APPENDIX D

APPENDIX D

STATISTICAL EVALUATION FOR LEAD DETECTED IN SOIL SAMPLES

D.1 Statistical Evaluation for Lead Detected in Soil Samples

Statistical methods were applied to the total lead data to evaluate: 1) the distribution of total lead concentrations for each sampling depth; 2) the upper confidence limits (UCLs) of the true means of the total lead concentrations for each sampling depth; and 3) if an acceptable correlation between total and soluble lead concentrations exists that would allow the prediction of soluble lead concentrations based on calculated UCLs. The statistical methods used are discussed in a book entitled *Statistical Methods for Environmental Pollution Monitoring,* by Richard Gilbert; in an EPA *Technology Support Center Issue* document entitled, *The Lognormal Distribution in Environmental Applications,* prepared by Ashok Singh et.al, dated December 1997; and in a book entitled *An Introduction to the Bootstrap,* by Bradley Efron and Robert J. Tibshirani.

D.1.1 Distribution of Total Lead Concentrations

The presence of non-detects and/or low concentrations in total lead data sets can strongly skew sample data towards low values. In these cases, the data is often lognormally distributed or nonparametric and classical statistical methods do not work properly since they assume that the data exhibit an underlying normal distribution. Consequently, it is necessary to evaluate the distributions of the total and lead data sets to apply the appropriate methods when determining the UCLs on the true total lead means. When evaluating the distribution of total lead concentrations, each sampling depth was treated as a separate data set.

D'Agostino's Test and the *W-Test* as described in Gilbert, were used to test the null hypothesis of underlying normal or lognormal distributions, or in other words, to test if either the non-transformed total lead data sets or the natural log-transformed total lead data sets are normally distributed. *D'Agostino's Test* was used on data sets with greater than 50 observations and *The W Test* was used on data sets with 50 or fewer observations. Each test was performed at the $\alpha = 0.05$ significance level and indicated the following in the tables below:

Utility and Demo Borings

Depth	Normal ?	Lognormal ?	Appropriate Method for UCL
Surface	Possibly	Possibly	Nonparametric Bootstrap
0.3 meter (1 foot) bgs	No	Possibly	Lognormal Theory Bootstrap
0.9 meter (3 feet) bgs	No	Possibly	Lognormal Theory Bootstrap
1.5 meters (4.9 feet) bgs	No	Possibly	Lognormal Theory Bootstrap

Other Borings

Depth	Normal ?	Lognormal ?	Appropriate Method for UCL
Surface	No	Possibly	Lognormal Theory Bootstrap
0.3 meter (1 foot) bgs	No	Possibly	Lognormal Theory Bootstrap
0.6 meter (2 feet) bgs	Possibly	No	Student's t Approach
0.9 meter (3 feet) bgs	No	Possibly	Lognormal Theory Bootstrap

Consequently, as indicated above, nonparametric Bootstrap techniques were used to calculate the UCLs for one data set, the Student's t approach was used to calculate the UCLs for one data set, and lognormal theory Bootstrap was used to calculate the UCLs for the remaining data sets. The data used and the calculations for *D'Agostinos Test* and the *W Test* are summarized as a portion of this appendix.

D.1.2 Calculating the UCLs for the True Mean

The upper one-sided 90% and 95% confidence limits (UCLs) of the true mean are defined as the values that, when calculated repeatedly for randomly drawn subsets of site data, equal or exceed the true mean 90% and 95% of the time, respectively. Statistical confidence limits are the classical tool for addressing uncertainties of a distribution mean. The UCLs of the true mean concentration are used as the mean concentrations because it is not possible to know the true mean due to the essentially infinite number of soil samples that could be collected from the site. The UCLs therefore account for uncertainties due to limited sampling data. As data become less limited at a site, uncertainties decrease and the UCLs move closer to the true mean.

The Bootstrap techniques used to calculate the UCLs are discussed in the previously referenced EPA document and in *An Introduction to the Bootstrap.* The UCLs summarized in the tables below:

Utility Trench and Demo Borings

Depth	90% UCL	95% UCL
Surface	116 mg/kg	120 mg/kg
0.3 meter (1 foot) bgs	264 mg/kg	291 mg/kg
0.9 meter (3 feet) bgs	482 mg/kg	546 mg/kg

Other Borings

Depth	90% UCL	95% UCL
Surface	413 mg/kg	447 mg/kg
0.3 meter (1 foot) bgs	442 mg/kg	481 mg/kg
0.6 meter (2 feet)	100 mg/kg	108 mg/kg
0.9 meter (3 feet) bgs	268 mg/kg	295 mg/kg

D.1.3 Correlation of Total and Soluble Lead

Total and corresponding soluble (WET) lead concentrations are bivariate data with a linear structure. This linear structure should allow for the prediction of soluble lead (WET) concentrations based on the UCLs calculated in above in Section D.1.2.

