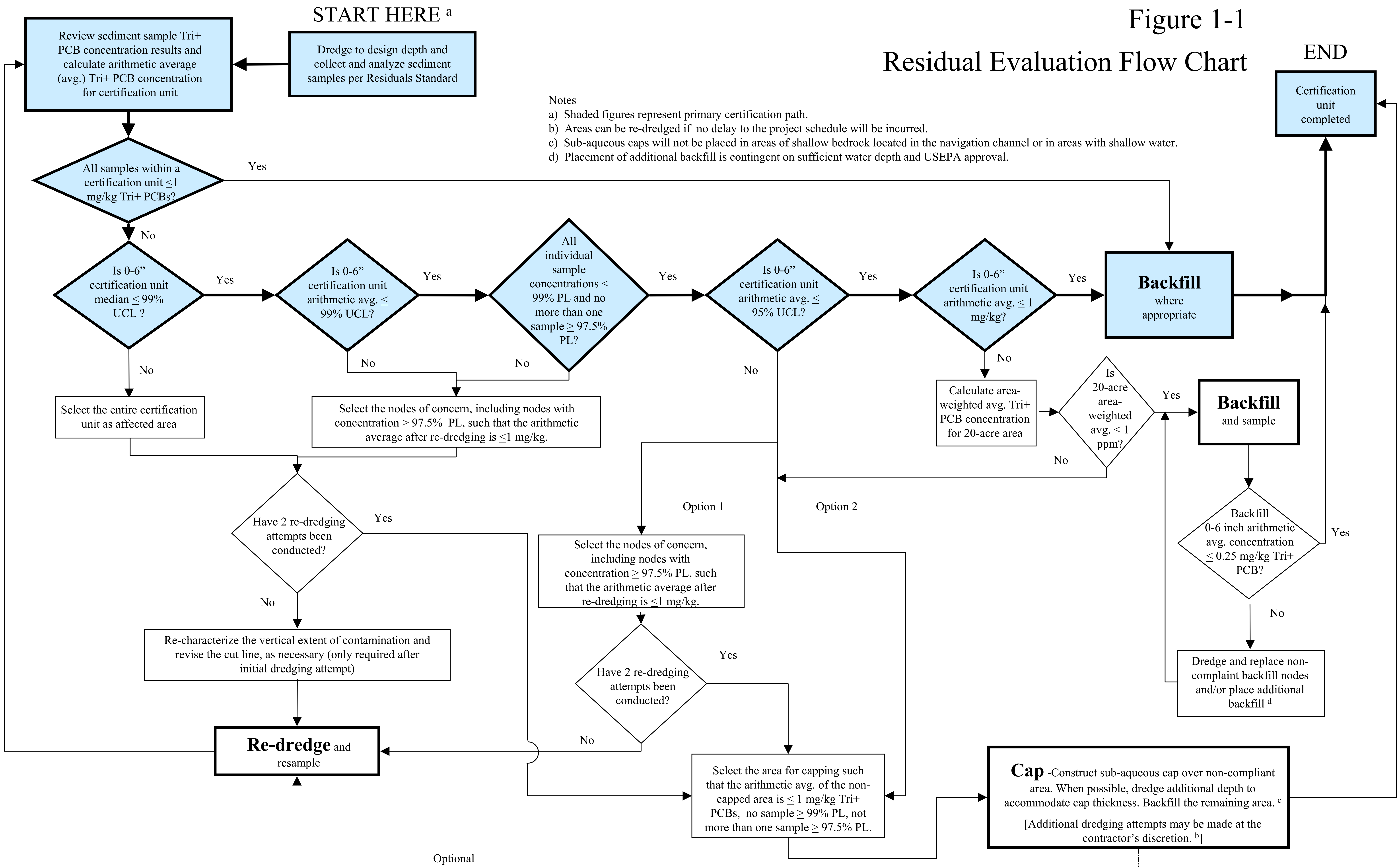
Figures

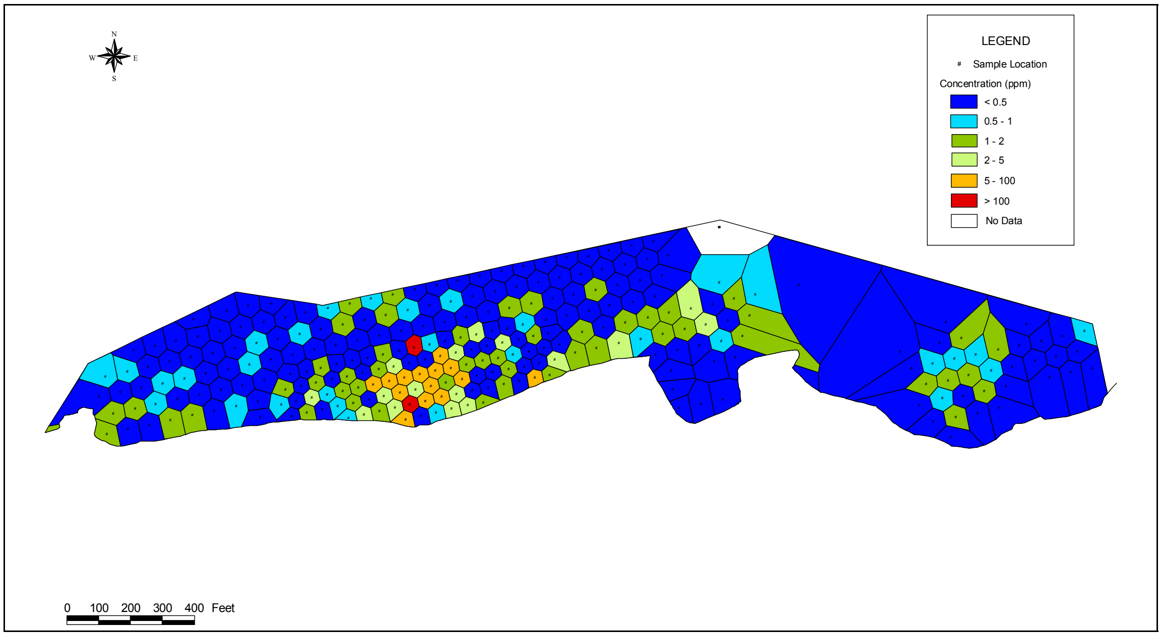
Figure 1-1

Residual Evaluation Flow Chart

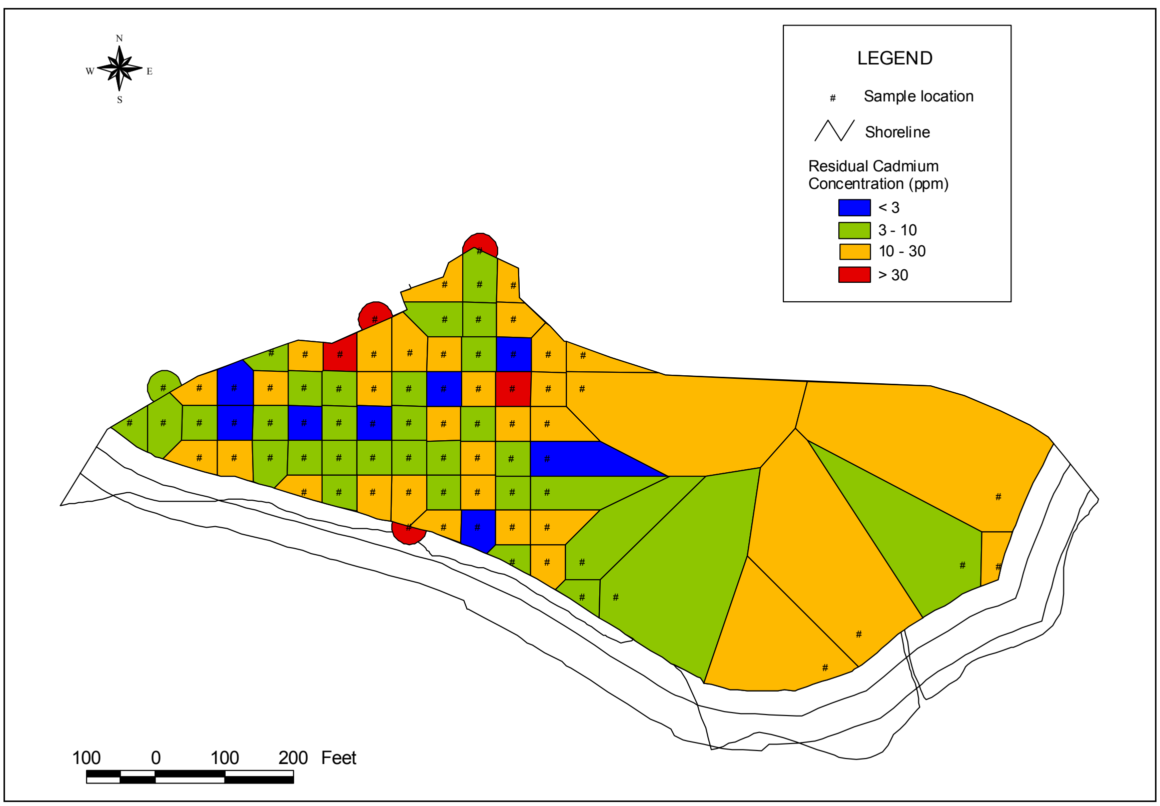


Notes
a) Shaded figures represent primary certification path.
b) Areas can be re-dredged if no delay to the project schedule will be incurred.
c) Sub-aqueous caps will not be placed in areas of shallow bedrock located in the navigation channel or in areas with shallow water.
d) Placement of additional backfill is contingent on sufficient water depth and USEPA approval.

