State Water Survey Division
WATER QUALITY SECTION
AT
PEORIA, ILLINOIS

Illinois Institute of
Natural
Resources

SWS Contract Report 260

WATER QUALITY ASSESSMENT AND WASTE ASSIMILATIVE ANALYSIS OF THE LAGRANGE POOL, ILLINOIS RIVER

By Thomas Butts, Donald Roseboom, Thomas Hill,
Shundar Lin, Davis Beuscher, Richard Twait, and Ralph Evans

Prepared for the Illinois Division of Water Resources
at the request of the U.S. Army Corps of Engineers

AUG. 26th 1818

June 1981

ANNOUNCING - A NEW PUBLICATION OF THE ILLINOIS STATE WATER SURVEY

Executive Summary

TITLE: Water Quality Assessment and Waste Assimilative Analysis of the LaGrange Pool, Illinois River

AUTHORS: Thomas Butts, Donald Roseboom, Thomas Hill, Shundar Lin, Davis Beuscher, Richard Twait, and Ralph Evans, Water Quality Section, Illinois State Water Survey

A study of the LaGrange pool — the reach of the lower Illinois Waterway between the city of Peoria (mile 166.1) and the LaGrange lock and dam (mile 80.2) showed that compliance with current water pollution control rules and regulations governing bacterial quality in Illinois is not achieved in the pool.

Among the other conclusions are:

- The types of types of algal organisms found in substantial quantities during the study, all common to the Illinois River, suggest that the Illinois River displays the physical characteristics of a river-lake hybrid, and that its algal population is derived from a combination of the in-stream growth of planktonic forms and the import of organisms from benthic communities.
- The average density of the benthic macroinvertebrate population was found to be 220 individuals per square meter, and the average number of taxa was 3.8. The average Illinois Environmental Protection Agency rating for the pool was 3.3, slightly worse than semi-polluted.
- The sediment oxygen demand, or SOD (the usage of dissolved oxygen in the overlying water by benthic organisms) appears to be caused principally by bacteria. Macroinvertebrate populations were too small to have a significant effect. SOD rates were low, ranging from 0.42 to 1.61 grams per square meter per day. At low flows the higher rate could have a small but significant influence on the dissolved oxygen resources of the pool.
- An analysis of the biochemical oxygen demand, or BOD (the amount of oxygen usage within water over a period of time) showed that there was a well-established heterotrophic (carbonaceous) bacterial population but a less viable autotrophic (nitrogenous) bacterial population. No single or primary source of the BOD loads could be isolated.

In another phase of the study, it was concluded that the diversion of water from Lake Michigan to the LaGrange pool at the rate of 6600 cubic feet per second during normal dry weather summertime stream flows would improve the dissolved oxygen conditions and assure compliance with current stream quality standards.

The study was conducted by researchers in the Water Quality Section of the Illinois State Water Survey. It represents the first study of such a wide range of water quality characteristics for a long stretch of the Illinois Waterway. Single copies are available free at the address below. Ask for Contract Report 260.

STATE WATER SURVEY DIVISION

605 East Springfield Avenue
P.O. Box 5050, Station A
Champaign, Illinois 61820-9050
217/333-2211

ENR
Illinois Department of
Energy and Natural Resources

CONTENTS

WATER QUALITY ASSESSMENT AND WASTE ASSIMILATIVE ANALYSIS OF THE LA GRANGE POOL, ILLINOIS RIVER

by Thomas Butts, Donald Roseboom, Thomas Hill, Shundar Lin,
Davis Beuscher, Richard Twait, and Ralph Evans

ABSTRACT

This study involves the reach of the lower Illinois Waterway between the city of Peoria (mile 166.1) and the LaGrange lock and dam (mile 80.2), making it essentially an extension of upper waterway studies previously conducted by T. Butts and others. Its major objectives were 1) to collect and analyze water quality data so that the oxygen demand sinks and attendant reactive rates persistently manifested within the pool could be isolated and better defined, and 2) to evaluate the potential effects of increased Lake Michigan diversion on the overall water quality and waste assimilative capacity within the pool. Analyses were made with respect to bacterial quality, algae, benthic macroinvertebrates, sediments and sediment oxygen demand (SOD), and biochemical oxygen demand (BOD).

Bacterial analyses revealed that compliance with current water pollution control rules and regulations governing bacterial quality in Illinois is not achieved in the LaGrange pool. Algal examinations showed that the succession of dominant algal species from June to September 1978, in choronological order, was *Cyclotella meneghiana, Navicula cryptocephala,* and *Aphanizomenon flos-aquae.* The mean density of the benthic macroinvertebrate population was found to be 220 individuals/m^2, the mean number of taxa was 3.8, and the mean IEPA rating for the pool was 3.3 (slightly worse than semi-polluted). The most important finding of the sediment-SOD study was that the SOD rates in the LaGrange pool are low on both a relative and an absolute basis. Biochemical oxygen demand analyses yielded main stem BOD curves indicative of a well-established heterotrophic (carbonaceous) bacterial population but a less viable autotrophic (nitrogenous) bacterial population. No single or primary source of the BOD loads could be isolated.

In another phase of the study, updated parametric information was integrated into the State Water Survey BOD-DO water quality model for evaluating ambient ongoing conditions, and the information was used to evaluate the effects of increased Lake Michigan diversion on the DO resources of the pool. Simulation runs were made using the total oxygen demand loads and 6600 cfs and 10,000 cfs diversion flows added to ambient conditions. Other simulations were performed using long-term laboratory BODs in combination with SOD rates; the maximum and minimum dissolved BOD loads; SOD as the only oxygen usage component; dissolved BOD as the only usage sink; and SOD plus dissolved BOD. It was concluded that the diversion of 6600 cfs to the LaGrange pool during normal dry weather summertime stream flows will improve the dissolved oxygen conditions and assure compliance with current stream quality standards.

INTRODUCTION

The Illinois Waterway is special among the many streams and rivers within Illinois. It drains 43 percent of the area of the state, and during dry weather its headwaters consist principally of treated Chicago area wastewaters diluted with flow diverted from Lake Michigan. Chicago area treated wastewater flows are derived from approximately 5.5 million people and a large industrial complex. A water quality study of the upper reaches of the waterway conducted by the State Water Survey (SWS) during the summers of 1971 and 1972 revealed that 98 percent of the total municipal discharges and 93 percent of all waste flow between Chillicothe (mile 179) and Chicago (mile 327.2) originate from the three major Metropolitan Sanitary District of Greater Chicago treatment plants.(Butts et al., 1975). Lake Michigan diversion is presently regulated by a 1967 U.S. Supreme Court decree which limits total diversion, including water supply, to a five-year annual average of 3200 cubic feet per second (cfs), with the -maximum annual rate in a given five-year accounting period not to exceed 110 percent of 3200 cfs.

This study involves the reach of the lower waterway between the city of Peoria (mile 166.1) and the LaGrange lock and dam (mile 80.2), making it essentially an extension of the upper waterway studies conducted between 1971 and 1973 (Butts, 1974; Butts, et al., 1975). Basically this study was designed and implemented using the methods and procedures developed and applied in the upper waterway studies.

The work has been funded under contractual agreement with the Chicago District of the U.S. Army Corps of Engineers. The data and analyses are to assist the Corps in their assessment of the environmental and ecological consequences of increasing Lake Michigan diversion up to 10,000 cfs, with particular reference to the water quality and waste assimilative characteristics of the LaGrange pool.

Study Area

The Illinois Waterway is a series of eight navigation pools extending 327.2 miles from Lake Michigan at Chicago to its confluence with the Mississippi River at Grafton. The pools and inclusive Corps milepoint (MP) designations are: Lockport (327.2-291.0), Brandon Road (291.0-286.0), Dresden Island (268.0-271.5), Marseilles (271.5-247.0), Starved Rock (247.0-231.0), Peoria (231.0-157.7), LaGrange (157.7-80.2), and Alton (80.2-0). The waterway and the portion studied is shown in figure 1.

The water course above DePue (MP 210) is characterized by a relatively steep gradient, a bed rock bottom, and a constricted channel having few side chutes, sloughs, and backwater lakes. Below DePue, the main river channel widens, as does the flood plain. The flood plain is dotted with numerous backwater lakes, ponds, sloughs, and man-made drainage structures and ditches used to dewater areas that formerly held water but that are now farmed. The lower river has been the recipient of much hydraulic fill as a result of glacial outwash and, in more recent times, of human physical alterations and abuses. The LaGrange pool, in particular, formerly had

Figure 1. Study area, LaGrange pool

numerous productive backwater areas. Many still exist, but those directly connected to the main channel have shown a rapid increase in siltation and a marked deterioration in water quality and wildlife habitat in the last fifty years (Bellrose et al., 1979).

Development along the lands immediately bordering the LaGrange pool has been limited primarily to that of an agrarian nature. Except in the Peoria-Pekin commercial and industrial complex located at the head end of the pool (MP 151 to MP 166) , few significant industrial operations exist. Marquette Heights (pop. 3500), Pekin (pop. 33,000), Havana (pop. 4500), and Beardstown (pop. 6500) are the only notable population centers located directly on the pool. Table 1 summarizes domestic and industrial waste load inputs located within the study area, which starts at MP 166.1 and ends

Table 1. Waste Load Discharges to Illinois River between Miles 166.1 and 80.2

Waste source	Waste flow (cfs)	Approximate ultimate BOD waste loads (lbs/day) Carbonaceous	Nitrogenous
East Peoria	4.58	1,700	200
Caterpillar	10.78	5,500	200
Peoria Sanitary District	57.0	14,000	3,500
Creve Coeur	.74	3,200	350
Marquette Heights	.34	400	200
Pekin	3.91	700	100
CPC International	1.18	1,600	150
Havana	.68	100	300
Beardstown Industrial Lagoon	1.88	1,500	1,700
Beardstown	1.82	1,900	900

at MP 80.2, the LaGrange lock and dam. The waste loads in terms of biochemical oxygen demand (BOD) are rough approximations and are presented to illustrate orders of magnitudes only. The waste loads originating from the Peoria-Pekin area have declined significantly in the last few years because of the closing of several large industries, the Hiram Walker Distillery, National Distillery, and Standard Brands food processing company.

Four major streams are tributary to the pool. These streams and their average annual flows are: the Mackinaw River (MP 147.8), 485 cfs; the Spoon River (MP 120.5), 1026 cfs; the Sangamon River (MP 88.9), 3231 cfs; and the LaMoine River (MP 83.7), 781 cfs.

Previous Studies and Observations

It is often said that the Illinois River is the most studied stream in the world. Much can be said in defense of this statement. Since the last quarter of the last century to the present, dozens of comprehensive detailed sanitary engineering and aquatic biology studies and investigations have been made. The list of investigators who have been involved is long and distinguished. Among the works that have contributed significantly to an understanding of the ills suffered by the waterway as a result of human activity and abuse are those of Forbes and Richardson (1919), Richardson (1921), Streeter (1926, 1935), Wisely and Klassen (1938), Mohlman et al. (1950), and Starrett (1971).

If a period of time were designated as the beginning of the degradation of the Illinois River, it would have to be the opening of the waterway to steamboats in 1828. This led to large-scale developments along the river, accompanied by some man-made physical changes in the river. The opening of the Illinois and Michigan (I & M) Canal in 1848 spurred additional growth along the valley by connecting Chicago area water courses directly to the river at LaSalle-Peru. More importantly, however, the I & M Canal provided an avenue by which organic pollution could reach the lower river from the rapidly expanding Chicago area.

By 1860, the problem of sewage discharges to waters in the Chicago area became so great that a sewerage commission was formed. An elaborate system was devised and implemented to flush and pump contaminated water to Lake Michigan and to the Illinois River via the I & M Canal. In 1865, the decision was made to "deep cut" the connection between the I & M Canal and the Chicago River to increase the canal flow for flushing purposes. The cut was completed in 1871 but was, in most respects, unsuccessful in relieving the unsanitary conditions in and around Chicago. Consequently, a commission was formed in 1886 to study additional alternatives. In 1889 a solution was recommended that gave birth to what is now known as the Chicago Sanitary and Ship Canal. This Canal was to be bigger, deeper, and more hydraulically efficient than the existing I & M Canal. Although some downriver opposition to this plan was encountered, all physical and political obstacles were eventually overcome and on January 17, 1900, popularly referred to then as "shovel day," the first Lake Michigan water was released into the high capacity canal.

Chicago alone was not responsible for the overall, continuous degradation of the Illinois River. For example, Professor John H. Long, a noted Northwestern University sanitarian and chemist, was retained by the Board of Health of Illinois from 1886 to 1889 to investigate and study the waste assimilative capacity of the river system from Chicago to Grafton (Soper et al., 1915). In reporting his findings, Professor Long is quoted as saying:

> From Ottawa through Henry, 125 miles from Bridgeport, to Peoria, 159 miles from Bridgeport, there was a slower, but not less certain improvement [in Illinois River water quality]. At Peoria, the river was again heavily contaminated by the discharge of wastes from cattle and distilleries. Peoria cattle shed filth, and not Chicago sewage, was the main factor in the animal pollution of the lower river.

Another observer around 1900 considered the Illinois River so offensive that he suggested damming the river below Peoria to create a huge septic tank so that farther downstream the river would regain at least some of its purity.

Pollution from land runoff was observed along the Illinois River early in the twentieth century. Forbes and Richardson (1919) reported that the flooding and scouring of the surface of the country, the washing of streets, and the flushing of sewers from heavy rains produced highly organically contaminated discharges.

The river was continuously subjected to many studies, surveys, and investigations after the opening of the Sanitary and Ship Canal. Overall, the water quality continued to deteriorate up to 1927. Significant improvements started to become evident in the early 1930s, however, after the completion of highly efficient treatment systems at Chicago and Peoria.

In a U.S. Public Health Service report, Hoskins et al. (1927) estimated that during 1922 the domestic and industrial pollution load being discharged directly to the waterway was equivalent to that from 6,225,000 people. Forty years later, another Public Health Service study was conducted (U.S. Public Health Service, 1963), and it was found that the loads being discharged were equivalent to that from only 1,752,000 people. This represents a 72 percent reduction in 40 years, which is amazing, since industrial and population growth ran counter to the reduction measures taken.

The last comprehensive water quality and waste assimilative studies made along the waterway are two State Water Survey studies: the study of the upper waterway by Butts et al. (1975), and the study of the LaGrange pool by Butts et al. (1970). These studies were prompted by the fact that cursory sampling and monitoring by state agencies such as the State Water Survey, State Natural History Survey, and State EPA indicated that improvements in some water quality indices were not being achieved commensurate with reductions in point source waste discharges. The river no longer resembled overflow from a septic tank as had been the case below- Peoria at the turn of the century; however, some of the basic and readily measurable water quality parameters., such as dissolved oxygen, continued to fall persistently below desirable levels.

The State Water Survey study of the upper waterway was generally successful in isolating and defining the subtle reasons for the continued degradation of the water course above Chillicothe. As an example, a reduction in waste assimilative capacity (due to the installation of the locks and dams during the late 1930s), coupled with sediment oxygen demand accelerated by sedimentation in pooled areas, was found to be a primary causative factor. Nitrification, the oxidation of ammonia, was also found to be a significant cause of oxygen depletion. The mechanisms by which these phenomena were creating severe oxygen depletions were defined, and specific recommendations were presented and outlined so that present day water quality standards could be met in the affected areas.

The LaGrange pool study was made prior to that of the upper waterway. Its approach was somewhat less comprehensive and the methodologies used in it were less well defined. No conclusive evidence was developed to pinpoint all the causes of the persistent low DOs observed during the summers of 1965, 1966, and 1967. Nitrification appeared to be implicated to a significant degree, but overall the oxygen demand load was so high that point sources, including those far upstream, such as those in the Chicago metropolitan area, could not account for the demand needed to create the DO sag curves observed in the pool. Nitrification appears to play a significant role in depressing DO levels in the pool, principally during periods of intermediate to high flows. At low flows, much of the large second stage (nitrogenous) BOD originating in the Chicago area is stabilized above Chillicothe (Butts, 1979). At the higher flows the dissolved ammonia does not have sufficient residence time upstream for complete biological stabilization. At flows in the order of 7000 to 8000 cfs at Peoria both carbonaceous and nitrogenous BOD loads at the Peoria dam are only about 29 percent of loads being discharged by point sources above Lockport (MP 292). However, at flows in the order of 12,000 to 13,000 cfs the carbonaceous and the nitrogenous BOD are 43 and 55 percent, respectively, of that discharged above Lockport (Butts, 1979).

Since the 1965-1967 study, the SWS has monitored the DO levels throughout the LaGrange pool twice: once during the summer of 1973 and once during the spring and summer of 1977. Although the 1973 summer flows were relatively high during most of the sampling period, DO concentrations as low as 3,0 mg/l were observed. During 1977, the flows were somewhat less than those of 1973 and the minimum DO recorded was 2.2 mg/l. Values ranging from 2.5 mg/l to 4.0 mg/l were commonly observed for long stretches within the pool on several days. These unfortunate conditions still persist in spite of the fact that millions of dollars have been spent since 1967 on expanding and upgrading existing sewage treatment facilities and providing new treatment plants where none had existed. Obviously, some unique problems are associated with waste load inputs to the pool and with the ability of the pool to assimilate them.

Study Objectives and Report Format

This study was designed to meet two objectives. The first and primary objective was to collect and analyze water quality data so that the oxygen demand sinks and attendant reactive rates that are persistently manifested within the pool could be isolated and better defined. The second objective was to evaluate the potential effects that increased diversion of Lake Michigan waters will have on the overall water quality and waste assimilative capacity within the pool. To achieve these objectives the following tasks were performed:

1) The Illinois River water immediately antecedent to the pool was routinely sampled for a variety of water quality parameters, including dissolved BOD. Sampling commenced at MP 166.1, a point known as the "narrows," and included approximately 8.5 miles of water above the LaGrange pool.

2) Dissolved oxygen and temperature measurements were routinely made at short, regular intervals throughout the study area.

3) Dissolved BOD samples were collected at strategic intervals, and long-term laboratory analyses were performed.

4) Suspended algae (phytoplankton) samples were collected at selected locations for species enumeration and identification.

5) Bacterial samples were collected at selected locations and analyzed in the laboratory for those organisms which are regarded as general indicators of pollution.

6) Ammonia and nitrate-nitrogen samples were collected and preserved in the field at selected locations.

7) Bottom sediments were collected at regularly spaced cross sections throughout the pool for use in characterizing and cataloging bottom conditions relative to states of degradation.

8) Sediment oxygen demand (SOD) measurements were made *in situ* at stations selected on the basis of the findings of task 7.

9) Benthic macroinvertebrate samples were collected for organism classification and enumeration at stations selected on the basis of the findings of task 7.

10) The water quality of the four major pool tributaries was characterized by sampling at stations near the stream confluences.

11) Identification was made of the location of backwater lakes which may at times have a modifying influence on the water quality of the main channel.

12) The SWS time-of-travel computer model and the stream cross-sectional data associated with it were revised. Improvements were made in the hydraulic and hydrologic concepts employed by the model, and the most updated Corps cross sections were obtained.

In this report, bacteria, algae, benthic macroinvertebrates, sediments and sediment oxygen demand, and biochemical oxygen demand are discussed in separate sections. A final section is then presented which deals with an overall assessment of water quality conditions made, using a BOD-DO mathematical model. The model uses as basic input some of the results derived and presented in the first five sections. Each section of the report presents some introductory or background information, details the methodologies and techniques used, presents and discusses the results, and provides a summary and conclusions.

The raw data and other details from the investigations are available as open file data at the Water Survey's Water Quality Section, Box 697, Peoria, Illinois.

Acknowledgments

This study was conducted as part of the work of the Water Quality Section of the Illinois State Water Survey, Stanley A. Changnon, Jr., Chief, under contract with the Chicago District U.S. Army Corps of Engineers. The funds used were authorized in the Water Resources Development Act of 1976 (PL 94-587) for the "Increased Lake Michigan Diversion at Chicago Demonstration and Study Program." Linda J. Johnson typed the original manuscript and the camera copy; John W. Brother, Jr., William Motherway, Jr., and Mary Carlson prepared the illustrations; and Gail Taylor edited the manuscript.

BACTERIAL QUALITY

Coliform bacteria have been used as indicators in measuring the occurrence and intensity of fecal contamination in natural waters for more than 50 years. Until recently the total coliform (TC) group, a heterogeneous collection of bacterial species, was the public health indicator for bacterial contamination. Since these bacteria are always present in the intestinal tracts of humans and other warm-blooded animals, the absence of TC bacteria is evidence of bacteriologically safe water. However, several strains of the total coliform group are not common to fecal matter but are of soil origin, which introduces complications in assessing stream water quality. More recently the fecal coliform (FC) subgroup of the total coliform bacteria group has been used to detect evidence of fecal pollution, and it is the bacterial indicator chosen by the Illinois Pollution Control Board for assessing the water quality of Illinois surface waters.

Studies of fecal streptococcus (FS) show that the density of these organisms is significantly higher in the feces of non-human warm-blooded animals than in humans. Since FC densities are primarily of human origin and FS densities are primarily of warm-blooded animal origin other than humans, it has been suggested that the ratio of their respective densities (FC/FS) may provide some insight regarding the relative magnitude of human versus non-human animals as sources of fecal pollution of stream waters.

Stream studies performed for bacterial assessment are best accomplished during stable stream flow conditions over an extended period of time. During the sampling period of this study, stable stream flow conditions did not prevail. As a consequence the validity of the results and subsequent conclusions reported here must be tempered by the realization that studies performed during different stream flow regimes may justify divergent views.

Methods

Water samples for bacterial examination were collected in sterile 250-ml glass bottles at 12 locations in the Illinois River and at one location each on four major tributary streams near their confluences with the river. Samples were usually collected in the channel of the river at a depth of about 6 feet. Twelve collections were made at each sampling station. On occasion problems were experienced in obtaining proper dilutions. As a consequence results on certain dates at some sampling locations number less than twelve.

The samples were iced immediately following collection and so maintained until examination. Laboratory examinations were performed the day following collections, using membrane filter procedures. Total coliform counts were made with the M-Endo agar LES two-step method. For fecal coliform and fecal streptococcus determinations, M-FC agar and KF-streptococcus agar, respectively, were used. All samples were examined in triplicate for identification and enumeration. Densities are reported in number of organisms per 100 ml.

Results

The area of study is about 86 miles in length, but the reach of principal interest is the LaGrange pool extending from milepoint (MP) 80.2 upstream to MP 157.7, a length of about 77.5 miles. Ten of the sampling stations are within the pool, with the remaining two upstream of it.

There are nine major municipal wastewater treatment plants discharging effluents into the study area, of which seven are located in the upper reach. The location, and type of treatment provided for each are shown in table 2. With few exceptions, if any, combined sewers serve the municipalities listed.

The ranges, geometric means, and geometric standard deviations of the bacterial densities for each station are summarized in tables 3, 4, and 5.

Bacterial densities varied significantly from day to day and from station to station. For the LaGrange pool the maximum TC density (110,000/ 100 ml) occurred on August 28 at MP 121.1; the minimum (1300/100 ml) occurred

Table 2. Municipal Wastewater Treatment Plants
with Discharge to Study Area

Name	Milepoint	Type of treatment
East Peoria #3	165.0	Secondary, chlorination
East Peoria #1	161.0	Secondary, chlorination
Peoria	160.2	Secondary, chlorination
Creve Coeur	158.0	Primary, chlorination
Marquette Heights	157.5	Primary, chlorination
Pekin #2	156.0	Secondary, chlorination
Pekin #1	152.2	Secondary, chlorination
Havana	119.0	Secondary, chlorination
Beardstown	87.9	Primary, chlorination

Table 3. Statistical Summary of Total Coliform Densities

(Organisms per 100 milliliters)

Milepoint or tributary	Number of samples	Minimum	Maximum	Geometric mean	Geom. std. deviation
166.1	10	570	3,100	1,400	1.80
160.7	12	580	5,400	1,900	2.45
157.6	10	2,300	23,000	5,900	2.12
152.0	12	2,100	15,000	5,200	1.95
150.0	11	5,700	25,000	11,000	1.56
145.5	12	3,400	25,000	12,000	1.75
139.0	10	4,800	54,000	14,000	1.98
129.5	11	4,500	62,000	11,000	2.19
121.1	12	2,600	110,000	12,000	2.78
113.3	11	2,800	53,000	11,000	2.61
93.6	11	1,300	49,000	6,700	2.97
80.2	11	1,700	43,000	6,300	2.79
Mackinaw R. (MP 147.8)	10	530	9,400	2,400	2.66
Spoon R. (MP 120.5)	8	1,300	9,700	3,100	2.03
Sangamon R. (MP 98.0)	11	400	8,400	2,000	3.45
LaMoine R. (MP 83.7)	11	680	19,000	3,800	3.25
LaGrange pool (157.7-80.2)	111	1,300	110,000	8,800	2.357

Table 4. Statistical Summary of Fecal Coliform Densities
(Organisms per 100 milliliters)

Milepoint or tributary	Number of samples	Minimum	Maximum	Geometric mean	Geom. std. deviation
166.1	11	67	870	370	2.13
160.7	11	110	1,400	460	1.85
157.6	12	550	3,200	1,200	1.69
152.0	11	480	2,700	1,300	1.68
150.0	12	500	4,500	2,100	1.89
145.5	11	750	5,500	2,900	1.92
139.0	11	690	12,000	3,100	2.57
129.5	12	1,000	12,000	2,800	2.24
121.1	12	190	9,800	2,700	3.05
113.3	11	700	7,400	2,300	2.24
93.6	10	280	5,900	1,400	2.23
80.2	11	350	4,600	1,400	2.15
Mackinaw R. (MP 147.8)	11	210	1,500	530	2.12
Spoon R. (MP 120.5)	11	160	1,900	450	2.12
Sangamon R. (MP 98.0)	11	160	2,400	600	2.44
LaMoine R. (MP 83.7)	12	120	5,500	900	3.31
LaGrange pool (157.7-80.2)	113	190	12,000	1,900	2.32

Table 5. Statistical Summary of Fecal Streptococcus Densities
(Organisms per 100 milliliters)

Milepoint or tributary	Number of Samples	Minimum	Maximum	Geometric Mean	Geom. std. deviation
166.1	11	52	1,300	250	3.30
160.7	12	60	3,000	310	4.21
157.6	12	140	2,200	560	2.72
152.0	12	110	5,800	690	3.02
150.0	12	180	4,600	970	2.88
145.5	12	160	5,900	1,000	3.31
139.0	11	180	2,700	750	2.97
129.5	12	90	3,200	510	3.03
121.1	12	80	3,700	640	3.73
113.3	11	110	8,200	770	3.72
93.6	12	130	6,000	1,000	3.72
80.2	12	110	7,600	1,200	3.18
Mackinaw R. (MP 147.8)	12	150	4,500	720	4.22
Spoon R. (MP 120.5)	12	110	2,500	910	3.61
Sangamon R. (MP 98.0)	12	45	6,300	720	3.85
LaMoine R. (MP 83.7)	12	300	25,000	1,500	3.26
LaGrange pool (157.7-80.2)	118	80	8,200	830	3.32

on September 19 at MP 93,6. The highest FC density (12,000/100 ml) occurred on July 31 at MP 129,5; the lowest (190/100 ml) was detected on June 26 at MP 121.1. The range of FS densities was from 8200/100 ml at MP 113.3 on July 17 to 80/100 ml at MP 121.1 on September 19.

As shown in tables 3, 4, and 5, the bacterial densities for the two stations above the pool (milepoints 166.1 and 160.7) and for the four tributaries are generally lower than within the pool. Notable exceptions are the fecal streptococcus densities for the LaMoine River (table 5). The observed geometric mean densities for TC and FC, and their respective ranges for each sampling stations, are depicted in figures 2 and 3. In each case, based upon the means, there is a progressive increase in bacterial densities with downstream movement from MP 166.1 to MP 139.0, Thereafter there is a gradual decrease in bacterial densities to MP 80.2. As shown in. figure 4, the pattern of FS mean densities differs from TC and FC patterns. As with TC and FC, there are increasing numbers of FS from MP 166,1 to MP 145.5, but thereafter there is a short-lived decline in FS densities to MP 129.5 followed by a gradual increase to MP 80.2.

The geometric means for TC and FC densities within the LaGrange pool for each sampling date are depicted in figure 5. The values for July 31 were derived from only 4 to 5 samples.

Discussion

The general standard for bacterial quality for most Illinois surface waters is set forth in Rule 203(g) of rules and regulations adopted by the Illinois Pollution Control Board (IEPA, 1977). It states:

> Based on a minimum of five samples, taken over not more than a 30-day period, fecal coliforms shall not exceed a geometric mean of 200/100 ml, nor shall more than 10 percent of the samples during any 30-day period exceed 400/100 ml.

Because of the paucity of bacterial data gained from collections on July 31, only the FC densities recorded for the 12 sampling stations during the period from August 7 to September 4 were evaluated in terms of Rule 203(g). The results are plotted in figure 3, As indicated in the figure, compliance with the rule pertaining to 200/100 ml is not achieved at any station. A review of the complete data obtained also shows that compliance with the rule pertaining to 400/100 ml was not achieved during this period.

Earlier work by Butts et al, (1975) on the Upper Illinois Waterway produced ranges and geometric means for all pools upstream of the LaGrange pool. The data are shown in tables 6 and 7 for TC and FC densities, respectively. The geometric mean of 8800 TC/100 ml in the LaGrange pool is substantially less than that for the upper pools, with the exception of the Peoria pool. The geometric mean of 1900 FC/100 ml in the LaGrange pool is about equal to that in the Marseilles pool but greater than observed in the Starved Rock and Peoria pools. Although the mean TC densities appear to fluctuate more than the mean FC densities in the LaGrange pool, as shown in figure 5, the overall magnitude of undulations suggests a relatively

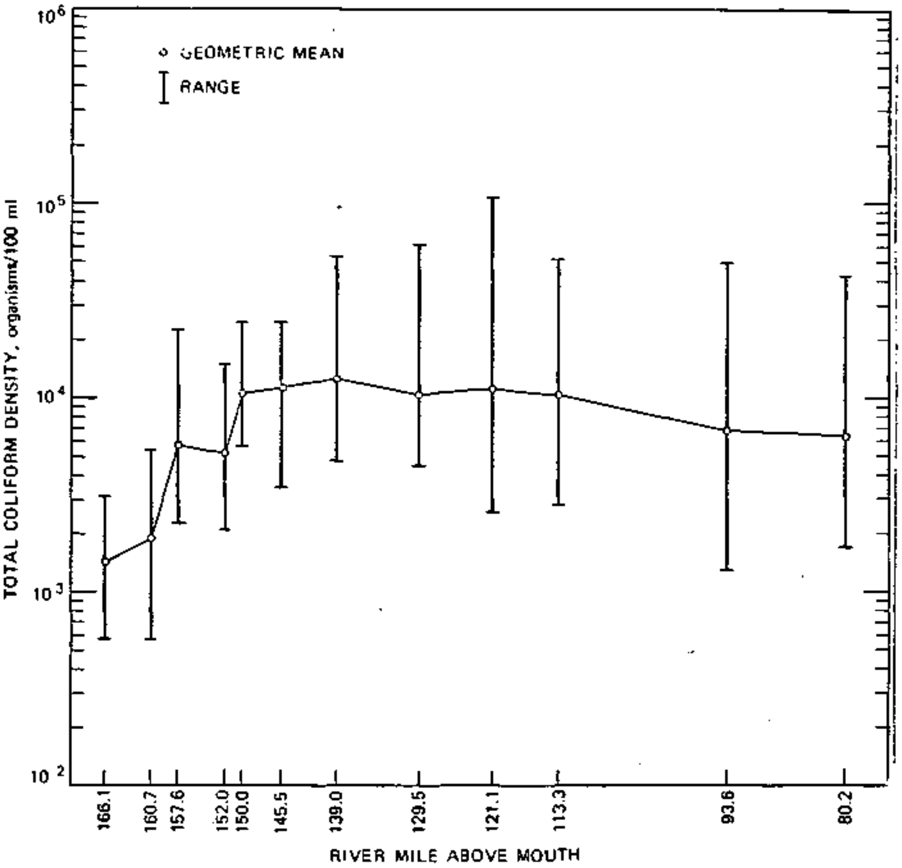


Figure 2. Density progression for total conform

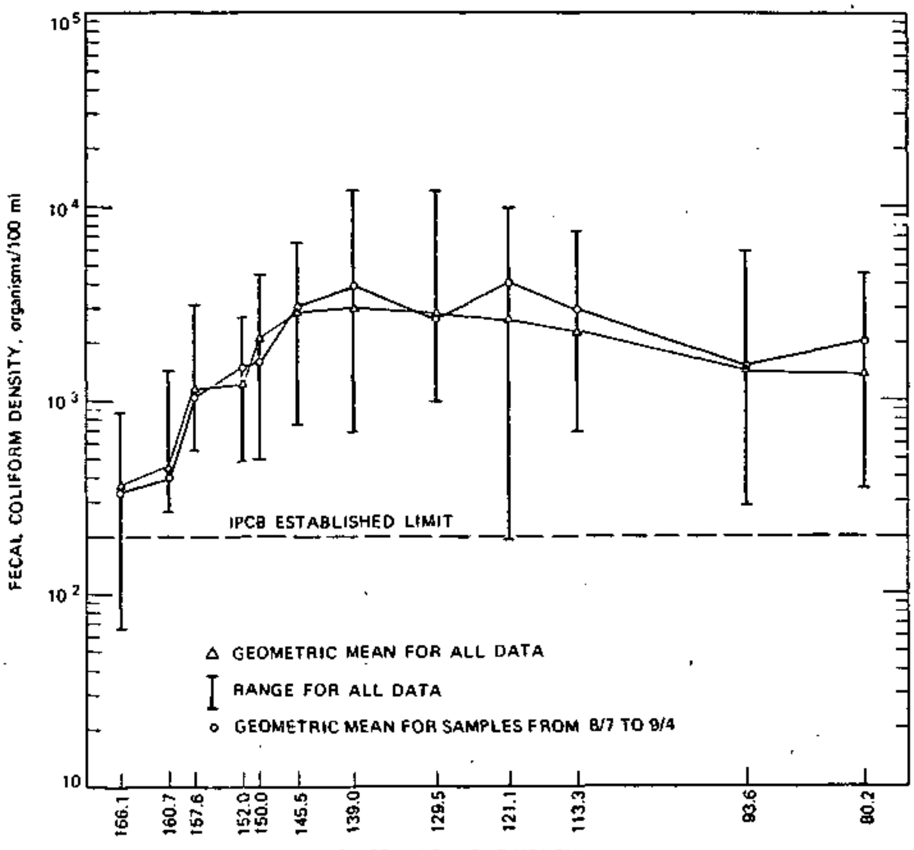


Figure 3. *Density progression for fecal conform*

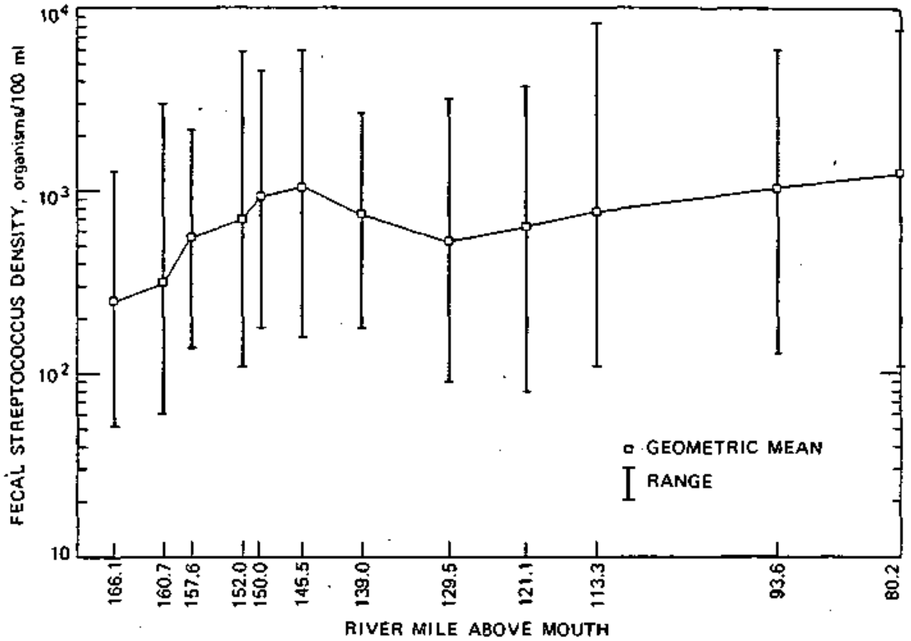


Figure 4. Density progression for fecal streptococcus

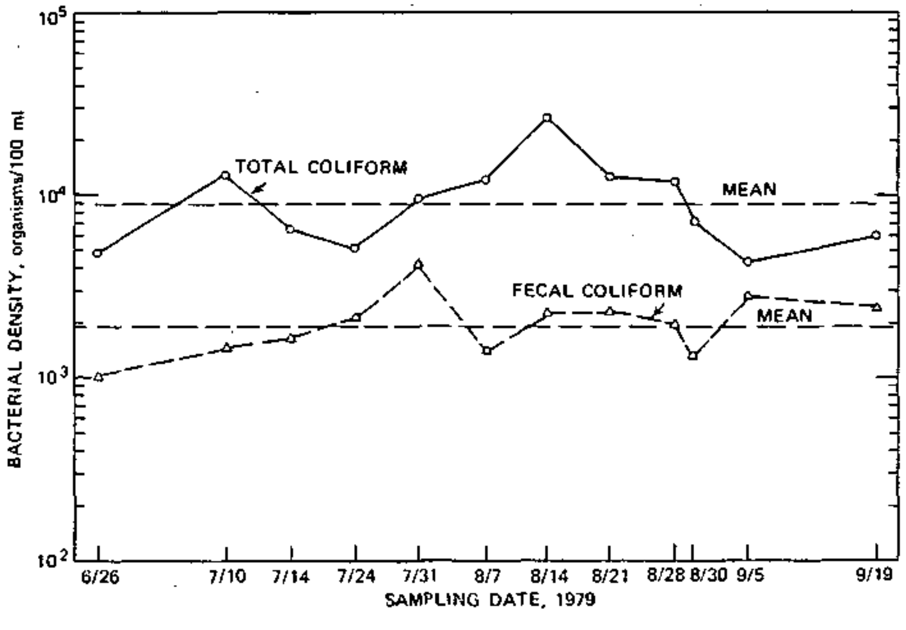


Figure 5. Geometric mean bacterial densities of the LaGrange pool

Table 6. Ranges and Means of Total Coliform Densities in Navigation Pools of Illinois Waterway

(Organisms per 100 milliliters)

Pool	No. of Samples	Minimum	Maximum	Geom. mean	Geom. std. deviation
Lockport	8	10,000	9,900,000	220,000	8.08
Brandon Road	17	10,000	9,500,000	240,000	3.79
Dresden Island	25	15,000	5,800,000	240,000	4.70
Marseilles	31	2,000	1,300,000	34,000	4.21
Starved Rock	23	2,400	280,000	14,000	3.07
Peoria	46	200	86,000	2,500	4.08
LaGrange	111	1,300	110,000	8,800	2.35

Table 7. Ranges and Means of Fecal Coliform Densities in Navigation Pools of Illinois Waterway

(Organisms per 100 milliliters)

Pool	No. of samples	Minimum	Maximum	Geom. mean	Geom. std. deviation
Lockport	8	200	400,000	8,200	14.09
Brandon Road	16	4,900	350,000	19,000	3.42
Dresden Island	25	1,000	400,000	12,000	4.86
Marseilles	31	100	240,000	1,700	5.41
Starved Rock	24	60	10,000	470	3.20
Peoria	46	4	7,000	200	4.44
LaGrange	113	190	12,000	1,900	2.32

stable mean population within the pool. This stability is more apparent when the standard deviations of the means are compared with those of other pools, as listed in tables 6 and 7.

The increase in TC and FC densities between milepoints 166.1 and 139.0 (see figures 2 and 3) is probably the influence of wastewater treatment plant effluents and the aftergrowth of *Aerobacter aerogenes*. There is a general tendency for bacteria to increase during the first 10-15 hours downstream from a point source of sewage discharge. Because of the uncertainty about the true nature of this increase, computation models used for defining rates of bacterial population dynamics within a stream are generally applied initially at the point of maximum bacterial density on the curve of progression. In this case that point is MP 139.0 for both TC and FC. For the purpose of mathematically defining the rate of bacterial density decline (often referred to as die-off, decay or death rates), Chick's law (Fair and Geyer, 1954) was used. The law is:

$$N = N_o 10^{-kt}$$

or (1)

$$\log N/N_o = -kt$$

where N and N are the bacterial densities at time 0 and t days, respectively, and k is the die-off or death rate.

For determining k, reliance was placed on the work of Kittrell and Furfari (1963), in which mean TC and FC densities are converted to bacterial population equivalents (BPE) by the following equations:

$$BPE = Q \text{ (cfs)} \times TC/100 \text{ ml} \times (6.1 \times 10^{-5}) \quad (2)$$

$$BPE = Q \text{ (cfs)} \times FC/100 \text{ ml} \times (5.88 \times 10^{-5}) \quad (3)$$

This procedure permits the incorporation of stream flow (Q), in this case mean Q, for respective mean densities of bacteria along the course of the stream from MP 139.0 to MP 80.2. It was determined that the k rate for the LaGrange pool was 0.13 per day and that the rate is equally applicable to TC and FC densities. A comparison of observed death rates for the LaGrange pool with other pools of the Illinois River is shown in table 8. A graphic comparison is depicted in figure 6. In general the death rate of TC and FC in the LaGrange pool, during the period of study, was substantially less than that observed in pools of the river upstream of it.

It has been observed that the rates of bacterial die-off are very high in heavily polluted streams. The opposite is true of deep sluggish streams with a high dilution factor. In essence a cleaner environment possesses poorer purification powers. As reported by Fair and Geyer (1959), "We arrive at the apparently anomalous conclusion that the destruction of enteric bacteria is more rapid (1) in heavily polluted streams than in clean streams, (2) in warm weather than in cold weather, and (3) in shallow turbulent streams than in deep sluggish bodies of water."

The historical record of bacteriological examinations of Illinois streams is based mainly on TC densities. The use of the ratio FC/TC permits an estimate of FC densities based on the historical record. A summary of FC/TC values for all sampling stations and the LaGrange pool is included in table 9. The mean value for the LaGrange pool is 0.306c Thus, on the average, about 31 percent of the total coliform population is made up of fecal coliform. This is much higher than the corresponding figures of 8.8 percent observed for the upper pools of the river (Illinois Environmental Protection Agency, 1977), 7.1 percent for the river at Peoria (Lin and Evans, 1980), 9.5 percent for the Spoon River (Lin et al., 1974), and 14.0 percent for the Ohio River (ORSANCO Water Users Committee, 1971). The ORSANCO Committee suggests that high FC/TC values might indicate inefficiencies in wastewater treatment plants. Low values are most likely caused by the aftergrowth of *Aerobacter aerogenes,* which produces abnormally high TC densities.

As mentioned earlier, Geldreich et al. (1964) believe that the use of FC/FS values is a more definitive tool for assessing pollution sources than relying solely on FC densities. However the best results are obtainable only if the sample is taken within a 24-hour stream flow time downstream of a pollution source. Furthermore, the ratio should not be used if

Table 8. Coliform Death Rates

(Death rate k per day)

Coliform type	Dresden Island and Marseilles pools	Starved Rock and Peoria pools	LaGrange pool
TC	0.62	0.33	0.13
FC	0.77	0.42	0.13

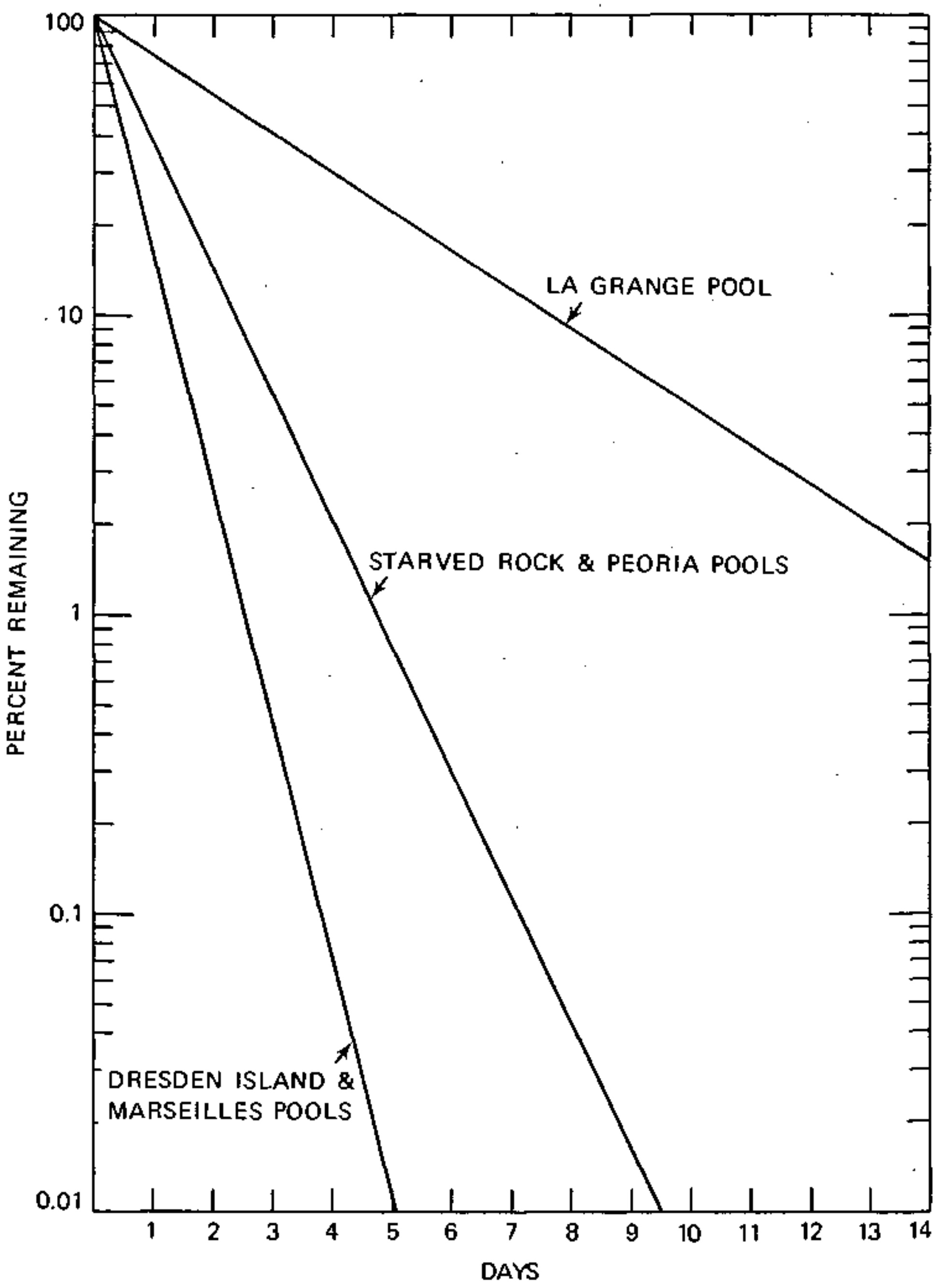


Figure 6. Death rate curves for fecal coliform in Illinois River

Table 9. FC/TC Ratio Values

Milepoint	Number of samples	FC/TC Value			Standard deviation
		Minimum	Maximum	Average	
166.1	10	0.116	0.564	.297	.184
160.7	11	.094	.506	.341	.250
157.6	10	.044	.786	.248	.226
152.0	11	.066	.591	.322	.203
150.0	11	.020	.410	.239	.107
145.5	11	.115	.450	.271	.097
149.0	10	.086	.800	.321	.257
129.5	11	.068	.914	.326	.290
121.1	12	.050	.754	.330	.265
113.3	11	.055	.933	.346	.326
93.6	10	.049	.723	.261	.202
80.2	11	.044	.833	.384	.281
Mackinaw R. (MP 147.8)	10	.083	.750	.267	.210
Spoon R. (MP 120.5)	8	.026	.377	.191	.133
Sangamon R. (MP 98.0)	11	.076	.867	.385	.256
LaMoine R. (MP 83.7)	11	.085	.811	.347	.233
LaGrange pool (157.7-80.2)	108	0.020	.933	.306	.231

FS densities are less than 100/100 ml. Values for FC/FS greater than 4.0 are indicative of fecal pollution principally of human origin, such as domestic wastewater. Ratios less than 0.7 are indicative of sources derived from non-human warm-blooded animals such as livestock, poultry, and wildlife. Intermediate values between 0.7 and 4.0 represent a mixed source.

Table 10 shows the percentages of FC/FS values that were greater than 4.0, between 4.0 and 0.7, and less than 0.7. Under the assumption that any

Table 10. Grouping of FC/FS Values

Milepoint or tributary	Number of ratios	Percentage FC/FS -4.0	Percentage 4.0 > FC/FS > 0.7	Percentage FC/FS - 0.7
166.1	8	12	50	38
160.7	7	0	57	43
157.6	12	50	25	25
152.0	11	27	46	27
150.0	11	18	83	9
145.5	11	55	36	9
139.0	11	36	55	9
129.5	11	55	36	9
121.1	11	45	55	0
113.3	10	30	50	20
93.6	10	10	50	40
80.2	11	28	36	36
Mackinaw R. (MP 147.8)	11	9	27	64
Spoon R. (MP 120.5)	10	0	20	80
Sanqamon R. (MP 98.0)	10	10	50	40
LaMoine R. (MP 83.7)	12	0	58	42

values equal to or greater than 4.0 represent primarily a human source, it appears that samples collected at mile 157.6 and that reach of the river from milepoints 145.5 to 113.3 reflect pollution of human origin. In contrast the samples taken from the four tributaries produce low FC/FS values indicative of fecal bacteria originating from animal waste other than humans. It is also apparent from the FC/FS values set forth in table 10 that the sources of fecal bacteria in the river are mixed most of the time.

Summary

1) An 86-mile reach of the Illinois River, including the 78-mile-long LaGrange pool, was sampled at 12 locations on 12 occasions. Four major tributaries of the LaGrange pool were also sampled on 12 occasions. Examinations were performed for densities of total coliform (TC), fecal coliform (FC), and fecal streptococcus (FS) bacteria.

2) Nine major municipal waste treatment plants discharge effluents into the study reach.

3) Bacterial densities immediately upstream of the LaGrange pool and in tributaries to the pool are generally lower than within the pool.

4) The geometric means of TC, FC, and FS within the pool are 8800/100 ml, 1900/100 ml, and 830/100 ml, respectively.

5) Compliance with current water pollution control rules and regulations governing bacterial quality in Illinois is not achieved in the LaGrange pool.

6) A progressive increase in TC and FC densities occurs with downstream movement in the upper 27 miles of the study reach, followed by a gradual decline or die-off. The increase probably results from the influence of wastewater treatment effluents and combined sewer overflows.

7) The rate of fecal coliform die-off in the LaGrange pool is 0.13 per day. This rate is substantially less than the 0.42 and 0.77 per day previously observed in the Starved Rock-Peoria pool sector and the Dresden Island-Marseilles pool sector, respectively.

8) On the average, about 31 percent of the total coliform bacteria population in the LaGrange pool is made up of fecal coliforms. This is much higher than the 8.8 to 9.5 percent observed in some other Illinois streams.

9) Although most of the time the sources of fecal bacteria in the pool are mixed, i.e., both human and non-human warm blooded animals, results indicate that in certain upper reaches the primary source is human.

10) Fecal bacteria densities in the major tributaries to the pool originate mostly from animal waste other than humans.

ALGAE

The recent history of algal collections on the Illinois River since 1965 indicates the predominance of diatoms, especially *Cyclotella* and *Navicula* genera, in terms of both frequency of occurrence and density (Lin et al., 1972, 1973, 1978; Wang et al., 1973). The reported mean summer density of diatoms is approximately 3000 cts/ml, and they comprise about 85 percent of total algal population. The green algae *Scenedesmus* and the flagellate *Euglena* also occur frequently, but with lower densities. Blue-green algae occurrences have been infrequent and low in count.

During August and September 1978, Sparks and Lubinski (1978) and Butts and Evans (1980) observed blue-green algal blooms with densities of about 1500 cts/ml. This was partially attributed to the absence of, or decreases in, barge traffic in the upper pools of the Illinois Waterway. Schnepper et al. (1980) found large increases in the dissolved oxygen and pH levels and decreases in the nitrate concentrations in Peoria Lake and the LaGrange pool (MP 170.9 to MP 80.2) during the week of September 5, 1978. The changes in water chemistry, shown in table 11, were coincident with an observed algal bloom of significant proportions. The following week, as shown in table 11, very low dissolved oxygen levels and relatively high ammonia concentrations occurred in Peoria Lake and the LaGrange pool. This is characteristic of water subject to the experience of an algal bloom and subsequent die-off.

As in the Illinois River, diatoms have been considered dominant in the tributaries to it. This is particularly the case for the LaGrange pool. The principal genera are *Cyclotella* and *Navicula.* Pulses of green algae *(Scenedesmus)* , flagellates *(Euglena),* and blue-green algae *(Aphanizomenon)* occasionally have been noted in the Sangamon and Mackinaw Rivers.

Table 11. Algae-Mediated Changes in Water Chemistry in Peoria Lake and the LaGrange Pool

River	DO		pH		NH_3-N		NO_3-N	
mile	9/5/78	9/12/78	9/5/78	9/12/78	9/7/78	9/12/78	9/5/78	9/12/78
170.9	12.8	6.4	9.18	8.35	0.01	0.01	1.08	1.28
159.9	11.5	3.6	9.27	8.39	0.04	0.19	0.84	1.24
150.2	8.2	4.1	9.18	8.11	0.20	0.36	0.77	1.20
140.1	8.3	3.0	9.13	8.11	0.22	0.51	0.73	1.13
129.9	8.5	3.7	9.18	8.37	0.19	0.61	0.72	0.91
119.9	8.0	3.0	9.15	8.40	0.09	0.39	0.80	0.85
110.9	8.8	2.7	9.02	8.23	0.05	0.30	0.82	0.95
100.9	8.4	2.8	9.11	8.17	0.04	0.30	0.88	1.05
90.2	9.2	2.4	8.90	8.07	0.00	0.31	1.06	1.04
80.2	7.3	2.8	8.77	8.05	0.01	0.24	1.23	0.95

Methods

Twenty-five water samples for algal examinations were obtained with a Juday sampler at a 3-foot depth at each of the 12 river sites during the period from June 20 to September 5. The sampling locations are set forth in table 12. The four shallow tributary rivers were also sampled 25 times. (The samples collected from the tributaries on July 31 were lost.) Additional samples were obtained from the Illinois River when algal blooms were noted visibly or were indicated by high dissolved oxygen levels. The samples were poured in a small-mouth glass bottle, containing formalin as a preservative, until a sample volume of 380 ml was attained. The samples were capped and stored at room temperature until examined.

Before examination each sample was thoroughly mixed and a l-ml aliquot was pipetted into a Sedgwick-Rafter cell. An inverted phase contrast microscope equipped with 10X eyepieces, 20X objective, and a Whipple disc was used for identification and counting purposes. Five short strips (about 280 fields) were counted. The algae were identified to species using several keys (Patrick and Reimer, 1966; Prescott, 1962 and 1970; Smith, 1950; Tiffany and Britton, 1951) and were grouped in four main types: blue-greens, greens, diatoms, and flagellates.

Algae of the blue-green type, of which there are about 1500 species, are usually characterized by a bluish-green color caused by an accessory pigment in addition to chlorophyll. A red pigment is sometimes present also. Most blue-green algae grown in nonfilamentous colonies or in branched or unbranched filaments. They are widely distributed and occur in varied habitats. but when they occur in massive numbers (a bloom) they are found at the water surface. They are found in ponds or lakes more frequently than in the running waters of a stream.

The green algae group includes about 7000 species. Although a number live in saltwater, the group as a whole is more characteristic of freshwater. They may be either free-floating or attached and are usually either single cells or filamentous colonies that, if numerous, give a green cast to water.

Table 12. Location of Stations for Algae Collections

Milepoint	Location
166.1	McCluggage Bridge
162.8	I-74 Bridge
157.6	Peoria Lock
150.0	LaMarsh Creek
145.5	Kingston Mines
139.0	Banner Pumping Station
129.5	Duck Creek
121.1	Havana
113.3	Upper End of Bath Chute
106.9	Lower End of Bath Chute
93.6	Beardstown
80.2	LaGrange Lock
Tributary	LaMoine @ Ripley
Tributary	Sangamon @ Chandlerville
Tributary	Spoon @ Il. Highway 78
Tributary	Mackinaw @ Powerton

Diatoms, which include about 16,000 species, are generally unicellular and free-floating; however, some live attached to plants or inert objects. The cell wall is composed of two halves (valves), one overlapping the other like the top and bottom of a pill box. Although there is variation in shape, generally the cell is oblong to circular and is made up mostly of silica. Diatoms vary in color from brown to green.

In several divisions of algae, including green, there are species that are unicellular and equipped with flagella, which are whiplike organs that make mobility possible. These are flagellates. Depending upon the species, the cells range from spherical to ovoid. They are frequently found in organically enriched waters.

For enumeration, blue-green algae were counted by the number of trichomes. Green algae were counted by individual cells except for *Actinastrum, Coelastrum,* and *Pediastrum,* which were counted by each colony observed. *Scenedesmus* was recorded by each cell packet, and diatoms were counted as one organism regardless of their grouping or connections.

Results

For the purpose of presenting the results obtained from 25 collections at 12 locations in the Illinois River and from 24 collections at one location on each of the four major tributaries to the LaGrange pool, this section has two main divisions: discussions of the river algae and the tributary algae. Because the study focuses on the navigation pool, a more rigorous examination of the algae collections in the Illinois River has been undertaken. The main purpose here is to provide basic information about the total algal densities, their genera and species distribution, spatial and temporal variations, predominance, bloom occurrences, and composition.

Illinois River

The algal densities observed for each location in the Illinois River are shown in table 13. Geometric mean densities ranged from 956 cts/ml at mile 150.0 to 1499 cts/ml at MP 139.0. A total of 70 species were recovered: 4 blue-greens, 39 diatoms, 19 greens, 7 flagellates, and 1 desmid. The number of species and genera and the predominant organisms are listed in table 14.

The principal blue-green species was *Aphanizomenon flos-aquae,* with infrequent occurrences of *Anacystic* spp. and *Oscillatoria* spp. The diatoms consisted mainly of *Cyclotella meneghiniana, Navicula cryptocephala,* and *Melosira granulata.* Green algae densities in the river were sparse except for a bloom of *Chlorella ellipsoidea* at MP 113.3 on September 5. In addition to that species of green algae, *Actinastrum hantzschii* occasionally contributed to green algae density. When green algae densities equaled or exceeded 200 cts/ml, the predominant species was *C. ellipsoidea.* Flagellate densities seldom exceeded 100 cts/ml and usually consisted solely of *Euglena viridis.*

Table 13. Total Algal Density, Illinois River

(Counts per milliliter)

Sampling period	Date (1979)	Milepoint 166.1	162.8	157.6	150.0	145.5	139.0
1	6/20	698	773	852	826	1005	857
2	6/25	597	625	1112	640	712	645
3	6/26	629	698	1054	762	942	841
4	7/2	1101	756	1365	1182	1255	958
5	7/3	1281	1136	989	1084	724	952
6	7/9	1329	1011	890	814	1223	762
7	7/10	760	815	1206	968	820	665
8	7/16	655	787	898	852	720	776
9	7/17	1144	898	867	915	910	777
10	7/23	1138	1668	762	836	612	916
11	7/24	845	1086	1133	799	974	1064
12	7/30	857	1044	888	1250	989	1822
13	7/31	1033	1165	1123	1091	1038	1265
14	8/6	1075	1138	1515	819	602	1609
15	8/7	1440	1615	18899	1000	1038	1324
16	8/13	1791	1699	1806	1181	1286	1737
17	8/14	1848	1419	1992	1266	1409	1923
18	8/20	19529	1727	1816	1203	1588	2013
19	8/21	1737	1525	1329	492	1535	1679
20	8/27	1775	1632	1483	624	815	1758
21	8/28	1938	1743	1785	836	984	1780
22	8/29	1874	1663	1595	873	868	1933
23	8/30	1765	17324	1621	1376	763	17272
24	9/4	2166	22574	1409	1308	980	1690
25	9/5	2336	27037	1542	1896	1455	20264

Sampling period	Date (1979)	Milepoint 129.5	121.1	113.3	106.9	93.6	80.2
1	6/20	815	739	670	874	736	688
2	6/25	718	630	1047	746	761	955
3	6/26	639		624	969	683	878
4	7/2	985	1292	910	1095	915	873
5	7/3	766	895	729	857	879	666
6	7/9	1001	778	1221	784	1059	1043
7	7/10	847	782	671	736	714	544
8	7/16	766	895	1116	784	693	868
9	7/17	996	803	565	582	778	1303
10	7/23	1016	1059	692	840	1022	1413
11	7/24	1022	693	729	948	842	713
12	7/30	989	9134	895	565	710	969
13	7/31	1196	847	757	660	773	856
14	8/6	1059	842	1112	720	1033	1059
15	8/7	1466	1117	1150	1250	1254	1244
16	8/13	20527	1429	1329	985	1721	1705
17	8/14	19740	16956	1298	1075	1632	1902
18	8/20	2172	15487	1086	1054	1626	1370
19	8/21	2002	1388	1123	947	1388	1658
20	8/27	1892	1382	1028	672	1499	1844
21	8/28	2013	1488	1313	1027	1526	1552
22	8/29	2113	1520	1398	1118	1557	1674
23	8/30	18479	17167	1938	1192	1461	1509
24	9/4	1955	1525	1668	1101	1568	1361
25	9/5	22890	1780	20053	1732	1727	1605

Table 14. Number of Algal Species, Number of Genera, and Predominant Forms Recovered, Illinois River

	Number of species	Number of genera	Principal genera	Principal species
Blue-creens	4	3	*Aphanizomenon*	*flos-aquae*
Diatoms	39	18	*Cyclotella* *Navicula* *Melosira* *Nitzschia* *Gyrosigma* *Surrirella*	*meneghiniana* *cryptocephala* *granulata* spp. spp. spp.
Greens	19	12	*Chlorella* *Actinastrum*	*ellipsoidea* *hantzschii*
Flagellates	7	5	*Euglena*	*viridis*
Desmids	1	1		
Total	70	39		

There were occasional occurrences of *E. gracilis* and *E. oxyuris.* A bloom of flagellates did occur coincident with the *C. ellipsoidea* at MP 113.3 on September 5, reaching a density of about 2100 cts/ml.

At times the algal densities significantly exceeded the geometric mean at 9 of the stations. The episodes are summarized in table 15. As shown in the table, significant algal densities occurred at 9 stations; the last three downstream stations did not experience unusually high densities. However, for 4 of the 9 stations (milepoints 157.6, 150.0, 145.5, and 113.3) high densities were detected only at one collection period. On the other hand, bloom conditions occurred at the other 5 stations as follows:

Milepoint	Number of high density occurrences
166.1	3
162.8	3
139.0	3
129.5	8
121.1	4

The main algal species producing high densities at the 5 stations were the diatom *N. Cryptocephala* and the blue-green *A. flos-aquae.* The samples from the stations at milepoints 166.1 and 162.8 generally reflect those algae flowing out of upper Peoria Lake, since the station at MP 166.1 is at the site of the Narrows (the outlet of upper Peoria Lake), and the station at MP 162.8 terminates a 3.3-mile stretch of lower Peoria lake. The other three stations are on a 24-mile reach of the river between MP 145.5 and MP 121.1. The significance of these sectors of the river as habitats for blue-green algae is shown in figure 7. Here the assumption is that any

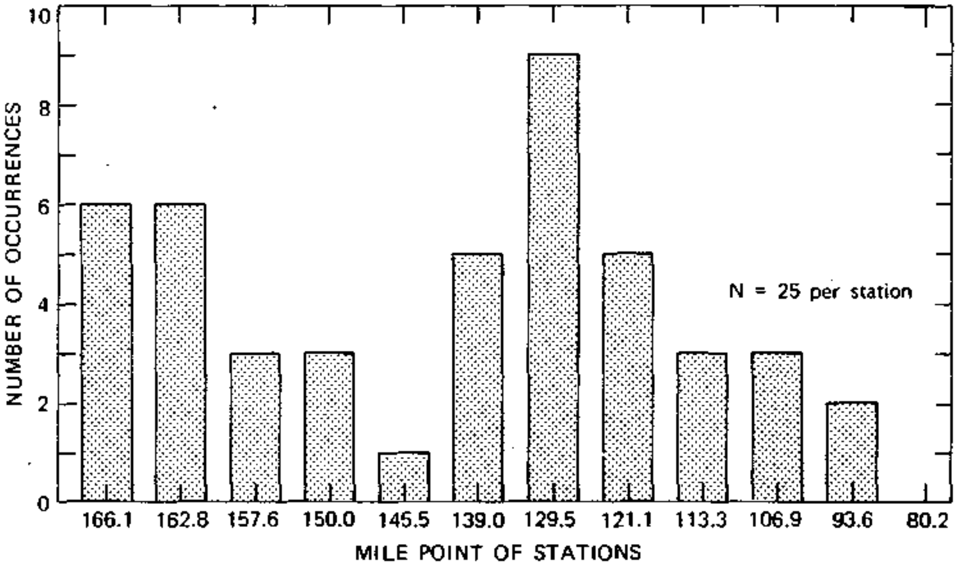


Figure 7. *Number of times blue-green algal densities exceeded 500 cts/ml at stations*

blue-green algal counts exceeding 500/ml indicate a nuisance bloom condition. As shown in figure 7, the sectors of the river represented by the 5 previously-mentioned stations support blue-green algae populations of bloom proportions on more occasions than the other 7 stations from which algae were recovered.

The temporal and spatial distributions of the most dominant blue-greens and diatoms recovered from the river are depicted in figures 8, 9, 10, and 11. Figure 8 shows the densities of *A. flos-aguae* at each sample location. With the exception of MP 150.0, there were occasional pulses of the algae during June and July. Commencing in August the densities of *A. flos-aguae* persisted throughout the course of the river for the remainder of the sampling periods, except at MP 145.5. As indicated, densities in excess of 500 cts/ml occurred sporadically. The densities shown for MP 150.0 remained uncharacteristically constant commencing in July, while the next downstream station (MP 145.5) did not conform to any predictable pattern compared to other stations in the river.

The most dominant diatom recovered from the river was *N. cryptocephala*. Figure 9 shows the densities developed by these benthic algae. These organisms were not recovered until the latter part of July, after which their population remained reasonably constant at most stations except milepoints 113.3 and 106.9. An explanation for this lack of constancy at the two stations will be presented later.

