

Protecting Our Water Environment



Metropolitan Water Reclamation District of Greater Chicago

**RESEARCH AND DEVELOPMENT
DEPARTMENT**

REPORT NO. 05-11

CONTINUOUS DISSOLVED OXYGEN MONITORING

IN THE CHICAGO WATERWAY SYSTEM

DURING 2004

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**CONTINUOUS DISSOLVED OXYGEN MONITORING
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DURING 2004**

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DISCLAIMER

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the Metropolitan Water Reclamation District of Greater Chicago.

SUMMARY AND CONCLUSIONS

Summary

More than 30 years ago, the Metropolitan Water Reclamation District of Greater Chicago (District) determined that applicable dissolved oxygen (DO) standards for deep draft navigable waterways in the Chicago area could not be maintained exclusively by improving the effluent quality from the three major District Water Reclamation Plants (WRPs) and by capturing and treating combined sewer overflows (CSOs).

In order to provide supplemental aeration, the District constructed and operated two diffused air instream aeration stations and five sidestream elevated pool aeration (SEPA) stations in Chicago area waterways. In August 1996, the District began planning a comprehensive DO monitoring study to identify reaches in the Chicago Waterway System where the DO concentration is less than the applicable Illinois Pollution Control Board (IPCB) water quality standards.

Initially, 20 stations were selected for monitoring from Wilmette, Illinois, on the North Shore Channel to the Lockport Powerhouse and Lock on the Chicago Sanitary and Ship Canal, using continuous water quality monitors, Models 6600 and 6920 manufactured by YSI Incorporated (YSI), Yellow Springs, Ohio. This monitoring was extended further downstream to Jefferson Street in Joliet, Illinois, on the Des Plaines River beginning in March 2000. Additional stations were added to the DO monitoring network in August 2001 in order to monitor the Calumet River System.

The present report includes hourly DO values at 21 stations from Wilmette to Lockport in the Chicago River System, 1 station in Joliet in the Des Plaines River System, and 13 stations in the Calumet River System.

In the Chicago River System, DO monitoring began at a new station at Foster Avenue on the North Shore Channel in September 2004. DO monitoring was discontinued in March 2004 at eight stations, including Linden Street and Simpson Street on the North Shore Channel, Division Street on the North Branch of the Chicago River, the Chicago River Controlling Works and Michigan Avenue on the Chicago River, Jackson Boulevard on the South Branch of the Chicago River, and River Mile 302.6 and Romeoville Road on the Chicago Sanitary and Ship Canal.

In the Calumet River System, DO monitoring was discontinued in March 2004 at six stations, including 130th Street on the Calumet River, Conrail Railroad on the Little Calumet River, and at Division Street, Kedzie Avenue, River Mile 311.7 and Southwest Highway on the Calumet-Sag Channel. The monitoring stations at Division Street and River Mile 311.7 were reactivated during September and October and were then returned to inactive status.

Conclusions

Chicago and Des Plaines River Systems. The results of the continuous DO monitoring conducted in the Chicago and Des Plaines River Systems during 2004 indicated the following.

1. DO supersaturation occurred at Main Street on the North Shore Channel, possibly due to oxygen produced by algae during daylight hours.
2. Hourly DO concentrations at or near zero were recorded numerous times at Simpson Street and Main Street on the North Shore Channel, 36th Street and

Interstate Highway 55 on Bubbly Creek, and at Route 83 on the Chicago Sanitary and Ship Canal.

3. Six monitoring stations recorded DO concentrations above the applicable IPCB standards at all times, including: Foster Avenue on the North Shore Channel, the Chicago River Controlling Works and Michigan Avenue on the Chicago River, Jackson Boulevard on the South Branch of the Chicago River, and River Mile 302.6 and Romeoville Road on the Chicago Sanitary and Ship Canal.
4. Three monitoring stations were above the applicable IPCB DO standard at least 99 percent of the time, including: Addison Street and Division Street on the North Branch of the Chicago River, and Loomis Street on the South Branch of the Chicago River.
5. The DO concentration was above the DO standard 90 to 98 percent of the time at five monitoring stations, including Fullerton Avenue and Kinzie Street on the North Branch of the Chicago River, Clark Street on the Chicago River, B&O Central Railroad on the Chicago Sanitary and Ship Canal, and Jefferson Street on the Des Plaines River.
6. Eight monitoring stations recorded DO levels above the applicable IPCB DO standards less than 90 percent of the time, including: Linden Street (71 percent), Simpson Street (48 percent), and Main Street (81 percent) on the North Shore Channel, 36th Street (71 percent) and Interstate Highway 55 (60 percent) on Bubbly Creek, and Cicero Avenue (77 percent), Route 83 (73 percent), and Lockport (73 percent) on the Chicago Sanitary and Ship Canal.

7. Based upon the results of this study, it appears that the North Shore Channel upstream of the North Side WRP and Bubbly Creek are the main areas, of those monitored, that are experiencing problems maintaining DO above the applicable DO standard. It also appears that the diffused air instream aeration stations on the North Shore Channel and North Branch are effective in maintaining compliance with DO standards in the waterways downstream of each station.

Calumet River System. The results of the continuous DO monitoring conducted in the Calumet River System during 2004 indicated the following.

1. DO supersaturation occurred at Torrence Avenue on the Grand Calumet River, possibly due to oxygen produced by algae during daylight hours.
2. Hourly DO concentrations at or near zero were recorded numerous times at Torrence Avenue on the Grand Calumet River, at Ashland Avenue on the Little Calumet River, and at 104th Avenue on the Calumet-Sag Channel.
3. Six monitoring stations recorded DO concentrations above the applicable IPCB standards at all times, including 130th Street on the Calumet River, Conrail Railroad on the Little Calumet River, and Division Street, Kedzie Avenue, River Mile 311.7, and Southwest Highway on the Calumet-Sag Channel.
4. Four monitoring stations were above the applicable IPCB DO standard at least 99 percent of the time, including: C&W Indiana Railroad and Halsted Street on the Little Calumet River, and Cicero Avenue and Route 83 on the Calumet-Sag Channel.

5. The DO concentration was above the DO standard 93 percent of the time at 104th Avenue on the Calumet-Sag Channel.
6. Two monitoring stations recorded DO concentrations above the applicable IPCB DO standard less than 90 percent of the time, including Torrence Avenue (78 percent) on the Grand Calumet River, and Ashland Avenue (57 percent) on the Little Calumet River.
7. Based upon the results of this study, it appears that the Grand Calumet River at Torrence Avenue and the Little Calumet River at Ashland Avenue are experiencing problems maintaining DO above the applicable DO standard. It also appears that the SEPA stations on the

Calumet River, Little Calumet River, and Calumet-Sag Channel are effective in maintaining compliance with DO standards in the waterways downstream of these stations.

The database resulting from the operation of the continuous DO monitors has been an important source of information for determining the DO levels in a complex, urbanized waterway system. This information will be useful in the future for determining the need and location for additional supplemental aeration capacity, understanding the temporal and transient impacts of CSOs, assessing the effects of reduced discretionary diversion from Lake Michigan, and calibrating and verifying an unsteady-state water quality model for the Chicago, Calumet, and Des Plaines River Systems.

INTRODUCTION

The Chicago Waterway System (CWS) consists of 78 miles of canals, which serve the Chicago area for two principal purposes, the drainage of urban storm water runoff and treated municipal wastewater effluent and the support of commercial navigation. Approximately 75 percent of the length is composed of man-made canals where no waterway existed previously and the remainder is composed of natural streams that have been deepened, straightened and/or widened to such an extent that reversion to the natural state is not possible. The flow of water in the CWS is artificially controlled by hydraulic structures. The CWS has two river systems, the Calumet River System and the Chicago River System (Lanyon, 2002).

Over the years, increased pollutant loading from urbanization throughout the Chicago metropolitan area and low stream velocities in Chicago area deep-draft waterways have caused DO concentrations to fall below DO standards established by the IPCB. More than 30 years ago, the District determined that applicable IPCB DO standards for Chicago area waterways could not be met exclusively by advanced wastewater treatment at its three major regional WRPs (Calumet, North Side, and Stickney) and by the capture and treatment of CSOs. In order to increase the DO concentration in the Chicago and Calumet River Systems, the District designed and constructed artificial aeration systems (instream diffuser and sidestream elevated pool aeration [SEPA] stations) during the late 1970s and early 1990s, respectively.

From October 1994 through May 1996, the Research and Development (R&D) Department conducted weekly DO surveys in the Chicago River System. Water samples were

collected manually, chemically fixed in the field, and returned to the laboratory for titration. The results from these surveys showed that DO concentrations in selected waterway reaches were less than IPCB DO standards applicable to these reaches.

In August 1996, R&D began developing a comprehensive field-monitoring program in order to locate and identify reaches in the Chicago River System where the DO concentration is less than the applicable IPCB DO standard. Initially, the program was to focus on the Chicago River System for a two-year period. Subsequently, the scope of the monitoring program was extended to four years, and the study area was expanded to include the Calumet River System for the latter two years. The resulting data have been used for the calibration and verification of a water quality model for the CWS.

Monitoring results for the CWS have been summarized by:

1. Polls (2002) from August 1998 through July 2000.
2. Dennison et al. (2004) from August 2000 through December 2001.
3. Dennison et al. (2004) from January 2002 through December 2002 (Chicago River System) and from August 2001 through December 2002 (Calumet River System).
4. Dennison et al. (2005) from January 2003 through December 2003.

This report covers the monitoring results for the period January 2004 through December 2004 for the Chicago River System, Des Plaines River System, and Calumet River System.

MONITORING STATIONS

Locations for 21 monitoring stations on the Chicago River System, 1 station on the Des Plaines River System, and 13 stations on the Calumet River System are shown in Figure 1. Chicago River System stations included: four stations on the North Shore Channel, four on the North Branch of the Chicago River, three on the Chicago River, one on the South Branch of the Chicago River, two on Bubbly Creek, and six on the Chicago Sanitary and Ship Canal. The one station on the Des Plaines River System was at Jefferson Street in Joliet. Calumet River System stations included one station on the Calumet River, one station on the Grand Calumet River, four stations on the Little Calumet River, and seven stations on the Calumet-Sag Channel. Table 1 describes the locations of all the monitoring stations. In March 2004, fourteen monitoring stations were

taken out of service in order to use the monitors at other locations, primarily in relatively shallow streams. In August 2004, a new monitoring station was installed at Foster Avenue on the North Shore Channel in order to monitor the DO of the North Shore Channel before its confluence with the North Branch of the Chicago River.

Criteria used to select monitoring stations included the following: (1) history of low DO, (2) above and below confluence of waterways, (3) proximity to instream aeration stations or SEPA stations, (4) below North Branch and Racine Avenue pumping stations, (5) above and below the North Side, Stickney, and Calumet WRPs, (6) below discretionary diversion locations, and (7) minimal cross-sectional DO variability.