To estimate the degree of interrelation between total and corresponding soluble (WET) lead values (x and y, respectively), the *correlation coefficient [r]* is used (see Davis pg. 40). The correlation coefficient is a ratio that ranges from +1 to –1. A *correlation coefficient* of +1 indicates a perfect direct relationship between two variables; a *correlation coefficient* of -1 indicates that one variable changes inversely with relation to the other. Between the two extremes is a spectrum of less-than-perfect relationships, including zero, which indicates the lack of any sort of linear relationship at all.

The *correlation coefficient* was calculated for 146 (x, y) data points and equaled 0.61. According to the Department headquarters, a *correlation coefficient* greater than or equal to 0.8 is adequate evidence that an acceptable correlation exists. A review of the x-y scatter plot included herein shows a large amount of scatter and the correlation coefficient of 0.61 confirms the absence of a reliable correlation and regression line equation.

Since an acceptable correlation does not exist, the soluble (WET) lead concentrations were estimated assuming that all of the total lead is soluble. Or in other words, the soluble (WET) lead concentrations expected for each depth were determined by calculating one-tenth of the total lead UCL since the WET uses a 1:10 dilution ratio. Regression analysis results and a scatter plot depicting (x, y) data points

along with the regression lines are included as a portion of this appendix. In addition, the expected soluble lead concentrations are shown next to the UCLs in Table D1.

TABLE D1
LEAD STATISTICS
OAKLAND MOLE

90% and 95% UCLs using Bootstrap Techniques and Their Predicted Soluble (WET) Lead Concentrations**

Utility Trench and Demo Borings

Depth (feet bgs)	90% UCL* (mg/kg)	Predicted Soluble Lead (mg/l)	95% UCL** (mg/kg)	Predicted Soluble Lead (mg/l)
0	116	12	120	12
1	264	26	291	29
3	482	48	546	55

Other Borings

Depth (feet bgs)	90% UCL* (mg/kg)	Predicted Soluble Lead (mg/l)	95% UCL** (mg/kg)	Predicted Soluble Lead (mg/l)
0	413	41	447	45
1	442	44	481	48
2	100**	10	108**	11
3	268	27	295	30

Notes:

* = 90% UCL applicable if soil will be reused on-site

** = 95% UCL applicable if soil will be relinquished to contractor for re-use off-site

bgs = below the ground surface

mg/kg = milligrams per kilogram

mg/l = miligrams per liter

** = These UCLs were calculated using the Student's t approach since the population was likely normally distributed. The other UCLs were calculated using the standard Bootstrap based on lognormal distribution theory since the populations were likely lognormally distributed.

Soluble lead concentrations were predicted by assuming all the lead is soluble (i.e., 0.1(total lead) since the correlation was poor.

slope 0.1

Project Name: Oakland Mole
Project Number: E8000-06-13
Task Order Number:

Regression Analysis Results for Total Lead vs. Soluble Lead (WET)

Regression Output:

Constant (b)	0
Slope (m)	0.0827
Correlation (r)	0.61
Number of (x, y) Observations	146
Total Lead Mean	150
Total Lead Standard Error	10
Total Lead Standard Deviation	117
Soluble Lead (WET) Mean	13.8
Soluble Lead (WET) Standard Error	1.0
Soluble Lead (WET) Standard Deviation	12.2

Regression Line: $y = m(x) + b$, where x = total lead and y = soluble lead (WET)

D'AGOSTINOS TEST FOR NON-TRANSFORMED TOTAL LEAD CONCENTRATIONS
Surface Samples - Utility Trench and Demo Borings

Oakland Mole - NON TRANSFORMED

i	(x)	Ordered (xi)	(i-b)xi	(xi-Xmean)2
1	110	12	-366	7889.9511
2	130.0	12	-354	7889.9511
3	94	16	-456	7195.3479
4	46	22	-605	6213.4432
5	12	23	-609.5	6056.7924
6	110.0	28	-714	5303.5384
7	28.0	39	-955.5	3822.3797
8	16.0	39	-916.5	3822.3797
9	22	39	-877.5	3822.3797
10	12.0	39.0	-838.5	3822.3797
11	23	45	-922.5	3116.4749
12	62	46	-897	3005.8241
13	200	46	-851	3005.8241
14	170	50	-875	2583.221
15	300	51	-841.5	2482.5702
16	91	55	-852.5	2099.967
17	230	57.0	-826.5	1920.6654
18	280	59	-796.5	1749.3638
19	78	62	-775	1507.4114
20	140	62.0	-713	1507.4114
21	160	66	-693	1212.8083
22	120	66	-627	1212.8083
23	110	66.0	-561	1212.8083
24	66	67	-502.5	1144.1575
25	100	68	-442	1077.5067
26	66	68	-374	1077.5067

Oakland Mole - NON TRANSFORMED

D'Agostino's Test

Normal Test

Xmean	100.8
n	63
s	67.8176
D	0.276991
Y	-1.35107
β	31.5
SUM [(i-a)xi]	74557
SUM [(xi-Xmean)2]	289751.1