The populations of the planktonic diatoms *C. meneghiniana* and *Melosira* spp. at selected locations are depicted in figures 10 and 11. The depictions are representative of all other sampling locations. *C. meneghiniana* organisms (figure 10) were generally persistent throughout the sampling season. The

Table 15. Locations, Dates, and Predominant Species When Algal Densities Significantly Exceeded Geometric Means

Station	Geom. mean (cts/ml)	Date and total (cts/ml)	Species	Species (cts/ml)
166.1	1365	8/20-19,529	N. cryptocephala	12,075
			A. flos-aquae	4,935
			C. meneghiniana	1,575
		9/4-2,166	A. flos-aquae	636
			N. cryptocephala	583
			A. cyanea	498
		9/5-2,326	A. flos-aquae	848
			N. cryptocephala	524
			A. cyanea	742
162.8	1635	8/30-17,324	A. flos-aquae	9,975
			C. meneghiniana	11,555
			N. cryptocephala	5,775
		9/4-22,574	A. flos-aquae	11,025
			N. cryptocephala	6,300
			A. cyanea	3,255
			C. meneghiniana	1,627
		9/5-27,037	A. flos-aquae	12,600
			N. cryptocephala	5,197
			A. cyanea	6,825
			C. meneghiniana	2,415
157.6	1387	8/7-18,899	N. cryptocephala	9,975
			C. meneghiniana	4,620
			A. flos-aquae	2,782
150.0	956	9/5-1,896	A. flos-aquae	742
			O. chlorina	482
			N. cryptocephala	466
145.5	978	8/20-1,588	N. cryptocephala	1,113
139.0	1499	8/20-2,013	N. cryptocephala	1,007
		8/30-17,272	A. flos-aquae	7,875
			C. meneghiniana	2,625
			N. cryptocephala	6,300
		9/5-20,264	A. flos-aquae	9,975
			C. meneghiniana	2,467
			N. cryptocephala	7,350

Melosira spp., unlike *C. meneghiniana,* occurred in a series of pulses, as shown in figure 11. Whereas the diatoms *N. cryptocephala* and *C. meneghiniana* frequently occurred in concentrations exceeding 500 cts/ml and 100 cts/ml, respectively, the species *Melosira* seldom occurred in densities greater than 100 cts/ml.

As noted earlier green algae did not contribute significantly to the algal population of the river. The dominant species was *C. ellipsoidea.* As shown in figure 12 for selected locations along the river, total densities

Table .15. Concluded

Station	Geom. mean (cts/ml)	Date and total (cts/ml)	Species	Species (cts/ml)
129.5	1383	8/13-20,525	A. *flos-aquae*	6,300
			N. *cryptocephala*	8,400
			C. *meneghiniana*	5,250
		8/14-19,740	A. *flos-aquae*	5,250
			N. *cryptocephala*	9,450
			C. *meneghiniana*	4,725
		8/20-2,172	A. *flos-aquae*	514
			N. *cryptocephala*	1,007
			C. *meneghiniana*	524
		8/21-2,002	A. *flos-aquae*	583
			N. *cryptocephala*	954
		8/28-2,172	A. *flos-aquae*	636
			N. *cryptocephala*	1,007
		8/29-2,113	A. *flos-aquae*	742
			N. *cryptocephala*	954
		8/30-18,479	A. *flos-aquae*	8,400
			N. *cryptocephala*	7,875
			C. *meneghiniana*	1,627
		9/5-22,890	A. flos-aquae	12,075
			N. cryptocephala	7,875
			C. menegniniana	2,940
121.1	1790	7/30-9,134	A. *flos-aquae* .	1,470
			N. *cryptocephala*	6,300
			M. *granulata*	1,155
		8/14-16,956	A. *flos-aquae*	2,520
			N. *cryptocephala*	12,075
			C. *meneghiniana*	1,732
		8/20-15,487	A. *flos-aquae*	2,100
			N. *cryptocephala*	9,975
			C. *meneghiniana*	2,730
		8/30-17,167	A. *flos-aquae*	4,620
			N. *cryptocephala*	10,500
			C. *meneghiniana*	1,522
113.3	1120	9/5-20,053	A. *flos-aquae*	11,025
			C. *meneghiniana*	3,832
			N. *viridis*	1,522
			C. *ellipsoidea*	3,097

of green algae frequently were 100 cts/ml or less. There was not a seasonal orientation to this occurrence. However, flagellates, consisting mostly of *E. viridis*, seemed to decline during most of August, as shown in figure 13. And, as with the green algae, their density was 100 cts/ml or less.

The seasonal composition of the algal population at each station is depicted in figure 14. This figure depicts the percent of the total algal

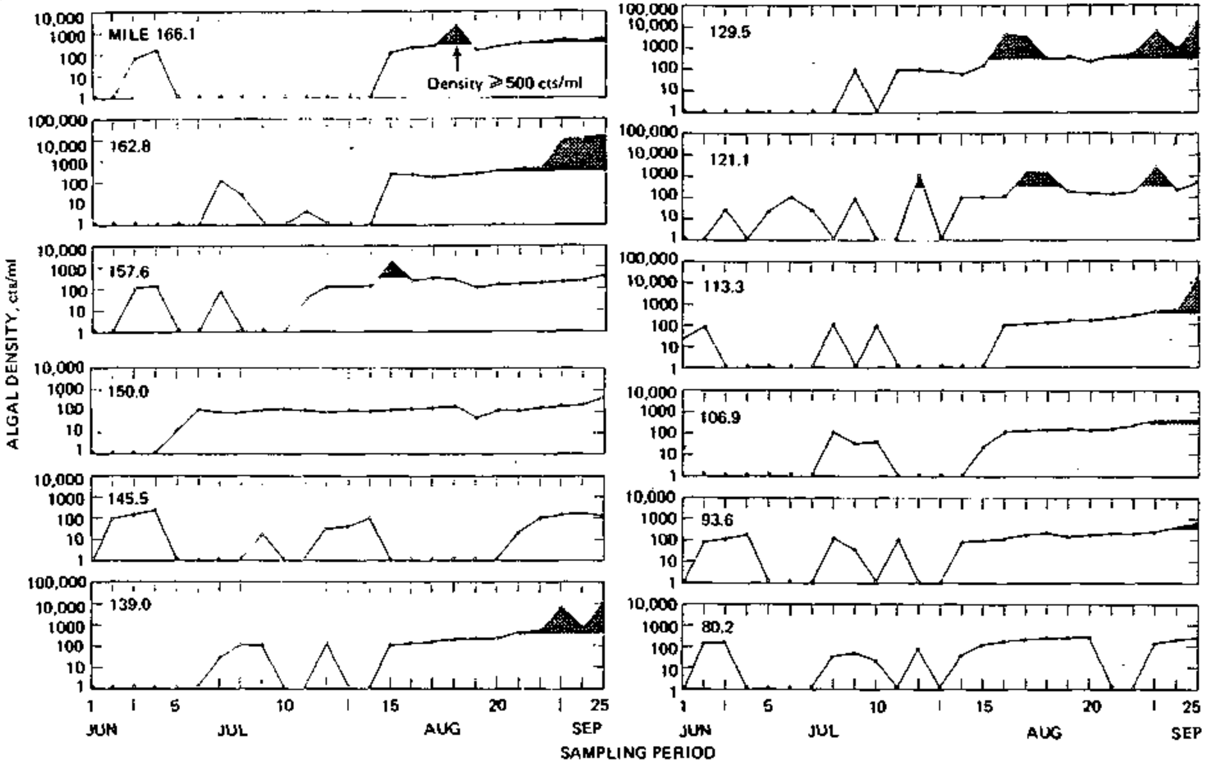


Figure 8. Density of `Aphanizomenon flos-aquae` *in Illinois River, 1979*

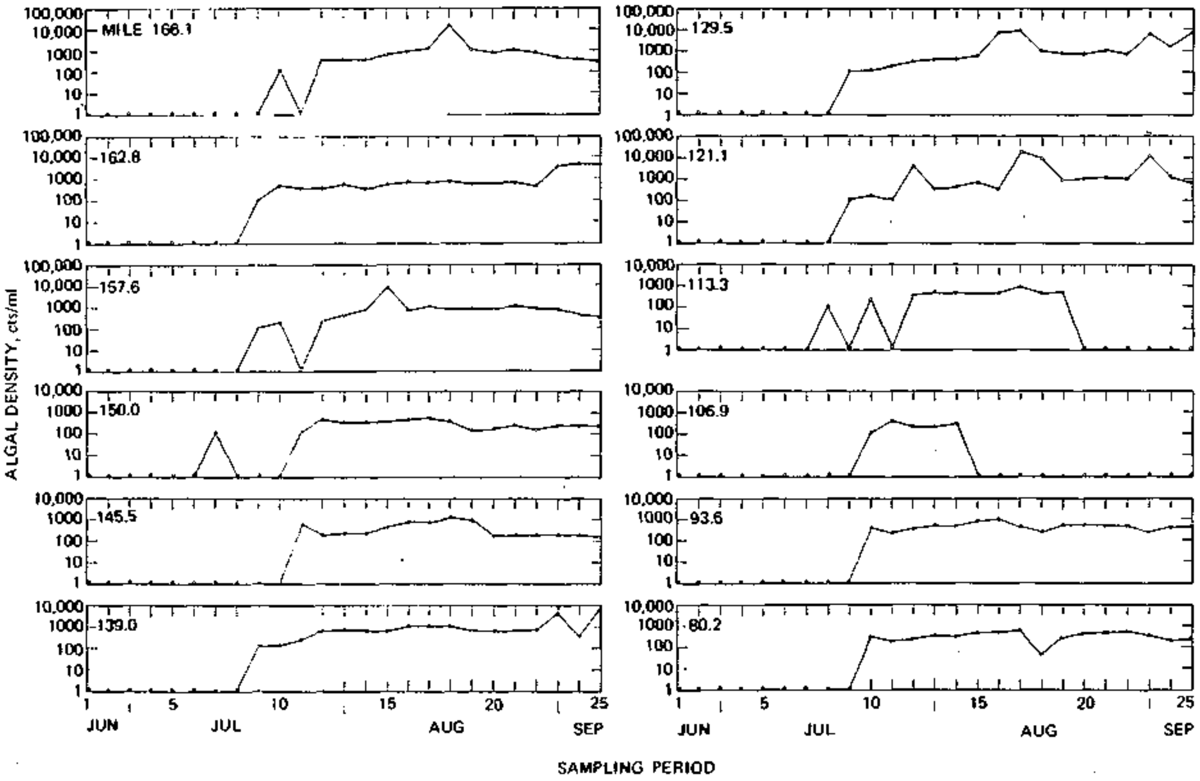


Figure 9. Density of `Navicula cryptocephala` *in Illinois River, 1979*

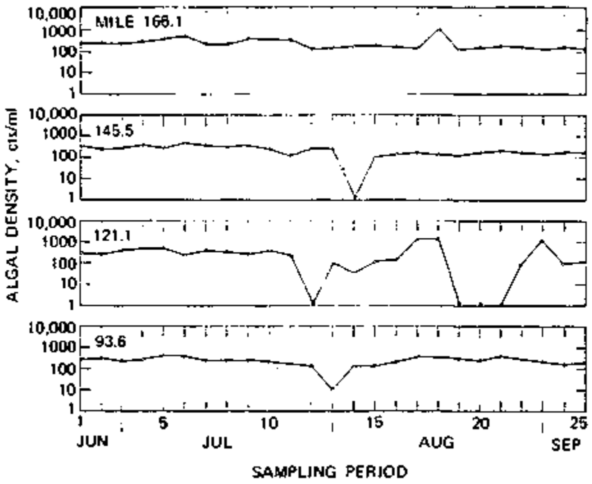


Figure 20. *Density of* Cyclotella meneghiniana *at selected locations in Illinois River, 1979*

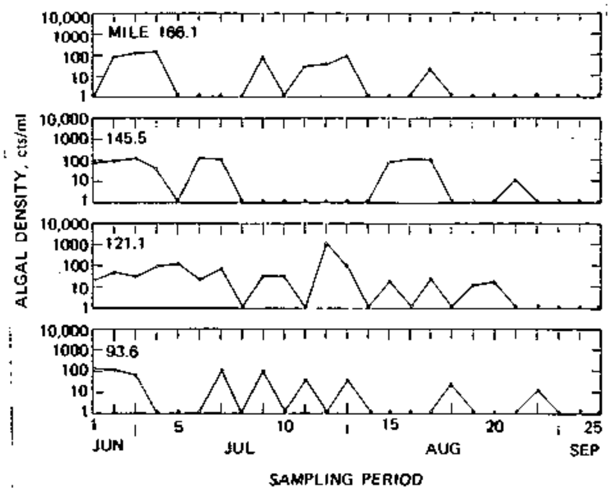


Figure 11. Density of Melosira *spp. at selected locations in Illinois River, 1979*

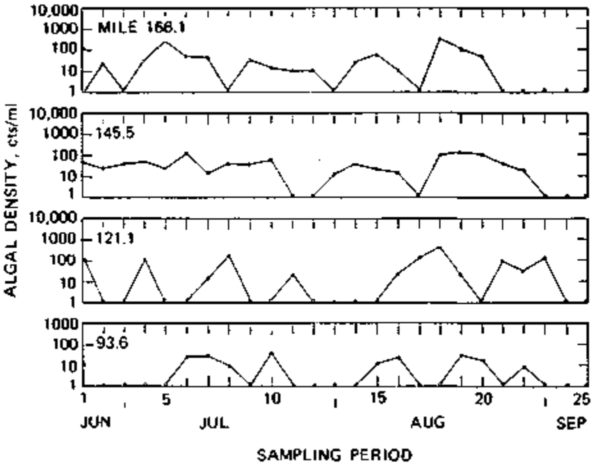


Figure 12. Density of green algae at selected locations in Illinois River, 1979

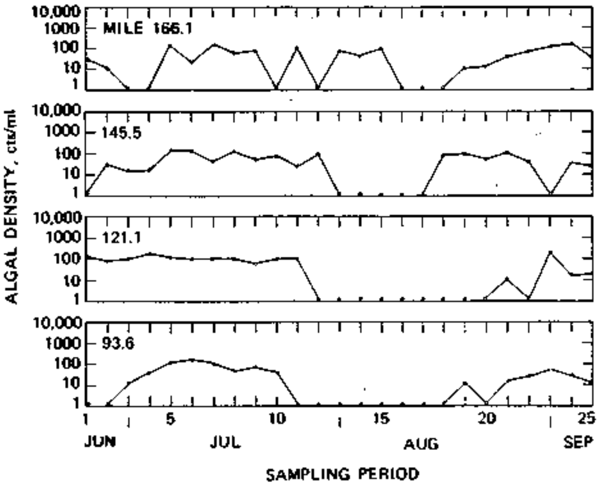


Figure 13. Density of flagellates at selected locations in Illinois River, 1979

population represented by diatoms, blue-greens, greens, and flagellates. The relative contribution of diatoms to the total population is quite obvious. From June until the latter part of August they made up about 70 to 90 percent of the total densities. Thereafter the percentage of blue-greens increased substantially until during the early days of September they were the prevailing phytoplankton at most stations.

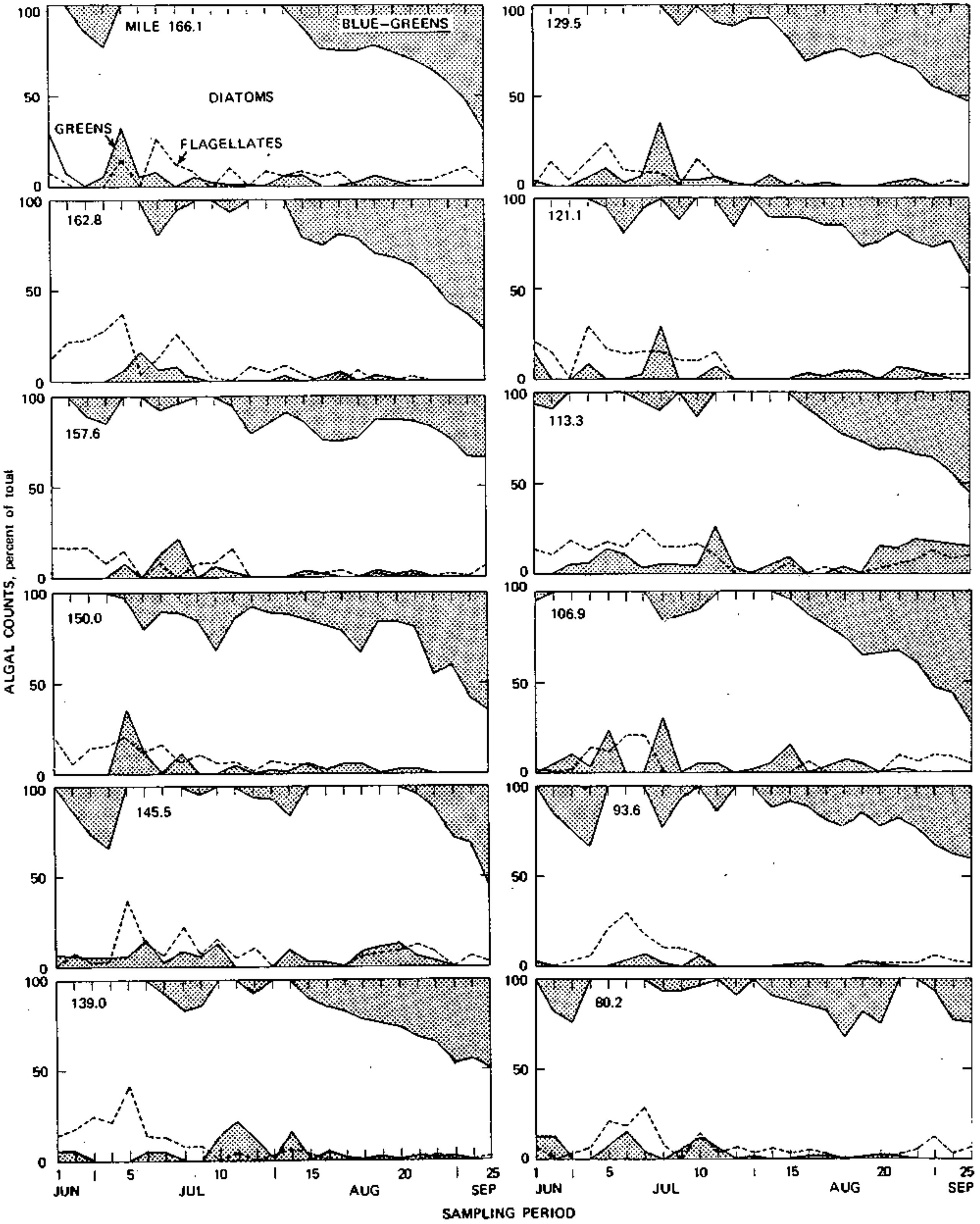


Figure 14. Variation in algal types, Illinois River, 1979

Tributaries

The major tributaries to the LaGrange pool are the Mackinaw, Spoon,. Sangamon, and LaMoine Rivers. Their approximate milepoint confluences with the pool, and the downstream sampling stations nearest to those confluences, are:

	Confluence	Station
Mackinaw	147.8	145.5
Spoon	120.5	113.3
Sangamon*	98.0	93.6
	88.9	80.2
LaMoine	83.7	80.2

* Two confluences, depending on flow

The algal densities recovered from the tributaries are shown in table 16. Geometric mean densities ranged from 1116 cts/ml in the Spoon River to 1913 cts/ml in the LaMoine River. A total of 53 species were recovered: 2 blue-greens, 32 diatoms, 13 greens, 5 flagellates, and 1 desmid. The number of species and genera and the predominant organisms are listed in table 17. The predominant species are the same as those observed in the Illinois River.

Table 16. Total Algal Density, Tributaries to the LaGrange. Pool

(Counts per milliliter)

Sampling period	Date (1979)	Mackinaw R.	Spoon R.	Sangamon R.	LaMoine R.
1	6/20	625	715	653	703
2	6/25	1442	20	916	888
3	6/26	1180	29	777	669
4	7/2	752	15592	13807	18478
5	7/3	534	545	24674	22049
6	7/9	713	747	926	941
7	7/10	571	1590	661	640
8	7/16	837	677	966	666
9	7/17	911	17009	17481	762
10	7/23	1345	18427	815	17850
11	7/24	649	19476	1218	18321
12	7/30	767	354	1075	16485
13	7/31*				
14	8/6	22889	469	242	1011
15	8/7	25357	460	492	1499
16	8/13	20422	845	746	1281
17	8/14	18794	969	1196	1414
18	8/20	16273	1609	1339	1249
19	8/21	1769	1128	1023	1079
20	8/27	1726	1344	1340	1090
21	8/28	1706	1020	1477	1319
22	8/29	1302	1647	1584	1435
23	8/30	1255	1513	1202	1319
24	9/4	1292	1451	1122	1402
25	9/5	1445	900	1207	1467

* Samples lost

As observed in the Illinois River, algal densities at times significantly exceeded the geometric mean densities of the tributaries. As shown in table 18, there were some differences in the time of bloom occurrences

Table 17. Number of Algal Species, Number of Genera, and Predominant Forms Recovered in Tributaries

	Number of species	Number of genera	Principal genera	Principal species
Blue-greens	2	2	Aphanizomenon	flos-aquae
Diatoms	32	15	Navicula Cyclotella Naviculum	cryptocephala meneghiniana gastrum
Greens	13	9	Chlorella Actinastrum	ellipsoidea hantzschii
Flagellates	5	3	Euglena Phacus	viridis pleuronectes
Desmids	1	1		
Total	53	30		

Table 18. Algal Bloom Occurrences, Major Species, and Densities in Tributaries

Mackinaw R. (Geom. mean: 1913 cts/ml)

	Cts/ml		Cts/ml		Cts/ml		Cts/ml
8/6	22,889	C. ellipsoidea	8,400	N. cryptocephala	8,400	C. meneghiniana	3,255
8/7	25,357	C. ellipsoidea	9,975	N. cryptocephala	10,500	A. flos-aquae	2,100
8/13	20,422	C. ellipsoidea	8,400	N. cryptocephala	9,975	A. flos-aquae	1,627
8/14	18,794	C. ellipsoidea	6,300	N. cryptocephala	8,400	A. flos-aquae	3,045
8/20	16,273	C. ellipsoidea	4,200	N. cryptocephala	6,300	A. flos-aquae	3,675

Spoon R. (Geom. mean: 1348 cts/ml)

	Cts/ml		Cts/ml		Cts/ml
7/2	15,592	C. meneghiniana	10,500	C. ellipsoidea	4,252
7/17	17,009	C. meneghiniana	11,550	N. cryptocephala	4,252
7/23	18,427	C. meneghiniana	11,025	C. ellipsoidea	4,515
7/24	19,476	C. meneghiniana	9,450	C. ellipsoidea	8,925

Sangamon R. (Geom. mean: 1116 cts/ml)

	Cts/ml		Cts/ml		Cts/ml
7/2	13,807	C. meneghiniana	11,025		
7/3	24,674	C. meneghiniana	13,650	C. ellipsoidea	8,925
7/17	17,481	C. meneghiniana	13,650	C. ellipsoidea	

LaMoine R. (Geom. mean: 1903 cts/ml)

	Cts/ml		Cts/ml		Cts/ml
7/2	18478	C. ellipsoidea	11,025		
7/3	22049	C. ellipsoidea	11,025		5,775
7/23	17850	N. cryptocephala	5,250	C. meneghiniana	9,975
7/24	18321	N. cryptocephala	5,040	C. meneghiniana	10,500
7/30	16485	N. cryptocephala	6,825	C. meneghiniana	9,450

between the Mackinaw River and the other tributaries. There was also a difference between the Mackinaw River and the other tributaries in terms of algal composition during bloom conditions. Exceptionally high density counts, generally in excess of 15,000 cts/ml, occurred during July in the Spoon, Sangamon, and LaMoine Rivers; correspondingly high counts occurred in the Mackinaw River during August. In addition to the major bloom species of *C. meneghiniana, C. ellipsoidea,* and *N. cryptocephala,* which occurred in all streams, the blue-green *A. flos-aquae* occurred in significant quantities only in the Mackinaw River.

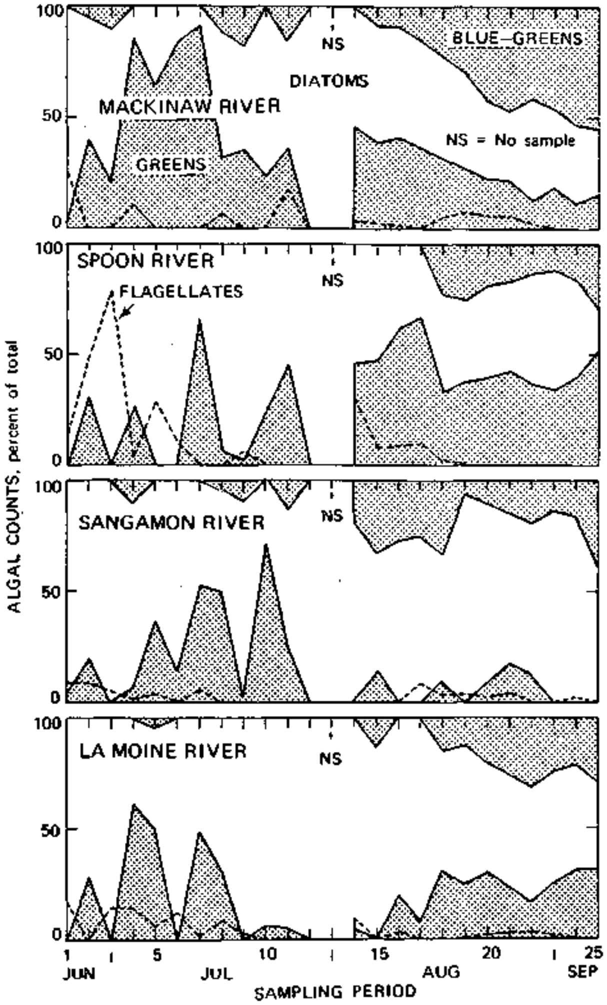


Figure 15. Variation in algal types, tributaries to Illinois River, 1979

The variations detected in the composition of the algal populations recovered from tributary waters are shown in figure 15. In terms of algal composition, the Mackinaw River is not the typical diatom stream of the Midwest. Greens predominated during July, though counts were not excessive (see table 16) , and the composition appears to be about evenly divided between greens, diatoms, and blue-greens during August (see table 18). In the other three tributaries diatoms - i.e., *C. meneghiniana* and *N. cryptocephala* - were generally the predominant organisms. However, during a period of "normal" density during August in the Spoon River, green algae combined with blue-greens were dominant.

Discussion

The art of establishing definitive relationships between algal populations and the physical and chemical characteristics of their aquatic habitat is more advanced for lake environments than for flowing streams. For many years there was much discussion as to whether or not running water supports a truly planktonic community. True plankters are normal constituents of lakes and ponds. These organisms are free-floating and can reproduce in that state. Table 19 lists the genera of algae commonly accepted as true plankters.

Table 19. Planktonic Genera

Diatoms	Flagellates
1. Asterionella	1. Cryptomonas
2. Tabellaria	2. Mallomonas
3. Fragilaria	3. Chlamydomonas
4. Melosira	4. Trachelomonas
5. Cyclotella	5. Euglena
6. Casconodiscus	6. Svnura
7. Stephanodiscus	7. Ceratium
Greens	Blue-greens
1. Scenedesmus	1. Gomphasphaeria
2. Ankistrodesmus	2. Aphanizomenon
3. Pediastrum	3. Anacystis
4. Chlorella	4. Anabaena
	5. Lyngbya

In contrast to suspended algae are those organisms that require "attachment" in order to reproduce. They may seek attachment on mud (epipelic), stones or similar objects (epilithic), or aquatic plants (epyphtic). Algae representative of mud or bottom origins are mostly diatoms and include *Navicula* spp., *Nitzschia* spp., *Surirella* spp., *Coloneis* spp., *Gyrosigma* spp., *Snyedra* spp., and *Diatoma* spp. These organisms are commonly referred to as "benthic algae". Their recovery in suspension in water is dependent upon their prior dislodgment from their bottom habitat.

The dominant diatoms recovered from the Illinois River and the four tributaries as part of this study included the true plankter *Cyclotella meneghiniana* and the benthic alga *Navicula cryptocephala.* Both of these species are widely distributed in Illinois waters. *C. meneghiniana* reproduces in eddies and backwaters and recolonizes continuously in stream flow. *N. cryptocephala* is often recovered in suspension despite the fact that its reproductive habitat is mud.

The blue-green alga *Aphanizomenon flos-aquae* is not commonly found in very large numbers in Illinois streams. The plankter often occurs in Illinois lakes and backwaters in bloom proportion during summer months.

The green alga *Chlorella ellipsoidea,* a planktonic organism, generally is found in Illinois lakes and slower moving streams.

The organisms, all common to the Illinois River and found in substantial quantities during this study, suggest two conclusions: (1) the. Illinois River displays the physical characteristics of a river-lake hybrid, and (2) its algal population is derived from a combination of the in-stream growth of planktonic forms and the import of organisms from benthic communities.

Another compounding factor that must influence the algal population of the 86-mile reach of the Illinois River is backwater lakes. This reach of the river is bordered by about 6500 acres of backwater lakes whose water levels are completely controlled by the pool elevation of the river. That is, these lakes are interconnected with the river at normal pool elevations, and consequently inflows to them or outflows from them are a function of river stage. The biological influence of these bodies of water on the river quality, though not yet quantified, can not be discounted.

Several unexpected events related to algal density, types, and composition occurred at some sampling locations and within a well-defined reach of the study area. These included:

1) Exceedingly high algal densities on more than one occasion at 5 of the 12 river stations, including the 24-mile reach between MP 145.5 and MP 121.1.

2) Sporadic densities of blue-green algae at MP 145.5 compared to rather constant occurrences and densities of blue-greens upstream, downstream, and in the Mackinaw River flowing in the river a short distance above MP 145.5.

3) The disappearance of *N. cryptocephala* at MP 113.3 in six consecutive sampling events despite concurrent detection of the organism upstream of the station, and the disappearance of the organism at MP 106.9 on eleven consecutive sampling events despite its continuing occurrence in substantial concentrations at the next downstream station during the same time period.

4) The occurrence of blue-green blooms in the Mackinaw River.

The occurrences and densities of excessive algal concentrations, including blue-green algae, at the five stations are summarized in table 15. and depicted in figure 7. The influence of the Mackinaw River can be discounted as an influence on the 24-mile stretch because the station downstream from its confluence with the pool (MP 145.5) did not reflect the magnitude or type of algal densities observed within the reach further downstream. A review of navigation charts indicates that the 24-mile reach of the river is bordered by drainage and levee districts. Presumably pumpage from the districts occurs at some point when river stages exceed a particular elevation. Around August 13 the river stage as measured at Havana was 433.0, or about 4 feet above normal. It continued to rise until it reached a stage of 437.4 (about 8.4 feet above normal pool) on August 27. It would not be unrealistic to assume that during this time period, which is coincident with the high densities of algae, including blue-greens, in the 24-mile stretch, pumps for the drainage districts were discharging impounded fertile water from the low bottoms into the river. The chemical and biological characteristics of district pumpage have not been examined. It is probable, however, that its influence on the river system is measurable. As for the two upstream stations, MP 166.1 and MP 162.8, the algal population and its composition is no doubt governed by Peoria Lake.

The sporadic blue-green populations at MP 145.5 (see figures 7 and 8 and table 15) compared to stations immediately upstream and downstream is difficult to explain. There are no apparent physical anomalies between it and its adjacent stations. The fact that the Mackinaw River enters the

Illinois River about 2.3 miles above the station, with occasional high densities of *A. flos-aquae* during August 7 to August 20 (see table 18), only compounds the mystery.

The disappearance of *N. cryptocephala* at MP 113.3 and MP 106.9 (see figure 9) may be expiained by the configuration of the river and the adjoining topographical features in that area. As suggested by figure 16, it is likely that, within the 6.4-mile reach between the two stations, substantial flow in the Illinois River may, under certain hydraulic conditions, course its way through Bath Chute. This is likely to happen during high flows. High flow did occur during the previously related disappearance of *Navicula cryptocephala* (11,200 cfs to 26,300 cfs). Whether or not this hypothesis is correct, this situation does point up the fact that the influence of flow patterns is a consideration in the selection of sampling locations on the Illinois River. Another facet of this will be discussed shortly.

The fact that the algal population of the Mackinaw River near its confluence with the Illinois River is not representative of the diatom-type normally characterizing Illinois streams is most likely due to the existence of upstream impoundments on that stream's watershed. Two bodies of water located on the watershed, Lake Bloomington and Lake Evergreen, serve as

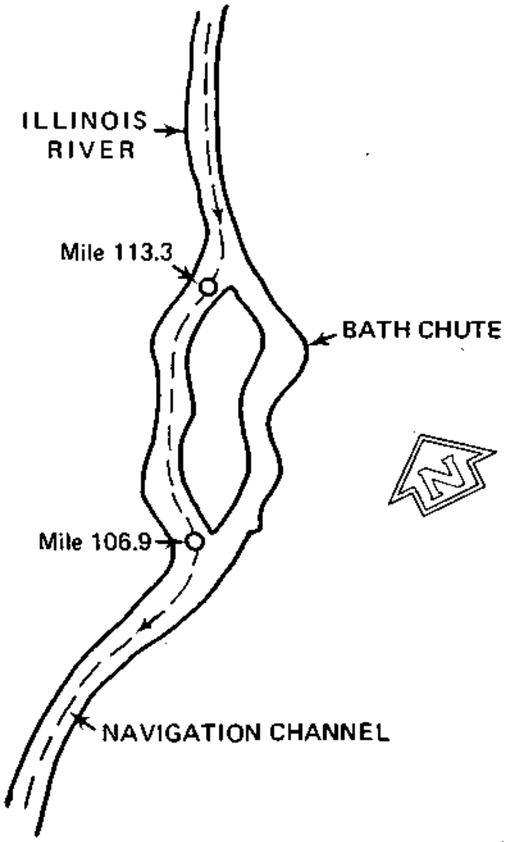


Figure 16. Relationship of Bath Chute to navigation channel of Illinois River

sources of public water supplies. Previous sampling projects on the Mackinaw River have detected the frequent occurrence of blue-green algae in its waters.

The sampling techniques and the selection of sampling stations may have contributed to some of the unexpected algal events at certain areas within the river during this study. As mentioned earlier, samples for algal examination were obtained at the 3-foot depth. On one occasion samples were collected at the water surface as well as the 3-foot depth for comparative purposes. The results are shown in table 20. When the surface sample and the 3-foot sample are compared for each milepoint, it appears that at milepoints 106.9, 145.5, and 162.8 the relationship for each algal species between the two separate points of sampling is acceptable. However, at MP 166.1 the results leave something to be desired. This location is at the Narrows separating Upper Peoria Lake from Lower Peoria Lake. It is a constriction within the waterway that must produce varying currents and velocities alien to the lake system. For algae collections, depth selection at this station is critical; its reliable use for algal collection is suspect.

On another occasion samples were collected on a cross section in the vicinity of MP 106.9. As shown in figure 16, this station is at the confluence of Bath Chute and the Illinois River; also, it is located on a curvature of the main stream. The sample was collected during flows of about 15,000 cfs. The results are shown in table 21. It is quite obvious that under certain flow regimes and physical configurations the sampling for algae recovery at multiple points on the cross section is essential.

Table 20. Comparison of Algal Samples: Surface vs 3-Foot Depth

	Milepoint							
	106.9		145.5		162.8		166.1	
Algal species	s	3'	S	3'	S	3'	S	3'
Aphanizomenon flos-aquae	583	636	386	312	15,277	12,600	10,027	848
Anacystis cyanea	535	689	774	471	10,290	6,825	8,715	742
Cyclotella meneghiniana	243	323	265	355	3,202	2,415	3,150	164
Euglena viridis	16	84	101	47	0	0	0	58
Navicula cryptocephala	0	0	360	270	6,090	5,197	4,252	524

Note: S = surface

Table 21. Algae Recovered from Cross Section near MP 106.9,
September 5, 1979

Algal species	Main channel 3'	Main channel surface	East bank surface	West bank surface
Aphanizomenon flos-aquae	636	583	323	7,717
Anacvstis cvanea	689	535	164	10,815
Cvclotella menechiniana	323	243	376	2,678
Euglena viridis	84	16	148	1,102

Summary

The succession of dominant algal species from June to September 1978, in chronological order, was *Cyclotella meneghiniana, Navicula cryptocephala,* and *Aphanizomenon flos-aquae. Cyclotella* was the dominant alga in terms of frequency (98 percent). In terms of density, *Navicula* succeeded *Cyclotella* as the dominant alga at almost all sampling stations in the main channel of the Illinois River by August.

In the tributaries the algal succession was similar but less distinct. While *Cyclotella* and *Navicula* were dominant, they occurred interchangeably throughout most of the sampling season. Only in the Mackinaw River did *Aphanizomenon* appear with the same frequency and density as in the Illinois River. *Chlorella ellipsoidea* occurred more often in the tributaries (60 percent) than in the main channel (8 percent).

Bloom densities of *Navicula* and *Aphanizomenon* occurred coincidently during August and September. The major number of these blooms were at milepoints 166.1 and 162.8 in Lake Peoria and at milepoints 139.0, 129.5, and 121.1 near Havana. These locations in the main channel are influenced by Lake Peoria and the backwater lakes and by drainage district pumping stations near Havana.

Consecutive absences of *Aphanizomenon* at MP 145.5 were recorded during early August, while sampling stations upstream and downstream had continuous populations and even blooms. Also, the eleven consecutive absences of *Navicula* at MP 106.9 and the six consecutive absences at MP 113.3 during August and September are very unusual, since *Navicula* was the dominant diatom at all other channel stations. Simultaneously with the disappearance of *Navicula* at MP 113.3, *Chlorella ellipsoidea* appeared in the same six sample events. This green alga was not common to the Illinois River. While there is no obvious reason for the disappearance of *Aphanizomenon,* the disappearance of *Navicula* is believed to be associated with the diversion of high flows through Bath Chute.

BENTHIC MACROINVERTEBRATES

A useful procedure in evaluating a riverine ecosystem is to examine benthic macroinvertebrate populations. Aquatic macroinvertebrates are defined as animals visible to the unaided eye and capable of being retained by a U.S. Standard No. 30 mesh sieve. These organisms are usually numerous and easily collected, and they often have a life cycle of a year or more. Benthic macroinvertebrates, being relatively stationary, tend to reflect the minimum environmental quality conditions at a given point in a stream. Fish, plankton, bacteria, and water samples tend to reflect environmental quality at a station at a particular moment. The standing macroinvertebrate community tends to represent the long-term summation of the physical and chemical aquatic environment. Disturbance of this community by poor water quality or by alterations to the benthic habitat may be detected by benthic sampling.

Methods

Sixteen benthic transect stations with three sampling points on each transect were sampled for macroinvertebrates. For each sampling transect, sampling point A was at a depth of 2 feet, sampling point B was at a depth of one-half the maximum channel depth, and sampling point C was at the maximum channel depth. Each sample consisted of three composited grab samples collected with a ponar dredge at each sampling point. Collections were made at each sampling point on three separate occasions. The abundance of macroinvertebrates, and the stream classifications based on Illinois Environmental Protection Agency (IEPA) procedures are tabulated in tables 22, 23, and 24 for the samples collected during July, September, and November, 1979, respectively.

Sample collection was facilitated by the use of a motorized winch and sorting table with a sieve mounted at the overflow. The general substrate type of each sample was noted in the field (see table 25), after which each sample was washed in a U.S. Standard No. 30-mesh sieve bucket and preserved in 95 percent ethyl alcohol.

In the laboratory the organisms were picked from the bottom sediments, identified, counted, and preserved.

The cumulative knowledge and experience of aquatic biologists have made possible the rating of aquatic organisms as to their pollution tolerance. Similarly, the rating of a benthic community's ecological balance has been formulated based on this accumulated knowledge. In this study a slight modification of the IEPA's stream classification system was utilized (Tucker and Ettinger, 1975). Point values have been assigned to each stream classification category so that mean values can be obtained. The general outline of the procedure involved is discussed below.

The tolerance status categories for aquatic macroinvertebrates found in Illinois waters are:

Table 22. Benthic Macroinvertebrate Abundance (number/m^2) and IEPA Stream Classifications of Benthic Sampling Stations (July Collection)

IEPA organism classification	Benthic station River mile Transect sampling point	1 157.1 A	 D	 C	2 152.5 A	 B	 C	3 145.8 A	 D	 C	4 140.0 A	 B	 C
	Taxa												
Intolerant	*Isonychia*												
	Nyctiophylax moestus						13						
	Truncilla donaciformis												
Moderate	*Cheumatopsyche*						64	13	364				
	Hydropsyche orris								64				
	Sphaerium												
Facultative	*Caenis*								6				
	Hexagenia limbata												
	Palpomyia												
	Pentagenia vitticera												
	Tricorythodes												
Tolerant	*Branchiura sowerbyi*											6	
	Chaoborus				6							13	
	Chironomidae	6			89	19	6	19	6		45	185	
	Gomphus												
	Hirudinea						13					13	
	Tubificidae		19	32	89	26	19	57	6	6		38	19
	Total number of individuals	6	19	32	184	45	115	89	446	6	45	255	19
	Total number of taxa	1	1	1	3	2	5	3	5	1	1	5	1
	IEPA stream classification	P	P	P	P	P	UB	SP	SP	P	P	P	P
	Assigned point value	4	4	4	4	4	2	3	3	4	4	4	4

IEPA organism classification	Benthic station River mile Transect sampling point	5 135.7 A	 B	 C	6 131.0 A	 B	 C	7 127.4 A	 B	 C	8 119.6 A	 B	 C
	Taxa												
Intolerant	*Isonychia*												
	Nyctiophylax moestus											6	
	Truncilla donaciformis												
Moderate	*Cheumatopsyche*		83									6	51
	Hydropsyche orris												
	Sphaerium							6				6	
Facultative	*Caenis*											6	
	Hexagenia limbata												
	Palpomyia												
	Pentagenia vittigera												
	Tricorythodes												
Tolerant	*Branchiura sowerbyi*												
	Chaoborus	19						6					
	Chironomidae	19	89		51	19	6	128	6	13	70	64	6
	Gomphus									6			
	Hirudinea												
	Tubificidae	38	6	13	51	19	38	102	38	268	57	32	51
	Total number of individuals	76	178	13	102	38	44	242	44	287	127	120	108
	Total number of taxa	3	3	1	2	2	2	4	2	3	2	6	3
	IEPA stream classification	P	SP	P	P	P	P	SP	P	P	P	SP	SP
	Assigned point value	4	3	4	4	4	4	3	4	4	4	3	3

Table 22. Concluded

IEPA organism classification	Benthic station River mile Transect sampling point		9 115.0			10 110.2			11 105.6			12 97.0	
		A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	*Isonychia*												
	Nyctiophylax moestus												
	Truncilla donaciformis		6										
Moderate	*Cheumatopsyche*		102			51		6	159			89	108
	Hydropsyche orris		70						26				13
	Sphaerium		38		6	38			6		13	32	
Facultative	*Caenis*												
	Hexagenia limbata		6										
	Palpomyia												
	Pentagenia vittigera												
	Tricorythodes		6										
Tolerant	*Branchiura sowerbyi*		6								6		6
	Chaoborus												
	Chironomidae	6	281		32	281		45	140		51	772	32
	Gomphus								6				
	Hirudinea												
	Tubificidae	26	19		45	6	57	83	19	13	19		
	Total number of individuals	32	534	0	83	376	57	134	356	13	89	893	159
	Total number of taxa	2	9	0	3	4	1	3	6	1	4	3	4
	IEPA stream classification	P	SP	BA	SP	SP	P	SP	SP	P	SP	SP	SP
	Assigned point value	4	3	5	3	3	4	3	3	4	3	3	3

IEPA organism classification	Benthic station River mile Transect sampling point		13 93.3			14 87.8			15 83.7			16 80.3	
		A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	*Isonychia*												6
	Nyctiophylax moestus												
	Truncilla donaciformis												
Moderate	*Cheumatopsyche*		19					6	6	115			6
	Hydropsyche orris									77			
	Sphaerium		6	6		6		6	6	45	57	26	19
Facultative	*Caenis*												
	Hexagenia limbata												
	Palpomyia						6						
	Pentagenia vittigera							51	96	6	26		19
	Tricorythodes												
Tolerant	*Branchiura sowerbyi*				19			19	6		26		6
	Chaoborus				6	6					19		
	Chironomidae	19	13		344	57		210	6	166	108	38	32
	Gomphus												
	Hirudinea												
	Tubificidae	6	6		389	96			19		153	13	19
	Total number of individuals	25	44	6	758	165	6	292	139	409	389	77	107
	Total number of taxa	2	4	1	4	4	1	5	6	5	6	3	7
	IEPA stream classification	P	SP	SP	P	SP	SP	SP	SP	SP	SP	SP	SP
	Assigned point value	4	3	3	4	3	3	3	3	3	3	3	3

Table 23. Benthic Macroinvertebrate Abundance (number/m^2) and IEPA Stream Classifications of Benthic Sampling Stations (September Collection)

IEPA organism classification	Benthic station	1			2			3			4		
	River mile	157.1			152.5			145.8			140.0		
	Transect sampling point	A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	*Nyctiophylax moestus*						32		13			6	
	Proptera laevissima												
	Stenonema						13		6				
Moderate	*Cheumatopsyche*						45		60			19	13
	Empididae												6
	Hydropsyche orris												
	Sphaerium				6								
Facultative	*Dubiraphia*												
	Hexagenia limbata												
	Oecetis												
	Palpomyia								6				
	Pentagenia vittigera							19			13		
Tolerant	*Branchiura sowerbyi*										6		
	Chaoborus					13							
	Chironomidae	262	108	89	153	198	83	159	13	13	734	32	19
	Gomphus												
	Hirudinea											13	
	Tubificidae	51	26		83	134	6	13	19	6	26	6	13
	Total number of individuals	313	134	89	242	345	179	191	117	19	779	76	51
	Total number of taxa	2	2	1	3	3	5	3	6	2	4	5	4
	IEPA stream classification	P	P	P	SP	P	UB	SP	UB	P	SP	SP	SP
	Assigned point value	4	4	4	3	4	2	3	2	4	3	3	3

IEPA organism classification	Benthic station	5			6			7			8		
	River mile	135.7			131.0			127.4			119.6		
	Transect sampling point	A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	*Nyctiophylax moestus*			6	13					6			13
	Proptera laevissima												
	Stenonema												
Moderate	*Cheumatopsyche*					6			70	13			242
	Empididae												
	Hydropsyche orris						6		32				
	Sphaerium							6	6				13
Facultative	*Dubiraphia*												
	Hexagenia limbata										6		
	Oecetis												
	Palpomyia												
	Pentagenia vittigera												
Tolerant	*Branchiura sowerbyi*					6							
	Chaoborus					13	26			6	6	77	
	Chironomidae	32	13	60	57	13	19	108	389	51	6	13	102
	Gomphus			6								6	
	Hirudinea												
	Tubificidae	26	6		19	19	19	19	26	13	121		19
	Total number of individuals	58	19	72	89	57	70	133	523	89	139	96	389
	Total number of taxa	2	2	3	3	5	4	3	5	5	4	3	5
	IEPA stream classification	P	P	SP	UB	SP	SP	SP	SP	SP	SP	P	SP
	Assigned point value	4	4	3	2	3	3	3	3	3	3	4	3

Table 23. Concluded

IEPA organism classification	Benthic station	9			10			11			12		
	River mile	115.0			110.2			105.6			97.0		
	Transect sampling point	A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	Nyctiophylax moestus					51			45	6	13		
	Proptera laevissima										6		
	Stenonema												
Moderate	Cheumatopsyche		6			70			134	13	6		
	Empididae												
	Hydropsyche orris								6				6
	Sphaerium		13		6	26		6	51		38	13	
Facultative	Dubiraphia								13				
	Hexagenia limbata												
	Oecetis												
	Palpomyia							6					6
	Pentagenia vittigera					6		6	51				
Tolerant	Branchiura sowerbyi	6						6		6			13
	Chaoborus												
	Chironomidae	6	26	19	6	300	19	147	1097	26	96	338	13
	Gomphus	6							6				
	Hirudinea												
	Tubificidae	19	70	6			19	32	45	6		19	26
	Total number of individuals	37	115	25	12	453	38	203	1448	57	159	370	64
	Total number of taxa	4	4	2	2	5	2	6	9	5	5	3	5
	IEPA stream classification	P	SP	P	SP	UB	P	SP	SP	UB	UB	SP	SP
	Assigned point value	4	3	4	3	2	4	3	3	2	2	3	3

IEPA organism classification	Benthic station	13			14			15			16		
	River mile	93.3			87.8			83.7			80.3		
	Transect sampling point	A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	Nyctiophylax moestus	6	26				6			19			
	Proptera laevissima												
	Stenonema												
Moderate	Cheumatopsyche		83				26			128		13	
	Empididae												
	Hydropsyche orris									6			
	Sphaerium	45	38					32	96	30	19	32	32
Facultative	Dubiraphia												
	Hexagenia limbata				51			121			57	13	6
	Oecetis												6
	Palpomyia												
	Pentagenia vittigera							6	140			83	
Tolerant	Branchiura sowerbyi							6	6	6	13	13	6
	Chaoborus					13	45		13		6	13	13
	Chironomidae	51	57	6	102	153	13	51	83	57	108	26	
	Gomphus							6	6			13	6
	Hirudinea										6		
	Tubificidae				32	89	26	57	26	32	325	77	19
	Total number of individuals	102	204	6	185	255	116	279	370	286	534	283	88
	Total number of taxa	3	4	1	3	3	5	7	7	7	7	9	7
	IEPA stream classification	SP	UB	P	SP	P	SP	SP	SP	SP	SP	SP	SP
	Assigned point value	3	2	4	3	4	3	3	3	3	3	3	3

Table 24. Benthic Macroinvertebrate Abundance (number/m^2) and IEPA Stream Classifications of Benthic Sampling Stations (November Collection)

IEPA organism classification	Benthic station	1			2			3			4		
	River mile	157.1			152.5			145.8			140.0		
	Transect sampling point	A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	*Nyctiophylax moestus*												
	Stenonema												
Moderate	*Argia*												
	Cheumatopsyche												
	Empididae												
	Hydropsyche orris												
	Sphaerium				6					6		13	
Facultative	*Caenis*												
	Corbicula manilensis								6				
	Hexagenia limbata												
	Palpomyia												
	Pentagenia vittigera												
	Stenelmis												
Tolerant	*Branchiura sowerbyi*					6					6		
	Chaoborus				6								
	Chironomidae	13	32		6		13	6	26	19	115	19	
	Gomphus								6		6		
	Hirudinea											6	
	Tubificidae	45	236	13	198	281		96	147	77	89	19	6
	Total number of individuals	58	268	13	216	287	13	102	185	108	216	57	6
	Total number of taxa	2	2	1	4	2	1	2	4	4	4	4	1
	IEPA stream classification	P	P	P	SP	P	P	P	SP	SP	P	SP	P
	Assigned point value	4	4	4	3	4	4	4	3	3	4	3	4

IEPA organism classification	Benthic station	5			6			7			8		
	River mile	135.7			131.0			127.4			119.6		
	Transect sampling point	A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	*Nyctiophylax moestus*									6			
	Stenonema												
Moderate	*Argia*												
	Cheumatopsyche									6			
	Empididae												
	Hydropsyche orris												
	Sphaerium									6			19
Facultative	*Caenis*												
	Corbicula manilensis												
	Hexagenia limbata											6	
	Palpomyia						6		6				
	Pentagenia vittigera					6							
	Stenelmis												
Tolerant	*Branchiura sowerbyi*				6				45		6	13	6
	Chaoborus					6			38			19	
	Chironomidae	32	13		6	6	19	6	64	26	26	57	140
	Gomphus										6		
	Hirudinea												
	Tubificidae	179	38	6	159	293	45	255	140	128	408	269	485
	Total number of individuals	211	51	6	171	311	70	261	293	172	446	363	650
	Total number of taxa	2	2	1	3	4	3	2	5	5	4	5	4
	IEPA stream classification	P	P	P	P	SP	SP	P	SP	SP	P	SP	SP
	Assigned point value	4	4	4	4	3	3	4	3	3	4	3	3

Table 24. Concluded

IEPA organism classification	Benthic station	9			10			11			12		
	River mile	115.0			110.2			105.6			97.0		
	Transect sampling point	A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	*Nyctiophylax moestus*			32		6							
	Stenonema								6				
Moderate	*Argia*			6									
	Cheumatopsyche			38		13			19	6			
	Empididae			6									
	Hydropsyche orris			6									
	Sphaerium				26			6	13		13	6	
Facultative	*Caenis*							6					
	Corbicula manilensis												
	Hexagenia limbata	6						6			6		
	Palpomyia		6			6	6	13	13				
	Pentagenia vittigera	13											
	Stenelmis			6							6		
Tolerant	*Branchiura sowerbyi*	45	89	6					13	6			
	Chaoborus		19	6		13				6		6	
	Chironomidae	77	38	179		70	13	96	128	13	619	434	
	Gomphus	6											
	Hirudinea												
	Tubificidae	306	147	13	147	236	26	313	38	13	115	83	6
	Total number of individuals	453	299	298	173	344	45	440	230	44	759	529	6
	Total number of taxa	6	5	10	2	6	3	6	7	5	5	4	1
	IEPA stream classification	SP	SP	UB	SP	SP	SP	SP	SP	SP	SP	SP	P
	Assigned point value	3	3	2	3	3	3	3	3	3	3	3	4

IEPA organism classification	Benthic station	13			14			15			16		
	River mile	93.3			87.8			83.7			80.3		
	Transect sampling point	A	B	C	A	B	C	A	B	C	A	B	C
	Taxa												
Intolerant	*Nyctiophylax moestus*		6	6									
	Stenonema		13										
Moderate	*Argia*												
	Cheumatopsyche		32										13
	Empididae												
	Hydropsyche orris												
	Sphaerium		6				13	19	19	57			6
Facultative	*Caenis*												
	Corbicula manilensis												
	Hexagenia limbata					51		19		19	45		19
	Palpomyia					6	13	6	19	6	6		
	Pentagenia vittigera					6							
	Stenelmis			6									
Tolerant	*Branchiura sowerbyi*		19	6	6	19	13	191	172	64	96	45	115
	Chaoborus					19			6	108	6	51	166
	Chironomidae	38	134	13	57	45	102	204	230	83	230	102	147
	Gomphus								6	6		6	
	Hirudinea												
	Tubificidae	57	19		1059	313	57	376	45	472	57	306	128
	Total number of individuals	95	229	31	1122	459	198	815	497	815	440	510	594
	Total number of taxa	2	7	4	3	7	5	6	7	8	6	5	7
	IEPA stream classification	P	SP	UB	P	SP	SP	SP	SP	SP	SP	P	SP
	Assigned point value	4	3	2	4	3	3	3	3	3	3	4	3

Table 25. Generalized Substrate Type at Benthic Sampling Stations

Mile-point	Sta. no.	Bank side* sampled	Sampling point A	B	C
157.1	1	R	Sand, black clay	Sand, shells	Sand
152.5	2	R	Silt, black clay	Silt, black clay	Sand, shells
145.8	3	L	Sand, tan gray clay	Sand, shells	Sand
140.0	4	L	Tan gray clay, sand	Sand, shells	Sand, shells
135.7	5	L	Sand, silt	Sand	Sand
131.0	6	L	Tan gray clay, sand	Sand, tan gray clay	Sand
127.4	7	L	Tan gray clay	Silt, tan gray clay	Sand
119.6	S	R	Silt	Silt, tan gray clay	Sand, shells
115.0	9	R	Tan gray clay, silt	Silt, tan gray clay	Sand
110.2	10	L	Tan gray clay	Tan gray clay	Sand, shells
105.6	11	L	Tan gray clay	Tan gray clay	Sand, shells
97.0	12	R	Tan gray clay, silt	Tan gray clay	Sand, shells
93.3	13	L	Tan gray clay	Tan gray clay	Sand, shells
87.8	14	L	Silt	Silt, sand	Sand
83.7	15	L	Tan gray clay	Tan gray clay, sand	Sand, tan gray clay
80.3	16	L	Tan gray clay	Tan gray clay, sand	Sand, tan gray clay

* Looking downstream

Intolerant: organisms whose life cycle is dependent upon a narrow range of environmental conditions. They are rarely found in areas of organic enrichment and are replaced by more tolerant species upon degradation of their environment.

Moderate: organisms which lack the extreme sensitivity to environmental stress displayed by intolerant species but which cannot adapt to severe environmental degradation. Such organisms normally increase in abundance with slight to moderate levels of organic enrichment.

Facultative: organisms which display the ability to survive over a wide range of environmental conditions and which possess a greater degree of tolerance to adverse conditions than either intolerant or moderate species. The facultative tolerance status also includes all organisms which depend upon surface air for respiration.

Tolerant: organisms which not only have the ability to survive over a wide range of environmental extremes but which are generally capable of thriving in water of extremely poor quality and even anaerobic conditions. Such organisms are often found in great abundance in areas of organic pollution.

The stream environments at the sampling stations on the Illinois Waterway were classified according to the following point system:

	Assigned point value
Balanced (B): intolerant organisms are many in number and species, or more in number than other forms present. (Intolerant present ≥ 50%; moderate, facultative, and tolerant usually present ≤ 50%.)	1

	Assigned point value
Unbalanced (UB): intolerant organisms are fewer in number than other forms combined, but combined with moderate forms, they usually outnumber tolerant forms. (Intolerant present < 50% but ≥ 10%; moderate, facultative, and tolerant usually present > 50%.)	2
Semi-polluted (SP): intolerant organisms are few or may not be present. Moderate and/or facultative organisms are present. (Intolerant present < 10%; moderate, facultative, and tolerant usually present > 90%.)	3
Polluted (P): intolerant organisms absent, only tolerant organisms present or no organisms present. (Tolerant present 100%.)*	4
Naturally or artificially bare area (BA).	5

* Organisms which are not adapted to inhabit a polluted environment are occasionally collected as a result of factors produced by the drift and are not representative.

Results

Sixteen stations, spaced approximately five river miles apart, were sampled for benthic macroinvertebrates in the LaGrange pool. Twenty-five different taxa were found in the 144 samples analyzed. The benthic community was composed mainly of Chironomidae (40 percent), Tubificidae (36 percent)/ *Cheumatopsyche* (7 percent), and *Sphaerium* (4 percent).

The mean density of individuals was $220/m^2$, the mean number of taxa was 3.8, and the mean IEPA rating for the LaGrange pool was 3.3. The observed mean values for each sampling period are shown in table 26. The increase in both density and kinds of organisms from the July to November collection may be due to the reestablishment of the benthic community from the near record river stages in spring 1979.

Table 26. Benthic Macroinvertebrate Seasonal and Sample Means (Arithmetic)

Collection	Mean # indiv/m^2/sample	Mean # taxa/sample	Mean IEPA point value/sample
July	162	3.1	3.5
September	208	4.1	3.1
November	291	4.1	3.3
All samples	220	3.8	3.3

The variability of individual samples in this study is illustrated by the fact that the highest (10) and lowest (0) number of taxa in a sample were found at station 9C during November and July collections, respectively. For this reason, mean values were relied on as much as possible. In the September collection, station 11B had the densest (1448/m^2) population. No organism was found at station 9C in the July collection.

Discussion

In some rivers or sectors of some rivers, the dissolved oxygen concentration does not always play a key role in governing the macroinvertebrate community characteristics. Figure 17 depicts the mean values for the dissolved oxygen concentration and I E P A rating at each of the benthic macroinvertebrate sampling stations. The mean dissolved oxygen concentrations showed an almost uniform reduction of about 1 mg/l from station 1 to station 16. The IEPA rating improved from a point value of 4.0 (polluted) to an approximate value of 3.0 (semi-polluted) at the same stations. In this study, the lowest observed dissolved oxygen concentration was 4.0 mg/l.

The mean values for the number of taxa and individuals per square meter are shown in figure 18 for each benthic sampling station. The mean number of taxa per sample was about 4.5 times greater at station 16 than at station 1. The mean number of individuals per square meter in each sample was more than 3 times greater at station 16 than at station 1. There is an improvement in IEPA ratings, and an increase in the number of taxa and density of individuals with downstream movement in the pool. This improvement in the quality of the benthic community is countered by a slight but constant decline in dissolved oxygen levels.

The very close agreement in variation between the number of taxa and population densities suggests that organic pollution is not the controlling factor in the distribution of benthic macroinvertebrates. Classically, the effect of organic pollution on the benthic community is characterized by a sharp reduction in number of taxa and a rapid rise in population density. The population density and taxa curves for the LaGrange pool are more suggestive of recovery from the effects of toxicants or habitat limitations. Only one sample out of 144 was devoid of macroinvertebrate organisms. That fact tends to eliminate toxicity as a prime consideration. This does not mean that low level chronic or selectively toxic substances are not present, especially in the upper half of the pool.

The sampling and characterization of substrate types is difficult and imprecise. Subtle changes in particle size distribution make differentiation between substrate types difficult. In the river, the substrate may change abruptly and may be found in a patchwork distribution. In spite of these limitations valuable insights can be gained from the observations of substrates identified during the study.

The mid-channel substrate samples (location C) were dominated by sand at all 16 stations (see table 25). The tan-gray clay type substrate dominated

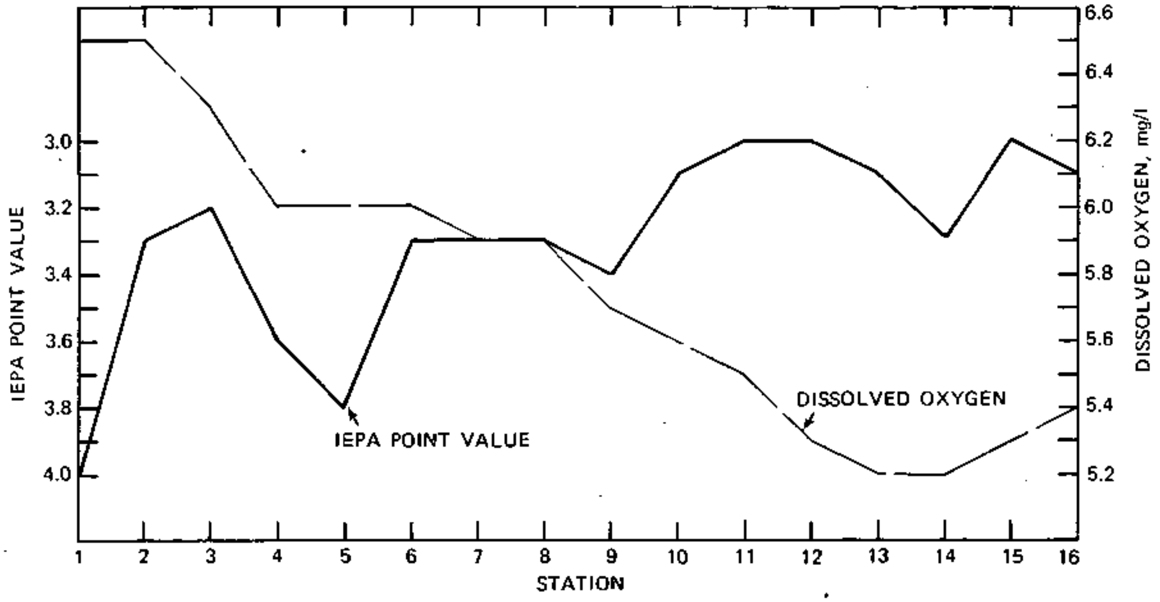


Figure 17. Study mean DO concentrations and IEPA ratings at benthic macroinvertebrate sampling stations

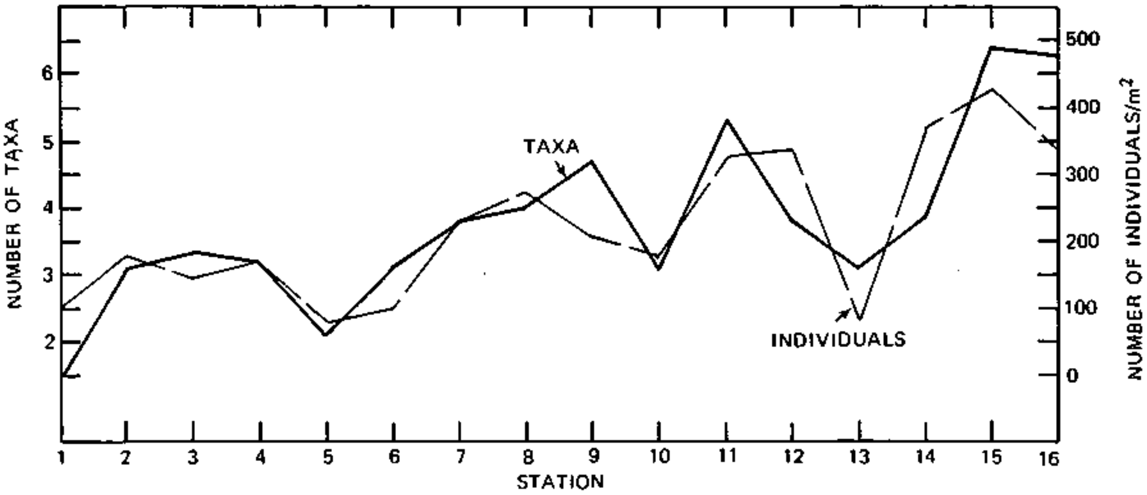


Figure 18. Mean values for number of taxa and individuals per square meter at benthic macroinvertebrate sampling stations

10 of the 2-foot stations (location A). The half maximum depth samples (location B) were equally dominated by sand, silt, and clay type substrates. The severe water turbulence in the channel caused by barge traffic presumably resuspends the channel substrate material, thereby preventing the accumulation of the smaller particle sizes. The relatively compact clays found in the shore areas seem resistant to the lesser turbulence caused by wave action. The B substrates are probably least affected by turbulence and are more variable in substrate type.

Figure 19 depicts a hypothetical half cross section of the Illinois River in the LaGrange pool, showing the lateral positions of samples taken. With a few exceptions, the "A" samples (2 feet) in the July collection were taken at locations that would be above water at normal pool stages. This lateral position is labeled I. The II position is the "A" sampling point that is always submerged at normal pool. Position III is a shallow shelf area, many feet from the shore and channel and always submerged at normal pool. All the "B" samples (one-half maximum depth) from all 3 collections were lateral position IV, and all "C" samples were considered position V.

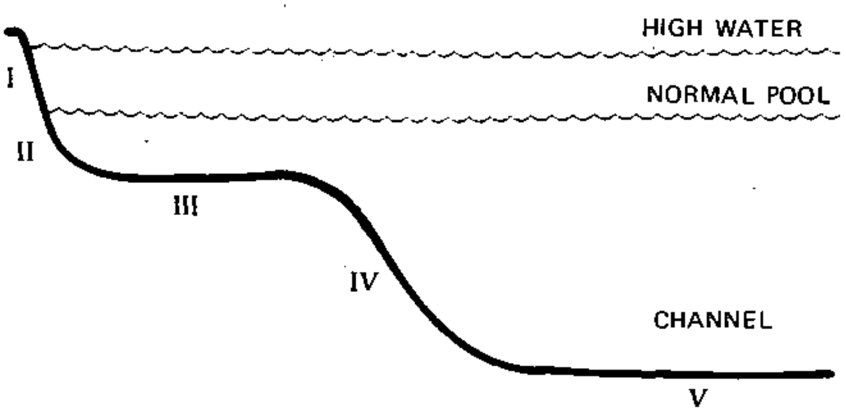
Figure 20 displays the mean values for number of taxa, individuals/m^2, and IEPA rating at each lateral position. Lateral position I had the lowest mean number of individuals/m^2 and taxa, and the worst IEPA rating. Although this position had been submerged for many months preceding the July collection, the macroinvertebrates were slow to colonize the shore areas above normal pool stages. The shallow shelf areas (position III) were the most productive in terms of number of individuals/m . The highest diversity (taxa/sample) and best IEPA rating were at the one-half maximum depth position (IV). Productivity and diversity were low at the mid-channel position.