Figure 2-1
Polygonal Declustering for Case Study Sites

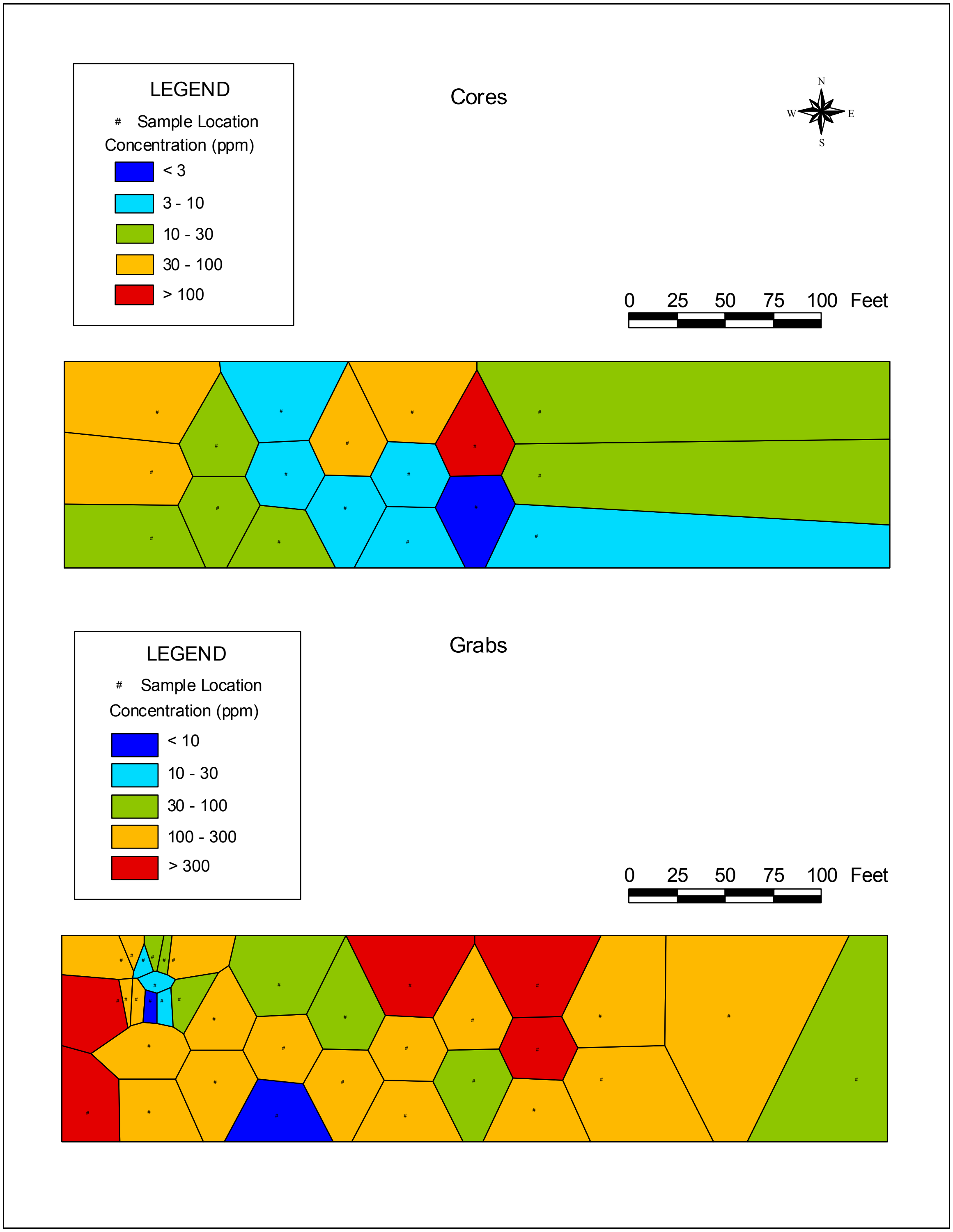


Reynolds Metals



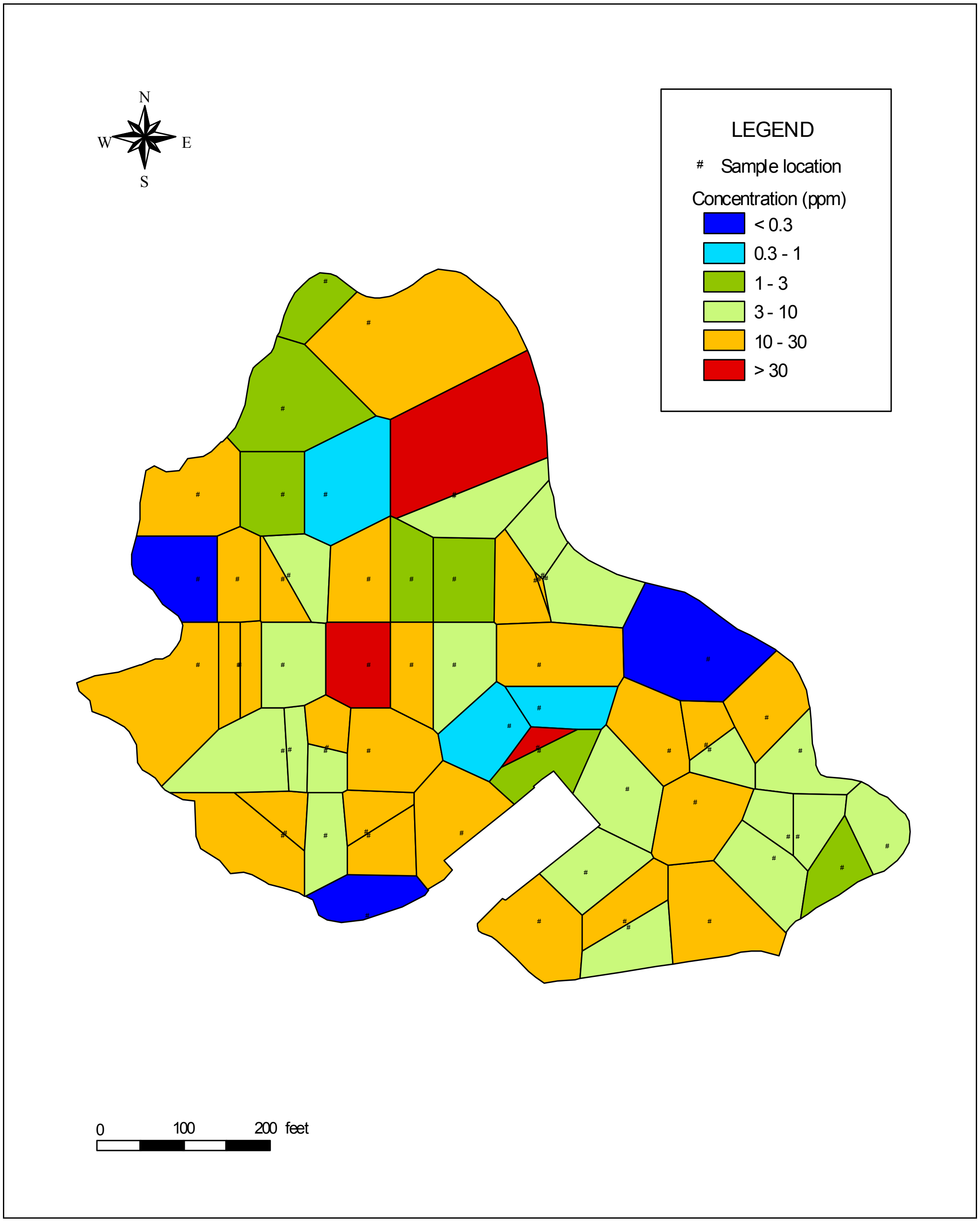
Marathon Battery East Foundry Cove

Figure 2-1
Polygonal Declustering for Case Study Sites



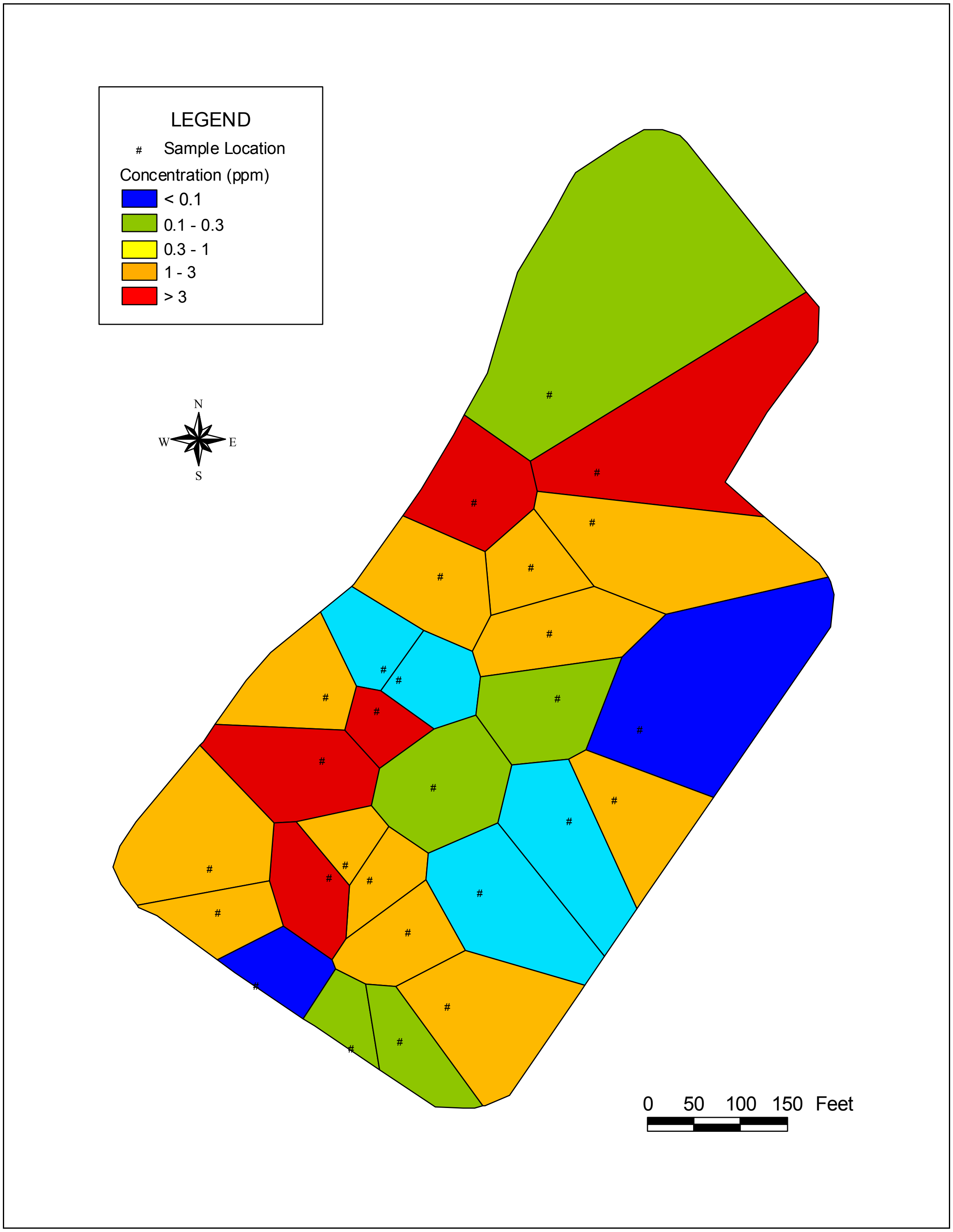
New Bedford Harbor

Figure 2-1
Polygonal Declustering for Case Study Sites



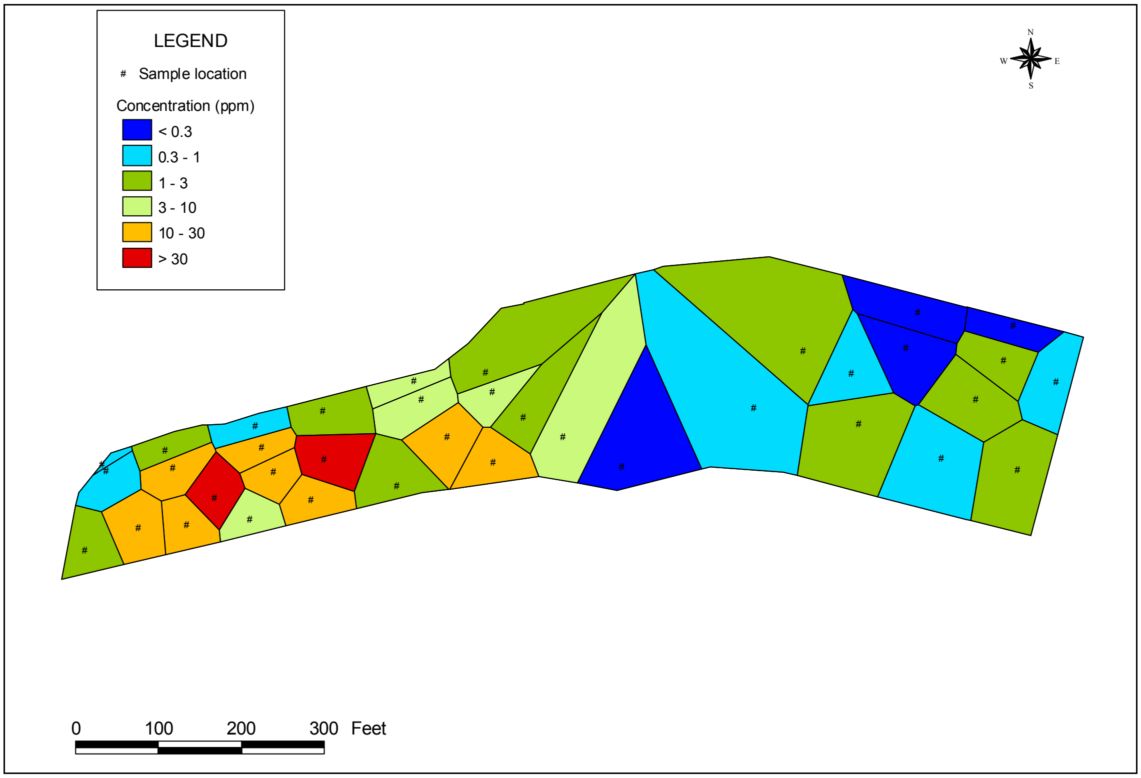
Cumberland Bay

Figure 2-1
Polygonal Declustering for Case Study Sites

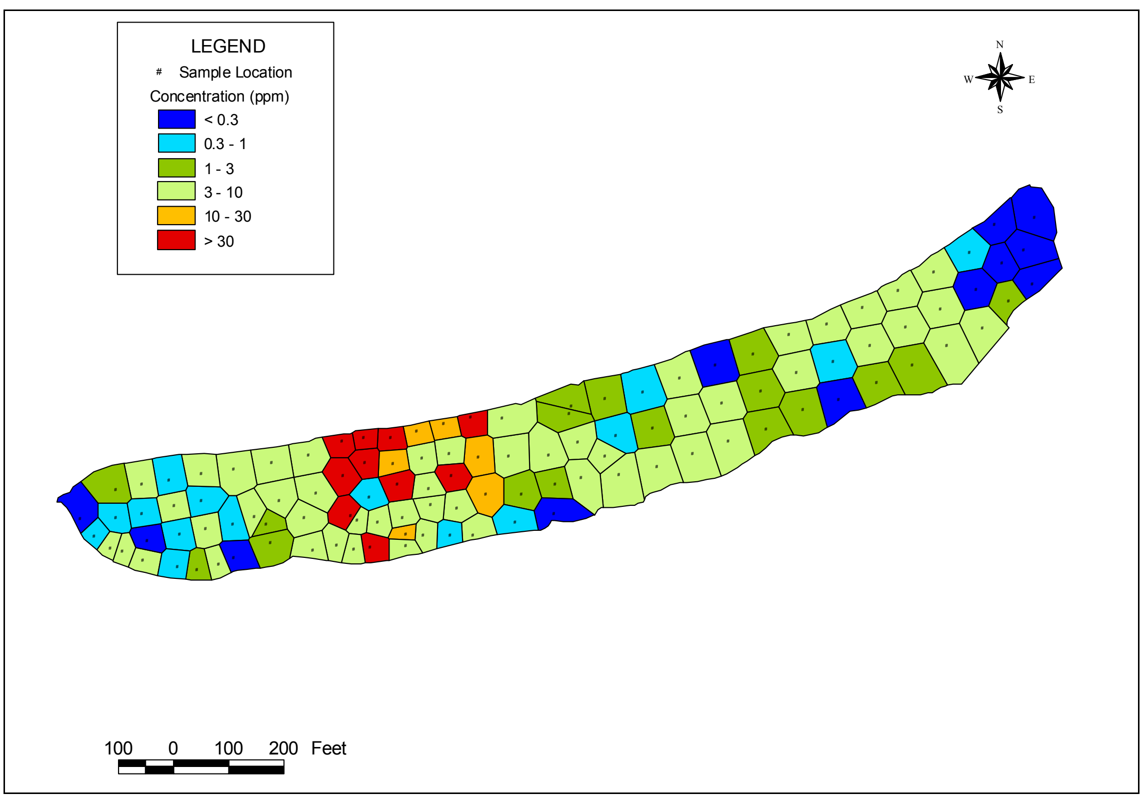


Fox River SMUs 56/57

Figure 2-1
Polygonal Declustering for Case Study Sites



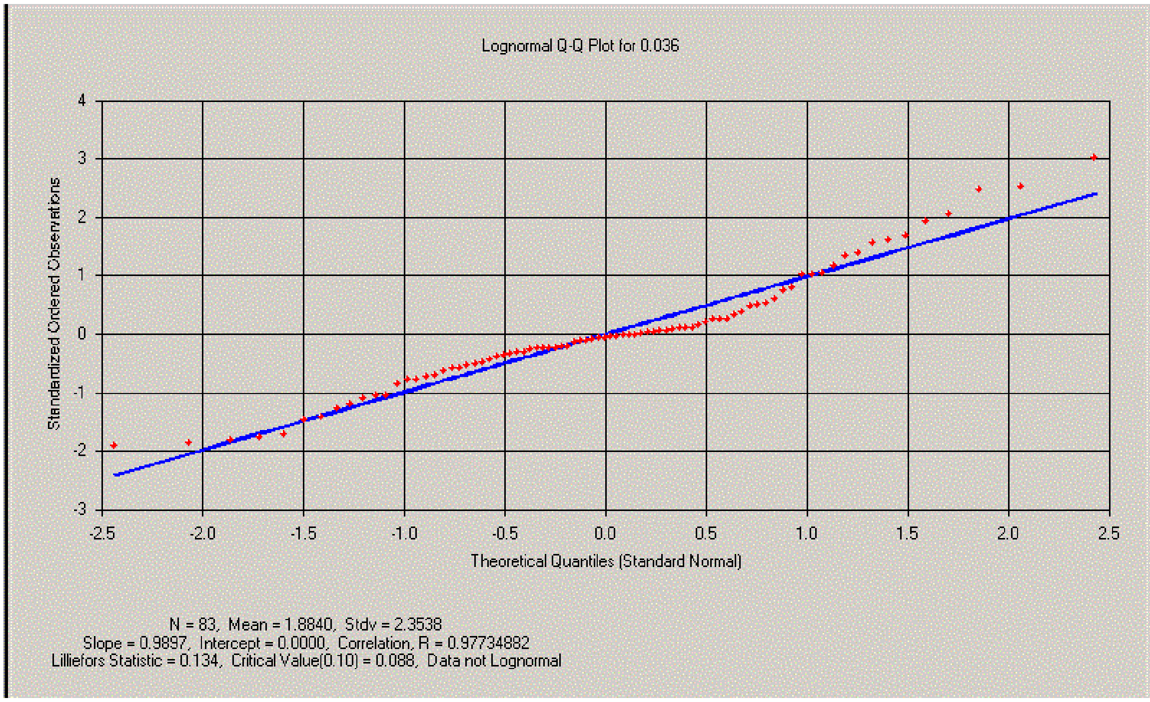
Fox River Deposition N



GM Massena

Figure 2-2
Q-Q Plots – Test for Lognormal or Approximately Lognormal Distributions (alpha=0.10)

GM Massena Pass 1



GM Massena Pass 2

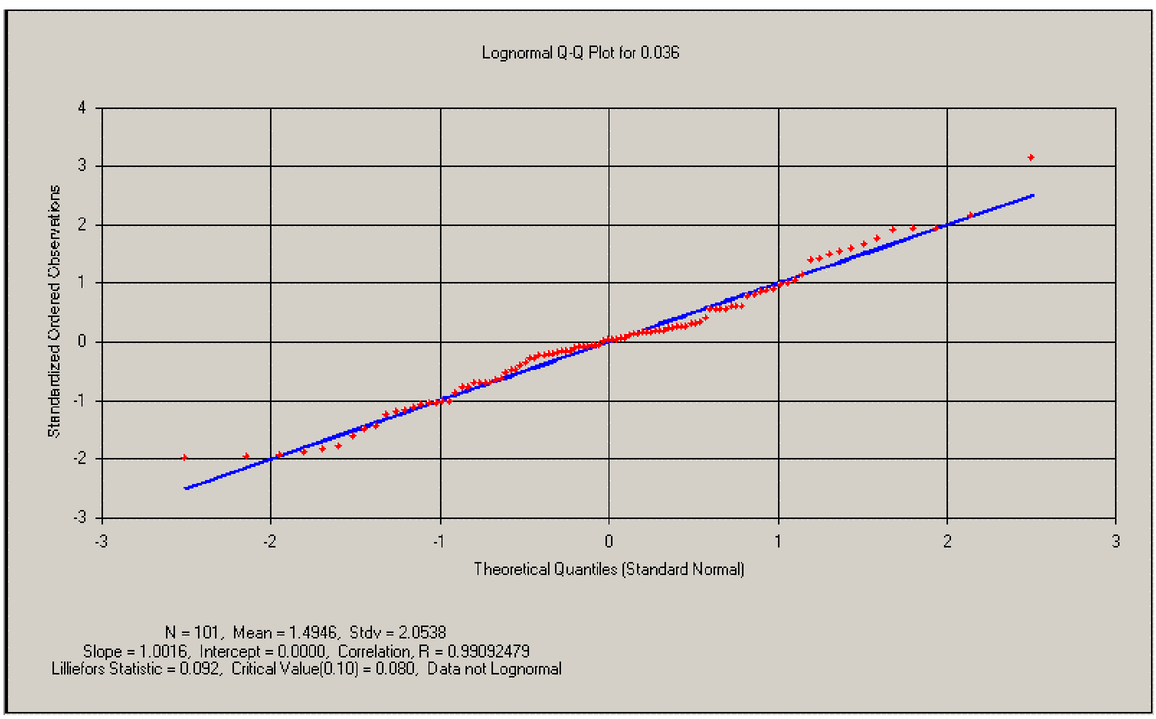
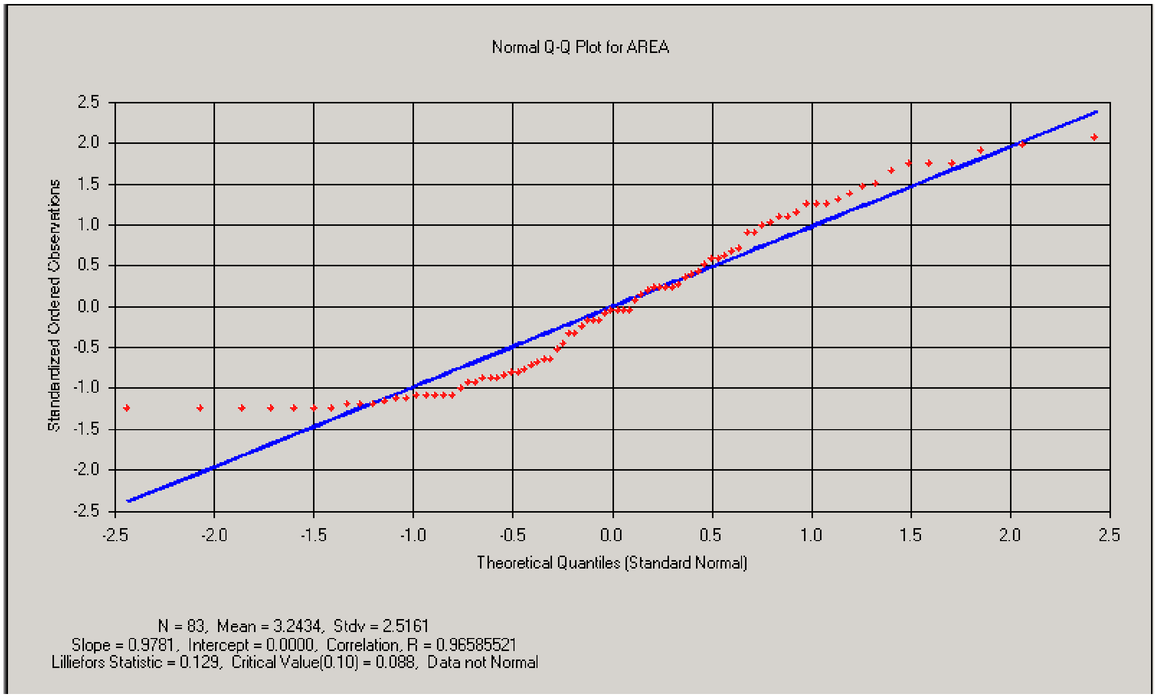


Figure 2-2
Q-Q Plots – Test for Lognormal or Approximately Lognormal Distributions (alpha=0.10)

GM Massena Uncapped Area



Reynolds Metals

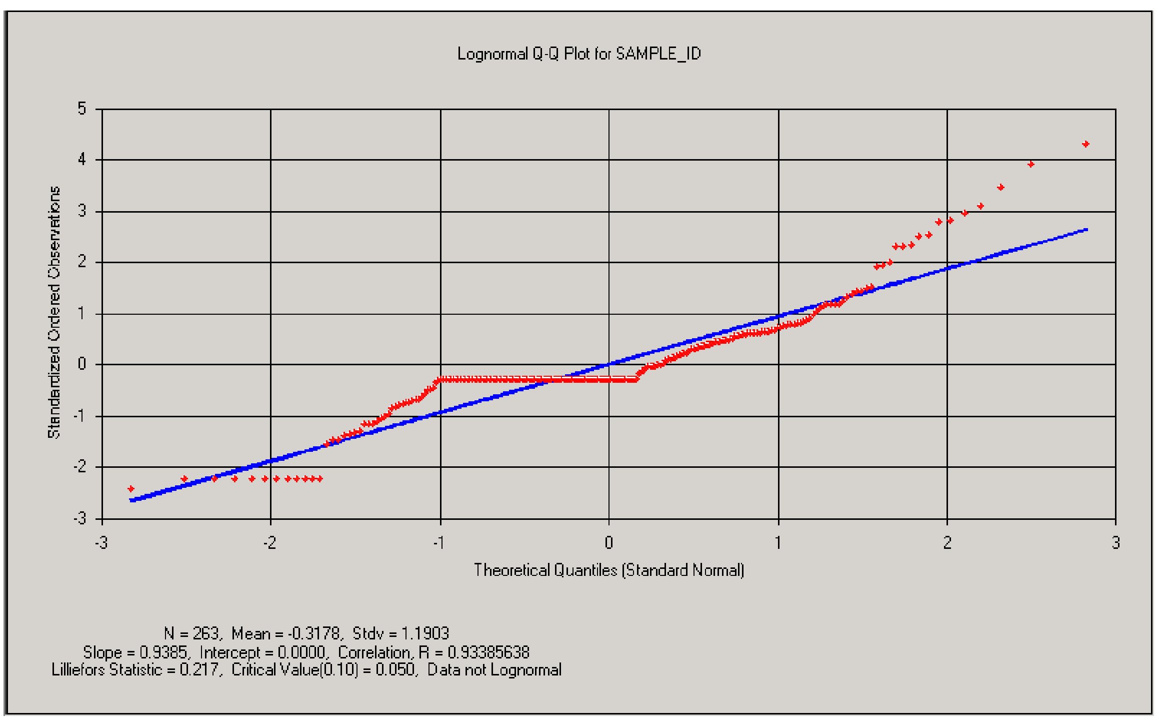
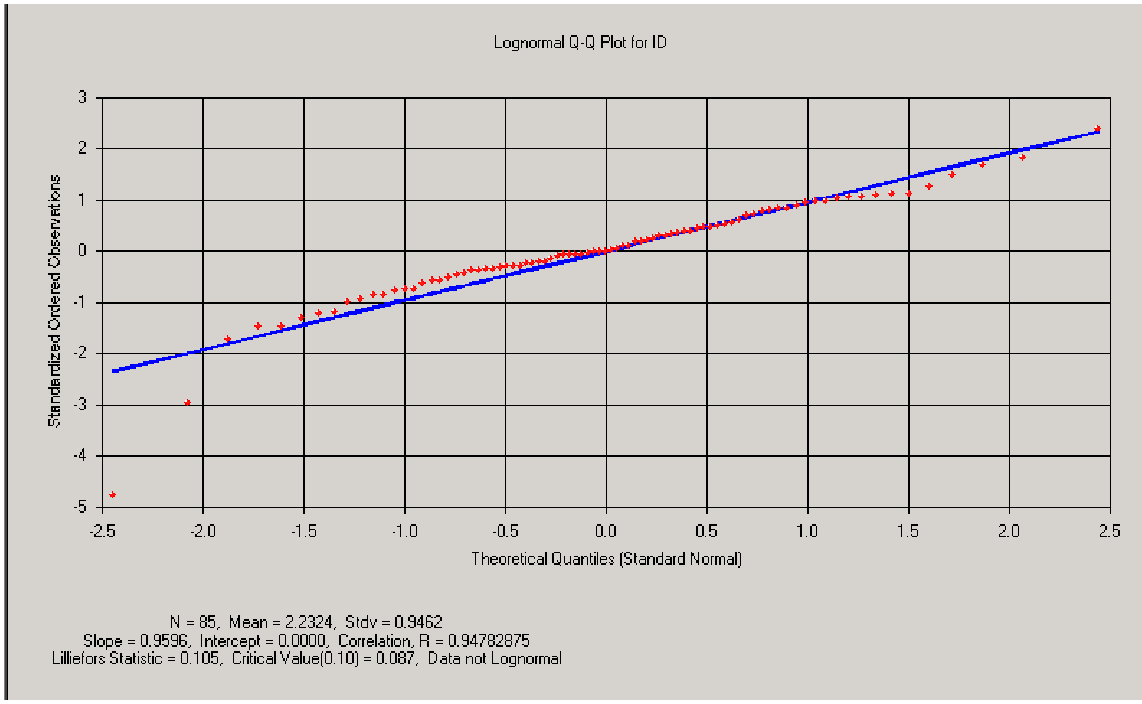


Figure 2-2
Q-Q Plots – Test for Lognormal or Approximately Lognormal Distributions (alpha=0.10)

Marathon Battery



New Bedford Harbor 0-1'

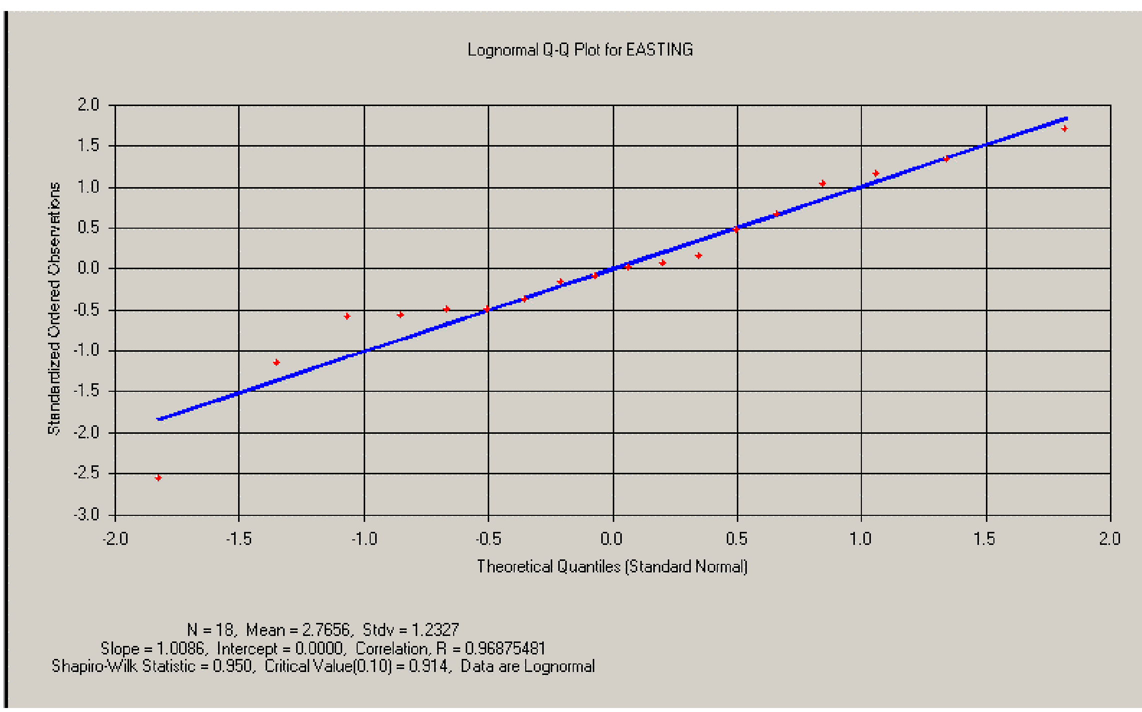
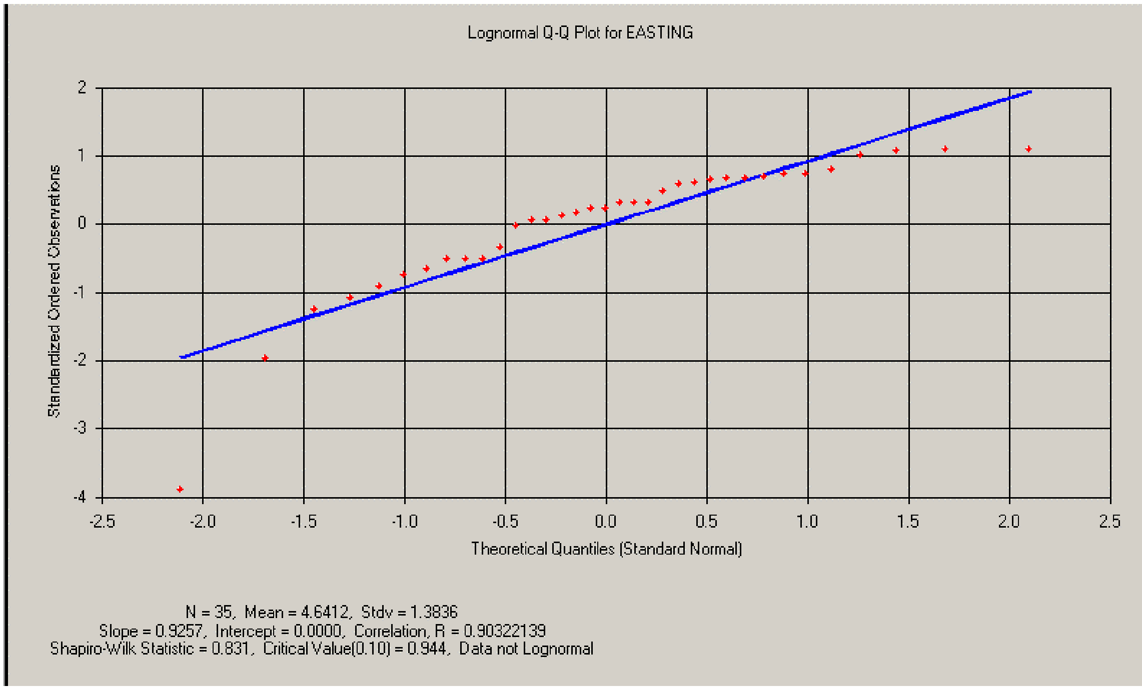


Figure 2-2
Q-Q Plots – Test for Lognormal or Approximately Lognormal Distributions (alpha=0.10)

New Bedford Harbor 0-2 cm



Cumberland Bay

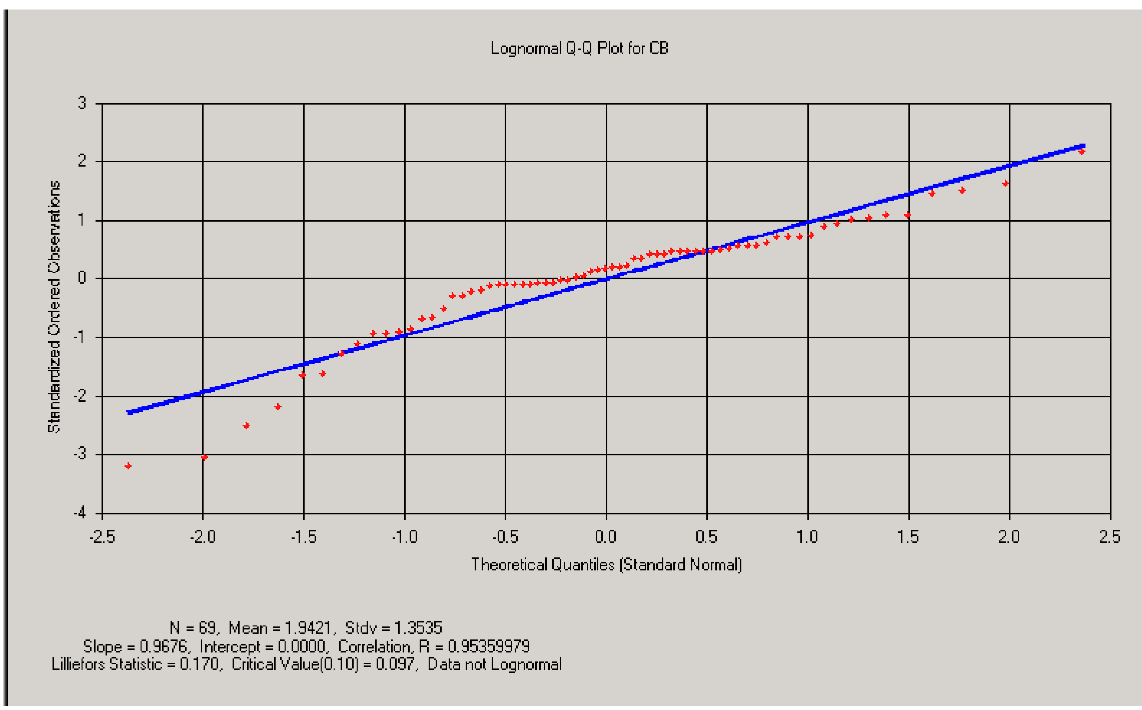
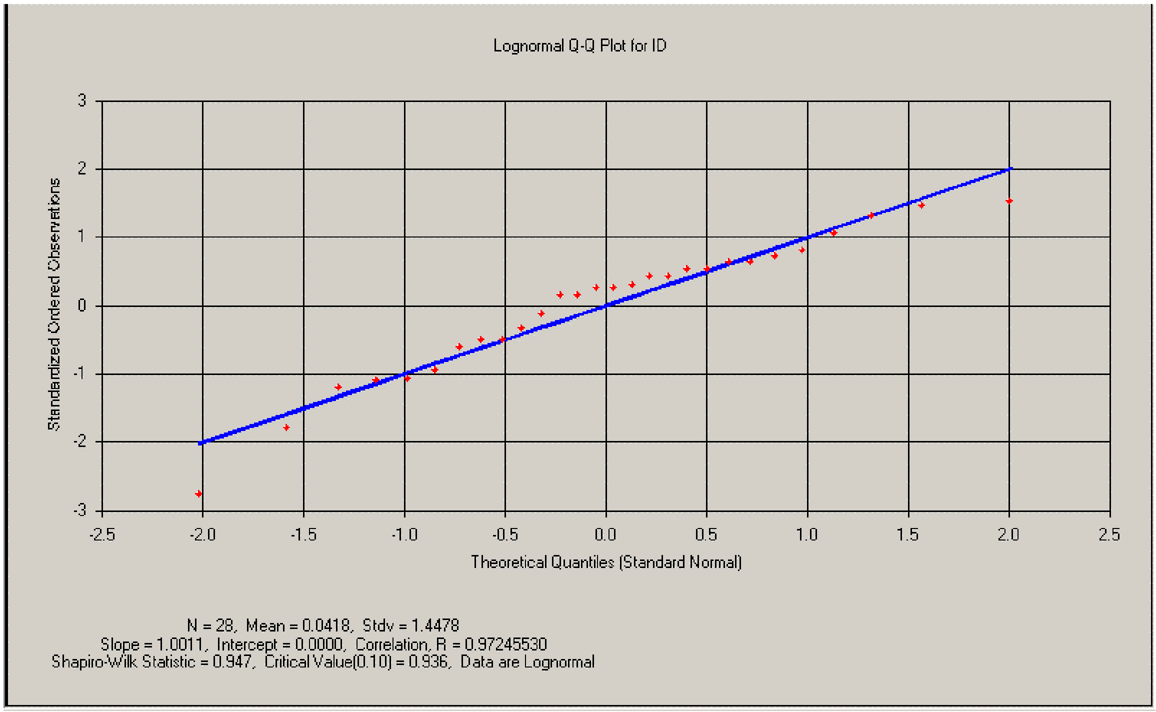