Significance Level	α/2	1-α/2
0.01	0.005	0.995
0.02	0.01	0.99
0.05	0.025	0.975
0.1	0.05	0.95
0.2	0.1	0.9

let a = 0.02 - for n = 63

Y0.01 = -3.360
Y0.99 = 1.236

Distribution may be normal since
-3.360 < -1.35 < 1.236

D'AGOSTINOS TEST FOR NON-TRANSFORMED TOTAL LEAD CONCENTRATIONS
Surface Samples - Other Borings

Oakland Mole - NON TRANSFORMED

i	(x)	Ordered (xi)	(i-b)xi	(xi-Xmean)2
1	290	2.5	-61.25	100139.98
2	36.0	5.6	-131.6	98187.608
3	1700	6.2	-139.5	97811.949
4	330	9.1	-195.65	96006.415
5	690	11	-225.5	94832.599
6	360.0	11	-214.5	94832.599
7	15.0	15	-277.5	92385.007
8	15.0	15	-262.5	92385.007
9	120	20	-330	89370.516
10	67.0	29	-449.5	84070.434
11	62	30	-435	83491.536
12	96	32	-432	82339.74
13	32	36	-450	80060.148
14	450	52.0	-598	71261.779
15	130	57	-598.5	68617.289
16	76	62	-589	66022.799
17	70	66	-561	63983.207
18	57	67.0	-502.5	63478.308
19	66	67	-435.5	63478.308
20	52	70.0	-385	61975.614
21	230	71	-319.5	61478.716
22	95	74.0	-259	60000.022
23	130	76	-190	59024.226
24	190	83	-124.5	55671.94
25	200	95	-47.5	50153.163
26	160	96	48	49706.265

Oakland Mole - NON TRANSFORMED

D'Agostino's Test

Normal Test

Xmean	318.9
n	51
s	914.8473
D	0.132523
Y	-35.6218
β	25.5
SUM [(i-a)xi]	315341.5
SUM [(xi-Xmean)2]	42684224

Significance Level	α/2	1-α/2
0.01	0.005	0.995
0.02	0.01	0.99
0.05	0.025	0.975
0.1	0.05	0.95
0.2	0.1	0.9

let a = 0.05 - for n = 51

Y0.025 = -2.8
Y0.975 = 1.04

Distribution is not normal since
-35.6 < -2.8

D'AGOSTINOS TEST FOR TRANSFORMED TOTAL LEAD CONCENTRATIONS
Surface Samples - Utility Trench and Demo Borings

Oakland Mole - LN TRANSFORMED

i	(x)	Ordered (xi	(i-b)xi	(xi-Xmean)2
1	4.7004804	2.48490665	-77.0321	3.5989457
2	4.8675345	2.48490665	-74.5472	3.5989457
3	4.5432948	2.77258872	-80.4051	2.5901899
4	3.8286414	3.09104245	-86.5492	1.6665595
5	2.4849066	3.13549422	-84.6583	1.5537652
6	4.7004804	3.33220451	-86.6373	1.1020609
7	3.3322045	3.66356165	-91.589	0.5161471
8	2.7725887	3.66356165	-87.9255	0.5161471
9	3.0910425	3.66356165	-84.2619	0.5161471
10	2.4849066	3.66356165	-80.5984	0.5161471
11	3.1354942	3.80666249	-79.9399	0.331008
12	4.1271344	3.8286414	-76.5728	0.3062007
13	5.2983174	3.8286414	-72.7442	0.3062007
14	5.1357984	3.91202301	-70.4164	0.2208741
15	5.7037825	3.93182563	-66.841	0.2026528
16	4.5108595	4.00733319	-64.1173	0.1403718
17	5.4380793	4.04305127	-60.6458	0.1148831
18	5.6347896	4.07753744	-57.0855	0.0926946
19	4.3567088	4.12713439	-53.6527	0.0649541
20	4.9416424	4.12713439	-49.5256	0.0649541
21	5.0751738	4.18965474	-46.0862	0.0369949
22	4.7874917	4.18965474	-41.8965	0.0369949
23	4.7004804	4.18965474	-37.7069	0.0369949
24	4.1896547	4.20469262	-33.6375	0.0314363
25	4.6051702	4.21950771	-29.5366	0.0264023
26	4.1896547	4.21950771	-25.317	0.0264023

Oakland Mole - LN TRANSFORMED

D'Agostino's Test

Lognormal Test

Xmean	4.4
n	63
s	0.7192
D	0.277559
Y	-1.20062
β	32
SUM [(i-a)xi]	792.3103
SUM [(xi-Xmean)2]	32.58804

Significance Level	α/2	1-α/2
0.01	0.005	0.995
0.02	0.01	0.99
0.05	0.025	0.975
0.1	0.05	0.95
0.2	0.1	0.9

let a = 0.02 - for n = 63

Y0.01 = -3.360
Y0.99 = 1.236

Distribution may be lognormal since
-3.360 < -1.20 < 1.236

D'AGOSTINOS TEST FOR TRANSFORMED TOTAL LEAD CONCENTRATIONS
Surface Samples - Other Borings

