Appendix E

Surface Water Risk Calculations and Summary Tables

Appendix E – Surface Water Risk Calculations and Summary Tables

ProUCL Outputs

- **Surface Water**

Summary Statistics

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- **Surface Water**

ProUCL Outputs

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Baseline Human Health Risk Assessment
Asarco LLC Hayden Plant Site, Hayden, Arizona

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General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_25	Surface Water	Aluminum

General Statistics

Number of Valid Samples	20	Number of Unique Samples	19

Raw Statistics		**Log-transformed Statistics**	
Minimum	64.5	Minimum of Log Data	4.167
Maximum	62000	Maximum of Log Data	11.03
Mean	8523	Mean of log Data	7.828
Median	2375	SD of log Data	1.583
SD	17040		
Coefficient of Variation	1.999		
Skewness	2.776		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.498	Shapiro Wilk Test Statistic	0.92
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	15111	95% H-UCL	31297
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	22231
95% Adjusted-CLT UCL	17317	97.5% Chebyshev (MVUE) UCL	28486
95% Modified-t UCL	15506	99% Chebyshev (MVUE) UCL	40774

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.473	Data appear Lognormal at 5% Significance Level	
Theta Star	18034		
nu star	18.9		
Approximate Chi Square Value (.05)	10.05	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	14790
Adjusted Chi Square Value	9.539	95% Jackknife UCL	15111
		95% Standard Bootstrap UCL	14565
Anderson-Darling Test Statistic	1.577	95% Bootstrap-t UCL	41505
Anderson-Darling 5% Critical Value	0.801	95% Hall's Bootstrap UCL	46406
Kolmogorov-Smirnov Test Statistic	0.229	95% Percentile Bootstrap UCL	14765
Kolmogorov-Smirnov 5% Critical Value	0.205	95% BCA Bootstrap UCL	17474
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	25132
		97.5% Chebyshev(Mean, Sd) UCL	32318
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	46435
95% Approximate Gamma UCL	16036		
95% Adjusted Gamma UCL	16891		

Potential UCL to Use		Use 95% Chebyshev (MVUE) UCL	22231

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_26	Surface Water	Arsenic

General Statistics

Number of Valid Samples	20	Number of Unique Samples	15

Raw Statistics		Log-transformed Statistics	
Minimum	2.7	Minimum of Log Data	0.993
Maximum	16.8	Maximum of Log Data	2.821
Mean	6.03	Mean of log Data	1.632
Median	6.15	SD of log Data	0.575
SD	3.838		
Coefficient of Variation	0.636		
Skewness	1.542		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.787	Shapiro Wilk Test Statistic	0.857
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	7.514	95% H-UCL	7.933
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.486
95% Adjusted-CLT UCL	7.758	97.5% Chebyshev (MVUE) UCL	11
95% Modified-t UCL	7.563	99% Chebyshev (MVUE) UCL	13.99

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	2.745	Data do not follow a Discernable Distribution (0.05)	
Theta Star	2.196		
nu star	109.8		
Approximate Chi Square Value (.05)	86.63	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	7.441
Adjusted Chi Square Value	85	95% Jackknife UCL	7.514
		95% Standard Bootstrap UCL	7.401
Anderson-Darling Test Statistic	1.241	95% Bootstrap-t UCL	8.161
Anderson-Darling 5% Critical Value	0.747	95% Hall's Bootstrap UCL	9.28
Kolmogorov-Smirnov Test Statistic	0.246	95% Percentile Bootstrap UCL	7.485
Kolmogorov-Smirnov 5% Critical Value	0.195	95% BCA Bootstrap UCL	7.65
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	9.77
		97.5% Chebyshev(Mean, Sd) UCL	11.39
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	14.57
95% Approximate Gamma UCL	7.644		
95% Adjusted Gamma UCL	7.79		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	9.77

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_27	Surface Water	Barium

General Statistics

Number of Valid Samples	20	Number of Unique Samples	18

Raw Statistics		Log-transformed Statistics	
Minimum	61.5	Minimum of Log Data	4.119
Maximum	1190	Maximum of Log Data	7.082
Mean	207.4	Mean of log Data	4.816
Median	86.85	SD of log Data	0.889
SD	299.3		
Coefficient of Variation	1.443		
Skewness	2.714		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.541	Shapiro Wilk Test Statistic	0.774
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	323.1	95% H-UCL	301.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	348.5
95% Adjusted-CLT UCL	360.8	97.5% Chebyshev (MVUE) UCL	422.1
95% Modified-t UCL	329.8	99% Chebyshev (MVUE) UCL	566.6

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.969	Data do not follow a Discernable Distribution (0.05)	
Theta Star	214		
nu star	38.75		
Approximate Chi Square Value (.05)	25.49	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	317.4
Adjusted Chi Square Value	24.64	95% Jackknife UCL	323.1
		95% Standard Bootstrap UCL	313.7
Anderson-Darling Test Statistic	2.435	95% Bootstrap-t UCL	596.9
Anderson-Darling 5% Critical Value	0.766	95% Hall's Bootstrap UCL	776.4
Kolmogorov-Smirnov Test Statistic	0.248	95% Percentile Bootstrap UCL	322.8
Kolmogorov-Smirnov 5% Critical Value	0.199	95% BCA Bootstrap UCL	376.7
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	499
		97.5% Chebyshev(Mean, Sd) UCL	625.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	873.2
95% Approximate Gamma UCL	315.2		
95% Adjusted Gamma UCL	326		

Potential UCL to Use	Use 95% Chebyshev (Mean, Sd) UCL	499

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_28	Surface Water	Beryllium

General Statistics

Number of Valid Samples	19	Number of Detected Data	12
Number of Unique Samples	10	Number of Non-Detect Data	7
		Percent Non-Detects	36.84%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.07	Minimum Detected	-2.659
Maximum Detected	8.3	Maximum Detected	2.116
Mean of Detected	1.452	Mean of Detected	-0.75
SD of Detected	2.596	SD of Detected	1.461
Minimum Non-Detect	0.66	Minimum Non-Detect	-0.416
Maximum Non-Detect	0.66	Maximum Non-Detect	-0.416

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.58	Shapiro Wilk Test Statistic	0.908
5% Shapiro Wilk Critical Value	0.859	5% Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.038	Mean	-0.882
SD	2.104	SD	1.156
95% DL/2 (t) UCL	1.875	95% H-Stat (DL/2) UCL	3.404

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.034
		SD in Log Scale	1.311
		Mean in Original Scale	1.026
		SD in Original Scale	2.113
		95% Percentile Bootstrap UCL	1.832
		95% BCA Bootstrap UCL	2.273

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**
k star (bias corrected)	0.473	Data appear Lognormal at 5% Significance Level
Theta Star	3.069	
nu star	11.35	
A-D Test Statistic	1.143	**Nonparametric Statistics**
5% A-D Critical Value	0.781	Kaplan-Meier (KM) Method
K-S Test Statistic	0.781	Mean 1.005
5% K-S Critical Value	0.258	SD 2.061
Data not Gamma Distributed at 5% Significance Level		SE of Mean 0.494
		95% KM (t) UCL 1.862
Assuming Gamma Distribution		95% KM (z) UCL 1.818
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 1.848
Minimum	0.07	95% KM (bootstrap t) UCL 6.546
Maximum	8.3	95% KM (BCA) UCL 1.989
Mean	1.429	95% KM (Percentile Bootstrap) UCL 1.919
Median	0.936	95% KM (Chebyshev) UCL 3.16
SD	2.036	97.5% KM (Chebyshev) UCL 4.092
k star	0.73	99% KM (Chebyshev) UCL 5.924
Theta star	1.956	
Nu star	27.75	Potential UCLs to Use
AppChi2	16.73	97.5% KM (Chebyshev) UCL 4.092
95% Gamma Approximate UCL	2.369	
95% Adjusted Gamma UCL	2.48	

Note: DL/2 is not a recommended method.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_29	Surface Water	Boron

General Statistics

Number of Valid Samples	20	Number of Unique Samples	16

Raw Statistics		Log-transformed Statistics	
Minimum	113	Minimum of Log Data	4.727
Maximum	225	Maximum of Log Data	5.416
Mean	134.6	Mean of log Data	4.889
Median	129	SD of log Data	0.153
SD	24.61		
Coefficient of Variation	0.183		
Skewness	2.985		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.632	Shapiro Wilk Test Statistic	0.719
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	144.1	95% H-UCL	142.9
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	154.4
95% Adjusted-CLT UCL	147.5	97.5% Chebyshev (MVUE) UCL	163.1
95% Modified-t UCL	144.7	99% Chebyshev (MVUE) UCL	180.2