Figure 2-2
Q-Q Plots – Test for Lognormal or Approximately Lognormal Distributions (alpha=0.10)

Fox River SMUs 56/57



Fox River Deposit N

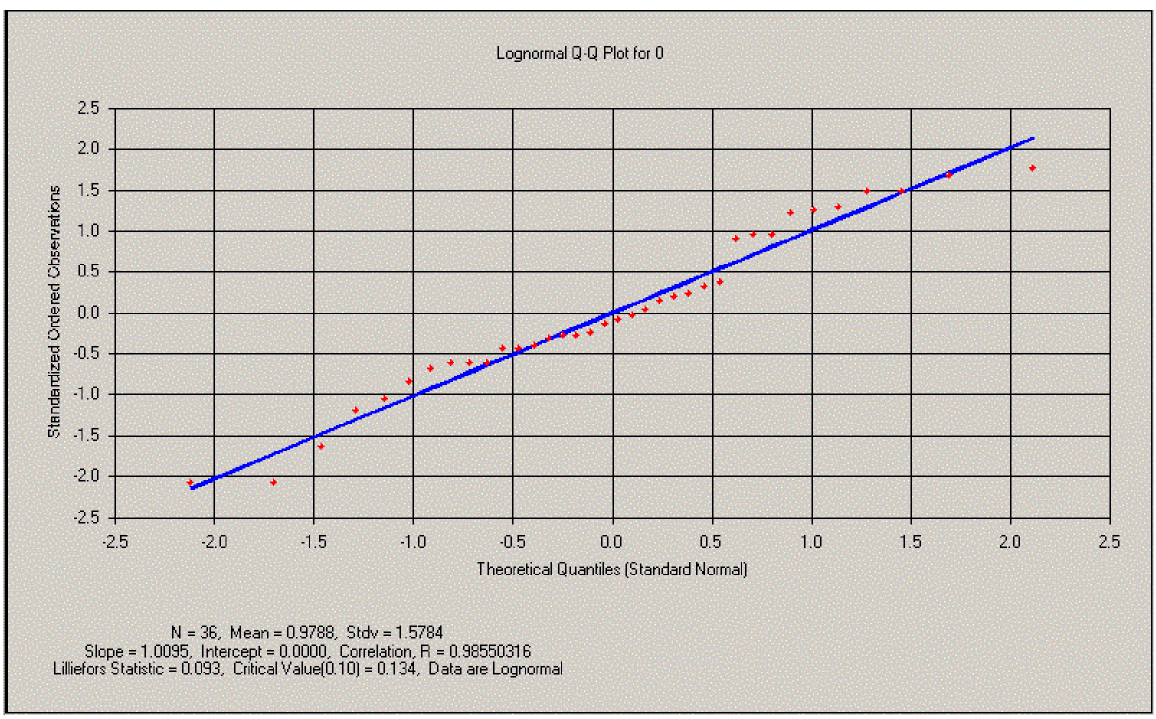
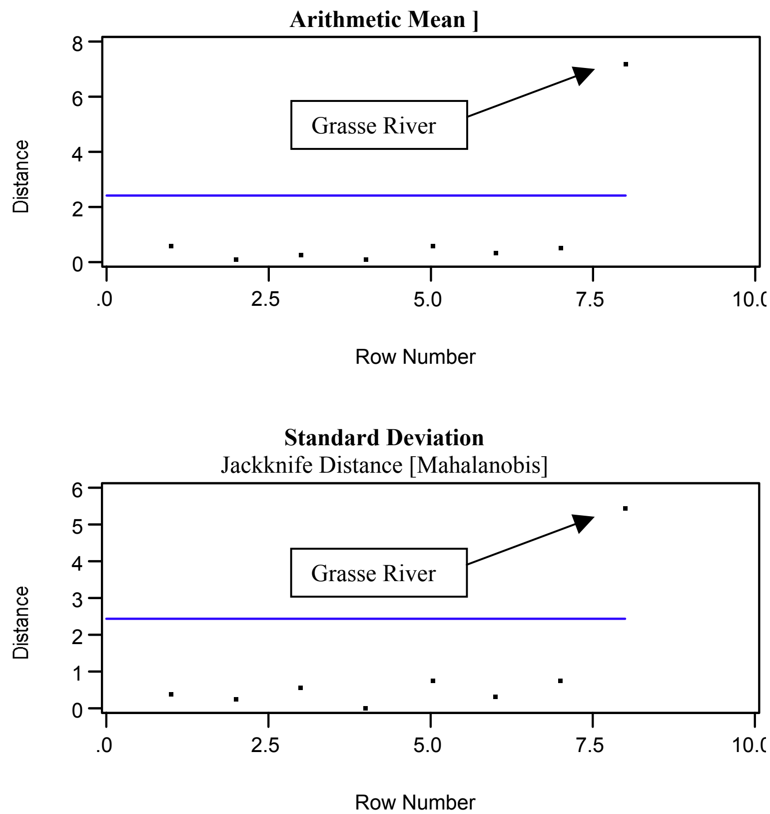


Figure 2-3
Mahalanobis Jackknife Distance For the Eight Case Studies



Points above the horizontal line are possible outliers. For both the arithmetic mean and the standard deviation, the Grasse River is flagged as a possible outlier.

Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets

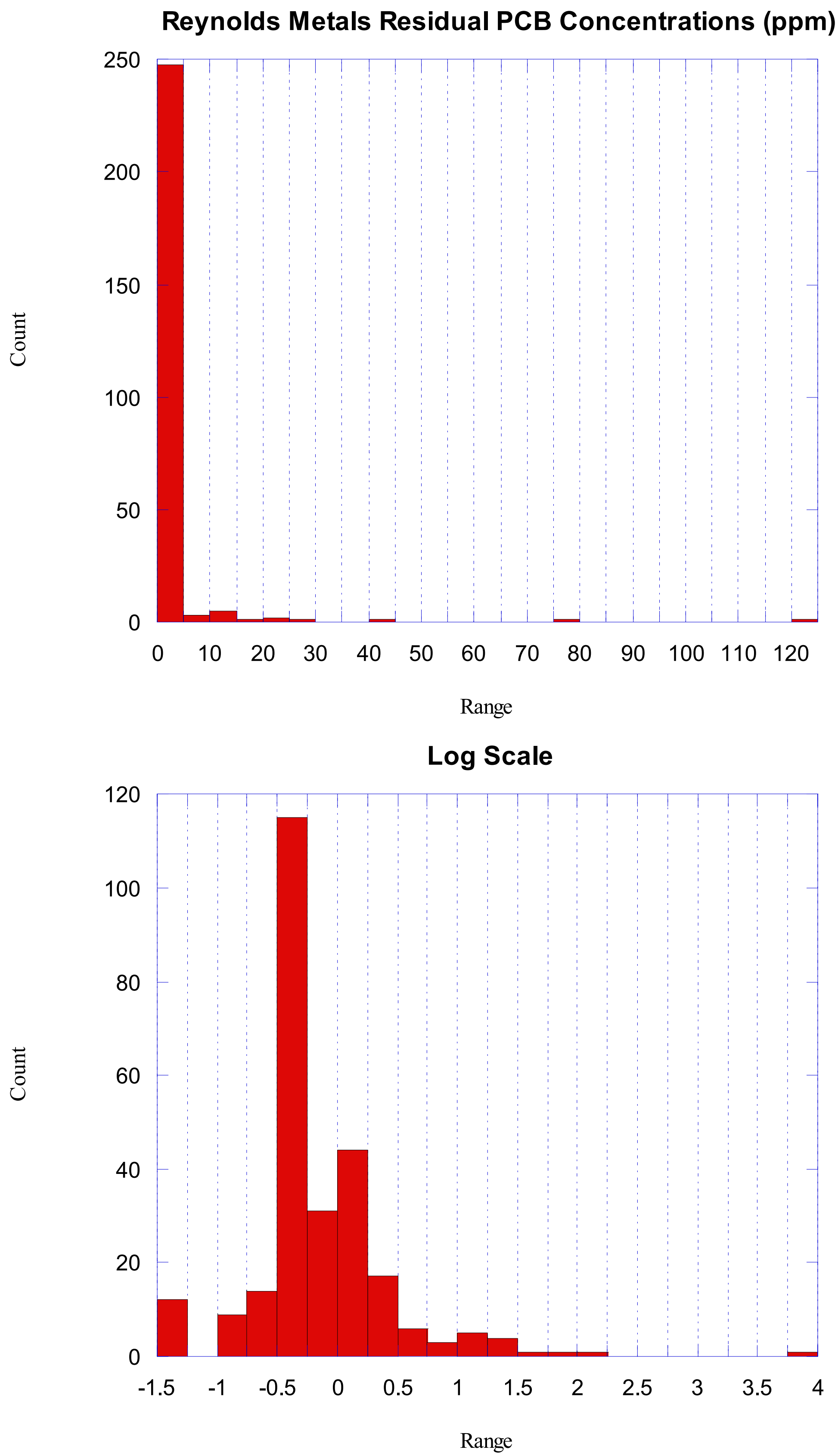
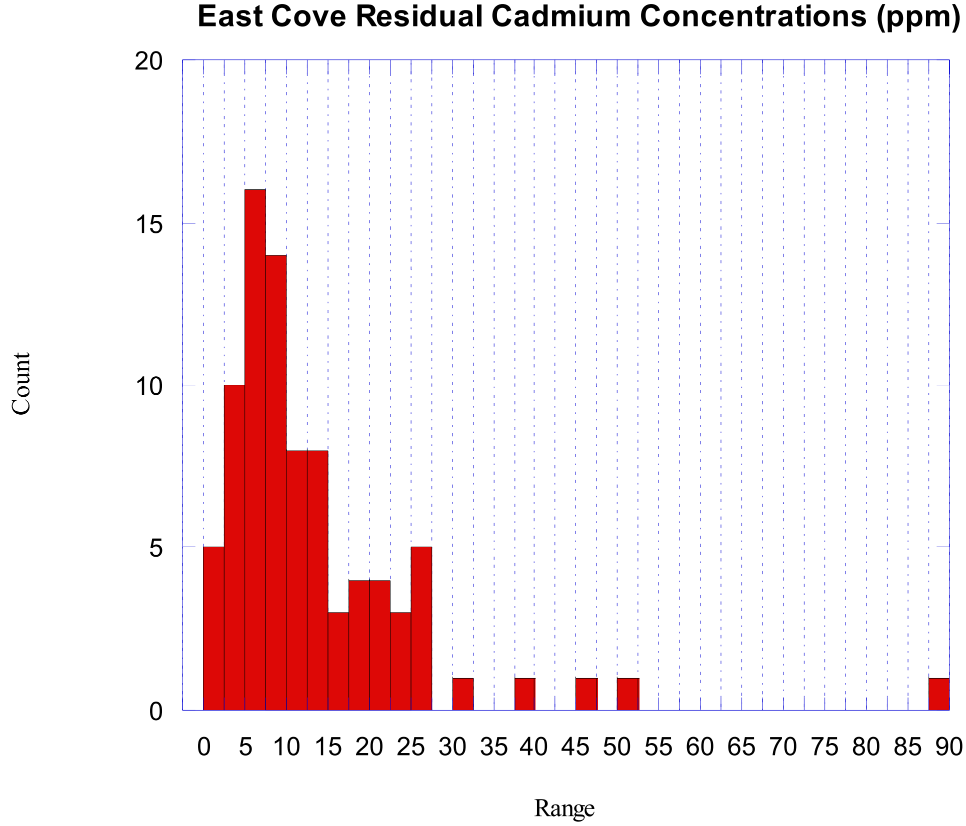


Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets



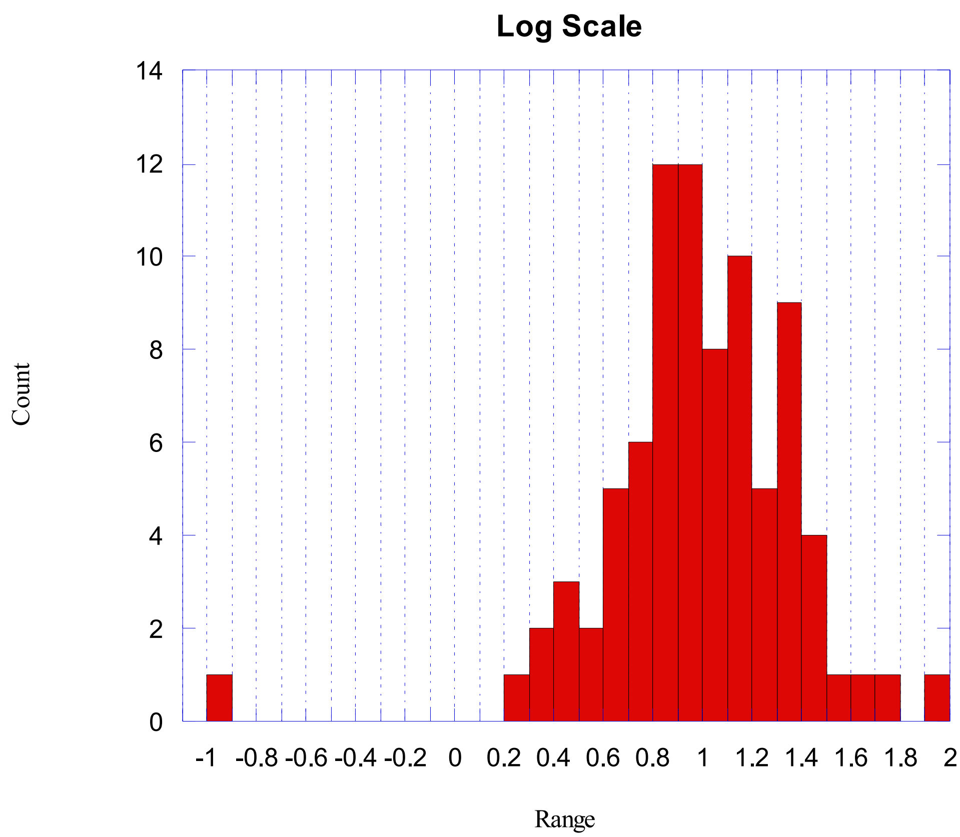
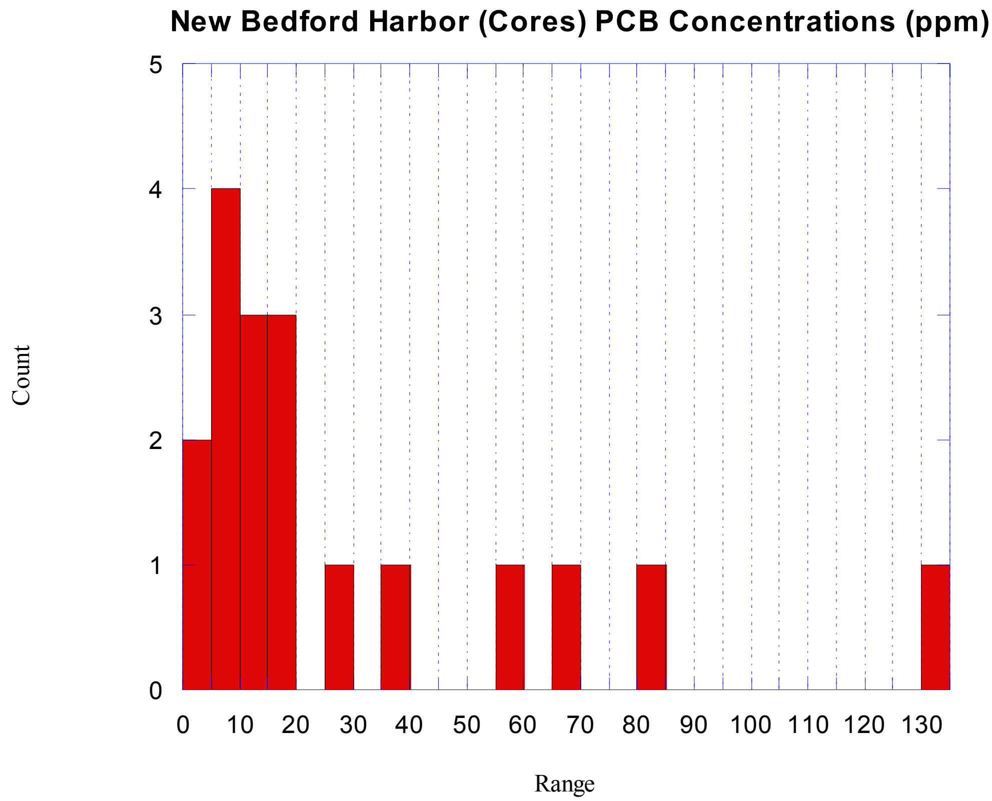


Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets



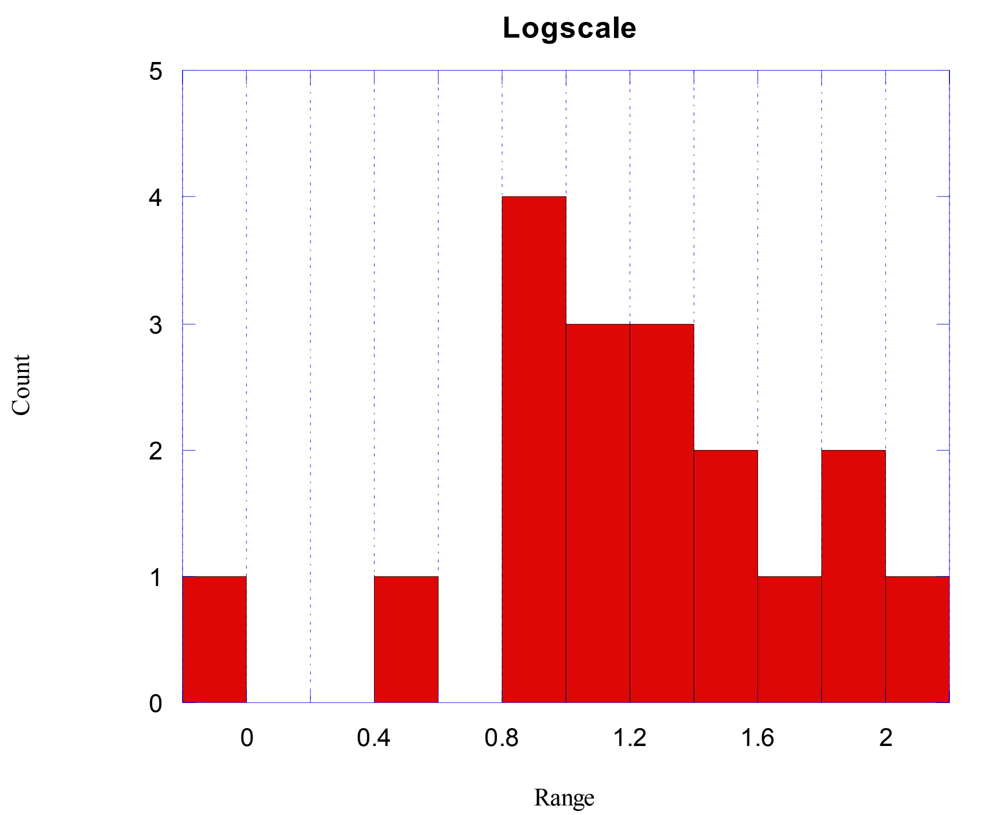
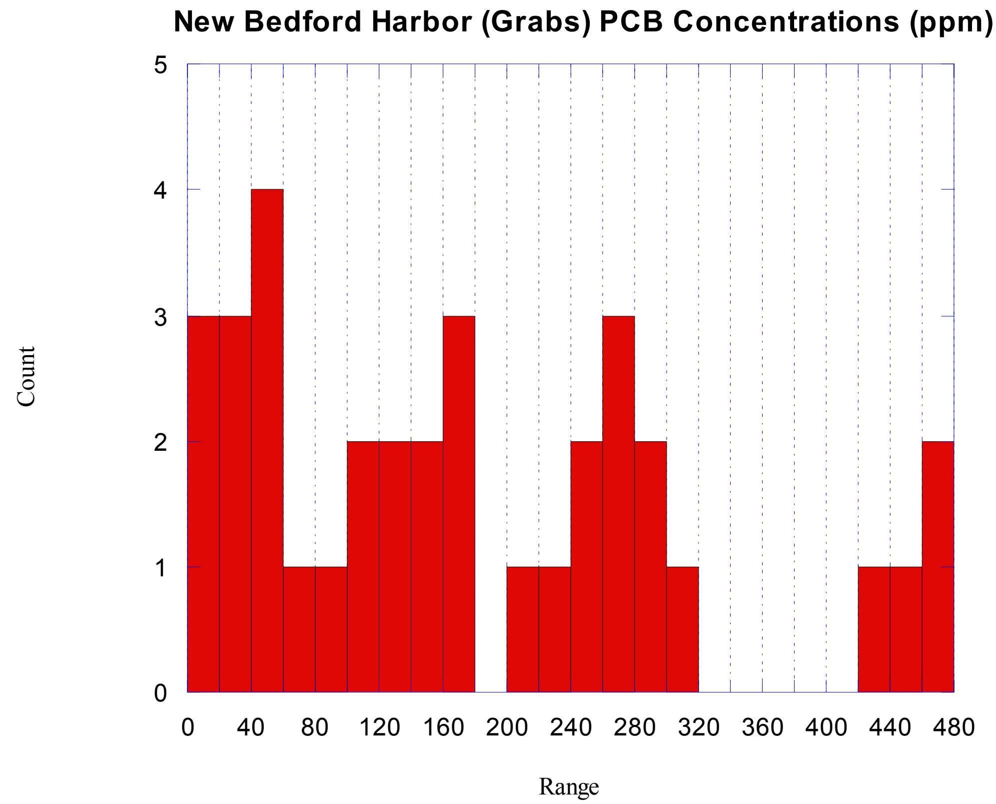


Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets



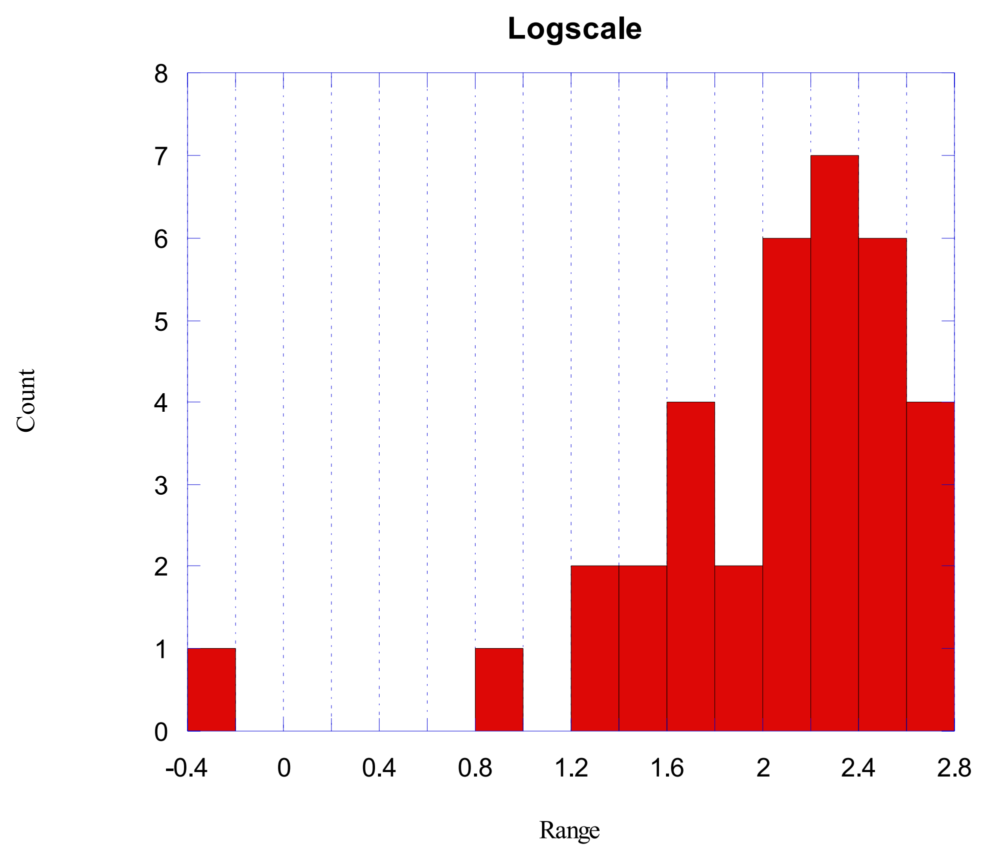


Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets

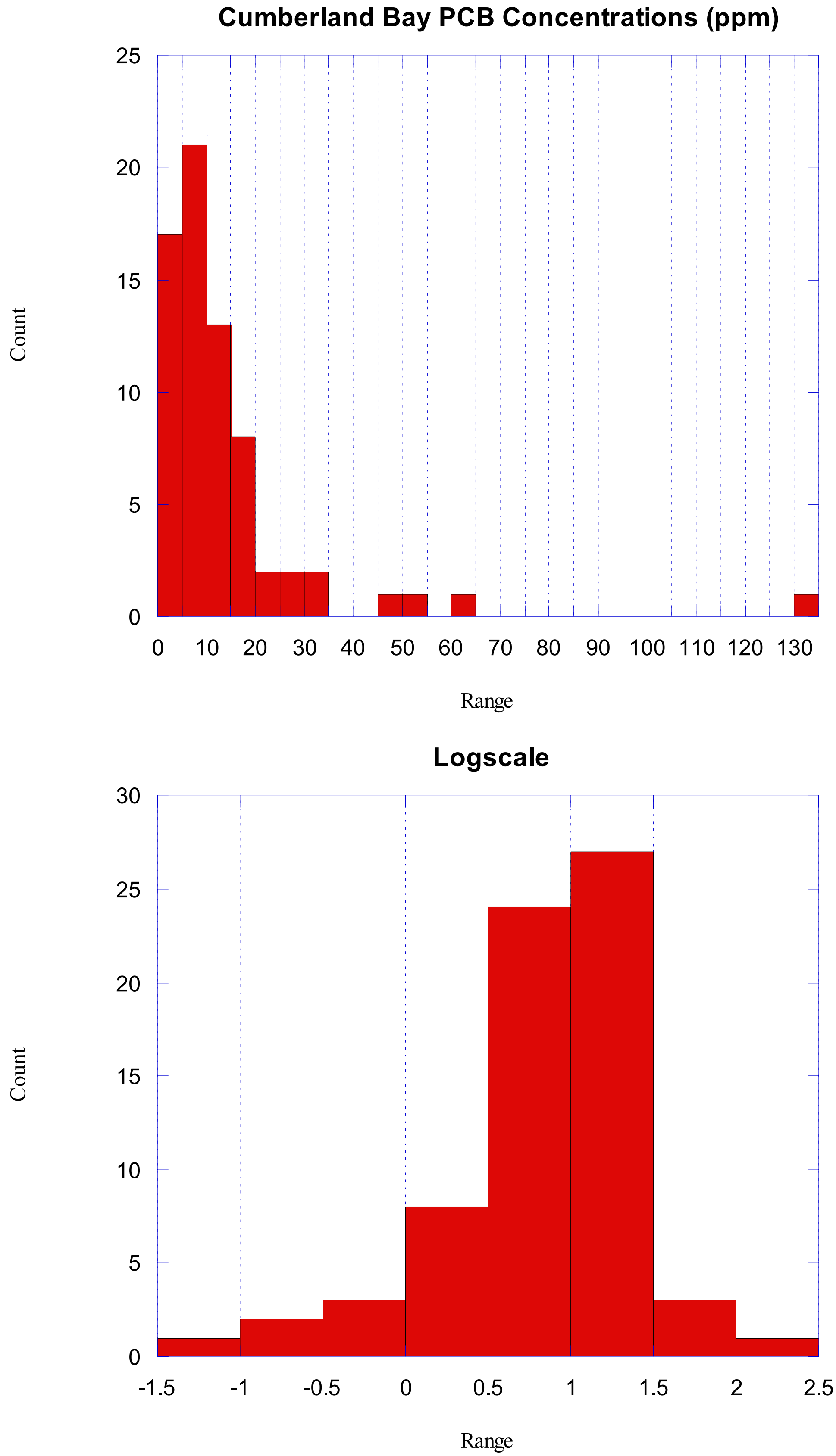
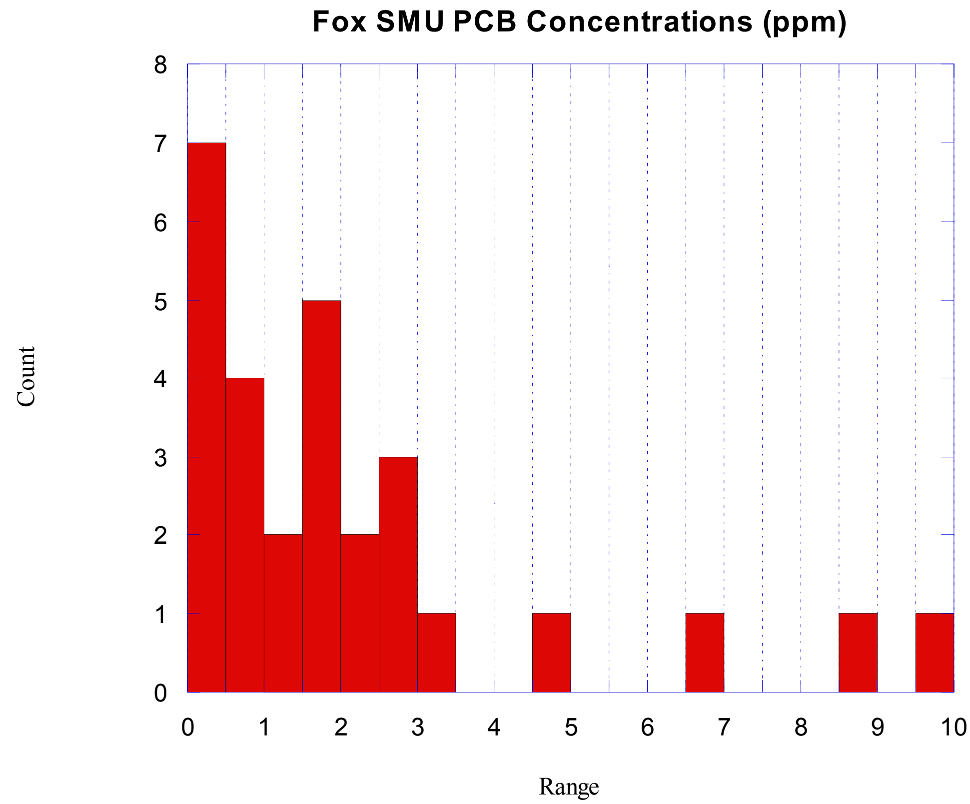


Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets



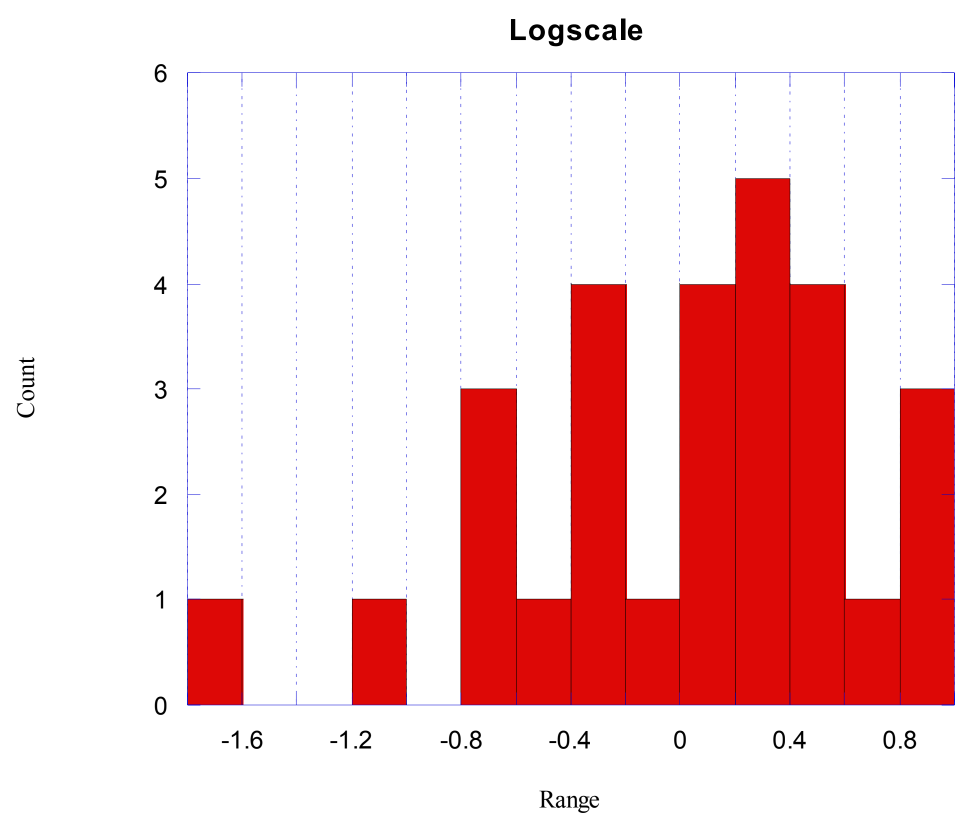
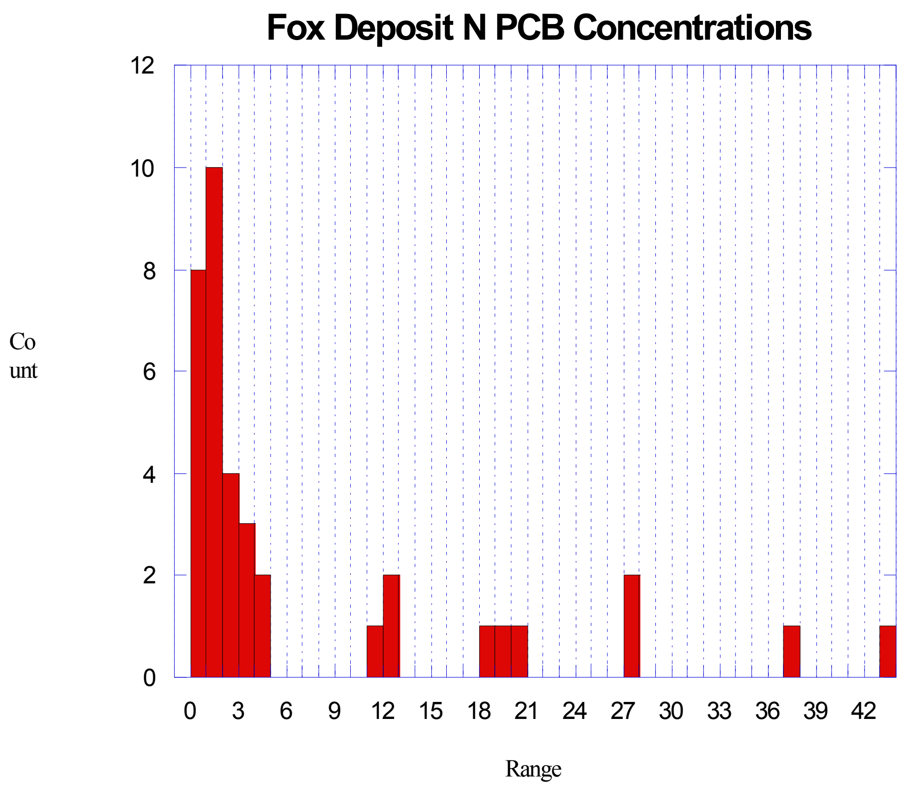


Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets



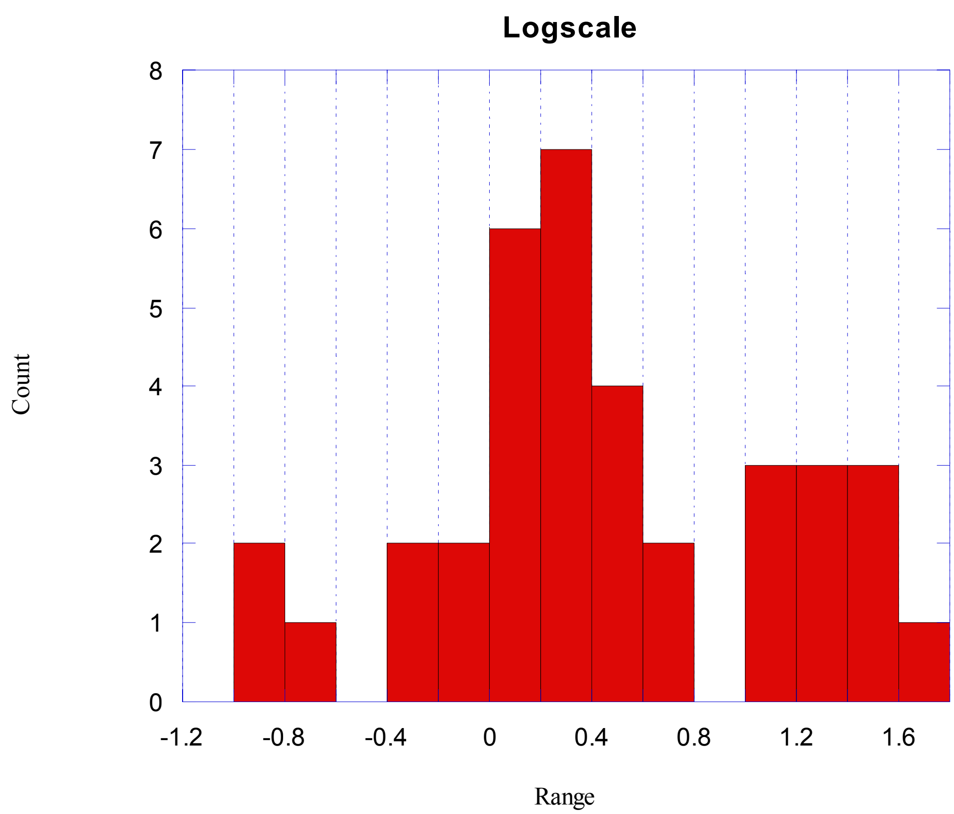
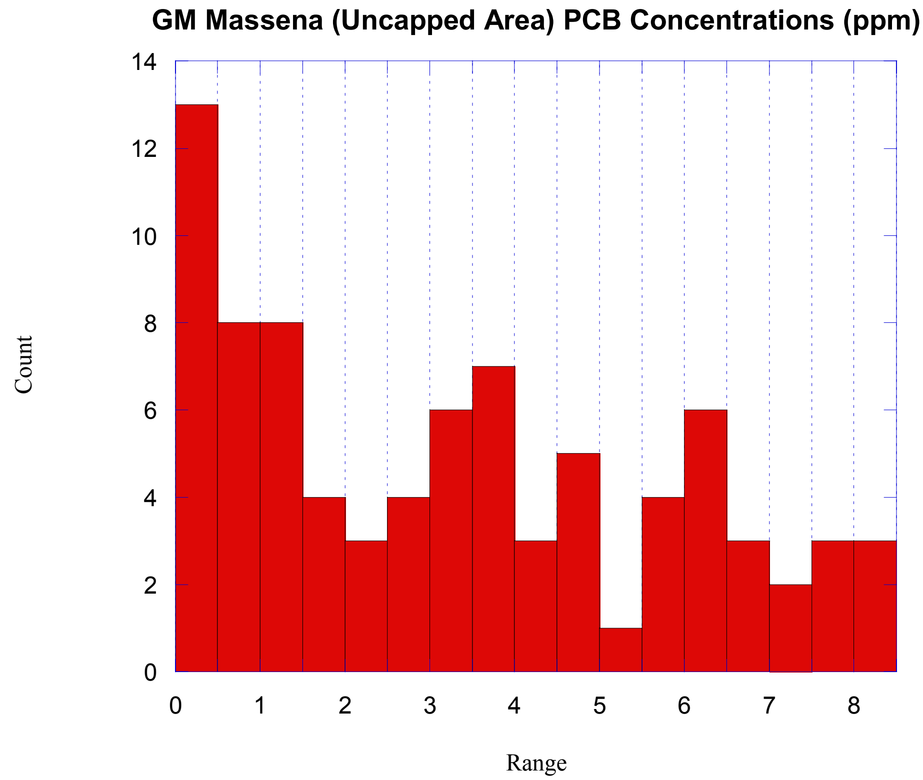


Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets



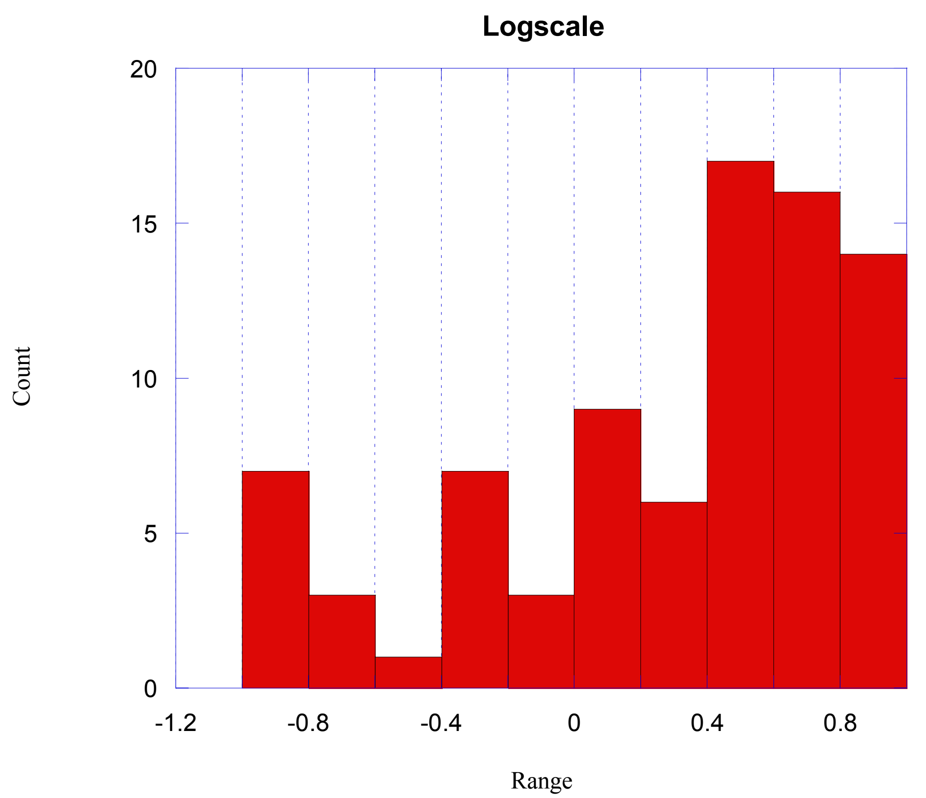
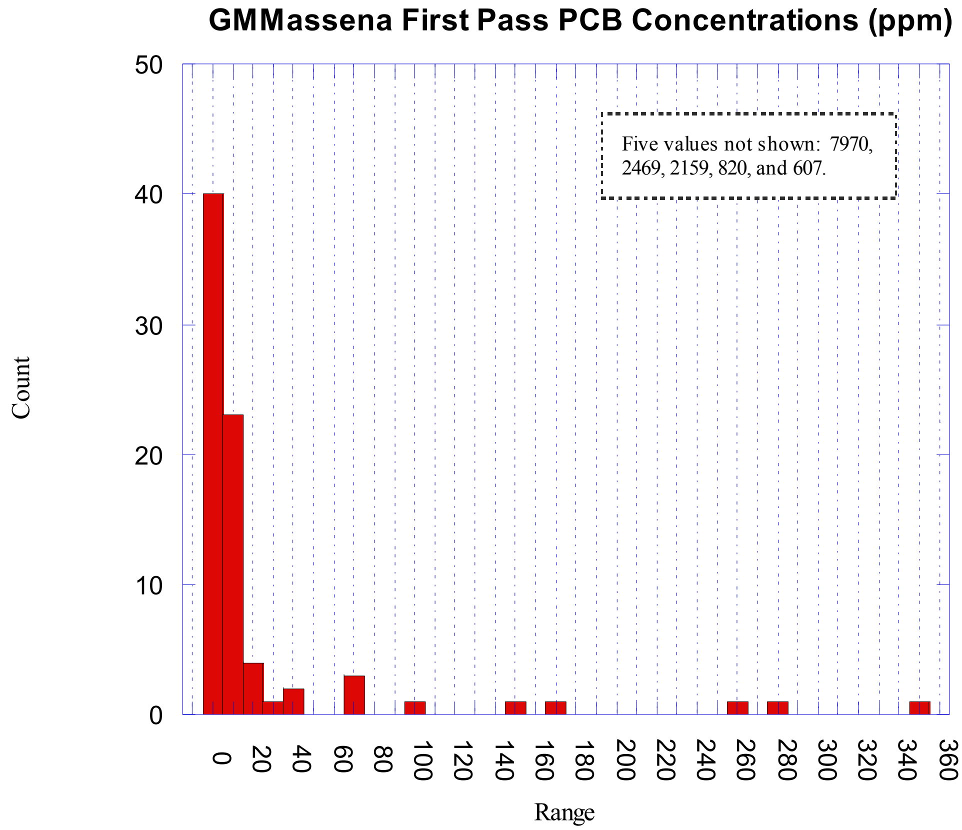


Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets



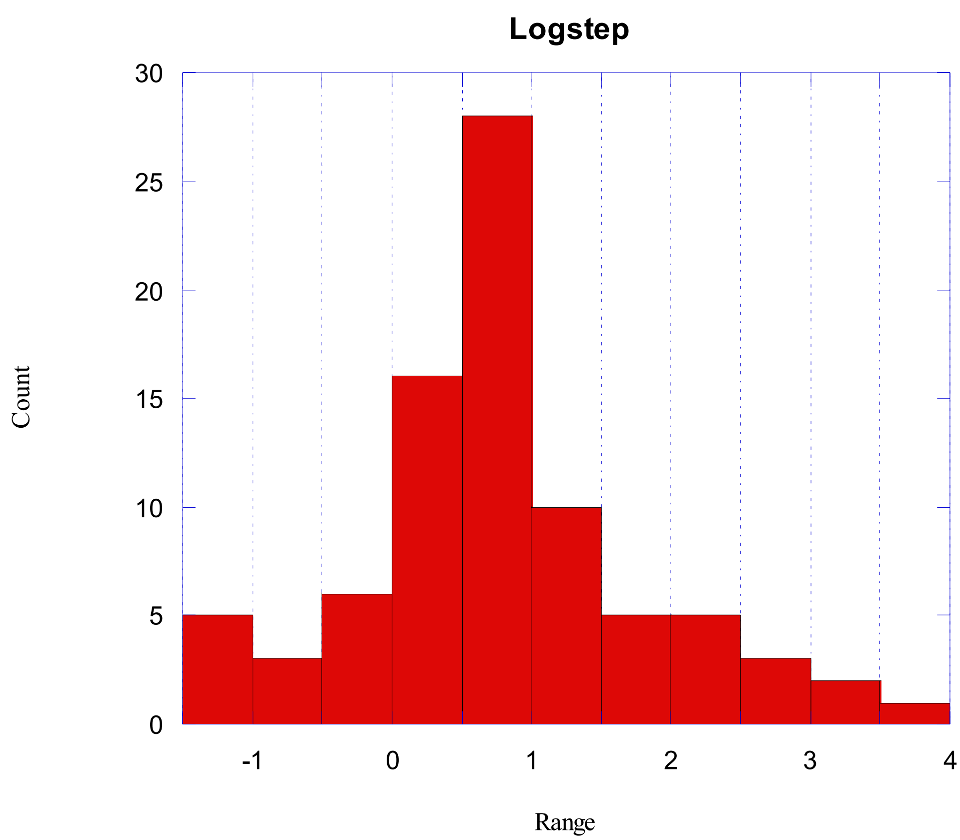


Figure 2-4
Histograms for Lognormal or Approximately Lognormal Data Sets

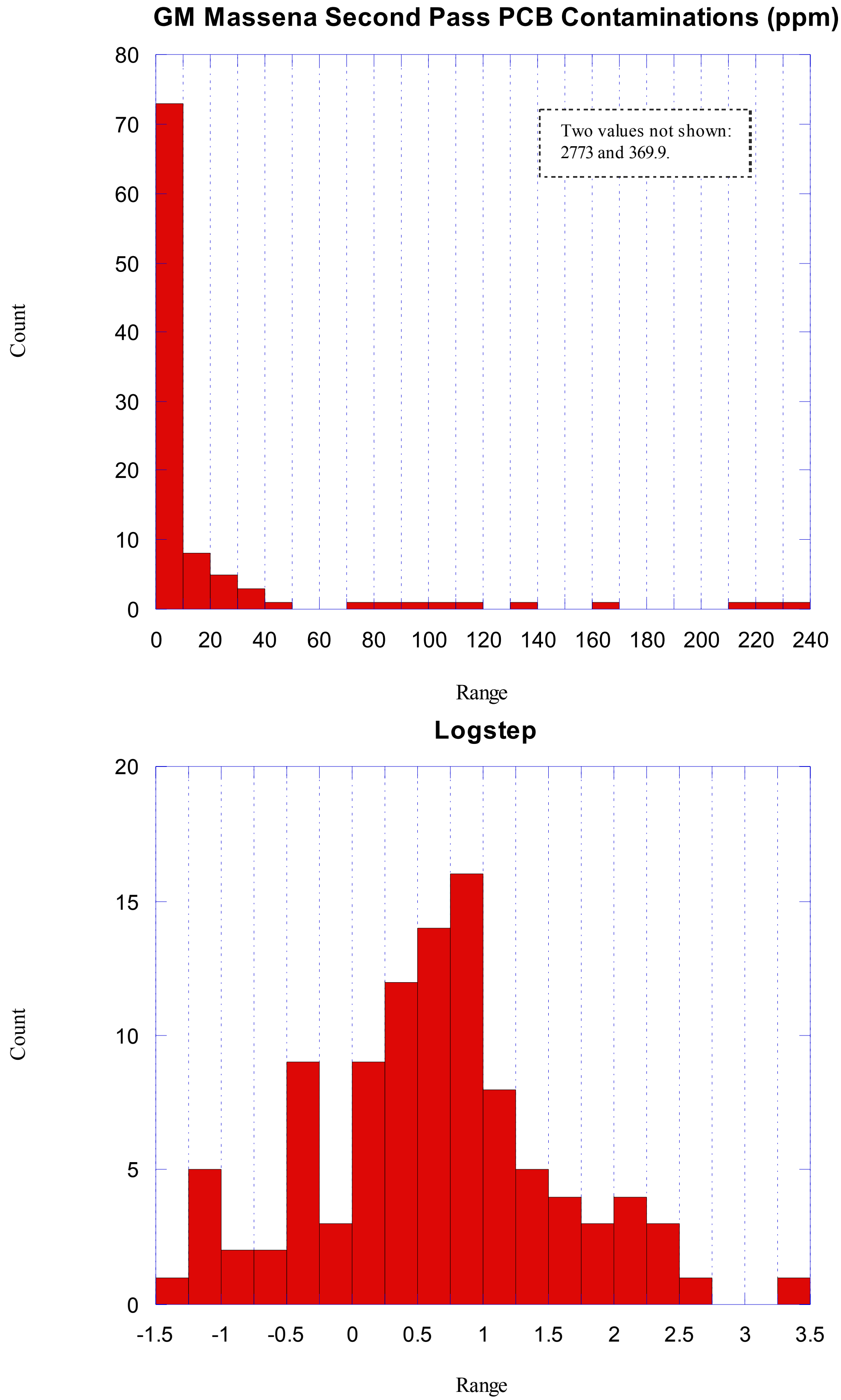
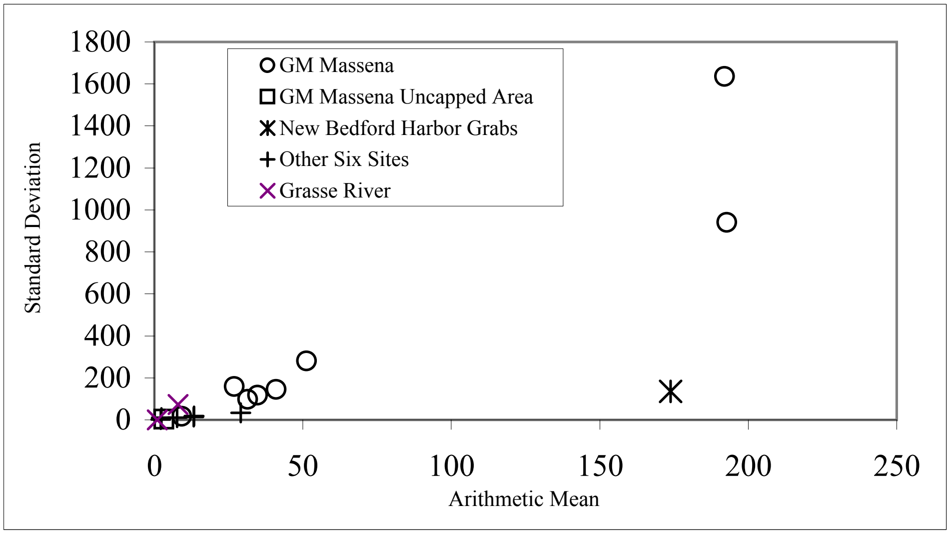


