ILLINOIS POLLUTION CONTROL BOARD
July 12, 2007

IN THE MATTER OF:	)	
	)	
PROPOSED AMENDMENTS TO	)	R04-25
DISSOLVED OXYGEN STANDARD 35 ILL.	)	(Rulemaking - Water)
ADM. CODE 302.206	)	

Proposed Rule. First Notice.

OPINION AND ORDER OF THE BOARD (by A.S. Moore):

For first-notice publication in the *Illinois Register*, the Board today adopts proposed amendments to Illinois' general use water quality standard for dissolved oxygen or "DO" (35 Ill. Adm. Code 302.206). The Board's first-notice amendments are based on aspects of both the proposal filed by the rulemaking proponent, the Illinois Association of Wastewater Agencies (IAWA), and the joint proposal later filed by the Illinois Department of Natural Resources (DNR) and the Illinois Environmental Protection Agency (IEPA). Further, the amendments proposed for first notice are consistent with the National Criteria Document or "NCD" for DO of the United States Environmental Protection Agency (USEPA), *Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Freshwater)* (USEPA, Chapman 1986).

This proposal for first notice includes a narrative DO standard, as well as a two-season numeric DO standard with values based on daily minima and 7- and 30-day averages. The proposal includes July in the "early life stages" season (March through July) of the proposed two-season DO standard. The egg, embryo, larval, and recently-hatched juvenile life stages of fish are more sensitive to low DO concentrations than later juvenile and adult stages. Additionally, the proposal designates stream segments to receive "enhanced" numeric dissolved oxygen standards to protect DO-sensitive fish and macroinvertebrate species present in meaningful amounts. An overview of all of the Board's main findings begins on the next page of this opinion.

INTRODUCTION

Dissolved oxygen, which is essential to aquatic organisms for aerobic respiration, occurs between water molecules as microscopic bubbles of oxygen that fish "breathe" through their gills.[1] Human activities, including biochemical oxygen demand or "BOD" and nutrient discharge, and natural processes affect DO levels in Illinois waters. The DO general use water quality standard is critical to many other regulatory programs, including "impairment" assessments and Total Maximum Daily Load or "TMDL" under Section 303(d) of the federal Clean Water Act (33 U.S.C. 1313(d)).

[1] Sheila F. Murphy, hydrologist/geologist, U.S. Geological Survey http://bcn.boulder.co.us/basin/data/BACT/info/DO.html (page last updated April 23, 2007).

Section 13(a)(1) of the Environmental Protection Act (Act) (415 ILCS 5/13(a)(1) (2006)) authorizes the Board to establish "[w]ater quality standards specifying . . . the minimum permissible concentrations of dissolved oxygen and other desirable matter in the waters." By this authority and to reflect the current science, the Board is proposing to update the existing DO water quality standard, which was adopted in 1972.

Almost all of the participants who have articulated a position in this rulemaking favor amending the current dissolved oxygen water quality standard for general use waters. There is also much consensus in the record on how the current standard should be amended, such as by adopting DO standards that change seasonally based on the life stages of fish. The two primary areas of disagreement among the rulemaking participants are (1) whether to include the month of July in the early life stages timeframe and (2) whether certain stretches of Illinois streams should have more protective DO standards than the rest of the general use waters based on the presence of allegedly DO-sensitive aquatic organisms. As noted above and for the reasons detailed in this opinion, the Board proposes for first notice to include July in the early life stages period and to include designated stream segments for enhanced DO protection.

The amendments proposed today should significantly improve the current DO standard. Unlike the current DO standard, the proposed amendments take into account the varied DO requirements of aquatic communities and the diverse range of natural aquatic conditions present across Illinois. The amendments will also allow both public and private resources to be focused on those waters most impacted by low DO.

The Board thanks all of those who have participated in this rulemaking and especially commends IAWA, DNR, and IEPA for their invaluable contributions to this record. The Board will accept written public comment on its proposed first-notice amendments for 45 days after they are published in the *Illinois Register*.

OVERVIEW OF THE BOARD'S MAIN FINDINGS

The following provides a summary, and the location within this opinion, of the Board's main findings. The Board finds that Illinois' current general use water quality standard for dissolved oxygen needs to be amended (p. 12) and that those amendments should be based primarily on USEPA's NCD for DO (p. 14).

The Board agrees with IAWA's proposed approach of having a two-season DO standard, one more protective for the sensitive early life stages of fish and another for other life stages. Further, the Board will proceed to first notice with IAWA's proposed numeric DO levels as follows, at least with respect to the vast majority of general use waters: for early life stages, a daily minimum DO concentration of 5.0 milligrams per liter (mg/L) and a seven-day mean of 6.0 mg/L DO; for other life stages, a daily minimum DO concentration of 3.5 mg/L and a seven-day mean minimum of 4.0 mg/L DO. As proposed by DNR and IEPA, and ultimately agreed to by IAWA, the Board is also proposing for first notice a 30-day mean DO standard of 5.5 mg/L for other life stages. (pp. 34-35)

The Board finds that the analyses of several grab and semi-continuous DO monitoring datasets provided in this record indicate that the current DO standard does not account for the seasonal variation and diurnal fluctuations of DO naturally occurring in streams. Beyond that, however, the Board finds that helpful conclusions cannot be drawn at this time from these DO datasets for the purposes of this rulemaking. (pp. 46-49)

The Board agrees with DNR and IEPA that certain stream segments, approximately 8% of general use stream miles in Illinois, require incrementally enhanced DO standards based on the presence of meaningful amounts of DO-sensitive aquatic organisms. Accordingly, the Board is proposing for first notice that these stream segments, identified in proposed Appendix D to Part 302, have the following DO standards: for early life stages, a daily minimum DO concentration of 5.0 mg/L and a seven-day mean of 6.25 mg/L DO; for other life stages, a daily minimum DO concentration of 4.0 mg/L, a seven-day mean minimum of 4.5 mg/L DO, and a 30-day mean DO standard of 6.0 mg/L. Of course, if a discharger believes these more protective DO standards are not warranted for a given stream segment, the discharger may seek site-specific relief from the Board, such as an adjusted standard or site-specific rule under the Act. (pp. 68-74)

To protect late spring and summer spawning, the Board finds that the month of July should be included in the early life stages (*i.e.*, March through July), as proposed by DNR and IEPA, rather than having the early life stages timeframe end on June 30, as IAWA proposes. (pp. 79-81)

As proposed by DNR and IEPA, and agreed to by IAWA, the Board is also proposing for first notice a narrative DO standard for quiescent and isolated sectors of general use waters, such as wetlands and waters below the thermocline in lakes, to ensure that the full array of general use waters are protected. The numeric DO standards would not apply in these isolated waters where naturally-occurring DO concentrations cannot reasonably be expected to attain numeric values set for most general use waters. (pp. 84-85)

The Board declines to adopt the following suggestions made during this proceeding: (1) to express the DO water quality standard as percent saturation rather than as concentration in mg/L (pp. 87-88); and (2) to include a minimum DO level of 6.5 mg/L for all general use waters when water temperature is 10°C or below (p. 89). The Board also declines to require that any IEPA "implementation rules" for DO monitoring or permitting be filed in this docket, but the Board does add specific language describing the 7-day mean minimum, the 7-day mean, and the 30-day mean. (pp. 92-94)

Additionally, the Board does not include in this first-notice proposal a "waiver" for urban-impacted streams or a separate "wet weather standard" based on stormwater runoff. Finally, the Board finds that the first-notice proposal will not have an adverse impact of the People of the State of Illinois. (pp. 96-97)

GUIDE TO THE BOARD'S OPINION AND ORDER

The Board's opinion is organized into the following main sections, beginning on the pages indicated below:

Section Heading	Page
Table of Proposed and Current Dissolved Oxygen Standards	4
Procedural Matters	6
Illinois' Current Dissolved Oxygen General Use Water Quality Standard	8
USEPA's National Criteria Document	13
Introduction to the IAWA Proposal	14
Introduction to the DNR/IEPA Proposal	16
Overview of Responses to the DNR/IEPA Proposal	22
IAWA Proposal	24
Dissolved Oxygen Data	35
DNR/IEPA Proposal To Have Enhanced Dissolved Oxygen Standards for Designated Stream Segments	49
DNR/IEPA Proposal to Include July in Early Life Stages	74
DNR/IEPA Proposal for a Narrative Standard	81
Dissolved Oxygen Saturation Versus Concentration	85
Proposed 6.5 mg/L Dissolved Oxygen	89
Implementation Concerns	90
Technical Feasibility and Economic Reasonableness	94
Conclusion	97

The Board's opinion is followed by the Board's order, which begins on page 98 of this document and contains the rule amendments being proposed for first notice.

TABLE OF PROPOSED AND CURRENT DISSOLVED OXYGEN STANDARDS

For ease of reference and comparison, the Board sets forth below in table form the dissolved oxygen levels as proposed by IAWA, as proposed jointly by DNR and IEPA, as set forth in USEPA's NCD, and as provided in the current Board regulations:

Time Period	1-day minimum*	7-day mean minimum**	7-day mean***	30-day mean****
IAWA Proposed Revisions to DO General Use Water Quality Standards (mg/L)				
March through June (early life stages)	5.0		6.0	
July through February (other life stages)	3.5	4.0		

Time Period	1-day minimum*	7-day mean minimum**	7-day mean***	30-day mean****
DNR/IEPA Proposed Revisions to DO General Use Water Quality Standards (mg/L)				
Level 1 (approx. 8% of General Use Stream Miles)				
March through July (early life stages)	5.0		6.25	
August through February (other life stages)	4.0	4.5		6.0
Level 2				
March through July (early life stages)	5.0		6.0	
August through February (other life stages)	3.5	4.0		5.5
Narrative Standard				
Year-round	General use waters at all locations shall maintain sufficient dissolved oxygen concentrations to prevent offensive conditions as required in Section 302.203 of this Part.			
Year-round	Quiescent and isolated sectors of General Use waters including but not limited to wetlands, sloughs, backwaters and below the thermocline in lakes and reservoirs shall be maintained at sufficient dissolved oxygen concentrations to support their natural ecological functions and resident aquatic communities.			
USEPA NCD for DO (mg/L)				
Warmwater				
Early life stages (warmwater)	5.0		6.0	
Other life stages (warmwater)	3.0	4.0		5.5
Coldwater				
Early life stages (coldwater)	5.0		6.5	
Other life stages (coldwater)	4.0	5.0		6.5
Current Illinois General Use Water Quality Standards for DO (mg/L)				
Year-round	16 hours of any 24-hour period		Anytime	
	6.0		5.0	

* Lowest value of DO measured during 24-hour calendar day

** Arithmetic mean of daily DO minima from current and previous 6 calendar days

*** Arithmetic mean of daily mean DO values from the current and previous 6 calendar days

**** Arithmetic mean of daily mean DO values from the current and previous 29 calendar days

Exh. 1; Exh. 2 (NCD); Exh. 20; Exh. 23, Figure 1, Table 1; PC 103 at 7-9; 35 Ill. Adm. Code 302.206.

PROCEDURAL MATTERS

Procedural History

On April 19, 2004, IAWA filed its rulemaking proposal to amend Illinois' general use water quality standard for dissolved oxygen.[2] The Board issued an order on May 6, 2004, accepting the IAWA proposal for hearing. DNR and IEPA filed their joint proposed revisions to the DO standard on April 4, 2006. Hearings concluded in November 2006 and public comments were filed as recently as June 2007.

As Toby Frevert, Manager of the Division of Water Pollution Control for IEPA, testified,

> Illinois' general use dissolved oxygen standard carries more significance than many of our other water quality standards and there is a wide diversity of opinion, perspective and attitude among the various constituencies participating in the proceeding. Exh. 14 at 2.

Given the significance of the DO general use water quality standard and the varied views of the rulemaking participants on how it should be revised, the Board has accommodated the wishes of the participants and allowed this rulemaking to proceed at a pace that would allow for continued stakeholder discussions. To that end, the hearing officer scheduled hearings only when the participants stated that they were ready to proceed and only after the hearing officer, at the participants' request, conducted six status conferences and received eight status reports over the course of nearly two years.

The Board has held five public hearings over six days in this rulemaking: (1) June 29, 2004, in Chicago; (2) August 12, 2004, in Springfield; (3) August 25, 2005, in Chicago; (4) April 25, 2006, in Springfield; and (5) November 2-3, 2006, in Springfield. The following 20 persons testified at the hearings indicated:

- Dennis Streicher, Director of Water and Wastewater for the City of Elmhurst (first, second, and third hearings, and fifth hearing);
- John Callahan, Executive Director of the Bloomington and Normal Water Reclamation District of McLean County (first and second hearings);
- Dr. James Garvey, Associate Professor of Zoology and Associate Director of the Fisheries and Illinois Aquaculture Center at Southern Illinois University (first, second, and third hearings, and fifth hearing);
- Roy Harsch, Drinker Biddle Gardner Carton, attorney for IAWA (first, second, and third hearings, and fifth hearing);
- Toby Frevert, Manager of the Division of Water Pollution Control for IEPA (all five hearings);

[2] The Board cites IAWA's "statement of reasons" included in its rulemaking proposal as "Statement at _."

- Dr. David Thomas, Chief of the Illinois Natural History Survey, DNR (second and third hearings);
- Mark Miller, Senior Policy Advisor for Lieutenant Governor Pat Quinn (second hearing);
- Stan Yonkauski, Deputy Counsel with DNR's Office of Legal Counsel (third hearing);
- Albert Ettinger, attorney for Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club (third hearing);
- Todd Main, Director of Policy and Planning, Friends of the Chicago River (third hearing);
- Dr. Thomas Murphy, Professor *Emeritus* of Chemistry, DePaul University (third, fourth, and fifth hearings);
- Roy Smogor, a stream biologist in IEPA's Surface Water Section (fourth and fifth hearings);
- Joel Cross, Acting Manager of the Watershed Protection Section within the Office of Resource Conservation of DNR (fourth and fifth hearings);
- Matthew Short with the Surface Water Section of IEPA (fourth hearing);
- Ann Holtrop, Watershed Information Specialist with the Watershed Protection Section of DNR (fourth hearing);
- Richard Lanyon, General Superintendent of the Metropolitan Water Reclamation District of Greater Chicago (fourth and fifth hearings);
- Thomas Muth, District Manager, Fox Metro Water Reclamation District (fifth hearing);
- Stephen Pescitelli, stream biologist with DNR (fifth hearing);
- Louis Kollias, Director of the Department of Research and Development with the Metropolitan Water Reclamation District of Greater Chicago (fifth hearing); and
- Cindy Skrukrud, Clean Water Advocate for the Illinois Chapter of the Sierra Club (fifth hearing).

The Board hearing officer accepted 41 hearing exhibits into the record. The hearing exhibits are described in Appendix I to this opinion and order. Upon receipt, the transcripts of the hearings were placed in the Clerk's Office On Line (COOL) on the Board's Web site at www.ipcb.state.il.us.[3] Many other documents from this rulemaking record are available through COOL, including Board opinions and orders, hearing officer orders, and public comments.

The Board has received 111 public comments in this proceeding.[4] Those who filed comments are listed in Appendix II to this opinion and order.

As required by Section 27(b) of the Act (415 ILCS 5/27(b) (2006)), the Board requested, in a letter of May 11, 2004, that the Department of Commerce and Economic Opportunity (DCEO) conduct an economic impact study (EcIS) for this rulemaking. In a letter of June 22, 2004, DCEO declined to perform an EcIS, noting its limited fiscal resources. When provided the opportunity at hearing, no one testified about DCEO's response. Tr.2 at 159.

---

[3] Hearing exhibits are cited as "Exh. _ at _." The hearing transcripts are cited as "Tr.1 at _" for the first hearing, "Tr.2 at _" for the second hearing, "Tr.3 at _" for the third hearing, "Tr.4 at _" for the fourth hearing, and "Tr.5 at _" for the fifth hearing.

[4] Public comments are cited as "PC _ at _."

Motions

On May 3, 2007, IAWA filed a motion for leave to avoid the requirement of serving the dissolved oxygen monitoring data attached to its public comment, PC 109, filed on April 24, 2007. IAWA notes that the data are voluminous and that the entire filing, including the DO data, is available on the Board's website. There has been no response to IAWA's motion, which the Board grants. *See* 35 Ill. Adm. Code 101.500(d).

On June 8, 2007, IEPA filed a motion for leave to file *instanter* a response to IAWA's PC 109, attaching the response. IEPA filed the motion because under the Board's procedural rules, responses to motions are due within 14 days after service of the motion. *See* 35 Ill. Adm. Code 101.500(d). IEPA's response, however, does not address IAWA's motion to avoid service of the DO data attached to PC 109, but rather addresses the substance of IAWA's public comment. The Board therefore denies as unnecessary IEPA's motion for leave and simply accepts IEPA's response as a public comment, PC 110.

Public Comments

First-notice publication in the *Illinois Register* of these proposed rule changes will start a period of 45 days during which anyone may file public comments with the Board at:

Office of the Clerk
Pollution Control Board
James R. Thompson Center
100 W. Randolph Street, Suite 11-500
Chicago, Illinois 60601

The Board encourages persons to file public comments on the proposed amendments. Docket R04-25 should be indicated on the public comment. Any person may file a public comment, regardless of whether the person has yet filed one.

Additionally, public comments in this rulemaking may be filed through COOL at www.ipcb.state.il.us. Any questions about electronic filing should be directed to the Clerk's Office at (312) 814-3629.[5]

ILLINOIS' CURRENT DISSOLVED OXYGEN GENERAL USE WATER QUALITY STANDARD

The Board's responsibility in this rulemaking arises from the Act, which charges the Board to "determine, define, and implement the environmental control standards applicable in

---

[5] Please note that all filings with the Clerk of the Board must be served on the hearing officer and on those persons on the Service List for this rulemaking. Before filing any document with the Clerk, please confirm with the Clerk's Office that you have the most recent version of the Service List.

the state of Illinois." 415 ILCS 5/5(b) (2006). Under Section 13 of the Act, the Board is granted specific rulemaking authority to establish water quality standards. *See* 415 ILCS 5/13 (2006). Section 13(a)(1) of the Act specifically addresses dissolved oxygen:

> (a) The Board, pursuant to procedures prescribed in Title VII of this Act, may adopt regulations to promote the purposes and provisions of this Title. Without limiting the generality of this authority, such regulations may among other things prescribe:
>
> > (1) Water quality standards specifying among other things, the maximum short-term and long-term concentrations of various contaminants in the waters, the *minimum permissible concentrations of dissolved oxygen* and other desirable matter in the waters, and the temperature of such waters. 415 ILCS 5/13(a)(1) (2006) (emphasis added).

The Board adopted Illinois' current General Use water quality standard for dissolved oxygen in 1972, at which time the Board found it "essential to an adequate fish population." Effluent Criteria, Water Quality Standards, Water Quality Standards Revisions for Intrastate Waters, R70-8, R71-14, R71-20, slip op. at 3 (Jan. 6, 1972). The standard is presently set forth at 35 Ill. Adm. Code 302.206 and reads as follows:

> Section 302.206 Dissolved Oxygen
>
> Dissolved oxygen (STORET number 00300) shall not be less than 6.0 mg/l during at least 16 hours of any 24 hour period, nor less than 5.0 mg/l at any time. 35 Ill. Adm. Code 302.206.

Accordingly, the current standard permits dissolved oxygen to be less than 6.0 mg/L no more than 8 hours in any 24-hour period, but at no time is dissolved oxygen allowed to fall below 5.0 mg/L. Section 302.206 is set forth in Part 302's Subpart B ("General Use Water Quality Standards"), which "contains general use water quality standards which must be met in waters of the State for which there is no specific designation (35 Ill. Adm. Code 303.201)." 35 Ill. Adm. Code 302.101(b); *see also* 35 Ill. Adm Code 302.201. Generally, "all waters of the State must meet the general use standards of Subpart B of Part 302," except as otherwise specifically provided in the Board's regulations, such as for waters designated as secondary contact and indigenous aquatic life waters. *See* 35 Ill. Adm. Code 303.201, 303.204.

Richard Lanyon is the General Superintendent of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) and formerly the Director of Research and Development for MWRDGC. He testified about the designated use class system for Illinois, pointing out that the "general use" class applies to more than 99% of the river miles in the State. Exh. 25 at 2. According to Lanyon, the "secondary contact and indigenous species aquatic life" class in northeastern Illinois includes approximately 87 miles, while few are designated in the "public water supply" class and none are designated in the "outstanding resource" class. *Id*.

The purpose of the general use water quality standards is to:

> protect the State's water for aquatic life . . ., wildlife, agricultural use, secondary contact use and most industrial uses and ensure the aesthetic quality of the State's aquatic environment. 35 Ill. Adm. Code 302.202.

IAWA asserts that the current DO standard is generally recognized to contain serious flaws and is inconsistent with the current science. IAWA states that it undertook the effort of updating the DO standard after conferring with IEPA because of the fundamental importance of the DO standard as a water quality measure and its use as a component of various water programs. PC 102 at 2.

Dr. James Garvey, an Associate Professor of Zoology and Associate Director of the Fisheries and Illinois Aquaculture Center at Southern Illinois University,[6] was retained by IAWA to evaluate Illinois' current DO general use water quality standard. Exh. 35 at 1. Dr. Garvey asserts that the current DO standard is unrealistic for most streams in the State because oxygen concentrations fluctuate both seasonally and daily, often declining below the State standards. According to Dr. Garvey, the current Illinois DO standard is "too simplistic for the diverse waters of Illinois." *Id*. at 1-2.

IAWA also notes that at the second hearing, Dr. David Thomas, Chief of the Illinois Natural History Survey of DNR presented a letter he had prepared at the request of the Lieutenant Governor's Office. While Dr. Thomas expressed concerns regarding IAWA's proposal, he acknowledged that the current DO standard is too high for many water bodies receiving discharges from wastewater treatment plants. PC 102 at 5; Tr.2 at 119.

Dennis Streicher represents IAWA and was the president of IAWA from 2004 to 2005. Streicher states that IAWA members knew five years ago that the current Illinois DO standard was incorrect. According to Streicher, they have worked with the existing rule and knew that it was unattainable even in those Illinois waters that are among the least impacted by human activities. Exh. 32 at 1-3.

DNR states that the existing DO water quality standard needs to be amended. PC 96 at 1. According to DNR, the existing standard does not adequately account for the "varied [DO] requirements of aquatic life" or for "how [DO] concentrations vary across a broad range of natural aquatic conditions throughout Illinois." *Id*., citing Exh. 23 at 1. IEPA echoes this sentiment, adding that "all agree that the current standard for Illinois General Use waters is too simplistic" and "needs to be revised." PC 103 at 1, 16. According to IEPA, it is undisputed that there are Illinois streams not meeting the current DO standard and that both the IAWA proposal and DNR/IEPA proposal would "result in some significant (but smaller) number of exceedances." *Id*. at 14.

---

[6] Dr. Garvey received a Ph.D in Zoology from Ohio State University, an M.S. in Zoology from Ohio State University, and a B.A. in Zoology from Miami University, Ohio. Exh. 5 at 1.

Frevert, Manager of the Division of Water Pollution Control for IEPA, testified that he believes the current dissolved oxygen standard is:

> overly simplistic, outdated and not serving the state well. In that regard, I agree with [IAWA's] perspective. The comments of Dave Thomas on behalf of the [DNR] focus on the variability of streams and their aquatic communities across Illinois. This variability is even more pronounced as you consider lakes, reservoirs, wetlands and other surface water bodies for which the dissolved oxygen standard applies. Exh. 14 at 1-2; *see also* Tr.2 at 123-130; Exh. 13.

DNR believes that this rulemaking record contains the "data and science known today to move forward with this significant improvement to the existing [DO] water quality standards." PC 96 at 13. DNR adds that the joint recommendations "will allow for targeting of limited state resources to the most critical waters impacted by low [DO] concentrations." *Id*. In the words of Joel Cross, Acting Manager of the Watershed Protection Section within the Office of Resource Conservation of DNR,[7] the joint-agency recommendations "significantly enhance protection for aquatic life in comparison to the [DO] standard currently in place." Tr.4 at 45.

IEPA similarly contends that the joint-agency proposal:

> will adequately protect Illinois aquatic life while providing a more realistic and useful standard; the recommended revisions will improve IEPA's ability to focus on those streams that are truly having or are most likely to have [DO] problems. PC 103 at 2.

DNR does not view the joint-agency proposal as seeking a "lowering of [DO] standards within some waters during certain times of the year, but rather as focusing needed protection for most sensitive types and life stages of aquatic life where required." Tr.4 at 46.

Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club state that the current DO standard is "too simple" and produces both "false positives (i.e. it indicates DO problems where DO levels are healthy) and false negatives (indicates that DO levels are healthy where they are not)." PC 101 at 1. The Illinois Chapter of the American Fisheries Society states that "there is general agreement that the existing standard is in need of revision." PC 100 at 1.

The Illinois Farm Bureau points out that "[s]cience has advanced and the understanding of natural systems and streams in Illinois has improved greatly since the standard was originally set." PC 2 at 2. According to the Illinois Farm Bureau:

---

[7] Cross has been employed with DNR for seven and one-half years. He was previously employed with IEPA for 19 years, the last nine of which he was Manager of the Surface Water Section and the Planning Section in the Division of Water Pollution Control. Cross holds a Bachelor's degree in Zoology from Southern Illinois University at Carbondale, Illinois. Tr.4 at 38-39.

> The current, questionable standard wastes time, efforts, and money and does not produce desired results. *** The flawed dissolved oxygen standard is not a "stand alone" issue. Other programs are based on Illinois' current outdated DO standard. The dissolved oxygen standard is connected to the 303(d) List Water Quality Impaired Streams and Lakes and therefore drives the development of total maximum daily loads (TMDLs).
>
> Many waters in Illinois are listed as impaired due to an existing dissolved oxygen standard that is overly protective and does not reflect the needs of Illinois streams. IEPA is developing TMDLs for streams on the 303(d) List. The process of TMDL development is costly by itself, not to mention the millions of dollars necessary for point and nonpoint sources to implement the plans to achieve load reductions. It is therefore increasingly critical to ensure that the dissolved oxygen standard used for the development of the 303(d) List is appropriate for Illinois streams. *Id*. at 2-3.

In addition, Lanyon of MWRDGC testified that it is difficult to determine compliance with the existing DO standard. Exh. 25 at 3, citing Tr.3 at 16. Enforcement of the standard would require that multiple grab samples be taken over a period of at least eight hours. According to Lanyon, 5.0 mg/L becomes a default standard applied for grab samples taken at any time during the day. Exh. 25 at 3.

The Board recognizes that the DO general use water quality standard is central to many regulatory programs, including the federal Clean Water Act's Section 303(d) impairment assessment and TMDL program. Further, the Board agrees that the State's current DO standard is outdated and needs to be amended consistent with USEPA's 1986 National Criteria Document or "NCD," as adapted to Illinois waters. Given the wide array of aquatic life and conditions across Illinois, the Board finds that the current DO standard is not sufficiently sophisticated. PC 96 at 1, citing Exh. 23 at 1; PC 101 at 1; PC 102 at 2, 5; PC 103 at 1, 16; Exh. 14 at 1; Exh. 32 at 1-3; Statement at 4-5. As Frevert of IEPA testified:

> We've got a standard now that's not helping us because we measure violations in places where we believe the uses and particularly the aquatic community is perfectly healthy and what it's expected to be. *** [T]he standard can be overly simplistic and it can't apply everywhere if it's actually going to help us manage our resources and our functions properly. Tr.4 at 70-71.
>
> The existing standard is so far out there and overly protective, it's identifying on a wholesale order streams that we need to focus on [such that] *** there are DO flags going off all over the place. Tr.5 at 32; *see also* Tr.4 at 81, 83.

The Board further finds that this rulemaking record, as fully discussed below, is adequate to proceed with a first-notice proposal that promises to significantly improve Illinois' current DO standard. PC 96 at 13; Statement at 1, 6.

USEPA'S NATIONAL CRITERIA DOCUMENT

Both the IAWA proposal and the DNR/IEPA proposal are based on the current USEPA National Criteria Document (NCD) for dissolved oxygen. Statement at 1; Exh. 23 at 2; Tr.4 at 32-33. The NCD, which was published in April 1986 and authored by Dr. Gary Chapman, reviews the data on the effects of low levels of DO on the health, growth, and reproduction of freshwater aquatic organisms. Data derived from fish studies were used to develop DO criteria to protect freshwater aquatic organisms. The NCD presents the DO criteria in terms "coldwater" and "warmwater" species, "life stages" of aquatic organisms, and duration of exposure to low DO concentrations. Statement at 1; Exh. 2 (NCD) at 1-4.

In the NCD, USEPA recommends separate DO criteria for coldwater and warmwater biota. While the coldwater criteria address the protection of salmonids, the warmwater criteria is meant to protect nonsalmonids, which include many coldwater and "coolwater" fish, plus all warmwater fish. Exh. 2 (NCD) at 2. In addition, the NCD provides for the establishment of seasonal criteria based on the life stages of aquatic organisms present as long as data is available to accurately determine the presence or absence of the more sensitive stages. *Id*. at 4. The early life stages include embryonic and larval stages and all juvenile forms to 30-days after hatching. *Id.* at 34.

The DO criteria are derived from production impairment estimates, which are primarily based on growth data and information on temperature, disease, and pollutant stresses. Exh. 2 (NCD) at 33. The NCD notes that the DO criteria values are set at 0.5 mg/L above the concentrations that would be expected to result in slight production impairment. Therefore, the DO criteria represent values between no production impairment and slight production impairment. Accordingly, USEPA states, each criterion may be viewed as an "estimate of the threshold concentration below which detrimental effects are expected." *Id*.

USEPA's criteria for coldwater fish apply to waters containing a population of one or more species in the family of *Salmonidae* or to waters containing other coldwater or coolwater fish determined to be more similar to salmonids in sensitivity than to most warmwater species. Exh. 2 (NCD) at 33. USEPA notes in the NCD that some coolwater species may need to be protected by the coldwater criteria where the warmwater criteria do not afford adequate protection for such species. The warmwater criteria protect the early life stages of warmwater fish as sensitive as channel catfish and other life stages of fish as sensitive as largemouth bass. *Id.*

The NCD recommends a daily minimum to ensure that no acute mortality of sensitive species occurs because of low DO concentrations. Exh. 2 (NCD) at 36. For early life stages, the NCD recommends that the averaging period should not exceed 7 days to adequately protect the most sensitive life stages of aquatic organisms. A 30-day average is recommended for other life stages. The NCD also recommends the use of 7-day mean minimum value for other life stages to prevent significant episodes of continuous or regularly recurring exposures to DO concentrations at or near the lethal threshold. *Id.*

The Board agrees with IAWA, DNR, and IEPA that USEPA's 1986 NCD should serve as "an important foundation" for updating Illinois' DO water quality standard. PC 103 at 12; *see also* Statement at 1; Exh. 23 at 2; Tr.4 at 32-33. The current Illinois standard for DO was adopted in 1972, 14 years before the NCD was issued by USEPA. Exh. 23 at 7. Not surprisingly then, as DNR and IEPA explain, the NCD's criteria for DO address several elements not addressed by Illinois' current standard. *Id*. at 5. First, the NCD accounts for differences in sensitivity to low DO among types of fish or macroinvertebrates. *Id*. Second, the State agencies continue, the NCD accounts for differences in DO sensitivity depending on the life stages of fish. *Id*. Third, according to the agencies, the NCD "provide[s] practical considerations that account for occasional natural occurrences of low [DO]." *Id*.

DNR and IEPA assert that adding these NCD elements would "greatly improve[] the utility of the Illinois standards." Exh. 23 at 7; *see also* Tr.4 at 46-47. The Board concurs and now proceeds to address the respective proposals of IAWA and DNR/IEPA, both of which are based on USEPA's NCD.

INTRODUCTION TO THE IAWA PROPOSAL

IAWA is an organization of over 100 members and affiliate members, including approximately 55 districts and municipalities. IAWA "support[s] administrators and managers of wastewater collection and treatment agencies in the State of Illinois," including publicly owned treatment works (POTWs), water reclamation districts, and municipalities, as well as the largest Illinois private wastewater treatment utility. IAWA Motion to Waive (April 19, 2004) at 1; Tr.1 at 13. IAWA's rulemaking proposal seeks to amend Illinois' current dissolved oxygen general use water quality standards at 35 Ill. Adm. Code 302.206.

The IAWA proposal would replace the existing DO standard (6.0 mg/L during 16 hours of any 24-hour period and an anytime minimum of 5.0 mg/L) with DO standards based on the USEPA's current National Criteria Document or NCD for dissolved oxygen. During the months of July through February, IAWA proposes a daily minimum DO concentration of 3.5 mg/L and a seven-day mean minimum of 4.0 mg/L. For the months of March through June, the IAWA proposal sets forth a daily minimum of 5.0 mg/L DO and a seven-day mean of 6.0 mg/L DO. Statement at 1-2, Exh. 1; PC 102 at 2. The IAWA maintains that its proposed standard is more conservative than the NCD regarding DO minima. PC 109 at 3.

IAWA states that the DO standards it proposes for the months of March through June address the early life stages of fish (egg, embryos, and larval stages) present in Illinois waters. The DO standards proposed for the months of July through February afford protection during other life stages, according to IAWA. Statement at 2. The IAWA states that in establishing the months of late spawning and protecting early life stages, its proposed standard adheres to the advice of local experts, as discussed below. PC 109 at 3.

IAWA describes March 1 through June 30 as the timeframe when early life stages of sensitive species are present and freshwater has the capacity to hold high oxygen concentrations. Further, according to IAWA, during warm, productive months and the remainder of the year when species with sensitive early life stages have largely completed reproduction, its proposed less stringent DO standards would apply. Exh. 16 at 2. Dr. Garvey emphasizes that IAWA included running means to avoid chronically low DO concentrations. Dr. Garvey states that IAWA's proposed numeric DO values are consistent with, and with respect to the 3.5 mg/L minimum value, more restrictive than, the 1986 USEPA NCD values. *Id.* at 3.

IAWA also asserts that the proposed seasonal DO standard structure is consistent with the NCD. IAWA notes that its proposal, however, does not include a 30-day DO standard recommended by the NCD. That is because, in IAWA's estimation, compliance with the applicable 7-day standard in most cases would ensure that the 30-day standard would also be met. Statement at 2. When compared to the existing Illinois DO standard, IAWA states that its proposed standard would require more extensive DO monitoring and may require the use of continuous monitors. *Id*.

Because DO is essential to aquatic organisms for aerobic respiration, IAWA states that regulatory agencies have established DO standards to ensure the maintenance of adequate DO in waterways. IAWA notes that the current Illinois DO standard, adopted in 1972, does not reflect the federal guidance and latest scientific data on DO. Statement at 4-5. The DO standard is central to many other regulatory programs, such as the Total Maximum Daily Load or TMDL and nutrient discharge control. IAWA therefore asserts that it is imperative that the DO standard be valid and based on scientific data and verifiable evidence. *Id*. at 5. In light of this, IAWA states that it decided to develop the necessary scientific information and propose a scientifically defensible DO standard. *Id.*

IAWA obtained the services of Dr. Garvey and Dr. Matt R. Whiles to conduct a "literature survey and data review of the effect of dissolved oxygen levels on fish species in Illinois." Statement at 5. IAWA states that Drs. Garvey and Whiles, who are professors in the Department of Zoology at Southern Illinois University, are recognized experts on fish species in Illinois and the effect of water quality on those fish. IAWA notes that prior to undertaking the assignment, Drs. Garvey and Whiles conferred with IEPA and DNR. Drs. Garvey and Whiles reviewed the nature of Illinois water systems, which they state are dominated by warmwater systems with exception of Lake Michigan. *Id.* at 6. They evaluated the effect of DO on warmwater organisms, including fish and macroinvertebrate responses to oxygen stress, and environmental variation in dissolved oxygen. Drs. Garvey and Whiles' assessment also included a review of literature on DO, including USEPA's NCD for DO. *Id*.

Drs. Garvey and Whiles summarized their findings in a report entitled "*An Assessment of National and Illinois Dissolved Oxygen Water Quality Criteria*" (April 2004) ("Assessment"). The Assessment concludes that Illinois' existing DO standard is overly restrictive and should be modified based on published research concerning natural fluctuations in aquatic systems and physiological tolerance of native aquatic life. Statement at 1. IAWA relies on the Assessment's conclusion to support its proposal. IAWA states that the proposal primarily affects wastewater dischargers that discharge oxygen depleting substances, including biochemical oxygen demand or "BOD" and nutrients. These dischargers include publicly owned treatment works or "POTWs," industrial dischargers, and agricultural point and nonpoint sources. *Id*. at 2.

IAWA's proposed amendments to Section 302.206 are set forth below, with proposed additions underlined and proposed deletions stricken through:

> Dissolved oxygen (STORET number 00300) shall be determined on a monthly basis as follows: ~~not be less than 6.0 mg/L during at least 16 hours of any 24 hour period, nor less than 5.0 mg/L at any time. 35 Ill. Adm. Code 302.206.~~
>
> a. During the months of July through February, dissolved oxygen shall not be less than a one day minimum concentration of 3.5 mg/l, and a seven day mean minimum of 4.0 mg/l. The mean minimum is defined as the average of the minimum daily recorded dissolved oxygen concentrations and should be based on a data recorder or representative grab samples.
>
> b. During the months of March through June, dissolved oxygen shall not be less than a one-day minimum dissolved oxygen concentration of 5.0 mg/l, and a seven day mean of 6.0 mg/l. The mean is defined as the average of the daily average value and should be based on data collected by semi-continuous data loggers or estimated from the representative daily maxima and minima values. Statement, Att. 1.

MWRDGC states that IAWA's proposed DO standard would establish a scientifically sound and practical DO standard for aquatic life in Illinois. PC 98 at 1. The Chemical Industry Council of Illinois (CICI) also supports IAWA's proposal. PC 95 at 1. CICI states that IAWA's proposal would establish a seasonal DO standard that is "protective of the early life stages of fish, aquatic insects and benthic organisms" and a minimum standard more stringent than that suggested in USEPA's NCD. *Id*. The Illinois Farm Bureau supports IAWA's proposal as "realistic and based on sound science." PC 2 at 1. According to the Farm Bureau, because "[i]mplementing standards is costly – both monetarily and time wise," it is "far better to have realistic standards that are achievable." *Id*. at 2.

Later in the rulemaking, after submission of the joint DNR/IEPA proposal, discussed below, IAWA asked that the Board adopt the 30-day average standard of 5.5 mg/L for other life stages and the narrative standard, both proposed by DNR and IEPA. PC 102 at 1.

INTRODUCTION TO THE DNR/IEPA PROPOSAL

In response to IAWA's proposal, DNR and IEPA also propose amendments to Section 302.206. The DNR/IEPA-proposed amendments to Section 302.206 share some aspects of the IAWA's suggested amendments, but also include substantial differences from those proposed by IAWA.

DNR does not believe that IAWA's proposed revisions to the DO water quality standard are adequate. PC 96 at 1. It is DNR's opinion that the IAWA proposal is inadequate because it fails to: (1) protect species more sensitive to low DO than channel catfish and largemouth bass; (2) provide adequate protection for early life stages; (3) address the range of waters contained in the general use category; and (4) adequately protect against long-term chronic effects of low DO. *Id*. at 2.

IEPA likewise states that IAWA's proposal "fails to adequately protect some Illinois fish and stream macroinverebrates that require minimum [DO] levels higher than the minima represented by the IAWA-proposed standards." PC 103 at 1-2. IEPA describes the NCD:

> It recommends different standards for the protection of species that are most sensitive to low [DO] ("coldwater["]) vs . those that are less sensitive to low [DO] ("warmwater["]). Specifically, the NCD limits "warmwater" species to those species that are equally or more tolerant of low [DO] levels as are largemouth bass (as adults) or channel catfish (as early life stages). The record shows that Illinois streams contain numerous fish species whose sensitivity to [DO] falls in between the needs of the NCD "warmwater" fishes and those of the "coldwater" salmonid species. *Id*. at 12-13, citing Tr.4 at 33-34, 97-98, Exh. 23 at 27-31.

According to IEPA, it and DNR developed a "technically sound and reasonable methodology to address this failing in the IAWA proposal and adapted the NCD to Illinois in a scientifically defensible manner." *Id*. at 13, citing Tr.4 at 40-43, Exh. 23.

DNR describes the "primary supporting documentation" for the IAWA proposal (Garvey/Whiles, April 2004 *An Assessment of National and Illinois Dissolved Oxygen Water Quality Criteria*, Exh. 1) as a "valid initial discussion" of the DO issue that nevertheless "falls short of providing the complete and necessary protection for DO sensitive species in Illinois, and species that are DO sensitive during early life stages." PC 96 at 11.

According to DNR, the additional studies relied upon by IAWA (Csoboth thesis; Dr. Davis' research on physical characteristics; application of "Liebig's law" for averaging conditions; analysis of continuous DO concentration data) "are limited in scope and statewide applicability," in contrast to the biological data and scientific literature presented in support of the DNR/IEPA joint recommendations. PC 96 at 11. DNR therefore urges the Board to use "extreme caution" in applying the studies relied upon by IAWA "to support broad, statewide conclusions for all waters applicable to these proposed amendments to the [DO] standard." *Id*. at 12.

Given these DNR concerns with IAWA's proposal, DNR:

> became involved in this proceeding because State law provides that the Department owns all aquatic life within our state boundaries and is responsible for regulating and managing these natural resources. PC 96 at 2; *see also* Tr.4 at 40.

According to DNR, there clearly is a need to protect DO-sensitive species and species that are DO-sensitive during early life stages, including the NCD required 30-day period for larval development. PC 96 at 12. DNR explains that after the August 25, 2005 hearing, IEPA and DNR jointly developed a set of recommendations to address the "shortcomings" of IAWA's proposal. *Id*. at 2.

DNR and IEPA state that they used USEPA's NCD as a "foundation from which to interpret and incorporate more-recent information specifically applicable to the [DO] needs of aquatic life in Illinois waters." Exh. 23 at 2; *see also* Tr.4 at 33. DNR asserts that the joint DNR/IEPA proposal makes "critical enhancements" to the IAWA proposal in four areas by including:

1. Two levels of numeric standards (instead of IAWA's one level) to protect identified DO-sensitive organisms in specified Illinois waters ("Level 1" (enhanced protection) and "Level 2" (Exh. 23, Figure 1));

2. An additional 30-day period needed to protect early life stages of fish (*i.e.*, March through July rather than IAWA's period of March through June);

3. A narrative standard to protect waters that "naturally cannot achieve consistently higher levels of [DO] such as wetlands, sloughs, river backwaters, and lakes and reservoirs below the thermocline" (IAWA's proposed DO standards would "apply universally to all General Use waters" (Exh. 23 at 2, citing Exh. 1)); and

4. 30-day chronic DO standards (*i.e.*, daily mean averaged over 30 days), consistent with USEPA's NCD and absent from the IAWA proposal, that apply to both levels of numeric standards for DO. PC 96 at 2; *see also* PC 103 at 2; Exh. 23 at 2-3, Figure 1; Tr.4 at 32-34, 46.

IEPA describes the first of the four above components as including both a "base condition or a base dissolved oxygen standard patterned after the structure recommended in USEPA's [NCD] and generally protective of a full and diverse aquatic community" (Tr.4 at 24, Frevert) and an incrementally "higher level that provides enhanced protection in waters that have organisms especially sensitive to low [DO] levels" (PC 103 at 2). According to Cross of DNR:

> A fundamental aspect of this position is that [DO] profiles naturally vary within general use waters throughout Illinois; therefore a single uniform standard is not appropriate given the available science today. Tr.4 at 40.

DNR maintains that the joint proposal's narrative standard (item 3 above) and 30-day chronic standards (item 4 above) "provide essential components to the [DO] standards necessary for USEPA approval." PC 96 at 13. Since the submittal of the joint DNR/IEPA proposal, DNR notes, IAWA has generally accepted the joint-agency proposal's narrative standard and the 30-day chronic standards. *Id*. at 2. As noted, in PC 102 filed on December 20, 2006, IAWA asks that the Board adopt a 30-day average standard of 5.5 mg/L for non-early life stages and the narrative standard, both as proposed by DNR and IEPA. PC 102 at 1. According to DNR, the remaining differences between IAWA and the State agencies consist of whether there should be separate numeric standards to protect DO-sensitive organisms (item 1 above) and whether July should be included among the months with more stringent standards to protect early life stages of fish (item 2 above). PC 96 at 2; *see also* PC 103 at 2-3, n.1.

DNR states that the joint-agency proposal is based on:

> The only statewide dataset in this record (biological data for fish and macroinvertebrates from 1,110 sampling sites),
>
> The use of scientifically valid and sound processes for developing the joint recommendations (described in detail within Exhibit #23),
>
> Compilation of spawning periods for Illinois fish species representing nearly 100 years of data and information from six of the foremost authoritative texts on the subject,
>
> Expertise from field biologists in both Illinois EPA and Illinois DNR, representing within IDNR alone, over 218 years of aquatic biology expertise in Illinois,
>
> Published scientific research from over 30 scientific literature sources contained within the Technical Support Document, Exhibit #23. PC 96 at 12.