Figure 21 depicts the mean number of taxa, number of individuals/m^2, and IEPA ratings for the various substrates encountered. Generally, the substrates that developed the highest diversity and productivity were either dominated or contained tan gray clay. Substrates containing or dominated by silt produced inconclusive results, possible due to the few samples recovered in this substrate type. Sandy substrates were generally lowest in diversity and productivity. Substrate cohesion and stability may be more important than strict substrate type in determining the nature of the benthic community. Certainly more study needs to be pursued along these lines.

Summary

1) Sixteen benthic transect stations with 3 sampling points on each transect (2 feet, one-half maximum depth and maximum depth) were each sampled in July, September, and November 1979.

2) The benthic community was composed mainly of Chironomidae (40 percent), Tubificidae (36 percent), *Cheumatopsyche* (7 percent) and *Sphaerium* (4 percent).



Lateral position

I Sample taken above normal pool
II Sample taken on incline at normal po
III Sample taken on shallow shelf
- ft samples
IV Sample taken on incline — mid-depth sample
V Sample taken at mid-channel

Figure 19. Hypothetical half cross section at Illinois River, showing lateral positions of benthic macroinvertebrate samples taken

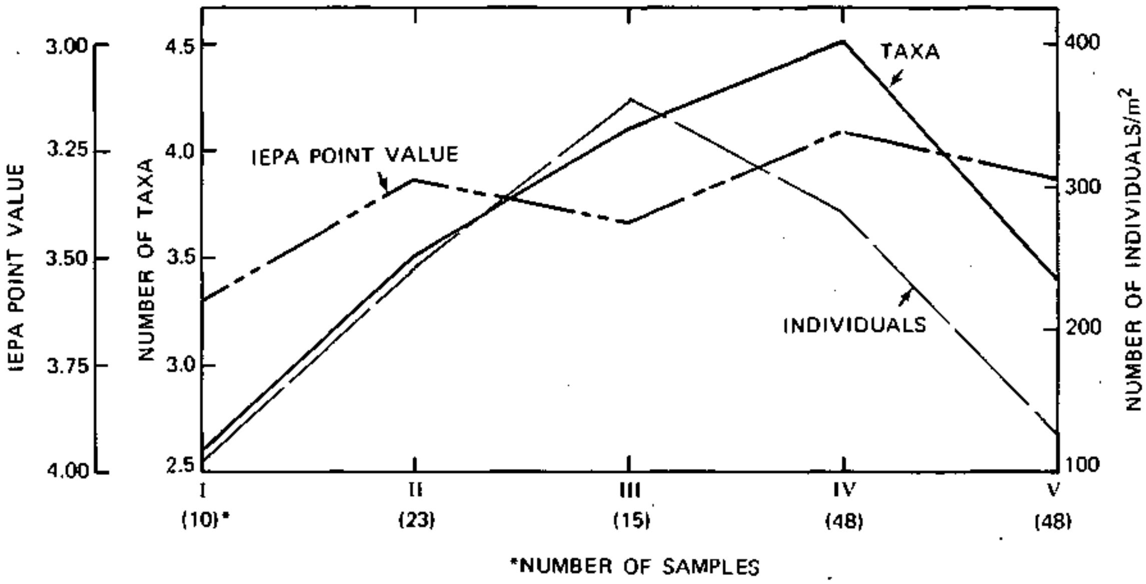


Figure 20. Mean values for number of taxa, number of individuals per square meter, and IEPA point value at lateral benthic macroinvertebrate sampling positions

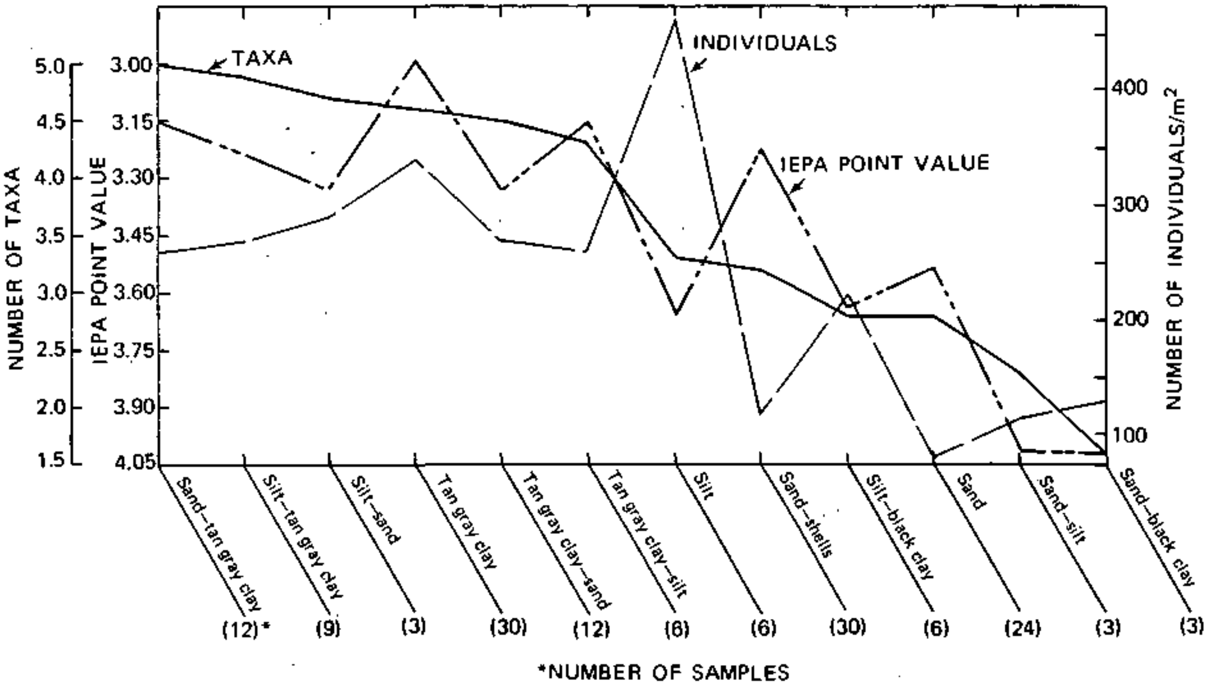


Figure 21. Mean value for number of taxa, number of individuals per square meter, and IEPA point value for substrate types

3) On the average 220 individuals/m^2 and 3.8 taxa were recovered, and an IEPA rating of 3.3 (slightly worse than semi-polluted) was determined.

4) Dissolved oxygen concentrations, within the limits observed, were not a governing factor in the distribution of the benthic macroinvertebrates. The lowest observed dissolved oxygen concentration was 4.0 mg/l. With downstream movement in the pool the benthic community improved while the mean dissolved oxygen levels declined slightly.

5) The close agreement between the number of taxa and population density suggests that toxicants at low concentrations or unfavorable habitat conditions determine the nature of the benthic community.

6) There is a tendency for sand to dominate the channel substrate and for tan gray clay to dominate the shallow areas. At the one-half depth the type of substrate is not predictable. River current, water turbulence, and wave action largely determine the substrate pattern.

7) Macroinvertebrates were slow to colonize shore areas above the normal pool level even after months of submergence. The shallow shelf areas had the densest populations, while the one-half

maximum depth had the most balanced benthic community. The channel benthos were low in diversity and density.

8) Substrates containing tan gray clay generally produced the most diverse and densest benthic community, and those containing sand produced the worst.

9) Substrate type appears to be a major limiting factor for benthic macroinvertebrate productivity in the LaGrange pool.

SEDIMENTS AND SEDIMENT OXYGEN DEMAND

Benthic sediments were collected at frequent intervals throughout the pool to document the general conditions and types of bed material that exist within the pool. The material was visually and subjectively described, and samples were analyzed in the laboratory for moisture and volatile solids content. The data were then screened and used to select broad classes of substrates appropriate for performing sediment oxygen demand (SOD) measurements and making benthos collections. Empirical procedures were used to investigate the potential relationships between SOD and several independent variables.

Sediment oxygen demand is defined broadly as the usage of dissolved oxygen in the overlying water by benthic organisms. In some instances, it could include or be the result of inorganic chemical oxidation reactions. However, under persistently aerobic conditions, such as prevail in the LaGrange pool, it results principally from biochemical oxygen demands of microorganisms and macroorganisms. The major microdemand is due to bacterial oxidation-reduction reactions; however, benthic dwelling diatoms, protozoa, and fungi respiration can be significant at times, especially in shallow streams. Macrodemand is caused by aufwuch communities (surface living organisms) and burrowing fauna. Worms, insect larvae and nymphs, leaches, and mussels are the principal burrowing types. Periphyton, or organisms which are attached to underwater substrate, represent an important source of benthic oxygen usage in some shallow streams, in some deep clear lakes, and in the littoral zones at most lakes.

Methods

Sediment samples for descriptive documentation and laboratory analyses for total solid and volatile solid content were collected at cross sections spaced on the average of 1.5 miles apart. At a given cross section samples were taken at the centerline of the navigation channel and at points midway between the channel and the right and left banks (with the banks referenced in a downstream direction). The samples were collected with a 9-inch ponar dredge which was opened onto a wide flat tray in the boat. Approximately 65 to 75 grams of sediments were obtained from the top 5 or 6. centimeters of the sediment sample when possible. where shells and large gravel predominated, the finest material in the sample was retained. The material was placed in a plastic bag, sealed with ties, and placed in a hard plastic, capped bottle.

The percent total dried solids is a general indicator of constituency, i.e., the degree of solidity or liquidity of the sediment material. It was determined by decanting the supernatant from the top of the samples after they had been refrigerated overnight. The residue was thoroughly mixed, and a portion was oven-dried at 103°C. The weight of the oven-dried residue divided by the weight of the decanted wet residue times 100 is defined as the percent dried solids. The percent of volatile solids was determined according to the American Public Health Association's *Standard Methods* (1975).

Sediment oxygen demand measurements were made *in situ* using the same static bell chamber sampler developed for use on the upper reaches of the waterway (Butts, 1974). However, some modification in operating procedure has evolved since it was first employed. The contained water is now circulated entirely within the sampler using a YSI 5795 submersible stirrer held in place by a large split collar welded to the top of the sampler. The DO-temperature probe is housed within the stirrer. The stirrer operates on five size C rechargeable nickel-cadmium batteries. The power pack and recharging system are integrated directly into the design of a YSI 57 DO meter.

A sediment sample for total solids and volatile solids analysis and a benthos sample were collected with a 9-inch ponar dredge in conjunction with running an SOD. Time constraints and the logistics involved in running a large number of SODs prohibited the taking of more than one benthos sample per SOD setting. The benthos sample was sieved through the Wildco 30-mesh bucket sieve without the benefit of salt flotation as was done during the regular benthos collection phase of this study. The DO-temperature meter was connected to a battery operated recorder to provide a continuous record of the DO usage. DO readings were manually recorded every 5 to 10 minutes as a check. Temperature readings were taken only at the beginning and at the end of a run. Two DO sampling bottles were incubated on the river bottom over the period of the SOD run to account for any planktonic respiration. Two "Winkler" DOs were run at the onset, and the incubated bottles were checked for DO at the end. Any differences which might have materialized were judged to be the result of algal respiration and were subtracted from the DO usage accounted for within the SOD chamber.

The SOD rates traced in the field are in units of milligrams per liter per minute (mg/l/min) and for convenience are converted to units of grams per square meter per day (g/m^2/day). The general conversion formula is:

$$SOD = (1440\ SV)/10^3 A \tag{4}$$

where

SOD = sediment oxygen demand, g/m^2/day

S = slope of some portion of the curve, mg/l/min

V = volume of sampler, liters

A = bottom area of sampler, m^2

The formula specific to the setup used during this study is:

$$SOD = 197.6S \tag{5}$$

Generally, this type of equation is applied to that portion of a curve which tends to be linear. Many curves, especially those generated for polluted sediments or those devoid of a large benthos biomass, evolve into a relatively straight line after the effects of initial bottom disturbances have subsided.

The ambient results produced by equation 5 are corrected to 20°C and 25°C for comparative purposes, using a modified form of the Arrhenius model. The model in generalized form as applied to SODs is:

$$SOD_T = SOD_A \quad (\theta^{T-A}) \qquad (6)$$

where

SOD_T = SOD rate at any temperature, T°C

SOD_A = SOD rate measured at a temperature A°C

θ = proportionality constant

In all previous SWS reports related to SOD (Butts, 1974; Lee et al., 1976; Butts and Sparks, 1977; Butts and Evans, 1978 and 1979; Roseboom et al., 1979) a θ-value of 1.047 was used (Velz, 1970), This figure is one that is generally accepted for use in correcting biochemical reaction rates in an aquatic environment for temperature fluctuations. Some recent studies on the effect of temperature on reaction rate changes of SOD in a natural environment suggest that θ specific to SOD is 1.085 (Walker and Snodgrass, 1979). Nevertheless a θ value of 1.047 was used for evaluation purposes in this study.

Stepwise multiple regression techniques were used to compare seven independent variables with SOD as the dependent variable. The independent variables were: 1) water depth referenced to flat pool, 2) water temperature, 3) initial DO in SOD chamber, 4) logarithms of the total number of macroorganisms, 5) logarithms of the total number of plankton, 6) percent dry solids, and 7) percent volatile solids. This analysis was made to determine if relationships exist between some readily measured physical or biological parameter and S0D. A well-defined relationship was envisioned for use in extrapolating SOD's throughout all reaches of the pool for use in the BOD-DO water quality model. Also, causal relationships, when significant, can be utilized in data interpretation relative to causes and effects.

The SODs expressed in terms of the standard areal rate units of $g/m^2/day$ can be converted to mg/l for a given segment or reach of water by the formula:

$$G' = 3.28Gt/H \qquad (7)$$

where

G' = oxygen used by sediments per reach, mg/l

G = SOD, $g/m^2/day$

t = detention time per reach, days

H = average water depth in reach, feet

This formula has been developed on the assumption that the bottom area of the water body approximates the water surface area, a valid assumption throughout the study area since the river is wide and the bottom is not irregular. This expression provides a rapid means of assessing the gross effect of SOD on flowing water under a wide variety of hydraulic and hydrologic conditions.

Results

Sediment samples were collected at 51 transects between June 21 and June 29 at a total of 153 locations. On the basis of the results of these collections, 17 sediment oxygen demand sampling stations were selected.

The SOD curves as traced in the field and the manually recorded results were interpreted and reduced to the results presented in table 27. Overall the results were good, and sufficient information was generated so that an evaluation could be made as to the relative effect SOD has on the DO resources within the pool.

Table 27. Ambient and Temperature-Corrected SOD Rates

	Station		Sediment station	Avg. temp.	Time frame	SOD g/m^2/day		
Date	No.	Milepoint	no.	(°C)	(minutes)	@ T°C	@ 20°C	@ 25°C
7/05/79	1	154.8L	6	23.3	0-7	0	0	0
				23.25	7-77	0.78	0.67	0.84
7/06	2	152.5L	9	22.1	0-31	0	0	0
				22.35	31-98	0.37	0.33	0.42
7/06	3	150.9L	12	22.65	0-63	0.94	0.83	1.05
7/06	4	148.1L		22.8	0-60	0.82	0.72	0.91
7/17	5	144.2L	24	26.65	0-70	0.85	0.62	0.79
7/17	6	140.0R	28	27.1	0-35	0.10	0.08	0.09
				27.1	35-46*	0.45	0.32	0.41
				27.1	0-60	1.15	0.83	1.05
7/18	7	134.0L	42	25.75	0-17*	0	0	0
				25.85	0-15	0.99	0.76	0.95
				25.95	15-30*	0	0	0
7/18	8	129.1L	51	26.5	0-21*	0.24	0.17	0.22
				26.5	0-25	0.79	0.59	0.74
				26.5	25-35*	0	0	0
7/18	9	127.4L	54	26.9	0-17*	0	0	0
				26.95	0-60	1.40	1.02	1.28
7/19	10	124.2L	60	25.85	0-65	0.91	0.70	0.88
7/19	11	118.0R	70	26.0	0-25*	0	0	0
				26.0	0-68	0.80	0.61	0.76
7/19	12	118.0L	72	26.05	0-65	0.S9	0.75	0.94
7/20	13	105.6L	96	26.0	0-30*	0.16	0.13	0.16
				26.8	0-27*	1.10	0.80	1.01
				26.85	0-50	1.28	0.94	1.18
				26.95	50-95	1.76	1.28	1.61
7/23	14	99.5L	108	27.2	0-67	1.09	0.78	0.99
7/23	15	95.8L	117	27.35	0-38	1.17	0.83	1.05
				27.45	38-58*	0	0	0
7/24	16	86.4R	136	27.6	0-66	0.82	0.58	0.73
7/24	17	80.3C	152	27.45	0-65	1.06	0.76	0.95

*Chamber undermined or not sealed

Note: L = left bank, R = right bank (looking downstream); C = channel; underscored values are those considered to best represent conditions at a given station

Some difficulty was encountered in the field in getting the sampling chamber sealed in the bottom, as noted in table 27. This was the result of unstable bottom conditions and unusually high flows with attendant high velocities. Extremes in sediment conditions were encountered, ranging from very hard compacted clay to loose sand, gravel, and shells. In hard clay, the cutting edge of the chamber could not penetrate to the sealing flange in some instances. This allowed river water at ambient DO levels eventually to break the seal and to enter the chamber, giving a false indication of little or no sediment oxygen consumption by the sediments. Loose sand, gravel, and shell bottom were also difficult to sample, especially in areas of high velocity. If the cutting edges were able to penetrate effectively initially, the loose material would soon erode away and the sampler would be undermined. A rapid flattening out of the recorder curve would be a clear indication that this had happened.

The situation on which results for station 13 (reported in table 27) are based is a good example of the difficulties encountered. Initially, an unsuccessful attempt was made to set up in the channel area, which had a clean fine sand-shell bottom. Only a small amount of DO usage (0.025 mg/l) appeared to have occurred in the chamber in 30 minutes, and this had occurred in an erratic way. The boat and rig were then moved close to shore; here a clean thin layer of fine sand on top of a pasty gray clay was encountered. A hard gravity drop was attempted with the sampler to penetrate the clay, but the seal appeared to have deterioated with time. As a last resort an investigator went overboard and manually forced the sampler down into the clay up to the sealing flanges. It had been sitting in a very tenuous, unlevel position on the surface of the bottom.

On the basis of the DO bottle incubations, it appears that algal respiration was not a factor influencing oxygen usage in the samples. In all cases, no significant change in DO occurred in the bottles.

The underscored values in table 27 are those which are considered to best represent the conditions at a given station. Throughout the study area a linear rate of usage was observed,indicating a bacterial demand.

The early SOD runs were made in deeper than normal water, while those near the end were conducted at nearly normal water depths. This information is summarized in table 28. Overall, a wide spectrum of depths was examined.

The results of the stepwise regression analysis are summarized in tables 29 and 30. Table 29 is a summary of the simple correlation coefficients existing between each matched set of variables; table 30 is a summary of the step additions of the seven independent variables relative to SOD rates. As shown in table 29, temperature appears to be the variable most highly correlated to SOD, although measurements were made over a relatively narrow temperature range of 22.2 to 27.6°C. Temperature and DO are highly correlated in a positive direction; this may be the result of algal productivity, since the temperature-algae and DO-algae correlation coefficients were 0.96 and 0.90, respectively, both highly significant values. As found in other SWS SOD studies (Butts, 1974; Butts and Evans, 1979) and by others (Hunter et al., 1973; Mathis and Butts, 1980), a relatively low cor-

Table 28. Water Depths and Pool Elevations
Encountered during SOD Sampling

Station No.	Station Mileppint	Ambient depth (ft)	Pool elev. (msl) Ambient	Pool elev. (msl) Normal	Normal pool depth Feet	Normal pool depth Meters
1	154.8L	8.0	434.2	430.0	3.8	1.16
2	152.5L	18.8	435.5	429.9	13.2	4.02
3	150.9L	17.0	435.3	429.9	11.6	3.54
4	148.1L	15.5	434.9	429.8	10.4	3.17
5	144.2L	6.0	434.0	429.7	1.7	0.52
6	140.0R	11.4	433.9	429.6	7.1	2.16
7	134.0L	8.0	433.4	429.5	4.1	1.25
8	129.1L	16.0	433.0	429.4	12.4	3.78
9	127.4L	5.5	432.9	429.4	2.0	0.61
10	124.2L	6.0	432.5	429.3	2.8	0.85
11	118.0R	14.5	430.9	429.3	12.9	3.93
12	118.0L	10.0	430.9	429.3	8.4	2.56
13	105.6L	4.0	430.5	429.2	2.7	0.82
14	99.5L	15.6	430.0	429.1	14.7	4.48
15	95.8L	13.6	429.8	429.1	12.9	3.93
16	86.4R	14.4	429.4	429.0	14.0	4.27
17	80.3C	17.9	429.0	429.0	17.9	5.46

Note: L = left bank, R = right bank (looking downstream); C = channel

Table 29. Simple Correlation Coefficient Matrix Derived
from SOD Stepwise Regression Analysis

	Depth	Temp	DO	Macro-organisms	Algae	% Solids	% Vol. solids	SOD
Depth (m)	---	.36	.17	.25	.32	.44	-.07	-.06
Temperature (°C)		---	.84	.69	.96	.84	.51	.72
Initial chamber DO (mg/l)			---	.42	.90	.85	.44	.56
Log no. macroorganisms (no./ml)				---	.59	.38	.51	.67
Log no. plankton algae (no./ml)					---	.85	.45	.65
% Solids						---	.11	.48
% Volatile solids							---	.50
SOD (g/mVday)								---

Table 30. Multiple Correlation Coefficients for Stepwise
Variable Additions Relative to SOD

Parameter	Multiple coefficients Correlation	Multiple coefficients Determination	Standard error of estimate
Temperature	.721	.520	0.27
Depth	.798	.637	0.25
Macroorganisms	.832	.693	0.23
Algae	.838	.703	0.24
% Volatile solids	.838	.703	0.25
Initial DO	.838	.703	0.26
% Solids	.838	.703	0.28

relation exists between volatile solids content (reflective of organic content) and SOD in stream bottoms not subjected directly to pollutional discharges.

The information outlined in table 30 shows that the interactions and interrelationships between just three variables - temperature, depth, and log of the number of macroorganisms - account for most of the explained variability. Temperature and depth in combination account for 63.7 percent of the sample variability; including the effects of the macroinvertebrates increases the explained variability to 69.3 percent. However, an insignificant increase is effected by including any of the remaining four parameters. Consequently, the most comprehensive and efficient empirical expression resulting from the regression analysis is:

$$SOD = 0.037T + 0.153 \log M - 0.089H -. 0.032$$

where

T = temperature, °C

M = number of benthic macroinvertebrates/ml

H = water column depth referenced to flat pool, m

However, since macroorganism populations are not readily definable or measured the use of equation 8 is somewhat constrained. The form of the equation including only the two readily measured variables, temperature and depth, can be applied without sacrificing much in accuracy. This equation is:

$$SOD = 0.05T - 0.09H - 0.07 \tag{9}$$

It has been used in this report to estimate average SOD rates for stream reaches in the BOD-DO model under specific hydraulic and temperature conditions. The parametric inputs should approximate those for which the stochastic formulation was derived. In this case "T" should range between approximately 20 and 22°C, and "H" should range between approximately 0.5 and 5.5 m.

Discussion

The most important finding of the sediment-SOD study is that the SOD rates in the LaGrange pool are low on both a relative and an absolute basis. Based on 90 SOD measurements on streams in northeastern Illinois ranging from clean to grossly polluted, Butts and Evans (1978) categorized sediments according to various states of degradation. Because of the broad classifications originally used and the subjective nature of the formulations, the same range groupings are felt to be representative and adequate for broad, illustrative usage. These groupings are presented in table 31. A rank ordering of the best estimate SOD rates set forth in table 27 is shown in table 32. Based on the categorizations in table 31, the worst bottom condition observed in the LaGrange pool would be one of slight degradation; 12 of the 17 observations would fall into the clean to moderately clean

Table 31. Generalized Benthic Sediment Conditions in Northeastern Illinois Streams as Characterized by SOD Rates*

Generalized benthic sediment condition	SOD Range at 25°C (g/m^2/day)
Clean	<0.5
Moderately clean	0.5-1.0
Slightly degraded	1.0-2.0
Moderately polluted	2.0-3.0
Polluted	3.0-5.0
Grossly polluted	5.0-10.0
Sewage sludge-like	>10.0

* From Butts and Evans, 1978

Table 32. Rank Order of SOD Rates Observed in the LaGrange Pool

Rank	Station	General bottom type	SOD @ 25°c g/m^2/day
1	13	Fine sand, clay-silt	1.61
2	9	Fine sand, clay-silt	1.28
3	3	Clay-silt	1.05
4	6	Clay-silt	1.05
5	15	Sand, gravel, shells	1.05
6	14	Fine sand, silt	.99
7	7	Fine sand, silt-clay	.95
8	17	Sand, shells, silt	.95
9	12	Sand, silt-clay	.94
10	4	Sand	.91
11	10	Sand, compacted silt-clay	.88
12	1	Sand	.84
13	5	Sand	.79
14	11	Sand, shells	.76
15	8	Fine sand, silt-clay	.74
16	16	Sand	.73
17	2	Sand	.42

Table 33. Summary of Illinois Waterway SOD Rates by Pool

Pool	No. of samples	SOD Rates @ 25°C (g/m^2/day) High	Low	Median	Average
Dresden Island*	12	10.09	1.92	3.76	4.55
Starved Rock*	2	2.10	2.07	2.08	2.08
Peoria*	8	3.00	0.50	1.32	1.54
LaGrange	17	1.61	0.42	0.94	0.94

*From Butts (1974)

classes. The SOD rates appear to be broadly related to the mix proportion of sand and silt-clay. The silty sands and pure sands tend to have the lower rates. The SOD rates in the LaGrange pool are distinctly lower than those measured in three upstream pools by Butts (1974). The comparisons are shown in table 33.

The actual effect of these relatively low rates on the DO resources of the pool can be ascertained accurately only by use of the BOD-DO model discussed in a later section of this report. The net effect within a given reach is dependent principally upon detention time, average depth, and aeration capacity. For a deep, slow-moving reach significant oxygen usage can occur by sediments exerting SOD rates in the range of 1.0 to 1.5 g/m /day. A quick, cursory calculation can be made using equation 7 to gain some insight into the approximate effect in selected areas of the pool. Station 12 located at MP 118.0 represents the average SOD of the whole pool. Hydraulic and hydrologic data are available for a reach inclusive of this sampling station starting at MP 119.7 and ending at MP 116.3. For 7-day, 10-year low flows the time-of-travel through the reach is 0.4 days and the average depth is 2.74 m. Substituting these values along with G = 0.94 g/m^2/day into equation 7 yields a DO usage of only 0.14 mg/l. At a much higher flow - for example, the 7-day 10-year low flow plus 10,000 cfs - the DO usage would be reduced to a rather insignificant 0.05 mg/l.

Summary

1) Benthic sediments were collected at 153 stations within the LaGrange pool. Most samples consisted of sand or sand and shells; some isolated areas consisted of watery muck and compacted silt-clay, but these areas were not extensive. The organic content of the sediments, including the watery muck and compacted silt clay areas, is low.

2) Seventeen SOD measurements were taken at stations representative of all the basic sediment types detected in the pool. SOD rates were low, ranging from 0.42 to 1.61 g/m^2/day. At low flows the higher rate could have a small but significant influence on the DO resources of the pool. The SOD appears to be caused principally by bacteria; macroinvertebrate populations were too small to have a significant effect.

BIOCHEMICAL OXYGEN DEMAND

Water samples for biochemical oxygen demand determinations were collected on 6 dates at 10 main stem and 4 tributary stream stations. Two main stem stations were located in the portion of the study area above the Peoria lock and dam, and the other 8 main stem stations were located within the pool. During the fourth run an extra sample was collected at Kingston Mines. The objective of these sample collections and laboratory analyses was to determine the ultimate oxygen demand load and the attendant rate of oxygen usage in the stream water.

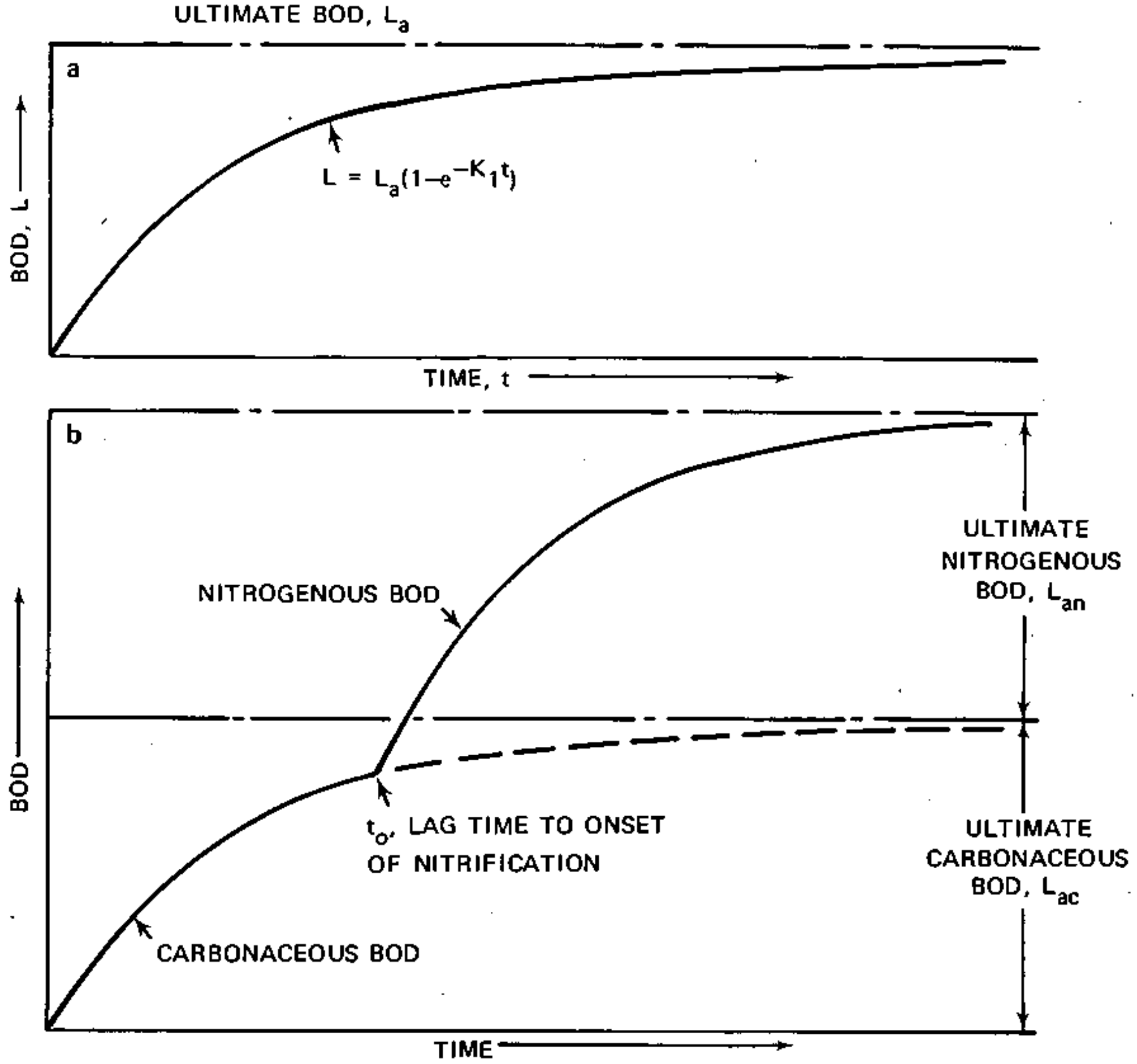
The demand of oxygen within water is usually measured indirectly in terms of the oxygen usage over a period of time, with the time factor usually in days. The amount of oxygen used is referred to as biochemical oxygen demand or BOD, and it represents the amount of oxygen required to stabilize dissolved and colloidal material in water subject to microbial processes. The rate of the BOD process has been found to closely follow first order kinetics, i.e., the rate of oxygen usage is directly proportional to the substrate (organic waste) concentration. A basic first-order BOD curve is schematically illustrated by figure 22a. When ammonia is present in wastewater or in an aquatic environment, bacterial oxidation of the ammonia will commence at some point in time. This reaction combined with the first stage or carbonaceous BOD yields the two-stage BOD curve schematically illustrated by figure 22b. The nitrogenous portion of the curve can be referred to as either second stage BOD, nitrogenous BOD, or nitrification.

The first stage represents the stabilization of carbonaceous material by a myriad of microorganisms. Generally, the organisms consist of heterotrophic bacteria and some protozoa. The generation time of these bacteria is in terms of minutes.

The second stage of the BOD curve represents the biochemical utilization of ammonia by autotrophic bacteria. Two very specialized bacteria, *Nitrosomonas* spp. and *Nitrobacter* spp. (see figure 22), are the dominant organisms involved in nitrification although others are known to exist. Theoretically 4.57 mg/l of oxygen is required to completely oxidize 1.0 mg/l of ammonia-N to nitrate-N, a stable end product under aerobic conditions.

Nitrification is very slow compared to the stabilization of carbonaceous substances in natural waters. The generation time of nitrifying bacteria ranges between 30 and 40 hours (compared to minutes for carbonaceous bacteria) , and they are much more sensitive to varying environmental conditions than are the heterotrophic organisms. Consequently, a lag time to the onset of the second stage curve results, as shown by figure 22b. Zanoni (1967) found that for a conventional activated sludge effluent the lag time ranged from 0 days at 30°C to 75 days at 5°C; at 25°C, the active phase of nitrification was found to commence generally in five days.

The significance of nitrification relative to water quality degradation in the Illinois Waterway has been documented only in recent years. Mohlman et al. (1950) were the first to really quantify its existence and magnitude along the upper portion of the waterway between Chicago and Peoria. In their study of the DO resources of the LaGrange pool, Butts et al. (1970) gathered data which showed that under some conditions ammonia oxidation could be the primary cause of severe oxygen depletion in the pool. A detailed study of the water quality of the upper waterway by Butts et al« (1975) clearly defined the mechanism by which second stage BOD loads are transferred downstream from the principal sources at the three major Chicago Metropolitan Sanitary District of Greater Chicago (MSD) sewage treatment plants. For seven sampling days in the waterway at Lockport, during the summer of 1971, an average NH_3-N load of 107,000 lbs/day was observed which closely matched the 106,800 lbs/day estimated to be coming from the three MSD plants and a major tributary, the Grand Calumet River. The hydraulic and hydrologic conditions dictate the reach of the waterway most severely affected. For high stream flows a major portion of this Chicago area second stage BOD load can be transferred into the lower end of the Peoria pool. and upon combining



(1) GENERAL EQUATION OF CARBONACEOUS DEOXYGENATION

$$C_xH_yO_z + O_2 \xrightarrow[\text{Microorganisms}]{\text{Saprophytic}} CO_2 + H_2O$$

(2) GENERAL EQUATION OF NITROGENOUS DEOXYGENATION

$$2NH_3 + 3O_2 \xrightarrow[\textit{Nitrosomonas Sp}]{\text{Nitrite Formers}} 2\,NO_2^- + 2H^+ + 2H_2O$$

$$2NO_2^- + O_2 \xrightarrow[\textit{Nitrobacter Sp}]{\text{Nitrate Formers}} 2\,NO_3^-$$

Figure 22. (a) Schematic of first order BOD curve
(b) Schematic carbonaceous-nitrogenous BOD curve

with the nominal load from the Peoria-Pekin area it can cause significant oxygen depletion in the LaGrange pool.

Methods

The BOD samples were collected at a 6-foot depth at the main stem stations and at mid-depth on the tributaries. The main stem samples were obtained with a sampler developed by the SWS, which was designed to open and fill two 2.4-liter glass jugs at the prescribed depth. Tributary samples had to be collected with a Juday sampler because of the shallow nature of the streams. The filled jugs were stored in styrofoam containers to minimize heat transfer during transportation. Analyses were started within 18 hours of sampling.

All BOD analyses were made using a modification of the jug aeration technique developed by Elmore (1955). This method circumvents the need for diluting the sample for long term runs. The basic procedure involves incubating at 20°C a number of BOD bottles containing a given sample, periodically making DO readings using a DO probe and BOD stirrer, using contents from one of the bottles as makeup water for the others, and combining and aerating all samples in a common container when DO readings fall below 2.0 mg/l.

Second stage BOD is isolated from the first stage by inhibiting the growth of nitrifying bacteria. A commercial formulation of N-Serve, 2-chloro-6-(trichloromethyl) pyridine, marketed by Hach Chemical Company as Formula 2533, was used as the inhibitor. A compatible set of uninhibited samples was incubated and the difference between these samples, the total BOD, and the inhibited samples is considered to be the nitrogenous BOD. The demand of the inhibited samples is considered to be the carbonaceous BOD.

Long-term runs were generally made up to 20 days, with some runs being slightly shorter and some slightly longer. A time sequence of 2, 3, 4, 5, 7, 9, 10, 12, 15, 18 and 20 days was most frequently used although some variance in this schedule did occur.

Ammonia and nitrate samples were collected at 16 main stem stations and on the four major tributaries. All samples were collected with the Juday sampler. Collections were made at 6-foot depths on the river and at mid-depth on the tributaries. Nitrogen samples were preserved by filtering them through a 37-mm diameter type HA, 0.45 μm millipore filter. The filter membranes were placed on filter pads. The membrane-pad combinations were housed inside 2-part 37-mm circular plastic monitors sealed by applying pressure around the outer edges. The samples were forced through the filter using a 100-cc plastic syringe, and the filtrates were collected in 100-ml plastic bottles.

Ammonia-nitrogen analyses were performed according to the Indophenol method (Harwood and Kuhy, 1970). Nitrate-nitrogen analyses were done according to the chromotrophic method (West and Ramachandran, 1966).

The basic first order BOD progression curve can be mathematically formulated as:

$$L = L_a (1 - e^{-K_1 t}) \qquad (10)$$

where

L = oxygen demand exerted up to time t

L_a = ultimate oxygen demand

K_1 = reaction rate to the base e, l/day

t = incubation time, days

When a delay occurs in the onset of oxygen usage a lag time factor (t) is introduced into the equation:

$$L = L_a [1 - e^{-K_1 (t - t_o)}] \qquad (11)$$

For upper Illinois Waterway BODs below the Chicago area the BOD curves are S-shaped and do not readily fit equations 10 and 11 (Butts et al. 1975). By adding a power factor (X) to the exponent of e in equation 11 a good fit was achieved. The power factor equation can be represented by:

$$L = L_a (1 - e^{-[K_1 (t - t_o)]^X}) \qquad (12)$$

The best value of "X" was found to be 2 for upper waterway data. These three equations were used to evaluate the BOD progression curves generated for this study. Best fits were achieved using a computer-programmed iterative procedure for the method of steepest descent.

A river deoxygenation rate constant (K) similar to that calculated by Butts et al. (1970) was calculated using BODs and time-of-travel. The computed ultimate BODs by station in terms of pounds per days were plotted versus time-of-travel in days. Theoretically, with limited downstream additions to the BOD load, a decrease of the BOD load in a downstream direction should proceed at an exponential rate; i.e., the plot should fit the following equation:

$$L_t = L_a e^{-K_d t} \qquad (13)$$

where

L_t = ultimate BOD in lbs/day remaining at time-of-travel, t in days

L_a = ultimate BOD at the beginning of the study area; i.e., t = 0

K_d = river deoxygenation rate constant, l/day

Investigations were made of the relationship between BOD concentrations and flows at given stations and also between the BOD concentrations of adjacent stations, using simple correlation procedures. Linear, semi-log, and log-log relationships were utilized.

Stepwise regression techniques were also used to determine causal relationships between total, carbonaceous, and nitrogenous BOD and a number of independent variables, A first trial computer run was made using nine independent variables: total and fecal coliform, fecal strep, plankton algae, flow, dissolved oxygen, temperature, ammonia, and nitrates. A second trial was made by dividing the plankton into four groupings including *Navicula* spp. (the predominant diatoms), green algae, blue-green algae, and flagellates.

Results

All planned 72 long-term BOD samples were collected on June 26, July 10 and 24, August 7 and 21, and September 5. The data were used for the computer input for parametric value solutions relative to equation 12 for the following criteria: ($x = 1$, $t_o = 0$) , ($x = 1$, t_o = variable), ($x = 2$, $t_o = 0$), and ($x = 2$, t_o = variable). Only the results for the first two runs involving a unity power factor are included in this report, and these results are summarized in the appendix. Unlike the results reported for the upper waterway (Butts et al., 1975) the curves did not tend to be S-shaped but tended to follow the more traditional BOD curve configurations.

The relative goodness of fit to the four sets of specifications is illustrated by the results summarized in table 34. For total, nitrogenous, and carbonaceous BOD at the main stem stations the best fit was achieved by the conditions $x = 1$ and t_o = variable. The next best fit was for the conditions $x = 1$ and $t_o= 0$. The differences in the standard error of estimate for these two conditions were small. It was decided that the basic first order reaction would be satisfactory for evaluating DO resources in the pool.

The results of the BOD analyses are summarized in terms of ultimates in tables 35 and 36 for the main stem stations and in tables 37 and 38 for the principal tributaries. On the average the BOD concentrations decrease in a downstream direction, but the total load appears to remain relatively constant throughout. The loads at the two stations above the Peoria dam were consistently higher than those within the pool. At times, the major tributaries produced significant load inputs. The Spoon River had the highest average BOD concentrations, while the Sangamon River, by virtue of its relatively large flow, contributed the greatest load. The Mackinaw River and LaMoine River load contributions are relatively minor.

Table 34. Best Fit Rankings for the Stated Specifications Applied to Equation 12

Specifications	$x=1, t_o=0$	$x=1, t_o$ =var.	$x=2, t_o=0$	$x=2, t_o$ =var.
		Total BOD		
Main stem	1.90	1.23	3.95	2.92
Tributaries	2.29	1.25	3.92	2.54
		Carbonaceous BOD		
Main stem	1.88	1.12	4.00	3.00
Tributaries	1.79	1.21	4.00	3.00
		Nitrogenous BOD		
Main stem	2.55	1.84	3.36	2.25
Tributaries	3.08	2.29	3.00	1.63

Table 35. Ultimate BOD Concentrations (mg/l) in the Illinois River Immediately above and in the LaGrange Pool

1979	Ultimate			Main stem sampling station milepoints							
date	BOD	166.1	160.7	157.6	152.0	150.0	139.0	129.5	113.3	93.6	80.2
6/26	Total	16.37	15.76	8.77	8.56	7.43	7.41	7.11	6.57	7.02	6.01
	Carb.	5.66	4.67	4.31	4.65	6.08	4.15	4.27	4.05	3.62	4.29
	Nit.	11.66	11.86 '	4.57	4.08	1.74	3.41	2.96	2.72	3.51	1.66
7/10	Total	9.47	9.01	9.57	10.63	10.82	i0.26	8.87	9.41	14.7	9.87
	Carb.	5.34	5.52	5.47	5.57	5.98	5.35	4.73	4.79	4.53	4.92
	Nit.	4.28	3.59	4.30	5.19	5.05	5.03	4.22	4.64	10.20	4.94
7/24	Total	9.87	9.37	8.87	9.20	9.81	7.82	9.05	10.03	6.14	7.44
	Carb.	6.64	6.29	4.56	4.84	4.76	4.51	3.65	4.92	3.59	3.78
	Nit.	3.20	2.93	4.42	4.60	5.10	3.57	5.45	5.04	2.73	3.74
8/07	Total	9.86	9.96	10.08	9.94	8.98	6.19	6.42	5.76	5,02	4.54
	Carb.	6.55	5.62	5.28	8.37	5.25	4.34	3.67	3.27	4.01	2.58
	Nit.	3.41	4.59	4.95	1.70	3.91	1.93	2.88	2.41	0.87	1.78
8/21	Total	5.88	5.84	5.85	5.97	5.81	7.53	7.27	8.40	6.01	6.17
	Carb.	3.47	3.46	3.45	3.44	3.67	3.87	3.77	5.04	4.17	3.44
	Nit.	2.44	2.46	2.41	2.67	2.26	3.77	3.52	3.47	1.78	2.70
9/05	Total	8.57	8.70	7.06	7.43	7.12	6.53	8.48	5.98	4.65	4.60
	Carb.	5.04	4.68	3.94	3.77	3.15	3.24	3.02	3.07	2.63	2.76
	Nit.	3.71	4.22	3.27	3.65	4.05	3.48	5.52	2.17	2.01	1.95
Avg.	Total	10.00	9.77	8.37	8.62	8.34	7.62	7.87	7.69	7.26	6.44
	Carb.	5.45	5.04	4.55	5.11	4.81	4.24	3.85	4.19	3.79	3.63
	Nit.	4.78	4.94	3.99	3.65	3.68	3.53	4.09	3.41	3.52	2.79

Table 36. Ultimate BOD Loads (lbs/day) in the Illinois River Immediately above and in the LaGrange Pool

1979	Ultimate			Main stem sampling station milepoints							
date	BOD	166.1	160.7	157.6	152.0	150.0	139.0	129.5	113.3	93.6	80.2
6/26	Total	562,900	539,000	299,200	290,400	253,600	282,200	309,300	367,500	472,100	493,200
	Carb.	194,600	159,700	147,000	157,800	205,900	158,000	185,800	226,500	256,900	352,000
	Nit.	400,900	405,700	152,100	132,700	47,700	124,100	123,600	152,100	211,800	136,200
7/10	Total	644,400	623,900	669,300	756,400	774,500	752,900	651,400	713,200	1,116,300	829,400
	Carb.	369,500	382,200	382,600	396,400	427,500	392,500	347,400	363,000	344,000	413,500
	Nit.	291,300	348,600	286,700	360,074	346,000	360,300	304,000	350,200	772,300	416,000
7/24	Total	332,500	312,500	294,100	302,000	320,800	267,800	328,700	413,400	279,600	402,200
	Carb.	223,700	209,800	151,200	158,900	155,700	154,400	132,600	202,800	163,500	204,300
	Nit.	107,800	97,700	142,900	143,000	165,100	113,400	196,100	210,600	116,100	197,800
8/07	Total	598,000	601,200	606,800	595,500	531,700	373,200	386,300	352,500	305,900	468,100
	Carb.	397,200	339,200	317,900	501,400	314,000	261,700	220,800	200,100	244,300	265,000
	Nit.	206,800	227,700	298,000	101,800	233,800	116,400	173,300	147,500	53,000	183,500.
8/21	Total	876,500	846,600	834,300	826,500	795,800	985,300	970,400	1,019,600	664,900	686,300
	Carb.	517,200	501,600	492,000	476,300	502,700	506,400	473,900	611,800	461,400	382,600
	Nit.	363,700	356,600	343,700	369,600	309,600	493,300	442,400	421,200	196,900	300,300
9/05	Total	625,900	651,000	535,600	577,300	557,800	548,200	758,500	596,400	516,200	568,100
	Carb.	368,100	350,200	298,900	292,900	246,800	272,000	270,100	305,600	292,000	340,900
	Nit.	271,000	315,800	248,000	283,600	317,300	292,100	493,700	216,000	223,100	240,800
Avg.	Total	607,900	595,700	539,900	558,000	538,900	534,900	567,400	576,900	559,200	574,500
	Carb.	345,000	323,800	298,300	330,600	310,000	290,800	271,800	318,300	293,700	326,400
	Nit.	273,600	275,300	245,200	231,800	236,600	249,900	288,900	249,600	262,200	245,800

Table 37. Ultimate BOD Concentrations (mg/l) in Principal Tributaries to the LaGrange Pool

1979 date	Ultimate BOD	Tributary Mackinaw	Spoon	Sangamon	LaMoine
6/26	Total	9.36	8.02	16.52	7.89
	Carb.	8.78	2.30	9.58	5.05
	Nit.	0.66	5.14	7.22	3.09
7/10	Total	5.55	3.61	4.29	10.32
	Carb.	2.46	2.60	3.88	6.77
	Nit.	3.19	0.80	0.42	3.69
7/24	Total	9.18	11.85	14.47	9.62
	Carb.	8.11	6.73	9.75	9.05
	Nit.	0.94	4.69	4.81	0.87
8/07	Total	13.45	21.06	2.52	6.44
	Carb.	7.87	15.73	1.22	3.80
	Nit.	4.83	6.23	1.26	2.55
8/21	Total	16.82	9.88	15.31	8.74
	Carb.	12.65	7.30	9.74	4.94
	Nit.	4.58	2.52	5.25	3.75
9/05	Total	8.63	15.43	13.57	4.91
	Carb.	4.34	8.45	8.06	2.79
	Nit.	4.48	5.02	5.67	2.21
Avg.	Total	10.50	11.64	11.11	7.99
	Carb.	7.37	8.10	7.04	5.40
	Nit.	3.11	4.72	4.11	2.69

Table 38. Ultimate BOD Loads (lbs/day) in Principal Tributaries to the LaGrange Pool

1979 date	Ultimate BOD	Tributary Mackinaw	Spoon	Sangamon	LaMoine
6/26	Total	7,500	25,800	102,000	7,700
	Carb.	7,000	7,400	59,300	5,000
	Nit.	500	16,500	44,700	3,000
7/10	Total	3,800	8,000	31,000	8,000
	Carb.	1,700	5,800	28,000	5,200
	Nit.	2,100	2,200	3,000	2,800
7/24	Total	4,400	16,200	75,400	3,800
	Carb..	3,900	9,200	50,800	3,600
	Nit.	500	7,000	24,600	200
8/07	Total	11,100	26,300	105,200	3,800
	Carb.	6,500	19,700	50,900	2,300
	Nit.	4,000	8,800	52,600	1,500
8/21	Total	14,600	43,800	97,500	12,900
	Carb.	11,000	32,400	62,000	7,300
	Nit.	4,000	11,200	33,400	5,500
9/05	Total	3,600	12,700	61,100	1,300
	Carb.	1,800	6,600	36,300	700
	Nit.	1,900	3,900	25,500	600
Avg.	Total	7,500	22,100	78,700	6,300
	Carb.	5,300	13,500	47,900	4,000
	Nit.	2,200	8,300	30,600	2,300

The correlations between the average ultimate BOD concentrations at adjacent stations are presented in table 39. Essentially the purpose of these calculations was to determine if the BOD observed at an upstream location on the main stem of the pool had a significant effect on the BOD at the next station immediately downstream. For the small sample size of 6 a relatively high correlation coefficient of 0.80 is needed to show significance at the 5 percent confidence level; i.e., one can be 95 percent confident that a correlation exists between the up and downstream BODs if the coefficient equals or exceeds 0.80. To be only 90 percent confident of this relationship a correlation coefficient of 0.73 is required. For the total and carbonaceous BOD the coefficients derived using a log-log transformation of the data appeared to give the overall highest values, while a linear relationship gave the best results for the nitrogenous demand. The values significant at the 5 percent confidence level are underlined in the appropriate columns in table 39.

Table 40 summarizes the correlations derived for each station by comparing the ultimate BOD concentration variations with stream flow variations.

Table 39. Correlations between Average Ultimate BOD Concentrations at Adjacent Stations

Stations

Stations	Total			Carbonaceous BOD			Nitrogenous BOD		
correlated	L	SL	LL	L	SL	LL	L	SL	LL
166.1-160.7	.99	.98	.99	.92	.93	.93	.98	.94	.95
160.7-157.6	.49	.53	.65	.76	.79	.82	.41	.41	.51
157.6-152.0	.96	.97	.97	.81	.87	.87	.13	.02	.08
152.0-150.0	.94	.95	.95	.52	.55	.64	.39	.29	.20
150.0-139.0	.57	.54	.47	.78	.80	.82	.23	.15	.08
139.0-129.5	.58	.58	.59	.84	.84	.85	.36	.43	.48
129.5-113.3	.67	.66	.65	.53	.57	.59	.36	.29	.33
113.3- 93.6	.53	.57	.59	.61	.62	.64	.56	.60	.60
93.6- 80.2	.91	.86	.90	.56	.55	.54	.80	.72	.68

Note: L = linear, SL = semi-log, LL = log-log; underscored values are those significant at the 5 percent confidence level

Table 40. Correlations between Average Flows in cfs and Average Ultimate BOD Concentrations at Given Stations

	Total			Carbonaceous BOD			Nitrogenous BOD		
Station	L	SL	LL	■ L	SL	LL	L	SL	LL
166.1	-.75	-.85	-.86	-.89	-.92	-.85	-.50	-.59	-.62
160.7	-.75	-.85	-.84	-.78	-.82	-.73	-.50	-.57	-.57
157.6	-.75	-.79	-.69	-.54	-.60	-.45	-.86	-.89	-.81
152.0	-.67	-.73	-.60	-.38	-.48	-.35	-.39	-.33	-.35
510.0	-.58	-.64	-.53	-.59	-.59	-.58	-.28	-.21	-.07
139.0	.01	.01	-.01	-.33	-.34	-.32	.21	.21	.17
129.5	-.13	-.11	-.12	-.21	-.22	-.21	-.04	.01	-.01
113.3	-.14	-.11	-.19	.02	-.01	-.09	-.31	-.27	-.33
93.6	-.13	-.18	-.11	-.29	-.34	-.27	-.11	-.09	-.04
80.2	-.58	-.63	-.60	-.59	-.61	-.55	-.50	-.49	-.50
Mackinaw	.55	.48	.42	.48	.39	.35	.21	.13	.10
Spoon	-.53	-.41	-.53	-.42	-.40	-.51	-.46	-.31	-.39
Sangamon	-.72	-.80	-.83	-.80	-.92	-.93	-.55	-.39	-.46
LaMoine	.39	.45	.55	-.03	.13	.24	.75	.65	.66

Note: L = linear, SL = semi-log, LL = log-log; underscored values are those significant at the 5 percent confidence level

The sample size again is 6 and the correlation coefficients need to equal or exceed 0.80 to be significant at the 5 percent confidence level. Those values which do so are underlined in table 40 under the column providing the best overall fit. Few matchups in either tables 39 and 40 demonstrate significant correlations. The correlations in table 40, however, are overwhelmingly negative, indicating a tendency toward a diluting effect of flow on BOD; i.e., as the stream flows increase the BOD concentrations decrease. The same tendency appeared to occur when all the data for all the stations were analyzed collectively. Maximum correlation coefficients were achieved using a log-log transformation.

The correlation coefficients for flow versus the total, carbonaceous, and nitrogenous fractions are, respectively, -0.51, -0.49, and -0.35. In this case with a sample size of 60 (6 dates, 10 stations), a correlation coefficient of only 0.25 is needed to be significant at the 5 percent level. Although the overall correlation coefficients are small they are significant, and thus flow can be confidently considered as an influence on BOD concentration at a given point and time in the study area. Flow accounts for about 24 percent of the variance in the carbonaceous BOD concentration, and 12 percent of the variance in the nitrogenous BOD concentration.

The simple correlation coefficients relating 16 parameters investigated during this study are presented in table 41.. This matrix of values is derived from a normal run of the stepwise regression computer program. The number of input data sets is limited to those dates and stations for which matching results are available for each parameter. The principal purpose of performing this analysis was to try to isolate some of the factors influencing the BOD in the pool. A total of 43 sets of data were available for the analysis. Some of the simple correlations produced by the stepwise regression analysis are logical, while others are not.

A first run was made using only total plankton as one of the independent variables. After a review of the results, the decision was made to divide the plankton into four groups: blue-green algae, flagellates, and the diatoms *Navicula* spp. and *Cyclotella* spp. This increased the explained variation in total, carbonaceous, and nitrogenous BOD from 32, 67, and 13 percent,

Table 41. Simple Correlation Coefficient Matrix Derived from BOD Stepwise Regression Analysis

	TC cts/ml	FS cts/ml	FC cts/ml	Flow cfs	DO mg/l	Temp °C	NH_3-N mg/l	$N0_3$-N ma/l	G.a. cts/ml	B-q.a. cts/ml	Flag. cts/ml	Navic. cts/ml	Cyclo. cts/ml
Total coliform	--												
Fecal strep	.53	--											
Fecal coliform	.55	.01	--										
Flow	.20	-.12	.14	--									
DO	-.27	-.11	-.38	-.38	-—								
Temperature	.01	.32	.02	-.32	.12	-—							
Ammonia-nitrogen	.34	.57	.30	-.39	-.07	.05	--						
Nitrate-nitrogen	-.19	-.18	-.19	-.63	.29	-.35	.19	--					
Green algae	.06	.30	0	-.17	.13	.21	.16	-.05	--				
Blue green algae	.09	-.26	.29	.47	-.19	.25	-.22	-.56	-.17	--			
Flagellates	-.34	-.11	-.16	-.41	.31	-.12	.04	.43	.33	-.40	--		
Navicula spp.	.13	-.02	.23	.33	-.22	.49	-.10	-.61	-.25	.58	-.65	--	
Cvclotell? spp.	-.03	-.17	.04	-.09	-.01	-.03	-.03	.09	.33	.21	.16	-.15	--
Total BOD	.01	.28	-.02	-.40	.38	-.02	.37	.13	.29	-.31	.33	-.39	.12
Carb. BOD	-.09	.37	-.29	-.44	.64	.14	.25	.15	.27	-.32	.34	-.36	-.07
Nit. BOD	.06	.15	.13	-.29	.15	.11.	.36	.10	.19	-.23	.21	-.28	.17

respectively, to 55, 74, and 39 percent. The regression analysis was terminated when a variable addition was found to be insignificant at the 5 percent level. A summary of the results is presented in table 42. The parameters are listed in the order of significance; i.e., flow appears to influence the total BOD the most, and ammonia the least, of the significant variables.

Summaries of the results of the ammonia and nitrate-nitrogen sampling are presented in tables 43 and 44 along with those values available from the brief 1973 sampling endeavor.

Discussion

The main stem BOD curves obtained are indicative of a well-established heterotrophic (carbonaceous) bacterial population but a less viable autotrophic (nitrogenous) bacterial population. The carbonaceous BOD curves, when fitted to equation 11, produce a negative t value, whereas when the nitrogenous data are fitted to the equation small positive t values are consistently produced. Apparently even at the relatively high flows experienced during some of the BOD sampling runs, the residual ammonia from Chicago

Table 42. Variable Coefficients and Y-Intercepts for
Significant Variable Additions in BOD Stepwise Regression Analysis

Total BOD

Multiple correlation coefficient (R)	Standard error of estimate	Y-axis intercept	Flow (cfs)	Log of Navicula (counts/ml)	NO_3-N (mg/l)	Temperature (°C)	DO (mg/l)	NH_3-N (mg/l)
0.40	1.93	9.79	-.0014					
0.49	1.86	10.13	-.0011	-.44				
0.61	1.71	16.99	-.0020	-.82	-1.48			
0.65	1.66	33.37	-.0033	-.58	-2.23	-.48		
0.71	1.57	31.02	-.0031	-.50	-2.38	-.56	0.80	
0.74	1.50	24.71	-.0024	-.54	-2.16	-.46	0.95	3.54

Carbonaceous BOD

			DO (mg/l)	Log of fecal strep (counts/ml)	Log of Navicula (counts/ml)	Log of total coliform (counts/ml)	NO_3-N (mg/l)	Flow (cfs)	Temperature (°C)	Log of blue-greens (counts/ml)
0.64	0.76	-0.46	.81							
0.78	0.62	-3.27	.84	.87						
0.81	0.60	-2.61	.81	.82	-.15					
0.82	0.59	-1.13	.77	1.00	-.14	-.46				
0.83	0.58	-1.19	.84	1.06	-.20	-.70	-.17			
0.84	0.57	0.98	.74	0.77	-.22	-.30	-.37	-.0004		
0.85	0.55	5.83	.78	0.87	-.13	-.36	-.58	-.0007	-.16	
0.86	0.55	6.15	.79	1.00	-.14	-.43	-.54	-.0008	-.18	.11

Nitrogenous BOD

			NH,-N mg/l	Log of Navicula (counts/ml)	NO_3-N (mg/l)	Flow (cfs)	Temperature (°C)	DO (mg/l)	fecal coliform (counts/ml)	Log of Cyclotella (counts/ml)
0.36	1.48	2.65	3.59							
0.44	1.45	3.24	3.31	-.28						
0.46	1.45	4.70	3.57	-.42	-.39					
0.51	1.42	7.16	2.78	-.44	-.75	-.0007				
0.58	1.36	23.11	2.02	-.21	-1.47	-.002	-.45			
0.60	1.36	21.74	2.33	-.19	-1.50	-.002	-.47	29		
0.61	1.36	19.33	1.76	-.22	-1.50	-.002	-.47	.38	.64	
0.63	1.36	17.75	1.92	-.19	-1.48	-.002	-.47	.39	.58	.58

Table 43. Summary of 1973 and 1979 Ammonia (NH_3-N) Nitrogen Values

	NH_3 concentration (mq/1)						NH loads (10^4 lbs/day)					
	1973 (N= 6)			1979 (N=13)			1973 (N=6)			1979 (N=13)		
MP	Max	Avg	Min	Max	Avq	Min	Max	Avg	Min	Max	Avg	Min
166.1	.32	.142	0	.48	.191	.05	2.06	.70	.12	2.82	1.32	.37
164.4	.34	.123	0	.48	.217	.03	2.18	.63	0	2.84	1.44	.22
162.5	.30	.103	.01	.43	.212	.04	1.93	.54	.03	2.83	1.45	.30
160.7	.23	.128	0	.42	.194	.03	1.41	.60	0	2.52	1.34	.22
159.4	.26	.148	0	.32	.208	.07	1.67	.69	0	2.59	1.44	.52
157.6	.29	.145	0	.33	.215	.06	1.86	.73	0	3.85	1.50	.46
152.0	.38	.165	.01	1.25	.363	.03	1.35	.74	.03	4.99	2.18	.23
150.0	.26	.150	.05	.89	.292	.06	1.47	.69	.21	3.72	1.78	.47
145.5	.27	.132	.02	.53	.228	.04	1.02	.61	.07	3.88	1.61	.32
139.0	.32	.177	.02.	.41	.233	.03	1.32	.85	.07	3.33	1.74	.25
129.5	.31	.178	0	.48	.272	.13	1.28	.90	0	3.80	2.01	.21
121.1	.42	.159	.01	.48	.245	.07	1.55	.76	.06	3.51	1.87	.22
113.3	.24	.150	0	.47	.249	.12	1.14	.82	0	3.48	1.88	.70
106.9	.24	.142	0	.46	.246	.01	1.70	.85	0	3.64	1.97	.06
93.6	.16	.062	0	.35	.236	.02	1.21	.86	0	5.46	1.98	.13
80.2	.12	.042	0	.34	.175	.05	1.43	.53	0	3.56	1.60	.62
	.42	.136	0	1.25	.221	.01	3718	770	0	5746	1.69	.06

Table 44. Summary of 1973 and 1979 Nitrate (NO -N) Nitrogen

	NO_3 concentrations (mq/1)						NO_3 load (10^5 lbs/day)					
	1973 (N=6)			1979 (N=13)			1973 (N=6)			1979 (N=13)		
MP	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min
166.1	3.97	3.27	2.95	6.08	3.54	2.52	2.55	1.43	.97	4.16	2.49	1.25
164.4	4.07	3.29	2.62	5.61	3.50	2.48	2.61	1.45	.99	4.11	2.45	1.22
162.8	3.90	3.33	2.60	5.31	3.38	2.38	2.50	1.46	1.04	3.99	2.38	1.21
160.7	3,90	3.29	2.45	4.98	3.37	2.36	2.50	1.45	.98	4.13	2.37	1.27
159.4	3.85	3.23	2.50	4.76	3.30	2.24	2.37	1.43	1.01	4.24	2.33	1.19
157.6	4.02	3.31	2.45	4.86	3.43	2.31	2.58	1.47	.99	4.19	2.43	1.25
152.0	3,85	3.23	2.55	4.84	3.35	2.20	2.44	1.45	.99	4.40	2.40	1.04
150.0	3.87	3.27	2.65	4.96	3.42	2.19	2.35	1.46	1.04	4.30	2.42	1.20
145.5	4.12	3.30	2.65	4.98	3.46	2.14	2.80	1.55	1.00	4.49	2.49	1.21
139.0	4.33	3.54	2.97	4.95	3.43	2.10	2.86	1.71	1.04	4.33	2.50	1.27
129.5	4.24	3.48	2.93	5.10	3.52	2.14	2.58	1.76	1.00	4.22	2.61	1.33
121.1	4,05	3.34	2.75	5.17	3.47	2.24	2.52	1.74	1.01	4.12	2.61	1.41
113.3	4,02	3.28	2.43	5.62	3.53	2.32	3.19	1.90	.98	4.64	2.76	1.52
106.9	4,35	3.37	2.40	5.43	3.53	2.48	3.76	2.02	.98	4.58	2.80	1.62
93.6	4.40	3.34	2.50	5.30	3.53	2.57	4.43	2.10	1.04	4.67	2.88	1.67
80.2	3.24	2.78	2.13	5.10	3.48	2.64	3.88	1.95	1.02	5.18	2.39	1.82
	4,40	3.30	2.13	5762	3.43	2.10	4.43	1.64	.97	5.18	2.58	1.04

or the ammonia input above Peoria is not sufficient to maintain a high density population of nitrifiers. The negative t_0 for carbonaceous BOD indicates that sufficient heterotrophs are available to immediately oxidize carbonaceous material which may be discharged in the Peoria-Pekin area. The nitrifying bacteria, however, appear to need time to build greater numbers, as evidenced by the positive lag time.

Table 45 summarizes the lag times for the second stage reactions for the six sampling dates. Greater lag times are in evidence at the upper end of the study area; a definite lessening of the lag time occurs in a downstream direction. The correlation between mile point and lag time is significant; linear, semi-log, and log-log coefficients are 0.76, 0.83, and 0.80, respectively. Consequently, a definite buildup of nitrifiers appears to be occurring in a downstream direction. The relatively large lag times observed above Peoria (MP 166.1) may indicate that the bacteria which had

Table 45. Relationship between Flow and Nitrogenous BOD Lag Time (t_{on}) at Individual Sampling Stations

MP	Avg t_{on}	R* Q versus t_{on}
166.1	1.211	-.76
160.7	.781	-.78
157.6	.486	-.19
152.0	.987	-.59
150.0	.506	-.60
139.0	.444	-.14
129.5	.223	-.26
113.3	.195	-.06
93.6	.268	.23
80.2	.208	-.60

* Correlation coefficient for 6 pairs of flow and t_{on}

been actively oxidizing upstream ammonia sources may actually be in the death phase under the flow condition occurring during this study. The lowering of the lag time at MP 157.6, a station immediately below the Great Peoria Sanitary District (GPsD) treatment plant outfall, may be influenced by the nitrified condition of the effluent. At the two stations above the GPSD discharge, significant negative correlations exist between flow and lag time; i.e., as the flows increase lag times decrease, indicating that viable nitrifying bacterial populations are pushed further downstream by increased flows.