Figure 2-5
Mean vs. Standard Deviation for the Case Study Sites



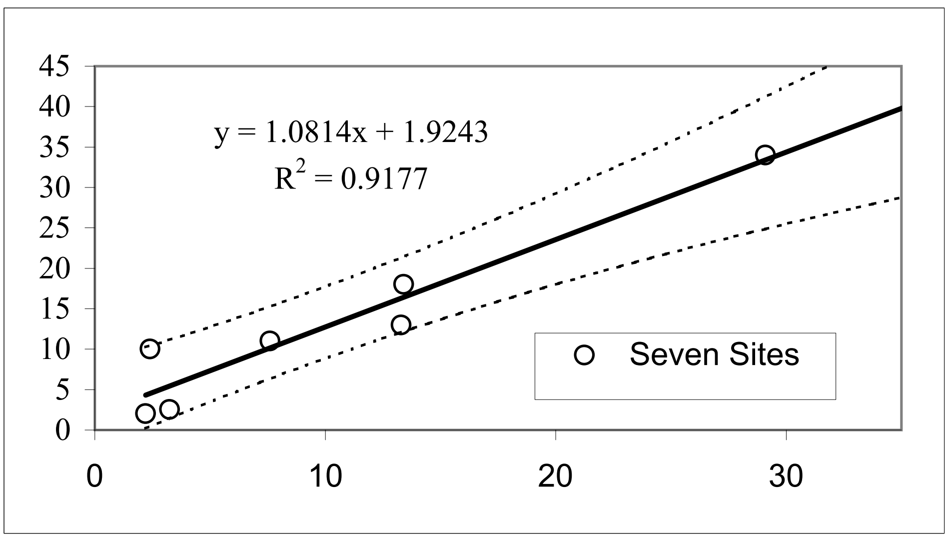
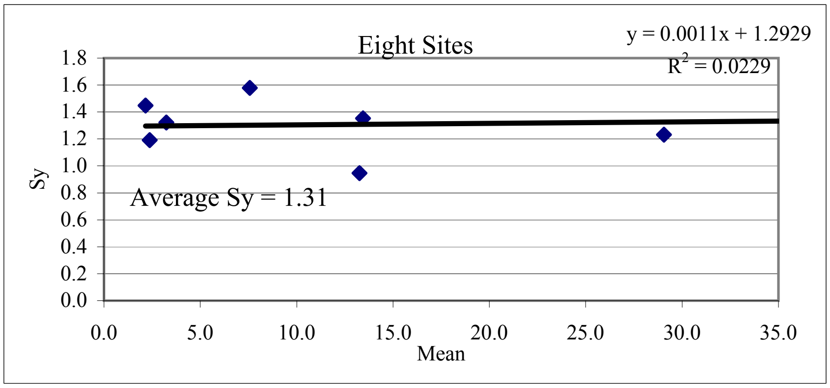


Figure 2-6
Mean vs. the Standard Deviation of the Logs for the Case Study Sites



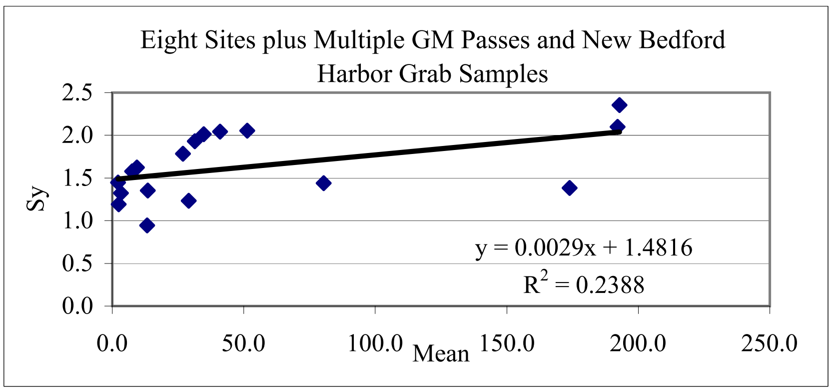


Figure 2-7
Estimated Tri+ PCB Concentrations in the Residual Layer
(Assuming 1% of the Inventory Remains after the Initial Dredging Attempt)

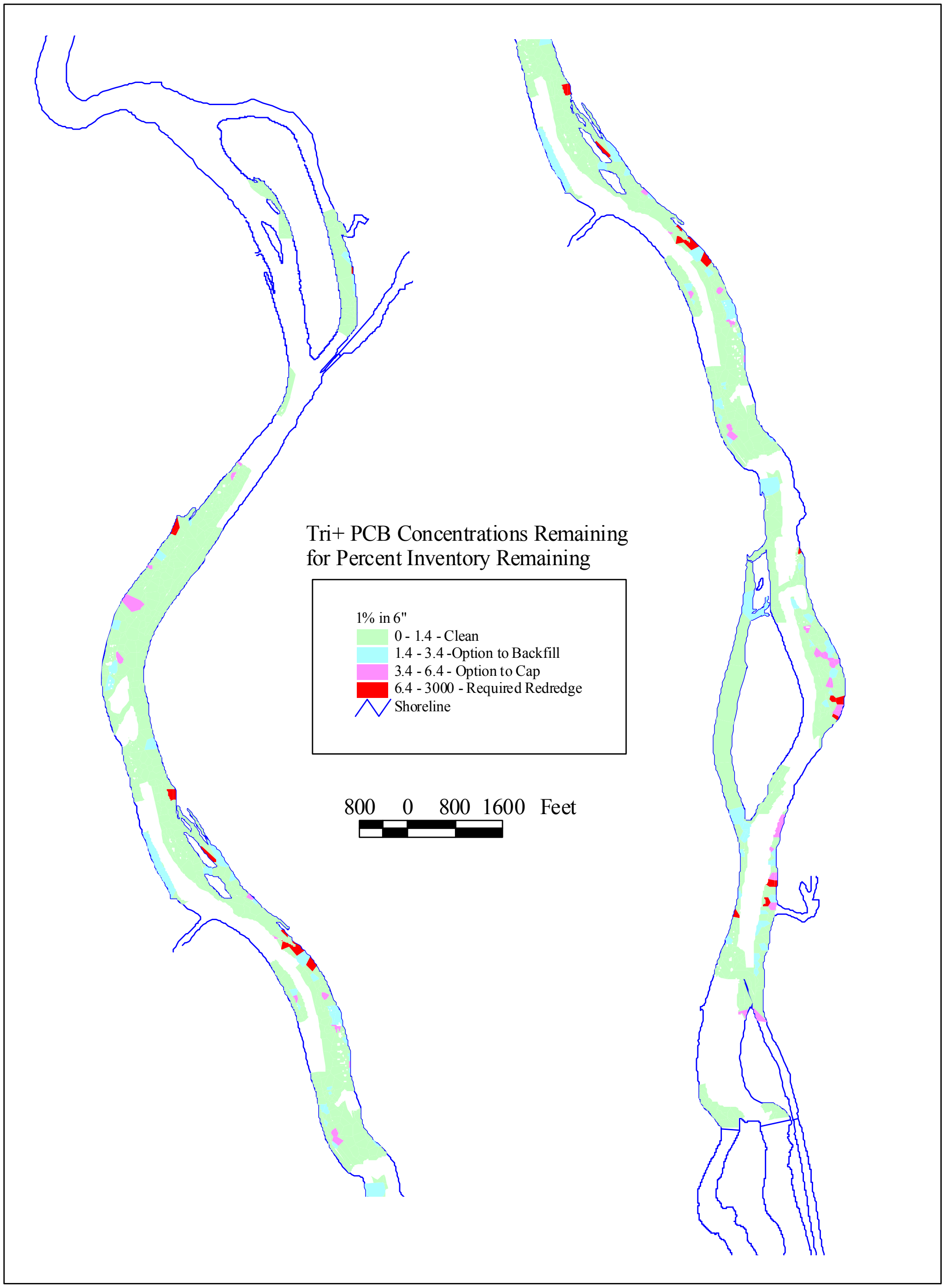


Figure 2-7
Estimated Tri+ PCB Concentrations in the Residual Layer
(Assuming 5% of the Inventory Remains after the Initial Dredging Attempt)

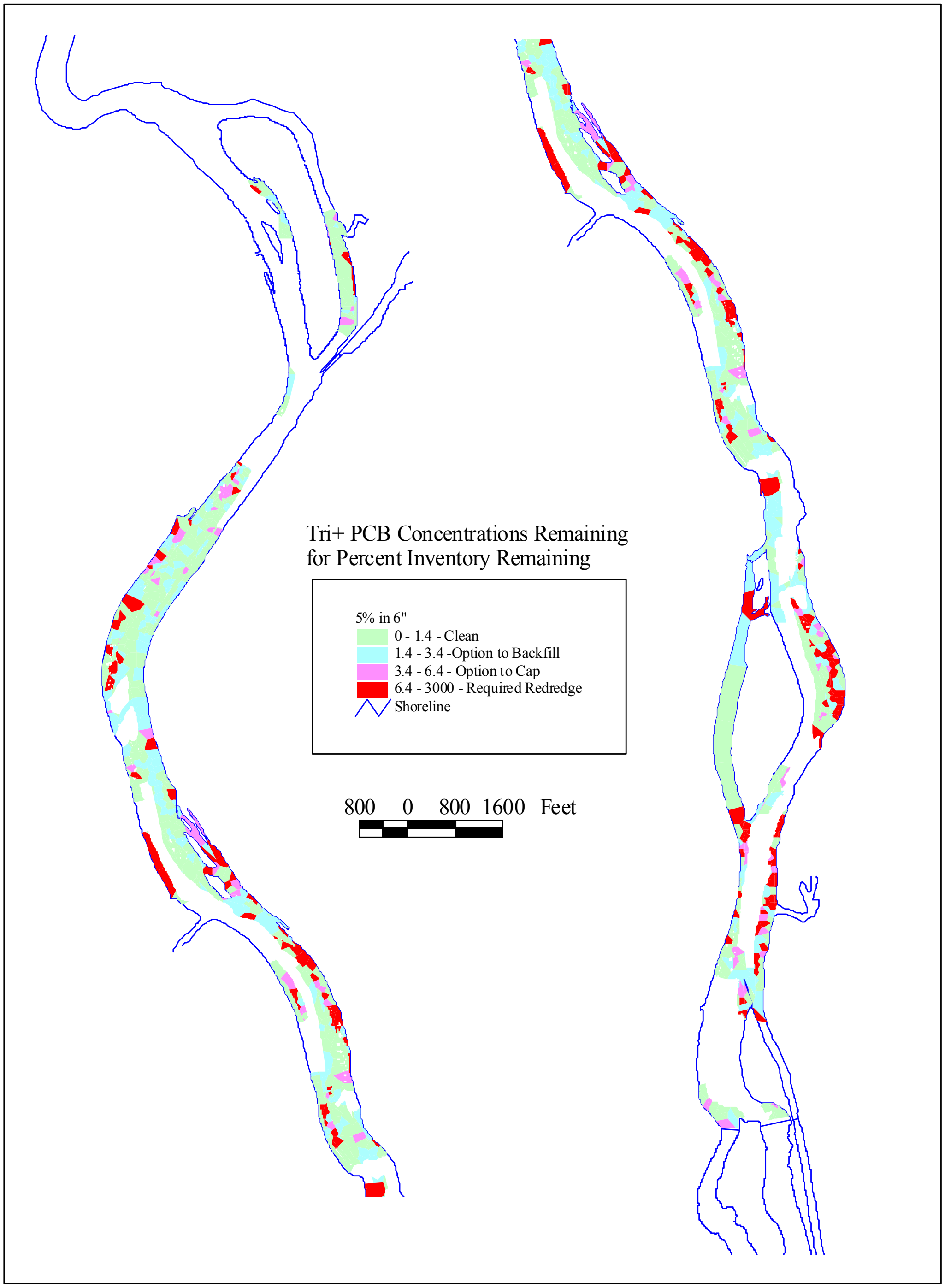


Figure 2-7
Estimated Tri+ PCB Concentrations in the Residual Layer
(Assuming 10% of the Inventory Remains after the Initial Dredging Attempt)

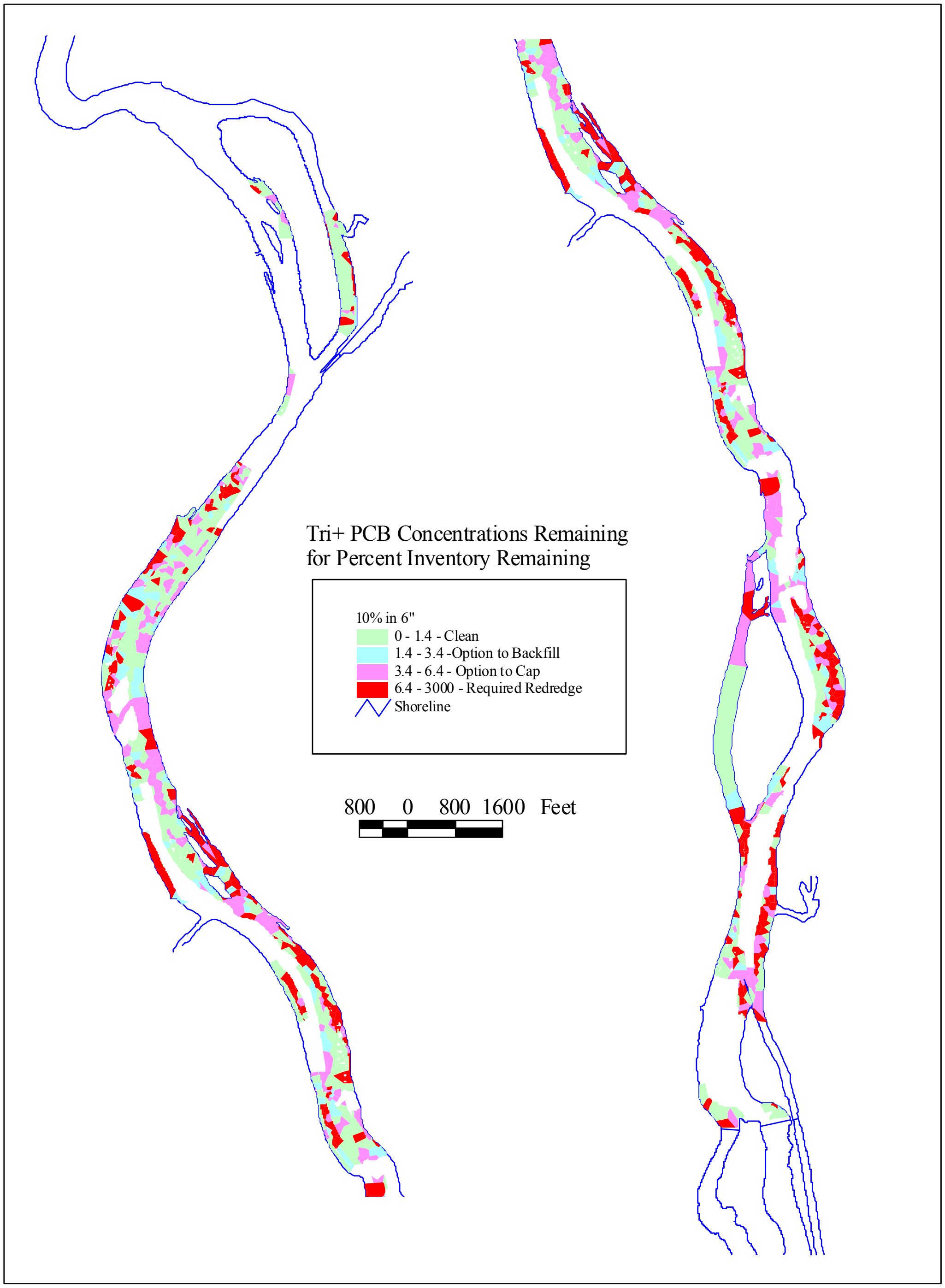
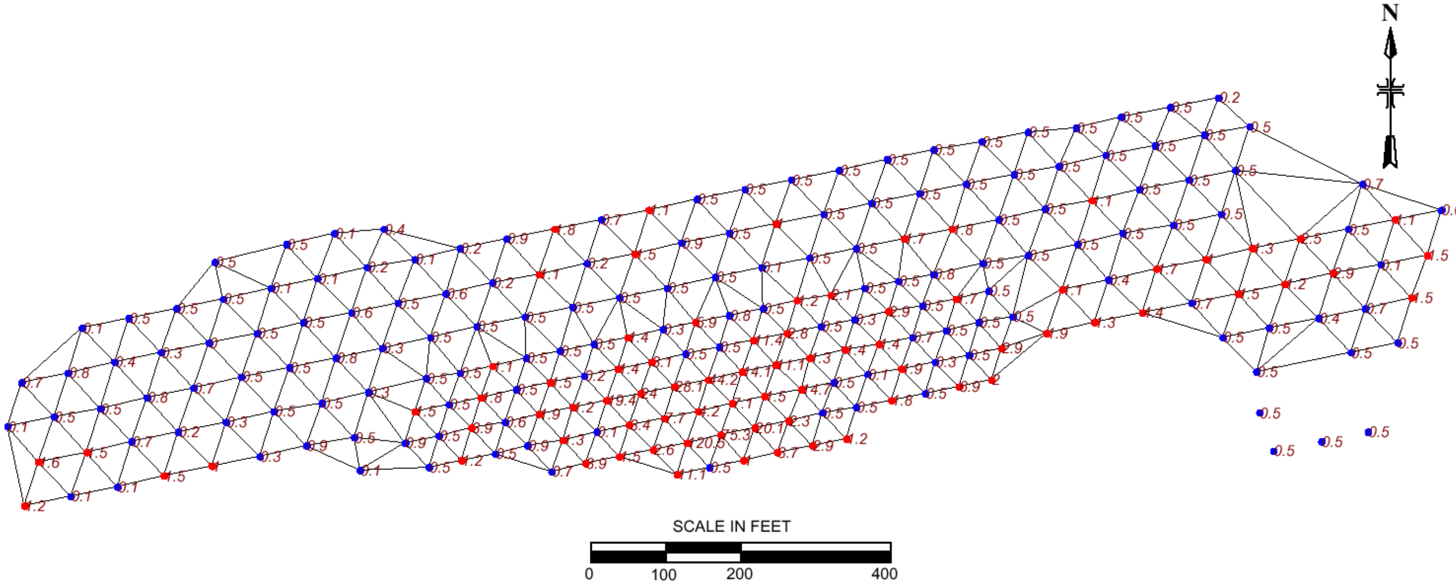


Figure 2-8
Reynolds Post-Dredging PCB Data Semi-Variogram Analysis 70’ x 70’ and 50’ x 50’ Triangular Grid Spacing



Sample containing total PCB concentration greater than 1 ppm

11.1 Concentration of Total PCBs in mg/kg

Sample containing total PCB concentration 1 ppm or less

0.6 Concentration of Total PCBs in mg/kg

From Bechtel Environmental, Inc./Metcalf & Eddy, Inc. 2000. Final Dredging Program Design Report for the River Remediation Project at the Reynolds Metals Company, St. Lawrence Reduction Plant, Massena, New York, Revision 3.
Prepared for Reynolds Metals Company. May 2000.