DNR maintains that the joint proposal with IEPA is "not unnecessarily over protective." PC 96 at 10, quoting Tr.4 at 46-47. IEPA describes the joint-agency proposal as "scientifically sound and defensible in light of the current available information on the [DO] needs of aquatic life in Illinois." PC 103 at 16.

Besides amendments to Section 302.206, the State agencies seek to add a new definition to Section 302.100 and add a list of "Stream Segments for Enhanced Dissolved Oxygen Protection" as Appendix D to Part 302. The proposed Appendix D is 37-pages long and designates stream segments by basin name, segment name, segment number, end points by latitude and longitude, and county. For example, the first two of the stream segments proposed for enhanced DO protection appear as follows in Appendix D:

BASIN NAME / Segment Name / Segment No.	End Points	Latitude	Longitude	COUNTY
Illinois				
Aux Sable Creek				
239				
	start	41.3982125891033	-88.3307365155966	GRUNDY
	end	41.5221610266554	-88.3153074461322	KENDALL
Baker Creek				
123				
	start	41.0993159446094	-87.833779044559	KANKAKEE
	end	41.1187483257075	-87.7916507082604	KANKAKEE

Exh. 21; PC 103 at 9.

The proposal to have designated stream segments receive enhanced DO standards are further discussed later in this opinion.

The amendments proposed by DNR and IEPA to Sections 302.100 and 302.206 are provided here, with proposed additions underlined and proposed deletions stricken through:

302.100 Definitions

"thermocline" means the plane of maximum rate of decrease of temperature with respect to depth in a thermally stratified body of water.

Section 302.206 Dissolved Oxygen

General use waters shall maintain dissolved oxygen concentrations at or above the minimum values contained in subsections (a), (b) and (c) of this Section.

a. General use waters at all locations shall maintain sufficient dissolved oxygen concentrations to prevent offensive conditions as required in Section 302.203 of this Part.[8] Quiescent and isolated sectors of General Use waters including but not limited to wetlands, sloughs, backwaters and below the thermocline in lakes and reservoirs shall be maintained at sufficient dissolved oxygen concentrations to support their natural ecological functions and resident aquatic communities.

b. Except in those waters identified in Appendix D of this Part, the dissolved oxygen concentration in the main body of all streams, in the water above the thermocline of thermally stratified lakes and reservoirs, and in the entire water column of unstratified lakes and reservoirs shall not be less than the following:

1. During the period of March through July,

A. 5.0 mg/l at any time; and

B. 6.0 mg/l as a daily mean averaged over 7 days.

2. During the period of August through February,

A. 3.5 mg/l at any time;

B. 4.0 mg/l as a daily minimum averaged over 7 days and;

[8] Section 302.203 reads in its entirety: "Waters of the State shall be free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth, color or turbidity of other than natural origin. The allowed mixing provisions of Section 302.102 shall not be used to comply with the provisions of this Section." 35 Ill. Adm. Code 302.203.

C. 5.5 mg/l as a daily mean averaged over 30 days.

c. The dissolved oxygen concentration in all sectors within the main body of all streams identified in Appendix D of this Part shall not be less than:

1. During the period of March through July,

A. 5.0 mg/l at any time; and

B. 6.25 mg/l as a daily mean averaged over 7 days.

2. During the period of August through February,

A. 4.0 mg/l at any time;

B. 4.5 mg/l as a daily minimum averaged over 7 days; and

C. 6.0 mg/l as a daily mean averaged over 30 days.

d. Assessing attainment of dissolved oxygen mean and minimum values.

1. Daily mean is the arithmetic mean of dissolved oxygen values measured in a single 24-hour calendar day.

2. Daily minimum is the minimum dissolved oxygen value as measured in a single 24-hour calendar day.

3. The measurements of dissolved oxygen used to determine attainment or lack of attainment with any of the dissolved oxygen standards in this Section must assure daily minima and daily means that represent the true daily minima and daily means.

4. The dissolved oxygen value used in calculating or determining any daily mean or daily minimum should not exceed the air-equilibrated value.

~~Dissolved oxygen (STORET number 00300) shall not be less than 6 .0 during at least 16 hours of any 24 hour period, nor less than 5.0 at any time.~~ Exh. 20; PC 103 at 7-9.

The Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club support the DNR/IEPA proposal, but suggest one modification to address concerns about oxygen saturation levels. PC 101 at 1, 7, 11. The one modification suggested by these environmental groups is to include a minimum DO level of 6.5 mg/L when water temperature is 10°C or below.

To arrive at the 6.5 mg/ DO value, the environmental groups rely on the testimony of Dr. Thomas Murphy, Professor *Emeritus* of Chemistry, DePaul University. *Id.* at 7, citing Tr.5 at 52.

For the Illinois Chapter of the American Fisheries Society, which "represents more than 250 fisheries and aquatic scientists within the state of Illinois," it is the "overwhelming consensus of the Chapter to fully support" the joint recommendations of DNR and IEPA. PC 100 at 1.

OVERVIEW OF RESPONSES TO THE DNR/IEPA PROPOSAL

IAWA states that the joint DNR/IEPA proposal differs from IAWA's proposal in three areas. First, the joint proposal extends the early life stage to July 31, rather than concluding on June 30 as proposed by IAWA. Second, the joint proposal includes higher ambient DO levels for proposed "enhanced" waters. Third, the joint proposal includes a narrative standard to address offensive conditions and account for quiescent and isolated sections of general use waters. PC 102 at 7-8. IAWA expresses serious concerns about "enhanced" waters and extending the early life stage period to the end of July. As stated above, IAWA has amended its proposal to include the 30-day average DO limit for other life stages, along with the narrative standard. *Id*. at 15

IAWA argues that the proposed list of enhanced water segments is not based on any data for DO, temperature, or habitat. PC 102 at 9. IAWA asserts that the proposed enhanced water list includes a number of segments that are presently on the federal Clean Water Act Section 303(d) list as impaired for DO. *Id*. at 9. IAWA maintains that Dr. Garvey's analysis of DO data, including grab samples from 1993 through 2003 and semi-continuous data from 2004 and 2005, shows that median DO concentrations in streams identified for enhanced protection decline during June through August to a benchmark level below 5 mg/L. *Id*. at 11.

Regarding IEPA's position that 2005 sampling data is not representative because of severe drought, IAWA notes that the drought conditions actually provided a worst-case scenario for assessing DO conditions in streams targeted for enhanced protection. Dr. Garvey's analysis shows that the IAWA's proposed standard of 3.5 mg/L was rarely violated in the streams. PC 102 at 11-12. According to IAWA, the joint proposal for a two-tiered system is premature and unwarranted by the data. *Id.* at 15-16.

IAWA asserts that its proposed 7-day minimum average of 4.0 mg/L, as it would apply in July, yields more potential violations than the joint DNR/IEPA proposal's 7-day minimum average as it would apply in August, indicating IAWA's standard's greater sensitivity to low DO conditions. *Id.* at 12.

Lanyon of MWRDGC recommends a standard identification, such as river miles, for streams selected to have enhanced DO standards. Exh. 25 at 12; Tr.4 at 155. Lanyon also cautioned that standards must be consistent for rivers shared with neighboring states. Exh. 25 at 12. In the Illinois River, Lanyon suggests there may be some enforcement ambiguity, pointing to one segment proposed to meet the higher DO standards while the up and downstream segments are not. *Id*. at 13.

Dr. Garvey also reviewed a November 12, 2004 draft report generated by Edward Rankin of the Center for Applied Bioassessment and Biocriteria in Ohio. Exh. 16, Att. 4. Dr. Garvey testified that the Rankin report emerged during stakeholder deliberations as the result of input from USEPA. According to Dr. Garvey, the Rankin survey shows a pronounced lack of correlation between DO and biological integrity, as quantified for fish or macroinvertebrates. However, at hearing, Dr. Garvey observed that the Rankin report does seem to indicate a weak trend between DO and habitat quality in the studied system, but he stressed the difficulty in assigning causality to DO as the major factor influencing the organisms in that particular system. Tr.3 at 61-62. Based on the Rankin survey, Dr. Garvey asserts that warmwater streams considered to be of high biological integrity in Ohio would violate the current Illinois DO standard, but probably not IAWA's proposed DO standard. Exh. 16 at 4.

Dr. Garvey expressed concern over the DNR/IEPA approach to selecting stream segments for enhanced DO protection. Dr. Garvey states that the State agencies "recommended an 'enhanced oxygen' tier for streams that contain fishes and invertebrates that were found by Ohio Environmental Protection Agency to occur in Ohio waters with high average oxygen concentrations." Exh. 35 at 3. The selection of stream segments "based solely on associations between aquatic organisms and average oxygen concentrations ignores other potential causal factors such as habitat quality, gradient, and temperature," according to Dr. Garvey. *Id*. Dr. Garvey then concludes:

> Thus, coining these organisms as "oxygen sensitive" and then using them to select enhanced tier waters may be completely spurious. Only through experiments that establish causality between oxygen tolerance and fish life processes can tolerance be assessed. *** Recall, these investigators [Smale and Rabeni] used a combination of lab assays and surveys to develop an index of oxygen sensitivity in Missouri streams. *Id*. at 3-4.

It is Dr. Garvey's view that "it appears that many of these streams, particularly the Fox River, fail to provide adequate oxygen for aquatic life during part of the summer." Exh. 35 at 10. Dr Garvey continues: "This causes me to question the linkage between the aquatic assemblages used to select the sites for enhanced status and oxygen needs of the resident organisms." *Id*.

Considering the data on breeding periods for fish, Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club support a standard that protects July spawning. PC 101 at 1, 3. These environmental groups point out that the argument made by IAWA for not extending the standard through July is not supported by any economic data showing it would be cheaper for dischargers. *Id*. at 4.

For low DO-sensitive species, Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club agree with the DNR/IEPA assessment of the stream segment lines. PC 101 at 1, 5. These environmental groups state that although low DO conditions may be found at a few sites in streams with DO-sensitive species, the whole water body should not be allowed to fall to that DO level. *Id*. at 5. According to the environmental groups, the presence of DO-sensitive fish in reaches with low DO for some period does not prove that the population is not already under stress and would not be affected if the entire segment were "hit" with low DO levels constantly or in combination with other stressors. *Id*. at 6.

The Illinois Chapter of the American Fisheries Society states that the IAWA proposal would "inadequately protect aquatic life throughout the range of aquatic habitats and environmental conditions present in Illinois." PC 100 at 1. The Illinois Chapter maintains that the DNR/IEPA proposal, in contrast, follows NCD protocol:

> for safeguarding organisms known to be sensitive to dissolved oxygen as well as early life stages (eggs, embryos, larvae) of *all* fish and aquatic invertebrates. *Id*. (emphasis in original).

According to the Illinois Chapter of the American Fisheries Society, only the DNR/IEPA proposal "recognizes the state's vast biological diversity and the resultant need to stratify water quality protection standards with regard to space and time." *Id*. at 2. The Illinois Chapter "fully supports the approach, methodology and resulting recommendations crafted by the two agencies with statutory responsibility for the protection of Illinois' fisheries and aquatic resources" and urges the Board to adopt the DNR/IEPA proposal. *Id*.

IAWA PROPOSAL

An Assessment of National and Illinois Dissolved Oxygen Water Quality Criteria (Garvey-Whiles, April 2004)

In support of its proposal to revise Illinois' current DO standard, IAWA submitted a report entitled "*An Assessment of National and Illinois Dissolved Oxygen Water Quality Criteria*" (Garvey-Whiles, April 2004) ("Assessment" or "Garvey-Whiles report"). The Assessment, which was prepared by Drs. Garvey and Whiles, includes a review of current literature on DO in natural systems and potential effects of hypoxia (low DO) on aquatic life, and an evaluation of the current Illinois DO standard and the national criteria. Further, the Assessment sets forth recommendations for reevaluating and modifying the current Illinois DO standard based on published research concerning natural fluctuations in aquatic systems and physiological tolerances of native aquatic life. Exh.1 at 6. The Assessment is summarized below.

Importance of DO in Freshwater Habitats

The Assessment notes that DO is a critical resource in fresh water because: DO is essential to aquatic organisms for aerobic respiration; it is less abundant in aquatic habitats due to its low solubility; and DO availability to aquatic organisms is influenced by a number of biotic and abiotic factors, such as metabolic processes, temperature, salinity, atmospheric and water pressure, and diffusion. Exh. 1 at 6. The levels of DO in freshwater habitats are affected by natural and anthropogenic activities. Particularly, activities resulting in discharges of nutrients and sediments, and thermal discharges lead to reduced oxygen concentrations. As such, regulatory agencies focus on DO levels in setting standards and monitoring requirements, since DO is a critical limiting resource in freshwater habitats and DO levels are influenced by human activities. *Id.* at 7-8. While there is general agreement that DO levels are an important component of water quality standards, the Assessment contends that there is less consensus when establishing standards for a given region and habitat or determining violations of the standards. *Id.* at 8.

Warmwater Organisms

The Assessment states that with the exception of certain species such as smallmouth bass, fish in warmwater systems are tolerant of temporary periods of low DO. Exh. 1 at 9, citing Chapman 1986 (NCD), Smale and Rabeni 1995a. However, some macroinvertebrates, such as burrowing mayflies and freshwater mussels are far less tolerant of prolonged exposure to hypoxic conditions than most fish. *Id.* at 9-10, citing Li-Yen 1998, Chapman 1986 (NCD), Winter *et al*. 1996, Corkum *et al*. 1997. The Assessment maintains that many *physiological* responses within the aquatic organisms occur to ensure survival under hypoxic conditions. These responses include increased ventilation to increase oxygen transfer across the respiratory surface, reduction of activity and metabolism, and reliance on anaerobic glycolysis. *Id.* at 11, citing Beamish 1964, Fernandes *et al*. 1995, MacCormick *et al*. 2003, Crocker and Cech 1997, Hagerman 1998, Childress and Siebel 1998, and Wu 2002.

The Garvey-Whiles report also notes that aquatic organisms have *behavioral* responses to hypoxic conditions. Organisms move from areas of low DO levels to areas with higher DO concentrations. Some stream fish and amphipods move towards the air-water interface during low DO conditions. Exh. 1 at 12, citing Henry and Danielopol 1998. Additionally, the Assessment states that early life stages of aquatic organisms are the most sensitive to hypoxic conditions. *Id.*, citing Chapman 1986 (NCD). The ability to tolerate hypoxia improves in aquatic organisms only upon formation of oxygen regulating structures such as gills and associated respiratory behavior. *Id.*, citing Jobling 1995. Aquatic species also adapt to cope with low DO conditions in nesting areas, according to the Assessment. These adaptations include nest fanning, and semibuoyant eggs or adhesive eggs that attach to vegetation. *Id.* at 13, citing Hale *et al*. 2003, Corbett and Powles 1986.

The Assessment maintains that the manner by which these adaptations allow aquatic species to "cope with natural cycles and spatial heterogeneity of dissolved oxygen must be considered when developing specific criteria." Exh. 1 at 13. Further, according to the Assessment:

> Because most species in Illinois spawn in spring when flow rates are high and temperature-induced hypoxia is low, seasonal fluctuations in dissolved oxygen must also be factored into the evaluation of dissolved oxygen criteria for Illinois. *Id*.

Aquatic Organisms Responses To Oxygen Stress

The Assessment states that a review of studies pertaining to warmwater fish species in Illinois indicates that adults and juveniles of most species survive DO levels that occasionally decline below 3 mg/L. Exh. 1 at 13, citing Chapman 1986 (NCD). The Assessment notes that the critical DO concentration, which is defined as the oxygen concentration at which ventilation ceases, for 35 fish species that inhabit small warmwater streams ranged from 0.49 mg/L to 1.5

mg/L. *Id.*, citing Smale and Rabeni 1995a. Based on this critical DO concentration range, the Garvey-Whiles report contends that the 1-day minimum of 3.0 mg/L DO recommended by the NCD for adult life stage warmwater fish is sufficiently protective of stream fish assemblages. *Id.* at 15.

The Assessment notes that during early life stages, tolerance of short-term exposure to hypoxia declined from embryonic to larval stages. Exh. 1 at 15, citing Peterka and Kent 1976. Many fish become free swimming upon transforming to larvae, and thus may not require high tolerance to low DO conditions in benthic spawning areas. However, species with benthic larvae would still be sensitive to chronic low DO levels, according to the Assessment. A non-linear regression analysis performed by Drs. Garvey and Whiles using Dr. Chapman's data (Chapman 1986 (NCD)) found the DO concentration at which 50% survival occurred (similar to LC50 value) for tolerant species to be 2.8 mg/L, and for intolerant species to be 4.3 mg/L. *Id.* at 16. A second analysis, done by using the two-dimensional Kolmogorov-Smirnov test, resulted in threshold DO concentrations of 3.72 mg/L and 3.75 mg/L for tolerant and intolerant species, respectively. Based on these analyses, the Assessment states that a conservative interpretation would be that survival of intolerant embryos and larvae begin to decline below 4.3 mg/L, and similar effects occur for tolerant species below 3.7 mg/L. *Id.*

According to the Assessment, low DO levels can reduce growth by reducing foraging behavior and increasing metabolic costs. Exh. 1 at 17. A number of studies have shown significant decline in growth at lower DO levels. *Id.* at 17, citing JRB Associates 1984. The Assessment notes, however, that extrapolating growth results from laboratory studies to the field is problematic because of differences in food availability. *Id.*, citing Chapman 1986 (NCD). The Assessment further notes that while there is not much information on the effect of low DO levels on reproductive viability, hypoxia has been shown to be an endocrine disruptor affecting fish reproductive success. *Id.* at 18, citing Wu *et al*. 2003. The Assessment states that a majority of Illinois warmwater fish species spawn between spring and early summer (March through June). The Garvey-Whiles report maintains that this time period, which corresponds to higher DO levels in streams and lakes, allows young fish to overlap with a spring pulse in primary production, and provides adequate time for fish to become large and survive the winter. *Id.* at 19, citing Garvey *et al*. 1998b. The Assessment states that a few species that continue to spawn through the summer must have adaptations to reproduce successfully. *Id.*

Regarding macroinvertebrates, the Assessment asserts that the communities and assemblages in habitats with low DO levels are dominated by taxa that breathe atmospheric oxygen through respiratory tubes or the use of transportable air stores. Exh. 1 at 19. Taxa associated with highly oxygenated environments use tracheal gills for respiration. They are usually underrepresented or absent in habitats with low DO, according to the Assessment. The distribution patterns of macroinvertebrates have been the basis for numerous macroinvertebrate-based biomonitoring programs because they are fairly consistent and good indicators of increasing organic pollution and associated low DO levels. *Id.* at 20, citing Hilsenhoff 1987, Hilsenoff 1988, Lenat 1993, Barbour *et al*. 1999.

According to the Garvey-Whiles report, because of the great diversity of freshwater invertebrates, there is not much information about their oxygen requirements and tolerances. A number of studies dealing with lethal effects for many taxa indicate a range of lethal DO minima from less than 0.6 mg/L for the midge *Tanytarsus* to 5.2 mg/L for an ephemerellid mayfly, and a DO96-hou LC-50 concentration between 3 to 4 mg/L for about half the insects studied. Exh. 1 at 20, citing Chapman 1986 (NCD). The assessment also notes that freshwater mussels exhibit a widespread range of tolerances to hypoxia. In addition to lethal effects, low DO levels result in reduced growth rates in macroinvetebrates because of decreased aerobic respiration rates and the use of energy reserves. *Id.* at 21, citing Fox and Sidney 1953, Erikson *et al*. 1996.

Dissolved Oxygen Variation in Natural Systems

The Assessment asserts that DO concentrations fluctuate even in pristine natural systems, causing organisms to move or tolerate occasional occurrence of hypoxia. Exh. 1 at 22. While most species have some adaptations to allow them to tolerate occasional low DO, others are specifically adapted to survive in areas of chronically low DO. *Id.* at 22, citing Hamburger *et al*. 2000, MacNeil *et al*. 2001.

The Assessment states that the typical occurrence of hypoxia in natural systems happens in stratified lakes during the summer when the lower strata of lakes become depleted of oxygen. Research has confirmed, continues the Assessment, that hypoxia in stratified lakes severely restricts habitat for fish and other organisms. *Id.* at 23, citing Nurenberg 1995a, Nurenbergb, 2002. The Assessment notes that suboptimal temperatures and low DO during summer months may cause "summer kills" of fish that have poor tolerance to hypoxia. Also, "winterkills" may occur under snow covered ice in lakes because of oxygen depletion caused by natural biologically processes. *Id.*

The Assessment states the while some studies have tried to link the oxygen-driven distribution of organisms in the field with laboratory-derived critical minima, there is no current published literature that explicitly links the distribution of organisms to the warmwater criteria recommended by the NCD or the Illinois standard. Exh. 1 at 25. A study used a laboratory-derived oxygen minima to generate a hypoxia tolerance index for a number of headwater streams and found that the hypoxia tolerance index had a strong correlation with the mean DO concentration. *Id.* at 25-26, citing Rabeni *et al*. 1995a and 1995b. This research provides a framework for characterizing streams by fish response to expected oxygen minima. *Id.* at 26. The Assessment notes that while the mechanisms underlying DO fluctuations have been understood, there is a need to document the spatial extent, duration, frequency, and magnitude of DO fluctuations. *Id*. at 26.

National and Illinois DO Standards

The Garvey-Whiles report states that USEPA's NCD recommends criteria based on a two-concentration structure, with both a mean and a minimum for both coldwater and warmwater systems. Exh. 1 at 8, citing Chapman 1986 (NCD). The criteria, which are further divided into early life stages and other life stages, reflect DO levels that are 0.5 mg/L above the levels that would cause impairment. Therefore, each criterion value is the threshold below which there may be some impairment. *Id.* at 27. The NCD recommends average levels over a period of seven days for early life stages of fish, when they are very sensitive to oxygen stress. A longer averaging period of 30 days is recommended for other life stages. *Id.* at 28. The daily minimum values are recommended to protect against acute stress or mortality of sensitive species. *Id.* The NCD also addresses unique problems posed by point source discharges in which DO concentrations can be manipulated. *Id.* at 29.

The Assessment notes that the Illinois DO standard was adopted in the 1970's. This standard, which is based on a simple minimum allowable concentration, does not address natural cycling of DO and it is not supported by recent scientific data on responses of aquatic life to hypoxic conditions, according to the Garvey-Whiles report. Exh. 1 at 9. The current Illinois standard does not differentiate between coldwater and warmwater organisms and is based on a single minimum, "rather than acknowledging that fluctuations may occur, necessitating inclusion of an average." *Id.* at 30.

Illinois Waters

The Garvey-Whiles report notes that most inland waters in Illinois are dominated by warmwater, non-salmonid faunal assemblages. While a formal definition of "warmwater systems" is still lacking, the Assessment defines warmwater systems as those that are typically diverse, centrarchid-dominated, and common in the midwestern and southern United States. Exh. 1 at 9, citing Magnuson *et al*. 1979b. The Assessment states that Illinois waters are designated by IEPA under several use categories, including aquatic life, primary contact, secondary contact, public water supply, fish consumption, and indigenous aquatic life. *Id.* at 31, citing IEPA 2002.

The Assessment focuses on the applicability of the DO standard for the State's aquatic life use category, which is "intended to provide full support for aquatic organisms." Exh. 1 at 31. The Assessment maintains that Illinois uses a valid approach to determine whether a waterbody meets the aquatic life designation. This approach, continues the Assessment, relies on the relevant biotic indicator, such as the Index of Biotic Integrity (IBI) for fish or the Macroinvertebrate Biotic Index (MBI), to assess the overall effects of water and habitat quality, and identifies impairments based on compliance with DO standards. Exh. 1 at 31-32, citing Karr 1981, Karr *et al*. 1986, Bertrand *et al*. 1996, IEPA 1994. The Assessment notes that while current IEPA methods for assessing health and impairment are adequate, the Illinois DO standards need to be refined. Specifically, the Assessment asserts that the current DO standards based on daily minima are too conservative and should be modified to reflect actual local conditions. *Id* at 35.

Garvey-Whiles Recommendations

The Garvey-Whiles report recommends that the Board adopt the NCD warmwater criteria with some modifications. During early life stages, the Assessment recommends a daily minimum DO level of 5.0 mg/L and a 7-day mean of 6.0 mg/L. The Assessment suggests March 1 through June 30 as the time period for the early life stages. Exh. 1 at 36. For the other life stages (*i.e.*, July 1 through February 28 or 29), the Assessment recommends a daily minimum DO level of 3.5 mg/L and a 7-day mean minimum of 4.0 mg/L. The Assessment asserts that its daily minimum DO level of 3.5 mg/L, which is higher than the 3.0 mg/L level recommended for other life stages by the NCD, is based on reevaluating the NCD to account for the adult life stages and spawning times for common warmwater fish taxa in Illinois. *Id.* at 37.

Dr. Garvey later testified further about the proposed two-season DO standard. During March through June, "when the majority of early life stages of many fishes and other aquatic organisms are produced," he recommends a DO concentration that provides "sufficient oxygen to support the metabolic needs of eggs and larvae." Exh. 35 at 2. During this time of year, according to Dr. Garvey, "streams are typically flowing, primary productivity is accelerating but not peaking, and temperatures are cool to moderate." *Id*. Therefore, Dr. Garvey continued, high DO concentrations are expected to be available to young aquatic organisms. Dr. Garvey further states that "[t]he literature and growing state-wide oxygen data set demonstrate that, for warm-water, low-gradient systems common in Illinois, concentrations should not decline below 5 mg/L and weekly averages should not decline below 6 mg/L." *Id*.

Another deviation from the NCD is the Assessment's exclusion of a 30-day mean DO criterion for other life stages. The Assessment maintains that a shorter window of time, ranging from 1-7 days, better captures responses of all life stages to changes in the DO level, and is more "biologically relevant." Exh. 1 at 35. Dr. Garvey later commented on the non-spring, 30-day mean of 5.5 mg/L advocated by NCD. According to Dr. Garvey, applying the 30-day mean generated many (23%) violations in a high-quality Illinois stream, Lusk Creek, and adding this standard may generate unmerited violations. Exh. 16 at 4. He says that the biological relevance of the 30-day mean DO standard remains unclear. *Id.* at 7. Dr. Garvey ultimately recommends a 30-day running average of 5.5 mg/L DO as recommended in the NCD, even though it has "little biological support" in his view. Exh. 35 at 2.

In addition to recommending the DO criteria described above, the Assessment includes recommendations on DO monitoring. In the case of manipulatable discharges, measurements should be taken at the zone of mixing and at an area beyond the direct influence of mixing, according to the assessment. Exh. 1 at 38. When diel fluctuations are extreme, the Assessment notes that monitoring should focus on daily minima. Further, detecting violations of daily minima using infrequent spot checks may be a better indicator of larger problems than those measured with a continuous data logger. *Id.* The Assessment recommends that DO measurements be taken in pool or run habitats in the water column. DO measurements should not be taken in riffles or at sediment/water interface, according to the Assessment. *Id.* at 39.

The Assessment clarifies that its recommendations are meant for only warmwater systems in Illinois and should not be applied to Lake Michigan, which is a large-scale, native coldwater fisheries system. The recommendations are also not appropriate for wetlands. Exh. 1 at 39-40. The Assessment states that there is a need for additional research on the specific relationship between biotic integrity, DO, and other water quality and habitat factors. Any research data that establishes relationships between biotic integrity and DO levels in Illinois streams will allow for the development of physiologically based hypoxic indices, which may be helpful in the monitoring and assessment of surface water habitats in Illinois. *Id.* at 41.

Dr. Garvey's Analysis of USGS and IEPA DO Data From Eight Illinois Streams (2001-2003)

Dr. Garvey testified that he applied Illinois' current DO standard and IAWA's proposed DO standard to eight Illinois streams for which extensive DO and temperature monitoring data were collected by the United States Geologic Survey (USGS) and IEPA. Exh. 9 at 2. His analysis is summarized in the report entitled "*Long Term Dynamics of Oxygen and Temperature in Illinois Streams*" (Garvey 2004), which is discussed in detail below. *See id.*, Att. 1. Dr. Garvey notes that his report was reviewed by USGS and IEPA staff, as well as by Dr. Whiles of Southern Illinois University, and reflects the comments of reviewers. *Id.*

Dr. Garvey asserts that the USGS-IEPA "long-term data are unprecedented" and that he is not aware of any similarly comprehensive dataset for streams of the Midwestern United States. Exh. 9 at 2-3. USGS and IEPA collected semi-continuous DO and temperature data for eight stream reaches during the late summer of 2001 through the fall of 2003. *Id.* at 3. The monitored stream reaches were the North Fork Vermillion River near Bismarck, the Middle Fork Vermillion River near Oakwood, the Vermillion River near Danville, Lusk Creek near Edyville, the Mazon River near Coal City, Rayse Creek near Waltonville, Salt Creek near Western Springs, and the Illinois River near Valley City. Dr. Garvey notes that the stream segments varied widely in physical characteristics, surrounding land use and latitude, and five of the stream segments are currently on the most recent federal Clean Water Act Section 303(d) impaired list. *Id.*

Dr. Garvey contends that the results of the analysis uphold the conclusion of the Garvey-Whiles report. He states that the DO levels in all eight streams violated Illinois' current DO standard. The frequency with which violations occurred ranged from 1% of the days to 65% of the days. Exh. 9 at 3. The violations occurred in unimpaired, unlisted stream segments, as well as in impaired Section 303(d)-listed stream segments. Dr. Garvey notes that it is generally expected that nutrient enrichment is the primary factor affecting dissolved oxygen dynamics. The monitoring data for Salt Creek, however, indicate that other factors such as stream physical habitat may also affect DO dynamics. *Id.* at 4.

Applying IAWA's proposed DO standard, Dr. Garvey states that the number of violations in unimpaired streams, such as Lusk Creek, is greatly reduced, while still capturing violations in impaired streams. Exh. 9 at 4. Dr. Garvey notes that the Lusk Creek segment, which is in the Lusk Creek Wilderness area of the Shawnee National Forest, is considered pristine with a highly regarded, intact, and diverse fish and macroinvertebrate assemblage. According to Dr. Garvey, the application of IAWA's proposed DO standard to the monitoring data resulted in an increase in the frequency of violations in two of the severely oxygen-impaired streams and indicated the time period when DO problems occur. *Id.*

Dr. Garvey states that the temperature data for Lusk Creek indicate that DO concentrations were lowest at intermediate summer temperatures and that there were no substantive differences in temperatures among streams across the north-south gradient of the State. Exh. 9 at 5. This, according to Dr. Garvey, suggests that it is not the seasonal maximum stream temperatures that reduce DO concentrations. He contends that the temperature data show that IAWA's proposed DO standard effectively captures oxygen dynamics occurring in natural, fully-functioning Illinois streams, such as Lusk Creek. *Id*.

Dr. Garvey also notes that habitat modification is a significant factor affecting resident species assemblages. Specifically, in pooled areas of streams where the frequency of violations of Illinois current DO standard is higher than in open reaches, Dr. Garvey argues that altering or degrading species composition results from changes in river habitat and oxygen dynamics, more so than just low DO concentrations. Exh. 9 at 6. He further states that the data for the eight monitored streams show no relationship between biotic integrity scores and oxygen minima as estimated by frequency of violations of either the current or IAWA-proposed standards. *Id.* The biotic integrity scores are more aligned with habitat quality factors such as stream's substrate, habitat diversity, and riparian vegetation, suggesting that habitat quality rather than DO primarily influences species composition. *Id*.

Finally, Dr. Garvey addressed the issue of early life stages, which IAWA proposes for March through June, as compared to the early life stages time period under Illinois' current ammonia standards, which extends through October. Dr. Garvey maintains that the proposed early life stage time period is appropriate for DO because the dynamics of DO and total ammonia differ in streams. Exh. 9 at 7. The total ammonia concentrations depend on discharge and do not vary on a seasonal basis, according to Dr. Garvey. Further, the toxicity of total ammonia increases with increasing temperature, requiring the application of the more stringent standard for a longer time period. Dr. Garvey also notes that according to Dr. Chapman, author of USEPA's NCD for DO, the timing of seasonal standards should be based on the experts' working knowledge of the fish community in the particular state. *Id.* at 7-8.

In sum, Dr. Garvey asserts that results of the eight-stream monitoring data analysis confirm the findings of the Garvey-Whiles report. He states that IAWA's proposed DO standards may be applied statewide. Dr. Garvey recommends, however, that regional standards or stream classifications be established eventually, giving consideration to biotic integrity, habitat quality, and water quality goals. Exh. 9 at 9.

***Long Term Dynamics of Oxygen and Temperature In Illinois Streams* (Garvey 2004)**

As stated above, the Garvey report (2004) details the evaluation of how Illinois' current and IAWA's proposed DO standards characterize streams in the State relative to season, stream quality, and geographic location. Exh. 9, Att. 1 at 3. Dr. Garvey analyzed water quality monitoring data for DO and temperature collected by USGS and IEPA in eight stream segments over a two-year period, as noted above. *Id*. IEPA and USGS measured temperature and DO at each stream site every 30 minutes during the late summer of 2001 through the fall of 2003. Using this data, the daily averages and daily minima were calculated for each stream by Dr. Garvey. For Illinois' current DO standard, a violation was determined by calculating the hours that the DO concentration was less than 5 mg/L. Similarly, for IAWA's proposed DO standard, daily minima, 7-day mean, and 7-day mean minima were calculated for each stream. The seven-day averages were determined as running averages across 7 days. *Id*. at 6-7. The characteristics of the monitored river segments are summarized in the table below. *Id.* at 3-6.

Characteristics of Eight Monitored Stream Segments (Garvey 2004)

River Segment	Location	Substrate	Width x Depth (m) at Logger	Stream Surface Area (km^2)	Drainage Area	Annual Mean Stream Flow (m^3/s)	303(d) Listed
North Fork Vermillion	East-Central Ill.	Gravel riffle with vegetation	20 x 0.3-1.0	1.14	Agricultural	8.8	Yes - pathogens
Middle Fork vermillion	East-Central Ill.	Gravel riffle with vegetation	30 x 1	5.4	Agricultural	11.4	No
Vermillion	East-Central Ill.	Gravel and sand	50 x 2-3	24.3	Agricultural	28.9	No
Lusk Creek	Southeastern Ill.	Sand, gravel cobble and bedrock	10 x 2	0.22	Forested (76%), Agricultural	1.7	No
Mazon River	North-Central Ill.	Rock and gravel riffle with vegetation in channel	50 x	17	Agricultural (94%), Urban (4%)	9.9	Yes – PCBs and pathogens
Rayse Creek	Southern Ill.	Not provided	6 x >1	0.62	Agricultural, Forested (17%)	2.5	Yes – nutrients, low pH, enrichment, pathogens, and suspended solids
Salt Creek	Northern	Partial riffle, heavy summer aquatic growth	23 x	7	Urban	3.8	Yes – nutrients, salinity, and pathogens
Illinois River	East-central	Not provided	200 x 8	1003	Forested (50%) Urban (50%)	643.5	Yes – metal and PCBs

Exh. 9, Att. 1 at 3-6.

The results indicate that DO levels declined below the current Illinois standard in all stream segments during the summer, with the frequency of violations ranging from 2% to 65% of the days during the two-year monitoring period. The DO pattern did not indicate any correlation with latitude, stream quality, or stream size, according to Dr. Garvey. Exh. 9, Att. 1 at 7. Regarding temperature, the differences in monthly averages among all streams were less than 4^{o}C during the summer. Dr. Garvey states that although temperature differences were more pronounced during the winter, oxygen stress is not as important during the winter. *Id*.

The Garvey report notes that the DO data for Lusk Creek, which is a forested and functioning stream, had a higher frequency of violations of the current DO standard than two of the impaired streams. This suggests to Dr. Garvey that the frequency of violations is not associated with stream impairment. Exh. 9, Att. 1 at 11. However, the application of the proposed IAWA standard to Lusk Creek data significantly reduced the frequency of DO violations. The proposed IAWA standard also increased the frequency of violations in Rayse Creek, which is an impaired stream. *Id.* This, maintains the Garvey report, suggests that land use, flow, and alteration of the watershed likely are major factors influencing oxygen dynamics in streams. Further, temperature and DO were negatively related in all streams. *Id.* at 10. However, in Lusk Creek, the lowest DO levels occurred at intermediate temperature. Based on DO-temperature data for Lusk Creek, the Garvey report contends that linkage between oxygen stress and high temperature stress for resident species appears to be relatively unimportant. *Id.* at 13.

The Garvey report maintains that rather than "linking temperature and oxygen, understanding the relationship between flow and oxygen will likely be more informative for predicting effects on resident organisms." Exh. 9, Att. 1 at 11. The report notes that DO levels are typically lower in pooled portions of streams. *Id.* at 13, citing Santucci and Gephard 2003, Hammer and Linke 2003. According to Garvey, species with adaptations to increased siltation, reduced flow, and increased open water are abundant in pooled areas, but flow-dwelling species are rare or absent. The Garvey report asserts that shifts in the community are likely caused by altered habitat rather than low DO levels. *Id.* at 13. According to the report, however, if IAWA's proposed standards are not met in the pooled areas of a stream, few organisms will persist regardless of habitat adaptations. *Id.* at 14.

Dr. Garvey later reiterated in testimony that the primary factor affecting biological integrity in streams is the physical template, and that the best method for monitoring integrity is through the assessment of the resident organisms. Dr. Garvey finds that oxygen typically occurring in natural streams explains very little of the variation in biological integrity. In his view, the goal of resource agencies should be to maintain oxygen concentrations above IAWA's proposed seasonal minima and focus their resources on improving the likely culprit affecting variance in integrity among warmwater streams: physical habitat. Exh. 16 at 8.

The Garvey report concludes, on the basis of the most comprehensive, long-term DO and temperature dataset available for Illinois, that IAWA's proposed standards:

> better capture oxygen violations in truly impaired streams (i.e., those with modified biota such as Rayse Creek) relative to fully functioning streams such as

> Lusk Creek with high quality habitat and a diverse aquatic biotic assemblage. If the frequent violations of the Illinois standard were biologically meaningful, then Lusk Creek would have a greatly reduced or modified assemblage and would be listed as impaired. This is not the case and the frequent declines in [DO] concentration approaching the proposed summer minimum within the pools of this system during summer do not compromise spawning fishes or other organisms. Exh. 9, Att. 1 at 14.

The report maintains that the species reproducing during the summer have adaptations for natural fluctuations in oxygen during the warmer season. Further, according to Dr. Garvey, alterations to habitat quality and stream flow significantly affect the composition of stream communities. *Id.* at 15.

Dr. Garvey testified that the data for the eight continuously monitored streams were subsequently refined, summarized, and published in a 2005 USGS report. Exh. 16, Att. 2. Dr. Garvey claims that analysis of these data by Paul Terrio of the USGS largely mirrored Dr. Garvey's analysis described above. According to Dr. Garvey, the IAWA proposed DO standard "works" by greatly reducing the percentage of violations in streams with high biological integrity but still correctly identifying degraded streams. Exh. 16 at 3-4, Att. 3.

Board Findings on the IAWA Proposal

The Board agrees with the Garvey-Whiles report that the current Illinois DO standard, adopted in 1972 is too simple to account for natural DO-concentration fluctuations and must be updated based on available scientific information and in accordance with USEPA's NCD.

The NCD recommends seasonal DO standards based on the anticipated presence or absence of "early life stages" of fish. As the Assessment states, it is when aquatic organisms are in their early life stages that they are most sensitive to hypoxia or low DO. It is therefore the early life stages, in contrast to the later juvenile and adult stages, that require greater protection through more stringent DO water quality standards. The IAWA proposal takes this approach. The Board finds that a two-season DO standard, lacking in the current regulation, should be adopted for Illinois.

The Board agrees with the Garvey-Whiles report that most inland waters in Illinois are dominated by warmwater, non-salmonid species and that the NCD's "warmwater" criteria accordingly should be the primary basis for revising Illinois' current DO standard. The NCD criteria are 0.5 mg/L above the DO levels expected to cause impairment and include both mean and minimum values. As the Garvey-Whiles report explains, the 7-day mean value is based on "average levels over a period of seven days for early life stages of fish, when they are very sensitive to oxygen stress," while the daily minimum values are "recommended to protect against acute stress or mortality of sensitive species." Exh. 1 at 28.

For early life stages, the DO standard should require sufficient amounts of dissolved oxygen to support the metabolic needs of eggs and larvae. The Assessment by Drs. Garvey and Whiles recommends a daily minimum DO level of 5.0 mg/L and a 7-day mean DO level of 6.0

mg/L during early life stages. The Board generally agrees that these values, which are NCD-recommended "warmwater" values, should be the DO water quality standards for early life stages. DNR and IEPA propose the same DO standards, which they characterize as "Level 2" standards, for most Illinois general use waters.

For the other life stages, the Board also agrees with Drs. Garvey and Whiles' recommendation of a daily minimum DO level of 3.5 mg/L and a 7-day mean minimum DO level of 4.0 mg/L. To account for the adult life stages and spawning times of common warmwater fish taxa in Illinois, the daily minimum DO level of 3.5 mg/L is higher than the NCD's level of 3.0 mg/L. The joint DNR/IEPA proposal recommends the same DO standards for its Level 2 waters. The Board also agrees with IAWA's eventual position to include a 30-day mean of 5.5 mg/L DO for other life stages, as recommended by the NCD and as proposed by DNR and IEPA for Level 2 waters.

The Assessment states that a majority of Illinois warmwater fish species spawn between spring and early summer (March through June). The Board further agrees with Drs. Garvey and Whiles that the months of March through June should be included in the early life stages timeframe, as IAWA proposes.

Accordingly, for first-notice, the Board will adopt a two-season general use water quality standard for DO as proposed by IAWA, with the more stringent early life stages DO standards applying from March 1 through June 30, but the Board will address below whether to also include the month of July in the early life stages time period. DNR and IEPA agree that March through June should be part of the early life stages, but also suggest including July.

Additionally, the Board will adopt for first notice the DO numeric values proposed by IAWA as general use water quality standards for the early life stage and other life stages, including the 30-day mean, but will address below whether enhanced numeric DO standards, which DNR and IEPA characterize as "Level 1" standards, should be applied to certain Illinois stream segments making up approximately 8% of general use stream miles.

Finally, the Garvey-Whiles report acknowledges that its recommended numeric DO values are inappropriate for wetlands. The Board agrees and will discuss this issue below when addressing the narrative DO standard proposed by the State agencies and agreed to by IAWA.

DISSOLVED OXYGEN DATA

IAWA's View of the DO Data

USGS and IEPA DO Data From Eight Illinois Streams (2001-2003)

IAWA maintains that Dr. Garvey's evaluation of DO monitoring data from eight streams intensively sampled by USGS and IEPA show that the "proposed standard greatly reduces the number of violations in unimpaired streams, such as Lusk Creek, while still capturing violations in impaired streams." PC 102 at 5. As discussed, Dr. Garvey states that DO levels in all eight streams violated Illinois' current DO standard at a frequency ranging from 1% to 65% of the days. Exh. 9 at 3. These violations occurred in unimpaired stream segments and in stream segments listed as impaired under Section 303(d) of the federal Clean Water Act. *Id.* at 4.

According to Dr. Garvey, IAWA's proposed DO standard significantly reduced the number of violations in unimpaired streams, but still resulted in violations in impaired streams, including an increase in the frequency of violations in two of the severely oxygen-impaired streams. Exh. 9 at 4. In other words, IAWA's proposed standards "better capture" DO violations in "truly impaired streams," while the current Illinois DO standards result in frequent violations in streams that are fully functioning with high quality habitats and diverse biotic assemblages. Exh. 9, Att. 1 at 14.

IEPA Grab Sample Data (1994-2003) and Semi-Continuous Monitoring Data (2004-2005); IAWA Semi-Continuous Monitoring Data (2005-2006)

Dr. Garvey reviewed data collected by IEPA, as well as data collected by IAWA members. In Dr. Garvey's opinion:

> The most compelling results derive from stream segments slated for enhanced dissolved oxygen protection by the proposed IDNR/IEPA two-tier approach. As I analyzed these data, it became apparent that many of these segments likely violate both the IDNR/IEPA and perhaps the IAWA proposed standards, even though "enhanced oxygen" taxa are present in the streams. Exh. 35 at 4.

IEPA Data. Dr. Garvey states that IEPA provided him with "grab" DO data collected during 1993 through 2003 "in streams that have fully met their aquatic use designation." Exh. 35 at 5. IEPA also provided data from 2004 and 2005 collected with semi-continuous data logging probes "in streams that have been tapped for inclusion in the 'enhanced oxygen' tier." *Id.* IEPA specifically describes this data as having been collected from "sites located on or within 1000 feet of a stream segment selected for the higher level of dissolved oxygen standards and recently (2004 or later) rated as 'full support' for Aquatic Life Use." Exh. 22 at 1.

Dr. Garvey states that the grab data demonstrate that median DO concentration declines during June through August, relative to other months. Exh. 35 at 5, Att. 3. Given that these grab samples were typically collected during the day, Dr. Garvey was not surprised that low DO concentrations were not frequently found. Exh. 35 at 5.

