Simmons - DNR, Leigh <leigh.simmons@state.co.us>

C1981019, Colowyo Mine, TR-148

Simmons - DNR, Leigh <leigh.simmons@state.co.us> To: "Trujillo - DNR, Zach" <zach.trujillo@state.co.us> Cc: Jason Musick <jason.musick@state.co.us> Thu, Jul 15, 2021 at 7:45 PM

Zach,

I have reviewed the response to the initial adequacy review of TR-148.

I recommend the approval of TR-148, my detailed memo is attached. Let me know if you need a copy of the word document.

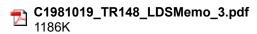
Leigh Simmons Environmental Protection Specialist



COLORADO Division of Reclamation, Mining and Safety Department of Natural Resources

P 303.866.3567 x 8121 | C 720.220.1180 | F 303.832.8106 1313 Sherman Street, Room 215, Denver, CO 80203 leigh.simmons@state.co.us | https://drms.colorado.gov

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Interoffice Memorandum

July 15, 2021

From: Leigh Simmons To: Zach Trujillo



Subject: Colowyo Mine (Permit No. C-1981-019) TR-148

Colowyo Coal Company (CCC) responded to the Division's initial adequacy review on June 15, 2021. In the cover letter to their response CCC declined to submit a copy of the historical monitoring data used to derive the UTLs for Manganese, Sulfate and Total Dissolved Solids that are proposed as estimates of existing ambient quality to be used as alternatives to the Reg. 41 table values, citing the fact that it had already been submitted in Annual Hydrology Reports. CCC also stated that the methodology and assumptions had already been described in the AECOM report.

The reason for my original request, and the goal of my review, was to:

- i. Verify the calculations made by AECOM; and
- ii. Assess the quality and validity of the data used in the calculations.

I used data copied from Exhibit 4 of the 1995 combined ARR/AHR document, available to the public at <u>https://dnrweblink.state.co.us/drms/0/doc/816256/Page1.aspx?searchid=4e8804e5-e337-456e-ab12-5c532c3132b9</u> to populate a spreadsheet (see Appendix 1).

I downloaded a copy of ProUCL 5.1, and the accompanying documentation from <u>https://www.epa.gov/land-research/proucl-software</u>

I analyzed the pooled data from the Gossard and NGSW wells collected earlier than January 31, 1994, using the "Upper Limits/BTV's" module of ProUCL. The results showed that the data for each parameter does not fit a discernable distribution. The computed values of the Upper Tolerance Limit, at the 95% confidence interval* matched those calculated by AECOM (see Appendix 2), confirming that the analysis presented to the Division is reproducible.

Historical data from the NGSW well is the best source available to assess "existing ambient quality as of January 31, 1994" in the alluvium of Goodspring Creek. As can be seen from the plot in Appendix 2, the data shows considerable temporal variation, and is suggestive of water that has already been impacted by mining activities. According to the RN-1 Findings document for the C1981019 permit:



The initial mining operations at Colowyo began in 1976 along the southern face of Streeter Draw. Box cut overburden material was placed in the Streeter Fill...

It is unfortunate that no baseline groundwater monitoring took place before the disturbance in Streeter Draw. NGSW would be adequately located for the purpose, immediately downstream of the point where Streeter Draw meets Goodspring Creek (though it is on the east side of the creek, when the west side would have been preferable), but was first monitored in 1989 meaning that 13 years of mining related impacts to the Goodspring Creek alluvium had the potential to occur before monitoring began.

Similarly, historical data from the Gossard well is the best source available to assess "existing ambient quality as of January 31, 1994" in the alluvium of Wilson Creek upstream of the confluence with Taylor Creek. Although monitoring of the Gossard Well began earlier than of the NGSW well, in 1983, it was still considerably after the area was subject to the impacts of mining activities.

