CHICAGO AREA CONFINED DISPOSAL FACILITY

MONITORING WELL DATA REPORT
1996 CALENDAR YEAR

March 1997
Environmental Engineering Section
U.S. Army Corps of Engineers, Chicago District
111 North Canal
Chicago, Illinois 60606-7206

Chicago Area Confined Disposal Facility
Monitoring Well Data Report
CY 1997

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (continued)

APPENDIX

1. PURPOSE

1.1 The Chicago Area Confined Disposal Facility (CDF) is a diked facility for the disposal and containment of polluted dredged materials from deep-draft federal navigation projects in Chicago, Illinois. The CDF was constructed in 1982-84, and is located in Calumet Harbor (figure 1). This facility was constructed and is operated and maintained by the Chicago District under authority of Public Law 91-611, Section 123. Adjoining interests for this project are the Chicago Regional Port District and the Chicago Park District.

1.2 During 1996 the CDF was routinely monitored as part of compliance with Illinois EPA water pollution control permit number 1992-EA-0476 issued May 14, 1992 with supplemental permit special conditions 2iii and 2v issued March 5, 1993 and compliance with Section 401 certification requirements. The permit expires May 1, 1997. This permit renews and replaces permit no. 1987-EA-2851 and its supplement number 1987-EA-2851-1.

1.3 Two types of monitoring are conducted at the CDF. Nine monitoring wells and one surface water station are monitored routinely during the year. This report will provide the results of monthly water quality monitoring at wells located around the CDF and at one Calumet Harbor near-dike surface water station during calendar year 1995. The second type of monitoring occurs during dredging events. Samples are collected from three monitoring wells and 7 to 9 surface water stations. The dredging event samples are collected immediately before, during, and immediately after the dredging and disposal operations. The disposal event operations monitoring results are provided in separate reports.

2. BACKGROUND

2.1 The Chicago Area CDF is an in-water structure specifically designed to receive polluted dredgings and prevent their reentry into the harbor or lake. The CDF is located adjacent to the Iroquois Landing port terminal and is north of Calumet Park. The facility is roughly triangular in shape and is about 43 acres in area. When constructed, the facility had a capacity for about 1.3 million cubic yards of dredged material. As of 1996, 405,000 cubic yards of dredged material have been mechanically placed in the facility. More detailed information on the CDF may be found in the Environmental Impact Statement for this project (Ref.. 1).

2.2 The Chicago CDF dike consists of a prepared limestone core, a synthetic liner placed against the core on the disposal side (inside face of dike), and larger stone on both sides of the dike to protect against wave action. A blanket of fine-grained sand was installed along the inside face of the dike to promote clogging of the core stone around perforations in the synthetic liner and provide an additional positive cutoff. Figure 2 is a typical cross section of the CDF dike.

2.3 The Chicago CDF has been used for six dredged material disposal operations since its construction. In the first dredged material disposal operation, sediment from the Calumet River was placed by mechanical means along the northwest corner of the CDF. During this operation, which took place from October 5 to December 3, 1984, about 100,000 cubic yards of sediment were disposed. The second use of the CDF was from July 29 to September 24, 1985. About 108,000 cubic yards of sediment from the Calumet River was placed mechanically at the northeast corner of the disposal facility. The third dredged material disposal operation was from May 10 to June 28, 1986. About 62,000 cubic yards of sediment from Chicago Harbor and Chicago River were placed mechanically along the CDF northern dike alignment between the two earlier placements. The fourth dredged material disposal operation occurred between April 4 and June 17, 1989. Approximately 70,100 cubic yards of sediment from Calumet River was mechanically placed north of the cross dike along the eastern dike of the CDF. The dredged material from the four disposal operations was placed so as to protect the dike sand blanket from wind induced wave erosion by the waters of the CDF pond. A fifth dredging and disposal operation was conducted by KCBX Terminals Company during the week of May 13 - 17th 1991. During this private operation approximately 3,100 cubic yards from the Calumet River were placed in the Chicago Area CDF. The sixth dredging and disposal operation took place from Dec 2 to Dec 30 1994. Sixty two thousand cubic yards from the Calumet River were mechanically placed along part of the eastern dike alignment slightly south of the northeast corner of the CDF. No dredged material was placed in the CDF in 1996.

