GOLDER

REPORT

Annual Groundwater Monitoring Report – 2019

Coal Combustion Residuals Landfill,
Nucla Station Ash Disposal Facility, Nucla, Colorado

Submitted to:

Tri-State Generation and Transmission Association, Inc.
PO Box 33695, Denver, Colorado 80233

COLORADO LICENSED
JASON E. OBERMEYER
1.29.20
40294
PROFESSIONAL ENGINEER

Submitted by:

Golder Associates Inc.
7245 West Alaska Drive, Suite 200, Lakewood, Colorado 80226

+1 303 980-0540

19118707

January 29, 2020

Executive Summary

This report summarizes the groundwater monitoring activities and results for the 2019 detection monitoring program for the coal combustion residuals (CCR) landfill that serves Nucla Station, along with the comparative statistical analysis. The CCR landfill, which is owned and operated by Tri-State Generation and Transmission Association, Inc., is currently in detection monitoring, and no program transitions occurred in 2019.

Three verified statistically significant increases (SSIs) were identified in 2019. These include field pH at well MO-1 and well MO-3 and total dissolved solids at well MO-2. A demonstration of natural variability or alternative source demonstration was prepared for each verified SSI, and it was recommended that the landfill remain in detection monitoring. As described in the Groundwater Monitoring System Certification (Golder 2019b) and the Groundwater Monitoring Statistical Methods Certification (Golder 2017), the groundwater monitoring and analytical procedures meet the requirements of 40 CFR 257 (the Coal Combustion Residuals Rule), and modifications to the monitoring network and sampling program are not recommended at this time.

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this report to describe the 2019 groundwater monitoring activities and comparative statistical analysis for the Nucla Station Ash Disposal Facility (the Facility), which is a coal combustion residuals (CCR) landfill owned and operated by Tri-State Generation and Transmission Association, Inc. (Tri-State). This report was written to meet the requirements of 40 CFR 257.90(e).

1.1 Facility Information

The facility serves as the location for final deposition of CCRs generated at Tri-State's Nucla Station, a 110-megawatt coal-fired electric generation plant located near Nucla, Colorado. Nucla Station was retired from service in September 2019. Within the 81.65-acre property of the Facility, the CCR disposal footprint comprises approximately 61 acres.

1.2 Purpose

The CCR Rule established specific requirements for reporting of groundwater monitoring and corrective action in 40 CFR 257.90. Per part (e) of 40 CFR 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.

2.0 GROUNDWATER MONITORING NETWORK PROGRAM STATUS

The groundwater monitoring system for the Nucla Station Ash Disposal Facility consists of five monitoring wells, as shown on Figure 1 (Golder 2019b). The two upgradient monitoring wells are MO-1 and MO-2. The three downgradient wells are MO-3, MO-4, and MO-5.

2.1 Completed Key Actions in 2019

The following key actions were completed in 2019:

- An updated Groundwater Monitoring System Certification (Golder 2019b) was placed within the operating record and on Tri-State's publicly accessible CCR website.
- The 2018 Annual Groundwater Monitoring Report was finalized and placed within the operating record and on Tri-State's publicly accessible CCR website.
- The fourth and fifth detection monitoring sampling events were performed on April 23 and 24, 2019 and October 22 and 29, 2019, respectively.
- A demonstration of natural variability was prepared as a result of a verified SSI for total dissolved solids in MO-2 (Appendix A), and it was recommended that the Facility remain in detection monitoring.
- An alternative source demonstration (ASD) was prepared as a result of a verified SSI for field pH in MO-1 (Appendix B), and it was recommended that the Facility remain in detection monitoring.

2.2 Installation and Decommissioning of Monitoring Wells

No monitoring wells were installed or decommissioned for the Nucla Station Ash Disposal Facility in 2019.

2.3 Problems and Resolutions

Groundwater levels were not measured at MO-5 during the October 2019 sampling event because the transducer was unable to connect to the laptop used to download the data. The transducer, connection cable, and laptop are being evaluated to limit future issues.

2.4 Proposed Key Activities for 2020

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

- Detection monitoring sampling events are planned to occur in the second and fourth quarters of 2020.

3.0 GROUNDWATER MONITORING PROGRAM STATUS

Activities associated with the groundwater monitoring program are described below.

3.1 Groundwater Flow

The groundwater elevation was measured in each well prior to purging during each sampling event, except in MO-5 during the October 2019 sampling event. Elevations are presented in Table 1 through Table 5. Groundwater elevations from the April 2019 and October 2019 sampling events are shown on Figure 1 and Figure 2, respectively. Groundwater levels in MO-2 and MO-5 have been slowly increasing since well installation in 2016. In 2019, the Groundwater Monitoring System Certification (Golder 2019b) was updated to indicate that MO-1 and MO-2 are both upgradient monitoring wells.

The Morrison aquifer is characterized as highly heterogeneous with zones that are variably transmissive and/or subjected to variable amounts of confining pressure. This characterization is supported by the differences in groundwater levels, water column heights, and recovery times observed in the monitoring wells that have been installed to serve as the groundwater monitoring system for the Facility. Sandstone lenses in the Morrison aquifer vary considerably with respect to transmissivity (i.e., thickness and hydraulic conductivity) and horizontal extent due to the alluvial, shoreline, and lacustrine environments that deposited the Salt Wash and Brushy Basin Members of the Morrison Formation, resulting in interbedded siltstone, mudstone, claystone, and shale units. Groundwater elevation data suggest a general southerly groundwater flow direction in the Morrison aquifer near the Nucla Station Ash Disposal Facility. However, the heterogeneity and interbedded nature of the Morrison Formation beneath the Facility, coupled with the observation that groundwater levels in the monitoring wells continue to stabilize at the time of this report’s preparation, confound the ability to precisely discern groundwater flow direction and rate.

3.2 Monitoring Data (Analytical Results)

Analytical results for the 2019 monitoring are shown in Table 1 through Table 5.

3.3 Samples Collected

Two samples were collected from MO-1 through MO-5 during 2019 for the detection monitoring program. These sampling events occurred in April and October 2019. A third sample was collected from MO-2 on January 29, 2019, from MO-5 on February 1, 2019, and from MO-3 on February 4, 2019, for confirmatory resampling associated with the detection monitoring program. MO-1 had two additional samples collected for confirmatory resampling associated with the detection monitoring program, one on February 1, 2019 and the other on September 5, 2019.

3.4 Comparative Statistical Analysis

The comparative statistical analysis is summarized below, and the results are presented in Table 6 through Table 10. A full description of the steps taken for the comparative statistical analysis can be found in the Groundwater Monitoring Statistical Methods Certification (Golder 2017).

3.4.1 Definitions

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

- SSI – is a statistically significant increase (SSI) and is defined as an analytical result that exceeds the parametric or non-parametric statistical limit established by the baseline statistical analysis.
- Potential Exceedance – is defined as an initial analytical result that exceeds the parametric 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 SSI.
- False-positive SSI – is defined as an analytical result that exceeds the statistical limit but can clearly be attributed to laboratory error or changes in analytical precision, or is invalidated through confirmatory resampling.
- Confirmatory resampling – is designated as the resampling event that occurs within 90 days of identifying an SSI over the statistical limit for determination of a verified SSI[1].
- Verified SSI – is interpreted as two consecutive SSIs (the original sample and the confirmatory resample for analytical results) for the same constituent at the same well.

3.4.2 Potential Exceedances

No potential exceedances[2] were identified for samples collected during the October 2019 sampling event.

3.4.3 False-positive Statistically Significant Increases

Confirmatory resampling for potential exceedances associated with the October 2018 sampling event occurred in January and February 2019. The resampling event identified four false positives associated with the October 2018 sampling event. These include field pH at MO-1, chloride and total dissolved solids at MO-3, and sulfate at MO-5. No further action is needed.

3.4.4 Verified Statistically Significant Increases

Field pH measurements for the samples collected from MO-3 during both 2019 detection monitoring events indicate verified SSIs. The initial exceedance for MO-3 field pH occurred during the April 2018 sampling event and was verified with confirmatory resampling conducted in July 2018. In September 2018[3], a demonstration of natural variability was conducted for field pH in MO-3, and it was recommended that the Facility remain in detection monitoring (Golder 2019a). The September 2018 demonstration of natural variability indicating that the

---

[1] Resampling might not occur within 90 days of the sampling event that resulted in the potential exceedance because of the additional time required for activities that must occur before a potential exceedance can be identified. These include sample delivery, analytical testing, review of results, and comparative statistical analysis.

[2] The term “unverified statistically significant increase” was used in previous annual groundwater monitoring reports for the Facility.

[3] Under 40 CFR 257.94(e)(2) these demonstrations should occur within 90 days of identifying the verified SSI. The demonstrations might not occur within 90 days of the confirmatory resample event that resulted in the verified SSI because of the additional time required for activities that must occur before a verified SSI can be identified. These include sample delivery, analytical testing, review of results, and comparative statistical analysis.

pH measurements reflect natural variability is applicable to the April 2019 and October 2019 measurements, and it is recommended that the Facility remain in detection monitoring.

The total dissolved solids result for the sample collected from MO-2 during the October 2018 detection monitoring event indicates a verified SSI. This was verified with confirmatory resampling conducted in January 2019. In May 2019, a demonstration of natural variability was conducted for total dissolved solids in MO-2, and it was recommended that the Facility remain in detection monitoring (Appendix A). The total dissolved solids measurements in April and October 2019 did not indicate an SSI.

The field pH measurements for the samples collected from MO-1 during both 2019 detection monitoring events indicate verified SSIs. The pH values at MO-1 were less than the lower statistical limit during the first semi-annual compliance event in April 2019 and during the confirmatory sampling event in September 2019, indicating an SSI[4]. In December 2019, an ASD was prepared for field pH in MO-1, and it was recommended that the Facility remain in detection monitoring (Appendix B). This ASD is also applicable to the SSI identified during the October 2019 sampling event.

4.0 PROGRAM TRANSITIONS

In the fourth quarter of 2017, the groundwater monitoring program for the Nucla Station Ash Disposal Facility transitioned from the baseline period to detection monitoring. The Facility remains in detection monitoring.

4.1.1 Detection Monitoring

Samples for the detection monitoring program are collected on a semi-annual basis, beginning with the sample collected in October 2017. Tri-State plans to collect semi-annual samples for the detection monitoring program in the second and fourth quarters of 2020. In 2019, a demonstration of natural variability was performed for total dissolved solids in MO-2 (Appendix A) and an ASD was performed for field pH in MO-1 (Appendix B).