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	34.33	Data do not follow a Discernable Distribution (0.05)	
Theta Star	3.92		
nu star	1373		
Approximate Chi Square Value (.05)	1288	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	143.6
Adjusted Chi Square Value	1282	95% Jackknife UCL	144.1
		95% Standard Bootstrap UCL	143.3
Anderson-Darling Test Statistic	2.178	95% Bootstrap-t UCL	159.5
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL	192.8
Kolmogorov-Smirnov Test Statistic	0.28	95% Percentile Bootstrap UCL	144.9
Kolmogorov-Smirnov 5% Critical Value	0.193	95% BCA Bootstrap UCL	148
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	158.5
		97.5% Chebyshev(Mean, Sd) UCL	168.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	189.3
95% Approximate Gamma UCL	143.4		
95% Adjusted Gamma UCL	144.2		

Potential UCL to Use		
	Use 95% Student's-t UCL	144.1
	or 95% Modified-t UCL	144.7

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_30	Surface Water	Cadmium

General Statistics

Number of Valid Samples	19	Number of Detected Data	10
Number of Unique Samples	8	Number of Non-Detect Data	9
		Percent Non-Detects	47.37%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.1	Minimum Detected	-2.303
Maximum Detected	3.4	Maximum Detected	1.224
Mean of Detected	0.701	Mean of Detected	-1.234
SD of Detected	1.127	SD of Detected	1.253
Minimum Non-Detect	0.25	Minimum Non-Detect	-1.386
Maximum Non-Detect	0.25	Maximum Non-Detect	-1.386

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.605	Shapiro Wilk Test Statistic	0.786
5% Shapiro Wilk Critical Value	0.842	5% Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.428	Mean	-1.634
SD	0.85	SD	0.987
95% DL/2 (t) UCL	0.766	95% H-Stat (DL/2) UCL	0.781

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.582
		SD in Log Scale	1.076
		Mean in Original Scale	0.45
		SD in Original Scale	0.845
		95% Percentile Bootstrap UCL	0.795
		95% BCA Bootstrap UCL	0.898

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.549	Data do not follow a Discernable Distribution (0.05)	
Theta Star	1.276		
nu star	10.98		
A-D Test Statistic	1.366	Nonparametric Statistics	
5% A-D Critical Value	0.762	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.762	Mean	0.431
5% K-S Critical Value	0.277	SD	0.826
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.2
		95% KM (t) UCL	0.778
Assuming Gamma Distribution		95% KM (z) UCL	0.76
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.769
Minimum	0.1	95% KM (bootstrap t) UCL	3.445
Maximum	3.4	95% KM (BCA) UCL	0.812
Mean	0.659	95% KM (Percentile Bootstrap) UCL	0.774
Median	0.4	95% KM (Chebyshev) UCL	1.302
SD	0.815	97.5% KM (Chebyshev) UCL	1.679
k star	0.975	99% KM (Chebyshev) UCL	2.42
Theta star	0.676		
Nu star	37.04	Potential UCLs to Use	
AppChi2	24.11	97.5% KM (Chebyshev) UCL	1.679
95% Gamma Approximate UCL	1.013		
95% Adjusted Gamma UCL	1.052		

Note: DL/2 is not a recommended method.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_31	Surface Water	Calcium

General Statistics

Number of Valid Samples	20	Number of Unique Samples	20

Raw Statistics		**Log-transformed Statistics**	
Minimum	46400	Minimum of Log Data	10.75
Maximum	381999	Maximum of Log Data	12.85
Mean	97090	Mean of log Data	11.28
Median	65700	SD of log Data	0.569
SD	84554		
Coefficient of Variation	0.871		
Skewness	2.641		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.59	Shapiro Wilk Test Statistic	0.766
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	129782	95% H-UCL	122043
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	145877
95% Adjusted-CLT UCL	140118	97.5% Chebyshev (MVUE) UCL	169066
95% Modified-t UCL	131643	99% Chebyshev (MVUE) UCL	214617

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.252	Data do not follow a Discernable Distribution (0.05)	
Theta Star	43109		
nu star	90.09		
Approximate Chi Square Value (.05)	69.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	128189
Adjusted Chi Square Value	67.76	95% Jackknife UCL	129782
		95% Standard Bootstrap UCL	127232
Anderson-Darling Test Statistic	2.479	95% Bootstrap-t UCL	179809
Anderson-Darling 5% Critical Value	0.749	95% Hall's Bootstrap UCL	216323
Kolmogorov-Smirnov Test Statistic	0.34	95% Percentile Bootstrap UCL	130895
Kolmogorov-Smirnov 5% Critical Value	0.195	95% BCA Bootstrap UCL	141945
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	179503
		97.5% Chebyshev(Mean, Sd) UCL	215163
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	285211
95% Approximate Gamma UCL	126391		
95% Adjusted Gamma UCL	129088		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	179503

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_32	Surface Water	Chromium

General Statistics

Number of Valid Samples	20	Number of Unique Samples	19

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.24	Minimum of Log Data	-1.427
Maximum	31.4	Maximum of Log Data	3.447
Mean	4.835	Mean of log Data	0.627
Median	1.655	SD of log Data	1.334
SD	8.376		
Coefficient of Variation	1.732		
Skewness	2.645		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.561	Shapiro Wilk Test Statistic	0.912
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	8.074	95% H-UCL	11.75
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10.67
95% Adjusted-CLT UCL	9.099	97.5% Chebyshev (MVUE) UCL	13.46
95% Modified-t UCL	8.258	99% Chebyshev (MVUE) UCL	18.94

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.581	Data appear Lognormal at 5% Significance Level	
Theta Star	8.324		
nu star	23.23		
Approximate Chi Square Value (.05)	13.27	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	7.916
Adjusted Chi Square Value	12.67	95% Jackknife UCL	8.074
		95% Standard Bootstrap UCL	7.847
Anderson-Darling Test Statistic	1.423	95% Bootstrap-t UCL	15.52
Anderson-Darling 5% Critical Value	0.789	95% Hall's Bootstrap UCL	23.17
Kolmogorov-Smirnov Test Statistic	0.246	95% Percentile Bootstrap UCL	8.109
Kolmogorov-Smirnov 5% Critical Value	0.203	95% BCA Bootstrap UCL	9.353
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	13
		97.5% Chebyshev(Mean, Sd) UCL	16.53
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	23.47
95% Approximate Gamma UCL	8.467		
95% Adjusted Gamma UCL	8.864		

Potential UCL to Use		Use 95% Chebyshev (MVUE) UCL	10.67

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_33	Surface Water	Cobalt

General Statistics

Number of Valid Samples	20	Number of Unique Samples	19

Raw Statistics		Log-transformed Statistics	
Minimum	0.2	Minimum of Log Data	-1.609
Maximum	39.2	Maximum of Log Data	3.669
Mean	5.04	Mean of log Data	0.447
Median	1.515	SD of log Data	1.464
SD	10.05		
Coefficient of Variation	1.994		
Skewness	2.907		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.507	Shapiro Wilk Test Statistic	0.889
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	8.926	95% H-UCL	13.84
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	11.17
95% Adjusted-CLT UCL	10.3	97.5% Chebyshev (MVUE) UCL	14.22
95% Modified-t UCL	9.17	99% Chebyshev (MVUE) UCL	20.2

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.49	Data do not follow a Discernable Distribution (0.05)	
Theta Star	10.29		
nu star	19.59		
Approximate Chi Square Value (.05)	10.55	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	8.737
Adjusted Chi Square Value	10.02	95% Jackknife UCL	8.926
		95% Standard Bootstrap UCL	8.647
Anderson-Darling Test Statistic	1.69	95% Bootstrap-t UCL	22.91
Anderson-Darling 5% Critical Value	0.799	95% Hall's Bootstrap UCL	27.74
Kolmogorov-Smirnov Test Statistic	0.242	95% Percentile Bootstrap UCL	8.974
Kolmogorov-Smirnov 5% Critical Value	0.204	95% BCA Bootstrap UCL	10.36
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	14.84
		97.5% Chebyshev(Mean, Sd) UCL	19.08
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	27.4
95% Approximate Gamma UCL	9.36		
95% Adjusted Gamma UCL	9.848		

Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	27.4

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_34	Surface Water	Copper

General Statistics

Number of Valid Samples	20	Number of Unique Samples	20

Raw Statistics		**Log-transformed Statistics**	
Minimum	4.5	Minimum of Log Data	1.504
Maximum	172	Maximum of Log Data	5.147
Mean	28.4	Mean of log Data	2.686
Median	12.6	SD of log Data	1.046
SD	44.62		
Coefficient of Variation	1.571		
Skewness	2.72		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.549	Shapiro Wilk Test Statistic	0.871
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	45.65	95% H-UCL	47.95
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	52.34
95% Adjusted-CLT UCL	51.29	97.5% Chebyshev (MVUE) UCL	64.45
95% Modified-t UCL	46.66	99% Chebyshev (MVUE) UCL	88.23

