
ANNUAL MONITORING REPORT

October 1988 - September 1989

USS DULUTH WORKS SITE

Prepared for
USS, a Division of USX Corporation

January 1990

By
Barr Engineering Co.
Minneapolis, Minnesota

ANNUAL MONITORING REPORT
OCTOBER, 1988 - SEPTEMBER, 1989
USS DULUTH WORKS SITE

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1
2.0 HYDROGEOLOGIC CONDITIONS	1
3.0 WATER QUALITY MONITORING PROGRAM	2
4.0 ANALYTICAL RESULTS	3
4.1 PAH and Phenolic Compounds	3
4.2 General Parameters	4
4.3 Metals	5
4.4 Field Data	5
5.0 QUALITY CONTROL REVIEW	5
6.0 RECOMMENDED MONITORING PLAN FOR 1990	6

TABLES

FIGURES

APPENDIX A Laboratory Data Reports
APPENDIX B Water Quality Graphs

ANNUAL MONITORING REPORT
OCTOBER, 1988 - SEPTEMBER, 1989
USS DULUTH WORK SITE

1.0 INTRODUCTION

The site of the former Duluth Works is located in the southern portion of the City of Duluth in St. Louis County, Minnesota. The Duluth Works was an integrated steel mill (coke production, steel production and finishing, and materials storage) that ended operation in May, 1979. The site is located adjacent to the St. Louis River estuary. A small stream with a 2.8 square mile drainage area flows through the northern portion of the site, immediately north of the former coke plant. The valley of this stream was used as a settling basin to dispose of wastes from operations at the coke plant. A small settling basin in the southern portion of the site was used to dispose of wastes from operations at the wire mill.

Routine water quality monitoring at the USS Duluth Works site began in September, 1985 in accordance with the Monitoring Plan contained in the May, 1985 document entitled "Plans Submitted Pursuant to Part IV and Part V, Task A to Exhibit A, March 26, 1985 Response Order by Consent, U.S. Steel Duluth Works Site" and as amended in the recommendations of the October, 1986 - September, 1987 Annual Monitoring Report. The following sections summarize the results of water quality monitoring during the period from October, 1988 to September, 1989.

2.0 HYDROGEOLOGIC CONDITIONS

The geologic and hydrogeologic setting of the USS Duluth Works Site is summarized in the May, 1985 Barr Engineering Co. report.

As part of the annual monitoring program, water levels were measured in the monitoring wells prior to purging of the wells and collection of samples. The groundwater elevations at the monitoring wells are shown in Figure 1. Surficial groundwater contours were constructed from water level data collected in June, 1989 (Table 1). Groundwater flow under the site is generally to the east toward the St. Louis River estuary. However, the stream that flows through the northern portion of the site also acts as a groundwater discharge zone for the northern portion of the site.

3.0 WATER QUALITY MONITORING PROGRAM

Sampling of monitoring wells and surface water stations at the USS Duluth Work Site was conducted in accordance with the procedures specified in the Quality Assurance/Quality Control Plan in the May, 1985 report and as amended in the recommendations of the October, 1987 - September, 1988 Annual Monitoring Report. The sampling locations are shown in Figure 2.

Samples were collected quarterly (December, March, June, and September) at Surface Stations CP-1, CP-2, CP-3, WM-1, and Seep 1. Samples were collected in June at Monitoring Wells W-6, W-7, W-8, W-9, and W-10.

Samples collected from the monitoring wells and surface stations were analyzed for the parameters in Table 2. Monitoring for phenolic compounds continued at Seep 1 and CP-3 during the third quarter of 1988. Samples collected in June, 1988 at Wells W-11, W-12, and W-13 were also analyzed for chloride.

Specific conductance, temperature, and pH were measured in the field immediately after collection of each sample.

4.0 ANALYTICAL RESULTS

Laboratory data reports for the analysis of samples collected at the USS Duluth Works Site during the period from October, 1988 to September, 1989 are in Appendix A.

4.1 PAH and Phenolic Compounds

The results of analysis of samples for PAH and phenolic compounds are presented in Table 3. The geographical distribution of PAH compounds at monitoring wells and surface stations in June, 1988 is shown in Figure 3. Geographical distributions for the analytical program parameters are shown for the June sampling event because this was the only sampling event where all monitoring wells were sampled.

PAH compounds included in the monitoring program are divided into two groups, List 1 and List 2. The List 1 compounds are suspected carcinogens and the List 2 are not suspected carcinogens. The highest concentrations of List 1 and List 2 PAH compounds were found in Monitoring Wells W-6 and Surface Stations CP-2, CP-3, Seep 1, and WM-1. The monitoring wells in the vicinity of the demolition landfill contained no detectable concentrations of List 1 compounds and low concentrations of List 2 compounds (<0.1 µg/L).

Phenolic compounds were not detected in either of the samples collected during the monitoring period (CP-3 and Seep 1).

Graphs illustrating the concentration of List 1 and List 2 PAH compounds in the surficial aquifer and surface waters during the period from 1985 to 1989 are shown in Appendix B. There has not been an apparent change in concentrations of List 1 or List 2 compounds in any of the monitoring wells or surface stations during the last 4 years.

4.2 General Parameters

General parameters in the monitoring program included total organic carbon, ammonia-nitrogen, cyanide, sulfate, and thiocyanate for all stations. Wells W-11, W-12, and W-13 were also analyzed for oxygen demand and total dissolved solids. The results of analysis of samples for general parameters are presented in Table 4. The geographic distribution of five general parameters (ammonia-nitrogen, total cyanide, thiocyanate, sulfate, total organic carbon) at monitoring wells and surface stations in June, 1989 are shown in Figure 4.

The concentrations of most general parameters in samples collected from monitoring stations at the site were low and demonstrated little spatial or temporal variability. The water quality standard for total cyanide in surface waters was exceeded at Surface Station CP-3 during one out of four sampling events. Sulfate levels in samples collected from Monitoring Well W-12 was higher than sulfate levels at other monitoring wells and surface stations.

Thiocyanate and sulfate were selected as indicator parameters for purposes of determining changes in contaminant concentrations with time. These parameters are considered possible indicators of groundwater and surface water contamination at the site for the following reasons: 1) the parameters have been consistently detected at elevated levels at the surface stations and monitoring wells at the site, and 2) thiocyanate and sulfate were major constituents of waste generated at the former steel mill. Graphs illustrating the concentration of thiocyanate and sulfate in the surficial aquifer and surface waters during the period from 1985 to 1989 are shown in Appendix B. There were not apparent changes in concentrations of sulfate and thiocyanate at the monitoring stations during the period from 1985 to 1988. The one possible exception is an increase in sulfate in the coke plant stream concentration of sulfate. This possible increase has been observed in both

the upstream (CP-1) station and the downstream stations (CP-2 and CP-3) and is therefore likely not related to the site.

4.3 Metals

Metals included in the monitoring program were unfiltered or total metals. Unfiltered samples were collected for analysis of metals at the surface stations in December, 1989.

The analytical results of samples for metals are presented in Table 5. The geographical distribution of five filtered metals (arsenic, chromium, lead, nickel, and zinc) at monitoring wells and surface stations in June, 1989 are shown in Figure 5.

The concentration of metals in samples collected at the site during the monitoring periods were below the RALs for drinking water.

4.4 Field Data

Results of field analysis of samples for specific conductance, temperature and pH are in Table 6.

5.0 QUALITY CONTROL REVIEW

Quality control procedures used in the collection and analysis of samples are described in the Quality Assurance/Quality Control Plan in the May, 1985 report. A review of the quality control data was conducted to assess the integrity of the sampling procedures and analytical results for samples collected during the annual monitoring program at the USS Duluth Works Site.

Field blank samples were collected during each sampling event and analyzed for PAH compounds and metals. The result of analysis of field blank

samples for PAH compounds and metals are presented in Tables 7 and 8, respectively. Detectable levels of metals and PAH compounds in the field blanks were used to determine possible false positive values in the water quality monitoring data. Potential false positive values in the data were defined as concentrations less than or equal to the amount described in the field blank. These values are footnoted with an "s" in the water quality monitoring data tables.