Dr. Garvey states that the continuous data demonstrate that DO in "enhanced" stream segments "more frequently declined below 5 mg/L and even occasionally below 3.5 mg/L." Exh. 35 at 6, Att. 3. He further points out that these low concentrations, which often violated both the IAWA and DNR/IEPA proposed standards, typically occurred during the night through dawn. According to Dr. Garvey, the enhanced-tier segments "more frequently (up to 20% of observations) [violated] the DNR/EPA minimum of 5 mg/L during July than the IAWA proposed standard of 3.5 mg/L during that month." *Id.* The streams that contained "oxygen sensitive" species "failed to meet the standard set for them by the IDNR/EPA proposal." *Id.* at 6.

Dr. Garvey states that, according to IEPA's Frevert, these data include results from 2005 when much of Illinois experienced a drought and therefore should be discounted because they were collected in extreme conditions. Exh. 35 at 6. Dr. Garvey disagrees with this view, citing "Liebig's Law of the Minimum," which Dr. Garvey describes as follows: "the distribution of all living organisms will not be dictated by the average conditions, but rather the availability of the most limiting condition." *Id*. at 6-7.

According to Dr. Garvey, the occasional "worst case" scenario limiting the oxygen available to local fauna determines the species composition and abundance present through time. Dr. Garvey testified that the extreme drought conditions in the stream segments proposed for enhanced protection "likely provided the worst case scenario and thereby insight into what the acute minimum should be to support a diverse aquatic assemblage." Exh. 35 at 7. Dr. Garvey asserts that IAWA's proposed minimum DO standard of 3.5 mg/L was "rarely [violated] in these streams" and "likely is near that extreme lower limit." *Id.* at 6-7, Att. 3.

IAWA Data. Several IAWA members installed semi-continuous DO loggers at stream sites that are in segments proposed by DNR and IEPA for enhanced standards. Dr. Garvey analyzed 2005 data from the Fox River and summer 2006 data from the DuPage, Kickapoo, Rock, and Vermilion Rivers. Exh. 35 at 8. According to Dr. Garvey, "[p]robably the most compelling result is the linear or log-linear relationship between daily discharge and median and minimum daily dissolved oxygen concentrations in the streams." *Id*., Att. 5. Dissolved oxygen concentrations declined sharply with declining daily discharge in the Fox River during 2005. *Id*. (Exhibit 5). In contrast, DO concentrations were either unrelated to discharge or negatively related in the other streams during 2006. *Id*. Dr. Garvey believes that "this issue needs to be incorporated into standard development and interpretation," given that discharge can explain up to 50% of the variation in DO concentrations. *Id.* at 9.

Dr. Garvey applied both the proposed DNR/IEPA enhanced DO standard and the proposed IAWA DO standard to the semi-continuous data. According to Dr. Garvey, several stream segments, including those in the DuPage, Fox, and Kickapoo Rivers, fail to meet the season-dependent acute minima of either proposed standard, "even given the proposed enhanced status of these systems." Exh. 35 at 9, Att. 6. This outcome was not surprising to Dr. Garvey because "some portions of the DuPage and Fox Rivers are currently listed with low dissolved oxygen as a probable cause for impairment." *Id.*, Att. 5. Dr. Garvey points out, however, that the Rock River, "which is listed as impaired due to low oxygen," had no violations of the minimum criteria. *Id.*, Att. 6.

Dr. Garvey found that seven-day mean DO standards proposed by IAWA and DNR/IEPA were "generally insensitive." Exh. 35 at 9, Att. 6. Dr. Garvey further testified:

> Interestingly, the IAWA proposed 7-day minimum standard of 4 mg/L which applies during July through February generated more violations than the IDNR/IEPA 7-day mean minimum of 4.5 mg/L which starts in August . . . . Although I did not expect this to occur, apparently applying the mean minimum criterion during July as per the IAWA proposal is more sensitive. Exh. 35 at 9, Att. 6.

Dr. Garvey states that the mean-minimum criterion appears to be "more sensitive" to frequent declines in oxygen during the summer because the "daily variation in dissolved oxygen concentrations differs more than the daily average (i.e., it is the variation not the mean that is sensitive)." *Id*. at 10.

It is Dr. Garvey's view that "it appears that many of these streams, particularly the Fox River, fail to provide adequate oxygen for aquatic life during part of the summer." Exh. 35 at 10. Dr Garvey continues: "This causes me to question the linkage between the aquatic assemblages used to select the sites for enhanced status and oxygen needs of the resident organisms." *Id*.

Dr. Garvey concludes that "oxygen can become a limiting dissolved gas" for aquatic organisms and, below some threshold, "we should expect to see deleterious effects and reductions in species composition and abundance." Exh. 35 at 10. Dr. Garvey states that all the data he has reviewed suggest that:

> a threshold does exist and that it occurs during the summer when concentrations are less than or equal to 3 mg/L as stated in the NCD and the Garvey and Wiles report. If a stream remains consistently above this level (i.e., never violates a 3.5 mg/L minimum), oxygen is no longer limiting for life and some other factor then limits organisms . . . probably habitat. *Id*.

Continuing his testimony, Dr. Garvey states "I favor scrapping dissolved oxygen as a standard altogether" because variable or low DO concentrations are "largely a symptom of habitat problems and their interactions with other factors such as chemical and biological pollutants . . . and . . . discharge." Exh. 35 at 11. Because eliminating DO as a water quality standard "is not currently a possibility," Dr. Garvey asserts that "it appears that the set of standards proposed in the Garvey and Whiles report stand the test of the data and should be adopted in the interim." *Id*.

Later, on December 18, 2006, at which time he was no longer under contract with IAWA, Dr. Garvey filed a public comment as an "interested and concerned private citizen of Illinois," adding to his remarks on habitat. PC 94 at 1. Dr. Garvey discusses the issue of habitat as a component of stream characteristics that allows systems to be resistant to changes in water quality. He notes that habitat has a "spatial component" that must be sufficiently available to allow an organism to "carry out its life history requirements and avoid local extinction." *Id*. This component may range from 10 kilometers for darters to thousands of kilometers for sturgeon and paddlefish. Dr. Garvey states that occasional declines in DO in portions of an organism's "spatial extent" will not be a problem if the organism has "refuges" down- or up-stream. *Id*.

However, continues Dr. Garvey, "habitat is becoming continually fragmented" due to development and agricultural activities in Illinois. PC 94 at 1. Habitat fragmentation becomes a problem during low DO levels when refuges are unavailable due to fragmentation:

> To alleviate this problem, I would love to elevate the concentration within all portions of Illinois streams to whatever level biologists want during whatever time of the year is convenient for the resident organisms. Unfortunately, the weight of the data collected to date suggests that dissolved oxygen concentrations in streams sag during the summer when flow declines and temperature rises. This is a natural tendency linked to physical factors currently beyond the biologist's control and are often independent of water quality. *Id*. at 1-2.

Dr. Garvey therefore urges caution in "developing rules that cannot be met" and recommends that the regulatory focus be on habitat and its "internal connectivity," with the goal of "creating large stretches of connected streams with well-developed riparian corridors and stable, functioning habitat." *Id*. at 2.

IAWA Semi-Continuous Data from Fox River, East Branch DuPage River, and Salt Creek (2006)

Dr. Garvey analyzed semi-continuous monitoring data from the Fox Metropolitan Reclamation District for 2006 (to compare with data collected by this agency in 2005) and from the DuPage River/Salt Creek Workgroup for the summer of 2006. Exh. 36 at 1. The three sites on the Fox River providing data are in stream segments proposed for enhanced DO standards under the DNR/IEPA proposal. The fives sites on the East Branch DuPage River and the three sites on Salt Creek providing data are near but not within the DNR/IEPA-proposed stream segments for enhanced DO protection. *Id*., Figure 1.

Dr. Garvey found that discharge in 2006 explained a portion of the variation in DO concentrations in many of the rivers, but acknowledged that the "strength of the relationship was weaker than that during the 2005 drought." Exh. 36 at 1. Additionally, a "low discharge typically constrained variation" in DO concentrations, keeping them at "relatively low levels." *Id*.

According to Dr. Garvey, the Fox River sites within the segments proposed for enhanced DO standards "typically fared worse in meeting both the IDNR/IEPA criteria and the IAWA proposed criteria" than the Salt Creek and East Branch DuPage River sites. Exh. 36 at 1. Dr. Garvey further found that:

> the greatest disparity between the performance of the IDNR/IEPA and IAWA proposed standards occurred during July, with the IDNR/IEPA standard identifying up to ten times more "violations" than the IAWA proposal. *Id*.

Dr. Garvey also observed that some reaches were "clearly impaired" with DO concentrations "extending far below 3 mg/L" (*e.g.*, East Branch DuPage River at St. Charles Road, and Salt Creek at Fullersburg Road). *Id*. According to Dr. Garvey, "these problems typically occurred before July and were identified similarly by both proposed standards."

Dr. Garvey notes that "some congruence occurred" in daily DO concentrations "between years across the three Fox River sites." Exh. 36 at 2. This suggests to Dr. Garvey that DO concentrations in river reaches are:

> somewhat predictable among years, even given annual variation in climate (e.g ., drought versus non-drought). This supports the hypothesis that organisms within streams are likely able to "anticipate" (through selection of life history strategies, reproductive allocation, etc.) seasonal changes in oxygen availability. *Id.*

Specifically, Dr. Garvey states that in July and August 2006, the Fox River sites within the segments proposed for enhanced DO standards "performed poorly" under the proposed minimum DO standards of both DNR/IEPA and IAWA. Exh. 36 at 3, Table 1. According to Dr. Garvey's analysis, the two proposed standards "fared similarly" on average across all sites, except for July where the DNR/IEPA standard "generated 11% violations among sites whereas the IAWA standard only generated 1%." *Id.* Both proposed standards, continues Dr. Garvey:

> found violations of the 7-day mean criterion, although the IAWA standard found 1% and the IDNR/IEPA found 6%, with about twice as many sites generating at least one violation of the IDNR/IEPA standard. The Fox River enhanced sites met this criterion for both standards. *Id.*, Table 2.

The DNR/IEPA 7-day mean-minimum standard "found 22% violations of observations, of which the Fox River in August was largely responsible," according to Dr. Garvey. *Id.*, Table 3. The IAWA 7-day mean-minimum standard "also detected low values in the Fox River, although it was less likely to generate violations for other sites and dates (17% for IAWA versus 46% for IDNR/IEPA)." *Id.* Neither the DNR/IEPA nor the IAWA 30-day standard "detected many violations." *Id.*, Table 4.

Dr. Garvey states that natural selection must favor traits that anticipate predictable environmental conditions for organisms to become "adapted" to their environment. Exh. 36 at 3. According to Dr. Garvey, fish and other organisms residing in low-gradient, warm-water streams "should have traits including reproductive schedules that are related to oxygen, if oxygen fluctuations within streams are somewhat predictable among years." *Id.* Dr. Garvey's "conservative" analysis for the Fox River in 2005 ("an extreme drought year") and 2006 ("a less extreme year") showed a relationship between daily values in each year, "suggesting that seasonal changes in oxygen are predictable and may select for life histories that anticipate summer oxygen sags." *Id.*, Figure 26

<u>Further Comment on IEPA (2004-2005) and IAWA (2005-2006) Semi-Continuous DO Data</u>

In his December 18, 2006 public comment filed simply as an interested citizen, Dr. Garvey presents further findings of his analysis of the semi-continuous monitoring DO data described above. Adding to his prior finding of the positive relationship between DO concentration and discharge in several study streams, Dr. Garvey states that he had since included water temperature as an additional factor. PC 94 at 1. He found that the rise in DO concentration was simultaneous with a decline in temperature:

> Knowing that water's capacity for oxygen increases with declining temperature, it further supports the supposition that increased flow plus reduced temperatures (combined with increased aeration) are predominately involved in dissolved oxygen dynamics in many Illinois streams. These physical factors cannot be regulated by statute, although regulating instream flow might be an issue worth some focus. *Id*.

<u>IEPA Semi-Continuous DO Data (2006)</u>

On April 24, 2007, IAWA submitted additional continuous DO measurement data for 32 Illinois river segments. The DO data was collected by IEPA during the summer and early fall of 2006. The sampled river segments include ten segments proposed to have "enhanced" DO standards, including the DO value of 6.25 mg/L during the months of February through July. Further, IAWA notes that all of the data was collected with continuous DO recorders during a non-drought year. PC 109 at 1-2.

IAWA contends that the results of Dr. Garvey's analysis of this IEPA DO data support the IAWA's proposed DO limits and the applicable timeframes. PC 109 at 2. IAWA maintains that when the application of the DNR/IEPA-proposed limits to the data is compared with the application of the IAWA-proposed limits, IAWA's proposed standards "are a better fit and generate fewer violations." *Id*. "This is true for both the DO concentrations and the dates," according to IAWA. *Id.*

Referring specifically to the stream segments proposed by DNR and IEPA to have enhanced DO protection, IAWA states that the DO data indicate that some of the segments violate the DO limits proposed by both IAWA and DNR/IEPA. PC 109 at 2. Given that the State agencies suggest that these segments sustain a population of DO-sensitive species, IAWA argues that this DO data:

> calls into question the methods and assumptions made by the agencies in determining which river segments should have the enhanced DO limits imposed or which fish species are truly DO sensitive. *Id.*

IAWA asserts that the 2006 DO monitoring data provide further support for its position that the joint DNR/IEPA enhanced standard for certain stream segments "does not represent natural dissolved oxygen conditions in Illinois waters." PC 109 at 2. IAWA acknowledges that:

> some waters in Illinois could be identified as requiring a different dissolved oxygen average or minima for certain least disturbed waters. However, the IAWA adamantly opposes establishing such criteria without the ground truthing data to support that designation. *** [IAWA] remind[s] the Board the IEPA and IDNR filed no data to support their joint proposal. They further testified that they made no attempt to ground truth their proposal against collected data. *Id*. at 3.

Therefore, IAWA urges the Board to reject State agencies' joint proposal and adopt IAWA's proposal, with the inclusion of the 30-day limit and the narrative standard. *Id*.

Dr. Garvey applied both the proposed IAWA standard and the proposed DNR/IEPA "enhanced" standard to IEPA's 2006 DO monitoring data from nine stream segments proposed for "enhanced" status. PC 109 at 4. The river name and the DNR/IEPA stream segment identification follow: Sugar Creek (BM-PS-C2); Hodges Creek (DAG-03); DuPage (GB-08); DuPage (GB-18); South Branch Kishwaukee (PQC-06); Hampshire (PQFD-01); Hampshire (PQFD-H-C3); East Branch Kishwaukee (PQI-10); and South Branch Kishwaukee (PQI-H-C5). *Id*.

Dr. Garvey states that with the exception of Sugar Creek, the proposed standards of IAWA and DNR/IEPA generated similar results in terms of violations. In Sugar Creek, the DNR/IEPA enhanced DO standard generated violations, while the IAWA standard did not. PC 109 at 6. Further, when DO data over the entire monitoring period for all of the stream segments selected for enhanced protection were analyzed for the minimum DO criterion, 10% of the data showed violations of the IAWA standard compared to 16% for the DNR/IEPA standard. *Id*. Dr. Garvey's report indicates that IAWA's DO limit would have also generated violations in Sugar Creek if the early life stages period were extended to include July, as proposed by the State agencies. *Id.* at 6, Table 2.

<u>DNR and IEPA's View of the DO Data</u>

DNR acknowledges that the continuous DO data provided in this record "from a handful of locations throughout the State" helps to quantify the natural variability of DO, "thus justifying the need to update the existing [DO] standards." PC 96 at 7. DNR nevertheless maintains that:

> it's the biological data (fish and macroinvertebrates) and scientific literature that describes their sensitivity to [DO] that is most relevant to deciding what the appropriate standards need to be to fully protect aquatic life. *Id*.; *see also* Tr.4 at 90-92.

DNR explains that the joint recommendations were based on "identifying the aquatic life needs for [DO]." PC 96 at 7. DNR asserts that the DO standards should be based solely on biological data. *Id*., citing Tr.5 at 43-44.

According to DNR, direct use of other abiotic data is neither necessary nor appropriate to establishing the standards. PC 96 at 7. DNR argues that while comparisons in the record of current DO measurements with proposed DO standards are interesting, DNR believes that:

> the basis for amending the [DO] standard should not be whether or not waters are currently meeting the proposed standards, but rather, standards are set at levels to meet aquatic life needs, including those life stages and species sensitive to [DO]. *Id*.

IEPA similarly adds that the continuous DO monitoring data collected by IAWA members has been presented "with little context regarding the meaning or possible interpretations" of that data: "Some sites were able to meet the proposed standard and some were not but no corresponding information about the actual biological conditions at the locations was provided." PC 103 at 10, 13, citing Tr.5 at 74-75. According to IEPA:

> In a more conventional water quality standard proceeding, ambient data is not used to drive the value set by the Board but to give the Board some insight into whether or not the proposed standard is likely to be attained in most areas of the State. In proposing standard changes to the Board, IEPA relies primarily on laboratory studies that evaluate the acute and chronic impacts to aquatic life of varying levels of a pollutant. The stakeholders to this proceeding seemed to agree (until Dr. Garvey's final pre-filed testimony) that the impacts of "desirable" parameters like dissolved oxygen—as compared to toxics—are less accurately measured by laboratory studies. *Id*. at 13-14.

IEPA also maintains that to better understand DO dynamics in Illinois streams, statewide DO information is needed, "not just a limited set of waters receiving effluent discharges" as provided by IAWA. *Id*. IEPA maintains that IAWA has never substantiated its claim that the DO data supports IAWA's proposal over that of DNR and IEPA. PC 103 at 12. Nor has IAWA, according to IEPA, ever "explained to the Board how to make use of available [DO] data." *Id*.

IEPA maintains that the newly available continuous DO monitoring data does not "explain what conditions are expected to be found in healthy streams." PC 103 at 14. IEPA explains that the "patterns varied so greatly between the limited numbers of sites" for which data was available that it was "impossible to draw meaningful conclusions about the needs of Illinois fish from available ambient water quality data." *Id*. IEPA and DNR, continues IEPA accordingly did not use the available ambient DO data in developing their proposal. *Id*.

For example, regarding the USGS and IEPA DO data (2001-2003) discussed above, IEPA notes that the "continuous DO data" is:

> From a pilot project limited in scope and geographic coverage; only eight sites were monitored intensively from about July 2001 to September 2003. Illinois EPA does not believe it is valid to generalize from these limited results to a statewide scale. Exh. 22 at 1.

Specifically, IEPA observes, four of the eight sites are on or near a General Use stream segment proposed for enhanced DO: Lusk Creek; North Fork Vermilion River; Middle Fork Vermilion River; and Mazon River. Exh. 22 at 2. Using the USGS/IEPA pilot-study data, only one of the four sites meets the IAWA-proposed standards, as indicated in Dr. Garvey's "Long term dynamics of oxygen and temperature in Illinois streams" (July 2004) at Table 1. *Id*. IEPA notes that, likewise, only one of the four sites meets the DNR/IEPA-proposed standards. These Comparisons, however, continues IEPA, are "hampered by the fact that about 40% of the 'useable' results were rated only as 'fair' or 'poor quality prior to manual data correction." *Id*.

Therefore, approximately 40% of the measurements could be "inaccurate by as much as 0.5 to 2.0 mg/L," according to IEPA. For this dataset, IEPA concludes:

> Given the small number of sites monitored, the limited geographic coverage, and the high potential for inaccuracy, these results have limited applicability for discerning patterns of dissolved oxygen at stream sites throughout the state. Exh. 22 at 2.

For IEPA's grab data (1994-2003) and continuous monitoring data (2004-2005), which provided DO values from sites located on or near stream segments proposed for enhanced DO protection, IEPA asserts that "little evidence exists to indicate that these General Use streams typically cannot meet the IDNR/IEPA-recommended daily minimum (acute) standard." Exh. 22 at 2. The dataset, however, "does not allow application of the more-important chronic dissolved oxygen standards." *Id*. Specifically, for the grab sample data from these stream sites, DO values "were never below the IDNR/IEPA-recommended daily minimum standard for more than 6% of sites statewide in any month." *Id*. The grab data therefore, in IEPA's estimation, "show little inability to meet the DNR/IEPA recommended daily minimum (acute) standard." *Id*.

IEPA maintains that the continuous monitoring data from 2004 "shows no evidence that the IDNR/IEPA-recommended daily minimum standard cannot be met," as none of the observed daily minima are less than 4 .0 mg/L in August or September. Exh. 22 at 2. The 2005 data "represent severe drought conditions over much of the state," according to IEPA. *Id.* at 2-3. For these "low-flow conditions," IEPA continues, DO is:

> expected to be atypically low with an increased chance of dropping below the daily minimum standard. In such extreme conditions, aquatic life are expected to be stressed. Illinois EPA recognizes that for the 2005 continuous-monitoring results, most sites did not meet the recommended daily minimum standard. Illinois EPA does not believe it is valid to generalize from the 2005 results to more-typical years. *Id*. at 3.

Upon IAWA's request, IEPA provided its most recent assessment information for stream segments, known as "Assessment Units," that meet all of the following:

1. Rated as "impaired" for Aquatic Life Use in the IEPA 2006 Assessment Database;

2. DO is identified as a potential cause of the Aquatic Life Use impairment; and

3. The Assessment Unit overlaps with a stream segment proposed to have enhanced DO standards. Exh. 22 at 4; *see also* Tr.4 at 99.

In all, twenty-two Assessment Units met these three criteria. Exh. 22 at 4. Smogor, a stream biologist in IEPA's Surface Water Section,[9] testified that the length of impaired streams represented less than 3% of the length of streams proposed for enhanced DO protection. Tr.4 at 99-101, 110. IEPA expects the DNR/IEPA standards to improve its "ability to distinguish between situations in which Aquatic Life Use is impaired due to low dissolved oxygen vs. not." Exh. 22 at 4.

IEPA therefore readily acknowledges that some of the stream segments proposed for enhanced DO protection may currently be impaired for DO. Exh. 22 at 4; Resp. at 1. In fact, most of IEPA's 2006 continuous monitoring data came from impaired locations. PC 110 at 2. In response to IAWA's Streicher concluding that IEPA's 2006 data support IAWA's proposed standard, IEPA states that Streicher has "misinterpreted" the data. Resp. at 1. The data consist of continuous DO measurements taken at ten Illinois stream locations. *Id*. According to IEPA, Streicher's claim that the data demonstrate that IAWA's standard is a "better fit" than the DNR/IEPA proposed standard is "neither supported by the 2006 results nor consistent with Dr. Garvey's summary statement." *Id*.

IEPA maintains that despite the many individual DO observations in the 2006 data, they "predominantly are from impaired locations and therefore are not useful for evaluating the relative efficacy of the two sets of dissolved oxygen standards." PC 110 at 2. Nor was the continuous monitoring designed to compare the effectiveness of the competing standards. According to IEPA:

> To be valid, such comparisons must be based on a larger, more representative dataset from locations that are achieving their biological potential and thus more likely to be harboring their full compliment of aquatic life.
>
> Because eight of the ten locations likely were not meeting their biological potential during the summer of 2006, it is not unreasonable to expect violations of dissolved oxygen standards. It is not scientifically valid to interpret violations of the IDNR/Illinois EPA standards at these locations as a worse fit than the IAWA-proposed standards, which were also violated at most of these impaired locations. *Id*.

<u>Other Participants' Views of the DO Data</u>

As noted above, Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club maintain that an entire water body should not be allowed to fall to low DO levels just because DO-sensitive species are present where a few samples with low DO concentrations were collected. PC 101 at 5. Further, the presence of DO-sensitive fish in low DO reaches does not

---

[9] Smogor has been with IEPA for approximately six years. Smogor has a Master of Science degree in Fisheries and Wildlife Sciences from Virginia Polytechnic Institute and State University, and a Bachelor of Science degree in Biology from the University of Illinois at Champaign-Urbana. Tr.4 at 31.

prove that the population would not be affected if the entire segment were experienced low DO levels, according to the environmental groups. *Id*. at 6.

CICI maintains that the data presented on behalf of IAWA's testimony represents "sound science which supports the petition and a proposed set of standards which are attainable." PC 95 at 1.

Board Findings on the Use of Dissolved Oxygen Data

IAWA relies on Dr. Garvey's analyses of DO monitoring data from several Illinois streams to support its proposal and to question the validity of the joint DNR/IEPA proposal, particularly the latter's proposed "enhanced" DO standard for certain stream segments. As discussed above, the DO datasets analyzed by Dr. Garvey include: (1) IEPA/USGS DO data collected during the late summer of 2001 through the fall of 2003; (2) IEPA's historical "grab" DO data collected during 1994 through 2003; (3) IEPA's semi-continuous DO data collected during 2004-2005 in or near stream segments proposed to have enhanced DO standards; (4) IAWA's semi-continuous DO data collected during 2005-2006 in stream segments proposed to have enhanced DO standards; and (5) IEPA's semi-continuous data collected during 2006 in stream segments proposed to have enhanced DO standards.

The Board appreciates the efforts of IAWA, and particularly those of Dr. Garvey, in evaluating the available DO data to provide a better understanding of DO dynamics in the monitored Illinois stream segments. After a thorough review, the Board makes a number of findings below regarding Dr. Garvey's analyses.

The Board finds that Dr. Garvey's analysis of the IEPA/USGS DO data shows the seasonal variation of DO levels with diurnal fluctuations in the monitored streams. As Dr. Garvey emphasizes, applying the current Illinois DO standard to the DO data results in a higher frequency of violations as compared to IAWA's proposed DO standard. The Board further finds that the results of the IEPA/USGS dataset suggest that the current DO standard fails to account for the natural seasonal variation and diurnal fluctuation of DO. For purposes of this rulemaking, however, the Board will not at this time draw broader conclusions from the IEPA/USGS data, given the small number of sites monitored, the limited geographic coverage, and the high proportion of data being rated as "fair" or "poor" quality. Exh. 22 at 2.

IEPA's grab data from 1994 through 2003 for streams meeting the aquatic use designation indicate a seasonal decline in DO during the summer months with an occasional decline below 5 mg/L. This is consistent with IEPA's assertion that the grab data show that approximately 94% of the monitored stream sites rated as fully supporting aquatic life and located on or near a stream segment selected for enhanced protection meet the enhanced daily minimum DO standard of the joint DNR/IEPA proposal. Exh. 22 at 2; Tr.5 at 21-22.

The semi-continuous DO data evaluated by Dr. Garvey address stream segments proposed by DNR and IEPA for enhanced DO standards. IEPA's 2004-2005 data show that a number of stream segments chosen to have enhanced DO standards fail to meet the both IAWA's and DNR/IEPA's proposed DO standards. As expected, in July, the frequency of violations of the DNR/IEPA minimum standard of 5 mg/L was higher than that for IAWA's minimum standard of 3.5 mg/L. The semi-continuous DO data collected by IAWA members also indicate that several stream segments designated for enhanced standards fail to meet the DO limits proposed by either IAWA or DNR/IEPA. Regarding Dr. Garvey's evaluation of the effect of discharge on DO levels, the Board believes that it is an interesting exercise to test the hypothesis that stream discharge drives the variation of DO in low gradient streams. The results of the analysis, however, are not conclusive.

Concerning certain of IAWA's semi-continuous DO data collected in stream segments proposed for enhanced standards, the Board wishes to clarify the import of Dr. Garvey's testimony that IAWA's proposal is "more sensitive" in particular circumstances than the DNR/IEPA proposal. Specifically, Dr. Garvey states:

> Interestingly, the IAWA proposed 7-day minimum standard of 4 mg/L which applies during July through February generated more violations than the IDNR/IEPA 7-day mean minimum of 4.5 mg/L which starts in August . . . . Although I did not expect this to occur, apparently applying the mean minimum criterion during July as per the IAWA proposal is more sensitive. Exh. 35 at 9, Att. 6.

As this testimony indicates, Dr. Garvey is not in this instance comparing all of the two proposals' respective DO standards that would apply in July. In comparing IAWA's 7-day mean minimum with DNR/IEPA's enhanced 7-day mean minimum, Dr. Garvey applied that IAWA standard to three months of DO data (July, August, and September), but applied that DNR/IEPA standard to only two months of DO data (August and September). Exh. 35, Att. 6, Table 3; Tr.5 at 152-54. As Dr. Garvey conceded at hearing, "it is kind of comparing apples to oranges in a lot of ways." Tr.5 at 153. Unlike the IAWA proposal, the joint DNR/IEPA proposal does not have a 7-day mean minimum standard during July. The DNR/IEPA proposal has an enhanced 7-day mean minimum of 4.5 mg/L that applies from August 1 to the end of February, *i.e.*, for seven months, one month less than IAWA proposes to have its 7-day mean minimum of 4.0 mg/L apply. In July, for example, IAWA also proposes a daily minimum DO standard of 3.5 mg/L, while DNR and IEPA also propose an enhanced daily minimum DO standard of 5.0 mg/L. Exh. 35, Table 1

In the quoted passage above then, Dr. Garvey is not comparing the relative sensitivity of the two competing proposals as a whole. Exh. 35, Tables 1-4. In fact, when later testifying about other DO data (2006 semi-continuous monitoring data from the Fox Metropolitan Reclamation District and the DuPage River/Salt Creek Workgroup), Dr. Garvey stated that "the greatest disparity between the performance of the IDNR/IEPA and IAWA proposed standards occurred during July, with the IDNR/IEPA standard identifying up to ten times more 'violations' than the IAWA proposal." Exh. 36 at 1, 3, Tables 1-4 (in July, the DNR/IEPA minimum standard "generated 11% violations among sites whereas the IAWA standard only generated 1%.").

Dr. Garvey's analysis of IEPA's 2006 DO data for nine stream segments proposed for enhanced standards indicates that except for Sugar Creek, both the IAWA standard and the DNR/IEPA standard generated similar results in terms of violations. For Sugar Creek, only the DNR/IEPA standard generated violations. The IAWA's DO standard would have also produced violations in Sugar Creek, if IAWA's proposed early life stage period included July. Moreover, as noted by IEPA, the 2006 DO data are predominantly from impaired locations that are not achieving their biological potential. PC 110 at 2. As such, the Board finds that the data are inappropriate for evaluating the relative effectiveness of two sets of proposed DO standards.

In summary, the Board finds that the analyses of several DO monitoring datasets, which include both grab and semi-continuous monitoring data, indicate that the current DO standard does not account for the naturally-occuring seasonal variation and diurnal fluctuations of in-stream DO concentrations. Beyond that, however, conclusions useful to this rulemaking cannot be drawn at this time from these DO datasets.

DO monitoring data from several stream segments proposed for the enhanced DO standard indicate that those stream segments violate both the IAWA and DNR/IEPA standards, with the frequency of violations higher when applying the DNR/IEPA standard. The Board cannot find that these results demonstrate that IAWA's proposed DO standard is a better "fit" than the DNR/IEPA standard, or *vice versa* for that matter. The data represent a small number of monitoring locations, are of limited geographic coverage, and vary in quality and monitoring objectives. Meaningfully interpreting DO data at various sampling locations is not possible without corresponding information on biological conditions at those locations.

When setting water quality standards, the Board places significant weight on adopting a standard that fully protects aquatic life, rather than simply trying to arrive at a standard that would be met by current stream conditions. Frevert testified about IAWA's questioning of how stream segments with samples violating the proposed enhanced DO standard could yet be home to "meaningful amounts" of DO-sensitive organisms:

> The fact that they are lower doesn't mean it's a fully protective condition. It's possible that DO sensitive organisms are in place and under some degree of stress, still hanging on to life, where we think a higher standard is appropriate anyway pursuant to the Clean Water Act procedures and the need for the standard to be protective. I don't think we want to set a standard that's on the ragged edge so the slightest little deviation from that standard has the system collapse. *** That doesn't mean that every system where those higher organisms can live is at the water quality condition we want or the standards we set . . . . [T]he fact that we say a standard is warranted doesn't mean it has to be an existing condition. Tr.5 at 30-31.

If stream segments do not meet the proposed DO standards upon adoption, the Board expects that those stream segments would be assessed in accordance with the requirements of Section 303(d) of the federal Clean Water Act. That provision requires states to identify and list waters that do not meet applicable water quality standards or do not fully support their designated uses. This list of impaired waters, known as the "303(d) list," is submitted to USEPA for review and approval. The federal Clean Water Act also requires that a TMDL be developed for each pollutant of an impaired water body. A TMDL must consider all potential sources of pollutants, whether point or nonpoint. It also takes into account a margin of safety, which reflects scientific uncertainty, as well as the effects of seasonal variation.

A new DO general use water quality standard in Illinois will impact these federally-driven requirements and should be better tailored than the current DO standard for identifying waters that are actually DO-impaired. One of the primary objectives of updating the standard is to "bring in some pragmatism," in the words of Frevert, and "pare back that list and help us find those places that really do need the attention," that is, "those streams with true DO problems." Tr.5 at 32.

DNR/IEPA PROPOSAL TO HAVE ENHANCED DO STANDARDS FOR DESIGNATED STREAM SEGMENTS

DNR and IEPA seek to replace the current general use DO standard with two levels of DO standards: Level 1 and Level 2. Each level would apply to one of two sets of general use waters. PC 96 at 9; Exh. 23 at 1, Figure 1. One level of standards (Level 2) would apply to "the large majority of General Use waters and is designed to ensure sufficient oxygen concentrations for the aquatic life therein." PC 96 at 9, quoting Exh. 23 at 1. Level 2 would require 5.0 mg/L as a daily minimum and 6.0 mg/L as a daily mean averaged over 7 days during the months when early life stages are present; for the rest of the year, the standards would be 3.5 mg/L as a daily minimum, 4.0 mg/L as a daily minimum averaged over 7 days and 5.5 mg/L as a daily mean averaged over 30 days. Tr.4 at 25-26. The State agencies, according to Frevert of IEPA, "believe these concepts recognize the importance of maintaining sufficiently high . . . levels of [DO] that ensure long-term support of healthy aquatic life communities." *Id*. at 26.

Another higher level of standards (Level 1) would apply to:

> a small, selected subset of General Use waters; these thresholds are designed to protect Illinois' most sensitive types and life stages of aquatic life that require relatively higher [DO] concentrations. PC 96 at 9, quoting Exh. 23 at 1.

According to the State agencies, these higher DO standards include a daily minimum of 4.0 mg/L (0.5 mg/L higher than Level 2), a daily mean value averaged over a 7-day period of 6.25 mg/L (0.25 mg/L higher than Level 2), and a daily mean averaged over 30 days of 6.0 mg/L (0.5 mg/L higher than Level 2). Tr.4 at 26. The State agencies "identify about 8% of the length of Illinois' 71,394 stream miles as requiring these higher [DO] levels [Level 1] (based on stream miles in the U.S. Geological Survey National Hydrography Dataset; see internet website: //nhd.usgs.gov/). Exh. 23 at 1; *see also* Tr.4 at 32.

Overview of DNR/IEPA Process for Selecting Stream Segments To Have Enhanced Dissolved Oxygen Standards

The State agencies established a process, Cross of DNR explains, to identify a "subset of waters that warrant an incrementally higher [DO] standard." Tr.4 at 40-41. DNR and IEPA took the following steps:

> First, identify fish and macroinvertebrates (other than mussels) that are sensitive to low DO;
>
> Second, investigate fish and macroinvertebrate communities to determine four biological measures: number of DO-sensitive fish species, proportion of individual fish that are sensitive, number of DO-sensitive macroinvertebrate taxa, and the proportion of individual macroinvertebrates that are sensitive;
>
> Third, identify a threshold value for each of these four biological measures that represented the typical amount known from healthy streams (i.e., the calculated median value from sampling sites attaining the "full support" Clean Water Act goal for aquatic life);
>
> Fourth, identify sites with a meaningful amount of DO-sensitive organisms by comparing values for each of the four biological measures with the established threshold values, and selecting those sites where at least two of the four biological measures equaled or
> exceeded their corresponding threshold values. *Id*. at 3-4.

Using this process, 374 sampling sites were identified by DNR and IEPA as candidates for enhanced DO protection of the 1,110 locations from which the State agencies had sampling results. Tr.4 at 42. The State agencies then extrapolated these 374 sampling sites to stream segments. According to DNR and IEPA, because of differing sampling methods for mussels, mussels were separately addressed: the locations of two DO-sensitive mussel species largely corresponded with the stream segments identified as needing an incrementally higher DO standards, but additional stream segments were selected based on the presence of these two DO-sensitive mussel species. *Id*. at 4-5.

Identifying DO-Sensitive Organisms

The State agencies believe that the warmwater NCD criteria are appropriate for most Illinois waters, but they "provide insufficient protection for several species of Illinois stream fish that inhabit a small but significant proportion of Illinois streams." Exh. 23 at 10. DNR and IEPA note that because the NCD warmwater criteria are based on "only a few tested 'warmwater' fish species," the criteria are "protective only of fishes as sensitive as channel catfish (early life stages) or largemouth bass (other life stages)." *Id*. According to the State agencies, over 160 fish species inhabit Illinois streams. *Id*., citing Smith 1979; Illinois Natural History Survey internet website: www.inks.uiuc.edu/cbd/ilspecies/fishsplist.html. Absolute sensitivity to low DO is unknown for a large majority of these species, according to the State agencies. *Id*.

Some Illinois fish species, DNR and IEPA continue, have "sensitivity between 'coldwater' species (e.g., trout, salmon) and the two species that represent the threshold of protection provided by USEPA's (1986) 'warmwater' criteria." Exh. 23 at 10. By way of example, the State agencies point to smallmouth bass, which live in Illinois streams and "have been noted by USEPA (1986) as one of the most sensitive of the non-salmonid species tested." *Id*. Because some Illinois fish have sensitivity between that of salmonids and largemouth bass or channel catfish, DNR and IEPA conclude:

> it is reasonable to expect that some Illinois waters inhabited by these "intermediate" species would require dissolved oxygen standards higher than the USEPA (1986) "warmwater" criteria but not as high as the "coldwater" criteria. *Id*.

According to the State agencies, the NCD "clearly recognizes this potential need":

> Some coolwater species may require more protection than that afforded by the other life stage criteria for warmwater fish and it may be desirable to protect sensitive coolwater species with the coldwater criteria. Many states have more stringent [DO] standards for cooler waters, waters that contain either salmonids, nonsalmonid coolwater fish, or the sensitive centrarchid, the smallmouth bass. *Id*. at 10-11, quoting Exh. 2 (NCD) at 33.

Dr. Thomas, Chief of the Illinois Natural History Survey of DNR, testified about an "intermediate" category between "warmwater" and "coldwater":

> The Garvey and Whiles report lumps Illinois fish into warm water and cold water. Many biologists recognize that there are many fishes that would fall into a more intermediate category of cool water fish. While there is no clear definition of what species could be classified as cool water fish, there would be general agreement that some fish communities thrive under conditions of more moderate summer temperatures and in well oxygenated water. Some of our finer Smallmouth bass streams would fall into this category, as would some of our spring feed streams and some of our wooded streams and lakes, particularly in northeastern Illinois. Tr.2 at 123.

The State agencies identified 31 Illinois stream-fish species that they believe are most sensitive to low DO and therefore require DO minima higher than the NCD's warmwater criteria, including the American brook lamprey, the northern hog sucker, the rock bass, the smallmouth bass, the banded sculpin, the bigeye chub, the brook stickleback, the stonecat, and the rainbow darter. Exh. 23 at 11, Table 2.

DNR and IEPA selected these fish "based primarily on field-based rankings of species' sensitivities to low [DO] (Rankin 2004)." Exh. 23 at 11. According to DNR and IEPA, Rankin (2004) used field data of approximately 90 fish species collected from "hundreds of stream locations in Ohio to determine a relative ranking of sensitivity for each species." *Id*. The rankings, continue the agencies, are based on "relations between observed [DO] concentrations and the relative abundance of each fish species." *Id*.

These rankings, DNR and IEPA maintain, provide "useful 'real-world' evidence of how the occurrence and abundance of fish at a site are related to [DO] concentrations." Exh. 23 at 11.

The State agencies acknowledge, however, that because these relations are "correlative," they do not provide "absolute evidence that low [DO] caused low observed abundance." The agencies assert, nevertheless, that:

> considering the limited information available on specific sensitivities of each of Illinois' many stream-fish species, Illinois DNR and Illinois EPA believe that Rankin's (2004) results pertain especially well to Illinois because over 80 of the Ohio fish species also inhabit Illinois streams. *Id*. at 11.

In ranking each fish species by its relative sensitivity to low DO, DNR and IEPA explain, Rankin (2004) "used weighted (by abundance) means of minimum [DO] concentrations." Exh. 23 at 11-12. For each species, the State agencies continue, the weighted mean represents the "typical daylight minimum [DO] concentration where the species tends to be most abundant." *Id*. at 12.

According to Rankin (2004), DO is "perhaps the most important chemical constituent limiting to aquatic life in streams across the U.S. [] because of its obvious importance for respiration." Exh. 16, Att. 4 at 1. Rankin notes that:

> [m]ost state water quality standards have developed [DO] requirement[s] based on the U.S. EPA (1986) criteria derivation guidelines using the most sensitive species (to low DO) that inhabit these waters based on a relatively abundant literature related to DO requirements. *Id*. at 1.
>
> ***
>
> Criteria for dissolved oxygen for streams are typically structured as a two number criteria with a minimum (never to [fall below]) value and as daily average values. Even though most state dissolved oxygen criteria are based on methodologies generated from controlled studies as outline[d] in the 1986 EPA guidelines (U.S. EPA 1986)[,] some states have modified criteria on the basis of ambient field data (Ohio EPA 1996) or have methodologies for site specific derivation of criteria due to natural conditions . . . . *Id*. at 13.

Rankin (2004) acknowledges that there is "some variability related to multiple stressors that influence the relationship of DO to aquatic communities in Ohio," but maintains that there still is a "clear threshold relationship between biological indicators of aquatic condition and ambient [DO]." Exh. 16, Att. 4 at 3.

There is a "continuum of sensitivity" to ambient DO concentrations across species and taxa that occur in Ohio, according to Rankin. Exh. 16, Att. 4 at 4. Rankin explains, for example, that "moderately sensitive" species (*e.g.*, sand shiner, golden redhorse) are either not found or are found at reduced abundance at sites with less than 3-4 mg/L of DO; two "highly sensitive" species are "rarely (black redhorse), if ever (variegate darter) found at [DO] concentrations less than 5 mg/L." *Id*. Using ambient biological data, Rankin states, "to help or adjust criteria such as [DO] takes advantage of the strength of well-founded biological monitoring to integrate the often complex pathways of influence of DO." *Id*. at 15.

During direct communications on January 31, 2006, between Edward T. Rankin, Senior Research Associate, Center for Applied Bioassessment and Biocriteria, Columbus, Ohio, and Roy Smogor, IEPA, Springfield, Illinois, "Rankin caution[ed] against using these numeric values directly; rather, he advise[d] that the relative rankings of the fish species are much more useful." Exh. 23 at 12; *see also* Tr.4 at 35.

Accordingly, DNR and IEPA used the relative DO sensitivities in Rankin (2004) and selected rock bass as a "benchmark species because of its affinity to transitional warm/cool waters." Exh. 23 at 12; Tr.4 at 97-98. The State agencies then explain the interplay between Rankin (2004), the NCD (USEPA, Chapman 1986), and their field experience to arrive at their 31 DO-sensitive fish species:

> all species ranked as equally or more sensitive than rock bass were considered as candidates for a list of Illinois fish species that are more sensitive to low [DO] than channel catfish and largemouth bass and thus require [DO] minima higher than the USEPA (1986) "warmwater" criteria. Rankin (2004) indicates that rock bass are more sensitive to low [DO] than both channel catfish and largemouth bass. *** Of 35 Illinois candidate species indicated in Rankin (2004) as equally or more sensitive than rock bass, eleven were not selected for the list of Illinois sensitive species. Based on their experience with these fishes in Illinois streams, Illinois DNR fisheries biologists believe that these excluded species are not especially sensitive to low [DO], relative to the other species considered. One species (i.e., brook stickleback) indicated in Rankin (2004) as less sensitive than rock bass, is included in the list of sensitive Illinois fishes. Additionally, five species not addressed in Rankin (2004) (i.e., northern brook lamprey, banded sculpin, longnose dace, Ozark minnow, and Iowa darter) were added to the list of sensitive fish species in Illinois. These six species are included based on their affinities to cool, well-oxygenated waters. USEPA (1986) acknowledges that "there is apparently enough anecdotal information to suggest that many coolwater species are more sensitive to [DO] depletion than are warmwater species" [Exh. 2(NCD) at 2] and therefore need incrementally higher protection for [DO]. Exh. 23 at 12-13.

As with fish, the State agencies continue, the NCD's warmwater criteria for DO are appropriate for most but not all Illinois waters, as they "provide insufficient protection for several types of aquatic macroinvertebrates that inhabit a small but significant proportion of Illinois streams." Exh. 23 at 15. DNR and IEPA state that a "macroinvertebrate" means "any invertebrate of a body size that would prevent it from passing through a sieve with mesh size of 595 µm (i.e., U.S. Standard No .30)" and that typical Illinois stream macroinvertebrates include insects, crayfish, scuds, sowbugs, worms, leeches, flatworms, snails, and mussels. *Id*. at 16. The State agencies note that the NCD relied primarily two studies of only a few insects and that scientific literature on how sensitive stream macroinvertebrates are to low DO is very limited. *Id*. at 15.

