2024 AWQR
Groundwater Sampling Summary
Sand Management Site

Boone, Iowa

July 2025

Prepared by

1631 NW 30th Court
Ankeny, Iowa 50023

SEE-001-024-391

1.0 INTRODUCTION

Besser Quinn owns a facility known as the Besser Quinn Sand Management Site. This site has received used foundry sand since 2000. The site is under closure procedures and is operating under DNR ID #08-BUD-08-99 as prepared by the Iowa Department of Natural Resource. The BUD initially required groundwater monitoring for four quarters of a year in 2020 which has since been reduced to semi-annually. This report presents the findings of two sampling events, August and December 2024.

1.1 OWNER INFORMATION

Besser Quinn Machine and Foundry
Division of the Besser International Pipe Machinery Corporation
1518 12th Street
Boone, Iowa 50036

Besser-Quinn - Pipe and Precast
Scott Moorman - 515-432-3553

1.2 SITE LOCATION INFORMATION

The Quinn Quarry Reclamation site is located along Boone County Road E-41, which was formerly USA Highway 30. The street address of the site is 1159 216th Drive. Figure 1 notes the location of the Besser Quinn Sand Management Site.

1.3 FIELD PROCEDURES

Typical field procedures initiate with review of the condition of the monitoring wells and measurement of groundwater levels. Groundwater is then removed by use of a dedicated bailer. The extracted groundwater is poured from the bailer to a clean liter poly bottle that will be later be used for the TSS sample. The water is then transferred to the other sample bottles. There are 7 bottles per sample. No order is used when filling the bottles. Temperature, conductance and pH is measured in the field. Bottles are labeled and placed in the sample cooler. Measuring devices are calibrated in the office.

1.4 EVENT DISSCUSSION

This report is directed at presenting chemical analysis of the two sampling events in 2024, one in August the second in December. The August sampling event was initially scheduled for June, however, most of Iowa was experiencing a drought and SEE requested that the sampling event be rescheduled with the hope that late summer rains

would raise the groundwater levels in the wells. This was not the case as the rains that did come did not raise the groundwater levels an appreciable amount.

1.4.1 August Sampling Event

The August sampling event was to be accomplished using a low flow pump to remove samples from the monitoring wells as the past use of bailers seemed to disturb the sediment in the bottom of the wells. The sediment situation was facilitated by the decreased volume of water in the monitoring wells. Of the six monitoring wells, only MW QN has a consistent ample quantity of water as it is located in a sand deposit of the former river bed and connected hydrogeologically to the river. The other wells are located in very tight glacial till.

MW QS was the first monitoring well to be purged for sampling. The depth to groundwater was noted at 0.21 feet higher than the previous sampling event. The low flow pump was lowered into the monitoring well at a slow rate of decent and the pump was activated. No water was pumped to the surface and the pump was removed to determine why. Upon pulling the pump up approximately 6 feet it was noted that the pump had pumped the water up the plastic tubing, but not to the surface. In other words, there was not sufficient water in the well other than to fill the tubing. The same procedure was undertaken at MW QN which has a higher groundwater level of approximately 15 to19 feet below ground surface. The pump was able to move the groundwater to the surface in MW QN. Mr. Rath was contacted by phone to discuss the inability to pump water to the surface. Mr. Rath suggested sampling the wells without purging.

MW QNW was the next well sampled by lowering the bailer very slowly into the well and extracting a limited amount of water. The bottles were filled, with the metals bottle and TSS bottle the last to be filled. These two bottles contained a significant amount of sediment. Sampling continued with MW QNE and MW QE using the sample bailer lowering process. However, with these wells the metals bottle was filled first and the TSS bottle was filled last. The standard sample collection process is to extract water from the wells and fill the TSS bottle from which the other sample bottles are filled. This process removes the need for a third container in the transfer process.

1.4.2 December Sampling Event

The groundwater measurements for the December sampling event were all lower than the August elevations, suggesting the pump would not discharge groundwater to the surface. Bailers were again used to collect samples. The sample collection method continued from the August event by lowering bailers slowly into the wells. Wells QNW and QE noted a significant reduction in TSS using this method of “slow” sampling.

2.0 SUBSURFACE CONDITIONS

2.1 GROUNDWATER DEPTH DISCUSSION

Historically the depth to groundwater in QN fluctuates a significant amount between sampling events. QN is located in a former river bed and is assumed to be influenced by the water level in the Des Moines River which is approximately 1,400 feet to the east. The relationship between the Des Moines River and the BUD site is demonstrated by the Lidar figure included in the Appendix of this report.

Tables 1A and 1B note the measured depth to groundwater for the August and December sampling events, respectively. QN experienced a 6.3 foot increase from December 2023 to August 2024 and then a decrease of 2.97 feet from August 2024 to December 2024. This well has historically noted significant groundwater elevation changes as it is positioned in a sand layer adjacent to the Des Moines River.

QNE experiences more elevation change than the other wells, other than QN, noting an increase of 1.2 feet from December 2023 to August, and then a decrease of 1.96 feet from August 2024 to December 2024. The other wells experienced limited elevation increases and decreases. A figure in included in the Appendix noting the historic groundwater levels for each well.

Table 1A
Groundwater Depth
August 2024

Monitoring well	Depth to water	Height of Riser	Well Screen	Surface Elevation	Previous Elevation December 2023	Groundwater Elevation August 2024	Elevation Change August 2024
QN	16.18	2.60	26’-36’	909.82	887.34	893.64	6.30
QNE	30.57	3.33	18'-50'	919.14	887.37	888.57	1.20
QNW	46.57	3.04	18'-50'	922.01	874.95	875.44	0.49
QS	41.54	3.13	18'-50'	916.18	874.43	874.64	0.21
QE	40.21	2.72	24’-34’	915.76	875.61	875.55	-0.06
QW	dry	3.05	34’-44’	912.19	Dry	Dry	Dry

Table 1B
Groundwater Depth
December 2024

Monitoring well	Depth to water	Height of Riser	Well Screen	Surface Elevation	Previous Elevation August 2024	Groundwater Elevation December 2024	Elevation Change December 2024
QN	16.18	2.60	26’-36’	909.82	893.64	890.67	-2.97
QNE	30.57	3.33	18'-50'	919.14	888.57	886.61	-1.96
QNW	46.57	3.04	18'-50'	922.01	875.44	875.02	-0.42
QS	41.54	3.13	18'-50'	916.18	874.64	874.42	-0.22
QE	40.21	2.72	24’-34’	915.76	875.55	874.08	-1.47
QW	dry	3.05	34’-44’	912.19	Dry	Dry	Dry

3.0 REVIEW OF GROUNDWATER ANALYSIS

Groundwater samples are typically obtained on two semi-annual occasions, August 12 and December 16, 2024. The samples were subjected to the analysis outlined in the BUD. Table 2 presents some of the concentration of detected materials in the groundwater samples. The full analysis is in the appendix. The BUD lists certain VOC compounds for analysis, further the BUD states that the groundwater analysis need not be performed on the VOC compounds if there are not found to be present in the sand being placed at the site. Per the most recent sand analysis, no VOCs were noted as present.

3.1 Groundwater Chemical Analyses

Tables 2A through 2F present the chemical analyses of certain metals that are typically found in the monitoring wells. The data is presented for each monitoring well individually for sampling events from 2021 through 2024. QN exhibits an increase in manganese from historic measurements in both August and December 2024 analyses. QNE appears to be stable, while QNW and QS some influence of excess TSS in the samples over the last couple of sampling events. QE is noted as consistent, while QW continues to be dry.

Table 2A
Historic Groundwater Analysis, ppm
Monitoring Well QN
March, June, September & December 2020, June 2021 & December 2021, June 2022
March 2023, June 2023, December 2023, August 2024, December 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
QN – June 2021	0.955	0.223	0.122	0.661	0.0034	0.013
QN – Dec. 2021	0.614	0.184	0.126	0.634	0.0025	0.017
QN – June 2022	0.333	0.024	0.056	0.124	0.0008	0020
QN – Dec. 2022	0.922	0.134	0.043	0.523	0.0059	0.025
QN – March 2023	0.782	0.124	0.0445	0.654	0.0027	0.016
QN – June 2023	0.689	0.115	0.0881	0.603	0.0061	0.0121
QN – Dec. 2023	0.691	0.090	0.0594	0.488	0.0025	0.169
QN – Aug. 2024	5.81	0.0147	0.0486	0.0374	0.0041	0.0094
QN – Dec. 2024	5.16	0.0143	0.0444	0.294	0.0100	0.0089

Table 2B
Historic Groundwater Analysis, ppm
Monitoring Well QNE
March, June, September & December 2020, June 2021 & December 2021, June 2022
March 2023, June 2023, December 2023, August 2024, December 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
QNE – June 2021	0.397	0.020	0.096	0.749	0.0006	ND
QNE – Dec. 2021	0.431	0.020	0.097	0.730	0.0007	ND
QNE – June 2022	0.313	0.018	0.100	0.608	0.0005	ND
QNE – Dec. 2022	0.399	0.014	0.096	0.632	0.0043	ND
QNE – Mar2023	0.639	0.0129	0.0907	0.671	0.0011	0.0053
QNE – June 2023	0.347	0.0117	0.100	0.620	0.0062	0.0044
QNE – Dec. 2023	0.555	0.0127	0.0992	0.625	0.0027	0.0066
QNE –Aug. 2024	0.042	0.0121	0.109	0.660	0.0009	0.0052
QNE – Dec. 2024	0.421	0.0117	0.100	0.622	0.0013	0.0044

Table 2C
Historic Groundwater Analysis, ppm
Monitoring Well QNW
March, June, September & December 2020, June 2021 & December 2021, June 2022
March 2023, June 2023, December 2023, August 2024, December 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
QNW – June 2021	0.701	ND	0.260	0.163	0.0033	ND
QNW- Dec. 2021	0.714	ND	0.309	0.0277	0.0067	ND
QNW – June 2022	5.24	0.018	1.82	0.122	0.0804	0.100
QNW – Dec. 2022	9.88	0.020	1.40	0.296	0.0581	0.091
QNW -Mar 2023	0.105	ND	0.195	0.147	0.0007	0.0040
QNW– June 2023	0.512	ND	0.249	0.138	0.0030	0.0056
QNW – Dec. 2023	49.9	0.155	9.41	1.29	0.727	1.37
QNW – Aug. 2024	4.42	0.0077	0.314	0.211	0.0087	0.0181
QNW – Dec. 2024	1.49	0.0042	0.248	0.220	0.0027	0.0051

Table 2D
Historic Groundwater Analysis, ppm
Monitoring Well QS
March, June, September & December 2020, June 2021 & December 2021, June 2022
March 2023, June 2023, December 2023, August 2024, December 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
QS – June 2021	0.429	ND	0.261	0.114	0.007	0.012
QS – Dec. 2021	0.078	ND	0.202	ND	0.0038	ND
QS – June 2022	20.0	0.022	3.89	0.139	0.226	0.336
QS – Dec. 2022	12.0	0.014	2.68	0.135	0.192	0.229
QS – Mar 2023	ND	ND	0.188	ND	ND	ND
QS – June 2023	2.42	ND	0.719	0.106	0.0357	0.0456
QS – Dec. 2023	22.5	0.0670	22.5	ND	1.62	1.89
QS – Aug. 2024	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample
QS – Dec. 2024	0.715	ND	0.366	ND	0.0108	0.0139

Table 2E
Historic Groundwater Analysis, ppm
Monitoring Well QE
March, June, September & December 2020, June 2021 & December 2021, June 2022
March 2023, June 2023, December 2023, August 2024, December 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
QE – June 2021	2.07	ND	0.0065	0.504	0.0017	ND
QE – Dec. 2021	3.01	ND	0.077	0.489	0.0024	0.015
QE – June 2022	0.719	ND	0.069	ND	0.0023	ND
QE – Dec 2022	1.5	0.019	0.152	0.645	0.0293	0.043
QE – Mar 2023	1.39	0.0041	0.637	0.167	0.0066	0.0157
QE – June 2023	3.03	0.0040	0.0778	0.385	0.0076	0.0116
QE – Dec 2023	1.48	0.0076	0.0716	0.629	0.0085	0.0248
QE – Aug 2024	2.86	0.0071	0.0659	0.0577	0.0058	0.0130
QE – Dec 2024	1.89	0.0129	0.0784	0.629	0.0163	0.0447

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Table 2F
Historic Groundwater Analysis, ppm
Monitoring Well QW
March, June, September & December 2020, June 2021 & December 2021, June 2022
March 2023, June 2023, December 2023, August 2024, December 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
QW – June 2021	0.504	ND	0.284	ND	0.0082	0.016
QW – Dec. 2021	0.059	ND	0.189	ND	0.0013	ND
QW – June 2022	2.02	ND	0.628	ND	0.0308	0.053
QW – Dec. 2022	Dry	Dry	Dry	Dry	Dry	Dry
QW – Mar 2023	Dry	Dry	Dry	Dry	Dry	Dry
QW – June 2023	Dry	Dry	Dry	Dry	Dry	Dry
QW – Dec. 2023	Dry	Dry	Dry	Dry	Dry	Dry
QW – Aug. 2024	Dry	Dry	Dry	Dry	Dry	Dry
QW – Dec. 2024	Dry	Dry	Dry	Dry	Dry	Dry

The first sampling event of 2023 included several other parameters consistent with the BUD. Those parameters include TOX, COD, nitrogen, phenols, and chloride. The full analysis notes the presence of chloride in all the wells. QNW notes chloride concentrations ranging from 157 to 398 mg/l. QN notes concentrations of chloride ranging normally from 20 to 50 mg/l.

However, in August 2024 the chloride concentration spiked at 99 mg/l. QN's location in the sand aquifer and somewhat near a rural residence with a septic system. might account for the spike. The chloride concentration in QN did drop to 49 mg/l in December 2024, suggesting the August concentration might be an anomaly. Other wells, QNE, QE, and QS note chloride concentrations ranging from 7 to 21 mg/l.

Phenols have been experienced periodically in all the wells, other than QW because of it being dry. The 2024 analyses noted phenols only in QNW during the August sampling at 0.0053 mg/l. Suggesting phenols are not problematic at the site.

COD has been experienced periodically in all the wells, other than QW because of it being dry. The 2024 analysis notes COD only in QE, 21 and 75 mg/l respectively for August and December, QNW, ND and 69 mg/l respectively for August and December, and QS, ND and 54 mg/l respectively for August and December.

No other chemical analysis is thought to be noteworthy.

4.0 PROTECTED GROUNDWATER REVIEW

The following tables present the chemical analyses for certain metals that have historically been detected in the groundwater samples at this site. The chemical analyses of the groundwater in comparison with the non-protected groundwater standards has historically noted limited exceedances. The 2024 sampling events note an increase in manganese in QN in both August and December. Cobalt is present in all the wells and slightly exceeds the limit in QS and QE in December. There is no explanation for these increases.

The comparison of the select metals to the protected groundwater standard are fairly consistent historically. Manganese is present in all the wells and historically exceeds the protected groundwater standard at each sampling event. Manganese continues to exceed the protected groundwater standard for both August and December in all wells.

The protected groundwater standard is exceeded for both cobalt and nickel during the 2024 sampling events. The cobalt limit was exceeded during the August sampling in QN, QE, QNW and assumed for QS if a sample could have been collected. Cobalt exceeded the protected standard in December for QN, QNE, QNW, and QS. The noted concentrations are consistent during 2024 and with past years. Nickel was exceeded in QNW and QE in August and QS and QE in December. Again, the concentrations are consistent with past analyses.

Other than manganese, the concentrations of metals noted in the groundwater are quite low with respect to the standards.

Table 3A
Groundwater Analysis to Non-Protected Groundwater Std., ppm
August 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
Non-Protected GW standard	4.9	0.2	10	30	0.01	0.7
QN –Aug. 2024	5.81	0.0147	0.0486	0.374	0.0041	0.0094
QNE – Aug. 2024	0.42	0.0121	0.109	0.660	0.0009	0.0052
QNW – Aug. 2024	4.42	0.0077	0.314	0.211	0.0087	0.0181
QS – Aug. 2024	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample
QE –Aug. 2024	2.86	0.0071	0.0659	0.577	0.0058	0.0130
QW – Aug. 2024	Dry	Dry	Dry	Dry	Dry	Dry

Table 3B
Groundwater Analysis to Non-Protected Groundwater Std., ppm
December 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
Non-Protected GW standard	4.9	0.2	10	30	0.01	0.7
QN –Dec. 2024	5.16	0.0143	0.0444	0.294	0.0100	0.0089
QNE – Dec. 2024	0.421	0.0117	0.100	0.622	0.0013	0.0044
QNW – Dec. 2024	1.49	0.0042	0.248	0.220	0.0027	0.0051
QS – Dec. 2024	0.715	ND	0.366	ND	0.0108	0.0139
QE –Dec. 2024	1.89	0.0129	0.0784	0.629	0.0163	0.0447
QW – Dec. 2024	Dry	Dry	Dry	Dry	Dry	Dry

Table 4A
Groundwater Analysis to Protected Groundwater Std., ppm
August 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
Protected GW standard	0.3	0.04	2.0	6.0	0.0021	0.1
QN –Aug. 2024	5.81	0.0147	0.0486	0.374	0.0041	0.0094
QNE – Aug. 2024	0.42	0.0121	0.109	0.660	0.0009	0.0052
QNW – Aug. 2024	4.42	0.0077	0.314	0.211	0.0087	0.0181
QS – Aug. 2024	No Sample	No Sample	No Sample	No Sample	No Sample	No Sample
QE –Aug. 2024	2.86	0.0071	0.0659	0.577	0.0058	0.0130
QW – Aug. 2024	Dry	Dry	Dry	Dry	Dry	Dry

Table 4B
Groundwater Analysis to Protected Groundwater Std., ppm
December 2024

Monitoring well	Manganese Total Metal	Molybdenum Total Metal	Barium Total Metal	Boron Total Metal	Cobalt Total Metal	Nickel Total Metal
Protected GW standard	0.3	0.04	2.0	6.0	0.0021	0.1
QN –Dec. 2024	5.16	0.0143	0.0444	0.294	0.0100	0.0089
QNE – Dec. 2024	0.421	0.0117	0.100	0.622	0.0013	0.0044
QNW – Dec. 2024	1.49	0.0042	0.248	0.220	0.0027	0.0051
QS – Dec. 2024	0.715	ND	0.366	ND	0.0108	0.0139
QE –Dec. 2024	1.89	0.0129	0.0784	0.629	0.0163	0.0447
QW – Dec. 2024	Dry	Dry	Dry	Dry	Dry	Dry

5.0 STATISTICAL REVIEW OF CHEMICAL ANALYSES

The chemical analyses data was presented to Otter Creek Environmental for statistical review. Complete statistical reports are included in the Appendix.

It is understood that sampling irregularities have most likely led to statistical analysis that includes poor or inaccurate analyses of metals, particularly in wells QS and QNW. Depending on past chemical analysis would most likely lead to incorrect assumptions and statistical analyses. However, the two 2024 sampling events noted an increase of manganese in MW QN. Historically, the manganese concentration in QN has been noted in the range of 0.1-0.2 mg/l. The first sampling of 2024 noted a manganese concertation of 5.81 mg/l and the second sampling, a

concentration of 5.16 mg/l. The statistical analysis notes QN being a control limit exceedance issue. The significant increase in the manganese concentration in QN is unexplainable. A current, June 2025, groundwater sample from QN notes a manganese concentration of 0.0238 mg/l. This will be discussed in the 2025 AWQR.

6.0 DISCUSSION OF REVIEW QUESITONS

The question has been presented addressing QN as a background well because of the elevated chloride analysis. The site is an anomaly within itself. QN is the only well not located in the glacial till soils and it represents what is present in the sand aquifer that is influenced by the Des Moines River. The location of QN suggests that it in a logical location for a background well with respect to the other wells located in the glacial till. Historically, the groundwater elevation in QN is higher than the other wells, with the exception of QNE. The wells located in the glacial till note a somewhat consistent hydrogeological gradient from north to south.

The continued presence of manganese and cobalt above the protected groundwater standard will be reviewed with the revision of the sampling method described below.

7.0 PROCESS REVISIONS

The 2024 groundwater sampling demonstrated that a change in process was appropriate. Since the monitoring wells QNW, QNE, QE, and QS currently have a limited amount of groundwater to sample and not enough water to pump the water from the wells, the method of slowly lowering the bailer into the well has been determined to be the most successful in obtaining a sample with limited sediment, TSS. QN continues to demonstrate a copious amount of water such that purging will be included in the sampling process.

The sampling process will initiate as in the past with the measurement of the depth to groundwater. No purging will be performed as the soil in which the wells are located is a very tight glacial till and recovery time is lengthy. Once the depth to water is determined, a bailer with a measured rope will be lowered to the groundwater elevation slowly and then allowed to enter the water slowly. A sample consists of 7 different bottles of different sizes, materials of construction, and preservatives. The bailer will be extracted and the TSS and metal bottles will be filled first. On the second lowering of the bailer, a second TSS bottle, or non-preserved liter plastic bottle will be used to capture the collected water. Other sample bottles will be filled from the non-preserved plastic bottle and the process repeated until all the bottles have been filled. If sufficient water without sediment is not available, additional trips will be made to the site. The same collection method will be used to fill the bottles that were not filled during the first sampling. A second TSS sample will be collected as a reference.

A well purging process to remove sediment from the monitoring wells is anticipated, however, to date the certified well contactors that have been contacted do not have equipment to purge wells.

Appendix

Site Location

Monitoring Well Locations

Lidar of Monitoring Well Locations

Historic Groundwater Level Chart

Historic Groundwater Chemical Analyses

Field Logs August 2024

Field Logs December 2024

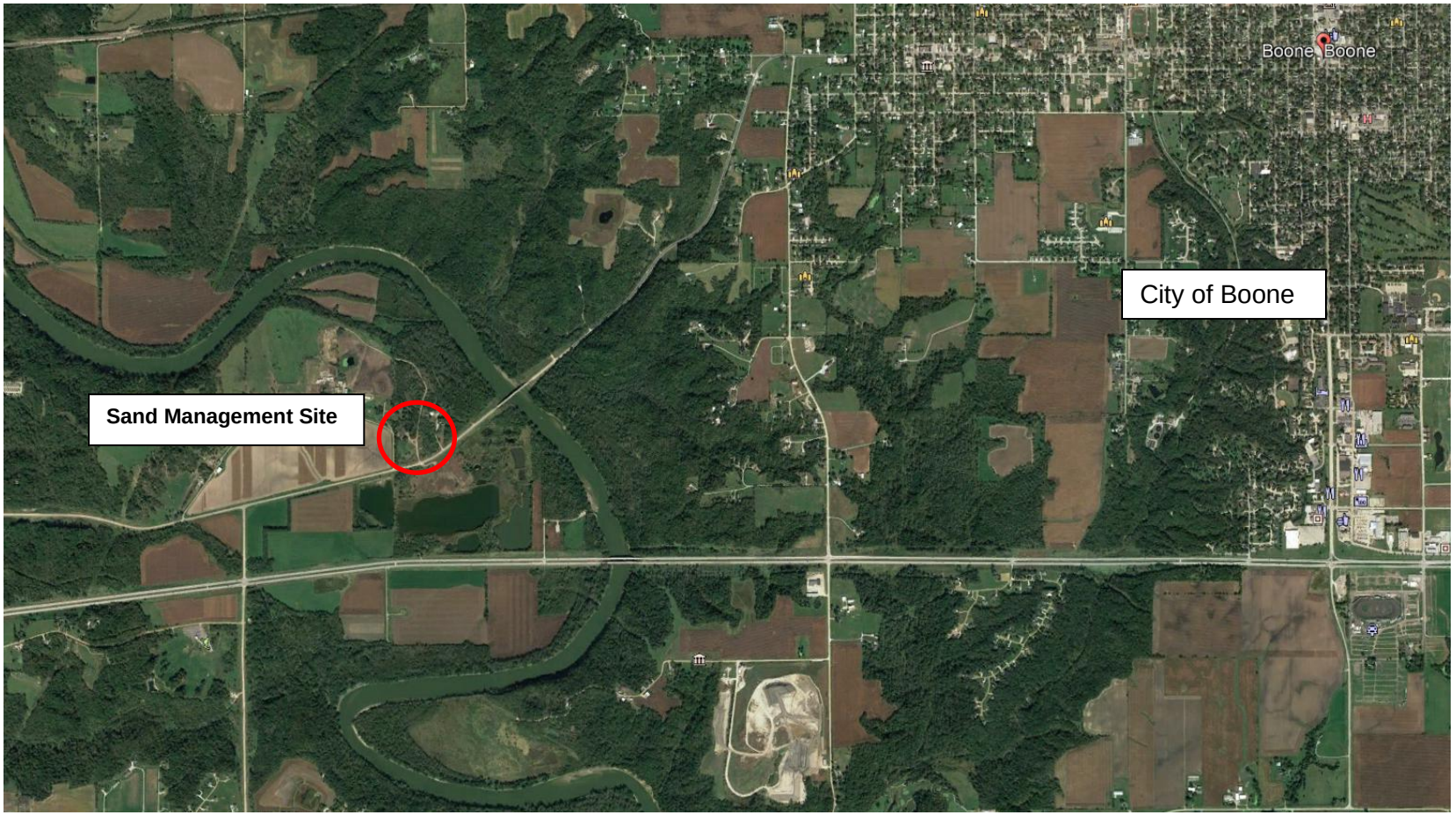
Statistical Review August 2024

Statistical Review December 2024

Chemical Analysis August 2024

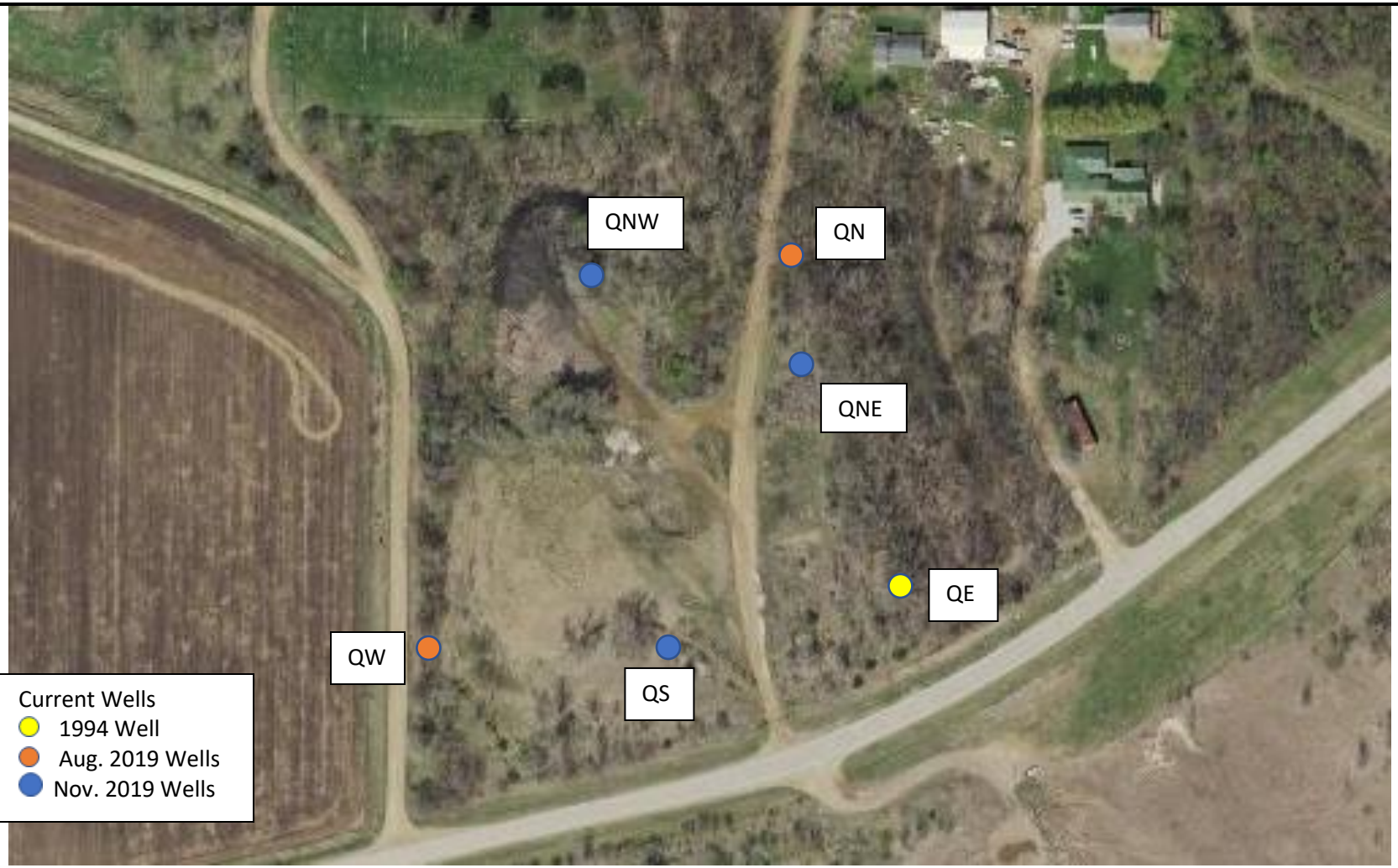
Chemical Analysis December 2024

Site Location



STONE ENVIRONMENTAL ENGINEERING	Site Location Bessser Quinn Sand Management Site Boone, Iowa	Figure D-1 July 2025

Monitoring Well Locations



STONE ENVIRONMENTAL ENGINEERING

Monitoring Well Locations
Besser-Quinn Sand Management Site
Boone, Iowa

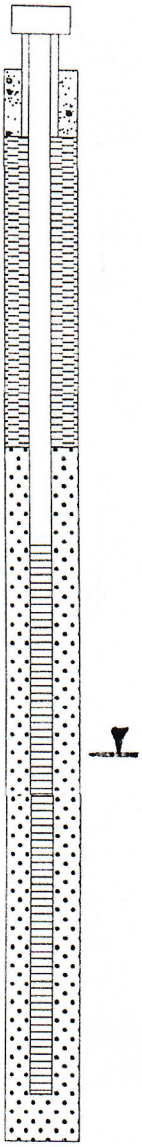
Figure 2

November 2019

3409 NE Briarwood Drive, Ankeny, Iowa 50021 515-689-7701 dstone@stoneenviro.com

Soil Boring Log And Monitoring Well Construction Diagram for: QFS-1R – QN

Facility Name: Quinn Quarry Reclamation Site	08-SDP-08-99	QFS-1R
Well Contractor Name: Mark C. Wiseman	Drilling Method**: 7.75" HSA	
Well Contractor Registration Number: 5902	Boring Depth (ft) x Diameter (in): 50' X 7.75"	
Logged by: Mark C. Wiseman	Ground Surface Elevation (ASL): 915.00	
Start Date: 6/24/19 2:36 pm / Finish Date: 6/24/19 4:20 pm	Top of Casing Elevation (ASL): 918.12	

Depth (feet)	Well Construction Details	Sample No.	Sample Type*	PID / FID PPM	USCS	Sample Descriptions: soil, color, classification, observation Example: Silty clay, dark gray, hard, moist, strong odor
0					CL	0' to 1' **TOPSOIL,** Very dark brown sandy lean clay, trace gravel, and roots, moist
2					SC	1' to 7' **GRANULAR ALLUVIUM,** Brown clayey coarse sand, with gravel, moist
4						
6					CL	9' to 8.5' **GRANULAR ALLUVIUM,** Brown sandy lean clay, trace gravel, moist
8					SC	8.5' to 17.5' **GRANULAR ALLUVIUM,** Dark brown, clayey medium to coarse sand with gravel, moist
10						
12						
14						
16						
18					CL	17.5' to 21' **GLACIAL TILL,** Brown sandy lean clay, very moist
20						
22					CH	21' to 23' **GLACIAL TILL,** Brown fat clay, trace sand, very moist
24					SM	23' to 25' **GLACIAL TILL,** Brown fine silty sand, moist
26					CL	25' to 35' **GLACIAL TILL,** Brown sandy lean clay, trace fine sand, very moist
28						
30						
32						
34					SM	35' to 46' **GRANULAR ALLUVIUM,** Brown fine silty sand, wet
36						
38						
40						
42						Clay seam at 42'
44						
46					SP	46' to 50' **GRANULAR ALLUVIUM,** Brown fine to medium sand with gravel, wet
48						
50						

*** Sample Types:**
Split Spoon (SS)
Continuous Core (CC)

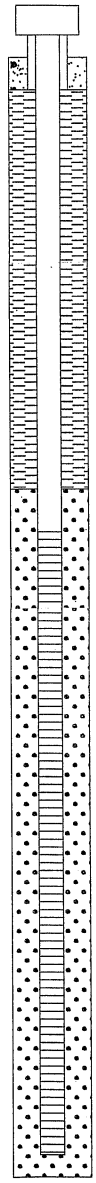
**** Drilling Method Options:**
Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)

Symbols to Use:
v – Static Water Level
s – sample collected

Observation Date:	6/24/2019				
Time	4:25 pm				
Static Water Level (ASL)	884.61				

Soil Boring Log And Monitoring Well Construction Diagram for: QFS-6

Facility Name: Quinn Quarry Reclamation Site	08-SDP-08-99	QFS-6
Well Contractor Name: Mark C. Wiseman	Drilling Method**: 7.75" HSA	
Well Contractor Registration Number: 5902	Boring Depth (ft) x Diameter (in): 30' X 7.75"	
Logged by: Mark C. Wiseman	Ground Surface Elevation (ASL): 922.01	
Start Date: 11/11/19 9:30 am / Finish Date: 11/11/19 12:30 pm	Top of Casing Elevation (ASL): 925.11	

Depth (feet)	Well Construction Details	Sample No.	Sample Type*	PID / FID PPM	USCS	Sample Descriptions: soil, color, classification, observation Example: Silty clay, dark gray, hard, moist, strong odor
0					SM	0' to 2.0' **GRANULAR ALLUVIUM,** Very dark gray fine silty sand, trace gravel, moist
2						
4					SC	2.0' to 17.0' **GRANULAR ALLUVIUM,** Very dark gray clayey fine sand, trace small gravel, moist
6						
8						
10						
12						
14						
16						
18						
20					CL	17' to 34' **GLACIAL TILL,** Brown sandy lean clay, moist Brown lean clay after 24' Trace sand and small gravel after 27'
22						
24						
26						
28						
30						
32						
34						
36					SC	34' to 37.5' **GRANULAR ALLUVIUM,** Brown clayey fine sand, moist
38					SM	37.5' to 40' **GRANULAR ALLUVIUM,** Brown silty fine to medium sand, with gravel, moist
40						
42					SM	40' to 49.5' **GRANULAR ALLUVIUM,** Brown fine silty sand, wet
44						
46						
48						
50					CL	49.5' to 50' **GLACIAL TILL,** Gray lean clay, very moist

*** Sample Types:**
Split Spoon (SS)
Continuous Core (CC)

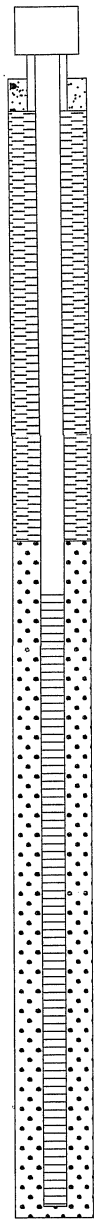
**** Drilling Method Options:**
Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)

Symbols to Use:
v – Static Water Level
s – sample collected

Observation Date:	6/24/2019	6/24/2019			
Time	1:25 pm	4:38 pm			
Static Water Level (ASL)	Dry	Dry			

Soil Boring Log And Monitoring Well Construction Diagram for: QFS-5

Facility Name: Quinn Quarry Reclamation Site	08-SDP-08-99	QFS-5
Well Contractor Name: Mark C. Wiseman	Drilling Method**: 7.75" HSA	
Well Contractor Registration Number: 5902	Boring Depth (ft) x Diameter (in): 50' X 7.75"	
Logged by: Mark C. Wiseman	Ground Surface Elevation (ASL): 919.14	
Start Date: 11/11/19 1:20 pm / Finish Date: 11/11/19 4:10 pm	Top of Casing Elevation (ASL): 922.45	

Depth (feet)	Well Construction Details	Sample No.	Sample Type*	PID / FID PPM	USCS	Sample Descriptions: soil, color, classification, observation Example: Silty clay, dark gray, hard, moist, strong odor
						
0					SM	0' to 4' **GRANULAR ALLUVIUM,** Brown silty medium to coarse sand, moist
2						
4						
6					CL	4' to 5.5' Brown sandy lean clay with small gravel, moist
8					SC	5.5' to 9' **GRANULAR ALLUVIUM, D**ark brown, clayey sand trace gravel, moist
10						7.5' Brown and very moist
12					CL	9' to 50' **GLACIAL TILL.** Very dark gray sandy lean clay, trace small gravel, moist
14						
16						Gray brown after 15'
18						Dark brown after 17.5'
20						
22						
24						Dark gray brown after 24'
26						Cobbles at 25'
28						Gray after 27'
30						
32						
34						
36						
38						
40						
42						
44						
46						
48						
50						

*** Sample Types:**
Split Spoon (SS)
Continuous Core (CC)

**** Drilling Method Options:**
Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)

Symbols to Use:
v – Static Water Level
s – sample collected

Observation Date:	11/11/2019	11/13/2019			
Time	4:15 pm	10:10 am			
Static Water Level (ASL)	Dry	Dry			

FOX ENGINEERING
AMES, IOWA

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LOG OF TEST BORING

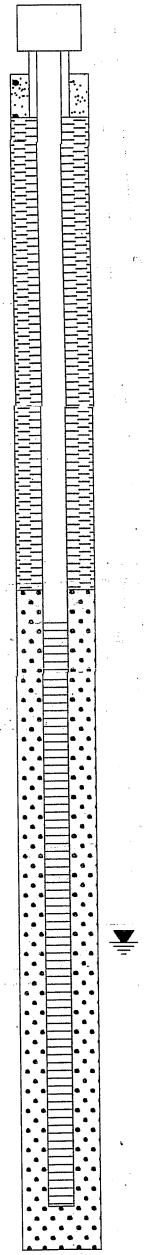
Drillers Hollett Boring No. QFS-3 - QE FOX Inspector Don Stone
FOX Project No. 2651-95A.320

Date Drilled July 7, 1995 Project Quinn Foundry
Surface Elevation Foundry Sand Management Site
Depth Drilled 45'
Drilling Method CFA
Depth to Water 30 ft @ completion (▽), ____ ft @ ____ hrs.(▼), ____ ft @ ____ hrs.

Depth ft	WELL DETAIL	COLOR	MC %	CONSISTENCY	WL	ELEV	Soil Description
	Cap	Black		Friable			Sandy Silt Topsoil
	Natural Soil	Light Brown		Loose			CRS Sand to Gravel w/ Silt & Clay
	Natural Soil	Dark Gray		Very Dense			Silty, Sandy, Clay Glacial till Heavy Clay Content
	Bentonite / Silica Sand / 10' Screen						

Soil Boring Log And Monitoring Well Construction Diagram for: QFS-4

Facility Name: Quinn Quarry Reclamation Site	08-SDP-08-99	QFS-4
Well Contractor Name: Mark C. Wiseman	Drilling Method**: 7.75" HSA	
Well Contractor Registration Number: 5902	Boring Depth (ft) x Diameter (in): 50' X 7.75"	
Logged by: Mark C. Wiseman	Ground Surface Elevation (ASL): 916.18	
Start Date: 11/13/19 8:14 am / Finish Date: 11/13/19 10:00 am	Top of Casing Elevation (ASL): 919.35	

Depth (feet)	Well Construction Details	Sample No.	Sample Type*	PID / FID PPM	USCS	Sample Descriptions: soil, color, classification, observation Example: Silty clay, dark gray, hard, moist, strong odor
						
0					CL	0' to 2.5' **TOPSOIL,** Very dark brown sandy lean clay, with small gravel, trace organics, moist
2					CL	2.5' to 6' **COHESIVE ALLUVIUM,** Brown sandy lean clay with small gravel, moist
4						
6					GC	6' to 11' **GRANULAR ALLUVIUM,** Brown clayey gravel with sand, moist
8						
10					SM	11' to 48' **GRANULAR ALLUVIUM**, Brown, fine silty sand, moist
12						
14						
16						
18						
20						
22						
24						
26						Trace small gravel after 27'
28						
30						Cobbles at 30'
32						
34						
36						
38						
40						
42						
44						
46						
48					SP	48' to 50' **GRANULAR ALLUVIUM,** Brown fine to medium sand, with small gravel, wet
50						

*** Sample Types:**
Split Spoon (SS)
Continuous Core (CC)

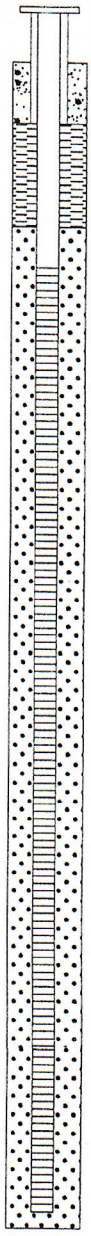
**** Drilling Method Options:**
Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)

Symbols to Use:
v – Static Water Level
s – sample collected

Observation Date:	11/13/2019				
Time	10:02 am				
Static Water Level (ASL)	880.73				

Soil Boring Log And Monitoring Well Construction Diagram for: QFS-2R – GW

Facility Name: Quinn Quarry Reclamation Site	08-SDP-08-99	QFS-2R
Well Contractor Name: Mark C. Wiseman	Drilling Method**: 7.75" HSA	
Well Contractor Registration Number: 5902	Boring Depth (ft) x Diameter (in): 30' X 7.75"	
Logged by: Mark C. Wiseman	Ground Surface Elevation (ASL): 926.00	
Start Date: 6/24/19 11:23 am / Finish Date: 6/24/19 1:00 pm	Top of Casing Elevation (ASL): 929.75	

Depth (feet)	Well Construction Details	Sample No.	Sample Type*	PID / FID PPM	USCS	Sample Descriptions: soil, color, classification, observation Example: Silty clay, dark gray, hard, moist, strong odor
0–30					SC	0' to 10.0" **GRANULAR ALLUVIUM,** Brown clayey sand, with gravel, some cobbles, trace roots, very moist Dark brown after 3.5'
					CL	10' to 15' **GLACIAL TILL,** Brown sandy lean clay, trace gravel, moist Cobble at 11.0'
					CL	15' to 22.5' **GLACIAL TILL,** Gray lean clay trace sand and small gravel, moist
					CH	22.5' to 30' **GLACIAL TILL,** Very dark gray fat clay and small gravel, moist With gray shale fragments after 28'

*** Sample Types:**
Split Spoon (SS)
Continuous Core (CC)

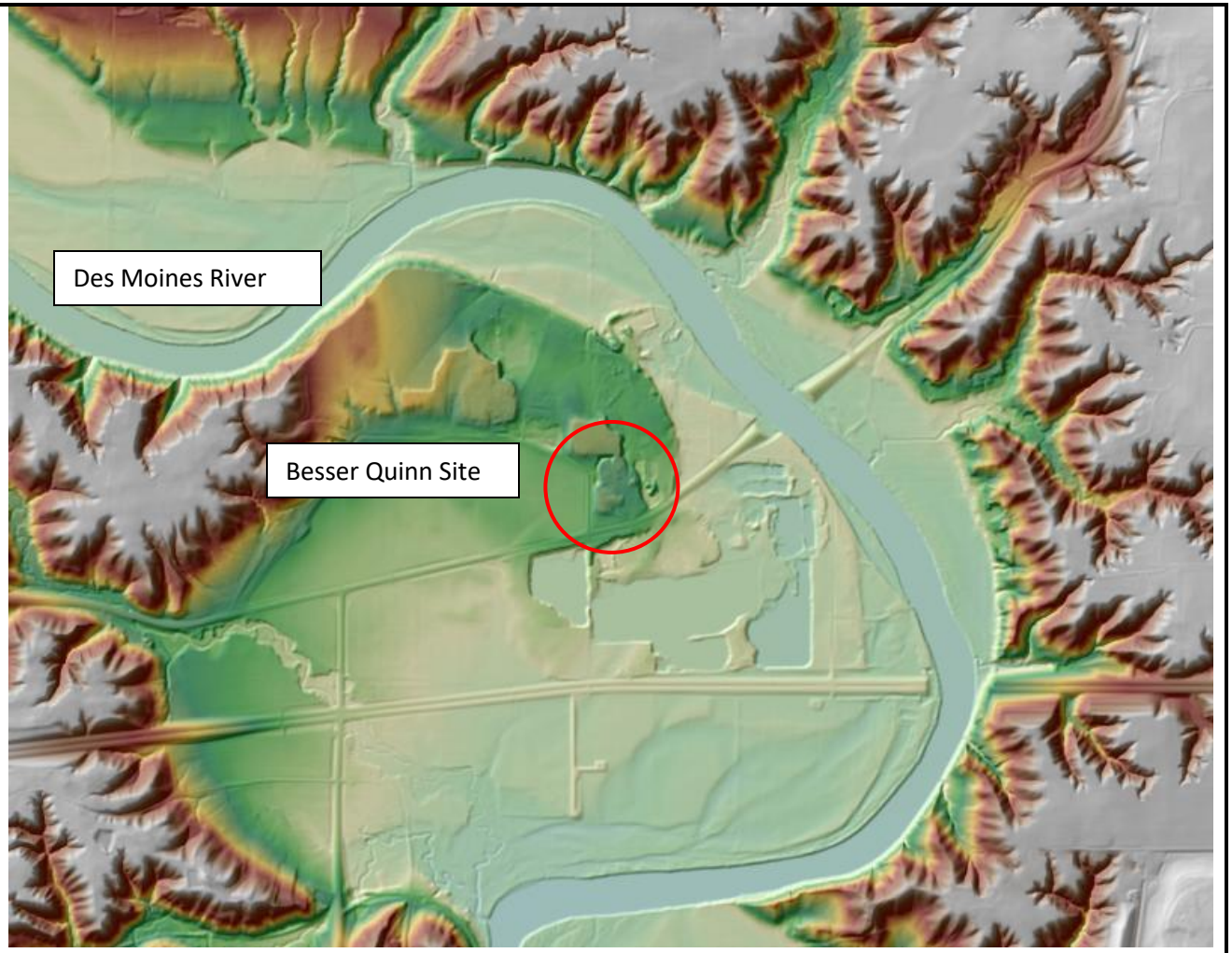
**** Drilling Method Options:**
Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)

Symbols to Use:
v – Static Water Level
s – sample collected

Observation Date:	6/24/2019	6/24/2019			
Time	1:25 pm	4:38 pm			
Static Water Level (ASL)	Dry	Dry			

Lidar of Monitoring Well Locations

Figure showing Des Moines River migration around the Besser Quinn Site noting how the site remains geologically different from adjacent land forms



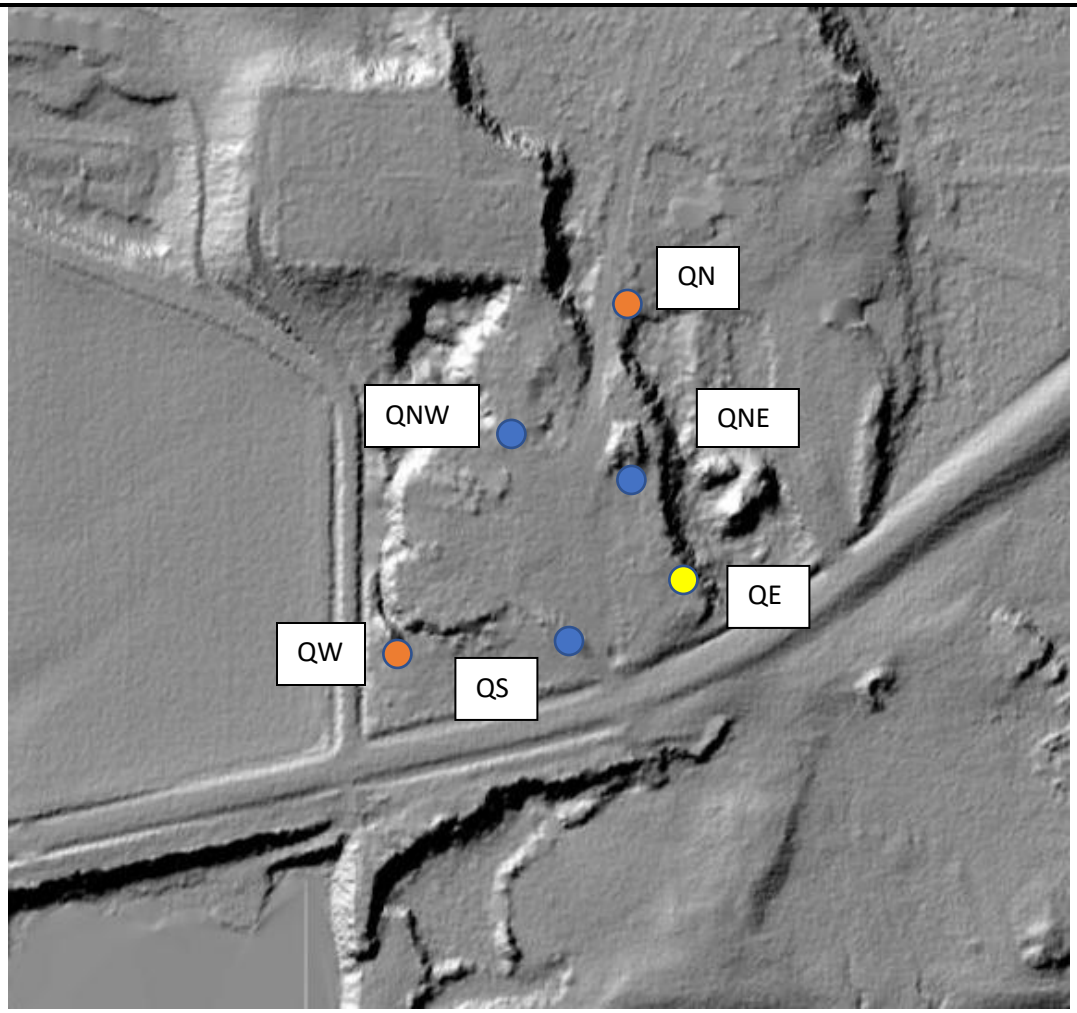
STONE ENVIRONMENTAL ENGINEERING

Site Location Through Lidar
Besser-Quinn Sand Management Site
Boone, Iowa

Figure 1

July 2025

1631 NW 30th Court, Ankeny, Iowa 50023 515-689-7701 dstone@stoneenviro.com



Current Wells
- 1994 Well
- Aug. 2019 Wells
- Nov. 2019 Wells

STONE ENVIRONMENTAL ENGINEERING

Monitoring Well Locations with Lidar
Besser-Quinn Sand Management Site
Boone, Iowa

