2021 ANNUAL GROUNDWATER REPORT

Prepared For

Camp Stanley Storage Activity
Boerne, Texas

Prepared By
PARSONS
Austin, Texas

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EXECUTIVE SUMMARY

This report provides an evaluation of results from groundwater monitoring conducted in 2021 at Camp Stanley Storage Activity (CSSA). Groundwater monitoring was performed on-post and off-post during the months of March, June, September, and December 2021. The CSSA groundwater monitoring program objectives are to determine groundwater flow direction and elevations, determine groundwater contaminant concentrations for characterization purposes, and identify meteorological and seasonal variations in physical and chemical properties. This report describes the physical and chemical characteristics of the groundwater monitoring results and changes occurring to the program during 2021.

- In 2011 one of the most severe droughts in central Texas history was recorded, followed by average to below-average rainfall from 2012 to 2014, then record rainfall in 2015 and 2016. In 2017 the rainfall total dropped back below-average about 8 inches. In 2018 rainfall exceeded the 30-year average by approximately 11 inches. In 2019 and 2020 the rainfall was back below the annual average by approximately 9 and 15 inches respectively. In 2021, rainfall measured at CSSA was 36.30 inches from the AOC-65 Weather Station (WS). This total was slightly below the 30-year average of 36.68 inches for the Boerne weather station monitored by the National Weather Service (NWS). During the same timeframe, 35 inches of rain fell at the San Antonio International Airport.
- Quarterly rainfall was sporadic throughout 2021 with the highest quarterly total falling in the 2nd quarter (13.92 inches). January through March reported the lowest quarterly total of 2.37 inches from the AOC-65 WS. This was followed by the most significant quarterly increase in aquifer water levels which occurred from April through June with the aquifer rebounding 155.34 feet. With average total rainfall in 2021; the Middle Trinity aquifer sustained a net gain of 89.97 feet in average water level elevation beneath CSSA and increased to 14.54 feet above its 15-year average (2007-2021).
- Both on- and off-post groundwater samples were collected quarterly in 2021 (March, June, September, and December) in accordance with the approved CSSA Long-Term Monitoring Optimization (LTMO) program. This plan was updated in 2020 along with the project DQO's and approved by the TCEQ and EPA in September 2020. The updated sampling schedule was implemented in December 2020 with most wells scheduled for sampling on a quarterly, 15-month, or 30-month interval. Results from March, June, September, and December 2021 sampling events are presented in this annual report.
- In 2021, a total of 16 samples were collected from 4 on-post drinking water wells. Contaminant concentrations above drinking water standards were not detected in the sampled wells. Also, no wells exceeded drinking water standards for metals in 2021.
- PFAS sampling was conducted in October 2021 from the CSSA drinking water wells. Results indicated no contaminant was detected above the regulatory standards.

- No samples were scheduled to be collected from Westbay® zones in 2021, in accordance with current LTMO and DQO sampling schedules.
- In 2021, a total of 50 samples were collected from 6 off-post wells and 6 granular activated carbon (GAC) wellhead treatment locations. VOC concentrations above drinking water standards were detected at 2 off-post wells (RFR-10 and OFR-3). RFR-10 and OFR-3 had GAC units installed at the wellheads in 2001 and 2002, respectively. These GAC filtration units remove VOC contamination prior to use. Samples collected after the treatment systems at RFR-10 and OFR-3 (post-GAC samples) continue to show that all VOCs are being removed from the well, and the treatment is effective. Off-post wells were not sampled for metals content as part of the groundwater program.

GEOSCIENTIST CERTIFICATION

2021 Annual Groundwater Monitoring Report

For

Department of the Army
Camp Stanley Storage Activity
Boerne, Texas

I, Adrien Lindley, P.G., hereby certify that the 2021 Annual Groundwater Monitoring Report for the Camp Stanley Storage Activity installation in Boerne, Texas accurately represents the site conditions of the subject area. This certification is limited only to geoscientific products contained in the subject report and is made on the basis of written and oral information provided by the Camp Stanley Storage Activity Environmental Office, laboratory data provided by APPL, and field data obtained during groundwater monitoring conducted at the site in 2021, and is true and accurate to the best of my knowledge and belief.

Adrien Lindley, P.G.
State of Texas
Geology License No. 10487

2/10/2022
Date

Parsons Government Services, Inc.
Firm registration No. 50316

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ACRONYMS AND ABBREVIATIONS

µg/L	Microgram Per Liter
§3008(h) Order	RCRA 3008(h) Administrative Order on Consent
AL	Action Level
AOC	Area of Concern
APPL	Agriculture and Priority Pollutants Laboratories, Inc.
BS	Bexar Shale
CC	Cow Creek
cis-1,2-DCE	*cis*-1,2-Dichloroethene
COC	Contaminants Of Concern
CSSA	Camp Stanley Storage Activity
DCP	Drought Contingency Plan
DQO	Data Quality Objectives
DVR	Data Validation Report
EXW	Extraction Well
GAC	Granular Activated Carbon
GPM	Gallons Per Minute
ISCO	In-Situ Chemical Oxidation
KSAT	San Antonio International Airport
LGR	Lower Glen Rose
LTMO	Long Term Monitoring Optimization
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MSL	Mean Sea Level
NCDC	National Climatic Data Center
NWS	National Weather Service
PCE	Tetrachloroethene
PFAS	Per- and Polyfluoroalkyl Substances
Plan	CSSA Off-Post Monitoring Program and Response Plan
QAPP	Quality Assurance Program Plan
RCRA	Resource Conservation and Recovery Act
RL	Reporting Limit
SAWS	San Antonio Water System
SCADA	Supervisory Control and Data Acquisition
SS	Secondary Standard
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
TGRGCD	Trinity-Glen Rose Groundwater Conservation District

ACRONYMS AND ABBREVIATIONS *(continued)*

UGR	Upper Glen Rose
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WS	Weather Station

1.0 INTRODUCTION

This report provides an evaluation of results from groundwater monitoring conducted in 2021 at Camp Stanley Storage Activity (CSSA). Groundwater monitoring was performed on-post and off-post during the months of March, June, September, and December. All wells sampled in 2021 are shown on **Figure 1.1**. This report describes the physical and chemical characteristics of the groundwater monitoring results and changes occurring to the program throughout 2021.

1.1 On-Post Groundwater Monitoring

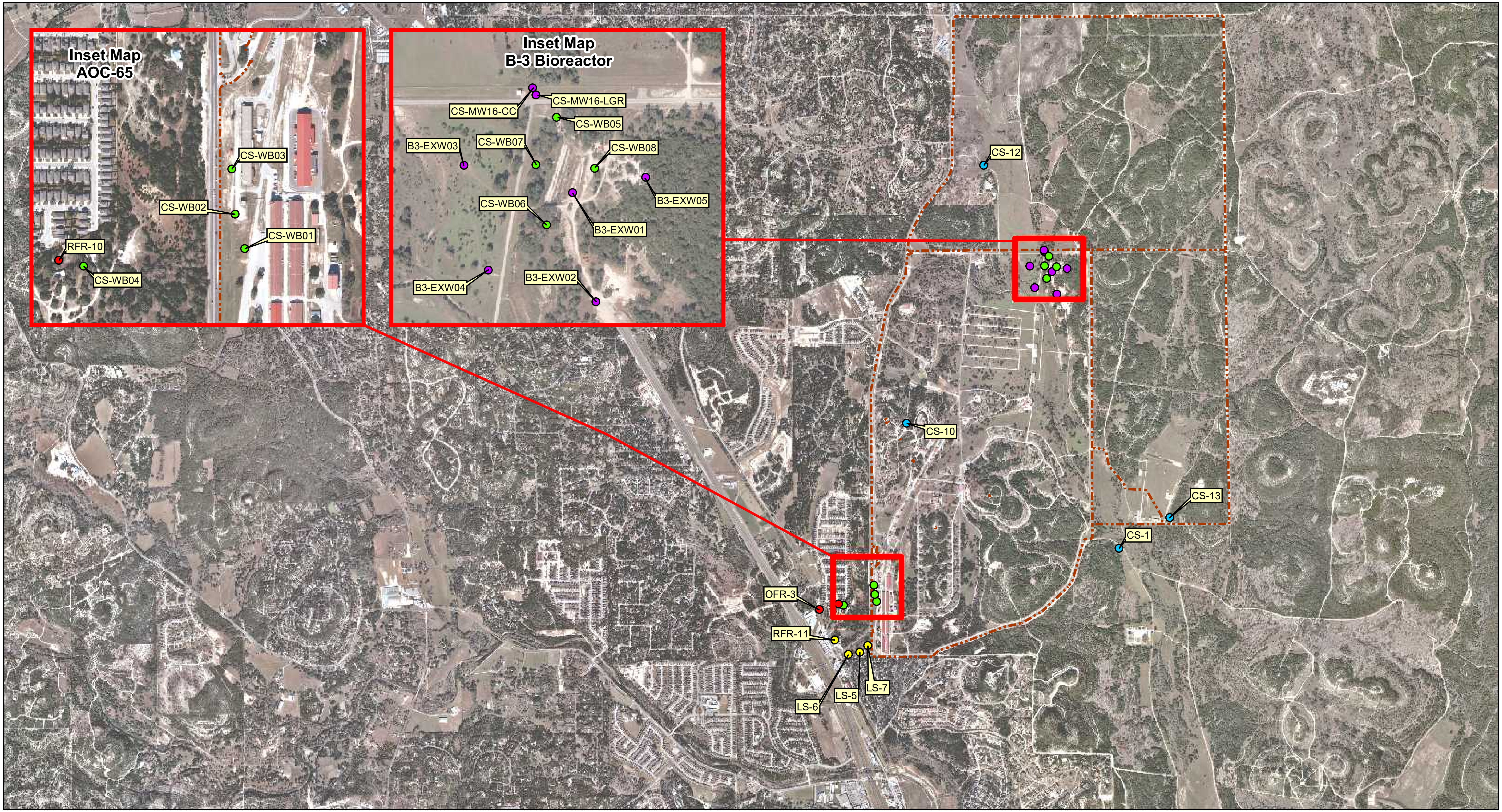
The current objectives of the CSSA on-post groundwater monitoring program are to monitor groundwater flow direction trends and elevations, determine groundwater contaminant concentrations for characterization purposes, and identify meteorological and seasonal variations in physical and chemical properties of the groundwater. The objectives incorporate and comply with the Resource Conservation and Recovery Act (RCRA) §3008(h) Administrative Order on Consent (§3008(h) Order) issued by the United States Environmental Protection Agency (USEPA) on May 5, 1999.

On-post groundwater monitoring was initiated in 1992 in response to volatile organic compound (VOC) contamination detected in CSSA drinking water supply well CS-MW16-LGR and continued periodically until the current CSSA quarterly groundwater monitoring program for on-post wells was initiated in December 1999.

The CSSA groundwater monitoring program follows the provisions of the *Final Data Quality Objectives (DQO) for the Groundwater Monitoring Program* (Parsons 2020) in **Appendix A**, as well as the recommendations of the *Three-Tiered Long Term Monitoring Network Optimization Evaluation* (Parsons 2020) which provided recommendations for sampling based on a long-term monitoring optimization (LTMO) study performed for the CSSA groundwater monitoring program. LTMO study sampling frequencies were initially implemented on-post in December 2005, as approved by the Texas Commission on Environmental Quality (TCEQ) and the USEPA. The LTMO evaluation was updated in 2010 using groundwater data from monitoring conducted between 2005 and 2009. It was approved by the TCEQ and USEPA and was implemented on- and off-post in June 2011. The next update to the LTMO and DQOs included monitoring data collected between 2010 and 2014, these plans were approved by the regulators in April and May 2016, respectively. The current update of the LTMO and DQOs used data collected from 2015 to 2019. Implementation of the latest revisions to the LTMO and DQOs began in December 2020 following approval from the USEPA and the TCEQ (**Appendix I**).

A comprehensive summary of the results from the 2021 on-post groundwater sampling events is presented in **Appendix B**. **Appendix C** presents Westbay® analytical results in graphical format. Abbreviated tables showing only the detected compounds are included in the groundwater results discussions in Section 2.2.1 of this report. **Appendix D** includes the potentiometric groundwater maps.

Ongoing remedial activities during the year have included liquid ISCO oxidant injections at AOC-65 and lactate injections within the bioreactor trenches at SWMU-B3. Remedial



Aerial Photo Date: 2013

N W E S

0 0.5 1 2 Miles

- Wells with VOC concentrations > MCL
- Wells with VOC concentrations between RL and MCL
- Wells with VOC concentrations < RL
- Non-detect
- Mulit-port Westbay Wells
- Other wells
- Fence Line

Figure 1.1

2021 Sampled On-Post and Off-Post Groundwater Wells Camp Stanley Storage Activity

PARSONS

C:\CSSA\GIS\MXD\ANNUAL_GW_FACT_SHEET\fig1.1_2021_sampled_wells_annual_gw_report.mxd - 1/10/2022 @ 1:44:42 PM system performance monitoring was performed at each site according to the provisions of the LTMO and are discussed in detail in the respective remedial system annual performance report.

In June 2021, 2,105 gallons of 5% permanganate solution were injected into infiltration cells and injection wells at AOC-65. Exterior infiltration cells NIC, MIC, and SIC received 720, 720, and 240 gallons respectively, interior vault infiltration cells East-VIC and West-VIC each received 175 gallons, and injection wells IIW-01, -02, and -04 each received 25 gallons of ISCO solution. Raw water from well CS-10 was used to dilute concentrated (40%) oxidant solution to the injection concentration (5%) (1,840 gallons) and for rinsing injection equipment (1,460 gallons). The rinse water was applied to exterior infiltration cells with 1,400 gallons applied to the southern infiltration cell (SIC) and 30 gallons each in the NIC and MIC.

At SWMU-B3, four totes (~250 gallons each) of WilClear Plus lactate solution were applied to the bioreactor trenches in June 2021. Each of the active trenches (T1, T2, and T6) received one tote of lactate solution. The remaining tote was applied to trenches T3, T4, and T5 simultaneously. Application of lactate solution is accomplished via the in-line eductor incorporated in the distribution system downstream of the 10,000-gallon holding tanks.

Off-post results for groundwater sampling and Granular Activated Carbon (GAC) maintenance are included as **Appendices E** and **F**. Laboratory data packages for 2021 were submitted to CSSA in electronic format separately from this report. **Appendix G** presents the associated data validation reports (DVR) for the December 2021 analytical package submittals. The March, June, and September DVRs are included with the quarterly groundwater reports.

1.2 Off-Post Groundwater Monitoring

The primary objective of the off-post groundwater monitoring program is to determine whether concentrations of VOCs detected in off-post public and private drinking water wells exceed safe drinking water standards. In off-post groundwater, the primary contaminants of concern (COC) are tetrachloroethene (PCE) and trichloroethene (TCE). A secondary objective of the off-post groundwater monitoring program is to determine the lateral and vertical extent of the contaminant plumes associated with past releases near Area of Concern (AOC)-65 or from Solid Waste Management Units (SWMU) B-3 and O-1. A third objective of the off-post groundwater monitoring program is to assess whether there are apparent trends in contaminant levels (decreasing or increasing) over time in the sampled wells.

CSSA was required by the §3008(h) Order to identify and locate both privately and publicly owned groundwater wells within ¼-mile of CSSA. The Offsite Well Survey Report (Parsons 2001) was submitted to fulfill this requirement. This survey was updated in 2010 to capture any new wells that have been added in the area and to extend the ¼-mile to ½-mile of CSSA (Parsons 2010). In total, 97 well locations are identified in the updated 2010 Well Survey. A total of 47 locations (45 active and 2 plugged) were identified within a ¼-mile radius, and another 39 locations (33 active and 6 plugged) are believed to exist between ¼ to ½-mile away from CSSA. Finally, a total of 11 locations (10 active and 1 plugged) were identified in a special interest area beyond the ½-mile survey that is considered to be downgradient of the CSSA VOC plumes.

After the 2010 Well Survey, the USEPA requested that CSSA identify additional wells beyond the ½-mile border to the south and west of the post. As a result, CSSA identified and added five wells that follow the Boerne Stage Road corridor, ranging in distance between 0.75 and 3 miles from CSSA. In accordance with the current DQO update, wells greater than 1.5 miles from CSSA or have a 5 year non-detect history are excluded from the sampling program. Some exceptions have been made to these stipulations based on proximity to the plume.

Additional background information regarding off-post private and public water supply wells is located in the ***CSSA Environmental Encyclopedia, Volume 5 Groundwater***. Some off-post wells were initially sampled in 1995 and quarterly sampling of off-post wells began in 2001 in accordance with the *Off-Post Monitoring Program and Response Plan* (CSSA 2002a) (Plan).

Under the Plan, the following criteria are used to determine the action levels for detected VOCs and to determine which off-post wells are sampled:

- If VOC contaminant levels are ≥90 percent of the maximum contaminant levels (MCL) based on preliminary data received from the laboratory and the well is used as a potable water source, the well will be taken offline and bottled water will be supplied within 24 hours after receipt of the data. For PCE and TCE, 90 percent of the MCL is 4.5 micrograms per liter (µg/L). A confirmation sample will be collected from the well within 14 days of receipt of the final validated analytical report. If the confirmation sample confirms COCs are at or above 90 percent of the MCLs, the well will be evaluated, and either installation of an appropriate method for wellhead treatment or connection to an alternative water source will be performed.
- If VOC contaminant levels are ≥80 but ≤90 percent of the MCL (>4.0 and <4.5 µg/L for PCE and TCE) during any single monitoring event based on preliminary data from the laboratory, and the well is used as a potable water source, it will be monitored monthly. If the monthly follow-up sampling confirms that COCs are ≥80 but ≤90 percent of the MCL, it will continue to be sampled monthly until the VOC levels fall below the 80 percent value.
- If any COC is detected at levels greater than or equal to the analytical method detection limit (MDL) (historically 0.06 µg/L for PCE and 0.05 µg/L for TCE), and <80 percent of the MCL, the well will be sampled on a quarterly basis. This sampling will be conducted concurrently with on-post sampling events and will be used to develop historical trends in the area. Quarterly sampling will continue for a minimum of 1 year, after which the sampling frequency will be reviewed and may be decreased.
- If COCs are not detected during the initial sampling event (i.e., no VOC contaminant levels above the MDL), further sampling of the well will be reconsidered. A well with no detectable VOCs may be removed from the sampling list. However, if analytical data suggest future plume migration could negatively influence the well, it will be re-sampled as needed. The well owner, USEPA, and TCEQ will be apprised of any re-sampling decisions regarding the non-detect wells.
- For locations where a wellhead treatment system has been installed, post-treatment samples will be collected and analyzed after initial system start-up and at 6-month intervals to confirm the system is effectively removing VOCs.

A comprehensive summary of the results from the 2021 off-post groundwater sampling events is presented in **Appendix E**. Abbreviated tables showing only the detected compounds are included in the groundwater results discussions in Section 2.2.2 of this report. **Appendix F** summarizes pre- and post-GAC filtration system sampling results.

The cumulative historical results from both on- and off-post groundwater monitoring are presented in summary tables located in the Introduction to the *On-Post and Off-Post Quarterly Groundwater Monitoring Program* (Tables 6 through 9), ***CSSA Environmental Encyclopedia, Volume 5 Groundwater.***

2.0 GROUNDWATER MONITORING RESULTS

2.1 Physical Characteristics

2.1.1 Water Level Measurements

Water level measurements were recorded during the March, June, September, and December 2021 events. A total of 55 water level measurements made from all monitoring wells and drinking water wells listed are in **Table 2.1**. Water levels from one off-post well (FO-20) are used to develop the northern perimeter of the gradient maps. Water levels were measured using an e-line indicator.

Water level elevations and quarterly elevation changes are summarized in **Table 2.1**. The average groundwater elevation measurements for each of the Lower Glen Rose (LGR), Bexar Shale (BS), and Cow Creek (CC) intervals of the Middle Trinity aquifer are provided in **Table 2.2**. The averages were calculated using groundwater elevations from wells screened in only one of the three intervals. Water elevations from 5 wells completed with open boreholes over multiple formations were not used. Total precipitation recorded in 2021 was a couple of inches above the average annual for the area.

CSSA operates two weather stations to monitor and record climatic conditions across the post. The B-3 weather station was sent in for sensor calibration May 25th to July 5th therefore no data was recorded during this timeframe. For the purposes of this discussion, the CSSA precipitation record has been utilized from the B-3 WS located at the northeastern corner of the inner cantonment and data from the AOC-65 WS located at the southwestern end of the inner cantonment. For longer term precipitation data, this report also utilizes precipitation data from the San Antonio International Airport (KSAT) because of the completeness and accuracy of the data.

The total amount of precipitation that fell in 2021 was 36.30 inches at the AOC-65 WS, which was above 21.41 inches that fell in 2020 (AOC-65 WS). In 2021, 35 inches of precipitation were measured at the KSAT weather station located at the San Antonio international airport. In 2020 the aquifer water levels were depleted due to below-average rainfall. With an above-average rainfall year, the aquifer rebounded in 2021. According to the National Weather Service (NWS), the 30-year average (1992-2021) for the Boerne, TX weather station is 36.68 inches.

The aquifer levels fell slightly during the first quarter of 2021, which received 2.37 inches of rainfall for the 3-month period (AOC-65 WS). January (0.98 inches), February (0.84 inches) and March rainfall (0.55 inches) came in below average. As a result, quarterly groundwater monitoring showed average aquifer levels decreased by 2.24 feet from December 2020 to March 2021. The aquifer rebounded significantly in the second quarter of 2021 with an average increase of 155.34 feet per well. The rainfall recorded at the AOC-65 weather station was 13.92 inches. From July through September 12.1 inches (AOC-65 WS) of rain fell, sending the aquifer back down 47.35 feet. The final quarter of the year recorded 7.91 inches of rainfall, resulting in aquifer water levels dropping another 15.79 feet from September to December.

Table 2.1
Summary of Groundwater Elevations and Changes, 2021

Well ID	TOC elevation (ft MSL)	March 2021 Elevations	June 2021 Elevations	September 2021 Elevations	December 2021 Elevations	Groundwater Elevation Change				Formations Screened		
						December 20 minus March 21	June minus March	September minus June	December minus September	LGR	BS	CC
CS-1*	**1169.27**	**824.82**	**1026.16**	**1009.79**	**976.74**	**63.90**	**201.34**	**-16.37**	**-33.05**	ALL		
CS-2	**1237.59**	**980.34**	**1118.53**	**1048.14**	**1028.14**	**-0.41**	**138.19**	**-70.39**	**-20.00**	X	?	
CS-3	1240.17	977.51	1118.91	1051.39	1032.46	-2.77	141.40	-67.52	-18.93	X		
CS-10	**1331.51**	**945.37**	**1090.71**	**1053.44**	**1032.79**	**-4.94**	**145.34**	**-37.27**	**-20.65**	ALL		
CS-12	**1274.09**	**985.50**	**1110.13**	**1048.79**	**1032.48**	**-1.98**	**124.63**	**-61.34**	**-16.31**	ALL		
CS-13*	**1193.26**	**897.62**	**1058.74**	**1039.05**	**1020.66**	**-95.23**	**161.12**	**-19.69**	**-18.39**	ALL		
CS-D	1236.03	978.97	1103.51	1046.56	1029.80	-2.11	124.54	-56.95	-16.76	X		
CS-MWG-LGR	1328.14	1014.41	1107.48	1061.48	1046.14	-3.05	93.07	-46.00	-15.34	X		
CS-MWH-LGR*	1319.19	1012.94	1092.39	991.23	977.82	-4.86	79.45	-101.16	-13.41	X		
CS-I	1315.20	1010.79	1110.46	1059.08	1045.89	-2.45	99.67	-51.38	-13.19	X		
CS-MW1-LGR	1220.73	973.56	1117.52	1059.16	1042.98	-4.58	143.96	-58.36	-16.18	X		
CS-MW1-BS	1221.09	971.14	1004.27	1054.73	1050.79	-0.91	33.13	50.46	-3.94		X	
CS-MW1-CC	1221.39	955.87	1068.06	1054.87	1037.61	-6.69	112.19	-13.19	-17.26			X
CS-MW2-LGR	1237.08	971.18	1105.17	1061.52	1044.39	-3.45	133.99	-43.65	-17.13	X		
CS-MW2-CC	1240.11	949.23	1032.13	1055.45	1040.97	-4.92	82.90	23.32	-14.48			X
CS-MW3-LGR	1334.14	979.33	1099.49	1052.61	1084.94	-1.72	120.16	-46.88	32.33	X		
CS-MW4-LGR	1209.71	971.96	1165.21	1127.20	1109.71	-3.27	193.25	-38.01	-17.49	X		
CS-MW5-LGR	1340.24	967.33	1097.53	1057.40	1040.49	-2.91	130.20	-40.13	-16.91	X		
CS-MW6-LGR	1232.25	937.10	1123.63	1066.15	1045.83	-2.79	186.53	-57.48	-20.32	X		
CS-MW6-BS	1232.67	916.37	1096.47	1062.10	1042.56	1.05	180.10	-34.37	-19.54		X	
CS-MW6-CC	1233.21	916.26	1097.23	1061.30	1041.90	0.84	180.97	-35.93	-19.40			X
CS-MW7-LGR	1202.27	923.87	1118.68	1056.62	1038.22	-1.40	194.81	-62.06	-18.40	X		
CS-MW7-CC	1201.84	906.71	1101.86	1057.62	1037.33	0.57	195.15	-44.24	-20.29			X
CS-MW8-LGR	1208.35	929.96	1122.45	1064.95	1044.52	-1.91	192.49	-57.50	-20.43	X		
CS-MW8-CC	1206.13	908.71	1101.41	1058.74	1038.67	0.75	192.70	-42.67	-20.07			X
CS-MW9-LGR	1257.27	986.97	1118.92	1050.09	1030.54	-1.09	131.95	-68.83	-19.55	X		
CS-MW9-BS	1256.73	987.21	1113.38	1063.56	1040.91	-0.81	126.17	-49.82	-22.65		X	
CS-MW9-CC	1255.95	973.80	1089.33	1050.45	1039.70	-9.57	115.53	-38.88	-10.75			X
CS-MW10-LGR	1189.53	893.20	1122.55	1055.31	1037.21	-0.77	229.35	-67.24	-18.10	X		
CS-MW10-CC	1190.04	885.86	1110.87	1048.23	1024.45	-1.06	225.01	-62.64	-23.78			X
CS-MW11A-LGR	1204.03	889.31	1102.21	1033.07	1022.20	-0.59	212.90	-69.14	-10.87	X		
CS-MW11B-LGR	1203.52	Dry	1009.57	1029.62	1014.47	NA	NA	20.05	-15.15	X		
CS-MW12-LGR	1259.07	971.48	1124.52	1055.34	1036.45	-2.11	153.04	-69.18	-18.89	X		
CS-MW12-BS	1258.37	973.10	1067.43	1076.99	1052.17	-0.52	94.33	9.56	-24.82		X	
CS-MW12-CC	1257.31	966.34	1088.17	1054.55	1041.07	-7.56	121.83	-33.62	-13.48			X
CS-MW16-LGR*	1244.60	978.67	1071.80	1019.52	1031.91	-2.30	93.13	-52.28	12.39	X		
CS-MW16-CC*	1244.51	882.24	1063.89	1053.71	949.72	-3.83	181.65	-10.18	-103.99			X
B3-EXW01*	1245.26	975.58	1097.34	987.53	978.98	-4.40	121.76	-109.81	-8.55	X		
B3-EXW02*	1249.66	974.39	1021.88	1058.15	981.04	-4.69	47.49	36.27	-77.11	X		
B3-EXW03*	1235.11	973.81	1086.89	1052.35	1013.08	-0.73	113.08	-34.54	-39.27	X		
B3-EXW04*	1228.46	973.21	1108.51	1056.55	1038.79	-52.80	135.30	-51.96	-17.76	X		
B3-EXW05*	1279.46	974.84	1094.48	1050.02	1032.72	-26.74	119.64	-44.46	-17.30	X		
CS-MW17-LGR	1257.01	936.26	1109.74	1052.83	1037.38	-1.79	173.48	-56.91	-15.45	X		
CS-MW18-LGR	1283.61	939.41	1122.73	1054	1034.00	-0.83	183.32	-68.73	-20.00	X		
CS-MW19-LGR	1255.53	952.4	1132.01	1070.18	1052.46	-0.79	179.61	-61.83	-17.72	X		
CS-MW20-LGR	1209.42	952.69	1135.42	1077.10	1060.11	-0.90	182.73	-58.32	-16.99	X		
CS-MW21-LGR	1184.53	934.48	1116.48	1055.64	1040.00	-1.19	182.00	-60.84	-15.64	X		
CS-MW22-LGR	1280.49	904.55	1107.99	1051.16	1032.39	5.42	203.44	-56.83	-18.77	X		
CS-MW23-LGR	1258.20	916.76	1113.67	1044.65	1030.00	-0.74	196.91	-69.02	-14.65	X		
CS-MW24-LGR	1253.90	980.12	1116.91	1049.04	1029.63	-1.71	136.79	-67.87	-19.41	X		
CS-MW25-LGR	1293.01	985.77	1106.63	1051.97	1032.47	-1.36	120.86	-54.66	-19.50	X		
CS-MW35-LGR	1186.97	891.92	1117.19	1052.30	1036.74	-1.23	225.27	-64.89	-15.56	X		
CS-MW36-LGR	1218.74	932.90	1123.19	1066.59	1045.46	-2.34	190.29	-56.60	-21.13	X		
CS-MW37-LGR	1205.83	898.52	1116.13	1053.51	1033.89	-1.39	217.61	-62.62	-19.62	X		
FO-20	**1327.00**	**1043.49**	**1099.08**	**1051.77**	**1055.22**	**-14.64**	**55.59**	**-47.31**	**3.45**	ALL		
		Average groundwater elevation change (all wells minus pumpers):				**-2.24**	**155.34**	**-47.35**	**-15.79**			
Notes:		**Net change in average groundwater elevation since December 2020:**				**89.97**						

Bold wells: CS-2, CS-10, CS-12, CS-13, and FO-20 are open boreholes across more than one formational unit.
? = Exact screening information unknown for this well.
Shaded wells are routinely pumped for either domestic, livestock, or environmental remediation purposes, and therefore are not used in calculating statistics.
CS-1, CS-10, CS-12, and CS-13 are current drinking water wells.
CS-MW16-LGR, CS-MW16-CC, B3-EXW01 through B3-EXW05 pumps are cycling continuously to feed the B-3 Bioreactor.
* = submersible pump running at time of water level measurement.
Formational average groundwater elevation is calculated from non-pumping wells screened in only one formation.
All measurements given in feet.
NA = Data not available or well is dry.

Table 2.2
Summary of Groundwater Elevation by Formation, 2021

Well ID	TOC elevation	2021 Groundwater Elevations				Formations Screened		
		March	June	September	December	LGR	BS	CC
CS-1*	**1169.27**	**824.82**	**1026.16**	**1009.79**	**976.74**	ALL		
CS-2	**1237.59**	**980.34**	**1118.53**	**1048.14**	**1028.14**	X	?	
CS-3	1240.17	977.51	1118.91	1051.39	1032.46	X		
CS-10*	**1331.51**	**945.37**	**1090.71**	**1053.44**	**1032.79**	ALL		
CS-12	**1274.09**	**985.50**	**1110.13**	**1048.79**	**1032.48**	ALL		
CS-13*	**1193.26**	**897.62**	**1058.74**	**1039.05**	**1020.66**	ALL		
CS-D	1236.03	978.97	1103.51	1046.56	1029.80	X		
CS-MWG-LGR	1328.14	1014.41	1107.48	1061.48	1046.14	X		
CS-MWH-LGR	1319.19	1012.94	1092.39	991.23	977.82	X		
CS-I	1315.20	1010.79	1110.46	1059.08	1045.89	X		
CS-MW1-LGR	1220.73	973.56	1117.52	1059.16	1042.98	X		
CS-MW1-BS	1221.09	971.14	1004.27	1054.73	1050.79		X	
CS-MW1-CC	1221.39	955.87	1068.06	1054.87	1037.61			X
CS-MW2-LGR	1237.08	971.18	1105.17	1061.52	1044.39	X		
CS-MW2-CC	1240.11	949.23	1032.13	1055.45	1040.97			X
CS-MW3-LGR	1334.14	979.33	1099.49	1052.61	1084.94	X		
CS-MW4-LGR	1209.71	971.96	1165.21	1127.20	1109.71	X		
CS-MW5-LGR	1340.24	967.33	1097.53	1057.40	1040.49	X		
CS-MW6-LGR	1232.25	937.10	1123.63	1066.15	1045.83	X		
CS-MW6-BS	1232.67	916.37	1096.47	1062.10	1042.56		X	
CS-MW6-CC	1233.21	916.26	1097.23	1061.30	1041.90			X
CS-MW7-LGR	1202.27	923.87	1118.68	1056.62	1038.22	X		
CS-MW7-CC	1201.84	906.71	1101.86	1057.62	1037.33			X
CS-MW8-LGR	1208.35	929.96	1122.45	1064.95	1044.52	X		
CS-MW8-CC	1206.13	908.71	1101.41	1058.74	1038.67			X
CS-MW9-LGR	1257.27	986.97	1118.92	1050.09	1030.54	X		
CS-MW9-BS	1256.73	987.21	1113.38	1063.56	1040.91		X	
CS-MW9-CC	1255.95	973.80	1089.33	1050.45	1039.70			X
CS-MW10-LGR	1189.53	893.20	1122.55	1055.31	1037.21	X		
CS-MW10-CC	1190.04	885.86	1110.87	1048.23	1024.45			X
CS-MW11A-LGR	1204.03	889.31	1102.21	1033.07	1022.20	X		
CS-MW11B-LGR	1203.52	Dry	1009.57	1029.62	1014.47	X		
CS-MW12-LGR	1259.07	971.48	1124.52	1055.34	1036.45	X		
CS-MW12-BS	1258.37	973.10	1067.43	1076.99	1052.17		X	
CS-MW12-CC	1257.31	966.34	1088.17	1054.55	1041.07			X
CS-MW16-LGR*	1244.60	978.67	1071.80	1019.52	1031.91	X		
CS-MW16-CC*	1244.51	882.24	1063.89	1053.71	949.72			X
B3-EXW01*	1245.26	975.58	1097.34	987.53	978.98	X		
B3-EXW02*	1249.66	974.39	1021.88	1058.15	981.04	X		
B3-EXW03*	1235.11	973.81	1086.89	1052.35	1013.08	X		
B3-EXW04*	1228.46	973.21	1108.51	1056.55	1038.79	X		
B3-EXW05*	1279.46	974.84	1094.48	1050.02	1032.72	X		
CS-MW17-LGR	1257.01	936.26	1109.74	1052.83	1037.38	X		
CS-MW18-LGR	1283.61	939.41	1122.73	1054	1034.00	X		
CS-MW19-LGR	1255.53	952.4	1132.01	1070.18	1052.46	X		
CS-MW20-LGR	1209.42	952.69	1135.42	1077.10	1060.11	X		
CS-MW21-LGR	1184.53	934.48	1116.48	1055.64	1040.00	X		
CS-MW22-LGR	1280.49	904.55	1107.99	1051.16	1032.39	X		
CS-MW23-LGR	1258.20	916.76	1113.67	1044.65	1030.00	X		
CS-MW24-LGR	1253.90	980.12	1116.91	1049.04	1029.63	X		
CS-MW25-LGR	1293.01	985.77	1106.63	1051.97	1032.47	X		
CS-MW35-LGR	1186.97	891.92	1117.19	1052.30	1036.74	X		
CS-MW36-LGR	1218.74	932.90	1123.19	1066.59	1045.46	X		
CS-MW37-LGR	1205.83	898.52	1116.13	1053.51	1033.89	X		
FO-20	**1327.00**	**1043.49**	**1099.08**	**1051.77**	**1055.22**	ALL		
Average groundwater elevation by formation, each event:	LGR:	950.17	1112.68	1055.13	1039.40	Average groundwater elevation by formation all of 2021:		1039.35
	BS:	961.96	1070.39	1064.35	1046.61			1035.82
	CC:	932.85	1086.13	1055.15	1037.71			1027.96

Notes:

Bold wells: CS-2, CS-10, CS-12, CS-13, and FO-20 are open boreholes across more than one formational unit.

? = Exact screening information unknown for this well.

Shaded wells are routinely pumped for either domestic, livestock, or environmental remediation purposes, and therefore are not used in calculating statistics.

CS-1, CS-10, CS-12, and CS-13 are current drinking water wells.

CS-MW16-LGR, CS-MW16-CC, B3-EXW01 through B3-EXW05 pumps are cycling continuously to feed the B-3 Bioreactor.

* = submersible pump running at time of water level measurement.

Formational average groundwater elevation is calculated from non-pumping wells screened in only one formation.

All measurements given in feet.

NA = Data not available or well is dry.

Through all the hydrologic cycles of 2021, the overall groundwater levels in the Middle Trinity aquifer increased 89.97 feet from January through December 2021, as shown in **Table 2.1**. **Figure 2.1** presents an 19-year history of the quarterly groundwater elevation measurements in the LGR segment of the aquifer in relation to quarterly and annual precipitation measured at the KSAT weather station.

Based on 2021 quarterly aquifer level measurements, **Figure 2.2** shows the relationships of the water level in each portion of the aquifer at CSSA cluster wells (CS-MW1, CS-MW2, CS-MW6, CS-MW7, CS-MW8, CS-MW9, CS-MW10, and CS-MW12). The general trend in **Figure 2.2** shows that at an individual well cluster location, the head in the LGR well is typically greater than in the CC well. This was most prominent in June when the water table was elevated due to above average rainfall. The amount of dissimilarity between water levels within a cluster is a good indicator of the degree of hydraulic separation between the formational units. Theoretically, intervals that are well connected hydraulically will have the same or very similar groundwater elevation. In prior years, the well clusters in the southern portion of the post (CS-MW6, CS-MW7, CS-MW8, and CS-MW10) show less hydraulic head separation between the LGR and CC production zones than cluster wells to the north (CS-MW1, CS-MW2, CS-MW9, and CS-MW12). In 2021, June showed the most hydraulic head separation throughout the post with the northern wells showing the most significant separation.

Under more favorable hydrologic conditions, the groundwater elevation in the BS typically falls between the LGR and CC elevations; this was evident in three sets of cluster wells in 2021. As seen in **Figure 2.2**, when water levels decrease as they did in the first, third, and fourth quarters of 2021, the BS groundwater elevation is generally higher than both of its counterparts. This phenomenon has been observed before in the cluster wells and is attributed to the low draining potential of the less permeable BS matrix during continual aquifer declines. In 2021, this is depicted in cluster wells CS-MW1, CS-MW9, and CS-MW12 in March, September, and December. Conversely, during recharge events, the groundwater in the BS wells will lag behind the LGR and CC wells. This was depicted in cluster wells CS-MW1, CS-MW6, and CS-MW12 in June 2021 due to increased rainfall that quarter.

2.1.2 Weather Station and Transducer Data

Of the 55 wells listed on **Table 2.1**, 5 are equipped with transducers to continuously log groundwater levels and 11 are providing telemetry directly to the Supervisory Control and Data Acquisition (SCADA) system. As previously noted, two weather stations are in place at CSSA, B-3 WS is located next to the B3-EXW01 well in the north-central region of CSSA, and AOC-65 WS in the southwest corner of CSSA at AOC-65. Both weather stations record meteorological data, including precipitation, wind speed, wind direction, temperature, etc. The data are recorded to evaluate weather trends in rainfall and groundwater recharge. However, for the purposes of this report the data from the AOC-65 WS is used because it has the highest degree of accuracy and reliability.

Sensitive

Figure 2.1 - Average LGR Groundwater Elevation and Quarterly/Annual Precipitation

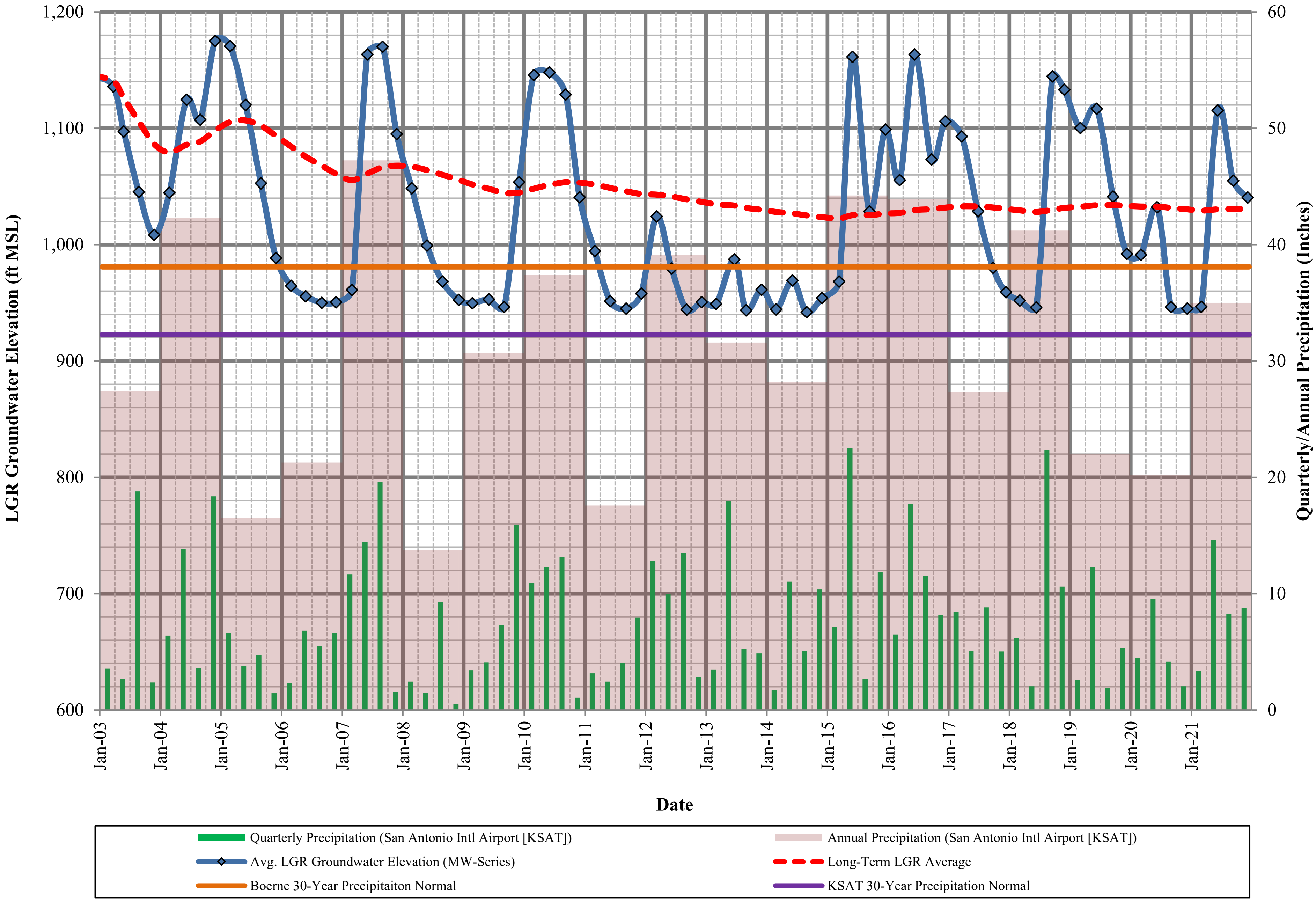
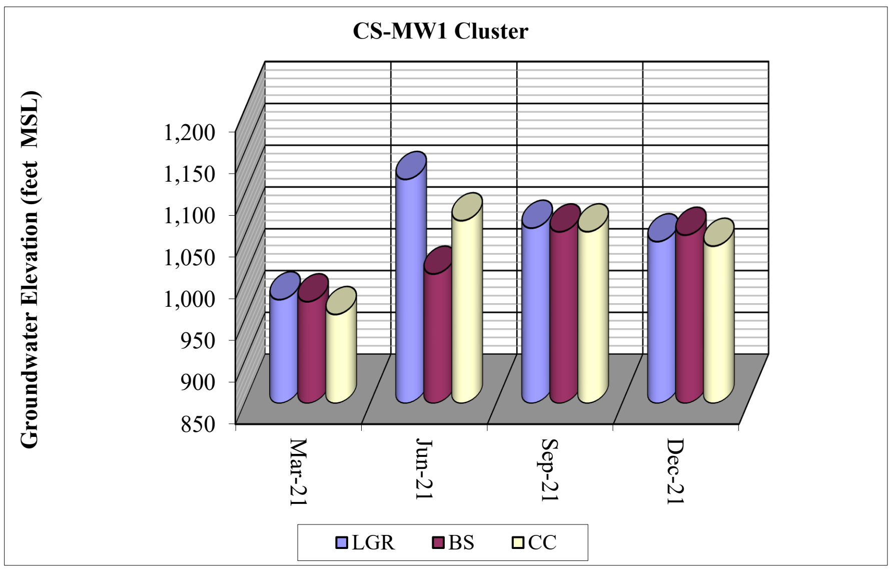
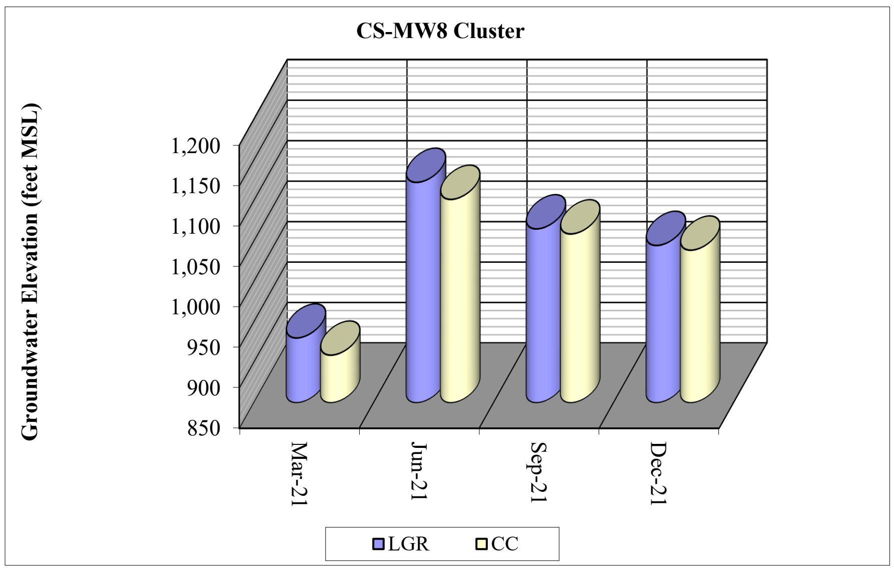
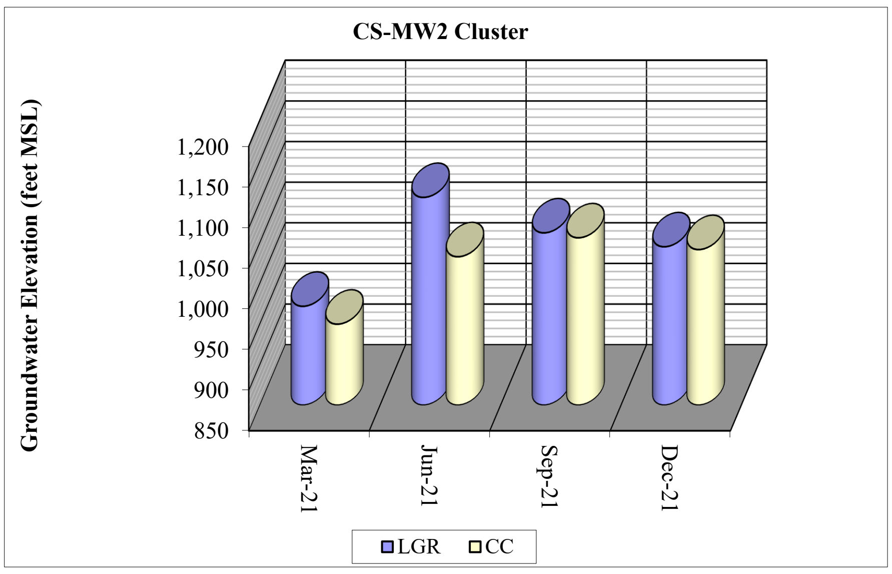
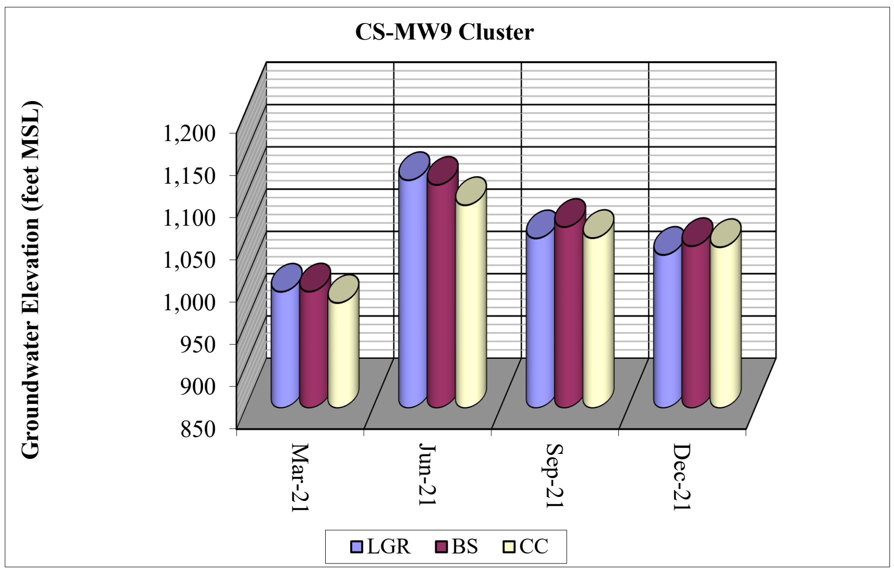


