interpreted as wind-blown dune sand deposits.

The Ogallala Formation (Tertiary Period) was encountered in each of the nine boreholes at a depth beginning at 16 to 38 feet bgs and extending to the bottom of the boreholes (109 to 133 feet bgs). The Ogallala Formation near the ash landfill may be separated into three general stratigraphic units:

- Upper silty clay paleosol unit
- Middle clayey or sandy silt unit
- Lower unit of either predominantly sand and gravel or an equivalent unit of predominantly silt and clay

The top of the Ogallala Formation is represented by a widespread paleosol (a previous soil horizon) that consists of a very stiff, reddish-brown to buff, low plasticity, silty clay to clayey silt with abundant calcareous nodules, calcareous matrix, and interbedded layers of caliche up to one foot thick. The thickness of the initial paleosol is about 8 to 10 feet, but the presence of interbedded caliche layers continues into the middle and lower Ogallala units.

The middle Ogallala Formation unit consists of a stiff to very stiff, buff-white to reddish-brown, low plasticity, clayey silt to sandy silt with abundant calcareous nodules, matrix, and caliche layers. Scattered occurrences of calcareously cemented siltstone layers from ½ to 1 foot thick are present in the lower part of this unit. The thickness of this middle unit ranges from about 25 to 35 feet. The clayey silts and sandy silts of this unit were possibly deposited as overbank or floodplain deposits in an alluvial depositional system.

There are two distinct lithofacies recognized in the lower Ogallala Formation unit. This unit is present for about 45 to 50 feet in the borings. One lithofacies consists of dense to very dense, reddish-brown, fine-grained silty sands grading into medium- and coarse-grained, poorly-graded sands with some fine gravels and some calcareously cemented sandstone beds (½ to 1 foot thick). This lithofacies was primarily encountered in borings on the northern side of the ash landfill (APMW-1, APMW-2, APMW-5, and EPMW-1).

The second lithofacies recognized in the lower unit consists of stiff to hard, reddish-brown, low plasticity clayey or sandy silts with some calcareously-cemented siltstone beds. This lithofacies was encountered in borings on the southern side of the ash landfill (APMW-3, APMW-4, EPMW-2, EPMW-3, and EPMW-4).

The lithologic differences and areal distribution of the two lower units suggest that the units were deposited in two separate facies of an alluvial system. The sand and gravel unit is possibly a series of longitudinal bars, channels, and channel-fill deposits, while the silt and clay unit is possibly a series of upper channel fills, overbank, or floodplain deposits (Woodward-Clyde 1991).

2.3 Site Hydrology

Based on observations made during logging of soil borings and findings of the Nebraska Water Survey Paper No. 70 (Goeke et al. 1992), the unsaturated geologic units underlying the ash landfill area consist of topsoil (0 to 4 feet thick), eolian silts and sands (15 to 25 feet thick), Ogallala Formation silts (40 to 50 feet thick), and Ogallala Formation sands and gravels (unsaturated portion of this unit is approximately 20 to 25 feet thick). Beneath these units lies 10 feet or more of saturated Ogallala Formation sands and gravels. Based on the site observations, the thickness of the vadose zone ranges from approximately 90 to 100 ft.

The saturated geologic units underlying the ash landfill area consist of Ogallala Formation silts and sands that extend to the bottom of the aquifer. The Ogallala Formation is underlain by the White River Group, which is composed of the Brule and Chadron formations. The bedrock formations of the White River Group are not considered to be an important potential source of water, and therefore their surface is considered to form the base of the aquifer and is regarded as the lower drilling limit for irrigation wells in the agricultural region near the Site. Underlying the White River Group is the impermeable Pierre Shale (Goeke et al. 1992).

Available groundwater elevation data indicate that groundwater beneath GGS flows from north to south (Figure 1). The groundwater gradient is controlled by the Sutherland Reservoir, an approximately 3,200-acre open water body located 1.5 miles north of the ash landfill that is used as a source of condenser cooling water for GGS. Since groundwater level monitoring began in 1996, regular water level fluctuations have been observed in the monitoring wells located around the ash landfill. These fluctuations are attributed to seasonal trends in water

consumption or recharge and precipitation patterns. In Figure 2, which shows a time-series plot of historical water levels in each monitoring well, it is also apparent that long-term changes in water levels have occurred between 1996 and 2019. In general, water levels rose by approximately 1.5 feet between 1996 and 2000, before declining by between 9 to 10 feet between 2000 and 2009. The cause of the decline is not clear, but possible explanations include a regional response to the drought being experienced by parts of the western United States and/or a change in the amount of groundwater used for irrigation in the area around the Site. Between 2009 and 2019 water levels have continued to show seasonal variability, with seasonal maximums occurring in the spring and seasonal minimums occurring in the fall, but there is no apparent long-term increasing or decreasing trend.

2.4 Groundwater Monitoring Network

Design of the CCR Final Rule-compliant ash landfill monitoring program considered the size, disposal and operational history, anticipated groundwater flow direction, and saturated thickness of the uppermost aquifer. Based on these factors, a monitoring well network that consists of four background monitoring wells and ten downgradient monitoring wells was installed around the ash landfill, the monitoring wells are listed in Table 1 and presented in Figure 1.

Table 1: Monitoring Well Network

Location	Background Monitoring Wells	Downgradient Monitoring Wells
Ash Landfill	APMW-5, APMW-15, APMW-16A, APMW-17	APMW-4, APMW-6, APMW-8A, APMW-10, APMW-11, APMW-12, APMW-13, APMW-14, APMW-18, APMW-19

The four upgradient monitoring wells included in the groundwater monitoring program are used to represent the background water quality, including its potential variability. The ten downgradient wells were installed along the western, southern, and eastern boundaries of the active CCR landfill. The depths of the monitoring wells were selected such that the monitoring wells are screened in the Ogallala Formation to yield groundwater samples that are representative of water quality in the uppermost aquifer.

2.5 Groundwater Conditions

Between December 2015 and June 2017, NPPD collected eight quarterly independent baseline groundwater samples from each of the background and downgradient monitoring wells listed in Table 1, as required by 40 CFR §257.94. The results of the baseline monitoring phase were used to develop appropriate and statistically valid baseline values for each constituent at each monitoring well (Golder 2017).

During the baseline monitoring period, fluoride concentrations were variable in the upgradient and downgradient groundwater, as shown in Appendix A, Figures A5 and A6. The fluoride concentrations in the upgradient and downgradient groundwater appear to peak seasonally, with the highest annual concentrations typically occurring in the samples collected during the first quarter of the baseline monitoring period. Fluoride concentrations in upgradient groundwater (based on 28 samples from four wells) ranged from <0.5 to 1.21 mg/L between December 2015 and June 2017. Downgradient groundwater was also variable (based on 78 samples from 10 wells), with fluoride concentrations ranging from <0.1 to 21.3 mg/L.

Fluoride concentrations in groundwater at APMW-19 remained below the practical quantitation limit (PQL) of 0.5 mg/L in all eight samples collected during the baseline monitoring period. Based on there being no detections

of fluoride during the baseline monitoring period at APMW-19, the PQL of 0.5 mg/L was selected as the non-parametric UPL for fluoride at this monitoring well.

Following completion of the eight baseline monitoring events, NPPD started collecting groundwater samples on a semiannual basis in November 2017 to support the detection monitoring program. Groundwater samples for detection monitoring were collected at all four background and ten downgradient monitoring wells and analyzed for 40 CFR Part 257 Appendix III constituents. During the detection monitoring program, the results of groundwater analysis are compared to the calculated prediction limits to determine whether groundwater quality remains consistent, or if changes are considered statistically significant increases (SSI).

The Q2 2018 detection monitoring event reported a fluoride concentration of 0.665 mg/L in groundwater at APMW-19, which exceeded the calculated UPL of 0.5 mg/L. Verification sampling was completed in November 2018 (i.e., Q4 2018) and the results confirmed the SSI for fluoride at APMW-19 with a fluoride concentration of 0.626 mg/L (Golder 2019).

2.6 Review of Sampling and Laboratory Testing Procedures

As part of the ASD, a review was conducted of the sampling and laboratory testing procedures used throughout baseline monitoring and detection monitoring to date, along with the collected results. Golder found that the analytical methodologies used were consistent with the stated objectives of the sampling program. The reporting limits used by the analytical laboratory indicated that while some non-detect results (i.e., results that were less than the PQL) had been reported with dilutions, the specified reporting limits were consistent throughout the monitoring program and accounted for dilutions. No anomalies were found within the sampling and laboratory testing procedures and the collected results are considered valid.

Additionally, a review of the statistical assessment methods and associated results found the procedures followed during baseline and detection monitoring to be consistent with the stated procedures listed in the published Groundwater Monitoring Statistical Methods Certification (Golder 2017). Calculated limits were found to be consistent with the chosen statistical procedures and recommended methodology found within the Unified Guidance (EPA 2009).

3.0 SAMPLING PROCEDURES AND ANALYTICAL METHODS

To assess groundwater downgradient of the GGS CCR facilities and collect data to support an ASD for fluoride, Golder and NPPD GGS staff performed supplemental assessment activities between January 20 and February 20, 2019. The following sections summarize the supplemental assessment activities.

3.1 Source Material Assessment

To characterize the potential for the material in the ash landfill to release fluoride, Golder retrieved an archived ash sample that was collected in a Shelby tube from historically placed CCR from ash pit 3, BH-1 at a depth of 15 feet below ground surface during drilling support for the 2015 Ash Landfill No. 3 liner construction. This sample was stored in a sealed, dry condition between collection and analysis.

Short-term leach testing of the ash sample by the synthetic precipitation leaching procedure (SPLP) was performed by a modified version of EPA Method 1312 (EPA 2008), in which a 4:1 leachate to ash ratio was used. The SPLP simulates the interaction between a solid and meteoric water, which provides a screening-level estimate of ash effluent water quality. The leachate sample produced by the SPLP was analyzed for fluoride and other parameters, as described in Section 3.3.

3.2 Groundwater and Surface Water

3.2.1 Sample Collection

NPPD GGS field personnel collected groundwater and evaporation pond surface water samples on February 20, 2019. Groundwater samples were collected from a subset of GGS monitoring wells, including: APMW-4, APMW-5, APMW-8A, APMW-12, APMW-14, APMW-17, APMW-18, and APMW-19 (Figure 1).

Groundwater and evaporation pond surface water samples were analyzed for field parameters, major cations, major anions, and selected dissolved metals.

3.3 Geochemical Analysis

The geochemical analysis of the ash SPLP leachate, groundwater, and surface water samples included fluid parameters, major cations and anions, and dissolved metals. The methods selected for these analyses are summarized below.

Major Cations and Anions/Field Parameters: Geochemical modeling of mineral solubility, metal attenuation and background contributions required analysis of major cations and anions because they affect and participate in sorption and mineral dissolution/precipitation reactions. Field parameters included pH, conductivity, and temperature.

Metals: Metals analyses (i.e., Appendix III and IV) are important to understand the geochemical properties of groundwater. For the ash SPLP leachate, metal results can be used for geochemical modeling and provide an indication of the leachable fraction of the solids (ITRC 2012). For groundwater, metals analysis allows for the delineation of a potential plume, and identification of background contributions from natural sources or off-site locations.

The laboratory analyzed SPLP leachate, groundwater and evaporation pond surface water using the following methods:

- Alkalinity following Standard Method (SM) 2320B Alkalinity by Titration (2005)
- Chloride, fluoride, and sulfate following USEPA SW846 9056A Determination of Inorganic Anions by Ion Chromatography Revision 1 (February 2007)
- pH following SM 4500 H⁺ B (2017)
- Arsenic, boron, barium, calcium, magnesium, molybdenum, potassium, selenium, and sodium following USEPA SW-846 6020A (November 2004)
- Ammonia following USEPA 350.1 Determination of Ammonia Nitrogen by Automated Colorimetry, Revision 2 (August 1993)
- Total Kjeldahl Nitrogen following USEPA 351.2 Determination of Total Kjeldahl Nitrogen by Semi-Automated Colorimetry, Revision 2 (August 1993)
- Total Nitrate-Nitrite Nitrogen following USEPA 353.2 Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry, Revision 2 (August 1993)

- Fluoride following SM 4500-F-C (2017)
- Dissolved Silica following SM4500-SiO₂-C Silica, Molybdosilicate Method (2017)

4.0 RESULTS OF SUPPLEMENTAL TESTING

4.1 Water Quality

Historical concentrations of Appendix III analytes and selected Appendix IV analytes to identify potential CCR seepage impacts (i.e., arsenic, barium, molybdenum, and selenium) are presented in time series plots in Appendix A. The plots include the results of the supplemental sampling that was conducted in support of the ASD. Sampling for the Appendix IV elements concluded with the end of baseline monitoring in Q2 2017, which means there is a gap of six quarters in the data plots until the supplemental sampling results are shown in Q1 2019.

A Piper diagram that shows the relative major ion chemistry for the supplemental groundwater and ash SPLP leachate samples is presented in Figure 3. The groundwater at the upgradient monitoring wells (APMW-5 and APMW-17) was dominated by calcium and bicarbonate. Samples from the downgradient monitoring wells APMW-4, APMW-8A, APMW-18, APMW-19 (i.e., the well with an SSI for fluoride), and APMW-14 were also majority calcium and bicarbonate. The downgradient well APMW-12 was the only well where the major ion composition was dominated by calcium and sulfate. The ash SPLP leachate and evaporation pond were both dominated by sodium and sulfate.

The fluoride concentrations in the supplemental groundwater samples were generally lower than the results from the Q4 2018 sampling event. The supplemental groundwater samples were analyzed with a lower PQL (0.1 mg/L) than previous baseline and detection monitoring (0.5 mg/L). Based on this lower PQL, the fluoride concentration at APMW-19 was observed at 0.158 mg/L, which is roughly one quarter the levels (0.665 mg/L in Q2 2018, and 0.626 mg/L in Q4 2018) that triggered the SSI. Upgradient well APMW-5 had fluoride concentrations in Q1 2019 that remained generally unchanged compared to the 2018 sampling events. Fluoride concentrations in groundwater at the rest of the upgradient and downgradient monitoring wells ranged from 0.10 to 0.25 mg/L, which are less than half of the PQL or detectable values that were reported in historical data. Given the concentrations of many other parameters (e.g., boron and sulfate) were detected at similar concentrations between the historical monitoring results and the Q1 2019 samples, it is possible that the changes in fluoride concentrations, which are relatively small on an absolute basis (i.e., changes of less than 0.5 mg/L), may be explained by seasonal changes in groundwater quality that preferentially affected the source(s) of fluoride and/or the factors that influence its solubility in groundwater.

The fluoride concentration in the evaporation pond was 0.584 mg/L during the Q1 2019 sampling. In the ash SPLP leachate the fluoride concentration was 1.52 mg/L.

4.2 Data Usability

Golder validated the groundwater data generated as part of the CCR monitoring program in accordance with the National Functional Guidelines for Inorganic Data Review (EPA 540-R-013-001, August 2014). All data included in this report have been accepted or qualified on the basis of specific QC criteria as described in the Coal Combustion Residuals Landfill Groundwater Monitoring System Certification (Golder 2017).

5.0 DATA EVALUATION AND FINDINGS

5.1 Potential Fluoride Sources

Several potential sources, other than the active CCR units, can contribute to fluoride to local groundwater at GGS, including outflows from the Sutherland Reservoir into regional groundwater, mineral dissolution from apatite and volcanic glass present in the aquifer, seepage from the Evaporation Pond, and seepage from historical deposits of fly ash that remain at GGS.

5.1.1 Regional Groundwater from Sutherland Reservoir

As described in Section 2.3, the groundwater gradient in the area around the ash landfill shows groundwater flows from north to south, rather than from south to north in the direction of the Platte River. The groundwater flow direction appears to be based on both the groundwater recharge provided by the Sutherland reservoir to the north of GGS, and groundwater extraction by irrigation wells located south of GGS that are pumped seasonally and used to support local agriculture.

The Sutherland Reservoir is fed by the Sutherland Canal, which delivers water from both the North and South Platte River for use as condenser cooling water at GGS. While the water quality of the Sutherland Reservoir has not been analyzed regularly, the USGS monitored South Platte river chemistry by collecting 69 samples between 1993 and 1995 as part of the National Water-Quality Assessment Program. Fluoride concentrations in the South Platte River upstream of the Sutherland Canal intake (near Balzac, CO) ranged from 0.6 to 1.1 mg/L. Fluoride concentrations in the South Platte River downstream of the Sutherland Reservoir (near the confluence of the North Platte River) ranged from 0.5 to 0.8 mg/L. The USGS also characterized surface waters along the North Platte River in 1993, by collecting nine samples upstream of the Sutherland Canal intake near Lisco, NE. The fluoride concentrations in the North Platte River water ranged from 0.4 mg/L to 0.6 mg/L. While the relative proportions of North and South Platte River waters flowing into the Sutherland Reservoir may vary seasonally, fluoride concentrations in both sources are consistent with the results of baseline groundwater monitoring at the background monitoring wells (<0.5 to 1.21 mg/L between December 2015 and June 2017), which are located upgradient of the CCR unit and are influenced by regional groundwater, and the fluoride concentrations measured at APMW-19 (0.665 mg/L in Q2 2018 and 0.626 mg/L in Q4 2018), which compared to the UPL (0.5 mg/L) for this well, triggered an SSI.

5.1.2 Apatite and Volcanic Glass

Geochemical interactions between groundwater and minerals in the aquifer cause groundwater to equilibrate with soluble minerals and eventually assume a water type that is indicative of the aquifer. Based on a literature review of Nebraska groundwater quality, which included the Gosselin et al. 1999 publication, Fluoride in Nebraska's Ground Water, there is evidence of naturally-occurring fluoride present in regional groundwater around GGS due to dissolution of minerals in the aquifer. According to Gosselin et al (1999), fluoride concentrations in shallow groundwater throughout the central to southwestern region of Nebraska range from 0.2 to 1.3 mg/L. Geochemical modeling results revealed that the majority of groundwater samples Gosselin et al (1999) collected from the Ogallala Formation were undersaturated or at equilibrium with respect to the accessory mineral apatite ($\text{Ca}_5\text{F}(\text{PO}_4)_3$). Apatite is a natural-occurring phosphate mineral that contains calcium, fluoride, and phosphate. In a separate study, Engberg and Spalding (1978) provide further evidence of apatite as a source of fluoride in the regional groundwater, particularly near the South Platte River. The groundwater samples with the highest fluoride concentrations exhibited a positive correlation with higher phosphate concentrations.

In addition to apatite, other mineral sources of fluoride are present in the Ogallala Formation. Gosselin et al. (1999) found eight groundwater samples were oversaturated with respect to apatite (i.e., concentrations of calcium, fluoride, and phosphate were present at a level at which apatite precipitation would be expected to occur) and theorized that another fluoride source mineral may be present in the aquifer. Volcanic glass from tephra, which was produced by historical eruptions that deposited volcanic debris across western Nebraska between 16.5 and 5 million years ago (Perkins et al. 2014), was identified as an additional potential source of fluoride through the characteristic ratios of the sodium and fluoride (Na/F) and potassium and fluoride (K/F) ions in groundwater.

5.1.3 Evaporation Pond

Although the evaporation pond is located to the east of APMW-19, and side-gradient in terms of groundwater flow (i.e., any seepage from the evaporation pond would not likely be detected at monitoring well APMW-19), evaporation pond water quality is described in this section as it contains water related to GGS plant operations. Groundwater quality at the three downgradient monitoring wells located around the evaporation pond (i.e., APMW-12, APMW-13, and APMW-14) indicates that process water discharged from the GGS plant and stored in the evaporation pond has migrated to groundwater. Historical concentrations of boron (Figure A1), chloride (Figure A4), sulfate (Figure A9), and TDS (Figure A10), elements that are typically associated with CCR, were detected at elevated levels at the three monitoring wells closest to the evaporation pond compared to the background monitoring wells.

Based on the slight differences in water quality between the groundwater at the monitoring wells APMW-12, APMW-13 and APMW-14 and the evaporation pond, mixing between the evaporation pond water and the upgradient groundwater likely occurs and groundwater at the monitoring wells is not entirely composed of seepage from the evaporation pond. This mixing reaction is supported by the Piper diagram in Figure 2, which shows samples from monitoring wells APMW-12 and APMW-14 plot on a mixing line between the evaporation pond and background groundwater end-member data points.

The fluoride concentration in evaporation pond water was 0.584 mg/L during the Q1 2019 sampling. Given the fluoride concentration in the evaporation pond was only slightly higher than the PQL for groundwater analysis, it appears that fluoride present in seepage from the evaporation pond was generally not detected in the groundwater.

Based on the similarities in water quality between the evaporation pond and adjacent groundwater monitoring wells, the evaporation pond is considered a potential source of fluoride at a low concentration to groundwater at GGS. However, it is unlikely the evaporation pond had any effect on groundwater quality at APMW-19, which is side gradient to groundwater flow underneath the CCR unit (Figure 1).

5.1.4 Historical Ash Landfills

Historical deposits of fly ash present at GGS in historic soil-lined landfill cells may release soluble constituents to groundwater as the seepage generated by infiltrating precipitation interacts with the ash. While it was not feasible to collect a sample of this seepage directly, the leachate from an ash sample collected and tested by Golder (method described in Section 3.1 and results described in Section 4.1) contained 1.52 mg/L fluoride, showing the ash is a potential fluoride source. However, the results of the SPLP testing should only be considered indicative of a potential fluoride source because it is difficult to directly compare the concentrations of fluoride in laboratory-generated leachate to the concentrations of fluoride in groundwater samples because the properties of the leaching test are different to the site (e.g., type of leaching solution, ratio of solid to liquid, and contact time).

SPLP leachate chemistry can be compared to groundwater data using ternary diagrams and cross plots of ion ratios, which reveal relative differences in concentrations. The ternary plot comparing sodium, calcium, and sulfate (Figure 4) reveals SPLP leachate from fly ash has higher relative sodium and sulfate abundances and lower relative calcium abundance compared to the upgradient and downgradient groundwater. If infiltrating precipitation was leaching fluoride from the fly ash, the relative concentrations of sodium, sulfate, and calcium in the groundwater would be more similar to the SPLP leachate of the fly ash, but this was not observed.

6.0 EVIDENCE OF AN ALTERNATIVE SOURCE

Based on the testing results and list of potential alternate sources of fluoride presented in this report, primary lines of evidence and conclusions drawn from the evidence used to support this ASD are provided in Table 2.

Table 2: Primary Lines of Evidence and Supporting ASD Analysis

Key Line of Evidence	Supporting Evidence	Description
Primary CCR Indicators	Boron and sulfate concentrations in groundwater	<p>Boron (Figure A1) and sulfate (Figure A9) are primary CCR indicators that occur at high concentrations in SPLP leachate generated from a fly ash sample.</p> <p>All upgradient and downgradient CCR unit monitoring wells, with the exception of monitoring wells near the evaporation pond that may be influenced by process waters, have boron concentrations below the PQL (typically <0.2 mg/L). Similarly, sulfate concentrations do not correlate with historical fluoride concentrations (Figure A5), which means that the two elements are unlikely to originate from the same source materials or that their concentrations are controlled by the same geochemical processes.</p>
Groundwater Geochemistry	Relative ion abundance differs from ash SPLP leachate	As presented in the Piper plot (Figure 3), relative differences in major ion concentrations show distinct differences between the ash SPLP leachate and the downgradient groundwater samples, including groundwater from APMW-19. The geochemical properties of the downgradient groundwater samples are not consistent with seepage from the CCR unit.
	Elevated and variable fluoride concentrations in background monitoring wells	In certain downgradient and upgradient wells, seasonal variability is observed in fluoride concentrations. In addition, fluoride concentrations in groundwater at background monitoring well APMW-5 were elevated above fluoride concentrations at monitoring well APMW-19 three times during the baseline monitoring period, as well as in Q2 2018 and Q1 2019. Since the CCR unit cannot influence the fluoride groundwater concentrations in the upgradient wells, the only explanation is that there is an alternate source of fluoride present.
Local Sources of Fluoride	Regional groundwater fluoride concentrations	Endberg and Spalding (1978) shows that that fluoride concentrations in groundwater near the South Platte River were greater than 1 mg/L. Additional work by Gosselin et al. 1999 also found regional groundwater fluoride concentrations ranged from 0.2 to 1.3 mg/L near GGS.

Key Line of Evidence	Supporting Evidence	Description
	Hydrogeology	The North and South Platte Rivers, which are ultimately the source of groundwater recharge from the Sutherland Reservoir located approximately 1.5 miles north of the ash landfill, have fluoride concentrations between 0.4 and 1.1 mg/L.
	Apatite and Volcanic Glass Weathering	Gosselin et al. (1999) found naturally-occurring fluoride (at concentrations of 0.2 to 1.3 mg/L) in regional groundwater around GGS was controlled by the weathering of apatite and volcanic glass. Local dissolution of apatite and/or volcanic glass around the ash landfill could explain the concentrations of fluoride detected in groundwater at both upgradient and downgradient wells and explain the SSI at monitoring well APMW-19.

7.0 CONCEPTUAL SITE MODEL

Golder developed a conceptual site model (CSM) that is presented graphically in Figure 5 to help frame and support the ASD assessment approach. The CSM presents the GGS site layout, a summary of the geologic and hydrogeologic information, and a discussion of groundwater monitoring data, which together lays the groundwork for consideration and development of the ASD. Additionally, the CSM summarizes the findings of literature research that suggest certain naturally-occurring groundwater conditions and mineral weathering reactions observed in Nebraska are present at the site and contribute to naturally elevated fluoride concentrations in groundwater around the ash landfill.

8.0 CONCLUSION

In accordance with §257.95(g)(3), this ASD has been prepared in response to the identification of an SSI for fluoride at monitoring well APMW-19 following the November 2018 sampling event for the ash landfill at Gerald Gentleman Station.

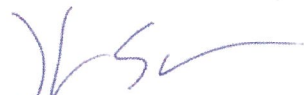
Supplemental sampling and review of historical analytical results indicate that the fluoride concentrations in groundwater at APMW-19 are not the result of seepage from the ash landfill but can be attributed to naturally-occurring fluoride from regional groundwater and the weathering of fluoride-rich materials in the Ogallala aquifer. Therefore, no further action (i.e., transition to Assessment Monitoring) is warranted, and the Gerald Gentleman Station ash landfill will remain in detection monitoring.