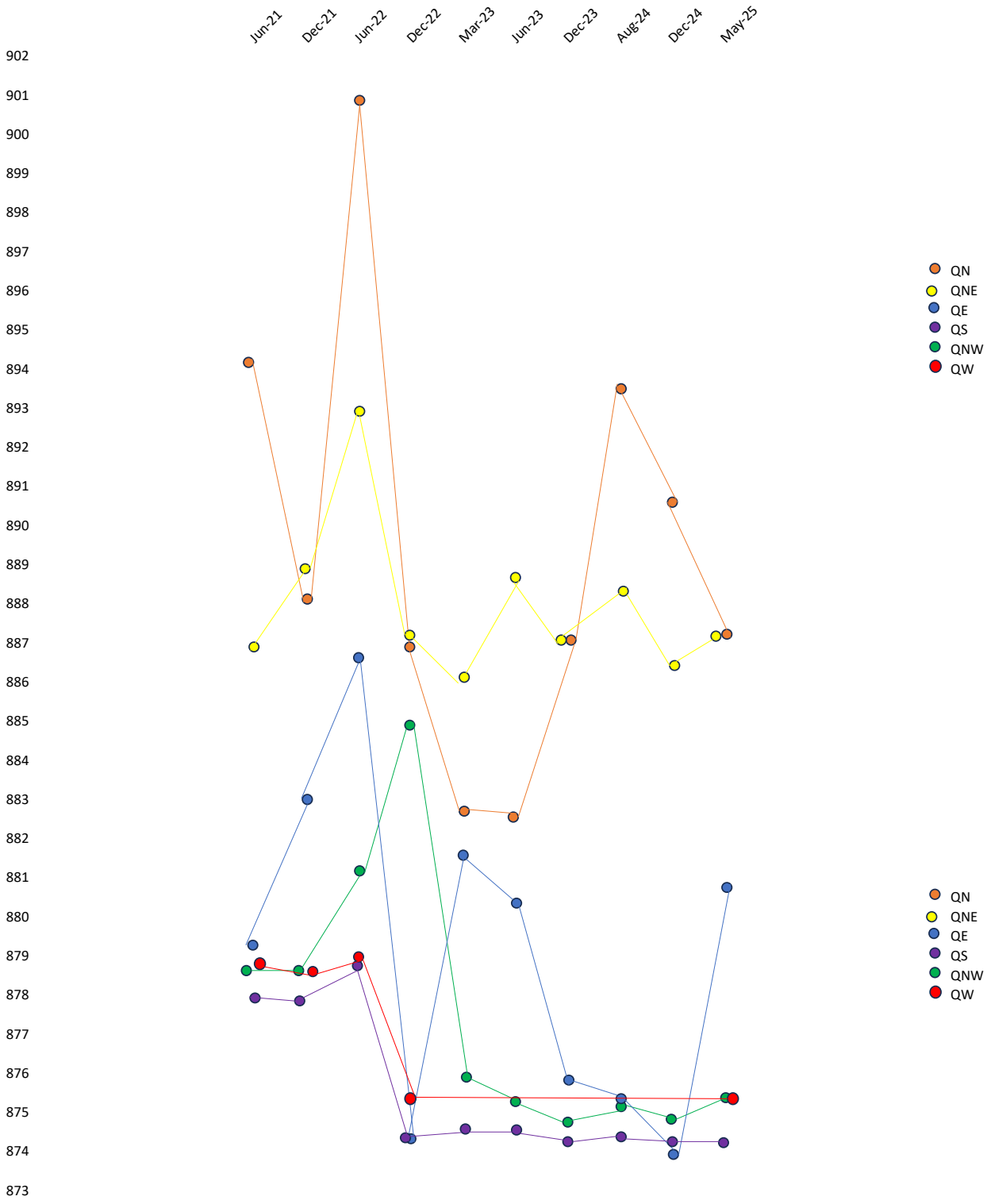
Figure 2

July 2025

1631 NW 30th Court, Ankeny, Iowa 50023 515-689-7701 dstone@stoneenviro.com

Historic Groundwater Level Chart

Besser Quinn Sand site Historic Groundwater Elevations



Historic Groundwater Chemical Analyses

Monitoring Well QN Historic Analysis

Date			Mar-20	Jun-20	Sep-20	Dec-20	Jun-21	Dec-21	Jun-22	Dec-22	Mar-23	Jun-23	Dec-23	Aug-24	Dec-24
Parameter			results, mg/l												
Barium, total	10	2.0	0.121	0.089	0.079	0.104	0.122	0.126	0.056	0.043	0.0445	0.0881	0.0594	0.0486	0.0444
Boron, total	30	6.0	0.544	0.479	0.185	0.52	0.661	0.634	0.124	0.523	0.654	0.603	0.488	0.374	0.294
Cobalt, total	0.01	0.0021	0.0039	0.0035	0.0029	0.0039	0.0034	0.0025	0.0008	0.0059	0.0027	0.0061	0.0025	0.0041	0.01
Nickel, total	0.7	0.1	0.019	0.02	0.017	0.016	0.013	0.017	0.02	0.025	0.0106	0.0121	0.0169	0.0094	0.0089
Manganese, total	4.9	0.3	1.15	0.945	0.857	1.1	0.955	0.614	0.333	0.922	0.782	0.689	73.5	5.81	5.16
Molybdenum, total	0.2	0.04	0.358	0.265	0.246	0.25	0.223	0.184	0.024	0.134	0.124	0.115	0.09	0.0147	0.0143
Fluoride			0.1	0.1	0.2	0.2	0.1	0.1	ND	0.2	0.2	0.2	0.2	0.1	0.2
Arsenic			ND	ND	ND	0.005	0.0116	ND	ND	0.0045	ND	0.0108	ND	0.0092	0.0069
Chromium, total			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper, total			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0048	ND	ND
Selenium, total			ND	ND	ND	ND	ND	ND	0.131	ND	ND	ND	ND	ND	ND
Zinc			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0014	ND	ND
Mercury			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lithium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead			ND	ND	ND	0.058	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aluminum											ND	0.148	0.209	0.125	0.175
TOX											ND	ND	ND	0.092	ND
COD											30	29	ND	ND	ND
Nitrogen											4.42	4.64	1.01	0.61	0.77
Phenols											ND	0.044	ND	ND	ND
Chloride											38.4	43.2	19.1	99.3	49

Monitoring Well QNE Historic Analysis

Date			Mar-20	Jun-20	Sep-20	Dec-20	Jun-21	Dec-21	Jun-22	Dec-22	Mar-23	Jun-23	Dec-23	Aug-24	Dec-24
Parameter			results, mg/l												
Barium, total	10	2.0	0.149	0.104	0.094	0.097	0.096	0.097	0.1	0.096	0.0907	0.1	0.0992	0.109	0.1
Boron, total	30	6.0	1.15	0.476	0.752	0.739	0.749	0.73	0.608	0.632	0.671	0.62	0.625	0.66	0.622
Cobalt, total	0.01	0.0021	0.0038	0.0019	0.0011	0.0013	0.0006	0.0007	0.0005	0.0043	0.0011	0.0062	0.0027	0.0009	0.0013
Nickel, total	0.7	0.1	0.016	0.018	0.015	0.012	ND	ND	ND	ND	0.0053	0.0044	0.0066	0.0052	0.0044
Manganese, total	4.9	0.3	1.46	0.616	0.689	0.604	0.397	0.431	0.313	0.399	0.639	0.347	0.555	0.402	0.421
Molybdenum, total	0.2	0.04	0.115	0.021	0.023	0.023	0.02	0.02	0.018	0.014	0.0129	0.0117	0.0127	0.0121	0.0117
Fluoride			0.1	ND	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.1
Arsenic			ND	ND	ND	ND	ND	ND	0.147	0.0046	ND	ND	ND	ND	ND
Chromium, total			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper, total			0.017	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0046	ND	ND
Selenium, total			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc			0.208	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lithium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aluminum											ND	0.12	0.31	0.092	0.095
TOX											ND	ND	0.014	ND	0.023
COD											ND	ND	ND	ND	ND
Nitrogen											1.49	1.27	1.39	1.52	1.68
Phenols											0.073	ND	ND	ND	ND
Chloride											7.4	8.4	8.5	6.5	7.6

Monitoring Well QNW Historic Analysis

Date			Mar-20	Jun-20	Sep-20	Dec-20	Jun-21	Dec-21	Jun-22	Dec-22	Mar-23	Jun-23	Dec-23	Aug-24	Dec-24
Parameter			results, mg/l												
Barium, total	10	2.0	0.226	0.17	2.45	0.287	0.26	0.309	1.82	1.4	0.195	0.249	9.41	0.314	0.248
Boron, total	30	6.0	0.174	ND	0.198	0.247	0.163	0.277	0.122	0.296	0.147	0.138	0.129	0.211	0.22
Cobalt, total	0.01	0.0021	0.0033	0.0074	0.0004	0.0004	0.0033	0.0007	0.0804	0.0581	0.0007	0.003	0.727	0.0087	0.0027
Nickel, total	0.7	0.1	ND	ND	ND	ND	ND	ND	0.1	0.091	0.004	0.0056	1.37	0.0181	0.0051
Manganese, total	4.9	0.3	1.04	0.302	0.056	0.045	0.701	0.714	5.24	9.88	0.105	0.512	49.9	4.42	1.49
Molybdenum, total	0.2	0.04	ND	ND	ND	ND	ND	ND	0.018	0.02	ND	ND	0.155	0.0077	0.0042
Fluoride			0.1	ND	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.2	ND	0.1	0.2
Arsenic			ND	0.0054	ND	ND	ND	0.0074	0.075	0.0653	ND	ND	0.765	0.0063	ND
Chromium, total			ND	ND	ND	ND	ND	ND	0.073	0.083	ND	ND	0.788	ND	ND
Copper, total			ND	ND	ND	ND	ND	ND	0.118	0.084	ND	ND	1.1	0.0071	ND
Selenium, total			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.112	ND	ND
Zinc			ND	ND	ND	ND	ND	ND	ND	0.198	ND	ND	3.11	ND	ND
Beryllium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0431	ND	ND
Mercury			ND	ND	ND	ND	ND	ND	ND	0.0011	ND	ND	ND	ND	ND
Lithium			ND	ND	ND	ND	ND	ND	ND	0.059	ND	ND	ND	ND	ND
Antimony			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium			ND	ND	ND	ND	ND	ND	ND	0.164	ND	ND	1.44	ND	ND
Lead			ND	ND	ND	ND	ND	ND	ND	0.055	ND	ND	0.859	ND	ND
Aluminum											ND	1.42	590	2.46	0.284
TOX											0.048	0.038	0.022	0.133	0.233
COD											87	ND	5000	ND	69
Nitrogen											0.2	ND	0.15	0.11	0.13
Phenols											ND	0.054	ND	0.053	ND
Chloride											398	265	157	241	319

Monitoring Well QE Historic Analysis

Date			Mar-20	Jun-20	Sep-20	Dec-20	Jun-21	Dec-21	Jun-22	Dec-22	Mar-23	Jun-23	Dec-23	Aug-24	Dec-24
Parameter			results, mg/l												
Barium, total	10	2.0	0.12	0.114	0.0063	0.052	0.065	0.077	0.069	0.152	0.0637	0.0778	0.716	0.0659	0.0784
Boron, total	30	6.0	0.293	0.185	0.524	0.523	0.504	0.489	ND	0.645	0.167	0.385	0.629	0.577	0.629
Cobalt, total	0.01	0.0021	0.0048	0.002	0.0004	0.0042	0.0017	0.0024	0.0023	0.0293	0.0066	0.0076	0.0085	0.0058	0.0163
Nickel, total	0.7	0.1	0.011	ND	ND	0.015	ND	ND	ND	0.043	0.0157	0.0116	0.0248	0.013	0.0447
Manganese, total	4.9	0.3	1.29	1.02	0.808	0.776	2.07	3.01	0.719	1.5	1.39	3.03	1.48	2.86	1.89
Molybdenum, total	0.2	0.04	ND	ND	ND	0.01	ND	ND	ND	0.019	0.0041	0.004	0.0076	0.0071	0.0129
Fluoride			0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.2	0.3	0.3	0.2	ND	0.1
Arsenic, total			0.0126	0.0071	0.0063	0.0048	0.0084	ND	ND	0.0411	ND	0.0082	0.004	0.0099	0.0044
Chromium, total			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper, total			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium, total			ND	ND	ND	ND	ND	0.054	0.084	ND	ND	ND	ND	ND	ND
Zinc			0.029	ND	ND	ND	ND	ND	ND	0.036	ND	ND	ND	ND	0.0449
Beryllium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mercury			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lithium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aluminum											0.051	0.298	1.27	0.078	ND
TOX											0.018	ND	ND	0.032	0.031
COD											28	21	110	21	75
Nitrogen											0.5	1.03	1.69	1.74	0.11
Phenols											0.038	ND	ND	ND	ND
Chloride											15.6	17.4	13.3	15.2	13.2

Monitoring Well QS Historic Analysis

Date			Mar-20	Jun-20	Sep-20	Dec-20	Jun-21	Dec-21	Jun-22	Dec-22	Mar-23	Jun-23	Dec-23	Aug-24	Dec-24
Parameter			results, mg/l												
Barium, total	10	2.0	2.99	0.256	0.25	0.384	0.261	0.202	3.89	2.68	0.188	0.719	22.5	Dry	0.366
Boron, total	30	6.0	0.162	ND	ND	ND	0.114	ND	0.139	0.135	ND	0.106	ND		ND
Cobalt, total	0.01	0.0021	0.227	0.0103	0.0064	0.0135	0.007	0.0038	0.226	0.192	ND	0.0357	1.62		0.0108
Nickel, total	0.7	0.1	0.338	0.021	0.015	0.025	0.012	ND	0.336	0.229	ND	0.0456	1.89		0.0139
Manganese, total	4.9	0.3	16.6	0.658	0.416	1.08	0.429	0.078	20.0	12.0	ND	2.42	93.1		0.715
Molybdenum, total	0.2	0.04	0.02	ND	ND	ND	ND	ND	0.022	0.014	ND	ND	0.067		ND
Fluoride			0.1	ND	ND	0.1	0.1	ND	0.1	ND	0.1	ND	ND		ND
Arsenic, total			0.18	0.0088	0.006	0.0071	0.0075	ND	0.151	0.137	ND	0.0252	1.08		0.0089
Chromium, total			0.145	0.008	0.006	0.013	ND	ND	0.149	0.11	ND	0.0168	0.666		ND
Copper, total			0.283	0.014	0.01	0.018	0.01	ND	0.316	0.216	ND	0.0042	1.65		0.0107
Selenium, total			ND	ND	ND	ND	ND	ND	0.073	ND	ND	0.0042	0.0925		ND
Zinc			ND	ND	0.02	ND	0.028	ND	0.573	0.392	ND	0.0731	3.61		ND
Beryllium			0.0042	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
Cadmium			0.005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND
Mercury			0.0007	ND	ND	ND	ND	ND	ND	0.00111	ND	ND	ND		ND
Lithium			0.077	ND	ND	ND	ND	ND	0.064	ND	ND	ND	ND		ND
Antimony			0.0033	ND	ND	ND	ND	ND	0.0038	0.0038	ND	ND	0.0307		ND
Thallium			0.0024	ND	ND	ND	ND	ND	0.002	ND	ND	ND	ND		ND
Vanadium			0.286	ND	ND	ND	ND	ND	0.31	0.232	ND	0.0365	1.24		ND
Lead			ND	0.013	ND	ND	ND	ND	0.16	0.106	ND	0.0196	ND		0.0063
Aluminum											ND	8.98	304		2.38
TOX											ND	ND	ND		ND
COD											1850	ND	ND		54
Nitrogen											ND	0.1	ND		ND
Phenols											ND	ND	ND		ND
Chloride											18.8	18.8	21.9		15.8

Monitoring Well QW Historic Analysis

Date			Mar-20	Jun-20	Sep-20	Dec-20	Jun-21	Dec-21	Jun-22	Dec-22	Mar-23	Jun-23	Dec-23	Aug-24	Dec-24
Parameter			results, mg/l												
Barium, total	10	2.0	0.176	0.151	0.156	0.17	0.065	0.189	0.628	Dry	Dry	Dry	Dry	Dry	Dry
Boron, total	30	6.0	ND	ND	ND	ND	0.504	ND	ND						
Cobalt, total	0.01	0.0021	0.0012	0.0004	0.0004	0.0009	0.0017	0.0013	0.0308						
Nickel, total	0.7	0.1	ND	ND	ND	ND	ND	ND	0.053						
Manganese, total	4.9	0.3	0.082	0.24	0.023	0.049	2.07	0.059	2.02						
Molybdenum, total	0.2	0.04	ND	ND	ND	ND	ND	ND	ND						
Fluoride			0.1	ND	0.1	0.2	0.1	0.2	0.1						
Arsenic			ND	ND	ND	ND	0.0084	ND	0.549						
Chromium, total			ND	ND	ND	ND	ND	ND	0.041						
Copper, total			ND	ND	ND	ND	ND	ND	0.057						
Selenium, total			ND	ND	ND	ND	ND	ND	0.129						
Zinc			ND	ND	ND	ND	ND	ND	0.22						
Beryllium			ND	ND	ND	ND	ND	ND	ND						
Cadmium			ND	ND	ND	ND	ND	ND	ND						
Mercury			ND	ND	ND	ND	ND	ND	ND						
Lithium			ND	ND	ND	ND	ND	ND	ND						
Antimony			ND	ND	ND	ND	ND	ND	0.0026						
Thallium			ND	ND	ND	ND	ND	ND	ND						
Vanadium			ND	ND	ND	ND	ND	ND	0.11						
Lead			ND	ND	ND	ND	ND	ND	ND						
Aluminum															
TOX															
COD															
Nitrogen															
Phenols															
Chloride															

Field Logs August 2024

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QN Weather: foggy misty 64

Date: 12 Aug 2024 Sampler Name: D. Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 26'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 912.42 Ground Surface Elevation (ft. MSL): 909.82

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			16.18
Water Elevation (ft. MSL):			893.64

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	12 Aug						
Depth to Water (ft)	16.18						
Volume Purged ( )							
Temp (°C)	64						
Sp. Cond (umhos/cm)	3190						
pH	6.6						
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☒ Yes ☐ No Color? ☐ Yes ☒ No

Comments: slightly septic

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QNE Weather: foggy misty 64

Date: 12 Aug 2024 Sampler Name: D. Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 18'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 922.47 Ground Surface Elevation (ft. MSL): 919.14

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			30.57
Water Elevation (ft. MSL):			888.57

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	12 Aug						
Depth to Water (ft)	30.57						
Volume Purged ( )							
Temp (°C)	63						
Sp. Cond (umhos/cm)	1200						
pH	6.9						
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☒ No Color? ☐ Yes ☒ No

Comments: some sediment with depth

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QNW Weather: foggy misty 64

Date: 12 Aug 2024 Sampler Name: D Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 18'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 925.05 Ground Surface Elevation (ft. MSL): 922.01

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			46.57
Water Elevation (ft. MSL):			875.44

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	12 Aug						
Depth to Water (ft)	46.57						
Volume Purged ( )							
Temp (°C)	64						
Sp. Cond (umhos/cm)	1860						
pH	6.9						
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☒ No Color? ☐ Yes ☒ No

Comments: more turbidity with depth

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QE Weather: foggy misty 64

Date: 12 Aug 2024 Sampler Name: D. Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 24'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 918.48 Ground Surface Elevation (ft. MSL): 915.76

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			40.21
Water Elevation (ft. MSL):			875.55

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	12 Aug						
Depth to Water (ft)	40.21						
Volume Purged ( )							
Temp (°C)	63						
Sp. Cond (umhos/cm)	3230						
pH	6.9						
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☒ No Color? ☒ Yes ☐ No

Comments: some sediment with depth

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #8-BUD-08-99

Well/Piezometer: MW QS Weather: foggy misty 64

Date: 12 Aug 2024 Sampler Name: D Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 18'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 919.31 Ground Surface Elevation (ft. MSL): 916.18

Field Observations

Locked: ☐ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			41.54
Water Elevation (ft. MSL):			874.64

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	12 Aug						
Depth to Water (ft)							
Volume Purged ( )							
Temp (°C)							
Sp. Cond (umhos/cm)							
pH							
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☐ No Color? ☐ Yes ☐ No

Comments: tried pump, did not have enough water in well to collect sample, made groundwater muddy, could not sample

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QW Weather: foggy misty 64

Date: 12 Aug 2024 Sampler Name:

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 34'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 915.24 Ground Surface Elevation (ft. MSL): 912.19

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			dry
Water Elevation (ft. MSL):			dry

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time							
Depth to Water (ft)							
Volume Purged ( )							
Temp (°C)							
Sp. Cond (umhos/cm)							
pH							
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☐ No Color? ☐ Yes ☐ No

Comments:

Field Logs December 2024

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QN Weather: cool sunny 28

Date: 16 Dec 2024 Sampler Name: D. Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 26'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 912.42 Ground Surface Elevation (ft. MSL): 909.82

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			19.15
Water Elevation (ft. MSL):			890.67

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	16 Dec						
Depth to Water (ft)	19.15						
Volume Purged ( )							
Temp (°C)	62						
Sp. Cond (umhos/cm)	2380						
pH	6.5						
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☒ Yes ☐ No Color? ☐ Yes ☒ No

Comments: slightly septic

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QNW Weather: cool sunny 28

Date: 16 Dec 2024 Sampler Name: D. Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 18'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 925.05 Ground Surface Elevation (ft. MSL): 922.01

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			46.99
Water Elevation (ft. MSL):			875.02

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: in office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	16 Dec						
Depth to Water (ft)	46.99						
Volume Purged ( )							
Temp (°C)	62						
Sp. Cond (umhos/cm)	2170						
pH	606						
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☒ No Color? ☐ Yes ☒ No

Comments: slightly more turbidity with depth

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QNE Weather: cool sunny 28

Date: 16 Dec 2024 Sampler Name: D. Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 18'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 922.47 Ground Surface Elevation (ft. MSL): 919.14

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			32.53
Water Elevation (ft. MSL):			886.61

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	16 Dec						
Depth to Water (ft)	32.53						
Volume Purged ( )							
Temp (°C)	63						
Sp. Cond (umhos/cm)	1100						
pH	6.8						
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☒ No Color? ☐ Yes ☒ No

Comments: some sediment with depth

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QE Weather: cool sunny 28

Date: 16 Dec 2024 Sampler Name: D. Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 24'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 918.48 Ground Surface Elevation (ft. MSL): 915.76

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			41.68
Water Elevation (ft. MSL):			874.08

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	16 Dec						
Depth to Water (ft)	41.68						
Volume Purged ( )							
Temp (°C)	62						
Sp. Cond (umhos/cm)	2580						
pH	6.5						
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☒ No Color? ☒ Yes ☐ No

Comments: some sediment with depth

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #8-BUD-08-99

Well/Piezometer: MW QS Weather: cool sunny 28

Date: 16 Dec 2024 Sampler Name: D Stone

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 18'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 919.31 Ground Surface Elevation (ft. MSL): 916.18

Field Observations

Locked: ☐ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			41.76
Water Elevation (ft. MSL):			874.42

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time	16 Dec						
Depth to Water (ft)	41.76						
Volume Purged ( )							
Temp (°C)	64						
Sp. Cond (umhos/cm)	1150						
pH	6.7						
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☒ No Color? ☒ Yes ☐ No

Comments: collected samples for all but formaldehyde then too much sediment

Groundwater Sampling Field Sheet

Disposal Site Name: Besser Quinn Permit No.: #08-BUD-08-99

Well/Piezometer: MW QW Weather: cool sunny 28

Date: 16 Dec 2024 Sampler Name:

Monitoring Well Details

Construction Data

Borehole Diameter (in): 6 Depth to Tope of Screen (ft): 34'

Casing Diameter (in): 2 Casing Material: 2' PVC

Top of Casing Elevation (ft. MSL): 915.24 Ground Surface Elevation (ft. MSL): 912.19

Field Observations

Locked: ☒ Yes ☐ No

	Before Purging	After Purging	Before Sampling
Depth to Water Level (ft.):			dry
Water Elevation (ft. MSL):			dry

Screen Submerged? (Depth to Water Level < Depth to Top of Screen) ☐ Yes ☐ No

	Start	End
Purge Date/Time	NA	

Well Conditions Commentary: no issues

Sampling Equipment (check one)

☐ Pump ☐ Interval Sampler

☒ Bailer ☐ Other (specify):

Equipment Name & Description:

Pump Types (check one)

☐ Submersible ☐ Peristaltic ☐ Bladder ☐ Inertial Lift Pump ☐ Other (specify):

Method (check one)

☐ Low Flow ☐ No Purge ☐ Purge

Options (check one)

☒ Dedicated ☐ Disposable ☐ Portable

Decontamination Method: In office, wash, rinse, wash, rinse

Field Analysis

							Final Reading
Date/Time							
Depth to Water (ft)							
Volume Purged ( )							
Temp (°C)							
Sp. Cond (umhos/cm)							
pH							
DO (mg/l)							
ORP (mV)							
Turbidity (NTU)							

Equipment Depth: Flow Rate: Volume Removed: Volume Sampled:

Odor? ☐ Yes ☐ No Color? ☐ Yes ☐ No

Comments:

Statistical Review August 2024

Results of the Ground Water Statistics

for Besser Quinn Quarry

First Semi-Annual Monitoring Event in 2024

Prepared for:
Besser Quinn Quarry
Boone, IA 50036

and

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Ankeny, IA 50021

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October 2024

INTRODUCTION

This report contains the results of the statistical analyses used to evaluate the ground water data obtained during the first semi-annual monitoring event in 2024 at Besser Quinn Quarry. The ground water at Besser Quinn Quarry is monitored by wells QE, QN, QNE, QNW, QS, and QW. These monitoring wells were sampled on August 12, 2024 and analyzed for the parameters required by permit. No sample was obtained at QS; well QW was reported to be dry.

The statistical plan is designed to detect a release from the facility at the earliest indication so that it is protective of human health and the environment. Both interwell and intrawell methodologies are described and then applied to the Besser Quinn Quarry data. The statistical plan conforms with IAC 567, Chapter 113.10, USEPA Guidance document ("*Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Unified Guidance"*, March 2009), and the American Society for Testing and Materials (ASTM) standard D6312-98, *Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs*.

Ground Water Monitoring Program

The groundwater monitoring network for Besser Quinn Quarry includes wells QE, QN, QNE, QNW, QS, and QW. Each of the groundwater monitoring wells is to be sampled at least semiannually and analyzed for the detection monitoring parameters listed below.

Detection monitoring constituents for Besser Quinn Quarry
Barium, Total
Boron, Total
Cobalt, Total
Manganese, Total
Molybdenum, Total
Nickel, Total

The ground water data obtained during the first semi-annual monitoring event in 2024 are summarized in Attachment A. The historical ground water data obtained from 2019 through the first semi-annual monitoring event in 2024 are summarized in Attachment B.

STATISTICAL METHODOLOGIES FOR DETECTION MONITORING

IAC 567, Chapter 113.10(4) provides several options for statistically evaluating the ground water data at those wells that monitor the open cells or contiguous MSWLF units. The preferred methods for comparing ground water data are using either prediction limits or using control charts. Both of these methods were applied to the Besser Quinn Quarry data using the DUMPStat® statistical program. DUMPStat® is a program for the statistical analysis of groundwater monitoring data using methods described in "Statistical Methods for Groundwater Monitoring" by Dr. Robert D. Gibbons. The DUMPStat program is completely consistent with all USEPA regulations and guidance and the ASTM D6312-98 guidance. Ground water statistics are to be done on the constituents listed.

Interwell Statistics: Upgradient versus Downgradient Comparisons

Interwell statistics are appropriate when the upgradient and downgradient wells monitor the same ground water formation and there is similar variability in the upgradient and downgradient zones. Site prediction limits are determined by pooling the historical ground water data from hydraulically upgradient wells. This statistical method compares the current downgradient determinations to site prediction limits and checks for exceedances. The type of prediction limit utilized (e.g., parametric or nonparametric) is based on the detection frequency and the data distribution of each parameter in the background data. The distribution of the background data is tested for normality using the Shapiro-Wilk test (Gibbons, 1994 and USEPA 1992). If the constituent is normally distributed, a normal prediction limit is used. If normality is rejected by the Shapiro-Wilk test, the background data is transformed by taking the natural logarithm. The Shapiro-Wilk test is then reapplied on the transformed data. If it is not rejected, lognormal prediction limits are used. If after transforming the data, normality is still rejected, nonparametric prediction limits are used for that analyte. The nonparametric prediction limit is the largest determination in the background measurements. For constituents where the background detection frequency is greater than 0% but less than 50%, nonparametric prediction limits will be used. If the detection frequency is 0% after thirteen samples have been collected, the practical quantitation limit (PQL) becomes the nonparametric prediction limit.

Results of the Interwell Statistics

The background data used in this statistical analysis includes the ground water data collected from ground water wells QE, QN, and QNE during the period from 2020 through the current data. A summary of the background data from monitoring wells QE, QN, and QNE is listed in Attachment C, Table 1 "Upgradient Data". This statistical method compares the current downgradient determinations to site prediction limits and checks for exceedances.

Table 2 "Most Current Downgradient Monitoring Data", summarizes the current data from downgradient well QNW compared to the site prediction limits. Prediction limit exceedances are flagged with asterisks. For the most current data, the site prediction limit exceedances detected are summarized in the table below.

Prediction Limit Exceedances at Besser Quinn Quarry during the First Semi-Annual Monitoring Event in 2024

Well	Parameter	Result	Prediction Limit	Prediction Limit Type	Verified/ Awaiting verification
QNW	Barium, mg/L	0.314	0.2050	Nonparametric	Verified
	Manganese, mg/L	4.42	3.8243	Lognormal	Verified

The detection frequencies of the parameters in the up and down gradient monitoring wells are summarized in Table 3. Table 4 summarizes the results of the Shapiro-Wilk test. Table 5 is a summary of the statistics and prediction limits determined. Time series graphs of each of the parameters at each well with the corresponding prediction limits are attached.

A statistical power curve indicates the expected false assessments for the site as a whole. The false positive rate for interwell analyses is the percentage of failures when the upgradient versus downgradient true mean difference equals zero. False negative rate indicates the chance of missing contamination at a single well

for a single constituent. The statistical power is a function of the number of wells included, the number of constituents compared, the detection frequencies, and the data distributions involved. For interwell analysis, the site-wide false positive rate is 1% and the test becomes sensitive to 5 standard deviation unit increases over background.

Intrawell statistics

Intrawell statistics are appropriate for facilities where the upgradient wells do not accurately characterize the natural ground water conditions downgradient from the facility. This may be due to different hydrogeological conditions where the wells are screened, having too few upgradient wells to account for the spatial variability, or the site exhibiting no definable hydraulic gradient. Intrawell statistics compare new measurements to the historical data at each ground water monitoring well independently. It is recommended that at least eight background samples be obtained prior to performing the statistics.

The most useful technique for intrawell comparisons is the combined Shewhart-CUSUM control chart. This control chart procedure is useful because it will detect releases both in terms of the constituent concentration and cumulative increases. This method is also extremely sensitive to sudden and gradual releases. A requirement for constructing these control charts is that the parameter is detected at a frequency greater than or equal to 25%, otherwise the data variance is not properly defined.

The combined Shewhart-CUSUM control chart assumes that the data are independent and normally distributed with a fixed mean and a constant variance. Independent data is much more critical than the normality assumption. To achieve independence, it is recommended that data are collected no more frequently than quarterly to account for seasonal variation. The combined Shewhart-CUSUM control chart is extremely robust to deviations from normality. Because the control charts do not use a specific multiplier based on a normal distribution, it is more conservative to assume normality.

It is recommended that at least eight rounds of data be available to provide a reliable estimate of the mean and standard deviation of the parameter concentration, although the control charts will be generated with as few as four data points. Having only four data points may produce greater uncertainty in the mean and standard deviation of the background data, leading to higher control limits, thus having a potentially high false negative rate.

Many groundwater monitoring parameters are not detected at a frequency great enough to generate the combined Shewhart-CUSUM control charts. For constituents that are detected less than 25% of the time at a particular well, the data should be plotted as a time series until a sufficient number of data points are available to provide a 99% confidence nonparametric prediction limit. Thirteen independent measurements (with 1 resample) are necessary to achieve a 99% confidence (1% false positive rate) nonparametric prediction limit. Eight independent measurements (for pass 1 of 2 resamples) are necessary to achieve a 99% confidence nonparametric prediction limit. The nonparametric prediction limit is the largest determination out of the data set collected for that well and parameter. If the detection frequency is 0% after thirteen samples have been collected, the practical quantitation limit (PQL) becomes the nonparametric prediction limit.

In developing the statistical background, the historical data must be thoroughly screened for anomalous data due to sampling error, analytical error, or simply by chance alone. An erroneous data point, if not removed prior to the mean and variance computations, would yield a larger control limit thus increasing the false negative rate. The DUMPStat® program screens for outliers using the Dixon test. Anomalous data will still be plotted on the graphs (with a unique symbol) but will not be included in the calculations.

The verification resample plan is an integral function of the statistical plan to reduce the probability that anomalous data obtained after the background has been established, is indicative of a release.

The background data for each well and constituent is tested for existing trends using Sen's nonparametric estimate of trend. If contamination exists prior to completing the background, the control limits could be potentially high and this control chart method would not be able to detect an increasing trend unless the increase is severe.

Results of the Intrawell Statistics

The monitoring constituents at wells QE, QN, QNE, QNW, and QS were evaluated using the combined Shewhart-CUSUM control chart method. The previous background included the four rounds of data obtained from March 2020 through December 2020. Since a minimum of eight rounds of data is recommended, the background was updated to include data obtained from March 2020 through December 2022.

A summary of the intrawell statistics is included in Attachment D, Table 1 "Summary Statistics and Intermediate Computations for Combined Shewhart-CUSUM Control Charts." The control charts or time series graphs follow the summary table. For the most current data, the control limit exceedances detected are summarized in the table below. No increasing trends were detected in the background data.

Control Limit Exceedances During the First Semi-Annual Monitoring Event in 2024

Well	Parameter	Result	CUSUM value	Control Limit	Control Limit Type	Verified/ Awaiting Verification
QN	Manganese, mg/L	5.81	5.5427	2.5968	Normal	Awaiting verification

A control chart factor was selected to provide a balance of the site-wide false positive and false negative rates. A statistical power curve indicates the expected false assessments for the site as a whole. The site-wide false positive rate is 5% and the test becomes sensitive to 4 standard deviation units over background.

Attachment A

Ground Water Data

Table 1

Analytical Data Summary for 8/12/2024

Constituents	Units	QE	QN	QNE	QNW
Barium, Total	mg/L	.0659	.0486	.1090	.3140
Boron, Total	mg/L	.577	.374	.660	.211
Cobalt, Total	mg/L	.0058	.0041	.0009	.0087
Manganese, Total	mg/L	2.860	5.810	.402	4.420
Molybdenum, Total	mg/L	.0071	.0147	.0121	.0077
Nickel, Total	mg/L	.0130	.0094	.0052	.0181

* - The displayed value is the arithmetic mean of multiple database matches.

Table 1

Analytical Data Summary for 8/12/2024

Constituents	Units	QE	QN	QNE	QNW
Aluminum	mg/L	.078	.125	.092	2.460
Ammonia	mg/L	1.74	.61	1.52	.11
Antimony, total	mg/L	<.002	<.002	<.002	<.002
Arsenic, total	mg/L	.0099	.0092	<.0040	.0063
Barium, Total	mg/L	.0659	.0486	.1090	.3140
Beryllium, total	mg/L	<.004	<.004	<.004	<.004
Boron, Total	mg/L	.577	.374	.660	.211
Cadmium, total	mg/L	<.0008	<.0008	<.0008	<.0008
Chloride	mg/L	15.2	99.3	6.5	241.0
Chromium, total	mg/L	<.008	<.008	<.008	<.008
Cobalt, Total	mg/L	.0058	.0041	.0009	.0087
COD	mg/L	21	<20	<20	<20
Copper, total	mg/L	<.0040	<.0040	.0052	.0071
Fluoride	mg/L	<.1	.1	.1	.1
Formaldehyde	ug/L	<20	<20	<10	<10
Iron	mg/L	12.300	15.700	.161	13.800
Lead, total	mg/L	<.0040	<.0040	<.0040	.0042
Magnesium	mg/L	140.0	164.0	62.2	68.3
Manganese, Total	mg/L	2.860	5.810	.402	4.420
Mercury, total	mg/L	<.0005	<.0005	<.0005	<.0005
Molybdenum, Total	mg/L	.0071	.0147	.0121	.0077
Nickel, Total	mg/L	.0130	.0094	.0052	.0181
Phenols	mg/L	<.035	<.035	<.035	.053
Selenium, total	mg/L	<.004	<.004	<.004	<.004
Silver, total	mg/L	<.004	<.004	<.004	<.004
Sulfate	mg/L	901	1010	233	134
Thallium, total	mg/L	<.002	<.002	<.002	<.002
TOX	mg/L	.032	.092	<.010	.133
TSS	mg/L	852	87	6	626
Vanadium, total	mg/L	<.02	<.02	<.02	<.02
Zinc, total	mg/L	<.020	<.020	<.020	<.002

* - The displayed value is the arithmetic mean of multiple database matches.

Attachment B

Historical Ground Water Data

Table 1

Analytical Data Summary for QE

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023	6/19/2023	12/1/2023	8/12/2024
Barium, Total	mg/L	.1200	.1140	.0630	.0520	.0065	.0770	.0690	.1520	.0637	.0778	.0716	.0659
Boron, Total	mg/L	.293	.185	.524	.523	.504	.489	<.100	.645	.167	.385	.629	.577
Cobalt, Total	mg/L	.0048	.0020	.0004	.0042	.0017	.0024	.0023	.0293	.0066	.0076	.0085	.0058
Manganese, Total	mg/L	1.290	1.020	.808	.776	2.070	3.010	.719	1.500	1.390	3.030	1.480	2.860
Molybdenum, Total	mg/L	<.0100	<.0100	<.0100	.0100	<.0100	<.0100	<.0100	.0190	.0041	.0040	.0076	.0071
Nickel, Total	mg/L	.0110	<.0100	<.0100	.0150	<.0100	.0150	<.0100	.0430	.0157	.0116	.0248	.0130

* - The displayed value is the arithmetic mean of multiple database matches.

Table 2

Analytical Data Summary for QN

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023	6/19/2023	12/1/2023	8/12/2024
Barium, Total	mg/L	.2050	.0890	.0790	.1040	.1220	.1260	.0560	.0430	.0445	.0881	.0594	.0486
Boron, Total	mg/L	.544	.479	.481	.520	.661	.634	.124	.523	.654	.603	.488	.374
Cobalt, Total	mg/L	.0039	.0035	.0029	.0039	.0034	.0025	.0008	.0059	.0027	.0061	.0025	.0041
Manganese, Total	mg/L	1.150	.945	.857	1.100	.955	.614	.333	.922	.782	.689	.691	5.810
Molybdenum, Total	mg/L	.3580	.2650	.2460	.2500	.2230	.1840	.0240	.1340	.1240	.1150	.0900	.0147
Nickel, Total	mg/L	.0190	.0200	.0170	.0160	.0130	.0170	.0200	.0250	.0106	.0121	.0169	.0094

* - The displayed value is the arithmetic mean of multiple database matches.

Table 3

Analytical Data Summary for QNE

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023	6/19/2023	12/1/2023	8/12/2024
Barium, Total	mg/L	.1490	.1040	.0940	.0970	.0960	.0970	.1000	.0960	.0907	.1000	.0992	.1090
Boron, Total	mg/L	1.1500	.4760	.0752	.7390	.7490	.7300	.6080	.6320	.6710	.6200	.6250	.6600
Cobalt, Total	mg/L	.0038	.0019	.0011	.0013	.0006	.0007	.0005	.0043	.0011	.0062	.0027	.0009
Manganese, Total	mg/L	1.460	.616	.698	.604	.397	.431	.313	.399	.639	.347	.555	.402
Molybdenum, Total	mg/L	.1150	.0210	.0230	.0230	.0200	.0200	.0180	.0140	.0129	.0117	.0127	.0121
Nickel, Total	mg/L	.0160	.0180	.0150	.0120	<.0100	<.0100	<.0100	<.0100	.0053	.0044	.0066	.0052

* - The displayed value is the arithmetic mean of multiple database matches.

Table 4

Analytical Data Summary for QNW

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023	6/19/2023	12/1/2023	8/12/2024
Barium, Total	mg/L	.226	.170	.245	.287	.260	.309	1.820	1.400	.195	.249	9.410	.314
Boron, Total	mg/L	.174	<.010	.198	.247	.163	.277	.122	.296	.147	.138	1.290	.211
Cobalt, Total	mg/L	.0033	.0074	.0004	.0004	.0033	.0067	.0804	.0581	.0007	.0030	.7270	.0087
Manganese, Total	mg/L	1.040	.302	.056	.045	.701	.714	5.240	9.880	.105	.512	49.900	4.420
Molybdenum, Total	mg/L	<.0100	<.0100	<.0100	<.0100	<.0100	<.0100	.0180	.0200	<.0040	<.0040	.1550	.0077
Nickel, Total	mg/L	<.0100	.0100	<.0100	<.0100	<.0100	<.0100	.1000	.0910	.0040	.0056	1.3700	.0181

* - The displayed value is the arithmetic mean of multiple database matches.

Table 5

Analytical Data Summary for QS

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023	6/19/2023	12/1/2023
Barium, Total	mg/L	2.990	.256	.250	.384	.261	.202	3.890	2.680	.188	.719	22.500
Boron, Total	mg/L	.162	<.010	<.010	<.010	.114	<.100	.139	.135	<.100	.106	<1.000
Cobalt, Total	mg/L	.2270	.0103	.0064	.0135	.0070	.0038	.2260	.1920	<.0004	.0357	1.6200
Manganese, Total	mg/L	16.600	.658	.419	1.080	.429	.078	20.000	12.000	<.004	2.420	93.100
Molybdenum, Total	mg/L	.020	<.010	<.010	<.010	<.010	<.010	.022	.014	<.004	<.004	.067
Nickel, Total	mg/L	.3380	.0210	.0150	.0250	.0120	<.0100	.3360	.2290	<.0040	.0456	1.8900

* - The displayed value is the arithmetic mean of multiple database matches.

Table 6

Analytical Data Summary for QW

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022
Barium, Total	mg/L	.176	.151	.156	.170	.284	.189	.628
Boron, Total	mg/L	<.01	<.01	<.01	<.01	<.01	<.10	<.10
Cobalt, Total	mg/L	.0012	.0004	.0004	.0009	.0082	.0013	.0308
Manganese, Total	mg/L	.082	.024	.023	.049	.504	.059	2.020
Molybdenum, Total	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Nickel, Total	mg/L	<.010	<.010	<.010	<.010	.016	<.010	.053

* - The displayed value is the arithmetic mean of multiple database matches.

Attachment C

Summary Tables and Graphs for the Interwell Comparisons

Table 1

Upgradient Data

Constituent	Units	Well	Date		Result	Adjusted	
Barium, Total	mg/L	QE	03/01/2020		0.1200		
Barium, Total	mg/L	QE	06/15/2020		0.1140		
Barium, Total	mg/L	QE	09/01/2020		0.0630		
Barium, Total	mg/L	QE	12/09/2020		0.0520		
Barium, Total	mg/L	QE	06/10/2021		0.0065		*
Barium, Total	mg/L	QE	12/09/2021		0.0770		
Barium, Total	mg/L	QE	06/21/2022		0.0690		
Barium, Total	mg/L	QE	12/06/2022		0.1520		
Barium, Total	mg/L	QE	03/22/2023		0.0637		
Barium, Total	mg/L	QE	06/19/2023		0.0778		
Barium, Total	mg/L	QE	12/01/2023		0.0716		
Barium, Total	mg/L	QE	08/12/2024		0.0659		
Boron, Total	mg/L	QE	03/01/2020		0.2930		
Boron, Total	mg/L	QE	06/15/2020		0.1850		
Boron, Total	mg/L	QE	09/01/2020		0.5240		
Boron, Total	mg/L	QE	12/09/2020		0.5230		
Boron, Total	mg/L	QE	06/10/2021		0.5040		
Boron, Total	mg/L	QE	12/09/2021		0.4890		
Boron, Total	mg/L	QE	06/21/2022	ND	0.1000		
Boron, Total	mg/L	QE	12/06/2022		0.6450		
Boron, Total	mg/L	QE	03/22/2023		0.1670		
Boron, Total	mg/L	QE	06/19/2023		0.3850		
Boron, Total	mg/L	QE	12/01/2023		0.6290		
Boron, Total	mg/L	QE	08/12/2024		0.5770		
Cobalt, Total	mg/L	QE	03/01/2020		0.0048		
Cobalt, Total	mg/L	QE	06/15/2020		0.0020		
Cobalt, Total	mg/L	QE	09/01/2020		0.0004		
Cobalt, Total	mg/L	QE	12/09/2020		0.0042		
Cobalt, Total	mg/L	QE	06/10/2021		0.0017		
Cobalt, Total	mg/L	QE	12/09/2021		0.0024		
Cobalt, Total	mg/L	QE	06/21/2022		0.0023		
Cobalt, Total	mg/L	QE	12/06/2022		0.0293		
Cobalt, Total	mg/L	QE	03/22/2023		0.0066		
Cobalt, Total	mg/L	QE	06/19/2023		0.0076		
Cobalt, Total	mg/L	QE	12/01/2023		0.0085		
Cobalt, Total	mg/L	QE	08/12/2024		0.0058		
Manganese, Total	mg/L	QE	03/01/2020		1.2900		
Manganese, Total	mg/L	QE	06/15/2020		1.0200		
Manganese, Total	mg/L	QE	09/01/2020		0.8080		
Manganese, Total	mg/L	QE	12/09/2020		0.7760		
Manganese, Total	mg/L	QE	06/10/2021		2.0700		
Manganese, Total	mg/L	QE	12/09/2021		3.0100		
Manganese, Total	mg/L	QE	06/21/2022		0.7190		
Manganese, Total	mg/L	QE	12/06/2022		1.5000		
Manganese, Total	mg/L	QE	03/22/2023		1.3900		
Manganese, Total	mg/L	QE	06/19/2023		3.0300		
Manganese, Total	mg/L	QE	12/01/2023		1.4800		
Manganese, Total	mg/L	QE	08/12/2024		2.8600		
Molybdenum, Total	mg/L	QE	03/01/2020	ND	0.0100		
Molybdenum, Total	mg/L	QE	06/15/2020	ND	0.0100		
Molybdenum, Total	mg/L	QE	09/01/2020	ND	0.0100		
Molybdenum, Total	mg/L	QE	12/09/2020		0.0100		
Molybdenum, Total	mg/L	QE	06/10/2021	ND	0.0100		
Molybdenum, Total	mg/L	QE	12/09/2021	ND	0.0100		
Molybdenum, Total	mg/L	QE	06/21/2022	ND	0.0100		
Molybdenum, Total	mg/L	QE	12/06/2022		0.0190		
Molybdenum, Total	mg/L	QE	03/22/2023		0.0041		
Molybdenum, Total	mg/L	QE	06/19/2023		0.0040		
Molybdenum, Total	mg/L	QE	12/01/2023		0.0076		
Molybdenum, Total	mg/L	QE	08/12/2024		0.0071		
Nickel, Total	mg/L	QE	03/01/2020		0.0110		
Nickel, Total	mg/L	QE	06/15/2020	ND	0.0100		
Nickel, Total	mg/L	QE	09/01/2020	ND	0.0100		
Nickel, Total	mg/L	QE	12/09/2020		0.0150		
Nickel, Total	mg/L	QE	06/10/2021	ND	0.0100		
Nickel, Total	mg/L	QE	12/09/2021		0.0150		
Nickel, Total	mg/L	QE	06/21/2022	ND	0.0100		
Nickel, Total	mg/L	QE	12/06/2022		0.0430		*
Nickel, Total	mg/L	QE	03/22/2023		0.0157		
Nickel, Total	mg/L	QE	06/19/2023		0.0116		
Nickel, Total	mg/L	QE	12/01/2023		0.0248		
Nickel, Total	mg/L	QE	08/12/2024		0.0130		
Barium, Total	mg/L	QN	03/01/2020		0.2050		
Barium, Total	mg/L	QN	06/15/2020		0.0890		

* - Outlier for that well and constituent.
** - ND value replaced with median RL.
*** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 1

Upgradient Data

Constituent	Units	Well	Date		Result	Adjusted	
Barium, Total	mg/L	QN	09/01/2020		0.0790		
Barium, Total	mg/L	QN	12/09/2020		0.1040		
Barium, Total	mg/L	QN	06/10/2021		0.1220		
Barium, Total	mg/L	QN	12/09/2021		0.1260		
Barium, Total	mg/L	QN	06/21/2022		0.0560		
Barium, Total	mg/L	QN	12/06/2022		0.0430		
Barium, Total	mg/L	QN	03/22/2023		0.0445		
Barium, Total	mg/L	QN	06/19/2023		0.0881		
Barium, Total	mg/L	QN	12/01/2023		0.0594		
Barium, Total	mg/L	QN	08/12/2024		0.0486		
Boron, Total	mg/L	QN	03/01/2020		0.5440		
Boron, Total	mg/L	QN	06/15/2020		0.4790		
Boron, Total	mg/L	QN	09/01/2020		0.4810		
Boron, Total	mg/L	QN	12/09/2020		0.5200		
Boron, Total	mg/L	QN	06/10/2021		0.6610		
Boron, Total	mg/L	QN	12/09/2021		0.6340		
Boron, Total	mg/L	QN	06/21/2022		0.1240		*
Boron, Total	mg/L	QN	12/06/2022		0.5230		
Boron, Total	mg/L	QN	03/22/2023		0.6540		
Boron, Total	mg/L	QN	06/19/2023		0.6030		
Boron, Total	mg/L	QN	12/01/2023		0.4880		
Boron, Total	mg/L	QN	08/12/2024		0.3740		
Cobalt, Total	mg/L	QN	03/01/2020		0.0039		
Cobalt, Total	mg/L	QN	06/15/2020		0.0035		
Cobalt, Total	mg/L	QN	09/01/2020		0.0029		
Cobalt, Total	mg/L	QN	12/09/2020		0.0039		
Cobalt, Total	mg/L	QN	06/10/2021		0.0034		
Cobalt, Total	mg/L	QN	12/09/2021		0.0025		
Cobalt, Total	mg/L	QN	06/21/2022		0.0008		
Cobalt, Total	mg/L	QN	12/06/2022		0.0059		
Cobalt, Total	mg/L	QN	03/22/2023		0.0027		
Cobalt, Total	mg/L	QN	06/19/2023		0.0061		
Cobalt, Total	mg/L	QN	12/01/2023		0.0025		
Cobalt, Total	mg/L	QN	08/12/2024		0.0041		
Manganese, Total	mg/L	QN	03/01/2020		1.1500		
Manganese, Total	mg/L	QN	06/15/2020		0.9450		
Manganese, Total	mg/L	QN	09/01/2020		0.8570		
Manganese, Total	mg/L	QN	12/09/2020		1.1000		
Manganese, Total	mg/L	QN	06/10/2021		0.9550		
Manganese, Total	mg/L	QN	12/09/2021		0.6140		
Manganese, Total	mg/L	QN	06/21/2022		0.3330		
Manganese, Total	mg/L	QN	12/06/2022		0.9220		
Manganese, Total	mg/L	QN	03/22/2023		0.7820		
Manganese, Total	mg/L	QN	06/19/2023		0.6890		
Manganese, Total	mg/L	QN	12/01/2023		0.6910		
Manganese, Total	mg/L	QN	08/12/2024		5.8100		*
Molybdenum, Total	mg/L	QN	03/01/2020		0.3580		
Molybdenum, Total	mg/L	QN	06/15/2020		0.2650		
Molybdenum, Total	mg/L	QN	09/01/2020		0.2460		
Molybdenum, Total	mg/L	QN	12/09/2020		0.2500		
Molybdenum, Total	mg/L	QN	06/10/2021		0.2230		
Molybdenum, Total	mg/L	QN	12/09/2021		0.1840		
Molybdenum, Total	mg/L	QN	06/21/2022		0.0240		
Molybdenum, Total	mg/L	QN	12/06/2022		0.1340		
Molybdenum, Total	mg/L	QN	03/22/2023		0.1240		
Molybdenum, Total	mg/L	QN	06/19/2023		0.1150		
Molybdenum, Total	mg/L	QN	12/01/2023		0.0900		
Molybdenum, Total	mg/L	QN	08/12/2024		0.0147		
Nickel, Total	mg/L	QN	03/01/2020		0.0190		
Nickel, Total	mg/L	QN	06/15/2020		0.0200		
Nickel, Total	mg/L	QN	09/01/2020		0.0170		
Nickel, Total	mg/L	QN	12/09/2020		0.0160		
Nickel, Total	mg/L	QN	06/10/2021		0.0130		
Nickel, Total	mg/L	QN	12/09/2021		0.0170		
Nickel, Total	mg/L	QN	06/21/2022		0.0200		
Nickel, Total	mg/L	QN	12/06/2022		0.0250		
Nickel, Total	mg/L	QN	03/22/2023		0.0106		
Nickel, Total	mg/L	QN	06/19/2023		0.0121		
Nickel, Total	mg/L	QN	12/01/2023		0.0169		
Nickel, Total	mg/L	QN	08/12/2024		0.0094		
Barium, Total	mg/L	QNE	03/01/2020		0.1490		
Barium, Total	mg/L	QNE	06/15/2020		0.1040		
Barium, Total	mg/L	QNE	09/01/2020		0.0940		
Barium, Total	mg/L	QNE	12/09/2020		0.0970		

* - Outlier for that well and constituent.
** - ND value replaced with median RL.
*** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 1

Upgradient Data

Constituent	Units	Well	Date		Result	Adjusted	
Barium, Total	mg/L	QNE	06/10/2021		0.0960		
Barium, Total	mg/L	QNE	12/09/2021		0.0970		
Barium, Total	mg/L	QNE	06/21/2022		0.1000		
Barium, Total	mg/L	QNE	12/06/2022		0.0960		
Barium, Total	mg/L	QNE	03/22/2023		0.0907		
Barium, Total	mg/L	QNE	06/19/2023		0.1000		
Barium, Total	mg/L	QNE	12/01/2023		0.0992		
Barium, Total	mg/L	QNE	08/12/2024		0.1090		
Boron, Total	mg/L	QNE	03/01/2020		1.1500		
Boron, Total	mg/L	QNE	06/15/2020		0.4760		
Boron, Total	mg/L	QNE	09/01/2020		0.0752		*
Boron, Total	mg/L	QNE	12/09/2020		0.7390		
Boron, Total	mg/L	QNE	06/10/2021		0.7490		
Boron, Total	mg/L	QNE	12/09/2021		0.7300		
Boron, Total	mg/L	QNE	06/21/2022		0.6080		
Boron, Total	mg/L	QNE	12/06/2022		0.6320		
Boron, Total	mg/L	QNE	03/22/2023		0.6710		
Boron, Total	mg/L	QNE	06/19/2023		0.6200		
Boron, Total	mg/L	QNE	12/01/2023		0.6250		
Boron, Total	mg/L	QNE	08/12/2024		0.6600		
Cobalt, Total	mg/L	QNE	03/01/2020		0.0038		
Cobalt, Total	mg/L	QNE	06/15/2020		0.0019		
Cobalt, Total	mg/L	QNE	09/01/2020		0.0011		
Cobalt, Total	mg/L	QNE	12/09/2020		0.0013		
Cobalt, Total	mg/L	QNE	06/10/2021		0.0006		
Cobalt, Total	mg/L	QNE	12/09/2021		0.0007		
Cobalt, Total	mg/L	QNE	06/21/2022		0.0005		
Cobalt, Total	mg/L	QNE	12/06/2022		0.0043		
Cobalt, Total	mg/L	QNE	03/22/2023		0.0011		
Cobalt, Total	mg/L	QNE	06/19/2023		0.0062		
Cobalt, Total	mg/L	QNE	12/01/2023		0.0027		
Cobalt, Total	mg/L	QNE	08/12/2024		0.0009		
Manganese, Total	mg/L	QNE	03/01/2020		1.4600		
Manganese, Total	mg/L	QNE	06/15/2020		0.6160		
Manganese, Total	mg/L	QNE	09/01/2020		0.6980		
Manganese, Total	mg/L	QNE	12/09/2020		0.6040		
Manganese, Total	mg/L	QNE	06/10/2021		0.3970		
Manganese, Total	mg/L	QNE	12/09/2021		0.4310		
Manganese, Total	mg/L	QNE	06/21/2022		0.3130		
Manganese, Total	mg/L	QNE	12/06/2022		0.3990		
Manganese, Total	mg/L	QNE	03/22/2023		0.6390		
Manganese, Total	mg/L	QNE	06/19/2023		0.3470		
Manganese, Total	mg/L	QNE	12/01/2023		0.5550		
Manganese, Total	mg/L	QNE	08/12/2024		0.4020		
Molybdenum, Total	mg/L	QNE	03/01/2020		0.1150		*
Molybdenum, Total	mg/L	QNE	06/15/2020		0.0210		
Molybdenum, Total	mg/L	QNE	09/01/2020		0.0230		
Molybdenum, Total	mg/L	QNE	12/09/2020		0.0230		
Molybdenum, Total	mg/L	QNE	06/10/2021		0.0200		
Molybdenum, Total	mg/L	QNE	12/09/2021		0.0200		
Molybdenum, Total	mg/L	QNE	06/21/2022		0.0180		
Molybdenum, Total	mg/L	QNE	12/06/2022		0.0140		
Molybdenum, Total	mg/L	QNE	03/22/2023		0.0129		
Molybdenum, Total	mg/L	QNE	06/19/2023		0.0117		
Molybdenum, Total	mg/L	QNE	12/01/2023		0.0127		
Molybdenum, Total	mg/L	QNE	08/12/2024		0.0121		
Nickel, Total	mg/L	QNE	03/01/2020		0.0160		
Nickel, Total	mg/L	QNE	06/15/2020		0.0180		
Nickel, Total	mg/L	QNE	09/01/2020		0.0150		
Nickel, Total	mg/L	QNE	12/09/2020		0.0120		
Nickel, Total	mg/L	QNE	06/10/2021	ND	0.0100		
Nickel, Total	mg/L	QNE	12/09/2021	ND	0.0100		
Nickel, Total	mg/L	QNE	06/21/2022	ND	0.0100		
Nickel, Total	mg/L	QNE	12/06/2022	ND	0.0100		
Nickel, Total	mg/L	QNE	03/22/2023		0.0053		
Nickel, Total	mg/L	QNE	06/19/2023		0.0044		
Nickel, Total	mg/L	QNE	12/01/2023		0.0066		
Nickel, Total	mg/L	QNE	08/12/2024		0.0052		

* - Outlier for that well and constituent.
** - ND value replaced with median RL.
*** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 2

Most Current Downgradient Monitoring Data

Constituent	Units	Well	Date	Result		Pred. Limit
Barium, Total	mg/L	QNW	08/12/2024	0.3140	***	0.2050
Boron, Total	mg/L	QNW	08/12/2024	0.2110	**	1.0374
Cobalt, Total	mg/L	QNW	08/12/2024	0.0087	**	0.0249
Manganese, Total	mg/L	QNW	08/12/2024	4.4200	***	3.8243
Molybdenum, Total	mg/L	QNW	08/12/2024	0.0077		0.3047
Nickel, Total	mg/L	QNW	08/12/2024	0.0181	**	0.0300

* - Current value failed - awaiting verification.
** - Current value passed - previous exceedance not verified.
*** - Current value failed - exceedance verified.
**** - Current value passed - awaiting one more verification.
***** - Insufficient background data to compute prediction limit.
ND = Not Detected, Result = detection limit.