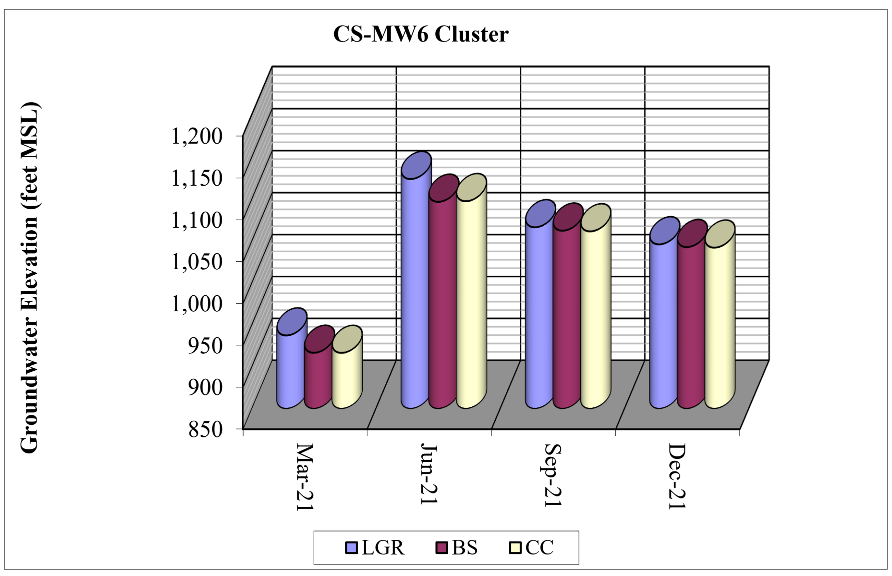
Figure 2.2
Comparison of Groundwater Elevations within Well Clusters

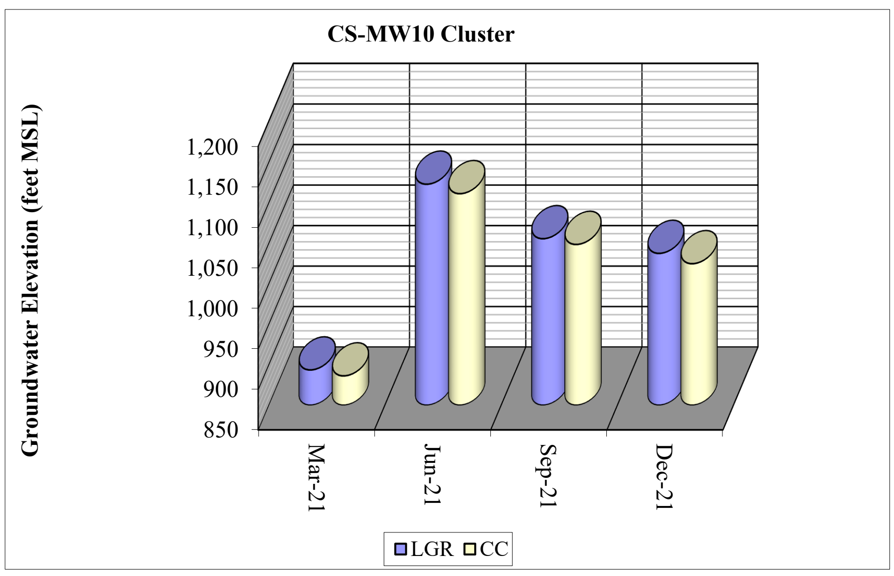


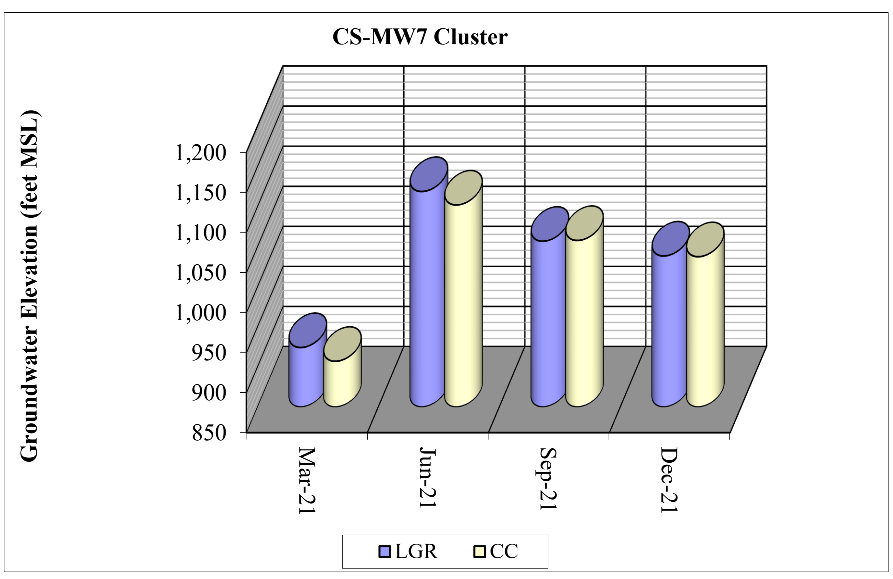


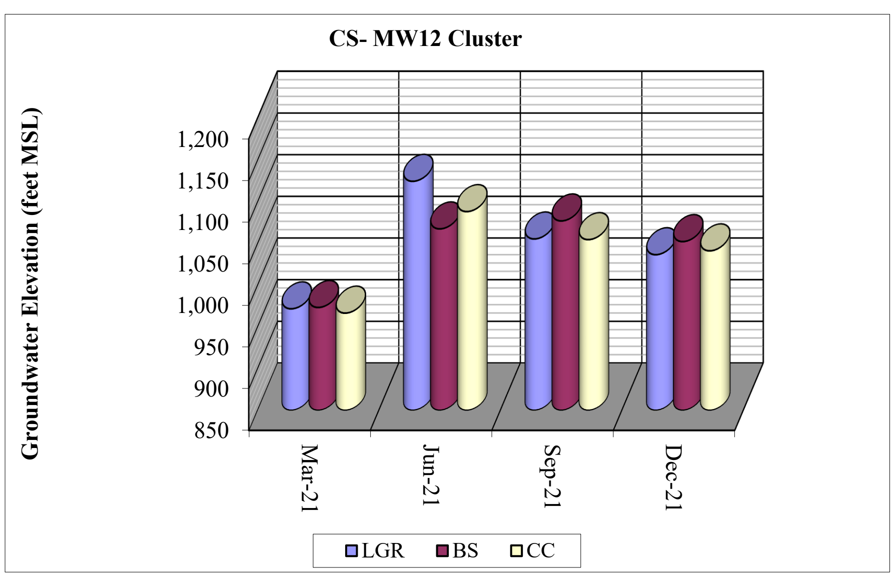












Continuous aquifer level data (January 1st through December 31st, 2021) collected from three wells screened within the LGR, and two wells screened within the CC are presented on **Figure 2.3** as well as the corresponding daily precipitation values. The wells presented in this figure are equipped with transducers set to record continuous water level measurements. Gaps in data are due to transducer malfunction or battery failure. Both CS-MW16-LGR and CS-MW16-CC are omitted from this graphic since they are actively pumping wells for the Bioreactor system, and therefore do not reflect static aquifer conditions. The active drinking water wells and the B3-EXW extraction wells were also omitted for the same reason. As in the past, the groundwater elevations indicate recharge of the LGR formation immediately after precipitation.

CSSA AOC-65 WS reported 95 rainfall events with a total precipitation of 36.30 inches. The rainfall in 2021 was below average in 6 of the months and above average the other 6 months of the year, with May reporting the highest monthly rainfall total of 7.82 inches. In 2021, 34.61 inches of rainfall was measured in the San Antonio Area, and 41.51 inches of rainfall was measured in Boerne, TX.

Based upon 30-year precipitation data (1992-2021), 2021 rainfall totals at CSSA ended about 0.38 inches below the Boerne NWS weather station average of 36.68 inches. For the same timeframe, the San Antonio NWS weather station reports a 30-year average of 32.10, which was 4.2 inches below the CSSA AOC-65 WS recorded total. Currently the San Antonio Water System (SAWS) is in 'Year Round Watering' drought restrictions and the Trinity Glen Rose Groundwater Conservation District (TGRGCD) also has 'Year Round Conservation' measures in effect.

Table 2.3 shows the total precipitation received each quarter, average groundwater elevations in each formation, the average groundwater elevation change in each formation, the approximate gradient, and approximate gradient flow direction for all monitoring events.

Fluctuations in groundwater levels are a function of precipitation or lack thereof and are shown as a series of peaks when water levels are high (due to above average precipitation or intense rain events) and troughs when water levels are low (caused by a dearth in precipitation) in **Figure 2.1**. Drought conditions are easily recognizable in this figure when the troughs fall to the elevation of the basal production elevation of the aquifer (~940 – 950 feet MSL). Drought conditions which began in 2020 continued through the first quarter of 2021. Prior to September 2020, the aquifer was last at the basal production elevation in June 2018. Record rains in September 2018 (wettest September on record for San Antonio) allowed the aquifer to rise nearly 200 feet during the quarter. Rains slackened in the fourth quarter and aquifer water levels fell slightly, ending the year slightly over 100 feet above the 2018 LGR long-term average groundwater elevation of 1030.61 feet. Below average rains in 2019 resulted in a steady decline in aquifer water levels, and by the end of the year, water levels were 40 feet below the long-term average (for 2019). Below average rains in 2020 continued the downward trend, and by September 2020, the LGR water level (946.42 feet) was near the basal production elevation, 85 feet below the long-term average. Little deviation in the LGR water level was observed between September 2020 and March 2021 as below average precipitation continued. Above average rains in May led to an almost 169-foot increase in LGR water level by June, 85 feet above the long-term average (1030.39 feet). Slightly above average rains in the third and fourth quarters of 2021 allowed LGR water levels to remain above the long-term average, however, water levels declined from 1,115.39 feet in June to 1,040.45 feet in December, 9.62 feet above the long-term average (1030.83 feet MSL).

Figure 2.3 Selected Wells Groundwater Elevations vs Precipitation Data

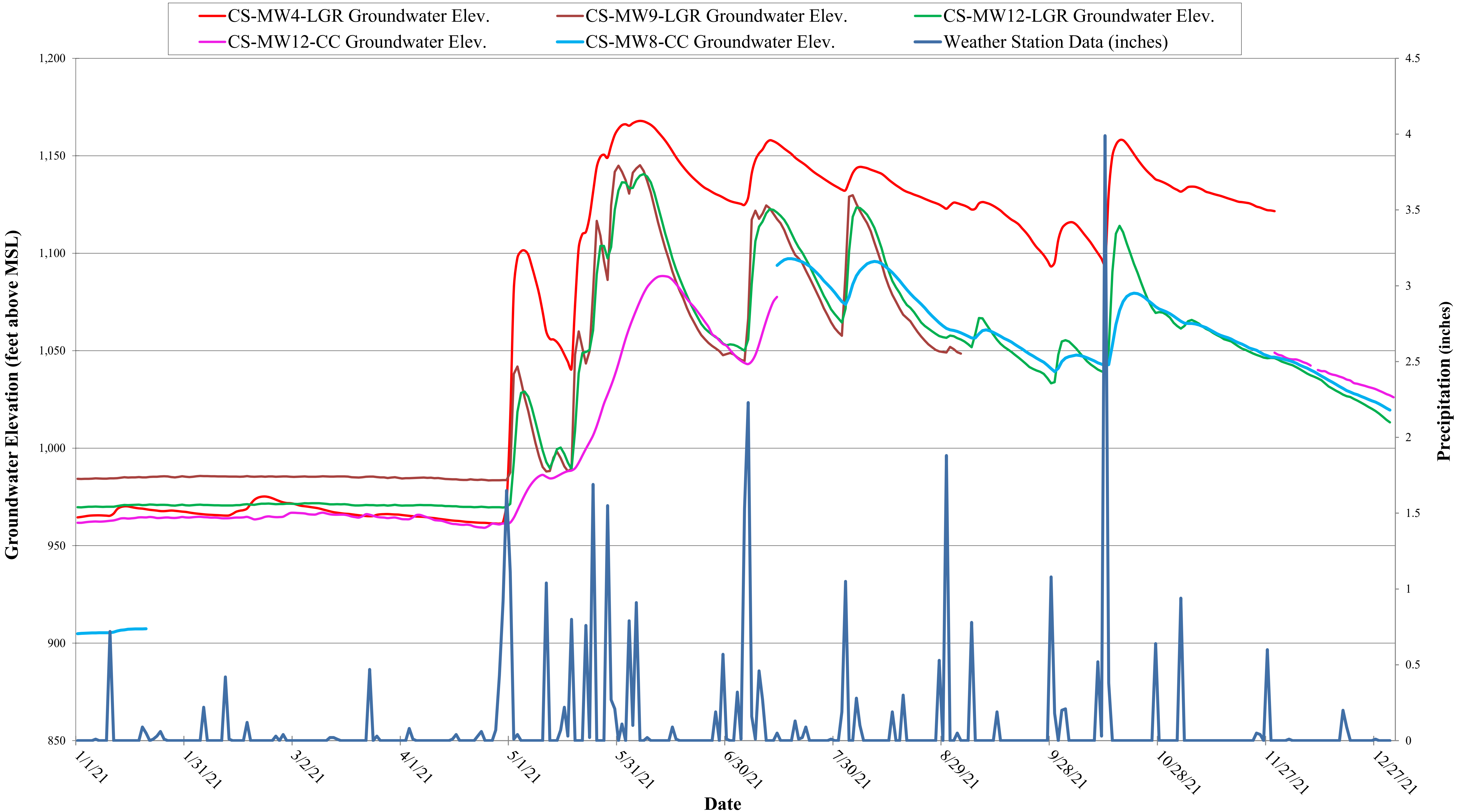


Table 2.3
Precipitation, Groundwater Elevation and Gradient

Quarterly Report (Month, year)	Total Quarterly precipitation (inches) B-3 WS	Total Quarterly precipitation (inches) AOC-65 WS	Average GW elevation Change (feet)	CS-MW18-LGR GW Elevation Change (feet)	Average GW Elevation			Approximate gradient (ft/ft)	Approximate gradient flow direction
					Lower Glen Rose	Bexar Shale	Cow Creek		
September-99	7.52	--	-188.4	--	979.80	--	--	0.007	Southwest
December-99	2.84	--	-4.9	--	973.10	--	--	0.004	Southwest
March-00	3.58	--	-9.3	--	970.94	--	--	0.009	South-southeast
June-00	11.1	--	11.77	--	976.27	--	--	0.006	Southeast
September-00	1.96	--	-6.34	--	967.03	--	--	0.006	Southeast
December-00	14.48	--	122.99	--	1118.59	--	--	0.005	South-southeast
March-01	10.13	--	53.19	--	1157.20	--	--	0.0125	Southeast
June-01	6.58	--	-47.5	--	1104.00	1106.85	1093.89	0.007	Southeast
September-01	14.73	--	23.96	--	1140.55	1098.18	1095.75	0.0067	Southeast
December-01	10.16	--	15.46	--	1149.68	1131.36	1125.63	0.0092	Southeast
March-02	2.25	--	-70.97	--	1077.91	1064.46	1059.27	0.0086	Southeast
June-02	4.46	--	-48.29	--	1030.51	1022.51	994.02	0.0137	South-southeast
September-02	30.98	--	104.5	--	1130.87	1129.21	1098.34	0.017	South-southeast
December-02	12.91	--	19.48	-2.84	1143.98	1148.26	1133.11	0.0061	South-southeast
March-03	6.22	6.68	-8.47	-1.99	1135.18	1140.52	1122.95	0.012	South-southeast
June-03	4.67	4.64	-41.08	-40.06	1097.87	1095.36	1069.02	0.0022	South-southwest
September-03	8.05	10.28	-52.85	-54.54	1046.77	1060.39	1025.61	0.0045	South-southwest
December-03	2.79	2.92	-32.85	-40.46	1011.38	1029.39	1002.07	0.0095	South-southwest
March-04	6.35	5.93	22.89	36.7	1043.68	1026.20	1017.98	0.0046	South-southwest
June-04	12.95	12.33	71.91	88.99	1121.80	1101.85	1074.56	0.0012	South-southwest
September-04	14.3	14.57	-8.05	-21.66	1106.43	1110.17	1074.96	0.003	South-southeast
December-04	21.04	23.12	63.07	76.62	1173.98	1159.46	1135.16	0.004	South-southeast
March-05	7.38	6.48	-6.47	-7.11	1168.46	1151.60	1127.58	0.00436	South-southeast
June-05	NA	5.29	-45.93	-61.3	1119.19	1125.27	1082.40	0.0041	South-southeast
September-05	NA	5.93	-61.24	-64.87	1054.88	1077.87	1033.65	0.0068	South-southwest
December-05	NA	2.41	-57.9	-69.24	994.23	1023.45	980.25	0.0054	South-southwest
March-06	2.52	1.11	-24.81	-33.89	974.10	990.23	948.80	0.0084	South-southwest
June-06	7.65	11.18	-9.46	-1.4	966.16	983.47	933.59	0.0104	South-southwest
September-06	3.42	3.12	-6.66	-4.81	961.07	979.78	922.34	0.0099	South
December-06	4.68	5.9	2.48	3.02	958.87	979.73	933.37	0.0099	South
March-07	9.83		14.53	-1.27	969.87	992.53	958.06	0.0079	South
June-07	11.99		182.09	234.13	1162.17	1119.36	1128.32	0.0016	Southeast
September-07	29.4		15.56	0.54	1168.77	1168.14	1154.47	0.0019	South
December-07	1.95		-70.45	-87.12	1095.68	1101.19	1088.93	0.0052	South-southeast
March-08	2.17	2.31	-42.45	-43.22	1050.23	1053.76	1047.78	0.0072	South
June-08	1.9	2.69	-51.71	-52.47	1002.44	1015.93	966.67	0.0047	South
September-08	6.06	6.95	-27.49	-45.80	976.18	991.62	953.41	0.0058	South
December-08	1.69	1.74	-15.48	-5.06	961.10	981.76	934.26	0.0080	South-southeast
March-09	2.58	3.16	-4.25	-2.15	957.48	973.36	916.24	0.0073	South-southeast
June-09	3.77	4.41	1.25	1.53	959.75	971.67	914.68	0.0059	South-southeast
September-09	NA	7.41	-7.76	-5.48	953.49	967.07	903.39	0.0054	South-southeast
December-09	NA	14.63	101.24	114.02	1051.77	1040.48	1026.64	0.00002	South
March-10	9.23	NA	91.51	100.05	1144.36	1128.84	1131.78	0.00052	South-southeast
June-10	NA	10.66	3.97	3.40	1147.52	1145.30	1114.38	0.00078	South-southeast
September-10	NA	10.91	-37.77	-15.95	1126.83	1070.13	1059.82	0.00085	South-southeast
December-10	NA	4.45	-63.93	-97.99	1045.26	1060.79	1011.76	0.00029	South-southeast
March-11	NA	2.57	-41.89	-52.73	997.07	1020.56	994.18	0.00314	South-southeast
June-11	0.91	0.83	-41.80	-46.77	957.42	983.63	917.00	0.00532	South-southeast
September-11	2.29	2.13	-8.81	-3.15	952.98	970.34	900.90	0.00533	South-southeast
December-11	9.85	11.71	14.73	8.05	963.15	972.51	922.89	0.00536	South-southeast
March-12	NA	8.58	57.04	75.20	1021.21	992.83	975.99	0.00066	South-southeast
June-12	NA	5.83	-30.83	-54.76	981.01	1012.98	964.88	0.00326	South-southeast
September-12	NA	9.95	-36.51	-26.02	952.92	975.91	909.63	0.00455	South-southeast
December-12	NA	7.12	8.92	4.15	957.47	984.75	930.15	0.00550	South-southeast
March-13	4.88	4.79	-2.93	-2.05	954.43	977.59	933.99	0.00605	South-southeast
June-13	12.26	9.57	34.90	24.00	989.52	999.66	974.67	0.00350	South-southeast
September-13	5.03	3.92	-43.40	-26.95	947.00	974.20	918.61	0.00541	South-southeast
December-13	11.84	10.92	16.28	7.70	964.12	974.92	939.82	0.00506	South-southeast
March-14	0.96	1.10	-12.81	-6.03	950.62	970.44	926.47	0.00620	South-southeast
June-14	8.73	8.03	22.53	11.46	972.10	984.11	960.81	0.00513	South-southeast
September-14	6.25	5.09	-26.88	-13.86	947.85	970.50	916.54	0.00550	South-southeast
December-14	9.34	7.38	11.64	7.35	958.45	974.38	935.08	0.00544	South-southeast
March-15	7.95	5.52	14.41	4.62	971.61	986.23	955.73	0.00550	South-southeast
June-15	18.62	15.44	176.73	222.23	1162.97	1108.95	1115.04	0.00052*	South-southeast

Table 2.3
Precipitation, Groundwater Elevation and Gradient

Quarterly Report (Month, year)	Total Quarterly precipitation (inches) B-3 WS	Total Quarterly precipitation (inches) AOC-65 WS	Average GW elevation Change (feet)	CS-MW18-LGR GW Elevation Change (feet)	Average GW Elevation			Approximate gradient (ft/ft)	Approximate gradient flow direction
					Lower Glen Rose	Bexar Shale	Cow Creek		
September-15	6.76	3.66	-119.17	-147.45	1027.92	1055.29	1011.95	0.0053*	South-southeast
December-15	20.18	13.87	68.26	80.93	1100.39	1087.93	1083.84	0.00131	South-southeast
March-16	5.66	3.57	-43.11	-47.05	1054.01	1055.45	1045.55	0.00012*	South-southeast
June-16	NA	19.70	106.82	112.86	1165.70	1147.18	1143.07	0.00012	South-southeast
September-16	15.88	15.57	-85.26	-97.17	1073.18	1093.95	1070.35	0.00012	South-southeast
December-16	7.01	6.92	26.04	38.09	1105.84	1080.99	1091.31	0.00094	South-southeast
March-17	7.61	NA	-8.57	-15.45	1091.92	1100.58	1088.08	0.00131	South-southeast
June-17	6.86	5.31	-62.72	-70.29	1027.70	1048.68	1024.34	0.00106*	South-southeast
September-17	9.48	8.07	-48.78	-61.23	982.86	990.06	963.31	0.00362	South-southeast
December-17	4.36	4.33	-14.91	-17.19	964.68	981.05	952.90	0.00157	South-southeast
March-18	5.72	4.91	-6.77	-2.89	956.99	976.48	944.46	0.00725	South
June-18	NA	4.03	-5.79	-3.82	952.67	979.07	935.15	0.00679	South
September-18	26.36	26.39	167.71	214.58	1141.66	1058.09	1075.72	0.00326	Southeast
December-18	13.03	13.11	9.93	-16.70	1134.52	1126.87	1118.53	0.00613	South-southeast
March-19	NA	2.53	-31.28	-36.73	1099.51	1110.72	1094.42	0.00363	South-southeast
June-19	16.05		15.36	18.43	1116.56	1115.32	1108.64	0.00453	South-southeast
September-19	2.19	2.35	-76.42	-83.03	1041.19	1045.32	1031.48	0.00048	South-southeast
December-19	7.27	4.15	-43.87	-51.28	993.03	1001.78	995.99	0.00637	South-southeast
March-20	NA	5.07	-2.43	-1.42	992.63	993.21	989.56	0.00409	Southeasterly
June-20	11.09	8.23	37.42	44.67	1032.12	1029.68	1025.54	0.00713	Southeasterly
September-20	8.42	6.56	-81.26	-90.29	951.41	964.49	928.70	0.01077	South-southeast
December-20	2.69	1.55	-1.01	1.74	950.07	961.66	929.39	0.00746	South-southeast
March-21	2.99	2.37	-2.24	-0.83	950.17	961.96	932.85	0.00611	Southerly
June-21	NA	13.92	155.34	183.32	1112.68	1070.39	1086.13	0.00216	South-southeast
September-21	NA	12.10	-47.35	-68.73	1055.13	1064.35	1055.15	0.00308	Southerly
December-21	10.22	7.91	-15.79	-20.00	1039.40	1046.61	1037.71	0.00441	South-southeast

GW = groundwater, ft MSL = feet above mean sea level, ft/ft = feet per foot, WS = weather station
NA = Data not available due to weather station outage.
2007 precipitation data was combined to fill in data gaps due to multiple weather station outages during SCADA installation.
* alternate wells were used in calculating gradient to generally describe the regional gradient

2.1.3 Potentiometric Data

The groundwater gradient/potentiometric surface figures presented in **Appendix D** incorporate measured groundwater elevations from the LGR, BS, and CC screened wells. Drought conditions, which began in 2017 were eased in 2018 following record precipitation in September 2018 which resulted in above-average aquifer water levels that persisted through the remainder of the year. Below-average rainfall in 2019 and 2020 resulted in a decline in aquifer water levels to well below the long-term average. Low aquifer water levels continued in 2021 until above average rains in May raised them above the long-term average. Slightly above average rain through the remainder of the year was enough to keep the aquifer levels elevated, though only slightly above the long-term average by December 2021. As shown in **Appendix D**, water levels at CSSA can vary greatly. This variability is associated with several factors:

- A low storage capacity for groundwater within the primary porosity (interstitial voids between grains) of the limestone matrix, which is inherent to carbonate mudstone aquifers. These aquifers with lower storage capacities are more susceptible to widely fluctuating groundwater levels (as compared to a well-sorted sand matrix). Within the Middle Trinity aquifer and other regional carbonate aquifers, their groundwater yield is mostly derived from secondary porosity features resulting from faults, fractures, and chemical dissolution of the bedrock (karst).
- Differences in well completion depths and formations screened;
- Differences in recharge rates due to increased secondary porosity associated with the Salado Creek area;
- Differences in recharge rates due to increased secondary porosity associated with local fault zones;
- Pumping from on- and off-post public and private water supply wells; and
- Locations of major faults or fractures.

2.1.4 Post-wide Flow Direction and Gradient

An average of the quarterly calculated LGR groundwater gradients in 2021 results in a flow direction to the south-southeast at 0.00426 ft/ft. Multiple disruptions to the natural groundwater flow are observed through the year. In March and September 2021, the flow direction was generally to the south with gradients of 0.00611 and 0.00236 ft/ft, respectively. In June and December, the flow direction is more south-southeasterly with gradients of 0.00414 and 0.00114 ft/ft, respectively. A depression in water levels in the southeast portion of the post from normal pumping operations at CS-1 is observed in March. In June, three cones of depression, centered on CS-MWH-LGR, CS-10, and bioreactor extraction wells, and groundwater mounding at CS-MW4-LGR are observed. In September and December no cone of depression is observed at CS-10, though the cones at CS-MWH-LGR and the bioreactor are seen, as is the mounding at CS-MW4-LGR. The groundwater mound at CS-MW4-LGR is a typical feature when water levels are above 970 feet MSL. In March, when the water level is just above 970 feet (~972 feet), this feature is not clearly visible. General groundwater flow directions and average gradients calculated during past monitoring events are provided in **Table 2.3** for comparison.

<u>Lower Glen Rose</u>

The 2021 potentiometric surface maps for LGR-screened wells **(Appendices D.1, D.4, D.7** and **D.10)** exhibited a wide range of groundwater elevations. To illustrate, the average groundwater elevation in the LGR segment of the aquifer varied by nearly 162.51 feet with the high recorded in June and the low in March. Groundwater elevations are generally higher in the northern and central portions of CSSA and decrease to the south. This is consistent with the natural dip of the formations and the greater fault displacement in the southern portion of CSSA. The removal of well CS-G from the gridding process negates a mounding effect due to perched groundwater that is present at that well, and misleadingly disrupts the normal southerly and easterly components of the North Pasture. This well, along with open borehole completions in wells CS-D, CS-2, and CS-4 are not fully penetrating into the LGR, and therefore are not considered within these maps.

Between the December 2020 and March 2021 monitoring events, aquifer levels remained stable, though well below the long-term average, with the average aquifer water level increasing a mere 1.61 feet. Water levels rebounded slightly following the second quarter's above-average rains, gaining 169 feet, but was followed by slightly above-average precipitation through the remainder of the year and subsequently declined 75 feet to an average elevation of 1040.45 feet in December 2021 which is 9.62 feet above the 19-year long-term average of 1,030.83 feet (**Table 2.1**). Quarterly LGR potentiometric maps show the effect precipitation (or lack thereof) has on the aquifer (**Appendix D.1**, **D.4**, **D.7**, and **D.10**). Overall, the LGR segment gained approximately 88 feet of aquifer elevation over the 12-month period between December 2020 and December 2021.

A typical feature as seen in Appendix D.4, D.7, and D.10 is the groundwater mounding effect centered on CS-MW4-LGR in the central portion of the post. This is a typical feature during non-drought conditions when the surrounding groundwater elevation is above the elevation of the aquifer basal production zone, approximately 970 feet mean sea level (MSL). Historical data has shown that this mounding effect can either be muted or completely removed under distressed aquifer levels. This feature is muted in March (Appendix E.1) as the groundwater elevation is just above the 970-foot mark (971.48 feet). Unlike the general trend at CSSA, groundwater flow appears to radiate outward from CS-MW4-LGR when mounding conditions are present. Presumably this region has a strong hydraulic connection to significant perched water either associated with Salado Creek or the hillsides to the east.

The groundwater drawdown due to the cyclic pumping of CS-MW16-LGR, B3-EXW01-LGR, B3-EXW02-LGR, B3-EXW03-LGR, B3-EXW04-LGR, B3-EXW05-LGR (Bioreactor System) is a recurring feature in the central portion of the post. In 2020, the cone of depression due to bioreactor operations is observed in June, September, and December. The operation of the bioreactor system and resultant groundwater "cone of depression" can vary due to combination of extraction wells actively pumping during the water level gauging effort. But as a collective system, they are effective in maintaining a zone of capture around the remediation system and re-injecting groundwater into the Bioreactor. Depending on the current pumping rates at the time of measurement, groundwater in the vicinity of the Bioreactor may be depressed by as much as 50 to 150 feet, as measured between a currently active extraction well (EXW) and other surrounding wells. Additional cones of depression are observed at wells CS-10 and CS-MWH-LGR as a result of pumping operations during the year.

Bexar Shale

Currently, groundwater head information is limited to four data points (CS-MW1-BS, CS-MW6-BS, CS-MW9-BS, and CS-MW12-BS) for the Bexar Shale hydrologic unit at CSSA. Given the paucity of well control, at best, the BS groundwater maps should be considered qualitative. The BS appears to have very limited groundwater that is likely associated with fracturing. Fractured bedrock such as this often results in discordant water levels between neighboring points and may not be a true indicator of flow direction. The appropriateness of preparing potentiometric surface maps for the BS is debatable, but these maps have been generated for completeness. Potentiometric maps for the Bexar Shale in 2021 are presented in **Appendices D.2, D.5, D.8** and **D.11**.

Compared to the LGR and CC segments, the BS aquitard fluctuates significantly less in response to both recharge and drought. After the 12-month period between December 2020 and December 2021, the BS segment had a net gain of 84.95 feet, whereas the LGR experienced a gain of 88 feet. Historical data has shown for a given precipitation event, the BS water level will "peak" anywhere between 15 and 30 days after the LGR and CC has already crested for the same rain event.

From a historical perspective, the potentiometric surface maps for BS-screened wells often exhibit groundwater flow in multiple directions. Historically, these flow directions are to the south, east, and occasionally to the north. In 2021, the BS potentiometric surface gradient is variable. In March, flow is to the south-southwest, while in June, flow is to the east, in September, flow is to the east and southeast, and in December, apparent mounding in the central portion of the post and flow to north and south is observed.

Cow Creek

As with the BS, the post wide monitoring of the CC groundwater is limited due to the small number of wells completed only in the CC. Four of the nine CC wells are concentrated in the vicinity of AOC-65. In June, during its highest groundwater elevations of the year, the CC groundwater exhibited an easterly gradient (**Appendix D.6**). When groundwater was at its lowest elevations, in March 2021 (**Appendices D.3**), the predominant gradient was more strongly to the south and a cone of depression is visible centered on the bioreactor recovery well CS-MW16-CC. The effects of continuous pumping of CS-MW16-CC influence groundwater gradients significantly in the CC interval near the Bioreactor. Prior studies have shown measurable pumping influence within the CC at distances of more than 2,000 feet from a CC pumping well, as measured at CS-MW1-CC. The cone of depression is also visible in the December potentiometric surface (**Appendix D.12**) and the gradient is to the south where not effected by pumping. In September, a northerly gradient is observed (**Appendix D.9**).

The CC responds almost as quickly as the LGR to a recharge event, presumably because of direct infiltration on the outcrop areas to the north of CSSA. However, the recharge rate in the CC is somewhat slower than the LGR, and the crest of a precipitation response may come 15 days later than what is observed in the LGR. Typically, the CC aquifer elevation response to recharge or discharge is less than the LGR segment. After the 12-month period between December 2020 and December 2021, the net gain of the CC segment was greater than 104 feet.

2.2 Chemical Characteristics

2.2.1 On-Post Analytical Results

The LTMO study implemented in December 2005, updated in 2010, 2015 and 2020, determines the frequency that on-post wells are sampled. An overview of sampling frequencies for on-post wells is given in **Table 2.4**. Sixteen on-post samples from 4 wells were scheduled to be collected in 2021 (4 in March, 4 in June, 4 in September, and 4 in December). All 16 samples were collected. No monitoring wells were scheduled for sampling in 2021.

The wells were sampled using either dedicated low-flow pumps, high capacity submersible pumps, or a dedicated solar-powered submersible pump (well CS-I). Samples were collected after field parameters (pH, temperature, conductivity) stabilized during well purging. Field parameters were recorded in the field logbook for each sampling event.

Groundwater samples were submitted to Agriculture & Priority Pollutants Laboratories, Inc. (APPL) of Clovis, California and Eurofins TestAmerica – Denver of Arvada, Colorado for analysis. The analytical program for on-post monitoring wells includes short-list VOC analysis and metals. The short list of VOC analytes included: *cis*-1.2-Dichloroethene (*cis*-1,2-DCE), PCE, TCE, and vinyl chloride. Drinking water wells were also sampled for the following metals: arsenic, barium, copper, chromium, cadmium, mercury, lead, and zinc.

Each sample is evaluated against either being qualitatively detected in trace amounts above the MDL [F-flagged data], quantitatively detected above the laboratory reporting limit (RL), or in exceedance of regulatory maximum contaminant level (MCL), action level (AL), or secondary standard (SS) comparison criteria. It is important to note that the RL value is significantly less than the promulgated groundwater standard criteria, and therefore the occurrence of a constituent above the RL does not necessarily indicate that there is an immediate concern, especially with the naturally occurring inorganics (metals) in groundwater. The only exception to this generalization is lead, where the RL (0.025 mg/L) is greater than the AL (0.015 mg/L).

Table 2.4
Overview of On-Post Sampling for 2021

Count	Well ID	*Analytes*	*Last Sample Date*	*Mar-21*	*Jun-21*	*Sep-21*	*Dec-21*	*LTMO Sampling Frequency**
1	CS-MW1-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
2	CS-MW1-BS	VOCs	Dec-12	NS	NS	NS	NS	as needed
3	CS-MW1-CC	VOCs	Dec-19	NS	NS	NS	NS	30 months
4	CS-MW2-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
5	CS-MW2-CC	VOCs	Dec-19	NS	NS	NS	NS	30 months
6	CS-MW3-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
7	CS-MW4-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
8	CS-MW5-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
9	CS-MW6-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
10	CS-MW6-BS	VOCs	Dec-12	NS	NS	NS	NS	as needed
11	CS-MW6-CC	VOCs	Dec-19	NS	NS	NS	NS	30 months
12	CS-MW7-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
13	CS-MW7-CC	VOCs	Dec-19	NS	NS	NS	NS	30 months
14	CS-MW8-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
15	CS-MW8-CC	VOCs	Dec-20	NS	NS	NS	NS	15 months
16	CS-MW9-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
17	CS-MW9-BS	VOCs	Dec-12	NS	NS	NS	NS	as needed
18	CS-MW9-CC	VOCs	Dec-19	NS	NS	NS	NS	30 months
19	CS-MW10-LGR	VOCs	Dec-19	NS	NS	NS	NS	15 months
20	CS-MW10-CC	VOCs	Dec-19	NS	NS	NS	NS	30 months
21	CS-MW11A-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
22	CS-MW11B-LGR	VOCs	Sep-18	NS	NS	NS	NS	15 months
23	CS-MW12-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
24	CS-MW12-BS	VOCs	Dec-12	NS	NS	NS	NS	as needed
25	CS-MW12-CC	VOCs	Dec-19	NS	NS	NS	NS	30 months
26	CW-MW17-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
27	CS-MW18-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
28	CS-MW19-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
29	CS-1	VOCs & metals (As,Ba,Cr, Cu,Cd,Hg,Pb,Zn)	Dec-21	S	S	S	S	Quarterly
30	CS-2	VOCs	Jun-20	NS	NS	NS	NS	30 months
31	CS-3	VOCs	Dec-20	NS	NS	NS	NS	15 months
33	CS-10	VOCs & metals (As,Ba,Cr, Cu,Cd,Hg,Pb,Zn)	Dec-21	S	S	S	S	Quarterly
34	CS-12	VOCs & metals (As,Ba,Cr, Cu,Cd,Hg,Pb,Zn)	Dec-21	S	S	S	S	Quarterly
35	CS-13	VOCs & metals (As,Ba,Cr, Cu,Cd,Hg,Pb,Zn)	Dec-21	S	S	S	S	Quarterly
36	CS-D	VOCs	Dec-19	NS	NS	NS	NS	15 months
37	CS-MWG-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
38	CS-MWH-LGR	VOCs	Jun-17	NS	NS	NS	NS	30 months
39	CS-I	VOCs	Dec-19	NS	NS	NS	NS	30 months
40	CS-MW20-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
41	CS-MW21-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
42	CS-MW22-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
43	CS-MW23-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
44	CS-MW24-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
45	CS-MW25-LGR	VOCs	Dec-19	NS	NS	NS	NS	30 months
46	CS-MW35-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
47	CS-MW36-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months
48	CS-MW37-LGR	VOCs	Dec-20	NS	NS	NS	NS	15 months

Notes/Abrreviations:
* New LTMO sampling frequency implemented December 2020.
S = Sample
NS = No Sample

Table 2.5
2021 On-post Groundwater COCs and Metals Analytical Results

Well ID	Laboratory	Sample Date	*cis*-1,2 DCE (ug/L)	PCE (ug/L)	TCE (ug/L)
CS-1	APPL	3/3/2021	--	--	--
	APPL	6/2/2021	--	--	--
	APPL	9/1/2021	--	--	--
	ETA	12/2/2021	--	--	--
Duplicate	ETA	12/2/2021	--	--	--
CS-10	APPL	3/3/2021	--	--	--
	APPL	6/2/2021	--	--	--
	APPL	9/1/2021	--	--	--
	ETA	12/2/2021	--	--	--
CS-12	APPL	3/3/2021	--	--	--
Duplicate	APPL	3/3/2021	--	--	--
	APPL	6/2/2021	--	--	--
	APPL	9/1/2021	--	--	--
Duplicate	APPL	9/1/2021	--	--	--
	ETA	12/2/2021	--	--	--
CS-13	APPL	3/3/2021	--	--	--
	APPL	6/2/2021	--	--	--
	APPL	9/1/2021	--	--	--
	ETA	12/2/2021	--	--	--
Comparison Criteria					
Maximum Contaminant Level (MCL)			**70**	**5.0**	**5.0**
APPL Reporting Limit (RL)			**1.2**	**1.4**	**1.0**
ETA Limit of Quantitation (LOQ)			**1.0**	**1.0**	**1.0**
Method Detection Limit (MDL)			**0.07**	**0.06**	**0.05**
ETA Detection Limit (DL)			**0.15**	**0.20**	**0.16**

Bold (red)	Value ≥ MCL
Bold (blue)	MCL > Value ≥ RL/LOQ
Bold	RL/LOQ > Value > MDL/DL

Samples analyzed by APPL, Inc. used method SW8260B.
Samples analyzed by ETA used method SW8260C.
VOC data reported in ug/L & metals data reported in mg/L.

Abbreviations/Notes:

µg/L	micrograms per liter
mg/L	milligrams per liter
Duplicate	Field Duplicate
TCE	Trichloroethene
PCE	Tetrachloroethene
DCE	Dichloroethene

Table 2.5
2021 On-post Groundwater COCs and Metals Analytical Results

Well ID	Sample Date	Laboratory	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)
CSSA Drinking Water Wells									
CS-1	3/3/2021	APPL	**0.00136F**	**0.0343**	--	--	--	--	--
	6/2/2021	APPL	--	**0.0367**	--	--	**0.004F**	--	--
	9/1/2021	APPL	**0.00641F**	**0.0365**	--	--	**0.008F**	--	--
	12/2/2021	ETA	--	**0.0357Q**	--	--	**0.00685J**	--	--
Duplicate	12/2/2021	ETA	--	**0.0374Q**	--	--	**0.00207J**	--	--
CS-10	3/3/2021	APPL	**0.00265F**	**0.041**	--	--	**0.025**	**0.0056F**	--
	6/2/2021	APPL	--	**0.0388**	--	--	**0.005F**	--	--
	9/1/2021	APPL	**0.00430F**	**0.0389**	--	--	--	--	--
	12/2/2021	ETA	--	**0.0378Q**	--	--	**0.00300**	--	--
CS-12	3/3/2021	APPL	**0.00306F**	**0.0316**	--	--	--	--	--
Duplicate	3/3/2021	APPL	--	**0.0335**	--	--	--	--	--
	6/2/2021	APPL	--	**0.0307**	--	--	--	--	**0.001**
	9/1/2021	APPL	**0.00324F**	**0.0299**	--	--	**0.008F**	--	--
Duplicate	9/1/2021	APPL	**0.00359F**	**0.0304**	--	--	--	--	--
	12/2/2021	ETA	**0.000338J**	**0.0301**	--	**0.000528J**	**0.00397**	--	--
CS-13	3/3/2021	APPL	**0.00098F**	**0.0297**	--	--	**0.005F**	--	--
	6/3/2021	APPL	--	**0.0342**	--	--	**0.011**	--	--
	9/1/2021	APPL	**0.00183F**	**0.0297**	--	--	**0.004F**	--	--
	12/2/2021	ETA	**0.00104J**	**0.0301Q**	--	--	**0.0309**	--	--
Comparison Criteria									
Maximum Contaminant Level (MCL)			**0.01**	**2.0**	**0.005**	**0.1**	**1.3**	**0.015 (AL)**	**0.002**
APPL Reporting Limit (RL)			**0.03**	**0.005**	**0.007**	**0.01**	**0.01**	**0.025**	**0.001**
ETA Limit of Quantitation (LOQ)			**0.005**	**0.003**	**0.001**	**0.01**	**0.002**	**0.003**	**0.002**
APPL Method Detection Limit (MDL)			**0.00022**	**0.0003**	**0.0005**	**0.001**	**0.003**	**0.0019**	**0.0001**
ETA Detection Limit (DL)			**0.00033**	**0.00029**	**0.00027**	**0.0005**	**0.00056**	**0.00018**	**0.000027**

Bold (red)	Value ≥ MCL
Bold (blue)	MCL > Value ≥ RL/LOQ
Bold	RL /LOQ> Value ≥ MDL/DL

Samples analyzed by APPL, Inc. used laboratory method EPA 6010B and SW7470A for mercury.
Samples analyzed by ETA used laboratory method EPA 6020A and SW7470A for mercury.
VOC data reported in µg/L & metals data reported in mg/L.

Abbreviations/Notes:

µg/L	micrograms per liter
mg/L	milligrams per liter
Duplicate	Field Duplicate
AL	Action Level
SS	Secondary Standard

Data Qualifiers:

F-The analyte was positively identified but the associated numerical value is below the RL.

Table 2.6 PFAS Analytical Results, October 2021

Camp Stanley Storage Activity (CSSA)
Boerne, Texas
Validated Analytical Results for PFAS Drinking Water Study - October 2021

		SAMPLE ID:	Texas Tier 1 PCL [1]	USEPA LHA Value [2]	USEPA RSL [3]	CS-1		CS-10		CS-12		CS-12-DUP		CS-13	
		DATE SAMPLED:				10/4/2021		10/4/2021		10/4/2021		10/4/2021		10/4/2021	
		LAB SAMPLE ID:				BA42453		BA42456		BA42449		BA42448		BA42452	
	CAS Number	Unit													
EPA 537.1 - PFAS in Drinking Water															
Perfluorobutanesulfonic acid (PFBS)	375-73-5	ng/L	34,000	--	6,000	0.27	U	**0.78**	F	0.27	U	**0.31**	F	0.27	U
Perfluorodecanoic acid (PFDA)	335-76-2	ng/L	370	--	--	0.37	U	0.37	U	0.37	U	0.37	U	0.37	U
Perfluorododecanoic acid (PFDoA)	307-55-1	ng/L	290	--	--	0.23	U	0.23	U	0.23	U	0.23	U	0.23	U
Perfluoroheptanoic acid (PFHpA)	375-85-9	ng/L	560	--	--	0.69	U	0.69	U	0.69	U	0.69	U	0.69	U
Perfluorohexanoic acid (PFHxA)	307-24-4	ng/L	93	--	--	0.46	U	**0.82**	F	0.46	U	0.46	U	0.46	U
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	ng/L	93	--	--	**0.34**	F	**5.4**		0.29	U	0.29	U	0.29	U
Perfluorononanoic acid (PFNA)	375-95-1	ng/L	290	--	--	0.59	U	0.59	U	0.59	U	0.59	U	0.59	U
Perfluorooctanoic acid (PFOA)	335-67-1	ng/L	290	70	400	0.47	U	**0.71**	F	0.47	U	0.47	U	0.47	U
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	ng/L	560	70	400	2.0	U	**8.4**		2.0	U	2.0	U	0.27	U
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	ng/L	290	--	--	0.19	U	0.19	U	0.19	U	0.19	U	0.19	U
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	ng/L	290	--	--	0.27	U	0.27	U	0.27	U	0.27	U	0.27	U
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	ng/L	290	--	--	0.38	U	0.38	U	0.38	U	0.38	U	0.38	U
DOD B-15 - PFAS in Water															
Perfluorobutanoic acid (PFBA)	375-22-4	ng/L	71,000	--	--	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Perfluorodecanesulfonic acid (PFDS)	335-77-3	ng/L	290	--	--	0.32	U	0.32	U	0.32	U	0.32	U	0.32	U
Perfluorooctane Sulfonamide (PFOSA)	754-91-6	ng/L	290	--	--	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Perfluoropentanoic acid (PFPeA)	2706-90-3	ng/L	93	--	--	0.31	U	0.31	U	0.31	U	0.31	U	0.31	U

QA NOTES AND DATA QUALIFIERS:

Sample CS-12-DUP is the field duplicate of sample CS-12.

ng/L - Nanograms per Liter.

(NO CODE) - Confirmed identification.

U - Analyte was not detected above the indicated Method Detection Limit (MDL). Note that for PFOS results reported at 2.0 U, the associated field blank samples contained similar concentrations; therefore, the original PFOS results were raised to the Reporting Limit and qualified U as non-detect.

F - Analyte was positively identified, but the quantitation is an estimation above the MDL and below the Reporting Limit (RL).

Detections are bolded.

No regulatory limits were exceeded.