Oakland Mole - LN TRANSFORMED

i	(x)	Ordered (xi	(i-b)xi	(xi-Xmean)2
1	5.6698809	0.91629073	-22.9073	13.105868
2	3.5835189	1.7227666	-41.3464	7.9170588
3	7.4383835	1.82454929	-41.9646	7.3546411
4	5.7990927	2.20827441	-48.582	5.4206039
5	6.5366916	2.39789527	-50.3558	4.5736022
6	5.886104	2.39789527	-47.9579	4.5736022
7	2.7080502	2.7080502	-51.453	3.3432047
8	2.7080502	2.7080502	-48.7449	3.3432047
9	4.7874917	2.99573227	-50.9274	2.373945
10	4.2046926	3.36729583	-53.8767	1.3670231
11	4.1271344	3.40119738	-51.018	1.2888972
12	4.5643482	3.4657359	-48.5203	1.1465217
13	3.4657359	3.58351894	-46.5857	0.9081604
14	6.1092476	3.95124372	-47.4149	0.3425173
15	4.8675345	4.04305127	-44.4736	0.2434852
16	4.3307333	4.12713439	-41.2713	0.1675748
17	4.2484952	4.18965474	-37.7069	0.1202971
18	4.0430513	4.20469262	-33.6375	0.1100918
19	4.1896547	4.20469262	-29.4328	0.1100918
20	3.9512437	4.24849524	-25.491	0.082943
21	5.4380793	4.26267988	-21.3134	0.0749739
22	4.5538769	4.30406509	-17.2163	0.0540229
23	4.8675345	4.33073334	-12.9922	0.0423372
24	5.2470241	4.41884061	-8.83768	0.0138422
25	5.2983174	4.55387689	-4.55388	0.0003022
26	5.0751738	4.56434819	0	0.0007759

Oakland Mole - LN TRANSFORMED

D'Agostino's Test

Lognormal Test

Xmean	4.5
n	51
s	1.4930
D	0.275433
Y	-1.58662
β	26
SUM [(i-a)xi]	1069.551
SUM [(xi-Xmean)2]	113.674

Significance Level	α/2	1-α/2
0.01	0.005	0.995
0.02	0.01	0.99
0.05	0.025	0.975
0.1	0.05	0.95
0.2	0.1	0.9

let a = 0.05 - for n = 51

Y0.025 = -2.8
Y0.975 = 1.04

Distribution may be lognormal since
-2.8 < -1.59 < 1.04

PROJECT: Oakland Mole
DEPTH: 1 ft Utility Trench and Demo Borings

a	X{n-i+1}-X[i]	[i]	X (mean)	(x-X)^2	x
0.5539	658.0	1	162	258299	670
0.3325	407.0	2	162	2326	210
0.2412	332.0	3	162	12049	52
0.1707	184.0	4	162	332	180
0.1099	152.0	5	162	35431	350
0.0539	10.0	6	162	66683	420
0.0000	—	7	162	22132	13
—	—	8	162	22431	12
—	—	9	162	17894	28
—	—	10	162	9954	62
—	—	11	162	20670	18
—	—	12	162	18433	26
—	—	13	162	9954	62
—	—	14	—	—	
—	—	15	—	—	
—	—	16	—	—	
—	—	17	—	—	
—	—	18	—	—	
—	—	19	—	—	
—	—	20	—	—	
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—	—	26	—	—	
		27	—	—	
		28	—	—	
		29	—	—	
		30	—	—	
		31	—	—	
		32	—	—	
		33	—	—	
		34	—	—	
		35	—	—	
		36	—	—	
		37	—	—	
		38	—	—	
		39	—	—	
		40	—	—	

W-Test for total lead - normal dist

			sum list
d	496588		364.4662
n	13		135.3275
k	6		80.0784
W	0.796		31.4088
			16.7048
k(n even)	n/2	FALSE	0.539
k(n odd)	(n-1)/2	TRUE	0
			0
			0

PROJECT: Oakland Mole
DEPTH: 1 ft Utility Trench and Demo Borings

W-Test for total lead - lognormal dist?

a	Y{n-l+1}-Y[l]	l	Y (mean)	(y-Y)^2	y	sum list
0.5539	4.0	1	4.28	4.95	6.51	2.227991
0.3325	3.5	2	4.28	1.13	5.35	1.155539
0.2412	3.0	3	4.28	0.11	3.95	0.715776
0.1707	2.1	4	4.28	0.83	5.19	0.356594
0.1099	1.9	5	4.28	2.48	5.86	0.204497
0.0539	0.2	6	4.28	3.09	6.04	0.009481
0.0000	---	7	4.28	2.95	2.56	0
---	---	8	4.28	3.23	2.48	0
---	---	9	4.28	0.90	3.33	0
---	---	10	4.28	0.02	4.13	0
---	---	11	4.28	1.94	2.89	0
---	---	12	4.28	1.05	3.26	0
---	---	13	4.28	0.02	4.13	0
---	---	14	---	---		0
---	---	15	---	---		0
---	---	16	---	---		0
---	---	17	---	---		0
---	---	18	---	---		0
---	---	19	---	---		0
---	---	20	---	---		0
---	---	21	---	---		0
---	---	22	---	---		0
---	---	23	---	---		0
---	---	24	---	---		0
---	---	25	---	---		0
---	---	26	---	---		0
		27	---	---		0
		28	---	---		0
		29	---	---		
		30	---	---		
		31	---	---		
		32	---	---		
		33	---	---		
		34	---	---		
		35	---	---		
		36	---	---		
		37	---	---		
		38	---	---		
		39	---	---		
		40	---	---		