Table 3

Detection Frequencies in Upgradient and Downgradient Wells

Constituent	Upgradient Detect	Upgradient N	Upgradient Proportion	Downgradient Detect	Downgradient N	Downgradient Proportion
Barium, Total	35	35	1.000	12	12	1.000
Boron, Total	33	34	0.971	11	12	0.917
Cobalt, Total	36	36	1.000	12	12	1.000
Manganese, Total	35	35	1.000	12	12	1.000
Molybdenum, Total	29	35	0.829	4	12	0.333
Nickel, Total	27	35	0.771	7	12	0.583

N = Total number of measurements in all wells.
Detect = Total number of detections in all wells.
Proportion = Detect/N.

Table 4

Shapiro-Wilk Multiple Group Test of Normality

Constituent	Detect	N	Detect Freq	G raw	G log	G cbrt	G sqrt	G sqr	G cub	Crit Value	Dist Form	Model Type
Barium, Total	35	35	1.000	4.486	2.610					2.326	non-norm	nonpar
Boron, Total	33	34	0.971	2.062	2.200					2.326	normal	normal
Cobalt, Total	36	36	1.000	3.537	0.696					2.326	lognor	lognor
Manganese, Total	35	35	1.000	2.520	1.979					2.326	lognor	lognor
Molybdenum, Total	29	35	0.829	1.107	1.905					2.326	normal	normal
Nickel, Total	27	35	0.771	1.206	0.900					2.326	normal	normal

* - Distribution override for that constituent.
Fit to distribution is confirmed if G <= critical value.
Model type may not match distributional form when detection frequency < 50%.

Table 5

Summary Statistics and Prediction Limits

Constituent	Units	Detect	N	Mean	SD	alpha	Factor	Pred Limit	Type	Conf
Barium, Total	mg/L	35	35					0.2050	nonpar	0.99
Boron, Total	mg/L	33	34	0.5454	0.1984	0.0100	2.4803	1.0374	normal	
Cobalt, Total	mg/L	36	36	-5.9325	0.9060	0.0100	2.4712	0.0249	lognor	
Manganese, Total	mg/L	35	35	-0.1688	0.6100	0.0100	2.4756	3.8243	lognor	
Molybdenum, Total	mg/L	29	35	0.0648	0.0969	0.0100	2.4756	0.3047	normal	
Nickel, Total	mg/L	27	35	0.0110	0.0077	0.0100	2.4756	0.0300	normal	

Conf = confidence level for passing initial test or one verification resample at all downgradient wells for a single constituent (nonparametric test only).
* - Insufficient Data.
** - Calculated limit raised to Manual Reporting Limit.
*** - Nonparametric limit based on ND value.
For transformed data, mean and SD in transformed units and prediction limit in original units.
All sample sizes and statistics are based on outlier free data.
For nonparametric limits, median reporting limits are substituted for extreme reporting limit values.

Table 6

Dixon's Test Outliers
1% Significance Level

Constituent	Units	Well	Date	Result	ND Qualifier	Date Range	N	Critical Value
Barium, Total	mg/L	QE	06/10/2021	0.0065		03/01/2020-08/12/2024	12	0.6425
Nickel, Total	mg/L	QE	12/06/2022	0.0430		03/01/2020-08/12/2024	12	0.6425
Boron, Total	mg/L	QN	06/21/2022	0.1240		03/01/2020-08/12/2024	12	0.6425
Manganese, Total	mg/L	QN	08/12/2024	5.8100		03/01/2020-08/12/2024	12	0.6425
Boron, Total	mg/L	QNE	09/01/2020	0.0752		03/01/2020-08/12/2024	12	0.6425
Molybdenum, Total	mg/L	QNE	03/01/2020	0.1150		03/01/2020-08/12/2024	12	0.6425

N = Total number of independent measurements in background at each well.
Date Range = Dates of the first and last measurements included in background at each well.
Critical Value depends on the significance level and on N-1 when the two most extreme values are tested or N for the most extreme value.

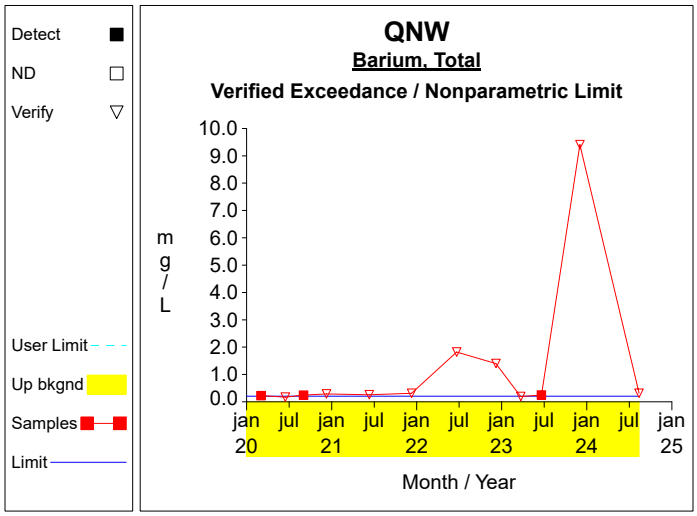
Table 8

Historical Downgradient Data for Constituent-Well Combinations that Failed the Current Statistical Evaluation or are in Verification Resampling Mode

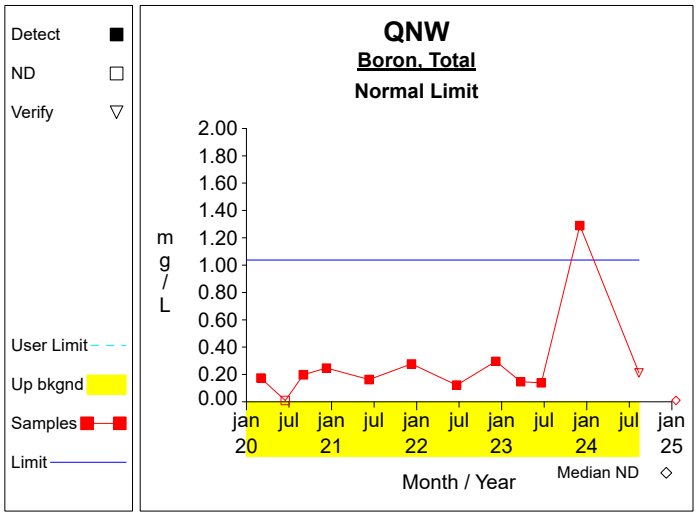
Constituent	Units	Well	Date		Result		Pred. Limit
Barium, Total	mg/L	QNW	03/01/2020		0.2260	*	0.2050
Barium, Total	mg/L	QNW	06/15/2020		0.1700		0.2050
Barium, Total	mg/L	QNW	09/01/2020		0.2450	*	0.2050
Barium, Total	mg/L	QNW	12/09/2020		0.2870	*	0.2050
Barium, Total	mg/L	QNW	06/10/2021		0.2600	*	0.2050
Barium, Total	mg/L	QNW	12/09/2021		0.3090	*	0.2050
Barium, Total	mg/L	QNW	06/21/2022		1.8200	*	0.2050
Barium, Total	mg/L	QNW	12/06/2022		1.4000	*	0.2050
Barium, Total	mg/L	QNW	03/22/2023		0.1950		0.2050
Barium, Total	mg/L	QNW	06/19/2023		0.2490	*	0.2050
Barium, Total	mg/L	QNW	12/01/2023		9.4100	*	0.2050
Barium, Total	mg/L	QNW	08/12/2024		0.3140	*	0.2050
Boron, Total	mg/L	QNW	03/01/2020		0.1740		1.0374
Boron, Total	mg/L	QNW	06/15/2020	ND	0.0100		1.0374
Boron, Total	mg/L	QNW	09/01/2020		0.1980		1.0374
Boron, Total	mg/L	QNW	12/09/2020		0.2470		1.0374
Boron, Total	mg/L	QNW	06/10/2021		0.1630		1.0374
Boron, Total	mg/L	QNW	12/09/2021		0.2770		1.0374
Boron, Total	mg/L	QNW	06/21/2022		0.1220		1.0374
Boron, Total	mg/L	QNW	12/06/2022		0.2960		1.0374
Boron, Total	mg/L	QNW	03/22/2023		0.1470		1.0374
Boron, Total	mg/L	QNW	06/19/2023		0.1380		1.0374
Boron, Total	mg/L	QNW	12/01/2023		1.2900	*	1.0374
Boron, Total	mg/L	QNW	08/12/2024		0.2110		1.0374
Cobalt, Total	mg/L	QNW	03/01/2020		0.0033		0.0249
Cobalt, Total	mg/L	QNW	06/15/2020		0.0074		0.0249
Cobalt, Total	mg/L	QNW	09/01/2020		0.0004		0.0249
Cobalt, Total	mg/L	QNW	12/09/2020		0.0004		0.0249
Cobalt, Total	mg/L	QNW	06/10/2021		0.0033		0.0249
Cobalt, Total	mg/L	QNW	12/09/2021		0.0067		0.0249
Cobalt, Total	mg/L	QNW	06/21/2022		0.0804	*	0.0249
Cobalt, Total	mg/L	QNW	12/06/2022		0.0581	*	0.0249
Cobalt, Total	mg/L	QNW	03/22/2023		0.0007		0.0249
Cobalt, Total	mg/L	QNW	06/19/2023		0.0030		0.0249
Cobalt, Total	mg/L	QNW	12/01/2023		0.7270	*	0.0249
Cobalt, Total	mg/L	QNW	08/12/2024		0.0087		0.0249
Manganese, Total	mg/L	QNW	03/01/2020		1.0400		3.8243
Manganese, Total	mg/L	QNW	06/15/2020		0.3020		3.8243
Manganese, Total	mg/L	QNW	09/01/2020		0.0560		3.8243
Manganese, Total	mg/L	QNW	12/09/2020		0.0450		3.8243
Manganese, Total	mg/L	QNW	06/10/2021		0.7010		3.8243
Manganese, Total	mg/L	QNW	12/09/2021		0.7140		3.8243
Manganese, Total	mg/L	QNW	06/21/2022		5.2400	*	3.8243
Manganese, Total	mg/L	QNW	12/06/2022		9.8800	*	3.8243
Manganese, Total	mg/L	QNW	03/22/2023		0.1050		3.8243
Manganese, Total	mg/L	QNW	06/19/2023		0.5120		3.8243
Manganese, Total	mg/L	QNW	12/01/2023		49.9000	*	3.8243
Manganese, Total	mg/L	QNW	08/12/2024		4.4200	*	3.8243
Nickel, Total	mg/L	QNW	03/01/2020	ND	0.0100		0.0300
Nickel, Total	mg/L	QNW	06/15/2020		0.0100		0.0300
Nickel, Total	mg/L	QNW	09/01/2020	ND	0.0100		0.0300
Nickel, Total	mg/L	QNW	12/09/2020	ND	0.0100		0.0300
Nickel, Total	mg/L	QNW	06/10/2021	ND	0.0100		0.0300
Nickel, Total	mg/L	QNW	12/09/2021	ND	0.0100		0.0300
Nickel, Total	mg/L	QNW	06/21/2022		0.1000	*	0.0300
Nickel, Total	mg/L	QNW	12/06/2022		0.0910	*	0.0300
Nickel, Total	mg/L	QNW	03/22/2023		0.0040		0.0300
Nickel, Total	mg/L	QNW	06/19/2023		0.0056		0.0300
Nickel, Total	mg/L	QNW	12/01/2023		1.3700	*	0.0300
Nickel, Total	mg/L	QNW	08/12/2024		0.0181		0.0300

* - Significantly increased over background.
** - Detect at limit for 100% NDs in background (NPPL only).
*** - Manual exclusion.
ND = Not Detected, Result = detection limit.

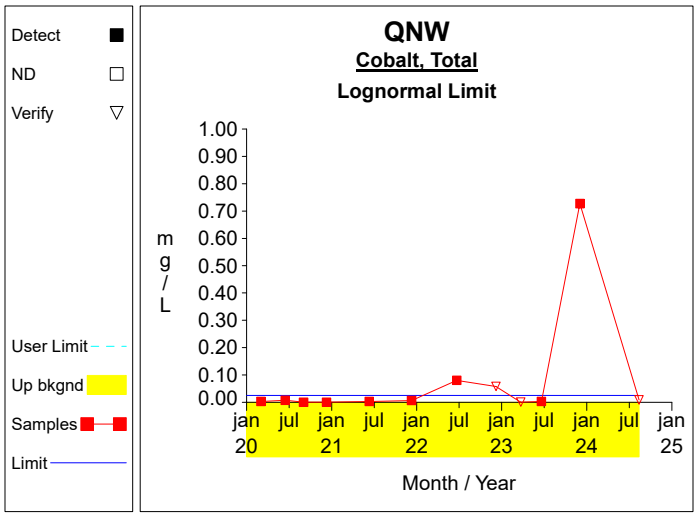
Up vs. Down Prediction Limits



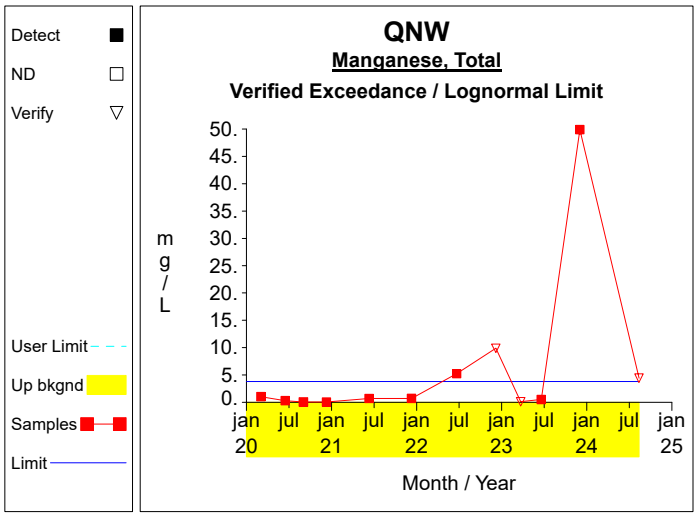
Graph 1



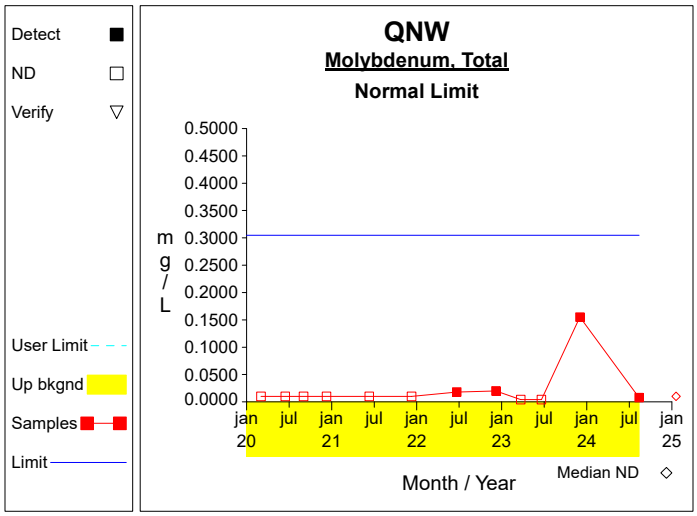
Graph 2



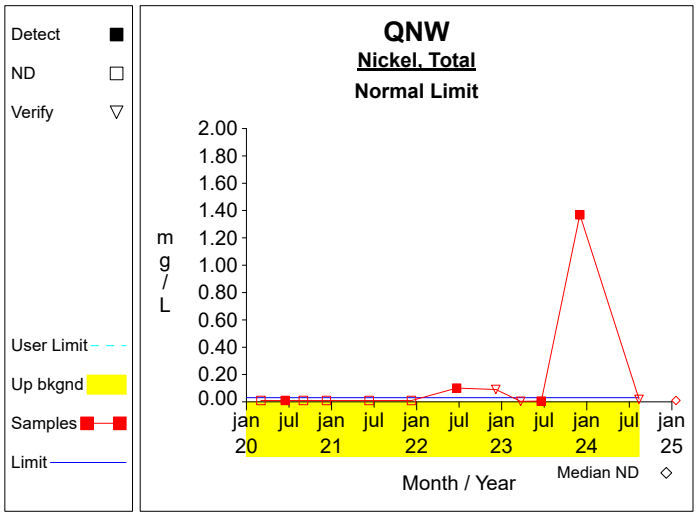
Graph 3



Graph 4



Graph 5

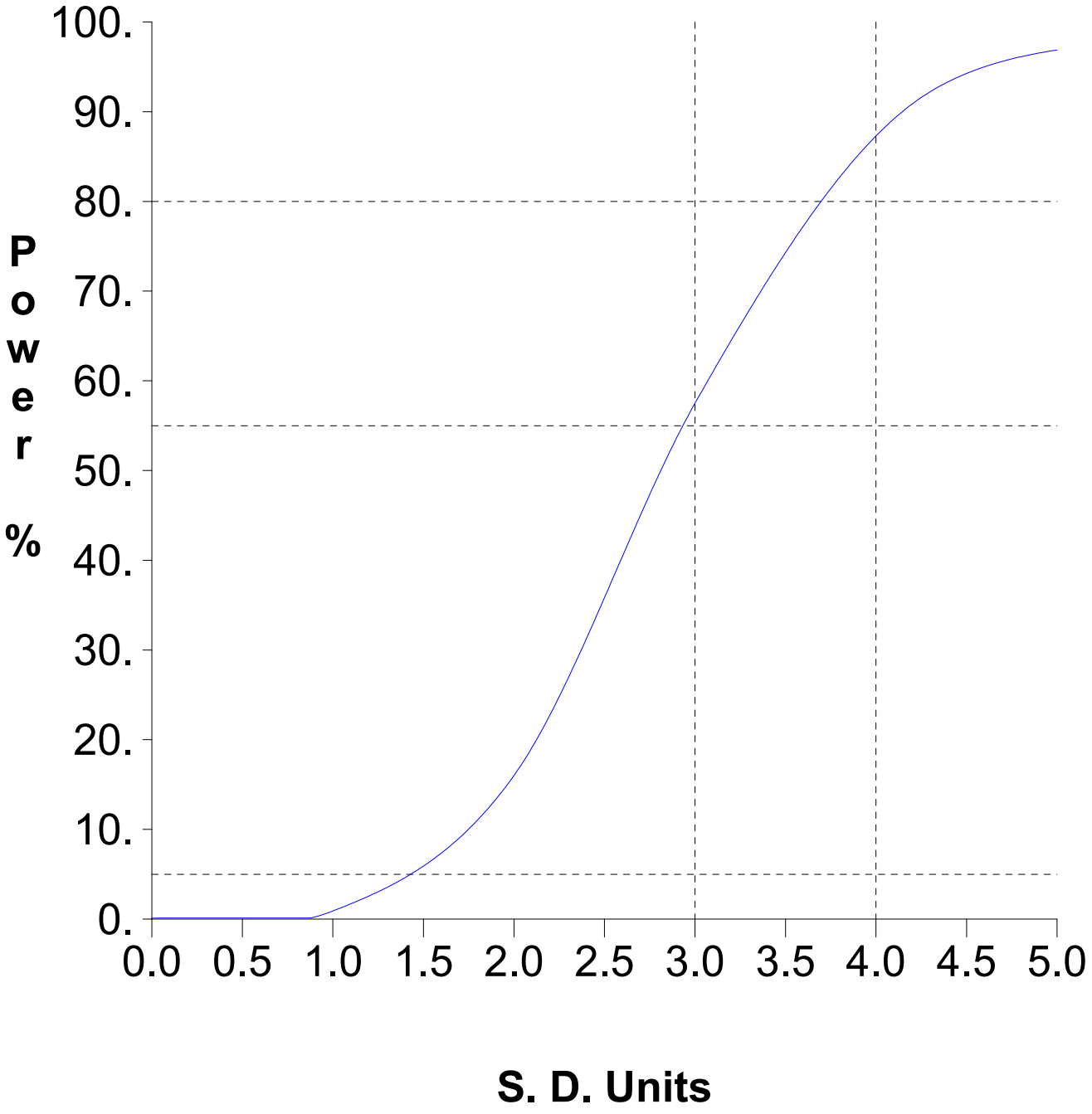


Graph 6

Prepared by: Otter Creek Environmental

False Positive and False Negative Rates for Current

Upgradient vs. Downgradient Monitoring Program



Worksheet 1 - Upgradient vs. Downgradient Comparisons
Barium, Total (mg/L)
Nonparametric Prediction Limit

Step	Equation	Description
1	PL = max(X) = **0.205**	Compute nonparametric prediction limit as largest background measurement.
2	Conf = **0.99**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Boron, Total (mg/L)
Normal Prediction Limit

Step	Equation	Description
1	$\overline{X}_1$ = **sum[X_1]** / **N_1** = **18.542** / **33** = **0.562**	Compute mean of N_1 detected measurements.
2	S_1 = ((**sum[X_1^2]**-**sum[X_1]**^{2}/**N_1**) / (**N_1**-1))^{½} = ((**11.41**-**343.806**/**33**) / (**33**-1))^{½} = **0.176**	Compute sd of N_1 detected measurements.
3	$\overline{X}$ = (1 - **N_0**/**N**) $\overline{\mathbf{X}}_1$ = (1 - **1**/**34**) **0.562** = **0.545**	Use Aitchison's method to adjust mean for presence of nondetects.
4	S = [(1 - **N_0**/**N**) * **S_1^2** + (**N_0**/**N**) (1 - (**N_0**-1)/(**N**-1)) $\overline{\mathbf{X}}_1^2$]^{½} = [(1 - **1**/**34**) * **0.176**^{2} + (**1**/**34**) (1 - (**1**-1)/(**34**-1)) **0.562**^{2}]^{½} = **0.198**	Use Aitchison's method to adjust sd for presence of nondetects.
5	alpha = min[(1-.95$^{1/\mathbf{K}}$)^{½}, .01] = min[(1-.95$^{1/\mathbf{6}}$)^{½}, .01] = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample.
6	PL = $\overline{\mathbf{X}}$ + **tS**(1+1/**N**)^{½} = **0.545** + (**2.445***0.198)(1+1/**34**)^{½} = **1.037**	One-sided normal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Cobalt, Total (mg/L)
Lognormal Prediction Limit

Step	Equation	Description
1	$Y = \log_e(X)$	Transform to natural logarithmic scale.
2	$\overline{Y}$ = **sum[Y]** / **N** = **-213.569** / **36** = **-5.932**	Compute mean on a natural log scale.
3	$S_Y = ((\mathbf{sum[Y^2]} - \mathbf{sum[Y]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{1295.714} - \mathbf{45611.517}/\mathbf{36}) / (\mathbf{36}-1))^{1/2}$ = **0.906**	Compute sd on a natural log scale.
4	alpha = min[$(1-.95^{1/\mathbf{K}})^{1/2}$, .01] = min[$(1-.95^{1/\mathbf{6}})^{1/2}$, .01] = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample.
5	$PL = \exp[\overline{\mathbf{Y}} + \mathbf{tS_Y}(1+1/\mathbf{N})^{1/2}]$ = exp[**-5.932** + (**2.438*****0.906**)$(1+1/\mathbf{36})^{1/2}$] = **0.025**	One-sided lognormal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Manganese, Total (mg/L)
Lognormal Prediction Limit

Step	Equation	Description
1	$Y = \log_e(X)$	Transform to natural logarithmic scale.
2	$\overline{Y}$ = **sum[Y]** / **N** = **-5.907** / **35** = **-0.169**	Compute mean on a natural log scale.
3	$S_Y = ((\mathbf{sum[Y^2]} - \mathbf{sum[Y]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{13.649} - \mathbf{34.893}/\mathbf{35}) / (\mathbf{35}-1))^{1/2}$ = **0.61**	Compute sd on a natural log scale.
4	alpha = min[$(1-.95^{1/\mathbf{K}})^{1/2}$, .01] = min[$(1-.95^{1/\mathbf{6}})^{1/2}$, .01] = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample.
5	PL = $\exp[\overline{\mathbf{Y}} + \mathbf{tS_Y}(1+1/\mathbf{N})^{1/2}]$ = exp[**-0.169** + (**2.441*****0.61**)$(1+1/\mathbf{35})^{1/2}$] = **3.824**	One-sided lognormal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Molybdenum, Total (mg/L)
Normal Prediction Limit

Step	Equation	Description
1	$\overline{X}_1 = \mathbf{sum[X_1]} / \mathbf{N_1}$ $= \mathbf{2.268} / \mathbf{29}$ $= \mathbf{0.078}$	Compute mean of N_1 detected measurements.
2	$S_1 = ((\mathbf{sum[X_1^2]} - \mathbf{sum[X_1]}^2/\mathbf{N_1}) / (\mathbf{N_1}-1))^{½}$ $= ((\mathbf{0.464}-\mathbf{5.143}/\mathbf{29}) / (\mathbf{29}-1))^{½}$ $= \mathbf{0.101}$	Compute sd of N_1 detected measurements.
3	$\overline{X} = (1 - \mathbf{N_0}/\mathbf{N}) \overline{\mathbf{X}}_1$ $= (1 - \mathbf{6}/\mathbf{35})\ \mathbf{0.078}$ $= \mathbf{0.065}$	Use Aitchison's method to adjust mean for presence of nondetects.
4	$S = [(1 - \mathbf{N_0}/\mathbf{N}) * \mathbf{S_1}^2 +$ $(\mathbf{N_0}/\mathbf{N}) (1 - (\mathbf{N_0}-1)/(\mathbf{N}-1)) \overline{\mathbf{X}}_1^2]^{½}$ $= [(1 - \mathbf{6}/\mathbf{35}) * \mathbf{0.101}^2 +$ $(\mathbf{6}/\mathbf{35}) (1 - (\mathbf{6}-1)/(\mathbf{35}-1)) \mathbf{0.078}^2]^{½}$ $= \mathbf{0.097}$	Use Aitchison's method to adjust sd for presence of nondetects.
5	$\text{alpha} = \min[(1-.95^{1/\mathbf{K}})^{½}, .01]$ $= \min[(1-.95^{1/\mathbf{6}})^{½}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
6	$PL = \overline{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{½}$ $= \mathbf{0.065}$ $+ (\mathbf{2.441}*\mathbf{0.097})(1+1/\mathbf{35})^{½}$ $= \mathbf{0.305}$	One-sided normal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Nickel, Total (mg/L)
Normal Prediction Limit

Step	Equation	Description
1	$\overline{X}_1 = \mathbf{sum[X_1]} / \mathbf{N_1}$ $= \mathbf{0.385} / \mathbf{27}$ $= \mathbf{0.014}$	Compute mean of N_1 detected measurements.
2	$S_1 = ((\mathbf{sum[X_1^2]} - \mathbf{sum[X_1]}^2/\mathbf{N_1}) / (\mathbf{N_1}-1))^{½}$ $= ((\mathbf{0.006}-\mathbf{0.148}/\mathbf{27}) / (\mathbf{27}-1))^{½}$ $= \mathbf{0.005}$	Compute sd of N_1 detected measurements.
3	$\overline{X} = (1 - \mathbf{N_0}/\mathbf{N}) \overline{\mathbf{X}}_\mathbf{1}$ $= (1 - \mathbf{8}/\mathbf{35}) \mathbf{0.014}$ $= \mathbf{0.011}$	Use Aitchison's method to adjust mean for presence of nondetects.
4	$S = [(1 - \mathbf{N_0}/\mathbf{N}) * \mathbf{S_1}^2 +$ $(\mathbf{N_0}/\mathbf{N}) (1 - (\mathbf{N_0}-1)/(\mathbf{N}-1)) \overline{\mathbf{X}}_\mathbf{1}^2]^{½}$ $= [(1 - \mathbf{8}/\mathbf{35}) * \mathbf{0.005}^2 +$ $(\mathbf{8}/\mathbf{35}) (1 - (\mathbf{8}-1)/(\mathbf{35}-1)) \mathbf{0.014}^2]^{½}$ $= \mathbf{0.008}$	Use Aitchison's method to adjust sd for presence of nondetects.
5	$\text{alpha} = \min[(1-.95^{1/\mathbf{K}})^{½}, .01]$ $= \min[(1-.95^{1/\mathbf{6}})^{½}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
6	$PL = \overline{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{½}$ $= \mathbf{0.011}$ $+ (\mathbf{2.441}*\mathbf{0.008})(1+1/\mathbf{35})^{½}$ $= \mathbf{0.03}$	One-sided normal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Attachment D

Summary Tables and Graphs for the Intrawell Comparisons

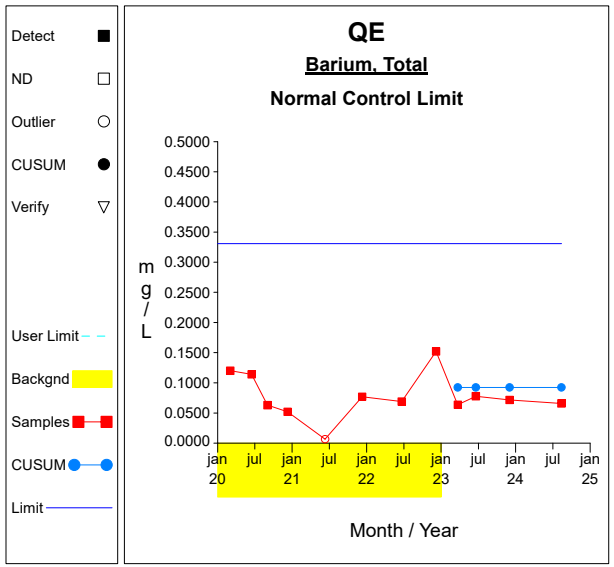
Table 1

Summary Statistics and Intermediate Computations for Combined Shewhart-CUSUM Control Charts

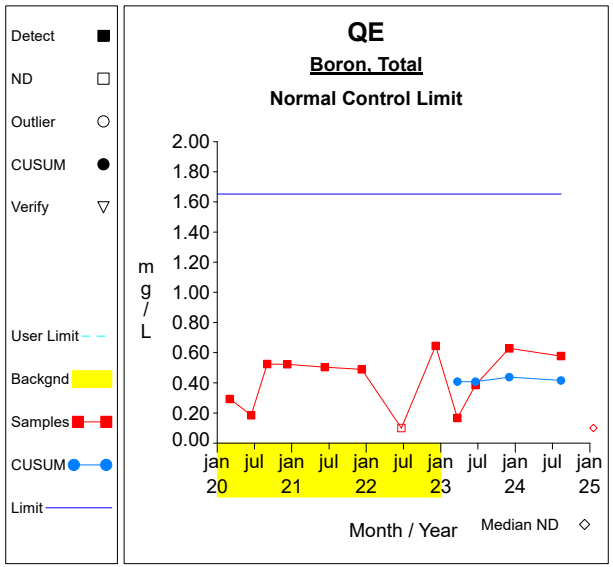
Constituent	Units	Well	N(back)	N(mon)	N(tot)	Mean	SD	R(i-1)	R(i)	S(i-1)	S(i)	Limit	Type	Conf	
Barium, Total	mg/L	QE	7	4	12	0.0924	0.0367	0.0716	0.0659	0.0924	0.0924	0.3307	normal		
Boron, Total	mg/L	QE	8	4	12	0.4079	0.1914	0.6290	0.5770	0.4376	0.4153	1.6520	normal		
Cobalt, Total	mg/L	QE	8	4	12	0.0059	0.0096	0.0085	0.0058	0.0059	0.0059	0.0680	normal		
Manganese, Total	mg/L	QE	8	4	12	1.3991	0.7938	1.4800	2.8600	1.5232	2.1903	6.5590	normal		
Molybdenum, Total	mg/L	QE	8	4	12	0.0111	0.0032	0.0076	0.0071	0.0111	0.0111	0.0318	normal		
Nickel, Total	mg/L	QE	7	4	12	0.0116	0.0024	0.0248	0.0130	0.0224	0.0215	0.0270	normal		
Barium, Total	mg/L	QN	8	4	12	0.1030	0.0505	0.0594	0.0486	0.1030	0.1030	0.4315	normal		
Boron, Total	mg/L	QN	7	4	12	0.5489	0.0717	0.4880	0.3740	0.5489	0.5489	1.0148	normal		
Cobalt, Total	mg/L	QN	7	4	12	0.0037	0.0011	0.0025	0.0041	0.0037	0.0037	0.0108	normal		
Manganese, Total	mg/L	QN	8	4	12	0.8595	0.2673	0.6910	5.8100	0.8595	5.5427	2.5968	normal		
Molybdenum, Total	mg/L	QN	7	4	12	0.2371	0.0699	0.0900	0.0147	0.2371	0.2371	0.6913	normal		
Nickel, Total	mg/L	QN	8	4	12	0.0184	0.0035	0.0169	0.0094	0.0184	0.0184	0.0414	normal		
Barium, Total	mg/L	QNE	8	4	12	0.1041	0.0184	0.0992	0.1090	0.1041	0.1041	0.2236	normal		
Boron, Total	mg/L	QNE	7	4	12	0.7263	0.2105	0.6250	0.6600	0.7263	0.7263	2.0942	normal		
Cobalt, Total	mg/L	QNE	8	4	12	0.0018	0.0015	0.0027	0.0009	0.0042	0.0018	0.0114	normal		
Manganese, Total	mg/L	QNE	8	4	12	0.6148	0.3665	0.5550	0.4020	0.6148	0.6148	2.9970	normal		
Molybdenum, Total	mg/L	QNE	7	4	12	0.0199	0.0031	0.0127	0.0121	0.0199	0.0199	0.0402	normal		
Nickel, Total	mg/L	QNE	8	4	12	0.0126	0.0032	0.0066	0.0052	0.0126	0.0126	0.0337	normal		
Barium, Total	mg/L	QNW	6	4	12	0.2495	0.0489	9.4100	0.3140	9.3611	0.2651	0.5673	normal		
Boron, Total	mg/L	QNW	7	4	12	0.2110	0.0641	1.2900	0.2110	1.2259	0.2110	0.6275	normal		
Cobalt, Total	mg/L	QNW	8	4	12	0.0200	0.0311	0.7270	0.0087	0.6959	0.0200	0.2220	normal		
Manganese, Total	mg/L	QNW	8	4	12	2.2473	3.5224	49.9000	4.4200	46.3776	2.2473	25.1427	normal		
Molybdenum, Total	mg/L	QNW	8	4	12	0.0123	0.0042	0.1550	0.0077	0.1508	0.0123	0.0396	normal		
Nickel, Total	mg/L	QNW	6	4	12								nonpar *		**

N(back) and N(mon) = Non-outlier measurements in the background and monitoring periods.
N(tot) = All independent measurements for that constituent and well.
For transformed data, mean and SD in transformed units and control limit in original units.
Conf = confidence level for passing initial test or one verification resample (nonparametric test only).
* - Insufficient Data.
** - Detection Frequency < 25%.
*** - Zero Variance.

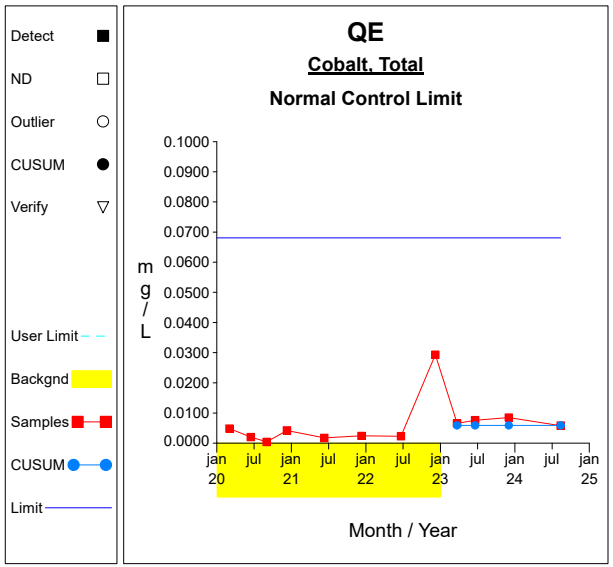
Intra-Well Control Charts / Prediction Limits



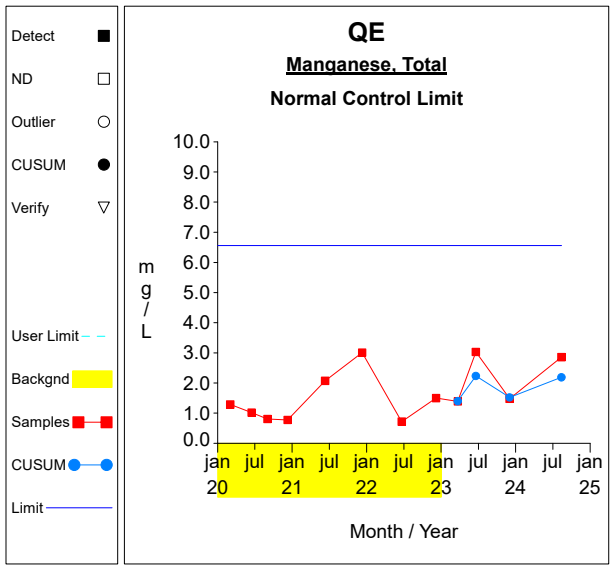
Graph 1



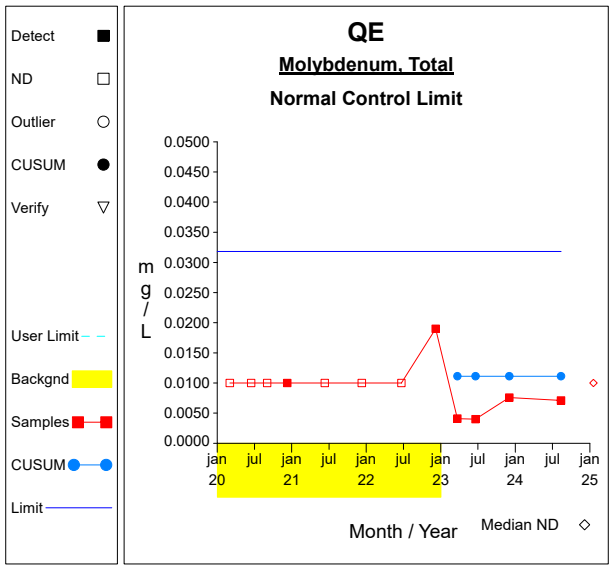
Graph 2



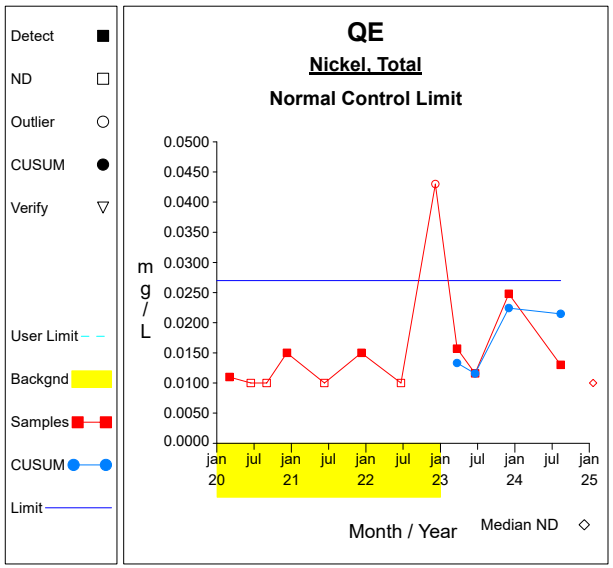
Graph 3



Graph 4



Graph 5



Graph 6

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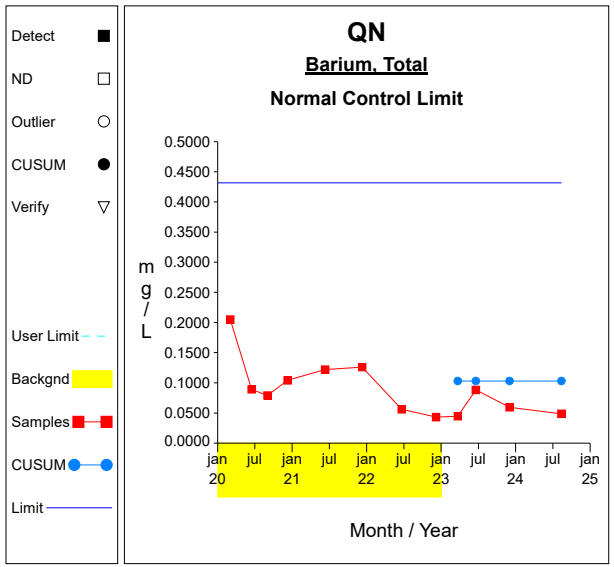
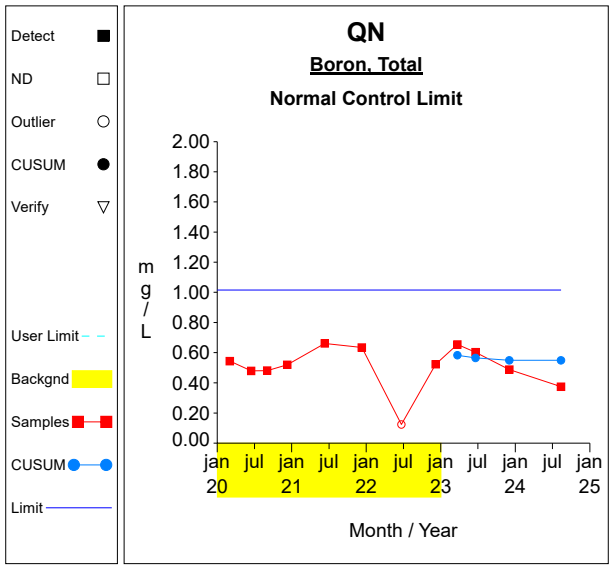
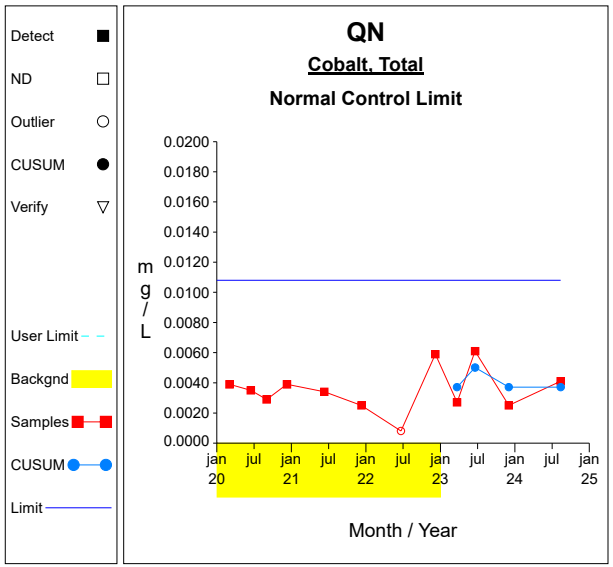
Intra-Well Control Charts / Prediction Limits



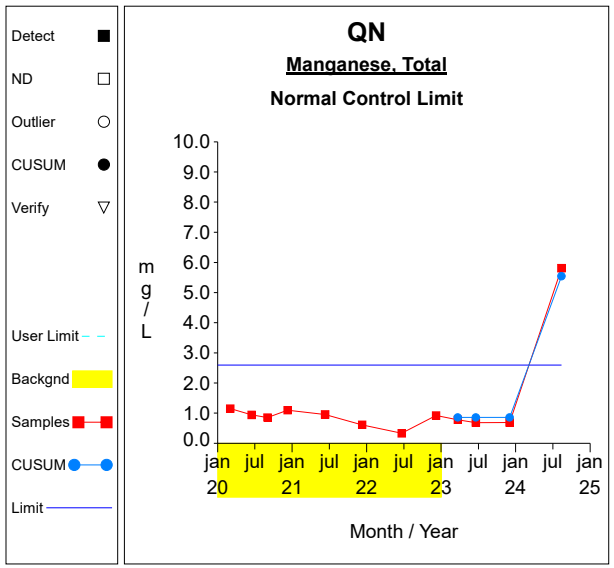
Graph 7



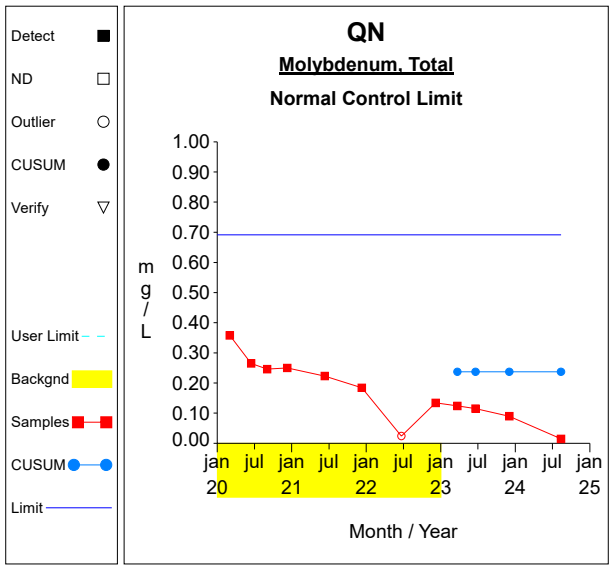
Graph 8



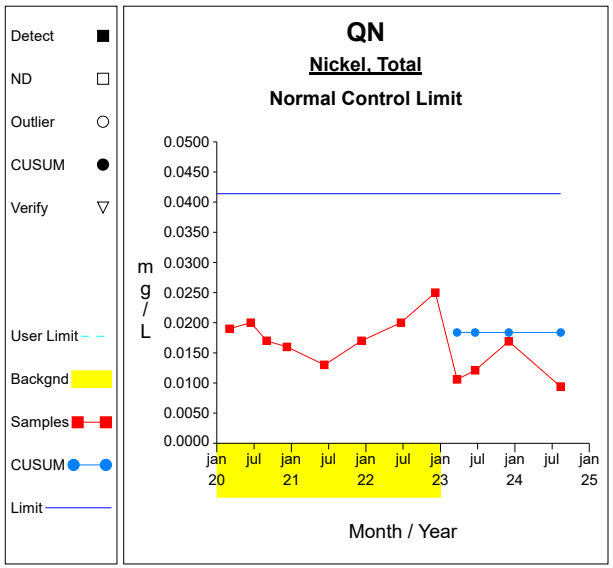
Graph 9



Graph 10



Graph 11



Graph 12

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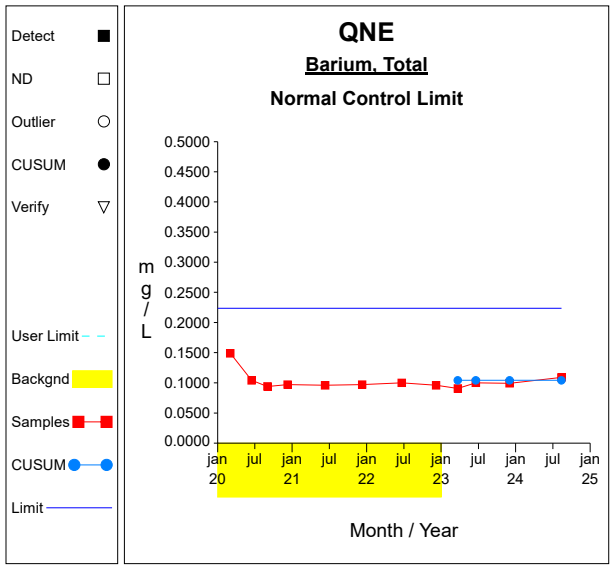
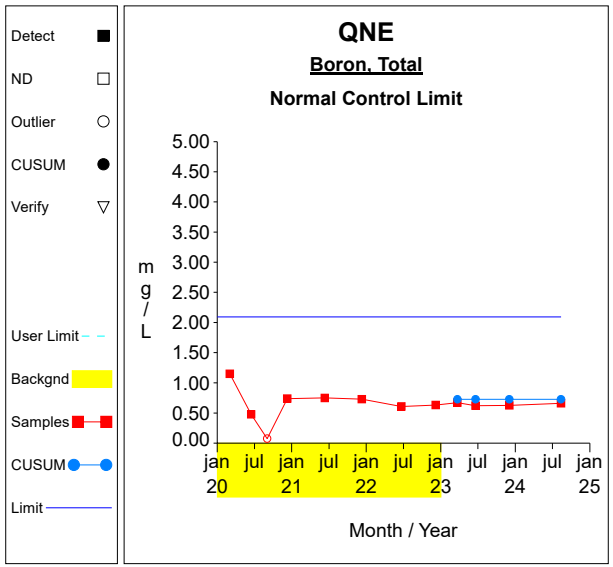
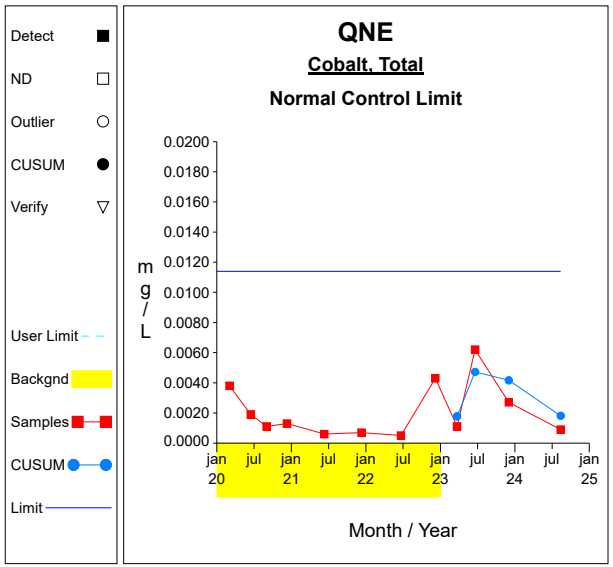
Intra-Well Control Charts / Prediction Limits



