

Metropolitan Water Reclamation District of Greater Chicago

100 East Erie Street Chicago, Illinois 60611-2803 312-751-5600

**CONTINUOUS DISSOLVED OXYGEN MONITORING
IN CHICAGO AREA WADEABLE STREAMS
DURING 2011**

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Particular thanks are due to Pamela Slaby for formatting, editing, and preparing the report for print.

DISCLAIMER

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the District.

INTRODUCTION

The District began monitoring the Chicago Area Waterway System with continuous dissolved oxygen monitors in 1998. The initial project involved monitoring the Chicago River System and later expanded into the Calumet River System. The Continuous Dissolved Oxygen Monitoring (CDOM) program was developed to identify reaches of the waterways where the dissolved oxygen (DO) concentrations were below the DO standards established by the Illinois Pollution Control Board (IPCB). In 2005 the CDOM program expanded again and started monitoring the Chicago area wadeable streams.

Low DO levels can be caused by a multitude of sources including low gradient streams, dams, combined sewer overflow (CSO), stormwater runoff, wastewater effluents, thermal discharges, respiration, decomposition and chemical reactions. Illinois streams that are found to not meet the state DO standards are placed on the 303(d) list of impaired waters by the Illinois Environmental Protection Agency (IEPA, 2010).

To better understand the DO concentrations in the wadeable streams within the Chicago area, monitoring locations were chosen to measure DO levels above and below discharges, impoundments, and major confluences. Wadeable sites were chosen within the Chicago River system, Upper Des Plaines River System, and Calumet River system.

One monitoring location is on the North Branch of the Chicago River. This location is upstream of the North Branch Dam. The North Branch watershed encompasses 113 square miles and is located both in Lake and Cook counties (Ogata, 1975).

Five monitoring locations are in the Upper Des Plaines River system. Two sites are on the Upper Des Plaines River and three sites are in Salt Creek. The entire Des Plaines River watershed covers approximately 700 square miles and originates in Wisconsin. The area within the District's jurisdiction flows southward through a highly urbanized watershed from the Lake-Cook County line to Highway 171, at which point it flows southwestward, parallel and adjacent to the Chicago Sanitary and Ship Canal, to Lockport (Schmeelk, et al., 1979). Salt Creek is an approximately 150 square mile watershed originating with the confluence of several small streams west of Palatine, Illinois (Polls et al., 1979). Salt Creek is a tributary to the Des Plaines River and their confluence is located in the town of Lyons.

One monitoring location is in the Calumet River system on the Little Calumet River. The Little Calumet River basin is located in northeastern Illinois and northwestern Indiana. The watershed drains an area of 242 square miles, 151.2 square miles of which are in Illinois (Northeastern Illinois Planning Commission, 1981).

This report covers the monitoring results for the period January 1, 2011, through December 31, 2011 for wadeable streams in the Chicago River System, Upper Des Plaines River System, and Calumet River System.

MONITORING STATIONS

Locations and Descriptions

The CDOM Program supplies the District with water quality data throughout the year for both the wadeable streams and deep-draft waterways within its jurisdiction. The CDOM stations are shown in Figure 1. Descriptions of the wadeable CDOM stations are listed in Table 1.

Effective January 2011, the District executed a plan to reduce the number of sampling stations for the CDOM program to enhance the program's efficiency. The wadeable CDOM stations at Ogden Avenue and Material Service Road on the Des Plaines River, Torrence Avenue on the Grand Calumet River, and Wentworth Avenue on the Little Calumet River were discontinued at the conclusion of 2010. The monitor housing at Irving Park Road on the Des Plaines River received irreparable damage after high flows in May of 2011 and was replaced with the monitoring station at Devon Avenue on the Des Plaines River in July 2011.

Designated Uses

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). The waterways described in this wadeable CDOM report are all designated General Use Waters.

Water Quality Standards

The IPCB has established water quality standards for DO in General Use Waters. In General Use Waters the DO shall not be less than 3.5 mg/L at any time and meet a 4.0 mg/L daily minimum averaged over seven days from August through February. In General Use Waters the DO shall not be less than 5.0 mg/L at any time and meet a 6.0 mg/L daily mean averaged over seven days from March through July. For this report, we have selected the any time standard when calculating percent compliance.

FIGURE 1: 2011 CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

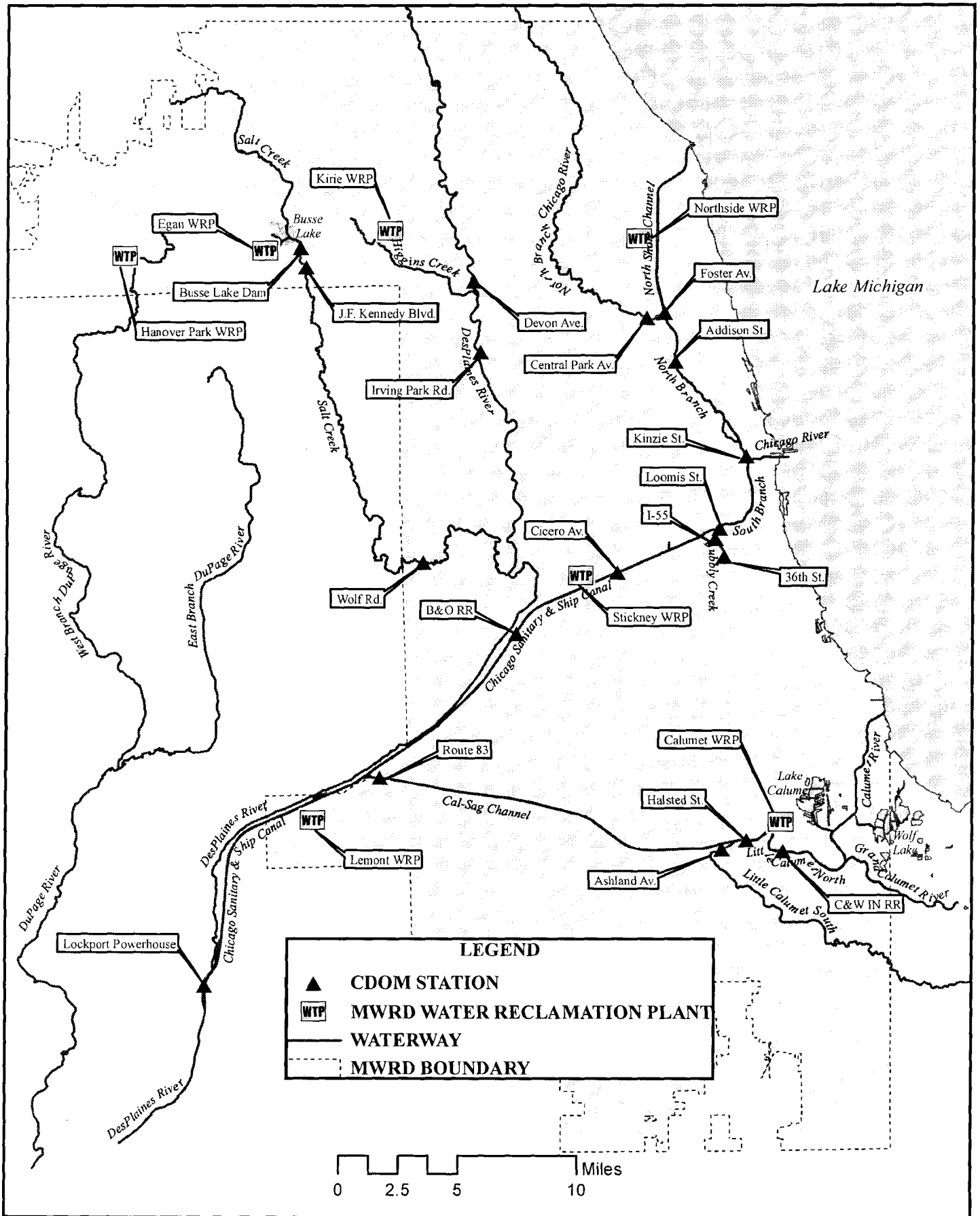


TABLE 1: WADEABLE STREAM CONTINUOUS DISSOLVED OXYGEN
MONITORING STATIONS DURING 2011

Monitoring Station	Waterway	Description of Monitoring Station
<u>Chicago River System</u>		
Central Park Avenue	North Branch Chicago River	0.8 mile above junction with North Shore Channel, water quality monitor on northeast side of Central Park Avenue bridge, 2 feet below water surface.
<u>Des Plaines River System</u>		
Devon Avenue	Des Plaines River	0.7 mile above junction with Willow Creek, water quality monitor on northwest side of Devon Avenue bridge, 2 feet below water surface.
Irving Park Road	Des Plaines River	3.1 miles below junction with Willow Creek, water quality monitor on northeast side of Irving Park Road bridge, 2 feet below water surface.
Busse Lake Dam	Salt Creek	0.1 mile above Egan WRP outfall, water quality monitor on bike path bridge support, downstream of Busse Woods South Dam, in center of creek, 2 feet below water surface.
J. F. Kennedy Boulevard	Salt Creek	0.8 mile below Egan WRP outfall, water quality monitor on southeast side of J. F. Kennedy Boulevard bridge, 2 feet below water surface.