2.4 Water quality monitoring at the CDF is conducted in two parts. Routine monitoring, as detailed in this report, is conducted for wells in the CDF dike and Iroquois Landing, and for one harbor station. Monitoring of additional stations in Calumet Harbor and of the CDF effluent is conducted only at times immediately before, during, and after disposal operations. Reports of the water quality monitoring during the 1984, 1985, 1986, 1989, and 1994 disposal operations are available separately from Chicago District files (Refs. 15, 16, 17, 18, 19). A brief data summary concerning the private disposal operation conducted in 1991 is also available.

2.5 Wells have been constructed on Iroquois Landing and on the CDF dike. A station on the CDF boat dock has also been established for monthly monitoring of Calumet Harbor near-dike surface water quality. During calendar year 1996 monitoring of the landing wells was on a quarterly basis. Dike wells were monitored on a monthly basis with some parameters being analyzed semi-annually. The surface water station at the CDF boat dock was monitored monthly for 18 parameters. Well parameter monitoring frequency is as shown in table 2. The objective of this monitoring is to detect migration of pollutants from the CDF to the harbor. Should monitoring detect significant migration of pollution, structural or operational modifications would be undertaken to correct the situation. This report presents the water quality data from the nine wells and one near-dike station (CDF boat dock) monitored during 1996.

3. SAMPLING AND ANALYTICAL PROCEDURES

3.1 Monitoring Wells

3.1.1 Nine wells constructed on Iroquois Landing and the CDF were monitored in 1996. Six are in the CDF dike (CH-04-83, CH-05-83, CH-07-84, CH-08-84, CH-09-84, and CH-10-84) and three are in the landing shore west of the CDF pond (CH-18-81, CH-19-81, and CH-20-81). The first two letters of the well designation denote the project where the well is located, the next two digits indicate the sequence identification of the well, and the last two digits of the well designation indicate the year the well was installed.

3.1.2 Descriptions of the construction of the monitoring wells are found in references 2 and 3. Soil profiles for the wells monitored in 1996 are found in reference 5. Estimated elevations at the well caps and screens and descriptions of the soils surrounding the screens are given in table 1. Except for well CH-7-84, dike well caps were replaced and raised on January 23, 1989 due to past vandalism and their weathered condition. Because of additional vandalism well cleaning and repair was also conducted beginning June 9, 1995 (Ref. 20). On December 1, 1995 the riser of well CH-07-84 was extended 15 inches and a new protective steel casing and lock were installed over the riser. According to the cleaning and repair observer's memory (when asked in March 1997) the steel casing of the well extends about two feet above the dike surface.

Table 1
Estimated Monitoring Well Elevations (1995) and Well Screens Soil Description

Well I.D.	Elevation (Feet LWD) at Cap	at Screen Top	Description of Soil at Screen
CH-18-81	+ 9.96	+ 1.0	Steel mill fill
CH-19-81	+18.00	+ 1.0	Steel mill fill
CH-20-81	+19.37	+ 1.0	Gravelly sand
CH-4-83	+12.38	+ 5.2	Prepared limestone
CH-5-83	+12.29	-17.9	Fine sand & silt
CH-7-84	+12.03 (old)	- 8.5	Prepared limestone
CH-7-84	+13.28 (estimate)	- 8.5	Prepared limestone
CH-8-84	+12.19	-28.5	Fine sand & silt
CH-9-84	+12.14	-18.0	Prepared limestone
CH-10-84	+12.22	-14.3	Silty Clay & Deposit

Elevation at Cap in feet referenced to Low Water Datum (LWD 1955).