NOTES:

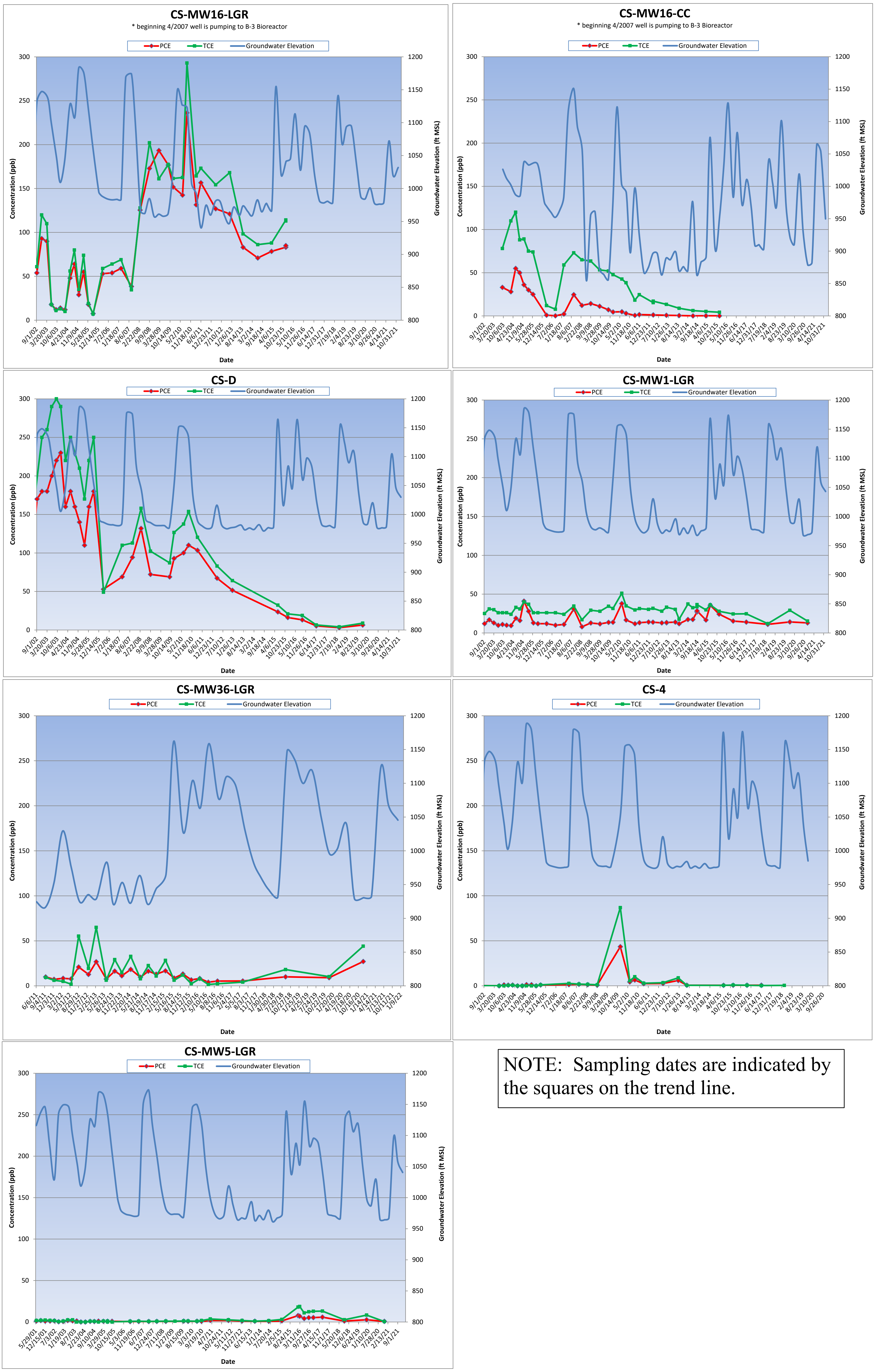
[1] - Texas Tier 1 PCL for Groundwater. Texas Commission on Environmental Quality (TCEQ); 2018: Texas Risk Reduction Program (TRRP); Protective Concentration Levels (PCLs); April 2018. (https://www.tceq.texas.gov/remediation/trrp/trrppcls.html)

[2] - USEPA Lifetime Health Advisory Value for PFOA and PFOS in Drinking Water. Applies to the individual results for PFOA and PFOS as well as the sum of PFOA + PFOS. USEPA; 2016; Drinking Water Health Advisory for PFOA and PFOS; Office of Water (430HT); Health and Ecological Criteria Division, Washington, DC 20460; EPA Document Numbers 822-R-16-004 and 822-R-16-005. (https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_health_advisory_final_508.pdf); (https://www.epa.gov/sites/production/files/2016-05/documents/pfos_health_advisory_final_508.pdf)

[3] - USEPA Groundwater Regional Screening Level. USEPA; 2020; Regional Screening Levels (RSLs); RSL User's Guide, and RSL Calculator, Tap Water; HQ=1; May 2020. (https://www.epa.gov/risk/regional-screening-levels-rsls)

Concentration trends are illustrated on **Figure 2.4** for wells CS-MW16-LGR, CS-MW16-CC, CS-D, CS-MW1-LGR, CS-MW5-LGR, CS-MW36-LGR, and CS-4. These wells were selected because they have historical detections of PCE and TCE that approach and/or exceed MCLs. **Figure 2.4** also includes groundwater elevation data from each respective well to determine if there are correlations between VOC concentrations and water level. This figure suggests that CS-MW1-LGR has the most direct correlation between PCE/TCE concentration and groundwater recharge events. CS-MW5-LGR also shows this correlation beginning in 2015. After that, discernible trends are less evident. Quarterly monitoring of CS-MW16-LGR and CS-D seems to indicate that increases in VOC concentrations lag recharge events by roughly six to nine months. CS-MW16-LGR and CS-MW16-CC have been removed from the groundwater monitoring program per the updated LTMO study and DQO's. Well CS-4 was plugged and abandoned on October 19, 2020.

Figure 2.4
On-Post Cumulative Analytical vs. Groundwater Elevation



NOTE: Sampling dates are indicated by the squares on the trend line.

Notable trends in other wells appear to be related more to remedial activities than precipitation/recharge events. Concentrations at CS-MW16-CC decreased between March 2004 and June 2005 during a 15-month pump test of that well. Then concentrations increased in early 2007 during a time that roughly corresponds to the start-up of SWMU B-3 Bioreactor operations. Since that time, groundwater has been cyclically pumped from CS-MW16-CC and applied to the bioreactor as a remedial alternative. During that timeframe, VOC concentrations have steadily decreased, with little fluctuation attributable to precipitation. It is debatable whether the CS-MW36-LGR concentrations have responded to the in-situ chemical oxidation (ISCO) injections at AOC-65 in August 2012, May-June 2013, September-October 2014, August-November 2015, January 2019, and June 2021. The singular PCE/TCE peak at CS-4 has been attributed to the SWMU B-3 flood test in September 2009.

The VOC concentrations at CS-MW5-LGR have historically been below the MCLs since the well's inception in 2001. However, PCE, TCE, and *cis*-1,2-DCE all increased five-fold in 2016 and remained at these levels through 2017. The significant increase in contamination in well CS-MW5-LGR could be a result of the above-average rainfall in 2015 and 2016. This, coupled with remedial activities at the SWMU B-3 bioreactor to the west of this well, may have contributed to this increase. In 2018, PCE and TCE fell back below their MCLs. However, in 2019 TCE was back above the MCL while PCE and *cis*-1,2-DCE stayed below the MCL. In 2020, VOC levels have dropped back below their MCLs with depleted corresponding water levels.

2.2.1.2 Drinking Water Supply Well Results

Four active CSSA drinking water supply wells (CS-1, CS-10, CS-12, and CS-13) were analyzed for VOCs, 8 metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, and zinc), and Per- and Polyfluoroalkyl Substances (PFAS) in 2021. Under the LTMO study, the drinking water supply wells are scheduled to be sampled quarterly (**Table 2.5, Table 2.6 & Appendix B**). The detections are summarized as follows:

- **CS-1** – No VOCs were detected during the 4 quarterly sampling events in 2021. Barium, copper, and zinc were detected above their applicable RLs while arsenic was detected below the RL. In October there were no PFAS detections above the regulatory limits.
- **CS-10** – No VOCs were detected during the four quarterly sampling events in 2021. Barium, copper, and zinc were detected above their RLs and arsenic and lead were detected below their applicable RLs. In October there were no PFAS detections above the regulatory limits.
- **CS-12** – No VOCs were detected during the four quarterly sampling events in 2021. Barium, copper, mercury and zinc were detected above their RLs along with arsenic, chromium and lead detected below their applicable RLs. In October there were no PFAS detections in the normal sample and the field duplicate showed no detections above the regulatory limits.
- **CS-13** – No VOCs were detected in this well in 2021. Barium, copper, and zinc were detected above their applicable RLs while arsenic was detected below the applicable RL. In October there were no PFAS detections in this well.

2.2.1.3 Westbay®-equipped Well Results

Eight wells equipped with the Westbay® multi-port interval sampling equipment have been installed at CSSA. Four wells (CS-WB05, CS-WB06, CS-WB07, and CS-WB08) are sampled as part of the SWMU B-3 bioreactor treatability study and are not addressed in this report. The remaining four wells (CS-WB01, CS-WB02, CS-WB03, and CS-WB04) are part of the groundwater monitoring program and are included in this report. Under the provisions of the groundwater monitoring DQOs and the 2020 updated LTMO study, the schedule for sampling CS-WB01, CS-WB02, CS-WB03, and CS-WB04 is every 15 months for the UGR, select LGR, and CC zones. Three WB04-LGR zones are on the 30-month schedule. An overview of sampling frequencies for Westbay® wells is given in **Table 2.7**. No zones were scheduled for sampling in 2021. The next 15-month sampling event is scheduled for March 2022 and results will be documented in the next annual report.

Table 2.7
Overview of Westbay Sampling for 2021

Westbay Interval	Last Sample Date	Mar-21	Jun-21	Sep-21	Dec-21	LTMO Sampling Frequency (as of Dec. 2020)
CS-WB01-UGR-01	Sep-18	NS	NS	NS	NS	15 months
CS-WB01-LGR-01	Dec-20	NS	NS	NS	NS	15 months
CS-WB01-LGR-02	Dec-20	NS	NS	NS	NS	15 months
CS-WB01-LGR-03	Dec-20	NS	NS	NS	NS	15 months
CS-WB01-LGR-04	Dec-20	NS	NS	NS	NS	15 months
CS-WB01-LGR-05	Dec-20	NS	NS	NS	NS	15 months
CS-WB01-LGR-06	Dec-20	NS	NS	NS	NS	15 months
CS-WB01-LGR-07	Dec-20	NS	NS	NS	NS	15 months
CS-WB01-LGR-08	Dec-20	NS	NS	NS	NS	15 months
CS-WB01-LGR-09	Dec-20	NS	NS	NS	NS	15 months
CS-WB02-UGR-01	Dec-04	NS	NS	NS	NS	15 months
CS-WB02-LGR-01	Sep-18	NS	NS	NS	NS	15 months
CS-WB02-LGR-02	Sep-18	NS	NS	NS	NS	15 months
CS-WB02-LGR-03	Dec-20	NS	NS	NS	NS	15 months
CS-WB02-LGR-04	Dec-20	NS	NS	NS	NS	15 months
CS-WB02-LGR-05	Dec-20	NS	NS	NS	NS	15 months
CS-WB02-LGR-06	Dec-20	NS	NS	NS	NS	15 months
CS-WB02-LGR-07	Dec-20	NS	NS	NS	NS	15 months
CS-WB02-LGR-08	Dec-20	NS	NS	NS	NS	15 months
CS-WB02-LGR-09	Dec-20	NS	NS	NS	NS	15 months
CS-WB03-UGR-01	Dec-20	NS	NS	NS	NS	15 months
CS-WB03-LGR-01	Dec-19	NS	NS	NS	NS	15 months
CS-WB03-LGR-02	Jun-16	NS	NS	NS	NS	15 months
CS-WB03-LGR-03	Dec-20	NS	NS	NS	NS	15 months
CS-WB03-LGR-04	Dec-20	NS	NS	NS	NS	15 months
CS-WB03-LGR-05	Dec-20	NS	NS	NS	NS	15 months
CS-WB03-LGR-06	Dec-20	NS	NS	NS	NS	15 months
CS-WB03-LGR-07	Dec-20	NS	NS	NS	NS	15 months
CS-WB03-LGR-08	Dec-20	NS	NS	NS	NS	15 months
CS-WB03-LGR-09	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-UGR-01	Nov-04	NS	NS	NS	NS	15 months
CS-WB04-LGR-01	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-LGR-02	Mar-10	NS	NS	NS	NS	30 months
CS-WB04-LGR-03	Dec-19	NS	NS	NS	NS	30 months
CS-WB04-LGR-04	Dec-19	NS	NS	NS	NS	30 months
CS-WB04-LGR-06	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-LGR-07	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-LGR-08	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-LGR-09	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-LGR-10	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-LGR-11	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-BS-01	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-BS-02	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-CC-01	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-CC-02	Dec-20	NS	NS	NS	NS	15 months
CS-WB04-CC-03	Dec-20	NS	NS	NS	NS	15 months

Profiling performed quarterly, in conjunction with post wide water levels.
S = sample
NS = no sample

2.2.2 Off-Post Analytical Results

The frequencies for sampling off-post wells in 2021 were determined by the updated *Three-Tiered Long Term Monitoring Network Optimization Evaluation* (Parsons 2020), in compliance with *The Plan*, and *DQOs for the Groundwater Monitoring Program* (Parsons 2020). These plans were updated in 2020 and new sampling frequencies were implemented in December 2020 after receiving TCEQ and EPA approval **(Appendix I)**. An overview of sampling frequencies for off-post wells is given in **Table 2.8**. Fifty off-post samples were collected from 6 wells during the 2021 quarterly monitoring events, and their locations are illustrated on **Figure 1.1**.

Off-post wells sampled during the quarterly monitoring events were selected based on previous sampling results and proximity to both the CSSA boundary and wells with detections of PCE and TCE. Public and private supply wells located west and south of CSSA were selected for these events. Samples were also collected from the off-post well GAC filtration systems after treatment during the March and September events. Additional post-GAC samples were collected after the semi-annual GAC maintenance was performed.

Off-post wells sampled in 2021 included (see **Figure 1.1** for well locations):

- Three privately-owned wells in the Leon Springs Villa area (LS-5, LS-6, and LS-7);
- One well used by the general public on Old Fredericksburg Road (OFR-3);
- Two privately-owned wells (RFR-10 & RFR-11) in the Ralph Fair Road area.

All wells were sampled from a tap located as close to the wellhead as possible. Most taps were installed by CSSA to obtain a representative groundwater sample before pressurization, storage, or the water supply distribution system. Water was purged to engage the well pump prior to sample collection. Conductivity, pH, and temperature readings were recorded to confirm adequate purging while the well was pumping. Purging measurements were recorded in the field logbook for each sampling event.

Groundwater samples from March, June, and September were submitted to APPL for analysis. Samples collected in December were submitted to Eurofins TestAmerica – Denver (ETA) for analysis. Groundwater samples were analyzed for the short list of VOCs (*cis*-1,2-DCE, PCE, TCE, and vinyl chloride) using SW-846 Method 8260B. Off-post wells are not analyzed for metals as part of the groundwater monitoring program.

The data packages containing the analytical results for the 2021 sampling events were reviewed and verified according to the guidelines outlined in the CSSA QAPP. After the data packages were received by Parsons, quarterly DVRs were submitted to CSSA as an attachment in the Quarterly Groundwater Reports. The December 2021 DVR is included in **Appendix G.**

Based on historical detections, the lateral extent of VOC contamination above the MDL extends approximately 2.7 miles beyond the west boundary of CSSA (well SLD-01) and 0.4 miles to the south of CSSA (well LS-4). Information such as well depth, pump depth, and other pertinent data necessary to characterize the vertical extent of migration is not readily available for most off-post wells. However, the typical well construction for the area is open borehole completions that penetrate the full thickness of the Middle Trinity aquifer (LGR, BS, and CC).

Concentrations of VOCs detected in 2021 are presented in **Table 2.9**. Full analytical results from the 2021 sampling events are presented in **Appendix E**. Concentration trends are illustrated on **Figures 2.5 and 2.6** for wells LS-5, LS-6, LS-7, OFR-3, RFR-10, and RFR-11 for PCE and TCE. These wells were selected because they have had detections of PCE and TCE that approach and/or exceed MCLs. **Figure 2.5** includes precipitation data from the weather stations located at CSSA, AOC-65 WS and B-3 WS. This figure suggests VOC concentrations in OFR-3 and RFR-10 are very sensitive to significant rain events and that VOC concentrations in LS-5, LS-6, and LS-7 are less sensitive to rainfall.

Data from RFR-11 presents a mixed picture. From October 2001 through December 2007, RFR-11 VOC concentration peaks showed a good correlation to significant rainfall events, but after 2007, this correlation is less pronounced. It may be coincidental, but the changes in rainfall/VOC concentration correlations in RFR-11 happened when the San Antonio Water System (SAWS) abandoned pumping of the Bexar Met public supply wells in Leon Springs Villas (LS-1, LS-2, LS-3, LS-4). In late 2018 PCE and TCE concentrations in RFR-11 rose above the MCL for the first time since 2007 but have since dropped back below the MCL. This spike could be due to significant rainfall in the later part of 2018 or the ongoing ISCO treatment at AOC-65 near CSSAs southern border fence line. **Figure 2.6** shows PCE and TCE concentrations with monthly water usage at each off-post well. The off-post GAC systems are equipped with flowmeters that track the gallons of water treated by the units. Data in this figure suggests little correlation between VOC concentrations and well pumping volumes.

Table 2-8
2021 Off-post Groundwater Sampling Rationale

Well ID	2021 Mar	Jun	Sept	Dec	Sampling Frequency
FO-J1	NS	NS	NS	NS	ownership in dispute, do not sample
I10-2	NS	NS	NS	NS	exclude after June-18; pump out
I10-8	NS	NS	NS	NS	30 month
I10-10	NS	NS	NS	NS	15 month
JW-7	NS	NS	NS	NS	30 month
JW-8	NS	NS	NS	NS	30 month
LS-5 [GAC]	[yellow]	[orange]	[orange]	[yellow]	Quarterly
LS-5-A2 [GAC]	[green]	NS	[green]	NS	Biannually (Mar & Sept)
LS-6 [GAC]	NA	[yellow]	[yellow]	[yellow]	Quarterly
LS-6-A2 [GAC]	[green]	NS	[yellow]	NS	Biannually (Mar & Sept)
LS-7 [GAC]	[yellow]	[yellow]	[yellow]	[yellow]	Quarterly
LS-7-A2 [GAC]	[green]	NS	[green]	NA	Biannually (Mar & Sept)
OFR-3 [GAC]	[orange]	[orange]	[red]	[orange]	Quarterly
OFR-3-A2 [GAC]	[green]	NS	[green]	NA	Biannually (Mar & Sept)
RFR-10 [GAC]	[red]	[red]	[red]	[red]	Quarterly
RFR-10-A2 [GAC]	[green]	NS	[green]	NS	Biannually (Mar & Sept)
RFR-10-B2 [GAC]	[green]	NS	[green]	NS	Biannually (Mar & Sept)
RFR-11 [GAC]	[yellow]	[yellow]	[yellow]	[yellow]	Quarterly
RFR-11-A2 [GAC]	[green]	NS	[green]	NS	Biannually (Mar & Sept)
RFR-12	NS	NS	NS	NS	15 month
RFR-14	NS	NS	NS	NS	15 month

[red] VOCs detected are greater than 90% of the MCL. Sample monthly; quarterly after GAC installation.

[orange] VOCs detected are greater than 80% of the MCL. The well will be placed on a monthly sampling schedule until GAC installation then quarterly sampling after GAC installation.

[yellow] VOCs detected are less than 80% of the MCL (<4.0 ppb and >0.06 ppb for PCE & <4.0 ppb >0.05 ppb for TCE). After four quarters of stable results the well can be removed from quarterly sampling.

[green] No VOCs detected. Sample on an as needed basis.

[lavender / GAC] This well has a GAC filtration unit installed by CSSA. Post GAC samples are collected every six months.
A1 - after GAC canister #1
A2 - after GAC canister #2

NS — Not sampled for that event.

NA — Not applicable, sample could not be collected due to pump outage or well access conflict.

LTMO has excluded the following wells from the program:

- -Dec. 2015: BSR-03, FO-8, FO-17, FO-22, HS-2, HS-3, I10-5, I10-7, JW-6, JW-9, JW-12, JW-13, JW-14, JW-15, JW-26, JW-27, JW-28, JW-29, JW-30, JW-31, OW-HH1, OW-CE1, OW-MT2, OW-DAIRYWELL, OW-HH3, RFR-3, RFR-4, RFR-5, RFR-8, RFR-9, RFR-13, SLD-01, and SLD-02. OW-HH3, RFR-3, RFR-4, RFR-5, RFR-8, RFR-9, RFR-13, SLD-01, and SLD-02.
- -Sept. 2016: JW-5, OW-HH2, and OW-BARNOWL.
- -Sept. 2017: BSR-04 and HS-1.
- -Mar. 2019: JW-20.

The following wells have been plugged and abandoned: I10-4, I10-9, LS-1, LS-4, OFR-1,

Table 2.9
2021 Off-Post Groundwater COCs Analytical Results

Well ID	Sample Date	Laboratory	*cis*-1,2-DCE (ug/L)	PCE (ug/L)	TCE (ug/L)
LS-5	3/1/2021	APPL	--	**1.01F**	**3.99**
	6/2/2021	APPL	--	**1.07F**	**4.21**
	9/1/2021	APPL	--	**1.24F**	**4.04**
	12/1/2021	ETA	--	**1.17**	**3.67**
LS-5-A2	3/1/2021	APPL	--	--	--
	4/5/2021	APPL	--	--	--
Duplicate	4/5/2021	APPL	--	--	--
	9/1/2021	APPL	--	--	--
	10/27/2021	APPL	--	--	--
LS-6	6/2/2021	APPL	--	**0.51F**	--
	9/1/2021	APPL	--	**0.99F**	**0.23F**
	12/1/2021	ETA	--	**1.01**	**0.792J**
LS-6-A2	4/5/2021	APPL	--	--	--
	9/1/2021	APPL	**0.16F**	--	--
	10/27/2021	APPL	--	--	--
Duplicate	10/27/2021	APPL	--	--	--
LS-7	3/1/2021	APPL	--	**1.61**	--
	6/2/2021	APPL	--	**0.65F**	--
	9/1/2021	APPL	--	**0.95F**	--
	12/1/2021	ETA	--	**0.991J**	**0.82J**
LS-7-A2	3/1/2021	APPL	--	--	--
	4/5/2021	APPL	--	--	--
	9/1/2021	APPL	--	--	--
	10/27/2021	APPL	--	--	--
OFR-3	3/1/2021	APPL	--	**4.25**	**2.38**
	6/2/2021	APPL	--	**4.50**	**3.26**
	9/1/2021	APPL	--	**5.50**	**3.31**
Duplicate	9/1/2021	APPL	--	**4.77**	**3.44**
	12/1/2021	ETA	--	**4.68**	**3.17**
OFR-3-A2	3/1/2021	APPL	--	--	--
	4/5/2021	APPL	--	--	--
	9/1/2021	APPL	--	--	--
	10/27/2021	APPL	--	--	--
RFR-10	3/1/2021	APPL	--	**6.12**	**1.71**
	6/2/2021	APPL	--	**6.30**	**4.93**
Duplicate	6/2/2021	APPL	--	**6.13**	**5.12**
	9/1/2021	APPL	--	**8.13**	**4.34**
	12/1/2021	ETA	--	**10.50**	**5.62**
RFR-10-A2	3/1/2021	APPL	--	--	--
Duplicate	3/1/2021	APPL	--	--	--
	4/5/2021	APPL	--	--	--
	9/1/2021	APPL	--	--	--
	10/27/2021	APPL	--	--	--
RFR-10-B2	3/1/2021	APPL	--	--	--
	4/5/2021	APPL	--	--	--
	9/1/2021	APPL	--	--	--
	10/27/2021	APPL	--	--	--
RFR-11	3/1/2021	APPL	--	--	**2.55**
	6/2/2021	APPL	--	**1.61**	--
	9/1/2021	APPL	--	**1.69**	**0.76F**
	12/1/2021	ETA	--	**1.49**	**1.3**
RFR-11-A2	3/1/2021	APPL	--	--	--
	4/5/2021	APPL	--	--	--
	9/1/2021	APPL	--	--	--
	10/27/2021	APPL	--	--	--
Comparison Criteria					
Maximum Contaminant Level (MCL)			70	5.0	5.0
APPL Reporting Limit (RL)			1.2	1.4	1.0
ETA Limit of Quantitation (LOQ)			1.0	1.0	1.0
Method Detection Limit (MDL)			0.07	0.06	0.05
ETA Detection Limit (DL)			0.15	0.20	0.16

Bold (red)	Value ≥ MCL
Bold (blue)	MCL > Value ≥ RL/LOQ
Bold	RL > Value > MDL/DL

Samples analyzed by APPL, Inc. used method SW8260B.
Samples analyzed by ETA used method SW8260C.
VOC data reported in ug/L & metals data reported in mg/L.

Table 2.9
2021 Off-Post Groundwater COCs Analytical Results

Well ID	Sample Date	Laboratory	*cis*-1,2-DCE (ug/L)	PCE (ug/L)	TCE (ug/L)

Abbreviations/Notes:

µg/L	micrograms per liter
mg/L	milligrams per liter
Duplicate	Field Duplicate
TCE	Trichloroethene
PCE	Tetrachloroethene
DCE	Dichloroethene

Data Qualifiers

NA = Analyte not analyzed

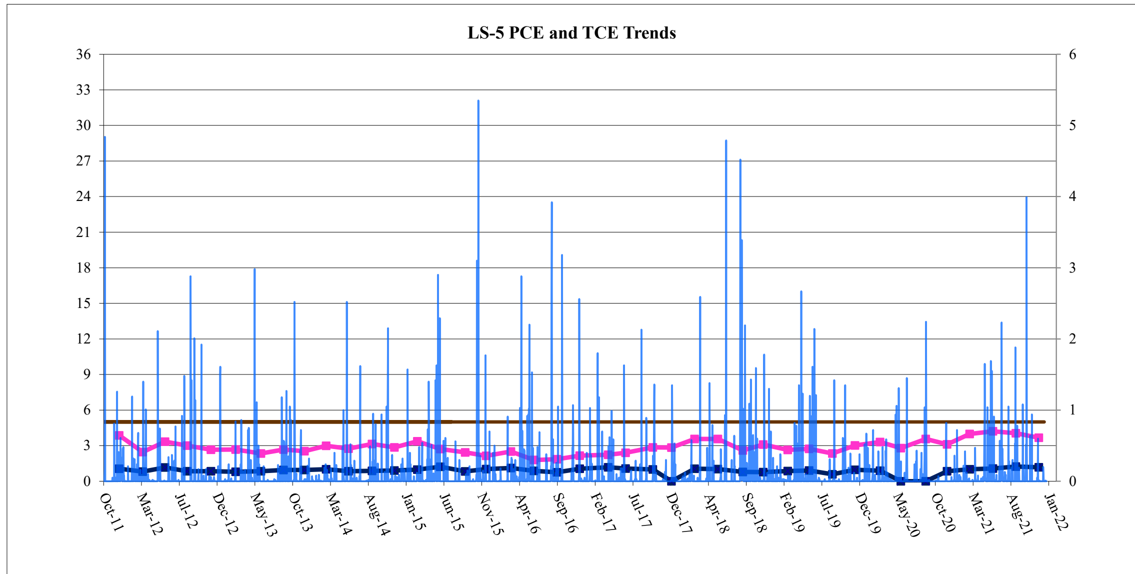
-- The analyte was analyzed for, but not detected. The associated numerical value is at or below The MDL/DL.

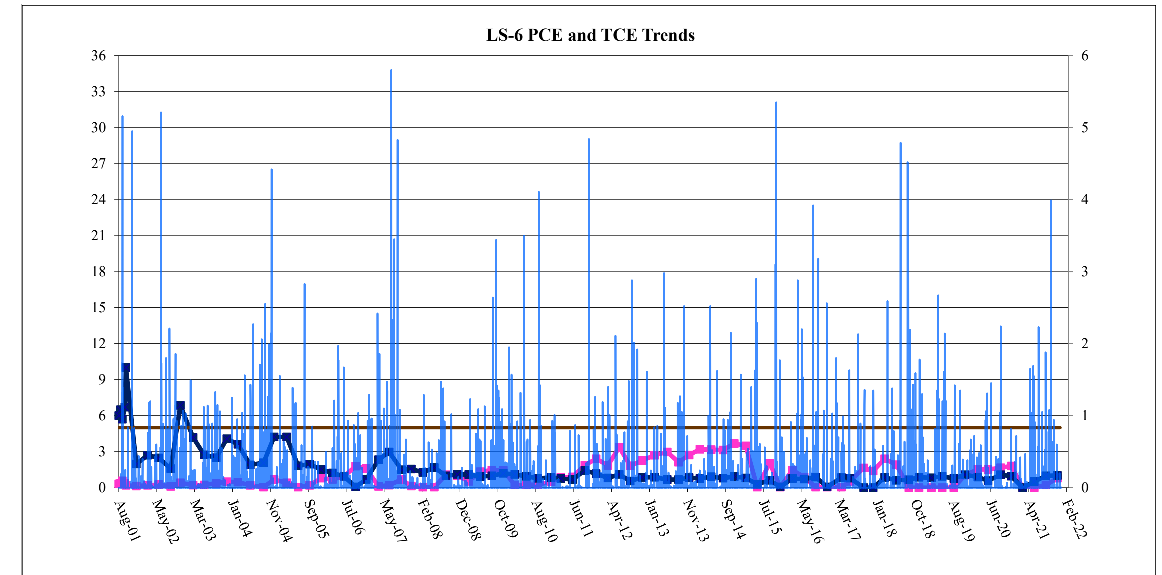
Q - One or more quality control criteria failed.

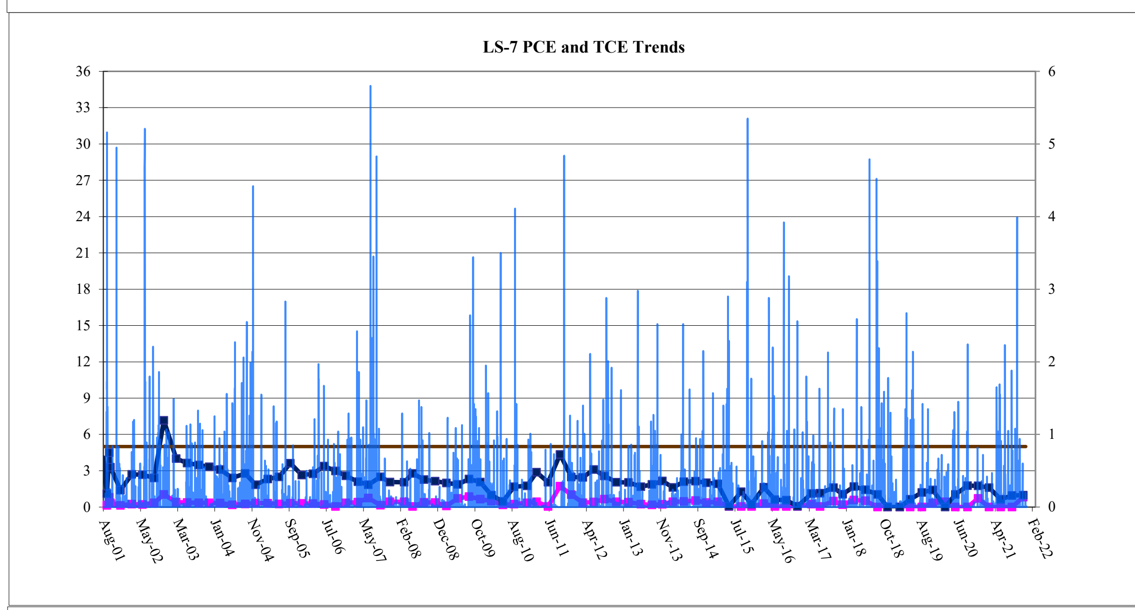
F-The analyte was positively identified but the associated numerical value is below the RL.

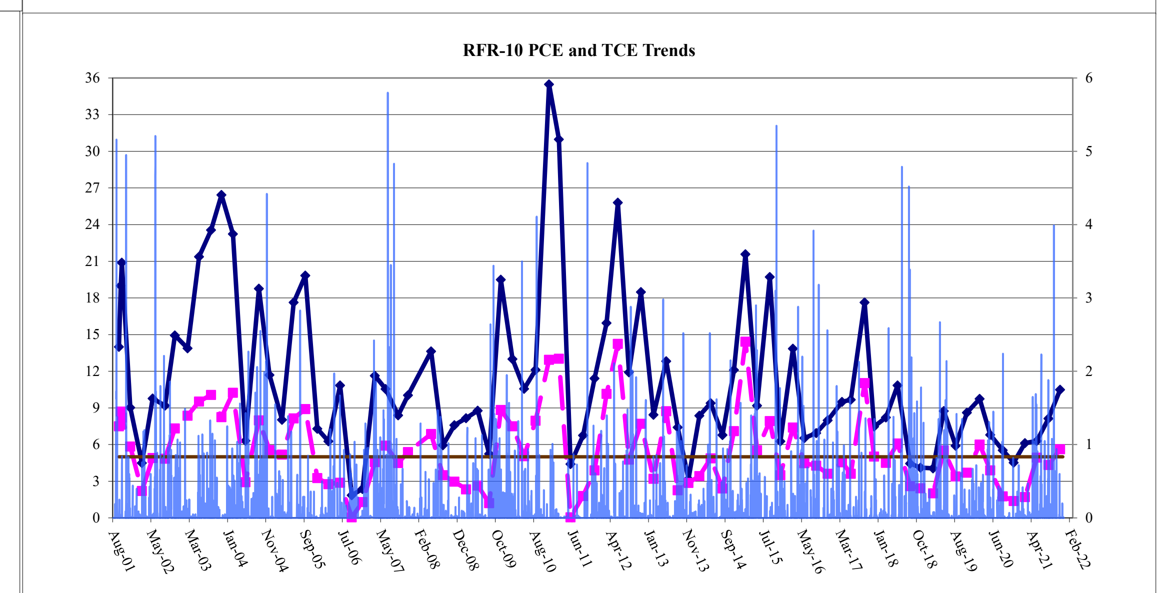
J - Estimated: The analyte was postively identified; the quantitation is an estimation.

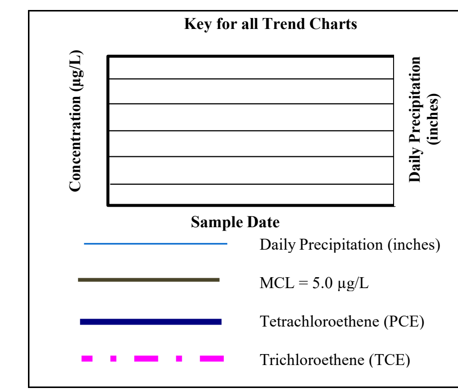
Figure 2.5
PCE and TCE Concentration Trends and Precipitation

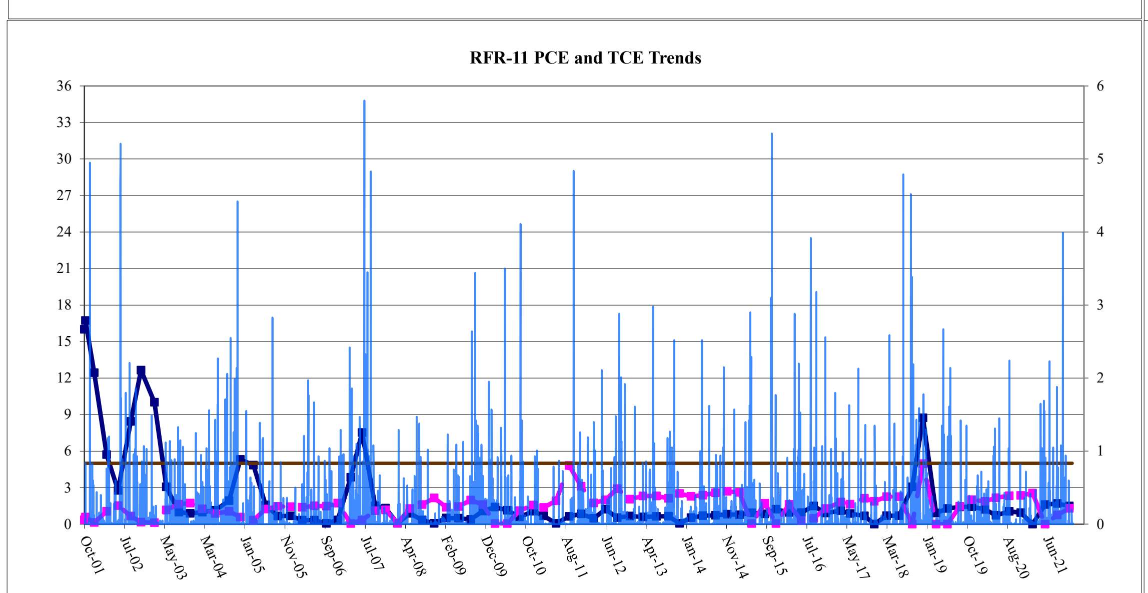












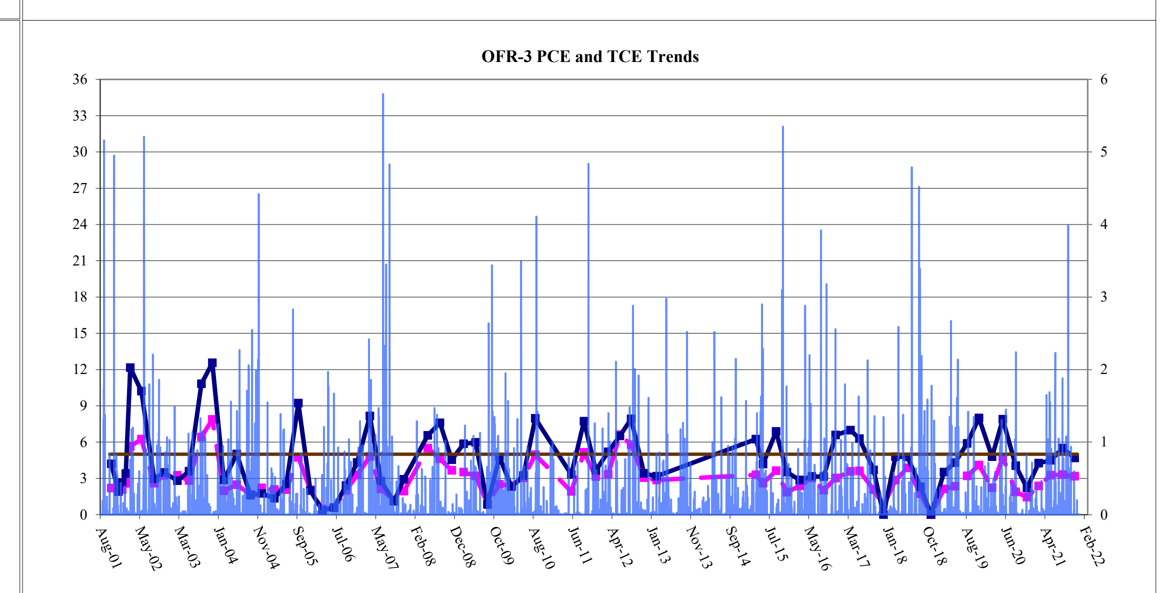
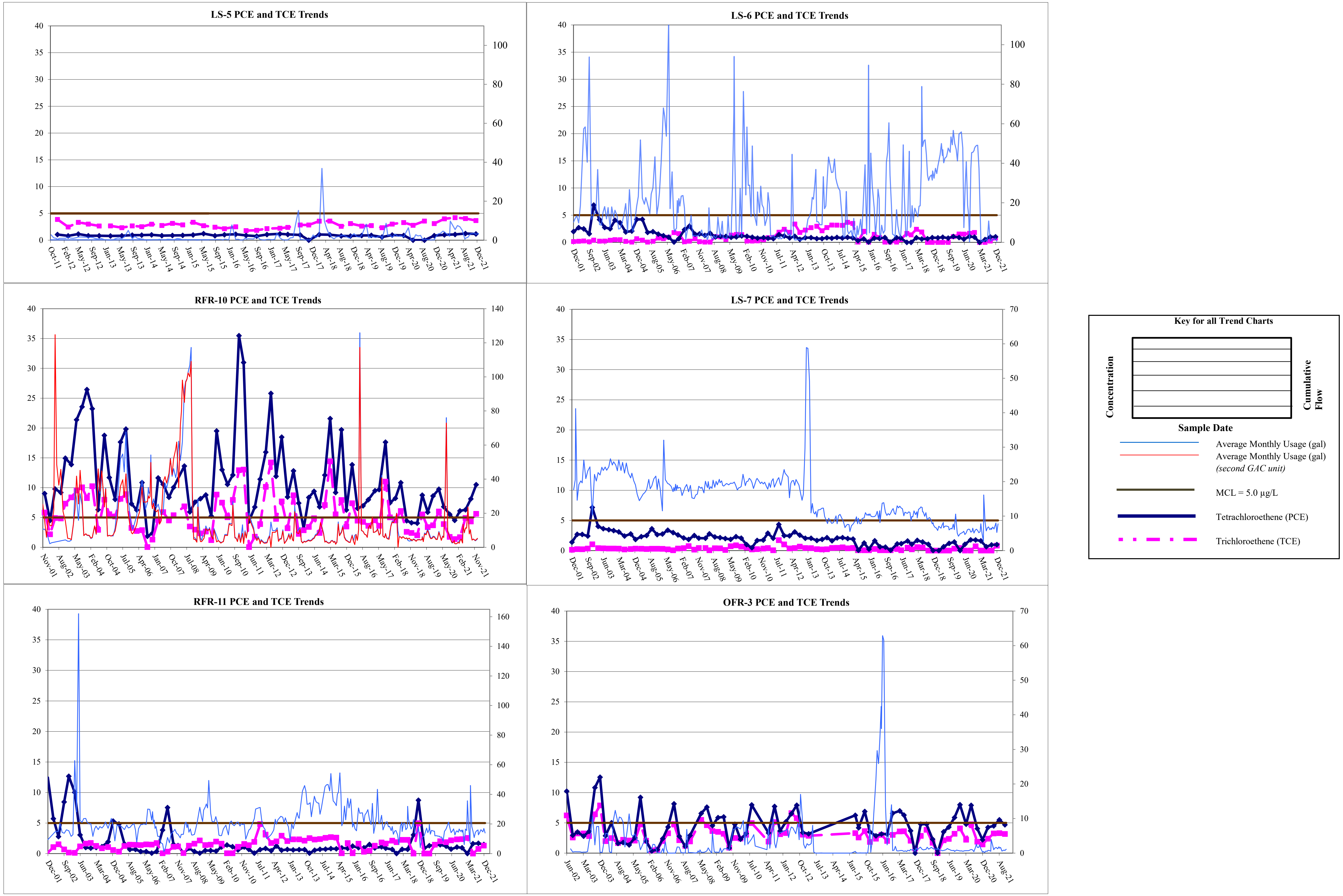


Figure 2.6
PCE and TCE Concentration Trends and Monthly Water Usage



2.2.2.1 Off-Post Wells with COC Detections above the MCL

During 2021, off-post wells RFR-10 and OFR-3 had raw water (pre-GAC) concentrations exceeding the MCL. Well RFR-10 concentrations exceeded the MCL for PCE during all four sampling events in 2021 and TCE also exceeded the MCL during the June and December events. Well OFR-3 exceeded the MCL for PCE during the September event. An evaluation of concentration trends through 2021 are included in **Figures 2.5 and 2.6**.

2.2.2.2 GAC Filtration Systems

All off-post drinking water wells that historically exceeded or approached their MCLs have already been equipped with GAC filtration systems. These wells, and the date the filtration system was installed, are listed in **Table 2.10**. CSSA maintains and operates these GAC filtration systems at no cost or inconvenience to the well owners.

Table 2.10 GAC Filtration Systems Installed

Well	Date Installed
LS-6	August 2001
LS-7	August 2001
OFR-3	April 2002
RFR-10	October 2001
RFR-11	October 2001
LS-5	October 2011

Semi-annual post-GAC confirmation samples are collected from all wells equipped with GAC filtration systems (**Appendix E**). The samples confirm that the GAC filtration systems are working effectively and that VOCs are reduced to concentrations below the applicable drinking water MCLs. Sample LS-6-A2 did report a trace detection of *cis*-1,2-DCE in September 2021. Because this trace detection (0.16 ppb) is only slightly above the laboratory's method detection limit for *cis*-1,2-DCE (0.07 ppb), and also because no *cis*-1,2-DCE was detected in the sample from well LS-6 prior to entry into the GAC filtration system, the presence of *cis*-1,2-DCE at the reported value is uncertain and questionable. The follow up post-GAC (LS-6-A2) sampling conducted on 10/27/21 after the carbon exchange indicated no detectable PCE, TCE, or *cis*-1,2-DCE.

Regular GAC maintenance/inspection occurs every 3 weeks. This task includes changing pre-GAC and post-GAC particulate filters and troubleshooting problems occurring with the systems. On April 1 and October 27, 2021, the carbon in the GAC filtration systems (LS-5, LS-6, LS-7, RFR-10, OFR-3, and RFR-11) was changed out along with other routine maintenance.

2.2.2.3 Off-Post Wells with COC Detections below the MCL

Detections from all wells sampled off-post are presented in **Table 2.9** and complete 2021 results are included in **Appendix E**. The groundwater monitoring results include wells where COCs were detected at levels below applicable MCLs. These detections occurred in wells LS-

5, LS-6, LS-7, and RFR-11. The detections below the MCL and above the RL are summarized as follows:

- **LS-5** – Concentration of TCE exceeded the RL in March, June, September, and December 2021. PCE was also detected above the RL in December and below the RL in March, June, and September sampling events. This well is equipped with a GAC filtration system.
- **LS-6** – Concentrations of PCE were above the RL in December and below the RL in June and September 2021. TCE was also detected in the September and December sampling events but below the RL. Samples were not collected in March due to the well being offline for repairs. This well is equipped with a GAC filtration system.
- **LS-7** – Concentrations of PCE exceeded the RL in March 2021 and was below the RL in June, September, and December. Concentrations of TCE were also present in December but below the RL. This well is equipped with a GAC filtration system.
- **RFR-11** – Concentrations of TCE were above the RL during the March and December sampling events. PCE was also detected above the RL in June, September, and December. This well is equipped with a GAC filtration system.

2.2.3 Isoconcentration Mapping

2.2.3.1 PCE, TCE, and cis-1,2-DCE

In annual reports prior to 2010, the maximum concentration detected during any quarterly event in the LGR wells (on-post and off-post) were contoured into isoconcentration contour maps for PCE, TCE, and *cis*-1,2-DCE. The reason for creating these "composite" maps resulted from the LTMO sampling frequency enacted in 2005. No single quarterly event included all of the wells in the sampling program. The LTMO program was updated in 2010 to include a "snapshot" sampling event in which all on- and off-post wells were sampled during the same event. These snapshot events began in September 2010 and occurred every 9 months. The 2015 update to the LTMO provides for a complete snapshot every 30 months with less inclusive events occurring every 15 months. The transition to the 2015 LTMO schedule began in late 2015 and was fully implemented in June of 2017 with the completion of the first 30-month snapshot event. The LTMO program was updated again in 2020, however the 15 or 30-month sampling frequencies were retained. Results from the December 2020 15-month event were utilized in generating the most recent plume isoconcentration contour maps and were presented in the *2020 Annual Groundwater Report*. As no 15- or 30-month sampling event occurred in 2021, no new isoconcentration contour maps are presented.

Another development in the representation of contamination in groundwater came in March 2012. At the direction of the USEPA (**Appendix I**), isoconcentration maps depicting groundwater contamination will no longer present isoconcentration contour lines below the laboratory RL, which is considered quantifiable data. Trace detections of contamination (F-flagged) data reported by the lab are considered qualitative results and therefore are not suitable for demonstrating the extent of contaminant plumes. Results below the RL are still presented on the maps but are not contained within an isoconcentration contour line. For the compounds reported, the RL (and lowest isoconcentration line) are as follows: *cis*-1,2-DCE (1.2 µg/L), PCE (1.4 µg/L), and TCE (1.0 µg/L).