9.0 REFERENCES

- Engberg, R.A., and R.F. Spalding. 1978. Groundwater quality atlas of Nebraska. Nebraska Conservation and Survey Division University of Nebraska: Resource Atlas, (3).
- EPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. EPA 530-R-09-007, March.
- EPA. 2014. National Functional Guidelines for Inorganic Data Review. EPA 540-R-013-001, August.
- Goeke, J.W., J.M. Peckenpaugh, R.E. Cady, and J.T. Dugan. 1992. Hydrogeology of Parts of the Twin Platte and Middle Republican Natural Resources Districts, Southwestern Nebraska, Nebraska Water Survey Paper No. 70, Conservation and Survey Division, University of Nebraska-Lincoln, 89 pp.
- Golder Associates Inc. 2017. Coal Combustion Residuals Landfill Groundwater Monitoring System Certification, Nebraska Public Power District Gerald Gentlemen Station, Sutherland, Nebraska.
- Golder Associates Inc. 2019. 2018 Annual Groundwater Monitoring Report, Nebraska Public Power District Gerald Gentlemen Station, Sutherland, Nebraska.
- Gosselin, D.C., J. Headrick, F.E. Harvey, R. Tremblay, and K. McFarland. 1999. Fluoride in Nebraska's ground water. Groundwater Monitoring & Remediation, 19(2), 87-95.
- Perkins, M.E., R.F. Diffendal, M.R. Voorhies, and B.P. Nash. 2014. Ashfall Tephra in the Ogallala Group of the Great Plains: Characteristics and Significance. 48th Annual Meeting of the Geological Society of America: North-Central Section. Poster. April.
- Steele, G.V., Cannia, J.C., 1997. Reconnaissance of Surface-Water Quality in the North Platte Natural Resources District, Western Nebraska 1993. Water-Resources Investigations Report 96-4316. U.S. Geological Survey. Lincoln, Nebraska.
- Woodward-Clyde Consultants. 1991. Design and Construction of a Groundwater Monitoring Network, Final Report, Gerald Gentleman Station, Nebraska Public Power District, Sutherland, Nebraska, WCC Project No. 90MC176, Omaha, Nebraska, September.

Signature Page

Golder Associates Inc.



Jacob Sauer
Senior Engineer



Hugh Davies
Senior Geochemist

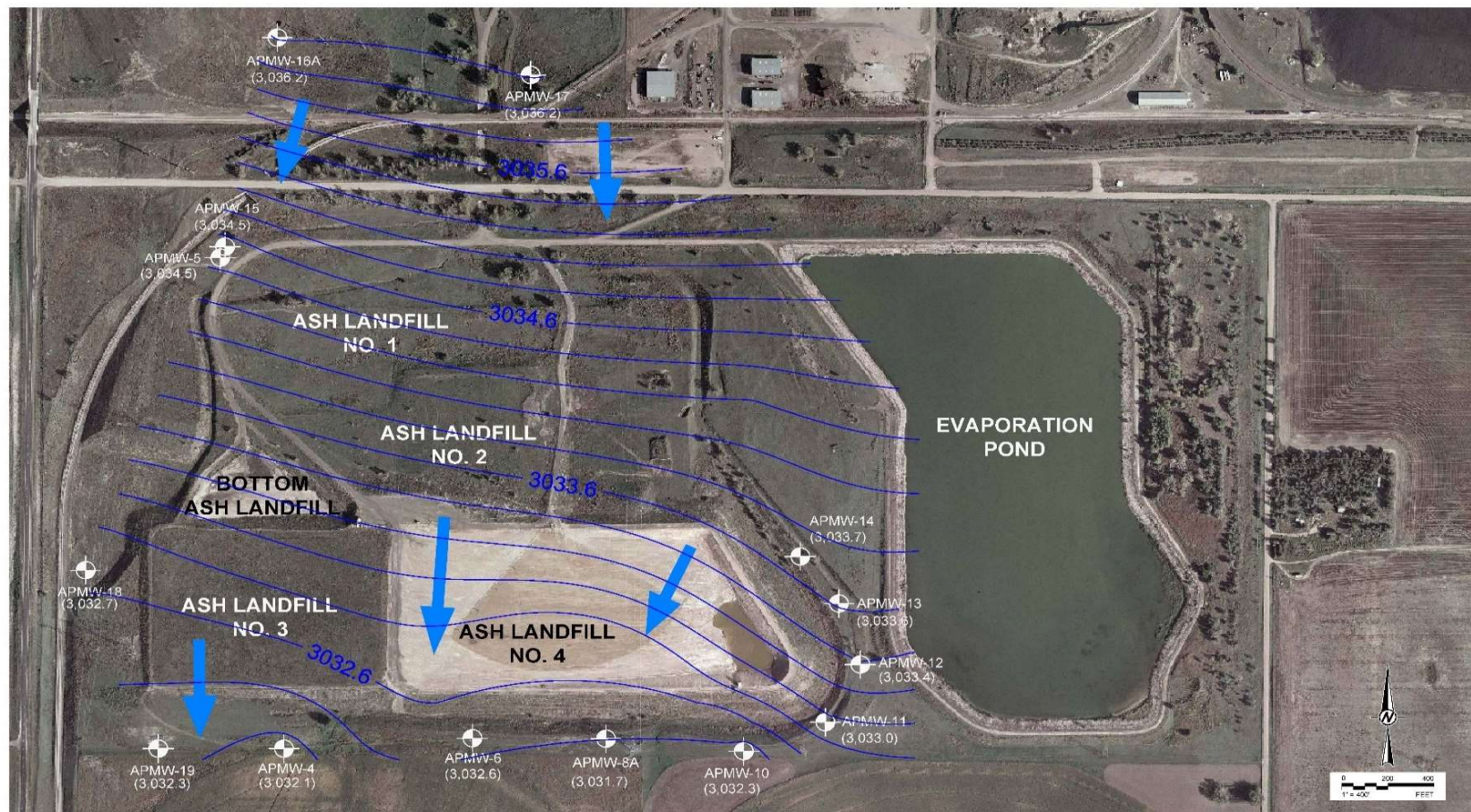


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Figures



NOTE
GROUNDWATER CONTOURS DEVELOPED FROM LEVELS MEASURED IN ACTIVE
MONITORING WELLS SHOWN AND LEVELS MEASURED IN INACTIVE WELLS.

Figure 1
Site Map with Groundwater Contours- November 2018

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

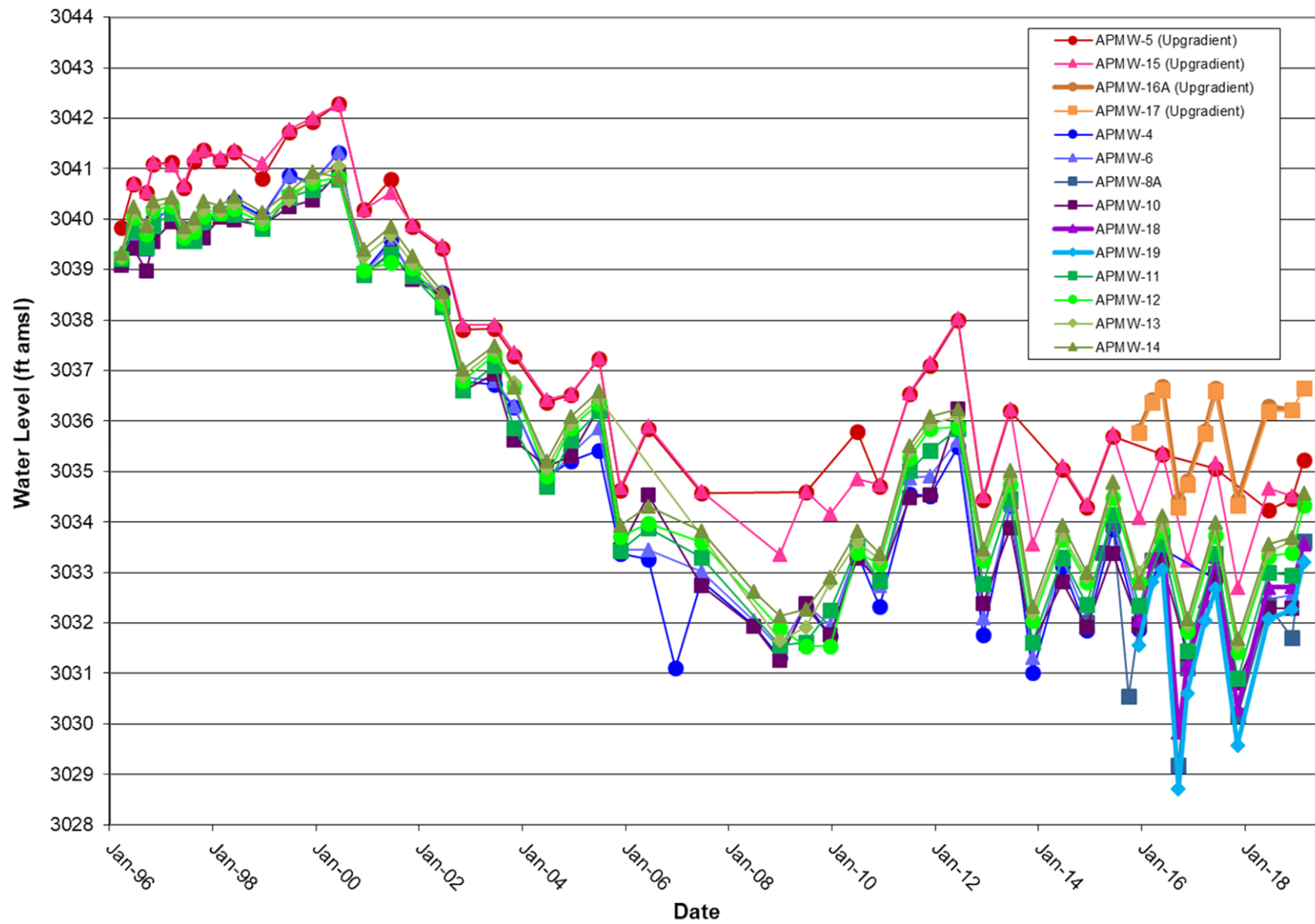


Figure 2
Groundwater Monitoring Well Water Levels
Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

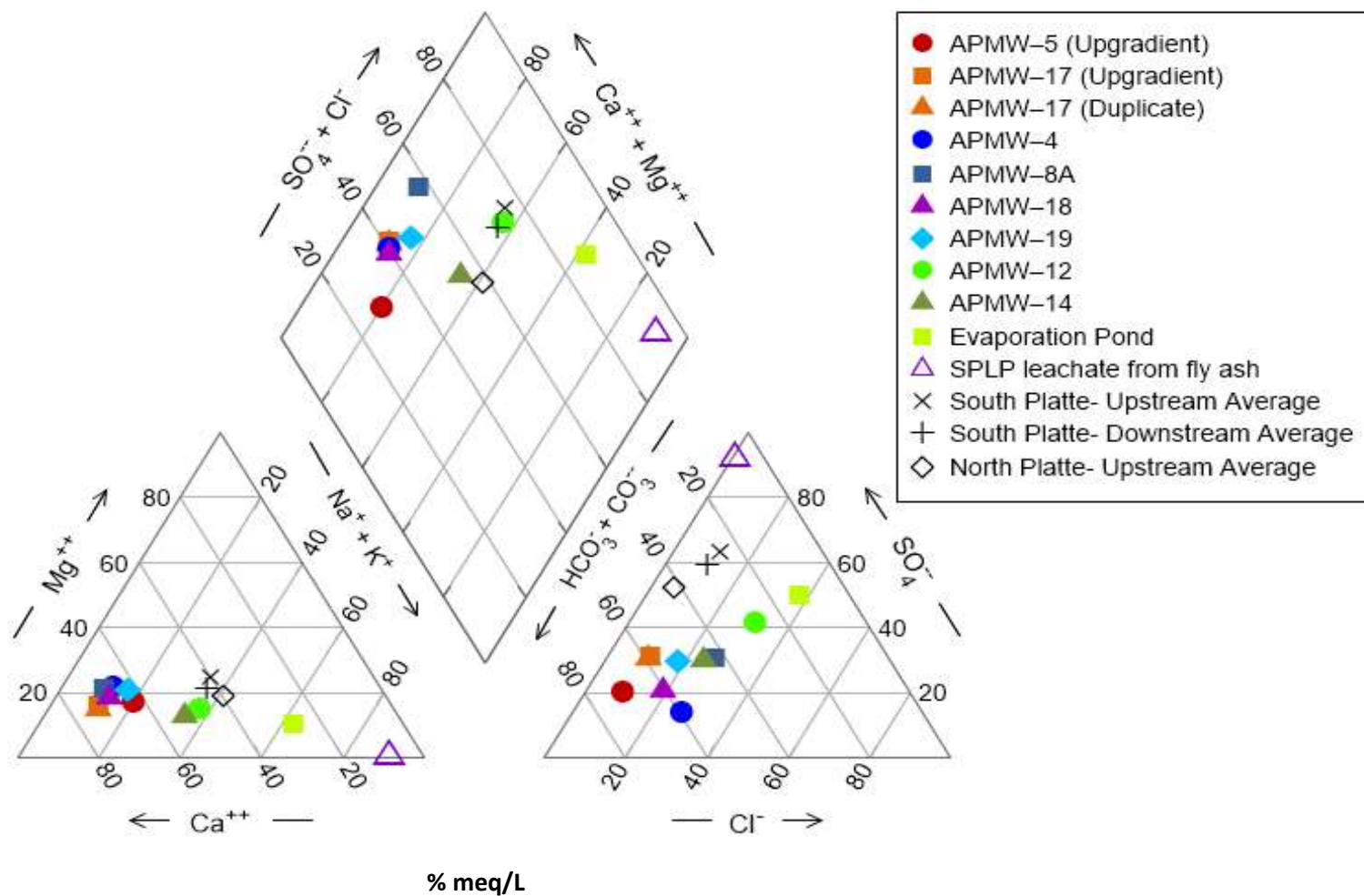


Figure 3
Piper Diagram of Groundwater and Potential Fluoride Sources

Alternate Source Demonstration
 Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

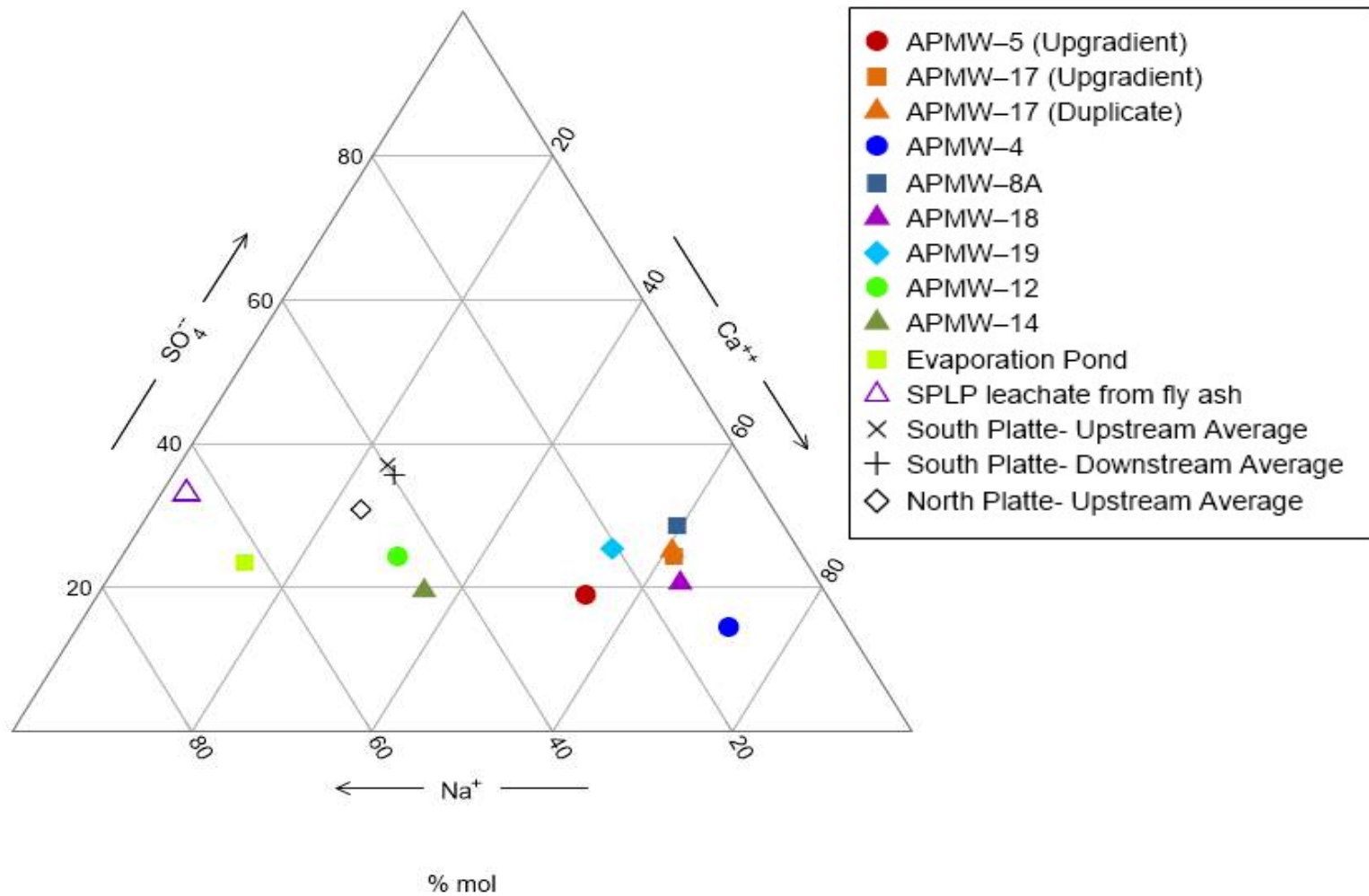


Figure 4
Ternary Diagram of Groundwater and Potential Fluoride Sources

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

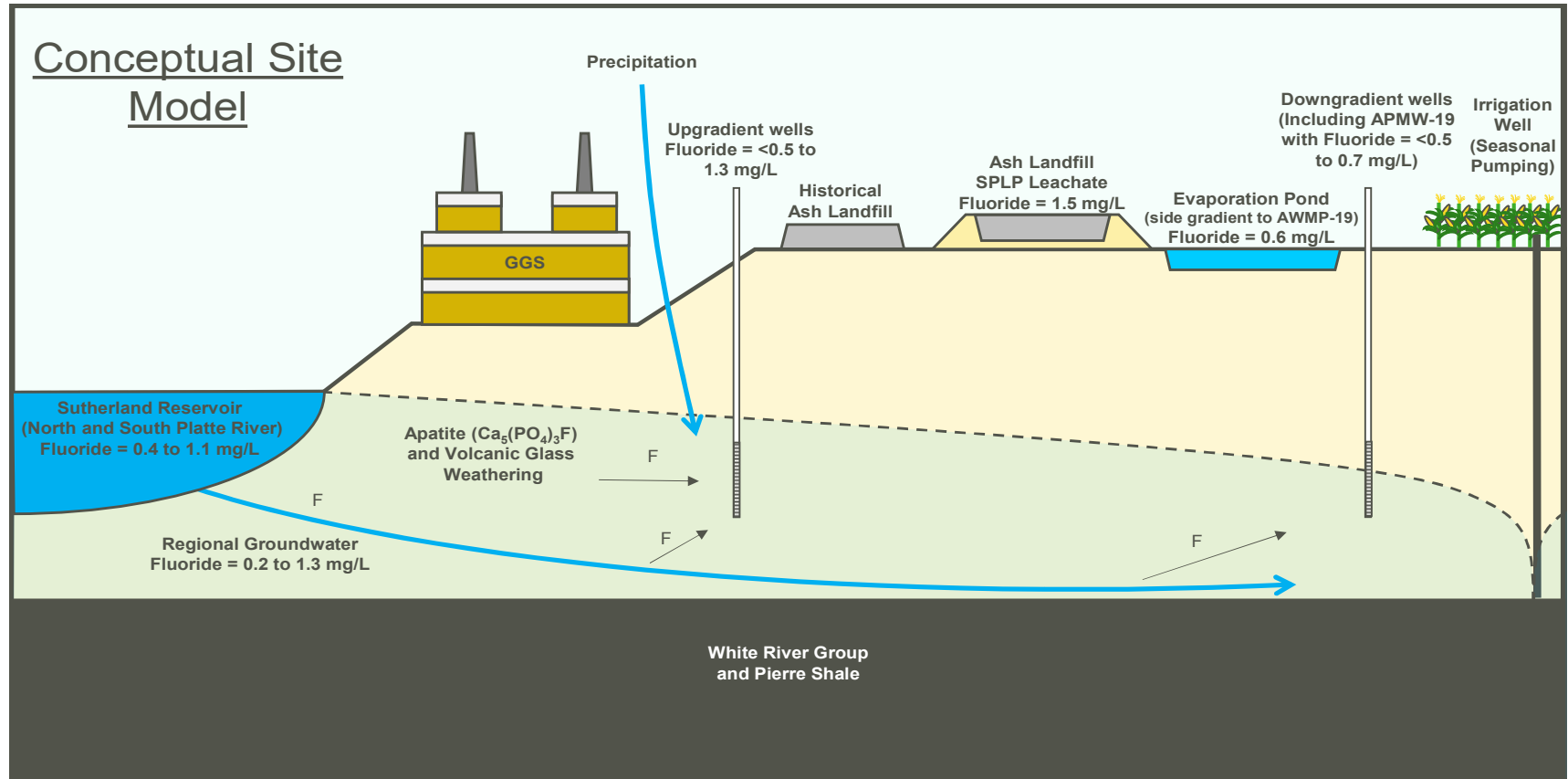


Figure 5
Conceptual Site Model

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

APPENDIX A

Historical Concentrations of Appendix III Analytes and Selected Appendix IV Analytes

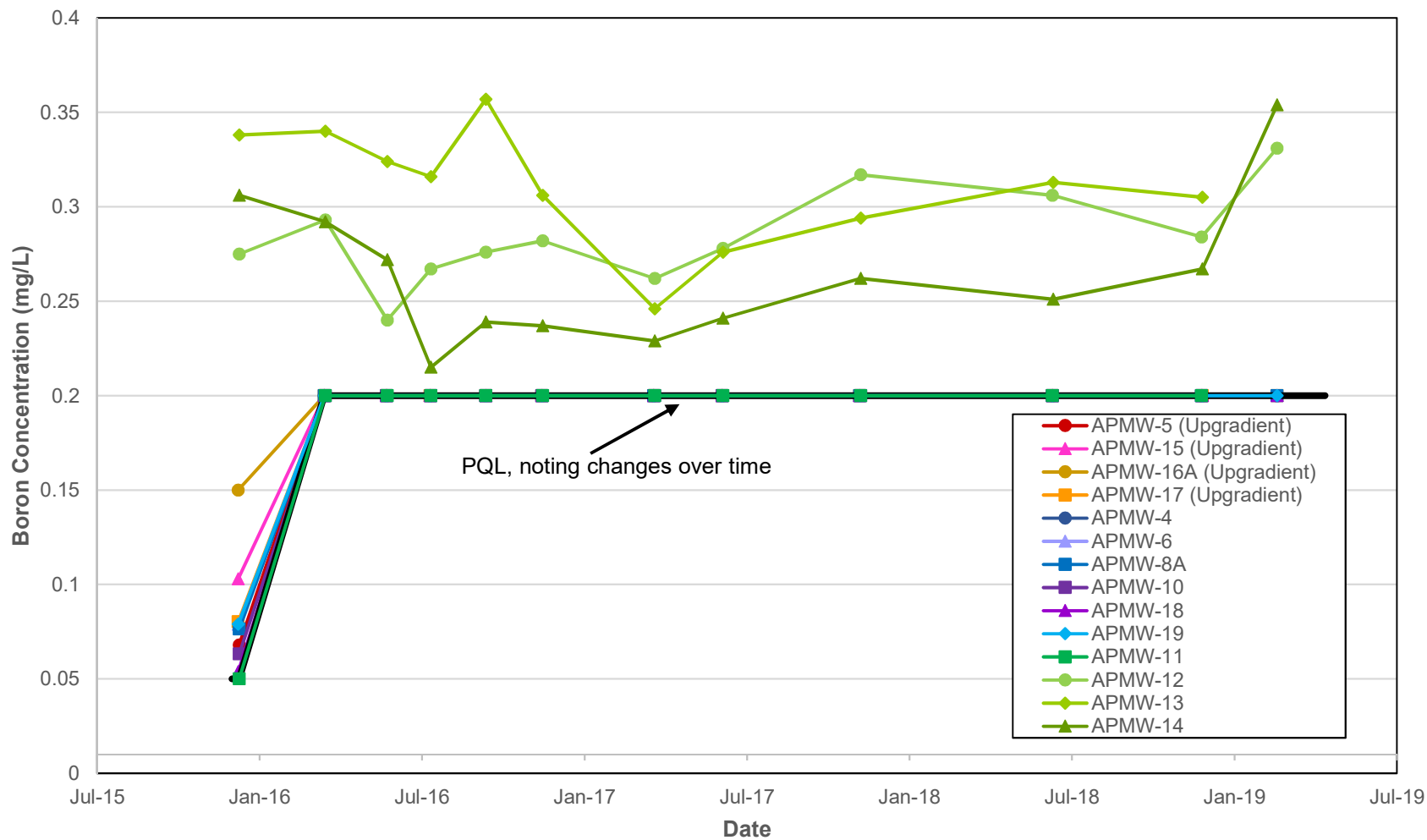


Figure A1
Groundwater Boron Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

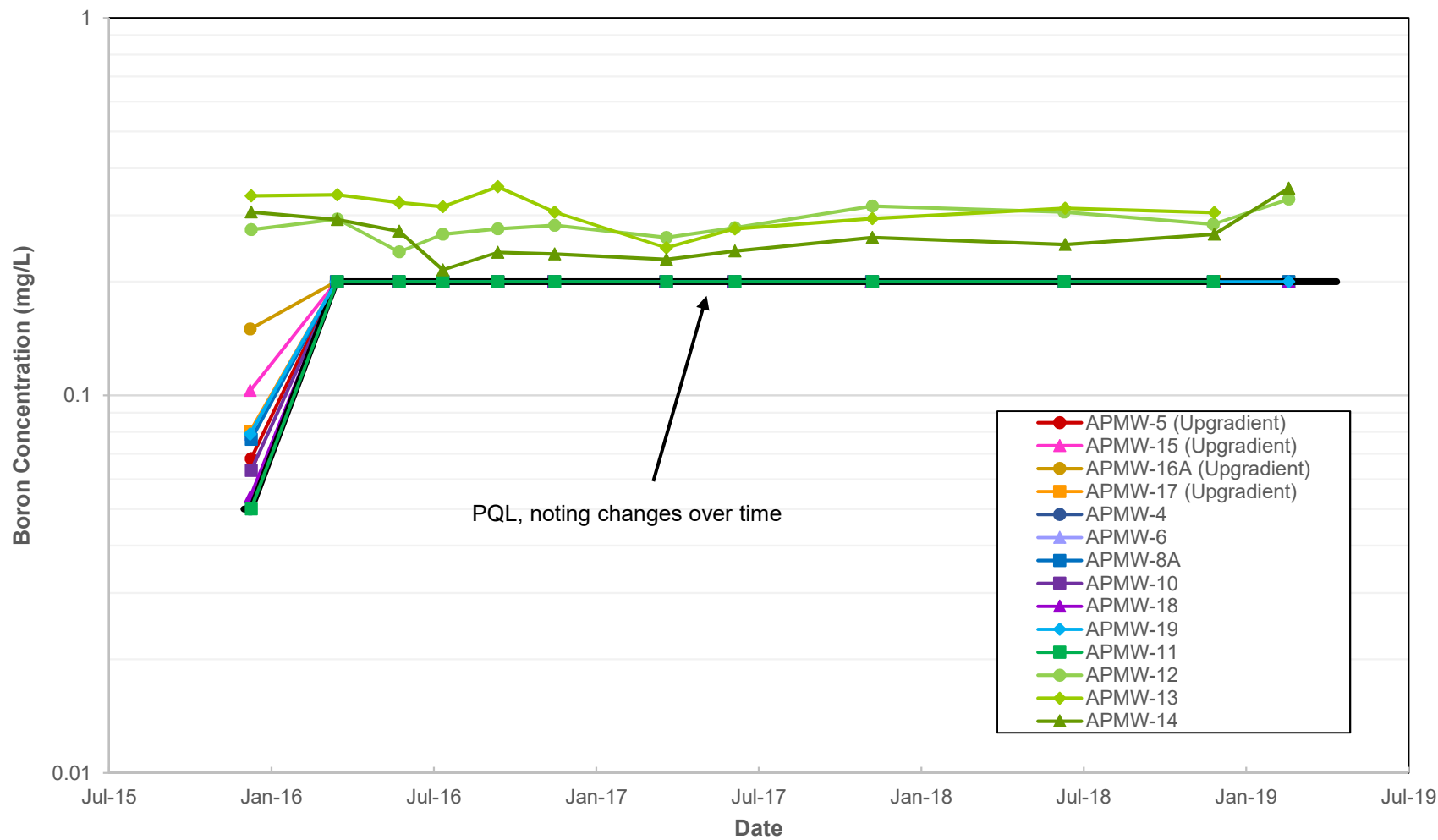


Figure A2
Groundwater Boron Concentrations (Log)

