

2020 Annual Groundwater Monitoring and Corrective Action Report: OUC Stanton Energy Center CCR

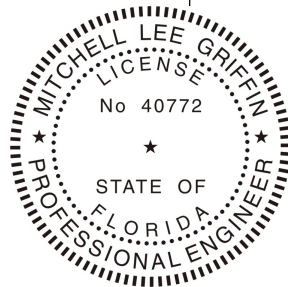
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Purpose

On April 17, 2015, the United States Environmental Protection Agency (EPA) published the final rule for the Coal Combustion Residuals (CCR) Rule, Subtitle D of 40 Code of Federal Regulations (CFR) 257. The CCR Rule established national minimum criteria for CCR disposal and became effective October 19, 2015. The CCR Rule applies to Orlando Utilities Commission (OUC) Stanton Energy Center (SEC) because of the disposal of CCR material generated from the combustion of coal at this facility. This technical memorandum fulfills the reporting requirements associated with the annual groundwater monitoring and corrective action report, Section 257.90 (2)(e), CFR.

The CCR Rule includes deadlines for the establishment of a groundwater monitoring system, sampling and analysis of groundwater requirements, the statistical analysis of the groundwater quality data, and specifying corrective actions (if necessary) for facilities disposing of CCR. The CCR Groundwater Monitoring and Corrective Action program is described in Sections 257.90 through 257.98 of the CCR Rule:

- Applicability (§257.90)
- Groundwater Monitoring Systems (§257.91)
- Groundwater Sampling and Analysis Requirements (§257.93)
- Detection Monitoring Program (§257.94)
- Assessment Monitoring Program (§257.95)
- Assessment of Corrective Measures (§257.96)
- Selection of Remedy (§257.97)
- Implementation of Corrective Action Program (§257.98)

Monitoring requirements for compliance are included in §257 sub-sections. How OUC met the requirements of the CCR program is described in the 2017 annual report (CH2M, 2018). The first annual report contained the results of the Groundwater Monitoring and Corrective Action program from July 2015 through December 2017. Subsequent OUC SEC annual reports were intended to only describe the status of the program for the given year in accordance with §257.90(e) (Table 1). This technical memorandum provides the required 2020 documentation to demonstrate the OUC SEC's compliance with the CCR Rule annual groundwater monitoring and corrective action report.

Table 1. Annual Groundwater Monitoring and Corrective Action Report (§257.90(e))

2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

Requirement	Response
A map, aerial image, or diagram showing the CCR unit and the background (or up-gradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit.	These are shown in Figures 2 and 3 in the background section
Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken.	No changes to the wells during this period
In addition to the monitoring data obtained under §257.90 through §257.98, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs.	See results section
A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels).	See discussion section
Other information required to be included in the annual report as specified in §257.90 through §257.98.	Part of discussion and conclusions

Background and Setting

SEC is located 12 miles southeast of Orlando, Florida. OUC has been operating SEC since 1987 and dry-managing CCRs in landfills on the west side of the property. The original, now closed, landfill (Vertical Expansion) received CCR from July 1987 through August 28, 2015. From the period of May 28 through August 15, 2015, the CCR directed to the Vertical Expansion was used to form part of the landfill cap. The cap was completed with 2 feet of soil and then sodded to stabilize the soil. The Vertical Expansion is exempt from the CCR Rule because it ceased operations prior to implementation. The Vertical Expansion has been closed (also called the "closed landfill") and is undergoing post-closure monitoring under OUC's Conditions of Certification with the Florida Department of Environmental Protection (FDEP). The closed landfill has a 6.42-megawatt solar power generation farm installed over its top.

The new active landfill (hereinafter "Horizontal Expansion") began receiving CCR in May 28, 2015 as a monofill that receives CCR produced by the SEC coal-fired power generating process. The Horizontal Expansion is positioned immediately west of and adjacent to the Vertical Expansion and immediately east of Innovation Way which is the approximate SEC western property boundary, Figure 1. The design standards for the Horizontal Expansion were compliant with Florida's municipal solid waste landfill requirements under Chapter 62-701, Florida Administrative Code. The Horizontal Expansion is fully double lined with a leachate collection system that pump into the lined Combustion Waste Storage Area (CWSA) Runoff Ponds and does not discharge into the surficial groundwater.

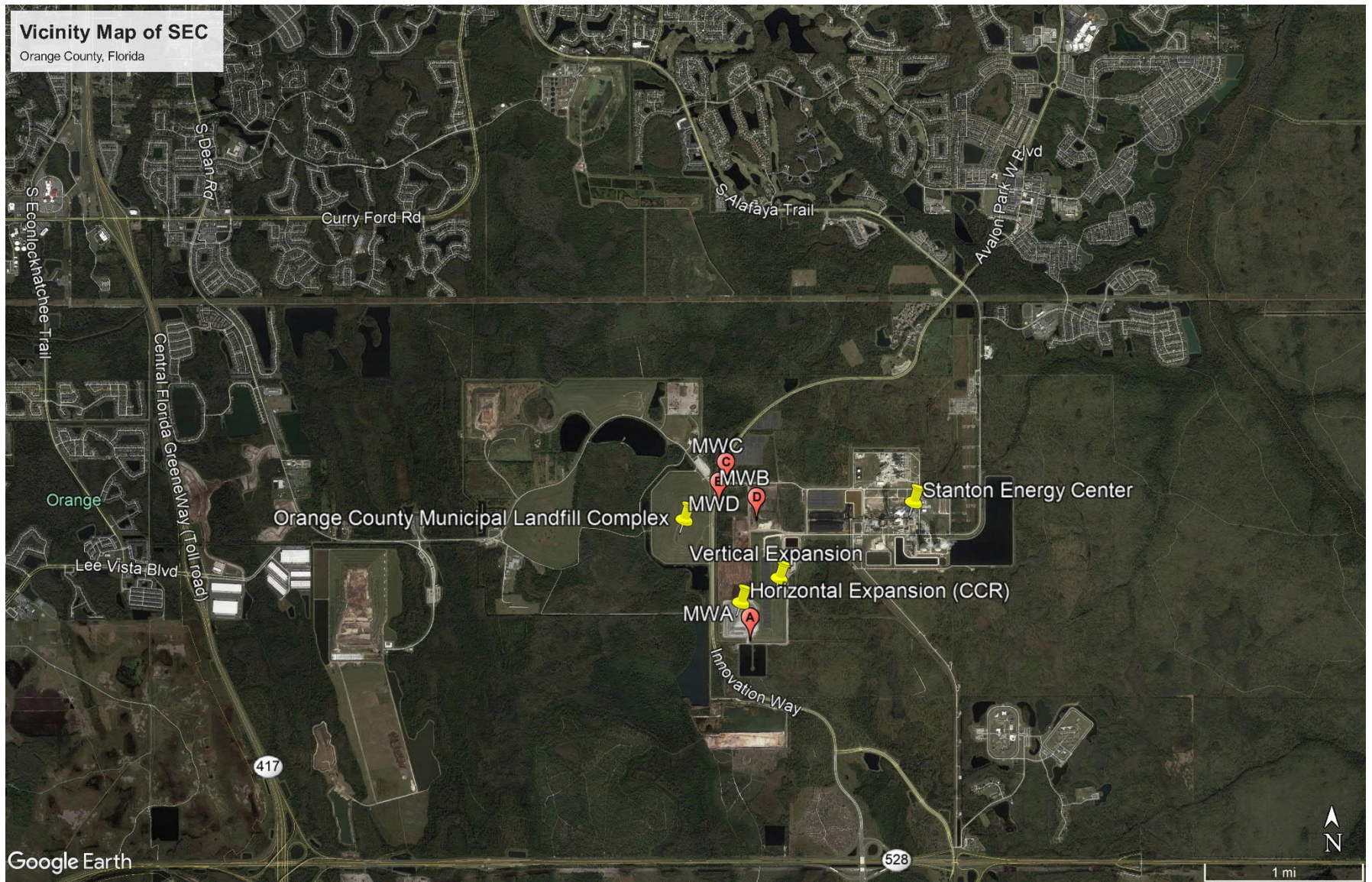


Figure 1. General Vicinity Map of OUC SEC and Landfills
2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

Groundwater conditions at SEC are regulated under two separate programs: the FDEP Power Plant Siting Act and the U.S. Environmental Protection Agency (EPA) CCR Rule. The FDEP monitoring program has been active since August 1986, while the CCR monitoring program began in October 2015. OUC has made a conscious effort to keep these programs separate because different regulatory requirements, different groundwater quality standards, and different monitored constituents. However, the groundwater conditions at the two adjacent SEC landfills are common.

Monitoring well locations were selected based on the groundwater gradient characteristics and the positions of the active and closed landfills but were also constrained by the western site boundary. The Orange County municipal solid waste landfill is immediately west of SEC. The physical constraints, the history of FDEP's groundwater monitoring and other investigation results were used to locate the monitoring wells for the CCR program. The western property boundary is the regional groundwater up-gradient edge of the SEC site (Figures 2 and 3). The surficial aquifer groundwater near the Horizontal Expansion is generally flowing outward from an apparent local groundwater level high under the Vertical Expansion (especially evident at the end of the wet season in Figure 3). The Horizontal Expansion is located adjacent to the Vertical Expansion, and the surficial groundwater gradient is toward the southwest initially, but the overall site gradient is still toward the northeast. Thus, the groundwater quality conditions near the Horizontal Expansion and monitored under the CCR program do not represent unaffected background conditions; they represent baseline conditions from the beginning of the CCR groundwater monitoring program.

No problems were encountered in the CCR monitoring program from July 2015 through 2020. Key program activities for 2020 were to review if the observed high levels of chlorides, calcium, and total dissolved solids (TDS) in the results could be attributed a source other than the CCR-regulated Horizontal Expansion, and prepare an annual report and upload the document to the OUC CCR website by January 31, 2021, and continue with CCR detection monitoring.

CCR Groundwater Data Screening and Decision Process through the Assessment Monitoring Program

The groundwater data and screening and decision process was derived from §257.90 through §257.98 of the CCR Rule. A summary of the monitoring process is:

1. Collect CCR period background water quality data, Appendix III and IV constituents. This step occurred between September 9, 2015 and July 20, 2017 at SEC and is completed.
2. Identify method(s) to evaluate the data for statistically significant trend changes for each well and constituent for Appendix III and IV constituents by well. This step was completed and documented in an October 2017 report.
3. Quantify criteria that define the limits for statistically significant change from background for each Appendix III and IV constituent by well. This was completed and documented in the 2017 annual report.
4. Establish a groundwater protection standard for each Appendix IV constituent [§257.95(h)]. Note that the CCR Rule does not list Appendix III constituents to establish groundwater protection standards. This was completed and documented in the 2017 annual report.
5. Collect detection program water quality data, Appendix III constituents (§257.94). The detection monitoring program sampling results are presented in the 2017 through 2020 annual reports.
6. Assess groundwater flow direction and rate. The detection monitoring program sampling results are presented in the 2017 through 2020 annual reports.

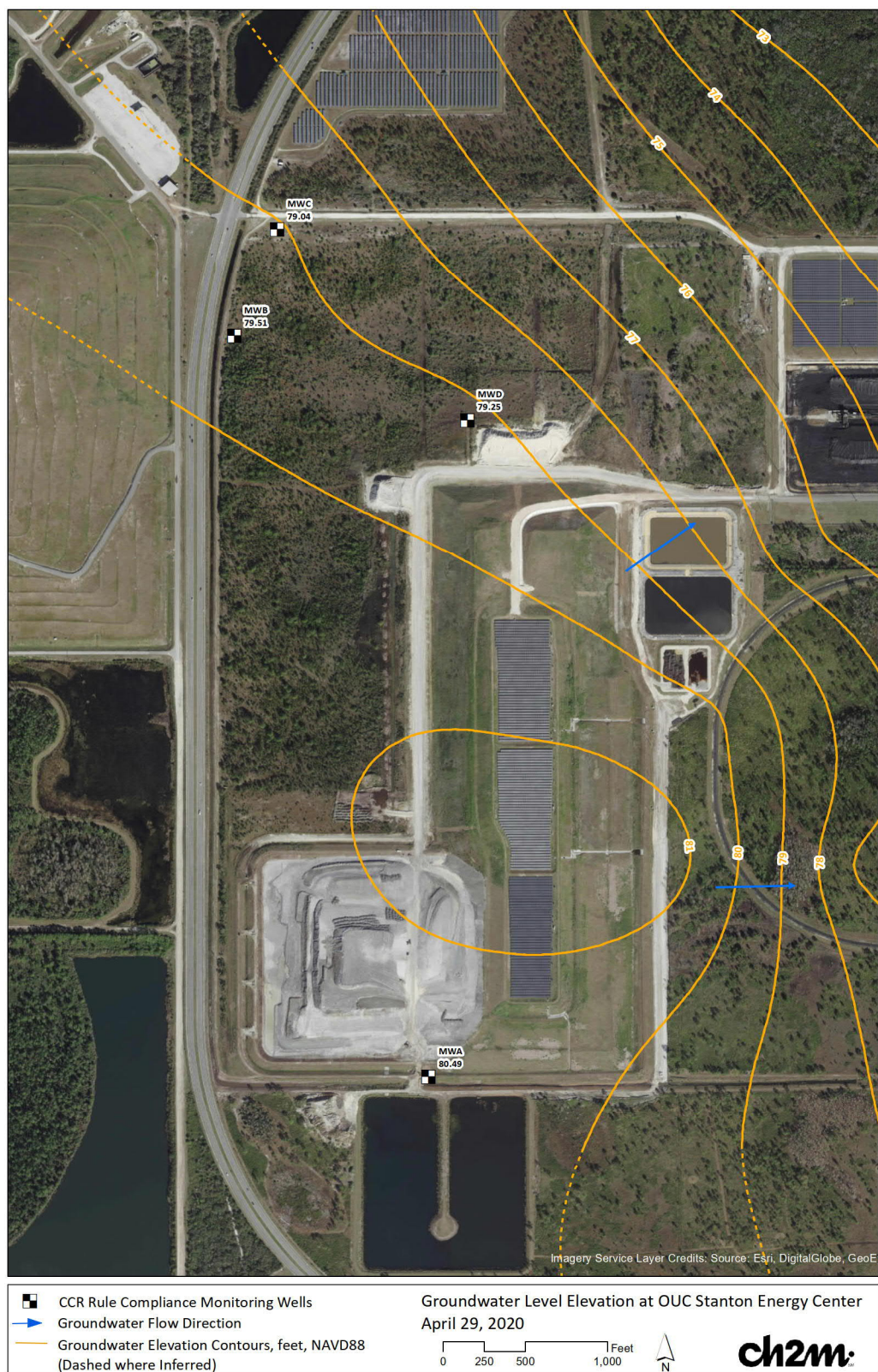


Figure 2. 2020 First Semi-Annual Event Groundwater Levels
2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