A blind duplicate or masked sample was collected at one monitoring station during each sampling event. The duplicate samples were analyzed for PAH compounds. Table 9 shows the analytical results of blind duplicate samples. Coefficients of variation were computed for each duplicate pair and are shown in Table 10. A coefficient of variation less than 0.25 is generally considered an indication of acceptable reproducibility of analytical results by the laboratory.

6.0 RECOMMENDED MONITORING PLAN FOR 1990

During 1990, it is anticipated that the Response Action Plan (RAP) for the site will be prepared. Part of the RAP is a recommended long-term monitoring plan for the site. Because the scope of the monitoring program will be evaluated as part of the RAP, no modifications to the existing plan will be prepared as part of this annual data report.

The monitoring program as specified in the May, 1985 Barr Engineering Co. report with the modifications recommended and approved in the October, 1986 - September, 1987 Annual Monitoring Report will continue to be the routine water quality monitoring plan for the USS Duluth Works Site during 1990 until the long-term monitoring plan is prepared as part of the RAP for the site.

TABLES

TABLE 1

GROUNDWATER ELEVATIONS
 (Elevations in Feet/MSL)

<u>Location</u>	<u>Elevation</u> <u>6/21-22/89</u>
W6	606.35
W7	620.75
W8	618.64
W9	619.02
W10	614.49
W11	615.09
W12	609.17
W13	622.80

TABLE 2
ANALYTICAL PROGRAM PARAMETERS

PAH and Heterocycles

benzo(a)anthracene	anthracene
dibenzo(ah)anthracene	fluoranthene
benzo(b)fluoranthene*	pyrene
benzo(a)pyrene	benzo(k)fluoranthene*
quinoline	benzo(e)pyrene
indeno(1,2,3-dc)pyrene	perylene
chrysene*	acridine
benzo(ghi)perylene	carbazole
indene	2,3-benzofuran
2,3-dihydroindene	dibenzofuran
naphthalene	benzo(b)thiophene
1-methylnaphthalene	dibenzothiophene
2-methylnaphthalene	indole
biphenyl	3-methylcholanthrene
acenaphthylene	triphenylene*
acenaphthene	phenanthridine
fluorene	isoquinoline
phenanthrene	

Phenols

phenol	4-nitrophenol
o-cresol	2,4-dinitrophenol
m-cresol and p-cresol*	4,6-dinitro-o-cresol
2-nitrophenol	2,4-dimethylphenol

Metals

chromium (total)
lead
nickel
zinc
arsenic

General Parameters

sulfate
ammonia
cyanide
thiocyanate
total organic carbon

*These compounds coelute and are structural isomers (benzo(b)fluoranthene with benzo(k)fluoranthene; chrysene with triphenylene; and m-cresol with p-cresol) and therefore cannot be individually quantified.

TABLE 3

WATER QUALITY MONITORING DATA
PAH AND PHENOLIC COMPOUNDS

(concentrations in ug/L)

	CP 1				CP 2			
	12/13/88	03/23/89	06/21/89	09/11/89	12/13/88	03/23/89	06/21/89	09/11/89
Quinoline	0.023	<0.0010	<0.0010	<0.0010	0.081	4.0	<0.0010	<0.040
Benzo(a)anthracene	<0.010	0.0020	0.0035	<0.0010	0.054	0.83	0.065	1.8
Chrysene	<0.010	<0.0010	0.0038 c	<0.0010	0.053 c	0.72 c	0.063 c	1.6 c
Benzo(b)fluoranthene	<0.010	<0.0010	<0.0010	<0.0010	<0.010	1.2 c	0.070 c	2.5 c
Benzo(a)pyrene	<0.010	<0.0010	<0.0010	<0.0010	<0.010	0.63	0.031	1.4
Indeno(1,2,3,cd)pyrene	<0.017	<0.0017	<0.0017	<0.0017	<0.017	0.36	0.023	0.98
Dibenzo(ah)anthracene	<0.014	<0.0014	<0.0014	<0.0014	<0.014	0.11	<0.0014	<0.056
Benzo(ghi)perylene	<0.010	<0.0010	<0.0010	<0.0010	<0.010	0.41	<0.010	<0.040
Sum List 1	0.023	ND	0.0073	ND	0.19	8.3	0.27	8.3
2,3-Benzofuran	DLND	0.0062	DLND	0.0058	DLND	0.18	DLND	DLND
2,3-Dihydroindene	<0.014	0.17	0.012	0.023	<0.014	0.32	0.011	<0.056
Indene	<0.010	0.045	0.014	0.011	<0.010	1.0	0.025	<0.040
Naphthalene	0.030	0.054	0.11	0.015	0.015	0.077	0.0066	0.16
Benzo(b)thiophene	0.042	<0.0010	<0.0010	0.0036	0.063	0.47	0.032	0.065
Isquinoline	0.071	DLND	DLND	DLND	0.21	2.1	DLND	DLND
Indole	<0.029	<0.0029	<0.0029	<0.0029	<0.029	<0.073	<0.0029	<0.12
2-Methylnaphthalene	<0.020	0.0046 s	0.0055	0.0033	<0.020	0.25	<0.0020	<0.080
1-Methylnaphthalene	<0.010	0.020	0.0048	0.0042	<0.010	1.7	<0.0010	<0.040
Biphenyl	<0.010	0.0023 s	0.0020	<0.0010	0.073	0.80	0.024	<0.040
Acenaphthylene	<0.010	0.0063	0.013	0.0049	0.59	3.6	0.0084	0.17
Acenaphthene	0.035	<0.0013	0.0058	0.0035	0.56	2.3	0.049	0.48
Dibenzofuran	0.020	0.0074	0.0083	0.0039	0.41	3.2	<0.0020	0.20
Fluorene	0.021	0.013	0.016	0.0064	0.26	4.9	0.25	0.40
Dibenzothiophene	DLND	0.0043	DLND	DLND	0.034	0.39	0.028	0.18
Phenanthrene	0.022	0.025	0.018	0.0057	0.032	3.5	0.074	2.1
Anthracene	<0.010	<0.0010	<0.0010	0.0019	0.10	1.2	0.12	0.96
Acridine	<0.018	<0.0018	<0.0018	<0.0018	0.32	1.2	<0.0018	0.22
Phenanthridine	<0.014	<0.0014	<0.0014	<0.0014	0.071	0.42	<0.0014	<0.056
Carbazole	0.063	0.028	0.011	0.0076	0.19	3.6	0.014	0.13
Fluoranthene	0.018	0.018	0.017	0.0069	0.99	3.8	1.2	8.1
Pyrene	0.019	0.012	0.011	0.0063	0.70	2.6	0.67	5.1
Triphenylene	<0.010	<0.0010	0.0038 c	<0.0010	0.053 c	0.72 c	0.063 c	1.6 c
Benzo(k)fluoranthene	<0.010	<0.0010	<0.0010	<0.0010	<0.010	1.2 c	0.070 c	2.5 c
7,12-Dimethylbenz(a)anthracene	DLND	DLND	DLND	DLND	DLND	DLND	DLND	DLND
Benzo(e)pyrene	<0.010	<0.0010	<0.0010	<0.0010	<0.010	0.29	0.023	0.68
Perylene	<0.010	<0.0010	<0.0010	<0.0010	<0.010	0.14	0.0078	0.34
3-Methylcholanthrene	DLND	DLND	DLND	DLND	DLND	DLND	DLND	DLND
Sum List 2	0.34	0.42	0.25	0.11	4.6	38	1.3	19

c Coeluting isomer. Concentration reported is total of the coeluting compound.
s Possible false positive value based on review of quality control data.
ND None detected.
DLND Not detected. Detection limit not determined.

.001

TABLE 3 (cont.)