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.787	Data do not follow a Discernable Distribution (0.05)	
Theta Star	36.08		
nu star	31.48		
Approximate Chi Square Value (.05)	19.66	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	44.81
Adjusted Chi Square Value	18.92	95% Jackknife UCL	45.65
		95% Standard Bootstrap UCL	44.73
Anderson-Darling Test Statistic	1.684	95% Bootstrap-t UCL	94.23
Anderson-Darling 5% Critical Value	0.773	95% Hall's Bootstrap UCL	131.1
Kolmogorov-Smirnov Test Statistic	0.207	95% Percentile Bootstrap UCL	45.42
Kolmogorov-Smirnov 5% Critical Value	0.2	95% BCA Bootstrap UCL	54.65
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	71.89
		97.5% Chebyshev(Mean, Sd) UCL	90.71
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	127.7
95% Approximate Gamma UCL	45.47		
95% Adjusted Gamma UCL	47.24		

Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	127.7

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_59	Surface Water	Iron

General Statistics

Number of Valid Samples	20	Number of Detected Data	19
Number of Unique Samples	19	Number of Non-Detect Data	1
		Percent Non-Detects	5.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	507	Minimum Detected	6.229
Maximum Detected	34500	Maximum Detected	10.45
Mean of Detected	5711	Mean of Detected	7.651
SD of Detected	9926	SD of Detected	1.376
Minimum Non-Detect	47.3	Minimum Non-Detect	3.857
Maximum Non-Detect	47.3	Maximum Non-Detect	3.857

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.557	Shapiro Wilk Test Statistic	0.864
5% Shapiro Wilk Critical Value	0.901	5% Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	5427	Mean	7.427
SD	9744	SD	1.673
95% DL/2 (t) UCL	9195	95% H-Stat (DL/2) UCL	27652
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	5115	Mean in Log Scale	7.487
SD	9834	SD in Log Scale	1.527
95% MLE (t) UCL	8917	Mean in Original Scale	5430
95% MLE (Tiku) UCL	8594	SD in Original Scale	9743
		95% Percentile Bootstrap UCL	9065
		95% BCA Bootstrap UCL	10527

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.554	Data do not follow a Discernable Distribution (0.05)	
Theta Star	10310		
nu star	21.05		
A-D Test Statistic	1.481	**Nonparametric Statistics**	
5% A-D Critical Value	0.792	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.792	Mean	5451
5% K-S Critical Value	0.208	SD	9485
Data not Gamma Distributed at 5% Significance Level		SE of Mean	2179
		95% KM (t) UCL	9219
Assuming Gamma Distribution		95% KM (z) UCL	9035
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	9213
Minimum	0	95% KM (bootstrap t) UCL	18463
Maximum	34500	95% KM (BCA) UCL	8892
Mean	5426	95% KM (Percentile Bootstrap) UCL	9241
Median	1704	95% KM (Chebyshev) UCL	14949
SD	9745	97.5% KM (Chebyshev) UCL	19058
k star	0.282	99% KM (Chebyshev) UCL	27131
Theta star	19238		
Nu star	11.28	Potential UCLs to Use	
AppChi2	4.758	97.5% KM (Chebyshev) UCL	19058
95% Gamma Approximate UCL	12866		
95% Adjusted Gamma UCL	13829		

Note: DL/2 is not a recommended method.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_60	Surface Water	Lead

General Statistics

Number of Valid Samples	20	Number of Unique Samples	16

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.14	Minimum of Log Data	-1.966
Maximum	163	Maximum of Log Data	5.094
Mean	18.85	Mean of log Data	1.158
Median	2.45	SD of log Data	1.867
SD	43.57		
Coefficient of Variation	2.311		
Skewness	2.889		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.47	Shapiro Wilk Test Statistic	0.915
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	35.7	95% H-UCL	99.96
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	48.27
95% Adjusted-CLT UCL	41.6	97.5% Chebyshev (MVUE) UCL	62.7
95% Modified-t UCL	36.75	99% Chebyshev (MVUE) UCL	91.04

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.351	Data appear Lognormal at 5% Significance Level	
Theta Star	53.69		
nu star	14.05		
Approximate Chi Square Value (.05)	6.603	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	34.88
Adjusted Chi Square Value	6.203	95% Jackknife UCL	35.7
		95% Standard Bootstrap UCL	35.09
Anderson-Darling Test Statistic	1.776	95% Bootstrap-t UCL	114.5
Anderson-Darling 5% Critical Value	0.829	95% Hall's Bootstrap UCL	112.7
Kolmogorov-Smirnov Test Statistic	0.242	95% Percentile Bootstrap UCL	36.28
Kolmogorov-Smirnov 5% Critical Value	0.208	95% BCA Bootstrap UCL	42.44
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	61.32
		97.5% Chebyshev(Mean, Sd) UCL	79.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	115.8
95% Approximate Gamma UCL	40.1		
95% Adjusted Gamma UCL	42.7		

Potential UCL to Use		Use 95% Chebyshev (MVUE) UCL	48.27

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_61	Surface Water	Magnesium

General Statistics

Number of Valid Samples	20	Number of Unique Samples	18

Raw Statistics		**Log-transformed Statistics**	
Minimum	13500	Minimum of Log Data	9.51
Maximum	44900	Maximum of Log Data	10.71
Mean	21135	Mean of log Data	9.898
Median	18250	SD of log Data	0.333
SD	8745		
Coefficient of Variation	0.414		
Skewness	1.994		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.71	Shapiro Wilk Test Statistic	0.823
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	24516	95% H-UCL	24251
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	27894
95% Adjusted-CLT UCL	25283	97.5% Chebyshev (MVUE) UCL	30892
95% Modified-t UCL	24662	99% Chebyshev (MVUE) UCL	36780

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	7.178	Data do not follow a Discernable Distribution (0.05)	
Theta Star	2944		
nu star	287.1		
Approximate Chi Square Value (.05)	248.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	24351
Adjusted Chi Square Value	246.1	95% Jackknife UCL	24516
		95% Standard Bootstrap UCL	24234
Anderson-Darling Test Statistic	1.756	95% Bootstrap-t UCL	27468
Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	28746
Kolmogorov-Smirnov Test Statistic	0.284	95% Percentile Bootstrap UCL	24480
Kolmogorov-Smirnov 5% Critical Value	0.194	95% BCA Bootstrap UCL	25145
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	29659
		97.5% Chebyshev(Mean, Sd) UCL	33347
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	40592
95% Approximate Gamma UCL	24383		
95% Adjusted Gamma UCL	24661		

Potential UCL to Use		Use 95% Student's-t UCL	24516
		or 95% Modified-t UCL	24662

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_62	Surface Water	Manganese

General Statistics

Number of Valid Samples	20	Number of Unique Samples	20

Raw Statistics		Log-transformed Statistics	
Minimum	80.5	Minimum of Log Data	4.388
Maximum	3540	Maximum of Log Data	8.172
Mean	514.9	Mean of log Data	5.516
Median	215	SD of log Data	1.073
SD	887.8		
Coefficient of Variation	1.724		
Skewness	2.918		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.511	Shapiro Wilk Test Statistic	0.861
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	858.2	95% H-UCL	859
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	925.6
95% Adjusted-CLT UCL	979.8	97.5% Chebyshev (MVUE) UCL	1143
95% Modified-t UCL	879.7	99% Chebyshev (MVUE) UCL	1569

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.725	Data do not follow a Discernable Distribution (0.05)	
Theta Star	710.3		
nu star	29		
Approximate Chi Square Value (.05)	17.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	841.4
Adjusted Chi Square Value	17.01	95% Jackknife UCL	858.2
		95% Standard Bootstrap UCL	836.5
Anderson-Darling Test Statistic	1.879	95% Bootstrap-t UCL	2232
Anderson-Darling 5% Critical Value	0.777	95% Hall's Bootstrap UCL	2636
Kolmogorov-Smirnov Test Statistic	0.226	95% Percentile Bootstrap UCL	843.4
Kolmogorov-Smirnov 5% Critical Value	0.201	95% BCA Bootstrap UCL	997.3
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1380
		97.5% Chebyshev(Mean, Sd) UCL	1755
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2490
95% Approximate Gamma UCL	843.3		
95% Adjusted Gamma UCL	877.8		

Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	2490

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_63	Surface Water	Mercury

General Statistics

Number of Valid Samples	19	Number of Detected Data	3
Number of Unique Samples	3	Number of Non-Detect Data	16
		Percent Non-Detects	84.21%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.034	Minimum Detected	-3.381
Maximum Detected	0.42	Maximum Detected	-0.868
Mean of Detected	0.258	Mean of Detected	-1.796
SD of Detected	0.2	SD of Detected	1.38
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	0.2	Maximum Non-Detect	-1.609

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Test Statistic	0.83
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.125	Mean	-2.223
SD	0.0892	SD	0.497
95% DL/2 (t) UCL	0.16	95% H-Stat (DL/2) UCL	0.179

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-3.17
		SD in Log Scale	1.192
		Mean in Original Scale	0.082
		SD in Original Scale	0.11
		95% Percentile Bootstrap UCL	0.126
		95% BCA Bootstrap UCL	0.14

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	N/A	Data appear Normal at 5% Significance Level
Theta Star	N/A	
nu star	N/A	
A-D Test Statistic	0.456	**Nonparametric Statistics**
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method
K-S Test Statistic	N/A	Mean 0.0694
5% K-S Critical Value	N/A	SD 0.104
Data not Gamma Distributed at 5% Significance Level		SE of Mean 0.0293
		95% KM (t) UCL 0.12
Assuming Gamma Distribution		95% KM (z) UCL 0.118
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 0.252
Minimum	N/A	95% KM (bootstrap t) UCL 0.0887
Maximum	N/A	95% KM (BCA) UCL 0.42
Mean	N/A	95% KM (Percentile Bootstrap) UCL 0.42
Median	N/A	95% KM (Chebyshev) UCL 0.197
SD	N/A	97.5% KM (Chebyshev) UCL 0.253
k star	N/A	99% KM (Chebyshev) UCL 0.361
Theta star	N/A	
Nu star	N/A	Potential UCLs to Use
AppChi2	N/A	95% KM (t) UCL 0.12
95% Gamma Approximate UCL	N/A	95% KM (Percentile Bootstrap) UCL 0.42
95% Adjusted Gamma UCL	N/A	

Note: DL/2 is not a recommended method.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_64	Surface Water	Molybdenum

General Statistics

Number of Valid Samples	20	Number of Unique Samples	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.33	Minimum of Log Data	-1.109
Maximum	20.1	Maximum of Log Data	3.001
Mean	5.142	Mean of log Data	1.377
Median	4.5	SD of log Data	0.822
SD	4.163		
Coefficient of Variation	0.81		
Skewness	2.787		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.646	Shapiro Wilk Test Statistic	0.789
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.751	95% H-UCL	8.663
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10.17
95% Adjusted-CLT UCL	7.292	97.5% Chebyshev (MVUE) UCL	12.22
95% Modified-t UCL	6.848	99% Chebyshev (MVUE) UCL	16.25

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.794	Data do not follow a Discernable Distribution (0.05)	
Theta Star	2.866		
nu star	71.76		
Approximate Chi Square Value (.05)	53.26	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	6.673
Adjusted Chi Square Value	52	95% Jackknife UCL	6.751
		95% Standard Bootstrap UCL	6.67
Anderson-Darling Test Statistic	1.703	95% Bootstrap-t UCL	9.029
Anderson-Darling 5% Critical Value	0.752	95% Hall's Bootstrap UCL	15.97
Kolmogorov-Smirnov Test Statistic	0.281	95% Percentile Bootstrap UCL	6.715
Kolmogorov-Smirnov 5% Critical Value	0.196	95% BCA Bootstrap UCL	7.38
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	9.199
		97.5% Chebyshev(Mean, Sd) UCL	10.95
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	14.4
95% Approximate Gamma UCL	6.928		
95% Adjusted Gamma UCL	7.096		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	9.199

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_65	Surface Water	Nickel

General Statistics

Number of Valid Samples	20	Number of Unique Samples	15

Raw Statistics		Log-transformed Statistics	
Minimum	0.55	Minimum of Log Data	-0.598
Maximum	50.1	Maximum of Log Data	3.914
Mean	8.553	Mean of log Data	1.495
Median	4.25	SD of log Data	1.102
SD	12.7		
Coefficient of Variation	1.485		
Skewness	2.693		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.577	Shapiro Wilk Test Statistic	0.908
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	13.46	95% H-UCL	16.35
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	17.36
95% Adjusted-CLT UCL	15.05	97.5% Chebyshev (MVUE) UCL	21.49
95% Modified-t UCL	13.75	99% Chebyshev (MVUE) UCL	29.6

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.796	Data appear Lognormal at 5% Significance Level	
Theta Star	10.74		
nu star	31.86		
Approximate Chi Square Value (.05)	19.96	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	13.22
Adjusted Chi Square Value	19.22	95% Jackknife UCL	13.46
		95% Standard Bootstrap UCL	13.07
Anderson-Darling Test Statistic	1.425	95% Bootstrap-t UCL	24.43
Anderson-Darling 5% Critical Value	0.773	95% Hall's Bootstrap UCL	38.51
Kolmogorov-Smirnov Test Statistic	0.24	95% Percentile Bootstrap UCL	13.44
Kolmogorov-Smirnov 5% Critical Value	0.2	95% BCA Bootstrap UCL	15.26
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	20.93
		97.5% Chebyshev(Mean, Sd) UCL	26.28
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	36.8
95% Approximate Gamma UCL	13.65		
95% Adjusted Gamma UCL	14.18		

Potential UCL to Use		Use 95% Chebyshev (MVUE) UCL	17.36

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_66	Surface Water	Potassium

General Statistics

Number of Valid Samples	20	Number of Unique Samples	19

Raw Statistics		**Log-transformed Statistics**	
Minimum	4670	Minimum of Log Data	8.449
Maximum	22300	Maximum of Log Data	10.01
Mean	7896	Mean of log Data	8.849
Median	6380	SD of log Data	0.46
SD	5054		
Coefficient of Variation	0.64		
Skewness	2.335		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.629	Shapiro Wilk Test Statistic	0.781
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	9850	95% H-UCL	9536
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	11268
95% Adjusted-CLT UCL	10385	97.5% Chebyshev (MVUE) UCL	12810
95% Modified-t UCL	9948	99% Chebyshev (MVUE) UCL	15839

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.579	Data do not follow a Discernable Distribution (0.05)	
Theta Star	2206		
nu star	143.2		
Approximate Chi Square Value (.05)	116.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	9755
Adjusted Chi Square Value	114.6	95% Jackknife UCL	9850
		95% Standard Bootstrap UCL	9716
Anderson-Darling Test Statistic	1.998	95% Bootstrap-t UCL	12587
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	18439
Kolmogorov-Smirnov Test Statistic	0.245	95% Percentile Bootstrap UCL	9894
Kolmogorov-Smirnov 5% Critical Value	0.195	95% BCA Bootstrap UCL	10329
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	12822
		97.5% Chebyshev(Mean, Sd) UCL	14954
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	19140
95% Approximate Gamma UCL	9702		
95% Adjusted Gamma UCL	9863		

Potential UCL to Use		Use 95% Student's-t UCL	9850
		or 95% Modified-t UCL	9948

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_67	Surface Water	Selenium

General Statistics

Number of Valid Samples	20	Number of Unique Samples	17

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.29	Minimum of Log Data	-1.238
Maximum	2	Maximum of Log Data	0.693
Mean	0.747	Mean of log Data	-0.428
Median	0.54	SD of log Data	0.512
SD	0.448		
Coefficient of Variation	0.599		
Skewness	1.696		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.809	Shapiro Wilk Test Statistic	0.947
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.92	95% H-UCL	0.942
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1.121
95% Adjusted-CLT UCL	0.952	97.5% Chebyshev (MVUE) UCL	1.286
95% Modified-t UCL	0.926	99% Chebyshev (MVUE) UCL	1.612

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.296	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	0.227		
nu star	131.9		
Approximate Chi Square Value (.05)	106.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	0.912
Adjusted Chi Square Value	104.5	95% Jackknife UCL	0.92
		95% Standard Bootstrap UCL	0.905
Anderson-Darling Test Statistic	0.68	95% Bootstrap-t UCL	1.005
Anderson-Darling 5% Critical Value	0.746	95% Hall's Bootstrap UCL	1.077
Kolmogorov-Smirnov Test Statistic	0.216	95% Percentile Bootstrap UCL	0.922
Kolmogorov-Smirnov 5% Critical Value	0.195	95% BCA Bootstrap UCL	0.948
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.183
		97.5% Chebyshev(Mean, Sd) UCL	1.372
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.743
95% Approximate Gamma UCL	0.926		
95% Adjusted Gamma UCL	0.942		