TABLE 1 (Continued): WADEABLE STREAM CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS DURING 2011

Monitoring Station	Waterway	Description of Monitoring Station
<u>Des Plaines River System (Continued)</u>		
Wolf Road	Salt Creek	8.0 miles above junction with Des Plaines River, water quality monitor on northwest side of Wolf Road bridge, 1 foot below water surface.
<u>Calumet River System</u>		
Ashland Avenue	Little Calumet River	0.5 mile above junction with Calumet-Sag Channel, water quality monitor attached to east side of Ashland Avenue bridge, 2 feet below water surface.

MATERIALS AND METHODS

Water Quality Monitor

The continuous water quality monitors (monitor) used to collect these data were manufactured by YSI Incorporated (YSI) of Yellow Springs, Ohio. DO was measured hourly using the YSI Model 6920 or Model 6600 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. Installation designs resulted in a fixed length of pipe at each location with multiple 2-inch circular openings on the submerged end to allow sufficient flow of water through the pipe. Each monitor housing was vertically mounted on the side of a bridge abutment with an access hatch on the top end to allow for periodic monitor exchange.

The District personnel retrieved each monitor from the field following 14 days of continuous monitoring. Prior to retrieval, a water sample was collected next to the protective housing for DO analysis using the Winkler method for subsequent comparison with the monitor results. 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 Oracle® database for data processing and storage. All DO data were carefully reviewed for accuracy.

The review process included the following:

1. Comparing the grab sample DO concentration measured in the field with the DO concentration recorded by the respective monitor retrieved in the field (DO rejection criteria = difference greater than 2.0 mg/L).
2. Comparing the last hourly DO concentration measured by the monitor retrieved in the field with the first hourly DO concentration recorded by a deployed monitor that replaced it. (DO rejection criteria = difference greater than 2.0 mg/L).
3. Comparing a DO concentration measured in a laboratory holding tank and a DO concentration recorded by a monitor after retrieval from the field (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 result in rejection of all readings.

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

Verification of Representative Data

During the spring, summer, and fall of 2011, cross-sectional DO surveys were conducted in the Chicago River System, Calumet River System, and Des Plaines River System to determine if a fixed continuous monitoring location represented the DO concentration across the waterway (Table A-8). 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 generally minimal (coefficient of variation < 10 percent) and equivalent (< 2 mg/L difference) to the DO concentration measured by the monitor at the fixed locations.

RESULTS

The annual minimum, maximum, and mean DO concentrations measured at all 7 stations during 2011 are shown in Table 2.

The number and percent of measured DO concentrations rejected and removed from the Oracle® database following review during 2011 are summarized in Table 3.

The number and percent of DO concentrations above the applicable IPCB DO standard for each waterway during 2011 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 seven monitoring stations during 2011. The current national one-day minimum dissolved oxygen criterion for adult life stages of fish is 3.0 mg/L (USEPA, 1986).

Individual graphs showing hourly DO concentrations at each monitoring station are indicated in Figure 2 through Figure 8.

Weekly DO summary statistics during 2011 are presented for each monitoring station in Appendix A, Tables A-1 through A-7.

Summary statistics for dissolved oxygen measurements made during cross-sectional surveys are shown in Appendix Table A-8.

Dissolved Oxygen Fluctuations

DO concentrations fluctuate seasonally and daily in the aquatic environment. DO is more soluble in cold water than warm water, a trend that can typically be seen in annual DO graphs where the colder months have higher mean DO concentrations than the warmer months. Daily fluctuations in DO can be caused by photosynthesis during daylight hours causing a surplus of DO, and conversely, respiration by aquatic plants and algae during the night, resulting in a deficiency of DO. Slower moving canals absorb less oxygen from the atmosphere than faster moving streams and rivers. Thermal loads from sources such as used cooling water can increase the temperature of the waterway, thereby depleting DO. Other deficiencies of DO can occur when materials that exhibit an oxygen demand are introduced into a waterway. These materials enter a waterway most often through wastewater treatment effluents, CSOs, and stormwater run-off. Stormwater run-off can also flush organic materials into the waterway. This is most evident during heavy rain storms that result in CSO events containing untreated waste and stormwater. More information on CSOs can be found on the District website at (www.mwrdd.org).

TABLE 2: MINIMUM, MAXIMUM, AND MEAN HOURLY DISSOLVED OXYGEN CONCENTRATIONS DURING 2011¹

Monitoring Station	Waterway	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
<u>Chicago River System</u>				
Central Park Avenue	North Branch Chicago River	1.0	16.9	8.8
<u>Des Plaines River System</u>				
Devon Avenue	Des Plaines River	3.6	13.3	8.2
Irving Park Road	Des Plaines River	5.8	15.5	11.3
Busse Lake Dam	Salt Creek	1.1	14.7	9.2
J. F. Kennedy Boulevard	Salt Creek	3.7	13.6	8.5
Wolf Road	Salt Creek	1.0	14.3	8.8
<u>Calumet River System</u>				
Ashland Avenue	Little Calumet River	2.1	18.0	9.0

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 CRITERIA DURING 2011¹

Monitoring Station	Waterway	Number of DO Values Rejected	Percent of DO Values Rejected
<u>Chicago River System</u>			
Central Park Avenue	North Branch Chicago River	1,684	19
<u>Des Plaines River System</u>			
Devon Avenue	Des Plaines River	250	6
Irving Park Road	Des Plaines River	336	11
Busse Lake Dam	Salt Creek	2,020	23
J. F. Kennedy Boulevard	Salt Creek	1,010	12
Wolf Road	Salt Creek	2,610	30
<u>Calumet River System</u>			
Ashland Avenue	Little Calumet River	3,366	38

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.

TABLE 4: NUMBER AND PERCENT OF DISSOLVED OXYGEN VALUES MEASURED ABOVE THE ILLINOIS POLLUTION CONTROL BOARD'S WATER QUALITY STANDARD DURING 2011¹

Monitoring Station	Waterway	IPCB DO Standard	Number of DO Values	Number Above Standard	Percent Above Standard
<u>Chicago River System</u>					
Central Park Avenue	North Branch Chicago River	3.5-5.0*	7,076	6,411	91
<u>Des Plaines River System</u>					
Devon Avenue	Des Plaines River	3.5-5.0*	3,800	3,695	97
Irving Park Road	Des Plaines River	3.5-5.0*	2,793	2,793	100
Busse Lake Dam	Salt Creek	3.5-5.0*	6,740	6,362	94
J. F. Kennedy Boulevard	Salt Creek	3.5-5.0*	7,750	7,588	98
Wolf Road	Salt Creek	3.5-5.0*	6,150	5,842	95
<u>Calumet River System</u>					
Ashland Avenue	Little Calumet River	3.5-5.0*	5,394	5,092	94

¹Dissolved oxygen was measured hourly using a YSI Model 6920 or Model 6600 continuous water quality monitor.
*IPCB general use DO standard is 5.0 mg/L from March through July and 3.5 mg/L for the balance of the year.

TABLE 5: PERCENT OF DISSOLVED OXYGEN VALUES IN
SELECTED RANGES DURING 2011

Monitoring Station	Waterway	Percent of DO Values in Range (mg/L)*					
		0-<1	1-<2	2-<3	3-<4	4-<5	≥5
<u>Chicago River System</u>							
Central Park Avenue	North Branch Chicago River	<1	<1	1	3	10	87
<u>Des Plaines River System</u>							
Devon Avenue	Des Plaines River	0	0	0	<1	4	96
Irving Park Road	Des Plaines River	0	0	0	0	0	100
Busse Lake Dam	Salt Creek	0	1	2	3	4	91
J. F. Kennedy Boulevard	Salt Creek	0	0	0	<1	3	97
Wolf Road	Salt Creek	<1	<1	<1	2	4	94
<u>Calumet River System</u>							
Ashland Avenue	Little Calumet River	0	0	<1	3	8	88

* Percentages greater than one are rounded to nearest whole number.

