2024
ANNUAL GROUNDWATER QUALITY REPORT

OF

THE CEDAR RAPIDS WPCF ASH MONOFILL
57-SDP-07-85P
CEDAR RAPIDS, IOWA

by:
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December, 2024

HLW Engineering Group
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3422-21A.320

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December 16, 2024

Mr. Brian Rath, P.E.
Environmental Engineer Senior
Iowa Department of Natural Resources
6200 Park Avenue, Suite 200
Des Moines, Iowa 50321

HLW Engineering Group
Engineering Management

RE: CEDAR RAPIDS WATER POLLUTION CONTROL FACILITIES ASH MONOFILL 2024 ANNUAL WATER QUALITY REPORT SDP PERMIT #57-SDP-07-85P

Dear Mr. Rath:

This letter forwards the results of water quality testing at the Cedar Rapids Water Pollution Control Facility (WPCF) Ash Monofill that was performed in accordance with Special Provision X.4 of the SDP Permit (Appendix A).

1. BACKGROUND INFORMATION

Site Facilities - Two lagoons with bentonite/clay liners were constructed in 1985 to receive ash slurry from the sludge incinerator at the Cedar Rapids WPCF. The industrial monofill (consisting of the two lagoons) operated under IDNR SDP Permit #57-SDP-07-85P. The ash slurry was deposited in the lagoons, allowed to dewater, and the dewatered ash was periodically removed from the lagoons for disposal.

Due to groundwater quality concerns, Special Provision 2a of the October 6, 2008 SDP Permit required that "A waste disposal unit shall be constructed in accordance with the liner requirements pursuant to Subparagraph 115.26(1)"d"(2) by September 23, 2011; and waste disposal shall cease in the North and South Cells." Ash disposal in the original lagoons ceased prior to September 23, 2011. Accumulated ash was removed from the south lagoon in 2011. Accumulated ash was removed from the north lagoon in 2013.

Two lined disposal areas have been constructed on site to replace the original lagoons. The design of the lined disposal areas exceeds the requirements of IAC 567-115 "Sanitary Landfills: Industrial Monofills" and IAC 567-113 "Sanitary Landfills for Municipal Solid Waste: Groundwater Protection Systems for the Disposal of Nonhazardous Wastes". The liner in each area consists of a Subtitle D compliant composite liner, a leachate collection layer, and an additional 60 mil HDPE flexible membrane liner over the top of the leachate collection layer/Subtitle D compliant composite liner. The objective of the additional 60 mil HDPE flexible membrane liner is to limit the liquid level that is directly in contact with the Subtitle D composite liner.

Construction of the lined South Disposal Area in the former south lagoon footprint was completed in 2011. The Quality Control and Assurance Report for the South Disposal Area was submitted on December 16, 2011 (Doc #67950). Ash deposition in the South Disposal Area was authorized in Special Provision X.2 of the SDP Permit dated February 9, 2012 and began in April, 2012.

Construction of the lined North Disposal Area in a portion of the former north lagoon footprint was completed in 2016. The Quality Control and Assurance Report for the North Disposal Area was submitted on October 13, 2016 (Doc #87418). Ash deposition in the North Disposal Area was authorized in Permit Amendment #2 dated November 15, 2016 and began in March, 2017.

Variance Applied to the Site - IAC 567-115.27(8) prohibits the disposal of free liquids or waste containing free liquid in a landfill. A variance from IAC 567-115.27(8) to allow the ash slurry to be deposited in the lined disposal area(s) was approved by IDNR on May 12, 2011 (Doc #65122). The variance is included in Appendix A.

IAC 567-115.26(4)"d" and "e" require sampling for dissolved metals and IAC 567-115.26(4)"f" requires annual sampling for total organic halogens and phenols. A variance from IAC 567-115.26(4) to allow sampling for total recoverable metals and from IAC 567-115.26(4)"f" to discontinue sampling for total organic halogens and phenols was approved by IDNR on September 12, 2018 (Doc #93200). The variance is included in Appendix A. Based on an email from IDNR on November 20, 2018 (Appendix A), total metals testing is currently required for arsenic, barium, iron, and magnesium.

The geology of the site has been documented in past Annual Water Quality Reports (AWQR) as well as the 2015 Permit Renewal Documentation (Doc #82547) and is not reiterated in this AWQR.

Impending HMSP Modifications - The Hydrologic Monitoring System Plan (HMSP) was approved in Special Provision X.4 of the SDP Permit (Appendix A). The approved HMSP includes the following nine (9) monitoring wells:

- upgradient, MW-26
- downgradient, MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, and MW-24.

Table 1 and 2 summarize the HMSP and the implementation schedule as approved in the Permit. The currently approved monitoring network is illustrated on Figures 1 and 2.

It has been recognized that the current HMSP is not appropriate to adequately monitor the site and incorporates a single background well (MW-26). Spatial variability exists throughout the site and cannot be quantified with the use of a single background well. Further, it is recognized that MW-26 is located remote to the area of interest in undisturbed glacial clay soils above the alluvial floodplain where the remaining wells are completed.

On September 7, 2023, IDNR was notified of the intent to construct significant modifications to the WPCF. The proposed modifications will include construction of a new disposal area east of the North Disposal Area, closure of the South Disposal Area, and installation of monitoring wells that will be included in a future HMSP. Abandonment of some of the monitoring wells that are included in the current

HMSP is also proposed. A request to postpone changes to the HMSP was filed by the Cedar Rapids WPCF (Doc #107650). The request asked that the HMSP be modified after construction of the WPCF upgrades is completed. The request was approved September 7, 2023 (Doc #107650). An updated HMSP was included in the Permit Modification request by HDR dated April 18, 2024 (Doc #109868). The updated HMSP was approved by IDNR in SDP Permit Revision #2 dated May 17, 2024. IDNR provided additional comments regarding the proposed abandonment of MW-3R1, MW-22, and MW-24 in a letter dated July 22, 2024. Based on that letter, abandonment of some of these points may not be allowed. As per the IDNR letter "the DNR recommends the permit holder plan on retaining these monitoring points unless something drastically changes".

At this time it is anticipated that the HMSP revisions will start being implemented in 2025.

Implied Significance of Water Quality Findings (2024) – Water quality is reported herein according to the current HMSP approved in the Permit. Given that the current HMSP approved in the Permit is recognized as inadequate by all parties and given that changes to the HMSP are warranted and are pending completion of the future plant modifications, it is requested that no binding conclusions be made regarding water quality at this time.

Conclusions related to water quality should be suspended until such time as the plant modifications are completed, the HMSP is defined in the future, and the use of intrawell statistics and/or interwell statistic combined with intrawell statistics are employed in the future.

Additional Documentation Required in the December 15, 2022 IDNR Letter –

The documentation required in the IDNR letter covering the sampling method and the verification method was provided in the 2023 AWQR (Doc #108495).

2. WATER QUALITY

The Spring and Fall 2024 semi-annual water sampling events were conducted in accordance with Special Provision X.4 of the SDP Permit (Appendix A).

Statistical Evaluations are prepared by Otter Creek Environmental Services annually. Results of the Ground Water Statistics for Ash Monofill Facility, Semi-Annual Monitoring Events in 2024 dated November, 2024 is included in Appendix B.

The laboratory Analytical Reports for the Spring and Fall sampling events are included in Appendix C. Field Sampling forms for the sampling events are included in Appendix D.

A comprehensive summary of Analytical Data for the episodes between April 26, 2018 and October 24, 2024 is included in Table 9.

3. BACKGROUND DATA VALIDATION

Background data for the facility is based on sampling results from April 26, 2018 to October 24, 2024 exclusively from MW-26. As noted above in the "Impending HMSP Modifications" section, modifications to the HMSP, including establishing new background wells, will commence in 2025.

4. STATISTICALLY SIGNIFICANT INCREASES (SSI)

The detected concentrations of each compound are compared to the prediction limit for each respective compound calculated based on the background data set from MW-26 (Table 5). A compound detected at a concentration that is in excess of the calculated prediction limit is recorded as a Statistically Significant Increase (SSI).

As noted earlier in this report, the database from the single background well is not appropriate to adequately monitor the site. Table 6 is a summary of potential SSI recorded based on the background established in MW-26. Every downgradient well has recorded SSI when the current HMSP is utilized and interwell statistics are employed.

Using an intrawell statistical approach there are no SSI recorded at the site in the Fall of 2024. Table 6A is a summary of potential SSI recorded in the Spring of 2024 based on control limits utilizing an intrawell statistical approach.

5. STATISTICALLY SIGNIFICANT LEVELS (SSL)

An evaluation of the Confidence Intervals is not completed herein, as such an evaluation is not considered appropriate at this time due to the significant changes in the HMSP that are anticipated to occur in 2025. It follows that the SSI for the site will be subject to significant changes based on the background wells included in the future HMSP. At this time, it is unclear which potential SSI merit evaluation for SSL. Additionally, there has been no consideration given to what site-specific GWPS may, or may not, apply to the site based on future prediction limit calculations if a different background set is ultimately approved.

Further, if an intrawell statistical approach is approved in the future then it appears that SSI may be few and/or may not exist, and an evaluation of potential SSL may not be required.

It is concluded that evaluation of potential SSL through a confidence interval evaluation should only be completed in the future when both the HMSP and the statistical approach are established.

6. WELL MAINTENANCE AND REEVALUATION PLAN

Monitoring well hydraulic conductivity data was assessed in 1992, 2000, 2005, 2014, 2019, and 2024. The previous Monitoring Well Performance Reevaluation was completed in 2019 and was included in the 2019 AWQR (Doc #96348). A Monitoring Well Performance Reevaluation was completed in 2024 and is included in Appendix E. Note that as per IAC 567-115.21 a Monitoring Well Performance Reevaluation should be completed every 5 years.

The frequency of groundwater level measurements was reduced from quarterly to semi-annually as per Special Provision X.4.h of the SDP Permit (Attachment A). Water elevation measurements were collected at each well during semi-annual sampling events (April, 2024 and October, 2024). The water elevations from each monitoring well are included in Table 4. Review of the water elevation data for 2024 does not indicate excessive variability compared to historic water elevation data. Based on the available water elevation data, the assessment of well conditions during sampling, and the hydrologic conditions at the site, the semi-annual water level measurements are interpreted to be sufficient to gauge notable changes in the site hydrology. The October, 2024 Water Table Contour Map (Figure 2) is included herein and illustrates groundwater flow paths across the site. As requested in the IDNR December 15, 2022 comment letter, the influence of the groundwater underdrain for the South Disposal Area has been incorporated into the Water Table Contour Map.

7. LCS PERFORMANCE

The leachate control system (LCS) in each disposal area consists of a drainage layer of a geonet composite (slopes) or clean sand (base) and leachate collection pipes that underlie the top flexible membrane liner of the double liner system. The LCS drains back to the WPCF for treatment and disposal.

A groundwater diversion system was installed under the South Disposal Area. The groundwater diversion system consists of a layer of geonet under the Subtitle D composite liner and a groundwater collection pipe. The groundwater diversion system drains back to the WPCF for treatment and disposal. Due to historical data documenting over a 5' separation between the base of waste elevation in the North Disposal Area and the groundwater elevations recorded in the site monitoring wells, a groundwater diversion system was not required for the North Disposal Area.

Two leachate head monitoring points were installed in the South Disposal Area. One point was installed in the drainage media to monitor the liquid level on the Subtitle D compliant liner, the other was installed in the leachate pipe trench. Note that approval to stop measuring "leachate head levels at the monitoring point in the South Cell located in the leachate pipe trench" was included in the IDNR letter dated August 28, 2017 (Doc #90204). A groundwater head monitoring point was also installed in the South Disposal Area.

Leachate levels in the leachate head monitoring point in the South Disposal Area were less than 12" in 2024 during all monthly measurements. The measurements are included on Table 12.

Groundwater levels in the groundwater head monitoring point in the South Disposal were less than 12" in 2024 during all monthly measurements. Based on the groundwater head data presented in Table 12 separation is maintained between the base of the waste and the groundwater surface.

One leachate head monitoring point was installed in the drainage media in the North Disposal Area to monitor the liquid level on the Subtitle D compliant liner.

As discussed in previous AWQR's, levels in the leachate head monitoring point in the North Disposal Area have consistently been recorded as greater than 12". The 2023 Spring Semi-Annual Engineer's Report (Doc #106153) contained the following regarding the historic elevated leachate levels: "In late 2022 a valve in the leachate conveyance system for the North Disposal Area was found to be inadvertently closed. The valve was opened and a subsequent drop in recorded leachate levels in the North Disposal Area was noted." No measurements in 2023 from the leachate head monitoring point exceeded 12". The measurement from the leachate head monitoring point on February 1, 2024 did exceed 12" (1.1' recorded). On February 13, 2024 City staff unsuccessfully attempted to pump accumulated water from the measurement point to determine if perched water in the point was the source of the elevated measurements. The point was measured again on February 14, 2024 and the measurement still exceeded 12" (1.1'). On February 15, 2024 City staff blew compressed air into the tubing in the measurement point to determine if debris in the tubing was the source of the elevated readings and the point measured 0.4' afterwards. All measurements during 2024, with the exception of the February 1, 2024 and February 14, 2024 measurements discussed above, have been less than 12". The measurements are included on Table 12.

The leachate collection pipes in the North and South Disposal Areas were cleaned during July, 2024 and September, 2024 respectively. The lines should be cleaned again in 2027, at the latest, to maintain the 3 year cleaning interval required by IAC 567-115.26(11)a.8.

Based on available data, it appears that the existing Leachate Collection System (North and South Disposal Areas) and Groundwater Diversion System (South Disposal Area only) is effective in maintaining control of the groundwater surface in the area.

8. RECOMMENDATIONS

a. Continue to perform monthly leachate head and groundwater head measurements and continue to reevaluate levels in the Annual Water Quality Report in November of each year.

b. Continue to perform semi-annual sampling episodes from site monitoring wells in accordance with Special Provision X.4 of the SDP Permit.

c. Following completion of CRWPCF improvements, the HMSP should be revised and the statistical approach for evaluation of water quality data should be established and approved.

d. Continue to perform semi-annual water level measurements in site monitoring wells in accordance with Special Provision X.4.h of the SDP Permit.

e. Continue to perform semi-annual Engineer's inspections as per the General Conditions of the SDP Permit.

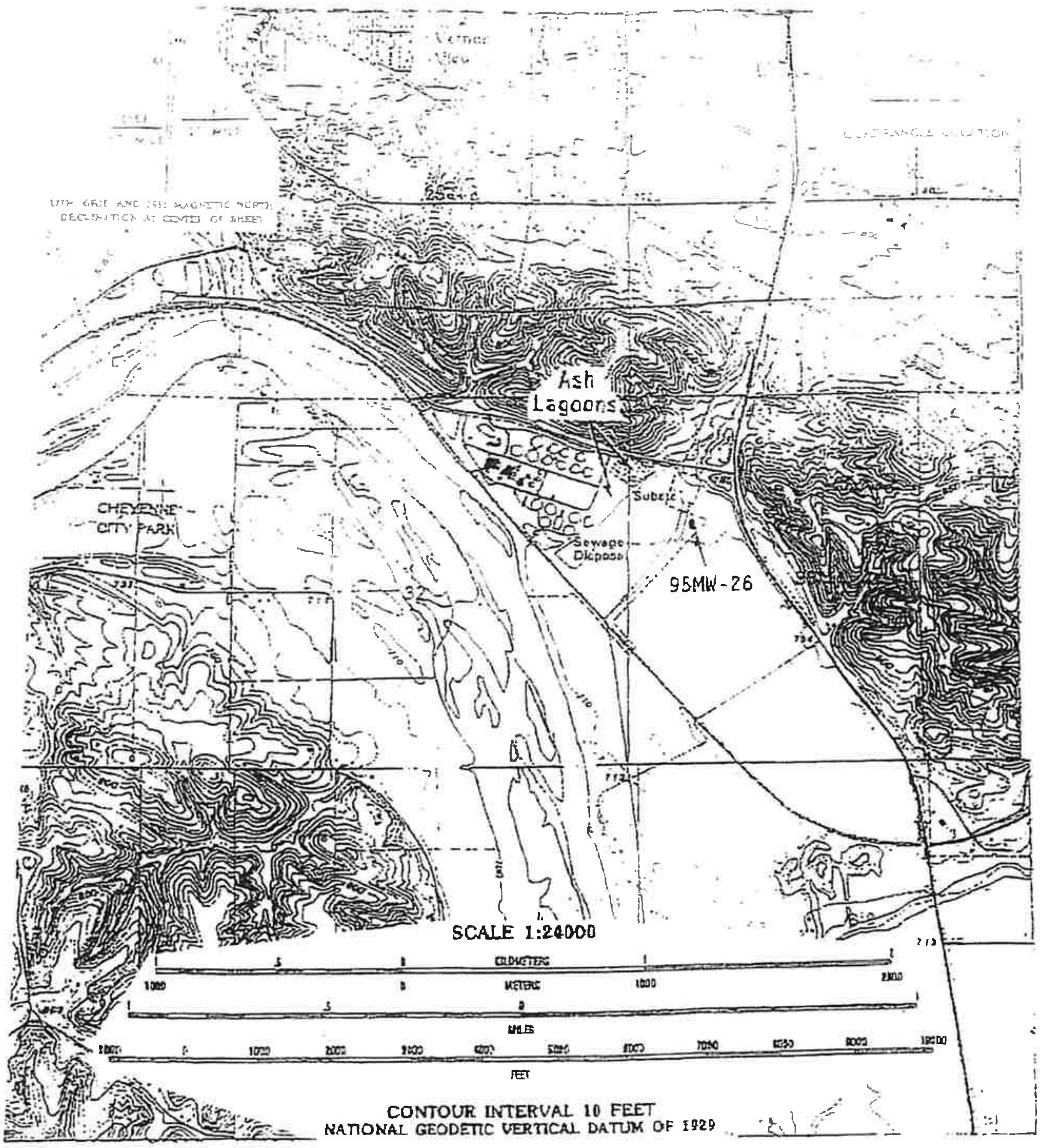
f. Continue to clean leachate collection lines on a three (3) year interval, at a minimum, in accordance with IAC 567-115.26(11)a.8. The next cleaning should be conducted in 2027 at the latest.

g. Perform the next Monitoring Well Maintenance Performance Reevaluation in 2029.

Please feel free to contact our office at (515) 733-4144 with any questions you may have.

DOUGLAS J. LUZBETAK LICENSED 12654 IOWA PROFESSIONAL ENGINEER	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa. 12/16/24 DOUGLAS J. LUZBETAK, P.E. DATE License number 12654 My license renewal date is December 31, 2024. Pages or sheets covered by this seal: All except Appendices A-D

cc: *Jason Decker, Environmental and Compliance Program Manager, Cedar Rapids WPCF (electronic copy)*



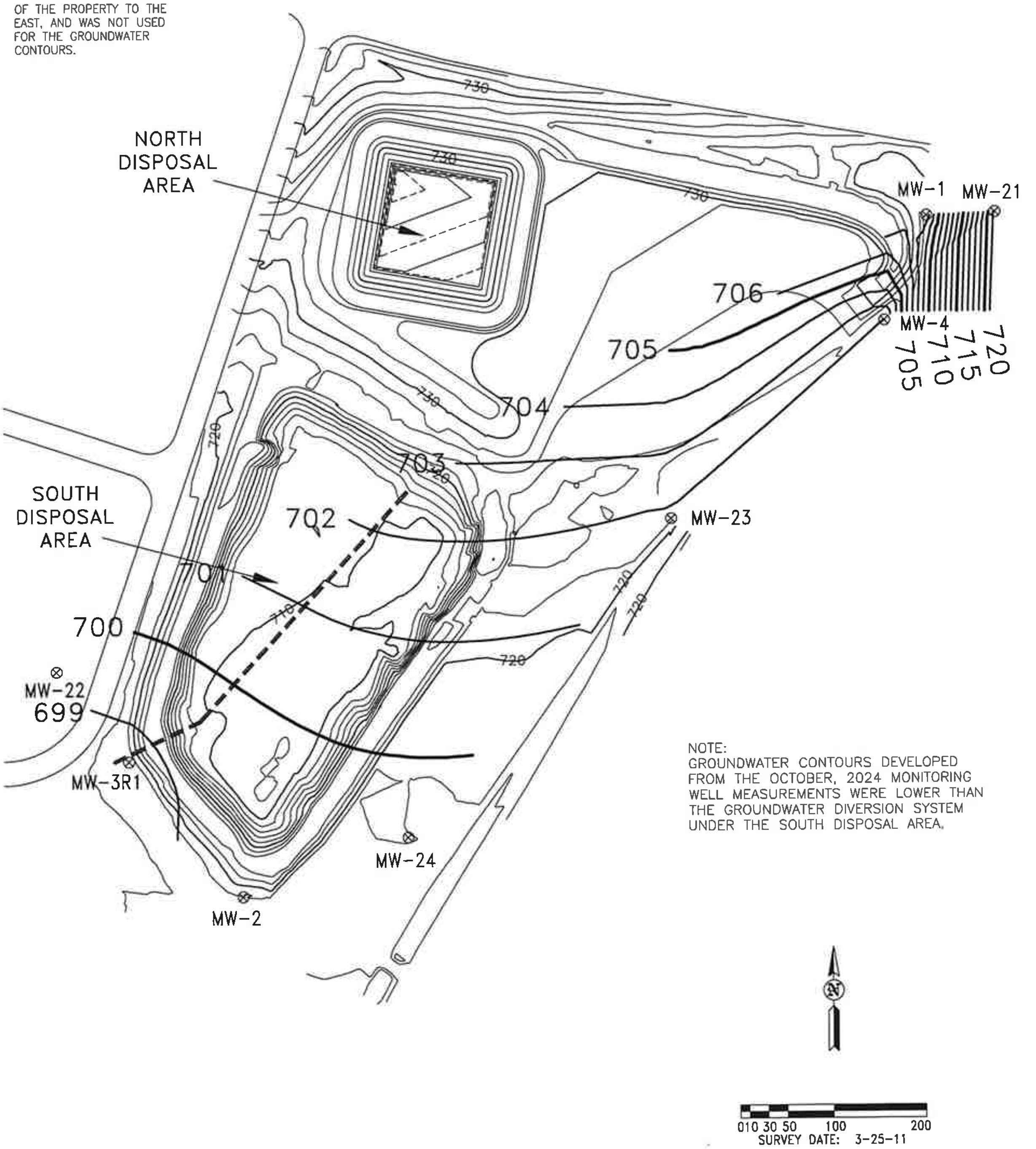
Map showing location of 95MW-26, the new background monitor well for Cedar Rapids Water Pollution Control Facility ash lagoons. Adapted from U.S. Geological Survey (1993) 7.5-minute Bertram Quadrangle.

Figure taken from 11/3/1995 letter from Midwest Environmental Consulting to IDNR

FIGURE: 1

WATER ELEVATION OCT 23–24, 2024	
WELL	ELEV.
MW–1	707.39
MW–2	699.58
MW–3R1	698.58
MW–4	701.97
MW–21	721.28
MW–22	699.28
MW–23	701.80
MW–24	699.37
MW–26	700.87

TABLE NOTES:
MW–26 IS LOCATED OFF OF THE PROPERTY TO THE EAST, AND WAS NOT USED FOR THE GROUNDWATER CONTOURS.



NOTE:
GROUNDWATER CONTOURS DEVELOPED FROM THE OCTOBER, 2024 MONITORING WELL MEASUREMENTS WERE LOWER THAN THE GROUNDWATER DIVERSION SYSTEM UNDER THE SOUTH DISPOSAL AREA.

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GROUNDWATER CONTOURS

ASH LAGOONS
CEDAR RAPIDS WATER POLLUTION CONTROL
CEDAR RAPIDS, IOWA

FIGURE: 2		
REVISION	NO	DATE
DRAWN DRA	PROJECT NO. 3422	DATE 11–3–24

Table 1 – Monitoring Program Summary

Table 1
Monitoring Program Summary
Annual Water Quality Report
Cedar Rapids WPCF Ash Monofill
Permit No. 57-SDP-07-85P

Water Table System

Monitoring Well	Formation	Current Monitoring Program	Change for next sampling event	Historic - Constituents that exceed a control limit	Current Year - Constituents that exceed a control limit	Historic - Constituents w/95% LCL over GWPS	2024 - Constituents w/95% LCL over GWPS	Total # of Samples in each monitoring program since April 26, 2018		
								Detection	Assessment	Corrective Action
MW-26	Glacial Till	Background	NC	*Not yet determined based on future HMSP changes and statistical methods employed in 2025*	*Not yet determined based on future HMSP changes and statistical methods employed in 2025*	NA	NA	14	0	0
MW-1	Glacial Till	Detection	NC			NA	NA	14	0	0
MW-2	Glacial Till	Detection	NC			NA	NA	14	0	0
MW-3R1	Glacial Till	Detection	NC			NA	NA	14	0	0
MW-4	Glacial Till	Detection	NC			NA	NA	14	0	0
MW-21	Glacial Till	Detection	NC			NA	NA	14	0	0
MW-22	Glacial Till	Detection	NC			NA	NA	15	0	0
MW-23	Glacial Till	Detection	NC			NA	NA	14	0	0
MW-24	Glacial Till	Detection	NC			NA	NA	14	0	0

Table 2 – Monitoring Program Implementation Schedule

Table 2
Monitoring Program Implementation Schedule
Annual Water Quality Report
Cedar Rapids WPCF Ash Monofill
Permit No. 57-SDP-07-85P

Monitoring Well	Recent Sampling Dates and Constituents	Current Year Sampling Dates and Constituents		Supplemental Sampling	
		April, 2025*	October, 2025*	Previously Collected	Next Event
MW-26 (b)	4/26/18, 10/15/18, 4/23/19, 10/22/19, 4/21/20, 10/12/20, 4/14/21, 10/19/21, 4/14/22, 10/13/22, 4/19/23, 10/20/23, 4/10/24, 10/23/24	List 1	List 1	N/A	N/A
MW-1	4/26/18, 10/15/18, 4/23/19, 10/22/19, 4/21/20, 10/13/20, 4/14/21, 10/19/21, 4/14/22, 10/13/22, 4/19/23, 10/20/23, 4/10/24,10/23/24	List 1	List 1	N/A	N/A
MW-2	4/27/18, 10/16/18, 4/24/19, 10/23/19, 4/21/20, 10/13/20, 4/15/21, 10/20/21, 4/15/22, 10/14/22, 4/19/23, 10/20/23, 4/11/24, 10/24/24	List 1	List 1	N/A	N/A
MW-3R1	6/5/18, 10/16/18, 4/24/19, 10/23/19, 4/21/20, 10/13/20, 4/15/21, 10/20/21, 4/15/22, 10/14/22, 4/19/23, 10/20/23, 4/11/24, 10/24/24	List 1	List 1	N/A	N/A
MW-4	4/26/18, 10/15/18, 4/23/19, 10/22/19, 4/21/20, 10/12/20, 4/14/21, 10/19/21, 4/14/22, 10/13/22, 4/19/23, 10/18/23. 4/10/24, 10/23/24	List 1	List 1	N/A	N/A
MW-21	4/26/18, 10/15/18, 4/24/19, 10/22/19, 4/21/20, 10/13/20, 4/14/21, 10/20/21, 4/14/22, 10/13/22, 4/19/23, 10/24/23, 4/11/24, 10/23/24	List 1	List 1	N/A	N/A
MW-22	4/27/18, 10/16/18, 4/24/19, 10/23/19, 4/21/20, 10/13/20, 4/15/21, 10/20/21, 4/15/22, 10/14/22, 4/20/23, 5/24/23, 10/20/23, 4/11/24, 10/24/24	List 1	List 1	N/A	N/A
MW-23	4/26/18, 10/16/18, 4/24/19, 10/23/19, 4/21/20, 10/12/20, 4/14/21, 10/19/21, 4/15/22, 10/13/22, 4/19/23, 10/18/23, 4/10/24, 10/23/24	List 1	List 1	N/A	N/A
MW-24	4/26/18, 10/16/18, 4/24/19, 10/23/19, 4/21/20, 10/12/20, 4/14/21, 10/19/21, 4/14/22, 10/13/22, 4/19/23, 10/18/23, 4/11/24, 10/23/24	List 1	List 1	N/A	N/A

*** Based on current HMSP**
(b) background well
List 1 - IAC 567-115.26(4)"e" minus dissolved Fe plus total As Ba, Fe, Mg

Table 3 – Monitoring Well Maintenance and Performance Reevaluation Schedule

Table 3
Monitoring Well Maintenance and Performance Revaluation Schedule
Annual Water Quality Report
Cedar Rapids WPCF Ash Monofill
Permit No. 57-SDP-07-85P

Compliance with:	Monitoring Calendar Years														
	1992	---	---	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
567 IAC 115.21(2)"a" - high and low water levels (biennial)	X			X	X	X	X	X	X	X	X	X	X	X	X
567 IAC 115.21(2)"b" - changes in the hydrologic setting and flow paths (biennial)	X			X	X	X	X	X	X	X	X	X	X	X	X
567 IAC 115.21(2)"c" - well depths (annual)	X			X	X	X	X	X	X	X	X	X	X	X	X
567 IAC 115.21(2)"d" - in-situ permeability testing (1 per 5 years)	X			X					X						

Compliance with:	Monitoring Calendar Years														
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
567 IAC 115.21(2)"a" - high and low water levels (biennial)	X	X	X	X	X	X	X	X	X	X	X	X	X	P	P
567 IAC 115.21(2)"b" - changes in the hydrologic setting and flow paths (biennial)	X	X	X	X	X	X	X	X	X	X	X	X	X	P	P
567 IAC 115.21(2)"c" - well depths (annual)	X	X	X	X	X	X	X	X	X	X	X	X	X	P	P
567 IAC 115.21(2)"d" - in-situ permeability testing (1 per 5 years)			X					X					X		

X = completed
P = Planned
N/A = Not Applicable

Table 4 – Monitoring Well Maintenance and Performance Summary

Table 4
Monitoring Well Maintenance and Performance Summary
Annual Water Quality Report
Cedar Rapids WPCF Ash Monofill
Permit No. 57-SDP-07-85P

Well	Top of casing	Top of Screen	Total Depth		Date of Measurements		Maximum Depth Discrepancy (ft)	Hydraulic Cond. (cm/sec)/date	Most Recent Recharge Rate	
					4/10/24-4/11/24	10/23/24-10/24/24			**2024**	Change
MW-26(b)	725.81	710.4	25.41	Groundwater Level (ft)	22.95	22.94	-0.4	>1.0E-03* 2000	>1.0E-03*	Not Appreciable
				Groundwater Elevation (Ft MSL)	702.86	702.87				
				Measured Well Depth (ft)	25.79	25.81				
				Submerged (+) or Exposed screen (-)	-7.54	-7.53				
MW-1	730.72	698.9	36.82	Groundwater Level (ft)	22.93	23.33	2.06	1.80E-04 1992	>1.0E-03*	Not Appreciable
				Groundwater Elevation (Ft MSL)	707.79	707.39				
				Measured Well Depth (ft)	34.78	34.76				
				Submerged (+) or Exposed screen (-)	8.89	8.49				
MW-2	720.04	704.4	25.64	Groundwater Level (ft)	20.5	20.46	-0.16	2.80E-01 1992	>1.0E-03*	Not Appreciable
				Groundwater Elevation (Ft MSL)	699.54	699.58				
				Measured Well Depth (ft)	25.7	25.8				
				Submerged (+) or Exposed screen (-)	-4.86	-4.82				
MW-3R1	719.42	702.7	26.75	Groundwater Level (ft)	20.86	20.84	-0.48	>1.0E-03* 2019	>1.0E-03*	Not Appreciable
				Groundwater Elevation (Ft MSL)	698.56	698.58				
				Measured Well Depth (ft)	27.16	27.23				
				Submerged (+) or Exposed screen (-)	-4.14	-4.12				
MW-4	726.78	703.9	27.88	Groundwater Level (ft)	24.71	24.81	0.11	3.00E-01 1992	>1.0E-03*	Not Appreciable
				Groundwater Elevation (Ft MSL)	702.07	701.97				
				Measured Well Depth (ft)	27.78	27.77				
				Submerged (+) or Exposed screen (-)	-1.83	-1.93				
MW-21	729.93	717.9	27.03	Groundwater Level (ft)	5.58	8.65	-0.46	1.10E-05 1992	6.73E-06	Not Appreciable
				Groundwater Elevation (Ft MSL)	724.35	721.28				
				Measured Well Depth (ft)	27.49	27.43				
				Submerged (+) or Exposed screen (-)	6.45	3.38				
MW-22	718.4	706.8	26.6	Groundwater Level (ft)	19.28	19.12	0.61	1.50E-01 1992	>1.0E-03*	Not Appreciable
				Groundwater Elevation (Ft MSL)	699.12	699.28				
				Measured Well Depth (ft)	26.58	25.99				
				Submerged (+) or Exposed screen (-)	-7.68	-7.52				
MW-23	725.41	701.9	33.51	Groundwater Level (ft)	23.54	23.61	-0.29	8.10E-02 1992	>1.0E-03*	Not Appreciable
				Groundwater Elevation (Ft MSL)	701.87	701.8				
				Measured Well Depth (ft)	33.8	33.76				
				Submerged (+) or Exposed screen (-)	-0.03	-0.1				
MW-24	720.27	705.7	29.57	Groundwater Level (ft)	20.94	20.9	-0.27	1.60E-01 1992	>1.0E-03*	Not Appreciable
				Groundwater Elevation (Ft MSL)	699.33	699.37				
				Measured Well Depth (ft)	29.84	29.73				
				Submerged (+) or Exposed screen (-)	-6.37	-6.33				

* Well recovery rates were too rapid to measure so assumed a hydraulic conductivity of greater than 1.0E-03 cm/sec.

Table 4A – Routine Water Levels

Table 4A
Supplemental Water Elevation Data
Annual Water Quality Report
Cedar Rapids WPCF Ash Lagoons
Permit No. 57-SDP-07-85P

	MW-1	MW-2	MW-3R1	MW-4	MW-21	MW-22	MW-23	MW-24	MW-26
TOC Elev. (ft)	730.72	720.04	719.42	726.78	729.93	718.4	725.41	720.27	725.81
Screened Int.	693.9-698.9	694.4-704.4	692.7-702.7	698.9-703.9	702.9-717.9	691.8-706.8	691.9-701.9	690.7-705.7	700.4-710.4
	Elev (ft)	Elev (ft)	Elev (ft)	Elev (ft)	Elev (ft)	Elev (ft)	Elev (ft)	Elev (ft)	Elev (ft)
11/6/95	710.55	700.77		704.83	724.68	701.45	704.40	702.40	704.83
3/12/96	709.47	700.35	---	702.33	724.15	700.40	702.26	701.25	703.08
6/20/96	712.02	701.77	---	704.80	724.22	702.03	704.52	702.93	705.66
10/9/96	709.48	700.10	---	702.53	723.84	700.08	702.27	---	703.71
4/9/97	710.27	702.15	---	705.13	724.49	702.20	703.43	702.55	703.08
10/9/97	708.08	698.98	---	702.67	723.68	699.23	702.53	700.67	703.46
4/15/98	710.76	700.96	---	705.18	725.11	701.04	705.16	702.82	705.27
10/16/98	711.62	702.94	---	704.45	725.60	702.86	704.52	703.58	705.71
4/7/99	711.95	701.69	---	708.33	725.71	702.86	708.38	703.88	704.63
10/1/99	710.92	701.81	---	707.83	724.71	703.01	707.64	703.86	703.40
4/26/00	709.86	701.39	---	706.79	724.94	701.96	706.45	703.01	703.51
10/13/00	711.07	703.08	---	708.80	724.79	703.80	708.49	704.75	705.26
4/20/01	715.83	706.93	---	712.51	725.05	707.15	712.23	709.06	709.85
10/4/01	711.84	703.94	---	708.94	723.68	704.20	708.57	705.40	707.10
4/18/02	711.21	702.90	---	706.87	724.22	703.11	707.53	705.04	706.69
10/9/02	712.16	704.58	---	708.25	724.42	704.41	707.93	705.59	707.51
4/4/03	709.20	701.33	---	705.66	724.43	701.40	705.37	702.97	705.13
10/10/03	709.35	702.86	---	708.24	725.62	703.10	707.75	704.32	705.71
4/15/04	712.94	---	---	711.41	723.74	---	711.83	---	707.29
10/18/04	710.47	699.69	---	705.86	723.18	700.26	705.59	702.76	705.97
4/18/05	711.10	702.46	---	707.87	724.39	702.15	708.06	705.94	707.48
10/20/05	708.02	699.79	---	703.67	722.09	699.87	703.56	701.82	704.33
4/13/06	709.42	701.34	---	704.51	724.11	701.05	704.96	703.27	704.09
10/5/06	707.67	700.20	---	703.37	722.19	700.23	703.34	701.89	703.76
4/19/07	710.31	705.23	---	705.62	724.45	704.85	706.73	705.94	704.22
10/4/07	709.25	701.71	---	704.07	723.64	701.42	704.12	703.11	704.57
4/23/08	716.87	706.35	---	714.64	725.66	705.90	713.75	709.35	712.61
10/9/08	711.70	698.57	---	704.14	723.23	698.18	703.49	701.00	705.87
4/29/09	715.60	708.12	---	714.28	725.61	707.75	713.76	709.53	711.40
10/9/09	715.02	705.23	---	711.12	725.53	705.54	711.18	707.06	709.26
4/9/10	716.73	706.54	---	711.52	725.56	706.32	710.94	707.85	709.25
10/12/10	714.02	701.38	---	708.20	724.27	701.34	707.50	703.73	707.35
4/20/11	714.25	705.17	---	708.86	725.87	704.90	708.46	705.57	708.23
10/13/11	711.51	699.23	---	704.68	723.47	699.25	704.12	701.44	705.42
4/25/12	710.84	699.13	697.93	703.02	723.69	698.63	702.76	701.07	704.42
10/3/12	707.97	697.57	696.48	701.56	719.05	697.02	701.23	699.33	702.89
1/10/13	707.64	696.99	695.74	700.74	723.52	696.16	700.48	698.53	702.05
4/11/13	708.88	697.97	697.27	702.12	725.80	696.82	703.45	701.93	702.39
7/18/13	711.53	699.09	697.87	704.47	722.67	698.53	704.03	701.51	705.66
10/10/13	707.52	697.95	696.83	702.42	722.52	697.22	702.13	699.91	703.93
1/10/14	---	697.52	696.70	701.76	713.41	697.02	701.49	699.25	703.01
4/9/14	708.30	697.99	696.95	701.79	723.91	697.10	701.86	699.93	702.72
7/17/14	712.67	699.81	698.74	704.57	724.16	699.32	704.23	701.99	706.26
10/16/14	710.35	698.45	697.82	702.99	725.68	698.25	702.51	700.31	704.78
1/16/15	709.04	697.90	697.32	701.95	723.93	697.60	701.53	699.49	703.66
4/15/15	708.72	697.69	697.06	701.69	723.98	697.35	701.33	699.30	703.30
7/15/15	710.82	698.33	697.69	702.72	722.93	698.09	702.25	700.09	704.59
10/12/15	709.52	698.15	697.46	702.13	723.14	697.77	701.77	699.75	703.81
1/14/16	---	698.56	697.98	702.99	724.41	698.40	702.53	700.38	705.04
4/7/16	711.57	698.57	697.99	702.96	725.54	698.36	702.51	700.31	704.98
7/6/16	711.72	699.01	698.44	703.32	725.08	698.78	702.82	700.70	705.27
10/11/16	713.28	700.11	699.26	704.42	723.73	699.61	703.89	701.88	706.52
1/17/17	711.70	699.24	698.69	703.73	723.64	699.03	703.24	700.98	705.48
4/20/17	712.94	699.75	699.06	704.03	725.44	699.26	703.55	701.46	706.93
7/20/17	712.08	699.41	698.92	703.93	723.53	699.25	703.42	701.16	705.71
10/18/17	710.18	698.67	---	702.47	722.93	698.46	702.09	699.18	704.06
1/18/18	709.60	698.23	---	701.62	723.59	---	701.31	698.57	703.03
4/26/18	710.21	698.44	---	702.06	723.69	698.17	701.72	698.88	703.51
7/11/18	710.22	699.02	697.81	702.53	722.61	698.90	702.16	699.40	703.83
10/16/18	711.27	700.15	698.55	703.68	725.09	699.60	703.34	700.64	705.42
1/25/19	---	699.75	698.52	703.90	723.94	698.57	703.47	700.44	705.56
4/23/19	713.12	700.63	699.03	705.43	724.93	700.22	704.83	701.45	707.26
7/15/19	713.67	701.14	699.58	705.82	722.56	700.86	705.26	701.87	707.12
10/22/19	712.71	700.49	698.96	704.74	724.63	700.09	704.19	701.06	706.42
1/8/20	711.76	700.07	698.64	704.11	724.14	699.69	703.58	700.54	705.79
4/21/20	712.37	700.73	699.13	704.35	723.96	700.10	703.85	700.94	706.01
7/23/20	712.17	699.81	699.37	704.07	722.73	699.47	703.56	700.39	705.66
10/12/20	710.31	699.99	698.09	703.10	722.81	699.11	702.71	699.82	704.56
4/14/21	711.61	700.12	698.49	704.07	724.74	700.08	703.56	700.53	706.09
10/19/21	708.87	698.70	697.60	701.87	722.09	698.49	701.57	698.84	703.18
4/14/22	709.63	699.59	698.11	702.92	724.15	698.97	702.61	699.75	703.97
10/13/22	708.32	699.39	698.29	702.16	721.82	699.06	701.91	699.33	703.25
4/19/23	710.52	700.55	699.19	704.20	723.55	699.97	703.81	700.82	705.42
10/18/23	706.79	699.24	698.32	701.53	720.11	698.99	701.36	699.00	702.62
4/10/24	707.79	699.54	698.56	702.07	724.35	699.12	701.87	699.33	702.86
10/23/24	707.39	699.58	698.58	701.97	721.28	699.28	701.80	699.37	702.87
Average	710.91	700.57	698.13	704.82	723.81	700.41	704.53	701.94	705.22
Max.	716.87	708.12	699.58	714.64	725.87	707.75	713.76	709.53	712.61
Min.	706.79	696.99	695.74	700.74	713.41	696.16	700.48	698.53	702.05
	MW-1	MW-2	MW-3R1	MW-4	MW-21	MW-22	MW-23	MW-24	MW-26

MW-3R (4/25/12 to 7/20/17) was abandoned during March, 2018 and replaced with MW-3R1 (7/11/18 to present)

Table 5 – Background Summary

Table 5
Background and GWPS Summary
Annual Water Quality Report
Cedar Rapids WPCF Ash Monofill
Permit No. 57-SDP-07-85P

Interwell Background Well - (MW-26)

Inorganics - Appendix I										
Constituent	**Units**	**Model Type**	**Samples - N**	**Detections**	**Mean**	**SD**	**Prediction Limit**	**Confidence**	**GWPS**	**Source**
Ammonia	mg/L	nonparametric	14	0			0.1340	0.94	30	SS
Arsenic (As)	µg/L	nonparametric	14	6			2.2700	0.94	10	SS
Barium (Ba)	µg/L	normal	14	14	142.0000	34.9681	237.8109		2000	SS
COD	mg/L	nonparametric	14	2			8.0000	0.94	NA	NA
Chloride	mg/L	normal	14	14	50.5370	18.1723	100.3283		NA	NA
Cobalt (Co)	µg/L	nonparametric	9	1			0.7500	0.88	2.1	SS
Iron (Fe)	µg/L	normal	12	10	390.2500	235.0281	1053.8260		NA	NA
Magnesium (Mg)	mg/L	normal	14	14	13.1300	3.7919	23.5196		NA	NA
pH	SU	normal	14	14	6.2971	0.2003	5.67-6.92		NA	NA
Specific conductance	µS	normal	14	14	459.3286	161.8383	902.7576		NA	NA

Table 6 – Summary of Well/Detected Constituent Pairs that Exceed the Prediction Limit (Interwell Statistical Evaluation)

Table 6
Summary of Well/Detected Constituent Pairs that Exceed the Prediction Limit (Interwell Statistics)
Annual Water Quality Report
Cedar Rapids WPCF Ash Monofill
Permit No. 57-SDP-07-85P

Well	Compound	Date	Result	Prediction	Monitoring Program
MW-1	Ammonia (mg/L)	04/10/24	0.55	0.1340	Assessment Monitoring
MW-1	Ammonia (mg/L)	10/23/24	0.53	0.1340	Assessment Monitoring
MW-1	Arsenic (ug/L)	04/10/24	3.65	2.2700	Assessment Monitoring
MW-1	Arsenic (ug/L)	10/23/24	3.70	2.2700	Assessment Monitoring
MW-1	Iron (ug/L)	04/10/24	5270	1053.8260	Assessment Monitoring
MW-1	Iron (ug/L)	10/23/24	5400	1053.8260	Assessment Monitoring
MW-1	Magnesium (mg/L)	04/10/24	29.4	23.5196	Assessment Monitoring
MW-1	Magnesium (mg/L)	10/23/24	29.0	23.5196	Assessment Monitoring
MW-1	pH (SU)	04/10/24	6.97	5.67-6.92	Assessment Monitoring
MW-1	Specific Conductance (uS)	10/23/24	956.5	902.76	Assessment Monitoring
MW-2	Cobalt (ug/L)	04/11/24	0.87	0.7500	Assessment Monitoring
MW-2	Cobalt (ug/L)	10/24/24	1.70	0.7500	Assessment Monitoring
MW-2	Magnesium (mg/L)	04/11/24	23.70	23.5196	Assessment Monitoring
MW-3R1	Ammonia (mg/L)	04/11/24	0.30	0.1340	Assessment Monitoring
MW-3R1	Ammonia (mg/L)	10/24/24	0.40	0.1340	Assessment Monitoring
MW-3R1	Arsenic (ug/L)	04/11/24	32.3	2.2700	Assessment Monitoring
MW-3R1	Arsenic (ug/L)	10/24/24	45.7	2.2700	Assessment Monitoring
MW-3R1	Barium (ug/L)	10/24/24	280	237.8109	Assessment Monitoring
MW-3R1	Cobalt (ug/L)	04/11/24	10.7	0.7500	Assessment Monitoring
MW-3R1	Cobalt (ug/L)	10/24/24	15.2	0.7500	Assessment Monitoring
MW-3R1	Iron (ug/L)	04/11/24	35500	1053.8260	Assessment Monitoring
MW-3R1	Iron (ug/L)	10/24/24	42500	1053.8260	Assessment Monitoring
MW-3R1	Magnesium (mg/L)	10/24/24	28.30	23.5196	Assessment Monitoring
MW-4	Ammonia (mg/L)	04/10/24	1.20	0.1340	Assessment Monitoring
MW-4	Ammonia (mg/L)	10/23/24	1.0	0.1340	Assessment Monitoring
MW-4	Arsenic (ug/L)	04/10/24	35.60	2.2700	Assessment Monitoring
MW-4	Arsenic (ug/L)	10/23/24	13.70	2.2700	Assessment Monitoring
MW-4	Barium (ug/L)	04/10/24	543	237.8109	Assessment Monitoring
MW-4	Barium (ug/L)	10/23/24	317	237.8109	Assessment Monitoring
MW-4	COD (mg/L)	04/10/24	18	8.0000	Assessment Monitoring
MW-4	Cobalt (ug/L)	04/10/24	126.00	0.7500	Assessment Monitoring
MW-4	Cobalt (ug/L)	10/23/24	5.29	0.7500	Assessment Monitoring
MW-4	Iron (ug/L)	04/10/24	83400	1053.8260	Assessment Monitoring
MW-4	Iron (ug/L)	10/23/24	5090	1053.8260	Assessment Monitoring
MW-4	Magnesium (mg/L)	04/10/24	34.1	23.5196	Assessment Monitoring
MW-4	Magnesium (mg/L)	10/23/24	29.1	23.5196	Assessment Monitoring
MW-21	Ammonia (mg/L)	10/23/24	0.2	0.1340	Assessment Monitoring
MW-21	Barium (ug/L)	04/11/24	343	237.8109	Assessment Monitoring
MW-21	Barium (ug/L)	10/23/24	350	237.8109	Assessment Monitoring
MW-21	Chloride (mg/L)	04/11/24	204	100.3283	Assessment Monitoring
MW-21	Chloride (mg/L)	10/23/24	215	100.3283	Assessment Monitoring
MW-21	Iron (ug/L)	10/23/24	1070	1053.8260	Assessment Monitoring
MW-21	Magnesium (mg/L)	04/11/24	53.1	23.5196	Assessment Monitoring
MW-21	Magnesium (mg/L)	10/23/24	54.8	23.5196	Assessment Monitoring
MW-21	Specific Conductance (uS)	04/11/24	1420	902.7576	Assessment Monitoring
MW-22	Ammonia (mg/L)	04/11/24	2.8	0.1340	Assessment Monitoring
MW-22	Ammonia (mg/L)	10/24/24	3.1	0.1340	Assessment Monitoring
MW-22	Arsenic (ug/L)	04/11/24	15.5	2.2700	Assessment Monitoring
MW-22	Arsenic (ug/L)	10/24/24	22.5	2.2700	Assessment Monitoring
MW-22	Barium (ug/L)	04/11/24	408	237.8109	Assessment Monitoring
MW-22	Barium (ug/L)	10/24/24	339	237.8109	Assessment Monitoring
MW-22	COD (mg/L)	04/11/24	47	8.0000	Assessment Monitoring
MW-22	Chloride (mg/L)	10/24/24	115.0	100.3283	Assessment Monitoring
MW-22	Cobalt (ug/L)	04/11/24	13.8	0.7500	Assessment Monitoring
MW-22	Cobalt (ug/L)	10/24/24	12.8	0.7500	Assessment Monitoring
MW-22	Iron (ug/L)	04/11/24	18200	1053.8260	Assessment Monitoring
MW-22	Iron (ug/L)	10/24/24	16100	1053.8260	Assessment Monitoring
MW-22	Magnesium (mg/L)	04/11/24	35.3	23.5196	Assessment Monitoring
MW-22	Magnesium (mg/L)	10/24/24	35.8	23.5196	Assessment Monitoring
MW-22	Specific Conductance (uS)	04/11/24	1038	902.7576	Assessment Monitoring
MW-23	Ammonia (mg/L)	04/10/24	1.1	0.1340	Assessment Monitoring
MW-23	Ammonia (mg/L)	10/23/24	1.1	0.1340	Assessment Monitoring
MW-23	Arsenic (ug/L)	04/10/24	10.5	2.2700	Assessment Monitoring
MW-23	Arsenic (ug/L)	10/23/24	7.9	2.2700	Assessment Monitoring
MW-23	Cobalt (ug/L)	04/10/24	1.9	0.7500	Assessment Monitoring
MW-23	Cobalt (ug/L)	10/23/24	1.96	0.7500	Assessment Monitoring
MW-23	Iron (ug/L)	04/10/24	5050	1053.8260	Assessment Monitoring
MW-23	Iron (ug/L)	10/23/24	4510	1053.8260	Assessment Monitoring
MW-23	Magnesium (mg/L)	04/10/24	37.3	23.5196	Assessment Monitoring
MW-23	Magnesium (mg/L)	10/23/24	38.1	23.5196	Assessment Monitoring
MW-23	pH (SU)	04/10/24	7.09	5.67-6.92	Assessment Monitoring
MW-23	pH (SU)	10/23/24	7.01	5.67-6.92	Assessment Monitoring
MW-23	Specific Conductance (uS)	04/10/24	1087	902.7576	Assessment Monitoring
MW-24	Ammonia (mg/L)	04/11/24	0.72	0.1340	Assessment Monitoring
MW-24	Ammonia (mg/L)	10/24/24	0.74	0.1340	Assessment Monitoring
MW-24	Chloride (ug/L)	10/23/24	128	100.3283	Assessment Monitoring
MW-24	Cobalt (ug/L)	04/11/24	1.10	0.7500	Assessment Monitoring
MW-24	Cobalt (ug/L)	10/23/24	1.70	0.7500	Assessment Monitoring
MW-24	Magnesium (mg/L)	04/11/24	26.0	23.5196	Assessment Monitoring
MW-24	Magnesium (mg/L)	10/23/24	31.90	23.5196	Assessment Monitoring
MW-24	pH(SU)	10/23/24	7.09	5.67-6.92	Assessment Monitoring

Table 6A – Summary of Well/Detected Constituent Pairs that Exceed the Control Limit (Intrawell Statistical Evaluation)

Table 6A
Summary of Well/Detected Constituent Pairs that Exceed the Control Limit (Intrawell Statistics)
Annual Water Quality Report
Cedar Rapids WPCF Ash Monofill
Permit No. 57-SDP-07-85P

Well	Compound	Date	Result	CUSUM Value	Control Limit	Monitoring Program
MW-4	Cobalt (ug/L)	04/10/24	126.00	133.7782	18.7891	Assessment Monitoring
MW-4	Iron (ug/L)	04/10/24	83400	81800.7886	16262.3741	Assessment Monitoring
MW-22	COD (mg/L)	04/11/24	47	45.9862	14.1452	Assessment Monitoring
MW-22	Cobalt (ug/L)	04/11/24	13.8	15.1526	14.3776	Assessment Monitoring

Table 7 – Summary of On-Going and Newly Identified Prediction Limit Exceedances (Not Used)

Table 8 – Summary of On-Going and Newly Identified Statistically Significant Levels (Not Used)

Table 9 –Analytical Data Summary

Analytical Data Summary for MW-1

Constituents	Units	4/26/2018	10/15/2018	4/23/2019	10/22/2019	4/21/2020	10/13/2020	4/14/2021	10/19/2021	4/14/2022	10/13/2022	4/19/2023	10/20/2023
Ammonia	mg/L	1.00	.53	1.10	.91	.58	.71	.63	.65	.74	.63	.61	.63
Arsenic, dissolved	ug/L	2.61											
Arsenic, total	ug/L	2.40	1.37	4.02	3.96	3.65	3.75	5.61	<.23	3.47	3.71	3.32	2.27
Barium, dissolved	ug/L	219											
Barium, total	ug/L	237	218	135	169	177	180	235	155	201	216	205	204
Chemical oxygen demand	mg/L	13.0	<7.0	18.0	7.0	17.0	22.0	32.0	<7.0	<5.7	<5.7	<5.7	<5.7
Chloride	mg/L	3.51	1.29	27.80	11.80	17.80	11.20	6.90	6.28	6.34	5.89	5.83	5.61
Cobalt, total	ug/L						.95	1.97	<1.25	<1.25	<.75	<.75	<.65
Iron, dissolved	ug/L	1690											
Iron, total	ug/L	2840.0	1900.0	6880.0	5820.0	45.8	5900.0	9720.0	4090.0	4100.0	4910.0	1270.0	779.0
Magnesium, dissolved	mg/L	25.9											
Magnesium, total	mg/L	29.0	32.0	20.7	25.8	23.5	24.2	29.3	20.9	28.7	29.2	28.3	31.9
pH	SU	6.50	7.22	7.03	7.21	7.23	7.03	7.40	7.40	7.50	7.17	7.33	7.20
Phenols, total	mg/L		<.1								<.1		
Specific conductance	uS	684.0	700.0	554.0	662.0	641.0	617.0	685.0	702.0	704.0	733.0	711.0	707.0
Temperature	C									10.7	13.0	12.6	16.0
Total organic halogens	mg/L		<.01								<.01		

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

Analytical Data Summary for MW-1

Constituents	4/10/2024	10/23/2024
Ammonia	.55	.53
Arsenic, dissolved		
Arsenic, total	3.65	<3.70
Barium, dissolved		
Barium, total	222	219
Chemical oxygen demand	<5.7	<5.7
Chloride	5.53	4.62
Cobalt, total	<.65	<1.70
Iron, dissolved		
Iron, total	5270.0	5400.0
Magnesium, dissolved		
Magnesium, total	29.4	29.0
pH	6.97	6.37
Phenols, total		
Specific conductance	721.0	956.5
Temperature	13.6	25.0
Total organic halogens		

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

Analytical Data Summary for MW-2

Constituents	Units	4/27/2018	10/16/2018	4/24/2019	10/23/2019	4/21/2020	10/13/2020	4/15/2021	10/20/2021	4/15/2022	10/14/2022	4/19/2023	10/20/2023
Ammonia	mg/L	<.500	<.500	<.500	<.200	<.100	<.280	<.134	<.134	<.134	<.114	<.104	<.104
Arsenic, dissolved	ug/L	2.26											
Arsenic, total	ug/L	1.90	1.70	1.47	1.49	1.45	1.36	1.23	<5.75	1.34	1.39	1.19	2.38
Barium, dissolved	ug/L	124											
Barium, total	ug/L	173	153	144	182	210	220	132	229	226	262	187	197
Chemical oxygen demand	mg/L	8.0	<7.0	7.0	<7.0	7.0	<7.0	<7.0	<7.0	<5.7	<5.7	<5.7	<5.7
Chloride	mg/L	43.600	47.120	39.600	24.600	36.200	42.800	47.500	70.322	84.210	59.800	69.500	56.900
Cobalt, total	ug/L						8.63	2.18	8.80	6.18	8.06	1.25	<.65
Iron, dissolved	ug/L	<.4											
Iron, total	ug/L	229.00	172.00	712.00	679.00	5.72	348.00	<681.50	<681.50	<681.50	<67.90	1100.00	757.00
Magnesium, dissolved	mg/L	21.7											
Magnesium, total	mg/L	23.9	23.3	20.1	22.3	23.0	21.5	21.9	17.1	28.4	21.2	27.9	31.4
pH	SU	6.69	6.16	6.32	6.22	6.56	6.46	6.30	6.70	6.60	6.83	6.47	6.70
Phenols, total	mg/L		<.1								<.1		
Specific conductance	uS	679.0	671.0	618.0	621.0	620.0	577.0	686.0	718.0	826.0	684.0	859.0	701.0
Temperature	C									9.0	12.9	11.9	16.2
Total organic halogens	mg/L		<.010								.017		

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

Analytical Data Summary for MW-2

Constituents	4/11/2024	10/24/2024
Ammonia	<.104	<.055
Arsenic, dissolved		
Arsenic, total	1.62	<3.70
Barium, dissolved		
Barium, total	114	126
Chemical oxygen demand	<5.7	<5.7
Chloride	64.600	100.000
Cobalt, total	.87	<1.70
Iron, dissolved		
Iron, total	<42.95	587.00
Magnesium, dissolved		
Magnesium, total	23.7	22.0
pH	6.71	6.48
Phenols, total		
Specific conductance	748.0	532.2
Temperature	11.9	11.3
Total organic halogens		

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

Analytical Data Summary for MW-21

Constituents	Units	4/26/2018	10/15/2018	4/24/2019	10/22/2019	4/21/2020	10/13/2020	4/14/2021	10/20/2021	4/14/2022	10/13/2022	4/19/2023	10/24/2023
Ammonia	mg/L	<.500	<.500	<.500	<.200	.100	<.280	<.134	.400	<.134	<.114	<.104	<.104
Arsenic, dissolved	ug/L	1.27											
Arsenic, total	ug/L	.98	1.83	.56	1.17	<2.00	1.52	1.58	<1.15	1.17	1.54	1.54	<1.45
Barium, dissolved	ug/L	368											
Barium, total	ug/L	406	372	413	438	401	338	347	229	325	307	269	301
Chemical oxygen demand	mg/L	10.0	8.0	10.0	7.0	9.0	11.0	8.0	6.0	9.0	<5.7	8.0	6.0
Chloride	mg/L	224.000	194.950	224.000	217.000	227.000	245.000	238.000	195.945	178.040	162.000	167.000	174.000
Cobalt, total	ug/L						.48	<1.25	<1.25	<1.25	<.75	<.75	<.65
Iron, dissolved	ug/L	24.2											
Iron, total	ug/L	194.0	323.0	193.0	460.0	<2.0	134.0	<681.5	<681.5	<681.5	147.0	162.0	126.0
Magnesium, dissolved	mg/L	52.7											
Magnesium, total	mg/L	60.1	55.3	58.7	58.0	59.6	56.8	55.4	36.9	51.5	43.9	47.0	52.7
pH	SU	6.79	6.36	6.78	6.83	6.86	6.74	6.80	6.70	6.70	6.82	6.92	6.90
Phenols, total	mg/L		<.1								<.1		
Specific conductance	uS	1554.0	1391.0	1590.0	1532.0	1661.0	1542.0	1649.0	1480.0	1484.0	1520.0	1443.0	1350.0
Temperature	C									8.8	13.0	12.0	14.5
Total organic halogens	mg/L		.039								.035		

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

Analytical Data Summary for MW-21

Constituents	4/11/2024	10/23/2024
Ammonia	<.104	.200
Arsenic, dissolved		
Arsenic, total	<1.45	<3.70
Barium, dissolved		
Barium, total	343	350
Chemical oxygen demand	<5.7	<5.7
Chloride	204.000	215.000
Cobalt, total	<.65	<1.70
Iron, dissolved		
Iron, total	58.0	1070.0
Magnesium, dissolved		
Magnesium, total	53.1	54.8
pH	6.67	6.83
Phenols, total		
Specific conductance	1420.0	874.5
Temperature	11.4	13.3
Total organic halogens		

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

Analytical Data Summary for MW-22

Constituents	Units	4/27/2018	10/16/2018	4/24/2019	10/23/2019	4/21/2020	10/13/2020	4/15/2021	10/20/2021	4/15/2022	10/14/2022	4/20/2023	5/24/2023
Ammonia	mg/L	6.4	4.0	3.7	3.9	5.9	4.9	3.6	2.8	3.8	2.8	2.6	2.2
Arsenic, dissolved	ug/L	24.9											
Arsenic, total	ug/L	19.00	14.60	19.80	16.00	11.60	7.42	15.00	15.20	16.00	25.00	17.80	23.70
Barium, dissolved	ug/L	264											
Barium, total	ug/L	315	225	281	269	440	318	326	241	361	567	900	327
Chemical oxygen demand	mg/L	8.0	<7.0	10.0	<7.0	8.0	<7.0	<7.0	<7.0	<5.7	<5.7	100.0	<5.7
Chloride	mg/L	148.0000	108.4200	121.0000	101.0000	106.0000	108.0000	101.0000	91.8850	106.8900	99.6000	74.8000	76.8876
Cobalt, total	ug/L						8.00	8.24	7.44	9.63	10.70	31.40	14.20
Iron, dissolved	ug/L	10600											
Iron, total	ug/L	12800.0	8130.0	18200.0	13600.0	93.3	3990.0	11700.0	9990.0	12000.0	19600.0	18300.0	19400.0
Magnesium, dissolved	mg/L	30.8											
Magnesium, total	mg/L	33.6	27.9	31.6	28.5	33.1	32.6	32.9	24.6	35.1	33.2	46.0	31.7
pH	SU	6.88	6.79	6.74	6.66	6.89	7.05	6.90	6.90	7.00	6.84	6.71	6.38
Phenols, total	mg/L		<.10								.12		
Specific conductance	uS	1340.0	1033.0	1142.0	972.0	1149.0	1041.0	1090.0	1028.0	1004.0	1035.0	988.0	948.0
Temperature	C									12.5	15.9	13.4	18.7
Total organic halogens	mg/L		<.010								.028		

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

Analytical Data Summary for MW-22

Constituents	10/20/2023	4/11/2024	10/24/2024
Ammonia	2.0	2.8	3.1
Arsenic, dissolved			
Arsenic, total	22.30	14.50	22.50
Barium, dissolved			
Barium, total	259	408	339
Chemical oxygen demand	<5.7	47.0	<5.7
Chloride	70.7000	81.7000	115.0000
Cobalt, total	10.10	13.80	12.80
Iron, dissolved			
Iron, total	6540.0	18200.0	16100.0
Magnesium, dissolved			
Magnesium, total	33.2	35.3	35.8
pH	6.80	6.84	6.92
Phenols, total			
Specific conductance	927.0	1038.0	668.4
Temperature	17.4	14.8	14.8
Total organic halogens			

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

Analytical Data Summary for MW-23

Constituents	Units	4/26/2018	10/16/2018	4/24/2019	10/23/2019	4/21/2020	10/12/2020	4/14/2021	10/19/2021	4/15/2022	10/13/2022	4/19/2023	10/18/2023
Ammonia	mg/L	1.7	1.6	1.7	1.8	1.1	1.5	1.1	1.3	1.4	1.3	1.2	1.2
Arsenic, dissolved	ug/L	15											
Arsenic, total	ug/L	32.20	15.20	18.80	14.60	30.40	31.80	21.90	9.40	16.50	11.50	18.10	10.90
Barium, dissolved	ug/L	115											
Barium, total	ug/L	212.0	132.0	160.0	153.0	202.0	181.0	159.0	98.6	137.0	129.0	135.0	134.0
Chemical oxygen demand	mg/L	5.0	<7.0	10.0	<7.0	<7.0	<7.0	<7.0	7.0	12.0	<5.7	6.0	<5.7
Chloride	mg/L	97.100	96.670	95.500	88.900	75.900	80.200	74.300	83.567	88.750	98.900	89.300	83.800
Cobalt, total	ug/L						2.39	1.84	<6.25	2.24	2.37	2.00	1.34
Iron, dissolved	ug/L	4860											
Iron, total	ug/L	14400	7000	8360	7430	118	12400	10300	4970	7520	5370	2460	1330
Magnesium, dissolved	mg/L	33.9											
Magnesium, total	mg/L	37.4	35.4	39.5	37.9	36.9	38.8	38.1	29.7	40.6	40.4	39.4	44.3
pH	SU	7.07	6.99	6.65	6.72	7.22	7.10	6.90	7.00	7.30	7.05	6.99	6.80
Phenols, total	mg/L		<.1								<.1		
Specific conductance	uS	1201.0	1117.0	1149.0	1112.0	1093.0	1067.0	1124.0	1158.0	1177.0	1215.0	1151.0	1118.0
Temperature	C									7.2	13.1	13.5	12.6
Total organic halogens	mg/L		.010								.021		

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

Analytical Data Summary for MW-23

Constituents	4/10/2024	10/23/2024
Ammonia	1.1	1.1
Arsenic, dissolved		
Arsenic, total	10.50	7.87
Barium, dissolved		
Barium, total	106.0	110.0
Chemical oxygen demand	<5.7	<5.7
Chloride	88.200	90.700
Cobalt, total	1.85	1.96
Iron, dissolved		
Iron, total	5050	4510
Magnesium, dissolved		
Magnesium, total	37.3	38.1
pH	7.09	7.01
Phenols, total		
Specific conductance	1087.0	666.9
Temperature	14.4	19.0
Total organic halogens		

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

Analytical Data Summary for MW-24

Constituents	Units	4/26/2018	10/16/2018	4/24/2019	10/23/2019	4/21/2020	10/12/2020	4/14/2021	10/19/2021	4/14/2022	10/13/2022	4/19/2023	10/18/2023
Ammonia	mg/L	2.80	2.00	1.50	1.50	1.00	1.20	1.00	1.10	1.10	.82	.76	.77
Arsenic, dissolved	ug/L	.725											
Arsenic, total	ug/L	2.10	.64	1.13	.78	.84	.68	<1.15	<5.75	<1.15	<.90	<.90	<1.45
Barium, dissolved	ug/L	134											
Barium, total	ug/L	634.0	307.0	407.0	271.0	344.0	305.0	292.0	129.0	179.0	466.0	218.0	158.0
Chemical oxygen demand	mg/L	9.0	<7.0	<7.0	<7.0	9.0	<7.0	<7.0	<7.0	<5.7	<5.7	<5.7	<5.7
Chloride	mg/L	87.900	101.180	90.800	107.000	91.100	92.300	84.900	98.878	97.990	98.700	69.200	83.200
Cobalt, total	ug/L						3.24	1.72	<6.25	2.45	4.31	2.09	<.65
Iron, dissolved	ug/L	12.6											
Iron, total	ug/L	3220.00	650.00	1430.00	936.00	9.34	524.00	<681.50	<681.50	<681.50	673.00	622.00	528.00
Magnesium, dissolved	mg/L	38.5											
Magnesium, total	mg/L	44.9	40.8	36.8	36.7	39.5	43.3	38.8	28.0	36.8	35.9	28.8	31.2
pH	SU	6.89	7.03	6.75	6.82	6.96	7.03	6.90	6.90	7.00	7.04	6.91	7.00
Phenols, total	mg/L		<.1								<.1		
Specific conductance	uS	1107	1011	963	968	1105	1073	1074	1090	1077	1009	862	885
Temperature	C									12.7	13.0	11.8	13.4
Total organic halogens	mg/L		<.01								.03		

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

Analytical Data Summary for MW-24

Constituents	4/11/2024	10/23/2024
Ammonia	.72	.74
Arsenic, dissolved		
Arsenic, total	<1.45	<3.70
Barium, dissolved		
Barium, total	93.6	109.0
Chemical oxygen demand	<5.7	<5.7
Chloride	82.000	128.000
Cobalt, total	1.10	<1.70
Iron, dissolved		
Iron, total	<42.95	636.00
Magnesium, dissolved		
Magnesium, total	26.0	31.9
pH	6.75	7.09
Phenols, total		
Specific conductance	855	547
Temperature	12.4	13.3
Total organic halogens		

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

Analytical Data Summary for MW-26

Constituents	Units	4/26/2018	10/15/2018	4/23/2019	10/22/2019	4/21/2020	10/12/2020	4/14/2021	10/19/2021	4/14/2022	10/13/2022	4/19/2023	10/20/2023
Ammonia	mg/L	<.500	<.500	<.500	<.200	<.100	<.280	<.134	<.134	<.134	<.114	<.104	<.104
Arsenic, dissolved	ug/L	<.04											
Arsenic, total	ug/L	.45	<.57	.36	<.75	2.27	.55	.47	<5.75	<1.15	1.09	<.90	<1.45
Barium, dissolved	ug/L	131											
Barium, total	ug/L	137	185	193	104	176	102	155	73	139	162	176	123
Chemical oxygen demand	mg/L	6.0	<7.0	<7.0	<7.0	8.0	<7.0	<7.0	<7.0	<5.7	<5.7	<5.7	<5.7
Chloride	mg/L	33.700	51.410	71.500	20.000	41.400	27.300	58.600	28.918	54.890	78.400	71.900	48.100
Cobalt, total	ug/L						.52	<.50	<6.25	<1.25	<.75	<.75	<.65
Iron, dissolved	ug/L	<.4											
Iron, total	ug/L	310.0	380.0	252.0	516.0	50.0	615.0	510.0	<272.6	<681.5	376.0	767.0	610.0
Magnesium, dissolved	mg/L	11											
Magnesium, total	mg/L	12.10	17.60	17.80	9.79	9.83	8.61	11.90	6.49	14.50	16.30	19.70	12.50
pH	SU	6.05	6.30	6.24	6.34	6.08	6.28	6.10	6.30	6.80	6.34	6.57	6.40
Phenols, total	mg/L		<.1								<.1		
Specific conductance	uS	143.0	545.0	649.0	305.0	389.0	319.0	546.0	355.0	538.0	646.0	709.0	461.0
Temperature	C									11.1	12.2	13.3	13.9
Total organic halogens	mg/L		<.010								.014		

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

Analytical Data Summary for MW-26

Constituents	4/10/2024	10/23/2024
Ammonia	<.104	<.055
Arsenic, dissolved		
Arsenic, total	<1.45	<3.70
Barium, dissolved		
Barium, total	123	140
Chemical oxygen demand	<5.7	<5.7
Chloride	57.800	63.600
Cobalt, total	<.65	<1.70
Iron, dissolved		
Iron, total	50.0	347.0
Magnesium, dissolved		
Magnesium, total	12.90	13.80
pH	6.21	6.15
Phenols, total		
Specific conductance	519.0	306.6
Temperature	13.2	11.9
Total organic halogens		

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

Analytical Data Summary for MW-3R1

Constituents	Units	6/5/2018	10/16/2018	4/24/2019	10/23/2019	4/21/2020	10/13/2020	4/15/2021	10/20/2021	4/15/2022	10/14/2022	4/19/2023	10/20/2023
Ammonia *	mg/L	.820	.980	1.500	1.300	.570	.750	<.134	.560	<.134	.610	.400	.300
Arsenic, dissolved	ug/L	25.4											
Arsenic, total	ug/L	372.0	59.6	62.3	62.9	82.5	50.3	77.6	30.7	64.7	57.0	61.2	30.0
Barium, dissolved	ug/L	172											
Barium, total	ug/L	1920	484	405	388	496	375	616	248	369	377	294	219
Chemical oxygen demand	mg/L		18.0	9.0	7.0	9.0	8.0	<7.0	<7.0	8.0	<5.7	8.0	<5.7
Chloride	mg/L	61.200	66.340	63.200	43.300	51.400	50.100	55.500	59.258	53.730	74.100	71.200	50.500
Cobalt, total	ug/L						10.20	11.90	9.73	12.00	13.10	13.00	11.40
Iron, dissolved	ug/L	31300											
Iron, total	ug/L	357000	66400	54900	44700	535	43100	61000	30000	52400	46000	14900	8350
Magnesium, dissolved	mg/L	28.5											
Magnesium, total	mg/L	525.0	127.0	62.4	39.9	45.8	33.7	53.0	33.9	35.3	46.5	33.2	27.1
pH	SU	6.89	6.70	6.98	6.58	6.86	6.81	6.70	6.70	6.70	6.76	6.59	6.70
Phenols, total	mg/L		<.1								<.1		
Specific conductance	uS	804.0	880.0	885.0	823.0	845.0	789.0	884.0	862.0	768.0	888.0	836.0	760.0
Temperature	C									12.2	14.8	14.2	16.6
Total organic halogens	mg/L		<.010								.028		

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

Analytical Data Summary for MW-3R1

Constituents	4/11/2024	10/24/2024
Ammonia	.300	.400
Arsenic, dissolved		
Arsenic, total	32.3	45.7
Barium, dissolved		
Barium, total	171	280
Chemical oxygen demand	<5.7	<5.7
Chloride	51.800	65.900
Cobalt, total	10.70	15.20
Iron, dissolved		
Iron, total	35500	42500
Magnesium, dissolved		
Magnesium, total	20.6	28.3
pH	6.63	6.80
Phenols, total		
Specific conductance	768.0	502.7
Temperature	14.0	13.6
Total organic halogens		

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

Analytical Data Summary for MW-4

Constituents	Units	4/26/2018	10/15/2018	4/23/2019	10/22/2019	4/21/2020	10/12/2020	4/14/2021	10/19/2021	4/14/2022	10/13/2022	4/19/2023	10/18/2023
Ammonia	mg/L	2.90	1.30	.90	1.20	.84	1.40	1.00	2.00	1.60	1.50	.62	1.60
Arsenic, dissolved	ug/L	28.3											
Arsenic, total	ug/L	25.7	26.5	13.4	26.3	14.7	15.1	14.2	18.8	31.5	22.3	11.7	17.4
Barium; dissolved	ug/L	305											
Barium, total	ug/L	372	270	282	350	301	279	343	378	500	404	235	458
Chemical oxygen demand	mg/L	17.0	<7.0	8.0	<7.0	10.0	7.0	<7.0	<7.0	14.0	<5.7	6.0	<5.7
Chloride	mg/L	103.00	79.99	86.50	48.70	55.10	60.90	75.10	84.40	90.34	85.80	64.20	76.50
Cobalt, total	ug/L						4.15	2.42	<6.25	7.14	15.10	8.29	7.85
Iron, dissolved	ug/L	4600											
Iron, total	ug/L	6740.0	6260.0	3690.0	7270.0	36.2	4910.0	4320.0	5800.0	8470.0	11600.0	3230.0	3930.0
Magnesium, dissolved	mg/L	32.7											
Magnesium, total	mg/L	35.8	27.7	30.3	22.7	23.6	23.0	28.9	25.1	32.1	32.5	25.2	36.9
pH	SU	6.25	6.72	6.63	6.45	6.75	6.64	6.70	6.90	6.90	6.83	6.69	6.80
Phenols, total	mg/L		<.1								<.1		
Specific conductance	uS	986.0	874.0	895.0	618.0	709.0	643.0	1090.0	917.0	915.0	934.0	782.0	869.0
Temperature	C									11.0	13.5	13.4	13.5
Total organic halogens	mg/L		<.010								.017		

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

Analytical Data Summary for MW-4

Constituents	4/10/2024	10/23/2024
Ammonia	1.20	1.00
Arsenic, dissolved		
Arsenic, total	35.6	13.7
Barium, dissolved		
Barium, total	543	317
Chemical oxygen demand	18.0	<5.7
Chloride	82.60	75.70
Cobalt, total	126.00	5.29
Iron, dissolved		
Iron, total	83400.0	5090.0
Magnesium, dissolved		
Magnesium, total	34.1	29.1
pH	6.43	6.75
Phenols, total		
Specific conductance	848.0	447.9
Temperature	13.4	16.4
Total organic halogens		

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

Table 10 – Historic SSI and SSL
(Not Used)

Table 11 – Corrective Action Trend Analysis
(Not Used)

Table 12 – Leachate/Groundwater Elevations

Table 12
Leachate/Groundwater Elevations
Annual Water Quality Report
Cedar Rapids WPCF Ash Monofill
Permit No. 57-SDP-07-85P

Date	South Disposal Area		North Disposal Area
	Groundwater Head Monitoring Point	Leachate Head Monitoring Point	Leachate Head Monitoring Point
1/2/2024	0.9'	0.4'	0.8'
2/1/2024	0.2'	0.3'	1.1'
2/14/2024	---	---	1.1'
2/15/2024	---	---	0.4'
2/29/2024	---	---	0.5'
3/1/2024	0.3'	0.2'	0.5'
3/8/2024	---	---	0.5'
3/24/2024	---	---	0.5'
4/1/2024	0.6'	0.5'	0.6'
5/1/2024	0.5'	0.4'	0.8'
6/5/2024	0.4'	0.3'	0.6'
7/1/2024	0.5'	0.4'	0.6'
8/1/2024	0.4'	0.3'	---
8/7/2024	---	---	0.8'
9/5/2024	0.9'	0.4'	0.9'
10/1/2024	0.9'	0.5'	0.8'
11/1/2024	0.7'	0.5'	0.7'

APPENDIX A

SDP Permit and Variances

May 17, 2022

ROY HESEMANN
CEDAR RAPIDS WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM ROAD SE
CEDAR RAPIDS IA 52403

RE: Cedar Rapids Water Pollution Control Facilities Ash Monofill
Permit No. 57-SDP-07-85P
Permit Revision #2

Dear Mr. Hesemann:

Enclosed is the revised permit for the Cedar Rapids Water Pollution Control Facilities Ash Monofill. The permit and the approved plans must be kept at the sanitary disposal project in accordance with Iowa Administrative Code 567 Paragraph 115.26(2)“c” (567 IAC 115.26(2)"c"). Please review the permit in its entirety with your operators, as they must become familiar with it.

The revised permit approves the Request for Permit Modification and the associated request to remove the South Disposal Area and construct the North 2 Lagoon. This and the other revisions are summarized in Section XI. Revision History at the end of the permit

Note that the permit may contain conditions that require a response or action by you, which if not properly complied with, may prompt enforcement action by the IDNR.

If you have any questions, you may contact me at (515) 537-4051 or brian.rath@dnr.iowa.gov.

Sincerely,

Brian L. Rath, P.E.
Environmental Engineer Senior
Land Quality Bureau

copy: DNR Field Office #1 – Manchester
Greg Shafer, HDR
Jason Decker, City of Cedar Rapids

IOWA DEPARTMENT OF NATURAL RESOURCES
SANITARY DISPOSAL PROJECT PERMIT
FOR INDUSTRIAL MONOFILLS

I. **Permit Number:** 57-SDP-07-85P

II. **Permitted Agency:** City of Cedar Rapids
Cedar Rapids Water Pollution Control Facilities Ash Monofill

III. **Project Location:** NE ¼, NE ¼, Sec.32, T83N, R6W
Linn County, Iowa

IV. **Responsible Official**

Name: Roy Hesemann
Address: Cedar Rapids Water Pollution Control Facilities
7525 Bertram Road SE
Cedar Rapids, IA 52403-7111
Phone: 319-286-5972
Email: NA

V. **Licensed Design Engineer**

Name: Douglas J. Luzbetak, P.E.
Address: HLW Engineering Group
204 West Broad Street
P.O. Box 314
Story City, Iowa 50248
Phone: 515-733-4144
Email: dluzbetak@hlwengineering.com

Iowa License Number: 12654

VI. **Date Permit Issued:** **October 29, 2021**
Date Permit Revised **May 17, 2024** **Revision #2**

VII. **Permit Expiration Date:** October 29, 2024

VIII. **Issued by:** ____
Environmental Services Division
for the Director

IX. General Provisions

The above named permitted agency is hereby authorized to operate a sanitary disposal project at the described location in conformance with Iowa Code section 455B, the rules pursuant thereto existing at the time of issuance, and any subsequent new rules which may be duly adopted, and any provisions contained in Section X of this permit.

The issuance of this permit in no way relieves the applicant of the responsibility for complying with all other local, state, and federal statutes, ordinances, and rules or other requirements applicable to the establishment and operation of this sanitary disposal project.

No legal or financial responsibility arising from the construction or operation of the approved project shall attach to the State of Iowa or the Department of Natural Resources (DNR) due to the issuance of this permit.

If title to this project is transferred, the new owner must apply to the DNR for a transfer of this permit within thirty days of the date of title transfer pursuant to rule 115.9(455B). This permit is void sixty days after the date of title transfer unless the DNR has transferred the permit.

The permit holder shall file a Quarterly Solid Waste Fee Schedule and Retained Fee Report utilizing the DNR's Form 542-3276 and remit tonnage fee payment, as applicable, for all wastes disposed at the sanitary disposal project in accordance with Iowa Code section 455B.310. The Reports will be due January 1, April 1, July 1 and October 1 for the quarters ending September 30, December 31, March 31 and June 30, respectively. The permit holder shall mail the completed report to the Solid Waste Section, Wallace State Office Building, 502 East Ninth Street, Des Moines, Iowa 50319. This reporting procedure supersedes any previous conflicting permit provisions.