DNR and IEPA observe that the NCD, with its criteria primarily fish-based, nevertheless recognizes that "[a]cutely lethal concentrations of [DO] appear to be higher for many aquatic insects than for fish." Exh. 23 at 15, quoting Exh. 2 (NCD) at 29. The NCD's recognition that some macroinvertebrates are more DO-sensitive than fish, the State agencies continue, is reflected in the NCD criteria, namely the "coldwater" daily minimum of 4.0 mg/L. The agencies quote the NCD:

> Although the acute lethal limit for salmonids is at or below 3 mg/l, the coldwater minimum has been established at 4 mg/l because a significant proportion of the insect species common to salmonid habitats are less tolerant of acute exposures to low dissolved oxygen than are salmonids. *Id*. at 16, quoting Exh. 2 (NCD) at 33.

Because there are some Illinois macroinvertebrates, according to DNR and IEPA, "as sensitive to low [DO] as those on which this USEPA (1986) 'coldwater' threshold was based[,] a daily minimum of 4.0 mg/l is appropriate for Illinois waters inhabited by these types." *Id*.

To determine the relative sensitivity to low DO of Illinois stream macroinvertebrates, DNR and IEPA used the "Illinois EPA Macroinvertebrate Tolerance List," which "reflects a long history of working with macroinvertebrates in Illinois" to evaluate the effects and extent of pollution. Exh. 23 at 16. The tolerance ratings are based primarily on organic pollution and go from 0 to 11, with a zero rating assigned to taxa found only in "unaltered streams of high water quality" and an 11 rating assigned to taxa known to occur in "severely polluted or disturbed streams." *Id*. at 17. The State agencies maintain that the tolerance rating, though not corresponding to a DO concentration, "does provide a relative ranking of macroinvertebrate sensitivity to primarily [DO]." Id. at 17-18.

The State agencies conclude that some Illinois macroinvertebrate taxa require higher DO minima than the NCD's warmwater criteria because:

> USEPA ([NCD]1986; Table 6, p. 22) includes three macroinvertebrate taxa found in Illinois that require 3.5 mg/l [DO] or higher to survive: *Baetisca laurentina*, *Hydropsyche* sp., and *Neophylax* sp. Additionally, Connolly et al. (2004) found sub-lethal effects on mayflies (order *Ephemeroptera*) when [DO] was in the 25-35% saturation range, which translates to a [DO] concentration of about 3.0 mg/l at the temperatures studied. The sub-lethal effects were related to the failure of some mayflies to emerge into the adult stage; thus, [DO] concentrations that drop to 3.0 mg/l could potentially hamper the sustainability of mayfly populations. *Id*. at 19.

The consensus of IEPA biologists was that macroinvertebrates with a tolerance rating of 3.5 or less (on the 0 to 11 scale) would require DO concentrations higher than the warmwater criteria. Exh. 23 at 18. Ultimately, after review by DNR and IEPA staff, the State agencies arrived at a list of macroinvertebrates that both have the 3.5 or less tolerance rating and occurred in the IEPA macroinvertebrate samples collected from wadeable streams between 2001 and 2004. *Id*. at 19. The list includes mayflies, dragonflies, and beetles. *Id*. at 19, 21.

The State agencies evaluated mussels separately. Acknowledging that there is limited scientific information, DNR identified two mussel species, the Rainbow and the Elephantear, as being "especially sensitive to low [DO] and thus requiring minima higher than the USEPA (1986) 'warmwater' criteria." Exh. 23 at 19. The agencies note that two studies, both from 2001, directly address the DO sensitivity of these two species. Concerning Rainbow mussels, the study (Chen *et al*. (2001)) concluded that they:

> generally live in well oxygenated stream and river riffles[,] exhibited the poorest ability to regulate [oxygen consumption] under conditions of low oxygen availability[, and] DO should probably be higher than 6 [mg/L] to ensure that aerobic metabolism remains relatively unchanged. *Id*. at 19-20, citing Chen *et al*. (2001) at 212, 214 .

Concerning Elephantear mussels, the study (Johnson *et al*. (2001)) concluded that they have "one of the highest mortality rates (82%) of the species studied when exposed to [DO] concentrations below 5 mg/l ." *Id*. at 20.

As discussed, DNR and IEPA "focus on relative rankings—rather than reported numeric thresholds—of [DO] sensitivity as the most valid and useful approach" to select the Illinois fish and macroinvertebrate types that require DO minima higher than the NCD warmwater criteria. Exh. 23 at 22.

IEPA reiterates that the list or subset of General Use waters (about 8% of the General Use stream miles) selected for higher DO standards resulted from the collaboration of DNR and IEPA "experts who know and understand Illinois streams and their resident aquatic life." PC 103 at 3-4. IEPA considers this list of stream segments a "primary feature of updating the current [DO] standard" and "necessary to provide adequate protection for aquatic life in streams throughout the entire state." *Id*. at 3. IEPA stresses that these waters warrant DO levels higher than USEPA's "warmwater" criteria:

> This subset of Illinois waters need higher standards because of a meaningful amount of fish and macroinvertebrates that are more sensitive to low [DO] than the relatively few organisms on which the USEPA's "warmwater" criteria are based. [citation omitted] IEPA and IDNR also testified that the [DO] necessary to protect the aquatic life in this selected subset of General Use waters is intermediate between the "coldwater" criteria and the "warmwater" criteria recommended in USEPA's [NCD]. *Id*. at 4, citing Tr.4 at 33-4.

Smogor of IEPA testified that he conferred with Edward T. Rankin concerning how Rankin's research of Ohio fish and DO could assist DNR and IEPA in identifying fish species that were especially sensitive to low DO. PC 103 at 4, citing Tr.4 at 35. According to IEPA, the two State agencies "then worked together to analyze which stream sites had a meaningful amount of sensitive organisms" (*id*.) and, in turn, "extrapolated the site-specific information" to arrive at the subset of General Use streams proposed for enhanced protection (*id*., citing Tr.4 at 38-45). IEPA asserts that the joint proposal's two levels of recommended DO standards are "based directly on an understanding of the differences in [DO] sensitivities among the biological communities occurring throughout Illinois." *Id*. at 4-5, citing Tr.4 at 122.

<u>Identifying Sites With a "Meaningful Amount" of DO-Sensitive Organisms</u>

Having identified DO-sensitive fish and macroinvertebrates, DNR and IEPA undertook to identify specific stream sites in Illinois that have a "meaningful amount" of these DO-sensitive organisms. Exh. 23 at 33. For fish, the State agencies used fish-community samples collected by DNR from 1994 through 2005, which included data from 1028 stations, including 98 large-river locations. *Id.* at 34. For macroinvertebrates other than mussels, the State agencies used macroinvertebrate-community samples collected in wadeable streams from 2001 through 2004 and available on the IEPA BIOS, including data from 380 stations. *Id.* For mussels, the State agencies used data compiled by the Illinois Natural History Survey from 1980 through 2005, which are based on field collections and museum records. The mussel species examined included those identified by DNR mussel experts as intolerant and riffle-dwelling and the stream locations were limited to where live mussels were present. *Id.* In all, DNR and IEPA evaluated 1110 sites, 329 of which had both fish and macroinvertebrate data, while 699 of the sites had only fish data and 82 of the sites had only macroinvertebrate data. *Id.* at 35.

The State agencies selected four biological measures to characterize each stream site, namely the (1) number of sensitive fish species (or (2) macroinvertebrate taxa) and the (3) proportion of individual fish (or (4) individual macroinvertebrates) that are sensitive. Exh. 23 at 35. (Mussels were separately addressed because their data did not comprise community assessments.) *Id.* DNR and IEPA then determined threshold values for the biological measures used to determine a meaningful amount of sensitive organisms "typical of healthy streams" by calculating the median value from sites identified as "attaining the Clean Water Act goal for aquatic life, referred to as full support." *Id.* According to the agencies, full support waters were chosen to limit the influence of environmental stresses:

> including habitat and chemicals. In large rivers, full support sites were chosen only from sites that fell on the main channel (i.e., not backwaters or side channels). The number of full support sites used to calculate threshold values varied from 45 sites in large rivers (i.e., Mississippi, Illinois, Wabash, and Ohio) to 368 sites for fish in streams and non-large rivers, with 246 full support sites for macroinvertebrates. *Id.*

The threshold values for the biological measures based on full support waters are as follows: for fish in large rivers, two sensitive taxa and 2.63% as sensitive individuals; for fish in non-large rivers or streams, four sensitive taxa and 9.3% as sensitive individuals; and for macroinvertebrates (other than mussels), five sensitive taxa and 6.25% as sensitive individuals. Exh. 23 at 36. The State agencies then compared each of the four biological measures for each site with these threshold values:

> Sites were selected as having a meaningful amount of sensitive organisms if at least two of the four biological measures considered equaled or exceeded the established threshold value for that measure. Sites that had fish-only or macroinvertebrate-only data were eligible for selection if they met or exceeded both thresholds for the available taxonomic group. *Id.*

The State agencies explain that site-specific information for mussels is not directly comparable because of differences in the methods used to collect mussels as opposed to other macroinvertebrates in Illinois streams. Instead, DNR and IEPA selected a site as having a meaningful amount of sensitive mussels present if the site was inhabited by at least one of the two identified DO-sensitive mussel species, *i.e.*, Rainbow mussel or *Villosa iris* and Elephantear mussel or *Elliptio crassidens*). Exh. 23 at 36.

Based on this analysis of fish and macroinvertebrates, DNR and IEPA identified 374 stream sites as having a meaningful amount of DO-sensitive organisms. Exh. 23 at 36, Figure 2.

Identifying Stream Segments for Enhanced DO Standards

DNR and IEPA take the position that having a meaningful amount of sensitive organisms at a site reflects the "need for enhanced [DO] protection at the site *as well as upstream of the site*." Exh. 23 at 38 (emphasis added). The State agencies base their position on the "widely documented knowledge that the physical and chemical properties of the water at a stream site reflect upstream influences." *Id*., citing, *e.g.*, Omemik *et al*. (1981), Smart *et al*. (1981); Hunsaker and Levine (1995), *but see* Allan and Johnson (1997).

DNR and IEPA, however, are unaware of any criteria that can definitively identify the "upstream extent of influence on [DO] for each site of concern." Exh. 23 at 38. The agencies therefore used what they describe as "some simple, practical constraints for extrapolating from site-specific information to upstream stream segments," all to arrive at those stream segments expected to have "meaningful amounts of sensitive organisms" which, in the agencies' opinion, require "enhanced [DO] standards, i.e., minima higher than the USEPA (1986) 'warmwater' criteria." *Id*.

The information primarily relied on by the State agencies to select stream segments for enhanced DO protection consisted of their sets of stream sites at which fish or macroinvertebrate samples indicate the presence or lack of a meaningful amount of sensitive organisms, Illinois streams that are part of the National Hydrography Dataset (1:100,000 map scale) sponsored by the U.S. Geological Survey and USEPA, and U.S. Geological Survey 7.5-minute topographic maps (1:24,000 map scale) for Illinois. Exh. 23 at 38-39.

For other than Illinois' largest streams (Illinois River, Mississippi River, Ohio River, and Wabash River), the agencies established several steps for extrapolating to determine whether stream segments need greater DO protection. Exh. 23 at 39-40, Figure 3. First, proceeding upstream, DNR and IEPA selected for enhanced protection any stream segment collocated with a site that has a meaningful amount of DO-sensitive organisms. *Id*. Second, for stream segments not collocated with, but upstream of, a site that has a meaningful amount of sensitive organisms, the segment was selected for enhanced protection if the following four items were satisfied:

1. The nearest downstream site with sufficient biological information has a meaningful amount of sensitive organisms;

2. The nearest downstream site with sufficient biological information is not a "large river" site (to avoid taking the "concept of upstream influence to an impractical extreme," DNR and IEPA did not select all stream segments that occur upstream of a large-river site with a meaningful amount of sensitive organisms);

3. The stream segment is not smaller than "third order" in size, as most of the site-based fish and macroinvertebrate information used came from third-order streams or larger; and

4. The stream segment is free-flowing, meaning "not obviously part of a lake, reservoir, or large-river backwater." *Id*.

Accordingly, the State agencies continue, for non-large rivers:

> selection of stream segments for enhanced protection proceeded upstream from any site that has a meaningful amount of sensitive organisms . . . . If a site was encountered that has sufficient biological information that indicates lack of a meaningful amount of sensitive organisms, then selection ceased about halfway to that point or at a practical endpoint such as an obvious confluence . . . . In a few cases, stream segments in the vicinity of a site that lacks a meaningful amount of sensitive organisms nonetheless were selected for enhanced [DO] protection because other nearby sites both upstream and downstream have meaningful amounts of sensitive organisms. Exh. 23 at 40-41, Figures 3 and 4.

For large rivers, DNR and IEPA selected for enhanced DO protection those segments that include a site with a meaningful amount of sensitive organisms. Exh. 23 at 41. For the part of Mississippi River comprising navigational pools, DNR and IEPA selected all segments in the same river pool as a site with a meaningful amount of sensitive organisms. For Illinois' other large rivers:

> segments in the vicinity of a site that lacks a meaningful amount of sensitive organisms nonetheless were selected for enhanced [DO] protection for situations in which other nearby sites both upstream and downstream have meaningful amounts of sensitive organisms. *Id*.

The State agencies then generated a list of all stream segments in Illinois selected by them for enhanced DO protection. Using a geographic information system (GIS), each selected stream segment was spatially located. The list provides the stream name and location information on each selected stream segment, including the latitude and longitude values for each starting and ending point and a unique segment number for each pair of starting and ending points. Exh. 23 at 41, Figure 5; Exh. 21; PC 103 at 9..

In turn, the selected stream segments were reviewed by field biologists affiliated with DNR and IEPA and evaluated against additional data on the presence of mussel species. Exh. 23 at 45. According to the State agencies, the limited evidence suggests that riffle-dwelling mussel species are more DO-sensitive than other types (*id*., citing Johnson *et al*. (2001)), and USEPA states in the NCD that "[i]n general, stream invertebrates that are requisite riffle-dwellers probably have a higher [DO] requirement than other aquatic invertebrates" (*id*., citing Exh. 2 (NCD) at 3). DNR and IEPA state that seven intolerant mussel species were identified as primarily riffle- dwelling by mussel experts in Illinois. *Id*., Table 6. The State agencies maintain that their use of fish and non-mussel macroinvertebrate data to select the stream segments for enhanced DO protection is corroborated by the mussels data, as 97% of the locations of riffle-dwelling mussels occur on segments chosen for higher DO standards. *Id*.; Exh. 21; PC 103 at 9.

Responses to DNR/IEPA Proposal to Have Enhanced DO Standards for Designated Stream Segments

The added feature of the joint DNR/IEPA proposal that Streicher of IAWA is most concerned with is the enhanced DO concentrations for selected river segments. Exh. 32 at 7-8. Streicher believes that the DO standard finally adopted in this proceeding should be a sound dissolved oxygen regulation that will be used to develop stream use classifications. It will also be used by IEPA in classifying streams as to attainment or impairment, used to develop TMDLs, and used as the basis for future nutrient rulemaking. *Id*. at 5-6.

According to IAWA, the joint DNR/IEPA "enhanced" water approach should be deferred until there is a scientifically-based, tiered-use proposal, relying on USEPA's guidance for developing tiered-use water quality standards. IAWA states that the record does not support the need for the enhanced water DO standard or provide the basis for designating enhanced water segments. PC 102 at 15.

As a compromise, IAWA states that if the Board finds any merit in the joint DNR/IEPA proposal's enhanced water segments, the Board should adopt only the appropriate DO *standard* for enhanced waters. IAWA asks that the Board not adopt the list of stream segments to receive enhanced DO standards until IEPA or DNR present the scientific and technical basis to justify including a segment or segments for enhanced protection. PC 102 at 15.

IAWA notes that it has already started work on the process of establishing appropriate tiered-use water quality standards. PC 102 at 15. Specifically, IAWA has begun work to develop a potential regulatory proposal to "replace the present one size fits all water quality standard approach with tiered use criteria and appropriate standards." Exh. 32 at 8. This effort includes participation from stakeholders including DNR, IEPA, USEPA, and various environmental groups. The work to date includes starting to identify the appropriate categories based on existing and attainable uses, after which the water quality standards, including DO concentrations, would be developed for each category. *Id*.

Streicher admits that those involved acknowledge that the tiered use process will be complex and take a long time. Exh. 32 at 8-9. Streicher believes that the tiered use work underway is the correct approach to resolving and addressing these complexities. He feels the best approach to take may be using biological criteria as a tool to identify different categories, as other states have and as suggested in the recently-circulated IEPA "White Paper." *Id*. at 9.

Streicher asserts that establishing specific numeric targets for DO without adequate data to support them is "re-creating a flawed and unworkable standard." Exh. 32 at 9. He "caution[s] the Board to be very careful about adopting an arbitrary tiered use or what is called a 'higher level' of waters in Illinois." *Id*. at 9-10 (Streicher later again "caution[s] the Board to be very careful about adopting this beginning of a tiered use system" without appropriately identifying the "correct numbers, the correct stream use categories and the stream[] segments that are appropriate for each category." Exh. 32 at 11. Streicher believes that the participants in this rulemaking seek to "fix a standard that most everyone now agrees is broken" and that standard should not be replaced it with another standard that also has no data to support it. *Id*. at 10.

Streicher further states:

> If the Board were to proceed establishing two tiers of dissolved oxygen standards it could be setting itself up for a future workload when each of the suggested river segments are analyzed and found to not need the suggested 6.25 mg/l dissolved oxygen concentration. Exh. 32 at 10.

Streicher maintains that it "seems extremely arbitrary" how DNR and IEPA arrived at identifying the segments for the enhanced protection. *Id*. He asserts that the proposed stream segments have not been "subject to any ground truthing," pointing out that no continuous DO measurements have ever been performed to show that the suggested 6.25 mg/L DO concentration is "either realistic or attainable in the proposed enhanced segments." *Id*.

According to Streicher, IEPA emphasizes that only 8% of the total length of Illinois stream miles would have the enhanced protection. Streicher argues that this 8% is "spread out across the State in a very widely dispersed sort of pattern." Exh. 32 at 10-11. Streicher believes that these designations should be by "basin or at least by sub-basin." *Id*. at 11. The data are increasingly showing that "habitat should be the characteristic determining which waters receive the designation." Streicher refers to Dr. Mark David as:

> one of the principal investigators working on an Illinois Department of Agriculture project investigating the sources and effects of nutrients in Illinois waters. Specifically, he is working with the Illinois Council for Food and Agricultural Research (C-FAR). While that effort is not yet complete[,] Dr. David was willing to state that his findings show that the greatest influence on biological diversity in Illinois waters is habitat. Diverse and intact habitats result in the greatest diversity of fish and macro-invertebrate communities. *Id.* at 11.

Streicher feels that the proposed 6.25 mg/L enhanced DO standard "is just wrong and is just as broken" as Illinois' current standard. Exh. 32 at 12. He believes it the 6.25 mg/L level is unattainable "even in the least impaired river systems." *Id*. Streicher emphasizes that IAWA DO data, discussed above, show that the 6.25 mg/L value "was not always achieved." *Id*.

Streicher poses four questions:

1. "[H]ow can these river segments support the diversity of fish the IDNR suggests are DO intolerant and [require] the protection of . . . a 6.25 mg/l average DO standard, yet are found in river segments that in fact have been shown do not achieve the 6.25 mg/l average?" Exh. 32 at 12.

2. "Why is it we see lower DO levels yet still find the river supports a diverse population of so called DO intolerant fish and other aquatic organisms?" *Id*.

3. "[W]here are the data to support the agencies position?" *Id*.

4. "Are we just finding a compromise that is not supported by any science?" *Id*.

CICI does not believe that DNR and IEPA have provided "the scientific evidence to support . . . the establishment of river segments that would be subject to an even more stringent standard . . . ." PC 95 at 1.

Thomas Murphy, Ph.D, commented on the NCD as a basis for the proposed standard. Dr. Murphy is an emeritus professor of chemistry at DePaul University, and has been a board member and technical advisor for the Lake Michigan Federation for approximately 20 years. Dr. Murphy observes that USEPA's 1986 NCD for DO (Chapman 1986) contains a disclaimer that most of the data are based on laboratory studies that are not directly applicable to natural situations. Dr. Murphy cites to the problems with this approach documented in the NCD: (1) abundant food is not provided in the wild and fish expend more energy foraging there; (2) in passing additional water over their gills to obtain needed oxygen, fish are exposed to increased amounts of toxins; (3) fish are at increased risk of disease; and (4) fish are at increased risk of predation. Of the three field studies discussed in the NCD (Exh. 2) at 19-20: "These three field studies all indicate that . . . sites with dissolved oxygen concentrations below 5 mg/l have fish assemblages with increasingly poorer population characteristics as the DO concentration becomes lower." Exh. 19 at 2.

Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club support providing enhanced protection for waters with habitat for oxygen sensitive species. PC 101 at 1. Further, these environmental groups agree with the State agencies' assessment of the stream segments. *Id*. at 1, 5. According to the environmental groups, IAWA's basic position against giving "this very modest level of extra protection" to areas harboring DO-sensitive species is to show that low DO concentrations have been found in these waters and argue that the aquatic organisms there "must have adapted to the low DO levels." *Id*. at 5. The environmental groups maintain, however, that:

> the fact that low DO conditions have been found at a few sites in streams with DO sensitive fish does not mean that whole water body could be allowed to fall to that DO level without ecological damage. Most obviously, if the whole Fox River had hit the extremely low DO levels found by some monitoring stations in 2005 and 2006, there would have been no live fish in the river. (Garvey, Nov. 2-3, 2006, Tr. 154-55) Plainly, at that time the fish in the affected

> segments found a place to swim. (Pescitelli and Garvey, Nov. 2-3, 2006, Tr. 34, 155) *Id*. at 5-6.

The environmental groups assert that Leibig's law of the minimum should not be used to "imply that fish must be adapted to every environment, including unstable environments, in which they can be found." *Id*. at 6.

Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club further assert that species populations may be "lost in particular areas and over time," plentiful one year, and scarce the next:

> It would not have been correct for a person in 1870 to look at the huge number of passenger pigeons still around and conclude that the bird had adapted to the European settlement of North America. Similarly, the fact that DO sensitive fish are present in a water segment despite findings of low DO in some reaches of the segment for some period does not prove that the population is not already under some stress and would not be affected if the entire segment were hit with such low DO levels constantly or in combination with high flows, a series of droughts or other stressors. (See Frevert, Cross, and Pescitelli, Nov. 2-3, 2006, Tr. 30-4) PC 101 at 6.

The Illinois Chapter of the American Fisheries Society states that it has reviewed the record and believes that the DNR/IEPA procedures for "earmarking 'Category I' stream segments are sound and scientifically based." PC 100 at 1. According to the Illinois Chapter:

> In formulating their recommendations, IDNR and IEPA relied heavily upon information gleaned by their cooperative basin survey program that has long served as a model for other states. The database amassed by their efforts spans over 25 years and includes well over a thousand individual samples from Illinois streams. Each sample includes data on fish, macroinvertebrates, habitat, and water and sediment chemistry. Although this body of information forms the backbone of the joint agency proposal, it is supplemented by dozens of scientific literature sources, a state-of-the-art Geographic Information System (GIS), and, of course, the collective experience of the dedicated field biologists within each agency who have collected these data over the decades. *Id*. at 1-2.

DNR/IEPA Response to Criticism of Selecting Stream Segments for Enhanced Dissolved Oxygen Protection

DNR takes issue with IAWA's claims that the joint agency process to select stream segments for enhanced DO standards was arbitrary. PC 96 at 3. According to DNR, USEPA's NCD accounts for differences in DO sensitivity among fish and macroinvertebrates by providing "two different levels of DO criteria." *Id*. DNR asserts that the joint-agency proposal for two levels of numeric DO standards is based on "this sound, scientific foundation. *Id*. The State agencies believe that the NCD provides the "basic framework" for determining a new DO standard in Illinois. Exh. 23 at 7.

The State agencies recognize, however, that there are some limits in using information in the NCD to revise Illinois DO standards. Exh. 23 at 5. Based on the information available at the time, DNR and IEPA maintain, the NCD "represented a practicable way of accounting for how different types and life stages of aquatic life were known to differ in their sensitivity to low [DO]." *Id*. at 6-7. The DNR and IEPA, continues the agencies, "build on this [NCD] framework" with information, made available since 1986, pertaining specifically to aquatic life in Illinois waters. *Id*. at 5, 7.

DNR states that it and IEPA reviewed available scientific literature since 1986 "related specifically to the DO tolerance of many types of fish and macroinvertebrates that inhabit Illinois waters." PC 96 at 3. Based on the literature and staff expertise, DNR continues, "we selected a set of species more sensitive to low DO than those protected by the IAWA proposal." *Id*., citing Exh. 23 at 10-21. Again, DNR maintains that the IAWA proposal is inadequate because it "fails to protect for species more sensitive to low [DO] than channel catfish and largemouth bass." *Id*. at 2.

Generally, according to the State agencies, to determine how the NCD criteria apply in Illinois, DNR and IEPA addressed two main questions:

1) Are the USEPA (1986) [DO] criteria sufficient for protecting the most sensitive (to low [DO]) of the numerous types and life stages of fish and macroinvertebrates that live in Illinois waters?

2) If not, then what alternative [DO] criteria would ensure sufficient protection and in which Illinois waters should these higher criteria apply? Exh. 23 at 5-6.

The NCD, according to DNR and IEPA, accounts for differences in DO sensitivity among types of fish or macroinvertebrates by providing "two different levels of [DO] criteria, labeled as: 'coldwater' vs. 'warmwater.'" Exh. 23 at 6. USEPA states in the NCD:

> Criteria for coldwater fish are intended to apply to waters containing a population of one or more species in the family Salmonidae (Bailey *et al*. 1970) or to waters containing other coldwater or coolwater fish deemed by the user too be closer to salmonids in sensitivity than to most warmwater species . . . The <u>warmwater criteria</u> are necessary to protect <u>early life stages of warmwater fish as sensitive as channel catfish</u> and to protect <u>other life stages of fish as sensitive as largemouth bass</u>. *Id*., quoting Exh. 2 (NCD) at 33 (emphasis added).

The State agencies note that besides the differences among species, the NCD "accounts for differences in [DO] sensitivity based on a fish's life stage: early life stages vs. other." *Id*.

According to DNR, the agencies established a detailed process for selecting "threshold values for each biological measure to determine what constituted a meaningful amount of DO sensitive organisms at a site." PC 96 at 3. citing Exh. 23 at Table 5. In turn, DNR explains, these threshold values were applied to "statewide biological databases" managed by DNR and IEPA. *Id*. DNR states that the "extrapolation of site-based analytical results to identify specific stream segments" requiring enhanced DO protection was conducted using "state-of-the-art Geographical Information Systems, or GIS technology." *Id*., citing Exh. 23 at 38-45. DNR concludes that this record shows the joint recommendations to protect DO-sensitive Illinois aquatic species are based on "sound and appropriate biological data collected statewide." *Id*.

Specifically, besides the proposed Level 2 standards, which reflect the NCD according to the State agencies, the proposed Level 1 standards (for approximately 8% of General Use stream miles) include a "daily minimum" (acute) DO level of 4.0 mg/L "to protect Illinois aquatic life that are most sensitive to low [DO] when early life stages of fish are absent." Exh. 23 at 7. DNR and IEPA assert that the 4.0 mg/L concentration is "based primarily on protecting the most-sensitive macroinvertebrates" and is consistent with the NCD, which provides:

> In summarizing the state of knowledge regarding the relative sensitivity of fish and invertebrates to low [DO], it seems that some species of insects and other crustaceans are killed at concentrations survived by all species of fish tested. Thus, while most fish will survive exposure to 3 mg/l, many species of invertebrates are killed by concentrations as high as 4 mg/l. *Id*. at 7-8, quoting Exh. 2 (NCD) at 23.

For the same Level 1 waters, DNR and IEPA recommend chronic DO standards that, in their words, "represent a practical balance." Exh. 23 at 8. The State agencies used "fish species' relative chronic sensitivities (Rankin 2004) and some limited information for macroinvertebrates," while acknowledging that they lacked specific information about "chronic thresholds for the large majority of Illinois organisms." *Id*. DNR and IEPA describe their practical balance:

> This balance primarily reflects that several Illinois fish species are intermediate in chronic sensitivity between sensitive salmonids (i.e., trout, salmon) and the two less sensitive species used as benchmarks for the USEPA (1986) "warmwater' criteria (i.e., largemouth bass, channel catfish). Consequently, Illinois DNR and Illinois EPA simply select [DO] concentrations halfway between the USEPA (1986) "coldwater" and "warmwater" chronic levels. For example, for the period when early life stages are absent, the USEPA "coldwater" threshold for the 7-day mean of daily minima is 5.0 mg/l, and the analogous "warmwater" threshold is 4.0 mg/l. Illinois DNR and Illinois EPA select the midpoint, 4.5 mg/l . . ., as the threshold for "intermediate" waters. *Id*.; Tr.4 at 33-34 (Smogor of IEPA testified that "[s]ome Illinois waters require [DO] levels higher than U.S. EPA's 'warmwater' criteria because of the presence of a meaningful amount of fish or macroinvertebrates that are more sensitive to low [DO] than the relatively few organisms on which U.S. EPA's 'warmwater' criteria are primarily based.").

DNR disputes Dr. Garvey's critique of the joint agency approach to identifying streams for enhanced protection based on DO-sensitive organisms. PC 96 at 6. Dr. Garvey testified:

> Only through experiments that establish causality between oxygen tolerance and fish life processes can tolerance be assessed. Again, these issues have been addressed in previous testimony when I described the research by Smale and Rabeni published in the *Transactions of the American Fisheries Society*. Recall, these investigators used a combination of lab assays and surveys to develop an index of oxygen sensitivity in Missouri streams. *Id*., quoting Exh. 35 at 3-4.

According to the State agencies' Technical Support Document (TSD), DNR and IEPA relied primarily on field-based relations between DO and fish abundance (Rankin 2004) because "traditional experimental information on [DO] is lacking for many Illinois fish species." Exh. 23 at 22. DNR concedes that Smale and Rabeni used a combination of lab assays and surveys, but maintains that Dr. Garvey "neglects to complete the story indicated by the evidence in Smale and Rabeni, as well as other literature." PC 96 at 6. The State agencies quote Smale and Rabeni in the TSD:

> Moreover, particularly for non-toxic substances like [DO], sole reliance on laboratory-based acute thresholds is not recommended. For example, in a laboratory-based study of stream-fish species' acute sensitivities to low [DO], Smale and Rabeni (1995) caution, "Considerable differences have been found between laboratory tolerance values and lethal conditions in natural situations (Moore 1942; Davis 1975). It may not be appropriate to use laboratory measurements to predict specific, numerical values of either hypoxia or hyperthermia that would be lethal to fish in the wild" (p. 699). Other scientists have long recognized this difficulty in applying laboratory-based thresholds of low dissolved oxygen as water-quality standards intended to protect fish in their natural habitats (Aquatic Life Advisory Committee of the Ohio River Valley Water Sanitation Commission 1956 ; Davis et al. 1979; USEPA 1986). Smale and Rabeni (1995) further state, "The complexity of environmental challenges faced by fish in natural situations does not inspire confidence in the applicability of apparently simplistic and reductionist laboratory tolerance data . . . . ***" (p. 711). Exh. 23 at 22-23, quoting Smale and Rabeni (1995) at 699, 711.

DNR maintains that the joint agency approach in identifying Illinois species that are DO-sensitive accounts for these concerns, which also pertain to analogous macroinvertebrate studies, and is fully supported by the scientific literature. PC 96 at 6; Exh. 23 at 23.

Dr. Garvey further criticized the joint agency approach:

> [T]he selection of streams based solely on associations between aquatic organisms and average oxygen concentrations ignores other potential causal factors such as habitat quality, gradient and temperature. Thus, coining these organisms as [']oxygen sensitive['] and then using them to select enhanced [tier] waters may b[e] completely spurious. PC 96 at 6, quoting Exh. 35 at 3.

DNR points to the TSD for a "complete and accurate account of how [DNR] and [IEPA] analyzed associations between fish and oxygen concentrations." PC 96 at 6, citing Exh. 23 at

10-13. DNR asserts that the testimony and scientific literature presented in the record make clear that the "coining of organisms as oxygen sensitive" is not only valid but a concept that the USEPA NCD requires States to address." *Id*. at 6-7.

DNR also responds to Dr. Garvey's claims that standard development should be focused primarily on the physical characteristics of streams. PC 96 at 8, quoting Exh. 35 at 5. Initially, DNR notes that IAWA's Streicher refers to the work of Dr. Mark David with the Illinois Council for Food and Agricultural Research (CFAR). *Id*. at 7, citing Exh. 32 at 11. DNR mentions that according to Streicher, Dr. David indicated that his findings so far, which are not complete, indicate that the greatest influence on biological diversity in Illinois waters is habitat: "Diverse and intact habitats result in the greatest diversity of fish and macro-invertebrate communities." *Id*., quoting Exh. 32 at 11.

DNR states that it "agrees with this research" and has "accepted this premise for a long time in management activities conducted to benefit the State's natural resources." PC 96 at 7-8. However, DNR continues, "biodiversity is not the issue." *Id*. at 8. DNR states that the presence of DO-sensitive organisms at sites in Illinois does not imply that those sites are biologically diverse. *Id*. According to DNR, Dr. Garvey "carries this premise even further" when he states that "stream physical characteristics trump water quality and need to be the primary focus of standard development." *Id*. DNR disagrees with this "broad, general conclusion" and asserts that:

> Water quality improvements over the last 30 or so years, since the enactment of the federal Clean Water Act, have resulted in major improvements in aquatic life in waters such as the Illinois River, where habitat during the same time period has been even further degraded. *Id*.

DNR also addresses one of the primary IAWA concerns with the joint agency proposal: "How can river segments recommended for enhanced protection for [DO] have a meaningful amount of DO sensitive taxa yet fail to meet the proposed [DO] standards?" PC 96 at 8. DNR first states that DO concentration data and biological data "are very different," as the former "only reflects the condition at that point for that particular time period it was collected." *Id*. Biological data, on the other hand, "reflects what the organisms are exposed to regarding stresses over time," according to DNR. *Id*.

DNR explains that minor excursions in DO concentrations for limited time periods may be tolerated. PC 96 at 8, citing Tr.5 at 30-35. If there are severe excursions over longer periods of time, however, DNR asserts that "organisms will seek other refuges in nearby tributaries or segments of stream and return when [DO] levels recover." *Id*. A DNR field biologist testified about observations of this phenomenon in the field "as a result of [DO] excursions." *Id*. Steve Pescitelli, a streams biologist with DNR in the northern section of Illinois, testified that during the extreme drought conditions of 2005:

> there was an intense alga bloom in the Fox River, and in our fall sport fish sampling, we ran across the mouth of the creek and it was extreme high density of fish, primarily large-bodied suckers who are DO sensitive, so there's evidence

> that they do actually find refuge in these areas where there are higher oxygen [concentrations]. Tr.5 at 33-34.

DNR also maintains that differing techniques for collecting DO concentration data and biological data "over microhabitats (riffle, run, pools) can also easily account for this seemingly apparent discrepancy in what the two data sets are indicating." PC 96 at 8-9. Cross of DNR testified that a wide variety of site-specific circumstances might account for "having DO sensitive species present and still an excursion in the DO standard," including "where the probe is in comparison to where the biological samples were actually collected." Tr.5 at 32-33. DNR asserts:

> Some of our most DO sensitive species can survive and thrive in waters that have occasional excursions in dissolved oxygen, however they will not survive long in a system that has dissolved oxygen excursions that occur frequently to 3.5 mg/L and is at a 7 day mean minimum of 4.0 mg/L. PC 96 at 9.

IEPA emphasizes the testimony of Frevert, who testified that when DO levels fall below the proposed standard, organisms may be under stress. PC 103 at 10, citing Tr.5 at at 30. IEPA also emphasized the testimony of Pescitelli, the DNR field biologist who testified that DO-sensitive fish seek areas of higher DO during times of low DO on the Fox River. *Id*., citing Tr.5 at 34.

DNR agrees with the general principles of "Leibig's law," as stated by Dr. Garvey, that "the distribution of all living organisms will not be dictated by average conditions, but rather the availability of the most limiting condition." PC 96 at 10, quoting Exh. 35 at 6-7. DNR takes issue, however, with the conclusion Dr. Garvey draws from Liebig's law. Dr Garvey testified that "[o]nly by identifying the limiting conditions, in other words the acute minimum oxygen concentration can we determine what should be present through time." *Id*. According to DNR, Dr. Garvey's conclusion:

> fails to recognize the significance that Illinois' environmental and natural resource programs place in biological data. The biological data reflects multiple stresses that may be present, and affecting the aquatic community function and structure over time. This is why biological data has been critical for decades, and states such as Ohio and Illinois have relied on the biological data to give a better indication of stream quality as part of monitoring and assessment programs. It is also the fundamental premise for the Illinois DNR and Illinois EPA joint recommendations and why the extensive biological data from both agencies was used in lieu of [DO] concentration data, or other abiotic data such as habitat and temperature. *Id*.

IEPA disputes IAWA's assertion that the proposed joint-agency enhanced standard of 6.25 mg/L for selected stream segments is baseless and nothing more than a compromise. PC 103 at 5 (citing Tr.5 at 76-78). IEPA comments that it and DNR took a "common-sense approach" in arriving at 6.25 mg/L, which is the "midpoint" between USEPA's "coldwater" and "warmwater" chronic criteria. *Id.*, citing Tr.4 at 111, Exh. 23 at 8. According to IEPA, the scientific evidence in the record demonstrates that:

> some types of fish and aquatic macroinvertebrates that live in Illinois streams needed more protection than that provided by the USEPA "warmwater" criteria or by the IAWA proposed standards. However, these Illinois organisms do not necessarily need protection at the highest levels, as required by salmonids (i.e. trout and salmon). *Id.*, citing Tr.4 at 111.

IEPA maintains that selecting the midpoint number between the USEPA "warmwater" and "coldwater" criteria is therefore "reasonable" and "technically sound." *Id.*

Board Findings on Enhanced DO Standards for Designated Stream Segments

"Intermediate" Species

As stated above, the Board places significant weight on fully protecting aquatic life when adopting water quality standards. The Board finds that IAWA's proposed DO standard, which is based on the NCD's "warmwater" criteria, is protective of most aquatic organisms present in general use waters of the State. The Board further finds that a small subset of general use waters, which provide habitat to certain DO-sensitive species of fish and macroinvertebrates, including mussels, requires an incrementally higher DO standard.

DO standards based on the NCD's "warmwater criteria" sufficiently protect most aquatic organisms in Illinois, but they do not adequately protect certain aquatic organisms with DO sensitivity between "coldwater" species (*e.g.*, trout, salmon) and "warmwater" species (*e.g.*, channel catfish, largemouth bass). The NCD recognizes that some "coolwater" species may require more protection than that given by the "warmwater" criteria and may even need to be protected with the "coldwater" criteria.

Illinois has over 160 fish species living in its waters. For example, Illinois streams are inhabited by smallmouth bass, which the NCD identifies as one of the most DO-sensitive of the non-salmonid species tested. Rock bass are also present in Illinois and are more sensitive to low DO than channel catfish and largemouth bass, which species provided the bases for the NCD's "warmwater" criteria. The Board finds that to fully protect aquatic life in Illinois streams, the DO standards must also protect "intermediate" organisms with DO sensitivity falling between that of "coldwater" and "warmwater" species.

Identification of DO-Sensitive Organisms

The record demonstrates that several Illinois species of fish and macroinvertebrates, including certain mussels, have DO sensitivity between the "coldwater" and "warmwater" species considered in the NCD. As described earlier, DNR/IEPA relied in part on Rankin (2004) to identify Illinois stream-fish believed to be most sensitive to low DO concentrations.

Rankin (2004) includes a ranking of relative DO sensitivity for approximately 90 fish species present in Ohio streams, based on extensive field data on fish species and in-stream DO concentrations. The DO sensitivity ranking was established on the basis of DO concentration and relative abundance of each fish species. Rankin (2004) states that there is strong threshold relationship between biological indicators of aquatic conditions and ambient DO. The Board recognizes that the correlative relationship between DO and fish abundance does not provide absolute proof that low DO concentrations result in low abundance. However, given that there is very limited information available on the specific sensitivities of each of Illinois' fish species, the Board finds that Rankin (2004) provides a good starting point for identifying DO-sensitive Illinois fish species. Over 80 of the fish species listed in Rankin (2004) are also present in Illinois streams.

The Board also finds that the State agencies appropriately selected the rock bass as the benchmark species for identifying Illinois DO-sensitive fish species. Rock bass are more sensitive to low DO than both channel catfish and largemouth bass, which represent the "warmwater" threshold in the NCD. Further, according to DNR fisheries biologists, rock bass have an "affinity to transitional warm/cool waters." Exh. 23 at 12. On Rankin's list of DO-sensitive fish species, 35 fish species were equally or more sensitive than rock bass. Based on the knowledge and experience of DNR fisheries biologists, 11 fish species were excluded from the list of 35 Illinois candidate species and 6 Illinois-specific fish species not addressed in Rankin (2004) were added to the list. Exh. 23 at 12.

As Cross of DNR testified:

> Rankin 2004[] was provided to us from USEPA. We used that as the starting point and tailored that to fish species that are also living in Illinois but may not be living in Ohio, so we used it as a starting point, but we had a lot of additional input from DNR fisheries biologists throughout the state that helped modify that basic report from Ohio. The macroinvertebrates and mussel DO sensitive species did not utilize the Ohio report at all. Those were based on other scientific data and information . . . . Tr.5 at 29-30.

As indicated, in addition to fish, DNR and IEPA considered Illinois aquatic macroinvertebrates that are sensitive to low DO. Certain types of macroinvertebrates that inhabit a small proportion of Illinois streams require DO minima higher than the "warmwater" criteria recommended by the NCD. USEPA recognizes the need for higher DO minima to protect macroinvertebrates. The NCD's "coldwater" minimum criteria are intended to be protective of macroinvertebrates.

The State agencies used the tolerance ratings found in "Illinois EPA's Macroinvertebrate Tolerance List" to develop a relative ranking of macroinvertebrate sensitivity to DO. Exh. 23 at 16. Although IEPA's tolerance ratings are based on organic pollution, the Board finds this approach to be appropriate. There is very limited information in the literature concerning the macroinvertebrate sensitivity to low DO. The record indicates, however, that macroinvertebrates that are intolerant of polluted waters are generally intolerant of moderate DO reductions. *Id*. at 17. Additionally, the State agencies limited the DO-sensitive macroinvertebrates to those present in Illinois as indicated by IEPA's sampling from wadeable Illinois streams between 2001 and 2004. *Id.* at 19. The State agencies identified 83 macroinvertebrate taxa as being sensitive to low DO.

Finally, the State agencies also addressed mussels. Exh. 23 at 19-20. The Board finds that the literature studies support their identification of two mussel species, the Rainbow and the Elephantear, as requiring higher DO minima than the NCD "warmwater" criteria.

Sites with Meaningful Amounts of DO-Sensitive Organisms

Upon identifying DO-sensitive organisms present in Illinois streams, DNR and IEPA developed a procedure to assess whether those organisms were present in meaningful amounts. The State agencies considered extensive biological data on Illinois fish and macroinvertebrates, evaluating data from 1,110 sites, of which 329 sites had both fish and macroinvertebrates data, 699 sites had only fish data, and 87 sites had only macroinvertebrate data. Exh. 23 at 34-35. Further, to characterize each site for the presence of DO-sensitive species/taxa, DNR and IEPA used four biological measures based on the number and proportion of sensitive species/taxa present at a stream site. The threshold values chosen for the four biological measures were premised on the presence of DO-sensitive species/taxa and their proportional abundance in healthy "full support" streams. The threshold values were based on the median values of DO-sensitive species/taxa at full support stream sampling sites, which included approximately 400 sites for fish and 246 sites for macroinvertebrates. *Id*. at 35.

The Board finds that a threshold based on the median value of DO-sensitive organisms present in healthy streams is appropriate for determining whether a "meaningful amount" of such organisms is present at each of the 1,110 stream sites evaluated by the State agencies. The use of data from healthy streams reduces the influence of environmental stresses, including habitats and chemicals. Tr.4 at 42. In addition, the Board finds that by selecting only those stream sites that equaled or exceeded the threshold for at least two of the four biological measures, the State agencies' methodology ensured that only sites with meaningful amounts of DO-sensitive organisms would qualify for the enhanced standard. The Board also finds that the presence of one of the two DO-sensitive mussel species at a site constitutes a meaningful amount based on the literature. DNR and IEPA identified 374 stream sites that have a meaningful amount of DO-sensitive organisms. Exh. 23 at 36.

Stream Segments for Enhanced DO Protection

The Board finds that the presence of a meaningful amount of DO-sensitive organisms requires enhanced DO protection both at that site and upstream of that site. A stream site's physical and chemical properties are influenced by upstream impacts. Criteria to definitively determine the extent of upstream influence, however, are not available. DNR and IEPA therefore used the map-based information describe above to identify stream segments expected to have meaningful amounts of DO-sensitive organisms.