4.1.2 Assessment Monitoring

The groundwater monitoring program for the Facility is not in assessment monitoring. Assessment monitoring has not been triggered as described in 40 CFR 257.95. As such, no ASDs have been made under an assessment monitoring program and no actions are required.

4.1.3 Corrective Measures and Assessment

The groundwater monitoring program for the Facility does not indicate the need for corrective measures. An assessment of corrective measures, as described in 40 CFR 257.96, is not required.

5.0 RECOMMENDATIONS AND CLOSING

This report presents the groundwater monitoring activities and results for the 2019 detection monitoring program for the Nucla Station Ash Disposal Facility, along with the comparative statistical analysis. The significant findings from the 2019 monitoring activities and comparative statistical analysis are as follows:

- Confirmatory resampling in January and February 2019 identified four false positives associated with the October 2018 sampling event.

[4] The term SSI is used to be consistent with generally accepted language, However, the SSI is for values less than the two-tailed pH limit.

- Field pH in MO-3 was identified as a verified SSI for both detection monitoring samples collected in 2019. A demonstration of natural variability was performed in 2018 indicating that the pH measurements reflect natural variability, which is applicable to both detection monitoring samples collected in 2019. It is recommended that the Facility remain in detection monitoring, and no further actions are required.
- A demonstration of natural variability was prepared for total dissolved solids in MO-2 in May 2019 and it is recommended that the Facility remain in detection monitoring. This was done in response to a verified SSI identified from the October 2018 sampling event, and no verified SSIs were identified from the 2019 sampling events. No further actions are required.
- Field pH in MO-1 was identified as a verified SSI for both detection monitoring samples collected in 2019. An ASD was performed in December 2019 and it was recommended that the Facility remain in detection monitoring. No further actions are required.

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

Signature Page

Golder Associates Inc.

Sara Harkins
Senior Project Geochemist

Jason Obermeyer, PE
Associate and Senior Consultant

SH/JO/dls

19118707-0003-7-R-0 Nucla_CCR_2019_AnnGWMonRpt 29JAN20.docx

6.0 REFERENCES

Golder Associates Inc. (Golder). 2017. Coal Combustion Residuals Landfill Groundwater Statistical Method Certification, Nucla Station Ash Disposal Facility. Report prepared for Tri-State Generation and Transmission Association, Inc. October 16.

Golder Associates Inc. (Golder). 2019a. Coal Combustion Residual Landfill Annual Groundwater Monitoring Report – 2018, Nucla Station Ash Disposal Facility. Report prepared for Tri-State Generation and Transmission Association, Inc. January 29.

Golder Associates Inc. (Golder). 2019b. Coal Combustion Residuals Landfill Groundwater Monitoring System Certification, Nucla Station Ash Disposal Facility. Report prepared for Tri-State Generation and Transmission Association, Inc. May 2.

Tables

Table 1. Sample Results Summary Table – MO-1

Analytes	Units	2/1/2019 Confirmatory Event	4/24/2019 Compliance Event	9/5/2019 Confirmatory Event	10/22/2019 Compliance Event
Static Water Level Elevation	ft amsl	--	5715.4	--	5715.4
Appendix III					
Boron, Total Recoverable	mg/L	--	0.40	--	0.39
Calcium, Total Recoverable	mg/L	--	6.0	--	8.7
Chloride	mg/L	--	309 H	--	276
Fluoride	mg/L	--	2.01 BH	--	1.64 B
pH, Field-Measured	pH units	11.8	11.9	11.9	11.9
Sulfate	mg/L	--	701 H	--	581
Total Dissolved Solids	mg/L	--	1830	--	1770

NOTES:

ft amsl: feet above mean sea level

mg/L: milligrams per liter

B: Analyte detected between the method detection limit and practical quantitation limit

H: Analyte was analyzed outside of hold time because a laboratory retest was requested due to a potential quality control/quality assurance issue identified during data review; the initial laboratory results were not confirmed and the analytical report was revised

Table 2. Sample Results Summary Table – MO-2

Analytes	Units	1/29/2019 Confirmatory Event	4/24/2019 Compliance Event	10/22/2019 Compliance Event
Static Water Level Elevation	ft amsl	--	5721.9	5728.0
Appendix III				
Boron, Total Recoverable	mg/L	--	0.4 B	0.3 B
Calcium, Total Recoverable	mg/L	--	56.2	59.3
Chloride	mg/L	--	2050	1980
Fluoride	mg/L	--	<12.5 U	<5.0 U
pH, Field-Measured	pH units	--	8.1	8.0
Sulfate	mg/L	--	2070	1950
Total Dissolved Solids	mg/L	6390	6200	6310

NOTES:
ft amsl: feet above mean sea level
mg/L: milligrams per liter
Non-detects are reported as less than the practical quantitation limit
B: Analyte detected between the method detection limit and practical quantitation limit
U: Analyte not detected above the practical quantitation limit

Table 3. Sample Results Summary Table – MO-3

Analytes	Units	2/4/2019 Confirmatory Event	4/23/2019 Compliance Event	10/22/2019 Compliance Event
Static Water Level Elevation	ft amsl	--	5637.5	5637.1
Appendix III				
Boron, Total Recoverable	mg/L	--	0.63	0.68
Calcium, Total Recoverable	mg/L	--	14.9	16.6
Chloride	mg/L	166	167	155
Fluoride	mg/L	--	2.73 B	2.58
pH, Field-Measured	pH units	--	8.0	8.0
Sulfate	mg/L	--	829	714
Total Dissolved Solids	mg/L	2500	2420	2390

NOTES:
ft amsl: feet above mean sea level
mg/L: milligrams per liter
B: Analyte detected between the method detection limit and practical quantitation limit

Table 4. Sample Results Summary Table – MO-4

Analytes	Units	4/23/2019 Compliance Event	10/29/2019 Compliance Event
Static Water Level Elevation	ft amsl	5635.0	5635.0
Appendix III			
Boron, Total Recoverable	mg/L	0.4 B	0.4 B
Calcium, Total Recoverable	mg/L	45.7	47.1
Chloride	mg/L	900	932
Fluoride	mg/L	<25 U	<6.25 U
pH, Field-Measured	pH units	7.5	7.6
Sulfate	mg/L	1920	1890
Total Dissolved Solids	mg/L	5110	5070

NOTES:
ft amsl: feet above mean sea level
mg/L: milligrams per liter
Non-detects are reported as less than the practical quantitation limit
B: Analyte detected between the method detection limit and practical quantitation limit
U: Analyte not detected above the practical quantitation limit

Table 5. Sample Results Summary Table – MO-5

Analytes	Units	2/1/2019	4/23/2019	10/29/2019
		Confirmatory Event	Compliance Event	Compliance Event
Static Water Level Elevation	ft amsl	--	5646.9	-- *
Appendix III				
Boron, Total Recoverable	mg/L	--	0.4 B	0.4 B
Calcium, Total Recoverable	mg/L	--	17.3	16.5
Chloride	mg/L	--	937	990
Fluoride	mg/L	--	<12.5 U	<6.25 U
pH, Field-Measured	pH units	--	8.2	8.3
Sulfate	mg/L	1890	1790	1810
Total Dissolved Solids	mg/L	--	5140	5210

NOTES:
ft amsl: feet above mean sea level
mg/L: milligrams per liter
Non-detects are reported as less than the practical quantitation limit
B: Analyte detected between the method detection limit and practical quantitation limit
U: Analyte not detected above the practical quantitation limit
* Water level not recorded because of issues with downloading transducer data

Table 6. Statistics Summary Table – MO-1

Analytes	Units	Selected Statistical Method	Statistical Limit	October 2018			April 2019			October 2019	
				Compliance Point (10/23/2018)	Confirmatory Resample (2/1/2019)	SSI Determination	Compliance Point (4/24/2019)	Confirmatory Resample (9/5/2019)	SSI Determination	Compliance Point (10/22/2019)	SSI Determination
Appendix III											
Boron, Total Recoverable[1]	mg/L	P-PL	0.43	0.38	--	No	0.40	--	No	0.39	No
Calcium, Total Recoverable[1]	mg/L	Trend[2]	NL	6.7	--	No	6.0	--	No	8.7	No
Chloride	mg/L	P-PL	341	296	--	No	309 H	--	No	276	No
Fluoride	mg/L	P-PL	2.8	1.65	--	No	2.01 BH	--	No	1.64 B	No
pH, Field-Measured[3]	pH units	P-PL	9.8, 10.0	11.8 (10.1)	11.8 (9.8)	False Positive	11.9 (9.7)	11.9 (9.3)	Verified SSI[4]	11.9 (9.1)	Verified SSI[4]
Sulfate	mg/L	Trend[2]	NL	728	--	No	701 H	--	No	581	No
Total Dissolved Solids	mg/L	Trend[2]	NL	1990	--	No	1830	--	No	1770	No

NOTES:

NL: statistical limit not calculated for analytes for which the Sen's Slope methodology was selected
P-PL: Parametric Prediction Limit
mg/L: milligrams per liter
Once a verified SSI is identified, confirmatory resampling is not necessary for subsequent SSIs
B: Analyte detected between the method detection limit and practical quantitation limit
H: Analyte was analyzed outside of hold time because a laboratory retest was requested due to a potential quality control/quality assurance issue identified during data review; the initial laboratory results were not confirmed and the analytical report was revised
1. Statistical limits were based on total analysis. Only total recoverable analyses were conducted for the compliance sampling events and have been used for comparisons.
2. Baseline data exhibited statistically significant decreasing trend. Therefore, a trend analysis is used for the determination of SSIs.
3. A statistical limit (two-tailed) was established using detrended data. Compliance data are detrended for comparison to statistical limit. Detrended value is shown in parentheses.
4. Successful alternative source demonstration prepared in December 2019 is applicable, and the Facility remains in detection monitoring.