FIGURE 1: CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS
IN THE CHICAGO WATERWAY SYSTEM

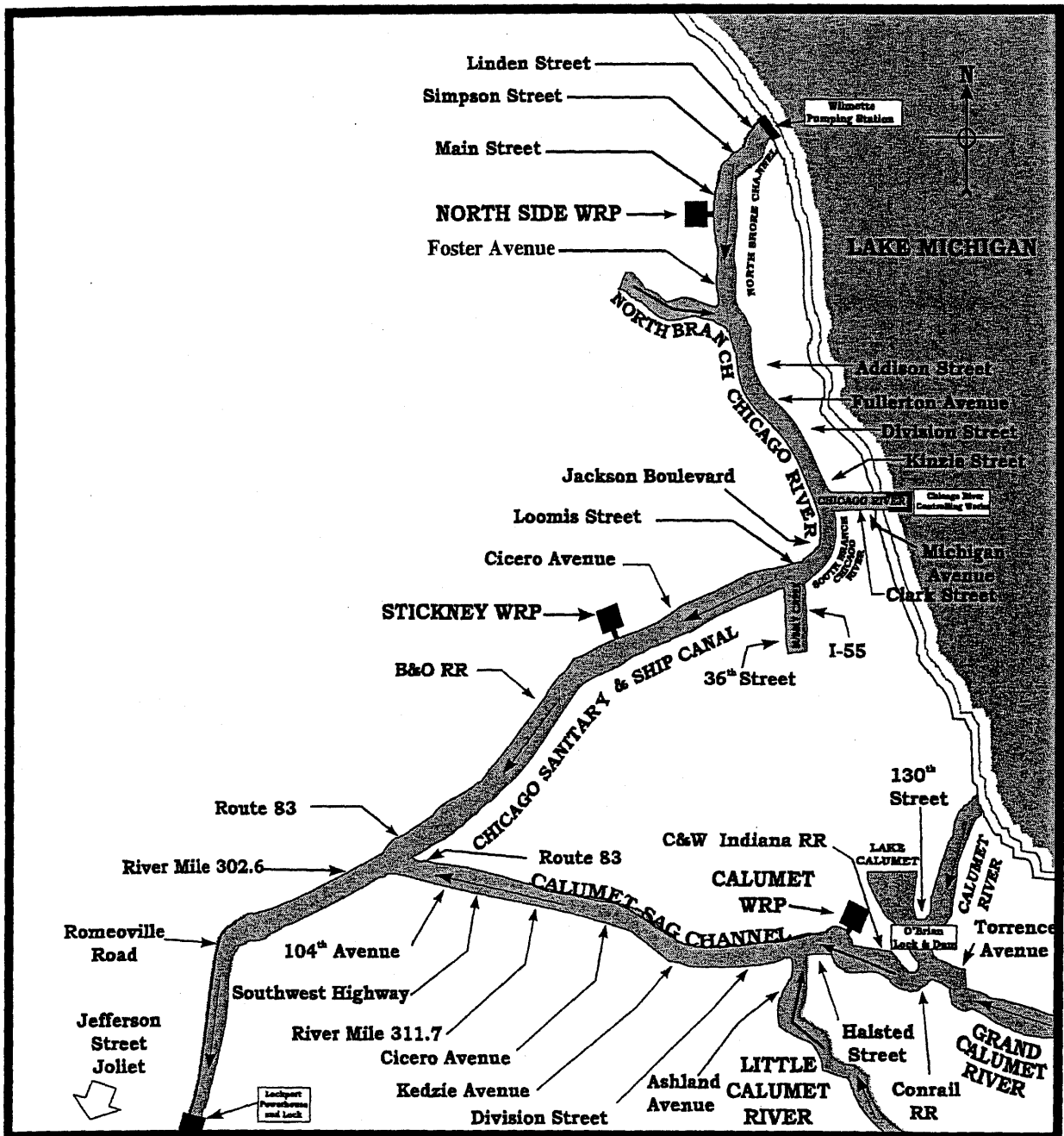


TABLE 1: CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

Monitoring Station	Waterway	Description of Monitoring Station
<u>Chicago River System</u>		
Linden Street	North Shore Channel	0.1 mile below Wilmette Pumping Station; 7.1 miles above North Side WRP outfall; water quality monitor under Linden Street bridge, center of channel, one foot above bottom.
Simpson Street	North Shore Channel	1.6 miles below Wilmette Pumping Station; 5.6 miles above North Side WRP outfall; water quality monitor under Simpson Street bridge, center of channel, one foot above bottom.
Main Street	North Shore Channel	3.5 miles below Wilmette Pumping Station; 0.8 mile above North Side WRP outfall; water quality monitor under Main Street bridge, center of channel, one foot above bottom.
Foster Avenue	North Shore Channel	3.2 miles below North Side WRP outfall; 0.1 mile above junction with North Branch Chicago River; water quality monitor on northwest side Foster Avenue bridge, three feet below water surface.
Addison Street	North Branch Chicago River	5.2 miles below North Side WRP outfall; water quality monitor on northwest side Addison Street bridge; three feet below water surface.
Fullerton Avenue	North Branch Chicago River	7.2 miles below North Side WRP outfall; 0.4 mile above Webster Aeration Station; water quality monitor on northwest side Fullerton Avenue bridge, three feet below water surface.
Division Street	North Branch Chicago River	8.8 miles below North Side WRP outfall; 1.4 miles below Webster Aeration Station; water quality monitor on northeast side Division Street bridge, three feet below water surface.

TABLE 1 (Continued): CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

Monitoring Station	Waterway	Description of Monitoring Station
<u>Chicago River System (Continued)</u>		
Kinzie Street	North Branch Chicago River	9.9 miles below North Side WRP outfall; 0.2 mile above junction with Chicago River; water quality monitor on northeast side Kinzie Street bridge, three feet below water surface.
Chicago River Controlling Works	Chicago River	0.1 mile below Chicago River Controlling Works; 1.5 miles above junction with South Branch Chicago River; water quality monitor on south guidewall of lock, three feet below water surface.
Michigan Avenue	Chicago River	0.8 mile below Chicago River Controlling Works; 0.8 mile above junction with South Branch Chicago River; water quality monitor on northeast side Michigan Avenue bridge, three feet below water surface.
Clark Street	Chicago River	1.2 miles below Chicago River Controlling Works; 0.4 mile above junction with South Branch Chicago River; water quality monitor on northeast side Clark Street bridge, three feet below water surface.
Jackson Boulevard	South Branch Chicago River	4.0 miles below junction with Chicago River; 0.4 mile below Fisk Generating Station discharge; water quality monitor on northeast side Loomis Street bridge, three feet below water surface.
Loomis Street	South Branch Chicago River	3.6 miles below junction with Chicago River; water quality monitor on northeast side Loomis Street bridge; three feet below water surface.
36 th Street	Bubbly Creek	0.2 mile below Racine Avenue Pumping Station; 1.2 miles above junction with South Branch of the Chicago River; water quality monitor attached to concrete wall on west side of river, three feet below water surface.

TABLE 1 (Continued): CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

Monitoring Station	Waterway	Description of Monitoring Station
<u>Chicago River System (Continued)</u>		
Interstate Highway 55	Bubbly Creek	1.0 mile below Racine Avenue Pumping Station; 0.4 mile above junction with South Branch of the Chicago River; water quality monitor on northeast side I-55 bridge, three feet below water surface.
Cicero Avenue	Chicago Sanitary and Ship Canal	1.5 miles above Stickney WRP outfall; 1.1 miles below Crawford Generating Canal Station cooling water discharge; water quality monitor on northeast side Cicero Avenue bridge, three feet below water surface.
B&O Central Railroad	Chicago Sanitary and Ship Canal	3.6 miles below Stickney WRP outfall; water quality monitor in center of canal, east side B&O Central RR bridge, three feet below water surface.
Route 83	Chicago Sanitary and Ship Canal	1.2 miles above junction with Calumet-Sag Channel; 1.1 miles above Canal Junction SEPA Station; water quality monitor 0.6 mile above Route 83 bridge, center of canal, one foot above bottom.
River Mile 302.6	Chicago Sanitary and Ship Canal	1.2 miles below junction with Calumet-Sag Channel; 1.3 miles below Canal Junction SEPA Station; water quality monitor in center of canal, one foot above bottom.
Romeoville Road	Chicago Sanitary and Ship Canal	7.1 miles below junction with Calumet-Sag Channel; 5.1 miles above Lockport Lock; water quality monitor on southeast side Romeoville Road bridge, three feet below water surface.
Lockport	Chicago Sanitary and Ship Canal	0.1 mile above Lockport Powerhouse; 1.1 miles above junction with Des Plaines River; water quality monitor on north side of canal, in forebay area on fender wall, three feet below water surface.

TABLE 1 (Continued): CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

Monitoring Station	Waterway	Description of Monitoring Station
<u>Des Plaines River System</u>		
Jefferson Street	Des Plaines River	3.0 miles below Lockport Lock; 2.1 miles below junction with Chicago Sanitary and Ship Canal; water quality monitor on southeast side Jefferson Street bridge, three feet below water surface.
<u>Calumet River System</u>		
130 th Street	Calumet River	6.3 miles below junction with Lake Michigan; 0.7 mile upstream of Thomas S. O'Brien Lock and Dam; water quality monitor at downstream end of LaFarge Corporation Chicago Terminal dock, three feet below water surface.
Torrence Avenue	Grand Calumet River	150 feet above junction with Calumet River; 100 feet below Torrence Avenue bridge; water quality monitor attached to bridge abutment on southeast side of river, two feet below water surface.
Conrail Railroad	Little Calumet River	0.4 mile below junction with Grand Calumet River; 1.0 mile below Thomas S. O'Brien Lock and Dam; water quality monitor on northeast side Conrail RR bridge, three feet below water surface.
C&W Indiana Railroad	Little Calumet River	3.6 miles below Thomas J. O'Brien Lock and Dam; 1.3 miles above Calumet WRP outfall; water quality monitor attached to northeast side C&W Indiana RR bridge, three feet below water surface.
Halsted Street	Little Calumet River	1.2 miles below Calumet WRP; 0.5 mile above junction with Calumet-Sag Channel; water quality monitor attached to southeast side Halsted Street bridge, three feet below water surface.
Ashland Avenue	Little Calumet River	0.5 mile above junction with Calumet-Sag Channel; water quality monitor attached to east side Ashland Avenue bridge, two feet below water surface.

TABLE 1 (Continued): CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

Monitoring Station	Waterway	Description of Monitoring Station
<u>Calumet River System (Continued)</u>		
Division Street	Calumet-Sag Channel	1.0 mile below junction with Little Calumet River; 0.4 mile above SEPA 3; water quality monitor attached to southwest side Division Street bridge, three feet below water surface.
Kedzie Avenue	Calumet-Sag Channel	1.1 miles below SEPA 3; 5.3 miles above SEPA 4; water quality monitor attached to northeast side Kedzie Avenue bridge, three feet below water surface.
Cicero Avenue	Calumet-Sag Channel	3.1 miles below SEPA 3; 3.3 miles above SEPA 4; water quality monitor attached to northwest side Cicero Avenue bridge three feet below water surface.
River Mile 311.7	Calumet-Sag Channel	6.4 miles below SEPA 3; 0.1 mile above SEPA 4; water quality monitor attached to concrete wall upstream of SEPA 4 intake structure, three feet below water surface
Southwest Highway	Calumet-Sag Channel	0.8 mile below SEPA 4; 7.0 miles above Canal Junction SEPA Station; monitor attached to southeast side Southwest Highway bridge, three feet below water surface.
104 th Avenue	Calumet-Sag Channel	4.6 miles below SEPA 4; 3.2 miles above Canal Junction SEPA Station; water quality monitor in center of channel, one foot above bottom.
Route 83	Calumet-Sag Channel	0.4 mile above junction with Chicago Sanitary & Ship Canal; 0.3 mile above Canal Junction SEPA Station; water quality monitor on southwest side Illinois Central-Gulf RR bridge, three feet below water surface.

MATERIALS AND METHODS

Water Quality Monitor

In the present study, DO was measured hourly using the YSI Model 6920 or Model 6600 continuous water quality monitor (monitor). In order to protect and safeguard the monitors from marine navigation and vandalism, the monitors were deployed in the field in stainless steel pipes. Two different installation designs were employed: (1) a 3-foot stainless steel pipe was suspended approximately 1 foot off the bottom of the waterway and oriented downstream such that the water passed through the pipe, and (2) a 12- to 15-foot pipe with multiple 2-inch circular openings was vertically mounted on the side of a bridge abutment.

Servicing the monitors followed a weekly schedule. Industrial Waste Division (IWD) personnel retrieved each monitor from the field following seven days of continuous monitoring. Prior to retrieval, a water sample for DO analysis was collected next to the protective housing. An additional monitor that had been previously calibrated and serviced in the laboratory was then deployed to replace the retrieved monitor. The retrieved monitors were returned to the laboratory for data downloading, exterior cleaning, servicing, and calibration of the DO sensors. The monitors were temporarily stored in holding tanks containing tap water for subsequent deployment during the following week.