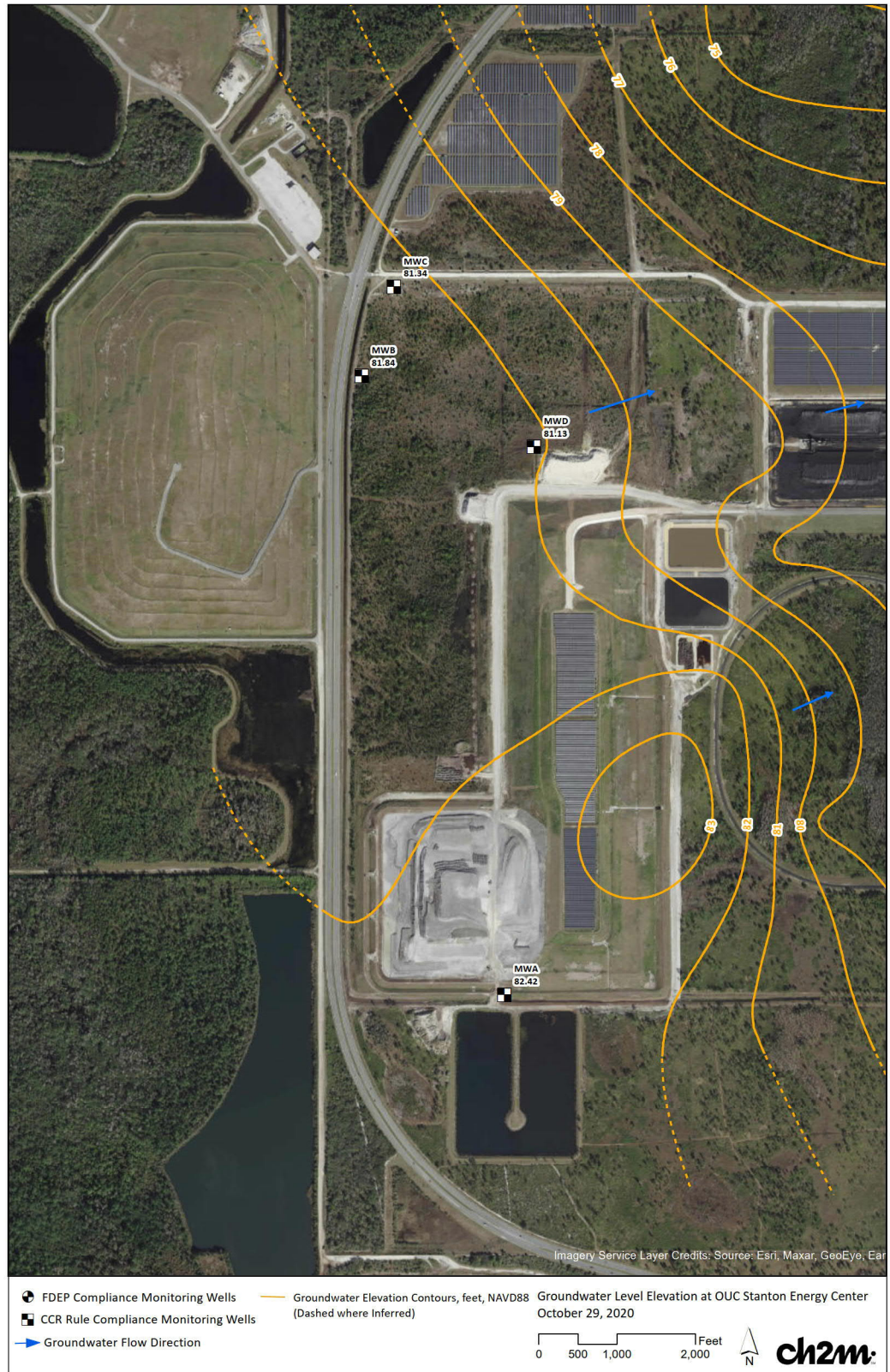


Figure 3. 2020 Second Semi-Annual Event Groundwater Levels
 2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

7. Compare detection program water quality data to the statistical trend criteria to evaluate for no significant trend change, or a significant trend change, from the background water quality data.
 - a. If the result is no significant trend change then continue with detection program monitoring
 - b. If the result is a significant trend change may be indicated, then resample within 90 days
 - i. Compare data to the statistical criteria for no significant trend change or significant trend change
 1. If the result is no significant trend change then continue with detection program monitoring
 2. If the result is significant trend change of one or more constituents at the waste boundary [§257.94(e)]
 - a. Establish an assessment monitoring program and post a notification on the CCR Web site that an assessment monitoring program has been established, or
 - b. Demonstrate that a source other than the CCR unit caused the significant increase within 90 days. Continue with the detection monitoring program.
 - c. After approximately 3 years of detection program monitoring reassess the statistical analyses of the groundwater water quality trends against the background data to identify if changes are needed.
8. Assessment monitoring program (§257.95)
 - a. Within 90 days of establishing an assessment monitoring program sample the groundwater for Appendix IV constituents, and then sample annually thereafter.
 - b. The number of samples, N, needs to be sufficient to support the statistical evaluation of the data [§257.93(e)]. The owner may demonstrate that an alternative sampling frequency is necessary during the active life and post-closure of the CCR unit based on site conditions; however, sample no less frequently than annually.
 - c. After obtaining the results from the above, within 90 days sample all wells for Appendix III and IV constituents, at least semi-annually. The number of samples, N, needs to be sufficient to support the statistical evaluation of the data [§257.93(e)].
 - i. Establish groundwater protection standards consistent with [§257.95(h)] as described in Item 4, above.
 - ii. If the sampling results for the Appendix III and IV constituents are below the established groundwater protection standards for two consecutive sampling events, the monitoring program may return to detection monitoring (Appendix III constituents). Notification that the detection monitoring program is resuming must be posted on the CCR Web site.
 - iii. If concentrations of one or more constituents are above background but below the groundwater protection standard continue with the assessment monitoring program.
 - iv. If concentrations of one or more constituents are statistically significant concentrations above the groundwater protection standard, post a notification

on the CCR Web site [§257.95(g)] and characterize the nature of the release [§257.95(g)(1)].

The 2017 and 2018 results and analysis indicated that calcium, chloride, pH (low) and TDS from MW-B, and calcium and chloride from MW-D fell outside the statistical confidence intervals. This did not mean that there was a problem, but continued scrutiny was needed to assess site conditions. Continued detection monitoring was conducted in 2019 and 2020. High levels of chlorides, calcium, and TDS were observed in the late 2019 and 2020 results. A closer review of the potential sources was conducted during 2020. This review indicated that the source was not from the CCR-regulated Horizontal Expansion and detection monitoring could continue.

Results of the Detection Monitoring Program – 2020

Monitoring Wells

The SEC CCR Horizontal Expansion groundwater monitoring system consists of 4 surficial aquifer monitoring wells. These wells are named MW-A, MW-B, MW-C, and MW-D. The monitoring wells are about 20 to 25 feet deep into the surficial aquifer. MW-A has an approximate 10-foot deeper installation depth because the land surface elevation at its location is approximately 10 feet higher than at the other wells. The horizon for the monitoring interval for MW-A is the same as the interval for MW-B, MW-C, and MW-D. MW-A is the up-gradient well and the other wells are downgradient based on local groundwater levels.

Groundwater Levels and Flow

Groundwater levels in the monitoring wells were collected with each sampling event and groundwater level elevation maps were prepared. Table 2 presents the well location and water level data. Figure 4 shows a chart of the semi-annual groundwater elevations. The semi-annual groundwater level maps are provided in Figures 2 and 3. In general, there are no major changes in groundwater levels and flow patterns across the site since 2015. The 2018 values were like those measured in 2016, while 2017 showed some larger variations. The 2019 levels were about 0.3- to 0.7-foot higher than 2018 levels for the dry and wet seasons, respectively. Water levels in October 2020 were the highest recorded to date because of the generally high rainfall during the summer 2020. These levels were similar to the 2017 levels and within the range monitored during the entire program, since 2015 (Figure 4). Overall, there is no substantial trend in groundwater levels as the 2020 levels were similar to the fall 2017 levels (less than 0.2-foot difference).

Table 2. Background and Operations Period Groundwater Levels – MW-A, MW-B, MW-C, and MW-D, OUC Stanton Energy Center

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DATE	Well	Florida State Plane East Zone (901)		Elevation TOC (feet, NAVD88)	Depth to Water (feet)	Water Level Elevation (feet, 88)
		Northing (feet)	Easting (feet)			
10/30/2015	MW-A	1504260	597643.8	95.77	13.6	82.17
4/29/2016					13.96	81.81
10/31/2016					13.53	82.24
4/25/2017					15.64	80.13
10/31/2017					13.31	82.46

Table 2. Background and Operations Period Groundwater Levels – MW-A, MW-B, MW-C, and MW-D, OUC Stanton Energy Center

2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

DATE	Well	Florida State Plane East Zone (901)		Elevation TOC (feet, NAVD88)	Depth to Water (feet)	Water Level Elevation (feet, 88)
		Northing (feet)	Easting (feet)			
4/27/2018					15.16	80.61
10/30/2018					14.20	81.57
4/29/2019					14.82	80.95
10/31/2019					13.94	81.83
4/29/2020					15.28	80.49
10/29/2020					13.35	82.42
10/30/2015	MW-B	1508750	596609.8	86.05	4.86	81.19
4/29/2016					5.20	80.85
10/31/2016					4.90	81.15
4/25/2017					7.25	78.80
10/31/2017					4.41	81.64
4/27/2018					6.17	79.88
10/30/2018					5.59	80.46
4/29/2019					5.74	80.31
10/31/2019					4.72	81.33
4/29/2020					6.54	79.51
10/31/2020					4.21	81.84
10/30/2015	MW-C	1509398	596841.6	86.84	6.22	80.62
4/29/2016					6.56	80.28
10/31/2016					6.14	80.70
4/25/2017					8.36	78.48
10/31/2017					5.67	81.17
4/27/2018					7.35	79.49
10/30/2018					6.90	79.94
4/29/2019					6.95	79.89
10/31/2019					5.94	80.90
4/29/2020					7.80	79.04
10/31/2020					5.50	81.34
10/30/2015	MW-D	1508237	597858.3	85.10	4.89	80.21
4/29/2016					5.58	79.52
10/31/2016					5.14	79.96
4/25/2017					7.44	77.66
10/31/2017					3.96	81.14
4/27/2018					5.79	79.31

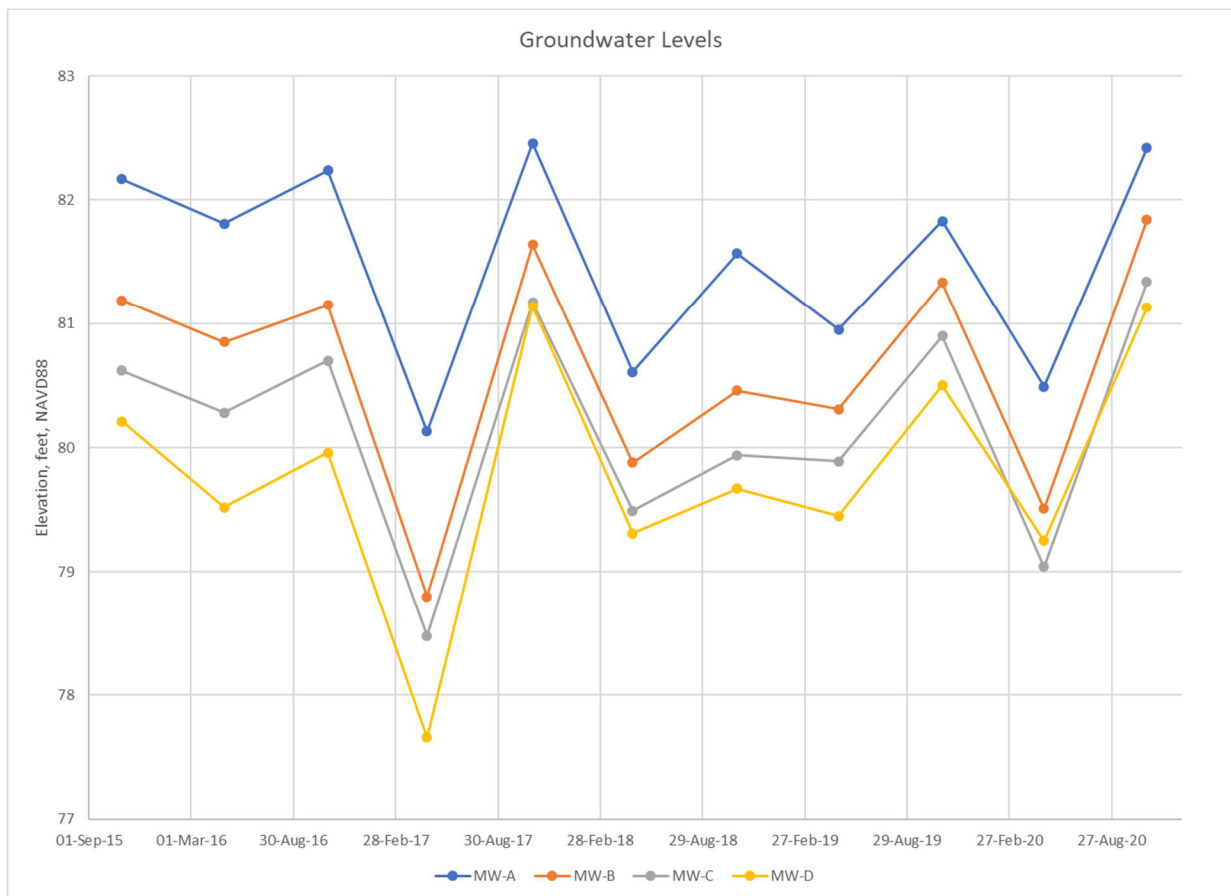
Table 2. Background and Operations Period Groundwater Levels – MW-A, MW-B, MW-C, and MW-D, OUC Stanton Energy Center

2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

DATE	Well	Florida State Plane East Zone (901)		Elevation TOC (feet, NAVD88)	Depth to Water (feet)	Water Level Elevation (feet, 88)
		Northing (feet)	Easting (feet)			
10/30/2018					5.43	79.67
4/29/2019					5.65	79.45
10/31/2019					4.60	80.50
4/29/2020					5.85	79.25
10/29/2020					3.97	81.13

TOC – Top of casing

NAVD88 – North American Vertical Datum of 1988

**Figure 4. Quarterly Groundwater Levels**
2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

Groundwater Sampling and Laboratory Analysis

The detection monitoring program began with establishing background groundwater quality conditions that consisted of collecting and analyzing quarterly samples between September 2015 and July 2017 for Appendix III and IV constituents. Sampling events to establish background water quality conditions were completed by October 17, 2017 in accordance with §257.94(b). MW-A is the background well and MW-B, MW-C, and MW-D are the three wells to monitor for compliance with the CCR.