Table 7. Statistics Summary Table – MO-2

Analytes	Units	Selected Statistical Method	Statistical Limit	October 2018			April 2019		October 2019	
				Compliance Point (10/22/2018)	Confirmatory Resample (1/29/2019)	SSI Determination	Compliance Point (4/24/2019)	SSI Determination	Compliance Point (10/22/2019)	SSI Determination
Appendix III										
Boron, Total Recoverable[1]	mg/L	P-PL	0.40	0.32	--	No	0.4 B	No	0.3 B	No
Calcium, Total Recoverable[1]	mg/L	P-PL	63.0	56.4	--	No	56.2	No	59.3	No
Chloride	mg/L	P-PL	2626	2010	--	No	2050	No	1980	No
Fluoride	mg/L	NP-PL	12.5	<12.5 U	--	No	<12.5 U	No	<5.0 U	No
pH, Field-Measured	pH units	P-PL	7.4, 8.9	8.1	--	No	8.1	No	8.0	No
Sulfate	mg/L	P-PL	2424	2070	--	No	2070	No	1950	No
Total Dissolved Solids	mg/L	NP-PL	6330	6460	6390	Verified SSI[2]	6200	No	6310	No

NOTES:

P-PL: Parametric Prediction Limit

NP-PL: Non-parametric Prediction Limit

mg/L: milligrams per liter

Non-detects are reported as less than the practical quantitation limit

B: Analyte detected between the method detection limit and practical quantitation limit

U: Analyte not detected above the practical quantitation limit

1. Statistical limits were based on total analysis. Only total recoverable analyses were conducted for the compliance sampling events and have been used for comparisons.

2. Successful demonstration of natural variability prepared in May 2019 is applicable, and the Facility remains in detection monitoring.

Table 8. Statistics Summary Table – MO-3

Analytes	Units	Selected Statistical Method	Statistical Limit	October 2018			April 2019		October 2019	
				Compliance Point (10/23/2018)	Confirmatory Resample (2/4/2019)	SSI Determination	Compliance Point (4/23/2019)	SSI Determination	Compliance Point (10/22/2019)	SSI Determination
Appendix III										
Boron, Total Recoverable[1]	mg/L	P-PL	0.75	0.61	--	No	0.63	No	0.68	No
Calcium, Total Recoverable[1]	mg/L	P-PL	19.6	14.5	--	No	14.9	No	16.6	No
Chloride	mg/L	P-PL	171	172	166	False Positive	167	No	155	No
Fluoride	mg/L	P-PL	3.50	2.94	--	No	2.73 B	No	2.58	No
pH, Field-Measured	pH units	NP-PL	7.7, 7.9	8.0	--	Verified SSI[2]	8.0	Verified SSI[2]	8.0	Verified SSI[2]
Sulfate	mg/L	P-PL	860	843	--	No	829	No	714	No
Total Dissolved Solids	mg/L	P-PL	2587	2600	2500	False Positive	2420	No	2390	No

NOTES:

P-PL: Parametric Prediction Limit

NP-PL: Non-parametric Prediction Limit

mg/L: milligrams per liter

Once a verified SSI is identified, confirmatory resampling is not necessary for subsequent SSIs

B: Analyte detected between the method detection limit and practical quantitation limit

1. Statistical limits were based on total analysis. Only total recoverable analyses were conducted for the compliance sampling events and have been used for comparisons.

2. Successful demonstration of natural variability prepared in September 2018 is applicable, and the Facility remains in detection monitoring.

Table 9. Statistics Summary Table – MO-4

Analytes	Units	Selected Statistical Method	Statistical Limit	April 2019		October 2019	
				Compliance Point (4/23/2019)	SSI Determination	Compliance Point (10/29/2019)	SSI Determination
Appendix III							
Boron, Total Recoverable[1]	mg/L	P-PL	0.47	0.4 B	No	0.4 B	No
Calcium, Total Recoverable[1]	mg/L	P-PL	53.3	45.7	No	47.1	No
Chloride	mg/L	P-PL	1090	900	No	932	No
Fluoride	mg/L	NP-PL	5	<25 U	No[2]	<6.25 U	No[3]
pH, Field-Measured	pH units	NP-PL	7.4, 7.6	7.5	No	7.6	No
Sulfate	mg/L	P-PL	2060	1920	No	1890	No
Total Dissolved Solids	mg/L	NP-PL	5210	5110	No	5070	No

NOTES:
P-PL: Parametric Prediction Limit
NP-PL: Non-parametric Prediction Limit
mg/L: milligrams per liter
Non-detects are reported as less than the practical quantitation limit
U: Analyte not detected above the practical quantitation limit
1. Statistical limits were based on total analysis. Only total recoverable analyses were conducted for the compliance sampling events and have been used for comparisons.
2. Result is not considered an SSI because it is a non-detect with a method detection limit of 5 mg/L, which is equal to the statistical limit.
3. Result is not considered an SSI because it is a non-detect with a method detection limit of 1.25 mg/L, which is below the statistical limit.

Table 10. Statistics Summary Table – MO-5

Analytes	Units	Selected Statistical Method	Statistical Limit	October 2018			April 2019		October 2019	
				Compliance Point (10/24/2018)	Confirmatory Resample (2/1/2019)	SSI Determination	Compliance Point (4/23/2019)	SSI Determination	Compliance Point (10/29/2019)	SSI Determination
Appendix III										
Boron, Total Recoverable[1]	mg/L	P-PL	0.51	0.4	--	No	0.4 B	No	0.4 B	No
Calcium, Total Recoverable[1]	mg/L	P-PL	54.5	22.1	--	No	17.3	No	16.5	No
Chloride	mg/L	P-PL	1309	1030	--	No	937	No	990	No
Fluoride	mg/L	P-PL	8.07	1.08	--	No	<12.5 U	No[2]	<6.25 U	No
pH, Field-Measured	pH units	NP-PL	7.6, 8.3	8.1	--	No	8.2	No	8.3	No
Sulfate	mg/L	P-PL	1955	1960	1890	False Positive	1790	No	1810	No
Total Dissolved Solids	mg/L	P-PL	5503	5300	--	No	5140	No	5210	No

NOTES:

P-PL: Parametric Prediction Limit

NP-PL: Non-parametric Prediction Limit

mg/L: milligrams per liter

Non-detects are reported as less than the practical quantitation limit

B: Analyte detected between the method detection limit and practical quantitation limit

U: Analyte not detected above the practical quantitation limit

1. Statistical limits were based on total analysis. Only total recoverable analyses were conducted for the compliance sampling events and have been used for comparisons.

2. Result is not considered an SSI because it is a non-detect with a method detection limit of 2.5 mg/L, which is below the statistical limit.

Figures

LEGEND

PROPERTY BOUNDARY

5870 EXISTING GROUND TOPOGRAPHY

MO-1 MONITORING WELL

5715.4 GROUNDWATER ELEVATION (APRIL 2019)

N

0 150 300

SCALE FEET

CLIENT

TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION
1100 WEST 116TH AVENUE
WESTMINSTER, COLORADO 80234

CONSULTANT

GOLDER

YYYY-MM-DD	2020-01-21
DESIGNED	BJP
PREPARED	BJP
REVIEWED	SAH
APPROVED	JEO

PROJECT

NUCLA STATION ASH DISPOSAL FACILITY
COAL COMBUSTION RESIDUALS LANDFILL
ANNUAL GROUNDWATER MONITORING REPORT

TITLE

MONITORING WELL LOCATIONS AND GROUNDWATER ELEVATIONS (APRIL 2019)

PROJECT NO.	REV.	FIGURE
19118707	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: J:\17JOBS\1779120 2017 Tri-State Nucla\CCR GW | File Name: CCR Well Locations-Aerial-Topo_April19.dwg

LEGEND

- PROPERTY BOUNDARY
- 5870 EXISTING GROUND TOPOGRAPHY
- MO-1 MONITORING WELL
- 5715.4 GROUNDWATER ELEVATION (OCTOBER 2019)

NOTE(S)

1. WATER LEVEL NOT RECORDED BECAUSE OF ISSUES WITH DOWNLOADING DATA FROM THE TRANSDUCER

N

0 150 300
SCALE FEET

CLIENT
TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION
1100 WEST 116TH AVENUE
WESTMINSTER, COLORADO 80234

CONSULTANT
GOLDER

YYYY-MM-DD	2020-01-21
DESIGNED	BJP
PREPARED	BJP
REVIEWED	SAH
APPROVED	JEO

PROJECT
NUCLA STATION ASH DISPOSAL FACILITY
COAL COMBUSTION RESIDUALS LANDFILL
ANNUAL GROUNDWATER MONITORING REPORT

TITLE
MONITORING WELL LOCATIONS AND GROUNDWATER ELEVATIONS (OCTOBER 2019)

PROJECT NO.	REV.	FIGURE
19118707	A	2

APPENDIX A

Demonstration of Natural Variability for Total Dissolved Solids at MO-2, Nucla Station Ash Disposal Facility

CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.94(e)(2)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations Section 257.94 (40 CFR 257.94), this written demonstration is accurate to the best of my knowledge and has been prepared in accordance with recognized and generally accepted good engineering practices, including the consideration of applicable industry standards, and the requirements of 40 CFR 257.94(e)(2).

Golder Associates Inc.

Signature

May 6, 2019

Date of Certification

Jason Obermeyer, PE

Name

40294

Colorado Professional Engineer Number

TECHNICAL MEMORANDUM

DATE May 6, 2019 **Reference No.** 19118707-0004-2-TM-A

TO Chantell Johnson
Tri-State Generation and Transmission Association, Inc.

CC Jason Obermeyer and Tricia Hall

FROM Sara Harkins **EMAIL SHarkins@Golder.com**

DEMONSTRATION OF NATURAL VARIABILITY FOR TOTAL DISSOLVED SOLIDS AT MO-2, NUCLA STATION ASH DISPOSAL FACILITY

Golder Associates Inc. (Golder) is providing this technical memorandum to support a demonstration of natural variability resulting in a statistically significant increase (SSI) for total dissolved solids (TDS) at groundwater monitoring well MO-2 located at the coal combustion residuals (CCR) landfill that serves the Nucla Generating Station, which is owned and operated by Tri-State Generation and Transmission Association, Inc. (Tri-State). Tri- State disposes of CCRs from the Nucla Generating Station in an existing Tri-State-owned CCR landfill, the Nucla Station Ash Disposal Facility (the Facility), which is located approximately 2.5 miles southeast of the Nucla Generating Station. Groundwater is being monitored at the Facility to meet the requirements of the US Environmental Protection Agency's (USEPA) CCR Rule (40 CFR Part 257).