The Basic Standards for Groundwater make explicit that the purpose of the interim narrative standard, when applied to contaminated groundwater is to prevent further contamination. The following passage is duplicated from 41.5.C.6.b.ii:

The interim standard shall not be interpreted or applied as defining or limiting the potential need for remediation of contaminated groundwater where remedial requirements are established under state or federal law. It is the Commission's intent that, to the maximum degree technically feasible and economically reasonable, remedial efforts should be directed at cleaning up groundwater contaminated by human activities to a degree such that it is usable for all existing and potential beneficial uses; this interim narrative standard is not intended to define when such remediation is or is not feasible. Where contamination already exists, this interim standard is merely intended to assure that conditions are not allowed to deteriorate further pending remedial action. The appropriate level of clean-up to be achieved may be addressed by this Commission in a future classification and standard-setting proceeding, or by other agencies with jurisdiction over remedial actions.

This review is focused on the establishment of numerical values for the Interim Narrative Standard at the new POC wells, not on the need or otherwise for remedial action, however no remedial action is recommended at this time.

*The calculation of an Upper Tolerance Limit at the 95% confidence interval is a widely accepted statistical method of determining a Background Threshold Value from an environmental data set. The method relies on a data set of adequate size for its validity; for non-parametric data, such as we are dealing with here, the required sample size is greater than would be the case if the data fit a distribution model. As the reports included in Appendix 2 show, the combined sample size is not large enough to calculate the Upper Tolerance Limit with 95% confidence – in fact the "Approximate Actual Confidence Coefficient achieved by UTL" values given in the ProUCL reports shows that the statistical confidence with the pooled data set is more like 82%. If the data sets for the two wells are separated, the statistical confidence in the calculated value decreases further to around 62%. In this situation I concur with AECOM's approach; the best compromise is to pool the two sets of data.