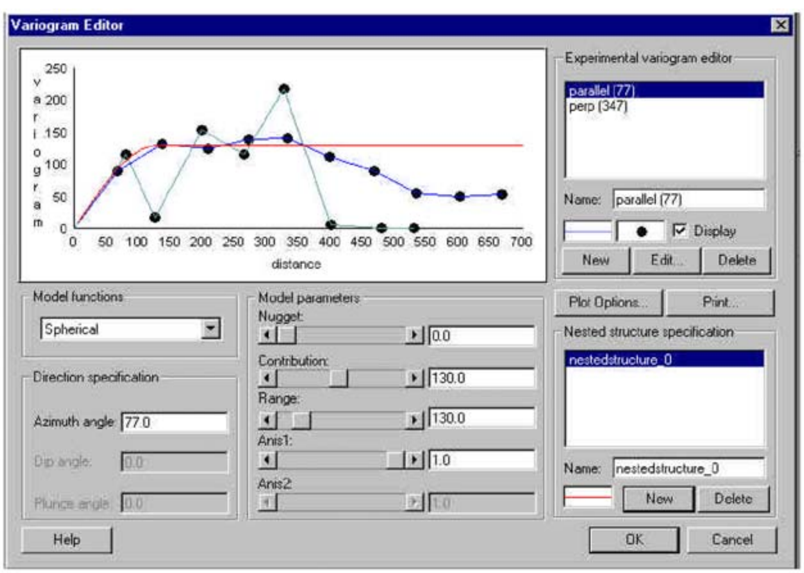
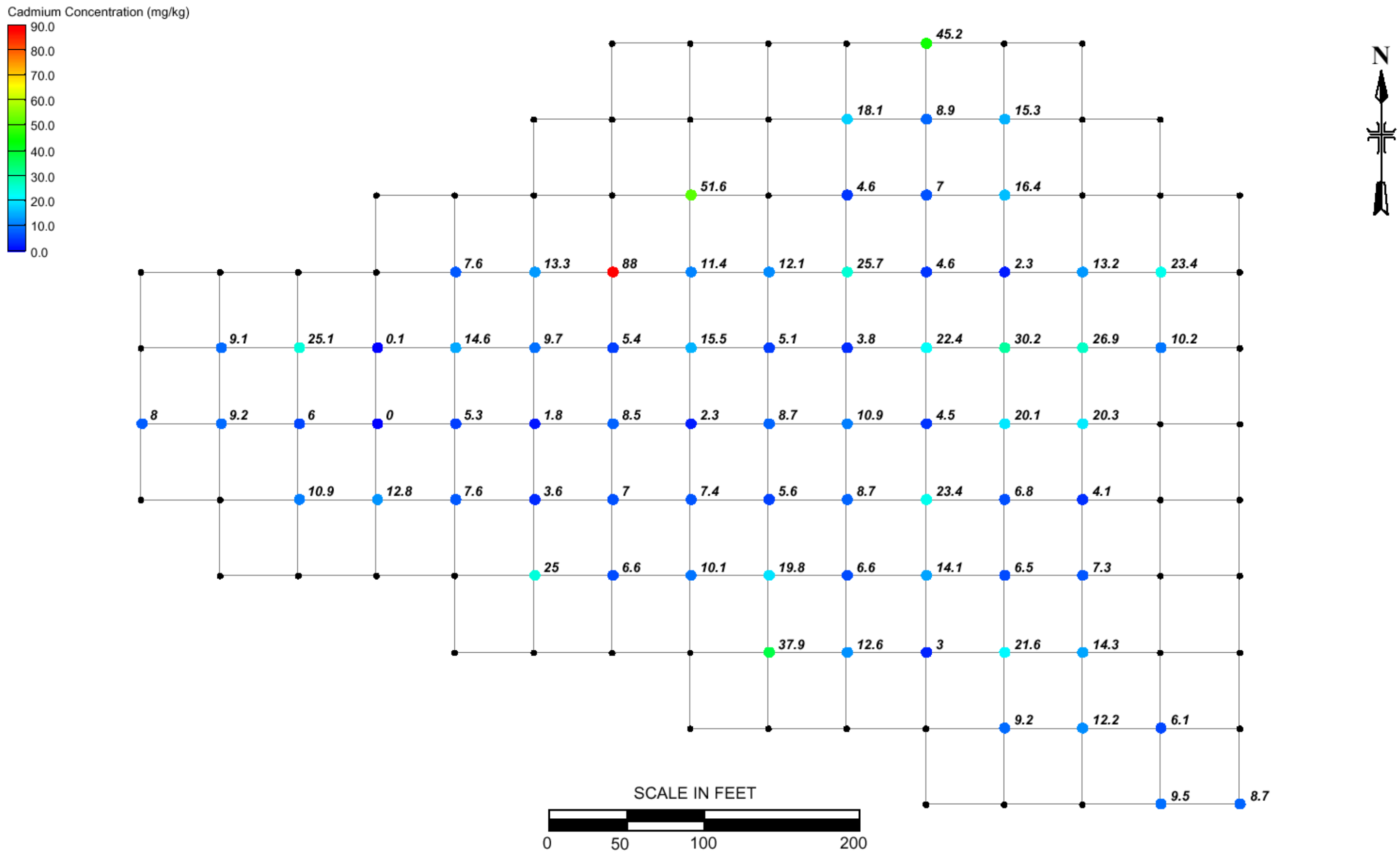


Figure 2-9
Marathon Battery Post-Dredging Cadmium Data Semi-Variogram Analysis 50’ x 50’ Sampling Grid



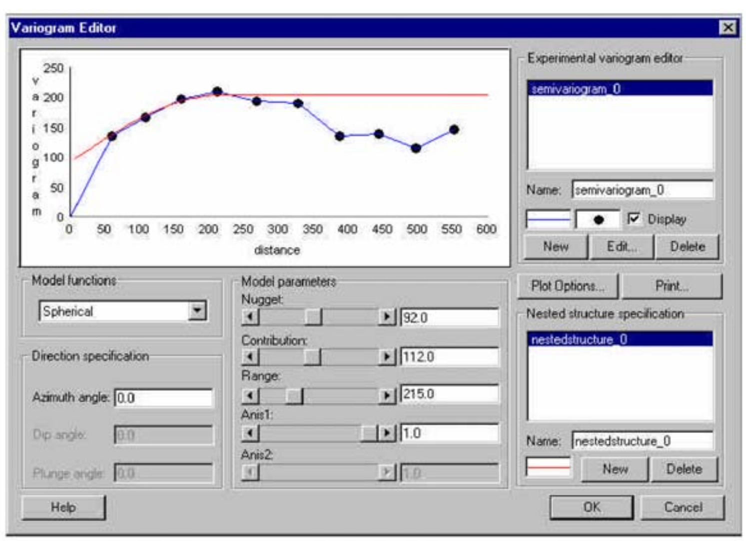
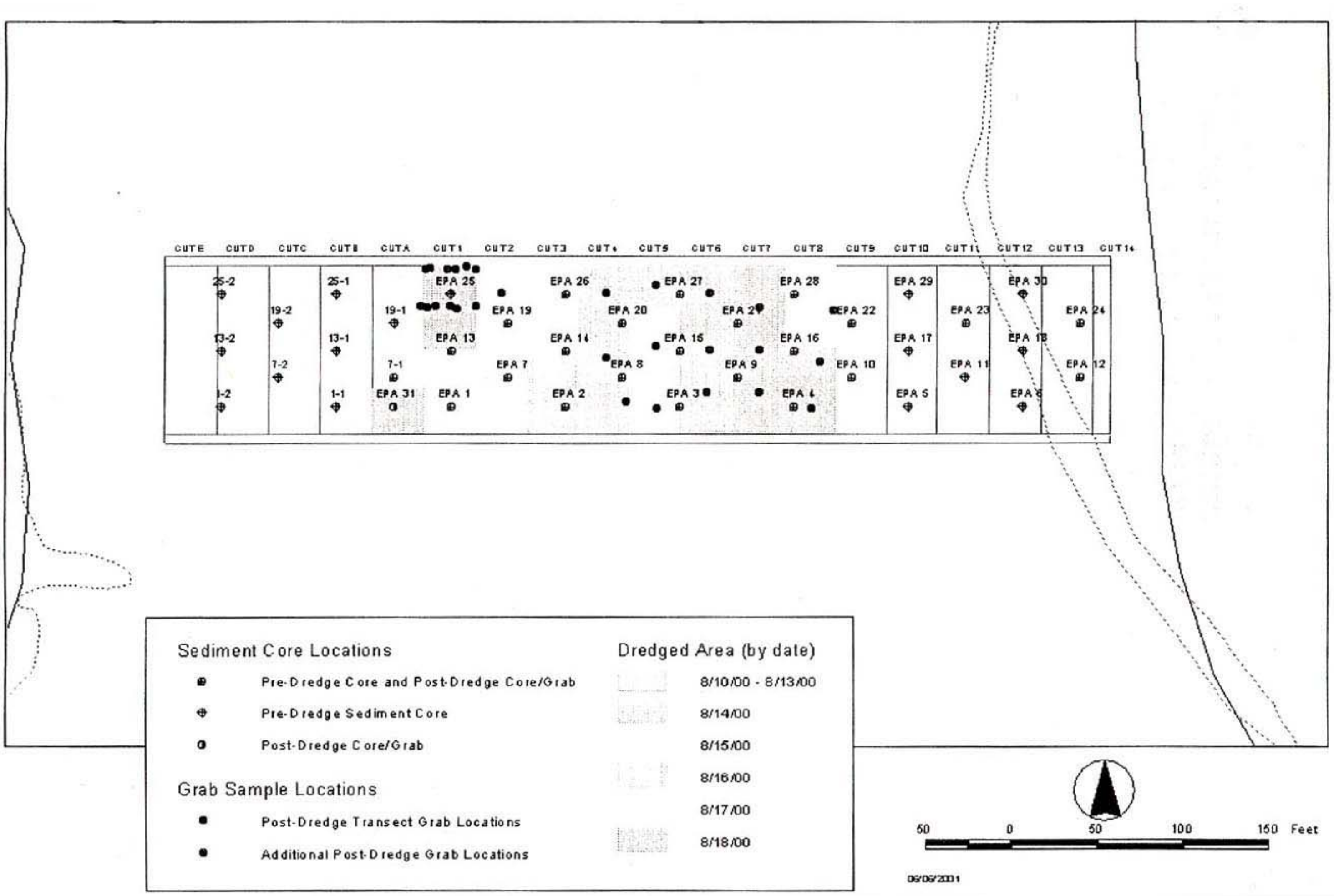
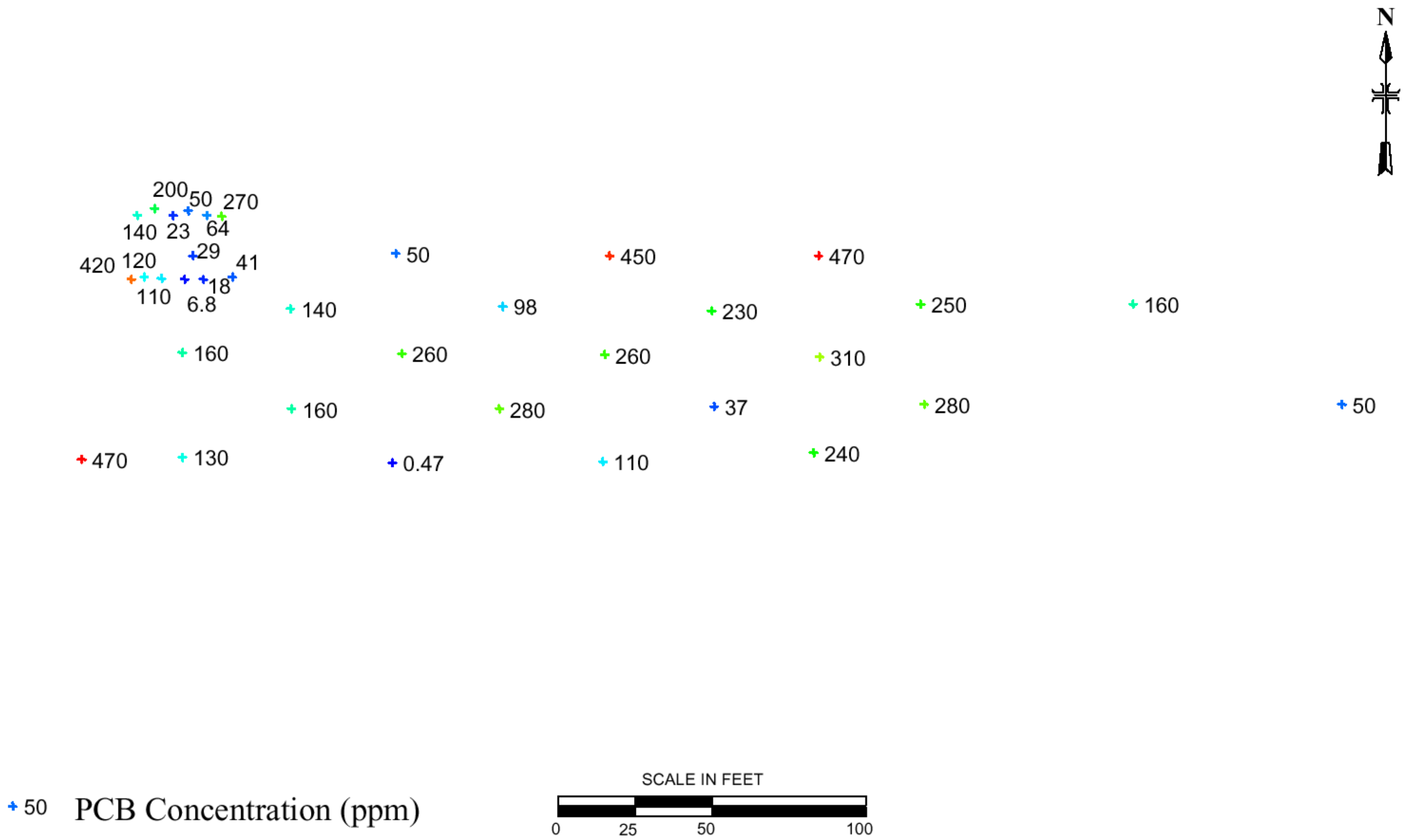


Figure 2-10
New Bedford Harbor Core and Grab Sample Locations



From U. S. Army Corps of Engineers (USACE). 2001. Final Pre-Design Field Test Dredge Technology Evaluation Report, New Bedford Harbor Superfund Site, New Bedford, Massachusetts. Prepared by Foster Wheeler Environmental Corporation, Boston, Massachusetts. August 2001.

Figure 2-11
New Bedford Harbor (Grab Sample Locations) Semi-Variogram Analysis Variable Grid Spacing



From U. S. Army Corps of Engineers (USACE). 2001. Final Pre-Design Field Test Dredge Technology Evaluation Report, New Bedford Harbor Superfund Site, New Bedford, Massachusetts. Prepared by Foster Wheeler Environmental Corporation, Boston, Massachusetts. August 2001.

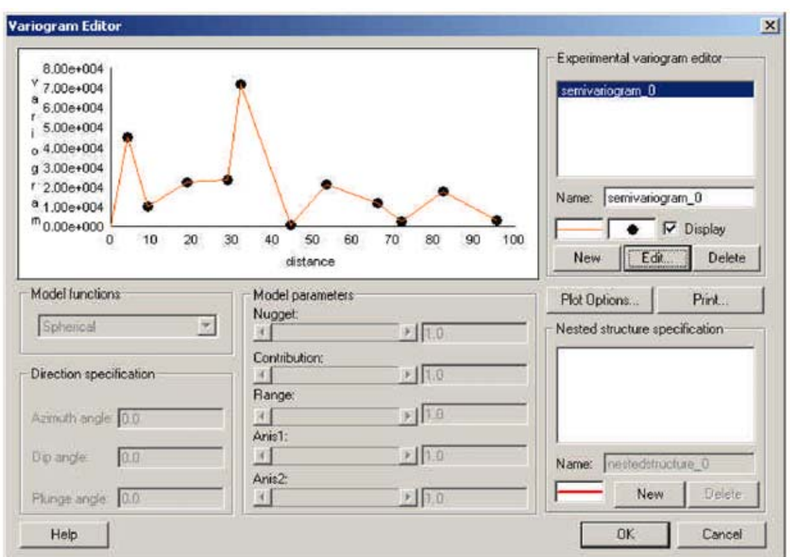
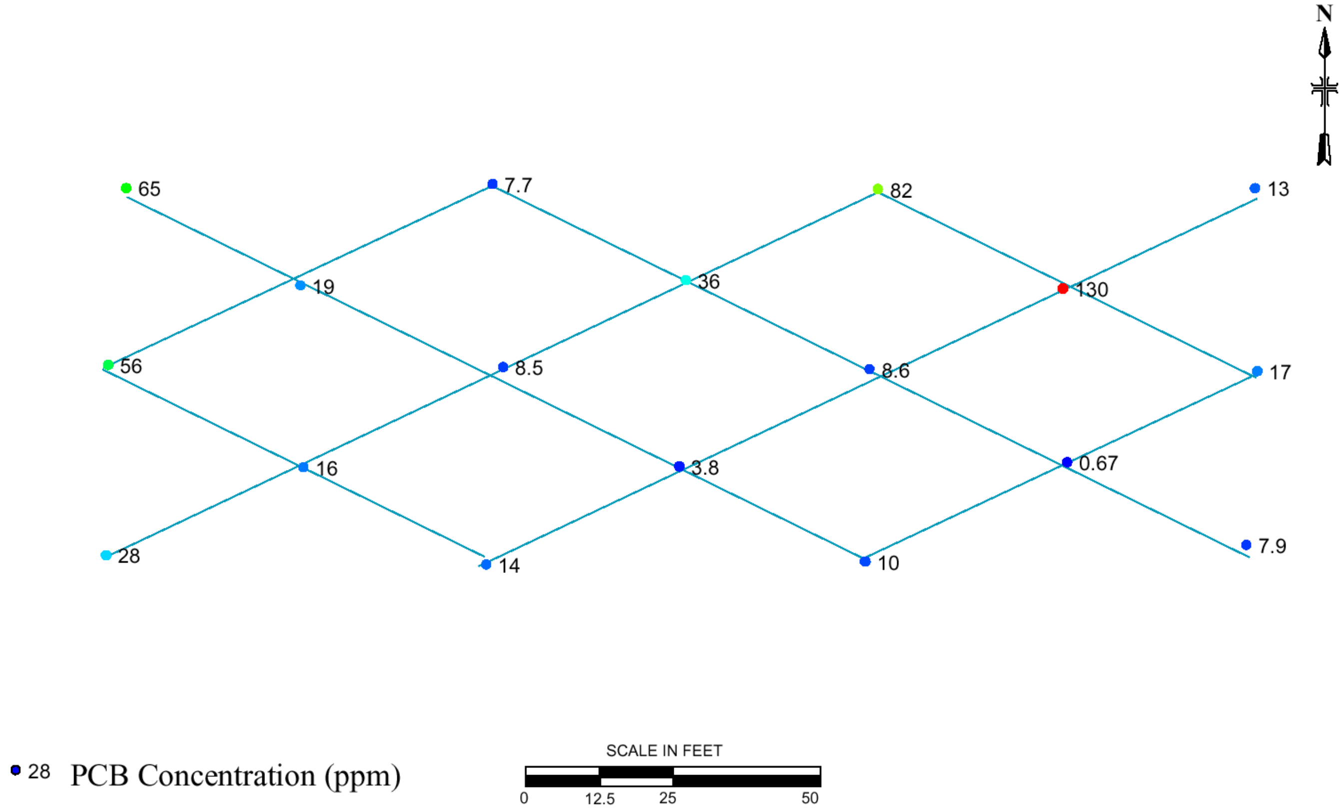


Figure 2-12
New Bedford Harbor Core Sample Semi-Variogram Analysis 40' Triangular Grid Spacing



From U. S. Army Corps of Engineers (USACE). 2001. Final Pre-Design Field Test Dredge Technology Evaluation Report, New Bedford Harbor Superfund Site, New Bedford, Massachusetts. Prepared by Foster Wheeler Environmental Corporation, Boston, Massachusetts. August 2001.

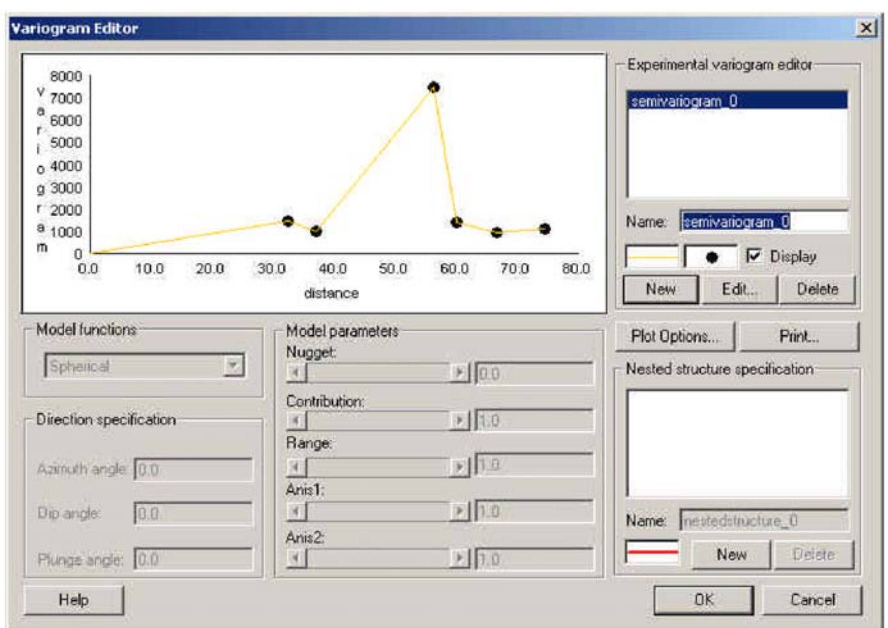
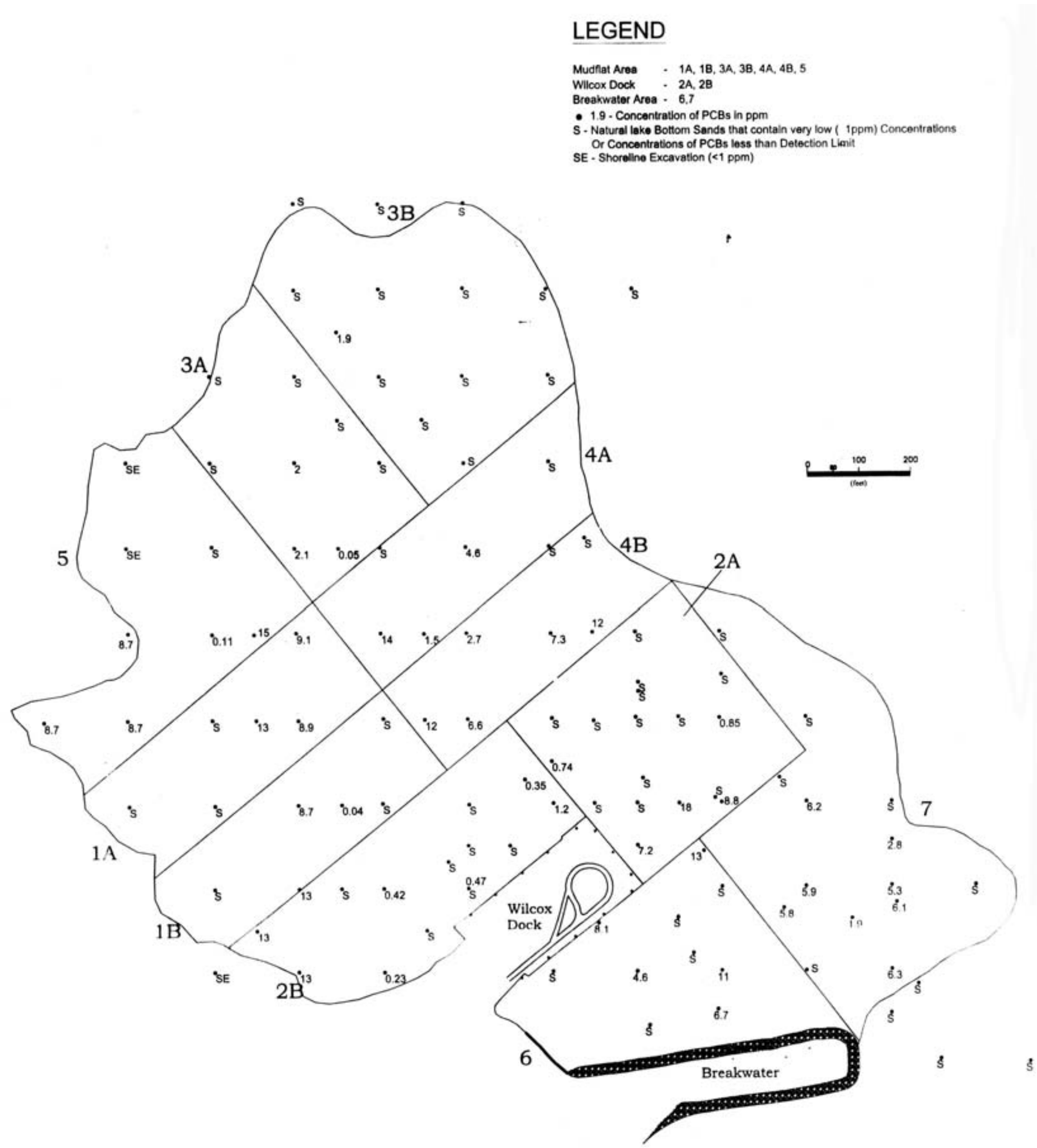
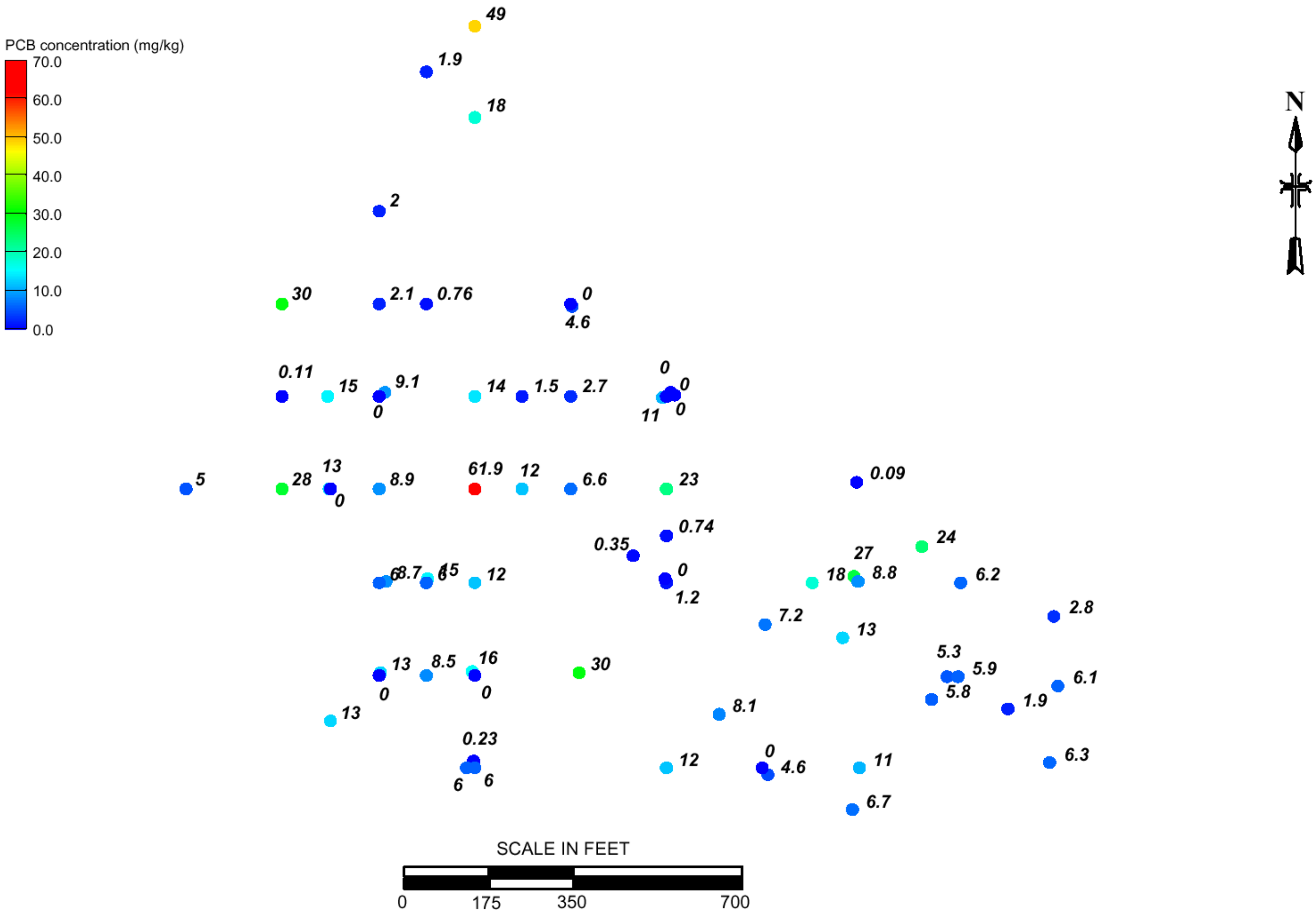