The permit holder shall weigh all solid waste collection vehicles and solid waste transport vehicles on a scale certified by the Iowa Department of Agriculture and Land Stewardship. If conditions are such that make it impractical to provide an on-site scale, then off-site scale facilities or an alternative method of calculating the tonnage disposed, may be used if justified and approved by the DNR. The permit holder shall comply with the waste weighing, record keeping and tonnage fee reporting requirements defined in rule 101.14(455B,455D). The scale weighing facilities shall comply with the certification and licensing requirements of the Iowa Department of Agriculture and Land Stewardship at all times. The permit holder shall maintain a current copy of the weighing scale facility licensing certificate issued by the Iowa Department of Agriculture and Land Stewardship at all times.

The permit holder shall ensure that the sanitary disposal project does not (1) cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements, pursuant to Section 402 of the Clean Water Act, and (2) cause the discharge of a nonpoint source of pollution into waters of the United States, including wetlands, that violates any requirement of an areawide or statewide water quality management plan that has been approved under Section 208 or 319 of the Clean Water Act.

The permit holder shall submit an updated Sanitary Landfill Financial Assurance Report Form no later than April 1st, annually, pursuant to rule 115.31(455B). Use of this form provides permit holders a uniform means of submitting all required documentation to ensure that closure and postclosure cost estimates and applicable financial assurance instruments are updated as required.
This facility shall be staked as necessary and inspected on a semiannual basis by a professional engineer licensed in the State of Iowa. The engineer shall prepare a brief report describing the site's conformance and nonconformance with the permit and the approved plans and specifications during the inspections. These reports shall be submitted by April 30 and October 31 each year to the Department's Main and local Field offices. The Department shall be notified if any inspection reveals any nonconformance with the permit and approved plans and specifications.

Failure to comply with Iowa Code Chapter 455B, or any rule of order promulgated pursuant thereto, or any or all provisions of this permit may result in 1) a civil penalty of up to $5000 for each day of violation, pursuant to Iowa Code section 455B.307, or 2) the suspension or revocation of this permit, pursuant to Iowa Code section 455B.305.

X. Special Provisions

1. The permit holder is authorized to accept sewage sludge incinerator ash from the Cedar Rapids Water Pollution Control Facilities for disposal. Wastes disposed at this site shall not exhibit toxic or hazardous properties. No hazardous wastes as defined by Iowa Code section 455B.411 may be disposed at this landfill.
2. The permit holder shall develop and operate the site in accordance with the 2021 Industrial Monofill Permit Renewal, dated June 7, 2021, as submitted by HLW Engineering Group, and the following:
   a. Waste disposal is limited to the North Cell and South Cell ash monofill disposal units. Any further expansion beyond these cells shall require prior Department approval.

      The permit holder shall continually review the design of the cell with all staff on-site for excavation of the lagoons. The permit holder shall limit the use of the excavators to a few well-trained operators.
   b. The Response to SDP Permit Amendment #1 (5/12/11) regarding operational procedures, dated May 26, 2011, as submitted by HLW Engineering Group, and approved on February 9, 2012, is incorporated as part of the permit documents.
   c. The permit holder shall representative sample and submit TCLP metals analytical results for the waste at the time of each permit renewal, or following any process modifications that may result in changes of waste characteristics. No waste ash that exhibits hazardous characteristics shall be disposed of at this site.

d. Surface water shall be diverted around the fill area and proper surface drainage shall be provided at all times.

e. The Emergency Response and Remedial Action Plan (ERRAP) as included in Appendix I, of the 2021 Industrial Monofill Permit Renewal, dated June 7, 2021, as submitted by HLW Engineering Group, in compliance with rule 115.30(455B) is incorporated as part of the permit documents. An updated ERRAP shall be submitted at the time of each permit renewal application. An updated ERRAP shall be included with any request for permit modification to incorporate a facility expansion or significant changes in facility operation that require modification of the currently approved ERRAP.

f. In accordance with the variance approval of May 12, 2011, the permit holder is authorized to accept liquids associated with ash slurry disposal at the referenced site. No other liquids are authorized for disposal without prior Department approval.

g. The Quality Control and Assurance Report for the Ash Lagoon Liner (South Lagoon), dated December 16, 2011 as submitted by HLW Engineering Group; and approved on February 9, 2012, is incorporated as part of the permit documents.

h. The Quality Control and Assurance Report for the North Ash Lagoon Liner, dated October 13, 2016, as prepared and submitted by HLW Engineering Group and approved on November 15, 2016, is incorporated as part of the permit documents.

i. The Quality Control and Assurance Report for the FML Repair-South Cell, dated August 15, 2017, as submitted by HLW Engineering Group, and approved on September 6, 2017, is incorporated as part of the permit documents.

j. The Permit Modification request, dated April 18, 2024, as submitted by HDR, and approved on April 29, 2024, is incorporated into the permit documents; and the Request for Authorization for Construction of North 2 Lagoon and Closure of South Disposal Area, as submitted by HDR on May 7, 2024, is approved and incorporated into the permit documents.

3. The Department authorizes the following alternative arrangement for reduction in fees owed for sewage sludge incinerator ash that is reclaimed from the landfill for beneficial use purposes.

a. The difference between the amount (in tons) of sewage sludge incinerator ash reclaimed for beneficial use(s) from the landfill and the amount of new waste disposed of during a quarter shall be used to calculate what/if any fees are owed at the end of each quarter. If the amount reclaimed is equal to or greater than the amount disposed, no fees are owed for that quarter.

b. Beneficial use projects shall comply with the state's solid waste by-product beneficial use determination rules (Iowa Administrative Code 567 Chapter 108) and be tracked and reported with each Quarterly Solid Waste Fee Schedule and Retained Fees Report including:

1. Location of beneficial use(s)
2. Description of beneficial use(s)

3. Quantities used for each beneficial use project

The Department shall have the sole authority to deny approval of a reported beneficial use if the proposed use is determined to have the primary purpose as a means of disposal, and any beneficial use would be incidental in nature.

4. Hydrologic monitoring at the site shall be conducted in accordance with the Hydrologic Monitoring System Plan (HMSP) contained in the Permit Modification Request, dated April 18, 2024, as submitted by HDR, and approved on April 29, 2024, and the following:

   a. The HMSP shall include upgradient groundwater monitoring points MW-1 and MW-21; crossgradient monitoring point MW-26, and downgradient groundwater monitoring points MW-2, MW-3RI, MW-4, , MW-22, MW-23, and MW-24. As construction commences (removal of the South Disposal Area and construction of the new North 2 Lagoon along with Water Pollution Control Facility Improvements in the vicinity), the following HMSP changes will occur.

      - MW-1 and MW-26 will be abandoned.
      - MW-21 will be retained as an upgradient/background well.
      - MW-4 and MW-23 will be abandoned and replaced.
      - MW-30, MW-31, and MW-32 will be installed as downgradient wells of the North Disposal Area Lagoons.
      - MW-2, MW-3R1, MW-22, and MW-24 may be abandoned after removal of the South Disposal Area and if constituents are below the groundwater protection standard as outlined in the Permit Modification Request.

   b. Monitoring points not used for water quality analysis may be retained as water level measuring points.

   c. Department construction documentation form 542-1277 and boring logs for all monitoring wells and piezometers shall be submitted within 30 days of installation. Department construction documentation form 542-1323 shall be submitted within 30 days of establishing surface water monitoring points.

   Monitoring points MW-20 and MW-25 have been plugged and abandoned or removed.

   The Abandoned Water Well Plugging Record for MW-3, dated July 28, 2011 and attached to the August 25, 2011 transmittal submitted by HLW Engineering Group, and approved on February 9, 2012, is incorporated as part of the permit documents.

   The Construction Documentation form for replacement well MW-3R, dated December 19, 2011 and attached to the January 9, 2012 transmittal submitted by HLW Engineering Group, and approved on February 9, 2012, is incorporated as part of the permit document.

   The Construction Documentation Form and Boring Log for replacement well MW-3RI, dated March 29, 2018 (Doc 92858), and approved on September 13, 2018, is incorporated as part of the permit documents.

The Abandoned Water Well Plugging Record for monitoring well MW-3R, as attached to the September 4, 2018 electronic mail submitted by HLW Engineering Group and approved on September 13, 2018, is incorporated as part of the permit documents.

d. Quarterly sampling shall be conducted in the first year for any newly installed monitoring points. Existing monitoring points had the quarterly sampling completed in October of 1996.

   Continued semiannual sampling shall take place in April and October of each year and be analyzed for the parameters listed in paragraph 115.26(4)“e”. Routine annual testing for any additional necessary parameters listed in paragraph 115.26(4)“f” shall be conducted during October of each year.

   Supplemental semiannual sampling and analysis of all monitoring points for arsenic, barium, and magnesium shall be conducted in addition to the routine test parameters. The additional testing may be discontinued upon all of the following: 1) The test results and a request for elimination of the additional sampling are submitted to the Department; and 2) The Department approves discontinuation of the additional sampling.

e. The Method Detection Limit (MDL) for the test parameters shall not exceed action levels as defined in 567 IAC Chapter 133. If the action levels cannot be feasibly achieved using procedures described in subrule 115.26(5), then the MDL shall not exceed the lowest feasible level.

f. In accordance with the variance, dated September 12, 2018, the permit holder is authorized to conduct sampling and analysis of total recoverable metals in lieu of sampling for dissolved metals as required by 567 IAC 115.26(4)”d”, and phenols and TOX, as required by 567 IAC 115.26(4)”f”.

g. Surface monitoring points must be clearly marked in the field and a method for measuring the flow rate at each sampling point shall be devised.

h. In accordance with the request contained in the 2020 AWQR, dated December 7, 2020, the permit holder is authorized to reduce the frequency of groundwater level measurements from quarterly to semiannually. The measurements shall be taken in, April and October of each year, with the results submitted in the corresponding semiannual monitoring reports. (Amendment #1)

i. An Annual Water Quality Report (AWQR) summarizing the effects the facility is having on groundwater and surface water quality shall be submitted to the Department by November 30 of each year. The AWQR report shall include the results of the routine groundwater measurements conducted at the monitoring points and by using the DNR AWQR Format.

5. The permit holder is exempt from monitoring and reporting methane gas levels in site structures and at the property boundary, as required by subrule 115.26(15). This exemption is in accordance with the variance approval letter of May 5, 1995. Variance approval was based on the inert nature of the incinerator ash waste deposited at this site.

However, in the event that methane gas is found to be present at the site, the Department's Main and Field Offices shall be notified, and gas monitoring shall be immediately implemented in accordance with subrule 115.26(15).

6. In accordance with the variance approval of April 27, 2005, the permit holder is not required to have a certified solid waste operator on duty during waste unloading, as required by rule 115.29(455B), since this site is required to have certified wastewater operators on staff. The variance approval shall hold until such time that the Department develops a certification program that relates more directly to this operation; and as long as certified wastewater operators are retained on site.

7. The permit holder shall close the landfill site in accordance with the Closure/Postclosure Plan (CPCP) as contained in Appendix H of the 2021 Industrial Monofill Permit Renewal, dated June 7, 2021, as submitted by HLW Engineering Group, and the following:

   a. The review comments, dated May 15, 1985 from the County Soil & Water Conservation District relative to compliance with wind and soil loss limit regulations, in accordance with paragraph 115.26(1)"j" for all development areas, are incorporated as part of the permit documents.

   b. Upon closure of both the North and South Lagoons, all ash material will be removed and disposed of in accordance with regulations at the time of closure, dikes and all infrastructure will be removed and the site(s) regraded, seeded, and repurposed for other uses by CRWPCF.

XI. Revision History

Date	Comment
10/29/2021	Permit Renewed
4/20/2022	Revision No. 1: Authorizes the permit holder to reduce the frequency of groundwater level measurements from quarterly to semiannually
5/xx/2024	Revision No. 2: Incorporates the Permit Modification request and Request for Authorization for Construction of North 2 Lagoon and Closure of South Disposal Area (Special Provision X.2.j). Revised the HMSP as defined in the Permit Modification request (Special Provision 4, 4.a, and 4.d).

RECEIVED MAY 2011

Fields of Opportunities

STATE OF IOWA

TERRY E. BRANSTAD, GOVERNOR
KIM REYNOLDS, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
ROGER L. LANDE, DIRECTOR

May 12, 2011

STEVE HERSHNER
CEDAR RAPIDS WATER POLLUTION CONTROL FACILITY
7525 BERTRAM ROAD SE
CEDAR RAPIDS IA 52403

Re: Cedar Rapids Water Pollution Control Facilities-Sludge Ash Storage Landfill
Permit #57-SDP-07-85P
IAC Rule Variance Request Approval

Dear Mr. Hershner:

This letter is to inform you that the rule variance request from 567 IAC 115.27(8) (455B, 455D) relative to the requirement that no free liquids or waste containing free liquid shall be disposed in a sanitary landfill, is hereby approved.

The permit holder has requested a waiver from subrule 567 IAC 115.27(8) which does not allow the disposal of free liquids or waste containing free liquids in a sanitary landfill. Approval of the variance is based on the fact that the City of Cedar Rapids is proposing to construct a liner in the south lagoon exceeding current standards for industrial waste landfills. The liner will consist of a Subtitle D compliant composite liner with an additional 60 mil HDPE liner over the top of the composite liner. The additional 60 mil HDPE liner will function to limit the liquid level on the Subtitle D compliant liner to less than 1 foot as required in 115.26(11)"a"(1). Leachate head measuring devices are being provided to measure the liquid level on the Subtitle D compliant composite liner.

If you have any questions, please contact Nina M. Koger at (515) 281-8986.

Sincerely,

Brian Tormey
Chief
Land Quality Bureau

IOWA DEPARTMENT OF NATURAL RESOURCES

GOVERNOR KIM REYNOLDS
LT. GOVERNOR ADAM GREGG
ACTING DIRECTOR BRUCE TRAUTMAN

September 12, 2018

Con 12-1-1
Doc # 93200

John Ernst
CEDAR RAPIDS WATER POLLUTION CONTROL FACILITY
7525 BERTRAM ROAD SE
CEDAR RAPIDS IA 52403

Re: Cedar Rapids Water Pollution Control Facilities-Sludge Ash Storage Landfill
Permit #57-SDP-07-85P
IAC Rule Variance Request Approval

Dear Mr. Ernst:

This letter is to inform you that the variance request to discontinue the collection of filtered samples for analysis of dissolved metals, as required by 567 IAC 115.26(4)"d", and phenols and TOX, as required by 567 IAC 115.26(4)"f"; and instead to conduct sampling and analysis of total recoverable metals, is approved.

This variance approval was granted based on the review of your *Petition for Variance*, dated September 12,)18.

This variance is applicable as long as the justification for the request remains the same. The permit for the referenced facility will be revised to reflect the same under separate cover.

If you have any questions, you may contact me at (515) 725-8309.

Sincerely,

Nina M. Booker

Nina M. Booker
Environmental Engineer Senior
Land Quality Bureau

cc: Field Office 1

Douglas J. Luzbetak, P.E.
HLW Engineering Group
204 West Broad Street
P.O. Box 314
Story City, IA 50248

Gmail

Doug Luzbetak <dluzbetak@hlwengineering.com>

Cedar Rapids WPCF

4 messages

Doug Luzbetak <dluzbetak@hlwengineering.com> Tue, Nov 20, 2018 at 3:42 PM
To: "Nina Booker [DNR]" <nina.booker@dnr.iowa.gov>

Nina,

On September 12, 2018, IDNR issued a variance for this facility that allowed sampling of total metals instead of dissolved metals. I just received the results from the Fall, 2018 sampling event. The sampling was completed for total arsenic, barium, iron, and magnesium. These are the same metals (as dissolved) that were sampled for previously. Will this list be sufficient, or does the department want additional total metals added to this list during future sampling.

Thank you for your help,

Doug

Doug Luzbetak, P.E.
HLW Engineering Group
204 West Broad Street
PO Box 314
Story City, IA 50248
(515)7334144
FAX (515)7334146
Cell (515)2900247
dluzbetak@hlwengineering.com

Booker, Nina <nina.booker@dnr.iowa.gov> Tue, Nov 20, 2018 at 3:49 PM
To: Doug Luzbetak <dluzbetak@hlwengineering.com>

Doug,
Unless there becomes a reason to add additional metals, the list can stay the same for now.

Nina

NOTE NAME CHANGE

Nina Booker | Environmental Engineer Senior
Iowa Department of Natural Resources
P 515-725-8309 | F 515-725-8202 | 502 E. 9th St., Des Moines, IA 50319
www.iowadnr.gov

[Quoted text hidden]

Doug Luzbetak <dluzbetak@hlwengineering.com> Tue, Nov 20, 2018 at 3:54 PM
To: "Nina Booker [DNR]" <nina.booker@dnr.iowa.gov>

Nina,

OK, we will have them use the same list next year. Thank you for the quick response.

Doug

Doug Luzbetak, P.E.

HLW Engineering Group
204 West Broad Street
PO Box 314
Story City, IA 50248
(515)7334144
FAX (515)7334146
Cell (515)2900247
dluzbetak@hlwengineering.com

[Quoted text hidden]

Booker, Nina <nina.booker@dnr.iowa.gov> Tue, Nov 20, 2018 at 3:56 PM
To: Doug Luzbetak <dluzbetak@hlwengineering.com>

You're welcome!

NOTE NAME CHANGE

Nina Booker | Environmental Engineer Senior
Iowa Department of Natural Resources
P 515-725-8309 | F 515-725-8202 | 502 E. 9th St., Des Moines, IA 50319
www.iowadnr.gov

[Quoted text hidden]

APPENDIX B

Statistical Report

Results of the Ground Water Statistics

for Ash Monofill Facility

Semi-Annual Monitoring Events in 2024

Prepared for:
Ash Monofill – Cedar Rapids Water Pollution Control Facility
7525 Bertram Road SE
Cedar Rapids, IA 52403

Prepared by:
Jeffrey A. Holmgren
Otter Creek Environmental Services, L.L.C.
40W565 Foxwick Court
Elgin, IL 60124
(847) 464-1355

November 2024

INTRODUCTION

This report contains the results of the statistical analyses used to evaluate the ground water data obtained during the semi-annual monitoring events in 2024 at the Ash Monofill Facility. The ground water at the Ash Monofill Facility is monitored by a network of wells including MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, MW-24, and MW-26 (upgradient). Monitoring wells MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, MW-24, and MW-26 were sampled during April 10-11, 2024 and October 23-24, 2024 and analyzed for the parameters required by permit. 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. The interwell and intrawell methodologies are described and then applied to the Ash Monofill Facility 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 the Ash Monofill Facility includes MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, MW-24, and MW-26. Each of the groundwater monitoring wells is to be sampled at least semiannually and analyzed for arsenic, barium, iron, magnesium, ammonia, COD, chloride, pH, and specific conductivity. The ground water data obtained during the semi-annual monitoring events in 2024 are summarized in Attachment A.

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. The site prediction limit method was first applied to the Ash Monofill Facility data using the DUMPStat® statistical program. An intrawell method was also then utilized to determine the most appropriate statistical method for this data set. 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.

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: First Semi-Annual Monitoring event in 2024

The background data used in this statistical analysis includes the ground water data collected from ground water well MW-26 during the period from April 2018 through April 2024. A summary of the background data from monitoring well MW-26 is listed in Attachment B, 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 April 2024 data from downgradient wells MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, and MW-24, 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 during the First Semi-Annual Monitoring Event in 2024

Well	Parameter	Result	Prediction Limit	Prediction Limit Type	Verified/ Awaiting verification
MW-1	Ammonia, mg/L	0.555	0.1340	Nonparametric	Verified
	Arsenic, µg/L	3.65	2.2700	Nonparametric	Verified
	Iron, µg/L	5270	1104.8345	Normal	Awaiting verification
	Magnesium, mg/L	29.4	24.0277	Normal	Verified
	pH, SU	6.97	5.66 - 6.95	Normal	Verified
MW-2	Cobalt, µg/L	0.87	0.7500	Nonparametric	Awaiting verification
MW-21	Barium, µg/L	343	243.2435	Normal	Verified
	Chloride, mg/L	204	100.9370	Normal	Verified
	Magnesium, mg/L	53.1	24.0277	Normal	Verified
	Specific conductance, µS	1420	921.4086	Normal	Verified

Prediction Limit Exceedances during the First Semi-Annual Monitoring Event in 2024 (cont.)

Well	Parameter	Result	Prediction Limit	Prediction Limit Type	Verified/ Awaiting verification
MW-22	Ammonia, mg/L	2.8	0.1340	Nonparametric	Verified
	Arsenic, µg/L	14.5	2.2700	Nonparametric	Verified
	Barium, µg/L	408	243.2435	Normal	Verified
	COD, mg/L	47.0	8.0000	Nonparametric	Awaiting verification
	Cobalt, µg/L	13.8	0.7500	Nonparametric	Verified
	Iron, µg/L	18200	1104.8345	Normal	Verified
	Magnesium, mg/L	35.3	24.0277	Normal	Verified
	Specific conductance, µS	1038	921.4086	Normal	Verified
MW-23	Ammonia, mg/L	1.1	0.1340	Nonparametric	Verified
	Arsenic, µg/L	10.5	2.2700	Nonparametric	Verified
	Cobalt, µg/L	1.85	0.7500	Nonparametric	Verified
	Iron, µg/L	5050	1104.8345	Normal	Verified
	Magnesium, mg/L	37.3	24.0277	Normal	Verified
	pH, SU	7.09	5.66 - 6.95	Normal	Awaiting verification
	Specific conductance, µS	1087	921.4086	Normal	Verified
MW-24	Ammonia, mg/L	0.72	0.1340	Nonparametric	Verified
	Cobalt, µg/L	1.1	0.7500	Nonparametric	Awaiting verification
	Magnesium, mg/L	26.0	24.0277	Normal	Verified
MW-3R1	Ammonia, mg/L	0.30	0.1340	Nonparametric	Verified
	Arsenic, µg/L	32.3	2.2700	Nonparametric	Verified
	Cobalt, µg/L	10.7	0.7500	Nonparametric	Verified
	Iron, µg/L	35500	1104.8345	Normal	Verified
MW-4	Ammonia, mg/L	1.2	0.1340	Nonparametric	Verified
	Arsenic, µg/L	35.6	2.2700	Nonparametric	Verified
	Barium, µg/L	543	243.2435	Normal	Verified
	COD, mg/L	18.0		Nonparametric	Awaiting verification
	Cobalt, µg/L	126	0.7500	Nonparametric	Verified
	Iron, µg/L	83400	1104.8345	Normal	Verified
	Magnesium, mg/L	34.1	24.0277	Normal	Verified

The detection frequencies of the parameters in the up and down gradient monitoring wells are summarized in Table 3. Arsenic, barium, chloride, iron, magnesium, pH, and specific conductance were detected at a frequency greater than or equal to 50% in the upgradient well so these parameters were tested for normality. The remainder of the parameters (ammonia and COD) are rarely detected (less than 50%) in the upgradient well so nonparametric prediction limits were be used in those cases.

Table 4 summarizes the results of the Shapiro-Wilk test. Table 5 is a summary of the statistics and prediction limits determined for the metals. Table 8 is a historical summary of the data at those wells that have indicated an exceedance. 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 10% and the test becomes sensitive to 5 standard deviation unit increases over background.

Intrawell statistics

Up-to down gradient comparisons were problematic due to (a) too few rounds of background data and (b) lack of special variability. It is recommended that a minimum of eight rounds of data are available prior to performing statistics. Also, having only one upgradient well, does not characterize the groundwater across the facility. In light of this, an intrawell approach is applied here.

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 landfill 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: First Semi-Annual Monitoring event in 2024

The arsenic, barium, iron, magnesium, ammonia, COD, chloride, pH, and specific conductivity data from wells MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, MW-24, and MW-26 were evaluated using the combined Shewhart-CUSUM control chart method. The previous background at each well included the five rounds of data obtained from April 2018 through April 2020. As ground water monitoring at a municipal solid waste facility proceeds, it is recommended to update background data sets periodically with valid detection monitoring results that are representative of background groundwater quality not affected by leakage from a monitored unit. Failure to update background will exclude factors such as natural temporal variation, changes in field or laboratory methodologies, and changes in the water table due to meteorological conditions or other influences. Since there have been no statistical failures attributed to the landfill, the background was updated to include data obtained from April 2018 through April 2022.

A summary of the intrawell statistics is included in Attachment C, 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 parameters evaluated, the statistical limit exceedances identified are summarized in the table below.

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
MW-22	COD, mg/L	47.0	45.9862	14.1452	Normal	Awaiting verification
	Cobalt, µg/L	13.8	15.1526	14.3776	Normal	Awaiting verification
MW-4	Cobalt, µg/L	126	133.7782	18.7891	Normal	Awaiting verification
	Iron, µg/L	83400	81810.7886	16262.3741	Normal	Awaiting verification

The cobalt exceedances were determined using four data points in the background date range provided.

No increasing trends were detected in the background data.

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. For intrawell analysis, the site-wide false positive rate is 21% and the test becomes sensitive to 5 standard deviation units over background. The false positive rate is much higher than desired but will come down once more data are available.

Results of the Interwell Statistics: Second Semi-Annual Monitoring event in 2024

Monitoring wells MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, MW-24, and MW-26 were sampled on October 23-24, 2024 and analyzed for the parameters required by permit. The background data used in this statistical analysis includes the ground water data collected from ground water well MW-26 during the period from April 2018 through October 2024. A summary of the background data from monitoring well MW-26 is listed in Attachment D, 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 October 2024 data from downgradient wells MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, and MW-24, 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 during the Second Semi-Annual Monitoring Event in 2024

Well	Parameter	Result	Prediction Limit	Prediction Limit Type	Verified/ Awaiting verification
MW-1	Ammonia, mg/L	0.53	0.1340	Nonparametric	Verified
	Iron, µg/L	5400	1053.8260	Normal	Verified
	Magnesium, mg/L	29.0	23.5196	Normal	Verified
	Specific conductance, µS	956	902.7576	Normal	Awaiting Verification

Prediction Limit Exceedances during the Second Semi-Annual Monitoring Event in 2024 (cont.)

Well	Parameter	Result	Prediction Limit	Prediction Limit Type	Verified/ Awaiting verification
MW-21	Ammonia, mg/L	0.20	0.1340	Nonparametric	Awaiting Verification
	Barium, µg/L	350	237.8109	Normal	Verified
	Chloride, mg/L	215	100.3282	Normal	Verified
	Iron, µg/L	1070	1053.8260	Normal	Awaiting Verification
	Magnesium, mg/L	54.8	23.5196	Normal	Verified
MW-22	Ammonia, mg/L	3.1	0.1340	Nonparametric	Verified
	Arsenic, µg/L	22.5	2.2700	Nonparametric	Verified
	Barium, µg/L	339	237.8109	Normal	Verified
	Chloride, mg/L	115	100.3282	Normal	Awaiting Verification
	Cobalt, µg/L	12.8	0.7500	Nonparametric	Verified
	Iron, µg/L	16100	1053.8260	Normal	Verified
	Magnesium, mg/L	35.8	23.5196	Normal	Verified
MW-23	Ammonia, mg/L	1.1	0.1340	Nonparametric	Verified
	Arsenic, µg/L	7.87	2.2700	Nonparametric	Verified
	Cobalt, µg/L	1.96	0.7500	Nonparametric	Verified
	Iron, µg/L	4510	1053.8260	Normal	Verified
	Magnesium, mg/L	38.1	23.5196	Normal	Verified
	pH, SU	7.01	5.67 – 6.92	Normal	Verified
MW-24	Ammonia, mg/L	0.74	0.1340	Nonparametric	Verified
	Chloride, mg/L	128	100.3282	Normal	Awaiting Verification
	Magnesium, mg/L	31.9	23.5196	Normal	Verified
	pH, SU	7.09	5.67 – 6.92	Normal	Awaiting Verification
MW-3R1	Ammonia, mg/L	0.40	0.1340	Nonparametric	Verified
	Arsenic, µg/L	45.7	2.2700	Nonparametric	Verified
	Barium, µg/L	280	237.8109	Normal	Awaiting Verification
	Cobalt, µg/L	15.2	0.7500	Nonparametric	Verified
	Iron, µg/L	42500	1053.8260	Normal	Verified
	Magnesium, mg/L	28.3	23.5196	Normal	Awaiting Verification
MW-4	Ammonia, mg/L	1.0	0.1340	Nonparametric	Verified
	Arsenic, µg/L	13.7	2.2700	Nonparametric	Verified
	Barium, µg/L	317	237.8109	Normal	Verified
	Cobalt, µg/L	5.29	0.7500	Nonparametric	Verified
	Iron, µg/L	5090	1053.8260	Normal	Verified
	Magnesium, mg/L	29.1	23.5196	Normal	Verified

The detection frequencies of the parameters in the up and down gradient monitoring wells are summarized in Table 3. Arsenic, barium, chloride, iron, magnesium, pH, and specific conductance were detected at a frequency greater than or equal to 50% in the upgradient well so these parameters were tested for normality. The remainder of the parameters (ammonia and COD) are rarely detected (less than 50%) in the upgradient well so nonparametric prediction limits were be used in those cases.

Table 4 summarizes the results of the Shapiro-Wilk test. Table 5 is a summary of the statistics and prediction limits determined for the metals. Table 8 is a historical summary of the data at those wells that have indicated an exceedance. 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 12% and the test becomes sensitive to 5 standard deviation unit increases over background.

Results of the Intrawell Statistics: Second Semi-Annual Monitoring event in 2024

The arsenic, barium, iron, magnesium, ammonia, COD, chloride, pH, and specific conductivity data from wells MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, MW-24, and MW-26 were evaluated using the combined Shewhart-CUSUM control chart method. The previous background at each well included the five rounds of data obtained from April 2018 through April 2020.

As ground water monitoring at a municipal solid waste facility proceeds, it is recommended to update background data sets periodically with valid detection monitoring results that are representative of background groundwater quality not affected by leakage from a monitored unit. Failure to update background will exclude factors such as natural temporal variation, changes in field or laboratory methodologies, and changes in the water table due to meteorological conditions or other influences. Since there have been no statistical failures attributed to the landfill, the background was updated to include data obtained from April 2018 through April 2022.

A summary of the intrawell statistics is included in Attachment E, 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 parameters evaluated, there were no statistical limit exceedances identified. No increasing trends were detected in the background data.

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. For intrawell analysis, the site-wide false positive rate is 21% and the test becomes sensitive to 5 standard deviation units over background. The false positive rate is much higher than desired but will come down once more data are available.

CONCLUSIONS

This document describes a comprehensive statistical plan designated for the Ash Monofill Facility. The ground water data was compared to background using both site prediction limits and intrawell control charts. Up-to down gradient comparisons were problematic due to having too few rounds of background data and the lack of special variability. It is recommended that a minimum of eight rounds of data are available prior to performing statistics. Also, having only one upgradient well, does not characterize the groundwater across the facility. Given the site data available, intrawell statistics are the most appropriate method for data comparisons at this time. For the most current data, there are no control limit exceedances detected.

Attachment A

Ground Water Data obtained in 2024

Table 1

Analytical Data Summary for 4/10/2024 to 4/11/2024

Constituents	Units	MW-1	MW-2	MW-21	MW-22	MW-23	MW-24	MW-26	MW-3R1	MW-4
Ammonia	mg/L	.550	<.104	<.104	2.800	1.100	.720	<.104	.300	1.200
Arsenic, total	ug/L	3.65	1.62	<1.45	14.50	10.50	<1.45	<1.45	32.30	35.60
Barium, total	ug/L	222.0	114.0	343.0	408.0	106.0	93.6	123.0	171.0	543.0
Chemical oxygen demand	mg/L	<5.7	<5.7	<5.7	47.0	<5.7	<5.7	<5.7	<5.7	18.0
Chloride	mg/L	5.53	64.60	204.00	81.70	88.20	82.00	57.80	51.80	82.60
Cobalt, total	ug/L	<.65	.87	<.65	13.80	1.85	1.10	<.65	10.70	126.00
Iron, total	ug/L	5270.00	<42.95	58.00	18200.00	5050.00	<42.95	50.00	35500.00	83400.00
Magnesium, total	mg/L	29.4	23.7	53.1	35.3	37.3	26.0	12.9	20.6	34.1
pH	SU	6.97	6.71	6.67	6.84	7.09	6.75	6.21	6.63	6.43
Specific conductance	uS	721	748	1420	1038	1087	855	519	768	848
Temperature	C	13.6	11.9	11.4	14.8	14.4	12.4	13.2	14.0	13.4

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

Table 2

Analytical Data Summary for 10/23/2024 to 10/24/2024

Constituents	Units	MW-1	MW-2	MW-21	MW-22	MW-23	MW-24	MW-26	MW-3R1	MW-4
Ammonia	mg/L	.530	<.055	.200	3.100	1.100	.740	<.055	.400	1.000
Arsenic, total	ug/L	<3.70	<3.70	<3.70	22.50	7.87	<3.70	<3.70	45.70	13.70
Barium, total	ug/L	219	126	350	339	110	109	140	280	317
Chemical oxygen demand	mg/L	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7
Chloride	mg/L	4.62	100.00	215.00	115.00	90.70	128.00	63.60	65.90	75.70
Cobalt, total	ug/L	<1.70	<1.70	<1.70	12.80	1.96	<1.70	<1.70	15.20	5.29
Iron, total	ug/L	5400	587	1070	16100	4510	636	347	42500	5090
Magnesium, total	mg/L	29.0	22.0	54.8	35.8	38.1	31.9	13.8	28.3	29.1
pH	SU	6.37	6.48	6.83	6.92	7.01	7.09	6.15	6.80	6.75
Specific conductance	uS	956.5	532.2	874.5	668.4	666.9	547.0	306.6	502.7	447.9
Temperature	C	25.0	11.3	13.3	14.8	19.0	13.3	11.9	13.6	16.4

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

Attachment B

Summary Tables and Graphs for the Interwell Comparisons
First Semi-Annual Monitoring Event in 2024

Table 1

Upgradient Data

Constituent	Units	Well	Date		Result	Adjusted	
Ammonia	mg/L	MW-26	04/26/2018	ND	0.5000	0.1340	**
Ammonia	mg/L	MW-26	10/15/2018	ND	0.5000	0.1340	**
Ammonia	mg/L	MW-26	04/23/2019	ND	0.5000	0.1340	**
Ammonia	mg/L	MW-26	10/22/2019	ND	0.2000	0.1340	**
Ammonia	mg/L	MW-26	04/21/2020	ND	0.1000	0.1340	**
Ammonia	mg/L	MW-26	10/12/2020	ND	0.2800	0.1340	**
Ammonia	mg/L	MW-26	04/14/2021	ND	0.1340		
Ammonia	mg/L	MW-26	10/19/2021	ND	0.1340		
Ammonia	mg/L	MW-26	04/14/2022	ND	0.1340		
Ammonia	mg/L	MW-26	10/13/2022	ND	0.1140	0.1340	**
Ammonia	mg/L	MW-26	04/19/2023	ND	0.1040	0.1340	**
Ammonia	mg/L	MW-26	10/20/2023	ND	0.1040	0.1340	**
Ammonia	mg/L	MW-26	04/10/2024	ND	0.1040	0.1340	**
Arsenic, total	ug/L	MW-26	04/26/2018		0.4500		
Arsenic, total	ug/L	MW-26	10/15/2018	ND	0.5700	1.1500	**
Arsenic, total	ug/L	MW-26	04/23/2019		0.3600		
Arsenic, total	ug/L	MW-26	10/22/2019	ND	0.7500	1.1500	**
Arsenic, total	ug/L	MW-26	04/21/2020		2.2700		
Arsenic, total	ug/L	MW-26	10/12/2020		0.5500		
Arsenic, total	ug/L	MW-26	04/14/2021		0.4700		
Arsenic, total	ug/L	MW-26	10/19/2021	ND	5.7500	1.1500	**
Arsenic, total	ug/L	MW-26	04/14/2022	ND	1.1500		
Arsenic, total	ug/L	MW-26	10/13/2022		1.0900		
Arsenic, total	ug/L	MW-26	04/19/2023	ND	0.9000	1.1500	**
Arsenic, total	ug/L	MW-26	10/20/2023	ND	1.4500	1.1500	**
Arsenic, total	ug/L	MW-26	04/10/2024	ND	1.4500	1.1500	**
Barium, total	ug/L	MW-26	04/26/2018		137.0000		
Barium, total	ug/L	MW-26	10/15/2018		185.0000		
Barium, total	ug/L	MW-26	04/23/2019		193.0000		
Barium, total	ug/L	MW-26	10/22/2019		104.0000		
Barium, total	ug/L	MW-26	04/21/2020		176.0000		
Barium, total	ug/L	MW-26	10/12/2020		102.0000		
Barium, total	ug/L	MW-26	04/14/2021		155.0000		
Barium, total	ug/L	MW-26	10/19/2021		73.0000		
Barium, total	ug/L	MW-26	04/14/2022		139.0000		
Barium, total	ug/L	MW-26	10/13/2022		162.0000		
Barium, total	ug/L	MW-26	04/19/2023		176.0000		
Barium, total	ug/L	MW-26	10/20/2023		123.0000		
Barium, total	ug/L	MW-26	04/10/2024		123.0000		
Chemical oxygen demand	mg/L	MW-26	04/26/2018		6.0000		
Chemical oxygen demand	mg/L	MW-26	10/15/2018	ND	7.0000		
Chemical oxygen demand	mg/L	MW-26	04/23/2019	ND	7.0000		
Chemical oxygen demand	mg/L	MW-26	10/22/2019	ND	7.0000		
Chemical oxygen demand	mg/L	MW-26	04/21/2020		8.0000		
Chemical oxygen demand	mg/L	MW-26	10/12/2020	ND	7.0000		
Chemical oxygen demand	mg/L	MW-26	04/14/2021	ND	7.0000		
Chemical oxygen demand	mg/L	MW-26	10/19/2021	ND	7.0000		
Chemical oxygen demand	mg/L	MW-26	04/14/2022	ND	5.7000	7.0000	**
Chemical oxygen demand	mg/L	MW-26	10/13/2022	ND	5.7000	7.0000	**
Chemical oxygen demand	mg/L	MW-26	04/19/2023	ND	5.7000	7.0000	**
Chemical oxygen demand	mg/L	MW-26	10/20/2023	ND	5.7000	7.0000	**
Chemical oxygen demand	mg/L	MW-26	04/10/2024	ND	5.7000	7.0000	**
Chloride	mg/L	MW-26	04/26/2018		33.7000		
Chloride	mg/L	MW-26	10/15/2018		51.4100		
Chloride	mg/L	MW-26	04/23/2019		71.5000		
Chloride	mg/L	MW-26	10/22/2019		20.0000		
Chloride	mg/L	MW-26	04/21/2020		41.4000		
Chloride	mg/L	MW-26	10/12/2020		27.3000		
Chloride	mg/L	MW-26	04/14/2021		58.6000		
Chloride	mg/L	MW-26	10/19/2021		28.9180		
Chloride	mg/L	MW-26	04/14/2022		54.8900		
Chloride	mg/L	MW-26	10/13/2022		78.4000		
Chloride	mg/L	MW-26	04/19/2023		71.9000		
Chloride	mg/L	MW-26	10/20/2023		48.1000		
Chloride	mg/L	MW-26	04/10/2024		57.8000		
Cobalt, total	ug/L	MW-26	10/12/2020		0.5200		
Cobalt, total	ug/L	MW-26	04/14/2021	ND	0.5000	0.7500	**
Cobalt, total	ug/L	MW-26	10/19/2021	ND	6.2500	0.7500	**
Cobalt, total	ug/L	MW-26	04/14/2022	ND	1.2500	0.7500	**
Cobalt, total	ug/L	MW-26	10/13/2022	ND	0.7500		
Cobalt, total	ug/L	MW-26	04/19/2023	ND	0.7500		
Cobalt, total	ug/L	MW-26	10/20/2023	ND	0.6500	0.7500	**
Cobalt, total	ug/L	MW-26	04/10/2024	ND	0.6500	0.7500	**
Iron, total	ug/L	MW-26	04/26/2018		310.0000		

* - 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	
Iron, total	ug/L	MW-26	10/15/2018		380.0000		
Iron, total	ug/L	MW-26	04/23/2019		252.0000		
Iron, total	ug/L	MW-26	10/22/2019		516.0000		
Iron, total	ug/L	MW-26	04/21/2020		50.0000		*
Iron, total	ug/L	MW-26	10/12/2020		615.0000		
Iron, total	ug/L	MW-26	04/14/2021		510.0000		
Iron, total	ug/L	MW-26	10/19/2021	ND	272.6000		
Iron, total	ug/L	MW-26	04/14/2022	ND	681.5000	272.6000	**
Iron, total	ug/L	MW-26	10/13/2022		376.0000		
Iron, total	ug/L	MW-26	04/19/2023		767.0000		
Iron, total	ug/L	MW-26	10/20/2023		610.0000		
Iron, total	ug/L	MW-26	04/10/2024		50.0000		*
Magnesium, total	mg/L	MW-26	04/26/2018		12.1000		
Magnesium, total	mg/L	MW-26	10/15/2018		17.6000		
Magnesium, total	mg/L	MW-26	04/23/2019		17.8000		
Magnesium, total	mg/L	MW-26	10/22/2019		9.7900		
Magnesium, total	mg/L	MW-26	04/21/2020		9.8300		
Magnesium, total	mg/L	MW-26	10/12/2020		8.6100		
Magnesium, total	mg/L	MW-26	04/14/2021		11.9000		
Magnesium, total	mg/L	MW-26	10/19/2021		6.4900		
Magnesium, total	mg/L	MW-26	04/14/2022		14.5000		
Magnesium, total	mg/L	MW-26	10/13/2022		16.3000		
Magnesium, total	mg/L	MW-26	04/19/2023		19.7000		
Magnesium, total	mg/L	MW-26	10/20/2023		12.5000		
Magnesium, total	mg/L	MW-26	04/10/2024		12.9000		
pH	SU	MW-26	04/26/2018		6.0500		
pH	SU	MW-26	10/15/2018		6.3000		
pH	SU	MW-26	04/23/2019		6.2400		
pH	SU	MW-26	10/22/2019		6.3400		
pH	SU	MW-26	04/21/2020		6.0800		
pH	SU	MW-26	10/12/2020		6.2800		
pH	SU	MW-26	04/14/2021		6.1000		
pH	SU	MW-26	10/19/2021		6.3000		
pH	SU	MW-26	04/14/2022		6.8000		
pH	SU	MW-26	10/13/2022		6.3400		
pH	SU	MW-26	04/19/2023		6.5700		
pH	SU	MW-26	10/20/2023		6.4000		
pH	SU	MW-26	04/10/2024		6.2100		
Specific conductance	uS	MW-26	04/26/2018		143.0000		
Specific conductance	uS	MW-26	10/15/2018		545.0000		
Specific conductance	uS	MW-26	04/23/2019		649.0000		
Specific conductance	uS	MW-26	10/22/2019		305.0000		
Specific conductance	uS	MW-26	04/21/2020		389.0000		
Specific conductance	uS	MW-26	10/12/2020		319.0000		
Specific conductance	uS	MW-26	04/14/2021		546.0000		
Specific conductance	uS	MW-26	10/19/2021		355.0000		
Specific conductance	uS	MW-26	04/14/2022		538.0000		
Specific conductance	uS	MW-26	10/13/2022		646.0000		
Specific conductance	uS	MW-26	04/19/2023		709.0000		
Specific conductance	uS	MW-26	10/20/2023		461.0000		
Specific conductance	uS	MW-26	04/10/2024		519.0000		

* - 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
Ammonia	mg/L	MW-1	04/10/2024		0.5500	***	0.1340
Arsenic, total	ug/L	MW-1	04/10/2024		3.6500	*	2.2700
Barium, total	ug/L	MW-1	04/10/2024		222.0000		243.2435
Chemical oxygen demand	mg/L	MW-1	04/10/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-1	04/10/2024		5.5300		100.9370
Cobalt, total	ug/L	MW-1	04/10/2024	ND	0.6500		0.7500
Iron, total	ug/L	MW-1	04/10/2024		5270.0000	*	1104.8345
Magnesium, total	mg/L	MW-1	04/10/2024		29.4000	***	24.0277
pH	SU	MW-1	04/10/2024		6.9700	***	5.66 - 6.95
Specific conductance	uS	MW-1	04/10/2024		721.0000		921.4086
Ammonia	mg/L	MW-2	04/11/2024	ND	0.1040		0.1340
Arsenic, total	ug/L	MW-2	04/11/2024		1.6200	**	2.2700
Barium, total	ug/L	MW-2	04/11/2024		114.0000		243.2435
Chemical oxygen demand	mg/L	MW-2	04/11/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-2	04/11/2024		64.6000		100.9370
Cobalt, total	ug/L	MW-2	04/11/2024		0.8700	*	0.7500
Iron, total	ug/L	MW-2	04/11/2024	ND	42.9500		1104.8345
Magnesium, total	mg/L	MW-2	04/11/2024		23.7000	**	24.0277
pH	SU	MW-2	04/11/2024		6.7100		5.66 - 6.95
Specific conductance	uS	MW-2	04/11/2024		748.0000		921.4086
Ammonia	mg/L	MW-21	04/11/2024	ND	0.1040		0.1340
Arsenic, total	ug/L	MW-21	04/11/2024	ND	1.4500		2.2700
Barium, total	ug/L	MW-21	04/11/2024		343.0000	***	243.2435
Chemical oxygen demand	mg/L	MW-21	04/11/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-21	04/11/2024		204.0000	***	100.9370
Cobalt, total	ug/L	MW-21	04/11/2024	ND	0.6500		0.7500
Iron, total	ug/L	MW-21	04/11/2024		58.0000		1104.8345
Magnesium, total	mg/L	MW-21	04/11/2024		53.1000	***	24.0277
pH	SU	MW-21	04/11/2024		6.6700		5.66 - 6.95
Specific conductance	uS	MW-21	04/11/2024		1420.0000	***	921.4086
Ammonia	mg/L	MW-22	04/11/2024		2.8000	***	0.1340
Arsenic, total	ug/L	MW-22	04/11/2024		14.5000	***	2.2700
Barium, total	ug/L	MW-22	04/11/2024		408.0000	***	243.2435
Chemical oxygen demand	mg/L	MW-22	04/11/2024		47.0000	*	8.0000
Chloride	mg/L	MW-22	04/11/2024		81.7000		100.9370
Cobalt, total	ug/L	MW-22	04/11/2024		13.8000	***	0.7500
Iron, total	ug/L	MW-22	04/11/2024		18200.0000	***	1104.8345
Magnesium, total	mg/L	MW-22	04/11/2024		35.3000	***	24.0277
pH	SU	MW-22	04/11/2024		6.8400		5.66 - 6.95
Specific conductance	uS	MW-22	04/11/2024		1038.0000	***	921.4086
Ammonia	mg/L	MW-23	04/10/2024		1.1000	***	0.1340
Arsenic, total	ug/L	MW-23	04/10/2024		10.5000	***	2.2700
Barium, total	ug/L	MW-23	04/10/2024		106.0000		243.2435
Chemical oxygen demand	mg/L	MW-23	04/10/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-23	04/10/2024		88.2000		100.9370
Cobalt, total	ug/L	MW-23	04/10/2024		1.8500	***	0.7500
Iron, total	ug/L	MW-23	04/10/2024		5050.0000	***	1104.8345
Magnesium, total	mg/L	MW-23	04/10/2024		37.3000	***	24.0277
pH	SU	MW-23	04/10/2024		7.0900	*	5.66 - 6.95
Specific conductance	uS	MW-23	04/10/2024		1087.0000	***	921.4086
Ammonia	mg/L	MW-24	04/11/2024		0.7200	***	0.1340
Arsenic, total	ug/L	MW-24	04/11/2024	ND	1.4500		2.2700
Barium, total	ug/L	MW-24	04/11/2024		93.6000		243.2435
Chemical oxygen demand	mg/L	MW-24	04/11/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-24	04/11/2024		82.0000		100.9370
Cobalt, total	ug/L	MW-24	04/11/2024		1.1000	*	0.7500
Iron, total	ug/L	MW-24	04/11/2024	ND	42.9500		1104.8345
Magnesium, total	mg/L	MW-24	04/11/2024		26.0000	***	24.0277
pH	SU	MW-24	04/11/2024		6.7500	**	5.66 - 6.95
Specific conductance	uS	MW-24	04/11/2024		855.0000		921.4086
Ammonia	mg/L	MW-3R1	04/11/2024		0.3000	***	0.1340
Arsenic, total	ug/L	MW-3R1	04/11/2024		32.3000	***	2.2700
Barium, total	ug/L	MW-3R1	04/11/2024		171.0000		243.2435
Chemical oxygen demand	mg/L	MW-3R1	04/11/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-3R1	04/11/2024		51.8000		100.9370
Cobalt, total	ug/L	MW-3R1	04/11/2024		10.7000	***	0.7500
Iron, total	ug/L	MW-3R1	04/11/2024		35500.0000	***	1104.8345
Magnesium, total	mg/L	MW-3R1	04/11/2024		20.6000	**	24.0277
pH	SU	MW-3R1	04/11/2024		6.6300		5.66 - 6.95
Specific conductance	uS	MW-3R1	04/11/2024		768.0000		921.4086
Ammonia	mg/L	MW-4	04/10/2024		1.2000	***	0.1340
Arsenic, total	ug/L	MW-4	04/10/2024		35.6000	***	2.2700

* - 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 2

Most Current Downgradient Monitoring Data

Constituent	Units	Well	Date		Result		Pred. Limit
Barium, total	ug/L	MW-4	04/10/2024		543.0000	***	243.2435
Chemical oxygen demand	mg/L	MW-4	04/10/2024		18.0000	*	8.0000
Chloride	mg/L	MW-4	04/10/2024		82.6000		100.9370
Cobalt, total	ug/L	MW-4	04/10/2024		126.0000	***	0.7500
Iron, total	ug/L	MW-4	04/10/2024		83400.0000	***	1104.8345
Magnesium, total	mg/L	MW-4	04/10/2024		34.1000	***	24.0277
pH	SU	MW-4	04/10/2024		6.4300		5.66 - 6.95
Specific conductance	uS	MW-4	04/10/2024		848.0000		921.4086

* - 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
Ammonia	0	13	0.000	79	105	0.752
Arsenic, total	6	13	0.462	92	105	0.876
Barium, total	13	13	1.000	105	105	1.000
Chemical oxygen demand	2	13	0.154	46	104	0.442
Chloride	13	13	1.000	105	105	1.000
Cobalt, total	1	8	0.125	47	65	0.723
Iron, total	9	11	0.818	92	105	0.876
Magnesium, total	13	13	1.000	105	105	1.000
pH	13	13	1.000	105	105	1.000
Specific conductance	13	13	1.000	105	105	1.000

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
Ammonia	0	13	0.000									nonpar
Arsenic, total	6	13	0.462	2.132	0.900					2.326	normal	nonpar
Barium, total	13	13	1.000	0.599	0.446					2.326	normal	normal
Chemical oxygen demand	2	13	0.154									nonpar
Chloride	13	13	1.000	0.568	0.235					2.326	normal	normal
Cobalt, total	1	8	0.125									nonpar
Iron, total	9	11	0.818	0.800	0.850					2.326	normal	normal
Magnesium, total	13	13	1.000	1.082	0.714					2.326	normal	normal
pH	13	13	1.000	0.979	0.798					2.326	normal	normal
Specific conductance	13	13	1.000	0.594	1.604					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
Ammonia	mg/L	0	13					0.1340	nonpar	***	0.93
Arsenic, total	ug/L	6	13					2.2700	nonpar		0.93
Barium, total	ug/L	13	13	142.1538	36.3910	0.0100	2.7779	243.2435	normal		
Chemical oxygen demand	mg/L	2	13					8.0000	nonpar		0.93
Chloride	mg/L	13	13	49.5322	18.5051	0.0100	2.7779	100.9370	normal		
Cobalt, total	ug/L	1	8					0.7500	nonpar	***	0.86
Iron, total	ug/L	9	11	394.1818	246.2130	0.0100	2.8863	1104.8345	normal		
Magnesium, total	mg/L	13	13	13.0785	3.9416	0.0100	2.7779	24.0277	normal		
pH	SU	13	13	6.3085	0.2038	0.0100	3.1619	5.66 - 6.95	normal		
Specific conductance	uS	13	13	471.0769	162.1139	0.0100	2.7779	921.4086	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
Iron, total	ug/L	MW-26	04/10/2024	50.0000		04/26/2018-04/10/2024	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
Ammonia	mg/L	MW-1	04/26/2018		1.0000	*	0.1340
Ammonia	mg/L	MW-1	10/15/2018		0.5300	*	0.1340
Ammonia	mg/L	MW-1	04/23/2019		1.1000	*	0.1340
Ammonia	mg/L	MW-1	10/22/2019		0.9100	*	0.1340
Ammonia	mg/L	MW-1	04/21/2020		0.5800	*	0.1340
Ammonia	mg/L	MW-1	10/13/2020		0.7100	*	0.1340
Ammonia	mg/L	MW-1	04/14/2021		0.6300	*	0.1340
Ammonia	mg/L	MW-1	10/19/2021		0.6500	*	0.1340
Ammonia	mg/L	MW-1	04/14/2022		0.7400	*	0.1340
Ammonia	mg/L	MW-1	10/13/2022		0.6300	*	0.1340
Ammonia	mg/L	MW-1	04/19/2023		0.6100	*	0.1340
Ammonia	mg/L	MW-1	10/20/2023		0.6300	*	0.1340
Ammonia	mg/L	MW-1	04/10/2024		0.5500	*	0.1340
Arsenic, total	ug/L	MW-1	04/26/2018		2.4000	*	2.2700
Arsenic, total	ug/L	MW-1	10/15/2018		1.3700		2.2700
Arsenic, total	ug/L	MW-1	04/23/2019		4.0200	*	2.2700
Arsenic, total	ug/L	MW-1	10/22/2019		3.9600	*	2.2700
Arsenic, total	ug/L	MW-1	04/21/2020		3.6500	*	2.2700
Arsenic, total	ug/L	MW-1	10/13/2020		3.7500	*	2.2700
Arsenic, total	ug/L	MW-1	04/14/2021		5.6100	*	2.2700
Arsenic, total	ug/L	MW-1	10/19/2021	ND	0.2300		2.2700
Arsenic, total	ug/L	MW-1	04/14/2022		3.4700	*	2.2700
Arsenic, total	ug/L	MW-1	10/13/2022		3.7100	*	2.2700
Arsenic, total	ug/L	MW-1	04/19/2023		3.3200	*	2.2700
Arsenic, total	ug/L	MW-1	10/20/2023		2.2700		2.2700
Arsenic, total	ug/L	MW-1	04/10/2024		3.6500	*	2.2700
Iron, total	ug/L	MW-1	04/26/2018		2840.0000	*	1104.8345
Iron, total	ug/L	MW-1	10/15/2018		1900.0000	*	1104.8345
Iron, total	ug/L	MW-1	04/23/2019		6880.0000	*	1104.8345
Iron, total	ug/L	MW-1	10/22/2019		5820.0000	*	1104.8345
Iron, total	ug/L	MW-1	04/21/2020		45.8000		1104.8345
Iron, total	ug/L	MW-1	10/13/2020		5900.0000	*	1104.8345
Iron, total	ug/L	MW-1	04/14/2021		9720.0000	*	1104.8345
Iron, total	ug/L	MW-1	10/19/2021		4090.0000	*	1104.8345
Iron, total	ug/L	MW-1	04/14/2022		4100.0000	*	1104.8345
Iron, total	ug/L	MW-1	10/13/2022		4910.0000	*	1104.8345
Iron, total	ug/L	MW-1	04/19/2023		1270.0000	*	1104.8345
Iron, total	ug/L	MW-1	10/20/2023		779.0000		1104.8345
Iron, total	ug/L	MW-1	04/10/2024		5270.0000	*	1104.8345
Magnesium, total	mg/L	MW-1	04/26/2018		29.0000	*	24.0277
Magnesium, total	mg/L	MW-1	10/15/2018		32.0000	*	24.0277
Magnesium, total	mg/L	MW-1	04/23/2019		20.7000		24.0277
Magnesium, total	mg/L	MW-1	10/22/2019		25.8000	*	24.0277
Magnesium, total	mg/L	MW-1	04/21/2020		23.5000		24.0277
Magnesium, total	mg/L	MW-1	10/13/2020		24.2000	*	24.0277
Magnesium, total	mg/L	MW-1	04/14/2021		29.3000	*	24.0277
Magnesium, total	mg/L	MW-1	10/19/2021		20.9000		24.0277
Magnesium, total	mg/L	MW-1	04/14/2022		28.7000	*	24.0277
Magnesium, total	mg/L	MW-1	10/13/2022		29.2000	*	24.0277
Magnesium, total	mg/L	MW-1	04/19/2023		28.3000	*	24.0277
Magnesium, total	mg/L	MW-1	10/20/2023		31.9000	*	24.0277
Magnesium, total	mg/L	MW-1	04/10/2024		29.4000	*	24.0277
pH	SU	MW-1	04/26/2018		6.5000		5.66 - 6.95
pH	SU	MW-1	10/15/2018		7.2200	*	5.66 - 6.95
pH	SU	MW-1	04/23/2019		7.0300	*	5.66 - 6.95
pH	SU	MW-1	10/22/2019		7.2100	*	5.66 - 6.95
pH	SU	MW-1	04/21/2020		7.2300	*	5.66 - 6.95
pH	SU	MW-1	10/13/2020		7.0300	*	5.66 - 6.95
pH	SU	MW-1	04/14/2021		7.4000	*	5.66 - 6.95
pH	SU	MW-1	10/19/2021		7.4000	*	5.66 - 6.95
pH	SU	MW-1	04/14/2022		7.5000	*	5.66 - 6.95
pH	SU	MW-1	10/13/2022		7.1700	*	5.66 - 6.95
pH	SU	MW-1	04/19/2023		7.3300	*	5.66 - 6.95
pH	SU	MW-1	10/20/2023		7.2000	*	5.66 - 6.95
pH	SU	MW-1	04/10/2024		6.9700	*	5.66 - 6.95
Arsenic, total	ug/L	MW-2	04/27/2018		1.9000		2.2700
Arsenic, total	ug/L	MW-2	10/16/2018		1.7000		2.2700
Arsenic, total	ug/L	MW-2	04/24/2019		1.4700		2.2700
Arsenic, total	ug/L	MW-2	10/23/2019		1.4900		2.2700
Arsenic, total	ug/L	MW-2	04/21/2020		1.4500		2.2700
Arsenic, total	ug/L	MW-2	10/13/2020		1.3600		2.2700

* - 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
Arsenic, total	ug/L	MW-2	04/15/2021		1.2300		2.2700
Arsenic, total	ug/L	MW-2	10/20/2021	ND	5.7500		2.2700
Arsenic, total	ug/L	MW-2	04/15/2022		1.3400		2.2700
Arsenic, total	ug/L	MW-2	10/14/2022		1.3900		2.2700
Arsenic, total	ug/L	MW-2	04/19/2023		1.1900		2.2700
Arsenic, total	ug/L	MW-2	10/20/2023		2.3800	*	2.2700
Arsenic, total	ug/L	MW-2	04/11/2024		1.6200		2.2700
Cobalt, total	ug/L	MW-2	10/13/2020		8.6300	*	0.7500
Cobalt, total	ug/L	MW-2	04/15/2021		2.1800	*	0.7500
Cobalt, total	ug/L	MW-2	10/20/2021		8.8000	*	0.7500
Cobalt, total	ug/L	MW-2	04/15/2022		6.1800	*	0.7500
Cobalt, total	ug/L	MW-2	10/14/2022		8.0600	*	0.7500
Cobalt, total	ug/L	MW-2	04/19/2023		1.2500	*	0.7500
Cobalt, total	ug/L	MW-2	10/20/2023	ND	0.6500		0.7500
Cobalt, total	ug/L	MW-2	04/11/2024		0.8700	*	0.7500
Magnesium, total	mg/L	MW-2	04/27/2018		23.9000		24.0277
Magnesium, total	mg/L	MW-2	10/16/2018		23.3000		24.0277
Magnesium, total	mg/L	MW-2	04/24/2019		20.1000		24.0277
Magnesium, total	mg/L	MW-2	10/23/2019		22.3000		24.0277
Magnesium, total	mg/L	MW-2	04/21/2020		23.0000		24.0277
Magnesium, total	mg/L	MW-2	10/13/2020		21.5000		24.0277
Magnesium, total	mg/L	MW-2	04/15/2021		21.9000		24.0277
Magnesium, total	mg/L	MW-2	10/20/2021		17.1000		24.0277
Magnesium, total	mg/L	MW-2	04/15/2022		28.4000	*	24.0277
Magnesium, total	mg/L	MW-2	10/14/2022		21.2000		24.0277
Magnesium, total	mg/L	MW-2	04/19/2023		27.9000	*	24.0277
Magnesium, total	mg/L	MW-2	10/20/2023		31.4000	*	24.0277
Magnesium, total	mg/L	MW-2	04/11/2024		23.7000		24.0277
Barium, total	ug/L	MW-21	04/26/2018		406.0000	*	243.2435
Barium, total	ug/L	MW-21	10/15/2018		372.0000	*	243.2435
Barium, total	ug/L	MW-21	04/24/2019		413.0000	*	243.2435
Barium, total	ug/L	MW-21	10/22/2019		438.0000	*	243.2435
Barium, total	ug/L	MW-21	04/21/2020		401.0000	*	243.2435
Barium, total	ug/L	MW-21	10/13/2020		338.0000	*	243.2435
Barium, total	ug/L	MW-21	04/14/2021		347.0000	*	243.2435
Barium, total	ug/L	MW-21	10/20/2021		229.0000		243.2435
Barium, total	ug/L	MW-21	04/14/2022		325.0000	*	243.2435
Barium, total	ug/L	MW-21	10/13/2022		307.0000	*	243.2435
Barium, total	ug/L	MW-21	04/19/2023		269.0000	*	243.2435
Barium, total	ug/L	MW-21	10/24/2023		301.0000	*	243.2435
Barium, total	ug/L	MW-21	04/11/2024		343.0000	*	243.2435
Chloride	mg/L	MW-21	04/26/2018		224.0000	*	100.9370
Chloride	mg/L	MW-21	10/15/2018		194.9500	*	100.9370
Chloride	mg/L	MW-21	04/24/2019		224.0000	*	100.9370
Chloride	mg/L	MW-21	10/22/2019		217.0000	*	100.9370
Chloride	mg/L	MW-21	04/21/2020		227.0000	*	100.9370
Chloride	mg/L	MW-21	10/13/2020		245.0000	*	100.9370
Chloride	mg/L	MW-21	04/14/2021		238.0000	*	100.9370
Chloride	mg/L	MW-21	10/20/2021		195.9450	*	100.9370
Chloride	mg/L	MW-21	04/14/2022		178.0400	*	100.9370
Chloride	mg/L	MW-21	10/13/2022		162.0000	*	100.9370
Chloride	mg/L	MW-21	04/19/2023		167.0000	*	100.9370
Chloride	mg/L	MW-21	10/24/2023		174.0000	*	100.9370
Chloride	mg/L	MW-21	04/11/2024		204.0000	*	100.9370
Magnesium, total	mg/L	MW-21	04/26/2018		60.1000	*	24.0277
Magnesium, total	mg/L	MW-21	10/15/2018		55.3000	*	24.0277
Magnesium, total	mg/L	MW-21	04/24/2019		58.7000	*	24.0277
Magnesium, total	mg/L	MW-21	10/22/2019		58.0000	*	24.0277
Magnesium, total	mg/L	MW-21	04/21/2020		59.6000	*	24.0277
Magnesium, total	mg/L	MW-21	10/13/2020		56.8000	*	24.0277
Magnesium, total	mg/L	MW-21	04/14/2021		55.4000	*	24.0277
Magnesium, total	mg/L	MW-21	10/20/2021		36.9000	*	24.0277
Magnesium, total	mg/L	MW-21	04/14/2022		51.5000	*	24.0277
Magnesium, total	mg/L	MW-21	10/13/2022		43.9000	*	24.0277
Magnesium, total	mg/L	MW-21	04/19/2023		47.0000	*	24.0277
Magnesium, total	mg/L	MW-21	10/24/2023		52.7000	*	24.0277
Magnesium, total	mg/L	MW-21	04/11/2024		53.1000	*	24.0277
Specific conductance	uS	MW-21	04/26/2018		1554.0000	*	921.4086
Specific conductance	uS	MW-21	10/15/2018		1391.0000	*	921.4086
Specific conductance	uS	MW-21	04/24/2019		1590.0000	*	921.4086
Specific conductance	uS	MW-21	10/22/2019		1532.0000	*	921.4086

* - Significantly increased over background.
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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
Specific conductance	uS	MW-21	04/21/2020		1661.0000	*	921.4086
Specific conductance	uS	MW-21	10/13/2020		1542.0000	*	921.4086
Specific conductance	uS	MW-21	04/14/2021		1649.0000	*	921.4086
Specific conductance	uS	MW-21	10/20/2021		1480.0000	*	921.4086
Specific conductance	uS	MW-21	04/14/2022		1484.0000	*	921.4086
Specific conductance	uS	MW-21	10/13/2022		1520.0000	*	921.4086
Specific conductance	uS	MW-21	04/19/2023		1443.0000	*	921.4086
Specific conductance	uS	MW-21	10/24/2023		1350.0000	*	921.4086
Specific conductance	uS	MW-21	04/11/2024		1420.0000	*	921.4086
Ammonia	mg/L	MW-22	04/27/2018		6.4000	*	0.1340
Ammonia	mg/L	MW-22	10/16/2018		4.0000	*	0.1340
Ammonia	mg/L	MW-22	04/24/2019		3.7000	*	0.1340
Ammonia	mg/L	MW-22	10/23/2019		3.9000	*	0.1340
Ammonia	mg/L	MW-22	04/21/2020		5.9000	*	0.1340
Ammonia	mg/L	MW-22	10/13/2020		4.9000	*	0.1340
Ammonia	mg/L	MW-22	04/15/2021		3.6000	*	0.1340
Ammonia	mg/L	MW-22	10/20/2021		2.8000	*	0.1340
Ammonia	mg/L	MW-22	04/15/2022		3.8000	*	0.1340
Ammonia	mg/L	MW-22	10/14/2022		2.8000	*	0.1340
Ammonia	mg/L	MW-22	04/20/2023		2.6000	*	0.1340
Ammonia	mg/L	MW-22	05/24/2023		2.2000	*	0.1340
Ammonia	mg/L	MW-22	10/20/2023		2.0000	*	0.1340
Ammonia	mg/L	MW-22	04/11/2024		2.8000	*	0.1340
Arsenic, total	ug/L	MW-22	04/27/2018		19.0000	*	2.2700
Arsenic, total	ug/L	MW-22	10/16/2018		14.6000	*	2.2700
Arsenic, total	ug/L	MW-22	04/24/2019		19.8000	*	2.2700
Arsenic, total	ug/L	MW-22	10/23/2019		16.0000	*	2.2700
Arsenic, total	ug/L	MW-22	04/21/2020		11.6000	*	2.2700
Arsenic, total	ug/L	MW-22	10/13/2020		7.4200	*	2.2700
Arsenic, total	ug/L	MW-22	04/15/2021		15.0000	*	2.2700
Arsenic, total	ug/L	MW-22	10/20/2021		15.2000	*	2.2700
Arsenic, total	ug/L	MW-22	04/15/2022		16.0000	*	2.2700
Arsenic, total	ug/L	MW-22	10/14/2022		25.0000	*	2.2700
Arsenic, total	ug/L	MW-22	04/20/2023		17.8000	*	2.2700
Arsenic, total	ug/L	MW-22	05/24/2023		23.7000	*	2.2700
Arsenic, total	ug/L	MW-22	10/20/2023		22.3000	*	2.2700
Arsenic, total	ug/L	MW-22	04/11/2024		14.5000	*	2.2700
Barium, total	ug/L	MW-22	04/27/2018		315.0000	*	243.2435
Barium, total	ug/L	MW-22	10/16/2018		225.0000		243.2435
Barium, total	ug/L	MW-22	04/24/2019		281.0000	*	243.2435
Barium, total	ug/L	MW-22	10/23/2019		269.0000	*	243.2435
Barium, total	ug/L	MW-22	04/21/2020		440.0000	*	243.2435
Barium, total	ug/L	MW-22	10/13/2020		318.0000	*	243.2435
Barium, total	ug/L	MW-22	04/15/2021		326.0000	*	243.2435
Barium, total	ug/L	MW-22	10/20/2021		241.0000		243.2435
Barium, total	ug/L	MW-22	04/15/2022		361.0000	*	243.2435
Barium, total	ug/L	MW-22	10/14/2022		567.0000	*	243.2435
Barium, total	ug/L	MW-22	04/20/2023		900.0000	*	243.2435
Barium, total	ug/L	MW-22	05/24/2023		327.0000	*	243.2435
Barium, total	ug/L	MW-22	10/20/2023		259.0000	*	243.2435
Barium, total	ug/L	MW-22	04/11/2024		408.0000	*	243.2435
Chemical oxygen demand	mg/L	MW-22	04/27/2018		8.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/16/2018	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/24/2019		10.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-22	10/23/2019	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/21/2020		8.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/13/2020	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/15/2021	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/20/2021	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/15/2022	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/14/2022	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/20/2023		100.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-22	05/24/2023	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/20/2023	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/11/2024		47.0000	*	8.0000
Cobalt, total	ug/L	MW-22	10/13/2020		8.0000	*	0.7500
Cobalt, total	ug/L	MW-22	04/15/2021		8.2400	*	0.7500
Cobalt, total	ug/L	MW-22	10/20/2021		7.4400	*	0.7500
Cobalt, total	ug/L	MW-22	04/15/2022		9.6300	*	0.7500
Cobalt, total	ug/L	MW-22	10/14/2022		10.7000	*	0.7500
Cobalt, total	ug/L	MW-22	04/20/2023		31.4000	*	0.7500

* - Significantly increased over background.
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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
Cobalt, total	ug/L	MW-22	05/24/2023		14.2000	*	0.7500
Cobalt, total	ug/L	MW-22	10/20/2023		10.1000	*	0.7500
Cobalt, total	ug/L	MW-22	04/11/2024		13.8000	*	0.7500
Iron, total	ug/L	MW-22	04/27/2018		12800.0000	*	1104.8345
Iron, total	ug/L	MW-22	10/16/2018		8130.0000	*	1104.8345
Iron, total	ug/L	MW-22	04/24/2019		18200.0000	*	1104.8345
Iron, total	ug/L	MW-22	10/23/2019		13600.0000	*	1104.8345
Iron, total	ug/L	MW-22	04/21/2020		93.3000		1104.8345
Iron, total	ug/L	MW-22	10/13/2020		3990.0000	*	1104.8345
Iron, total	ug/L	MW-22	04/15/2021		11700.0000	*	1104.8345
Iron, total	ug/L	MW-22	10/20/2021		9990.0000	*	1104.8345
Iron, total	ug/L	MW-22	04/15/2022		12000.0000	*	1104.8345
Iron, total	ug/L	MW-22	10/14/2022		19600.0000	*	1104.8345
Iron, total	ug/L	MW-22	04/20/2023		18300.0000	*	1104.8345
Iron, total	ug/L	MW-22	05/24/2023		19400.0000	*	1104.8345
Iron, total	ug/L	MW-22	10/20/2023		6540.0000	*	1104.8345
Iron, total	ug/L	MW-22	04/11/2024		18200.0000	*	1104.8345
Magnesium, total	mg/L	MW-22	04/27/2018		33.6000	*	24.0277
Magnesium, total	mg/L	MW-22	10/16/2018		27.9000	*	24.0277
Magnesium, total	mg/L	MW-22	04/24/2019		31.6000	*	24.0277
Magnesium, total	mg/L	MW-22	10/23/2019		28.5000	*	24.0277
Magnesium, total	mg/L	MW-22	04/21/2020		33.1000	*	24.0277
Magnesium, total	mg/L	MW-22	10/13/2020		32.6000	*	24.0277
Magnesium, total	mg/L	MW-22	04/15/2021		32.9000	*	24.0277
Magnesium, total	mg/L	MW-22	10/20/2021		24.6000	*	24.0277
Magnesium, total	mg/L	MW-22	04/15/2022		35.1000	*	24.0277
Magnesium, total	mg/L	MW-22	10/14/2022		33.2000	*	24.0277
Magnesium, total	mg/L	MW-22	04/20/2023		46.0000	*	24.0277
Magnesium, total	mg/L	MW-22	05/24/2023		31.7000	*	24.0277
Magnesium, total	mg/L	MW-22	10/20/2023		33.2000	*	24.0277
Magnesium, total	mg/L	MW-22	04/11/2024		35.3000	*	24.0277
Specific conductance	uS	MW-22	04/27/2018		1340.0000	*	921.4086
Specific conductance	uS	MW-22	10/16/2018		1033.0000	*	921.4086
Specific conductance	uS	MW-22	04/24/2019		1142.0000	*	921.4086
Specific conductance	uS	MW-22	10/23/2019		972.0000	*	921.4086
Specific conductance	uS	MW-22	04/21/2020		1149.0000	*	921.4086
Specific conductance	uS	MW-22	10/13/2020		1041.0000	*	921.4086
Specific conductance	uS	MW-22	04/15/2021		1090.0000	*	921.4086
Specific conductance	uS	MW-22	10/20/2021		1028.0000	*	921.4086
Specific conductance	uS	MW-22	04/15/2022		1004.0000	*	921.4086
Specific conductance	uS	MW-22	10/14/2022		1035.0000	*	921.4086
Specific conductance	uS	MW-22	04/20/2023		988.0000	*	921.4086
Specific conductance	uS	MW-22	05/24/2023		948.0000	*	921.4086
Specific conductance	uS	MW-22	10/20/2023		927.0000	*	921.4086
Specific conductance	uS	MW-22	04/11/2024		1038.0000	*	921.4086
Ammonia	mg/L	MW-23	04/26/2018		1.7000	*	0.1340
Ammonia	mg/L	MW-23	10/16/2018		1.6000	*	0.1340
Ammonia	mg/L	MW-23	04/24/2019		1.7000	*	0.1340
Ammonia	mg/L	MW-23	10/23/2019		1.8000	*	0.1340
Ammonia	mg/L	MW-23	04/21/2020		1.1000	*	0.1340
Ammonia	mg/L	MW-23	10/12/2020		1.5000	*	0.1340
Ammonia	mg/L	MW-23	04/14/2021		1.1000	*	0.1340
Ammonia	mg/L	MW-23	10/19/2021		1.3000	*	0.1340
Ammonia	mg/L	MW-23	04/15/2022		1.4000	*	0.1340
Ammonia	mg/L	MW-23	10/13/2022		1.3000	*	0.1340
Ammonia	mg/L	MW-23	04/19/2023		1.2000	*	0.1340
Ammonia	mg/L	MW-23	10/18/2023		1.2000	*	0.1340
Ammonia	mg/L	MW-23	04/10/2024		1.1000	*	0.1340
Arsenic, total	ug/L	MW-23	04/26/2018		32.2000	*	2.2700
Arsenic, total	ug/L	MW-23	10/16/2018		15.2000	*	2.2700
Arsenic, total	ug/L	MW-23	04/24/2019		18.8000	*	2.2700
Arsenic, total	ug/L	MW-23	10/23/2019		14.6000	*	2.2700
Arsenic, total	ug/L	MW-23	04/21/2020		30.4000	*	2.2700
Arsenic, total	ug/L	MW-23	10/12/2020		31.8000	*	2.2700
Arsenic, total	ug/L	MW-23	04/14/2021		21.9000	*	2.2700
Arsenic, total	ug/L	MW-23	10/19/2021		9.4000	*	2.2700
Arsenic, total	ug/L	MW-23	04/15/2022		16.5000	*	2.2700
Arsenic, total	ug/L	MW-23	10/13/2022		11.5000	*	2.2700
Arsenic, total	ug/L	MW-23	04/19/2023		18.1000	*	2.2700
Arsenic, total	ug/L	MW-23	10/18/2023		10.9000	*	2.2700
Arsenic, total	ug/L	MW-23	04/10/2024		10.5000	*	2.2700

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Constituent	Units	Well	Date		Result		Pred. Limit
Cobalt, total	ug/L	MW-23	10/12/2020		2.3900	*	0.7500
Cobalt, total	ug/L	MW-23	04/14/2021		1.8400	*	0.7500
Cobalt, total	ug/L	MW-23	10/19/2021	ND	6.2500		0.7500
Cobalt, total	ug/L	MW-23	04/15/2022		2.2400	*	0.7500
Cobalt, total	ug/L	MW-23	10/13/2022		2.3700	*	0.7500
Cobalt, total	ug/L	MW-23	04/19/2023		2.0000	*	0.7500
Cobalt, total	ug/L	MW-23	10/18/2023		1.3400	*	0.7500
Cobalt, total	ug/L	MW-23	04/10/2024		1.8500	*	0.7500
Iron, total	ug/L	MW-23	04/26/2018		14400.0000	*	1104.8345
Iron, total	ug/L	MW-23	10/16/2018		7000.0000	*	1104.8345
Iron, total	ug/L	MW-23	04/24/2019		8360.0000	*	1104.8345
Iron, total	ug/L	MW-23	10/23/2019		7430.0000	*	1104.8345
Iron, total	ug/L	MW-23	04/21/2020		118.0000		1104.8345
Iron, total	ug/L	MW-23	10/12/2020		12400.0000	*	1104.8345
Iron, total	ug/L	MW-23	04/14/2021		10300.0000	*	1104.8345
Iron, total	ug/L	MW-23	10/19/2021		4970.0000	*	1104.8345
Iron, total	ug/L	MW-23	04/15/2022		7520.0000	*	1104.8345
Iron, total	ug/L	MW-23	10/13/2022		5370.0000	*	1104.8345
Iron, total	ug/L	MW-23	04/19/2023		2460.0000	*	1104.8345
Iron, total	ug/L	MW-23	10/18/2023		1330.0000	*	1104.8345
Iron, total	ug/L	MW-23	04/10/2024		5050.0000	*	1104.8345
Magnesium, total	mg/L	MW-23	04/26/2018		37.4000	*	24.0277
Magnesium, total	mg/L	MW-23	10/16/2018		35.4000	*	24.0277
Magnesium, total	mg/L	MW-23	04/24/2019		39.5000	*	24.0277
Magnesium, total	mg/L	MW-23	10/23/2019		37.9000	*	24.0277
Magnesium, total	mg/L	MW-23	04/21/2020		36.9000	*	24.0277
Magnesium, total	mg/L	MW-23	10/12/2020		38.8000	*	24.0277
Magnesium, total	mg/L	MW-23	04/14/2021		38.1000	*	24.0277
Magnesium, total	mg/L	MW-23	10/19/2021		29.7000	*	24.0277
Magnesium, total	mg/L	MW-23	04/15/2022		40.6000	*	24.0277
Magnesium, total	mg/L	MW-23	10/13/2022		40.4000	*	24.0277
Magnesium, total	mg/L	MW-23	04/19/2023		39.4000	*	24.0277
Magnesium, total	mg/L	MW-23	10/18/2023		44.3000	*	24.0277
Magnesium, total	mg/L	MW-23	04/10/2024		37.3000	*	24.0277
pH	SU	MW-23	04/26/2018		7.0700	*	5.66 - 6.95
pH	SU	MW-23	10/16/2018		6.9900	*	5.66 - 6.95
pH	SU	MW-23	04/24/2019		6.6500		5.66 - 6.95
pH	SU	MW-23	10/23/2019		6.7200		5.66 - 6.95
pH	SU	MW-23	04/21/2020		7.2200	*	5.66 - 6.95
pH	SU	MW-23	10/12/2020		7.1000	*	5.66 - 6.95
pH	SU	MW-23	04/14/2021		6.9000		5.66 - 6.95
pH	SU	MW-23	10/19/2021		7.0000	*	5.66 - 6.95
pH	SU	MW-23	04/15/2022		7.3000	*	5.66 - 6.95
pH	SU	MW-23	10/13/2022		7.0500	*	5.66 - 6.95
pH	SU	MW-23	04/19/2023		6.9900	*	5.66 - 6.95
pH	SU	MW-23	10/18/2023		6.8000		5.66 - 6.95
pH	SU	MW-23	04/10/2024		7.0900	*	5.66 - 6.95
Specific conductance	uS	MW-23	04/26/2018		1201.0000	*	921.4086
Specific conductance	uS	MW-23	10/16/2018		1117.0000	*	921.4086
Specific conductance	uS	MW-23	04/24/2019		1149.0000	*	921.4086
Specific conductance	uS	MW-23	10/23/2019		1112.0000	*	921.4086
Specific conductance	uS	MW-23	04/21/2020		1093.0000	*	921.4086
Specific conductance	uS	MW-23	10/12/2020		1067.0000	*	921.4086
Specific conductance	uS	MW-23	04/14/2021		1124.0000	*	921.4086
Specific conductance	uS	MW-23	10/19/2021		1158.0000	*	921.4086
Specific conductance	uS	MW-23	04/15/2022		1177.0000	*	921.4086
Specific conductance	uS	MW-23	10/13/2022		1215.0000	*	921.4086
Specific conductance	uS	MW-23	04/19/2023		1151.0000	*	921.4086
Specific conductance	uS	MW-23	10/18/2023		1118.0000	*	921.4086
Specific conductance	uS	MW-23	04/10/2024		1087.0000	*	921.4086
Ammonia	mg/L	MW-24	04/26/2018		2.8000	*	0.1340
Ammonia	mg/L	MW-24	10/16/2018		2.0000	*	0.1340
Ammonia	mg/L	MW-24	04/24/2019		1.5000	*	0.1340
Ammonia	mg/L	MW-24	10/23/2019		1.5000	*	0.1340
Ammonia	mg/L	MW-24	04/21/2020		1.0000	*	0.1340
Ammonia	mg/L	MW-24	10/12/2020		1.2000	*	0.1340
Ammonia	mg/L	MW-24	04/14/2021		1.0000	*	0.1340
Ammonia	mg/L	MW-24	10/19/2021		1.1000	*	0.1340
Ammonia	mg/L	MW-24	04/14/2022		1.1000	*	0.1340
Ammonia	mg/L	MW-24	10/13/2022		0.8200	*	0.1340
Ammonia	mg/L	MW-24	04/19/2023		0.7600	*	0.1340