The first and second stage BOD composition as a percentage of total BOD is given in table 46. The percentage of carbonaceous demand is the greater for all stations except on occasions at MP 129.5. Overall the carbonaceous demand makes up about 56 percent of the total BOD, while the nitrogenous demand is about 44 percent. This is almost identical to the 57 versus 43 split reported by Butts et al. (1970) for samples collected 14 years earlier. For the tributaries the carbonaceous demand contributed, on the average, a greater portion of the BOD (65 percent) than did the nitrogenous (35 percent). The average 64-35 break was relatively consistent for all the

Table 46. Ultimate Carbonaceous and Nitrogenous BOD Percentage Composition

	6/26		7/10		7/24		8/07		8/21		9/05		Avg.	
MP	Carb	Nit	Carb	Nit	Carb	Nit	Carb	Nit	Carb	Nit	Carb	Nit	Carb	Nit
166.1	32.7	67.3	55.5	44.5	67.5	32.5	65.8	34.2	58.7	41.3	57.6	42.4	56.3	43.7
160.7	28 3	71.7	60.6	39.4	68.2	31.8	55.0	45.0	58.4	41.6	52.6	47.4	53.9	46.1
157.6	48 5	51.5	55.8	44.2	50.8	49.2	51.6	48.4	58.9	41.1	54.6	45.4	53.4	46.4
152.0	53.3	46.7	51.8	48.2	51.3	48.7	83.1	16.9	56.3	43.7	50.8	49.2	57.8	42.2
152.0	77 7	22.3	54.2	45.8	48.3	51.7	57.3	42.7	61.9	38.1	43.8	56.3	57.2	42.8
139.0	54.9	45.1	51.5	48.5	55.8	44.2	69.2	30.8	50.7	49.3	48.2	51.8	55.0	45.0
129 5	59 1	40.9	52.8	47.2	40.1	59.9	56.0	44.0	51.7	48.3	35.4	64.6	49.2	50.8
113.3	59.8	40.2	50.8	49.2	49.4	50.6	57.6	42.4	59.2	40.8	58.6	41.4	55.9	44.1
93 6	52.1	47.9	30.8	69.2	56.8	43.2	82.2	17.8	70.1	29.9	56.7	43.3	58.1	41.9
80.2	72.1	27.9	49.9	50.1	50.3	49.7	59.2	40.8	56.0	44.0	58.6	41.4	57.7	42.3
Avg.	53.9	46.1	51.4	48.6	53.8	46.2	63.7	36.3	58.2	41.8	51.7	48.3		
Mack.	93.0	7.0	43.5	56.5	89.6	10.4	62.0	38.0	73.4	26.6	49.2	50.8	68.4	31.6
Spoon	30.9	69.1	76.5	23.5	58.9	41.1	71.6	28.4	74.3	25.7	62.7	37.3	62.D	37.5
Sang.	57.0	43.0	90.2	9.8	67.0	33.0	49.2	50.8	65.0	35.0	58.7	41.3	64.5	33.5
LaMo.	62.0	38.0	64.7	35.3	91.2	8.8	59.8	40.2	56.8	43.2	55.8	44.2	65.0	35.0

tributaries; however, individually each tributary sampling group exhibited considerable variability as shown by the results presented in table 46.

BOD loads versus milepoints are plotted and shown in figures 23 through 28. Figure 23 also contains curves representative of adjustments in the main stem loads for major tributary influences. The adjustments were made for the carbonaceous and nitrogenous fractions for all six dates, and these results are given in table 47. The adjustments were made by applying equation 13, using deoxygenation rates (K_1). The Sangamon River is the only tributary which appears to consistently contribute a large biodegradable waste load to the pool. However, its effect on pool DO levels is minimal because its confluence is only about nine miles above the LaGrange dam. The "total to total" listing under the "Tributary % contribution" heading in table 47 is based upon a total derived by adding the carbonaceous and nitrogenous values, and not the total BOD values, in table 37. In most instances the Mackinaw, Spoon, and LaMoine Rivers contribute less than 10 percent of the load.

A river deoxygenation rate (K_d), as defined in equation 13 and computed during the 1965-67 study (Butts et al., 1970), could not be realistically computed for any one of the six sets of data available during this study. As can be seen from examining figures 23 through 28 the load

Table 47. BOD Load Contributions from
Tributaries at LaGrange Pool BOD Sampling Sites

		BOD loads (lbs/day)				Pool minus		Tributary % contribution				
	Sta	Pool		Tributary		trib. load		Carb to	Nit to	Carb to	Nit to	Total to
Date	MP	Carb	Nit	Carb	Nit	Carb	Nit	Carb	Nit	total	total	total
6/26	139.0	158,000	124,100	6,409	477	151,619	123,623	4.1	0.4	2.3	0.2	2.5
	129.5	185,800	123,600	5,874	448	179,926	123,152	3.2	0.4	1.9	0.2	2.1
	113.3	226,500	152,100	12,318	16,381	214,182	135,719	5.4	10.8	3.3	4.3	7.6
	93.6	256,900	211,800	11,095	15,267	245,805	196,533	4.3	3.3	2.4	3.3	5.7
	80.2	352,200	136,200	69,907	60,612	282,093	75,588	20.0	7.2	14.3	12.4	26.7
7/10	139.0	392,500	36,300	1,618	2,012	390,882	358,288	0.4	0.6	0.2	0.3	0.5
	129.5	347,400	204,000	1,528	1,920	345,872	302,080	0.4	0.6	0.2	0.3	0.5
	113.3	363,000	350,200	6,981	3,822	356,019	346,378	1.9	1.1	1.0	0.5	1.5
	93.6	344,000	772,300	6,352	3,482	337,527	768,771	1.9	0.5	0.6	0.3	0.9
	80.2	413,500	416,000	36,900	8,868	376,600	407,132	8.9	2.1	4.4	1.1	5.5
7/24	139.0	154,400	113,400	3,505	471	150,895	112,929	2.3	0.4	1.3	0.2	1.5
	129.5	132,600	196,100	3,166	454	129,434	195,646	2.4	0.2	1.0	0.1	1.1
	113.3	202,800	210,600	11,323	7,176	191,477	203,424	5.6	3.4	2.7	1.7	4.4
	93.6	163,500	116,100	10,062	6,605	153,438	109,495	6.2	5.7	3.6	2.4	6.0
	80.2	204,300	197,800	58,170	28,443	146,130	169,357	28.5	14.4	14.5	7.1	21.6
8/07	139.0	261,700	116,400	6,157	3,862	255,543	112,538	2.4	3.3	1.6	1.0	2.6
	129.5	220,800	173,300	5,755	3,690	215,045	169,610	2.6	2.1	1.5	0.9	2.4
	113.3	200,100	147,500	23,701	11,964	176,399	135,536	11.8	8.1	6.8	3.4	10.2
	93.6	244,300	53,000	21,702	10,056	223,098	42,944	8.7	19.0	7.1	3.4	10.5
	80.2	265,000	183,500	69,606	56,088	195,394	127,412	26.3	30.6	15.5	12.5	28.0
3/21	139.0	506,400	493,300	10,674	3,889	495,726	489,411	2.1	0.8	1.1	0.4	1.5
	129.5	473,900	442,400	10,258	3,805	463,642	438,595	2.2	0.9	1.1	0.4	1.5
	113.3	611,800	421,200	41,176	14,711	570,624	406,489	6.7	3.5	4.0	1.4	5.4
	93.6	461,400	196,900	39,325	13,951	422,075	182,949	8.5	7.1	6.0	2.1	8.1
	80.2	382,600	300,300	102,908	48,959	279,692	251,341	26.9	16.3	15.1	7.2	22.3
9/05	139.0	272,000	292,100	1,724	1,812	270,276	290,288	0.6	0.6	0.3	0.3	0.6
	129.5	270,100	493,700	1,635	1,740	268,465	491,960	0.6	0.4	0.2	0.2	0.4
	113.3	305,600	216,000	7,929	5,503	279,671	210,497	2.6	2.5	1.5	1.1	2.6
	93.6	292,000	223,100	7,492	5,124	284,508	211,976	2.6	2.3	1.5	1.0	2.5
	80.2	340,900	240,800	42,684	29,459	298,216	211.340	12.5	12.2	7.3	5.1	12.4

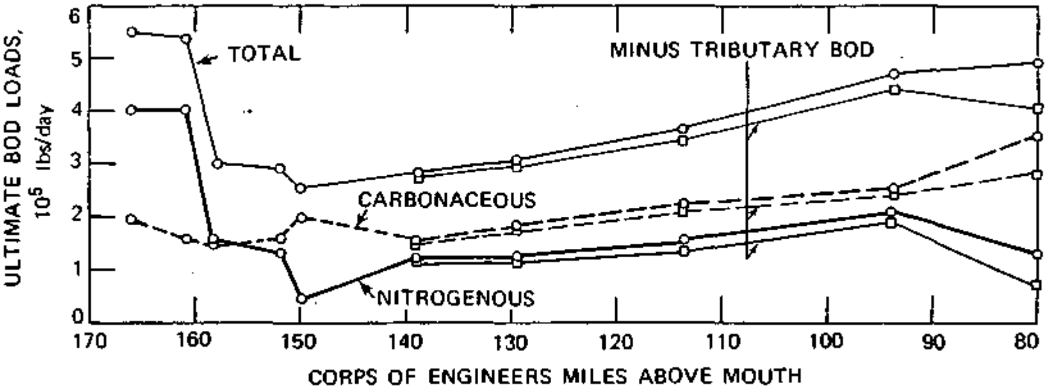


Figure 23. Ultimate BOD loads, June 26, 1979

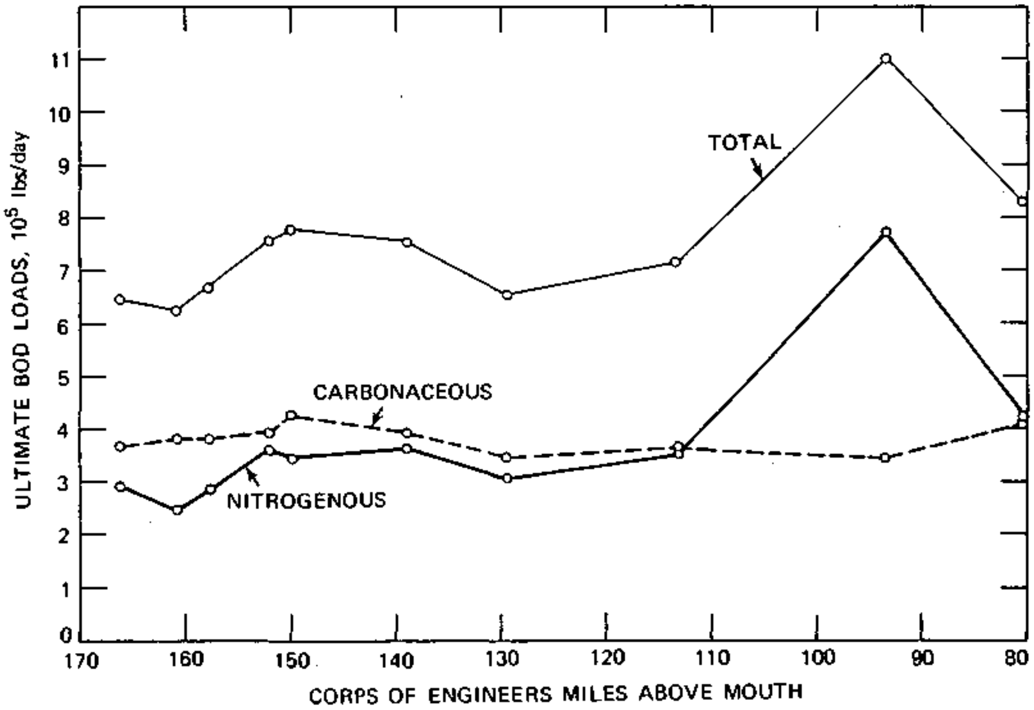


Figure 24. Ultimate BOD loads, July 10, 1979

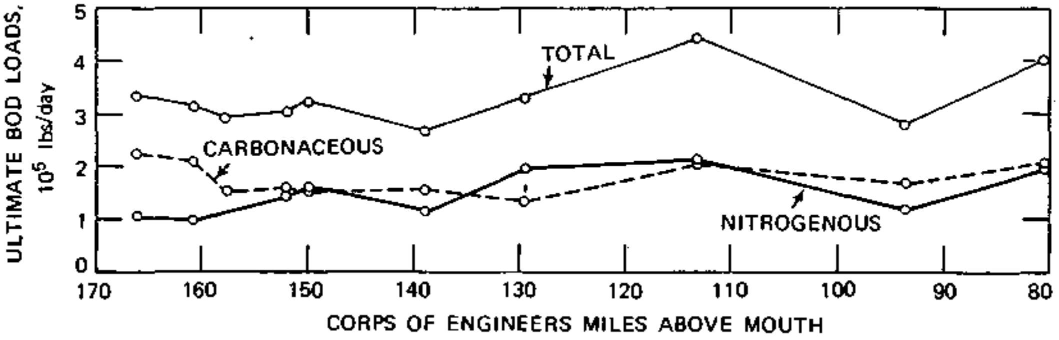


Figure 25. Ultimate BOD loads, July 24, 1979

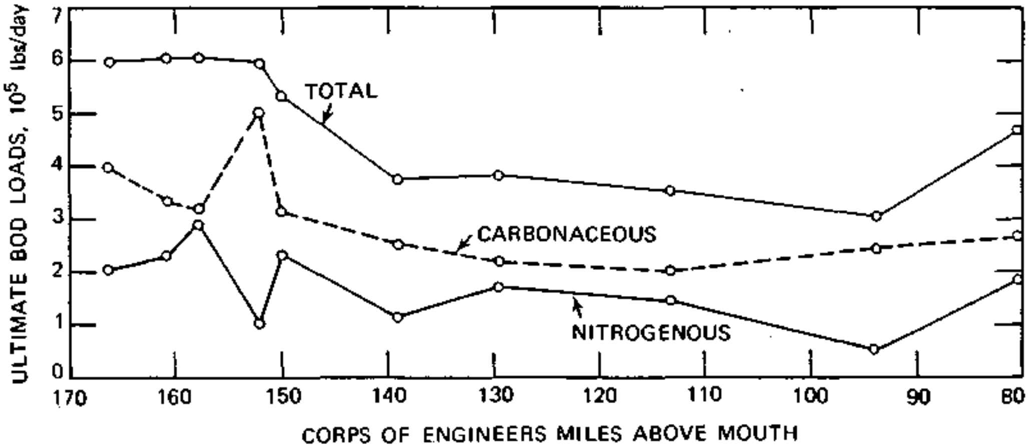


Figure 26. Ultimate BOD loads, August 7, 1979

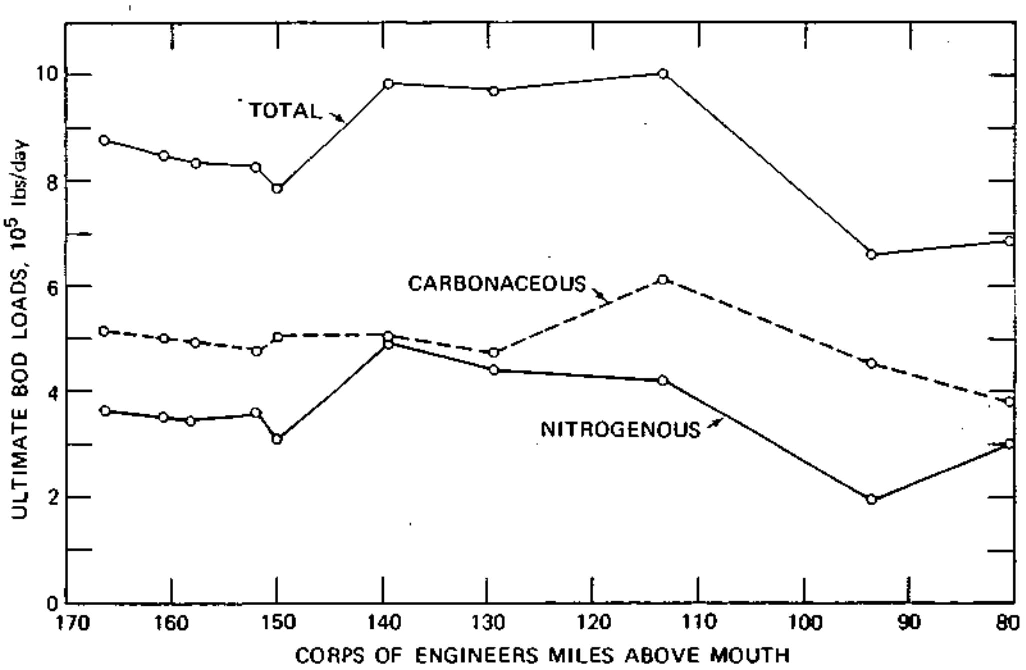


Figure 27. Ultimate BOD loads, August 21, 1979

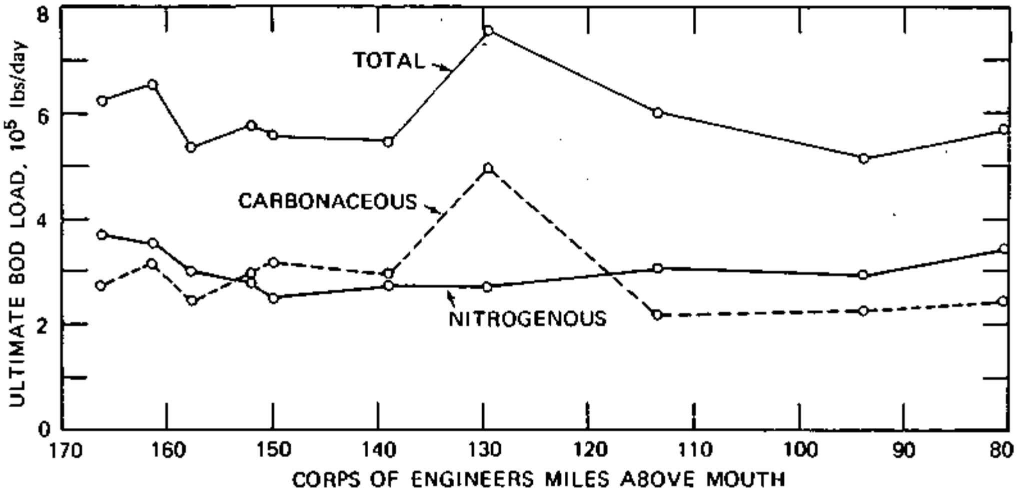


Figure 28. Ultimate BOD loads, September 5, 1979

remains relatively constant or increases slightly in a downstream direction even when the tributary inputs are considered. This indicates either that significant inputs are occurring from nonpoint or unknown point sources or that "slugs" of BOD are being measured. Some of the possible sources are backwater lake overflows, drainage district pumping, and instream channel scour during high flows.

During this study and during the 1973 and 1977 DO runs, large inflows heavily laden with algae were observed to occur from backwater lakes after a sudden drop in the main river channel stage subsequent to extended bankfull or overbank conditions. The existence of many drainage district pumping stations along the banks of the pool makes surface runoff a plausible source. Instream scour, while obviously occurring, does not appear to be a prime contributor based on the sediment survey results; i.e., most of the pool contains relatively clean sand, shells, and gravel, and in the absence of these materials, the bottom is hard pan silt clay which is not easily resuspended.

Through the use of flow and tributary adjusted loads, differences between the stations for incremental BOD concentration inputs have been calculated, and they are presented in table 48. The results presented in the table are rather inconclusive - the data are fragmented and highly variable. Unfortunately on some of the days BOD collections were made, incremental flow additions were negative between some stations. For example, on June 26 the flow decreased from 6378 cfs at MP 166.1 to 6267 at MP 145.5 and then increased to 11,802 cfs at MP 80.2. An extreme case occurred on August 21 at MP 166.1 The estimated flow was 27,648 cfs, and it steadily decreased to 18,193 cfs at MP 80.2. Such occurrences resulted in the appearance of many of the zeros given in table 48. In view of the fact that little or no incre-

Table 48. Computed Carbonaceous and Nitrogenous BOD Concentrations (mg/l) for Uniform Flow Additions between Sampling Stations

	Sampling date											
	6/26		7/10		7/24		8/07		8/21		9/05	
MP	Carb	Nit	Carb	Nit	Carb	Nit	Carb	Nit	Carb	Nit	Carb	Nit
166.1												
	0	0	10.6	47.9	0	0	0	0	0	0	0	25,0
160.7												
	0	0	0.6	0	0	0	0	0	0	0	0	0
157.6												
	0	0	11.28	60.0	0	0	0	0	0	0	0	74.0
152.0												
	0	0	80.7	0	0	0	0	0	0	0	0	0
150.0												
	0	0	0	10.2	0	0	0	0	0	0	4.5	0
139.0												
	5.2	0	0	0	0	0	0	0	0	0	0	40.0
129.5												
	6.9	2.3	81.8	357.2	12.7	1.6	0	0	0	0	1.2	0
113.3												
	2.8	5.4	0	2901	0	0	0	0	0	0	0.4	0.2
93.6												
	7.0	0	381.0	0	0	20.52	0	0	0	0	1.8	0
80.2												

mental addition in flow occurred much of the time during BoD sampling, the peaks in BOD loads evident in figures 23 through 28 may be partially the result of slug loads passing through the pool during periods of very unstable flows.

The BOD concentrations, as opposed to loads, definitely tended to decrease in a downstream direction, as shown in table 35. However, a commensurate downstream change in flow occurred, as demonstrated by the curves shown in figure 29. Between MP 157.6 at the Peoria dam and MP 93.6 above the Sangamon River, the flow increased 13.3 percent while total BOD concentration decreased 13.3 percent. This is just another means of verifying the relatively static average BOD loads summarized in table 36. This implies that under the flow regimes sampled, BOD additions are being supplied at approximately the same rate as the ambient loads are being reduced..

Figures 30 and 31 demonstrate the extreme variability in ammonia and nitrate-nitrogen loads experienced during the study. Two facts relative to the ammonia data and the average curve are evident. Noticeable ammonia additions occur in the Peoria-Pekin area, and loads throughout the pool remain relatively constant. The nitrates show a slight increase downstream on the average. This is expected in that this form of nitrogen is common in surface runoff from agricultural lands, and it is an end product of the oxidation of ammonia indigenous to the pool.

As mentioned previously, 4.57 mg/l of oxygen is required to completely oxidize 1.0 mg/l of ammonia-N. In other words, 1.0 mg/l of ammonia can

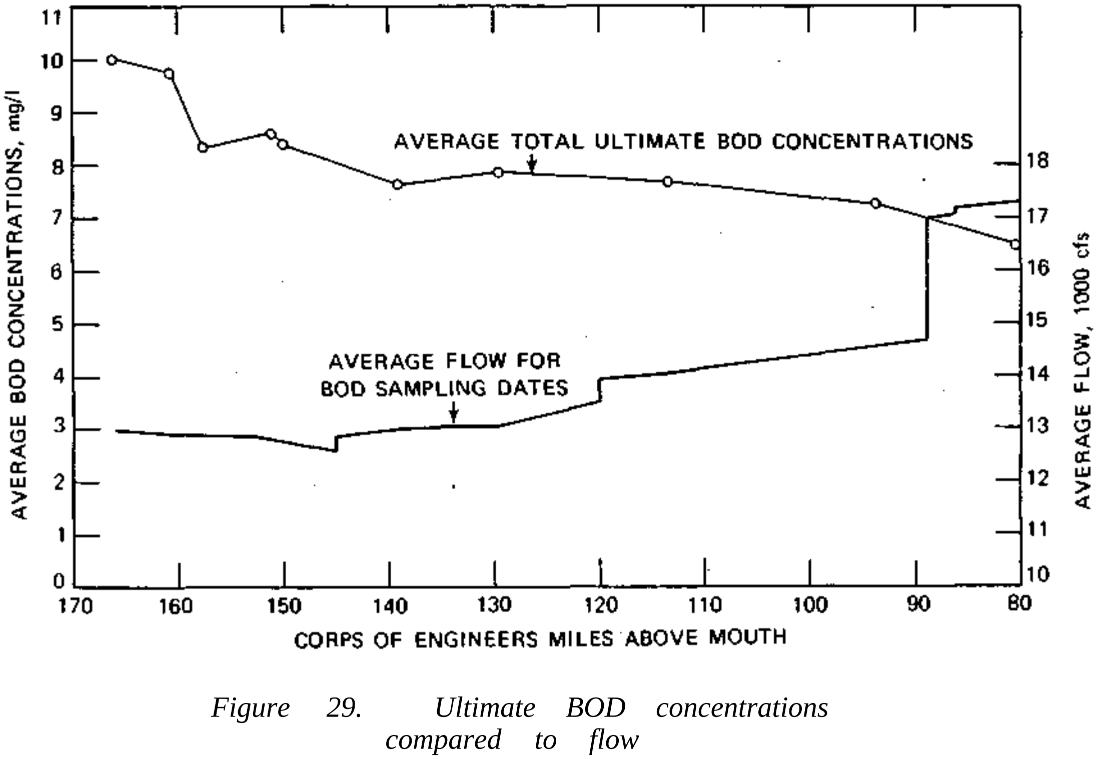


Figure 29. Ultimate BOD concentrations compared to flow

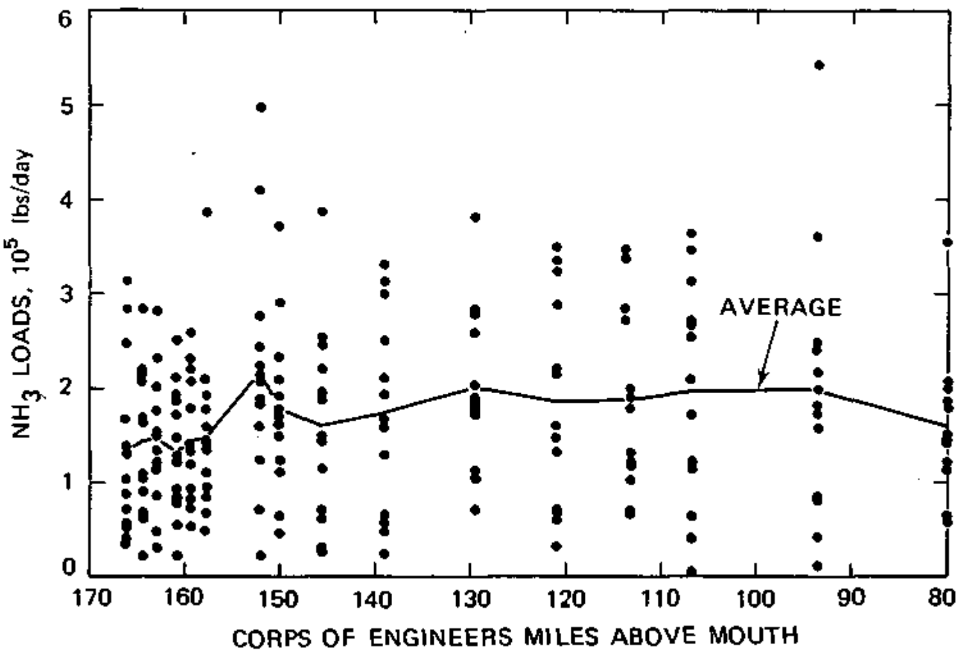


Figure 30. warm weather ammonia-nitrogen loads

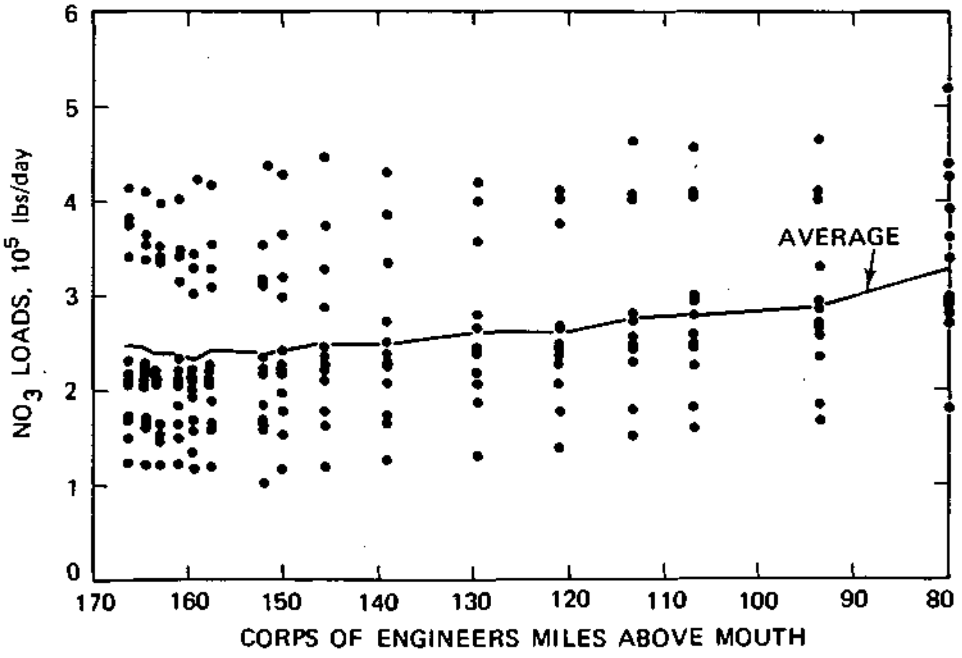


Figure 31. Warm weather nitrate-nitrogen loads

theoretically be expected to produce 4.57 mg/l of ultimate nitrogenous BOD. The ammonia concentrations measured in the river during this study are not of sufficient magnitude to account for most of the nitrogenous BOD values observedo For example, on June 26 at station 152.0 the ammonia-N concentration was 0.47 mg/l, which should have resulted in an ultimate nitrogenous BOD of 2.15 mg/l. However, on this date at this station, the ultimate nitrogenous BOD was 4.08 mg/l under laboratory conditions.

On rare occurrences a fairly good match does occur, as was the case at station 152.0 on July 24. The ammonia concentration was 1.25 mg/l, giving a theoretical ultimate second stage BOD of 5.71 mg/l versus a laboratory determination of 4.60 mg/l. The correlation coefficients contained in table 41 reveal that NH -N is the parameter most highly correlated to nitrogenous BOD, although the correlation is small; it is however, statistically significant at the 5 percent level.

The reason for the weak correlation is not readily apparent. The sampling technique and sample preservation procedure have been thoroughly tested and are not felt to be inadequate in any way. Supportive of this contention is the fact that the ammonia results of routine weekly water chemistry sampling of the Illinois River at approximately the same site as sampling station 160.7 yielded an average NH -N concentration of 0.234 mg/l versus 0.194 mg/l for study samples. Both sample groups were composed of 13 samples, and no statistically significant difference could be shown to exist between the means at the 5 percent level.

Summary

1) Ten stations on the main stem of the Illinois River were sampled for BOD. Two stations were located above the Peoria lock and dam, while eight were in the LaGrange pool. The Mackinaw, Spoon, Sangamon, and LaMoine Rivers were sampled near their confluence with the Illinois River in the LaGrange pool. Collections were made on six dates starting in late June and ending in early September.

2) Long-term BOD analyses were performed following a general sequence of 2, 3, 4, 5, 7, 9, 10, 12, 15, 18, and 20 days. Total and nitrifying inhibited BODs were directly measured. The inhibited results were considered representative of the carbonaceous oxygen demand, while the difference between the inhibited and the total demand was assumed to be the second stage or nitrogenous demand.

3) The carbonaceous BOD composition averaged 56 percent of the total BOD, versus 57 percent observed during the last comprehensive study done during 1965 through 1967. The average carbonaceous composition for the tributaries was 65 percent.

4) The flows encountered on the sampling dates ranged from moderately high to very high. Over this wide range of flows.the ultimate total BOD concentrations remained relatively constant at a given station; and while these concentrations, ranging from a maximum of 16.37 at MP 166.1 to a minimum of 4.54 at MP 80.2, were not excessively high they represented hundreds of thousands of pounds of BOD. Because of the high flows the total BOD loads in the river were much higher than those observed during the 1965-1967 study.

5) No single or primary source of the loads could be isolated. Knowledge of the area suggests that the sources may be a combination of nonpoint and surface runoff, possibly some backwater lake drainage, upstream inflow, and some contributions from the Peoria-Pekin area. Stepwise regression techniques, employing 14 independent variables, failed to reveal any parameters which are highly correlated to BOD in the study area. The major tributaries at times produce a small but significant input. The Sangamon River is an especially large contributor at times, with its input representing as much as 30 percent of the river load. However, this load is discharged to the last 9 miles of the pool and its effect is probably felt more in the Alton pool.

6) The total and carbonaceous BOD curves fit first order kinetics very well. The nitrogenous curves are less definitive, but simple first order fits appeared to be appropriate for modeling purposes. The carbonaceous curves displayed essentially no lag times in their structure. However, on some dates and at some stations significant lag times were derived for the best fits for the second stage curves.

7) Ammonia-nitrogen concentrations were relatively low. Upstream residuals in combination with a noticeable input at Peoria-Pekin maintained NH -N at levels at generally less than 0.5 mg/l. The measured ammonia could not fully account for the ultimate nitrogenous BOD measured in the laboratory at 20°C. Nitrate-nitrogen loads increased steadily in a downstream direction, indicating that nitrification was occurring in the pool and/or that agricultural runoff was contributing significantly to the water quality in the pool.

DISSOLVED OXYGEN MODELING

Low dissolved oxygen concentrations have plagued the reach of the Illinois River between Peoria and Beardstown since the completion of the LaGrange lock and dam and the attendant formation of the LaGrange pool in 1939. From 1964 to 1971 William C. Starrett of the Illinois Natural History Survey made yearly water quality sampling runs starting at the lower end of the Alton pool and ending at the Lockport lock and dam. (W.C. Starrett, personal communication, 1971). During each of these yearly runs, the minimum DO level in the pool fell below present-day Illinois Environmental Protection Agency minimum standards as specified under rules of the Illinois Pollution Control Board. The LaGrange pool falls under rule 203(d) which states:

> Dissolved oxygen 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.

On the last run made by Starrett on July 1, 1971, the majority of the DO concentrations were below 2.0 mg/l in the lower half of the pool, and long reaches fell as low as 1.0 mg/l.

During the 1965-1967 study of the LaGrange pool by Butts et al. (1970), minimum DOs as low as 0.4 mg/l were observed under extremely low flows of long duration. Subsequent to this last formal study of the pool, the State Water Survey has conducted two monitoring studies of the DO resources in the pool. Seven runs were made during the summer of 1973, and 12 during 1977. Minimum DOs observed during 1973 and 1977 were, respectively, 3.0 mg/l and 2.2 mg/l. Obviously chronic low DOs still plague the pool even after the upgrading of almost all sewage and industrial waste plants along the entire Illinois Waterway system.

The objectives of this phase of the study were (1) to integrate updated parametric information into the State Water Survey BOD-DO water quality model for evaluating ambient ongoing conditions, and (2) to use this information to evaluate the effects increased Lake Michigan diversion will have on the DO resources of the pool.

Methods

The basic model used by the SWS to evaluate BOD-DO relationships in a flowing stream is a simple one-dimensional model in which the basic components are computed separately and then algebraically combined to obtain a net DO concentration. The basic formulation is:

$$DO_n = DO_a - DO_u + DO_r + DO_x \qquad (14)$$

where

$D0_n$ = net dissolved oxygen at end of a reach

DO_a = initial dissolved oxygen at beginning of a reach

DO_u = dissolved oxygen biologically used

DO_r = dissolved oxygen addition through aeration

DO_x = dissolved oxygen inputs of tributaries

Details of the methodologies that can be used to compute the various components of equation 14 are outlined in detail in previous SWS publications and reports (Butts et al., 1970, 1974, 1975).

The DO term in this work includes DO usage due to carbonaceous and nitrogenous BOD and to sediment oxygen demand. Both forms of dissolved BOD are assumed to follow first order biochemical oxidation reactions. SOD inputs are in units of $g/m^2/day$ and are converted to concentrations (mg/l) for given reaches. SOD was adjusted for temperature variations in conjunction with a 0 value of 1.047. SODs specific to the reaches in question within the pool were estimated using the empirical regression equation previously presented; i.e., SOD = 0.05T - 0.09N - 0.07.

The aeration factor, DO , was computed using the theoretical concepts advocated by Velz (1947, 1970). Dissolved oxygen saturation values (DO) were computed by the following formulation (Committee on Sanitary Engineering Research, 1960) :

$$DO_s = 14.652 - 0.41022T + 0.007991\ T^2 - 0.000077774t^3 \qquad (15)$$

Dissolved oxygen inputs of tributaries were adjusted on a mass balance basis.

Hydraulic and hydrologic parameters were computed using a flow and time-of-travel simulating program based on volume displacement. Cross-sectional data were updated using the most recent Corps of Engineers 1977 and 1978 soundings. Flows were based on values reported by the U.S. Geological Survey for the main stem gaging stations at Marseilles, Kingston Mines, and Meredosia, and for gages on the major tributaries. Unit flow for incremental stream additions was computed by subtracting tributary flows from the flow difference between two consecutive main stem gages, dividing by the mileage separating the main stem gages, and then -multiplying this by the mileage from the upstream gage to the point in question. Flow duration curves were plotted for the main stem gaging stations using the data published by Curtis (1969). Stream mileages utilized in the computer input for the time-of-travel program differ somewhat from those used by the Corps of Engineers. The horizontal and longitudinal distances were electronically traced from the areal maps supplied by the Corps, which contain their latest sounding information. These electronically traced values were fed directly into the time-of-travel computer program without any adjustments.

Dissolved oxygen and temperature measurements were made at 6-foot depths at 29 stations within the pool on 25 dates. Also, eight stations were measured in the Peoria pool above the Peoria dam and on the Mackinaw, Spoon, Sangamon, and LaMoine Rivers near their mouths. Galvanic cell DO analyzers equipped with temperature probes were used to collect DO and temperature data. The DO probes were frequently checked by the Winkler method and/or by air calibration.

When DO_n, DO_a, and DO_x are known and DO_r is estimated, the DO used per reach can be c6mputed from equation 14. By summing up the accumulation of DO with time-of-travel through pool, a calculated BOD curve can be generated which represents the total oxygen demand (including any effects of SOD) which is needed to obtain the observed DO sag curve. Such curves were generated for each of the 25 dates on which DO observations were made. Ultimate BODs (L) and deoxygenation rates (K_1) can be computed in a fashion similar to those presented previously for measured BOD data.

Simulation runs were made using the BOD loads generated in conjunction with hydraulic and hydrologic conditions for diversions of 6600 cfs and 10,000 cfs superimposed upon 7-day, 10-year low flows.

Results

The differences in the SWS-traced mileages within the pool and those used by the Corps are presented in table 49. All tabular references to milepoint (MP) sampling stations will be given according to the Corps designations. However, all model computations are based on SWS-derived values.

Figure 32 presents the flow duration curves for the Marseilles, Kingston Mines, and Meredosia gages. Figure 33 shows hydrographs of stream flow which occurred during April through September 1979. The vertical arrows represent significant rainfall occurrences at Peoria during the sampling period. Tables 50 and 51 summarize flow conditions encountered during each of the sampling dates.

A summary of the unreduced DO and temperature measurements is presented in table 52. Table 53 summarizes the DO and temperature data collected during 1973 and 1977, and table 54 presents information on corresponding flows.

Table 49. Comparison of Corps of Engineers (COE) Milepoints and Those Traced by the State Water Survey (SWS)

Sampling point mile designation		Sampling point mile designation	
COE	SWS	COE	SWS
157.6	158.16	121.1	121.41
155.0	155.61	119.7	120.03
153.0	153.66	116.3	116.59
152.0	152.64	113.3	113.65
151.0	151.68	110.2	110.44
150.0	150.70	106.9	107.10
148.2	148.71	103.4	103.50
147.3	148.12	99.5	99.69
145.5	146.10	97.2	97.58
143.2	143.87	93.6	93.60
139.0	139.61	89.2	89.23
135.7	136.14	85.5	85.49
132.0	132.58	82.3	82.19
129.5	129.99	80.2	80.07
125.8	126.28		

	MP	
Tributary confluence	COE	SWS
Mackinaw	147.8	148.45
Spoon	120.5	120.82
Sangamon	88.9 (98.0)	88.94 (98.19)
LaMoine	83.7	83.66
Gaging stations		
Kingston Mines	145.3	145.95
Meredosia	71.1	70.07

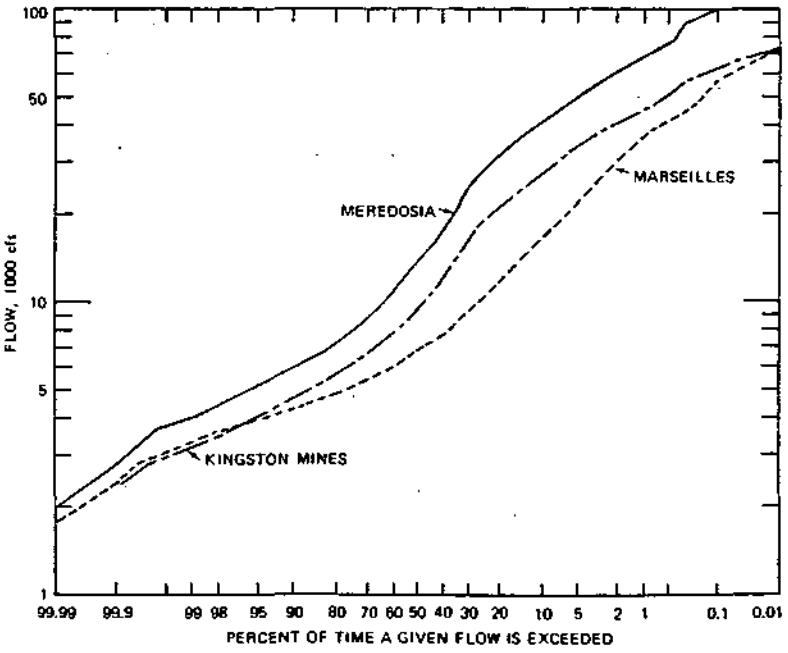


Figure 32. Flow duration curves for USGS gaging stations at Marseilles, Kingston Mines, and Meredosia

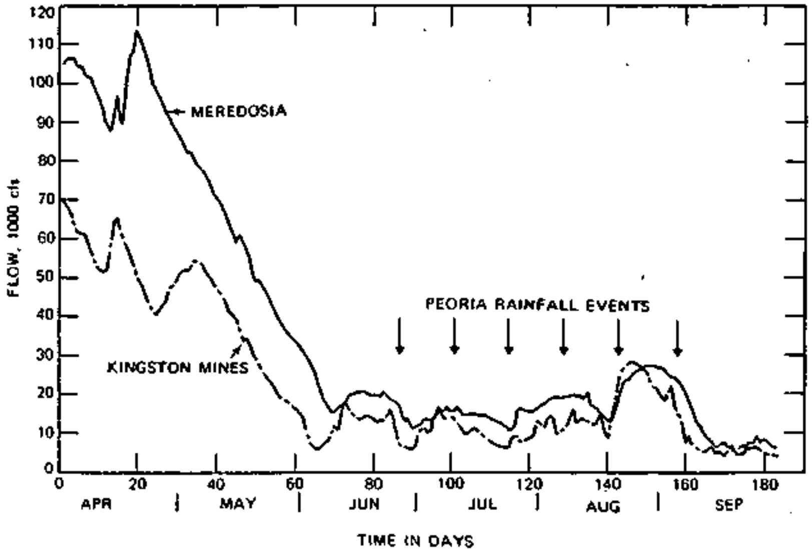


Figure 33. Flow hydrographs for Kingston Mines and Meredosia USGS gaging stations, 1979

Table 50. Main Stem Flows and Flow Durations
Encountered during 1979 Sampling Dates

Date	t_2	Flow (cfs)			Duration (%)		
1979	days	Mer	KM	Mar	Mer	KM	Mar
6/20	3.13371	19300	12300	7280	37.0	39.5	44.3
6/25	3.81291	17900	8450	4840	39.8	55.5	80.0
6/26	4.20983	16200	6400	5300	42.2	72.4	72.0
7/2	3.06318	13500	11800	6040	51.0	40.8	59.9
7/3	3.45253	13400	9800	6520	51.5	48.0	53.8
7/9	2.80950	15800	14000	7470	43.8	34.5	42.3
7/10	2.92931	15600	13600	7580	44.0	35.5	41.9
7/16	3.42233	14600	10100	7190	47.0	47.0	46.2
7/17	3.50128	14300	9590	7800	48.0	49.7	39.0
7/23	4.42456	11500	6300	4620	58.0	73.5	84.8
7/24	4.68660	10400	6100	6290	62.0	75.2	56.0
7/30	3.41540	15300	9170	12500	45.0	51.5	17.7
7/31	2.89122	16000	13000	11900	42.5	37.5	19.5
8/6	3.48541	19000	10300	11800	37.5	46.0	20.0
8/7	3.34196	19100	11200	10400	37.0	42.5	25.0
8/13	2.73530	20600	13000	8780	34.5	37.4	33.5
8/14	3.44693	12100	12500	6990	56.0	38.8	48.5
8/20	2.23204	16100	19700	17800	45.5	23.0	8.5
8/21	2.13196	19700	24900	26500	36.0	13.2	3.0
8/27	2.20270	27200	26300	13100	26.3	11.2	16.0
8/28	2.22924	27400	25800	11400	26.1	12.0	21.6
8/29	2.39937	27500	22500	12300	26.0	16.8	18.4
8/30	2.40900	27100	22000	9280	26.4	17.6	30.5
9/4	2.62342	24500	17100	7950	31.6	28.6	37.9
9/5	2.78925	23900	14900	5870	31.5	33.1	62.4

Note: Mer = Meredosia, KM = Kingston Mines, Mar = Marseilles

Table 51. LaGrange Pool Tributary Stream Flows for 1979 Sampling Dates

	Tributary flows (cfs)			
Date	Mackinaw	Spoon	Sangamon	LaMoine
6/20	249	1383	1532	254
6/25	157	620	1149	183
6/26	148	596	1149	182
7/2	116	486	1008	151
7/3	116	441	1001	151
7/9	133	439	1074	143
7/10	126	413	1340	143
7/16	594	880	1245	93
7/16	339	786	1394	121
7/23	95	264	987	73
7/24	89	254	966	74
7/30	582	619	3159	286
7/31	434	922	3234	177
8/6	175	260	7787	169
8/7	153	232	7745	110
8/13	117	163	2340	52
8/14	105	145	2074	52
8/20	169	307	1085	48
8/21	161	823	1181	273
8/27	292	391	1447	78
8/28	225	334	1500	56
8/29	185	283	1394	47
8/30	158	249	1287	41
9/4	84	154	883	69
9/5	77	145	835	49

Table 52. Summary of 1979 Temperature and DO Results for 25 Observation Dates

Sta	Temperature	(°C)		DO concentration	(mg/l)	
MP	Max	Avg	Min	Max	Avg	Min
166.1	29.8	25.5	22.2	7.0	6.42	5.6
165.3	30.0	25.4	22.2	9.7	6.80	5.2
164.4	29.5	25.3	22.0	8.1	6.31	5.3
162.8	29.5	25.3	22.0	8.1	6.51	5.4
161.6	29.5	25.4	22.0	8.3	6.46	5.4
160.7	29.8	25.4	22.0	8.1	6.44	5.3
159.4	30.0	25.4	22.0	9.3	6.69	5.4
158.0	29.8	25.4	22.0	8.9	6.32	5.3
157.6	29.8	25.5	23.0	8.8	6.52	5.3
155.0	29.8	25.6	22.8	8.4	6.52	5.3
153.0	30.0	25.8	23.0	8.3	6.54	5.5
152.0	30.0	25.8	23.0	8.2	6.50	5.5
151.0	29.8	25.8	23.0	8.8	6.50	5.4
150.0	29.5	25.8	23.0	8.8	6.43	5.4
148.2	29.5	25.7	23.0	8.3	6.36	5.5
147.3	29.5	25.7	23.0	8.1	6.38	5.5
145.5	29.8	25.6	23.0	7.6	6.30	5.3
143.2	29.5	25.7	23.0	7.7	6.22	5.3
139.0	29.5	25.7	23.0	7.4	6.00	4.7
135.7	29.5	25.7	22.8	7.4	5.97	4.7
132.0	29.5	25.7	23.0	7.5	5.95	4.9
129.5	29.2	25.7	23.0	7.6	5.95	4.9
125.8	29.2	25.7	23.0	7.5	5.91	4.7
121.1	29.0	25.7	23.0	7.1	5.71	4.6
119.7	29.0	25.7	23.0	7.4	5.85	4.6
116.3	29.0	25.7	23.0	6.9	5.71	4.6
113.3	29.0	25.7	23.0	7.0	5.70	4.6
110.2	29.0	25.8	23.2	7.2	5.62	4.5
106.9	29.0	25.8	23.2	6.8	5.56	4.5
103.4	29.0	25.8	23.2	6.6	5.46	4.3
99.5	29.0	25.8	23.5	6.4	5.33	4.3
97.2	29.0	25.8	23.5	6.4	5.33	4.3
93.6	28.8	25.8	23.5	6.3	5.24	4.3
89.2	28.8	25.9	23.8	6.5	5.21	4.2
85.5	28.2	25.9	23.8	6.7	5.22	4.1
82.3	28.0	25.9	23.8	7.5	5.40	4.1
80.2	28.0	25.9	23.8	7.3	5.42	4.0
Mackinaw	29.0	24.6	20.8	12.2	9.31	5.7
Spoon	31.0	26.6	24.0	11.2	7.34	4.1
Sangamon	28.5	25.8	23.0	15.3	10.32	5.5
LaMoine	30.5	25.6	21.0	16.0	7.79	5.2

The computed ultimate total BODs at the uppermost station in the LaGrange pool, based on the use of equation 14 in conjunction with observed DO and temperature data and estimated reaeration, are summarized in table 55 and compared to laboratory values when possible. Superficially, the comparison looks poor; however, one must keep in mind that the laboratory BODs reflect only dissolved BOD, whereas the computed values take into account the DO drop in the pool due to both dissolved BOD and SOD. Also, the computed curves are fitted to data involving relatively short time intervals. Time-of-travel during the BOD collection dates ranged from just a little more than two to fewer than five days. Mathematically, in the curve fitting technique, these short time intervals tend to result in higher deoxygenation rates (K) and lower ultimates. This is evident from the data in table 55. Similar results have been observed in other waste assimilative investigations con-

Table 53. Summary of 1973 and 1977 Temperature and DO Results

	1973 data (n=7)						1977 data (n=12)					
	Temperature (°C)			DO conc. (mg/l)			Temperature (°C)			DO conc. (mg/l)		
MP	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min
166.1	28.2	25.2	20.1	7.2	6.10	4.9	29.2	25.1	19.1	11.05	6.62	5.4
165.3	28.4	25.2	20.3	7.45	6.41	5.8	28.3	25.6	19.5	9.3	6.56	5.15
164.4	28.3	25.3	20.5	7.3	6.30	5.6	28.2	24.6	19.9	8.95	6.52	5.35
162.8	28.8	25.3	20.1	7.1	6.24	4.9	28.2	24.6	19.8	9.1	6.33	5.0
161.6	28.6	25.2	20.3	7.1	6.24	5.0	28.9	24.7	18.8	8.75	6.08	4.55
160.7	28.5	25.3	20.5	7.2	6.30	4.9	29.0	24.9	19.8	8.6	6.16	4.85
159.4	28.5	25.3	20.7	7.2	6.20	4.85	29.9	24.9	19.8	8.5	6.09	4.5
158.0	28.6	25.3	20.4	6.85	6.06	4.7	29.9	25.0	20.0	8.1	5.84	4.25
157.6	28.4	25.3	20.3	7.75	6.75	5.35	31.0	26.0	19.9	8.4	6.53	5.65
155.0	28.5	25.4	20.1	7.6	6.74	5.5	31.1	26.1	20.7	8.6	6.48	5.6
153.0	28.7	26.0	21.1	7.4	6.62	5.35	31.1	26.6	21.3	8.5	6.30	5.1
152.0	28.7	26.0	20.9	7.15	6.50	5.3	31.0	26.6	21.5	8.0	6.10	4.9
151.0	28.6	25.9	21.0	7.2	6.46	5.2	31.0	26.6	21.5	8.0	5.96	4.75
150.0	28.6	25.8	21.0	6.8	6.24	4.95	30.9	26.6	21.5	7.85	5.87	4.55
148.2	28.7	25.8	21.0	6.65	6.07	4.9	30.7	26.4	21.4	7.9	.5.78	4.5
147.3	28.8	25.7	21.0	6.6	6.08	4.9	30.8	26.4	21.6	7.8	5.73	4.4
145.5	28.4	25.7	21.4	6.75	6.06	4.85	29.5	26.3	21.5	7.6	5.73	4.7
143.2	28.6	25.7	21.7	6.75	5.97	4.8	29.8	26.4	21.5	7.8	5.73	4.8
139.0	28.9	25.8	21.6	6.4	5.53	4.35	29.9	26.6	22.2	8.0	5.57	4.3
135.7	28.8	25.7	21.1	6.95	5.58	4.4	29.9	26.7	22.1	7.75	5.44	4.2
132.0	28.8	25.9	21.2	7.85	5.66	4.1	30.1	26.8	21.8	7.5	5.43	4.0
129.5	28.8	25.9	21.3	7.25	5.55	4.05	30.0	26.7	22.0	8.2	5.46	3.85
125.8	28.6	26.0	22.3	7.0	5.34	3.75	30.0	26.8	22.1	8.0	5.02	3.5
121.1	28.8	26.2	22.4	7.1	5.17	3.3	30.2	27.1	22.6	8.1	4.87	3.25
119.7	28.8	26.1	22.1	7.4	5.41	3.6	30.2	27.0	22.5	9.0	5.04	3.3
116.3	28.8	26.2	22.3	7.15	5.17	3.35	30.9	27.3	22.7	8.0	4.69	3.15
113.3	28.8	26.2	22.3	7.25	5.10	3.30	30.9	27.3	22.8	8.4	4.70	3.05
110.2	28.8	26.2	22.3	7.4	5.05	3.25	30.8	27.1	22.3	7.4	4.57	2.8
106.9	28.8	26.3	23.0	7.05	4.90	3.35	30.5	27.1	22.4	7.45	4.51	2.8
103.4	28.8	26.4	22.4	6.8	4.79	3.5	31.3	27.3	22.2	7.95	4.63	2.65
99.5	28.8	26.3	22.5	6.9	4.66	3.2	31.0	27.2	22.2	8.0	4.46	2.25
97.2	28.8	26.4	22.6	7.1	4.68	3.05	30.9	27.2	22.5	7.6	4.28	2.4
93.6	28.8	26.4	22.8	6.8	4.58	3.0	31.0	27.3	22.2	7.4	4.27	2.4
89.2	28.8	26.3	22.7	6.6	4.61	3.15	31.0	27.4	22.7	8.15	4.51	2.15
85.5	28.4	25.8	22.2	5.5	4.58	3.5	31.0	27.6	22.3	8.6	4.65	2.55
82.3	28.8	26.0	22.2	6.6	5.01	3.5	31.1	27.5	22.1	7.7	4.65	2.3
80.2	28.8	25.8	22.3	5.4	4.54	3.2	31.2	27.5	22.6	7.8	4.49	2.25
Mack.	24.4	21.4	16.5	9.3	7.80	6.2	32.0	23.1	19.5	16.1.	8.95	5.4
Spoon	26.5	23.8	19.3	7.65	6.76	5.7	31.2	26.1	19.7	10.7	6.53	2.5
Sang.	28.8	26.3	22.0	8.3	5.4	3.5	28.2	24.0	21.5	15.4	9.48	6.2
LaMo.	26.2	22.6	19.8	6.3	4.88	3.2	29.9	25.8	21.7	10.3	6.68	4.3

ducted by the SWS (Butts et al., 1970, 1974, 1975). However, these results basically are compatible, as will be demonstrated subsequently.

The true effect of BOD on DO in a confined reach or pool is a function not only of the ultimate BOD but also of the deoxygenation rate. A high deoxygenation rate in conjunction with a relatively low ultimate load can often produce the same DO sag curve as a high ultimate load with an attendant low deoxygenation rate. Table 56 demonstrates that essentially the same amount of BOD was expended for both computed and laboratory values (corrected for SOD) within the time-of-travel constraints for each date.

Figures 34 through 37 depict simulation results which encompass all phases of flow ranges encountered during the study. Also shown on these figures are the predicted DO curves for diversion flows of 6600 cfs and

Table 54. Main Stem Flows and Flow Durations Encountered during 1973 and 1977 Sampling Dates

	Flow (cfs)			Duration (%)		
Date	Her	KM	Mar	Mer	KM	Mar
7/10/73	41,100	21,100	8,410	9.5	19.5	35.0
7/17	25,800	7,590	4,760	28.5	62.5	82.0
7/25	21,000	12,600	8,980	34.2	39.0	32.5
8/03	22,800	9,820	6,580	32.5	47.5	53.0
8/20	11,200	7,850	4,600	59.0	60.5	85.5
9/06	9,060	6,470	4,500	68.5	72.0	87.5
9/14	7,400	6,350	4,000	79.0	72.5	93.7
5/25/77	12,700	7,680	4,960	54.0	76.5	78.5
6/09	7,230	4,800	5,310	79.5	81.0	72.0
7/01	7,600	7,500	11,700	77.5	63.0	20.5
7/07	9,800	7,880	5,050	65.0	60.0	76.5
7/11	8,700	7,560	4,300	71.0	62.5	90.5
7/14	8,180	6,650	3,710	74.0	70.5	96.9
7/20	9,290	7,700	4,920	67.5	61.5	78.8
7/22	9,230	8,430	3,600	67.8	55.6	97.9
7/25	7,550	7,030	4,320	78.0	67.0	90.2
7/28	7,070	6,150	3,650	81.5	75.0	97.5
8/15	25,000	20,000	12,100	30.0	22.0	19.0
8/19	22,500	8,530	4,980	33.0	55.0	77.8

Note: Mer = Meredosia, KM = Kingston Mines, Mar = Marseilles

Table 55. Comparison of Computed BODs (DO Drop and Aeration) versus Bottle BODs Incubated in the Laboratory at 20°C

	Ultimate BOD (mg/l)		Deoxygenation rates (l/day)		Computed BOD values adjusted for
Date	Computed	Bottle*	Computed	Bottle*	SOD usage
6/20	5.45		0.293		4.60
6/25	6.19		0.225		5.23
6/26	9.52	9.35	0.195	0.140	8.45
7/02	6.10		0.360		5.23
7/03	4.97		0.218		3.99
7/09	3.94		0.337		3.22
7/10	6.53	10.51	0.294	0.158	5.74
7/16	8.67		0.273		7.61
7/17	8.54		0.227		7.48
7/23	8.67		0.191		7.14
7/24	10.09	10.22	0.199	0.163	8.52
7/30	9.40		0.256		8.25
7/31	7.83		0.334		6.90
8/06	6.16		0.272		5.00
8/07	7.46	11.93	0.287	0.185	6.33
8/13	8.24		0.223		7.51
8/14	6.48		0.293		5.60
8/20	3.80		0.440		3.19
8/21	2.84	6.48	0.359	0.152	2.34
8/27	3.32		0.402		2.81
8/28	3.72		0.370		3.24
8/29	4.05		0.282		3.52
8/30	4.21		0.352		3.65
9/04	5.02		0.292		4.33
9/05	5.62	7.94	0.357	0.160	4.88

*MP 157.6 values adjusted to ambient river temperature (see Butts et al., 1973)

Table 56. Comparison of Computed BODs and Bottle BODs for BOD Expended within the LaGrange Pool

Date	Time-of-travel (days)	BOD expended in pool (mg/l)		
		Computed	Bottle	Bottle and SOD
6/26	4.20983	5.33	4.16	5.23
7/10	2.92931	3.77	3.89	4.68
7/24	4.68660	6.12	5.46	7.03
8/07	3.34196	4.69	4.69	5.82
8/21	2.13196	2.31	3.30	3.80
9/05	2.78925	3.54	2.86	3.60

10,000 cfs superimposed upon ambient conditions observed or calculated for each date. Table 57 is a summary of the observed versus computed minimum DOs for each date. Also included are the minimum values predicted to occur during the two selected diversion flows; these predicted minimum values are contingent upon the fact that the reaeration at the Peoria dam will remain unchanged with increased diversion. This is probably an invalid assumption, as will be noted later in this discussion.

Figures 38 through 43 show the simulation fits achieved using laboratory BODs obtained at station 157.6 for the six dates on which BOD collections were made. Incremental SOD rates were calculated according to equation 9 and used to compute DO usage in conjunction with BOD at MP 157.6.

Table 57. Summary of Observed and Computed Minimum DO Concentrations within the LaGrange Pool

Date	Observed at ambient Q	Computed at ambient Q	Computed at Q + 6600 cfs	Computed at Q + 10,000 cfs
6/20	5.3	4.8	5.4	5.6
6/25	5.9	5.8	6.6	6.9
6/26	5.8	5.7	6.8	7.1
7/2	6.3	5.6	6.6	6.8
7/3	5.5	6.6	7.2	7.4
7/9	5.8	5.5	6.4	6.1
7/10	4.7	4.6	5.5	5.7
7/16	4.3	4.1	5.3	5.5
7/17	4.3	4.5	5.7	5.9
7/23	5.7	5.4	6.6	6.8
7/24	4.7	4.8	5.5	6.0
7/30	4.0	3.6	4.9	5.3
7/31	4.0	3.4	4.6	4.9
8/6	5.1	4.5	5.6	5.8
8/7	4.7	4.1	5.6	5.8
8/13	4.6	5.0	5.7	6.0
8/14	5.0	4.7	5.8	6.2
8/20	5.6	5.4	6.0	6.2
8/21	4.9	4.9	5.2	5.3
8/27	5.1	4.9	5.1	5.2
8/28	4.9	3.6	5.0	5.1
8/29	5.4	5.2	5.7	5.8
8/30	5.0	4.8	5.3	5.4
9/4	4.9	4.8	5.2	5.4
9/5	4.9	4.3	5.0	5.2

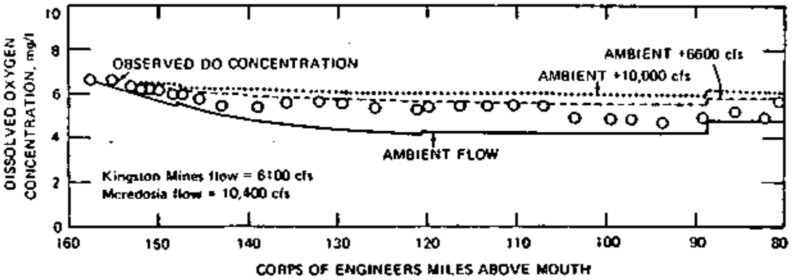


Figure 34. Simulation results based on computed BOD, July 24, 1979

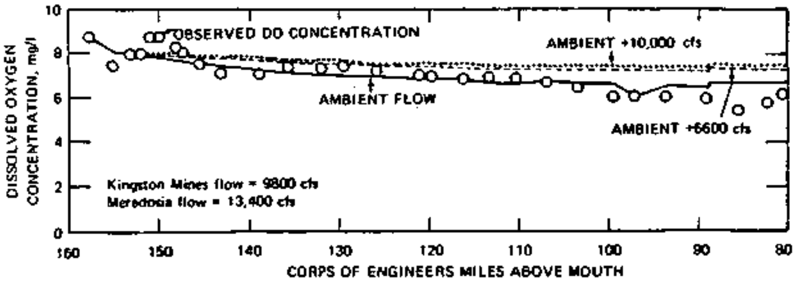


Figure 35. simulation results based on computed BOD, July 3, 1979

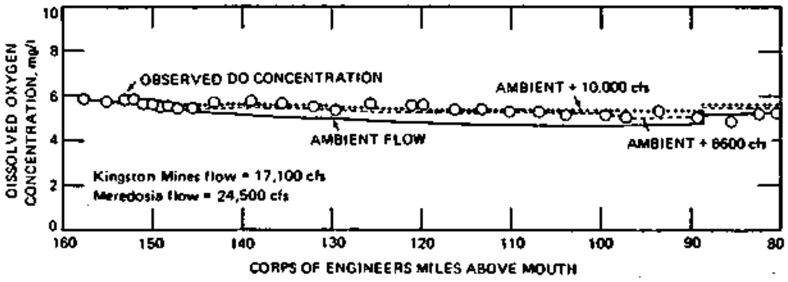


Figure 36. Simulation results based on computed BOD, September 4, 1979

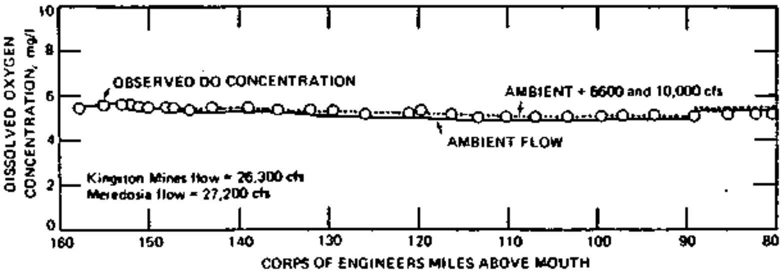


Figure 37. Simulation results based on computed BOD, August 27. 1979

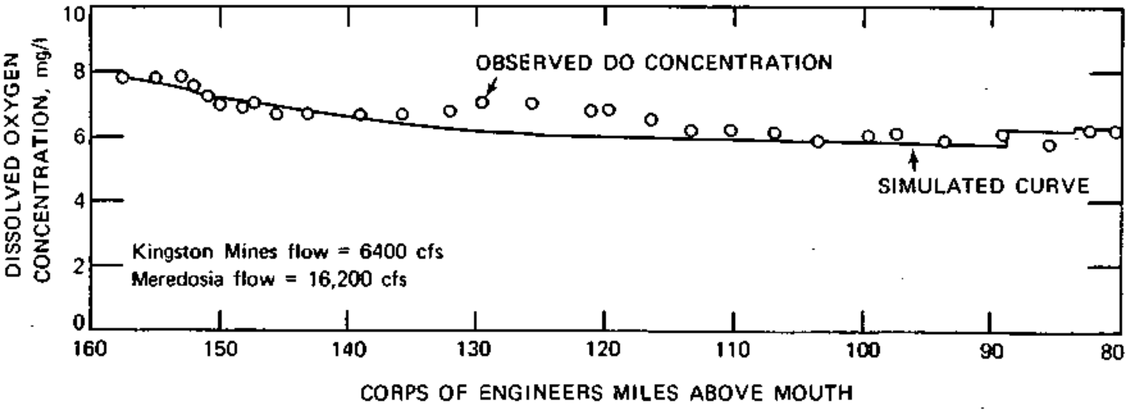


Figure 38. Simulation fits based on June 26, 1979, MP 157.6 laboratory BODs, and SODs measured throughout pool

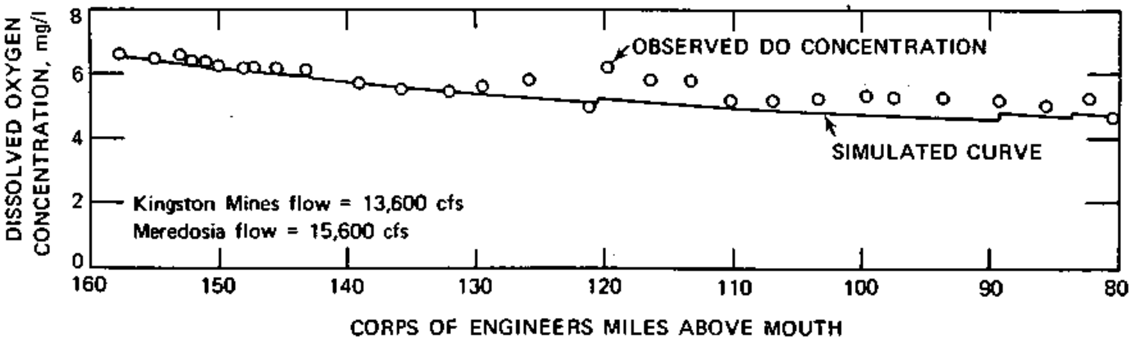


Figure 39. Simulation fits based on July 10, 1979, MP 157.6 laboratory BODs, and SODs measured throughout pool

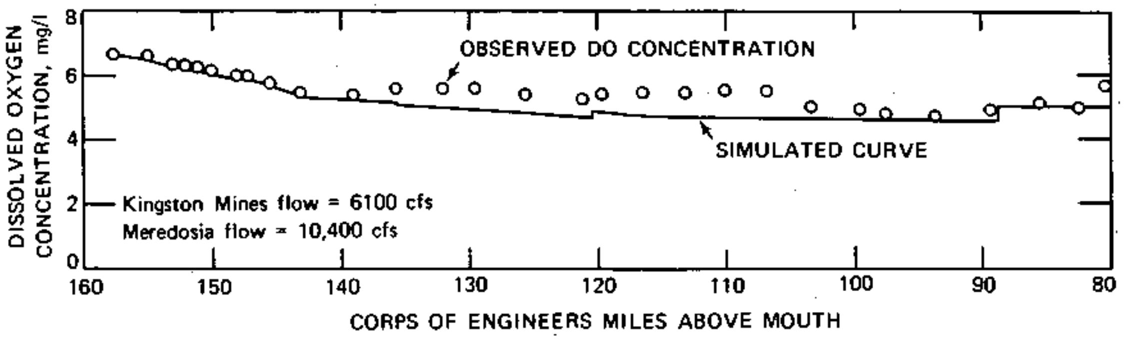


Figure 40. Simulation fits based on July 24, 1979, MP 157.6 laboratory BODs, and SODs measured throughout pool

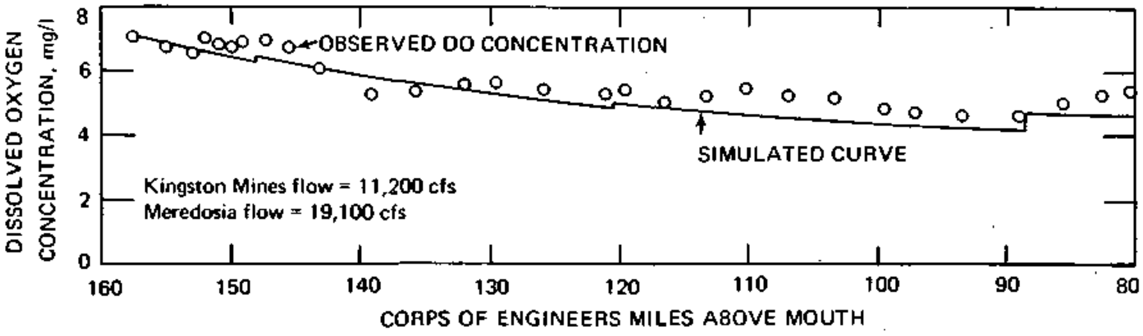


Figure 41. Simulation fits based on August 7, 1979, MP 157.6 laboratory BODs, and SODs measured throughout pool

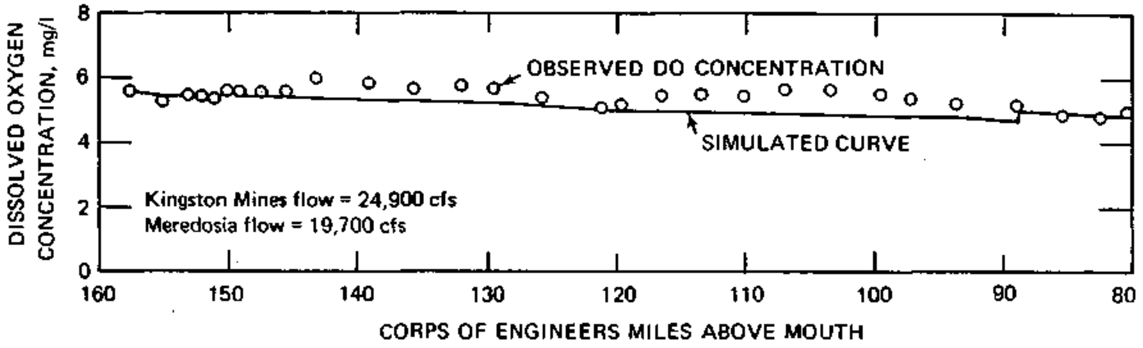


Figure 42. Simulation fits based on August 21, 1979, MP 157.6 laboratory BODs, and SODs measured throughout pool

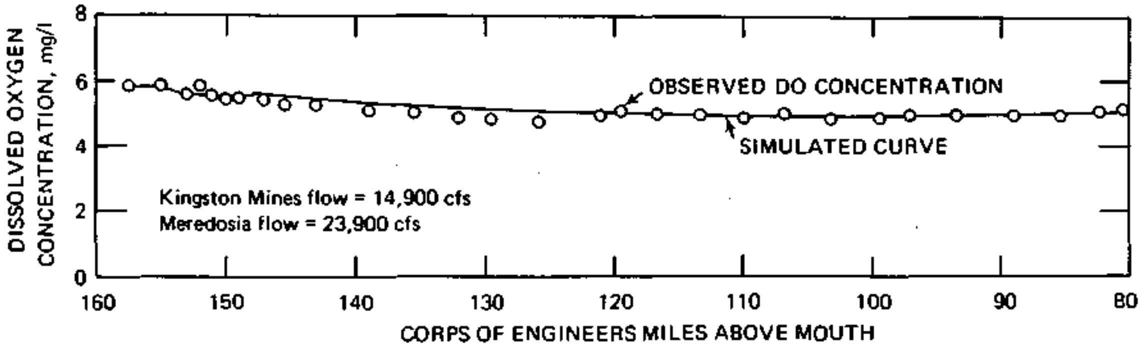


Figure 43. Simulation fits based on September 5, 1979, MP 157.6 laboratory BODs, and SODs measured throughout pool

Discussion

As becomes readily evident upon examination of figure 33, very unusual flow conditions occurred just prior to the initiation of sampling in late June and during the sampling period. Near record floods occurred during April while high but steadily declining flows occurred during May; from early June to the middle of September unstable stream flows persisted.