Figure 2-13
Cumberland Bay Semi-Variogram Analysis Variable Sample Spacing



From Department of Environmental Conservation (NYSDEC). 2002. Draft Final Construction Certification Report, Cumberland Bay Sludge Bed Removal and Disposal Contract (OU1), April 1999 – July 2001. Prepared by Earth Tech, Latham, New York. April 2002

Figure 2-13 (Cont'd)
Cumberland Bay Semi-Variogram Analysis Variable Sample Spacing



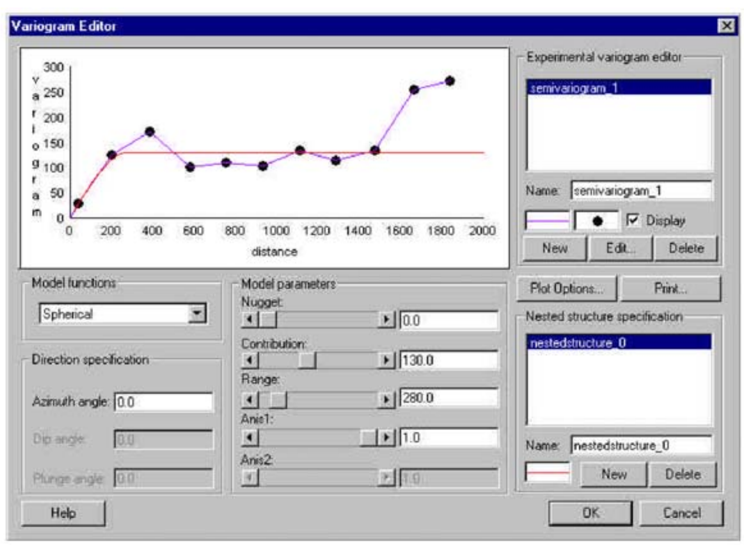
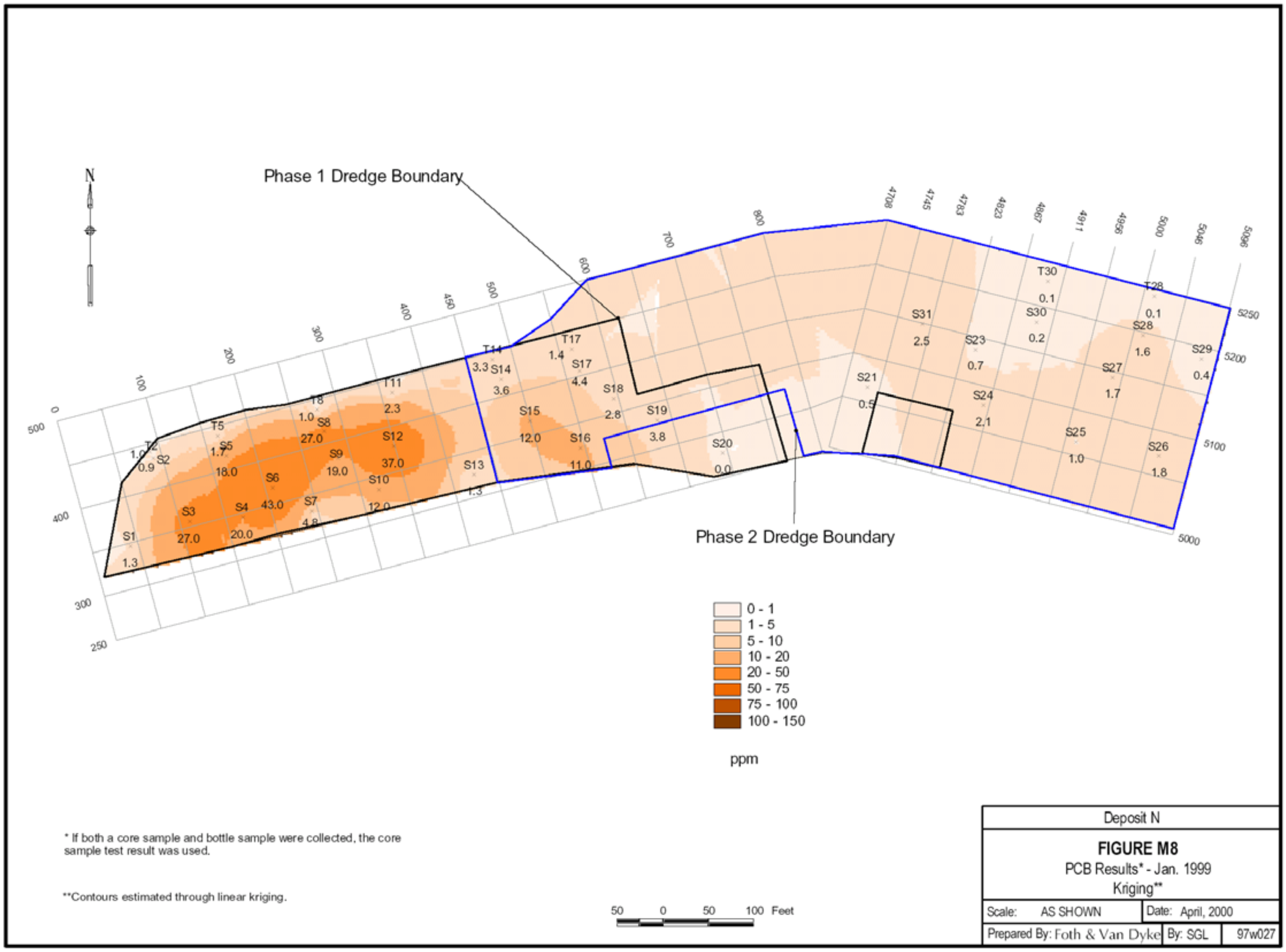
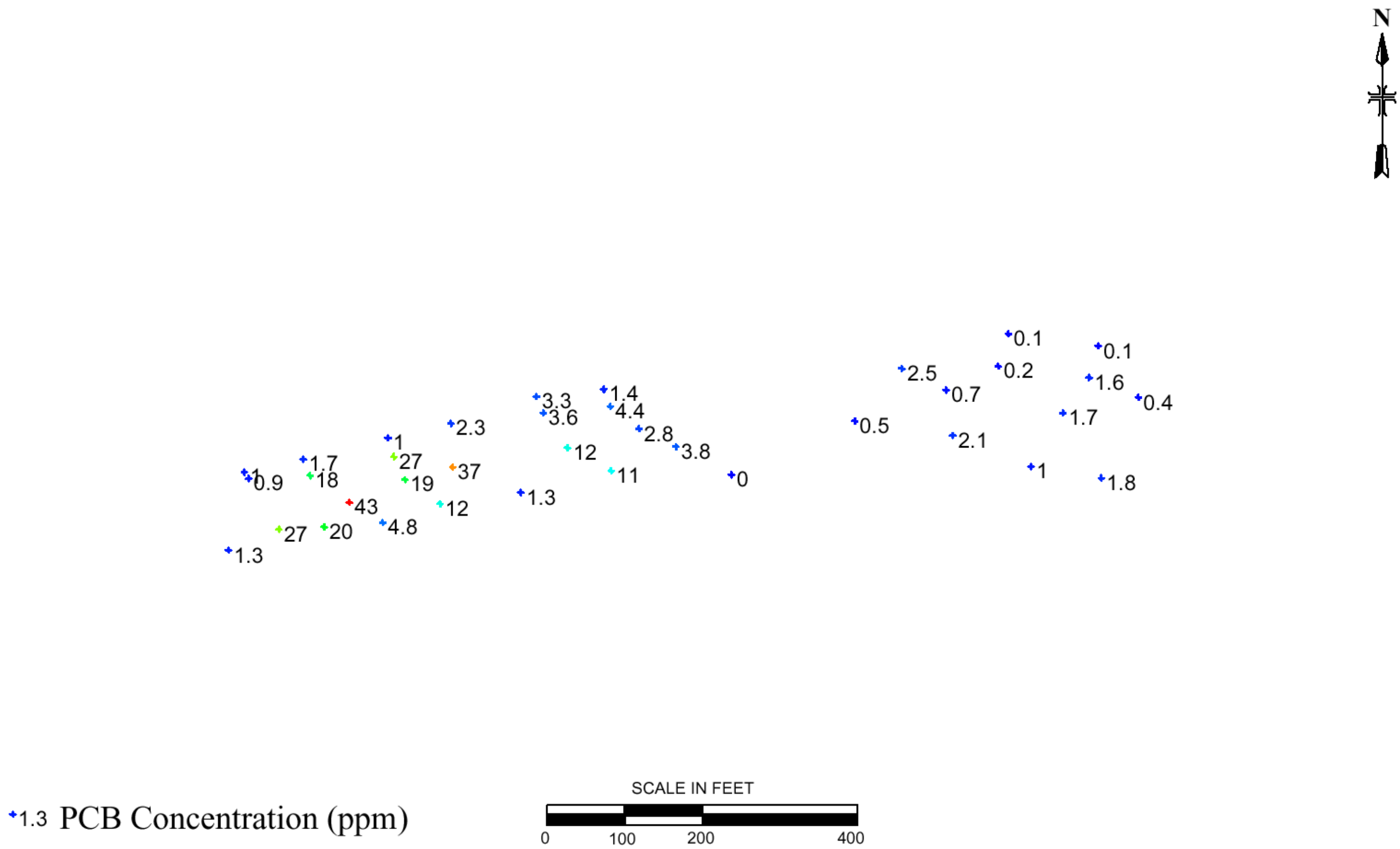


Figure 2-14
Fox River Deposit N Semi-Variogram Analysis Variable Sample Spacing



From Wisconsin Department of Natural Resources, 2000. Summary Report Fox River Deposit N. Prepared by Foth and Van Dyke. April 2000.

Figure 2-14 (Cont'd)
Fox River Deposit N Semi-Variogram Analysis Variable Sample Spacing



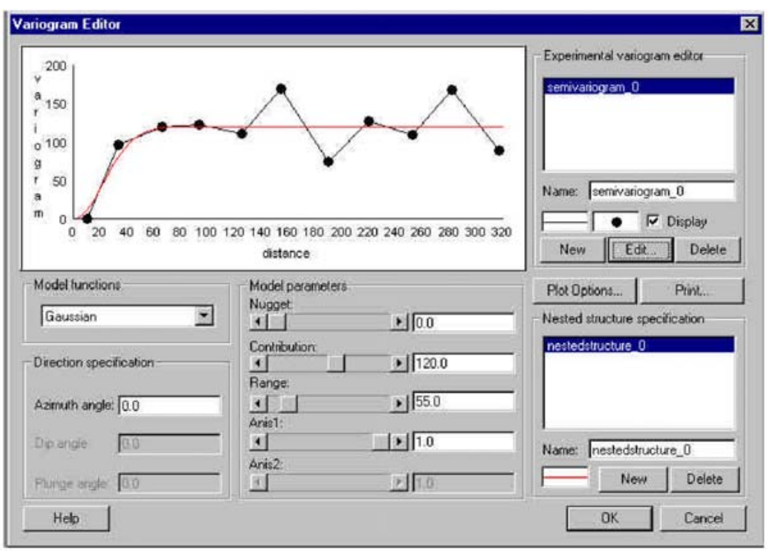
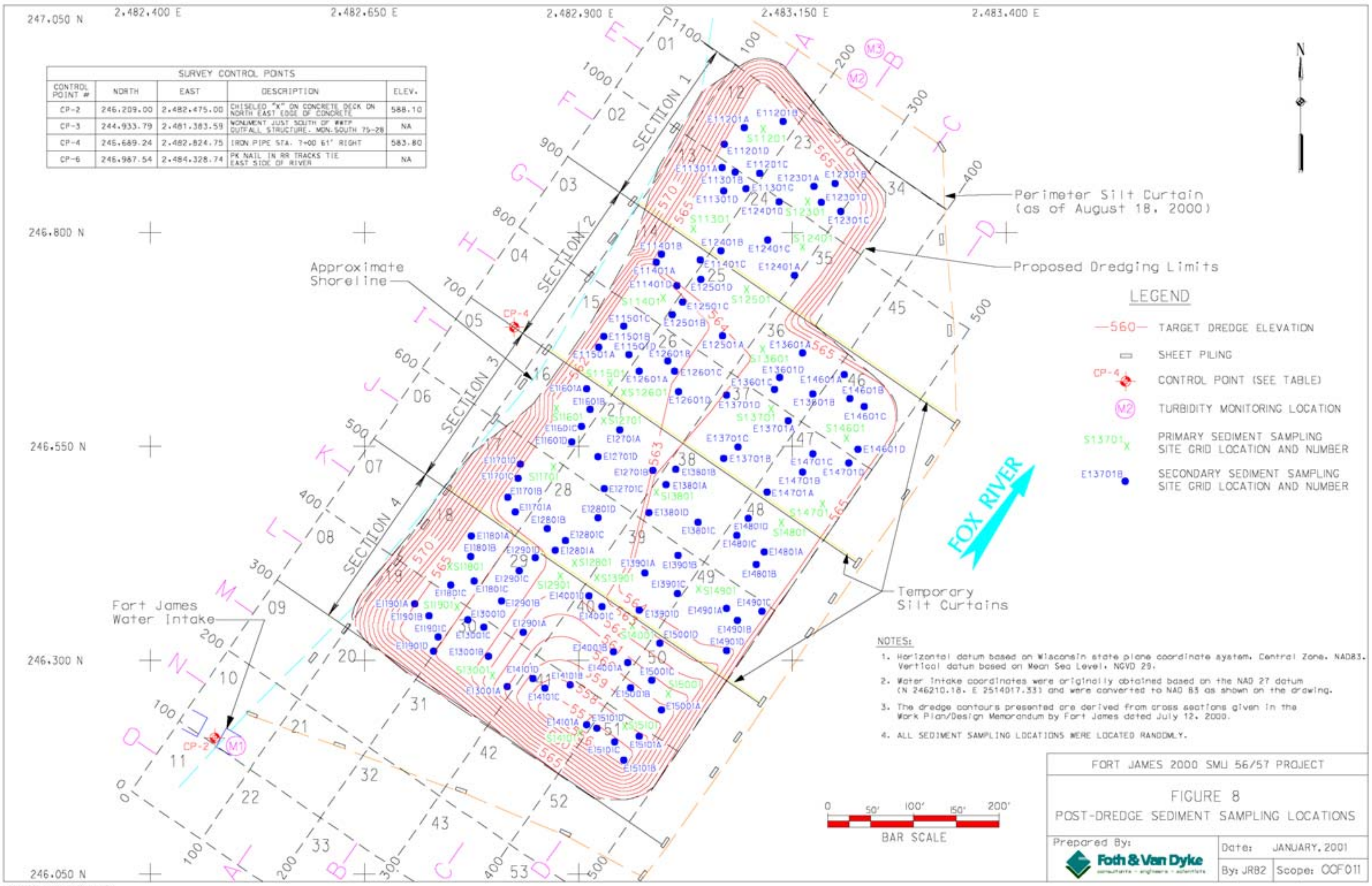
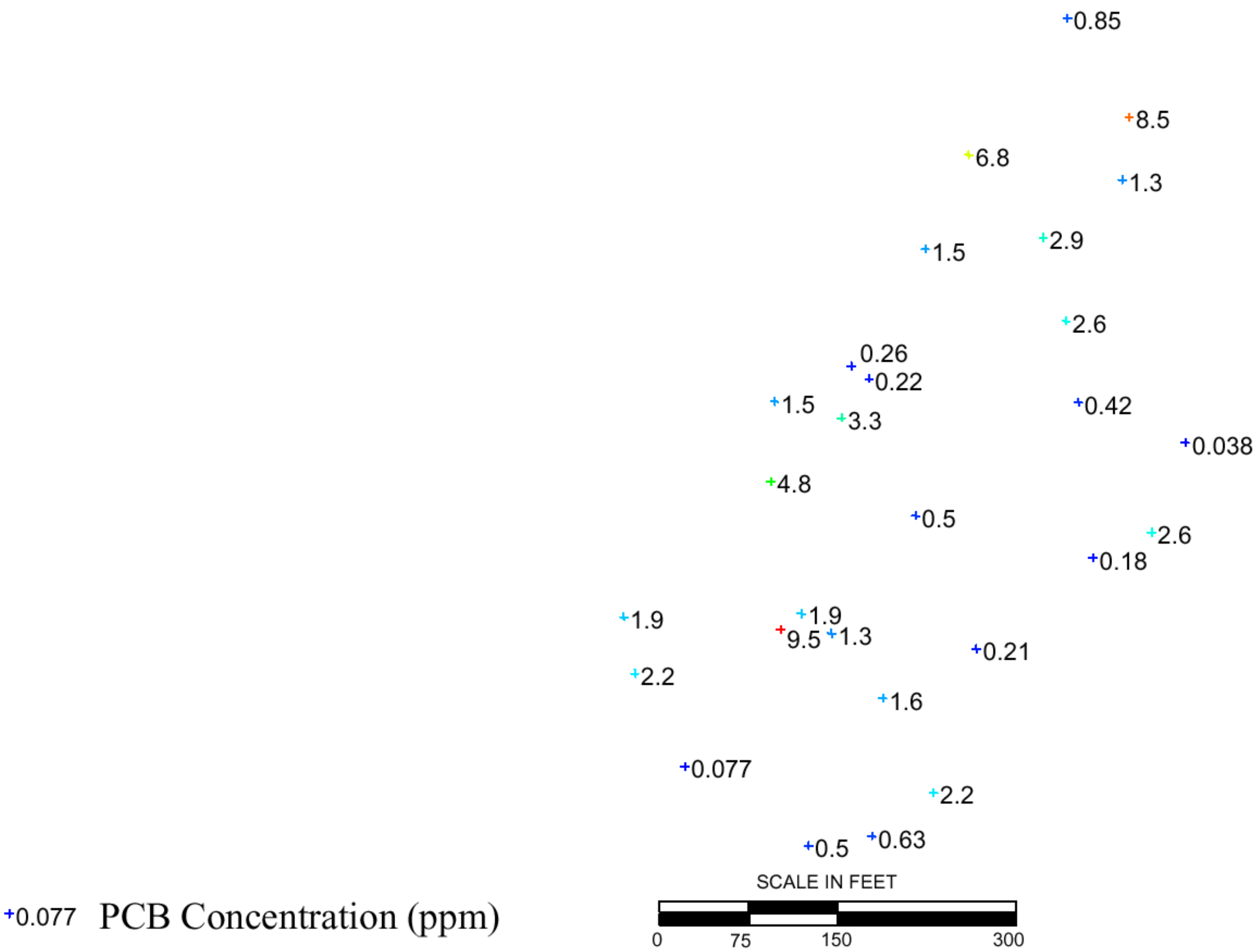


Figure 2-15
Fox River SMUs 56/57 Semi-Variogram Analysis Variable Sample Spacing



From Wisconsin Department of Natural Resources and United States Environmental Protection Agency, 2001. Final Report 2000 Sediment Management Unit 56/57 Project Lower Fox River, Green Bay, Wisconsin. Prepared by Fort James Corporation, Foth & Van Dyke and Hart Crowser, Inc. January 2001.

Figure 2-15 (Cont'd)
Fox River SMUs 56/57 Semi-Variogram Analysis Variable Sample Spacing



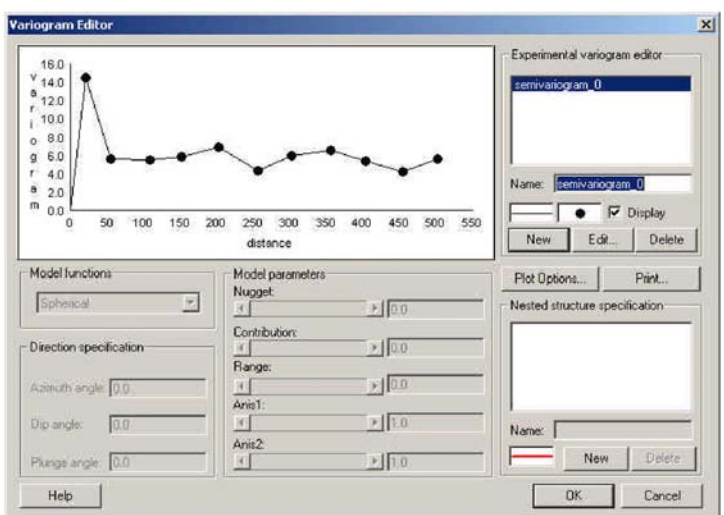
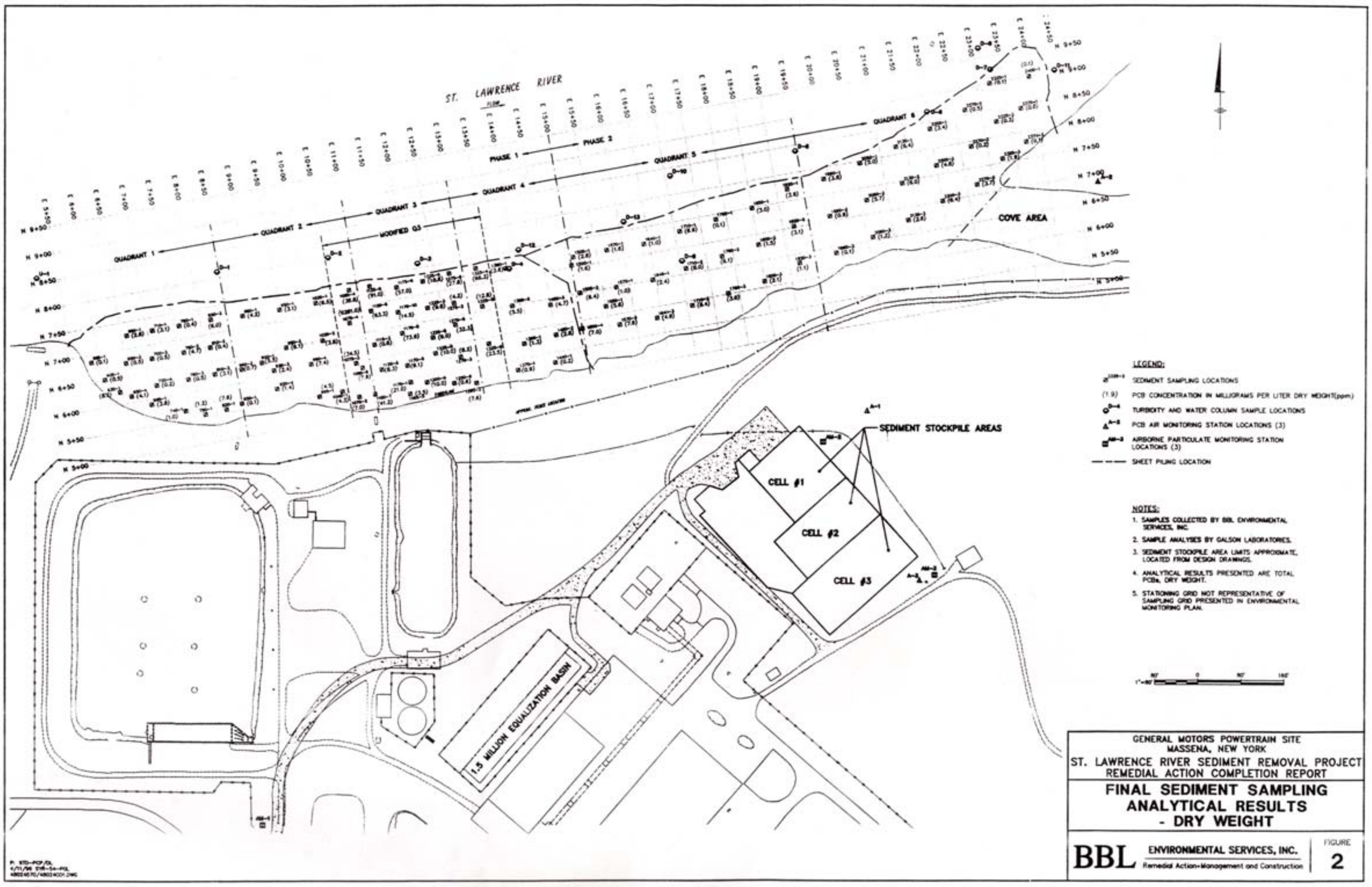
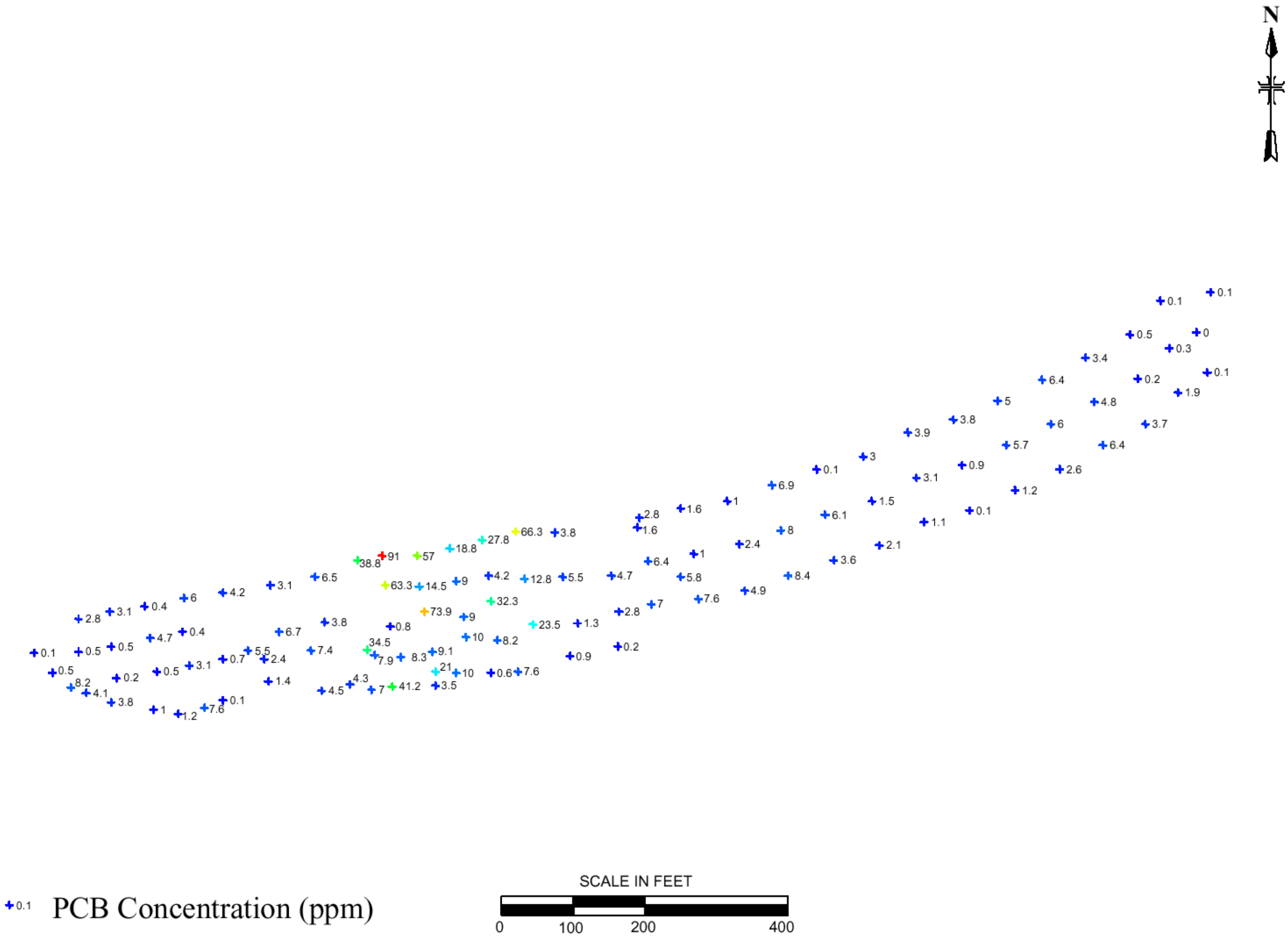