To better represent the plume source areas, data from the Westbay® wells were composited into the isoconcentration maps. Previously, only data from the deepest LGR zone were included in the isoconcentration maps, though, these data do not reflect the range of VOC concentrations observed in all zones within the LGR at each well. In Westbay® wells CS-WB01 through CS-WB03 there are nine discrete sampling zones within the LGR and ten LGR zones in CS-WB04. Utilizing the highest concentration observed from any of the LGR zones in a single Westbay® well is a more conservative approach to defining plume geometries. As an example, WB03 is located near the suspected source area at AOC-65. Typically, the PCE concentrations observed in the lowest zone (LGR-09) is less than 5 ppb (below the MCL), while zones LGR-05, -04, -02, and -01 all indicate the presence of PCE at or above the MCL.

All zones of Westbay® wells 01 through 04 have been incorporated in the groundwater monitoring program and are sampled according to the recommendations from the latest LTMO and all LGR zones are scheduled to be sampled in March 2022. Data from these samples will be reviewed, and the highest concentrations recorded for each well will be included in the isoconcentration contour maps to delineate Plume 2. The inclusion of data from zones other than LGR-09 does not appreciably affect the overall plume footprint, though it does help define the core of the plume. The bioreactor extraction wells EXW-01 through EXW-05 and CS-MW16-LGR and Westbay® wells CS-WB05 through CS-WB08 are similarly scheduled for sampling in March 2022 as part of the SWMU B-3 Bioreactor operations and the subsequent sampling results will be used to delineate the central portion of Plume 1.

Isoconcentration maps have also been prepared based on analytical data collected in 2006 through 2020. Those isoconcentration maps are available for review in the ***CSSA Environmental Encyclopedia, Volume 5 Groundwater***, in the *2006* through *2020 Annual Groundwater Reports*. In general, the most recent (2020) plume extent is consistent with previous (2019) data and plume geometries have changed little since the inclusion of the highest recorded concentrations in Westbay® well LGR zones. These data, having been previously included in the *2020 Annual Groundwater Report,* are presented in **Table 2.11** for completeness.

Table 2.11 Comparison of 2019 & 2020 PCE, TCE, and cis-1,2-DCE Max. Levels

	PCE		TCE		cis-DCE	
	2019	2020	2019	2020	2019	2020
B-3 Plume 1						
CS-EXW01	80.59	14.85	90.36	26.81	111.63	171.46J
CS-D	6.48	NS	9.03	NS	5.86	NS
CS-MW1-LGR	14.27	12.99	29.16	15.40	19.63	16.25
CS-MW5-LGR	2.67	0.66F	8.29	0.47F	10.77	2.09
AOC-65 Plume 2						
RFR-10	8.75	4.52	5.52	1.39	0.44	ND
CS-MW36-LGR	9.09	27.06	10.25	44.14	0.28	1.14F
CS-WB02-LGR-09	5.44	6.07	5.18	6.19	ND	0.08F
CS-WB03-UGR-01	23,894	7,625	ND	270.31	ND	21.75

3.0 GROUNDWATER MONITORING PROGRAM CHANGES

3.1 Access Agreements Obtained in 2021

Access agreements are signed by off-post well owners to grant permission to CSSA to collect groundwater samples from each well. Most of our off-post access agreements were renewed in 2020. The agreement for well JW-7 was received March 4,2021. Outstanding agreements remain for FO-J1 and I10-8. CSSA was informed that the ownership of well FO-J1 is in litigation and we should refrain from sampling until this is cleared up. Additional attempts to retain an agreement from I10-8 will resume, this well is scheduled to be sampled in March 2022.

3.2 Wells Added to or Removed from Program

Based on the 2020 update to the LTMO study and DQO's for the groundwater monitoring program wells can be excluded from the program based on their history of non-detects. No wells met this criterion in 2021.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation of the on- and off-post groundwater monitoring program data collected in 2021, the following conclusions and recommendations can be made:

- The four current CSSA drinking water wells had no VOC or metals detections above the MCL, SS, or AL in 2021 (**Table 2.5**).
- PFAS sampling was conducted in October 2021. Results indicated no contaminant was detected above the regulatory standard (**Table 2.6**).
- Westbay® samples were not collected in 2021. The Westbay® wells at AOC-65 continue to indicate the strong presence of contamination near the source area (CS-WB03). Significant contamination above the MCLs continues to exist near-surface and in the lower-yielding upper strata of the aquifer. The concentrations in the upper WB03-UGR-01 zone increased significantly in September 2012, likely due to the ISCO injection into the AOC-65 trench performed in August 2012. In May-June 2013, a larger scale ISCO injection was performed and the levels in this upper zone remained elevated. In September-October 2014, an even larger ISCO injection was performed and the VOC concentrations showed a steep decline in some intervals of the aquifer by December 2014. From August-September 2015 a smaller injection was performed using permanganate and injecting into newly installed infiltration cells in the road west of Building 90. This in turn significantly increased concentration in the upper WB03-UGR-01 zone. In December 2016 permanganate paraffin wax cylinders were installed in 6 select wells at AOC-65. The cylinders are infused with solid permanganate crystals which allow the permanganate to be released passively. This method allows permanganate treatment of groundwater under various (flood or drought) conditions. The 2017 and 2018 results indicate contamination levels remain steady. In October 2018 four additional candles were added to select wells. In 2019 a small injection of liquid permanganate was performed in IIWs and infiltration cells. Cylinders were exchanged in 2020 in the 10 selected wells and were adjusted quarterly to ensure treatment of over the length of the water column in each well. In June 2021, another liquid permanganate injection was performed at both interior and exterior infiltration cells and IIWs. Future sampling results will determine the effectiveness of slow-release and injection treatments. In most cases throughout the post, VOC contamination in the main portion of aquifer remains at concentrations below the MCLs.
- Off-post wells OFR-3 and RFR-10 exceeded the MCL for PCE and/or TCE in 2021. Wells OFR-3, RFR-10, LS-5, LS-6, LS-7, and RFR-11, are equipped with a GAC filtration systems and should remain on the quarterly sampling schedule in the future. The GAC filtration systems will continue to be maintained by CSSA.
- **Figure 2.5** shows VOC concentrations in RFR-10 and OFR-3 are very sensitive to rainfall events while VOC concentrations in LS-5, LS-6, LS-7; and RFR-11 show less fluctuations after significant precipitation. This observation suggests RFR-10 and OFR-3 may be located along a fracture pattern that ties into the AOC-65 source area.

5.0 REFERENCES

CSSA 2002. *CSSA Quality Assurance Program Plan*.

CSSA 2002a. *Off-Post Monitoring Program and Response Plan*.

CSSA 2008. *CSSA Environmental Encyclopedia*, www.stanley.army.mil

Parsons 2001. *Offsite Well Survey Report*.

Parsons 2005. *Three-Tiered Long Term Monitoring Network Optimization Evaluation.*

Parsons 2006. *Data Quality Objectives for the Groundwater Monitoring Program.*

Parsons 2010. *Updated Off-Post Well Survey Report*.

Parsons 2016a. *Data Quality Objectives for the Groundwater Monitoring Program. Revised January 2016.*

Parsons 2016b. *2015 Update: Three-Tiered Long Term Monitoring Network Optimization Evaluation.*

Parsons 2020. *2020 Update: Three-Tiered Long Term Monitoring Network Optimization Evaluation.*

Parsons 2020. *Data Quality Objectives for the Groundwater Monitoring Program. Revised April 2020.*

NOAA, National Weather Service Forecast, Monthly/Annual/Average Precipitation Boerne and San Antonio (KSAT), Texas (1989 - 2021), http://nowdata.rcc-acis.org/ewx/

APPENDIX A

EVALUATION OF DATA QUALITY OBJECTIVES ATTAINMENT

ON-POST AND OFF-POST

Appendix A. On-Post Evaluation of Data Quality Objectives Attainment

Activity	Objectives	Action	Objective Attained?	Recommendations
Field Sampling	Conduct field sampling in accordance with procedures defined in the project work plan, SAP, QAPP, and HSP.	All sampling was conducted in accordance with the procedures described in the project plans.	Yes.	NA
Characterization of Environmental Setting (Hydrogeology)	Prepare water-level contour and/or potentiometric maps for each formation of the Middle Trinity Aquifer (3.5.3).	Potentiometric surface maps were prepared based on water levels measured in each of CSSA's wells screened in three formations in 2021.	To the extent possible with data available. Due to the limited data available and the fact that wells are completed across multiple water-bearing units, potentiometric maps should only be used for regional water flow direction, not local. Ongoing pumping in the CSSA area likely affects the natural groundwater flow direction.	As additional wells are installed screened in distinct formations, future evaluations will eliminate reliance on wells screened across multiple formations.
	Describe the flow system, including the vertical and horizontal components of flow (2.1.9).	Potentiometric maps were created using 2021 water level data, and horizontal flow direction was tentatively identified. Insufficient data are currently available to determine vertical component of flow.	As described above, due to the lack of aquifer-specific water level information, potentiometric surface maps should only be used as an estimate of regional flow direction.	Same as above.
	Define formation(s) in the Middle Trinity Aquifer are impacted by the VOC contaminants (2.1.3).	Quarterly groundwater monitoring provides information on Middle Trinity Aquifer impacts. Monitoring wells equipped with Westbay® - multi-port samplers are sampled by zone, the LGR, BS, and CC zones are sampled every 15 months and select LGR zones are sampled every 30 months. Selected zones from these wells were sampled in 2021.	Yes.	Continue sampling.

Activity	Objectives	Action	Objective Attained?	Recommendations
	Identify any temporal changes in hydraulic gradients due to seasonal influences (2.1.5).	Downloaded data from continuous-reading transducer in wells: CS-MW4-LGR, CS-MW9-LGR, CS-MW12-LGR, CS-MW12-CC, and CS-MW8-CC. Data was also downloaded from the northern and southern continuous-reading weather stations B-3 WS and AOC-65 WS. Water levels will be graphed from selected wells against precipitation through 2021 and will be included in this annual groundwater report.	Yes.	Continue collection of transducer data and possibly install transducers in other cluster wells.
Contamination Characterization (Groundwater Contamination)	Characterize the horizontal and vertical extent of any immiscible or dissolved plume(s) originating from the Facility (3.1.2).	Samples for laboratory analysis were collected from 4 of 48 CSSA wells. All 16 samples scheduled to be collected in 2021 were collected.	The horizontal and vertical extent of groundwater contamination is continuously monitored.	Continue groundwater monitoring and construct additional wells as necessary.
	Determine the horizontal and vertical concentration profiles of all constituents of concern (COCs) in the groundwater that are measured by USEPA-approved procedures (3.1.2). COCs are those chemicals that have been detected in groundwater in the past and their daughter (breakdown) products.	Samples were analyzed for the selected VOCs using USEPA method SW8260B. Drinking water wells were also sampled for metals (As, Ba, Cr, Cu, Cd, Hg, Pb, Zn). Analyses were conducted in accordance with the AFCEE QAPP and approved variances. All RLs were below MCLs, as listed below: **ANALYTE** / **RL (µg/L)** / **MCL (µg/L)** *cis*-1,2-DCE / 1.2 / 70 Vinyl Chloride / 1.1 / 2 PCE / 1.4 / 5 TCE / 1.0 / 5	Yes.	Continue sampling.

Activity	Objectives	Action	Objective Attained?	Recommendations
Contamination Characterization (Groundwater Contamination) (Continued)		**ANALYTE** / **RL (µg/L)** / **MCL (µg/L)** Arsenic 30 10 Barium 5 2000 Chromium 10 100 Copper 10 1300 (AL) Zinc 50 5000 (SS) Cadmium 7 5 Lead 25 15 (AL) Mercury 1 2		
	Meet AFCEE QAPP quality assurance requirements.	Samples were analyzed in accordance with the CSSA QAPP and approved variances. Parsons chemists verified all data and performed data validation according to the CSSA QAPP and approved variances.	Yes.	NA
		All data flagged with a "U", "J", "M", and "F" are usable for characterizing contamination. All "R" flagged data are considered unusable.	Yes.	NA
		An MDL study for arsenic, cadmium, and lead was not performed within a year of the analyses, as required by the AFCEE QAPP.	The laboratory performed new MDL studies in February 2001 for these metals and the new MDL values were found to be almost identical to the previous MDLs and all met the associated AFCEE QAPP requirements. MDLs for these three metals are well below MCLs. In addition, the laboratory performed daily calibrations and RL verifications for these metals, both of which demonstrate the laboratory's ability to detect and quantitate these metals at RL levels. These daily analyses also indicate that concentrations above the laboratory RL for these compounds were not affected by the expired MDL study.	Use results for groundwater characterization purposes.

Activity	Objectives	Action	Objective Attained?	Recommendations
Remediation	Determine goals and create cost-effective and technologically appropriate methods for remediation (2.2.1).	Continued data collection will provide analytical results for accomplishing this objective.	Ongoing.	Continue sampling and evaluation, including quarterly groundwater monitoring teleconferences to address remediation.
	Determine placement of new wells for monitoring (2.3.1, 3.6)	Sampling frequency and sample locations to be monitored (including any new wells) will be based on trend data from monitoring event(s) (3.1.5).	Ongoing.	Continue quarterly groundwater teleconferences to discuss sampling frequency and placement of new monitor wells.
Project schedule/ Reporting	Produce a quarterly monitoring project schedule as a road map for sampling, analysis, validation, verification, reviews, and reports.	Prepare schedules and sampling guidelines prior to each quarterly sampling event.	Yes.	Continue sampling schedule preparation each quarter.

Appendix A Off-Post Evaluation of Data Quality Objectives Attainment

Activity	Objectives	Action	Objective Attained?	Recommendations
Field Sampling	Conduct field sampling in accordance with procedures defined in the project work plan, SAP, QAPP, and HSP.	All sampling was conducted in accordance with the procedures described in the project plans.	Yes	NA
Contamination Characterization (Groundwater Contamination)	Determine the potential extent of off-post contamination (§2.3.1 of the DQOs for the Groundwater Contamination Investigation, revised 2015).	Samples for laboratory analysis were collected from selected off-post public and private wells, which are located within a ½ mile radius of CSSA. Also, selected wells outside the ½ mile radius were sampled at the request of the EPA.	Partially	Continue sampling wells in accordance with the LTMO study recommendations. If significant changes are seen in contaminant concentrations, then consider adding wells in the vicinity back to the sampling schedule to track any plume movement.
	Meet CSSA QAPP quality assurance requirements.	Samples were analyzed in accordance with the CSSA QAPP and approved variances. Parsons chemists verified all data and performed data validation according to the CSSA QAPP and approved variances.	Yes	NA
		All data flagged with a "U", "M", and "J" are usable for characterizing contamination.	Yes	NA

Activity	Objectives	Action	Objective Attained?	Recommendations
	Evaluate CSSA monitoring program and expand as necessary (§2.3.1 of the DQOs for the Groundwater Contamination Investigation, revised 2015). Determine locations of future monitoring locations.	Evaluation of data collected is ongoing and is reported in this annual groundwater report and will be reported in future quarterly groundwater reports. Additional information covering the CSSA monitoring program is available in Volume 5, CSSA Environmental Encyclopedia.	Yes	Continue data evaluation and quarterly teleconferences for evaluation of the monitoring program. Each teleconference/planning session covers expansion of the quarterly monitoring program, if necessary.
Project schedule/ Reporting	The quarterly monitoring project schedule shall provide a schedule for sampling, analysis, validation, verification, reviews, and reports for monitoring events off-post.	A schedule for sampling, analysis, validation, verification, data review and reports are provided in this annual groundwater report and will be reported in future quarterly groundwater reports. Additional information covering the CSSA monitoring program is available in Volume 5, CSSA Environmental Encyclopedia.	Yes	Continue quarterly and annual reporting to include a schedule for sampling, analysis, validation, verification, data review and data reports.

Activity	Objectives	Action	Objective Attained?	Recommendations
Remediation	Evaluate the effectiveness of GACs (§3.2.3) and install as needed (§3.2.5 both of the DQOs for the Groundwater Contamination Investigation, revised 2015).	Perform maintenance as needed. Install new GACs as needed.	Yes	Maintenance to the off-post GAC systems to be continued by Parsons' personnel approximately every 3 weeks. Semi annual (or as needed) maintenance to the off-post GAC systems by additional subcontractors to continue. Evaluations of future sampling results for installation of new GAC systems will occur as needed.

APPENDIX B

2021 QUARTERLY ON-POST GROUNDWATER ANALYTICAL RESULTS

Appendix B
2021 Quarterly On-Post Groundwater Monitoring Analytical Results, VOCs

Well ID		Laboratory	Sample Date	*cis*-1,2 DCE (ug/L)	PCE (ug/L)	TCE (ug/L)	Vinyl chloride (ug/L)
CS-1		APPL	3/3/2021	0.07U	0.06U	0.05U	0.08U
		APPL	6/2/2021	0.07U	0.06U	0.05U	0.08U
		APPL	9/1/2021	0.07U	0.06U	0.05U	0.08U
		ETA	12/2/2021	0.150U	0.200U	0.160UQ	0.100U
	Duplicate	ETA	12/2/2021	0.150U	0.200U	0.160UQ	0.100U
CS-10		APPL	3/3/2021	0.07U	0.06U	0.05U	0.08U
		APPL	6/2/2021	0.07U	0.06U	0.05U	0.08U
		APPL	9/1/2021	0.07U	0.06U	0.05U	0.08U
		ETA	12/2/2021	0.150U	0.200U	0.160UQ	0.100U
CS-12		APPL	3/3/2021	0.07U	0.06U	0.05U	0.08U
	Duplicate	APPL	3/3/2021	0.07U	0.06U	0.05U	0.08U
		APPL	6/2/2021	0.07U	0.06U	0.05U	0.08U
		APPL	9/1/2021	0.07U	0.06U	0.05U	0.08U
	Duplicate	APPL	9/1/2021	0.07U	0.06U	0.05U	0.08U
		ETA	12/2/2021	0.15U	0.20U	0.16UQ	0.10U
CS-13		APPL	3/3/2021	0.07U	0.06U	0.05U	0.08U
		APPL	6/2/2021	0.07U	0.06U	0.05U	0.08U
		APPL	9/1/2021	0.07U	0.06U	0.05U	0.08U
		ETA	12/2/2021	0.150U	0.200U	0.160UQ	0.100U
Comparison Criteria							
Maximum Contaminant Level (MCL)				**70**	**5.0**	**5.0**	**2.0**
APPL Reporting Limit (RL)				**1.2**	**1.4**	**1.0**	**1.1**
ETA Limit of Quantitation (LOQ)				**1.0**	**1.0**	**1.0**	**1.5**
Method Detection Limit (MDL)				**0.07**	**0.06**	**0.05**	**0.08**
ETA Detection Limit (DL)				**0.15**	**0.20**	**0.16**	**0.10**

Bold (red)	Value ≥ MCL
Bold (blue)	MCL > Value ≥ RL/LOQ
Bold	RL/LOQ > Value > MDL/DL

Samples analyzed by APPL, Inc. used method SW8260B.
Samples analyzed by ETA used method SW8260C.
VOC data reported in ug/L & metals data reported in mg/L.

Abbreviations/Notes:

µg/L	micrograms per liter
mg/L	milligrams per liter
Duplicate	Field Duplicate
TCE	Trichloroethene
PCE	Tetrachloroethene
DCE	Dichloroethene

Data Qualifiers
NA = Analyte not analyzed
U-The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL/DL.
Q - One or more quality control criteria failed.
F-The analyte was positively identified but the associated numerical value is below the RL.

Appendix B
2021 Quarterly On-post Groundwater Analytical Results, Metals

Well ID	Sample Date	Laboratory	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)
CSSA Drinking Water Wells									
CS-1	3/3/2021	APPL	**0.00136F**	**0.0343**	0.0005U	0.0010U	0.003U	0.0019U	0.0001U
	6/2/2021	APPL	0.00022U	**0.0367**	0.0005U	0.0010U	**0.004F**	0.0019U	0.0001U
	9/1/2021	APPL	**0.00641F**	**0.0365**	0.0005U	0.0010U	**0.008F**	0.0019U	0.0001U
	12/2/2021	ETA	0.00033U	**0.0357Q**	0.000265U	0.000500U	**0.00685J**	0.003U	0.0000270U
Duplicate	12/2/2021	ETA	0.000330U	**0.0374Q**	0.000265U	0.000500U	**0.00207J**	0.003U	0.0000270U
CS-10	3/3/2021	APPL	**0.00265F**	**0.041**	0.0005U	0.0010U	**0.025**	**0.0056F**	0.0001U
	6/2/2021	APPL	0.00022U	**0.0388**	0.0005U	0.0010U	**0.005F**	**0.0019U**	0.0001U
	9/1/2021	APPL	**0.00430F**	**0.0389**	0.0005U	0.0010U	0.003U	0.0019U	0.0001U
	12/2/2021	ETA	0.000330U	**0.0378Q**	0.000265U	0.000500U	**0.00300**	0.003U	0.0000270U
CS-12	3/3/2021	APPL	**0.00306F**	**0.0316**	0.0005U	0.0010U	0.003U	0.0019U	0.0001U
Duplicate	3/3/2021	APPL	0.00022U	**0.0335**	0.0005U	0.0010U	0.003U	0.0019U	0.0001U
	6/2/2021	APPL	0.00022U	**0.0307**	0.0005U	0.0010U	0.003U	0.0019U	**0.001**
	9/1/2021	APPL	**0.00324F**	**0.0299**	0.0005U	0.0010U	**0.008F**	0.0019U	0.0001U
Duplicate	9/1/2021	APPL	**0.00359F**	**0.0304**	0.0005U	0.0010U	0.003U	0.0019U	0.0001U
	12/2/2021	ETA	**0.000338J**	**0.0301**	0.000265U	**0.000528J**	**0.00397**	0.003U	0.000027U
CS-13	3/3/2021	APPL	**0.00098F**	**0.0297**	0.0005U	0.0010U	**0.005F**	0.0019U	0.0001U
	6/3/2021	APPL	0.00022U	**0.0342**	0.0005U	0.0010U	**0.011**	0.0019U	0.0001U
	9/1/2021	APPL	**0.00183F**	**0.0297**	0.0005U	0.0010U	**0.004F**	0.0019U	0.0001U
	12/2/2021	ETA	**0.00104J**	**0.0301Q**	0.000265U	0.0005U	**0.0309**	0.003U	0.000027U
Comparison Criteria									
Maximum Contaminant Level (MCL)			**0.01**	**2.0**	**0.005**	**0.1**	**1.3**	**0.015 (AL)**	**0.002**
APPL Reporting Limit (RL)			**0.03**	**0.005**	**0.007**	**0.01**	**0.01**	**0.025**	**0.001**
ETA Limit of Quantitation (LOQ)			**0.005**	**0.003**	**0.001**	**0.01**	**0.002**	**0.003**	**0.002**
APPL Method Detection Limit (MDL)			**0.00022**	**0.0003**	**0.0005**	**0.001**	**0.003**	**0.0019**	**0.0001**
ETA Detection Limit (DL)			**0.00033**	**0.00029**	**0.00027**	**0.0005**	**0.00056**	**0.00018**	**0.000027**

Bold (red)	Value ≥ MCL
Bold (blue)	MCL > Value ≥ RL/LOQ
Bold	RL /LOQ> Value ≥ MDL/DL

Samples analyzed by APPL, Inc. used laboratory method EPA 6010B and SW7470A for mercury.
Samples analyzed by ETA used laboratory method EPA 6020A and SW7470A for mercury.

Appendix B
2021 Quarterly On-post Groundwater Analytical Results, Metals

Well ID	Sample Date	Laboratory	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)

VOC data reported in µg/L & metals data reported in mg/L.

Abbreviations/Notes:

µg/L	micrograms per liter
mg/L	milligrams per liter
Duplicate	Field Duplicate
AL	Action Level
SS	Secondary Standard

Data Qualifiers:

F-The analyte was positively identified but the associated numerical value is below the RL.

J - Analyte detected, concentration estimated.

Q - One or more quality control criteria failed.

M - Matrix effect present.

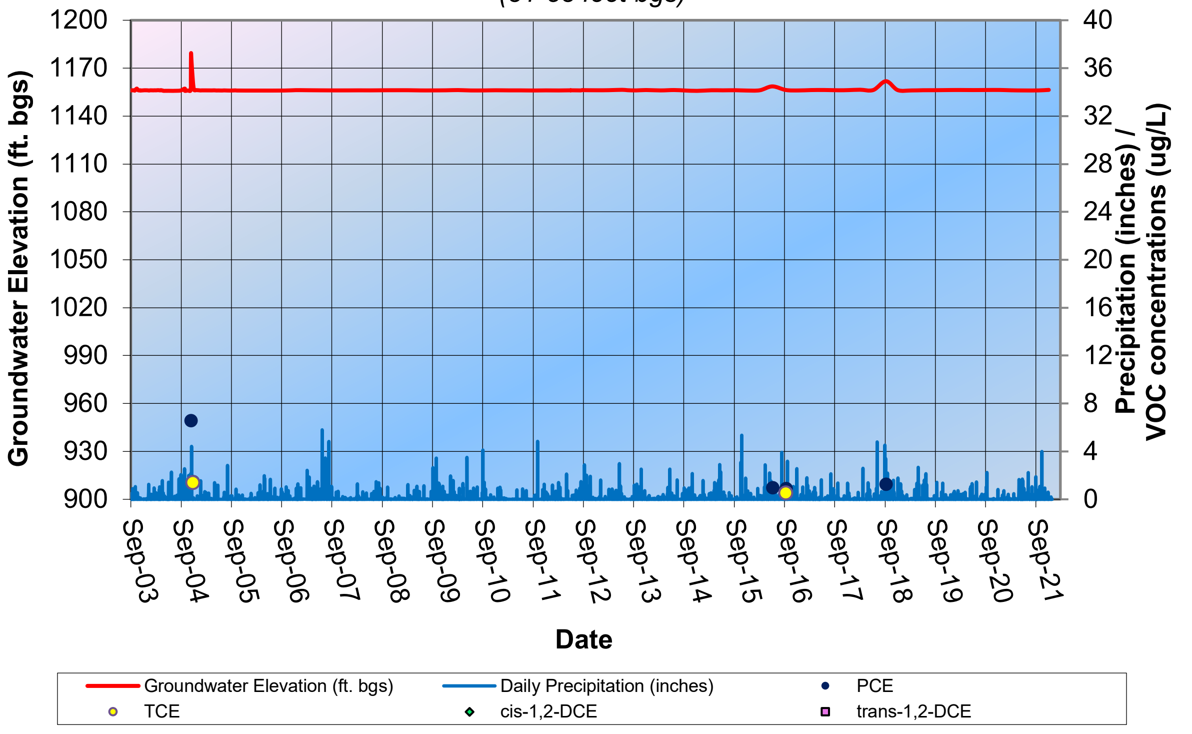
U-The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL/LOQ.

APPENDIX C

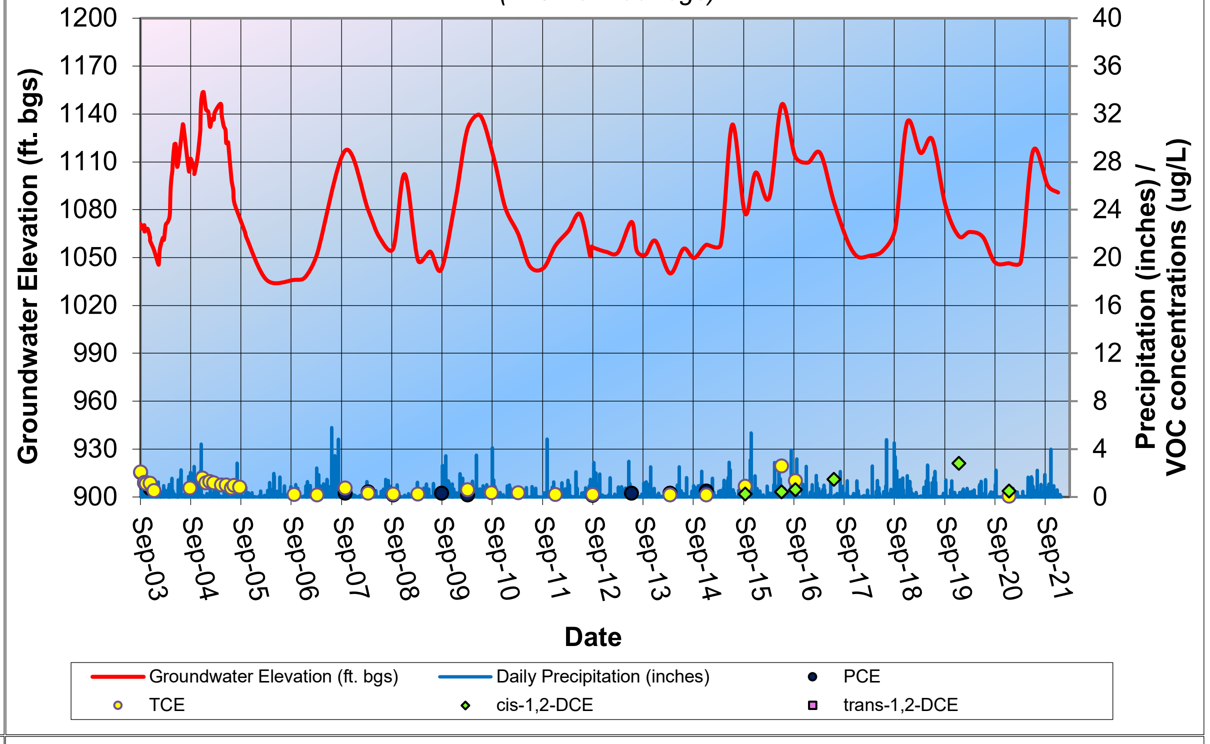
CUMULATIVE WESTBAY® ANALYTICAL GRAPHS

Appendix C.1 - CS-WB01 Culmulative VOC Concentrations, Groundwater Level, and Precipitation

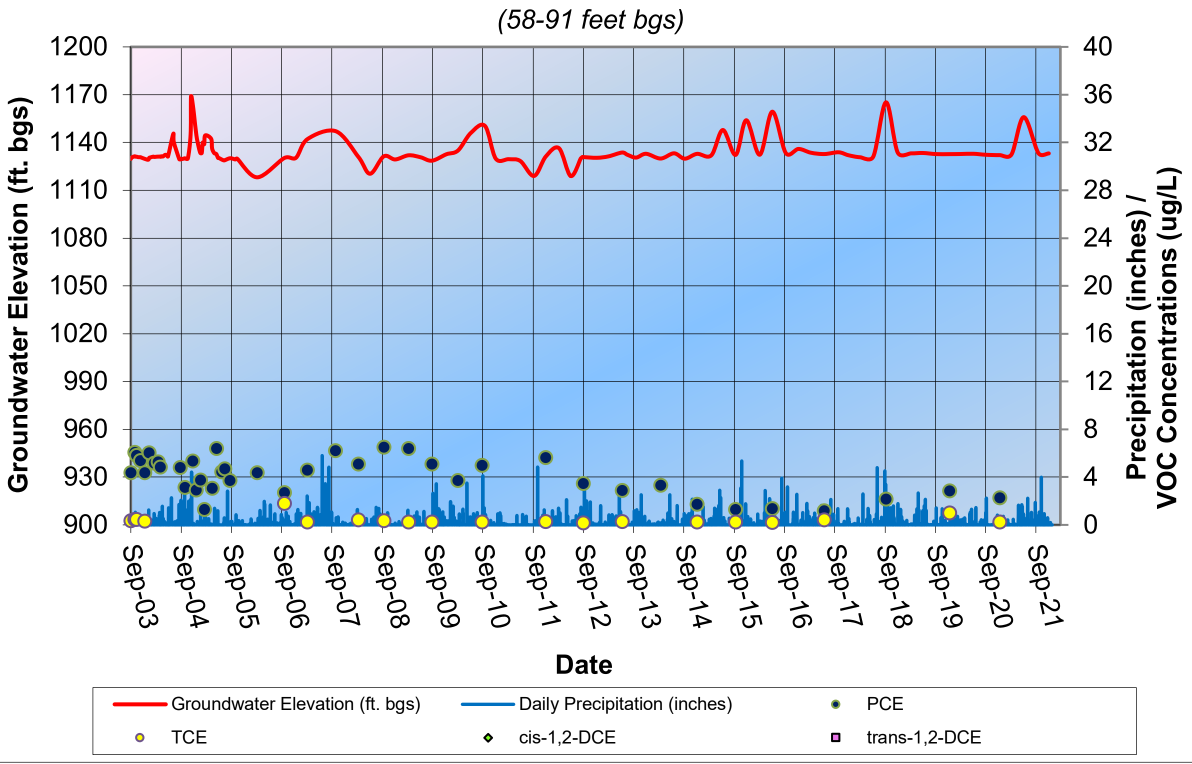
WB01-UGR01
(31-53 feet bgs)



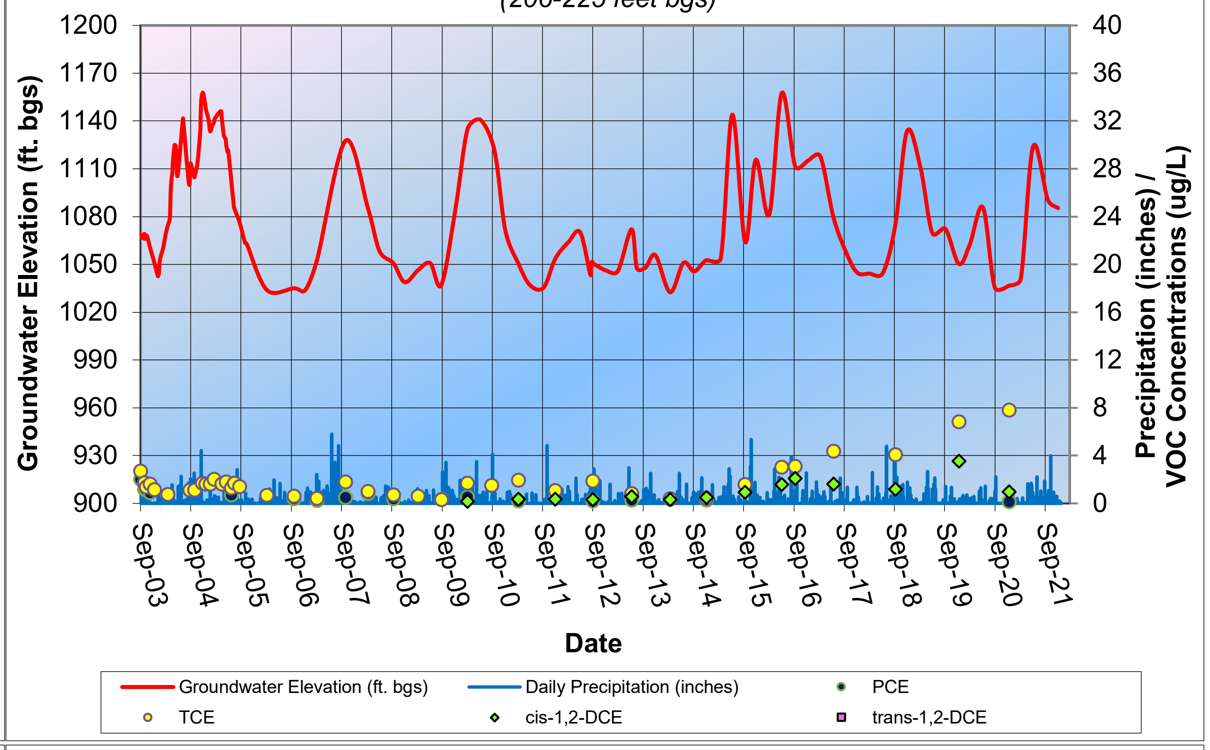
WB01-LGR05
(178-201 feet bgs)



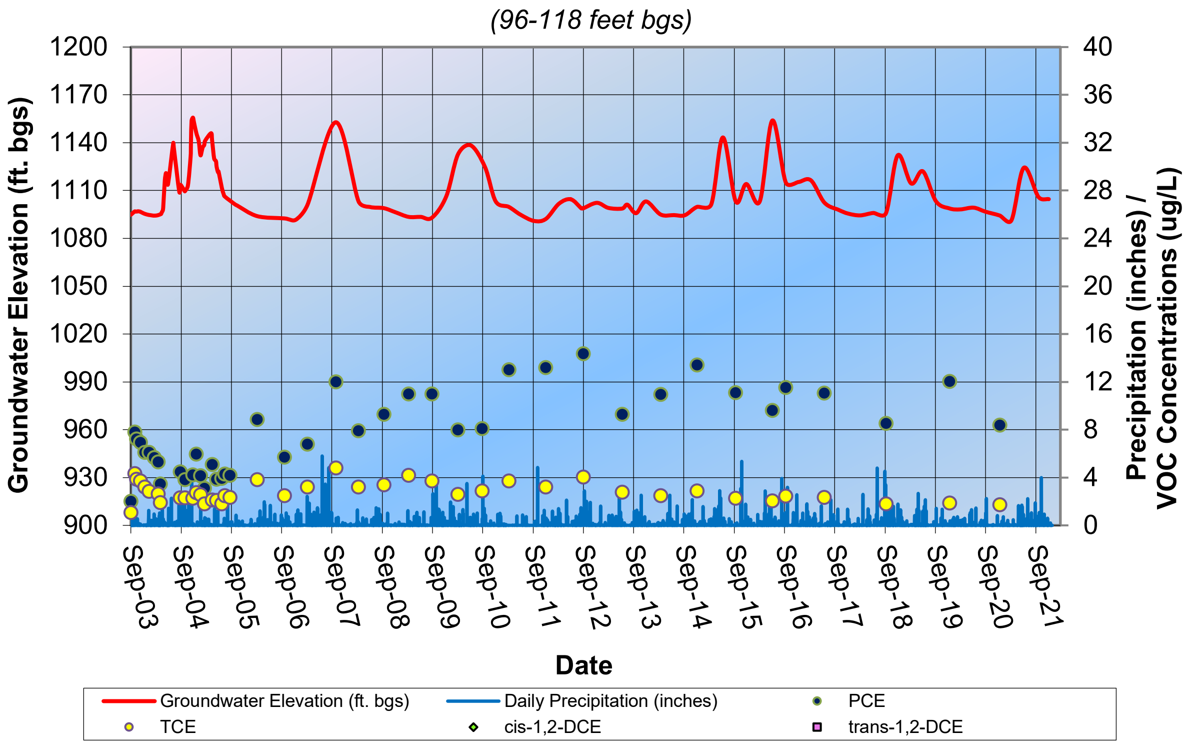
WB01-LGR01
(58-91 feet bgs)



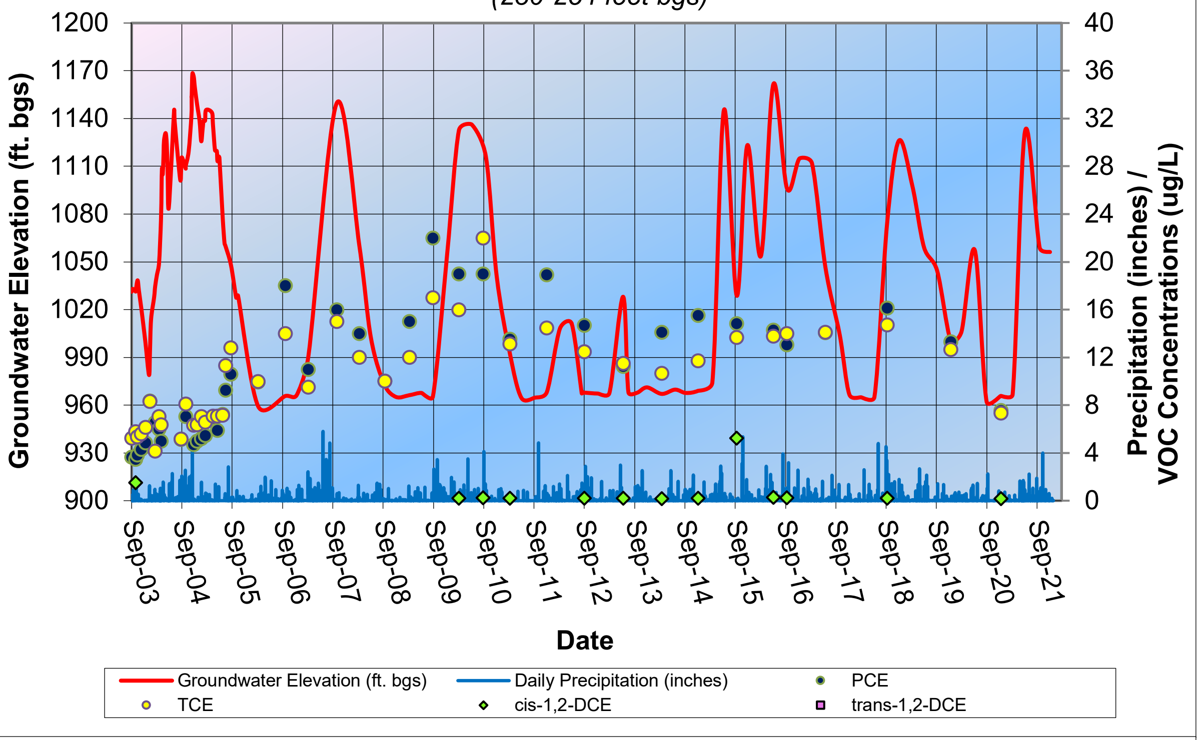
WB01-LGR06
(206-225 feet bgs)



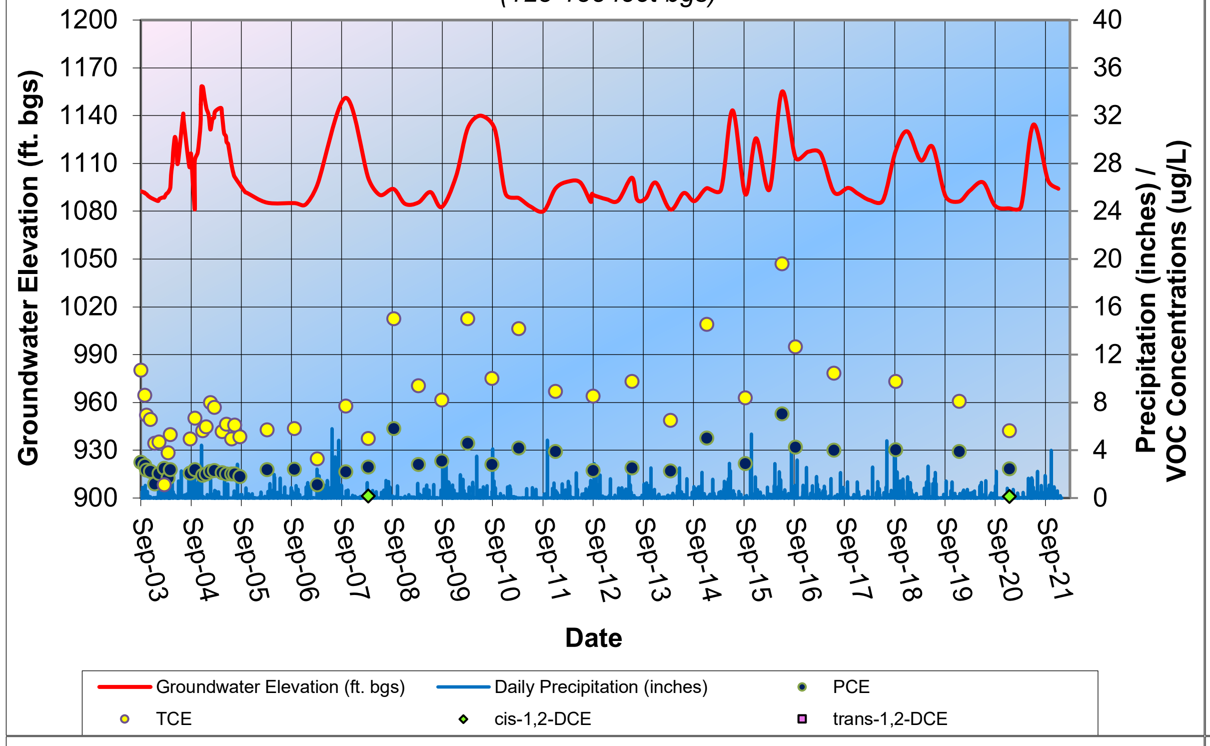
WB01-LGR02
(96-118 feet bgs)



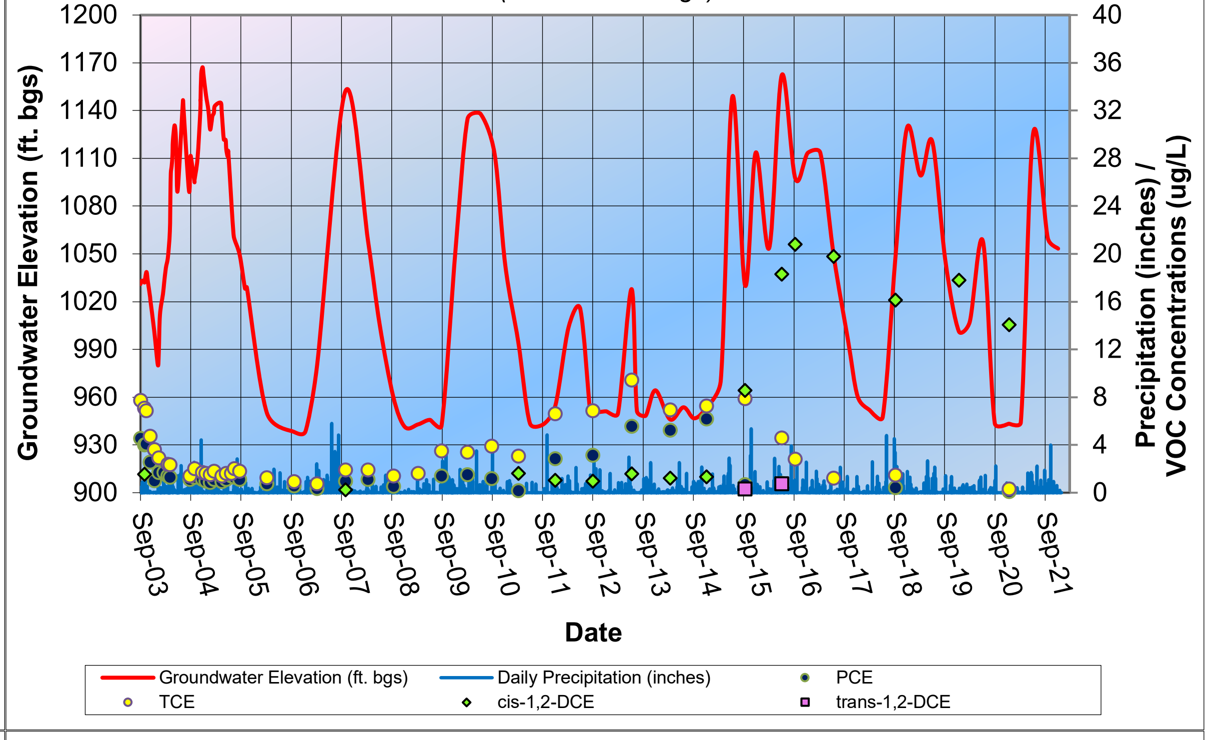
WB01-LGR07
(230-254 feet bgs)



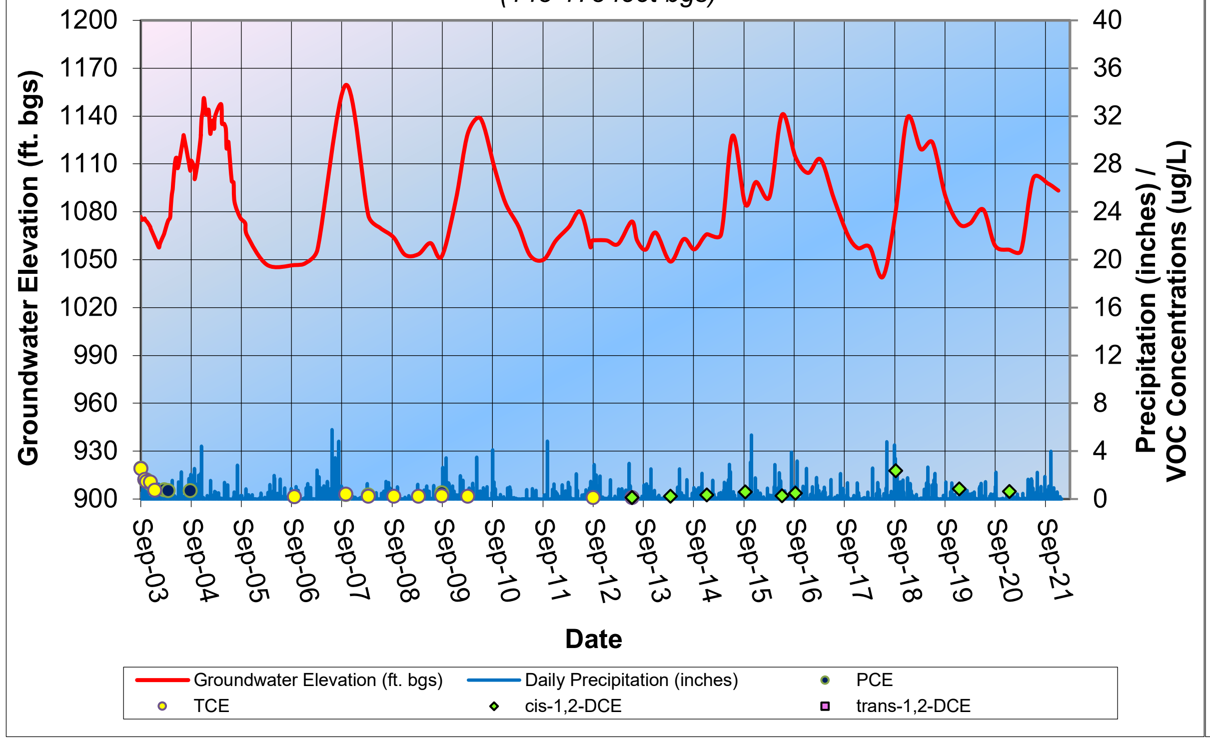
WB01-LGR03
(123-138 feet bgs)