* - 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
Ammonia	mg/L	MW-24	10/18/2023		0.7700	*	0.1340
Ammonia	mg/L	MW-24	04/11/2024		0.7200	*	0.1340
Cobalt, total	ug/L	MW-24	10/12/2020		3.2400	*	0.7500
Cobalt, total	ug/L	MW-24	04/14/2021		1.7200	*	0.7500
Cobalt, total	ug/L	MW-24	10/19/2021	ND	6.2500		0.7500
Cobalt, total	ug/L	MW-24	04/14/2022		2.4500	*	0.7500
Cobalt, total	ug/L	MW-24	10/13/2022		4.3100	*	0.7500
Cobalt, total	ug/L	MW-24	04/19/2023		2.0900	*	0.7500
Cobalt, total	ug/L	MW-24	10/18/2023	ND	0.6500		0.7500
Cobalt, total	ug/L	MW-24	04/11/2024		1.1000	*	0.7500
Magnesium, total	mg/L	MW-24	04/26/2018		44.9000	*	24.0277
Magnesium, total	mg/L	MW-24	10/16/2018		40.8000	*	24.0277
Magnesium, total	mg/L	MW-24	04/24/2019		36.8000	*	24.0277
Magnesium, total	mg/L	MW-24	10/23/2019		36.7000	*	24.0277
Magnesium, total	mg/L	MW-24	04/21/2020		39.5000	*	24.0277
Magnesium, total	mg/L	MW-24	10/12/2020		43.3000	*	24.0277
Magnesium, total	mg/L	MW-24	04/14/2021		38.8000	*	24.0277
Magnesium, total	mg/L	MW-24	10/19/2021		28.0000	*	24.0277
Magnesium, total	mg/L	MW-24	04/14/2022		36.8000	*	24.0277
Magnesium, total	mg/L	MW-24	10/13/2022		35.9000	*	24.0277
Magnesium, total	mg/L	MW-24	04/19/2023		28.8000	*	24.0277
Magnesium, total	mg/L	MW-24	10/18/2023		31.2000	*	24.0277
Magnesium, total	mg/L	MW-24	04/11/2024		26.0000	*	24.0277
pH	SU	MW-24	04/26/2018		6.8900		5.66 - 6.95
pH	SU	MW-24	10/16/2018		7.0300	*	5.66 - 6.95
pH	SU	MW-24	04/24/2019		6.7500		5.66 - 6.95
pH	SU	MW-24	10/23/2019		6.8200		5.66 - 6.95
pH	SU	MW-24	04/21/2020		6.9600	*	5.66 - 6.95
pH	SU	MW-24	10/12/2020		7.0300	*	5.66 - 6.95
pH	SU	MW-24	04/14/2021		6.9000		5.66 - 6.95
pH	SU	MW-24	10/19/2021		6.9000		5.66 - 6.95
pH	SU	MW-24	04/14/2022		7.0000	*	5.66 - 6.95
pH	SU	MW-24	10/13/2022		7.0400	*	5.66 - 6.95
pH	SU	MW-24	04/19/2023		6.9100		5.66 - 6.95
pH	SU	MW-24	10/18/2023		7.0000	*	5.66 - 6.95
pH	SU	MW-24	04/11/2024		6.7500		5.66 - 6.95
Ammonia	mg/L	MW-3R1	06/05/2018		0.8200	*	0.1340
Ammonia	mg/L	MW-3R1	10/16/2018		0.9800	*	0.1340
Ammonia	mg/L	MW-3R1	04/24/2019		1.5000	*	0.1340
Ammonia	mg/L	MW-3R1	10/23/2019		1.3000	*	0.1340
Ammonia	mg/L	MW-3R1	04/21/2020		0.5700	*	0.1340
Ammonia	mg/L	MW-3R1	10/13/2020		0.7500	*	0.1340
Ammonia	mg/L	MW-3R1	04/15/2021	ND	0.1340		0.1340
Ammonia	mg/L	MW-3R1	10/20/2021		0.5600	*	0.1340
Ammonia	mg/L	MW-3R1	04/15/2022	ND	0.1340		0.1340
Ammonia	mg/L	MW-3R1	10/14/2022		0.6100	*	0.1340
Ammonia	mg/L	MW-3R1	04/19/2023		0.4000	*	0.1340
Ammonia	mg/L	MW-3R1	10/20/2023		0.3000	*	0.1340
Ammonia	mg/L	MW-3R1	04/11/2024		0.3000	*	0.1340
Arsenic, total	ug/L	MW-3R1	06/05/2018		372.0000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/16/2018		59.6000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/24/2019		62.3000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/23/2019		62.9000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/21/2020		82.5000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/13/2020		50.3000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/15/2021		77.6000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/20/2021		30.7000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/15/2022		64.7000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/14/2022		57.0000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/19/2023		61.2000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/20/2023		30.0000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/11/2024		32.3000	*	2.2700
Cobalt, total	ug/L	MW-3R1	10/13/2020		10.2000	*	0.7500
Cobalt, total	ug/L	MW-3R1	04/15/2021		11.9000	*	0.7500
Cobalt, total	ug/L	MW-3R1	10/20/2021		9.7300	*	0.7500
Cobalt, total	ug/L	MW-3R1	04/15/2022		12.0000	*	0.7500
Cobalt, total	ug/L	MW-3R1	10/14/2022		13.1000	*	0.7500
Cobalt, total	ug/L	MW-3R1	04/19/2023		13.0000	*	0.7500
Cobalt, total	ug/L	MW-3R1	10/20/2023		11.4000	*	0.7500
Cobalt, total	ug/L	MW-3R1	04/11/2024		10.7000	*	0.7500
Iron, total	ug/L	MW-3R1	06/05/2018		357000.0000	*	1104.8345

* - 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
Iron, total	ug/L	MW-3R1	10/16/2018		66400.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	04/24/2019		54900.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	10/23/2019		44700.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	04/21/2020		535.0000		1104.8345
Iron, total	ug/L	MW-3R1	10/13/2020		43100.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	04/15/2021		61000.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	10/20/2021		30000.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	04/15/2022		52400.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	10/14/2022		46000.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	04/19/2023		14900.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	10/20/2023		8350.0000	*	1104.8345
Iron, total	ug/L	MW-3R1	04/11/2024		35500.0000	*	1104.8345
Magnesium, total	mg/L	MW-3R1	06/05/2018		525.0000	*	24.0277
Magnesium, total	mg/L	MW-3R1	10/16/2018		127.0000	*	24.0277
Magnesium, total	mg/L	MW-3R1	04/24/2019		62.4000	*	24.0277
Magnesium, total	mg/L	MW-3R1	10/23/2019		39.9000	*	24.0277
Magnesium, total	mg/L	MW-3R1	04/21/2020		45.8000	*	24.0277
Magnesium, total	mg/L	MW-3R1	10/13/2020		33.7000	*	24.0277
Magnesium, total	mg/L	MW-3R1	04/15/2021		53.0000	*	24.0277
Magnesium, total	mg/L	MW-3R1	10/20/2021		33.9000	*	24.0277
Magnesium, total	mg/L	MW-3R1	04/15/2022		35.3000	*	24.0277
Magnesium, total	mg/L	MW-3R1	10/14/2022		46.5000	*	24.0277
Magnesium, total	mg/L	MW-3R1	04/19/2023		33.2000	*	24.0277
Magnesium, total	mg/L	MW-3R1	10/20/2023		27.1000	*	24.0277
Magnesium, total	mg/L	MW-3R1	04/11/2024		20.6000		24.0277
Ammonia	mg/L	MW-4	04/26/2018		2.9000	*	0.1340
Ammonia	mg/L	MW-4	10/15/2018		1.3000	*	0.1340
Ammonia	mg/L	MW-4	04/23/2019		0.9000	*	0.1340
Ammonia	mg/L	MW-4	10/22/2019		1.2000	*	0.1340
Ammonia	mg/L	MW-4	04/21/2020		0.8400	*	0.1340
Ammonia	mg/L	MW-4	10/12/2020		1.4000	*	0.1340
Ammonia	mg/L	MW-4	04/14/2021		1.0000	*	0.1340
Ammonia	mg/L	MW-4	10/19/2021		2.0000	*	0.1340
Ammonia	mg/L	MW-4	04/14/2022		1.6000	*	0.1340
Ammonia	mg/L	MW-4	10/13/2022		1.5000	*	0.1340
Ammonia	mg/L	MW-4	04/19/2023		0.6200	*	0.1340
Ammonia	mg/L	MW-4	10/18/2023		1.6000	*	0.1340
Ammonia	mg/L	MW-4	04/10/2024		1.2000	*	0.1340
Arsenic, total	ug/L	MW-4	04/26/2018		25.7000	*	2.2700
Arsenic, total	ug/L	MW-4	10/15/2018		26.5000	*	2.2700
Arsenic, total	ug/L	MW-4	04/23/2019		13.4000	*	2.2700
Arsenic, total	ug/L	MW-4	10/22/2019		26.3000	*	2.2700
Arsenic, total	ug/L	MW-4	04/21/2020		14.7000	*	2.2700
Arsenic, total	ug/L	MW-4	10/12/2020		15.1000	*	2.2700
Arsenic, total	ug/L	MW-4	04/14/2021		14.2000	*	2.2700
Arsenic, total	ug/L	MW-4	10/19/2021		18.8000	*	2.2700
Arsenic, total	ug/L	MW-4	04/14/2022		31.5000	*	2.2700
Arsenic, total	ug/L	MW-4	10/13/2022		22.3000	*	2.2700
Arsenic, total	ug/L	MW-4	04/19/2023		11.7000	*	2.2700
Arsenic, total	ug/L	MW-4	10/18/2023		17.4000	*	2.2700
Arsenic, total	ug/L	MW-4	04/10/2024		35.6000	*	2.2700
Barium, total	ug/L	MW-4	04/26/2018		372.0000	*	243.2435
Barium, total	ug/L	MW-4	10/15/2018		270.0000	*	243.2435
Barium, total	ug/L	MW-4	04/23/2019		282.0000	*	243.2435
Barium, total	ug/L	MW-4	10/22/2019		350.0000	*	243.2435
Barium, total	ug/L	MW-4	04/21/2020		301.0000	*	243.2435
Barium, total	ug/L	MW-4	10/12/2020		279.0000	*	243.2435
Barium, total	ug/L	MW-4	04/14/2021		343.0000	*	243.2435
Barium, total	ug/L	MW-4	10/19/2021		378.0000	*	243.2435
Barium, total	ug/L	MW-4	04/14/2022		500.0000	*	243.2435
Barium, total	ug/L	MW-4	10/13/2022		404.0000	*	243.2435
Barium, total	ug/L	MW-4	04/19/2023		235.0000		243.2435
Barium, total	ug/L	MW-4	10/18/2023		458.0000	*	243.2435
Barium, total	ug/L	MW-4	04/10/2024		543.0000	*	243.2435
Chemical oxygen demand	mg/L	MW-4	04/26/2018		17.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-4	10/15/2018	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/23/2019		8.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	10/22/2019	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/21/2020		10.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-4	10/12/2020		7.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/14/2021	ND	7.0000		8.0000

* - 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
Chemical oxygen demand	mg/L	MW-4	10/19/2021	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/14/2022		14.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-4	10/13/2022	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/19/2023		6.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	10/18/2023	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/10/2024		18.0000	*	8.0000
Cobalt, total	ug/L	MW-4	10/12/2020		4.1500	*	0.7500
Cobalt, total	ug/L	MW-4	04/14/2021		2.4200	*	0.7500
Cobalt, total	ug/L	MW-4	10/19/2021	ND	6.2500		0.7500
Cobalt, total	ug/L	MW-4	04/14/2022		7.1400	*	0.7500
Cobalt, total	ug/L	MW-4	10/13/2022		15.1000	*	0.7500
Cobalt, total	ug/L	MW-4	04/19/2023		8.2900	*	0.7500
Cobalt, total	ug/L	MW-4	10/18/2023		7.8500	*	0.7500
Cobalt, total	ug/L	MW-4	04/10/2024		126.0000	*	0.7500
Iron, total	ug/L	MW-4	04/26/2018		6740.0000	*	1104.8345
Iron, total	ug/L	MW-4	10/15/2018		6260.0000	*	1104.8345
Iron, total	ug/L	MW-4	04/23/2019		3690.0000	*	1104.8345
Iron, total	ug/L	MW-4	10/22/2019		7270.0000	*	1104.8345
Iron, total	ug/L	MW-4	04/21/2020		36.2000		1104.8345
Iron, total	ug/L	MW-4	10/12/2020		4910.0000	*	1104.8345
Iron, total	ug/L	MW-4	04/14/2021		4320.0000	*	1104.8345
Iron, total	ug/L	MW-4	10/19/2021		5800.0000	*	1104.8345
Iron, total	ug/L	MW-4	04/14/2022		8470.0000	*	1104.8345
Iron, total	ug/L	MW-4	10/13/2022		11600.0000	*	1104.8345
Iron, total	ug/L	MW-4	04/19/2023		3230.0000	*	1104.8345
Iron, total	ug/L	MW-4	10/18/2023		3930.0000	*	1104.8345
Iron, total	ug/L	MW-4	04/10/2024		83400.0000	*	1104.8345
Magnesium, total	mg/L	MW-4	04/26/2018		35.8000	*	24.0277
Magnesium, total	mg/L	MW-4	10/15/2018		27.7000	*	24.0277
Magnesium, total	mg/L	MW-4	04/23/2019		30.3000	*	24.0277
Magnesium, total	mg/L	MW-4	10/22/2019		22.7000		24.0277
Magnesium, total	mg/L	MW-4	04/21/2020		23.6000		24.0277
Magnesium, total	mg/L	MW-4	10/12/2020		23.0000		24.0277
Magnesium, total	mg/L	MW-4	04/14/2021		28.9000	*	24.0277
Magnesium, total	mg/L	MW-4	10/19/2021		25.1000	*	24.0277
Magnesium, total	mg/L	MW-4	04/14/2022		32.1000	*	24.0277
Magnesium, total	mg/L	MW-4	10/13/2022		32.5000	*	24.0277
Magnesium, total	mg/L	MW-4	04/19/2023		25.2000	*	24.0277
Magnesium, total	mg/L	MW-4	10/18/2023		36.9000	*	24.0277
Magnesium, total	mg/L	MW-4	04/10/2024		34.1000	*	24.0277

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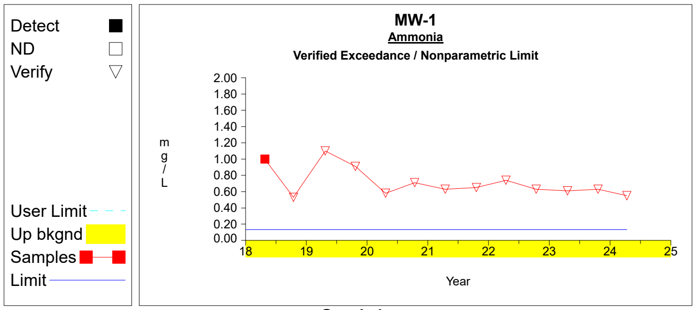
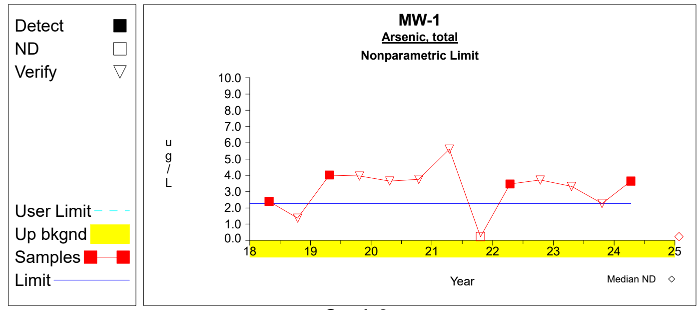
ND = Not Detected, Result = detection limit.

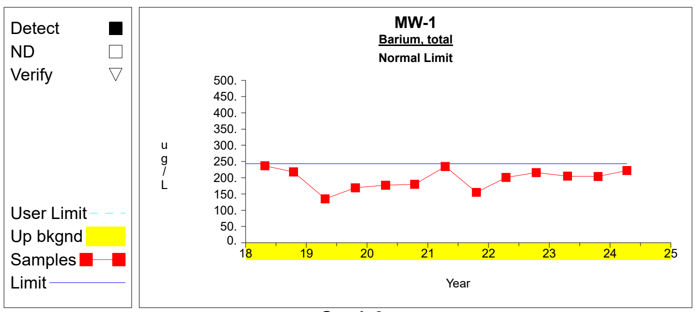
Up vs. Down Prediction Limits



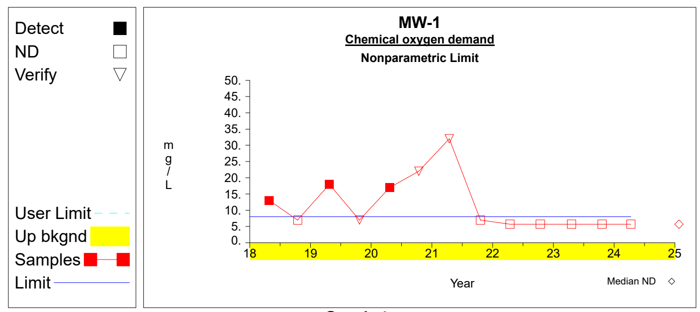
Graph 1



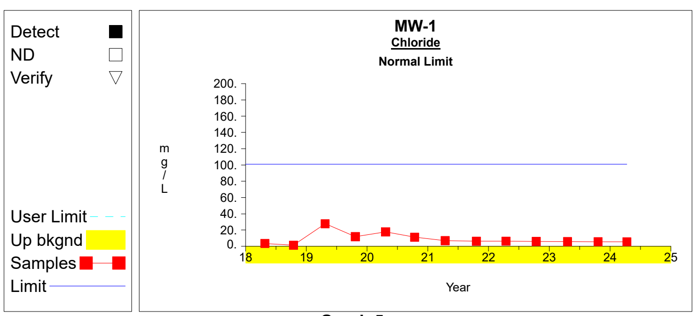
Graph 2



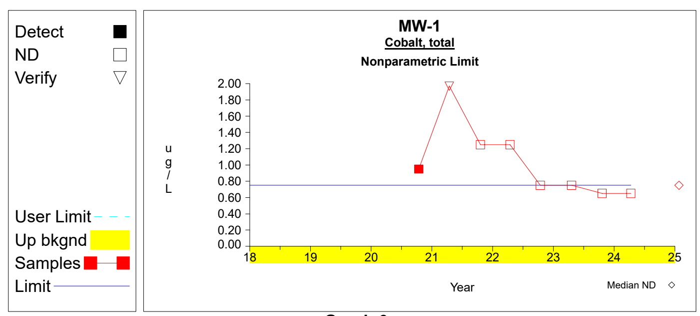
Graph 3



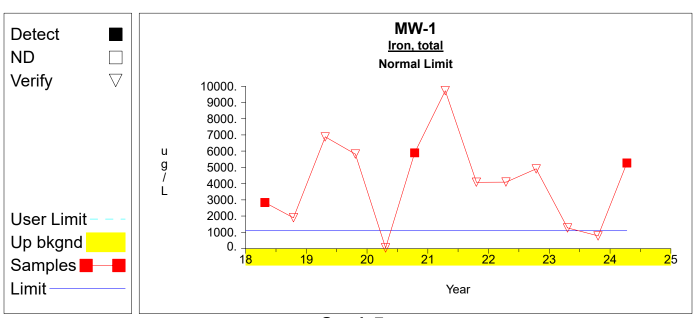
Graph 4



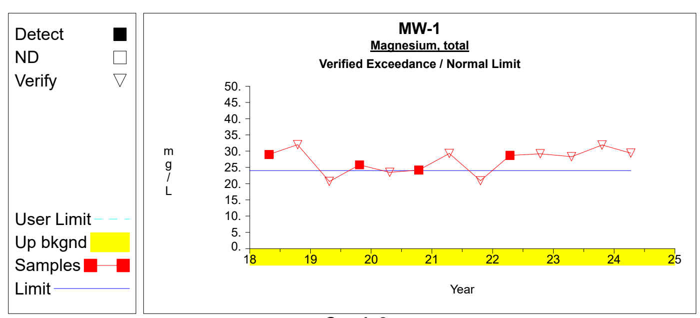
Graph 5



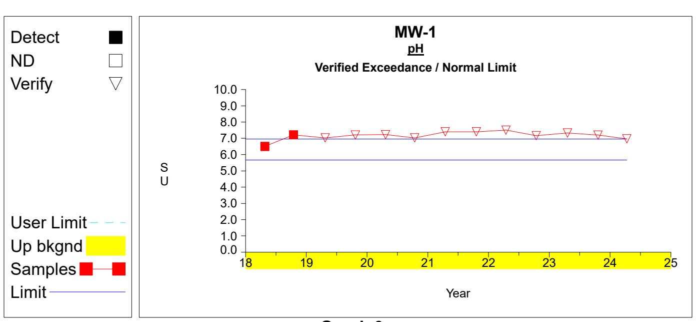
Graph 6



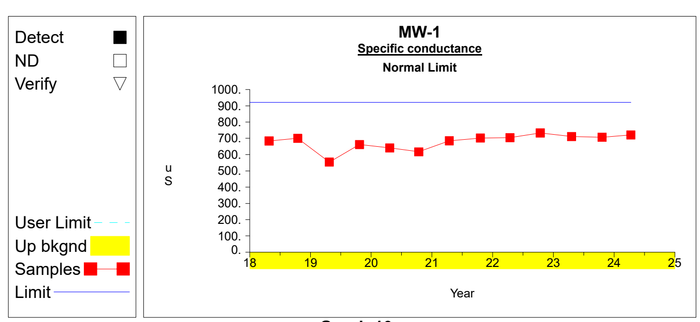
Graph 7



Graph 8

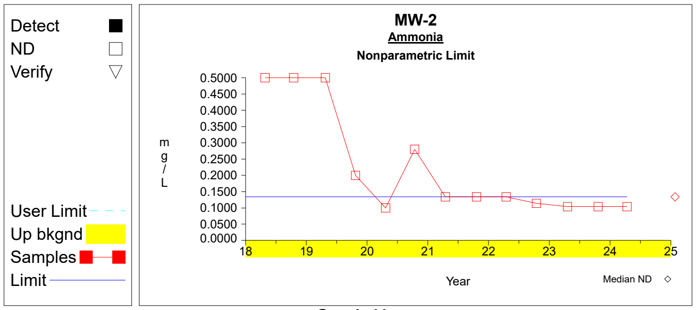


Graph 9

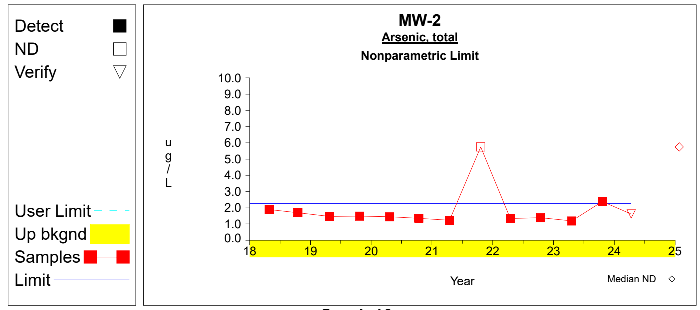


Graph 10

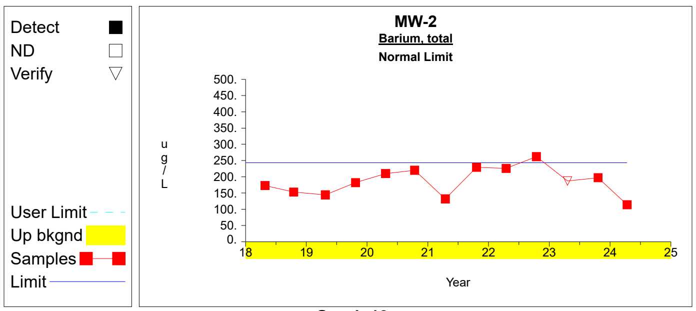
Up vs. Down Prediction Limits



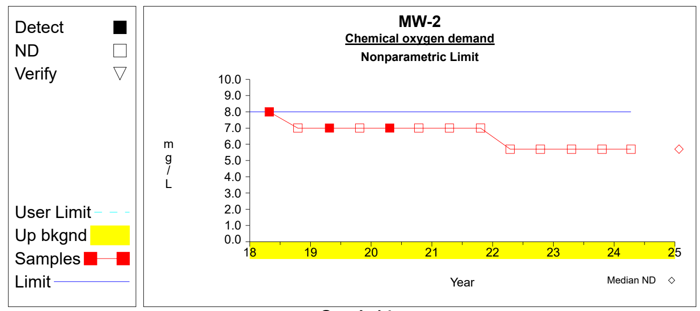
Graph 11



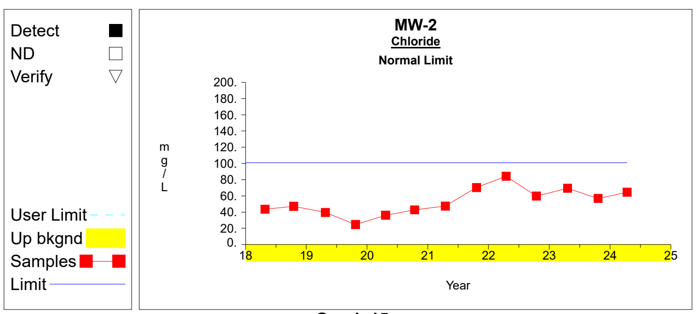
Graph 12



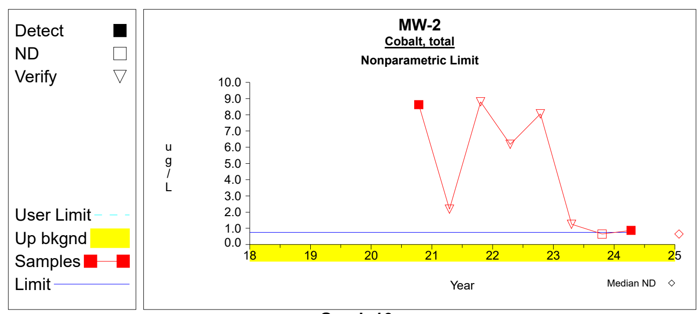
Graph 13



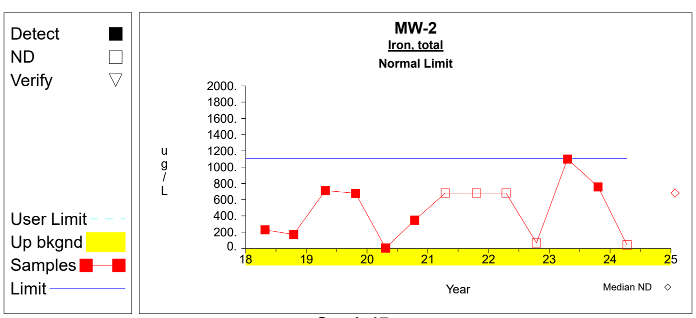
Graph 14



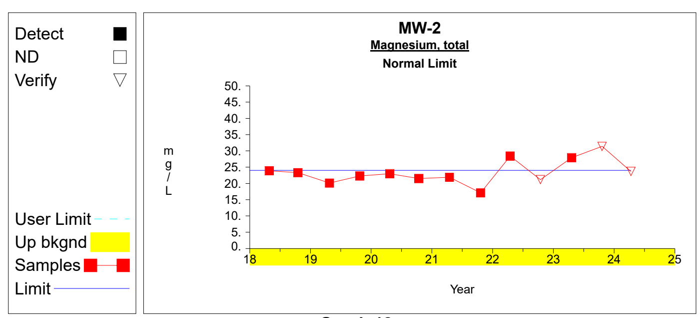
Graph 15



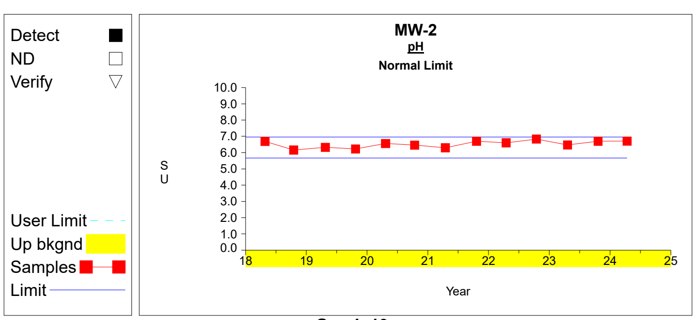
Graph 16



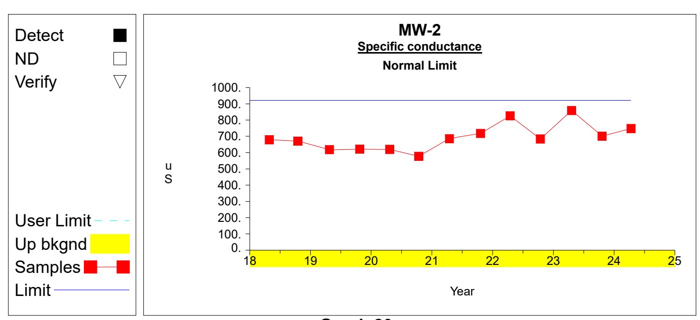
Graph 17



Graph 18



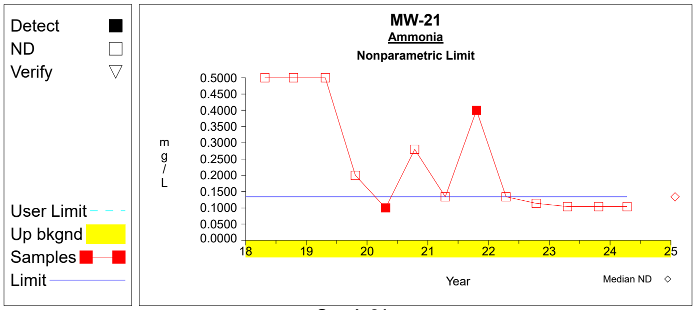
Graph 19



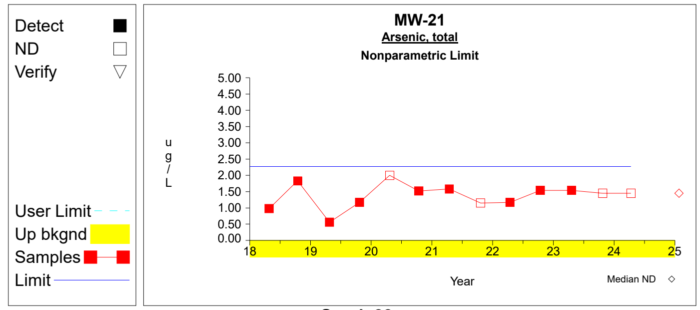
Graph 20

Ash Monofill [GW] November 2024

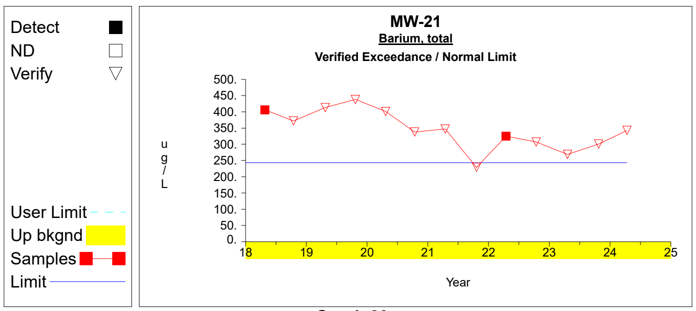
Up vs. Down Prediction Limits



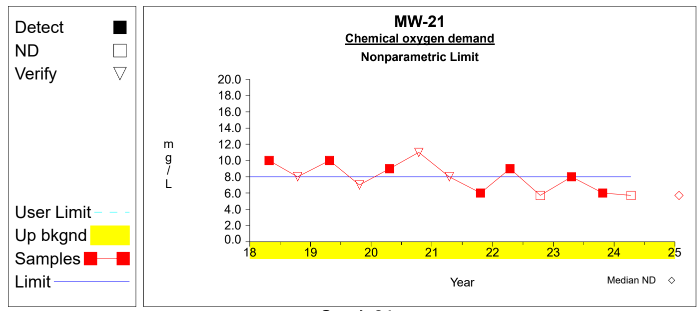
Graph 21



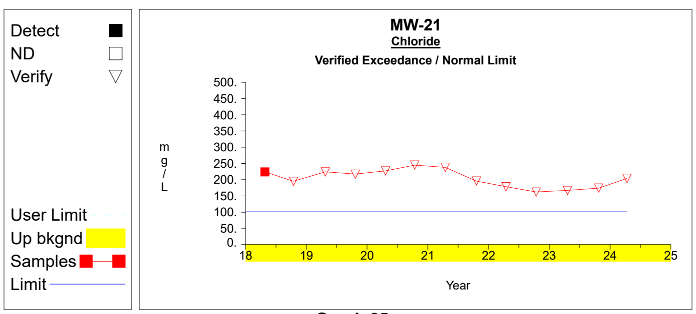
Graph 22



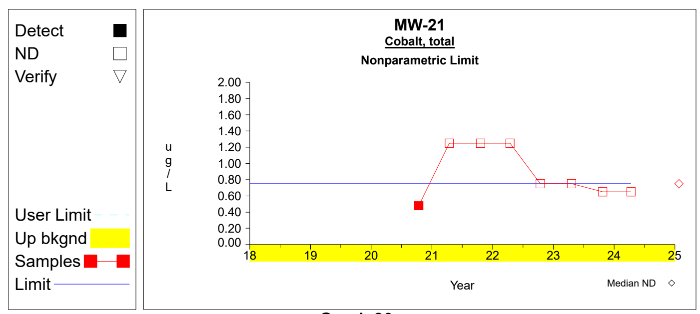
Graph 23



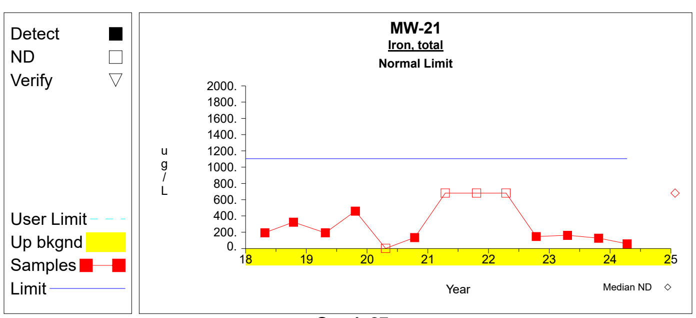
Graph 24



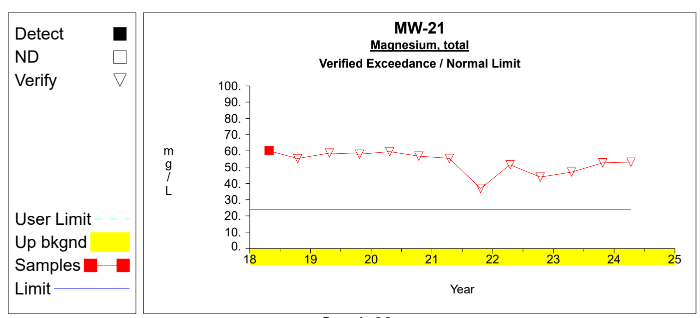
Graph 25



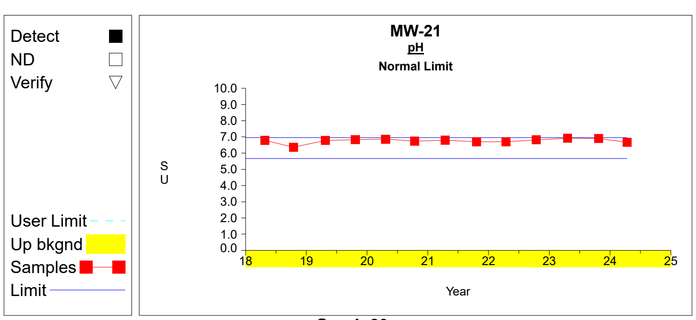
Graph 26



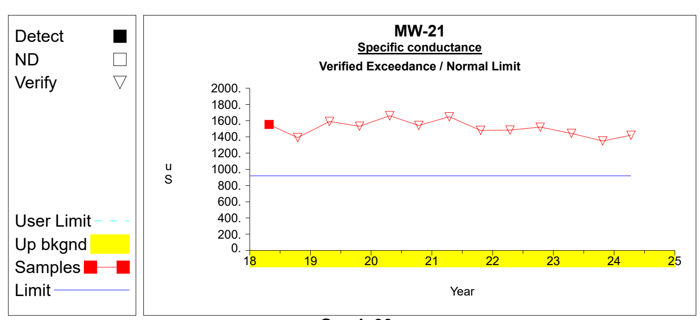
Graph 27



Graph 28



Graph 29



Graph 30

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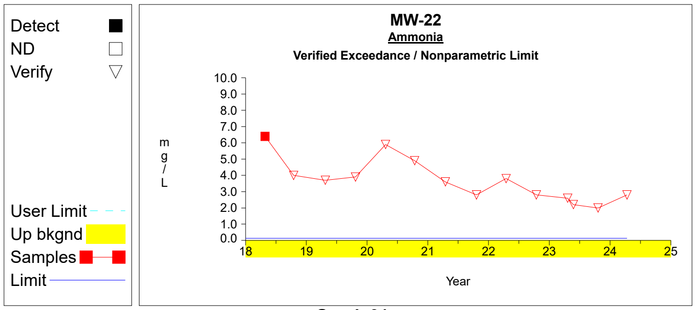
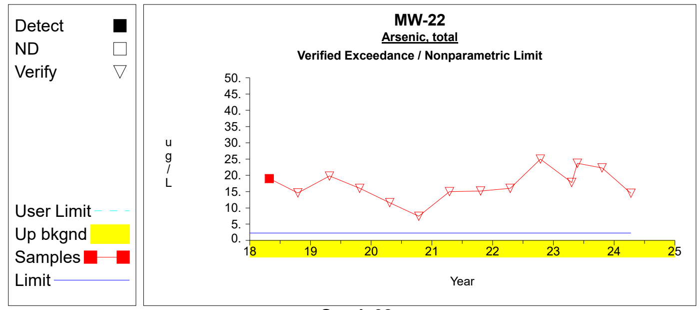
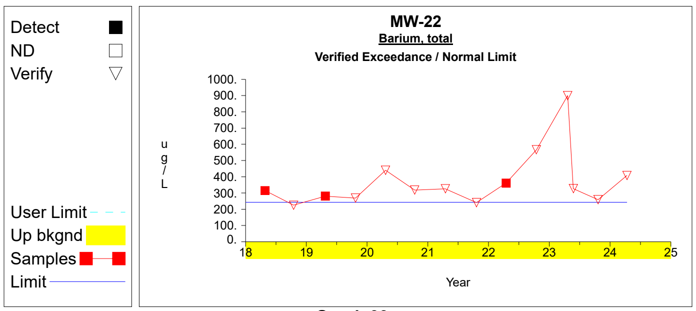
Up vs. Down Prediction Limits



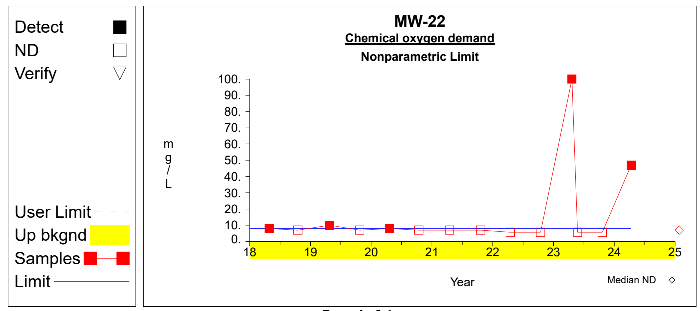
Graph 31



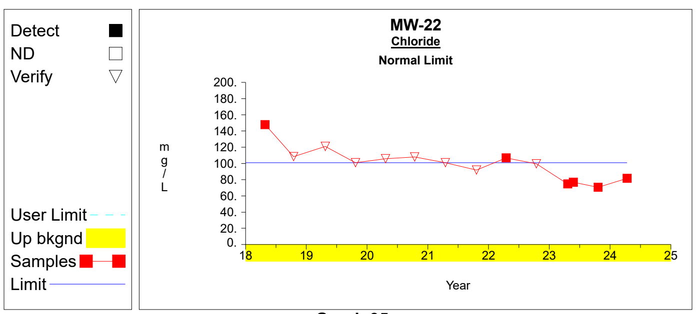
Graph 32



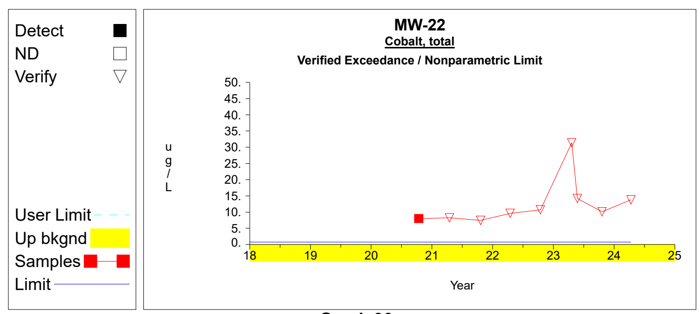
Graph 33



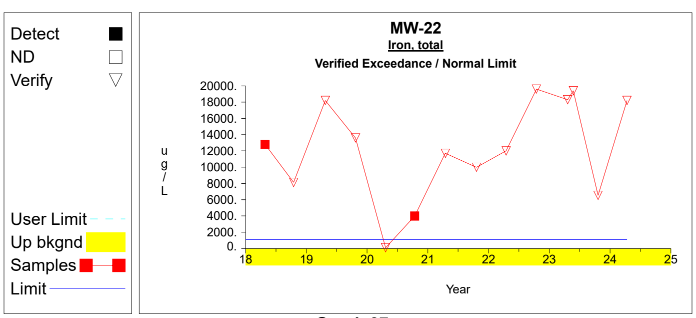
Graph 34



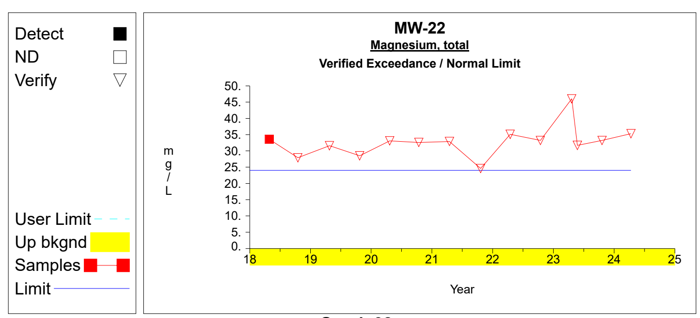
Graph 35



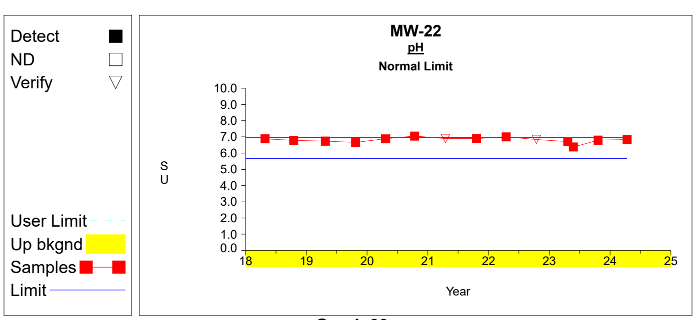
Graph 36



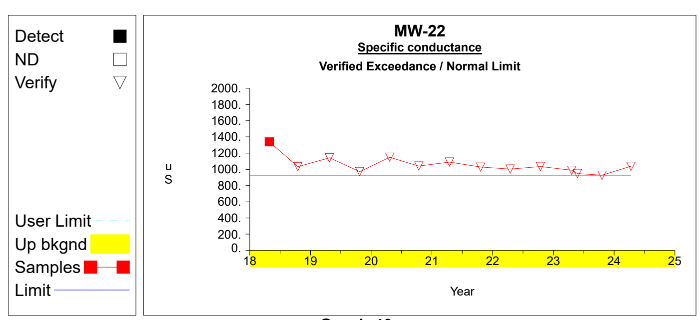
Graph 37



Graph 38

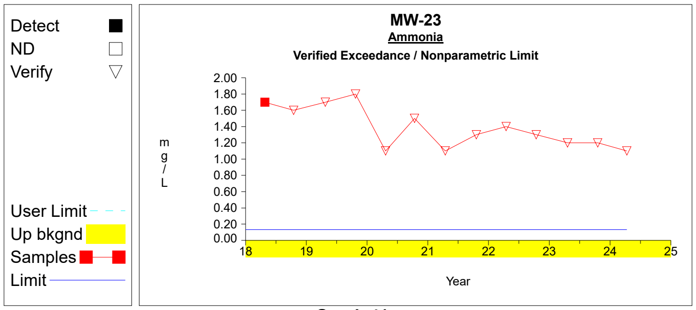


Graph 39

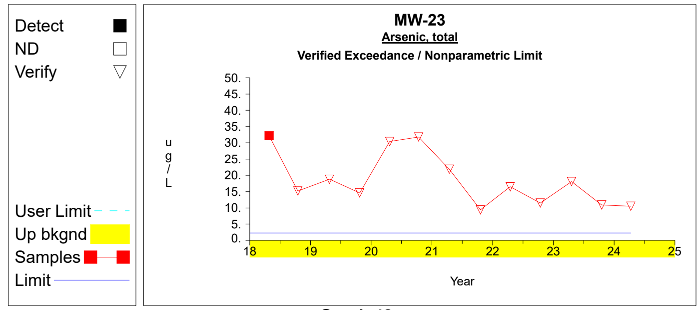


Graph 40

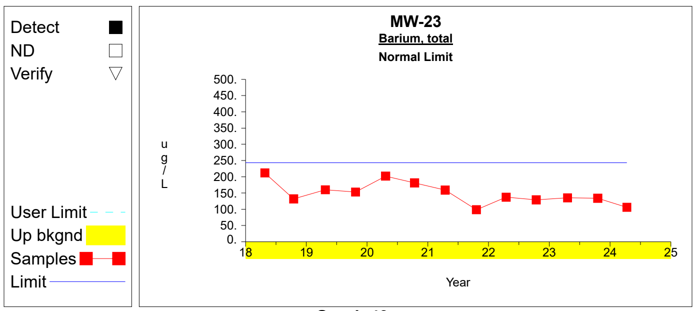
Up vs. Down Prediction Limits



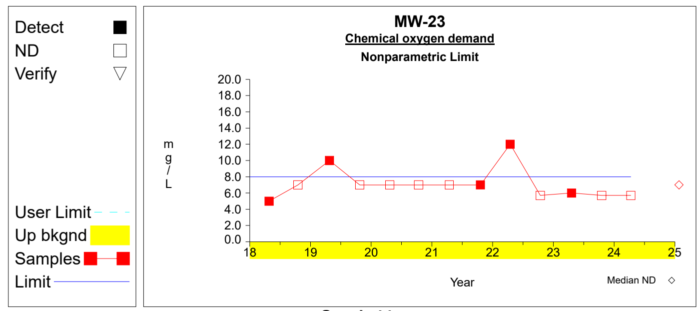
Graph 41



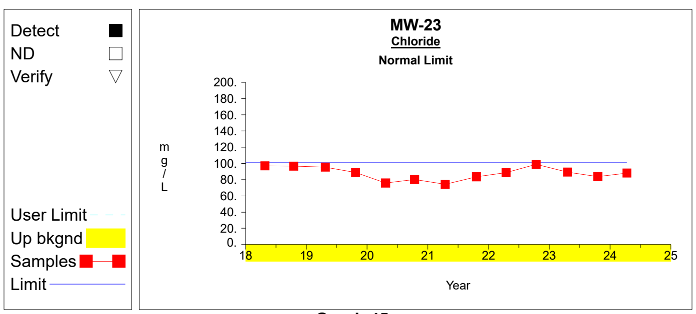
Graph 42



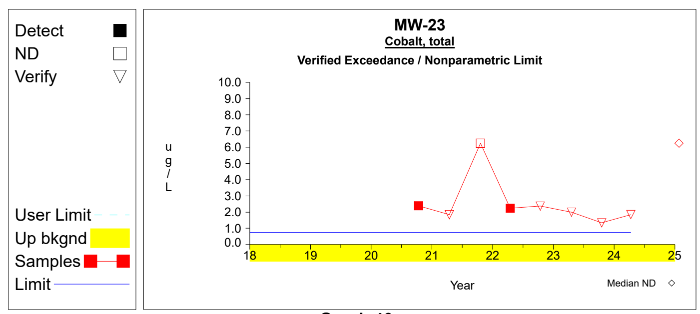
Graph 43



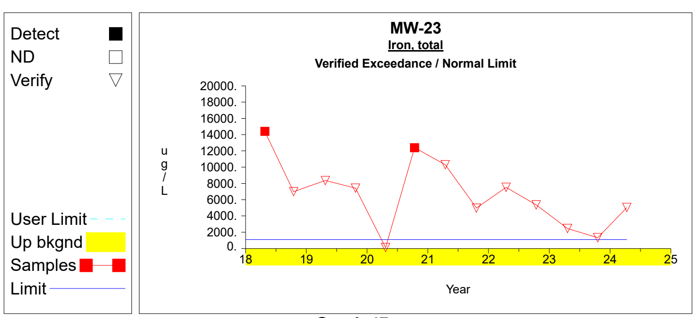
Graph 44



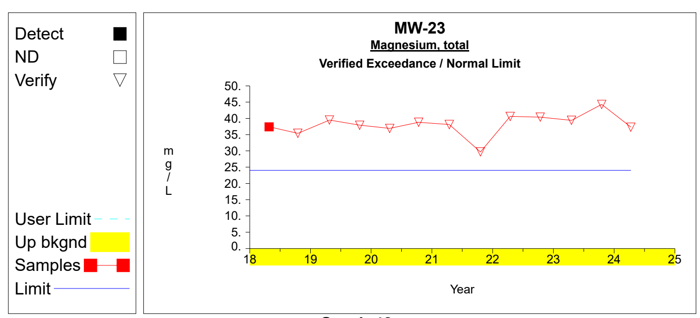
Graph 45



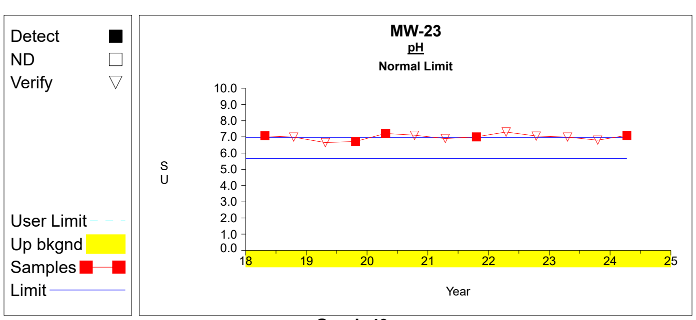
Graph 46



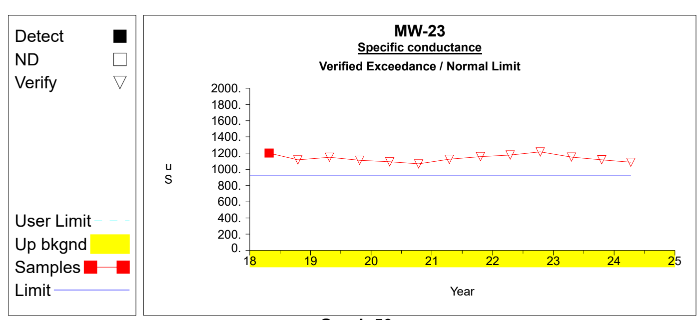
Graph 47



Graph 48



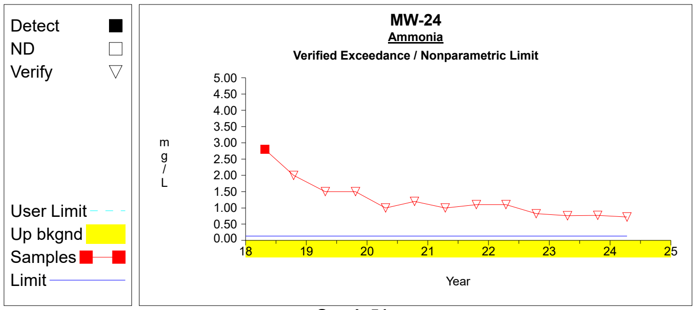
Graph 49



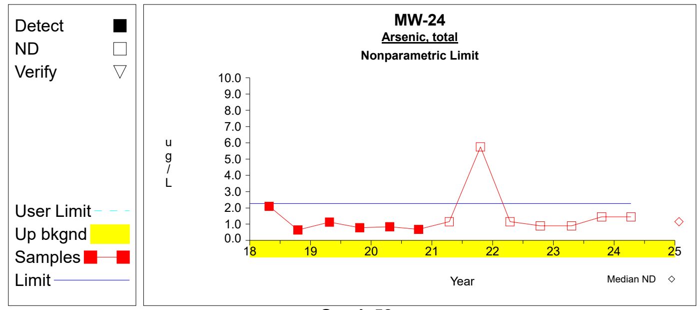
Graph 50

Ash Monofill [GW] November 2024

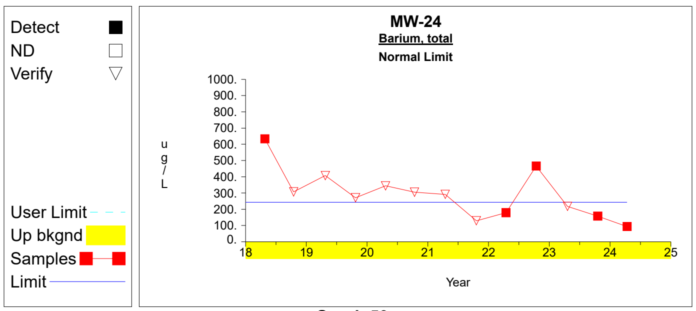
Up vs. Down Prediction Limits



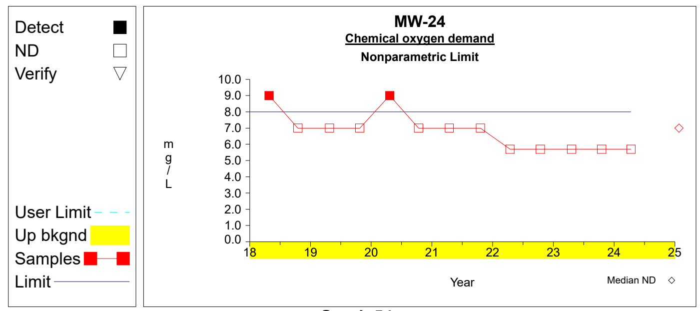
Graph 51



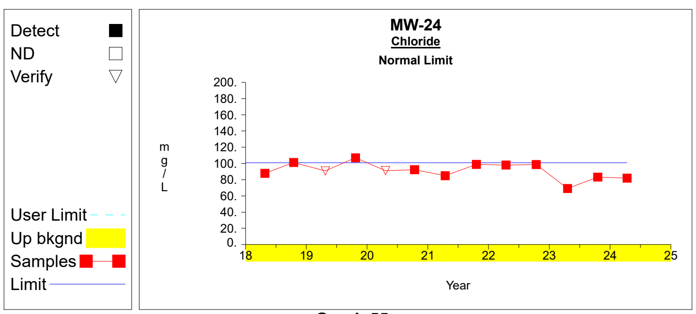
Graph 52



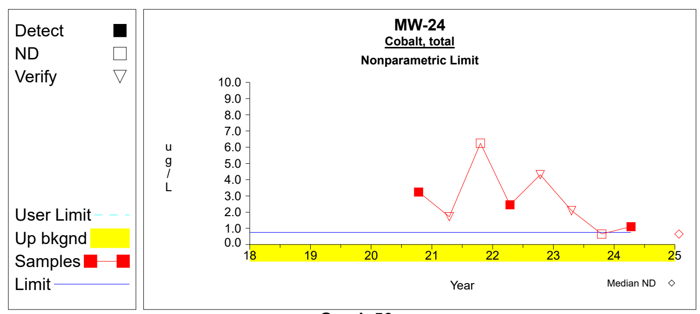
Graph 53



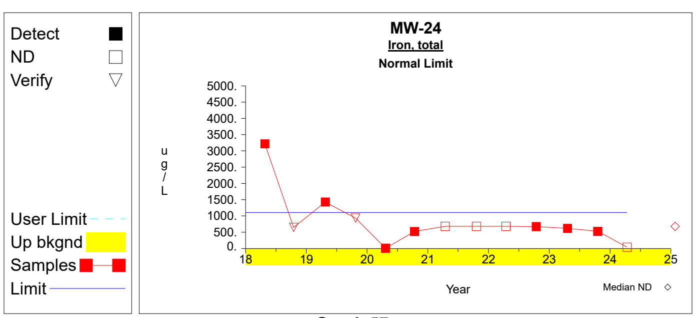
Graph 54



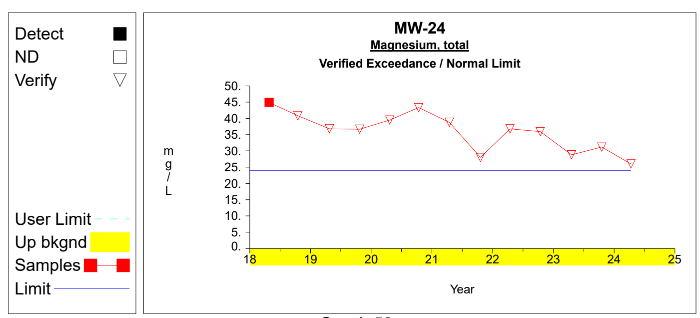
Graph 55



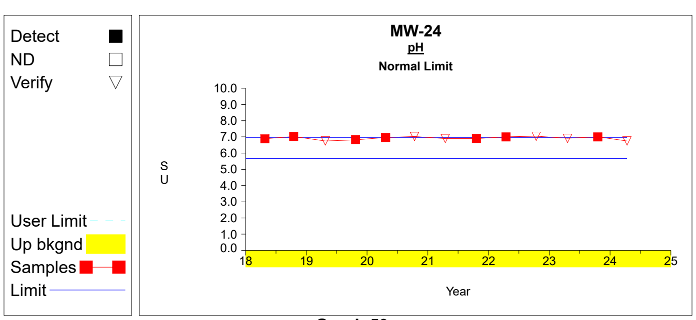
Graph 56



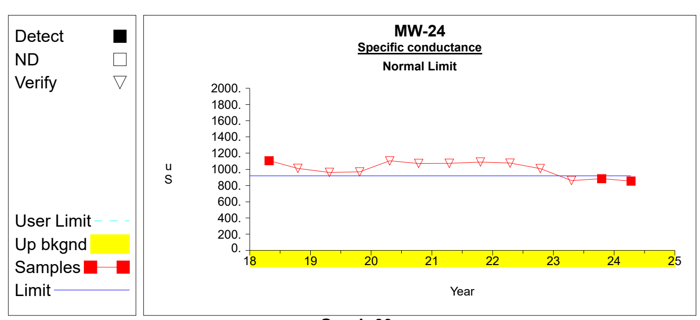
Graph 57



Graph 58



Graph 59



Graph 60

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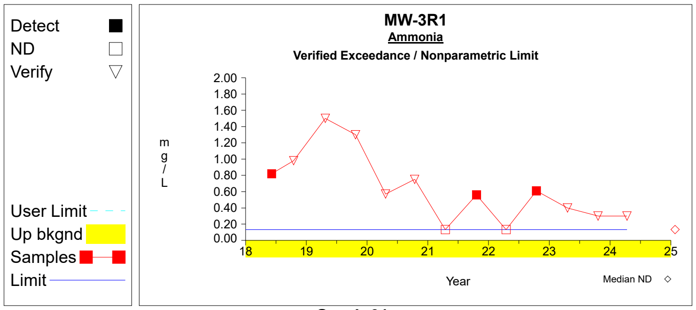
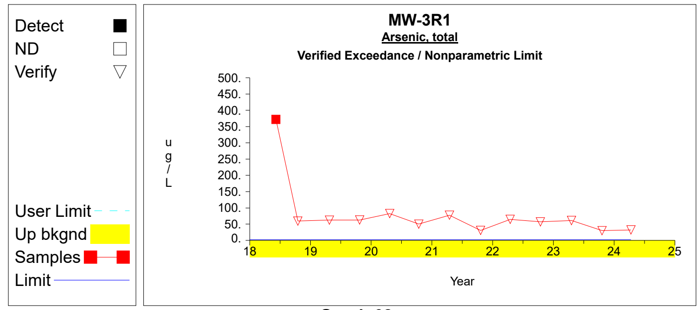
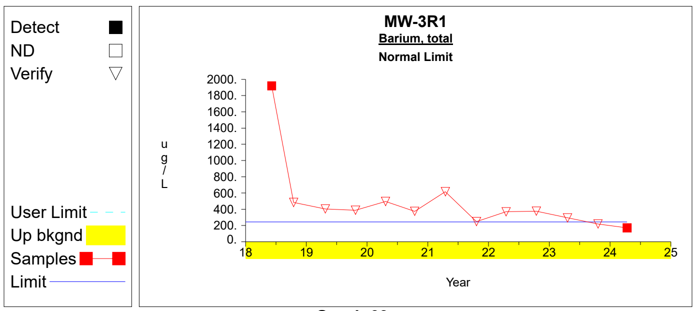
Up vs. Down Prediction Limits



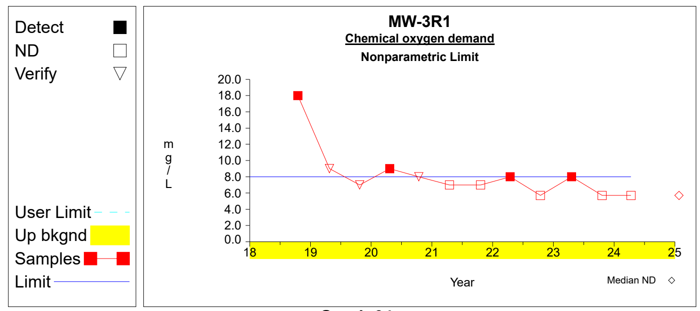
Graph 61



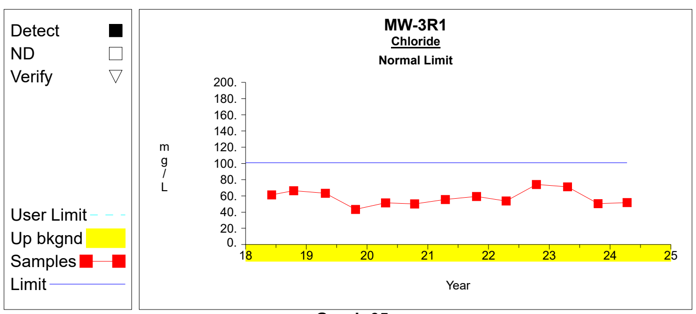
Graph 62



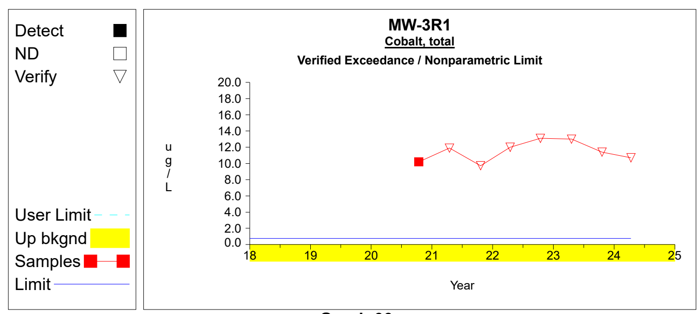
Graph 63



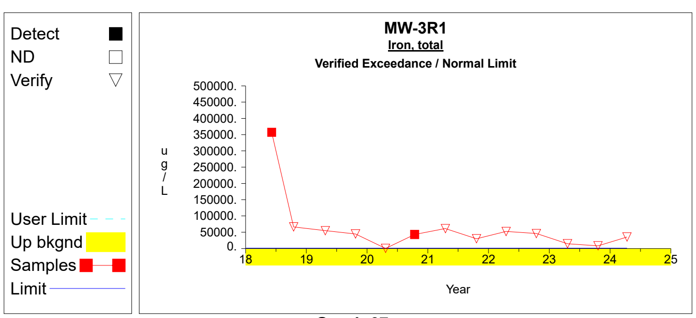
Graph 64



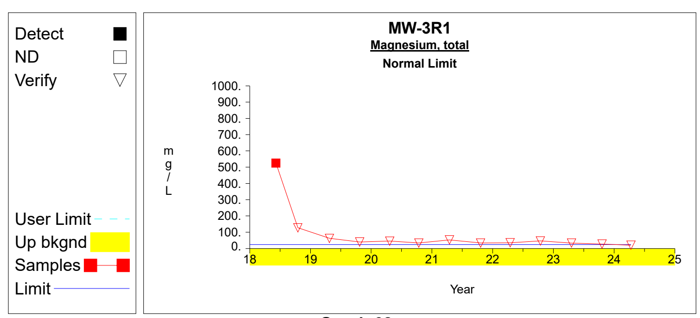
Graph 65



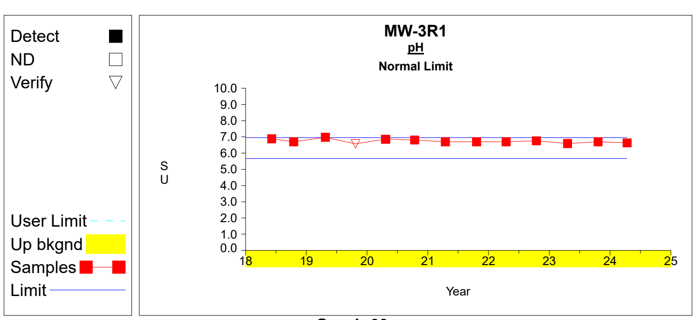
Graph 66



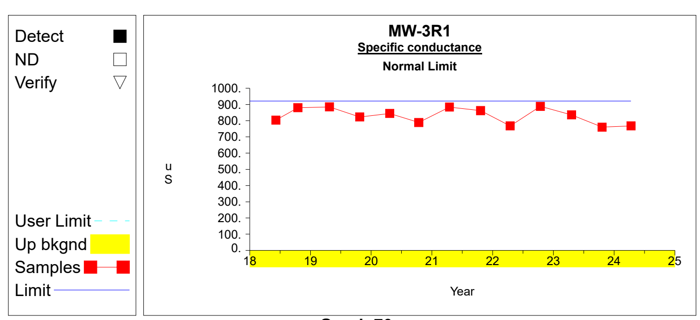
Graph 67



Graph 68

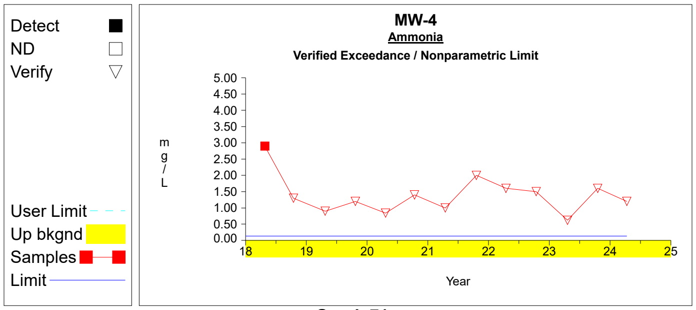


Graph 69

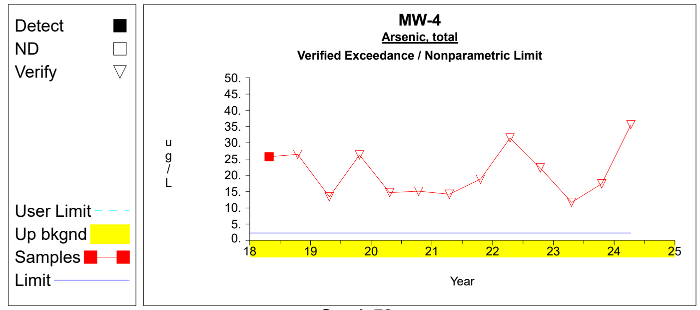


Graph 70

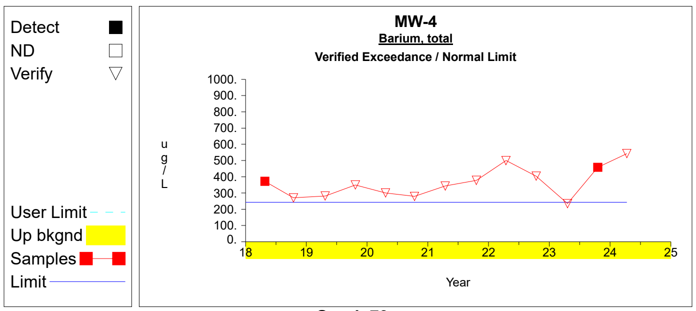
Up vs. Down Prediction Limits



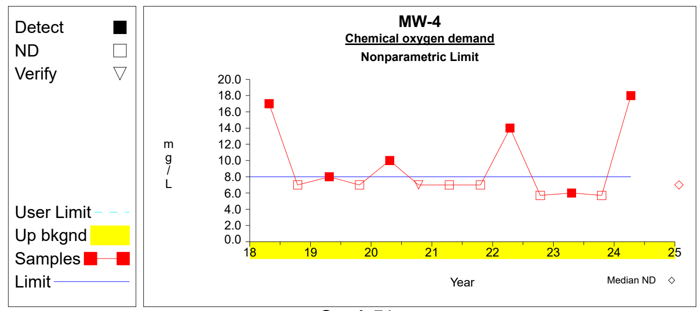
Graph 71



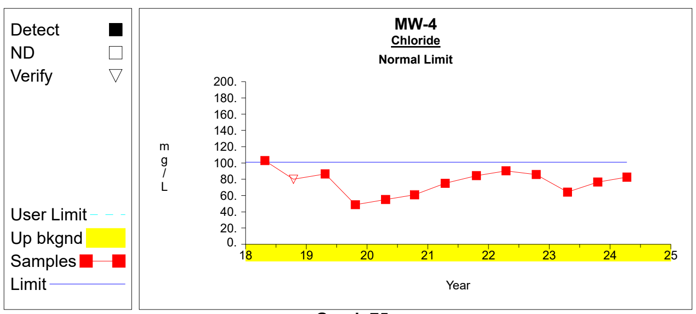
Graph 72



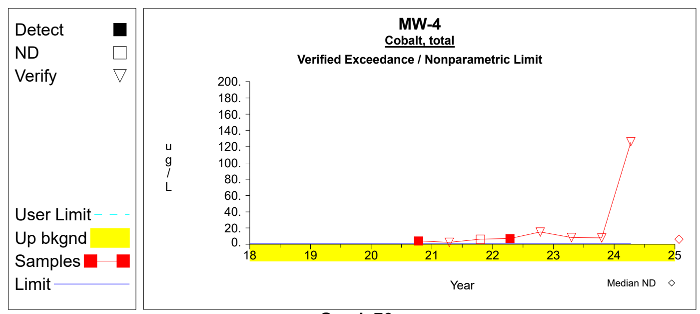
Graph 73



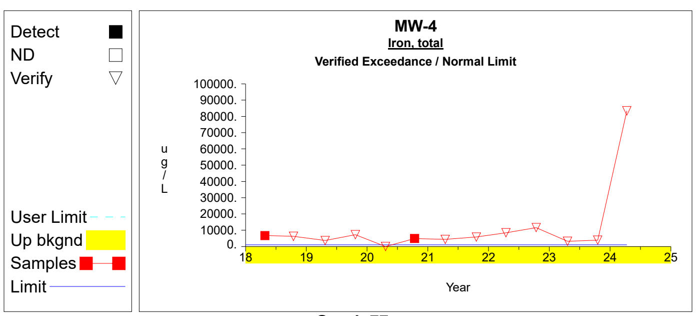
Graph 74



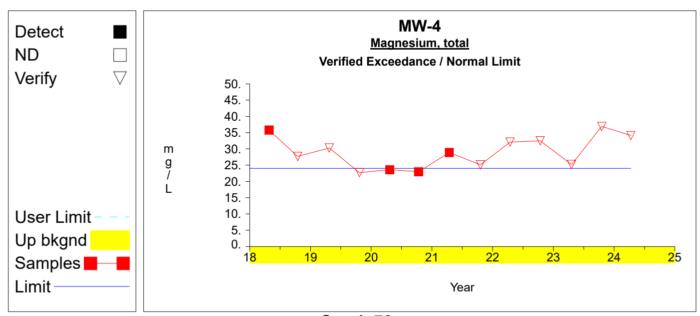
Graph 75



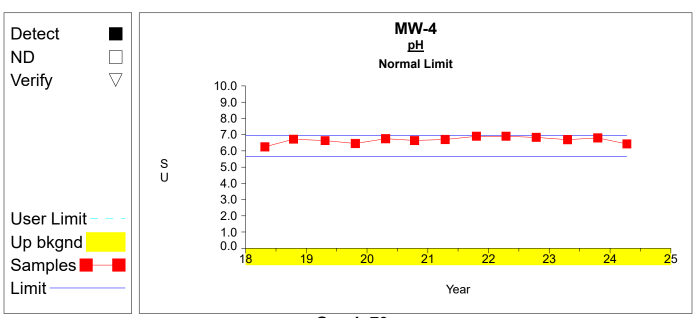
Graph 76



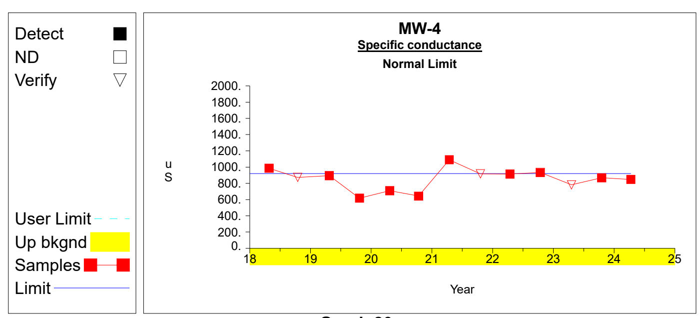
Graph 77



Graph 78

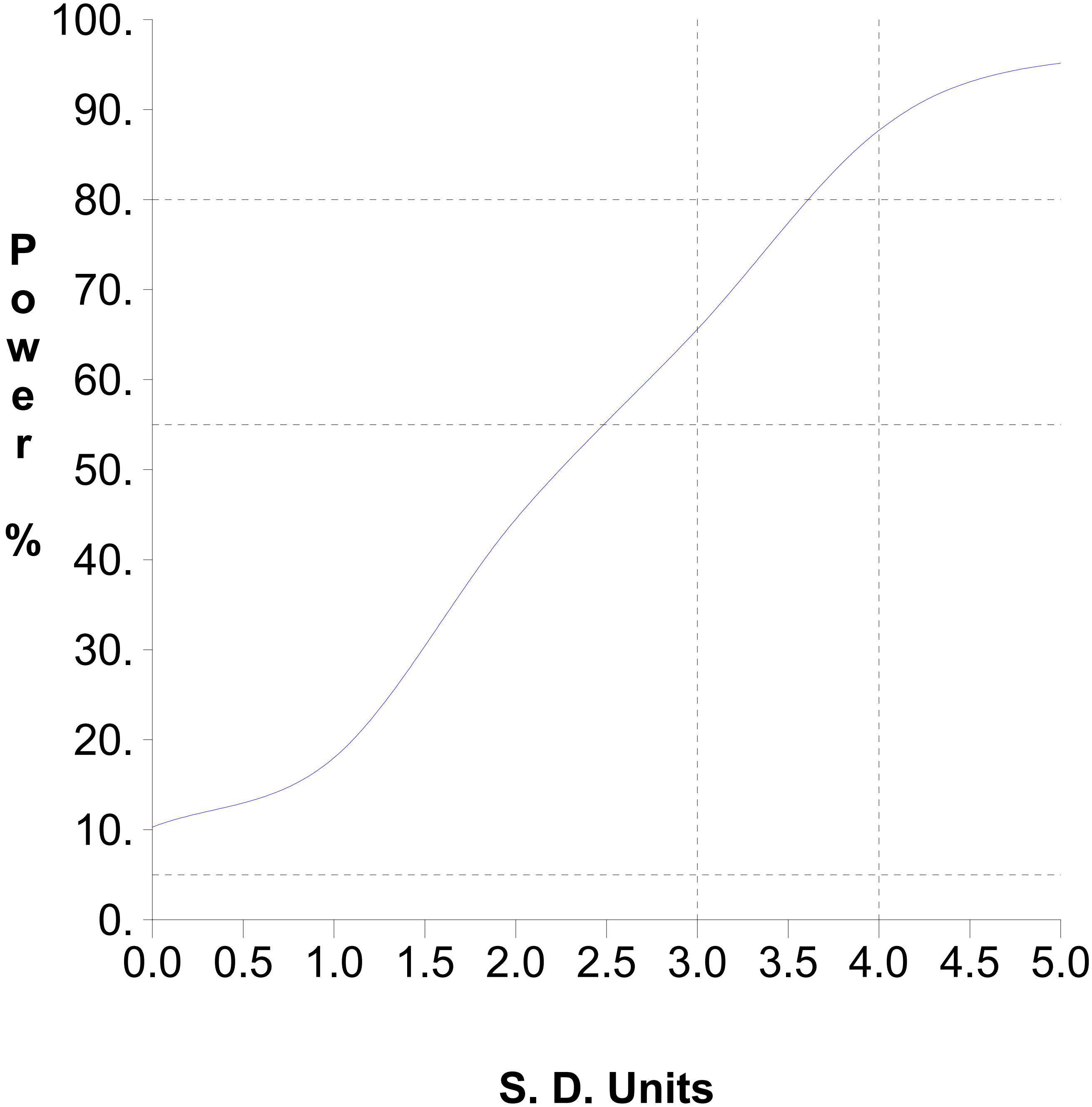


Graph 79



Graph 80

False Positive and False Negative Rates for Current Upgradient vs. Downgradient Monitoring Program



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

Step	Equation	Description
1	PL = median(X) = **0.134**	Compute nonparametric prediction limit as median reporting limit in background.
2	Conf = **0.934**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Arsenic, total (ug/L)
Nonparametric Prediction Limit

Step	Equation	Description
1	PL = max(X) = **2.27**	Compute nonparametric prediction limit as largest background measurement.
2	Conf = **0.934**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Barium, total (ug/L)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{1848.0} / \mathbf{13}$ $= \mathbf{142.154}$	Compute upgradient mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{278592.0} - \mathbf{3.42}\times 10^{\mathbf{6}}/\mathbf{13}) / (\mathbf{13}-1))^{1/2}$ $= \mathbf{36.391}$	Compute upgradient sd.
3	$\text{alpha} = \min[(1-.95^{1/\mathbf{K}})^{1/2}, .01]$ $= \min[(1-.95^{1/\mathbf{80}})^{1/2}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
4	$PL = \bar{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{1/2}$ $= \mathbf{142.154}$ $+ (\mathbf{2.677} * \mathbf{36.391})(1+1/\mathbf{13})^{1/2}$ $= \mathbf{243.243}$	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
Chemical oxygen demand (mg/L)
Nonparametric Prediction Limit

Step	Equation	Description
1	PL = max(X) = **8.0**	Compute nonparametric prediction limit as largest background measurement.
2	Conf = **0.934**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

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

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{643.918} / \mathbf{13}$ $= \mathbf{49.532}$	Compute upgradient mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{36003.921} - \mathbf{414630.391}/\mathbf{13}) / (\mathbf{13}-1))^{1/2}$ $= \mathbf{18.505}$	Compute upgradient sd.
3	$\text{alpha} = \min[(1-.95^{1/\mathbf{K}})^{1/2}, .01]$ $= \min[(1-.95^{1/\mathbf{80}})^{1/2}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
4	$PL = \bar{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{1/2}$ $= \mathbf{49.532}$ $+ (\mathbf{2.677}*\mathbf{18.505})(1+1/\mathbf{13})^{1/2}$ $= \mathbf{100.937}$	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 (ug/L)
Nonparametric Prediction Limit

Step	Equation	Description
1	PL = max(X) = **0.75**	Compute nonparametric prediction limit as largest background measurement.
2	Conf = **0.864**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Iron, total (ug/L)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X}_1 = \mathbf{sum[X_1] / N_1}$ $= \mathbf{4336.0} / \mathbf{9}$ $= \mathbf{481.778}$	Compute mean of N_1 detected measurements.
2	$S_1 = ((\mathbf{sum[X_1^2]\text{-}sum[X_1]^2/N_1}) / (\mathbf{N_1}\text{-}1))^{½}$ $= ((\mathbf{2.31{\times}10^6\text{-}1.88{\times}10^7/9}) / (\mathbf{9}\text{-}1))^{½}$ $= \mathbf{166.344}$	Compute sd of N_1 detected measurements.
3	$\bar{X} = (1 - \mathbf{N_0/N})\ \mathbf{\bar{X}_1}$ $= (1 - \mathbf{2/11})\ \mathbf{481.778}$ $= \mathbf{394.182}$	Use Aitchison's method to adjust mean for presence of nondetects.
4	$S = [(1 - \mathbf{N_0/N}) * \mathbf{S_1}^2 +$ $(\mathbf{N_0/N}) (1 - (\mathbf{N_0}\text{-}1)/(\mathbf{N}\text{-}1))\ \mathbf{\bar{X}_1}^2]^{½}$ $= [(1 - \mathbf{2/11}) * \mathbf{166.344}^2 +$ $(\mathbf{2/11}) (1 - (\mathbf{2}\text{-}1)/(\mathbf{11}\text{-}1))\ \mathbf{481.778}^2]^{½}$ $= \mathbf{246.213}$	Use Aitchison's method to adjust sd for presence of nondetects.
5	$\text{alpha} = \min[(1\text{-}.95^{1/\mathbf{K}})^{½}, .01]$ $= \min[(1\text{-}.95^{1/\mathbf{80}})^{½}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
6	$PL = \mathbf{\bar{X}} + \mathbf{tS}(1+1/\mathbf{N})^{½}$ $= \mathbf{394.182}$ $+ (\mathbf{2.763}*\mathbf{246.213})(1+1/\mathbf{11})^{½}$ $= \mathbf{1104.834}$	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
Magnesium, total (mg/L)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **170.02** / **13** = **13.078**	Compute upgradient mean.
2	S = ((**sum[X^2]** - **sum[X]^2**/**N**) / (**N**-1))$^{1/2}$ = ((**2410.035** - **28906.8**/**13**) / (**13**-1))$^{1/2}$ = **3.942**	Compute upgradient sd.
3	alpha = min[(1-.95$^{1/K}$)$^{1/2}$, .01] = min[(1-.95$^{1/80}$)$^{1/2}$, .01] = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample.
4	PL = $\bar{X}$ + **tS**(1+1/**N**)$^{1/2}$ = **13.078** + (**2.677*****3.942**)(1+1/**13**)$^{1/2}$ = **24.028**	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
pH (SU)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **82.01** / **13** = **6.308**	Compute upgradient mean.
2	S = ((**sum[X^2]** - **sum[X]^2**/**N**) / (**N**-1))$^{1/2}$ = ((**517.855** - **6725.64**/**13**) / (**13**-1))$^{1/2}$ = **0.204**	Compute upgradient sd.
3	alpha = min[(1-.95$^{1/K}$)$^{1/2}$, .01] = min[(1-.95$^{1/80}$)$^{1/2}$, .01] = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample. Two-sided probability.
4	PL = $\bar{X}$ ± **tS**(1+1/**N**)$^{1/2}$ = **6.308** ± (**3.047*****0.204**)(1+1/**13**)$^{1/2}$ = **5.664**, **6.953**	Two-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
Specific conductance (uS)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **6124.0** / **13** = **471.077**	Compute upgradient mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{3.20}\times\mathbf{10^6} - \mathbf{3.75}\times\mathbf{10^7}/\mathbf{13}) / (\mathbf{13}-1))^{1/2}$ = **162.114**	Compute upgradient sd.
3	alpha = $\min[(1-.95^{1/\mathbf{K}})^{1/2}, .01]$ $= \min[(1-.95^{1/\mathbf{80}})^{1/2}, .01]$ = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample.
4	$PL = \bar{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{1/2}$ = **471.077** $+ (\mathbf{2.677}*\mathbf{162.114})(1+1/\mathbf{13})^{1/2}$ = **921.409**	One-sided normal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Attachment C

Summary Tables and Graphs for the Intrawell Comparisons
First Semi-Annual Monitoring Event in 2024

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	
Ammonia	mg/L	MW-1	9	4	13	0.7611	0.1978	0.6300	0.5500	0.7611	0.7611	2.0466	normal		
Arsenic, total	ug/L	MW-1	9	4	13	3.1622	1.5982	2.2700	3.6500	3.1622	3.1622	13.5503	normal		
Barium, total	ug/L	MW-1	9	4	13	189.6667	35.5282	204.0000	222.0000	189.6667	189.6667	420.5997	normal		
Chemical oxygen demand	mg/L	MW-1	9	4	13	14.4444	8.7194	5.7000	5.7000	14.4444	14.4444	71.1205	normal		
Chloride	mg/L	MW-1	9	4	13	10.3244	8.1872	5.6100	5.5300	10.3244	10.3244	63.5412	normal		
Cobalt, total	ug/L	MW-1	4	4	8	1.3550	0.4337	0.6500	0.6500	1.3550	1.3550	4.1741	normal		
Iron, total	ug/L	MW-1	8	4	13	5156.2500	2478.8704	779.0000	5270.0000	5156.2500	5156.2500	21268.9073	normal		
Magnesium, total	mg/L	MW-1	9	4	13	26.0111	3.9813	31.9000	29.4000	27.9187	27.3262	51.8899	normal		
pH	SU	MW-1	9	4	13	7.1689	0.2980	7.2000	6.9700	7.1689	7.1689	5.23 - 9.11	normal		
Specific conductance	uS	MW-1	9	4	13	661.0000	49.9274	707.0000	721.0000	679.2177	689.2902	985.5284	normal		
Ammonia	mg/L	MW-2	9	4	13								nonpar *		**
Arsenic, total	ug/L	MW-2	8	4	13	1.4925	0.2142	2.3800	1.6200	2.1658	2.0791	2.8848	normal		
Barium, total	ug/L	MW-2	9	4	13	185.4444	37.3032	197.0000	114.0000	185.4444	185.4444	427.9152	normal		
Chemical oxygen demand	mg/L	MW-2	9	4	13	7.1111	0.3333	5.7000	5.7000	7.1111	7.1111	9.2778	normal		
Chloride	mg/L	MW-2	9	4	13	48.4391	18.0710	56.9000	64.6000	48.4391	48.4391	165.9005	normal		
Cobalt, total	ug/L	MW-2	4	4	8	6.4475	3.0866	0.6500	0.8700	6.4475	6.4475	26.5102	normal		
Iron, total	ug/L	MW-2	8	4	13	523.0625	231.6665	757.0000	42.9500	870.6044	523.0625	2028.8950	normal		
Magnesium, total	mg/L	MW-2	9	4	13	22.3889	3.0387	31.4000	23.7000	30.8337	29.1062	42.1403	normal		
pH	SU	MW-2	9	4	13	6.4456	0.2034	6.7000	6.7100	6.4986	6.5597	5.12 - 7.77	normal		
Specific conductance	uS	MW-2	9	4	13	668.4444	73.4934	701.0000	748.0000	744.5688	750.6310	1146.1515	normal		
Ammonia	mg/L	MW-21	9	4	13								nonpar *		**
Arsenic, total	ug/L	MW-21	9	4	13	1.2344	0.3704	1.4500	1.4500	1.2344	1.2344	3.6423	normal		
Barium, total	ug/L	MW-21	9	4	13	363.2222	63.0273	301.0000	343.0000	363.2222	363.2222	772.8999	normal		
Chemical oxygen demand	mg/L	MW-21	9	4	13	8.6667	1.5811	6.0000	5.7000	8.6667	8.6667	18.9441	normal		
Chloride	mg/L	MW-21	9	4	13	215.9928	21.9695	174.0000	204.0000	215.9928	215.9928	358.7944	normal		
Cobalt, total	ug/L	MW-21	4	4	8	1.0575	0.3850	0.6500	0.6500	1.0575	1.0575	3.5600	normal		
Iron, total	ug/L	MW-21	8	4	13	418.5625	239.2071	126.0000	58.0000	418.5625	418.5625	1973.4086	normal		
Magnesium, total	mg/L	MW-21	9	4	13	54.7000	7.1798	52.7000	53.1000	54.7000	54.7000	101.3689	normal		
pH	SU	MW-21	9	4	13	6.7289	0.1486	6.9000	6.6700	6.7939	6.7289	5.76 - 7.69	normal		
Specific conductance	uS	MW-21	9	4	13	1542.5556	85.2674	1350.0000	1420.0000	1542.5556	1542.5556	2096.7936	normal		
Ammonia	mg/L	MW-22	9	5	14	4.3333	1.1683	2.0000	2.8000	4.3333	4.3333	11.9275	normal		
Arsenic, total	ug/L	MW-22	9	5	14	14.9578	3.7121	22.3000	14.5000	29.0781	24.9081	39.0867	normal		
Barium, total	ug/L	MW-22	9	5	14	308.4444	65.5098	259.0000	408.0000	339.5819	373.6277	734.2578	normal		
Chemical oxygen demand	mg/L	MW-22	9	5	14	7.5556	1.0138	5.7000	47.0000	7.5556	45.9862	14.1452	normal		
Chloride	mg/L	MW-22	9	5	14	110.2439	16.1508	70.7000	81.7000	110.2439	110.2439	215.2241	normal		
Cobalt, total	ug/L	MW-22	4	5	9	8.3275	0.9308	10.1000	13.8000	10.6109	15.1526	14.3776	normal		
Iron, total	ug/L	MW-22	8	5	14	11301.2500	4157.6279	6540.0000	18200.0000	13305.7385	16046.8606	38325.8313	normal		
Magnesium, total	mg/L	MW-22	9	5	14	31.1000	3.3771	33.2000	35.3000	38.5686	39.3915	53.0513	normal		
pH	SU	MW-22	9	5	14	6.8678	0.1219	6.8000	6.8400	6.8678	6.8678	6.08 - 7.66	normal		
Specific conductance	uS	MW-22	9	5	14	1088.7778	111.5154	927.0000	1038.0000	1088.7778	1088.7778	1813.6282	normal		
Ammonia	mg/L	MW-23	9	4	13	1.4667	0.2598	1.2000	1.1000	1.4667	1.4667	3.1554	normal		
Arsenic, total	ug/L	MW-23	9	4	13	21.2000	8.4049	10.9000	10.5000	21.2000	21.2000	75.8319	normal		
Barium, total	ug/L	MW-23	9	4	13	159.4000	35.4237	134.0000	106.0000	159.4000	159.4000	389.6542	normal		
Chemical oxygen demand	mg/L	MW-23	9	4	13	7.6667	2.0616	5.7000	5.7000	7.6667	7.6667	21.0668	normal		
Chloride	mg/L	MW-23	9	4	13	86.7652	8.7783	83.8000	88.2000	86.7652	86.7652	143.8243	normal		
Cobalt, total	ug/L	MW-23	4	4	8	3.1800	2.0598	1.3400	1.8500	3.1800	3.1800	16.5686	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.