Potential UCL to Use		Use 95% Approximate Gamma UCL	0.926

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_68	Surface Water	Silver

General Statistics

Number of Valid Samples	18	Number of Detected Data	3
Number of Unique Samples	3	Number of Non-Detect Data	15
		Percent Non-Detects	83.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.04	Minimum Detected	-3.219
Maximum Detected	0.08	Maximum Detected	-2.526
Mean of Detected	0.06	Mean of Detected	-2.853
SD of Detected	0.02	SD of Detected	0.348
Minimum Non-Detect	0.02	Minimum Non-Detect	-3.912
Maximum Non-Detect	0.77	Maximum Non-Detect	-0.261

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	18
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	1	Shapiro Wilk Test Statistic	0.99
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.103	Mean	-2.788
SD	0.1	SD	1.124
95% DL/2 (t) UCL	0.144	95% H-Stat (DL/2) UCL	0.416

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-3.596
		SD in Log Scale	0.529
		Mean in Original Scale	0.0315
		SD in Original Scale	0.0185
		95% Percentile Bootstrap UCL	0.039
		95% BCA Bootstrap UCL	0.0411

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	N/A	Data appear Normal at 5% Significance Level
Theta Star	N/A	
nu star	N/A	

A-D Test Statistic	0.252	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.0467
5% K-S Critical Value	N/A	SD	0.0133
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.00544
		95% KM (t) UCL	0.0561
Assuming Gamma Distribution		95% KM (z) UCL	0.0556
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0599
Minimum	N/A	95% KM (bootstrap t) UCL	0.053
Maximum	N/A	95% KM (BCA) UCL	0.08
Mean	N/A	95% KM (Percentile Bootstrap) UCL	0.08
Median	N/A	95% KM (Chebyshev) UCL	0.0704
SD	N/A	97.5% KM (Chebyshev) UCL	0.0807
k star	N/A	99% KM (Chebyshev) UCL	0.101
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	0.0561
95% Gamma Approximate UCL	N/A	95% KM (Percentile Bootstrap) UCL	0.08
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_69	Surface Water	Sodium

General Statistics

Number of Valid Samples	20	Number of Unique Samples	15

Raw Statistics		**Log-transformed Statistics**	
Minimum	93900	Minimum of Log Data	11.45
Maximum	174999	Maximum of Log Data	12.07
Mean	118930	Mean of log Data	11.67
Median	124000	SD of log Data	0.159
SD	19646		
Coefficient of Variation	0.165		
Skewness	0.97		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.884	Shapiro Wilk Test Statistic	0.913
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	126526	95% H-UCL	126850
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	137419
95% Adjusted-CLT UCL	127174	97.5% Chebyshev (MVUE) UCL	145433
95% Modified-t UCL	126684	99% Chebyshev (MVUE) UCL	161174

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	34.77	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	3421		
nu star	1391		
Approximate Chi Square Value (.05)	1305	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	126155
Adjusted Chi Square Value	1299	95% Jackknife UCL	126526
		95% Standard Bootstrap UCL	125930
Anderson-Darling Test Statistic	0.686	95% Bootstrap-t UCL	127450
Anderson-Darling 5% Critical Value	0.74	95% Hall's Bootstrap UCL	128733
Kolmogorov-Smirnov Test Statistic	0.164	95% Percentile Bootstrap UCL	126400
Kolmogorov-Smirnov 5% Critical Value	0.193	95% BCA Bootstrap UCL	126625
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	138078
		97.5% Chebyshev(Mean, Sd) UCL	146364
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	162639
95% Approximate Gamma UCL	126730		
95% Adjusted Gamma UCL	127368		

Potential UCL to Use		Use 95% Approximate Gamma UCL	126730

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_70	Surface Water	Thallium

General Statistics

Number of Valid Samples	19	Number of Detected Data	8
Number of Unique Samples	7	Number of Non-Detect Data	11
		Percent Non-Detects	57.89%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.06	Minimum Detected	-2.813
Maximum Detected	0.86	Maximum Detected	-0.151
Mean of Detected	0.264	Mean of Detected	-1.888
SD of Detected	0.318	SD of Detected	1.06
Minimum Non-Detect	0.05	Minimum Non-Detect	-2.996
Maximum Non-Detect	1	Maximum Non-Detect	0

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	19
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.688	Shapiro Wilk Test Statistic	0.82
5% Shapiro Wilk Critical Value	0.818	5% Shapiro Wilk Critical Value	0.818
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.356	Mean	-1.429
SD	0.25	SD	1.054
95% DL/2 (t) UCL	0.455	95% H-Stat (DL/2) UCL	2.525

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.192
		SD in Log Scale	1.107
		Mean in Original Scale	0.2
		SD in Original Scale	0.243
		95% Percentile Bootstrap UCL	0.289
		95% BCA Bootstrap UCL	0.313

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.73	Data Follow Appr. Gamma Distribution at 5% Significance Level
Theta Star	0.361	
nu star	11.69	
A-D Test Statistic	0.914	**Nonparametric Statistics**
5% A-D Critical Value	0.735	Kaplan-Meier (KM) Method
K-S Test Statistic	0.735	Mean 0.226
5% K-S Critical Value	0.301	SD 0.277
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean 0.0938
		95% KM (t) UCL 0.389
Assuming Gamma Distribution		95% KM (z) UCL 0.38
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 0.391
Minimum	0.0502	95% KM (bootstrap t) UCL 1.114
Maximum	0.86	95% KM (BCA) UCL 0.392
Mean	0.291	95% KM (Percentile Bootstrap) UCL 0.384
Median	0.18	95% KM (Chebyshev) UCL 0.635
SD	0.255	97.5% KM (Chebyshev) UCL 0.811
k star	1.207	99% KM (Chebyshev) UCL 1.159
Theta star	0.241	
Nu star	45.87	Potential UCLs to Use
AppChi2	31.33	95% KM (t) UCL 0.389
95% Gamma Approximate UCL	0.427	
95% Adjusted Gamma UCL	0.441	

Note: DL/2 is not a recommended method.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_71	Surface Water	Vanadium

General Statistics

Number of Valid Samples	20	Number of Unique Samples	16

Raw Statistics		**Log-transformed Statistics**	
Minimum	4.4	Minimum of Log Data	1.482
Maximum	56.6	Maximum of Log Data	4.036
Mean	15.07	Mean of log Data	2.411
Median	10.45	SD of log Data	0.749
SD	14.19		
Coefficient of Variation	0.942		
Skewness	2.129		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.689	Shapiro Wilk Test Statistic	0.859
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	20.56	95% H-UCL	21.79
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	25.89
95% Adjusted-CLT UCL	21.9	97.5% Chebyshev (MVUE) UCL	30.82
95% Modified-t UCL	20.81	99% Chebyshev (MVUE) UCL	40.5

Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.569	Data do not follow a Discernable Distribution (0.05)	
Theta Star	9.606		
nu star	62.75		
Approximate Chi Square Value (.05)	45.53	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	20.29
Adjusted Chi Square Value	44.37	95% Jackknife UCL	20.56
		95% Standard Bootstrap UCL	20.08
Anderson-Darling Test Statistic	1.411	95% Bootstrap-t UCL	26.09
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	49.64
Kolmogorov-Smirnov Test Statistic	0.272	95% Percentile Bootstrap UCL	20.41
Kolmogorov-Smirnov 5% Critical Value	0.197	95% BCA Bootstrap UCL	21.82
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	28.9
		97.5% Chebyshev(Mean, Sd) UCL	34.89
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	46.64
95% Approximate Gamma UCL	20.77		
95% Adjusted Gamma UCL	21.31		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	28.9

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\lhilsche\Asarco Hayden\mar08\EPCs5\all5.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

File #	Media	Parameter
_72	Surface Water	Zinc

General Statistics

Number of Valid Samples	20	Number of Unique Samples	20

Raw Statistics		Log-transformed Statistics	
Minimum	2.4	Minimum of Log Data	0.875
Maximum	237	Maximum of Log Data	5.468
Mean	32.43	Mean of log Data	2.354
Median	7.9	SD of log Data	1.419
SD	62.28		
Coefficient of Variation	1.92		
Skewness	2.77		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.529	Shapiro Wilk Test Statistic	0.873
Shapiro Wilk Critical Value	0.905	Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	56.51	95% H-UCL	82.44
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	69.51
95% Adjusted-CLT UCL	64.55	97.5% Chebyshev (MVUE) UCL	88.2
95% Modified-t UCL	57.95	99% Chebyshev (MVUE) UCL	124.9