3.1.3 Screens for wells CH-18, 19, and 20 were placed at the same level (+1 LWD) in the heterogeneous fill material of the landing. Iroquois Landing is a lake fill composed largely of wastes from a steel mill and other industries previously on or near this site. Screens for

wells CH-04, 07, and 09 (referred to as shallow dike wells) were placed at varying levels in the dike's prepared limestone core. The crushed limestone is six inches or less in diameter and is quite permeable. Screens for wells CH-05, 08, and 10 (referred to as deep dike wells) were placed in the lake bottom underneath the dike. These lake bottom deposits are fine-grained sand and silt. The relative positions of the shallow and deep dike wells are illustrated in figure 3.

3.2 Monitoring Station

3.2.1 In late 1986 a near-dike surface monitoring station (CH-11-87) was established at the Chicago CDF boat dock to monitor water quality in the Calumet River. The station is located near well CH-10-84 and is shown on figure 4. In 1996 the station was monitored for 24 parameters at a monthly frequency.

3.3 Monitoring Procedures

3.3.1 The parameters, wells, and frequency of monitoring are shown on table 2. Arsenic, manganese, and total Kjeldahl nitrogen are historically present in samples of the Iroquois Landing ground water. Historically, samples from the landing wells analyzed for cadmium, chromium, copper and nickel showed non-detectable to generally low concentrations with few large fluctuations. Therefore they were not monitored in 1996. These parameters were monitored on a quarterly or annual basis after July 1986. Field filtering with 0.45 micron filters on sample aliquots began in July 1986 as shown in table 3.

3.3.2 The Ohio River Division Laboratory (ORD) was contracted by the Chicago District to contract collection of and to analyze water samples collected in 1996. Ohio River Division Laboratory subcontracted field collection to Core Laboratories, Inc. of Valparaiso, Indiana during 1996.

3.3.3 ORD water quality laboratory has a quality control program administered by a member of the ORD staff. Procedures are based on guidance developed by the Corps and other recognized experts. Quality control/assurance programs are required. Records of field duplicates, field blanks, and documentation of other Quality Control (QC) can be provided. Chain of custody and sample receipt records are available in Chicago District files. The ORD Water Quality Lab was inspected in 1994 by the Corps St. Louis Laboratory.

3.3.4 Water samples were placed in glass or plastic containers, and chemically preserved in accordance with USEPA recommended methods and shipped to ORD. Chemical parameters analyzed and laboratory methods used (Refs. 21 and 22) in 1996 are shown on table 3.

Table 2

Sampling Frequency[1] Matrix for Monitoring Wells During 1996

	Dike Wells CH-4,5,7,8,9,10	Landing Wells CH-18,19,20	Surface Station CH-11[2]
1 Solids, Suspended (Residue, Non-Filterable)	M	Q	M
2 pH (field)	M	Q	M
3 Temperature (field)	M	Q	M
4 Hardness (Tot as $CaCO_3$)		A	
5 Ammonia - Nitrogen (Diss NH_3- N)	M	Q	M
6 Phosphorous (Total)	M	Q	M
7 Tot Recoverable Petroleum Hydrocarbons (Used instead of Oil and Grease for 1996)	M	A	M
8 Iron (Dissolved)		Q	
9 Lead (Dissolved)	Q	Q	M
10 Zinc (Dissolved)	M	Q	M
11 Cyanide (Total)	Q	Q	M
12 PCBs (Total) or Aroclors	M	Q	M
13 Mercury (Dissolved)	M	Q	M
14 Manganese (Dissolved)	M		M
15 Arsenic (Dissolved)	Q		M
16 Cadmium (Dissolved)	Q		M
17 Chromium (Dissolved)	Q		M
18 Copper (Dissolved)	Q		M
19 Nickel (Dissolved)	Q		M
20 Total Kjeldahl Nitrogen (as N)	M	Q	M
21 Total Dissolved Solids	.	Q	A

NOTE 1: Frequency monitored (M = Monthly, Q = Quarterly; S = Semi annual event, A = Annual event)