Data Management and Review

Hourly DO data were directly exported electronically from individual monitors to a specially designed Access[®] database for data processing and storage. Following data downloading, the weekly DO data was carefully reviewed for accuracy.

The review process included the following: (1) Comparing a grab sample DO concentration measured in the field with a DO concentration recorded by a retrieved monitor (DO rejection criteria = difference greater than 2.0 mg/L), (2) Comparing the last hourly DO concentration measured by a retrieved monitor with the first hourly DO concentration recorded by a deployed monitor (DO rejection criteria = difference greater than 2.0 mg/L), and (3) Comparing a DO concentration measured in a laboratory holding tank and a DO concentration recorded by a retrieved monitor (DO rejection criteria = difference greater than 1.0 mg/L). Criterion 3 would entail rejection of all hourly readings, criteria 1 and 2 may or may not reject all readings.

After careful review of the DO data, weekly summary statistics (mean, minimum, maximum, and percent observations above DO standard) and individual line drawings for each monitoring station showing hourly DO concentrations were prepared.

Verification of Representative Data

During the spring, summer, and fall of 2004, cross-sectional DO surveys were conducted in the CWS to determine if a fixed continuous monitoring location represented the DO concentration across the waterway. Verification was achieved by comparing the DO concentrations measured in grab samples at multiple fixed locations and depths across the waterway with the fixed monitor measurements. The results from the cross-sectional surveys clearly showed that the differences across the waterway were minimal and equivalent to the DO concentration measured by the monitor at the fixed locations.

RESULTS AND DISCUSSION

The annual minimum, maximum, and mean DO concentrations measured at all 35 stations during 2004 are shown in [Table 2](#).

The number and percent of measured DO concentrations rejected and removed from the Access[®] database following review during 2004 are summarized in [Table 3](#). Based on the data review methodology previously described, six percent of the data were rejected. The number of DO concentrations rejected ranged from a low of zero at Simpson Street (North Shore Channel), River Mile 302.6 and Romeoville Road (Chicago Sanitary and Ship Canal), Torrence Avenue (Grand Calumet River), Conrail Railroad (Little Calumet River), and Division Street and Route 83 (Calumet-Sag Channel), to a high of 83 percent at Linden Street on the North Shore Channel.

The number and percent of DO concentrations above the applicable IPCB DO standard for each waterway during 2004 are presented in [Table 4](#). The DO data shown in [Table 4](#) do not include the DO concentrations rejected during the data review.

[Table 5](#) shows the percent distribution of DO concentrations from <1.0 mg/L to >5.0 mg/L at the 35 monitoring stations during 2004. The current national one-day minimum dissolved oxygen criterion for adult life stages of fish is 3.0 mg/L (Chapman, 1986).

Weekly DO summary statistics during 2004 are presented for each monitoring station in [Appendix A, Tables A-1 through A-35](#).

The IPCB has assigned water uses for specific water bodies within the state of Illinois. All waters in Illinois are designated for General Use, except those selected as

Secondary Contact and Indigenous Aquatic Life Waters (Secondary Contact).

In the Chicago and Calumet River Systems, General Use Waters include the North Shore Channel from Lake Michigan to the North Side WRP, and the Chicago and Calumet Rivers.

Secondary Contact Waters include the North Shore Channel from the North Side WRP to the North Branch of the Chicago River, the North Branch of the Chicago River from the North Shore Channel to the Chicago River, the South Branch of the Chicago River, Bubbly Creek, the Chicago Sanitary and Ship Canal, the Grand Calumet River, the deep draft portion of the Little Calumet River, the Calumet-Sag Channel, and the Des Plaines River from its confluence with the Chicago Sanitary and Ship Canal to the Interstate Highway 55 bridge southwest of Joliet.

The IPCB has established water quality standards for DO in both General Use and Secondary Contact Waters. In General Use Waters, the DO shall not be less than 6.0 mg/L during 16 hours of any 24-hour period, nor less than 5.0 mg/L at any time. In Secondary Contact Waters, the DO shall not be less than 4.0 mg/L at any time, except in the Calumet-Sag Channel where the DO shall not be less than 3.0 mg/L at any time. For this report, we have selected the 5.0 mg/L DO standard when calculating percent compliance for General Use Waters.

Chicago River System

North Shore Channel. Linden Street. From March 10 through March 23, the maximum DO was 12.8 mg/L, the minimum was 1.8 mg/L, and the mean was 7.5 mg/L. The

TABLE 2: MINIMUM, MAXIMUM, AND MEAN HOURLY DISSOLVED OXYGEN VALUES¹

Monitoring Station	Waterway	DO Values (mg/L)		
		Minimum	Maximum	Mean
<u>Chicago River System</u>				
Linden Street	North Shore Channel	1.8	12.8	7.5
Simpson Street	North Shore Channel	0.0	13.6	5.1
Main Street	North Shore Channel	0.0	26.5	8.4
Foster Avenue	North Shore Channel	4.1	9.2	7.1
Addison Street	North Branch Chicago River	0.3	11.1	7.0
Fullerton Avenue	North Branch Chicago River	0.0	10.6	6.1
Division Street	North Branch Chicago River	1.2	10.3	6.9
Kinzie Street	North Branch Chicago River	0.7	11.3	6.1
Chgo. River Controlling Works	Chicago River	6.7	14.8	11.4
Michigan Avenue	Chicago River	7.1	14.1	11.0
Clark Street	Chicago River	1.7	15.3	8.1
Jackson Boulevard	South Branch Chicago River	5.3	12.8	8.0
Loomis Street	South Branch Chicago River	2.5	11.7	6.7
36 th Street	Bubbly Creek	0.0	16.8	6.3
Interstate Highway 55	Bubbly Creek	0.0	12.1	4.5
Cicero Avenue	Chicago Sanitary and Ship Canal	0.1	9.8	5.1
B&O Central Railroad	Chicago Sanitary and Ship Canal	0.1	10.5	6.4
Route 83	Chicago Sanitary and Ship Canal	0.0	9.2	4.9
River Mile 302.6	Chicago Sanitary and Ship Canal	4.6	9.0	7.4
Romeoville Road	Chicago Sanitary and Ship Canal	5.2	10.8	7.4
Lockport Powerhouse	Chicago Sanitary and Ship Canal	1.2	8.9	5.2
<u>Des Plaines River System</u>				
Jefferson Street	Des Plaines River	2.7	11.8	7.0
<u>Calumet River System</u>				
130 th Street	Calumet River	11.3	13.4	12.3
Torrence Avenue	Grand Calumet River	0.0	27.9	7.3
Conrail Railroad	Little Calumet River	10.0	15.0	12.4
C&W Indiana Railroad	Little Calumet River	2.7	15.6	8.9
Halsted Street	Little Calumet River	2.5	10.3	6.9
Ashland Avenue	Little Calumet River	0.0	16.8	6.8
Division Street	Calumet-Sag Channel	3.7	10.0	7.2
Kedzie Avenue	Calumet-Sag Channel	7.0	12.3	8.7
Cicero Avenue	Calumet-Sag Channel	1.8	10.5	6.8
River Mile 311.7	Calumet-Sag Channel	3.9	12.2	7.7
Southwest Highway	Calumet-Sag Channel	7.3	10.4	8.8
104 th Avenue	Calumet-Sag Channel	0.0	10.9	6.4
Route 83	Calumet-Sag Channel	2.2	10.9	6.6

¹Dissolved oxygen was measured hourly using a YSI Model 6920 or Model 6600 continuous water quality monitor.

TABLE 3: NUMBER AND PERCENT OF DISSOLVED OXYGEN VALUES NOT MEETING ACCEPTANCE CRITERIA¹

Monitoring Station	Waterway	Number of DO Values Rejected	Percent of DO Values Rejected
<u>Chicago River System</u>			
Linden Street	North Shore Channel	1,648 ²	83
Simpson Street	North Shore Channel	0	0
Main Street	North Shore Channel	926	11
Foster Avenue	North Shore Channel	250	7
Addison Street	North Branch Chicago River	502	6
Fullerton Avenue	North Branch Chicago River	168	2
Division Street	North Branch Chicago River	301	15
Kinzie Street	North Branch Chicago River	253	3
Chgo. River Controlling Works	Chicago River	471	24
Michigan Avenue	Chicago River	337	17
Clark Street	Chicago River	191	2
Jackson Boulevard	South Branch Chicago River	144	7
Loomis Street	South Branch Chicago River	504	6
36 th Street	Bubbly Creek	1,002	11
Interstate Highway 55	Bubbly Creek	672	8
Cicero Avenue	Chicago Sanitary and Ship Canal	360	4
B&O Central Railroad	Chicago Sanitary and Ship Canal	364	4
Route 83	Chicago Sanitary and Ship Canal	668	8
River Mile 302.6	Chicago Sanitary and Ship Canal	0	0
Romeoville Road	Chicago Sanitary and Ship Canal	0	0
Lockport Powerhouse	Chicago Sanitary and Ship Canal	168	2
<u>Des Plaines River System</u>			
Jefferson Street	Des Plaines River	606	7
<u>Calumet River System</u>			
130 th Street	Calumet River	253	13
Torrence Avenue	Grand Calumet River	0	0
Conrail Railroad	Little Calumet River	0	0
C&W Indiana Railroad	Little Calumet River	1,179	13
Halsted Street	Little Calumet River	169	2
Ashland Avenue	Little Calumet River	453	5
Division Street	Calumet-Sag Channel	0	0
Kedzie Avenue	Calumet-Sag Channel	206	10
Cicero Avenue	Calumet-Sag Channel	43	<1
River Mile 311.7	Calumet-Sag Channel	174	5
Southwest Highway	Calumet-Sag Channel	119	6
104 th Avenue	Calumet-Sag Channel	1,075	12
Route 83	Calumet-Sag Channel	0	0

¹Dissolved oxygen was measured hourly using a YSI Model 6920 or Model 6600 continuous water quality monitor. DO values were rejected based on quality control check and/or operational problems with monitor.

²Monitor could not be retrieved due to ice from January 1 through March 9 during which time the battery failed and all data were lost.

TABLE 4: NUMBER AND PERCENT OF DISSOLVED OXYGEN VALUES MEASURED ABOVE THE ILLINOIS POLLUTION CONTROL BOARD'S WATER QUALITY STANDARD¹

Monitoring Station	Waterway	IPCB DO Standard	Number of DO Values	Number of DO Values Above Standard	Percent of DO Values Above Standard
<u>Chicago River System</u>					
Linden Street	North Shore Channel	5	335	237	71
Simpson Street	North Shore Channel	5	1,981	961	48
Main Street	North Shore Channel	5	7,827	6,314	81
Foster Avenue	North Shore Channel	4	3,362	3,362	100
Addison Street	North Branch Chicago River	4	8,276	8,195	99
Fullerton Avenue	North Branch Chicago River	4	8,610	8,261	96
Division Street	North Branch Chicago River	4	1,676	1,665	99
Kinzie Street	North Branch Chicago River	4	8,530	8,268	97
Chgo. River Controlling Works	Chicago River	5	1,508	1,508	100
Michigan Avenue	Chicago River	5	1,641	1,641	100
Clark Street	Chicago River	5	8,590	8,403	98
Jackson Boulevard	South Branch Chicago River	4	1,834	1,834	100
Loomis Street	South Branch Chicago River	4	8,279	8,214	99
36 th Street	Bubbly Creek	4	7,605	5,396	71
Interstate Highway 55	Bubbly Creek	4	8,109	4,891	60
Cicero Avenue	Chicago Sanitary and Ship Canal	4	8,588	6,591	77
B&O Railroad	Chicago Sanitary and Ship Canal	4	8,416	8,146	97
Route 83	Chicago Sanitary and Ship Canal	4	8,114	5,913	73
River Mile 302.6	Chicago Sanitary and Ship Canal	4	2,026	2,026	100
Romeoville Road	Chicago Sanitary and Ship Canal	4	2,003	2,003	100
Lockport Powerhouse	Chicago Sanitary and Ship Canal	4	8,611	6,311	73
<u>Des Plaines River System</u>					
Jefferson Street	Des Plaines River	4	8,176	8,021	98
<u>Calumet River System</u>					
130 th Street	Calumet River	5	1,749	1,749	100
Torrence Avenue	Grand Calumet River	4	8,781	6,818	78
Conrail Railroad	Little Calumet River	4	2,005	2,005	100
C&W Indiana Railroad	Little Calumet River	4	7,604	7,554	99
Halsted Street	Little Calumet River	4	8,610	8,570	>99
Ashland Avenue	Little Calumet River	5	8,327	4,713	57
Division Street	Calumet-Sag Channel	3	3,516	3,516	100
Kedzie Avenue	Calumet-Sag Channel	3	1,798	1,798	100
Cicero Avenue	Calumet-Sag Channel	3	8,731	8,674	99
River Mile 311.7	Calumet-Sag Channel	3	3,342	3,342	100
Southwest Highway	Calumet-Sag Channel	3	1,883	1,883	100
104 th Avenue	Calumet-Sag Channel	3	7,710	7,205	93
Route 83	Calumet-Sag Channel	3	8,783	8,719	99

¹Dissolved oxygen was measured hourly using a YSI Model 6920 or Model 6600 continuous water quality monitor.