FIGURE 2: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT CENTRAL PARK AVENUE ON THE NORTH BRANCH CHICAGO RIVER FROM JANUARY 1, 2011, THROUGH DECEMBER 31, 2011

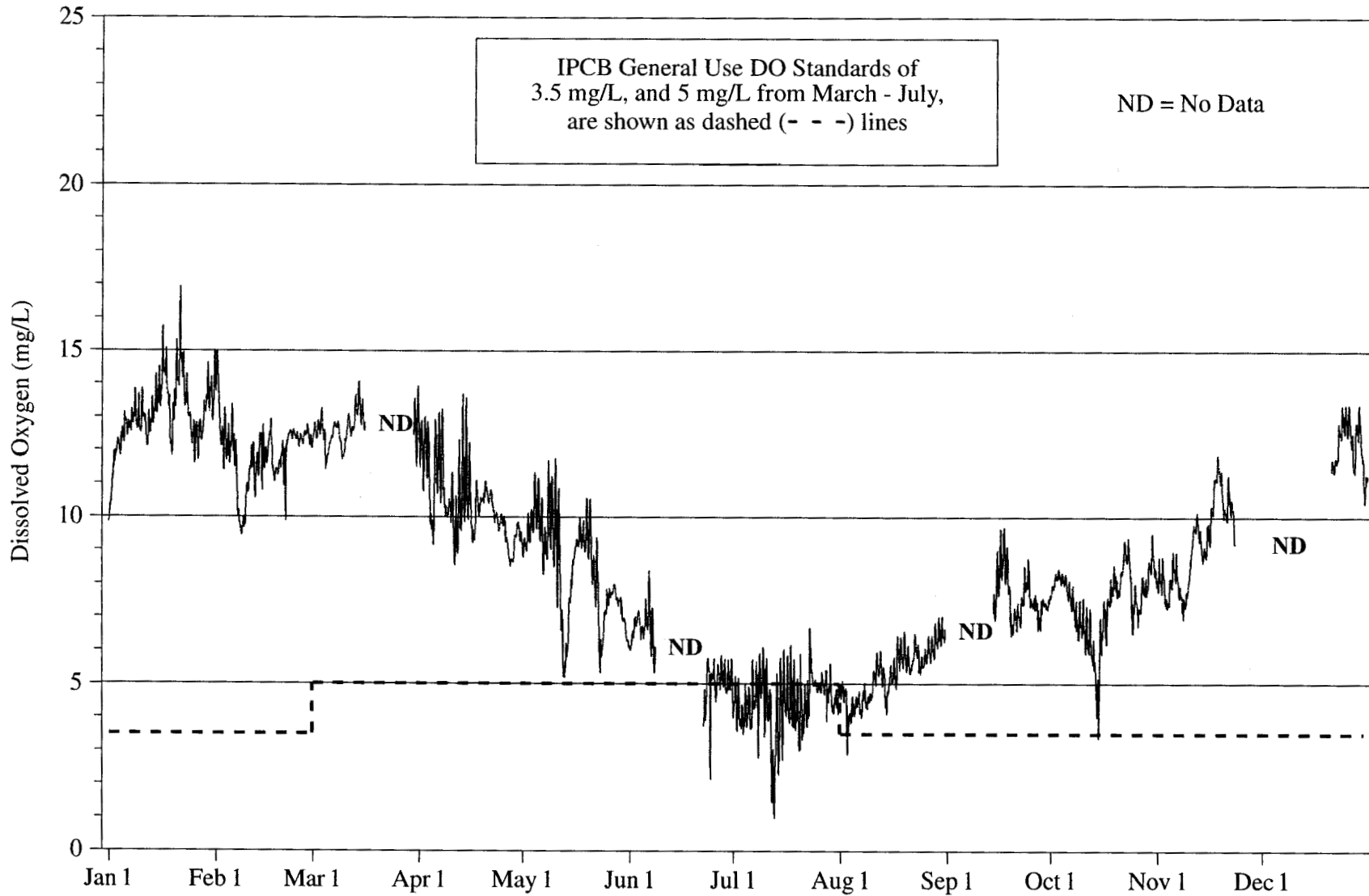


FIGURE 3: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT DEVON AVENUE ON THE DES PLAINES RIVER FROM JANUARY 1, 2011, THROUGH DECEMBER 31, 2011

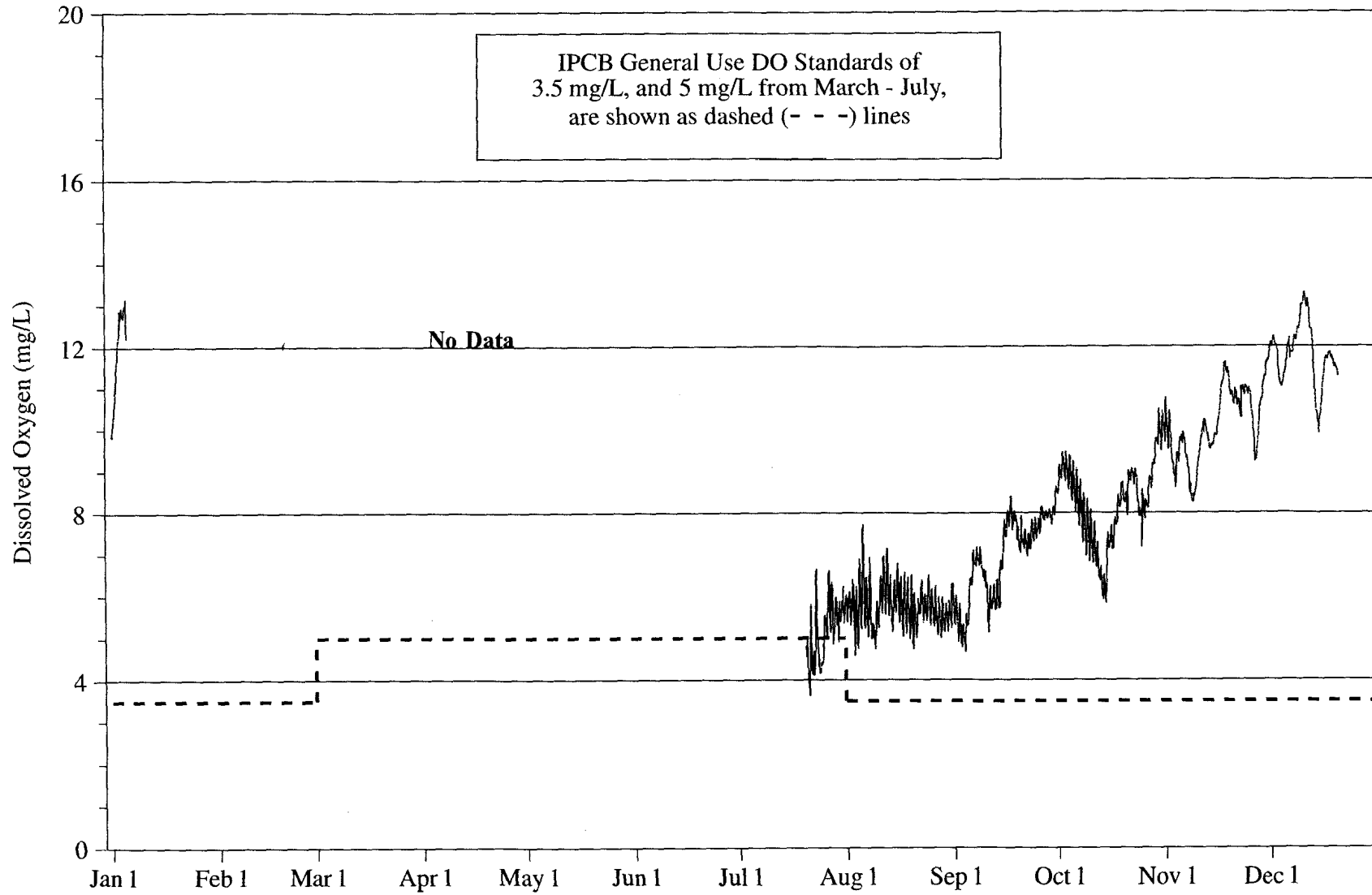


FIGURE 4: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT IRVING PARK ROAD ON THE DES PLAINES RIVER FROM JANUARY 1, 2011, THROUGH DECEMBER 31, 2011



FIGURE 5: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT BUSSE LAKE DAM ON SALT CREEK FROM JANUARY 1, 2011, THROUGH DECEMBER 31, 2011