1.0 NUCLA STATION CCR GROUNDWATER MONITORING PROGRAM

The groundwater monitoring system for the Facility consists of five monitoring wells (MO-1, MO-2, MO-3, MO-4 and MO-5). Baseline groundwater samples were collected on an approximately monthly basis between December 13, 2016 and August 8, 2017, at each of the monitoring wells (additional baseline samples were collected from MO-2 and MO-4 on October 3, 2017). The resulting data were used to establish intrawell baseline statistical limits for each Appendix III constituent at each well. Intrawell baseline statistical limits represent groundwater conditions in each individual well (USEPA 2009). Samples collected after baseline statistical limits were established are part of the detection monitoring program. Data from detection monitoring are compared to the statistical limits to assess possible changes in groundwater chemistry at each well. When the concentration of a given constituent exceeds the statistical limit in two consecutive sampling events, it is considered a verified SSI over the baseline concentration.

At MO-2, TDS concentration exceeded the upper non-parametric statistical limit of 6330 mg/L during the semi- annual compliance event in October 2018 (6460 mg/L), and the SSI was confirmed by a confirmatory resampling event in February 2019 (6390 mg/L). The non-parametric limit is the highest concentration observed during the baseline period for the well. A non-parametric methodology was selected for TDS at MO-2 because the baseline data were not normally or lognormally distributed, which is a requirement to implement a parametric methodology.

The following sections describe the site geology, provide comparisons to other CCR groundwater monitoring wells at the site and explain the statistical methodology relevant to the TDS concentration measurements at MO-2. This demonstration is performed in accordance with the statistical method certification for the Facility (Golder 2017) to meet the requirements of 40 CFR 257.94(e)(2), which states that the site may remain in detection monitoring if a demonstration can be made that a source other than the regulated CCR unit caused the SSI or that the SSI was a result of an error in sampling, analysis, or statistical evaluation or natural variability in groundwater quality that was not fully captured during baseline data collection. More specifically, this technical memorandum supports the demonstration that the SSI for TDS at MO-2 (October 2018 and February 2019 samples) was a result of continued well stabilization that prevented fully capturing natural variability in groundwater quality during baseline data collection.

2.0 GEOLOGY AND HYDROGEOLOGY

Near-surface geology at the Nucla Station Ash Disposal Facility is generally characterized by a thin layer (0 to 15 feet thick) of unconsolidated regolith underlain by 0 to approximately 110 feet of the Dakota Sandstone, approximately 90 to 210 feet of the Burro Canyon Formation and the Morrison Formation, which is approximately 700 to 800 feet thick regionally. The uppermost aquifer at the site is within the Morrison Formation.

The Morrison aquifer is characterized as highly heterogeneous with zones that are variably transmissive and/or subjected to variable amounts of confining pressure. This characterization is supported by the differences in groundwater levels, water column heights and recovery times observed in the monitoring wells that have been installed to serve as the groundwater monitoring system for the Facility. Sandstone lenses in the Morrison aquifer vary considerably with respect to transmissivity (i.e., thickness and hydraulic conductivity) and horizontal extent due to the alluvial, shoreline, and lacustrine environments that deposited the Salt Wash and Brushy Basin Members of the Morrison Formation, resulting in interbedded siltstone, mudstone, claystone and shale units. Groundwater elevation data suggest a general southerly and westerly groundwater flow direction in the Morrison aquifer near the Nucla Station Ash Disposal Facility. However, the heterogeneity and interbedded nature of the Morrison Formation beneath the Facility, coupled with the observation that groundwater levels in some of the monitoring wells (including MO-2) continue to stabilize, confound the ability to precisely discern groundwater flow direction and hydraulic connection.

3.0 GROUNDWATER MONITORING SYSTEM

The Groundwater Monitoring System Certification (Golder 2019) indicates that the groundwater monitoring system that has been designed and constructed for the Nucla Station Ash Disposal Facility meets the requirements of 40 CFR 257.91. The site layout and monitoring network are presented in Figure 1. MO-1 and MO-2 are the Facility upgradient wells and MO-3, MO-4 and MO-5 are the Facility downgradient wells. Since MO-2 is designated as an upgradient well, it is unlikely that the increases in TDS concentration are due to impacts from the Facility. Figure 2 shows groundwater elevations for the monitoring wells spanning the monitoring program. While water levels have slowly risen in MO-2 since well installation, this water level increase is indicative of stabilization of a deep, low-yield well and does not represent a rise in water levels due to a release from the Facility.

The monitoring system wells are installed in the Morrison aquifer and it was noted in the 2017 Annual Groundwater Monitoring Report that the Morrison aquifer contains heterogeneous zones with variable transmissivity and/or confining pressure. This makes it possible that well stabilization could take an extended period of time in some wells. Additionally, the Morrison aquifer functions as a confined aquifer in the area of the

Facility. At the time when baseline groundwater data for the Facility were being collected to meet timeframes established under 40 CFR Part 257, groundwater levels in MO-2 had not yet stabilized; in fact, they continue to rise at the time of this report's preparation. This continued rise indicates that the conditions monitored by the well continue to stabilize and may not be fully indictive of formation conditions. As discussed below, this ongoing stabilization influences water quality monitored by the well.

4.0 SUMMARY OF MO-2 TDS RESULTS

A time series graph of the available TDS results for MO-2 is presented in Figure 3. TDS concentration is predominately a function of major ion concentrations; therefore, Figure 3 also presents major ion results. A piper diagram depicting the proportions of major cations and anions for the February 2017, April 2017 and October 2018 sampling events is presented in Figure 4. Although the TDS concentrations have slightly increased with time (Figure 3) the relative proportions of major cations and anions has not changed over time (Figure 4). The dominant ions are chloride, sulfate and dissolved sodium and the pattern of concentration through time for these ions is mirrored in the TDS results.

Due to the time constraints associated with the implementation of the CCR Rule (40 CFR Part 257), the baseline data for the CCR program were collected on a compressed schedule, which consisted of approximately monthly sampling between December 2016 and August 2017 (and limited additional sampling in October 2017). We consider it likely that this compressed schedule (less than one year) did not allow for MO-2 to stabilize with groundwater concentrations representative of formation conditions and natural variability. In addition to the ongoing stabilization influencing the reported TDS concentrations, this is reflected in the water elevations discussed above. Figure 5 demonstrates that the slope of the TDS concentrations (and water elevation) is lower for the more recent data than for the early data collected from the well. This reduction in slope indicates that the conditions are likely becoming closer to stabilizing.

5.0 NON-PARAMETRIC PREDICTION LIMITS AND FALSE POSITIVE RATE

The primary goal in a groundwater detection monitoring program is to identify real changes to groundwater quality if they occur, with a specific focus on increasing concentrations in detection monitoring data when compared to baseline data. Statistical tests are used to identify the possible presence of elevated concentrations and they must have adequate statistical power to do so. Statistical power is the likelihood of detecting a change in concentrations when a change is present in reality. A second critical goal is to avoid false positive errors (Type I errors), which occur when changes are incorrectly identified as being significantly different than baseline when contamination does not exist.

A site-wide false positive rate (SWFPR) is used to measure the susceptibility to false positive errors. The Unified Guidance (USEPA 2009) recommends an annual SWFPR of 10%. This SWFPR equates to a *target* per well- constituent false positive rate of 0.50% using equation 19.17 in the Unified Guidance:

$$\alpha_{w\,.\,c} = 1 - (1 - \alpha)^{1/(w\,.\,c)}$$

where α is the SWFPR, w equals the actual number of downgradient compliance wells (three in this case) and c is the number of monitoring constituents (seven in this case). However, based on Table 19-19 in Appendix D of the Unified Guidance the *achievable* false positive rate for a non-parametric prediction limit with a baseline dataset of eight measurements where two statistical evaluations are performed per year is 4.2% (much greater than the target of 0.50% noted above). The only way to reduce this false positive rate would be to increase the number of baseline samples, which was not feasible under the time constraints of the CCR Rule. Thus, there is a relatively high probability of falsely identifying groundwater contamination for parameters that are being tested with a non-parametric methodology at the Facility, which may have occurred during the comparative statistical analysis for TDS concentration in MO-2. Unfortunately, due to the nature of the non-parametric prediction limits, the false positive rate will remain elevated for the Facility until more sampling events are conducted. The data from future sampling events can be incorporated into an updated baseline period in accordance with the statistical methodology for the Facility (Golder 2017), which will result in either one of the following: 1) the underlying data distribution can be defined and a parametric methodology can be implemented, or 2) a non-parametric prediction limit can be constructed on a greater number of samples.

6.0 SUMMARY AND CONCLUSIONS

This demonstration details the rationale behind Golder's conclusion that the statistically significant increase in TDS concentration at MO-2 is not an indication of groundwater impacts from the Nucla Station Ash Disposal Facility, but rather a reflection of continued well stabilization and natural variability. The lines of evidence can be summarized as follows:

- Well MO-2 is located upgradient of the facility; therefore, in the absence of evidence of mounding under the facility it is unlikely that a change in concentration in MO-2 could be related to a release from the Facility.
- Due to time constraints associated with the implementation of the CCR Rule (40 CFR Part 257), the baseline data for the CCR program were collected on a compressed schedule, which did not allow time for groundwater levels in MO-2 to stabilize after well installation and between sampling events. The continued stabilization is reflected in the groundwater quality results for samples collected from MO-2.
- Because of the limited number of baseline samples currently available, the selected statistical methodology to assess TDS data at MO-2, a non-parametric prediction limit, has a relatively high false positive rate.

Based on the findings of this demonstration, Golder recommends that Tri-State continue with the detection monitoring program for the Nucla Station Ash Disposal Facility.

7.0 REFERENCES

Golder Associates Inc. (Golder). 2017. Coal Combustion Residuals Landfill Groundwater Statistical Method Certification, Nucla Station Ash Disposal Facility, Nucla, Colorado. October 16.

Golder Associates Inc. (Golder). 2019. Coal Combustion Residuals Landfill Groundwater Monitoring System Certification, Nucla Station Ash Disposal Facility, Nucla, Colorado. May 2.