Based on the October 2017 results, OUC resampled MW-B for calcium, chloride, pH (low), and TDS; and MW-D for calcium and chloride on January 25, 2018. The resampled data were evaluated against the October 30, 2017 background sample results to determine the next action. Two parameters were confirmed to be potential statistically significant increase (SSI), pH and total dissolved solids (TDS) in MW-B. The apparently confirmed well-constituent pairs identified for a SSI at well MW-B may not be a SSI due to lack of a sufficient quantity of background data. Until more data are collected a reliable test to detect the existence of a trend cannot be made and there are higher chances of making a false positive error.

Several parameters being monitored had trends noted during the CCR background period. In the past, the upper prediction limits (UPL, and lower prediction limit [LPL] for pH) were tested by modifying the baseline UPL/LPL with the trend parameter. This made the limits slope with time, and in some instances the limits approached zero - which is not feasible. Because it was difficult to see the change over time when both the observed data and probability limits both vary, for the 2019 and 2020 annual reports, the UPL/LPL were held constant and the observed data were adjusted by the trend parameters (that is, “detrended” by applying the slope parameter to the observed data as shown by example on the bottom of Table 3). Time series plots were created to show the change in the observations over time against a constant limit. These plots are discussed further in the next section.

The 2020 semi-annual sampling results are shown in Table 4 (and Appendix A). The following results are noted:

- Based on the March 25, 2020 compliance monitoring sampling event, high values were identified at all 3 wells for similar constituent pairs:
 - Well MW-B for calcium, chloride, and TDS. Retesting was done because the sampled concentrations were high when compared to the baseline data and were outside of their limits because of the trend adjustment. The retest values were similarly high again. When looking at the results in comparison to the other wells, these high constituent levels were observed at all wells. Additional discussion is included below on alternative sources.
 - Well MW-C for pH and TDS. Retesting was conducted and both pH and TDS remained above the detrended UPL. Additional discussion is included below on alternative sources. Calcium was later determined to be a little above the UPL but a data entry error was not discovered until much later so no retesting was done.
 - Well MW-D for calcium, chloride, fluoride, pH, sulfate, and TDS. Retesting was conducted and calcium, chloride, sulfate, and TDS spiked above their upper probability limits. Also, pH was below the lower probability limit which was also part of a longer-term trend at the site that should be re-evaluated with additional data. Fluoride values were higher than the UPL but the high calcium and chloride values could have interfered with these readings.
- Based on the September 14, 2020 compliance monitoring sampling event, high values were identified at all 3 wells like earlier tests:
 - Well MW-B for calcium, chloride, pH, and TDS. pH was measured at a reasonable level when compared to the baseline, but the negative trend from the baseline needs to be reevaluated.

- o Well MW-C for pH and TDS; with levels similar to the March sampling. Fluoride was also higher than the UPL.
 - o Well MW-D for calcium, chloride, fluoride, pH, sulfate, and TDS. Calcium, chloride and TDS concentrations were lower compared to earlier levels.
- Retesting for the September 2020 event is being conducted.

Table 3. Detection Monitoring Parameters Tolerance Limits and Trend Parameters

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Well	Constituent	UPL	LPL	Unit	Limit Trend Slope	Detrended
MW-B	Boron	41.2		ug/L	0.1064	Y
	Calcium	30000		ug/L	-37.26	Y
	Chloride	123000		ug/L	-127.1	Y
	Fluoride	230		ug/L		
	pH	4.55	3.87	pH Units	0.0008951	Y
	Sulfate	61300		ug/L		
	TDS	292000		ug/L	-195.8	Y
MW-C	Boron	31.1		ug/L		
	Calcium	8370		ug/L		
	Chloride	8550		ug/L	12.5	Y
	Fluoride	100		ug/L		
	pH	5.73	5.03	pH Units	-0.0004337	Y
	Sulfate	2370		ug/L		
	TDS	70800		ug/L		
MW-D	Boron	32.6		ug/L		
	Calcium	5730		ug/L	-3.194	Y
	Chloride	18000		ug/L	11.3	Y
	Fluoride	120		ug/L		
	pH	6.23	4.92	pH Units	-0.002029	Y
	Sulfate	330		ug/L		
	TDS	114000		ug/L		

UPL and LPL are the upper and lower probability limits. These are also referred to as the tolerance levels.

µg/L = micrograms per liter

“Detrended” means that the data need to be adjusted for the trend. The trend is applied to the days since the baseline period began (9/9/2015) to the observed data. The trend's case is opposite when applied to the data; for example, boron March 28, 2019 adjustment is $-0.1064 \times 1296 \text{ days} = -138 \text{ ug/L}$. The detrended March 2019 boron value is $112 - 138 = -26 \text{ ug/L}$.

Table 4. Summary of 2020 Annual Data Detection Monitoring Results
2022 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

Well						First Semi-Annual Sampling Event on 3/25/2020					Second Semi-Annual Sampling Event on 9/14/2020				
						Observed Value	Detrended / Observed Value	Within Compliance	Retest Values	Detrended Retest Value	Potential SSI	Observed Value	Detrended / Observed Value	Within Compliance	Is Retesting Required?
MW-B	Boron	µg/L		41.2	Y	134	-43	Yes		NA	92	-103	Yes		
	Calcium	µg/L		30,000	Y	2,020	63,834	No	1,690	65,926	Yes	9,050	77,310	No	Yes
	Chloride	µg/L		123,000	Y	17,500	228,359	No	16,600	235,720	Yes	40,200	273,047	No	Yes
	pH	pH Units	3.87	4.55	Y	5.47	3.99	Yes		NA	4.48	2.84	No	Yes	
	Fluoride	µg/L		230		150 U	150	Yes		NA	90	90	Yes		
	Sulfate	µg/L		61,300		36,400	36,400	Yes		NA	35,800	35,800	Yes		
	TDS	µg/L		292,000	Y	111,000	435,832	No	106,000	443,559	Yes	162,000	520,706	No	Yes
MW-C	Boron	µg/L		31.1		20 U	20	Yes		NA	11	11	Yes		
	Calcium	µg/L		8,370		8,930	8,930	No	No retest conducted because of data entry error	NA	7,550	7,550	Yes		
	Chloride	µg/L		8,550	Y	25,300	4,563	Yes		NA	26,000	3,100	Yes		
	pH	pH Units	5.03	5.73	Y	5.71	6.43	No	5.2	6.0	Yes	5.16	5.95	No	Yes
	Fluoride	µg/L		100		100	100	Yes		NA	110	110	No	Yes	
	Sulfate	µg/L		2,370		1,940	1,940	Yes		NA	220U	220	Yes		
	TDS	µg/L		70,800		99,000	99,000	No	99,000	99,000	Yes	97,000	97,000	No	Yes
MW-D	Boron	µg/L		32.6		20 U	20	Yes		NA	13	13	Yes		
	Calcium	µg/L		5,730	Y	168,000	173,299	No	661,000	666,507	Yes	159,000	164,851	No	Yes
	Chloride	µg/L		18,000	Y	556,000	537,253	No	2,240,000	2,220,519	Yes	387,000	366,298	No	Yes
	pH	pH Units	4.92	6.23	Y	4.24	7.61	No	4.1	7.5	Yes	4.72	8.44	No	Yes
	Fluoride	µg/L		120		170	170	No	370	370	Yes	310	310	No	Yes
	Sulfate	µg/L		330		4,120	4,120	No	13,500	13,500	Yes	3,420	3,420	No	Yes
	TDS	µg/L		114,000		1,590,000	1,590,000	No	4,710,000	4,710,000	Yes	1,090,000	1,090,000	No	Yes

Retest for first event occurred 05/29/2020. Retest results for second event is pending.
SSI = statistically significant increase; LPL = lower probability limit; UPL = upper probability limit

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Data Discussion

Considering the original baseline date and the 2017 through 2020 data, the original trends estimated on the smaller background dataset seemed to be inaccurate for some constituents at some wells: boron, pH, and sulfate. Figure 5 shows the detrended data over time. Since these few parameters have consistent trends for some wells, it is possible that their original baseline trend analysis was not representative. For accurate trends, the time series plots of the detrended data should be relatively flat, like it is for MW-C pH and sulfate. MW-B sulfate had no trend in the original analysis, but it appears to be trending given the larger dataset. The dataset needs to be reanalyzed and the entire record considered to evaluate whether the background levels established during the baseline period are still valid.

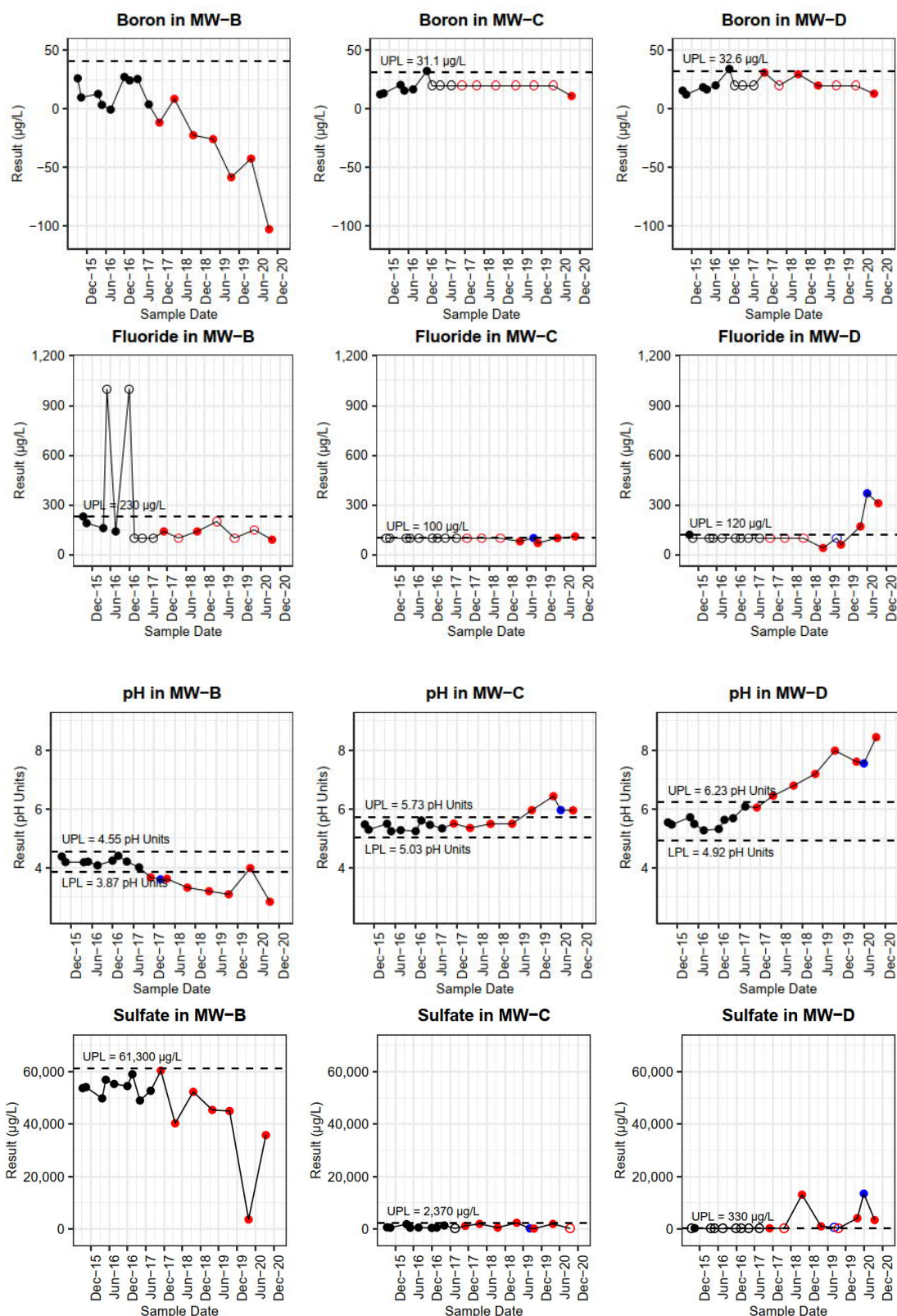
For other data, the time series plot indicated that there could have been a change occurring around 2017. The chlorides, calcium, and TDS concentrations started to raise in mid-2017 in MW-B and MW-D by 2018 (Figure 6). However, during 2020 there was a major spike in these three parameters which indicates that there is a potential new source or introduction of these inorganic minerals in the shallow groundwater.

Potential Alternative Sources Review

MW-B and MW-D are not close to the new, double-lined Horizontal Expansion subject to the CCR regulation. MW-B is about 3,125 linear feet and MW-D is about 2,600 linear feet from the new landfill. MW-C is further north. The rise in calcium, chloride, and TDS concentrations measured in these monitoring wells started in mid-2017, approximately 780 days from the initiation of storing material in the new Horizontal Expansion. The calculated groundwater flow rate in the western part of the site is approximately 5 feet per year under the prevailing gradient. The groundwater travel time from the northern edge of active cell of the Horizontal Expansion to either monitoring well is expected to be several hundred years.