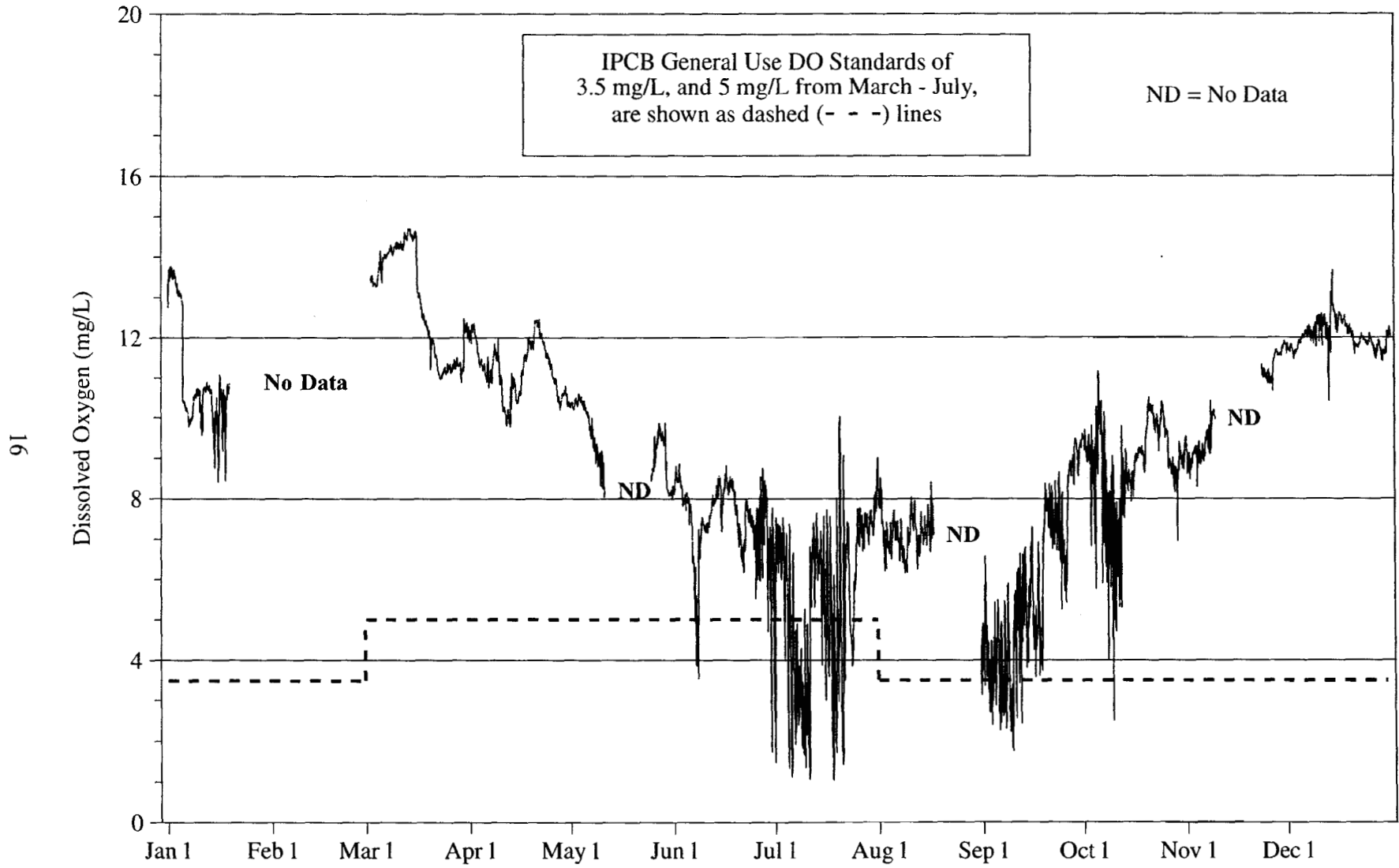


FIGURE 6: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT J. F. KENNEDY BOULEVARD ON SALT CREEK FROM JANUARY 1, 2011, THROUGH DECEMBER 31, 2011

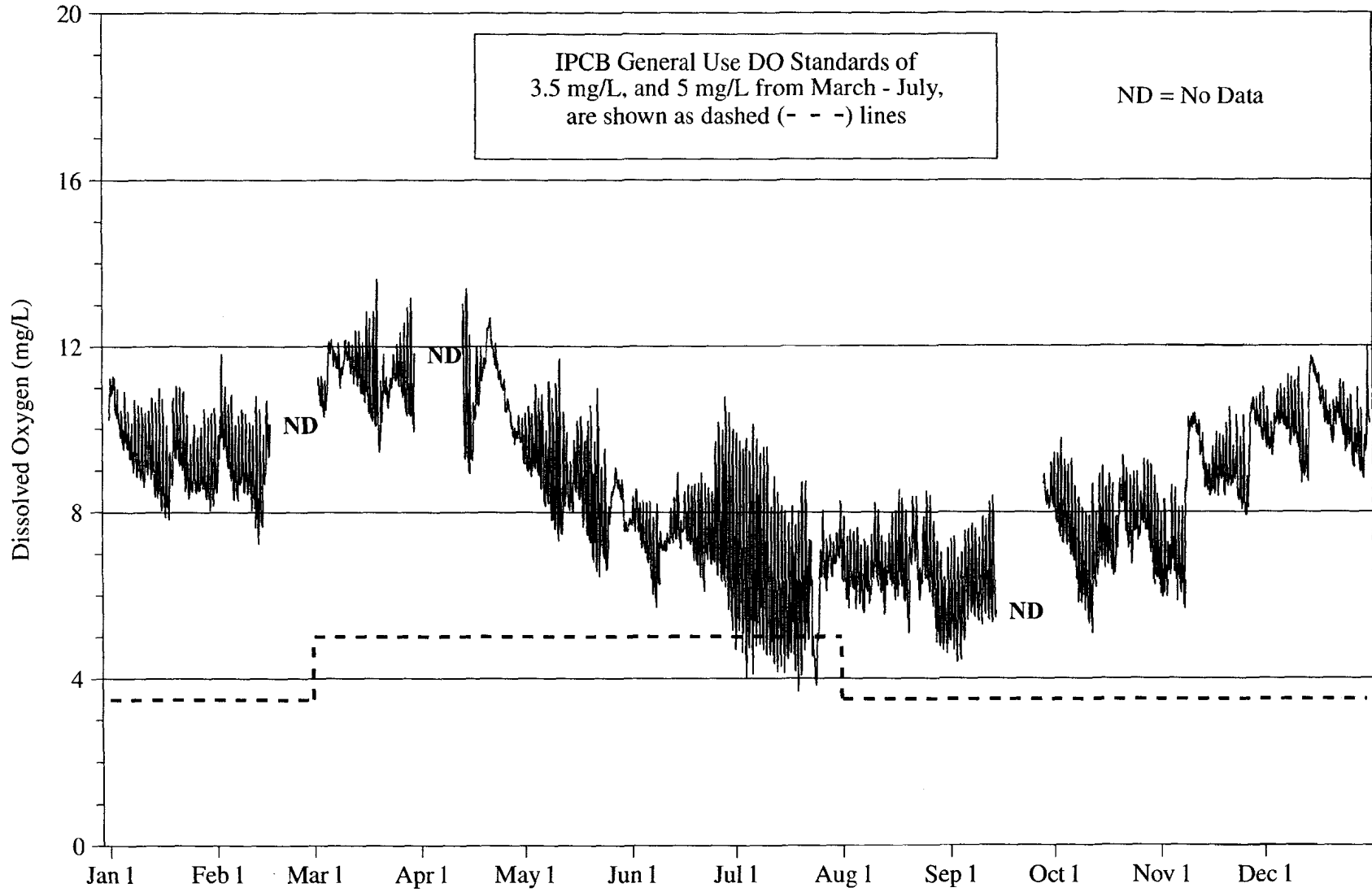


FIGURE 7: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT WOLF ROAD ON SALT CREEK FROM JANUARY 1, 2011, THROUGH DECEMBER 31, 2011