Figure 2-16
GM Massena Semi-Variogram Analysis Variable Sample Spacing



From BBL Environmental Services, Inc.1996. St. Lawrence River Sediment Removal Project Remedial Action Completion Report, General Motors Powertrain, Massena, New York. Prepared for General Motors Powertrain. June 1996.

Figure 2-16 (Cont'd)
GM Massena Semi-Variogram Analysis Variable Sample Spacing



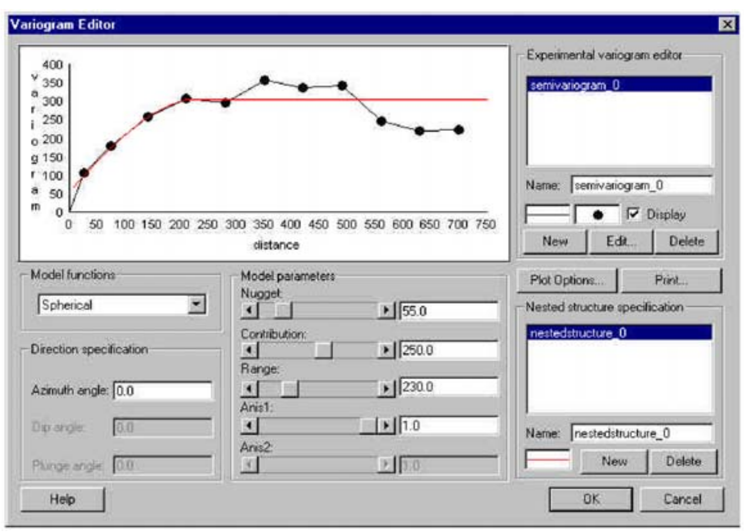
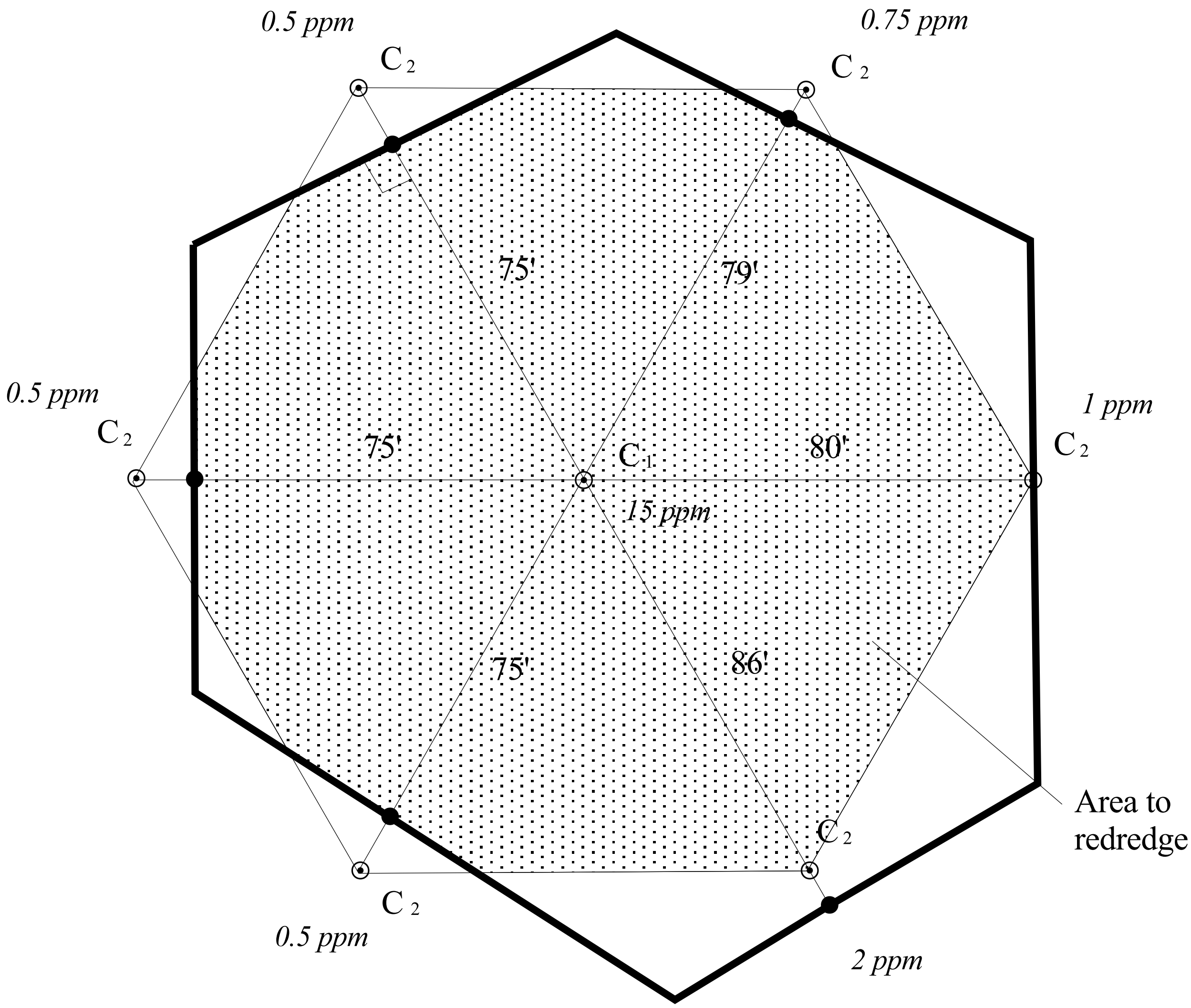


Figure 3-1
Example of Determining the Extent of Re-dredging



Notes: The distance (d) between the nodes is 80'.
Each side of the boundary is perpendicular to the axis between the nodes.
The non-compliant area will not extend beyond the hexagon formed by connecting the 6 surrounding nodes.
The drawing is conceptual and not to scale.

Attachment A

Draft Performance Standard for Dredging Residuals

Case Study Raw Residuals Data

All concentrations in parts per million (ppm)

Reynolds Metals (PCBs)					
0.04	0.5 U	0.5 U	0.5 U	0.93	1.60
0.05 U	0.5 U	0.5 U	0.5 U	0.93	1.70
0.05 U	0.5 U	0.5 U	0.5 U	0.94	1.72
0.05 U	0.5 U	0.5 U	0.5 U	0.97	1.74
0.05 U	0.5 U	0.5 U	0.5 U	1.00	1.77
0.05 U	0.5 U	0.5 U	0.5 U	1.01	1.79
0.05 U	0.5 U	0.5 U	0.5 U	1.03	1.80
0.05 U	0.5 U	0.5 U	0.5 U	1.04	1.80
0.05 U	0.5 U	0.5 U	0.5 U	1.07	1.86
0.05 U	0.5 U	0.5 U	0.5 U	1.07	1.90
0.05 U	0.5 U	0.5 U	0.5 U	1.09	1.93
0.05 U	0.5 U	0.5 U	0.5 U	1.09	1.99
0.11	0.5 U	0.5 U	0.5 U	1.10	2.05
0.12	0.5 U	0.5 U	0.5 U	1.12	2.32
0.13	0.5 U	0.5 U	0.5 U	1.13	2.48
0.14	0.5 U	0.5 U	0.5 U	1.14	2.60
0.14	0.5 U	0.5 U	0.5 U	1.18	2.84
0.15	0.5 U	0.5 U	0.5 U	1.20	2.86
0.15	0.5 U	0.5 U	0.586	1.22	2.90
0.18	0.5 U	0.5 U	0.6	1.23	2.90
0.18	0.5 U	0.5 U	0.61	1.23	2.91
0.18	0.5 U	0.5 U	0.624	1.24	3.09
0.19	0.5 U	0.5 U	0.651	1.24	3.44
0.20	0.5 U	0.5 U	0.67	1.26	3.65
0.21	0.5 U	0.5 U	0.683	1.26	3.93
0.23	0.5 U	0.5 U	0.689	1.30	3.94
0.26	0.5 U	0.5 U	0.692	1.31	4.19
0.27	0.5 U	0.5 U	0.696	1.37	4.37
0.28	0.5 U	0.5 U	0.696	1.37	6.94
0.29	0.5 U	0.5 U	0.7	1.40	7.14
0.29	0.5 U	0.5 U	0.717	1.44	7.73
0.30	0.5 U	0.5 U	0.719	1.45	11.1
0.31	0.5 U	0.5 U	0.741	1.45	11.1
0.32	0.5 U	0.5 U	0.745	1.46	11.4
0.32	0.5 U	0.5 U	0.773	1.47	14.1
0.33	0.5 U	0.5 U	0.78	1.49	14.7
0.36	0.5 U	0.5 U	0.797	1.50	19.4
0.40	0.5 U	0.5 U	0.811	1.50	20.1
0.40	0.5 U	0.5 U	0.835	1.50	24.0
0.42	0.5 U	0.5 U	0.835	1.52	28.1
0.48	0.5 U	0.5 U	0.847	1.53	44.2
0.49	0.5 U	0.5 U	0.866	1.54	75.3
0.5 U	0.5 U	0.5 U	0.889	1.55	120.5
0.5 U	0.5 U	0.5 U	0.901	1.59	5941

East Foundry Cove (Cadmium)	
1.1 U	9.7
0.1	10.1
1.8	10.2
2.3	10.9
2.3	10.9
2.7	11.4
2.9	11.6
3	12.1
3.6	12.2
3.8	12.6
4.1	12.8
4.1	13.2
4.5	13.3
4.6	14.1
4.6	14.2
5.1	14.3
5.3	14.6
5.4	15.3
5.6	15.5
6	16.4
6.1	17.9
6.5	18.1
6.5	19.3
6.6	19.8
6.6	20.1
6.8	20.3
7	21.6
7	22.4
7	23.4
7.3	23.4
7.4	24.2
7.6	25
7.6	25.1
8	25.7
8.5	26.5
8.7	26.9
8.7	30.2
8.7	37.9
8.7	45.2
8.9	51.6
9.1	88
9.2	
9.2	
9.5	

Cumberland Bay (PCBs)	
5	0.74
28	0.35
0.11	130
30	1.2
13	7.2
12.96	12
13	8.1
15	13
18.58	4.6
13	6.7
6	11
8.7	13
8.9	18
15	8.8
9.1	27
2.1	0.09
2	24
8.5	6.2
6	5.9
15	5.8
6	6.3
6	6.1
0.23	1.9
13.44	5.3
16	2.8
12	
61.92	
14	
0.76	
18	
1.9	
49	
1.5	
12	
30	
6.6	
2.7	
52	
4.6	
18	
7.3	
3.4	
11	
23	

Grasse River (PCBs)
1.1
12.7
22
34
51
55
71
86
91
130
150
260

GM Massena (PCBs)		
Uncapped Area		Capped Area
0.1	3.1	0.6
0.1	3.1	0.8
0.1	3.1	3.5
0.1	3.4	4.2
0.1	3.6	7
0.1	3.7	7.9
0.1	3.8	8.2
0.2	3.8	8.3
0.2	3.8	9
0.2	3.8	9
0.3	3.9	9.1
0.4	4.1	10
0.4	4.2	10
0.5	4.3	12.8
0.5	4.5	14.5
0.5	4.7	18.8
0.5	4.7	21
0.5	4.8	23.5
0.7	4.9	27.8
0.9	5	32.3
0.9	5.5	34.5
1	5.5	38.8
1	5.7	41.2
1	5.8	57
1.1	6	63.3
1.2	6	66.3
1.2	6.1	73.9
1.3	6.4	91
1.4	6.4	6281
1.5	6.4	
1.6	6.5	
1.6	6.7	
1.9	6.9	
2.1	7	
2.4	7.4	
2.4	7.6	
2.6	7.6	
2.8	7.6	
2.8	8	
2.8	8.2	
3	8.4	
3.1	U	

Fox River (PCBs)	
Deposit N	SMU 56/57
U	0.038 U
0.1	0.077
0.1	0.18
0.2	0.21
0.4	0.22
0.5	0.26
0.7	0.42
0.9	0.5
1.0	0.5
1.0	0.63
1.0	0.85
1.3	1.3
1.3	1.3
1.4	1.5
1.6	1.5
1.7	1.6
1.7	1.9
1.8	1.9
2.1	2.2
2.3	2.2
2.5	2.6
2.8	2.6
3.3	2.9
3.6	3.3
3.8	4.8
4.4	6.8
4.8	8.5
11	9.5
12	
12	
18	
19	
20	
27	
27	
37	
43	

New Bedford Harbor (PCBs)	
Cores (0-1')	Grabs
0.67	0.47
3.8	6.8
7.7	18
7.9	23
8.5	29
8.6	37
10	41
13	50
14	50
16	50
17	64
19	98
28	110
36	110
56	120
65	130
82	140
130	140
	160
	160
	160
	200
	230
	240
	250
	260
	260
	260
	270
	280
	280
	310
	420
	450
	470
	470

TAMS,
An Earth Tech Company

Interoffice Memorandum

To: Residuals Team | Location: | Date: December 2, 2002

From: Claire Hunt | Location: NJO | Job No.: 56513

Subject: New Bedford Harbor Pre Design Field Test Residuals Results

At New Bedford Harbor, a Pre-Design Field Test was performed to evaluate a dredge system. A hydraulic excavator equipped with a slurry-processing unit was selected for this study. One objective of this test was to evaluate the dredge performance relative to removal of the PCB-contaminated sediment. This objective was assessed by the ability to remove the sediments to a given depth horizon and the effectiveness of the contaminant removal. The effectiveness of contaminant removal was judged on the basis of pre and post-dredge sample concentrations.

Pre-dredge cores were collected on a grid within the 100 x 400 foot test area. The cores were sectioned into one-foot segments down to four feet below the sediment surface. One-foot deep post-dredge cores were collected to assess the removal efficiency. The regular spacing of the samples allowed the data to be mapped using geostatistical methods. A total of 23 pre-dredging and 18 post-dredging cores were collected.

Post-dredge 0-2 cm grabs were also collected at each coring location. A total of 23 post-dredging grabs were collected. These sample results were taken to assess the amount of recontamination of the surface from suspension of material during dredging and sloughing of the sediment adjacent to the target area. Recontamination from suspended material was considered likely because the sediment is high in silt and clay content with high water content.

Using geostatistical methods, it was estimated that the1,539 kg of PCBs were contained within the top 3 feet of sediment. The majority of the inventory (1,281 kg) was contained within the top foot, with lower amounts below (220 kg 1-2 feet and 38 kg 2-3 feet). Post dredging, it was estimated that only 44 kg of PCBs remained in the target area. This is equivalent to a 97% removal efficiency.

Pre dredging, the average concentration in the 0-1 foot layer was 857 ppm. The deeper layers had lower concentrations of 147 ppm in the 1-2 foot layer and 26 ppm in the 2-3 foot layer. Post dredging, the top 0-1 foot layer had a concentration of 29 ppm, which is only 3% of the pre-dredge 0-1 foot concentration.

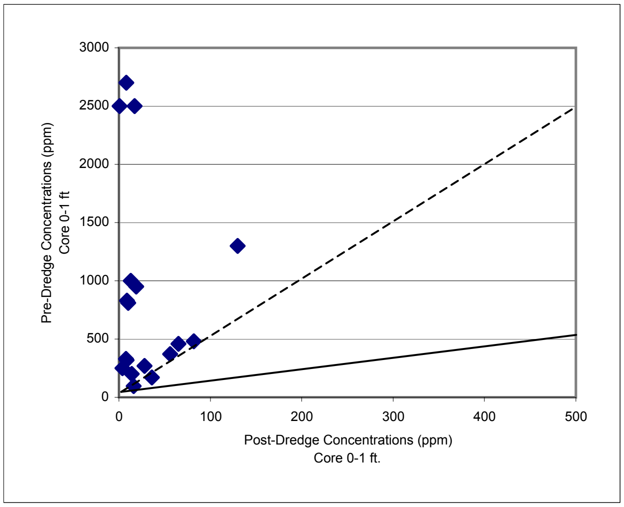
The PCB concentrations of the pre and post dredging samples are graphed for each location in Figure A-1. The top two graphs show the post dredging core results versus the 0-1 foot pre-dredge concentration and the maximum pre-dredge concentration. For all locations the concentration post dredging decreased (all points are above the solid line). In addition, most locations show at least an 80% reduction in concentration (all points except one are above the dashed line). The bottom two graphs show the post dredging grab results versus the 0-1 foot pre-dredge concentration and the maximum pre-dredge concentration. For the surface layer, there are locations that show increased concentrations over the pre-dredge concentrations (points below the solid line). There are numerous locations with concentrations that have less than an 80% reduction in concentration (points below the dashed line). If the predredging concentrations were approximately 50 ppm, all points below the dashed line would have concentrations in excess of 10 ppm.

The results of these grab samples have implications for the method of sampling for residuals. A thin veneer of highly concentrated material may be present on the surface post dredging. It would be difficult to develop a threshold for this layer that was achievable and not unreasonably high. This layer, though highly concentrated does not have an impact on the inventory or the 0-1 foot concentration both of which showed a 97% reduction. Because this layer does not have an appreciable impact on concentration, it is more reasonable to measure the concentration in the 0-6 inch layer. From an engineering perspective, 6 inches is likely to be the minimum re-dredge depth for most dredges.

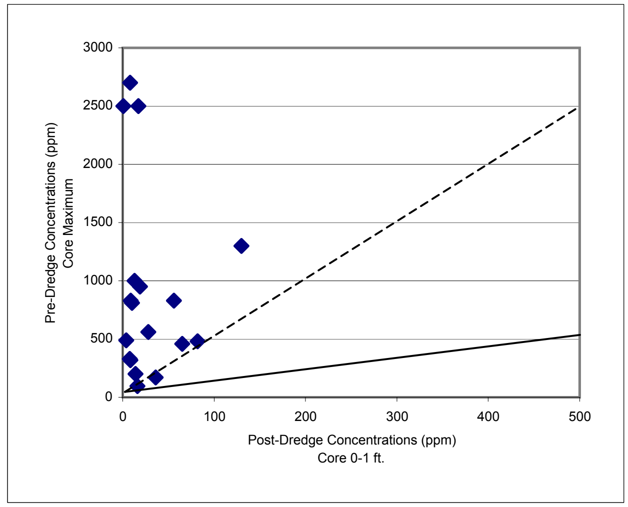
Ignoring this veneer of contamination will leave behind a portion of the inventory. Solving for the concentration in the top 2 cm of a sample, where the remainder of the 0-6 inch sample has a concentration of 1, and the length-weighted concentration of the 0-6 inch sample is 1.5 ppm, the concentration of the top 2 cm cannot exceed 4.81 ppm. Assuming a surface concentration of 4.81 ppm in a layer 2 cm thick, with a density of 1.1 g/cc for the entire 266 acres of the Thompson Island Pool, 114 kg or 0.44% of the approximately 26,000 kg of PCBs estimated to be contained in the sediments would remain. This contamination will be contained and diluted by backfill.

Figure A-1
New Bedford Harbor Pre- and Post-Dredging Residuals Concentrations

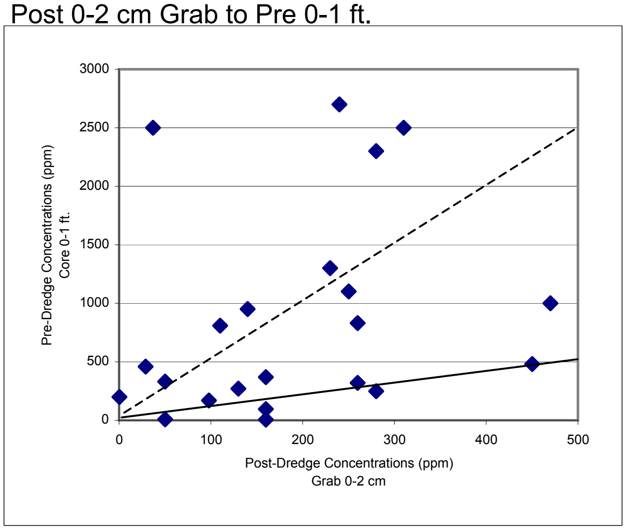
Post 0-1 ft. to Pre 0-1 ft.



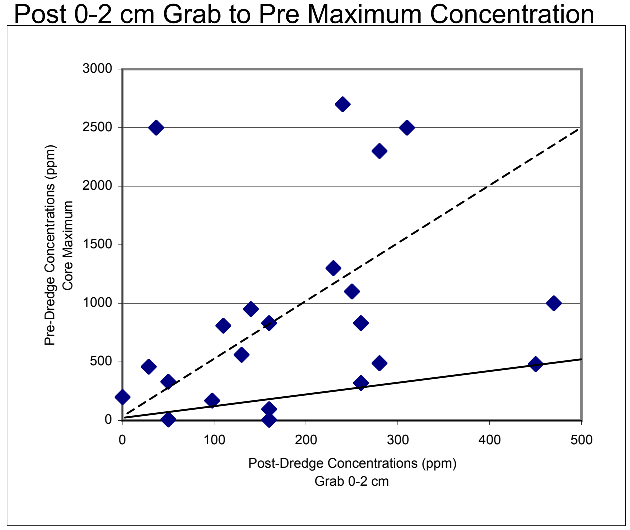
Post 0-1 ft. to Pre Maximum Concentration



Post 0-2 cm Grab to Pre 0-1 ft.



Post 0-2 cm Grab to Pre Maximum Concentration



Solid line - points below this line have increased concentrations post dredgin
Dashed line - points below this line have concentrations that are at least one-fifth the initial concentration.
If the initial concentration was 50 ppm, points below this line would be more than 10 ppm.