d 22.7135
n 13
k 6
W 0.960

k(n even) n/2 FALSE
k(n odd) (n-1)/2 TRUE

FOR n = 13 AND FOR a = 0.05
W0.05 = 0.866

SINCE 0.960 > 0.866

THE DISTRIBUTION MAY BE LOGNORMAL

PROJECT: Oakland Mole
DEPTH: 3 ft Utility Trench and Demo Borings

W-Test for total lead - lognormal dist?

a	Y{n-l+1}-Y[l]	l	Y (mean)	(y-Y)^2	y	sum list
0.5739	5.9	1	3.67	9.83	6.80	3.378035
0.3291	5.1	2	3.67	5.40	5.99	1.67024
0.2141	3.4	3	3.67	0.03	3.83	0.721608
0.1224	2.8	4	3.67	1.98	5.08	0.34781
0.0399	0.9	5	3.67	1.07	4.70	0.034786
---	---	6	3.67	7.57	0.92	0
---	---	7	3.67	3.85	1.70	0
---	---	8	3.67	7.57	0.92	0
---	---	9	3.67	1.26	4.79	0
---	---	10	3.67	2.96	1.95	0
---	---	11	---	---		0
---	---	12	---	---		0
---	---	13	---	---		0
---	---	14	---	---		0
---	---	15	---	---		0
---	---	16	---	---		0
---	---	17	---	---		0
---	---	18	---	---		0
---	---	19	---	---		0
---	---	20	---	---		0
---	---	21	---	---		0
---	---	22	---	---		0
---	---	23	---	---		0
---	---	24	---	---		0
---	---	25	---	---		0
---	---	26	---	---		0
		27	---	---		0
		28	---	---		0
		29	---	---		
		30	---	---		
		31	---	---		
		32	---	---		
		33	---	---		
		34	---	---		
		35	---	---		
		36	---	---		
		37	---	---		
		38	---	---		
		39	---	---		
		40	---	---		

d 41.51189
n 10
k 5
W 0.912

k(n even) n/2 TRUE
k(n odd) (n-1)/2 FALSE

FOR n = 10 AND FOR a = 0.05
W0.05 = 0.842

SINCE 0.912 > 0.842

THE DISTRIBUTION MAY BE LOGNORMAL

PROJECT: Oakland Mole
DEPTH: 4.9 ft Utility Trench and Demo Borings

W-Test for total lead - lognormal dist?

a	Y{n-l+1}-Y[l]	l	Y (mean)	(y-Y)^2	y	sum list
0.6872	5.2	1	2.37	1.00	3.37	3.5686
0.1677	2.5	2	2.37	5.61	0.00	0.411034
---	---	3	2.37	2.11	0.92	0
---	---	4	2.37	7.97	5.19	0
---	---	5	---	---		0
---	---	6	---	---		0
---	---	7	---	---		0
---	---	8	---	---		0
---	---	9	---	---		0
---	---	10	---	---		0
---	---	11	---	---		0
---	---	12	---	---		0
---	---	13	---	---		0
---	---	14	---	---		0
---	---	15	---	---		0
---	---	16	---	---		0
---	---	17	---	---		0
---	---	18	---	---		0
---	---	19	---	---		0
---	---	20	---	---		0
---	---	21	---	---		0
---	---	22	---	---		0
---	---	23	---	---		0
---	---	24	---	---		0
---	---	25	---	---		0
---	---	26	---	---		0
		27	---	---		0
		28	---	---		0
		29	---	---		
		30	---	---		
		31	---	---		
		32	---	---		
		33	---	---		
		34	---	---		
		35	---	---		
		36	---	---		
		37	---	---		
		38	---	---		
		39	---	---		
		40	---	---		