TABLE 5: PERCENT OF DISSOLVED OXYGEN VALUES IN SELECTED RANGES

Monitoring Station	Waterway	Percent of DO Values in Range (mg/L)					
		<1	1-2	2-3	3-4	4-5	>5
<u>Chicago River System</u>							
Linden Street	North Shore Channel	0	1	3	6	19	71
Simpson Street	North Shore Channel	19	6	8	10	9	48
Main Street	North Shore Channel	4	2	3	4	6	81
Foster Avenue	North Shore Channel	0	0	0	0	0	100
Addison Street	North Branch Chicago River	<1	<1	<1	<1	1	99
Fullerton Avenue	North Branch Chicago River	2	<1	1	1	9	87
Division Street	North Branch Chicago River	0	<1	<1	<1	<1	99
Kinzie Street	North Branch Chicago River	<1	<1	2	1	10	87
Chgo. River Controlling Works	Chicago River	0	0	0	0	0	100
Michigan Avenue	Chicago River	0	0	0	0	0	100
Clark Street	Chicago River	0	<1	<1	1	1	98
Jackson Blvd.	South Branch Chicago River	0	0	0	0	0	100
Loomis Street	South Branch Chicago River	0	0	<1	1	5	94
36 th Street	Bubbly Creek	2	3	9	15	18	53
Interstate Highway 55	Bubbly Creek	13	6	9	12	18	42
Cicero Avenue	Chicago Sanitary and Ship Canal	1	3	6	13	21	56
B&O Railroad	Chicago Sanitary and Ship Canal	1	<1	1	2	9	87
Route 83	Chicago Sanitary and Ship Canal	5	2	4	16	29	44
River Mile 302.6	Chicago Sanitary and Ship Canal	0	0	0	0	0	100
Romeoville Road	Chicago Sanitary and Ship Canal	0	0	0	0	0	100
Lockport Powerhouse	Chicago Sanitary and Ship Canal	0	1	6	20	28	45
<u>Des Plaines River System</u>							
Jefferson Street	Des Plaines River	0	0	<1	2	12	86
<u>Calumet River System</u>							
130 th Street	Calumet River	0	0	0	0	0	100
Torrence Avenue	Grand Calumet River	10	<2	4	7	8	70
Conrail Railroad	Little Calumet River	0	0	0	0	0	100
C&W Indiana Railroad	Little Calumet River	0	0	<1	<1	<2	98
Halsted Street	Little Calumet River	0	0	<1	<1	3	96
Ashland Avenue	Little Calumet River	2	2	8	14	17	57
Division Street	Calumet-Sag Channel	0	0	0	<1	3	97
Kedzie Avenue	Calumet-Sag Channel	0	0	0	0	0	100
Cicero Avenue	Calumet-Sag Channel	0	<1	1	2	11	86
River Mile 311.7	Calumet-Sag Channel	0	0	0	<1	2	98
Southwest Highway	Calumet-Sag Channel	0	0	0	0	0	100
104 th Avenue	Calumet-Sag Channel	5	<1	2	2	14	77
Route 83	Calumet-Sag Channel	0	0	1	7	15	77

monitor could not be retrieved due to ice from January 1 through March 9 during which time the battery failed and all data were lost. Monitoring at Linden Street was discontinued after March 23, 2004. The IPCB requires that the DO concentration in those portions of the North Shore Channel classified as General Use Waters shall not be less than 5.0 mg/L at any time. Seventy-one percent of the DO measurements were above the IPCB General Use DO standard. DO concentrations below the 5.0 mg/L standard occurred during March (Figure 2). Four percent of the DO measurements at Linden Street were below 3.0 mg/L (Table 5).

Simpson Street. From January 1 through March 23, the DO ranged from zero to 13.6 mg/L. The mean DO was 5.1 mg/L. Monitoring at Simpson Street was discontinued after March 23, 2004. Forty-eight percent of the DO measurements were above the 5.0 mg/L IPCB General Use DO standard. DO measurements below the IPCB standard occurred from January through March (Figure 3). Thirty-two percent of the DO concentrations were below 3.0 mg/L (Table 5).

Main Street. DO ranged from zero to 26.5 mg/L. Mean DO was 8.4 mg/L. Eighty-one percent of the DO measurements were above the 5.0 mg/L IPCB General Use DO standard. DO concentrations below the IPCB standard occurred during January and from March through December (Figure 4). Nine percent of the DO concentrations were below 3.0 mg/L (Table 5).

Foster Avenue. DO Monitoring was initiated at Foster Avenue on August 3, 2004. From August 3 through December 31, DO ranged from 4.1 mg/L to 9.2 mg/L. The mean DO was 7.1 mg/L. All DO measurements were above the 4.0 mg/L IPCB Secondary Contact DO standard (Figure 5 and Table 5).

North Branch of the Chicago River, Addison Street. The DO ranged from 0.3 mg/L to 11.1 mg/L. The mean DO was 7.0 mg/L. Ninety-nine percent of the DO measurements were above the 4.0 mg/L IPCB Secondary Contact DO standard. DO measurements below the IPCB standard occurred during February, May, and July (Figure 6). Less than one percent of the DO concentrations recorded at Addison Street were below 3.0 mg/L (Table 5).

Fullerton Avenue. DO ranged from zero to 10.6 mg/L. Mean DO was 6.1 mg/L. Ninety-six percent of the DO measurements at Fullerton Avenue were above the 4.0 mg/L IPCB Secondary Contact DO standard. DO measurements below the IPCB standard occurred during February, and from April through November 2004 (Figure 7). Three percent of the DO concentrations were below 3.0 mg/L (Table 5).

Division Street. Monitoring at Division Street was discontinued after March 23, 2004. DO ranged from 1.2 mg/L to 10.3 mg/L. Mean DO was 6.9 mg/L. From January 1 through March 23, 99 percent of the DO measurements were above the 4.0 mg/L IPCB Secondary Contact DO standard. DO concentrations below the IPCB standard occurred during February (Figure 8). Less than one percent of the DO concentrations were below 3.0 mg/L (Table 5).

Kinzie Street. DO ranged from 0.7 mg/L to 11.3 mg/L (Figure 5). Mean DO was 6.1 mg/L. Ninety-seven percent of the DO measurements were above the 4.0 mg/L IPCB Secondary Contact DO standard. DO measurements below the IPCB standard occurred during February, April through August, and during October and November (Figure 9). Two percent of the DO concentrations were below 3.0 mg/L (Table 5).

FIGURE 2: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT LINDEN STREET ON THE NORTH SHORE CHANNEL
FROM JANUARY 2004 THROUGH DECEMBER 2004

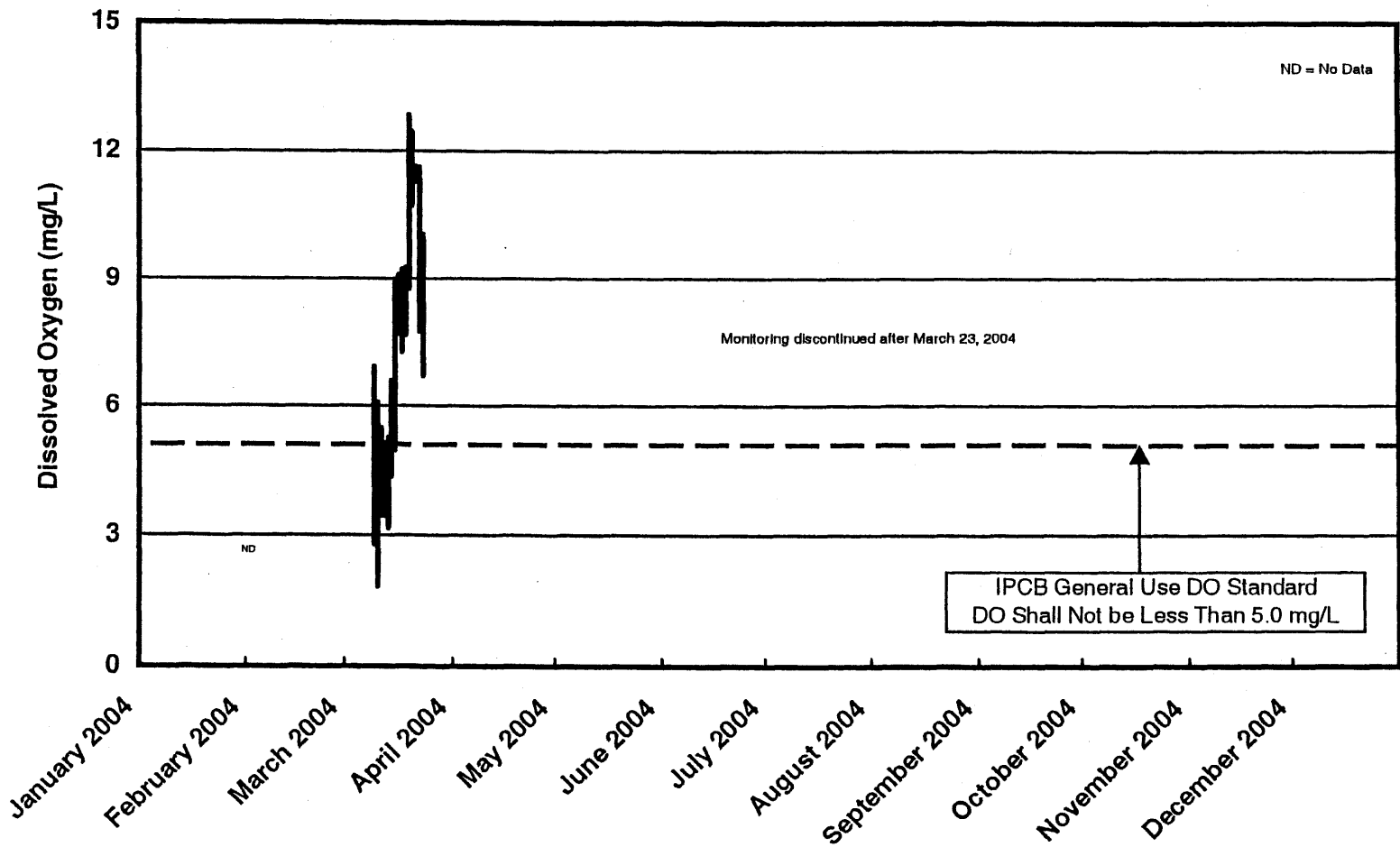


FIGURE 3: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT SIMPSON STREET ON THE NORTH SHORE CHANNEL
FROM JANUARY 2004 THROUGH DECEMBER 2004