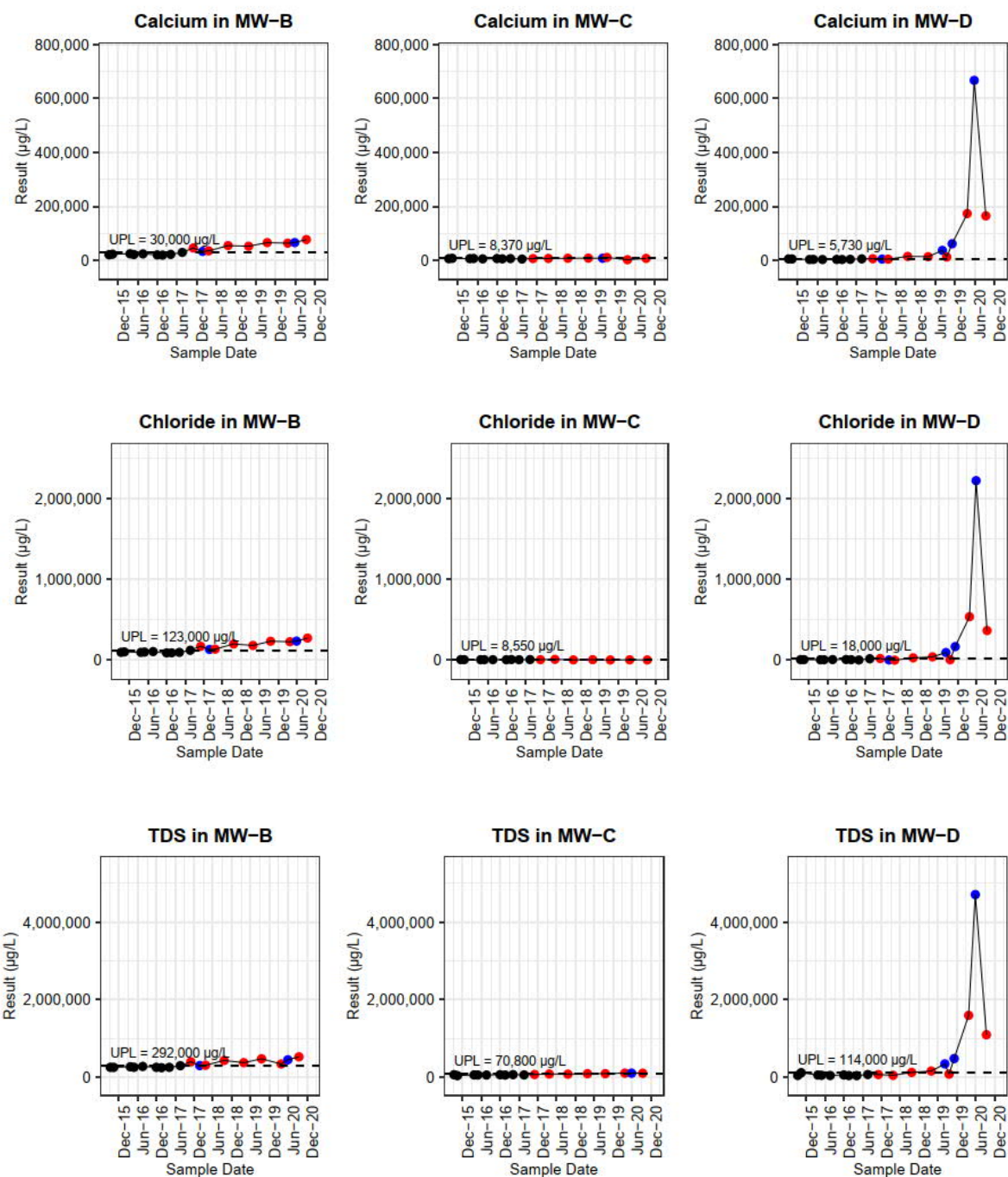
MW-B is closer to the western boundary of the property than MW-D and the water level elevation in MW-B is consistently about 0.25- to 0.7-foot higher than the elevation in MW-D (Table 2 and Figure 4). Since MW-B chlorides, calcium, and TDS concentrations appeared to rise sooner than at MW-D, it is possible that there is an influence entering offsite from the west. MW-D is not directly downgradient of MW-B. MW-C is much closer to MW-B and is downgradient, yet it is not experiencing a similar rise in calcium, chlorides, or TDS (a slight rise, but not as much). As discussed in the 2018 Annual Report, there is also limerock stored near MW-D which could be a source of the type of constituents observed rising.

Sample results from the first semi-annual sampling event conducted on March 25, 2020 required retesting for identified potential SSIs at wells MW-B, MW-C, and MW-D for pH, fluoride, sulfate, calcium, chloride, and total dissolved solids (requirements varied per well). After checking with the lab and retesting on May 29, 2020 it was determined that the data at MW-D for calcium, chloride, and TDS were confirmed as significantly higher than the UPL. In fact, the concentrations for these three parameters were orders of magnitude different from the baseline data (40 to 120 times the upper limit). The pH was also greater than the upper limit when the baseline trend was applied, but the pH value is higher than background levels but the baseline period trend needs to be reanalyzed. The fluoride concentrations at MW-C and MW-D were also higher than the UPL, but the fluoride data during the baseline period were below detection. The values now have some above detection, so a new re-baselining of the background values is needed. The calcium, chloride, and TDS concentrations at MW-B in the retest results (potential SSIs), were about 2 times the upper limit. At MW-C only pH and TDS were retested. The pH retest value was 5.2 standard units and while that was higher than the baseline UPL, the data is trending higher now, and the data needs to be reanalyzed. The TDS retest concentration was the same as the March concentration, which was 140 times the upper limit and a potential SSI. The September 14, 2020 routine tests results are also indicating levels of calcium, chlorides, pH, and TDS at the three wells similar to the retest values.



Black dots are background data; red dots are detection data; blue dots are resampled data

Figure 5. Well-Constituent Results that are Candidates for Updated Trend and Limit Analysis
2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report



Black dots are background data; red dots are detection data; blue dots are resampled data

Figure 6. Candidate Well-Constituent Pairs that are Candidates Additional Analysis for Alternative Sources
2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

During 2020, after these SSIs were observed, an Alternative Source investigation was conducted to determine whether a source other than the CCR unit was the cause the significant increases (Appendix B). Since the concentrations in MW-D have been higher than at the other MWs, and it is primarily calcium, chloride, and TDS at issue, the focus of the alternative sources is primarily on these three constituents. High calcium and chloride values would contribute to the high TDS values, as well as other dissolved salts and minerals. A stationary source, like the Horizontal Expansion, would be

expected to contribute to high levels for an extended period. The calcium, chloride, and TDS values rapidly increased and reduce so this type of response suggests an alternative source.

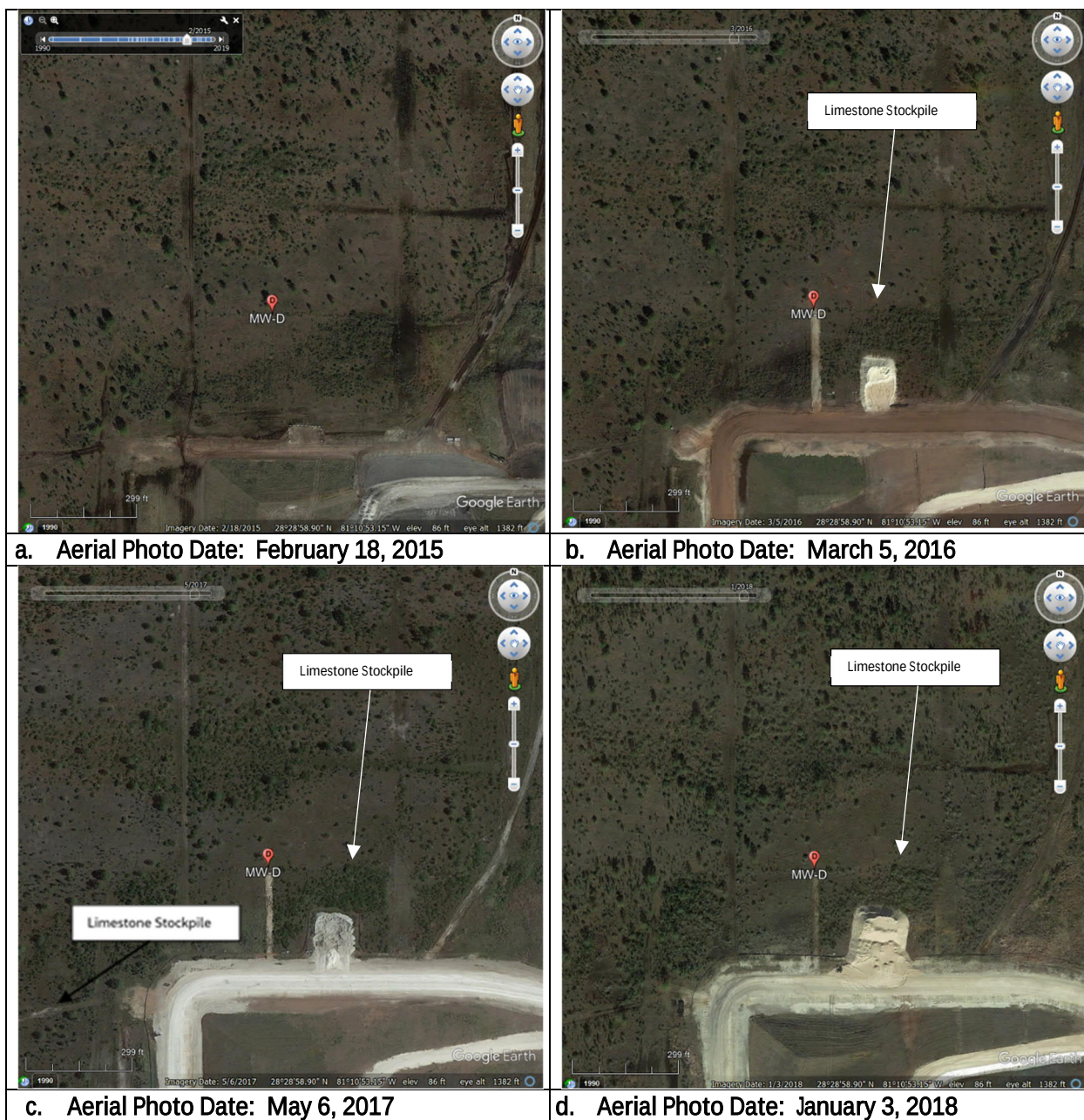
Changed Site Conditions near MW-D

During the CCR monitoring history a stockpile of limestone (also called limerock) to support waste management operations was placed near MW-D. Aerial photographs of presence and positions of the stockpile at six different times are presented in Figures 7a through 7f. The MWs wells were installed in August 2015 and the limestone stockpile was not observed during the time of MW construction; therefore, the February 18, 2015 aerial photograph represents the preconstruction condition at the site. Over time the stockpile grew and the position of the northwest corner of the stockpile came within approximately 75 feet of MW-D. It is hypothesized that stormwater runoff from the pile could have impacted groundwater quality at MW-D through direct infiltration and groundwater transport, or overland flow then infiltration and groundwater transport around the general area. The stockpile was removed in January 2020. The spike in TDS-related data occurred in 2020, so it is possible that there was a residual influence of the near-surface groundwater from the stockpile, or perhaps, the removal efforts mixed limerock into the surface soil causing the great spike in concentrations. Given that the concentrations of calcium and chloride dropped as precipitously as they rose, it is possible that the spike was temporary as residual materials were flushed through the soil and into the near-surface groundwater. High levels were still present in September 2020, but not near the spiked levels. Additional monitoring is needed to identify longer term residual groundwater quality trends at MW-D.

OUC has started the construction of a new CCR Horizontal Expansion cell adjacent to and north of the current one. Like the existing cell, it will be lined in accordance to state municipal solid waste rules. The land to the southwest and west of MW-D was cleared and grubbed to support this construction, which also could have had hydrologic impacts to the near-surface groundwater. The groundwater table is only about 2-feet below land surface in this area and the MWs are 30 feet deep with the screened intervals from 20 to 30 feet deep (screens fully submersed in the groundwater). As the new cell was excavated (since fall 2019) additional rainfall and runoff could have been retained and percolated into the ground between the CCR active cell and the MWs. After the new cell is lined, then this area would cease to contribute stormwater. MW-D is over 2,600 feet from the north side of existing cell and 1,200 feet from the north side of the new cell. The work staging area was built about 300 feet from MW-D and a new haul road is adjacent to it (Figure 7f). MW-B, which also had elevated TDS, is about 3,200 feet from the existing CCR cell and 1,700 feet from the new cell excavation. MW-C is the furthest north and away from the existing cell (about 3,800 feet) and disturbed soils, and it had the lowest elevated TDS concentrations.

A longer sampling period of CCR Appendix III Constituents for Detection Monitoring plus major ions is necessary to confirm the temporary nature of the results.

Figures 7a through 7f. OUC CCR Groundwater Monitoring MW-D Area Over Time
2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report



Figures 7a through 7f. OUC CCR Groundwater Monitoring MW-D Area Over Time
 2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report



Geochemical Pattern Analysis

Additional groundwater sampling of the four CCR MWs was conducted on July 13, 2020 for a suite of major anions and cations for a geochemical analysis to identify if the groundwaters at the MWs are from different sources. These additional parameters for geochemical pattern analysis included: bicarbonate/carbonate (HCO_3/CO_3), chloride (Cl), sulfate (SO_4), calcium (Ca), magnesium (Mg), potassium (K), and sodium (Na). These additional parameters were also sampled September 14, 2020. The geochemical pattern analysis used the method described by Piper (1944). The results of the July 2020 sampling are presented in Table 5. The results from the September 2020 sampling is shown in Table 6. The low percent difference between the total cations and anions indicate that the basic geochemistry constituents are in balance at each MW and suitable to use for the pattern analysis.

Piper's graphical method plots the equivalent concentration results (milliequivalents per liter, meq/L) of the sampled common water ions over a diamond grid. Sample results that plot close to one another are geochemically similar indicating a common source; sample results that do not plot close to one another are geochemically dissimilar indicating different sources.