2 Harbor water surface station sample taken directly from dock.

Table 3
Laboratory Methods Used For Parameters Analyzed in 1996

STORET No.	Parameter	EPA Analytical Method No.	0.45 u Filtration Required in Field
70300	Solids, Dissolved 180 ^{0}C	160.1	Yes
00530	Solids, Suspended	160.2	
00900	Hardness (as $CaCO_3$)	130.2	
45501	Tot Recoverable Petroleum Hydrocarbons	418.1/9070*	
00665	Phosphorous (Total)	365.1	
00612	Ammonia - Nitrogen (diss)	350.1	Yes
00625	Total Kjeldahl Nitrogen	351.2	
00720	Cyanide (total)	335.2	
01000	Arsenic (dissolved)	200.2	Yes
01025	Cadmium (dissolved)	200.7	Yes
01030	Chromium (dissolved)	200.7	Yes
01040	Copper (dissolved)	200.7	Yes
01046	Iron (dissolved)	200.7	Yes
01049	Lead (dissolved)	200.2	Yes
01056	Manganese (dissolved)	200.7	Yes
71890	Mercury (dissolved)	245.1	Yes
01065	Nickel (dissolved)	200.7	Yes
01090	Zinc (dissolved)	200.7	Yes
39516	PCBs (total)	608**/8081*	
00010	Temperature (^{o}C) (field)	S.M. 2550	
00403	pH (lab)	150.1	

Methods used are from USEPA, March 1983, Methods for Chemical Analysis of Water and Wastes, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, EPA-600/4-79-020, Revised March 1983.

* Method used is from USEPA SW-846 Test Methods for Evaluating Solid Waste Physical/Chemical Methods 1992 Revision.

** Method used is from USEPA, July 1982, Methods for Organic Chemical Analysis of Municipal and Industrial Waste water, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, EPA-600/4-82-057.

S.M. = Standard Methods

4. MONITORING RESULTS

4.1 Piezometric Results

4.1.1 Piezometric data provides the elevation of the water table. Aside from the monitoring wells, there are two water level monitoring stations in the area. The National Oceanographic and Atmospheric Administration (NOAA) maintains a continuous water level monitoring station at Calumet Harbor (station #7044). The USGS (under contract to the Corps) maintains a continuous water level monitoring station within the CDF pond. Data from these stations is used to compare monthly single time monitoring well measurements to the day's mean lake (Calumet Harbor) and day's mean CDF pond water surface elevations. A summary of the piezometric data for 1996 is shown in table 4. Water level data from the USGS gage in the CDF pond was not available for all 1996 calendar days because of equipment maintenance problems.

4.1.2. Quarterly piezometric data from 1996 showed some landing well water readings to be higher than harbor level, ranging from 0.18 feet to 2.18 feet higher. Historically, monitoring had also shown the water table in the dike wells to be generally the same as lake level. This trend continued in 1996, as the dike wells were generally within 0.5 foot above the daily mean harbor water level to 0.9 foot below the daily mean harbor level. Figure 5 shows a comparison of water level elevation for Calumet Harbor and the CDF pond. Generally, the two daily mean water surface elevations (pond and harbor) were within 0.5 feet as shown in table 4 and figure 5.

4.2 General Well Water Quality Results

4.2.1 The 1996 Water Quality Sample Data and Sample Statistics of nine monitoring wells and one water station are provided in Appendix A.

4.2.2. Because the CDF is adjacent to water on two sides and land on the third side, interpretation of the groundwater monitoring data is difficult. An additional complicating factor is that groundwater from Iroquois Landing flows towards, and thus influences, the water quality within and below the CDF. Due to these factors, monitoring of the dike and landing wells is of limited value when trying to assess CDF impacts on river and harbor water quality. To make any definitive statements about the migration of the material within the CDF and its influence on Calumet Harbor, a comparison must be based on samples taken simultaneously within and outside the CDF. Also, background samples must be collected in the river and harbor in order to determine any natural variability. This type of information is gathered during disposal operations and can be used as a basis for comparison. It should be noted that disposal operations possess the highest potential for

impact on Calumet Harbor due to sediment resuspension within the CDF during disposal. Variability in data acquisition over time, consisting of analysis by multiple laboratories, use of different detection limits, and having a mixed set of total and dissolved analysis, prevents the use of group analysis. However, the range within the data can be evaluated, (maximum, mean, and minimum) and used to determine if there is indication of impact from the CDF to the river or harbor.