WATER QUALITY MONITORING DATA
PAH AND PHENOLIC COMPOUNDS

(concentrations in ug/L)

	CP 3				WM 1			
	12/13/88	03/23/89	06/22/89	09/11/89	12/13/88	03/23/89	06/22/89	09/11/89
Quinoline	<0.010	3.1	<0.0040	<0.0080	<0.0020	<0.020	<0.0010	<0.0080
Benzo(a)anthracene	<0.010	<0.025	0.14	0.10	0.042	<0.020	0.0055	<0.0080
Chrysene	<0.010	<0.025	0.12 c	0.072 c	0.053 c	<0.020	0.0084 c	<0.0080
Benzo(b)fluoranthene	<0.010	<0.025	0.15 c	0.076 c	0.068 c	<0.020	<0.0010	<0.0080
Benzo(a)pyrene	<0.010	<0.025	0.061	0.040	0.015	<0.020	<0.0010	<0.0080
Indeno(1,2,3,cd)pyrene	<0.017	<0.043	<0.0068	<0.014	<0.0034	<0.034	<0.0017	<0.014
Dibenzo(ah)anthracene	<0.014	<0.035	<0.0056	<0.011	<0.0028	<0.028	<0.0014	<0.011
Benzo(ghi)perylene	<0.010	<0.025	<0.0040	<0.0080	<0.0020	<0.020	<0.0010	<0.0080
Sum List 1	ND	3.1 ✓	0.46 47	0.29 ✓	0.18	ND	0.014	ND
2,3-Benzofuran	0.026	0.20	0.011	DLND	DLND	DLND	0.019	0.0081
2,3-Dihydroindene	0.033	0.40	<0.0056	<0.11	0.21	0.50	0.052	0.026
Indene	0.028	2.0	0.024	0.023	0.11	0.024	0.064	0.12
Naphthalene	0.014	0.36	0.010	<0.015	0.19	<0.038	0.12	<0.015
Benzo(b)thiophene	0.040	0.63	0.015	0.070	0.022	<0.020	0.011	0.011
Isoquinoline	DLND	1.2	DLND	DLND	DLND	DLND	DLND	DLND
Indole	<0.029	<0.073	<0.012	<0.023	0.021	<0.058	<0.0029	<0.023
2-Methylnaphthalene	<0.020	0.44	<0.0080	<0.016	0.014	<0.040	0.0057	<0.016
1-Methylnaphthalene	0.041	1.4	<0.0040	<0.0080	0.066	0.056	0.0080	<0.0080
Biphenyl	0.12	0.68	0.019	<0.0080	0.025	0.029	0.0064	<0.0080
Acenaphthylene	0.41	2.8	0.085	0.051	0.054	<0.020	0.0064	0.0089
Acenaphthene	0.46	1.7	0.081	0.18	1.7	1.2	0.11	0.18
Dibenzofuran	0.45	3.0	0.012	0.026	0.56	0.44	0.035	0.039
Fluorene	0.52	4.3	0.19	<0.11	0.39	0.99	0.16	0.034
Dibenzothiophene	0.054	0.33	0.013	0.041	0.033	0.073	0.013	DLND
Phenanthrene	0.0072	2.2	0.070	0.033	0.16	0.096	0.056	<0.0080
Anthracene	0.099	0.72	0.085	0.019	0.028	0.027	0.012	<0.0080
Acridine	0.072	1.0	<0.0072	0.18	<0.0036	<0.036	<0.0018	<0.014
Phenanthridine	<0.014	0.28	<0.0056	<0.011	<0.0028	<0.028	<0.0014	<0.011
Carbazole	0.44	3.0	0.099	0.040	0.21	0.57	0.065	<0.0088
Fluoranthene	0.74	1.7	1.3	1.7	0.25	0.16	0.083	0.19
Pyrene	0.44	0.92	0.79	0.78	0.16	0.082	0.035	0.10
Triphenylene	<0.010	<0.025	0.12 c	0.072 c	0.053 c	<0.020	0.0084 c	<0.0080
Benzo(k)fluoranthene	<0.010	<0.025	0.15 c	0.076 c	0.068 c	<0.020	<0.0010	<0.0080
7,12-Dimethylbenz(a)anthracene	DLND	DLND	DLND	DLND	DLND	DLND	DLND	DLND
Benzo(e)pyrene	<0.010	<0.025	0.038	0.023	0.019	<0.020	<0.0010	<0.0080
Perylene	<0.010	<0.025	0.013	<0.0080	<0.0020	<0.020	<0.0010	<0.0080
3-Methylcholanthrene	DLND	DLND	DLND	DLND	DLND	DLND	DLND	DLND
Sum List 2	4.0 ✓	29 ✓	2.8	3.1	4.2	4.3	0.86	0.71
Phenol	--	--	2.13	3.71	--	--	--	--
2-Chlorophenol	--	--	--	<6	--	--	--	--
2-Nitrophenol	--	--	--	<6	--	--	--	--
2,4-Dimethylphenol	--	--	--	<6	--	--	--	--
Benzoic Acid	--	--	--	<30	--	--	--	--
2,4-Dichlorophenol	--	--	--	<6	--	--	--	--
4-Chloro-3-methylphenol	--	--	--	<6	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	<6	--	--	--	--
2,4-Dinitrophenol	--	--	--	<30	--	--	--	--
4-Nitrophenol	--	--	--	<30	--	--	--	--
2-Methyl-4,6-dinitrophenol	--	--	--	<30	--	--	--	--
Pentachlorophenol	--	--	--	<6	--	--	--	--
O-Cresol	--	--	--	<6	--	--	--	--
M-Cresol	--	--	--	<6	--	--	--	--
P-Cresol	--	--	--	<6	--	--	--	--

c Coeluting isomer. Concentration reported is total of the coeluting compound.
 ND None detected.
 DLND Not detected. Detection limit not determined.
 -- Not analyzed.

TABLE 3 (cont.)

WATER QUALITY MONITORING DATA
PAH AND PHENOLIC COMPOUNDS

(concentrations in ug/L)