d 16.694
n 4
k 2
W 0.949

k(n even) n/2 TRUE
k(n odd) (n-1)/2 FALSE

FOR n = 4 AND FOR a = 0.05
W0.05 = 0.748

SINCE 0.949 > 0.748

THE DISTRIBUTION MAY BE LOGNORMAL

PROJECT: Oakland Mole
DEPTH: 1 ft Other Borings

a	X(n-i+1)-X[i]	[i]	X (mean)	(x-X)^2	x
0.3989	3497.5	1	331	26023	170
0.2755	2393.7	2	331	2633	280
0.2380	1493.0	3	331	3444	390
0.2104	1490.5	4	331	10040562	3500
0.1880	441.0	5	331	1365824	1500
0.1689	360.0	6	331	1365824	1500.0
0.1520	280.0	7	331	108120	2.5
0.1366	238.0	8	331	70392	66.0
0.1225	215.0	9	331	44654	120
0.1092	135.0	10	331	79138	50
0.0967	130.0	11	331	75249	57
0.0848	120.0	12	331	76904	54
0.0733	106.0	13	331	44654	120
0.0622	95.0	14	331	90791	30
0.0515	63.0	15	331	48980	110
0.0409	54.0	16	331	76350	55
0.0305	52.0	17	331	81976	45
0.0203	50.0	18	331	81976	45
0.0101	29.0	19	331	128	320
0.0000	---	20	331	84865	40
---	---	21	331	44654	120
---	---	22	331	22896	180
---	---	23	331	61165	84
---	---	24	331	62658	81
---	---	25	331	103565	10
---	---	26	331	44654	120.0
		27	331	105180	7
		28	331	105635	6.3
		29	331	69335	68.00
		30	331	79138	50
		31	331	29349	160
		32	331	5086	260
		33	331	16560	460
		34	331	4279456	2400
		35	331	83703	42
		36	331	97541	19
		37	331	32875	150.0
		38	331	22896	180
		39	331	68286	70.0
		40	---	---	

W-Test for total lead - normal dist

			sum list
d	1.9E+07		1395.153
n	39		659.4644
k	19		355.334
W	0.480		313.6012
			82.908
k(n even)	n/2	FALSE	60.804
k(n odd)	(n-1)/2	TRUE	42.56
			32.5108
			26.3375
			14.742
			12.571
			10.176
			7.7698
			5.909
			3.2445
			2.2086
			1.586
			1.015
			0.2929
			0
			0
			0
			0
			0
			0
			0
			0

FOR n = 39 AND FOR a = 0.05
W0.05 = 0.939

SINCE 0.480 < 0.939

THE DISTRIBUTION IS NOT NORMAL

PROJECT: Oakland Mole
DEPTH: 2 ft Other Borings

a	X(n-i+1)-X	[i]	X (mean)	(x-X)^2	x
0.5888	147.5	1	77	5575	2.5
0.3244	92.0	2	77	1534	38.0
0.1976	88.0	3	77	17	73.0
0.0947	16.0	4	77	27	72.0
0.0000	---	5	77	2791	130.0
---	---	6	77	5305	130.0
---	---	7	77	1237	42.0
---	---	8	77	407	57.0
---	---	9	77	2791	130.0
---	---	10	---	---	
---	---	11	---	---	
---	---	12	---	---	
---	---	13	---	---	
---	---	14	---	---	
---	---	15	---	---	
---	---	16	---	---	
---	---	17	---	---	
---	---	18	---	---	
---	---	19	---	---	
---	---	20	---	---	
---	---	21	---	---	
---	---	22	---	---	
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---	---	25	---	---	
---	---	26	---	---	
---	---	27	---	---	
---	---	28	---	---	
---	---	29	---	---	
---	---	30	---	---	
---	---	31	---	---	
---	---	32	---	---	
---	---	33	---	---	
---	---	34	---	---	
---	---	35	---	---	
---	---	36	---	---	
---	---	37	---	---	
---	---	38	---	---	
---	---	39	---	---	
---	---	40	---	---	

W-Test for total lead - normal dist

			sum list
d	19684		86.848
n	9		29.8448
k	4		17.3888
W	0.934		1.5152
			0
k(n even)	n/2	FALSE	0
k(n odd)	(n-1)/2	TRUE	0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

FOR n = 9 AND FOR a = 0.05
W0.05 = 0.829

SINCE 0.934 > 0.829

THE DISTRIBUTION MAY BE NORMAL

PROJECT: Oakland Mole
DEPTH: 3 ft Other Borings

a	X(n-i+1)-X[i]	/	X (mean)	(x-X)^2	x
0.4968	1096.5	1	157	8721	250
0.3273	372.1	2	157	276	140
0.2540	242.0	3	157	19213	18
0.1988	166.0	4	157	49902	380
0.1534	122.0	5	157	15778	31
0.1109	99.0	6	157	8763	63
0.0725	73.0	7	157	1340	120
0.0359	50.0	8	157	708	130
0.0000	---	9	157	2173	110
---	---	10	157	22085	8
---	---	11	157	22115	8
---	---	12	157	23443	4
---	---	13	157	9334	60
---	---	14	157	12015	47
---	---	15	157	547	180
---	---	16	157	20338	14
---	---	17	157	889981	1100
---	---	18	---	---	
---	---	19	---	---	
---	---	20	---	---	
---	---	21	---	---	
---	---	22	---	---	
---	---	23	---	---	
---	---	24	---	---	
---	---	25	---	---	
---	---	26	---	---	
		27	---	---	
		28	---	---	
		29	---	---	
		30	---	---	
		31	---	---	
		32	---	---	
		33	---	---	
		34	---	---	
		35	---	---	
		36	---	---	
		37	---	---	
		38	---	---	
		39	---	---	
		40	---	---	

W-Test for total lead - normal dist

			sum list
d	1106734		544.7412
n	17		121.7883
k	8		61.468
W	0.5751		33.0008
			18.7148
k(n even)	n/2	FALSE	10.9791
k(n odd)	(n-1)/2	TRUE	5.2925
			1.795
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