4.2.4 Suspended Solids. When comparing total suspended solids concentrations from the monitored wells over time, it is apparent that wide fluctuations have occurred. This is likely caused by fine particles at the well screens being resuspended by the hand bailer or down-hole pumps during well purging before sampling. The wells (except well CH-08-84) were cleaned by the bailer method in December 1995. Well CH-08-84 was cleaned by peristaltic pump using 45 feet of tubing to reach the bottom of the well.

4.2.5. Trace amounts of fine particulates were retrieved from the wells. After all the cleaning criteria were met: well CH-4-83 water color was light gray; well CH-5-83 water was gray black, silty, and had a slight odor; well CH-7-84 was clear to the eye; CH-8-84 water was slightly cloudy, light brown, and fine sand with no odor; well CH-9-84 water was clear; well CH-10-84 water was clear; well CH-18-81 water was clear with a trace of silt, very slightly gray, with possible slag fill particulate; well CH-19-81 water was clear with a slight unknown odor; and well CH-20-81 water was clear(Ref. 20).

4.3 Iroquois Landing Water Quality

4.3.1. In general, water quality from the wells on Iroquois Landing continued to be poor in 1996. General characteristics from 1983 through 1995 monitoring continued to be evident. The landing water continues to be hard with one reading of 800+ mg/l recorded. Dissolved solids concentrations were high in all three wells. Well CH-19-81 has high pH ranging from 11.5 to 12.5. This high pH may indicate the basicity of the steel mill waste used as part of the landing fill. Total NH_3-N ranged from 0.85 mg/l to 2.96 mg/l in well CH-18-81, from 4.87 mg/l to 5.6 mg/l in well CH-19-81, and was below detectable limits in well CH-20-81. Total phosphorus ranged from 0.057 mg/l to 0.545 mg/l in well CH-18-81, was nondetectable in well CH-19-81, and ranged from 0.0419 mg/l to 0.0435 mg/l in well CH-20-81. Mercury was not detected in any samples from the landing wells CH-18-81 and CH-20-81. In landing well CH-19-81 mercury was found at 0.69 ug/l in the August sample. Cyanide was present at low concentrations ranging from 0.02 mg/l to 0.07 mg/l from the landing wells.

4.4 "Deep" Dike Well Water Quality

4.4.1 Sample results in 1996 indicate that water quality in the "deep" dike wells (CH-05-83, CH-08-84, and CH-10-84) has not changed significantly since 1995. Mercury was detected in two samples from well CH-05-83 at concentrations of 0.3 and 0.35 ug/l, in well CH-08-84 at 0.26 and 0.42 ug/l, and in Well CH-10-84 at 0.15 and 1.12 ug/l. Well CH-10-84 TSS samples were above 15 mg/l with only one below the detectable limit. They ranged from 23 mg/l to 39 mg/l. Three CH-08-83 samples were also at 26, 24, and 27 mg/l in August, September and October 1996 respectively. One CH-05-83 sample taken in October was at 20 mg/l. All other TSS deep dike well samples were below 15 mg/l. Total phosphorous samples ranged from 0.041 mg/l to 0.656 mg/l in well CH-05-83, from 0.138 mg/l to 0.765 mg/l in well CH-08-84, and from 0.1037 mg/l to 0.464 mg/l in well CH-10-84. The samples analyzed for total NH_3-N ammonia ranged from 1.0 mg/l to 2.29 mg/l in well CH-05-83, 1.77 mg/l to 3.45 mg/l in well CH-8-84, and 0.96 mg/l to 12.5 mg/l in well CH-10-84.