	SEEP 1				W6	W7	W8	W9
	12/13/88	03/23/89	06/21/89	09/11/89				
Quinoline	<0.0010	<0.020	<0.0020	<0.0040	<0.0080	<0.0010	<0.0010	<0.0010
Benzo(a)anthracene	<0.0010	<0.020	0.023	0.14	0.51	<0.0010	0.0059	0.015
Chrysene	<0.0010	<0.020	0.052 c	0.28 c	0.46 c	<0.0010	0.0062 c	0.014 c
Benzo(b)fluoranthene	<0.0010	<0.020	<0.0020	0.15 c	0.62 c	<0.0010	0.0089 c	0.026 c
Benzo(a)pyrene	<0.0010	<0.020	<0.0020	0.11	0.32	<0.0010	0.0043	0.010
Indeno(1,2,3,cd)pyrene	<0.0017	<0.034	<0.0034	0.031	0.25	<0.0017	<0.0017	0.0093
Dibenzo(ah)anthracene	<0.0014	<0.028	<0.0028	<0.0056	<0.011	<0.0014	<0.0014	<0.0014
Benzo(ghi)perylene	<0.0010	<0.020	<0.0020	0.10	0.23	<0.0010	<0.0010	0.0072
Sum List 1	ND	ND	0.074	0.81	2.4	ND	0.025	0.081
2,3-Benzofuran	DLND	DLND	DLND	0.0091	DLND	DLND	DLND	DLND
2,3-Dihydroindene	0.0082	0.62	0.13	0.15	0.037	<0.0014	0.0047	0.0031
Indene	0.0036	<0.020	<0.0020	0.0071	<0.0080	<0.0010	<0.0010	<0.0010
Naphthalene	0.023	<0.038	0.016	0.21	2.0	0.0096	0.030	0.010
Benzo(b)thiophene	0.036	<0.020	0.20	0.73	0.031	<0.0010	<0.0010	<0.0010
Isoquinoline	DLND	DLND	DLND	DLND	DLND	DLND	DLND	DLND
Indole	<0.0029	<0.058	<0.0058	<0.012	0.023	<0.0029	<0.0029	<0.0029
2-Methylnaphthalene	<0.0020	<0.040	<0.0040	<0.0080	0.13	0.0043	0.021	0.0046
1-Methylnaphthalene	<0.0010	<0.020	<0.0020	<0.0040	0.055	0.0032	0.015	0.0029
Biphenyl	<0.0010	<0.020	<0.0020	<0.0040	0.066	<0.0010	0.024	<0.0010
Acenaphthylene	<0.0010	<0.020	0.18	<0.0040	0.010	<0.0010	0.0072	<0.0010
Acenaphthene	<0.0013	1.4	0.90	0.94	0.065	<0.0013	0.0041	<0.0013
Dibenzofuran	<0.0020	0.32	0.35	0.28	0.19	<0.0020	0.0078	<0.0020
Fluorene	<0.0014	1.6	0.67	0.31	0.40	<0.0014	0.018	<0.0014
Dibenzothiophene	DLND	0.65	0.46	0.46	0.16	DLND	0.0020	DLND
Phenanthrene	<0.0010	<0.020	0.031	<0.0040	1.9	<0.0010	0.011	0.014
Anthracene	<0.0010	<0.020	0.076	<0.0040	0.55	<0.0010	0.020	0.0046
Acridine	<0.0018	<0.036	<0.0036	<0.0072	<0.014	<0.0018	<0.0018	<0.0018
Phenanthridine	<0.0014	<0.028	<0.0028	<0.0056	<0.011	<0.0014	<0.0014	<0.0014
Carbazole	<0.0011	<0.022	<0.0022	<0.0044	0.096	<0.0011	0.011	<0.0011
Fluoranthene	<0.0010	0.071	0.13	<0.49	2.5	<0.0010	0.021	0.033
Pyrene	0.042	0.063	0.15	0.74	2.0	<0.0010	0.015	0.026
Triphenylene	<0.0010	<0.020	0.052 c	0.28 c	0.46 c	<0.0010	0.0062 c	0.014 c
Benzo(k)fluoranthene	<0.0010	<0.020	<0.0020	0.15 c	0.62 c	<0.0010	0.0089 c	0.026 c
7,12-Dimethylbenz(a)anthracene	DLND	DLND	DLND	DLND	DLND	DLND	DLND	DLND
Benzo(e)pyrene	<0.0010	<0.020	<0.0020	0.15	0.23	<0.0010	0.0028	0.0078
Perylene	<0.0010	<0.020	<0.0020	0.020	0.10	<0.0010	<0.0010	0.0029
3-Methylcholanthrene	DLND	DLND	DLND	DLND	DLND	DLND	DLND	DLND
Sum List 2	0.11	4.7	3.3	4.3	10	0.017	0.19	0.11
Phenol	--	--	--	<6	--	--	--	--
2-Chlorophenol	--	--	--	<6	--	--	--	--
2-Nitrophenol	--	--	--	<6	--	--	--	--
2,4-Dimethylphenol	--	--	--	<6	--	--	--	--
Benzoic Acid	--	--	--	<30	--	--	--	--
2,4-Dichlorophenol	--	--	--	<6	--	--	--	--
4-Chloro-3-methylphenol	--	--	--	<6	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	<6	--	--	--	--
2,4-Dinitrophenol	--	--	--	<30	--	--	--	--
4-Nitrophenol	--	--	--	<30	--	--	--	--
2-Methyl-4,6-dinitrophenol	--	--	--	<30	--	--	--	--
Pentachlorophenol	--	--	--	<6	--	--	--	--
O-Cresol	--	--	--	<6	--	--	--	--
M-Cresol	--	--	--	<6	--	--	--	--
P-Cresol	--	--	--	<6	--	--	--	--

c Coeluting isomer. Concentration reported is total of the coeluting compound.
 ND None detected.
 DLND Not detected. Detection limit not determined.
 -- Not analyzed.

TABLE 3 (cont.)

WATER QUALITY MONITORING DATA
PAH AND PHENOLIC COMPOUNDS

(concentrations in ug/L)

	W10	W11	W12	W13
	-----	-----	-----	-----
	06/21/89	06/21/89	06/21/89	06/21/89
Quinoline	<0.0010	<0.0010	<0.0010	<0.0010
Benzo(a)anthracene	<0.0010	<0.0010	<0.0010	<0.0010
Chrysene	<0.0010	<0.0010	<0.0010	<0.0010
Benzo(b)fluoranthene	<0.0010	<0.0010	<0.0010	<0.0010
Benzo(a)pyrene	<0.0010	<0.0010	<0.0010	<0.0010
Indeno(1,2,3,cd)pyrene	<0.0017	<0.0017	<0.0017	<0.0017
Dibenzo(ah)anthracene	<0.0014	<0.0014	<0.0014	<0.0014
Benzo(ghi)perylene	<0.0010	<0.0010	<0.0010	<0.0010
Sum List 1	ND	ND	ND	ND
2,3-Benzofuran	DLND	0.011	DLND	DLND
2,3-Dihydroindene	<0.0014	<0.0014	<0.0014	<0.0014
Indene	<0.0010	<0.0010	<0.0010	<0.0010
Naphthalene	0.0091	0.0092	0.0091	0.010
Benzo(b)thiophene	0.0021	0.014	0.078	0.0043
Isoquinoline	DLND	DLND	DLND	DLND
Indole	<0.0029	<0.0029	<0.0029	<0.0029
2-Methylnaphthalene	0.0049	0.0052	0.0024	0.0049
1-Methylnaphthalene	0.0029	0.0034	0.0020	0.0031
Biphenyl	<0.0010	<0.0010	0.0033	<0.0010
Acenaphthylene	<0.0010	<0.0010	<0.0010	<0.0010
Acenaphthene	<0.0013	<0.0013	<0.0013	<0.0013
Dibenzofuran	<0.0020	<0.0020	<0.0020	<0.0020
Fluorene	<0.0014	<0.0014	<0.0014	<0.0014
Dibenzothiophene	DLND	DLND	DLND	DLND
Phenanthrene	0.0024	<0.0010	0.0020	0.0033
Anthracene	<0.0010	<0.0010	<0.0010	<0.0010
Acridine	<0.0018	<0.0018	<0.0018	<0.0018
Phenanthridine	<0.0014	<0.0014	<0.0014	<0.0014
Carbazole	<0.0011	<0.0011	<0.0011	<0.0011
Fluoranthene	<0.0010	<0.0010	<0.0010	0.011
Pyrene	<0.0010	<0.0010	<0.0010	0.0076
Triphenylene	<0.0010	<0.0010	<0.0010	<0.0010
Benzo(k)fluoranthene	<0.0010	<0.0010	<0.0010	<0.0010
7,12-Dimethylbenz(a)anthracene	DLND	DLND	DLND	DLND
Benzo(e)pyrene	<0.0010	<0.0010	<0.0010	<0.0010
Perylene	<0.0010	<0.0010	<0.0010	<0.0010
3-Methylcholanthrene	DLND	DLND	DLND	DLND
Sum List 2	0.021	0.043	0.097	0.044

ND None detected.

DLND Not detected. Detection limit not determined.

.001

TABLE 4

WATER QUALITY MONITORING DATA
GENERAL PARAMETERS

(concentrations in mg/L)