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.505	Data do not follow a Discernable Distribution (0.05)	
Theta Star	64.17		
nu star	20.22		
Approximate Chi Square Value (.05)	11.01	**Nonparametric Statistics**	
Adjusted Level of Significance	0.038	95% CLT UCL	55.33
Adjusted Chi Square Value	10.47	95% Jackknife UCL	56.51
		95% Standard Bootstrap UCL	54.95
Anderson-Darling Test Statistic	1.684	95% Bootstrap-t UCL	133.4
Anderson-Darling 5% Critical Value	0.797	95% Hall's Bootstrap UCL	166.2
Kolmogorov-Smirnov Test Statistic	0.236	95% Percentile Bootstrap UCL	56.34
Kolmogorov-Smirnov 5% Critical Value	0.204	95% BCA Bootstrap UCL	65.78
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	93.13
		97.5% Chebyshev(Mean, Sd) UCL	119.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	171
95% Approximate Gamma UCL	59.54		
95% Adjusted Gamma UCL	62.59		

Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	171

Summary Statistics

Table of Contents for Surface Water - Residential Exposure Scenario
Baseline Human Health Risk Assessment
ASARCO LLC Hayden Plant Site, Hayden, Arizona

Table #	Title
Table E-1	Summary Statistics for Surface Water
Table E-2	Risk Calculation Worksheet for Surface Water - Carcinogenic Effects - Recreation Exposure Scenario
Table E-3	Risk Calculation Worksheet for Surface Water - Noncarcinogenic Effects - Recreation Exposure Scenario
Table E-4	Detailed Summary of Recreation Cancer Risks and Noncancer Hazards - Gila River and San Pedro River - Surface Water
Table E-5	Summary of Recreation Cancer Risks and Noncancer Hazards - Gila River and San Pedro River - Surface Water
Attachment E-1	Model for Estimating Dermal Exposure from Contact with Chemicals in Water - Adult Swimmer
Attachment E-1a	Model for Estimating Dermal Exposure from Contact with Chemicals in Water - Child Swimmer

Table E-1
Risk Calculation Worksheet for Surface Water
Baseline Human Health Risk Assessment
ASARCO LLC Hayden Plant Site, Hayden, Arizona

Parameter	Number of Detects	Number of Analyses	Percent Detects	Units	Minimum Detected Value	Maximum Detected Value	Minimum DL for Non-detects	Maximum DL for Non-detects	Location of Maximum Detected Concentration	Arithmetic Mean Value	Standard Deviation	Exposure Point Concentration	EPC Basis	Exposure Point Concentration (may be Max)	EPC Basis (may be Max)
Aluminum	20	20	100	UG/L	64.5	62,000	NA	NA	GR-SW-06	8,520	17,000	22,200	95% Chebyshev (MVUE) UCL	22,200	95% Chebyshev (MVUE) UCL
Arsenic	20	20	100	UG/L	2.7	16.8	NA	NA	GR-SW-06	6.03	3.84	9.77	95% Chebyshev (Mean, Sd) UCL	9.77	95% Chebyshev (Mean, Sd) UCL
Barium	20	20	100	UG/L	61.5	1,190	NA	NA	GR-SW-06	207	299	499	95% Chebyshev (Mean, Sd) UCL	499	95% Chebyshev (Mean, Sd) UCL
Beryllium	12	19	63	UG/L	0.07	8.3	0.66	0.66	GR-SW-06	1.04	2.1	4.09	97.5% KM (Chebyshev) UCL	4.09	97.5% KM (Chebyshev) UCL
Boron	20	20	100	UG/L	113	225	NA	NA	SPR-SW-02	135	24.6	144	95% Student's-t UCL	144	95% Student's-t UCL
Cadmium	10	19	53	UG/L	0.1	3.4	0.25	0.25	GR-SW-06	0.428	0.85	1.68	97.5% KM (Chebyshev) UCL	1.68	97.5% KM (Chebyshev) UCL
Calcium	20	20	100	UG/L	46,400	382,000	NA	NA	GR-SW-06	97,100	84,600	180,000	95% Chebyshev (Mean, Sd) UCL	180,000	95% Chebyshev (Mean, Sd) UCL
Chromium	20	20	100	UG/L	0.24	31.4	NA	NA	GR-SW-06	4.84	8.38	10.7	95% Chebyshev (MVUE) UCL	10.7	95% Chebyshev (MVUE) UCL
Cobalt	20	20	100	UG/L	0.2	39.2	NA	NA	GR-SW-06	5.04	10.1	27.4	99% Chebyshev (Mean, Sd) UCL	27.4	99% Chebyshev (Mean, Sd) UCL
Copper	20	20	100	UG/L	4.5	172	NA	NA	GR-SW-06	28.4	44.6	128	99% Chebyshev (Mean, Sd) UCL	128	99% Chebyshev (Mean, Sd) UCL
Cyanide, Total	1	19	5	UG/L	16.2	16.2	3.8	10	GR-SW-07	4.99	2.96	7.95	Too Few Unique Detected Values *	7.95	Too Few Unique Detected Values *
Iron	19	20	95	UG/L	507	34,500	47.3	47.3	GR-SW-06	5,430	9,740	19,100	97.5% KM (Chebyshev) UCL	19,100	97.5% KM (Chebyshev) UCL
Lead	20	20	100	UG/L	0.14	163	NA	NA	GR-SW-06	18.9	43.6	48.3	95% Chebyshev (MVUE) UCL	48.3	95% Chebyshev (MVUE) UCL
Magnesium	20	20	100	UG/L	13,500	44,900	NA	NA	GR-SW-07	21,100	8,750	24,500	95% Student's-t UCL	24,500	95% Student's-t UCL
Manganese	20	20	100	UG/L	80.5	3,540	NA	NA	GR-SW-06	515	888	2,490	99% Chebyshev (Mean, Sd) UCL	2,490	99% Chebyshev (Mean, Sd) UCL
Mercury	3	19	16	UG/L	0.034	0.42	0.2	0.2	GR-SW-06	0.125	0.0892	0.12	95% KM (t) UCL	0.12	95% KM (t) UCL
Molybdenum	20	20	100	UG/L	0.33	20.1	NA	NA	SPR-SW-02	5.14	4.16	9.2	95% Chebyshev (Mean, Sd) UCL	9.2	95% Chebyshev (Mean, Sd) UCL
Nickel	20	20	100	UG/L	0.55	50.1	NA	NA	GR-SW-06	8.55	12.7	17.4	95% Chebyshev (MVUE) UCL	17.4	95% Chebyshev (MVUE) UCL
Potassium	20	20	100	UG/L	4,670	22,300	NA	NA	GR-SW-07	7,900	5,050	9,850	95% Student's-t UCL	9,850	95% Student's-t UCL
Selenium	20	20	100	UG/L	0.29	2	NA	NA	GR-SW-06	0.747	0.448	0.926	95% Approximate Gamma UCL	0.926	95% Approximate Gamma UCL
Silver	3	18	17	UG/L	0.04	0.08	0.02	0.77	GR-SW-03	0.103	0.1	0.0561	95% KM (t) UCL	0.0561	95% KM (t) UCL
Sodium	20	20	100	UG/L	93,900	175,000	NA	NA	SPR-SW-02	119,000	19,600	127,000	95% Approximate Gamma UCL	127,000	95% Approximate Gamma UCL
Thallium	8	19	42	UG/L	0.06	0.86	0.05	1	GR-SW-06	0.356	0.25	0.389	95% KM (t) UCL	0.389	95% KM (t) UCL
Vanadium	20	20	100	UG/L	4.4	56.6	NA	NA	GR-SW-06	15.1	14.2	28.9	95% Chebyshev (Mean, Sd) UCL	28.9	95% Chebyshev (Mean, Sd) UCL
Zinc	20	20	100	UG/L	2.4	237	NA	NA	GR-SW-06	32.4	62.3	171	99% Chebyshev (Mean, Sd) UCL	171	99% Chebyshev (Mean, Sd) UCL

Risk Calculations

Table E-2
Risk Calculation Worksheet for Surface Water - Carcinogenic Effects - Recreation Exposure Scenario
Baseline Human Health Risk Assessment
ASARCO LLC Hayden Plant Site, Hayden, Arizona

Exposure Scenario Information		
	Exposure Scenario:	Recreation
	Scenario Timeframe:	Chronic
	Exposure Medium:	Surface Water
	Exposure Point:	In Stream
	Receptor Population:	Adult/Child Swimmer
	Receptor Age:	Adult/Child