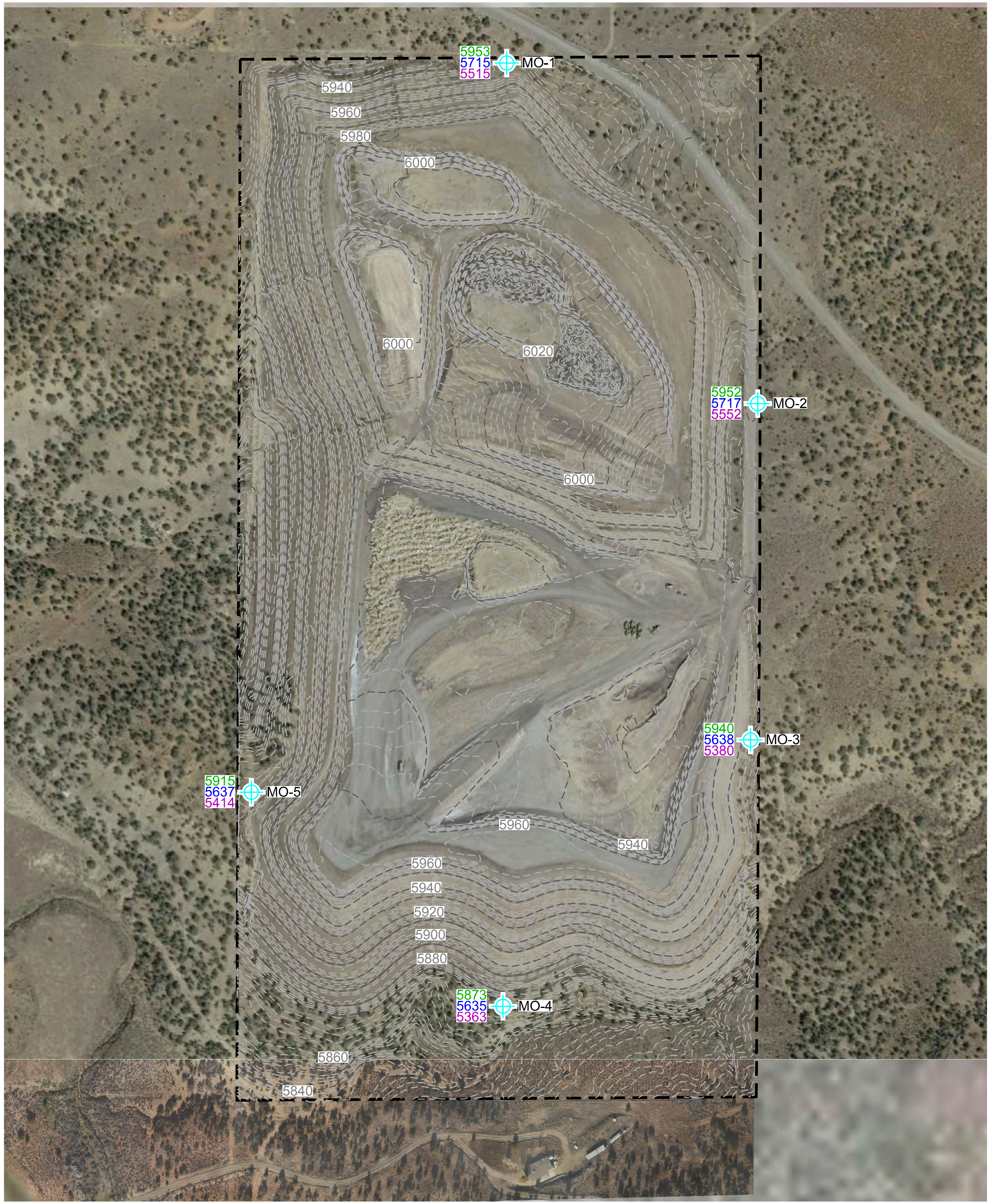
US Environmental Protection Agency (USEPA). Office of Solid Waste, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. March.

ATTACHMENTS

Figure 1 – Monitoring Well Locations and October 2018 Groundwater Elevations
Figure 2 – Time Series of Groundwater Elevations
Figure 3 – Time Series of Total Dissolved Solids and Major Ion Concentrations
Figure 4 – Piper Diagram: Major Cations and Anions
Figure 5 – TDS and Water Elevation Trends

SH/cc
19118707-0004-2-TM-0 MO-2_TDS_ASD.docx

Figures



LEGEND

- PROPERTY BOUNDARY
- 6020 EXISTING GROUND TOPOGRAPHY
- MO-1 MONITORING WELL
- 5915 GROUND SURFACE ELEVATION
- 5915 GROUNDWATER ELEVATION (OCTOBER 2018)
- 5915 BOTTOM OF MONITORING WELL ELEVATION

N

0 150 300
SCALE FEET

CLIENT
TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION
1100 WEST 116TH AVENUE
WESTMINSTER, COLORADO 80234

CONSULTANT

GOLDER

YYYY-MM-DD	2019-04-25
DESIGNED	KAC
PREPARED	KAC
REVIEWED	SAH
APPROVED	JEO

PROJECT
DEMONSTRATION OF NATURAL VARIABILITY FOR TOTAL DISSOLVED SOLIDS AT MO-2, NUCLA STATION ASH DISPOSAL FACILITY

TITLE
MONITORING WELL LOCATIONS

PROJECT NO.	REV.	FIGURE
19118707	2	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

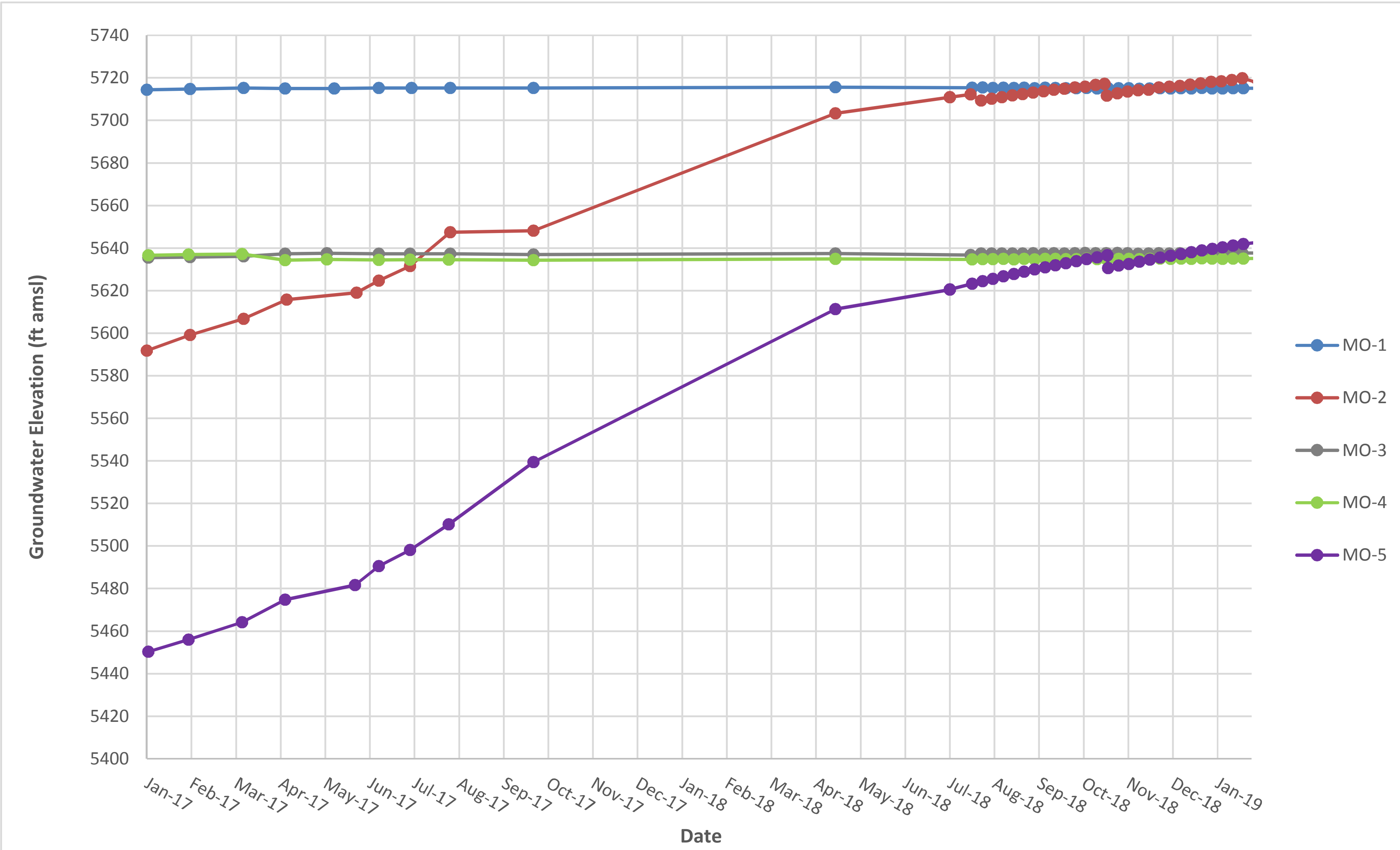


Figure 2

Time Series of Groundwater Elevations

Demonstration of Natural Variability for Total Dissolved Solids at MO-2

Tri-State Generation and Transmission Association, Inc.

Golder Associates

C:\Users\rgrippon\Golder Associates\P19118707.2019 Nucla - 2-TM-A\[Fig 2-3 and 5.xlsx]2