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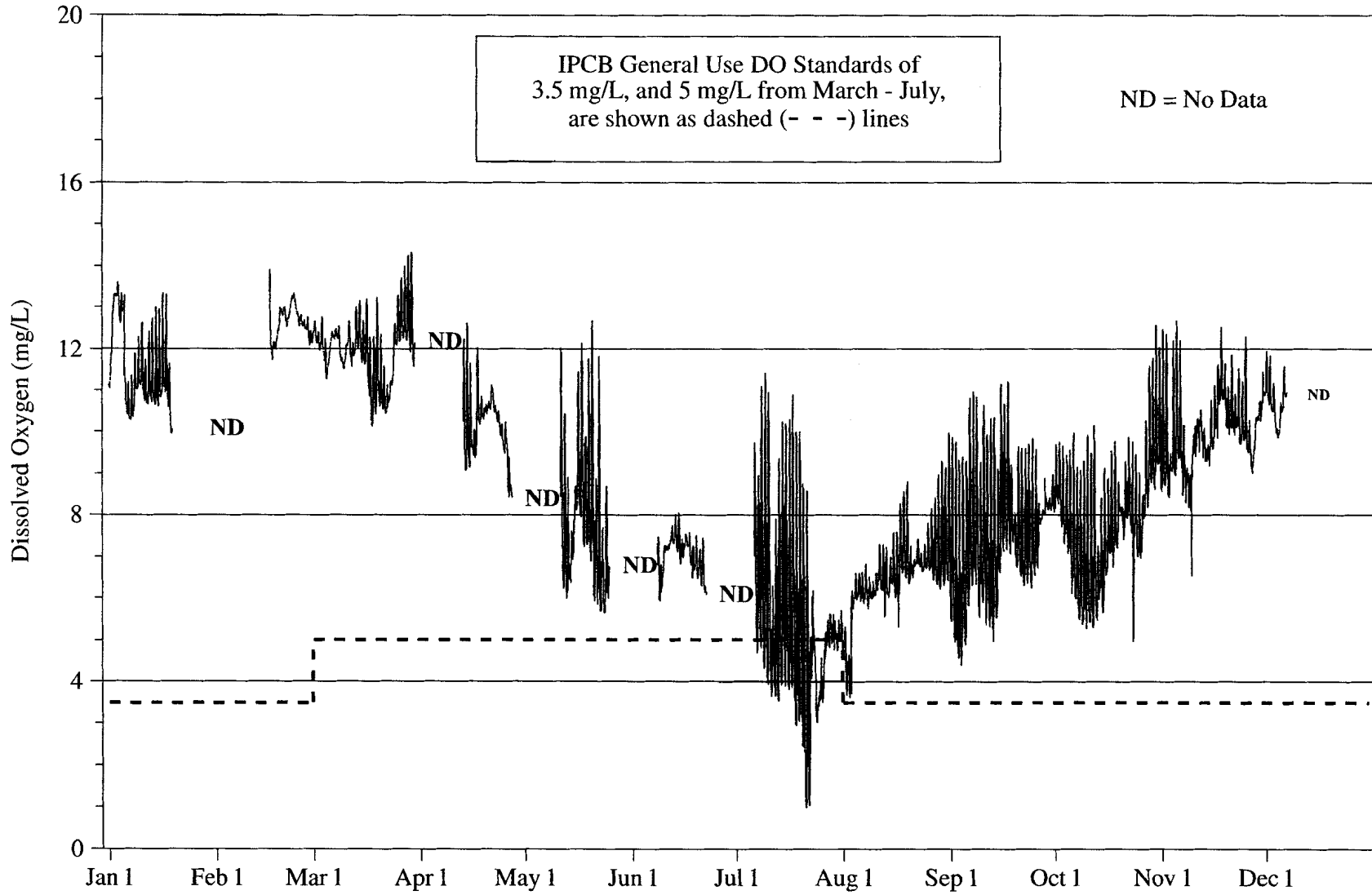
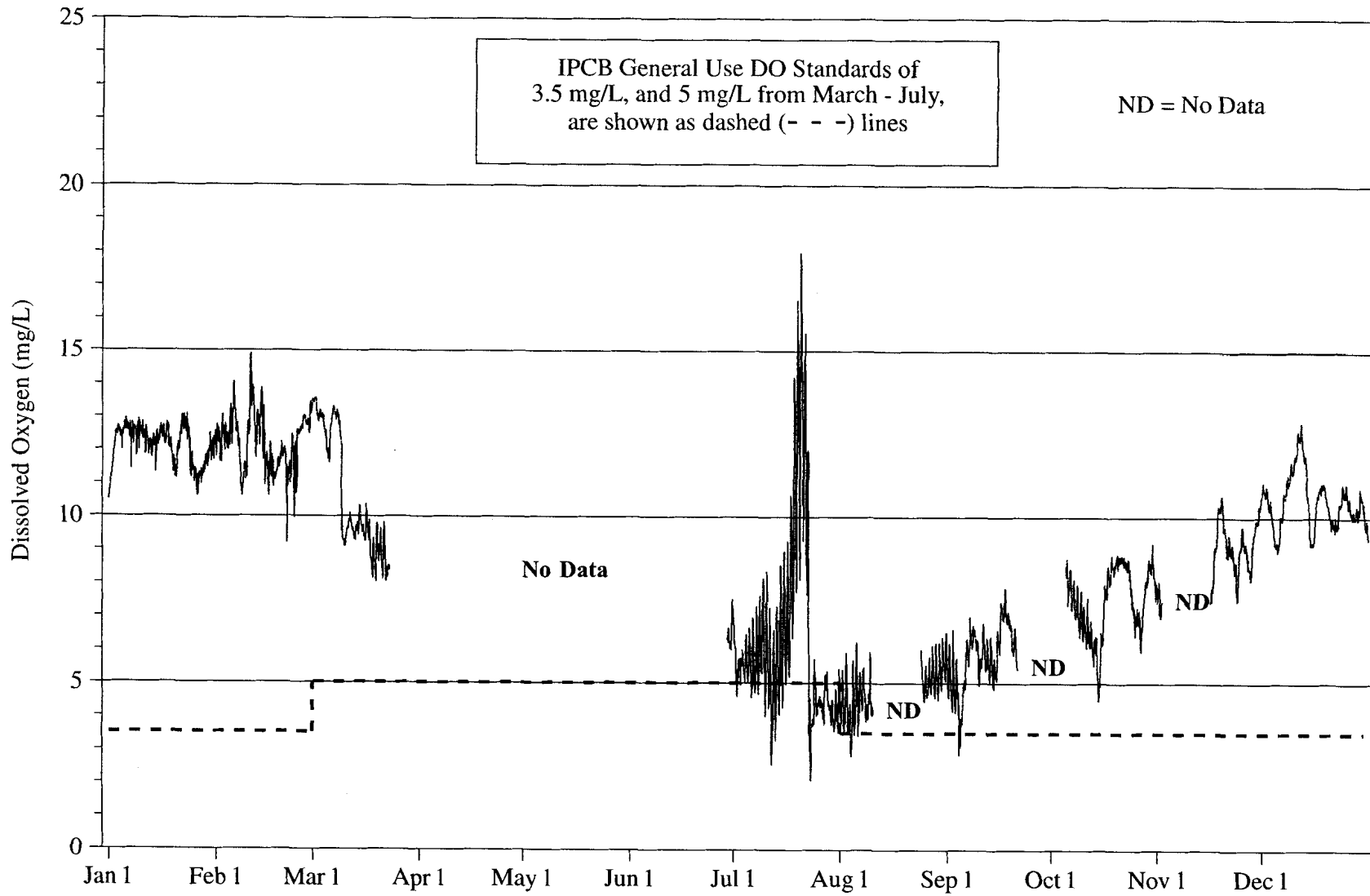


FIGURE 8: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT ASHLAND AVENUE ON THE LITTLE CALUMET RIVER FROM JANUARY 1, 2011, THROUGH DECEMBER 31, 2011