Exposure Scenario/Exposure Area Description

Site Risks

Gila River and San Pedro River - Surface Water

Exposure Parameter	Variable	Adult Value	Child Value	Units
Drinking Water Ingestion Rate	IDW	50	50	ml/hr
Exposure Frequency	EF	33	33	day/yr
Exposure Duration	ED	24	6	yr
Exposure Time	ET	2.6	2.6	hr/day
Skin Surface Area (Water Contact)	SA_w	18,000	12,000	cm^2 [water]
Body Weight	BW	70	28	kg
Averaging Time for carcinogens	ATc	70	70	yr
Averaging Time for noncarcinogens	ATnc	24	6	yr
Conversion Factor (yr to day)	CF_1	2.74E-03	2.74E-03	yrs/day
Conversion Factor (ug to mg)	CF_2	1.00E-03	1.00E-03	mg/ug
Conversion Factor (ml to L)	CF_3	1.00E-03	1.00E-03	ml/L

Risk Calculations

		Exposure Route = Oral			Exposure Route = Dermal			Exposure Route = Inhalation			
Chemical of Potential Concern	**RME Medium EPC Value, Cw [ug/L]**	**Chronic Daily Intake [mg/kg/day]**	**Cancer Slope Factor, SF $[mg/kg/day]^{-1}$**	**Cancer Risk [-]**	**Chronic Daily Intake [mg/kg/day]**	**Cancer Slope Factor, SF $[mg/kg/day]^{-1}$**	**Cancer Risk [-]**	**Chronic Daily Intake [mg/kg/day]**	**Cancer Slope Factor, SF $[mg/kg/day]^{-1}$**	**Cancer Risk [-]**	**Total Cancer Risk [-]**
Adult Swimmer											
Aluminum	2.22E+04	1.28E-03	NA		4.60E-04	NA		NA	NA		
Arsenic	9.77E+00	5.62E-07	1.50E+00	8.44E-07	2.02E-07	1.50E+00	3.04E-07	NA	1.51E+01		1.15E-06
Iron	1.91E+04	1.10E-03	NA		3.96E-04	NA		NA	NA		
Manganese	2.49E+03	1.43E-04	NA		5.16E-05	NA		NA	NA		
Vanadium	2.89E+01	1.66E-06	NA		5.99E-07	NA		NA	NA		
Child Swimmer											
Aluminum	2.22E+04	7.96E-04	NA		1.91E-04	NA		NA	NA		
Arsenic	9.77E+00	3.50E-07	1.50E+00	5.25E-07	8.41E-08	1.50E+00	1.26E-07	NA	1.51E+01		6.52E-07
Iron	1.91E+04	6.85E-04	NA		1.64E-04	NA		NA	NA		
Manganese	2.49E+03	8.93E-05	NA		2.14E-05	NA		NA	NA		
Vanadium	2.89E+01	1.04E-06	NA		2.49E-07	NA		NA	NA		
Total Adult Swimmer				8.4E-07			3.0E-07			--	1.1E-06
Total Child Swimmer				5.3E-07			1.3E-07			--	6.5E-07
Total Adult/Child Swimmer		(76.1% Contribution)		1.4E-06	(23.9% Contribution)		4.3E-07			--	1.8E-06

Notes:
NA = no data; this toxicity value is not available in the standard U.S. EPA toxicity value databases. Inhalation of nonvolatile chemicals was not considered for surface water.
RME = reasonable maximum exposure.
EPC = exposure point concentration.

Table E-3
Risk Calculation Worksheet for Surface Water - Noncarcinogenic Effects - Recreation Exposure Scenario
Baseline Human Health Risk Assessment
ASARCO LLC Hayden Plant Site, Hayden, Arizona

Exposure Scenario Information		
	Exposure Scenario:	Recreation
	Scenario Timeframe:	Chronic
	Exposure Medium:	Surface Water
	Exposure Point:	In Stream
	Receptor Population:	Adult/Child Swimmer
	Receptor Age:	Adult/Child

Exposure Scenario/Exposure Area Description

Site Risks

Gila River and San Pedro River - Surface Water

Exposure Parameter	Variable	Adult Value	Child Value	Units
Drinking Water Ingestion Rate	IDW	50	50	ml/hr
Exposure Frequency	EF	33	33	day/yr
Exposure Duration	ED	24	6	yr
Exposure Time	ET	2.6	2.6	hr/day
Skin Surface Area (Water Contact)	SA_w	18,000	12,000	cm^2 [water]
Body Weight	BW	70	28	kg
Averaging Time for carcinogens	ATc	70	70	yr
Averaging Time for noncarcinogens	ATnc	24	6	yr
Conversion Factor (yr to day)	CF_1	2.74E-03	2.74E-03	yrs/day
Conversion Factor (ug to mg)	CF_2	1.00E-03	1.00E-03	mg/ug
Conversion Factor (ml to L)	CF_3	1.00E-03	1.00E-03	ml/L

Risk Calculations

		Exposure Route = Oral			Exposure Route = Dermal			Exposure Route = Inhalation			
Chemical of Potential Concern	**RME Medium EPC Value, Cw [ug/L]**	**Chronic Daily Intake [mg/kg/day]**	**Reference Dose RfD [mg/kg/day]**	**Hazard Quotient [-]**	**Chronic Daily Intake [mg/kg/day]**	**Reference Dose RfD [mg/kg/day]**	**Hazard Quotient [-]**	**Chronic Daily Intake [mg/kg/day]**	**Reference Dose RfD [mg/kg/day]**	**Hazard Quotient [-]**	**Total Hazard Quotient [-]**
Adult Swimmer											
Aluminum	2.22E+04	3.73E-03	1.00E+00	3.73E-03	1.34E-03	1.00E+00	1.34E-03	NA	1.40E-03		5.07E-03
Arsenic	9.77E+00	1.64E-06	3.00E-04	5.47E-03	5.91E-07	3.00E-04	1.97E-03	NA	NA		7.44E-03
Iron	1.91E+04	3.21E-03	3.00E-01	1.07E-02	1.15E-03	3.00E-01	3.85E-03	NA	NA		1.45E-02
Manganese	2.49E+03	4.18E-04	2.40E-02	1.74E-02	1.51E-04	2.40E-02	6.27E-03	NA	1.40E-05		2.37E-02
Vanadium	2.89E+01	4.85E-06	1.00E-03	4.85E-03	1.75E-06	1.00E-03	1.75E-03	NA	NA		6.60E-03
Child Swimmer											
Aluminum	2.22E+04	9.29E-03	1.00E+00	9.29E-03	2.23E-03	1.00E+00	2.23E-03	NA	1.40E-03		1.15E-02
Arsenic	9.77E+00	4.09E-06	3.00E-04	1.36E-02	9.81E-07	3.00E-04	3.27E-03	NA	NA		1.69E-02
Iron	1.91E+04	7.99E-03	3.00E-01	2.66E-02	1.92E-03	3.00E-01	6.39E-03	NA	NA		3.30E-02
Manganese	2.49E+03	1.04E-03	2.40E-02	4.34E-02	2.50E-04	2.40E-02	1.04E-02	NA	1.40E-05		5.38E-02
Vanadium	2.89E+01	1.21E-05	1.00E-03	1.21E-02	2.90E-06	1.00E-03	2.90E-03	NA	NA		1.50E-02
Total Adult Swimmer				3.7E-02			1.3E-02			--	0.05
Total Child Swimmer			(80.6% Contribution)	9.3E-02		(19.4% Contribution)	2.2E-02			--	0.1

Notes:
NA = no data; this toxicity value is not available in the standard U.S. EPA toxicity value databases. Inhalation of nonvolatile chemicals was not considered for surface water.
RME = reasonable maximum exposure.
EPC = exposure point concentration.