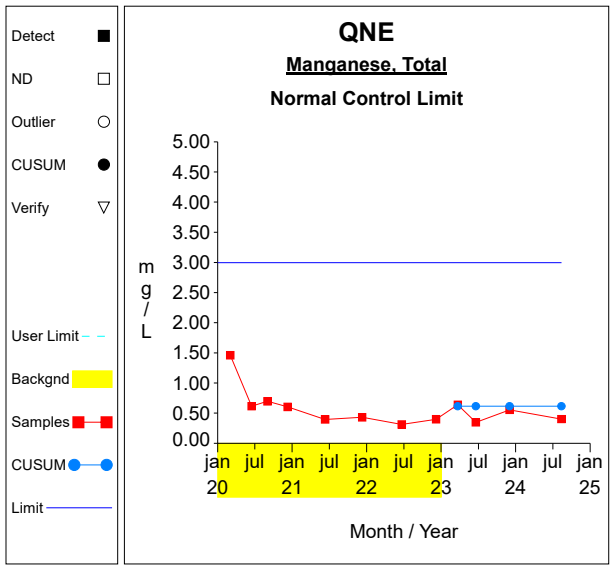
Graph 13



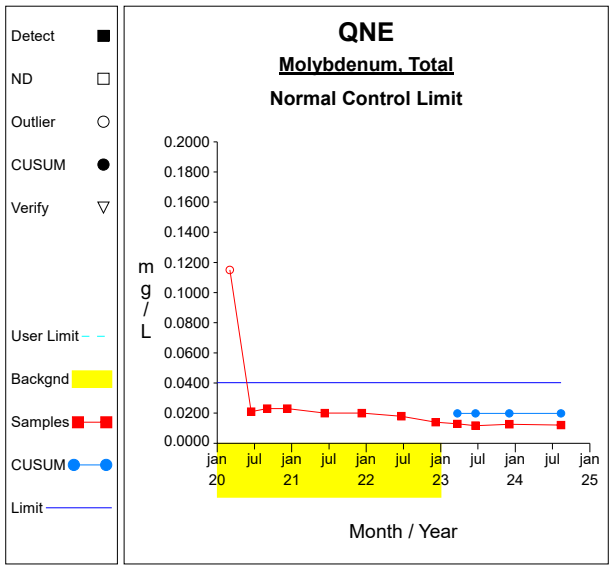
Graph 14



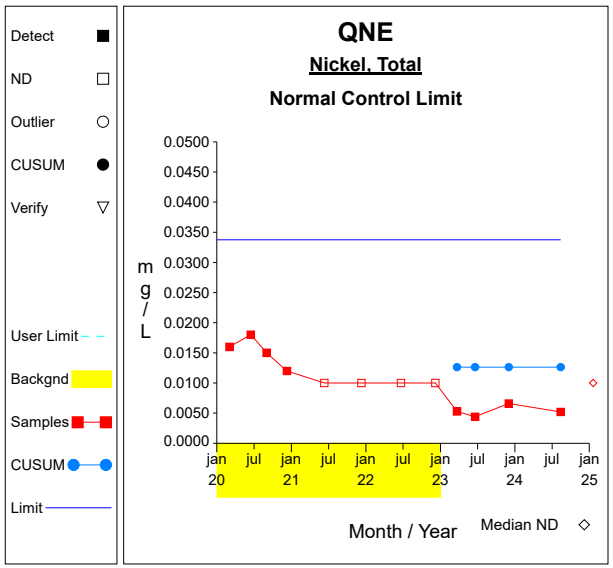
Graph 15



Graph 16



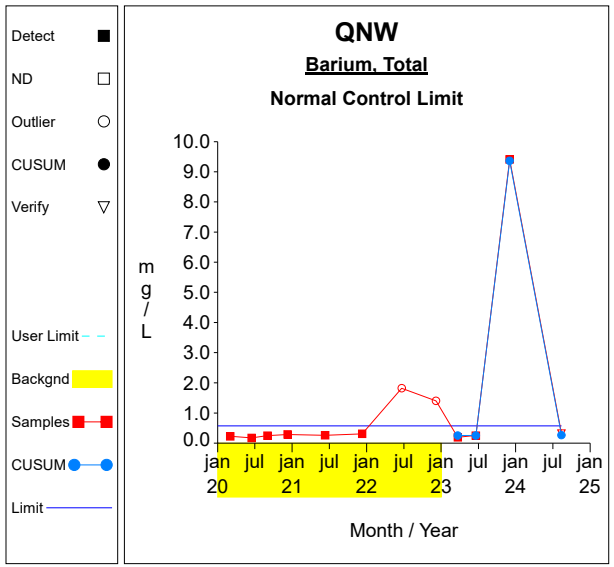
Graph 17



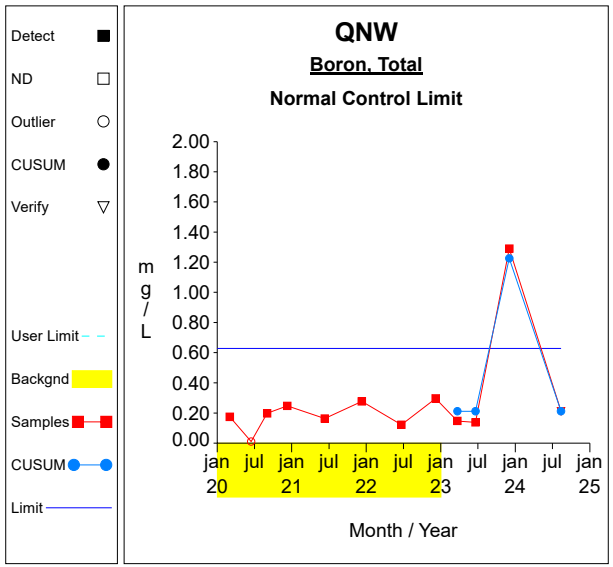
Graph 18

Prepared by: Otter Creek Environmental

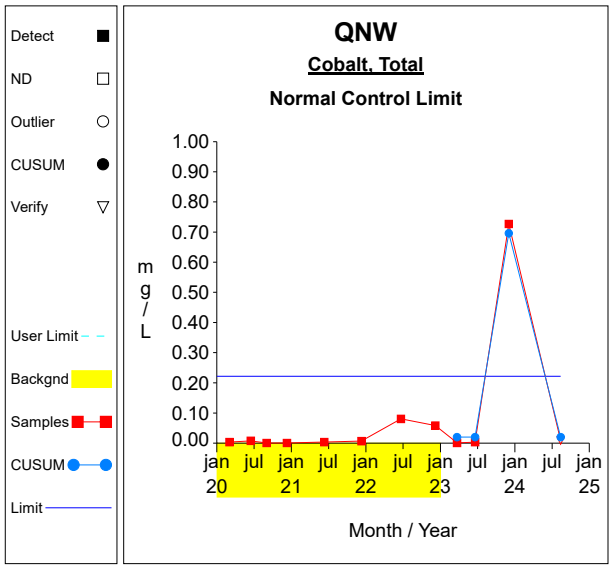
Intra-Well Control Charts / Prediction Limits



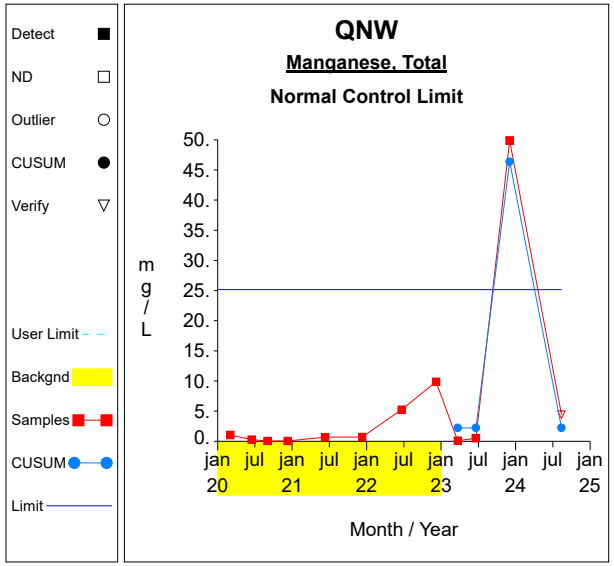
Graph 19



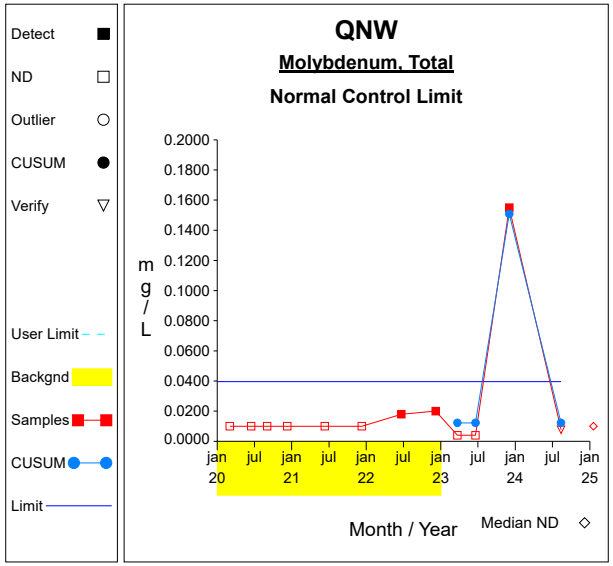
Graph 20



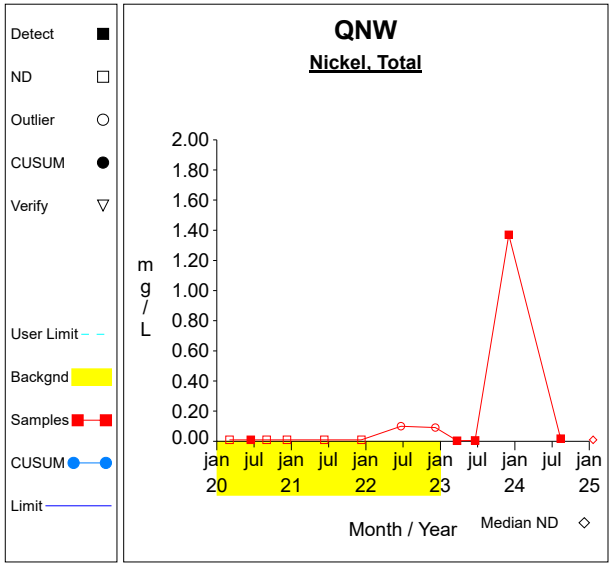
Graph 21



Graph 22



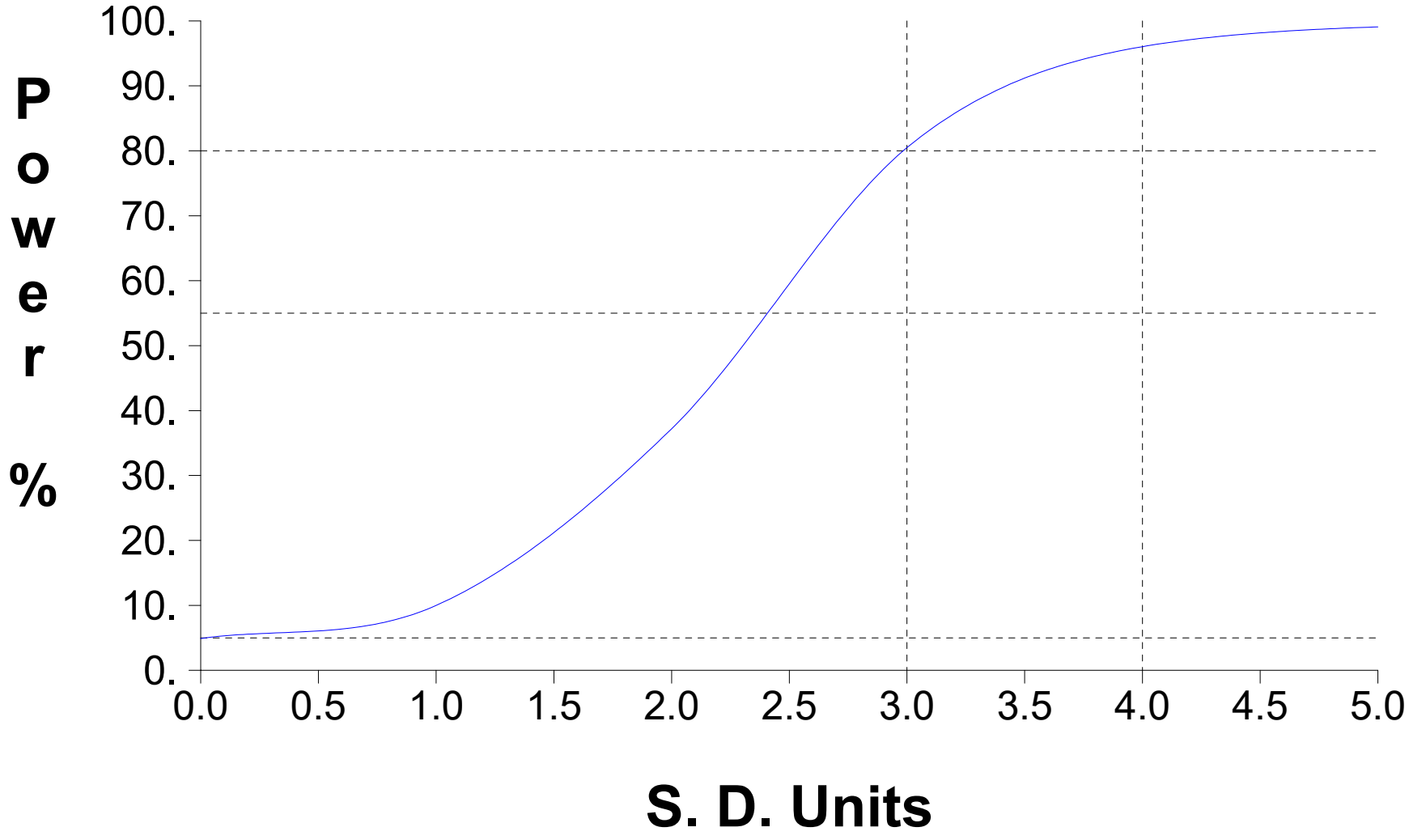
Graph 23



Graph 24

Prepared by: Otter Creek Environmental

False Positive and False Negative Rates for Current Intra-Well Control Charts Monitoring Program



Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.647** / **7** = **0.092**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.068** - **0.419/7**) / (**7**-1))^{½} = **0.037**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.092** + **6.5** * **0.037** = **0.331**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-0.015**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - $\mathbf{Z}_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.117**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Boron, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **3.263** / **8** = **0.408**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.587** - **10.647**/**8**) / (**8**-1))^{½} = **0.191**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.408** + **6.5** * **0.191** = **1.652**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.057**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.252**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.047** / **8** = **0.006**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**9.17**x**10**$^{-4}$ - **0.002**/**8**) / (**8**-1))^{½} = **0.01**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.006** + **6.5** * **0.01** = **0.068**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **4.26**x**10**$^{-4}$	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.003**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Manganese, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **11.193** / **8** = **1.399**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**20.072** - **125.283**/**8**) / (**8**-1))^{½} = **0.794**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **1.399** + **6.5** * **0.794** = **6.559**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.019**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.973**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Molybdenum, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.089** / **8** = **0.011**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.001** - **0.008**/**8**) / (**8**-1))^{½} = **0.003**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.011** + **6.5** * **0.003** = **0.032**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **21.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **21.0**^{½}) / 2 = **8.67**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **0.0**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Nickel, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.081** / **7** = **0.012**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**9.71**x**10**$^{-4}$ - **0.007**/**7**) / (**7**-1))^{½} = **0.002**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.012** + **6.5** * **0.002** = **0.027**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **34.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **34.667**^{½}) / 2 = **3.652**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.003**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.824** / **8** = **0.103**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.103** - **0.679**/**8**) / (**8**-1))^{½} = **0.051**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.103** + **6.5** * **0.051** = **0.431**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.029**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.102**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Boron, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **3.842** / **7** = **0.549**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**2.14** - **14.761**/**7**) / (**7**-1))^{½} = **0.072**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.549** + **6.5** * **0.072** = **1.015**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **0.019**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.115**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.026** / **7** = **0.004**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.04**x**10**$^{-4}$ - **6.76**x**10**$^{-4}$/**7**) / (**7**-1))^{½} = **0.001**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.004** + **6.5** * **0.001** = **0.011**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-1.02**x**10**$^{-4}$	Sen's estimator of trend.
6	var(S) = **43.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **43.333**^{½}) / 2 = **2.844**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.002**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Manganese, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **6.876** / **8** = **0.86**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**6.41** - **47.279**/**8**) / (**8**-1))^{½} = **0.267**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.86** + **6.5** * **0.267** = **2.597**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.207**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.55**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Molybdenum, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1.66** / **7** = **0.237**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.423** - **2.756**/**7**) / (**7**-1))^{½} = **0.07**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.237** + **6.5** * **0.07** = **0.691**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-0.058**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.16**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Nickel, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.147** / **8** = **0.018**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.003** - **0.022**/**8**) / (**8**-1))^{½} = **0.004**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.018** + **6.5** * **0.004** = **0.041**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **7.17**x**10**$^{-4}$	Sen's estimator of trend.
6	var(S) = **63.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **63.333**^{½}) / 2 = **4.745**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.005**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.833** / **8** = **0.104**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.089** - **0.694**/**8**) / (**8**-1))^{½} = **0.018**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.104** + **6.5** * **0.018** = **0.224**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.002**	Sen's estimator of trend.
6	var(S) = **63.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **63.333**^{½}) / 2 = **4.745**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.043**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Boron, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **5.084** / **7** = **0.726**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**3.958** - **25.847**/**7**) / (**7**-1))^{½} = **0.21**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.726** + **6.5** * **0.21** = **2.094**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-0.079**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.367**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.014** / **8** = **0.002**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**4.05**x**10**$^{-5}$ - **2.02**x**10**$^{-4}$/**8**) / (**8**-1))^{½} = **0.001**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.002** + **6.5** * **0.001** = **0.011**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-5.61**x**10**$^{-4}$	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.003**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Manganese, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **4.918** / **8** = **0.615**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**3.964** - **24.187**/**8**) / (**8**-1))^{½} = **0.367**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.615** + **6.5** * **0.367** = **2.997**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.2**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.682**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Molybdenum, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.139** / **7** = **0.02**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.003** - **0.019**/**7**) / (**7**-1))^{½} = **0.003**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.02** + **6.5** * **0.003** = **0.04**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-0.003**	Sen's estimator of trend.
6	var(S) = **42.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **42.333**^{½}) / 2 = **2.933**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.006**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Nickel, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.101** / **8** = **0.013**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.001** - **0.01**/**8**) / (**8**-1))^{½} = **0.003**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.013** + **6.5** * **0.003** = **0.034**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.003**	Sen's estimator of trend.
6	var(S) = **56.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **56.667**^{½}) / 2 = **5.245**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.006**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1.497** / **6** = **0.25**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.385** - **2.241**/**6**) / (**6**-1))^{½} = **0.049**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.25** + **6.5** * **0.049** = **0.567**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **6** * (**6**-1) / 2 = **15**	Number of sample pairs during trend detection period.
5	S = **0.05**	Sen's estimator of trend.
6	var(S) = **28.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**15** - **2.326** * **28.333**^{½}) / 2 = **1.309**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.15**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Boron, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1.477** / **7** = **0.211**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.336** - **2.182**/**7**) / (**7**-1))^{½} = **0.064**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.211** + **6.5** * **0.064** = **0.628**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **0.03**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.103**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.16** / **8** = **0.02**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.01** - **0.026**/**8**) / (**8**-1))^{½} = **0.031**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.02** + **6.5** * **0.031** = **0.222**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.007**	Sen's estimator of trend.
6	var(S) = **63.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **63.333**^{½}) / 2 = **4.745**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.005**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Manganese, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **17.978** / **8** = **2.247**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**127.251** - **323.208**/**8**) / (**8**-1))^{½} = **3.522**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **2.247** + **6.5** * **3.522** = **25.143**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **1.072**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.781**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Molybdenum, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.098** / **8** = **0.012**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.001** - **0.01**/**8**) / (**8**-1))^{½} = **0.004**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.012** + **6.5** * **0.004** = **0.04**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **37.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **37.0**^{½}) / 2 = **6.926**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **0.0**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Nickel, Total (mg/L) at QNW

Insufficient data to perform analysis

Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Barium, Total	mg/L	QE	03/01/2020	yes	0.1200					
Barium, Total	mg/L	QE	06/15/2020	yes	0.1140					
Barium, Total	mg/L	QE	09/01/2020	yes	0.0630					
Barium, Total	mg/L	QE	12/09/2020	yes	0.0520					
Barium, Total	mg/L	QE	06/10/2021	yes	0.0065		yes			*
Barium, Total	mg/L	QE	12/09/2021	yes	0.0770					
Barium, Total	mg/L	QE	06/21/2022	yes	0.0690					
Barium, Total	mg/L	QE	12/06/2022	yes	0.1520					
Barium, Total	mg/L	QE	03/22/2023		0.0637			0.0924		
Barium, Total	mg/L	QE	06/19/2023		0.0778			0.0924		
Barium, Total	mg/L	QE	12/01/2023		0.0716			0.0924		
Barium, Total	mg/L	QE	08/12/2024		0.0659			0.0924		
Boron, Total	mg/L	QE	03/01/2020	yes	0.2930					
Boron, Total	mg/L	QE	06/15/2020	yes	0.1850					
Boron, Total	mg/L	QE	09/01/2020	yes	0.5240					
Boron, Total	mg/L	QE	12/09/2020	yes	0.5230					
Boron, Total	mg/L	QE	06/10/2021	yes	0.5040					
Boron, Total	mg/L	QE	12/09/2021	yes	0.4890					
Boron, Total	mg/L	QE	06/21/2022	yes	0.1000	ND				
Boron, Total	mg/L	QE	12/06/2022	yes	0.6450					
Boron, Total	mg/L	QE	03/22/2023		0.1670			0.4079		
Boron, Total	mg/L	QE	06/19/2023		0.3850			0.4079		
Boron, Total	mg/L	QE	12/01/2023		0.6290			0.4376		
Boron, Total	mg/L	QE	08/12/2024		0.5770			0.4153		
Cobalt, Total	mg/L	QE	03/01/2020	yes	0.0048					
Cobalt, Total	mg/L	QE	06/15/2020	yes	0.0020					
Cobalt, Total	mg/L	QE	09/01/2020	yes	0.0004					
Cobalt, Total	mg/L	QE	12/09/2020	yes	0.0042					
Cobalt, Total	mg/L	QE	06/10/2021	yes	0.0017					
Cobalt, Total	mg/L	QE	12/09/2021	yes	0.0024					
Cobalt, Total	mg/L	QE	06/21/2022	yes	0.0023					
Cobalt, Total	mg/L	QE	12/06/2022	yes	0.0293					
Cobalt, Total	mg/L	QE	03/22/2023		0.0066			0.0059		
Cobalt, Total	mg/L	QE	06/19/2023		0.0076			0.0059		
Cobalt, Total	mg/L	QE	12/01/2023		0.0085			0.0059		
Cobalt, Total	mg/L	QE	08/12/2024		0.0058			0.0059		
Manganese, Total	mg/L	QE	03/01/2020	yes	1.2900					
Manganese, Total	mg/L	QE	06/15/2020	yes	1.0200					
Manganese, Total	mg/L	QE	09/01/2020	yes	0.8080					
Manganese, Total	mg/L	QE	12/09/2020	yes	0.7760					
Manganese, Total	mg/L	QE	06/10/2021	yes	2.0700					
Manganese, Total	mg/L	QE	12/09/2021	yes	3.0100					
Manganese, Total	mg/L	QE	06/21/2022	yes	0.7190					
Manganese, Total	mg/L	QE	12/06/2022	yes	1.5000					
Manganese, Total	mg/L	QE	03/22/2023		1.3900			1.3991		
Manganese, Total	mg/L	QE	06/19/2023		3.0300			2.2362		
Manganese, Total	mg/L	QE	12/01/2023		1.4800			1.5232		
Manganese, Total	mg/L	QE	08/12/2024		2.8600			2.1903		
Molybdenum, Total	mg/L	QE	03/01/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	06/15/2020	yes	0.0100	ND				

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*** - ND value replaced with median RL.
**** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Molybdenum, Total	mg/L	QE	09/01/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	12/09/2020	yes	0.0100					
Molybdenum, Total	mg/L	QE	06/10/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	12/09/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	06/21/2022	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	12/06/2022	yes	0.0190					
Molybdenum, Total	mg/L	QE	03/22/2023		0.0041			0.0111		
Molybdenum, Total	mg/L	QE	06/19/2023		0.0040			0.0111		
Molybdenum, Total	mg/L	QE	12/01/2023		0.0076			0.0111		
Molybdenum, Total	mg/L	QE	08/12/2024		0.0071			0.0111		
Nickel, Total	mg/L	QE	03/01/2020	yes	0.0110					
Nickel, Total	mg/L	QE	06/15/2020	yes	0.0100	ND				
Nickel, Total	mg/L	QE	09/01/2020	yes	0.0100	ND				
Nickel, Total	mg/L	QE	12/09/2020	yes	0.0150					
Nickel, Total	mg/L	QE	06/10/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QE	12/09/2021	yes	0.0150					
Nickel, Total	mg/L	QE	06/21/2022	yes	0.0100	ND				
Nickel, Total	mg/L	QE	12/06/2022	yes	0.0430		yes			*
Nickel, Total	mg/L	QE	03/22/2023		0.0157			0.0133		
Nickel, Total	mg/L	QE	06/19/2023		0.0116			0.0116		
Nickel, Total	mg/L	QE	12/01/2023		0.0248			0.0224		
Nickel, Total	mg/L	QE	08/12/2024		0.0130			0.0215		
Barium, Total	mg/L	QN	03/01/2020	yes	0.2050					
Barium, Total	mg/L	QN	06/15/2020	yes	0.0890					
Barium, Total	mg/L	QN	09/01/2020	yes	0.0790					
Barium, Total	mg/L	QN	12/09/2020	yes	0.1040					
Barium, Total	mg/L	QN	06/10/2021	yes	0.1220					
Barium, Total	mg/L	QN	12/09/2021	yes	0.1260					
Barium, Total	mg/L	QN	06/21/2022	yes	0.0560					
Barium, Total	mg/L	QN	12/06/2022	yes	0.0430					
Barium, Total	mg/L	QN	03/22/2023		0.0445			0.1030		
Barium, Total	mg/L	QN	06/19/2023		0.0881			0.1030		
Barium, Total	mg/L	QN	12/01/2023		0.0594			0.1030		
Barium, Total	mg/L	QN	08/12/2024		0.0486			0.1030		
Boron, Total	mg/L	QN	03/01/2020	yes	0.5440					
Boron, Total	mg/L	QN	06/15/2020	yes	0.4790					
Boron, Total	mg/L	QN	09/01/2020	yes	0.4810					
Boron, Total	mg/L	QN	12/09/2020	yes	0.5200					
Boron, Total	mg/L	QN	06/10/2021	yes	0.6610					
Boron, Total	mg/L	QN	12/09/2021	yes	0.6340					
Boron, Total	mg/L	QN	06/21/2022	yes	0.1240		yes			*
Boron, Total	mg/L	QN	12/06/2022	yes	0.5230					
Boron, Total	mg/L	QN	03/22/2023		0.6540			0.5823		
Boron, Total	mg/L	QN	06/19/2023		0.6030			0.5648		
Boron, Total	mg/L	QN	12/01/2023		0.4880			0.5489		
Boron, Total	mg/L	QN	08/12/2024		0.3740			0.5489		
Cobalt, Total	mg/L	QN	03/01/2020	yes	0.0039					
Cobalt, Total	mg/L	QN	06/15/2020	yes	0.0035					
Cobalt, Total	mg/L	QN	09/01/2020	yes	0.0029					
Cobalt, Total	mg/L	QN	12/09/2020	yes	0.0039					

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**** - ND value replaced with manual RL.
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Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Cobalt, Total	mg/L	QN	06/10/2021	yes	0.0034					
Cobalt, Total	mg/L	QN	12/09/2021	yes	0.0025					
Cobalt, Total	mg/L	QN	06/21/2022	yes	0.0008		yes			*
Cobalt, Total	mg/L	QN	12/06/2022	yes	0.0059					
Cobalt, Total	mg/L	QN	03/22/2023		0.0027			0.0037		
Cobalt, Total	mg/L	QN	06/19/2023		0.0061			0.0050		
Cobalt, Total	mg/L	QN	12/01/2023		0.0025			0.0037		
Cobalt, Total	mg/L	QN	08/12/2024		0.0041			0.0037		
Manganese, Total	mg/L	QN	03/01/2020	yes	1.1500					
Manganese, Total	mg/L	QN	06/15/2020	yes	0.9450					
Manganese, Total	mg/L	QN	09/01/2020	yes	0.8570					
Manganese, Total	mg/L	QN	12/09/2020	yes	1.1000					
Manganese, Total	mg/L	QN	06/10/2021	yes	0.9550					
Manganese, Total	mg/L	QN	12/09/2021	yes	0.6140					
Manganese, Total	mg/L	QN	06/21/2022	yes	0.3330					
Manganese, Total	mg/L	QN	12/06/2022	yes	0.9220					
Manganese, Total	mg/L	QN	03/22/2023		0.7820			0.8595		
Manganese, Total	mg/L	QN	06/19/2023		0.6890			0.8595		
Manganese, Total	mg/L	QN	12/01/2023		0.6910			0.8595		
Manganese, Total	mg/L	QN	08/12/2024		5.8100			5.5427		**
Molybdenum, Total	mg/L	QN	03/01/2020	yes	0.3580					
Molybdenum, Total	mg/L	QN	06/15/2020	yes	0.2650					
Molybdenum, Total	mg/L	QN	09/01/2020	yes	0.2460					
Molybdenum, Total	mg/L	QN	12/09/2020	yes	0.2500					
Molybdenum, Total	mg/L	QN	06/10/2021	yes	0.2230					
Molybdenum, Total	mg/L	QN	12/09/2021	yes	0.1840					
Molybdenum, Total	mg/L	QN	06/21/2022	yes	0.0240		yes			*
Molybdenum, Total	mg/L	QN	12/06/2022	yes	0.1340					
Molybdenum, Total	mg/L	QN	03/22/2023		0.1240			0.2371		
Molybdenum, Total	mg/L	QN	06/19/2023		0.1150			0.2371		
Molybdenum, Total	mg/L	QN	12/01/2023		0.0900			0.2371		
Molybdenum, Total	mg/L	QN	08/12/2024		0.0147			0.2371		
Nickel, Total	mg/L	QN	03/01/2020	yes	0.0190					
Nickel, Total	mg/L	QN	06/15/2020	yes	0.0200					
Nickel, Total	mg/L	QN	09/01/2020	yes	0.0170					
Nickel, Total	mg/L	QN	12/09/2020	yes	0.0160					
Nickel, Total	mg/L	QN	06/10/2021	yes	0.0130					
Nickel, Total	mg/L	QN	12/09/2021	yes	0.0170					
Nickel, Total	mg/L	QN	06/21/2022	yes	0.0200					
Nickel, Total	mg/L	QN	12/06/2022	yes	0.0250					
Nickel, Total	mg/L	QN	03/22/2023		0.0106			0.0184		
Nickel, Total	mg/L	QN	06/19/2023		0.0121			0.0184		
Nickel, Total	mg/L	QN	12/01/2023		0.0169			0.0184		
Nickel, Total	mg/L	QN	08/12/2024		0.0094			0.0184		
Barium, Total	mg/L	QNE	03/01/2020	yes	0.1490					
Barium, Total	mg/L	QNE	06/15/2020	yes	0.1040					
Barium, Total	mg/L	QNE	09/01/2020	yes	0.0940					
Barium, Total	mg/L	QNE	12/09/2020	yes	0.0970					
Barium, Total	mg/L	QNE	06/10/2021	yes	0.0960					
Barium, Total	mg/L	QNE	12/09/2021	yes	0.0970					

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Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Barium, Total	mg/L	QNE	06/21/2022	yes	0.1000					
Barium, Total	mg/L	QNE	12/06/2022	yes	0.0960					
Barium, Total	mg/L	QNE	03/22/2023		0.0907			0.1041		
Barium, Total	mg/L	QNE	06/19/2023		0.1000			0.1041		
Barium, Total	mg/L	QNE	12/01/2023		0.0992			0.1041		
Barium, Total	mg/L	QNE	08/12/2024		0.1090			0.1041		
Boron, Total	mg/L	QNE	03/01/2020	yes	1.1500					
Boron, Total	mg/L	QNE	06/15/2020	yes	0.4760					
Boron, Total	mg/L	QNE	09/01/2020	yes	0.0752		yes			*
Boron, Total	mg/L	QNE	12/09/2020	yes	0.7390					
Boron, Total	mg/L	QNE	06/10/2021	yes	0.7490					
Boron, Total	mg/L	QNE	12/09/2021	yes	0.7300					
Boron, Total	mg/L	QNE	06/21/2022	yes	0.6080					
Boron, Total	mg/L	QNE	12/06/2022	yes	0.6320					
Boron, Total	mg/L	QNE	03/22/2023		0.6710			0.7263		
Boron, Total	mg/L	QNE	06/19/2023		0.6200			0.7263		
Boron, Total	mg/L	QNE	12/01/2023		0.6250			0.7263		
Boron, Total	mg/L	QNE	08/12/2024		0.6600			0.7263		
Cobalt, Total	mg/L	QNE	03/01/2020	yes	0.0038					
Cobalt, Total	mg/L	QNE	06/15/2020	yes	0.0019					
Cobalt, Total	mg/L	QNE	09/01/2020	yes	0.0011					
Cobalt, Total	mg/L	QNE	12/09/2020	yes	0.0013					
Cobalt, Total	mg/L	QNE	06/10/2021	yes	0.0006					
Cobalt, Total	mg/L	QNE	12/09/2021	yes	0.0007					
Cobalt, Total	mg/L	QNE	06/21/2022	yes	0.0005					
Cobalt, Total	mg/L	QNE	12/06/2022	yes	0.0043					
Cobalt, Total	mg/L	QNE	03/22/2023		0.0011			0.0018		
Cobalt, Total	mg/L	QNE	06/19/2023		0.0062			0.0047		
Cobalt, Total	mg/L	QNE	12/01/2023		0.0027			0.0042		
Cobalt, Total	mg/L	QNE	08/12/2024		0.0009			0.0018		
Manganese, Total	mg/L	QNE	03/01/2020	yes	1.4600					
Manganese, Total	mg/L	QNE	06/15/2020	yes	0.6160					
Manganese, Total	mg/L	QNE	09/01/2020	yes	0.6980					
Manganese, Total	mg/L	QNE	12/09/2020	yes	0.6040					
Manganese, Total	mg/L	QNE	06/10/2021	yes	0.3970					
Manganese, Total	mg/L	QNE	12/09/2021	yes	0.4310					
Manganese, Total	mg/L	QNE	06/21/2022	yes	0.3130					
Manganese, Total	mg/L	QNE	12/06/2022	yes	0.3990					
Manganese, Total	mg/L	QNE	03/22/2023		0.6390			0.6148		
Manganese, Total	mg/L	QNE	06/19/2023		0.3470			0.6148		
Manganese, Total	mg/L	QNE	12/01/2023		0.5550			0.6148		
Manganese, Total	mg/L	QNE	08/12/2024		0.4020			0.6148		
Molybdenum, Total	mg/L	QNE	03/01/2020	yes	0.1150		yes			*
Molybdenum, Total	mg/L	QNE	06/15/2020	yes	0.0210					
Molybdenum, Total	mg/L	QNE	09/01/2020	yes	0.0230					
Molybdenum, Total	mg/L	QNE	12/09/2020	yes	0.0230					
Molybdenum, Total	mg/L	QNE	06/10/2021	yes	0.0200					
Molybdenum, Total	mg/L	QNE	12/09/2021	yes	0.0200					
Molybdenum, Total	mg/L	QNE	06/21/2022	yes	0.0180					
Molybdenum, Total	mg/L	QNE	12/06/2022	yes	0.0140					

* - Outlier for that well and constituent.
** - Non-outlier detected sample Result and / or CUSUM value exceeds limit.
*** - ND value replaced with median RL.
**** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Molybdenum, Total	mg/L	QNE	03/22/2023		0.0129			0.0199		
Molybdenum, Total	mg/L	QNE	06/19/2023		0.0117			0.0199		
Molybdenum, Total	mg/L	QNE	12/01/2023		0.0127			0.0199		
Molybdenum, Total	mg/L	QNE	08/12/2024		0.0121			0.0199		
Nickel, Total	mg/L	QNE	03/01/2020	yes	0.0160					
Nickel, Total	mg/L	QNE	06/15/2020	yes	0.0180					
Nickel, Total	mg/L	QNE	09/01/2020	yes	0.0150					
Nickel, Total	mg/L	QNE	12/09/2020	yes	0.0120					
Nickel, Total	mg/L	QNE	06/10/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QNE	12/09/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QNE	06/21/2022	yes	0.0100	ND				
Nickel, Total	mg/L	QNE	12/06/2022	yes	0.0100	ND				
Nickel, Total	mg/L	QNE	03/22/2023		0.0053			0.0126		
Nickel, Total	mg/L	QNE	06/19/2023		0.0044			0.0126		
Nickel, Total	mg/L	QNE	12/01/2023		0.0066			0.0126		
Nickel, Total	mg/L	QNE	08/12/2024		0.0052			0.0126		
Barium, Total	mg/L	QNW	03/01/2020	yes	0.2260					
Barium, Total	mg/L	QNW	06/15/2020	yes	0.1700					
Barium, Total	mg/L	QNW	09/01/2020	yes	0.2450					
Barium, Total	mg/L	QNW	12/09/2020	yes	0.2870					
Barium, Total	mg/L	QNW	06/10/2021	yes	0.2600					
Barium, Total	mg/L	QNW	12/09/2021	yes	0.3090					
Barium, Total	mg/L	QNW	06/21/2022	yes	1.8200		yes			*
Barium, Total	mg/L	QNW	12/06/2022	yes	1.4000		yes			*
Barium, Total	mg/L	QNW	03/22/2023		0.1950			0.2495		
Barium, Total	mg/L	QNW	06/19/2023		0.2490			0.2495		
Barium, Total	mg/L	QNW	12/01/2023		9.4100			9.3611		**
Barium, Total	mg/L	QNW	08/12/2024		0.3140			0.2651		
Boron, Total	mg/L	QNW	03/01/2020	yes	0.1740					
Boron, Total	mg/L	QNW	06/15/2020	yes	0.0100	ND	yes			*
Boron, Total	mg/L	QNW	09/01/2020	yes	0.1980					
Boron, Total	mg/L	QNW	12/09/2020	yes	0.2470					
Boron, Total	mg/L	QNW	06/10/2021	yes	0.1630					
Boron, Total	mg/L	QNW	12/09/2021	yes	0.2770					
Boron, Total	mg/L	QNW	06/21/2022	yes	0.1220					
Boron, Total	mg/L	QNW	12/06/2022	yes	0.2960					
Boron, Total	mg/L	QNW	03/22/2023		0.1470			0.2110		
Boron, Total	mg/L	QNW	06/19/2023		0.1380			0.2110		
Boron, Total	mg/L	QNW	12/01/2023		1.2900			1.2259		**
Boron, Total	mg/L	QNW	08/12/2024		0.2110			0.2110		
Cobalt, Total	mg/L	QNW	03/01/2020	yes	0.0033					
Cobalt, Total	mg/L	QNW	06/15/2020	yes	0.0074					
Cobalt, Total	mg/L	QNW	09/01/2020	yes	0.0004					
Cobalt, Total	mg/L	QNW	12/09/2020	yes	0.0004					
Cobalt, Total	mg/L	QNW	06/10/2021	yes	0.0033					
Cobalt, Total	mg/L	QNW	12/09/2021	yes	0.0067					
Cobalt, Total	mg/L	QNW	06/21/2022	yes	0.0804					
Cobalt, Total	mg/L	QNW	12/06/2022	yes	0.0581					
Cobalt, Total	mg/L	QNW	03/22/2023		0.0007			0.0200		
Cobalt, Total	mg/L	QNW	06/19/2023		0.0030			0.0200		

* - Outlier for that well and constituent.
** - Non-outlier detected sample Result and / or CUSUM value exceeds limit.
*** - ND value replaced with median RL.
**** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Cobalt, Total	mg/L	QNW	12/01/2023		0.7270			0.6959		**
Cobalt, Total	mg/L	QNW	08/12/2024		0.0087			0.0200		
Manganese, Total	mg/L	QNW	03/01/2020	yes	1.0400					
Manganese, Total	mg/L	QNW	06/15/2020	yes	0.3020					
Manganese, Total	mg/L	QNW	09/01/2020	yes	0.0560					
Manganese, Total	mg/L	QNW	12/09/2020	yes	0.0450					
Manganese, Total	mg/L	QNW	06/10/2021	yes	0.7010					
Manganese, Total	mg/L	QNW	12/09/2021	yes	0.7140					
Manganese, Total	mg/L	QNW	06/21/2022	yes	5.2400					
Manganese, Total	mg/L	QNW	12/06/2022	yes	9.8800					
Manganese, Total	mg/L	QNW	03/22/2023		0.1050			2.2473		
Manganese, Total	mg/L	QNW	06/19/2023		0.5120			2.2473		
Manganese, Total	mg/L	QNW	12/01/2023		49.9000			46.3776		**
Manganese, Total	mg/L	QNW	08/12/2024		4.4200			2.2473		
Molybdenum, Total	mg/L	QNW	03/01/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	06/15/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	09/01/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	12/09/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	06/10/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	12/09/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	06/21/2022	yes	0.0180					
Molybdenum, Total	mg/L	QNW	12/06/2022	yes	0.0200					
Molybdenum, Total	mg/L	QNW	03/22/2023		0.0040	ND		0.0123		
Molybdenum, Total	mg/L	QNW	06/19/2023		0.0040	ND		0.0123		
Molybdenum, Total	mg/L	QNW	12/01/2023		0.1550			0.1508		**
Molybdenum, Total	mg/L	QNW	08/12/2024		0.0077			0.0123		
Nickel, Total	mg/L	QNW	03/01/2020	yes	0.0100	ND				
Nickel, Total	mg/L	QNW	06/15/2020	yes	0.0100					
Nickel, Total	mg/L	QNW	09/01/2020	yes	0.0100	ND				
Nickel, Total	mg/L	QNW	12/09/2020	yes	0.0100	ND				
Nickel, Total	mg/L	QNW	06/10/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QNW	12/09/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QNW	06/21/2022	yes	0.1000		yes			*
Nickel, Total	mg/L	QNW	12/06/2022	yes	0.0910		yes			*
Nickel, Total	mg/L	QNW	03/22/2023		0.0040					
Nickel, Total	mg/L	QNW	06/19/2023		0.0056					
Nickel, Total	mg/L	QNW	12/01/2023		1.3700					
Nickel, Total	mg/L	QNW	08/12/2024		0.0181					

* - Outlier for that well and constituent.
** - Non-outlier detected sample Result and / or CUSUM value exceeds limit.
*** - ND value replaced with median RL.
**** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 4

Dixon's Test Outliers
1% Significance Level

Constituent	Units	Well	Date	Result	ND Qualifier	Date Range	N	Critical Value
Barium, Total	mg/L	QE	06/10/2021	0.0065		03/01/2020-12/06/2022	8	0.6808
Nickel, Total	mg/L	QE	12/06/2022	0.0430		03/01/2020-12/06/2022	8	0.6808
Boron, Total	mg/L	QN	06/21/2022	0.1240		03/01/2020-12/06/2022	8	0.6808
Cobalt, Total	mg/L	QN	06/21/2022	0.0008		03/01/2020-12/06/2022	8	0.6808
Molybdenum, Total	mg/L	QN	06/21/2022	0.0240		03/01/2020-12/06/2022	8	0.6808
Boron, Total	mg/L	QNE	09/01/2020	0.0752		03/01/2020-12/06/2022	8	0.6808
Molybdenum, Total	mg/L	QNE	03/01/2020	0.1150		03/01/2020-12/06/2022	8	0.6808
Barium, Total	mg/L	QNW	06/21/2022	1.8200		03/01/2020-12/06/2022	8	0.6371
Barium, Total	mg/L	QNW	12/06/2022	1.4000		03/01/2020-12/06/2022	8	0.6371
Boron, Total	mg/L	QNW	06/15/2020	0.0100	< 0.0100	03/01/2020-12/06/2022	8	0.6808
Nickel, Total	mg/L	QNW	06/21/2022	0.1000		03/01/2020-12/06/2022	8	0.6371
Nickel, Total	mg/L	QNW	12/06/2022	0.0910		03/01/2020-12/06/2022	8	0.6371

N = Total number of independent measurements in background at each well.
Date Range = Dates of the first and last measurements included in background at each well.
Critical Value depends on the significance level and on N-1 when the two most extreme values are tested or N for the most extreme value.

Statistical Review December 2024

Results of the Ground Water Statistics

for Besser Quinn Quarry

Second Semi-Annual Monitoring Event in 2024

Prepared for:
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INTRODUCTION

This report contains the results of the statistical analyses used to evaluate the ground water data obtained during the second semi-annual monitoring event in 2024 at Besser Quinn Quarry. The ground water at Besser Quinn Quarry is monitored by wells QE, QN, QNE, QNW, QS, and QW. These monitoring wells were sampled in December 2024 and analyzed for the parameters required by permit. Well QW was reported to be dry.

The statistical plan is designed to detect a release from the facility at the earliest indication so that it is protective of human health and the environment. Both interwell and intrawell methodologies are described and then applied to the Besser Quinn Quarry data. The statistical plan conforms with IAC 567, Chapter 113.10, USEPA Guidance document ("*Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Unified Guidance"*, March 2009), and the American Society for Testing and Materials (ASTM) standard D6312-98, *Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs*.

Ground Water Monitoring Program

The groundwater monitoring network for Besser Quinn Quarry includes wells QE, QN, QNE, QNW, QS, and QW. Each of the groundwater monitoring wells is to be sampled at least semiannually and analyzed for the detection monitoring parameters listed below.

Detection monitoring constituents for Besser Quinn Quarry
Barium, Total
Boron, Total
Cobalt, Total
Manganese, Total
Molybdenum, Total
Nickel, Total

The ground water data obtained during the second semi-annual monitoring event in 2024 are summarized in Attachment A. The historical ground water data obtained from 2019 through the second semi-annual monitoring event in 2024 are summarized in Attachment B.

STATISTICAL METHODOLOGIES FOR DETECTION MONITORING

IAC 567, Chapter 113.10(4) provides several options for statistically evaluating the ground water data at those wells that monitor the open cells or contiguous MSWLF units. The preferred methods for comparing ground water data are using either prediction limits or using control charts. Both of these methods were applied to the Besser Quinn Quarry data using the DUMPStat® statistical program. DUMPStat® is a program for the statistical analysis of groundwater monitoring data using methods described in "Statistical Methods for Groundwater Monitoring" by Dr. Robert D. Gibbons. The DUMPStat program is completely consistent with all USEPA regulations and guidance and the ASTM D6312-98 guidance. Ground water statistics are to be done on the constituents listed.

Interwell Statistics: Upgradient versus Downgradient Comparisons

Interwell statistics are appropriate when the upgradient and downgradient wells monitor the same ground water formation and there is similar variability in the upgradient and downgradient zones. Site prediction limits are determined by pooling the historical ground water data from hydraulically upgradient wells. This statistical method compares the current downgradient determinations to site prediction limits and checks for exceedances. The type of prediction limit utilized (e.g., parametric or nonparametric) is based on the detection frequency and the data distribution of each parameter in the background data. The distribution of the background data is tested for normality using the Shapiro-Wilk test (Gibbons, 1994 and USEPA 1992). If the constituent is normally distributed, a normal prediction limit is used. If normality is rejected by the Shapiro-Wilk test, the background data is transformed by taking the natural logarithm. The Shapiro-Wilk test is then reapplied on the transformed data. If it is not rejected, lognormal prediction limits are used. If after transforming the data, normality is still rejected, nonparametric prediction limits are used for that analyte. The nonparametric prediction limit is the largest determination in the background measurements. For constituents where the background detection frequency is greater than 0% but less than 50%, nonparametric prediction limits will be used. If the detection frequency is 0% after thirteen samples have been collected, the practical quantitation limit (PQL) becomes the nonparametric prediction limit.

Results of the Interwell Statistics

The background data used in this statistical analysis includes the ground water data collected from ground water wells QE, QN, and QNE during the period from 2020 through the current data. A summary of the background data from monitoring wells QE, QN, and QNE is listed in Attachment C, Table 1 "Upgradient Data". This statistical method compares the current downgradient determinations to site prediction limits and checks for exceedances.

Table 2 "Most Current Downgradient Monitoring Data", summarizes the current data from downgradient well QNW compared to the site prediction limits. Prediction limit exceedances are flagged with asterisks. For the most current data, the site prediction limit exceedances detected are summarized in the table below.

Prediction Limit Exceedances at Besser Quinn Quarry
during the Second Semi-Annual Monitoring Event in 2024

Well	Parameter	Result	Prediction Limit	Prediction Limit Type	Verified/ Awaiting verification
QNW	Barium, mg/L	0.248	0.2050	Nonparametric	Verified
QS	Barium, mg/L	0.366	0.2050	Nonparametric	Verified

The detection frequencies of the parameters in the up and down gradient monitoring wells are summarized in Table 3. Table 4 summarizes the results of the Shapiro-Wilk test. Table 5 is a summary of the statistics and prediction limits determined. Time series graphs of each of the parameters at each well with the corresponding prediction limits are attached.

A statistical power curve indicates the expected false assessments for the site as a whole. The false positive rate for interwell analyses is the percentage of failures when the upgradient versus downgradient true mean difference equals zero. False negative rate indicates the chance of missing contamination at a single well

for a single constituent. The statistical power is a function of the number of wells included, the number of constituents compared, the detection frequencies, and the data distributions involved. For interwell analysis, the site-wide false positive rate is 1% and the test becomes sensitive to 5 standard deviation unit increases over background.

Intrawell statistics

Intrawell statistics are appropriate for facilities where the upgradient wells do not accurately characterize the natural ground water conditions downgradient from the facility. This may be due to different hydrogeological conditions where the wells are screened, having too few upgradient wells to account for the spatial variability, or the site exhibiting no definable hydraulic gradient. Intrawell statistics compare new measurements to the historical data at each ground water monitoring well independently. It is recommended that at least eight background samples be obtained prior to performing the statistics.

The most useful technique for intrawell comparisons is the combined Shewhart-CUSUM control chart. This control chart procedure is useful because it will detect releases both in terms of the constituent concentration and cumulative increases. This method is also extremely sensitive to sudden and gradual releases. A requirement for constructing these control charts is that the parameter is detected at a frequency greater than or equal to 25%, otherwise the data variance is not properly defined.

The combined Shewhart-CUSUM control chart assumes that the data are independent and normally distributed with a fixed mean and a constant variance. Independent data is much more critical than the normality assumption. To achieve independence, it is recommended that data are collected no more frequently than quarterly to account for seasonal variation. The combined Shewhart-CUSUM control chart is extremely robust to deviations from normality. Because the control charts do not use a specific multiplier based on a normal distribution, it is more conservative to assume normality.

It is recommended that at least eight rounds of data be available to provide a reliable estimate of the mean and standard deviation of the parameter concentration, although the control charts will be generated with as few as four data points. Having only four data points may produce greater uncertainty in the mean and standard deviation of the background data, leading to higher control limits, thus having a potentially high false negative rate.