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

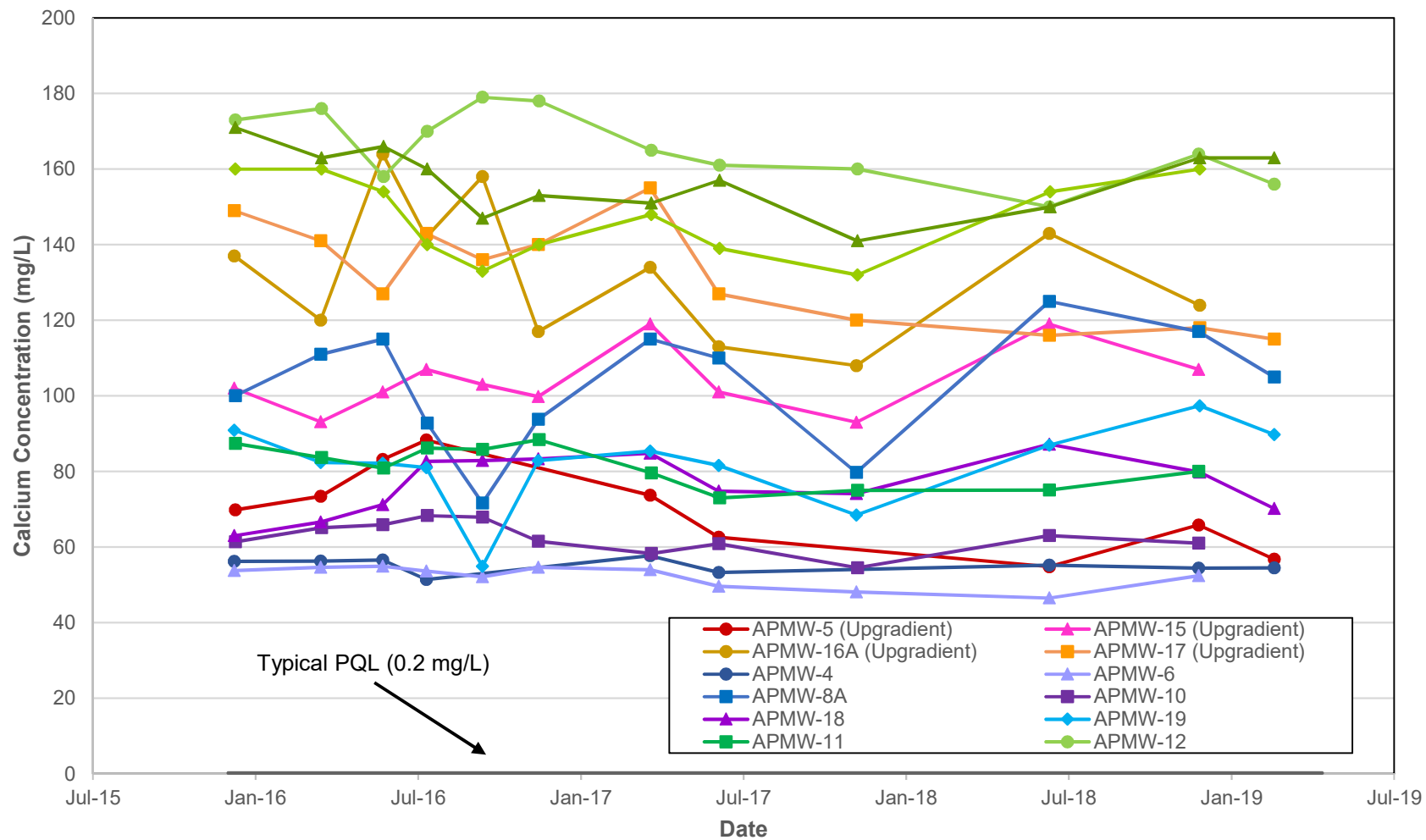


Figure A3
Groundwater Calcium Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

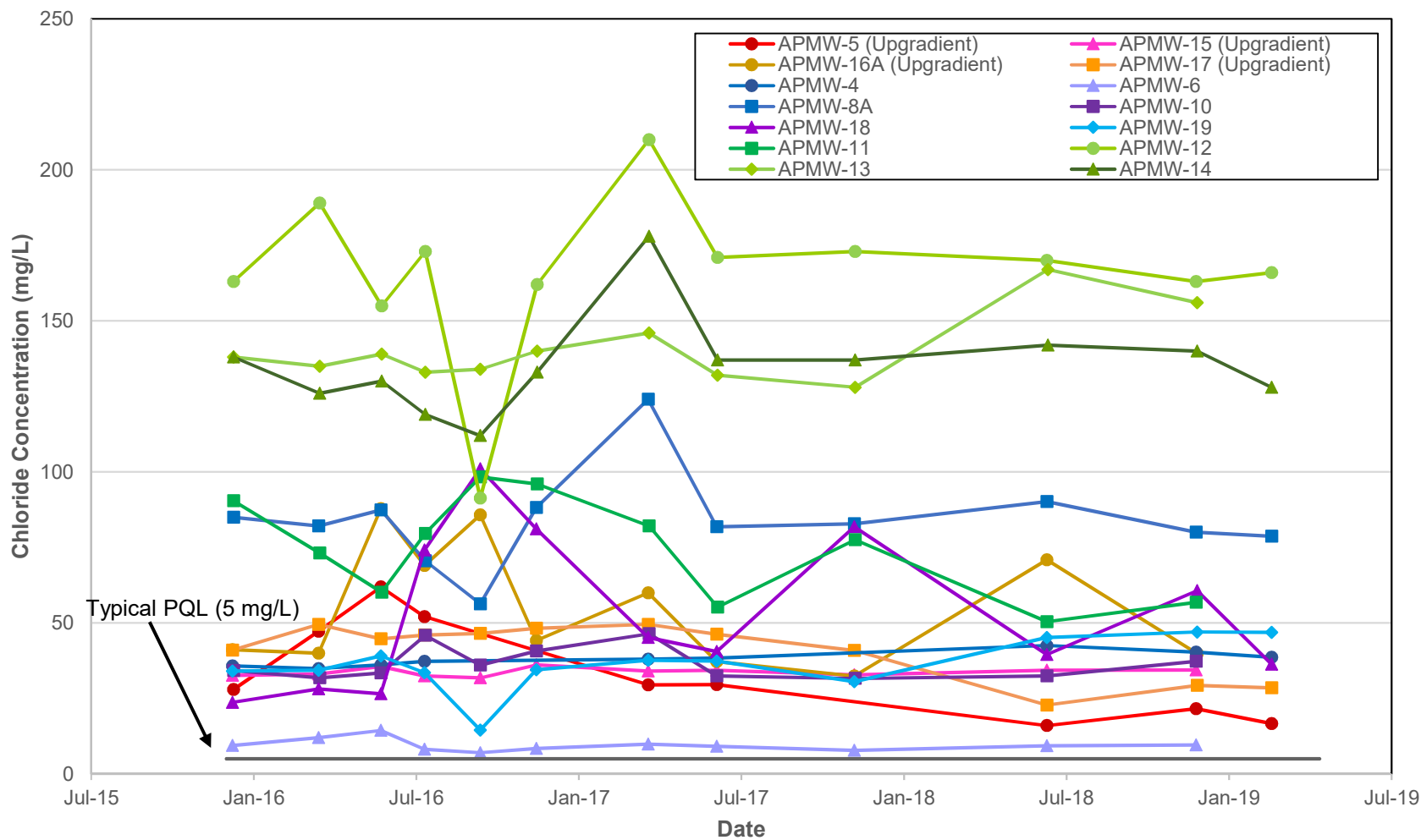


Figure A4
Groundwater Chloride Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

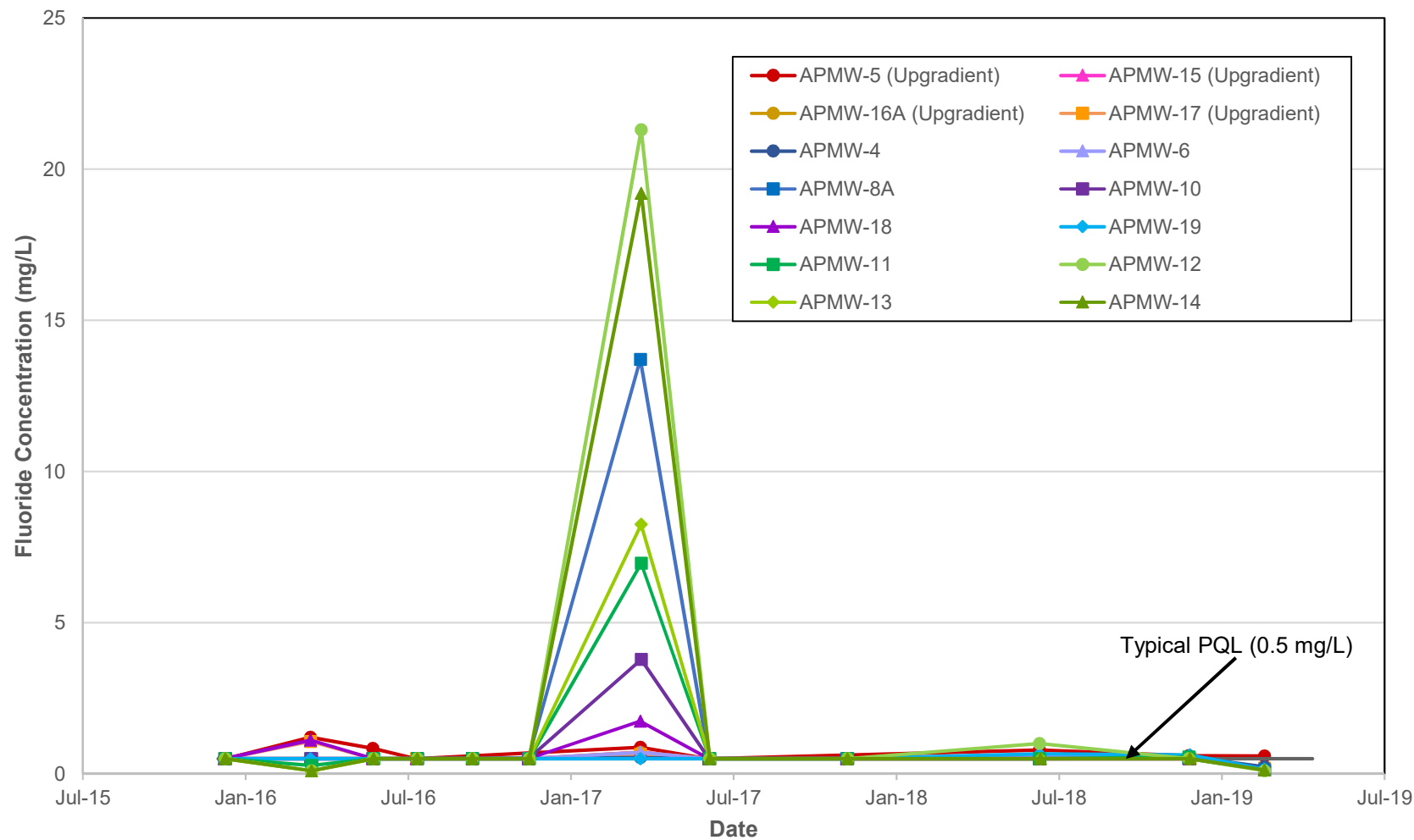


Figure A5
Groundwater Fluoride Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

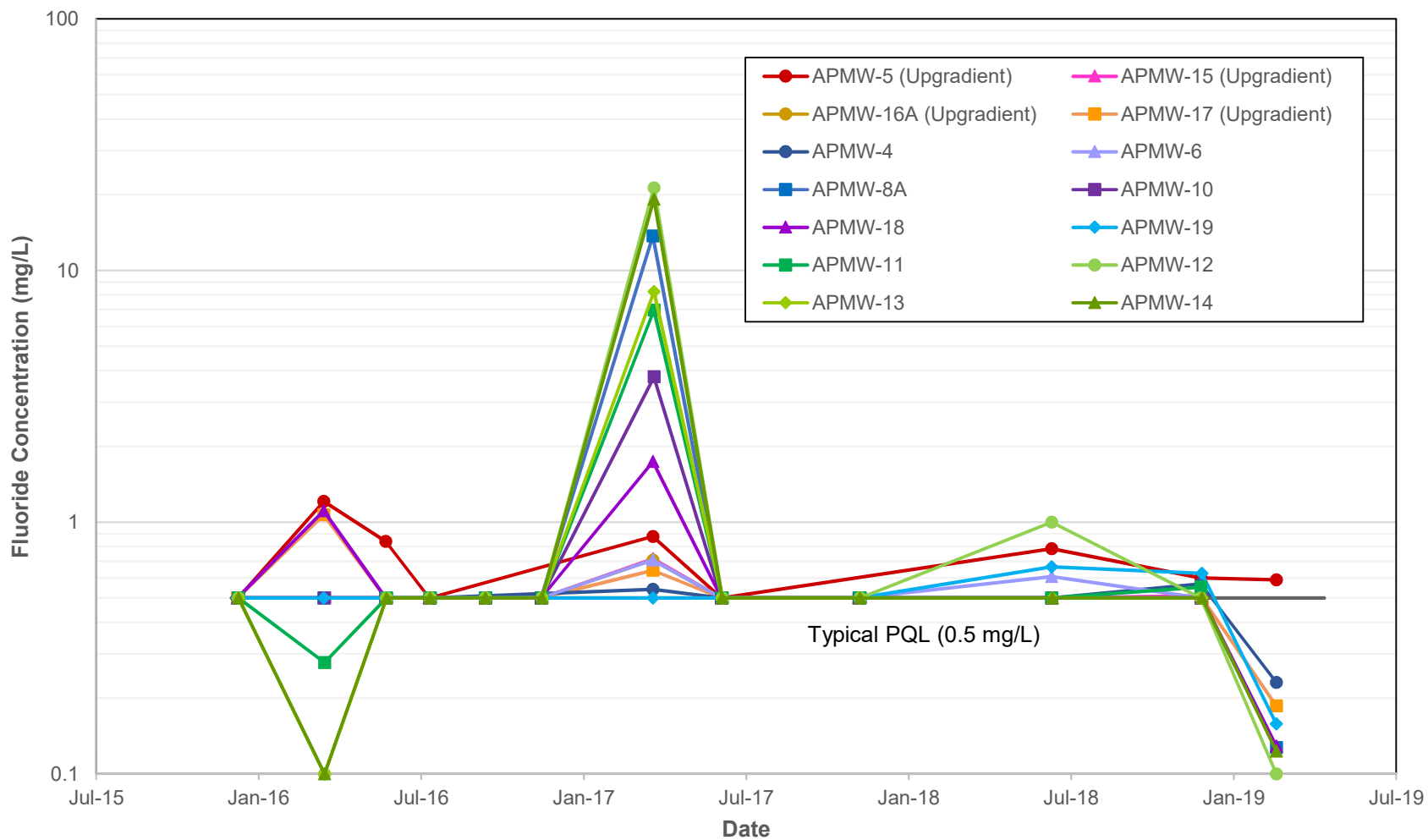


Figure A6
Groundwater Fluoride Concentrations (Log)

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

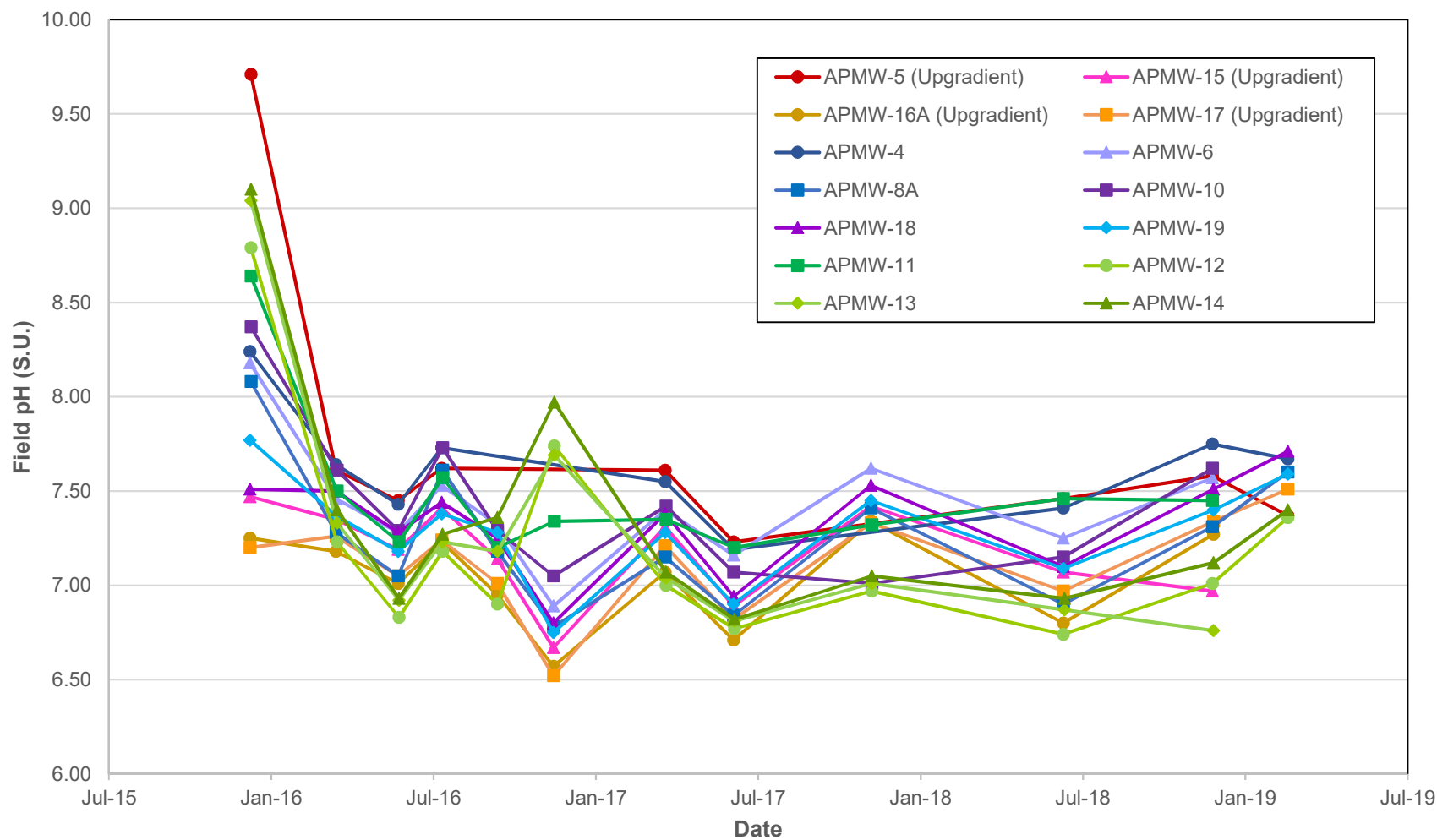


Figure A7
Groundwater Field pH

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

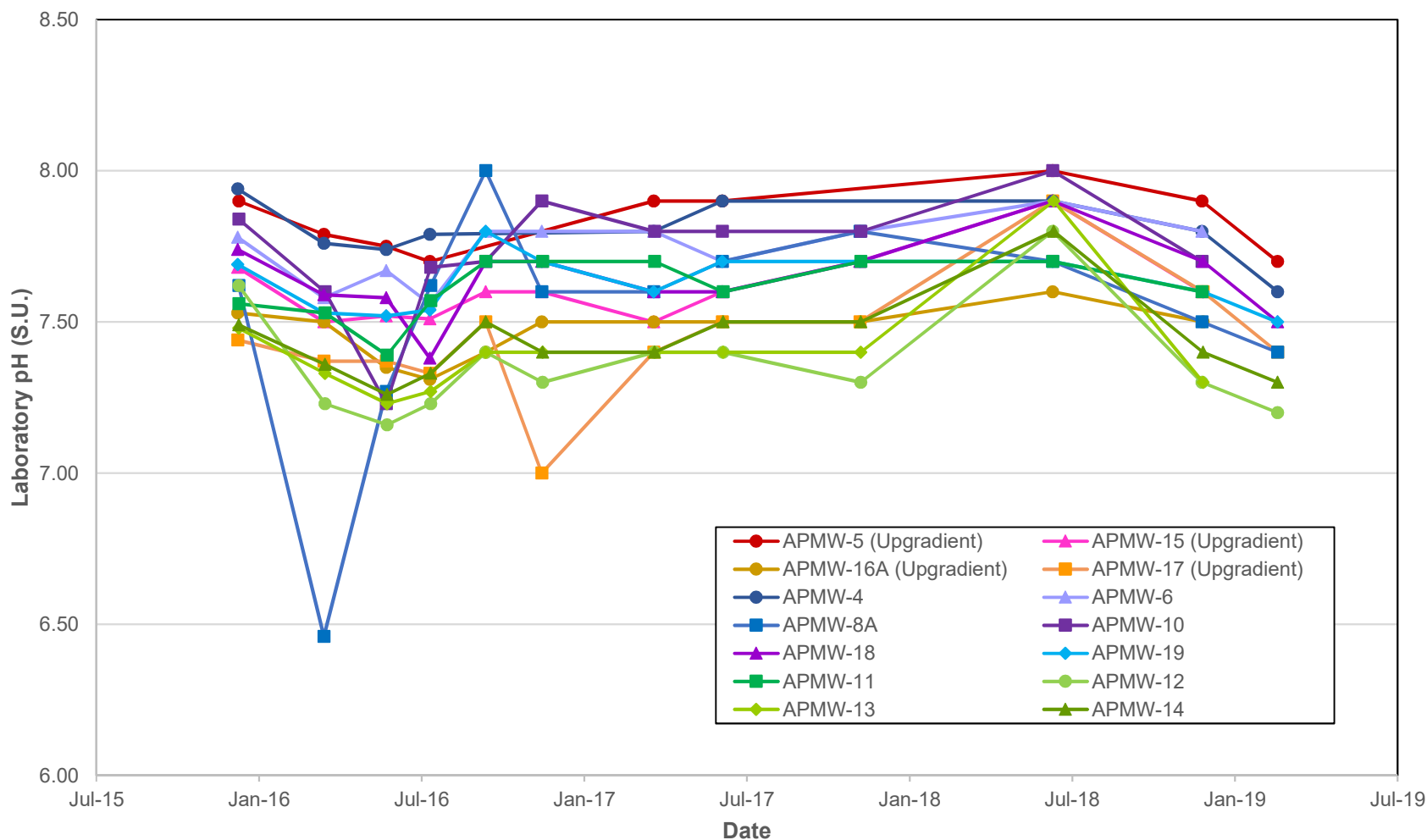


Figure A8
Groundwater Laboratory pH

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

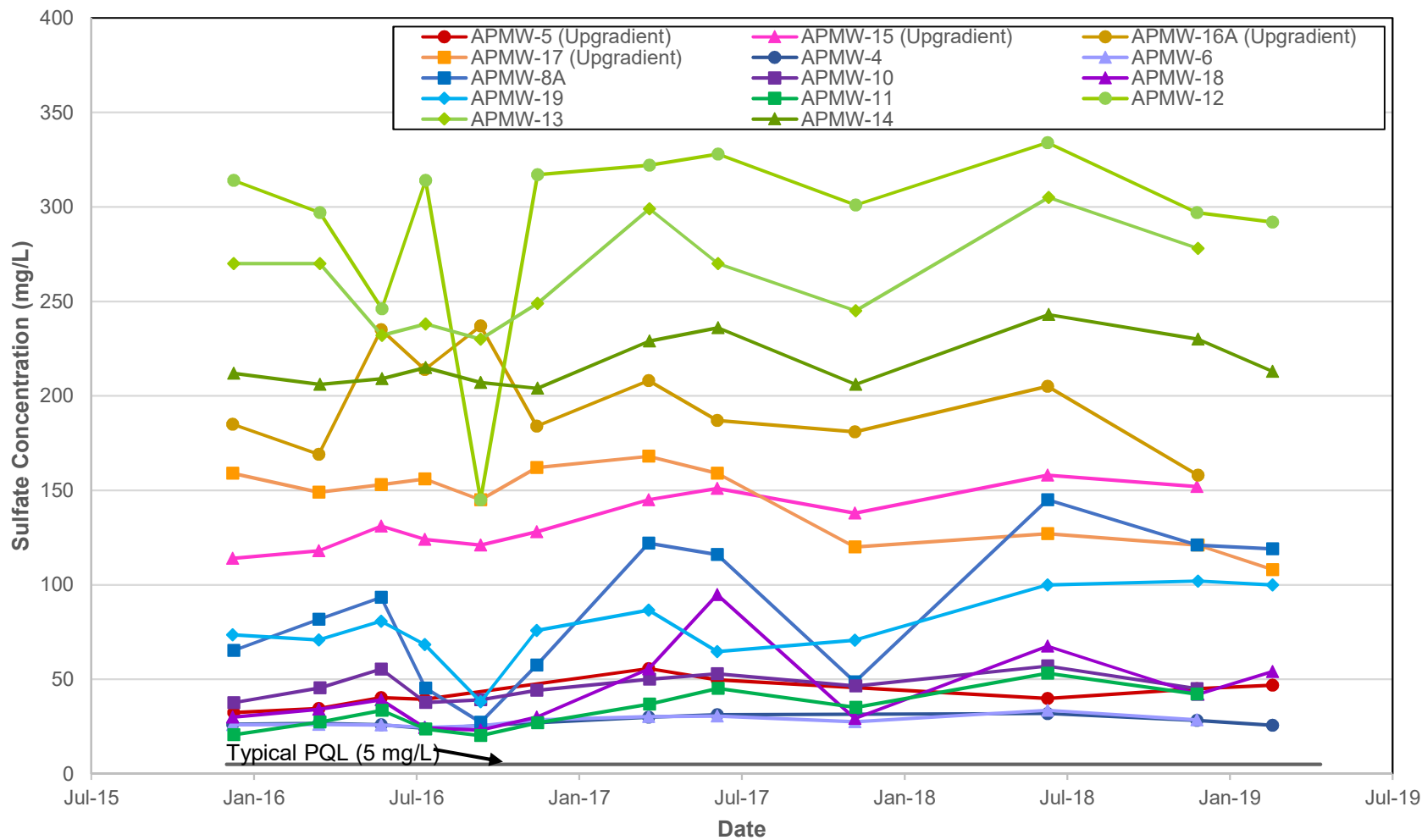


Figure A9
Groundwater Sulfate Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