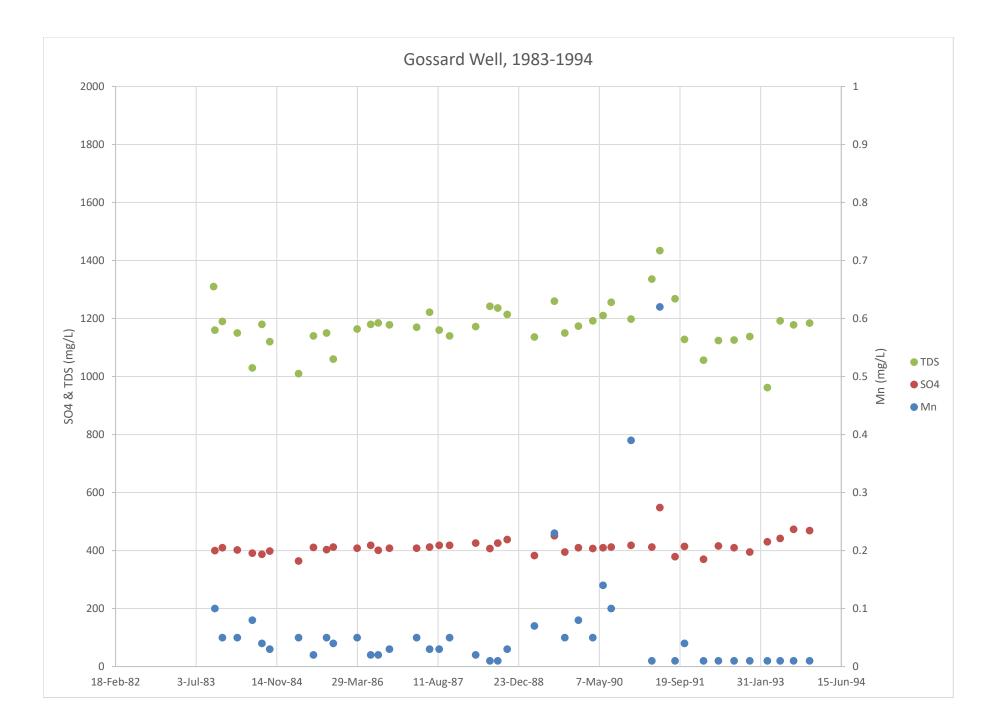
<u>Summary</u>

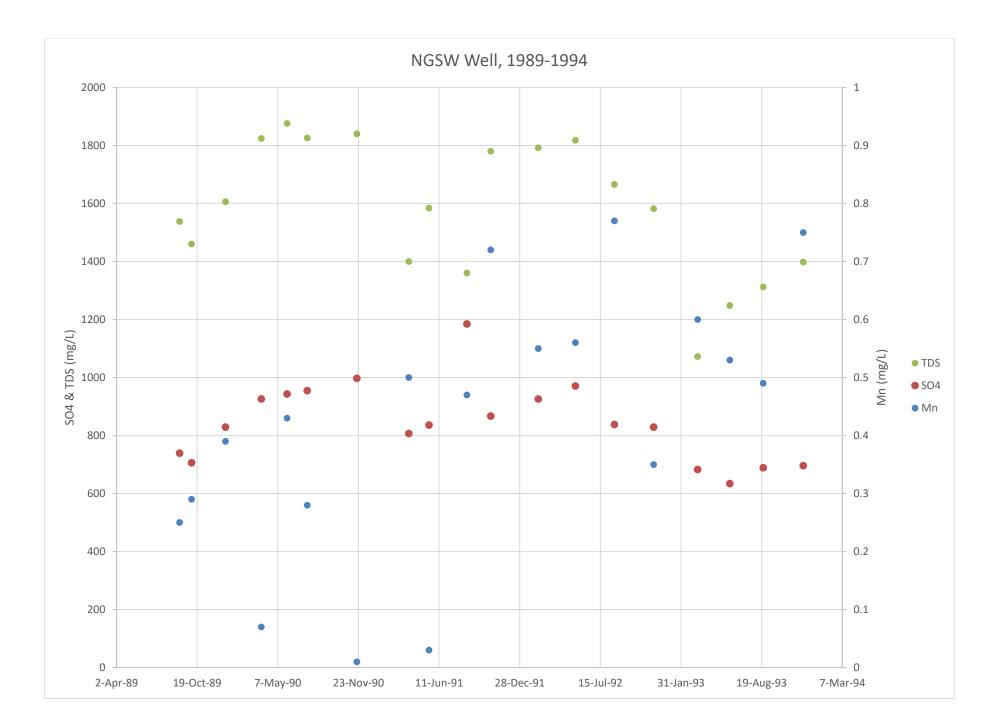
With TR-148 CCC and their consultant AECOM have proposed the establishment of two new POC wells, and numerical parameter values that implement the applicable interim narrative standard at those POC wells. The methods used to determine the proposed locations and values have been presented to the Division in the form of a report which is proposed to be added to the PAP as an Exhibit, and are both defensible and reproducible. I recommend the approval of TR-148 and the recognition that the operator has complied with the requirements of Stipulation 7.

Appendix 1: Historical monitoring data from the Gossard and NGSW wells

Gossard Well		COA (/1)	
Date	IVIn (mg/L)	SO4 (mg/L)	
19-Oct-83	0.1	100	1310
27-Oct-83	0.1	400	1160
12-Dec-83	0.05	410	1190
14-Mar-84	0.05	402	1150
15-Jun-84	0.08	391	1030
13-Aug-84	0.04	387	1180
5-Sep-84			
1-Oct-84	0.03	398	1120
29-Mar-85	0.05	364	1010
29-Jun-85	0.02	411	1140
22-Jul-85			
20-Aug-85			
18-Sep-85	0.05	403	1150
19-Sep-85			
16-Oct-85			
30-Oct-85	0.04	412	1060
27-Mar-86	0.05	408	1164
19-Jun-86	0.02	418	1180
24-Jul-86			
5-Aug-86	0.02	401	1185
10-Sep-86	0.01		
13-Oct-86	0.03	408	1178
31-Mar-87	0.05	408	1170
19-Jun-87	0.03	412	1222
18-Aug-87	0.03	418	1160
21-Oct-87	0.05	418	1140
31-Mar-88	0.03	410	1140
27-Jun-88	0.02	407	1242
15-Aug-88	0.01	407	1242
12-Oct-88	0.01	420	1230
30-Mar-89			
	0.07	383	1136
1-Aug-89	0.23	451	1260
4-Oct-89	0.05	395	1150
28-Dec-89	0.08	410	1174
27-Mar-90	0.05	407	1192
30-May-90	0.14	410	1210
19-Jul-90	0.1	412	1256
19-Nov-90	0.39	418	1198
28-Mar-91	0.01	412	1336
17-May-91	0.62	548	1434
19-Aug-91	0.01	379	1268
17-Oct-91	0.04	414	1128
12-Feb-92	0.01	370	1056
14-May-92	0.01	416	1124
19-Aug-92	0.01	410	1126
24-Nov-92	0.01	395	1138
13-Mar-93	0.01	430	962
1-Jun-93	0.01	442	1192
23-Aug-93	0.01	473	1178
30-Nov-93	0.01	469	1184