Many groundwater monitoring parameters are not detected at a frequency great enough to generate the combined Shewhart-CUSUM control charts. For constituents that are detected less than 25% of the time at a particular well, the data should be plotted as a time series until a sufficient number of data points are available to provide a 99% confidence nonparametric prediction limit. Thirteen independent measurements (with 1 resample) are necessary to achieve a 99% confidence (1% false positive rate) nonparametric prediction limit. Eight independent measurements (for pass 1 of 2 resamples) are necessary to achieve a 99% confidence nonparametric prediction limit. The nonparametric prediction limit is the largest determination out of the data set collected for that well and parameter. If the detection frequency is 0% after thirteen samples have been collected, the practical quantitation limit (PQL) becomes the nonparametric prediction limit.

In developing the statistical background, the historical data must be thoroughly screened for anomalous data due to sampling error, analytical error, or simply by chance alone. An erroneous data point, if not removed prior to the mean and variance computations, would yield a larger control limit thus increasing the false negative rate. The DUMPStat® program screens for outliers using the Dixon test. Anomalous data will still be plotted on the graphs (with a unique symbol) but will not be included in the calculations.

The verification resample plan is an integral function of the statistical plan to reduce the probability that anomalous data obtained after the background has been established, is indicative of a release.

The background data for each well and constituent is tested for existing trends using Sen's nonparametric estimate of trend. If contamination exists prior to completing the background, the control limits could be potentially high and this control chart method would not be able to detect an increasing trend unless the increase is severe.

Results of the Intrawell Statistics

The monitoring constituents at wells QE, QN, QNE, QNW, and QS were evaluated using the combined Shewhart-CUSUM control chart method. The previous background included the four rounds of data obtained from March 2020 through December 2020. Since a minimum of eight rounds of data is recommended, the background was updated to include data obtained from March 2020 through December 2022.

A summary of the intrawell statistics is included in Attachment D, Table 1 "Summary Statistics and Intermediate Computations for Combined Shewhart-CUSUM Control Charts." The control charts or time series graphs follow the summary table. For the most current data, the control limit exceedances detected are summarized in the table below. No increasing trends were detected in the background data.

Control Limit Exceedances During the Second Semi-Annual Monitoring Event in 2024

Well	Parameter	Result	CUSUM value	Control Limit	Control Limit Type	Verified/ Awaiting Verification
QE	Nickel, mg/L	0.0447	0.0522	0.0270	Normal	Awaiting verification
QN	Manganese, mg/L	5.16	4.8927	2.5968	Normal	Verified

A control chart factor was selected to provide a balance of the site-wide false positive and false negative rates. A statistical power curve indicates the expected false assessments for the site as a whole. The site-wide false positive rate is 6% and the test becomes sensitive to 4 standard deviation units over background.

Attachment A

Ground Water Data

Table 1

Analytical Data Summary for 12/1/2024

Constituents	Units	QE	QN	QNE	QNW	QS
Aluminum	mg/L	<.050	.175	.095	.284	2.380
Antimony, total	mg/L	<.002	<.002	<.002	<.002	<.002
Arsenic, total	mg/L	.0044	.0069	<.0040	<.0040	.0089
Barium, Total	mg/L	.0784	.0444	.1000	.2480	.3660
Beryllium, total	mg/L	<.004	<.004	<.004	<.004	<.004
Boron, Total	mg/L	.629	.294	.622	.220	<.100
Cadmium, total	mg/L	<.0008	<.0008	<.0008	<.0008	<.0008
Chloride	mg/L	13.2	49.0	7.6	319.0	15.8
Chromium, total	mg/L	<.008	<.008	<.008	<.008	<.008
Cobalt, Total	mg/L	.0163	.0100	.0013	.0027	.0108
COD	mg/L	75	<20	<20	69	54
Copper, total	mg/L	<.0040	<.0040	<.0040	<.0040	.0107
Fluoride	mg/L	.1	.2	.1	.2	<.1
Lead, total	mg/L	<.0040	<.0040	<.0040	<.0040	.0063
Lithium, total	mg/L	<.05	<.05	<.05	<.05	<.05
Manganese, Total	mg/L	1.890	5.160	.421	1.490	.715
Mercury, total	mg/L	<.0005	<.0005	<.0005	<.0005	<.0005
Molybdenum, Total	mg/L	.0129	.0143	.0117	.0042	<.0040
Nickel, Total	mg/L	.0447	.0089	.0044	.0051	.0139
Nitrogen	mg/L	.11	.77	1.68	.13	<.01
Phenols	mg/L	<.035	<.035	<.035	<.035	<.035
Selenium, total	mg/L	<.004	<.004	<.004	<.004	<.004
Thallium, total	mg/L	<.002	<.002	<.002	<.002	<.002
TOX	mg/L	.031	<.010	.023	.233	<.010
Vanadium, total	mg/L	<.02	<.02	<.02	<.02	<.02
Zinc, total	mg/L	.0449	<.0200	<.0200	<.0200	<.0200

* - The displayed value is the arithmetic mean of multiple database matches.

Attachment B

Historical Ground Water Data

Table 1

Analytical Data Summary for QE

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023
Aluminum	mg/L									
Ammonia	mg/L									
Antimony, total	mg/L						<.002	<.002		
Arsenic, total	mg/L						<.0040	<.0040		
Barium, Total	mg/L	.1200	.1140	.0630	.0520	.0065	.0770	.0690	.1520	.0637
Beryllium, total	mg/L						<.004	<.004		
Boron, Total	mg/L	.293	.185	.524	.523	.504	.489	<.100	.645	.167
Cadmium, total	mg/L						<.0050	<.0050		
Chloride	mg/L									
Chromium, total	mg/L						<.005	<.005		
Cobalt, Total	mg/L	.0048	.0020	.0004	.0042	.0017	.0024	.0023	.0293	.0066
COD	mg/L									
Conductivity	uS/cm						2730	763		
Copper, total	mg/L						<.010	<.010		
Fluoride	mg/L						.2	.1		
Formaldehyde	ug/L									
Iron	mg/L									
Lead, total	mg/L						<.010	<.010		
Lithium, total	mg/L						<.05	<.05		
Magnesium	mg/L									
Manganese, Total	mg/L	1.290	1.020	.808	.776	2.070	3.010	.719	1.500	1.390
Mercury, total	mg/L						<.0005	<.0005		
Molybdenum, Total	mg/L	<.0100	<.0100	<.0100	.0100	<.0100	<.0100	<.0100	.0190	.0041
Nickel, Total	mg/L	.0110	<.0100	<.0100	.0150	<.0100	.0150	<.0100	.0430	.0157
Nitrogen	mg/L									
pH	pH						6.6	6.8		
Phenols	mg/L									
Selenium, total	mg/L						.054	.084		
Silver, total	mg/L						<.005	<.005		
Sulfate	mg/L									
Thallium, total	mg/L						<.002	<.002		
TOX	mg/L									
TSS	mg/L									
Vanadium, total	mg/L						<.05	<.05		
Zinc, total	mg/L						<.0200	<.0200		

* - The displayed value is the arithmetic mean of multiple database matches.

Table 1

Analytical Data Summary for QE

Constituents	6/19/2023	12/1/2023	8/12/2024	12/1/2024
Aluminum		.127	.078	<.050
Ammonia		1.69	1.74	
Antimony, total		<.002	<.002	<.002
Arsenic, total		.0040	.0099	.0044
Barium, Total	.0778	.0716	.0659	.0784
Beryllium, total		<.004	<.004	<.004
Boron, Total	.385	.629	.577	.629
Cadmium, total		<.0008	<.0008	<.0008
Chloride		13.3	15.2	13.2
Chromium, total		<.008	<.008	<.008
Cobalt, Total	.0076	.0085	.0058	.0163
COD		110	21	75
Conductivity				
Copper, total		<.004	<.004	<.004
Fluoride		.2	<.1	.1
Formaldehyde		<10	<20	
Iron		2.49	12.30	
Lead, total		<.004	<.004	<.004
Lithium, total				<.05
Magnesium		132	140	
Manganese, Total	3.030	1.480	2.860	1.890
Mercury, total		<.0005	<.0005	<.0005
Molybdenum, Total	.0040	.0076	.0071	.0129
Nickel, Total	.0116	.0248	.0130	.0447
Nitrogen				.11
pH				
Phenols		<.035	<.035	<.035
Selenium, total		<.004	<.004	<.004
Silver, total		<.004	<.004	
Sulfate		835	901	
Thallium, total		<.002	<.002	<.002
TOX		<.010	.032	.031
TSS		241	852	
Vanadium, total		<.02	<.02	<.02
Zinc, total		<.0200	<.0200	.0449

* - The displayed value is the arithmetic mean of multiple database matches.

Table 2

Analytical Data Summary for QN

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023
Aluminum	mg/L									
Ammonia	mg/L									
Antimony, total	mg/L						<.002	<.002		
Arsenic, total	mg/L						<.0040	<.0040		
Barium, Total	mg/L	.2050	.0890	.0790	.1040	.1220	.1260	.0560	.0430	.0445
Beryllium, total	mg/L						<.004	<.004		
Boron, Total	mg/L	.544	.479	.481	.520	.661	.634	.124	.523	.654
Cadmium, total	mg/L						<.0050	<.0050		
Chloride	mg/L									
Chromium, total	mg/L						<.005	<.005		
Cobalt, Total	mg/L	.0039	.0035	.0029	.0039	.0034	.0025	.0008	.0059	.0027
COD	mg/L									
Conductivity	uS/cm						958	1780		
Copper, total	mg/L						<.0100	<.0100		
Fluoride	mg/L						.1	<.1		
Formaldehyde	ug/L									
Iron	mg/L									
Lead, total	mg/L						<.010	<.010		
Lithium, total	mg/L						<.05	<.05		
Magnesium	mg/L									
Manganese, Total	mg/L	1.150	.945	.857	1.100	.955	.614	.333	.922	.782
Mercury, total	mg/L						<.0005	<.0005		
Molybdenum, Total	mg/L	.3580	.2650	.2460	.2500	.2230	.1840	.0240	.1340	.1240
Nickel, Total	mg/L	.0190	.0200	.0170	.0160	.0130	.0170	.0200	.0250	.0106
Nitrogen	mg/L									
pH	pH						6.8	6.5		
Phenols	mg/L									
Selenium, total	mg/L						<.050	.131		
Silver, total	mg/L						<.005	<.005		
Sulfate	mg/L									
Thallium, total	mg/L						<.002	<.002		
TOX	mg/L									
TSS	mg/L									
Vanadium, total	mg/L						<.05	<.05		
Zinc, total	mg/L						<.02	<.02		

* - The displayed value is the arithmetic mean of multiple database matches.

Table 2

Analytical Data Summary for QN

Constituents	6/19/2023	12/1/2023	8/12/2024	12/1/2024
Aluminum		.209	.125	.175
Ammonia		1.01	.61	
Antimony, total		<.002	<.002	<.002
Arsenic, total		<.0040	.0092	.0069
Barium, Total	.0881	.0594	.0486	.0444
Beryllium, total		<.004	<.004	<.004
Boron, Total	.603	.488	.374	.294
Cadmium, total		.0014	<.0008	<.0008
Chloride		19.1	99.3	49.0
Chromium, total		<.008	<.008	<.008
Cobalt, Total	.0061	.0025	.0041	.0100
COD		<54	<20	<20
Conductivity				
Copper, total		.0048	<.0040	<.0040
Fluoride		.2	.1	.2
Formaldehyde		12.9	<20.0	
Iron		.613	15.700	
Lead, total		<.004	<.004	<.004
Lithium, total				<.05
Magnesium		73.5	164.0	
Manganese, Total	.689	.691	5.810	5.160
Mercury, total		<.0005	<.0005	<.0005
Molybdenum, Total	.1150	.0900	.0147	.0143
Nickel, Total	.0121	.0169	.0094	.0089
Nitrogen				.77
pH				
Phenols		<.035	<.035	<.035
Selenium, total		<.004	<.004	<.004
Silver, total		<.004	<.004	
Sulfate		331	1010	
Thallium, total		<.002	<.002	<.002
TOX		<.010	.092	<.010
TSS		21	87	
Vanadium, total		<.02	<.02	<.02
Zinc, total		<.02	<.02	<.02

* - The displayed value is the arithmetic mean of multiple database matches.

Table 3

Analytical Data Summary for QNE

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023
Aluminum	mg/L									
Ammonia	mg/L									
Antimony, total	mg/L						<.002	<.002		
Arsenic, total	mg/L						<.004	<.004		
Barium, Total	mg/L	.1490	.1040	.0940	.0970	.0960	.0970	.1000	.0960	.0907
Beryllium, total	mg/L						<.004	<.004		
Boron, Total	mg/L	1.1500	.4760	.0752	.7390	.7490	.7300	.6080	.6320	.6710
Cadmium, total	mg/L						<.0050	<.0050		
Chloride	mg/L									
Chromium, total	mg/L						<.005	<.005		
Cobalt, Total	mg/L	.0038	.0019	.0011	.0013	.0006	.0007	.0005	.0043	.0011
COD	mg/L									
Conductivity	uS/cm						920	976		
Copper, total	mg/L						<.0100	<.0100		
Fluoride	mg/L						.2	.1		
Formaldehyde	ug/L									
Iron	mg/L									
Lead, total	mg/L						<.010	<.010		
Lithium, total	mg/L						<.05	<.05		
Magnesium	mg/L									
Manganese, Total	mg/L	1.460	.616	.698	.604	.397	.431	.313	.399	.639
Mercury, total	mg/L						<.0005	<.0005		
Molybdenum, Total	mg/L	.1150	.0210	.0230	.0230	.0200	.0200	.0180	.0140	.0129
Nickel, Total	mg/L	.0160	.0180	.0150	.0120	<.0100	<.0100	<.0100	<.0100	.0053
Nitrogen	mg/L									
pH	pH						6.8	6.7		
Phenols	mg/L									
Selenium, total	mg/L						<.050	.147		
Silver, total	mg/L						<.005	<.005		
Sulfate	mg/L									
Thallium, total	mg/L						<.002	<.002		
TOX	mg/L									
TSS	mg/L									
Vanadium, total	mg/L						<.05	<.05		
Zinc, total	mg/L						<.02	<.02		

* - The displayed value is the arithmetic mean of multiple database matches.

Table 3

Analytical Data Summary for QNE

Constituents	6/19/2023	12/1/2023	8/12/2024	12/1/2024
Aluminum		.310	.092	.095
Ammonia		1.39	1.52	
Antimony, total		<.002	<.002	<.002
Arsenic, total		<.004	<.004	<.004
Barium, Total	.1000	.0992	.1090	.1000
Beryllium, total		<.004	<.004	<.004
Boron, Total	.6200	.6250	.6600	.6220
Cadmium, total		<.0008	<.0008	<.0008
Chloride		8.5	6.5	7.6
Chromium, total		<.008	<.008	<.008
Cobalt, Total	.0062	.0027	.0009	.0013
COD		<54	<20	<20
Conductivity				
Copper, total		.0046	.0052	<.0040
Fluoride		.1	.1	.1
Formaldehyde		<10	<10	
Iron		.917	.161	
Lead, total		<.004	<.004	<.004
Lithium, total				<.05
Magnesium		60.6	62.2	
Manganese, Total	.347	.555	.402	.421
Mercury, total		<.0005	<.0005	<.0005
Molybdenum, Total	.0117	.0127	.0121	.0117
Nickel, Total	.0044	.0066	.0052	.0044
Nitrogen				1.68
pH				
Phenols		<.035	<.035	<.035
Selenium, total		<.004	<.004	<.004
Silver, total		<.004	<.004	
Sulfate		241	233	
Thallium, total		<.002	<.002	<.002
TOX		.014	<.010	.023
TSS		12	6	
Vanadium, total		<.02	<.02	<.02
Zinc, total		<.02	<.02	<.02

* - The displayed value is the arithmetic mean of multiple database matches.

Table 4

Analytical Data Summary for QNW

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023
Aluminum	mg/L									
Ammonia	mg/L									
Antimony, total	mg/L						<.002	<.002		
Arsenic, total	mg/L						.0074	.0750		
Barium, Total	mg/L	.226	.170	.245	.287	.260	.309	1.820	1.400	.195
Beryllium, total	mg/L						<.004	<.004		
Boron, Total	mg/L	.174	<.010	.198	.247	.163	.277	.122	.296	.147
Cadmium, total	mg/L						<.0050	<.0050		
Chloride	mg/L									
Chromium, total	mg/L						<.005	.073		
Cobalt, Total	mg/L	.0033	.0074	.0004	.0004	.0033	.0067	.0804	.0581	.0007
COD	mg/L									
Conductivity	uS/cm						814	883		
Copper, total	mg/L						<.0100	.1180		
Fluoride	mg/L						.1	.1		
Formaldehyde	ug/L									
Iron	mg/L									
Lead, total	mg/L						<.0100	.0610		
Lithium, total	mg/L						<.05	<.05		
Magnesium	mg/L									
Manganese, Total	mg/L	1.040	.302	.056	.045	.701	.714	5.240	9.880	.105
Mercury, total	mg/L						<.0005	<.0005		
Molybdenum, Total	mg/L	<.0100	<.0100	<.0100	<.0100	<.0100	<.0100	.0180	.0200	<.0040
Nickel, Total	mg/L	<.0100	.0100	<.0100	<.0100	<.0100	<.0100	.1000	.0910	.0040
Nitrogen	mg/L									
pH	pH						6.7	6.8		
Phenols	mg/L									
Selenium, total	mg/L						<.050	.086		
Silver, total	mg/L						<.005	<.005		
Sulfate	mg/L									
Thallium, total	mg/L						<.002	<.002		
TOX	mg/L									
TSS	mg/L									
Vanadium, total	mg/L						<.050	.147		
Zinc, total	mg/L						<.020	.211		

* - The displayed value is the arithmetic mean of multiple database matches.

Table 4

Analytical Data Summary for QNW

Constituents	6/19/2023	12/1/2023	8/12/2024	12/1/2024
Aluminum		590.000	2.460	.284
Ammonia		.15	.11	
Antimony, total		<.020	<.002	<.002
Arsenic, total		.7650	.0063	<.0040
Barium, Total	.249	9.410	.314	.248
Beryllium, total		<.040	<.004	<.004
Boron, Total	.138	1.290	.211	.220
Cadmium, total		.0431	<.0008	<.0008
Chloride		157	241	319
Chromium, total		.788	<.008	<.008
Cobalt, Total	.0030	.7270	.0087	.0027
COD		5000	<20	69
Conductivity				
Copper, total		1.1000	.0071	<.0040
Fluoride		<.1	.1	.2
Formaldehyde		<20	<10	
Iron		2070.0	13.8	
Lead, total		.8590	.0042	<.0040
Lithium, total				<.05
Magnesium		1370.0	68.3	
Manganese, Total	.512	49.900	4.420	1.490
Mercury, total		<.0050	<.0005	<.0005
Molybdenum, Total	<.0040	.1550	.0077	.0042
Nickel, Total	.0056	1.3700	.0181	.0051
Nitrogen				.13
pH				
Phenols		<.035	.053	<.035
Selenium, total		.112	<.004	<.004
Silver, total		<.040	<.004	
Sulfate		144	134	
Thallium, total		<.020	<.002	<.002
TOX		.022	.133	.233
TSS		307	626	
Vanadium, total		1.440	<.020	<.020
Zinc, total		3.110	<.002	<.020

* - The displayed value is the arithmetic mean of multiple database matches.

Table 5

Analytical Data Summary for QS

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022	12/6/2022	3/22/2023
Aluminum	mg/L									
Ammonia	mg/L									
Antimony, total	mg/L						<.0020	.0038		
Arsenic, total	mg/L						<.0040	.1510		
Barium, Total	mg/L	2.990	.256	.250	.384	.261	.202	3.890	2.680	.188
Beryllium, total	mg/L						<.004	<.004		
Boron, Total	mg/L	.162	<.010	<.010	<.010	.114	<.100	.139	.135	<.100
Cadmium, total	mg/L						<.0050	<.0050		
Chloride	mg/L									
Chromium, total	mg/L						<.005	.149		
Cobalt, Total	mg/L	.2270	.0103	.0064	.0135	.0070	.0038	.2260	.1920	<.0004
COD	mg/L									
Conductivity	uS/cm						793	688		
Copper, total	mg/L						<.0100	.3160		
Fluoride	mg/L						<.1	.1		
Formaldehyde	ug/L									
Iron	mg/L									
Lead, total	mg/L						<.0100	.1600		
Lithium, total	mg/L						<.050	.064		
Magnesium	mg/L									
Manganese, Total	mg/L	16.600	.658	.419	1.080	.429	.078	20.000	12.000	<.004
Mercury, total	mg/L						<.0005	<.0005		
Molybdenum, Total	mg/L	.020	<.010	<.010	<.010	<.010	<.010	.022	.014	<.004
Nickel, Total	mg/L	.3380	.0210	.0150	.0250	.0120	<.0100	.3360	.2290	<.0040
Nitrogen	mg/L									
pH	pH						6.9	6.8		
Phenols	mg/L									
Selenium, total	mg/L						<.0500	.0730		
Silver, total	mg/L						<.005	<.005		
Sulfate	mg/L									
Thallium, total	mg/L						<.002	.002		
TOX	mg/L									
TSS	mg/L									
Vanadium, total	mg/L						<.05	.31		
Zinc, total	mg/L						<.020	.573		

* - The displayed value is the arithmetic mean of multiple database matches.

Table 5

Analytical Data Summary for QS

Constituents	6/19/2023	12/1/2023	12/1/2024
Aluminum		304.00	2.38
Ammonia		<.1	
Antimony, total		.0307	<.0020
Arsenic, total		1.0800	.0089
Barium, Total	.719	22.500	.366
Beryllium, total		<.040	<.004
Boron, Total	.106	<1.000	<.100
Cadmium, total		.0296	<.0008
Chloride		21.9	15.8
Chromium, total		.666	<.008
Cobalt, Total	.0357	1.6200	.0108
COD		<54	54
Conductivity			
Copper, total		1.6500	.0107
Fluoride		<.1	<.1
Formaldehyde		<10	
Iron		2280	
Lead, total		1.0100	.0063
Lithium, total			<.050
Magnesium		1120	
Manganese, Total	2.420	93.100	.715
Mercury, total		<.0050	<.0005
Molybdenum, Total	<.004	.067	<.004
Nickel, Total	.0456	1.8900	.0139
Nitrogen			<.01
pH			
Phenols		<.035	<.035
Selenium, total		.0925	<.0040
Silver, total		<.040	
Sulfate		133	
Thallium, total		<.020	<.002
TOX		<.01	<.01
TSS		15700	
Vanadium, total		1.24	<.02
Zinc, total		3.610	<.020

* - The displayed value is the arithmetic mean of multiple database matches.

Table 6

Analytical Data Summary for QW

Constituents	Units	3/1/2020	6/15/2020	9/1/2020	12/9/2020	6/10/2021	12/9/2021	6/21/2022
Antimony, total	mg/L						<.0020	.0026
Arsenic, total	mg/L						<.0040	.0549
Barium, Total	mg/L	.176	.151	.156	.170	.284	.189	.628
Beryllium, total	mg/L						<.004	<.004
Boron, Total	mg/L	<.01	<.01	<.01	<.01	<.01	<.10	<.10
Cadmium, total	mg/L						<.005	<.005
Chromium, total	mg/L						<.005	.041
Cobalt, Total	mg/L	.0012	.0004	.0004	.0009	.0082	.0013	.0308
Conductivity	uS/cm						508	640
Copper, total	mg/L						<.010	.057
Fluoride	mg/L						.2	.1
Lead, total	mg/L						<.010	.064
Lithium, total	mg/L						<.05	<.05
Manganese, Total	mg/L	.082	.024	.023	.049	.504	.059	2.020
Mercury, total	mg/L						<.0005	<.0005
Molybdenum, Total	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Nickel, Total	mg/L	<.010	<.010	<.010	<.010	.016	<.010	.053
pH	pH						7.1	7.0
Selenium, total	mg/L						<.050	.129
Silver, total	mg/L						<.005	<.005
Thallium, total	mg/L						<.002	<.002
Vanadium, total	mg/L						<.05	.11
Zinc, total	mg/L						<.02	.22

* - The displayed value is the arithmetic mean of multiple database matches.

Attachment C

Summary Tables and Graphs for the Interwell Comparisons

Table 1

Upgradient Data

Constituent	Units	Well	Date		Result	Adjusted	
Barium, Total	mg/L	QE	03/01/2020		0.1200		
Barium, Total	mg/L	QE	06/15/2020		0.1140		
Barium, Total	mg/L	QE	09/01/2020		0.0630		
Barium, Total	mg/L	QE	12/09/2020		0.0520		
Barium, Total	mg/L	QE	06/10/2021		0.0065		*
Barium, Total	mg/L	QE	12/09/2021		0.0770		
Barium, Total	mg/L	QE	06/21/2022		0.0690		
Barium, Total	mg/L	QE	12/06/2022		0.1520		
Barium, Total	mg/L	QE	03/22/2023		0.0637		
Barium, Total	mg/L	QE	06/19/2023		0.0778		
Barium, Total	mg/L	QE	12/01/2023		0.0716		
Barium, Total	mg/L	QE	08/12/2024		0.0659		
Barium, Total	mg/L	QE	12/01/2024		0.0784		
Boron, Total	mg/L	QE	03/01/2020		0.2930		
Boron, Total	mg/L	QE	06/15/2020		0.1850		
Boron, Total	mg/L	QE	09/01/2020		0.5240		
Boron, Total	mg/L	QE	12/09/2020		0.5230		
Boron, Total	mg/L	QE	06/10/2021		0.5040		
Boron, Total	mg/L	QE	12/09/2021		0.4890		
Boron, Total	mg/L	QE	06/21/2022	ND	0.1000		
Boron, Total	mg/L	QE	12/06/2022		0.6450		
Boron, Total	mg/L	QE	03/22/2023		0.1670		
Boron, Total	mg/L	QE	06/19/2023		0.3850		
Boron, Total	mg/L	QE	12/01/2023		0.6290		
Boron, Total	mg/L	QE	08/12/2024		0.5770		
Boron, Total	mg/L	QE	12/01/2024		0.6290		
Cobalt, Total	mg/L	QE	03/01/2020		0.0048		
Cobalt, Total	mg/L	QE	06/15/2020		0.0020		
Cobalt, Total	mg/L	QE	09/01/2020		0.0004		
Cobalt, Total	mg/L	QE	12/09/2020		0.0042		
Cobalt, Total	mg/L	QE	06/10/2021		0.0017		
Cobalt, Total	mg/L	QE	12/09/2021		0.0024		
Cobalt, Total	mg/L	QE	06/21/2022		0.0023		
Cobalt, Total	mg/L	QE	12/06/2022		0.0293		
Cobalt, Total	mg/L	QE	03/22/2023		0.0066		
Cobalt, Total	mg/L	QE	06/19/2023		0.0076		
Cobalt, Total	mg/L	QE	12/01/2023		0.0085		
Cobalt, Total	mg/L	QE	08/12/2024		0.0058		
Cobalt, Total	mg/L	QE	12/01/2024		0.0163		
Manganese, Total	mg/L	QE	03/01/2020		1.2900		
Manganese, Total	mg/L	QE	06/15/2020		1.0200		
Manganese, Total	mg/L	QE	09/01/2020		0.8080		
Manganese, Total	mg/L	QE	12/09/2020		0.7760		
Manganese, Total	mg/L	QE	06/10/2021		2.0700		
Manganese, Total	mg/L	QE	12/09/2021		3.0100		
Manganese, Total	mg/L	QE	06/21/2022		0.7190		
Manganese, Total	mg/L	QE	12/06/2022		1.5000		
Manganese, Total	mg/L	QE	03/22/2023		1.3900		
Manganese, Total	mg/L	QE	06/19/2023		3.0300		
Manganese, Total	mg/L	QE	12/01/2023		1.4800		
Manganese, Total	mg/L	QE	08/12/2024		2.8600		
Manganese, Total	mg/L	QE	12/01/2024		1.8900		
Molybdenum, Total	mg/L	QE	03/01/2020	ND	0.0100		
Molybdenum, Total	mg/L	QE	06/15/2020	ND	0.0100		
Molybdenum, Total	mg/L	QE	09/01/2020	ND	0.0100		
Molybdenum, Total	mg/L	QE	12/09/2020		0.0100		
Molybdenum, Total	mg/L	QE	06/10/2021	ND	0.0100		
Molybdenum, Total	mg/L	QE	12/09/2021	ND	0.0100		
Molybdenum, Total	mg/L	QE	06/21/2022	ND	0.0100		
Molybdenum, Total	mg/L	QE	12/06/2022		0.0190		
Molybdenum, Total	mg/L	QE	03/22/2023		0.0041		
Molybdenum, Total	mg/L	QE	06/19/2023		0.0040		
Molybdenum, Total	mg/L	QE	12/01/2023		0.0076		
Molybdenum, Total	mg/L	QE	08/12/2024		0.0071		
Molybdenum, Total	mg/L	QE	12/01/2024		0.0129		
Nickel, Total	mg/L	QE	03/01/2020		0.0110		
Nickel, Total	mg/L	QE	06/15/2020	ND	0.0100		
Nickel, Total	mg/L	QE	09/01/2020	ND	0.0100		
Nickel, Total	mg/L	QE	12/09/2020		0.0150		
Nickel, Total	mg/L	QE	06/10/2021	ND	0.0100		
Nickel, Total	mg/L	QE	12/09/2021		0.0150		
Nickel, Total	mg/L	QE	06/21/2022	ND	0.0100		
Nickel, Total	mg/L	QE	12/06/2022		0.0430		*
Nickel, Total	mg/L	QE	03/22/2023		0.0157		

* - Outlier for that well and constituent.
** - ND value replaced with median RL.
*** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 1

Upgradient Data

Constituent	Units	Well	Date		Result	Adjusted	
Nickel, Total	mg/L	QE	06/19/2023		0.0116		
Nickel, Total	mg/L	QE	12/01/2023		0.0248		
Nickel, Total	mg/L	QE	08/12/2024		0.0130		
Nickel, Total	mg/L	QE	12/01/2024		0.0447		*
Barium, Total	mg/L	QN	03/01/2020		0.2050		
Barium, Total	mg/L	QN	06/15/2020		0.0890		
Barium, Total	mg/L	QN	09/01/2020		0.0790		
Barium, Total	mg/L	QN	12/09/2020		0.1040		
Barium, Total	mg/L	QN	06/10/2021		0.1220		
Barium, Total	mg/L	QN	12/09/2021		0.1260		
Barium, Total	mg/L	QN	06/21/2022		0.0560		
Barium, Total	mg/L	QN	12/06/2022		0.0430		
Barium, Total	mg/L	QN	03/22/2023		0.0445		
Barium, Total	mg/L	QN	06/19/2023		0.0881		
Barium, Total	mg/L	QN	12/01/2023		0.0594		
Barium, Total	mg/L	QN	08/12/2024		0.0486		
Barium, Total	mg/L	QN	12/01/2024		0.0444		
Boron, Total	mg/L	QN	03/01/2020		0.5440		
Boron, Total	mg/L	QN	06/15/2020		0.4790		
Boron, Total	mg/L	QN	09/01/2020		0.4810		
Boron, Total	mg/L	QN	12/09/2020		0.5200		
Boron, Total	mg/L	QN	06/10/2021		0.6610		
Boron, Total	mg/L	QN	12/09/2021		0.6340		
Boron, Total	mg/L	QN	06/21/2022		0.1240		*
Boron, Total	mg/L	QN	12/06/2022		0.5230		
Boron, Total	mg/L	QN	03/22/2023		0.6540		
Boron, Total	mg/L	QN	06/19/2023		0.6030		
Boron, Total	mg/L	QN	12/01/2023		0.4880		
Boron, Total	mg/L	QN	08/12/2024		0.3740		
Boron, Total	mg/L	QN	12/01/2024		0.2940		
Cobalt, Total	mg/L	QN	03/01/2020		0.0039		
Cobalt, Total	mg/L	QN	06/15/2020		0.0035		
Cobalt, Total	mg/L	QN	09/01/2020		0.0029		
Cobalt, Total	mg/L	QN	12/09/2020		0.0039		
Cobalt, Total	mg/L	QN	06/10/2021		0.0034		
Cobalt, Total	mg/L	QN	12/09/2021		0.0025		
Cobalt, Total	mg/L	QN	06/21/2022		0.0008		
Cobalt, Total	mg/L	QN	12/06/2022		0.0059		
Cobalt, Total	mg/L	QN	03/22/2023		0.0027		
Cobalt, Total	mg/L	QN	06/19/2023		0.0061		
Cobalt, Total	mg/L	QN	12/01/2023		0.0025		
Cobalt, Total	mg/L	QN	08/12/2024		0.0041		
Cobalt, Total	mg/L	QN	12/01/2024		0.0100		
Manganese, Total	mg/L	QN	03/01/2020		1.1500		
Manganese, Total	mg/L	QN	06/15/2020		0.9450		
Manganese, Total	mg/L	QN	09/01/2020		0.8570		
Manganese, Total	mg/L	QN	12/09/2020		1.1000		
Manganese, Total	mg/L	QN	06/10/2021		0.9550		
Manganese, Total	mg/L	QN	12/09/2021		0.6140		
Manganese, Total	mg/L	QN	06/21/2022		0.3330		
Manganese, Total	mg/L	QN	12/06/2022		0.9220		
Manganese, Total	mg/L	QN	03/22/2023		0.7820		
Manganese, Total	mg/L	QN	06/19/2023		0.6890		
Manganese, Total	mg/L	QN	12/01/2023		0.6910		
Manganese, Total	mg/L	QN	08/12/2024		5.8100		*
Manganese, Total	mg/L	QN	12/01/2024		5.1600		*
Molybdenum, Total	mg/L	QN	03/01/2020		0.3580		
Molybdenum, Total	mg/L	QN	06/15/2020		0.2650		
Molybdenum, Total	mg/L	QN	09/01/2020		0.2460		
Molybdenum, Total	mg/L	QN	12/09/2020		0.2500		
Molybdenum, Total	mg/L	QN	06/10/2021		0.2230		
Molybdenum, Total	mg/L	QN	12/09/2021		0.1840		
Molybdenum, Total	mg/L	QN	06/21/2022		0.0240		
Molybdenum, Total	mg/L	QN	12/06/2022		0.1340		
Molybdenum, Total	mg/L	QN	03/22/2023		0.1240		
Molybdenum, Total	mg/L	QN	06/19/2023		0.1150		
Molybdenum, Total	mg/L	QN	12/01/2023		0.0900		
Molybdenum, Total	mg/L	QN	08/12/2024		0.0147		
Molybdenum, Total	mg/L	QN	12/01/2024		0.0143		
Nickel, Total	mg/L	QN	03/01/2020		0.0190		
Nickel, Total	mg/L	QN	06/15/2020		0.0200		
Nickel, Total	mg/L	QN	09/01/2020		0.0170		
Nickel, Total	mg/L	QN	12/09/2020		0.0160		
Nickel, Total	mg/L	QN	06/10/2021		0.0130		

* - Outlier for that well and constituent.
** - ND value replaced with median RL.
*** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 1

Upgradient Data

Constituent	Units	Well	Date		Result	Adjusted	
Nickel, Total	mg/L	QN	12/09/2021		0.0170		
Nickel, Total	mg/L	QN	06/21/2022		0.0200		
Nickel, Total	mg/L	QN	12/06/2022		0.0250		
Nickel, Total	mg/L	QN	03/22/2023		0.0106		
Nickel, Total	mg/L	QN	06/19/2023		0.0121		
Nickel, Total	mg/L	QN	12/01/2023		0.0169		
Nickel, Total	mg/L	QN	08/12/2024		0.0094		
Nickel, Total	mg/L	QN	12/01/2024		0.0089		
Barium, Total	mg/L	QNE	03/01/2020		0.1490		
Barium, Total	mg/L	QNE	06/15/2020		0.1040		
Barium, Total	mg/L	QNE	09/01/2020		0.0940		
Barium, Total	mg/L	QNE	12/09/2020		0.0970		
Barium, Total	mg/L	QNE	06/10/2021		0.0960		
Barium, Total	mg/L	QNE	12/09/2021		0.0970		
Barium, Total	mg/L	QNE	06/21/2022		0.1000		
Barium, Total	mg/L	QNE	12/06/2022		0.0960		
Barium, Total	mg/L	QNE	03/22/2023		0.0907		
Barium, Total	mg/L	QNE	06/19/2023		0.1000		
Barium, Total	mg/L	QNE	12/01/2023		0.0992		
Barium, Total	mg/L	QNE	08/12/2024		0.1090		
Barium, Total	mg/L	QNE	12/01/2024		0.1000		
Boron, Total	mg/L	QNE	03/01/2020		1.1500		
Boron, Total	mg/L	QNE	06/15/2020		0.4760		
Boron, Total	mg/L	QNE	09/01/2020		0.0752		*
Boron, Total	mg/L	QNE	12/09/2020		0.7390		
Boron, Total	mg/L	QNE	06/10/2021		0.7490		
Boron, Total	mg/L	QNE	12/09/2021		0.7300		
Boron, Total	mg/L	QNE	06/21/2022		0.6080		
Boron, Total	mg/L	QNE	12/06/2022		0.6320		
Boron, Total	mg/L	QNE	03/22/2023		0.6710		
Boron, Total	mg/L	QNE	06/19/2023		0.6200		
Boron, Total	mg/L	QNE	12/01/2023		0.6250		
Boron, Total	mg/L	QNE	08/12/2024		0.6600		
Boron, Total	mg/L	QNE	12/01/2024		0.6220		
Cobalt, Total	mg/L	QNE	03/01/2020		0.0038		
Cobalt, Total	mg/L	QNE	06/15/2020		0.0019		
Cobalt, Total	mg/L	QNE	09/01/2020		0.0011		
Cobalt, Total	mg/L	QNE	12/09/2020		0.0013		
Cobalt, Total	mg/L	QNE	06/10/2021		0.0006		
Cobalt, Total	mg/L	QNE	12/09/2021		0.0007		
Cobalt, Total	mg/L	QNE	06/21/2022		0.0005		
Cobalt, Total	mg/L	QNE	12/06/2022		0.0043		
Cobalt, Total	mg/L	QNE	03/22/2023		0.0011		
Cobalt, Total	mg/L	QNE	06/19/2023		0.0062		
Cobalt, Total	mg/L	QNE	12/01/2023		0.0027		
Cobalt, Total	mg/L	QNE	08/12/2024		0.0009		
Cobalt, Total	mg/L	QNE	12/01/2024		0.0013		
Manganese, Total	mg/L	QNE	03/01/2020		1.4600		
Manganese, Total	mg/L	QNE	06/15/2020		0.6160		
Manganese, Total	mg/L	QNE	09/01/2020		0.6980		
Manganese, Total	mg/L	QNE	12/09/2020		0.6040		
Manganese, Total	mg/L	QNE	06/10/2021		0.3970		
Manganese, Total	mg/L	QNE	12/09/2021		0.4310		
Manganese, Total	mg/L	QNE	06/21/2022		0.3130		
Manganese, Total	mg/L	QNE	12/06/2022		0.3990		
Manganese, Total	mg/L	QNE	03/22/2023		0.6390		
Manganese, Total	mg/L	QNE	06/19/2023		0.3470		
Manganese, Total	mg/L	QNE	12/01/2023		0.5550		
Manganese, Total	mg/L	QNE	08/12/2024		0.4020		
Manganese, Total	mg/L	QNE	12/01/2024		0.4210		
Molybdenum, Total	mg/L	QNE	03/01/2020		0.1150		*
Molybdenum, Total	mg/L	QNE	06/15/2020		0.0210		
Molybdenum, Total	mg/L	QNE	09/01/2020		0.0230		
Molybdenum, Total	mg/L	QNE	12/09/2020		0.0230		
Molybdenum, Total	mg/L	QNE	06/10/2021		0.0200		
Molybdenum, Total	mg/L	QNE	12/09/2021		0.0200		
Molybdenum, Total	mg/L	QNE	06/21/2022		0.0180		
Molybdenum, Total	mg/L	QNE	12/06/2022		0.0140		
Molybdenum, Total	mg/L	QNE	03/22/2023		0.0129		
Molybdenum, Total	mg/L	QNE	06/19/2023		0.0117		
Molybdenum, Total	mg/L	QNE	12/01/2023		0.0127		
Molybdenum, Total	mg/L	QNE	08/12/2024		0.0121		
Molybdenum, Total	mg/L	QNE	12/01/2024		0.0117		
Nickel, Total	mg/L	QNE	03/01/2020		0.0160		

* - Outlier for that well and constituent.
** - ND value replaced with median RL.
*** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 1

Upgradient Data

Constituent	Units	Well	Date		Result	Adjusted	
Nickel, Total	mg/L	QNE	06/15/2020		0.0180		
Nickel, Total	mg/L	QNE	09/01/2020		0.0150		
Nickel, Total	mg/L	QNE	12/09/2020		0.0120		
Nickel, Total	mg/L	QNE	06/10/2021	ND	0.0100		
Nickel, Total	mg/L	QNE	12/09/2021	ND	0.0100		
Nickel, Total	mg/L	QNE	06/21/2022	ND	0.0100		
Nickel, Total	mg/L	QNE	12/06/2022	ND	0.0100		
Nickel, Total	mg/L	QNE	03/22/2023		0.0053		
Nickel, Total	mg/L	QNE	06/19/2023		0.0044		
Nickel, Total	mg/L	QNE	12/01/2023		0.0066		
Nickel, Total	mg/L	QNE	08/12/2024		0.0052		
Nickel, Total	mg/L	QNE	12/01/2024		0.0044		

* - Outlier for that well and constituent.
** - ND value replaced with median RL.
*** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 2

Most Current Downgradient Monitoring Data

Constituent	Units	Well	Date		Result		Pred. Limit
Barium, Total	mg/L	QNW	12/01/2024		0.2480	***	0.2050
Boron, Total	mg/L	QNW	12/01/2024		0.2200		1.1500
Cobalt, Total	mg/L	QNW	12/01/2024		0.0027		0.0290
Manganese, Total	mg/L	QNW	12/01/2024		1.4900	**	3.8993
Molybdenum, Total	mg/L	QNW	12/01/2024		0.0042		0.2921
Nickel, Total	mg/L	QNW	12/01/2024		0.0051		0.0294
Barium, Total	mg/L	QS	12/01/2024		0.3660	***	0.2050
Boron, Total	mg/L	QS	12/01/2024	ND	0.1000		1.1500
Cobalt, Total	mg/L	QS	12/01/2024		0.0108	**	0.0290
Manganese, Total	mg/L	QS	12/01/2024		0.7150	**	3.8993
Molybdenum, Total	mg/L	QS	12/01/2024	ND	0.0040		0.2921
Nickel, Total	mg/L	QS	12/01/2024		0.0139	**	0.0294

* - Current value failed - awaiting verification.
** - Current value passed - previous exceedance not verified.
*** - Current value failed - exceedance verified.
**** - Current value passed - awaiting one more verification.
***** - Insufficient background data to compute prediction limit.
ND = Not Detected, Result = detection limit.

Table 3

Detection Frequencies in Upgradient and Downgradient Wells

Constituent	Upgradient Detect	Upgradient N	Upgradient Proportion	Downgradient Detect	Downgradient N	Downgradient Proportion
Barium, Total	38	38	1.000	25	25	1.000
Boron, Total	36	37	0.973	17	25	0.680
Cobalt, Total	39	39	1.000	24	25	0.960
Manganese, Total	37	37	1.000	24	25	0.960
Molybdenum, Total	32	38	0.842	9	25	0.360
Nickel, Total	29	37	0.784	18	25	0.720

N = Total number of measurements in all wells.
Detect = Total number of detections in all wells.
Proportion = Detect/N.

Table 4

Shapiro-Wilk Multiple Group Test of Normality

Constituent	Detect	N	Detect Freq	G raw	G log	G cbrt	G sqrt	G sqr	G cub	Crit Value	Dist Form	Model Type
Barium, Total	38	38	1.000	4.961	3.187					2.326	non-norm	nonpar
Boron, Total	36	37	0.973	2.605	3.107					2.326	non-norm	nonpar
Cobalt, Total	39	39	1.000	4.167	0.271					2.326	lognor	lognor
Manganese, Total	37	37	1.000	2.513	1.989					2.326	lognor	lognor
Molybdenum, Total	32	38	0.842	1.264	2.001					2.326	normal	normal
Nickel, Total	29	37	0.784	1.708	1.344					2.326	normal	normal

* - Distribution override for that constituent.
Fit to distribution is confirmed if G <= critical value.
Model type may not match distributional form when detection frequency < 50%.

Table 5

Summary Statistics and Prediction Limits

Constituent	Units	Detect	N	Mean	SD	alpha	Factor	Pred Limit	Type	Conf
Barium, Total	mg/L	38	38					0.2050	nonpar	0.99
Boron, Total	mg/L	36	37					1.1500	nonpar	0.99
Cobalt, Total	mg/L	39	39	-5.8701	0.9479	0.0100	2.4594	0.0290	lognor	
Manganese, Total	mg/L	37	37	-0.1658	0.6188	0.0100	2.4670	3.8993	lognor	
Molybdenum, Total	mg/L	32	38	0.0607	0.0939	0.0100	2.4631	0.2921	normal	
Nickel, Total	mg/L	29	37	0.0108	0.0075	0.0100	2.4670	0.0294	normal	

Conf = confidence level for passing initial test or one verification resample at all downgradient wells for a single constituent (nonparametric test only).
* - Insufficient Data.
** - Calculated limit raised to Manual Reporting Limit.
*** - Nonparametric limit based on ND value.
For transformed data, mean and SD in transformed units and prediction limit in original units.
All sample sizes and statistics are based on outlier free data.
For nonparametric limits, median reporting limits are substituted for extreme reporting limit values.

Table 6

Dixon's Test Outliers
1% Significance Level

Constituent	Units	Well	Date	Result	ND Qualifier	Date Range	N	Critical Value
Barium, Total	mg/L	QE	06/10/2021	0.0065		03/01/2020-12/01/2024	13	0.6174
Nickel, Total	mg/L	QE	12/06/2022	0.0430		03/01/2020-12/01/2024	13	0.6425
Nickel, Total	mg/L	QE	12/01/2024	0.0447		03/01/2020-12/01/2024	13	0.6425
Boron, Total	mg/L	QN	06/21/2022	0.1240		03/01/2020-12/01/2024	13	0.6174
Manganese, Total	mg/L	QN	08/12/2024	5.8100		03/01/2020-12/01/2024	13	0.6425
Manganese, Total	mg/L	QN	12/01/2024	5.1600		03/01/2020-12/01/2024	13	0.6425
Boron, Total	mg/L	QNE	09/01/2020	0.0752		03/01/2020-12/01/2024	13	0.6174
Molybdenum, Total	mg/L	QNE	03/01/2020	0.1150		03/01/2020-12/01/2024	13	0.6174

N = Total number of independent measurements in background at each well.
Date Range = Dates of the first and last measurements included in background at each well.
Critical Value depends on the significance level and on N-1 when the two most extreme values are tested or N for the most extreme value.

Table 8

Historical Downgradient Data for Constituent-Well Combinations that Failed the Current Statistical Evaluation or are in Verification Resampling Mode

Constituent	Units	Well	Date		Result		Pred. Limit
Barium, Total	mg/L	QNW	03/01/2020		0.2260	*	0.2050
Barium, Total	mg/L	QNW	06/15/2020		0.1700		0.2050
Barium, Total	mg/L	QNW	09/01/2020		0.2450	*	0.2050
Barium, Total	mg/L	QNW	12/09/2020		0.2870	*	0.2050
Barium, Total	mg/L	QNW	06/10/2021		0.2600	*	0.2050
Barium, Total	mg/L	QNW	12/09/2021		0.3090	*	0.2050
Barium, Total	mg/L	QNW	06/21/2022		1.8200	*	0.2050
Barium, Total	mg/L	QNW	12/06/2022		1.4000	*	0.2050
Barium, Total	mg/L	QNW	03/22/2023		0.1950		0.2050
Barium, Total	mg/L	QNW	06/19/2023		0.2490	*	0.2050
Barium, Total	mg/L	QNW	12/01/2023		9.4100	*	0.2050
Barium, Total	mg/L	QNW	08/12/2024		0.3140	*	0.2050
Barium, Total	mg/L	QNW	12/01/2024		0.2480	*	0.2050
Manganese, Total	mg/L	QNW	03/01/2020		1.0400		3.8993
Manganese, Total	mg/L	QNW	06/15/2020		0.3020		3.8993
Manganese, Total	mg/L	QNW	09/01/2020		0.0560		3.8993
Manganese, Total	mg/L	QNW	12/09/2020		0.0450		3.8993
Manganese, Total	mg/L	QNW	06/10/2021		0.7010		3.8993
Manganese, Total	mg/L	QNW	12/09/2021		0.7140		3.8993
Manganese, Total	mg/L	QNW	06/21/2022		5.2400	*	3.8993
Manganese, Total	mg/L	QNW	12/06/2022		9.8800	*	3.8993
Manganese, Total	mg/L	QNW	03/22/2023		0.1050		3.8993
Manganese, Total	mg/L	QNW	06/19/2023		0.5120		3.8993
Manganese, Total	mg/L	QNW	12/01/2023		49.9000	*	3.8993
Manganese, Total	mg/L	QNW	08/12/2024		4.4200	*	3.8993
Manganese, Total	mg/L	QNW	12/01/2024		1.4900		3.8993
Barium, Total	mg/L	QS	03/01/2020		2.9900	*	0.2050
Barium, Total	mg/L	QS	06/15/2020		0.2560	*	0.2050
Barium, Total	mg/L	QS	09/01/2020		0.2500	*	0.2050
Barium, Total	mg/L	QS	12/09/2020		0.3840	*	0.2050
Barium, Total	mg/L	QS	06/10/2021		0.2610	*	0.2050
Barium, Total	mg/L	QS	12/09/2021		0.2020		0.2050
Barium, Total	mg/L	QS	06/21/2022		3.8900	*	0.2050
Barium, Total	mg/L	QS	12/06/2022		2.6800	*	0.2050
Barium, Total	mg/L	QS	03/22/2023		0.1880		0.2050
Barium, Total	mg/L	QS	06/19/2023		0.7190	*	0.2050
Barium, Total	mg/L	QS	12/01/2023		22.5000	*	0.2050
Barium, Total	mg/L	QS	12/01/2024		0.3660	*	0.2050
Cobalt, Total	mg/L	QS	03/01/2020		0.2270	*	0.0290
Cobalt, Total	mg/L	QS	06/15/2020		0.0103		0.0290
Cobalt, Total	mg/L	QS	09/01/2020		0.0064		0.0290
Cobalt, Total	mg/L	QS	12/09/2020		0.0135		0.0290
Cobalt, Total	mg/L	QS	06/10/2021		0.0070		0.0290
Cobalt, Total	mg/L	QS	12/09/2021		0.0038		0.0290
Cobalt, Total	mg/L	QS	06/21/2022		0.2260	*	0.0290
Cobalt, Total	mg/L	QS	12/06/2022		0.1920	*	0.0290
Cobalt, Total	mg/L	QS	03/22/2023	ND	0.0004		0.0290
Cobalt, Total	mg/L	QS	06/19/2023		0.0357	*	0.0290
Cobalt, Total	mg/L	QS	12/01/2023		1.6200	*	0.0290
Cobalt, Total	mg/L	QS	12/01/2024		0.0108		0.0290
Manganese, Total	mg/L	QS	03/01/2020		16.6000	*	3.8993
Manganese, Total	mg/L	QS	06/15/2020		0.6580		3.8993
Manganese, Total	mg/L	QS	09/01/2020		0.4190		3.8993
Manganese, Total	mg/L	QS	12/09/2020		1.0800		3.8993
Manganese, Total	mg/L	QS	06/10/2021		0.4290		3.8993
Manganese, Total	mg/L	QS	12/09/2021		0.0780		3.8993
Manganese, Total	mg/L	QS	06/21/2022		20.0000	*	3.8993
Manganese, Total	mg/L	QS	12/06/2022		12.0000	*	3.8993
Manganese, Total	mg/L	QS	03/22/2023	ND	0.0040		3.8993
Manganese, Total	mg/L	QS	06/19/2023		2.4200		3.8993
Manganese, Total	mg/L	QS	12/01/2023		93.1000	*	3.8993
Manganese, Total	mg/L	QS	12/01/2024		0.7150		3.8993
Nickel, Total	mg/L	QS	03/01/2020		0.3380	*	0.0294
Nickel, Total	mg/L	QS	06/15/2020		0.0210		0.0294
Nickel, Total	mg/L	QS	09/01/2020		0.0150		0.0294
Nickel, Total	mg/L	QS	12/09/2020		0.0250		0.0294
Nickel, Total	mg/L	QS	06/10/2021		0.0120		0.0294
Nickel, Total	mg/L	QS	12/09/2021	ND	0.0100		0.0294
Nickel, Total	mg/L	QS	06/21/2022		0.3360	*	0.0294
Nickel, Total	mg/L	QS	12/06/2022		0.2290	*	0.0294
Nickel, Total	mg/L	QS	03/22/2023	ND	0.0040		0.0294

* - Significantly increased over background.
** - Detect at limit for 100% NDs in background (NPPL only).
*** - Manual exclusion.
ND = Not Detected, Result = detection limit.