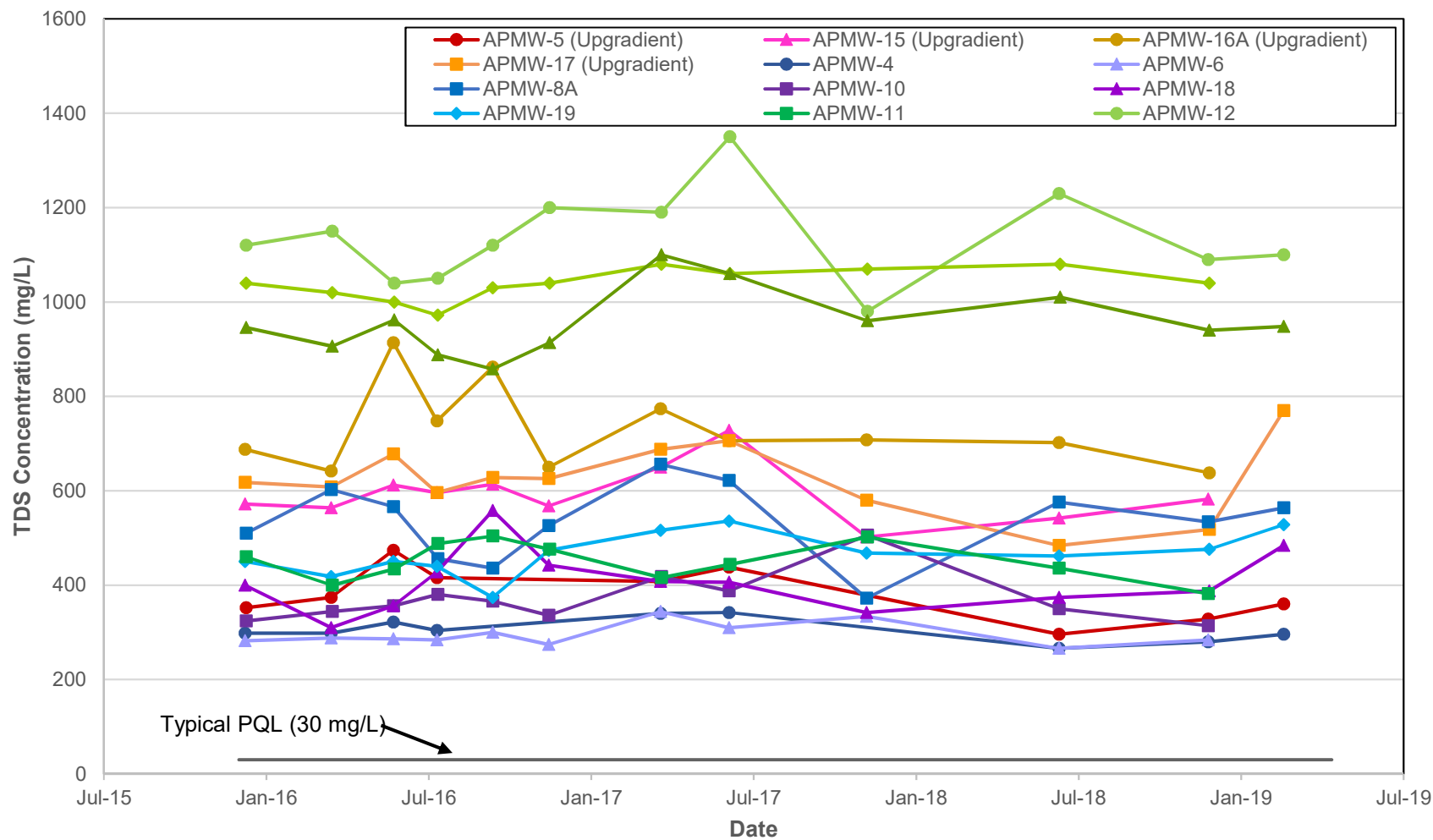


Figure A10
Groundwater TDS Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

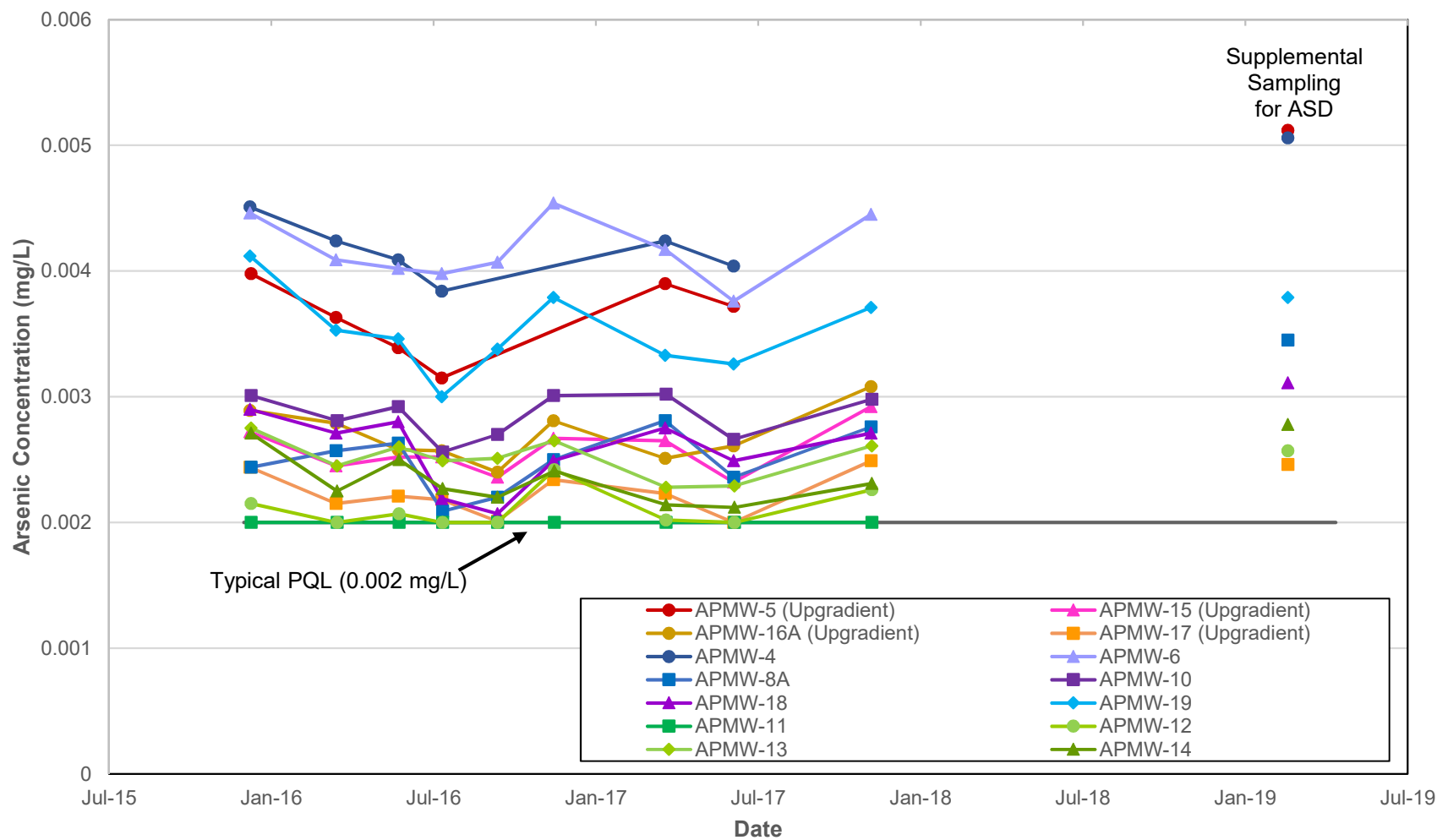


Figure A11
Groundwater Arsenic Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

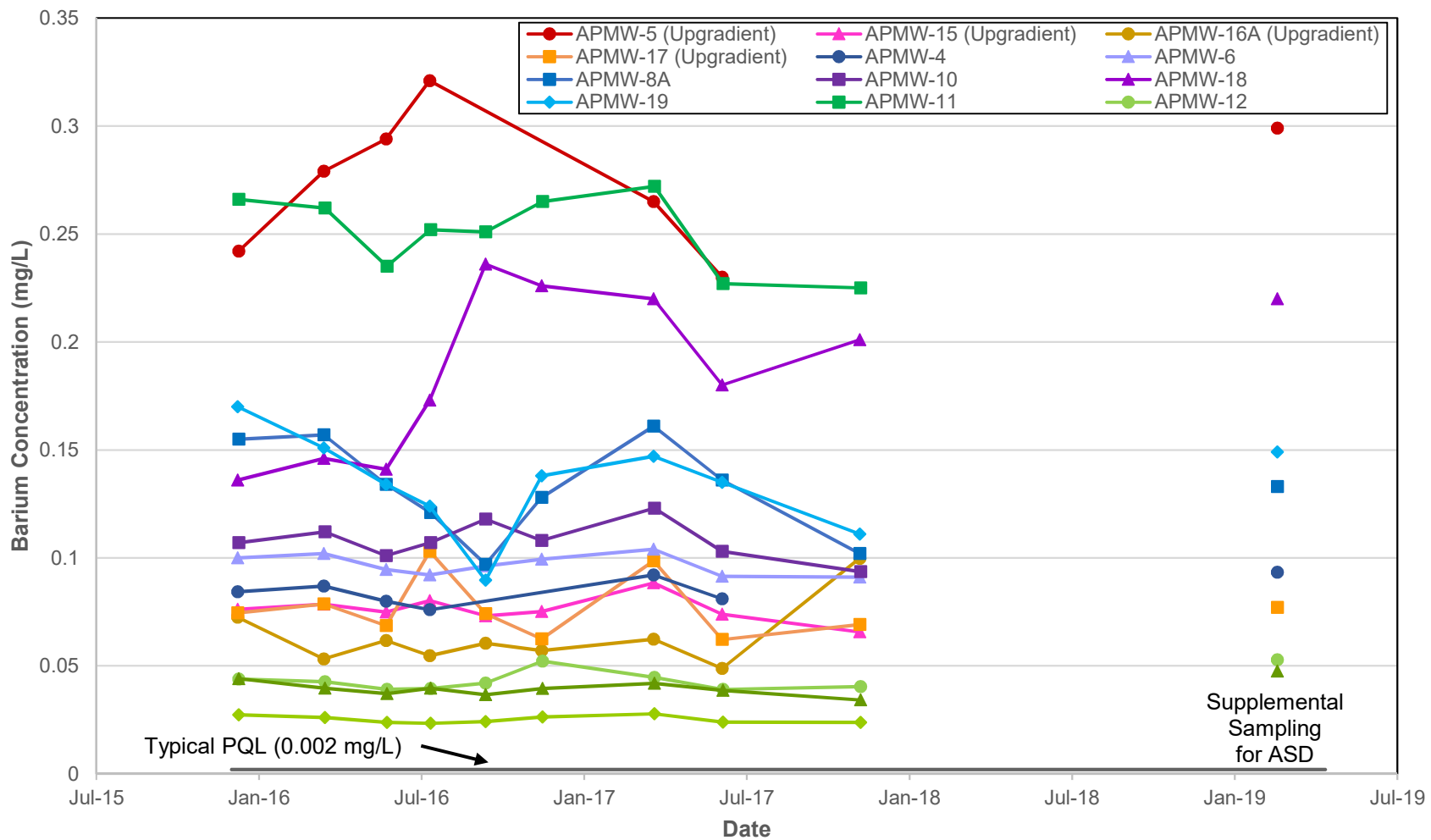


Figure A12
Groundwater Barium Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

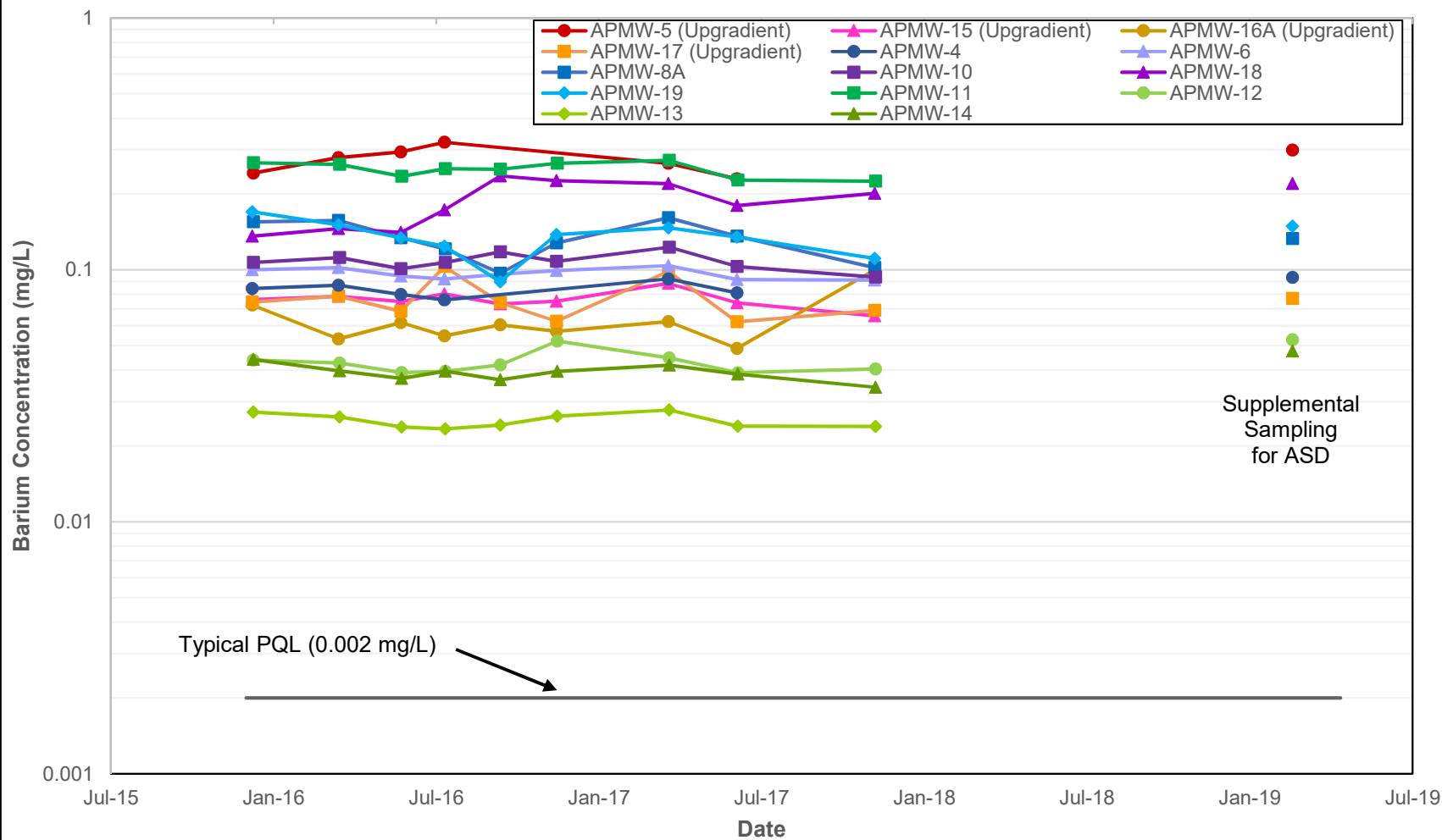


Figure A13
Groundwater Barium Concentrations (Log)

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

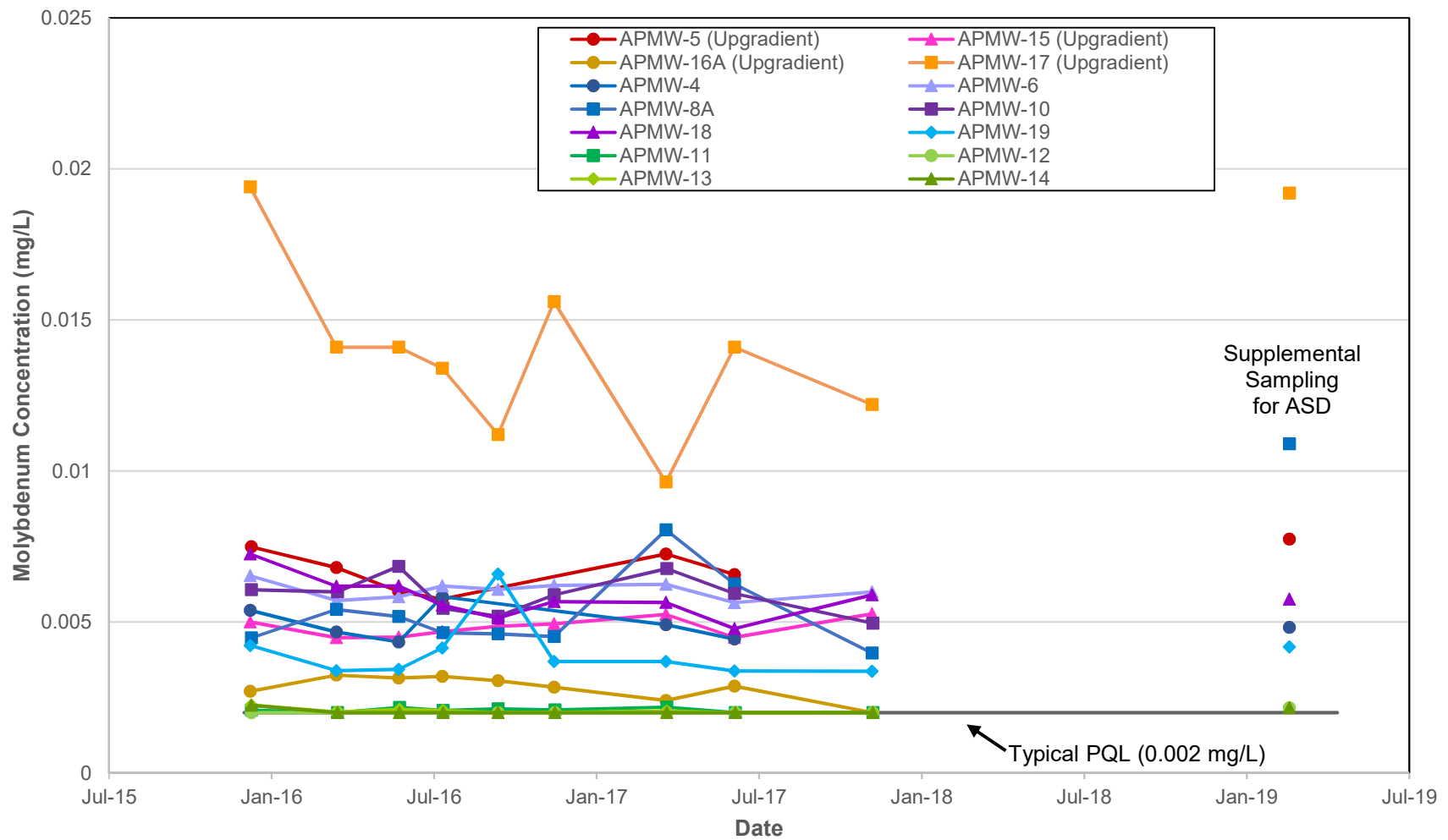


Figure A14
Groundwater Molybdenum Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates

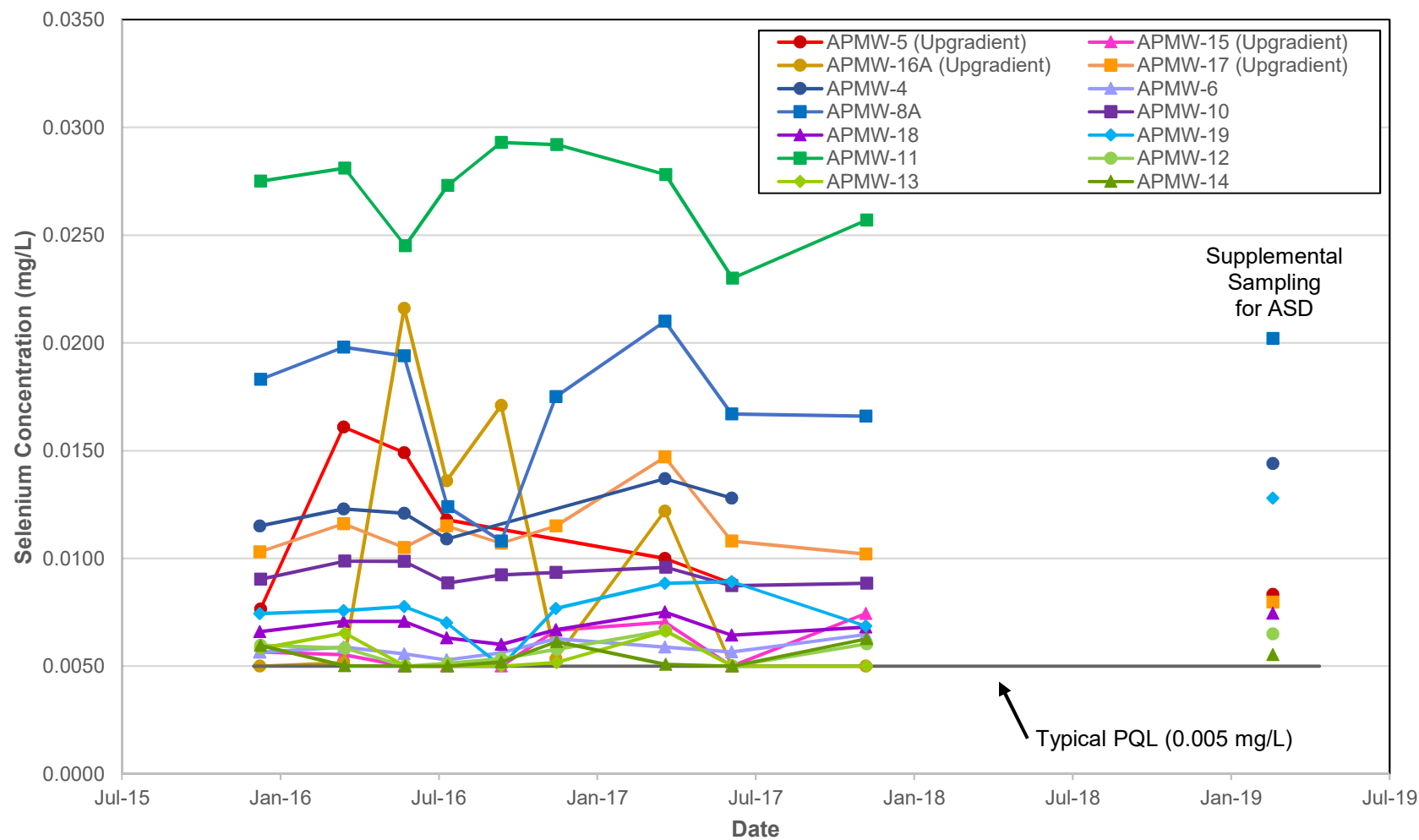


Figure A15
Groundwater Selenium Concentrations

Alternate Source Demonstration
Nebraska Public Power District - Gerald Gentleman Station

Golder Associates



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APPENDIX B

**Alternative Source Demonstration –
Q2 2019 Detection Monitoring Event**



REPORT

Alternate Source Demonstration

Nebraska Public Power District

Submitted to:

Nebraska Public Power District

Gerald Gentleman Station, 6089 South Highway 25, Sutherland, Nebraska 69165

Submitted by:

Golder Associates Inc.