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	
Iron, total	ug/L	MW-23	8	4	13	9047.5000	3109.8404	1330.0000	5050.0000	9047.5000	9047.5000	29261.4624	normal		
Magnesium, total	mg/L	MW-23	9	4	13	37.1444	3.1682	44.3000	37.3000	41.1318	38.1191	57.7380	normal		
pH	SU	MW-23	9	4	13	6.9944	0.2133	6.8000	7.0900	6.9944	6.9944	5.61 - 8.38	normal		
Specific conductance	uS	MW-23	9	4	13	1133.1111	42.0935	1118.0000	1087.0000	1133.1111	1133.1111	1406.7187	normal		
Ammonia	mg/L	MW-24	9	4	13	1.4667	0.5958	0.7700	0.7200	1.4667	1.4667	5.3395	normal		
Arsenic, total	ug/L	MW-24	9	4	13	1.0689	0.4413	1.4500	1.4500	1.0689	1.0689	3.9371	normal		
Barium, total	ug/L	MW-24	9	4	13	318.6667	144.3373	158.0000	93.6000	318.6667	318.6667	1256.8590	normal		
Chemical oxygen demand	mg/L	MW-24	9	4	13								nonpar *		**
Chloride	mg/L	MW-24	9	4	13	94.6720	7.0513	83.2000	82.0000	94.6720	94.6720	140.5052	normal		
Cobalt, total	ug/L	MW-24	4	4	8	3.4150	1.9893	0.6500	1.1000	3.4150	3.4150	16.3455	normal		
Iron, total	ug/L	MW-24	8	4	13	1100.5625	901.5777	528.0000	42.9500	1100.5625	1100.5625	6960.8174	normal		
Magnesium, total	mg/L	MW-24	9	4	13	38.4000	4.8678	31.2000	26.0000	38.4000	38.4000	70.0404	normal		
pH	SU	MW-24	9	4	13	6.9200	0.0954	7.0000	6.7500	6.9200	6.9200	6.30 - 7.54	normal		
Specific conductance	uS	MW-24	9	4	13	1052.0000	56.4424	885.0000	855.0000	1052.0000	1052.0000	1418.8759	normal		
Ammonia	mg/L	MW-26	9	4	13								nonpar *		**
Arsenic, total	ug/L	MW-26	9	4	13	0.7889	0.5763	1.4500	1.4500	0.7889	0.7889	4.5351	normal		
Barium, total	ug/L	MW-26	9	4	13	140.4444	41.2193	123.0000	123.0000	140.4444	140.4444	408.3697	normal		
Chemical oxygen demand	mg/L	MW-26	9	4	13								nonpar *		**
Chloride	mg/L	MW-26	9	4	13	43.0798	17.0679	48.1000	57.8000	61.0369	58.6892	154.0209	normal		
Cobalt, total	ug/L	MW-26	4	4	8	1.0675	0.3650	0.6500	0.6500	1.0675	1.0675	3.4400	normal		
Iron, total	ug/L	MW-26	8	4	13	391.0250	138.3588	610.0000	50.0000	709.2574	391.0250	1290.3572	normal		
Magnesium, total	mg/L	MW-26	9	4	13	12.0689	3.9159	12.5000	12.9000	12.6146	12.0689	37.5221	normal		
pH	SU	MW-26	9	4	13	6.2767	0.2241	6.4000	6.2100	6.2767	6.2767	4.82 - 7.73	normal		
Specific conductance	uS	MW-26	9	4	13	421.0000	159.3730	461.0000	519.0000	495.8810	434.5080	1456.9244	normal		
Ammonia	mg/L	MW-3R1	9	4	13	0.7498	0.4677	0.3000	0.3000	0.7498	0.7498	3.7901	normal		
Arsenic, total	ug/L	MW-3R1	8	4	13	61.3250	15.9933	30.0000	32.3000	61.3250	61.3250	165.2813	normal		
Barium, total	ug/L	MW-3R1	8	4	13	422.6250	109.3434	219.0000	171.0000	422.6250	422.6250	1133.3572	normal		
Chemical oxygen demand	mg/L	MW-3R1	8	4	12	9.1250	3.6815	5.7000	5.7000	9.1250	9.1250	33.0549	normal		
Chloride	mg/L	MW-3R1	9	4	13	56.0031	7.2377	50.5000	51.8000	62.0807	56.0031	103.0481	normal		
Cobalt, total	ug/L	MW-3R1	4	4	8	10.9575	1.1627	11.4000	10.7000	12.0969	10.9575	18.5151	normal		
Iron, total	ug/L	MW-3R1	7	4	13	50357.1429	12210.2221	8350.0000	35500.0000	50357.1429	50357.1429	129723.5865	normal		
Magnesium, total	mg/L	MW-3R1	9	4	13	106.2222	159.7377	27.1000	20.6000	106.2222	106.2222	1144.5170	normal		
pH	SU	MW-3R1	9	4	13	6.7689	0.1244	6.7000	6.6300	6.7689	6.7689	5.96 - 7.58	normal		
Specific conductance	uS	MW-3R1	9	4	13	837.7778	43.8685	760.0000	768.0000	837.7778	837.7778	1122.9230	normal		
Ammonia	mg/L	MW-4	9	4	13	1.4600	0.6511	1.6000	1.2000	1.4600	1.4600	5.6920	normal		
Arsenic, total	ug/L	MW-4	9	4	13	20.6889	6.8296	17.4000	35.6000	20.6889	28.7704	65.0814	normal		
Barium, total	ug/L	MW-4	9	4	13	341.6667	72.1613	458.0000	543.0000	385.8387	515.0108	810.7150	normal		
Chemical oxygen demand	mg/L	MW-4	9	4	13	9.3333	3.7081	5.7000	18.0000	9.3333	14.2919	33.4360	normal		
Chloride	mg/L	MW-4	9	4	13	76.0033	17.8265	76.5000	82.6000	76.0033	76.0033	191.8759	normal		
Cobalt, total	ug/L	MW-4	4	4	8	4.9900	2.1229	7.8500	126.0000	14.8912	133.7782	18.7891	normal		
Iron, total	ug/L	MW-4	8	4	13	5932.5000	1589.2114	3930.0000	83400.0000	5932.5000	81810.7886	16262.3741	normal		
Magnesium, total	mg/L	MW-4	9	4	13	27.6889	4.5253	36.9000	34.1000	32.3747	34.2605	57.1035	normal		
pH	SU	MW-4	9	4	13	6.6600	0.2068	6.8000	6.4300	6.6600	6.6600	5.32 - 8.00	normal		
Specific conductance	uS	MW-4	9	4	13	849.6667	159.6731	869.0000	848.0000	849.6667	849.6667	1887.5418	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.

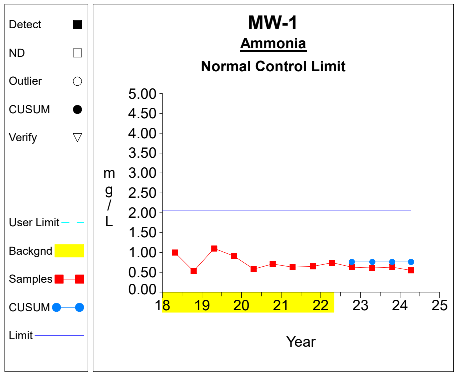
Table 4

Dixon's Test Outliers
1% Significance Level

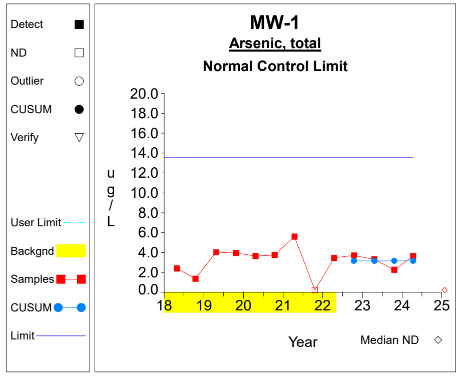
Constituent	Units	Well	Date	Result	ND Qualifier	Date Range	N	Critical Value
Iron, total	ug/L	MW-1	04/21/2020	45.8000		04/26/2018-04/14/2022	9	0.6346
Arsenic, total	ug/L	MW-2	10/20/2021	5.7500	< 5.7500	04/27/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-2	04/21/2020	5.7200		04/27/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-21	04/21/2020	2.0000	< 2.0000	04/26/2018-04/14/2022	9	0.6346
Iron, total	ug/L	MW-22	04/21/2020	93.3000		04/27/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-23	04/21/2020	118.0000		04/26/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-24	04/21/2020	9.3400		04/26/2018-04/14/2022	9	0.6346
Arsenic, total	ug/L	MW-3R1	06/05/2018	372.0000		06/05/2018-04/15/2022	9	0.6346
Barium, total	ug/L	MW-3R1	06/05/2018	1920.0000		06/05/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-3R1	06/05/2018	357000.0000		06/05/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-3R1	04/21/2020	535.0000		06/05/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-4	04/21/2020	36.2000		04/26/2018-04/14/2022	9	0.6346

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.

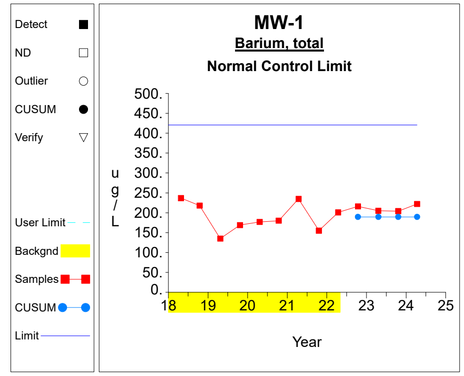
Intra-Well Control Charts / Prediction Limits



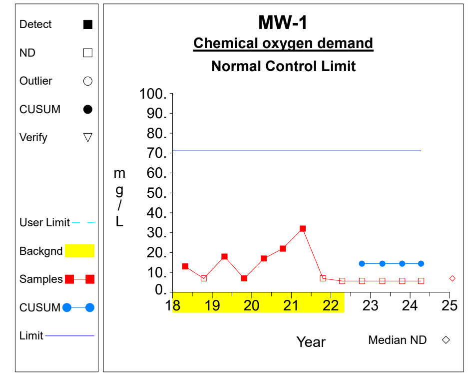
Graph 1



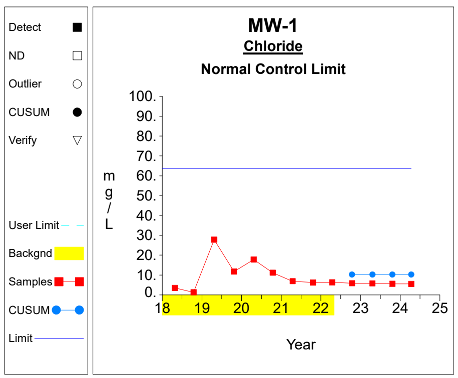
Graph 2



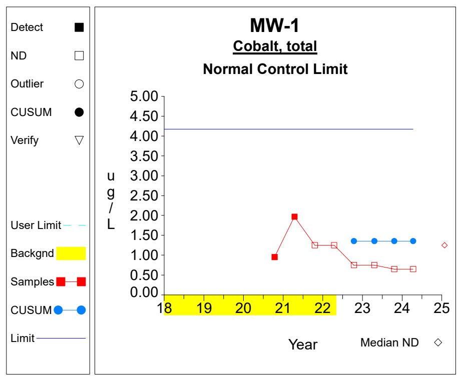
Graph 3



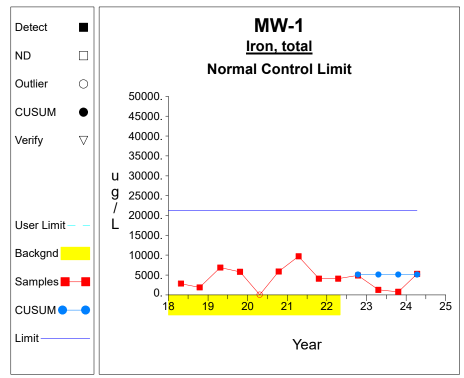
Graph 4



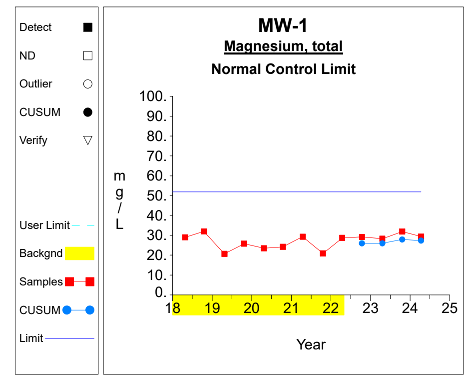
Graph 5



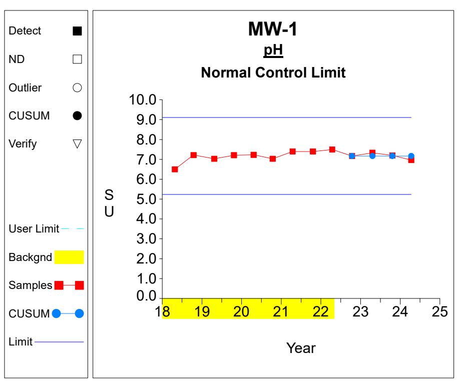
Graph 6



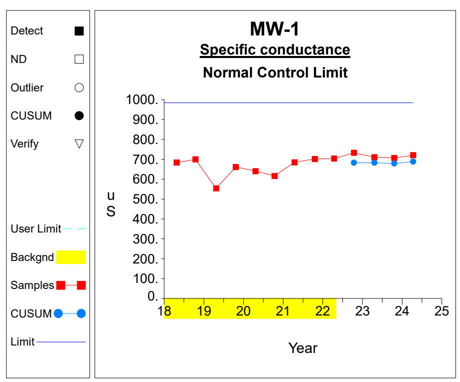
Graph 7



Graph 8



Graph 9



Graph 10

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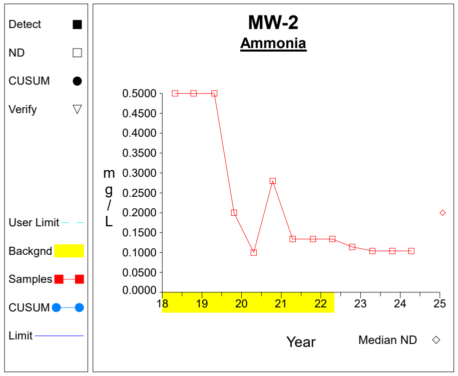
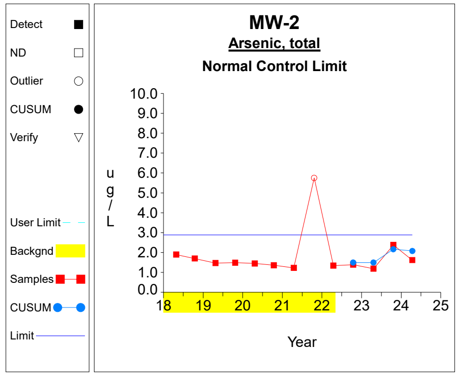
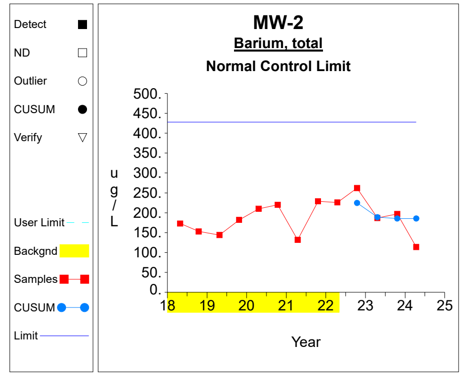
Intra-Well Control Charts / Prediction Limits



Graph 11



Graph 12



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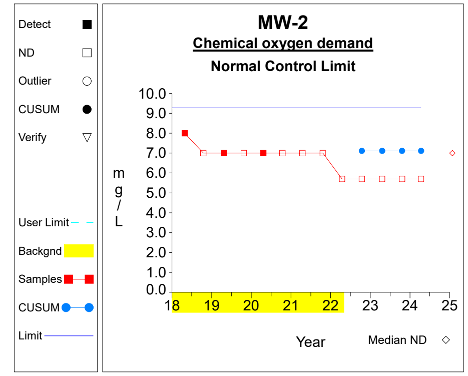
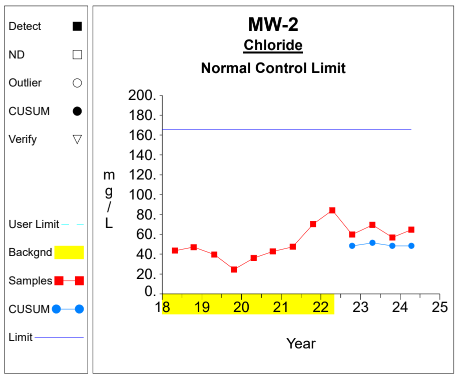


Graph 14



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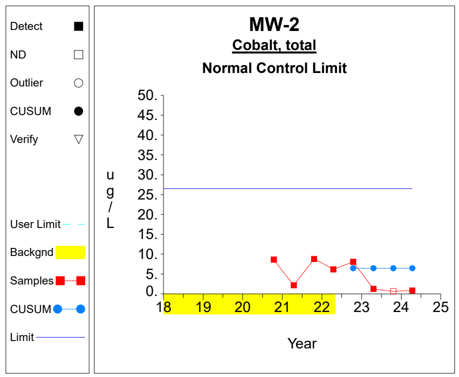

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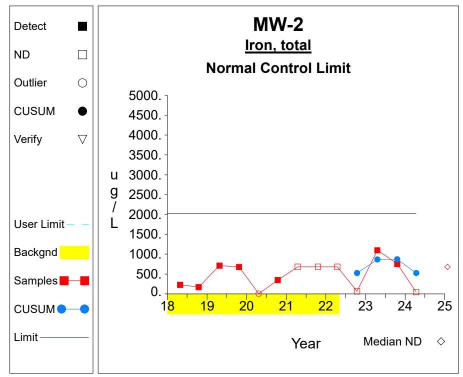

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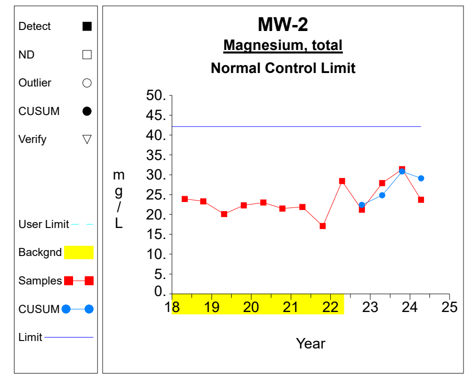

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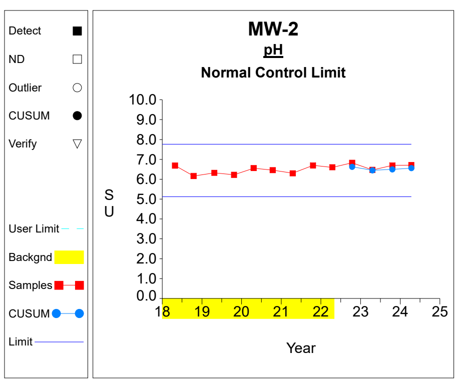
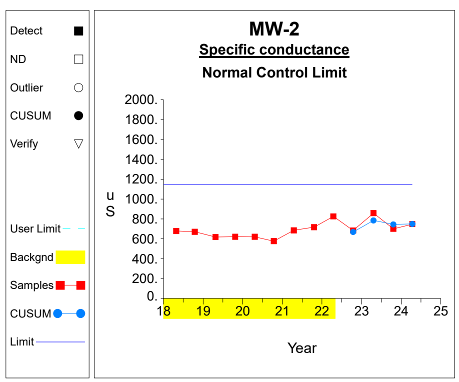
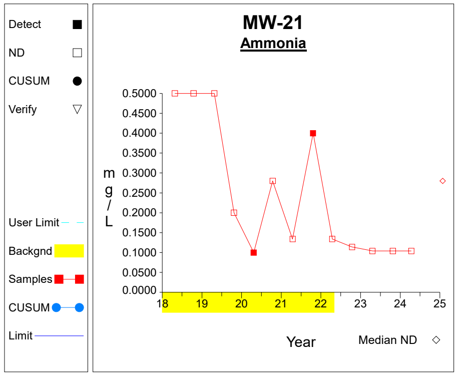


Graph 19



Graph 20

Intra-Well Control Charts / Prediction Limits



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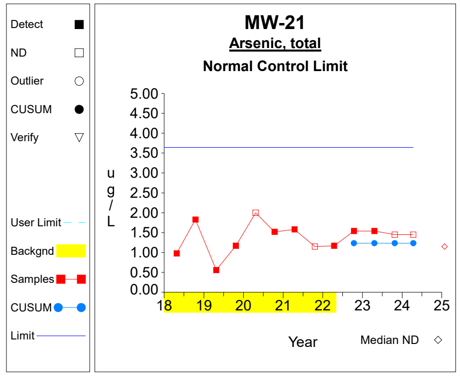

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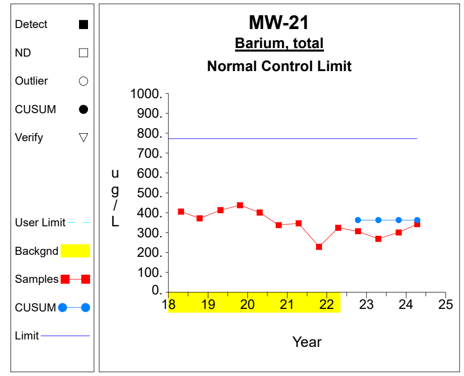

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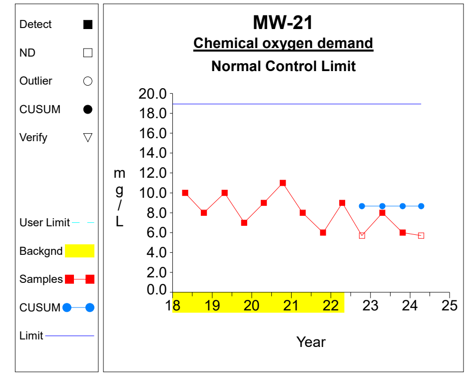

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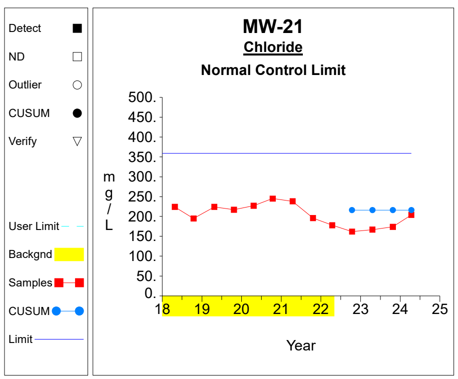

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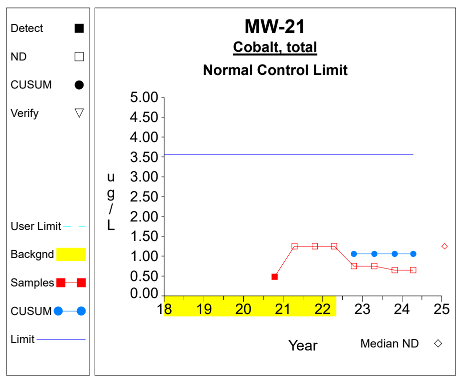

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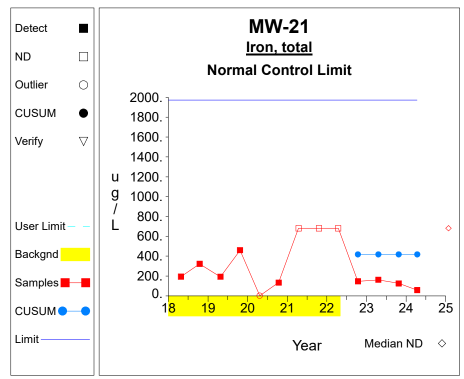

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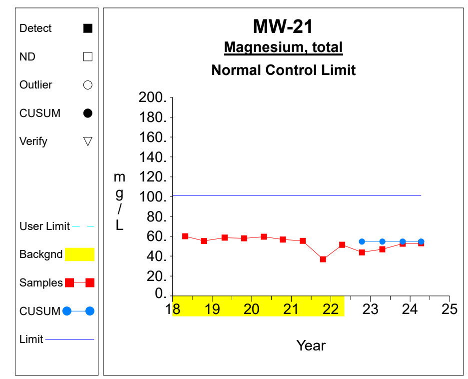

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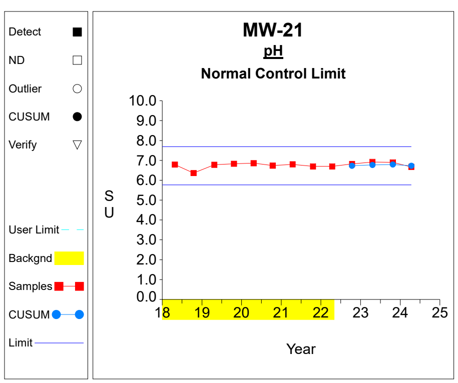

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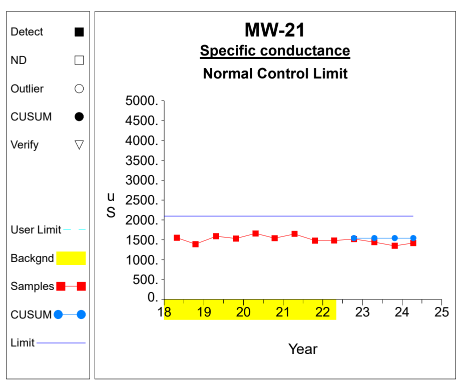

Graph 30

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Ash Monofill [GW]

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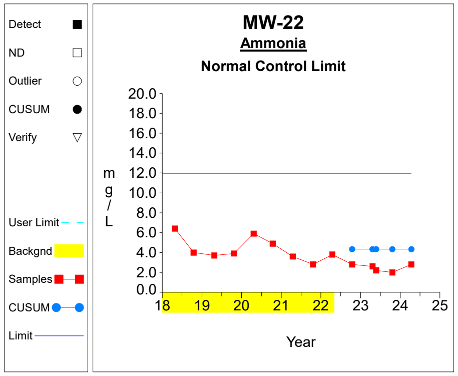
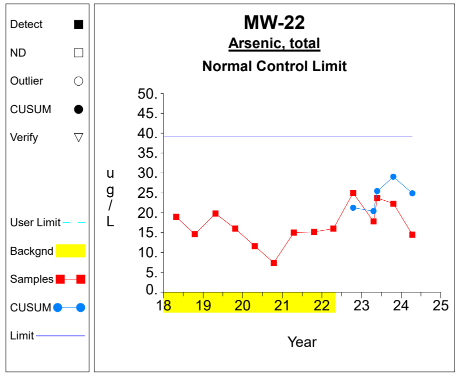
Intra-Well Control Charts / Prediction Limits



Graph 31



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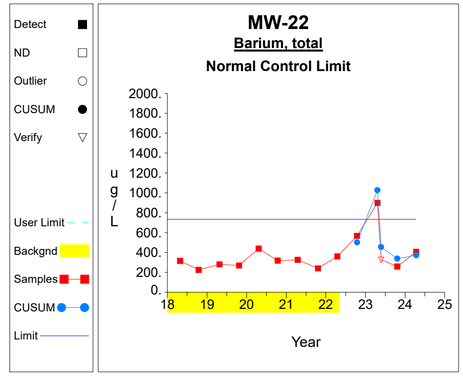

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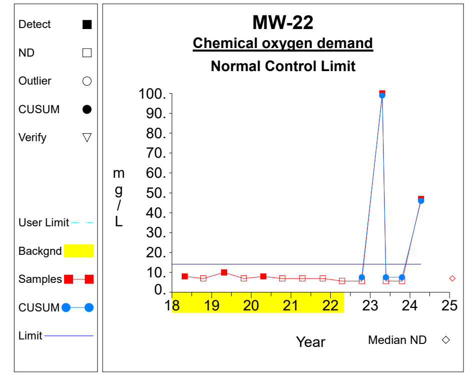

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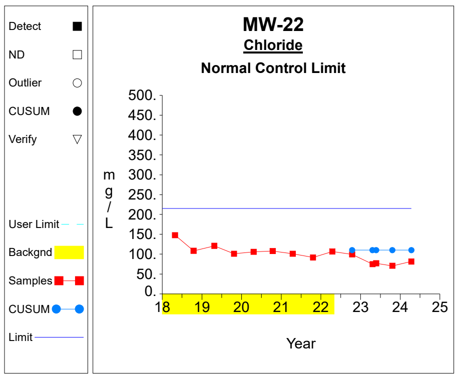

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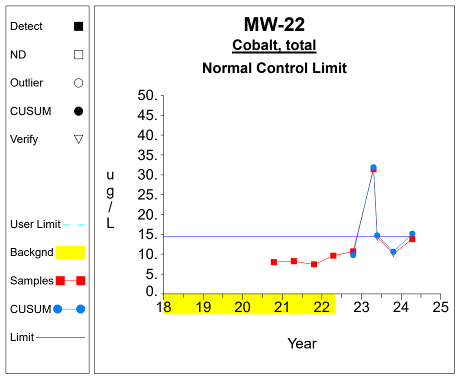

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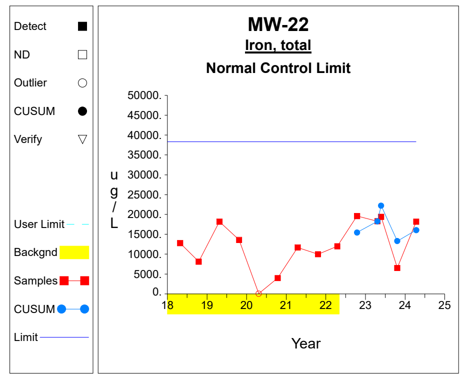

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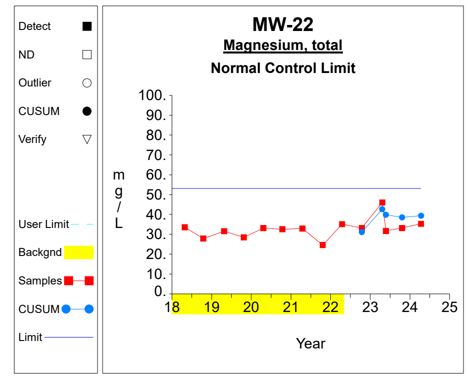

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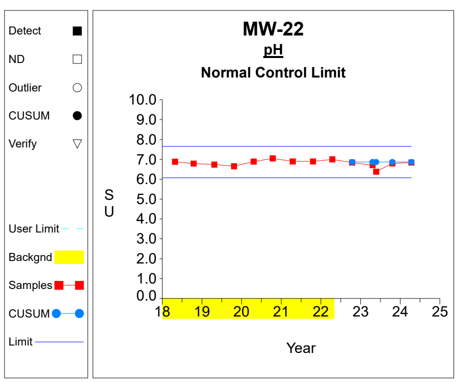

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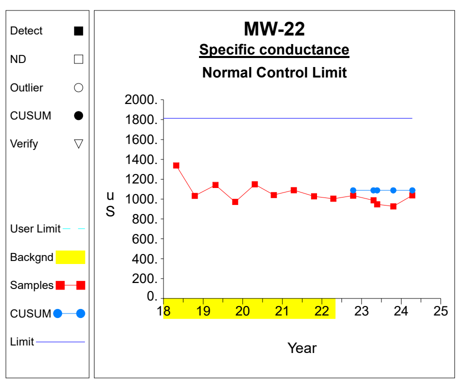

Graph 40

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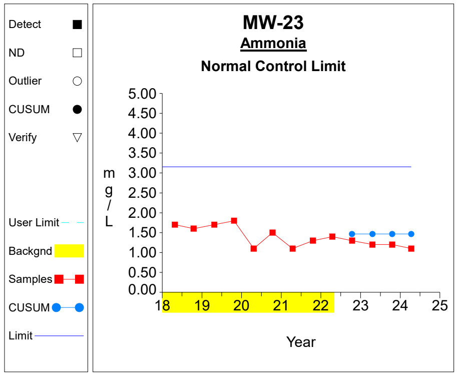
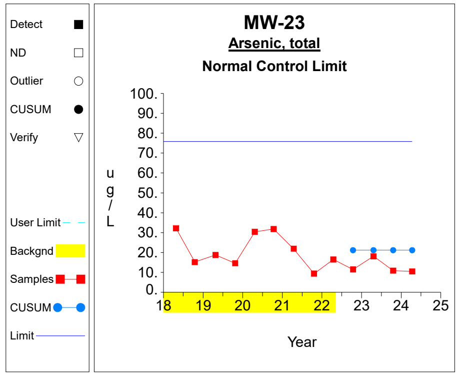
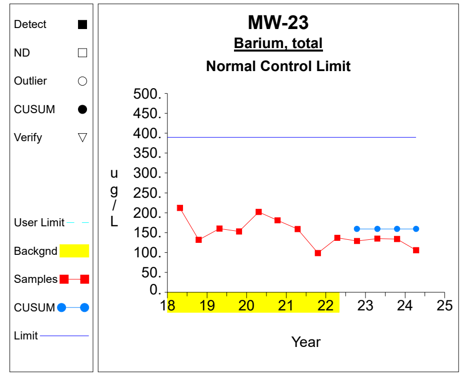
Intra-Well Control Charts / Prediction Limits



Graph 41



Graph 42



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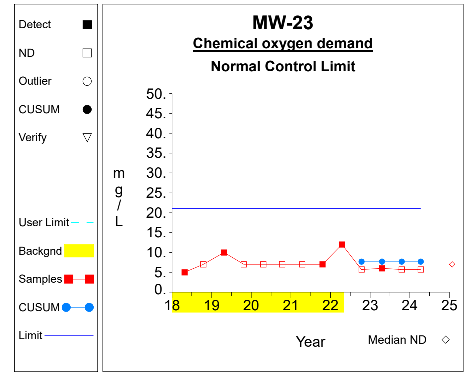
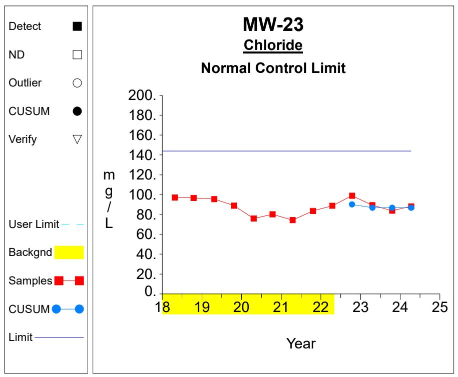


Graph 44



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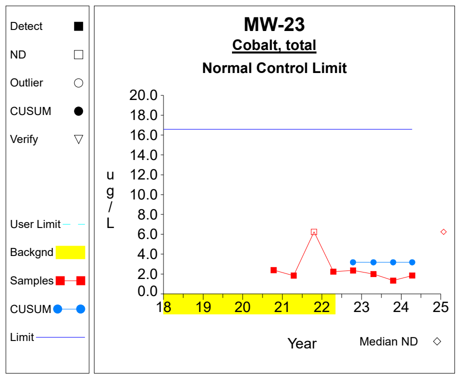

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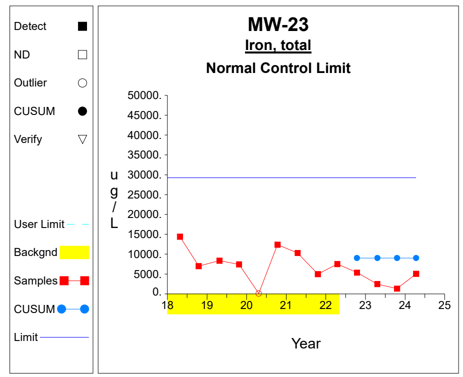
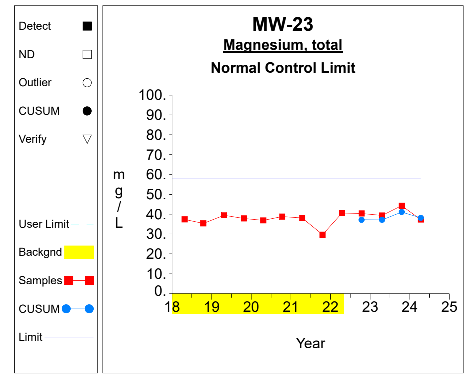
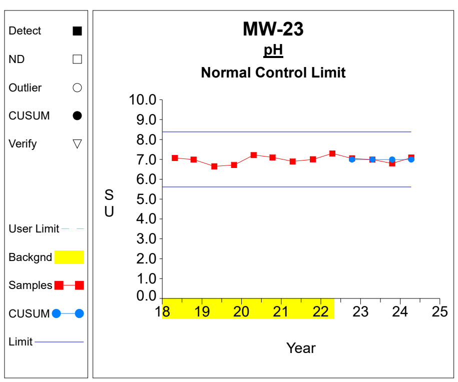


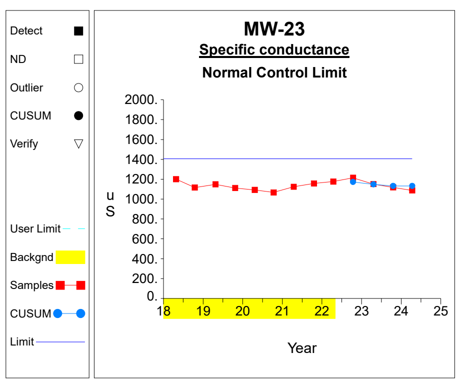
Graph 47



Graph 48



Graph 49



Graph 50

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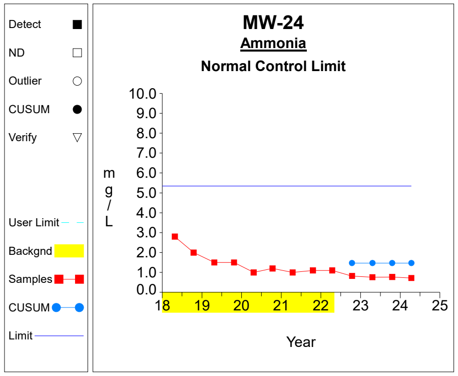
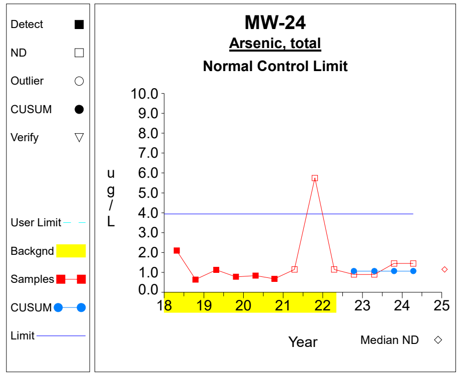
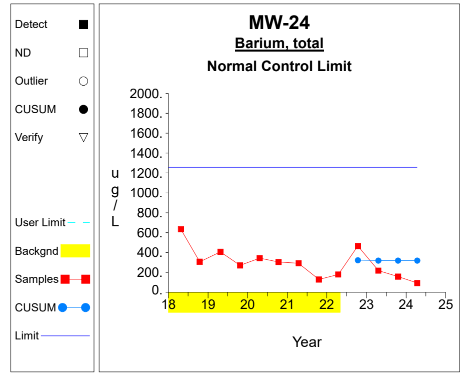
Intra-Well Control Charts / Prediction Limits



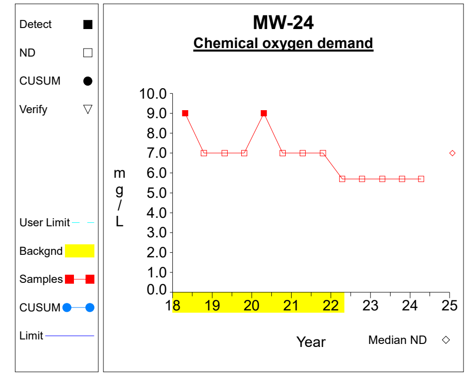
Graph 51



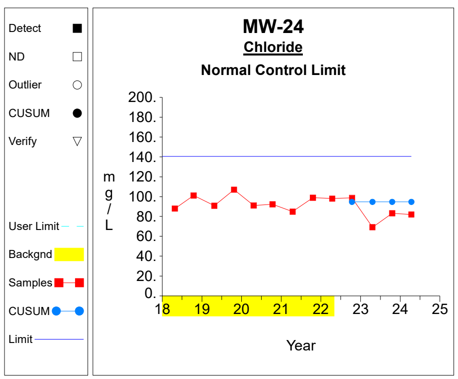
Graph 52



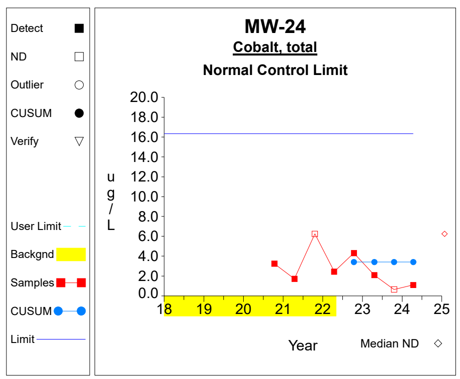
Graph 53



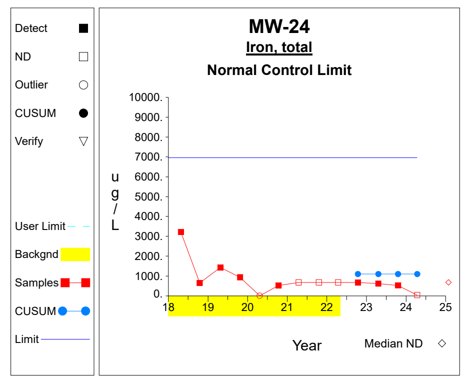
Graph 54



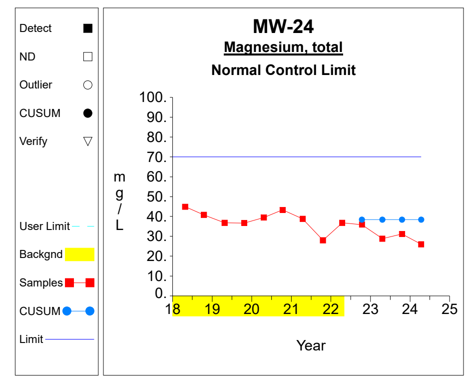
Graph 55



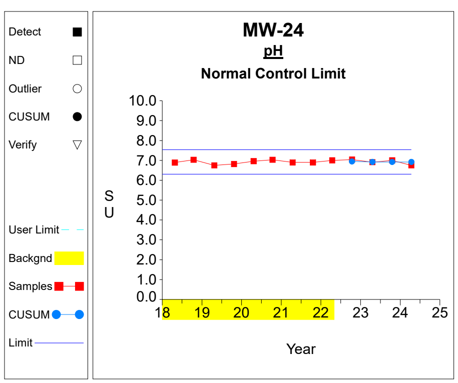
Graph 56



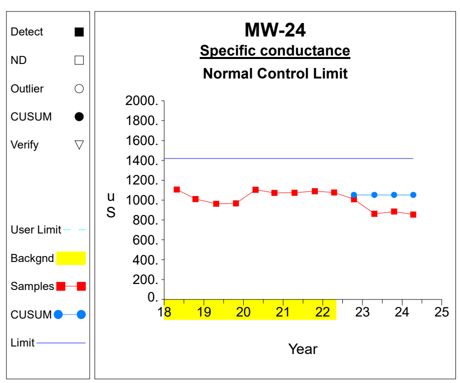
Graph 57



Graph 58



Graph 59



Graph 60

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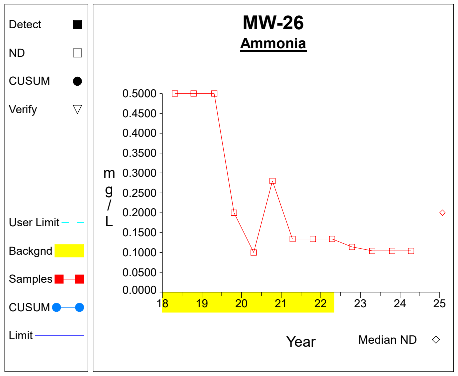
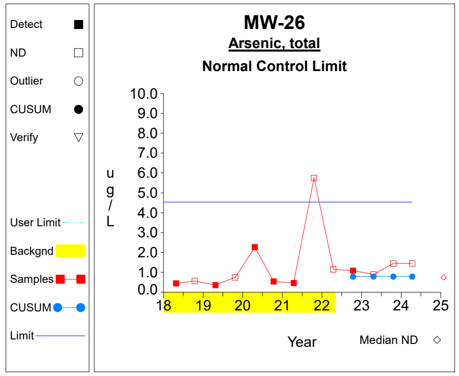
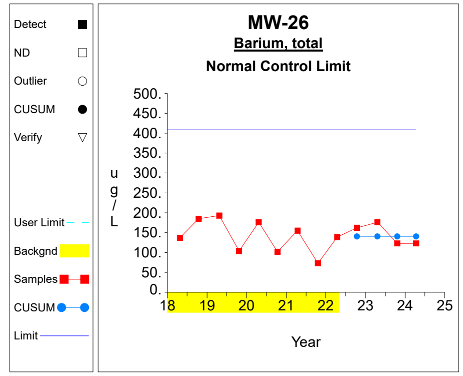
Intra-Well Control Charts / Prediction Limits



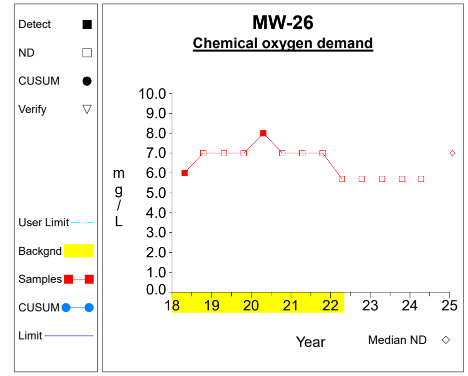
Graph 61



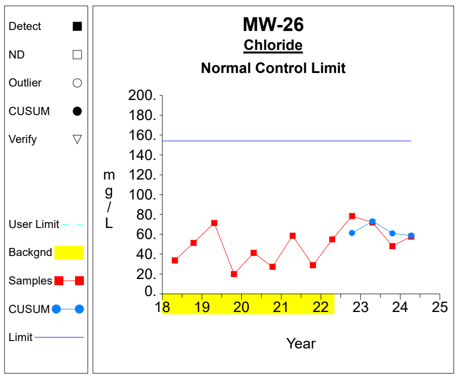
Graph 62



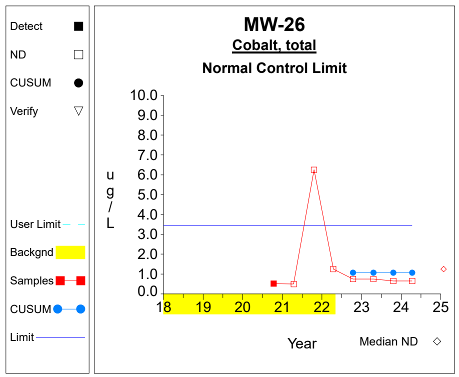
Graph 63



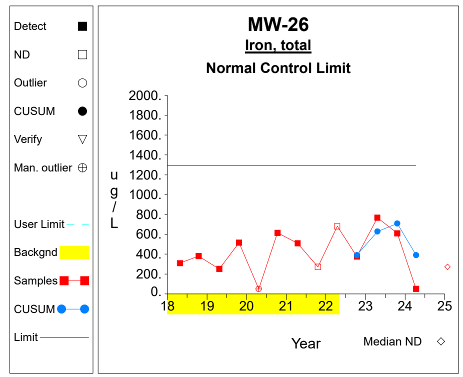
Graph 64



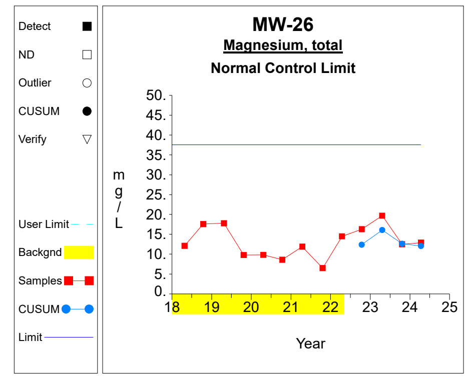
Graph 65



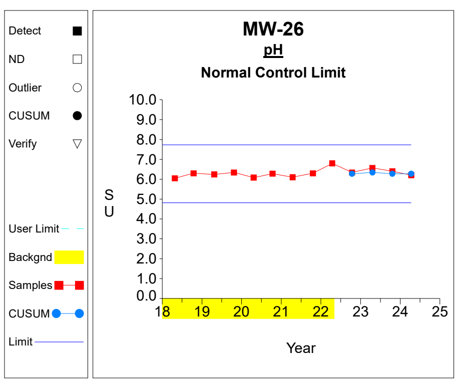
Graph 66



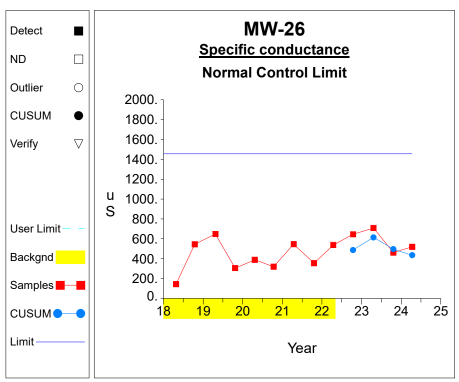
Graph 67



Graph 68



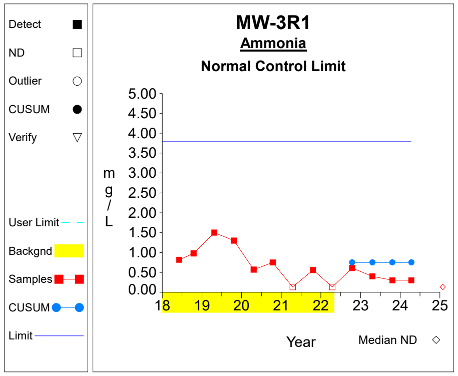
Graph 69



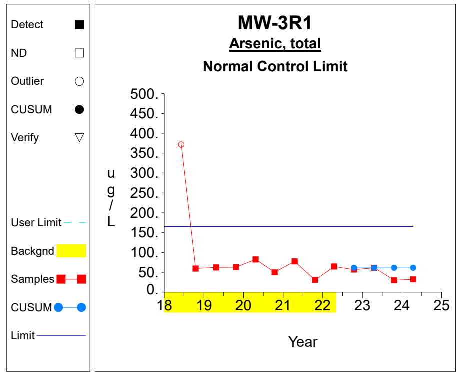
Graph 70

Prepared by: Otter Creek Environmental

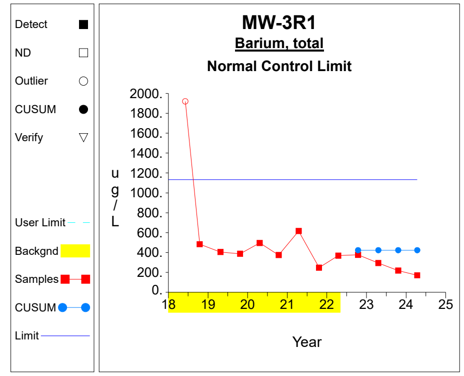
Intra-Well Control Charts / Prediction Limits



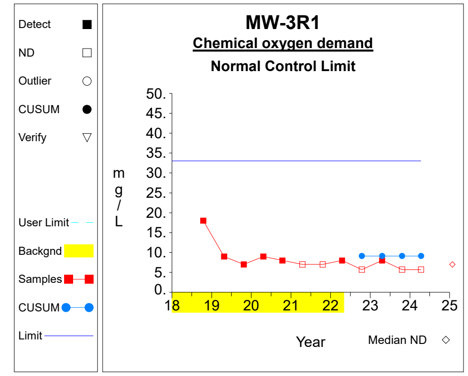
Graph 71



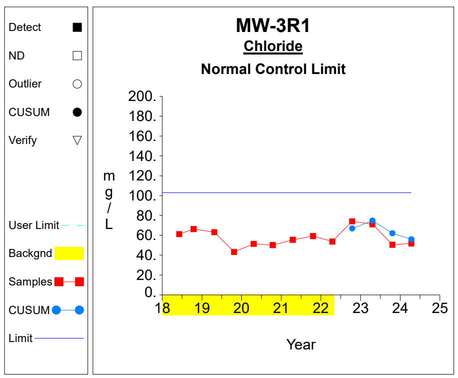
Graph 72



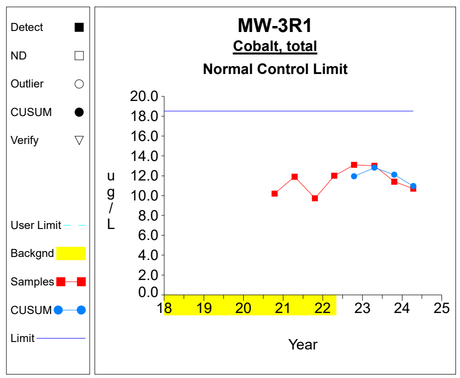
Graph 73



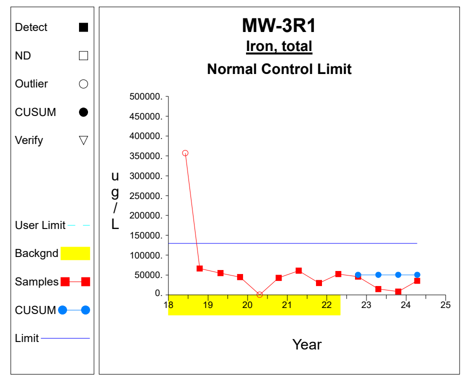
Graph 74



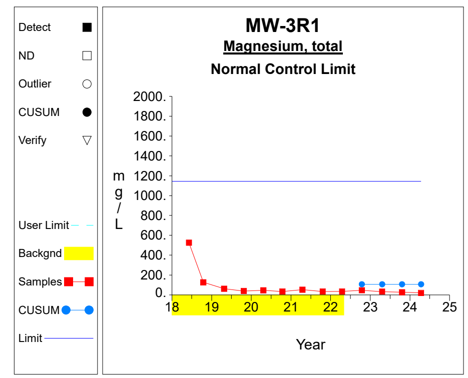
Graph 75



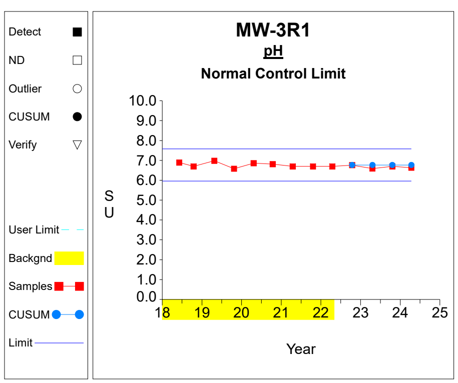
Graph 76



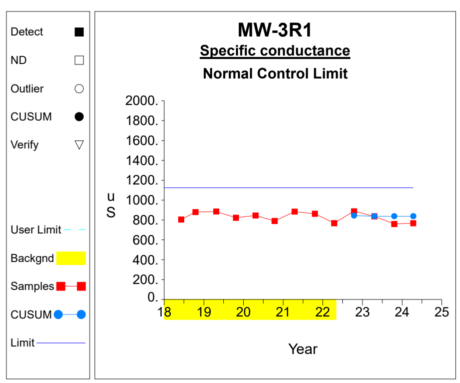
Graph 77



Graph 78

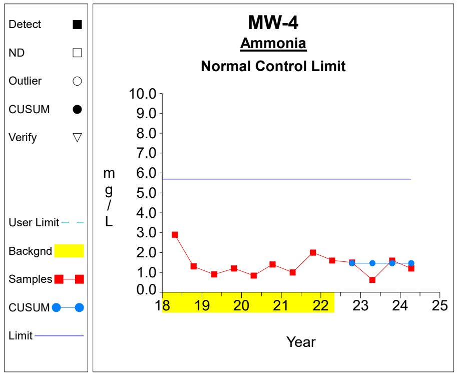


Graph 79

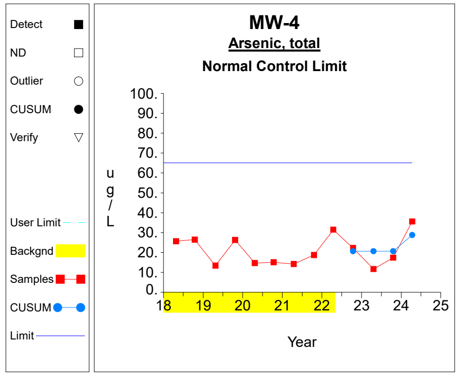


Graph 80

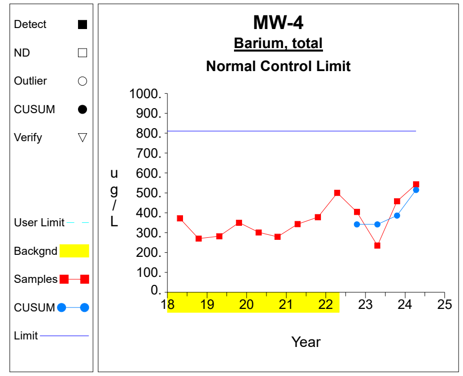
Intra-Well Control Charts / Prediction Limits