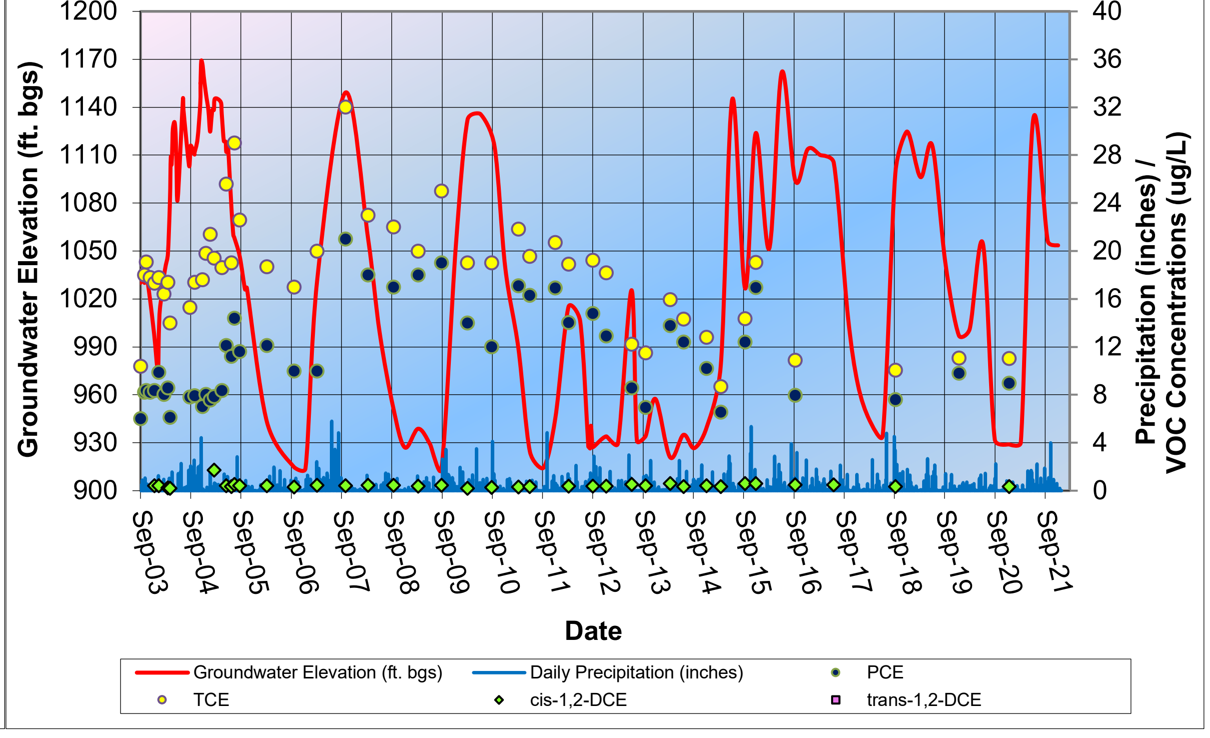
WB01-LGR08
(259-295 feet bgs)



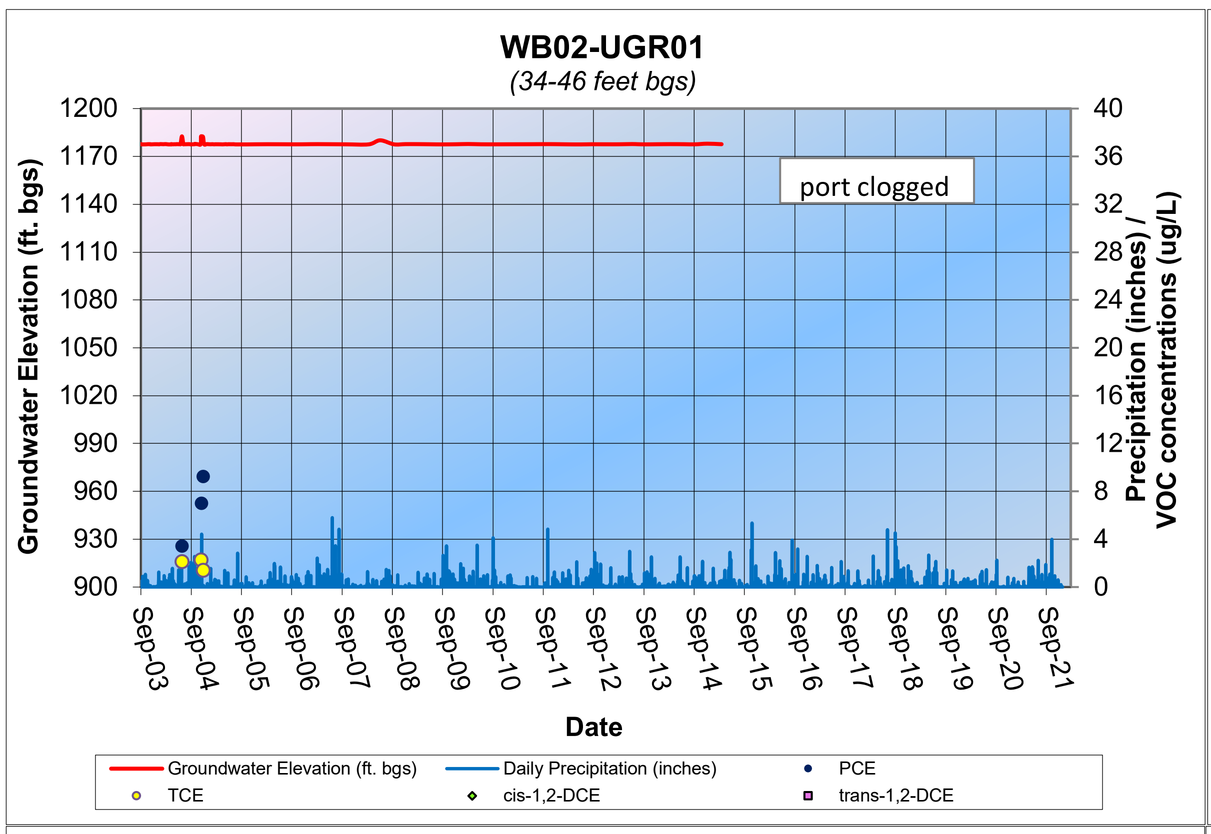
WB01-LGR04
(143-173 feet bgs)

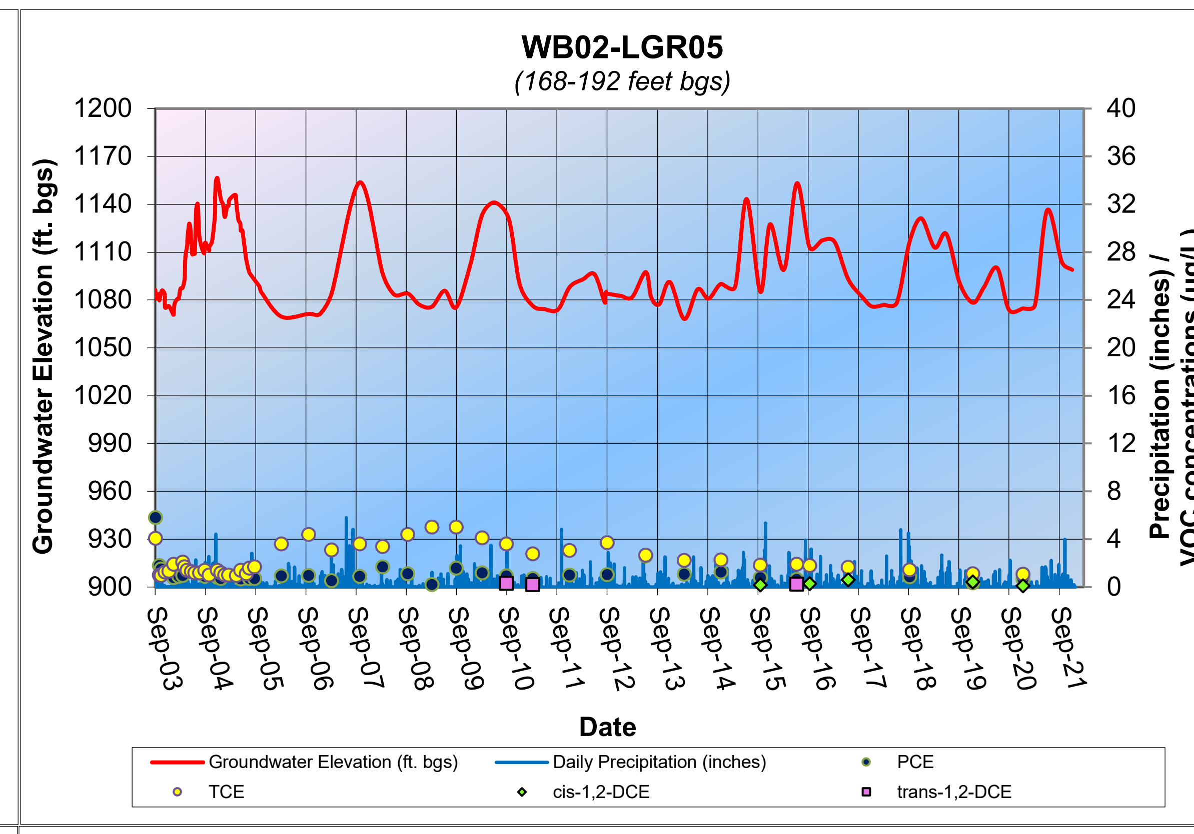


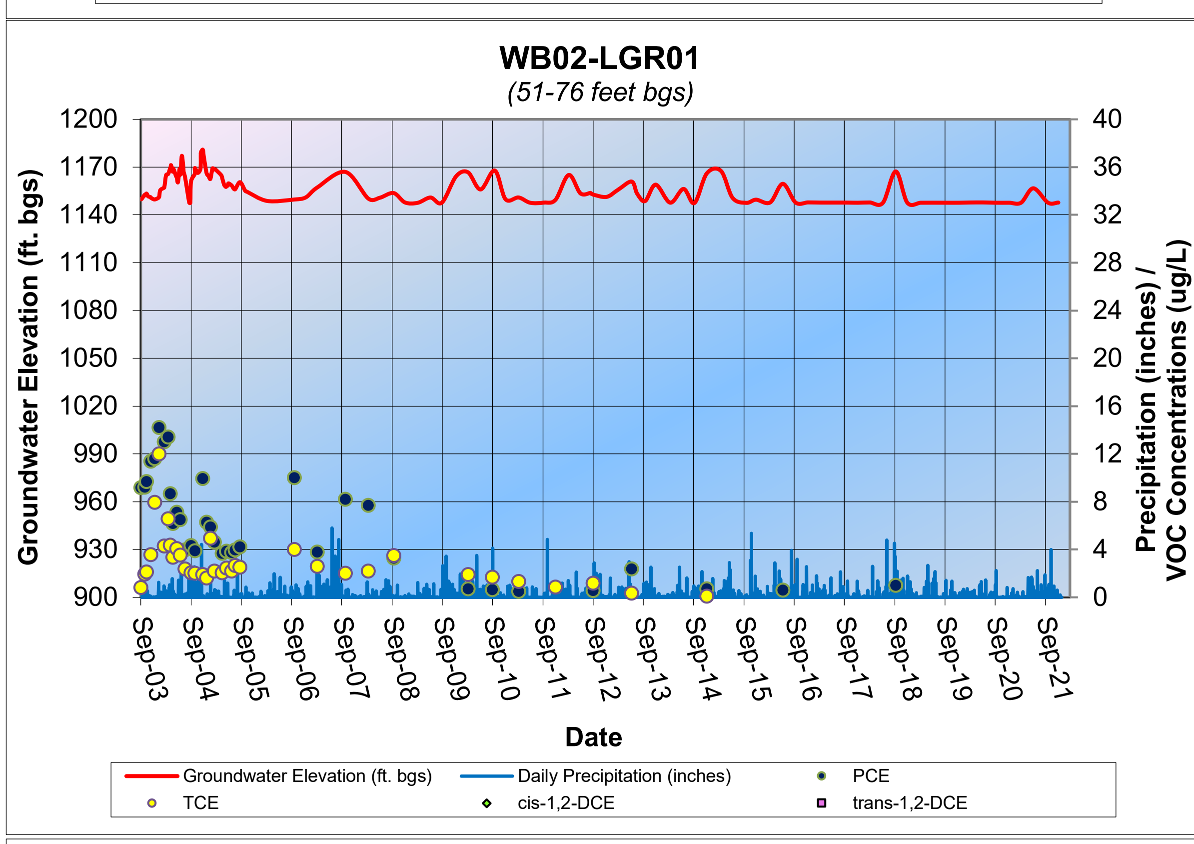
WB01-LGR09
(300-314 feet bgs)

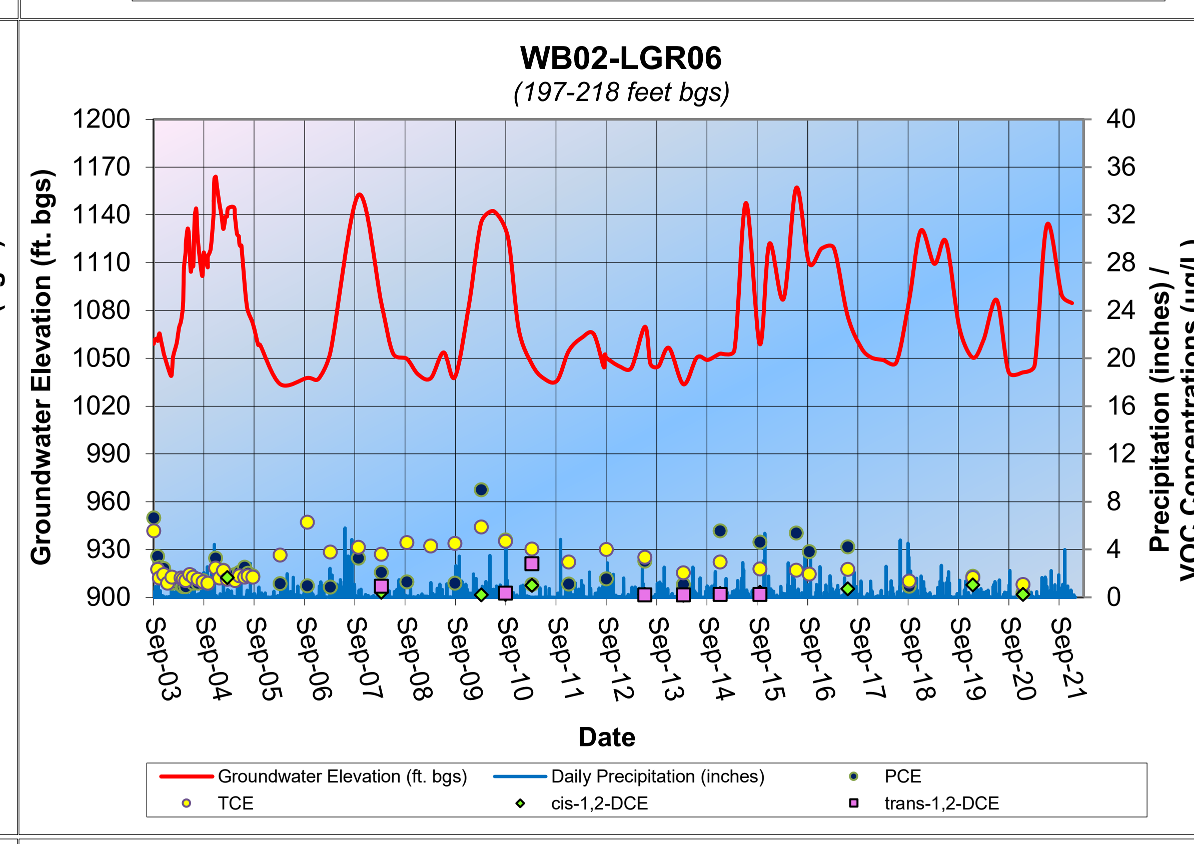


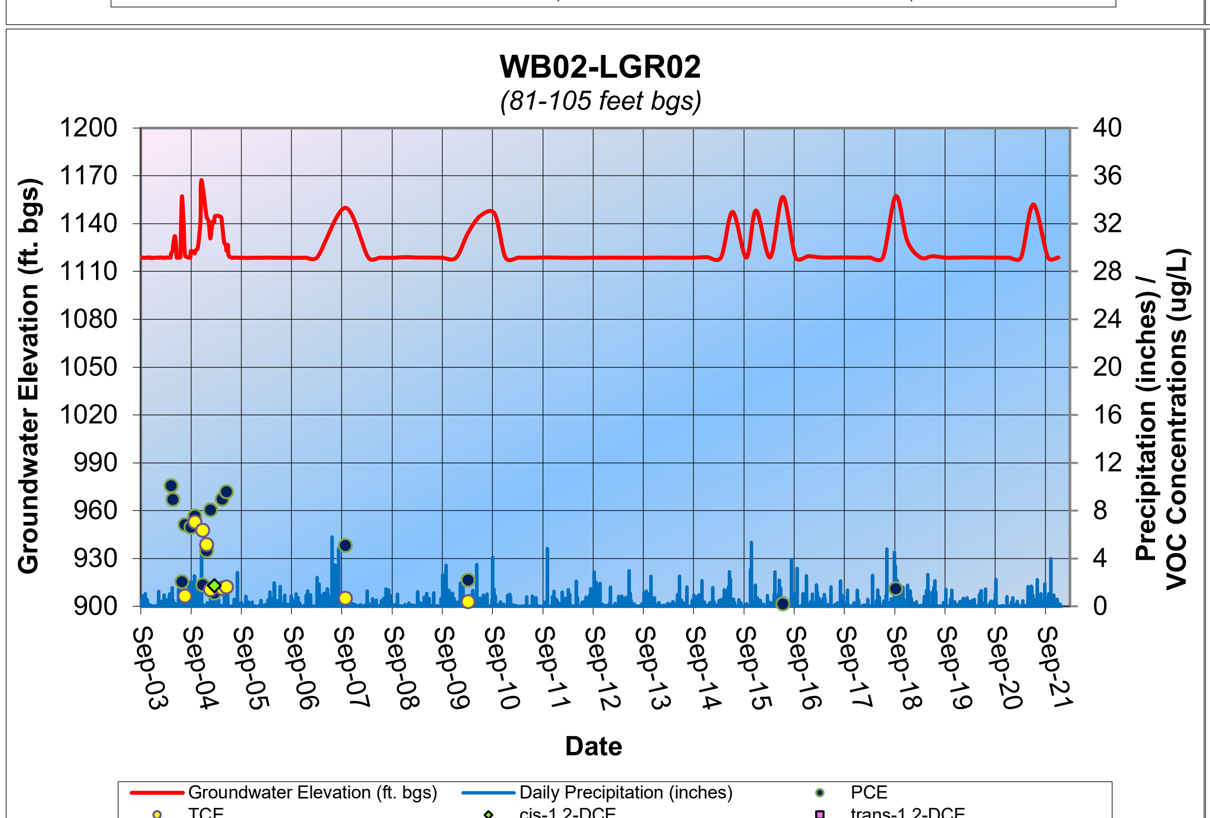
Appendix C.2 - CS-WB02 Culmulative VOC Concentrations, Groundwater Level, and Precipitation

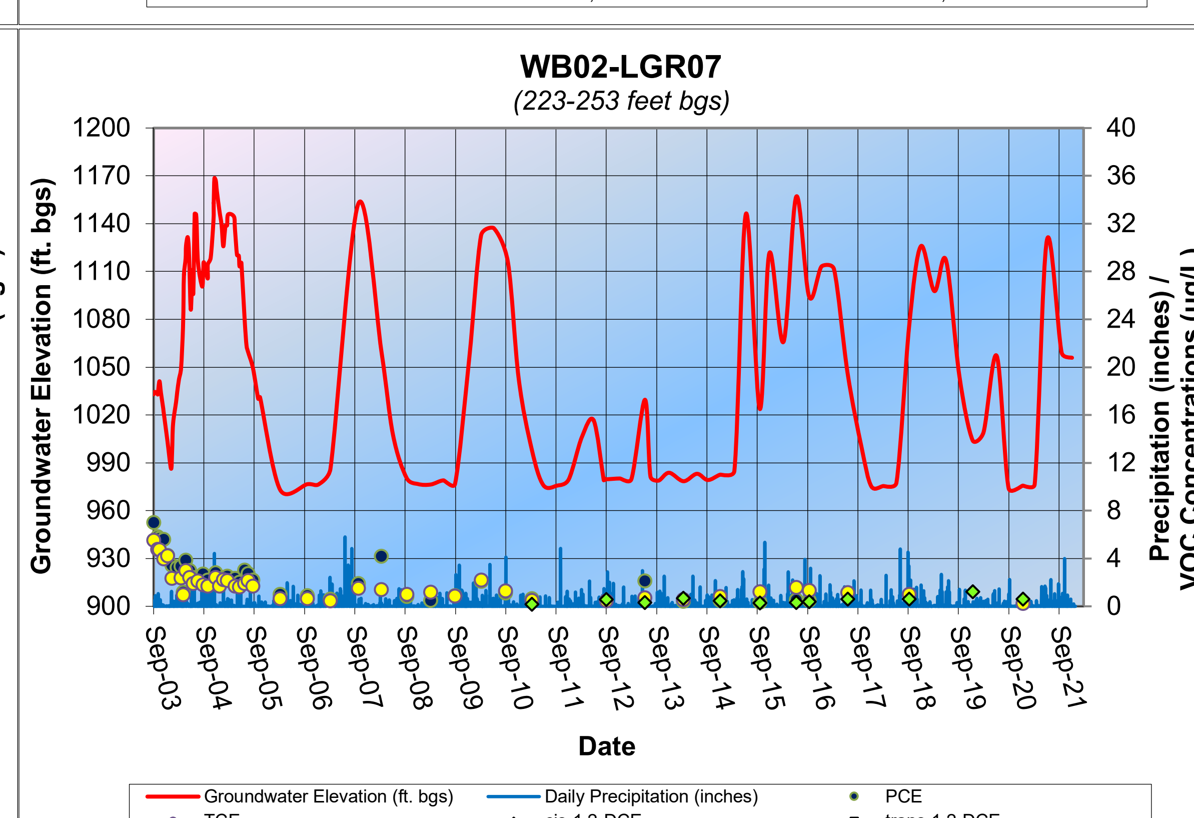


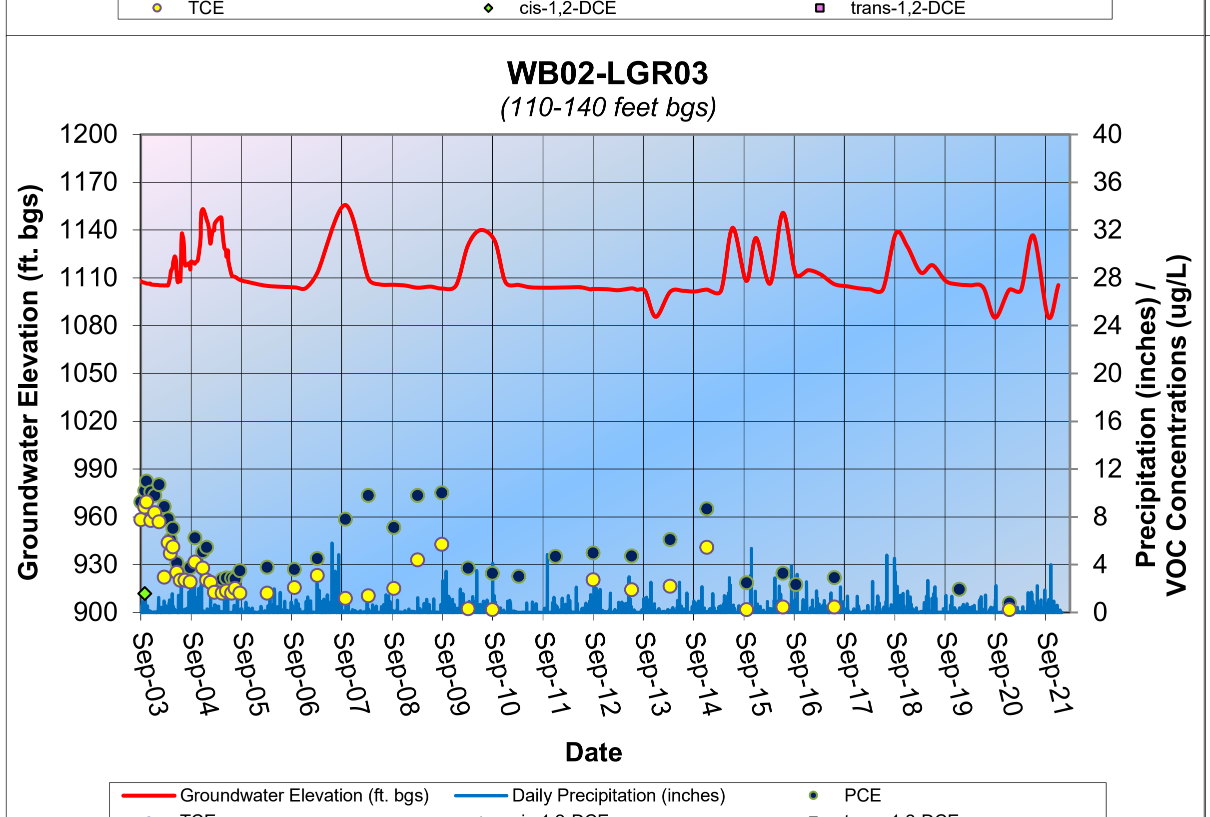


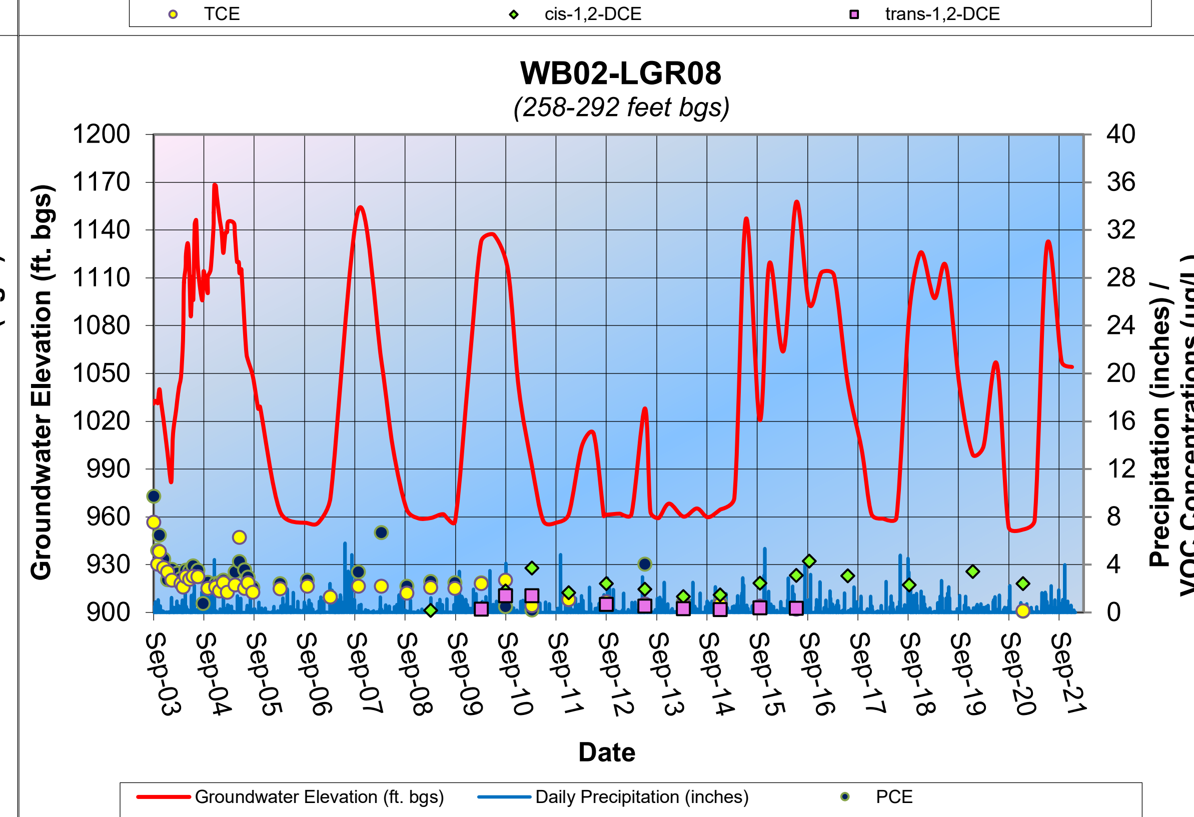


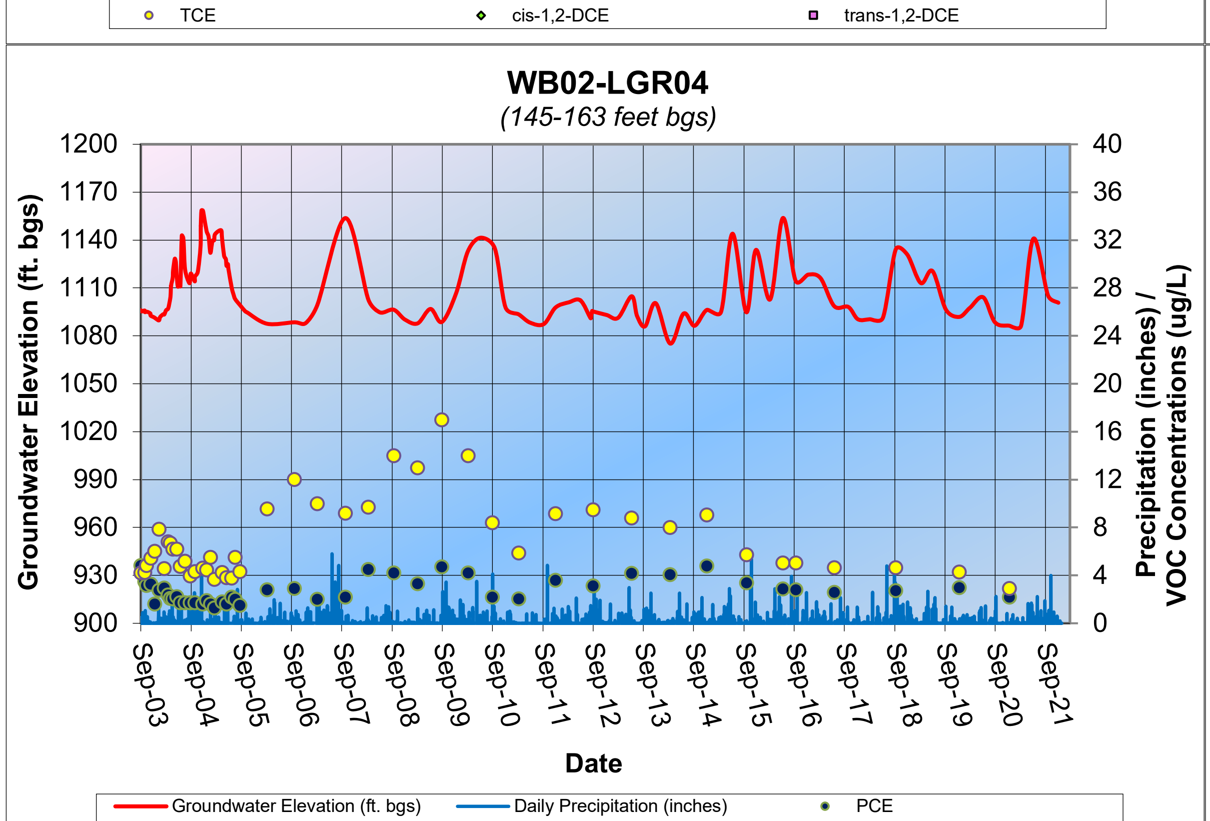


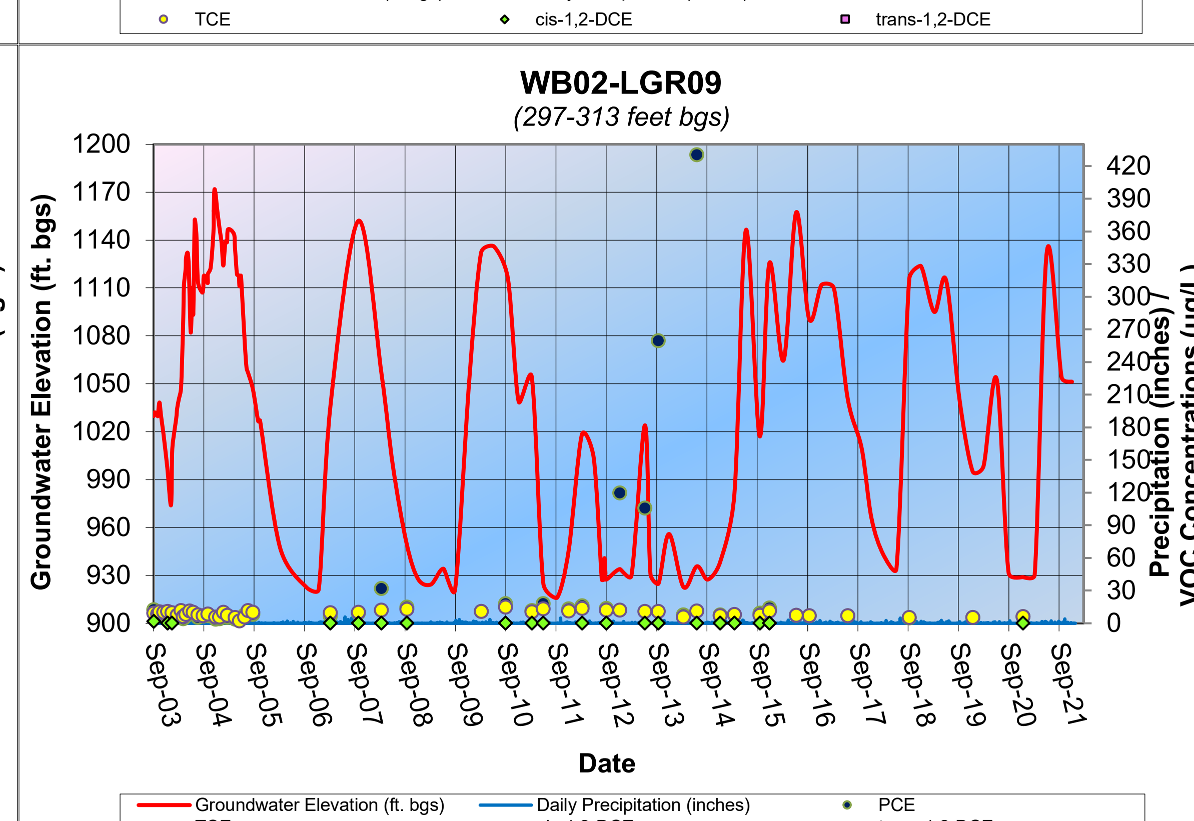






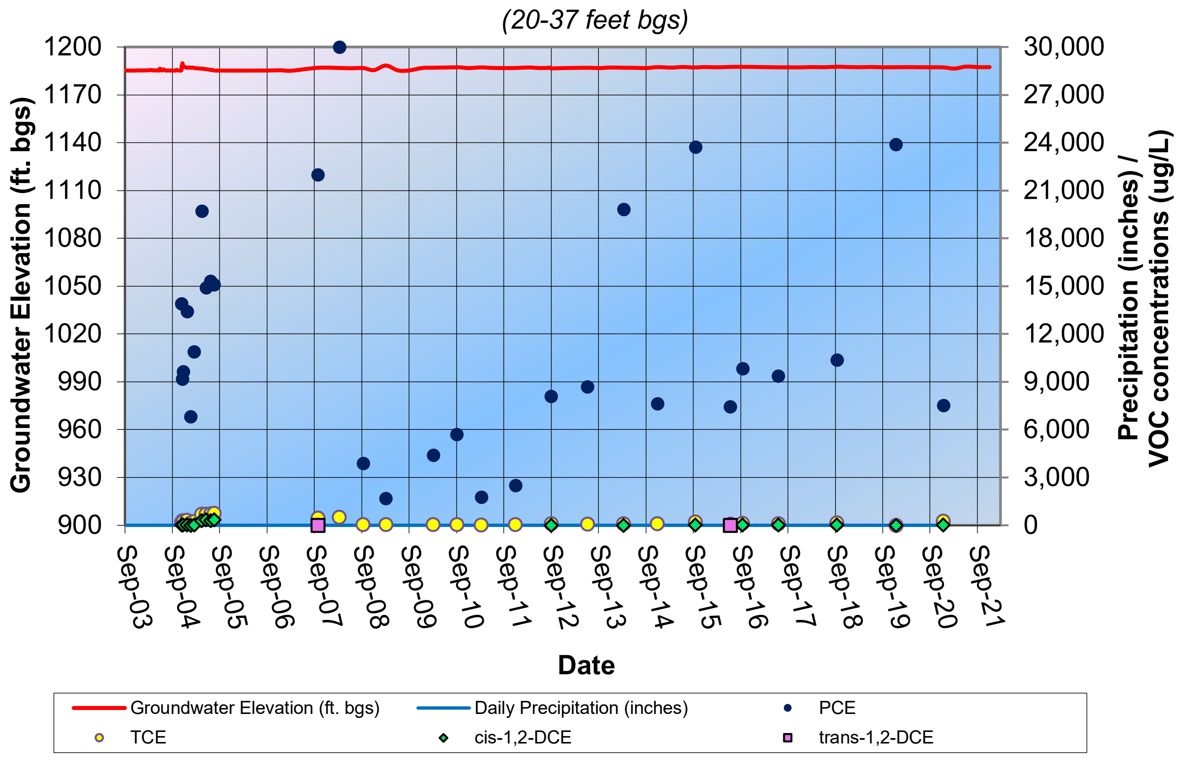




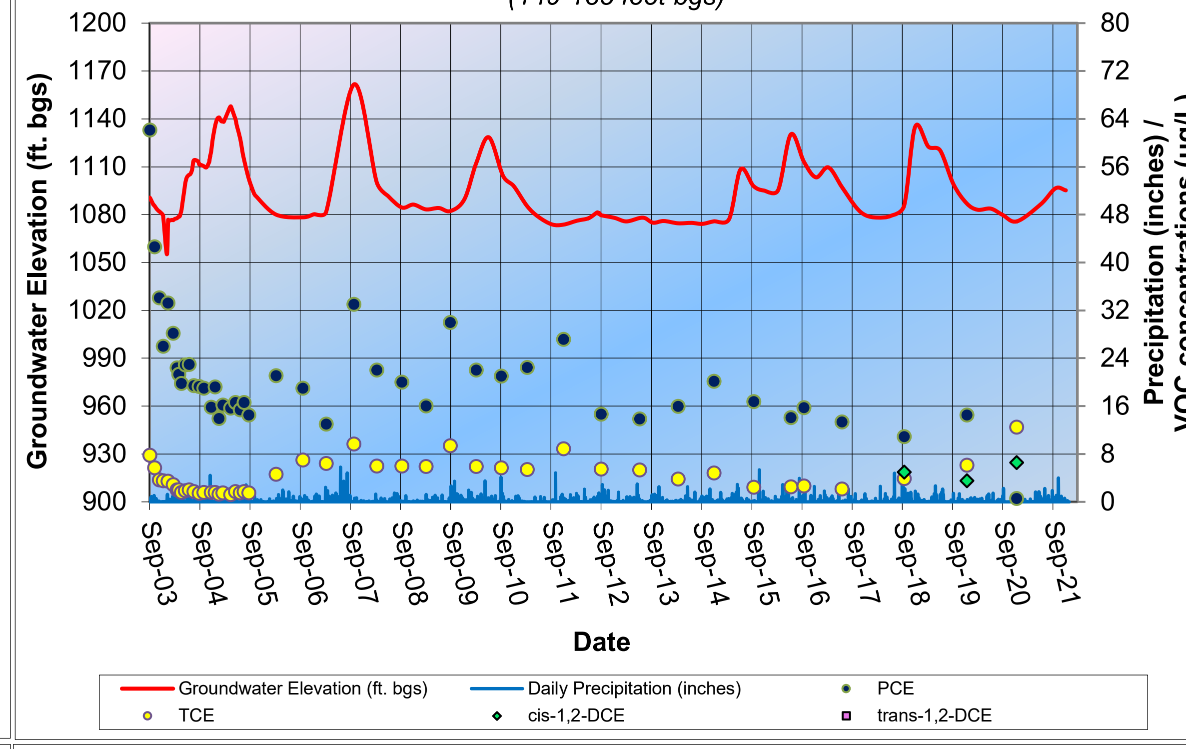


Appendix C.3 - CS-WB03 Culmulative VOC Concentrations, Groundwater Level, and Precipitation

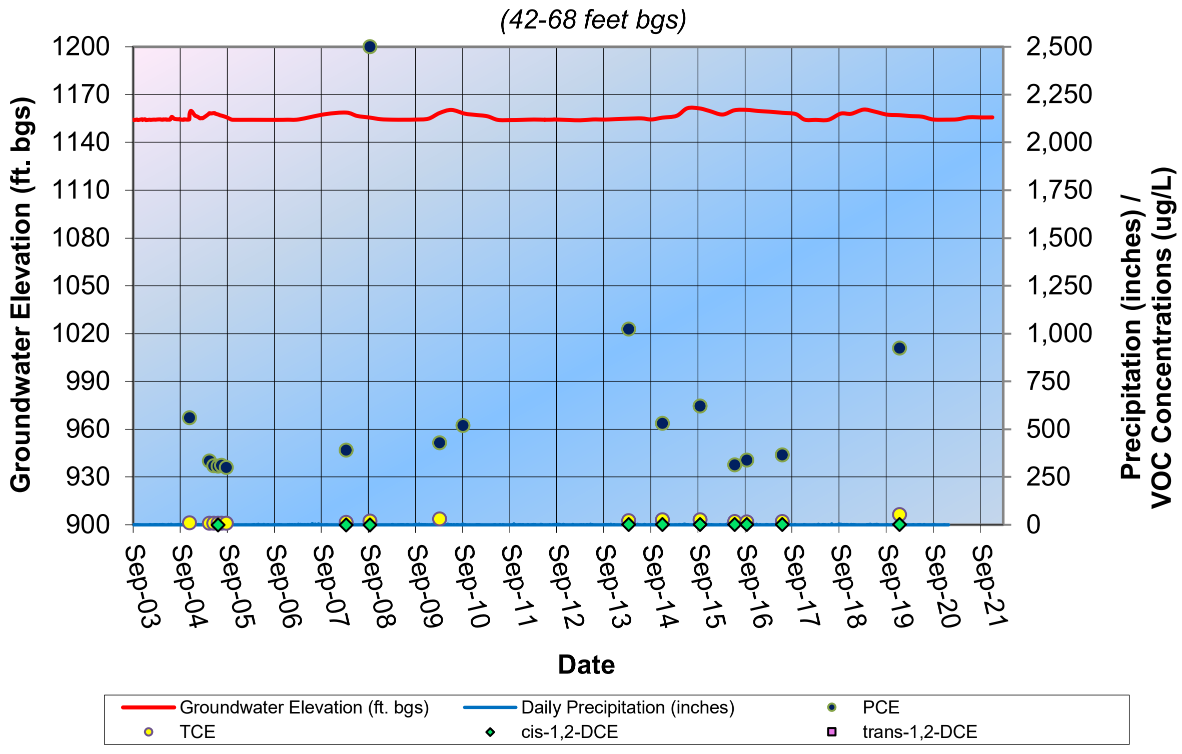
WB03-UGR01
(20-37 feet bgs)



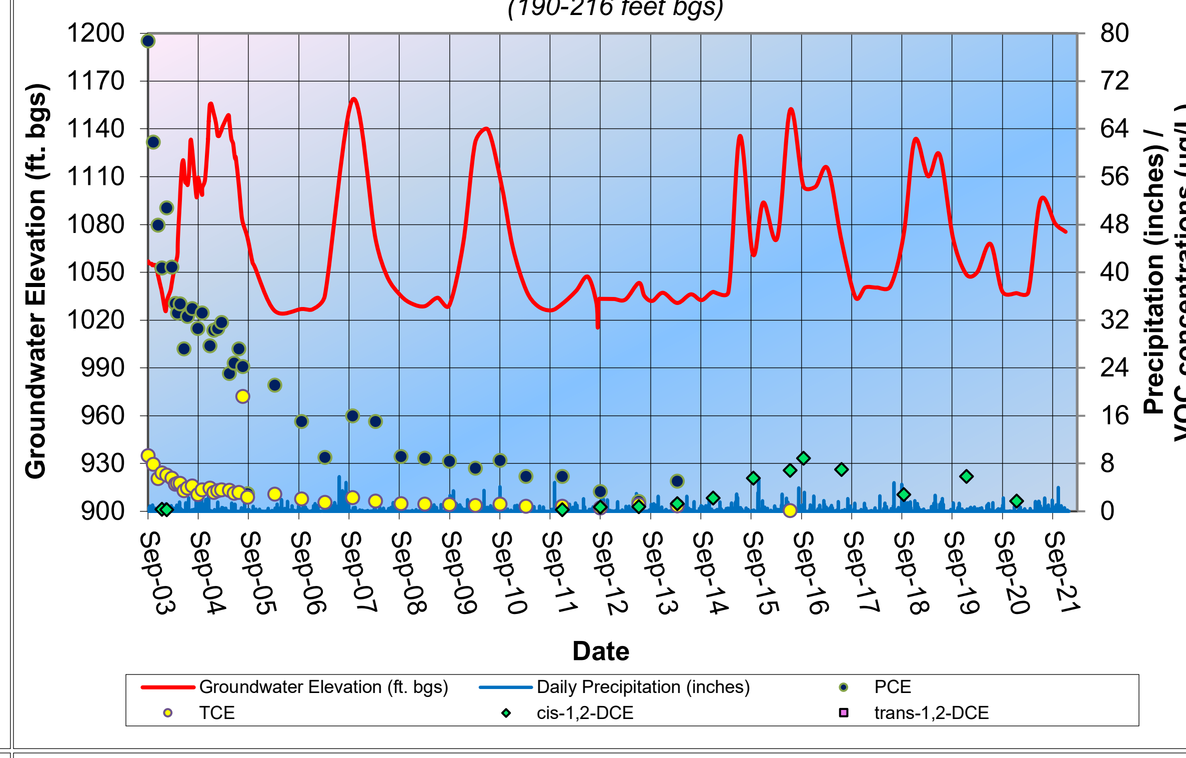
WB03-LGR05
(149-185 feet bgs)