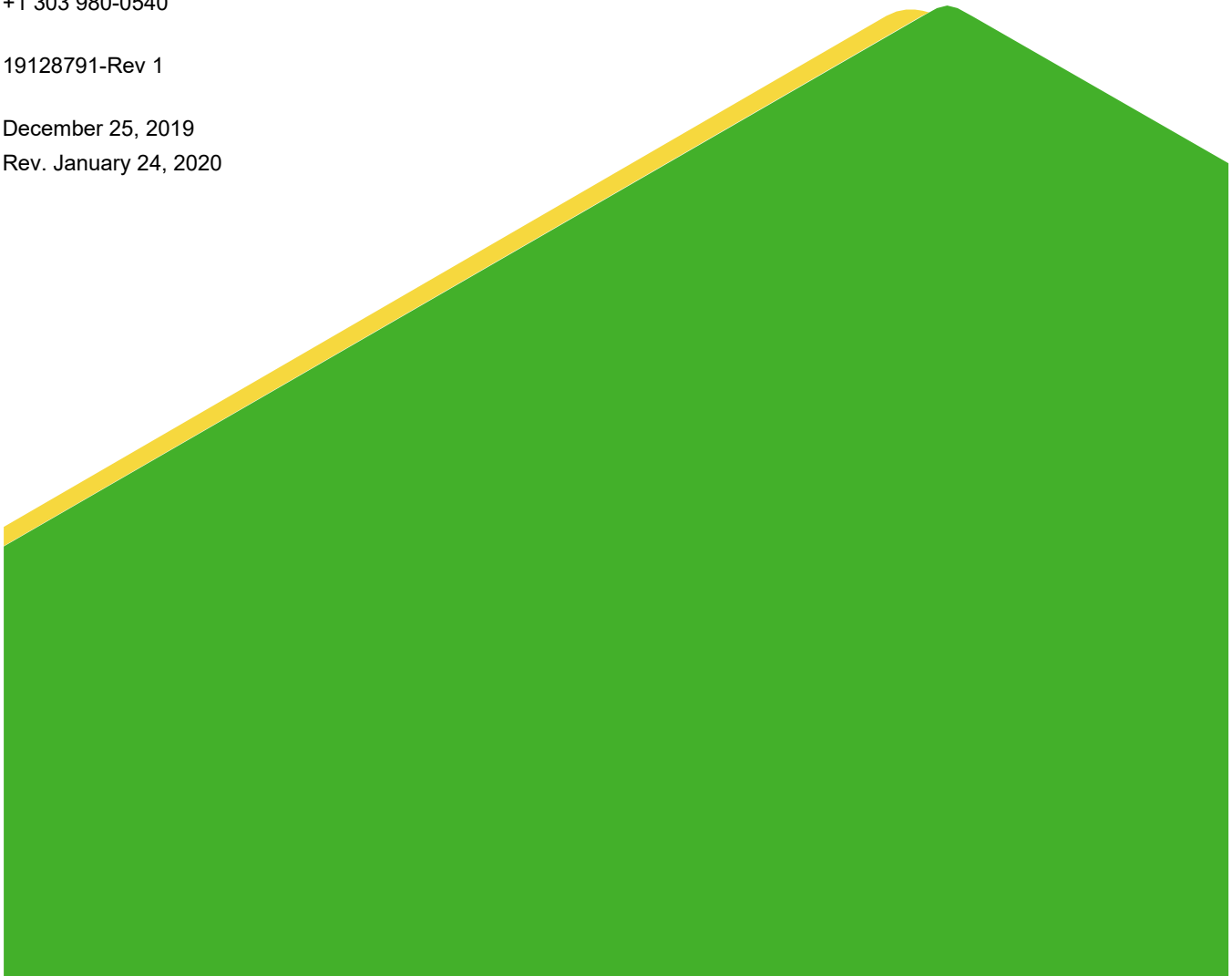
7245 W Alaska Drive, Suite 200, Lakewood, Colorado, USA 80226

+1 303 980-0540

19128791-Rev 1

December 25, 2019

Rev. January 24, 2020



Revision History

<u>Revision Number/Date</u>	<u>Revision</u>
Rev 0 – December 25, 2020	Final – <i>Alternate Source Demonstration</i> issued
Rev 1 – January 24, 2020	Revised to correct date on page 1 from August 25, 2019 to September 25, 2019

Distribution List

Nebraska Public Power District

Golder Associates Inc.

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APPENDICES**APPENDIX A**

Historical Concentrations of Appendix III and Selected Appendix IV Analytes

1.0 INTRODUCTION

On behalf of Nebraska Public Power District (NPPD), Golder Associates Inc. (Golder) performed a statistical evaluation of groundwater geochemistry results from the second quarter groundwater detection monitoring event of 2019 at Gerald Gentleman Station (GGS or Site) ash landfill (or CCR Unit), located at 6089 South Highway 25, Sutherland, Lincoln County, Nebraska (Figure 1). The statistical evaluation was performed in accordance with applicable provisions of 40 Code of Federal Regulations (CFR) Part 257, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals (CCR) from Electric Utilities; Final Rule" (CCR Final Rule), as amended, and corresponding regulations under Nebraska Administrative Code (NAC) Title 132, Chapter 7 (Integrated Solid Waste Management Regulations, Groundwater Monitoring and Remedial Action).

Statistical analyses of the Appendix III detection monitoring data for chloride in groundwater at the downgradient monitoring well APMW-19 indicated a potential exceedance of the statistical limit based on the parametric Cumulative Sum analysis (CUSUM) in the Q4 2018 sampling results, which was subsequently verified as evidence of a statistically-significant increase (SSI) after the Q2 2019 event. Although determination of an SSI generally indicates that the groundwater monitoring program should transition from detection monitoring to assessment monitoring, 40 CFR §257.94(e)(2) allows the owner or operator (i.e., NPPD) 90 days from the date of determination (September 25, 2019) to demonstrate a source other than the CCR unit, or another condition, caused the potential SSI for chloride at APMW-19.

Golder's review of the hydrological and geologic conditions at the Site indicated the potential for the SSI to have resulted from a source other than the CCR unit. To assess potential chloride sources and the natural variability of chloride concentrations in groundwater, NPPD collected and analyzed CCR-impacted water from the ash landfills, surface water from the Sutherland Reservoir, and groundwater samples. Based upon this assessment and in accordance with provisions of the CCR Final Rule, Golder prepared this Alternative Source Demonstration (ASD) for the CCR unit. This ASD includes an evaluation of geological, hydrogeological, and chemical information regarding ash, surface water, and groundwater obtained from surface waters and monitoring wells installed within and adjacent to the CCR Unit.

This ASD conforms to the requirements of 40 CFR §257.94(e)(2) and provides the basis for concluding that the apparent SSI is not a result of a release from the CCR Unit. The following sections provide a summary of the GGS CCR Unit, sampling procedures and analytical methods, analytical and geochemical assessment results, a Conceptual Site Model, and lines of evidence demonstrating an alternative source is responsible for the chloride SSI.

2.0 BACKGROUND

2.1 Description of Waste Disposal Area

The ash landfill at GGS is located southwest of the plant's generation facility, in the northern one-half of Section 30, Township 13N, Range 33W. The ash disposal facility consists of Ash Landfill Nos. 1, 2, 3, and 4 and the bottom ash landfill. Ash Landfill Nos. 1 and 2 are closed, and Ash Landfill Nos. 3 and 4 are active (Figure 1). The bottom ash landfill was closed in October 2018.

Fly ash is currently disposed at Ash Landfill No. 4 and in the east cell of Ash Landfill No. 3. The liner design at Ash Landfill No. 4 consists of a 60-mil high density polyethylene (HDPE) geomembrane over compacted subgrade. Prior to geomembrane installation, the existing subgrade was scored to a depth of at least 6 inches and compacted to 95 percent of its maximum dry density (standard Proctor). Smooth HDPE geomembrane was placed on the bottom of the ash landfill and textured HDPE geomembrane was placed on the side slopes. Construction quality assurance

(CQA) for the geomembrane installation was performed by Golder Construction Services and completed on November 15, 1994. There is no Leachate Collection System (LCS) at Ash Landfill No. 4.

The original liner at Ash Landfill No. 3 consisted of 2 feet of soil compacted to 95 percent of the standard Proctor maximum dry density. The average permeability of the liner was 1.2×10^{-8} cm/sec. Ash Landfill No. 3 was previously closed in 1995 with 2.0 to 7.5 feet of soil cover. This cover was removed and the historically placed CCR was covered with a new liner in 2015. The new liner system at Ash Landfill No. 3 consists of a prepared subgrade overlain by a geosynthetic clay liner (GCL) and 60-mil linear low-density polyethylene (LLDPE) geomembrane. Ash Landfill No. 3 also has a 1-foot LCS sand layer that reports to two sumps. Construction of the new Ash Landfill No. 3 liner system was completed in November 2015.

To the east of the ash landfill, plant process water, such as boiler blowdown, is managed in a 50-acre evaporation pond, as shown in Figure 1. The bottom of the approximately 8 to 10 foot (ft) deep evaporation pond consists of re-compacted native soils.

2.2 Site Geology

The geologic sequence near the ash landfill was summarized by Woodward-Clyde in 1991. In the report, nine boreholes (APMW-1, APMW-2, APMW-3, APMW-4, APMW-5, EPMW-1, EPMW-2, EPMW-3, and EPMW-4) were used to characterize the Site geology. The geologic sequence, from top to bottom, was described as follows:

- 4 to 5 feet of topsoil and/or fill
- 20 to 35 feet of eolian silty sands
- 8 to 10 feet of silty clay paleosol at the top of the Ogallala Formation
- 25 to 35 feet of Ogallala Formation silts
- Approximately 50 feet of Ogallala Formation sands or Ogallala Formation silts and clays, to the bottoms of the boreholes

The topsoil layer consists of stiff, dark brown, low to medium plasticity silty clay directly overlying the eolian silts and sands. Thickness of topsoil ranges from 0 to 4 feet. The fill material consists of stiff, dark brown, low plasticity sandy silty clay with trace gravel and other debris. Fill thickness ranges from 0 to 5 feet.

The eolian silts and sands (Quaternary Period) consist of loose to medium dense, tan, very fine-grained, well-rounded, and well-sorted sandy silts and silty sands. The thickness of this unit ranges from 17 feet (APMW-5) to 34 feet (EPMW-2). Materials with a bimodal texture (two distinct grain sizes) are present in the lower part of this unit. The eolian silts and sands are interpreted as wind-blown dune sand deposits.

The Ogallala Formation (Tertiary Period) was encountered in each of the nine boreholes at a depth beginning at 16 to 38 feet bgs and extending to the bottom of the boreholes (109 to 133 feet bgs). The Ogallala Formation near the ash landfill may be separated into three general stratigraphic units:

- Upper silty clay paleosol unit
- Middle clayey or sandy silt unit
- Lower unit of either predominantly sand and gravel or an equivalent unit of predominantly silt and clay

The top of the Ogallala Formation is represented by a widespread paleosol (a previous soil horizon) that consists of a very stiff, reddish-brown to buff, low plasticity, silty clay to clayey silt with abundant calcareous nodules, calcareous matrix, and interbedded layers of caliche up to one foot thick. The thickness of the initial paleosol is about 8 to 10 feet, but the presence of interbedded caliche layers continues into the middle and lower Ogallala units.

The middle Ogallala Formation unit consists of a stiff to very stiff, buff-white to reddish-brown, low plasticity, clayey silt to sandy silt with abundant calcareous nodules, matrix, and caliche layers. Scattered occurrences of calcareously cemented siltstone layers from ½ to 1 foot thick are present in the lower part of this unit. The thickness of this middle unit ranges from about 25 to 35 feet. The clayey silts and sandy silts of this unit were possibly deposited as overbank or floodplain deposits in an alluvial depositional system.

There are two distinct lithofacies recognized in the lower Ogallala Formation unit. This unit is present for about 45 to 50 feet in the borings. One lithofacies consists of dense to very dense, reddish-brown, fine-grained silty sands grading into medium- and coarse-grained, poorly-graded sands with some fine gravels and some calcareously cemented sandstone beds (½ to 1 foot thick). This lithofacies was primarily encountered in borings on the northern side of the ash landfill (APMW-1, APMW-2, APMW-5, and EPMW-1).

The second lithofacies recognized in the lower unit consists of stiff to hard, reddish-brown, low plasticity clayey or sandy silts with some calcareously-cemented siltstone beds. This lithofacies was encountered in borings on the southern side of the ash landfill (APMW-3, APMW-4, EPMW-2, EPMW-3, and EPMW-4).

The lithologic differences and areal distribution of the two lower units suggest that the units were deposited in two separate facies of an alluvial system. The sand and gravel unit is possibly a series of longitudinal bars, channels, and channel-fill deposits, while the silt and clay unit is possibly a series of upper channel fills, overbank, or floodplain deposits (Woodward-Clyde 1991).

2.3 Site Hydrogeology

Based on observations made during logging of soil borings and findings of the Nebraska Water Survey Paper No. 70 (Goeke et al. 1992), the unsaturated geologic units underlying the ash landfill area consist of topsoil (0 to 4 feet thick), eolian silts and sands (15 to 25 feet thick), Ogallala Formation silts (40 to 50 feet thick), and Ogallala Formation sands and gravels (unsaturated portion of this unit is approximately 20 to 25 feet thick). Beneath these units lies 10 feet or more of saturated Ogallala Formation sands and gravels. Based on the Site observations, the thickness of the vadose zone ranges from approximately 90 to 100 ft.

The saturated geologic units underlying the ash landfill area consist of Ogallala Formation silts and sands that extend to the bottom of the aquifer. The Ogallala Formation is underlain by the White River Group, which is composed of the Brule and Chadron formations. The bedrock formations of the White River Group are not considered to be an important potential source of water, and therefore their surface is considered to form the base of the aquifer and is regarded as the lower drilling limit for irrigation wells in the agricultural region near the Site. Underlying the White River Group is the impermeable Pierre Shale (Goeke et al. 1992).

Available groundwater elevation data indicate that groundwater beneath GGS flows from north to south (Figure 1). The groundwater gradient is controlled by the Sutherland Reservoir, an approximately 3,200-acre open water body located 1.5 miles north of the ash landfill that is used as a source of condenser cooling water for GGS. Since groundwater level monitoring began in 1996, regular water level fluctuations have been observed in the monitoring wells located around the ash landfill. These fluctuations are attributed to seasonal trends in water consumption or recharge and precipitation patterns. In Figure 2, which shows a time-series plot of historical water

levels in each monitoring well, it is also apparent that long-term changes in water levels have occurred between 1996 and 2019. In general, water levels rose by approximately 1.5 feet between 1996 and 2000, before declining by between 9 to 10 feet between 2000 and 2009. The cause of the decline is not clear, but possible explanations include a regional response to the drought being experienced by parts of the western United States and/or a change in the amount of groundwater used for irrigation in the area around the Site. Between 2009 and 2019 water levels have continued to show seasonal variability, with seasonal maximums occurring in the spring and seasonal minimums occurring in the fall, but there is no apparent long-term increasing or decreasing trend.

2.4 Groundwater Monitoring Network

Design of the CCR Final Rule-compliant ash landfill monitoring program considered the size, disposal and operational history, anticipated groundwater flow direction, and saturated thickness of the uppermost aquifer. Based on these factors, a monitoring well network that consists of four background monitoring wells and ten downgradient monitoring wells was installed around the ash landfill. The monitoring wells are listed in Table 1 and presented in Figure 1.

Table 1: Monitoring Well Network

Location	Background Monitoring Wells	Downgradient Monitoring Wells
Ash Landfill	APMW-5, APMW-15, APMW-16A, APMW-17	APMW-4, APMW-6, APMW-8A, APMW-10, APMW-11, APMW-12, APMW-13, APMW-14, APMW-18, APMW-19

The four upgradient monitoring wells included in the groundwater monitoring program are used to represent the background water quality, including its potential variability. The ten downgradient wells were installed along the western, southern, and eastern boundaries of the active ash landfill. The depths of the monitoring wells were selected such that the monitoring wells are screened in the Ogallala Formation to yield groundwater samples that are representative of water quality in the uppermost aquifer.

2.5 Groundwater Conditions

Between December 2015 and June 2017, NPPD collected eight quarterly independent baseline groundwater samples from each of the background and downgradient monitoring wells listed in Table 1, as required by 40 CFR §257.94. The results of the baseline monitoring phase were used to develop appropriate and statistically valid baseline values for each constituent at each monitoring well (Golder 2017).

During the baseline monitoring period, chloride concentrations were variable in the upgradient and downgradient groundwater, as shown in Appendix A, Figure A4. Chloride concentrations in upgradient groundwater (based on 28 samples from four wells) ranged from 28 to 87.8 mg/L between December 2015 and June 2017. Downgradient groundwater quality was also variable (based on 78 samples from 10 wells), with chloride concentrations ranging from 7.02 to 210 mg/L.

Chloride concentrations in groundwater at APMW-19 remained relatively steady during the baseline monitoring period, with values ranging between 14.5 and 39.1 mg/L in the eight samples collected. A concentration of 49.12 mg/L was selected as the statistical limit for chloride at this monitoring well.

Following completion of the eight baseline monitoring events, NPPD started collecting groundwater samples on a semiannual basis in November 2017 to support the detection monitoring program. Groundwater samples for

detection monitoring were collected at all four background and ten downgradient monitoring wells and analyzed for 40 CFR Part 257 Appendix III constituents. During the detection monitoring program, the results of groundwater analysis are compared to the calculated prediction limits to determine whether groundwater quality remains consistent, or if changes are considered statistically significant increases (SSI).

The Q4 2018 detection monitoring event reported a chloride concentration of 47.0 mg/L in groundwater at APMW-19 and the parametric CUMSUM value exceeded the calculated statistical limit of 49.12 mg/L. Verification sampling was completed in June 2019 (i.e., Q2 2019) and the results confirmed the SSI for chloride at APMW-19 with a chloride concentration of 55.3 mg/L.

2.6 Review of Sampling and Laboratory Testing Procedures

As part of the ASD, a review was conducted of the sampling and laboratory testing procedures used throughout baseline monitoring and detection monitoring to date, along with the collected results. Golder found that the analytical methodologies used were consistent with the stated objectives of the sampling program. No anomalies were found within the sampling and laboratory testing procedures and the collected results are considered valid.

Additionally, a review of the statistical assessment methods and associated results found the procedures followed during baseline and detection monitoring to be consistent with the stated procedures listed in the published Groundwater Monitoring Statistical Methods Certification (Golder 2017). Calculated limits were found to be consistent with the chosen statistical procedures and recommended methodology found within the Unified Guidance (EPA 2009).

3.0 SAMPLING PROCEDURES AND ANALYTICAL METHODS

To assess groundwater downgradient of the GGS CCR facilities and collect data to support an ASD for chloride, Golder and NPPD GGS staff performed supplemental assessment activities between October 28 and November 5, 2019. The following sections summarize the supplemental assessment activities.

3.1 Ash Impacted Water

To characterize the potential for the material in the ash landfill to release chloride, NPPD GGS field personnel retrieved sump water from Ash Landfill No. 3 and pond water in direct contact with CCR materials in Ash Landfill No.4 on October 28th, 2019.

3.2 Surface Water

Surface water samples were collected from the Sutherland Reservoir and Sutherland Canal on October 28th, 2019, to access the source of regional groundwater at the Site.

3.3 Groundwater

As part of the Q4 2019 assessment monitoring, NPPD GGS field personnel collected groundwater on November 5, 2019. Groundwater samples were collected from the ten GGS monitoring wells listed in Table 1 and tested for an expanded analyte list, including field parameters, major cations, major anions, and select dissolved metals (Section 3.4).

3.4 Geochemical Analysis

The geochemical analysis of groundwater and surface water samples included fluid parameters, major cations and anions, and dissolved metals. The methods selected for these analyses are summarized below.

Major Cations and Anions and Field Parameters: Geochemical modeling of mineral solubility, metal attenuation and background contributions required analysis of major cations and anions because they affect and participate in sorption and mineral dissolution/precipitation reactions. Field parameters included pH, conductivity, and temperature.

Metals: Metals analyses (i.e., Appendix III and IV) are important to understand the geochemical properties of groundwater. For groundwater, metals analysis allows for the delineation of a potential plume, and identification of background contributions from natural sources or off-site locations.

The laboratory analyzed the ash landfill water, groundwater and surface waters using the following methods:

- Alkalinity following Standard Method (SM) 2320B Alkalinity by Titration (2005)
- Chloride, fluoride, and sulfate following USEPA SW846 9056A Determination of Inorganic Anions by Ion Chromatography Revision 1 (February 2007)
- pH following SM 4500 H+ B (2017)
- Arsenic, boron, barium, calcium, magnesium, molybdenum, potassium, selenium, and sodium following USEPA SW-846 6020A (November 2004)
- Ammonia following USEPA 350.1 Determination of Ammonia Nitrogen by Automated Colorimetry, Revision 2 (August 1993)
- Total Kjeldahl Nitrogen following USEPA 351.2 Determination of Total Kjeldahl Nitrogen by Semi-Automated Colorimetry, Revision 2 (August 1993)
- Total Nitrate-Nitrite Nitrogen following USEPA 353.2 Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry, Revision 2 (August 1993)
- Fluoride following SM 4500-F-C (2017)
- Dissolved Silica following SM4500-SiO₂-C Silica, Molybdosilicate Method (2017)

4.0 RESULTS OF SUPPLEMENTAL TESTING

4.1 Water Quality

Historical concentrations of Appendix III analytes and selected Appendix IV analytes to identify potential CCR seepage impacts (i.e., arsenic, barium, molybdenum, and selenium) are presented in time series plots in Appendix A. The plots include the results of the supplemental samples that were collected in Q1 2019 to support the Q4 2018 ASD for fluoride at APMW-19 (Golder 2019). Sampling for the Appendix IV elements concluded with the end of baseline monitoring in Q2 2017, which means there is a gap of six quarters in the data plots until the supplemental sampling results are shown in Q1 2019.

Figure 3 presents a Piper diagram with relative major ion chemistry for the monitoring well groundwater samples (Q1 2019 supplemental samples and Q4 2019 assessment monitoring samples), regional groundwater sources (Sutherland Reservoir, Sutherland Canal, Average North and South Platte River), and coal ash impacted waters (Ash Landfill No. 3 sump water, Ash Landfill No. 4 surface pond water, fly ash SPLP leachate, and Evaporation Pond water). The groundwater at the upgradient monitoring wells was dominated by calcium and bicarbonate.

Samples from the downgradient monitoring wells were also majority calcium and bicarbonate ions. The downgradient well APMW-12 was the only well where the major ion composition was dominated by calcium and sulfate. The Sutherland Reservoir and Canal water, along with the average North and South Platte River waters are generally dominated by calcium, sodium, bicarbonate and sulfate. The Ash Landfill No. 3 sump water sample was primarily sodium bicarbonate and the Ash Landfill No. 4 pond water was dominated by sodium and sulfate. The evaporation pond water also contained majority sodium and sulfate ions.

5.0 DATA EVALUATION

5.1 Potential Chloride Sources

Several potential sources, other than the active CCR units, can contribute to chloride to local groundwater at GGS, including outflows from the Sutherland Reservoir into regional groundwater, seepage from the Evaporation Pond, and seepage from historical deposits of fly ash that remain at GGS. These four potential sources of chloride to groundwater are described in this section.

5.1.1 Regional Groundwater from Sutherland Reservoir

As described in Section 2.3, the groundwater gradient in the area around the ash landfill shows groundwater flows from north to south, rather than from south to north in the direction of the Platte River. The groundwater flow direction appears to be based on both the groundwater recharge provided by the Sutherland Reservoir to the north of GGS and groundwater extraction by irrigation wells located south of GGS that are pumped seasonally and used to support local agriculture.

The Sutherland Reservoir is fed by the Sutherland Canal, which delivers water from both the North and South Platte River for use as condenser cooling water at GGS. The USGS monitored South Platte river chemistry by collecting 69 samples between 1993 and 1995 as part of the National Water-Quality Assessment Program. Chloride concentrations in the South Platte River upstream of the Sutherland Canal intake (near Balzac, CO) ranged from 21 to 94 mg/L. Chloride concentrations in the South Platte River downstream of the Sutherland Reservoir and near the confluence with the North Platte River ranged from 30 to 76 mg/L. The USGS also characterized surface waters along the North Platte River in 1993 by collecting nine samples upstream of the Sutherland Canal intake near Lisco, NE. Chloride concentrations in the North Platte River water ranged from 14 to 25 mg/L.

The chloride concentrations of the Sutherland Reservoir and Sutherland Canal in October 2019 were 21.9 and 20.9 mg/L, respectively (Section 3.2). Three water samples were also collected from the center of the Sutherland Reservoir by the USGS between August 2005 and December 2006, with chloride concentrations ranging from 23.5 to 27.1 mg/L. These chloride concentrations were similar to concentrations observed in the North Platte River and were lower than the South Platte River.