4.4.2 In general, the water quality of the “deep” dike wells is reflective of bottom sediment waters. Samples range from high values to relatively low values. The mean sample concentration tends to be near the minimum or below the midpoint for measured sample concentrations of total phosphorous for calendar year 1996 as shown on figure 6. In 1996 the total NH_3-N mean concentration in deep well CH-10-84 is more than double mean concentrations in deep wells CH-05-83 and CH-08-84 for 1996. The mean concentration of NH_3-N in deep well CH-10-84 is also five times the mean in landing well CH-18-81 and only 1.5 times the mean concentration in landing well CH-19-81. Well CH-20-81 NH_3-N concentrations were all non detects. In 1995 during well cleaning it was discovered that a stone or other obstruction had lodged in well CH-05-83.

4.4.3 There may be similarity between the mean concentration of NH_3-N in well CH-04-83 and CH-10-84 as shown on figure 7. However, the CH-04-83 mean is based on only two detectable concentrations. The dates of the detectable sample concentrations are September 24, 1996 and October 24, 1996. The laboratory case narrative mentions all temperature blanks were below 4 degrees centigrade at the time of cooler receipt on the dates of the two detectable CH-04-83 NH_3-N samples. Warmer temperature can affect nutrient results due to biological activity. The lab felt that the fall lake turnover might have influenced the results for well CH-04-83. This would mean that the two detectable sample results are representative. NH_3-N quality control results for the September sampling event list one QC sample percent recovery at 119%, two points outside the upper recovery limit of 117%. According to the lab an isolated number two points out is not unusual. It is customary to look for a pattern rather than isolated numbers when something is wrong with the laboratory analyses procedures. There appears to be no pattern in this instance.

4.4.4 As shown in figure 8 the mean concentration of total kjeldahl nitrogen (TKN) in well CH-10-84 is more than three times the mean concentration in the other two deep wells and two of the three shallow wells. In addition, the “landing” and “deep” dike well geochemical environment is different than the “shallow” wells which will influence chemical speciation.

4.5 "Shallow" Dike Well Water Quality

4.5.1 Since the shortest seepage travel path from the CDF to the harbor or river is through the dike, the “shallow” wells along with measurement inside and outside the CDF should provide during dredged material disposal the most decisive information regarding any potential CDF impacts to Calumet Harbor or River. No dredged material was disposed to the CDF in 1996. Results for 1996 indicate that water quality in the three "shallow" dike wells (CH-04-83, CH-07-84, and CH-09-84) continued to be typical of Calumet Harbor. The 1996 data indicated only a 0.3 ug/l mercury concentration in one of the 36 shallow well samples. The remaining 35 were non-detects. Previous mercury measurements from 1994 are within the range of ambient Calumet Harbor and River concentrations and would not suggest contamination migration. Also 1995 and 1996 data indicate that the elevated value (6.8 ug/l) in well CH-9-84 in 1993 is an anomaly. A comparison among sampling locations and concentration of the nutrients Phosphorous, Ammonia-Nitrogen, and TKN is shown in figures 6, 7, and 8 respectively.

4.5.2 Total ammonia nitrogen was not found in 1996 in any samples from shallow wells CH-07-84 and CH-09-84. Total ammonia nitrogen was found in 2 of 12 samples from well CH-04-84 at concentrations of 6.5 mg/l. and 8.5 mg/l.

5. SUMMARY

5.1 Monitoring data from wells in Iroquois Landing and the dike of the Chicago Area Confined Disposal Facility during calendar year 1996 are provided. Three wells on the landing and six (three "deep" and three "shallow") wells on the dike were monitored.

5.2 The quality of ground water in Iroquois Landing is poor. The water is hard and alkaline. There appears to be no change in ground water quality during 1996 on Iroquois Landing. The quality of water from the deep dike wells may indicate typical lake bottom surface sediment limnology. Analysis of the 1996 data indicate that the Chicago Area CDF appears to have had no adverse effect on the waters of the Calumet Harbor or Calumet River.

6. REFERENCES

1. USACE, May 1982, Final Environmental Impact Statement Chicago Area Confined Disposal Facility and Maintenance Dredging in Cook County, Illinois, Chicago District, Chicago, Illinois.