	NGSW Well			
L)	Date	Mn (mg/L)	SO4 (mg/L)	TDS (mg/L)
10	5-Sep-89	0.25	739	1538
60	5-Oct-89	0.29	706	1460
90	28-Dec-89	0.39	829	1606
50	27-Mar-90	0.07	926	1824
30	30-May-90	0.43	943	1876
80	19-Jul-90	0.28	955	1826
	19-Nov-90	0.01	997	1840
20	28-Mar-91	0.5	807	1400
10	17-May-91	0.03	836	1584
40	19-Aug-91	0.47	1185	1360
	17-Oct-91	0.72	867	1780
	12-Feb-92	0.55	926	1792
50	14-May-92	0.56	971	1818
	19-Aug-92	0.77	838	1666
	24-Nov-92	0.35	829	1582
60	13-Mar-93	0.6	683	1072
64	1-Jun-93	0.53	634	1248
80	23-Aug-93	0.49	689	1312
	30-Nov-93	0.75	696	1398
.				





Appendix 2: ProUCL reports showing calculated UTLs for Mn, SO₄, and TDS using pooled data from Gossard and NGSW wells

	А	В	С	D E	F	G H I J K	L					
1		1		Background Statistics	for Uncenso	ored Full Data Sets						
2		User Selec	ted Options									
3	Date	/Time of Co	omputation	ProUCL 5.17/15/2021 2								
4			From File	G:\My Drive\Document	s\01_Mines\	Colowyo\TR148\Pre1994_Combined.xlsx						
5			I Precision	OFF								
6	C	Confidence (95%								
7			Coverage	95%								
8		uture K Ob		1								
9	Number of	Bootstrap C	Operations	2000		-						
10	Mn (mg/L)											
11	iviiri (irig/ L)											
12 13	General St	atistics										
13			Total N	lumber of Observations	61	Number of Distinct Observations	27					
14						Number of Missing Observations	1					
16				Minimum	0.01	First Quartile	0.02					
17				Second Largest	0.75	Median	0.05					
18				Maximum	0.77	Third Quartile	0.29					
19				Mean	0.177	SD	0.228					
20				Coefficient of Variation	1.29	Skewness	1.287					
21				Mean of logged Data	-2.707	SD of logged Data	1.479					
22												
23		Critical Values for Background Threshold Values (BTVs)										
24	Tolerance Factor K (For UTL) 2.013 d2max (for USL)											
25												
26					Normal C							
27				apiro Wilk Test Statistic		Normal GOF Test						
28			59	% Shapiro Wilk P Value		Data Not Normal at 5% Significance Level						
29			E0/	Lilliefors Test Statistic	0.304	Lilliefors GOF Test						
30			5%	Lilliefors Critical Value	0.113	Data Not Normal at 5% Significance Level % Significance Level						
31				Data Not	Normal at 5							
32				Background S	latistics Ass	uming Normal Distribution						
33 34			95% UT	L with 95% Coverage		90% Percentile (z)	0.468					
35				95% UPL (t)	0.56	95% Percentile (z)	0.551					
36				95% USL	0.867	99% Percentile (z)	0.706					
37												
38					Gamma (GOF Test						
39				A-D Test Statistic	3.057	Anderson-Darling Gamma GOF Test						
40				5% A-D Critical Value	0.804	Data Not Gamma Distributed at 5% Significance Lev	/el					
41				K-S Test Statistic	0.222	Kolmogorov-Smirnov Gamma GOF Test						
42				5% K-S Critical Value	0.119	Data Not Gamma Distributed at 5% Significance Lev	/el					
43				Data Not Gamn	na Distribute	ed at 5% Significance Level						
44												
45					Gamma							
46				k hat (MLE)	0.631	k star (bias corrected MLE)	0.611					
47				Theta hat (MLE)	0.28	Theta star (bias corrected MLE)	0.289					
48			N A1 -	nu hat (MLE)	76.95	nu star (bias corrected)	74.5					
49			MLE	Mean (bias corrected)	0.177	MLE Sd (bias corrected)	0.226					
50				Rackaround St	atistice Acc	uming Gamma Distribution						
51		95% Wilcon	Hilferty (\\/L	I) Approx. Gamma UPL		90% Percentile	0.457					
52				/) Approx. Gamma UPL	0.633	95% Percentile	0.437					
53	9.				0.000		0.001					