5/2/2019 19118707

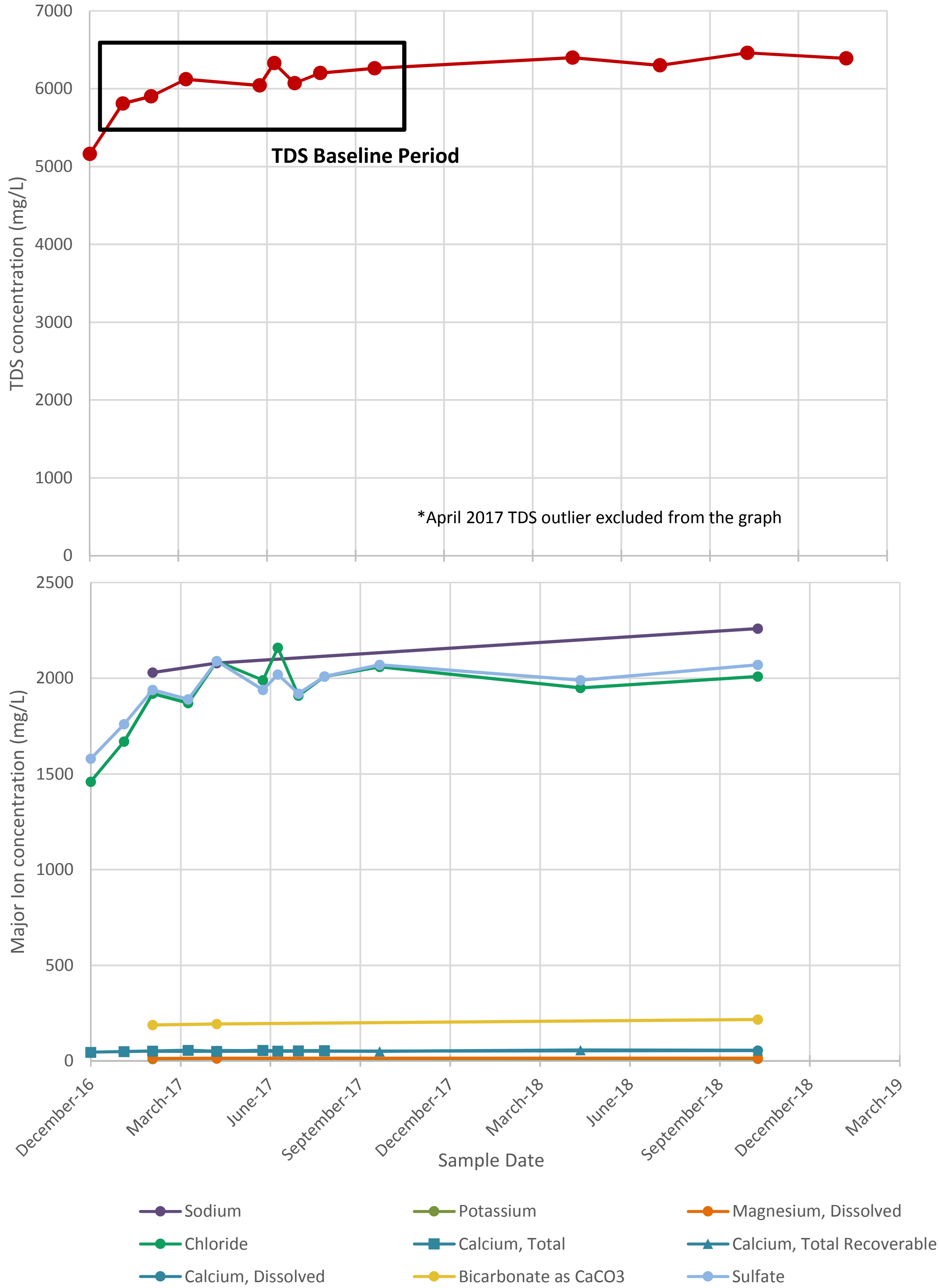


Figure 3

Time Series of Total Dissolved Solids and Major Ion Concentrations

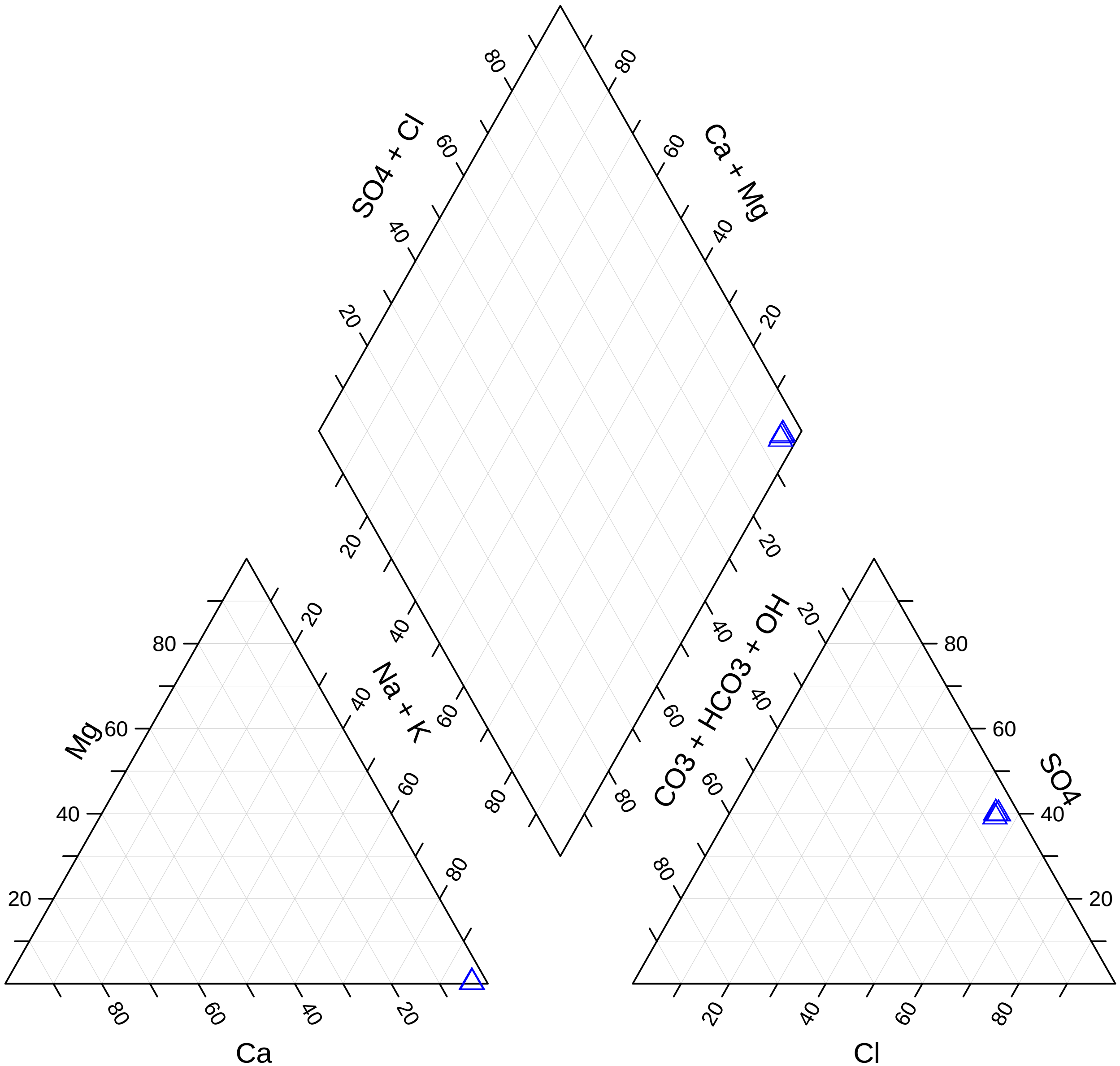
Demonstration of Natural Variability for Total Dissolved Solids at MO-2

Tri-State Generation and Transmission Association, Inc.

C:\Users\trippon\Golder Associates\P19118707.2019 Nucla - 2-TM-A\[Fig 2-3 and 5.xlsx]3

5/2/2019 19118707.00

Golder Associates



CLIENT
Tri-State Generation and Transmission Association, Inc.
Nucla Station Ash Disposal Facility

PROJECT
Nucla Station CCR Groundwater Program
Demonstration of Natural Variability for Total Dissolved Solids at MO-2

CONSULTANT

GOLDER

YYYY-MM-DD	2019-04-25
PREPARED	TH
DESIGN	SH
REVIEW	SH
APPROVED	JO

TITLE
Piper Diagram: Major Cations and Anions

PROJECT No.	Rev.	Figure Number
19118707	0	4

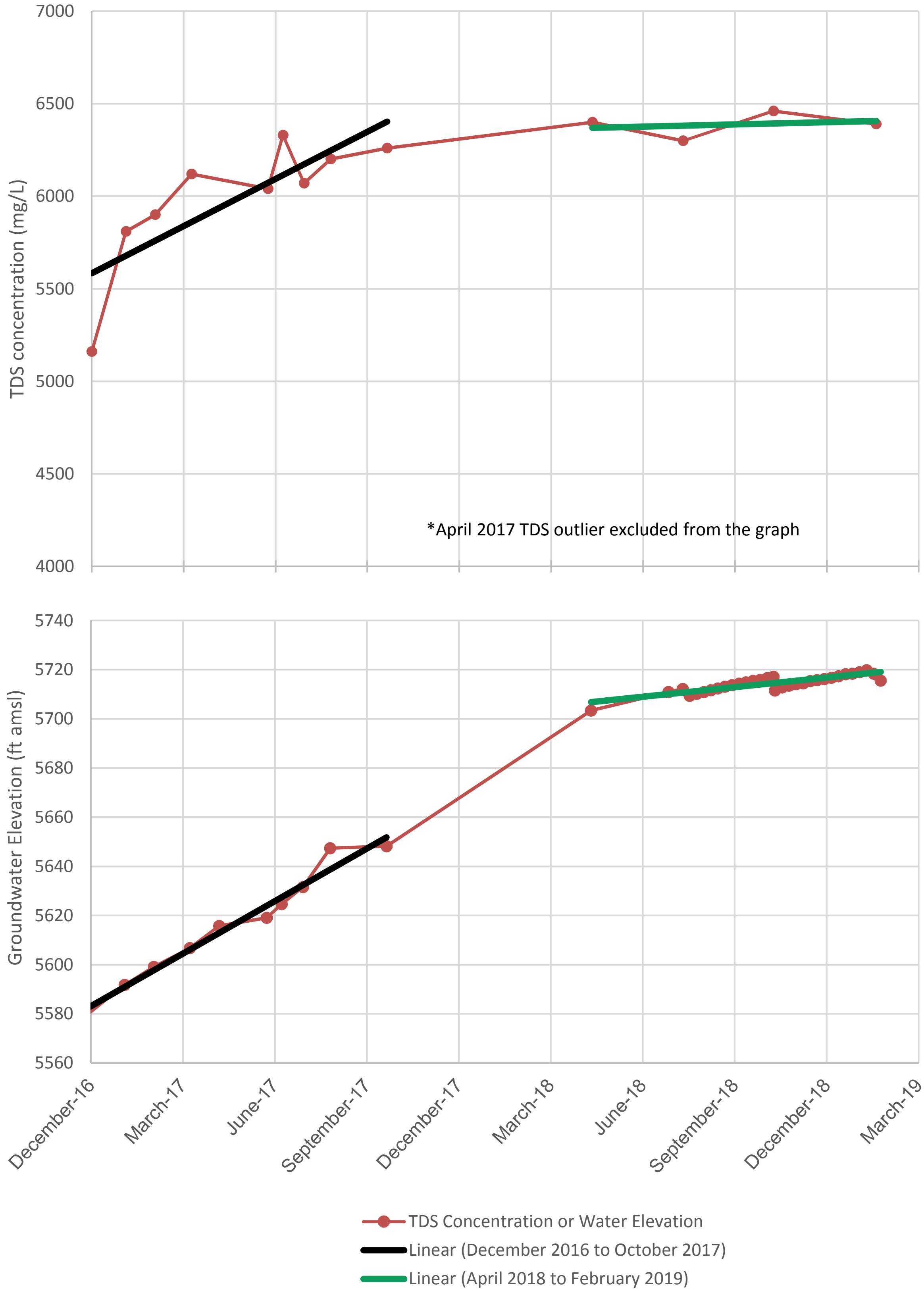


Figure 5

TDS and Water Elevation Trends

Demonstration of Natural Variability for Total Dissolved Solids at MO-2

Tri-State Generation and Transmission Association, Inc.