Under the DNR/IEPA joint proposal, for other than large rivers (Illinois River, Mississippi River, Ohio River, and Wabash River), any stream segment collocated with a site that has a meaningful amount of DO-sensitive organisms was targeted for enhanced DO protection. From that site, enhanced protection would extend upstream, continuing toward a site where sufficient biological information indicates meaningful amounts of sensitive organisms are lacking. The segment proposed for enhanced standards would culminate either at the halfway point toward that site lacking a meaningful amount of sensitive organisms or at a practical endpoint like an obvious confluence. Exh. 23 at 40.

For stream segments *not* collocated with a site having a meaningful amount of sensitive organisms, the State agencies used four criteria to assess whether enhanced DO protection is warranted. These criteria address the downstream presence of a meaningful amount of sensitive organisms, the size of the stream, and the nature of the stream flow. Additionally, enhanced protection was extended to segments in large rivers having a site with a meaningful amount of sensitive organisms. For the Mississippi River navigational pools, all segments in the same river pool as a site with a meaningful amount of sensitive organisms were selected. For the other large rivers, segments in the vicinity of a site lacking a meaningful amount of sensitive organisms were still selected for enhanced standards in order to address instances where nearby sites both upstream and downstream do have meaningful amounts of sensitive organisms.

The Board finds that DNR and IEPA have taken a reasonable approach to identifying stream segments that should be protected by enhanced DO standards. The approach takes into account the biological data at a stream site and the upstream impacts on that site. The use of the geographic information system (GIS) to spatially locate each stream segment designated for enhanced protection ensures accurate delineation of each stream segment, with latitude and longitude values for each starting and ending point. Approximately 8% of the length of Illinois stream miles would be designated for enhanced protection. Exh. 23 at 1; Exh. 21; PC 103 at 9.

Enhanced DO Standards

The DNR/IEPA joint proposal identifies the enhanced DO standards as “Level 1” standards and they would apply only in the main body of stream segments designated for enhanced DO protection. The proposed “Level 2” DO standards would apply in the main body of other streams, in the water above the thermocline of thermally stratified lakes and reservoirs, and in the entire water column of unstratified lakes and reservoirs. As discussed below, a narrative DO standard rather than any numeric DO standard would apply in quiescent and isolated sectors of general use waters.

As for the enhanced DO or Level 1 standards themselves, during early life stages, the State agencies propose a 7-day mean standard of 6.25 mg/L, which is 0.25 mg/L higher than the corresponding Level 2 standard. Also during early life stages, the Level 1 daily minimum DO standard is 5.0 mg/L, which is the same as the corresponding Level 2 standard.

For other life stages, DNR and IEPA propose an enhanced daily minimum DO standard of 4.0 mg/L, an enhanced 7-day mean minimum DO standard of 4.5 mg/L, and an enhanced 30-day mean DO standard of 6.0 mg/L. Each of these enhanced standards for other life stages is 0.5 mg/L higher than the corresponding Level 2 DO standard. Again, once IAWA agreed to the 30-

day mean for other life stages, the DNR/IEPA-proposed Level 2 numeric values and the IAWA-proposed numeric values became identical.

The Board notes that except for the Level 1 daily minimum standard of 5.0 mg/L during early life stages and the Level 1 daily minimum standard of 4.0 mg/L during other life stages, each of the enhanced DO standards represents the midpoint between the "warmwater" and "coldwater" criteria recommended by USEPA in the NCD. Frevert of IEPA testified:

> [T]he area where we sort of look for middle ground was in an average statistic, not an instantaneous value. *** [W]e believe there's more statistical significance to a smaller increment if you look at it over an average period of time, and to just arbitrarily pick one or the other [*i.e.*, the "warmwater" value or the "coldwater" value] we thought was less sound judgment than finding a middle ground, and an average figure will let you explore the smaller middle ground levels, so that was our logic. Tr.4 at 105-06.

Smogor of IEPA added:

> [T]here are certain species in Illinois that need more protection than the warm water value but they didn't quite need the protection of salmonids, trout and salmon, and so realizing that they were somewhere in the middle, it -- to us it was common sense to pick a middle value. Tr.4 at 111.

Because the enhanced standards are intended to protect aquatic organisms whose DO sensitivity lies between that of "coldwater" and "warmwater" species, the Board finds it appropriate to establish the mean value enhanced DO standards at the midpoint between the "warmwater" and "coldwater" criteria. The Board finds that this is not merely a "compromise" as argued by IAWA, but rather a practical approach reflecting common sense. Given the lack of information on the specific DO sensitivities of Illinois fish species, the Board finds that this approach is reasonable for setting the chronic enhanced DO standards.

The enhanced daily minimum standard of 5.0 mg/L during early life stages is identical to the corresponding NCD "coldwater" and "warmwater" standard, as well as the corresponding IAWA standard. Regarding the enhanced daily minimum standard of 4.0 mg/L during other life stages, the Board finds that the proposed standard, which is at the same level recommended by the NCD for "coldwater" species, is needed to protect the most sensitive Illinois macroinvertebrates. Certain Illinois macroinvertebrates are as sensitive to low DO as some of the taxa considered in establishing the NCD "coldwater" criteria. Tr.4 at 96.

<u>Concluding Discussion on Enhanced DO Standards for Designated Stream Segments</u>

The Board finds that DNR/IEPA's proposal to have enhanced DO standards for designated stream segments is reasonable and well-supported by this record. The process for selecting these stream segments, which constitute roughly 8% of Illinois' general use stream miles, was rational, painstakingly detailed, and contrary to IAWA's claims, not arbitrary.

The State agencies have submitted extensive biological information and expert testimony in support of the proposal. Rankin (2004) provides a reasonable basis for identifying DO-sensitive fish species in Illinois streams. DNR and IEPA have established the presence of "meaningful amounts" of DO-sensitive organisms in specified Illinois streams by relying on extensive fish and macroinvertebrate data from approximately 1,100 stream sites across the State. The Board further finds that to identify stream sites with meaningful amounts of DO-sensitive organisms, the State agencies used reasonable biological measures and properly relied on threshold values based on data from healthy streams. For the Board's task today of setting DO water quality standards at levels that meet the needs of aquatic life, the Board agrees with the State agencies that the biological data and scientific literature on the DO-sensitivity of aquatic life are more helpful than the limited DO datasets emphasized by IAWA.

The Board also agrees with the State agencies' rationale for extrapolating stream sites with a meaningful amount of DO-sensitive species to stream segments by considering upstream influences on stream site conditions. Applying GIS to map the stream segments helps to ensure the accuracy of the spatial location of each segment chosen for enhanced DO protection. Proposed Appendix D to Part 302 lists these stream segments by basin name, segment name, segment number, end points by latitude and longitude, and county. The Board solicits comment on MWRDGC's suggestion that these stream segments also be identified by "river mile."

The Board finds that the enhanced DO standards proposed by DNR and IEPA are appropriate for protecting Illinois aquatic organisms whose DO sensitivity is between that of "warmwater" and "coldwater" species. An alternative to the DNR/IEPA-proposed enhanced standards would be to protect Illinois DO-sensitive organisms using USEPA's "coldwater" criteria, as suggested in the NCD. The Board finds, however, that the joint proposal properly adapts the NCD to Illinois streams based on the literature, the biological data, and the State agencies' vast field experience. As Frevert of IEPA testified, the joint proposal recommends "an incrementally higher DO for aquatic communities that we know from the rest of our biological science prefer higher DO conditions." Tr.5 at 29-30. Of course, any discharger maintaining that the enhanced DO standards are not necessary for a given stream segment may seek site-specific relief from the Board as provided in the Act, such as by adjusted standard or site-specific rule (415 ILCS 5/27, 28.1 (2006)).

Finally, the Board disagrees with IAWA's position that any consideration of enhanced DO standards must be deferred to a future rulemaking that addresses tiered-use water quality standards. The Board is aware of both IAWA's and IEPA's efforts to develop a framework for establishing tiered aquatic life use water quality standards. The development of those standards, however, is at a very early stage and may take a long time to come to fruition. As Frevert of IEPA testified:

> That C-FAR [Council for Food and Agricultural Research] research or nutrient research, some of the wetlands work we're doing, some of our own evolution and our monitoring programs, everybody here at the table recognizes we're going to know more about dissolved oxygen five or ten years from now than we do now, and we fully expect that the dissolved oxygen standard is warranting of additional review as time and knowledge moves forward. Our position is that we know

> enough now to know we can make a significant incremental improvement over the standard we placed on the books [35] years ago. Not that it's perfect, but that it is a major step forward, and we intend to follow that up and we assume there'll be future steps. I want to caution everybody to wait for the next study because there's always going to be a next study. Tr.4 at 130.

Given the record in this rulemaking, the Board finds no reason to postpone adoption of enhanced DO standards until the tiered aquatic life use standards are developed.

DNR/IEPA PROPOSAL TO INCLUDE JULY IN EARLY LIFE STAGES

DNR and IEPA state that USEPA's recommendations in the NCD for DO " are clear in the need to protect for early life stages of fish." Exh. 23 at 23. As the current Illinois DO water quality standards were adopted years before the 1986 NCD, they "do not specifically address these early life stages through a defined sensitive season." *Id*. The State agencies recommend an additional 30-day period (through July 31) as necessary to protect the early life stages of fish, in contrast to IAWA's recommended date of June 30. Tr.4 at 44.

Specifically, IEPA states that the joint agency proposal recommends a "longer early life stages present period (i.e., extending through July 31)" to protect early life stages of fish and "ensure the long-term survival and viability of Illinois fish species," including smallmouth bass and channel catfish. PC 103 at 6, citing Tr.4 at 44, Exh. 23 at 23-31. Cross of DNR states:

> In general, by July 31, all late spawning fish species will have a substantial majority of their spawning and fry development into dates when higher [DO] standards will be in effect. Even though some larvae will be present into August, Illinois DNR fisheries managers believe the July 31 date should not be detrimental to the overall recruitment of a year class for fish species. Tr.4 at 44.

In contrast, according to Cross, IAWA's proposed June 30 cutoff protects only the majority of spring season spawns, but neglects to include the summer season spawns and a 30-day period to protect post-hatch embryonic and yolk-sac fry development. *Id*.

DNR maintains that IAWA's proposal to end the sensitive stage at June 30 "fails to provide adequate protection for early life stages." PC 96 at 3. USEPA's 1986 NCD for DO, IEPA notes, emphasizes the need to protect early life stages. PC 103 at 6. DNR also cites the NCD, where USEPA defines early life stages including "all embryonic and larval stages and juvenile forms to 30-days following hatching." PC 96 at 3, citing Exh. 2 (NCD) at 34. DNR maintains that the joint agency recommendation:

> for an additional 30-day period (through July 31) necessary to protect early life stages of fish, is based on extensive spawning information and data from six authoritative texts which represent nearly 100 years of fish species spawning information. *Id*. at 3-4, citing Exh. 23, Table 4.

DNR emphasizes that there is a clear "biological need" to extend enhanced protection for early life stages through July, rather than ending in June as IAWA proposes. *Id*. at 4. According to DNR, the June 30 ending date of IAWA "neglects to include protection for post-hatch embryonic and yolk-sac development as required by USEPA" in the NCD. *Id*., citing Exh. 2 (NCD). In IEPA's words, "[b]ased on the scientific literature, IAWA's June 30 cut-off date likely fails to provide sufficient time for the protection of post-hatch and embryonic and yolk-sac fry development for several Illinois fish species." PC 103 at 6, citing Tr.4 at 44, Exh. 23 at 26-31.

DNR contrasts its "extensive compilation of spawning information" (citing Exh. 23 at Table 4) with the testimony of IAWA's expert witness, Dr. Garvey, who "attempts to describe spawning strategies in Illinois fish." PC 96 at 4, citing Exh. 23 at 24. Many of the fish species evaluated by Dr .Garvey, according to the State agencies, are "spring spawners." Exh. 23 at 25. Based on review of the literature for Illinois fish species, the State agencies addressed fish that spawn either in the late spring (*i.e.*, may spawn into late June) or primarily in the summer. *Id*.

DNR and IEPA state that late spring spawners include channel catfish and smallmouth bass, both of which are important for Illinois recreational fishing. Exh. 23 at 25. The agencies note that:

- Simon and Wallus (2003) stated that channel catfish "yolk-sac larvae and early juveniles were collected mid-May through August with peaks in June and July in the Tennessee and lower Ohio Rivers." *Id*., quoting Simon and Wallus (2003) at 100.

- The Michigan Department of Natural Resources (Michigan DNR) has documented spawning periods for smallmouth bass between late April and early July in Michigan. For smallmouth bass in Wisconsin, Simonson (2001) reports spawning periods from mid-May through June.

According to the TSD, first-hand knowledge and field observations by DNR resource managers support the findings of Simon and Wallus (2003), Michigan DNR (2004), and Simonson (2001). *Id*. In Illinois, the State agencies add, studies confirm that smallmouth bass spawn from mid-April through late June with the main spawning period in June. *Id*., citing Smith (1979); Sallee *et al*. (1991).

To identify fish species that are summer spawners, DNR and IEPA relied on published text of the natural history of fishes from Illinois (Smith 1979), Missouri (Pflieger 1997), Virginia (Jenkins and Burkhead 1994), Tennessee (Etnier and Starves 1993), Wisconsin (Becker 1983), and Arkansas (Robison and Buchanan 1988), focusing on species common to Illinois. Exh. 23 at 25-26. The State agencies defined the "spawning period" as the time of egg deposition and fertilization, excluding the other early life stages of embryonic and fry development. *Id*. at 26, Table 4.

The State agencies emphasize that two of the fish species with summer spawning periods, the bigmouth shiner and the stonecat, were identified by DNR and IEPA fisheries scientists and resource managers as "more-sensitive to low [DO] than most other Illinois stream-fish species." Exh. 23 at 26, Table 4. DNR and IEPA conclude that generally, by July 31:

> all late spawning fish species will have a substantial majority of their spawning and fry development into dates when higher dissolved oxygen standards will be in effect. Even though some larvae will be present into August, Illinois fisheries managers believe the July 31 date should not be detrimental to the overall recruitment of a year class for fish species. *Id*.

According to the State agencies, their proposed additional 30-day period is necessary to protect the summer spawners and the early life stages of Illinois fish. The IAWA proposal of ending the enhanced DO standard on June 30, continues DNR and IEPA, while protective of the majority of spring spawners, "neglects to include the spawning period of the 'summer' spawners, and neglects to include a 30-day period for protection of post-hatch embryonic and yolk-sac fry development." *Id*. at 26-27.

Dr. Thomas of DNR's Illinois Natural History Survey stated that "many fish continue to spawn until later in the summer, and sunfishes and bass in particular will re-nest a number of times if early attempts to spawn fail or are delayed." Exh. 13 at 2.

Responses to DNR/IEPA Proposal to Include July as an Early Life Stage

IAWA objects to what it characterizes as the joint DNR-IEPA proposal's "arbitrary" inclusion of July in the "cool weather months" that would be subject to the more stringent DO limits. Exh. 32 at 14. Streicher states that the entire dataset presented shows that DO levels throughout Illinois in July routinely fall below that found in the cooler months. He claims that July is a "hot month with resulting increases in water temperature and lower DO saturation." *Id*. According to Streicher, including July in the early life stage:

> means the establishment of a DO limitation that is currently not being attained, is generally not attainable and one which will lead to expenditures of public funds to attempt to meet an unattainable goal. *Id.*

Dr. Garvey testified that latitudinal differences in spring warming in Illinois might influence when sensitive early life stages are present. Exh. 16 at 5-6, Att. 5. Dr. Garvey presented a December 12, 2004 draft study of his regarding how the temperature available for spawning fish differed between northern and southern Illinois streams. Dr. Garvey found that by June 30, most fish in southern Illinois likely have completed spawning, while most spawning in northern Illinois may not be initiated until late June, with 95% initiating spawning by early July in the north. Previous research published by Drs. Garvey and Stein shows that most production of larval gizzard shad and bluegill occurred before July in central Ohio reservoirs. *Id.* at 6, Att. 7.

Dr. Garvey asserts that species spawning in the summer must be able to tolerate occasionally low DO concentrations or they would not persist in nature. He says the fact that streams in violation of the current DO standard are listed as containing sensitive species by DNR supports this suggestion. Exh. 16 at 6. In February 2005, Dr. Garvey conducted an exercise to show why offspring produced before June 30 would likely contribute disproportionately to fish production. *Id.*, Att. 8. According to Dr. Garvey, this study was based on his peer-reviewed literature demonstrating that the earliest spawned fish in an annual cohort likely have the highest survival. A paper published by Drs. Garvey, Herra, and Leggett (2002) shows that only the oldest and largest sunfish present during the fall survived to spring. Dr. Garvey states that this pattern does appear to hold generally among species. *Id.*, Att. 9. Dr. Garvey concludes that the June 30 end point for the south and perhaps July 15 for the north is sufficient to provide protection for most fishes spawning in the state. *Id.* at 7.

Dr. Garvey later suggests that "[e]vidence is mounting" that the majority of reproduction of Illinois aquatic organisms either occurs before July 1 or late-spawning organisms have early life stages tolerant of low DO. Exh. 35 at 3. According to Dr. Garvey, based on this record, streams meeting IAWA's proposed DO standards for July through February (daily acute minimum of 3.5 mg/L and seven-day average of daily minima of 4 mg/L) appear to contain robust and diverse biological assemblages while those streams that do not meet those standards are typically impaired. *Id*.

IAWA argues that Dr. Garvey's testimony supports the proposed date of June 30 to move from the early life stage DO standard to the DO standard applicable for the remainder of the year. PC 102 at 5. IAWA notes that Dr. Garvey's analysis of existing data shows that DO levels in July decline below 6.0 mg/L and 5.0 mg/L. While certain species continue to reproduce in July and some species reproduce throughout the year, IAWA contends that Dr. Garvey's testimony shows that these species have substantial reproduction during cooler months to ensure natural recruitment. *Id.* IAWA asserts that Dr. Garvey is a recognized expert whose testimony should be controlling in deciding the cut-off date for the early life stage period. *Id.* at 14.

Considering the data on breeding periods for fish, Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club support extending the early life stage through July to protect July spawners:

> IEPA/IDNR science is based on a lot more data than the IAWA Proposal as to breeding periods for fish. IEPA and IDNR looked at species across the state and a broad range of species. (Ex. 23) *** On the other hand, the IAWA Proposal, a "one size fits all standard" as to the relevant water bodies, is based almost entirely on studies of fish in southern lllinois supplemented recently by one study of a backwater lake near Grafton. (Garvey, Nov. 2-3, 2006, Tr. 126) Further, IAWA argues that most fish complete most of their breeding before July without breaking down the larval periods for species (Garvey Nov. 2-3, 2006, Tr. 177-78) or recognizing that the known late spawn may be important for species to compensate for high flow periods in spring. (Pescitelli, Nov. 2-3, 2006, Tr. 35-7) PC 101 at 3-4.

These environmental groups also respond to what they characterize as IAWA "implicitly" arguing that it would be "cheaper for Illinois dischargers" to have a June 30 cut-off date for the early life stages timeframe:

> This suggestion should be rejected because it is not supported by any economic data. (See Streicher, Aug. 25, 2005, Tr. 61) Indeed, for this argument to make sense there must be a number of dischargers that would face substantial costs to meet the current standard in July that they would not incur if they only had to meet the current standard in June and a 3.5 mg/L standard in July. It is particularly hard to imagine how this could be done given, first, that many dischargers are currently discharging to water bodies known to violate standards in June, a month that everyone agrees should continue to be governed by the 5 mg/L minimum and, second, that IEPA only very rarely uses the DO standard in permit writing. (Frevert, Nov. 2-3, 2006, Tr. 255-6) *Id*. at 4.

The Illinois Chapter of the American Fisheries Society states that it has reviewed the record and believes that the DNR/IEPA procedures "to select a protected spawning/post-spawning period . . . are sound and scientifically based." PC 100 at 1.

DNR/IEPA Response to Criticism of Including July as an Early Life Stage

DNR disagrees with Dr. Garvey's conclusions that:

> Evidence is mounting that the majority of reproduction of aquatic organisms in Illinois [either] occurs before July 1 (see Csoboth 2006 thesis, SIUC: Exhibit 1) or late-spawning organisms have early life stages that are tolerant to low [DO] concentrations. PC 96 at 4, quoting Exh. 35 at 3.

According to DNR, the Csoboth 2006 thesis, cited above by Dr. Garvey, is "limited in geographic scope and cannot be extrapolated to all water types in all parts of the State." PC 96 at 4. Further, DNR asserts that the testimony of DNR biologists and the extensive data and scientific literature provided and cited by DNR contradict Dr. Garvey's opinion about late-spawning organisms having low-DO tolerant early life stages. *Id*., citing Tr.5 at 35-40, Exh. 23 at 24-26. DNR quotes from the USEPA's NCD, which states: "The warm water criteria are necessary to protect early life stages of warm water fish as sensitive as channel catfish . . . ." *Id*. at 4-5, also citing Exh. 23 at 6. It is DNR's position that it has provided evidence showing channel catfish spawning through July 31 (citing Exh. 23 at Table 4), which "demonstrates that it is absolutely necessary to provide the additional 30-day protection." *Id*. at 5.

IEPA similarly disputes the testimony of Dr. Garvey that whatever spawning occurs toward the end of the spawning period (in many cases July and August) is largely unimportant to the well-being of the species. PC 103 at 7, citing Tr.3 at 79-100, Exh. 6, Attachment 8; Exh. 23 at 24. According to IEPA, Dr. Garvey's position is not supported by the literature for Illinois fish that spawn either in the late spring or primarily in the summer, or by the first-hand knowledge and field observations of DNR. *Id*., citing Exh. 23 at 25-31.

IEPA maintains that protecting early life stages through July 31 ensures that "all later-spawning fish species will have completed a substantial majority of their spawning and fry development during the time when appropriate higher dissolved oxygen standards are in effect." PC 103 at 6, citing Tr.4 at 44, Exh. 23 at 23-31. According to IEPA, to protect all Illinois fish in

General Use waters adequately, the early life stages must include "not only the typical early spawning period, but also part of the late spawning" because "in some years [when early season spawning is unsuccessful for any of many environmental causes], the relative importance of the late-spawned fish is much greater than in a typical year when the majority of recruitment comes from the earlier-spawned individuals." *Id*. at 6-7, citing Exh. 23 at 24-25. In such instances, according to the State agencies, the late season spawning "may provide the only individuals recruited to the population in that year." Exh. 23 at 24.

IEPA points out that the NCD allows for less restrictive DO standards during times of the year when sensitive life stages of fish are not expected to be present, but only if the State can demonstrate that the "recommended periods accurately reflect the conditions present in the State." PC 103 at 13. In this respect, IEPA asserts that IAWA's proposal is "under-protective" and that only by adopting July 31 as the end date for the sensitive life stage will the Board be consistent with the NCD and protective of aquatic life. *Id*.

Board Findings on July as Early Life Stage

The Board agrees with both IAWA and the State agencies that the early life stages of fish must be protected with higher DO standards, as recommended by the NCD. Although the NCD recommends DO criteria for early life stages, the NCD does not recommend a specific time period during which the higher standards should apply. According to the NCD, early life stages include all embryonic and larval stages and all juvenile forms to 30-days following hatching. Exh. 2 (NCD) at 34. The NCD states that the early life stages criteria are intended to apply only where and when these stages occur. *Id.* at 33. The NCD therefore indicates that states should adopt such standards when state-specific fish spawning information is available to define the early life stages period.

As discussed above, the record contains sufficient fish spawning data and expert testimony to support the adoption of DO standards for the protection of early life stages of fish in Illinois. The only issue that needs to be resolved relates to defining the seasonal time period when early life stages are present in Illinois waters. IAWA's proposal specifies an early life stages period starting on March 1 and ending on June 30. DNR and IEPA propose a longer period by extending the early life stage period to the end of July.

IAWA relies primarily on Dr. Garvey's testimony for limiting the early life stages period to June 30. Dr. Garvey's initial recommendation notes that IAWA's proposed early life stages time period protects spring spawning fish and accounts for fluctuations and reduced DO levels during the summer months. Exh. 1 at 36. Further, Dr. Garvey contends that non-spring spawners have adaptations that allow them to persist under natural oxygen concentrations expected during the summer. *Id.* Dr. Garvey also asserts that occasional declines in the survival of late spawning in species with extended reproduction have relatively small effects on overall production. Exh. 16, Att. 8 at 4.

In his later testimony, Dr. Garvey states that:

> By June 30th, most fishes in Southern Illinois likely have completed spawning. In the northern half of the state, most spawning may not be initiated until late June. Spawning in the central portion of the state likely occurs during mid June. Exh. 16 at 6.

While Dr. Garvey maintains his position that late spring or summer spawners persist in nature by adapting to the natural decline in DO levels, he concludes that a "June 30th cutoff for the south and perhaps July 15th for the north is sufficient to provide protection for most fishes spawning in the state." *Id.* at 7.

IAWA nevertheless maintains that inclusion of July in the early life stages period, which includes the cooler weather months, is arbitrary because the DO monitoring data show that DO levels in July fall below that found in cooler months. IAWA contends that the more stringent DO standard applicable to early life stages is generally not attainable in July because of higher water temperature and lower DO saturation.

The State agencies' proposal extends early life stages to July 31 to afford protection for late spring and summer spawners. DNR and IEPA note that Dr. Garvey's assertions regarding the significance of late spawning are valid only if critical spawning periods have passed and early spawning is not affected by changes in typical natural conditions. Exh. 23 at 24. However, in years where early spawning is affected by various environmental stressors, the State agencies observe that recruitment to the population may come only from "late" season spawning.

Pescitelli, streams biologist with DNR, testified that while "we can debate the percentages," it is "clear that there's lots of species that spawn after July 1." Tr.5 at 36. Pescitelli also took issue with Dr. Garvey's position that late spawners contribute insignificantly to the species population:

> these smaller stream and river fish, the way they're spawning, to avoid high flow, and if you look at the flow records, at least in northern Illinois, there is -- June is a very high flow month and that the enemy of a spawning fish is floods, and that may not be true in a large river system, but in a small river system it's true, and these big flash floods disrupt the spawning act itself, flush eggs into areas that are not suitable for incubation. So these fish actually delay spawning until July and August when the flows are more stable. That's their strategy, and for those species, they contribute the largest portion of the population continuing into the future, so there's a whole -- and there's a whole bunch of these species now. They do, as Dr. Garvey said, spread their spawning out, some of them, at least, and the reason for that is to try to hedge against high water flows, not, as he says, to hedge against dissolved oxygen problems later in the season, because we don't see those in a natural stream in August. We don't see dissolved oxygen problems in a natural stream; at least I never have. I have seen them in October and November. There's a lot of leaf matter in the stream and there's no flow, so they're not in a rush to get done before August because there's no DO in August, because there is plenty. Tr.5 at 36-37.

The DNR/IEPA fisheries scientists evaluated the available literature for late spawning Illinois fish to determine whether such species must be afforded additional protection. The spawning data compiled by the State agencies show that a number fish species have late spring or summer spawning periods. DNR and IEPA state that some of the late spawning species, such as channel catfish and smallmouth bass, have recreational (fishing) significance in Illinois and two of the summer spawning species, the bigmouth shiner and stonecat, have been identified as being more sensitive to low DO than most other Illinois fish species. Exh. 23 at 25-26. The State agencies contend that by extending the early life stages period to July 31, "all late spawning fish species will have a substantial majority of their spawning and fry development into dates when higher dissolve oxygen standards will be in effect." *Id.* at 26.

The Board finds that while the fish spawning data and expert testimony presented by IAWA generally address the protection of early life stages of spring spawners, the proposal does not provide adequate protection for late spring and summer spawners. Moreover, even for the majority of spring spawners, the early life stages time period proposed by IAWA does not include a 30-day period to protect post-hatch embryonic and yolk-sac fry development. The Board believes that the early life stages time period must be established on the basis of fish spawning and fry development data that address Illinois fish assemblages, including late spring and summer spawners.

The Board finds that including July in the early life stages time period, as proposed by the State agencies, provides important protectionto Illinois fish species that spawn during the late spring and summer. Significantly, the July 31 end date affords 30-day post hatch protection for spring spawners, which was not taken into account by the IAWA proposal. The July 31 end date comes 16 days after the July 15th end date suggested by Dr. Garvey for northern streams. Given that a large number of Illinois fish species spawn during the late spring and summer, and some of them have recreational significance, the Board finds it appropriate to extend the early life stages period through July.

Finally, the Board reiterates that when adopting a water quality standard, the Board places significant weight on fully protecting aquatic life. The Board will not decline to extend critical DO protection because of IAWA concerns about the attainability of more stringent early life stages standards in July. This is particularly so as IAWA's assertions are based on DO data that is, as discussed above, from a small number of monitoring locations, limited in geographic coverage, and varying in quality and monitoring objectives.

DNR/IEPA PROPOSAL FOR A NARRATIVE STANDARD

DNR and IEPA observe that their proposed DO standards include "absolute, instantaneous thresholds called 'daily minima.'" Exh. 23 at 32. The State agencies acknowledge, however, that this type of "acute water-quality standard reflects an unrealistic, idealized expectation" because:

> In reality, under some natural conditions, [DO] concentrations are likely to drop to levels normally expected to be acutely harmful to aquatic life. In surface waters, [DO] concentrations are influenced directly or indirectly by numerous

> interacting environmental factors, including temperature, atmospheric pressure, light intensity, ice cover, water clarity, and photosynthesis and respiration of plants and animals. Particular combinations of these factors can result in low [DO] levels unrelated to human impacts. *Id*.

According to DNR and IEPA, stratification in lakes and low flow in streams during summer and fall, for example, can result in DO "depression." Exh. 23 at 32, citing Hynes (1970). Aquatic life can be meaningfully affected, continue the agencies, by "acute or chronic differences as small as 0.5 to 1.0 mg/l" DO. *Id*. These small but critical differences "coupled with relatively high natural variability confound the ability to select [DO] thresholds (i.e., water quality standards) that can consistently distinguish deleterious human impacts from natural influences on aquatic life." *Id*. DNR and IEPA further state that these difficulties have been widely recognized by developers of DO water quality standards (Aquatic Life Advisory Committee of the Ohio River Valley Water Sanitation Commission (1955); Davis (1975); Davis *et al*. (1979); Truelson (1997)), including USEPA in its NCD. *Id*. at 32-33, citing Exh. 2 (NCD) at 28.

DNR and IEPA maintain that useful DO standards for Illinois must accommodate "the reality of how [DO] naturally varies through time and across locations in Illinois." Exh. 23 at 33. The State agencies propose an "additional narrative part of the [DO] standards" to address these concerns. *Id*. Frevert of IEPA testified that the numeric standards:

> apply in the main body of a stream. In other words, we're not restricting applicability . . . of those values to either pool or riffle stretches; rather, it applies throughout. The obvious departure from this uniform application applies to isolated areas such as backwater sloughs and portions of lakes and reservoirs below the thermocline where lower oxygen concentrations can be expected to occur naturally. Tr.4 at 27.

Frevert clarified that the "offensive conditions" language, as proposed by the State agencies, would (1) apply in wetlands, sloughs, backwaters, and below the thermocline in lakes and reservoirs, and (2) not modify the application of 35 Ill. Adm. Code 302.203. Tr.5 at 15-16. The first sentence of the proposed DNR/IEPA narrative standard, according to Frevert, was included to "show that we're not abandoning the existing standard for offensive conditions." Tr.4 at 62.

Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club express concern about how the various terms in the narrative standard would be interpreted. The environmental groups identify terms such as "quiescent", "lake" and "isolated" as vague. PC 101 at 7. According to Frevert's testimony, the proposed use of the word "quiescent" is "intended to describe the state of motion of a water that is still and where there is no or minimal mixing or diffusion at the air/water interface," while the term "isolated sector" is "intended to describe a water body that is separate from the main river or stream flow [and is] not intended to refer to the presence of dry areas between the main river and the isolated sector." Tr.5 at 13.

The State agencies propose to add a definition of "thermocline," meaning "the plane of maximum rate of decrease of temperature with respect to depth in a thermally stratified body of water." PC 103 at 7. Frevert testified that waters with "thermoclines" are waters that "seasonally thermally stratify and in which a maximum rate of temperature change with depth can be determined by measuring temperature at equal depth intervals from the surface to the bottom." Tr.5 at 12. Smogor of IEPA testified that a "thermally stratified" body of water is one:

> that because of differences in temperature from the surface to the bottom, the water takes on a different density with temperature, and in the summer that happens and sometimes also happens in the winter. So water has certain properties whereas it lowers in temperature towards about 4 degrees celsius, it increases in density, and as it goes from 4 degrees celsius down to 0 degrees celsius, actually, its density decreases. That's why ice floats. So as water gets colder, it sinks to the bottom until it gets even colder, and then it goes back to the top, and that's why water freezes from the top down. In the summer and in the winter, because of these density differences, there's a stratification. There's strata of different densities of water with the heaviest water on the bottom, the most dense water on the bottom and the least dense water on the top. Tr.4 at 53.

Matt Short of IEPA's Surface Water Section testified that when IEPA conducts lake surveys, it measures water temperature, DO, pH, and conductivity "every two feet, starting at the surface and all the way to the bottom, until two feet off the bottom." Tr.5 at 20.

Frevert testified about the numeric DO standards' inapplicability below the thermocline:

> the DO standards apply in those upper stratas. While we cannot expect to meet DO in the lower isolated water bodies simply because the aerating dynamics don't exist, it's clear above that thermocline, and those DO standards do apply. *** A body that's deep enough and the energy or the dynamics are not conditions to have thorough mixing, you're going to have a zone in a lower area which cannot maintain oxygen. We're trying to acknowledge that. Tr.4 at 58-59.

A lake also can be stratified at some times of the year but then not at other times, Frevert added:

> Seasonally the lake can be fully mixed and you don't have a stratified condition, so you also need to show -- if you're applying the [numeric DO] standard above stratification, above the thermocline, there needs to be a thermocline for that concept to hold, and sometimes there isn't. Tr.4 at 60.

Frevert described the "natural ecological functions" of lakes and reservoirs below a thermocline as follows: transforming and decomposing organic material and mineralizing inorganic particles. Tr.5 at 15. As for "resident ecological communities" that are natural below a thermocline in a lake or reservoir, Frevert commented: "Benthos consists primarily of midges and worms. Other dipterans may also use this zone but are less common." *Id*.

Frevert further testified on the scope and meaning of the narrative standard:

> Regarding the single sentence in the proposed regulatory language that includes the terms wetland, slough and backwater, Illinois EPA intended merely to provide a general description and some common examples of locations at which it is not necessary to achieve the explicit numeric criteria to ensure natural and healthy aquatic life. These types of locations are outside of the main body of a stream or outside of the area above the thermocline in waters that seasonally thermally stratify. *** In using the terms "lake" and "reservoir," Illinois EPA intends . . . these terms to represent waters in which thermal stratification occurs regularly on a seasonal basis and in which a thermocline can be determined by measuring temperature at equal depth intervals from the surface to the bottom. Tr.5 at 13-14.

The Board notes that the proposed narrative DO standard has two components: one to protect the ecological function of quiescent and isolated sectors of general use waters, and another to ensure that offensive conditions do not occur in any general use waters. As to the former, the Board finds that under certain natural conditions unaffected by deleterious human activities, dissolved oxygen may periodically decline below numeric standards to concentrations typically considered acutely harmful to aquatic life. USEPA observed this phenomenon in its NCD:

> Naturally-occurring [DO] concentrations may occasionally fall below target criteria levels due to a combination of low flow, high temperature, and natural oxygen demand. Under these circumstances the numerical criteria should be considered unattainable, but naturally-occurring conditions which fail to meet criteria should not be interpreted as violations of criteria. Although further reductions in [DO] may be inadvisable, effects of any reductions should be compared to natural ambient conditions and not to ideal conditions. Exh. 2 (NCD) at 28.

To address these unavoidable situations, one component of the proposed narrative standard requires that quiescent and isolated sectors of general use waters, such as wetlands and waters below the thermocline in lakes, be maintained at sufficient DO concentrations to support their natural ecological functions and resident aquatic communities. This provision reflects the:

> recognition of why we cannot attain and we don't believe it's reasonable to expect to attain the standards we set for the bulk of the general use waters in Illinois. There are isolated areas where the physical and chemical and biological circumstances are such that you cannot maintain that standard. Nevertheless, you must maintain sufficient oxygen that you don't have other problems develop, like odors and things of that nature. Tr.4 at 61-62 (quoting Frevert).

The numeric standards for DO proposed today do not apply in these quiescent and isolated sectors, but rather only in the main body of streams, in the water above the thermocline of thermally stratified lakes and reservoirs, and in the entire water column of unstratified lakes and reservoirs. The Board agrees with IEPA that this narrative provision will supplement the numeric DO standards, helping to ensure that environmentally acceptable conditions are provided "throughout the full spectrum of General Use waters." Tr.4 at 25 (quoting Frevert).

The other component of the proposed narrative standard cross-references the existing Board regulation at Section 302.203 on offensive conditions. The Board finds that this narrative provision eliminates any potential doubt that even with the new DO standards, general use waters at all locations must still maintain sufficient DO concentrations to prevent offensive conditions. Tr.4 at 62. Section 302.203, entitled "Offensive Conditions," provides:

> Waters of the State shall be free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth, color or turbidity of other than natural origin. The allowed mixing provisions of Section 302.102 shall not be used to comply with the provisions of this Section. 35 Ill. Adm. Code 302.203.

After submission of the joint DNR/IEPA proposal, IAWA asked that the Board adopt the narrative standard and the "thermocline" definition proposed by DNR and IEPA. PC 102 at 1. There is no opposition in this rulemaking record to these provisions. The Board finds that the narrative standard proposed by the State agencies is a necessary and appropriate supplement to the numeric standards. The Board includes the proposed narrative standard and related definition of "thermocline" in the first-notice proposal.

DISSOLVED OXYGEN SATURATION VERSUS CONCENTRATION

Dr. Murphy's Proposal to Use Percent Saturation

Dr. Murphy raises the issue of mathematically relating percent saturation and concentration in mg/L, stating that they are not equivalent measures of the availability of oxygen to organisms. Dr. Murphy explains while DO is often reported in mg/L concentration, the percent saturation or oxygen tension should be used to express the availability of oxygen to organisms. Dr. Murphy suggests that the DO water quality standard be based on oxygen availability using the percent saturation rather than the concentration. Exh. 19 at 2. According to Dr. Murphy, the percent saturation is what an organism experiences. Exh. 27 at 3.

Reviewing USEPA's 1986 NCD for DO (Chapman 1986), Dr. Murphy notes that most of the reports of DO concentrations in the NCD do not include the temperature of the measurement, which precludes determining the percent saturation of dissolved oxygen. Exh. 27 at 1; Exh. 31 at 2. Dr. Murphy cites to a reference book on the principles of respiratory physiology by Pierre Dejours (1981), *Principles of Comparative Respiratory Physiology*. Dr. Murphy states that the book discusses gas exchange in organisms, including fish and other aquatic organisms. In chapters relevant to aquatic organisms, Dr. Murphy counted 88 equations that related to gas exchange or transport in the functioning of organisms. Dr. Murphy emphasizes that in each equation, the gas was expressed in units of pressure; gas concentration in mg/L was not used. Exh. 27 at 2.

Dr. Murphy points out the proposed standards and supporting documents are based on units of mass in mg/L. According to Dr. Murphy, there is a proportionality between pressure units and mass units, and the proportionality factor differs depending on temperature. Exh. 27 at 3. Dr. Murphy explains that oxygen has a higher solubility in cold water than in warm water, such that 100 percent oxygen saturation is 14.6 mg/L at 0°C and at 7.5 mg/L at 30°C. Therefore, Dr. Murphy calculates that waters at 0°C with 7.5 mg/L are 51 percent saturated. *Id*.

Relating oxygen saturation to fish health, Dr. Murphy quotes Davis, John C. (1975), "Minimal DO Requirements of Aquatic Life with Emphasis on Canadian Species: A Review," *Canadian Journal of Fisheries and Aquatic Sciences*, 32,2295-2332:

> It must be emphasized that . . . fish require both the correct oxygen tension (pressure) gradient to move O_2 into the blood and sufficient oxygen (per unit volume of water breathed) to fulfill the requirements of metabolism. Exh. 31 at 3.

Dr. Murphy also refers to recommended DO criteria for the protection of fish populations, emphasizing that Davis (1975) recommended criteria in units of percent saturation, not mg/L. Exh. 27 at 3, citing to Davis (1975) at 32,2295-2332.

Dr. Murphy explains the transfer of gases between phases (such as between air and water across the water surface, or between water and a fish across a gill surface) is driven by the difference in partial pressure of the two phases. Exh. 31 at 2. The concentration of oxygen dissolved in the water is a function of the pressure of oxygen in the atmosphere as well as the temperature and salinity of the water. *Id*. More oxygen, continues Dr. Murphy, is required to saturate water at 0°C than at 25°C, making oxygen more available to an organism at warmer temperatures than cooler ones. *Id*. Dr. Murphy calculates that a concentration of 4 mg/L DO represents 53% saturation at 30°C and 27% saturation at 0°C. *Id*.

Dr. Murphy proposes reevaluating the DO data in the record in terms of percent saturation and revising the proposed standards. According to Dr. Murphy, to account for oxygen saturation at differing temperature ranges, the DO standard (in mg/L) could be set higher for the lower temperatures. Exh. 31 at 3. Dr. Murphy suggests dividing the DNR/IEPA-proposed tiers into three or more sections, each covering a limited temperature range, and setting separate DO standards for each temperature range based on the percent saturation. Using the percent saturation, Dr. Murphy states the corresponding mass of oxygen could be determined and used as a proxy for a pressure-based standard. Exh. 27 at 4-5, Exh. 31 at 3.

<u>Responses to Dr. Murphy's Proposal to Use Percent Saturation</u>

As for using saturation to determine DO criteria, IEPA states that the "methodology [is] substantially different than that used by IEPA and IDNR." PC 103 at 15. IEPA maintains that there is "no connection between this recommendation and the needs of the fish found in Illinois streams." PC 103 at 15.

MWRDGC states that DO has been expressed as mg/L in water quality standards since before the Clean Water Act of 1972 and is currently expressed that way throughout the United States. PC 98 at 1. MWRDGC points to the testimony of Dr. Murphy where he indicates that a DO saturation level of 47% or greater is protective. *Id*., citing Tr.5 at 51-52. MWRDGC states that Dr. Murphy did not provide evidence specific to Illinois showing DO saturation during the August - February period is limiting or harmful to fish, or that conditions become bad for fish below 47%. According to the MWRDGC, the needs of fish change during this time of year. PC 98 at 1.

MWRDGC also asserts that concentration and percent saturation are proportional so the standard could be based on either, but that there is no sound theoretical reason for assuming that the availability of DO to fish is better represented by percent saturation than by concentration. PC 98 at 2.

At the time of the November 2006 hearing, Louis Kollias was the Director of Research and Development for MWRDGC. Exh. 41 at 2. He responded to the testimony of Dr. Murphy concerning percent saturation. *Id*., citing Tr.3 at 185-193, Tr.4 at 170-172. According to Kollias, USEPA's NCD noted that a committee of scientists, established by the Research Advisory Board of the International Joint Commission, reviewed the DO criterion for the Great Lakes. The committee concluded that a criterion based on dissolved oxygen concentration was preferable to one based on percent saturation (or oxygen partial pressure). The committee reasoned the rate of oxygen transfer across fish gills is directly proportional to dissolved oxygen concentration, and that the total amount of oxygen delivered to the gills is a more specific limiting factor than is oxygen partial pressure *per se*. Kollias states that USEPA agreed with this conclusion. Exh. 41 at 2, referring to Exh. (NCD) at 2.

Citing Davis (1975), Kollias reiterates that partial pressure, percent saturation, and concentration of DO are all interrelated. Kollias continues citing Davis (1975), stating that fish require both the correct oxygen tension (pressure) gradient to oxygen into the blood and sufficient oxygen concentration (amount per volume of water breathed) to fulfill the requirements of metabolism. According to Kollias, the majority of monitoring data and data in the scientific literature relating to fish are based on DO concentration in mg/L. Exh. 41 at 2.

Kollias adds that DO concentration is easier to measure and control. Kollias states that controlling DO concentration through supplemental aeration and mechanical means is possible, but controlling oxygen tension is much more difficult and oxygen saturation can be extremely variable. Exh. 41 at 2.

<u>Board Findings on Use of Percent Saturation</u>

In the introduction of the NCD, USEPA discusses how DO criteria proposed by various agencies and researchers have generally reflected two basic schools of thought. Exh. 2 (NCD) at 1. One involved a dynamic approach where the criteria would vary with natural ambient DO minima or with the DO requirements of fish in terms of percent saturation. *Id*. This is similar to the approach proposed by Dr. Murphy. The other approach maintained that a single minimum allowable concentration should adequately protect the diversity of aquatic life. *Id*. The NCD ultimately supported a two-concentration criteria (a mean concentration and minimum concentration in mg/L). *Id*. at 2, 34.