The relative proportions of North and South Platte River waters that flow into the Sutherland Reservoir are not available, but given the difference in the chloride concentrations of the two sources, the water in the Sutherland Reservoir could have had a large impact on the historical chloride concentrations within the Sutherland Reservoir and the groundwater underneath the Site. Higher proportions of South Platte River water within the Sutherland Reservoir could lead to a groundwater quality with a chloride concentration sufficiently high enough to cause the elevated chloride concentrations measured at the upgradient monitoring wells at the Site and the chloride concentrations measured at APMW-19 (47.0 mg/L in Q4 2018 and 55.3 mg/L in Q2 2019), which triggered the SSI.

Figure 4 displays a box and whisker plot of the chloride concentrations from the monitoring well network and possible chloride sources at or near the Site. The distribution shows a large variability in chloride concentrations in the background monitoring wells APMW-5, APMW-15, APMW-16A, and APMW-17. This variability may reflect large chloride concentration fluctuations that occur over time in the Sutherland Reservoir. This hypothesis is further supported by Engberg and Spalding (1978), which found elevated chloride concentrations between 10 and 100 mg/L in the regional groundwater of central Nebraska that were near the South Platte River.

5.1.2 Evaporation Pond

Although the evaporation pond is located to the east of APMW-19, and side-gradient in terms of groundwater flow (i.e., seepage from the evaporation pond would be unlikely to be detected at monitoring well APMW-19), evaporation pond water quality is described in this section as it contains water related to GGS plant operations.

Groundwater quality at the three downgradient monitoring wells located around the evaporation pond (i.e., APMW-12, APMW-13, and APMW-14) indicates that process water discharged from the GGS plant and stored in the evaporation pond has migrated to groundwater. Historical concentrations of boron (Figure A1), chloride (Figure A4), sulfate (Figure A9), and TDS (Figure A10), elements that are typically associated with CCR, were detected at elevated levels at the three monitoring wells closest to the evaporation pond compared to the background monitoring wells.

Based on the slight differences in water quality between the groundwater at the monitoring wells APMW-12, APMW-13 and APMW-14 and the evaporation pond, mixing between the evaporation pond water and the upgradient groundwater likely occurs and groundwater at the monitoring wells is not entirely composed of seepage from the evaporation pond. This mixing reaction is supported by the Piper diagram in Figure 3, which shows samples from monitoring wells APMW-12 and APMW-14 plot on a mixing line between the evaporation pond and background groundwater end-member data points.

The chloride concentration in the evaporation pond water was 252 mg/L during the Q1 2019 sampling. Based on the similarities in water quality between the evaporation pond and adjacent groundwater monitoring wells, the evaporation pond is considered a potential source of chloride to groundwater at GGS. However, it is unlikely the evaporation pond influenced groundwater quality at APMW-19, which is side gradient to groundwater flow underneath the evaporation pond (Figure 1).

5.1.3 Historical Ash Landfills

Historical deposits of fly ash present at GGS in historic soil-lined Ash Landfill Nos. 1 and 2 may release soluble constituents to groundwater as the seepage generated by infiltrating precipitation interacts with the ash. While it was not feasible to collect a sample of this seepage directly, ash-impacted waters from Ash Landfills Nos. 3 and 4 (Section 3.1) had chloride concentrations of 69 and 463 mg/L, respectively. These results demonstrate that the historical ash could be a potential chloride source.

A ternary plot comparing sodium, calcium, and sulfate (Figure 5) reveals that ash impacted waters have higher relative sodium abundances and lower relative calcium abundance compared to the upgradient and downgradient groundwater. If infiltrating precipitation was leaching chloride from the historical fly ash, the relative concentrations of sodium, sulfate, and calcium in the groundwater would be similar to the ash impacted waters, but this was not observed.

6.0 EVIDENCE OF AN ALTERNATIVE SOURCE

Based on the testing results and list of potential alternate sources of chloride presented in this report, primary lines of evidence and conclusions drawn from the evidence used to support this ASD are provided in Table 2.

Table 2: Primary Lines of Evidence and Supporting ASD Analysis

Key Line of Evidence	Supporting Evidence	Description
Primary CCR Indicators	Boron and sulfate concentrations in groundwater	Boron (Figure A1) and sulfate (Figure A7) are primary CCR indicators based on high concentrations in pond water from Ash Landfill No.4 (13.8 mg/L and 1810 mg/L, respectively). All upgradient and downgradient CCR unit monitoring wells, with the exception of monitoring wells near the evaporation pond that may be influenced by process waters, have boron concentrations below the PQL (typically <0.2 mg/L). Similarly, sulfate concentrations do not correlate with historical chloride concentrations (Figure A5), which means that the two elements are unlikely to originate from the same source materials or that their concentrations are controlled by the same geochemical processes.
	Relative ion abundance in groundwater differs from ash landfill water	As presented in the Piper plot (Figure 3), relative differences in major ion concentrations show distinct differences between the ash-impacted sump and pond waters, and the downgradient groundwater samples, including groundwater from APMW-19. The geochemical properties of the downgradient groundwater samples are not consistent with seepage from the CCR unit.
Groundwater Geochemistry	Elevated and variable chloride concentrations in background monitoring wells	Chloride concentrations in groundwater at background monitoring wells APMW-5, APMW-16A, and APMW-17 were elevated above chloride concentrations at monitoring well APMW-19 throughout the baseline monitoring period. Since the CCR unit cannot influence the chloride groundwater concentrations in the upgradient wells, the only explanation is that there is an alternate source of chloride present.
	Regional groundwater chloride concentrations	Endberg and Spalding (1978) shows that that chloride concentrations in groundwater near the South Platte River have historically ranged between 10 and 100 mg/L.
Local Sources of Chloride	Hydrogeology	The North and South Platte Rivers, which are ultimately the source of groundwater recharge from the Sutherland Reservoir located approximately 1.5 miles north of the ash landfill, have chloride concentrations between 20 and 94 mg/L.

7.0 CONCEPTUAL SITE MODEL

Golder developed a conceptual site model (CSM) that is presented graphically in Figure 6 to help frame and support the ASD assessment approach. The CSM presents the GGS site layout, a summary of the geologic and hydrogeologic information, and a discussion of groundwater monitoring data, which together lays the groundwork for consideration and development of the ASD. Additionally, the CSM summarizes the findings of literature

research that suggest certain naturally occurring groundwater conditions observed in Nebraska are present at the site and may contribute to naturally elevated chloride concentrations in groundwater around the ash landfill.

8.0 CONCLUSION

In accordance with §257.95(g)(3), this ASD has been prepared in response the identification of an SSI for chloride at monitoring well APMW-19 following the Q2 2019 sampling event for the ash landfill at Gerald Gentleman Station.

Supplemental sampling and review of historical analytical results indicate that the chloride concentrations in groundwater at APMW-19 are not the result of seepage from the ash landfill but can be attributed to naturally occurring chloride from regional groundwater. Therefore, no further action (i.e., transition to Assessment Monitoring) is warranted, and the Gerald Gentleman Station ash landfill will remain in detection monitoring.

9.0 REFERENCES

Steele, G.V., Cannia, J.C., 1997. Reconnaissance of Surface-Water Quality in the North Platte Natural Resources District, Western Nebraska 1993. Water-Resources Investigations Report 96-4316. U.S. Geological Survey. Lincoln, Nebraska.

Goeke, J.W., J.M. Peckenpaugh, R.E. Cady, and J.T. Dugan. 1992. Hydrogeology of Parts of the Twin Platte and Middle Republican Natural Resources Districts, Southwestern Nebraska, Nebraska Water Survey Paper No. 70, Conservation and Survey Division, University of Nebraska-Lincoln, 89 pp.

Golder Associates Inc. 2017. Coal Combustion Residuals Landfill Groundwater Monitoring System Certification, Nebraska Public Power District Gerald Gentlemen Station, Sutherland, Nebraska.

Golder Associates Inc. 2019. Alternate Source Demonstration, Nebraska Public Power District Gerald Gentlemen Station, Sutherland, Nebraska, April.

Engberg, R.A., and R.F. Spalding. 1978. Groundwater quality atlas of Nebraska. Nebraska Conservation and Survey Division University of Nebraska: Resource Atlas, (3).

EPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. EPA 530-R-09-007, March.

EPA. 2014. National Functional Guidelines for Inorganic Data Review. EPA 540-R-013-001, August.


Woodward-Clyde Consultants. 1991. Design and Construction of a Groundwater Monitoring Network, Final Report, Gerald Gentleman Station, Nebraska Public Power District, Sutherland, Nebraska, WCC Project No. 90MC176, Omaha, Nebraska, September.

Signature Page

Golder Associates Inc.



Jacob Sauer
Senior Engineer

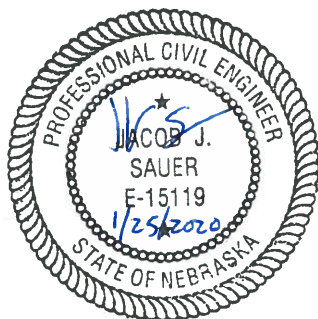


Hugh Davies
Senior Geochemist

JS/HD/ds

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FIGURES

FIGURE 1

Site Map with Groundwater
Contours – July 2019

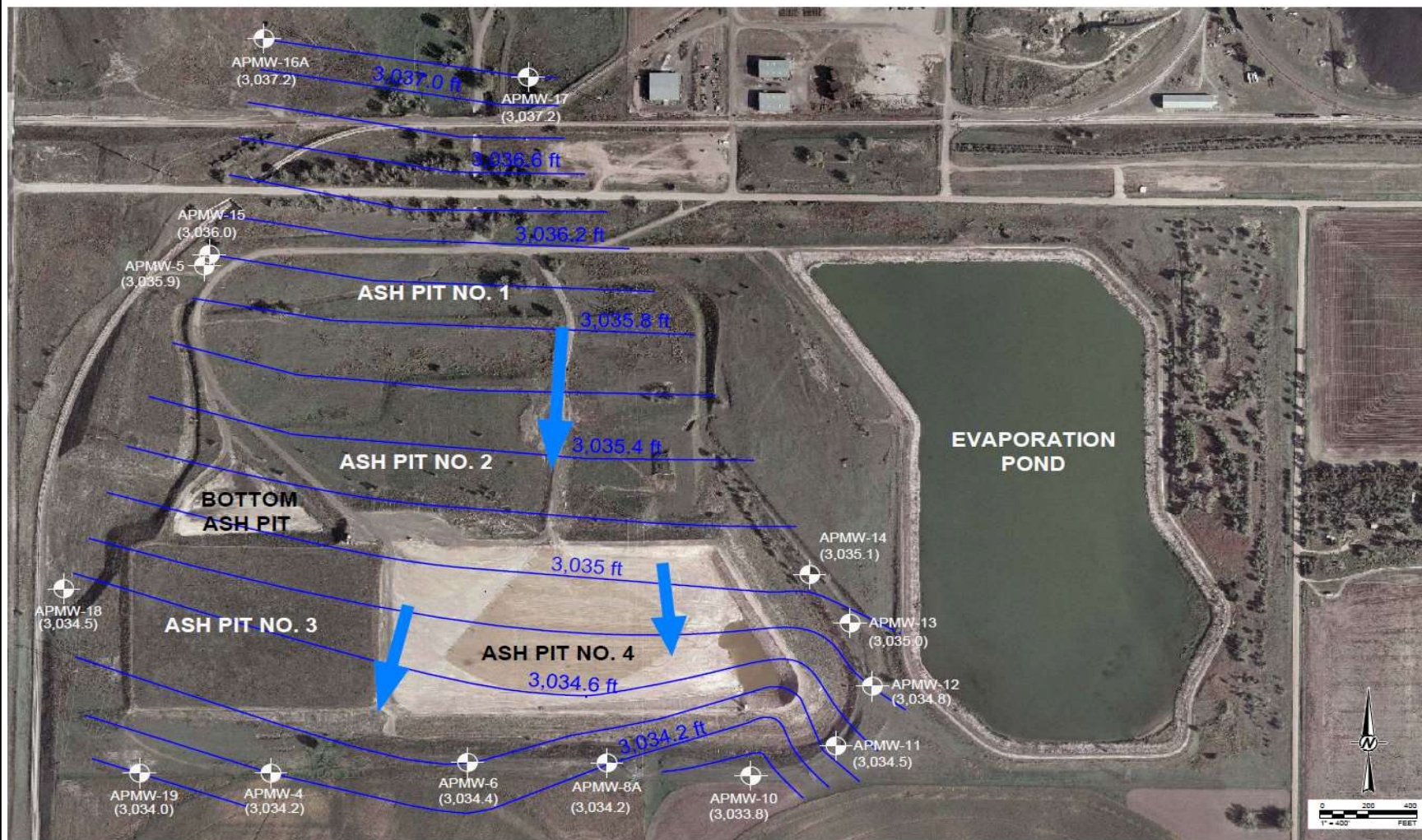


Figure 1
Site Map with Groundwater Contours- July 2019

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FIGURE 2

Groundwater Monitoring Well Water Levels

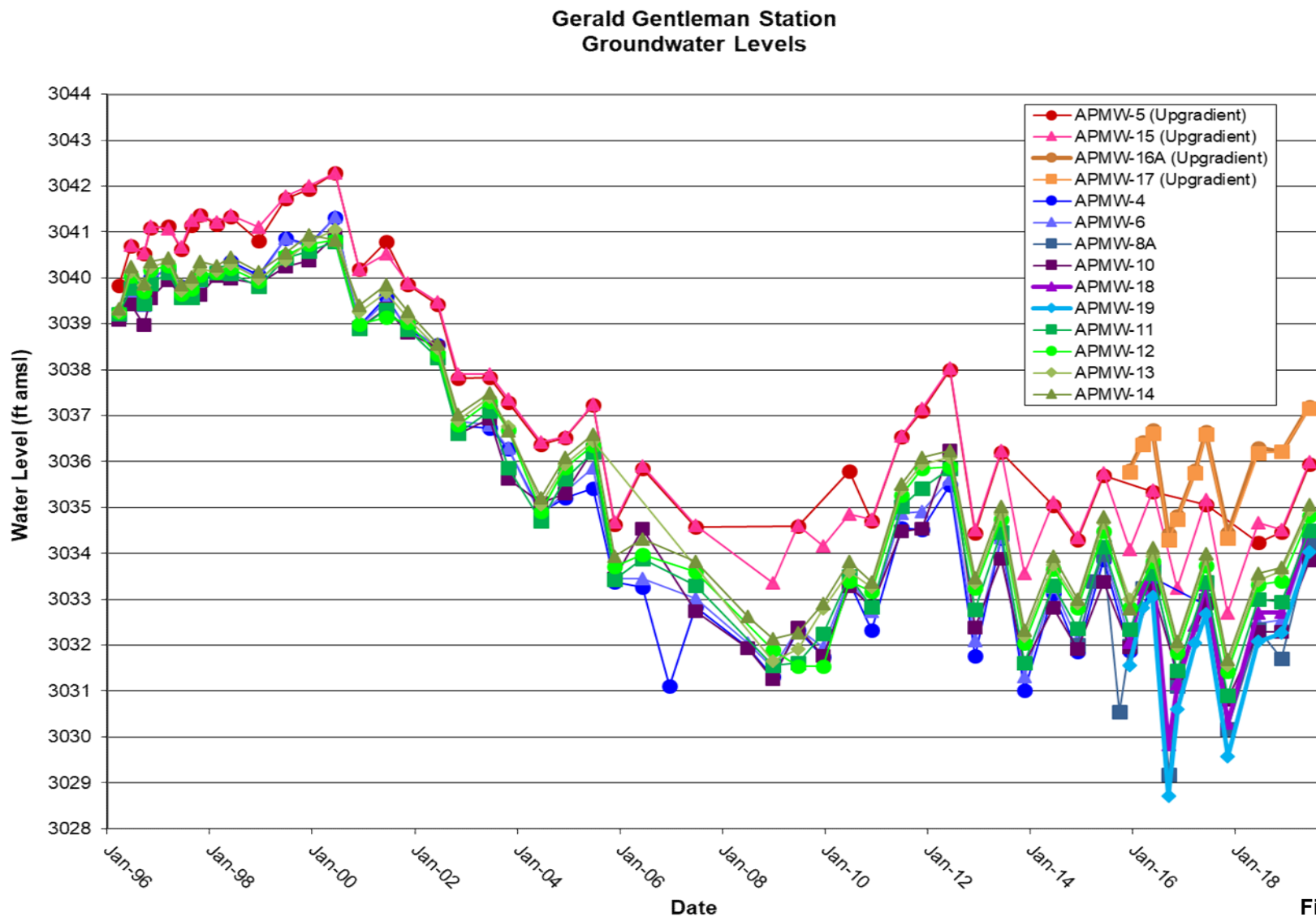


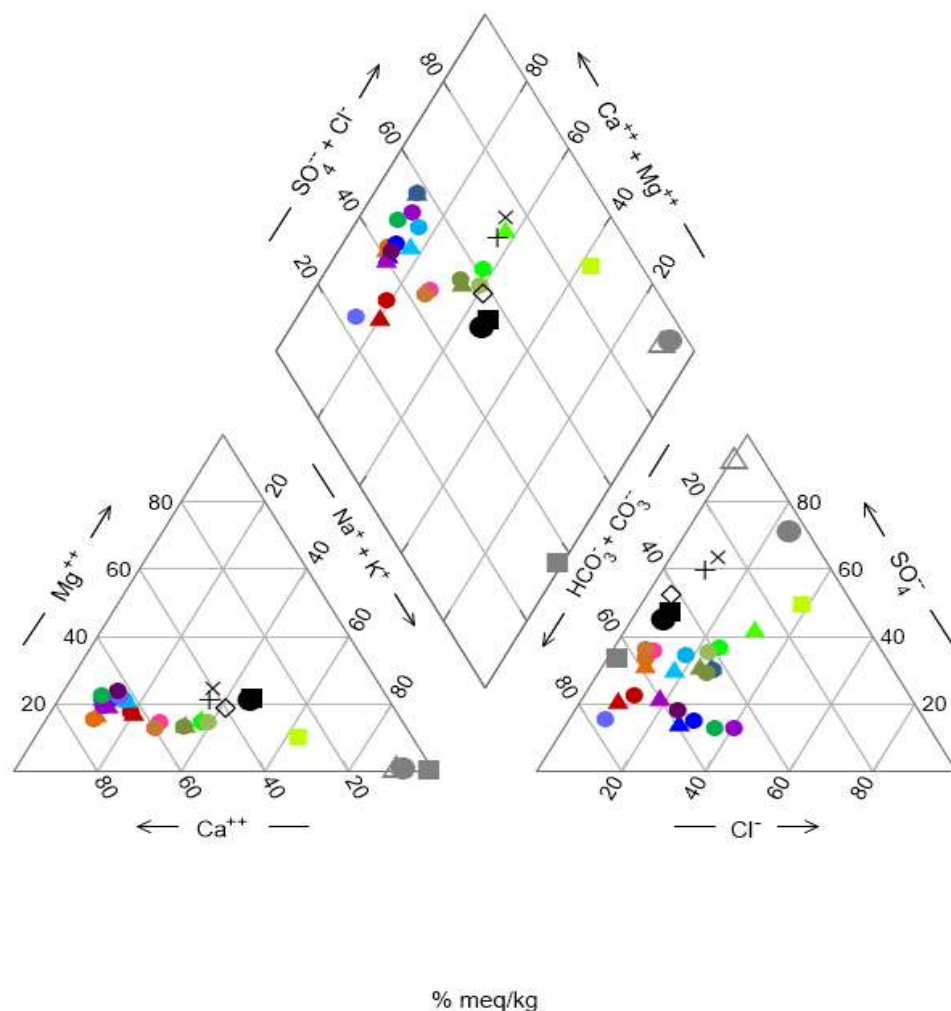
Figure 2
Groundwater Monitoring Well Water Levels

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FIGURE 3

Piper Diagram of Groundwater and Potential Fluoride Sources



- ▲ APMW-5 (Upgradient; Q1 2019)
- APMW-5 (Upgradient; Q4 2019)
- ▲ APMW-17 (Upgradient; Q1 2019)
- APMW-17 (Upgradient; Q4 2019)
- APMW-15 (Upgradient; Q4 2019)
- APMW-16A (Upgradient; Q4 2019)
- ▲ APMW-4 (Q1 2019)
- APMW-4 (Q4 2019)
- ▲ APMW-8A (Q1 2019)
- APMW-8A (Q4 2019)
- ▲ APMW-18 (Q1 2019)
- APMW-18 (Q4 2019)
- ▲ APMW-19 (Q1 2019)
- APMW-19 (Q4 2019)
- ▲ APMW-12 (Q1 2019)
- APMW-12 (Q4 2019)
- ▲ APMW-14 (Q1 2019)
- APMW-14 (Q4 2019)
- APMW-6 (Q4 2019)
- APMW-10 (Q4 2019)
- APMW-11 (Q4 2019)
- APMW-13 (Q4 2019)
- Evaporation Pond (Q1 2019)
- × South Platte- Upstream Average
- + South Platte- Downstream Average
- ◇ North Platte- Upstream Average
- Reservoir (Q4 2019)
- Canal (Q4 2019)
- Ash Pit 3 Sump (Q4 2019)
- Ash Pit 4 Pond (Q4 2019)
- △ SPLP leachate from fly ash