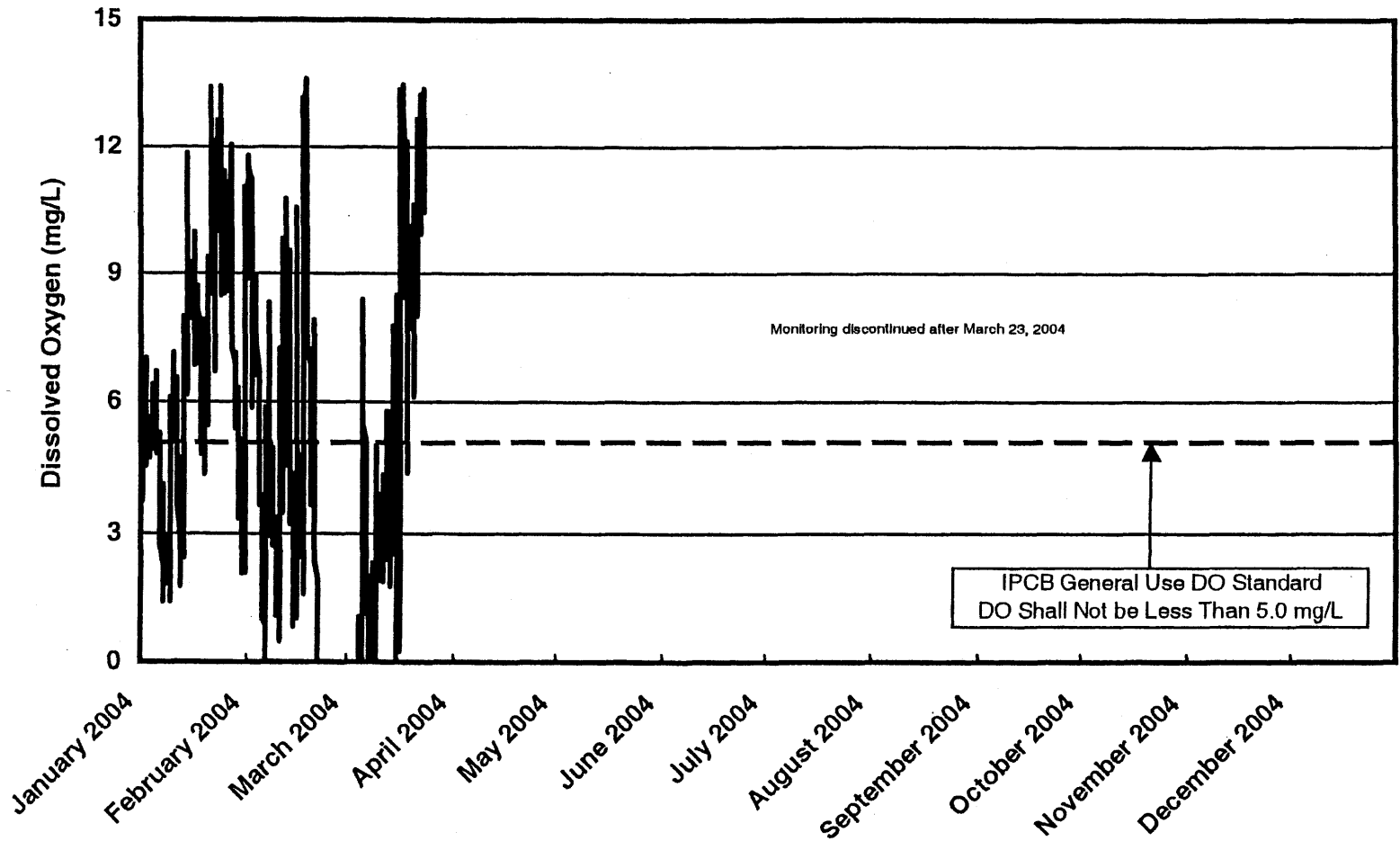


FIGURE 4: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT MAIN STREET ON THE NORTH SHORE CHANNEL
FROM JANUARY 2004 THROUGH DECEMBER 2004

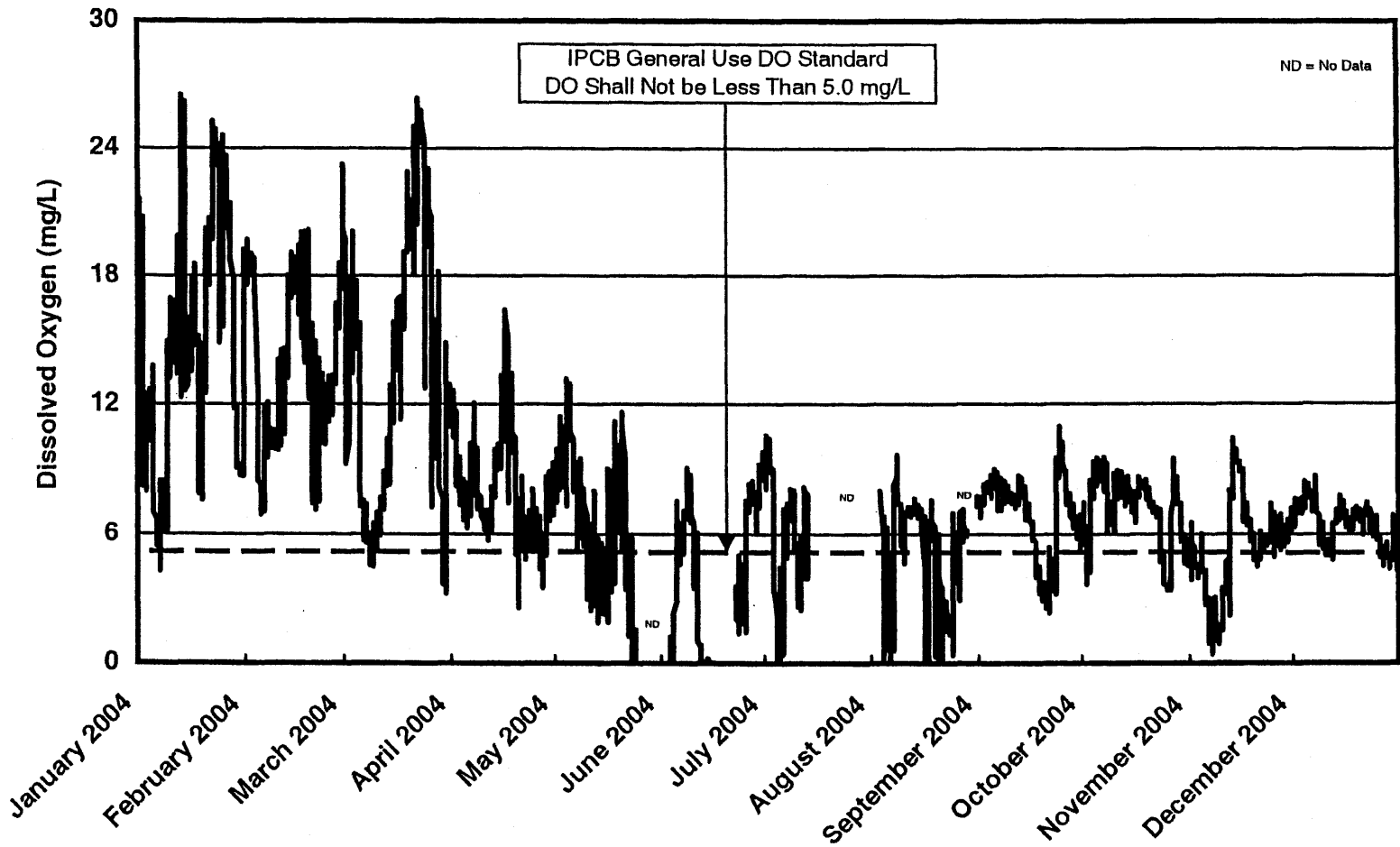


FIGURE 5: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT FOSTER AVENUE ON THE NORTH SHORE CHANNEL
FROM JANUARY 2004 THROUGH DECEMBER 2004

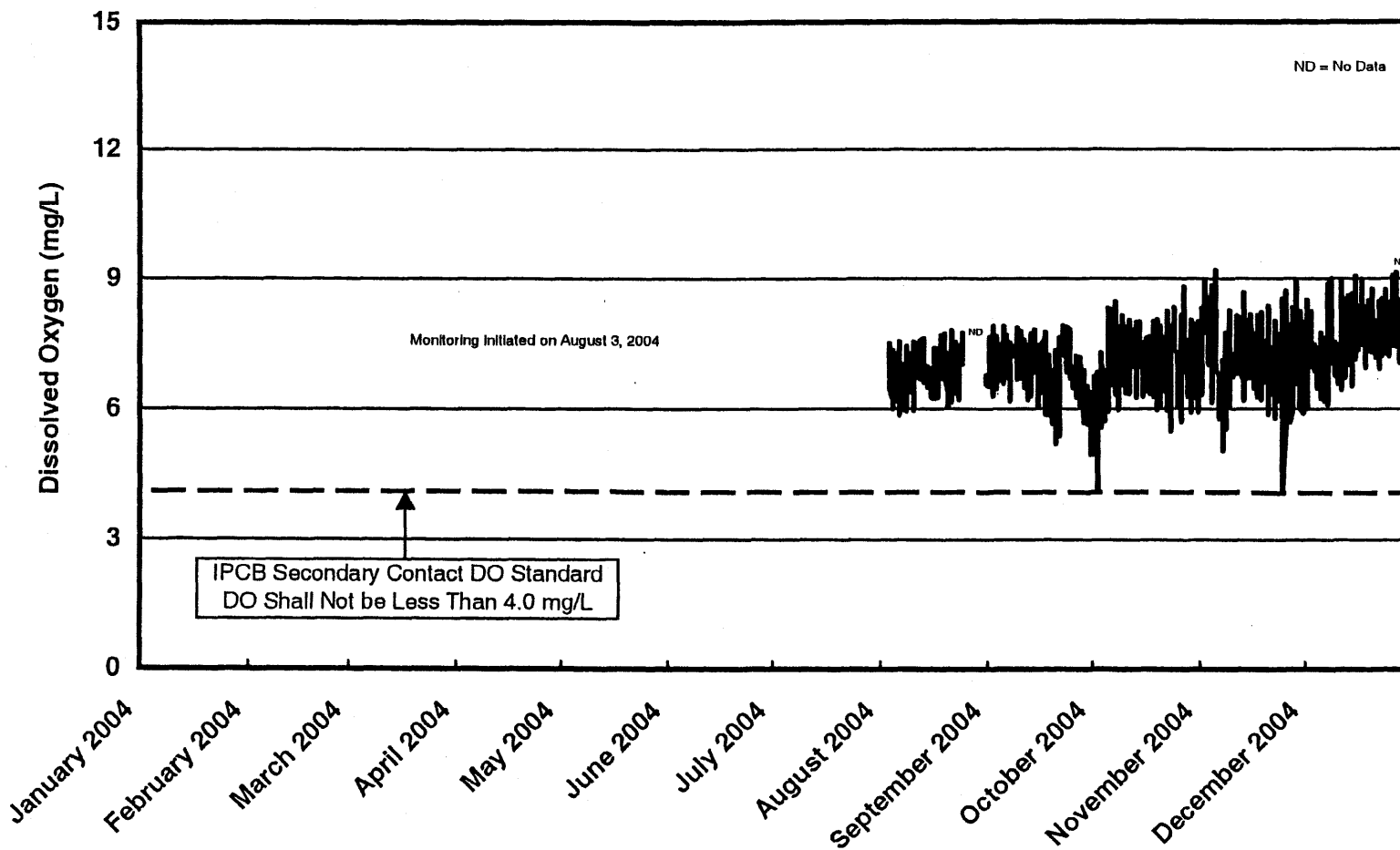


FIGURE 6: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT ADDISON STREET ON THE NORTH BRANCH OF THE CHICAGO RIVER
FROM JANUARY 2004 THROUGH DECEMBER 2004