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APPENDIX A

WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS AT ALL
WADEABLE STREAM MONITORING STATIONS DURING 2011

TABLE A-1: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT CENTRAL PARK AVENUE ON THE
 NORTH BRANCH CHICAGO RIVER DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
01/01/11 - 01/02/11	48	9.9	12.0	11.0	100
01/03/11 - 01/09/11	168	11.8	13.8	12.7	100
01/10/11 - 01/16/11	168	12.1	15.7	13.3	100
01/17/11 - 01/23/11	168	11.8	16.9	13.9	100
01/24/11 - 01/30/11	168	11.6	14.6	12.9	100
01/31/11 - 02/06/11	168	11.4	15.0	12.8	100
02/07/11 - 02/13/11	168	9.5	12.5	10.9	100
02/14/11 - 02/20/11	168	10.8	12.9	11.8	100
02/21/11 - 02/27/11	168	9.9	12.8	12.4	100
02/28/11 - 03/06/11	168	11.4	13.3	12.4	100
03/07/11 - 03/13/11	168	11.7	13.7	12.6	100
03/14/11 - 03/20/11	57	12.6	14.1	13.2	100
03/21/11 - 03/27/11			NO DATA		
03/28/11 - 04/03/11	109	10.8	13.9	12.4	100
04/04/11 - 04/10/11	168	9.2	13.2	10.8	100
04/11/11 - 04/17/11	168	8.6	13.7	10.4	100
04/18/11 - 04/24/11	168	9.6	11.1	10.3	100
04/25/11 - 05/01/11	168	8.5	10.1	9.3	100
05/02/11 - 05/08/11	168	8.3	11.7	9.8	100
05/09/11 - 05/15/11	167	5.2	11.8	8.0	100
05/16/11 - 05/22/11	168	7.3	10.6	9.1	100
05/23/11 - 05/29/11	168	5.3	8.0	7.2	100
05/30/11 - 06/05/11	168	6.0	7.5	6.7	100
06/06/11 - 06/12/11	60	5.3	8.4	6.6	100
06/13/11 - 06/19/11			NO DATA		
06/20/11 - 06/26/11	109	2.2	5.8	4.9	52
06/27/11 - 07/03/11	168	3.5	5.8	4.8	40
07/04/11 - 07/10/11	168	2.8	6.1	4.6	26
07/11/11 - 07/17/11	168	1.0	6.2	4.0	21
07/18/11 - 07/24/11	168	3.0	6.7	4.5	28
07/25/11 - 07/31/11	168	3.9	5.6	4.8	21
08/01/11 - 08/07/11	168	2.9	5.1	4.4	98
08/08/11 - 08/14/11	168	4.1	6.0	5.0	100
08/15/11 - 08/21/11	168	4.8	6.6	5.6	100

TABLE A-1 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT CENTRAL PARK AVENUE ON THE
 NORTH BRANCH CHICAGO RIVER DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
08/22/11 - 08/28/11	168	5.3	6.8	5.9	100
08/29/11 - 09/04/11	59	6.1	7.0	6.5	100
09/05/11 - 09/11/11		NO DATA			
09/12/11 - 09/18/11	108	6.9	9.7	8.3	100
09/19/11 - 09/25/11	168	6.4	8.8	7.4	100
09/26/11 - 10/02/11	168	6.6	8.3	7.5	100
10/03/11 - 10/09/11	168	6.3	8.5	7.7	100
10/10/11 - 10/16/11	168	3.4	7.6	6.1	99
10/17/11 - 10/23/11	168	6.2	9.4	8.0	100
10/24/11 - 10/30/11	168	6.5	9.5	7.8	100
10/31/11 - 11/06/11	168	7.3	9.0	8.1	100
11/07/11 - 11/13/11	168	7.0	10.1	8.5	100
11/14/11 - 11/20/11	168	8.7	11.9	10.2	100
11/21/11 - 11/27/11	57	9.2	11.2	10.3	100
11/28/11 - 12/18/11		NO DATA			
12/19/11 - 12/25/11	110	11.4	13.4	12.3	100
12/26/11 - 12/31/11	144	10.4	13.4	12.1	100

¹IPCB general use DO standard is 3.5 mg/L, and 5.0 mg/L from March - July.

TABLE A-2: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT DEVON AVENUE ON THE
 DES PLAINES RIVER DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
01/01/11 - 01/02/11	48	9.8	12.2	10.9	100
01/03/11 - 01/09/11	58	12.2	13.2	12.7	100
01/10/11 - 07/17/11		NO DATA			
07/18/11 - 07/24/11	110	3.6	6.7	4.6	20
07/25/11 - 07/31/11	168	4.4	6.6	5.5	90
08/01/11 - 08/07/11	167	4.6	7.7	5.9	100
08/08/11 - 08/14/11	168	4.8	7.1	5.8	100
08/15/11 - 08/21/11	168	4.7	6.8	5.7	100
08/22/11 - 08/28/11	168	5.0	6.5	5.7	100
08/29/11 - 09/04/11	168	4.7	6.3	5.4	100
09/05/11 - 09/11/11	168	5.2	7.2	6.4	100
09/12/11 - 09/18/11	168	5.7	8.4	7.0	100
09/19/11 - 09/25/11	168	7.0	7.9	7.4	100
09/26/11 - 10/02/11	167	7.5	9.5	8.3	100
10/03/11 - 10/09/11	168	7.0	9.5	8.4	100
10/10/11 - 10/16/11	167	5.9	8.1	6.9	100
10/17/11 - 10/23/11	168	7.1	9.1	8.4	100
10/24/11 - 10/30/11	168	7.2	10.5	8.8	100
10/31/11 - 11/06/11	168	8.6	10.8	9.7	100
11/07/11 - 11/13/11	168	8.3	10.2	9.3	100
11/14/11 - 11/20/11	168	9.5	11.6	10.5	100
11/21/11 - 11/27/11	168	9.2	11.1	10.6	100
11/28/11 - 12/04/11	168	9.7	12.2	11.4	100
12/05/11 - 12/11/11	168	11.0	13.3	12.2	100
12/12/11 - 12/18/11	168	9.9	13.1	11.6	100
12/19/11 - 12/25/11	59	11.3	11.8	11.6	100
12/26/11 - 12/31/11		NO DATA			

¹IPCB general use DO standard is 3.5 mg/L, and 5.0 mg/L from March - July.

TABLE A-3: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT IRVING PARK ROAD ON THE
 DES PLAINES RIVER DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
01/01/11 - 01/02/11	48	10.0	12.6	11.2	100
01/03/11 - 01/09/11	168	11.8	13.5	12.5	100
01/10/11 - 01/16/11	168	11.7	13.8	12.4	100
01/17/11 - 01/23/11	168	10.9	14.7	12.8	100
01/24/11 - 01/30/11	168	12.0	14.5	13.0	100
01/31/11 - 02/06/11	168	12.3	15.2	13.1	100
02/07/11 - 02/13/11	168	11.7	15.5	13.0	100
02/14/11 - 02/20/11	166	10.7	12.9	11.6	100
02/21/11 - 02/27/11	168	11.8	12.5	12.1	100
02/28/11 - 03/06/11	58	11.4	11.8	11.5	100
03/07/11 - 03/13/11			NO DATA		
03/14/11 - 03/20/11	111	5.8	10.1	9.1	100
03/21/11 - 03/27/11	168	9.3	12.4	10.5	100
03/28/11 - 04/03/11	168	11.1	13.1	12.2	100
04/04/11 - 04/10/11	168	9.6	11.4	10.3	100
04/11/11 - 04/17/11	168	8.6	11.0	9.7	100
04/18/11 - 04/24/11	168	9.7	11.0	10.3	100
04/25/11 - 05/01/11	168	8.0	9.9	9.0	100
05/02/11 - 05/08/11	168	8.8	10.9	9.7	100
05/09/11 - 05/15/11	58	7.6	9.9	9.1	100
05/16/11 - 12/31/11			NO DATA		

¹IPCB general use DO standard is 3.5 mg/L, and 5.0 mg/L from March - July.

TABLE A-4: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT BUSSE LAKE DAM ON
 SALT CREEK DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
01/01/11 - 01/02/11	48	12.8	13.8	13.5	100
01/03/11 - 01/09/11	168	9.8	13.6	11.3	100
01/10/11 - 01/16/11	168	8.4	11.1	10.3	100
01/17/11 - 01/23/11	58	8.4	10.9	10.3	100
01/24/11 - 02/27/11			NO DATA		
02/28/11 - 03/06/11	108	13.3	14.2	13.6	100
03/07/11 - 03/13/11	168	14.0	14.7	14.3	100
03/14/11 - 03/20/11	167	11.2	14.7	13.2	100
03/21/11 - 03/27/11	168	11.0	12.0	11.3	100
03/28/11 - 04/03/11	168	10.9	12.5	11.8	100
04/04/11 - 04/10/11	168	10.6	12.0	11.3	100
04/11/11 - 04/17/11	168	9.8	11.6	10.6	100
04/18/11 - 04/24/11	168	11.4	12.5	11.9	100
04/25/11 - 05/01/11	168	10.2	11.5	10.7	100
05/02/11 - 05/08/11	168	8.9	10.6	10.1	100
05/09/11 - 05/15/11	58	8.0	9.4	8.8	100
05/16/11 - 05/22/11			NO DATA		
05/23/11 - 05/29/11	109	8.5	9.9	9.3	100
05/30/11 - 06/05/11	168	7.4	8.9	8.2	100
06/06/11 - 06/12/11	168	3.5	8.1	6.9	92
06/13/11 - 06/19/11	168	7.2	8.8	8.1	100
06/20/11 - 06/26/11	168	5.5	8.5	7.2	100
06/27/11 - 07/03/11	168	1.5	8.8	6.7	90
07/04/11 - 07/10/11	168	1.1	7.4	3.8	23
07/11/11 - 07/17/11	168	1.1	7.7	5.7	76
07/18/11 - 07/24/11	168	1.1	10.1	4.8	45
07/25/11 - 07/31/11	168	5.9	9.0	7.4	100
08/01/11 - 08/07/11	168	6.2	8.5	7.2	100
08/08/11 - 08/14/11	168	6.2	8.0	7.0	100
08/15/11 - 08/21/11	58	6.7	8.4	7.3	100
08/22/11 - 08/28/11			NO DATA		
08/29/11 - 09/04/11	110	2.4	6.6	4.0	81
09/05/11 - 09/11/11	168	1.8	6.3	4.1	63
09/12/11 - 09/18/11	168	2.4	7.3	5.2	99