Figure 3
Piper Diagram of Groundwater and Potential Fluoride Sources

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FIGURE 4

Box and Whisker Plot of Chloride Concentrations

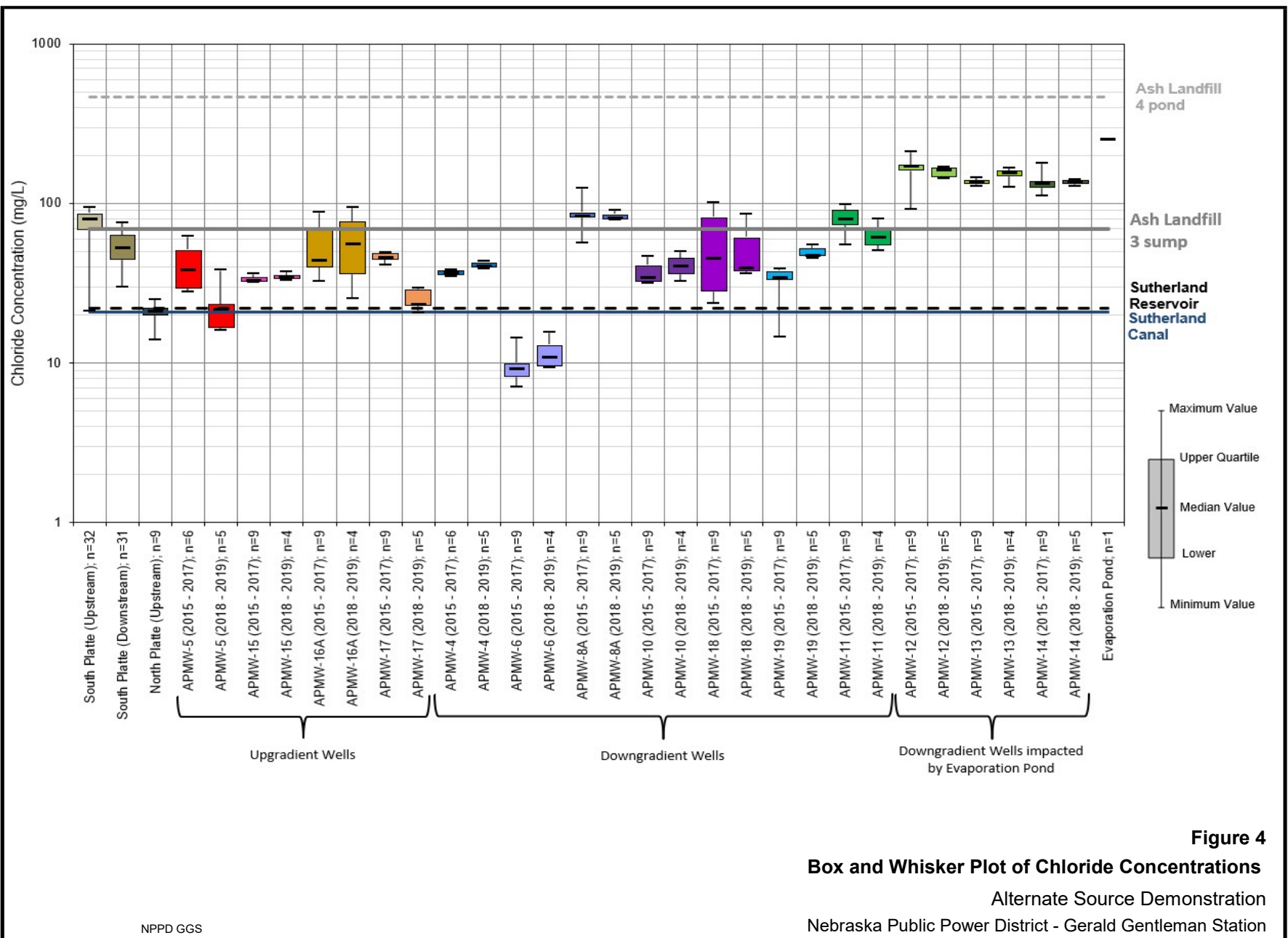


Figure 4

Box and Whisker Plot of Chloride Concentrations

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FIGURE 5

Ternary Diagram of Groundwater and Potential Chloride Sources

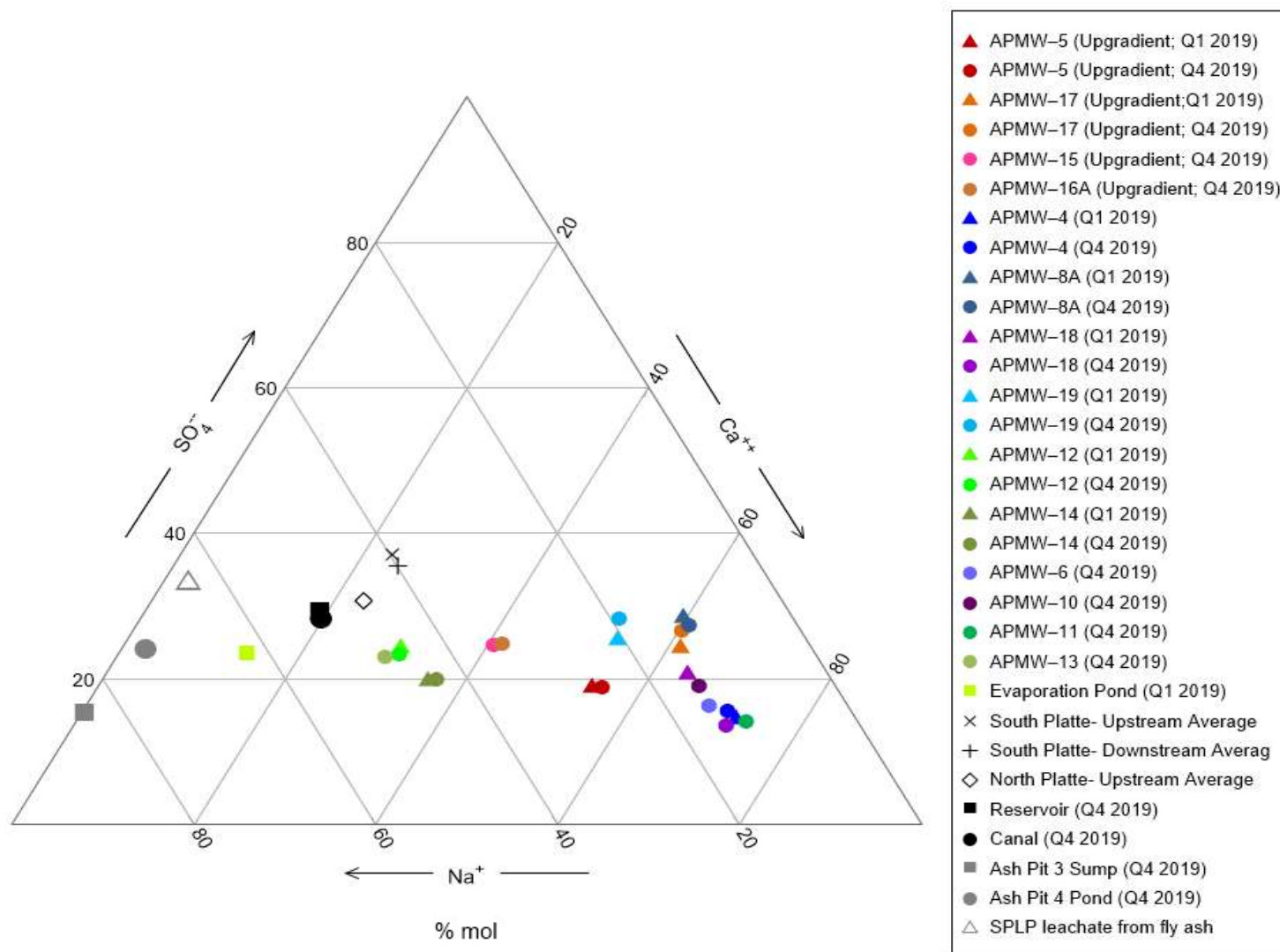


Figure 5
Ternary Diagram of Groundwater and Potential Chloride Sources

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FIGURE 6

Conceptual Site Model

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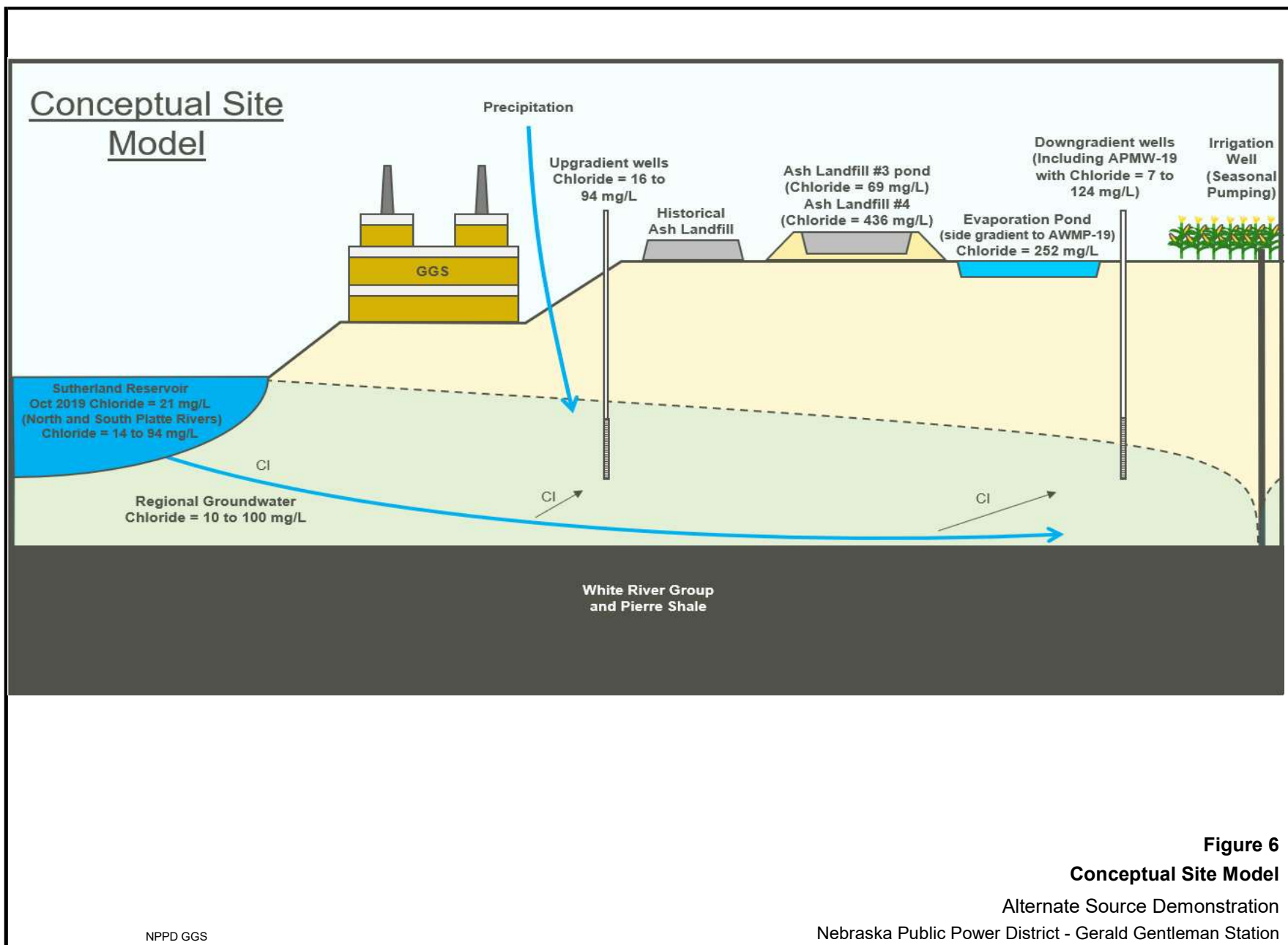


Figure 6
Conceptual Site Model

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APPENDIX A

Time Series

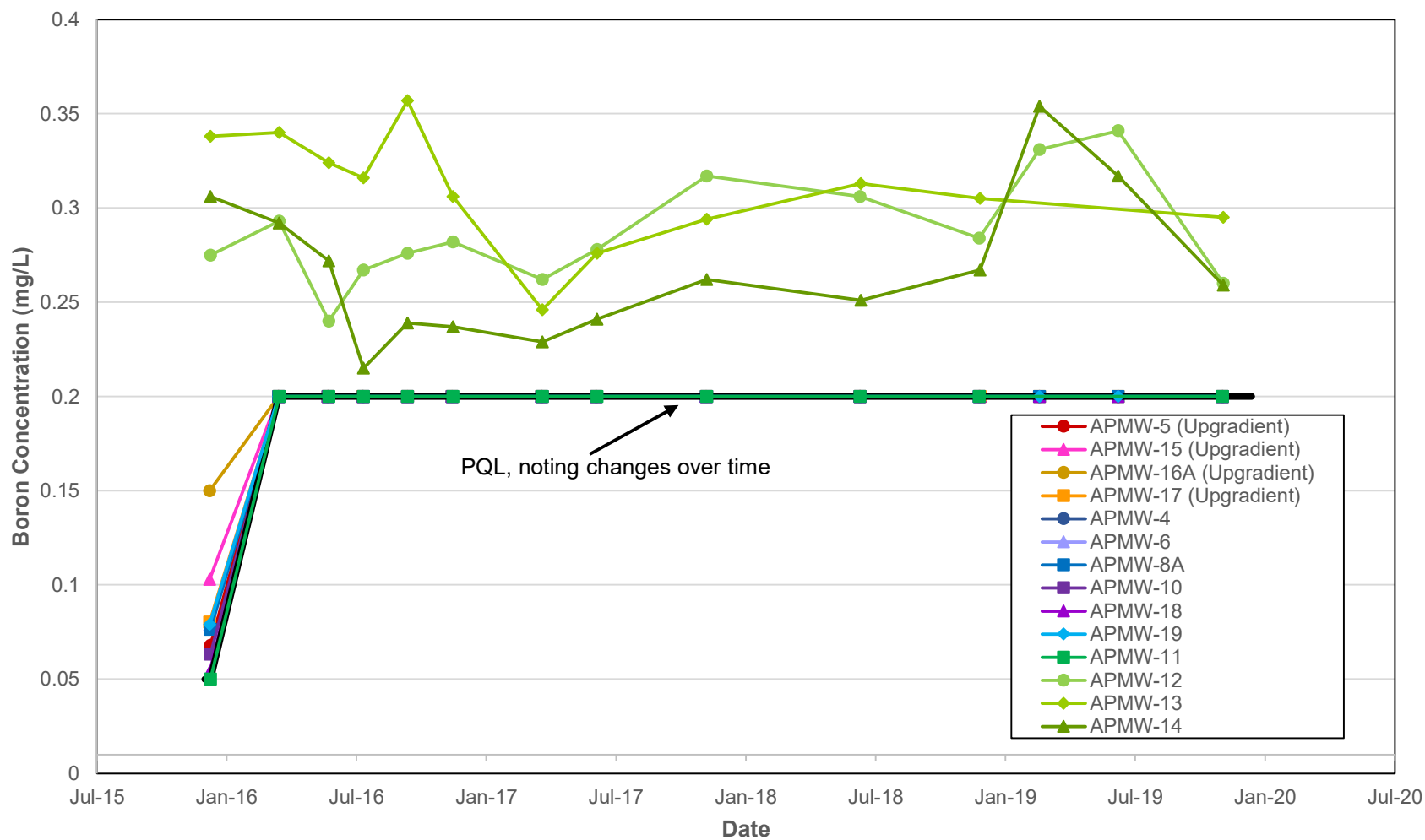


Figure A1
Groundwater Boron Concentrations

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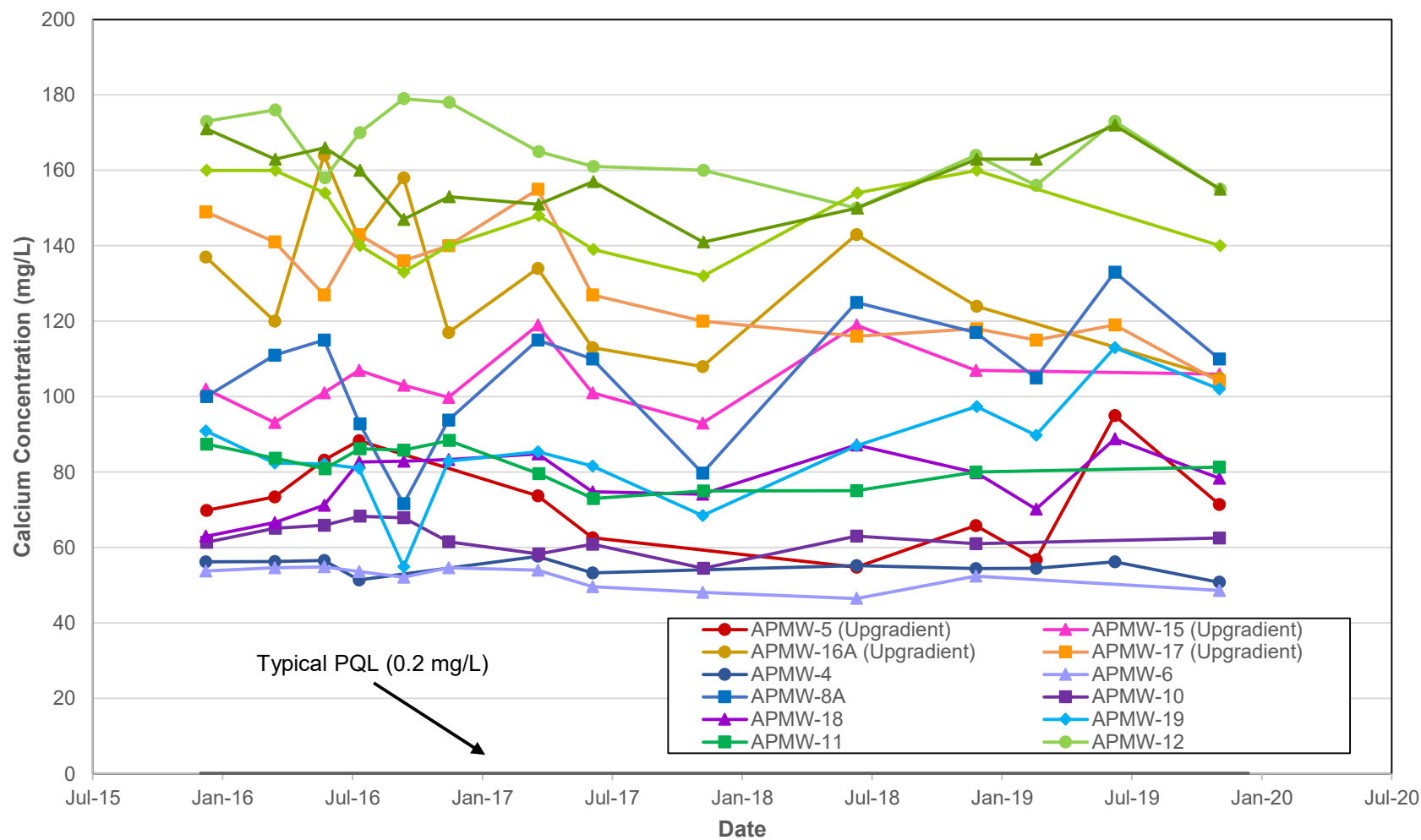


Figure A2
Groundwater Calcium Concentrations

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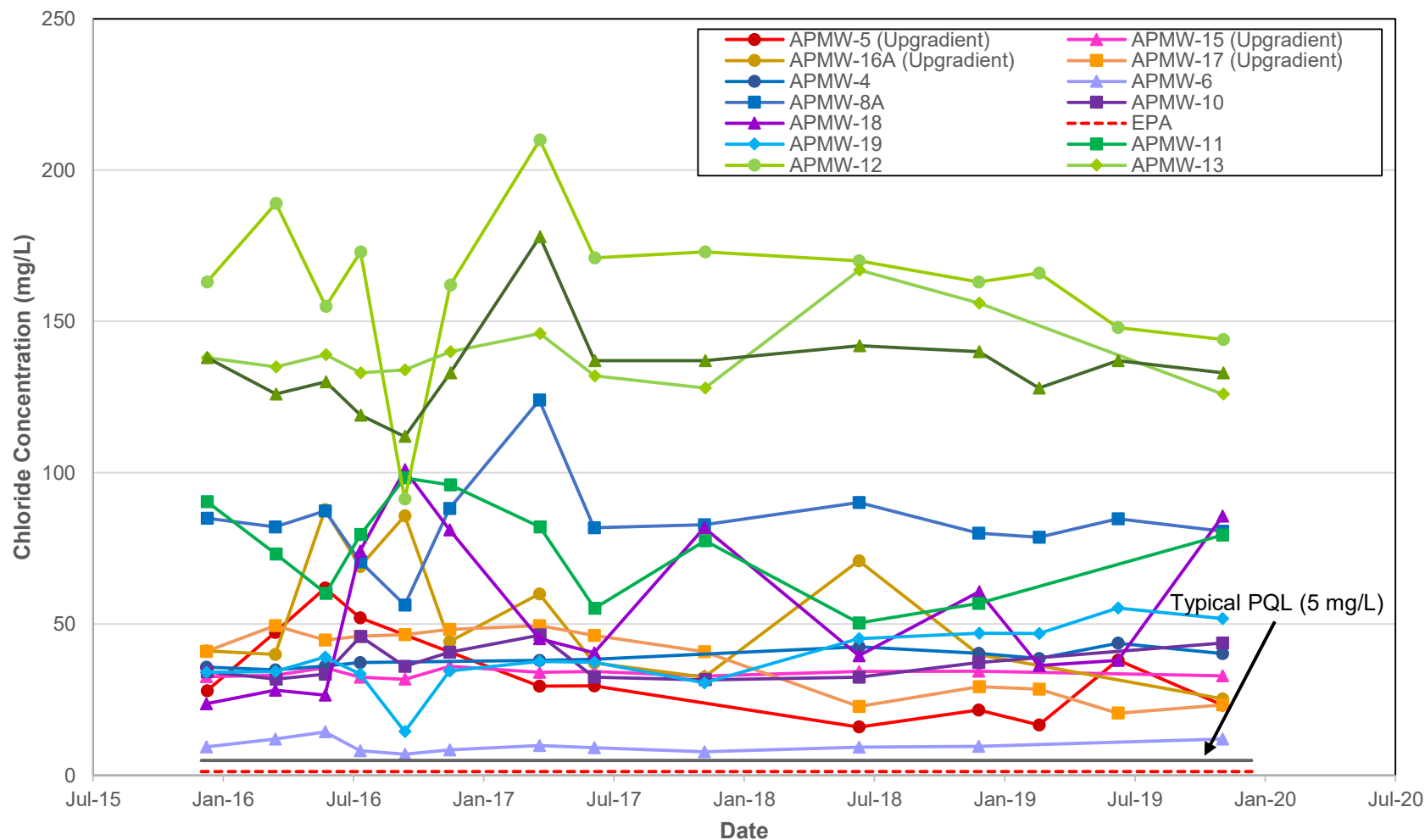


Figure A3
Groundwater Chloride Concentrations

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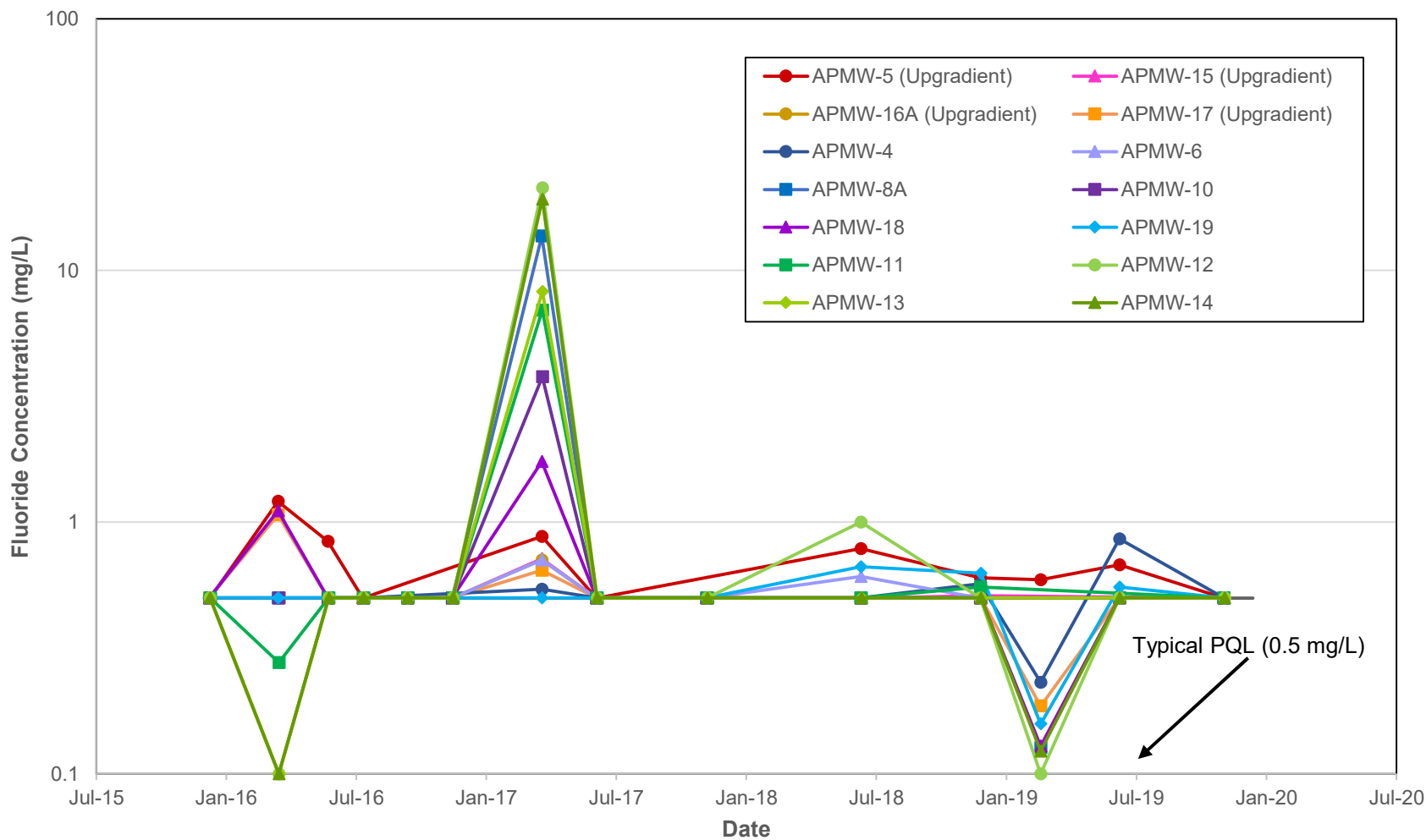


Figure A4
Groundwater Fluoride Concentrations

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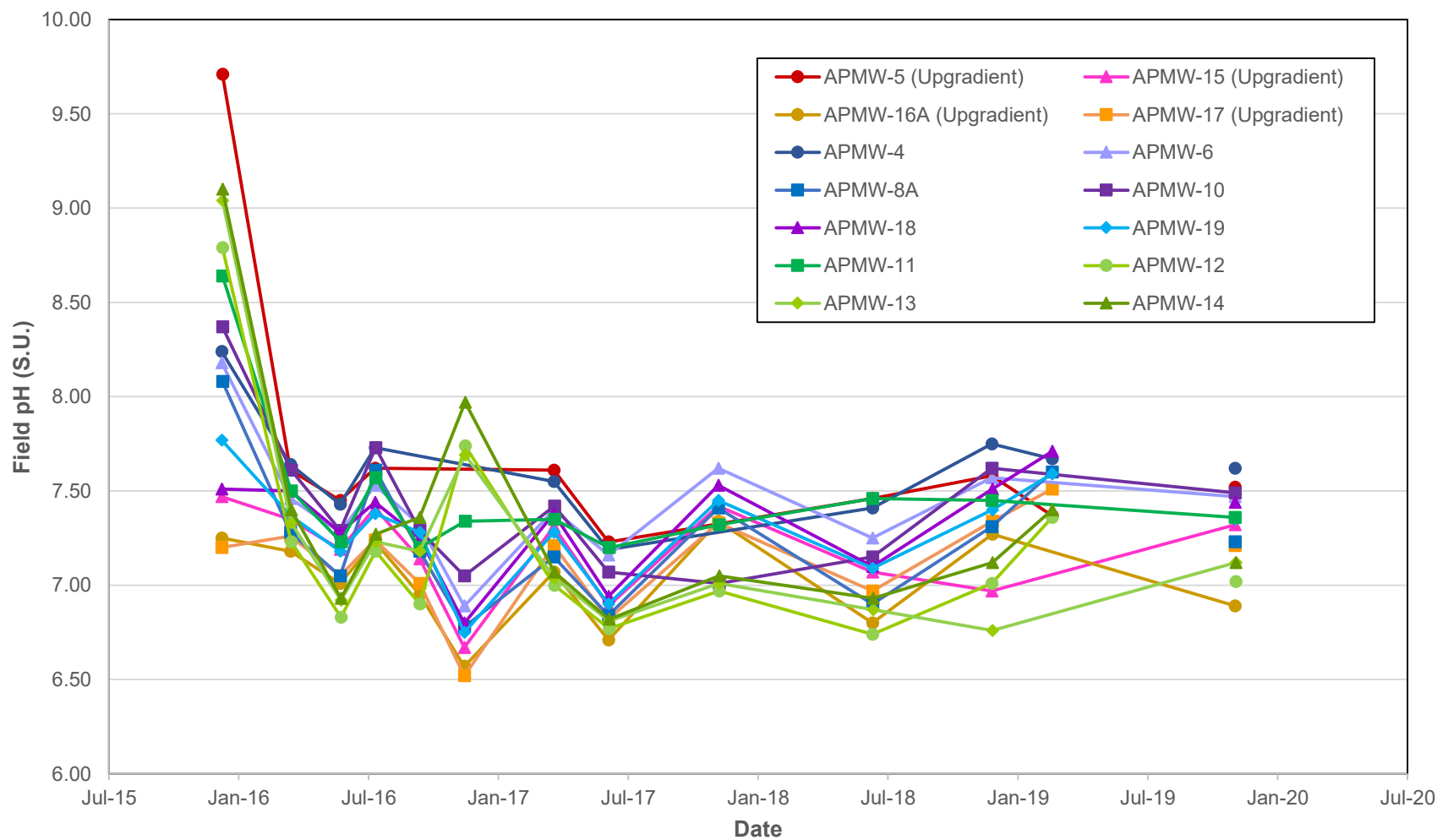