APPENDIX B

Alternative Source Demonstration for Field pH at MO-1, Nucla Station Ash Disposal Facility

CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.94(e)(2)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations Section 257.94 (40 CFR 257.94), this written demonstration is accurate to the best of my knowledge and has been prepared in accordance with recognized and generally accepted good engineering practices, including the consideration of applicable industry standards, and the requirements of 40 CFR 257.94(e)(2).

Golder Associates Inc.

Signature

December 4, 2019

Date of Certification

Jason Obermeyer, PE

Name

40294

Colorado Professional Engineer Number

COLORADO LICENSED
JASON E. OBERMEYER
40294
PROFESSIONAL ENGINEER

TECHNICAL MEMORANDUM

DATE December 4, 2019 **Reference No.** 19118707

TO Chantell Johnson
Tri-State Generation and Transmission Association, Inc.

CC Jason Obermeyer

FROM Sara Harkins **EMAIL SHarkins@Golder.com**

ALTERNATIVE SOURCE DEMONSTRATION FOR FIELD pH AT MO-1, NUCLA STATION ASH DISPOSAL FACILITY

Golder Associates Inc. (Golder) is providing this technical memorandum to support an alternative source demonstration for a statistically significant increase[1] (SSI) in field-measured pH at groundwater monitoring well MO-1 located at the coal combustion residuals (CCR) landfill that serves the Nucla Generating Station, which is owned and operated by Tri-State Generation and Transmission Association, Inc. (Tri-State). Tri-State disposes of CCRs from the Nucla Generating Station in an existing Tri-State-owned CCR landfill, the Nucla Station Ash Disposal Facility (the Facility), which is located approximately 2.5 miles southeast of the Nucla Generating Station. Groundwater is being monitored at the Facility to meet the requirements of the US Environmental Protection Agency's (USEPA) CCR Rule (40 CFR Part 257).

1.0 CCR GROUNDWATER MONITORING PROGRAM

The groundwater monitoring system for the Facility consists of five monitoring wells (MO-1, MO-2, MO-3, MO-4 and MO-5). Baseline groundwater samples were collected on an approximately monthly basis between December 13, 2016 and August 8, 2017 at each of the monitoring wells (additional baseline samples were collected from MO-2 and MO-4 on October 3, 2017). The resulting data were used to establish intrawell baseline statistical limits for each Appendix III constituent at each well. Intrawell baseline statistical limits represent groundwater conditions in each individual well (USEPA 2009). Samples collected after baseline statistical limits were established are part of the detection monitoring program. Data from detection monitoring are compared to the statistical limits to assess possible changes in groundwater chemistry at each well. When the concentration of a given constituent exceeds the statistical limit in two consecutive sampling events, it is considered a verified SSI over the baseline concentration. In the case of pH, which is a two-tailed limit, values below the lower statistical limit also indicate an SSI.

The parametric statistical limits established for pH at MO-1 are based on detrended data, as the baseline data exhibit a statistically significant upward trend, with baseline values ranging from 9.5 to 10.1 standard units (SU). Sample results that are part of the detection monitoring program are detrended prior to comparison to the

[1] The term SSI is used to be consistent with generally accepted language; however, as detailed in Section 1.0, the SSI is for values less than the two-tailed pH limit.

statistical limits, in accordance with the Statistical Method Certification for the Facility (Golder 2017). The pH values at MO-1 were less than the lower statistical limit of 9.8 SU during the first semi-annual compliance event in April 2019 (11.9 SU, 9.7 SU detrended) and during the confirmatory sampling event in September 2019 (11.9 SU, 9.3 SU detrended), indicating an SSI.

This demonstration is performed in accordance with the Statistical Method Certification for the Facility (Golder 2017) to meet the requirements of 40 CFR 257.94(e)(2), which states that the site may remain in detection monitoring if a demonstration can be made that a source other than the regulated CCR unit caused the SSI or that the SSI was a result of an error in sampling, analysis, or statistical evaluation or natural variability in groundwater quality that was not fully captured during baseline data collection. More specifically, this technical memorandum supports the demonstration that the SSI for pH at MO-1 (April 2019 and September 2019 samples) was a result of well stabilization and the Facility is not the source of the changing values because the well is located upgradient of the Facility.

2.0 GEOLOGY AND HYDROGEOLOGY

Near-surface geology at the Nucla Station Ash Disposal Facility is generally characterized by a thin layer (0 to 15 feet thick) of unconsolidated regolith underlain by 0 to approximately 110 feet of the Dakota Sandstone, approximately 90 to 210 feet of the Burro Canyon Formation and the Morrison Formation, which is approximately 700 to 800 feet thick regionally. The uppermost aquifer at the Facility is within the Morrison Formation, with the depths to groundwater in the monitoring wells ranging from 230 feet to 302 feet in April 2019.

The Morrison aquifer is characterized as highly heterogeneous with zones that are variably transmissive and/or subjected to variable amounts of confining pressure. This characterization is supported by the differences in groundwater levels, water column heights and recovery times observed in the monitoring wells that have been installed to serve as the groundwater monitoring system for the Facility. Sandstone lenses in the Morrison aquifer vary considerably with respect to transmissivity (i.e., thickness and hydraulic conductivity) and horizontal extent due to the alluvial, shoreline and lacustrine environments that deposited the Salt Wash and Brushy Basin Members of the Morrison Formation, resulting in interbedded siltstone, mudstone, claystone and shale units. Groundwater elevation data suggest a general southerly and westerly groundwater flow direction in the Morrison aquifer near the Nucla Station Ash Disposal Facility.

3.0 GROUNDWATER MONITORING SYSTEM

The Groundwater Monitoring System Certification for the Facility (Golder 2019) indicates that the groundwater monitoring system that has been designed and constructed for the Nucla Station Ash Disposal Facility meets the requirements of 40 CFR 257.91. The site layout and monitoring network are presented in Figure 1. MO-1 and MO-2 are the Facility upgradient wells and MO-3, MO-4 and MO-5 are the Facility downgradient wells. Since MO-1 is designated as an upgradient well, and in the absence of evidence of mounding under the Facility, it is very unlikely that the SSI for pH at MO-1 is an indication of a release from the Facility.

4.0 SUMMARY OF MO-1 pH MEASUREMENTS

Time series graphs of the available pH measurements (both raw measurements and detrended data) for MO-1 are presented in Figure 2. Due to the time constraints associated with the implementation of the CCR Rule (40 CFR Part 257), the baseline data for the CCR program were collected on a compressed schedule, which consisted of approximately monthly sampling between December 2016 and August 2017 (and limited additional sampling in October 2017). As mentioned in Section 1.0, the statistical limits established for pH at MO-1 are based on detrended data because the baseline data exhibit a statistically significant upward trend. Establishing a statistical limit on detrended data assumes that the trend observed in the baseline period continues during compliance monitoring. Figure 2 demonstrates that the recent compliance data have deviated from the baseline trend and are visually stable. If this visual trend continues, a statistical trend test can be conducted once sufficient data are collected (minimum eight points) and the baseline period can be shifted to account for the newer data, in accordance with the Statistical Method Certification for the Facility (Golder 2017).

5.0 SUMMARY AND CONCLUSIONS

This demonstration details the rationale behind Golder's conclusion that the SSI for pH at MO-1 (results below the lower statistical limit) is not an indication of groundwater impacts from the Nucla Station Ash Disposal Facility because MO-1 is located upgradient of the facility. Therefore, in the absence of evidence of mounding under the Facility, it is very unlikely that the SSI for pH at MO-1 is an indication of a release from the Facility. Recent pH measurements are visually stable; consequently, the identified SSI is the result of a limitation associated with the detrending methodology.

Based on the findings of this demonstration, Golder recommends that Tri-State continue with the detection monitoring program for the Nucla Station Ash Disposal Facility.

6.0 REFERENCES

Golder Associates Inc. (Golder). 2017. Coal Combustion Residuals Landfill Groundwater Statistical Method Certification, Nucla Station Ash Disposal Facility, Nucla, Colorado. October 16.

Golder Associates Inc. (Golder). 2019. Coal Combustion Residuals Landfill Groundwater Monitoring System Certification, Nucla Station Ash Disposal Facility, Nucla, Colorado. May 2.