	CP 1				CP 2			
	12/13/88	03/23/89	06/21/89	09/11/89	12/13/88	03/23/89	06/21/89	09/11/89
Ammonia Nitrogen	2.4	0.6	<0.1	<0.1	0.3	1.0	<0.1	0.2
Chloride	--	--	--	--	--	--	--	--
Cyanide, total	<0.01	0.01	<0.01	<0.01	0.02	0.04	<0.01	0.05
Sulfate	70	56	60	23	85	74	65	140
Thiocyanate	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chemical Oxygen Demand	--	--	--	--	--	--	--	--
Total Dissolved Solids	--	--	--	--	--	--	--	--
Total Organic Carbon	4.3	5.8	8.2	9.6	4.5	8.1	13	9.4
	CP 3				WM 1			
	12/13/88	03/23/89	06/22/89	09/11/89	12/13/88	03/23/89	06/22/89	09/11/89
Ammonia Nitrogen	0.3	1.0	<0.1	0.2	<0.1	0.6	<0.1	0.1
Chloride	--	--	--	--	--	--	--	--
Cyanide, total	0.04	0.06	0.03	0.04	<0.01	<0.01	<0.01	<0.01
Sulfate	180	96	73	140	280	330	240	240
Thiocyanate	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chemical Oxygen Demand	--	--	--	--	--	--	--	--
Total Dissolved Solids	--	--	--	--	--	--	--	--
Total Organic Carbon	7.0	6.7	8.3	7.2	7.6	5.6	8.7	12
	SEEP 1				W6	W7	W8	W9
	12/13/88	03/23/89	06/21/89	09/11/89	06/22/89	06/22/89	06/22/89	06/22/89
Ammonia Nitrogen	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	<0.1	<0.1
Chloride	--	--	--	--	--	--	--	--
Cyanide, total	0.01	<0.01	<0.01	<0.01	0.05	0.01	<0.01	<0.01
Sulfate	160	150	180	190	200	430	8	94
Thiocyanate	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chemical Oxygen Demand	--	--	--	--	--	--	--	--
Total Dissolved Solids	--	--	--	--	--	--	--	--
Total Organic Carbon	6.3	5.7	9.6	10	21.0	7.2	14	9.8
	W10	W11	W12	W13				
	06/21/89	06/21/89	06/21/89	06/21/89				
Ammonia Nitrogen	<0.1	<0.1	<0.1	<0.1				
Chloride	--	5	8	10				
Cyanide, total	0.01	<0.01	0.02	0.01				
Sulfate	170	360	540	160				
Thiocyanate	<1.0	<1.0	<1.0	<1.0				
Chemical Oxygen Demand	--	7	14	6				
Total Dissolved Solids	--	1000	1200	660				
Total Organic Carbon	7.7	7.5	5.1	3.9				

-- Not analyzed.

.005

TABLE 5

WATER QUALITY MONITORING DATA
METALS

(concentrations in ug/L, unless noted otherwise)

	CP 1				CP 2			
	12/13/88	03/23/89	06/21/89	09/11/89	12/13/88	03/23/89	06/21/89	09/11/89
Arsenic	<2	1	<20	<2	<2	2	<20	3
Cadmium	--	--	--	--	--	--	--	--
Chromium, total	<1	1	2	<1	<1	1	11	2
Lead	<1	<5	53	<2	<1	<5	10	9
Nickel	<50	5	<50	<2	<50	5	<50	<2
Zinc, mg/L	<0.01	<0.01	<0.03	<0.01	<0.01	0.01	0.07	0.03

	CP 3				WM 1			
	12/13/88	03/23/89	06/22/89	09/11/89	12/13/88	03/23/89	06/22/89	09/11/89
Arsenic	<2	1	<20	2	<2	<1	<20	<2
Cadmium	--	--	--	--	--	--	--	--
Chromium, total	<1	<1	<5	<1	<1	1	<5	1
Lead	<1	<5	<10	<2	<1	<5	<10	<2
Nickel	<50	6	<50	<2	<50	10	<50	<2
Zinc, mg/L	<0.01	0.02	0.03	<0.01	0.05	0.03	0.02	0.05

	SEEP 1				W6	W7	W8	W9
	12/13/88	03/23/89	06/21/89	09/11/89	06/22/89	06/22/89	06/22/89	06/22/89
Arsenic	<2	<1	<20	2	3	<2	<2	<2
Cadmium	--	--	--	--	--	--	--	--
Chromium, total	<1	<1	7	2	7	11	<1	4
Lead	<1	<5	58	3	<1	<1	<1	<1
Nickel	<50	6	<50	<2	<50	<50	<50	<50
Zinc, mg/L	<0.01	<0.01	0.03	0.06	<0.01	0.02	<0.01	<0.01

	W10	W11	W12	W13
	06/21/89	06/21/89	06/21/89	06/21/89
Arsenic	<1	<1	<1	<1
Cadmium	--	0.4	<0.1	0.7
Chromium, total	2	1	2	1
Lead	<1	<1	<1	<1
Nickel	<50	60	<50	<50
Zinc, mg/L	0.05	0.02	0.02	0.07

-- Not analyzed.

.004

TABLE 6

WATER QUALITY MONITORING DATA
FIELD PARAMETERS

	CP 1				CP 2			
	12/13/88	03/23/89	06/21/89	09/11/89	12/13/88	03/23/89	06/21/89	09/11/89
pH, standard units	8.6*	7.0	7.3	8.0	7.9*	6.9	7.3	8.0
Specific Conductance, umhos/cm@25oC	440	890	510	260	540	948	550	600
Temperature, oC	1	3.0	17.0	14.0	1	4.0	19.0	15.0

	CP 3				WM 1			
	12/13/88	03/23/89	06/22/89	09/11/89	12/13/88	03/23/89	06/22/89	09/11/89
pH, standard units	7.8*	7.0	7.6	8.2	7.3*	6.6	7.6	8.0
Specific Conductance, umhos/cm@25oC	700	1100	700	600	940	1200	1200	850
Temperature, oC	1	1.0	19.0	15.0	1	3.0	19.0	16.0

	SEEP 1				W6	W7	W8	W9
	12/13/88	03/23/89	06/21/89	09/11/89	06/22/89	06/22/89	06/22/89	06/22/89
pH, standard units	7.6*	6.8	7.5	7.5	8.4	7.1	6.8	7.3
Specific Conductance, umhos/cm@25oC	950	850	1000	900	630	1800	1300	590
Temperature, oC	7	8.0	15.0	12.0	12.0	14.0	10.0	12.0

	W10	W11	W12	W13
	06/21/89	06/21/89	06/21/89	06/21/89
pH, standard units	7.5	7.1	7.1	7.4
Specific Conductance, umhos/cm@25oC	900	1400	1700	1600
Temperature, oC	11.0	12.0	13.0	11.0

* Measurement performed in the laboratory.

.007

TABLE 7

QUALITY CONTROL DATA
FIELD BLANK SAMPLES

(concentrations in ug/L)

	FIELD BLANKS				
	12/13/88	03/23/89	06/22/89	09/11/89	09/11/89
Quinoline	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Benzo(a)anthracene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Chrysene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Benzo(b)fluoranthene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Benzo(a)pyrene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Indeno(1,2,3,cd)pyrene	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017
Dibenzo(ah)anthracene	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014
Benzo(ghi)perylene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
2,3-Benzofuran	DLND	DLND	DLND	DLND	DLND
2,3-Dihydroindene	<0.0014	<0.0014	<0.0014	0.0017	0.0016
Indene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Naphthalene	0.0035	0.0062	<0.0019	<0.0019	<0.0020
Benzo(b)thiophene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Isoquinoline	DLND	DLND	DLND	DLND	DLND
Indole	<0.0029	<0.0029	<0.0029	<0.0029	<0.0029
2-Methylnaphthalene	<0.0020	0.0027	<0.0020	<0.0020	<0.0020
1-Methylnaphthalene	<0.0010	0.0015	<0.0010	<0.0010	<0.0010
Biphenyl	<0.0010	0.0017	<0.0010	<0.0010	<0.0010
Acenaphthylene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Acenaphthene	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013
Dibenzofuran	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Fluorene	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014
Dibenzothiophene	DLND	DLND	DLND	DLND	DLND
Phenanthrene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Anthracene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Acridine	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018
Phenanthridine	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014
Carbazole	<0.0011	<0.0011	<0.0011	<0.0011	<0.0011
Fluoranthene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Pyrene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Triphenylene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Benzo(k)fluoranthene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
7,12-Dimethylbenz(a)anthracene	DLND	DLND	DLND	DLND	DLND
Benzo(e)pyrene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Perylene	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
3-Methylcholanthrene	DLND	DLND	DLND	DLND	DLND

DLND Not detected. Detection limit not determined.

TABLE 8

QUALITY CONTROL DATA
FIELD BLANK SAMPLES

(concentrations in ug/L, unless noted otherwise)

	FIELD BLANKS		
	12/13/88	03/23/89	09/11/89
Arsenic	<2	<1	<2
Cadmium	--	--	--
Chromium, total	<1	<1	<1
Lead	<1	<5	<2
Nickel	<50	<1	<2
Zinc, mg/L	<0.01	<0.01	<0.01

-- Not analyzed.