Table E-4
Detailed Summary of Recreation Cancer Risks and Noncancer Hazards - Gila River and San Pedro River - Surface Water
Baseline Human Health Risk Assessment
ASARCO LLC Hayden Plant Site, Hayden, Arizona

Property	Receptor	COPC	RME Medium EPC Value (ug/L)	Carcinogenic Risk				Noncarcinogenic HI			
				Oral	Dermal	Inhalation	Total	Oral	Dermal	Inhalation	Total
Surface Water	**Adult Swimmer**	Aluminum	2.22E+04					3.73E-03	1.34E-03		5.07E-03
		Arsenic	9.77E+00	8.44E-07	3.04E-07		1.15E-06	5.47E-03	1.97E-03		7.44E-03
		Iron	1.91E+04					1.07E-02	3.85E-03		1.45E-02
		Manganese	2.49E+03					1.74E-02	6.27E-03		2.37E-02
		Vanadium	2.89E+01					4.85E-03	1.75E-03		6.60E-03
		Total					1.1E-06				0.1
	Child Swimmer	Aluminum	2.22E+04					9.29E-03	2.23E-03		1.15E-02
		Arsenic	9.77E+00	5.25E-07	1.26E-07		6.52E-07	1.36E-02	3.27E-03		1.69E-02
		Iron	1.91E+04					2.66E-02	6.39E-03		3.30E-02
		Manganese	2.49E+03					4.34E-02	1.04E-02		5.38E-02
		Vanadium	2.89E+01					1.21E-02	2.90E-03		1.50E-02
		Total					6.5E-07				0.1
	Adult/Child Swimmer	Aluminum	2.22E+04								
		Arsenic	9.77E+00	1.37E-06	4.30E-07		1.80E-06				
		Iron	1.91E+04								
		Manganese	2.49E+03								
		Vanadium	2.89E+01								
		Total					1.8E-06				NA

Notes:
NA = Not applicable

Table E-5
Summary of Recreation Cancer Risks and Noncancer Hazards - Gila River and San Pedro River - Surface Water
Baseline Human Health Risk Assessment
ASARCO LLC Hayden Plant Site, Hayden, Arizona

Media	Adult plus Child Cancer Risks	Child Noncancer Hazards
Surface Water	2E-06	0.1

Attachment E-1 - Adult Swimmer
Model for Estimating Dermal Exposure from Contact with Chemicals in Water - Adult Swimme
Baseline Human Health Risk Assessment
ASARCO LLC Hayden Plant Site, Hayden, Arizona

Source: EPA, 2004. RAGS Part E

ORGANICS

If $t_{event} \leq t^*$:

$$DA_{event_1} = 2 \times FA \times K_p \times C_v \sqrt{\frac{6 \times tau \times t_{event}}{\Pi}}$$

If $t_{event} > t^*$:

$$DA_{event_2} = FA \times K_p \times C_v \left[\frac{t_{event}}{1+B} + 2 \times tau \times \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$$

INORGANICS

$$DA_{event} = K_p \times C_v \times t_{event}$$

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT \times 365\, days/year}$$

$$\log K_p = -2.8 + 0.66 \log K_{ow} - 0.0056 MW$$

$$B = K_p \frac{\sqrt{MW}}{2.6}$$

Dermally-absorbed dose	DAD	calculated	mg/kg-day
Concentration in water	Conc (Cv)	chem-specific	mg/cm3
permeability coefficient	Kp	calculated	cm/hr
Lag time per event (hours)	*tau* (τ)	calculated	hours
Time to reach steady-state (hours)	t*	calculated	hours
Dimensionless coefficient	B	calculated	
Pi	π	3.1416	
Exposure Time	t_event	2.6	hr/event
Number of exposure events	EV	1	event/day
Exposure Duration	ED	24	year
Exposure Frequency	EF	33	days/year
Exposed Skin Surface Area	SA	18000	cm2
Body Weight	BW	70	kg
Averaging time - noncarcinogenic	AT_N	24	years
Averaging time - carcinogenic	AT_C	70	years
Conversion Factor		0.001	mg/ug

Thickness of stratum corneum	*lsc* (cm)	0.001
Molecular Weight	g/mol	chem-specific
log octanol-water partition coefficient	Log Kow	chem-specific
log permeability coefficient	log Kp	calculated
Permeability coefficient (cm/hr)	Kp	calculated
Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis	B	calculated
across the stratum corneum (cm2/hr)	Dsc	calculated
Lag time per event (hours)	τ	calculated
Time to reach steady-state (hours)	t*	calculated
methodology (see equations A7 and A8, USEPA, 2001)	b,c	calculated

Constituent	Conc (mg/L)	Conc (mg/cm3)	MW	FA	Log Kow	Kp (cm/hr) Select	Log Kp	B	Dsc/lsc	Dsc (cm2/hr)	τ (hours)	b	c	t* (hours)	DA_inorg (mg/cm2-event)	DA_1 (mg/cm2-event)	DA_2 (mg/cm2-event)	Selected DA (mg/cm2-event)	DAD_carcinogenic (mg/kg-day)	DAD_non-carcinogenic (mg/kg-day)
Metals																				
Aluminum	2.2E+01	2.2E-02	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	5.77E-05	NA	NA	5.77E-05	4.60E-04	1.34E-03
Arsenic	9.8E-03	9.8E-06	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	2.54E-08	NA	NA	2.54E-08	2.02E-07	5.91E-07
Iron	1.9E+01	1.9E-02	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	4.97E-05	NA	NA	4.97E-05	3.96E-04	1.15E-03
Manganese	2.5E+00	2.5E-03	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	6.47E-06	NA	NA	6.47E-06	5.16E-05	1.51E-04
Selenium	9.3E-04	9.3E-07	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	2.41E-09	NA	NA	2.41E-09	1.92E-08	5.60E-08
Vanadium	2.9E-02	2.9E-05	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	7.51E-08	NA	NA	7.51E-08	5.99E-07	1.75E-06

Attachment E-1a - Child Swimmer
Model for Estimating Dermal Exposure from Contact with Chemicals in Water - Child Swimme
Baseline Human Health Risk Assessment
ASARCO LLC Hayden Plant Site, Hayden, Arizona

Source: EPA, 2004. RAGS Part E

ORGANICS

If $t_{event} \leq t^*$:

$$DA_{event_1} = 2 \times FA \times K_p \times C_v \sqrt{\frac{6 \times tau \times t_{event}}{\Pi}}$$

If $t_{event} > t^*$:

$$DA_{event_2} = FA \times K_p \times C_v \left[\frac{t_{event}}{1+B} + 2 \times tau \times \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$$

INORGANICS

$$DA_{event} = K_p \times C_v \times t_{event}$$

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT \times 365\, days/year}$$

$$\log K_p = -2.8 + 0.66 \log K_{ow} - 0.0056 MW$$

$$B = K_p \frac{\sqrt{MW}}{2.6}$$

Dermally-absorbed dose	DAD	calculated	mg/kg-day
Concentration in water	Conc (Cv)	chem-specific	mg/cm3
permeability coefficient	Kp	calculated	cm/hr
Lag time per event (hours)	*tau* (τ)	calculated	hours
Time to reach steady-state (hours)	t*	calculated	hours
Dimensionless coefficient	B	calculated	
Pi	π	3.1416	
Exposure Time	t_event	2.6	hr/event
Number of exposure events	EV	1	event/day
Exposure Duration	ED	6	year
Exposure Frequency	EF	33	days/year
Exposed Skin Surface Area	SA	12000	cm2
Body Weight	BW	28.1	kg
Averaging time - noncarcinogenic	AT_N	6	years
Averaging time - carcinogenic	AT_C	70	years
Conversion Factor		0.001	mg/ug

Thickness of stratum corneum	*lsc* (cm)	0.001
Molecular Weight	g/mol	chem-specific
log octanol-water partition coefficient	Log Kow	chem-specific
log permeability coefficient	log Kp	calculated
Permeability coefficient (cm/hr)	Kp	calculated
Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis	B	calculated
across the stratum corneum (cm2/hr)	Dsc	calculated
Lag time per event (hours)	τ	calculated
Time to reach steady-state (hours)	t*	calculated
methodology (see equations A7 and A8, USEPA, 2001)	b,c	calculated

Constituent	Conc (mg/L)	Conc (mg/cm3)	MW	FA	Log Kow	Kp (cm/hr) Select	Log Kp	B	Dsc/lsc	Dsc (cm2/hr)	τ (hours)	b	c	t* (hours)	DA_inorg (mg/cm2-event)	DA_1 (mg/cm2-event)	DA_2 (mg/cm2-event)	Selected DA (mg/cm2-event)	DAD_carcinogenic (mg/kg-day)	DAD_non-carcinogenic (mg/kg-day)
Metals																				
Aluminum	2.2E+01	2.2E-02	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	5.77E-05	NA	NA	5.77E-05	1.91E-04	2.23E-03
Arsenic	9.8E-03	9.8E-06	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	2.54E-08	NA	NA	2.54E-08	8.41E-08	9.81E-07
Iron	1.9E+01	1.9E-02	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	4.97E-05	NA	NA	4.97E-05	1.64E-04	1.92E-03
Manganese	2.5E+00	2.5E-03	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	6.47E-06	NA	NA	6.47E-06	2.14E-05	2.50E-04
Selenium	9.3E-04	9.3E-07	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	2.41E-09	NA	NA	2.41E-09	7.97E-09	9.30E-08
Vanadium	2.9E-02	2.9E-05	NA	1.0	NA	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	7.51E-08	NA	NA	7.51E-08	2.49E-07	2.90E-06