TABLE A-4 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT BUSSE LAKE DAM ON
 SALT CREEK DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
09/19/11 - 09/25/11	168	5.3	8.7	7.4	100
09/26/11 - 10/02/11	168	5.9	9.7	9.0	100
10/03/11 - 10/09/11	168	2.5	11.2	8.5	99
10/10/11 - 10/16/11	168	4.7	9.8	7.9	100
10/17/11 - 10/23/11	168	8.6	10.5	9.6	100
10/24/11 - 10/30/11	168	6.9	10.4	9.2	100
10/31/11 - 11/06/11	168	8.3	9.6	9.1	100
11/07/11 - 11/13/11	59	9.1	10.4	9.7	100
11/14/11 - 11/20/11			NO DATA		
11/21/11 - 11/27/11	109	10.7	11.7	11.2	100
11/28/11 - 12/04/11	168	11.5	11.9	11.7	100
12/05/11 - 12/11/11	168	11.8	12.6	12.1	100
12/12/11 - 12/18/11	168	10.4	13.7	12.4	100
12/19/11 - 12/25/11	168	11.6	12.3	12.0	100
12/26/11 - 12/31/11	144	11.4	12.3	11.8	100

¹IPCB general use DO standard is 3.5 mg/L, and 5.0 mg/L from March - July.

TABLE A-5: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT J. F. KENNEDY BOULEVARD ON
 SALT CREEK DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
01/01/11 - 01/02/11	48	10.2	11.3	10.9	100
01/03/11 - 01/09/11	168	8.8	11.0	9.8	100
01/10/11 - 01/16/11	168	8.1	11.0	9.2	100
01/17/11 - 01/23/11	168	7.8	11.0	9.3	100
01/24/11 - 01/30/11	168	8.0	10.5	8.9	100
01/31/11 - 02/06/11	168	8.2	11.8	9.5	100
02/07/11 - 02/13/11	168	7.3	10.8	8.9	100
02/14/11 - 02/20/11	58	7.6	10.7	9.2	100
02/21/11 - 02/27/11			NO DATA		
02/28/11 - 03/06/11	109	10.3	12.2	11.2	100
03/07/11 - 03/13/11	168	11.0	12.4	11.7	100
03/14/11 - 03/20/11	167	9.5	13.6	11.1	100
03/21/11 - 03/27/11	168	10.2	12.6	11.2	100
03/28/11 - 04/03/11	59	10.0	13.2	11.1	100
04/04/11 - 04/10/11			NO DATA		
04/11/11 - 04/17/11	110	8.9	13.4	10.6	100
04/18/11 - 04/24/11	168	10.5	12.7	11.7	100
04/25/11 - 05/01/11	168	9.1	11.2	10.1	100
05/02/11 - 05/08/11	168	8.0	11.2	9.4	100
05/09/11 - 05/15/11	168	7.3	11.7	8.8	100
05/16/11 - 05/22/11	168	6.5	11.0	8.6	100
05/23/11 - 05/29/11	167	6.6	9.5	8.2	100
05/30/11 - 06/05/11	168	6.8	8.5	7.7	100
06/06/11 - 06/12/11	168	5.7	8.3	7.1	100
06/13/11 - 06/19/11	168	6.8	8.9	7.8	100
06/20/11 - 06/26/11	168	6.1	10.2	7.6	100
06/27/11 - 07/03/11	168	4.6	10.8	7.3	98
07/04/11 - 07/10/11	168	4.0	10.1	6.8	83
07/11/11 - 07/17/11	168	4.1	8.9	6.0	67
07/18/11 - 07/24/11	168	3.7	8.7	5.6	56
07/25/11 - 07/31/11	168	4.9	8.3	6.8	99
08/01/11 - 08/07/11	168	5.6	7.9	6.6	100
08/08/11 - 08/14/11	168	5.5	8.2	6.7	100
08/15/11 - 08/21/11	168	5.1	8.5	6.9	100

TABLE A-5 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT J. F. KENNEDY BOULEVARD ON
 SALT CREEK DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
08/22/11 - 08/28/11	168	4.9	8.5	6.7	100
08/29/11 - 09/04/11	168	4.4	7.4	5.7	100
09/05/11 - 09/11/11	168	4.9	7.9	6.3	100
09/12/11 - 09/18/11	58	5.3	8.4	6.5	100
09/19/11 - 09/25/11		NO DATA			
09/26/11 - 10/02/11	110	7.7	9.4	8.4	100
10/03/11 - 10/09/11	168	5.8	9.8	7.5	100
10/10/11 - 10/16/11	168	5.1	9.1	6.9	100
10/17/11 - 10/23/11	168	6.5	9.4	7.7	100
10/24/11 - 10/30/11	168	6.3	9.3	7.8	100
10/31/11 - 11/06/11	168	5.9	8.6	7.0	100
11/07/11 - 11/13/11	168	5.7	10.4	9.1	100
11/14/11 - 11/20/11	168	8.4	10.1	8.9	100
11/21/11 - 11/27/11	168	7.9	10.6	9.0	100
11/28/11 - 12/04/11	168	9.4	11.0	10.1	100
12/05/11 - 12/11/11	168	9.1	11.5	10.3	100
12/12/11 - 12/18/11	168	8.7	11.8	10.5	100
12/19/11 - 12/25/11	168	9.4	11.2	10.2	100
12/26/11 - 12/31/11	144	8.8	12.0	9.8	100

¹IPCB general use DO standard is 3.5 mg/L, and 5.0 mg/L from March - July.

TABLE A-6: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT WOLF ROAD ON
 SALT CREEK DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
01/01/11 - 01/02/11	48	11.1	13.3	12.3	100
01/03/11 - 01/09/11	168	10.3	13.6	11.7	100
01/10/11 - 01/16/11	168	10.6	13.3	11.4	100
01/17/11 - 01/23/11	57	10.0	13.3	11.0	100
01/24/11 - 02/13/11			NO DATA		
02/14/11 - 02/20/11	110	11.7	13.9	12.5	100
02/21/11 - 02/27/11	168	12.1	13.3	12.8	100
02/28/11 - 03/06/11	168	11.3	12.8	12.1	100
03/07/11 - 03/13/11	168	11.5	13.0	12.1	100
03/14/11 - 03/20/11	167	10.1	13.2	11.7	100
03/21/11 - 03/27/11	168	10.5	14.0	11.8	100
03/28/11 - 04/03/11	58	11.6	14.3	12.7	100
04/04/11 - 04/10/11			NO DATA		
04/11/11 - 04/17/11	110	9.1	12.6	10.3	100
04/18/11 - 04/24/11	168	9.7	11.1	10.5	100
04/25/11 - 05/01/11	58	8.4	10.2	9.3	100
05/02/11 - 05/08/11			NO DATA		
05/09/11 - 05/15/11	111	6.0	12.0	7.6	100
05/16/11 - 05/22/11	168	5.7	12.7	8.5	100
05/23/11 - 05/29/11	58	5.7	8.7	6.6	100
05/30/11 - 06/05/11			NO DATA		
06/06/11 - 06/12/11	110	5.9	7.7	7.0	100
06/13/11 - 06/19/11	168	6.5	8.0	7.2	100
06/20/11 - 06/26/11	57	6.1	7.5	6.6	100
06/27/11 - 07/03/11			NO DATA		
07/04/11 - 07/10/11	110	4.0	11.4	7.0	72
07/11/11 - 07/17/11	168	3.5	10.9	5.9	51
07/18/11 - 07/24/11	168	1.0	10.0	4.6	33
07/25/11 - 07/31/11	168	3.4	5.7	4.8	51
08/01/11 - 08/07/11	168	3.6	6.8	5.6	100
08/08/11 - 08/14/11	168	5.6	7.3	6.3	100
08/15/11 - 08/21/11	168	5.3	8.8	6.9	100
08/22/11 - 08/28/11	168	6.3	9.0	7.1	100
08/29/11 - 09/04/11	168	4.4	10.0	6.9	100