The equivalent ion concentrations were plotted (percent meq/L) and aligned to a geochemical facies pattern, as described by hatari labs (2018). The overlay of the OUC CCR results and the faces pattern are presented in Figure 8 for July and Figure 9 for September (Lorenz and Diekoff, 2017). The results of the procedure show that the position of the MW-D groundwater plot away from the positions of the groundwater from the other three monitoring wells. The July and September data were very similar and plot nearly on top of one another. The results indicate that groundwater at MW-D plots as calcium-chloride-type water, while MW-A and MW-C plot as transitional mixed type and sodium-chloride-type water and MW-B plots as sodium-chloride-type water. Given the great difference in calcium, chloride, and TDS concentrations at MW-D, it is likely that its proximity to the limerock and construction zone impacted it greater than at the other MWs.

Table 5. July 13, 2020 Geochemical Sampling Results with Ion Balances

2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

	Anions				Cations			
Site	Cl	CO ₃	HCO ₃	SO ₄	Ca	Mg	Na	K
	Concentration (mg/L)							
MW-A	17,500	0	0	1,060	4,900	3.9	4,840	1,440
MW-B	36.6	0	2	38.3	7.19	3.39	21.7	5.34
MW-C	27.3	0	9	2.36	7.41	1.01	10.6	1.13
MW-D	138	0	2	0.68	49.2	6.36	13.4	2.2
	Concentration (meq/L)							
MW-A	492	0.00	0.00	22.08	245	0.32	210	37
MW-B	1.03	0.00	0.03	0.80	0.36	0.28	0.94	0.14
MW-C	0.77	0.00	0.09	0.05	0.37	0.08	0.46	0.03
MW-D	3.88	0.00	0.02	0.01	2.46	0.52	0.58	0.06
	Concentration Percentage of meq/L							
MW-A	95.7	0.0	0.0	4.3	49.7	0.1	42.7	7.5
MW-B	55.7	0.0	1.1	43.2	20.9	16.2	54.9	8.0
MW-C	84.6	0.0	9.9	5.4	39.3	8.8	48.8	3.1
MW-D	99.1	0.0	0.5	0.4	67.9	14.5	16.1	1.6
	Ion Balance							
Site	Sum of Anions	Sum of Cations	Ion Balance					
MW-A	514	493	2.1%					
MW-B	1.85	1.72	3.6%					
MW-C	0.91	0.94	-2.0%					
MW-D	3.91	3.62	3.8%					

Notes:

Bicarbonate (HCO₃), carbonate (CO₃), chloride (Cl), sulfate (SO₄), calcium (Ca), magnesium (Mg), potassium (K), and sodium (Na)
 mg/L= milligram per liter; meq/L = milliequivalents per liter

Percentage meq is the percent of the sum of the four anions/cations listed

The ion balance was calculated (in meq/L) as the total dissolved-anions concentration minus the total dissolved-cation concentration divided by the total concentration of ions

Table 6. September 14, 2020 Geochemical Sampling Results with Ion Balances

2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

	Anions				Cations			
Site	Cl	CO ₃	HCO ₃	SO ₄	Ca	Mg	Na	K
	Concentration (mg/L)							
MW-A	18,000	0	1	1,110	5,100	3.80	5,150	1,480
MW-B	40.2	0	3	35.80	9.05	3.15	25.4	2.73
MW-C	26.0	0	13	0.22	7.55	1.04	11.0	1.03
MW-D	387	0	3	3.42	159	12.8	40.4	4.37
	Concentration (meq/L)							
MW-A	506	0	0.01	23.13	255	0.31	224	37.95
MW-B	1.13	0	0.03	0.75	0.45	0.26	1.10	0.07
MW-C	0.73	0	0.13	0.00	0.38	0.09	0.48	0.03
MW-D	10.87	0	0.03	0.07	7.95	1.05	1.76	0.11
	Concentration Percentage of meq/L							
MW-A	95.6	0.0	0.0	4.4	49.3	0.1	43.3	7.3
MW-B	59.4	0.0	1.4	39.2	24.0	13.7	58.6	3.7
MW-C	66.3	0.0	33.1	0.6	39.0	8.8	49.4	2.7
MW-D	99.1	0.0	0.3	0.6	73.1	9.7	16.2	1.0
	Ion Balance							
Site	Sum of Anions	Sum of Cations	Ion Balance					
MW-A	529	517	1.1%					
MW-B	1.90	1.89	0.4%					
MW-C	0.86	0.97	-5.6%					
MW-D	10.97	10.87	0.5%					

See Table 5 notes for definitions.

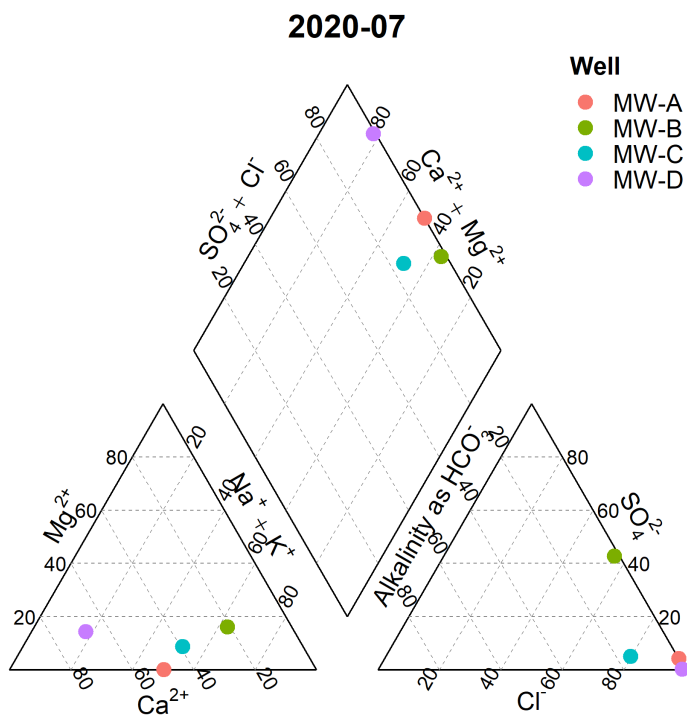


Figure 8. July 2020 Results of Geochemical Facies Pattern and Analysis Results (after hatari labs, 2018)
2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

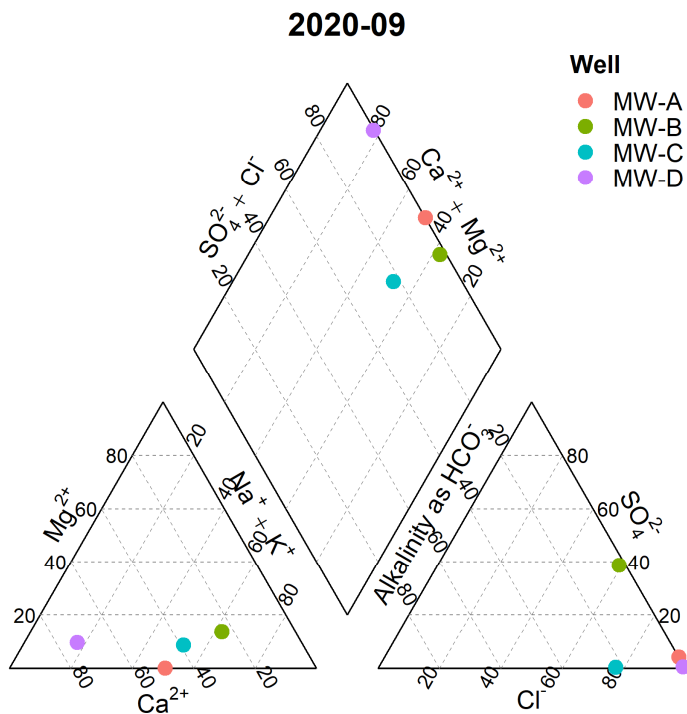


Figure 9. September 2020 Results of Geochemical Facies Pattern and Analysis Results (after hatari labs, 2018)
2020 Coal Combustion Residuals Annual Groundwater Monitoring and Corrective Action Report

Conclusion

The general purpose of the 2020 annual report is to document the results of the CCR detection monitoring conducted at OUC SEC. The results indicated that analyses of several parameter fell outside the expected statistical significance interval based on the original background analysis of the CCR data. None of these values exceed or constitute a violation of groundwater standards levels. These SSIs are derived from a comparison of the results to a statistical analysis of a limited number of background readings during the baseline period. With the additional data over time, some of the observed trends need to be re-evaluated with the additional information. Similarly, the fluoride values are no longer all below detection levels, so a new statistical evaluation is required to reassess the background levels.

If an SSI is verified using the detection monitoring program, the site assessment monitoring program must be initiated for all monitoring wells within 90 days and continue at semiannual frequency. Alternately, the owner of the facility must demonstrate that a source other than the CCR unit is responsible for the increase. During 2020 an investigation was conducted to determine whether a source other than the CCR unit was the cause the significant increases. The CCR Horizontal Expansion is relatively new (5 years old) and located away from the compliance MWs. Groundwater does not move very quickly along the low gradient landscape at OUC Stanton Energy Center. The proximity of the newly disturbed land and the start of construction is coincidental to the timing of the jump in concentrations in the MWs. It is unlikely that the lined CCR cell would be a source of identified SSIs when there are more likely alternative sources in the area. If the Horizontal Expansion was the primary source of elevated concentrations, the levels would remain high. Instead, the high values of calcium, chloride, and TDS fluctuated to lower levels, so that is indicative of a spill or temporary influence.

A review of the site conditions indicates that the limerock pile is more likely a contributor to concentration increases in MW-D. From this analysis it is concluded that the groundwater at MW-D is of different geochemical type of a different source that from MW-A, MW-B, and MW-C. The limerock was a potential alternative source located near MW-D for several years and the analysis supports a potential alternate source for the SSI at MW-D and MW-B. The limerock pile located near MW-D was removed January 2020 and land restored. MW-C data indicate the results are in range of natural variability. Because calcium and chloride are mobile dissolved ions, there could have been a widespread groundwater influence from the clearing and grubbing of the area for the new construction. High TDS is associated with these high ion concentrations too.

Based on the review of the data against projected trends, potential sources of constituents from surrounding land uses, and the principal component analysis conducted in 2018, it is concluded that SSIs of constituents are not verified to be from the CCR and it is not appropriate to proceed to assessment monitoring. In addition, the statistical baseline and trend analysis will be repeated in 2021 to evaluate the original trends estimates made with the limited data. There is reasonable documentation that the high concentration of dissolved ions is from an alternative source and that continued Detection Monitoring is recommended with additional ionic groundwater data collection so this situation can continue to be reviewed.

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Appendix A

Laboratory Analysis Results

OUC Stanton CCR Monitoring Well Results, 2020								
Location ID	Sample Date	Parameter Name	MCL	Final Result Text	Final Result Units	Final Reporting Limit (PQL)	Final Detection Limit (MDL)	Qualifier Flag
MW-B	3/25/2020	Boron		134	µg/L	50	20	
MW-B	3/25/2020	Calcium		2020	µg/L	500	30	
MW-B	3/25/2020	Chloride	250000	17500	µg/L	5000	620	
MW-B	3/25/2020	Fluoride	4000	150 U	µg/L	150	100	U
MW-B	3/25/2020	pH		5.47	pH Units			
MW-B	3/25/2020	Sulfate	250000	36400	µg/L	1100	330	
MW-B	3/25/2020	TDS	500000	111000	µg/L	5000	5000	
MW-B	5/29/2020	Calcium		1690	µg/L	500	30	
MW-B	5/29/2020	Chloride	250000	16600	µg/L	1000	120	
MW-B	5/29/2020	TDS	500000	106000	µg/L	5000	5000	
MW-B	7/13/2020	Calcium		7190	µg/L	500	30	
MW-B	7/13/2020	Chloride		36600	µg/L	1000	120	
MW-B	7/13/2020	Sulfate		38300	µg/L	3300	1100	
MW-B	9/14/2020	Boron		92	µg/L	5	5	
MW-B	9/14/2020	Calcium		9050	µg/L	500	30	
MW-B	9/14/2020	Chloride		40200	µg/L	5000	620	
MW-B	9/14/2020	Fluoride		90	µg/L	100	30	I
MW-B	9/14/2020	pH		4.48	pH Units			
MW-B	9/14/2020	Sulfate		35800	µg/L	3300	1100	
MW-B	9/14/2020	TDS		162000	µg/L	5000	5000	
MW-C	3/25/2020	Boron		20 U	µg/L	50	20	U
MW-C	3/25/2020	Calcium		8930	µg/L	500	30	
MW-C	3/25/2020	Chloride		25300	µg/L	1000	120	
MW-C	3/25/2020	Fluoride		100	µg/L	100	30	
MW-C	3/25/2020	pH		5.71	pH Units			
MW-C	3/25/2020	Sulfate	250000	1940	µg/L	390	130	
MW-C	3/25/2020	TDS		99000	µg/L	5000	5000	
MW-C	5/29/2020	pH	6.5 to 8.5	5.21	pH Units			
MW-C	5/29/2020	TDS	500000	99000	µg/L	5000	5000	
MW-C	7/13/2020	Calcium		7410	µg/L	500	30	
MW-C	7/13/2020	Chloride		27300	µg/L	1000	120	
MW-C	7/13/2020	Sulfate		2360	µg/L	660	220	
MW-C	9/14/2020	Boron		11	µg/L	5	5	
MW-C	9/14/2020	Calcium		7550	µg/L	500	30	
MW-C	9/14/2020	Chloride		26000	µg/L	1000	120	
MW-C	9/14/2020	Fluoride		110	µg/L	100	30	

OUC Stanton CCR Monitoring Well Results, 2020								
Location ID	Sample Date	Parameter Name	MCL	Final Result Text	Final Result Units	Final Reporting Limit (PQL)	Final Detection Limit (MDL)	Qualifier Flag
MW-C	9/14/2020	pH		5.16	pH Units			
MW-C	9/14/2020	Sulfate		220 U	µg/L	660	220	U
MW-C	9/14/2020	TDS		97000	µg/L	5000	5000	
MW-D	3/25/2020	Boron		20 U	µg/L	50	20	U
MW-D	3/25/2020	Calcium		168000	µg/L	2500	150	
MW-D	3/25/2020	Chloride		556000	µg/L	100000	12300	
MW-D	3/25/2020	Fluoride		170	µg/L	200	60	I
MW-D	3/25/2020	pH		4.24	pH Units			
MW-D	3/25/2020	Sulfate		4120	µg/L	1320	440	
MW-D	3/25/2020	TDS		1590000	µg/L	20000	20000	
MW-D	5/29/2020	Calcium		661000	µg/L	10000	600	
MW-D	5/29/2020	Chloride	250000	2240000	µg/L	100000	12300	
MW-D	5/29/2020	Fluoride	4000	370	µg/L	100	30	
MW-D	5/29/2020	pH	6.5 to 8.5	4.05	pH Units			
MW-D	5/29/2020	Sulfate	250000	13500	µg/L	13200	4400	
MW-D	5/29/2020	TDS	500000	4710000	µg/L	5000	5000	
MW-D	7/13/2020	Calcium		49200	µg/L	500	30	
MW-D	7/13/2020	Chloride		138000	µg/L	5000	620	
MW-D	7/13/2020	Sulfate		680	µg/L	660	220	
MW-D	9/14/2020	Boron		13	µg/L	5	5	
MW-D	9/14/2020	Calcium		159000	µg/L	2500	150	
MW-D	9/14/2020	Chloride		387000	µg/L	20000	2460	
MW-D	9/14/2020	Fluoride		310	µg/L	100	30	
MW-D	9/14/2020	pH		4.72	pH Units			
MW-D	9/14/2020	Sulfate		3420	µg/L	660	220	
MW-D	9/14/2020	TDS		1090000	µg/L	5000	5000	

Flags: U = Results below method detection limit; I = The reported value is greater than or equal to the laboratory method detection limit but less than the laboratory practical quantitation limit.