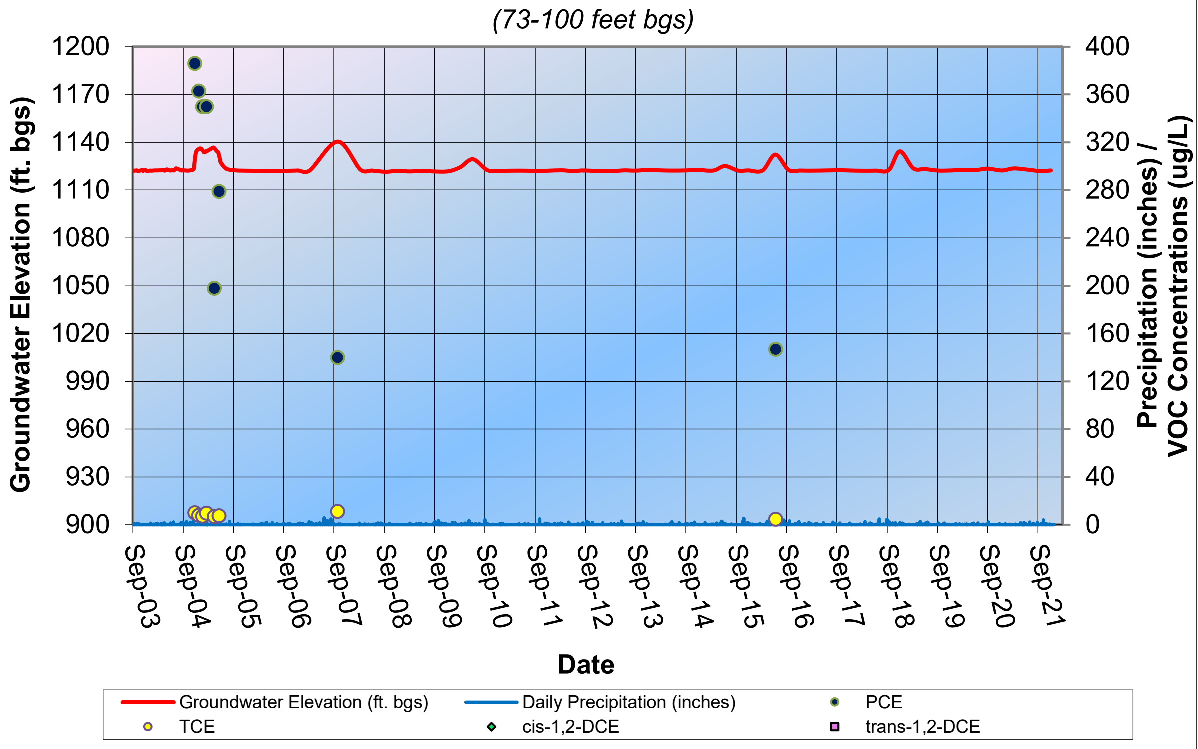
WB03-LGR01
(42-68 feet bgs)



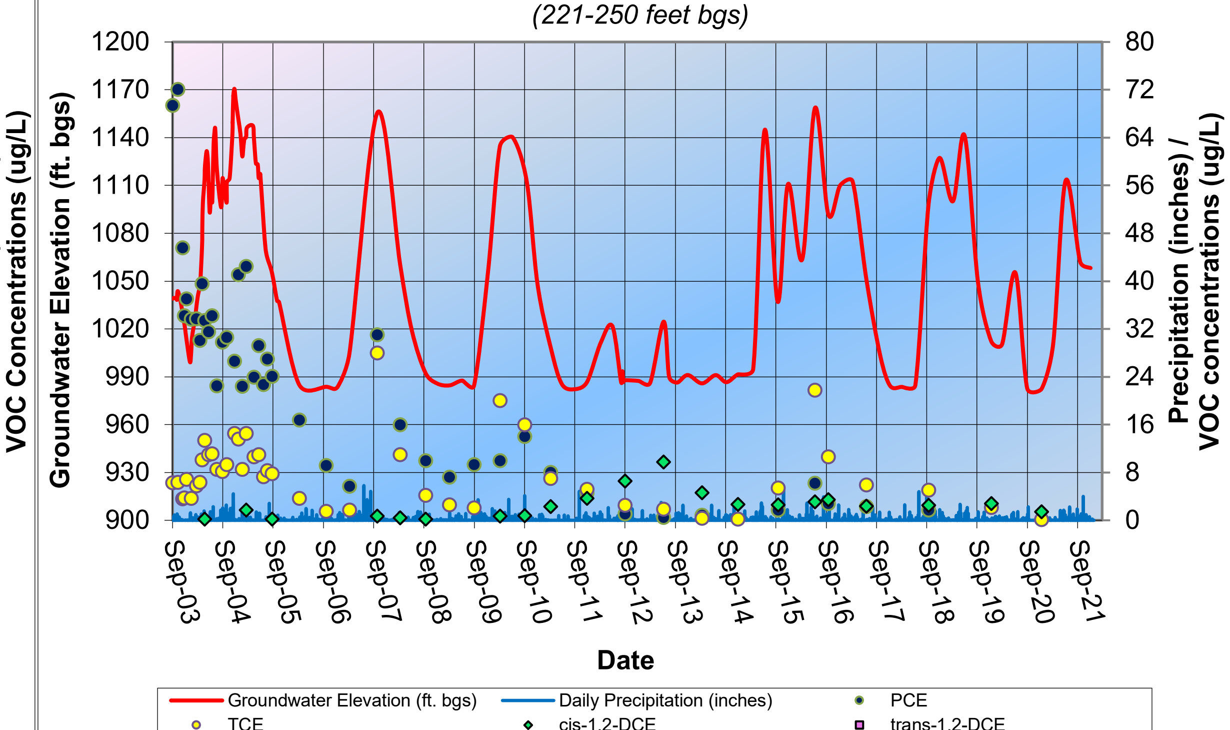
WB03-LGR06
(190-216 feet bgs)



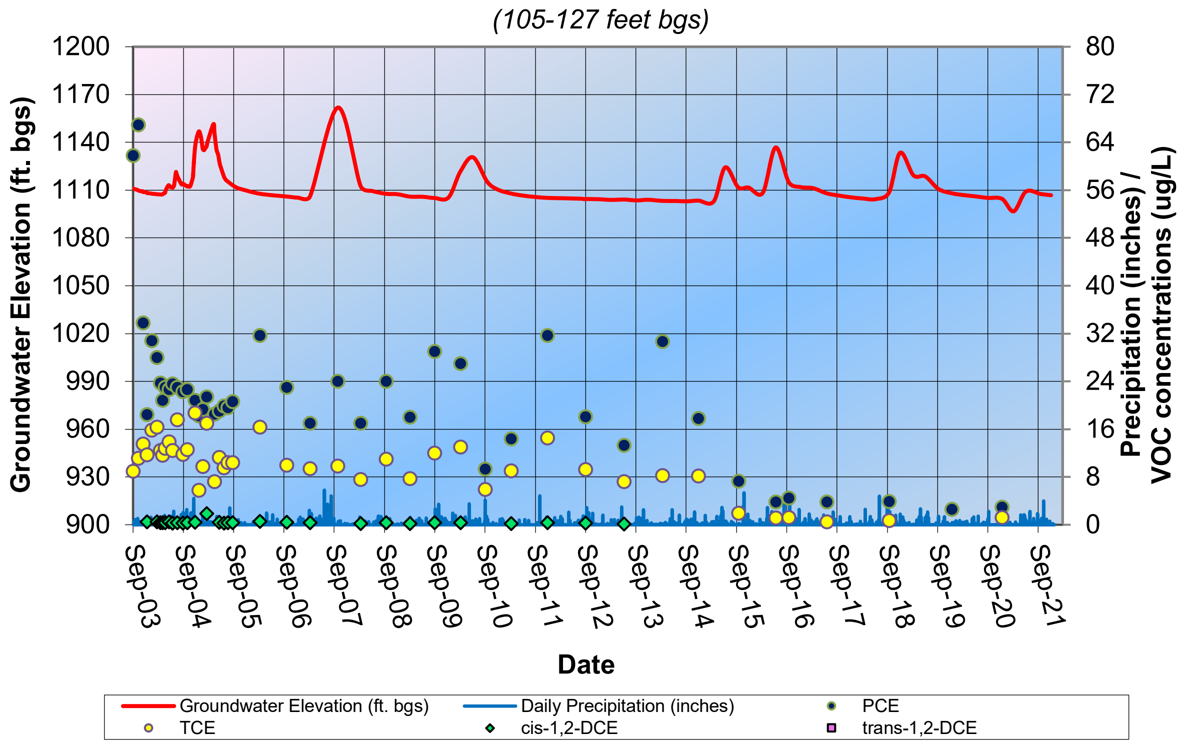
WB03-LGR02
(73-100 feet bgs)



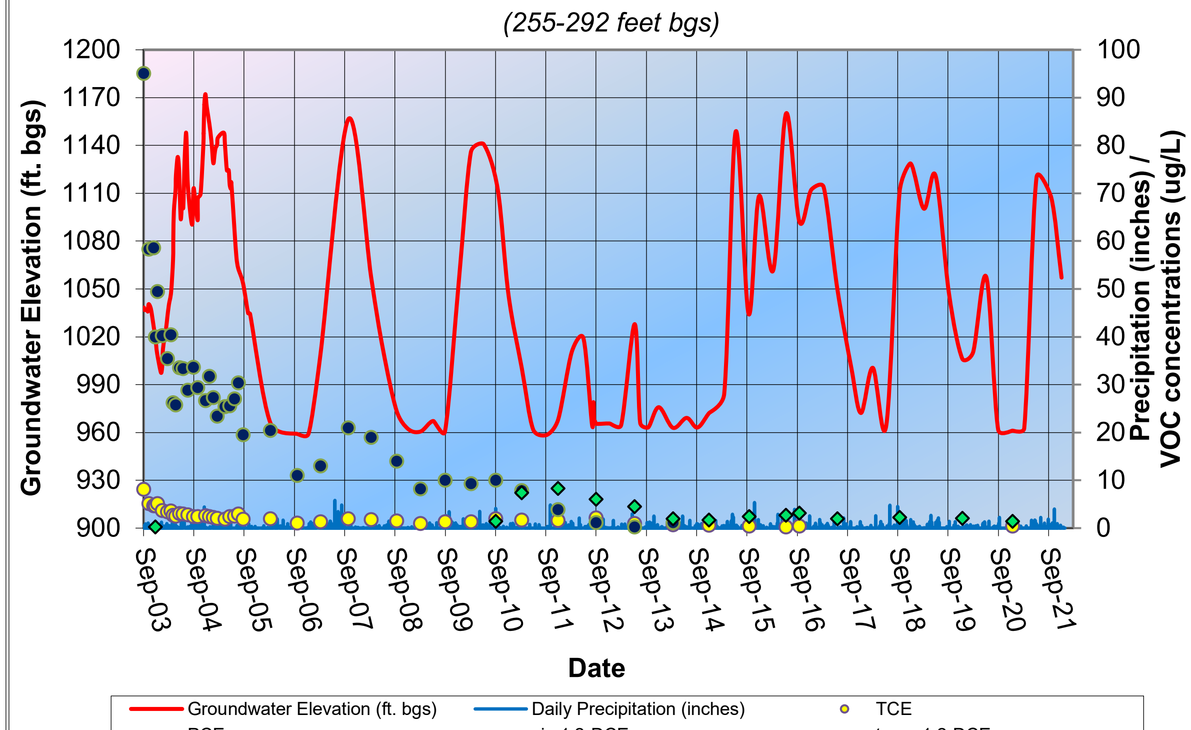
WB03-LGR07
(221-250 feet bgs)



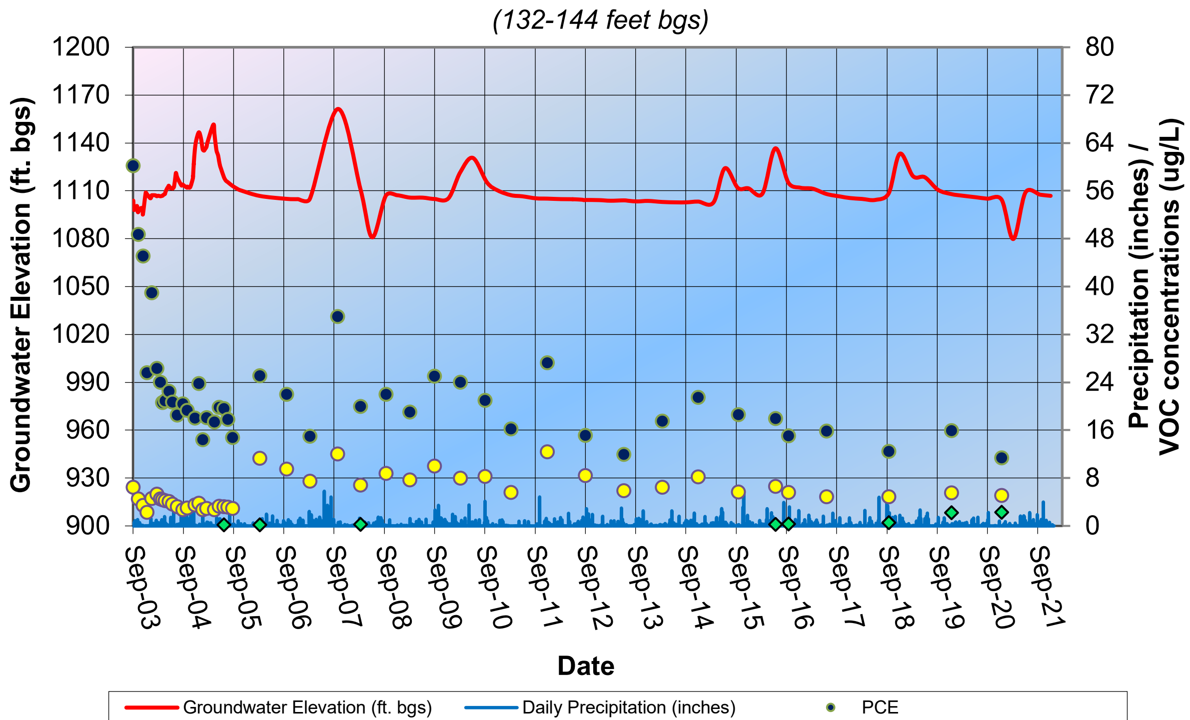
WB03-LGR03
(105-127 feet bgs)



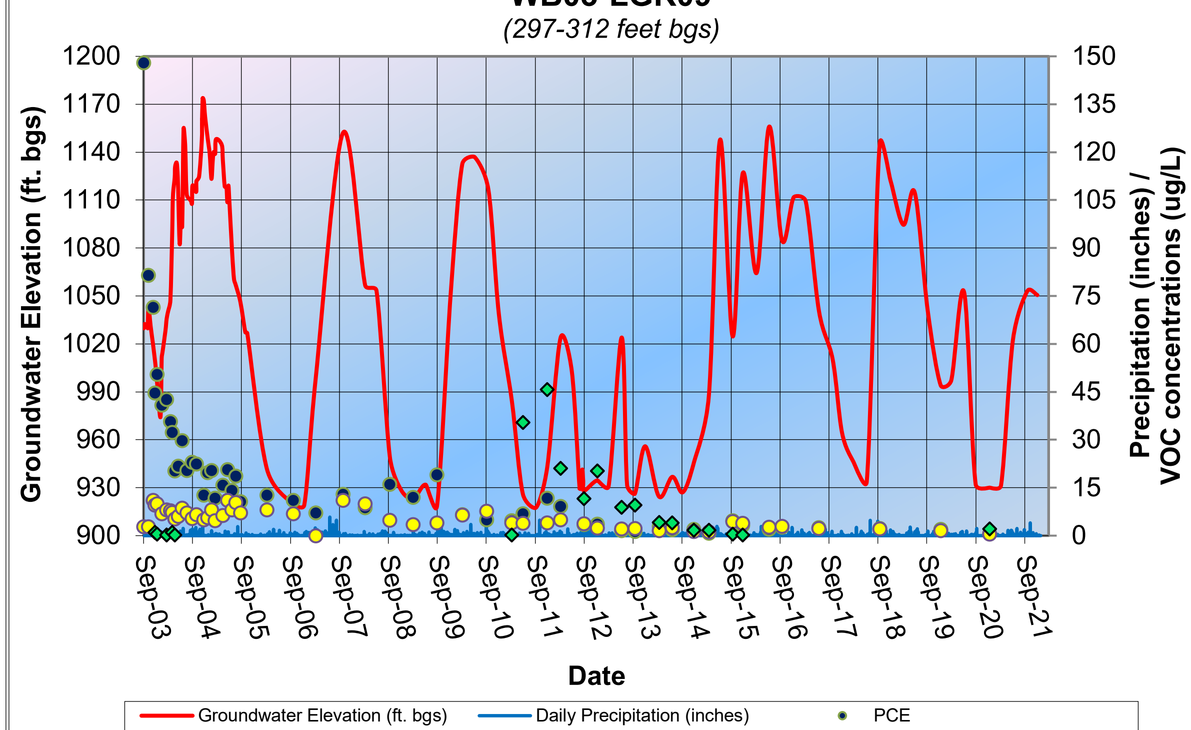
WB03-LGR08
(255-292 feet bgs)



WB03-LGR04
(132-144 feet bgs)

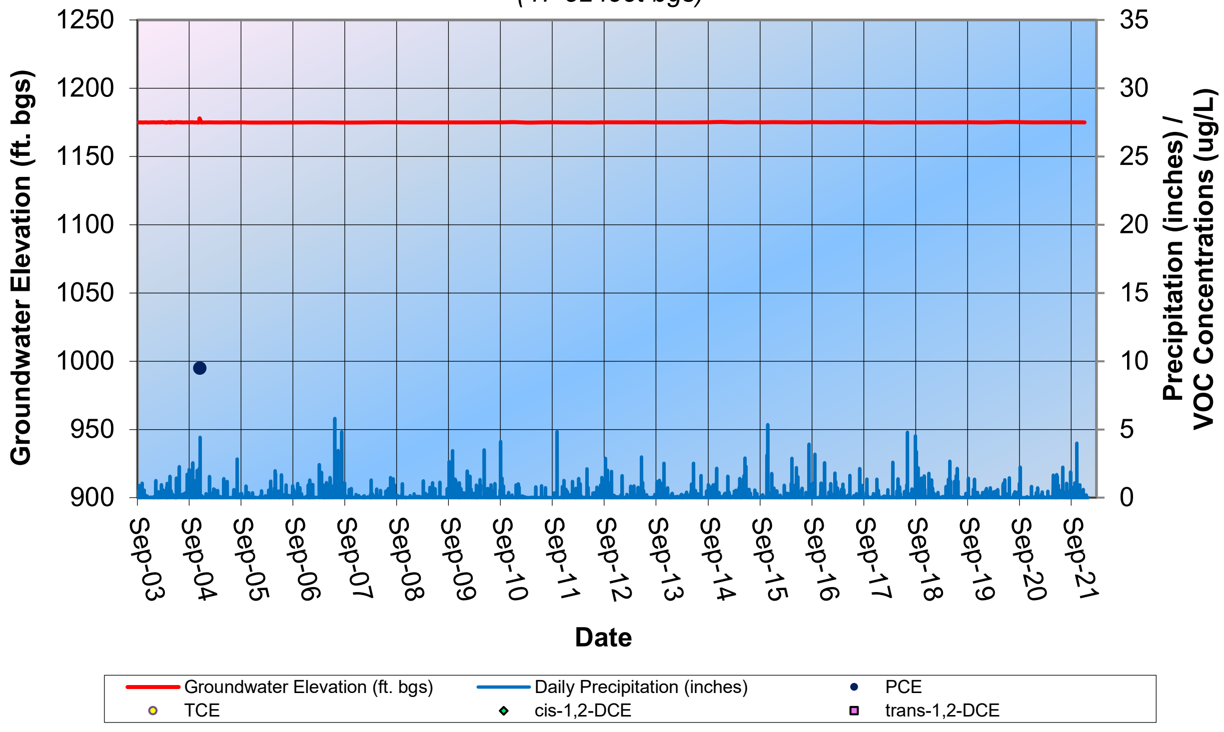


WB03-LGR09
(297-312 feet bgs)

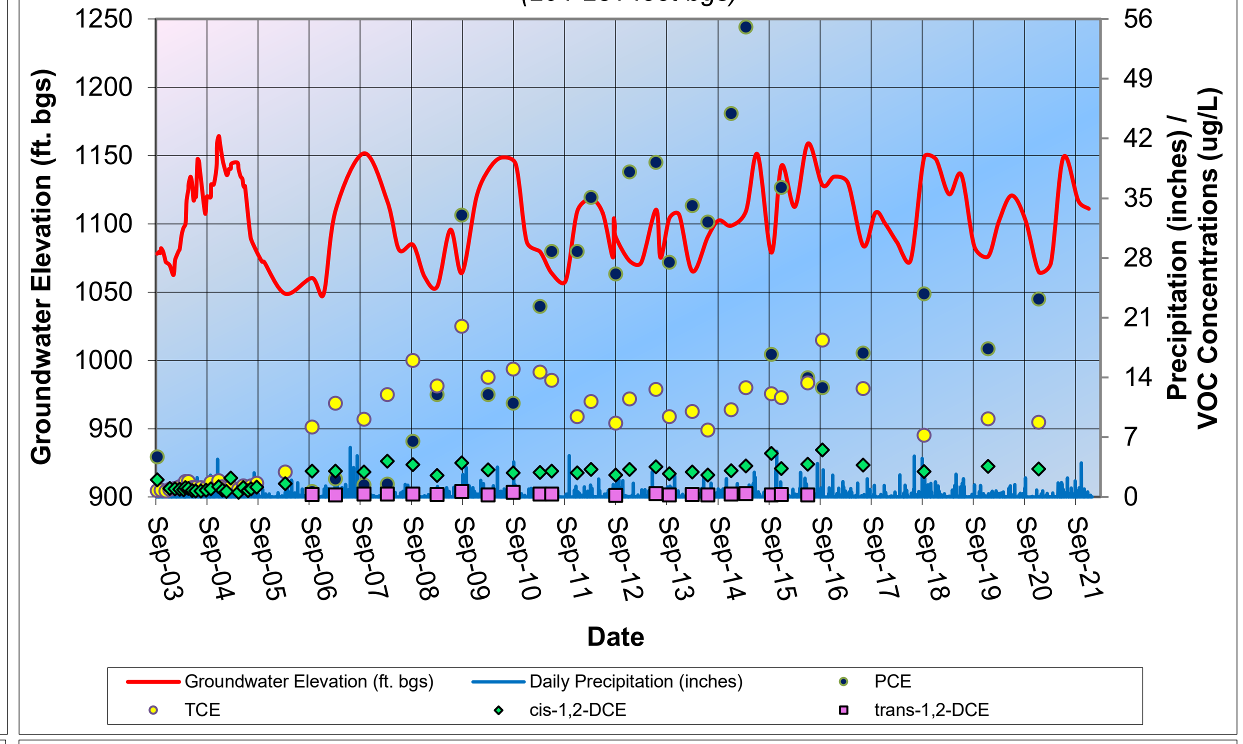


Appendix C.4 - CS-WB04 Culmulative VOC Concentrations, Groundwater Level, and Precipitation

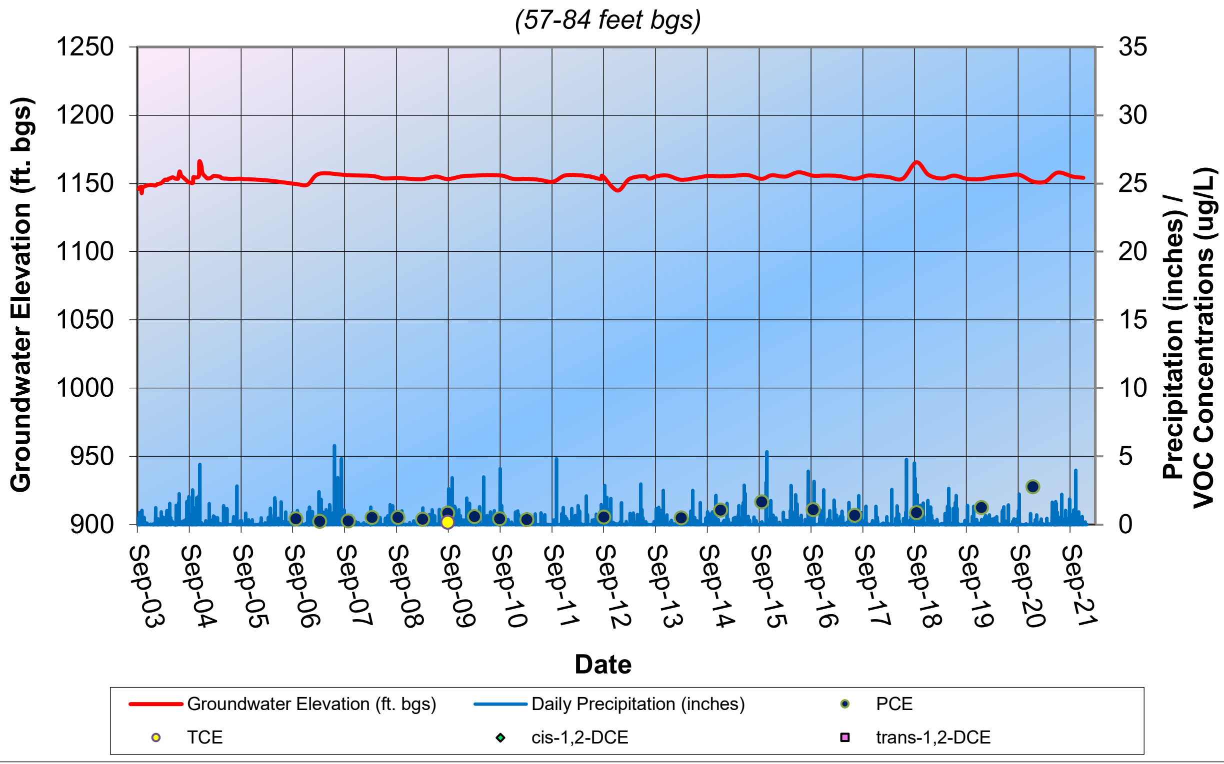
WB04-UGR01
(47-52 feet bgs)



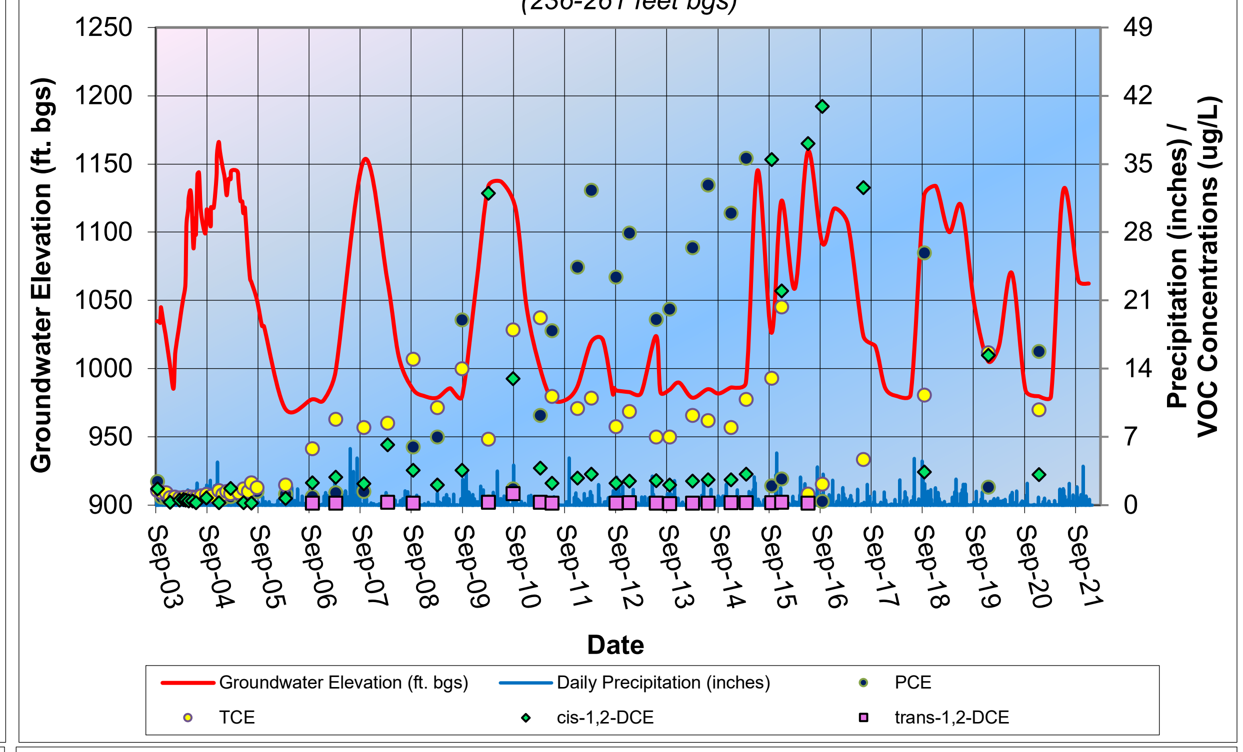
WB04-LGR06
(204-231 feet bgs)



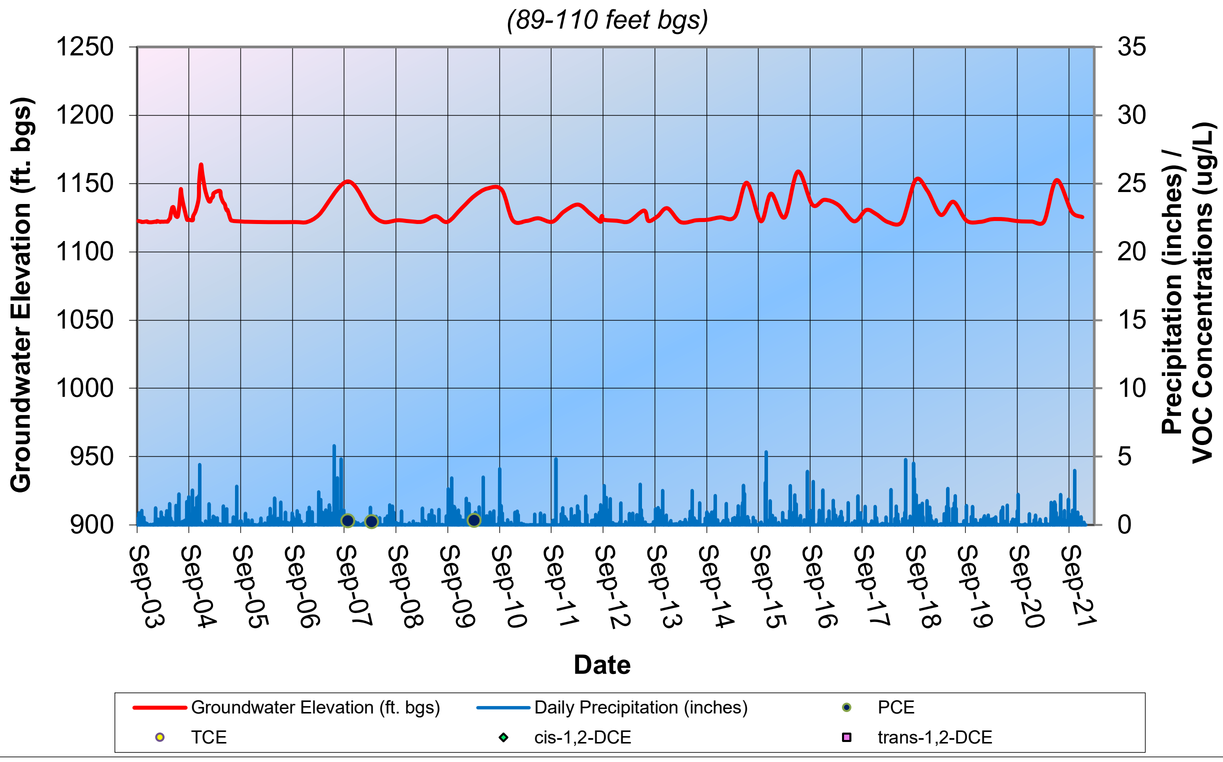
WB04-LGR01
(57-84 feet bgs)



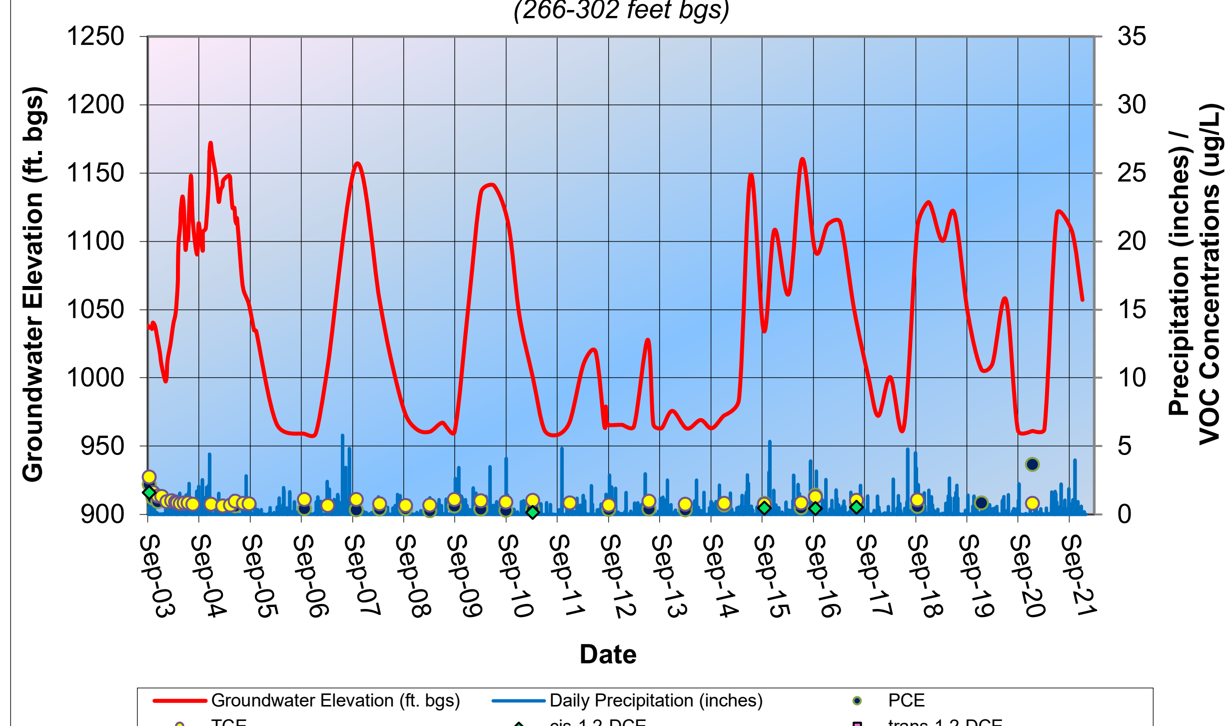
WB04-LGR07
(236-261 feet bgs)



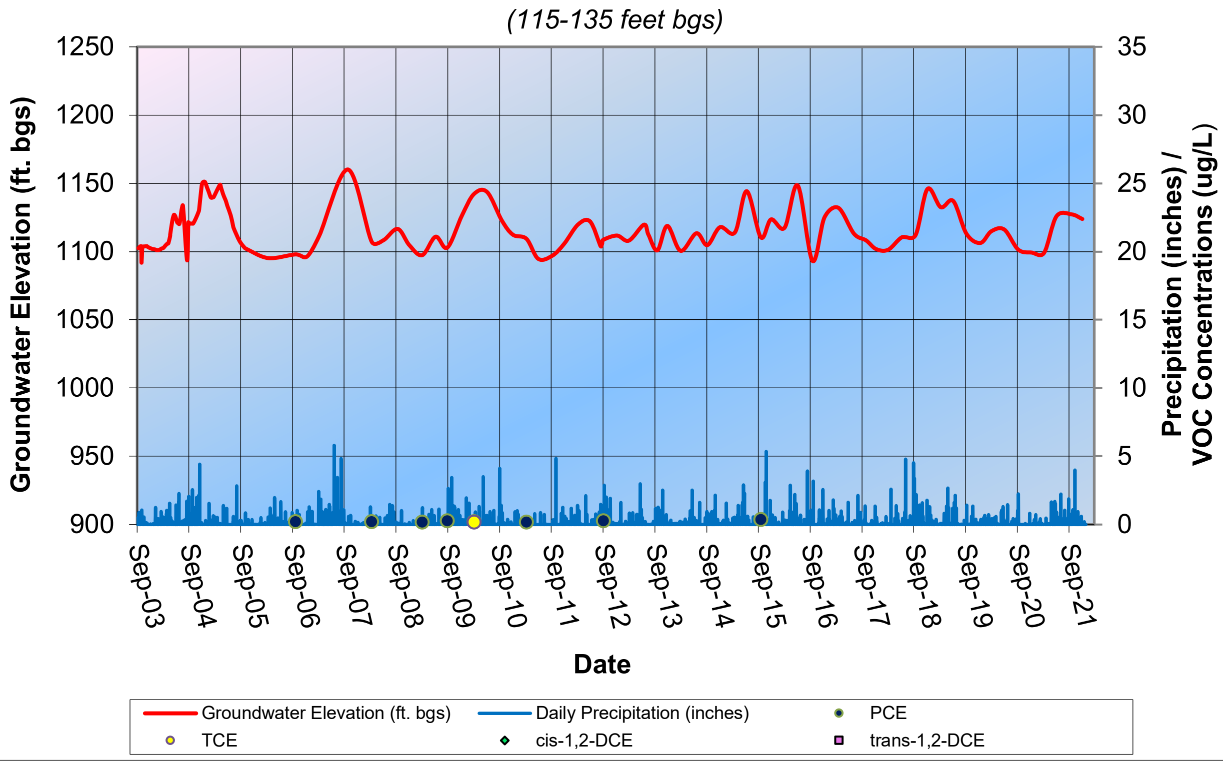
WB04-LGR02
(89-110 feet bgs)



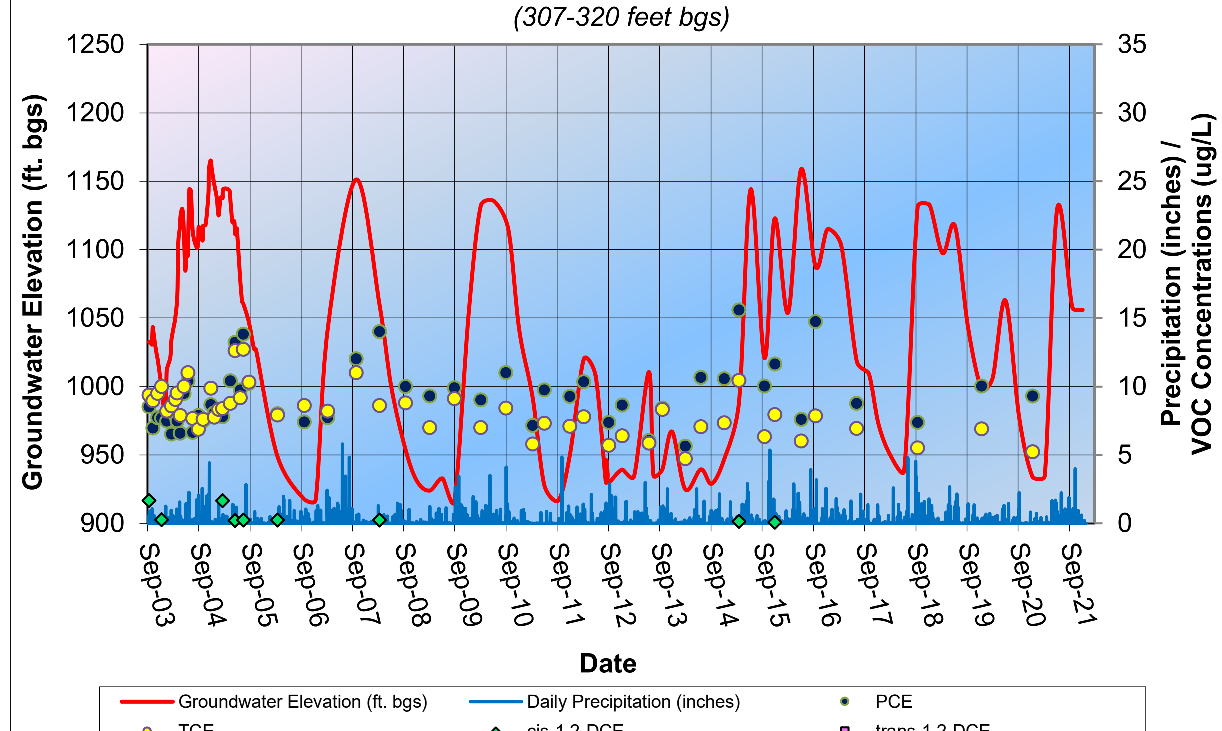
WB04-LGR08
(266-302 feet bgs)



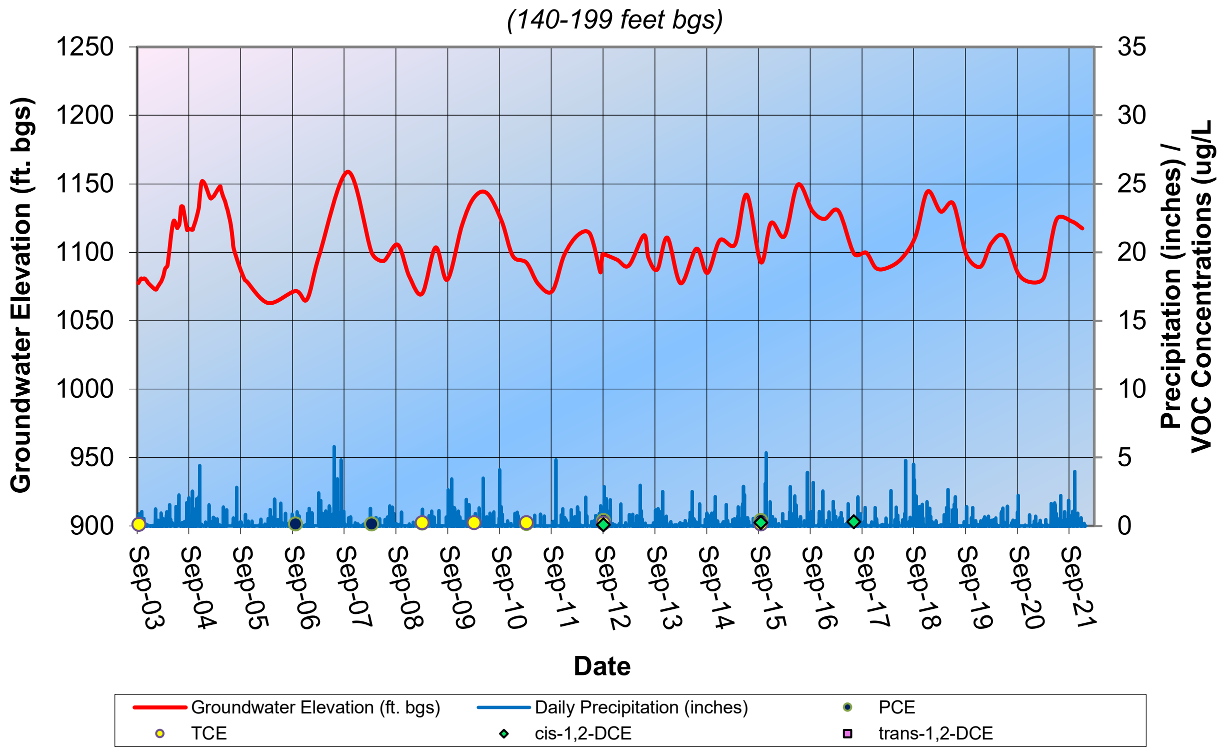
WB04-LGR03
(115-135 feet bgs)



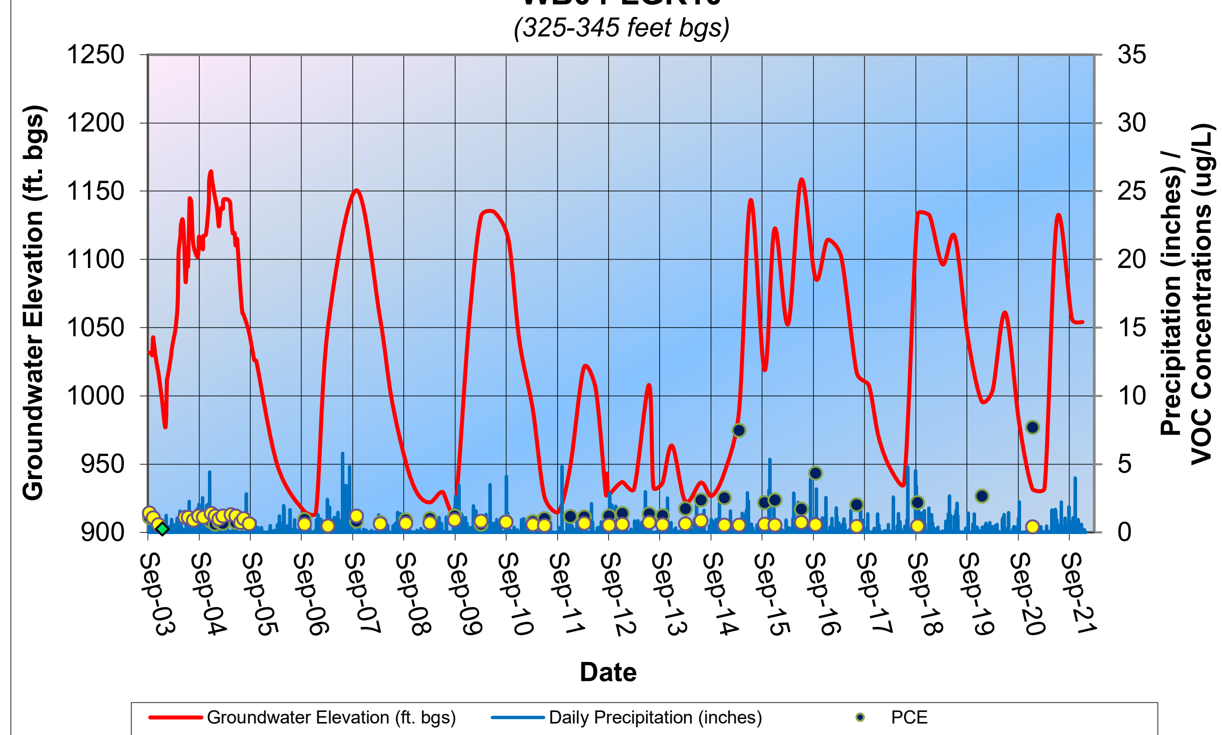
WB04-LGR09
(307-320 feet bgs)



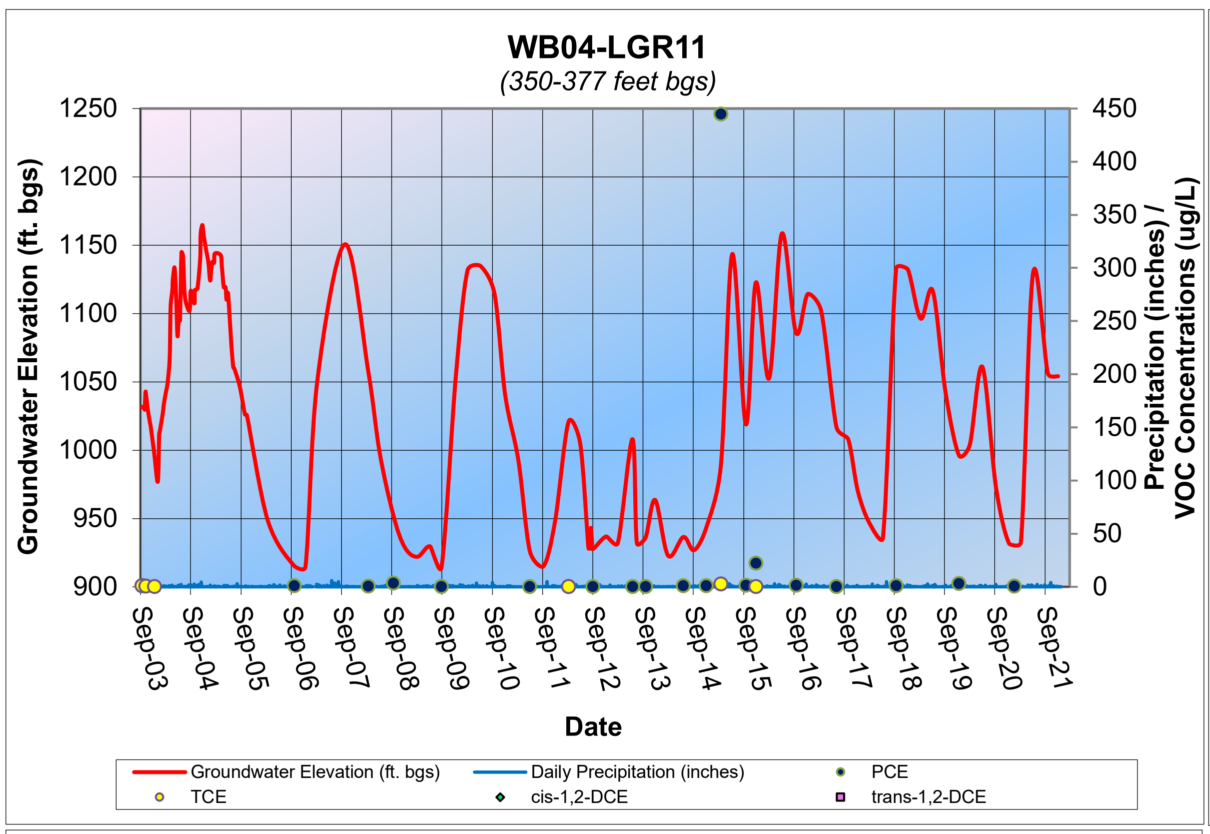
WB04-LGR04
(140-199 feet bgs)