	А	В	С	D	E	F	G	Н	I	J	К	L		
54	95%	95% WH Approx. Gamma UTL with 95% Coverage 0.788 99% Percentile									1.051			
55	95% HW Approx. Gamma UTL with 95% Coverage 0.849													
56		95% WH USL 1.559 95% HW USL												
57														
58						Lognorma	I GOF Test							
59			Sha	apiro Wi	lk Test Statistic	0.88		•	0	normal GOI				
60			59	% Shapi	ro Wilk P Value	2.1135E-6				5% Signific				
61				Lilliefo	rs Test Statistic	0.151		Lilli	efors Logno	ormal GOF 1	ſest			
62			5%	Lilliefor	s Critical Value				•	5% Signific	ance Level			
63					Data Not L	ognormal a	t 5% Signific	cance Level						
64														
65					Background Sta		iming Logno	rmal Distrib	ution					
66			95% U1	L with	95% Coverage						ercentile (z)	0.445		
67					95% UPL (t)		_				ercentile (z)	0.761		
68					95% USL	5.931				99% Pe	ercentile (z)	2.085		
69														
70					Vonparametric		-	-						
71					Data do not fo	ollow a Disc	cernible Dist	ribution (0.0)5)					
72														
73					parametric Upp		r Backgrour	nd Threshole						
74					er of Statistic, r					FL with 95%	J	0.75		
75		Appr	ox, f used to	compu	te achieved CC	1.579	oproximate					0.816		
76	0 = 0 /						Approximat	te Sample S		•		93		
77	95%	Percentile E	Bootstrap UI	L with	95% Coverage	0.75	_	95% BCA I	Bootstrap U	FL with 95%	.	0.75		
78				000/ 0	95% UPL	0.71					6 Percentile	0.55		
79					hebyshev UPL	0.865	_				6 Percentile	0.62		
80				95% C	hebyshev UPL	1.177				99%	Percentile	0.758		
81					95% USL	0.77								
82	N.		-(110) +							-1				
83					ld a conservativ				· · ·					
84	11	ieretore, on			stimate a BTV	-		· · · · · · · · · · · · · · · · · · ·			ee of outliers	5		
85		The			sists of observa						data			
86					provide a balan									
87		repres	sents a dack	ground	data set and wh	ieri many oi	ISITE ODSERVA	auons need	to be compa	area with the	BIV.			
88														