Appendix B

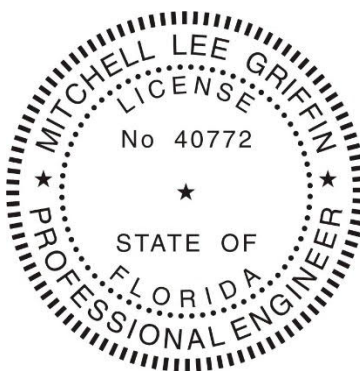
2020 Alternative Source Demonstration

2020 Alternate Source Demonstration for CCR Monitoring Wells: OUC Stanton Energy Center CCR

PREPARED FOR: Orlando Utility Commission
PREPARED BY: CH2M HILL Engineers, Inc.
DATE: October 12, 2020
PROJECT NUMBER: D3292400.A.PN.OE.09_DR

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This report has been digitally sealed by Mitchell L. Griffin, P.E. on the date adjacent to the seal.

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Executive Summary

The Orlando Utilities Commission (OUC) has been conducting groundwater monitoring associated with the new coal combustion residuals (CCR) landfill consistent with the United States Environmental Protection Agency's (EPA's) CCR Rule¹ since September 2015. Activities and results prior to 2020 have been documented and posted on OUC's CCR website, as required by the CCR Rule. The OUC CCR groundwater monitoring system consists of one background monitoring well (MW), MW-A, and three compliance MWs, MW-B, MW-C, and MW-D. Sample results from the first semi-annual sampling event conducted on March 25, 2020 required retesting for identified statistically significant increases (SSIs) at wells MW-B, MW-C, and MW-D for pH, fluoride (F), sulfate (SO₄), calcium (Ca), chloride (Cl), and total dissolved solids (TDS) (requirements varied per well). After checking the results with the lab and retesting on May 29, 2020, it was determined that the data at MW-D for Ca, Cl, and TDS were confirmed as SSIs that could not be explained by statistical analysis alone. In fact, the concentrations for these three parameters were orders of magnitude different from the baseline data (40 to 120 times the upper limit) which is quite unusual. The pH was also greater than the upper limit when the baseline trend was applied, but the value of 4.1 standard units is not a quality issue. The F concentration at MW-D was also a little higher than the statistical upper limit, but since there were high dissolved solids there could have been contributing factors. The Ca, Cl, and TDS concentrations were also unusually high at MW-B in the retest results (potential SSIs), but only about 2 times the upper limit. At MW-C only pH and TDS were retested. The pH retest value was 5.2 standard units and while that was high compared to baseline, it was not a quality issue. The TDS retest concentration was the same as the March concentration, which was unusually high (140 times the upper limit) and a potential SSI.

The groundwater sampling and statistical analyses of the groundwater quality data sets from the four MWs will be presented in the 2020 annual groundwater monitoring and corrective action report for the

¹ <https://www.epa.gov/coalash/coal-ash-rule>, accessed September 2, 2020.

OUC Stanton Energy Center. This document presents a demonstration that the confirmed SSIs identified at the MWs are from an alternate source meeting the requirement of the CCR Rule to continue in the Detection Monitoring program. Since the concentrations in MW-D have been so much higher than at the other MWs, and it is primarily Ca, Cl, and TDS at issue, the discussion focuses primarily on these three constituents.

As part of the alternate source demonstration, additional data were collected in July 2020 to conduct the ionic balance and investigate geochemical pattern analysis of the groundwater, but the Ca and Cl concentrations had unexpectedly dropped to very low concentrations (just as they unexpectedly rose). Consequently, these recent high concentrations could be transient and not from a long-term seepage source from the CCR landfill. Using the March 2020 and May 2020 resampling groundwater quality data, preliminary geochemical analysis, ion ratios, using the ions from the CCR Rule Appendix III parameter data indicated that the SSI was not linked to the regulated CCR unit. Results of this analysis indicated that the groundwater quality at MW-D was geochemically different than the water quality observed at other three MWs leading to the conclusion of an alternate source for MW-D. This alternate source could be influencing the other two compliance MWs. This demonstration is documented in this memorandum. Subsequently, continued Detection Monitoring is recommended with additional ionic groundwater data collection so this situation can continue to be reviewed.

Background

OUC has been operating the Stanton Energy Center electrical power generation plant southeast of Orlando, Florida since 1987. From 1987 to July 2017 CCR was deposited in the original onsite landfill. The original landfill was capped and closed prior to the prescribed date of the CCR Rule, October 17, 2017, exempting it from the rule. Monitoring of the closed landfill has been and continues to be conducted in coordination with the Florida Department of Environmental Protection (FDEP) since July 1986 under the state's Conditions of Certification (COC). OUC designed, permitted, and constructed a new lined CCR landfill under Florida's municipal solid waste rules. The new landfill was placed into service in July 2017 and is OUC's only regulated CCR unit under EPA's CCR Rule.

The CCR well monitoring network was installed in August 2015, consisted of 4 MWs. MW-A is the background MW and MW-B, MW-C, and MW-D are compliance MWs (Figure 1). Background period groundwater quality sampling was performed from September 2015 through July 2017. Operational monitoring has been performed semi-annually beginning October 2017 to the present under the Detection Monitoring program of the CCR Rule. Data from the background monitoring period were used to establish statistically based evaluation criteria consistent with the CCR Rule. These baseline data established potential trends, when present, and statistical upper limits (and lower limit for pH) that are typically set at 95 percent confidence interval.

The March 25, 2020 semi-annual sampling and selective retest resampling on May 29, 2020 to confirm groundwater quality, determined that SSIs at the MWs associated with the active CCR unit was potentially present. When an SSI is concluded from analysis of the data, the CCR Rule requires that the Detection Monitoring program is to convert to an Assessment Monitoring program unless a source other than the regulated CCR unit caused the identified SSI, or laboratory error, or natural variation of the groundwater quality can be demonstrated. Additional groundwater sampling of the four CCR MWs was conducted on July 13, 2020 for a suite of major anions and cations for a geochemical analysis to identify if the groundwaters at the MWs are from different sources.

Figure 1. OUC's CCR Groundwater Monitoring Network for the Regulated CCR Landfill

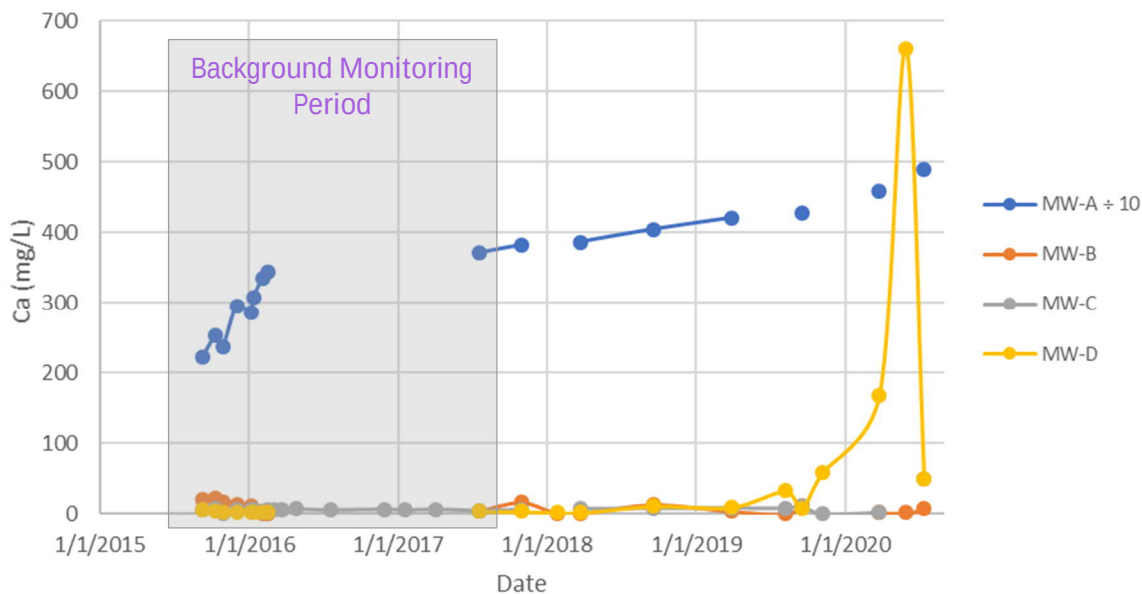


Groundwater Quality Data

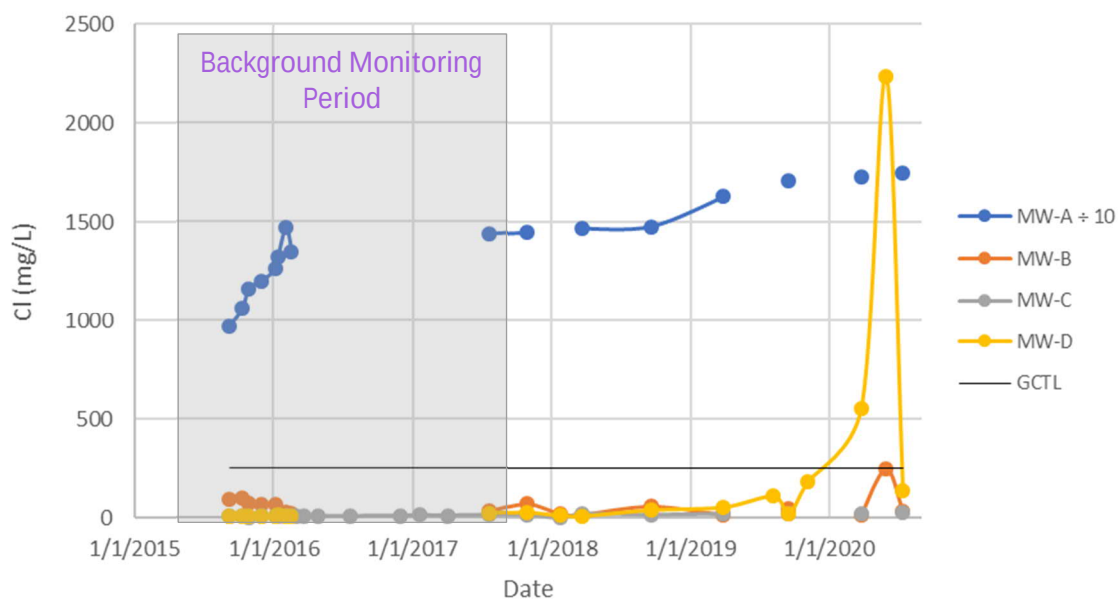
For the first part of this analysis Ca, Cl, SO₄, and TDS are presented to show patterns among the MWs in Figures 2a through 2d. The background monitoring period is identified on the charts. Of interest are the concentrations of Ca and Cl at MW-D that began to increase in September 17, 2019 continued through the May 29, 2020 confirmatory selective resampling. The patterns show a sharp increase of

concentrations in May that precipitated the July 13, 2020 sampling the four MWs for major anions and cations (bicarbonate/carbonate [HCO_3/CO_3], Cl , SO_4 , Ca , magnesium [Mg], potassium [K], and sodium [Na]) for geochemical pattern analysis. The July 13 sampling results in Figures 2a and 2b, respectively, had a sharp decrease of Ca and Cl concentrations.