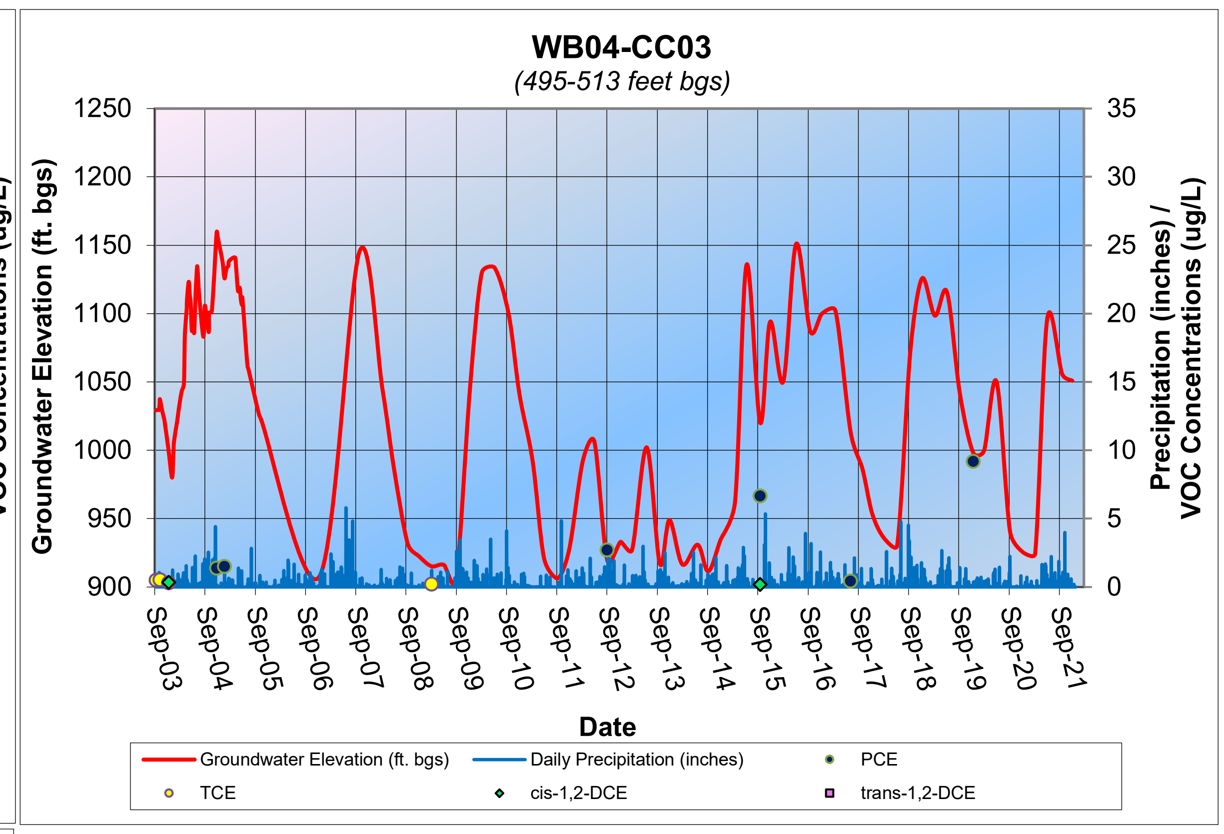


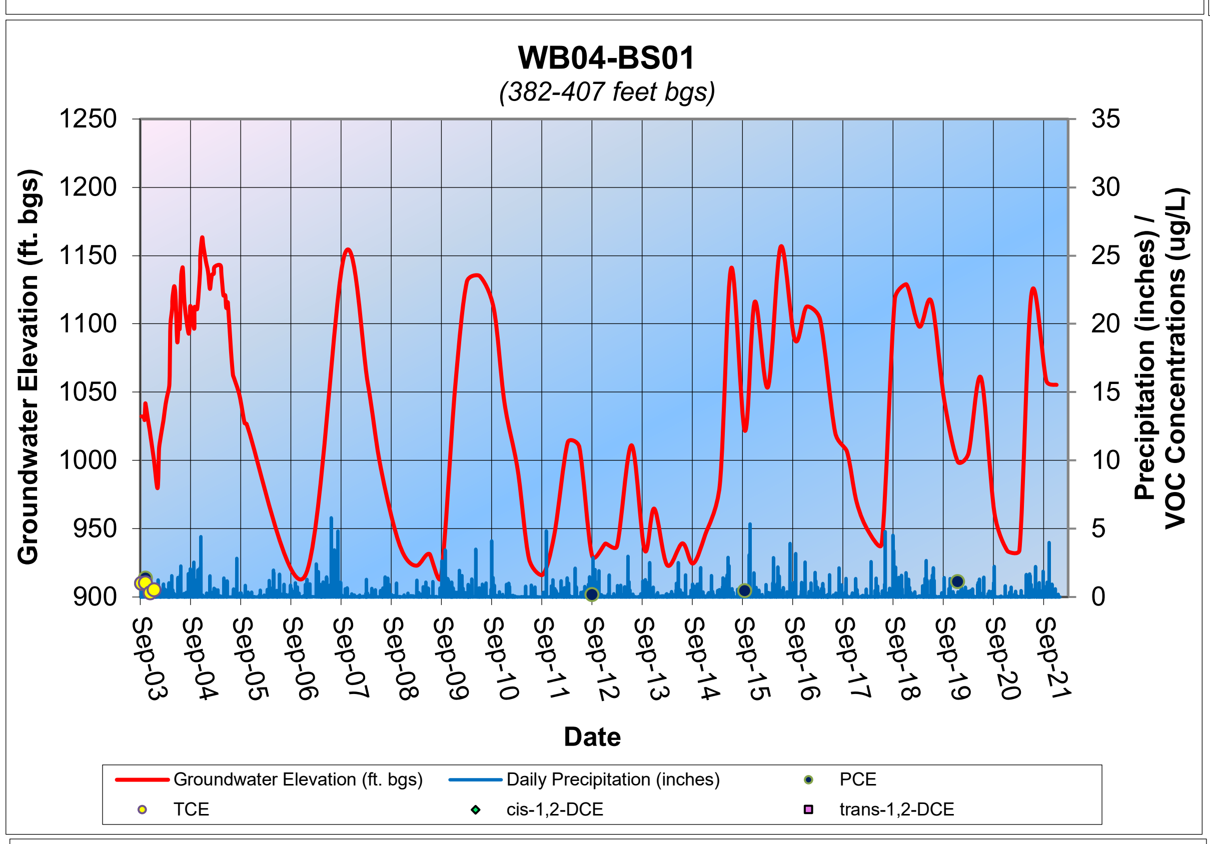
WB04-LGR10
(325-345 feet bgs)

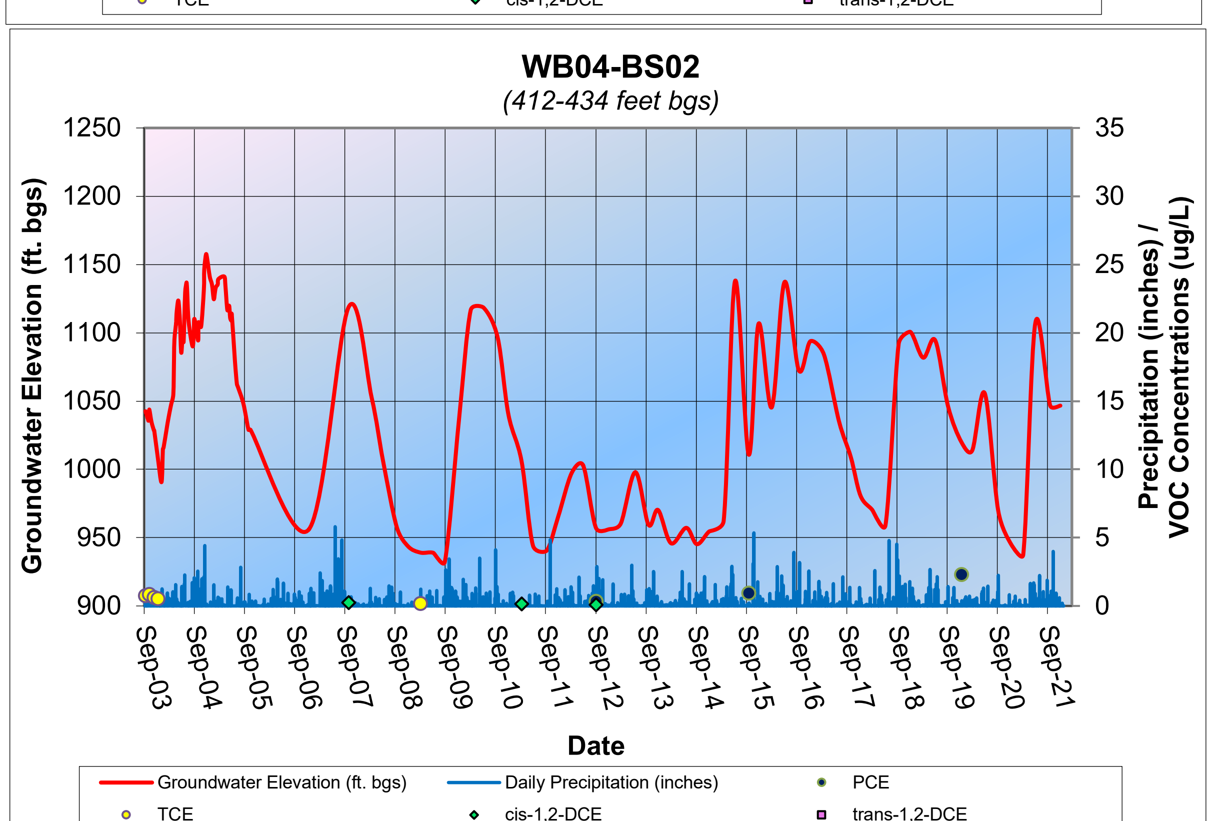


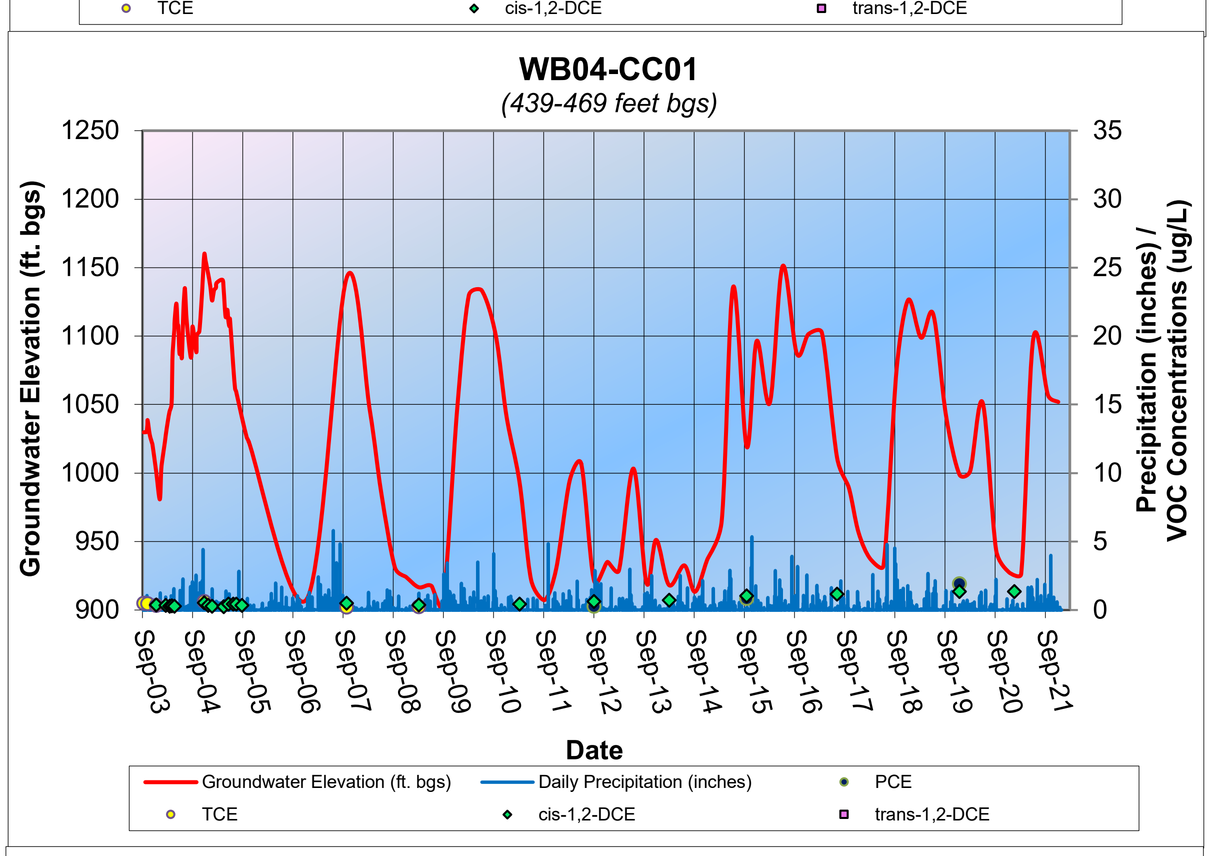
Appendix C.4 - CS-WB04 Culmulative VOC Concentrations, Groundwater Level, and Precipitation

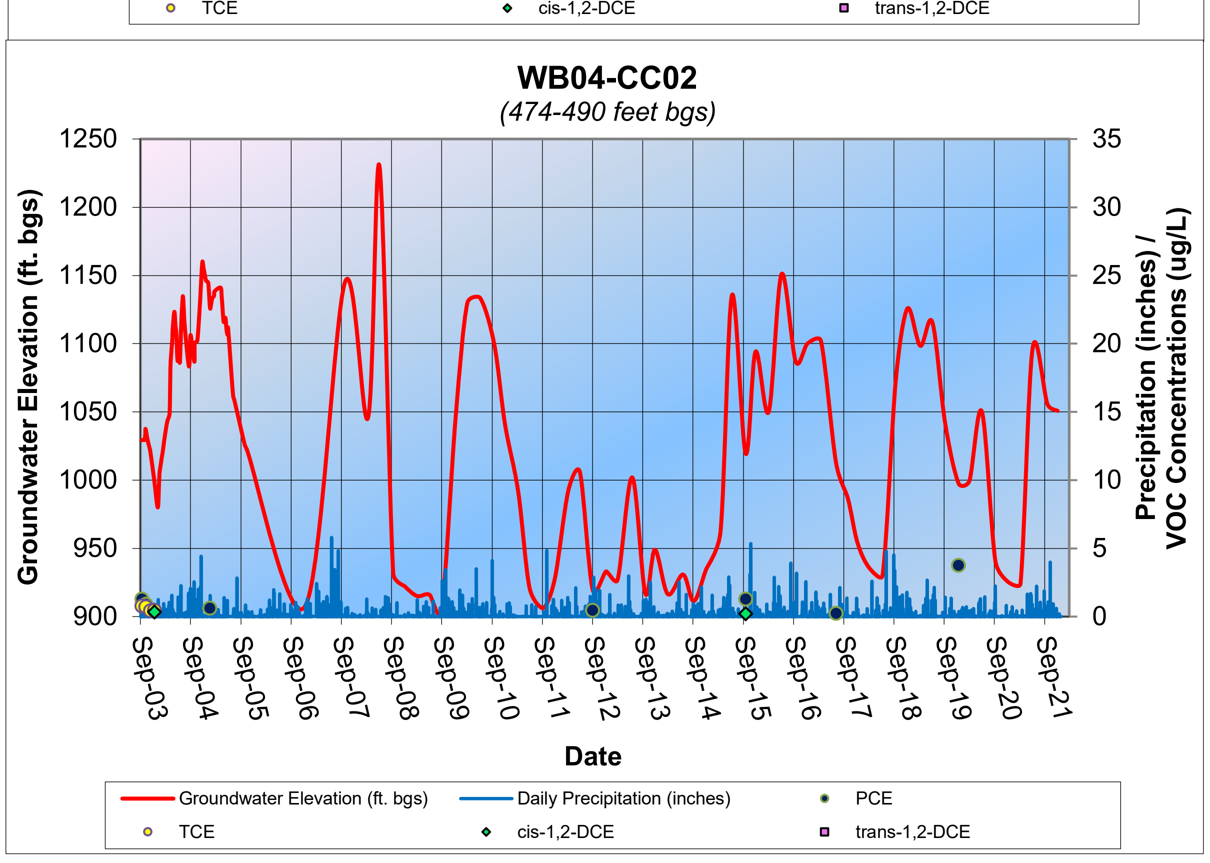






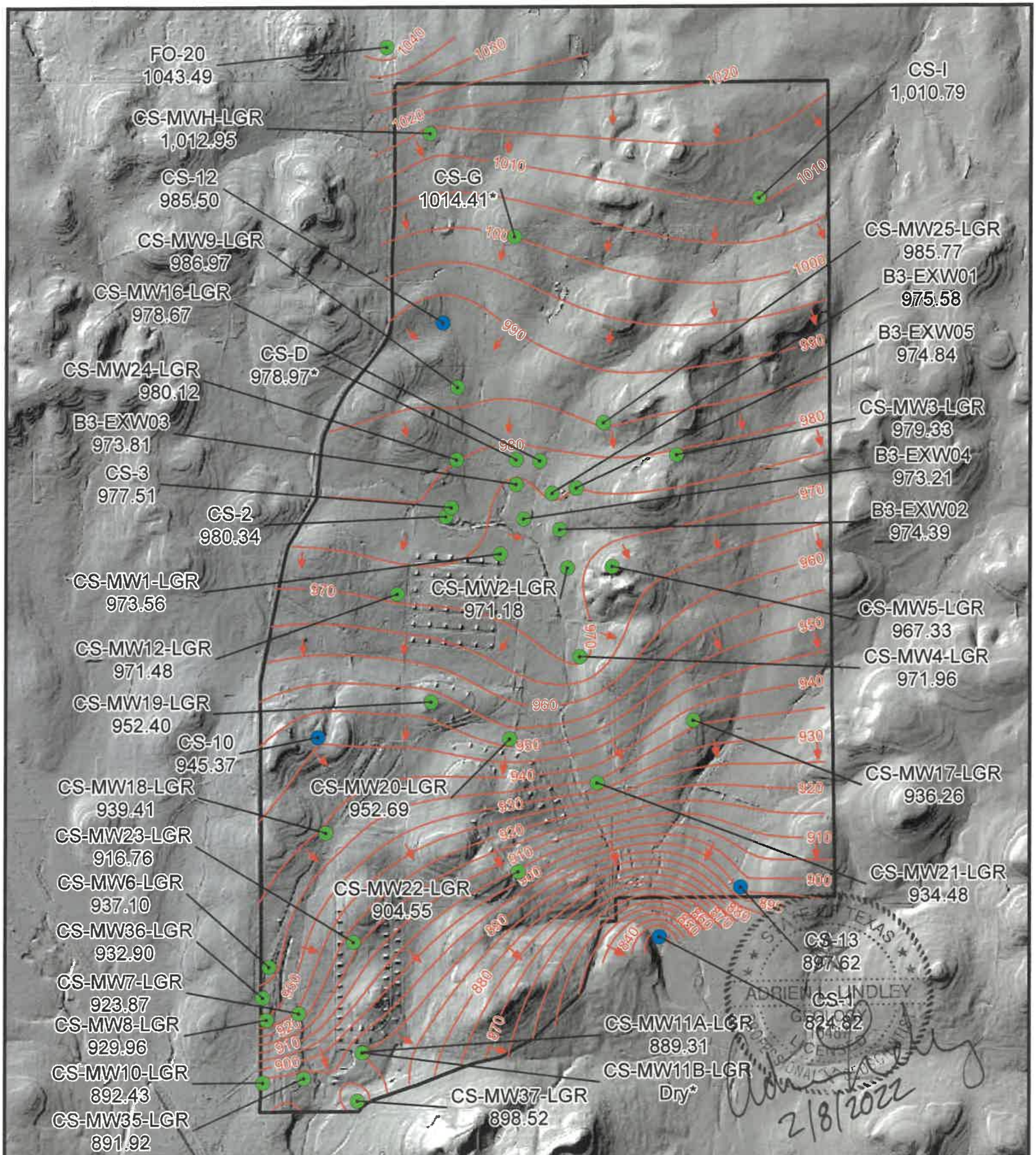






APPENDIX D

POTENTIOMETRIC MAPS FOR MARCH, JUNE, SEPTEMBER, DECEMBER 2021



Flow direction

Outer fence

LGR Groundwater Contours

LGR Wells and groundwater elevation (ft above msl)

Drinking water wells (may be completed in LGR, BS, and/or CC)

N

0 0.5 Miles

* Not a fully penetrating well into LGR. Groundwater elevation not used in contouring

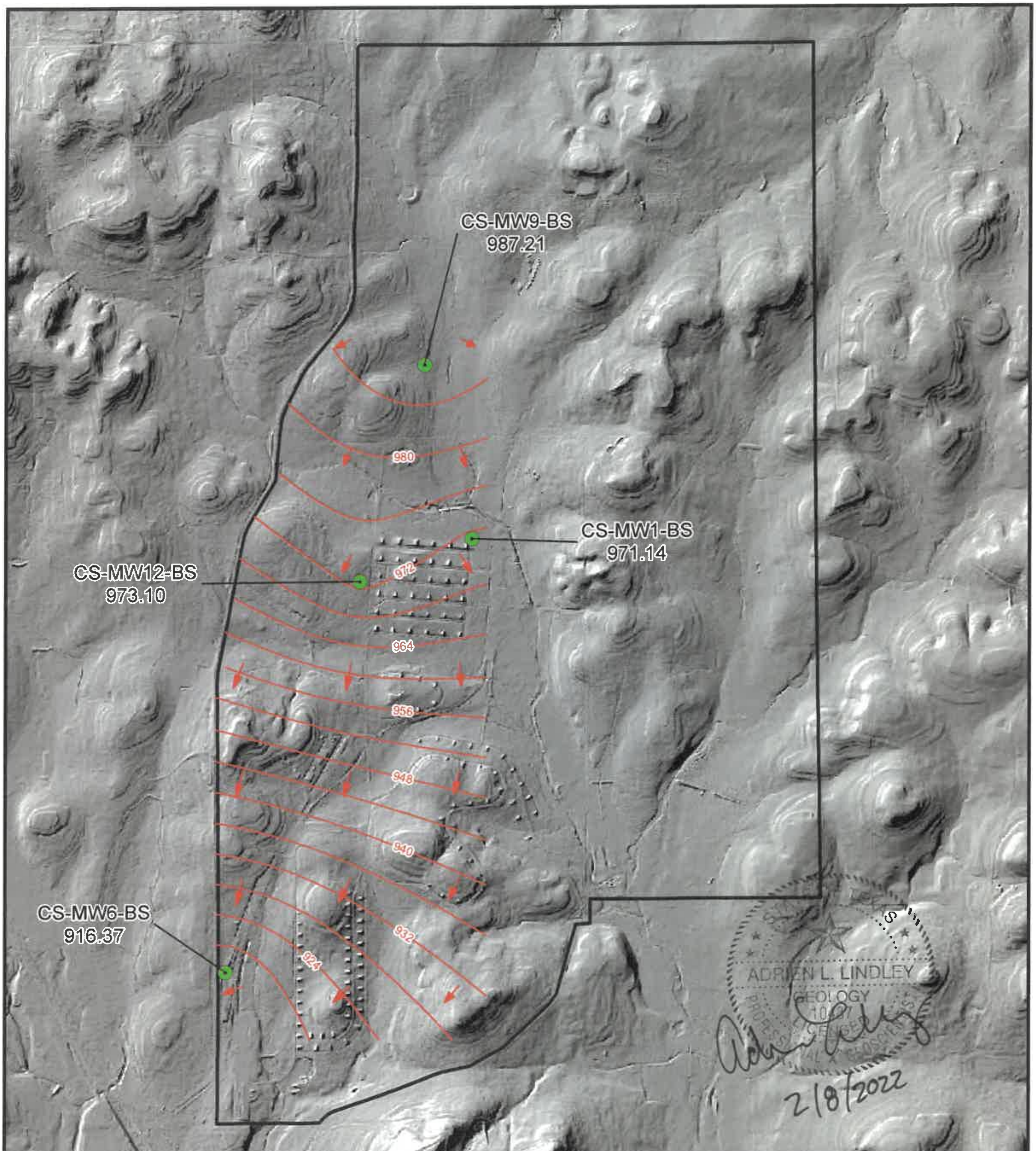
Figure D.1

March 2021 Potentiometric Surface Map, LGR Wells

Camp Stanley Storage Activity

PARSONS

C:\CSSA\GIS\GW_POTENTIOMETRIC\MAR2021\Mar21_potentiometric_lgr.mxd - 4/14/2021 @ 1:10:09 PM



N

0 0.5 Miles

Flow direction
Outer fence
BS Groundwater Contours
BS Wells and groundwater elevation (ft above msl)

C:\CSSA\GIS\GW_POTENTIOMETRIC\MAR2021\Mar21_potentiometric_bs.mxd - 4/14/2021 @ 2:40:16 PM

Figure D.2

March 2021 Potentiometric Surface Map, BS Wells

Camp Stanley Storage Activity

PARSONS

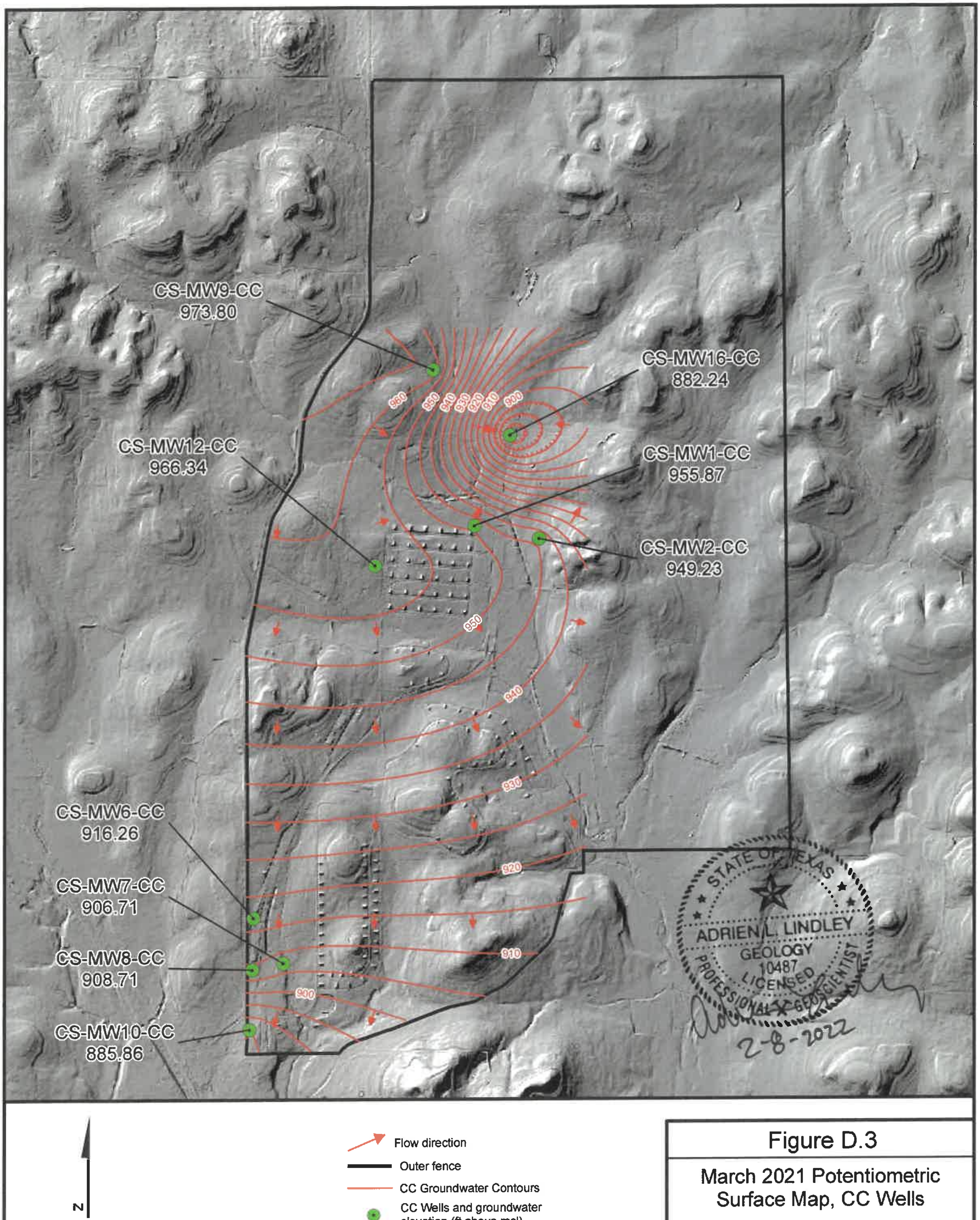


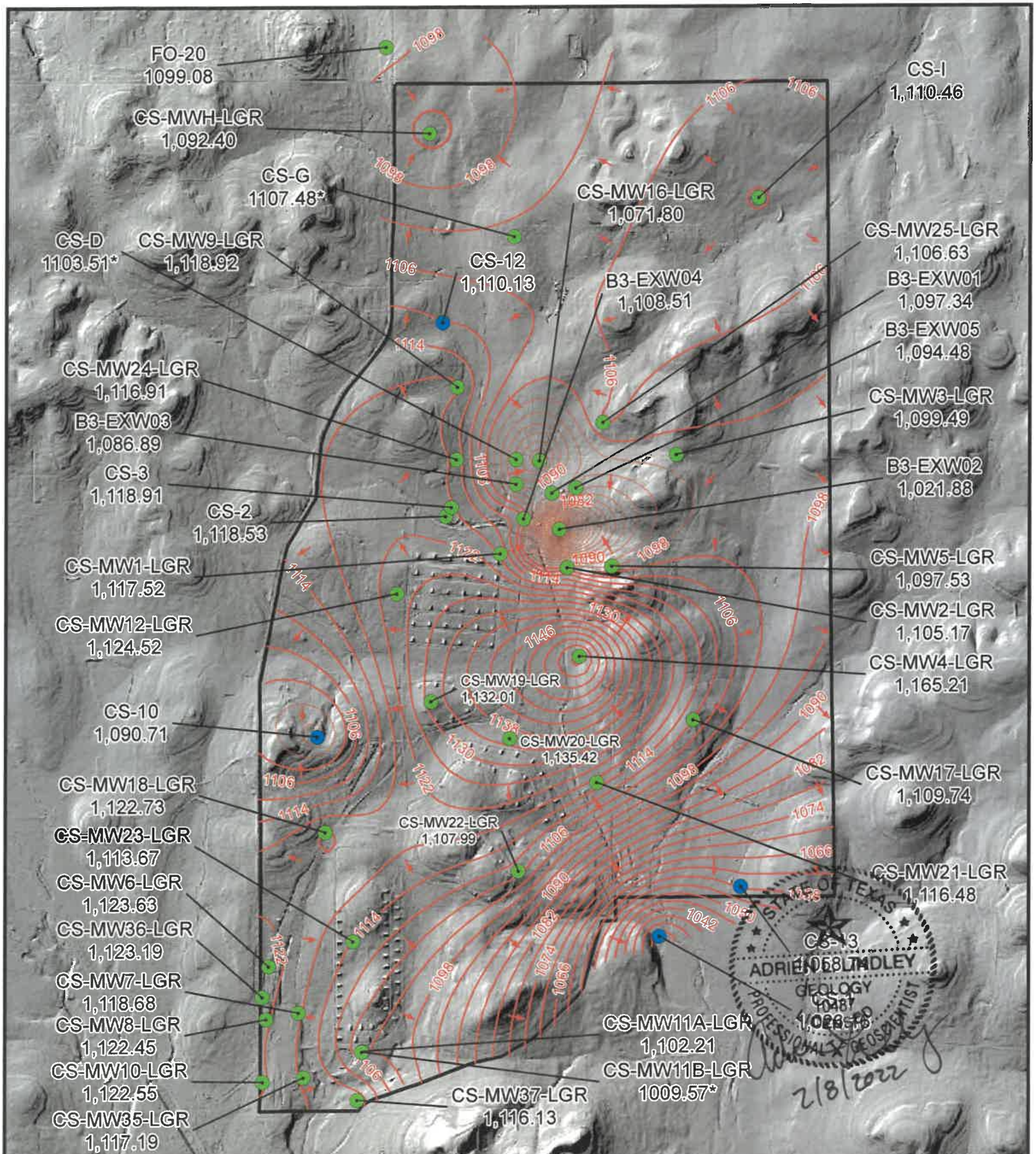
Figure D.3

March 2021 Potentiometric Surface Map, CC Wells

Camp Stanley Storage Activity

PARSONS

C:\CSSA\GIS\GW_POTENTIOMETRIC\MAR2021\Mar21_potentiometric_cc.mxd - 4/14/2021 @ 3:03:30 PM



N

0 0.5 Miles

Flow direction
Outer fence
LGR Groundwater Contours
LGR Wells and groundwater elevation (ft above msl)
Drinking water wells (may be completed in LGR, BS, and/or CC)

* Not a fully penetrating well into LGR. Groundwater elevation not used in contouring

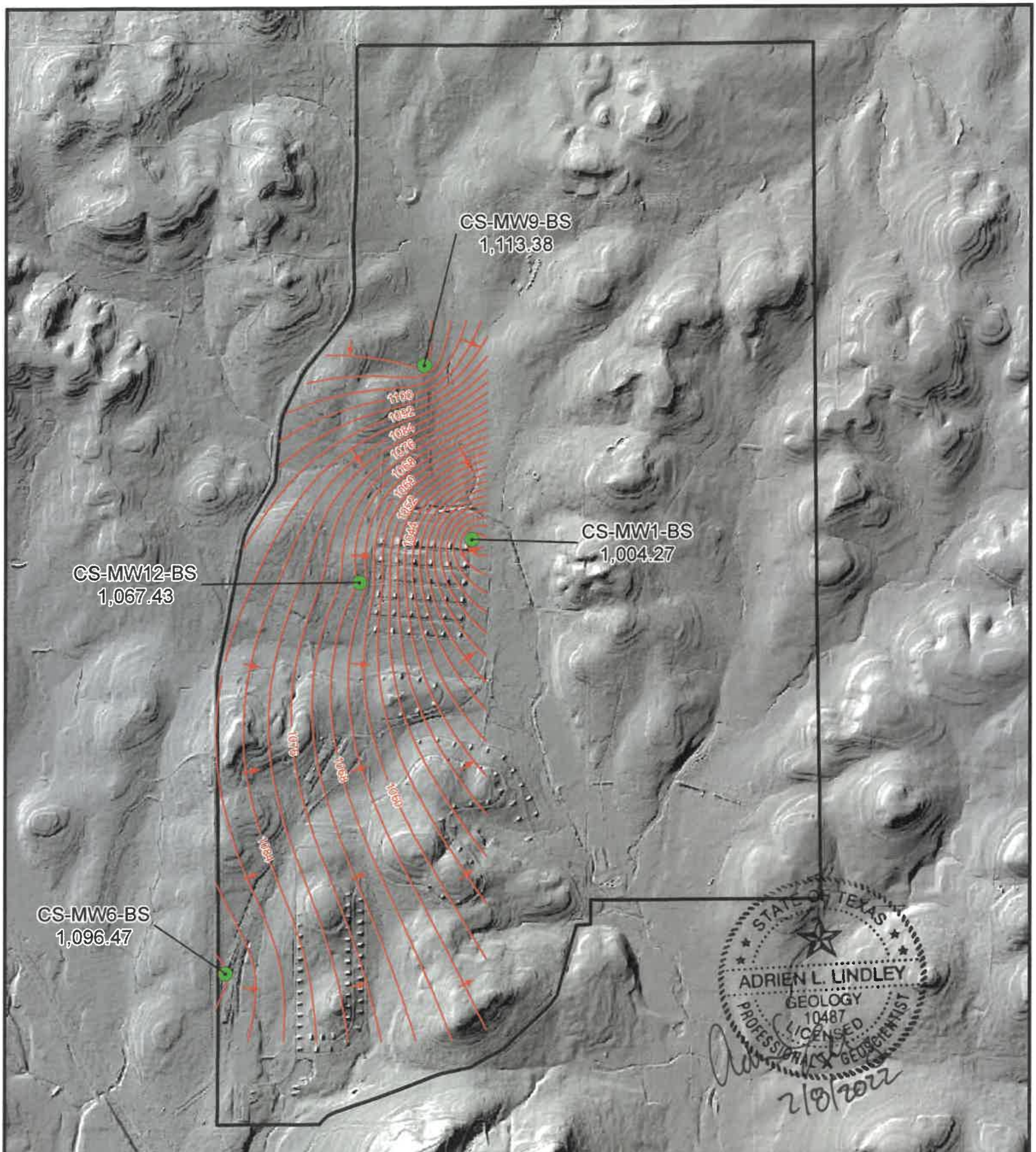
C:\CSSA\GIS\GW_POTENTIOMETRIC\JUN2021\Jun21_potentiometric_lgr.mxd - 7/14/2021 @ 5:30:46 PM

Figure D.4

June 2021 Potentiometric Surface Map, LGR Wells

Camp Stanley Storage Activity

PARSONS



N

0 0.5 Miles

Flow direction

Outer fence

BS Groundwater Contours

BS Wells and groundwater elevation (ft above msl)

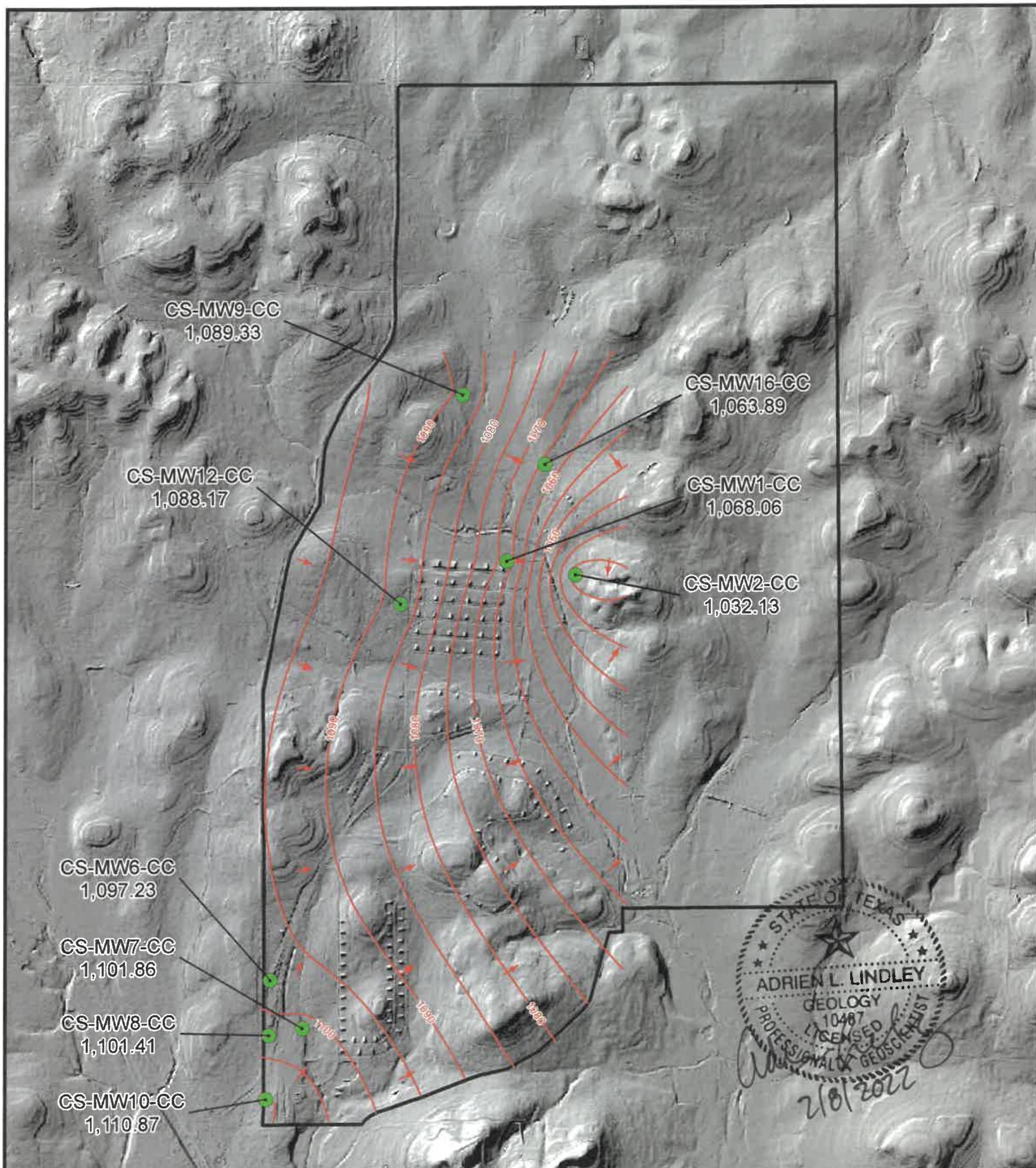
Figure D.5

June 2021 Potentiometric Surface Map, BS Wells

Camp Stanley Storage Activity

PARSONS

C:\CSSA\GIS\GW_POTENTIOMETRIC\JUN2021\Jun21_potentiometric_bs.mxd - 7/14/2021 @ 6:12:08 PM



N

0 0.5 Miles

Flow direction
Outer fence
CC Groundwater Contours
CC Wells and groundwater elevation (ft above msl)

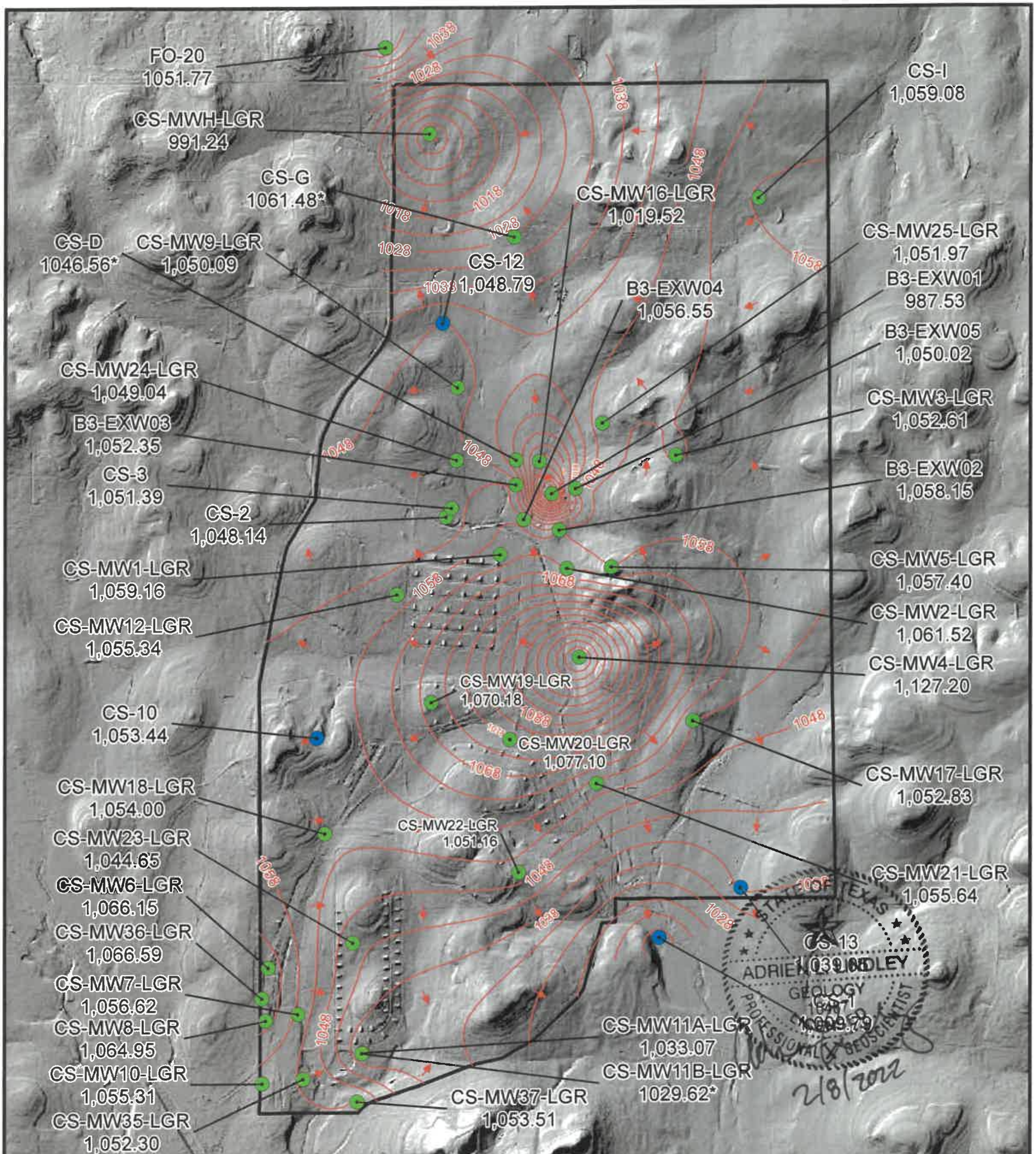
Figure D.6

June 2021 Potentiometric Surface Map, CC Wells

Camp Stanley Storage Activity

PARSONS

C:\CSSA\GIS\GW_POTENTIOMETRIC\JUN2021\Jun21_potentiometric_cc.mxd - 7/14/2021 @ 5:59:12 PM



N

0 0.5 Miles

Flow direction

Outer fence

LGR Groundwater Contours

LGR Wells and groundwater elevation (ft above msl)

Drinking water wells (may be completed in LGR, BS, and/or CC)

* Not a fully penetrating well into LGR. Groundwater elevation not used in contouring

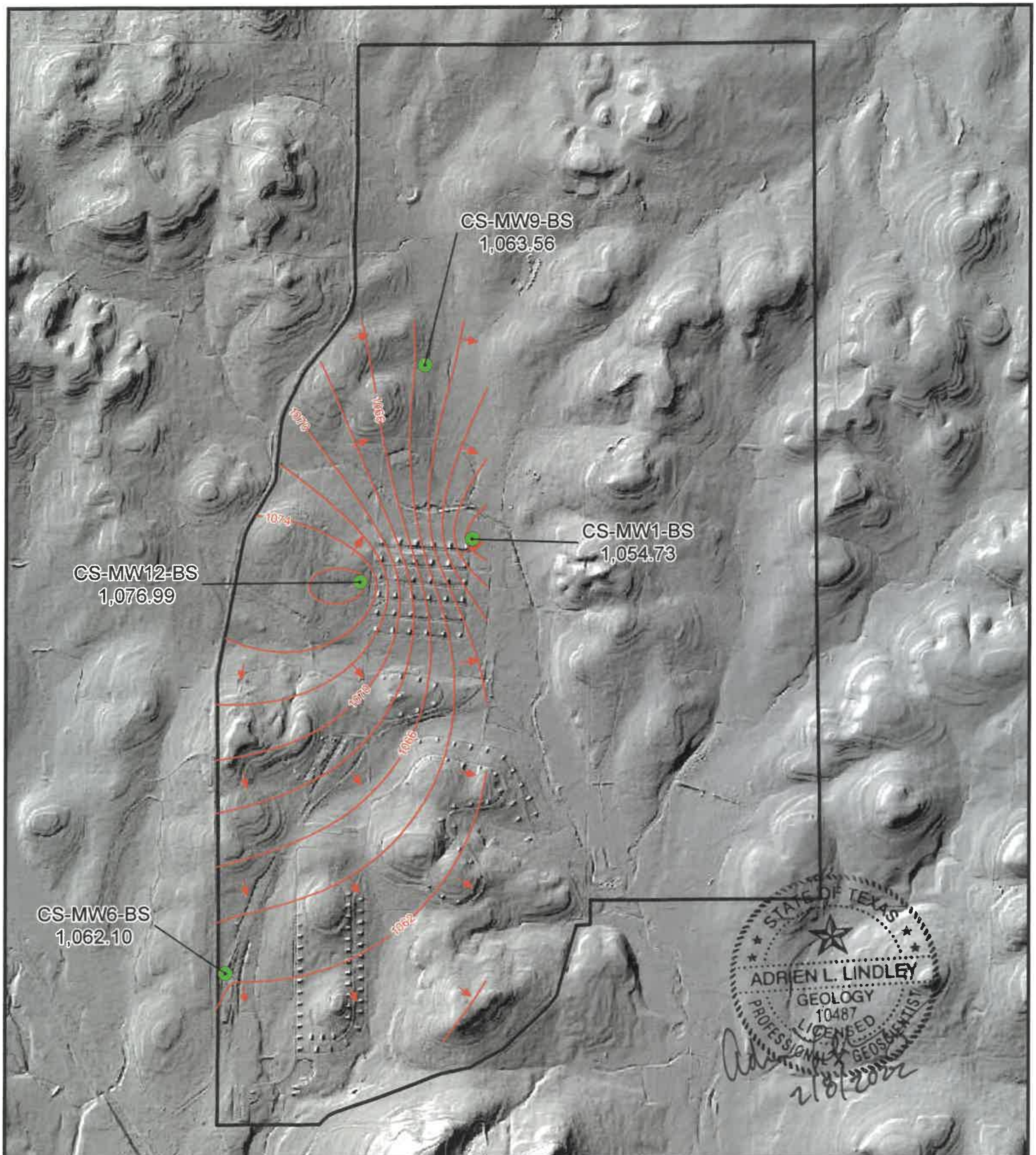
C:\CSSA\GIS\GW_POTENTIOMETRIC\SEP2021\Sep21_potentiometric_lgr.mxd - 11/30/2021 @ 1:01:02 PM