	А	В	С	D E	F	G H I J K	L							
1	Background Statistics for Uncensored Full Data Sets													
2	User Selected Options													
3	Date	/Time of Co	mputation	ProUCL 5.17/15/2021 2	2:14:34 PM									
4		From File G:\My Drive\Documents\01_Mines\Colowyo\TR148\Pre1994_Combined.xlsx												
5	Full Precision OFF													
6	Confidence Coefficient 95%													
7		Coverage 95%												
8	New or F	New or Future K Observations 1												
9	Number of	Bootstrap C	perations	2000										
10														
11	SO4 (mg/L)												
12														
13	General St	atistics												
14			Total N	lumber of Observations	61	Number of Distinct Observations	45							
15						Number of Missing Observations	1							
16				Minimum		First Quartile	408							
17				Second Largest		Median	418							
18				Maximum	1185	Third Quartile	696							
19				Mean Coefficient of Variation	548.6 0.394	SD Skewness	216.1 1.206							
20							0.344							
21	Mean of logged Data 6.244 SD of logged Data													
22		Critical Values for Beakground Threshold Values (PTVa)												
23	Critical Values for Background Threshold Values (BTVs) Tolerance Factor K (For UTL) 2.013 d2max (for USL)													
24 25	Tolerance Factor K (For UTL) 2.013 d2max (for USL)													
25					Normal C	GOF Test								
20			Sh	apiro Wilk Test Statistic		Normal GOF Test								
28				% Shapiro Wilk P Value		Data Not Normal at 5% Significance Level								
29				Lilliefors Test Statistic	0.314	Lilliefors GOF Test								
30			5%	Lilliefors Critical Value	0.113	Data Not Normal at 5% Significance Level								
31				Data Not	Normal at 5	% Significance Level								
32														
33				Background S	tatistics Ass	suming Normal Distribution								
34			95% U	L with 95% Coverage	983.7	90% Percentile (z)	825.6							
35				95% UPL (t)	912.6	95% Percentile (z)	904.1							
36				95% USL	1204	99% Percentile (z)	1051							
37														
38						GOF Test								
39				A-D Test Statistic		Anderson-Darling Gamma GOF Test								
40				5% A-D Critical Value		Data Not Gamma Distributed at 5% Significance Lev	/el							
41				K-S Test Statistic	0.304	Kolmogorov-Smirnov Gamma GOF Test	un l							
42				5% K-S Critical Value		Data Not Gamma Distributed at 5% Significance Level	/el							
43				Data Not Gamn	na Distribute	ed at 5% Significance Level								
44					Commo	Statistics								
45				k hat (MLE)	7.989	k star (bias corrected MLE)	7.607							
46				Theta hat (MLE)		Theta star (bias corrected MLE)	72.12							
47	I neta nat (MLE) 68.67 I neta star (Dias corrected MLE) nu hat (MLE) 974.7 nu star (bias corrected MLE)													
48	nu hat (MLE) 9/4.7 nu star (bias corrected) MLE Mean (bias corrected) 548.6 MLE Sd (bias corrected)													
49 50					0.0		198.9							
50 51				Background St	atistics Ass	uming Gamma Distribution								
51	9	95% Wilson	Hilferty (WH	I) Approx. Gamma UPL		90% Percentile	814							
53				/) Approx. Gamma UPL	915.9	95% Percentile	911.4							
55			• `											

	А	В	С	D	E	F	G	Н	I	J	К	L			
54	95%	WH Approx.	. Gamma U1	L with	95% Coverage	1009	99% Percentile 1114								
55	95% HW Approx. Gamma UTL with 95% Coverage 1013														
56	95% WH USL 1339 95% HW USL														
57															
58						Lognorma	I GOF Test								
59			Sha	apiro W	lk Test Statistic	0.757		Shap	iro Wilk Log	normal GO	⁻ Test				
60			59	% Shapi	ro Wilk P Value	3.307E-13		Data Not L	ognormal a	5% Signific	ance Level				
61				Lilliefo	rs Test Statistic	0.294		Lilli	efors Logno	ormal GOF ⁻	ſest				
62			5%	Lilliefo	rs Critical Value	0.113			-	5% Signific	ance Level				
63					Data Not L	ognormal a	t 5% Signific	ance Level							
64															
65					Background Sta		ming Logno	rmal Distrib	ution						
66			95% U1	L with	95% Coverage	1029					ercentile (z)	800			
67					95% UPL (t)	919	_				ercentile (z)	906.6			
68					95% USL	1462				99% P	ercentile (z)	1146			
69															
70					Nonparametric										
71					Data do not fo	ollow a Disc	ernible Dist	ribution (0.0)5)						
72				N.L			Dealers		4) / - 1						
73					parametric Upp		r Backgroun	id Threshol				007			
74		A			ler of Statistic, r	60				FL with 95%	-	997			
75		Appr	ox, t used to	compu	te achieved CC	1.579	oproximate				-	0.816			
76	0.59/	Doroontilo E		-1i+b	95% Coverage	997	Approximat	•		to achieve s TL with 95%		93 997			
77	95%	Percentile			95% Coverage 95% UPL	997	-	95% BCA I			6 Percentile	997			
78				Q0% (95% UPL Chebyshev UPL	1202					6 Percentile	926			
79					Chebyshev UPL	1202					6 Percentile	1072			
80				5570 0	95% USL	1185	-					1072			
81					5570 USL	1100									
82 83	No	ote: The use	of USL ten	ds to vie	eld a conservativ	e estimate	of BTV, esp	ecially when	the sample	e size starts	exceeding 2	0.			
83 84					estimate a BTV of										
84 85												-			
05		and consists of observations collected from clean unimpacted locations.													
86		The use of USL tends to provide a balance between false positives and false negatives provided the data													
86 87					provide a balan data set and wh										