Figure A5
Groundwater Field pH

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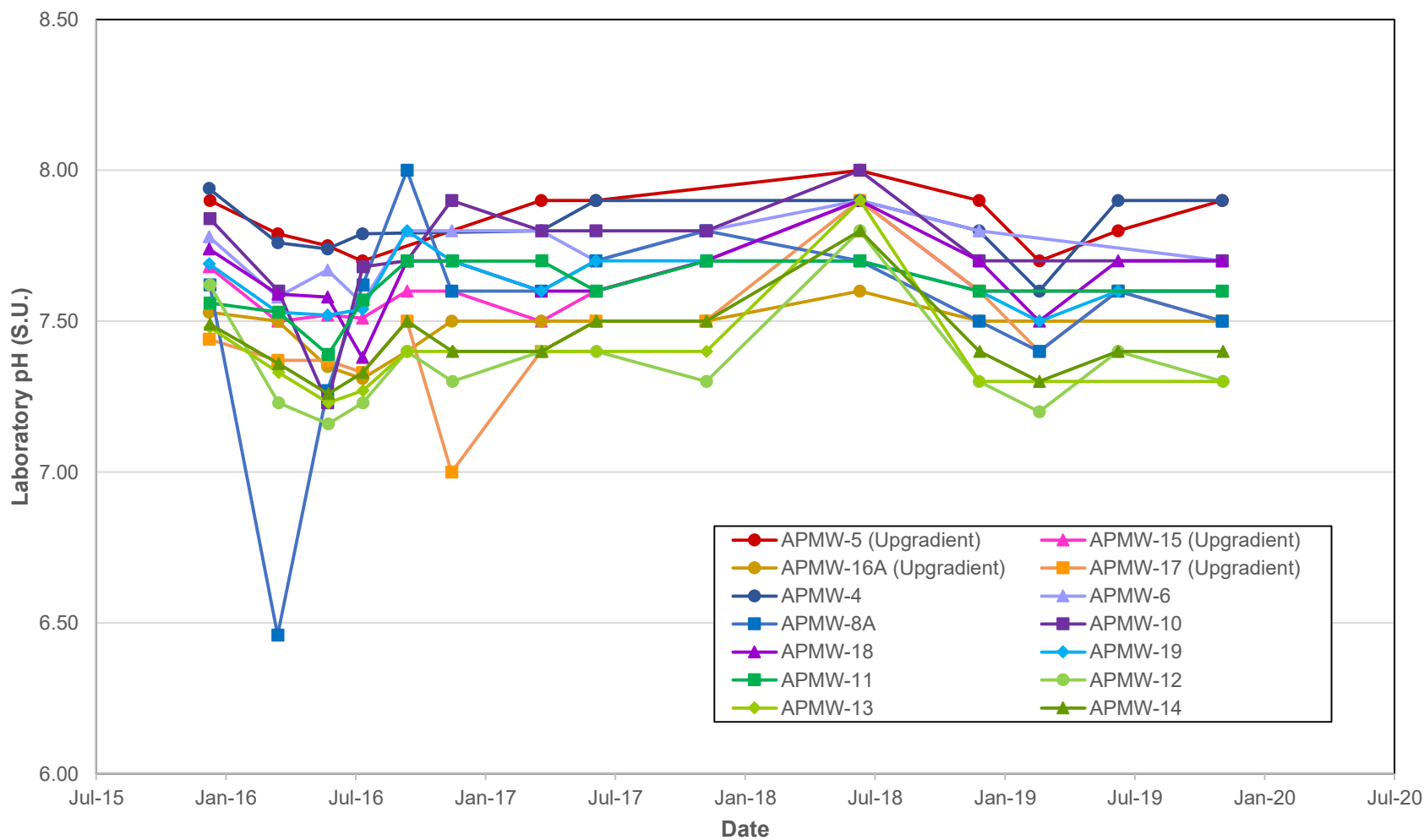


Figure A6
Groundwater Laboratory pH

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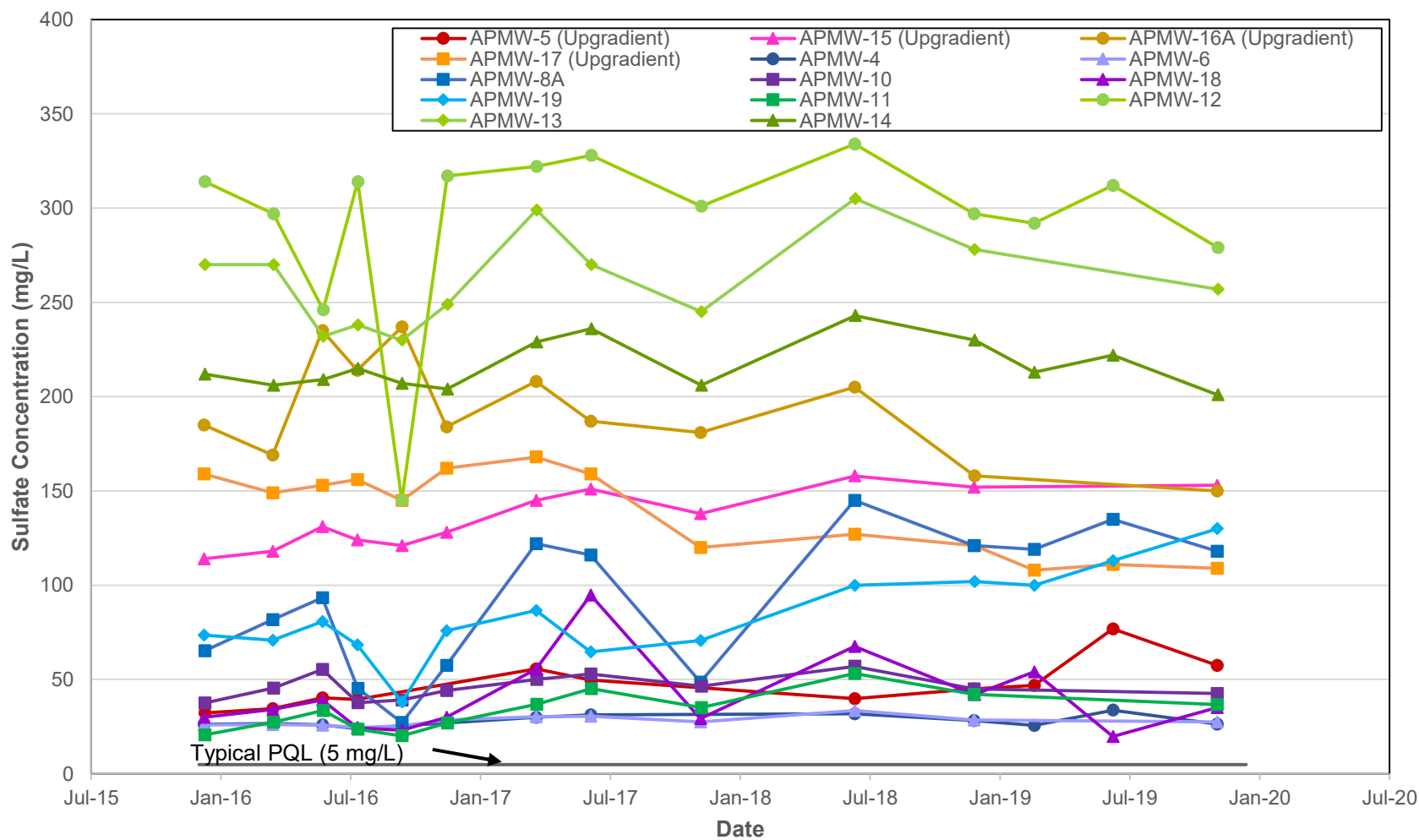


Figure A7
Groundwater Sulfate Concentrations

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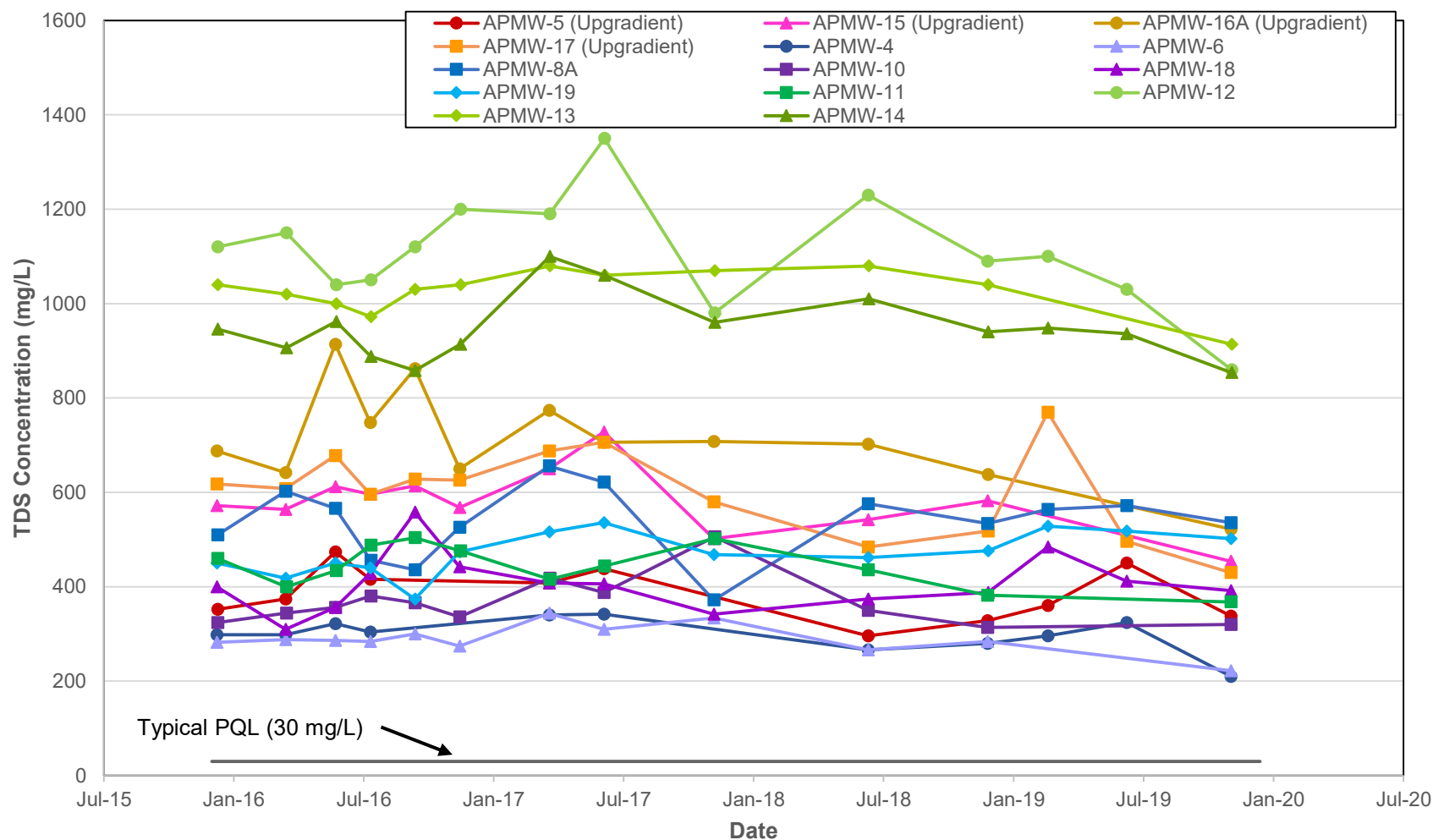


Figure A8
Groundwater TDS Concentrations

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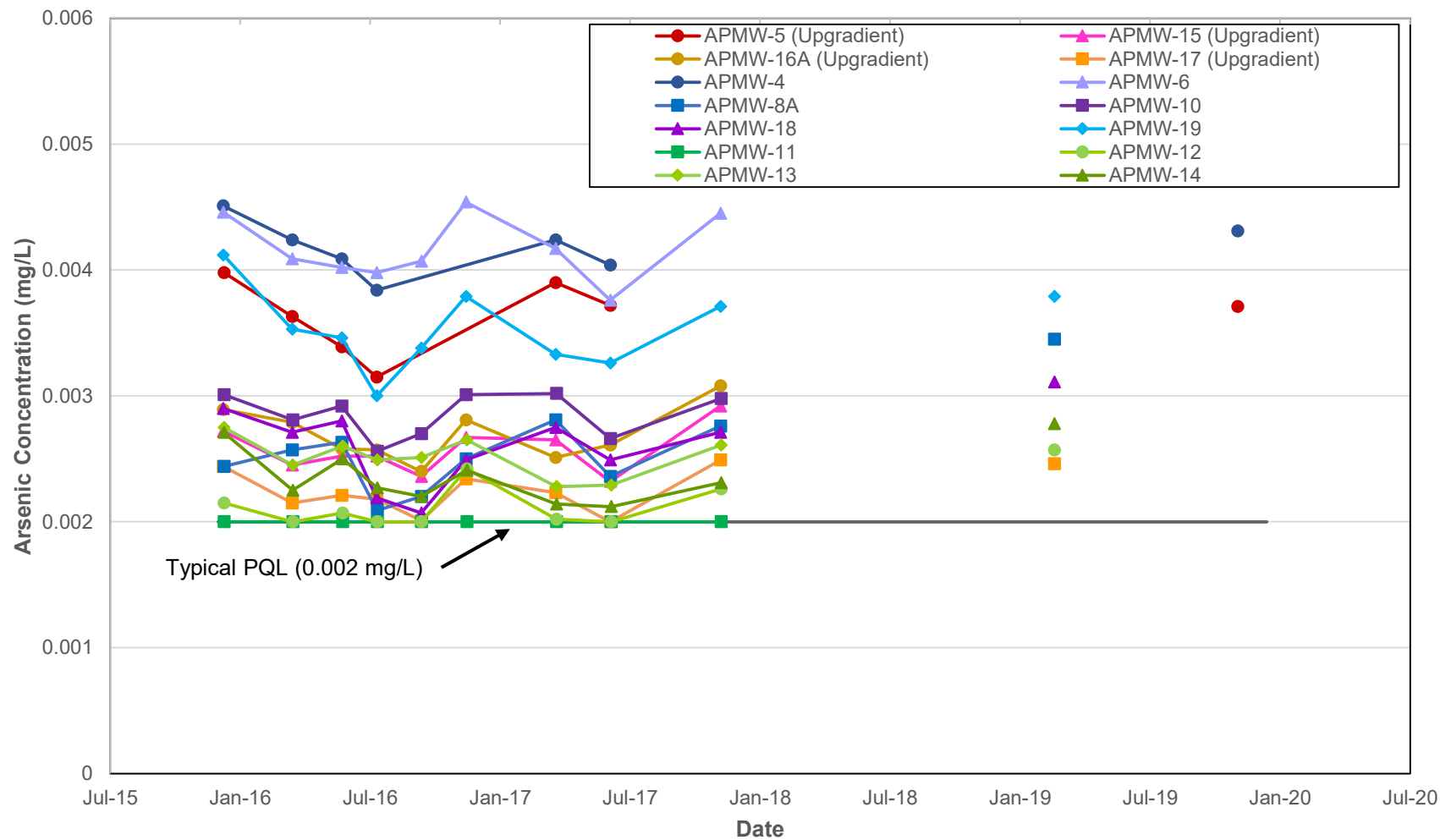


Figure A9
Groundwater Arsenic Concentrations

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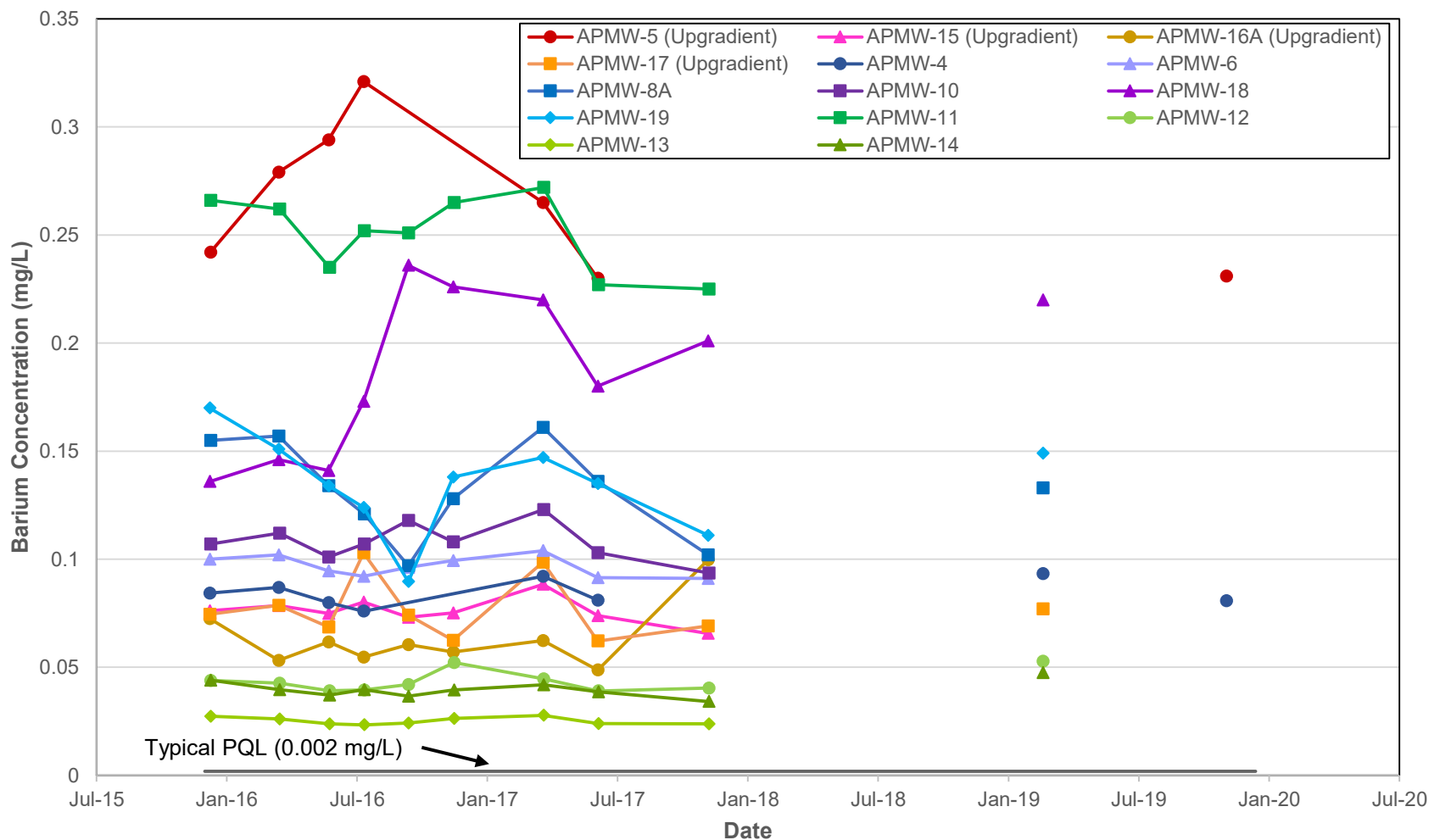


Figure A10
Groundwater Barium Concentrations

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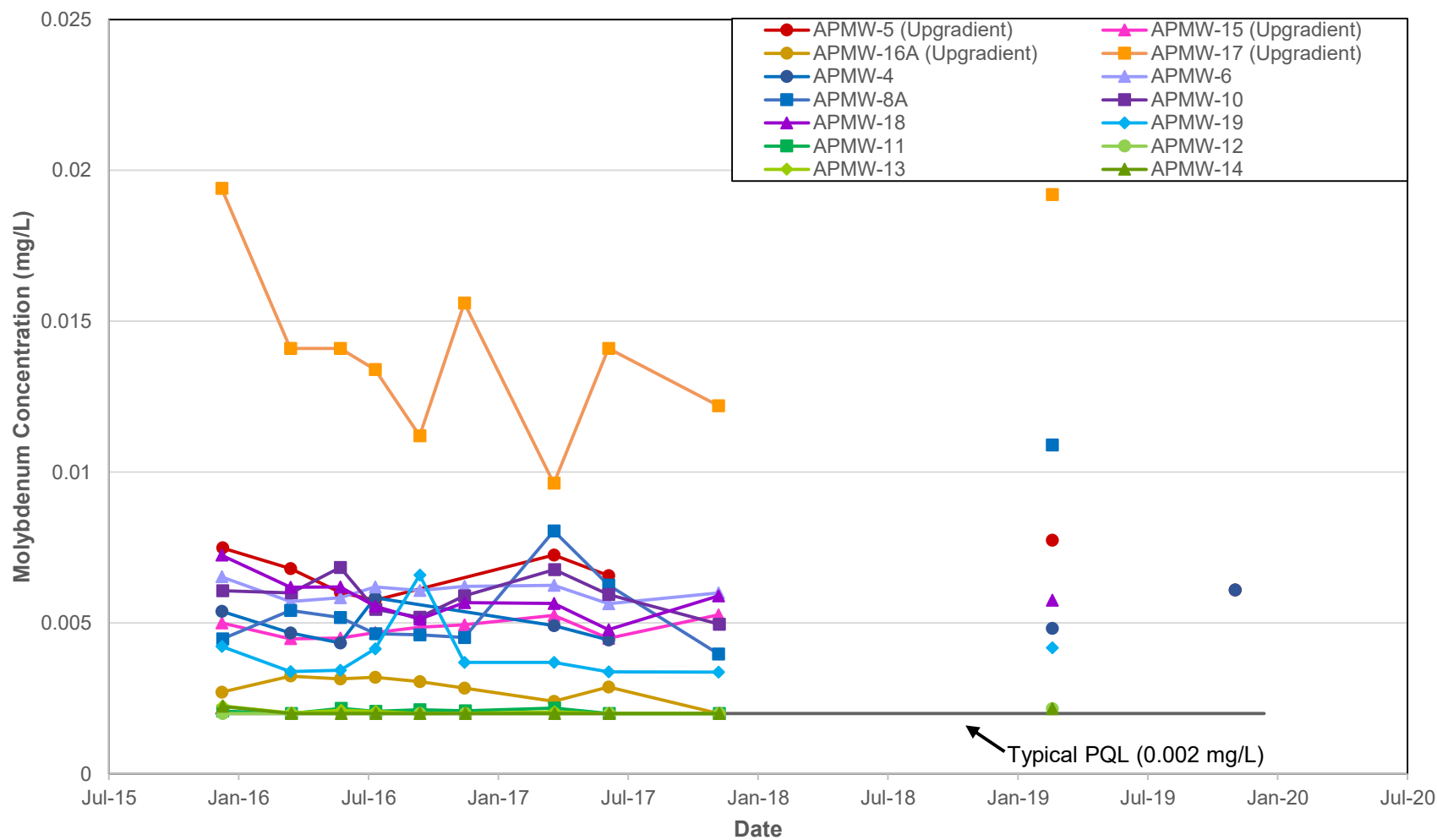


Figure A11
Groundwater Molybdenum Concentrations

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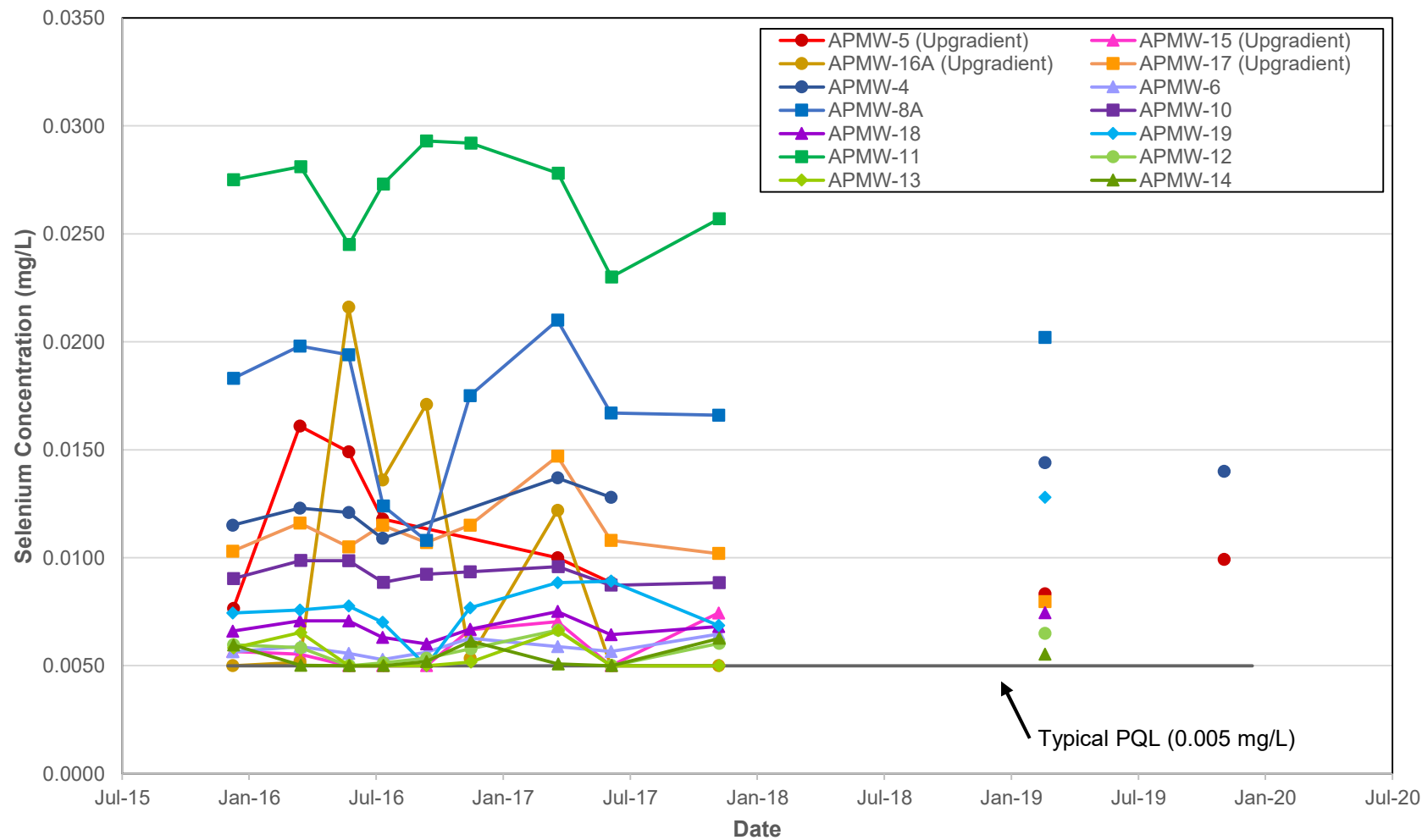


Figure A12
Groundwater Selenium Concentrations

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