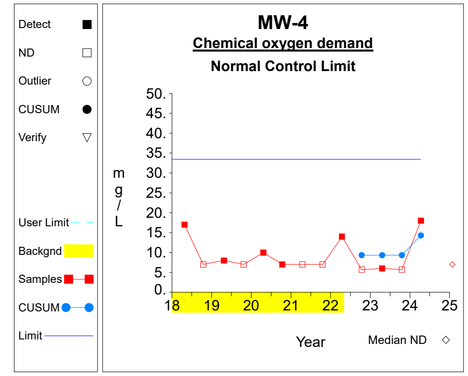
Graph 81



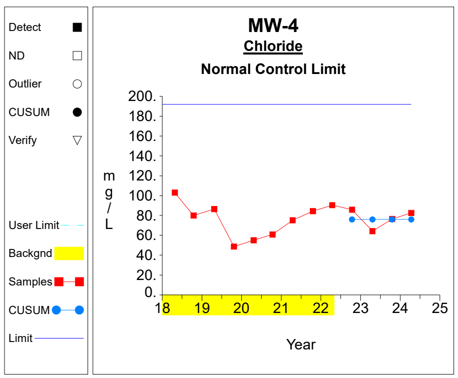
Graph 82



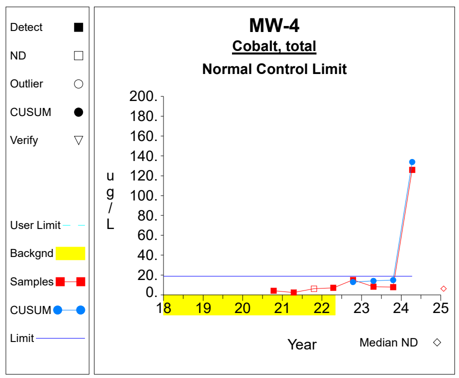
Graph 83



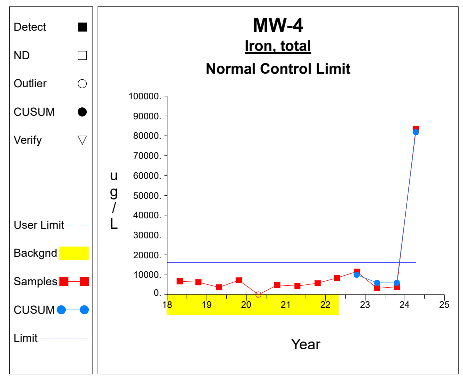
Graph 84



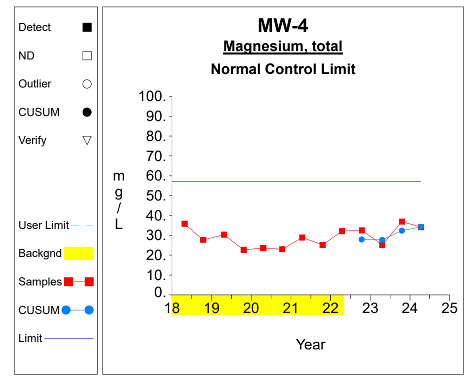
Graph 85



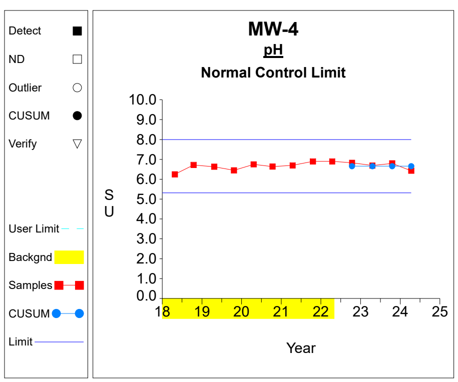
Graph 86



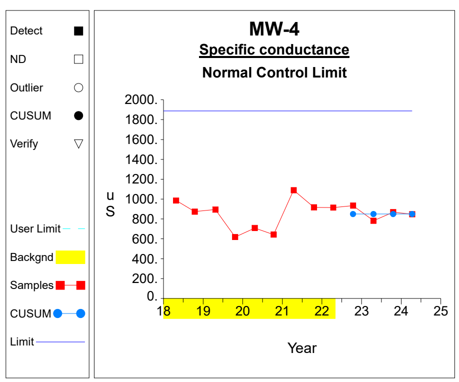
Graph 87



Graph 88

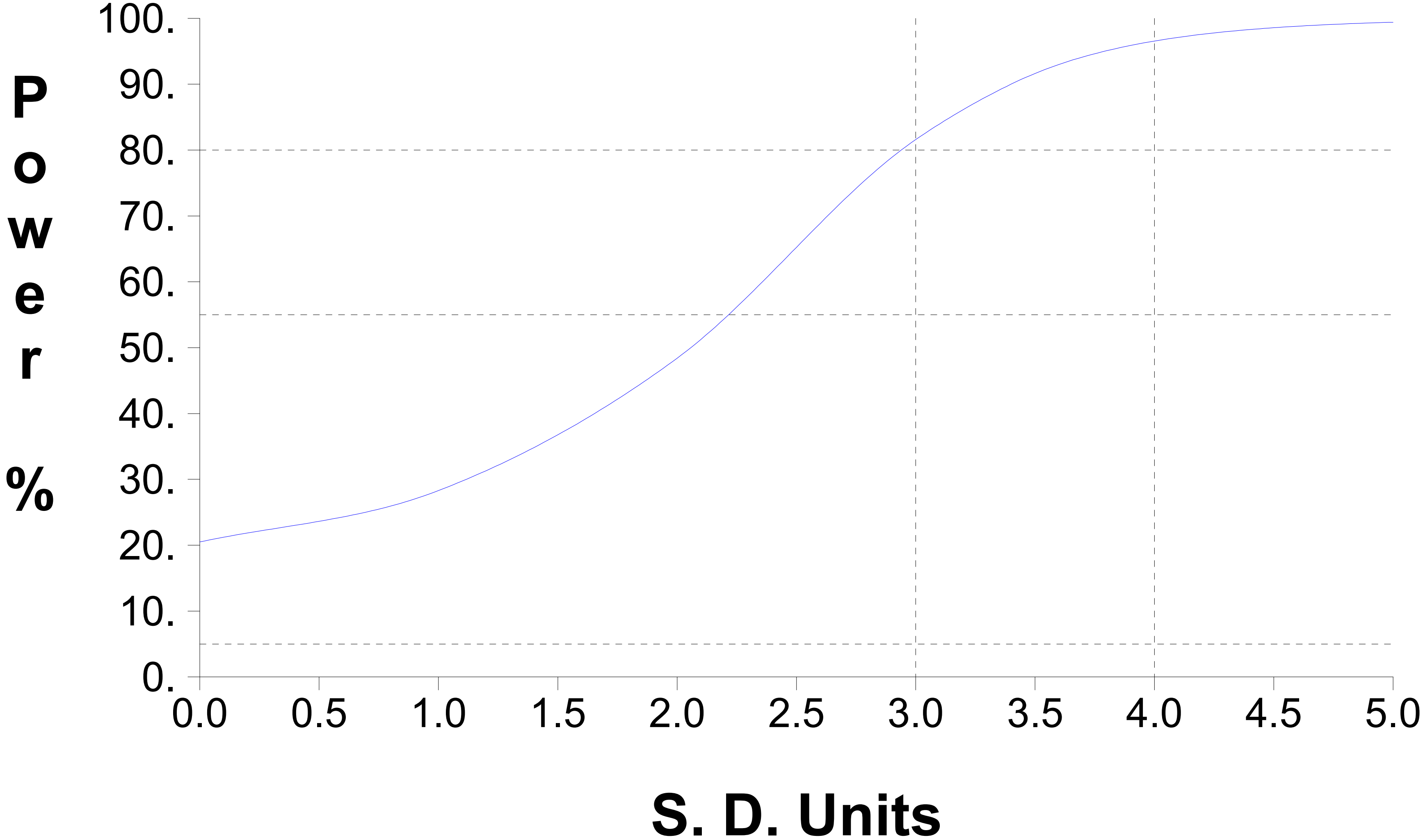


Graph 89



Graph 90

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



Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **6.85** / **9** = **0.761**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**5.527** - **46.923**/**9**) / (**9**-1))^{½} = **0.198**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **0.761** + **6.5** * **0.198** = **2.047**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.063**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.215**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **28.46** / **9** = **3.162**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**110.43** - **809.972**/**9**) / (**9**-1))$^{1/2}$ = **1.598**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **3.162** + **6.5** * **1.598** = **13.55**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.059**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1.576**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **1707.0** / **9** = **189.667**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**333859.0 - 2.91**×**10^6/9**) / (**9**-1))$^{1/2}$ = **35.528**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **189.667** + **6.5** * **35.528** = **420.6**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-2.768**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36 - 2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-34.98**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **130.0** / **9** = **14.444**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{2486.0} - \mathbf{16900.0/9}) / (\mathbf{9}-1))^{1/2}$ = **8.719**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S** = **14.444** + **6.5** * **8.719** = **71.12**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **83.333**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{83.333}^{1/2}) / 2$ = **7.383**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-6.065**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **92.92** / **9** = **10.324**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**1495.588** - **8634.126**/**9**) / (**9**-1))$^{1/2}$ = **8.187**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **10.324** + **6.5** * **8.187** = **63.541**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.909**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-8.857**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **5.42** / **4** = **1.355**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**7.908** - **29.376/4**) / (**4**-1))$^{1/2}$ = **0.434**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1.355** + **6.5** * **0.434** = **4.174**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.1**	Sen's estimator of trend.
6	var(S) = **7.667**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**6** - **2.326** * **7.667**$^{1/2}$) / 2 = **-0.22**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1.398**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **41250.0** / **8** = **5156.25**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**2.56**x**10^8** - **1.70**x**10^9**/**8**) / (**8**-1))^{½} = **2478.87**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **5156.25** + **6.5** * **2478.87** = **21268.907**	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 = **338.29**	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_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1867.062**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **234.1** / **9** = **26.011**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**6216.01** - **54802.81**/**9**) / (**9**-1))$^{1/2}$ = **3.981**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **26.011** + **6.5** * **3.981** = **51.89**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.772**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-4.02**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **64.52** / **9** = **7.169**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**463.247** - **4162.83/9**) / (**9**-1))^{½} = **0.298**	Compute background sd.
3	SCL = **$\bar{X}$** ± **F** * **S** = **7.169** ± **6.5** * **0.298** = **5.232**, **9.106**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.143**	Sen's estimator of trend.
6	var(S) = **90.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **90.0**^{½}) / 2 = **6.967**	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
Specific conductance (uS) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **5949.0** / **9** = **661.0**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**3.95x10^6** - **3.54x10^7**/**9**) / (**9**-1))^{½} = **49.927**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **661.0** + **6.5** * **49.927** = **985.528**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **10.372**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-39.313**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **11.94** / **8** = **1.493**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**18.142** - **142.564**/**8**) / (**8**-1))$^{1/2}$ = **0.214**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1.493** + **6.5** * **0.214** = **2.885**	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 = **-0.168**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **65.333**$^{1/2}$) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.265**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{1669.0} / \mathbf{9}$ $= \mathbf{185.444}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{320639.0} - \mathbf{2.79}\times\mathbf{10^6}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{37.303}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{185.444} + \mathbf{6.5} * \mathbf{37.303}$ $= \mathbf{427.915}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{18.2}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \mathbf{-14.357}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **64.0** / **9** = **7.111**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{456.0} - \mathbf{4096.0}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ = **0.333**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **7.111** + **6.5** * **0.333** = **9.278**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **26.667**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{26.667}^{1/2}) / 2$ = **11.994**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th 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
Chloride (mg/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **435.952** / **9** = **48.439**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**23729.612** - **190054.146**/**9**) / (**9**-1))$^{1/2}$ = **18.071**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **48.439** + **6.5** * **18.071** = **165.901**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **9.786**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	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) = **-3.775**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **25.79** / **4**	
	= **6.448**	
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**194.862** - **665.124**/**4**) / (**4**-1))$^{1/2}$	
	= **3.087**	
3	SCL = $\bar{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **6.448** + **6.5** * **3.087**	
	= **26.51**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **4** * (**4**-1) / 2	
	= **6**	
5	S = **-0.731**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**6** - **2.326** * **8.667**$^{1/2}$) / 2	
	= **-0.424**	
8	LCL(S) = **-12.81**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **4184.5** / **8** = **523.063**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]^2**/**N**) / (**N**-1))$^{1/2}$ = ((**2.56x10^6** - **1.75x10^7**/**8**) / (**8**-1))$^{1/2}$ = **231.667**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **523.063** + **6.5** * **231.667** = **2028.895**	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 = **68.32**	Sen's estimator of trend.
6	var(S) = **61.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **61.667**$^{1/2}$) / 2 = **4.867**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-22.18**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **201.5** / **9** = **22.389**	Compute background mean.
2	S = ((**sum[X²] - sum[X]²/N**) / (**N**-1))$^{1/2}$ = ((**4585.23** - **40602.25/9**) / (**9**-1))$^{1/2}$ = **3.039**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **22.389** + **6.5** * **3.039** = **42.14**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.617**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $\mathbf{Z}_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-2.692**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\overline{X} = \textbf{sum[X]} / \textbf{N}$ $= \textbf{58.01} / \textbf{9}$ $= \textbf{6.446}$	Compute background mean.
2	$S = ((\textbf{sum[X}^2\textbf{]} - \textbf{sum[X]}^2/\textbf{N}) / (\textbf{N}-1))^{½}$ $= ((\textbf{374.238} - \textbf{3365.16/9}) / (\textbf{9}-1))^{½}$ $= \textbf{0.203}$	Compute background sd.
3	$SCL = \overline{\textbf{X}} \pm \textbf{F} * \textbf{S}$ $= \textbf{6.446} \pm \textbf{6.5} * \textbf{0.203}$ $= \textbf{5.123}, \textbf{7.768}$	Compute combined Shewhart-CUSUM normal control interval.
4	$N' = \textbf{N} * (\textbf{N}-1) / 2$ $= \textbf{9} * (\textbf{9}-1) / 2$ $= \textbf{36}$	Number of sample pairs during trend detection period.
5	$S = \textbf{0.076}$	Sen's estimator of trend.
6	$var(S) = \textbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\textbf{N'} - \textbf{Z}_{.99} * \textbf{var(S)}^{½}) / 2$ $= (\textbf{36} - \textbf{2.326} * \textbf{92.0}^{½}) / 2$ $= \textbf{6.845}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \textbf{-0.207}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **6016.0** / **9**	
	= **668.444**	
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**4.06**x**10^6** - **3.62**x**10^7**/**9**) / (**9**-1))$^{1/2}$	
	= **73.493**	
3	SCL = $\bar{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **668.444** + **6.5** * **73.493**	
	= **1146.151**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **13.405**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**36** - **2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-41.993**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **11.11** / **9** = **1.234**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**14.813** - **123.432/9**) / (**9**-1))$^{1/2}$ = **0.37**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **1.234** + **6.5** * **0.37** = **3.642**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.045**	Sen's estimator of trend.
6	var(S) = **90.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **90.0**$^{1/2}$) / 2 = **6.967**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.365**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\overline{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{3269.0} / \mathbf{9}$ $= \mathbf{363.222}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{1.22 \times 10^6} - \mathbf{1.07 \times 10^7}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{63.027}$	Compute background sd.
3	$SCL = \overline{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{363.222} + \mathbf{6.5} * \mathbf{63.027}$ $= \mathbf{772.9}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-28.587}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	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	$LCL(S) = \mathbf{-78.691}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **78.0** / **9** = **8.667**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**696.0** - **6084.0**/**9**) / (**9**-1))$^{1/2}$ = **1.581**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **8.667** + **6.5** * **1.581** = **18.944**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.419**	Sen's estimator of trend.
6	var(S) = **89.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **89.0**$^{1/2}$) / 2 = **7.028**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1.993**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{1943.935} / \mathbf{9}$ $= \mathbf{215.993}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{½}$ $= ((\mathbf{423737.187} - \mathbf{3.78{\times}10^6/9}) / (\mathbf{9}-1))^{½}$ $= \mathbf{21.969}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{215.993} + \mathbf{6.5} * \mathbf{21.969}$ $= \mathbf{358.794}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-2.348}$	Sen's estimator of trend.
6	$var(S) = \mathbf{91.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{½}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{91.0}^{½}) / 2$ $= \mathbf{6.906}$	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	$LCL(S) = \mathbf{-25.91}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **4.23** / **4** = **1.058**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**4.918** - **17.893/4**) / (**4**-1))$^{1/2}$ = **0.385**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1.058** + **6.5** * **0.385** = **3.56**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.257**	Sen's estimator of trend.
6	var(S) = **5.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**6** - **2.326** * **5.0**$^{1/2}$) / 2 = **0.399**	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
Iron, total (ug/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **3348.5** / **8** = **418.563**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{1.80 \times 10^6} - \mathbf{1.12 \times 10^7/8}) / (\mathbf{8}-1))^{1/2}$ = **239.207**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S** = **418.563** + **6.5** * **239.207** = **1973.409**	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 = **128.654**	Sen's estimator of trend.
6	var(S) = **61.667**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{28} - \mathbf{2.326} * \mathbf{61.667}^{1/2}) / 2$ = **4.867**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-26.421**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **492.3** / **9** = **54.7**	Compute background mean.
2	S = ((**sum[X²]** - **sum[X]²/N**) / (**N**-1))$^{1/2}$ = ((**27341.21** - **242359.29**/**9**) / (**9**-1))$^{1/2}$ = **7.18**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **54.7** + **6.5** * **7.18** = **101.369**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-1.717**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-6.982**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **60.56** / **9** = **6.729**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**407.678** - **3667.514**/**9**) / (**9**-1))^{½} = **0.149**	Compute background sd.
3	SCL = **$\overline{X}$** ± **F** * **S** = **6.729** ± **6.5** * **0.149** = **5.763**, **7.695**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.02**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **91.0**^{½}) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.082**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **13883.0** / **9**	
	= **1542.556**	
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**2.15x10^7** - **1.93x10^8**/**9**) / (**9**-1))$^{1/2}$	
	= **85.267**	
3	SCL = $\bar{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **1542.556** + **6.5** * **85.267**	
	= **2096.794**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **-8.562**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z$_{.99}$** * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**36** - **2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-93.711**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **39.0** / **9** = **4.333**	Compute background mean.
2	S = ((**sum[X²] - sum[X]²/N**) / (**N**-1))$^{1/2}$ = ((**179.92** - **1521.0/9**) / (**9**-1))$^{1/2}$ = **1.168**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **4.333** + **6.5** * **1.168** = **11.927**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.38**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-2.063**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **134.62** / **9** = **14.958**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]^2**/**N**) / (**N**-1))$^{1/2}$ = ((**2123.856** - **18122.544**/**9**) / (**9**-1))$^{1/2}$ = **3.712**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **14.958** + **6.5** * **3.712** = **39.087**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.717**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **91.0**$^{1/2}$) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-7.68**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **2776.0** / **9** = **308.444**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**890574.0** - **7.71**×**10^6**/**9**) / (**9**-1))$^{1/2}$ = **65.51**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **308.444** + **6.5** * **65.51** = **734.258**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **19.335**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-45.408**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **68.0** / **9** = **7.556**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**522.0** - **4624.0**/**9**) / (**9**-1))$^{1/2}$ = **1.014**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **7.556** + **6.5** * **1.014** = **14.145**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **62.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **62.667**$^{1/2}$) / 2 = **8.793**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1.01**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **992.195** / **9** = **110.244**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**111470.222** - **984450.918**/**9**) / (**9**-1))^{½} = **16.151**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **110.244** + **6.5** * **16.151** = **215.224**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-6.386**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **91.0**^{½}) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-16.374**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **33.31** / **4** = **8.328**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**279.988** - **1109.556**/**4**) / (**4**-1))^{½} = **0.931**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **8.328** + **6.5** * **0.931** = **14.378**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.78**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**6** - **2.326** * **8.667**^{½}) / 2 = **-0.424**	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) = **-1.553**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **90410.0** / **8** = **11301.25**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.14x10^9** - **8.17x10^9/8**) / (**8**-1))^{½} = **4157.628**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **11301.25** + **6.5** * **4157.628** = **38325.831**	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 = **-508.374**	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_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-5838.096**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **279.9** / **9** = **31.1**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**8796.13** - **78344.01/9**) / (**9**-1))$^{1/2}$ = **3.377**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **31.1** + **6.5** * **3.377** = **53.051**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.592**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	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) = **-2.906**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **61.81** / **9** = **6.868**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**424.616** - **3820.476**/**9**) / (**9**-1))^{½} = **0.122**	Compute background sd.
3	SCL = $\overline{X}$ ± **F** * **S** = **6.868** ± **6.5** * **0.122** = **6.075**, **7.66**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.05**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **91.0**^{½}) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.129**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{9799.0} / \mathbf{9}$ $= \mathbf{1088.778}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{1.08 \times 10^7} - \mathbf{9.60 \times 10^7}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{111.515}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{1088.778} + \mathbf{6.5} * \mathbf{111.515}$ $= \mathbf{1813.628}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-47.936}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \mathbf{-120.527}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **13.2** / **9** = **1.467**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{19.9} - \mathbf{174.24}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ = **0.26**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **1.467** + **6.5** * **0.26** = **3.155**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.1**	Sen's estimator of trend.
6	var(S) = **90.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{90.0}^{1/2}) / 2$ = **6.967**	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) = **-0.304**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{190.8} / \mathbf{9}$ $= \mathbf{21.2}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{4610.1} - \mathbf{36404.64/9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{8.405}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{21.2} + \mathbf{6.5} * \mathbf{8.405}$ $= \mathbf{75.832}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-1.417}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	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	$LCL(S) = \mathbf{-12.049}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1434.6** / **9** = **159.4**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{238713.96} - \mathbf{2.06}\times\mathbf{10^6}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ = **35.424**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **159.4** + **6.5** * **35.424** = **389.654**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-13.311**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ = **6.845**	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) = **-43.964**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **69.0** / **9** = **7.667**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**563.0** - **4761.0**/**9**) / (**9**-1))$^{1/2}$ = **2.062**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **7.667** + **6.5** * **2.062** = **21.067**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **63.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **63.667**$^{1/2}$) / 2 = **8.72**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th 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
Chloride (mg/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **780.887** / **9** = **86.765**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**68370.305** - **609784.507**/**9**) / (**9**-1))^{½} = **8.778**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **86.765** + **6.5** * **8.778** = **143.824**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-4.121**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	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) = **-10.676**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **12.72** / **4** = **3.18**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**53.178** - **161.798**/**4**) / (**4**-1))^{½} = **2.06**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **3.18** + **6.5** * **2.06** = **16.569**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.15**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**6** - **2.326** * **8.667**^{½}) / 2 = **-0.424**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-8.223**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **72380.0** / **8** = **9047.5**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**7.23**x**10^8** - **5.24**x**10^9**/**8**) / (**8**-1))$^{1/2}$ = **3109.84**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **9047.5** + **6.5** * **3109.84** = **29261.462**	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 = **-1024.295**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **65.333**$^{1/2}$) / 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) = **-5230.686**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **334.3** / **9**	
	= **37.144**	
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**12497.69** - **111756.49**/**9**) / (**9**-1))$^{1/2}$	
	= **3.168**	
3	SCL = $\bar{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **37.144** + **6.5** * **3.168**	
	= **57.738**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **0.352**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**36** - **2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-3.322**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **62.95** / **9** = **6.994**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**440.664** - **3962.703**/**9**) / (**9**-1))^{½} = **0.213**	Compute background sd.
3	SCL = $\overline{X}$ ± **F** * **S** = **6.994** ± **6.5** * **0.213** = **5.608**, **8.381**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.067**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.237**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **10198.0** / **9**	
	= **1133.111**	
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$	Compute background sd.
	$= ((\mathbf{1.16 \times 10^7} - \mathbf{1.04 \times 10^8/9}) / (\mathbf{9}-1))^{1/2}$	
	= **42.093**	
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **1133.111** + **6.5** * **42.093**	
	= **1406.719**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **-1.049**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	$= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$	
	= **6.845**	
8	LCL(S) = **-54.438**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **13.2** / **9** = **1.467**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**22.2** - **174.24**/**9**) / (**9**-1))$^{1/2}$ = **0.596**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **1.467** + **6.5** * **0.596** = **5.339**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.304**	Sen's estimator of trend.
6	var(S) = **89.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **89.0**$^{1/2}$) / 2 = **7.028**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.66**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\overline{X} = \mathbf{sum[X]} / \mathbf{N}$	Compute background mean.
	$= \mathbf{9.62} / \mathbf{9}$	
	$= \mathbf{1.069}$	
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$	Compute background sd.
	$= ((\mathbf{11.84} - \mathbf{92.544/9}) / (\mathbf{9}-1))^{1/2}$	
	$= \mathbf{0.441}$	
3	$SCL = \overline{\mathbf{X}} + \mathbf{F} * \mathbf{S}$	Compute combined Shewhart-CUSUM normal control limit.
	$= \mathbf{1.069} + \mathbf{6.5} * \mathbf{0.441}$	
	$= \mathbf{3.937}$	
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$	Number of sample pairs during trend detection period.
	$= \mathbf{9} * (\mathbf{9}-1) / 2$	
	$= \mathbf{36}$	
5	$S = \mathbf{0.009}$	Sen's estimator of trend.
6	$var(S) = \mathbf{88.333}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	$= (\mathbf{36} - \mathbf{2.326} * \mathbf{88.333}^{1/2}) / 2$	
	$= \mathbf{7.069}$	
8	$LCL(S) = \mathbf{-0.335}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **2868.0** / **9** = **318.667**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.08x10^6** - **8.23x10^6/9**) / (**9**-1))^{½} = **144.337**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **318.667** + **6.5** * **144.337** = **1256.859**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-74.046**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-150.037**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **852.048** / **9**	
	= **94.672**	
2	S = ((**sum[X²] - sum[X]²/N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**81062.851 - 725985.794/9**) / (**9**-1))$^{1/2}$	
	= **7.051**	
3	SCL = $\bar{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **94.672** + **6.5** * **7.051**	
	= **140.505**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **1.315**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2	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.
	= (**36 - 2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-6.55**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\overline{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{13.66} / \mathbf{4}$ $= \mathbf{3.415}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{½}$ $= ((\mathbf{58.521} - \mathbf{186.596}/\mathbf{4}) / (\mathbf{4}-1))^{½}$ $= \mathbf{1.989}$	Compute background sd.
3	$SCL = \overline{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{3.415} + \mathbf{6.5} * \mathbf{1.989}$ $= \mathbf{16.346}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{4} * (\mathbf{4}-1) / 2$ $= \mathbf{6}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{0.102}$	Sen's estimator of trend.
6	$var(S) = \mathbf{8.667}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{½}) / 2$ $= (\mathbf{6} - \mathbf{2.326} * \mathbf{8.667}^{½}) / 2$ $= \mathbf{-0.424}$	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	$LCL(S) = \mathbf{-7.836}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **8804.5** / **8** = **1100.563**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**1.54**x**10^7** - **7.75**x**10^7**/**8**) / (**8**-1))$^{1/2}$ = **901.578**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **1100.563** + **6.5** * **901.578** = **6960.817**	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 = **-150.307**	Sen's estimator of trend.
6	var(S) = **61.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **61.667**$^{1/2}$) / 2 = **4.867**	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) = **-1004.476**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **345.6** / **9** = **38.4**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**13460.6** - **119439.36/9**) / (**9**-1))$^{1/2}$ = **4.868**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **38.4** + **6.5** * **4.868** = **70.04**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-1.682**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **91.0**$^{1/2}$) / 2 = **6.906**	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) = **-7.685**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **62.28** / **9** = **6.92**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{431.05} - \mathbf{3878.798/9}) / (\mathbf{9}-1))^{1/2}$ = **0.095**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ ± **F** * **S** = **6.92** ± **6.5** * **0.095** = **6.3**, **7.54**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.024**	Sen's estimator of trend.
6	var(S) = **90.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{90.0}^{1/2}) / 2$ = **6.967**	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) = **-0.052**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$	Compute background mean.
	$= \mathbf{9468.0} / \mathbf{9}$	
	$= \mathbf{1052.0}$	
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$	Compute background sd.
	$= ((\mathbf{9.99 \times 10^6} - \mathbf{8.96 \times 10^7}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$	
	$= \mathbf{56.442}$	
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$	Compute combined Shewhart-CUSUM normal control limit.
	$= \mathbf{1052.0} + \mathbf{6.5} * \mathbf{56.442}$	
	$= \mathbf{1418.876}$	
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$	Number of sample pairs during trend detection period.
	$= \mathbf{9} * (\mathbf{9}-1) / 2$	
	$= \mathbf{36}$	
5	$S = \mathbf{6.514}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	$= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$	
	$= \mathbf{6.845}$	
8	$LCL(S) = \mathbf{-33.3}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **7.1** / **9** = **0.789**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**8.258** - **50.41/9**) / (**9**-1))$^{1/2}$ = **0.576**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **0.789** + **6.5** * **0.576** = **4.535**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.024**	Sen's estimator of trend.
6	var(S) = **83.333**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **83.333**$^{1/2}$) / 2 = **7.383**	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) = **-0.178**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1264.0** / **9** = **140.444**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**191114.0** - **1.60**×**10^6**/**9**) / (**9**-1))$^{1/2}$ = **41.219**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **140.444** + **6.5** * **41.219** = **408.37**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-15.782**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-50.301**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **387.718** / **9** = **43.08**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**19033.301** - **150325.248/9**) / (**9**-1))^{½} = **17.068**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **43.08** + **6.5** * **17.068** = **154.021**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **1.292**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-19.047**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N**	Compute background mean.
	= **4.27** / **4**	
	= **1.068**	
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$	Compute background sd.
	$= ((\mathbf{4.958} - \mathbf{18.233/4}) / (\mathbf{4}-1))^{1/2}$	
	= **0.365**	
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **1.068** + **6.5** * **0.365**	
	= **3.44**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **4** * (**4**-1) / 2	
	= **6**	
5	S = **0.243**	Sen's estimator of trend.
6	var(S) = **5.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	$= (\mathbf{6} - \mathbf{2.326} * \mathbf{5.0}^{1/2}) / 2$	
	= **0.399**	
8	LCL(S) = **0.0**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **3128.2** / **8** = **391.025**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]^2**/**N**) / (**N**-1))$^{1/2}$ = ((**1.36x10^6** - **9.79x10^6**/**8**) / (**8**-1))$^{1/2}$ = **138.359**	Compute background sd.
3	SCL = **$\bar{X}$** + **F** * **S** = **391.025** + **6.5** * **138.359** = **1290.357**	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 = **-2.032**	Sen's estimator of trend.
6	var(S) = **64.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **64.333**$^{1/2}$) / 2 = **4.672**	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) = **-230.907**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **108.62** / **9** = **12.069**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1433.595** - **11798.304/9**) / (**9**-1))^{½} = **3.916**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **12.069** + **6.5** * **3.916** = **37.522**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-1.315**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-4.631**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **56.49** / **9** = **6.277**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**354.971** - **3191.12**/**9**) / (**9**-1))^{½} = **0.224**	Compute background sd.
3	SCL = $\bar{X}$ ± **F** * **S** = **6.277** ± **6.5** * **0.224** = **4.82**, **7.733**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.033**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **91.0**^{½}) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.083**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{3789.0} / \mathbf{9}$ $= \mathbf{421.0}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{1.80 \times 10^6} - \mathbf{1.44 \times 10^7}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{159.373}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{421.0} + \mathbf{6.5} * \mathbf{159.373}$ $= \mathbf{1456.924}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{30.223}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	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	$LCL(S) = \mathbf{-122.58}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **6.748** / **9** = **0.75**	Compute background mean.
2	S = ((**sum[X²] - sum[X]²/N**) / (**N**-1))^{½} = ((**6.81** - **45.536/9**) / (**9**-1))^{½} = **0.468**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **0.75** + **6.5** * **0.468** = **3.79**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.241**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **91.0**^{½}) / 2 = **6.906**	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) = **-0.577**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **490.6** / **8** = **61.325**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**31876.54** - **240688.36**/**8**) / (**8**-1))^{½} = **15.993**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **61.325** + **6.5** * **15.993** = **165.281**	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 = **0.767**	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_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-17.398**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **3381.0** / **8** = **422.625**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{1.51 \times 10^6} - \mathbf{1.14 \times 10^7/8}) / (\mathbf{8}-1))^{1/2}$ = **109.343**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **422.625** + **6.5** * **109.343** = **1133.357**	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 = **-26.639**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{28} - \mathbf{2.326} * \mathbf{65.333}^{1/2}) / 2$ = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-157.342**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **73.0** / **8** = **9.125**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**761.0** - **5329.0/8**) / (**8**-1))^{½} = **3.682**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **9.125** + **6.5** * **3.682** = **33.055**	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 = **-0.892**	Sen's estimator of trend.
6	var(S) = **59.667**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**28** - **2.326** * **59.667**^{½}) / 2 = **5.016**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-4.401**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{504.028} / \mathbf{9}$ $= \mathbf{56.003}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{28646.209} - \mathbf{254044.225/9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{7.238}$	Compute background sd.
3	$SCL = \overline{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{56.003} + \mathbf{6.5} * \mathbf{7.238}$ $= \mathbf{103.048}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-1.964}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	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	$LCL(S) = \mathbf{-9.05}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **43.83** / **4** = **10.958**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**484.323** - **1921.069/4**) / (**4**-1))^{½} = **1.163**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **10.958** + **6.5** * **1.163** = **18.515**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.649**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**6** - **2.326** * **8.667**^{½}) / 2 = **-0.424**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-4.213**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **352500.0** / **7** = **50357.143**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.86x10^{10}** - **1.24x10^{11}**/**7**) / (**7**-1))^{½} = **12210.222**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **50357.143** + **6.5** * **12210.222** = **129723.587**	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 = **-7380.33**	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_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-21486.682**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **956.0** / **9**	
	= **106.222**	
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**305677.4** - **913936.0/9**) / (**9**-1))$^{1/2}$	
	= **159.738**	
3	SCL = $\bar{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **106.222** + **6.5** * **159.738**	
	= **1144.517**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **-22.403**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**36** - **2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-148.524**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **60.92** / **9** = **6.769**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**412.485** - **3711.246**/**9**) / (**9**-1))^{½} = **0.124**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ ± **F** * **S** = **6.769** ± **6.5** * **0.124** = **5.96**, **7.578**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.053**	Sen's estimator of trend.
6	var(S) = **83.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **83.333**^{½}) / 2 = **7.383**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.12**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{7540.0} / \mathbf{9}$ $= \mathbf{837.778}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{½}$ $= ((\mathbf{6.33{\times}10^6} - \mathbf{5.69{\times}10^7}/\mathbf{9}) / (\mathbf{9}-1))^{½}$ $= \mathbf{43.868}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{837.778} + \mathbf{6.5} * \mathbf{43.868}$ $= \mathbf{1122.923}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-7.8}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{½}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{½}) / 2$ $= \mathbf{6.845}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \mathbf{-47.264}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **13.14** / **9** = **1.46**	Compute background mean.
2	S = ((**sum[X²] - sum[X]²/N**) / (**N**-1))^½ = ((**22.576** - **172.66**/**9**) / (**9**-1))^½ = **0.651**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1.46** + **6.5** * **0.651** = **5.692**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.05**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**^½) / 2 = (**36** - **2.326** * **92.0**^½) / 2 = **6.845**	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) = **-0.772**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **186.2** / **9** = **20.689**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2**/**N**) / (**N**-1))^{½} = ((**4225.42** - **34670.44**/**9**) / (**9**-1))^{½} = **6.83**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **20.689** + **6.5** * **6.83** = **65.081**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.404**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-6.041**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **3075.0** / **9** = **341.667**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**1.09x10^6** - **9.46x10^6/9**) / (**9**-1))$^{1/2}$ = **72.161**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **341.667** + **6.5** * **72.161** = **810.715**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **30.064**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-36.027**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **84.0** / **9** = **9.333**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**894.0** - **7056.0**/**9**) / (**9**-1))^{½} = **3.708**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **9.333** + **6.5** * **3.708** = **33.436**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **75.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **75.333**^{½}) / 2 = **7.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-3.093**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **684.03** / **9**	
	= **76.003**	
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**54530.846** - **467897.041**/**9**) / (**9**-1))$^{1/2}$	
	= **17.827**	
3	SCL = $\bar{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **76.003** + **6.5** * **17.827**	
	= **191.876**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **1.378**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**36** - **2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-18.432**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **19.96** / **4** = **4.99**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{113.121} - \mathbf{398.402/4}) / (\mathbf{4}-1))^{1/2}$ = **2.123**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **4.99** + **6.5** * **2.123** = **18.789**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **2.025**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{6} - \mathbf{2.326} * \mathbf{8.667}^{1/2}) / 2$ = **-0.424**	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) = **-3.436**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **47460.0** / **8** = **5932.5**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**2.99x10^8** - **2.25x10^9/8**) / (**8**-1))^{½} = **1589.211**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **5932.5** + **6.5** * **1589.211** = **16262.374**	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 = **337.269**	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_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1502.491**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **249.2** / **9** = **27.689**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**7063.9** - **62100.64/9**) / (**9**-1))^{½} = **4.525**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **27.689** + **6.5** * **4.525** = **57.104**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.786**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)^{½}**) / 2 = (**36 - 2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-5.637**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **59.94** / **9** = **6.66**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**399.542** - **3592.804/9**) / (**9**-1))^{½} = **0.207**	Compute background sd.
3	SCL = $\bar{X}$ ± **F** * **S** = **6.66** ± **6.5** * **0.207** = **5.316**, **8.004**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.12**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **91.0**^{½}) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.011**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **7647.0** / **9** = **849.667**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**6.70x10^6** - **5.85x10^7/9**) / (**9**-1))^{½} = **159.673**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **849.667** + **6.5** * **159.673** = **1887.542**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **7.778**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-176.81**	One-sided lower confidence limit for slope.

Attachment D

Summary Tables and Graphs for the Interwell Comparisons
Second Semi-Annual Monitoring Event in 2024

Table 1

Upgradient Data

Constituent	Units	Well	Date		Result	Adjusted	
Ammonia	mg/L	MW-26	04/26/2018	ND	0.5000	0.1340	**
Ammonia	mg/L	MW-26	10/15/2018	ND	0.5000	0.1340	**
Ammonia	mg/L	MW-26	04/23/2019	ND	0.5000	0.1340	**
Ammonia	mg/L	MW-26	10/22/2019	ND	0.2000	0.1340	**
Ammonia	mg/L	MW-26	04/21/2020	ND	0.1000	0.1340	**
Ammonia	mg/L	MW-26	10/12/2020	ND	0.2800	0.1340	**
Ammonia	mg/L	MW-26	04/14/2021	ND	0.1340		
Ammonia	mg/L	MW-26	10/19/2021	ND	0.1340		
Ammonia	mg/L	MW-26	04/14/2022	ND	0.1340		
Ammonia	mg/L	MW-26	10/13/2022	ND	0.1140	0.1340	**
Ammonia	mg/L	MW-26	04/19/2023	ND	0.1040	0.1340	**
Ammonia	mg/L	MW-26	10/20/2023	ND	0.1040	0.1340	**
Ammonia	mg/L	MW-26	04/10/2024	ND	0.1040	0.1340	**
Ammonia	mg/L	MW-26	10/23/2024	ND	0.0550	0.1340	**
Arsenic, total	ug/L	MW-26	04/26/2018		0.4500		
Arsenic, total	ug/L	MW-26	10/15/2018	ND	0.5700	1.1500	**
Arsenic, total	ug/L	MW-26	04/23/2019		0.3600		
Arsenic, total	ug/L	MW-26	10/22/2019	ND	0.7500	1.1500	**
Arsenic, total	ug/L	MW-26	04/21/2020		2.2700		
Arsenic, total	ug/L	MW-26	10/12/2020		0.5500		
Arsenic, total	ug/L	MW-26	04/14/2021		0.4700		
Arsenic, total	ug/L	MW-26	10/19/2021	ND	5.7500	1.1500	**
Arsenic, total	ug/L	MW-26	04/14/2022	ND	1.1500		
Arsenic, total	ug/L	MW-26	10/13/2022		1.0900		
Arsenic, total	ug/L	MW-26	04/19/2023	ND	0.9000	1.1500	**
Arsenic, total	ug/L	MW-26	10/20/2023	ND	1.4500	1.1500	**
Arsenic, total	ug/L	MW-26	04/10/2024	ND	1.4500	1.1500	**
Arsenic, total	ug/L	MW-26	10/23/2024	ND	3.7000	1.1500	**
Barium, total	ug/L	MW-26	04/26/2018		137.0000		
Barium, total	ug/L	MW-26	10/15/2018		185.0000		
Barium, total	ug/L	MW-26	04/23/2019		193.0000		
Barium, total	ug/L	MW-26	10/22/2019		104.0000		
Barium, total	ug/L	MW-26	04/21/2020		176.0000		
Barium, total	ug/L	MW-26	10/12/2020		102.0000		
Barium, total	ug/L	MW-26	04/14/2021		155.0000		
Barium, total	ug/L	MW-26	10/19/2021		73.0000		
Barium, total	ug/L	MW-26	04/14/2022		139.0000		
Barium, total	ug/L	MW-26	10/13/2022		162.0000		
Barium, total	ug/L	MW-26	04/19/2023		176.0000		
Barium, total	ug/L	MW-26	10/20/2023		123.0000		
Barium, total	ug/L	MW-26	04/10/2024		123.0000		
Barium, total	ug/L	MW-26	10/23/2024		140.0000		
Chemical oxygen demand	mg/L	MW-26	04/26/2018		6.0000		
Chemical oxygen demand	mg/L	MW-26	10/15/2018	ND	7.0000	5.7000	**
Chemical oxygen demand	mg/L	MW-26	04/23/2019	ND	7.0000	5.7000	**
Chemical oxygen demand	mg/L	MW-26	10/22/2019	ND	7.0000	5.7000	**
Chemical oxygen demand	mg/L	MW-26	04/21/2020		8.0000		
Chemical oxygen demand	mg/L	MW-26	10/12/2020	ND	7.0000	5.7000	**
Chemical oxygen demand	mg/L	MW-26	04/14/2021	ND	7.0000	5.7000	**
Chemical oxygen demand	mg/L	MW-26	10/19/2021	ND	7.0000	5.7000	**
Chemical oxygen demand	mg/L	MW-26	04/14/2022	ND	5.7000		
Chemical oxygen demand	mg/L	MW-26	10/13/2022	ND	5.7000		
Chemical oxygen demand	mg/L	MW-26	04/19/2023	ND	5.7000		
Chemical oxygen demand	mg/L	MW-26	10/20/2023	ND	5.7000		
Chemical oxygen demand	mg/L	MW-26	04/10/2024	ND	5.7000		
Chemical oxygen demand	mg/L	MW-26	10/23/2024	ND	5.7000		
Chloride	mg/L	MW-26	04/26/2018		33.7000		
Chloride	mg/L	MW-26	10/15/2018		51.4100		
Chloride	mg/L	MW-26	04/23/2019		71.5000		
Chloride	mg/L	MW-26	10/22/2019		20.0000		
Chloride	mg/L	MW-26	04/21/2020		41.4000		
Chloride	mg/L	MW-26	10/12/2020		27.3000		
Chloride	mg/L	MW-26	04/14/2021		58.6000		
Chloride	mg/L	MW-26	10/19/2021		28.9180		
Chloride	mg/L	MW-26	04/14/2022		54.8900		
Chloride	mg/L	MW-26	10/13/2022		78.4000		
Chloride	mg/L	MW-26	04/19/2023		71.9000		
Chloride	mg/L	MW-26	10/20/2023		48.1000		
Chloride	mg/L	MW-26	04/10/2024		57.8000		
Chloride	mg/L	MW-26	10/23/2024		63.6000		
Cobalt, total	ug/L	MW-26	10/12/2020		0.5200		
Cobalt, total	ug/L	MW-26	04/14/2021	ND	0.5000	0.7500	**
Cobalt, total	ug/L	MW-26	10/19/2021	ND	6.2500	0.7500	**
Cobalt, total	ug/L	MW-26	04/14/2022	ND	1.2500	0.7500	**

* - 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	
Cobalt, total	ug/L	MW-26	10/13/2022	ND	0.7500		
Cobalt, total	ug/L	MW-26	04/19/2023	ND	0.7500		
Cobalt, total	ug/L	MW-26	10/20/2023	ND	0.6500	0.7500	**
Cobalt, total	ug/L	MW-26	04/10/2024	ND	0.6500	0.7500	**
Cobalt, total	ug/L	MW-26	10/23/2024	ND	1.7000	0.7500	**
Iron, total	ug/L	MW-26	04/26/2018		310.0000		
Iron, total	ug/L	MW-26	10/15/2018		380.0000		
Iron, total	ug/L	MW-26	04/23/2019		252.0000		
Iron, total	ug/L	MW-26	10/22/2019		516.0000		
Iron, total	ug/L	MW-26	04/21/2020		50.0000		*
Iron, total	ug/L	MW-26	10/12/2020		615.0000		
Iron, total	ug/L	MW-26	04/14/2021		510.0000		
Iron, total	ug/L	MW-26	10/19/2021	ND	272.6000		
Iron, total	ug/L	MW-26	04/14/2022	ND	681.5000	272.6000	**
Iron, total	ug/L	MW-26	10/13/2022		376.0000		
Iron, total	ug/L	MW-26	04/19/2023		767.0000		
Iron, total	ug/L	MW-26	10/20/2023		610.0000		
Iron, total	ug/L	MW-26	04/10/2024		50.0000		*
Iron, total	ug/L	MW-26	10/23/2024		347.0000		
Magnesium, total	mg/L	MW-26	04/26/2018		12.1000		
Magnesium, total	mg/L	MW-26	10/15/2018		17.6000		
Magnesium, total	mg/L	MW-26	04/23/2019		17.8000		
Magnesium, total	mg/L	MW-26	10/22/2019		9.7900		
Magnesium, total	mg/L	MW-26	04/21/2020		9.8300		
Magnesium, total	mg/L	MW-26	10/12/2020		8.6100		
Magnesium, total	mg/L	MW-26	04/14/2021		11.9000		
Magnesium, total	mg/L	MW-26	10/19/2021		6.4900		
Magnesium, total	mg/L	MW-26	04/14/2022		14.5000		
Magnesium, total	mg/L	MW-26	10/13/2022		16.3000		
Magnesium, total	mg/L	MW-26	04/19/2023		19.7000		
Magnesium, total	mg/L	MW-26	10/20/2023		12.5000		
Magnesium, total	mg/L	MW-26	04/10/2024		12.9000		
Magnesium, total	mg/L	MW-26	10/23/2024		13.8000		
pH	SU	MW-26	04/26/2018		6.0500		
pH	SU	MW-26	10/15/2018		6.3000		
pH	SU	MW-26	04/23/2019		6.2400		
pH	SU	MW-26	10/22/2019		6.3400		
pH	SU	MW-26	04/21/2020		6.0800		
pH	SU	MW-26	10/12/2020		6.2800		
pH	SU	MW-26	04/14/2021		6.1000		
pH	SU	MW-26	10/19/2021		6.3000		
pH	SU	MW-26	04/14/2022		6.8000		
pH	SU	MW-26	10/13/2022		6.3400		
pH	SU	MW-26	04/19/2023		6.5700		
pH	SU	MW-26	10/20/2023		6.4000		
pH	SU	MW-26	04/10/2024		6.2100		
pH	SU	MW-26	10/23/2024		6.1500		
Specific conductance	uS	MW-26	04/26/2018		143.0000		
Specific conductance	uS	MW-26	10/15/2018		545.0000		
Specific conductance	uS	MW-26	04/23/2019		649.0000		
Specific conductance	uS	MW-26	10/22/2019		305.0000		
Specific conductance	uS	MW-26	04/21/2020		389.0000		
Specific conductance	uS	MW-26	10/12/2020		319.0000		
Specific conductance	uS	MW-26	04/14/2021		546.0000		
Specific conductance	uS	MW-26	10/19/2021		355.0000		
Specific conductance	uS	MW-26	04/14/2022		538.0000		
Specific conductance	uS	MW-26	10/13/2022		646.0000		
Specific conductance	uS	MW-26	04/19/2023		709.0000		
Specific conductance	uS	MW-26	10/20/2023		461.0000		
Specific conductance	uS	MW-26	04/10/2024		519.0000		
Specific conductance	uS	MW-26	10/23/2024		306.6000		

* - 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
Ammonia	mg/L	MW-1	10/23/2024		0.5300	***	0.1340
Arsenic, total	ug/L	MW-1	10/23/2024	ND	3.7000	**	2.2700
Barium, total	ug/L	MW-1	10/23/2024		219.0000		237.8109
Chemical oxygen demand	mg/L	MW-1	10/23/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-1	10/23/2024		4.6200		100.3283
Cobalt, total	ug/L	MW-1	10/23/2024	ND	1.7000		0.7500
Iron, total	ug/L	MW-1	10/23/2024		5400.0000	***	1053.8260
Magnesium, total	mg/L	MW-1	10/23/2024		29.0000	***	23.5196
pH	SU	MW-1	10/23/2024		6.3700	**	5.67 - 6.92
Specific conductance	uS	MW-1	10/23/2024		956.5000	*	902.7576
Ammonia	mg/L	MW-2	10/24/2024	ND	0.0550		0.1340
Arsenic, total	ug/L	MW-2	10/24/2024	ND	3.7000		2.2700
Barium, total	ug/L	MW-2	10/24/2024		126.0000		237.8109
Chemical oxygen demand	mg/L	MW-2	10/24/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-2	10/24/2024		100.0000		100.3283
Cobalt, total	ug/L	MW-2	10/24/2024	ND	1.7000	**	0.7500
Iron, total	ug/L	MW-2	10/24/2024		587.0000		1053.8260
Magnesium, total	mg/L	MW-2	10/24/2024		22.0000	**	23.5196
pH	SU	MW-2	10/24/2024		6.4800		5.67 - 6.92
Specific conductance	uS	MW-2	10/24/2024		532.2000		902.7576
Ammonia	mg/L	MW-21	10/23/2024		0.2000	*	0.1340
Arsenic, total	ug/L	MW-21	10/23/2024	ND	3.7000		2.2700
Barium, total	ug/L	MW-21	10/23/2024		350.0000	***	237.8109
Chemical oxygen demand	mg/L	MW-21	10/23/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-21	10/23/2024		215.0000	***	100.3283
Cobalt, total	ug/L	MW-21	10/23/2024	ND	1.7000		0.7500
Iron, total	ug/L	MW-21	10/23/2024		1070.0000	*	1053.8260
Magnesium, total	mg/L	MW-21	10/23/2024		54.8000	***	23.5196
pH	SU	MW-21	10/23/2024		6.8300		5.67 - 6.92
Specific conductance	uS	MW-21	10/23/2024		874.5000	**	902.7576
Ammonia	mg/L	MW-22	10/24/2024		3.1000	***	0.1340
Arsenic, total	ug/L	MW-22	10/24/2024		22.5000	***	2.2700
Barium, total	ug/L	MW-22	10/24/2024		339.0000	***	237.8109
Chemical oxygen demand	mg/L	MW-22	10/24/2024	ND	5.7000	**	8.0000
Chloride	mg/L	MW-22	10/24/2024		115.0000	*	100.3283
Cobalt, total	ug/L	MW-22	10/24/2024		12.8000	***	0.7500
Iron, total	ug/L	MW-22	10/24/2024		16100.0000	***	1053.8260
Magnesium, total	mg/L	MW-22	10/24/2024		35.8000	***	23.5196
pH	SU	MW-22	10/24/2024		6.9200		5.67 - 6.92
Specific conductance	uS	MW-22	10/24/2024		668.4000	**	902.7576
Ammonia	mg/L	MW-23	10/23/2024		1.1000	***	0.1340
Arsenic, total	ug/L	MW-23	10/23/2024		7.8700	***	2.2700
Barium, total	ug/L	MW-23	10/23/2024		110.0000		237.8109
Chemical oxygen demand	mg/L	MW-23	10/23/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-23	10/23/2024		90.7000		100.3283
Cobalt, total	ug/L	MW-23	10/23/2024		1.9600	***	0.7500
Iron, total	ug/L	MW-23	10/23/2024		4510.0000	***	1053.8260
Magnesium, total	mg/L	MW-23	10/23/2024		38.1000	***	23.5196
pH	SU	MW-23	10/23/2024		7.0100	***	5.67 - 6.92
Specific conductance	uS	MW-23	10/23/2024		666.9000	**	902.7576
Ammonia	mg/L	MW-24	10/23/2024		0.7400	***	0.1340
Arsenic, total	ug/L	MW-24	10/23/2024	ND	3.7000		2.2700
Barium, total	ug/L	MW-24	10/23/2024		109.0000		237.8109
Chemical oxygen demand	mg/L	MW-24	10/23/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-24	10/23/2024		128.0000	*	100.3283
Cobalt, total	ug/L	MW-24	10/23/2024	ND	1.7000	**	0.7500
Iron, total	ug/L	MW-24	10/23/2024		636.0000		1053.8260
Magnesium, total	mg/L	MW-24	10/23/2024		31.9000	***	23.5196
pH	SU	MW-24	10/23/2024		7.0900	*	5.67 - 6.92
Specific conductance	uS	MW-24	10/23/2024		547.0000		902.7576
Ammonia	mg/L	MW-3R1	10/24/2024		0.4000	***	0.1340
Arsenic, total	ug/L	MW-3R1	10/24/2024		45.7000	***	2.2700
Barium, total	ug/L	MW-3R1	10/24/2024		280.0000	*	237.8109
Chemical oxygen demand	mg/L	MW-3R1	10/24/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-3R1	10/24/2024		65.9000		100.3283
Cobalt, total	ug/L	MW-3R1	10/24/2024		15.2000	***	0.7500
Iron, total	ug/L	MW-3R1	10/24/2024		42500.0000	***	1053.8260
Magnesium, total	mg/L	MW-3R1	10/24/2024		28.3000	*	23.5196
pH	SU	MW-3R1	10/24/2024		6.8000		5.67 - 6.92
Specific conductance	uS	MW-3R1	10/24/2024		502.7000		902.7576
Ammonia	mg/L	MW-4	10/23/2024		1.0000	***	0.1340
Arsenic, total	ug/L	MW-4	10/23/2024		13.7000	***	2.2700

* - 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 2

Most Current Downgradient Monitoring Data

Constituent	Units	Well	Date		Result		Pred. Limit
Barium, total	ug/L	MW-4	10/23/2024		317.0000	***	237.8109
Chemical oxygen demand	mg/L	MW-4	10/23/2024	ND	5.7000	**	8.0000
Chloride	mg/L	MW-4	10/23/2024		75.7000		100.3283
Cobalt, total	ug/L	MW-4	10/23/2024		5.2900	***	0.7500
Iron, total	ug/L	MW-4	10/23/2024		5090.0000	***	1053.8260
Magnesium, total	mg/L	MW-4	10/23/2024		29.1000	***	23.5196
pH	SU	MW-4	10/23/2024		6.7500		5.67 - 6.92
Specific conductance	uS	MW-4	10/23/2024		447.9000		902.7576

* - 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
Ammonia	0	14	0.000	86	113	0.761
Arsenic, total	6	14	0.429	96	113	0.850
Barium, total	14	14	1.000	113	113	1.000
Chemical oxygen demand	2	14	0.143	46	112	0.411
Chloride	14	14	1.000	113	113	1.000
Cobalt, total	1	9	0.111	51	73	0.699
Iron, total	10	12	0.833	100	113	0.885
Magnesium, total	14	14	1.000	113	113	1.000
pH	14	14	1.000	113	113	1.000
Specific conductance	14	14	1.000	113	113	1.000

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
Ammonia	0	14	0.000									nonpar
Arsenic, total	6	14	0.429	2.132	0.900					2.326	normal	nonpar
Barium, total	14	14	1.000	0.829	0.473					2.326	normal	normal
Chemical oxygen demand	2	14	0.143									nonpar
Chloride	14	14	1.000	0.561	0.633					2.326	normal	normal
Cobalt, total	1	9	0.111									nonpar
Iron, total	10	12	0.833	0.273	0.955					2.326	normal	normal
Magnesium, total	14	14	1.000	1.618	0.718					2.326	normal	normal
pH	14	14	1.000	1.165	0.969					2.326	normal	normal
Specific conductance	14	14	1.000	0.463	1.386					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
Ammonia	mg/L	0	14					0.1340	nonpar	***	0.94
Arsenic, total	ug/L	6	14					2.2700	nonpar		0.94
Barium, total	ug/L	14	14	142.0000	34.9681	0.0100	2.7400	237.8109	normal		
Chemical oxygen demand	mg/L	2	14					8.0000	nonpar		0.94
Chloride	mg/L	14	14	50.5370	18.1723	0.0100	2.7400	100.3283	normal		
Cobalt, total	ug/L	1	9					0.7500	nonpar	***	0.88
Iron, total	ug/L	10	12	390.2500	235.0281	0.0100	2.8234	1053.8260	normal		
Magnesium, total	mg/L	14	14	13.1300	3.7919	0.0100	2.7400	23.5196	normal		
pH	SU	14	14	6.2971	0.2003	0.0100	3.1118	5.67 - 6.92	normal		
Specific conductance	uS	14	14	459.3286	161.8383	0.0100	2.7400	902.7576	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
Iron, total	ug/L	MW-26	04/10/2024	50.0000		04/26/2018-10/23/2024	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
Ammonia	mg/L	MW-1	04/26/2018		1.0000	*	0.1340
Ammonia	mg/L	MW-1	10/15/2018		0.5300	*	0.1340
Ammonia	mg/L	MW-1	04/23/2019		1.1000	*	0.1340
Ammonia	mg/L	MW-1	10/22/2019		0.9100	*	0.1340
Ammonia	mg/L	MW-1	04/21/2020		0.5800	*	0.1340
Ammonia	mg/L	MW-1	10/13/2020		0.7100	*	0.1340
Ammonia	mg/L	MW-1	04/14/2021		0.6300	*	0.1340
Ammonia	mg/L	MW-1	10/19/2021		0.6500	*	0.1340
Ammonia	mg/L	MW-1	04/14/2022		0.7400	*	0.1340
Ammonia	mg/L	MW-1	10/13/2022		0.6300	*	0.1340
Ammonia	mg/L	MW-1	04/19/2023		0.6100	*	0.1340
Ammonia	mg/L	MW-1	10/20/2023		0.6300	*	0.1340
Ammonia	mg/L	MW-1	04/10/2024		0.5500	*	0.1340
Ammonia	mg/L	MW-1	10/23/2024		0.5300	*	0.1340
Arsenic, total	ug/L	MW-1	04/26/2018		2.4000	*	2.2700
Arsenic, total	ug/L	MW-1	10/15/2018		1.3700		2.2700
Arsenic, total	ug/L	MW-1	04/23/2019		4.0200	*	2.2700
Arsenic, total	ug/L	MW-1	10/22/2019		3.9600	*	2.2700
Arsenic, total	ug/L	MW-1	04/21/2020		3.6500	*	2.2700
Arsenic, total	ug/L	MW-1	10/13/2020		3.7500	*	2.2700
Arsenic, total	ug/L	MW-1	04/14/2021		5.6100	*	2.2700
Arsenic, total	ug/L	MW-1	10/19/2021	ND	0.2300		2.2700
Arsenic, total	ug/L	MW-1	04/14/2022		3.4700	*	2.2700
Arsenic, total	ug/L	MW-1	10/13/2022		3.7100	*	2.2700
Arsenic, total	ug/L	MW-1	04/19/2023		3.3200	*	2.2700
Arsenic, total	ug/L	MW-1	10/20/2023		2.2700		2.2700
Arsenic, total	ug/L	MW-1	04/10/2024		3.6500	*	2.2700
Arsenic, total	ug/L	MW-1	10/23/2024	ND	3.7000		2.2700
Iron, total	ug/L	MW-1	04/26/2018		2840.0000	*	1053.8260
Iron, total	ug/L	MW-1	10/15/2018		1900.0000	*	1053.8260
Iron, total	ug/L	MW-1	04/23/2019		6880.0000	*	1053.8260
Iron, total	ug/L	MW-1	10/22/2019		5820.0000	*	1053.8260
Iron, total	ug/L	MW-1	04/21/2020		45.8000		1053.8260
Iron, total	ug/L	MW-1	10/13/2020		5900.0000	*	1053.8260
Iron, total	ug/L	MW-1	04/14/2021		9720.0000	*	1053.8260
Iron, total	ug/L	MW-1	10/19/2021		4090.0000	*	1053.8260
Iron, total	ug/L	MW-1	04/14/2022		4100.0000	*	1053.8260
Iron, total	ug/L	MW-1	10/13/2022		4910.0000	*	1053.8260
Iron, total	ug/L	MW-1	04/19/2023		1270.0000	*	1053.8260
Iron, total	ug/L	MW-1	10/20/2023		779.0000		1053.8260
Iron, total	ug/L	MW-1	04/10/2024		5270.0000	*	1053.8260
Iron, total	ug/L	MW-1	10/23/2024		5400.0000	*	1053.8260
Magnesium, total	mg/L	MW-1	04/26/2018		29.0000	*	23.5196
Magnesium, total	mg/L	MW-1	10/15/2018		32.0000	*	23.5196
Magnesium, total	mg/L	MW-1	04/23/2019		20.7000		23.5196
Magnesium, total	mg/L	MW-1	10/22/2019		25.8000	*	23.5196
Magnesium, total	mg/L	MW-1	04/21/2020		23.5000		23.5196
Magnesium, total	mg/L	MW-1	10/13/2020		24.2000	*	23.5196
Magnesium, total	mg/L	MW-1	04/14/2021		29.3000	*	23.5196
Magnesium, total	mg/L	MW-1	10/19/2021		20.9000		23.5196
Magnesium, total	mg/L	MW-1	04/14/2022		28.7000	*	23.5196
Magnesium, total	mg/L	MW-1	10/13/2022		29.2000	*	23.5196
Magnesium, total	mg/L	MW-1	04/19/2023		28.3000	*	23.5196
Magnesium, total	mg/L	MW-1	10/20/2023		31.9000	*	23.5196
Magnesium, total	mg/L	MW-1	04/10/2024		29.4000	*	23.5196
Magnesium, total	mg/L	MW-1	10/23/2024		29.0000	*	23.5196
pH	SU	MW-1	04/26/2018		6.5000		5.67 - 6.92
pH	SU	MW-1	10/15/2018		7.2200	*	5.67 - 6.92
pH	SU	MW-1	04/23/2019		7.0300	*	5.67 - 6.92
pH	SU	MW-1	10/22/2019		7.2100	*	5.67 - 6.92
pH	SU	MW-1	04/21/2020		7.2300	*	5.67 - 6.92
pH	SU	MW-1	10/13/2020		7.0300	*	5.67 - 6.92
pH	SU	MW-1	04/14/2021		7.4000	*	5.67 - 6.92
pH	SU	MW-1	10/19/2021		7.4000	*	5.67 - 6.92
pH	SU	MW-1	04/14/2022		7.5000	*	5.67 - 6.92
pH	SU	MW-1	10/13/2022		7.1700	*	5.67 - 6.92
pH	SU	MW-1	04/19/2023		7.3300	*	5.67 - 6.92
pH	SU	MW-1	10/20/2023		7.2000	*	5.67 - 6.92
pH	SU	MW-1	04/10/2024		6.9700	*	5.67 - 6.92
pH	SU	MW-1	10/23/2024		6.3700		5.67 - 6.92
Specific conductance	uS	MW-1	04/26/2018		684.0000		902.7576

* - 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
Specific conductance	uS	MW-1	10/15/2018		700.0000		902.7576
Specific conductance	uS	MW-1	04/23/2019		554.0000		902.7576
Specific conductance	uS	MW-1	10/22/2019		662.0000		902.7576
Specific conductance	uS	MW-1	04/21/2020		641.0000		902.7576
Specific conductance	uS	MW-1	10/13/2020		617.0000		902.7576
Specific conductance	uS	MW-1	04/14/2021		685.0000		902.7576
Specific conductance	uS	MW-1	10/19/2021		702.0000		902.7576
Specific conductance	uS	MW-1	04/14/2022		704.0000		902.7576
Specific conductance	uS	MW-1	10/13/2022		733.0000		902.7576
Specific conductance	uS	MW-1	04/19/2023		711.0000		902.7576
Specific conductance	uS	MW-1	10/20/2023		707.0000		902.7576
Specific conductance	uS	MW-1	04/10/2024		721.0000		902.7576
Specific conductance	uS	MW-1	10/23/2024		956.5000	*	902.7576
Cobalt, total	ug/L	MW-2	10/13/2020		8.6300	*	0.7500
Cobalt, total	ug/L	MW-2	04/15/2021		2.1800	*	0.7500
Cobalt, total	ug/L	MW-2	10/20/2021		8.8000	*	0.7500
Cobalt, total	ug/L	MW-2	04/15/2022		6.1800	*	0.7500
Cobalt, total	ug/L	MW-2	10/14/2022		8.0600	*	0.7500
Cobalt, total	ug/L	MW-2	04/19/2023		1.2500	*	0.7500
Cobalt, total	ug/L	MW-2	10/20/2023	ND	0.6500		0.7500
Cobalt, total	ug/L	MW-2	04/11/2024		0.8700	*	0.7500
Cobalt, total	ug/L	MW-2	10/24/2024	ND	1.7000		0.7500
Magnesium, total	mg/L	MW-2	04/27/2018		23.9000	*	23.5196
Magnesium, total	mg/L	MW-2	10/16/2018		23.3000		23.5196
Magnesium, total	mg/L	MW-2	04/24/2019		20.1000		23.5196
Magnesium, total	mg/L	MW-2	10/23/2019		22.3000		23.5196
Magnesium, total	mg/L	MW-2	04/21/2020		23.0000		23.5196
Magnesium, total	mg/L	MW-2	10/13/2020		21.5000		23.5196
Magnesium, total	mg/L	MW-2	04/15/2021		21.9000		23.5196
Magnesium, total	mg/L	MW-2	10/20/2021		17.1000		23.5196
Magnesium, total	mg/L	MW-2	04/15/2022		28.4000	*	23.5196
Magnesium, total	mg/L	MW-2	10/14/2022		21.2000		23.5196
Magnesium, total	mg/L	MW-2	04/19/2023		27.9000	*	23.5196
Magnesium, total	mg/L	MW-2	10/20/2023		31.4000	*	23.5196
Magnesium, total	mg/L	MW-2	04/11/2024		23.7000	*	23.5196
Magnesium, total	mg/L	MW-2	10/24/2024		22.0000		23.5196
Ammonia	mg/L	MW-21	04/26/2018	ND	0.5000		0.1340
Ammonia	mg/L	MW-21	10/15/2018	ND	0.5000		0.1340
Ammonia	mg/L	MW-21	04/24/2019	ND	0.5000		0.1340
Ammonia	mg/L	MW-21	10/22/2019	ND	0.2000		0.1340
Ammonia	mg/L	MW-21	04/21/2020		0.1000		0.1340
Ammonia	mg/L	MW-21	10/13/2020	ND	0.2800		0.1340
Ammonia	mg/L	MW-21	04/14/2021	ND	0.1340		0.1340
Ammonia	mg/L	MW-21	10/20/2021		0.4000	*	0.1340
Ammonia	mg/L	MW-21	04/14/2022	ND	0.1340		0.1340
Ammonia	mg/L	MW-21	10/13/2022	ND	0.1140		0.1340
Ammonia	mg/L	MW-21	04/19/2023	ND	0.1040		0.1340
Ammonia	mg/L	MW-21	10/24/2023	ND	0.1040		0.1340
Ammonia	mg/L	MW-21	04/11/2024	ND	0.1040		0.1340
Ammonia	mg/L	MW-21	10/23/2024		0.2000	*	0.1340
Barium, total	ug/L	MW-21	04/26/2018		406.0000	*	237.8109
Barium, total	ug/L	MW-21	10/15/2018		372.0000	*	237.8109
Barium, total	ug/L	MW-21	04/24/2019		413.0000	*	237.8109
Barium, total	ug/L	MW-21	10/22/2019		438.0000	*	237.8109
Barium, total	ug/L	MW-21	04/21/2020		401.0000	*	237.8109
Barium, total	ug/L	MW-21	10/13/2020		338.0000	*	237.8109
Barium, total	ug/L	MW-21	04/14/2021		347.0000	*	237.8109
Barium, total	ug/L	MW-21	10/20/2021		229.0000		237.8109
Barium, total	ug/L	MW-21	04/14/2022		325.0000	*	237.8109
Barium, total	ug/L	MW-21	10/13/2022		307.0000	*	237.8109
Barium, total	ug/L	MW-21	04/19/2023		269.0000	*	237.8109
Barium, total	ug/L	MW-21	10/24/2023		301.0000	*	237.8109
Barium, total	ug/L	MW-21	04/11/2024		343.0000	*	237.8109
Barium, total	ug/L	MW-21	10/23/2024		350.0000	*	237.8109
Chloride	mg/L	MW-21	04/26/2018		224.0000	*	100.3283
Chloride	mg/L	MW-21	10/15/2018		194.9500	*	100.3283
Chloride	mg/L	MW-21	04/24/2019		224.0000	*	100.3283
Chloride	mg/L	MW-21	10/22/2019		217.0000	*	100.3283
Chloride	mg/L	MW-21	04/21/2020		227.0000	*	100.3283
Chloride	mg/L	MW-21	10/13/2020		245.0000	*	100.3283
Chloride	mg/L	MW-21	04/14/2021		238.0000	*	100.3283

*   - 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
Chloride	mg/L	MW-21	10/20/2021		195.9450	*	100.3283
Chloride	mg/L	MW-21	04/14/2022		178.0400	*	100.3283
Chloride	mg/L	MW-21	10/13/2022		162.0000	*	100.3283
Chloride	mg/L	MW-21	04/19/2023		167.0000	*	100.3283
Chloride	mg/L	MW-21	10/24/2023		174.0000	*	100.3283
Chloride	mg/L	MW-21	04/11/2024		204.0000	*	100.3283
Chloride	mg/L	MW-21	10/23/2024		215.0000	*	100.3283
Iron, total	ug/L	MW-21	04/26/2018		194.0000		1053.8260
Iron, total	ug/L	MW-21	10/15/2018		323.0000		1053.8260
Iron, total	ug/L	MW-21	04/24/2019		193.0000		1053.8260
Iron, total	ug/L	MW-21	10/22/2019		460.0000		1053.8260
Iron, total	ug/L	MW-21	04/21/2020	ND	2.0000		1053.8260
Iron, total	ug/L	MW-21	10/13/2020		134.0000		1053.8260
Iron, total	ug/L	MW-21	04/14/2021	ND	681.5000		1053.8260
Iron, total	ug/L	MW-21	10/20/2021	ND	681.5000		1053.8260
Iron, total	ug/L	MW-21	04/14/2022	ND	681.5000		1053.8260
Iron, total	ug/L	MW-21	10/13/2022		147.0000		1053.8260
Iron, total	ug/L	MW-21	04/19/2023		162.0000		1053.8260
Iron, total	ug/L	MW-21	10/24/2023		126.0000		1053.8260
Iron, total	ug/L	MW-21	04/11/2024		58.0000		1053.8260
Iron, total	ug/L	MW-21	10/23/2024		1070.0000	*	1053.8260
Magnesium, total	mg/L	MW-21	04/26/2018		60.1000	*	23.5196
Magnesium, total	mg/L	MW-21	10/15/2018		55.3000	*	23.5196
Magnesium, total	mg/L	MW-21	04/24/2019		58.7000	*	23.5196
Magnesium, total	mg/L	MW-21	10/22/2019		58.0000	*	23.5196
Magnesium, total	mg/L	MW-21	04/21/2020		59.6000	*	23.5196
Magnesium, total	mg/L	MW-21	10/13/2020		56.8000	*	23.5196
Magnesium, total	mg/L	MW-21	04/14/2021		55.4000	*	23.5196
Magnesium, total	mg/L	MW-21	10/20/2021		36.9000	*	23.5196
Magnesium, total	mg/L	MW-21	04/14/2022		51.5000	*	23.5196
Magnesium, total	mg/L	MW-21	10/13/2022		43.9000	*	23.5196
Magnesium, total	mg/L	MW-21	04/19/2023		47.0000	*	23.5196
Magnesium, total	mg/L	MW-21	10/24/2023		52.7000	*	23.5196
Magnesium, total	mg/L	MW-21	04/11/2024		53.1000	*	23.5196
Magnesium, total	mg/L	MW-21	10/23/2024		54.8000	*	23.5196
Specific conductance	uS	MW-21	04/26/2018		1554.0000	*	902.7576
Specific conductance	uS	MW-21	10/15/2018		1391.0000	*	902.7576
Specific conductance	uS	MW-21	04/24/2019		1590.0000	*	902.7576
Specific conductance	uS	MW-21	10/22/2019		1532.0000	*	902.7576
Specific conductance	uS	MW-21	04/21/2020		1661.0000	*	902.7576
Specific conductance	uS	MW-21	10/13/2020		1542.0000	*	902.7576
Specific conductance	uS	MW-21	04/14/2021		1649.0000	*	902.7576
Specific conductance	uS	MW-21	10/20/2021		1480.0000	*	902.7576
Specific conductance	uS	MW-21	04/14/2022		1484.0000	*	902.7576
Specific conductance	uS	MW-21	10/13/2022		1520.0000	*	902.7576
Specific conductance	uS	MW-21	04/19/2023		1443.0000	*	902.7576
Specific conductance	uS	MW-21	10/24/2023		1350.0000	*	902.7576
Specific conductance	uS	MW-21	04/11/2024		1420.0000	*	902.7576
Specific conductance	uS	MW-21	10/23/2024		874.5000		902.7576
Ammonia	mg/L	MW-22	04/27/2018		6.4000	*	0.1340
Ammonia	mg/L	MW-22	10/16/2018		4.0000	*	0.1340
Ammonia	mg/L	MW-22	04/24/2019		3.7000	*	0.1340
Ammonia	mg/L	MW-22	10/23/2019		3.9000	*	0.1340
Ammonia	mg/L	MW-22	04/21/2020		5.9000	*	0.1340
Ammonia	mg/L	MW-22	10/13/2020		4.9000	*	0.1340
Ammonia	mg/L	MW-22	04/15/2021		3.6000	*	0.1340
Ammonia	mg/L	MW-22	10/20/2021		2.8000	*	0.1340
Ammonia	mg/L	MW-22	04/15/2022		3.8000	*	0.1340
Ammonia	mg/L	MW-22	10/14/2022		2.8000	*	0.1340
Ammonia	mg/L	MW-22	04/20/2023		2.6000	*	0.1340
Ammonia	mg/L	MW-22	05/24/2023		2.2000	*	0.1340
Ammonia	mg/L	MW-22	10/20/2023		2.0000	*	0.1340
Ammonia	mg/L	MW-22	04/11/2024		2.8000	*	0.1340
Ammonia	mg/L	MW-22	10/24/2024		3.1000	*	0.1340
Arsenic, total	ug/L	MW-22	04/27/2018		19.0000	*	2.2700
Arsenic, total	ug/L	MW-22	10/16/2018		14.6000	*	2.2700
Arsenic, total	ug/L	MW-22	04/24/2019		19.8000	*	2.2700
Arsenic, total	ug/L	MW-22	10/23/2019		16.0000	*	2.2700
Arsenic, total	ug/L	MW-22	04/21/2020		11.6000	*	2.2700
Arsenic, total	ug/L	MW-22	10/13/2020		7.4200	*	2.2700
Arsenic, total	ug/L	MW-22	04/15/2021		15.0000	*	2.2700

* - 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
Arsenic, total	ug/L	MW-22	10/20/2021		15.2000	*	2.2700
Arsenic, total	ug/L	MW-22	04/15/2022		16.0000	*	2.2700
Arsenic, total	ug/L	MW-22	10/14/2022		25.0000	*	2.2700
Arsenic, total	ug/L	MW-22	04/20/2023		17.8000	*	2.2700
Arsenic, total	ug/L	MW-22	05/24/2023		23.7000	*	2.2700
Arsenic, total	ug/L	MW-22	10/20/2023		22.3000	*	2.2700
Arsenic, total	ug/L	MW-22	04/11/2024		14.5000	*	2.2700
Arsenic, total	ug/L	MW-22	10/24/2024		22.5000	*	2.2700
Barium, total	ug/L	MW-22	04/27/2018		315.0000	*	237.8109
Barium, total	ug/L	MW-22	10/16/2018		225.0000		237.8109
Barium, total	ug/L	MW-22	04/24/2019		281.0000	*	237.8109
Barium, total	ug/L	MW-22	10/23/2019		269.0000	*	237.8109
Barium, total	ug/L	MW-22	04/21/2020		440.0000	*	237.8109
Barium, total	ug/L	MW-22	10/13/2020		318.0000	*	237.8109
Barium, total	ug/L	MW-22	04/15/2021		326.0000	*	237.8109
Barium, total	ug/L	MW-22	10/20/2021		241.0000	*	237.8109
Barium, total	ug/L	MW-22	04/15/2022		361.0000	*	237.8109
Barium, total	ug/L	MW-22	10/14/2022		567.0000	*	237.8109
Barium, total	ug/L	MW-22	04/20/2023		900.0000	*	237.8109
Barium, total	ug/L	MW-22	05/24/2023		327.0000	*	237.8109
Barium, total	ug/L	MW-22	10/20/2023		259.0000	*	237.8109
Barium, total	ug/L	MW-22	04/11/2024		408.0000	*	237.8109
Barium, total	ug/L	MW-22	10/24/2024		339.0000	*	237.8109
Chemical oxygen demand	mg/L	MW-22	04/27/2018		8.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/16/2018	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/24/2019		10.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-22	10/23/2019	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/21/2020		8.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/13/2020	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/15/2021	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/20/2021	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/15/2022	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/14/2022	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/20/2023		100.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-22	05/24/2023	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-22	10/20/2023	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-22	04/11/2024		47.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-22	10/24/2024	ND	5.7000		8.0000
Chloride	mg/L	MW-22	04/27/2018		148.0000	*	100.3283
Chloride	mg/L	MW-22	10/16/2018		108.4200	*	100.3283
Chloride	mg/L	MW-22	04/24/2019		121.0000	*	100.3283
Chloride	mg/L	MW-22	10/23/2019		101.0000	*	100.3283
Chloride	mg/L	MW-22	04/21/2020		106.0000	*	100.3283
Chloride	mg/L	MW-22	10/13/2020		108.0000	*	100.3283
Chloride	mg/L	MW-22	04/15/2021		101.0000	*	100.3283
Chloride	mg/L	MW-22	10/20/2021		91.8850		100.3283
Chloride	mg/L	MW-22	04/15/2022		106.8900	*	100.3283
Chloride	mg/L	MW-22	10/14/2022		99.6000		100.3283
Chloride	mg/L	MW-22	04/20/2023		74.8000		100.3283
Chloride	mg/L	MW-22	05/24/2023		76.8876		100.3283
Chloride	mg/L	MW-22	10/20/2023		70.7000		100.3283
Chloride	mg/L	MW-22	04/11/2024		81.7000		100.3283
Chloride	mg/L	MW-22	10/24/2024		115.0000	*	100.3283
Cobalt, total	ug/L	MW-22	10/13/2020		8.0000	*	0.7500
Cobalt, total	ug/L	MW-22	04/15/2021		8.2400	*	0.7500
Cobalt, total	ug/L	MW-22	10/20/2021		7.4400	*	0.7500
Cobalt, total	ug/L	MW-22	04/15/2022		9.6300	*	0.7500
Cobalt, total	ug/L	MW-22	10/14/2022		10.7000	*	0.7500
Cobalt, total	ug/L	MW-22	04/20/2023		31.4000	*	0.7500
Cobalt, total	ug/L	MW-22	05/24/2023		14.2000	*	0.7500
Cobalt, total	ug/L	MW-22	10/20/2023		10.1000	*	0.7500
Cobalt, total	ug/L	MW-22	04/11/2024		13.8000	*	0.7500
Cobalt, total	ug/L	MW-22	10/24/2024		12.8000	*	0.7500
Iron, total	ug/L	MW-22	04/27/2018		12800.0000	*	1053.8260
Iron, total	ug/L	MW-22	10/16/2018		8130.0000	*	1053.8260
Iron, total	ug/L	MW-22	04/24/2019		18200.0000	*	1053.8260
Iron, total	ug/L	MW-22	10/23/2019		13600.0000	*	1053.8260
Iron, total	ug/L	MW-22	04/21/2020		93.3000		1053.8260
Iron, total	ug/L	MW-22	10/13/2020		3990.0000	*	1053.8260
Iron, total	ug/L	MW-22	04/15/2021		11700.0000	*	1053.8260
Iron, total	ug/L	MW-22	10/20/2021		9990.0000	*	1053.8260

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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
Iron, total	ug/L	MW-22	04/15/2022		12000.0000	*	1053.8260
Iron, total	ug/L	MW-22	10/14/2022		19600.0000	*	1053.8260
Iron, total	ug/L	MW-22	04/20/2023		18300.0000	*	1053.8260
Iron, total	ug/L	MW-22	05/24/2023		19400.0000	*	1053.8260
Iron, total	ug/L	MW-22	10/20/2023		6540.0000	*	1053.8260
Iron, total	ug/L	MW-22	04/11/2024		18200.0000	*	1053.8260
Iron, total	ug/L	MW-22	10/24/2024		16100.0000	*	1053.8260
Magnesium, total	mg/L	MW-22	04/27/2018		33.6000	*	23.5196
Magnesium, total	mg/L	MW-22	10/16/2018		27.9000	*	23.5196
Magnesium, total	mg/L	MW-22	04/24/2019		31.6000	*	23.5196
Magnesium, total	mg/L	MW-22	10/23/2019		28.5000	*	23.5196
Magnesium, total	mg/L	MW-22	04/21/2020		33.1000	*	23.5196
Magnesium, total	mg/L	MW-22	10/13/2020		32.6000	*	23.5196
Magnesium, total	mg/L	MW-22	04/15/2021		32.9000	*	23.5196
Magnesium, total	mg/L	MW-22	10/20/2021		24.6000	*	23.5196
Magnesium, total	mg/L	MW-22	04/15/2022		35.1000	*	23.5196
Magnesium, total	mg/L	MW-22	10/14/2022		33.2000	*	23.5196
Magnesium, total	mg/L	MW-22	04/20/2023		46.0000	*	23.5196
Magnesium, total	mg/L	MW-22	05/24/2023		31.7000	*	23.5196
Magnesium, total	mg/L	MW-22	10/20/2023		33.2000	*	23.5196
Magnesium, total	mg/L	MW-22	04/11/2024		35.3000	*	23.5196
Magnesium, total	mg/L	MW-22	10/24/2024		35.8000	*	23.5196
Specific conductance	uS	MW-22	04/27/2018		1340.0000	*	902.7576
Specific conductance	uS	MW-22	10/16/2018		1033.0000	*	902.7576
Specific conductance	uS	MW-22	04/24/2019		1142.0000	*	902.7576
Specific conductance	uS	MW-22	10/23/2019		972.0000	*	902.7576
Specific conductance	uS	MW-22	04/21/2020		1149.0000	*	902.7576
Specific conductance	uS	MW-22	10/13/2020		1041.0000	*	902.7576
Specific conductance	uS	MW-22	04/15/2021		1090.0000	*	902.7576
Specific conductance	uS	MW-22	10/20/2021		1028.0000	*	902.7576
Specific conductance	uS	MW-22	04/15/2022		1004.0000	*	902.7576
Specific conductance	uS	MW-22	10/14/2022		1035.0000	*	902.7576
Specific conductance	uS	MW-22	04/20/2023		988.0000	*	902.7576
Specific conductance	uS	MW-22	05/24/2023		948.0000	*	902.7576
Specific conductance	uS	MW-22	10/20/2023		927.0000	*	902.7576
Specific conductance	uS	MW-22	04/11/2024		1038.0000	*	902.7576
Specific conductance	uS	MW-22	10/24/2024		668.4000		902.7576
Ammonia	mg/L	MW-23	04/26/2018		1.7000	*	0.1340
Ammonia	mg/L	MW-23	10/16/2018		1.6000	*	0.1340
Ammonia	mg/L	MW-23	04/24/2019		1.7000	*	0.1340
Ammonia	mg/L	MW-23	10/23/2019		1.8000	*	0.1340
Ammonia	mg/L	MW-23	04/21/2020		1.1000	*	0.1340
Ammonia	mg/L	MW-23	10/12/2020		1.5000	*	0.1340
Ammonia	mg/L	MW-23	04/14/2021		1.1000	*	0.1340
Ammonia	mg/L	MW-23	10/19/2021		1.3000	*	0.1340
Ammonia	mg/L	MW-23	04/15/2022		1.4000	*	0.1340
Ammonia	mg/L	MW-23	10/13/2022		1.3000	*	0.1340
Ammonia	mg/L	MW-23	04/19/2023		1.2000	*	0.1340
Ammonia	mg/L	MW-23	10/18/2023		1.2000	*	0.1340
Ammonia	mg/L	MW-23	04/10/2024		1.1000	*	0.1340
Ammonia	mg/L	MW-23	10/23/2024		1.1000	*	0.1340
Arsenic, total	ug/L	MW-23	04/26/2018		32.2000	*	2.2700
Arsenic, total	ug/L	MW-23	10/16/2018		15.2000	*	2.2700
Arsenic, total	ug/L	MW-23	04/24/2019		18.8000	*	2.2700
Arsenic, total	ug/L	MW-23	10/23/2019		14.6000	*	2.2700
Arsenic, total	ug/L	MW-23	04/21/2020		30.4000	*	2.2700
Arsenic, total	ug/L	MW-23	10/12/2020		31.8000	*	2.2700
Arsenic, total	ug/L	MW-23	04/14/2021		21.9000	*	2.2700
Arsenic, total	ug/L	MW-23	10/19/2021		9.4000	*	2.2700
Arsenic, total	ug/L	MW-23	04/15/2022		16.5000	*	2.2700
Arsenic, total	ug/L	MW-23	10/13/2022		11.5000	*	2.2700
Arsenic, total	ug/L	MW-23	04/19/2023		18.1000	*	2.2700
Arsenic, total	ug/L	MW-23	10/18/2023		10.9000	*	2.2700
Arsenic, total	ug/L	MW-23	04/10/2024		10.5000	*	2.2700
Arsenic, total	ug/L	MW-23	10/23/2024		7.8700	*	2.2700
Cobalt, total	ug/L	MW-23	10/12/2020		2.3900	*	0.7500
Cobalt, total	ug/L	MW-23	04/14/2021		1.8400	*	0.7500
Cobalt, total	ug/L	MW-23	10/19/2021	ND	6.2500		0.7500
Cobalt, total	ug/L	MW-23	04/15/2022		2.2400	*	0.7500
Cobalt, total	ug/L	MW-23	10/13/2022		2.3700	*	0.7500
Cobalt, total	ug/L	MW-23	04/19/2023		2.0000	*	0.7500

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Table 8

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Constituent	Units	Well	Date		Result		Pred. Limit
Cobalt, total	ug/L	MW-23	10/18/2023		1.3400	*	0.7500
Cobalt, total	ug/L	MW-23	04/10/2024		1.8500	*	0.7500
Cobalt, total	ug/L	MW-23	10/23/2024		1.9600	*	0.7500
Iron, total	ug/L	MW-23	04/26/2018		14400.0000	*	1053.8260
Iron, total	ug/L	MW-23	10/16/2018		7000.0000	*	1053.8260
Iron, total	ug/L	MW-23	04/24/2019		8360.0000	*	1053.8260
Iron, total	ug/L	MW-23	10/23/2019		7430.0000	*	1053.8260
Iron, total	ug/L	MW-23	04/21/2020		118.0000		1053.8260
Iron, total	ug/L	MW-23	10/12/2020		12400.0000	*	1053.8260
Iron, total	ug/L	MW-23	04/14/2021		10300.0000	*	1053.8260
Iron, total	ug/L	MW-23	10/19/2021		4970.0000	*	1053.8260
Iron, total	ug/L	MW-23	04/15/2022		7520.0000	*	1053.8260
Iron, total	ug/L	MW-23	10/13/2022		5370.0000	*	1053.8260
Iron, total	ug/L	MW-23	04/19/2023		2460.0000	*	1053.8260
Iron, total	ug/L	MW-23	10/18/2023		1330.0000	*	1053.8260
Iron, total	ug/L	MW-23	04/10/2024		5050.0000	*	1053.8260
Iron, total	ug/L	MW-23	10/23/2024		4510.0000	*	1053.8260
Magnesium, total	mg/L	MW-23	04/26/2018		37.4000	*	23.5196
Magnesium, total	mg/L	MW-23	10/16/2018		35.4000	*	23.5196
Magnesium, total	mg/L	MW-23	04/24/2019		39.5000	*	23.5196
Magnesium, total	mg/L	MW-23	10/23/2019		37.9000	*	23.5196
Magnesium, total	mg/L	MW-23	04/21/2020		36.9000	*	23.5196
Magnesium, total	mg/L	MW-23	10/12/2020		38.8000	*	23.5196
Magnesium, total	mg/L	MW-23	04/14/2021		38.1000	*	23.5196
Magnesium, total	mg/L	MW-23	10/19/2021		29.7000	*	23.5196
Magnesium, total	mg/L	MW-23	04/15/2022		40.6000	*	23.5196
Magnesium, total	mg/L	MW-23	10/13/2022		40.4000	*	23.5196
Magnesium, total	mg/L	MW-23	04/19/2023		39.4000	*	23.5196
Magnesium, total	mg/L	MW-23	10/18/2023		44.3000	*	23.5196
Magnesium, total	mg/L	MW-23	04/10/2024		37.3000	*	23.5196
Magnesium, total	mg/L	MW-23	10/23/2024		38.1000	*	23.5196
pH	SU	MW-23	04/26/2018		7.0700	*	5.67 - 6.92
pH	SU	MW-23	10/16/2018		6.9900	*	5.67 - 6.92
pH	SU	MW-23	04/24/2019		6.6500		5.67 - 6.92
pH	SU	MW-23	10/23/2019		6.7200		5.67 - 6.92
pH	SU	MW-23	04/21/2020		7.2200	*	5.67 - 6.92
pH	SU	MW-23	10/12/2020		7.1000	*	5.67 - 6.92
pH	SU	MW-23	04/14/2021		6.9000		5.67 - 6.92
pH	SU	MW-23	10/19/2021		7.0000	*	5.67 - 6.92
pH	SU	MW-23	04/15/2022		7.3000	*	5.67 - 6.92
pH	SU	MW-23	10/13/2022		7.0500	*	5.67 - 6.92
pH	SU	MW-23	04/19/2023		6.9900	*	5.67 - 6.92
pH	SU	MW-23	10/18/2023		6.8000		5.67 - 6.92
pH	SU	MW-23	04/10/2024		7.0900	*	5.67 - 6.92
pH	SU	MW-23	10/23/2024		7.0100	*	5.67 - 6.92
Specific conductance	uS	MW-23	04/26/2018		1201.0000	*	902.7576
Specific conductance	uS	MW-23	10/16/2018		1117.0000	*	902.7576
Specific conductance	uS	MW-23	04/24/2019		1149.0000	*	902.7576
Specific conductance	uS	MW-23	10/23/2019		1112.0000	*	902.7576
Specific conductance	uS	MW-23	04/21/2020		1093.0000	*	902.7576
Specific conductance	uS	MW-23	10/12/2020		1067.0000	*	902.7576
Specific conductance	uS	MW-23	04/14/2021		1124.0000	*	902.7576
Specific conductance	uS	MW-23	10/19/2021		1158.0000	*	902.7576
Specific conductance	uS	MW-23	04/15/2022		1177.0000	*	902.7576
Specific conductance	uS	MW-23	10/13/2022		1215.0000	*	902.7576
Specific conductance	uS	MW-23	04/19/2023		1151.0000	*	902.7576
Specific conductance	uS	MW-23	10/18/2023		1118.0000	*	902.7576
Specific conductance	uS	MW-23	04/10/2024		1087.0000	*	902.7576
Specific conductance	uS	MW-23	10/23/2024		666.9000		902.7576
Ammonia	mg/L	MW-24	04/26/2018		2.8000	*	0.1340
Ammonia	mg/L	MW-24	10/16/2018		2.0000	*	0.1340
Ammonia	mg/L	MW-24	04/24/2019		1.5000	*	0.1340
Ammonia	mg/L	MW-24	10/23/2019		1.5000	*	0.1340
Ammonia	mg/L	MW-24	04/21/2020		1.0000	*	0.1340
Ammonia	mg/L	MW-24	10/12/2020		1.2000	*	0.1340
Ammonia	mg/L	MW-24	04/14/2021		1.0000	*	0.1340
Ammonia	mg/L	MW-24	10/19/2021		1.1000	*	0.1340
Ammonia	mg/L	MW-24	04/14/2022		1.1000	*	0.1340
Ammonia	mg/L	MW-24	10/13/2022		0.8200	*	0.1340
Ammonia	mg/L	MW-24	04/19/2023		0.7600	*	0.1340
Ammonia	mg/L	MW-24	10/18/2023		0.7700	*	0.1340

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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
Ammonia	mg/L	MW-24	04/11/2024		0.7200	*	0.1340
Ammonia	mg/L	MW-24	10/23/2024		0.7400	*	0.1340
Chloride	mg/L	MW-24	04/26/2018		87.9000		100.3283
Chloride	mg/L	MW-24	10/16/2018		101.1800	*	100.3283
Chloride	mg/L	MW-24	04/24/2019		90.8000		100.3283
Chloride	mg/L	MW-24	10/23/2019		107.0000	*	100.3283
Chloride	mg/L	MW-24	04/21/2020		91.1000		100.3283
Chloride	mg/L	MW-24	10/12/2020		92.3000		100.3283
Chloride	mg/L	MW-24	04/14/2021		84.9000		100.3283
Chloride	mg/L	MW-24	10/19/2021		98.8780		100.3283
Chloride	mg/L	MW-24	04/14/2022		97.9900		100.3283
Chloride	mg/L	MW-24	10/13/2022		98.7000		100.3283
Chloride	mg/L	MW-24	04/19/2023		69.2000		100.3283
Chloride	mg/L	MW-24	10/18/2023		83.2000		100.3283
Chloride	mg/L	MW-24	04/11/2024		82.0000		100.3283
Chloride	mg/L	MW-24	10/23/2024		128.0000	*	100.3283
Cobalt, total	ug/L	MW-24	10/12/2020		3.2400	*	0.7500
Cobalt, total	ug/L	MW-24	04/14/2021		1.7200	*	0.7500
Cobalt, total	ug/L	MW-24	10/19/2021	ND	6.2500		0.7500
Cobalt, total	ug/L	MW-24	04/14/2022		2.4500	*	0.7500
Cobalt, total	ug/L	MW-24	10/13/2022		4.3100	*	0.7500
Cobalt, total	ug/L	MW-24	04/19/2023		2.0900	*	0.7500
Cobalt, total	ug/L	MW-24	10/18/2023	ND	0.6500		0.7500
Cobalt, total	ug/L	MW-24	04/11/2024		1.1000	*	0.7500
Cobalt, total	ug/L	MW-24	10/23/2024	ND	1.7000		0.7500
Magnesium, total	mg/L	MW-24	04/26/2018		44.9000	*	23.5196
Magnesium, total	mg/L	MW-24	10/16/2018		40.8000	*	23.5196
Magnesium, total	mg/L	MW-24	04/24/2019		36.8000	*	23.5196
Magnesium, total	mg/L	MW-24	10/23/2019		36.7000	*	23.5196
Magnesium, total	mg/L	MW-24	04/21/2020		39.5000	*	23.5196
Magnesium, total	mg/L	MW-24	10/12/2020		43.3000	*	23.5196
Magnesium, total	mg/L	MW-24	04/14/2021		38.8000	*	23.5196
Magnesium, total	mg/L	MW-24	10/19/2021		28.0000	*	23.5196
Magnesium, total	mg/L	MW-24	04/14/2022		36.8000	*	23.5196
Magnesium, total	mg/L	MW-24	10/13/2022		35.9000	*	23.5196
Magnesium, total	mg/L	MW-24	04/19/2023		28.8000	*	23.5196
Magnesium, total	mg/L	MW-24	10/18/2023		31.2000	*	23.5196
Magnesium, total	mg/L	MW-24	04/11/2024		26.0000	*	23.5196
Magnesium, total	mg/L	MW-24	10/23/2024		31.9000	*	23.5196
pH	SU	MW-24	04/26/2018		6.8900		5.67 - 6.92
pH	SU	MW-24	10/16/2018		7.0300	*	5.67 - 6.92
pH	SU	MW-24	04/24/2019		6.7500		5.67 - 6.92
pH	SU	MW-24	10/23/2019		6.8200		5.67 - 6.92
pH	SU	MW-24	04/21/2020		6.9600	*	5.67 - 6.92
pH	SU	MW-24	10/12/2020		7.0300	*	5.67 - 6.92
pH	SU	MW-24	04/14/2021		6.9000		5.67 - 6.92
pH	SU	MW-24	10/19/2021		6.9000		5.67 - 6.92
pH	SU	MW-24	04/14/2022		7.0000	*	5.67 - 6.92
pH	SU	MW-24	10/13/2022		7.0400	*	5.67 - 6.92
pH	SU	MW-24	04/19/2023		6.9100		5.67 - 6.92
pH	SU	MW-24	10/18/2023		7.0000	*	5.67 - 6.92
pH	SU	MW-24	04/11/2024		6.7500		5.67 - 6.92
pH	SU	MW-24	10/23/2024		7.0900	*	5.67 - 6.92
Ammonia	mg/L	MW-3R1	06/05/2018		0.8200	*	0.1340
Ammonia	mg/L	MW-3R1	10/16/2018		0.9800	*	0.1340
Ammonia	mg/L	MW-3R1	04/24/2019		1.5000	*	0.1340
Ammonia	mg/L	MW-3R1	10/23/2019		1.3000	*	0.1340
Ammonia	mg/L	MW-3R1	04/21/2020		0.5700	*	0.1340
Ammonia	mg/L	MW-3R1	10/13/2020		0.7500	*	0.1340
Ammonia	mg/L	MW-3R1	04/15/2021	ND	0.1340		0.1340
Ammonia	mg/L	MW-3R1	10/20/2021		0.5600	*	0.1340
Ammonia	mg/L	MW-3R1	04/15/2022	ND	0.1340		0.1340
Ammonia	mg/L	MW-3R1	10/14/2022		0.6100	*	0.1340
Ammonia	mg/L	MW-3R1	04/19/2023		0.4000	*	0.1340
Ammonia	mg/L	MW-3R1	10/20/2023		0.3000	*	0.1340
Ammonia	mg/L	MW-3R1	04/11/2024		0.3000	*	0.1340
Ammonia	mg/L	MW-3R1	10/24/2024		0.4000	*	0.1340
Arsenic, total	ug/L	MW-3R1	06/05/2018		372.0000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/16/2018		59.6000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/24/2019		62.3000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/23/2019		62.9000	*	2.2700