	A B	С	D E	F	G H	I J	К	L						
1		0		for Uncensored Full Data Sets										
2	User Selected Options													
3		Date/Time of Computation ProUCL 5.17/15/2021 2:15:11 PM												
4		From File	G:\My Drive\Documents	s\01_Mines\	Colowyo\TR148\Pre199	94_Combined.xlsx								
5	Full Precision OFF													
6	Confidence Coefficient 95%													
7		Coverage	95%											
8	New or Future K Observations 1													
9	Number of Bootstrap	Operations	2000											
10														
	TDS (mg/L)													
12														
	General Statistics													
14		Total Number of Observations 62 Number of Distinct Observations												
15			Minimum	962		F	irst Quartile	1150						
16			Second Largest	1840			Median	1192						
17			Maximum	1876		TI	nird Quartile	1389						
18			Mean	1298			SD	237.4						
19			Coefficient of Variation	0.183			Skewness	1.233						
20			Mean of logged Data	7.153		SD of	logged Data	0.169						
21														
22	Critical Values for Background Threshold Values (BTVs)													
23	Tolerance Factor K (For UTL) 2.01 d2max (for USL)													
24														
25				Normal C	OF Test									
26	Shapiro Wilk Test Statistic 0.817 Normal GOF Test													
27		5'	% Shapiro Wilk P Value		Data Not	Normal at 5% Significa	nce Level							
28	Lilliefors Test Statistic 0.227 Lilliefors GOF Test													
29		5%	Lilliefors Critical Value	0.112		Normal at 5% Significa	nce Level							
30				Normal at 5	% Significance Level									
31			Background St	atistics Ass	uming Normal Distribut	lion								
32 33		95% U	L with 95% Coverage	1775			ercentile (z)	1602						
33			95% UPL (t)	1697			ercentile (z)	1688						
35			95% USL	2019			ercentile (z)	1850						
36							. /							
37				Gamma (GOF Test									
38			A-D Test Statistic	3.778	Anders	on-Darling Gamma G	OF Test							
39			5% A-D Critical Value	0.748	Data Not Gamr	ma Distributed at 5% Sig	gnificance Le	vel						
40			K-S Test Statistic	0.208	Kolmogo	orov-Smirnov Gamma	GOF Test							
41			5% K-S Critical Value	0.113		ma Distributed at 5% Sig	gnificance Le	evel						
42			Data Not Gamm	na Distribute	ed at 5% Significance L	evel								
43														
44				Gamma	Statistics			32.36						
45	k hat (MLE) 33.99 k star (bias corrected MLE)													
46	Theta hat (MLE) 38.17 Theta star (bias corrected MLE													
47	nu hat (MLE) 4215 nu star (bias corrected)													
48	MLE Mean (bias corrected) 1298 MLE Sd (bias corrected)													
49			Packground Ct	atistics Ass	Iming Commo Distribu	tion								
50		n Hilforty (\M/L	-		uming Gamma Distribu		6 Dercontile	1597						
51	95% Wilson Hilferty (WH) Approx. Gamma UPL169890% Percentile95% Hawkins Wixley (HW) Approx. Gamma UPL169895% Percentile													
52								1694 1886						
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