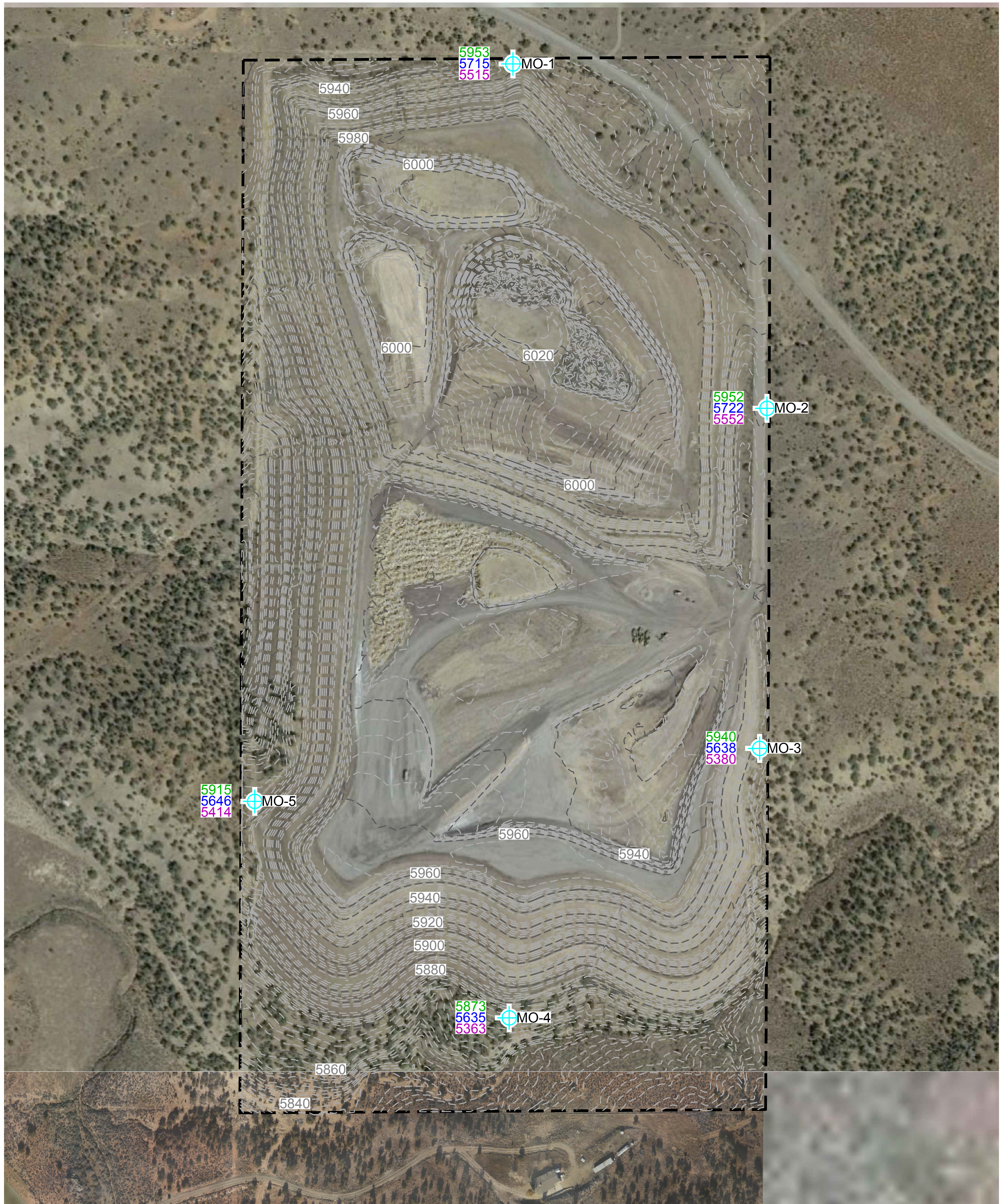
US Environmental Protection Agency (USEPA). Office of Solid Waste, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. March.

ATTACHMENTS

Figure 1 – Monitoring Well Locations and April 2019 Groundwater Elevations
Figure 2 – Time Series of MO-1 pH Measurements

SH/JO/cc
19118707-009--5-TM-0-MO-1_pH_ASD.docx

Figures



LEGEND

— — —	PROPERTY BOUNDARY
6020	EXISTING GROUND TOPOGRAPHY
MO-1	MONITORING WELL
5915	GROUND SURFACE ELEVATION
5915	GROUNDWATER ELEVATION (APRIL 2019)
5915	BOTTOM OF MONITORING WELL ELEVATION

N

0 150 300
SCALE FEET

CLIENT
TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION
1100 WEST 116TH AVENUE
WESTMINSTER, COLORADO 80234

PROJECT
ALTERNATIVE SOURCE DEMONSTRATION FOR FIELD pH AT MO-1, NUCLA STATION ASH DISPOSAL FACILITY

CONSULTANT

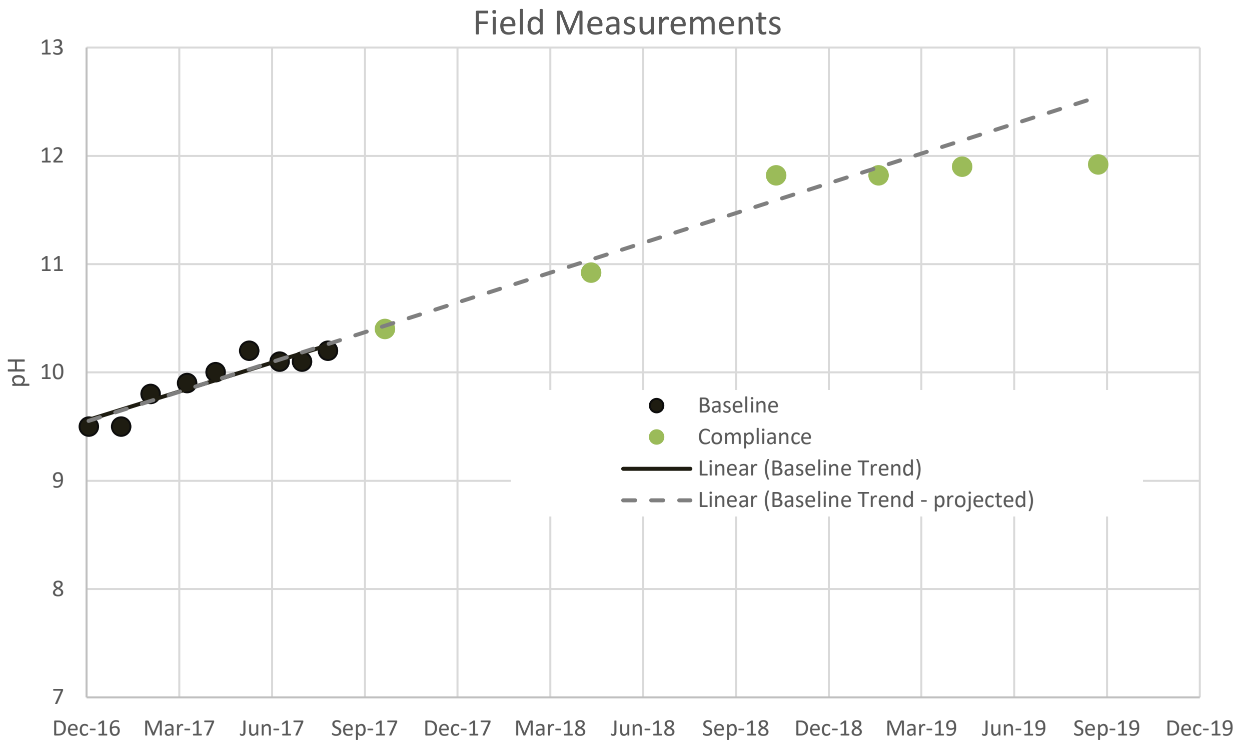
GOLDER

YYYY-MM-DD	2019-11-20
DESIGNED	KAC
PREPARED	KAC
REVIEWED	SAH
APPROVED	JEO

TITLE
MONITORING WELL LOCATIONS AND APRIL 2019 GROUNDWATER ELEVATIONS

PROJECT NO.	REV.	FIGURE
19118707	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



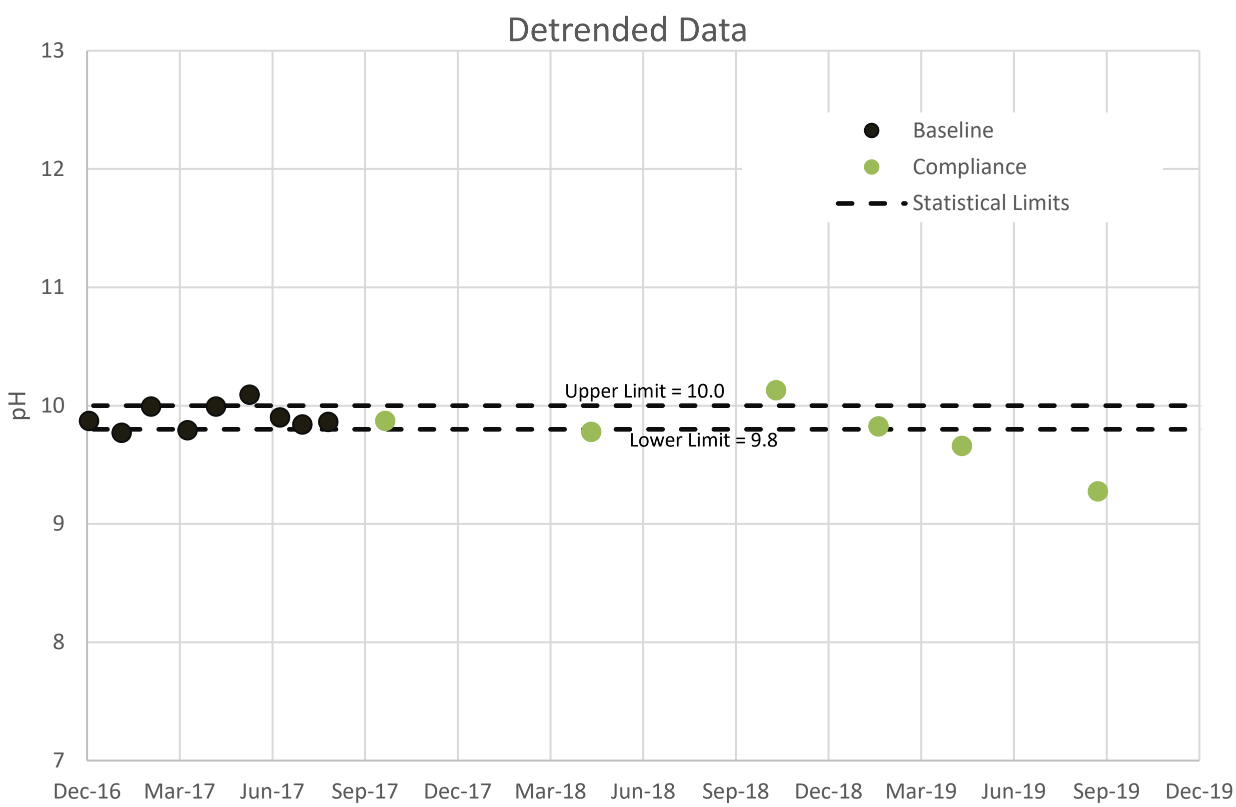


Figure 2

Time Series of MO-1 pH Measurements

Alternative Source Demonstration for Field pH at MO-1

Tri-State Generation and Transmission Association, Inc.

GOLDER

C:\Users\CoCarpenter\Golder Associates\19118707, 2019 Nucla - 6 Deliverables\TechMemos\2-TM MO-2_TDS_ASD\5-TM-0\[Fig 2.xlsx]2_alt

12/4/2019 19118707

Golder Associates

golder.com