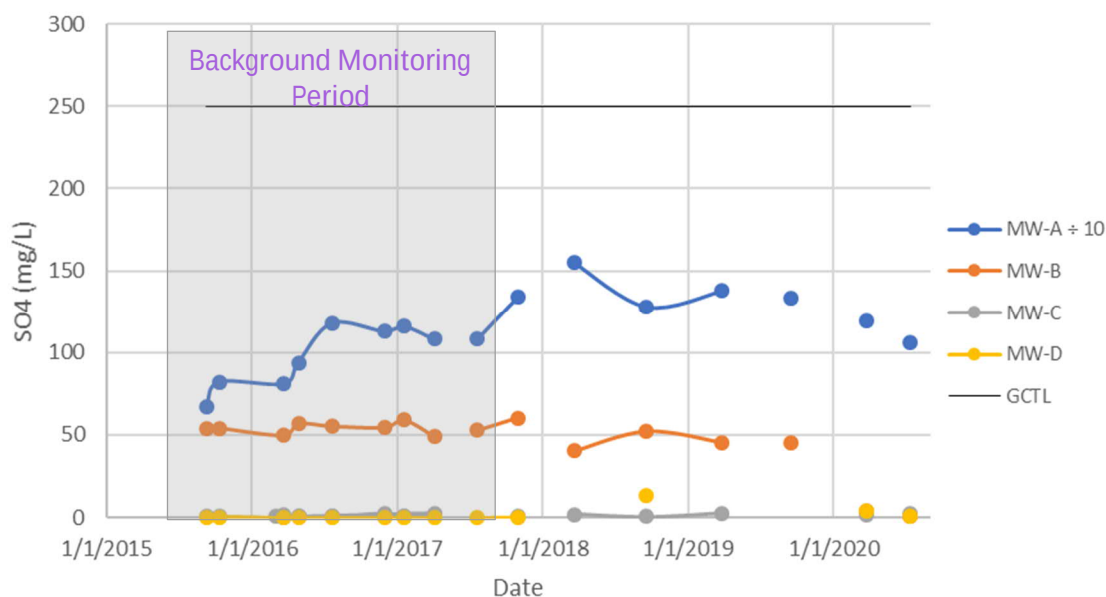
Figures 2a through 2d. Raw Groundwater Quality at the CCR Monitoring Wells



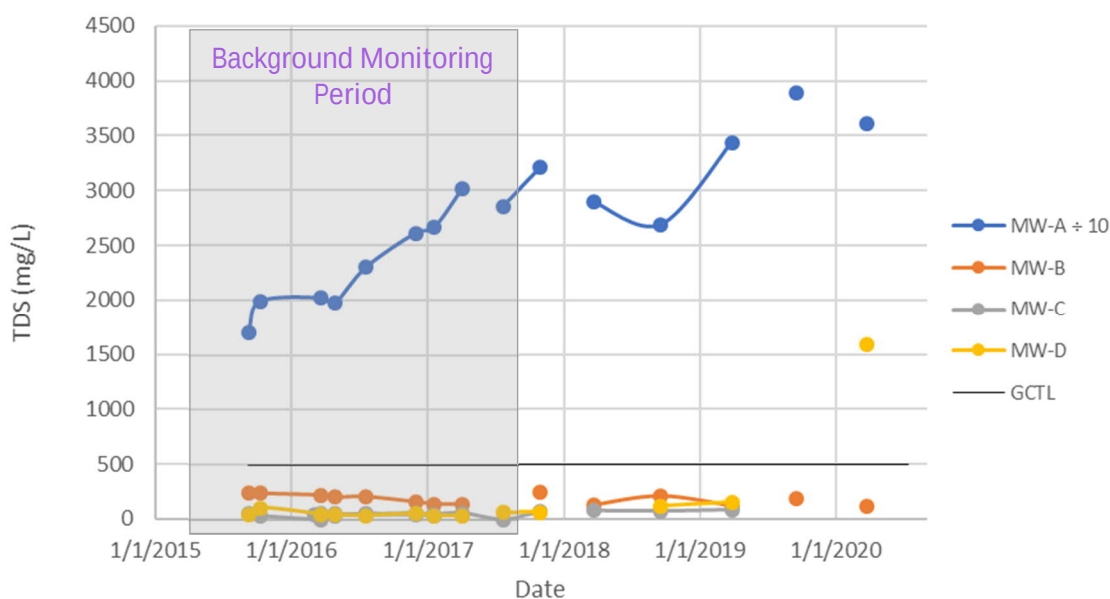
2a. Calcium



2b. Chloride



2c. Sulfate



2d. Total Dissolved Solids

Changed Site Conditions Near MW-D

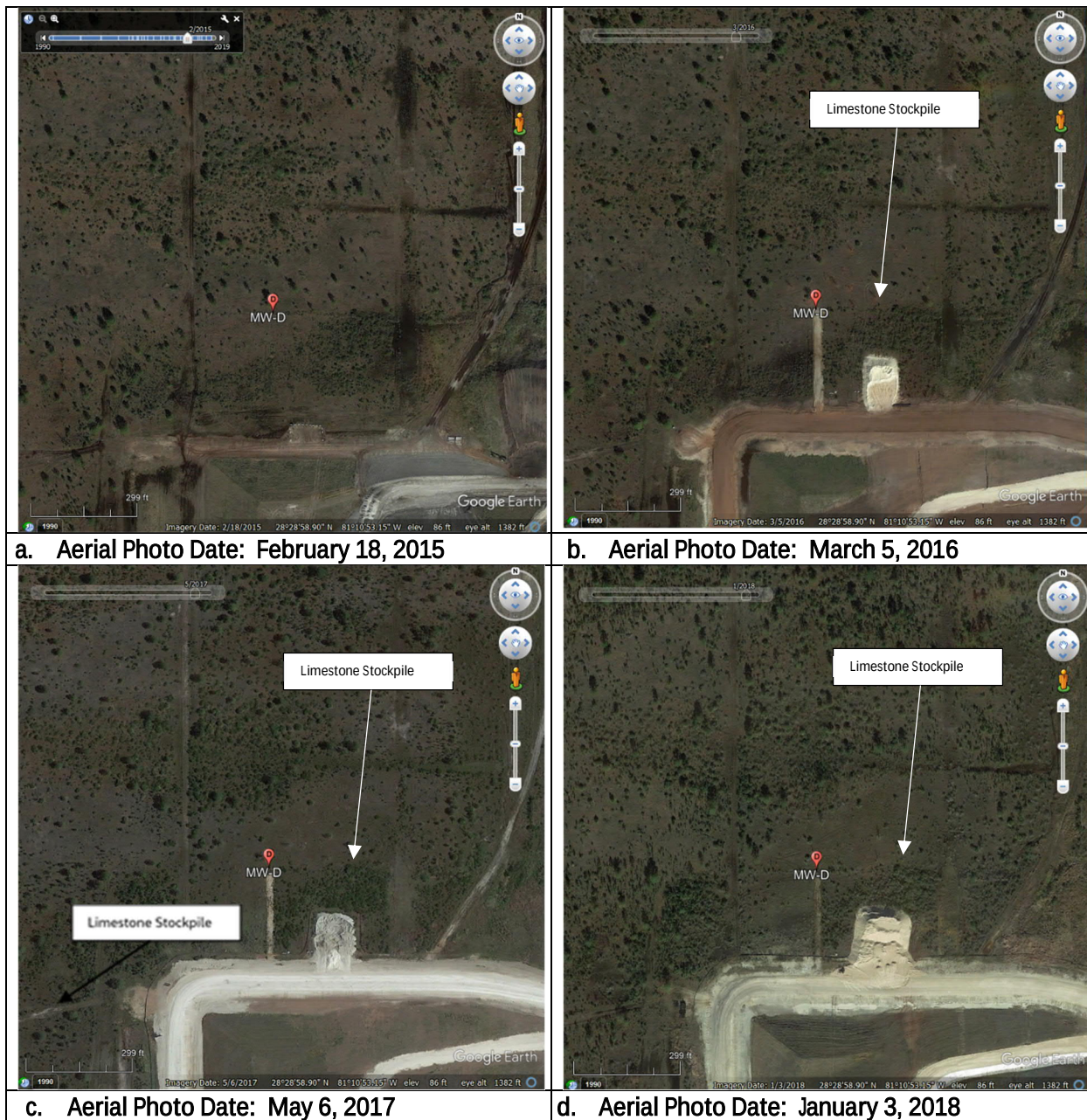
During the CCR monitoring history a stockpile of limestone (also called limerock) to support landfill operations was placed near MW-D. Aerial photographs of presence and positions of the stockpile at six different times are presented in Figures 3a through 3f. The MWs wells were installed in August 2015 and the limestone stockpile was not observed during the time of MW construction; therefore, the February 18, 2015 aerial photograph represents the preconstruction condition at the site. Over time the stockpile grew and the position of the northwest corner of the stockpile came within approximately 75 feet of MW-D. It is hypothesized that stormwater runoff from the pile could have impacted groundwater quality at MW-D through direct infiltration and groundwater transport, or overland flow then infiltration and groundwater transport around the general area. The stockpile was removed in January 2020. The

spike in Ca-related data occurred in 2020, so it is possible that there was a residual influence of the near-surface groundwater from the stockpile, or perhaps, the removal efforts mixed limerock into the surface soil causing the great spike in concentrations. Given that the concentrations of Ca and Cl dropped as precipitously as they rose, it is possible that the spike was temporary as residual materials were flushed through the soil and into the near-surface groundwater. Additional monitoring is needed to identify longer term residual groundwater quality trends at MW-D.

OUC has started the construction of a new CCR landfill cell adjacent to and north of the current one. Like the existing cell, it will be lined in accordance to state municipal solid waste rules. The land to the southwest and west of MW-D was cleared and grubbed to support this construction, which also could have hydrologic impacts to the near-surface groundwater. The groundwater table is only about 2-feet below land surface in this area and the MWs are 30 feet deep with the screened intervals from 20 to 30 feet deep (screens fully submersed in the groundwater). As the new cell was excavated (since fall 2019) additional rainfall and runoff could have been retained and percolated into the ground between the CCR landfill and the MWs. After the new cell is lined, then this area would cease to contribute stormwater. MW-D is over 2,600 feet from the north side of existing cell and 1,200 feet from the north side of the new cell. The work staging area was built about 300 feet from MW-D and a new haul road is adjacent to it (Figure 3f). MW-B, which also had elevated TDS, is about 3,200 feet from the existing CCR cell and 1,700 feet from the new cell excavation. MW-C is the furthest north and away from the existing landfill (about 3,800 feet) and disturbed soils, and it had the lowest elevated TDS concentrations.

A longer sampling period of CCR Appendix III Constituents for Detection Monitoring plus major ions is necessary to confirm the temporary nature of the results.

Figures 3a through 3f. OUC CCR Groundwater Monitoring MW-D Area Over Time



Figures 3a through 3f. OUC CCR Groundwater Monitoring MW-D Area Over Time



Geochemical Pattern Analysis

OUC resampled the four CCR MWs on July 13, 2020 for a suite of major ions for geochemical pattern analysis using the method described by Piper (1944). The results of the July 2020 sampling are presented in Table 1. The low percent difference between the cations and anions indicate that the basic geochemistry constituents are in balance at each MW and suitable to use for the pattern analysis.

Piper's graphical method plots the equivalent concentration results (milliequivalents per liter, meq/L) of the sampled common water ions over a diamond grid. Sample results that plot close to one another are geochemically similar indicating a common source; sample results that do not plot close to one another are geochemically dissimilar indicating different sources.

Table 1. July 13, 2020 Geochemical Sampling Results with Ion Balances

Site	Anions				Cations			
	Cl	CO ₃	HCO ₃	SO ₄	Ca	Mg	Na	K
	Concentration (mg/L)							
MW-A	17,500	0	0	1,060	4,900	3.9	4,840	1,440
MW-B	36.6	0	2	38.3	7.19	3.39	21.7	5.34
MW-C	27.3	0	9	2.36	7.41	1.01	10.6	1.13
MW-D	138	0	2	0.68	49.2	6.36	13.4	2.2
	Concentration (meq/L)							
MW-A	492	0	0	22	245	0.32	210	37
MW-B	1.03	0.00	0.03	0.80	0.36	0.28	0.94	0.14
MW-C	0.77	0.00	0.15	0.05	0.37	0.08	0.46	0.03
MW-D	3.88	0.00	0.03	0.01	2.46	0.52	0.58	0.06

Table 1. July 13, 2020 Geochemical Sampling Results with Ion Balances

	Anions				Cations			
Site	Cl	CO ₃	HCO ₃	SO ₄	Ca	Mg	Na	K
	Concentration Percentage of meq/L							
MW-A	95.7	0.0	0.0	4.3	49.8	0.1	42.7	7.5
MW-B	55.4	0.0	1.6	43.0	20.9	16.3	54.7	8.1
MW-C	79.4	0.0	15.5	5.2	39.4	8.5	48.9	3.2
MW-D	99.0	0.0	0.8	0.3	68.0	14.4	16.0	1.7
	Ion Balance							
Site	Sum of Anions	Sum of Cations	Ion Balance					
MW-A	514	493	2%					
MW-B	1.86	1.72	4%					
MW-C	0.96	0.94	1%					
MW-D	3.92	3.62	4%					

Notes:

Bicarbonate (HCO₃), carbonate (CO₃), chloride (Cl), sulfate (SO₄), calcium (Ca), magnesium (Mg), potassium (K), and sodium (Na)

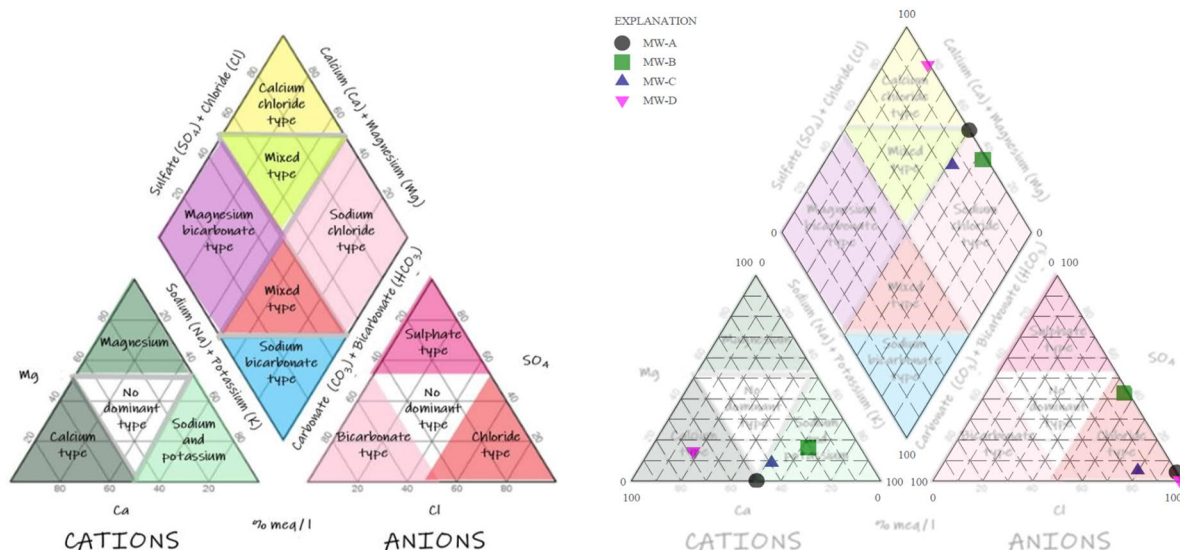
mg/L= milligram per liter; meq/L = milliequivalents per liter