.006

TABLE 9

QUALITY CONTROL DATA
BLIND DUPLICATE SAMPLES

(concentrations in ug/L)

	WM 1		WM 1	
	03/23/89 Sample	03/23/89 Duplicate	09/11/89 Sample	09/11/89 Duplicate
Quinoline	<0.020	<0.020	<0.0080	<0.0040
Benzo(a)anthracene	<0.020	<0.020	<0.0080	<0.0040
Chrysene	<0.020	<0.020	<0.0080	<0.0040
Benzo(b)fluoranthene	<0.020	<0.020	<0.0080	<0.0040
Benzo(a)pyrene	<0.020	<0.020	<0.0080	<0.0040
Indeno(1,2,3,cd)pyrene	<0.034	<0.034	<0.014	<0.0068
Dibenzo(ah)anthracene	<0.028	<0.028	<0.011	<0.0056
Benzo(ghi)perylene	<0.020	<0.020	<0.0080	<0.0040
Sum List 1	ND	ND	ND	ND
2,3-Benzofuran	DLND	DLND	0.0081	DLND
2,3-Dihydroindene	0.50	0.40	0.026	0.031
Indene	0.024	0.029	0.12	0.16
Naphthalene	<0.038	<0.038	<0.015	<0.0076
Benzo(b)thiophene	<0.020	<0.020	0.011	0.015
Isoquinoline	DLND	DLND	DLND	DLND
Indole	<0.058	<0.058	<0.023	<0.012
2-Methylnaphthalene	<0.040	<0.040	<0.016	<0.0080
1-Methylnaphthalene	0.056	0.031	<0.0080	<0.0040
Biphenyl	0.029	<0.020	<0.0080	<0.0040
Acenaphthylene	<0.020	0.028	0.0089	0.018
Acenaphthene	1.2	1.5	0.18	0.24
Dibenzofuran	0.44	0.42	0.039	0.052
Fluorene	0.99	0.91	0.034	0.041
Dibenzothiophene	0.073	0.062	DLND	DLND
Phenanthrene	0.096	0.098	<0.0080	<0.0040
Anthracene	0.027	0.031	<0.0080	<0.0040
Acridine	<0.036	<0.036	<0.014	<0.0072
Phenanthridine	<0.028	<0.028	<0.011	<0.0056
Carbazole	0.57	0.56	<0.0088	<0.0044
Fluoranthene	0.16	0.17	0.19	0.14
Pyrene	0.082	0.091	0.10	0.092
Triphenylene	<0.020	<0.020	<0.0080	<0.0040
Benzo(k)fluoranthene	<0.020	<0.020	<0.0080	<0.0040
7,12-Dimethylbenz(a)anthracene	DLND	DLND	DLND	DLND
Benzo(e)pyrene	<0.020	<0.020	<0.0080	<0.0040
Perylene	<0.020	<0.020	<0.0080	<0.0040
3-Methylcholanthrene	DLND	DLND	DLND	DLND
Sum List 2	4.3	4.3	0.71	0.79

ND None detected.

DLND Not detected. Detection limit not determined.

.008

TABLE 10
STATISTICAL ANALYSIS
BLIND DUPLICATE SAMPLES
PAH COMPOUNDS

<u>Station</u>	<u>Sampling Date</u>	<u>Coefficient of Variation</u>
WM-1	03/23/89	0.19
WM-1	09/11/89	0.26