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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
Arsenic, total	ug/L	MW-3R1	04/21/2020		82.5000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/13/2020		50.3000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/15/2021		77.6000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/20/2021		30.7000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/15/2022		64.7000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/14/2022		57.0000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/19/2023		61.2000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/20/2023		30.0000	*	2.2700
Arsenic, total	ug/L	MW-3R1	04/11/2024		32.3000	*	2.2700
Arsenic, total	ug/L	MW-3R1	10/24/2024		45.7000	*	2.2700
Barium, total	ug/L	MW-3R1	06/05/2018		1920.0000	*	237.8109
Barium, total	ug/L	MW-3R1	10/16/2018		484.0000	*	237.8109
Barium, total	ug/L	MW-3R1	04/24/2019		405.0000	*	237.8109
Barium, total	ug/L	MW-3R1	10/23/2019		388.0000	*	237.8109
Barium, total	ug/L	MW-3R1	04/21/2020		496.0000	*	237.8109
Barium, total	ug/L	MW-3R1	10/13/2020		375.0000	*	237.8109
Barium, total	ug/L	MW-3R1	04/15/2021		616.0000	*	237.8109
Barium, total	ug/L	MW-3R1	10/20/2021		248.0000	*	237.8109
Barium, total	ug/L	MW-3R1	04/15/2022		369.0000	*	237.8109
Barium, total	ug/L	MW-3R1	10/14/2022		377.0000	*	237.8109
Barium, total	ug/L	MW-3R1	04/19/2023		294.0000	*	237.8109
Barium, total	ug/L	MW-3R1	10/20/2023		219.0000		237.8109
Barium, total	ug/L	MW-3R1	04/11/2024		171.0000		237.8109
Barium, total	ug/L	MW-3R1	10/24/2024		280.0000	*	237.8109
Cobalt, total	ug/L	MW-3R1	10/13/2020		10.2000	*	0.7500
Cobalt, total	ug/L	MW-3R1	04/15/2021		11.9000	*	0.7500
Cobalt, total	ug/L	MW-3R1	10/20/2021		9.7300	*	0.7500
Cobalt, total	ug/L	MW-3R1	04/15/2022		12.0000	*	0.7500
Cobalt, total	ug/L	MW-3R1	10/14/2022		13.1000	*	0.7500
Cobalt, total	ug/L	MW-3R1	04/19/2023		13.0000	*	0.7500
Cobalt, total	ug/L	MW-3R1	10/20/2023		11.4000	*	0.7500
Cobalt, total	ug/L	MW-3R1	04/11/2024		10.7000	*	0.7500
Cobalt, total	ug/L	MW-3R1	10/24/2024		15.2000	*	0.7500
Iron, total	ug/L	MW-3R1	06/05/2018		357000.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	10/16/2018		66400.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	04/24/2019		54900.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	10/23/2019		44700.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	04/21/2020		535.0000		1053.8260
Iron, total	ug/L	MW-3R1	10/13/2020		43100.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	04/15/2021		61000.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	10/20/2021		30000.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	04/15/2022		52400.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	10/14/2022		46000.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	04/19/2023		14900.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	10/20/2023		8350.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	04/11/2024		35500.0000	*	1053.8260
Iron, total	ug/L	MW-3R1	10/24/2024		42500.0000	*	1053.8260
Magnesium, total	mg/L	MW-3R1	06/05/2018		525.0000	*	23.5196
Magnesium, total	mg/L	MW-3R1	10/16/2018		127.0000	*	23.5196
Magnesium, total	mg/L	MW-3R1	04/24/2019		62.4000	*	23.5196
Magnesium, total	mg/L	MW-3R1	10/23/2019		39.9000	*	23.5196
Magnesium, total	mg/L	MW-3R1	04/21/2020		45.8000	*	23.5196
Magnesium, total	mg/L	MW-3R1	10/13/2020		33.7000	*	23.5196
Magnesium, total	mg/L	MW-3R1	04/15/2021		53.0000	*	23.5196
Magnesium, total	mg/L	MW-3R1	10/20/2021		33.9000	*	23.5196
Magnesium, total	mg/L	MW-3R1	04/15/2022		35.3000	*	23.5196
Magnesium, total	mg/L	MW-3R1	10/14/2022		46.5000	*	23.5196
Magnesium, total	mg/L	MW-3R1	04/19/2023		33.2000	*	23.5196
Magnesium, total	mg/L	MW-3R1	10/20/2023		27.1000	*	23.5196
Magnesium, total	mg/L	MW-3R1	04/11/2024		20.6000		23.5196
Magnesium, total	mg/L	MW-3R1	10/24/2024		28.3000	*	23.5196
Ammonia	mg/L	MW-4	04/26/2018		2.9000	*	0.1340
Ammonia	mg/L	MW-4	10/15/2018		1.3000	*	0.1340
Ammonia	mg/L	MW-4	04/23/2019		0.9000	*	0.1340
Ammonia	mg/L	MW-4	10/22/2019		1.2000	*	0.1340
Ammonia	mg/L	MW-4	04/21/2020		0.8400	*	0.1340
Ammonia	mg/L	MW-4	10/12/2020		1.4000	*	0.1340
Ammonia	mg/L	MW-4	04/14/2021		1.0000	*	0.1340
Ammonia	mg/L	MW-4	10/19/2021		2.0000	*	0.1340
Ammonia	mg/L	MW-4	04/14/2022		1.6000	*	0.1340
Ammonia	mg/L	MW-4	10/13/2022		1.5000	*	0.1340

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Constituent	Units	Well	Date		Result		Pred. Limit
Ammonia	mg/L	MW-4	04/19/2023		0.6200	*	0.1340
Ammonia	mg/L	MW-4	10/18/2023		1.6000	*	0.1340
Ammonia	mg/L	MW-4	04/10/2024		1.2000	*	0.1340
Ammonia	mg/L	MW-4	10/23/2024		1.0000	*	0.1340
Arsenic, total	ug/L	MW-4	04/26/2018		25.7000	*	2.2700
Arsenic, total	ug/L	MW-4	10/15/2018		26.5000	*	2.2700
Arsenic, total	ug/L	MW-4	04/23/2019		13.4000	*	2.2700
Arsenic, total	ug/L	MW-4	10/22/2019		26.3000	*	2.2700
Arsenic, total	ug/L	MW-4	04/21/2020		14.7000	*	2.2700
Arsenic, total	ug/L	MW-4	10/12/2020		15.1000	*	2.2700
Arsenic, total	ug/L	MW-4	04/14/2021		14.2000	*	2.2700
Arsenic, total	ug/L	MW-4	10/19/2021		18.8000	*	2.2700
Arsenic, total	ug/L	MW-4	04/14/2022		31.5000	*	2.2700
Arsenic, total	ug/L	MW-4	10/13/2022		22.3000	*	2.2700
Arsenic, total	ug/L	MW-4	04/19/2023		11.7000	*	2.2700
Arsenic, total	ug/L	MW-4	10/18/2023		17.4000	*	2.2700
Arsenic, total	ug/L	MW-4	04/10/2024		35.6000	*	2.2700
Arsenic, total	ug/L	MW-4	10/23/2024		13.7000	*	2.2700
Barium, total	ug/L	MW-4	04/26/2018		372.0000	*	237.8109
Barium, total	ug/L	MW-4	10/15/2018		270.0000	*	237.8109
Barium, total	ug/L	MW-4	04/23/2019		282.0000	*	237.8109
Barium, total	ug/L	MW-4	10/22/2019		350.0000	*	237.8109
Barium, total	ug/L	MW-4	04/21/2020		301.0000	*	237.8109
Barium, total	ug/L	MW-4	10/12/2020		279.0000	*	237.8109
Barium, total	ug/L	MW-4	04/14/2021		343.0000	*	237.8109
Barium, total	ug/L	MW-4	10/19/2021		378.0000	*	237.8109
Barium, total	ug/L	MW-4	04/14/2022		500.0000	*	237.8109
Barium, total	ug/L	MW-4	10/13/2022		404.0000	*	237.8109
Barium, total	ug/L	MW-4	04/19/2023		235.0000		237.8109
Barium, total	ug/L	MW-4	10/18/2023		458.0000	*	237.8109
Barium, total	ug/L	MW-4	04/10/2024		543.0000	*	237.8109
Barium, total	ug/L	MW-4	10/23/2024		317.0000	*	237.8109
Chemical oxygen demand	mg/L	MW-4	04/26/2018		17.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-4	10/15/2018	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/23/2019		8.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	10/22/2019	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/21/2020		10.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-4	10/12/2020		7.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/14/2021	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	10/19/2021	ND	7.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/14/2022		14.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-4	10/13/2022	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/19/2023		6.0000		8.0000
Chemical oxygen demand	mg/L	MW-4	10/18/2023	ND	5.7000		8.0000
Chemical oxygen demand	mg/L	MW-4	04/10/2024		18.0000	*	8.0000
Chemical oxygen demand	mg/L	MW-4	10/23/2024	ND	5.7000		8.0000
Cobalt, total	ug/L	MW-4	10/12/2020		4.1500	*	0.7500
Cobalt, total	ug/L	MW-4	04/14/2021		2.4200	*	0.7500
Cobalt, total	ug/L	MW-4	10/19/2021	ND	6.2500		0.7500
Cobalt, total	ug/L	MW-4	04/14/2022		7.1400	*	0.7500
Cobalt, total	ug/L	MW-4	10/13/2022		15.1000	*	0.7500
Cobalt, total	ug/L	MW-4	04/19/2023		8.2900	*	0.7500
Cobalt, total	ug/L	MW-4	10/18/2023		7.8500	*	0.7500
Cobalt, total	ug/L	MW-4	04/10/2024		126.0000	*	0.7500
Cobalt, total	ug/L	MW-4	10/23/2024		5.2900	*	0.7500
Iron, total	ug/L	MW-4	04/26/2018		6740.0000	*	1053.8260
Iron, total	ug/L	MW-4	10/15/2018		6260.0000	*	1053.8260
Iron, total	ug/L	MW-4	04/23/2019		3690.0000	*	1053.8260
Iron, total	ug/L	MW-4	10/22/2019		7270.0000	*	1053.8260
Iron, total	ug/L	MW-4	04/21/2020		36.2000		1053.8260
Iron, total	ug/L	MW-4	10/12/2020		4910.0000	*	1053.8260
Iron, total	ug/L	MW-4	04/14/2021		4320.0000	*	1053.8260
Iron, total	ug/L	MW-4	10/19/2021		5800.0000	*	1053.8260
Iron, total	ug/L	MW-4	04/14/2022		8470.0000	*	1053.8260
Iron, total	ug/L	MW-4	10/13/2022		11600.0000	*	1053.8260
Iron, total	ug/L	MW-4	04/19/2023		3230.0000	*	1053.8260
Iron, total	ug/L	MW-4	10/18/2023		3930.0000	*	1053.8260
Iron, total	ug/L	MW-4	04/10/2024		83400.0000	*	1053.8260
Iron, total	ug/L	MW-4	10/23/2024		5090.0000	*	1053.8260
Magnesium, total	mg/L	MW-4	04/26/2018		35.8000	*	23.5196
Magnesium, total	mg/L	MW-4	10/15/2018		27.7000	*	23.5196

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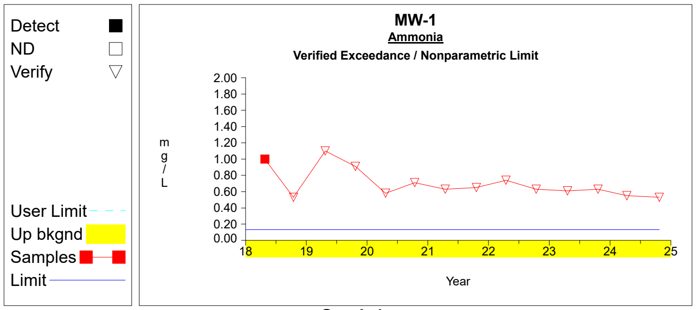
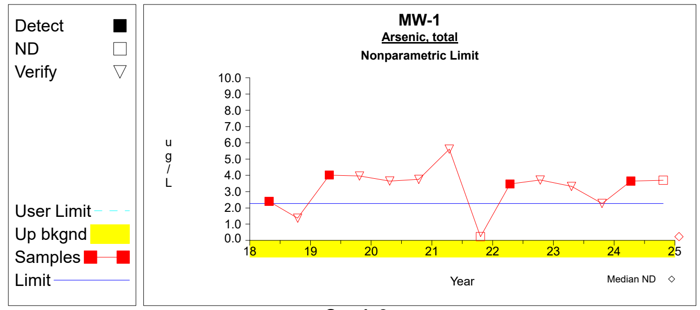
Constituent	Units	Well	Date		Result		Pred. Limit
Magnesium, total	mg/L	MW-4	04/23/2019		30.3000	*	23.5196
Magnesium, total	mg/L	MW-4	10/22/2019		22.7000		23.5196
Magnesium, total	mg/L	MW-4	04/21/2020		23.6000	*	23.5196
Magnesium, total	mg/L	MW-4	10/12/2020		23.0000		23.5196
Magnesium, total	mg/L	MW-4	04/14/2021		28.9000	*	23.5196
Magnesium, total	mg/L	MW-4	10/19/2021		25.1000	*	23.5196
Magnesium, total	mg/L	MW-4	04/14/2022		32.1000	*	23.5196
Magnesium, total	mg/L	MW-4	10/13/2022		32.5000	*	23.5196
Magnesium, total	mg/L	MW-4	04/19/2023		25.2000	*	23.5196
Magnesium, total	mg/L	MW-4	10/18/2023		36.9000	*	23.5196
Magnesium, total	mg/L	MW-4	04/10/2024		34.1000	*	23.5196
Magnesium, total	mg/L	MW-4	10/23/2024		29.1000	*	23.5196

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

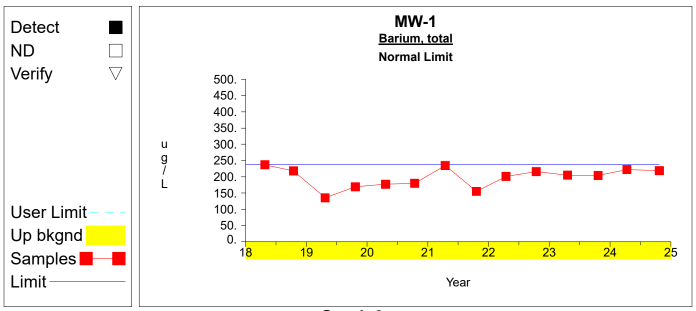
Up vs. Down Prediction Limits



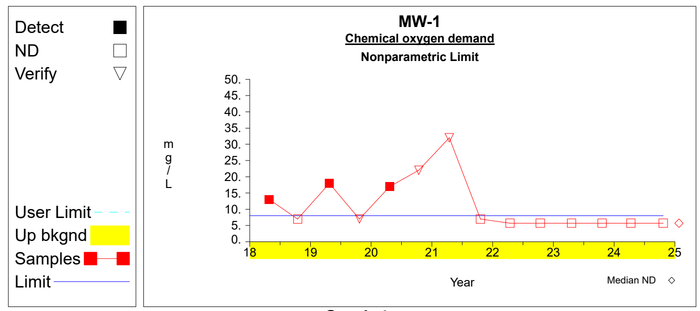
Graph 1



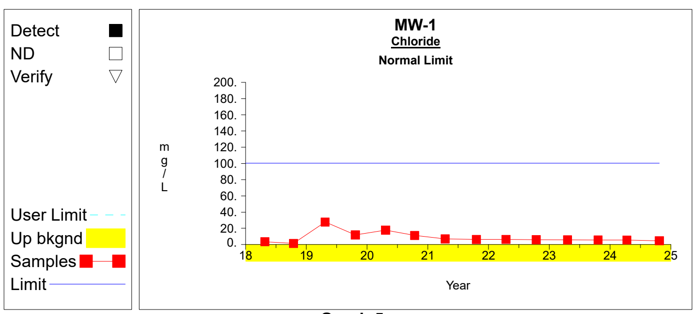
Graph 2



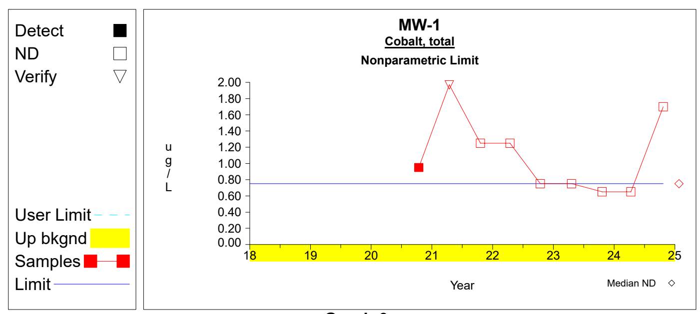
Graph 3



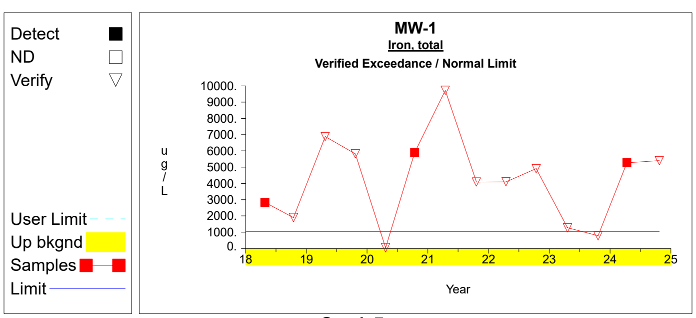
Graph 4



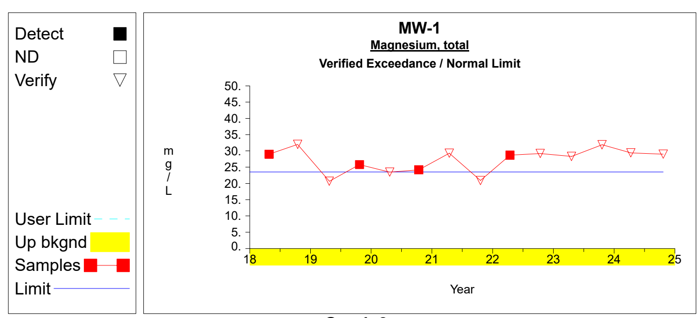
Graph 5



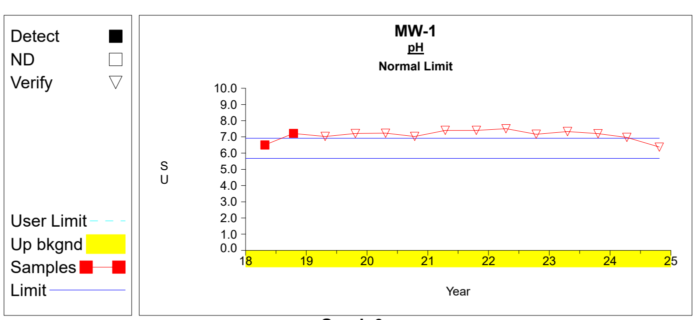
Graph 6



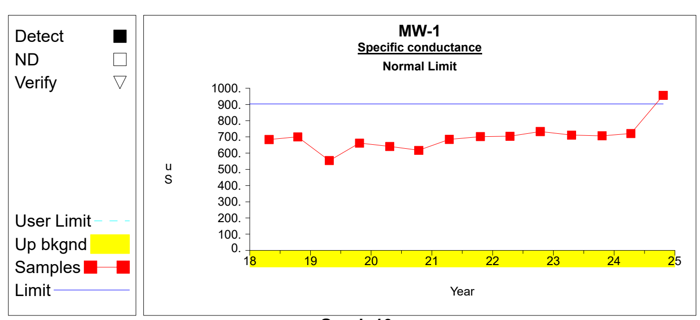
Graph 7



Graph 8



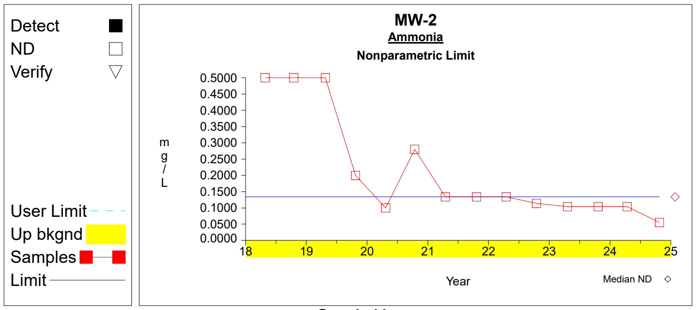
Graph 9



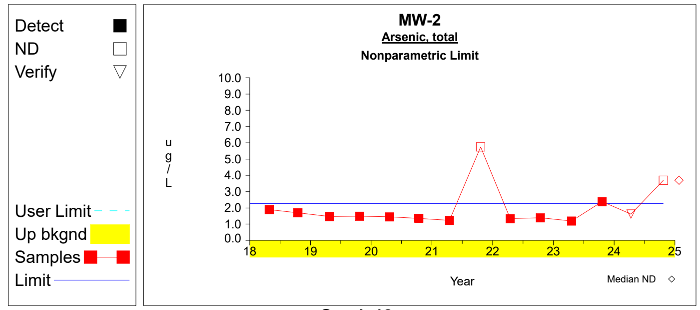
Graph 10

Prepared by: Otter Creek Environmental

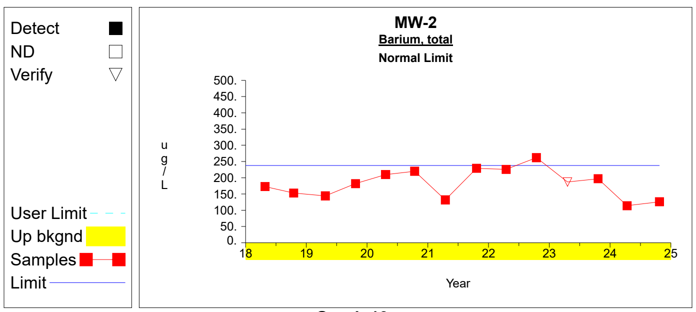
Up vs. Down Prediction Limits



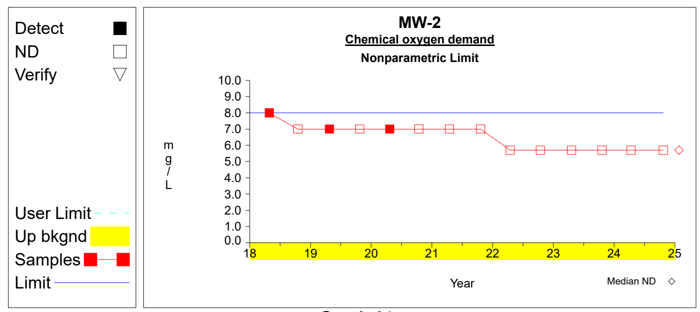
Graph 11



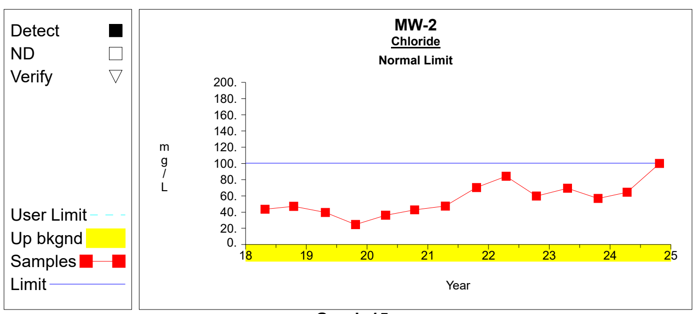
Graph 12



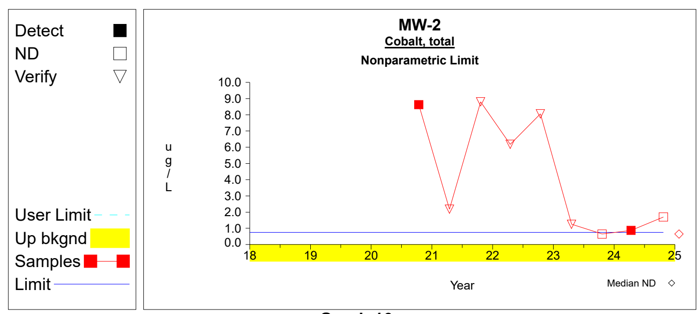
Graph 13



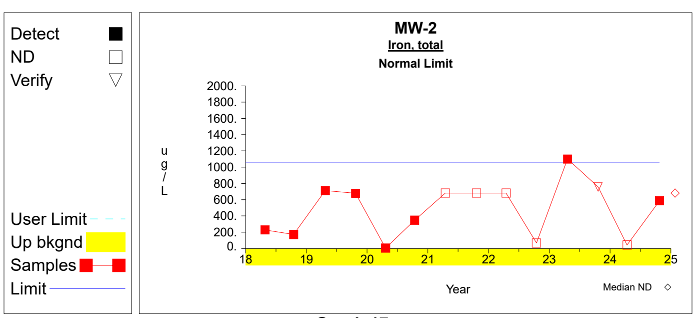
Graph 14



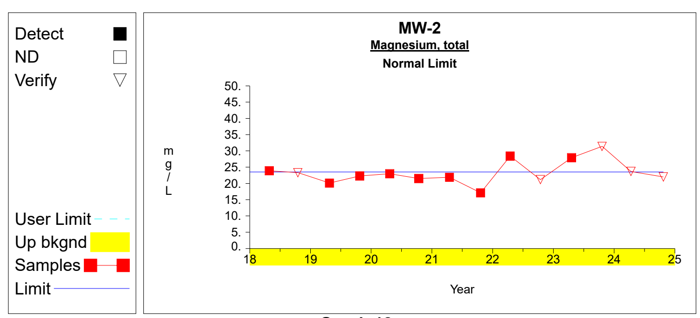
Graph 15



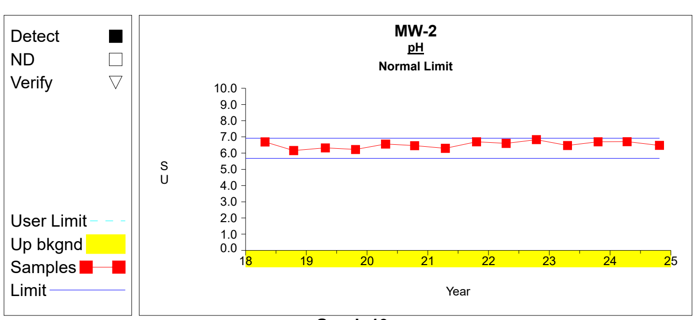
Graph 16



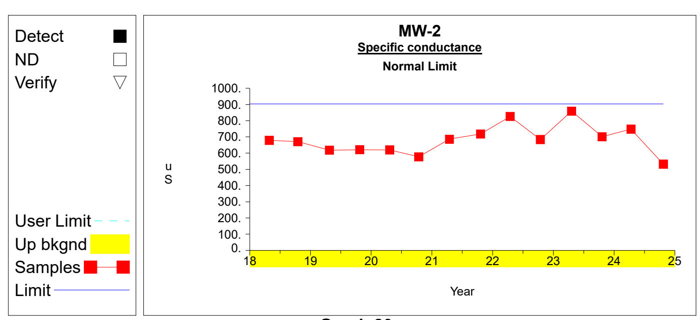
Graph 17



Graph 18

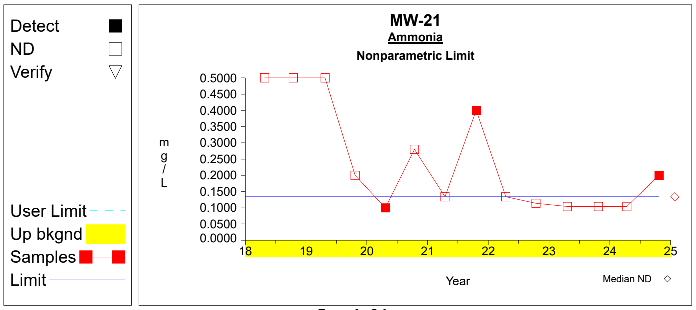


Graph 19

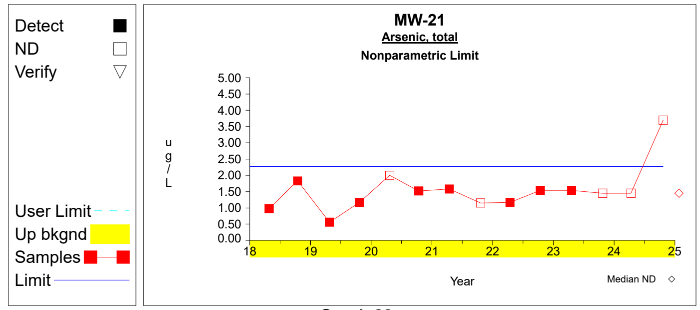


Graph 20

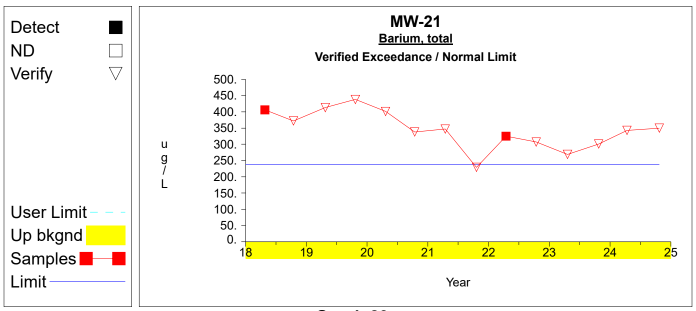
Up vs. Down Prediction Limits



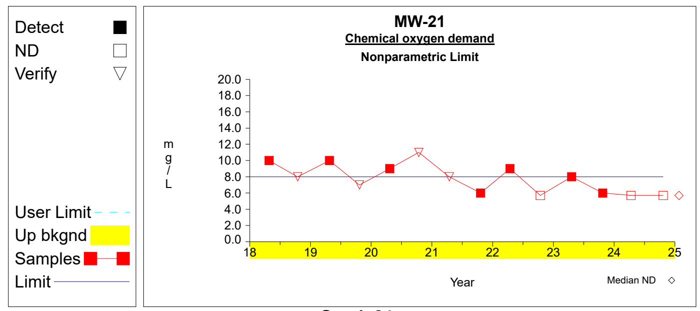
Graph 21



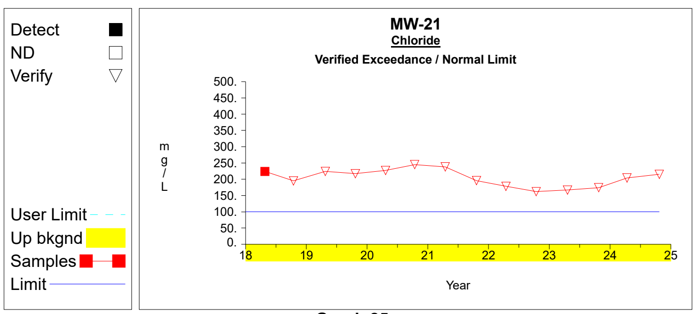
Graph 22



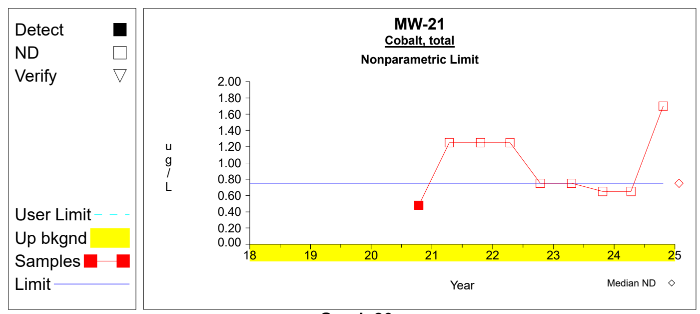
Graph 23



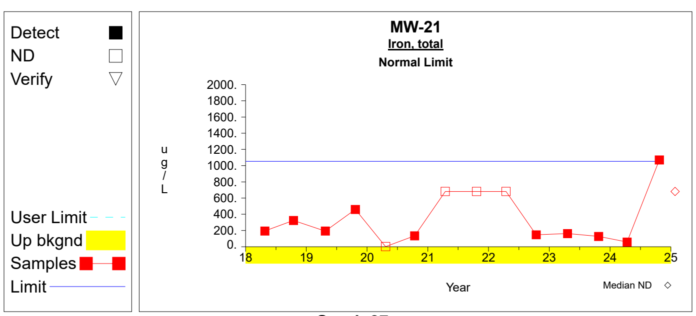
Graph 24



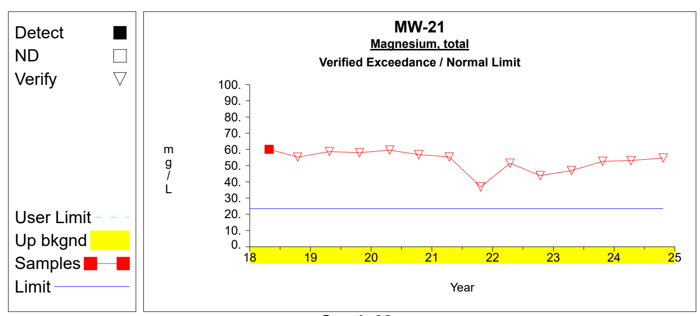
Graph 25



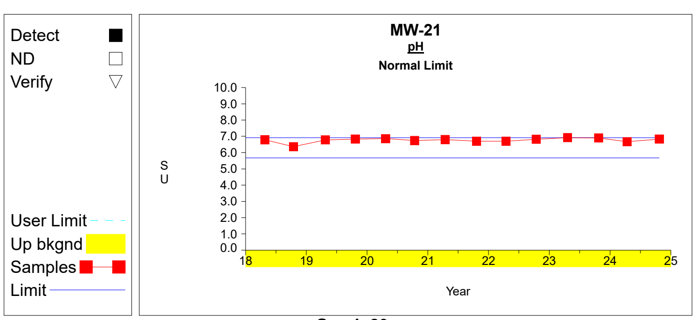
Graph 26



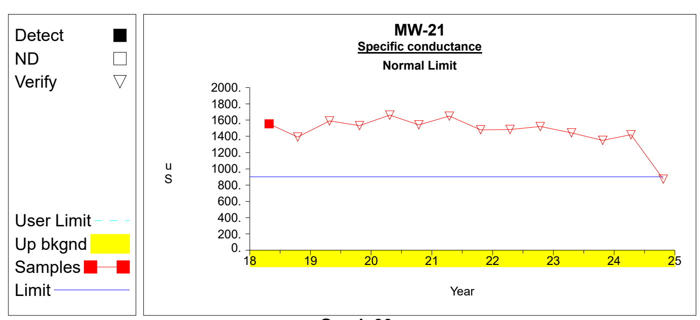
Graph 27



Graph 28

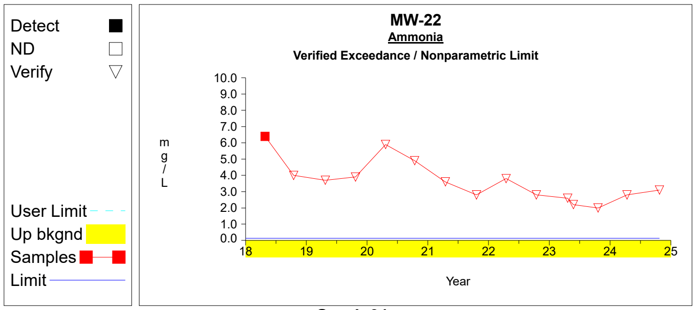


Graph 29

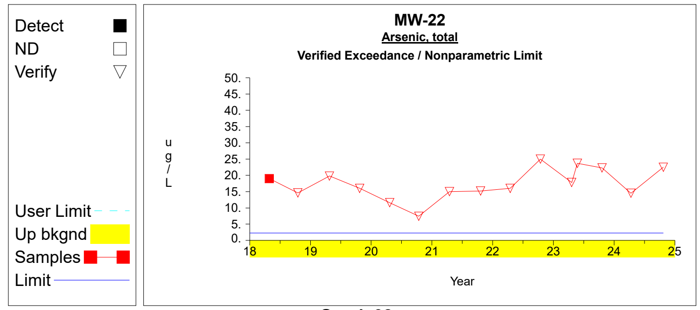


Graph 30

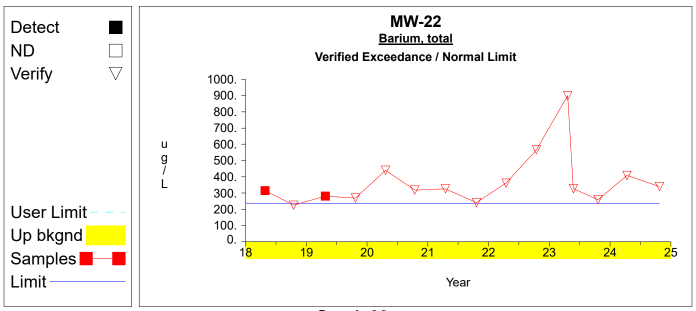
Up vs. Down Prediction Limits



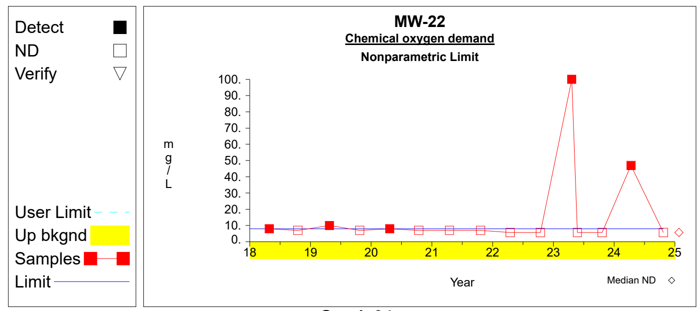
Graph 31



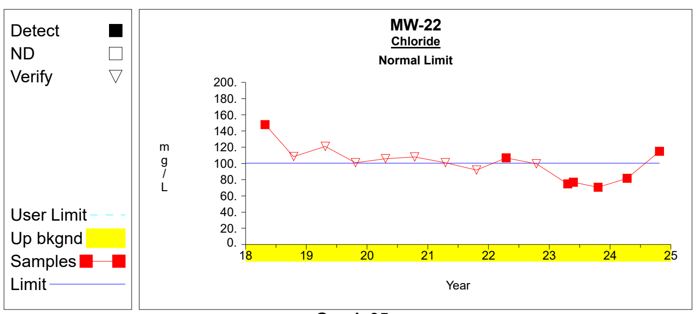
Graph 32



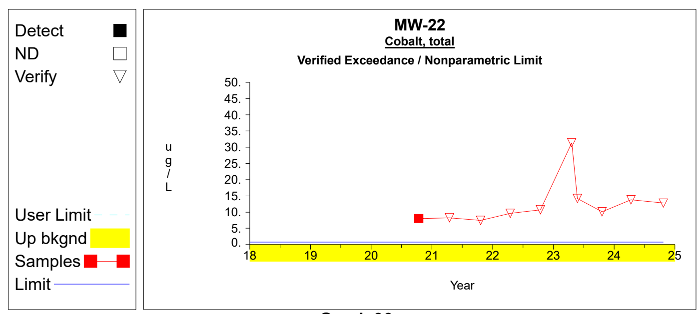
Graph 33



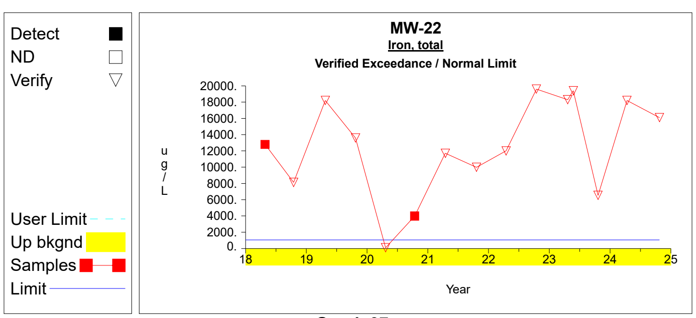
Graph 34



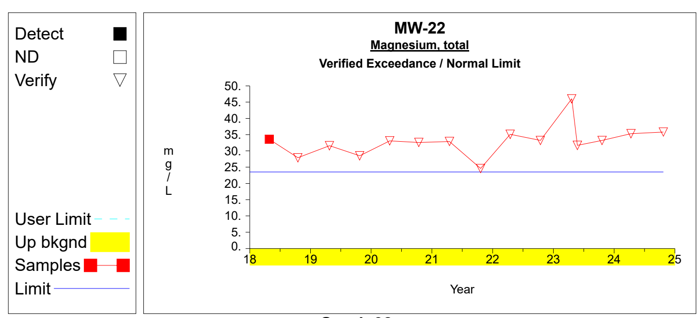
Graph 35



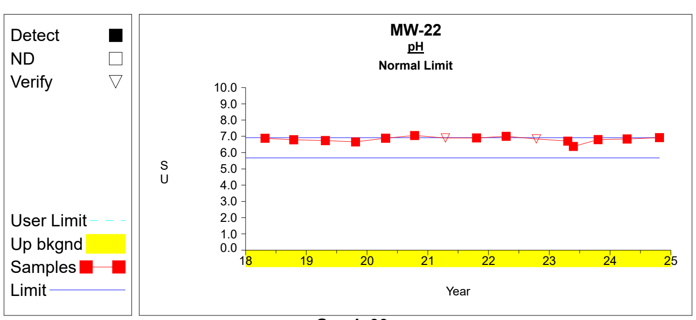
Graph 36



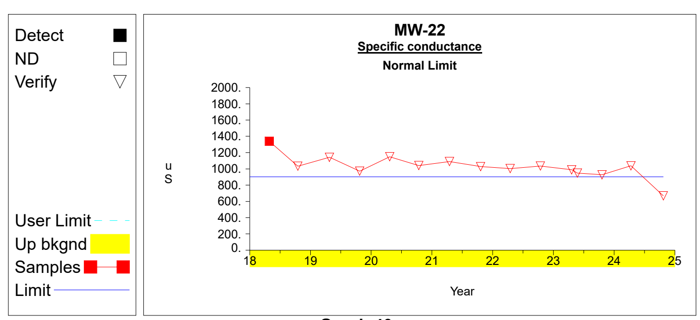
Graph 37



Graph 38

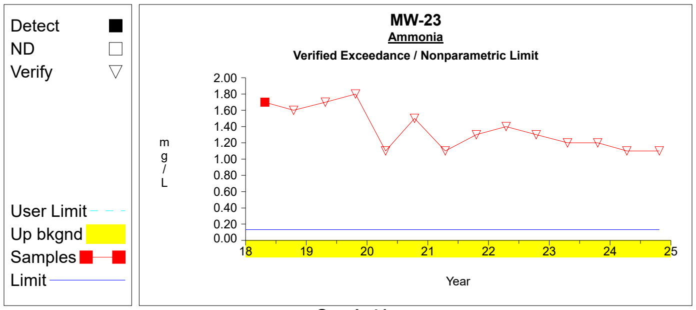


Graph 39

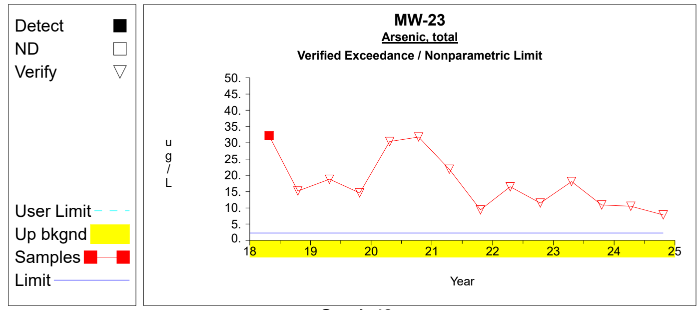


Graph 40

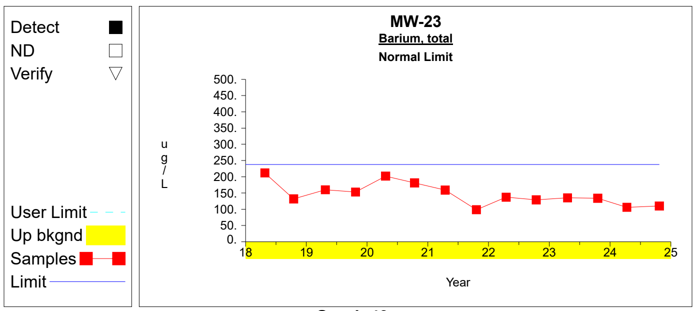
Up vs. Down Prediction Limits



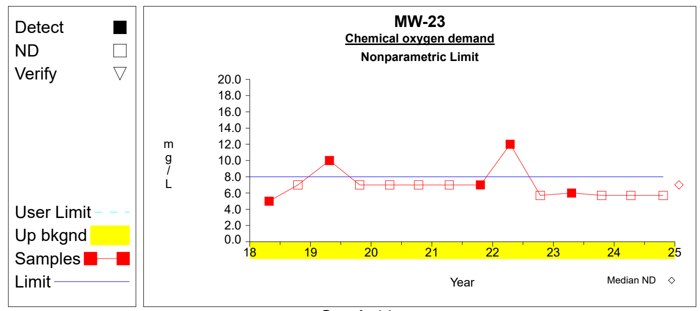
Graph 41



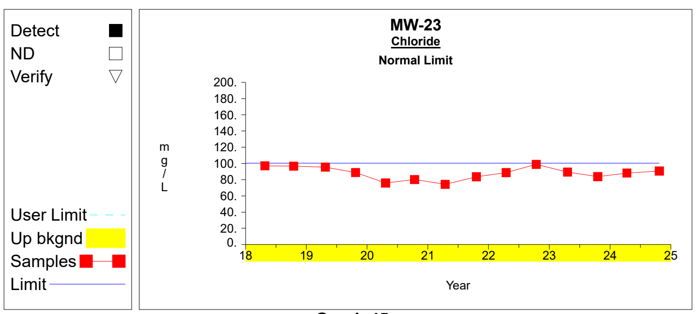
Graph 42



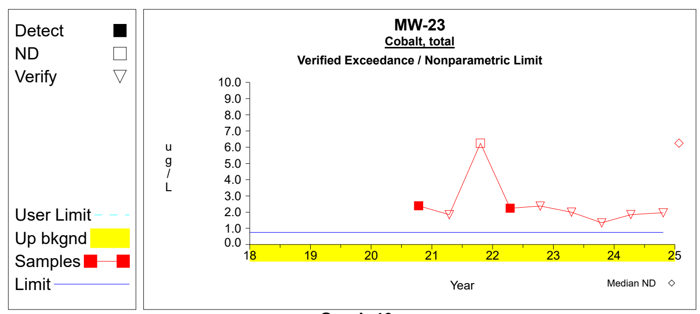
Graph 43



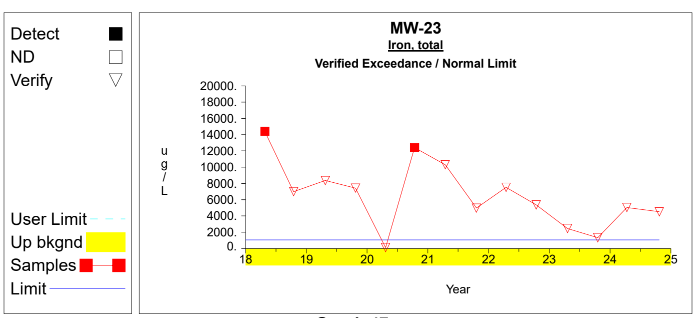
Graph 44



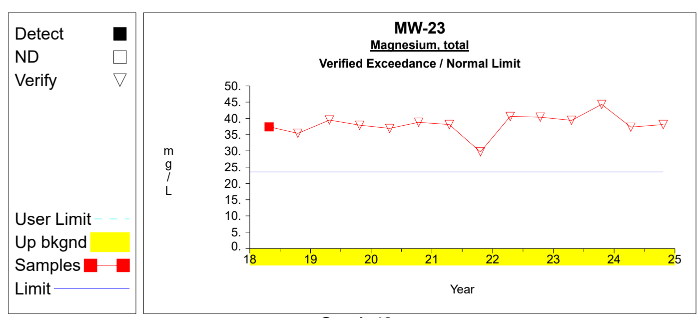
Graph 45



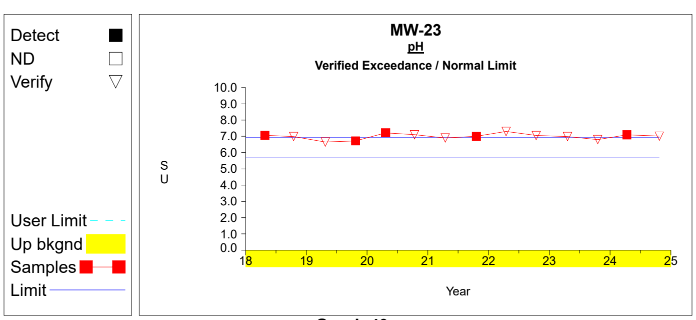
Graph 46



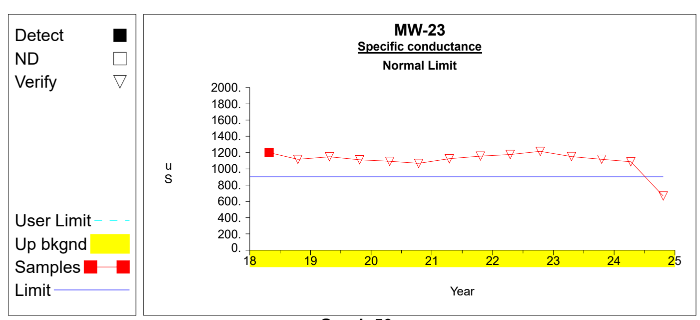
Graph 47



Graph 48

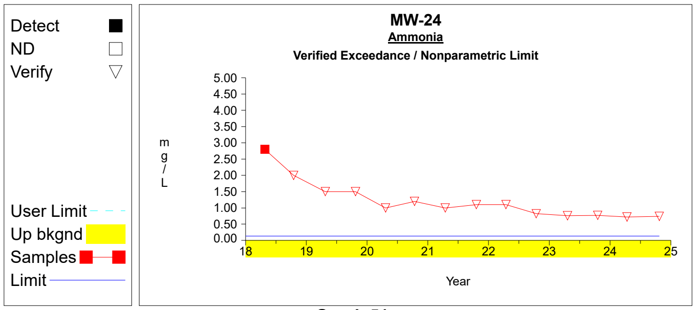


Graph 49

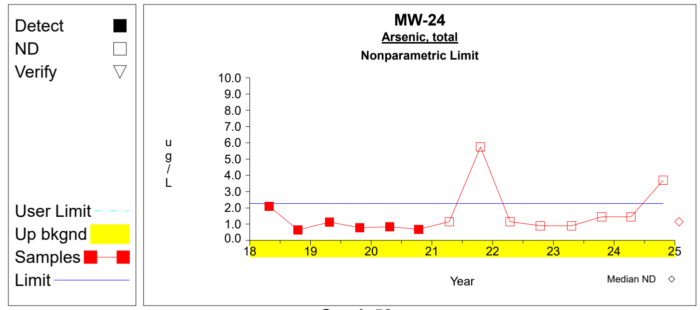


Graph 50

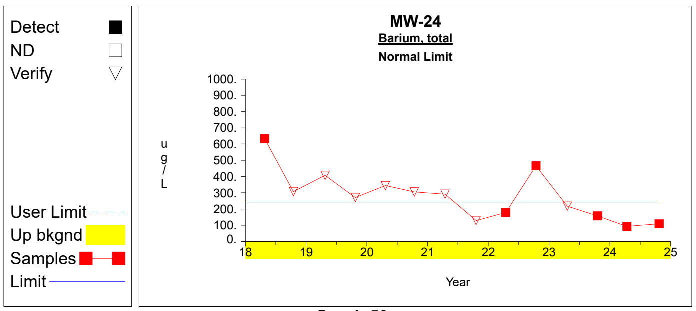
Up vs. Down Prediction Limits



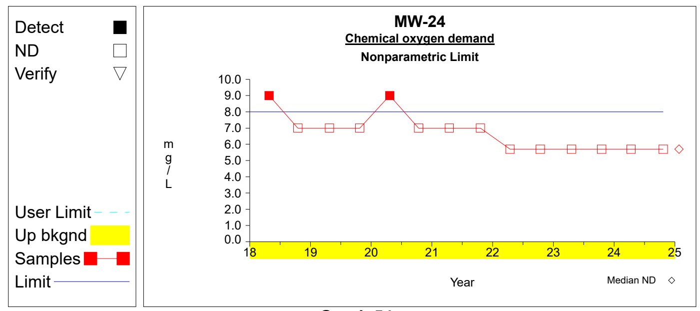
Graph 51



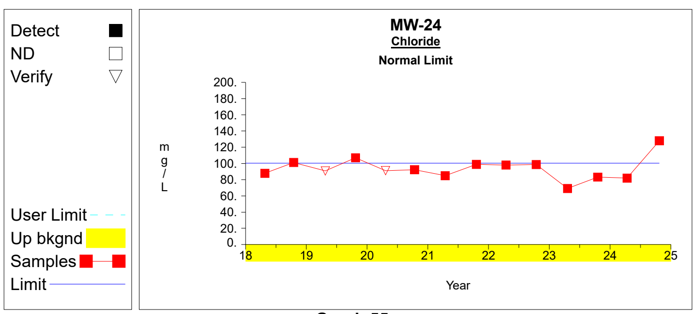
Graph 52



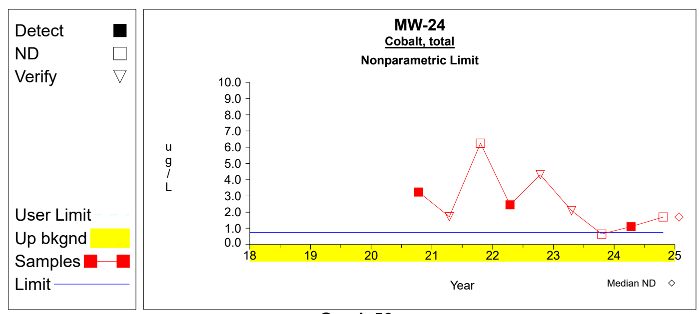
Graph 53



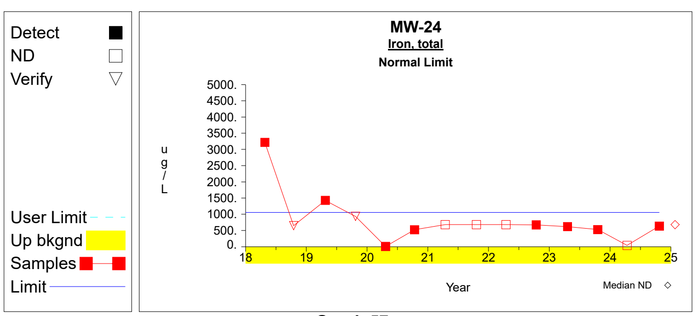
Graph 54



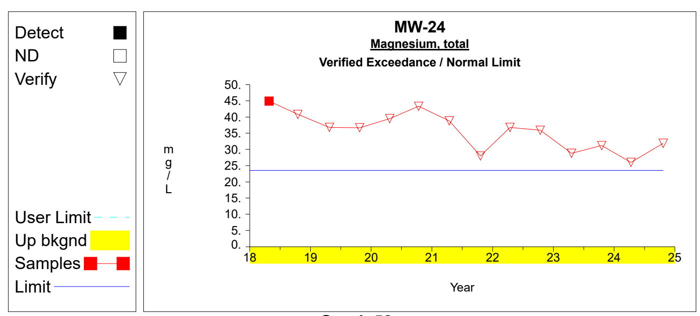
Graph 55



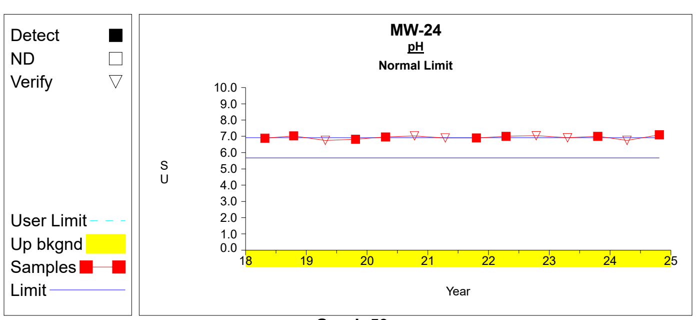
Graph 56



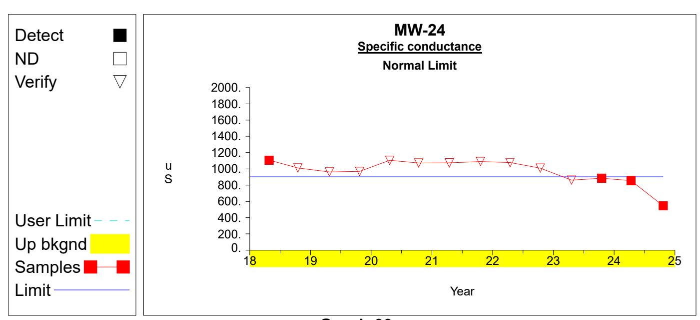
Graph 57



Graph 58

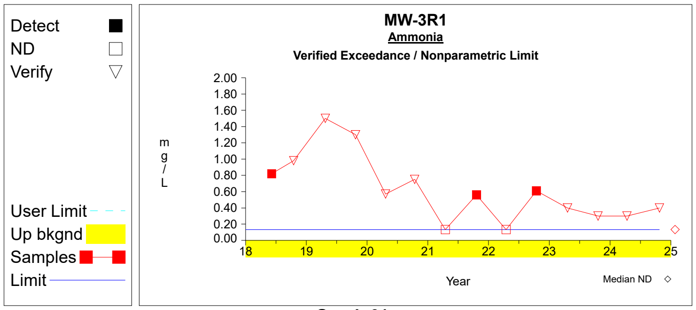


Graph 59

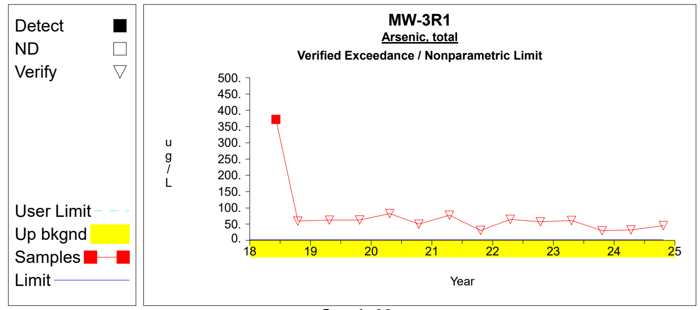


Graph 60

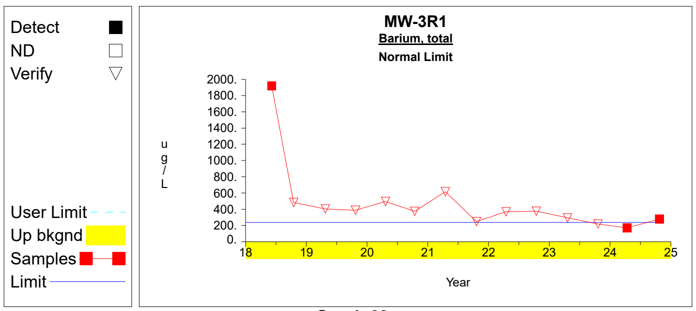
Up vs. Down Prediction Limits



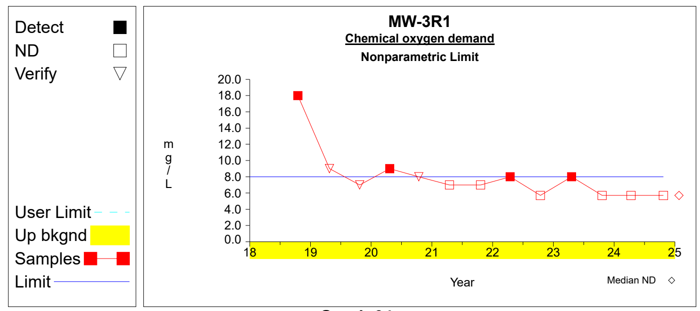
Graph 61



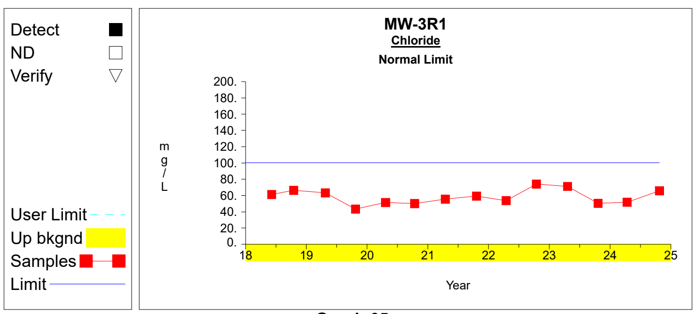
Graph 62



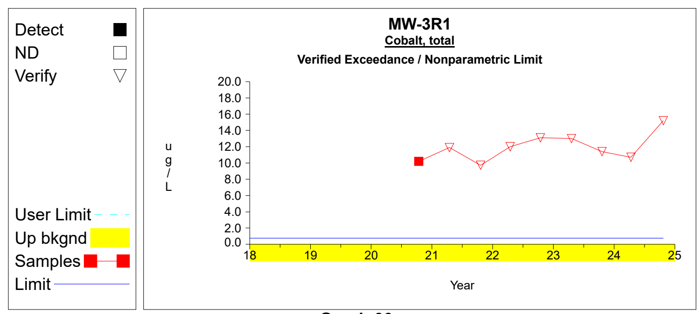
Graph 63



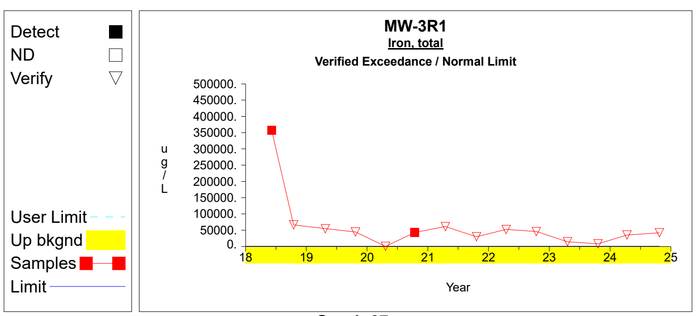
Graph 64



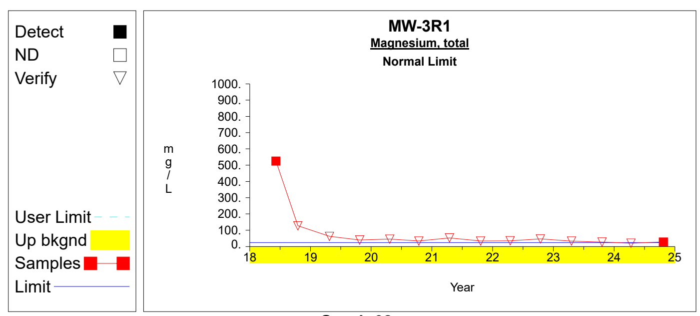
Graph 65



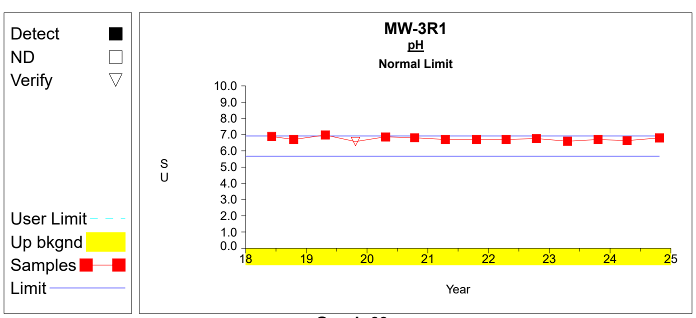
Graph 66



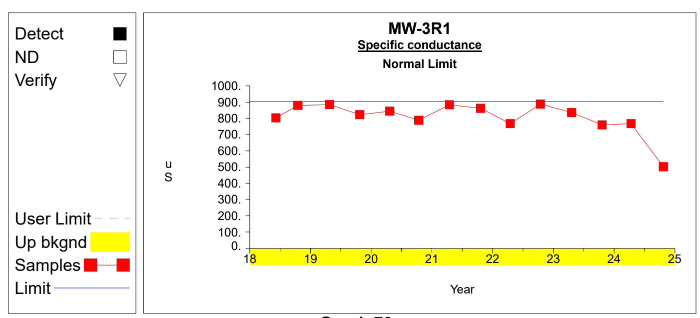
Graph 67



Graph 68

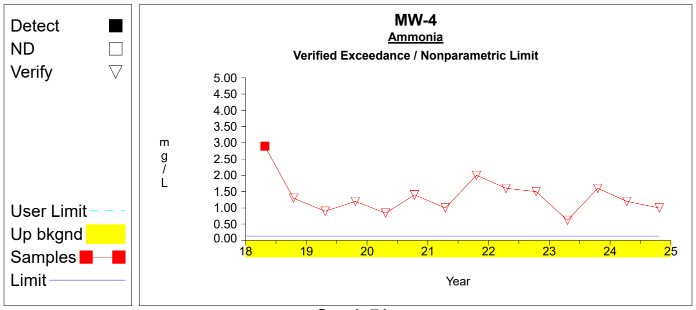


Graph 69

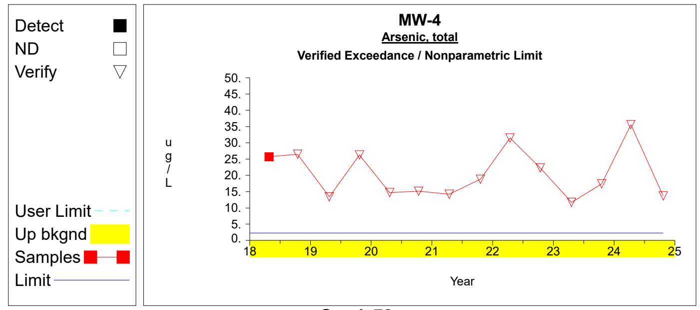


Graph 70

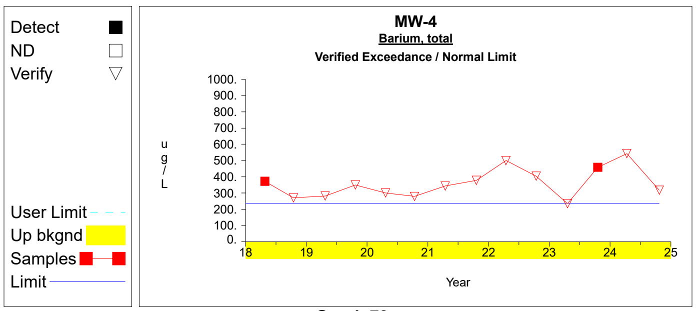
Up vs. Down Prediction Limits



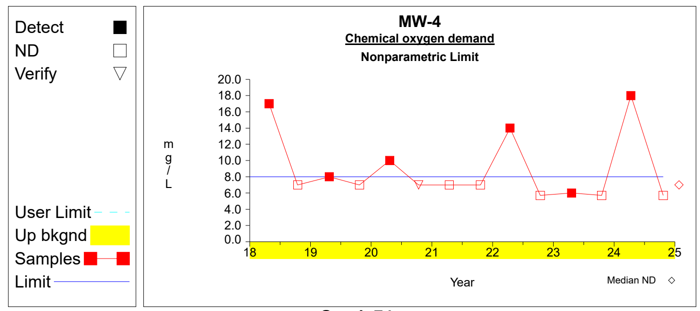
Graph 71



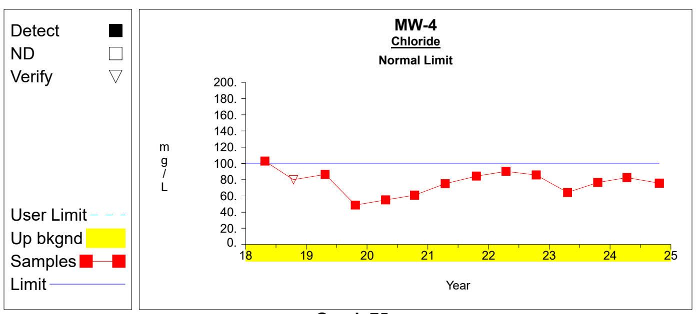
Graph 72



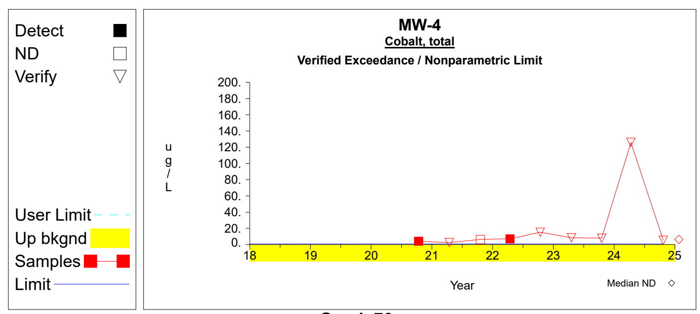
Graph 73



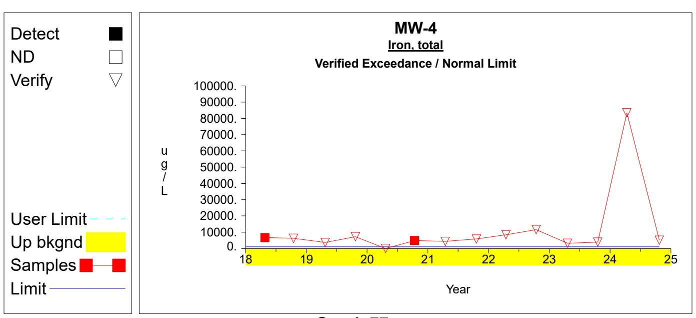
Graph 74



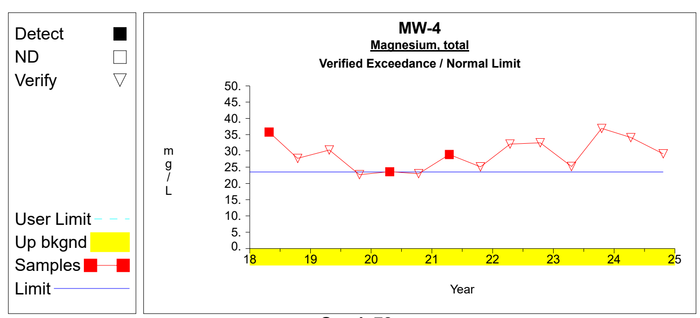
Graph 75



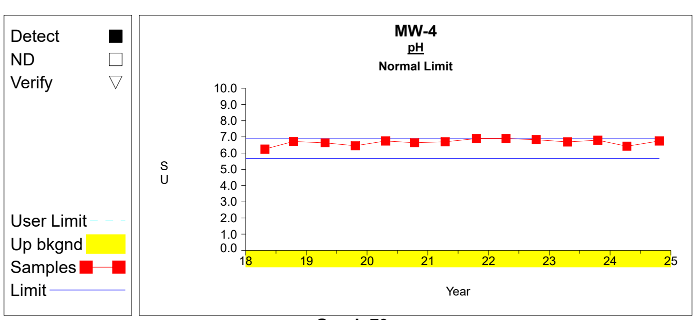
Graph 76



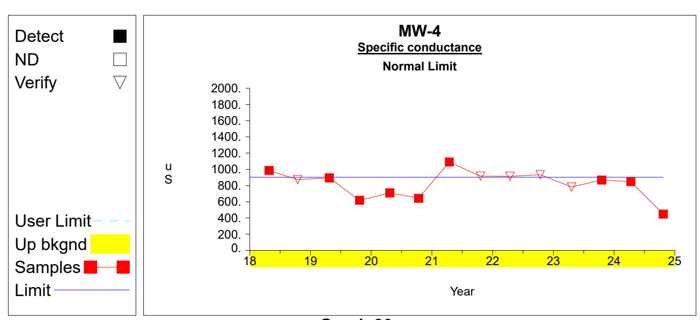
Graph 77



Graph 78

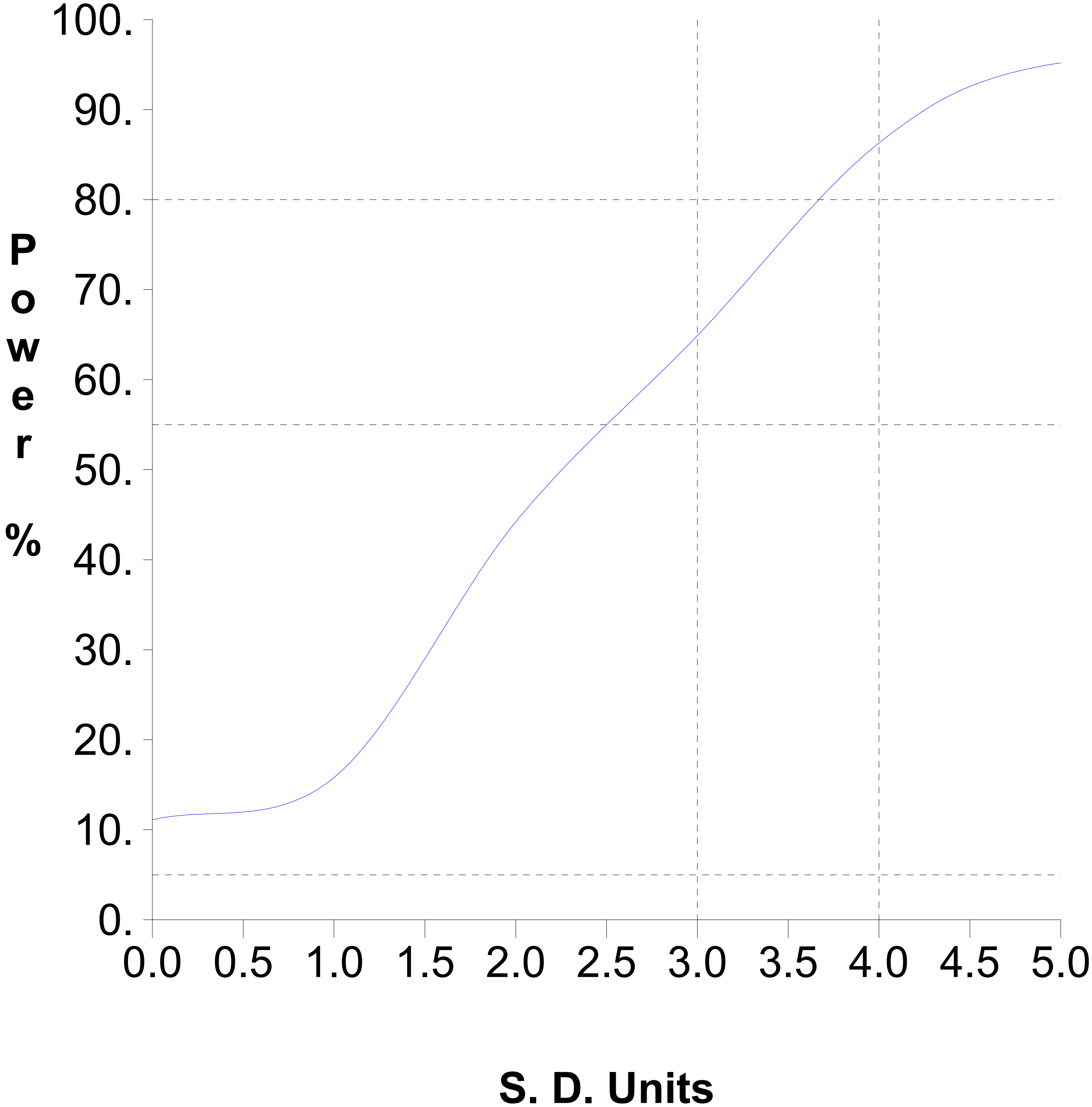


Graph 79



Graph 80

False Positive and False Negative Rates for Current Upgradient vs. Downgradient Monitoring Program



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

Step	Equation	Description
1	PL = median(X) = **0.134**	Compute nonparametric prediction limit as median reporting limit in background.
2	Conf = **0.941**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Arsenic, total (ug/L)
Nonparametric Prediction Limit

Step	Equation	Description
1	PL = max(X) = **2.27**	Compute nonparametric prediction limit as largest background measurement.
2	Conf = **0.941**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Barium, total (ug/L)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{1988.0} / \mathbf{14}$ $= \mathbf{142.0}$	Compute upgradient mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{298192.0} - \mathbf{3.95}\times\mathbf{10^6}/\mathbf{14}) / (\mathbf{14}-1))^{1/2}$ $= \mathbf{34.968}$	Compute upgradient sd.
3	$alpha = min[(1-.95^{1/\mathbf{K}})^{1/2}, .01]$ $= min[(1-.95^{1/\mathbf{80}})^{1/2}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
4	$PL = \bar{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{1/2}$ $= \mathbf{142.0}$ $+ (\mathbf{2.647}*\mathbf{34.968})(1+1/\mathbf{14})^{1/2}$ $= \mathbf{237.811}$	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
Chemical oxygen demand (mg/L)
Nonparametric Prediction Limit

Step	Equation	Description
1	PL = max(X) = **8.0**	Compute nonparametric prediction limit as largest background measurement.
2	Conf = **0.941**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

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

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{707.518} / \mathbf{14}$ $= \mathbf{50.537}$	Compute upgradient mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{40048.881} - \mathbf{500581.72}/\mathbf{14}) / (\mathbf{14}-1))^{1/2}$ $= \mathbf{18.172}$	Compute upgradient sd.
3	$\text{alpha} = \min[(1-.95^{1/\mathbf{K}})^{1/2}, .01]$ $= \min[(1-.95^{1/\mathbf{80}})^{1/2}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
4	$PL = \bar{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{1/2}$ $= \mathbf{50.537}$ $+ (\mathbf{2.647}*\mathbf{18.172})(1+1/\mathbf{14})^{1/2}$ $= \mathbf{100.328}$	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 (ug/L)
Nonparametric Prediction Limit

Step	Equation	Description
1	PL = max(X) = **0.75**	Compute nonparametric prediction limit as largest background measurement.
2	Conf = **0.885**	Confidence level is based on N, K and resampling strategy (see Gibbons 1994).