This information is important in that less than ideal results can be expected to be achieved when sampling occurs during erratic flow conditions. Velz (1970) emphasized this in a chapter on "Time and Intensity of Sampling - Correlation with Stable Hydrograph":

> The most important factor that affects sampling is the daily hydrograph. The ideal time for sampling is during a steady runoff pattern, but sampling should not commence until the hydrograph has attained stability for a period at least equal to the time of passage through the critical reach of the river to remove the influence of any preceding instability. In addition to stability, a level of runoff should be anticipated that will produce a significant sag in the dissolved oxygen profile but not deplete the dissolved oxygen at any location. Such a level can be decided on from previous surveys or from preliminary computations of dissolved oxygen profiles expected from the current BOD waste loading.
>
> . . . for a gradually declining hydrograph usually a week of stability prior to commencement of sampling is adequate to establish an equilibrium condition along the river course. If the hydrograph is flashy, punctuated with sudden peaks and rapid declines, it is desirable to delay commencement of sampling for more than a week to dissipate the influence of the preceding freshet.

If adherence to these obviously desirable criteria had been followed during this study, little or no sampling would have been done within time frame constraints. The detailed SWS study of the pool by Butts et al. (1970), the SWS monitoring studies conducted during 1973 and 1977, and Illinois Natural History monitoring runs of the Illinois River during the 1960s and early 1970s provided an excellent basis for judging what the best hydraulic and hydrologic conditions are for conducting a DO-BOD study of the pool. During the 1965-1967 SWS study the time-of-travel through the pool ranged from 3.30 days to 6.50 days with a median value of 4.79 days for 14 sampling runs. Examination of figure 33 reveals that essentially no 5- or 6-day periods of stable flow existed during 1979. Not only was the flow pattern unstable; it was unstable under high flow conditions. The time-of-travel for the 25 sampling dates is listed in table 50. Values ranged from a minimum of 2.13 days to a maximum of 4.69 days, while the median value was only 3.06 days. These short pool detention times limit the effects of dissolved biochemical oxygen demand and sediment oxygen demand activities within the pool. However, even under such unfavorable flow conditions, significant information has been developed from the raw data and the BOD-DO model output. This has led to a better understanding of the nature of the dissolved oxygen balance within the pool.

Foremost is the revelation that even under sustained high flow conditions the Illinois EPA minimum DO standard of 5.0 mg/l is frequently not achieved. On 12 of the 25 dates, the DO was less than 5.0 mg/l, while on two additional days it was right at 5.0 mg/l (see table 57) . Often low DOs during high flows are associated with a "first flush" phenomenon. Since the pool was being "flushed" almost continuously from April through early September, the DO conditions as observed in the pool during this study cannot be readily equated to this phenomenon. while sewer flushing and overflows plus nonpoint surface runoff undoubtedly are instrumental in creating lower than desirable DO concentrations, other mechanisms play equally important roles.

Figure 44 shows the weak relationship which exists between the minimum DO within the pool and the flow at the Meredosia gage for 44 dates sampled during 1973, 1977, and 1979. Of significance is the fact that the flow was never less than 7000 cfs on any of the dates and ranged as high as 43,000 cfs. A very low correlation existed between the two variables, indicating that when the discharge of Meredosia exceeds 7000 cfs, flow rates have a minimal effect on the minimum DO in the pool. To even be significant at the 5 percent level the correlation coefficient has to be at least 0.29, and this would indicate that flow variation would explain only about 9 percent of the DO variability.

Figure 45 depicts an interesting relationship at station MP 157.6 located immediately below the Peoria dam. The DO values measured here generally represent the maximum in the pool. Again, the relationship between DO and flow is not well defined, but it is significant in that its absolute numerical value is greater than 0.29 and an inverse relationship exists between the two variables. In other words some phenomenon is causing the maximum DO in the pool to be lowered, although ever so slightly, when flow rates increase. A partial answer lies in the findings by Butts and Evans (1980) in their study of the aeration at dams along the Illinois Waterway.

Wicket dams, such as the Peoria structure, were found to produce less reaeration as flows increase. This phenomenon is inherent in the method of operation of a wicket structure. A wicket is a horizontally bottom-hinged gate which is lowered to let boats pass upstream when high discharge rates are reached. The Peoria dam contains 135 such wickets, and between each is a 4-inch space. These spaces are left open until low flows dictate their closing by the insertion of 4-inch by 4-inch wooden needles. Consequently, at intermediate discharges, most of the flow squirts through the cracks between the wickets, producing minimal aeration, while during high flows the flattened wickets produce no aeration. The aeration coefficient, when the wickets and needles were in place, was found to be 1.0. With the wickets up and no needles in, the coefficient was reduced to 0.2. This fact undoubtedly accounts for the results shown by figures 44 and 45, and it is

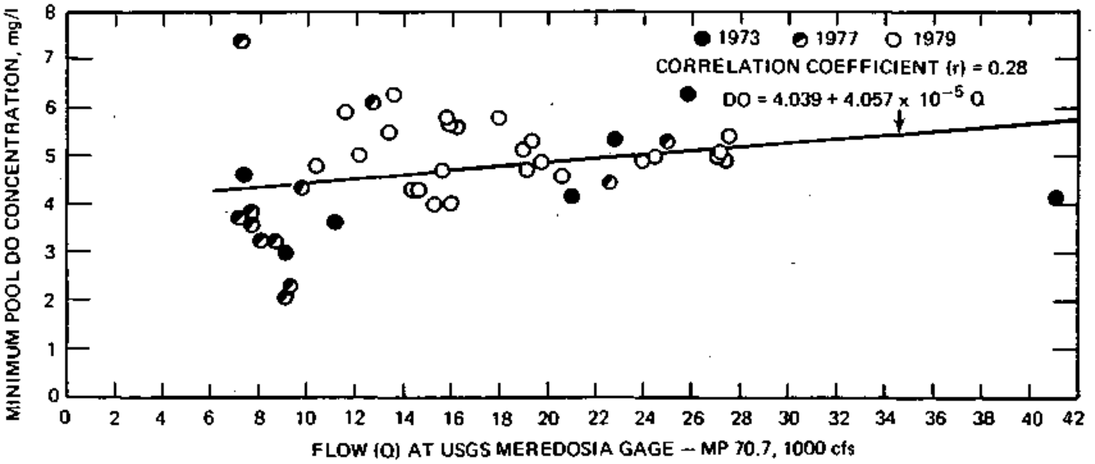


Figure 44. Minimum pool DO versus flow at Meredosia USGS gage (1973, 1977, and 1979 data)

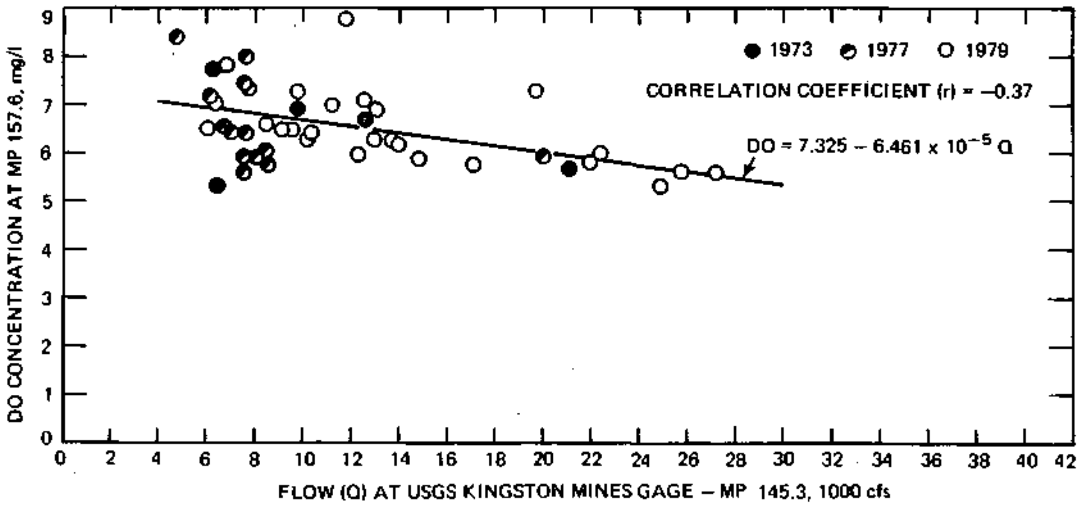


Figure 45. DO at MP 157.6 versus flow at Kingston Mines USGS gage (1973, 1977, and 1979 data)

important to keep this in mind when considering the effects of increased diversion on the DO resources within the pool. Increased diversion may result not only in a tradeoff of DOs (i.e., increased flow may reduce the time-of-travel in the pool, thereby reducing the biochemical DO usage), but also in less aeration at the Peoria dam under certain conditions.

The relative effect of SOD on the total DO usage was evaluated by comparing pool DO usage due to SOD (calculated using equation 9 in conjunction with average pool depths and the pool detention times listed in table 50) with the total amount of dissolved BOD expended (using computed L_as and K_ls) for the time-of-travel through the pool. The numerical values of the SOD rates in terms of grams/m^2/day are relatively low in the pool. They fall at the high end of the range for moderately clean sediments as classified by Butts and Evans (1978). However, because of the relatively shallow, sluggish nature of the pool, oxygen usage by the sediments can be significant over the wide range of flows encountered during this study. This is demonstrated by the data presented in table 58. On July 24, the lowest flow day (the highest time-of-travel), 1.57 mg/l of DO was depleted as a result of SOD. This consisted of approximately 25.7 percent of the total DO usage. During the period of highest flow (lowest time-of-travel) only 0.50 mg/l of DO was used to satisfy the SOD, but this constituted almost one-third of the total oxygen uptake since a relatively low total "computed" BOD existed at the time. On the average the SOD represented about 25 percent of the total demand on the oxygen resources of the pool.

Figure 46 delineates oxygen usage in terms of mg/l as a function of time-of-travel through the pool for the 25 sampling dates. Approximately 0.3 mg/l of DO can be expected to be consumed by the sediments for each day of increase in travel time through the pool.

A better picture of the significance of the effect of SOD on DO can be achieved by examining a hypothetical situation involving 7-day, 10-year low flows in the main stem of the river and tributaries. For these conditions the time-of-travel within the pool is computed as 9.36 days with an average

Table 58. DO Usage in Pool Due to Sediment Oxygen Demand

	Average pool SOD @ ambient temperature		Computed total BOD parameters		Total DO used for pool time-of-travel	
Date	g/m^2/day	mg/l	L_a* (mg/l)	K_1 (l/day)	(mg/l)	% Due to SOD
6/20	0.928	0.85	5.45	.293	3.27	26.0
6/25	0.863	0.96	6.19	.225	3.57	26.9
6/26	0.834	1.07	9.52	.195	5.33	20.1
7/02	0.922	0.87	6.10	.360	4.08	21.3
7/03	0.933	0.98	4.97	.218	2.63	37.2
7/09	0.869	0.72	3.94	.337	2.41	29.9
7/10	0.912	0.79	6.53	.294	3.77	21.0
7/16	1.032	1.06	8.67	.273	5.26	20.1
7/17	0.995	1.06	8.54	.227	4.68	22.6
7/23	1.057	1.53	8.67	.191	4.95	30.9
7/24	1.054	1.57	10.09	.199	6.12	25.7
7/30	1.079	1.15	9.40	.256	5.48	21.0
7/31	1.062	0.93	7.83	.334	4.85	19.2
8/06	1.110	1.16	6.16	.272	3.77	30.7
8/07	1.127	1.13	7.46	.287	4.60	24.6
8/13	.900	0.73	8.24	.223	3.76	19.4
8/14	.862	0.88	6.48	.293	4.12	21.4
8/20	.935	0.61	3.80	.440	2.38	25.7
8/21	.864	0.50	2.84	.359	1.51	32.9
8/27	.935	0.51	3.32	.402	1.95	26.1
8/28	.864	0.48	3.72	.370	2.09	23.0
8/29	.888	0.53	4.05	.282	1.99	26.6
8/30	.910	0.56	4.21	.352	2.41	23.3
9/04	.973	0.69	5.02	.292	2.69	25.7
9/05	.975	0.74	5.62	.357	3.54	20.9

* As projected to occur at MP 157.6

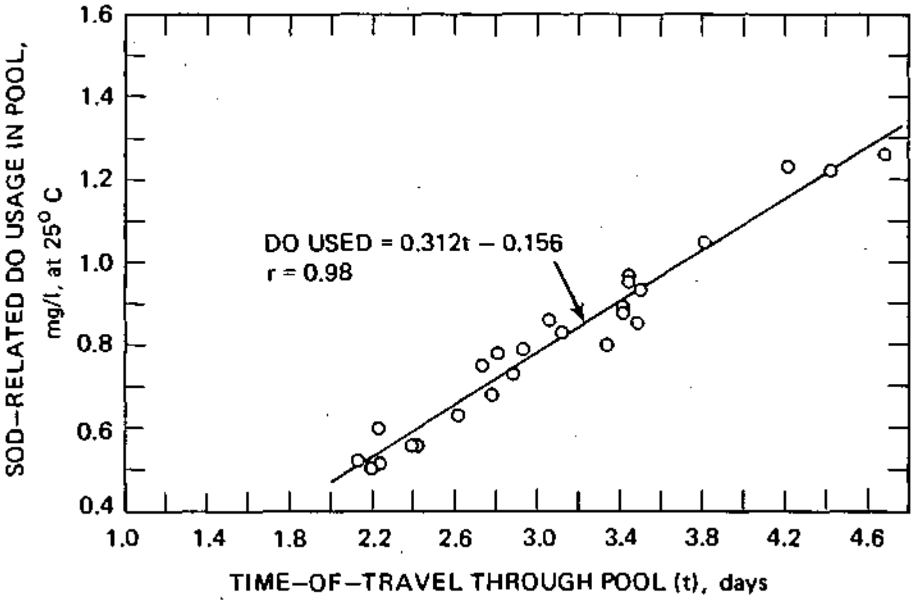


Figure 46. SOD usage as a function of time-of-travel through pool

pool depth of 9.59 feet. At such a low flow, the average pool water temperature could be expected to reach at least 20°C. Substituting these values into equation 9 and then substituting the results into equation 7 yields a DO usage (G') due to SOD of 2.14 mg/l. This is a substantial demand on dissolved oxygen resources.

The relative importance of the three principal sources of oxygen depletion was developed for two specific flow conditions: 7-day, 10-year low flow and 7-day, 10-year low flow + 6600 cfs. A simple model was developed using equation 10 for DO usage due to dissolved carbonaceous and nitrogenous BOD, and equation 7 for DO usage due to SOD. Carbonaceous BOD and SOD rate functions were corrected for temperature variations using a θ-value of 1.047 in conjunction with equation 6. Nitrogenous BOD rates were corrected for temperature using the following equations (Zanoni, 1967):

$$K_{N(T)} = K_{N(20)} (1.097^{T-20}) \quad T = 10\text{-}22°C \qquad (16)$$

$$K_{N(T)} = K_{N(20)} (1.203)(0.877^{T-22}) \quad T = 22\text{-}30°C \qquad (17)$$

where

K_{NT} = nitrogenous deoxygenation rate at temperature T°C, l/day

$K_{N(20)}$ = nitrogenous deoxygenation rate at 20 C, l/day

The ultimate carbonaceous concentrations were adjusted for temperature variations using the following equation developed and applied by Kittrell and Kochtitzky (1947):

$L_{ac(T)} + L_{ac(20)} [1 + {}_{o}02(T-20)]$ (18)

where

$L_{ac(T)}$ = the ultimate carbonaceous BOD at temperature T

$L_{ac(20)}$ = the ultimate carbonaceous BOD at 20°C

Equations 16, 17, and 18 also are integral parts of the BOD-DO sag computer model.

The average pool SOD rate was estimated on the basis of the average pool depth and time-of-travel through the pool in conjunction with equation 7. The SOD factor, G, in equation 7 was estimated using equation 9 at a temperature of 20°C.

The results for analyses made for 7-day, 10-year low flow and 7-day, 10-year low flow + 6600 cfs are presented in figures 47 and 48, respectively. The deoxygenation rate factors shown represent the average of the six values

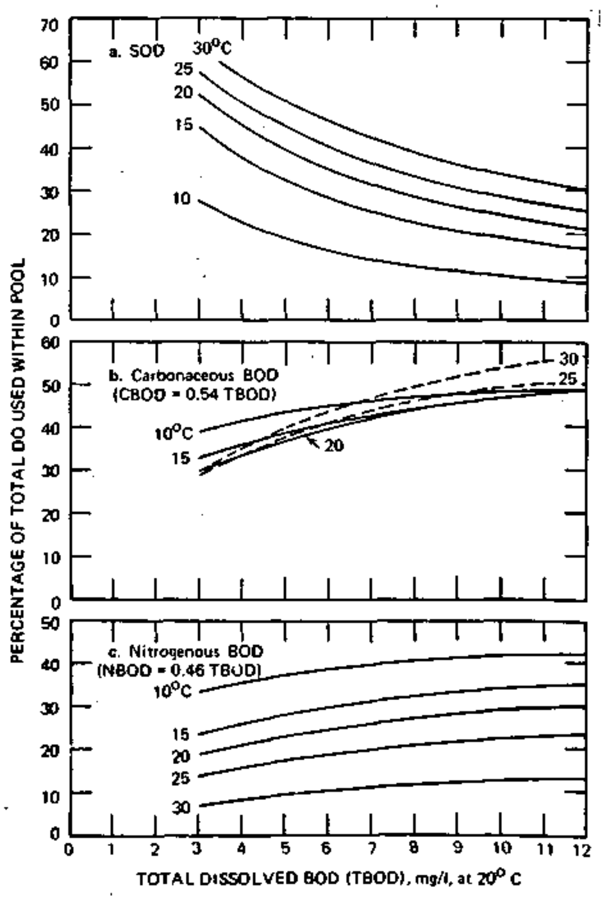


Figure 47. Relative DO usage, 7-day, 10-year low flow (t = 9.36 days, H = 9.59 ft, $K_{c(20)}$ = 0.137 l/day, $K_{n(20)}$ = 0.096 l/day)

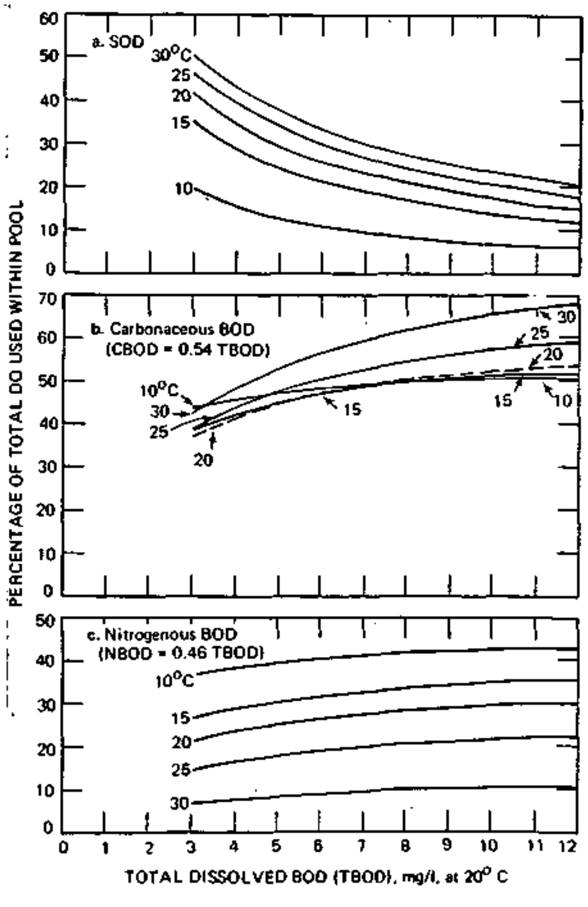


Figure 48. Relative DO usage, 7-day, 10-year low flow + 6600 cfs (t = 3.56 days, H = 10.41 ft, K = 0.137 l/day, $K_{n(20)}$ = 0.096 l/day)

computed for the long term BODs run at station MP 157.6; the ratios of CBOD and NBOD to total BOD of 0.54 and 0.46, respectively, represent the proportions found to exist on the average throughout the pool.

The results of these analyses were interesting for several reasons. It was shown that for any given dissolved BOD load the proportion of the DO usage attributable to SOD increased significantly with temperature, while just the reverse was true for nitrogenous BOD. For example, at a 7-day, 10-year low flow at 10°C and 12 mg/l TBOD, 8.8 percent of the total DO used is due to sediments while 42.4 percent is due to nitrogenous demand. However at 30°C, 30.1 percent is due to SOD and only 13.4 percent to NBOD. The percentage composition due to CBOD exhibits only relatively small changes over a wide range of temperatures; for conditions just discussed, CBOD accounted for 48.8 percent of the DO usage at low temperatures and 56.5 percent at high temperatures.

Figure 48 reveals that an addition of 6600 cfs to the low flow reduces the influence of SOD on the DO usage significantly. At 30°C and 12 mg/l TBOD the SOD accounts for only 20.3 percent of the total. The percentage of the demand due to NBOD also shows a slight decrease to 11.2 percent, while CBOD shows an increase to 68.5 percent.

Commensurate with an increase in flow is a reduction in time-of-travel and an increase in depth, both of which result in a reduction in the effects of SOD on the overlying water. The dissolved BOD fraction usages are dependent upon time only.

Simulation runs were made with the DO-BOD model to determine the relative effect of SOD and dissolved BOD on DO throughout the pool. Figure 49 shows the results of three simulation runs: for 7-day, 10-year low flows and for 6600 cfs and 10,000 cfs additions to this flow. For very low flows, the SOD alone will cause a small oxygen sag in the pool, but a much greater sag is caused by dissolved BOD. The combined effects of SOD and dissolved BOD will depress the DO approximately 1.0 mg/l - lower than the minimum concentration predicted for the dissolved BOD usage alone. The addition of 6600 cfs to the flow increases the DO concentration to levels well above the minimum standard of 5.0 mg/l; however, increasing the diversion to 10,000 cfs has little additional value. Note that slightly lower DOs are predicted for MP 157.6 during diversion flows. At the low flow, a concentration of 7.1 mg/l can be expected, whereas at the low flow plus 10,000 cfs, this value will be reduced to 6.5 mg/l. These values are based on the data depicted in figure 45 and are supported by the study of the aeration characteristics of the dam made by Butts and Evans (1980).

The relative effects of the different fractions of DO usage in the pool, as a unit, are depicted in figures 47 and 48. Corollary to this, the effects of these fractions for various subreaches throughout the pool were computed for low flows and are summarized in figure 50. At the head end of the pool, the carbonaceous BOD causes the more significant DO sink, whereas in the extreme lower reaches SOD becomes the predominant factor. Because of the low flow (high detention time) and the attendant high water temperature, coupled

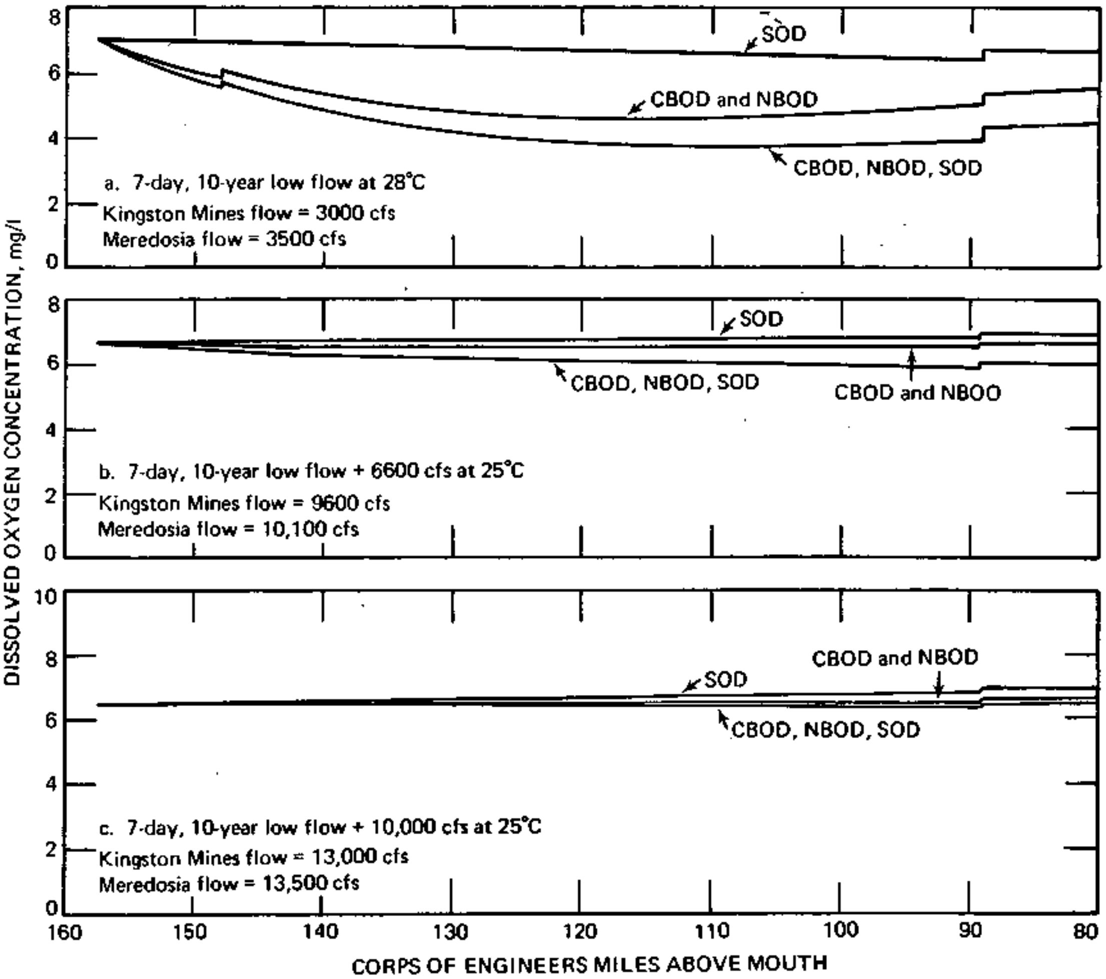


Figure 49. DO sag curves simulated using three oxygen demand factions in combination with 7-day, 10-year low flow and 7-day, 10-year low flow-plus 6600 and 10,000 cfs diversions (CBOD =6.48 mg/l, NBOD =5.52 mg/l,

$K_{c(20)} = 0.137$ l/day, $K_{n(20)} = 0.096$ l/day)

with the fact that the CBOD concentration and deoxygenation rate are higher, the carbonaceous BOD is quickly satisfied in the upper reaches of the pool. Since the SOD rate is considered a zero order reaction in this study, its absolute influence remains basically constant throughout and thereby constitutes a greater relative fraction of the total usage in a downstream direction. Nitrification is severely retarded at 28°C, and the nitrogenous deoxygenation factor is small. Consequently, a large residual of the second stage BOD will exist in the lower reaches compared to the first stage BOD. The relative influence of each demand at a point of time of 4.68 days (midpoint of travel time which approximates average conditions) agrees quite well with the average conditions presented in figure 47 for a TBOD of 12 mg/l. The CBOD represents slightly more than 50 percent of the total, while NBOD and SOD represent around 20 percent and 30 percent, respectively.

A final analysis was made of a somewhat hypothetical situation in which the maximum and minimum BOD loads measured at MP 157.6 were superim-

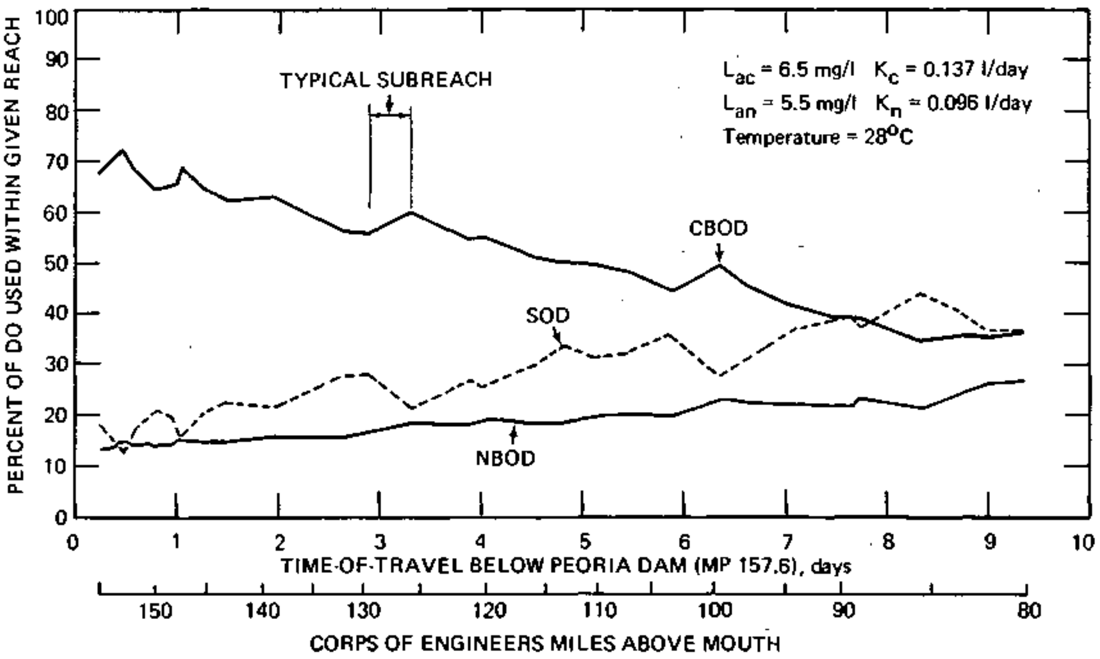


Figure 50. Percentage of DO used by CBOD, NBOD, and SOD for subreaches within the LaGrange pool (7-day, 10-year low flow)

posed on the 7-day, 10-year low flow. The results of these simulations are presented in figure 51. The maximum load occurred during very high flow conditions on August 21, 1979. This load obviously cannot be transferred directly to low flow conditions since, within a short distance below the dam, complete oxygen depletion would occur. An addition of 6600 cfs, however, would provide DO values comparable to those observed during this study, and a 10,000 cfs diversion would provide significant improvements.

The minimum load occurred on June 26, 1979, one of the lowest flow days during which sampling was done. The results are realistic; during the 1977 sampling period a minimum pool DO of 2.2 mg/l was observed. As shown in figure 51b, aminimum concentration of approximately 2.5 mg/l is predicted for a 7-day, 10-year low flow at the minimum load observed during 1979. The addition of 6600 cfs via diversion would raise the DO slightly above the minimum acceptable standard. Increasing diversion to 10,000 cfs would not be of significant benefit.

Summary

1) Dissolved oxygen and temperature measurements were made at 37 locations between MP 166.1 and MP 80.2 along the Illinois River and on the four major tributaries - the Mackinaw, Spoon, Sangamon, and LaMoine Rivers - on 25 different dates between June 20 and September 5, 1979. Stream flows were generally higher and more erratic than desirable for conducting a waste

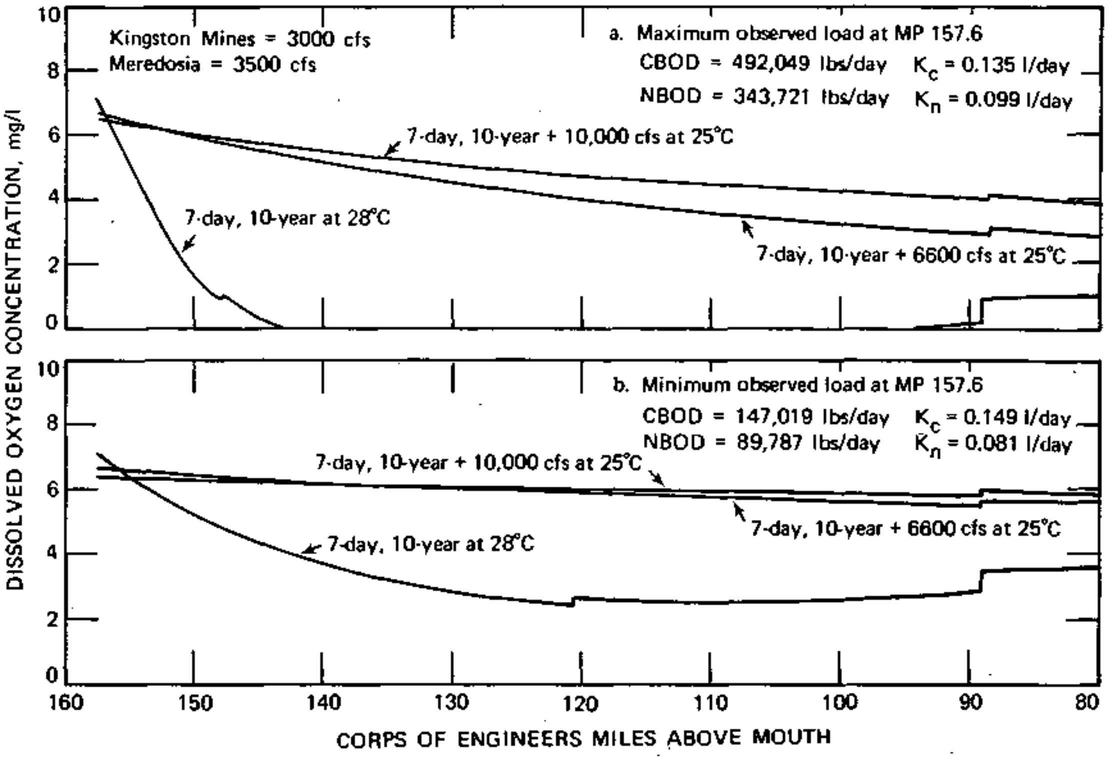


Figure 51. DO sag curves simulated using maximum and minimum BOD loads for MP 157.6 superimposed upon 7-day, 10-year low flow; 7-day, 10-year flow + 6600 cfs; and 7-day, 10-year flow + 10,000 cfs

assimilation type study. The lowest flow at Kingston Mines had a 75.2 percent duration; i.e., 75.2 percent of the time flows are expected to be greater than this. Some of the flows were very high, having durations of 11 to 12 percent. In general, stream flows were higher than normally expected during summer months.

2) Although stream flows were relatively high, the minimum IEPA DO standard of 5.0 mg/l was equaled or violated on 14 of 25 days, and very high water temperatures were recorded. The minimum DO observed was 4.0 mg/l, while the maximum temperature was 30.0°C. The tributary DOs and temperatures were generally higher than those for the Illinois River. The minimum DO of 4.1 mg/l and maximum temperature of 31.0°C recorded for the Spoon River were the extremes for all the tributaries. Only the Sangamon River has a high enough flow on a sustained basis to influence the DO and temperature conditions in the LaGrange pool.

3) Higher flows tend to produce slightly lower DO at the beginning of the pool, but they produce higher, more stable levels throughout the length of the pool. Higher flows result in lower DOs

below the Peoria dam because the aeration capacity of the dam is reduced. A five-fold increase in flow from 4000 cfs to 20,000 cfs would probably cause a 1.0 mg/l reduction in DO at MP 157.6 just below the dam.

4) The total oxygen-demanding substances required to produce the dissolved oxygen changes observed during each sampling date were determined and DO usage versus time-of-travel was simulated. The minimum and maximum loads derived for the pool were, respectively, 255,300 lbs/day (@ K = 0.218 l/day) and 561,700 lbs/day (@ K = 0.223 l/day). The former occurred when flows in the pool ranged between 16,000 and 20,000 cfs, while the latter occurred for flows ranging between 19,000 and 26,000 cfs. These loads represent the combined carbonaceous, nitrogenous, and sediment oxygen demands. The Survey DO-BOD model was used for simulation runs using the total oxygen demand loads and 6600 cfs and 10,000 cfs diversion flows added to ambient conditions. At ambient flows up to about 10,000 cfs, an addition of 6600 cfs resulted in significant improvements in the DO levels. However, increasing the diversion to the 10,000 cfs level provided insignificant improvement., Adding any amount of diversion to ambient flows above 10,000 cfs in the pool would yield little improvement in DO concentrations.

5) DO simulations were also performed using the long-term BODs determined in the laboratory in combination with the sediment oxygen demand rates measured within the pool. Good to excellent fits were achieved with the observed changes in DO. This indicates that the DO changes within the pool are influenced primarily by loads imposed at the head end of the pool and by the demand of sediments within the pool.

6) The relative influence of the three primary oxygen demand sinks - carbonaceous BOD, nitrogenous BOD, and sediment oxygen demand - on the DO resources of the pool were examined. For 7-day, 10-year low flow conditions at 30°C, using assumed CBODs and NBODs at 6.5 mg/l and 5.5 mg/l, respectively, in conjunction with measured SODs the relative impact of each oxygen demand component is as follows: CBOD, 56.5 percent; NBOD, 13.4 percent; SOD, 30.1 percent. Adding 6600 cfs diversion flow to the low flow base changed the relative influence thus: CBOD, 68.5 percent; NBOD, 11.2 percent; SOD, 20.3 percent.

These values reflect pool averages only. At the beginning of the pool under 7-day, 10-year low flow conditions, the CBOD accounts for 65 to 72 percent of the oxygen usage while at the end it accounts for only 35 to 40 percent. In the meantime, the SOD fraction increases from about 15-20 percent to around 40 percent and the NBOD increases from about 15 percent to a little over 25 percent.

7) simulations were also performed using SOD as the only oxygen usage component, dissolved BOD as the only usage sink, and SOD plus dissolved BOD for 1) 7-day, 10-year low flow, 2) low flow plus 6600 cfs, and 3) low flow plus 10,000 cfs. At low flow, SOD alone can cause a minor DO sag; however, when an additional 6600 cfs is added, the Do level remains at about 6.0 mg/l throughout the pool. At a 10,000 cfs addition the DO levels tend to show small increases downstream. The dissolved BOD alone causes the greatest drop in DO - about 2.4 mg/l during low flows. The inclusion of SOD in the simulation lowers it an additional 1.0 mg/l.

8) A final simulation was made in which the maximum and minimum dissolved BOD load, calculated for station 157.6 on the basis of laboratory results, were superimposed upon 7-day, 10-year low flows plus the two diversion additions. The maximum load occurred during a very high flow day resulting in a CBOD of 492,000 lbs/day (K_c = 0.315 l/day) and an associated NBOD of 343,700 lbs/day (K_n = 0.99 l/day). The minimum CBOD was 147,000 lbs/day (K_c = 8.149 l/day) with an associated NBOD of 89,800 lbs/day (K = 0.081 l/day). The maximum load applied to the low flow resulted in total oxygen depletion within ten miles of the dam; an addition of 6600 cfs increased the minimum DO to about 3 mg/l; and a 10,000 cfs addition provided another 1 mg/l increase. The minimum load applied to the low flow lowered the DO to a realistic value of 2.5 mg/l; adding 6600 cfs raised the minimum level significantly to almost 6.0 mg/l; and a 10,000 cfs addition provided no substantial improvement.

9) The diversion of 6600 cfs to the LaGrange pool during normal dry weather summertime stream flows will improve the dissolved oxygen conditions and assure compliance with current stream quality standards.

REFERENCES

American Public Health Association. 1975. *standard methods for the examination of water and wastewater.* 14th Edition, New York.

Bellrose, F. C., F. L. Paveglio, Jr., and D. w. Steffeck. 1979. *Waterfowl populations and the changing environment of the Illinois River Valley.* Illinois Natural History Survey Bulletin v. 32 article 1, 54 p.

Butts, T. A. 1974. *Measurements of sediment oxygen demand characteristics in the upper Illinois waterway*, Illinois State Water Survey Report of Investigation 76, 32 p.

Butts, T. A. 1979. *Effects of Lake Michigan diversion waters on the concentrations of dissolved oxygen in the Illinois waterway.* Special report prepared by the SWS for the Chicago District of the U.S. Army Corps of Engineers.

Butts, T. A., and R. L. Evans. 1978. *Sediment oxygen demand studies of selected northeastern Illinois streams.* Illinois State Water Survey Circular 129, 178 p.

Butts, T. A., and R. L. Evans. 1979. *Sediment oxygen demand in a shallow oxbow lake.* Illinois State Water Survey Circular 136, 28 p.

Butts, T. A., and R. L. Evans. 1980. *Aeration characteristics of flow release controls on Illinois waterway dams.* Illinois State Water Survey Contract Report 233, prepared for the Illinois Division of Water Resources at the request of the U.S. Army Corps of Engineers, 69 p.

Butts, T. A., R. L. Evans, and S. Lin. 1975. *Water quality features of the Upper Illinois waterway.* Illinois State Water Survey Report of Investigation 79, 60 p.

Butts, T. A., R. L. Evans, and J, B. Stall. 1974. *A waste allocation study of selected streams in Illinois.* Illinois State Water Survey Contract Report prepared for Illinois Environmental Protection Agency.

Butts, T. A., V. Kothandaraman, and R, L. Evans, 1973, *Practical considerations for assessing the waste assimilative capacity of Illinois streams.* Illinois State Water Survey Circular 110, 49 p.

Butts, T. A., D. H. Schnepper, and R, L. Evans, 1970, *Dissolved oxygen resources and waste assimilative capacity of the LaGrange pool, Illinois River.* Illinois State Water Survey Report of Investigation 64, 28 p.

Butts, T. A., and R. E, Sparks. 1977. *Sediment oxygen demand - fingernail clam relationship in the Mississippi River, Keokuk Pool,* Paper presented at the 1977 Joint Meeting of the Illinois State Academy of Science and Missouri Academy of Science, University of Missouri, St. Louis.

Committee on Sanitary Engineering Research. 1960. *Solubility of atmospheric oxygen in water.* American society of Civil Engineering Journal of Sanitary Engineering Division v. 86(7): 41-53.

Curtis, G. w. 1969. *statistical summaries of Illinois streamflow data.* United states Department of the Interior, Geological Survey, water Resources Division, Champaign, IL.

Elmore, H. L. 1955. *Determinations of BOD by a reaeration technique.* Sewage and Industrial Wastes v. 27(9): 993-1002.

Fair, G. M., and J. C. Geyer. 1959. *Water supply and waste-water disposals,* John Wiley & Sons Inc., New York.

Forbes, S. A., and R. E. Richardson. 1919. *Some recent changes in Illinois River biology.* Illinois State Natural History Survey Bulletin 13(6), 156 p.

Geldreich, E. E., H. F. Clark, and C. B. Huff. 1964. *A study of pollution indicators in a waste stabilization Pond.* Journal of water Pollution Control Federation v. 36(11): 1372-1379.

Harwood, J. E., and A. L. Kuhy. 1970. *A colorimetric method for ammonia in natural waters.* water Research v. 4: 805-811.

Hoskins, J. K., L. G. Williams, and C. C. Ruchhoff. 1927. *A study of the pollution and natural purification of the Illinois River. I. Surveys and laboratory studies.* U.S. Public Health service Bulletin 171, 208 p.

Hunter, J. V., M. A. Hartnett, and A. P. Cryan. 1973. *A study of the factors determining the oxygen uptake of benthal stream deposits.* Department of Environmental Sciences, Rutger University, Project B-022-N.U., Office of Water Resources Research, Department of the Interior.

Illinois Environmental Protection Agency. 1977. *Illinois Pollution Control Board rules and regulations - Chapter 3: Water Pollution,* Springfield, Illinois. 54 p.

Kittrell, F. W., and S. A. Furfari. 1963. *observations of coliform bacteria in streams.* Journal of Water Pollution Control Federation v. 35(11): 1361-1385.

Kittrell, F. W., and 0. W. Kochtitzky, Jr. 1947. *Natural purification characteristics of a shallow turbulent stream.* Sewage works Journal v. 19(6): 1032.

Lee, M. T., J. B. Stall, and T. A. Butts. 1976. *The 1975 sediment survey of Lake Meredosia.* Illinois State Water Survey Special Report for Illinois Division of Water Resources, 33 p.

Lin, S. D., and R. L. Evans. 1980. *Coliforms and fecal streptococcus in the Illinois River at Peoria, 1971-1976.* Illinois State Water Survey-Report of Investigation 93, 32 p.

Lin, S. D., R. L. Evans, and D. B. Beuscher. 1972. *Algae in the upper Illinois Waterway.* Paper presented at the 65th annual meeting Illinois State Academy of Science, western Illinois University, Macomb.

Lin, S. D., R. L. Evans, and D. B. Beuscher. 1973. *Algae in the Spoon River, 1971-1972.* Water Resources Bulletin v. 9(6): 1112-1124.

Lin, s. D., R. L. Evans, and D. B. Beuscher. 1974. *Bacteriological assessment of Spoon River water quality.* Applied Microbiology v. 28 (2): 288-297.

Lin, S. D., R. L. Evans, and D. B. Beuscher. 1978. *Algae in selected Illinois Streams, 1971-1976.* Report of Investigation 86, State of Illinois Dept. of Registration and Education.

Mathis, B. J., and T. A. Butts. In press 1981. *Sediment oxygen demand and its effect on dissolved oxygen in a cutoff meander of the Kaskaskia River.* University of Illinois Water Resources Center Report.

Mohlman, F. W., E. Hurwitz, G. R. Barnett, and H. P. Kramer. 1950. *Experience with modified methods for BOD.* sewage Works Journal v. 22(1): 31-40.

ORSANCO water Users Committee. 1971. *Total coliform: fecal coliform ratio for evaluation of raw water bacterial quality.* Journal of Water Pollution Control Federation v. 43(4): 630-640.

Patrick, R., and C. W. Reimer. 1966. *The diatoms of the United States, volume 1.* The Academy of Natural Sciences of Philadelphia, 688 p.

Prescott, G. W. 1962. *Algae of the western Great Lakes area.* Wm. C. Brown Co., Publishers, Dubuque, Iowa, 977 p.

Prescott, G. w. 1970. *How to know the fresh-water algae.* Wm. C. Brown Co., Publishers, Dubuque, Iowa, 348 p.

Richardson, R. E. 1921. *The small bottom and shore fauna of the middle and lower Illinois River and its connecting lakes, Chillicothe to Grafton: its valuations; its sources of food supply; and its relation to the fishery.* Illinois State Natural History Survey Bulletin 13(15), 522 p.

Roseboom, D. P., R. L. Evans, W. Wang, T. A. Butts, and R. M. Twait. 1979. *Effect of bottom conditions on eutrophy of impoundments.* Illinois State Water Survey Circular 139, 57 p.

Schnepper, D.H., R. Sinclair, V. Kothandaraman, and R. L. Evans. 1980. *Effects of Lake Michigan diversion on the water chemistry of the Illinois Waterway*. Illinois State Water Survey Contract Report 234, prepared for the Illinois Division of Water Resources at the request of the U.S. Army Corps of Engineers, 77 p.

Smith, G. M. 1950c *The fresh-water algae of the United States.* McGraw-Hill Book Co., Inc., New York, 2nd Edition, 719 p.

Soper, G. A., J. D. Watson, and A. J. Martin. 1915. *Disposal of the sewage and protection of the water supply of Chicago, Illinois,* A report to the Chicago Real Estate Board, p. 98-102.

Sparks, R. and K. Lubinskio 1978. Unpublished data, Illinois State Natural History Survey.

Starrett, W. C. 1971. *A survey of the mussels (Unionacea) of the Illinois River: a polluted stream,* Illinois State Natural History Survey Bulletin v. 30 Article 5, 403 p.

Streeter, H. w. 1926. *The rate of atmospheric reaeration of sewage polluted streams.* Transactions of the American Society of Civil Engineers v. 89: 1351-1364.

Streeter, H. W. 1935. *Measures of natural oxidation in polluted streams, I: The oxygen demand factor.* Sewage Works Journal v. 7(2): 251-279.

Tiffany, L. H., and M. E. Britton. 1951. *The algae of Illinois.* University of Chicago Press, 407 p.

Tucker, W. J., and W. H. Ettinger. 1975. *A biological investigation of the South Fork, Sangamon River and tributaries.* Illinois Environmental Protection Agency, Springfield, Illinois.

U.S. Public Health Service. 1963. *Report on the Illinois River system - water quality conditions - part II, tables - chapters 2 and 3.* U.S. Dept. of Health, Education and Welfare, U.S.P.H.S., Division of Water Supply and Pollution Control, Great Lakes - Illinois River Basins Project.

Velz, C. J. 1947. *Factors influencing self-purification and their relation to pollution abatement.* Sewage Works Journal v. 19(7): 629-644.

Velz, C. J. 1970. *Applied stream sanitation.* John Wiley & Sons, Inc., New York, p. 168.

Walker, R. R., and W. J. Snodgrass. 1979. *Modelling sediment oxygen demand in Hamilton Harbor,* Unpublished report. Water Research Group, Faculty of Engineering, McMaster University, Hamilton, Ontario.

Wang, W., W. T. Sullivan, and R. L. Evans. 1973. *A technique for evaluating algal growth potential in Illinois surface waters.* Report of Investigation 72, State of Illinois Dept. of Registration and Education.

West, P. W., and T. P. Ramachandran. 1966. *Spectropholometric determination of nitrate using chromotrophic acid.* Anal. Chimica Acta. v. 35: 317.

Wisely, W. H., and C. W. Klassen. 1938. *The pollution and natural purification of Illinois River below Peoria.* Sewage Works Journal v. 10(3): 569-595.

Zanoni, A. E. 1967. *Effluent deoxygenation at different temperatures.* Marquette University, Milwaukee, Wisconsin, Civil Engineering Department Report 100-SA, p. 76.

Appendix. Parametric Values of Steepest Descent Fit to First Order BOD Reaction Model with K_1 (base e) in l/day, L_a in mg/l, and t_o in days

		BOD Type								
1979		Total			Carbonaceous			Nitrogenous		
Date	MP	K_1	L_a	t_o	K_1	L_a	t_o	K_1	L_a	t_o
6/26	166.1	.070	16.37	0	.113	5.66	0	.049	11.66	0
		.058	19.80	0.800	.109	5.70	-0.160	.043	14.55	1.668
	160.7	.064	15.76	0	.136	4.67	0	.043	11.68	0
		.041	24.82	1.258	.135	4.68	-0.008	.028	21.98	2.517
	157.6	.120	8.77	0	.149	4.31	0	.093	4.57	0
		.125	8.60	0.054	.155	4.27	0.119	.092	4.61	.073
	152.0	.121	8.56	0	.151	4.66	0	.087	4.08	0
		.132	8.33	0.195	.148	4.68	-0.039	.105	3.85	0.669
	150.0	.132	7.49	0	.137	6.08	0	.074	1.74	0
		.135	7.49	0.137	.136	6.09	-0.010	.120	1.42	0.849
	139.0	.127	,7.41	0	.142	4.15	0	.101	3.41	0
		.127	7.47	0.084	.138	4.17	-0.082	.104	3.44	0.336
	129.5	.112	7.12	0	.123	4.27	0	.090	2.96	0
		.118	7.02	0.161	.125	4.26	0.058	.089	3.064	0.330
	113.3	.128	6.57	0	.141	4.05	0	.095	2.72	0
		.128	6.59	0.032	.135	4.10	-0.085	.098	2.70	0.169
	93.6	.115	7.02	0	.150	3.82	0	.073	3.51	0
		.120	6.93	0.157	.150	3.81	-0.049	.087	3.30	0.696
	80.2	.125	6.01	0	.124	4.29	0	.129	1.66	0
		.127	5.99	0.104	.125	4.29	0.045	.152	1.60	0.425
	Mack.	.135	9.37	0	.125	8.78	0	.277	0.66	0
		.129	9.45	-0.136	.122	8.84	-0.110	.296	0.66	0.234
	Spoon	.051	8.02	0	.102	2.30	0	.043	5.14	0
		.039	11.57	1.852	.114	2.21	0.258	.049	6.01	2.704
	Sang.	.084	16.52	0	.110	9.58	0	.056	7.22	0
		.063	20.42	0.168	.107	9.66	-0.044	.064	7.51	1.459
	LaMo.	.128	7.89	0	.136	5.05	0	.098	3.09	0
		.129	7.92	0.050	.125	5.19	-0.178	.112	2.97	0.479
7/10	166.1	.126	9.47	0	.133	5.34	0	.111	4.28	0
		.128	9.49	0.119	.139	5.25	0.068	.112	4.32	0.222
	160.7	.111	9.01	0	.134	5.52	0	.079	3.59	0
		.114	8.96	0.156	.131	5.59	0.210	.087	3.52	0.550
	157.6	.126	9.57	0	.124	5.42	0	.081	5.19	0
		.128	9.53	0.052	.125	5.40	0.019	.101	4.92	0.969
	152.0	.115	10.63	0	.154	5.57	0	.081	5.19	0
		.124	10.41	0.235	.154	5.55	-0.028	.101	4.92	0.969
	150.0	.137	10.82	0	.139	5.98	0	.121	5.05	0
		.141	10.73	0.115	.141	5.93	-0.005	.128	4.99	0.249
	139.0	.139	10.26	0	.149	5.35	0	.122	5.03	0
		.147	10.16	0.192	.142	5.42	-0.114	.144	4.83	0.565
	129.5	.156	8.87	0	.140	4.73	0	.170	4.22	0
		.151	8.97	-0.068	.135	4.78	-0.075	.168	4.22	-0.058
	113.3	.133	9.41	0	.124	4.80	0	.143	4.64	0
		.130	9.50	-0.026	.124	4.85	0.144	.131	4.76	-0.216
	93.6	.096	14.70	0	.122	4.53	0	.086	10.20	0
		.098	14.94	0.369	.120	4.55	-0.008	.095	10.16	0.655

Appendix. Continued

					BOD Type					
		Total			Carbonaceous			Nitrogenous		
1979 Date	MP	K_1	L_a	t_o	K_1	L_a	t_o	K_1	L_a	t_o
	80.2	.111	9.87	0	.115	4.92	0	.107	4.95	0
		.111	9.88	0.008	.116	4.92	0.046	.104	5.00	-0.074
	Mack.	.068	5.55	0	.103	2.46	0	.046	3.19	0
		.049	7.13	0.190	.110	2.40	0.142	.046	3.54	1.229
	Spoon	.102	3.61	0	.111	2.60	0	.128	0.80	0
		.100	3.64	-0.082	.116	2.56	0.060	.124	0.81	-0.014
	Sang.	.145	4.30	0	.139	3.88	0	.224	0.41	0
		.140	4.33	-0.068	.133	3.94	-0.111	.249	0.41	0.297
	LaMo.	.099	10.32	0	.116	6.78	0	.069	3.69	0
		.098	10.42	0.103	.117	6.73	-0.002	.081	3.48	0.603
7/24	166.1	.111	9.87	0	.123	6.64	0	.092	3.20	0
		.111	9.87	0.017	.114	6.76	-0.289	.112	3.04	0.767
	160.7	.104	9.37	0	.131	6.29	0	0.71	2.93	0
		.105	9.40	0.115	.119	6.45	-0.285	.097	2.73	1.573
	157.6	.115	8.87	0	.160	4.56	0	.081	4.42	0
		.119	8.82	0.171	.149	4.63	-0.215	.100	4.19	0.965
	152.0	.114	9.20	0	.169	4.84	0	.072	4.60	0
		.117	9.21	.185	.161	4.87	-0.169	.095	4.23	1.164
	150.0	.129	9.82	0	.174	4.76	0	.099	5.10	0
		.131	9.82	.132	.157	4.87	-0.262	.114	4.98	0.732
	139.0	.112	7.82	0	.172	4.51	0	.061	3.57	0
		.109	7.95	0.009	.150	4.65	-0.363	.081	3.29	1.448
	129.5	.108	9.05	0	.156	3.65	0	.084	5.45	0
		.110	9.04	0.105	.136	3.77	-0.423	.098	5.26	0.705
	113.3	.103	10.03	0	.124	4.92	0	.087	5.04	0
		.107	9.89	0.103	.116	5.00	-0.248	.096	5.00	0.609
	93.6	.109	6.14	0	.106	3.60	0	.099	2.73	0
		.102	6.25	-0.188	.095	3.71	-0.421	.097	2.75	-0.045
	80.2	.081	7.44	0	.115	3.78	0	.055	3.75	0
		.064	8.42	-0.364	.104	3.88	-0.433	.055	3.90	0.526
	Mack.	.108	9.18	0	.110	8.11	0	.131	0.94	0
		.104	9.24	-0.193	.100	8.37	-0.287	.146	0.91	0.391
	Spoon	.084	11.85	0	.118	6.73	0	.062	4.69	0
		.07.2	12.85	-0.227	.089	7.40	-0.831	.085	4.35	1.810
	Sang.	.087	14.47	0	.101	9.75	0	.062	4.82	0
		.068	16.39	-0.307	.094	10.01	-0.183	.049	5.75	0.069
	LaMo.	.137	9.63	0	.120	9.05	0	.323	0.87	0
		.129	9.74	-0.232	.107	9.32	-0.355	.342	0.87	0.251
8/07	166.1	.117	9.87	0	.117	6.55	0	.107	3.41	0
		.177	9.89	0.808	.112	6.64	-0.178	.128	3.26	0.586
	160.7	.123	9.96	0	.169	5.62	0	.077	4.59	0
		.123	9.97	0.009	.152	5.74	-0.294	.095	4.33	0.865
	157.6	.121	10.08	0	.150	5.28	0	.092	4.95	0
		.122	10.04	-0.006	.134	5.42	-0.347	.104	4.79	0.477
	152.0	.114	9.34	0	.135	8.37	0	.044	1.70	0
		.118	9.88	0.130	.136	8.37	0.053	.054	1.67	1.846

Appendix. Continued

		BOD			Type					
			Total			Carbonaceous			Nitrogenous	
1979 Date	MP	K_1	L_a	t_o	K_1	L_a	t_o	K_1	L_a	t_o
	150.0	.128	8.98	0	.161	5.25	0	.088	3.91	0
		.126	9.09	0.070	.149	5.34	-0.179	.107	3.71	0.789
	145.5	.111	11.57	0	.136	6.14	0	.088	5.46	0
		.115	11.52	0.174	.122	6.32	-0.299	.110	5.19	0.890
	139.0	.143	6.19	0	.156	4.34	0	.105	1.93	0
		.129	6.35	-0.268	.150	4.37	-0.144	.083	2.11	-0.582
	129.5	.138	6.42	0	.171	3.67	0	.096	2.89	0
		.124	6.57	-0.364	.156	3.73	-0.285	.088	2.97	-0.329
	113.3	.159	5.76	0	.143	3.28	0	.223	2.41	0
		.142	5.90	-0.303	.123	3.39	-0.481	.225	2.40	0.021
	93.6	.172	5.02	0	.176	4.01	0	.381	0.87	0
		.150	5.15	-0.379	.164	3.55	-0.196	.316	0.89	-0.205
	80.2	.135	4.54	0	.172	2.59	0	.134	1.78	0
		.126	4.61	-0.248	.152	2.64	-0.365	.147	1.74	0.195
	Mack.	.090	13.45	0	.119	7.87	0	.082	4.83	0
		.090	13.49	-0.034	.110	7.98	-0.302	.081	4.83	-0.006
	Spoon	.085	21.06	0	.083	15.73	0	.078	6.23	0
		.072	23.54	0.141	.064	17.93	-0.364	.098	5.80	0.904
	Sang.	.188	2.52	0	.363	1.22	0	.144	1.26	0
		.179	2.52	-0.212	.317	1.23	-0.208	.148	1.26	0.251
	LaMo.	.155	6.44	0	.152	3.80	0	.191	2.55	0
		.141	6.57	-0.275	.131	3.93	-0.426	.199	2.51	-0.038
8/21	166.1	.116	5.88	0	.120	3.47	0	.106	2.44	0
		.110	5.98	-0.123	.111	3.55	-0.257	.112	2.38	0.136
	160.7	.114	5.84	0	.128	3.47	0	.091	2.46	0
		.109	5.94	-0.106	.113	3.57	-0.426	.099	2.40	-0.305
	157.6	.119	5.85	0	.135	3.45	0	.099	2.41	0
		.114	5.90	-0.193	.116	3.58	-0.522	.111	2.32	0.341
	152.0	.110	5.97	0	.132	3.44	0	.079	2.68	0
		.108	5.96	-0.127	.112	3.57	-0.570	.088	2.59	0.435
	150.0	.121	5.81	0	.119	3.67	0	.111	2.26	0
		.111	6.00	-0.171	.105	3.79	-0.475	.128	2.16	0.355
	139.0	.105	7.53	0	.138	3.87	0	.076	3.77	0
		.100	7.65	-0.096	.123	3.96	-0.424	.088	3.61	0.575
	129.5	.109	7.27	0	.121	3.77	0	.097	3.52	0
		.102	7.43	-0.204	.111	3.84	-0.334	.094	3.58	-0.005
	113.3	.111	8.40	0	.104	5.04	0	.120	3.47	0
		.107	8.58	0.035	.095	5.19	-0.312	.135	3.36	0.382
	93.6	.116	6.02	0	.109	4.17	0	.160	1.78	0
		.114	6.04	-0.109	.100	4.28	-0.273	.164	1.77	0.135
	80.2	.125	6.17	0	.121	3.44	0	.139	2.70	0
		.119	6.25	-0.154	.110	3.53	-0.340	.143	2.68	0.013
	Mack.	.117	16.82	0	.147	12.65	0	.059	4.58	0
		.117	16.84	-0.025	.151	12.60	0.136	.059	4.53	-0.207
	Spoon	.108	9.88	0	.136	7.30	0	.064	2.52	0
		.100	10.15	-0.203	.125	7.47	-0.223	.069	2.45	0.283

Appendix. Concluded

1979 Date	MP	Total K_1	Total L_a	Total t_o	BOD Type Carbonaceous K_1	BOD Type Carbonaceous L_a	BOD Type Carbonaceous t_o	Nitrogenous K_1	Nitrogenous L_a	Nitrogenous t_o
	Sang.	.088	15.31	0	.094.	9.74	0	.092	5.25	0
		.088	15.57	0.194	.093	9.78	-0.045	.104	5.16	0.655
	LaMo.	.108	8.74	0	.139	4.94	0	.084	3.76	0
		.105	8.85	-0.004	.127	5.04	-0.302	.089	3.79	0.544
9/05	166.1	.096	8.57	0	.136	5.04	0	.056	3.71	0
		.097	8.58	0.086	.126	5.14	-0.233	.074	3.41	1.308
	160.7	.091	8.70	0	.153	4.68	0	.049	4.22	0
		.094	8.68	0.196	.146	4.72	-0.129	.066	4.02	2.068
	157.6	.120	7.06	0	.104	3.94	0	.130	3.27	0
		.116	7.16	-0.031	.100	3.98	-0.154	.136	3.23	0.093
	152.0	.098	7.44	0	.134	3.77	0	.073	3.65	0
		.104	7.30	0.180	.125	3.84	-0.175	.085	3.52	0.841
	150.0	.117	7.12	0	.109	3.15	0	.119	4.05	0
		.117	7.12	0.026	.103	3.19	-0.163	.119	4.06	0.062
	139.0	.112	6.54	0	.121	3.24	0	.093	3.48	0
		.108	6.68	0.053	.113	3.31	-0.204	.100	3.43	0.322
	129.5	.080	8.48	0	.114	3.02	0	.066	5.52	0
		.073	9.04	0.078	.103	3.11	-0.329	.072	5.46	0.688
	113.3	.121	5.98	0	.111	3.55	0	.140	2.44	0
		.119	6.01	-0.043	.106	3.58	-0.163	.152	2.39	0.205
	93.6	.116	4.66	0	.101	2.63	0	.142	2.01	- 0
		.118	4.62	0.018	.094	2.69	-0.210	.165	1.94	0.369
	80.2	.126	4.60	0	.091	2.76	0	.177	1.95	0
		.125	4.60	-0.031	.090	2.77	-0.085	.190	1.92	0.160
	Mack.	.133	8.63	0	.171	4.34	0	.097	4.49	0
		.130	8.64	-0.131	.162	4.38	-0.148	.098	4.45	-0.063
	Spoon	.115	15.43	0	.159	9.10	0	.073	6.48	0
		.114	15.45	-0.040	.151	9.19	-0.140	.080	6.41	0.670
	Sang.	.079	13.57	0	.098	8.06	0	.056	5.68	0
		.062	15.81	0.061	.098	8.05	-0.059	.047	6.95	1.023
	LaMo.	.105	4.91	0	.142	2.80	0	.068	2.21.	0
		.101	4.94	-0.229	.128	2.86	-0.359	.070	2.19	0.214

State Water Survey Division
WATER QUALITY SECTION
AT
PEORIA, ILLINOIS

Illinois Department of
Energy and Natural Resources

SWS Contract Report 324

THE EFFECTS OF LAKE MICHIGAN DISCRETIONARY DIVERSION STRATEGIES ON ILLINOIS WATERWAY DISSOLVED OXYGEN RESOURCES

by

Thomas A. Butts, Donald H. Schnepper, and Krishan P. Singh

Prepared for the
Illinois Environmental Protection Agency

July 1983

CONTENTS

THE EFFECTS OF LAKE MICHIGAN DISCRETIONARY DIVERSION STRATEGIES ON ILLINOIS WATERWAY DISSOLVED OXYGEN RESOURCES

by Thomas A. Butts, Donald H. Schnepper, and Krishan P. Singh

ABSTRACT

The dissolved oxygen (DO) levels in the Illinois Waterway from Lockport to the Mississippi River during summer low flow conditions are greatly influenced by the quantity of water diverted from Lake Michigan into the waterway system. By U.S. Supreme Court decree, the total diversion from the lake, for all uses, is limited to 3200 cfs on an average annual basis. Of this, only 320 cfs is permitted for discretionary use in diluting wastewater discharges into the waterway system. Presently about 75 percent of this discretionary allocation is utilized during July, August, and September at a rate of 1280 cfs. Lake outlets are located at three widely separated points. A BOD-DO model study was performed to determine the optimum withdrawal rates at each point needed to provide the best overall DO balance in the channels above Lockport. The residual biochemical oxygen demand and ammonia load at Lockport were then used, in conjunction with the optimum DO, to model the DO profiles and residual ammonia and BOD_{5C} levels in the waterway below Lockport.