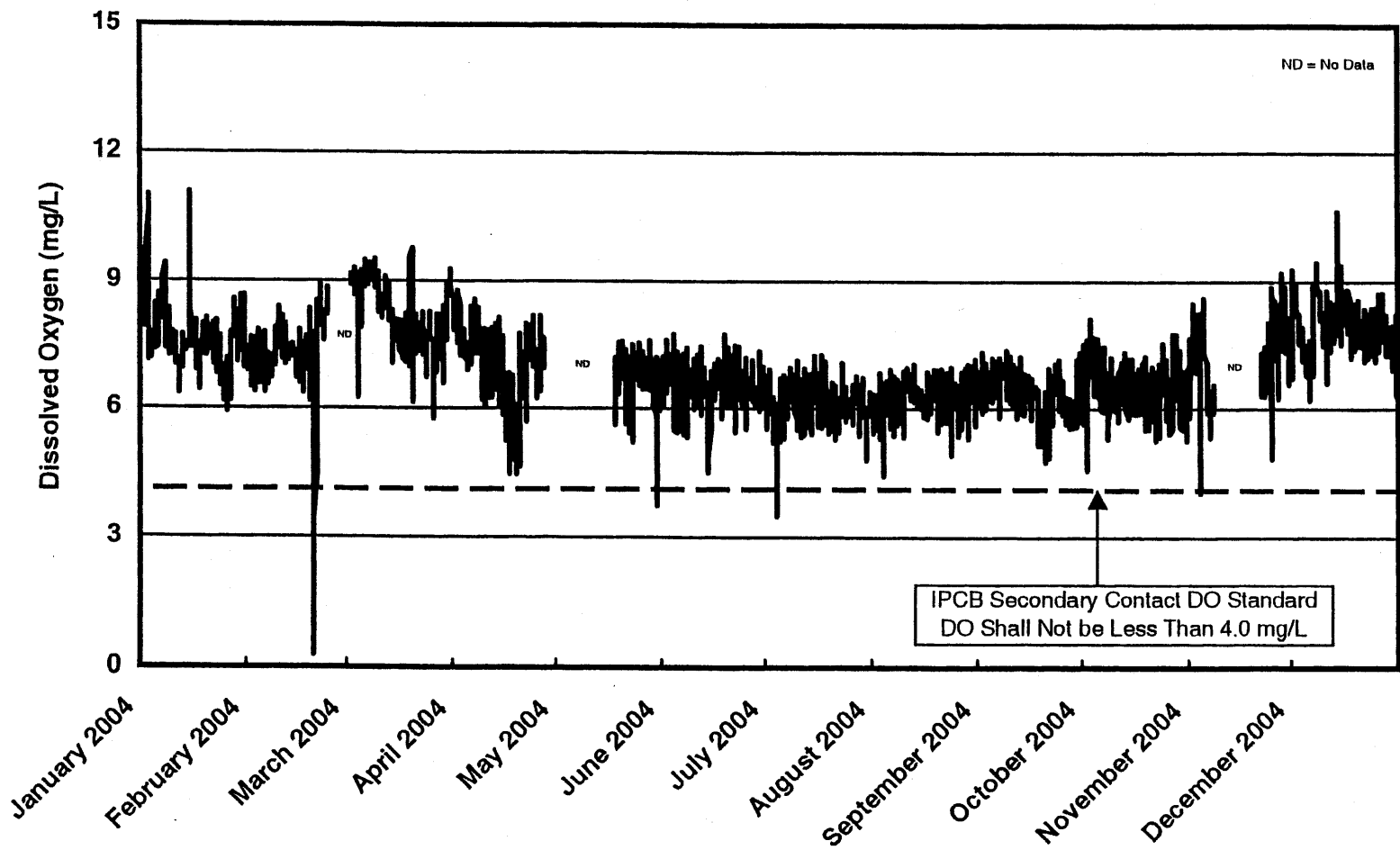


FIGURE 7: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT FULLERTON AVENUE ON THE NORTH BRANCH OF THE CHICAGO RIVER
FROM JANUARY 2004 THROUGH DECEMBER 2004

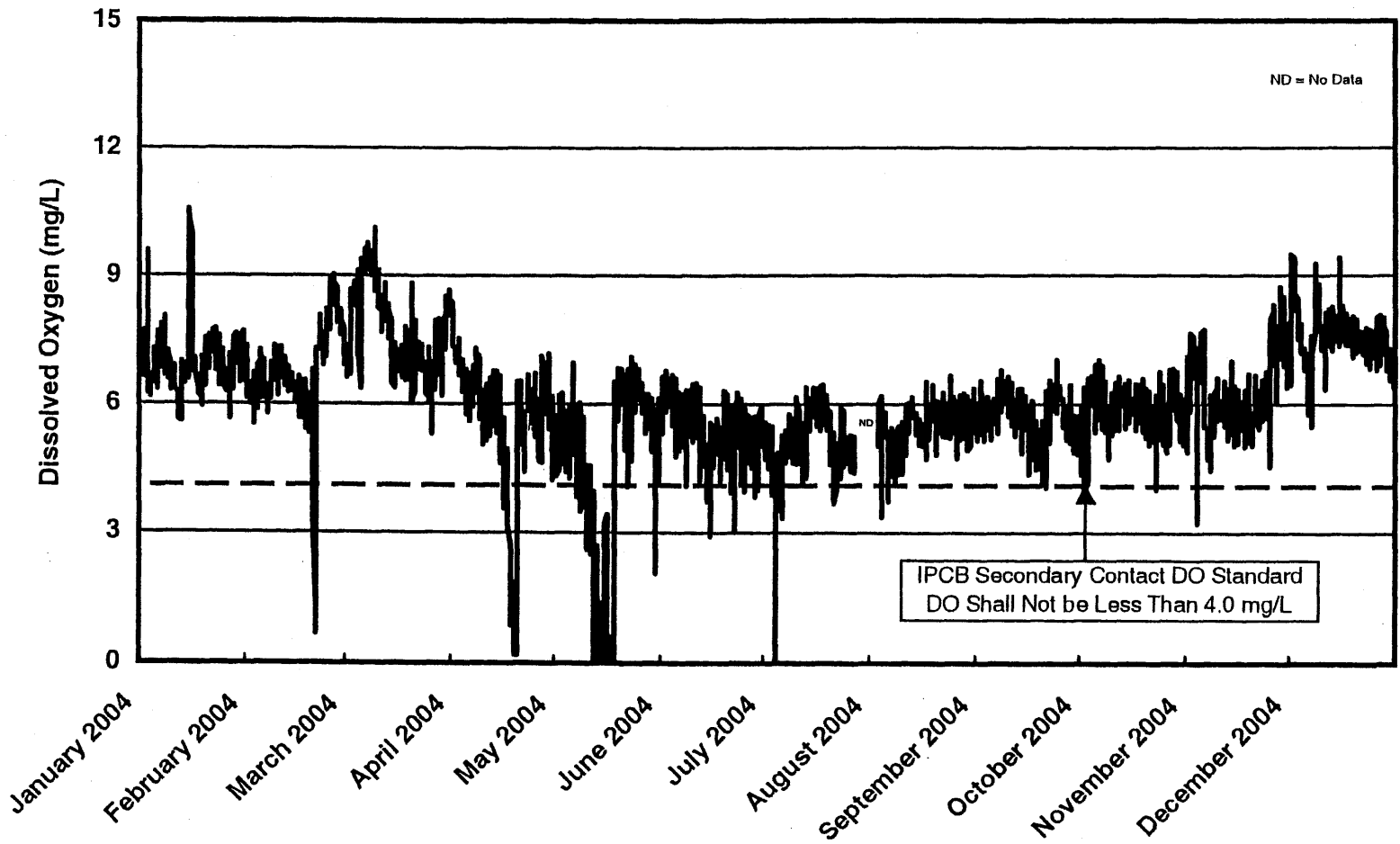


FIGURE 8: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT DIVISION STREET ON THE NORTH BRANCH OF THE CHICAGO RIVER
FROM JANUARY 2004 THROUGH DECEMBER 2004

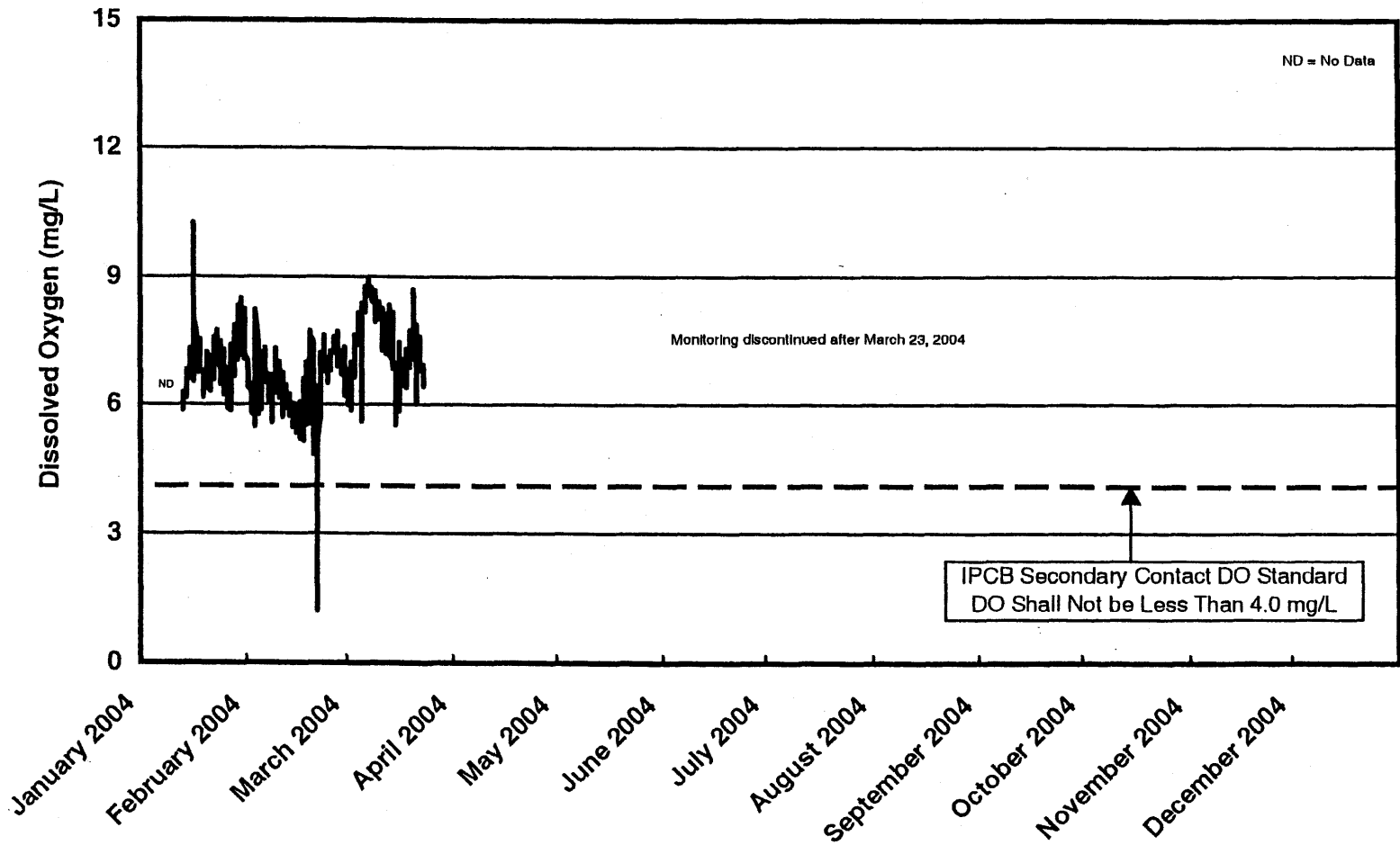
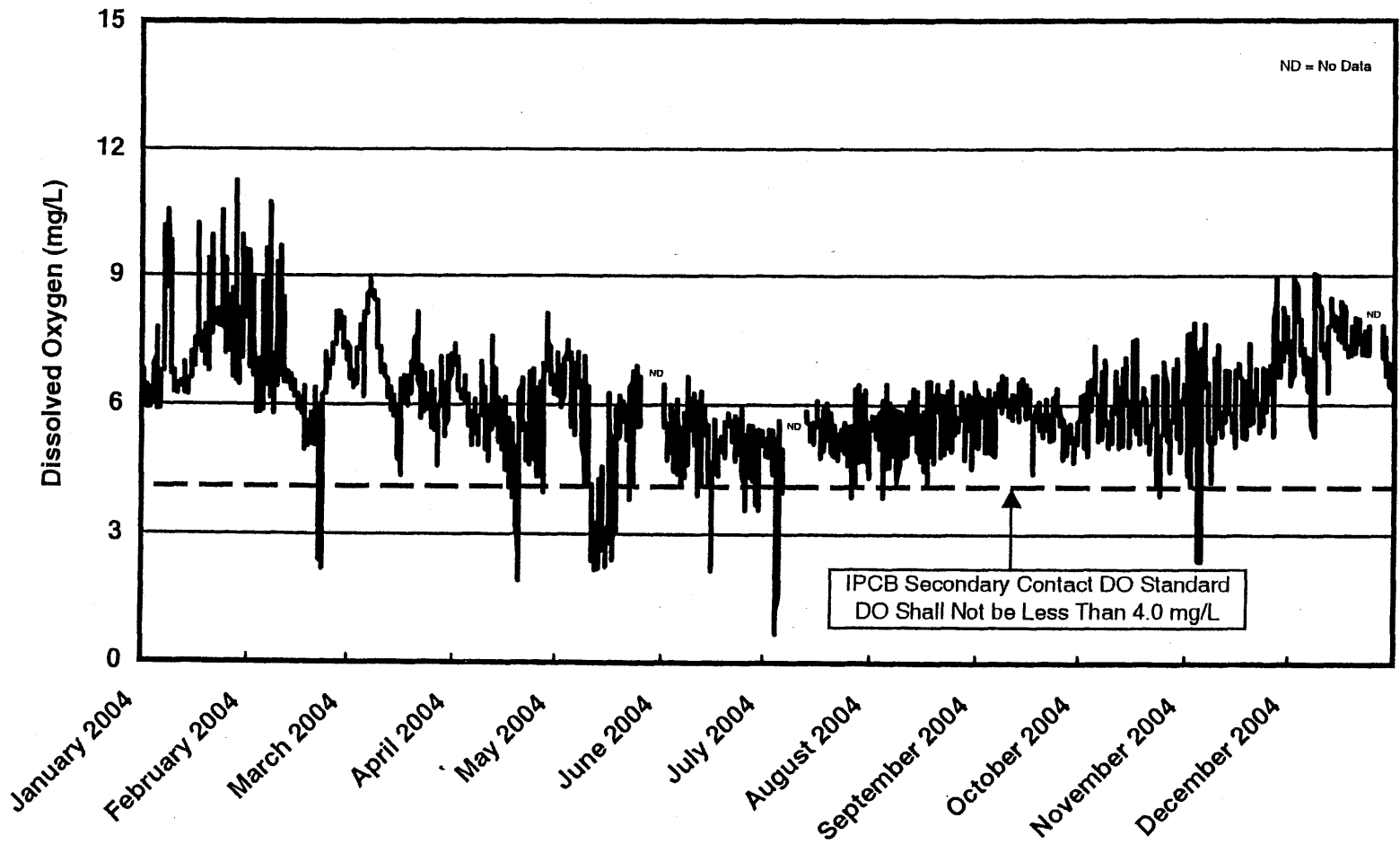