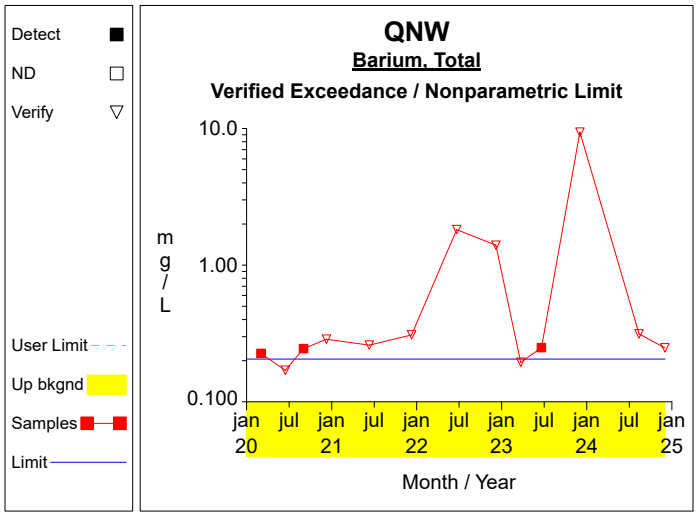
Table 8

Historical Downgradient Data for Constituent-Well Combinations that Failed the Current Statistical Evaluation or are in Verification Resampling Mode

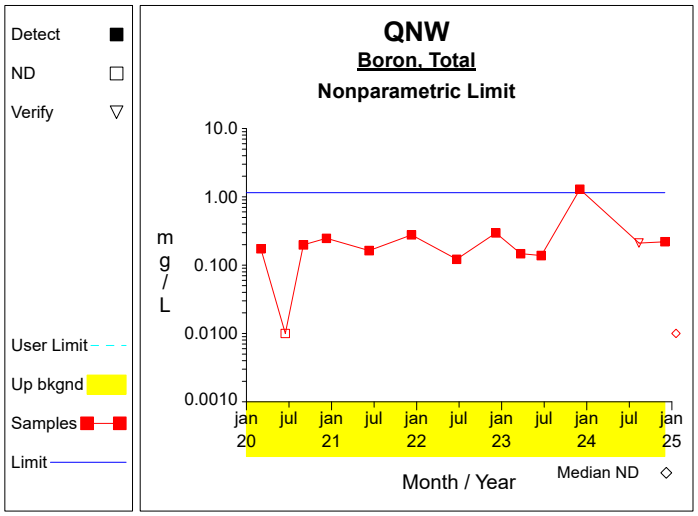
Constituent	Units	Well	Date		Result		Pred. Limit
Nickel, Total	mg/L	QS	06/19/2023		0.0456	*	0.0294
Nickel, Total	mg/L	QS	12/01/2023		1.8900	*	0.0294
Nickel, Total	mg/L	QS	12/01/2024		0.0139		0.0294

* - Significantly increased over background.
** - Detect at limit for 100% NDs in background (NPPL only).
*** - Manual exclusion.
ND = Not Detected, Result = detection limit.

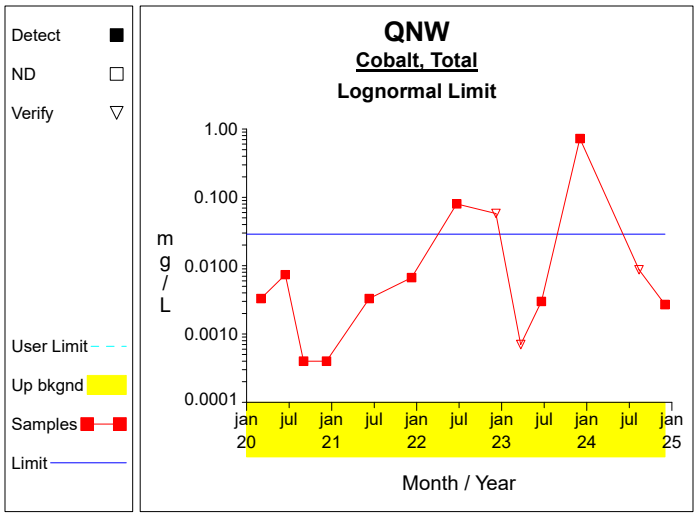
Up vs. Down Prediction Limits



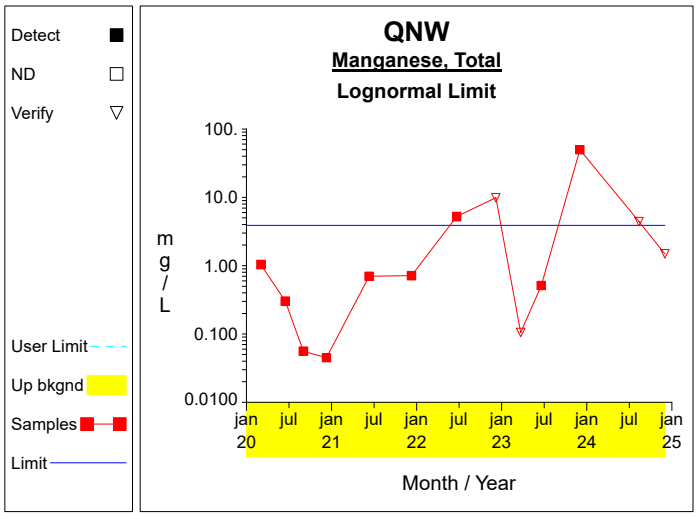
Graph 1



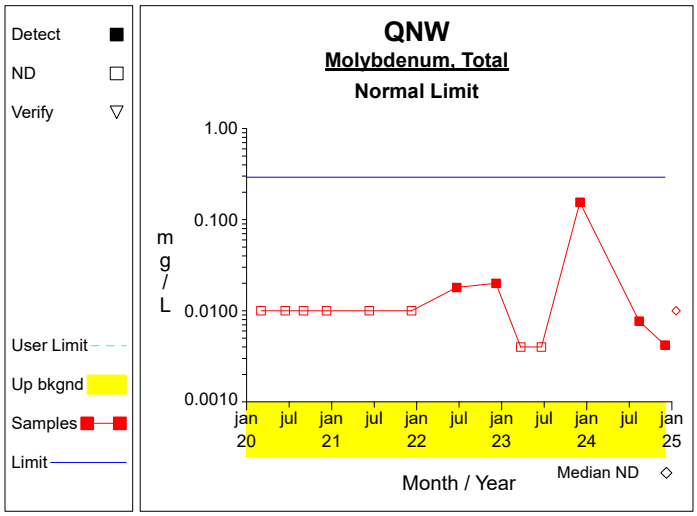
Graph 2



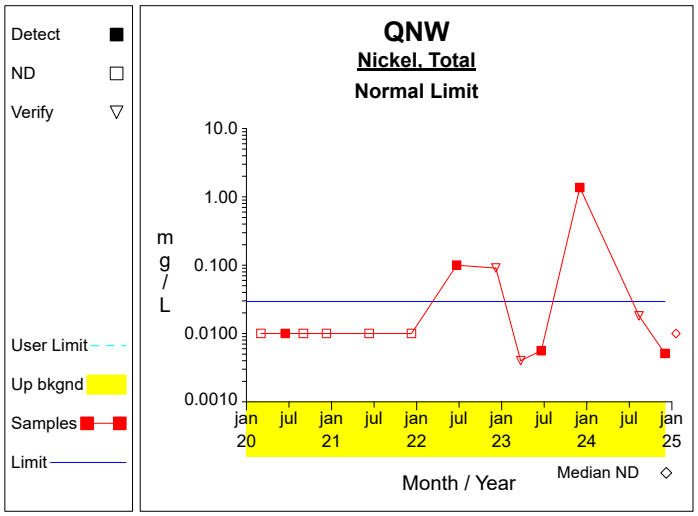
Graph 3



Graph 4



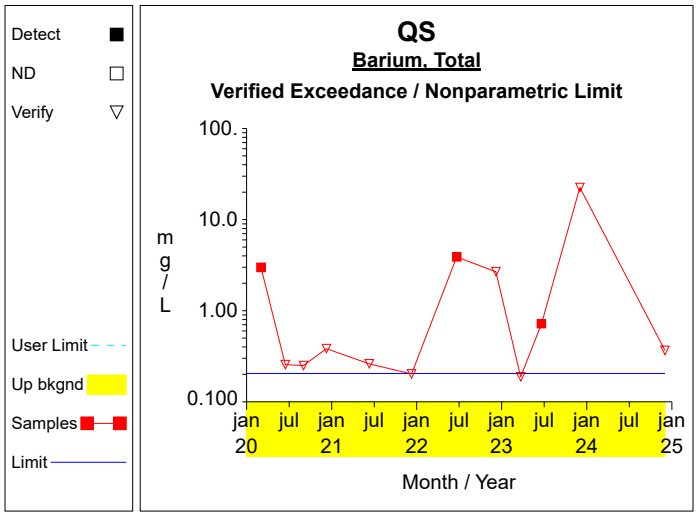
Graph 5



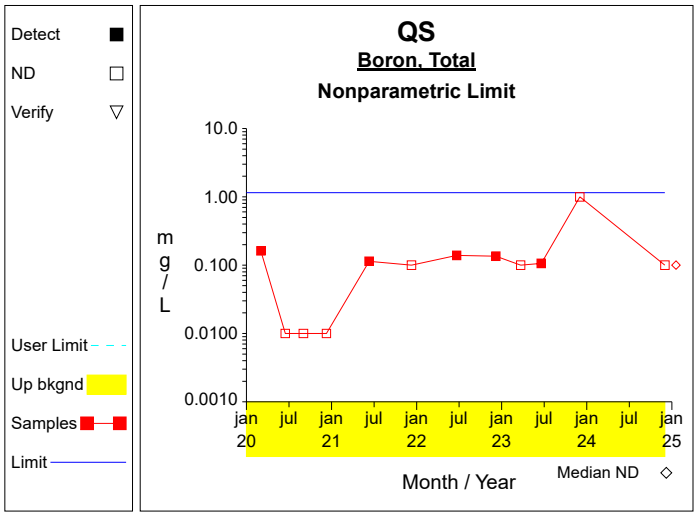
Graph 6

Prepared by: Otter Creek Environmental

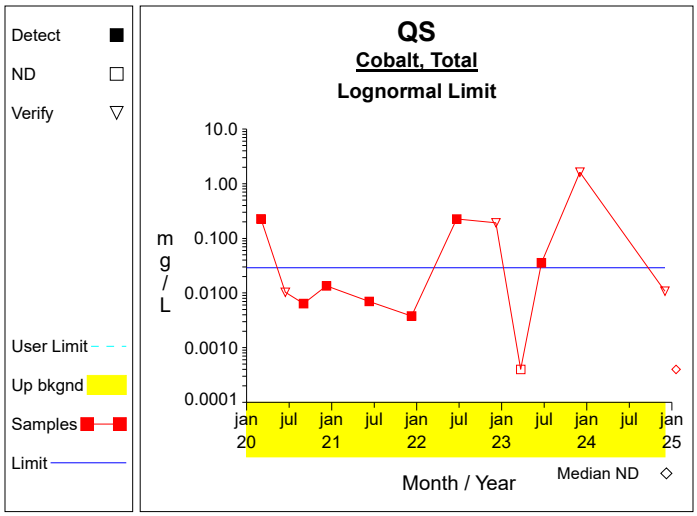
Up vs. Down Prediction Limits



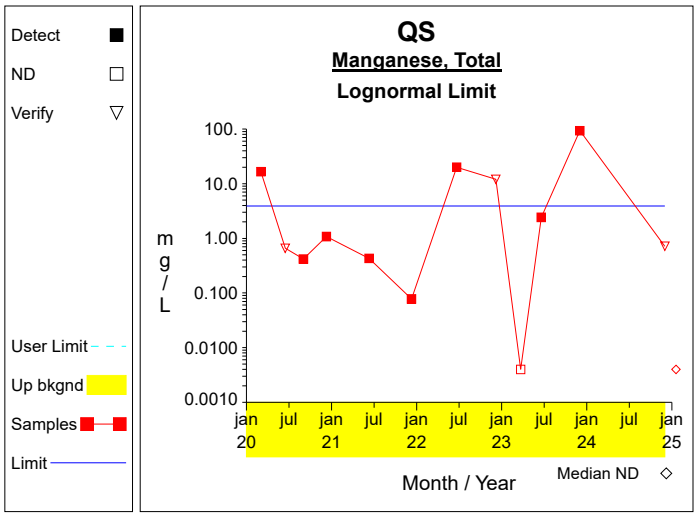
Graph 7



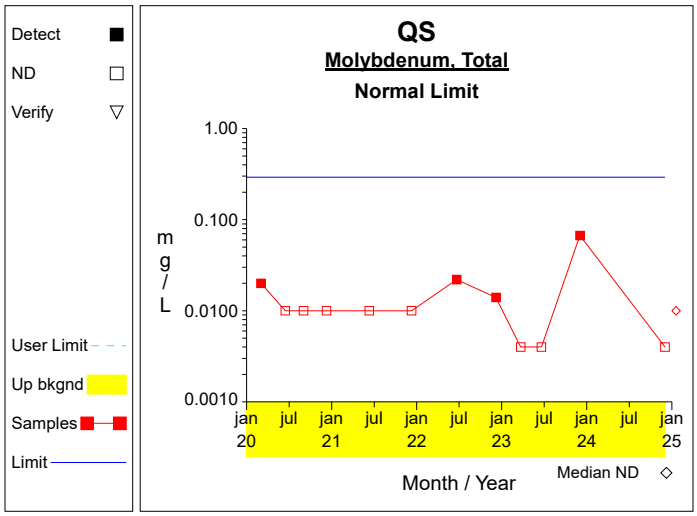
Graph 8



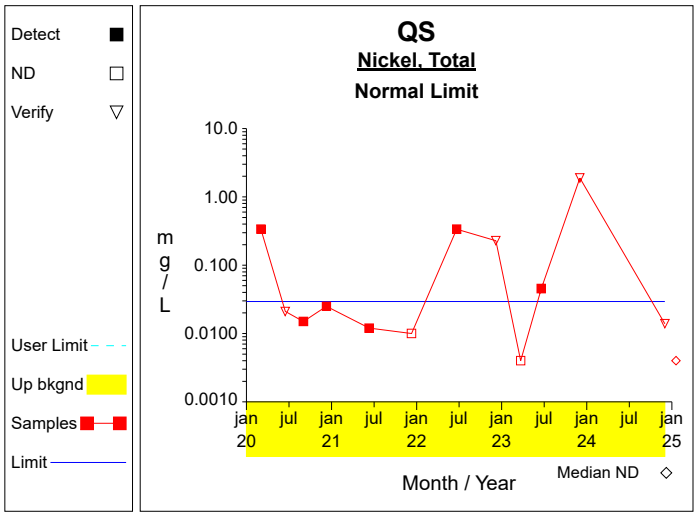
Graph 9



Graph 10



Graph 11

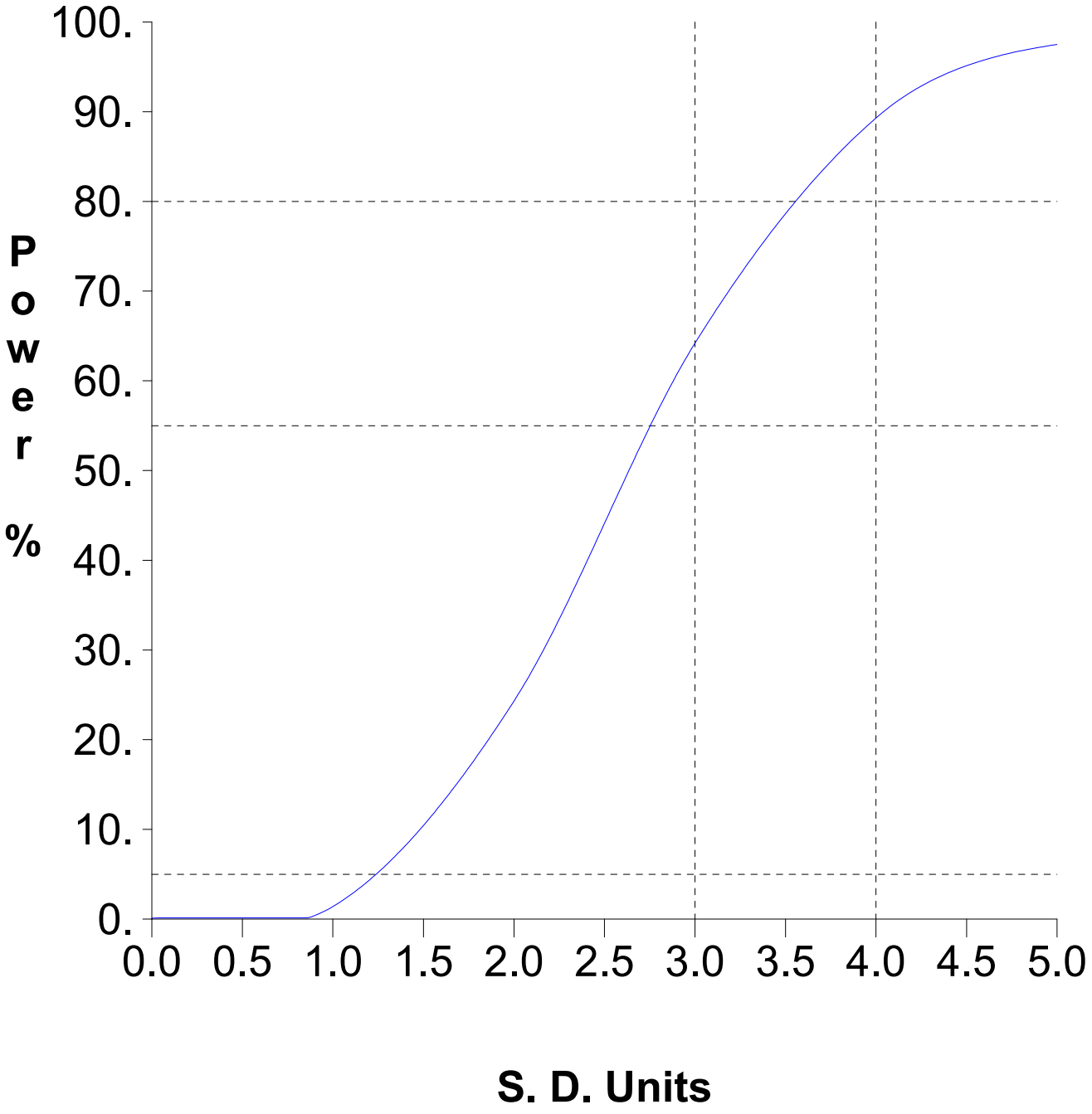


Graph 12

Prepared by: Otter Creek Environmental

False Positive and False Negative Rates for Current

Upgradient vs. Downgradient Monitoring Program



Worksheet 1 - Upgradient vs. Downgradient Comparisons
Barium, Total (mg/L)
Nonparametric Prediction Limit

Step	Equation	Description
1	PL = max(X) = **0.205**	Compute nonparametric prediction limit as largest background measurement.
2	Conf = **0.99**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Boron, Total (mg/L)
Nonparametric Prediction Limit

Step	Equation	Description
1	PL = max(X) = **1.15**	Compute nonparametric prediction limit as largest background measurement.
2	Conf = **0.99**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Cobalt, Total (mg/L)
Lognormal Prediction Limit

Step	Equation	Description
1	$Y = \log_e(X)$	Transform to natural logarithmic scale.
2	$\overline{Y}$ = **sum[Y]** / **N** = **-228.936** / **39** = **-5.87**	Compute mean on a natural log scale.
3	$S_Y = ((\mathbf{sum[Y^2]} - \mathbf{sum[Y]}^2/\mathbf{N}) / (\mathbf{N}-1))^{½}$ $= ((\mathbf{1378.029} - \mathbf{52411.546}/\mathbf{39}) / (\mathbf{39}-1))^{½}$ = **0.948**	Compute sd on a natural log scale.
4	alpha = min[$(1-.95^{1/\mathbf{K}})^{½}$, .01] = min[$(1-.95^{1/\mathbf{12}})^{½}$, .01] = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample.
5	$PL = \exp[\overline{\mathbf{Y}} + \mathbf{tS_Y}(1+1/\mathbf{N})^{½}]$ $= \exp[\mathbf{-5.87}$ $+ (\mathbf{2.428}*\mathbf{0.948})(1+1/\mathbf{39})^{½}]$ = **0.029**	One-sided lognormal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Manganese, Total (mg/L)
Lognormal Prediction Limit

Step	Equation	Description
1	$Y = \log_e(X)$	Transform to natural logarithmic scale.
2	$\overline{Y}$ = **sum[Y]** / **N** = **-6.136** / **37** = **-0.166**	Compute mean on a natural log scale.
3	$S_Y = ((\mathbf{sum[Y^2]} - \mathbf{sum[Y]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{14.803} - \mathbf{37.645}/\mathbf{37}) / (\mathbf{37}-1))^{1/2}$ = **0.619**	Compute sd on a natural log scale.
4	alpha = min[$(1-.95^{1/\mathbf{K}})^{1/2}$, .01] = min[$(1-.95^{1/\mathbf{12}})^{1/2}$, .01] = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample.
5	$PL = \exp[\overline{\mathbf{Y}} + \mathbf{tS_Y}(1+1/\mathbf{N})^{1/2}]$ = exp[**-0.166** + (**2.434*****0.619**)(1+1/**37**)$^{1/2}$] = **3.899**	One-sided lognormal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Molybdenum, Total (mg/L)
Normal Prediction Limit

Step	Equation	Description
1	$\overline{X}_1 = \mathbf{sum[X_1]} / \mathbf{N_1}$ $= \mathbf{2.307} / \mathbf{32}$ $= \mathbf{0.072}$	Compute mean of N_1 detected measurements.
2	$S_1 = ((\mathbf{sum[X_1^2]} - \mathbf{sum[X_1]}^2/\mathbf{N_1}) / (\mathbf{N_1}-1))^{½}$ $= ((\mathbf{0.465} - \mathbf{5.321}/\mathbf{32}) / (\mathbf{32}-1))^{½}$ $= \mathbf{0.098}$	Compute sd of N_1 detected measurements.
3	$\overline{X} = (1 - \mathbf{N_0}/\mathbf{N}) \overline{\mathbf{X}}_\mathbf{1}$ $= (1 - \mathbf{6}/\mathbf{38}) \mathbf{0.072}$ $= \mathbf{0.061}$	Use Aitchison's method to adjust mean for presence of nondetects.
4	$S = [(1 - \mathbf{N_0}/\mathbf{N}) * \mathbf{S_1}^2 +$ $(\mathbf{N_0}/\mathbf{N}) (1 - (\mathbf{N_0}-1)/(\mathbf{N}-1)) \overline{\mathbf{X}}_\mathbf{1}^2]^{½}$ $= [(1 - \mathbf{6}/\mathbf{38}) * \mathbf{0.098}^2 +$ $(\mathbf{6}/\mathbf{38}) (1 - (\mathbf{6}-1)/(\mathbf{38}-1)) \mathbf{0.072}^2]^{½}$ $= \mathbf{0.094}$	Use Aitchison's method to adjust sd for presence of nondetects.
5	$\text{alpha} = \min[(1-.95^{1/\mathbf{K}})^{½}, .01]$ $= \min[(1-.95^{1/\mathbf{12}})^{½}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
6	$PL = \overline{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{½}$ $= \mathbf{0.061}$ $+ (\mathbf{2.431} * \mathbf{0.094})(1+1/\mathbf{38})^{½}$ $= \mathbf{0.292}$	One-sided normal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Nickel, Total (mg/L)
Normal Prediction Limit

Step	Equation	Description
1	$\overline{X}_1 = \mathbf{sum[X_1]} / \mathbf{N_1}$ $= \mathbf{0.398} / \mathbf{29}$ $= \mathbf{0.014}$	Compute mean of N_1 detected measurements.
2	$S_1 = ((\mathbf{sum[X_1^2]} - \mathbf{sum[X_1]}^2/\mathbf{N_1}) / (\mathbf{N_1}-1))^{½}$ $= ((\mathbf{0.006} - \mathbf{0.158}/\mathbf{29}) / (\mathbf{29}-1))^{½}$ $= \mathbf{0.006}$	Compute sd of N_1 detected measurements.
3	$\overline{X} = (1 - \mathbf{N_0}/\mathbf{N}) \overline{\mathbf{X}}_\mathbf{1}$ $= (1 - \mathbf{8}/\mathbf{37}) \mathbf{0.014}$ $= \mathbf{0.011}$	Use Aitchison's method to adjust mean for presence of nondetects.
4	$S = [(1 - \mathbf{N_0}/\mathbf{N}) * \mathbf{S_1}^2 +$ $(\mathbf{N_0}/\mathbf{N}) (1 - (\mathbf{N_0}-1)/(\mathbf{N}-1)) \overline{\mathbf{X}}_\mathbf{1}^2]^{½}$ $= [(1 - \mathbf{8}/\mathbf{37}) * \mathbf{0.006}^2 +$ $(\mathbf{8}/\mathbf{37}) (1 - (\mathbf{8}-1)/(\mathbf{37}-1)) \mathbf{0.014}^2]^{½}$ $= \mathbf{0.008}$	Use Aitchison's method to adjust sd for presence of nondetects.
5	$\text{alpha} = \min[(1-.95^{1/\mathbf{K}})^{½}, .01]$ $= \min[(1-.95^{1/\mathbf{12}})^{½}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
6	$PL = \overline{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{½}$ $= \mathbf{0.011}$ $+ (\mathbf{2.434}*\mathbf{0.008})(1+1/\mathbf{37})^{½}$ $= \mathbf{0.029}$	One-sided normal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Attachment D

Summary Tables and Graphs for the Intrawell Comparisons

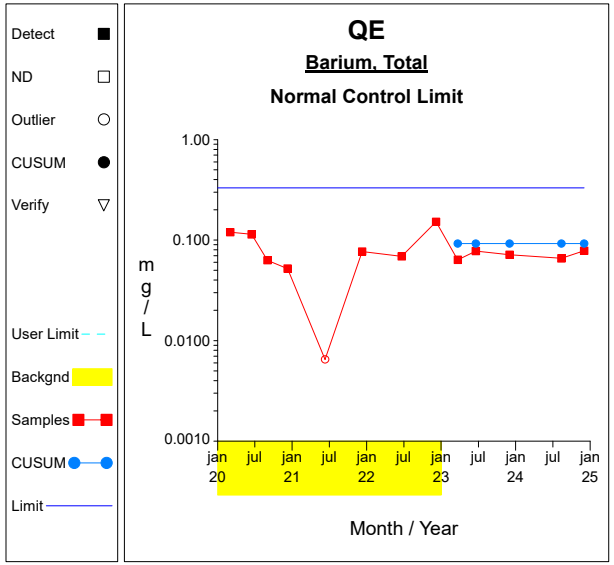
Table 1

Summary Statistics and Intermediate Computations for Combined Shewhart-CUSUM Control Charts

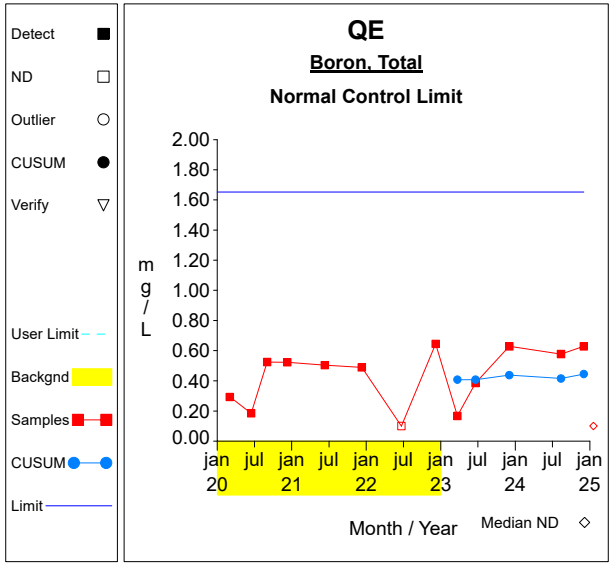
Constituent	Units	Well	N(back)	N(mon)	N(tot)	Mean	SD	R(i-1)	R(i)	S(i-1)	S(i)	Limit	Type	Conf	
Barium, Total	mg/L	QE	7	5	13	0.0924	0.0367	0.0659	0.0784	0.0924	0.0924	0.3307	normal		
Boron, Total	mg/L	QE	8	5	13	0.4079	0.1914	0.5770	0.6290	0.4153	0.4450	1.6520	normal		
Cobalt, Total	mg/L	QE	8	5	13	0.0059	0.0096	0.0058	0.0163	0.0059	0.0067	0.0680	normal		
Manganese, Total	mg/L	QE	8	5	13	1.3991	0.7938	2.8600	1.8900	2.1903	1.8873	6.5590	normal		
Molybdenum, Total	mg/L	QE	8	5	13	0.0111	0.0032	0.0071	0.0129	0.0111	0.0111	0.0318	normal		
Nickel, Total	mg/L	QE	7	5	13	0.0116	0.0024	0.0130	0.0447	0.0215	0.0522	0.0270	normal		
Barium, Total	mg/L	QN	8	5	13	0.1030	0.0505	0.0486	0.0444	0.1030	0.1030	0.4315	normal		
Boron, Total	mg/L	QN	7	5	13	0.5489	0.0717	0.3740	0.2940	0.5489	0.5489	1.0148	normal		
Cobalt, Total	mg/L	QN	7	5	13	0.0037	0.0011	0.0041	0.0100	0.0037	0.0089	0.0108	normal		
Manganese, Total	mg/L	QN	8	5	13	0.8595	0.2673	5.8100	5.1600	5.5427	4.8927	2.5968	normal		
Molybdenum, Total	mg/L	QN	7	5	13	0.2371	0.0699	0.0147	0.0143	0.2371	0.2371	0.6913	normal		
Nickel, Total	mg/L	QN	8	5	13	0.0184	0.0035	0.0094	0.0089	0.0184	0.0184	0.0414	normal		
Barium, Total	mg/L	QNE	8	5	13	0.1041	0.0184	0.1090	0.1000	0.1041	0.1041	0.2236	normal		
Boron, Total	mg/L	QNE	7	5	13	0.7263	0.2105	0.6600	0.6220	0.7263	0.7263	2.0942	normal		
Cobalt, Total	mg/L	QNE	8	5	13	0.0018	0.0015	0.0009	0.0013	0.0018	0.0018	0.0114	normal		
Manganese, Total	mg/L	QNE	8	5	13	0.6148	0.3665	0.4020	0.4210	0.6148	0.6148	2.9970	normal		
Molybdenum, Total	mg/L	QNE	7	5	13	0.0199	0.0031	0.0121	0.0117	0.0199	0.0199	0.0402	normal		
Nickel, Total	mg/L	QNE	8	5	13	0.0126	0.0032	0.0052	0.0044	0.0126	0.0126	0.0337	normal		
Barium, Total	mg/L	QNW	6	5	13	0.2495	0.0489	0.3140	0.2480	0.2651	0.2495	0.5673	normal		
Boron, Total	mg/L	QNW	7	5	13	0.2110	0.0641	0.2110	0.2200	0.2110	0.2110	0.6275	normal		
Cobalt, Total	mg/L	QNW	8	5	13	0.0200	0.0311	0.0087	0.0027	0.0200	0.0200	0.2220	normal		
Manganese, Total	mg/L	QNW	8	5	13	2.2473	3.5224	4.4200	1.4900	2.2473	2.2473	25.1427	normal		
Molybdenum, Total	mg/L	QNW	8	5	13	0.0123	0.0042	0.0077	0.0042	0.0123	0.0123	0.0396	normal		
Nickel, Total	mg/L	QNW	6	5	13								nonpar *		**
Barium, Total	mg/L	QS	8	4	12	1.3641	1.5470	22.5000	0.3660	20.9530	1.3641	11.4196	normal		
Boron, Total	mg/L	QS	8	4	12	0.0738	0.0694	1.0000	0.1000	0.0738	0.0738	0.5246	normal		
Cobalt, Total	mg/L	QS	8	4	12	0.0857	0.1076	1.6200	0.0108	1.5124	0.0857	0.7851	normal		
Manganese, Total	mg/L	QS	8	4	12	6.4080	8.3924	93.1000	0.7150	84.7076	6.4080	60.9585	normal		
Molybdenum, Total	mg/L	QS	8	4	12	0.0133	0.0050	0.0670	0.0040	0.0620	0.0133	0.0458	normal		
Nickel, Total	mg/L	QS	8	4	12	0.1233	0.1510	1.8900	0.0139	1.7390	0.1233	1.1047	normal		

N(back) and N(mon) = Non-outlier measurements in the background and monitoring periods.
N(tot) = All independent measurements for that constituent and well.
For transformed data, mean and SD in transformed units and control limit in original units.
Conf = confidence level for passing initial test or one verification resample (nonparametric test only).
* - Insufficient Data.
** - Detection Frequency < 25%.
*** - Zero Variance.

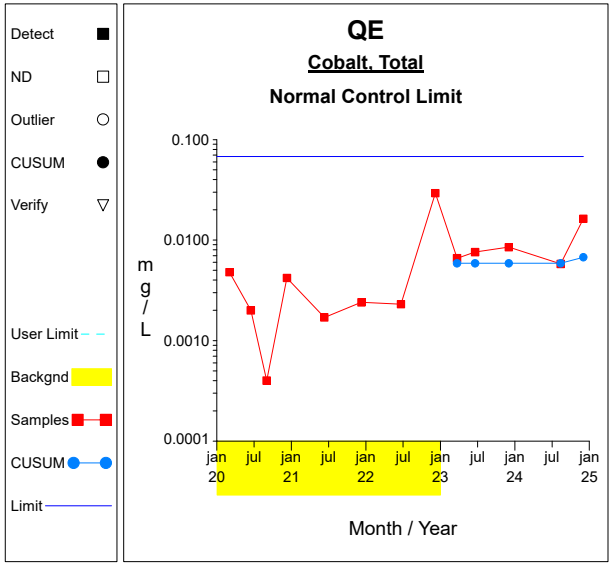
Intra-Well Control Charts / Prediction Limits



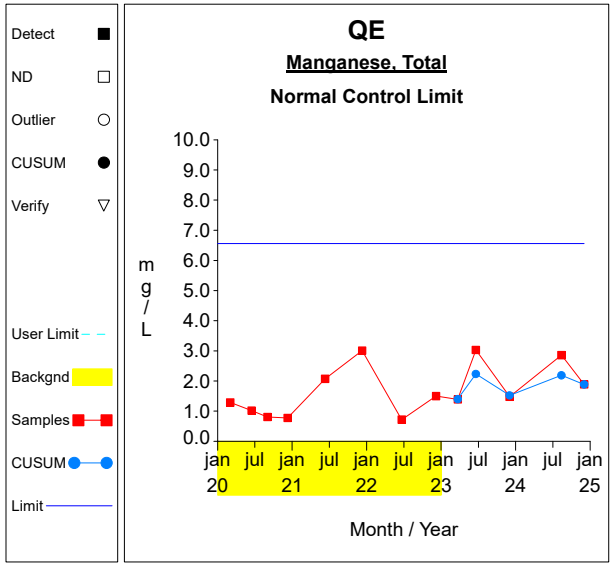
Graph 1



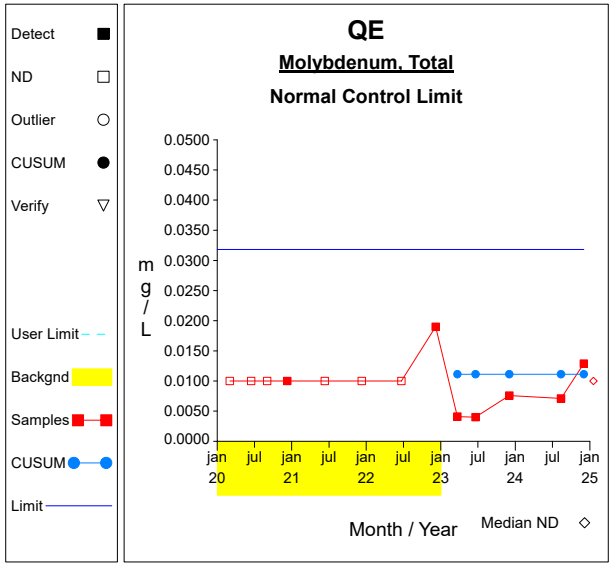
Graph 2



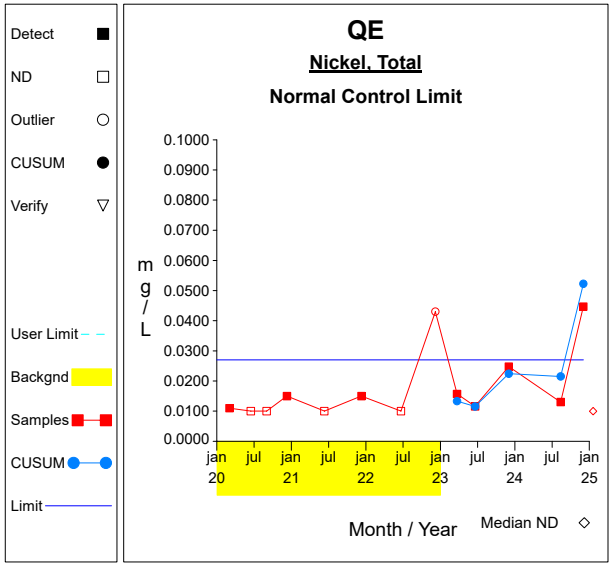
Graph 3



Graph 4



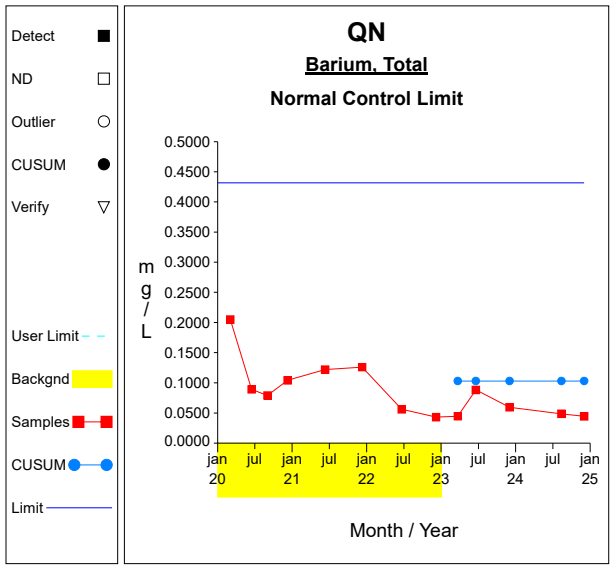
Graph 5



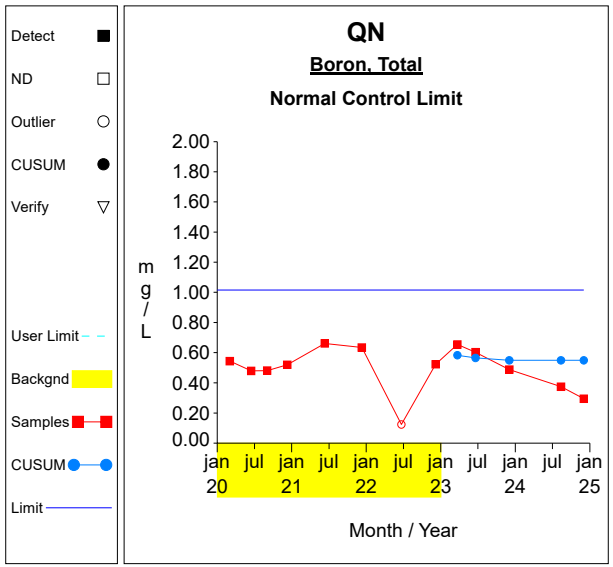
Graph 6

Prepared by: Otter Creek Environmental

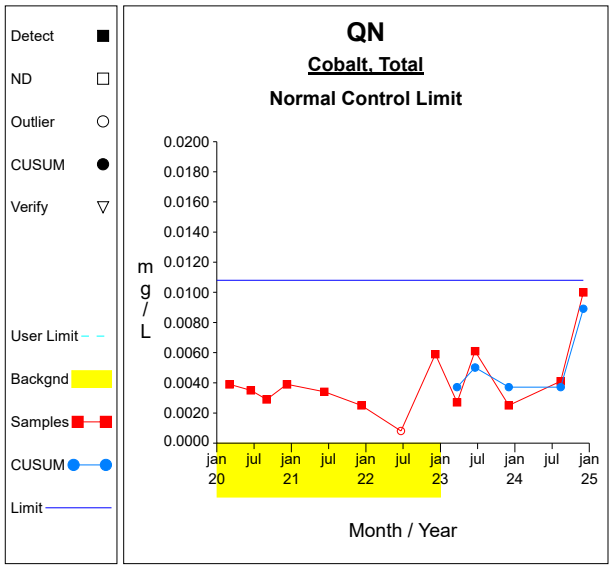
Intra-Well Control Charts / Prediction Limits



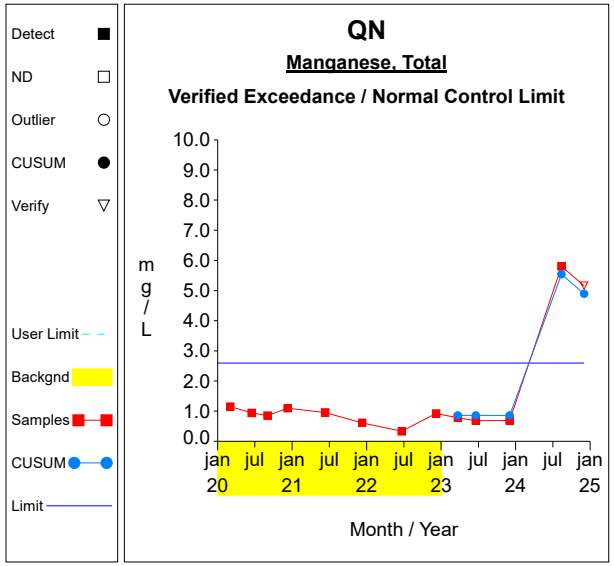
Graph 7



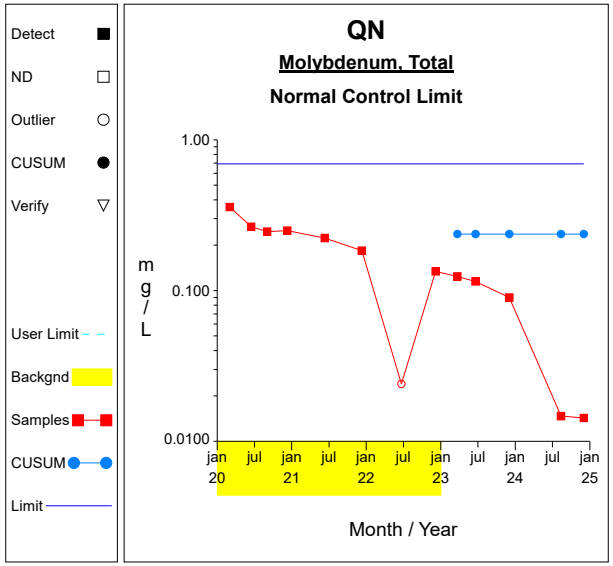
Graph 8



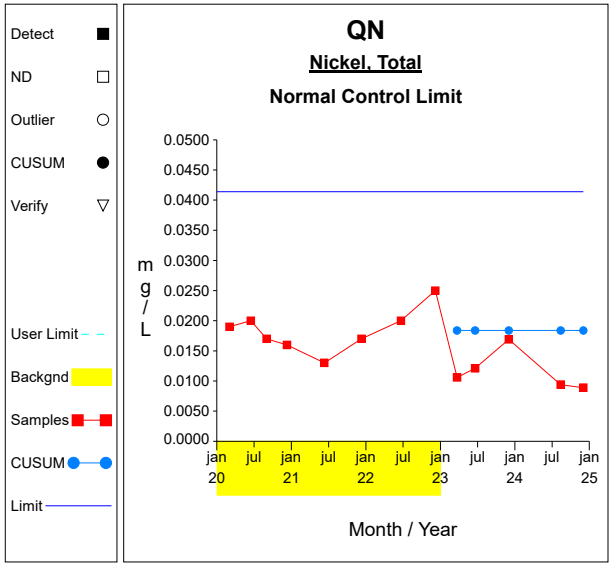
Graph 9



Graph 10



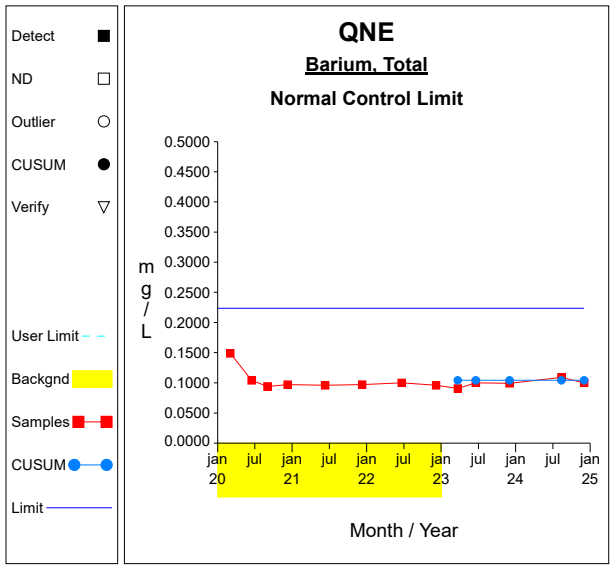
Graph 11



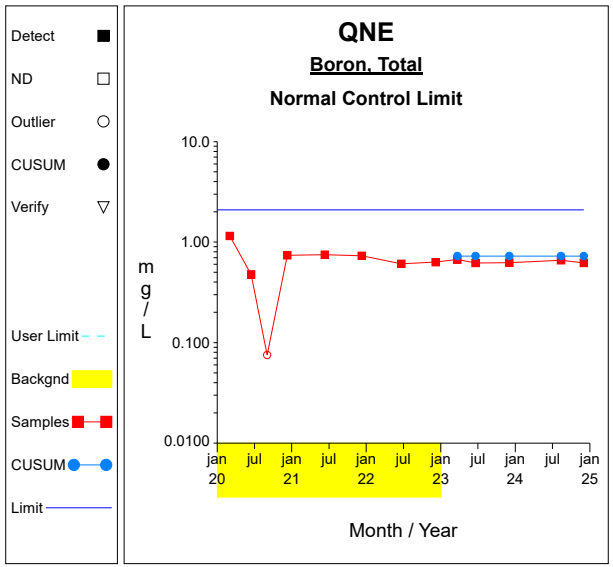
Graph 12

Prepared by: Otter Creek Environmental

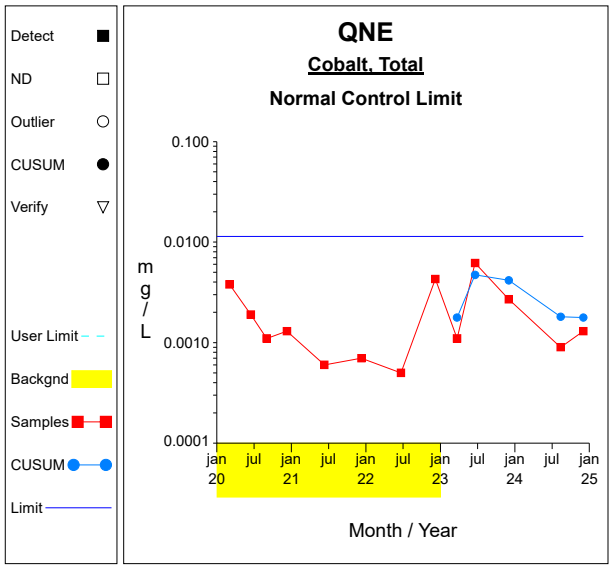
Intra-Well Control Charts / Prediction Limits



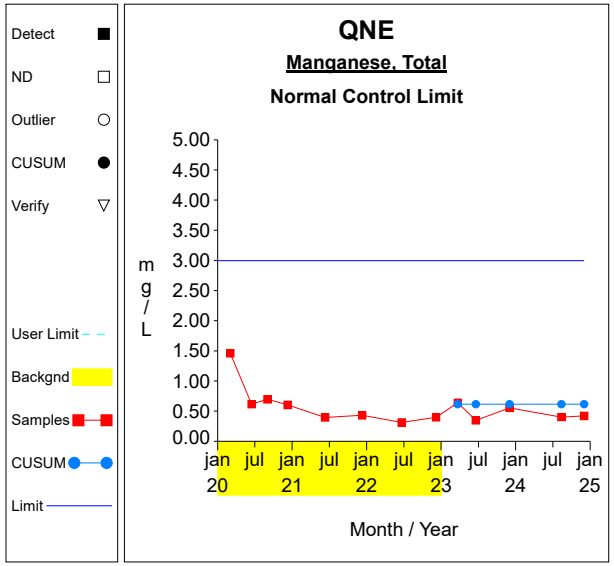
Graph 13



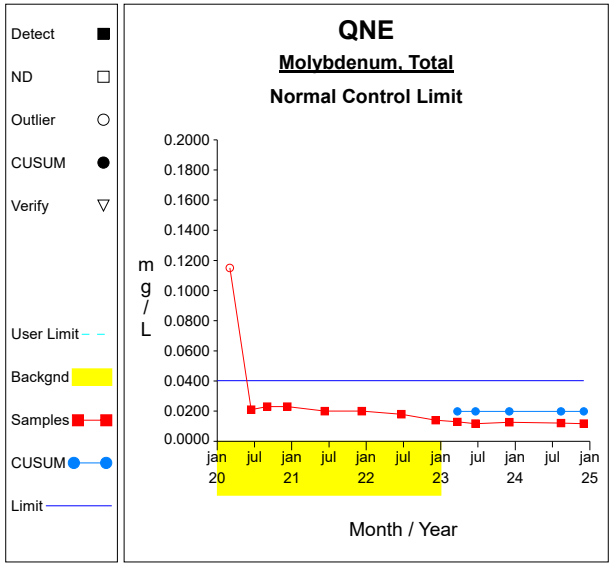
Graph 14



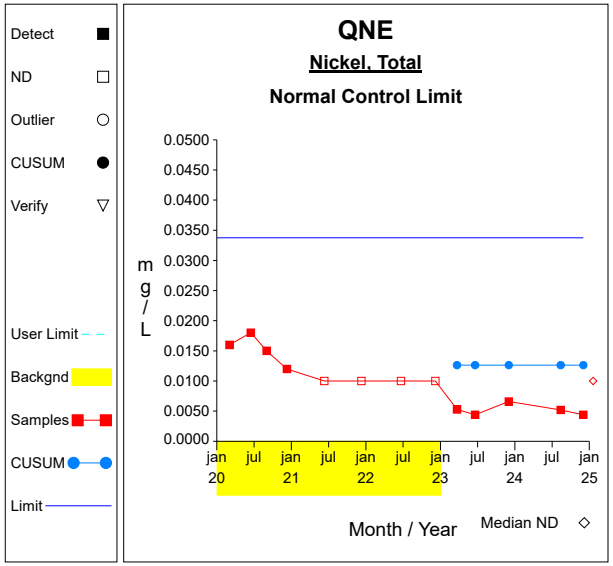
Graph 15



Graph 16



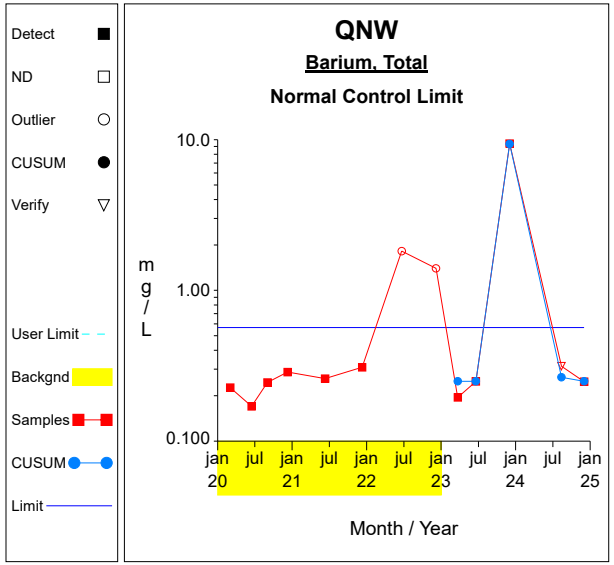
Graph 17



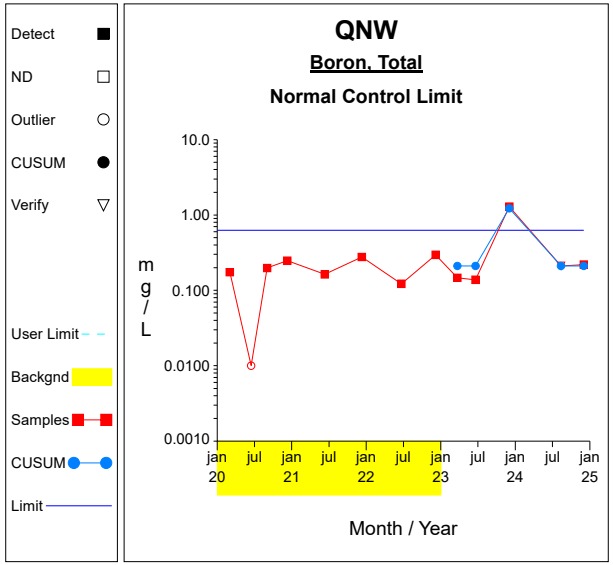
Graph 18

Prepared by: Otter Creek Environmental

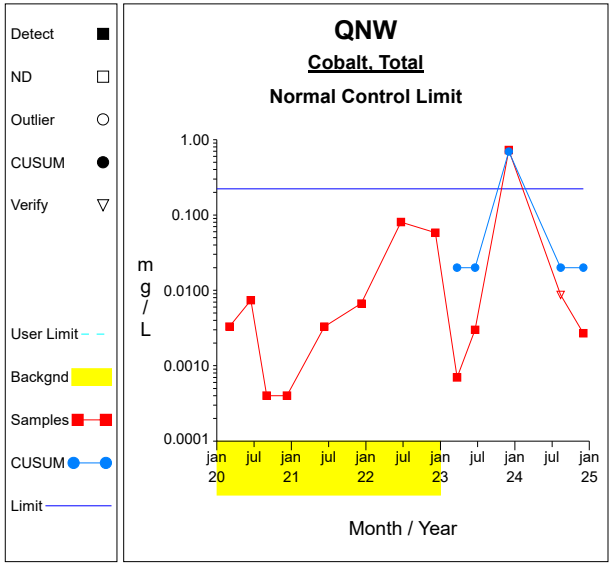
Intra-Well Control Charts / Prediction Limits