The optimum diversion scheme selected provided DO, BOD_{5C}, and NH3-N inputs at Lockport of 2.86, 1.77, and 1.73 mg/l, respectively. These values were not adequate to prevent DO standards from being violated. The critical reach occurred in the Peoria pool beginning 90 miles downstream of Lockport. A minimum DO of about 3.1 mg/l is predicted to occur here. Only a limited number of options are available to improve this situation, and none appears capable of bringing DO Revels up to standard during very low flow periods.

INTRODUCTION

The Illinois Waterway is special among the many streams and rivers within Illinois: it drains 43 percent of the state and small portions of Wisconsin and Indiana, as shown by figure 1. During dry weather, its headwaters consist principally of treated Chicago area wastewaters diluted with flow diverted from Lake Michigan. The waterway is no longer a free flowing stream; it consists of eight navigational pools extending over 327 miles between the Mississippi River and Lake Michigan, as shown by figure 2.

Chicago area treated wastewater flows are derived from approximately 5.4 million people and a large, mixed industrial base. The Metropolitan Sanitary District of Greater Chicago (MSD) operates treatment facilities which discharge an average of 1400 million gallons per day of secondary and

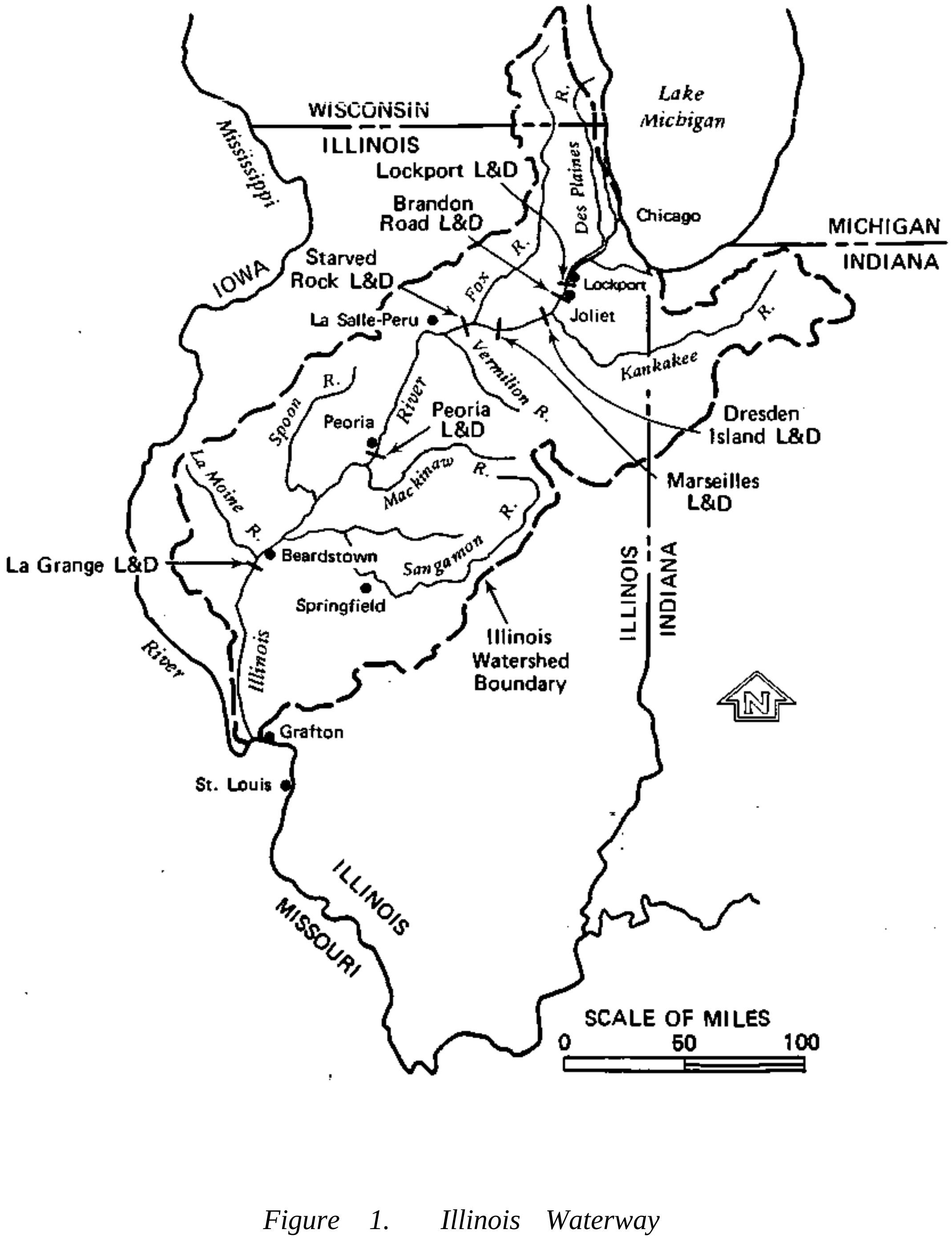


Figure 1. Illinois Waterway

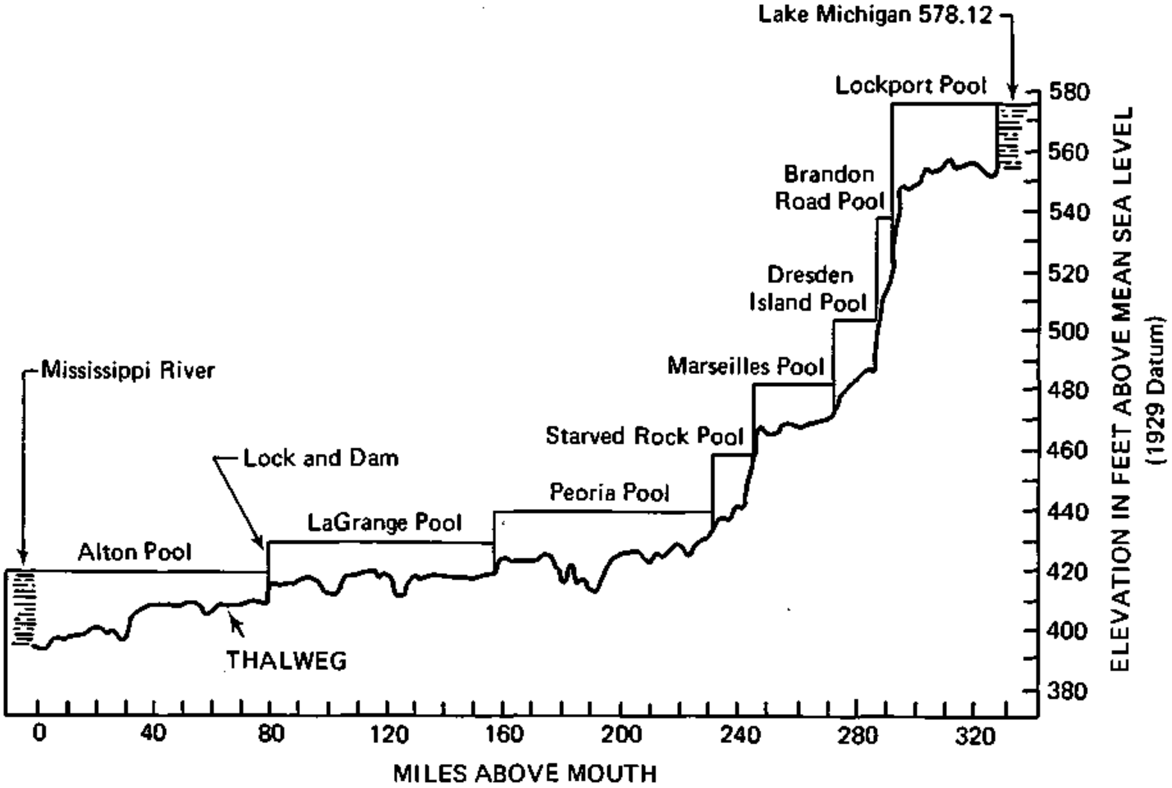


Figure 2. Illinois Waterway profile

tertiary treated sewage into 70.5 miles of constructed channels and "improved" natural water courses, as shown in figure 3 (Currie and Kendrick, 1981) .

Historical Perspective

Prior to 1900 most Chicago area wastes were discharged to Lake Michigan via either the Chicago River or the Calumet River systems, which are shown in figure 3. In 1871, a deep cut was made between the Chicago River and the Illinois and Michigan (I & M) Canal as a means of flushing a significant portion of the wastes down the canal and eventually to the Illinois River at LaSalle-Peru where the canal intersects the river. In most respects, this attempt to relieve the Chicago area of unsanitary water conditions was unsuccessful. Consequently, plans were soon formulated to dig what was to become known as the Chicago Sanitary and Ship Canal. This canal was to be bigger, deeper, and more hydraulically efficient than the old I S M canal. Although some downriver opposition to this plan was encountered, all physical and political obstacles were eventually overcome, and on January 17, 1900, popularly referred to then as "shovel day," the first Lake Michigan water was released into the high capacity canal.

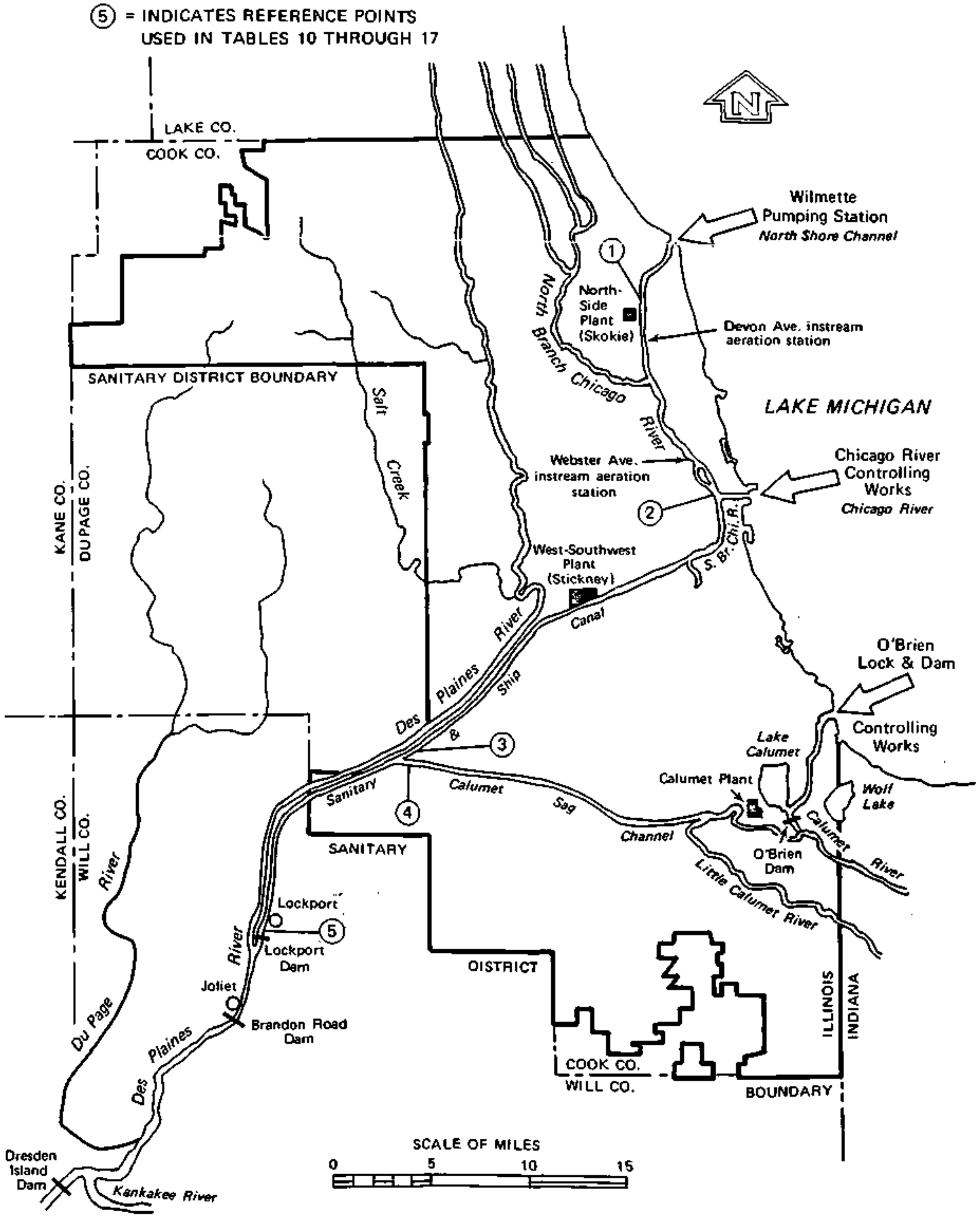


Figure 3. Chicago area drainage system

This act drew immediate opposition, and over the long term, many lawsuits materialized. The first of a long list of such lawsuits was the one filed in 1900 by the State of Missouri which claimed that typhoid bacteria from Chicago were polluting its Mississippi River water supply. The case went to the U.S. Supreme Court, where Missouri lost (Currie and Kendrick, 1981).

The Sanitary and Ship Canal is designed to handle a maximum flow of 10,000 cfs. However, in 1913 the United States filed the first of a long succession of suits designed to limit total diversion well below this. This suit requested a diversion limitation of 4167 cfs (Currie and Kendrick, 1981), and a U.S. Supreme Court decision was rendered in 1925 upholding this request. This constraint prompted the MSD to construct major treatment facilities to prevent downstream water quality deterioration.

Two other significant lawsuit decrees relative to diversion limitations (State of Illinois, 1980) are *Wisconsin v. Illinois (1930)* and *Wisconsin V. Illinois (1967)*'. As a result of the first case the Secretary of War issued a permit limiting the annual average diversion to 1500 cfs exclusive of municipal water supply needs. The second suit forms the basis for the present day diversion restrictions. It was prompted by a December 17, 1956, U.S. Supreme Court authorization to increase the diversion from 1500 cfs to a maximum of 8500 cfs through January 31, 1957, which then was extended through February 28, 1957. However, total diversion up to this maximum was allowed to occur subsequently at times until the U.S. Supreme Court ruled on June 12, 1967 that the State of Illinois cannot allocate or divert total flows greater than 3200 cfs on an average annual basis using a 5-year accounting period.

This 1967 decree was amended on December 1, 1980. Presently, the 1967 ruling and the 1980 amendments dictate present operating policy. The principal components of this policy are (Currie and Kendrick, 1981):

1) The regulation of discretionary diversion (direct wastewater dilution needs) and storm water runoff flow is the responsibility of the Illinois Department of Transportation, Division of Water Resources. Prior to 1967, the MSD was responsible for these actions.

2) A 40-year accounting period is to be used for computing the 3200 cfs average annual diversion, as opposed to the previously set 5-year period.

3) Discretionary diversion is set at a maximum of 320 cfs on an average annual basis.

4) The accounting year runs from October through September. Previously it ran from March through February. The new period coincides with the USGS standard "water year."

As an outgrowth of the 1980 amendments the Division of Water Resources issued a water allocation order (State of Illinois, 1980) directing various municipalities and subdivisions to fully utilize the flexibility of the

40-year averaging period. The order also limits the MSD to 255 cfs for navigation-related operations. Included are 130 cfs (40-year period) for lockages, 30 cfs (40-year period) for lock leakages, and 95 cfs (5-year period) for navigational makeup. The order, however, limits utilization of the 320 cfs direct diversion allocation to the time period ending October 1, 2000.

After the year 2000, the MSD Tunnel and Reservoir Project (TARP) phase I and instream aeration projects are projected to be completed, and the Division of Waterways has reduced the discretionary diversion commensurately to 101 cfs up to the year 2020.

Study Area

The water courses studied include the main diversion channels in the Chicago area (see figure 3) down to the Lockport dam, and the main stem of the Illinois Waterway from Lockport to Grafton on the Mississippi River (see figure 1). As shown in figure 3, lake diversion to the canal system is controlled at the Wilmette pumping station (WPS), the Chicago River controlling works (CRCW), and the O'Brien lock and dam and controlling works (O'Brien); releases from the system are controlled at the Lockport dam. The maximum diversion channel capacities for WPS, CRCW, and O'Brien are, respectively, 700, 500, and 3600 cfs (Macaitis and Cameron, 1977),

The WPS flow is discharged into the 7.63-mile-long North Shore Channel, which in turn discharges into a 7,85-mile-long channelized section of the North Branch of the Chicago River. The North Branch is tributary to the Chicago River at a point 1.31 miles from the lake (referenced to the CRCW). The combined WPS and CRCW diversions are routed down a channelized section of the South Branch of the Chicago River. At a point 4,83 miles downstream the Sanitary and Ship Canal branches from the South Branch and runs 30.06 miles to Lockport.

The Thomas J. O'Brien lock and controlling works is located 6,9 miles from the lake on the Calumet River. Diversion is passed through the controlling works, down a 6.7-mile reach of the Calumet River, and then into the Cal-Sag Channel which flows for approximately 16.5 miles before it empties into the Sanitary and Ship Canal. At this point all Chicago area waste and diversion flow are combined. The Sanitary and Ship Canal ends approximately one mile below the Lockport dam. Little aeration occurs at the dam because most of the flow is passed through penstocks for hydroelectric power generation (Butts and Evans, 1980).

The Sanitary and Ship Canal empties into the Des Plaines River and becomes the main stem of the Illinois Waterway for approximately 17 miles. At river mile point (MP) 272.86 it joins the Kankakee River, forming the Illinois River.

The Illinois Waterway really consists of eight navigation pools controlled by seven lock and dams on the waterway and the Alton dam on the

Mississippi (see figure 2). The gradient above the Starved Rock dam is relatively steep, and the five pools in this area are short and deep; the three pools below are long and somewhat shallower. Except for very short reaches below some of the dam flow release structures and approximately 2.5 miles of rapids below the Marseilles dam, the waterway has been completely restructured by man and no longer constitutes a free flowing stream. This has seriously reduced the organic waste assimilative capacity of the water course.

Pooling has reduced velocities and increased depths, which in turn has reduced natural reaeration, increased sediment deposition, and promoted algal production in some areas. Most of the dissolved oxygen (DO) required by saprophytic and autotrophic bacteria to stabilize oxygen-demanding wastes is now supplied almost instantly at the dam sites. The degree of reaeration achieved at each site is dependent upon the design of the flow release structure and the head loss.

The major metropolitan areas along the waterway below Chicago are the Joliet-Lockport, LaSalle-Peru, and Peoria-Pekin areas. Below Pekin (MP 150) the riverside population is small, and little industrial development exists. Above Peoria-Pekin numerous small to middle-size communities exist, and industrial development along the river is extensive. Commercial navigation along the entire waterway is extensive throughout the year.

Scope of Study

The output from this study is the result of a three-part endeavor. First a major effort was made to update the State Water Survey (SWS) computer files with the latest Corps of Engineers (COE) river sounding and cross sectional information. Along with this the SWS low flow waterway hydraulic and hydrologic computer model was revised and improved.

Next, various discretionary diversion routing schemes were examined to find the one which provided-the best overall average DO concentrations within the Chicago drainage system above the Lockport Dam. This was accomplished using the MSD water quality model and advice and information supplied by MSD personnel.

Selection of the best overall diversion scheme provided input information at Lockport for use in evaluating downstream water quality conditions. This third endeavor was accomplished using the SWS dissolved oxygen - biochemical oxygen demand (BOD) model for a limited number of critical low flow and waste load conditions. The net result of this overall effort was the development of ideas and concepts which could aid regulatory personnel in efficiently managing the water quality of the waterway during low flow conditions, consistent with the constraints imposed upon the MSD and the State in using the discretionary diversion allotment.

The report consists of four major sections. The first section presents details of the methods and procedures used and discusses the sources of input data. The second section outlines the results and presents them in generalized schematic or tabular form. The third section discusses the results and draws some conclusions, and the fourth section considers alternative management procedures and related concepts.

Acknowledgments

This study was conducted under the supervision of Ralph L. Evans, Head, Water Quality Section of the Illinois State Water Survey. Special acknowledgment is given to Robert Currie and Ken Kendrick of MSD, who provided technical advice and produced the desired computer outputs for the Chicago area drainage canals and channels. Thanks also are extended to Robert Sinclair, who gathered and organized the vast amount of cross sectional data and information for computer use; to Carl Lonnquist, who revised the hydraulic model; and to Dana Shackleford, who produced most of the SWS water quality model outputs.

Illustrations were prepared by John W. Brother, Jr., William Motherway, Jr., and Linda Riggin. Gail Taylor edited the report and Linda J. Johnson typed the original manuscript and the camera copy.

The project was supported by funds granted by the Illinois Environmental Protection Agency (IEPA).

METHODS AND PROCEDURES

All the information generated from this study was derived with existing data and tried and proven mathematical models and concepts. No field sampling was done. However, considerable effort was expended in gathering existing data from the files of IEPA, the U.S. Army Corps of Engineers, MSD, and the Illinois State Water Survey.

Hydraulic and Hydrologic Model and Data

Hydraulic and hydrologic parameters for the waterway between Lockport and Grafton were computed with the use of a flow and time-of-travel simulating program based on volume displacement, i.e., time equals the volume of water divided by the flow rate. This concept, although basically very simple, can be used to generate reliable information for steady state low flows, the condition under which most DO investigations are made. Critical to the accuracy and reliability of information generated are the quality and quantity of stream cross-sectional data available or used. This study provided the opportunity for the Water Survey to update its Illinois Waterway computer cross section file between the Peoria and Lockport dams. The computer file had already been updated with current information for the section of the waterway between Grafton and Peoria during the completion of another study (Butts et al., 1981).

The Corps of Engineers is required to maintain minimal channel depths in navigable streams such as the Illinois Waterway. As a part of the project of maintaining a navigation channel in the Illinois Waterway, the Corps has established permanent bench marks along the river which define cross sections. Soundings of the river bed are routinely made, and these data are plotted on maps at scales of 1" = 100' or 1" = 200". The most current maps (1977 through 1982) were obtained from the Corps. From these maps a data base of cross sections was generated by choosing cross sections along the river spaced at an average interval of approximately 930 feet.

Computer programs were written to utilize the Wang 720C Programmable Calculator and the Numonics Graphics Calculator in converting the graphic data to digital information. The programs were written so that the river mile location of the cross section was determined and sounding depths were measured as distances from the right bank of the river. The digital information generated was entered into permanent storage on tape.

The output from the hydraulic-hydrologic program includes cross section number, mile point, flow at the end of a reach, average flow within a reach, average cross sectional area and average depth within a reach, time of travel within a reach, accumulated time of travel, and reach lengths and volumes. Inputs required are staff gage elevations and main stem and tributary discharges.

Water Quality Modeling

The water quality modeling was done in two steps. First the Chicago area channels were analyzed through use of the MSD water quality model. The output from this model was then utilized as input to the SWS model which was used to simulate water quality conditions between Lockport and Grafton.

The MSD model is computerized, has been calibrated and verified numerous times, and was readily accessible for use at a nominal charge. Also the MSD has on file a large amount of basic input data such as stream geometry information and sediment oxygen demand measurements which are specific to this area. Similarly, a readily available data base was on file for the waterway below Lockport, which had been specifically designed for use as input to the SWS model.

The models have both been developed on the basis of first order oxygenation-deoxygenation principles. However, some inherent differences exist in the final form of the two. The MSD model is built around the basic Streeter Phelps DO sag equation, whereas the SWS model treats aeration and deaeration as separate entities according to the concepts of the Velz modification of the Black and Phelps methodology.

MSP Model Application

Model Development

The MSD model is a steady state form of the Streeter Phelps equation applicable to a continuous system. Modifications of the basic equation to account for nitrogenous BOD, sediment oxygen demand (SOD), and instream aeration have been made. Expressed in terms of the natural logarithm (base *e)* the equation takes the form:

$$D = \frac{K_c L_{ac}}{K_2 - K_c} \left(e^{-K_c t} - e^{-K_2 t} \right) + \frac{K_n L_{an}}{K_2 - K_n} \left(e^{-K_n (t - t_o)} - e^{-K_2 (t - t_o)} \right) + D_a{}^{-K_2 t} + G \qquad (1)$$

where D is the DO deficit at time t in days; K_C and K_n are respectively the carbonaceous and nitrogenous deoxygenation coefficients in days^{-1}; L_{ac} and L_{an} are, respectively, the ultimate carbonaceous and nitrogenous BOD in lbs/days; K_2 is the reaeration coefficient in days^{-1}; t_O is the lag time to the onset of nitrification in days; D_a is the initial DO deficit; and G is the sediment oxygen demand in mg/l. Assumptions which have been made relative to usage of the model are: 1) one dimensional flow, 2) steady state conditions, 3) constant water depth, 4) instantaneous flow mixing, and 5) an algal productivity to respiration ratio of unity (The Metropolitan Sanitary District of Greater Chicago, 1976).

The reaeration calculations are made using a modification of the isotropic flow form of the O'Connor-Dobbins reaeration equation:

$$K_2 = \frac{24 (D_L V)^{0.8}}{H^{1.5}} \qquad (2)$$

where K_2 = the reaeration coefficient to the base *e* in days^{-1}

D_L = diffusivity coefficient = 8.1 × 10^{-5} ft /hr at 20°C

V = average velocity in ft/hr

H = average depth in ft

A value of 0.10 is the minimum value utilized; smaller values are reset to equal 0.10.

The nitrogenous BOD is assumed to follow first-order kinetics; however, a lag time of four days (to = 4) is imposed upon its inception. This essentially transfers all the ammonia load to Lockport unoxidized since travel times in the channel network are less than four days. If travel times exceeded four days, DO levels in the channel network would be very low. This would in itself suppress nitrification significantly, causing a transfer of the load, unchanged, to Lockport.

Sediment oxygen rate demand, G, in g/m^2/day is calculated using the Filos-Molof formula:

$$G = A\,[1-e^{-(1.22)(DO)}] \tag{3}$$

where A is a constant, the value of which depends upon the nature of the sediments; and DO is the DO concentration of the overlying water in mg/l. The expression indicates that when. DO levels fall below 2.0 mg/l, SOD rates decrease at an increasing rate; above 2.0 mg/l SOD rates are relatively independent of DO levels. SOD rates applied to this study are based upon *in situ,* measurements by MSD during 1972.

Deoxygenation temperature corrections are made using the equation:

$$K_T = K_{20}\,(1.047)^{(T-20)} \tag{4}$$

where K_T is the deoxygenation coefficient at T°C and K_{20} is the deoxygenation coefficient at 20°C.

DO saturation is computed using the ASCE formula:

$$DO_s = 14.652 - 0.41022T + 0.007991T^2 - 0.00007777T^3 \tag{5}$$

where DO_S = DO saturation at T°C.

The basic data input utilized in the model includes: 1) diversion and treatment plant flows, 2) diversion and treatment plant total BOD and ammonia loads, 3) SOD rates, 4) hydraulic geometry information including depths and cross sectional areas, 5) water temperature, and 6) instream aeration stations and efficiencies.

Model Application

The model was used to determine the optimum or best DO balance within the Chicago area drainage channel network by proportioning discretionary diversion for 100 trials at the three diversion points. The average annual allowable diversion is 320 cfs; however for this study it will be assumed that essentially all the allotted flow is used during July, August, and September, giving a three month-rate of 1280 cfs. The actual diversion figure was arrived at by allowing a 10 percent nondiversion time element due to rainfall.

Waste loads and water quality data inputs were estimated by examining the 1980 and 1981 MSD plant and lake sampling records. Values- which appeared to best represent conditions during the period of interest are given in table 1. In addition, out of the 100 runs, a number of trials were made by varying certain water quality parameters at specific locations. For instance an assumption was made that the Calumet plant was upgraded to achieve BOD_{5C} and ammonia outputs of 7 mg/ and 2 mg/l, respectively. Also, the system was examined for sensitivity to input DOs by varying the lake and plant DOs over a wide range of values. Similarly, the system was examined for sensitivity to variable lake BOD_{5c} inputs.

Table 1. Parametric Values Chosen for Input to MSD Water Quality Model for Dry Weather Conditions

Source	Flow (cfs)	DO (mg/l)	BOD_{5C} (mg/l)	NH_3-N (mg/l)	Temperature (° C)
Northside plant	433.2	6.5	7.0	2.0	20.56
West-Southwest plant	1268.5	8.0	5.0	1.0	22.22
Calumet plant	340.3	6.5	14.0	13.0	21.11
Lake-Jardine plant	*	8.4	2.5	0.005	23.00
Lake-South filtration plant	*	8.4	2.5	0.005	23.00

* A total of 1280 cfs at three diversion points

Table 2. Uncontrollable Lake Diversion Flows

(Flows in cubic feet per second)

Diversion need	Diversion location WPS	CRCW	O'Brien
Lockage	0	100	100
Leakage	3	11	11
Navigation makeup	£	80	80
Totals	3	191	191

Note: WPS=Wilmette pumping station; CRCW=Chicago River controlling works; O'Brien=O'Brien lock and controlling works

Besides the plant flows and discretionary diversion, certain uncontrollable flows are additive to the system (see table 2).

The two instream aeration stations, one at Devon Avenue (MP 334.8) on the North Shore Channel and the other at Webster Avenue (MP 328.8) on . the North Branch of the Chicago River (see figure 3), were assumed operational at either 50 or 75 percent efficiency; the majority of the runs were made at 75 percent efficiency. The maximum capacities of the Devon and Webster stations are 13,300 and 8,000 lbs/day of DO, respectively. Four trials were run for placement of 1, 2, 3, and 4 aerators having DO transfer capacities of 13,300 lbs/day of DO at a point immediately below the Calumet plant.

Simulation water temperatures in the channel and river system ranged from a low of 20.56° C near the Northside plant outfall to a residual value of 26° C at Lockport. In some interior reaches temperatures as high as 28° C were reached.

SWS Model Application

Model Development

The basic model used by the SWS (State Water Survey) to evaluate BOD-DO relationships in a flowing stream is a simple one-dimensional model in which the basic components are computed separately and then algebraically combined to obtain a net DO concentration. The basic formulation is:

$$DO_n = DO_a - DO_u + DO_r + DO_x \qquad (6)$$

where DO_n is the net DO at the end of a reach; DO is the initial DO at the beginning of a reach; DOu is the DO used biologically; DO_r is the DO addition due to aeration; and $D0_X$ is the DO addition due to dam aeration and/or tributary inputs.

Details of the methodologies that can be used to compute the various components of equation 6 have been outlined in detail in previous SWS publications and reports (Butts et al., 1970, 1974, 1975, 1981).

For this study, the $D0_u$ term includes DO usage due to carbonaceous and nitrogenous BOD and to sediment oxygen demand. The ratio of algal productivity to respiration is assumed to be unity although the model can handle values greater or lesser than 1 when derived on a diurnal basis. Both forms of BOD are programmed to follow first order biochemical oxidation reactions as expressed by the general equation:

$$BOD_t = L_a \, (1-e^{-K_1(t-t_o)}) \qquad (7)$$

where BOD_t is the BOD exerted over a time period t in days; L_a is the ultimate BOD; K_1 is the rate coefficient; and t_0 is the lag time in days to the onset of usage and in this case is equal to zero for carbonaceous demand.

The SOD portion of DO usage is computed using the expression:

$$G' = \frac{3.28Gt}{H} \qquad (8)$$

where G' is the oxygen usage per reach in mg/l; G is the SOD rate in g/m^2/day; t is the detention time per reach in days; and H is the average reach water depth in feet. Temperature corrections are applied through the use of equation 4. Unlike in the MSD model, no allowance is made for reducing the SOD rates when the overlying water DO falls below 2 mg/l. Based on several hundred *in situ* SOD measurements made by the Water Survey over the last few years the conclusion has been reached that when the SOD is due primarily to bacterial respiration the DO uptake rate remains relatively constant even at DO concentrations below 2 (Butts et al., 1974, 1981, 1982; Lee et al., 1975; Butts and Evans, 1978 and 1979; Roseboom et al., 1979; Mathis and Butts, 1981). The benthic biomass in the whole length of the waterway, except in a few short reaches, is sparse and most SOD is bacteria-related.

The aeration factor DO_r is computed using the theoretical concepts advocated by Velz (1947, 1970). Reference should be made to the Velz publications or to the 1973 report by Butts et al. for a detailed discussion of this somewhat complicated and lengthy computational procedure.

Dissolved oxygen, ammonia, and BOD inputs from tributaries are adjusted on a mass balance basis.

Aeration at the dam sites is accounted for through use of the British weir equation:

$$\frac{C_S - C_A}{C_S - C_B} = 1 + 0.38abh\,(1 - 0.11h)\,(1 + .046T) \qquad (9)$$

where C_S is the DO saturation concentration at a given temperature; C_A and C_B are, respectively, the DO concentrations above and below the dam flow release structure; a is the water quality factor; b is the weir aeration coefficient; h is the static head loss at the dam in meters; and T is the water temperature in °C. The Water Survey has studied the aeration characteristics of all the Illinois Waterway dams, and the appropriate water quality factors and weir aeration coefficients were selected from those reported by Butts and Evans (1980).

Inherent in the model design is the need to divide the water course into short well defined reaches. The oxygen credits and debits are balanced within each reach. When the net DO falls below 2.0 mg/l at the end of a reach, nitrification is not allowed to proceed until the DO level recovers and stabilizes above 2.0 mg/l.

Model Application

The SWS model was used to evaluate water quality conditions in the Illinois Waterway between Lockport and Grafton. Initial conditions were set at Lockport by the output achieved for optimum discretionary diversion using the MSD model. The residual carbonaceous BOD, ammonia, and DO loads at Lockport were routed downstream, and appropriate additional industrial, domestic, and tributary inputs were added for a number of hydraulic and hydrologic conditions. The strategy was to first evaluate the situation for downstream 7-day, 10-year low flow conditions. If standards could not be met under this restrictive low flow, additional flow regimes and/or waste reduction schemes were to be evaluated to determine what is needed to meet standards or to find out under what flow conditions the standards could be expected to be met.

The initial evaluation was based upon flow derived by adding to all waterway 7-day, 10-year low flows the excess flow generated at Lockport using the discretionary diversion allotment, the flows in tables 1 and 2, and Lockport area domestic and industrial waste inputs. The adjusted 7-day, 10-year low flow at Lockport is 2320 cfs. The flow routed through the Chicago channel and river system to Lockport is 4126.5 cfs; the input at Lockport is 12.5 cfs. This totals 4139 cfs, or 1819 cfs in excess of the 7-day, 10-year figure.

Adding 1819 cfs to the 7-day, 10-year low flows at downstream gaging stations results in the first trial "design" values given in table 3. The 9/27/71 and 9/3/71 design figures were used for evaluating conditions for incremental flow increases above the 7-day, 10-year base. These two dates

Table 3. Low Flow Characteristics of the Illinois Waterway for Three Design Flows

Gaging station	Corps MP	7-day, 10-year low flow (cfs)	Design flows (cfs)		
			1st trial	9/27/71	9/3/71
Lockport	291.04	2320	4139	4139	4139
Marseilles	246.60	3240	5059	6860	7810
Henry	196.12	3424	5243	6828	8146
Kingston Mines	145.41	3000	4819	6880	9000
Meredosia	70.81	3500	5319	7100	9850
Grafton	0	3600	5419	6515	10,201

were chosen because the flows at all the locations had been relatively stable for several weeks, and DO profiles from Lockport to Chillicothe are available for these dates (Butts et al., 1975) for comparative purposes.

Point source waste load information was obtained principally from IEPA files in Maywood, Peoria, and Springfield. A minor amount of dated supplemental information was available in Water Survey files and was used when necessary to fill in the gaps of the more current information supplied by IEPA. All tributary stream load estimates were made using recent SWS sampling results. The Mackinaw, Spoon, Sangamon, and LaMoine Rivers were sampled and analyzed for long term BOD values, ammonia, and DO levels during the summer of 1979; similarly the Des Plaines, DuPage, Kankakee, and Vermilion Rivers were sampled during 1982. Inputs from the lesser tributaries were estimated with the nearest measured tributary as a guide. Table 4 summarizes the tributary input data used for the runs made under the three flow conditions.

The file data carbonaceous BOD is in terms of 5 days at 20°C (BOD_{5C}). All this information had to be converted to ultimate demands compatible with river deoxygenation reaction rates. Both carbonaceous and nitrogenous reaction rates were varied throughout the waterway in accordance with long-term BOD information contained in studies by Butts et al. (1975, 1981).

Table 4. Tributary Input Data Used in Simulations

Tributary	Corps MP	BOD_{5C} conc. (mg/l)		Flows (cfs)		
		Carb.	Nit.	7-day, 10-yr.	9/27/71	9/3/71
Des Plaines R.	290.00	3.28	1.74	29	126	66
DuPage R.	276.82	3.29	2.09	46	62	44
Kankakee R.	272.86	1.67	0.86	635	1980	710
Mazon R.	263.54	2.35	1.00	0	15	4
Fox R.	239.77	3.64	1.56	208	342	427
Vermilion R.	226.34	2.32	1.07	8	19	10
I & M Canal	210.80	1.50	1.00	25	2	4
Bureau Cr.	209.03	1.50	1.00	18	2	4
Farm Cr.	163.00	2.00	0.20	0	4	3
Kickapoo Cr.	159.66	2.00	0.20	1	26	8
Mackinaw R.	147.73	3.79	0.94	47	55	18
Spoon R.	120.50	2.90	0.80	25	78	36
Sangamon R.	88.90	2.75	0.83	287	722	405
LaMoine R.	83.74	2.75	1.11	12	26	27
Macoupin Cr.	23.26	2.75	1.11	3	21	11

The river reaction rates selected for use within defined reaches of the waterway are presented in table 5.

Equation 7 was used to convert the carbonaceous BOD_{5C} values to ultimates. For example, with t = 5 days, $t_0 = 0$, BOD_{5C} = a specified value, and $K_{1c} = 0.0677$ day^{-1}, the ultimate BOD (L_{ac}) inputs down to mile 165.30 would equal $BOD_{5c}/0.287$. At mile 165.30, a BOD_{5c} would be calculated on the basis of the residual ultimate having a $K_{1C} = 0.0677$ day^{-1}. A new ultimate would then be computed on the basis of $K_{1C} = 0.123$ day^{-1}.

All ammonia-N point discharges, except for the tributaries, were converted to ultimates by multiplying the load by 4.57; 4.57 mg/l of oxygen is stoicheiometrically required to completely oxidize 1.0 mg/l of NH_3-N. The nitrogenous ultimate is theoretically independent of the rate, negating a need for downstream adjustments. The mile point locations of the values given in table 5 shift slightly upstream or downstream for low flows smaller or greater than the 7-day, 10-year value since the point of change is dependent on time and not on location. For nitrogenous BOD usage, t_0 in equation 7 was set at approximately 3.0 days on the basis of the findings of Butts et al. (1975).

The sediment oxygen demand rate inputs were derived from *in situ* measurements taken by the Water Survey along almost the whole length of the waterway from Lockport to Grafton during the last ten years. Values between Chillicothe and Lockport were estimated from those reported by Butts (1974), while those for the LaGrange pool are from Butts et al. (1981). Measurements have been made in the Peoria area of the Peoria pool and a limited number have been made in the lower Alton pool but have yet to be reported; these results are summarized in table 6. Table 7 lists the actual SOD rates applied to various subreaches in each pool for the simulations made during this study.

When a dam is encountered, the last DO calculated above the dam is set equal to C_A in equation 9, and the program proceeds to calculate the downstream DO (C_B) using specified values of a, b, h, and T. Table 8 lists the values of these parameters utilized for study simulations. The aeration coefficient was set equal to 0 for both the Lockport and Marseilles dams. All low flow is routed through the power plant penstocks at the Lockport site, while all flow below 8500 cfs is diverted through the Illinois Power Company hydroelectric plant at Marseilles (Butts et al., 1975). Very little reaeration is produced in flows routed through power plants.

Table 5. BOD Reaction Rates Applied to
Specified Reaches of Waterway for 7-day, 10-year Low Flow

Inclusive Corps MP	BOD reaction rates (day) Carbonaceous (K_{1C})	Nitrogenous (K_{1C})
291.02 - 254.35	0.0677	0
254.35 - 165.30	0.0677	0.1195
165.30 - 80.19	0.1230	0.0920
80.19 - 0	0.1150	0.0550

Table 6. 1982 Peoria Pool and 1980 Alton Pool *In Situ* SOD Results

Pool	Corps MP	SOD ($g/m^2/d$ at 20° C)
Peoria	165.84R	1.41
	165.25R	1.56
	164.40R	2.27
	163.62R	2.10
	162.90R	1.71
	162.77R	0.54
	162.77L	1.25
	162.68R	2.01
	162.21R	0.84
	161.51R	0.69
	161.51L	0.82
	160.97R	0.91
	160.97L	1.00
	160.12R	1.30
	160.12L	0.87
	158.57R	0.56
	158.57L	1.09
Alton	36.50R	0.55
	29.30R	0.58
	18.90R	0.29
	8.30R	1.46

Note: R and L = right and left banks, respectively, looking downstream

Table 7. SOD Rates Utilized for Subreaches throughout Waterway below Lockport

Pool	Corps MP	SOD $g/m^2/d$	Pool	Corps MP	SOD $g/m^2/d$
Brandon Road	291.02		Peoria	231.02	
	290.00	1.0		229.60	0.5
	286.17	3.5		226.34	2.0
Dresden Island	285.81	0.5		188.64	1.5
	285.40	2.0		183.00	2.5
	283.74	3.5		170.90	1.5
	280.38	3.0	LaGrange	157.70	1.0
	278.19	2.5		155.00	0.6
	277.71	3.0		153.00	0.5
	273.50	3.5		83.74	0.6
	272.86	2.0	Alton	80.19	0.5
Marseilles	271.46	3.0		55.00	0.5
	270.21	0.5		30.00	0.6
Starved Rock	246.98	1.5		23.26	0.5
	244.05	0.5		20.00	0.3
	234.50	1.5		15.00	0.5
	231.02	1.0		10.00	0.7
				0.00	1.0

Table 8. Data Input Used to Compute Dam Aeration for Simulated Conditions

Dam	Water temperature,T (C)	Water quality factor, a	Dam aeration coefficient, b	Head loss, h(ft) 7-d, 10-yr	9/27/71	9/3/71
Lockport*	26	1.28	0*	38.3	36.0	35.0
Brandon Road	26	1.29	25	34.0	33.5	33.5
Dresden Island	26	0.95	2	21.8	20.3	19.8
Marseilles	26	1.14	0*	14.3	9.7	9.7
Starved Rock	27	1.09	0.8	18.2	17.4	16.9
Peoria	28	1.19	1.0	10.0	9.3	6.4
LaGrange	28	1.32	0.6	9.8	7.5	6.4

* No low flow aeration

Note: b = 1.0 for flows in excess of 8500 cfs

The use of equation 9 is limited to uses where the head loss is 9.0 meters or less; consequently, for the Lockport and Brandon Road dams the h-factor is artificially set equal to 9 meters (29.52 ft.) and aeration is calculated on this basis. Note from table 8 that water temperatures are varied slightly, increasing in a downstream direction.

RESULTS

The results will be presented in three parts. First, pertinent general information will be given that has been derived from the updating of the Illinois Waterway cross-sectional data file and the subsequent revision of the Water Quality Section's low flow time-of-travel computer program. Next the output from the use of the MSD water quality model for various discretionary diversion schemes will be presented, and finally the effects of the optimum diversionary scheme on downstream water quality will be shown.

Hydraulic and Hydrologic Information

More than 1650 cross sections between Lockport and Grafton have been cataloged into the SWS data file. One of the results of the effort was to better define the longitudinal length of the waterway. The U.S. Army Corps-of Engineers mileage does not represent the true distance the main stream of water has to travel within selected reaches of the waterway. This is an important element to consider when evaluating time-dependent water quality parameters such as ammonia, BOD, SOD, and DO.

The river miles, as measured by the Water Survey, are presented and compared to the Corps designations in Appendix A. Differences occur for a number of reasons. Besides differences attributable to accuracy errors, which obviously can be a factor, the Corps distances deviate from those measured by the Water Survey for two major reasons: 1) the Corps retains original mileage designations even when channel shortening and straightening has occurred, and 2) the Corps measures mileage along direct navigation approaches to the locks whereas the actual water flow is usually over a more circuitous route via spillway and riffle areas. The effect of the former practice is to exaggerate the length, whereas the effect of the latter is to reduce it. The two, however, appear to balance each other in the end as can be noted from the upstream net results at Lockport (Corps MP 291.0) in Appendix A; only 0.04 of a mile separates the Corps designation from that actually measured by the Water Survey.

Nevertheless, differences do become obvious in specific pools or reaches. For example, because of channel shortening in the Starved Rock pool (Corps MP 230.0 to 247.0) the official designated distance is approximately 17 miles while the actual distance is 16.77 miles, almost a quarter of a mile shorter. Subsequent results will be referenced to Corps mileage for convenience, but all computations will have been done using Water Survey lengths.

A copy of a computer printout showing the input data and the subsequent output for the 7-day,10-year low flow simulation is presented in Appendix B. Included in the output is the Water Survey mile point, flow at the end of a reach (F), average flow within a reach (AVF), average reach cross-sectional area (AVA), average reach width (AVW), average reach depth (AVD), reach time of travel (DT), accumulated time of travel (SUMT), reach distance (DIS), and reach volume (VOL).

The basic hydraulic and hydrologic information for the simulation runs made under the three flow conditions are summarized by pools in table 9. Of particular note are the extremely long travel times involved during low flows. By definition 7-day, 10-year low flows can persist only during 7 continuous days and not the 20 to 30 days required to traverse the entire water course during low flow periods.

MSP Water Quality Model

The results of the hundred discretionary diversion trial runs are summarized in tables 10 through 17. The waste load inputs and water quality data selected as representative for July, August, and September low flow conditions are presented as sub-tables or lists at the beginning of each of these tables; Figure 3 should be referred to for the locations of the predicted DO values presented in the tables.

Table 10 presents the results for the most basic trial conditions. Existing waste and water quality conditions are used as inputs (as listed in the sub-table), and waterway conditions are examined at instream aeration efficiencies of 50 and 75 percent. From these results, the overall best diversionary scheme was selected. No clear-cut choice was evident, but run number 10 appears to give the best overall system DO balance.

Almost all runs produced DO levels at Lockport within small deviations of each other. For the 44 runs listed, the mean DO was 2.91 mg/l and the standard deviation was 0.09 mg/l. The mean Lockport DO at 50 percent aeration efficiency was 2.88 mg/l but the average was increased only slightly to 2.93 mg/l by increasing the efficiency to 75 percent.

Table 9. Hydraulic and Hydrologic Data Summaries by Pool

Pool	Inclusive MP Corps	Inclusive MP SWS	SWS length (mi)	Average flow (cfs) 7d, 10y	Average flow (cfs) 9/27/71	Average flow (cfs) 9/3/71	Average depth (ft) 7d, 10y	Average depth (ft) 9/27/71	Average depth (ft) 9/3/71
	291.04	291.00							
Brandon Rd.	286.17	286.25	4.75	4,173	4,266	4,346	13.5	14.0	14.0
Dresden Is.	271.46	272.52	14.73	4,302	4,620	5,064	9.9	10.2	10.2
Marseilles	246.98	246.78	24.74	4,999	6,701	6,995	9.4	10.2	10.4
Starved Rock	231.02	231.02	15.76	5,155	6,777	8,015	8.6	9.0	9.0
Peoria	157.70	158.06	72.96	5,148	6,884	8,327	9.4	9.6	9.7
LaGrange	80.19	80.01	78.05	4,742	6.774	9,190	9.4	9.4	10.2
Alton	0.00	0.00	80.01	5,362	6,841	10,001	9.3	9.0	9.4

Pool	Average velocity (fos) 7d, lOy	Average velocity (fos) 9/27/71	Average velocity (fos) 9/3/71	Accumulated travel time (days) 7d, lOy	Accumulated travel time (days) 9/27/71	Accumulated travel time (days) 9/3/71
				0	0	0
Brandon Rd.	0.71	0.69	0.71	0.411	0.419	0.409
Dresden Is.	0.59	0.58	0.64	1.946	2.024	1.885
Marseilles	0.82	0.95	0.97	3.783	3.557	3.375
Starved Rock	0.82	1.02	1.17	4.953	4.501	4.195
Peoria	0.41	0.51	0.60	15.955	13.276	11.606
LaGrange	0.81	1.10	1.19	21.860	17.606	15.603
Alton	0.62	0.71	0.73	29.733	24.523	22.272

Internally, however, significant differences were evident. For example, increasing the diversion down Cal-Sag Channel at the expense of the other two diversion points appeared to increase the Cal-Sag Channel DO without significantly affecting the DO in other critical locations, including Lockport. Comparing run 16 with run 66 illustrates this point. Increasing the Cal-Sag diversion by 236 cfs in run 66 over the amount in run 16 increases the minimum DO in the Cal-Sag by 0.5 mg/l, whereas at other points in the system, a decrease of only about half of this value is experienced. On the basis of an overall rational assessment of the results presented in table 10, run number 10 was selected to represent starting conditions for evaluating water conditions downstream of Lockport.

Tables 11 through 17 represent special or modified conditions. Table 11 contains information for many of the same diversion schemes as presented in table 10; however, the Calumet sewage treatment plant treatment efficiencies have been arbitrarily set equal to those of the Northside plant (see sub-table information). Tables 12 through 16 all have as a common denominator the diversions used for run 10, the optimum run under existing conditions. The variables in each case are: table 12 - Lake Michigan (Wilmette pumping station, Chicago River controlling works, O'Brien lock and controlling works) BOD_{5c}; table 13 - Lake Michigan DOs; table 14 - Calumet plant DOs; table 15 - West-Southwest plant DOs; and table 16 - Northside plant DOs. Table 17 lists conditions resulting from the hypothetical installation of instream aeration in the Cal-Sag Channel below the Calumet treatment plant.

Selection of run 10 established the following baseline information at Lockport:

Flow: 4126.49 cfs BOD_{5C} = 1.766 mg/l

Temperature: 26.0°C NH -N = 1.727 mg/l

DO = 2.863 mg/l

Table 10. Minimum DO Concentrations within Selected Channel Reaches for Various Discretionary Diversion Flow Combinations and Specific Waste Inputs of:

	NS	WSW	Cal.	L.M.
BOD_{5C} (mg/l)	7	5	14	2.5
NH_3-N (mg/l)	2	1	13	.005
DO (mg/l)"	6.5	8.0	6.5	8.4
Discharge (cfs)	433.2	1268.5	340.3	*

Instream Aeration Efficiency = 50%

Run	Discretionary diversion (cfs)			Minimum predicted DO (mg/l) at points referenced in fig. 3				
no.	WPS	CRCW	O'Brien	1	2	3	4	5
1	128	640	512	2.15	2.48	4.29	0.79	2.89
2	128	704	448	2.15	2.48	4.35	0.68	2.95
3	128	768	384	2.15	2.48	4.41	0.58	3.00
4	192	576	512	3.83	2.89	4.27	0.79	2.88
5	192	640	448	3.83	2.89	4.33	0.68	2.93
6	192	704	384	3.83	2.89	4.38	0.58	2.98
7	256	512	512	4.81	3.28	4.25	0.79	2.87
8	256	576	448	4.81	3.28	4.31	0.68	2.92
9	256	640	384	4.81	3.28	4.36	0.58	2.97
50	200	448	632	3.98	2.94	4.15	1.03	2.81
51	180	448	652	3.59	2.82	4.14	1.07	2.80
52	160	448	672	3.11	2.69	4.12	1.12	2.80
53	240	300	740	4.61	3.19	4.04	1.26	2.76
54	240	350	690	4.61	3.19	4.09	1.15	2.78.
55	240	400	640	4.61	3.19	4.13	1.05	2.80

Instream Aeration Efficiency = 75%

Run no.	WPS	CRCW	O'Brien	1	2	3	4	5
10	200	448	632	3.98	3.91	4.26	1.03	2.86
11	200	512	568	3.98	3.91	4.32	0.90	2.90
12	200	576	504	3.98	3.91	4.38	0.78	2.94
13	200	640	440	3.98	3.91	4.44	0.67	2.99
14	200	704	376	3.98	3.91	4.50	0.57	3.05
15	160	448	672	3.11	3.69	4.23	1.12	2.85
16	160	576	544	3.11	3.69	4.35	0.85	2.92
17	160	704	416	3.11	3.69	4.47	0.63	3.02
18	180	448	652	3.58	3.80	4.24	1.07	2.85
19	180	576	524	3.58	3.80	4.37	0.82	2.93
20	180	704	396	3.58	3.80	4.48	0.60	3.03
32	215	660	405	4.24	4.00	4.47	0.61	3.02
33	215	690	375	4.24	4.00	4.49	0.57	3.05
34	215	630	435	4.24	4.00	4.44	0.66	3.00
35	205	660	415	4.07	3.94	4.46	0.63	3.01
36	205	690	385	4.07	3.94	4.49	0.58	3.04
37	205	630	445	4.07	3.94	4.43	0.67	2.99
38	225	660	395	4.40	4.05	4.47	0.60	3.03
39	225	690	365	4.40	4.05	4.50	0.56	3.06
40	225	630	425	4.40	4.05	4.45	0.64	3.00
59	200	300	780	3.98	3.91	4.11	1.35	2.80
60	200	350	730	3.98	3.91	4.16	1.24	2.82
61	200	400	680	3.98	3.91	4.21	1.13	2.84
62	240	300	740	4.61	4.13	4.14	1.26	2.81
63	240	350	690	4.61	4.13	4.20	1.15	2.83
64	240	400	640	4.61	4.13	4.25	1.05	2.85
65	150	300	830	2.84	3.63	4.05	1.46	2.78
66	150	350	780	2.84	3.63	4.11	1.35	2.80
67	150	400	730	2.84	3.63	4.16	1.24	2.82

Note: In this and subsequent tables, NS = Northside plant; WSW = West-Southwest plant; Cal. = Calumet plant; L.M. = Lake Michigan; WPS = Wilmette pumping station; CRCW = Chicago River controlling works; O'Brien = O'Brien lock and controlling works

Table 11. Minimum DO Concentrations within Selected Channel Reaches for Various Discretionary Diversion Flow Combinations and Specific Waste Inputs of:

	NS	WSW	Cal.	L.M.
BOD_{5C} (mg/l)	7	5	7	2.5
NH_3-N (mg/l)	2	1	2	.005
DO (mg/l)	6.5	8.0	6.5	8.4
Discharge (cfs)	433.2	1268.5	340.3	*

Instream Aeration Efficiency = 50%

Run no.	*Discretionary diversion (cfs) WPS	CRCW	O'Brien	Minimum predicted DO (mg/l) at points referenced in fig. 3: 1	2	3	4	5
56	205	295	780	4.07	2.97	4.00	2.10	3.09
57	215	285	780	4.24	3.04	4.00	2.10	3.09
58	225	275	780	4.40	3.10	4.00	2.10	3.09

Instream Aeration Efficiency = 75%

Run no.	WPS	CRCW	O'Brien	1	2	3	4	5
21	200	448	632	3.98	3.91	3.19	1.84	3.19
22	200	512	568	3.98	3.91	3.22	1.74	3.22
23	200	576	504	3.98	3.91	3.25	1.63	3.25
24	200	640	440	3.98	3.91	3.29	1.52	3.29
25	200	704	376	3.98	3.91	3.33	1.42	3.33
26	160	448	672	3.11	3.69	3.18	1.91	3.18
27	160	576	544	3.11	3.69	3.24	1.69	3.24
28	160	704	416	3.11	3.69	3.31	1.48	3.31
29	180	448	652	3.58	3.80	3.19	1.88	3.19
30	180	576	524	3.58	3.80	3.25	1.66	3.25
31	180	704	396	3.58	3.80	3.32	1.45	3.32
41	215	325	740	4.24	4.00	4.15	2.03	3.15
42	215	365	700	4.24	4.00	4.19	1.96	3.17
43	215	285	780	4.24	4.00	4.11	2.10	3.14
44	205	335	740	4.07	3.94	4.15	2.03	3.15
45	205	375	700	4.07	3.94	4.19	1.96	3.17
46	205	295	780	4.07	3.94	4.11	2.10	3.14
47	225	315	740	4.40	4.05	4.15	2.03	3.15
48	225	355	700	4.40	4.05	4.19	1.96	3.16
49	225	275	780	4.40	4.05	4.10	2.10	3.14
68	150	300	830	2.84	2.19	4.05	2.19	3.12
69	150	350	780	2.84	2.10	4.11	2.10	3.14
70	150	400	730	2.74	2.01	4.16	2.01	3.16

Table 12. Minimum DO Concentrations within Selected Channel Reaches for Variable Lake Michigan BOD_{5C} Concentrations for Conditions of:

	NS	WSW	Cal.	WPS	CRCW	O'Brien
BOD_{5C} (mg/l)	7	5	14	*	*	*
NH_3-N (mg/l)	2	1	13	.005	.005	.005
DO (mg/l)	6.5	8.0	6.5	8.4	8.4	8.4
Discharge (cfs)	433.2	1268.5	340.3	200	448	632

Instream Aeration Efficiency = 75%

Run no.	*L.M. BOD_{5C}	Minimum predicted DO (mg/l) at points referenced in fig. 3: 1	2	3	4	5
71	1	4.55	4.18	4.55	1.38	3.16
72	2	4.17	4.00	4.36	1.14	2.96
73	3	3.79	3.83	4.17	0.92	2.77
74	4	3.41	3.65	3.97	0.73	2.58
75	5	3.03	3.48	3.78	0.56	2.41
76	6	2.65	3.31	3.59	0.42	2.25

Table 13. Minimum DO Concentrations within Selected Channel Reaches for Variable Lake Michigan DO Concentrations for Conditions of:

	NS	WSW	Cal.	WPS	CRCW	O'Brien
BOD_{5C} (mg/l)	7	5	14	2.5	2.5	2.5
NH_3-N (mg/l)	2	1	13	.005	.005	.005
DO (mg/l)	6.5	8.0	6.5	*	*	*
Discharge (cfs)	433.2	1268.5	340.3	200	448	632

Instream Aeration Efficiency = 75%

Run no.	*L.M. DO	Minimum predicted DO (mg/l) at points referenced in fig. 3: 1	2	3	4	5
77	5	1.62	3.51	3.90	0.77	2.61
78	6	2.27	3.62	4.00	0.84	2.68
79	7	2.97	3.74	4.11	0.92	2.76
80	8	3.69	3.86	4.22	1.00	2.83
81	9	4.42	3.99	4.32	1.08	2.91
82	10	5.16	4.11	4.43	1.18	2.99

Table 14. Minimum DO Concentrations within Selected Channel Reaches for Variable Calumet Plant Effluent DO Concentrations for Conditions of:

	NS	WSW	Cal.	WPS	CRCW	O'Brien
BOD_{5C} (mg/l)	7	5	14	2.5	2.5	2.5
NH_3-N (mg7l)	2	1	13	.005	.005	.005
DO (mg/l)	6.5	8.0	*	8.4	8.4	8.4
Discharge (cfs)	433.2	1268.5	340.3	200	448	632

Instream Aeration Efficiency = 75%

Run no.	*Cal. DC)	Minimum predicted DO (mg/l) at points referenced in fig. 3: 1	2	3	4	5
83	3	3.98	3.91	4.26	0.75	2.78
84	4	3.98	3.91	4.26	0.82	2.80
85	5	3.98	3.91	4.26	0.90	2.82
86	6	3.98	3.91	4.26	0.99	2.85
87	7	3.98	3.91	4.26	1.08	2.88

Table 15. Minimum DO Concentrations within Selected Channel Reaches for Variable West-Southwest Plant Effluent DO Concentrations for Conditions of:

	NS	WSW	Cal.	WPS	CRCW	O'Brien
BOD_{5C} (mg/l)	7	5	14	2.5	2.5	2.5
NH_3-N (mg/l)	2	1	13	.005	.005	.005
DO (mg/l)	6.5	*	6.5	8.4	8.4	8.4
Discharge (cfs)	433.2	1268.5	340.3	200	448	632

Instream Aeration Efficiency = 75%

Run no.	*WSW DO	Minimum predicted DO (mg/l) at points referenced in fig. 3: 1	2	3	4	5
88	4	3.98	3.91	2.85	1.03	2.16
89	5	3.98	3.91	3.20	1.03	2.33
90	6	3.98	3.91	3.55	1.03	2.51
91	7	3.98	3.91	3.91	1.03	2.69

Table 16. Minimum DO Concentrations within Selected Channel Reaches for Variable Northside Plant Effluent DO Concentrations for Conditions of:

	NS	WSW	Cal.	WPS	CRCW	O'Brien
BOD_{5C}(mg/l)	7	5	14	2.5	2.5	2.5
NH_3-N (mg/l)	2	1	13	.005	.005	.005
DO (mg/l)	*	8.0	6.5	8.4	8.4	8.4
Discharge (cfs)	433.2	1268.5	340.3	200	448	632

Instream Aeration Efficiency = 75%

Run no.	*NS DO	Minimum predicted DO (mg/l) at points referenced in fig. 3 _1	_2	_3	_4	_5
92	3	3.98	2.66	4.12	1.03	2.79
93	4	3.98	3.01	4.16	1.03	2.81
94	5	3.98	3.36	4.20	1.03	2.83
95	6	3.98	3.72	4.24	1.03	2.85
96	7	3.98	4.10	4.28	1.03	2.87

Table 17. Minimum DO Concentrations within Selected Channel Reaches for Variable Instream Aeration Capacity below Calumet Plant Discharge (MSD River Mile 51) for Conditions of:

	NS	WSW	Cal.	WPS	CRCW	O'Brien
BOD_{5C} (mg/l)	7	5	7	2.5	2.5	2.5
NH_3-N (mg/l)	2	1 2	.005		.005	.005
DO (mg/l)	6.5	8.0	6.5	8.4	8.4	8.4
Discharge (cfs)	433.2	1268.5	340.3	215	235	830

Instream Aeration Efficiency = 75%

Run no.	Aerator capacity at MSD Mile 51 (lbs/dav O_2)	Minimum predicted DO (mg/l) at points referenced in fig. 3 _1	_2	_3	_4	_5
97	13,300	4.24	4.00	4.05	2.83	3.34
98	26,600	4.24	4.00	4.05	3.49	3.57
99	39,900	4.24	4.00	4.05	4.15	3.80
100	53,200	4.24	4.00	4.05	4.83	4.03

SWS Water Quality Model

The baseline waste load data established at Lockport were used in conjunction with point load discharges along the waterway to develop low flow DO profiles. The waste source inventory is summarized in table 18 for three periods: the 12 months of 1971, the 12 months of 1980, and 3 months (July, August, and September) of 1980. Listed for historical and comparative purposes are some industrial sources which were in existence in 1971 but which

Table 18. Waste Discharge Loads Discharged Directly to the Illinois Waterway

					Average waste loads (lbs/day)					
		Average flow (mgd)			BOD_{5c} at 20°C			NH_3-N		
	Corps	12 month		3 mo.	12 month		3 mo.	12 month		3 mo.
Load Source	MP	1971	1980	1980	1971	1980	1980	1971	1980	1980
Sanitary Shin Canal	291.04	2670.87	2670.87	2670.87	72,817	61,095	38,711	101,461	51,436	38,488
Lockoort	290.76	2.00	2.68	3.17	134	205	264	117	87	103
Locknort Heights	290.76		0.15	0.10		44	15		19	13
Texaco	290.76	5.89	4.53	4.56	196	183	177	295	159	156
GAF Corp.	290.00	2.20	0.34	0.34	846	28	26	129	20	20
U.S. Steel	288.90	23.00	0.40	0.43	1,743	0	0	316	0	0
Joliet West	286.17		3.49	3.27		170	200		17	16
Joliet East	286.17	21.20	17.63	18.00	4,952	2,717	2,898	2,158	2,039	2,134
Com. Ed. Joliet	284.37		0.04	0.02		8	3		10	5.
Olin Blockson	284.37	3.00	0.05	0.05	856	.3	3	107	0	0
Caterpillar	283.74	0.77	0.87	0.90	157	46	46	8	0	0
Amoco Chemical	280.38	0.82	0.77	0.80	121	39	31	123	7	7
SteDan Chemical	280.05	0.84	0.73	0.80	10	91	56	18	0	0
Mobil Refinery	278.19	2.40	2.92	3.23	846	377	565	1,895	410	475
Joliet Ammo Plant	277.71		0.91	0.42		30	12		0	0
Mobil Chemical	277.71	0.13	0.15	0.14	7	13	8	120	0	0
Glidden-Durkee	276.41	0.22	0.27	0.34	1057	6	13	9	5	6
Com. Ed. Dresden	272.14		7.58	6.07		865	380		0	6
N. Illinois Gas	270.57		0.38	0.31		24	26		0	0
Reichhold Chemical	270.21	0.10	0.10	0.15	121	3	3	6	0	0
N. Petrochemical	269.86	1.01	1.92	1.63	205	74	77	39	6	0
Com. Ed. Collins	690.00		0.03	0.01		2	<1		0	0
Federal Paper Co.	264.30	2.70	0	0	1,031	0	0	3	0	0
Morris	262.79	0.76	1.33	1.40	106	134	175	17	59	52
DuPont Corp.	254.35	1.63	1.02	0.78	61	97	87	152	103	67
Seneca	252.44		0.30	0.30		138	130		38	38
National Phosphate	249.80	1.67	0	0	138	0	0	63	0	0
Illinois Nitrogen	248.71	16.30	13.30	9.70	2,174	0	0	3,478	611	415
Nabisco	246.66	0.36	0	0	880	0	0	0	0	0
Marseilles	246.10	1.10	0.98	1.00	626	58	50	136	9	9
Borg Warner	244.05	0.56	0.71	0.67	69	56	56	277	150	29
Ottawa	239.17	2.98	2.45	2.53	439	116	99	15	21	21
LOF Corp.	237.50	3.73	2.03	1.70	134	93	71	0	0	0
Utica	229.57	0.15			29			6		
Com. Ed. LaSalle			0.05	0.05		7	6		0	0
Illinois Cement	223.00		<0.01	<0.01		<1	<1		<1	0
LaSalle	223.00	1.20	1.33	1.23	463	138	31	103	11	10
Carus Chemical	223.00		1.13	1.27		0	0		18	. 11
Peru	222.00	1.84	3.06	2.73	106	128	76	16	26	23
Spring Valley	218.00	0.88	0.90	0.83	121	62	42	22	34	31
DePue	210.80	0.20	0.42	0.37	19	77	41	7	7	6
J & L Steel	208.20	3.60	2.56		412		0			
B. F. Goodrich	198.02	1.00	0.76	0.67	151	76	57	192	127	112
Sparland	190.00		0.03	0.03		1	<1		1	<1
Lacon	188.64	0.28	0.22	0.20	90	36	25	14	8	7
Chillicothe	179.10	0.46	0.51	0.50	92	66	57	21	77	75
Cat Mossville	174.40		1.03	0.91		171	111		9	8
E. Peoria #3	165.30		0.95	0.90		93	105		34	32
E. Peoria #1	160.72	2.96	1.85	1.80	622	147	135	44	25	24
Cat. E. Peoria	160.68	6.98	7.50	8.00	1,976	839	533	41	63	67
Peoria S.D.	160.05	36.89	24.05	24.13	7,925	1,387	1,071	1,321	665	537
Creve Coeur	158.16	0.48	0.79	0.73	1,456	399	336	73	110	102
Marquette Hts.	157.53	0.22	0.36	0.40	169	225	197	45	63	70
Pekin #2	156.00		.0.80	0.80		120	120		72	72
CILCO Edwards	154.48		<0.01	<0.01		<1	<1		<1	<1
Pekin #1	152.20	2.53	2.10	2.60	285	194	296	24	189	234
Pekin Energy Co.*	151.60	0.76	25.50	25.50	713	2,124	2,124	32	22	21
Midwest Solventst	151.30	0.36	2.26	1.45	108	153	131	6	0	2
Quaker Oats	151.20		0.43	0.43		169	168		1	1
Cat Mapleton	147.29		3.96	1.00		410	211		33	33
Havana	119.17	0.44	0.38	0.47	37	34	38	63	7	8
Illinois Power Co.	118.50		0.01	0.13		<1	<1		<1	<1
Beardstown	87.90	1.18	0.82	0.90	849	216	255	196	69	75
Beard. Ind. Lagoons	87.95	1.22	0	0	659	0	0	365	0	0
CIPS	70.81		<0.01	<0.01		<1	<1		<1	<1
National Starch	70.00		0.33	0.27		10	10	.	0	0

*Formerly CPC International

tFormerly American Distillery Co.

no longer discharge. All known point sources are included; some are very small and have no discernible effects on the waterway DO resources but have been included for "bookkeeping" purposes.