The NCD characterizes the two-concentration criteria as a "more simplistic approach" than dynamic variable criteria expressed as percent saturation. Exh. 2 (NCD) at 1-2. When trying to apply the more simplistic approach, the NCD states that expressing the criteria as a percent saturation:

> could often result in unnecessarily stringent criteria in the cold months and potentially unprotective criteria during periods of high ambient temperature or at high elevations. Oxygen partial pressure is subject to the same temperature problems as percent saturation. *Id*. at 1.

The "temperature problems" arise because temperature is not one of the specific parameters in the simpler approaches of the two-concentration national criteria or the similarly crafted IAWA or DNR/IEPA proposals. Temperature is only indirectly reflected in the seasonal assignments of differing life stages. The "unnecessarily stringent" or "potentially unprotective" issues arise because a similarly simple DO criteria (mean and minimum) expressed as a percent saturation would not reflect the dynamics of an additional parameter for temperature variability. Although Dr. Murphy proposed a dynamic approach that would involve using three or more temperature ranges within each of the life stages and tiers and using mg/L as a proxy for percent saturation, the NCD considers using a criteria in terms of mg/L easier to administer than percent saturation. *Id*.

According to the NCD, the amount of DO available to aquatic organisms is also expressed more directly in terms of mg/L than percent saturation. Exh. 2 (NCD) at 1. As Dr. Murphy testified, "[e]verybody uses milligrams per liter because that's what you're measuring." Tr.3 at 201. Percent saturation must be calculated and requires temperature data and a proportionality factor. Exh. 27 at 2; PC 83 at 2; Tr.3 at 202. As Kollias of MWRDGC observed, most DO data from monitoring and in the scientific literature relating to fish are based on mg/L. Exh. 41 at 2.

As to what a fish "experiences," Dr. Murphy and Kollias both quote Davis (1975), which emphasizes that fish require both the correct oxygen tension (pressure) gradient and sufficient oxygen (per unit of water breathed). Exh. 31 at 3; Exh. 41 at 2. The NCD also references Davis (1975), and the related conclusions of the committee established by the Research Advisory Board of the International Joint Commission are summarized in the NCD. Exh. 2 (NCD) at 1-2. The committee found that "the rate of oxygen transfer across fish gills is directly dependent on the mean difference in oxygen partial pressure across the gill." *Id*. at 2. The committee further found that "the total amount of oxygen delivered to the gills is a more specific limiting factor than is oxygen partial pressure per se." *Id.*

Although dissolved oxygen concentration, partial pressure, and percent saturation are all interrelated, the Board finds that relying on a criteria based on concentration in mg/L is the more direct and practical approach. The Board relies on the findings of the committee set forth in the NCD as described above. As to the supporting body of scientific evidence, currently most DO monitoring data and the scientific literature regarding fish are based on mg/L. Additionally, the two-concentration criteria structure presented in the NCD and followed in the IAWA and DNR/IEPA proposals represents USEPA's preferred approach to date.

PROPOSED 6.5 mg/L DISSOLVED OXYGEN

The one modification to the DNR/IEPA proposal suggested by Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club is to include a minimum DO level of 6.5 mg/L when water temperature is 10°C or below. The environmental groups rely on Dr. Murphy's testimony to arrive at the 6.5 mg/L DO value to address concerns about oxygen saturation levels. PC 101 at 7, citing Tr.5 at 52.

Although the environmental groups state that the "practical problems of considering percentage saturation can be overcome by using technology no more complex than a thermometer," they suggest instead using a standard that relies on measurement in mg/L. PC 101 at 7. The environmental groups reason that sufficient DO saturation could be ensured during periods of cold temperature if the DNR/IEPA proposal were modified to include a minimum DO level of 6.5 mg/L when water temperature is 10°C or below. *Id.* The environmental groups estimate the proposed modification would not affect many streams or dischargers because discharges from sewage treatment plants raise ambient water temperatures in the winter. *Id.*

DNR commented on the original proposal of the environmental groups, made at the November 2006 hearing, that there be a minimum DO concentration of 6.5 mg/L from December through March for both Level I and Level II waters under the DNR/IEPA proposal. PC 96 at 11. DNR recognizes that the proposed addition is based on Dr. Murphy's testimony, in which he expressed concern that the revised standard would not ensure sufficient DO for aquatic life during low temperatures. *Id.* If the Board is going to adopt a minimum DO concentration of 6.5 mg/L, DNR encourages the Board to consider basing the standard "on a temperature basis, when water temperatures reach 10 degrees centigrade or below, in lieu of the calendar months of December through March." *Id.* Of course, the environmental groups modified their proposal accordingly, as explained above.

The Board notes, however, that according to DNR, it is likely that the physiological needs of aquatic organisms at low temperatures are lessened because of "lower metabolic rates during these cold periods." PC 96 at 11. The Board further notes that, as IEPA observed, no one in this proceeding had previously suggested that the Illinois' current DO standard of 6.0 mg/L is inadequate to protect Illinois aquatic life, "rather that it inadequately addresses the natural variability of [DO]." PC 103 at 15. Moreover, USEPA's NCD does not appear to contemplate a temperature-triggered DO standard.

The Board finds that there is simply not enough evidence in this record to demonstrate that a 6.5 mg/L DO standard whenever water temperature is 10°C or lower is necessary or appropriate to supplement the numeric and narrative standards described above for Illinois general use waters and being proposed for first notice today. The Board invites public comment on whether other states with conditions similar to Illinois have adopted numeric DO standards whose applicability is based explicitly on water temperature.

IMPLEMENTATION CONCERNS

Monitoring and Calculating

When compared to Illinois' existing DO standard, IAWA states that its proposed standard would require more extensive DO monitoring and may require using continuous monitors. Statement at 2. IAWA's proposal includes language on monitoring. IAWA proposed that the "mean minimum" DO level "should be based on a data recorder or representative grab samples" and that the "mean" DO level "should be based on data collected by semi-continuous data loggers or estimated from the representative daily maxima and minima values."

Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club express concern that implementation procedures for defining averages and providing monitoring have not been developed in the record. PC 101 at 2, 7. For example, questions remain as to whether IEPA will develop implementation rules to require continuous monitoring, predawn monitoring, or monitoring with certain safeguards. The environmental groups state that this might impact whether water bodies are included in the TMDL list because monitoring that only occurs during daylight hours would not show that a water body has adequate DO levels at all times. *Id*. at 8.

Lanyon of MWRDGC indicated that the joint DNR/IEPA proposal is unclear if the daily mean would be calculated based on seven consecutive days or any seven days in the five-month period. Exh. 25 at 11. Similarly unclear are the calculations for the 7- and 30-day averages, according to Lanyon. *Id*. at 12. Referring to MWRDGC's current water quality monitoring efforts in the Illinois Waterway between Peoria and Lockport, Lanyon notes that MWRDGC would not have sufficient data to calculate 7- and 30-day averages. *Id*. at 13.

Lanyon comments that the DNR/IEPA-proposed definition of "daily mean" may have little practical value unless IEPA expands its monitoring program or requires permittees to conduct more frequent monitoring. Exh. 25 at 13. MWRDGC's ambient water quality monitoring program collects samples monthly, which would not be sufficient for calculating a daily mean or 7- or 30-day averages. *Id*. Kollias of MWRDGC states that the proposed rules need clarification as to what method should be used to calculate the 7-day daily minimum, 7-day daily mean, and the 30-day average of daily means, as well as how many sample points must be maintained. Exh. 41 at 8. Lanyon testified that a "protocol" should:

> address both time and space issues, time in terms of how often one samples, what interval of data is used, whether it's monthly, daily, hourly, 15 minutes, or in terms of space as to what segment -- or what point in the reach one should monitor, should it be the upstream end of the reach, the downstream end of the reach. Since the State has gone to the extent of dividing up our waterways into water body segments or assessment units, as they were referred to today, we should have some clarity as to where in these segments or units we should be performing the monitoring. Tr.4 at 151.

Permits

In response to a question about how compliance with the joint-agency proposed DO standards would be determined, Frevert of IEPA testified:

> Compliance determinations will be made by direct measurement of the resource where the standard applies. Compliance of specific discharges will be based upon the enforceable discharge limitations contained with each facility's NPDES [National Pollutant Discharge Elimination System] permit. [Regarding] stream assessments performed pursuant to the Clean Water Act [303(d)] requirements, the Agency is assessing the degree of attainment or support of the aquatic use. To the extent that the aquatic community shows signs of impairment, DO measurements will be used to determine whether oxygen stress is a potential cause or contributor to the observed impairment. Tr.5 at 16-17.

As for point source dischargers located immediately upstream of proposed enhanced DO segments, IEPA states that it "does not intend to modify its approach to permit issuance." Exh. 22 at 3. Specifically, according to IEPA:

> In most instances authorization of point source discharge containing deoxygenating material, limits for Biochemical Oxygen Demand are based upon direct application of technology based treatment limits specified in state effluent standards, federal secondary treatment requirements for domestic sewage and federal "categorical" effluent limits for industrial wastewater dischargers. In the case of lagoon exemptions for smaller facilities there is a provision to relax technology based requirements if it can be demonstrated that water quality standards would be attained with the relaxed limits. Should the standards change, the demonstrations supporting issuance of a lagoon exemption would be compared to whatever the new standard becomes. *Id*.

Further, IEPA states that it does not routinely establish DO limits in NPDES permits, unless the discharge is a "substantial or dominant portion of the stream flow below the point of discharge." Exh. 22 at 3. In these instances, IEPA notes, the DO water quality standard will be violated immediately downstream of the discharge point "if the oxygen content of the discharge itself is substantially below the standard." *Id*. As a matter of practice, IEPA has:

> applied a minimum oxygen content limit for the discharge based upon the need to meet the stream standard and as a readily available and affordable technology. IEPA anticipated few if any permitted discharges in the state where the dominance of discharge relative to the base stream flow will be changed by any action by the Board. Should the standard change, particularly through inclusion of a seven day average, permit limits may be adjusted to coincide with the standard average, but the need to assure an oxygenated discharge will not change. *Id*.

Although not before the Board at this time, Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club raise the issue of permit limits for deoxygenating wastes. PC 101 at 2. Frevert testified that the DO water quality standard was only rarely, if ever, used to set permit limits because the Agency uses instead the deoxygenating waste rule to establish permit limits. *Id*. at 10. The environmental groups are concerned about low DO levels in waters that receive high levels of sewerage discharges because the "tightest" discharge limit under 35 Ill. Adm. Code 304.120 is 10 mg/L $CBOD_5$. *Id*. The environmental groups mention that other states use models to determine the limits for deoxygenating wastes, and suggest Illinois do the same. *Id*. at 11.

Board Findings on Implementation Concerns

The Board appreciates the concerns of the participants over how the new DO standards will be implemented, as well as IEPA's perspective on the permitting process. At one point in this proceeding, back on July 21, 2004, Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club filed a "motion to suspend consideration of proposed amendments to the dissolved oxygen standard pending development of draft implementation rules." Ultimately, these environmental groups withdrew their motion.

The Board notes that, on occasion, draft IEPA"implementation procedures" have been made part of a Board rulemaking docket setting a water quality standard. *See* Revision to Antidegradation Rules: 35 Ill. Adm. Code 302.105, 303.205, 303.206, and 102.800-102.830, R01-13. Before withdrawing their motion to suspend the DO rulemaking, Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club cited an ammonia rulemaking, Triennial Water Quality Review: Amendments to 35 Ill. Adm. Code 302.202, 302.212, 302.213, 304.122 and 304.301 (Ammonia Nitrogen), R94-1(B), as an example of a proceeding in which IEPA should have filed draft IEPA implementation procedures to avoid subsequent confusion with permitting. Mot. to Suspend at 4. The Board agrees with IEPA, however, that the ammonia standard itself, which varies with the temperature and pH of the receiving stream, necessitated a permitting process for ammonia discharges that was "unusual and uncomparably complicated." IEPA Resp. to Mot. to Suspend at 4 (Aug. 6, 2004).

The Board further agrees with IEPA that developing or adopting IEPA implementation "rules" is not necessarily a prerequisite to USEPA approval of these DO water quality standards. IEPA Resp. to Mot. to Suspend at 4-5. Moreover, Frevert of IEPA testified that he does not anticipate IEPA adopting any regulations on DO sampling:

> I don't anticipate any agency rules on that. We certainly establish our own field practices and field methodology, and we may identify some guidelines there for applications in certain types of circumstances, but that -- again, that's our field methods and manuals. That's not a regulation or an agency rule. Tr.5 at 253.

The new DO standards will now include 7- and 30-day averages to help ensure that aquatic organisms are not subject to chronically low DO. This critical enhancement to Illinois' current standard alone is expected to lead to additional monitoring beyond that presently performed to determine compliance with 6.0 mg/L during 16 hours of any 24-hour period and 5.0 mg/L at any time. As discussed below, the proposed first-notice amendments will describe how to assess attainment of the DO mean and minimum values. The DO data needed to make these assessments will no doubt inform the eventual monitoring process. As IEPA pointed out early in this rulemaking, the temporal detail and measurement techniques necessary to determine compliance with the DO standard are "an inherent part of the standard itself, not separate implementation procedures." IEPA Resp. to Mot. to Suspend at 3 (Aug. 6, 2004).

On carrying out a measuring program to determine attainment of the DO standard, Frevert testified:

> It is their responsibility to assure that the way they design their monitoring system and the way they collect their data, it is truly representative, not misrepresentative of the normal variation. You can't go out and get three samples at nine at night, ten o'clock at night and eleven o'clock at night and pretend they represent the full 24-hour period. And I'm not trying to specify how many samples is the minimum to do it correctly. I think that would be a difficult or impossible task, but you must -- if you're collecting data and you're using it to draw conclusions or make assertions about compliance with this standard, it's your responsibility to look at the representativeness of your monitoring scheme and its statistical reliability. Tr.4 at 75-76.

IEPA has stated in this record that DO is not routinely included as an NPDES permit effluent concentration and that even for dischargers located immediately upstream of stream segments selected for enhanced DO protection, IEPA does not plan to modify its permit issuance approach. According to Frevert:

> The DO standard that we've selected for any particular stream, whether it be tier one or tier two, is based on our understanding of the relative sensitivity of the biological community that we believe is there. That in and of itself is not going to have much, if any, impact at all on permit limitations, so we would do a normal permitting. If indeed the stream is impaired, whether it be in a level one or level two classification, and a point source is a significant contributing factor to it, I'm not sure the answer to that is immediately go and try to tweak the permit. It's try to figure out what's going on and to what extent that treatment facility is really not adequately controlling their waste, and we're not going to know that, and I don't believe whether the stream falls in tier one or tier two is going to make any difference in the way we treat that situation. Tr.4 at 122-23; *see also* Tr.5 at 254-56 (less than 1% of Illinois NPDES discharge permits have conditions requiring in-stream monitoring to assess DO attainment; the vast majority of the permits have discharge limits of 10 or 20 mg/L $CBOD_5$ set under the deoxygenating waste (35 Ill. Adm. Code 304.120)).

Having carefully reviewed the record and prior relevant rulemaking precedent, the Board is not convinced that any monitoring or permitting requirements for the new DO standards need to be a part of this docket. This docket has appropriately developed to the point where the Board can propose what the dissolved oxygen condition of Illinois general use waters should be. That task of the Board's is "fundamentally different [from] . . . day-to-day implementation and management and monitoring and enforcement decisions." Tr.1 at 142-43 (quoting Frevert). The Board finds that the focus of this proceeding should remain on the water quality standards themselves, the adoption of which should not be delayed.

The Board finds that subsection (d) of the DNR/IEPA-proposed Section 302.206 provides a detailed account of how to assess attainment of daily mean and minimum DO values. For example, the "daily mean" is described as "the arithmetic mean of dissolved oxygen values measured in a single 24-hour calendar day," while the "daily minimum" is described as "the minimum dissolved oxygen value as measured in a single 24-hour calendar day." By way of illustration and for context, the proposed numeric DO standards during August through February (*i.e.*, non-early life stages) for most general use waters would be 3.5 mg/L "at any time," 4.0 mg/L as a "daily minimum averaged over 7 days," (*i.e.*, the 7-day mean minimum), and 5.5 mg/L as a "daily mean averaged over 30 days" (*i.e.*, the 30-day mean). The proposed DO numeric standard during March through July (*i.e.*, early life stages) for most general use waters would be 6.0 mg/L as a "daily mean averaged over 7 days" (*i.e.*, the 7-day mean).

The Board agrees, however, with MWRDGC and the environmental groups that subsection (d) could benefit from specific language on how to assess attainment of the 7-day mean minimum, the 7-day mean, and the 30-day mean. The joint proposal's approach of referring to the daily mean or minimum "averaged over [7 or 30] days" is potentially subject to conflicting interpretation. To address this concern, the Board has added language adapted from the joint DNR/IEPA TSD on determining the 7- and 30-day values. Set forth in subsections (d)(5)-(7), the Board proposes the following for first notice:

1. The 7-day mean minimum is "the arithmetic mean of daily minimum dissolved oxygen values from the current and previous 6 calendar days."

2. The 7-day mean is "the arithmetic mean of daily mean dissolved oxygen values from the current and previous 6 calendar days."

3. The 30-day mean is "the arithmetic mean of daily mean dissolved oxygen values from the current and previous 29 calendar days."

TECHNICAL FEASIBILITY AND ECONOMIC REASONABLENESS

Lanyon of MWRDGC commented on the Use Attainability Analysis (UAA) being conducted by IEPA for the Chicago Area Waterways (CAWs) and the Lower Des Plaines River (LDPR). MWRDGC is a principal participant in the UAA. The UAA, Lanyon explains, includes approximately 90 miles of mostly secondary contact and indigenous aquatic life waters (to which these proposed DO standards would not apply), but also some general use waters. The UAA waters are impacted by combined sewer and stormwater overflows containing bacterial contamination and oxygen-demanding substances. Exh. 25 at 3-4; Exh. 40 at 2-3; Tr.4 at 158-59.

These UAA locations, according to Lanyon, meet the water quality standards most of the time, except for bacteria and DO. Lanyon attributes the lack of compliance with the current DO standard to the combined sewer and stormwater overflows, runoff from nonpoint areas, warm water temperatures, and low velocities in the CAWs. Exh. 25 at 3-4; Exh. 40 at 2-3. Lanyon attributes DO compliance difficulties in the CAWs to the oxygen demanding substances in the water reclamation plant effluents, which account for approximately 70% of the annual flow leaving the CAWs at Lockport. Exh. 40 at 3.

For these reasons, MWRDGC finds it necessary to provide supplemental aeration in waterways downstream of effluent outfalls to meet the applicable standard. Exh. 25 at 4; Exh. 40 at 4. MWRDGC is currently investigating the engineering feasibility and cost of additional supplemental aeration facilities to achieve DO concentrations of 4.0, 5.0, and 6.0 mg/L in the CAWs. Exh. 25 at 8. Preliminary results indicate such costs would probably exceed $100 million. *Id.* Even under the DNR/IEPA proposal, the urban-impacted streams (Des Plaines, Little Calumet, North Branch, and Salt Creek Rivers identified in Exh. 25, Att. 4.) do not all fare well by Lanyon's estimation. Exh. 25 at 14.

As part of the CAWs UAA Study, Lanyon states that MWRDGC has evaluated feasible technologies to address the DO deficiencies during warm weather, which run from $200 to $360 million on a present worth basis. Exh. 40 at 3. Wet weather-related DO deficiencies will be addressed by the MWRDGC's Tunnel and Reservoir Plan (TARP), expected to be completed in 2019. *Id*. at 2-3.

Lanyon addressed the variability of DO throughout the day in the Chicago Waterway System (CWS), the waterways that receive treated effluents from the Calumet, Lemont, North Side, and Stickney Water Reclamation Plants. Exh. 25 at 4. Variation of DO throughout the day due to photosynthetic activity is slight in channel reaches with continuous flow, and Lanyon attributes this to turbidity preventing the penetration of light. In reaches where there is little or no flow, diurnal variation can be as much as 5 mg/L with a minimum DO concentration of zero. *Id*. at 5.

To determine how well the CAWs would comply with the proposed DNR/IEPA standards, Kollias of MWRDGC summarized DO measurements from MWRDGC's Continuous Dissolved Oxygen Monitoring (CDOM) Program. For the August 2005 through February 2006 period, eight of twelve shallow water CDOM locations were 100% compliant, as were five of twenty deep-draft locations. For the March 2006 through July 2006 period, two of twelve shallow water CDOM locations were 100% compliant, as was one of the twenty deep-draft locations. Exh. 41 at 6-7. Kollias asserts that this analysis gives insight into the impact of the joint DNR/IEPA proposal. *Id*. at 8-9.

Lanyon believes that of all the monitoring locations in the CAWs, only one location, the Chicago River at Clark Street, is expected to be able to meet the DNR/IEPA-proposed standard. Exh. 40 at 4. Lanyon argues that any proposal must carry "a reasonable chance that compliance will occur." Exh. 25 at 15. Lanyon recommends, for urban-impacted and CSO-impacted streams, a "waiver" provision be created to allow time to study the affordability and feasibility of compliance alternatives. *Id*.; Exh. 41 at 9. Lanyon also suggests a "separate wet weather standard" that would apply following stormwater runoff, allowing reduced DO levels for a limited time period. Exh. 25 at 15; Exh. 41 at 9.

To meet the DO standards that result from the UAA Studies, Lanyon indicates that MWRDGC is planning to add supplemental aeration facilities to its capital improvement program. Lanyon explains that when a proposed rulemaking for the CAWs comes before the Board in the future, it will include some other water quality standard than is being proposed by either the IAWA or DNR/IEPA. Exh. 40 at 4-5.

The Board appreciates the MWRDGC's insights into the UAA and its comments on the dissolved oxygen issues in the CAWs, LDPR, and CWS. A new DO standard has the potential to primarily affect wastewater dischargers (*e.g.*, POTWs, industrial dischargers, and agricultural point and nonpoint sources) that discharge oxygen-depleting substances, including BOD and nutrients. Tr.4 at 80-84; Statement at 2.

Section 27(a) of the Act directs the Board to take into account the "technical feasibility and economic reasonableness of measuring or reducing the particular type of pollution" when conducting a substantive rulemaking. 415 ILCS 5/27(a) (2006). The new DO standard likely will indirectly impact technical and economic issues for particular pollutants in discharges. Section 27(b) of the Act requires the Board to determine whether a proposed substantive regulation "has any adverse economic impact on the people of the State of Illinois." 415 ILCS 5/27(b) (2006). The Board finds that the difficulties and costs described by MWRDGC, however, would not be caused by this rulemaking.

There is no dispute in this record that there are Illinois streams not meeting Illinois' current DO standard, or that both the IAWA proposal and DNR/IEPA proposal would "result in some significant (but smaller) number of exceedances [violations]." PC 103 at 14. As IEPA notes:

> In nearly every instance, this rulemaking is expected to be less restrictive than the current [DO] standard and therefore less likely to yield exceedances (violations) of no environmental significance. PC 103 at 11; *see also* Tr.4 at 161 (Lanyon conceded on cross-examination that neither IAWA's nor DNR/IEPA's proposal "would impose a stricter DO standard than we have on the books today").

IEPA goes further, maintaining that because the DNR/IEPA-proposed DO standards more accurately reflect aquatic community needs, the joint-agency proposal "will actually be economically beneficial by more accurately focusing environmental management resources" on waters "in need." *Id*. The Board agrees and finds that the amendments proposed for first notice will not have an adverse impact on the People of the State of Illinois.

Moreover, as discussed above, the Board does not establish an ambient water quality standard for dissolved oxygen based on whether Illinois waters presently comply with the standard. The Board's primary task in this rulemaking is to establish the "minimum permissible concentrations of dissolved oxygen" that will protect aquatic organisms in general use waters based on the scientific evidence. 415 ILCS 5/13(a)(1) (2006); *see also* PC 103 at 12. In doing so, the Board fulfills its responsibility under the federal Clean Water Act to, in IEPA's words, "update outdated standards to reflect the current science." *Id.* That said, this record's evidence indicates that even for sites on or near the approximately 8% of general use stream miles proposed for enhanced DO protection, 94% of the grab data demonstrated compliance with the joint proposal's acute minima standard. Exh. 22 at 2.

Finally, the Board declines to incorporate into the rule the suggestions of MWRDGC for a "waiver provision for urban impacted streams to study technology for compliance" and a "separate wet weather standard following storm water runoff." Tr.5 at 230. As discussed above, the Act already provides several ways to seek either temporary or permanent site-specific relief from rules of general applicability, in the form of petitions for variances, adjusted standards, and site-specific rules. These mechanisms allow for case-by-case demonstrations before the Board based on factors such as compliance with the general rule imposing an "arbitrary and unreasonable hardship" (415 ILCS 5/35(a) (2006)), "factors relating to that petitioner are substantially and significantly different from the factors relied upon by the Board in adopting the general regulation" (415 ILCS 5/28.1(c)(1) (2006)), and the factors of "technical feasibility and economic reasonableness" (415 ILCS 5/27(a) (2006)).

CONCLUSION

Illinois' current general use water quality standard for dissolved oxygen, adopted in 1972, is outdated and too simplistic to account for the natural variability of waters and their aquatic communities across this State. The DO standard proposed today for first notice is consistent with USEPA's NCD as adapted to Illinois waters and reflects the current science. By allowing both public and private resources to be concentrated on general use waters that are truly impaired by low DO levels, the proposal promises to significantly and economically enhance the protection of Illinois aquatic life.

The Board is adopting the essential elements of IAWA's proposal, but with critical additions proposed by DNR and IEPA. The IAWA proposal of a two-season DO standard with averaging and DO values consistent with the NCD "warmwater" criteria is a major step toward modernizing the Illinois standard, but it does not go far enough. It is true that *most* of Illinois's aquatic organisms can be characterized as having the DO-sensitivity of "warmwater" organisms and that *most* spawning is completed in the spring. As this record shows, however, IAWA's proposal does not adequately address the fact that there are significant "intermediate" organisms and "late spring and summer spawners" in Illinois. The Board accordingly is proposing that designated stream segments (approximately 8% of Illinois' 71,394 general use stream miles) have enhanced DO standards based on the presence of meaningful amounts of DO-sensitive organisms and that the month of July be included in the sensitive "early life stages" timeframe (*i.e.*, March through July). The record demonstrates that these additional protections over and above the IAWA proposal are necessary to fully protect Illinois aquatic life.

The Board agrees with Joel Cross, Acting Manager of DNR's Watershed Protection Section, that this proposal is not a "lowering of dissolved oxygen standards within some waters during certain times of the year, but rather [a] focusing [of] needed protection for most sensitive types and life stages of aquatic life where required." Tr.4 at 46. The first-notice proposal provides enhanced DO protection when and where it is most needed. Further, the narrative standard proposed today ensures that the full range of general use waters in Illinois is protected against low DO. As stated by the Illinois Chapter of the American Fisheries Society, today's proposal provides a "flexible standard which affords full protection of Illinois' aquatic life without unduly burdening the regulated community with a rigid, antiquated standard." PC 100 at 2.

The Board also agrees with IEPA that fully restructuring Illinois' water quality standards based on a tiered-use classification system will take years. The information in this record has yielded a greatly improved DO standard. Adopting that standard should not be delayed. As suggested early in this proceeding by Toby Frevert, IEPA's Manager of the Division of Water Pollution Control, we will probably never reach a "perfect understanding of dissolved oxygen to have a perfect standard," but that should not deter improving upon the current standard when the evidence allows. Exh. 14 at 3. The evidence in this record so allows. Moreover, Section 303(c)(1) of the federal Clean Water Act (33 U.S.C. 1313(c)(1)) requires states to undergo periodic and continuing reviews and updates of their water quality standards. The Board has every expectation that progress toward some form of tiered-use system will continue and that when adequately developed, a rulemaking proposal will be filed with the Board.

Additionally, the Board recognizes that after implementation of the final DO standard adopted in this rulemaking, further study may reveal that regulatory relief is warranted for specific stream stretches. The Act has mechanisms already in place, such as adjusted standards, that allow for case-by-case, site-specific relief when the necessary demonstrations are made before the Board.

The Board thanks all of those who have participated in this proceeding and encourages their continued participation. The rulemaking record had benefited greatly from the active participation of many individuals and organizations, including Environmental Law & Policy Center, Prairie Rivers Network, Sierra Club, MWRDGC, and the Office of Lieutenant Governor Pat Quinn. The Board expresses deep gratitude to IAWA, DNR, and IEPA for their especially thorough contributions to this record. IAWA was of course under no legal obligation to initiate this proceeding, but having done so, it has been instrumental in updating the State's DO standard for the first time in some 35 years. DNR and IEPA drew upon their vast collective experience with Illinois waters in what has been an exceptional cooperative effort between the two State agencies.

For first-notice publication in the *Illinois Register* and as described in this opinion, the Board is proposing amendments to Sections 302.100 and 302.206 and proposing a new Appendix D to Part 302. The Board will accept written public comment on its first-notice proposal for 45 days after publication in the *Illinois Register*.

ORDER

The Board directs the Clerk to file the following proposed amendments with the Office of the Secretary of State for publication of first notice in the *Illinois Register*. Proposed additions to Part 302 are underlined and proposed deletions appear stricken.

TITLE 35: ENVIRONMENTAL PROTECTION
SUBTITLE C: WATER POLLUTION
CHAPTER I: POLLUTION CONTROL BOARD

PART 302
WATER QUALITY STANDARDS

SUBPART A: GENERAL WATER QUALITY PROVISIONS

Section
302.100 Definitions
302.101 Scope and Applicability
302.102 Allowed Mixing, Mixing Zones and ZIDs
302.103 Stream Flows
302.104 Main River Temperatures
302.105 Antidegradation

SUBPART B: GENERAL USE WATER QUALITY STANDARDS

Section
302.201 Scope and Applicability
302.202 Purpose
302.203 Offensive Conditions
302.204 pH
302.205 Phosphorus
302.206 Dissolved Oxygen
302.207 Radioactivity
302.208 Numeric Standards for Chemical Constituents
302.209 Fecal Coliform
302.210 Other Toxic Substances
302.211 Temperature
302.212 Total Ammonia Nitrogen
302.213 Effluent Modified Waters (Ammonia)(Repealed)

SUBPART C: PUBLIC AND FOOD PROCESSING WATER SUPPLY STANDARDS

Section
302.301 Scope and Applicability
302.302 Algicide Permits
302.303 Finished Water Standards
302.304 Chemical Constituents
302.305 Other Contaminants
302.306 Fecal Coliform
302.207 Radium 226 and 228

SUBPART D: SECONDARY CONTACT AND INDIGENOUS AQUATIC LIFE STANDARDS

Section
302.401 Scope and Applicability
302.402 Purpose
302.403 Unnatural Sludge
302.404 pH
302.405 Dissolved Oxygen
302.406 Fecal Coliform (Repealed)
302.407 Chemical Constituents
302.408 Temperature
302.409 Cyanide
302.410 Substances Toxic to Aquatic Life

SUBPART E: LAKE MICHIGAN BASIN WATER QUALITY STANDARDS

Section
302.501 Scope, Applicability, and Definitions
302.502 Dissolved Oxygen
302.503 pH
302.504 Chemical Constituents
302.505 Fecal Coliform
302.506 Temperature
302.507 Thermal Standards for Existing Sources on January 1, 1971
302.508 Thermal Standards for Sources Under Construction But Not In Operation on January 1, 1971
302.509 Other Sources
302.510 Incorporations by Reference
302.515 Offensive Conditions
302.520 Regulation and Designation of Bioaccumulative Chemicals of Concern (BCCs)
302.521 Supplemental Antidegradation Provisions for Bioaccumulative Chemicals of Concern (BCCs)
302.525 Radioactivity
302.530 Supplemental Mixing Provisions for Bioaccumulative Chemicals of Concern (BCCs)
302.535 Ammonia Nitrogen
302.540 Other Toxic Substances
302.545 Data Requirements
302.550 Analytical Testing
302.553 Determining the Lake Michigan Aquatic Toxicity Criteria or Values - General Procedures
302.555 Determining the Tier I Lake Michigan Acute Aquatic Toxicity Criterion (LMAATC): Independent of Water Chemistry
302.560 Determining the Tier I Lake Michigan Basin Acute Aquatic Life Toxicity Criterion (LMAATC): Dependent on Water Chemistry

302.563 Determining the Tier II Lake Michigan Basin Acute Aquatic Life Toxicity Value (LMAATV)
302.565 Determining the Lake Michigan Basin Chronic Aquatic Life Toxicity Criterion (LMCATC) or the Lake Michigan Basin Chronic Aquatic Life Toxicity Value (LMCATV)
302.570 Procedures for Deriving Bioaccumulation Factors for the Lake Michigan Basin
302.575 Procedures for Deriving Tier I Water Quality Criteria and Values in the Lake Michigan Basin to Protect Wildlife
302.580 Procedures for Deriving Water Quality Criteria and Values in the Lake Michigan Basin to Protect Human Health – General
302.585 Procedures for Determining the Lake Michigan Basin Human Health Threshold Criterion (LMHHTC) and the Lake Michigan Basin Human Health Threshold Value (LMHHTV)
302.590 Procedures for Determining the Lake Michigan Basin Human Health Nonthreshold Criterion (LMHHNC) or the Lake Michigan Basin Human Health Nonthreshold Value (LMHHNV)
302.595 Listing of Bioaccumulative Chemicals of Concern, Derived Criteria and Values

SUBPART F: PROCEDURES FOR DETERMINING WATER QUALITY CRITERIA

Section

302.601 Scope and Applicability
302.603 Definitions
302.604 Mathematical Abbreviations
302.606 Data Requirements
302.612 Determining the Acute Aquatic Toxicity Criterion for an Individual Substance – General Procedures
302.615 Determining the Acute Aquatic Toxicity Criterion - Toxicity Independent of Water Chemistry
302.618 Determining the Acute Aquatic Toxicity Criterion - Toxicity Dependent on Water Chemistry
302.621 Determining the Acute Aquatic Toxicity Criterion - Procedure for Combinations of Substances
302.627 Determining the Chronic Aquatic Toxicity Criterion for an Individual Substance - General Procedures
302.630 Determining the Chronic Aquatic Toxicity Criterion - Procedure for Combinations of Substances
302.633 The Wild and Domestic Animal Protection Criterion
302.642 The Human Threshold Criterion
302.645 Determining the Acceptable Daily Intake
302.648 Determining the Human Threshold Criterion
302.651 The Human Nonthreshold Criterion
302.654 Determining the Risk Associated Intake
302.657 Determining the Human Nonthreshold Criterion
302.658 Stream Flow for Application of Human Nonthreshold Criterion
302.660 Bioconcentration Factor

302.663 Determination of Bioconcentration Factor
302.666 Utilizing the Bioconcentration Factor
302.669 Listing of Derived Criteria

APPENDIX A References to Previous Rules
APPENDIX B Sources of Codified Sections
APPENDIX C Maximum total ammonia nitrogen concentrations allowable for certain combinations of pH and temperature
TABLE A pH-Dependent Values of the AS (Acute Standard)
TABLE B Temperature and pH-Dependent Values of the CS (Chronic Standard) for Fish Early Life Stages Absent
TABLE C Temperature and pH-Dependent Values of the CS (Chronic Standard) for Fish Early Life Stages Present
APPENDIX D Section 302.206(d): Stream Segments for Enhanced Dissolved Oxygen Protection

AUTHORITY: Implementing Section 13 and authorized by Sections 11(b) and 27 of the Environmental Protection Act [415 ILCS 5/13, 11(b), and 27]

SOURCE: Filed with the Secretary of State January 1, 1978; amended at 2 Ill. Reg. 44, p. 151, effective November 2, 1978; amended at 3 Ill. Reg. 20, p. 95, effective May 17, 1979; amended at 3 Ill. Reg. 25, p. 190, effective June 21, 1979; codified at 6 Ill. Reg. 7818; amended at 6 Ill. Reg. 11161, effective September 7, 1982; amended at 6 Ill. Reg. 13750, effective October 26, 1982; amended at 8 Ill. Reg. 1629, effective January 18, 1984; peremptory amendments at 10 Ill. Reg. 461, effective December 23, 1985; amended at R87-27 at 12 Ill. Reg. 9911, effective May 27, 1988; amended at R85-29 at 12 Ill. Reg. 12082, effective July 11, 1988; amended in R88-1 at 13 Ill. Reg. 5998, effective April 18, 1989; amended in R88-21(A) at 14 Ill. Reg. 2899, effective February 13, 1990; amended in R88-21(B) at 14 Ill. Reg. 11974, effective July 9, 1990; amended in R94-1(A) at 20 Ill. Reg. 7682, effective May 24, 1996; amended in R94-1(B) at 21 Ill. Reg. 370, effective December 23, 1996; expedited correction at 21 Ill. Reg. 6273, effective December 23, 1996; amended in R97-25 at 22 Ill. Reg. 1356, effective December 24, 1997; amended in R99-8 at 23 Ill. Reg. 11249, effective August 26, 1999; amended in R01-13 at 26 Ill. Reg. 3505, effective February 22, 2002; amended in R02-19 at 26 Ill. Reg. 16931, effective November 8, 2002; amended in R02-11 at 27 Ill. Reg. 166, effective December 20, 2002; amended in R04-21 at 30 Ill. Reg. 4919, effective March 1, 2006; amended in R04-25 at 31 Ill. Reg. ___________, effective ______________.

SUBPART A: GENERAL WATER QUALITY PROVISIONS

Section 302.100 Definitions

Unless otherwise specified, the definitions of the Environmental Protection Act (Act) [415 ILCS 5] and 35 Ill. Adm. Code 301 apply to this Part. As used in this Part, each of the following definitions has the specified meaning.

"Acute Toxicity" means the capacity of any substance or combination of substances to cause mortality or other adverse effects in an organism resulting from a single or short-term exposure to the substance.

"Adverse Effect" means any gross or overt effect on an organism, including but not limited to reversible histopathological damage, severe convulsions, irreversible functional impairment and lethality, as well as any non-overt effect on an organism resulting in functional impairment or pathological lesions which may affect the performance of the whole organism, or which reduces an organism's ability to respond to an additional challenge.

"Chronic Toxicity" means the capacity of any substance or combination of substances to cause injurious or debilitating effects in an organism which result from exposure for a time period representing a substantial portion of the natural life cycle of that organism, including but not limited to the growth phase, the reproductive phases or such critical portions of the natural life cycle of that organism.

"Criterion" means the numerical concentration of one or more toxic substances derived in accordance with the procedures in Subpart F of this Part which, if not exceeded, would assure compliance with the narrative toxicity standard of Section 302.210 of this Part.

“Early Life Stages” of fish means the pre-hatch embryonic period, the post-hatch free embryo or yolk-sac fry, and the larval period, during which the organism feeds. Juvenile fish, which are anatomically similar to adults, are not considered an early life stage.

"Hardness" means a water quality parameter or characteristic consisting of the sum of calcium and magnesium concentrations expressed in terms of equivalent milligrams per liter as calcium carbonate. Hardness is measured in accordance with methods specified in 40 CFR 136, incorporated by reference in 35 Ill. Adm. Code 301.106.

"Mixing Zone" means a portion of the waters of the State identified as a region within which mixing is allowed pursuant to Section 302.102(d) of this Part.

“Thermocline” means the plane of maximum rate of decrease of temperature with respect to depth in a thermally stratified body of water.

"Total Residual Chlorine" or "TRC" means those substances which include combined and uncombined forms of both chlorine and bromine and which are expressed, by convention, as an equivalent concentration of molecular chlorine. TRC is measured in accordance with methods specified in 40 CFR 136, incorporated by reference in 35 Ill. Adm. Code

301.106.

"Toxic Substance" means a chemical substance that causes adverse effects in humans, or in aquatic or terrestrial animal or plant life. Toxic substances include, but are not limited to, those substances listed in 40 CFR 302.4, incorporated by reference in 35 Ill. Adm. Code 301.106, or any "chemical substance" as defined by the Illinois Chemical Safety Act [430 ILCS 45]

"ZID" or "Zone of Initial Dilution" means a portion of a mixing zone, identified pursuant to Section 302.102(e) of this Part, within which acute toxicity standards need not be met.

(Source: Amended at 31 Ill. Reg. __________, effective ________________)

SUBPART B: GENERAL USE WATER QUALITY STANDARDS

Section 302.206 Dissolved Oxygen

General use waters must maintain dissolved oxygen concentrations at or above the values contained in subsections (a), (b) and (c) of this Section. ~~Dissolved oxygen (STORET number 00300) shall not be less than 6.0 mg/L during at least 16 hours of any 24 hour period, nor less than 5.0 mg/L at any time.~~

a) General use waters at all locations must maintain sufficient dissolved oxygen concentrations to prevent offensive conditions as required in Section 302.203 of this Part. Quiescent and isolated sectors of General Use waters including but not limited to wetlands, sloughs, backwaters and waters below the thermocline in lakes and reservoirs must be maintained at sufficient dissolved oxygen concentrations to support their natural ecological functions and resident aquatic communities.

b) Except in those waters identified in Appendix D of this Part, the dissolved oxygen concentration in the main body of all streams, in the water above the thermocline of thermally stratified lakes and reservoirs, and in the entire water column of unstratified lakes and reservoirs must not be less than the following:

1) During the period of March through July,

A) 5.0 mg/L at any time; and

B) 6.0 mg/L as a daily mean averaged over 7 days.

2) During the period of August through February,

A) 3.5 mg/L at any time;

B) 4.0 mg/L as a daily minimum averaged over 7 days and;

C) 5.5 mg/L as a daily mean averaged over 30 days.

c) The dissolved oxygen concentration in all sectors within the main body of all streams identified in Appendix D of this Part must not be less than:

1) During the period of March through July,

A) 5.0 mg/L at any time; and

B) 6.25 mg/L as a daily mean averaged over 7 days.

2) During the period of August through February,

A) 4.0 mg/L at any time;

B) 4.5 mg/L as a daily minimum averaged over 7 days; and

C) 6.0 mg/L as a daily mean averaged over 30 days.

d) Assessing attainment of dissolved oxygen mean and minimum values.

1) Daily mean is the arithmetic mean of dissolved oxygen values measured in a single 24-hour calendar day.

2) Daily minimum is the minimum dissolved oxygen value as measured in a single 24-hour calendar day.

3) The measurements of dissolved oxygen used to determine attainment or lack of attainment with any of the dissolved oxygen standards in this Section must assure daily minima and daily means that represent the true daily minima and daily means.

4) The dissolved oxygen value used in calculating or determining any daily mean or daily minimum should not exceed the air-equilibrated value.

5) Daily minimum averaged over 7 days is the arithmetic mean of daily minimum dissolved oxygen values from the current and previous 6 calendar days.

6) Daily mean averaged over 7 days is the arithmetic mean of daily mean dissolved oxygen values from the current and previous 6 calendar days.

7) Daily mean averaged over 30 days is the arithmetic mean of daily mean dissolved oxygen values from the current and previous 29 calendar days.

(Source: Amended at 31 Ill. Reg. __________, effective ________________)

302.Appendix D Section 302.206(d): Stream Segments for Enhanced Dissolved Oxygen Protection

BASIN NAME
Segment Name
Segment No.

End Points	Latitude	Longitude	COUNTY

Illinois

Aux Sable Creek
239

start	41.3982125891033	-88.3307365155966	GRUNDY
end	41.5221610266554	-88.3153074461322	KENDALL

Baker Creek
123

start	41.0993159446094	-87.833779044559	KANKAKEE
end	41.1187483257075	-87.7916507082604	KANKAKEE

Baptist Creek
160

start	40.5172643895406	-90.9781701980636	HANCOCK
end	40.5217773790395	-90.9703232423026	HANCOCK

Barker Creek
170

start	40.4730175690641	-90.3623822544051	FULTON
end	40.4505102531327	-90.423698306895	FULTON

Battle Creek
196

start	41.791467372356	-88.6440656199133	DEKALB
end	41.8454435074814	-88.6580317835588	DEKALB

Big Bureau Creek
209

start	41.2403303426443	-89.3778305139628	BUREAU
end	41.6599418992971	-89.0880711727354	LEE

Big Rock Creek
275

start	41.6325949399571	-88.5379727020413	KENDALL
end	41.7542831812644	-88.5621629654129	KANE

Blackberry Creek
271

start	41.6432480686252	-88.451129393594	KENDALL
end	41.7663693677829	-88.3855968808499	KANE

Boone Creek
284

start	42.3430701828297	-88.2604646456881	MCHENRY
end	42.3116813126792	-88.3284649937798	MCHENRY

Buck Creek
225

start	41.4305449377211	-88.7732713228626	LASALLE
end	41.4508806057478	-88.919966063547	LASALLE

403

start	40.6513984442885	-88.8660496976016	MCLEAN
end	40.6757825960266	-88.8490439132056	MCLEAN

Camp Creek
116

start	41.0119168530464	-89.7317034650143	STARK
end	41.0202988179758	-89.6817209218761	STARK

BASIN NAME / Segment Name / Segment No.	End Points	Latitude	Longitude	COUNTY
168				
	start	40.2936155016035	-90.7791785207262	MCDONOUGH
	end	40.3985161419285	-90.5089903510732	MCDONOUGH
Camp Run				
115				
	start	41.0119168530464	-89.7317034650143	STARK
	end	41.0575944852479	-89.6822685234528	STARK
Cantway Slough				
250				
	start	41.1654521279715	-87.6179423055771	KANKAKEE
	end	41.1204910206261	-87.6018847740212	KANKAKEE
Cedar Creek				
164				
	start	40.4187924503946	-91.0119249544251	HANCOCK
	end	40.4320989747514	-90.9816512014458	HANCOCK
Central Ditch				
17				
	start	40.2466345144431	-89.8605138200519	MASON
	end	40.259146892407	-89.8331744969958	MASON
Clear Creek				
70				
	start	40.2358631766436	-89.1715114085864	LOGAN
	end	40.2817523596784	-89.2105606026356	MCLEAN
Coal Creek				
173				
	start	40.6458316286298	-90.2773695191768	FULTON
	end	40.6911917975894	-90.0990104026141	FULTON
Collins Run				
243				
	start	41.4219631544372	-88.3508108111242	GRUNDY
	end	41.4172036201222	-88.3955434158999	GRUNDY
Conover Branch				
184				
	start	39.8376993452498	-90.1465720267561	MORGAN
	end	39.8696939232648	-90.1234898871846	MORGAN
Coon Creek				
60				
	start	40.1076562155273	-89.0130117597621	DEWITT
	end	40.1755351290733	-88.8857086715202	DEWITT
Coop Branch				
31				
	end	39.2042878811665	-90.0972130791043	MACOUPIN
	end	39.1194481626997	-89.9878509202749	MACOUPIN
Coopers Defeat Creek				
114				
	start	41.1557502062867	-89.748162019475	STARK
	end	41.1485959333575	-89.6944246708098	STARK
Copperas Creek				
88				
	start	40.4856512052475	-89.8867983078194	FULTON
	end	40.549513691198	-89.9011907117391	FULTON
Court Creek				
122				

BASIN NAME

Segment Name

Segment No.