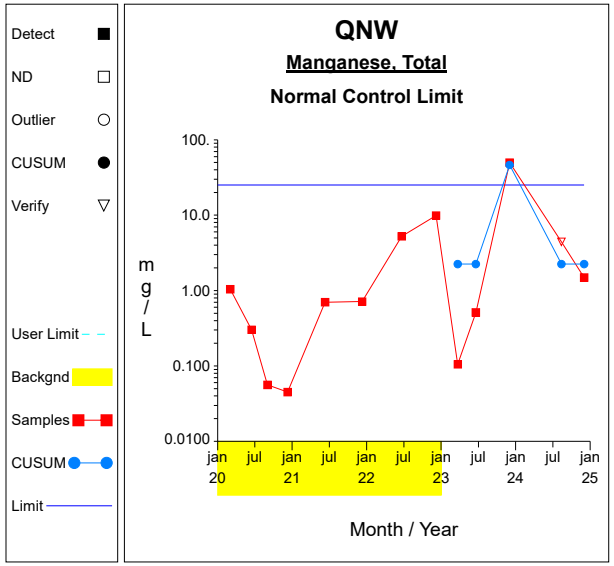
Graph 19



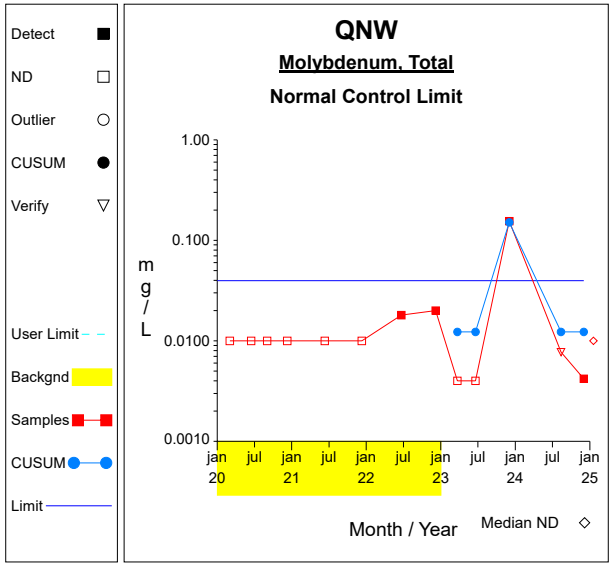
Graph 20



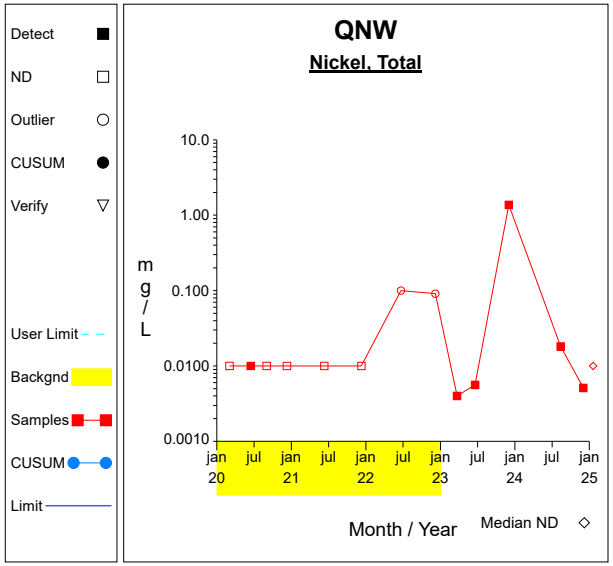
Graph 21



Graph 22



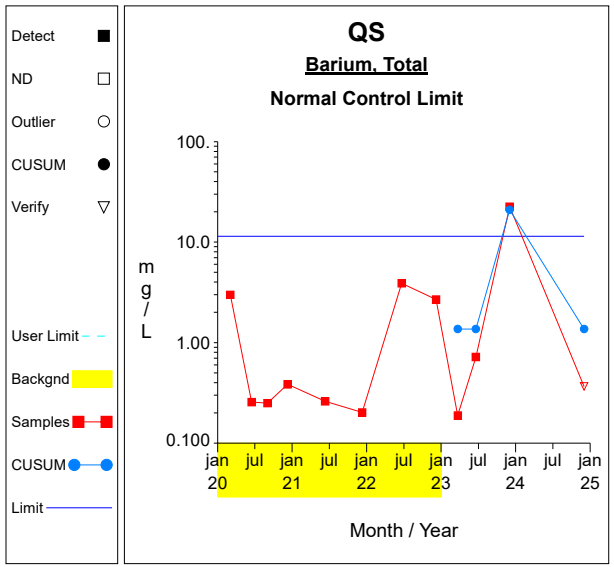
Graph 23



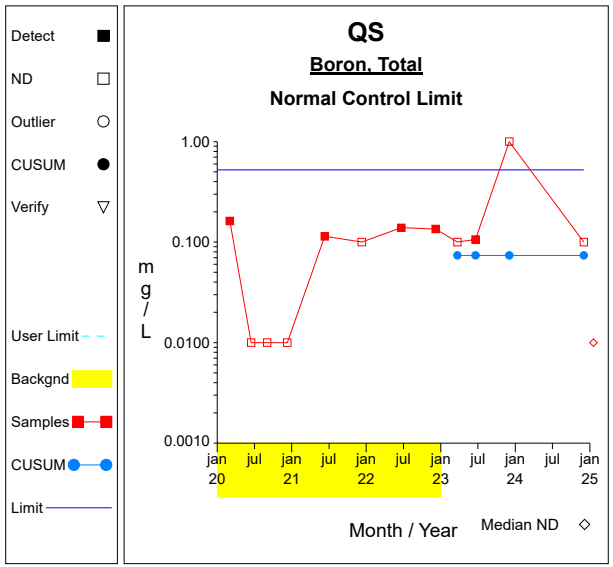
Graph 24

Prepared by: Otter Creek Environmental

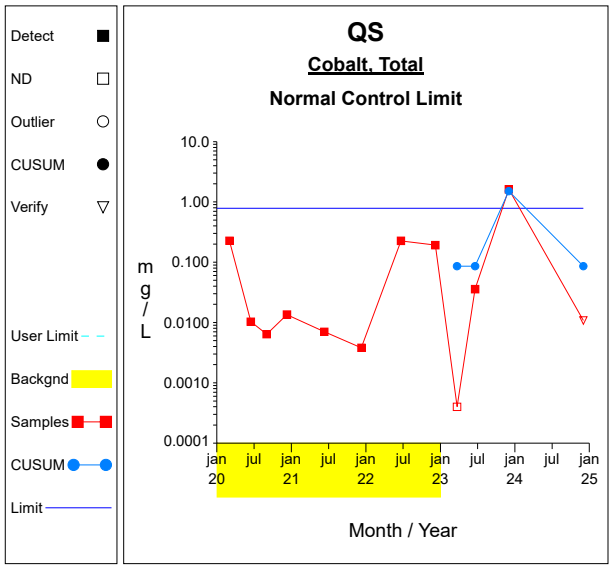
Intra-Well Control Charts / Prediction Limits



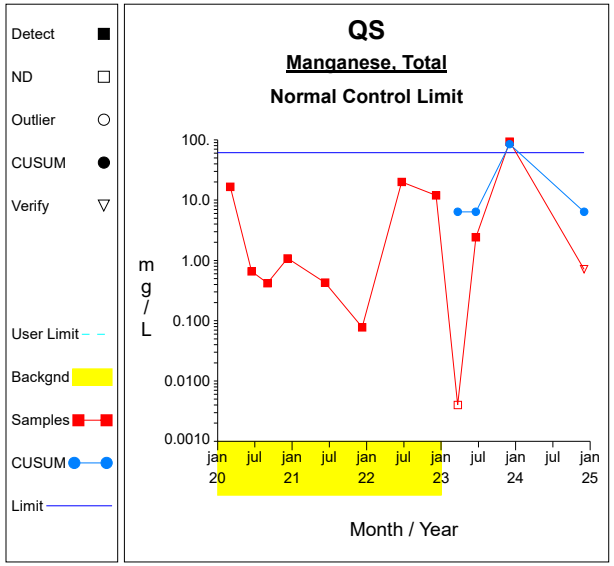
Graph 25



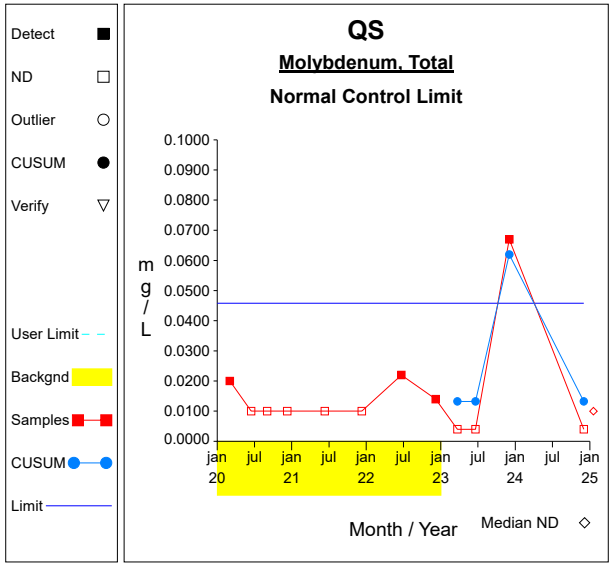
Graph 26



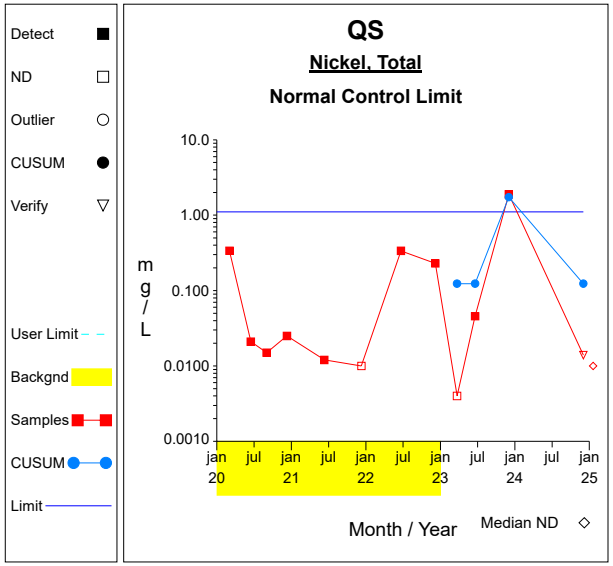
Graph 27



Graph 28



Graph 29



Graph 30

Prepared by: Otter Creek Environmental

False Positive and False Negative Rates for Current Intra-Well Control Charts Monitoring Program

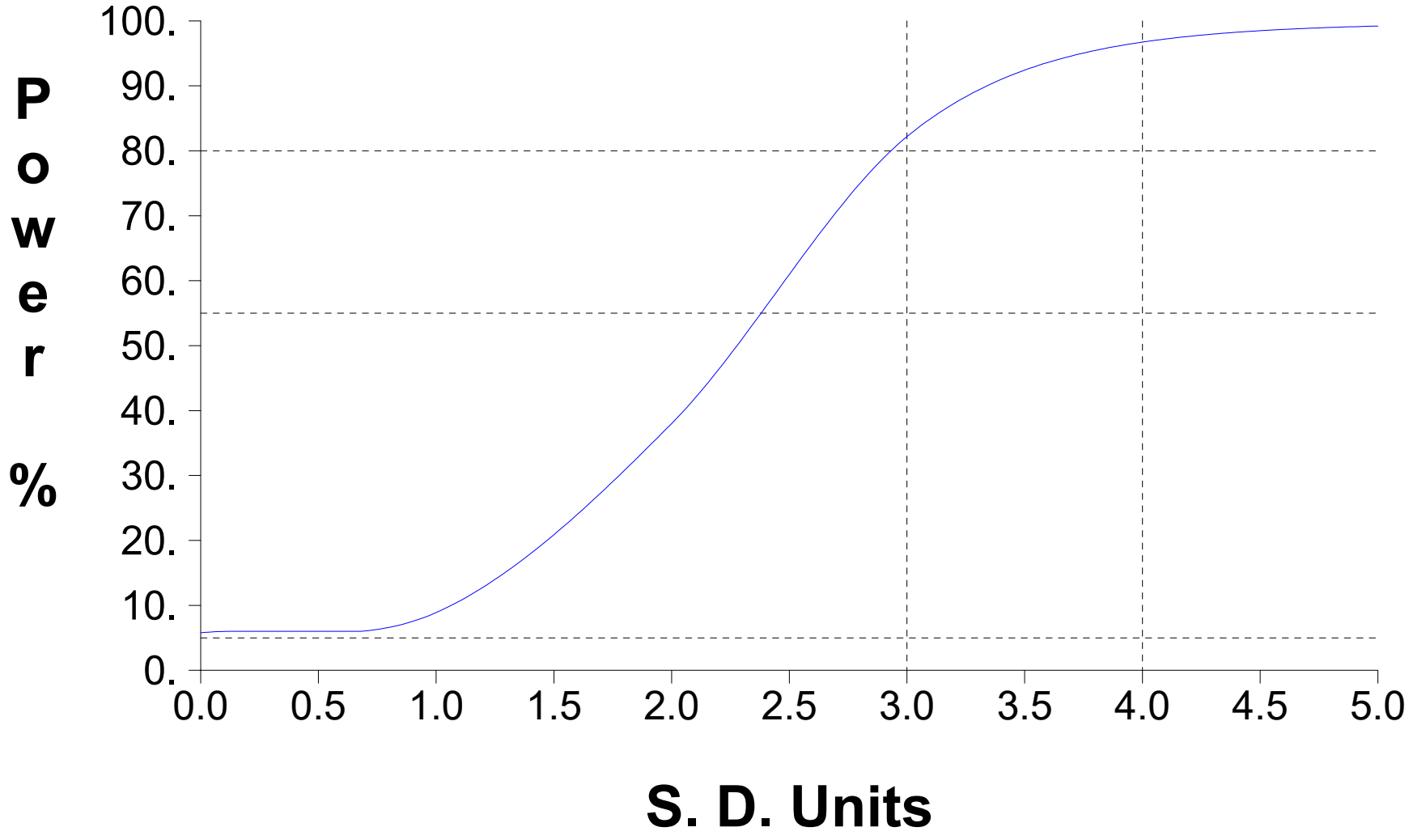


Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Barium, Total	mg/L	QE	03/01/2020	yes	0.1200					
Barium, Total	mg/L	QE	06/15/2020	yes	0.1140					
Barium, Total	mg/L	QE	09/01/2020	yes	0.0630					
Barium, Total	mg/L	QE	12/09/2020	yes	0.0520					
Barium, Total	mg/L	QE	06/10/2021	yes	0.0065		yes			*
Barium, Total	mg/L	QE	12/09/2021	yes	0.0770					
Barium, Total	mg/L	QE	06/21/2022	yes	0.0690					
Barium, Total	mg/L	QE	12/06/2022	yes	0.1520					
Barium, Total	mg/L	QE	03/22/2023		0.0637			0.0924		
Barium, Total	mg/L	QE	06/19/2023		0.0778			0.0924		
Barium, Total	mg/L	QE	12/01/2023		0.0716			0.0924		
Barium, Total	mg/L	QE	08/12/2024		0.0659			0.0924		
Barium, Total	mg/L	QE	12/01/2024		0.0784			0.0924		
Boron, Total	mg/L	QE	03/01/2020	yes	0.2930					
Boron, Total	mg/L	QE	06/15/2020	yes	0.1850					
Boron, Total	mg/L	QE	09/01/2020	yes	0.5240					
Boron, Total	mg/L	QE	12/09/2020	yes	0.5230					
Boron, Total	mg/L	QE	06/10/2021	yes	0.5040					
Boron, Total	mg/L	QE	12/09/2021	yes	0.4890					
Boron, Total	mg/L	QE	06/21/2022	yes	0.1000	ND				
Boron, Total	mg/L	QE	12/06/2022	yes	0.6450					
Boron, Total	mg/L	QE	03/22/2023		0.1670			0.4079		
Boron, Total	mg/L	QE	06/19/2023		0.3850			0.4079		
Boron, Total	mg/L	QE	12/01/2023		0.6290			0.4376		
Boron, Total	mg/L	QE	08/12/2024		0.5770			0.4153		
Boron, Total	mg/L	QE	12/01/2024		0.6290			0.4450		
Cobalt, Total	mg/L	QE	03/01/2020	yes	0.0048					
Cobalt, Total	mg/L	QE	06/15/2020	yes	0.0020					
Cobalt, Total	mg/L	QE	09/01/2020	yes	0.0004					
Cobalt, Total	mg/L	QE	12/09/2020	yes	0.0042					
Cobalt, Total	mg/L	QE	06/10/2021	yes	0.0017					
Cobalt, Total	mg/L	QE	12/09/2021	yes	0.0024					
Cobalt, Total	mg/L	QE	06/21/2022	yes	0.0023					
Cobalt, Total	mg/L	QE	12/06/2022	yes	0.0293					
Cobalt, Total	mg/L	QE	03/22/2023		0.0066			0.0059		
Cobalt, Total	mg/L	QE	06/19/2023		0.0076			0.0059		
Cobalt, Total	mg/L	QE	12/01/2023		0.0085			0.0059		
Cobalt, Total	mg/L	QE	08/12/2024		0.0058			0.0059		
Cobalt, Total	mg/L	QE	12/01/2024		0.0163			0.0067		
Manganese, Total	mg/L	QE	03/01/2020	yes	1.2900					
Manganese, Total	mg/L	QE	06/15/2020	yes	1.0200					
Manganese, Total	mg/L	QE	09/01/2020	yes	0.8080					
Manganese, Total	mg/L	QE	12/09/2020	yes	0.7760					
Manganese, Total	mg/L	QE	06/10/2021	yes	2.0700					
Manganese, Total	mg/L	QE	12/09/2021	yes	3.0100					
Manganese, Total	mg/L	QE	06/21/2022	yes	0.7190					
Manganese, Total	mg/L	QE	12/06/2022	yes	1.5000					
Manganese, Total	mg/L	QE	03/22/2023		1.3900			1.3991		
Manganese, Total	mg/L	QE	06/19/2023		3.0300			2.2362		
Manganese, Total	mg/L	QE	12/01/2023		1.4800			1.5232		

* - Outlier for that well and constituent.
** - Non-outlier detected sample Result and / or CUSUM value exceeds limit.
*** - ND value replaced with median RL.
**** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Manganese, Total	mg/L	QE	08/12/2024		2.8600			2.1903		
Manganese, Total	mg/L	QE	12/01/2024		1.8900			1.8873		
Molybdenum, Total	mg/L	QE	03/01/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	06/15/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	09/01/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	12/09/2020	yes	0.0100					
Molybdenum, Total	mg/L	QE	06/10/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	12/09/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	06/21/2022	yes	0.0100	ND				
Molybdenum, Total	mg/L	QE	12/06/2022	yes	0.0190					
Molybdenum, Total	mg/L	QE	03/22/2023		0.0041			0.0111		
Molybdenum, Total	mg/L	QE	06/19/2023		0.0040			0.0111		
Molybdenum, Total	mg/L	QE	12/01/2023		0.0076			0.0111		
Molybdenum, Total	mg/L	QE	08/12/2024		0.0071			0.0111		
Molybdenum, Total	mg/L	QE	12/01/2024		0.0129			0.0111		
Nickel, Total	mg/L	QE	03/01/2020	yes	0.0110					
Nickel, Total	mg/L	QE	06/15/2020	yes	0.0100	ND				
Nickel, Total	mg/L	QE	09/01/2020	yes	0.0100	ND				
Nickel, Total	mg/L	QE	12/09/2020	yes	0.0150					
Nickel, Total	mg/L	QE	06/10/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QE	12/09/2021	yes	0.0150					
Nickel, Total	mg/L	QE	06/21/2022	yes	0.0100	ND				
Nickel, Total	mg/L	QE	12/06/2022	yes	0.0430		yes			*
Nickel, Total	mg/L	QE	03/22/2023		0.0157			0.0133		
Nickel, Total	mg/L	QE	06/19/2023		0.0116			0.0116		
Nickel, Total	mg/L	QE	12/01/2023		0.0248			0.0224		
Nickel, Total	mg/L	QE	08/12/2024		0.0130			0.0215		
Nickel, Total	mg/L	QE	12/01/2024		0.0447			0.0522		**
Barium, Total	mg/L	QN	03/01/2020	yes	0.2050					
Barium, Total	mg/L	QN	06/15/2020	yes	0.0890					
Barium, Total	mg/L	QN	09/01/2020	yes	0.0790					
Barium, Total	mg/L	QN	12/09/2020	yes	0.1040					
Barium, Total	mg/L	QN	06/10/2021	yes	0.1220					
Barium, Total	mg/L	QN	12/09/2021	yes	0.1260					
Barium, Total	mg/L	QN	06/21/2022	yes	0.0560					
Barium, Total	mg/L	QN	12/06/2022	yes	0.0430					
Barium, Total	mg/L	QN	03/22/2023		0.0445			0.1030		
Barium, Total	mg/L	QN	06/19/2023		0.0881			0.1030		
Barium, Total	mg/L	QN	12/01/2023		0.0594			0.1030		
Barium, Total	mg/L	QN	08/12/2024		0.0486			0.1030		
Barium, Total	mg/L	QN	12/01/2024		0.0444			0.1030		
Boron, Total	mg/L	QN	03/01/2020	yes	0.5440					
Boron, Total	mg/L	QN	06/15/2020	yes	0.4790					
Boron, Total	mg/L	QN	09/01/2020	yes	0.4810					
Boron, Total	mg/L	QN	12/09/2020	yes	0.5200					
Boron, Total	mg/L	QN	06/10/2021	yes	0.6610					
Boron, Total	mg/L	QN	12/09/2021	yes	0.6340					
Boron, Total	mg/L	QN	06/21/2022	yes	0.1240		yes			*
Boron, Total	mg/L	QN	12/06/2022	yes	0.5230					
Boron, Total	mg/L	QN	03/22/2023		0.6540			0.5823		

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Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Boron, Total	mg/L	QN	06/19/2023		0.6030			0.5648		
Boron, Total	mg/L	QN	12/01/2023		0.4880			0.5489		
Boron, Total	mg/L	QN	08/12/2024		0.3740			0.5489		
Boron, Total	mg/L	QN	12/01/2024		0.2940			0.5489		
Cobalt, Total	mg/L	QN	03/01/2020	yes	0.0039					
Cobalt, Total	mg/L	QN	06/15/2020	yes	0.0035					
Cobalt, Total	mg/L	QN	09/01/2020	yes	0.0029					
Cobalt, Total	mg/L	QN	12/09/2020	yes	0.0039					
Cobalt, Total	mg/L	QN	06/10/2021	yes	0.0034					
Cobalt, Total	mg/L	QN	12/09/2021	yes	0.0025					
Cobalt, Total	mg/L	QN	06/21/2022	yes	0.0008		yes			*
Cobalt, Total	mg/L	QN	12/06/2022	yes	0.0059					
Cobalt, Total	mg/L	QN	03/22/2023		0.0027			0.0037		
Cobalt, Total	mg/L	QN	06/19/2023		0.0061			0.0050		
Cobalt, Total	mg/L	QN	12/01/2023		0.0025			0.0037		
Cobalt, Total	mg/L	QN	08/12/2024		0.0041			0.0037		
Cobalt, Total	mg/L	QN	12/01/2024		0.0100			0.0089		
Manganese, Total	mg/L	QN	03/01/2020	yes	1.1500					
Manganese, Total	mg/L	QN	06/15/2020	yes	0.9450					
Manganese, Total	mg/L	QN	09/01/2020	yes	0.8570					
Manganese, Total	mg/L	QN	12/09/2020	yes	1.1000					
Manganese, Total	mg/L	QN	06/10/2021	yes	0.9550					
Manganese, Total	mg/L	QN	12/09/2021	yes	0.6140					
Manganese, Total	mg/L	QN	06/21/2022	yes	0.3330					
Manganese, Total	mg/L	QN	12/06/2022	yes	0.9220					
Manganese, Total	mg/L	QN	03/22/2023		0.7820			0.8595		
Manganese, Total	mg/L	QN	06/19/2023		0.6890			0.8595		
Manganese, Total	mg/L	QN	12/01/2023		0.6910			0.8595		
Manganese, Total	mg/L	QN	08/12/2024		5.8100			5.5427		**
Manganese, Total	mg/L	QN	12/01/2024		5.1600			4.8927		**
Molybdenum, Total	mg/L	QN	03/01/2020	yes	0.3580					
Molybdenum, Total	mg/L	QN	06/15/2020	yes	0.2650					
Molybdenum, Total	mg/L	QN	09/01/2020	yes	0.2460					
Molybdenum, Total	mg/L	QN	12/09/2020	yes	0.2500					
Molybdenum, Total	mg/L	QN	06/10/2021	yes	0.2230					
Molybdenum, Total	mg/L	QN	12/09/2021	yes	0.1840					
Molybdenum, Total	mg/L	QN	06/21/2022	yes	0.0240		yes			*
Molybdenum, Total	mg/L	QN	12/06/2022	yes	0.1340					
Molybdenum, Total	mg/L	QN	03/22/2023		0.1240			0.2371		
Molybdenum, Total	mg/L	QN	06/19/2023		0.1150			0.2371		
Molybdenum, Total	mg/L	QN	12/01/2023		0.0900			0.2371		
Molybdenum, Total	mg/L	QN	08/12/2024		0.0147			0.2371		
Molybdenum, Total	mg/L	QN	12/01/2024		0.0143			0.2371		
Nickel, Total	mg/L	QN	03/01/2020	yes	0.0190					
Nickel, Total	mg/L	QN	06/15/2020	yes	0.0200					
Nickel, Total	mg/L	QN	09/01/2020	yes	0.0170					
Nickel, Total	mg/L	QN	12/09/2020	yes	0.0160					
Nickel, Total	mg/L	QN	06/10/2021	yes	0.0130					
Nickel, Total	mg/L	QN	12/09/2021	yes	0.0170					
Nickel, Total	mg/L	QN	06/21/2022	yes	0.0200					

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Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Nickel, Total	mg/L	QN	12/06/2022	yes	0.0250					
Nickel, Total	mg/L	QN	03/22/2023		0.0106			0.0184		
Nickel, Total	mg/L	QN	06/19/2023		0.0121			0.0184		
Nickel, Total	mg/L	QN	12/01/2023		0.0169			0.0184		
Nickel, Total	mg/L	QN	08/12/2024		0.0094			0.0184		
Nickel, Total	mg/L	QN	12/01/2024		0.0089			0.0184		
Barium, Total	mg/L	QNE	03/01/2020	yes	0.1490					
Barium, Total	mg/L	QNE	06/15/2020	yes	0.1040					
Barium, Total	mg/L	QNE	09/01/2020	yes	0.0940					
Barium, Total	mg/L	QNE	12/09/2020	yes	0.0970					
Barium, Total	mg/L	QNE	06/10/2021	yes	0.0960					
Barium, Total	mg/L	QNE	12/09/2021	yes	0.0970					
Barium, Total	mg/L	QNE	06/21/2022	yes	0.1000					
Barium, Total	mg/L	QNE	12/06/2022	yes	0.0960					
Barium, Total	mg/L	QNE	03/22/2023		0.0907			0.1041		
Barium, Total	mg/L	QNE	06/19/2023		0.1000			0.1041		
Barium, Total	mg/L	QNE	12/01/2023		0.0992			0.1041		
Barium, Total	mg/L	QNE	08/12/2024		0.1090			0.1041		
Barium, Total	mg/L	QNE	12/01/2024		0.1000			0.1041		
Boron, Total	mg/L	QNE	03/01/2020	yes	1.1500					
Boron, Total	mg/L	QNE	06/15/2020	yes	0.4760					
Boron, Total	mg/L	QNE	09/01/2020	yes	0.0752		yes			*
Boron, Total	mg/L	QNE	12/09/2020	yes	0.7390					
Boron, Total	mg/L	QNE	06/10/2021	yes	0.7490					
Boron, Total	mg/L	QNE	12/09/2021	yes	0.7300					
Boron, Total	mg/L	QNE	06/21/2022	yes	0.6080					
Boron, Total	mg/L	QNE	12/06/2022	yes	0.6320					
Boron, Total	mg/L	QNE	03/22/2023		0.6710			0.7263		
Boron, Total	mg/L	QNE	06/19/2023		0.6200			0.7263		
Boron, Total	mg/L	QNE	12/01/2023		0.6250			0.7263		
Boron, Total	mg/L	QNE	08/12/2024		0.6600			0.7263		
Boron, Total	mg/L	QNE	12/01/2024		0.6220			0.7263		
Cobalt, Total	mg/L	QNE	03/01/2020	yes	0.0038					
Cobalt, Total	mg/L	QNE	06/15/2020	yes	0.0019					
Cobalt, Total	mg/L	QNE	09/01/2020	yes	0.0011					
Cobalt, Total	mg/L	QNE	12/09/2020	yes	0.0013					
Cobalt, Total	mg/L	QNE	06/10/2021	yes	0.0006					
Cobalt, Total	mg/L	QNE	12/09/2021	yes	0.0007					
Cobalt, Total	mg/L	QNE	06/21/2022	yes	0.0005					
Cobalt, Total	mg/L	QNE	12/06/2022	yes	0.0043					
Cobalt, Total	mg/L	QNE	03/22/2023		0.0011			0.0018		
Cobalt, Total	mg/L	QNE	06/19/2023		0.0062			0.0047		
Cobalt, Total	mg/L	QNE	12/01/2023		0.0027			0.0042		
Cobalt, Total	mg/L	QNE	08/12/2024		0.0009			0.0018		
Cobalt, Total	mg/L	QNE	12/01/2024		0.0013			0.0018		
Manganese, Total	mg/L	QNE	03/01/2020	yes	1.4600					
Manganese, Total	mg/L	QNE	06/15/2020	yes	0.6160					
Manganese, Total	mg/L	QNE	09/01/2020	yes	0.6980					
Manganese, Total	mg/L	QNE	12/09/2020	yes	0.6040					
Manganese, Total	mg/L	QNE	06/10/2021	yes	0.3970					

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Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Manganese, Total	mg/L	QNE	12/09/2021	yes	0.4310					
Manganese, Total	mg/L	QNE	06/21/2022	yes	0.3130					
Manganese, Total	mg/L	QNE	12/06/2022	yes	0.3990					
Manganese, Total	mg/L	QNE	03/22/2023		0.6390			0.6148		
Manganese, Total	mg/L	QNE	06/19/2023		0.3470			0.6148		
Manganese, Total	mg/L	QNE	12/01/2023		0.5550			0.6148		
Manganese, Total	mg/L	QNE	08/12/2024		0.4020			0.6148		
Manganese, Total	mg/L	QNE	12/01/2024		0.4210			0.6148		
Molybdenum, Total	mg/L	QNE	03/01/2020	yes	0.1150		yes			*
Molybdenum, Total	mg/L	QNE	06/15/2020	yes	0.0210					
Molybdenum, Total	mg/L	QNE	09/01/2020	yes	0.0230					
Molybdenum, Total	mg/L	QNE	12/09/2020	yes	0.0230					
Molybdenum, Total	mg/L	QNE	06/10/2021	yes	0.0200					
Molybdenum, Total	mg/L	QNE	12/09/2021	yes	0.0200					
Molybdenum, Total	mg/L	QNE	06/21/2022	yes	0.0180					
Molybdenum, Total	mg/L	QNE	12/06/2022	yes	0.0140					
Molybdenum, Total	mg/L	QNE	03/22/2023		0.0129			0.0199		
Molybdenum, Total	mg/L	QNE	06/19/2023		0.0117			0.0199		
Molybdenum, Total	mg/L	QNE	12/01/2023		0.0127			0.0199		
Molybdenum, Total	mg/L	QNE	08/12/2024		0.0121			0.0199		
Molybdenum, Total	mg/L	QNE	12/01/2024		0.0117			0.0199		
Nickel, Total	mg/L	QNE	03/01/2020	yes	0.0160					
Nickel, Total	mg/L	QNE	06/15/2020	yes	0.0180					
Nickel, Total	mg/L	QNE	09/01/2020	yes	0.0150					
Nickel, Total	mg/L	QNE	12/09/2020	yes	0.0120					
Nickel, Total	mg/L	QNE	06/10/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QNE	12/09/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QNE	06/21/2022	yes	0.0100	ND				
Nickel, Total	mg/L	QNE	12/06/2022	yes	0.0100	ND				
Nickel, Total	mg/L	QNE	03/22/2023		0.0053			0.0126		
Nickel, Total	mg/L	QNE	06/19/2023		0.0044			0.0126		
Nickel, Total	mg/L	QNE	12/01/2023		0.0066			0.0126		
Nickel, Total	mg/L	QNE	08/12/2024		0.0052			0.0126		
Nickel, Total	mg/L	QNE	12/01/2024		0.0044			0.0126		
Barium, Total	mg/L	QNW	03/01/2020	yes	0.2260					
Barium, Total	mg/L	QNW	06/15/2020	yes	0.1700					
Barium, Total	mg/L	QNW	09/01/2020	yes	0.2450					
Barium, Total	mg/L	QNW	12/09/2020	yes	0.2870					
Barium, Total	mg/L	QNW	06/10/2021	yes	0.2600					
Barium, Total	mg/L	QNW	12/09/2021	yes	0.3090					
Barium, Total	mg/L	QNW	06/21/2022	yes	1.8200		yes			*
Barium, Total	mg/L	QNW	12/06/2022	yes	1.4000		yes			*
Barium, Total	mg/L	QNW	03/22/2023		0.1950			0.2495		
Barium, Total	mg/L	QNW	06/19/2023		0.2490			0.2495		
Barium, Total	mg/L	QNW	12/01/2023		9.4100			9.3611		**
Barium, Total	mg/L	QNW	08/12/2024		0.3140			0.2651		
Barium, Total	mg/L	QNW	12/01/2024		0.2480			0.2495		
Boron, Total	mg/L	QNW	03/01/2020	yes	0.1740					
Boron, Total	mg/L	QNW	06/15/2020	yes	0.0100	ND	yes			*
Boron, Total	mg/L	QNW	09/01/2020	yes	0.1980					

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Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Boron, Total	mg/L	QNW	12/09/2020	yes	0.2470					
Boron, Total	mg/L	QNW	06/10/2021	yes	0.1630					
Boron, Total	mg/L	QNW	12/09/2021	yes	0.2770					
Boron, Total	mg/L	QNW	06/21/2022	yes	0.1220					
Boron, Total	mg/L	QNW	12/06/2022	yes	0.2960					
Boron, Total	mg/L	QNW	03/22/2023		0.1470			0.2110		
Boron, Total	mg/L	QNW	06/19/2023		0.1380			0.2110		
Boron, Total	mg/L	QNW	12/01/2023		1.2900			1.2259		**
Boron, Total	mg/L	QNW	08/12/2024		0.2110			0.2110		
Boron, Total	mg/L	QNW	12/01/2024		0.2200			0.2110		
Cobalt, Total	mg/L	QNW	03/01/2020	yes	0.0033					
Cobalt, Total	mg/L	QNW	06/15/2020	yes	0.0074					
Cobalt, Total	mg/L	QNW	09/01/2020	yes	0.0004					
Cobalt, Total	mg/L	QNW	12/09/2020	yes	0.0004					
Cobalt, Total	mg/L	QNW	06/10/2021	yes	0.0033					
Cobalt, Total	mg/L	QNW	12/09/2021	yes	0.0067					
Cobalt, Total	mg/L	QNW	06/21/2022	yes	0.0804					
Cobalt, Total	mg/L	QNW	12/06/2022	yes	0.0581					
Cobalt, Total	mg/L	QNW	03/22/2023		0.0007			0.0200		
Cobalt, Total	mg/L	QNW	06/19/2023		0.0030			0.0200		
Cobalt, Total	mg/L	QNW	12/01/2023		0.7270			0.6959		**
Cobalt, Total	mg/L	QNW	08/12/2024		0.0087			0.0200		
Cobalt, Total	mg/L	QNW	12/01/2024		0.0027			0.0200		
Manganese, Total	mg/L	QNW	03/01/2020	yes	1.0400					
Manganese, Total	mg/L	QNW	06/15/2020	yes	0.3020					
Manganese, Total	mg/L	QNW	09/01/2020	yes	0.0560					
Manganese, Total	mg/L	QNW	12/09/2020	yes	0.0450					
Manganese, Total	mg/L	QNW	06/10/2021	yes	0.7010					
Manganese, Total	mg/L	QNW	12/09/2021	yes	0.7140					
Manganese, Total	mg/L	QNW	06/21/2022	yes	5.2400					
Manganese, Total	mg/L	QNW	12/06/2022	yes	9.8800					
Manganese, Total	mg/L	QNW	03/22/2023		0.1050			2.2473		
Manganese, Total	mg/L	QNW	06/19/2023		0.5120			2.2473		
Manganese, Total	mg/L	QNW	12/01/2023		49.9000			46.3776		**
Manganese, Total	mg/L	QNW	08/12/2024		4.4200			2.2473		
Manganese, Total	mg/L	QNW	12/01/2024		1.4900			2.2473		
Molybdenum, Total	mg/L	QNW	03/01/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	06/15/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	09/01/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	12/09/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	06/10/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	12/09/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QNW	06/21/2022	yes	0.0180					
Molybdenum, Total	mg/L	QNW	12/06/2022	yes	0.0200					
Molybdenum, Total	mg/L	QNW	03/22/2023		0.0040	ND		0.0123		
Molybdenum, Total	mg/L	QNW	06/19/2023		0.0040	ND		0.0123		
Molybdenum, Total	mg/L	QNW	12/01/2023		0.1550			0.1508		**
Molybdenum, Total	mg/L	QNW	08/12/2024		0.0077			0.0123		
Molybdenum, Total	mg/L	QNW	12/01/2024		0.0042			0.0123		
Nickel, Total	mg/L	QNW	03/01/2020	yes	0.0100	ND				

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Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Nickel, Total	mg/L	QNW	06/15/2020	yes	0.0100					
Nickel, Total	mg/L	QNW	09/01/2020	yes	0.0100	ND				
Nickel, Total	mg/L	QNW	12/09/2020	yes	0.0100	ND				
Nickel, Total	mg/L	QNW	06/10/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QNW	12/09/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QNW	06/21/2022	yes	0.1000		yes			*
Nickel, Total	mg/L	QNW	12/06/2022	yes	0.0910		yes			*
Nickel, Total	mg/L	QNW	03/22/2023		0.0040					
Nickel, Total	mg/L	QNW	06/19/2023		0.0056					
Nickel, Total	mg/L	QNW	12/01/2023		1.3700					
Nickel, Total	mg/L	QNW	08/12/2024		0.0181					
Nickel, Total	mg/L	QNW	12/01/2024		0.0051					
Barium, Total	mg/L	QS	03/01/2020	yes	2.9900					
Barium, Total	mg/L	QS	06/15/2020	yes	0.2560					
Barium, Total	mg/L	QS	09/01/2020	yes	0.2500					
Barium, Total	mg/L	QS	12/09/2020	yes	0.3840					
Barium, Total	mg/L	QS	06/10/2021	yes	0.2610					
Barium, Total	mg/L	QS	12/09/2021	yes	0.2020					
Barium, Total	mg/L	QS	06/21/2022	yes	3.8900					
Barium, Total	mg/L	QS	12/06/2022	yes	2.6800					
Barium, Total	mg/L	QS	03/22/2023		0.1880			1.3641		
Barium, Total	mg/L	QS	06/19/2023		0.7190			1.3641		
Barium, Total	mg/L	QS	12/01/2023		22.5000			20.9530		**
Barium, Total	mg/L	QS	12/01/2024		0.3660			1.3641		
Boron, Total	mg/L	QS	03/01/2020	yes	0.1620					
Boron, Total	mg/L	QS	06/15/2020	yes	0.0100	ND				
Boron, Total	mg/L	QS	09/01/2020	yes	0.0100	ND				
Boron, Total	mg/L	QS	12/09/2020	yes	0.0100	ND				
Boron, Total	mg/L	QS	06/10/2021	yes	0.1140					
Boron, Total	mg/L	QS	12/09/2021	yes	0.1000	ND			0.0100	***
Boron, Total	mg/L	QS	06/21/2022	yes	0.1390					
Boron, Total	mg/L	QS	12/06/2022	yes	0.1350					
Boron, Total	mg/L	QS	03/22/2023		0.1000	ND		0.0738		
Boron, Total	mg/L	QS	06/19/2023		0.1060			0.0738		
Boron, Total	mg/L	QS	12/01/2023		1.0000	ND		0.0738		
Boron, Total	mg/L	QS	12/01/2024		0.1000	ND		0.0738		
Cobalt, Total	mg/L	QS	03/01/2020	yes	0.2270					
Cobalt, Total	mg/L	QS	06/15/2020	yes	0.0103					
Cobalt, Total	mg/L	QS	09/01/2020	yes	0.0064					
Cobalt, Total	mg/L	QS	12/09/2020	yes	0.0135					
Cobalt, Total	mg/L	QS	06/10/2021	yes	0.0070					
Cobalt, Total	mg/L	QS	12/09/2021	yes	0.0038					
Cobalt, Total	mg/L	QS	06/21/2022	yes	0.2260					
Cobalt, Total	mg/L	QS	12/06/2022	yes	0.1920					
Cobalt, Total	mg/L	QS	03/22/2023		0.0004	ND		0.0857		
Cobalt, Total	mg/L	QS	06/19/2023		0.0357			0.0857		
Cobalt, Total	mg/L	QS	12/01/2023		1.6200			1.5124		**
Cobalt, Total	mg/L	QS	12/01/2024		0.0108			0.0857		
Manganese, Total	mg/L	QS	03/01/2020	yes	16.6000					
Manganese, Total	mg/L	QS	06/15/2020	yes	0.6580					

* - Outlier for that well and constituent.
** - Non-outlier detected sample Result and / or CUSUM value exceeds limit.
*** - ND value replaced with median RL.
**** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 2

Analytical Data and CUSUM Summary

Constituent	Units	Well	Date	Background	Result		Outlier	CUSUM	Adjusted	
Manganese, Total	mg/L	QS	09/01/2020	yes	0.4190					
Manganese, Total	mg/L	QS	12/09/2020	yes	1.0800					
Manganese, Total	mg/L	QS	06/10/2021	yes	0.4290					
Manganese, Total	mg/L	QS	12/09/2021	yes	0.0780					
Manganese, Total	mg/L	QS	06/21/2022	yes	20.0000					
Manganese, Total	mg/L	QS	12/06/2022	yes	12.0000					
Manganese, Total	mg/L	QS	03/22/2023		0.0040	ND		6.4080		
Manganese, Total	mg/L	QS	06/19/2023		2.4200			6.4080		
Manganese, Total	mg/L	QS	12/01/2023		93.1000			84.7076		**
Manganese, Total	mg/L	QS	12/01/2024		0.7150			6.4080		
Molybdenum, Total	mg/L	QS	03/01/2020	yes	0.0200					
Molybdenum, Total	mg/L	QS	06/15/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QS	09/01/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QS	12/09/2020	yes	0.0100	ND				
Molybdenum, Total	mg/L	QS	06/10/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QS	12/09/2021	yes	0.0100	ND				
Molybdenum, Total	mg/L	QS	06/21/2022	yes	0.0220					
Molybdenum, Total	mg/L	QS	12/06/2022	yes	0.0140					
Molybdenum, Total	mg/L	QS	03/22/2023		0.0040	ND		0.0133		
Molybdenum, Total	mg/L	QS	06/19/2023		0.0040	ND		0.0133		
Molybdenum, Total	mg/L	QS	12/01/2023		0.0670			0.0620		**
Molybdenum, Total	mg/L	QS	12/01/2024		0.0040	ND		0.0133		
Nickel, Total	mg/L	QS	03/01/2020	yes	0.3380					
Nickel, Total	mg/L	QS	06/15/2020	yes	0.0210					
Nickel, Total	mg/L	QS	09/01/2020	yes	0.0150					
Nickel, Total	mg/L	QS	12/09/2020	yes	0.0250					
Nickel, Total	mg/L	QS	06/10/2021	yes	0.0120					
Nickel, Total	mg/L	QS	12/09/2021	yes	0.0100	ND				
Nickel, Total	mg/L	QS	06/21/2022	yes	0.3360					
Nickel, Total	mg/L	QS	12/06/2022	yes	0.2290					
Nickel, Total	mg/L	QS	03/22/2023		0.0040	ND		0.1233		
Nickel, Total	mg/L	QS	06/19/2023		0.0456			0.1233		
Nickel, Total	mg/L	QS	12/01/2023		1.8900			1.7390		**
Nickel, Total	mg/L	QS	12/01/2024		0.0139			0.1233		

* - Outlier for that well and constituent.
** - Non-outlier detected sample Result and / or CUSUM value exceeds limit.
*** - ND value replaced with median RL.
**** - ND value replaced with manual RL.
ND = Not detected, Result = detection limit.

Table 4

Dixon's Test Outliers
1% Significance Level

Constituent	Units	Well	Date	Result	ND Qualifier	Date Range	N	Critical Value
Barium, Total	mg/L	QE	06/10/2021	0.0065		03/01/2020-12/06/2022	8	0.6808
Nickel, Total	mg/L	QE	12/06/2022	0.0430		03/01/2020-12/06/2022	8	0.6808
Boron, Total	mg/L	QN	06/21/2022	0.1240		03/01/2020-12/06/2022	8	0.6808
Cobalt, Total	mg/L	QN	06/21/2022	0.0008		03/01/2020-12/06/2022	8	0.6808
Molybdenum, Total	mg/L	QN	06/21/2022	0.0240		03/01/2020-12/06/2022	8	0.6808
Boron, Total	mg/L	QNE	09/01/2020	0.0752		03/01/2020-12/06/2022	8	0.6808
Molybdenum, Total	mg/L	QNE	03/01/2020	0.1150		03/01/2020-12/06/2022	8	0.6808
Barium, Total	mg/L	QNW	06/21/2022	1.8200		03/01/2020-12/06/2022	8	0.6371
Barium, Total	mg/L	QNW	12/06/2022	1.4000		03/01/2020-12/06/2022	8	0.6371
Boron, Total	mg/L	QNW	06/15/2020	0.0100	< 0.0100	03/01/2020-12/06/2022	8	0.6808
Nickel, Total	mg/L	QNW	06/21/2022	0.1000		03/01/2020-12/06/2022	8	0.6371
Nickel, Total	mg/L	QNW	12/06/2022	0.0910		03/01/2020-12/06/2022	8	0.6371

N = Total number of independent measurements in background at each well.
Date Range = Dates of the first and last measurements included in background at each well.
Critical Value depends on the significance level and on N-1 when the two most extreme values are tested or N for the most extreme value.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.647** / **7** = **0.092**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.068** - **0.419/7**) / (**7**-1))^{½} = **0.037**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.092** + **6.5** * **0.037** = **0.331**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-0.015**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.117**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Boron, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **3.263** / **8** = **0.408**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.587** - **10.647**/**8**) / (**8**-1))^{½} = **0.191**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.408** + **6.5** * **0.191** = **1.652**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.057**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.252**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.047** / **8** = **0.006**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**9.17**x**10**$^{-4}$ - **0.002**/**8**) / (**8**-1))^{½} = **0.01**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.006** + **6.5** * **0.01** = **0.068**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **4.26**x**10**$^{-4}$	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.003**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Manganese, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **11.193** / **8** = **1.399**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**20.072** - **125.283**/**8**) / (**8**-1))^{½} = **0.794**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **1.399** + **6.5** * **0.794** = **6.559**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.019**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.973**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Molybdenum, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.089** / **8** = **0.011**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.001** - **0.008**/**8**) / (**8**-1))^{½} = **0.003**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.011** + **6.5** * **0.003** = **0.032**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **21.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **21.0**^{½}) / 2 = **8.67**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **0.0**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Nickel, Total (mg/L) at QE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.081** / **7** = **0.012**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**9.71**x**10**$^{-4}$ - **0.007**/**7**) / (**7**-1))^{½} = **0.002**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.012** + **6.5** * **0.002** = **0.027**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **34.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **34.667**^{½}) / 2 = **3.652**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.003**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.824** / **8** = **0.103**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.103** - **0.679**/**8**) / (**8**-1))^{½} = **0.051**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.103** + **6.5** * **0.051** = **0.431**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.029**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.102**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Boron, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **3.842** / **7** = **0.549**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**2.14** - **14.761**/**7**) / (**7**-1))^{½} = **0.072**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.549** + **6.5** * **0.072** = **1.015**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **0.019**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.115**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.026** / **7** = **0.004**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.04**x**10**$^{-4}$ - **6.76**x**10**$^{-4}$/**7**) / (**7**-1))^{½} = **0.001**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.004** + **6.5** * **0.001** = **0.011**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-1.02**x**10**$^{-4}$	Sen's estimator of trend.
6	var(S) = **43.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **43.333**^{½}) / 2 = **2.844**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.002**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Manganese, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **6.876** / **8** = **0.86**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**6.41** - **47.279**/**8**) / (**8**-1))^{½} = **0.267**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.86** + **6.5** * **0.267** = **2.597**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.207**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.55**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Molybdenum, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1.66** / **7** = **0.237**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.423** - **2.756**/**7**) / (**7**-1))^{½} = **0.07**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.237** + **6.5** * **0.07** = **0.691**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-0.058**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.16**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Nickel, Total (mg/L) at QN
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.147** / **8** = **0.018**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.003** - **0.022**/**8**) / (**8**-1))^{½} = **0.004**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.018** + **6.5** * **0.004** = **0.041**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **7.17**x**10**$^{-4}$	Sen's estimator of trend.
6	var(S) = **63.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **63.333**^{½}) / 2 = **4.745**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.005**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.833** / **8** = **0.104**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.089** - **0.694**/**8**) / (**8**-1))^{½} = **0.018**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.104** + **6.5** * **0.018** = **0.224**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.002**	Sen's estimator of trend.
6	var(S) = **63.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **63.333**^{½}) / 2 = **4.745**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.043**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Boron, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **5.084** / **7** = **0.726**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**3.958** - **25.847**/**7**) / (**7**-1))^{½} = **0.21**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.726** + **6.5** * **0.21** = **2.094**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-0.079**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.367**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.014** / **8** = **0.002**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**4.05**x**10**$^{-5}$ - **2.02**x**10**$^{-4}$/**8**) / (**8**-1))^{½} = **0.001**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.002** + **6.5** * **0.001** = **0.011**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-5.61**x**10**$^{-4}$	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.003**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Manganese, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **4.918** / **8** = **0.615**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**3.964** - **24.187**/**8**) / (**8**-1))^{½} = **0.367**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.615** + **6.5** * **0.367** = **2.997**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.2**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.682**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Molybdenum, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.139** / **7** = **0.02**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.003** - **0.019**/**7**) / (**7**-1))^{½} = **0.003**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.02** + **6.5** * **0.003** = **0.04**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **-0.003**	Sen's estimator of trend.
6	var(S) = **42.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **42.333**^{½}) / 2 = **2.933**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.006**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Nickel, Total (mg/L) at QNE
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.101** / **8** = **0.013**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.001** - **0.01**/**8**) / (**8**-1))^{½} = **0.003**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.013** + **6.5** * **0.003** = **0.034**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.003**	Sen's estimator of trend.
6	var(S) = **56.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **56.667**^{½}) / 2 = **5.245**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.006**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1.497** / **6** = **0.25**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.385** - **2.241**/**6**) / (**6**-1))^{½} = **0.049**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.25** + **6.5** * **0.049** = **0.567**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **6** * (**6**-1) / 2 = **15**	Number of sample pairs during trend detection period.
5	S = **0.05**	Sen's estimator of trend.
6	var(S) = **28.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**15** - **2.326** * **28.333**^{½}) / 2 = **1.309**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.15**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Boron, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1.477** / **7** = **0.211**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.336** - **2.182**/**7**) / (**7**-1))^{½} = **0.064**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.211** + **6.5** * **0.064** = **0.628**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **7** * (**7**-1) / 2 = **21**	Number of sample pairs during trend detection period.
5	S = **0.03**	Sen's estimator of trend.
6	var(S) = **44.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**21** - **2.326** * **44.333**^{½}) / 2 = **2.756**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.103**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.16** / **8** = **0.02**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.01** - **0.026**/**8**) / (**8**-1))^{½} = **0.031**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.02** + **6.5** * **0.031** = **0.222**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.007**	Sen's estimator of trend.
6	var(S) = **63.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **63.333**^{½}) / 2 = **4.745**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.005**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Manganese, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **17.978** / **8** = **2.247**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**127.251** - **323.208**/**8**) / (**8**-1))^{½} = **3.522**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **2.247** + **6.5** * **3.522** = **25.143**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **1.072**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.781**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Molybdenum, Total (mg/L) at QNW
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.098** / **8** = **0.012**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.001** - **0.01**/**8**) / (**8**-1))^{½} = **0.004**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.012** + **6.5** * **0.004** = **0.04**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **37.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **37.0**^{½}) / 2 = **6.926**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **0.0**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Nickel, Total (mg/L) at QNW

Insufficient data to perform analysis

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, Total (mg/L) at QS
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **10.913** / **8** = **1.364**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**31.639** - **119.094**/**8**) / (**8**-1))^{½} = **1.547**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **1.364** + **6.5** * **1.547** = **11.42**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.01**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-2.337**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Boron, Total (mg/L) at QS
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.59** / **8** = **0.074**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.077** - **0.348**/**8**) / (**8**-1))^{½} = **0.069**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.074** + **6.5** * **0.069** = **0.525**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **56.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **56.667**^{½}) / 2 = **5.245**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.074**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, Total (mg/L) at QS
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.686** / **8** = **0.086**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.14** - **0.471**/**8**) / (**8**-1))^{½} = **0.108**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.086** + **6.5** * **0.108** = **0.785**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.001**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.145**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Manganese, Total (mg/L) at QS
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **51.264** / **8** = **6.408**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**821.525** - **2627.998**/**8**) / (**8**-1))^{½} = **8.392**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **6.408** + **6.5** * **8.392** = **60.959**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.11**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-14.568**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Molybdenum, Total (mg/L) at QS
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.106** / **8** = **0.013**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.002** - **0.011**/**8**) / (**8**-1))^{½} = **0.005**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.013** + **6.5** * **0.005** = **0.046**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **48.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **48.667**^{½}) / 2 = **5.887**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.006**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Nickel, Total (mg/L) at QS
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **0.986** / **8** = **0.123**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**0.281** - **0.972**/**8**) / (**8**-1))^{½} = **0.151**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.123** + **6.5** * **0.151** = **1.105**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **8** * (**8**-1) / 2 = **28**	Number of sample pairs during trend detection period.
5	S = **-0.004**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**28** - **2.326** * **65.333**^{½}) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1^{th} largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.242**	One-sided lower confidence limit for slope.