2. USACE, June 1984, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1983, Chicago District, Chicago, Illinois.

3. USACE, May 1985, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1984, Chicago District, Chicago, Illinois.

4. USACE, May 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1985, Chicago District, Chicago, Illinois.

5. USACE, June 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1986, Chicago District, Chicago, Illinois.

6. USACE, July 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1987, Chicago District, Chicago, Illinois.

7. USACE, December 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1988, Chicago District, Chicago, Illinois.

8. USACE, June 1990, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1989, Chicago District, Chicago, Illinois.

9. USACE, June 1993, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1990, Chicago District, Chicago, Illinois.

10. USACE, March 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1991, Chicago District, Chicago, Illinois.

11. USACE, May 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1992, Chicago District, Chicago, Illinois.

12. USACE, Sep 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1993 Calendar Year, Chicago District, Chicago, Illinois.

13. USACE, April 1995, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1994 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

14. USACE, August 1996, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1995 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

15. USACE, April 1985, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations , October 1984 to December 1984, Daily & Associates, Engineers, Inc. for Chicago District.

16. USACE, February 1986, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations July 1985 to September 1985, Daily & Associates, Engineers, Inc. for Chicago District.

17. USACE, October 1986, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations April 1986 to July 1986, Daily & Associates, Engineers, Inc. for Chicago District.

18. USACE, December 1989, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations April 1989 Through June 1989, Randolph & Associates, Inc. for Chicago District.

19. USACE, November 1995, Report on Maintenance Dredging of Calumet River (12/2/94 through 12/31/94), Volume I, Chicago District, Chicago, Illinois

20. USACE, Feb. 1996, Well Cleaning and Repair, Chicago Area Confined Disposal Facility Calumet Harbor, Illinois, Midwest Engineering Services, Inc. for Chicago District, Chicago, Illinois

21. USEPA, March 1983, Methods for Chemical Analysis of Water and Wastes, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, EPA-600/4-79-020 Revised March 1983.

22. USEPA, July 1982, Methods for Organic Chemical Analysis of Municipal and Industrial Waste water, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, EPA-600/4-82-057.

23. USEPA, Nov. 1986, Test Methods for Evaluating Solid Waste, Volumes IA through IC and II, Office of Solid Waste and Emergency Response, Washington, DC 20460, SW-846 Third Edition.

24. Illinois EPA, March 1995, Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, State of Illinois Rules and Regulations as amended through December 30, 1994.

25. Baker, Robert A. (Editor), 1980, Contaminants and Sediments Volume 1, Fate and Transport, Case Studies, Modeling, Toxicity, Ann Arbor Science Publishers Inc. / The Butterworth Group, Ann Arbor, Michigan.

26. Gaugush, R. F., tech. ed. 1986. "Statistical Methods for Reservoir Water Quality Investigations," Instruction Report E-86-2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

27. Khalid, R. A.; Gambrell, R. P.; Verloo, M. G.; Patrick Jr., W.H.; May 1977 Transformations of Heavy Metals and Plant Nutrients in Dredged Sediments as Affected by Oxidation Reduction Potential and pH; Volume 1. Literature Review, Contract Report D-77-4, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

28. Matthess, Georg, 1982, The Properties of Ground water,
translated by Harvey, John C., John Wiley & Sons Inc., New York.

29. Ruttner, Franz, 1973, Fundamentals of Limnology, translated by Frey, D.G. and Fry, F.E.J., Third Edition University of Toronto Press, Toronto, Canada.

30. Skoog, Douglas A.; West, Donald M., 1974, Analytical Chemistry, An Introduction, Second Edition, Holt, Rinehart and Winston, Inc.

31. January 1993, Environment Reporter, State Water Laws Vol. 2
The Bureau of National Affairs, Inc. 1231 25th Street, N.W., Washington, D.C. 20037

Chicago Area Confined Disposal Facility
Monitoring Well Data Report
CY 1996

Appendix A

Water Quality Sample Data and Sample Statistics

Chicago Area Confined Disposal Facility
Monitoring Well Data Report
CY 1996

Appendix B

Quality Control Quality Assurance

Chicago Area Confined Disposal Facility
Monitoring Well Data Report
CY 1996

Appendix C

Statistical Summary for Period of Record 1983 - 1995