End Points		Latitude	Longitude	COUNTY
	start	40.9184191403691	-90.1108008628507	KNOX
	end	40.9349919352638	-90.2673514797552	KNOX
Cox Creek				
177				
	start	40.0231674243157	-90.1158780774246	CASS
	end	39.9657957063914	-90.0180644049351	CASS
Crane Creek				
174				
	start	40.1328714038267	-89.9709414534257	MENARD
	end	40.2466345144431	-89.8605138200519	MASON
Crow Creek				
102				
	start	40.9323207251964	-89.4264477600798	MARSHALL
	end	40.9663161180876	-89.2558617294218	MARSHALL
Deer Creek				
59				
	start	40.117679723776	-89.3801215076251	LOGAN
	end	40.1915602627115	-89.1582023776838	LOGAN
Dickerson Slough				
421				
	start	40.3597968706068	-88.3225685158141	CHAMPAIGN
	end	40.4568389800294	-88.3442742579475	FORD
Drummer Creek				
423				
	start	40.37389931547	-88.3480753423386	CHAMPAIGN
	end	40.479101489993	-88.388698487066	FORD
Dry Fork				
35				
	start	39.1989703827155	-89.9609795725648	MACOUPIN
	end	39.1445756951412	-89.8876581181152	MACOUPIN
Du Page River				
268				
	start	41.4988385272507	-88.2166248594859	WILL
	end	41.7019525201778	-88.1476209409341	WILL
Eagle Creek				
392				
	start	41.1360015419764	-88.8528525904771	LASALLE
	end	41.1291172842462	-88.8664977236647	LASALLE
East Aux Sable Creek				
240				
	start	41.5221610266554	-88.3153074461322	KENDALL
	end	41.6231669397764	-88.2938779285952	KENDALL
East Branch Big Rock Creek				
277				
	start	41.7542830239271	-88.5621632556731	KANE
	end	41.8161922949561	-88.6002917634599	KANE
East Branch Copperas Creek				
47				
	start	40.549514632509	-89.901189903351	FULTON

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
end	40.6583152735498	-89.8516717710553	PEORIA

East Fork La Moine River

167

End Points	Latitude	Longitude	COUNTY
start	40.3962156185095	-90.9339386121768	HANCOCK
end	40.4506930058171	-90.758703782814	MCDONOUGH

East Fork Mazon River

256

End Points	Latitude	Longitude	COUNTY
start	41.1872307009926	-88.2731640461448	GRUNDY
end	41.0815161304671	-88.3093601699244	LIVINGSTON

East Fork Spoon River

110

End Points	Latitude	Longitude	COUNTY
start	41.2158736312898	-89.6870256054763	STARK
end	41.2603216291895	-89.7311074496692	BUREAU

Easterbrook Drain

410

End Points	Latitude	Longitude	COUNTY
start	40.3687232740908	-88.5787269955356	MCLEAN
end	40.3909243275675	-88.5484031360558	MCLEAN

Exline Slough

252

End Points	Latitude	Longitude	COUNTY
start	41.1187483257075	-87.7916507082604	KANKAKEE
end	41.3377194296138	-87.674538578544	WILL

Fargo Run

94

End Points	Latitude	Longitude	COUNTY
start	40.8110626738718	-89.7625906815013	PEORIA
end	40.7936211492847	-89.7147157689809	PEORIA

Ferson Creek

281

End Points	Latitude	Longitude	COUNTY
start	41.9275380999085	-88.3177738518806	KANE
end	41.9518312998438	-88.3965138071814	KANE

Fitch Creek

131

End Points	Latitude	Longitude	COUNTY
start	41.0629732421579	-89.9929808862433	KNOX
end	41.1048465021615	-90.0171275726119	KNOX

Forked Creek

265

End Points	Latitude	Longitude	COUNTY
start	41.312634893655	-88.1518349597477	WILL
end	41.4208599921871	-87.8221168060732	WILL

Forman Creek

129

End Points	Latitude	Longitude	COUNTY
start	41.0920068762041	-90.1229512077171	KNOX
end	41.061779692349	-90.1373931430424	KNOX

Fourmile Grove Creek

232

End Points	Latitude	Longitude	COUNTY
start	41.5880621752377	-89.0154533767497	LASALLE
end	41.6281572065102	-89.0480036727754	LEE

Fox Creek

121

End Points	Latitude	Longitude	COUNTY
start	41.2158736312898	-89.6870256054763	STARK
end	41.2178841576744	-89.6378797955943	BUREAU

Fox River

270

End Points	Latitude	Longitude	COUNTY
start	41.6177003859476	-88.5558384703467	KENDALL
end	41.7665361019038	-88.3100243828453	KANE

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
Friends Creek			
56			
start	39.9296881580789	-88.7753341828841	MACON
end	40.0511150621524	-88.756810733868	MACON
Furrer Ditch			
175			
start	40.259146892407	-89.8331744807195	MASON
end	40.256856262248	-89.8235353908665	MASON
Gooseberry Creek			
138			
start	41.0815161304671	-88.3093601699244	LIVINGSTON
end	41.0229178273291	-88.3433997610298	LIVINGSTON
181			
start	41.2273512263311	-88.3737634512576	GRUNDY
end	41.1567969821084	-88.3954921510714	GRUNDY
Grindstone Creek			
169			
start	40.2936155016035	-90.7791785207262	MCDONOUGH
end	40.3128991202966	-90.6514786739624	MCDONOUGH
Hall Ditch			
176			
start	40.214043063866	-89.8947856138658	MASON
end	40.1996396083582	-89.8430392085184	MASON
Hallock Creek			
101			
start	40.9330251540704	-89.523027406387	PEORIA
end	40.9162496002415	-89.5368879858621	PEORIA
Haw Creek			
125			
start	40.8575772861862	-90.2335091570553	KNOX
end	40.9174343445877	-90.3387634753254	KNOX
Henline Creek			
401			
start	40.5867014223785	-88.6971328093932	MCLEAN
end	40.6247936449316	-88.6315733675586	MCLEAN
Henry Creek			
100			
start	40.932455717876	-89.5256512687818	PEORIA
end	40.9472322228041	-89.5711427004422	PEORIA
Hermon Creek			
126			
start	40.7818347201379	-90.2738699961108	KNOX
end	40.7628476930817	-90.3372052339614	KNOX
Hickory Creek			
244			
start	41.5038289458964	-88.0990240076033	WILL
end	41.4935392717868	-87.8108342251738	WILL
Hickory Grove Ditch			
87			
start	40.4870721779667	-89.7285827911466	TAZEWELL
end	40.4136575635669	-89.7349507058786	MASON
Hickory Run			
93			

BASIN NAME

Segment Name

Segment No.

End Points		Latitude	Longitude	COUNTY
	start	40.8217198390551	-89.7449749384213	PEORIA
	end	40.8581447502391	-89.7622130910013	PEORIA
Hillsbury Slough				
416				
	start	40.3453953438371	-88.3035309970523	CHAMPAIGN
	end	40.3928682378873	-88.2265028280313	CHAMPAIGN
Hodges Creek				
34				
	start	39.2630316914552	-90.1858200381692	GREENE
	end	39.2801974743086	-90.1528766403572	GREENE
Hurricane Creek				
44				
	start	39.449376470161	-90.5400508230403	GREENE
	end	39.4781872332274	-90.4508986197452	GREENE
Illinois River				
236				
	start	41.3255740245957	-88.9910230492306	LASALLE
	end	41.3986780470527	-88.2686499362959	GRUNDY
Indian Creek				
120				
	start	40.988610901184	-89.8221496834014	STARK
	end	41.2003389912185	-89.9349435285117	HENRY
182				
	start	39.8785447641605	-90.3782080959549	CASS
	end	39.8234731084942	-90.103743390331	MORGAN
224				
	start	41.7480730242898	-88.8741562924388	DEKALB
	end	41.7083887626958	-88.9437996894049	LEE
226				
	start	41.4400734113231	-88.7627018786422	LASALLE
	end	41.7377348577433	-88.8557728844589	DEKALB
396				
	start	40.7701181840118	-88.4858209632899	LIVINGSTON
	end	40.6469799222669	-88.4812665778082	LIVINGSTON
Iroquois River				
253				
	start	41.0739205590002	-87.8152251833303	KANKAKEE
	end	40.9614905075375	-87.8149010739444	IROQUOIS
447				
	start	40.7817769095357	-87.7532807121524	IROQUOIS
	end	40.8174648935578	-87.5342555764515	IROQUOIS
Jack Creek				
109				
	start	41.1283656948767	-89.7699479168181	STARK
	end	41.150467875432	-89.8374616586589	STARK
Jackson Creek				
246				
	start	41.4325013563553	-88.1725611633353	WILL
	end	41.4638503957577	-87.9160301224816	WILL
Joes Creek				
33				
	start	39.2801974743086	-90.1528766403572	GREENE
	end	39.3757180969001	-90.0772968234561	MACOUPIN

BASIN NAME

Segment Name / Segment No.	End Points	Latitude	Longitude	COUNTY
Johnny Run				
258				
	start	41.2826709079541	-88.3633805819326	GRUNDY
	end	41.0807507198308	-88.5801638050665	LIVINGSTON
Jordan Creek				
266				
	start	41.3044458242397	-88.1279087273328	WILL
	end	41.3077177643453	-88.1188984685001	WILL
Judd Creek				
106				
	start	41.089645284216	-89.1847595119809	MARSHALL
	end	41.0429807674449	-89.1339049242164	MARSHALL
Kankakee River				
248				
	start	41.3923135096469	-88.2590124225285	GRUNDY
	end	41.1660752568715	-87.526360971907	KANKAKEE
Kickapoo Creek				
57				
	start	39.9932216924528	-88.8083252484687	MACON
	end	39.9987405799186	-88.8205170598483	MACON
65				
	start	40.1286520491088	-89.4532728967436	LOGAN
	end	40.4376592310728	-88.8667409562596	MCLEAN
92				
	start	40.6548826785105	-89.6134608723157	TAZEWELL
	end	40.9170471944911	-89.6577393908301	PEORIA
Kings Mill Creek				
83				
	start	40.4558745105979	-89.1642930044364	MCLEAN
	end	40.509184986927	-89.0937965002854	MCLEAN
La Harpe Creek				
159				
	start	40.4678428297867	-91.0424167497572	HANCOCK
	end	40.5172643895406	-90.9781701980636	HANCOCK
La Moine River				
158				
	start	40.3320849972693	-90.8997234923388	MCDONOUGH
	end	40.5923258750258	-91.0177293656635	HANCOCK
Lake Fork				
61				
	start	40.0837107988142	-89.3969397975165	LOGAN
	end	39.9367293000733	-89.2343282851812	LOGAN
Langan Creek				
254				
	start	40.9614905075375	-87.8149010739444	IROQUOIS
	end	40.9432018898477	-88.0465558527168	IROQUOIS
Lime Creek				
214				
	start	41.4515003790233	-89.5271752648714	BUREAU
	end	41.4951141474998	-89.456554884734	BUREAU
Little Indian Creek				
183				
	start	39.8355964564522	-90.1231971747256	MORGAN

BASIN NAME

Segment Name

Segment No.

End Points		Latitude	Longitude	COUNTY
	end	39.8658175367056	-90.0423591294145	MORGAN
227				
	start	41.5091299863247	-88.7725444056074	LASALLE
	end	41.749433980972	-88.8141442269697	DEKALB
Little Kickapoo Creek				
67				
	start	40.3336625070255	-88.9736094275975	MCLEAN
	end	40.394785197415	-88.9473142490326	MCLEAN
Little Mackinaw River				
82				
	start	40.4423190352496	-89.4617848276975	TAZEWELL
	end	40.4481261917524	-89.4329939054056	TAZEWELL
Little Rock Creek				
274				
	start	41.6345548769785	-88.5384723455853	KENDALL
	end	41.7895688619816	-88.6981590581244	DEKALB
Little Sandy Creek				
107				
	start	41.0912632622075	-89.2247552498617	MARSHALL
	end	41.125352501365	-89.1758716886846	PUTNAM
Little Senachwine Creek				
99				
	start	40.9533145540839	-89.5292433956921	PEORIA
	end	41.0084439145565	-89.5499765139822	MARSHALL
Little Vermilion River				
233				
	start	41.3237602050852	-89.0811945323001	LASALLE
	end	41.5760289435671	-89.0829047126545	LASALLE
Lone Tree Creek				
418				
	start	40.3750682121535	-88.3819688457729	CHAMPAIGN
	end	40.3145980401842	-88.4738655755984	MCLEAN
Long Creek				
163				
	start	40.4466427913955	-91.0499607552846	HANCOCK
	end	40.4297652043359	-91.1507109600489	HANCOCK
Long Point Creek				
68				
	start	40.2755311999445	-89.0786438507327	DEWITT
	end	40.2549604211821	-88.9826285651361	DEWITT
394				
	start	41.038177645276	-88.7908409579793	LIVINGSTON
	end	41.0018214714974	-88.8534349418926	LIVINGSTON
Mackinaw River				
397				
	start	40.5796794158534	-89.2813445945626	TAZEWELL
	end	40.5649627479232	-88.478822725546	MCLEAN
Macoupin Creek				
32				
	start	39.1989703827155	-89.9609795725648	MACOUPIN
	start	39.2121253451487	-90.2312084410337	JERSEY
Madden Creek				
413				

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
start	40.0943580002069	-88.5400649488702	PIATT
end	40.2109635906658	-88.4943738561926	PIATT

Masters Creek

220

End Points	Latitude	Longitude	COUNTY
start	41.4976109383336	-89.4125473607076	BUREAU
end	41.5439000049343	-89.421988392756	BUREAU

Masters Fork

217

End Points	Latitude	Longitude	COUNTY
start	41.4531024225454	-89.4290492805799	BUREAU
end	41.5702310455498	-89.3821188149649	BUREAU

Mazon River

257

End Points	Latitude	Longitude	COUNTY
start	41.3086768327676	-88.3389845675056	GRUNDY
end	41.1872307009926	-88.2731640461448	GRUNDY

Mendota Creek

234

End Points	Latitude	Longitude	COUNTY
start	41.5281666288805	-89.1041764154672	LASALLE
end	41.5282367334928	-89.1224368860589	LASALLE

Middle Branch of Copperas Creek

90

End Points	Latitude	Longitude	COUNTY
start	40.549514632509	-89.901189903351	FULTON
end	40.5980896362772	-89.9368482699851	FULTON

Middle Creek

165

End Points	Latitude	Longitude	COUNTY
start	40.3957329294144	-90.9741776721721	HANCOCK
end	40.3888894030526	-91.0072502737366	HANCOCK

Mill Creek

494

End Points	Latitude	Longitude	COUNTY
start	41.8213649020421	-88.3222376599138	KANE
end	41.9231053361497	-88.4419826012614	KANE

Mole Creek

390

End Points	Latitude	Longitude	COUNTY
start	41.0193910577853	-88.8019375580673	LIVINGSTON
end	40.9109452909954	-88.9263176124884	LIVINGSTON

Morgan Creek

272

End Points	Latitude	Longitude	COUNTY
start	41.6481172046369	-88.4151168308869	KENDALL
end	41.6530911245692	-88.3631669287476	KENDALL

Mud Creek

449

End Points	Latitude	Longitude	COUNTY
start	40.637099482441	-87.5885960450541	IROQUOIS
end	40.6100172186722	-87.5261312404789	IROQUOIS

Mud Run

117

End Points	Latitude	Longitude	COUNTY
start	41.0092425694765	-89.7790957399812	STARK
end	40.9876287937001	-89.6785472090663	STARK

Murray Slough

259

End Points	Latitude	Longitude	COUNTY
start	41.2428845425989	-88.3615508333781	GRUNDY
end	41.054741775769	-88.5825975362008	LIVINGSTON

Nettle Creek

237

End Points	Latitude	Longitude	COUNTY
start	41.3559056532822	-88.4326806825019	GRUNDY

BASIN NAME

Segment Name

Segment No.

End Points		Latitude	Longitude	COUNTY
	end	41.3989525138118	-88.5519708865374	GRUNDY
Nippersink Creek				
285				
	start	42.403479031235	-88.1904263022916	LAKE
	end	42.408321560969	-88.341299199739	MCHENRY
289				
	start	42.3885864249526	-88.3641081665149	MCHENRY
	end	42.4692291197455	-88.4764236384547	MCHENRY
North Branch Crow Creek				
103				
	start	40.9663161180876	-89.2558617294218	MARSHALL
	end	41.0005549578781	-89.1943061363378	MARSHALL
North Branch Nippersink Creek				
286				
	start	42.4376632559979	-88.2872504317539	MCHENRY
	end	42.4945866793007	-88.3294075716268	MCHENRY
North Creek				
119				
	start	40.9486975483619	-89.7633680090807	PEORIA
	end	40.9421533616142	-89.7281078793964	PEORIA
North Fork Lake Fork				
62				
	start	39.9367293000733	-89.2343282851812	LOGAN
	end	40.0523211989442	-89.0999303242614	DEWITT
North Fork Salt Creek				
71				
	start	40.2675598120912	-88.7867164044023	DEWITT
	end	40.3620541452609	-88.7204600533309	MCLEAN
Otter Creek				
171				
	start	40.2161621556914	-90.164317977292	FULTON
	end	40.3182822717998	-90.3860609925548	FULTON
279				
	start	41.9619670384069	-88.3574449893747	KANE
	end	41.9903303640688	-88.3568570687618	KANE
393				
	start	41.1611802253124	-88.8310854379729	LASALLE
	end	41.1541734588026	-88.7148550047115	LASALLE
Panther Creek				
178				
	start	40.0231674243157	-90.1158780774246	CASS
	end	39.9411115612757	-90.0607356525317	CASS
405				
	start	40.6607941387838	-89.196034413193	WOODFORD
	end	40.8483817762616	-89.0003562591212	WOODFORD
Paw Paw Run				
231				
	start	41.6177945875792	-88.8847204360202	LASALLE
	end	41.6630271288718	-88.9144064528509	DEKALB
Pike Creek				
216				
	start	41.5121637096396	-89.3366888940457	BUREAU
	end	41.5707857354427	-89.2125163729316	BUREAU

BASIN NAME Segment Name Segment No. End Points		Latitude	Longitude	COUNTY
388				
	start	40.8655185113965	-88.7090974772719	LIVINGSTON
	end	40.7989226101833	-88.7756316859923	LIVINGSTON
Pond Creek				
212				
	start	41.3494925800361	-89.5685244208084	BUREAU
	end	41.3541221673156	-89.6001721270724	BUREAU
Poplar Creek				
493				
	start	42.0127893042098	-88.2799278350546	KANE
	end	42.0604682884044	-88.151517184544	COOK
Prairie Creek				
69				
	start	40.2688606116755	-89.1209318708141	DEWITT
	end	40.3183618654781	-89.1150133167993	MCLEAN
79				
	start	40.1610672222447	-89.6159697428554	MASON
	end	40.3105388304102	-89.4819788351989	LOGAN
264				
	start	41.3410818305214	-88.1859963163497	WILL
	end	41.4048430210988	-87.9636949110551	WILL
391				
	start	41.0691920852358	-88.8106812576958	LIVINGSTON
	end	41.0162806406811	-89.0122375626521	LASALLE
Prairie Creek Ditch				
81				
	start	40.242940205103	-89.5831738921535	LOGAN
	end	40.268603376062	-89.5902703680441	LOGAN
Prince Run				
118				
	start	40.9953442805941	-89.7634490486344	STARK
	end	40.9486975483619	-89.7633680090807	PEORIA
Rob Roy Creek				
495				
	start	41.6340658591268	-88.530902327864	KENDALL
	end	41.7208669225124	-88.4449822691918	KENDALL
Rock Creek				
180				
	start	39.9533586794244	-89.7717217346798	MENARD
	end	39.9192042890665	-89.881417605895	MENARD
251				
	start	41.2029705333006	-87.9860450524621	KANKAKEE
	end	41.2416733683013	-87.9199539652218	KANKAKEE
Rocky Run				
221				
	start	41.2966432755716	-89.5031050607007	BUREAU
	end	41.2892114895079	-89.5271301009319	BUREAU
Rooks Creek				
386				
	start	40.9620056243899	-88.737743684525	LIVINGSTON
	end	40.7615433072922	-88.6752675977812	LIVINGSTON
Salt Creek				
58				

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
start	40.1286520491088	-89.4532728967436	LOGAN
end	40.1404369482862	-88.8817439726269	DEWITT

409

End Points	Latitude	Longitude	COUNTY
start	40.2793653821328	-88.6019348286105	DEWITT
end	40.3687232740908	-88.5787269955356	MCLEAN

Sandy Creek

105

End Points	Latitude	Longitude	COUNTY
start	41.1083947129797	-89.3471796913242	PUTNAM
end	41.0855613697751	-89.0792291942694	MARSHALL

Sangamon River

408

End Points	Latitude	Longitude	COUNTY
start	40.0056362283258	-88.6286241506431	PIATT
end	40.4223231153926	-88.67328493366	MCLEAN

Senachwine Creek

96

End Points	Latitude	Longitude	COUNTY
start	40.929825860388	-89.4632928486271	PEORIA
end	41.0900318754938	-89.5885134178247	MARSHALL

Short Creek

162

End Points	Latitude	Longitude	COUNTY
start	40.4611057719393	-91.0582083107674	HANCOCK
end	40.4682735975769	-91.0704506789577	HANCOCK

Short Point Creek

389

End Points	Latitude	Longitude	COUNTY
start	40.9883827214271	-88.7830008925065	LIVINGSTON
end	40.8951301673701	-88.8749997260932	LIVINGSTON

Silver Creek

111

End Points	Latitude	Longitude	COUNTY
start	41.2185762138697	-89.6793069447094	STARK
end	41.2431713087936	-89.6494927441058	BUREAU

South Branch Crow Creek

104

End Points	Latitude	Longitude	COUNTY
start	40.9663161180876	-89.2558617294218	MARSHALL
end	40.9410075148431	-89.1948285503851	MARSHALL

South Branch Forked Creek

267

End Points	Latitude	Longitude	COUNTY
start	41.2631372965881	-88.0315238211836	WILL
end	41.292604367733	-87.9621751169561	KANKAKEE

South Fork Lake Fork

63

End Points	Latitude	Longitude	COUNTY
start	39.9367293000733	-89.2343282851812	LOGAN
end	39.9674631778105	-89.0884701339793	MACON

South Fork Vermilion River

395

End Points	Latitude	Longitude	COUNTY
start	40.7701181840118	-88.4858209632899	LIVINGSTON
end	40.7234241258087	-88.355790853647	LIVINGSTON

Spoon River

3

End Points	Latitude	Longitude	COUNTY
start	40.883272448156	-90.0994555125119	KNOX
end	41.2158736312898	-89.6870256054763	STARK

Spring Creek

161

End Points	Latitude	Longitude	COUNTY
start	40.5838583294631	-91.0397056763892	HANCOCK
end	40.595079516268	-91.0572149428165	HANCOCK

BASIN NAME / Segment Name / Segment No.	End Points	Latitude	Longitude	COUNTY
166				
	start	40.4506930058171	-90.758703782814	MCDONOUGH
	end	40.5047702003096	-90.7202911238868	MCDONOUGH
223				
	start	41.3114342012759	-89.1969933188526	BUREAU
	end	41.5341774964794	-89.1599030581214	LASALLE
Stevens Creek				
55				
	start	39.833172054334	-89.008501860042	MACON
	end	39.8725126750168	-88.9902570309468	MACON
Sugar Creek				
76				
	start	40.1505909949415	-89.6335239996087	MENARD
	end	40.3515916252906	-89.1626966142058	MCLEAN
124				
	start	40.9273148603695	-90.1168866799652	KNOX
	end	40.9407150872189	-90.126984172004	KNOX
448				
	start	40.7817769095357	-87.7532807121524	IROQUOIS
	end	40.650106664471	-87.5259225515566	IROQUOIS
Sutphens Run				
228				
	start	41.5813276727649	-88.9196815109252	LASALLE
	end	41.5940767755281	-89.0434408697488	LASALLE
Swab Run				
127				
	start	40.8043825531334	-90.0417502151246	KNOX
	end	40.8089204046364	-89.9959890937906	KNOX
Tenmile Creek				
64				
	start	40.1166122038468	-89.0605809659338	DEWITT
	end	40.1573804135529	-88.9870426654374	DEWITT
Timber Creek				
77				
	start	40.3499903738803	-89.1633832938062	MCLEAN
	end	40.3824906556377	-89.0653243216353	MCLEAN
Trim Creek				
249				
	start	41.1679695055755	-87.6275919071884	KANKAKEE
	end	41.3235679470585	-87.6273348723156	WILL
Turkey Creek				
172				
	start	40.5312633037562	-90.2784734138591	FULTON
	end	40.6100168551688	-90.1683886238592	FULTON
402				
	start	40.6346912128201	-88.8256051903746	MCLEAN
	end	40.6636296144043	-88.7848217949076	MCLEAN
Tyler Creek				
283				
	start	42.057069434075	-88.2869209701875	KANE
	end	42.0886074301339	-88.3939734393445	KANE
Unnamed Tributary				
230				

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
start	41.6008353940091	-88.9239309686064	LASALLE
end	41.6393800996109	-88.95237726256	LEE

406

start	40.8483817762616	-89.0003562591212	WOODFORD
end	40.8446321845668	-88.9879480330159	WOODFORD

Unnamed Tributary of Big Bureau Creek

222

start	41.2923889187328	-89.4849627504116	BUREAU
end	41.2746773653832	-89.4967232161933	BUREAU

Unnamed Tributary of Coopers Defeat Creek

113

start	41.1485959333575	-89.6944246708098	STARK
end	41.1432423938169	-89.6549152326434	STARK

Unnamed Tributary of Dickerson Slough

422

start	40.4068214049304	-88.3388760698826	FORD
end	40.4286849455119	-88.3118606581845	FORD

Unnamed Tributary of Drummer Creek

425

start	40.430183509928	-88.3944923485681	FORD
end	40.4228198536222	-88.4420280012069	FORD

Unnamed Tributary of East Branch of Copperas Creek

89

start	40.59257130763	-89.8385498955685	PEORIA
start	40.59257130763	-89.8385498955685	PEORIA

Unnamed Tributary of East Fork of Spoon River

112

start	41.1911731339471	-89.6948993736812	STARK
end	41.1958777466981	-89.6635132189552	STARK

Unnamed Tributary of Indian Creek

185

start	39.8195431621523	-90.231206997871	MORGAN
end	39.7997709298014	-90.2444898890822	MORGAN

229

start	41.5989641246871	-88.913295513256	LASALLE
end	41.6212302072922	-88.9971274321449	LASALLE

Unnamed Tributary of Jackson Creek

247

start	41.4328713295604	-88.0777949404827	WILL
end	41.4181859202087	-88.0389954976751	WILL

Unnamed Tributary of Johnny Run

261

start	41.1315090714299	-88.5704499691513	GRUNDY
end	41.1211734141418	-88.5813177275807	GRUNDY

Unnamed Tributary of Kickapoo Creek

66

start	40.4376592310728	-88.8667409562596	MCLEAN
end	40.4499435649154	-88.7941853627565	MCLEAN

95

start	40.843847234267	-89.6598940056171	PEORIA
end	40.8376970553513	-89.655765678658	PEORIA

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
Unnamed Tributary of Lone Tree Creek			
417			
start	40.3145980401842	-88.4738655755984	MCLEAN
end	40.3084681821929	-88.4721825603404	MCLEAN
419			
start	40.3200878690807	-88.4758169784284	MCLEAN
end	40.3246054213609	-88.502979969789	MCLEAN
420			
start	40.3555955038811	-88.4486860730234	CHAMPAIGN
end	40.3553786361326	-88.4890287857383	MCLEAN
Unnamed Tributary of Mackinaw River			
398			
start	40.5649627479232	-88.478822725546	MCLEAN
end	40.4956570103387	-88.5106552787079	MCLEAN
399			
start	40.558742486097	-88.5447290418444	MCLEAN
end	40.532461937187	-88.5550436512012	MCLEAN
400			
start	40.5536214693649	-88.6155771894066	MCLEAN
end	40.5386135050112	-88.6150100834316	MCLEAN
Unnamed Tributary of Masters Creek			
219			
start	41.5407471962821	-89.4154110620948	BUREAU
end	41.5452528261938	-89.4136798690744	BUREAU
Unnamed Tributary of Masters Fork			
218			
start	41.510430587881	-89.3900507138719	BUREAU
end	41.6181398940954	-89.2965280984998	LEE
Unnamed Tributary of Nettle Creek			
238			
start	41.4088814108094	-88.5216683950888	GRUNDY
end	41.4186133676397	-88.5339604493093	GRUNDY
Unnamed Tributary of Nippersink Creek			
255			
start	42.4692291197455	-88.4764236384547	MCHENRY
end	42.4695432978934	-88.5110499918451	MCHENRY
288			
start	42.4176539163554	-88.3444740410368	MCHENRY
end	42.4179067763647	-88.3502762821058	MCHENRY
290			
start	42.3969278131381	-88.4109784072142	MCHENRY
end	42.3875994074602	-88.4491666706176	MCHENRY
Unnamed Tributary of North Fork of Salt Creek			
72			
start	40.3598944577027	-88.7302360564635	MCLEAN
end	40.3817246400667	-88.7481607936989	MCLEAN
73			
start	40.3620541452609	-88.7204600533309	MCLEAN
end	40.3690272117515	-88.6961244618476	MCLEAN
75			
start	40.2987649882463	-88.7603546124853	MCLEAN
end	40.3051172967471	-88.7525145171727	MCLEAN
Unnamed Tributary of Panther Creek			

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
179			
start	39.9411115612757	-90.0607356525317	CASS
end	39.9350887523192	-90.047762075576	CASS
Unnamed Tributary of Pond Creek			
211			
start	41.3541221673156	-89.6001721270724	BUREAU
end	41.3352313411595	-89.5875580793812	BUREAU
Unnamed Tributary of Prairie Creek			
78			
start	40.2086608970772	-89.6103029312127	MASON
end	40.2239585519289	-89.638616348402	MASON
80			
start	40.3105388304102	-89.4819788351989	LOGAN
end	40.3114851545122	-89.4410508250634	LOGAN
Unnamed Tributary of Rooks Creek			
387			
start	40.7615433072922	-88.6752675977812	LIVINGSTON
end	40.7348742139519	-88.6985073106457	MCLEAN
Unnamed Tributary of Salt Creek			
412			
start	40.3090617343957	-88.6002511568763	MCLEAN
end	40.3165662374132	-88.6011454430269	MCLEAN
Unnamed Tributary of Sandy Creek			
108			
start	41.0816545465891	-89.0921996326175	MARSHALL
end	41.0690044849354	-89.0872784559417	MARSHALL
Unnamed Tributary of Sangamon River			
414			
start	40.2187198550443	-88.3726776422252	CHAMPAIGN
end	40.207759150969	-88.3556670563292	CHAMPAIGN
415			
start	40.2618571248343	-88.3804307110291	CHAMPAIGN
end	40.2604569179243	-88.4076966986332	CHAMPAIGN
Unnamed Tributary of Senachwine Creek			
97			
start	41.0729094906046	-89.5194162172506	MARSHALL
end	41.1005615839111	-89.5247542292286	MARSHALL
98			
start	41.0008160428297	-89.5071527441621	MARSHALL
end	41.0407981005047	-89.5430844273656	MARSHALL
Unnamed Tributary of Walnut Creek			
130			
start	41.0811500581416	-90.0632765005186	KNOX
end	41.0847653353348	-90.0680765817376	KNOX
132			
start	41.0602585608831	-89.9869046205873	KNOX
end	41.0721601609241	-89.9735120056073	STARK
133			
start	41.0262443553352	-89.9515238620326	STARK
end	41.0340788244836	-89.924721175772	STARK
Unnamed Tributary of West Bureau Creek			
215			
start	41.4606455355906	-89.5251264675481	BUREAU

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
end	41.4958522845312	-89.5472802493082	BUREAU

Unnamed Tributary of West Fork Sugar Creek

85

start	40.3381506914873	-89.2954898975603	TAZEWELL
end	40.3660114221746	-89.2448498120596	MCLEAN

86

start	40.3105145326502	-89.3291625265707	LOGAN
end	40.3299182729366	-89.3779530037535	TAZEWELL

Valley Run

241

start	41.4172036201222	-88.3955434158999	GRUNDY
end	41.5039796750174	-88.5041976708714	KENDALL

Vermilion Creek

235

start	41.4768291322914	-89.0571044195371	LASALLE
end	41.5338604103044	-89.0473804190906	LASALLE

Vermilion River

385

start	41.3202746199326	-89.067686548398	LASALLE
end	40.8817674383366	-88.6504671722722	LIVINGSTON

Walnut Creek

128

start	40.9597510841493	-89.9769499175619	PEORIA
end	41.12653217294	-90.2059192933585	KNOX

404

start	40.6253040823561	-89.239009045057	WOODFORD
end	40.7670065190601	-89.3054156233977	WOODFORD

Waubonsie Creek

273

start	41.6864691774875	-88.3543291766866	KENDALL
end	41.727653072306	-88.2817226140407	KANE

Waupecan Creek

262

start	41.3345412028515	-88.4648617458928	GRUNDY
end	41.1880870688571	-88.5889392759762	LASALLE

Welch Creek

278

start	41.7390229211455	-88.5133300234389	KANE
end	41.7542282081589	-88.4963865174814	KANE

West Branch Big Rock Creek

276

start	41.7542830239271	-88.5621632556731	KANE
end	41.791467372356	-88.6440656199133	DEKALB

West Branch Drummer Creek

424

start	40.4348513301682	-88.3934764271309	FORD
end	40.4490333768479	-88.4056995893214	FORD

West Branch Du Page River

269

start	41.7019525201778	-88.1476209409341	WILL
end	41.7799425869794	-88.1712650214772	DUPAGE

West Branch of Easterbrook Drain

411

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
start	40.3633709579832	-88.5816306009141	MCLEAN
end	40.3762064931712	-88.5843753634505	MCLEAN

West Branch of Horse Creek

263

End Points	Latitude	Longitude	COUNTY
start	41.2492485076225	-88.1312055809841	WILL
end	41.0019131557324	-88.1364114459172	KANKAKEE

West Branch of Lamarsh Creek

91

End Points	Latitude	Longitude	COUNTY
start	40.5615978513207	-89.6991824445749	PEORIA
end	40.640281675188	-89.7388615248892	PEORIA

West Branch Panther Creek

407

End Points	Latitude	Longitude	COUNTY
start	40.7528335084236	-89.1030067348099	WOODFORD
end	40.7954060105963	-89.1900600098668	WOODFORD

West Bureau Creek

213

End Points	Latitude	Longitude	COUNTY
start	41.3209910742583	-89.5195916727401	BUREAU
end	41.478267808168	-89.5152211006131	BUREAU

West Fork Mazon River

260

End Points	Latitude	Longitude	COUNTY
start	41.2530670781541	-88.3508667933585	GRUNDY
end	41.0302502359071	-88.5226194555857	LIVINGSTON

West Fork Salt Creek

74

End Points	Latitude	Longitude	COUNTY
start	40.317360196629	-88.7559599297755	MCLEAN
end	40.3372561693307	-88.8039670869984	MCLEAN

West Fork Sugar Creek

84

End Points	Latitude	Longitude	COUNTY
start	40.2844404292499	-89.332075650855	LOGAN
end	40.4558745105979	-89.1642930044364	MCLEAN

Wolf Creek

497

End Points	Latitude	Longitude	COUNTY
start	41.1540042913791	-88.8612912917747	LASALLE
end	41.1611802253124	-88.8310854379729	LASALLE

Kaskaskia

Bearcat Creek

37

End Points	Latitude	Longitude	COUNTY
start	39.0121682814832	-89.5317265036074	BOND
end	39.0568357269204	-89.4889786056249	MONTGOMERY

Becks Creek

45

End Points	Latitude	Longitude	COUNTY
start	39.1565938305703	-88.9491156388975	FAYETTE
end	39.3602481794208	-89.0227919838743	SHELBY

Brush Creek

39

End Points	Latitude	Longitude	COUNTY
start	39.1385354787129	-89.5805305687638	MONTGOMERY
end	39.1539913389194	-89.561368040102	MONTGOMERY

Cress Creek

41

End Points	Latitude	Longitude	COUNTY
start	39.1652709439739	-89.5012992382647	MONTGOMERY
end	39.1962551507602	-89.5131844155481	MONTGOMERY

Dry Fork

BASIN NAME

Segment Name

Segment No.

Segment	End Points	Latitude	Longitude	COUNTY
43				
	start	39.036113738887	-89.2488135289512	FAYETTE
	end	39.1033131262537	-89.2984242244004	MONTGOMERY
East Fork Shoal Creek				
23				
	start	38.8310032253066	-89.4990300331039	BOND
	end	38.9226451880864	-89.4117554251748	BOND
Gerhardt Creek				
27				
	start	38.3445550793694	-90.0600653224456	ST. CLAIR
	end	38.367857922464	-90.0997565611344	MONROE
Hurricane Creek				
42				
	start	38.9180334233238	-89.2472989134191	FAYETTE
	end	39.2167946546678	-89.2767284135051	MONTGOMERY
Loop Creek				
21				
	start	38.4738791704891	-89.8286629587977	ST. CLAIR
	end	38.4996759642082	-89.9058988238884	ST. CLAIR
Middle Fork Shoal Creek				
40				
	start	39.0848984732588	-89.5438724131899	MONTGOMERY
	end	39.1868483992515	-89.4798528829252	MONTGOMERY
Mitchell Creek				
48				
	start	39.1565938305703	-88.9491156388975	FAYETTE
	end	39.3191569074355	-88.9291931738519	SHELBY
Mud Creek				
51				
	start	39.4078984061571	-88.8964126852371	SHELBY
	end	39.4786612118046	-88.9523280946578	SHELBY
Ninemile Creek				
30				
	start	38.0441291788376	-89.9112042263573	RANDOLPH
	end	38.0507383485977	-89.8278402421236	RANDOLPH
Opossum Creek				
46				
	start	39.2718719283603	-89.006345202583	SHELBY
	end	39.2833737967471	-89.0555186821259	SHELBY
Prairie du Long Creek				
24				
	start	38.2583950460692	-89.9674114204896	MONROE
	end	38.3425597902873	-90.0517323138269	ST. CLAIR
Robinson Creek				
50				
	start	39.3519556417502	-88.8434641389225	SHELBY
	end	39.5215530679793	-88.8331635597113	SHELBY
Rockhouse Creek				
25				
	start	38.279441694169	-90.0367398173562	MONROE
	end	38.2999005789932	-90.1039357731424	MONROE
Section Creek				
49				

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
start	39.1835497280833	-88.9455894742885	FAYETTE
end	39.1959160048126	-88.961892707007	FAYETTE

Shoal Creek

22

start	38.4831106563982	-89.5775456200079	WASHINGTON
end	38.5557239981111	-89.4968640710432	CLINTON

36

start	38.8310032008922	-89.4990300493802	BOND
end	39.0848755752581	-89.5439018081354	MONTGOMERY

Silver Creek

20

start	38.3369025707936	-89.8753691916515	ST. CLAIR
end	38.5568068204478	-89.8305698867169	ST. CLAIR

Stringtown Branch

53

start	39.7138824796477	-88.6677549810426	MOULTRIE
end	39.7363136714592	-88.6944718913546	MOULTRIE

Unnamed Tributary of Gerhardt Creek

26

start	38.367857922464	-90.0997565611344	MONROE
end	38.3742880966457	-90.1107074126403	MONROE

Unnamed Tributary of Okaw River

54

start	39.734248747064	-88.6620801587617	MOULTRIE
end	39.80990395294	-88.6969360645412	PIATT

Walters Creek

28

start	38.3425597902873	-90.0517323138269	ST. CLAIR
end	38.3445550793694	-90.0600653224456	ST. CLAIR

West Fork Shoal Creek

38

start	39.1385354787129	-89.5805305687638	MONTGOMERY
end	39.1877434015581	-89.6041666305308	MONTGOMERY

West Okaw River

52

start	39.6158126349278	-88.7105522558061	MOULTRIE
end	39.7564321977535	-88.630211952428	MOULTRIE

Mississippi River

Apple River

372

start	42.3210892387922	-90.2520915343109	JO DAVIESS
end	42.5078007598632	-90.1320538371008	JO DAVIESS

Bear Creek

199

start	40.1421908412793	-91.322057103417	ADAMS
end	40.3507607406412	-91.1831593883194	HANCOCK

Bigneck Creek

205

start	40.1189668648562	-91.2247381726013	ADAMS
end	40.118891177483	-91.1409739765636	ADAMS

Burton Creek

192

BASIN NAME

Segment Name

Segment No.