FIGURES



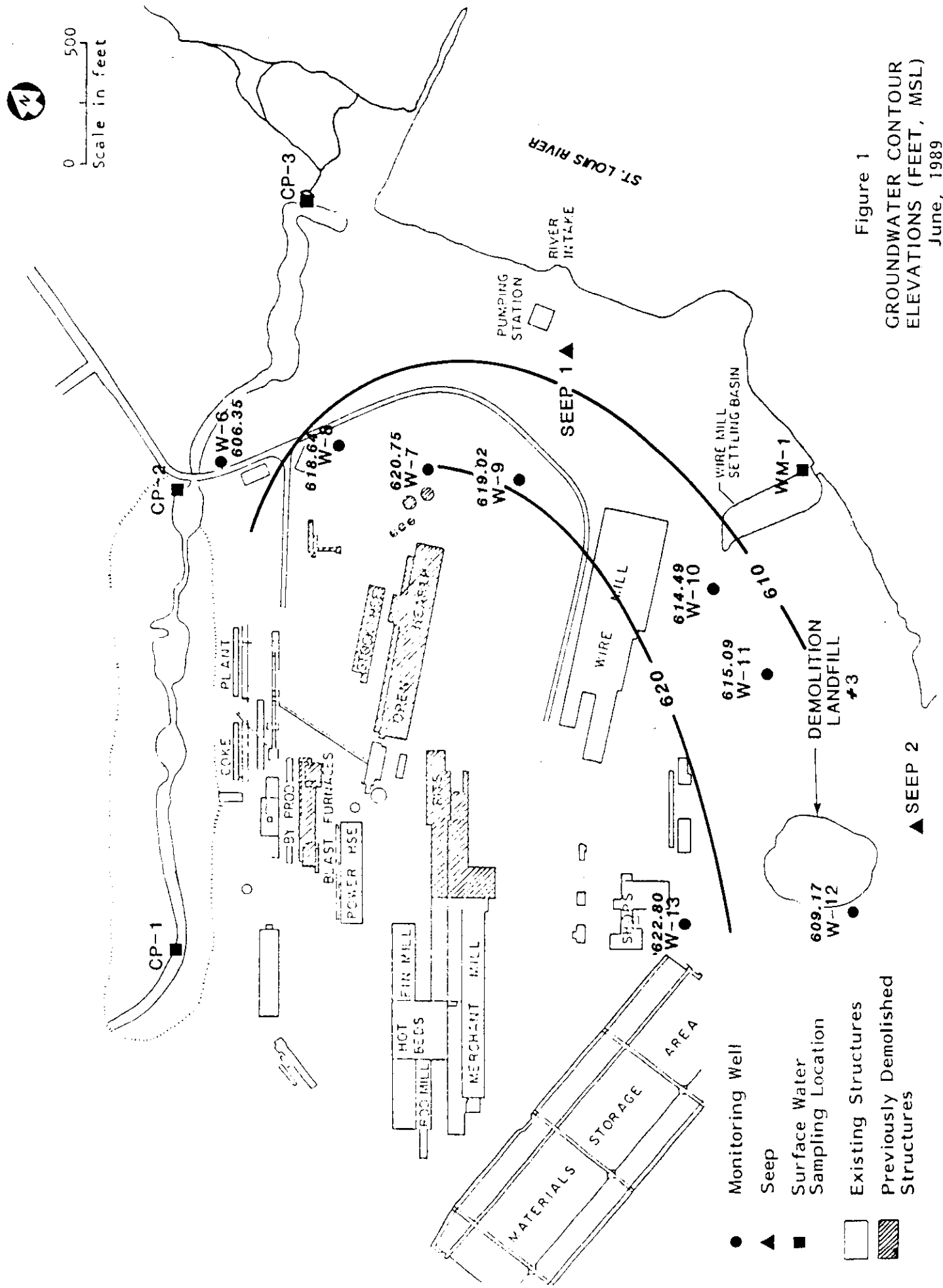


Figure 1
GROUNDWATER CONTOUR
ELEVATIONS (FEET, MSL)
June, 1989

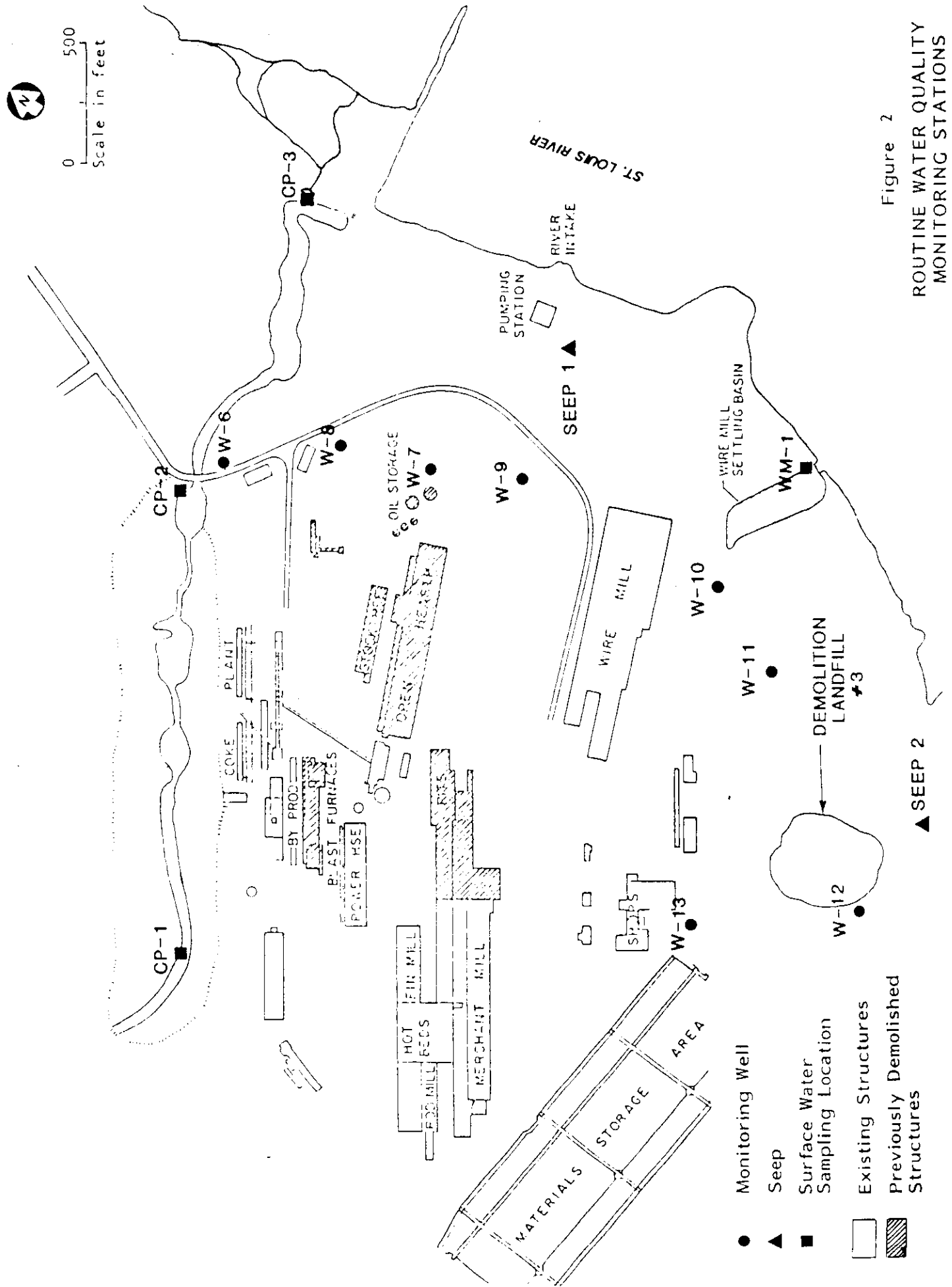
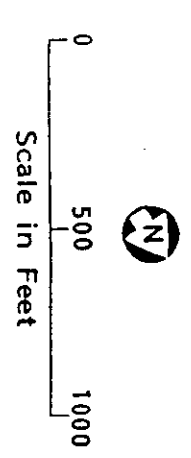
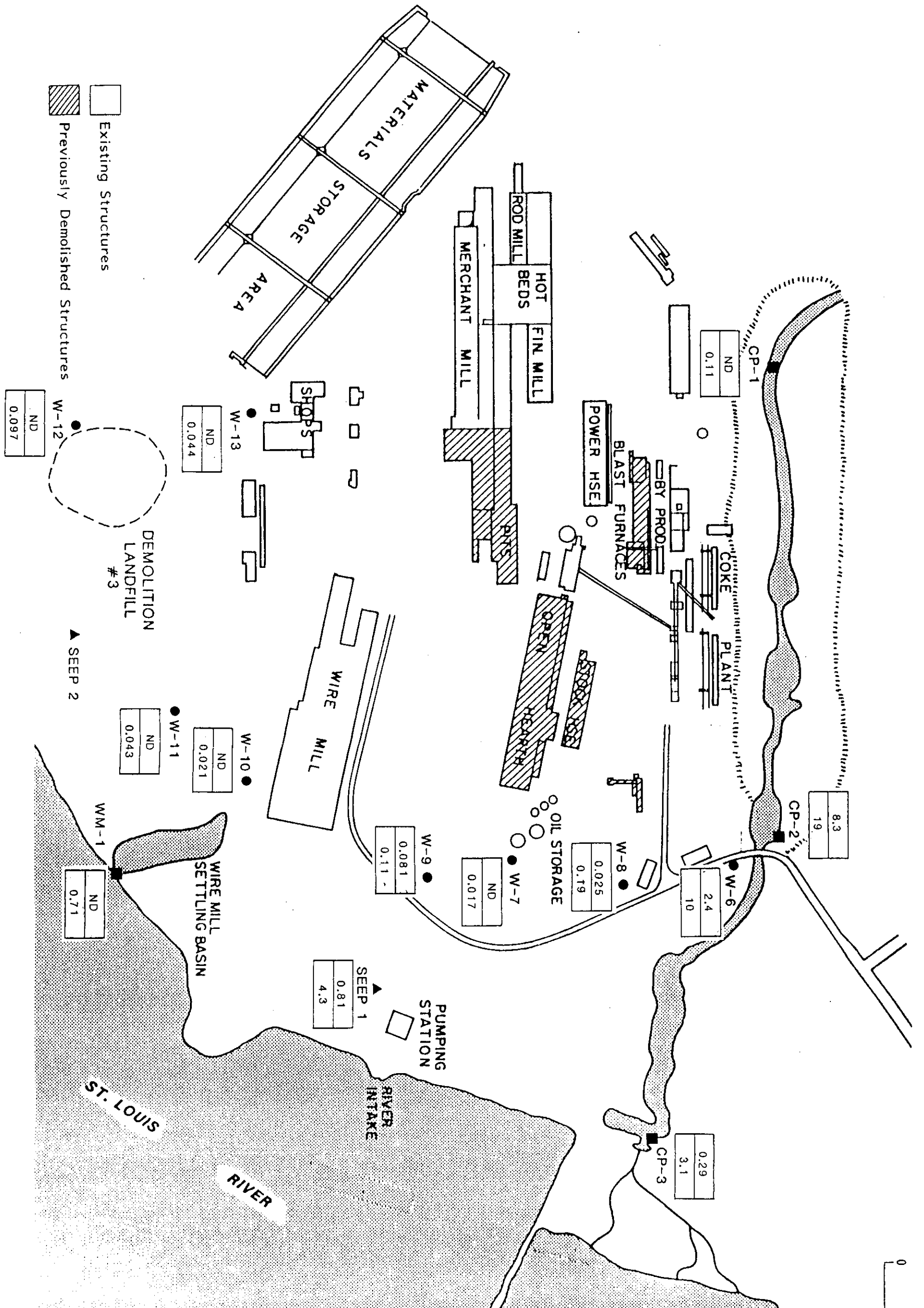