Table 19 summarizes the results for the three periods, and compares the absolute and relative 1971 and 1980 yearly average contributions. Noteworthy is the fact that the 1980 3-month $B0D_{5C}$ load contributed by Chicago is significantly different from the 1980 yearly contribution. This is primarily because the 1980 yearly averages at the Northside and WSW plants exceed the 3-month averages by 2.8 mg/l and 3.0 mg/l, respectively. The Chicago area percentage contribution has increased, although in absolute terms the load has actually been reduced 16.1 percent. Relative to this, however, is the fact that the downstream load has been reduced a monumental 61.1 percent, an extremely commendable accomplishment. Just as commendable is the fact that both area NH3-N loads have been reduced by around 50 percent.

The yearly 1971 and 1980 and 3-month 1980 loads presented in table 18, when applied to 7-day, 10-year low flows, produced the DO profiles outlined in figures 4 through 8. Also presented in these figures are the curves produced as a result of applying the 3-month loads to the 9/27/71 and 9/3/71 flow conditions. Residual BOD_{5C} and ammonia concentrations produced as a result of these simulations are presented for numerous points along the waterway in tables 20 and 21.

DISCUSSION AND CONCLUSIONS

A generalized discussion of the results will be presented, and some comparisons will be made with field DO sampling results obtained during 1982. Specific ideas and concepts relative to management strategies will be presented in the next section.

Finite proportionment of the discretionary diversion flow does not appear to be warranted relative to water quality conditions below Lockport. A minor exception to this may be the Brandon Road pool. Basically, proportional diversion is pertinent only to DO levels in the Chicago area drainage system. As noted earlier only minor fluctuations occur in the DO levels at Lockport irrespective of the diversion scheme employed. Since no nitrifi-

Table 19. Comparison of Chicago Area Loads
to Total Downstream Contributions

	$B0D_{5C}$(lbs/day)			NH3-N (lbs/day)			1971 to 1980	
	12 month		3 mo.	12 month		3 mo.	% reduction	
Source	1971	1980	1980	1971	1980	1980	$B0D_{5C}$	NH3-N
Chicago residual at Lockport	72,817	61,095	38,711	101,461	51,436	38,488	16.1	49.3
Direct discharges below Lockport	33,191	12,906	11,653	12,072	5,445	5,137	61.1	54.9
Total	106,008	74,001	50,364	113,533	56,881	43,625	30.2	49.9
% Chicago residual	68.7	82.6	76.9	89.4	90.4	88.2		
% Contributed below Lockport	31.3	17.4	23.1	10.6	9.6	11.8		

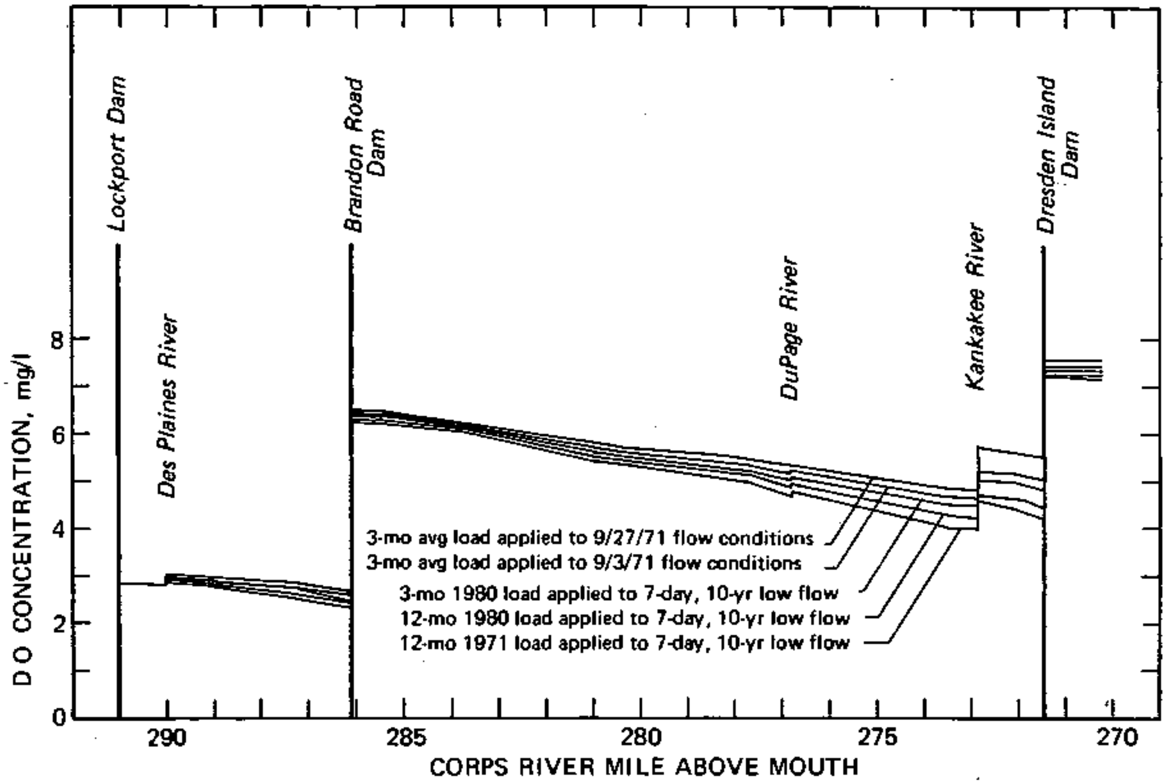


Figure 4. Brandon Road and Dresden Island pool DO curves for various conditions

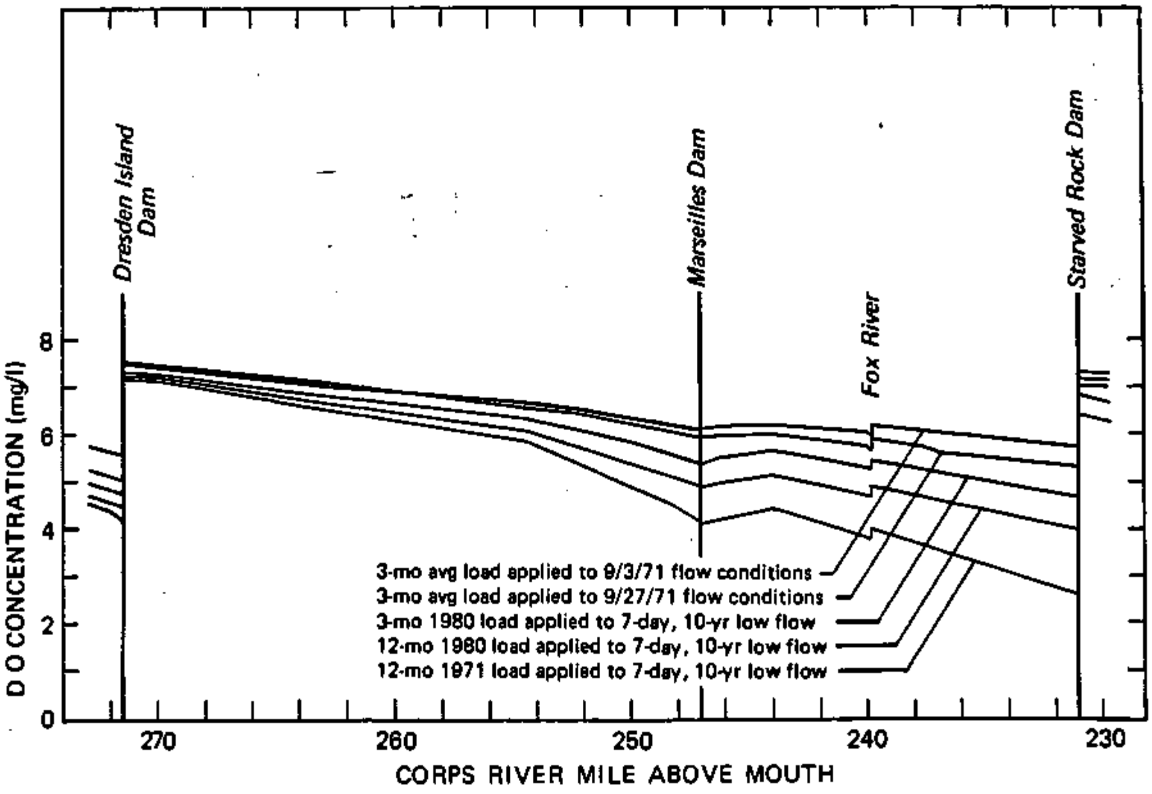


Figure 5. Marseilles and Starved Rock pool DO curves for various conditions

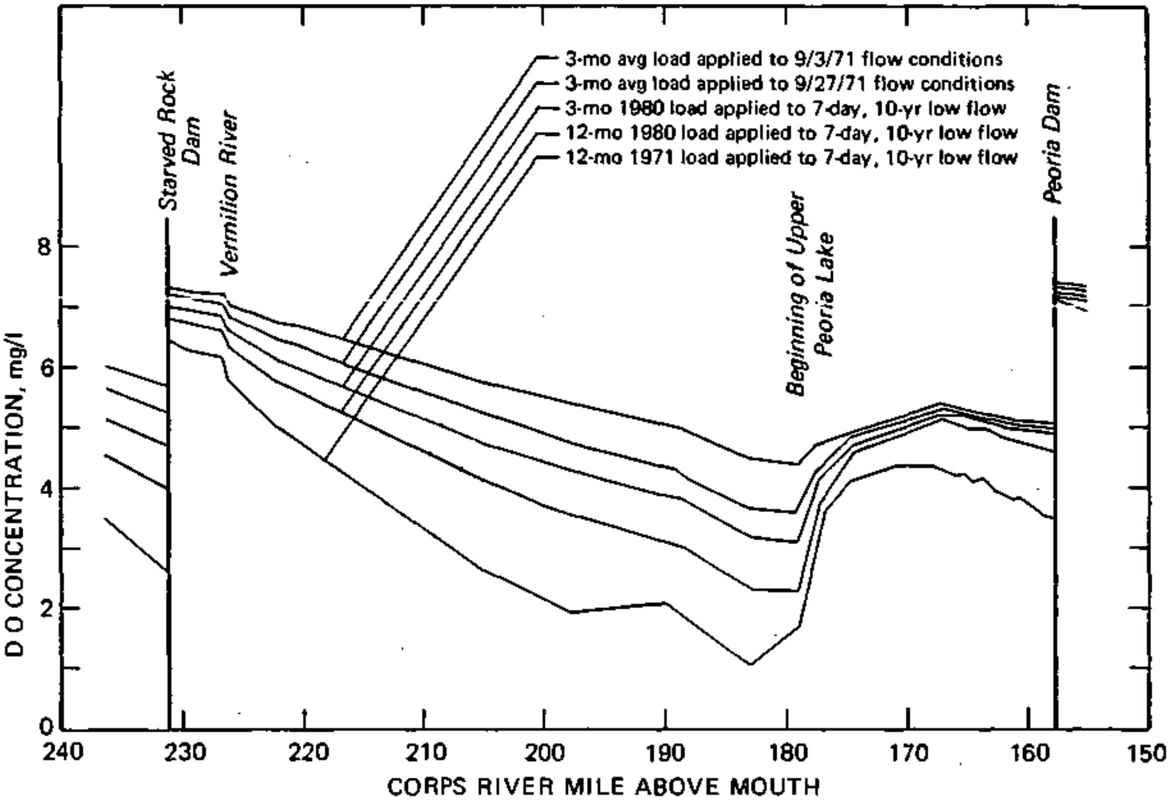


Figure 6. Peoria pool DO curves for various conditions

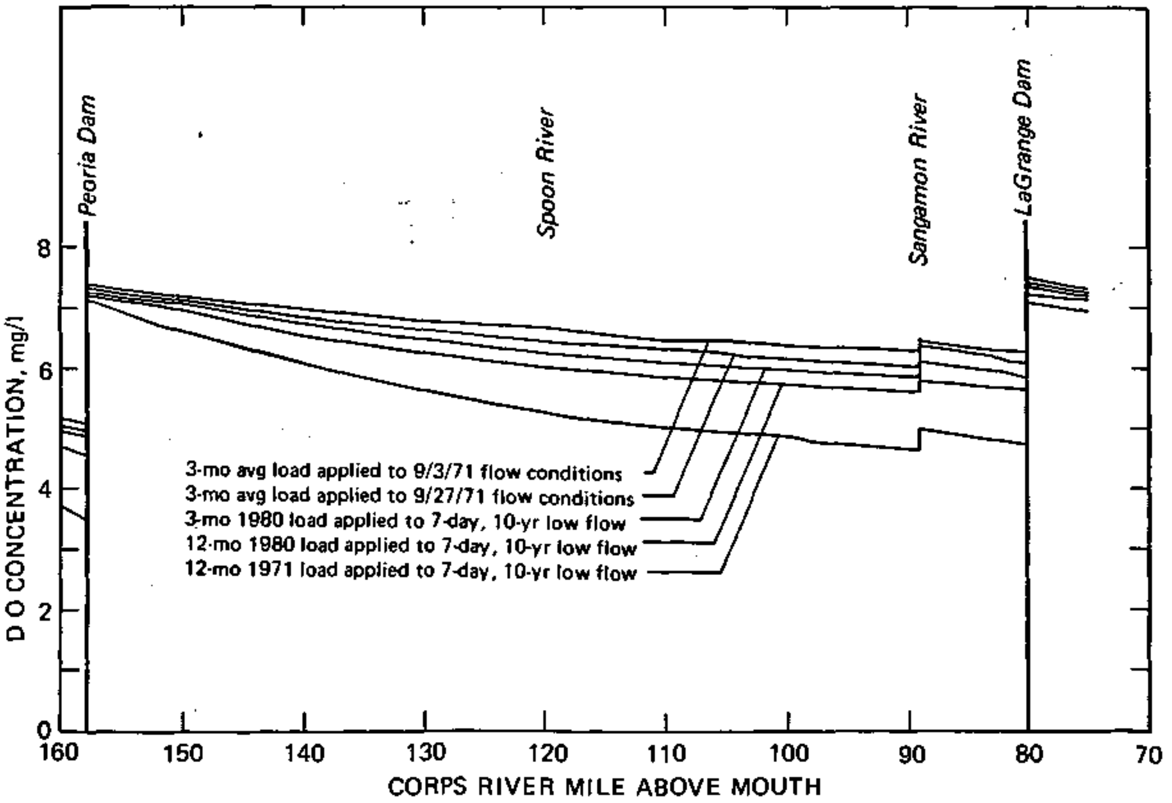


Figure 7. LaGrange pool DO curves for various conditions

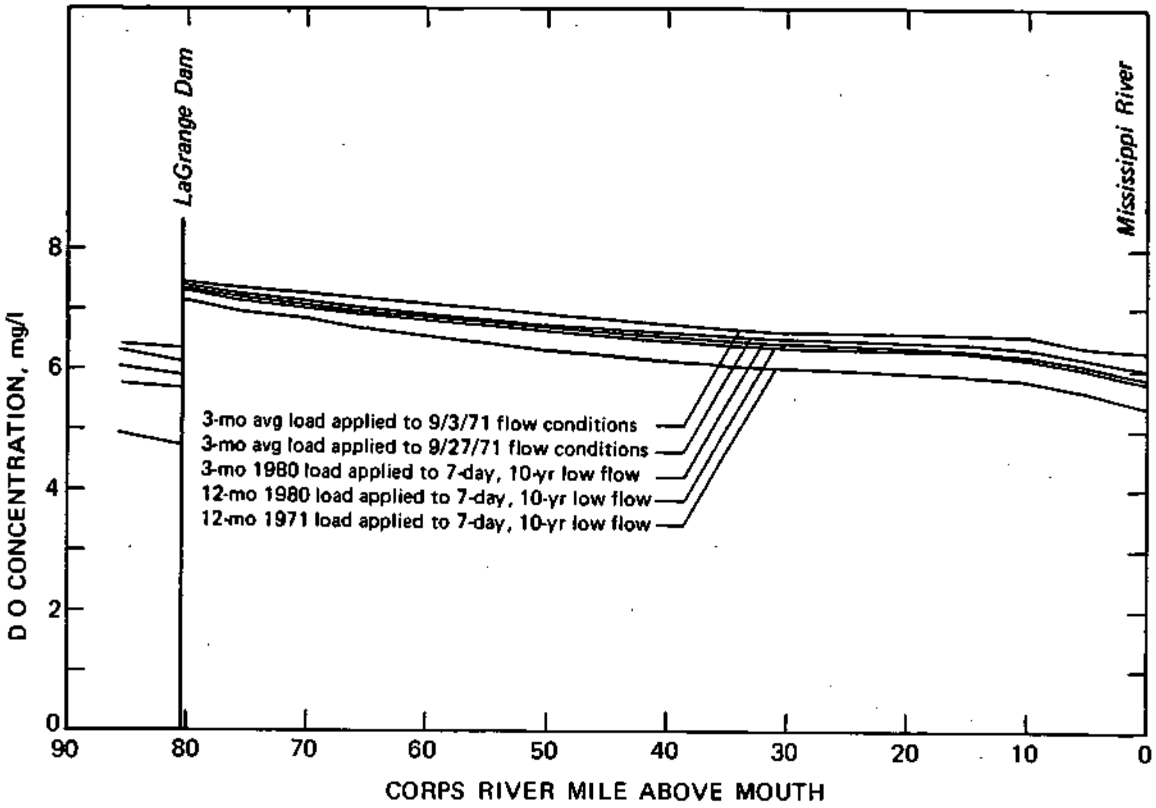


Figure 8. Alton pool DO curves for various conditions

cation occurs above Lockport, the ammonia load is totally unaffected by the amount or nature of the diversion.

Although carbonaceous BOD is used within the system in quantities proportional to detention times within specific channels, the net BOD_{5C} concentrations show almost no variance at Lockport, as shown in table 22. BOD_{5C} and NH_3-N loads can be significantly reduced at Lockport only by reducing the plant loads, particularly those from the Calumet plant, as indicated by the values in table 22 for the diversion schemes in tables 11 and 17. Also the sensitivity of the BOD at Lockport to large changes in lake diversion water BOD concentrations is minimal as shown by the data in table 22 for the diversion scheme in table 12; a six-fold increase in lake BOD_{5C} from 1.0 to 6.0 mg/l resulted in only a 0.3 mg/l BOD_{5C} increase at Lockport.

Dissolved oxygen conditions in the Brandon Road pool are almost totally dependent upon the net DO concentration above the Lockport dam since very little aeration occurs at the structure and the assimilation capacity of the pool is poor. During low flow conditions in the Brandon Road pool, minimum DOs will drop to values slightly lower than the value above the Lockport dam as demonstrated by the lower curve given in figure 9. However, the effect of Lockport DOs on values downstream of Brandon Road are minimized be-

Table 20. Simulated BOD$_{5c}$ and NH$_3$-N Concentrations at Selected Mile Points CMP) for 7-day, 10-year Low Flows

Corns	Flow	BOD$_{5C}$ (mg/l)			HH$_3$-N (mq/1)		
		12 month		3 mo.	12 month		3 mo.
MP	(cfs)	1971	1980	1980	1971	1980	1980
291.02	4139	3.28	2.76	1.75	4.56	2.32	1.73
290.00	4173	3.29	2.74	1.75	4.54	2.30	1.73
286.17	4190	3.18	2.65	1.69	4.52	2.29	1.72
286.13	4190	3.40	2.78	1.82	4.62	2.39	1.81
284.37	4199	3.40	2.75	1.81	4.61	2.38	1.81
283.74	4202	3.39	2.73	1.80	4.61	2.40	1.81
280.38	4218	3.27	2.64	1.74	4.60	2.37	1.80
278.19	4228	3.25	2.61	1.73	4.67	2.38	1.82
277.71	4230	3.23	2.60	1.73	4.67	2.38	1.82
276.82	4280	3.25	2.58	1.73	4.63	2.37	1.81
272.86	4934	2.92	2.57	1.65	4.07	2.11	1.62
272.14	4937	2.89	2.58	1.65	4.07	2.10	1.62
271.46	4941	2.86	2.34	1.64	4.06	2.10	1.62
270.21	4947	2.85	2.33	1.62	4.06	2.10	1.62
262.79	4982	2.76	2.23	1.55	4.03	2.09	1.61
254.35	5021	2.60	2.10	1.47	4.01	2.07	1.60
252.44	5031	2.55	2.07	1.45	3.94	2.04	1.57
248.71	5048	2.55	2.00	1.40	3.94	2.00	1.54
246.98	5057	2.56	1.96	1.37	3.87	1.96	1.51
244.05	5055	2.55	1.96	1.37	3.87	1.96	1.51
239.77	5256	2.52	1.97	1.42	3.67	1.87	1.44
239.17	5255	2.53	1.97	1.42	3.65	1.86	1.44
237.50	5253	2.50	1.94	1.40	3.62	1.85	1.42
231.02	5244	2.37	1.84	1.33	3.46	1.77	1.36
226.34	5245	2.31	1.79	1.29	3.39	1.73	1.34
223.00	5240	2.26	1.75	1.26	3.32	1.69	1.31
222.00	5238	2.25	1.74	1.25	3.30	1.69	1.30
218.00	5232	2.19	1.70	1.22	3.23	1.65	1.28
210.80	5247	2.07	1.61	1.16	3.08	1.58	1.22
209.03	5262	2.05	1.58	1.14	3.04	1.55	1.20
199.02	5246	1.87	1.44	1.04	2.82	1.44	1.11
190.00	5186	1.74	1.34	0.97	2.84	1.36	1.06
188.64	5172	1.71	1.32	0.95	2.80	1.35	1.04
179.10	5084	1.55	l.20	0.86	2.85	1.25	0.97
174.40	5040	1.39	1.07	0.78	2.71	1.15	0.89
165.30	4955	1.07	0.83	0.60	2.79	0.98	0.75
160.70	4913	0.95	0.70	0.50	2.17	0.92	0.72
160.05	4907	1.23	0.74	0.53	2.21	0.94	0.73
158.16	4890	1.23	0.72	0.52	2.13	0.94	0.73
157.70	4886	1.22	0.72	0.52	2.19	0.94	0.73
156.00	4870	1.20	0.71	0.52	2.18	0.94	0.73
152.00	4833	1.17	0.70	0.51	2.17	0.94	0.74
151.20	4826	1.19	0.78	0.60	2.17	0.94	0.74
147.73	4884	1.17	0.78	O.60	2.13	0.92	0.72
147.29	4863	1.17	0.80	0.61	2.14	0.93	0.73
120.50	4903	0.85	0.59	0.45	1.93	0.84	0.66
119.17	4906	0.84	0.58	0.45	1.92	0.84	0.66
88.90	5265	0.71	0.52	0.44	1.65	0.73	0.58
83.74	5289	0.64	0.47	0.35	1.59	0.70	0.56
80.19	5298	0.59	0.43	0.22	1.55	0.69	0.54
70.81	5319	0.53	0.39	0.20	1.52	0.67	0.53
0.00	5419	0.16	0.11	0.06	1.20	0.53	0.42

Table 21. Simulated $B0D_{5C}$ and NH_3-N Concentrations at Selected Mile Points (MP) for 9/27/71 and 9/3/71 Flow Conditions

	9/27/71 flow			9/3/71 flow		
Corps MP	Flow (cfs)	BOD_{5C} (mg/l)	NH_3-N (mg/l)	Flow (cfs)	BOD_{5C} (mg/l)	NH_3-N (mg/l)
291.02	4139	1.74	1.74	4139	1.74	1.74
290.00	4152	1.82	1.76	4207	1.75	1.72
286.17	4322	1.69	1.69	4508	1.58	1.60
286.13	4323	1.83	1.78	4511	1.71	1.69
284.37	4345	1.80	1.77	4627	1.66	1.65
283.74	4353	1.79	1.77	4670	1.63	1.64
280.38	4392	1.72	1.75	4877	1.52	1.57
278.19	4418	1.71	1.76	5016	1.48	1.54
277.71	4424	1.70	1.76	5046	1.46	1.53
276.82	4434	1.72	1.77	5101	1.46	1.53
272.86	4545	2.34	1.91	5404	1.55	1.49
272.14	6534	1.62	1.33	6159	1.36	1.31
271.46	6542	1.61	1.33	6202	1.34	1.30
270.21	6557	1.60	1.32	6285	1.32	1.28
263.54	6638	1.53	1.31	6713	1.19	1.20
262.79	6663	1.53	1.30	6766	1.18	1.20
254.35	6764	1.44	1.29	7302	1.05	1.11
252.44	6878	1.42	1.27	9425	1.02	1.08
248.98	6833	1.38	1.24	7666	0.97	1.03
246.98	6855	1.35	1.22	7785	0.94	1.00
244.05	6839	1.35	1.22	7804	0.94	1.00
239.77	6802	1.51	1.24	7794	1.12	1.03
239.17	7140	1.43	1.18	8220	1.25	0.97
237.50	7127	1.42	1.17	8216	1.05	0.96
231.02	7079	1.37	1.14	8203	1.01	0.94
226.34	7043	1.35	1.12	8193	1.00	0.92
223.00	7037	1.32	1.10	8197	0.98	0.91
222.00	7028	1.32	1.10	8194	0.97	0.90
218.00	6996	1.29	1.08	8185	0.95	0.89
210.80	6940	1.24	1.05	8170	0.92	0.86
209.03	6927	1.23	1.04	8170	0.91	0.86
198.02	6843	1.15	0.99	8150	0.85	0.81
190.00	6824	1.08	0.94	8245	0.79	0.77
188.64	6823	1.06	0.93	8270	0.78	0.76
179.10	6817	0.97	0.87	8424	0.71	0.70
174.40	6814	0.88	0.80	8500	0.65	0.65
165.30	6808	0.71	0.70	8649	0.53	0.57
163.00	6806	0.62	0.67	8685	0.48	0.55
160.70	6809	0.61	0.67	8726	0.47	0.54
160.05	6809	0.64	0.68	8736	0.49	0.55
158.16	6833	0.62	0.67	8776	0.47	0.55
157.70	6833	0.62	0.67	8783	0.48	0.55
156.00	6832	0.62	0.67	8810	0.47	0.54
152.00	6829	0.60	0.67	8875	0.46	0.54
151.20	6829	0.66	0.67	8888	0.50	0.54
147.73	6881	0.67	0.66	8968	0.49	0.53
147.29	6881	0.67	0.67	8970	0.49	0.53
120.50	6678	0.58	0.65	9127	0.39	0.49
119.17	6745	0.57	0.64	9170	0.38	0.48
88.90	6498	0.75	0.67	9326	0.42	0.47
83.74	7178	0.64	0.59	9158	0.41	0.47
80.19	7174	0.59	0.58	9803	0.37	0.43
70.81	7100	0.55	0.58	9850	0.33	0.42
23.26	6752	0.37	0.56	10078	0.20	0.38
0.00	6515	0.21	0.52	10201	0.12	0.52

Table 22. Residual BOD_{5C} and NH_3-N Concentrations at Lockport

Table number of diversion scheme	No.of values	NH_3-N (mg/l)	BOD_{5c} (mg/l) Low	Avg.	High	Comments
10	44	1.73	1.72	1.734	1.74	Ambient July, Aug., Sept. conditions
13	6	1.73	1.73	1.737	1.74	Lake DOs varied
14	5	1.73	1.73	1.736	1.74	Calumet plant (CSTP) DOs varied
15	4	1.73	1.74	1.740	1.74	West-Southwest Plant DOs varied
16	5	1.73	1.74	1.740	1.74	Northside Plant DOs varied
11	26	0.82	1.53	1.539	1.57	CSTP BOD_{5c}=7;NH,-N=2
17	4	0.82	1.53	1.530	1.53	CSTP BOD_{5c}=7;NH,-N=2 with instream aeration varied"below CSTP
12	6	1.73	1.65	1.800	1.95	Lake BOD_{5c} varied 1 to 6 mg/l

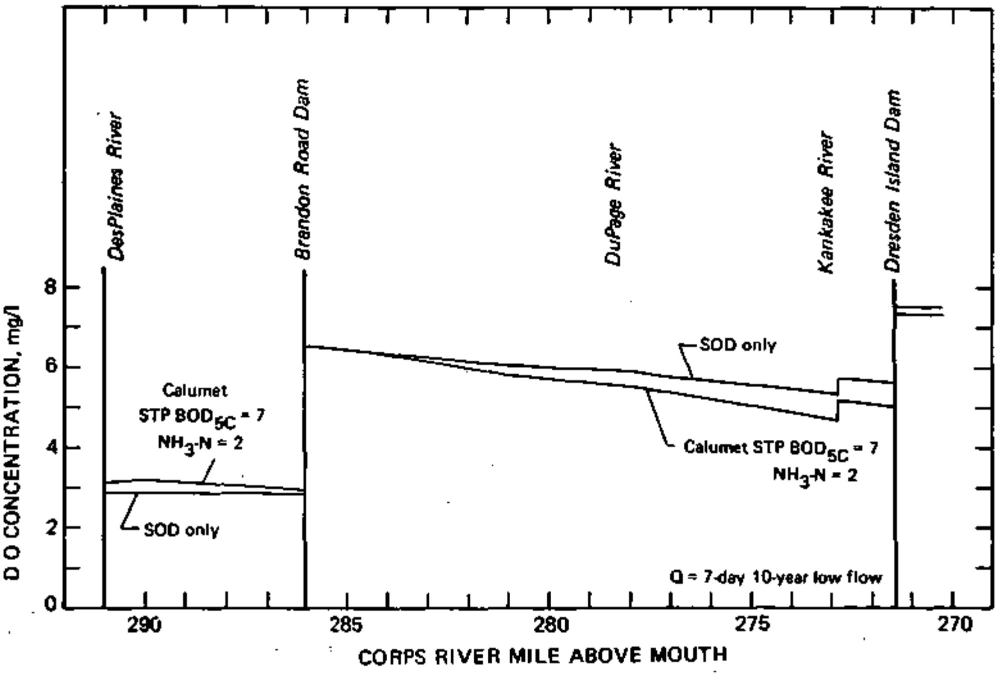


Figure 9. Brandon Road and Dresden Island pool DO curves for a Calumet Sewage Treatment Plant BOD_{5C} of 7 mg/l and an NH_3-N of 2 mg/l and for all other plant BOD_{5C} and NH_3-N inputs equal to the 1980 S-month average

cause of the very high reaeration capacity of the Brandon Road dam. This is illustrated by the upper curve in figure 9. Even if the Lockport DO is zero, a DO reserve of about 5.7 mg/l can be expected to occur at the beginning of the Dresden Island pool. Figure 4 shows that minimum DO standards (2.0 mg/l and 5.0 mg/l above and below Corps MP 278.0, respectively) are nearly met in the Dresden Island pool by using all the discretionary diversion allotment during the 3-month period. The Kankakee River comes to the aid of the DO resources in the lower reaches of the pool.

Excellent aeration is achieved at the Dresden Island dam, providing a good initial DO reserve for water entering the Marseilles pool. This, coupled with the facts that the pool assimilative capacity is relatively good (see velocity and depths, table 9) and low SODs exist throughout the pool length (see table 7), prevents the minimum DO standard of 5.0 mg/l from being violated. This pool historically has demonstrated its ability to sustain relatively high DO levels. The lowest DO level recorded for 25 sampling runs made by Butts et al. (1975) during 1971-1972 was 3.70 mg/l and that occurred right above the dam. Sixteen of the runs had minimum DOs of 4.50 mg/l or better, with the highest being 6.20 mg/l.

These minimum values show good agreement with the minimum pool DO of 4.14 mg/l computed using the 3-month "design" flow in conjunction with the 1971 12-month average loads (see figure 5). The minimum DO computed using the 3-month load imposed upon the "design," 9/27/71, and 9/3/71 flows were 5.44, 5.92, and 6.15 mg/l, respectively. These values, in turn, are comparable to those observed during a number of sampling runs made during July, August, and September 1982. For a wide range of flows the 1982 observations ranged from 5.5 mg/l to 7.5 mg/l.

Nitrification begins in the Marseilles pool. During the "design flow," it is initiated around MP 254. For the higher simulated flows it commences a few miles farther downstream.

Unfortunately the "design," 9/27/71 and 9/3/71 flow DO sag curves which start to develop in the Marseilles pool continue to do so unabated in the Starved Rock pool since all the flow is diverted for power generation, resulting in little aeration at the Marseilles dam. As a result the 5.0 mg/l DO standard is violated to a small degree in the last four or five miles of the Starved Rock pool. In actuality though, this violation presently is seldom observed during daylight hours because primary productivity enhances daytime DO concentrations in the wide, shallow lower reach of the pool. The minimum daytime DO observed during 1982 sampling was 6.2 mg/l; however, a nighttime low of 5.5 mg/l occurred during a diurnal sampling period in September 1982.

Good aeration is achieved at the Starved Rock dam, but it is not sufficient to prevent standard violations within the Peoria pool. The middle section of the pool is the critical section of the waterway during low to intermediate flow conditions. The pool is long and somewhat sluggish, and nitrification becomes a dominant factor. A minimum DO of about 3.0 mg/l can be expected to occur near Chillicothe (MP 179) for "design" flow conditions of around 5084 cfs. The 9/3/71 flow of 8424 cfs for this reach was not quite sufficient to bring the DO up to standard. Extrapolation indicates that between 9000 and 9500 cfs is needed.

Below MP 179 the river enters Upper Peoria Lake; it becomes shallower, and since most of the flow remains in the channel, this reach tends to assimilate wastes better, as shown by figure 6. Also, primary productivity at times appears to enhance DO levels in this area. September 1982 diurnal sampling showed a wide swing in DO levels in the lake, ranging from a high of 13.4 mg/l during the day to a low of 6.7 mg/l during the night. The 1982 summer flows, however, were much greater than the "design" flow, and the minimum points on the DO sag curve were pushed farther downstream; a minimum value of 4.8 was observed at MP 170.9.

Neither the LaGrange nor the Alton pool DO resources appear to become stressed under "design" flow conditions based on the model output. However, historically the standards are violated for significantly greater flows where the ammonia load is "pushed" down into the LaGrange pool. For instance, on July 30, 1979, with flows in the pool ranging between 9200 cfs on the upper end to 15,000 cfs on the lower end a minimum DO of 4.0 mg/l was observed (Butts et al., 1981).

MANAGEMENT STRATEGIES

The model runs show that 320 cfs average annual discretionary diversion dispensed over a 3-month summer period (at 1280 cfs) will not be sufficient to maintain DO standards below Lockport. This is despite the fact that significant reductions have been made in waste load discharges all along the waterway in the last ten years. The last major plant or discharge that appears to be a candidate for improvements which will result in discernible changes in water quality is the Calumet plant. Effort and money should be expended to bring the effluent quality in line with that routinely produced at the Northside plant.

Figures 9 through 13 show the improvements in DO which could be expected if the Calumet BOD_{5C} and NH_3-N discharges were reduced to 7 mg/l and 2 mg/l, respectively, during summer low flow conditions. The middle reach of the Peoria pool remains critical but the minimum DO is raised somewhat from 3.1 to 3.7 mg/l. The BOD_{5C} and NH_3-N concentrations for these conditions at selected points along the waterway are given in table 23. Comparison of these results with the 3-month results in table 20 shows that downstream ammonia concentrations are reduced considerably. For example, at Peoria (MP 160.05) projected ammonia concentrations for ambient and improved conditions are, respectively, 0.74 and 0.42 mg/l. The effect on BOD_{5C} is much less.

Purely from a dissolved' oxygen standpoint, expenditure of funds for local reductions at other point discharge sites does not seem warranted. The fact is that bottom sediments alone will cause significant oxygen depletion in all the pools above the Peoria dam as illustrated by the top curves shown in figures 9 through 11. Even if all point loads were eliminated, the maintenance of a minimum DO of 5.0 mg/l appears somewhat questionable in some short reaches of the Dresden Island and Peoria pools.

The results of extensive sampling by Water Survey personnel of the waterway sediments from Lockport to Grafton over the last ten years indicate that waterway SOD rates appear to be little influenced by treatment plant discharges. The SOD rates below the Dresden Island dam will continue to exert the same ambient demands irrespective of what is done in the Chicago area to eliminate storm overflows or to improve treatment plant efficiencies. By creating relatively deep pools and long residence times, the dams will perpetuate the negative influence of sedimentation and attendant SODs on the dissolved oxygen resources of the upper reaches of the waterway. Rela-

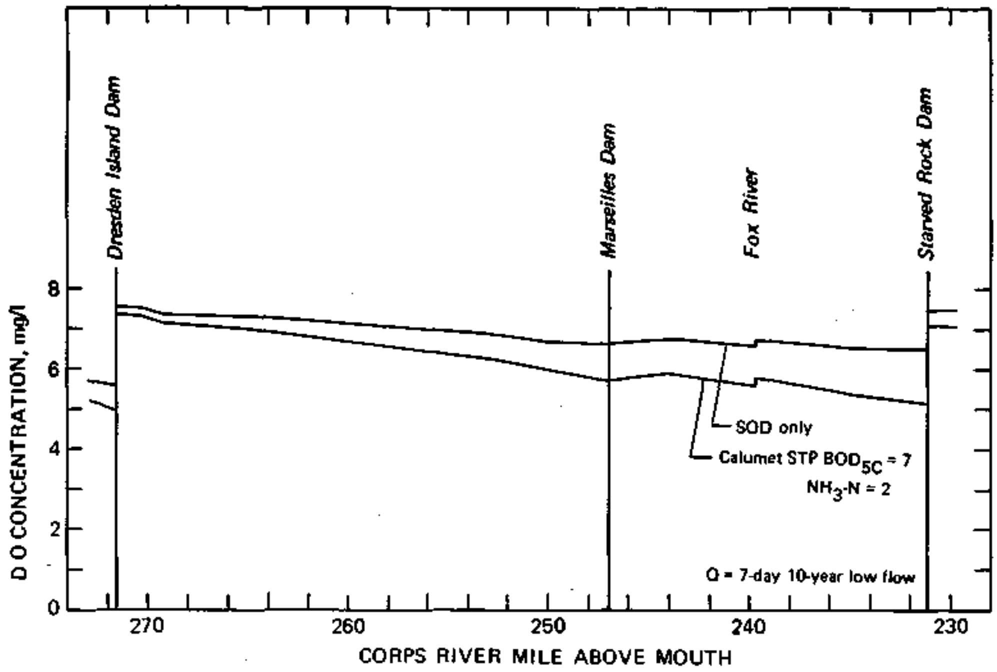


Figure 10. Marseilles and Starved Rock pool DO curves
for a Calumet Sewage Treatment Plant BOD_{5C} *of 7 mg/l and an* NH_3*-N of 2 mg/l*
and for all other plant BOD_{5C} *and* NH_3*-N inputs equal to the 1980 3-month average*

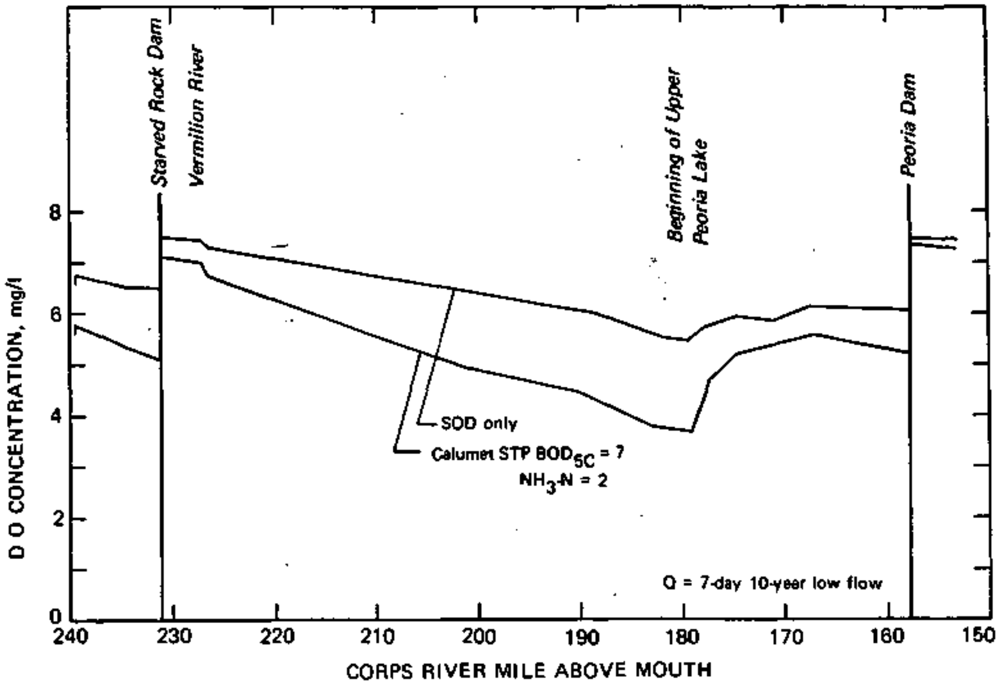


Figure 11. Peoria pool DO curves
for a Calumet Sewage Treatment Plant BOD_{5C} *of 7 mg/l and an* NH_3*-N of 2 mg/l*
and for all other plant BOD,- and NH_3*-N inputs equal to the 1980 3-month average*

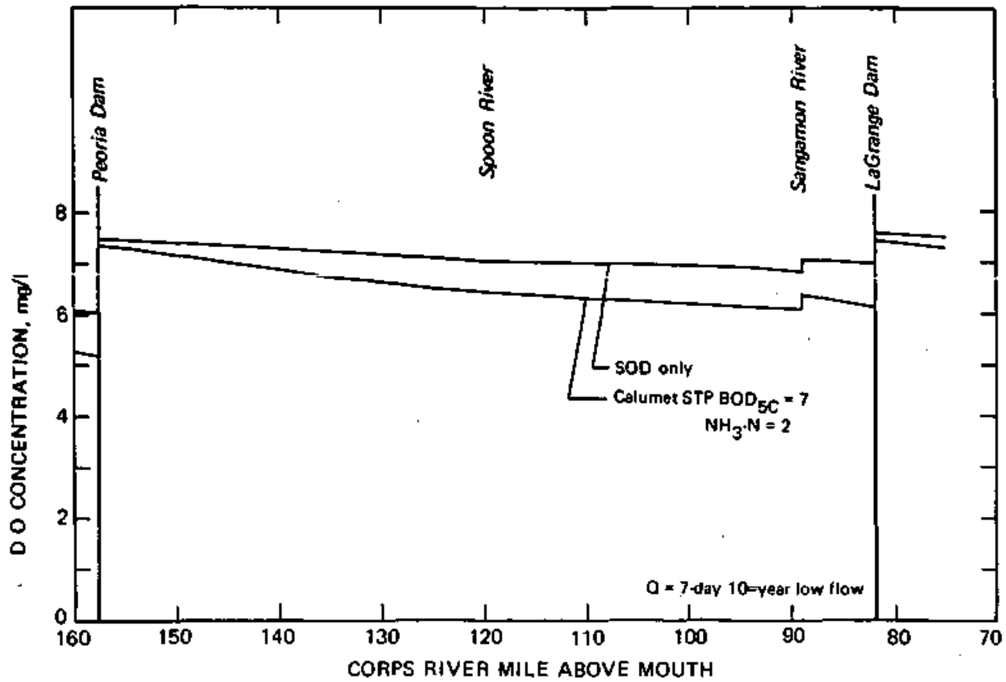


Figure 12. LaGrange pool DO curves for a Calumet Sewage Treatment Plant BOD_{5C} of 7 mg/l and an NH_3-N of 2 mg/l and for all other plant BOD_{5C} and NH_3-N inputs equal to the 1980 Z-month average

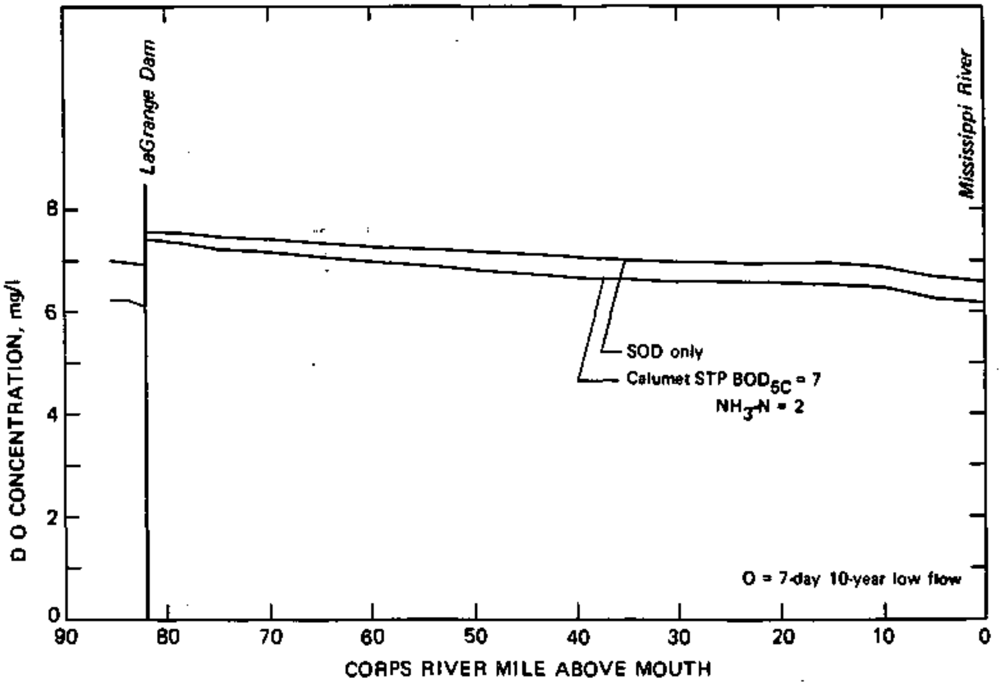


Figure 13. Alton pool DO curves for a Calumet Sewage Treatment Plant BOD_{5c} of 7 mg/l and an NH_3-N of 2 mg/l and for all other plant BOD_{5C} and NH_3-N inputs equal to the 1980 3-month average

Table 23. Simulated BOD_{5C} and NH_3-N Concentrations at Selected Mile Points (MP) for 7-day, 10-year Low Flow with Calumet Plant BOD_{5C} = 7 mg/l and NH_3-N = 2 mg/l

Corps MP	Flow (cfs)	BOD_{5c} (mg/l)	NH3-N (mg/l)	Corns MP	Flow (cfs)	BOD_{5c} (mg/l)	NH_3-N (ma/l)
291.02	4139	1.54	0.82	165.30	4955	0.55	0.42
290.00	4144	1.56	0.82	160.70	4913	0.46	0.40
286.17	4190	1.49	0.81	160.05	4907	0.50	0.42
286.13	4190	1.63	0.91	158.16	4890	0.48	0.42
284.37	4199	1.62	0.91	157.70	4886	0.49	0.42
283.74	4202	1.61	0.91	156.00	4870	0.48	0.42
280.38	4218	1.56	0.90	152.00	4833	0.48	0.43
278.19	4228	1.55	0.92	151.20	4826	0.56	0.43
277.71	4230	1.55	0.92	147.73	4837	0.58	0.43
276.82	4234	1.57	0.93	147.29	4863	0.58	0.43
272.86	4299	1.73	0.98	120.50	4878	0.43	0.39
272.14	4937	1.51	0.85	119.17	4906	0.43	0.39
271.46	4941	1.49	0.85	88.90	4978	0.45	0.37
270.21	4947	1.48	0.85	83.74	5277	0.38	0.34
2.62.79	4982	1.42	0.85	80.19	5298	0.36	0.33
254.35	5021	1.34	0.84	70.81	5319	0.32	0.33
252.44	5031	1.32	0.83	0.00	5419	0.09	0.26
248.71	5048	1.28	0.82				
246.98	5057	1.25	0.80				
244.05	5055	1.25	0.80				
239.77	5048	1.36	0.82				
239.17	5255	1.31	0.78				
237.50	5253	1.29	0.77				
231.02	5244	1.22	0.74				
226.34	5237	1.20	0.73				
223.00	5240	1.16	0.71				
222.00	5238	1.16	0.71				
218.00	5232	1.13	0.69				
210.80	5222	1.07	0.67				
209.03	5244	1.06	0.66				
198.02	5246	0.96	0.61				
190.00	5186	0.89	0.58				
188.64	5172	0.88	0.57				
179.10	5084	0.80	0.53				
174.40	5040	0.72	0.49				

tive to this, thoughts of increasing pool depth's either by dredging or raising dam heights should be discouraged.

Sediments associated with storm water overflows and sewage treatment plant discharges from the Chicago area appear to have the greatest effect on the water quality of the lower wide portion of the Brandon Road pool and most of the Dresden Island pool. Sedimentation immediately above the Brandon Road dam in the last 20 years has been just short of phenomenal. Prior to the update of the Water Survey cross-sectional data for use in this study, the average water depth used for the first mile above the dam for low flow conditions was 22.3 feet. The present updated depth is now only 11.9 feet.

During periods of minimal diversion, the sediments reduce the DO in the overlying water to very low levels. During 1982 SWS sampling, dissolved oxygen concentrations as low as 0.4 mg/l were observed in the area of the dam. Values below 2.0 mg/l were common; an examination of figure 4 reveals that values around 2.5 mg/l can be expected to occur with 1280 cfs diversion during July, August, and September. However, with little or no diversion during late spring or early summer dry periods, very low DO levels will occur. For example, on May 25, 1982 the minimum observed DO in the Brandon Road pool was 0.4 mg/l and the value immediately above the dam was 0.7 mg/l.

The maintenance of a minimum DO of 2.0 mg/l during warm weather appears to be achievable throughout the Brandon Road pool only during periods of discretionary diversion. Without diversion during all critical periods, consideration should be given to either supplementing the DO in the pool or eliminating the sediments. The latter alternative appears less attractive. Dredging and disposing of the highly polluted sediments would be expensive and would provide only a temporary symptomatic cure without addressing the root cause. Only by eliminating polluted sediment discharges from storm and combined sewer overflows can a continuous buildup of polluted bottom sediments be avoided. In addition, dredging would be partially self-defeating since the detention time has been reduced by almost 50 percent because of the filling of the pool, thereby reducing the total oxygen used by a like amount. Even with dredging, a residue would probably persist which would exert a significant SOD for many years under the influence of much longer detention times.

Four Alternative Strategies

Consideration should be given to supplementing the DO resources of the Brandon Road pool either at the Lockport dam or immediately above or below it. Possible alternatives are: 1) instream aeration above the dam, 2) instream aeration below the dam, 3) air inducement into the penstocks, and 4) elimination of hydropower production. Historically (Butts et al., 1975) and currently (1982 Water Survey sampling), DO levels above the Lockport dam persistently fall below 1.0 mg/l. On 12 of the 19 days sampled during 1982, the DOs fell below 1.0 mg/l and on nine of these days they were essentially zero. The model runs showed that approximately 3.0 mg/l DO can be maintained at Lockport for 1280 cfs diversion. At diversion flows less than this, sharp drops in DO can be expected, and for little or no diversion DO levels approaching zero will occur and will be carried over into the Brandon Road pool during periods of power generation.

All four alternatives listed above pose some problems relative to actual implementation. The purpose of this study was to explore and present solutions; it did not include preparing and presenting engineering designs and cost analyses even on a preliminary basis. However, a discussion of some obvious limitations which could hinder the practical application of each appears to be warranted. The only difference between alternatives 1 and 2 is the location of the aerators at the dam. The physical placement of the aerators seems better suited above than below the dam. An enclosed bay, protected by a fender wall, exists above the dam at the penstock intakes, whereas below the dam the tailrace is swift and at times turbulent.

However, an upstream location could possibly create a cavitation problem in the turbines since entrapped air bubbles could coalesce in the penstocks. If this is a possibility downstream placement would alleviate this problem. In either case, though, instream aeration probably cannot supply all the oxygen needed to insure compliance with minimum DO standards in the Brandon Road pool. This is demonstrated by the following load matrix:

0	1 2		
1	27,500		
2	50,000	27,500	
3	73,000	27,500	27,500

When the water above the dam is void of DO (Column 0), approximately 73,000 lbs/day of dissolved oxygen would have to be generated to maintain 3.0 mg/l (line 3) at the Brandon Road dam. The maximum production capacity of any of the proposed MSD instream aeration installations is 40,000 lbs/day at the Stevenson Expressway in the Sanitary and Ship Canal. With this amount used as an indication of the upper practical limit, only about 2 mg/l could be maintained when the canal DO is void of oxygen. For an ambient 1.0 mg/l level, a generation of 50,000 lbs/day would bring the Brandon Road pool DO almost up to standard. Only a 27,500 lbs/day generation would be needed to raise an ambient level of 2.0 mg/l to 3.0 mg/l.

The induction of air into the water stream in hydroelectric generating facilities (alternative 3 above) is known as turbine aspiration or turbine venting. Some studies have been conducted to explore the feasibility of utilizing this method to supplement DO in the releases from high head hydroelectric plants, but it has not been applied in continuous full scale operations. Reference should be made to the works of Raney (1977) and TVA (1981) for a detailed discussion of the basic concepts involved and the state of the art of this process. The U.S. Army Corps of Engineers (1982) proposed to use this technique to supplement DO at the navigation dams along the waterway in the event hydroelectric generating plants are established at the Brandon Road, Dresden Island, and Starved Rock dams.

TVA studies of prototype installations showed that turbine venting coupled with hub baffling can increase DO levels by as much as 4.5 mg/l, but at the expense of a 3 percent loss in power generation. Use of hub baffles alone produced a 2.5 mg/l increase with a power loss of about 2 percent. These figures are for an installation 265 feet high, whereas the Lockport dam is only 35 feet high. The percentage loss in generating capacity for the much lower Lockport dam would likely be somewhat greater. This would result in a significant revenue loss to the MSD, possibly in the range of $60,000 to $100,000 per year assuming power production is worth at least $2,000,000 per year to the MSD.

Alternative 4 superficially looks attractive but in actuality is not. It is totally unacceptable to the MSD (personal communication), and for some very good reasons. First it would eliminate several million dollars' worth of electricity generated annually that offsets a significant portion of MSD's operating expenses. The elimination of the facilities would run counter to the present national trend toward energy conservation. Elimination of the facility would also be contradictory to the Corps of Engineers plans of adding hydroelectric generating plants at the Brandon Road, Dresden Island, and Starved Rock dams. Finally, the mere elimination of the generating plant would not insure reaeration at the dam. The penstocks would have to be eliminated and a spillway built in place of them, which would be very costly and possibly impractical.

Preferred Strategies

Overall turbine venting and/or hub baffling appears to be the most practical solution. With the current Corps of Engineers studies being conducted relative to using this method at proposed hydropower sites along the waterway, the practicality of employing this method should become known in the near future. Instream aeration with aerator placement above the dam should receive second consideration, and aerator placement below the dam should receive third consideration. Elimination of the power plant and subsequent installation of a spillway should at this time be placed a distant fourth.

Improved Calumet treatment plant efficiencies coupled with instream aeration in the Cal-Sag Channel below the plant appears to offer an attractive overall management alternative. Reference to run 97 in table 17 shows that, for the specified diversion scheme in conjunction with Calumet plant discharges of BOD_{5C} = 7 mg/l and NH_3-N = 2 mg/l and instream aeration capable of delivering 13,300 lbs/day of dissolved oxygen, over 2.8 mg/l of DO can be maintained throughout the system. About 3.3 mg/l of DO can be expected to be carried over into the Brandon Road pool, and the effects further downstream would be essentially equal to those described by figures 9 through 13.

Instream aeration capable of producing 26,600 lbs/day of DO in the Cal-Sag Channel would probably produce DOs in excess of 3.5 mg/l throughout the drainage system. This coupled with a high degree of nitrification within the Calumet plant would probably promote the onset of nitrification above Lockport, which in turn would alleviate considerable stress on the downstream DO resources. It would reduce the nitrogenous BOD load and effectively move the major impact area farther upstream. Care would have to be taken, though, to insure that during non-diversion periods additional instream aeration is available when needed to maintain a viable nitrifying environment.

Both upgrading the Calumet plant to a BOD_{5C} of 7 mg/l and an ammonia of 2 mg/l and installing instream aeration below the plant are technically and economically feasible. These desirable effluent limits can be achieved and realistically maintained from a process and operation standpoint, although according to MSD officials (private communication) it would be more difficult to do so than is presently the case at the Skokie and Stickney plants. This is because the Calumet plant influent consists of a high percentage of industrial wastes which vary considerably in quality and quantity, whereas the Skokie and Stickney plants receive primarily domestic loads.

Instream aeration has never been considered by MSD officials as a replacement for on-bank treatment; they consider it as a supplemental source of DO only. They feel that even with an upgrading of the Calumet plant coupled with instream aeration, nitrification still will not commence within the Calumet-Sag Channel. Whether instream aeration will actually increase the DO levels in the channel can, at present, be evaluated only from a design and specification viewpoint supplemented by an evaluation of the results being produced by the two aeration stations now on line in the Northshore Channel - Chicago River drainage area. The real success of any implementation and management program reduces to the basic problem of funding; the basic "seeds" for detailed engineering analyses and design have been presented in this study.

REFERENCES

Butts, T.A. 1974. *Measurements of sediment oxygen demand characteristics in the upper Illinois Waterway.* Illinois state Water Survey Report of Investigation 76, 32 p.

Butts, T.A., and R.L. Evans. 1978. *Sediment oxygen demand studA.es of selected northeastern Illinois streams.* Illinois State Water Survey Circular 129, 129 p.

Butts, T.A., and R.L. Evans. 1979. *Sediment oxygen demand in a shallow oxbow lake.* Illinois State Water Survey Circular 136, 28 p.

Butts, T.A., and R.L. Evans. 1980. *Aeration characteristics of flow release controls on Illinois Waterway dams.* Illinois State Water Survey Circular 145, 59 p.

Butts, T.A., R.L. Evans, and s. Lin. 1975. *Water quality features of the upper Illinois Waterway.* Illinois State Water Survey Report of Investigation 79, 60 p.

Butts, T.A., R.L. Evans, and R.E. Sparks. 1982. *Sediment oxygen demand - fingernail clam relationship in the Mississippi River Keokuk pool.* Transactions of the Illinois State Academy of Science v. 75:29-39.

Butts, T.A., R.L. Evans, and J.B. Stall. 1974. *A waste allocation study of selected streams in Illinois.* Illinois State Water Survey Contract Report prepared for Illinois EPA.

Butts, T.A., V. Kothandaraman, and R.L. Evans. 1973. *Practical considerations for assessing the waste assimilative capacity of Illinois streams.* Illinois State Water Survey Circular 110, 49 p.

Butts, T.A., D. Roseboom, T. Hill, S. Lin, D. Beuscher, R. Twait, and R.L. Evans. 1981. *Water quality assessment and waste assimilative analysis of the LaGrange pool, Illinois River.* Illinois State Water Survey Contract Report 260, 116 p.

Butts, T.A., D.H. schnepper, and R.L. Evans. 1970. *Dissolved oxygen resources and waste assimilative capacity of the LaGrange pool, Illinois Fiver.* Illinois State Water Survey Report of Investigation 64, 28 p.

Currie, R.G., and K. Kendrick. 1981. *Facilities planning study update supplement and summary action plan.* The Metropolitan Sanitary District of Greater Chicago.

Lee, M.T., J.B. Stall, and T.A. Butts. 1975. *The 1975 sediment survey of Lake Meredosia.* Illinois State Water Survey Special Report.

Macaitis, B., and E. Cameron. 1977. *The Lake Michigan discretionary diversion flow MSDGC operational plan.* The Metropolitan Sanitary District of Greater Chicago.

Mathis, B.J., and T.A.. Butts. 1981. *Sediment oxygen demand and effect on dissolved oxygen in a cutoff meander of the Kaskaskia River.* University of Illinois Water Resources Center Research Report 162.

Raney, D.c. 1977. *Turbine aspiration for oxygen supplementation,* Journal of the Environmental Engineering Division, ASCE, v. 103 (EE2), Proc. Paper 12890, April 1977, pp. 341-352.

Roseboom, D.P., R.L. Evans, W. Wang, T.A. Butts, and R.M. Twait. 1979. *Effect of bottom conditions on eutropliy of impoundments.* Illinois State Water Survey Circular 139, 139 p.

State of Illinois. 1980. *In the matter of allocation of water from Lake Michigan - Opinion and order of the secretary: LM080-4.* Illinois Department of Transportation, Division of Water Resources, Springfield, 77 p.

Tennessee Valley Authority. 1981. *Improving reservoir releases.* Tennessee Valley Authority, Office of Natural Resources, Division of Water Resources, TVA/ONR/WR-82/6.

The Metropolitan Sanitary District of Greater Chicago. 1976. *Lake diversion testimony technical report - The effects of lake diversion on meeting water quality standards.* MSDGC - R0176LD3A, 36 p.

U.S. Army Corps of Engineers. 1982. *Final feasibility report for hydropower, Brandon Road lock and dam, Illinois Waterway, main report with environmental assessment.* U.S. Army Corps of Engineers Rock Island District, 102 p.

Velz, c.J. 1947. *Factors influencing self-purification and their relation to pollution abatement.* Sewage Works Journal, v. 19(7):629-644.

Velz, C.J. 1970. *Applied stream sanitation.* John Wiley & Sons, Inc., New York, p. 168.