End Points		Latitude	Longitude	COUNTY
	start	39.8643091712617	-91.343323220756	ADAMS
	end	39.92393403238	-91.2381482737218	ADAMS

Camp Creek

140

	start	41.2607621817314	-90.514303172809	MERCER
	end	41.3114464274682	-90.2476056448033	HENRY

142

	start	41.2202380211465	-90.895164796358	MERCER
	end	41.2787933006746	-90.6950345992843	MERCER

Carroll Creek

349

	start	42.1027782814517	-90.0265311556732	CARROLL
	end	42.0906369943302	-89.8985337135691	CARROLL

Clear Creek

6

	start	37.4821139304798	-89.377768200259	UNION
	end	37.5377402977406	-89.331689550578	UNION

381

	start	42.4468385101031	-90.0472460146999	JO DAVIESS
	end	42.4780763391708	-90.035127804618	JO DAVIESS

Coon Creek

376

	start	42.4035528739642	-90.1272819897867	JO DAVIESS
	end	42.4347098804951	-90.1169407822902	JO DAVIESS

Copperas Creek

148

	start	41.3717279574558	-90.901871458269	ROCK ISLAND
	end	41.3616090539824	-90.7468725613692	ROCK ISLAND

Deep Run

155

	start	40.7779166934519	-90.9639489255706	HENDERSON
	end	40.794076798068	-90.9474772904134	HENDERSON

Dixson Creek

154

	start	40.7684181600505	-90.9376123103323	HENDERSON
	end	40.7650613473293	-90.9262679175808	HENDERSON

Dutch Creek

4

	start	37.4593003249666	-89.3688365937935	UNION
	end	37.4147572383786	-89.2744790735331	UNION

East Fork Galena River

383

	start	42.450241615252	-90.3876497193745	JO DAVIESS
	end	42.4876693698893	-90.286894403861	JO DAVIESS

Edwards River

145

	start	41.1459068953479	-90.9832855425151	MERCER
	end	41.2835429634312	-90.1022166001482	HENRY

Eliza Creek

146

	start	41.2754465656779	-90.9740195834639	MERCER
	end	41.2948140261561	-90.8870757880317	MERCER

Ellison Creek

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
153			
start	40.7615810139869	-91.0723400800456	HENDERSON
end	40.7295594797542	-90.7480413061409	WARREN
Galena River			
382			
start	42.450241615252	-90.3876497193745	JO DAVIESS
end	42.5068721036534	-90.390459616835	JO DAVIESS
Green Creek			
5			
start	37.4514943718452	-89.3379244013686	UNION
end	37.4666314694209	-89.3048476846202	UNION
Hadley Creek			
188			
start	39.7025380326419	-91.1396851101986	PIKE
end	39.7351716794518	-90.9664567571417	PIKE
Hells Branch			
378			
start	42.3582317355027	-90.185076448587	JO DAVIESS
end	42.4166702490621	-90.1660286242329	JO DAVIESS
Henderson Creek			
134			
start	41.0518601460692	-90.652709618504	WARREN
end	41.0728998007979	-90.3331881878676	KNOX
150			
start	40.8788582366336	-90.9641994146698	HENDERSON
end	40.989888583038	-90.8698875032336	HENDERSON
Hillery Creek			
144			
start	41.2699394405307	-90.2020116075301	HENRY
end	41.2553101029329	-90.1954503442612	HENRY
Honey Creek			
157			
start	40.7000823335975	-91.0347691132118	HENDERSON
end	40.7064734203141	-90.8589436695132	HENDERSON
186			
start	39.4871465283426	-90.7799240715991	PIKE
end	39.5633421986505	-90.8011460205638	PIKE
207			
start	40.1052246871151	-91.2149469620062	ADAMS
end	40.0689996865178	-91.2253825583113	ADAMS
Hutchins Creek			
7			
start	37.5043385818368	-89.3755380391598	UNION
end	37.58788138261	-89.3917584202331	UNION
Little Bear Creek			
194			
start	40.3213003292038	-91.2390256840921	HANCOCK
end	40.302753021887	-91.3102530307924	HANCOCK
Little Creek			
200			
start	40.1807360433073	-91.2803860136891	ADAMS
end	40.230127123031	-91.3051461065984	HANCOCK
McCraney Creek			

BASIN NAME / Segment Name / Segment No. / End Points		Latitude	Longitude	COUNTY
189				
	start	39.7167396162723	-91.1729844320811	PIKE
	end	39.8572624790589	-91.0907175471865	ADAMS
Mill Creek				
191				
	start	39.8643091712617	-91.343323220756	ADAMS
	end	39.9675786362521	-91.2477003180771	ADAMS
377				
	start	42.3539782358808	-90.1879698650198	JO DAVIESS
	end	42.4518923573772	-90.2485882677025	JO DAVIESS
496				
	start	38.9472270910927	-90.2956721236088	JERSEY
	end	38.9871246152411	-90.3431576290565	JERSEY
Mississippi River				
2				
	end	37.1887629940337	-89.4576720472899	ALEXANDER
29				
	start	38.8664117755941	-90.1477786925267	MADISON
	end	38.327795025976	-90.3709302644266	MONROE
384				
	start	42.5079432477656	-90.6430378486115	JO DAVIESS
	end	41.5746193723759	-90.392321397091	ROCK ISLAND
440				
	start	39.326689248302	-90.8243988873681	CALHOUN
	end	39.8935238218567	-91.4437639810547	ADAMS
Mud Creek				
202				
	start	40.1812148450863	-91.2785060826782	ADAMS
	end	40.1852755387137	-91.2660018265735	ADAMS
Nichols Run				
156				
	start	40.7735451176215	-90.9672827833242	HENDERSON
	end	40.7648298879037	-90.9675416302885	HENDERSON
North Henderson Creek				
136				
	start	41.0973619647032	-90.7191141378965	MERCER
	end	41.119743833988	-90.4494190524502	MERCER
Parker Run				
141				
	start	41.2623500459087	-90.4891341819923	MERCER
	end	41.2260011828886	-90.4145431241447	HENRY
Pigeon Creek				
190				
	start	39.7143204171354	-91.2372670411405	PIKE
	end	39.8220301600964	-91.2087922935523	ADAMS
Pope Creek				
137				
	start	41.1401437091914	-90.8116816399802	MERCER
	end	41.1394137238591	-90.2877112230995	KNOX
Sixmile Creek				
187				
	start	39.4592604039597	-90.8902507134236	PIKE
	end	39.5431657559583	-90.8891598316201	PIKE

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
Slater Creek			
198			
start	40.291601584329	-91.2423526162923	HANCOCK
end	40.2822885732908	-91.2189777154329	HANCOCK
Smith Creek			
152			
start	40.9297989285848	-90.9146232873076	HENDERSON
end	40.9291958384872	-90.7919464822621	HENDERSON
South Edwards River			
139			
start	41.2656645104853	-90.2611866223557	HENRY
end	41.1927071399434	-90.0393078982573	HENRY
South Fork Apple River			
380			
start	42.4468385101031	-90.0472460146999	JO DAVIESS
end	42.4176188464167	-89.9845802036023	JO DAVIESS
South Fork Bear Creek			
203			
start	40.1677973436879	-91.2933473698779	ADAMS
end	40.0950329934447	-91.0607522810856	ADAMS
South Henderson Creek			
135			
start	41.0188478643653	-90.4811337762604	WARREN
end	41.0121123609019	-90.4338464913801	KNOX
151			
start	40.8788582366336	-90.9641994146698	HENDERSON
end	40.8534764362853	-90.8707263659685	HENDERSON
Straddle Creek			
301			
start	42.0906369943302	-89.8985337135691	CARROLL
end	42.1316680929413	-89.783599495409	CARROLL
Thurman Creek			
204			
start	40.1277667094818	-91.234525810555	ADAMS
end	40.1580795200863	-91.1501036788115	ADAMS
Tournear Creek			
193			
start	39.9042285951329	-91.2447718289928	ADAMS
end	39.8738503674823	-91.1658282439773	ADAMS
Unnamed Tributary of Apple River			
375			
start	42.3613497834653	-90.1603277978963	JO DAVIESS
end	42.3651703478401	-90.1182227692179	JO DAVIESS
Unnamed Tributary of Bear Creek			
197			
start	40.3187160045841	-91.2379753573306	HANCOCK
end	40.3220475782343	-91.2218711128768	HANCOCK
201			
start	40.2483484763178	-91.2634157983708	HANCOCK
end	40.2576281291385	-91.2420554576986	HANCOCK
Unnamed Tributary of Copperas Creek			
149			
start	41.3759130587612	-90.8569366994939	ROCK ISLAND

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
end	41.3735944469795	-90.829794872711	ROCK ISLAND

Unnamed Tributary of Furnace Creek

373

start	42.3419228115146	-90.2583358633166	JO DAVIESS
end	42.3737126096251	-90.2971522307335	JO DAVIESS

374

start	42.3419228115146	-90.2583358633166	JO DAVIESS
end	42.3615209718591	-90.24931703774	JO DAVIESS

Unnamed Tributary of South Edwards River

143

start	41.2011516193172	-90.1850818577344	HENRY
end	41.1943841818099	-90.1839265246101	HENRY

Unnamed Tributary of South Fork of Bear Creek

206

start	40.0797919556019	-91.1461193615862	ADAMS
end	40.0587441356106	-91.1467388825794	ADAMS

West Fork Apple River

379

start	42.4777531846594	-90.1103501186504	JO DAVIESS
end	42.4739843218597	-90.1321517307332	JO DAVIESS

West Fork of Bear Creek

195

start	40.3385207135212	-91.2203393068898	HANCOCK
end	40.3592824400704	-91.2334357995319	HANCOCK

Yankee Branch

147

start	41.2850778212191	-90.9379823025264	MERCER
end	41.2926277702981	-90.9335620769218	MERCER

Ohio

Big Creek

16

start	37.4366764302436	-88.3127424957005	HARDIN
end	37.5591274535694	-88.3148730216063	HARDIN

Big Grand Pierre Creek

13

start	37.4163002207384	-88.4338876873615	POPE
end	37.5702304746463	-88.4292613661871	POPE

Hayes Creek

10

start	37.4452331751972	-88.7114120959417	JOHNSON
end	37.4559134065693	-88.6286228702431	POPE

Hicks Branch

14

start	37.5432903813926	-88.4245265989312	POPE
end	37.5391971894773	-88.4135144509885	HARDIN

Little Lusk Creek

12

start	37.4991426291527	-88.5277357332102	POPE
end	37.5247950767618	-88.5017934865946	POPE

Little Saline River

9

start	37.6429893859023	-88.6229273282692	SALINE

BASIN NAME
Segment Name
Segment No.

End Points	Latitude	Longitude	COUNTY
end	37.5783125058777	-88.7169929932876	JOHNSON

Lusk Creek
11

End Points	Latitude	Longitude	COUNTY
start	37.3685952948804	-88.4926140087969	POPE
end	37.5649232438096	-88.5644984122843	POPE

Miss River
2

End Points	Latitude	Longitude	COUNTY
start	36.9810279805712	-89.1311552055554	ALEXANDER

Ohio River
1

End Points	Latitude	Longitude	COUNTY
start	36.9810279805712	-89.1311552055554	ALEXANDER
end	37.7995447392016	-88.0255709974801	GALLATIN

Simmons Creek
15

End Points	Latitude	Longitude	COUNTY
start	37.4274681380208	-88.4392381154217	POPE
end	37.4644921054999	-88.4850750109356	POPE

South Fork Saline River
8

End Points	Latitude	Longitude	COUNTY
start	37.6372646144582	-88.6447143188352	SALINE
end	37.6650992000287	-88.7471054185807	WILLIAMSON

Unnamed Tributary of Big Creek
18

End Points	Latitude	Longitude	COUNTY
start	37.4816237108967	-88.3412279259479	HARDIN
end	37.4836843600581	-88.3434390004066	HARDIN

Wabash River
488

End Points	Latitude	Longitude	COUNTY
start	37.7995447392016	-88.0255709974801	GALLATIN

Rock
Beach Creek
302

End Points	Latitude	Longitude	COUNTY
start	41.8989215290323	-89.121081932608	OGLE
end	41.8637759544565	-89.185844184387	LEE

Beaver Creek
322

End Points	Latitude	Longitude	COUNTY
start	42.2551087433884	-88.9247700103803	BOONE
end	42.4341346635117	-88.7603784300954	BOONE

Black Walnut Creek
341

End Points	Latitude	Longitude	COUNTY
start	42.1132080942552	-89.2141520188153	OGLE
end	42.061557908797	-89.2316600156935	OGLE

Brown Creek
335

End Points	Latitude	Longitude	COUNTY
start	42.3568412672282	-89.4493817584574	STEPHENSON
end	42.3697340053709	-89.4802304815634	STEPHENSON

Buffalo Creek
358

End Points	Latitude	Longitude	COUNTY
start	41.9242552302868	-89.6809355972221	WHITESIDE
end	41.9752373833258	-89.6243677263482	OGLE

Cedar Creek
337

End Points	Latitude	Longitude	COUNTY
start	42.3709196286357	-89.670256711355	STEPHENSON
end	42.3896058186609	-89.5870343171161	STEPHENSON

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
Coal Creek			
208			
start	41.3941767873198	-89.8287586795479	BUREAU
end	41.2930847238959	-89.6659810678663	BUREAU
Coon Creek			
304			
start	42.0365871032824	-89.489365571257	OGLE
end	42.0550520228278	-89.4762995939105	OGLE
326			
start	42.254519734978	-88.7945563884938	BOONE
end	42.1336677087989	-88.6039205825106	DEKALB
Crane Grove Creek			
371			
start	42.2656461748962	-89.6058461735176	STEPHENSON
end	42.2317224844045	-89.5804359629382	STEPHENSON
Deer Creek			
307			
start	42.1046195671697	-88.7267155451459	DEKALB
end	42.1076541965304	-88.6684575625598	DEKALB
Dry Creek			
332			
start	42.4322162336943	-89.0509181181504	WINNEBAGO
end	42.4892211712754	-88.9789486331688	WINNEBAGO
East Branch South Branch of Kishwaukee River			
306			
start	42.0108038948242	-88.7236807475971	DEKALB
end	41.9822037358546	-88.5449399063616	KANE
East Fork Mill Creek			
343			
start	42.1402053009442	-89.2945061380348	OGLE
end	42.1744627607887	-89.268245093523	OGLE
Elkhorn Creek			
350			
start	41.8392614813286	-89.6956810578758	WHITESIDE
end	42.0864514128748	-89.636841111792	OGLE
Franklin Creek			
303			
start	41.8885909580789	-89.4120344682789	OGLE
end	41.830393186845	-89.3092915487959	LEE
Goose Creek			
356			
start	41.9282951879448	-89.692114617634	WHITESIDE
end	41.9476422569681	-89.6849104470831	OGLE
Green River			
359			
start	41.6266589513433	-89.5688644755145	LEE
end	41.8177589430141	-89.1263088319088	LEE
Kilbuck Creek			
312			
start	42.1838622639314	-89.1301689015062	WINNEBAGO
end	41.9181917577798	-88.9212387567239	DEKALB
Kingsbury Creek			
311			

BASIN NAME Segment Name Segment No. End Points	Latitude	Longitude	COUNTY
start	42.1077794424363	-88.8726630666396	DEKALB
end	42.1579325310556	-88.8548684690422	BOONE
Kishwaukee River			
318			
start	42.1866384939252	-89.1320796977525	WINNEBAGO
end	42.2666635150817	-88.5250450377336	MCHENRY
Kyte River			
295			
start	41.9881250432719	-89.3232327202272	OGLE
end	41.9206998470585	-89.0576692414087	OGLE
Leaf River			
345			
start	42.093677393629	-89.3249228482157	OGLE
end	42.1545774626081	-89.5725820219443	OGLE
Lost Creek			
368			
start	42.245723132043	-89.7807765552299	STEPHENSON
end	42.2314500223394	-89.7709518073782	STEPHENSON
Middle Creek			
344			
start	42.1559584011258	-89.2911997709031	OGLE
end	42.1737499306461	-89.2931763612625	OGLE
Mill Creek			
342			
start	42.1206847838382	-89.2792143996076	OGLE
end	42.2092574596508	-89.3358557551327	WINNEBAGO
Mosquito Creek			
323			
start	42.3066628798583	-88.9047855300292	BOONE
end	42.3100003482313	-88.9099328193755	BOONE
327			
start	42.246521748985	-88.7802719043895	BOONE
end	42.1906300595167	-88.7849304281662	BOONE
Mud Creek			
325			
start	42.2592878387497	-88.7503449689069	BOONE
end	42.2805097009077	-88.7381130663589	BOONE
346			
start	42.1301628959448	-89.4043328758949	OGLE
end	42.1639762007661	-89.4554911246235	OGLE
North Branch Kishwaukee River			
320			
start	42.2655855837644	-88.5514660318739	MCHENRY
end	42.4163330454161	-88.5232715616737	MCHENRY
North Branch Otter Creek			
292			
start	42.4412940471901	-89.3074016078782	WINNEBAGO
end	42.4570625094589	-89.356265092275	WINNEBAGO
North Fork Kent Creek			
333			
start	42.2621663352674	-89.0944316410734	WINNEBAGO
end	42.310438304708	-89.1651357273603	WINNEBAGO
Otter Creek			

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
291			
start	42.4565457866811	-89.2410171137247	WINNEBAGO
end	42.4412940471901	-89.3074016078782	WINNEBAGO
348			
start	42.1345277930786	-89.411492883497	OGLE
end	42.1911608097275	-89.4222625773931	OGLE
Owens Creek			
310			
start	42.1012605056104	-88.8850996053184	DEKALB
end	41.994362186304	-88.8506687869106	DEKALB
Pine Creek			
305			
start	41.9113031895505	-89.452879176459	OGLE
end	42.0376146514025	-89.4909007464322	OGLE
Piscasaw Creek			
324			
start	42.2618063936707	-88.8176068924198	BOONE
end	42.3916885547221	-88.7041339551642	MCHENRY
Raccoon Creek			
328			
start	42.4479288873423	-89.098286193015	WINNEBAGO
end	42.4829761640917	-89.1400856130022	WINNEBAGO
Reid Creek			
353			
start	41.8644109921615	-89.5919014348703	LEE
end	41.9135187969506	-89.5728723309406	OGLE
Richland Creek			
336			
start	42.3456275295301	-89.6832413426115	STEPHENSON
end	42.5047442687577	-89.6477619118761	STEPHENSON
Rock River			
294			
start	41.9881250432719	-89.3232327202272	OGLE
end	42.4962174640048	-89.0418910839077	WINNEBAGO
Rock Run			
490			
start	42.3211872463585	-89.4237342452712	STEPHENSON
end	42.4281098959774	-89.4483616268915	STEPHENSON
Rush Creek			
321			
start	42.2560676137827	-88.7031592940742	MCHENRY
end	42.4031741332744	-88.5930626223964	MCHENRY
Silver Creek			
338			
start	42.0611717976691	-89.335901928201	OGLE
end	42.0866765435436	-89.3839889015445	OGLE
Skunk Creek			
354			
start	41.8794703976699	-89.7072621672884	WHITESIDE
end	41.897582187238	-89.7290746844729	WHITESIDE
South Branch Kishwaukee River			
308			
start	42.2001609257306	-88.9840657029051	WINNEBAGO

BASIN NAME

Segment Name

Segment No.

End Points		Latitude	Longitude	COUNTY
	end	41.9015798699947	-88.7706697182685	DEKALB
315				
	start	42.2627093767756	-88.5609522875415	MCHENRY
	end	42.1066209842679	-88.4620443477841	KANE
South Branch of Otter Creek				
280				
	start	42.4412940471901	-89.3074016078782	WINNEBAGO
	end	42.4343122756071	-89.3600650183381	WINNEBAGO
South Fork of Leaf River				
347				
	start	42.1296104494647	-89.4546456401589	OGLE
	end	42.1085718337046	-89.5037134270228	OGLE
South Kinnikinnick Creek				
330				
	start	42.419961259532	-89.018119476068	WINNEBAGO
	end	42.4190921988888	-88.8710507717794	BOONE
Spring Creek				
339				
	start	42.0709215390383	-89.325546679708	OGLE
	end	42.0590157098796	-89.3110803788049	OGLE
Spring Run				
313				
	start	42.0402370001041	-89.0065478421579	OGLE
	end	42.0507770466662	-88.9858854279893	OGLE
Steward Creek				
297				
	start	41.8903673258897	-89.1021064698423	OGLE
	end	41.8259979751563	-88.9624738458404	LEE
Stillman Creek				
340				
	start	42.1259475370515	-89.2319193482332	OGLE
	end	42.0372051268587	-89.1542573242497	OGLE
Sugar Creek				
352				
	start	41.8392614813286	-89.6956810578758	WHITESIDE
	end	41.8644109921615	-89.5919014348703	LEE
Sugar River				
293				
	start	42.4357992567436	-89.1971727593158	WINNEBAGO
	end	42.4982890047043	-89.2624235677856	WINNEBAGO
Sumner Creek				
334				
	start	42.3227762010459	-89.3830042631004	WINNEBAGO
	end	42.25195988987	-89.3997975146614	STEPHENSON
Turtle Creek				
329				
	start	42.4929910323531	-89.0439958173493	WINNEBAGO
	end	42.4961371053418	-89.0246519221989	WINNEBAGO
Unnamed Tributary				
361				
	start	41.6608316904842	-89.4728200038511	LEE
	end	41.6425311558513	-89.4137140926471	LEE
365				

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
start	41.7443681625006	-89.168951821186	LEE
end	41.738182745458	-89.1042187039322	LEE
492			
start	42.1246069284208	-88.5882544654343	DEKALB
end	42.1028295788327	-88.5105326912596	KANE
Unnamed Tributary of Buffalo Creek			
357			
start	41.9332348110612	-89.6342816030603	OGLE
end	41.93890647032	-89.6092042883405	OGLE
Unnamed Tributary of Coon Creek			
282			
start	42.1336677087989	-88.6039205825106	DEKALB
end	42.0754334787177	-88.5442273447775	KANE
491			
start	42.150113155436	-88.6091713292612	DEKALB
end	42.1691790844289	-88.5070973943593	MCHENRY
Unnamed Tributary of Elkhorn Creek			
355			
start	41.9378871254405	-89.7318712136894	CARROLL
end	41.9525180771018	-89.7332762139612	CARROLL
Unnamed Tributary of Green River			
360			
start	41.8177589430141	-89.1263088319088	LEE
end	41.8012094828667	-89.0296681468724	LEE
362			
start	41.66455888603	-89.4729486542104	LEE
end	41.650155479351	-89.4398464027055	LEE
364			
start	41.750735979575	-89.2189268880904	LEE
end	41.7278383993539	-89.1577958588247	LEE
366			
start	41.7304138832457	-89.2547363744761	LEE
end	41.7421804770435	-89.2683034846455	LEE
367			
start	41.7336722733557	-89.2459381167869	LEE
end	41.6996843512729	-89.2025409068097	LEE
489			
start	41.7765356433433	-89.1781811586274	LEE
end	41.791148742648	-89.1782543204659	LEE
Unnamed Tributary of Kyte River			
298			
start	41.969037423435	-89.2727932207785	OGLE
end	41.9423468128644	-89.2676252361535	OGLE
299			
start	41.9474122868214	-89.1742920304606	OGLE
end	41.9511979792854	-89.1378721025283	OGLE
Unnamed Tributary of North Branch Kishwaukee River			
319			
start	42.4163330454161	-88.5232715616737	MCHENRY
end	42.4218523642031	-88.5063783493938	MCHENRY
Unnamed Tributary of Rock River			
331			
start	42.3730089457359	-89.0581319432428	WINNEBAGO

End Points	Latitude	Longitude	COUNTY
BASIN NAME			
Segment Name			
Segment No.			
end	42.382841503485	-89.0950184603254	WINNEBAGO
Unnamed Tributary of South Branch Kishwaukee River			
309			
start	42.1219922946716	-88.9236557341498	DEKALB
end	42.1138208388943	-88.9372243118963	DEKALB
316			
start	42.1565644453666	-88.4449935784875	MCHENRY
end	42.1594149792506	-88.4178533576301	MCHENRY
317			
start	42.234010247227	-88.5199093723576	MCHENRY
end	42.2225793216803	-88.5259266256801	MCHENRY
Unnamed Tributary of Spring Run			
314			
start	42.0401565844742	-88.9948863767949	OGLE
end	42.0116835703089	-88.9710672286801	OGLE
Unnamed Tributary of Steward Creek			
296			
start	41.8444592840822	-89.0070046248547	LEE
end	41.8601589546913	-88.9714244440014	LEE
300			
start	41.871719116543	-89.069434926448	LEE
end	41.8792477545579	-89.037635229652	LEE
Unnamed Tributary of Yellow Creek			
369			
start	42.3067615221991	-89.8535571166391	STEPHENSON
end	42.3493669268537	-89.8275355259147	STEPHENSON
West Fork Elkhorn Creek			
351			
start	42.0864514128748	-89.636841111792	OGLE
end	42.0924853439498	-89.6474944357754	OGLE
Willow Creek			
363			
start	41.7653209616214	-89.1943294683724	LEE
end	41.7141851660088	-89.032161004274	LEE
Yellow Creek			
370			
start	42.2899156684427	-89.5696276563017	STEPHENSON
end	42.3796215769162	-89.9350879560031	JO DAVIESS
Wabash			
Bean Creek			
437			
start	40.2950579779894	-87.7823902126108	VERMILION
end	40.3344744135429	-87.7494458762005	VERMILION
Big Creek			
457			
start	39.3351439545995	-87.5878012286214	CLARK
start	39.436126036547	-87.7023848396263	CLARK
Bluegrass Creek			
436			
start	40.301292752824	-87.7969361668719	VERMILION
end	40.381268589802	-87.8562389558508	VERMILION
Brouilletts Creek			

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
450			
start	39.7057649552945	-87.5509615193818	EDGAR
end	39.797449971524	-87.7178559181463	EDGAR
Brush Creek			
468			
start	38.993072718826	-88.1273817532169	JASPER
end	38.9675510537677	-88.1471375817992	JASPER
Brushy Fork			
484			
start	39.7161188745587	-88.0853294840712	DOUGLAS
end	39.8111289403664	-87.8839288887749	EDGAR
Buck Creek			
435			
start	40.3115126234324	-87.9255710854089	VERMILION
end	40.2862675329103	-87.9704593374522	CHAMPAIGN
Cassell Creek			
473			
start	39.4866434423672	-88.2094970436354	COLES
end	39.4909698054293	-88.207848854172	COLES
Catfish Creek			
477			
start	39.680891264864	-87.9341744320393	EDGAR
end	39.6581354970801	-87.8937116601235	EDGAR
Clark Branch			
483			
start	39.8111289403664	-87.8839288887749	EDGAR
end	39.8226610039489	-87.8513747624001	EDGAR
Collison Branch			
439			
start	40.2351860050982	-87.7725365689525	VERMILION
end	40.2197161120333	-87.803155121171	VERMILION
Cottonwood Creek			
469			
start	39.2033657707304	-88.2765033266093	CUMBERLAND
end	39.3142137713574	-88.229342077034	CUMBERLAND
Crabapple Creek			
452			
start	39.7057649552945	-87.5509615193818	EDGAR
end	39.8065708276187	-87.6467768455628	EDGAR
Crooked Creek			
465			
start	38.9817031629594	-88.066438923761	JASPER
end	39.0356467346919	-88.0923368283887	JASPER
Deer Creek			
485			
start	39.7053403128076	-88.0850387247647	DOUGLAS
end	39.7025679945443	-88.2058470030399	DOUGLAS
Donica Creek			
479			
start	39.6453315324326	-87.9892294370803	COLES
end	39.6172623271272	-87.9782640861296	COLES
Dudley Branch			
475			

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
start	39.5115642227627	-88.0564563693231	COLES
end	39.5068188298145	-88.043669581567	COLES

East Crooked Creek

287

End Points	Latitude	Longitude	COUNTY
start	39.0356467346919	-88.0923368283887	JASPER
end	39.1659729856615	-88.0610310241876	JASPER

East Fork Big Creek

458

End Points	Latitude	Longitude	COUNTY
start	39.436126036547	-87.7023848396263	CLARK
end	39.5471103780713	-87.760040304497	EDGAR

Embarras River

460

End Points	Latitude	Longitude	COUNTY
start	38.9148628762488	-87.9834798036322	JASPER
end	39.7161188745587	-88.0853294840712	DOUGLAS

Feather Creek

432

End Points	Latitude	Longitude	COUNTY
start	40.1172818042134	-87.8342855159987	VERMILION
end	40.1416543211304	-87.8399367268356	VERMILION

Greasy Creek

480

End Points	Latitude	Longitude	COUNTY
start	39.6325904592965	-88.0822649850404	COLES
end	39.6182255297223	-88.1320998047424	COLES

Hickory Creek

464

End Points	Latitude	Longitude	COUNTY
start	38.9714278418083	-87.972721454297	JASPER
end	38.99191464315	-87.989292523907	JASPER

Hickory Grove Creek

478

End Points	Latitude	Longitude	COUNTY
start	39.6581354970801	-87.8937116601235	EDGAR
end	39.5712873627184	-87.8825676201308	EDGAR

Hurricane Creek

470

End Points	Latitude	Longitude	COUNTY
start	39.2889007816578	-88.1544749600653	CUMBERLAND
end	39.3793118297358	-88.0668208708762	COLES

Jordan Creek

433

End Points	Latitude	Longitude	COUNTY
start	40.0794151192358	-87.7990673709556	VERMILION
end	40.0588834821927	-87.8360461636444	VERMILION

443

End Points	Latitude	Longitude	COUNTY
start	40.3360527696651	-87.6231745570584	VERMILION
end	40.3553265493525	-87.5278198412106	VERMILION

Kickapoo Creek

471

End Points	Latitude	Longitude	COUNTY
start	39.4379695819539	-88.1681483569976	COLES
end	39.4597583113682	-88.2917593820249	COLES

Knights Branch

438

End Points	Latitude	Longitude	COUNTY
start	40.2763499940372	-87.7961879249888	VERMILION
end	40.2520446574291	-87.8336356533235	VERMILION

Little Embarras River

476

End Points	Latitude	Longitude	COUNTY
start	39.5736361588448	-88.0726889440362	COLES
end	39.680891264864	-87.9341744320393	EDGAR

BASIN NAME / Segment Name / Segment No. / End Points	Latitude	Longitude	COUNTY
Little Vermilion River			
426			
start	39.9463345271443	-87.5536756201362	VERMILION
end	39.9593741043792	-87.6447473681732	VERMILION
Middle Branch			
442			
start	40.3096675860339	-87.6376716065503	VERMILION
end	40.417753327133	-87.5275419211693	VERMILION
Middle Fork Vermilion River			
428			
start	40.1035656386662	-87.7169902321166	VERMILION
end	40.4043343147541	-88.0191381621282	FORD
Mill Creek			
487			
start	39.2394256838229	-87.6762126527038	CLARK
end	39.3566749194214	-87.7425049309309	CLARK
Muddy Creek			
242			
start	39.1821395682335	-88.2309155529877	CUMBERLAND
end	39.2033657707304	-88.2765033266093	CUMBERLAND
North Fork of Embarras River			
461			
start	38.9148628762488	-87.9834798036322	JASPER
end	39.0924749553725	-87.9784039128617	JASPER
North Fork Vermilion River			
441			
start	40.236054881277	-87.6293326109766	VERMILION
end	40.5010729612407	-87.5261721834388	IROQUOIS
Panther Creek			
462			
start	39.0924749553725	-87.9784039128617	JASPER
end	39.184289386946	-88.0087906828419	CUMBERLAND
Polecat Creek			
474			
start	39.5013303165832	-88.1055006912296	COLES
end	39.5162859310237	-88.0338496162262	COLES
Riley Creek			
472			
start	39.4712869216685	-88.2108945161318	COLES
end	39.5116227820733	-88.2569469311765	COLES
Salt Fork			
429			
start	40.1035656386662	-87.7169902321166	VERMILION
end	40.0368232483006	-88.0746580039075	CHAMPAIGN
455			
start	39.7425080214619	-87.572919448772	EDGAR
end	39.8018493662144	-87.5775868051385	EDGAR
Snake Creek			
454			
start	39.7128111863363	-87.6415954465778	EDGAR
end	39.7066978623237	-87.6543043306751	EDGAR
South Fork Brouilletts Creek			
453			

BASIN NAME

Segment Name

Segment No.

End Points	Latitude	Longitude	COUNTY
start	39.7256495590209	-87.6437626049444	EDGAR
end	39.7319449005729	-87.6951881181821	EDGAR

Stony Creek

431

End Points	Latitude	Longitude	COUNTY
start	40.0943454186494	-87.8170769835194	VERMILION
end	40.1548847864725	-87.8840063394108	VERMILION

Sugar Creek

456

End Points	Latitude	Longitude	COUNTY
start	39.4838820536199	-87.5320762217325	EDGAR
end	39.6298164781408	-87.6762882912482	EDGAR

Unnamed Tributary of Big Creek

459

End Points	Latitude	Longitude	COUNTY
start	39.5047911835054	-87.7121475341945	EDGAR
end	39.5692784693864	-87.7194139533441	EDGAR

Unnamed Tributary of Brouilletts Creek

451

End Points	Latitude	Longitude	COUNTY
start	39.797449971524	-87.7178559181463	EDGAR
end	39.831592697221	-87.7758036967074	EDGAR

Unnamed Tributary of Brushy Fork

482

End Points	Latitude	Longitude	COUNTY
start	39.7340344129883	-88.0771406153965	DOUGLAS
end	39.802586616189	-88.0753634663247	DOUGLAS

Unnamed Tributary of Deer Creek

486

End Points	Latitude	Longitude	COUNTY
start	39.7102184848625	-88.1385435180688	DOUGLAS
end	39.678866903649	-88.1425332064637	DOUGLAS

Unnamed Tributary of Embarras River

467

End Points	Latitude	Longitude	COUNTY
start	38.9934159067144	-88.129258689394	JASPER
end	39.0034725453128	-88.1210073578163	JASPER

Unnamed Tributary of Greasy Creek

481

End Points	Latitude	Longitude	COUNTY
start	39.6182255297223	-88.1320998047424	COLES
end	39.621059195964	-88.1538483534688	COLES

Unnamed Tributary of Hickory Creek

210

End Points	Latitude	Longitude	COUNTY
start	38.99191464315	-87.989292523907	JASPER
end	39.0117394234421	-87.9896104862878	JASPER

Unnamed Tributary of Middle Fork Vermilion River

434

End Points	Latitude	Longitude	COUNTY
start	40.3478602982847	-87.9479087836067	CHAMPAIGN
end	40.3408935605508	-87.9885982351498	CHAMPAIGN

Unnamed Tributary of Stony Creek

430

End Points	Latitude	Longitude	COUNTY
start	40.1548847864725	-87.8840063394108	VERMILION
end	40.1706704853124	-87.9033972187304	VERMILION

Unnamed Tributary or North Fork of the Vermilion River

444

End Points	Latitude	Longitude	COUNTY
start	40.3553498759616	-87.6852979017427	VERMILION
end	40.3665727663496	-87.733231992072	VERMILION

445

End Points	Latitude	Longitude	COUNTY
start	40.483638183168	-87.5751075709757	VERMILION
end	40.4930209841439	-87.5771391859822	IROQUOIS

BASIN NAME / Segment Name / Segment No. / End Points		Latitude	Longitude	COUNTY
446				
	start	40.423223711311	-87.6788932053507	VERMILION
	end	40.4280461995299	-87.6895565256772	VERMILION
Vermilion River				
427				
	start	40.0116868805566	-87.5337540394346	VERMILION
	end	40.1035656386662	-87.7169902321166	VERMILION
Wabash River				
488				
	end	39.3034266238732	-87.605592332246	CLARK
West Crooked Creek				
466				
	start	39.0356467346919	-88.0923368283887	JASPER
	end	39.0545759701349	-88.1009871944535	JASPER
West Fork Big Creek				
19				
	start	39.436126036547	-87.7023848396263	CLARK
	end	39.5012337820195	-87.8003199656505	EDGAR
Willow Creek				
463				
	start	39.0191952007294	-87.9402449982878	CRAWFORD
	end	39.0529145507759	-87.9280073176635	CRAWFORD

(Source: Added at 31 Ill. Reg. ____________, effective _______________)

IT IS SO ORDERED.

I, John T. Therriault, Assistant Clerk of the Illinois Pollution Control Board, certify that the Board adopted the above opinion and order on July 12, 2007, by a vote of 4-0.

John T. Therriault, Assistant Clerk
Illinois Pollution Control Board

APPENDIX I TO THE OPINION AND ORDER
R04-25
HEARING EXHIBITS

First Hearing: June 29, 2004, Chicago

Exhibit 1: "An Assessment of National and Illinois Dissolved Oxygen Water Quality Criteria" James E. Garvey and Matt R. Whiles (Apr. 2004)

Exhibit 2: "Ambient Water Quality Criteria for Dissolved Oxygen" USEPA (Apr. 1986)

Exhibit 3: Resume of Dennis Streicher

Exhibit 4: Copies of letters from Dennis Streicher to various organizations concerning the proposed rulemaking

Exhibit 5: Resume of James E. Garvey

Exhibit 6: Resume of Matt R. Whiles

Exhibit 7: From R02-19, written testimony of Robert J. Sheehan & Table 1 "Spawning periods for fishes in Illinois"

Exhibit 8: "Influences of Hypoxia and Hyperthermia on Fish Species Composition in Headwater Streams" Martin A. Smale and Chalres F. Rabeni (1995)

Second Hearing: August 12, 2004, Springfield

Exhibit 9: Pre-filed Testimony of Dr. James E. Garvey, with attached July 2004 report entitled "Long Term Dynamics of Oxygen and Temperature in Illinois Streams" by Dr. Garvey.

Exhibit 10: Electronic comments by Dr. Gary Chapman in the margins of "An Assessment of National and Illinois Dissolved Oxygen Water Quality Criteria" James E. Garvey and Matt R. Whiles (Apr. 2004)

Exhibit 11: One-page hard copy of e-mail sent July 22, 2004 at 8:52 a.m. from Roy M. Harsch regarding IEPA "implementation rules"

Exhibit 12: Letter entitled "Fight Effort to Lower Fox Oxygen Criteria," from David J. Horn, appearing on the Opinion page of the *Daily Herald*

Exhibit 13: Letter dated July 30, 2004 from David L. Thomas, Ph.D, Chief of the Illinois Natural History Survey to Lieutenant Governor Pat Quinn

Third Hearing: August 25, 2005

Exhibit 14: Statement of Toby Frevert, Manager of the Division of Water Pollution Control, IEPA

Exhibit 15: Pre-filed Testimony of Dennis Streicher, Director of Water and Wastewater with the City of Elmhurst, and President of IAWA

Exhibit 16: Pre-filed Testimony of Dr. James E. Garvey, with nine attachments

Exhibit 17: One-page list of streams entitled "Table 2 – Testimony of David L. Thomas, August 2005"

Exhibit 18: Pre-filed Testimony of Todd Main, Director of Policy and Planning, Friends of the Chicago River

Exhibit 19: Pre-filed Testimony of Thomas J. Murphy, Emeritus Professor of Chemistry, Environmental Science Program, DePaul University

Fourth Hearing: April 25, 2006

Exhibit 20: IEPA/DNR Proposed Rule Language (Attached to 4/4/06 Pre-filed Testimony of IEPA/DNR)

Exhibit 21: IEPA/DNR Proposed Section 302.Appendix D: Stream Segments for Enhanced Dissolved Oxygen Protection (Attached to 4/4/06 Pre-filed Testimony of IEPA/DNR)

Exhibit 22: IEPA's April 24, 2006 Response to Dennis Streicher of IAWA (includes compact disc of Dissolved Oxygen Results at IEPA Stream Sites (Selected Sites), Grab Samples (1994-2003), Continuous Monitoring Data (2004-2005))

Exhibit 23: IEPA/DNR Technical Support Document (Mar. 31, 2006) (Attached to 4/4/06 Pre-filed Testimony of IEPA/DNR)

Exhibit 24: Compact disc of IEPA/DNR Proposed Streams for Enhanced Dissolved Oxygen Protection (Attached to 4/4/06 Pre-filed Testimony of IEPA/DNR)

Exhibit 25: Amended Pre-filed Testimony of Richard Lanyon on behalf of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)

Exhibit 26: USEPA Method # 360.1, Approved for NPDES (Issued 1971), Oxygen, Dissolved (Membrane Electrode)

Exhibit 27: Testimony of Thomas J. Murphy, Emeritus Professor of Chemistry, Environmental Science Program, DePaul University

Status Conference Call: June 5, 2006

Exhibit 28: Compact disc with May 19, 2006 cover letter from DNR (five copies of disc) (disc includes the information from Exhibit 24, as well as the following information: stream segments that IEPA identified in the 2006 Assessment Database as being aquatic life use impaired (including segments where low dissolved oxygen is identified as a potential cause of impairment); and National Pollutant Discharge Elimination System (NPDES) discharge points and associated metadata)

Fifth Hearing: November 2-3, 2006

Exhibit 29: Pre-filed Questions of Environmental Law & Policy Center of the Midwest (ELPC), Prairie Rivers Network (PRN), and Sierra Club Directed to IEPA/DNR

Exhibit 30: IEPA/DNR Responses to Pre-filed Questions of ELPC, PRN, & Sierra Club

Exhibit 31: Pre-filed Testimony of Thomas J. Murphy, Emeritus Professor of Chemistry, Environmental Science Program, DePaul University

Exhibit 32: Pre-filed Testimony of Dennis Streicher

Exhibit 33: Certifications of Dissolved Oxygen Sample Collection by the Fox Metro Water Reclamation District, the City of Naperville, the Greater Peoria Sanitary District, the Village of Plainfield, the Rock River Water Reclamation District, and the Wheaton Sanitary District

Exhibit 34: Compact disc of IAWA Dissolved Oxygen Sampling Data

Exhibit 35: Pre-filed Testimony of Dr. James E. Garvey

Exhibit 36: Additional Testimony of Dr. James E. Garvey

Exhibit 37: Abstract of presentation made to the North American Benthological Society entitled "Effects of hypoxia on brood survival in the freshwater mussel, *Venustaconcha ellipsiformis*," B.E. Kaiser, M.C. Barnhart

Exhibit 38: "Anthropogenic Inputs of Nitrogen and Phosphorus and Riverine Export for Illinois, USA," Mark B. David, Lowell E. Gentry, reprinted from the *Journal of Environmental Quality*

Exhibit 39: "Biological Criteria and Tiered Aquatic Life Uses: Potential Changes to Illinois Water Quality Standards," IEPA Bureau of Water (Sept. 2006)

Exhibit 40: Pre-filed Testimony of Richard Lanyon, MWRDGC

Exhibit 41: Pre-filed Testimony of Louis Kollias, MWRDGC

APPENDIX II TO THE OPINION AND ORDER
R04-25
PUBLIC COMMENTS

PC 1 Robert W. Schanzle, President, Illinois Chapter of the American Fisheries Society
PC 2 Nancy Erickson, Director, Natural and Environmental Resources of Illinois Farm Bureau
PC 2.5 Metropolitan Water Reclamation District
PC 3 Thomas E. Tarasiuk
PC 4 Theresa A. Kolady
PC 5 Elaine R. Parnell
PC 6 Donald E. Lupei
PC 7 Justin Czapczyk
PC 8 Gary A. Jannusch
PC 9 Margaret E. Fox
PC 10 Richard A. Hilton
PC 11 Lois Johnson
PC 12 R. Gilkerson
PC 13 Ward P. Schwartz
PC 14 Patrick A. Kimse
PC 15 Jennifer Oviedo
PC 16 Angie Ali
PC 17 The Martlings
PC 18 George W. Carpenter
PC 19 Michele K. Mellor
PC 20 Brandon Zaleiski
PC 21 Edgar Oviedo
PC 22 Paul B. Smith
PC 23 Michael Kirschman
PC 24 The Thrashers
PC 25 The Workman's
PC 26 Alison Richards
PC 27 David J. Horn
PC 28 John E. Mozzocco
PC 29 Jody Strohm
PC 30 Pamela Pesertell
PC 31 The Fishers
PC 32 William H. Holleman
PC 33 Susan Stillinger
PC 34 Linda Gray
PC 35 M. Mey
PC 36 Kris A. Hall
PC 37 A. K. Helland
PC 38 Clifford L. White, Jr.
PC 39 W. H. Brisker
PC 40 Mark Donnelly
PC 41 Lenore G. Lee

PC 42 John D. McKee
PC 43 Donna Erfort
PC 44 Jyoti Srikishan
PC 45 Patricia Gebhardt
PC 46 Lara Miller
PC 47 Amanda B. Reyes
PC 48 Pat Dieckhoff
PC 49 Mary J. Zaander
PC 50 David H. Arnett
PC 51 Ann Schneck
PC 52 Dawn Rosch
PC 53 Caroline M. Quinlan
PC 54 Rick Maring
PC 55 Kyla Jacobsen
PC 56 The Shroders
PC 57 Ken Schaefer
PC 58 Brad Hoar
PC 59 The Masonicks
PC 60 Dennis Paige
PC 61 Kelley Ann Kepes
PC 62 Danielle Ebersole
PC 63 Christoph Parat
PC 64 Michael Ander
PC 65 Jean Leverenz
PC 66 Judith Boettmer
PC 67 John A. Olson
PC 68 David L. Segel
PC 69 Henry J. Wolf
PC 70 Ann Anderson
PC 71 James O. Breen
PC 72 Robert C. Arnet
PC 73 The Szymanskyj's
PC 74 Nikki Dahlin
PC 75 Gloria Klimek
PC 76 John Webb
PC 77 Mary Robbins
PC 78 Day Waterman
PC 79 Philip W. Cunio
PC 80 Lana M. Haley
PC 81 Jean Flemma, Executive Director, Prairie Rivers Network
PC 82 Dennis Streicher for Illinois Association of Wastewater Agencies
PC 83 Thomas J. Murphy, Ph.D.
PC 84 Todd Main, Policy Director, Friends of the Chicago River
PC 85 Stanton A. Browning, Executive Director, Greater Peoria Sanitary District
PC 86 Gregory J. Brunst, Director, Village of Addison
PC 87 Clifford L. White, Jr., Environmental Services Superintendent, City of St. Charles

PC 88 Downers Grove Sanitary District
PC 89 Thomas F. Muth, Manager, Fox Metro Water Reclamation District
PC 90 George R. Schillinger, Executive Director, American Bottoms Regional Wastewater Treatment Facility
PC 91 Michael R. Little, Executive Director, Urbana & Champaign Sanitary District
PC 92 Jane M. Carlson, P.E. and Troy W. Stinson, P.E. of Strand Associates, Inc.
PC 93 Steve Olsen, Plant Foreman of Dekalb Sanitary District
PC 94 Dr. James E. Garvey
PC 95 Chemical Industry Council of Illinois
PC 96 Illinois Department of Natural Resources
PC 97 James L. Daugherty, District Manager, Thorn Creek Basin Sanitary District
PC 98 Metropolitan Water Reclamation District of Greater Chicago
PC 99 Mayor Arthur J. Washkowiak of City of LaSalle
PC 100 Illinois Chapter of the American Fisheries Society
PC 101 Environmental Law & Policy Center, Prairie Rivers Network, and Sierra Club
PC 102 Illinois Association of Wastewater Agencies
PC 103 Illinois Environmental Protection Agency
PC 104 Darrel R. Gavle, P.E. and Pavel Hajda, Ph.D of Baxter & Woodman, Inc. Consulting Engineers
PC 105 Thomas J. Murphy, Ph.D.
PC 106 James E. Huff, P.E., Vice President, Huff & Huff, Inc.
PC 107 Dennis Streicher of Illinois Association of Wastewater Agencies
PC 108 Robert Fischer, Ph.D, President, ILAFS, Professor of Biology, Associate Chair, Biology, Eastern Illinois University
PC 109 Dennis Streicher of IAWA and Professor Jim Garvey of IAWA
PC 110 Illinois Environmental Protection Agency's Response to Dennis Streicher's Public Comment of April 24, 2007