Percentage meq is the percent of the sum of the four anions/cations listed

The ion balance was calculated (in meq/L) as the total dissolved-anions concentration minus the total dissolved-cation concentration divided by the total concentration of ions

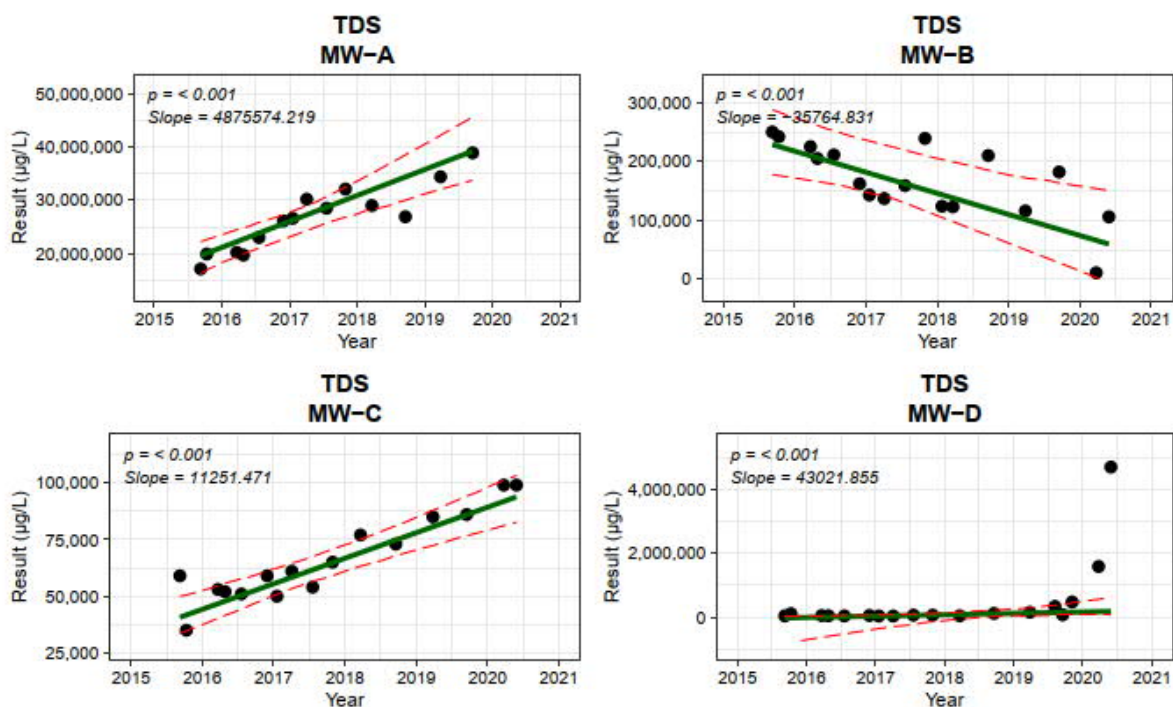
The equivalent ion concentrations were plotted (percent meq/L) and aligned to a geochemical facies pattern, as presented by hatari labs (2018). The overlay of the OUC CCR results and the faces pattern are presented in Figure 4. The results of the procedure show that the position of the MW-D groundwater (as indicated by the inverted magenta triangle) plot away from the positions of the groundwater from the other three monitoring wells. The results indicate that groundwater at MW-D plots as calcium-chloride-type water, while MW-A and MW-C plot as transitional mixed type and sodium-chloride-type water and MW-B plots as sodium-chloride-type water. Given the great difference in Ca, Cl, and TDS concentrations at MW-D, it is likely that its proximity to the limerock and construction zone impacted it greater than at the other MWs.

Figure 4. Results of Geochemical Facies Pattern and Analysis Results (after hatari labs, 2018)

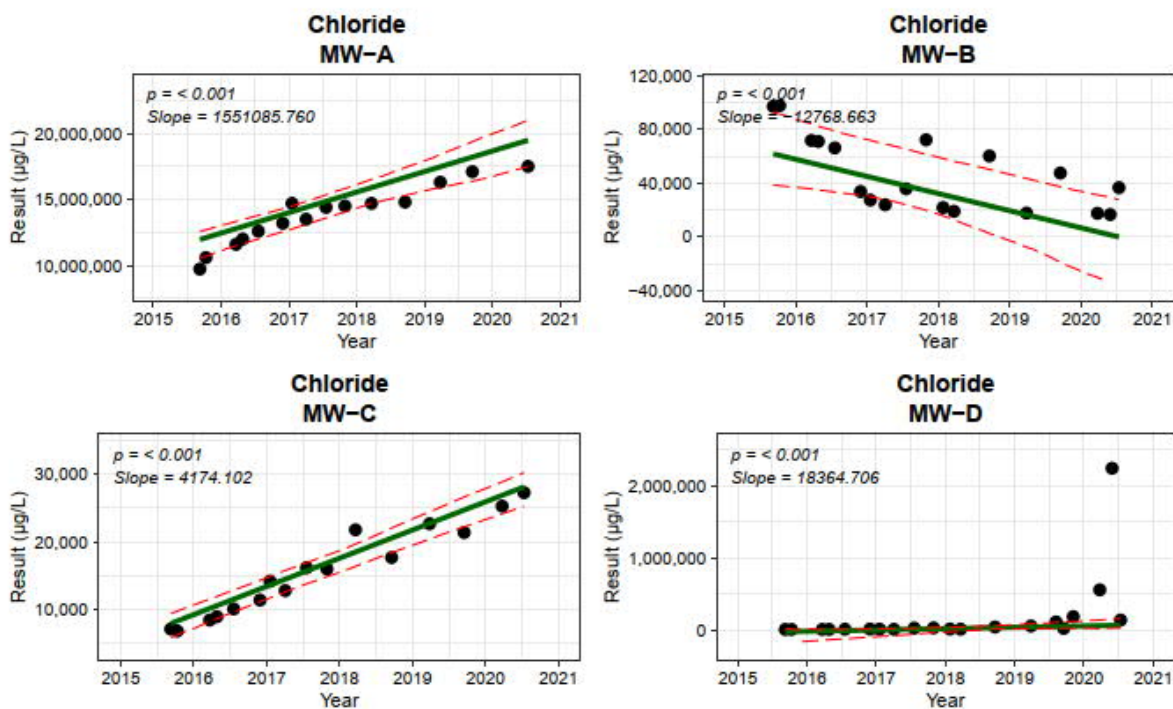


The concentrations and trend analysis of TDS, Ca and Cl are shown in Figures 5a through 5c. There are seasonal fluctuations of concentrations, which are more apparent in the MW-B results, with higher concentrations during the wet season (spring to fall). The 2020 spike in Ca concentrations (Cl and TDS too at MW-D) was rapid and unexpectedly high. Similarly, the reduction in July 2020 concentrations was rapid and unexpectedly low (Table 1). The May 2020 concentrations at MW-D were much higher than the other two compliance wells. However, the concentrations are not out of range of those monitored at MW-A. Figure 6 illustrates that high concentrations in Ca and Cl correlate with each other at MW-D, but not so much at MW-C. At MW-C, these two parameters were less than their upper limit and in compliance. The spread of Ca and Cl data at MW-C could be attributed to natural variability. At MW-D and MW-B, the high concentration type spikes in these two parameters coincided, which indicated a strong source.

Figures 5a through 5c. Total Dissolved Solids, Calcium, and Chloride Trend Data from CCR Monitoring Wells

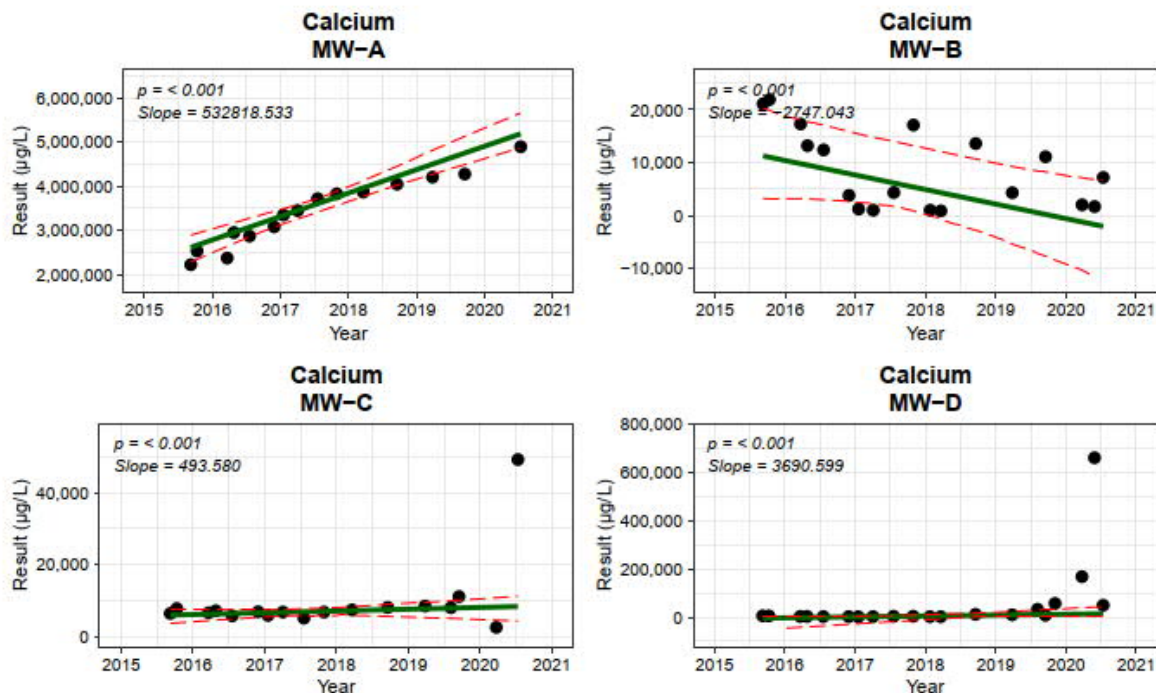


5a. Total Dissolved Solids



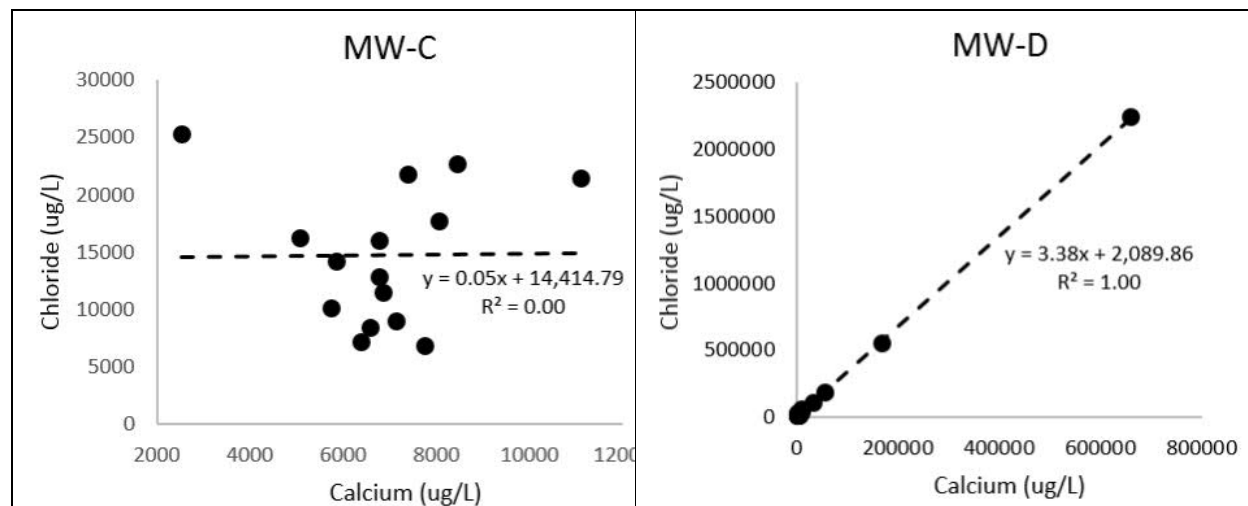
5b. Chloride

Figures 5a through 5c. Total Dissolved Solids, Calcium, and Chloride Trend Data from CCR Monitoring Wells



5c. Calcium

Figure 6. Calcium and Chloride Comparison from CCR Monitoring Wells MW-C and MW-D



Conclusion

The CCR landfill is relatively new (5 years old) and located far away from the compliance MWs. Groundwater does not move very quickly along the low gradient landscape at OUC Stanton Energy Center. The proximity of the newly disturbed land and the start of construction is coincidental to the timing of the jump in concentrations in the MWs. It is unlikely that the lined CCR landfill would be a source of identified SSIs when there are more likely alternative sources in the area.

From this analysis it is concluded that the groundwater at MW-D is of different geochemical type of a different source than from MW-A, MW-B, and MW-C. There was a potential alternative source located near MW-D for several years and the analysis supports a potential alternate source for the SSI at MW-D and MW-B. MW-C data indicate the results are in range of natural variability. Because Ca and Cl are mobile dissolved ions, there could have been a widespread groundwater influence from the clearing and grubbing of the area. High TDS is associated with these high ion concentrations too.

Recommendations

1. OUC's CCR groundwater monitoring program should remain in the Detection Monitoring program.
2. The monitored constituent list be expanded to include the additional major ions shown in Table 1 to continue Piper diagram plotting method to assess groundwater quality faces types through time.

References

- hatarilabs, What is a Piper diagram for water chemistry analysis and how to create one?, <https://www.hatarilabs.com/ih-en/what-is-a-piper-diagram-and-how-to-create-one>, July 5, 2018.
- Piper, A.M., 1944. A graphic procedure in the geochemical interpretation of water-analyses. Eos, Transactions American Geophysical Union, 25(6), pp 914–928.
- U.S. Environmental Protection Agency (EPA). 2020. Disposal of Coal Combustion Residuals from Electric Utilities Rulemakings. Website with history and linking rule and updates. <https://www.epa.gov/coalash/coal-ash-rule>, Accessed September 2, 2020.