FIGURE 9: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT KINZIE STREET ON THE NORTH BRANCH OF THE CHICAGO RIVER
FROM JANUARY 2004 THROUGH DECEMBER 2004



Chicago River. *Chicago River Controlling Works (CRCW).* From January through March 23, DO ranged from 6.7 mg/L to 14.8 mg/L. Mean DO was 11.4 mg/L. Monitoring at CRCW was discontinued after March 23, 2004. All DO measurements at CRCW were above the 5.0 mg/L IPCB General Use DO standard ([Figure 10](#) and [Table 5](#)).

Michigan Avenue. From January through March 23, DO ranged from 7.1 mg/L to 14.1 mg/L. Mean DO was 11.0 mg/L. Monitoring at Michigan Avenue was discontinued after March 23, 2004. All DO measurements at Michigan Avenue were above the 5.0 mg/L IPCB General Use DO standard. ([Figure 11](#) and [Table 5](#)).

Clark Street. DO ranged from 1.7 mg/L to 15.3 mg/L. Mean DO was 8.1 mg/L. Ninety-eight percent of the DO measurements were above the 5.0 mg/L IPCB General Use DO standard. DO measurements below the IPCB standard occurred from March through May ([Figure 12](#)). Less than one percent of the DO concentrations were below 3.0 mg/L ([Table 5](#)).

South Branch of the Chicago River. *Jackson Boulevard.* From January 1 through March 23, DO ranged from 5.3 mg/L to 12.8 mg/L. Mean DO was 8.0 mg/L. Monitoring at Jackson Boulevard was discontinued after March 23, 2004. All DO measurements were above the 4.0 IPCB Secondary Contact DO standard ([Figure 13](#) and [Table 5](#)).

Loomis Street. DO ranged from 2.5 mg/L to 11.7 mg/L. Mean DO was 6.7 mg/L. Ninety-nine percent of the DO measurements were above the 4.0 mg/L IPCB Secondary Contact DO standard. DO concentrations below the IPCB standard occurred from April through June and during October through November ([Figure 14](#)). Less than one percent of the DO concentrations were below 3.0 mg/L ([Table 5](#)).

Bubbly Creek. *36th Street.* DO ranged from zero to 16.8 mg/L. Mean DO was 6.3 mg/L. Seventy-one percent of the DO measurements were above the 4.0 mg/L IPCB Secondary Contact DO standard. DO measurements below the IPCB standard occurred from April through November ([Figure 15](#)). Fourteen percent of the DO concentrations were below 3.0 mg/L ([Table 5](#)).

Interstate Highway 55 (I-55). DO ranged from zero to 12.1 mg/L. Mean DO was 4.5 mg/L. Sixty percent of the DO measurements were above the 4.0 mg/L IPCB Secondary Contact DO standard. DO measurements below the IPCB standard occurred from March through December ([Figure 16](#)). Twenty-eight percent of the DO concentrations were below 3.0 mg/L ([Table 5](#)).

Chicago Sanitary and Ship Canal. *Cicero Avenue.* DO ranged from 0.1 mg/L to 9.8 mg/L. Mean DO was 5.1 mg/L. Seventy-seven percent of the DO measurements were above the 4.0 mg/L IPCB Secondary Contact DO standard. DO measurements below the IPCB standard occurred from March through December ([Figure 17](#)). Ten percent of the DO concentrations were below 3.0 mg/L ([Table 5](#)).

B&O Central Railroad. DO ranged from 0.1 mg/L to 10.5 mg/L. Mean DO was 6.4 mg/L. Ninety-seven percent of the DO measurements were above the 4.0 mg/L IPCB Secondary Contact DO standard. DO measurements below the IPCB standard occurred from April through November ([Figure 18](#)). Two percent of the DO concentrations were below 3.0 mg/L ([Table 5](#)).

Route 83. DO ranged from zero to 9.2 mg/L. Mean DO was 4.9 mg/L. Seventy-three percent of the DO measurements were above the IPCB Secondary Contact DO standard. DO measurements below the IPCB standard occurred during all months except February

FIGURE 10: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT THE CHICAGO RIVER CONTROLLING WORKS ON THE CHICAGO RIVER FROM JANUARY 2004 THROUGH DECEMBER 2004

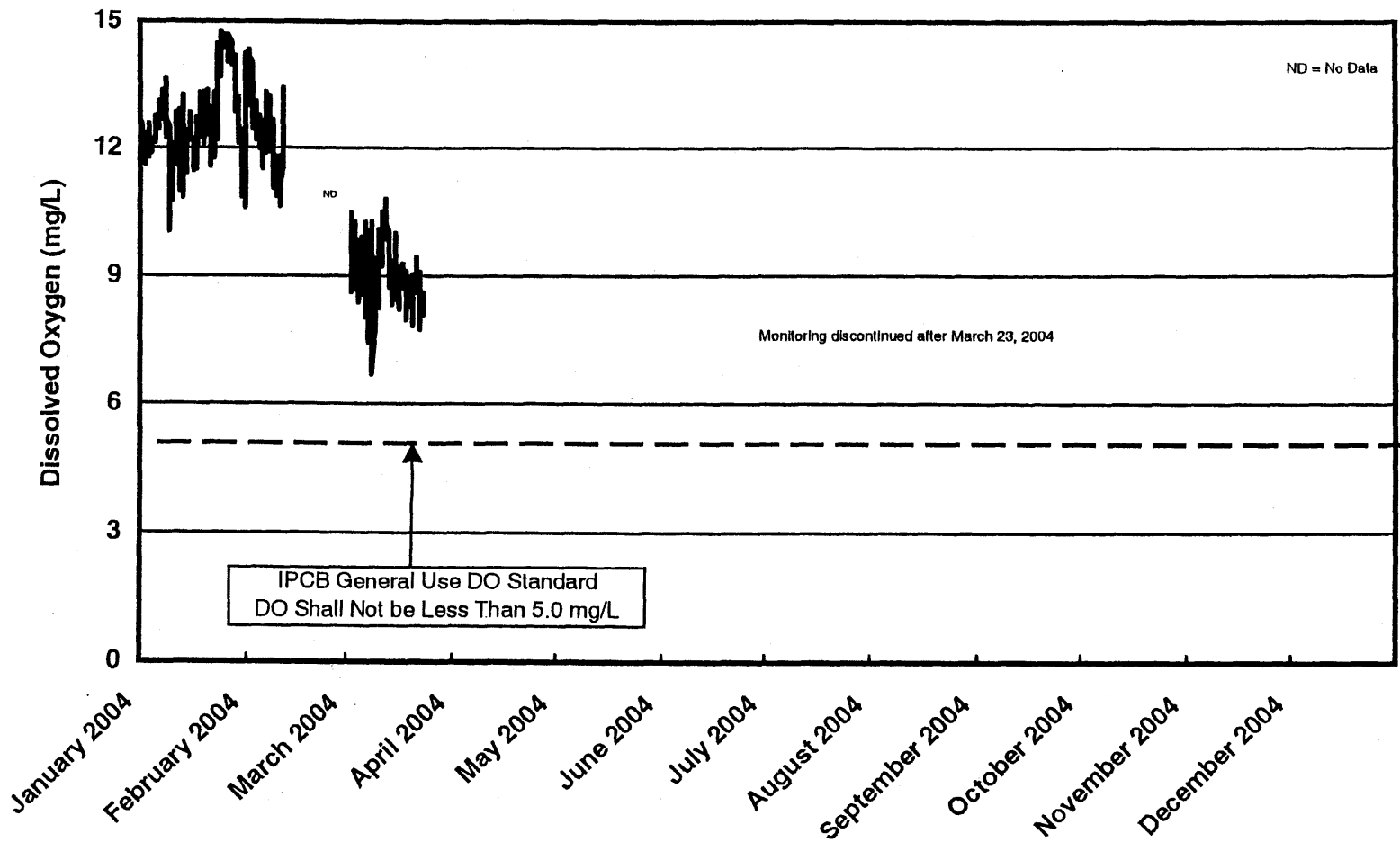


FIGURE 11: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT MICHIGAN AVENUE ON THE CHICAGO RIVER
FROM JANUARY 2004 THROUGH DECEMBER 2004