Worksheet 1 - Upgradient vs. Downgradient Comparisons
Iron, total (ug/L)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X}_1 = \mathbf{sum[X_1] / N_1}$ $= \mathbf{4683.0} / \mathbf{10}$ $= \mathbf{468.3}$	Compute mean of N_1 detected measurements.
2	$S_1 = ((\mathbf{sum[X_1^2]}-\mathbf{sum[X_1]}^2/\mathbf{N_1}) / (\mathbf{N_1}-1))^{½}$ $= ((\mathbf{2.43}\times\mathbf{10^6}-\mathbf{2.19}\times\mathbf{10^7}/\mathbf{10}) / (\mathbf{10}-1))^{½}$ $= \mathbf{162.518}$	Compute sd of N_1 detected measurements.
3	$\bar{X} = (1 - \mathbf{N_0}/\mathbf{N})\ \bar{\mathbf{X}}_\mathbf{1}$ $= (1 - \mathbf{2}/\mathbf{12})\ \mathbf{468.3}$ $= \mathbf{390.25}$	Use Aitchison's method to adjust mean for presence of nondetects.
4	$S = [(1 - \mathbf{N_0}/\mathbf{N}) * \mathbf{S_1}^2 + (\mathbf{N_0}/\mathbf{N}) (1 - (\mathbf{N_0}-1)/(\mathbf{N}-1))\ \bar{\mathbf{X}}_\mathbf{1}^2]^{½}$ $= [(1 - \mathbf{2}/\mathbf{12}) * \mathbf{162.518}^2 + (\mathbf{2}/\mathbf{12}) (1 - (\mathbf{2}-1)/(\mathbf{12}-1))\ \mathbf{468.3}^2]^{½}$ $= \mathbf{235.028}$	Use Aitchison's method to adjust sd for presence of nondetects.
5	$alpha = \min[(1-.95^{1/\mathbf{K}})^{½}, .01]$ $= \min[(1-.95^{1/\mathbf{80}})^{½}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
6	$PL = \bar{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{½}$ $= \mathbf{390.25} + (\mathbf{2.713}*\mathbf{235.028})(1+1/\mathbf{12})^{½}$ $= \mathbf{1053.826}$	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
Magnesium, total (mg/L)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **183.82** / **14** = **13.13**	Compute upgradient mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**2600.475** - **33789.792**/**14**) / (**14**-1))$^{1/2}$ = **3.792**	Compute upgradient sd.
3	alpha = min[(1-.95$^{1/\mathbf{K}}$)$^{1/2}$, .01] = min[(1-.95$^{1/\mathbf{80}}$)$^{1/2}$, .01] = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample.
4	PL = $\bar{\mathbf{X}}$ + **tS**(1+1/**N**)$^{1/2}$ = **13.13** + (**2.647*****3.792**)(1+1/**14**)$^{1/2}$ = **23.52**	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
pH (SU)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **88.16** / **14** = **6.297**	Compute upgradient mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**555.678** - **7772.186**/**14**) / (**14**-1))$^{1/2}$ = **0.2**	Compute upgradient sd.
3	alpha = min[(1-.95$^{1/\mathbf{K}}$)$^{1/2}$, .01] = min[(1-.95$^{1/\mathbf{80}}$)$^{1/2}$, .01] = **0.01**	Adjusted per comparison false positive rate. Pass initial or 1 resample. Two-sided probability.
4	PL = $\bar{\mathbf{X}}$ ± **tS**(1+1/**N**)$^{1/2}$ = **6.297** ± (**3.006*****0.2**)(1+1/**14**)$^{1/2}$ = **5.674**, **6.92**	Two-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
Specific conductance (uS)
Normal Prediction Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{6430.6} / \mathbf{14}$ $= \mathbf{459.329}$	Compute upgradient mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{½}$ $= ((\mathbf{3.29}\text{x}\mathbf{10^6} - \mathbf{4.14}\text{x}\mathbf{10^7}/\mathbf{14}) / (\mathbf{14}-1))^{½}$ $= \mathbf{161.838}$	Compute upgradient sd.
3	$\text{alpha} = \min[(1-.95^{1/\mathbf{K}})^{½}, .01]$ $= \min[(1-.95^{1/\mathbf{80}})^{½}, .01]$ $= \mathbf{0.01}$	Adjusted per comparison false positive rate. Pass initial or 1 resample.
4	$PL = \bar{\mathbf{X}} + \mathbf{tS}(1+1/\mathbf{N})^{½}$ $= \mathbf{459.329}$ $+ (\mathbf{2.647}*\mathbf{161.838})(1+1/\mathbf{14})^{½}$ $= \mathbf{902.758}$	One-sided normal prediction limit (t is Student's t on N-1 degrees of freedom and 1-alpha confidence level).

Attachment E

Summary Tables and Graphs for the Intrawell Comparisons
Second Semi-Annual Monitoring Event in 2024

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	
Ammonia	mg/L	MW-1	9	5	14	0.7611	0.1978	0.5500	0.5300	0.7611	0.7611	2.0466	normal		
Arsenic, total	ug/L	MW-1	9	5	14	3.1622	1.5982	3.6500	3.7000	3.1622	3.1622	13.5503	normal		
Barium, total	ug/L	MW-1	9	5	14	189.6667	35.5282	222.0000	219.0000	189.6667	189.6667	420.5997	normal		
Chemical oxygen demand	mg/L	MW-1	9	5	14	14.4444	8.7194	5.7000	5.7000	14.4444	14.4444	71.1205	normal		
Chloride	mg/L	MW-1	9	5	14	10.3244	8.1872	5.5300	4.6200	10.3244	10.3244	63.5412	normal		
Cobalt, total	ug/L	MW-1	4	5	9	1.3550	0.4337	0.6500	1.7000	1.3550	1.3550	4.1741	normal		
Iron, total	ug/L	MW-1	8	5	14	5156.2500	2478.8704	5270.0000	5400.0000	5156.2500	5156.2500	21268.9073	normal		
Magnesium, total	mg/L	MW-1	9	5	14	26.0111	3.9813	29.4000	29.0000	27.3262	26.3337	51.8899	normal		
pH	SU	MW-1	9	5	14	7.1689	0.2980	6.9700	6.3700	7.1689	7.1689	5.23 - 9.11	normal		
Specific conductance	uS	MW-1	9	5	14	661.0000	49.9274	721.0000	956.5000	689.2902	934.8628	985.5284	normal		
Ammonia	mg/L	MW-2	9	5	14								nonpar *		**
Arsenic, total	ug/L	MW-2	8	5	14	1.4925	0.2142	1.6200	3.7000	2.0791	1.4925	2.8848	normal		
Barium, total	ug/L	MW-2	9	5	14	185.4444	37.3032	114.0000	126.0000	185.4444	185.4444	427.9152	normal		
Chemical oxygen demand	mg/L	MW-2	9	5	14	7.1111	0.3333	5.7000	5.7000	7.1111	7.1111	9.2778	normal		
Chloride	mg/L	MW-2	9	5	14	48.4391	18.0710	64.6000	100.0000	48.4391	81.9290	165.9005	normal		
Cobalt, total	ug/L	MW-2	4	5	9	6.4475	3.0866	0.8700	1.7000	6.4475	6.4475	26.5102	normal		
Iron, total	ug/L	MW-2	8	5	14	523.0625	231.6665	42.9500	587.0000	523.0625	523.0625	2028.8950	normal		
Magnesium, total	mg/L	MW-2	9	5	14	22.3889	3.0387	23.7000	22.0000	29.1062	25.6786	42.1403	normal		
pH	SU	MW-2	9	5	14	6.4456	0.2034	6.7100	6.4800	6.5597	6.4456	5.12 - 7.77	normal		
Specific conductance	uS	MW-2	9	5	14	668.4444	73.4934	748.0000	532.2000	750.6310	668.4444	1146.1515	normal		
Ammonia	mg/L	MW-21	9	5	14								nonpar *		**
Arsenic, total	ug/L	MW-21	9	5	14	1.2344	0.3704	1.4500	3.7000	1.2344	1.2344	3.6423	normal		
Barium, total	ug/L	MW-21	9	5	14	363.2222	63.0273	343.0000	350.0000	363.2222	363.2222	772.8999	normal		
Chemical oxygen demand	mg/L	MW-21	9	5	14	8.6667	1.5811	5.7000	5.7000	8.6667	8.6667	18.9441	normal		
Chloride	mg/L	MW-21	9	5	14	215.9928	21.9695	204.0000	215.0000	215.9928	215.9928	358.7944	normal		
Cobalt, total	ug/L	MW-21	4	5	9	1.0575	0.3850	0.6500	1.7000	1.0575	1.0575	3.5600	normal		
Iron, total	ug/L	MW-21	8	5	14	418.5625	239.2071	58.0000	1070.0000	418.5625	830.7929	1973.4086	normal		
Magnesium, total	mg/L	MW-21	9	5	14	54.7000	7.1798	53.1000	54.8000	54.7000	54.7000	101.3689	normal		
pH	SU	MW-21	9	5	14	6.7289	0.1486	6.6700	6.8300	6.7289	6.7289	5.76 - 7.69	normal		
Specific conductance	uS	MW-21	9	5	14	1542.5556	85.2674	1420.0000	874.5000	1542.5556	1542.5556	2096.7936	normal		
Ammonia	mg/L	MW-22	9	6	15	4.3333	1.1683	2.8000	3.1000	4.3333	4.3333	11.9275	normal		
Arsenic, total	ug/L	MW-22	9	6	15	14.9578	3.7121	14.5000	22.5000	24.9081	28.7382	39.0867	normal		
Barium, total	ug/L	MW-22	9	6	15	308.4444	65.5098	408.0000	339.0000	373.6277	338.6735	734.2578	normal		
Chemical oxygen demand	mg/L	MW-22	9	6	15	7.5556	1.0138	47.0000	5.7000	45.9862	7.5556	14.1452	normal		
Chloride	mg/L	MW-22	9	6	15	110.2439	16.1508	81.7000	115.0000	110.2439	110.2439	215.2241	normal		
Cobalt, total	ug/L	MW-22	4	6	10	8.3275	0.9308	13.8000	12.8000	15.1526	14.1526	14.3776	normal		
Iron, total	ug/L	MW-22	8	6	15	11301.2500	4157.6279	18200.0000	16100.0000	16046.8606	16687.9827	38325.8313	normal		
Magnesium, total	mg/L	MW-22	9	6	15	31.1000	3.3771	35.3000	35.8000	39.3915	40.7144	53.0513	normal		
pH	SU	MW-22	9	6	15	6.8678	0.1219	6.8400	6.9200	6.8678	6.8678	6.08 - 7.66	normal		
Specific conductance	uS	MW-22	9	6	15	1088.7778	111.5154	1038.0000	668.4000	1088.7778	1088.7778	1813.6282	normal		
Ammonia	mg/L	MW-23	9	5	14	1.4667	0.2598	1.1000	1.1000	1.4667	1.4667	3.1554	normal		
Arsenic, total	ug/L	MW-23	9	5	14	21.2000	8.4049	10.5000	7.8700	21.2000	21.2000	75.8319	normal		
Barium, total	ug/L	MW-23	9	5	14	159.4000	35.4237	106.0000	110.0000	159.4000	159.4000	389.6542	normal		
Chemical oxygen demand	mg/L	MW-23	9	5	14	7.6667	2.0616	5.7000	5.7000	7.6667	7.6667	21.0668	normal		
Chloride	mg/L	MW-23	9	5	14	86.7652	8.7783	88.2000	90.7000	86.7652	86.7652	143.8243	normal		
Cobalt, total	ug/L	MW-23	4	5	9	3.1800	2.0598	1.8500	1.9600	3.1800	3.1800	16.5686	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.

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	
Iron, total	ug/L	MW-23	8	5	14	9047.5000	3109.8404	5050.0000	4510.0000	9047.5000	9047.5000	29261.4624	normal		
Magnesium, total	mg/L	MW-23	9	5	14	37.1444	3.1682	37.3000	38.1000	38.1191	37.1444	57.7380	normal		
pH	SU	MW-23	9	5	14	6.9944	0.2133	7.0900	7.0100	6.9944	6.9944	5.61 - 8.38	normal		
Specific conductance	uS	MW-23	9	5	14	1133.1111	42.0935	1087.0000	666.9000	1133.1111	1133.1111	1406.7187	normal		
Ammonia	mg/L	MW-24	9	5	14	1.4667	0.5958	0.7200	0.7400	1.4667	1.4667	5.3395	normal		
Arsenic, total	ug/L	MW-24	9	5	14	1.0689	0.4413	1.4500	3.7000	1.0689	1.0689	3.9371	normal		
Barium, total	ug/L	MW-24	9	5	14	318.6667	144.3373	93.6000	109.0000	318.6667	318.6667	1256.8590	normal		
Chemical oxygen demand	mg/L	MW-24	9	5	14								nonpar *		**
Chloride	mg/L	MW-24	9	5	14	94.6720	7.0513	82.0000	128.0000	94.6720	120.9487	140.5052	normal		
Cobalt, total	ug/L	MW-24	4	5	9	3.4150	1.9893	1.1000	1.7000	3.4150	3.4150	16.3455	normal		
Iron, total	ug/L	MW-24	8	5	14	1100.5625	901.5777	42.9500	636.0000	1100.5625	1100.5625	6960.8174	normal		
Magnesium, total	mg/L	MW-24	9	5	14	38.4000	4.8678	26.0000	31.9000	38.4000	38.4000	70.0404	normal		
pH	SU	MW-24	9	5	14	6.9200	0.0954	6.7500	7.0900	6.9200	6.9946	6.30 - 7.54	normal		
Specific conductance	uS	MW-24	9	5	14	1052.0000	56.4424	855.0000	547.0000	1052.0000	1052.0000	1418.8759	normal		
Ammonia	mg/L	MW-26	9	5	14								nonpar *		**
Arsenic, total	ug/L	MW-26	9	5	14	0.7889	0.5763	1.4500	3.7000	0.7889	0.7889	4.5351	normal		
Barium, total	ug/L	MW-26	9	5	14	140.4444	41.2193	123.0000	140.0000	140.4444	140.4444	408.3697	normal		
Chemical oxygen demand	mg/L	MW-26	9	5	14								nonpar *		**
Chloride	mg/L	MW-26	9	5	14	43.0798	17.0679	57.8000	63.6000	58.6892	62.1416	154.0209	normal		
Cobalt, total	ug/L	MW-26	4	5	9	1.0675	0.3650	0.6500	1.7000	1.0675	1.0675	3.4400	normal		
Iron, total	ug/L	MW-26	8	5	14	391.0250	138.3588	50.0000	347.0000	391.0250	391.0250	1290.3572	normal		
Magnesium, total	mg/L	MW-26	9	5	14	12.0689	3.9159	12.9000	13.8000	12.0689	12.0689	37.5221	normal		
pH	SU	MW-26	9	5	14	6.2767	0.2241	6.2100	6.1500	6.2767	6.2767	4.82 - 7.73	normal		
Specific conductance	uS	MW-26	9	5	14	421.0000	159.3730	519.0000	306.6000	434.5080	421.0000	1456.9244	normal		
Ammonia	mg/L	MW-3R1	9	5	14	0.7498	0.4677	0.3000	0.4000	0.7498	0.7498	3.7901	normal		
Arsenic, total	ug/L	MW-3R1	8	5	14	61.3250	15.9933	32.3000	45.7000	61.3250	61.3250	165.2813	normal		
Barium, total	ug/L	MW-3R1	8	5	14	422.6250	109.3434	171.0000	280.0000	422.6250	422.6250	1133.3572	normal		
Chemical oxygen demand	mg/L	MW-3R1	8	5	13	9.1250	3.6815	5.7000	5.7000	9.1250	9.1250	33.0549	normal		
Chloride	mg/L	MW-3R1	9	5	14	56.0031	7.2377	51.8000	65.9000	56.0031	58.6623	103.0481	normal		
Cobalt, total	ug/L	MW-3R1	4	5	9	10.9575	1.1627	10.7000	15.2000	10.9575	14.0373	18.5151	normal		
Iron, total	ug/L	MW-3R1	7	5	14	50357.1429	12210.2221	35500.0000	42500.0000	50357.1429	50357.1429	129723.5865	normal		
Magnesium, total	mg/L	MW-3R1	9	5	14	106.2222	159.7377	20.6000	28.3000	106.2222	106.2222	1144.5170	normal		
pH	SU	MW-3R1	9	5	14	6.7689	0.1244	6.6300	6.8000	6.7689	6.7689	5.96 - 7.58	normal		
Specific conductance	uS	MW-3R1	9	5	14	837.7778	43.8685	768.0000	502.7000	837.7778	837.7778	1122.9230	normal		
Ammonia	mg/L	MW-4	9	5	14	1.4600	0.6511	1.2000	1.0000	1.4600	1.4600	5.6920	normal		
Arsenic, total	ug/L	MW-4	9	5	14	20.6889	6.8296	35.6000	13.7000	28.7704	20.6889	65.0814	normal		
Barium, total	ug/L	MW-4	9	5	14	341.6667	72.1613	543.0000	317.0000	515.0108	418.1828	810.7150	normal		
Chemical oxygen demand	mg/L	MW-4	9	5	14	9.3333	3.7081	18.0000	5.7000	14.2919	9.3333	33.4360	normal		
Chloride	mg/L	MW-4	9	5	14	76.0033	17.8265	82.6000	75.7000	76.0033	76.0033	191.8759	normal		
Cobalt, total	ug/L	MW-4	4	5	9	4.9900	2.1229	126.0000	5.2900	133.7782	13.0682	18.7891	normal		
Iron, total	ug/L	MW-4	8	5	14	5932.5000	1589.2114	83400.0000	5090.0000	81810.7886	5932.5000	16262.3741	normal		
Magnesium, total	mg/L	MW-4	9	5	14	27.6889	4.5253	34.1000	29.1000	34.2605	31.1462	57.1035	normal		
pH	SU	MW-4	9	5	14	6.6600	0.2068	6.4300	6.7500	6.6600	6.6600	5.32 - 8.00	normal		
Specific conductance	uS	MW-4	9	5	14	849.6667	159.6731	848.0000	447.9000	849.6667	849.6667	1887.5418	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.

Table 4

Dixon's Test Outliers
1% Significance Level

Constituent	Units	Well	Date	Result	ND Qualifier	Date Range	N	Critical Value
Iron, total	ug/L	MW-1	04/21/2020	45.8000		04/26/2018-04/14/2022	9	0.6346
Arsenic, total	ug/L	MW-2	10/20/2021	5.7500	< 5.7500	04/27/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-2	04/21/2020	5.7200		04/27/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-21	04/21/2020	2.0000	< 2.0000	04/26/2018-04/14/2022	9	0.6346
Iron, total	ug/L	MW-22	04/21/2020	93.3000		04/27/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-23	04/21/2020	118.0000		04/26/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-24	04/21/2020	9.3400		04/26/2018-04/14/2022	9	0.6346
Arsenic, total	ug/L	MW-3R1	06/05/2018	372.0000		06/05/2018-04/15/2022	9	0.6346
Barium, total	ug/L	MW-3R1	06/05/2018	1920.0000		06/05/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-3R1	06/05/2018	357000.0000		06/05/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-3R1	04/21/2020	535.0000		06/05/2018-04/15/2022	9	0.6346
Iron, total	ug/L	MW-4	04/21/2020	36.2000		04/26/2018-04/14/2022	9	0.6346

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.

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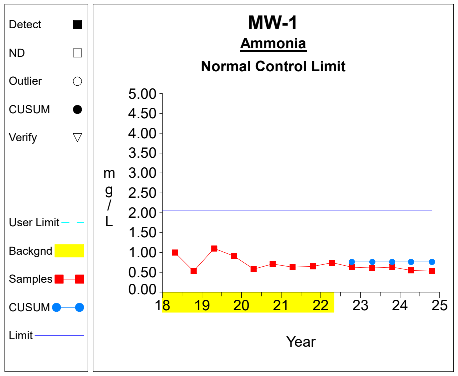
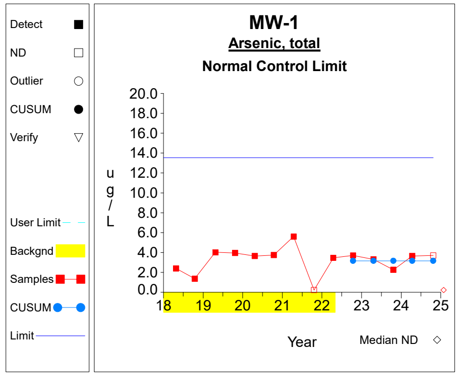
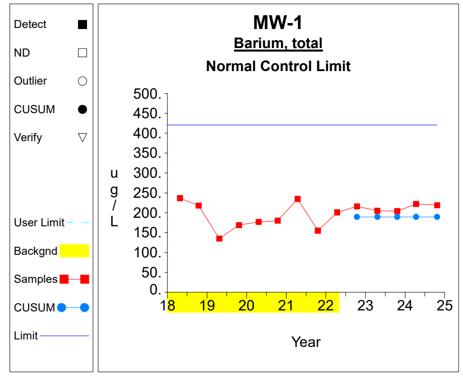
Intra-Well Control Charts / Prediction Limits



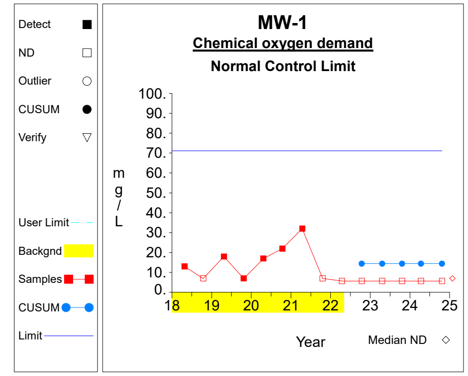
Graph 1



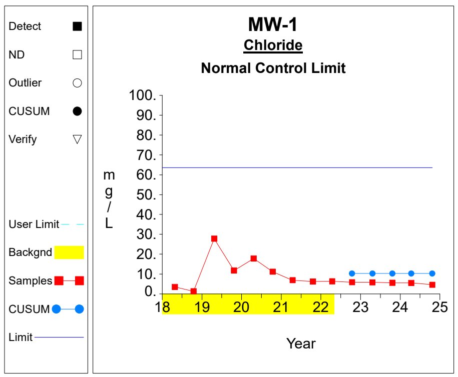
Graph 2



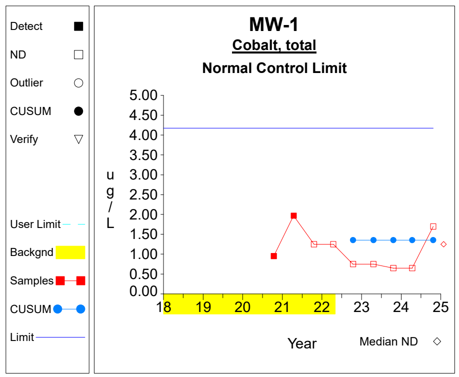
Graph 3



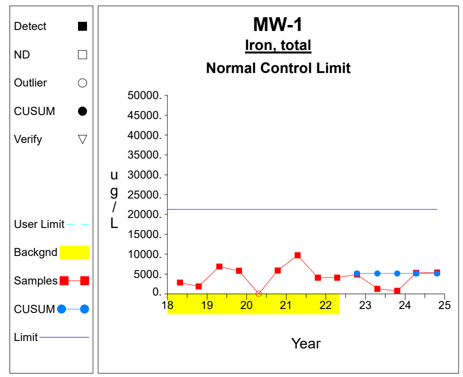
Graph 4



Graph 5



Graph 6



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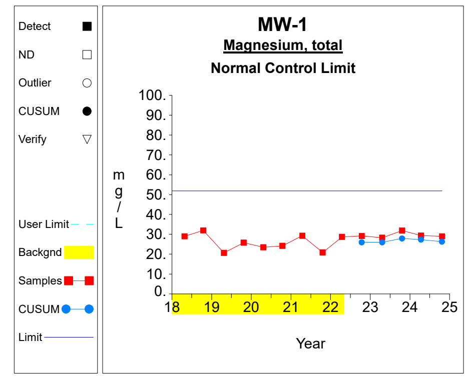

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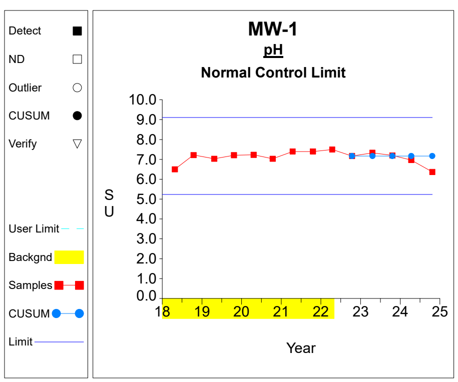
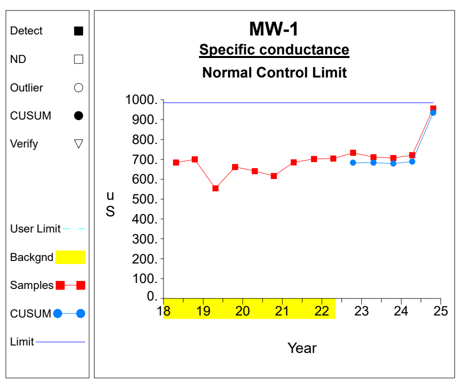


Graph 9



Graph 10

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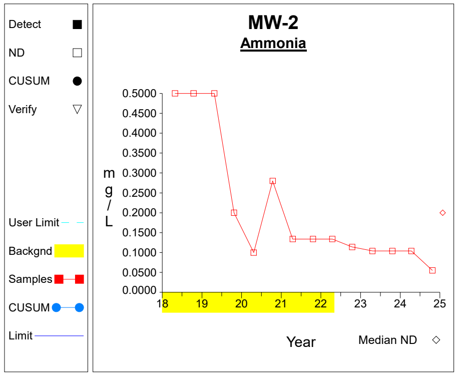
Intra-Well Control Charts / Prediction Limits



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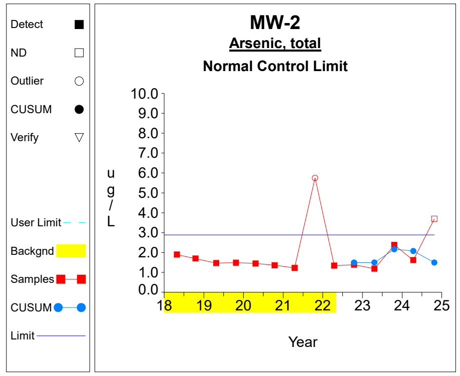

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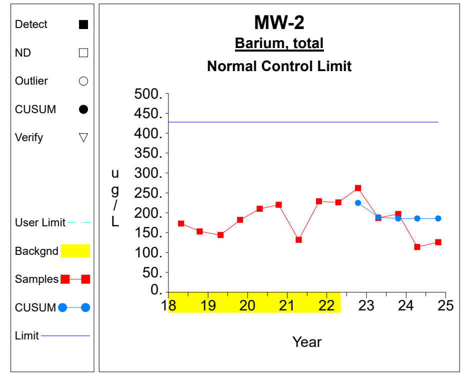

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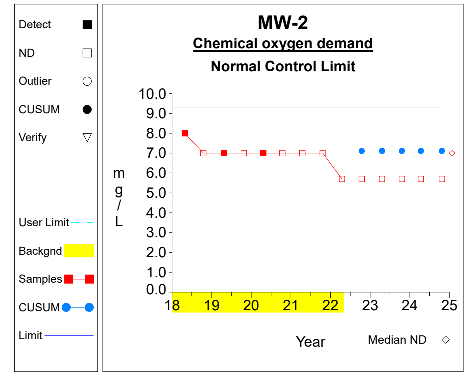

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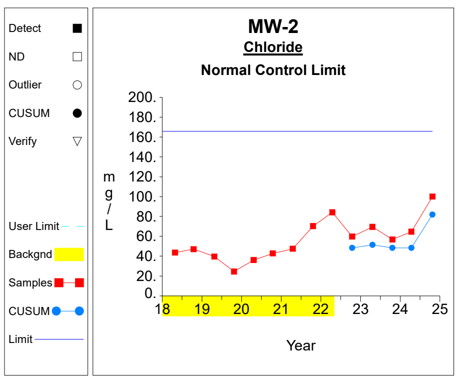

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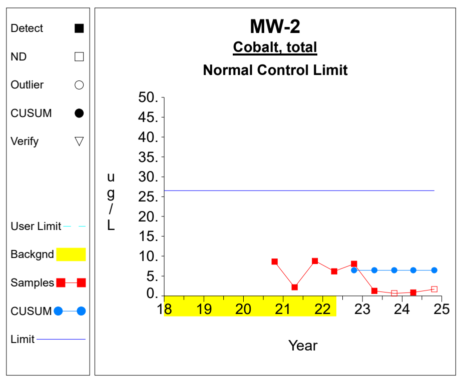

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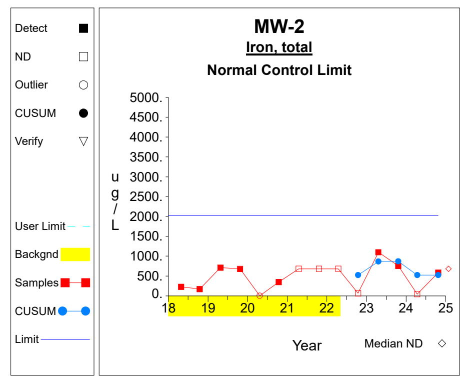

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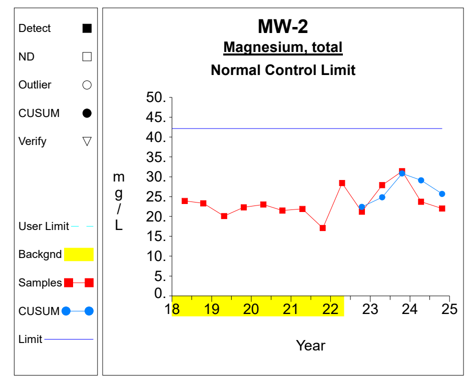

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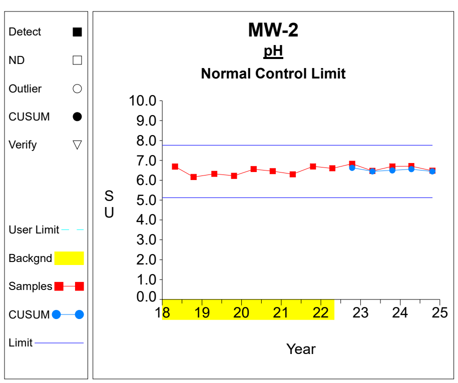

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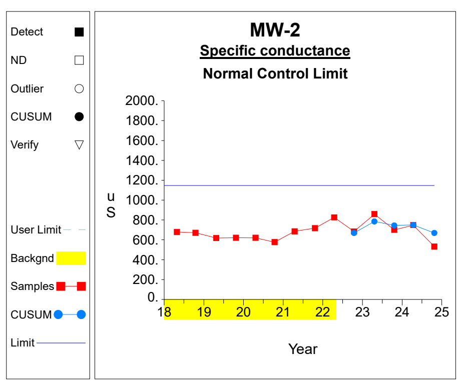
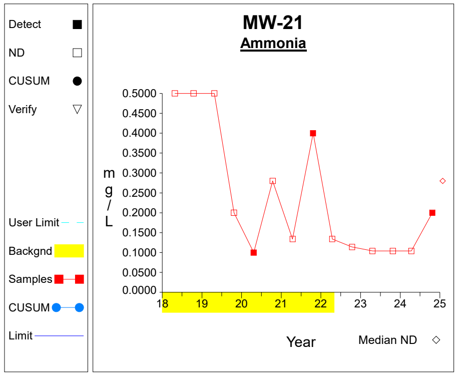


Graph 20

Intra-Well Control Charts / Prediction Limits



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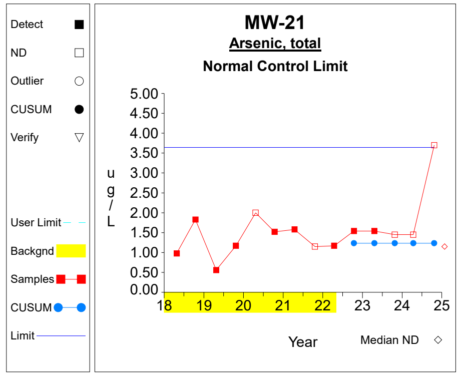

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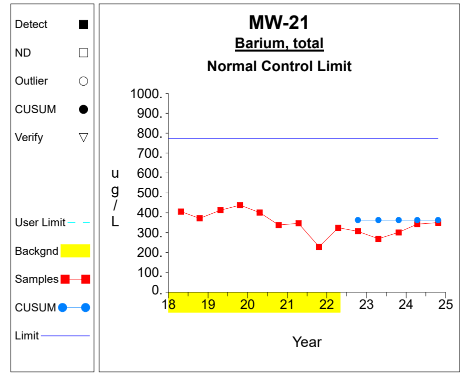

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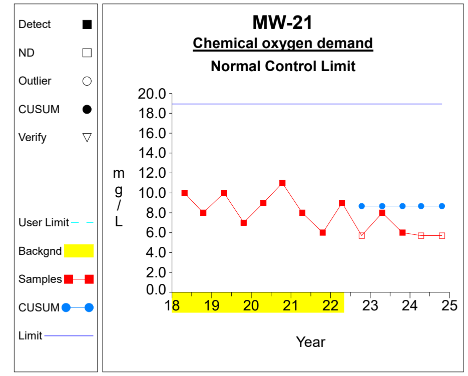

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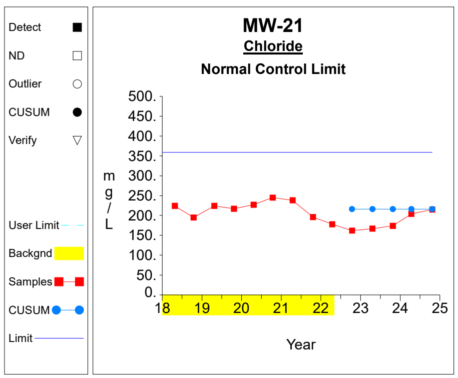

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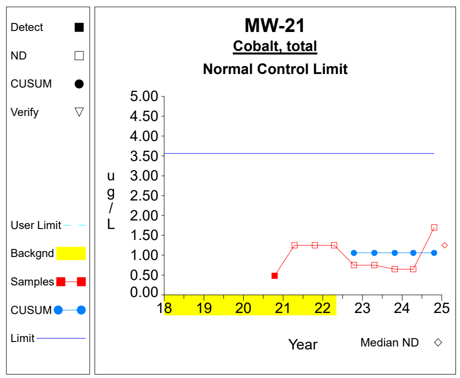

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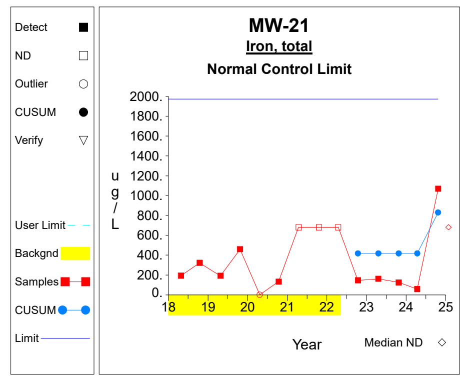

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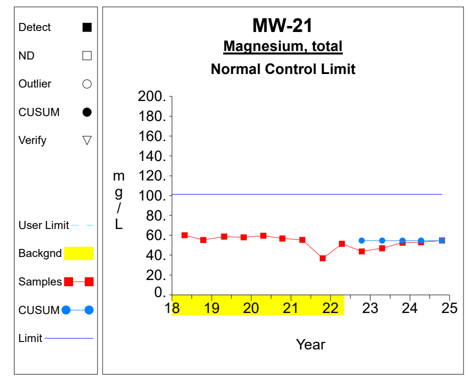

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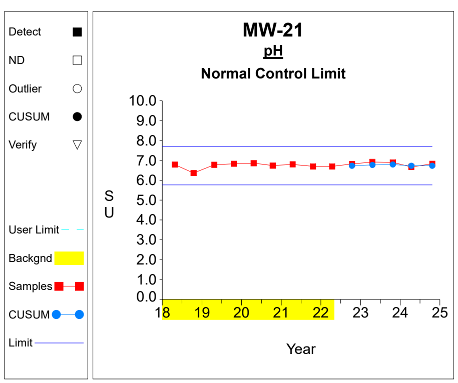

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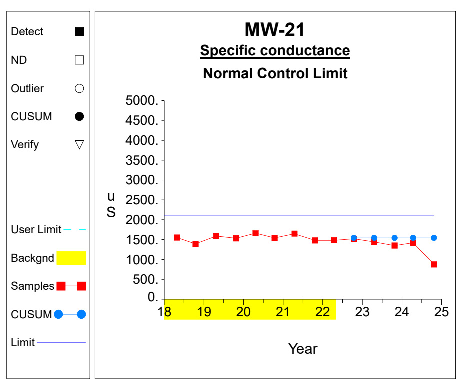

Graph 30

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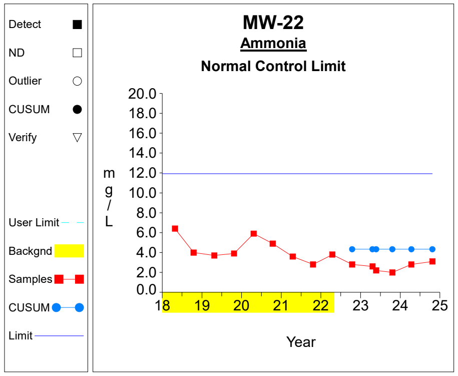
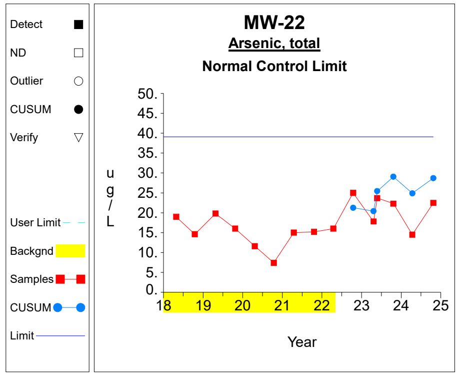
Intra-Well Control Charts / Prediction Limits



Graph 31



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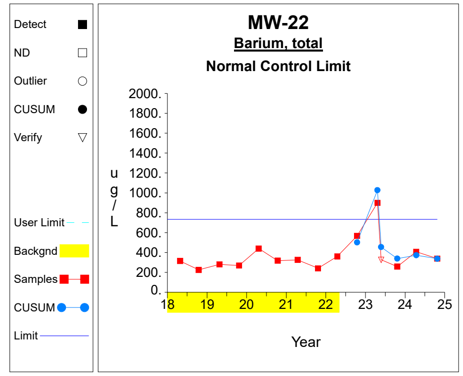

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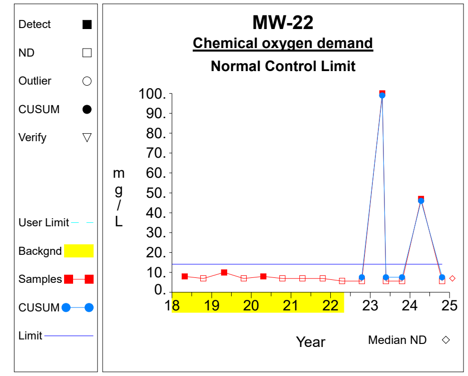

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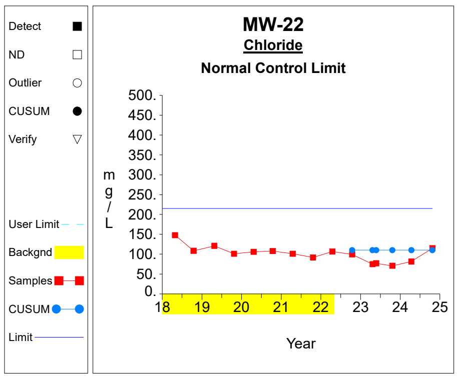

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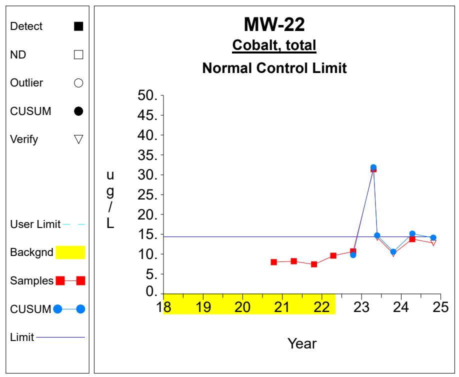
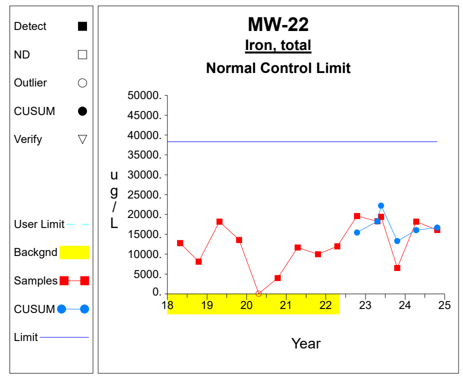


Graph 36



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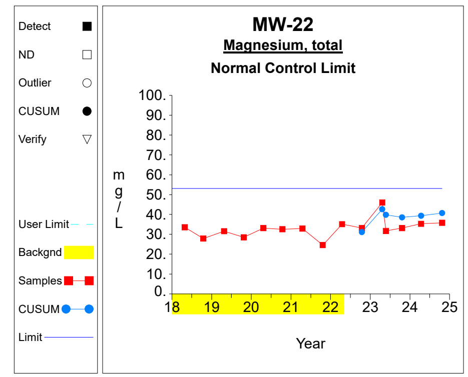

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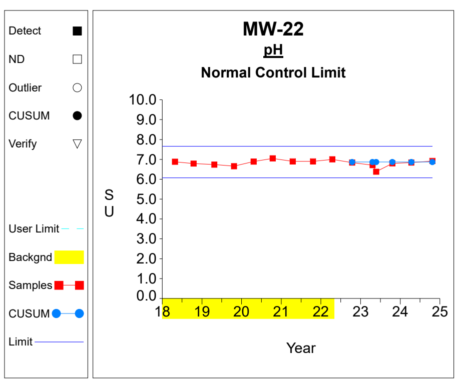

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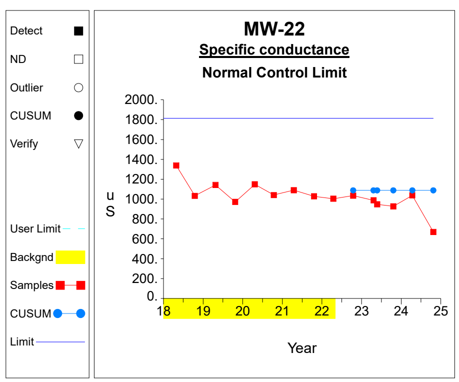

Graph 40

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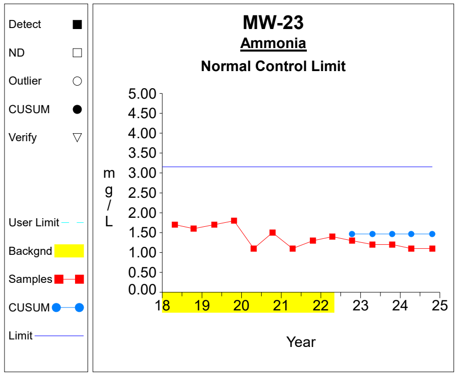
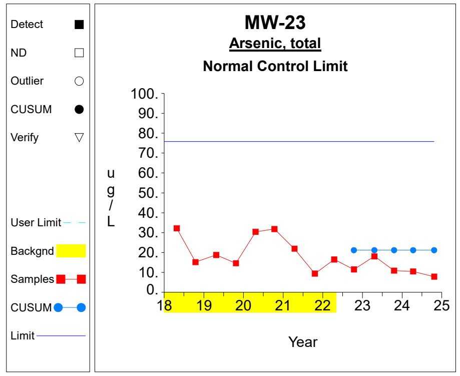
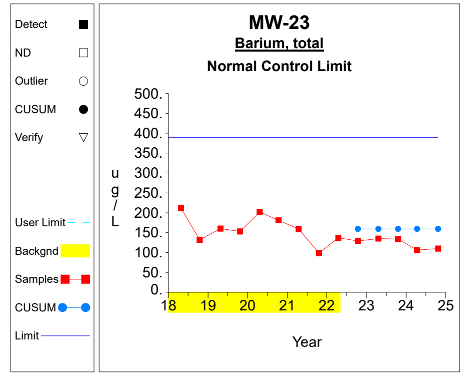
Intra-Well Control Charts / Prediction Limits



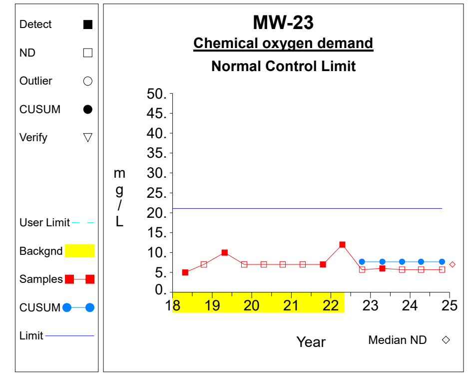
Graph 41



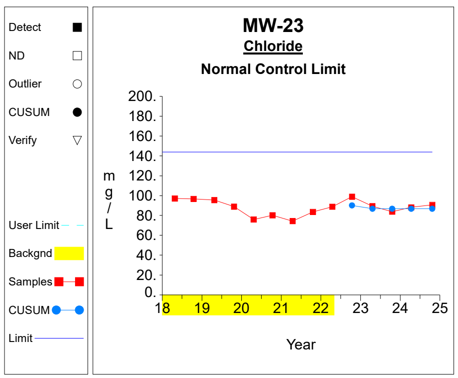
Graph 42



Graph 43



Graph 44



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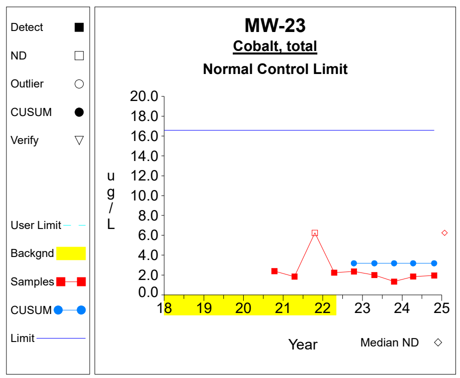

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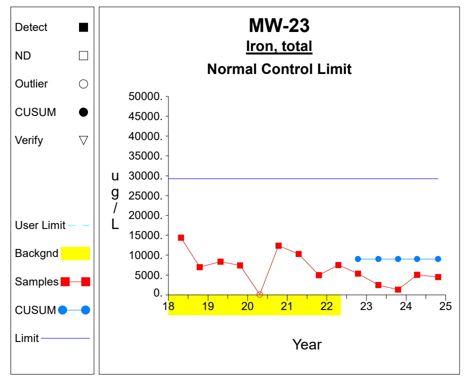
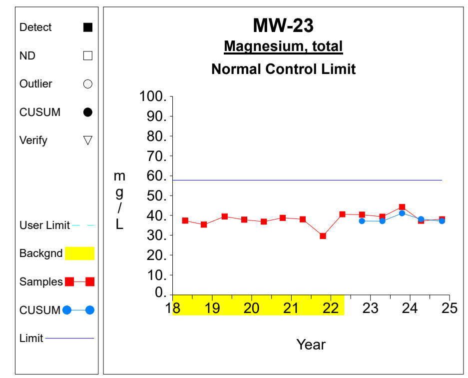
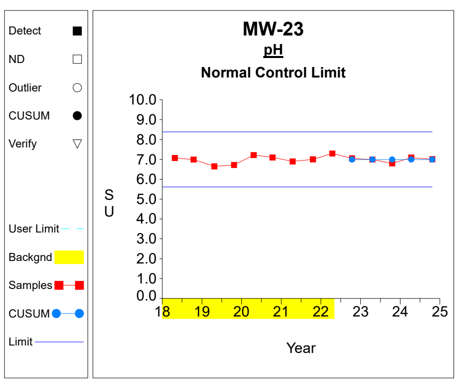


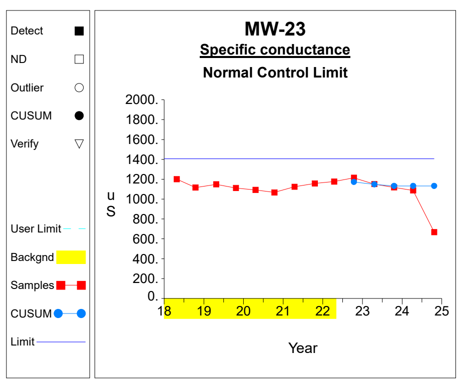
Graph 47



Graph 48



Graph 49



Graph 50

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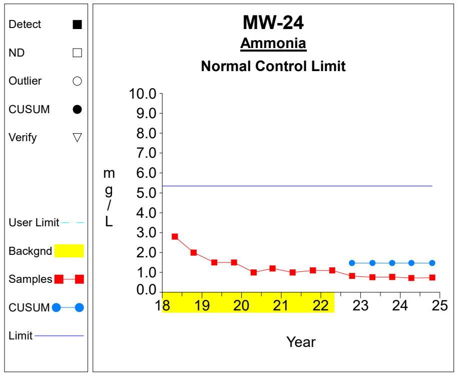
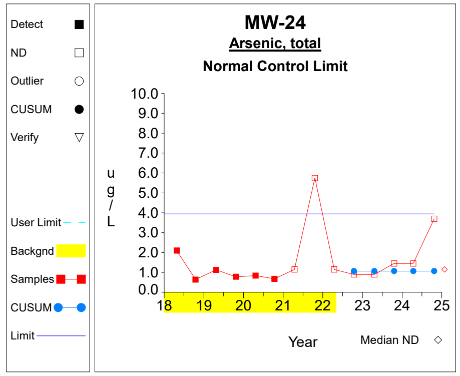
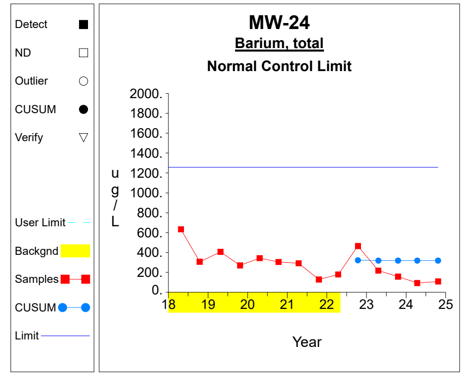
Intra-Well Control Charts / Prediction Limits



Graph 51



Graph 52



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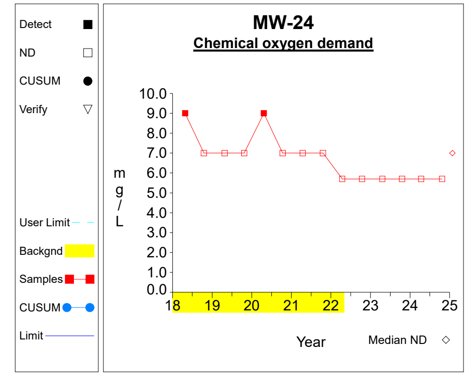
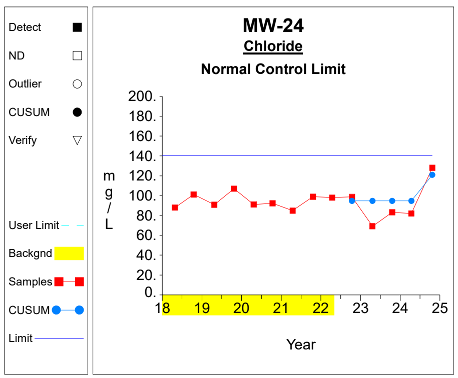
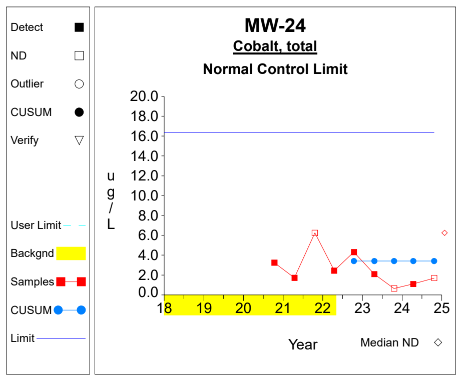


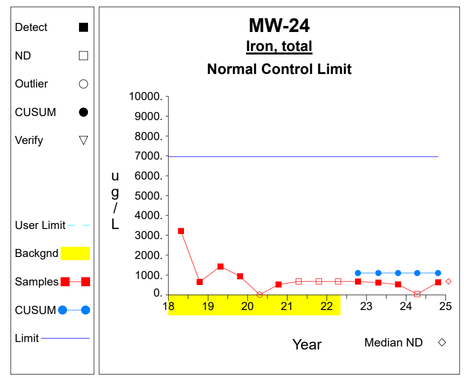
Graph 54



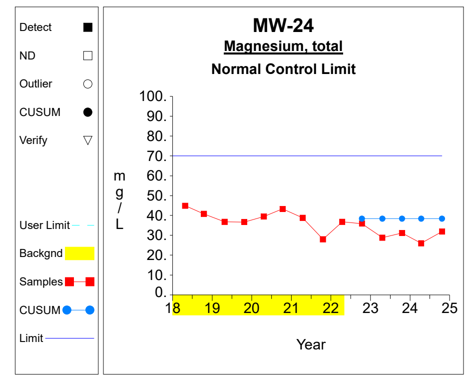
Graph 55



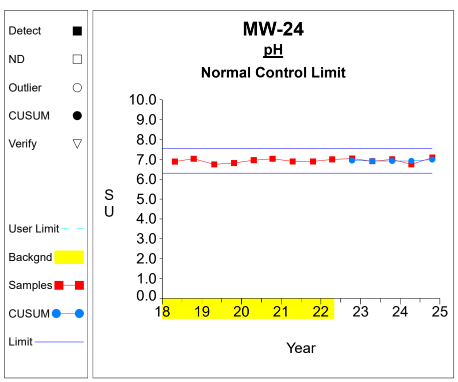
Graph 56



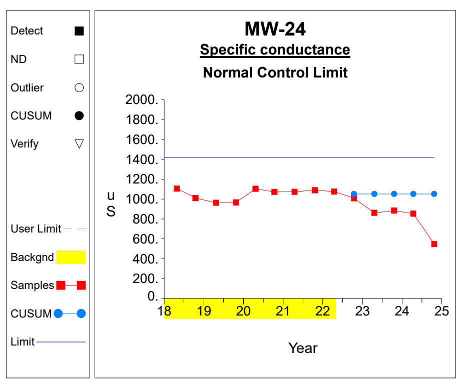
Graph 57



Graph 58



Graph 59



Graph 60

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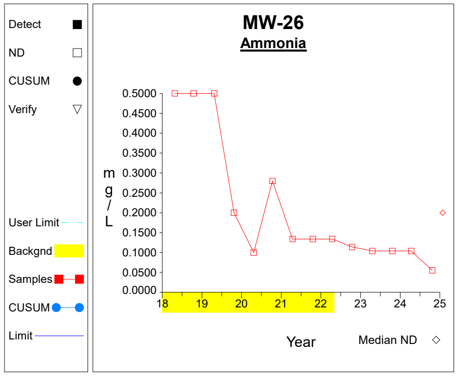
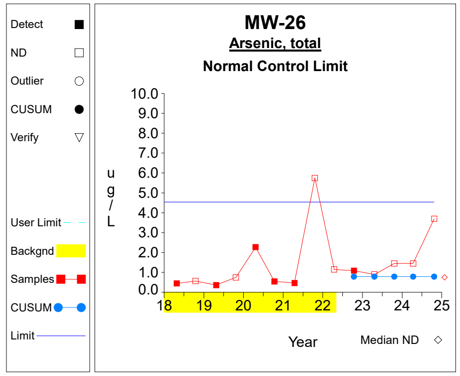
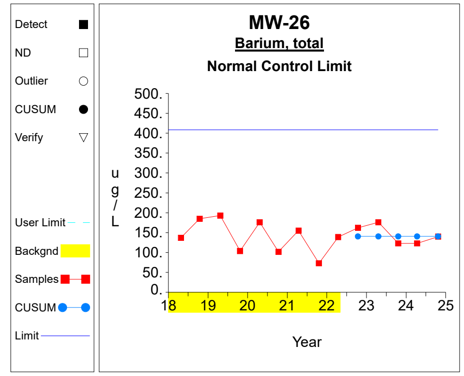
Intra-Well Control Charts / Prediction Limits



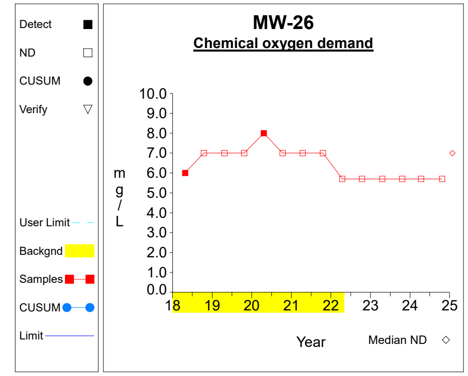
Graph 61



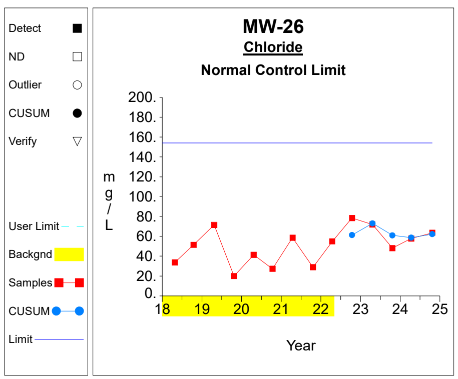
Graph 62



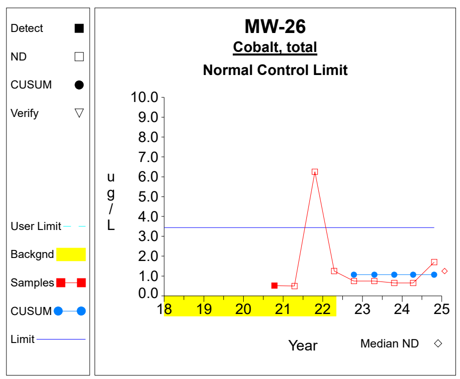
Graph 63



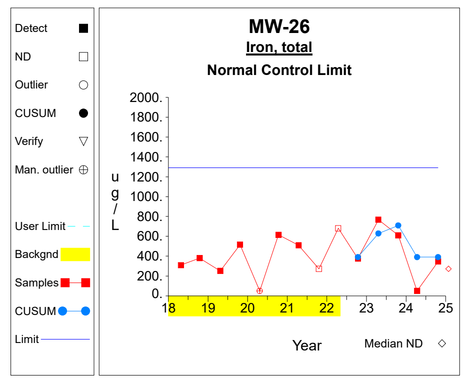
Graph 64



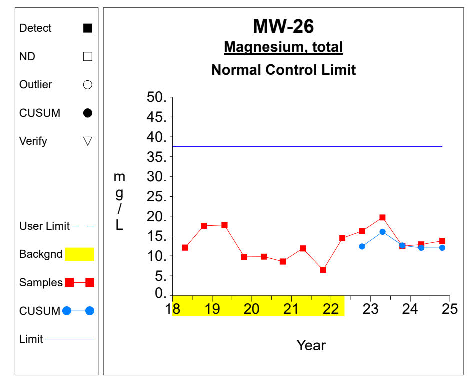
Graph 65



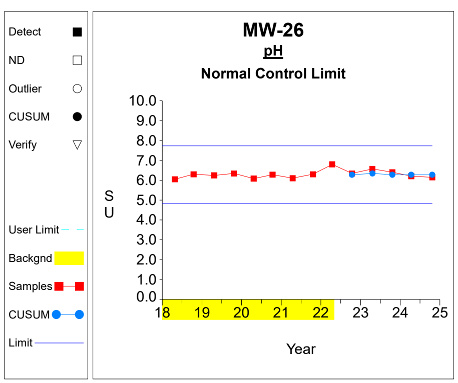
Graph 66



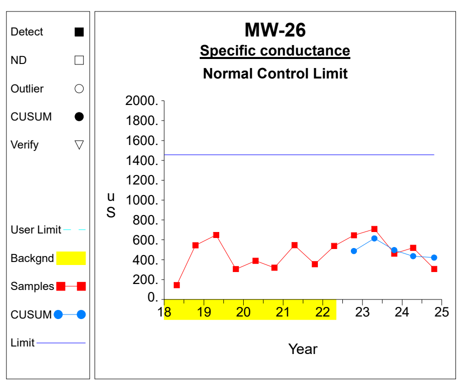
Graph 67



Graph 68

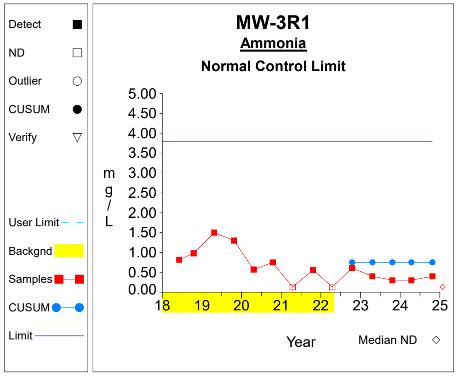


Graph 69

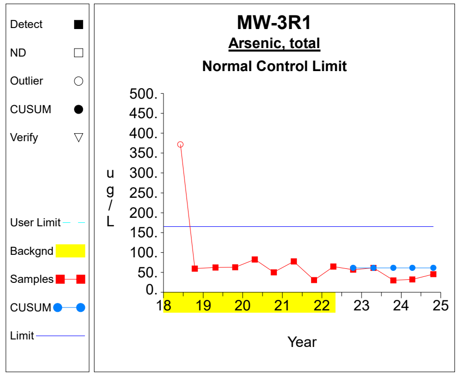


Graph 70

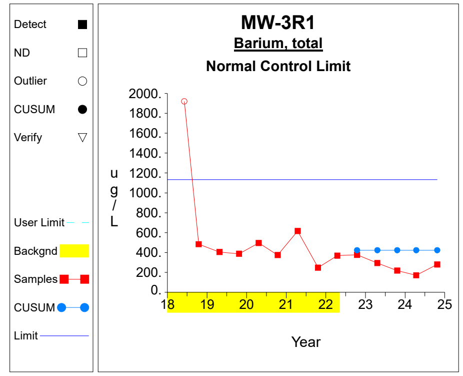
Intra-Well Control Charts / Prediction Limits



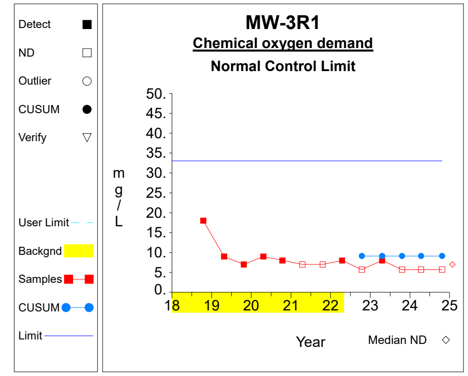
Graph 71



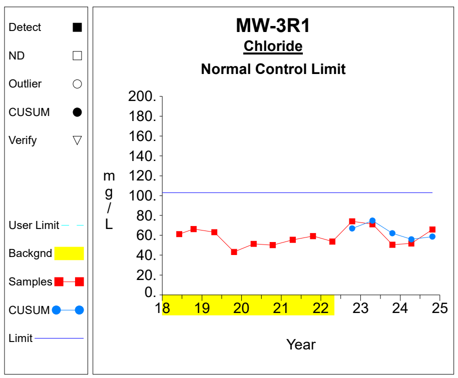
Graph 72



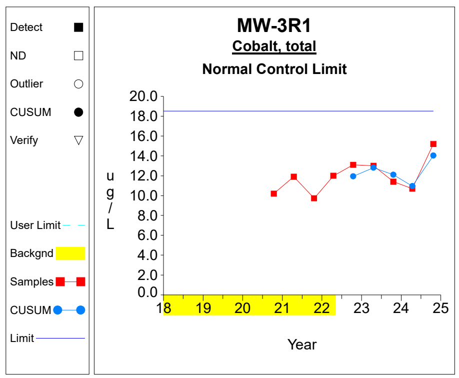
Graph 73



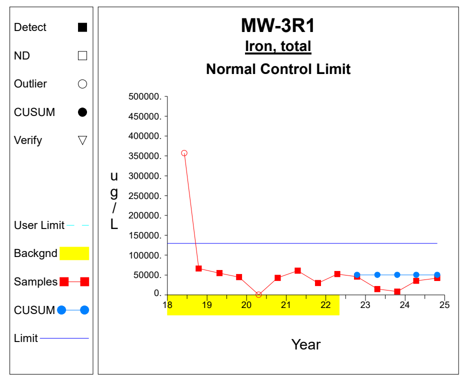
Graph 74



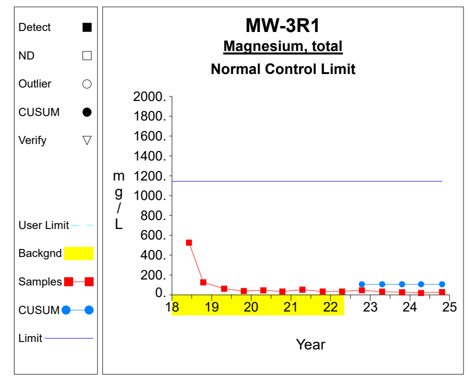
Graph 75



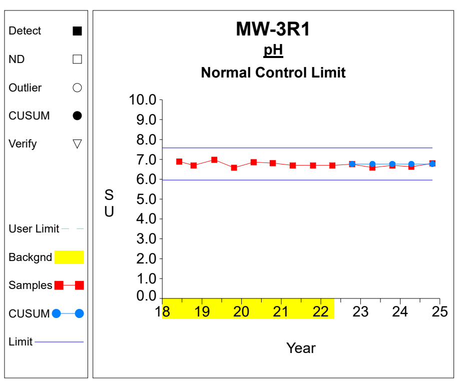
Graph 76



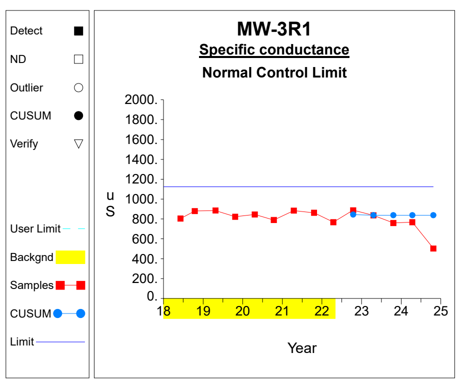
Graph 77



Graph 78



Graph 79



Graph 80

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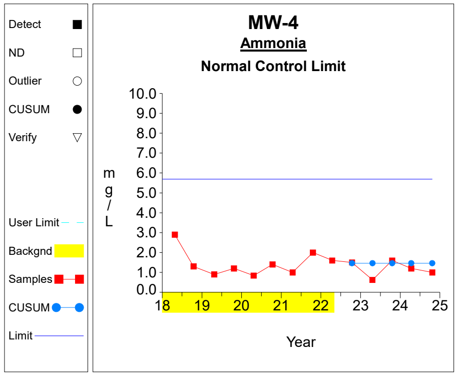
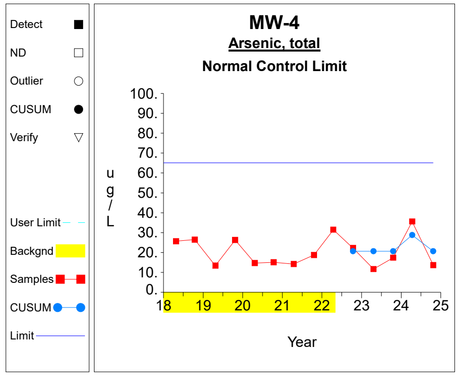
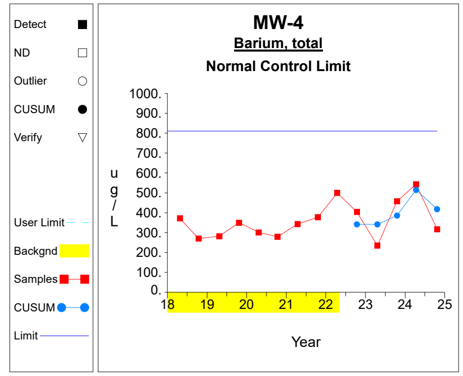
Intra-Well Control Charts / Prediction Limits



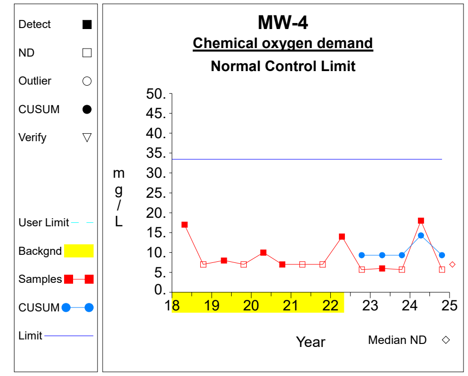
Graph 81



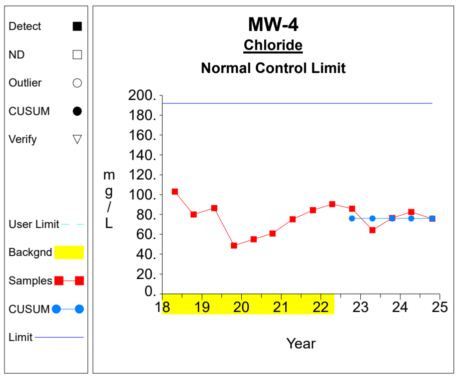
Graph 82



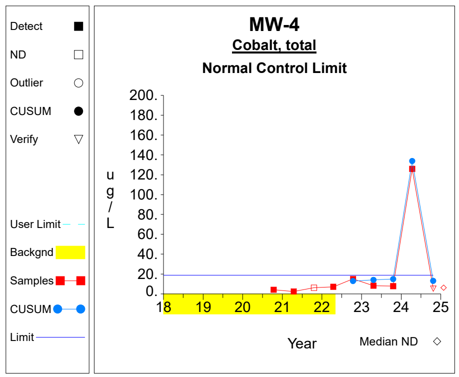
Graph 83



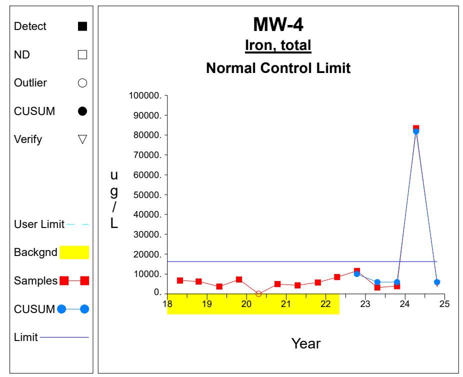
Graph 84



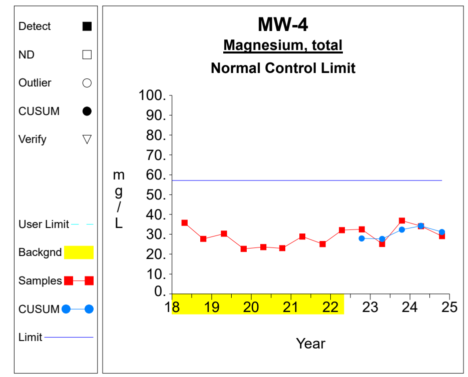
Graph 85



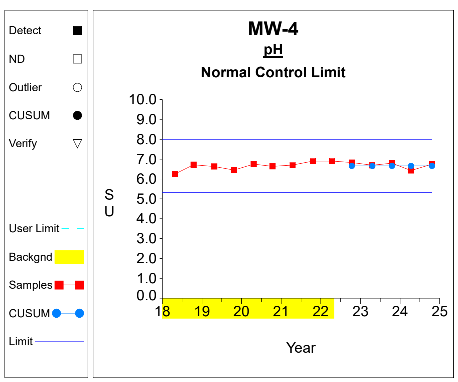
Graph 86



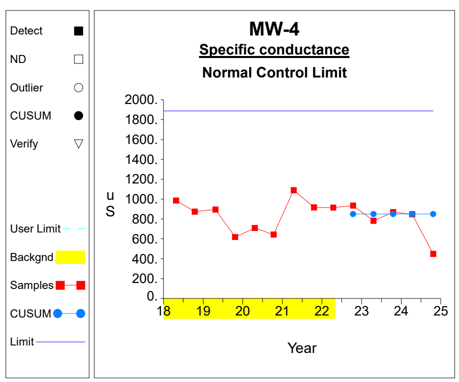
Graph 87



Graph 88



Graph 89



Graph 90

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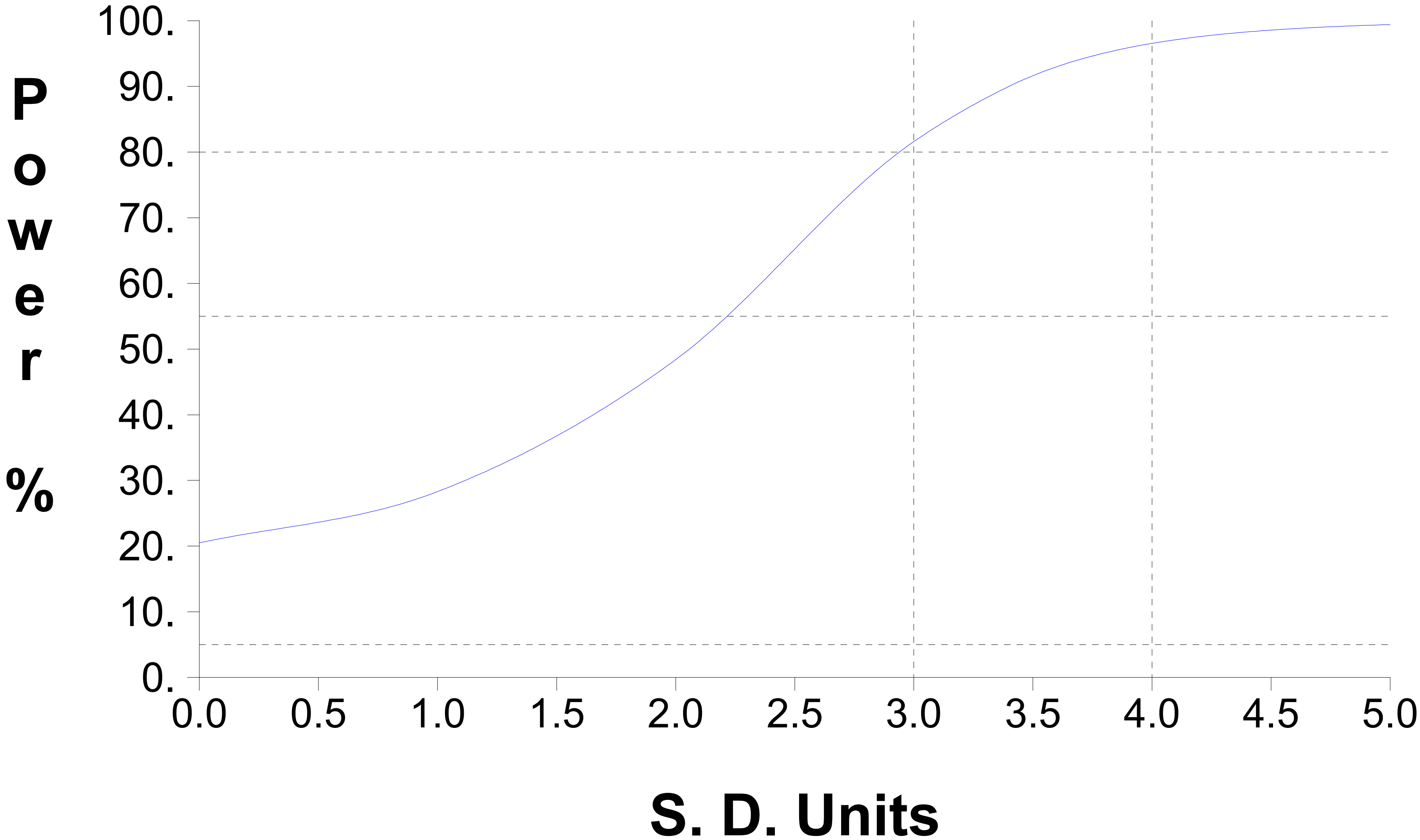
False Positive and False Negative Rates for Current Intra-Well Control Charts Monitoring Program



Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **6.85** / **9** = **0.761**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**5.527** - **46.923**/**9**) / (**9**-1))$^{1/2}$ = **0.198**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **0.761** + **6.5** * **0.198** = **2.047**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.063**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.215**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N**	Compute background mean.
	= **28.46** / **9**	
	= **3.162**	
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**110.43** - **809.972**/**9**) / (**9**-1))$^{1/2}$	
	= **1.598**	
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **3.162** + **6.5** * **1.598**	
	= **13.55**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **0.059**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**36** - **2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-1.576**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **1707.0** / **9** = **189.667**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**333859.0** - **2.91**×**10^6**/**9**) / (**9**-1))^{½} = **35.528**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **189.667** + **6.5** * **35.528** = **420.6**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-2.768**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	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) = **-34.98**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **130.0** / **9** = **14.444**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**2486.0** - **16900.0/9**) / (**9**-1))$^{1/2}$ = **8.719**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **14.444** + **6.5** * **8.719** = **71.12**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **83.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **83.333**$^{1/2}$) / 2 = **7.383**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-6.065**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **92.92** / **9** = **10.324**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{1495.588} - \mathbf{8634.126}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ = **8.187**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S** = **10.324** + **6.5** * **8.187** = **63.541**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.909**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-8.857**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **5.42** / **4** = **1.355**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**7.908** - **29.376/4**) / (**4**-1))^{½} = **0.434**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1.355** + **6.5** * **0.434** = **4.174**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.1**	Sen's estimator of trend.
6	var(S) = **7.667**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**6** - **2.326** * **7.667**^{½}) / 2 = **-0.22**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1.398**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **41250.0** / **8** = **5156.25**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**2.56**x**10^8** - **1.70**x**10^9**/**8**) / (**8**-1))^{½} = **2478.87**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **5156.25** + **6.5** * **2478.87** = **21268.907**	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 = **338.29**	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_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1867.062**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N**	Compute background mean.
	= **234.1** / **9**	
	= **26.011**	
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$	Compute background sd.
	$= ((\mathbf{6216.01} - \mathbf{54802.81/9}) / (\mathbf{9}-1))^{1/2}$	
	= **3.981**	
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **26.011** + **6.5** * **3.981**	
	= **51.89**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **-0.772**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$	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.
	$= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$	
	= **6.845**	
8	LCL(S) = **-4.02**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **64.52** / **9** = **7.169**	Compute background mean.
2	S = ((**sum[X²] - sum[X]²/N**) / (**N**-1))^½ = ((**463.247** - **4162.83/9**) / (**9**-1))^½ = **0.298**	Compute background sd.
3	SCL = $\bar{X}$ ± **F** * **S** = **7.169** ± **6.5** * **0.298** = **5.232**, **9.106**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.143**	Sen's estimator of trend.
6	var(S) = **90.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**^½) / 2 = (**36** - **2.326** * **90.0**^½) / 2 = **6.967**	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
Specific conductance (uS) at MW-1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **5949.0** / **9** = **661.0**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{3.95 \times 10^6} - \mathbf{3.54 \times 10^7}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ = **49.927**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **661.0** + **6.5** * **49.927** = **985.528**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **10.372**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ = **6.845**	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) = **-39.313**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **11.94** / **8** = **1.493**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{18.142} - \mathbf{142.564}/\mathbf{8}) / (\mathbf{8}-1))^{1/2}$ = **0.214**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **1.493** + **6.5** * **0.214** = **2.885**	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 = **-0.168**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{28} - \mathbf{2.326} * \mathbf{65.333}^{1/2}) / 2$ = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.265**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\overline{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{1669.0} / \mathbf{9}$ $= \mathbf{185.444}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{320639.0} - \mathbf{2.79 \times 10^6/9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{37.303}$	Compute background sd.
3	$SCL = \overline{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{185.444} + \mathbf{6.5} * \mathbf{37.303}$ $= \mathbf{427.915}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{18.2}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	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	$LCL(S) = \mathbf{-14.357}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **64.0** / **9** = **7.111**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{456.0} - \mathbf{4096.0/9}) / (\mathbf{9}-1))^{1/2}$ = **0.333**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S** = **7.111** + **6.5** * **0.333** = **9.278**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **26.667**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{26.667}^{1/2}) / 2$ = **11.994**	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
Chloride (mg/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N**	Compute background mean.
	= **435.952** / **9**	
	= **48.439**	
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**23729.612** - **190054.146**/**9**) / (**9**-1))$^{1/2}$	
	= **18.071**	
3	SCL = $\overline{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **48.439** + **6.5** * **18.071**	
	= **165.901**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **9.786**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2	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.
	= (**36** - **2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-3.775**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **25.79** / **4** = **6.448**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**194.862** - **665.124/4**) / (**4**-1))$^{1/2}$ = **3.087**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **6.448** + **6.5** * **3.087** = **26.51**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **-0.731**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**6** - **2.326** * **8.667**$^{1/2}$) / 2 = **-0.424**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-12.81**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **4184.5** / **8** = **523.063**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{2.56 \times 10^6} - \mathbf{1.75 \times 10^7}/\mathbf{8}) / (\mathbf{8}-1))^{1/2}$ = **231.667**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S** = **523.063** + **6.5** * **231.667** = **2028.895**	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 = **68.32**	Sen's estimator of trend.
6	var(S) = **61.667**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{28} - \mathbf{2.326} * \mathbf{61.667}^{1/2}) / 2$ = **4.867**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-22.18**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **201.5** / **9**	
	= **22.389**	
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$	Compute background sd.
	$= ((\mathbf{4585.23} - \mathbf{40602.25/9}) / (\mathbf{9}-1))^{1/2}$	
	= **3.039**	
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **22.389** + **6.5** * **3.039**	
	= **42.14**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **-0.617**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	$= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$	
	= **6.845**	
8	LCL(S) = **-2.692**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **58.01** / **9** = **6.446**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**374.238** - **3365.16**/**9**) / (**9**-1))^{½} = **0.203**	Compute background sd.
3	SCL = $\bar{X}$ ± **F** * **S** = **6.446** ± **6.5** * **0.203** = **5.123**, **7.768**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.076**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.207**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-2
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **6016.0** / **9** = **668.444**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**4.06x10^6** - **3.62x10^7/9**) / (**9**-1))^{½} = **73.493**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **668.444** + **6.5** * **73.493** = **1146.151**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **13.405**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-41.993**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{11.11} / \mathbf{9}$ $= \mathbf{1.234}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{14.813} - \mathbf{123.432/9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{0.37}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{1.234} + \mathbf{6.5} * \mathbf{0.37}$ $= \mathbf{3.642}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{0.045}$	Sen's estimator of trend.
6	$var(S) = \mathbf{90.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z_{.99}} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{90.0}^{1/2}) / 2$ $= \mathbf{6.967}$	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	$LCL(S) = \mathbf{-0.365}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{3269.0} / \mathbf{9}$ $= \mathbf{363.222}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{1.22 \times 10^6} - \mathbf{1.07 \times 10^7}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{63.027}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{363.222} + \mathbf{6.5} * \mathbf{63.027}$ $= \mathbf{772.9}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-28.587}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \mathbf{-78.691}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **78.0** / **9** = **8.667**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**696.0** - **6084.0/9**) / (**9**-1))^{½} = **1.581**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **8.667** + **6.5** * **1.581** = **18.944**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.419**	Sen's estimator of trend.
6	var(S) = **89.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **89.0**^{½}) / 2 = **7.028**	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) = **-1.993**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1943.935** / **9** = **215.993**	Compute background mean.
2	S = ((**sum[X²] - sum[X]**²/**N**) / (**N**-1))$^{1/2}$ = ((**423737.187** - **3.78x10⁶/9**) / (**9**-1))$^{1/2}$ = **21.969**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **215.993** + **6.5** * **21.969** = **358.794**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-2.348**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **91.0**$^{1/2}$) / 2 = **6.906**	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) = **-25.91**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{4.23} / \mathbf{4}$ $= \mathbf{1.058}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2] - sum[X]^2/N}) / (\mathbf{N}-1))^{½}$ $= ((\mathbf{4.918 - 17.893/4}) / (\mathbf{4}-1))^{½}$ $= \mathbf{0.385}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{1.058} + \mathbf{6.5} * \mathbf{0.385}$ $= \mathbf{3.56}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{4} * (\mathbf{4}-1) / 2$ $= \mathbf{6}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{0.257}$	Sen's estimator of trend.
6	$var(S) = \mathbf{5.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{½}) / 2$ $= (\mathbf{6} - \mathbf{2.326} * \mathbf{5.0}^{½}) / 2$ $= \mathbf{0.399}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \mathbf{0.0}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **3348.5** / **8** = **418.563**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.80**x**10^6** - **1.12**x**10^7**/**8**) / (**8**-1))^{½} = **239.207**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **418.563** + **6.5** * **239.207** = **1973.409**	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 = **128.654**	Sen's estimator of trend.
6	var(S) = **61.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**^{½}) / 2 = (**28** - **2.326** * **61.667**^{½}) / 2 = **4.867**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-26.421**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **492.3** / **9** = **54.7**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{27341.21} - \mathbf{242359.29/9}) / (\mathbf{9}-1))^{1/2}$ = **7.18**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S** = **54.7** + **6.5** * **7.18** = **101.369**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-1.717**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ = **6.845**	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) = **-6.982**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **60.56** / **9** = **6.729**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{407.678} - \mathbf{3667.514/9}) / (\mathbf{9}-1))^{1/2}$ = **0.149**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ ± **F** * **S** = **6.729** ± **6.5** * **0.149** = **5.763**, **7.695**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.02**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{91.0}^{1/2}) / 2$ = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.082**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-21
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N**	Compute background mean.
	= **13883.0** / **9**	
	= **1542.556**	
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$	Compute background sd.
	$= ((\mathbf{2.15 \times 10^7} - \mathbf{1.93 \times 10^8}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$	
	= **85.267**	
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **1542.556** + **6.5** * **85.267**	
	= **2096.794**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **-8.562**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	$= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$	
	= **6.845**	
8	LCL(S) = **-93.711**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **39.0** / **9** = **4.333**	Compute background mean.
2	S = ((**sum[X²] - sum[X]²/N**) / (**N**-1))$^{1/2}$ = ((**179.92** - **1521.0/9**) / (**9**-1))$^{1/2}$ = **1.168**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **4.333** + **6.5** * **1.168** = **11.927**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.38**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-2.063**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **134.62** / **9** = **14.958**	Compute background mean.
2	S = ((**sum[X²]** - **sum[X]**²/**N**) / (**N**-1))^½ = ((**2123.856** - **18122.544/9**) / (**9**-1))^½ = **3.712**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **14.958** + **6.5** * **3.712** = **39.087**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.717**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**^½) / 2 = (**36** - **2.326** * **91.0**^½) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-7.68**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **2776.0** / **9** = **308.444**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{890574.0} - \mathbf{7.71{\times}10^6/9}) / (\mathbf{9}-1))^{1/2}$ = **65.51**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S** = **308.444** + **6.5** * **65.51** = **734.258**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **19.335**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-45.408**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **68.0** / **9** = **7.556**	Compute background mean.
2	$S = ((\text{sum}[X^2] - \text{sum}[X]^2/N) / (N-1))^{1/2}$ $= ((522.0 - 4624.0/9) / (9-1))^{1/2}$ = **1.014**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **7.556** + **6.5** * **1.014** = **14.145**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **62.667**	Variance estimate for slope.
7	$M_1(S) = (N' - Z_{.99} * \text{var}(S)^{1/2}) / 2$ $= (36 - 2.326 * 62.667^{1/2}) / 2$ = **8.793**	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) = **-1.01**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{992.195} / \mathbf{9}$ $= \mathbf{110.244}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{111470.222} - \mathbf{984450.918}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{16.151}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{110.244} + \mathbf{6.5} * \mathbf{16.151}$ $= \mathbf{215.224}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-6.386}$	Sen's estimator of trend.
6	$var(S) = \mathbf{91.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{91.0}^{1/2}) / 2$ $= \mathbf{6.906}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \mathbf{-16.374}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **33.31** / **4** = **8.328**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**279.988** - **1109.556**/**4**) / (**4**-1))$^{1/2}$ = **0.931**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **8.328** + **6.5** * **0.931** = **14.378**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.78**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**6** - **2.326** * **8.667**$^{1/2}$) / 2 = **-0.424**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1.553**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N**	Compute background mean.
	= **90410.0** / **8**	
	= **11301.25**	
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½}	Compute background sd.
	= ((**1.14**x**10^9** - **8.17**x**10^9**/**8**) / (**8**-1))^{½}	
	= **4157.628**	
3	SCL = **$\overline{X}$** + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **11301.25** + **6.5** * **4157.628**	
	= **38325.831**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **8** * (**8**-1) / 2	
	= **28**	
5	S = **-508.374**	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	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**28** - **2.326** * **65.333**^{½}) / 2	
	= **4.6**	
8	LCL(S) = **-5838.096**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **279.9** / **9** = **31.1**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**8796.13** - **78344.01**/**9**) / (**9**-1))^{½} = **3.377**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **31.1** + **6.5** * **3.377** = **53.051**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.592**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-2.906**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **61.81** / **9** = **6.868**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**424.616** - **3820.476/9**) / (**9**-1))^{½} = **0.122**	Compute background sd.
3	SCL = $\bar{X}$ ± **F** * **S** = **6.868** ± **6.5** * **0.122** = **6.075**, **7.66**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.05**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **91.0**^{½}) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.129**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-22
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **9799.0** / **9** = **1088.778**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.08x10^7** - **9.60x10^7/9**) / (**9**-1))^{½} = **111.515**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1088.778** + **6.5** * **111.515** = **1813.628**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-47.936**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	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) = **-120.527**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **13.2** / **9** = **1.467**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**19.9** - **174.24**/**9**) / (**9**-1))^{½} = **0.26**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **1.467** + **6.5** * **0.26** = **3.155**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.1**	Sen's estimator of trend.
6	var(S) = **90.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **90.0**^{½}) / 2 = **6.967**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.304**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{190.8} / \mathbf{9}$ $= \mathbf{21.2}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{4610.1} - \mathbf{36404.64/9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{8.405}$	Compute background sd.
3	$SCL = \overline{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{21.2} + \mathbf{6.5} * \mathbf{8.405}$ $= \mathbf{75.832}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-1.417}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \mathbf{-12.049}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **1434.6** / **9** = **159.4**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**238713.96** - **2.06**x**10^6**/**9**) / (**9**-1))^{½} = **35.424**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **159.4** + **6.5** * **35.424** = **389.654**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-13.311**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	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) = **-43.964**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **69.0** / **9** = **7.667**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{563.0} - \mathbf{4761.0/9}) / (\mathbf{9}-1))^{1/2}$ = **2.062**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **7.667** + **6.5** * **2.062** = **21.067**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **63.667**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{63.667}^{1/2}) / 2$ = **8.72**	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
Chloride (mg/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N**	Compute background mean.
	= **780.887** / **9**	
	= **86.765**	
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**68370.305** - **609784.507/9**) / (**9**-1))$^{1/2}$	
	= **8.778**	
3	SCL = $\overline{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **86.765** + **6.5** * **8.778**	
	= **143.824**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **-4.121**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**36** - **2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-10.676**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **12.72** / **4** = **3.18**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**53.178 - 161.798/4**) / (**4**-1))^{½} = **2.06**	Compute background sd.
3	SCL = **$\bar{X}$** + **F** * **S** = **3.18** + **6.5** * **2.06** = **16.569**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.15**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)^{½}**) / 2 = (**6** - **2.326** * **8.667^{½}**) / 2 = **-0.424**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-8.223**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{72380.0} / \mathbf{8}$ $= \mathbf{9047.5}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{7.23 \times 10^8} - \mathbf{5.24 \times 10^9/8}) / (\mathbf{8}-1))^{1/2}$ $= \mathbf{3109.84}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{9047.5} + \mathbf{6.5} * \mathbf{3109.84}$ $= \mathbf{29261.462}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{8} * (\mathbf{8}-1) / 2$ $= \mathbf{28}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-1024.295}$	Sen's estimator of trend.
6	$var(S) = \mathbf{65.333}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{28} - \mathbf{2.326} * \mathbf{65.333}^{1/2}) / 2$ $= \mathbf{4.6}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \mathbf{-5230.686}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **334.3** / **9** = **37.144**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**12497.69** - **111756.49**/**9**) / (**9**-1))$^{1/2}$ = **3.168**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **37.144** + **6.5** * **3.168** = **57.738**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.352**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z$_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	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) = **-3.322**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **62.95** / **9** = **6.994**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{440.664} - \mathbf{3962.703/9}) / (\mathbf{9}-1))^{1/2}$ = **0.213**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ ± **F** * **S** = **6.994** ± **6.5** * **0.213** = **5.608**, **8.381**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.067**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ = **6.845**	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) = **-0.237**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-23
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **10198.0** / **9** = **1133.111**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.16**x**10^7** - **1.04**x**10^8**/**9**) / (**9**-1))^{½} = **42.093**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **1133.111** + **6.5** * **42.093** = **1406.719**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-1.049**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-54.438**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **13.2** / **9** = **1.467**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**22.2** - **174.24**/**9**) / (**9**-1))^{½} = **0.596**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1.467** + **6.5** * **0.596** = **5.339**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.304**	Sen's estimator of trend.
6	var(S) = **89.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **89.0**^{½}) / 2 = **7.028**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.66**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **9.62** / **9** = **1.069**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**11.84** - **92.544**/**9**) / (**9**-1))^{½} = **0.441**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1.069** + **6.5** * **0.441** = **3.937**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.009**	Sen's estimator of trend.
6	var(S) = **88.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **88.333**^{½}) / 2 = **7.069**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.335**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **2868.0** / **9** = **318.667**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**1.08x10^6** - **8.23x10^6/9**) / (**9**-1))$^{1/2}$ = **144.337**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **318.667** + **6.5** * **144.337** = **1256.859**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-74.046**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	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) = **-150.037**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **852.048** / **9** = **94.672**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**81062.851** - **725985.794**/**9**) / (**9**-1))$^{1/2}$ = **7.051**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **94.672** + **6.5** * **7.051** = **140.505**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **1.315**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-6.55**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **13.66** / **4** = **3.415**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**58.521** - **186.596/4**) / (**4**-1))^{½} = **1.989**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **3.415** + **6.5** * **1.989** = **16.346**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.102**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**6** - **2.326** * **8.667**^{½}) / 2 = **-0.424**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-7.836**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **8804.5** / **8** = **1100.563**	Compute background mean.
2	S = ((**sum[X²]** - **sum[X]**²/**N**) / (**N**-1))$^{1/2}$ = ((**1.54x10⁷** - **7.75x10⁷/8**) / (**8**-1))$^{1/2}$ = **901.578**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1100.563** + **6.5** * **901.578** = **6960.817**	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 = **-150.307**	Sen's estimator of trend.
6	var(S) = **61.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **61.667**$^{1/2}$) / 2 = **4.867**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-1004.476**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **345.6** / **9** = **38.4**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]^2**/**N**) / (**N**-1))$^{1/2}$ = ((**13460.6** - **119439.36**/**9**) / (**9**-1))$^{1/2}$ = **4.868**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **38.4** + **6.5** * **4.868** = **70.04**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-1.682**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **91.0**$^{1/2}$) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-7.685**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **62.28** / **9** = **6.92**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**431.05** - **3878.798**/**9**) / (**9**-1))$^{1/2}$ = **0.095**	Compute background sd.
3	SCL = $\overline{X}$ ± **F** * **S** = **6.92** ± **6.5** * **0.095** = **6.3**, **7.54**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.024**	Sen's estimator of trend.
6	var(S) = **90.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **90.0**$^{1/2}$) / 2 = **6.967**	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) = **-0.052**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-24
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **9468.0** / **9** = **1052.0**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**9.99x10^6** - **8.96x10^7**/**9**) / (**9**-1))^{½} = **56.442**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1052.0** + **6.5** * **56.442** = **1418.876**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **6.514**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-33.3**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **7.1** / **9** = **0.789**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**8.258** - **50.41**/**9**) / (**9**-1))^{½} = **0.576**	Compute background sd.
3	SCL = **$\bar{X}$** + **F** * **S** = **0.789** + **6.5** * **0.576** = **4.535**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.024**	Sen's estimator of trend.
6	var(S) = **83.333**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)^{½}**) / 2 = (**36** - **2.326** * **83.333**^{½}) / 2 = **7.383**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.178**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{1264.0} / \mathbf{9}$ $= \mathbf{140.444}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{191114.0} - \mathbf{1.60 \times 10^6/9}) / (\mathbf{9}-1))^{1/2}$ $= \mathbf{41.219}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{140.444} + \mathbf{6.5} * \mathbf{41.219}$ $= \mathbf{408.37}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-15.782}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ $= \mathbf{6.845}$	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	$LCL(S) = \mathbf{-50.301}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **387.718** / **9**	
	= **43.08**	
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**19033.301** - **150325.248/9**) / (**9**-1))$^{1/2}$	
	= **17.068**	
3	SCL = $\bar{X}$ + **F** * **S**	Compute combined Shewhart-CUSUM normal control limit.
	= **43.08** + **6.5** * **17.068**	
	= **154.021**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **1.292**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**36** - **2.326** * **92.0**$^{1/2}$) / 2	
	= **6.845**	
8	LCL(S) = **-19.047**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **4.27** / **4** = **1.068**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**4.958** - **18.233/4**) / (**4**-1))^{½} = **0.365**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **1.068** + **6.5** * **0.365** = **3.44**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.243**	Sen's estimator of trend.
6	var(S) = **5.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - $Z_{.99}$ * **var(S)**^{½}) / 2 = (**6** - **2.326** * **5.0**^{½}) / 2 = **0.399**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th 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
Iron, total (ug/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **3128.2** / **8** = **391.025**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**1.36x10^6** - **9.79x10^6/8**) / (**8**-1))$^{1/2}$ = **138.359**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **391.025** + **6.5** * **138.359** = **1290.357**	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 = **-2.032**	Sen's estimator of trend.
6	var(S) = **64.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **64.333**$^{1/2}$) / 2 = **4.672**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-230.907**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **108.62** / **9** = **12.069**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**1433.595** - **11798.304/9**) / (**9**-1))^{½} = **3.916**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **12.069** + **6.5** * **3.916** = **37.522**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-1.315**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	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) = **-4.631**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N**	Compute background mean.
	= **56.49** / **9**	
	= **6.277**	
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$	Compute background sd.
	= ((**354.971** - **3191.12**/**9**) / (**9**-1))$^{1/2}$	
	= **0.224**	
3	SCL = $\bar{X}$ ± **F** * **S**	Compute combined Shewhart-CUSUM normal control interval.
	= **6.277** ± **6.5** * **0.224**	
	= **4.82**, **7.733**	
4	N' = **N** * (**N**-1) / 2	Number of sample pairs during trend detection period.
	= **9** * (**9**-1) / 2	
	= **36**	
5	S = **0.033**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
	= (**36** - **2.326** * **91.0**$^{1/2}$) / 2	
	= **6.906**	
8	LCL(S) = **-0.083**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-26
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **3789.0** / **9** = **421.0**	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{1/2}$ $= ((\mathbf{1.80{\times}10^6} - \mathbf{1.44{\times}10^7}/\mathbf{9}) / (\mathbf{9}-1))^{1/2}$ = **159.373**	Compute background sd.
3	SCL = $\bar{\mathbf{X}}$ + **F** * **S** = **421.0** + **6.5** * **159.373** = **1456.924**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **30.223**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z}_{.99} * \mathbf{var(S)}^{1/2}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{1/2}) / 2$ = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-122.58**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **6.748** / **9** = **0.75**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**6.81** - **45.536**/**9**) / (**9**-1))^{½} = **0.468**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **0.75** + **6.5** * **0.468** = **3.79**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.241**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **91.0**^{½}) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.577**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **490.6** / **8** = **61.325**	Compute background mean.
2	S = ((**sum[X²] - sum[X]²/N**) / (**N**-1))$^{1/2}$ = ((**31876.54** - **240688.36/8**) / (**8**-1))$^{1/2}$ = **15.993**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **61.325** + **6.5** * **15.993** = **165.281**	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 = **0.767**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **65.333**$^{1/2}$) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-17.398**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **3381.0** / **8** = **422.625**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**1.51**x**10^6** - **1.14**x**10^7**/**8**) / (**8**-1))$^{1/2}$ = **109.343**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **422.625** + **6.5** * **109.343** = **1133.357**	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 = **-26.639**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **65.333**$^{1/2}$) / 2 = **4.6**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-157.342**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **73.0** / **8** = **9.125**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**761.0** - **5329.0**/**8**) / (**8**-1))^{½} = **3.682**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **9.125** + **6.5** * **3.682** = **33.055**	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 = **-0.892**	Sen's estimator of trend.
6	var(S) = **59.667**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**28** - **2.326** * **59.667**^{½}) / 2 = **5.016**	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) = **-4.401**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X} = \textbf{sum[X]} / \textbf{N}$ $= \textbf{504.028} / \textbf{9}$ $= \textbf{56.003}$	Compute background mean.
2	$S = ((\textbf{sum[X}^{\textbf{2}}\textbf{]} - \textbf{sum[X]}^2/\textbf{N}) / (\textbf{N}-1))^{1/2}$ $= ((\textbf{28646.209} - \textbf{254044.225/9}) / (\textbf{9}-1))^{1/2}$ $= \textbf{7.238}$	Compute background sd.
3	$SCL = \overline{\textbf{X}} + \textbf{F} * \textbf{S}$ $= \textbf{56.003} + \textbf{6.5} * \textbf{7.238}$ $= \textbf{103.048}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \textbf{N} * (\textbf{N}-1) / 2$ $= \textbf{9} * (\textbf{9}-1) / 2$ $= \textbf{36}$	Number of sample pairs during trend detection period.
5	$S = \textbf{-1.964}$	Sen's estimator of trend.
6	$var(S) = \textbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\textbf{N'} - \textbf{Z}_{.99} * \textbf{var(S)}^{1/2}) / 2$ $= (\textbf{36} - \textbf{2.326} * \textbf{92.0}^{1/2}) / 2$ $= \textbf{6.845}$	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	$LCL(S) = \textbf{-9.05}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **43.83** / **4** = **10.958**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**484.323** - **1921.069/4**) / (**4**-1))^{½} = **1.163**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **10.958** + **6.5** * **1.163** = **18.515**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **0.649**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**^{½}) / 2 = (**6** - **2.326** * **8.667**^{½}) / 2 = **-0.424**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-4.213**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **352500.0** / **7** = **50357.143**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.86x10^{10}** - **1.24x10^{11}**/**7**) / (**7**-1))^{½} = **12210.222**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **50357.143** + **6.5** * **12210.222** = **129723.587**	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 = **-7380.33**	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_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-21486.682**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **956.0** / **9** = **106.222**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**305677.4** - **913936.0/9**) / (**9**-1))$^{1/2}$ = **159.738**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **106.222** + **6.5** * **159.738** = **1144.517**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-22.403**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	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) = **-148.524**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **60.92** / **9** = **6.769**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**412.485** - **3711.246/9**) / (**9**-1))$^{1/2}$ = **0.124**	Compute background sd.
3	SCL = $\overline{X}$ ± **F** * **S** = **6.769** ± **6.5** * **0.124** = **5.96**, **7.578**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.053**	Sen's estimator of trend.
6	var(S) = **83.333**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **83.333**$^{1/2}$) / 2 = **7.383**	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) = **-0.12**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-3R1
Normal Control Limit

Step	Equation	Description
1	$\bar{X} = \mathbf{sum[X]} / \mathbf{N}$ $= \mathbf{7540.0} / \mathbf{9}$ $= \mathbf{837.778}$	Compute background mean.
2	$S = ((\mathbf{sum[X^2]} - \mathbf{sum[X]}^2/\mathbf{N}) / (\mathbf{N}-1))^{½}$ $= ((\mathbf{6.33 \times 10^6} - \mathbf{5.69 \times 10^7}/\mathbf{9}) / (\mathbf{9}-1))^{½}$ $= \mathbf{43.868}$	Compute background sd.
3	$SCL = \bar{\mathbf{X}} + \mathbf{F} * \mathbf{S}$ $= \mathbf{837.778} + \mathbf{6.5} * \mathbf{43.868}$ $= \mathbf{1122.923}$	Compute combined Shewhart-CUSUM normal control limit.
4	$N' = \mathbf{N} * (\mathbf{N}-1) / 2$ $= \mathbf{9} * (\mathbf{9}-1) / 2$ $= \mathbf{36}$	Number of sample pairs during trend detection period.
5	$S = \mathbf{-7.8}$	Sen's estimator of trend.
6	$var(S) = \mathbf{92.0}$	Variance estimate for slope.
7	$M_1(S) = (\mathbf{N'} - \mathbf{Z_{.99}} * \mathbf{var(S)}^{½}) / 2$ $= (\mathbf{36} - \mathbf{2.326} * \mathbf{92.0}^{½}) / 2$ $= \mathbf{6.845}$	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	$LCL(S) = \mathbf{-47.264}$	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Ammonia (mg/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **13.14** / **9** = **1.46**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2**/**N**) / (**N**-1))^{½} = ((**22.576** - **172.66**/**9**) / (**9**-1))^{½} = **0.651**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **1.46** + **6.5** * **0.651** = **5.692**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.05**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.772**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Arsenic, total (ug/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **186.2** / **9** = **20.689**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**4225.42** - **34670.44**/**9**) / (**9**-1))$^{1/2}$ = **6.83**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **20.689** + **6.5** * **6.83** = **65.081**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.404**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	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) = **-6.041**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Barium, total (ug/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **3075.0** / **9** = **341.667**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**1.09**x**10^6** - **9.46**x**10^6**/**9**) / (**9**-1))^{½} = **72.161**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **341.667** + **6.5** * **72.161** = **810.715**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **30.064**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**^{½}) / 2 = (**36** - **2.326** * **92.0**^{½}) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-36.027**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chemical oxygen demand (mg/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X] / N** = **84.0 / 9** = **9.333**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))^{½} = ((**894.0 - 7056.0/9**) / (**9**-1))^{½} = **3.708**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **9.333 + 6.5 * 3.708** = **33.436**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.0**	Sen's estimator of trend.
6	var(S) = **75.333**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$ * var(S)**^{½}) / 2 = (**36 - 2.326 * 75.333**^{½}) / 2 = **7.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-3.093**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Chloride (mg/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **684.03** / **9** = **76.003**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**54530.846** - **467897.041/9**) / (**9**-1))$^{1/2}$ = **17.827**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **76.003** + **6.5** * **17.827** = **191.876**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **1.378**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N' - $Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	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) = **-18.432**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Cobalt, total (ug/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **19.96** / **4** = **4.99**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**113.121** - **398.402**/**4**) / (**4**-1))$^{1/2}$ = **2.123**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **4.99** + **6.5** * **2.123** = **18.789**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **4** * (**4**-1) / 2 = **6**	Number of sample pairs during trend detection period.
5	S = **2.025**	Sen's estimator of trend.
6	var(S) = **8.667**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z**$_{.99}$ * **var(S)**$^{1/2}$) / 2 = (**6** - **2.326** * **8.667**$^{1/2}$) / 2 = **-0.424**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-3.436**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Iron, total (ug/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **47460.0** / **8** = **5932.5**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**2.99x10^8** - **2.25x10^9**/**8**) / (**8**-1))$^{1/2}$ = **1589.211**	Compute background sd.
3	SCL = $\overline{\mathbf{X}}$ + **F** * **S** = **5932.5** + **6.5** * **1589.211** = **16262.374**	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 = **337.269**	Sen's estimator of trend.
6	var(S) = **65.333**	Variance estimate for slope.
7	M_1(S) = (**N' - Z$_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**28** - **2.326** * **65.333**$^{1/2}$) / 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) = **-1502.491**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Magnesium, total (mg/L) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\overline{X}$ = **sum[X]** / **N** = **249.2** / **9** = **27.689**	Compute background mean.
2	S = ((**sum[X^2] - sum[X]^2/N**) / (**N**-1))$^{1/2}$ = ((**7063.9** - **62100.64/9**) / (**9**-1))$^{1/2}$ = **4.525**	Compute background sd.
3	SCL = $\overline{X}$ + **F** * **S** = **27.689** + **6.5** * **4.525** = **57.104**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **-0.786**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	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) = **-5.637**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
pH (SU) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **59.94** / **9** = **6.66**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))^{½} = ((**399.542** - **3592.804**/**9**) / (**9**-1))^{½} = **0.207**	Compute background sd.
3	SCL = $\bar{X}$ ± **F** * **S** = **6.66** ± **6.5** * **0.207** = **5.316**, **8.004**	Compute combined Shewhart-CUSUM normal control interval.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **0.12**	Sen's estimator of trend.
6	var(S) = **91.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **$Z_{.99}$** * **var(S)**^{½}) / 2 = (**36** - **2.326** * **91.0**^{½}) / 2 = **6.906**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-0.011**	One-sided lower confidence limit for slope.

Worksheet 2 - Intra-Well Control Charts / Prediction Limits
Specific conductance (uS) at MW-4
Normal Control Limit

Step	Equation	Description
1	$\bar{X}$ = **sum[X]** / **N** = **7647.0** / **9** = **849.667**	Compute background mean.
2	S = ((**sum[X^2]** - **sum[X]**^{2}/**N**) / (**N**-1))$^{1/2}$ = ((**6.70x10^6** - **5.85x10^7/9**) / (**9**-1))$^{1/2}$ = **159.673**	Compute background sd.
3	SCL = $\bar{X}$ + **F** * **S** = **849.667** + **6.5** * **159.673** = **1887.542**	Compute combined Shewhart-CUSUM normal control limit.
4	N' = **N** * (**N**-1) / 2 = **9** * (**9**-1) / 2 = **36**	Number of sample pairs during trend detection period.
5	S = **7.778**	Sen's estimator of trend.
6	var(S) = **92.0**	Variance estimate for slope.
7	M_1(S) = (**N'** - **Z$_{.99}$** * **var(S)**$^{1/2}$) / 2 = (**36** - **2.326** * **92.0**$^{1/2}$) / 2 = **6.845**	Ordinal position for one-sided lower confidence limit for slope. The LCL is the M_1th largest slope estimate. When M_1 is not an integer, interpolation is used.
8	LCL(S) = **-176.81**	One-sided lower confidence limit for slope.

APPENDIX C

Laboratory Analytical Data

CITY OF CEDAR RAPIDS - UTILITIES LABORATORY

CENTRAL LAB - WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 5/14/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW26**

Lab Sample ID: AG13994

Sample Collection Date: 4/10/2024 Time: 13:15
Lab Submittal Date: 4/11/2024 Time: 14:36

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	25.79	ft	0.01	SOLINST	ARC	4/11/2024
Depth to water from TC	22.95	ft	0.01	SOLINST	ARC	4/11/2024
pH-Field	6.21	SU	0.01	EPA 9040	ARC	4/11/2024
Sp. Cond.-Field	519	µS	1	EPA 9050	ARC	4/11/2024
Temperature	13.2	°C	0.1	SM 2550B	ARC	4/11/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	4/29/2024
Ammonia (as N)	<0.313	mg/L	0.104	SM 4500 NH3 F	MDK	4/12/2024
Chloride	57.8	mg/L	0.674	EPA 300.0	CCK/AEB	4/15/2024
Metals ICP-MS						
Arsenic, Total	<0.00145	mg/L	0.00145	EPA 6020A	MLU	5/8/2024
Barium, Total	0.123	mg/L	0.00070	EPA 6020A	MLU	5/8/2024
Iron, Total	0.0500	mg/L	0.04295	EPA 6020A	MLU	5/8/2024
Magnesium, Total	12.9	mg/L	0.43195	EPA 6020A	MLU	5/8/2024
Cobalt, Total	<0.00065	mg/L	0.00065	EPA 6020A	MLU	5/8/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

I certify under penalty of law that I believe the reported information above is true, accurate, and complete

ug/L - microgram per liter (ppb) mg/L - milligrams per liter (ppm)
ND - Not detected at or above reporting limit.
SM - Standard Methods SW - Test Methods for Evaluating Solid Waste (SW-846)

ACCREDITATIONS:
IOWA DNR : 096

CITY OF CEDAR RAPIDS - UTILITIES LABORATORY

CENTRAL LAB - WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 5/14/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW21**

Lab Sample ID: AG13995

Sample Collection Date: 4/11/2024 Time: 9:53
Lab Submittal Date: 4/11/2024 Time: 14:36

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	27.49	ft	0.01	SOLINST	ARC	4/11/2024
Depth to water from TC	5.58	ft	0.01	SOLINST	ARC	4/11/2024
pH-Field	6.67	SU	0.01	EPA 9040	ARC	4/11/2024
Sp. Cond.-Field	1420	µS	1	EPA 9050	ARC	4/11/2024
Temperature	11.4	°C	0.1	SM 2550B	ARC	4/11/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	4/29/2024
Ammonia (as N)	<0.313	mg/L	0.104	SM 4500 NH3 F	MDK	4/12/2024
Chloride	204	mg/L	0.674	EPA 300.0	CCK/AEB	4/15/2024
Metals ICP-MS						
Arsenic, Total	<0.00145	mg/L	0.00145	EPA 6020A	MLU	5/8/2024
Barium, Total	0.343	mg/L	0.00070	EPA 6020A	MLU	5/8/2024
Iron, Total	0.0580	mg/L	0.04295	EPA 6020A	MLU	5/8/2024
Magnesium, Total	53.1	mg/L	0.43195	EPA 6020A	MLU	5/8/2024
Cobalt, Total	<0.00065	mg/L	0.00065	EPA 6020A	MLU	5/8/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

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7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 5/14/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW1**

Lab Sample ID: AG13996

Sample Collection Date: 4/10/2024 Time: 11:42
Lab Submittal Date: 4/11/2024 Time: 14:36

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	34.78	ft	0.01	SOLINST	ARC	4/11/2024
Depth to water from TC	22.93	ft	0.01	SOLINST	ARC	4/11/2024
pH-Field	6.97	SU	0.01	EPA 9040	ARC	4/11/2024
Sp. Cond.-Field	721	µS	1	EPA 9050	ARC	4/11/2024
Temperature	13.6	°C	0.1	SM 2550B	ARC	4/11/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	4/29/2024
Ammonia (as N)	0.55	mg/L	0.104	SM 4500 NH3 F	MDK	4/12/2024
Chloride	5.53	mg/L	0.674	EPA 300.0	CCK/AEB	4/15/2024
Metals ICP-MS						
Arsenic, Total	0.00365	mg/L	0.00145	EPA 6020A	MLU	5/8/2024
Barium, Total	0.222	mg/L	0.00070	EPA 6020A	MLU	5/8/2024
Iron, Total	5.27	mg/L	0.04295	EPA 6020A	MLU	5/8/2024
Magnesium, Total	29.4	mg/L	0.43195	EPA 6020A	MLU	5/8/2024
Cobalt, Total	<0.00065	mg/L	0.00065	EPA 6020A	MLU	5/8/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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IOWA DNR : 096

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7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 5/14/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW4**

Lab Sample ID: AG13997

Sample Collection Date: 4/10/2024 Time: 13:44
Lab Submittal Date: 4/11/2024 Time: 14:36

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	27.78	ft	0.01	SOLINST	ARC	4/11/2024
Depth to water from TC	24.71	ft	0.01	SOLINST	ARC	4/11/2024
pH-Field	6.43	SU	0.01	EPA 9040	ARC	4/11/2024
Sp. Cond.-Field	848	µS	1	EPA 9050	ARC	4/11/2024
Temperature	13.4	°C	0.1	SM 2550B	ARC	4/11/2024
Chemical Oxygen Demand	18	mg/L	5.7	HACH 8000	BKY	4/29/2024
Ammonia (as N)	1.2	mg/L	0.104	SM 4500 NH3 F	MDK	4/12/2024
Chloride	82.6	mg/L	0.674	EPA 300.0	CCK/AEB	4/15/2024
Metals ICP-MS						
Arsenic, Total	0.0356	mg/L	0.00145	EPA 6020A	MLU	5/8/2024
Barium, Total	0.543	mg/L	0.00070	EPA 6020A	MLU	5/8/2024
Iron, Total	83.4	mg/L	0.04295	EPA 6020A	MLU	5/8/2024
Magnesium, Total	34.1	mg/L	0.43195	EPA 6020A	MLU	5/8/2024
Cobalt, Total	0.126	mg/L	0.00065	EPA 6020A	MLU	5/8/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 5/14/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW23**

Lab Sample ID: AG13998

Sample Collection Date: 4/10/2024 Time: 14:40
Lab Submittal Date: 4/11/2024 Time: 14:36

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	33.80	ft	0.01	SOLINST	ARC	4/11/2024
Depth to water from TC	23.54	ft	0.01	SOLINST	ARC	4/11/2024
pH-Field	7.09	SU	0.01	EPA 9040	ARC	4/11/2024
Sp. Cond.-Field	1087	µS	1	EPA 9050	ARC	4/11/2024
Temperature	14.4	°C	0.1	SM 2550B	ARC	4/11/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	4/29/2024
Ammonia (as N)	1.1	mg/L	0.104	SM 4500 NH3 F	MDK	4/12/2024
Chloride	88.2	mg/L	0.674	EPA 300.0	CCK/AEB	4/15/2024
Metals ICP-MS						
Arsenic, Total	0.0105	mg/L	0.00145	EPA 6020A	MLU	5/8/2024
Barium, Total	0.106	mg/L	0.00070	EPA 6020A	MLU	5/8/2024
Iron, Total	5.05	mg/L	0.04295	EPA 6020A	MLU	5/8/2024
Magnesium, Total	37.3	mg/L	0.43195	EPA 6020A	MLU	5/8/2024
Cobalt, Total	0.00185	mg/L	0.00065	EPA 6020A	MLU	5/8/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

CITY OF CEDAR RAPIDS - UTILITIES LABORATORY

CENTRAL LAB - WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 5/14/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW24**

Lab Sample ID: AG13999

Sample Collection Date: 4/11/2024 Time: 10:40
Lab Submittal Date: 4/11/2024 Time: 14:36

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	29.84	ft	0.01	SOLINST	ARC	4/11/2024
Depth to water from TC	20.94	ft	0.01	SOLINST	ARC	4/11/2024
pH-Field	6.75	SU	0.01	EPA 9040	ARC	4/11/2024
Sp. Cond.-Field	855	µS	1	EPA 9050	ARC	4/11/2024
Temperature	12.4	°C	0.1	SM 2550B	ARC	4/11/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	4/29/2024
Ammonia (as N)	0.72	mg/L	0.104	SM 4500 NH3 F	MDK	4/12/2024
Chloride	82.0	mg/L	0.674	EPA 300.0	CCK/AEB	4/15/2024
Metals ICP-MS						
Arsenic, Total	<0.00145	mg/L	0.00145	EPA 6020A	MLU	5/8/2024
Barium, Total	0.0936	mg/L	0.00070	EPA 6020A	MLU	5/8/2024
Iron, Total	<0.04295	mg/L	0.04295	EPA 6020A	MLU	5/8/2024
Magnesium, Total	26.0	mg/L	0.43195	EPA 6020A	MLU	5/8/2024
Cobalt, Total	0.00110	mg/L	0.00065	EPA 6020A	MLU	5/8/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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ND - Not detected at or above reporting limit.
SM - Standard Methods SW - Test Methods for Evaluating Solid Waste (SW-846)

ACCREDITATIONS:
IOWA DNR : 096

CITY OF CEDAR RAPIDS - UTILITIES LABORATORY

CENTRAL LAB - WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 5/14/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW2**

Lab Sample ID: AG14000

Sample Collection Date: 4/11/2024 Time: 11:42
Lab Submittal Date: 4/11/2024 Time: 14:36

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	25.70	ft	0.01	SOLINST	ARC	4/11/2024
Depth to water from TC	20.50	ft	0.01	SOLINST	ARC	4/11/2024
pH-Field	6.71	SU	0.01	EPA 9040	ARC	4/11/2024
Sp. Cond.-Field	748	µS	1	EPA 9050	ARC	4/11/2024
Temperature	11.9	°C	0.1	SM 2550B	ARC	4/11/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	4/29/2024
Ammonia (as N)	<0.313	mg/L	0.104	SM 4500 NH3 F	MDK	4/12/2024
Chloride	64.6	mg/L	0.674	EPA 300.0	CCK/AEB	4/15/2024
Metals ICP-MS						
Arsenic, Total	0.00162	mg/L	0.00145	EPA 6020A	MLU	5/8/2024
Barium, Total	0.114	mg/L	0.00070	EPA 6020A	MLU	5/8/2024
Iron, Total	<0.04295	mg/L	0.04295	EPA 6020A	MLU	5/8/2024
Magnesium, Total	23.7	mg/L	0.43195	EPA 6020A	MLU	5/8/2024
Cobalt, Total	0.00087	mg/L	0.00065	EPA 6020A	MLU	5/8/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

I certify under penalty of law that I believe the reported information above is true, accurate, and complete

ug/L - microgram per liter (ppb) mg/L - milligrams per liter (ppm)
ND - Not detected at or above reporting limit.
SM - Standard Methods SW - Test Methods for Evaluating Solid Waste (SW-846)

ACCREDITATIONS:
IOWA DNR : 096

CITY OF CEDAR RAPIDS - UTILITIES LABORATORY

CENTRAL LAB - WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 5/14/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW3R1**

Lab Sample ID: AG14001

Sample Collection Date: 4/11/2024 Time: 12:15
Lab Submittal Date: 4/11/2024 Time: 14:36

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	27.16	ft	0.01	SOLINST	ARC	4/11/2024
Depth to water from TC	20.86	ft	0.01	SOLINST	ARC	4/11/2024
pH-Field	6.63	SU	0.01	EPA 9040	ARC	4/11/2024
Sp. Cond.-Field	768	µS	1	EPA 9050	ARC	4/11/2024
Temperature	14.0	°C	0.1	SM 2550B	ARC	4/11/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	4/29/2024
Ammonia (as N)	0.3	mg/L	0.104	SM 4500 NH3 F	MDK	4/12/2024
Chloride	51.8	mg/L	0.674	EPA 300.0	CCK/AEB	4/15/2024
Metals ICP-MS						
Arsenic, Total	0.0323	mg/L	0.00145	EPA 6020A	MLU	5/8/2024
Barium, Total	0.171	mg/L	0.00070	EPA 6020A	MLU	5/8/2024
Iron, Total	35.5	mg/L	0.04295	EPA 6020A	MLU	5/8/2024
Magnesium, Total	20.6	mg/L	0.43195	EPA 6020A	MLU	5/8/2024
Cobalt, Total	0.0107	mg/L	0.00065	EPA 6020A	MLU	5/8/2024

Sample Comments: Created 2018

Bruce M. Lyon
Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

CITY OF CEDAR RAPIDS - UTILITIES LABORATORY

CENTRAL LAB - WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 5/14/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW22**

Lab Sample ID: AG14002

Sample Collection Date: 4/11/2024 Time: 12:53
Lab Submittal Date: 4/11/2024 Time: 14:36

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	26.58	ft	0.01	SOLINST	ARC	4/11/2024
Depth to water from TC	19.28	ft	0.01	SOLINST	ARC	4/11/2024
pH-Field	6.84	SU	0.01	EPA 9040	ARC	4/11/2024
Sp. Cond.-Field	1038	µS	1	EPA 9050	ARC	4/11/2024
Temperature	14.8	°C	0.1	SM 2550B	ARC	4/11/2024
Chemical Oxygen Demand	47	mg/L	5.7	HACH 8000	BKY	4/29/2024
Ammonia (as N)	2.8	mg/L	0.104	SM 4500 NH3 F	MDK	4/12/2024
Chloride	81.7	mg/L	0.674	EPA 300.0	CCK/AEB	4/15/2024
Metals ICP-MS						
Arsenic, Total	0.0145	mg/L	0.00145	EPA 6020A	MLU	5/8/2024
Barium, Total	0.408	mg/L	0.00070	EPA 6020A	MLU	5/8/2024
Iron, Total	18.2	mg/L	0.04295	EPA 6020A	MLU	5/8/2024
Magnesium, Total	35.3	mg/L	0.43195	EPA 6020A	MLU	5/8/2024
Cobalt, Total	0.0138	mg/L	0.00065	EPA 6020A	MLU	5/8/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

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7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 11/15/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW26**

Lab Sample ID: AG30766

Sample Collection Date: 10/23/2024 Time: 10:08
Lab Submittal Date: 10/24/2024 Time: 13:02

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	25.81	ft	0.01	SOLINST	ARC	10/23/2024
Depth to water from TC	22.94	ft	0.01	SOLINST	ARC/CCK	10/23/2024
pH-Field	6.15	SU	0.01	EPA 9040	ARC/CCK	10/23/2024
Sp. Cond.-Field	306.6	µS	1	EPA 9050	ARC/CCK	10/23/2024
Temperature	11.9	°C	0.1	SM 2550B	ARC/CCK	10/23/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	11/13/2024
Ammonia (as N)	<0.164	mg/L	0.055	SM 4500 NH3 F	HMB	10/25/2024
Chloride	63.6	mg/L	0.744	EPA 300.0	CCK	10/25/2024
Metals ICP-MS						
Arsenic, Total	<0.0037	mg/L	0.00370	EPA 6020A	MLU	11/5/2024
Barium, Total	0.140	mg/L	0.00205	EPA 6020A	MLU	11/5/2024
Iron, Total	0.347	mg/L	0.18965	EPA 6020A	MLU	11/5/2024
Magnesium, Total	13.8	mg/L	0.07995	EPA 6020A	MLU	11/5/2024
Cobalt, Total	<0.0017	mg/L	0.00170	EPA 6020A	MLU	11/5/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

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7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 11/15/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW21**

Lab Sample ID: AG30767

Sample Collection Date: 10/23/2024 Time: 8:16
Lab Submittal Date: 10/24/2024 Time: 13:02

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	27.43	ft	0.01	SOLINST	ARC/CCK	10/23/2024
Depth to water from TC	8.65	ft	0.01	SOLINST	ARC/CCK	10/23/2024
pH-Field	6.83	SU	0.01	EPA 9040	ARC/CCK	10/23/2024
Sp. Cond.-Field	874.5	µS	1	EPA 9050	ARC/CCK	10/23/2024
Temperature	13.3	°C	0.1	SM 2550B	ARC/CCK	10/23/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	11/13/2024
Ammonia (as N)	0.2	mg/L	0.055	SM 4500 NH3 F	HMB	10/25/2024
Chloride	215	mg/L	0.744	EPA 300.0	CCK	10/25/2024
Metals ICP-MS						
Arsenic, Total	<0.0037	mg/L	0.00370	EPA 6020A	MLU	11/5/2024
Barium, Total	0.350	mg/L	0.00205	EPA 6020A	MLU	11/5/2024
Iron, Total	1.07	mg/L	0.18965	EPA 6020A	MLU	11/5/2024
Magnesium, Total	54.8	mg/L	0.07995	EPA 6020A	MLU	11/5/2024
Cobalt, Total	<0.0017	mg/L	0.00170	EPA 6020A	MLU	11/5/2024

Sample Comments:

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Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

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7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 11/15/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW1**

Lab Sample ID: AG30768

Sample Collection Date: 10/23/2024 Time: 9:42
Lab Submittal Date: 10/24/2024 Time: 13:02

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	34.76	ft	0.01	SOLINST	ARC/CCK	10/23/2024
Depth to water from TC	23.33	ft	0.01	SOLINST	ARC/CCK	10/23/2024
pH-Field	6.37	SU	0.01	EPA 9040	ARC/CCK	10/23/2024
Sp. Cond.-Field	956.5	µS	1	EPA 9050	ARC/CCK	10/23/2024
Temperature	25.0	°C	0.1	SM 2550B	ARC/CCK	10/23/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	11/13/2024
Ammonia (as N)	0.53	mg/L	0.055	SM 4500 NH3 F	HMB	10/25/2024
Chloride	4.62	mg/L	0.744	EPA 300.0	CCK	10/25/2024
Metals ICP-MS						
Arsenic, Total	<0.0037	mg/L	0.00370	EPA 6020A	MLU	11/5/2024
Barium, Total	0.219	mg/L	0.00205	EPA 6020A	MLU	11/5/2024
Iron, Total	5.40	mg/L	0.18965	EPA 6020A	MLU	11/5/2024
Magnesium, Total	29.0	mg/L	0.07995	EPA 6020A	MLU	11/5/2024
Cobalt, Total	<0.0017	mg/L	0.00170	EPA 6020A	MLU	11/5/2024

Sample Comments:

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Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

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7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 11/15/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW4**

Lab Sample ID: AG30769

Sample Collection Date: 10/23/2024 Time: 10:37
Lab Submittal Date: 10/24/2024 Time: 13:02

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	27.77	ft	0.01	SOLINST	ARC/CCK	10/23/2024
Depth to water from TC	24.81	ft	0.01	SOLINST	ARC/CCK	10/23/2024
pH-Field	6.75	SU	0.01	EPA 9040	ARC/CCK	10/23/2024
Sp. Cond.-Field	447.9	µS	1	EPA 9050	ARC/CCK	10/23/2024
Temperature	16.4	°C	0.1	SM 2550B	ARC/CCK	10/23/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	11/13/2024
Ammonia (as N)	1.0	mg/L	0.055	SM 4500 NH3 F	HMB	10/25/2024
Chloride	75.7	mg/L	0.744	EPA 300.0	CCK	10/25/2024
Metals ICP-MS						
Arsenic, Total	0.0137	mg/L	0.00370	EPA 6020A	MLU	11/5/2024
Barium, Total	0.317	mg/L	0.00205	EPA 6020A	MLU	11/5/2024
Iron, Total	5.09	mg/L	0.18965	EPA 6020A	MLU	11/5/2024
Magnesium, Total	29.1	mg/L	0.07995	EPA 6020A	MLU	11/5/2024
Cobalt, Total	0.00529	mg/L	0.00170	EPA 6020A	MLU	11/5/2024

Sample Comments:

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Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

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7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 11/15/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW23**

Lab Sample ID: AG30770

Sample Collection Date: 10/23/2024 Time: 11:10
Lab Submittal Date: 10/24/2024 Time: 13:02

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	33.76	ft	0.01	SOLINST	ARC/CCK	10/24/2024
Depth to water from TC	23.61	ft	0.01	SOLINST	ARC/CCK	10/23/2024
pH-Field	7.01	SU	0.01	EPA 9040	ARC/CCK	10/23/2024
Sp. Cond.-Field	666.9	µS	1	EPA 9050	ARC/CCK	10/23/2024
Temperature	19.0	°C	0.1	SM 2550B	ARC/CCK	10/23/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	11/13/2024
Ammonia (as N)	1.1	mg/L	0.055	SM 4500 NH3 F	HMB	10/25/2024
Chloride	90.7	mg/L	0.744	EPA 300.0	CCK	10/25/2024
Metals ICP-MS						
Arsenic, Total	0.00787	mg/L	0.00370	EPA 6020A	MLU	11/5/2024
Barium, Total	0.110	mg/L	0.00205	EPA 6020A	MLU	11/5/2024
Iron, Total	4.51	mg/L	0.18965	EPA 6020A	MLU	11/5/2024
Magnesium, Total	38.1	mg/L	0.07995	EPA 6020A	MLU	11/5/2024
Cobalt, Total	0.00196	mg/L	0.00170	EPA 6020A	MLU	11/5/2024

Sample Comments:

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Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

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CENTRAL LAB - WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 11/15/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW24**

Lab Sample ID: AG30771

Sample Collection Date: 10/23/2024 Time: 11:40
Lab Submittal Date: 10/24/2024 Time: 13:02

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	29.73	ft	0.01	SOLINST	ARC/CCK	10/23/2024
Depth to water from TC	20.90	ft	0.01	SOLINST	ARC/CCK	10/23/2024
pH-Field	7.09	SU	0.01	EPA 9040	ARC/CCK	10/23/2024
Sp. Cond.-Field	547.0	µS	1	EPA 9050	ARC/CCK	10/23/2024
Temperature	13.3	°C	0.1	SM 2550B	ARC/CCK	10/23/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	11/13/2024
Ammonia (as N)	0.74	mg/L	0.055	SM 4500 NH3 F	HMB	10/25/2024
Chloride	128	mg/L	0.744	EPA 300.0	CCK	10/25/2024
Metals ICP-MS						
Arsenic, Total	<0.0037	mg/L	0.00370	EPA 6020A	MLU	11/5/2024
Barium, Total	0.109	mg/L	0.00205	EPA 6020A	MLU	11/5/2024
Iron, Total	0.636	mg/L	0.18965	EPA 6020A	MLU	11/5/2024
Magnesium, Total	31.9	mg/L	0.07995	EPA 6020A	MLU	11/5/2024
Cobalt, Total	<0.0017	mg/L	0.00170	EPA 6020A	MLU	11/5/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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ACCREDITATIONS:
IOWA DNR : 096

CITY OF CEDAR RAPIDS - UTILITIES LABORATORY

CENTRAL LAB - WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 11/15/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW2**

Lab Sample ID: AG30772

Sample Collection Date: 10/24/2024 Time: 8:55
Lab Submittal Date: 10/24/2024 Time: 13:02

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	25.80	ft	0.01	SOLINST	ARC/CCK	10/24/2024
Depth to water from TC	20.46	ft	0.01	SOLINST	ARC/CCK	10/24/2024
pH-Field	6.48	SU	0.01	EPA 9040	ARC/CCK	10/24/2024
Sp. Cond.-Field	532.2	µS	1	EPA 9050	ARC/CCK	10/24/2024
Temperature	11.3	°C	0.1	SM 2550B	ARC/CCK	10/24/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	11/13/2024
Ammonia (as N)	<0.164	mg/L	0.055	SM 4500 NH3 F	HMB	10/25/2024
Chloride	100	mg/L	0.744	EPA 300.0	CCK	10/25/2024
Metals ICP-MS						
Arsenic, Total	<0.0037	mg/L	0.00370	EPA 6020A	MLU	11/5/2024
Barium, Total	0.126	mg/L	0.00205	EPA 6020A	MLU	11/5/2024
Iron, Total	0.587	mg/L	0.18965	EPA 6020A	MLU	11/5/2024
Magnesium, Total	22.0	mg/L	0.07995	EPA 6020A	MLU	11/5/2024
Cobalt, Total	<0.0017	mg/L	0.00170	EPA 6020A	MLU	11/5/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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ND - Not detected at or above reporting limit.
SM - Standard Methods   SW - Test Methods for Evaluating Solid Waste (SW-846)

ACCREDITATIONS:
IOWA DNR : 096

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(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 11/15/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW3R1**

Lab Sample ID: AG30773

Sample Collection Date: 10/24/2024 Time: 9:48
Lab Submittal Date: 10/24/2024 Time: 13:02

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	27.23	ft	0.01	SOLINST	ARC/CCK	10/24/2024
Depth to water from TC	20.84	ft	0.01	SOLINST	ARC/CCK	10/24/2024
pH-Field	6.80	SU	0.01	EPA 9040	ARC/CCK	10/24/2024
Sp. Cond.-Field	502.7	µS	1	EPA 9050	ARC/CCK	10/24/2024
Temperature	13.6	°C	0.1	SM 2550B	ARC/CCK	10/24/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	11/13/2024
Ammonia (as N)	0.4	mg/L	0.055	SM 4500 NH3 F	HMB	10/25/2024
Chloride	65.9	mg/L	0.744	EPA 300.0	CCK	10/25/2024
Metals ICP-MS						
Arsenic, Total	0.0457	mg/L	0.00370	EPA 6020A	MLU	11/5/2024
Barium, Total	0.280	mg/L	0.00205	EPA 6020A	MLU	11/5/2024
Iron, Total	42.5	mg/L	0.18965	EPA 6020A	MLU	11/5/2024
Magnesium, Total	28.3	mg/L	0.07995	EPA 6020A	MLU	11/5/2024
Cobalt, Total	0.0152	mg/L	0.00170	EPA 6020A	MLU	11/5/2024

Sample Comments: Created 2018

Bruce M. Lyon
Utilities Quality Assurance Officer

I certify under penalty of law that I believe the reported information above is true, accurate, and complete

ug/L - microgram per liter (ppb) mg/L - milligrams per liter (ppm)
ND - Not detected at or above reporting limit.
SM - Standard Methods SW - Test Methods for Evaluating Solid Waste (SW-846)

ACCREDITATIONS:
IOWA DNR : 096

CITY OF CEDAR RAPIDS - UTILITIES LABORATORY

CENTRAL LAB - WATER POLLUTION CONTROL FACILITIES
7525 BERTRAM RD SE, CEDAR RAPIDS, IA 52403-7111
(319)-286-5286 FAX (319)-286-5287

ANALYTICAL DATA REPORT

Report Date 11/15/2024

Report To: Justin Schroeder
Utilities Environmental Mgr
7525 Bertram Rd SE
Cedar Rapids IA 52403-7111

Site: Cedar Rapids Water Pollution Control Facility Sludge Ash Landfill

Permit : 57-SDP-7-85P

Sample Point: **East Ash Lagoon MW22**

Lab Sample ID: AG30774

Sample Collection Date: 10/24/2024 Time: 10:28
Lab Submittal Date: 10/24/2024 Time: 13:02

Test Parameter	Result	Units	Reporting Limit	Method	Analyst	Analysis Date
Well Depth from TC	25.99	ft	0.01	SOLINST	ARC/CCK	10/24/2024
Depth to water from TC	19.12	ft	0.01	SOLINST	ARC/CCK	10/24/2024
pH-Field	6.92	SU	0.01	EPA 9040	ARC/CCK	10/24/2024
Sp. Cond.-Field	668.4	µS	1	EPA 9050	ARC/CCK	10/24/2024
Temperature	14.8	°C	0.1	SM 2550B	ARC/CCK	10/24/2024
Chemical Oxygen Demand	<5.7	mg/L	5.7	HACH 8000	BKY	11/13/2024
Ammonia (as N)	3.1	mg/L	0.055	SM 4500 NH3 F	HMB	10/25/2024
Chloride	115	mg/L	0.744	EPA 300.0	CCK	10/25/2024
Metals ICP-MS						
Arsenic, Total	0.0225	mg/L	0.00370	EPA 6020A	MLU	11/5/2024
Barium, Total	0.339	mg/L	0.00205	EPA 6020A	MLU	11/5/2024
Iron, Total	16.1	mg/L	0.18965	EPA 6020A	MLU	11/5/2024
Magnesium, Total	35.8	mg/L	0.07995	EPA 6020A	MLU	11/5/2024
Cobalt, Total	0.0128	mg/L	0.00170	EPA 6020A	MLU	11/5/2024

Sample Comments:

Bruce M. Lyon
Utilities Quality Assurance Officer

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ug/L - microgram per liter (ppb)   mg/L - milligrams per liter (ppm)
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SM - Standard Methods   SW - Test Methods for Evaluating Solid Waste (SW-846)

ACCREDITATIONS:
IOWA DNR : 096

APPENDIX D

Field Sampling Forms

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW21**   Well Type : Downgradient

Sample collector(s): ARC/AEB/AMM   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked? YES   Comments

Well Capped? YES   Standing Water or Litter? NONE

Concrete Seal? NOT VISIBLE   Weather Conditions?: Calm

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing 729.93   Ground Elevation:

Depth of Well, from TC 27.49   Inner casing dia. (in.) 2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	04/10/24	10:23	5.58	724.35
After Purging	04/10/24	10:57	25.68	704.25
Before Sampling	04/11/24	9:53	5.62	724.31

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 11

Number of Well Volumes Purged (based on current water level) : 3.1   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.67	SU
Specific Conductance:	1420	uS/cm
Temperature:	11.4	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments: Initial Turbidity: NONE   Sample Turbidity: NONE

Sample Color: NONE   Sample Odor: NONE

QC Samples:

pH Meter Checks (7 or 4): 6.99

Utilities QA Officer   5/13/2024

I certify under penalty of law that I believe the reported information above is true, accurate, and complete.

542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW1**   Well Type : Downgradient

Sample collector(s): ARC   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked? YES   Comments

Well Capped? YES   Standing Water or Litter? NONE

Concrete Seal? OK   Weather Conditions?: Calm, Mild

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing 730.72   Ground Elevation:

Depth of Well, from TC 34.78   Inner casing dia. (in.) 2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	04/10/24	11:09	22.93	707.79
After Purging	04/10/24	11:30	24.74	705.98
Before Sampling	04/10/24	11:42	23.27	707.45

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 6

Number of Well Volumes Purged (based on current water level) : 3.1   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.97	SU
Specific Conductance:	721	uS/cm
Temperature:	13.6	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments: Initial Turbidity: SLIGHT   Sample Turbidity: NONE

Sample Color: NONE   Sample Odor: NONE

QC Samples:

pH Meter Checks (7 or 4): 7.05

Utilities QA Officer   5/13/2024

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542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW4**   Well Type : Downgradient

Sample collector(s): ARC   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	NOT VISIBLE	Weather Conditions?:	Calm

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	726.78	Ground Elevation:	
Depth of Well, from TC	27.78	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	04/10/24	13:31	24.71	702.07
After Purging	04/10/24	13:39	24.69	702.09
Before Sampling	04/10/24	13:44	24.69	702.09

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 2

Number of Well Volumes Purged (based on current water level) : 4.0   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.43	SU
Specific Conductance:	848	uS/cm
Temperature:	13.4	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	SLIGHT	Sample Turbidity:	SLIGHT
	Sample Color:	GREY	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7.04

Utilities QA Officer   5/13/2024

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542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW23**   Well Type : Downgradient

Sample collector(s): ARC   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	NOT VISIBLE	Weather Conditions?:	Calm

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	725.41	Ground Elevation:	
Depth of Well, from TC	33.80	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	04/10/24	14:14	23.54	701.87
After Purging	04/10/24	14:39	23.55	701.86
Before Sampling	04/10/24	14:40	23.55	701.86

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 5.1

Number of Well Volumes Purged (based on current water level) : 3.0   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	7.09	SU
Specific Conductance:	1087	uS/cm
Temperature:	14.4	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	HEAVY	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7.02

Utilities QA Officer   5/13/2024

I certify under penalty of law that I believe the reported information above is true, accurate, and complete.

542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW24**   Well Type : Downgradient

Sample collector(s): ARC/AEB/AMM   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	OK	Weather Conditions?:	Overcast, Windy

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	720.27	Ground Elevation:	
Depth of Well, from TC	29.84	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	04/11/24	10:17	20.94	699.33
After Purging	04/11/24	10:37	20.94	699.33
Before Sampling	04/11/24	10:40	20.94	699.33

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 5

Number of Well Volumes Purged (based on current water level) : 3.4   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.75	SU
Specific Conductance:	855	uS/cm
Temperature:	12.4	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity: SLIGHT		Sample Turbidity:	NONE
	Sample Color: NONE		Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7

Utilities QA Officer   5/13/2024

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FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill — Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW2** — Well Type : Downgradient

Sample collector(s): ARC/AEB/AMM — Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	OK	Weather Conditions?:	Overcast, Windy

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	720.04	Ground Elevation:	
Depth of Well, from TC	25.70	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	04/11/24	11:23	20.50	699.54
After Purging	04/11/24	11:39	20.51	699.53
Before Sampling	04/11/24	11:42	20.51	699.53

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 3

Number of Well Volumes Purged (based on current water level) : 3.5 — Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.71	SU
Specific Conductance:	748	uS/cm
Temperature:	11.9	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	HEAVY	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7.04

Utilities QA Officer — 5/13/2024

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542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW3R1**   Well Type : Downgradient

Sample collector(s): ARC/AEB/AMM   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	CRACKED	Weather Conditions?:	Overcast, Windy

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	719.42	Ground Elevation:	
Depth of Well, from TC	27.16	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	04/11/24	11:56	20.86	698.56
After Purging	04/11/24	12:14	20.85	698.57
Before Sampling	04/11/24	12:15	20.85	698.57

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 3.5

Number of Well Volumes Purged (based on current water level) : 3.4   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.63	SU
Specific Conductance:	768	uS/cm
Temperature:	14.0	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	HEAVY	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7.1

Utilities QA Officer   5/13/2024

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542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW22**   Well Type : Downgradient

Sample collector(s): ARC/AEB/AMM   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked? YES   Comments

Well Capped? YES   Standing Water or Litter? NONE

Concrete Seal? Grnd Separating fr   Weather Conditions?: Overcast, Windy

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing 718.40   Ground Elevation:

Depth of Well, from TC 26.58   Inner casing dia. (in.) 2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	04/11/24	12:35	19.28	699.12
After Purging	04/11/24	12:52	19.28	699.12
Before Sampling	04/11/24	12:53	19.28	699.12

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 4

Number of Well Volumes Purged (based on current water level) : 3.4   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.84	SU
Specific Conductance:	1038	uS/cm
Temperature:	14.8	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments: Initial Turbidity: HEAVY   Sample Turbidity: SLIGHT

Sample Color: GREY   Sample Odor: NONE

QC Samples:

pH Meter Checks (7 or 4): 7

Utilities QA Officer   5/13/2024

I certify under penalty of law that I believe the reported information above is true, accurate, and complete.   542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill — Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW26** — Well Type : Background

Sample collector(s): ARC — Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

		Comments	
Well Locked?	YES		
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	NOT VISIBLE	Weather Conditions?:	Calm

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	725.81	Ground Elevation:	
Depth of Well, from TC	25.79	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	04/10/24	13:03	22.95	702.86
After Purging	04/10/24	13:12	22.92	702.89
Before Sampling	04/10/24	13:15	22.92	702.89

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 2

Number of Well Volumes Purged (based on current water level) : 4.3 — Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.21	SU
Specific Conductance:	519	uS/cm
Temperature:	13.2	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	NONE	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples: Dupl & Blnk

pH Meter Checks (7 or 4): 7.13

Utilities QA Officer — 5/13/2024

I certify under penalty of law that I believe the reported information above is true, accurate, and complete.

542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill　　　Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N　**MW21**　　　Well Type : Downgradient

Sample collector(s):　ARC/CCK　　　Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	NOT VISIBLE	Weather Conditions?:	Clear, Calm

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	729.93	Ground Elevation:	
Depth of Well, from TC	27.43	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	10/23/24	8:33	8.65	721.28
After Purging	10/23/24	8:59	24.08	705.85
Before Sampling	10/24/24	8:16	8.51	721.42

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 9.5

Number of Well Volumes Purged (based on current water level) : 3.1　　Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.83	SU
Specific Conductance:	875	uS/cm
Temperature:	13.3	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	NONE	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7.04

Utilities QA Officer　　　10/28/2024

I certify under penalty of law that I believe the reported information above is true, accurate, and complete.　　542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW1**   Well Type : Downgradient

Sample collector(s): ARC/CCK   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	Litter
Concrete Seal?	OK	Weather Conditions?:	Overcast, Windy

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	730.72	Ground Elevation:	
Depth of Well, from TC	34.76	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	10/23/24	9:12	23.33	707.39
After Purging	10/23/24	9:39	24.61	706.11
Before Sampling	10/23/24	9:42	24.61	706.11

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 6

Number of Well Volumes Purged (based on current water level) : 3.2   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.37	SU
Specific Conductance:	957	uS/cm
Temperature:	25.0	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	HEAVY	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7.02

Utilities QA Officer   10/28/2024

I certify under penalty of law that I believe the reported information above is true, accurate, and complete.   542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW4**   Well Type : Downgradient

Sample collector(s): ARC/CCK   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	NOT VISIBLE	Weather Conditions?:	Clear, Windy

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	726.78	Ground Elevation:	
Depth of Well, from TC	27.77	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	10/23/24	10:24	24.81	701.97
After Purging	10/23/24	10:36	24.81	701.97
Before Sampling	10/23/24	10:37	24.81	701.97

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 2.5

Number of Well Volumes Purged (based on current water level) : 5.2   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.75	SU
Specific Conductance:	448	uS/cm
Temperature:	16.4	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	NONE	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7.01

Utilities QA Officer   10/28/2024

I certify under penalty of law that I believe the reported information above is true, accurate, and complete.

542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW23**   Well Type : Downgradient

Sample collector(s): ARC/CCK   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	NOT VISIBLE	Weather Conditions?:	Clear, Windy

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	725.41	Ground Elevation:	
Depth of Well, from TC	33.76	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	10/23/24	10:48	23.61	701.80
After Purging	10/23/24	11:07	23.61	701.80
Before Sampling	10/23/24	11:10	23.61	701.80

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 5

Number of Well Volumes Purged (based on current water level) : 3.0   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	7.01	SU
Specific Conductance:	667	uS/cm
Temperature:	19.0	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	HEAVY	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7.04

Utilities QA Officer   10/28/2024

I certify under penalty of law that I believe the reported information above is true, accurate, and complete.   542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW24**   Well Type : Downgradient

Sample collector(s): ARC/CCK   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	NOT VISIBLE	Weather Conditions?:	Clear, Windy

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	720.27	Ground Elevation:	
Depth of Well, from TC	29.73	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	10/23/24	11:19	20.90	699.37
After Purging	10/23/24	11:37	20.9	699.37
Before Sampling	10/23/24	11:40	20.9	699.37

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 5

Number of Well Volumes Purged (based on current water level) : 3.5   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	7.09	SU
Specific Conductance:	547	uS/cm
Temperature:	13.3	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	NONE	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7

Utilities QA Officer   10/28/2024

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FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW2**   Well Type : Downgradient

Sample collector(s): ARC/CCK   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked?	YES	Comments	
Well Capped?	YES	Standing Water or Litter?	NONE
Concrete Seal?	OK	Weather Conditions?:	Clear, Calm

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing	720.04	Ground Elevation:	
Depth of Well, from TC	25.80	Inner casing dia. (in.)	2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	10/24/24	8:31	20.46	699.58
After Purging	10/24/24	8:53	20.46	699.58
Before Sampling	10/24/24	8:55	20.46	699.58

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 3

Number of Well Volumes Purged (based on current water level) : 3.4   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.48	SU
Specific Conductance:	532	uS/cm
Temperature:	11.3	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments:	Initial Turbidity:	NONE	Sample Turbidity:	NONE
	Sample Color:	NONE	Sample Odor:	NONE

QC Samples:

pH Meter Checks (7 or 4): 7.01

Utilities QA Officer   10/28/2024

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FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW3R1** Well Type : Downgradient

Sample collector(s): ARC/CCK Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked? YES

Comments

Well Capped? YES Standing Water or Litter? NONE

Concrete Seal? CRACKED Weather Conditions?: Clear, Calm

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing 719.42 Ground Elevation:

Depth of Well, from TC 27.23 Inner casing dia. (in.) 2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	10/24/24	9:07	20.84	698.58
After Purging	10/24/24	9:47	20.85	698.57
Before Sampling	10/24/24	9:48	20.85	698.57

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 3.5

Number of Well Volumes Purged (based on current water level) : 3.4 Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.80	SU
Specific Conductance:	503	uS/cm
Temperature:	13.6	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments: Initial Turbidity: SLIGHT Sample Turbidity: NONE

Sample Color: YELLOW Sample Odor: EGG

QC Samples:

pH Meter Checks (7 or 4): 7.1

Utilities QA Officer 10/28/2024

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542-1322

FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill   Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW22**   Well Type : Downgradient

Sample collector(s): ARC/CCK   Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked? YES   Comments

Well Capped? YES   Standing Water or Litter? NONE

Concrete Seal? OK   Weather Conditions?: Clear, Calm

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing 718.40   Ground Elevation:

Depth of Well, from TC 25.99   Inner casing dia. (in.) 2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	10/24/24	10:09	19.12	699.28
After Purging	10/24/24	10:25	19.09	699.31
Before Sampling	10/24/24	10:28	19.09	699.31

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 3.5

Number of Well Volumes Purged (based on current water level) : 3.1   Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.92	SU
Specific Conductance:	668	uS/cm
Temperature:	14.8	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments: Initial Turbidity: HEAVY   Sample Turbidity: NONE

Sample Color: NONE   Sample Odor: NONE

QC Samples:

pH Meter Checks (7 or 4): 7

Utilities QA Officer   10/28/2024

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FORM FOR
GROUNDWATER SAMPLING AND/OR
GROUNDWATER ELEVATION MEASURMENT

Site Name: Cedar Rapids Water Pollution Control Ash Lagoon Landfill Permit No.: 57-SDP-7-85P

Monitoring Well/Piezometer N **MW26** Well Type : Background

Sample collector(s): ARC/CCK Laboratory Services, City of Cedar Rapids

A. MONITORING WELL/PIEZOMETER CONDITIONS

Well Locked? YES

Well Capped? YES

Concrete Seal? NOT VISIBLE

Comments

Standing Water or Litter? NONE

Weather Conditions?: Clear, Windy

B. GROUNDWATER ELEVATION MEASUREMENT (+/- 0.01 foot, MSL)

Elevation, top of inner well casing 725.81

Depth of Well, from TC 25.81

Ground Elevation:

Inner casing dia. (in.) 2

Groundwater Level (+/- 0.01 foot below top of inner casing, MSL):

	Date	Time	Depth to Water	Water Elevation
Before Purging	10/23/24	9:57	22.94	702.87
After Purging	10/23/24	10:06	22.95	702.86
Before Sampling	10/23/24	10:08	22.95	702.86

Water levels measured with Solinst Electronic Depth Tape

C. WELL PURGING

Quantity of Water Removed from Well (gallons): 2.5

Number of Well Volumes Purged (based on current water level) : 5.3

Was Well Purged Dry? NO

Equipment Used: (W) = Waterra Inertial Pump, (B) = Disposable Bailer: GeoTech

All purging and sampling equipment used is dedicated or disposable.

D. FIELD MEASUREMENT

Field measurements (at sample time)

pH:	6.15	SU
Specific Conductance:	307	uS/cm
Temperature:	11.9	deg C

Field measurements made with an Oakton pH/Con 10 meter with a combination pH/ conductivity and temperature probe.

Sampling Comments: Initial Turbidity: NONE Sample Turbidity: NONE

Sample Color: NONE Sample Odor: NONE

QC Samples:

pH Meter Checks (7 or 4): 6.99

Utilities QA Officer 10/28/2024

I certify under penalty of law that I believe the reported information above is true, accurate, and complete.

542-1322

APPENDIX E

2024 Monitoring Well Maintenance Performance Reevaluation

Monitoring Well Maintenance Performance Reevaluation Plan

INTRODUCTION

The purpose of a Monitoring Well Maintenance Performance Reevaluation is to ensure that all monitoring wells included in the approved Hydrologic Monitoring System Plan (HMSP) remain reliable monitoring points. A Monitoring Well Maintenance Performance Reevaluation (MWMPRP) is required to be performed every five (5) years at industrial monofills (IAC 567-115.21(2)"d").

A total of nine (9) monitoring wells are included in the approved HMSP for the Cedar Rapids WPCF ash monofill (Figure 2). The nine (9) monitoring wells are designated MW-26 (background), MW-1, MW-2, MW-3R1, MW-4, MW-21, MW-22, MW-23, and MW-24.

Assessment of the well function and/or well deterioration is made through direct observation and measurement and through indirect testing methods. Assessment of the site hydrologic conditions is also made to determine whether changes in the static water level and/or groundwater flow path has occurred.

ASSESSMENT OF MONITORING WELL CONDITION

Physical Condition - Observation of the physical condition of each well is made during each sampling episode. Observation indicates that all protective casings and locks are in place and operable. All well casings are capped. The PVC well casings appear to allow adequate access to the groundwater for water depth measurements and water sampling activities.

Well Depth and Sedimentation - Annual well depth measurements are made. Table 1 (Attachment A) summarizes the original well depth and the most recent (October 23-24, 2024) well depths. The difference in the original bottom elevation and the October 23-24, 2024 bottom elevation is estimated to represent sedimentation in the well. As summarized in Table 1, sedimentation is minimal in all wells. Sedimentation is recorded to be 1.0 ft or less in all wells except MW-1. At MW-1 sedimentation is recorded at 2.06 ft. In 2019 sedimentation in MW-1 was recorded as 2.08 ft. The sediment recorded in the monitoring wells is not considered problematic at this time. Sedimentation does not appear to impact well production and/or sampling at any of the HMSP wells.

In-situ Hydraulic Conductivity Testing - Monitoring wells MW-1, MW-2, MW-3, and MW-4 were installed in 1985. MW-21, MW-22, MW-23, and MW-24 were installed in 1992. MW-26 was installed in 1995. Boring logs and well construction documentation for these wells was included in the 2008 Permit Renewal Application (Doc #18311). MW-3 was abandoned during the construction of the south cell of the monofill in 2011. Abandonment documentation for MW-3 was submitted to IDNR August 25, 2011 (Doc #66513). MW-3R (replacing MW-3) was installed in 2012 and abandoned in 2018. Construction documentation for MW-3R was submitted to IDNR January 9, 2012 (Doc #68186). Abandonment documentation for MW-3R was received by IDNR September 4, 2018 (Doc #93095). MW-3R1 (replacing MW-3R) was installed in 2018. Construction documentation for MW-3R1 was received by IDNR July 5, 2018 (Doc #92858).

The record was reviewed and results of historic in-situ hydraulic conductivity testing at each of the nine (9) monitoring wells is summarized in Table 2 (Attachment A). In-situ hydraulic conductivity testing was again performed for the nine (9) wells on October 23-24, 2024. The reported hydraulic conductivities (Table 2) seem reasonable in comparison to the historic values and do not demonstrate considerable changes at any monitoring point except at MW-1 and MW-21 in comparison to the 2019 calculations. The calculated hydraulic conductivity at MW-1 increased when compared to that calculated in 2019. The calculated hydraulic conductivity at MW-21 decreased in comparison to that calculated in 2019. Note that the final water level reading at MW-21 occurred after the well had fully recovered which would cause the reported hydraulic conductivity to be less (slower) than the actual value. Variability in the calculated hydraulic conductivities is not attributed to well deterioration. It is our interpretation that the variability is not excessive and falls within the anticipated range of deviation.

ASSESSMENT OF SITE HYDROLOGIC CONDITIONS

Flow Paths - Figure 1 of the AWQR is an overall Site Plan. Figure 2 is a Groundwater Contour Map and illustrates the water table surface in October, 2024. The shape of the water table surface illustrated on the map is relatively unchanged from the previous year's map.

Groundwater flow at the site is inward from the northeast and is <u>not</u> affected by the groundwater diversion system under the south cell of the monofill. The wells are positioned such that the flow paths are adequately intersected and any release will be detected by the monitoring system.

Water Level Condition and Well Location - A summary of historic water elevation data (1995-2024) is included in Table 4A of the AWQR. Water elevation data over the past five (5) years is fairly static.

Table 3 (Attachment A) is a summary of the recorded October 23-24, 2024 water level data, along with pertinent well construction information. Column 8 of Table 3 is a direct comparison of the static water elevation (October, 2024) to the top of screen elevation in each respective well. A positive value indicates that the static water level is above the top of the screen, while a negative value indicates a static water level that is below the top of the screen (within the screened interval).

Review of Table 3 indicates that the static water elevation is above the top of screen in MW-1 and MW-21. The top of screen is exposed at MW-2, MW-3R1, MW-4, MW-22, MW-

24, and MW-26. Exposure of the well screen to the atmosphere does not appear to be detrimental to the integrity of the screens of the monitoring wells listed above. Excessive encrustation is not anticipated on the PVC screen.

Draw-down in the water table recorded at the site monitoring wells during purging and bail testing (Column 11, Table 3) indicates that the water table surface descends into the screened interval in all wells except MW-1 during purging activities. MW-1 exhibits relatively high hydraulic conductivity and appreciable draw down is not achieved during purging. It is, however, anticipated that the samples collected reflect water quality at the water table surface.

Replacement of those wells where the water table is above the screened interval is not recommended.

CONCLUSIONS & RECOMMENDATIONS

Assessment of the monitoring well condition indicates that all wells are in satisfactory condition and have not experienced excessive sedimentation. Excessive well deterioration is not apparent based on the comparison of historic in-situ hydraulic conductivity testing and the hydraulic conductivity testing performed in October, 2024.

The water table surface is relatively unchanged between 1995 and 2024, and the wells are interpreted to be located appropriately to detect water quality changes.

Water levels in a few of the site monitoring wells are consistently above the screened interval. However, well purging prior to sampling appears adequate to lower the water table surface into the screened interval at all but one (1) well during sampling. Regardless, the water samples collected appear to adequately reflect water quality in the subsurface saturated soils.

No changes to the monitoring wells are recommended based on the discussion above; however, significant changes to the Hydrologic Monitoring System Plan are anticipated in 2025 due to upcoming construction activities at the facility. Further assessment of the monitoring well conditions should be made in 2029.

ATTACHMENT A

MWMPRP Table 1 – Assessment of Well Depth & Sedimentation
MWMPRP Table 2 – Hydraulic Conductivity Summary Data
MWMPRP Table 3 – Water Elevation Versus Top of Screen

TABLE 1
Assessment of Well Depth & Sedimentation
Cedar Rapids WPCF Ash Monofill
IDNR Permit #57-SDP-07-85P

Well No.	Top of Casing Elevation	Original Bottom Depth	Original Bottom Elevation	October, 2024 Bottom Depth	October, 2024 Bottom Elevation	October, 2024 Sediment Thickness (ft)
MW-1	730.72	36.82	693.9	34.76	695.96	2.06
MW-2	720.04	25.64	694.4	25.8	694.24	-0.16
MW-3R1	719.42	26.75	692.67	27.23	692.19	-0.48
MW-4	726.78	27.88	698.9	27.77	699.01	0.11
MW-21	729.93	27.03	702.9	27.43	702.5	-0.4
MW-22	718.4	26.6	691.8	25.99	692.41	0.61
MW-23	725.41	33.51	691.9	33.76	691.65	-0.25
MW-24	720.27	29.57	690.7	29.73	690.54	-0.16
MW-26	725.81	25.41	700.4	25.81	700	-0.4

TABLE 2
Hydraulic Conductivity Summary Data
Cedar Rapids WPCF Ash Monofill
IDNR Permit #57-SDP-07-85P

Well No.	Installation Date	1992 K cm/sec	2000 K cm/sec	2005 K cm/sec	2014 K cm/sec	2019 K cm/sec	2024 K cm/sec
MW-1	9/26/1985	1.8E-04	1.0E-04	7.0E-05	1.0E-04	4.5E-05	>1.0E-03*
MW-2	9/26/1985	2.8E-01	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*
MW-3	9/26/1985	4.0E-01	>1.0E-03*	>1.0E-03*	DNE	DNE	DNE
MW-3R	12/19/2011	DNE	DNE	DNE	>1.0E-03*	DNE	DNE
MW-3R1	3/29/2018	DNE	DNE	DNE	DNE	>1.0E-03*	>1.0E-03*
MW-4	10/5/1985	3.0E-01	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*
MW-21	1/30/1992	1.1E-05	7.0E-06	5.0E-06	6.0E-06	1.5E-05	6.7E-06
MW-22	1/29/1992	1.5E-01	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*
MW-23	1/28/1992	8.1E-02	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*
MW-24	1/30/1992	1.6E-01	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*
MW-26	8/23/1995	DNE	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*	>1.0E-03*

* Well recovery rates were too rapid to measure; therefore, assume a hydraulic conductivity of greater than 1.0E-03 cm/sec

DNE - Did not exist/Does not exist

NOTES:

1. 1992 data from Green Environmental Services
2. 2000 and 2005 data from Midwest Environmental Consulting
3. 2014, 2019, and 2024 data from CRWPCF personnel
4. MW-3 was abandoned 7/28/11
5. MW-3R was abandoned 3/18

TABLE 3
Water Elevation Versus Top of Screen (October, 2024)
Cedar Rapids WPCF Ash Monofill
IDNR Permit #57-SDP-07-85P

Well No.	Top of Casing Elevation	Top of Screen Elevation	Bottom of Screen Elevation	Screen Length	Static Water Depth	Static Water Elevation	Static Water Level Versus Top of Screen	Purged Water Depth	Purged Water Elevation	Purged Water Level Versus Top of Screen
MW-1	730.72	698.9	693.9	5	23.33	707.39	8.49	24.61	706.11	7.21
MW-2	720.04	704.4	694.4	10	20.46	699.58	-4.82	20.46	699.58	-4.82
MW-3R1	719.42	702.7	692.7	10	20.84	698.58	-4.12	20.85	698.57	-4.13
MW-4	726.78	703.9	698.9	5	24.81	701.97	-1.93	24.81	701.97	-1.93
MW-21	729.93	717.9	702.9	15	8.65	721.28	3.38	24.08	705.85	-12.05
MW-22	718.4	706.8	691.8	15	19.12	699.28	-7.52	19.09	699.31	-7.49
MW-23	725.41	701.9	691.9	10	23.61	701.8	-0.1	23.61	701.8	-0.1
MW-24	720.27	705.7	690.7	15	20.9	699.37	-6.33	20.9	699.37	-6.33
MW-26	725.81	710.4	700.4	10	22.94	702.87	-7.53	22.95	702.86	-7.54

"-" = feet below top of screen (within the screened interval). All positive values are feet above the screen.