FOR n = 17 AND FOR a = 0.05
W0.05 = 0.892

SINCE 0.575 < 0.892

THE DISTRIBUTION IS NOT NORMAL

PROJECT: Oakland Mole
DEPTH: 1 ft Other Borings

a	Y(n-l+1)-Y[l]	l	Y (mean)	(y-Y)^2	y
0.3989	7.2	1	4.58	0.30	5.14
0.2755	5.9	2	4.58	1.10	5.63
0.2380	5.4	3	4.58	1.91	5.97
0.2104	5.1	4	4.58	12.79	8.16
0.1880	3.2	5	4.58	7.45	7.31
0.1689	2.6	6	4.58	7.45	7.31
0.1520	2.1	7	4.58	13.45	0.92
0.1366	1.9	8	4.58	0.16	4.19
0.1225	1.8	9	4.58	0.04	4.79
0.1092	1.4	10	4.58	0.45	3.91
0.0967	1.3	11	4.58	0.29	4.04
0.0848	1.2	12	4.58	0.35	3.99
0.0733	1.1	13	4.58	0.04	4.79
0.0622	1.0	14	4.58	1.40	3.40
0.0515	0.7	15	4.58	0.01	4.70
0.0409	0.6	16	4.58	0.33	4.01
0.0305	0.6	17	4.58	0.60	3.81
0.0203	0.5	18	4.58	0.60	3.81
0.0101	0.3	19	4.58	1.40	5.77
0.0000	---	20	4.58	0.80	3.69
---	---	21	4.58	0.04	4.79
---	---	22	4.58	0.37	5.19
---	---	23	4.58	0.02	4.43
---	---	24	4.58	0.04	4.39
---	---	25	4.58	5.44	2.25
---	---	26	4.58	0.04	4.79
		27	4.58	6.96	1.95
		28	4.58	7.53	1.8405496
		29	4.58	0.13	4.22
		30	4.58	0.45	3.912023
		31	4.58	0.24	5.0751738
		32	4.58	0.95	5.5606816
		33	4.58	2.39	6.131226
		34	4.58	10.24	7.783224
		35	4.58	0.72	3.7376696
		36	4.58	2.69	2.944439
		37	4.58	0.18	5.0
		38	4.58	0.37	5.1929569
		39	4.58	0.11	4.2
		40	---	---	

W-Test for total lead - lognormal dist?

			sum list
d	89.87284		2.889722
n	39		1.637207
k	19		1.27742
W	0.964		1.06503
			0.599116
k(n even)	n/2	FALSE	0.43322
k(n odd)	(n-1)/2	TRUE	0.316075
			0.259147
			0.214867
			0.151383
			0.123866
			0.103776
			0.079618
			0.062405
			0.038339
			0.024452
			0.017324
			0.010942
			0.003091
			0
			0
			0
			0
			0
			0
			0
			0

FOR n = 39 AND FOR a = 0.05

W0.05 = 0.939

SINCE 0.964 > 0.939

THE DISTRIBUTION MAY BE LOGNORMAL

PROJECT: Oakland Mole
DEPTH: 2 ft Other Borings

a	Y(n-l+1)-Y[l]	l	Y (mean)	(y-Y)^2	y
0.5888	4.1	1	3.96	9.27	0.92
0.3244	1.2	2	3.96	0.10	3.64
0.1976	1.1	3	3.96	0.11	4.29
0.0947	0.2	4	3.96	0.10	4.28
0.0000	---	5	3.96	0.82	4.87
---	---	6	3.96	1.10	5.01
---	---	7	3.96	0.05	3.74
---	---	8	3.96	0.01	4.04
---	---	9	3.96	0.82	4.87
---	---	10	---	---	
---	---	11	---	---	
---	---	12	---	---	
---	---	13	---	---	
---	---	14	---	---	
---	---	15	---	---	
---	---	16	---	---	
---	---	17	---	---	
---	---	18	---	---	
---	---	19	---	---	
---	---	20	---	---	
---	---	21	---	---	
---	---	22	---	---	
---	---	23	---	---	
---	---	24	---	---	
---	---	25	---	---	
---	---	26	---	---	
		27	---	---	
		28	---	---	
		29	---	---	
		30	---	---	
		31	---	---	
		32	---	---	
		33	---	---	
		34	---	---	
		35	---	---	
		36	---	---	
		37	---	---	
		38	---	---	
		39	---	---	
		40	---	---	

W-Test for total lead - lognormal dist?

			sum list
d	12.385		2.41075
n	9		0.398995
k	4		0.223261
W	0.754		0.02343
			0
k(n even)	n/2	FALSE	0
k(n odd)	(n-1)/2	TRUE	0
			0
			0
			0
			0
			0
			0

DESCRIPTION OF DATA SET

Oakland Mole - Utility and Demo (surface)

DATA SET STATISTICS

Number of Samples	63
Arithemetic Mean	101
Standard Deviation (x)	68
MVUE Mean	104
Bootstrap Estimate of Population Mean	101
Bootstrap Estimate of Standard Error	9
Bootstrap Estimate of Population Mean (MVUE)	104
Bootstrap Estimate of Standard Error (MVUE)	10