Figure D.7

September 2021 Potentiometric Surface Map, LGR Wells

Camp Stanley Storage Activity

PARSONS



N

0 0.5 Miles

Flow direction

Outer fence

BS Groundwater Contours

BS Wells and groundwater elevation (ft above msl)

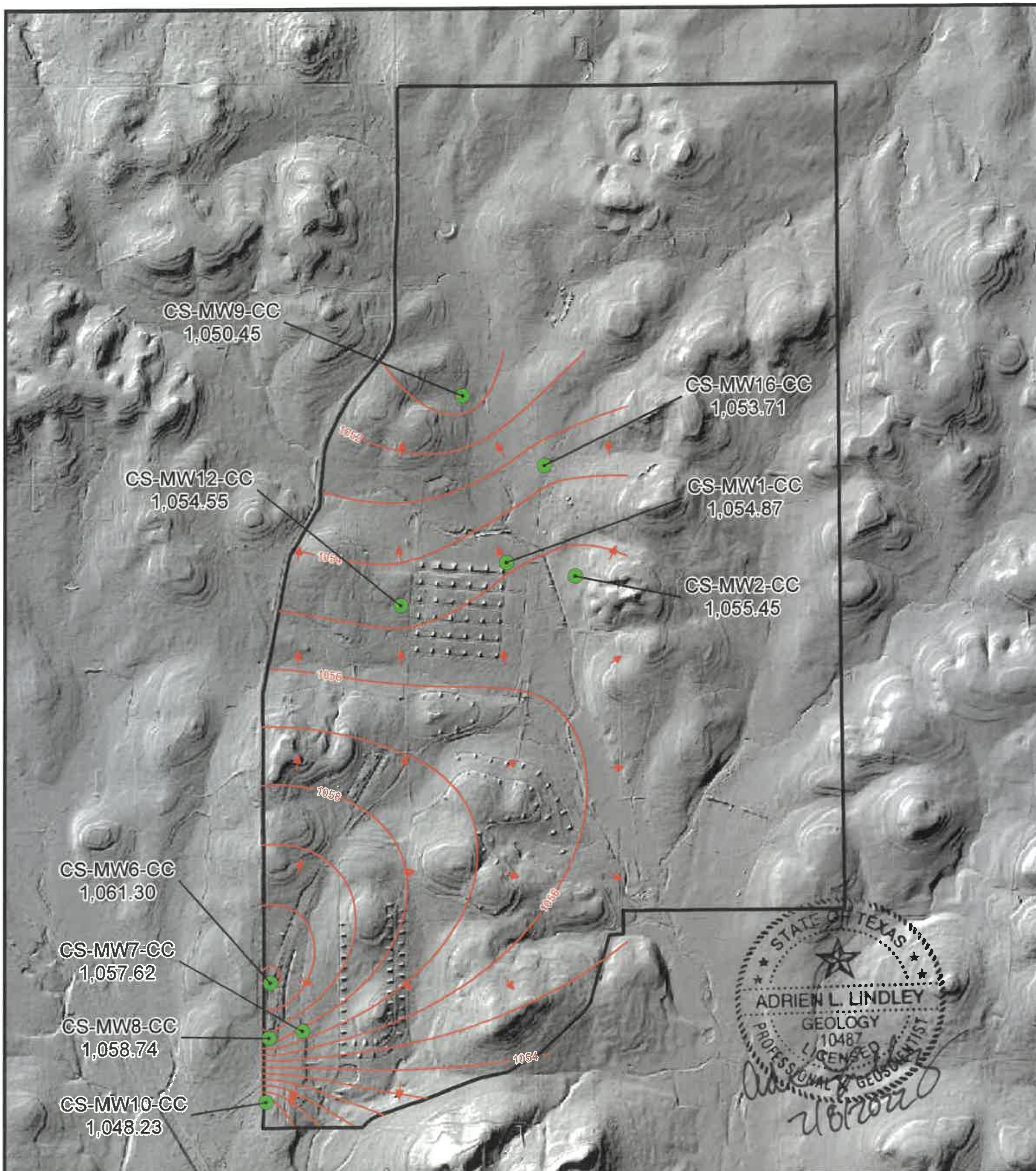
C:\CSSA\GIS\GW_POTENTIOMETRIC\SEP2021\Sep21_potentiometric_bs.mxd - 11/30/2021 @ 1:08:16 PM

Figure D.8

September 2021 Potentiometric Surface Map, BS Wells

Camp Stanley Storage Activity

PARSONS



N

0 0.5 Miles

Flow direction
Outer fence
CC Groundwater Contours
CC Wells and groundwater elevation (ft above msl)

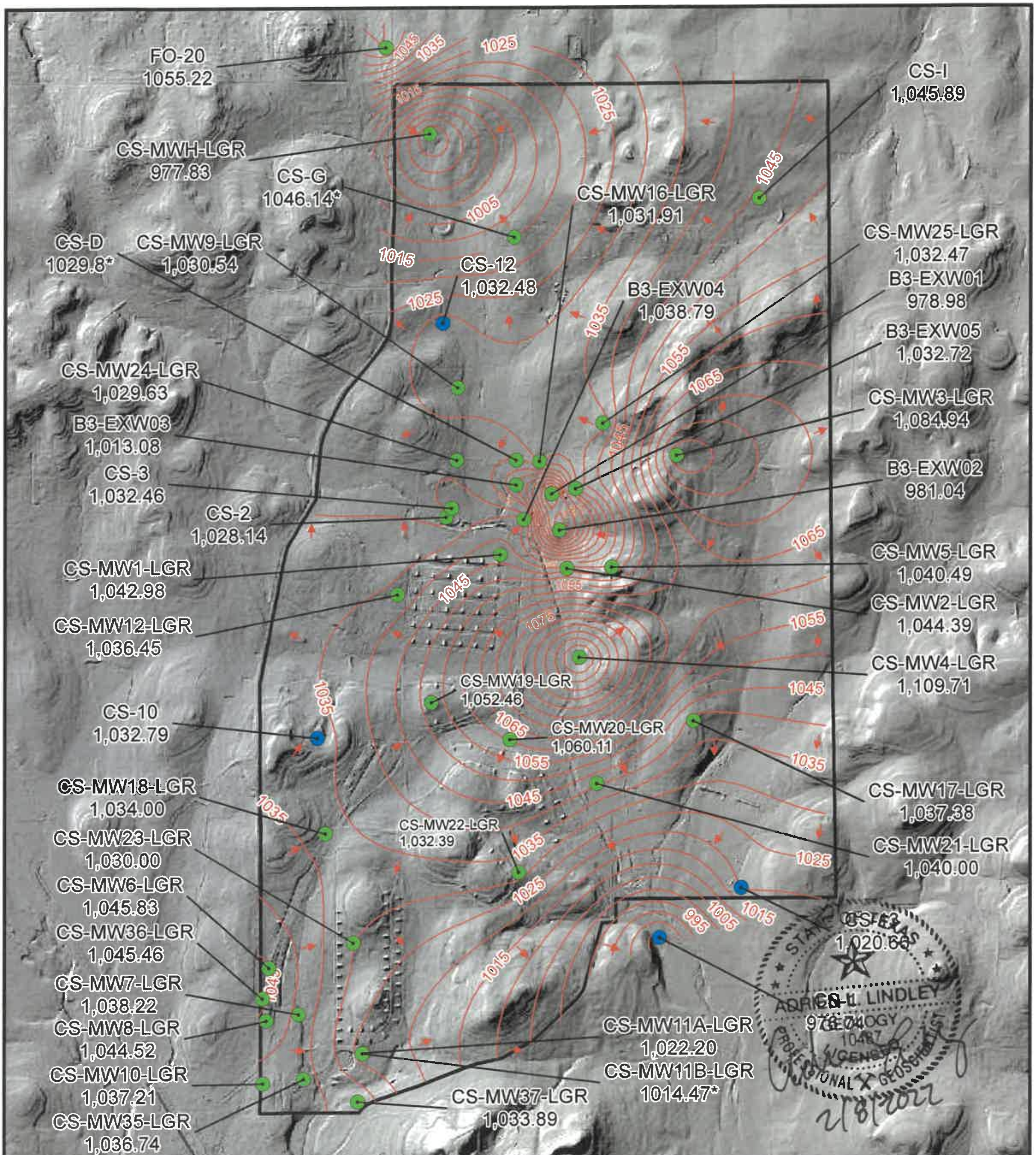
Figure D.9

September 2021 Potentiometric Surface Map, CC Wells

Camp Stanley Storage Activity

PARSONS

C:\CSSA\GIS\GW_POTENTIOMETRIC\SEP2021\Sep21_potentiometric_cc.mxd - 11/30/2021 @ 1:05:31 PM



N

0 0.5 Miles

Flow direction

Outer fence

LGR Groundwater Contours

LGR Wells and groundwater elevation (ft above msl)

Drinking water wells (may be completed in LGR, BS, and/or CC)

* Not a fully penetrating well into LGR. Groundwater elevation not used in contouring

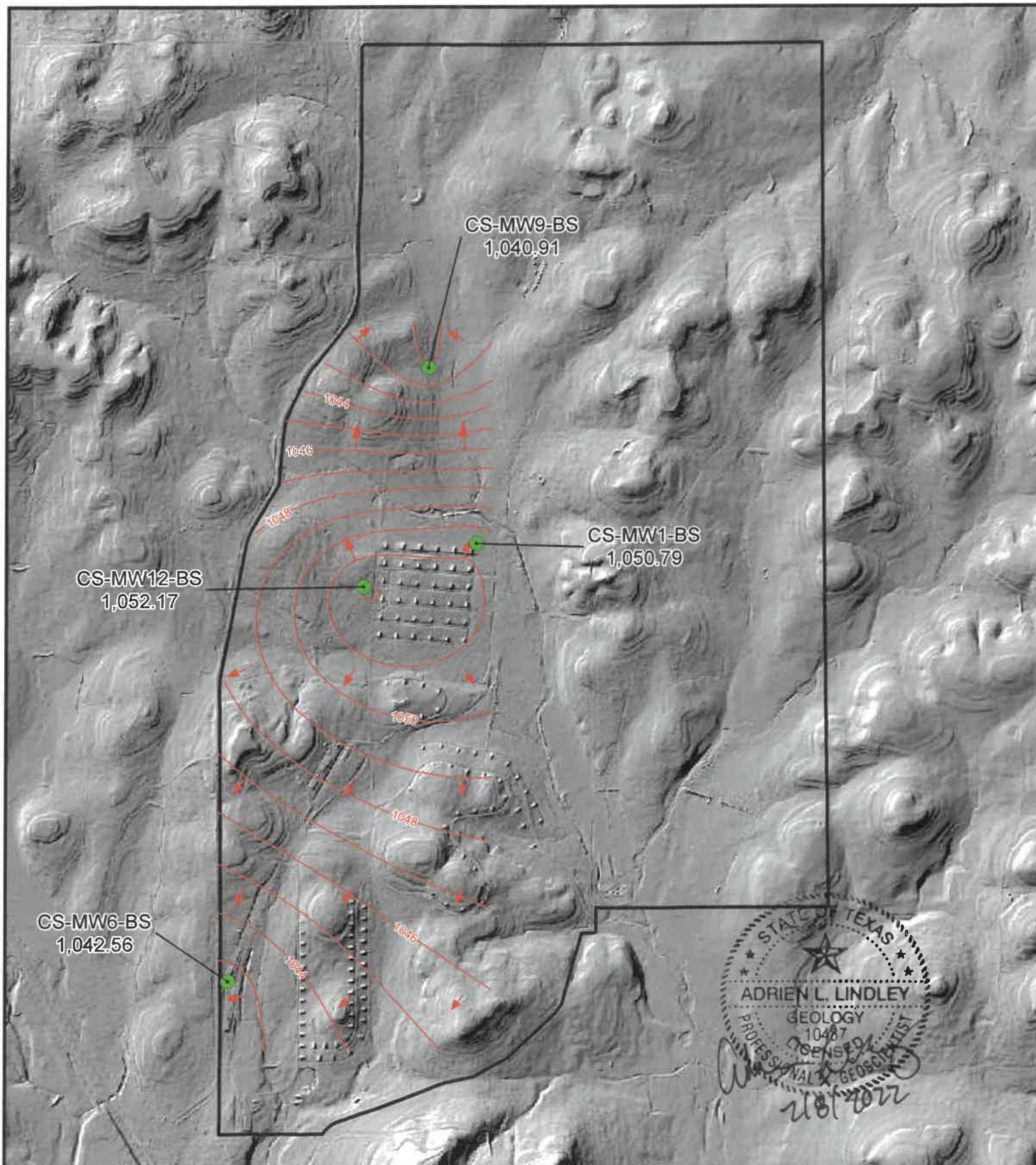
C:\CSSA\GIS\GW_POTENTIOMETRIC\DEC2021\Dec21_potentiometric_lgr.mxd - 1/11/2022 @ 12:56:56 PM

Figure D.10

December 2021 Potentiometric Surface Map, LGR Wells

Camp Stanley Storage Activity

PARSONS



N

0 0.5 Miles

Flow direction

Outer fence

BS Groundwater Contours

BS Wells and groundwater elevation (ft above msl)

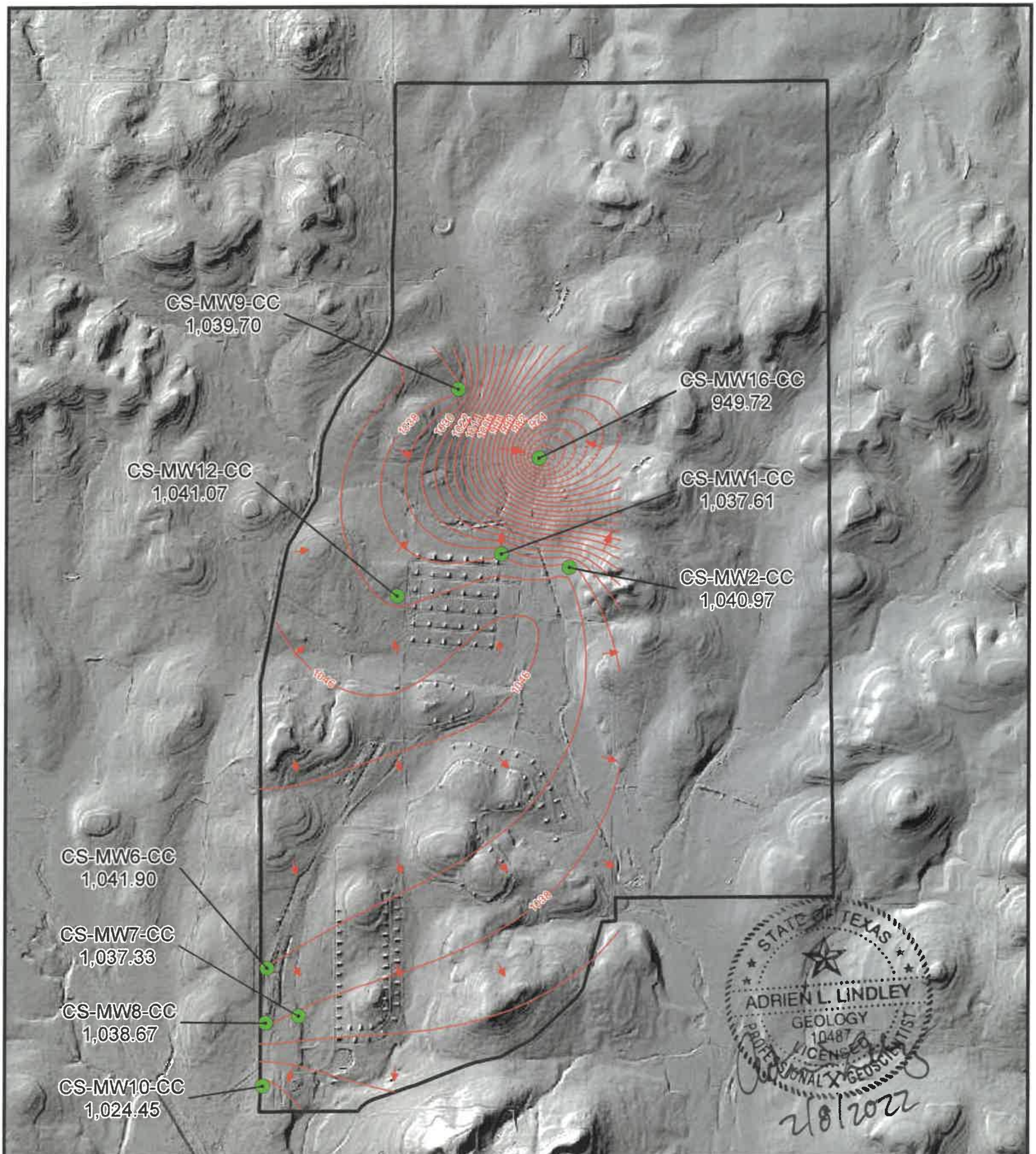
C:\CSSA\GIS\GW_POTENTIOMETRIC\DEC2021\Dec21_potentiometric_bs.mxd - 1/11/2022 @ 1:53:34 PM

Figure D.11

December 2021 Potentiometric Surface Map, BS Wells

Camp Stanley Storage Activity

PARSONS



N

0 — 0.5 Miles

Flow direction

Outer fence

CC Groundwater Contours

CC Wells and groundwater elevation (ft above msl)

Figure D.12

December 2021 Potentiometric Surface Map, CC Wells

Camp Stanley Storage Activity

PARSONS

C:\CSSA\GIS\GW_POTENTIOMETRIC\DEC2021\Dec21_potentiometric_cc.mxd - 1/11/2022 @ 2:16:21 PM

APPENDIX E

2021 QUARTERLY OFF-POST GROUNDWATER ANALYTICAL RESULTS

Appendix E
2021 Quarterly Off-Post Groundwater Monitoring Analytical Results

Well ID		Sample Date	Laboratory	*cis*-1,2-DCE (ug/L)	PCE (ug/L)	TCE (ug/L)
LS-5		3/1/2021	APPL	0.07U	**1.01F**	**3.99**
		6/2/2021	APPL	0.07U	**1.07F**	**4.21**
		9/1/2021	APPL	0.07U	**1.24F**	**4.04**
		12/1/2021	ETA	0.15U	**1.17**	**3.67**
LS-5-A2		3/1/2021	APPL	0.07U	0.06U	0.05U
		4/5/2021	APPL	0.07U	0.06U	0.05U
	Duplicate	4/5/2021	APPL	0.07U	0.06U	0.05U
		9/1/2021	APPL	0.07U	0.06U	0.05U
		10/27/2021	APPL	0.07U	0.06U	0.05U
LS-6		6/2/2021	APPL	0.07U	**0.51F**	0.05U
		9/1/2021	APPL	0.07U	**0.99F**	**0.23F**
		12/1/2021	ETA	0.15U	**1.01**	**0.792J**
LS-6-A2		4/5/2021	APPL	0.07U	0.06U	0.05U
		9/1/2021	APPL	**0.16F**	0.06U	0.05U
		10/27/2021	APPL	0.07U	0.06U	0.05U
	Duplicate	10/27/2021	APPL	0.07U	0.06U	0.05U
LS-7		3/1/2021	APPL	0.07U	**1.61**	0.05U
		6/2/2021	APPL	0.07U	**0.65F**	0.05U
		9/1/2021	APPL	0.07U	**0.95F**	0.05U
		12/1/2021	ETA	0.15U	**0.991J**	**0.82J**
LS-7-A2		3/1/2021	APPL	0.07U	0.06U	0.05U
		4/5/2021	APPL	0.07U	0.06U	0.05U
		9/1/2021	APPL	0.07U	0.06U	0.05U
		10/27/2021	APPL	0.07U	0.06U	0.05U
OFR-3		3/1/2021	APPL	0.07U	**4.25**	**2.38**
		6/2/2021	APPL	0.07U	**4.50**	**3.26**
		9/1/2021	APPL	0.07U	**5.50**	**3.31**
	Duplicate	9/1/2021	APPL	0.07U	**4.77**	**3.44**
		12/1/2021	ETA	0.15U	**4.68**	**3.17**
OFR-3-A2		3/1/2021	APPL	0.07U	0.06U	0.05U
		4/5/2021	APPL	0.07U	0.06U	0.05U
		9/1/2021	APPL	0.07U	0.06U	0.05U
		10/27/2021	APPL	0.07U	0.06U	0.05U
RFR-10		3/1/2021	APPL	0.07U	**6.12**	**1.71**
		6/2/2021	APPL	0.07U	**6.30**	**4.93**
	Duplicate	6/2/2021	APPL	0.07U	**6.13**	**5.12**
		9/1/2021	APPL	0.07U	**8.13**	**4.34**
		12/1/2021	ETA	0.15U	**10.50**	**5.62**
RFR-10-A2		3/1/2021	APPL	0.07U	0.06U	0.05U
	Duplicate	3/1/2021	APPL	0.07U	0.06U	0.05U
		4/5/2021	APPL	0.07U	0.06U	0.05U
		9/1/2021	APPL	0.07U	0.06U	0.05U
		10/27/2021	APPL	0.07U	0.06U	0.05U
RFR-10-B2		3/1/2021	APPL	0.07U	0.06U	0.05U
		4/5/2021	APPL	0.07U	0.06U	0.05U
		9/1/2021	APPL	0.07U	0.06U	0.05U
		10/27/2021	APPL	0.07U	0.06U	0.05U
RFR-11		3/1/2021	APPL	0.07U	0.06U	**2.55**
		6/2/2021	APPL	0.07U	**1.61**	0.05U
		9/1/2021	APPL	0.07U	**1.69**	**0.76F**
		12/1/2021	ETA	0.15U	**1.49**	**1.3**
RFR-11-A2		3/1/2021	APPL	0.07U	0.06U	0.05U
		4/5/2021	APPL	0.07U	0.06U	0.05U
		9/1/2021	APPL	0.07U	0.06U	0.05U
		10/27/2021	APPL	0.07U	0.06U	0.05U
Comparison Criteria						
Maximum Contaminant Level (MCL)				**70**	**5.0**	**5.0**
APPL Reporting Limit (RL)				**1.2**	**1.4**	**1.0**
ETA Limit of Quantitation (LOQ)				**1.0**	**1.0**	**1.0**
Method Detection Limit (MDL)				**0.07**	**0.06**	**0.05**
ETA Detection Limit (DL)				**0.15**	**0.20**	**0.16**

Bold (red)	Value ≥ MCL
Bold (blue)	MCL > Value ≥ RL/LOQ
Bold	RL > Value > MDL/DL

Samples analyzed by APPL, Inc. used method SW8260B.
Samples analyzed by ETA used method SW8260C.
VOC data reported in ug/L & metals data reported in mg/L.

Appendix E
2021 Quarterly Off-Post Groundwater Monitoring Analytical Results

Well ID	Sample Date	Laboratory	*cis*-1,2-DCE (ug/L)	PCE (ug/L)	TCE (ug/L)

Abbreviations/Notes:

µg/L	micrograms per liter
mg/L	milligrams per liter
Duplicate	Field Duplicate
TCE	Trichloroethene
PCE	Tetrachloroethene
DCE	Dichloroethene

APPENDIX F

PRE- AND POST-GAC SAMPLE COMPARISONS FOR WELLS LS-5, LS-6, LS-7, OFR-3, RFR-10, AND RFR-11

APPENDIX F

PRE- AND POST-GAC SAMPLE COMPARISONS FOR WELLS LS-5, LS-6, LS-7, RFR-10, RFR-11, AND OFR-3

LS-5					LS-6				
	PCE (µg/L)		TCE (µg/L)			PCE (µg/L)		TCE (µg/L)	
Date	Pre	Post	Pre	Post	Date	Pre	Post	Pre	Post
3/1/21	1.01	ND	3.99	ND	3/1/21	NA	NA	NA	NA
4/5/21	NA	ND	NA	ND	4/5/21	NA	ND	NA	ND
4/5/21 FD	NA	ND	NA	ND	6/2/21	0.51	NA	ND	NA
6/2/21	1.07	NA	4.21	NA	9/1/21	0.99	ND	0.23	ND
9/1/21	1.24	ND	4.04	ND	10/27/21	NA	ND	NA	ND
10/27/21	NA	ND	NA	ND	10/27/21 FD	NA	ND	NA	ND
12/1/21	1.17	NA	3.67	NA	12/1/21	1.01	NA	0.79	NA

LS-7					RFR-10				
	PCE (µg/L)		TCE (µg/L)			PCE (µg/L)		TCE (µg/L)	
Date	Pre	Post	Pre	Post	Date	Pre	Post	Pre	Post
3/1/21	1.61	ND	ND	ND	3/1/21	**6.12**	ND	**1.71**	ND
4/5/21	NA	ND	NA	ND	3/1/21 FD	NA	ND	NA	ND
6/2/21	0.65	NA	ND	NA	4/5/21	NA	ND	NA	ND
9/1/21	0.95	ND	ND	ND	6/2/21	**6.30**	NA	4.93	NA
10/27/21	NA	ND	NA	ND	6/2/21 FD	**6.13**	NA	**5.12**	NA
12/1/21	0.99	NA	0.82	NA	9/1/21	**8.13**	ND	4.34	ND
					10/27/21	NA	ND	NA	ND
					12/1/21	**10.50**	NA	5.62	NA

RFR-11					**OFR-3**				
	PCE (µg/L)		**TCE (µg/L)**			**PCE (µg/L)**		**TCE (µg/L)**	
Date	**Pre**	**Post**	**Pre**	**Post**	**Date**	**Pre**	**Post**	**Pre**	**Post**
3/1/21	ND	ND	2.55	ND	3/1/21	4.25	ND	2.38	ND
4/5/21	NA	ND	NA	ND	4/5/21	NA	ND	NA	ND
6/2/21	1.61	NA	ND	NA	6/2/21	4.50	NA	3.26	NA
9/1/21	1.69	ND	0.76	ND	9/1/21	**5.50**	ND	3.31	ND
10/27/21	NA	ND	NA	ND	9/1/21 FD	4.77	ND	3.44	ND
12/1/21	1.49	NA	1.3	NA	10/27/21	NA	ND	NA	ND
					12/1/21	4.68	NA	3.17	NA

NA – not applicable (not sampled during this event)
ND – indicates analyte was not detected at or above the MDL.
FD – field duplicate.

APPENDIX G

DECEMBER 2021
DATA VERIFICATION REPORTS

Lab Data Package # 280-156314-1

DATA VERIFICATION SUMMARY REPORT

for groundwater samples collected from

CAMP STANLEY STORAGE ACTIVITY

BOERNE, TEXAS

Data Verification by: Sandra de las Fuentes
Parsons - Austin

INTRODUCTION

The following data verification summary report covers twenty water samples collected from Camp Stanley Storage Activity (CSSA) December 1 and 2, 2021. The samples were assigned to the following Sample Delivery Group (SDG).

280-156314

The field QC sample associated with this SDG was one trip blank (TB), one matrix spike/matrix spike duplicate (MS/MSD) set, and one field duplicate (FD). No ambient blanks were collected. During the initiation of this project, it was determined that ambient blanks were not necessary, due to the absence of a source at these sites.

All samples were collected by Parsons and analyzed by Eurofins TestAmerica in Denver, Colorado (ETA) following the procedures outlined in Quote#56009117. Samples in this SDG were shipped to the laboratory in a single cooler, which was received by the laboratory at an acceptable temperature of 0.3ºC.

SAMPLE IDs AND REQUESTED PARAMETERS

Sample ID	Matrix	VOCs	Metals	Mercury	Comments
TB-1	Water	X			
LS-7	Water	X			
LS-5	Water	X			
OFR-3	Water	X			
RFR-10	Water	X			
RFR-11	Water	X			
LS-6	Water	X			
CS-12	Water	X	X	X	MS/MSD
CS-13	Water	X	X	X	
CS-1	Water	X	X	X	
CS-1-FD	Water	X	X	X	FD of CS-1
CS-10	Water	X	X	X	

EXTRACTION, ANALYTICAL, AND REPORTING DETAILS

Parameter	Matrix	Prep Method	Analytical Method	Units
VOCs	Water	SW5030B	SW8260C	µg/L
Metals	Water	SW3020A	SW6020A	mg/L
Mercury	Water	SW7470A	SW7470A	mg/L

EVALUATION CRITERIA

The data submitted by the laboratory has been reviewed and verified following the guidelines outlined in Quote#56009117 and in the spirit of the CSSA QAPP, Version 1.0. The control limits used to evaluate the surrogates, laboratory control samples (LCSs), and MS/MSDs are also referenced in the DoD QSM, version 5.3 for the methods in this data set. Information reviewed in the data package included sample results; field and laboratory quality control samples; calibrations; case narratives; raw data; chain-of-custody (COC) forms and the sample receipt checklist. The findings presented in this report are based on the reviewed information, and whether the guidelines in the quote and CSSA QAPP were met.

A table detailing the data qualifiers applied, removed, or changed for the sample in this SDG as a result of the data validation process is included at the end of this report.

VOLATILES

General

The volatiles portion of this data package consisted of fourteen (14) groundwater samples, including one (1) TB, one (1) MS/MSD set and one (1) FD. All samples were collected on October 1 and 2, 2021 and analyzed for a reduced list of VOCs which included: *cis*-1,2-dichloroethene (cis 1,2-DCE), tetrachloroethene, trichloroethene (TCE), and vinyl chloride.

The VOC analyses were performed using United States Environmental Protection Agency (USEPA) SW846 Method 8260C. The samples were analyzed in two analytical batches, #560213 and #560251, under one initial calibration (ICAL). All samples were analyzed following the procedures outlined in Quote#56009117 and were prepared and analyzed within the holding time required by the method. All analyses were performed undiluted.

Accuracy

Accuracy was evaluated using the percent recovery (%R) obtained from the laboratory control sample (LCS), LCS duplicate (LCSD), the MS, MSD, and the surrogate spikes. Sample CS-12 was designated as the MS/MSD on the COC.

All LCS, LCSD, MS and MSD spike recoveries were within acceptance criteria.

The surrogate spike recoveries were within acceptance criteria, except as follows.

Sample ID	Surrogate	Recovery	Recovery Criteria
TB-1	1,2-Dichloroethane-d4	119	81-118%
TB-1	4-Bromofluorobenzene	116	85-114%
CS-12	1,2-Dichloroethane-d4	121	81-118%
CS-12-MS	1,2-Dichloroethane-d4	120	81-118%
CS-12-MSD	1,2-Dichloroethane-d4	126	81-118%
CS-13	1,2-Dichloroethane-d4	120	81-118%
CS-1	1,2-Dichloroethane-d4	121	81-118%
CS-1-FD	1,2-Dichloroethane-d4	121	81-118%
CS-10	1,2-dichloroethane-d4	125	81-118%

All surrogates listed above recovered high. The samples did not contain any target analytes; therefore, reanalysis was not required by the laboratory. The surrogates are associated with the TCE results, which the laboratory qualified with 'Q' flags. Since data quality was not affected, the data validator removed the Q flags.

Precision

Precision was evaluated using the relative percent difference (RPD) obtained from the LCS/LCSD and MS/MSD results. Precision was further evaluated by comparing the field duplicate analyte results. Sample CS-1-FD was collected and analyzed as the field duplicate of CS-1.

The LCS/LCSD and MS/MSD RPDs were within acceptance criteria.

There were no target VOCs detected above the reporting limit (RL) in the parent or FD samples.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents actual site conditions. Representativeness has been evaluated by:

- Comparing the COC procedures to those described in the CSSA QAPP;
- Comparing actual analytical procedures to those described in the CSSA QAPP;
- Evaluating holding times; and
- Examining laboratory blank and TB for cross contamination of samples during sample collection, transportation, and analysis.

All samples in this data package were analyzed following the COC and the analytical procedures described in the CSSA QAPP, Version 1.0. All samples were prepared and analyzed within the holding time required by the method.

- All instrument performance check criteria were met.
- All initial calibration criteria were met.
- All initial calibration verification (ICV) criteria were met. The ICV was prepared using a secondary source standard.
- All continuing calibration verification (CCV) criteria were met.

- All internal standard criteria were met.

Two method blanks were associated with the VOC analyses in this SDG. The MBs were non-detect for all target VOCs.

There was one trip blank sample associated with the VOC analyses in this SDG. The TB was non-detect for all target VOCs.

Completeness

Completeness has been evaluated in accordance with the CSSA QAPP. The number of usable results has been divided by the number of possible individual analyte results and expressed as a percentage to determine the completeness of the data set.

All VOC results for the samples in this SDG were considered usable. The completeness for this SDG is 100%, which meets the minimum acceptance criteria of 95%.

ICP-MS METALS

General

The ICP-MS portion of this SDG consisted of seven (7) groundwater samples, including one (1) FD, and one (1) MS/MSD set. All samples were collected on October 2, 2021. The samples were analyzed for arsenic, barium, cadmium, chromium, copper, lead, and zinc.

The ICP-MS metals analyses were performed using USEPA SW846 Method 6020A. All samples were analyzed following the procedures outlined in the Quote#56009117 and were prepared and analyzed within the holding time required by the method.

The samples for ICP-MS metals were digested in batch #560049 and analyzed in batches #560714 and #560935 (copper only). All analyses were performed undiluted.

Accuracy

Accuracy was evaluated using the percent recovery obtained from the LCS, LCSD, MS, and MSD. Sample CS-12 was designated as the MS/MSD on the COC.

All LCS, LCSD, MS, and MSD recoveries were within acceptance.

Precision

Precision was measured based on the RPD of LCSD/LCSD, MS/MSD results and parent/FD sample results. Sample CS-1-FD was collected and analyzed as the field duplicate of CS-1.

The LCS/LCSD and MS/MSD RPDs were within acceptance criteria.

Only the target metals detected above the reporting limit (RL) in the parent and FD samples were evaluated for RPD. All target metals met acceptance criteria for precision, except as follows.

Sample ID	Metal	Parent (mg/L)	FD (mg/L)	RPD	Criteria (RPD)
CS-1 / CS-1-FD	Copper Zinc	0.00685 0.0509	0.00207 0.0338	106.7 40.4	≤20

Copper and Zinc were qualified as estimated (J) due to the high reproducibility noted.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents actual site conditions. Representativeness has been evaluated by:

- Comparing the COC procedures to those described in the CSSA QAPP;
- Comparing actual analytical procedures to those described in the CSSA QAPP;
- Evaluating preservation and holding times; and
- Examining laboratory blank for cross contamination of samples during analysis.

All samples were analyzed following the COC and the analytical procedures described in the CSSA QAPP, Version 1.0, prepared and analyzed within the holding time required by the method.

- All initial calibration criteria were met.
- All second source verification criteria were met. The ICV was prepared using a secondary source.
- All CCV criteria were met.
- All CCVL criteria were met, except for the following. CCVL-280-560714 (12/14/21 20:00) reported Barium above the acceptance range of 70-130%, at 134%. All associated samples reported Barium at greater than 10 times the level of the CCVL, therefore data was not affected. The laboratory applied 'Q' flags to the Barium results in the associated samples, although the data validator removed them.
- All interference check (ICSA/ICSAB) criteria were met, except as follows. ICSA 280-560714/22 reported Barium greater than the LOD. The vendor acknowledges that these elements are trace impurities in the ICSA standard and are not indicative of matrix interference. The laboratory qualified the associated data with 'Q' flags, although the data validator removed them, since data quality was not affected.
- Dilution test (DT) was not applicable since all target metals met criteria in the MS/MSD.
- Post digestion spike (PDS) was also not applicable since all target metals met criteria in the MS/MSD samples.
- The initial calibration blank (ICB) and continuing calibration blank (CCB) samples were all non-detect.

One method blank was analyzed in association with the ICP-MS analyses in this SDG. The method blank was free of target metals at or above the RL, except as follows.

Blank ID	Metal	Conc. (mg/L)	LOQ (mg/L)
MB 280-560049/1-A (Batch # 560714)	Lead	0.000279 J	0.00300

The method blank above was associated with all the samples in the SDG. No action was required for analytes that were detected greater than 5 times the amount found in the MB. The following samples had Lead detected at less than 5 times the amount found in the MB.

Sample ID	Lead Conc. (mg/L)	Lead LOQ (mg/L)
CS-12	0.000554 J	0.00300
CS-13	0.00114 J	
CS-1	0.000770 J	
CS-1-FD	0.000420 J	
CS-10	0.000423 J	

For all samples listed above, the lead results were raised to the LOQ and qualified as non-detect (U).

Completeness

Completeness has been evaluated by comparing the total number of samples collected with the total number of samples with valid analytical data.

All ICP-MS metals results for the samples in this SDG were considered usable. The completeness for the ICP-MS metals portion of this SDG is 100%, which meets the minimum acceptance criteria of 95%.

MERCURY

General

The mercury portion of this SDG consisted of seven (7) groundwater samples, including one (1) FD, and one (1) MS/MSD set. All samples were collected on October 2, 2021 and were analyzed for mercury.

The mercury analyses were performed using USEPA SW846 Method 7470A. The samples were analyzed following the procedures outlined in the CSSA QAPP, prepared and analyzed within the holding time required by the method.

The mercury samples were prepared in batch #560195 and analyzed in batch #560368. All analyses were performed undiluted.

Accuracy

Accuracy was evaluated using the percent recovery obtained from the LCS, LCSD, MS and MSD. Sample CS-12 was designated as the MS/MSD on the COC.

The LCS, LCSD, MS and MSD recoveries were within acceptance criteria.

Precision

Precision was measured based on the RPD of MS/MSD results and parent/FD sample results. Sample CS-1-FD was collected and analyzed as the field duplicate of CS-1.

The LCS/LCSD and MS/MSD RPDs were within acceptance criteria.

Mercury was not detected above the reporting limit (RL) in the parent or FD samples.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents actual site conditions. Representativeness has been evaluated by:

- Comparing the COC procedures to those described in the CSSA QAPP;
- Comparing actual analytical procedures to those described in the CSSA QAPP;
- Evaluating holding times; and
- Examining laboratory blanks for cross contamination of samples during analysis.

All samples were analyzed following the COC and the analytical procedures described in the CSSA QAPP, prepared and analyzed within the holding times required by the method.

- All initial calibration criteria were met.
- All second source verification criteria were met. The ICV was prepared using a secondary source.
- All CCV criteria were met.

There was one method blank, and several calibration blanks associated with the mercury analyses in this SDG. All blanks were free of mercury.

Completeness

Completeness has been evaluated by comparing the total number of samples collected with the total number of samples with valid analytical data.

Mercury result for the samples in this SDG was considered usable. The completeness for the mercury portion of this SDG is 100%, which meets the minimum acceptance criteria of 95%.

DATA QUALIFIER DEFINITIONS

The data qualifiers are defined in Table 6.1-1 of the project-specific UFP-QAPP, as follows:

Data Validation Codes and Definitions

Data Qualifiers	Definitions
U	The analyte was analyzed for, but not detected. The associated numerical value is at or below the Method Detection Limit (MDL).
F	The analyte was positively identified; the quantitation is an estimation above the MDL and below the Reporting Limit (RL)
J	The analyte was positively identified, but the quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria.
UJ	The analyte was analyzed for, but not detected; the associated numerical value is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria.
M	A matrix effect was present.
R	Data is rejected as unusable due to serious deficiencies in meeting certain analyte-specific quality control criteria.

DATA QUALIFIER CHANGES

The following data qualifiers were added, removed, or changed as a result of the data validation process:

Sample ID	Analyte	Units	Original Result	Final Result	Reason Code
CS-1	Copper	mg/L	0.00685	0.00685 J	D1
CS-1	Zinc	mg/L	0.0509	0.0509 J	D1
CS-1-FD	Copper	mg/L	0.00207	0.00207 J	D1
CS-1-FD	Zinc	mg/L	0.0338	0.0338 J	D1
CS-12	Lead	mg/L	0.000554 J	0.00300 U	B4
CS-13	Lead	mg/L	0.00114 J	0.00300 U	B4
CS-1	Lead	mg/L	0.000770 J	0.00300 U	B4
CS-1-FD	Lead	mg/L	0.000420 J	0.00300 U	B4
CS-10	Lead	mg/L	0.000423 J	0.00300 U	B4

REASON CODE DEFINITIONS

Reason codes were used to document the logic behind all data validation qualifiers. The following reason codes for data qualification were associated with the samples in this SDG:

D1: Field duplicate precision infraction

B4: Method Blank Infraction (Qualified Detect)

APPENDIX H

LTMO AND DQO REGULATOR APPROVAL CORRESPONDENCE

September 18, 2020
September 23, 2020

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

September 18, 2020

Via E-mail

Mr. John Ferguson
Installation Manager
Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015

Re: Approval
Data Quality Objectives Groundwater Monitoring Program and Three-Tiered Long-Term Monitoring Network Optimization Evaluation, dated September 15, 2020
Camp Stanley Storage Activity, Boerne, Texas
TCEQ SWR No. 69026; CN602728206; RN100662840
EPA ID No. TX2210020739

The Texas Commission on Environmental Quality (TCEQ) has reviewed the above-referenced submittal that documented the optimization of the sampling and analysis plans for the site. The TCEQ concurs with the recommended optimization; please proceed with its implementation.

Questions concerning this letter should be directed to me at (512) 239-6526. When responding by mail, please submit one paper copy and one electronic copy (on USB or disc) of all correspondence and reports to the TCEQ Remediation Division at Mail Code MC-127. An additional copy should be submitted in electronic format to the local TCEQ Region Office. The information in the reference block should be included in all submittals. Note that the electronic and hard copies should be identical, complete copies. A Correspondence ID Form (TCEQ Form 20428) must accompany each document submitted to the Remediation Division and should be affixed to the front of your submittal. The Correspondence ID Form helps ensure that your documents are identified correctly and are routed to the applicable program for a timely response.

Sincerely,

Timothy Brown

Timothy Brown, Project Manager
Team 1, VCP-CA Section
Remediation Division
Texas Commission on Environmental Quality

TKB/mdh

cc: Ms. Julie Burdy, Parsons Inc., 9101 Burnet Road, Suite 210, Austin, TX 78758
Via E-mail

Mr. Cameron Lopez, Waste Section Manager, TCEQ Region 13 Office, San Antonio
Via E-mail

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1201 Elm Street, Suite 500
Dallas, Texas 75270-2102

Transmitted via e-mail

September 23, 2020

Mr. John Ferguson
Acting Installation Manager
Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015-4800

RE: *2020 Revision of Data Quality Objectives (DQOs) – Groundwater Monitoring Program*
Camp Stanley Storage Activity, Boerne, Texas

Dear Mr. Ferguson:

The 2020 Revision of Data Quality Objectives (DQOs) – Groundwater Monitoring Program for Camp Stanley Storage Activity (CSSA) has been reviewed by the U.S. EPA in accordance with the final Resource Conservation and Recovery Act (RCRA) § 3008(h) Administrative Order on Consent for CSSA, (Order) Docket No. RCRA-VI 002(h)99-H FY99, dated May 5, 1999.

The purpose of the 2020 DQOs revision is to incorporate recent changes in the groundwater monitoring program, including implementing the 2020 Long Term Monitoring Optimization (LTMO) recommendations for both on-post and off post wells. The revised DQO's meets the temporal and spatial objectives of the CSSA groundwater monitoring program. The EPA approves the 2020 Revision, and it should be incorporated into the overall CSSA groundwater monitoring program.

Please add the 2020 DQO Revision to the Administrative Record at https://www.stanley.army.mil. If you have any questions, please feel to contact me at 214-665-8317 or via e-mail at lyssy.gregory@epa.gov.

Sincerely,

Greg J. Lyssy

Greg J. Lyssy
Senior Project Manager
RCRA Corrective Action Section (6LCR-RC)

cc: Margarita Loya, CSSA
Tim Brown, TCEQ
Jorge Salazar, TCEQ
Laurie King, EPA
Julie Burdey, Parsons
Shannon Schoepflin, Parsons
Scott Pearson. Parsons

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1201 Elm Street, Suite 500
Dallas, Texas 75270-2102

Transmitted via e-mail

September 18, 2020

Mr. John Ferguson
Acting Installation Manager
Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015-4800

RE: *RCRA Three-Tiered Long Term Monitoring Network Optimization Evaluation*
Camp Stanley Storage Activity, Boerne, Texas

Dear Mr. Ferguson:

The Three-Tiered Long Term Monitoring Network Optimization (LTMO) Evaluation, dated May 2020, for Camp Stanley Storage Activity (CSSA), has been reviewed by the U.S. EPA in accordance with the final Resource Conservation and Recovery Act (RCRA) § 3008(h) Administrative Order on Consent for CSSA, (Order) Docket No. RCRA-VI 002(h)99-H FY99, dated May 5, 1999.

The purpose of the LTMO Evaluation is to ensure that the groundwater monitoring program adequately addresses the monitoring requirements of the remedial actions at the Site, both temporally and spatially. CSSA has been collecting groundwater data since the early 1990's and has optimized the monitoring program several times to ensure that an optimal monitoring program is in place. The proposed sampling schedule in the LTMO Evaluation meets the temporal and spatial objectives of the CSSA groundwater monitoring program and is hereby approved.

Please add the Evaluation to the Administrative Record at *https://www.stanley.army.mil*. If you have any questions, please feel to contact me at 214-665-8317 or via e-mail at *lyssy.gregory@epa.gov*.

Sincerely,

Greg J. Lyssy

Greg J. Lyssy
Senior Project Manager
RCRA Corrective Action Section (6LCR-RC)

cc: Margarita Loya, CSSA
Tim Brown, TCEQ
Jorge Salazar, TCEQ
Laurie King, EPA
Julie Burdey, Parsons
Shannon Schoepflin, Parsons
Adrian Lindley, Parsons

APPENDIX I

USEPA CONSTITUENT CONCENTRATION MAPS LETTER

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Transmitted via e-mail

February 13, 2012

MEMORANDUM

FROM: *Greg J. Lyssy*
Senior Project Manager
Federal Facilities Section (6PD-F)

TO: Gabriel Moreno-Ferguson
CSSA

CC: Kirk Coulter
TCEQ

RE: **CSSA Constituent Concentration Maps**

This Memo is written pursuant to our meeting on January 24, 2012, and as a follow-up to the discussions on the graphical depiction of analytical data in groundwater plume maps, and in accordance with the final Resource Conservation and Recovery Act (RCRA), Section 3008(h) Administrative Order on Consent (Order) for Camp Stanley Storage Activity (CSSA), Docket No. RCRA-VI 002(h)99-H FY99, dated May 5, 1999.

Historically, CSSA has created groundwater plume delineation maps utilizing all analytical data, including historical data points as well as data points that are near or at the method detection limit of the constituents. Preparing plume maps utilizing data points that are in the part per trillion range (and several orders of magnitude below the Maximum Contaminant Levels (MCLs)) may create a misleading graphical representation of the actual plume size.

In order to have consistency on plume maps across different facilities, it is my recommendation that CSSA create a groundwater plume map at the MCL (or appropriate regulatory level if there is not an MCL) for the constituents of concern (COCs). In addition, CSSA should also create a groundwater plume map that depicts isoconcentrations at 20% of the MCL.

If desired, CSSA may create a ***base*** groundwater plume map using data near the method detection limit, but that map ***must*** contain qualifying information on the data that was used to create the map.

Groundwater monitoring of the plume at CSSA is required, and will continue to be required, as long as the Order is in place and there are COCs in the groundwater.

If CSSA, or your technical consultants, have any questions regarding this Memo, please do not hesitate to call me at 214.665.8317, or I may be contacted via e-mail at *lyssy.gregory@epa.gov*.