Figure 2
ROUTINE WATER QUALITY
MONITORING STATIONS

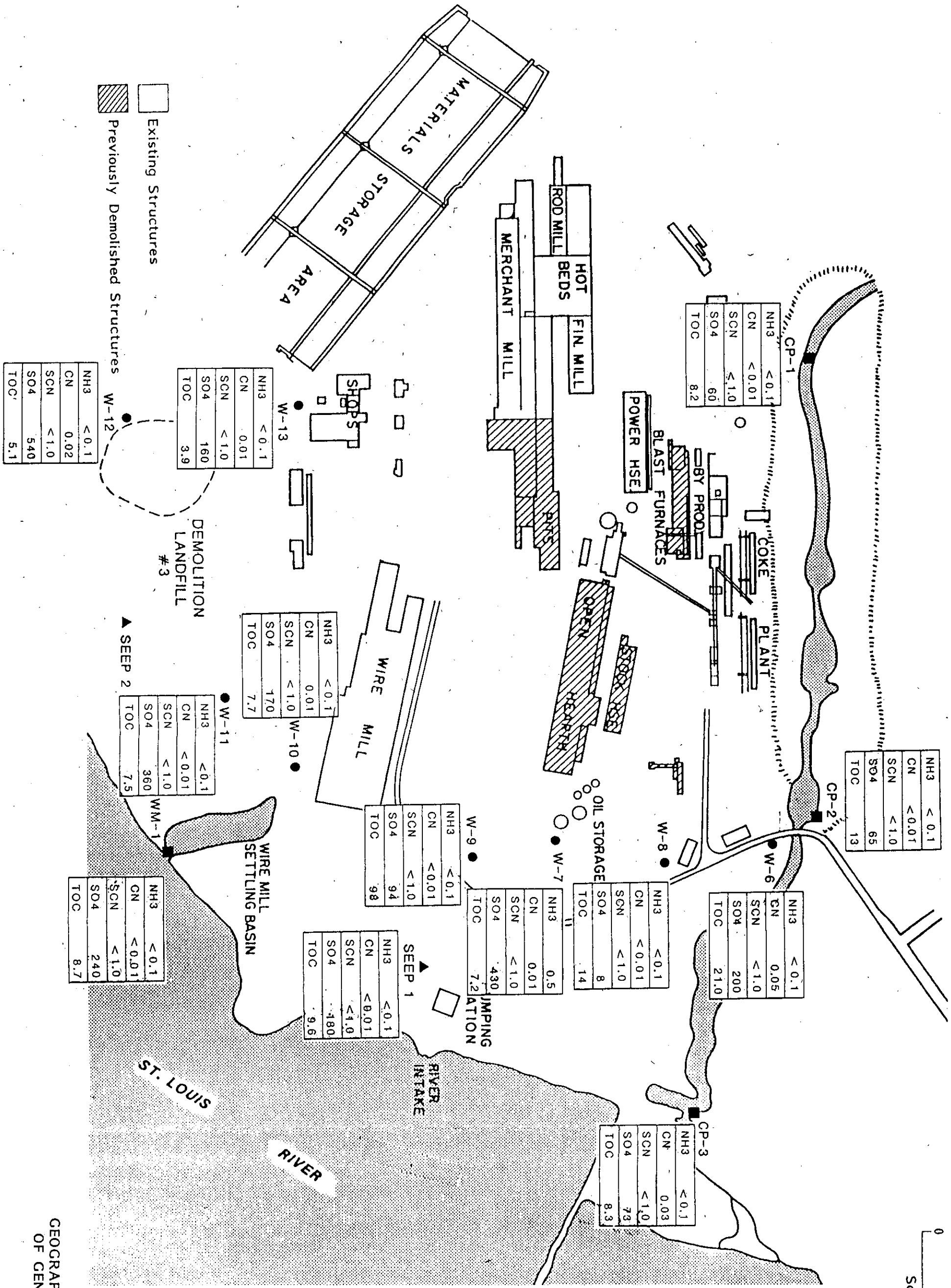


Sum List 1 Compounds (ug/L)
Sum List 2 Compounds (ug/L)
ND Not Detected

Figure 3
 GEOGRAPHICAL DISTRIBUTION
 OF PAH COMPOUNDS
 June, 1989



0 500 1000
Scale in Feet



NH3 = Ammonia-Nitrogen
CN = Total Cyanide
SCN = Thiocyanate
SO4 = Sulfate
TOC = Total Organic Carbon

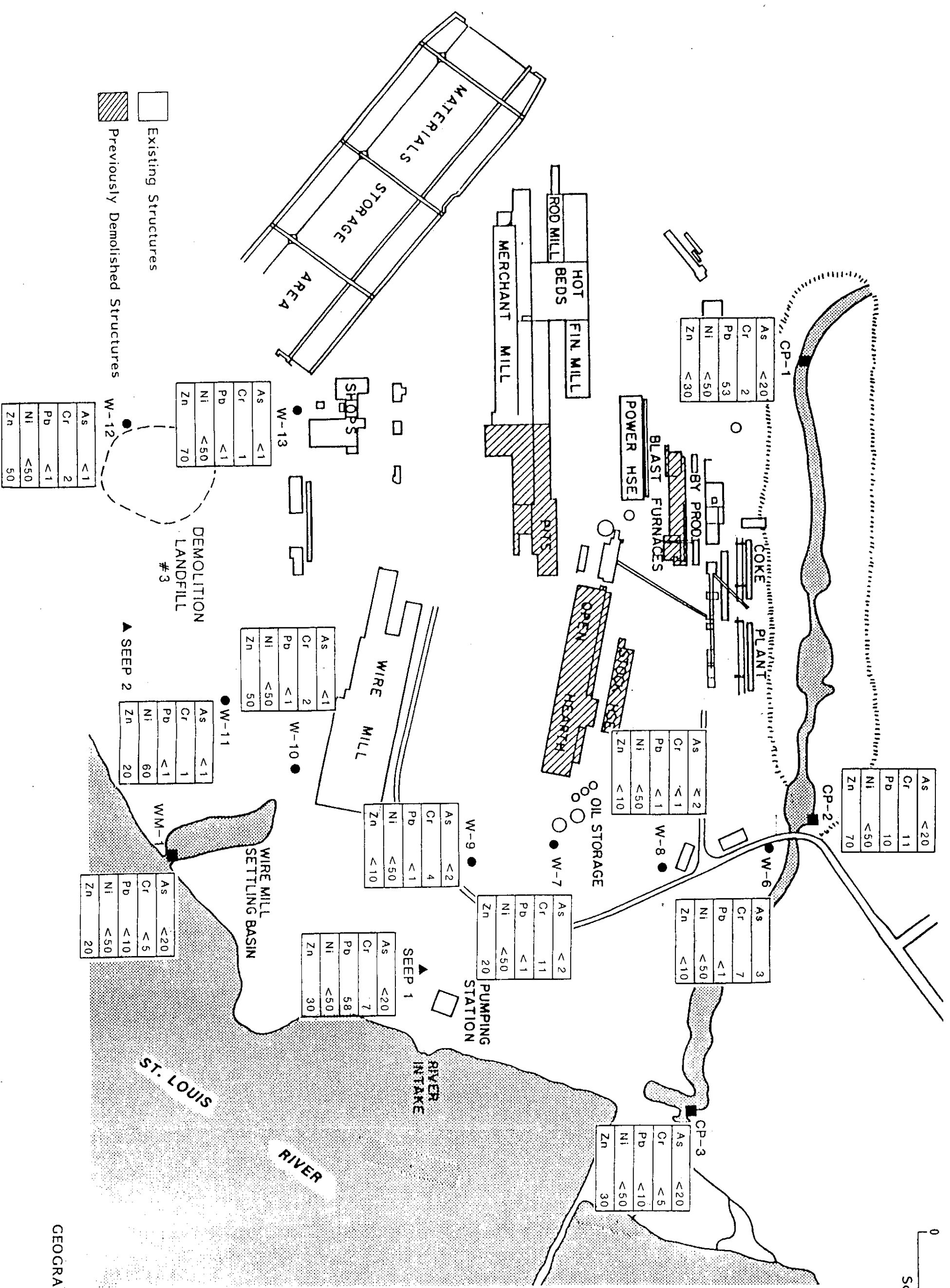
Concentration in mg/L

Figure 4

GEOGRAPHICAL DISTRIBUTION
OF GENERAL PARAMETERS
June, 1989



0 500 1000
Scale in Feet



As = Arsenic
 Cr = Chromium
 Pb = Lead
 Ni = Nickel
 Zn = Zinc

Concentration in ug/L

Figure 5
 GEOGRAPHICAL DISTRIBUTION
 OF METALS
 June, 1989