Chemical Analysis August 2024

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CERTIFICATE OF ANALYSIS

1HH1175

Stone Environmental Engineering

Donn Stone
1631 NW 30th Court
Ankeny, IA 50021

Project Name: SEE 001

Project / PO Number: SEE 001
Received: 08/14/2024
Reported: 08/29/2024

Analytical Testing Parameters

Client Sample ID: QN
Sample Matrix: Aqueous
Lab Sample ID: 1HH1175-01
Collected By: DLS
Collection Date: 08/12/2024 10:46

Determination of Carbonyl Compounds	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 8315								
Formaldehyde	<20.0	20.0	ug/L	1		08/15/24 1422	08/17/24 1511	PDS

Determination of Conventional Chemistry Parameters	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 410.4								
COD, total	<20	20	mg/L	1		08/19/24 1143	08/19/24 1246	CES
EPA 420.1								
Phenols, total	<0.035	0.035	mg/L	1		08/28/24 0839	08/28/24 1604	KKJ
EPA 9020								
Total Organic Halogens (TOX)	**0.092**	0.010	mg/L	1	**TX1**	08/27/24 0000	08/28/24 1440	LNH
TIMBERLINE								
Nitrogen, Ammonia	**0.61**	0.10	mg/L	1		08/26/24 1253	08/26/24 1554	JAC
USGS I-3765-85								
Total Suspended Solids (TSS)	**87**	1	mg/L	1		08/15/24 1624	08/16/24 0910	RDH

Determination of Inorganic Anions	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 9056								
Fluoride	**0.1**	0.1	mg/L	1		08/26/24 0000	08/27/24 0203	MID
Chloride	**99.3**	10.0	mg/L	10		08/26/24 0000	08/26/24 1428	MID
Sulfate	**1010**	10.0	mg/L	10		08/26/24 0000	08/26/24 1428	MID

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 3005A/EPA 6020A								
Antimony, total	<0.0020	0.0020	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Arsenic, total	**0.0092**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Barium, total	**0.0486**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Beryllium, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Cadmium, total	<0.0008	0.0008	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Chromium, total	<0.0080	0.0080	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Cobalt, total	**0.0041**	0.0004	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Copper, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Lead, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Manganese, total	**5.81**	0.100	mg/L	100		08/15/24 1613	08/20/24 1209	RVV
Molybdenum, total	**0.0147**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Nickel, total	**0.0094**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2017	RVV

Client Sample ID:	QN		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HH1175-01	**Collection Date:**	08/12/2024 10:46

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
Selenium, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Silver, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Thallium, total	<0.0020	0.0020	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Vanadium, total	<0.0200	0.0200	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
Zinc, total	<0.0200	0.0200	mg/L	4		08/15/24 1613	08/19/24 2017	RVV
EPA 3010A/EPA 6010B								
Aluminum, total	**0.125**	0.050	mg/L	1		08/16/24 0732	08/20/24 0018	JAR
Boron, total	**0.374**	0.100	mg/L	1		08/16/24 0732	08/21/24 0343	JAR
Iron, total	**15.7**	0.100	mg/L	1		08/16/24 0732	08/20/24 0018	JAR
Magnesium, total	**164**	0.100	mg/L	1		08/16/24 0732	08/20/24 0018	JAR
EPA 7470A								
Mercury, total	<0.00050	0.00050	mg/L	1		08/16/24 1502	08/20/24 1056	JAR

CERTIFICATE OF ANALYSIS

1HH1175

Client Sample ID:	QNE		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HH1175-02	**Collection Date:**	08/12/2024 10:06

Determination of Carbonyl Compounds	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 8315								
Formaldehyde	<10.0	10.0	ug/L	1		08/15/24 1422	08/17/24 1530	PDS

Determination of Conventional Chemistry Parameters	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 410.4								
COD, total	<20	20	mg/L	1		08/19/24 1143	08/19/24 1246	CES
EPA 420.1								
Phenols, total	<0.035	0.035	mg/L	1		08/28/24 0839	08/28/24 1604	KKJ
EPA 9020								
Total Organic Halogens (TOX)	<0.010	0.010	mg/L	1		08/27/24 0000	08/28/24 1440	LNH
TIMBERLINE								
Nitrogen, Ammonia	**1.52**	0.10	mg/L	1		08/26/24 1253	08/26/24 1556	JAC
USGS I-3765-85								
Total Suspended Solids (TSS)	**6**	1	mg/L	1		08/15/24 1624	08/16/24 0910	RDH

Determination of Inorganic Anions	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 9056								
Fluoride	**0.1**	0.1	mg/L	1		08/26/24 0000	08/27/24 0225	MID
Chloride	**6.5**	1.0	mg/L	1		08/26/24 0000	08/27/24 0225	MID
Sulfate	**233**	10.0	mg/L	10		08/26/24 0000	08/26/24 1451	MID

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 3005A/EPA 6020A								
Antimony, total	<0.0020	0.0020	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Arsenic, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Barium, total	**0.109**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Beryllium, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Cadmium, total	<0.0008	0.0008	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Chromium, total	<0.0080	0.0080	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Cobalt, total	**0.0009**	0.0004	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Copper, total	**0.0052**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Lead, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Manganese, total	**0.402**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Molybdenum, total	**0.0121**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Nickel, total	**0.0052**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Selenium, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Silver, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Thallium, total	<0.0020	0.0020	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Vanadium, total	<0.0200	0.0200	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
Zinc, total	<0.0200	0.0200	mg/L	4		08/15/24 1613	08/19/24 2023	RVV
EPA 3010A/EPA 6010B								

CERTIFICATE OF ANALYSIS

1HH1175

Client Sample ID:	QNE		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HH1175-02	**Collection Date:**	08/12/2024 10:06

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
Aluminum, total	**0.092**	0.050	mg/L	1		08/16/24 0732	08/20/24 0027	JAR
Boron, total	**0.660**	0.100	mg/L	1		08/16/24 0732	08/21/24 0352	JAR
Iron, total	**0.161**	0.100	mg/L	1		08/16/24 0732	08/20/24 0027	JAR
Magnesium, total	**62.2**	0.100	mg/L	1		08/16/24 0732	08/20/24 0027	JAR
EPA 7470A								
Mercury, total	<0.00050	0.00050	mg/L	1		08/16/24 1502	08/20/24 1058	JAR

Client Sample ID:	QE		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HH1175-03	**Collection Date:**	08/12/2024 11:30

Determination of Carbonyl Compounds	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 8315								
Formaldehyde	<20.0	20.0	ug/L	1		08/15/24 1422	08/17/24 1549	PDS

Determination of Conventional Chemistry Parameters	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 410.4								
COD, total	**21**	20	mg/L	1		08/19/24 1143	08/19/24 1246	CES
EPA 420.1								
Phenols, total	<0.035	0.035	mg/L	1		08/28/24 0839	08/28/24 1604	KKJ
EPA 9020								
Total Organic Halogens (TOX)	**0.032**	0.010	mg/L	1	**TX1, TX2**	08/27/24 0000	08/28/24 1440	LNH
TIMBERLINE								
Nitrogen, Ammonia	**1.74**	0.10	mg/L	1		08/26/24 1253	08/26/24 1559	JAC
USGS I-3765-85								
Total Suspended Solids (TSS)	**852**	1	mg/L	1		08/15/24 1624	08/16/24 0910	RDH

Determination of Inorganic Anions	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 9056								
Fluoride	<0.1	0.1	mg/L	1		08/26/24 0000	08/27/24 0248	MID
Chloride	**15.2**	1.0	mg/L	1		08/26/24 0000	08/27/24 0248	MID
Sulfate	**901**	10.0	mg/L	10		08/26/24 0000	08/26/24 1513	MID

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 3005A/EPA 6020A								
Antimony, total	<0.0020	0.0020	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Arsenic, total	**0.0099**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Barium, total	**0.0659**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Beryllium, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Cadmium, total	<0.0008	0.0008	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Chromium, total	<0.0080	0.0080	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Cobalt, total	**0.0058**	0.0004	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Copper, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Lead, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Manganese, total	**2.86**	0.100	mg/L	100		08/15/24 1613	08/20/24 1209	RVV
Molybdenum, total	**0.0071**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Nickel, total	**0.0130**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Selenium, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Silver, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Thallium, total	<0.0020	0.0020	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Vanadium, total	<0.0200	0.0200	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
Zinc, total	<0.0200	0.0200	mg/L	4		08/15/24 1613	08/19/24 2029	RVV
EPA 3010A/EPA 6010B								

Client Sample ID:	QE		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HH1175-03	**Collection Date:**	08/12/2024 11:30

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
Aluminum, total	**0.078**	0.050	mg/L	1		08/16/24 0732	08/20/24 0033	JAR
Boron, total	**0.577**	0.100	mg/L	1		08/16/24 0732	08/21/24 0358	JAR
Iron, total	**12.3**	0.100	mg/L	1		08/16/24 0732	08/20/24 0033	JAR
Magnesium, total	**140**	0.100	mg/L	1		08/16/24 0732	08/20/24 0033	JAR
EPA 7470A								
Mercury, total	<0.00050	0.00050	mg/L	1		08/16/24 1502	08/20/24 1101	JAR

CERTIFICATE OF ANALYSIS

1HH1175

Client Sample ID:	QNW		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HH1175-04	**Collection Date:**	08/12/2024 12:16

Determination of Carbonyl Compounds	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 8315								
Formaldehyde	<10.0	10.0	ug/L	1		08/15/24 1422	08/17/24 1608	PDS

Determination of Conventional Chemistry Parameters	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 410.4								
COD, total	<20	20	mg/L	1		08/19/24 1143	08/19/24 1246	CES
EPA 420.1								
Phenols, total	**0.053**	0.035	mg/L	1		08/26/24 0847	08/26/24 1714	KKJ
EPA 9020								
Total Organic Halogens (TOX)	**0.133**	0.010	mg/L	1	**TX1**	08/27/24 0000	08/28/24 1440	LNH
TIMBERLINE								
Nitrogen, Ammonia	**0.11**	0.10	mg/L	1		08/26/24 1253	08/26/24 1601	JAC
USGS I-3765-85								
Total Suspended Solids (TSS)	**626**	1	mg/L	1		08/15/24 1624	08/16/24 0910	RDH

Determination of Inorganic Anions	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 9056								
Fluoride	**0.1**	0.1	mg/L	1		08/26/24 0000	08/27/24 0310	MID
Chloride	**241**	10.0	mg/L	10		08/26/24 0000	08/26/24 1536	MID
Sulfate	**134**	10.0	mg/L	10		08/26/24 0000	08/26/24 1536	MID

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 3005A/EPA 6020A								
Antimony, total	<0.0020	0.0020	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Arsenic, total	**0.0063**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Barium, total	**0.314**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Beryllium, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Cadmium, total	<0.0008	0.0008	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Chromium, total	<0.0080	0.0080	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Cobalt, total	**0.0087**	0.0004	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Copper, total	**0.0071**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Lead, total	**0.0042**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Manganese, total	**4.42**	0.100	mg/L	100		08/15/24 1613	08/20/24 1209	RVV
Molybdenum, total	**0.0077**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Nickel, total	**0.0181**	0.0040	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Selenium, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Silver, total	<0.0040	0.0040	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Thallium, total	<0.0020	0.0020	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Vanadium, total	<0.0200	0.0200	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
Zinc, total	<0.0200	0.0200	mg/L	4		08/15/24 1613	08/19/24 2035	RVV
EPA 3010A/EPA 6010B								

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Microbac Laboratories, Inc., Newton

CERTIFICATE OF ANALYSIS

1HH1175

Client Sample ID:	QNW		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HH1175-04	**Collection Date:**	08/12/2024 12:16

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
Aluminum, total	**2.46**	0.050	mg/L	1		08/16/24 0732	08/20/24 0042	JAR
Boron, total	**0.211**	0.100	mg/L	1		08/16/24 0732	08/21/24 0409	JAR
Iron, total	**13.8**	0.100	mg/L	1		08/16/24 0732	08/20/24 0042	JAR
Magnesium, total	**68.3**	0.100	mg/L	1		08/16/24 0732	08/20/24 0042	JAR
EPA 7470A								
Mercury, total	<0.00050	0.00050	mg/L	1		08/16/24 1502	08/20/24 1103	JAR

Definitions

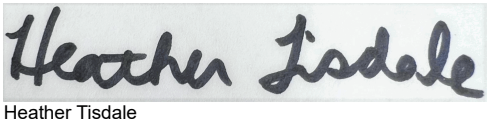
RL: Reporting Limit

TX1: Repeated analysis of this sample consistently exceeded greater than 10% breakthrough to the second column.

TX2: The RPD value for the sample duplicates are outside of acceptance limits due to matrix interference. The reported value is an average of all test measurements.

Report Comments

Reviewed and Approved By:



Heather Tisdale

Customer Relationship Specialist

heather.tisdale@microbac.com

08/29/24 12:30

CHAIN OF CUSTODY RECORD

MICROBAC®
600 East 17th Stre
Newton, IA 50208
641-792-8451

1 H H 1 1 7 5

Stone Environmental Engineering
PM: Heather Tisdale

SITE INFORMATION

Sampler:

Project: SEE 001

REPORT TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50021

INVOICE TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50021

SPECIAL INSTRUCTIONS

None pH & CONDUCTIVITY — REPORT SEPERATELY

Turn Around Time
☒ Standard ☐ RUSH, need by ___/___/___

LAB USE ONLY

Work Order 1HH1175
Temperature 2.1
Turn-Cooler: No

- ☐ Custody Seal
- ☒ Containers Intact
- ☒ COC/Labels Agree
- ☐ Preservation Confirmed
- ☒ Received on Ice

Number	Sample Identification / Client ID	Matrix	Sample Type	Date	Time	Number of Containers	Analyses	Lab Sample Number
-001	GW-	Aqueous	GRAB	8/12	10:46	7	8315@Formaldehyde, 9020-100, ag-t-6020, al-t-6010, as-t-6020, ba-t-6020, be-t-6020, b-t-6010, cd-t-6020, cl-9056-w, cod-t-410.4, cond-2510, co-t-6020, cr-t-6020, cu-t-6020, f-9056, fe-t-6010, hg-t-7470, mg-t-6010, mn-t-6020, mo-t-6020, nh3-timberline, ni-t-6020, pb-t-6020, ph-4500, phenol-t-420.1, sb-t-6020, se-t-6020, so4-9056-w, tl-t-6020, tss-i-3765-85, v-t-6020, zn-t-6020	01

Relinquished By: [signature] Date/Time: 13 Aug 0700

Received By: ___ Date/Time: ___

Relinquished By: [signature] Date/Time: 8/14/2024 2:38 PM

Received for Lab By: [signature] Date/Time: ___

Remarks:

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CHAIN OF C

MICROBAC®
600 East 17th Street S
Newton, IA 50208
641-792-8451

1HH1175

Stone Environmental Engineering
PM: Heather Tisdale

SITE INFORMATION
Sampler:
Project: SEE 001

REPORT TO
Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50021

INVOICE TO
Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50021

SPECIAL INSTRUCTIONS
None X pH & conductivity
Turn Around Time
☑ Standard ☐ RUSH, need by ___/___/___

LAB USE ONLY
Work Order 1HH1175
Temperature 2.1
Turn-Cooler: No

- Custody Seal
- Containers Intact
- COC/Labels Agree
- Preservation Confirmed
- Received on Ice

Number	Sample Identification / Client ID	Matrix	Sample Type	Date	Time	Number of Containers	Analyses	Lab Sample Number
-002	QNE	Aqueous	GRAB	8/12	10:00	7	8315@Formaldehyde, 9020-100, ag-t-6020, al-t-6010, as-t-6020, ba-t-6020, be-t-6020, b-t-6010, cd-t-6020, cl-9056-w, cod-t-410.4, cond-2510, co-t-6020, cr-t-6020, cu-t-6020, f-9056, fe-t-6010, hg-t-7470, mg-t-6010, mn-t-6020, mo-t-6020, nh3-timberline, ni-t-6020, pb-t-6020, ph-4500, phenol-t-420.1, sb-t-6020, se-t-6020, so4-9056-w, tl-t-6020, tss-i-3765-85, v-t-6020, zn-t-6020	02

Relinquished By — Date/Time: 13 Aug 0700
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CHAIN OF CUS[illegible]RECORD

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600 East 17th Street Sou
Newton, IA 50208
641-792-8451

1HH1175
Stone Environmental Engineering
PM: Heather Tisdale

SITE INFORMATION
Sampler:
Project: SEE 001

REPORT TO
Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50021

INVOICE TO
Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50021

SPECIAL INSTRUCTIONS
None / PH; CONDUCTIVITY
REPORT SODIALITY
Turn Around Time
☐ Standard ☐ RUSH, need by ___/___/___

LAB USE ONLY
Work Order 1HH1175
Temperature 2.1
Turn-Cooler: No

- ☐ Custody Seal
- ☒ Containers Intact
- ☒ COC/Labels Agree
- ☐ Preservation Confirmed
- ☑ Received on Ice

Number	Sample Identification / Client ID	Matrix	Sample Type	Date	Time	Number of Containers	Analyses	Lab Sample Number
-003	QE	Aqueous	GRAB	8/12	11:30	7	8315@Formaldehyde, ag-t-6020, as-t-6020, be-t-6020, cd-t-6020, cod-t-410.4, co-t-6020, cu-t-6020, fe-t-6010, mg-t-6010, mo-t-6020, ni-t-6020, ph-4500, sb-t-6020, so4-9056-w, tss-t-3765-85, zn-t-6020, 9020-100, al-t-6010, ba-t-6020, b-t-6010, cl-9056-w, cond-2510, cr-t-6020, f-9056, hg-t-7470, mn-t-6020, nh3-timberline, pb-t-6020, phenol-t-420.1, se-t-6020, tl-t-6020, v-t-6020	03

Relinquished By — Date/Time: 13 Aug 0700
Received By — Date/Time:
Relinquished By — Date/Time:
Received for Lab By — Date/Time: 8/14/2024 2:39 JW

Remarks:

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CHAIN OF

MICROBAC®

600 East 17th Stree
Newton, IA 50208
641-792-8451

1 H H 1 1 7 5

Stone Environmental Engineering
PM: Heather Tisdale

SITE INFORMATION

Sampler:

Project: SEE 001

REPORT TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50021

TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50021

SPECIAL INSTRUCTIONS

Note pH, Conductivity Report Seperately

Turn Around Time

☒ Standard ☐ RUSH, need by ___/___/___

LAB USE ONLY

Work Order 1HH1175

Temperature 2.1

Turn-Cooler: No

☒ Custody Seal
☒ Containers Intact
☒ COC/Labels Agree
☐ Preservation Confirmed
☑ Received on Ice

Number	Sample Identification / Client ID	Matrix	Sample Type	Date	Time	Number of Containers	Analyses	Lab Sample Number
-004	QNW	Aqueous	GRAB	8/12	12:16	7	8315@Formaldehyde, ag-t-6020, as-t-6020, be-t-6020, cd-t-6020, cod-t-410.4, co-t-6020, cu-t-6020, fe-t-6010, mg-t-6010, mo-t-6020, ni-t-6020, ph-4500, sb-t-6020, so4-9056-w, tss-i-3765-85, zn-t-6020, 9020-100, al-t-6010, ba-t-6020, b-t-6010, cl-9056-w, cond-2510, cr-t-6020, f-9056, hg-t-7470, mn-t-6020, nh3-timberline, pb-t-6020, phenol-t-420.1, se-t-6020, tl-t-6020, v-t-6020	04

Relinquished By: [signature] Date/Time: 13 Aug 16 0700

Received By: Date/Time:

Relinquished By: [signature] Date/Time: 8/14/2024 2:39 PM

Received for Lab By: Date/Time:

Remarks:

Original - Lab Copy Yellow - Sampler Copy

Chemical Analysis December 2024

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Microbac Laboratories, Inc., Newton

CERTIFICATE OF ANALYSIS

1HL1259

Stone Environmental Engineering

Donn Stone
1631 NW 30th Court
Ankeny, IA 50023

Project Name: SEE 001

Project / PO Number: N/A
Received: 12/17/2024
Reported: 01/07/2025

Analytical Testing Parameters

Client Sample ID: MW QN
Sample Matrix: Aqueous
Lab Sample ID: 1HL1259-01
Collected By: DLS
Collection Date: 12/16/2024 10:25

Determination of Carbonyl Compounds	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 8315								
Formaldehyde	<20.0	20.0	ug/L	1		12/18/24 0914	12/19/24 1153	PDS

Determination of Conventional Chemistry Parameters	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 410.4, Rv. 2 (1993)								
COD, total	<54	54	mg/L	1		12/23/24 0911	12/24/24 0823	CES
EPA 420.1								
Phenols, total	<0.035	0.035	mg/L	1		12/31/24 0829	12/31/24 1608	KKJ
EPA 9020B								
Total Organic Halogens (TOX)	<0.010	0.010	mg/L	1		01/02/25 0000	01/03/25 1552	CSM
SM 2510 B-2011								
Conductivity	**2380**	2.0	uS/cm	1		12/18/24 1340	12/18/24 1448	BSS
SM 4500-H+ B-2011								
pH	**6.5**	0.5	pH	1	**H4**	12/18/24 1342	12/18/24 1453	BSS
TIMBERLINE								
Nitrogen, Ammonia	**0.77**	0.50	mg/L	5		12/23/24 1622	12/24/24 1119	RAF
USGS I-3765-85								
Total Suspended Solids (TSS)	**112**	5	mg/L	5		12/18/24 1125	12/19/24 0755	MEAH

Determination of Inorganic Anions	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 9056A								
Fluoride	**0.2**	0.1	mg/L	1		12/31/24 0000	12/31/24 1233	MID
Chloride	**49.0**	1.0	mg/L	1		12/31/24 0000	12/31/24 1233	MID
Sulfate	**751**	10.0	mg/L	10		01/02/25 0000	01/02/25 1316	ZZZ

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 3005A/EPA 6020A								
Antimony, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Arsenic, total	**0.0069**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Barium, total	**0.0444**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Beryllium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Cadmium, total	<0.0008	0.0008	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Chromium, total	<0.0080	0.0080	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Cobalt, total	**0.0100**	0.0004	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Copper, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1935	RVV

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CERTIFICATE OF ANALYSIS

1HL1259

Client Sample ID:	MW QN		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HL1259-01	**Collection Date:**	12/16/2024 10:25

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
Lead, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Manganese, total	**5.16**	0.100	mg/L	100		12/19/24 0854	12/26/24 1134	RVV
Molybdenum, total	**0.0143**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Nickel, total	**0.0089**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Selenium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Silver, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Thallium, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Vanadium, total	<0.0200	0.0200	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
Zinc, total	<0.0200	0.0200	mg/L	4		12/19/24 0854	12/20/24 1935	RVV
EPA 3010A/EPA 6010B								
Aluminum, total	**0.175**	0.050	mg/L	1		12/20/24 1341	12/24/24 0129	JAR
Boron, total	**0.294**	0.100	mg/L	1		12/20/24 1341	12/24/24 0129	JAR
Iron, total	**29.0**	0.100	mg/L	1		12/20/24 1341	12/24/24 0129	JAR
Magnesium, total	**99.9**	0.100	mg/L	1		12/20/24 1341	12/24/24 0129	JAR
EPA 7470A								
Mercury, total	<0.00050	0.00050	mg/L	1		12/20/24 1407	12/23/24 1249	JAR

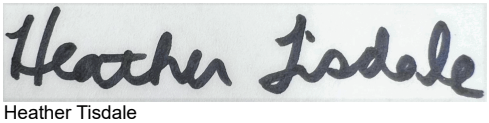
Definitions

H4: The test was performed outside of the EPA recommended holding time of 15 minutes.

RL: Reporting Limit

Report Comments

Reviewed and Approved By:



Heather Tisdale
Customer Relationship Specialist
heather.tisdale@microbac.com
01/07/25 09:26

Keystone LABORATORIES
A Microbac Company

600 East
Newton,
641-792-

1HL1259

Stone Environmental Engineering
PM: Heather Tisdale

www.keystonelabs.com

SITE INFORMATION

Sampler:

Project: SEE 001

REPORT TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

INVOICE TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

SPECIAL INSTRUCTIONS

None

Turn Around Time

☐ Standard ☐ RUSH, need by ___/___/___

LAB USE ONLY

Work Order 1HL1259
Temperature 8.9
Turn-Cooler: No

- ☐ Custody Seal
- ☒ Containers Intact
- ☒ COC/Labels Agree
- ☐ Preservation Confirmed
- ☐ Received on Ice N/A

Number	Sample Identification / Client ID	Matrix	Sample Type	Date	Time	Number of Containers	Analyses	Lab Sample Number
-001	MW QN	Aqueous	GRAB	16 DEC	1025	7	8315@Formaldehyde, 9020-100, ag-t-6020, al-t-6010, as-t-6020, ba-t-6020, be-t-6020, b-t-6010, cd-t-6020, cl-9056-w, cod-t-410.4, cond-2510, co-t-6020, cr-t-6020, cu-t-6020, f-9056, fe-t-6010, hg-t-7470, mg-t-6010, mn-t-6020, mo-t-6020, nh3-timberline, ni-t-6020, pb-t-6020, ph-4500, phenol-t-420.1, sb-t-6020, se-t-6020, so4-9056-w, tl-t-6020, tss-i-3765-85, v-t-6020, zn-t-6020	01

Relinquished By — Date/Time: 17 DEC 0700

Received By — Date/Time

Relinquished By — Date/Time

Received for Lab By: Randy Wood — Date/Time: 12/17/24 0905

Remarks:

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CERTIFICATE OF ANALYSIS

1HL1257

Stone Environmental Engineering

Donn Stone
1631 NW 30th Court
Ankeny, IA 50023

Project Name: SEE 001

Project / PO Number: N/A
Received: 12/17/2024
Reported: 01/07/2025

Analytical Testing Parameters

Client Sample ID: QNW
Sample Matrix: Aqueous
Lab Sample ID: 1HL1257-01
Collected By: DLS
Collection Date: 12/16/2024 10:59

Determination of Carbonyl Compounds	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 8315								
Formaldehyde	<20.0	20.0	ug/L	1		12/18/24 0914	12/19/24 1133	PDS

Determination of Conventional Chemistry Parameters	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 410.4, Rv. 2 (1993)								
COD, total	**69**	54	mg/L	1		12/20/24 0816	12/20/24 1600	CES
EPA 420.1								
Phenols, total	<0.035	0.035	mg/L	1		12/31/24 0829	12/31/24 1608	KKJ
EPA 9020B								
Total Organic Halogens (TOX)	**0.223**	0.010	mg/L	1	**TX1**	01/02/25 0000	01/03/25 1552	CSM
SM 2510 B-2011								
Conductivity	**2170**	2.0	uS/cm	1		12/18/24 1340	12/18/24 1448	BSS
SM 4500-H+ B-2011								
pH	**6.6**	0.5	pH	1	**H4**	12/18/24 1342	12/18/24 1453	BSS
TIMBERLINE								
Nitrogen, Ammonia	**0.13**	0.10	mg/L	1		12/23/24 1622	12/24/24 1118	RAF
USGS I-3765-85								
Total Suspended Solids (TSS)	**229**	7	mg/L	7		12/18/24 1505	12/19/24 0940	KDA

Determination of Inorganic Anions	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 9056A								
Fluoride	**0.2**	0.1	mg/L	1		12/31/24 0000	12/31/24 1214	MID
Chloride	**319**	10.0	mg/L	10		12/31/24 0000	12/31/24 1948	MID
Sulfate	**212**	10.0	mg/L	10		12/31/24 0000	12/31/24 1948	ZZZ

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 3005A/EPA 6020A								
Antimony, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Arsenic, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Barium, total	**0.248**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Beryllium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Cadmium, total	<0.0008	0.0008	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Chromium, total	<0.0080	0.0080	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Cobalt, total	**0.0027**	0.0004	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Copper, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV

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Microbac Laboratories, Inc., Newton

CERTIFICATE OF ANALYSIS

1HL1257

Client Sample ID:	QNW		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HL1257-01	**Collection Date:**	12/16/2024 10:59

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
Lead, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Manganese, total	**1.49**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Molybdenum, total	**0.0042**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Nickel, total	**0.0051**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Selenium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Silver, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Thallium, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Vanadium, total	<0.0200	0.0200	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
Zinc, total	<0.0200	0.0200	mg/L	4		12/19/24 0854	12/20/24 1929	RVV
EPA 3010A/EPA 6010B								
Aluminum, total	**0.284**	0.050	mg/L	1		12/20/24 1341	12/24/24 0110	JAR
Boron, total	**0.220**	0.100	mg/L	1		12/20/24 1341	12/24/24 0110	JAR
Iron, total	**2.50**	0.100	mg/L	1		12/20/24 1341	12/24/24 0110	JAR
Magnesium, total	**76.3**	0.100	mg/L	1		12/20/24 1341	12/24/24 0110	JAR
EPA 7470A								
Mercury, total	<0.00050	0.00050	mg/L	1		12/20/24 1407	12/23/24 1246	JAR

Definitions

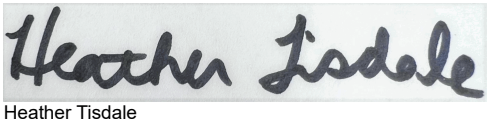
H4: The test was performed outside of the EPA recommended holding time of 15 minutes.

RL: Reporting Limit

TX1: Repeated analysis of this sample consistently exceeded greater than 10% breakthrough to the second column.

Report Comments

Reviewed and Approved By:



Heather Tisdale
Customer Relationship Specialist
heather.tisdale@microbac.com
01/07/25 09:26

CHAIN OF CUSTODY RECO

Keystone LABORATORIES
A Microbac Company
600 East 17th Street South
Newton, IA 50208
641-792-8451

1HL1257

Stone Environmental Engineering
PM: Heather Tisdale

www.keystonelabs.com

SITE INFORMATION
Sampler:
Project: SEE 001

REPORT TO
Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

INVOICE TO
Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

SPECIAL INSTRUCTIONS
None

Turn Around Time
☐ Standard ☐ RUSH, need by ___/___/___

LAB USE ONLY
Work Order 1HL1257
Temperature 0.5
Turn-Cooler: No

☐ Custody Seal
☒ Containers Intact
☒ COC/Labels Agree
☐ Preservation Confirmed
☒ Received on Ice

Number	Sample Identification / Client ID	Matrix	Sample Type	Date	Time	Number of Containers	Analyses	Lab Sample Number
-002	QNW	Aqueous	GRAB	12/11/24	~~1100~~ 1059	7	8315@Formaldehyde, 9020-100, ag-t-6020, al-t-6010, as-t-6020, ba-t-6020, be-t-6020, b-t-6010, cd-t-6020, cl-9056-w, cod-t-410.4, cond-2510, co-t-6020, cr-t-6020, cu-t-6020, f-9056, fe-t-6010, hg-t-7470, mg-t-6010, mn-t-6020, mo-t-6020, nh3-timberline, ni-t-6020, pb-t-6020, ph-4500, phenol-t-420.1, sb-t-6020, se-t-6020, so4-9056-w, tl-t-6020, tss-i-3765-85, v-t-6020, zn-t-6020	1

Relinquished By — Date/Time 12/11/24 0700

Relinquished By — Date/Time

Received By — Date/Time

Received for Lab By — Date/Time 12/11/24 0955

Remarks:

Original - Lab Copy Yellow - Sampler Copy

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Microbac Laboratories, Inc., Newton

CERTIFICATE OF ANALYSIS

1HL1260

Stone Environmental Engineering

Donn Stone
1631 NW 30th Court
Ankeny, IA 50023

Project Name: SEE 001

Project / PO Number: N/A
Received: 12/17/2024
Reported: 01/07/2025

Analytical Testing Parameters

Client Sample ID: QNZ
Sample Matrix: Aqueous
Lab Sample ID: 1HL1260-01
Collected By: DLS
Collection Date: 12/16/2024 11:26

Determination of Carbonyl Compounds	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 8315								
Formaldehyde	<10.0	10.0	ug/L	1		12/18/24 0914	12/19/24 1214	PDS

Determination of Conventional Chemistry Parameters	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 410.4, Rv. 2 (1993)								
COD, total	<54	54	mg/L	1		12/18/24 1611	12/19/24 1531	CES
EPA 420.1								
Phenols, total	<0.035	0.035	mg/L	1		12/31/24 0829	12/31/24 1608	KKJ
EPA 9020B								
Total Organic Halogens (TOX)	**0.023**	0.010	mg/L	1	**TX1**	01/02/25 0000	01/03/25 1552	CSM
SM 2510 B-2011								
Conductivity	**1100**	2.0	uS/cm	1		12/18/24 1340	12/18/24 1448	BSS
SM 4500-H+ B-2011								
pH	**6.8**	0.5	pH	1	**H4**	12/18/24 1342	12/18/24 1453	BSS
TIMBERLINE								
Nitrogen, Ammonia	**1.68**	0.10	mg/L	1		12/23/24 1622	12/24/24 1121	RAF
USGS I-3765-85								
Total Suspended Solids (TSS)	**15**	2	mg/L	2		12/18/24 1125	12/19/24 0755	MEAH

Determination of Inorganic Anions	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 9056A								
Fluoride	**0.1**	0.1	mg/L	1		12/31/24 0000	12/31/24 1251	MID
Chloride	**7.6**	1.0	mg/L	1		12/31/24 0000	12/31/24 1251	MID
Sulfate	**227**	5.0	mg/L	5		12/31/24 0000	12/31/24 2055	MID

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 3005A/EPA 6020A								
Antimony, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Arsenic, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Barium, total	**0.100**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Beryllium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Cadmium, total	<0.0008	0.0008	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Chromium, total	<0.0080	0.0080	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Cobalt, total	**0.0013**	0.0004	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Copper, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV

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Microbac Laboratories, Inc., Newton

CERTIFICATE OF ANALYSIS

1HL1260

Client Sample ID:	QNZ		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HL1260-01	**Collection Date:**	12/16/2024 11:26

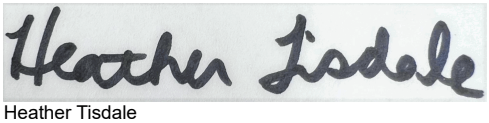
Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
Lead, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Manganese, total	**0.421**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Molybdenum, total	**0.0117**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Nickel, total	**0.0044**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Selenium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Silver, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Thallium, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Vanadium, total	<0.0200	0.0200	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
Zinc, total	<0.0200	0.0200	mg/L	4		12/19/24 0854	12/20/24 1941	RVV
EPA 3010A/EPA 6010B								
Aluminum, total	**0.095**	0.050	mg/L	1		12/20/24 1341	12/24/24 0139	JAR
Boron, total	**0.622**	0.100	mg/L	1		12/20/24 1341	12/24/24 0139	JAR
Iron, total	**0.111**	0.100	mg/L	1		12/20/24 1341	12/24/24 0139	JAR
Magnesium, total	**57.1**	0.100	mg/L	1		12/20/24 1341	12/24/24 0139	JAR
EPA 7470A								
Mercury, total	<0.00050	0.00050	mg/L	1		12/20/24 1407	12/23/24 1251	JAR

Definitions

H4:	The test was performed outside of the EPA recommended holding time of 15 minutes.
RL:	Reporting Limit
TX1:	Repeated analysis of this sample consistently exceeded greater than 10% breakthrough to the second column.

Report Comments

Reviewed and Approved By:



Heather Tisdale
Customer Relationship Specialist
heather.tisdale@microbac.com
01/07/25 09:25

CHAIN OF CUST

Keystone LABORATORIES
A Microbac Company
600 East 17th Street South
Newton, IA 50208
641-792-8451

1HL1260

Stone Environmental Engineering
PM: Heather Tisdale

SITE INFORMATION

Sampler:

Project: SEE 001

REPORT TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

INVOICE TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

SPECIAL INSTRUCTIONS

None

Turn Around Time

☐ Standard ☐ RUSH, need by ___/___/___

LAB USE ONLY

Work Order 1HL1260
Temperature 7.7
Turn-Cooler: No

- ☐ Custody Seal
- ☒ Containers Intact
- ☒ COC/Labels Agree
- ☐ Preservation Confirmed
- ☒ Received on Ice

Number	Sample Identification / Client ID	Matrix	Sample Type	Date	Time	Number of Containers	Analyses	Lab Sample Number
-003	QNE	Aqueous	GRAB	4 DGC	1126	7	8315@Formaldehyde, 9020-100, ag-t-6020, al-t-6010, as-t-6020, ba-t-6020, be-t-6020, b-t-6010, cd-t-6020, cl-9056-w, cod-t-410.4, cond-2510, co-t-6020, cr-t-6020, cu-t-6020, f-9056, fe-t-6010, hg-t-7470, mg-t-6010, mn-t-6020, mo-t-6020, nh3-timberline, ni-t-6020, pb-t-6020, ph-4500, phenol-t-420.1, sb-t-6020, se-t-6020, so4-9056-w, tl-t-6020, tss-i-3765-85, v-t-6020, zn-t-6020	1

Relinquished By — Date/Time: 12/9/24 0700

Received By — Date/Time

Relinquished By — Date/Time

Received for Lab By: Lacy Wood — Date/Time: 12/10/24 0905

Remarks:

Original - Lab Copy Yellow - Sampler Copy

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Microbac Laboratories, Inc., Newton

CERTIFICATE OF ANALYSIS

1HL1255

Stone Environmental Engineering

Donn Stone
1631 NW 30th Court
Ankeny, IA 50023

Project Name: SEE 001

Project / PO Number: N/A
Received: 12/18/2024
Reported: 01/03/2025

Analytical Testing Parameters

Client Sample ID: QE
Sample Matrix: Aqueous
Lab Sample ID: 1HL1255-01
Collected By: DLS
Collection Date: 12/16/2024 12:02

Determination of Conventional Chemistry Parameters	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 410.4, Rv. 2 (1993)								
COD, total	**75**	54	mg/L	1		01/02/25 1041	01/02/25 1304	CES
EPA 420.1								
Phenols, total	<0.035	0.035	mg/L	1		01/03/25 0831	01/03/25 1436	CES
SM 2510 B-2011								
Conductivity	**2580**	2.0	uS/cm	1		12/18/24 1340	12/18/24 1448	BSS
SM 4500-H+ B-2011								
pH	**6.5**	0.5	pH	1	**H4**	12/18/24 1342	12/18/24 1453	BSS
TIMBERLINE								
Nitrogen, Ammonia	**0.11**	0.10	mg/L	1		12/30/24 1254	12/30/24 1429	SDF
USGS I-3765-85								
Total Suspended Solids (TSS)	**194**	4	mg/L	4		12/18/24 0948	12/18/24 1535	LAW

Determination of Inorganic Anions	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 9056A								
Fluoride	**0.1**	0.1	mg/L	1		12/31/24 0000	12/31/24 1138	MID
Chloride	**13.2**	1.0	mg/L	1		12/31/24 0000	12/31/24 1138	MID
Sulfate	**807**	10.0	mg/L	10		01/02/25 0000	01/02/25 1253	ZZZ

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 3005A/EPA 6020A								
Antimony, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Arsenic, total	**0.0044**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Barium, total	**0.0784**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Beryllium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Cadmium, total	<0.0008	0.0008	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Chromium, total	<0.0080	0.0080	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Cobalt, total	**0.0163**	0.0004	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Copper, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Lead, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Manganese, total	**1.89**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Molybdenum, total	**0.0129**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Nickel, total	**0.0447**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Selenium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Silver, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Thallium, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1846	RVV

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CERTIFICATE OF ANALYSIS

1HL1255

Client Sample ID:	QE		
Sample Matrix:	Aqueous	**Collected By:**	DLS
Lab Sample ID:	1HL1255-01	**Collection Date:**	12/16/2024 12:02

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
Vanadium, total	<0.0200	0.0200	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
Zinc, total	**0.0449**	0.0200	mg/L	4		12/19/24 0854	12/20/24 1846	RVV
EPA 3010A/EPA 6010B								
Aluminum, total	**0.301**	0.050	mg/L	1		12/20/24 1341	12/24/24 0030	JAR
Boron, total	**0.629**	0.100	mg/L	1		12/20/24 1341	12/24/24 0030	JAR
Iron, total	**2.12**	0.100	mg/L	1		12/20/24 1341	12/24/24 0030	JAR
Magnesium, total	**129**	0.100	mg/L	1	**M6**	12/20/24 1341	12/24/24 0030	JAR
EPA 7470A								
Mercury, total	<0.00050	0.00050	mg/L	1		12/20/24 1407	12/23/24 1242	JAR

Definitions

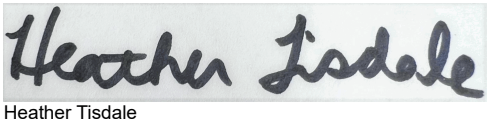
H4: The test was performed outside of the EPA recommended holding time of 15 minutes.

M6: Matrix spike recovery is outside of acceptance limits. The analyte concentration is greater than 4X the spiking level.

RL: Reporting Limit

Report Comments

Reviewed and Approved By:



Heather Tisdale
Customer Relationship Specialist
heather.tisdale@microbac.com
01/03/25 16:15

CHAIN OF CUSTODY

Keystone LABORATORIES
A Microbac Company
600 East 17th Street South
Newton, IA 50208
641-792-8451

1HL1255

Stone Environmental Engineering
PM: Heather Tisdale

ted: 12/9/2024 9:54:01A

www.keystonelabs.

SITE INFORMATION

Sampler:

Project: SEE 001

REPORT TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

INVOICE TO

Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

SPECIAL INSTRUCTIONS

None

Turn Around Time

☐ Standard ☐ RUSH, need by ___/___/___

LAB USE ONLY

Work Order 1HL1255

Temperature 0.5

Turn-Cooler: No

- ☐ Custody Seal
- ☒ Containers Intact
- ☒ COC/Labels Agree
- ☐ Preservation Confirmed
- ☒ Received on Ice

Number	Sample Identification / Client ID	Matrix	Sample Type	Date	Time	Number of Containers	Analyses	Lab Sample Number
-004	QE	Aqueous	GRAB	DEC 16	1202	3	8315@Formaldehyde, 9020-100, ag-t-6020, al-t-6010, as-t-6020, ba-t-6020, be-t-6020, b-t-6010, cd-t-6020, cl-9056-w, cod-t-410.4, cond-2510, co-t-6020, cr-t-6020, cu-t-6020, f-9056, fe-t-6010, hg-t-7470, mg-t-6010, mn-t-6020, mo-t-6020, nh3-timberline, ni-t-6020, pb-t-6020, ph-4500, phenol-t-420.1, sb-t-6020, se-t-6020, so4-9056-w, tl-t-6020, tss-i-3765-85, v-t-6020, zn-t-6020	1

Relinquished By 12/17 0700 Date/Time

Received By Date/Time

Relinquished By Date/Time

Received for Lab By Larry Wood 12/17/24 0505 Date/Time

Remarks:

Original - Lab Copy Yellow - Sampler Copy

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CERTIFICATE OF ANALYSIS

1HL1256

Stone Environmental Engineering

Donn Stone
1631 NW 30th Court
Ankeny, IA 50023

Project Name: SEE 001

Project / PO Number: N/A
Received: 12/17/2024
Reported: 01/07/2025

Analytical Testing Parameters

Client Sample ID: Q5
Sample Matrix: Aqueous
Lab Sample ID: 1HL1256-01
Collected By: Larry Wood
Collection Date: 12/16/2024 12:47

Determination of Carbonyl Compounds	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 8315								
Formaldehyde	<10.0	10.0	ug/L	1		12/18/24 0914	12/19/24 1113	PDS

Determination of Conventional Chemistry Parameters	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 410.4, Rv. 2 (1993)								
COD, total	**55**	54	mg/L	1		12/23/24 0911	12/24/24 0823	CES
EPA 420.1								
Phenols, total	<0.070	0.070	mg/L	1	**A9**	12/31/24 0829	12/31/24 1608	KKJ
EPA 9020B								
Total Organic Halogens (TOX)	<0.010	0.010	mg/L	1		01/02/25 0000	01/03/25 1552	CSM
SM 2510 B-2011								
Conductivity	**1150**	2.0	uS/cm	1		12/18/24 1340	12/18/24 1448	BSS
SM 4500-H+ B-2011								
pH	**6.7**	0.5	pH	1	**H4**	12/18/24 1342	12/18/24 1453	BSS
TIMBERLINE								
Nitrogen, Ammonia	<0.10	0.10	mg/L	1		12/20/24 1242	12/20/24 1435	RAF
USGS I-3765-85								
Total Suspended Solids (TSS)	**632**	20	mg/L	20		12/18/24 1505	12/19/24 0940	KDA

Determination of Inorganic Anions	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 9056A								
Fluoride	<0.1	0.1	mg/L	1		12/31/24 0000	12/31/24 1156	MID
Chloride	**15.8**	1.0	mg/L	1		12/31/24 0000	12/31/24 1156	MID
Sulfate	**107**	1.0	mg/L	1		12/31/24 0000	12/31/24 1156	MID

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
EPA 3005A/EPA 6020A								
Antimony, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Arsenic, total	**0.0089**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Barium, total	**0.366**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Beryllium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Cadmium, total	<0.0008	0.0008	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Chromium, total	<0.0080	0.0080	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Cobalt, total	**0.0108**	0.0004	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Copper, total	**0.0107**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV

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Microbac Laboratories, Inc., Newton

CERTIFICATE OF ANALYSIS

1HL1256

Client Sample ID:	Q5		
Sample Matrix:	Aqueous	**Collected By:**	Larry Wood
Lab Sample ID:	1HL1256-01	**Collection Date:**	12/16/2024 12:47

Determination of Total Metals	Result	RL	Units	DF	Note	Prepared	Analyzed	Analyst
Lead, total	**0.0063**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Manganese, total	**0.715**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Molybdenum, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Nickel, total	**0.0139**	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Selenium, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Silver, total	<0.0040	0.0040	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Thallium, total	<0.0020	0.0020	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Vanadium, total	<0.0200	0.0200	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
Zinc, total	**0.0241**	0.0200	mg/L	4		12/19/24 0854	12/20/24 1923	RVV
EPA 3010A/EPA 6010B								
Aluminum, total	**2.38**	0.050	mg/L	1		12/20/24 1341	12/24/24 0104	JAR
Boron, total	<0.100	0.100	mg/L	1		12/20/24 1341	12/24/24 0104	JAR
Iron, total	**13.6**	0.100	mg/L	1		12/20/24 1341	12/24/24 0104	JAR
Magnesium, total	**49.7**	0.100	mg/L	1		12/20/24 1341	12/24/24 0104	JAR
EPA 7470A								
Mercury, total	<0.00050	0.00050	mg/L	1		12/20/24 1407	12/23/24 1244	JAR

Definitions

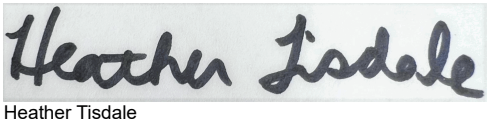
A9: Sample was improperly preserved.

H4: The test was performed outside of the EPA recommended holding time of 15 minutes.

RL: Reporting Limit

Report Comments

Reviewed and Approved By:



Heather Tisdale
Customer Relationship Specialist
heather.tisdale@microbac.com
01/07/25 09:26

CHAIN OF CUSTODY RECORD

Keystone LABORATORIES
A Microbac Company
600 East 17th Street South
Newton, IA 50208
641-792-8451

1HL1256

Stone Environmental Engineering
PM: Heather Tisdale

SITE INFORMATION
Sampler:
Project: SEE 001

REPORT TO
Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

INVOICE TO
Donn Stone
Stone Environmental Engineering
1631 NW 30th Court
Ankeny, IA 50023

SPECIAL INSTRUCTIONS
None

Turn Around Time
☐ Standard ☐ RUSH, need by ___/___/___

LAB USE ONLY
Work Order 1HL1256
Temperature 0.5
Turn-Cooler: No

- ☐ Custody Seal
- ☒ Containers Intact
- ☒ COC/Labels Agree
- ☐ Preservation Confirmed
- ☒ Received on Ice

Number	Sample Identification / Client ID	Matrix	Sample Type	Date	Time	Number of Containers	Analyses	Lab Sample Number
-005	QS	Aqueous	GRAB	Dec 16	1247	6	8315@Formaldehyde ag-t-6020 as-t-6020 be-t-6020 cd-t-6020 cod-t-410.4 co-t-6020 cu-t-6020 fe-t-6010 mg-t-6010 mo-t-6020 ni-t-6020 ph-4500 sb-t-6020 so4-9056-w tss-i-3765-85 zn-t-6020 9020-100 al-t-6010 ba-t-6020 b-t-6010 cl-9056-w cond-2510 cr-t-6020 f-9056 hg-t-7470 mn-t-6020 nh3-timberline pb-t-6020 phenol-t-420.1 se-t-6020 tl-t-6020 v-t-6020	1

Relinquished By DSA Date/Time 12/17 0700

Received By Date/Time

Relinquished By Date/Time

Received for Lab By Kay Wood 12/17/24 0905 Date/Time

Remarks:

Original - Lab Copy Yellow - Sampler Copy