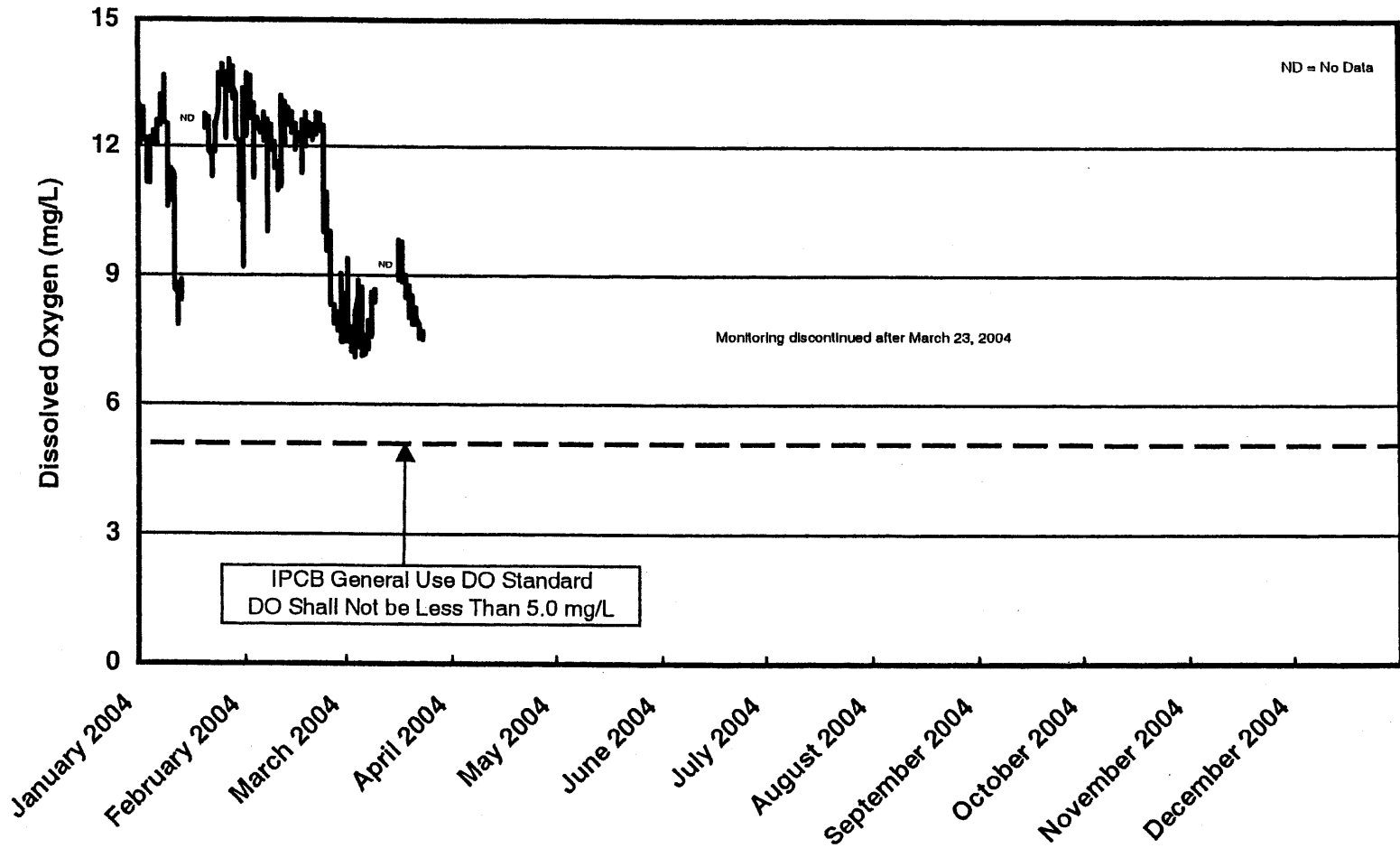


FIGURE 12: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT CLARK STREET ON THE CHICAGO RIVER
FROM JANUARY 2004 THROUGH DECEMBER 2004

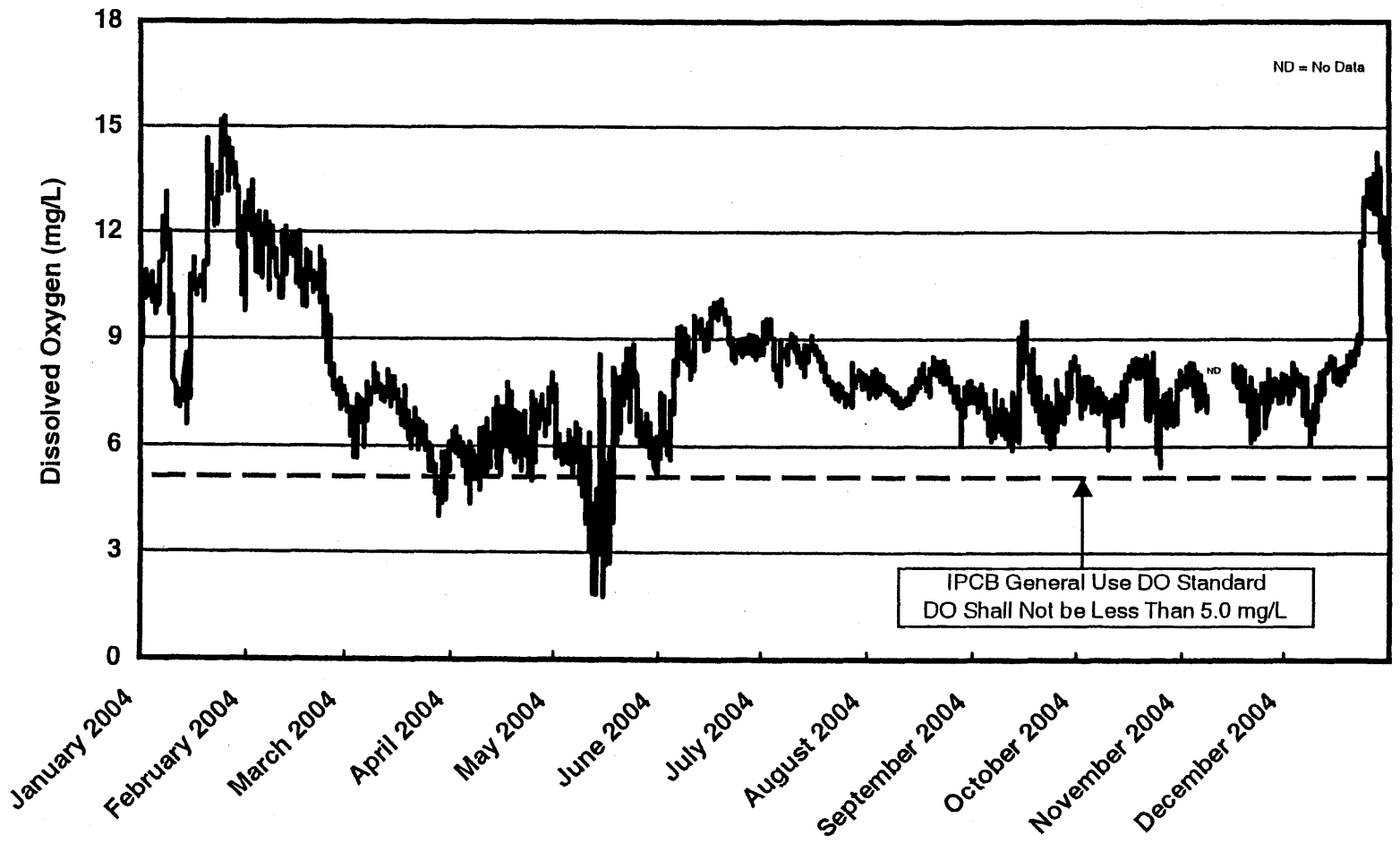


FIGURE 13: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT JACKSON BOULEVARD ON THE SOUTH BRANCH OF THE CHICAGO RIVER
FROM JANUARY 2004 THROUGH DECEMBER 2004

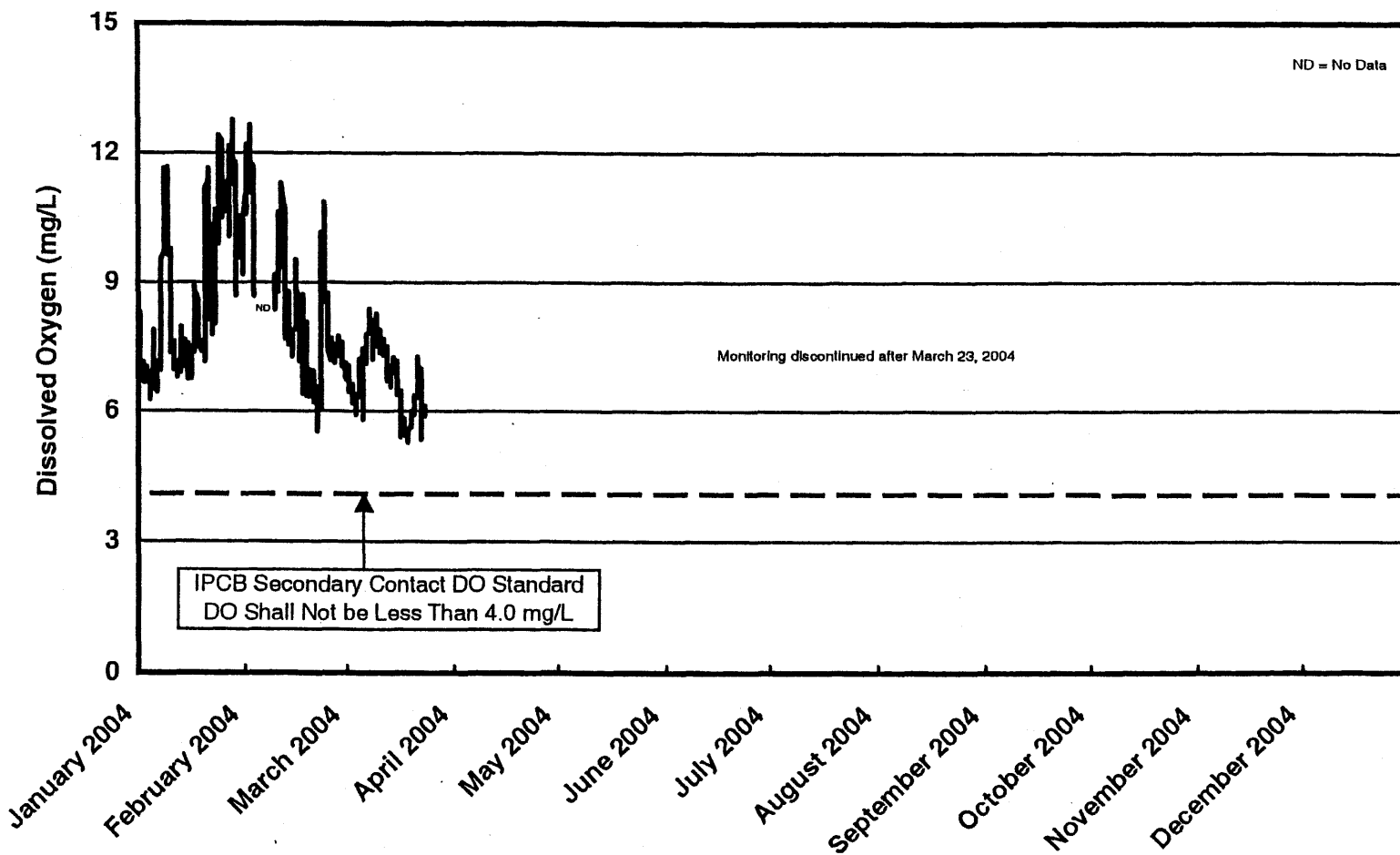


FIGURE 14: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT LOOMIS STREET ON THE SOUTH BRANCH OF THE CHICAGO RIVER
FROM JANUARY 2004 THROUGH DECEMBER 2004