TABLE A-6 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT WOLF ROAD ON
 SALT CREEK DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
09/05/11 - 09/11/11	168	4.9	11.0	7.5	100
09/12/11 - 09/18/11	167	5.0	11.2	7.9	100
09/19/11 - 09/25/11	168	6.2	9.8	7.6	100
09/26/11 - 10/02/11	168	6.7	9.7	8.3	100
10/03/11 - 10/09/11	168	5.4	10.0	7.4	100
10/10/11 - 10/16/11	168	5.3	10.2	6.9	100
10/17/11 - 10/23/11	168	5.0	9.9	8.0	100
10/24/11 - 10/30/11	168	7.0	12.6	8.8	100
10/31/11 - 11/06/11	168	8.4	12.7	9.9	100
11/07/11 - 11/13/11	168	6.5	10.5	9.5	100
11/14/11 - 11/20/11	168	9.2	12.5	10.4	100
11/21/11 - 11/27/11	168	9.0	12.3	10.2	100
11/28/11 - 12/04/11	168	9.6	11.9	10.6	100
12/05/11 - 12/11/11	57	9.9	11.6	10.7	100
12/12/11 - 12/31/11			NO DATA		

¹IPCB general use DO standard is 3.5 mg/L, and 5.0 mg/L from March - July.

TABLE A-7: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT ASHLAND AVENUE ON THE
 LITTLE CALUMET RIVER DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
01/01/11 - 01/02/11	48	10.5	12.6	11.6	100
01/03/11 - 01/09/11	168	11.4	12.9	12.6	100
01/10/11 - 01/16/11	168	11.3	12.8	12.3	100
01/17/11 - 01/23/11	168	11.2	13.1	12.3	100
01/24/11 - 01/30/11	168	10.6	12.7	11.6	100
01/31/11 - 02/06/11	168	11.6	14.0	12.5	100
02/07/11 - 02/13/11	168	10.6	14.9	12.4	100
02/14/11 - 02/20/11	168	10.6	13.9	11.7	100
02/21/11 - 02/27/11	168	9.2	13.0	12.1	100
02/28/11 - 03/06/11	168	11.6	13.6	12.9	100
03/07/11 - 03/13/11	168	9.1	13.3	10.7	100
03/14/11 - 03/20/11	168	8.0	10.4	9.3	100
03/21/11 - 03/27/11	57	8.0	9.8	8.6	100
03/28/11 - 06/26/11			NO DATA		
06/27/11 - 07/03/11	110	4.6	7.5	6.0	95
07/04/11 - 07/10/11	168	4.0	8.4	5.9	84
07/11/11 - 07/17/11	167	2.6	10.6	6.0	69
07/18/11 - 07/24/11	168	2.1	18.0	9.3	76
07/25/11 - 07/31/11	168	3.6	5.4	4.3	10
08/01/11 - 08/07/11	168	2.8	6.2	4.4	90
08/08/11 - 08/14/11	58	3.8	5.9	4.4	100
08/15/11 - 08/21/11			NO DATA		
08/22/11 - 08/28/11	110	4.5	6.2	5.2	100
08/29/11 - 09/04/11	168	2.9	6.6	5.1	95
09/05/11 - 09/11/11	168	3.7	7.0	5.8	100
09/12/11 - 09/18/11	168	4.8	7.9	6.2	100
09/19/11 - 09/25/11	58	5.4	6.9	6.3	100
09/26/11 - 10/02/11			NO DATA		
10/03/11 - 10/09/11	109	6.4	8.7	7.6	100
10/10/11 - 10/16/11	168	4.5	8.0	6.3	100
10/17/11 - 10/23/11	167	7.6	8.9	8.5	100
10/24/11 - 10/30/11	168	6.0	9.2	7.6	100
10/31/11 - 11/06/11	58	7.0	8.5	7.7	100
11/07/11 - 11/13/11			NO DATA		

TABLE A-7 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
 AT ASHLAND AVENUE ON THE
 LITTLE CALUMET RIVER DURING 2011

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)			Percent DO Values ≥ (3.5, 5.0) mg/L ¹ IPCB Standard
		Minimum	Maximum	Mean	
11/14/11 - 11/20/11	109	7.4	10.6	9.4	100
11/21/11 - 11/27/11	168	7.5	9.7	8.8	100
11/28/11 - 12/04/11	167	8.1	11.1	10.0	100
12/05/11 - 12/11/11	168	9.0	12.6	10.7	100
12/12/11 - 12/18/11	168	9.2	12.9	10.8	100
12/19/11 - 12/25/11	168	9.6	11.0	10.3	100
12/26/11 - 12/31/11	144	9.4	10.9	10.2	100

¹IPCB general use DO standard is 3.5 mg/L, and 5.0 mg/L from March - July.

TABLE A-8: SUMMARY STATISTICS FOR DISSOLVED OXYGEN MEASUREMENTS
MADE DURING CROSS-SECTIONAL SURVEYS IN 2011

Waterway, Station, and Date	Field Monitor Dissolved Oxygen (mg/L)	Cross-Sectional DO Samples						
		Cross Section Depth Range (feet)	N*	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation (mg/L)	Coefficient of Variation (%)
<u>North Branch Chicago River</u>								
<u>Central Park Avenue</u>								
04/11/2011	9.18	1.0 – 1.1	6	9.37	9.47	9.43	0.04	0.42
08/19/2011	6.22	0.4 – 1.2	6	6.16	6.29	6.21	0.06	0.98
10/28/2011	7.64	0.2 – 0.2	2	7.95	7.99	7.97	0.03	0.35
<u>Des Plaines River</u>								
<u>Devon Avenue</u>								
08/19/2011	5.25	1.0 – 2.3	6	5.50	5.78	5.61	0.11	1.87
10/28/2011	8.93	0.7 – 2.3	5	8.74	8.96	8.80	0.09	1.03
<u>Irving Park Road</u>								
4/11/2011	8.66	1.0 – 4.0	8	9.00	9.07	9.03	0.02	0.26

TABLE A-8 (Continued): SUMMARY STATISTICS FOR DISSOLVED OXYGEN MEASUREMENTS
MADE DURING CROSS-SECTIONAL SURVEYS IN 2011

Waterway, Station, and Date	Field Monitor Dissolved Oxygen (mg/L)	Cross Section Depth Range (feet)	N*	Cross-Sectional DO Samples				
				Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation (mg/L)	Coefficient of Variation (%)
<u>Salt Creek</u>								
<u>BusseLake Dam</u>								
04/11/2011	10.18	1.9 – 2.7	6	10.38	10.44	10.40	0.03	0.24
08/19/2011	NA	1.2 – 2.8	6	8.25	8.84	8.47	0.29	3.40
10/28/2011	8.41	1.8 – 2.2	6	8.96	9.14	9.07	0.08	0.85
<u>J.F. Kennedy Boulevard</u>								
04/11/2011	NA	0.5 – 1.8	6	10.08	10.11	10.09	0.01	0.14
08/19/2011	6.94	0.7 – 1.7	6	6.79	7.21	7.05	0.20	2.85
10/28/2011	8.56	0.2 – 1.0	3	8.49	8.57	8.52	0.04	0.51
<u>Wolf Road</u>								
04/11/2011	NA	1.1 – 1.8	6	8.88	8.94	8.92	0.02	0.27
08/19/2011	7.09	0.8 – 1.9	6	6.71	6.82	6.76	0.05	0.71
10/28/2011	9.36	0.7 – 1.4	3	9.50	9.69	9.61	0.10	1.02

TABLE A-8 (Continued): SUMMARY STATISTICS FOR DISSOLVED OXYGEN MEASUREMENTS
MADE DURING CROSS-SECTIONAL SURVEYS IN 2011

Waterway, Station, and Date	Field Monitor Dissolved Oxygen (mg/L)	Cross Section Depth Range (feet)	N*	Cross-Sectional DO Samples				
				Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation (mg/L)	Coefficient of Variation (%)
<u>Little Calumet River</u>								
<u>Ashland Avenue</u>								
04/04/2011	NA	0.1 – 0.6	6	9.51	9.69	9.60	0.08	0.80
08/22/2011	NA	2.2 – 2.5	6	4.42	4.49	4.44	0.03	0.58
10/21/2011	8.78	1.8 – 3.6	7	8.56	8.62	8.58	0.03	0.29

*Number of DO measurements made across transect during cross-sectional survey.

NA = Not Available.