NONPARAMETRIC BOOTSTRAP

Bootstrap Type	**90%UCL**	**95%UCL**
Percentile Bootstrap	113	116
Pivotal (t) Bootstrap	114	117
Standard Bootstrap	112	115

LOGNORMAL THEORY BOOTSTRAP

Bootstrap Type	**90%UCL**	**95%UCL**
Percentile Bootstrap	117	121
Standard Bootstrap	116	120

DESCRIPTION OF DATA SET

Oakland Mole - Utility and Demo (1 foot)

DATA SET STATISTICS

Number of Samples	13
Arithemetic Mean	162
Standard Deviation (x)	203
MVUE Mean	166
Bootstrap Estimate of Population Mean	162
Bootstrap Estimate of Standard Error	56
Bootstrap Estimate of Population Mean (MVUE)	170
Bootstrap Estimate of Standard Error (MVUE)	74

NONPARAMETRIC BOOTSTRAP

Bootstrap Type	**90%UCL**	**95%UCL**
Percentile Bootstrap	239	264
Pivotal (t) Bootstrap	281	359
Standard Bootstrap	234	255

LOGNORMAL THEORY BOOTSTRAP

Bootstrap Type	**90%UCL**	**95%UCL**
Percentile Bootstrap	273	304
Standard Bootstrap	264	291

DESCRIPTION OF DATA SET

Oakland Mole - Utility and Demo (3 feet)

DATA SET STATISTICS

Number of Samples	10
Arithemetic Mean	175
Standard Deviation (x)	282
MVUE Mean	235
Bootstrap Estimate of Population Mean	178
Bootstrap Estimate of Standard Error	85
Bootstrap Estimate of Population Mean (MVUE)	256
Bootstrap Estimate of Standard Error (MVUE)	176

NONPARAMETRIC BOOTSTRAP

Bootstrap Type	90%UCL	95%UCL
Percentile Bootstrap	297	328
Pivotal (t) Bootstrap	578	748
Standard Bootstrap	288	318

LOGNORMAL THEORY BOOTSTRAP

Bootstrap Type	90%UCL	95%UCL
Percentile Bootstrap	469	603
Standard Bootstrap	482	546

DESCRIPTION OF DATA SET

Oakland Mole - Other Borings (surface)

DATA SET STATISTICS

Number of Samples	51
Arithemetic Mean	319
Standard Deviation (x)	924
MVUE Mean	278
Bootstrap Estimate of Population Mean	322
Bootstrap Estimate of Standard Error	133
Bootstrap Estimate of Population Mean (MVUE)	294
Bootstrap Estimate of Standard Error (MVUE)	93

NONPARAMETRIC BOOTSTRAP

Bootstrap Type	90%UCL	95%UCL
Percentile Bootstrap	504	574
Pivotal (t) Bootstrap	877	1055
Standard Bootstrap	492	540

LOGNORMAL THEORY BOOTSTRAP

Bootstrap Type	90%UCL	95%UCL
Percentile Bootstrap	411	466
Standard Bootstrap	413	447

DESCRIPTION OF DATA SET

Oakland Mole - Other Borings (1 foot)

DATA SET STATISTICS

Number of Samples	39
Arithemetic Mean	331
Standard Deviation (x)	709
MVUE Mean	300
Bootstrap Estimate of Population Mean	331
Bootstrap Estimate of Standard Error	113
Bootstrap Estimate of Population Mean (MVUE)	304
Bootstrap Estimate of Standard Error (MVUE)	107

NONPARAMETRIC BOOTSTRAP

Bootstrap Type	**90%UCL**	**95%UCL**
Percentile Bootstrap	476	530
Pivotal (t) Bootstrap	558	691
Standard Bootstrap	476	517

LOGNORMAL THEORY BOOTSTRAP

Bootstrap Type	**90%UCL**	**95%UCL**
Percentile Bootstrap	432	493
Standard Bootstrap	442	481

DESCRIPTION OF DATA SET

Oakland Mole - Other Borings (2 feet)

DATA SET STATISTICS

Number of Samples	9
Arithemetic Mean	77
Standard Deviation (x)	50

UCL (Normal Distribution)

Type	90%UCL	95%UCL
Student's t	100	108

DESCRIPTION OF DATA SET

Oakland Mole - Other Borings (3 feet)

DATA SET STATISTICS

Number of Samples	17
Arithemetic Mean	157
Standard Deviation (x)	263
MVUE Mean	169
Bootstrap Estimate of Population Mean	160
Bootstrap Estimate of Standard Error	63
Bootstrap Estimate of Population Mean (MVUE)	173
Bootstrap Estimate of Standard Error (MVUE)	74

NONPARAMETRIC BOOTSTRAP

Bootstrap Type	90%UCL	95%UCL
Percentile Bootstrap	244	275
Pivotal (t) Bootstrap	395	498
Standard Bootstrap	240	263

LOGNORMAL THEORY BOOTSTRAP

Bootstrap Type	90%UCL	95%UCL
Percentile Bootstrap	268	309
Standard Bootstrap	268	295