Appendix A

U.S. Army Corps of Engineers
Illinois Waterway Mile Point Designations
Compared to Illinois State Water Survey Designations

SWS to Corps Illinois Waterway Mile Point Conversions

Corps	SWS	Corps	SWS	Corps	SWS	Corps	SWS	Corps	SWS	Corps	SWS	Corps	SWS	Corps	SWS
291	290.96	253	252.97	215	215.27	177	177.35	139	139.33	101	101.24	63	63.13	25	25.11
290	289.94	252	252.00	214	214.26	176	176.33	138	138.33	100	100.22	62	62.14	24	24.16
289	288.93	251	251.00	213	213.30	175	175.32	137	137.31	99	99.22	61	61.11	23	23.26
288	287.93	250	249.99	212	212.30	174	174.36	136	136.33	98	98.21	60	60.09	22	22.27
287	286.97	249	248.94	211	211.34	173	173.31	135	135.34	97	97.21	59	59.20	21	21.27
286	286.07	248	247.94	210	210.32	172	172.35	134	134.34	96	96.20	58	58.18	20	20.25
285	285.01	247	246.80	209	209.35	171	171.35	133	133.34	95	95.18	57	57.16	19	19.24
284	284.00	246	245.90	208	208.34	170	170.32	132	132.34	94	94.17	56	56.21	18	18.23
283	283.04	245	244.74	207	207.36	169	169.32	131	131.32	93	93.20	55	55.18	17	17.23
282	282.04	244	243.67	206	206.40	168	168.29	130	130.32	92	92.15	54	54.18	16	16.22
281	281.09	243	242.78	205	205.35	167	167.47	129	129.32	91	91.15	53	53.19	15	15.17
280	280.09	242	241.77	204	204.39	166	166.45	128	128.32	90	90.14	52	52.19	14	14.18
279	279.12	241	240.83	203	203.41	165	165.37	127	127.32	89	89.10	51	51.20	13	13.10
278	278.12	240	239.45	202	202.43	164	164.36	126	126.32	88	88.09	50	50.21	12	12.11
277	277.14	239	238.46	201	201.45	163	163.41	125	125.31	87	87.08	49	49.21	11	11.12
276	276.02	238	237.45	200	200.48	162	162.40	124	124.31	86	86.04	48	48.21	10	10.11
275	275.02	237	236.43	199	199.51	161	161.39	123	123.29	85	85.02	47	47.22	9	9.10
274	274.04	236	235.56	198	198.51	160	160.37	122	122.30	84	83.95	46	46.23	8	8.08
273	273.04	235	234.80	197	197.52	159	159.32	121	121.27	83	82.92	45	45.24	7	7.05
272	272.05	234	233.80	196	196.53	158	158.31	120	120.26	82	81.89	44	44.22	6	5.98
271	271.03	233	232.81	195	195.44	157	157.36	119	119.26	81	81.90	43	43.24	5	4.87
270	270.02	232	231.80	194	194.41	156	156.36	118	118.27	80	79.82	42	42.20	4	4.02
269	269.01	231	231.00	193	193.43	155	155.36	117	117.26	79	78.98	41	41.22	3	3.08
268	268.00	230	230.03	192	192.47	154	154.35	116	116.26	78	77.97	40	40.22	2	2.05
267	267.01	229	229.03	191	191.48	153	153.35	115	115.25	77	76.96	39	39.20	1	1.0
266	266.00	228	228.06	190	190.51	152	152.36	114	114.25	76	76.20	38	38.23	0	0
265	265.00	227	227.03	189	189.40	151	151.36	113	113.24	75	75.14	37	37.26		
264	263.99	226	226.15	188	188.42	150	150.35	112	112.24	74	74.10	36	36.22		
263	262.98	225	225.17	187	187.39	149	149.33	111	111.24	73	73.07	35	35.22		
262	261.99	224	224.16	186	186.40	148	148.36	110	110.23	72	72.06	35	34.23		
261	260.97	223	223.23	185	185.40	147	147.36	109	109.23	71	71.08	33	33.27		
260	259.98	222	222.21	184	184.39	146	146.33	108	108.23	70	70.19	32	32.20		
259	258.99	221	221.25	183	183.39	145	145.35	107	107.26	69	69.19	31	31.20		
258	257.97	220	220.24	182	182.37	144	144.35	106	106.24	68	68.19	30	30.13		
257	256.98	219	219.25	181	181.38	143	143.35	105	105.24	67	67.20	29	29.14		
256	255.98	218	218.24	180	180.40	142	142.35	104	104.24	66	66.13	28	28.09		
255	254.99	217	217.26	179	179.40	141	141.35	103	103.24	65	65.15	27	27.09		
254	254.00	216	216.26	178	178.37	140	140.34	102	102.23	64	64.15	26	26.09		

Appendix B

Computer Printout of 7-Day, 10-Year Low Flow Hydraulic and Hydrologic Data

ABBREVIATIONS USED IN APPENDIX B

F = flow at the end of a reach
AVF = average flow within a reach
AVA = average reach cross-sectional area
AVW = average reach width
AVD = average reach depth
DT = reach time of travel
SUMT = accumulated time of travel
DIS = reach distance
VOL = reach volume

```
 TYPE,0/CC
7D10Y+1019 DATA    PROCESSED 82/12/21. AT 13.59.15.

STAFF GAGE ELEVATIONS     USGS GAGING STATIONS
   0.00  418.04              0.00  5419.
  21.74  418.13             70.89  5319.
  31.66  418.25            145.76  4819.
  43.39  418.60            196.66  5243.
  56.14  419.05            246.39  5059.
  61.47  419.20            291.00  4139.
  70.89  419.65
  80.00  420.22           TRIBUTARY CONFLUENCE
  80.01  429.00            289.94    29.
  88.91  429.04            276.96    46.
  97.40  429.09            272.90   635.
 111.44  429.20            239.17   208.
 119.90  429.28            226.50     8.
 128.86  429.40            211.19    25.
 137.21  429.56            209.34    18.
 145.76  429.77            160.03     1.
 153.31  429.95            148.09    47.
 158.05  430.00            120.78    25.
 158.06  440.00             88.94   287.
 164.61  440.01             83.72    12.
 180.68  440.05             23.44     3.
 196.66  440.09
 207.85  440.14
 218.69  440.17
 223.05  440.21
 231.01  440.30
 231.02  458.51
 246.77  458.51
 246.78  482.76
 271.51  482.76
 271.52  504.54
 286.24  504.54
 286.25  538.55
 291.00  538.55
```

```
   MILE     F(CFS)    AVF(CFS)   AVA(FT2)     AVW(FT)    AVD(FT)       DT(D)     SUMT(D)          DIS(FT)      VOL(FT3)
 290.990   4139.047   4139.047   2140.500    148.000   14.46284       .00032      .00032              53.         56509
 290.680   4140.506   4139.926   3406.283    238.667   14.27214       .01449      .01480            1637.       5242970
 289.940   4143.990   4142.421   4209.092    289.333   14.54755       .04566      .06046            3907.      16349925
 288.660   4179.015   4176.232   4555.556    412.125   11.05382       .08496      .14542            6758.      30771886
 287.230   4185.747   4182.529   5104.636    316.364   16.13534       .10559      .25101            7550.      38219178
 286.250   4190.360   4188.748  11985.575   1007.339   11.89825       .15986      .41086            5174.      59383008
 286.210   4190.549   4190.549   1348.500    707.000    1.90736       .00137      .41223             211.       1080805
 285.820   4192.385   4191.961   1351.925    524.000    2.58001       .00619      .41842            2059.       2495402
 285.330   4194.691   4194.244   4094.775    697.000    5.87486       .01996      .43838            2587.       7794044
 284.390   4199.116   4197.017   5339.990    510.600   10.45826       .07281      .51118            4963.      26424171
 284.010   4200.905   4200.089   5777.017    648.333    8.91057       .03122      .54241            2006.      11370491
 283.720   4202.270   4201.941   5621.000    603.000    9.32172       .02250      .56490            1531.       8491402
 281.090   4214.651   4208.170   7579.487    857.867    8.83527       .29787      .86277           13886.     110474588
 280.470   4217.570   4216.299   7243.200    689.750   10.50120       .06430      .92708            3274.      23574056
 278.300   4227.785   4223.124   5536.346    506.214   10.93676       .17498     1.10205           11458.      64168371
 278.120   4228.632   4228.632   8227.800    658.000   12.50426       .01992     1.12197             950.       7311190
 277.820   4230.044   4229.621   7517.900    693.000   10.84834       .03286     1.15483            1584.      12040222
 276.960   4234.093   4232.671   7951.500   1056.200    7.52840       .09641     1.25124            4541.      35385464
 276.220   4283.576   4282.199   8169.312   1138.750    7.17393       .08813     1.33937            3907.      32648513
 273.560   4296.098   4290.284   8030.166    727.875   11.03234       .30307     1.64244           14045.     113496033
 272.900   4299.205   4297.670   7415.920    663.400   11.17866       .06948     1.71193            3485.      27008265
 272.410   4936.512   4935.394  11126.537    855.250   13.00969       .06698     1.77891            2587.      28603678
 272.190   4937.547   4937.547  12891.550    853.000   15.11319       .03132     1.81023            1162.      13517104
 271.670   4939.995   4938.654  16181.837   1106.000   14.63096       .10192     1.91215            2746.      43696359
 271.520   4940.701   4940.395  18224.525   1309.000   13.92248       .03354     1.94569             792.      14324715
 270.640   4944.844   4942.720   3233.500    637.125    5.07514       .03483     1.98053            4646.      16712644
 270.230   4946.774   4946.774   4350.550    449.000    9.68942       .01979     2.00032            2165.       8544357
 267.090   4961.555   4953.893   4628.678    557.389    8.30422       .18084     2.18115           16579.      77523443
 265.000   4971.394   4966.983   5523.360    603.000    9.15980       .14034     2.32150           11035.      60455087
 263.670   4977.655   4974.454   5800.700    627.714    9.24099       .09408     2.41558            7022.      40479321
 263.520   4978.361   4978.361   5140.650    518.000    9.92403       .01006     2.42564             792.       4343724
 262.750   4981.986   4980.329   5875.660    584.400   10.05418       .05608     2.48172            4066.      24183731
 261.580   4987.494   4984.837   5627.329    602.143    9.34550       .08110     2.56282            6178.      35122746
 257.970   5004.488   4995.608   5260.526    565.421    9.30373       .23234     2.79516           19061.     101215823
 256.000   5013.761   5008.836   6091.145    650.364    9.36575       .14755     2.94271           10402.      64068907
 254.350   5021.529   5017.543   6083.067    679.667    8.95007       .12090     3.06360            8712.      52510000
 252.970   5028.025   5024.724   7386.775    713.500   10.35287       .12417     3.18777            7286.      54013762
 252.420   5030.614   5029.414   6269.375    651.000    9.63038       .04202     3.22979            2904.      18558103
```

MILE	F(CFS)	AVF (CFS)	AVA (FT^2)	AVW (FT)	AVD (FT)	DT (D)	SUMT(D)	DIS(FT)	VOL(FT^3)
250.010	5041.959	5036.553	7516.679	719.000	10.45435	.21879	3.44858	12725.	95643719
248.650	5048.361	5045.530	7841.450	800.571	9.79482	.12951	3.57810	7181.	56841676
247.080	5055.752	5052.208	8863.157	791.000	11.20500	.16454	3.74264	8290.	72353758
246.780	5057.164	5057.164	10988.750	930.000	11.81586	.04021	3.78284	1584.	17566243
246.750	5057.305	5057.305	255.700	600.000	.42617	.00018	3.78302	158.	890560
245.900	5061.307	5059.471	514.375	644.000	.79872	.00498	3.78801	4488.	2210683
243.730	5054.988	5056.708	1325.918	541.545	2.44840	.03293	3.82093	11458.	15322664
243.420	5054.521	5054.739	4964.650	598.500	8.29515	.01809	3.83902	1637.	7969719
242.680	5053.405	5054.068	5902.250	679.667	8.68404	.05356	3.89258	3907.	23398505
239.450	5048.533	5051.058	5835.233	616.933	9.45845	.22822	4.12080	17054.	100467802
239.170	5048.111	5048.111	8329.500	724.000	11.50483	.02765	4.14845	1478.	12065001
238.630	5255.297	5255.639	8946.833	754.333	11.86058	.05597	4.20441	2851.	25476958
236.970	5252.793	5253.965	7087.833	693.111	10.22611	.13564	4.34005	8765.	62237344
236.290	5251.768	5252.167	11492.287	958.750	11.98674	.08506	4.42511	3590.	38943498
234.300	5248.767	5250.204	8319.670	837.907	9.92911	.19563	4.62074	10507.	91732172
231.060	5243.880	5246.087	10269.676	949.723	10.81334	.32293	4.94367	17107.	151498145
231.020	5243.820	5243.820	20132.071	1323.316	15.21335	.00971	4.95338	211.	4405559
229.630	5241.724	5242.832	4273.004	833.203	5.12841	.07243	5.02581	7339.	34585982
228.850	5240.547	5241.060	5852.757	579.156	10.10566	.05316	5.07897	4118.	24104485
226.500	5237.003	5238.781	5813.617	607.158	9.57512	.15816	5.23713	12408.	71857225
224.890	5242.575	5243.751	7293.603	663.199	10.99761	.13658	5.37370	8501.	63101482
223.350	5240.252	5241.314	9202.393	566.248	16.25154	.16100	5.53471	8131.	74272021
222.660	5239.212	5239.604	6210.329	456.845	13.59396	.05348	5.58819	3643.	24602805
222.210	5238.533	5238.820	5487.929	417.847	13.13382	.02681	5.61500	2376.	12369350
220.100	5235.351	5236.830	6109.460	627.018	9.74368	.15016	5.76516	11141.	68608287
218.240	5232.546	5233.848	7085.386	722.822	9.80240	.15313	5.91829	9821.	69526708
217.340	5231.188	5231.728	7000.998	807.691	8.66791	.07423	5.99252	4752.	33587179
213.660	5225.638	5228.377	7186.636	712.130	10.09174	.30784	6.30037	19430.	140131361
211.190	5221.913	5223.731	8372.033	830.719	10.07806	.24060	6.54096	13042.	108671104
209.720	5244.696	5245.775	7899.172	655.835	12.04444	.13306	6.67402	7762.	60482306
209.360	5244.153	5244.289	7655.090	886.752	8.63273	.03248	6.70651	1901.	14798439
208.510	5260.872	5261.394	9197.346	732.131	12.56244	.08934	6.79584	4488.	40624262
205.350	5256.106	5258.455	8771.354	791.752	11.07841	.32178	7.11762	16685.	147531129
200.840	5249.304	5252.642	8056.721	698.241	11.53860	.42093	7.53856	23813.	191451639
198.530	5245.820	5247.576	9956.059	1052.707	9.45758	.24517	7.78372	12197.	113228773
197.450	5244.191	5245.041	10097.282	1053.459	9.58488	.12586	7.90958	5702.	57112561
196.660	5243.000	5243.445	10426.652	1220.142	8.54544	.09991	8.00950	4171.	45610022
190.510	5185.971	5213.195	9777.656	1105.021	8.84839	.65453	8.66402	32472.	326386968
189.040	5172.339	5178.923	12514.847	1110.483	11.26973	.21729	8.88131	7762.	98308826
188.420	5166.590	5169.032	12269.858	951.688	12.89274	.09135	8.97266	3274.	40836026

MILE	F(CFS)	AVF (CFS)	AVA (FT^2)	AVW (FT)	AVD (FT)	DT (D)	SUMT (D)	DIS (FT)	VOL (FT^3)
183.390	5119.946	5143.550	12525.503	1094.299	11.44621	.74383	9.71649	26558.	333676936
179.510	5083.967	5101.864	8978.351	913.382	9.82979	.41339	10.12988	20486.	183852091
179.400	5082.947	5082.947	15590.159	6400.787	2.43566	.01392	10.14380	581.	6834619
177.490	5065.235	5073.813	20401.694	6269.296	3.25422	.46130	10.60510	10085.	204220585
175.220	5044.185	5054.166	25187.481	7114.650	3.54023	.66152	11.26662	11986.	295526525
174.790	5040.198	5041.990	29388.549	8532.067	3.44448	.15444	11.42106	2270.	67657763
171.260	5007.464	5021.824	21280.442	5915.076	3.59766	.91631	12.33737	18638.	413434366
167.470	4972.319	4989.116	32476.400	6713.831	4.83724	1.49821	13.83557	20011.	652921375
166.550	4963.787	4966.963	10508.892	876.761	11.98605	.12561	13.96119	4858.	56605549
165.690	4955.813	4960.449	21814.689	3561.327	6.12544	.22955	14.19074	4541.	102733672
165.650	4955.442	4955.442	26561.448	4923.382	5.39496	.01371	14.20444	211.	5080965
165.060	4949.971	4951.087	32753.687	5370.751	6.09853	.23230	14.43674	3115.	100062159
164.720	4946.818	4946.818	31729.079	5101.476	6.21959	.13226	14.56900	1795.	56547854
164.240	4942.367	4944.067	28501.219	5283.276	5.39461	.17351	14.74251	2534.	79618421
163.410	4934.670	4937.069	43471.395	7017.408	6.19479	.39147	15.13398	4382.	176296022
163.160	4932.352	4932.352	23233.847	2214.846	10.49005	.09920	15.23317	1320.	49351737
162.850	4929.477	4929.477	18406.771	1666.904	11.04249	.07892	15.31209	1637.	34078681
161.950	4921.131	4925.420	10178.155	784.185	12.97928	.10373	15.41582	4752.	46435166
161.080	4913.064	4916.819	8718.914	805.903	10.81881	.09365	15.50947	4594.	39824685
160.930	4911.673	4911.673	13364.380	1035.904	12.90117	.02070	15.53017	792.	9047911
160.420	4906.943	4908.520	12484.249	998.413	12.50410	.07988	15.61005	2693.	33911767
160.030	4903.327	4905.058	9609.424	824.698	11.65205	.04783	15.65788	2059.	20406092
159.680	4901.081	4901.081	14507.485	1045.107	13.88134	.05272	15.71060	1848.	22972505
158.890	4893.756	4896.692	12325.289	648.708	18.99975	.12071	15.83131	4171.	51635851
158.480	4887.954	4891.461	13347.302	707.759	18.85854	.06838	15.89970	2165.	28936537
158.310	4888.377	4888.377	10904.606	803.013	13.57961	.02492	15.92461	898.	10585384
158.060	4886.059	4887.079	10062.472	722.544	13.92646	.03078	15.95539	1320.	13239423
156.360	4870.295	4878.656	5425.586	566.723	9.57361	.10334	16.05873	8976.	45164722
155.360	4861.022	4865.963	4607.028	562.158	8.19526	.05773	16.11647	5280.	24397204
153.350	4842.383	4852.000	5272.022	508.874	10.36018	.13330	16.24977	10613.	56189590
152.360	4833.202	4837.508	5564.209	589.440	9.43982	.06882	16.31859	5227.	28922123
151.550	4825.691	4828.798	5459.686	624.020	8.74922	.05757	16.37615	4277.	24161185
151.360	4823.929	4823.929	4533.539	538.096	8.42516	.00980	16.38596	1003.	4128933
150.350	4814.563	4819.316	4729.275	589.907	8.01698	.05898	16.44494	5333.	25050568
148.480	4797.223	4806.161	4621.514	524.066	8.81857	.10751	16.55244	9874.	44888399
147.730	4837.268	4812.555	5111.098	528.952	9.66269	.04843	16.60088	3960.	20237132
147.620	4836.248	4836.248	5298.663	544.049	9.73931	.00745	16.60832	501.	3113213
145.770	4819.093	4827.467	5358.616	608.168	8.81108	.12472	16.73305	9768.	52110650
143.590	4824.101	4821.652	5387.355	657.222	8.19717	.14801	16.88106	11510.	62020805
139.360	4834.045	4829.120	5243.043	583.022	8.99287	.27994	17.16100	22334.	117061575

MILE	F(CFS)	AVF (CFS)	AVA (FT^2)	AVW (FT)	AVD (FT)	DT (D)	SUMT (D)	DIS (FT)	VOL (FT^3)
136.060	4841.802	4837.760	4950.310	589.665	8.39512	.20592	17.36772	17424.	86369548
132.260	4850.735	4846.284	4800.583	616.596	7.78563	.22980	17.59751	20064.	96313606
129.590	4857.011	4853.909	4971.134	629.902	7.89192	.16694	17.76446	14098.	70100261
126.180	4865.028	4860.971	5586.366	530.946	10.52154	.23972	18.00418	18005.	100810879
121.340	4876.405	4870.660	6063.481	666.558	9.09670	.36022	18.36440	25555.	153465089.
120.780	4877.722	4877.181	9460.899	960.243	9.85261	.06775	18.43215	2957.	28661178.
119.890	4904.814	4903.844	6298.151	631.718	9.96988	.07148	18.50363	4699.	30388134.
119.430	4905.895	4905.437	5518.952	594.520	9.28303	.03155	18.53517	2429.	13414507.
116.570	4912.618	4909.166	5996.645	672.855	8.91224	.21344	18.74862	15101.	90704200.
113.540	4919.741	4916.220	5902.324	714.507	8.26069	.22218	18.97080	15998.	94432016
110.410	4927.099	4923.417	4807.945	516.458	9.30945	.18673	19.15753	16526.	79578982
107.090	4934.903	4930.990	4676.028	499.803	9.35573	.19294	19.35047	17530.	82363086.
103.550	4943.225	4939.274	5946.931	678.653	8.76285	.25758	19.60805	18691.	110177019
99.700	4952.275	4947.799	6489.514	546.066	11.88413	.30900	19.91705	20328.	132277392
98.210	4955.778	4954.156	6180.196	534.528	11.56197	.11245	20.02950	7867.	48251615
97.400	4957.682	4956.746	6192.003	637.410	9.71432	.06273	20.09223	4277.	26968934
93.740	4966.286	4962.277	5983.362	614.431	9.73806	.26956	20.36179	19325.	115800025.
89.340	4976.629	4971.558	7022.318	760.787	9.23034	.37778	20.73958	23232.	162824790
88.940	4977.569	4977.169	7622.098	687.489	11.08686	.03719	20.77677	2112.	16113441.
85.500	5272.656	5268.539	10284.761	1099.660	9.35268	.40804	21.18481	18163.	186376650
83.720	5276.840	5274.753	10834.328	997.947	10.85662	.22371	21.40852	9398.	102089515.
82.160	5292.507	5290.483	9597.035	748.054	12.82933	.17634	21.58486	8237.	81012863
82.110	5292.625	5292.625	13133.775	1023.983	12.82616	.00760	21.59245	264.	3473103
80.010	5297.561	5295.133	11082.028	847.810	13.07136	.26803	21.86049	11088.	123011239.
79.860	5297.914	5297.914	7037.651	734.106	9.58670	.01604	21.87653	792.	8162531.
75.140	5309.009	5303.370	6008.375	776.287	7.73989	.32746	22.20398	24922.	150783740.
70.890	5319.000	5313.999	6056.012	750.591	8.06832	.28956	22.49354	22440.	136174339.
65.150	5326.854	5323.031	6107.306	806.373	7.57380	.40110	22.89463	30307.	185272565.
60.090	5333.778	5330.294	6400.279	808.050	7.92065	.37430	23.26893	26717.	173409550.
55.180	5340.496	5337.182	6668.141	773.047	8.62579	.37487	23.64381	25925.	173464046.
50.210	5347.297	5343.933	7019.972	883.366	7.94684	.39758	24.04139	26242.	184148610
45.240	5354.097	5350.616	6863.527	837.441	8.19584	.38563	24.42702	26242.	179355062.
40.220	5360.966	5357.507	7702.307	959.197	8.02995	.44146	24.86848	26506.	204748109.
35.220	5367.808	5364.434	7756.534	1076.425	7.20583	.43843	25.30691	26400.	204137490.
30.130	5374.773	5371.344	9133.899	1087.282	8.40067	.52626	25.83318	26875.	244831578.
23.440	5383.927	5379.448	6924.963	739.436	9.36519	.52745	26.36063	35323.	245871997.
20.550	5390.881	5388.998	10190.743	1003.901	10.15115	.32874	26.68936	15259.	153989899.
15.170	5398.243	5394.638	10476.353	1066.840	9.81999	.63692	27.32629	28406.	297836908.
10.110	5405.166	5401.814	11662.416	901.254	12.94022	.66256	27.98885	26717.	315006680.
4.870	5412.336	5408.747	13115.945	1153.333	11.37221	.77585	28.76470	27667.	362776550.
.000	5419.000	5415.567	17468.641	1097.722	15.91354	.96821	29.73291	25713.	454301259.

State Water Survey Division
WATER QUALITY SECTION
AT
PEORIA, ILLINOIS

Illinois Department of
Energy and Natural Resources

SWS Contract Report 373

THE IMPACT OF GREATER PEORIA SANITARY DISTRICT AMMONIA DISCHARGES ON ILLINOIS RIVER WATER QUALITY

by

Thomas A. Butts, Dana B. Shackleford, Thomas £ Hill,
and Ralph L Evans

Prepared for the
Greater Peoria Sanitary District

November 1985

CONTENTS

THE IMPACT OF GREATER PEORIA SANITARY DISTRICT AMMONIA DISCHARGES ON ILLINOIS RIVER WATER QUALITY

by

Thomas A. Butts, Dana B. Shackleford, Thomas E. Hill, and Ralph L. Evans

INTRODUCTION

The Illinois Pollution Control Board (IPCB) and the Illinois Environmental Protection Agency (IEPA) are concerned about ammonia-nitrogen (ammonia-N) in surface water because it can be toxic to fish under certain conditions and because its bio-oxidation can depress dissolved oxygen (DO) concentrations. The IPCB and IEPA have formulated and published rules and regulations to control ammonia-N concentrations in wastewater effluents and surface waters of the state. Generally, these rules and regulations are designed to directly safeguard the water quality of receiving streams. However, one special rule somewhat arbitrarily limits ammonia-N concentrations in effluents from treatment plants handling 50,000 or more raw population equivalents (PE) discharging to the Illinois Waterway to 2.5 mg/l during April through October, and to 4 mg/l at other times.

The Greater Peoria Sanitary District (GPSD) treats a raw PE considerably in excess of 50,000. Consequently, the GPSD approach to ammonia-N removal is predicated on and dictated by this restriction. However, GPSD officials question whether adherence to this rule is essential for achieving or maintaining stream water quality standards below the plant outfall. A study conducted by the Water Quality Section of the Illinois State Water Survey (ISWS) was designed to provide an answer to this question.

General Information

The Greater Peoria Sanitary District sewage treatment plant is located south of Peoria with the effluent discharging to the Illinois Waterway at river mile point 160.1 Csee figure 1). It is a high rate activated sludge plant utilizing the Kraus process of returning digested sludge to the aeration system. Special treatment is provided for ammonia-N removal: the secondary effluent is passed through 84 rotating

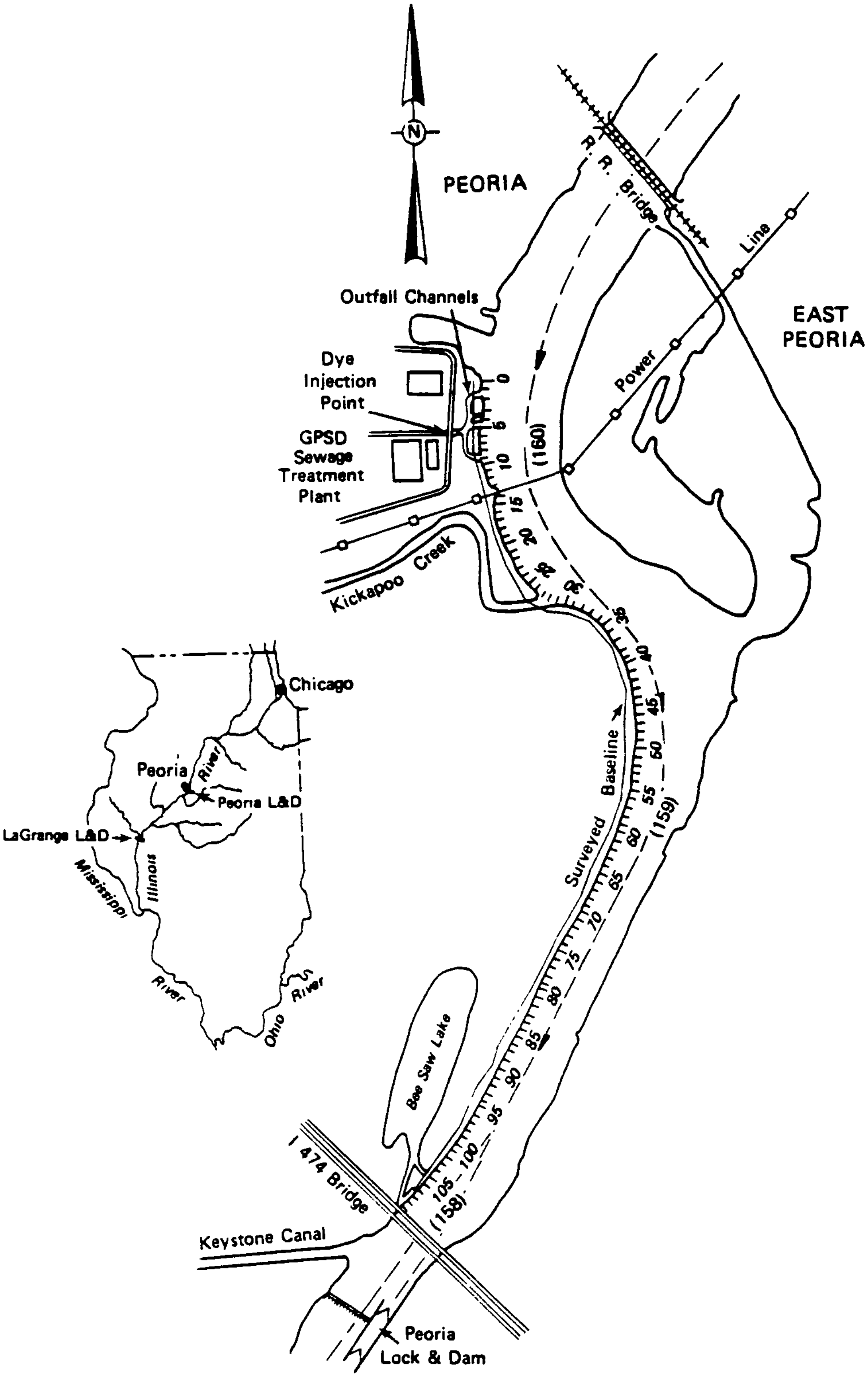


Figure 1. Study area and vicinity map

biological contactors which support a large population of nitrifying bacteria. Deep tertiary sewage ponds are used to remove suspended solids (SS) and some biochemical oxygen demand (BOD). The effluent is chlorinated.

The plant is designed to handle an average hydraulic load of 37 million gallons per day (mgd). The preliminary and primary treatment facilities can handle a maximum flow of 154 mgd, of which 60 mgd can be routed through the secondary treatment phase. The average annual dry weather flow presently runs about 25 mgd. The average design waste loading is approximately 120,000 pounds per day of 5-day BOD (approximately 706,000 PE) and 132,000 pounds per day of suspended solids.

In the past, the plant received heavy industrial waste loads from three major industries: Pabst Brewing Company, Hiram Walker Distillery, and Bemis Bag Company. These wastes were highly organic and composed mostly of carbonaceous material. Presently only Bemis is operating; Pabst Brewing has shut down, and the Hiram Walker Distillery has been taken over by Archer Daniels Midland Company (ADM) for the production of commercial grade alcohol. It produces more wastes than the old Hiram Walker operation.

Regulatory Implications

IEPA rules and regulations pertaining to effluent discharge and stream water quality standards are contained in State of Illinois Rules and Regulations, Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, dated April 1, 1984. Five sections within these rules and regulations are pertinent to ammonia-N relative to general water use. These are:

Section number	Subject
302.210	Substances Toxic to Aquatic Life
302.212	Ammonia Nitrogen and Un-ionized Ammonia
304.105	Violation of Water Quality Standards
304.122	Nitrogen
304.301	Exceptions for Ammonia Nitrogen Water Quality Violations

Four of the five sections are related to stream water quality standards; the exception is rule 304.122, which arbitrarily limits ammonia discharge concentrations irrespective of receiving stream water quality conditions. The four general rules are designed to limit effluent ammonia discharges only to the degree needed to meet stream standards. In contrast, paragraph a) of Section 304.122 stipulates:

> No effluent from any source which discharges to the Illinois River, the Des Plaines River downstream of its confluence with the Chicago River System or the Calumet River System, and whose untreated waste load is 50,000 or more population equivalents shall contain more than 2.5 mg/l of ammonia-nitrogen as N during the months of April through October, or 4 mg/l at other times.

Only three governmental agencies operating sewerage works fall under this rule. They are the Metropolitan Sanitary District of Greater Chicago (MSD), the city of Joliet, and the Greater Peoria Sanitary District. These three agencies must comply with the above regulation even in the absence of evidence that stream water standards are being violated.

Some justification exists for limiting ammonia-N concentrations in the effluents from the various MSD plants and Joliet. Butts et al. (1975) showed that ammonia-N loads originating above river mile 273, near the junction of the Des Plaines and Kankakee Rivers, must be reduced significantly if dissolved oxygen levels are to be improved down to Chillicothe (mile 179). Oxygen suppression also occurs in the LaGrange pool below Peoria, but two relatively recent studies (Butts et al. [1981] and Butts et al. [1983]) indicate somewhat indirectly that present GPSD ammonia-N discharges probably have minimal effect on the DO resources of the LaGrange pool. Butts et al. (1981) showed that during dry, warm 7-day, 10-year low flows the oxygen demand was 57 percent carbonaceous, 13 percent nitrogenous (ammonia-N oxidation), and 30 percent sediment oxygen demand. A BOD-DO model study conducted by Butts et al. (1983) reveals that, for 7-day, 10-year low flows, the time of travel between Chicago and Peoria is so great that most of the carbonaceous and nitrogenous demand would be exerted before it reaches the Peoria area. Consequently, the residual Chicago area loads combined with the GPSD inputs are so small that they have very little impact on LaGrange pool DO resources.

The question that needs to be resolved based on the facts presented above is whether the restrictive limitations imposed upon the GPSD treatment plant as set forth in paragraph a) of Section 304.122 are essential in preventing water quality standard violations in the Illinois River below Peoria. This study was designed and implemented to answer this question.

Scope and Purpose of Study

The primary purpose of this study was to determine the maximum ammonia concentrations which would be permissible in the GPSD-treated effluent to ensure that:

1. Illinois River water ammonia-N levels are not raised to levels which are toxic to native fish as specified in Section 302.210.

2. Illinois River ammonia-N water quality standards are not violated as specified in Section 302.212.

3. Illinois River dissolved oxygen water quality standards are not violated as specified in Section 302.206.

Historical data on ammonia-N, temperature, and pH, collected weekly by the ISWS at river mile 161.6 C1.5 miles above the GPSD outfall), were used to partially assess the implications of acute toxicity. Data from January 1978 through November 1984 were assembled and reviewed to provide background information on water quality conditions above the GPSD discharge. In addition, new stream water quality data were generated above the plant, in the vicinity of the outfall, and approximately 2 miles below the plant on a weekly basis over a 4-month span. Fluorescent dye was used to trace the mixing and dispersion characteristics of the effluent with the river. This was needed as part of the study because Section 302.102 of the IPCB Rules and Regulations permits water quality standard violations within a prescribed area of the receiving stream, defined as a mixing zone. The ISWS BOD-DO water quality model was used to predict DO concentration in the LaGrange pool under various flow and waste load scenarios.

Acknowledgments

This study was sponsored and funded by the Greater Peoria Sanitary District. The work was performed under the general supervision of the Chief of the Illinois State Water Survey. The entire staff of the Water Quality Section of the Water Survey participated in some phase of the study at various times. Specifically, thanks are extended to Jud Williams, Brent Gregory, John Mathis, and Harvey Adkins who spent many difficult and trying hours clearing away Illinois River "jungle," fighting off barges, and pounding 2 x 2's to establish sampling transects. Similar thanks are extended to Bart Doty and his GPSD surveying crew who battled the "jungle," mud, high water, and general confusion to establish the excellent survey baseline that the sampling transects were tied into. Also, thanks are given to Don Roseboom, Don

Schnepper, Dave Hullinger, Raman Raman, Dave Beuscher, and Linda Johnson who spent long hours on sampling boat and/or laboratory seats performing routine duties.

Without the expert advice and guidance of Bob Tolf and Larry Hughes of the GPSD, several phases of the study would have been much more difficult, and their input is greatly appreciated. Special thanks are extended to the United States Geological Survey for their loan of an Aminco fluorometer.

The illustrations were prepared by John Brother, Jr., Lynn Weiss, and William Motherway, Jr., and the original manuscript was edited by Gail Taylor. Also, Robert Sinclair made a major contribution to the preparation of a large number of report figures via the use of his Prime computer digitizing program, which was used for plotting the large number of contour figures contained herein. Special mention is due James Carlisle, Executive Director of the Greater Peoria Sanitary District, since he originally envisioned the need for the study and provided needed assistance throughout.

METHODS AND PROCEDURES

The study had two principal components. One was basically a water quality study of the river, while the other was a hydraulic study of effluent mixing with river flow. The two components, however, are interrelated. The water quality investigation will allow present and future assessments to be made on the impact of GPSD ammonia-N discharges on the river, while the mixing and dispersion study using a fluorescent dye tracer will provide regulatory officials with information for defining a mixing zone specific to the GPSD effluent discharge system. In addition, it will allow the characterization of dilution and dispersion effects on relatively conservative substances (those with low biodegradability) in waste discharges under a wide variety of physical conditions.

Water Quality Sampling Procedures

River water was sampled on 16 dates starting on July 11, 1984 and ending on October 25, 1984. Samples were collected approximately one mile above the outfall area at river mile point 160.95, at the outfall area at river mile point 160.01, and at a location two miles below the outfall area at river mile point 158.01. Samples were collected in the navigation channel centerline at each location, and on verticals located 100 to 150 feet from the right bank looking downstream. At each location, collections were made at the surface, 3-foot, mid-depth, and near bottom elevations.

Field measurements were made for temperature and pH at all locations, while dissolved oxygen (DO) concentrations were measured only at the centerline vertical at mile 158.01. Ammonia-N samples were collected at all points on all dates, while nitrate-N and total Kjeldahl-N samples were collected at selected points starting on July 24, 1984. Also, late in August turbidity readings were made on selected samples.

Sample collections were made at various depths using a battery operated pump. All nitrogen samples were ice cooled in the field and refrigerated in the laboratory until analyses were completed.

Initially the intent was to collect river water samples the day before a mixing zone-dispersion run was to be done. The dye runs were tentatively set for Tuesdays with water quality sampling to be done on Monday. This beginning of the week schedule provided a factor of safety for getting in a weekly run in case of bad weather. If rain occurred early in the week, the dye runs could be postponed until either Wednesday or Thursday. Friday runs were undesirable because this would require weekend laboratory work.

While the theory behind this schedule appeared to be good, the plan proved to be flawed as the weeks passed. On Monday, August 20, about midway into the study, ISWS personnel discovered that the GPSD was not discharging any effluent on this date while river sampling was in progress. An investigation turned up the fact that for dry weather mixing zone runs for discharge rates of 30 mgd or greater the GPSD had to store some flow in the plant diurnal storage basin. In other words, if the dry weather plant flow was only 20 mgd, and a dye run was planned for a 40-mgd discharge rate, much of the flow from the previous day had to be retained to provide 40 mgd during the 11- to 12-hour period needed to complete a dye run.

After August 20, river water quality sampling was changed to Thursdays, two days after a dye run. A two-day lag after the dye run was required instead of a one-day lag because all the laboratory personnel were tied up through Wednesday evenings performing dye tests. Two of the seven runs completed through August 20 were done at times when the GPSD was not discharging. However, the results of this oversight proved to be somewhat beneficial in the overall evaluation at the end since it provided some background information on river water quality in the absence of any discharge from the GPSD treatment plant.

During the water quality sampling runs, a small quantity of the samples collected at each sampling point was retained for fluorescence determinations. These data provided background fluorescent information for the river water.

Water Quality Analytical Procedures

The water quality parameters DO, pH, and temperature were measured in the field at the time of sampling. OOs were run using a YSI Model 57 DO-temperature meter and probe combination calibrated using the modified Winkler procedure. The pH determinations were made using a portable battery-operated pH meter equipped with a combination glass electrode. Temperatures were measured using a standardized mercury-filled glass thermometer.

Ammonia, nitrate, and total Kjeldahl-N samples and turbidity samples were analyzed in the laboratory. Ammonia-N and Kjeldahl-N determinations were made using a colorimetric procedure requiring digestion and distillation using phenol and hypochlorate. Nitrate samples were filtered through a 0.45-micron membrane filter immediately upon receipt from the field. Concentrations were determined using a chromotrophic acid colorimetric procedure. Turbidities were run on an HF Instruments model DRT turbidimeter, with the results reported in NTU's.

All other water quality parameters were analyzed using the methods outlined in the 16th edition of Standard Methods.

Mixing Zone and Effluent Dispersion Sampling Procedures

The mixing zone and dispersion portion of the study was conducted similarly to the combined sewer overflow mixing zone study outlined by Butts et al. C1984). Basically fluorescent dye was injected into the GPSD effluent and traced as it mixed with river water. Figure 1 shows the portion of the Illinois River in which mixing and dispersion were studied. Transects were established for possible sampling locations from a point about 150 feet above the outfall delta (station 0+00) to a point under the 1-474 Interstate bridge (station 110+00). Thi3 reach is inclusive between river mile points 160.01 and 157.9.

Establishment of Sampling Stations

A baseline, as shown on figure 1, was surveyed roughly following the path of the river at low water set-back distances ranging from approximately 25 to 185 feet. This line was established by a GPSD surveying crew. At the same time it was laid out, a Water Survey crew established sampling points along the shore line using 2" x 2" white painted wooden stakes (see figures 2, 3, and 4). The transect line was tied into the baseline by turning clockwise angles and measuring distances to the shoreline 2" x 2" stakes. Sampling transects were located at 50-foot intervals up to station 11+00 and at 100-foot intervals thereafter.

Figure 2. Transect sampling station orientation stakes

Figure 3. GPSD outfall delta, showing transect stakes

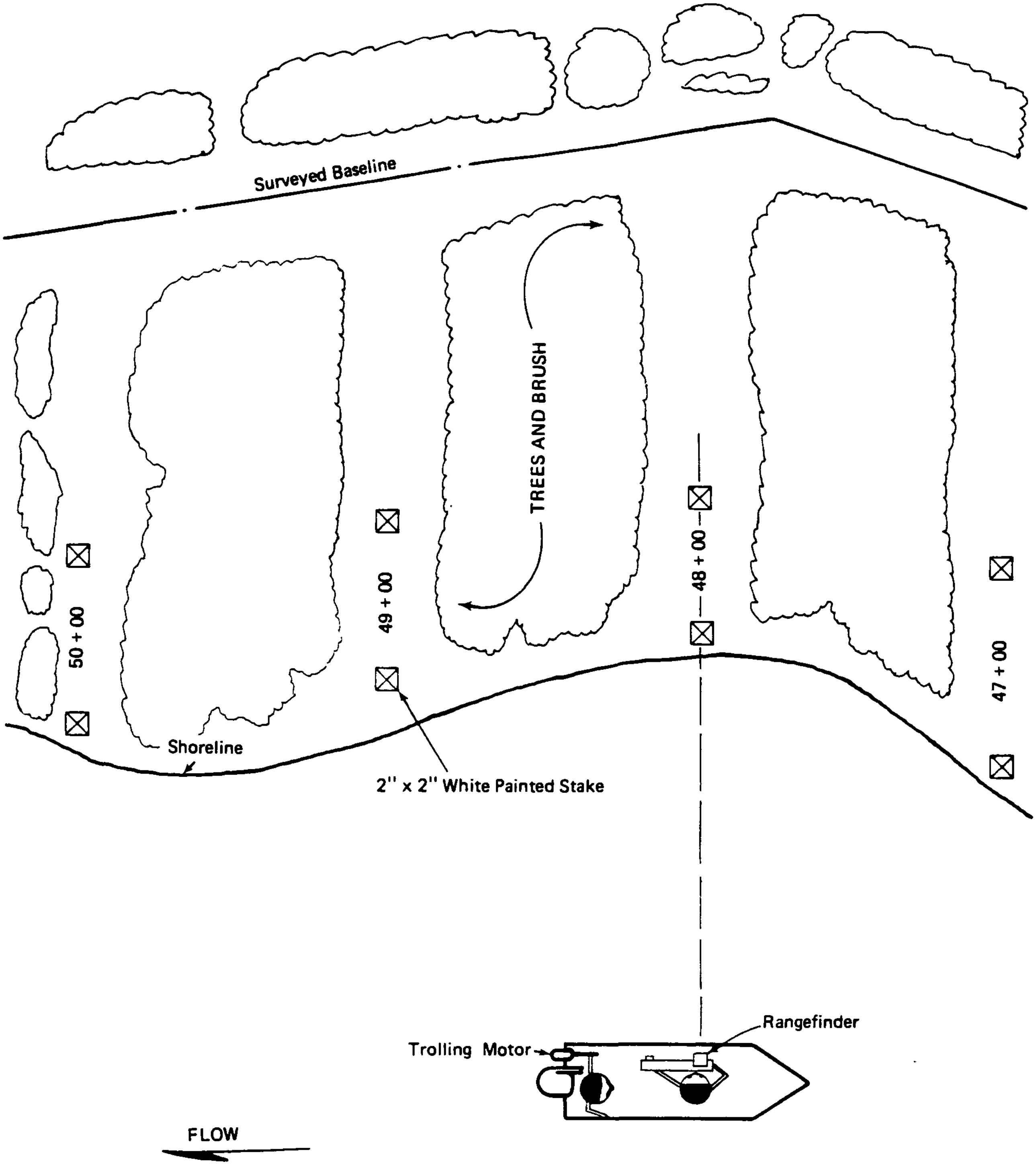


Figure 4. Schematic outline illustrating sampling location orientation

Transverse locations were established as shown on figures 4 and 5. Boat positions would be established by lining up the two white stakes and measuring the distance from the shoreline stake using high quality range finders. Three of the four boats used in sampling utilized the range finder shown in figure 5. The boat sampling in the immediate area of the outfall used a range finder which was highly accurate for close distances but had a range outward of only about one-third that of the model used by the other boats. The specifications of both models are given in Appendix A.

The baseline was tied into the Illinois State Coordinate System (Anderson, 1949) for future reference if needed. The original survey baseline notes are on file with the GPSD. The 2" x 2" stakes were cut off one foot above ground or shore level in the hope that they could be reset readily if needed within a year or two.

Dye Injection Procedures

The fluorescent dye tracer, Rhodamine WT, was injected into the treated effluent at a point shown on figure 1. The

Figure 5. Lining up on transect stakes using the range finder

dye is of the same quality and has the same physical and chemical characteristics as that used by Butts et al. (1984) in their Peoria combined sewer overflow mixing zone study. The manufacturer states that the dye color was developed to produce a high tinctorial strength and a low tendency to stain silt, dirt, and other suspended matter in shallow and inland waters. However, Bencala et al. (1983) found that losses of Rhodamine WT up to 55 percent occurred in shallow mountain streams, and laboratory experiments showed that streambed sand and gravel sediments have an appreciable capacity for Rhodamine WT sorption. If this is true, the specific results of the data generated during this study may be slightly in error; however, the final overall conclusions derived will not be significantly altered.

The dye injection point was at a manhole on top of a levee protecting the treatment plant from Illinois River flooding. A small storage shed was constructed to house the dye and dye injection equipment during the course of the study. The shed and injection system are shown in figures 6 and 7. The shed was modularly constructed for quick assembly and disassembly.

The dye injection system shown in figure 7 consists of a dye storage tank, a metering pump, a 12-volt battery, and a 10-amp battery charger. A second tank was provided and filled with clean water for use in cleaning and flushing the metering pump at the end of a run. The water and dye storage tanks are plastic cylinders, 24 inches in diameter and 40 inches high, specifically designed for mixing and storing corrosive chemicals. The tanks are nominally rated at 65 gallons but are capable of storing a significantly greater volume of liquid. A bottom side wall spigot was fitted with a 1-1/2-inch plastic ball valve reduced to accept 3/8-inch plastic tubing which was compatible with the pump requirement. Both drums were calibrated in 8-liter increments up to 256 liters. In addition, for use in storing cleaning and flushing water, the water tank was also considered to be a backup to the dye dilution drum in case problems developed. Also, at the beginning, two 250-pound drums containing 20 percent solutions of Rhodamine WT dye were stored in an elevated position in the shed. A spigot similar to the one installed on the diluted dye storage cylinder was installed In the dye drums so that controlled volumes of dye could easily be drawn off and transferred to the dilution container as needed for each run.

Two dye injection pumps were used over the course of the field rune; both were Fluid Metering, Inc. rotating-reciprocating piston pumps specifically designed for accurate handling of corrosive liquids. Each was fitted at the discharge end with a micrometer flow adjustment kit which

Figure 6. Dye injection shed and weather station

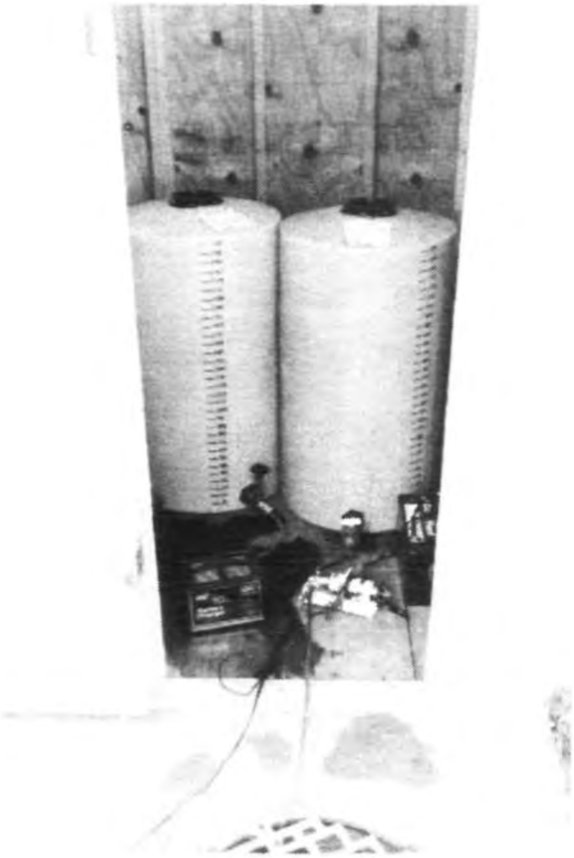


Figure 7. Dye injection system

allowed precise stroke adjustments of 0.1 percent. The pump used initially was the same one used by Butts et al. (1984) in the Peoria CSO mixing zone study. It was checked in the laboratory for reproducibility of the calibration curves developed for use during the CSO mixing zone study. The pump performance was found to be reproducible; however, the pump failed after the fourth run was completed and was replaced with a new pump with identical manufacturer's specifications. The manufacturer's specifications are presented in Appendix A along with the calibration data generated for both pumps. For each pump, the piston, cylinder case, and cylinder liner materials consisted, respectively, of alumina ceramic, 316 stainless steel, and sintered carbon. Although the pumps should perform similarly, the calibration data in Appendix A show that the old pump far exceeded the manufacturer's ratings under all conditions. The new pump capacities were much lower overall and were more in line with those specified by the manufacturer.

The dye metering pumps were driven by D.C. motors connected to 12-volt batteries. However, since A.C. power was available at the site, a 10-amp battery charger was included in the system to prevent a drain on the battery.

The metering pump was operated under a positive suction head and a negative discharge head due to a drop of about 15 feet in the manhole. This caused the semi-rigid plastic discharge line to partially collapse but not to the extent that the relatively low dye injection flow rates were restricted.

River Sampling Methodology

With slight modifications, the dye sampling technique used was similar to that devised and used by Butts et al. (1984) during the Peoria CSO mixing zone study. The river reach between stations 0+00 and 108+00 was divided into four subreaches for sampling by separate boats. The boats were outfitted as shown in figures 8, 9, and 10. Also, each boat was equipped with Anchormate II systems whereby the boat operators could lower 18-pound mushroom anchors that were bow-mounted (see figures 2 and 5) and controlled at the stern using reel and braking fixtures (see figure 9).

The sampling scheme was developed around equipment that: (I) was simple and reliable, thereby minimizing operational problems; (2) provided a means of rapidly producing a large number of repetitive samples; (3) contained mechanisms, parts, and conduits which were immune to dye adsorption; and (4) was affordable. The controlling factor in the design of the system was the need to collect a large number of samples over

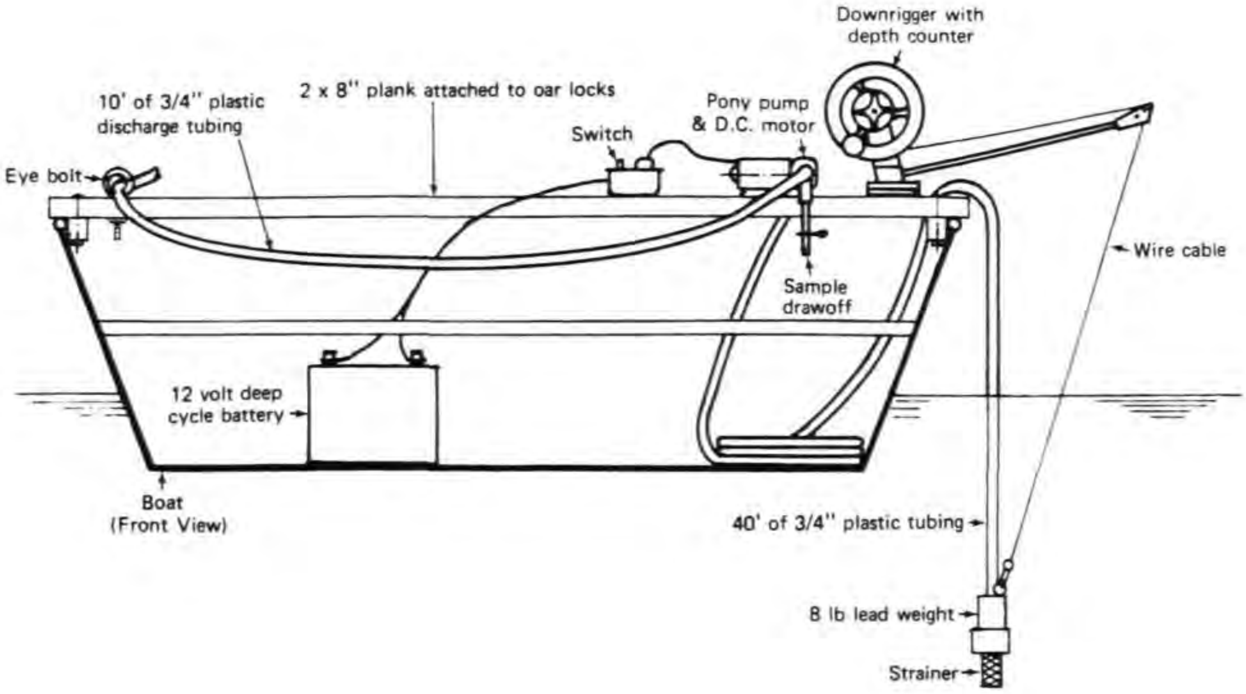


Figure 8. Schematic of boat equipped with dye sampling setup

Figure 9. Sampling crew establishing position on transect

Figure 10. Close-up of sampling equipment in operation

a 3- to 4-hour sampling period. All things considered, 800 samples were deemed the minimum required to accurately describe mixing and dispersion in the study area. Each of the four subreach boats collected 150 dye samples per run while a fifth boat collected 200 additional samples: 100 at the edge of the water and another 100 between 10 and 13 feet from shore. Eight hundred samples were about the maximum number which could be collected in the field and analyzed in the laboratory within 24 hours as required.

As shown in figures 8 and 10, a sampling hose was connected to a pump and attached to a fishing downrigger. The downrigger, equipped with a depth counter, provided precise sampling elevations and permitted quick and easy adjustments to changing water depths. The pump discharge was equipped with a plastic tee to which 5/16-inch PVC drawoff tubing was attached and fitted with a pinch clamp. A 105-amp RV/deep cycle battery was connected to a switch/plug box conveniently located for flow control. A waste line from the tee was threaded through an eye-bolt on the opposite side of the boat to minimize disturbance in the sampling area. A 2" x 8" plank, secured with bolts through the oarlocks on three boats and through inside handles on the fourth, was used to position the equipment.

Three of the downriggers were Big Jon Models D476 while the fourth was a Big Jon Model D425J. All were equipped with 200 feet of 150-pound test stainless steel line. The depth counter could be read to within one-half foot.

The pumps were D.C. powered Model 365 Proven Pony pumps which were all refitted with new rubber impellers and gaskets since their prior usage during the Peoria CSO mixing zone study. The rubber impellers are extremely susceptible to wear and stoppage by coarse sand and pebbles, so to minimize this problem each suction line was fitted with fine mesh strainers. The 40-foot suction and 10-foot discharge lines were 3/4-inch Nalge 8000 PVC tubing which, when tested before the Peoria CSO mixing zone study started, exhibited the best resistance to fluorescent dye adsorption. All of the sampling boards were checked for pumping rates, and for each, the complete flushing times were found to be slightly less than 16 seconds. Consequently, a 30-second flushing period was used in the field as a factor of safety as was done successfully during the Peoria CSO mixing zone study.

To minimize mixing and dispersion disturbance and water contamination, small boats equipped with electric trolling motors were used for navigation. Initially sampling at each subreach was designed to begin at the lowest theoretical concentration point, i.e., the bottom point on the outermost channel side vertical at the last transect of each subreach. Thereafter each successive transect was to be sampled from the outside in and from bottom to top. However, the early results indicated that such a refinement was needed only for subreach I near the outfall and possibly for subreach 2. Consequently, boats 3 and 4 began sampling upstream and working downstream. Making this change allowed boats 3 and 4 to start sampling earlier without compromising the steady state dye sampling scheme.

All samples collected by the shoreline boat (number 5) crew were taken by hand at the surface. Sampling commenced at station 0+00 and ended at station 110+00. Between 0+00 and 11+00 shoreline and 10 to 13 feet outward, samples were collected at 50-foot intervals. Between 11+00 and 72+00 collections were made at 100-foot intervals, whereas 200-foot intervals were used thereafter. The boat was powered by a trolling motor. Occasionally barge fleeting along the west bank prevented access to some of the sampling stations.

Samples were collected in 20-ml Wheaton 180 glass liquid scintillation vials. For field use and ease of handling, 100-lot cases were used (see figures 5 and 10).

Prerun Preparation

In preparation for the regular mixing and dispersion runs, a time of travel checK was made between the outfall and two transects, 12+00 and 104+00, in the study reach. On July 9, 1984, three days before the first scheduled run, the effluent was slugged with a large volume of dye when the river flow was 8910 cfs. The time of travel sampling proved to be only partially successful; only the tail end or back side of the dye curve at station 104+00 was detected. The detention time in the total study reach was less than what had been expected based on the information obtained farther upstream at station 25+00. However, sufficient time of travel information was acquired so that a reasonable time schedule could be worked out for the mixing zone and dispersion sampling run scheduled for July 12, 1984.

On July 17, the effluent was again slugged with dye when the river flow was 9307 cfs. The results are shown in figures 11 and 12. Overall this run was successful. Peak times were obtained for all the stations sampled except those close to shore. These results were used as a guide for initiating boat sampling times during the remainder of the study.

On the day prior to a scheduled "dye" run, the U.S. Geological Survey flow gaging station at Kingston Mines Criver mile 145.5) was read in terms of feet. The flow in cfs was then estimated using a rating table supplied by the USGS. For the first run, the volume of dye needed to detect a certain concentration at the end of the 2-mile study reach was ascertained using the Cobb and Bailey C1965) formula:

$$V_d = 102{,}000{,}000\ (C_2/C_d)\ Qt_t \quad . . . . (1)$$

where V_d = dye volume in milliliters, C_d = dye concentration in micrograms per liter (ug/l), C_2 = desired sampling point dye concentration in micrograms per liter, Q = stream flow in cfs, and t_t = injection time in hours. The factor t. was set equal to what was considered a conservative time required for the dye to reach steady state conditions throughout the study reach plus 3 hours for sampling. A downstream concentration for the first run was set at 0.5 µg/l.

The July 11, 1984 flow at Kingston Mines was estimated to be approximately 8000 cfs; at this flow the time required to reach steady state conditions was estimated to be 5 hours, and allowing 3 hours for sampling set t_t at 8 hours. The dye concentration (C_d) equals 200,000,000 µg/l since the commercial solution is 20 percent dye. Substituting these values into equation 1 yields a dye volume of about 16,000 ml. Therefore, 16,000 ml of the 20 percent solution had to be

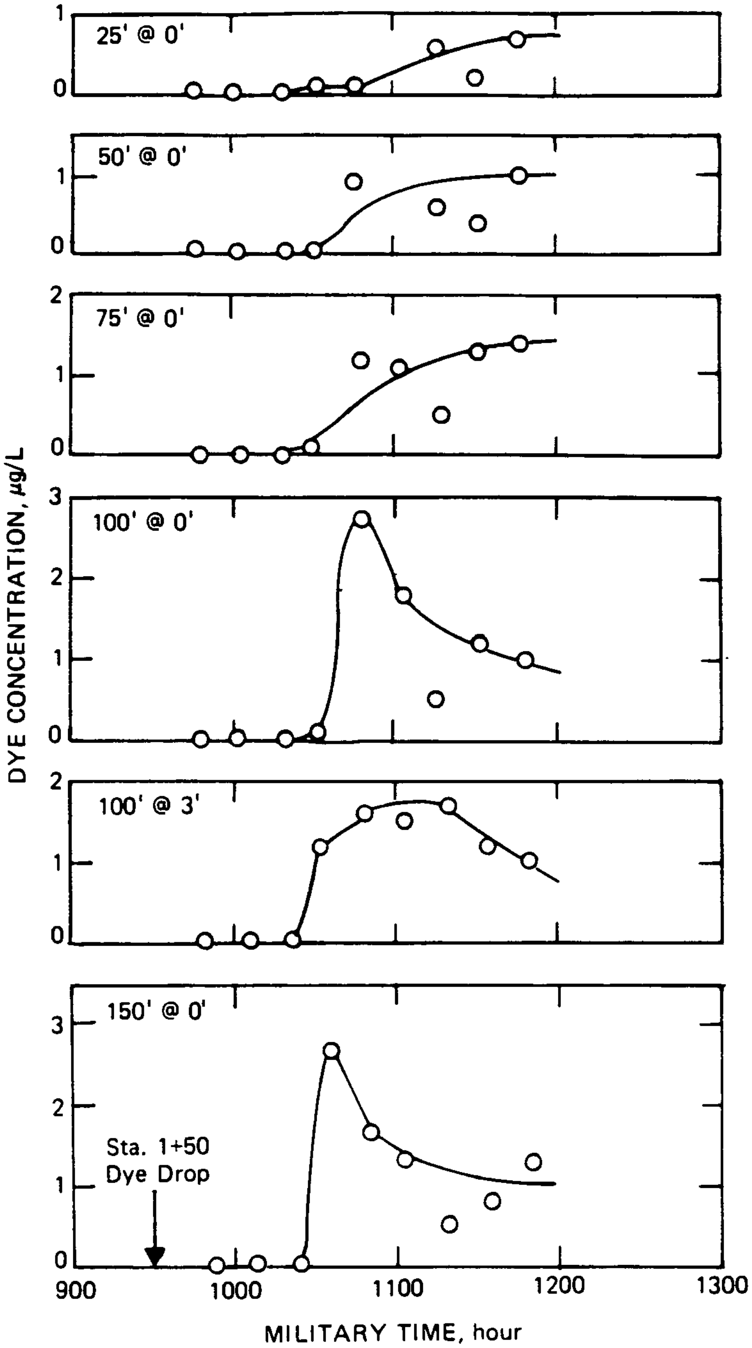


Figure 11. Time of travel between stations 1+50 and 25+00; river flow = 9307 ofs; 25' = distance from right bank looking downstream; @ 0' = depth

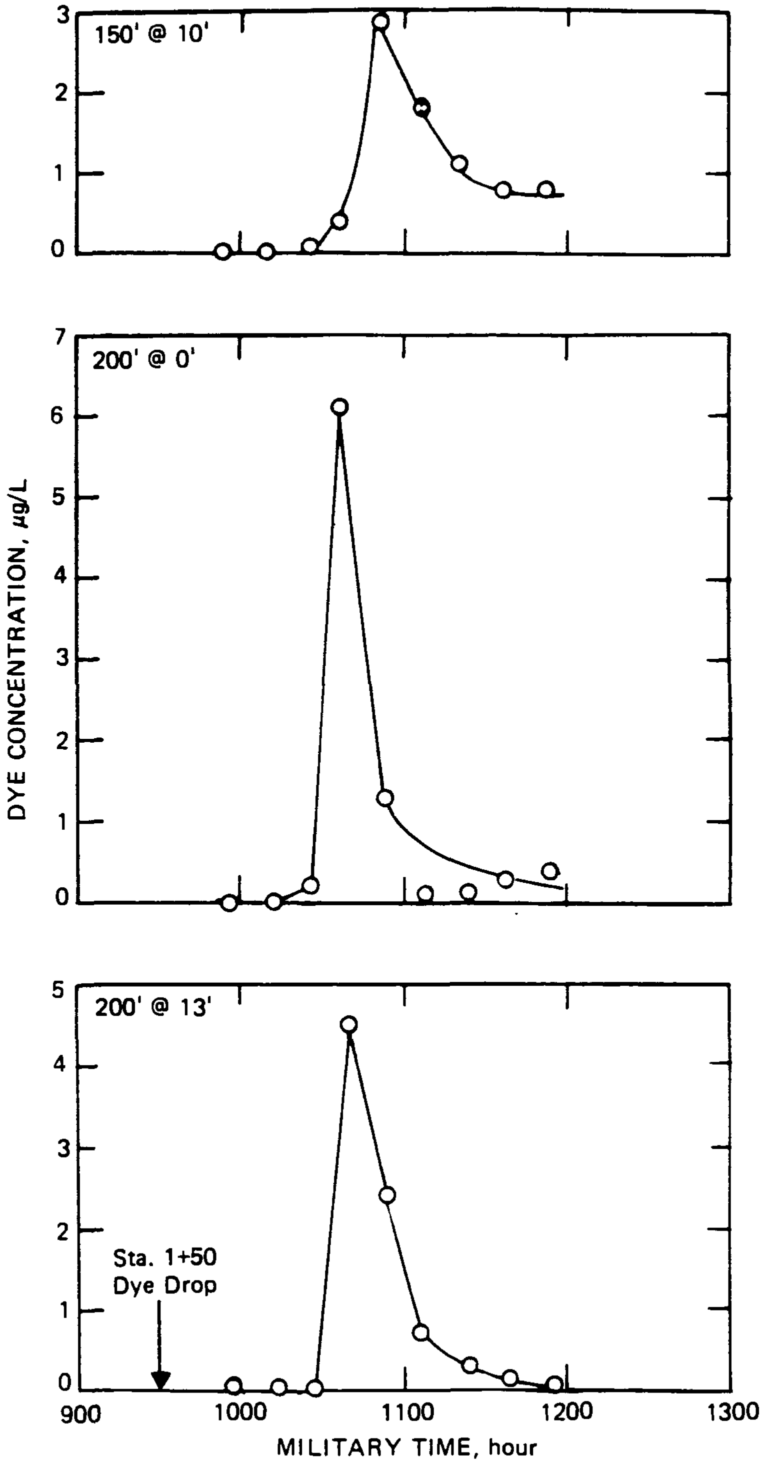


Figure 11. Continued

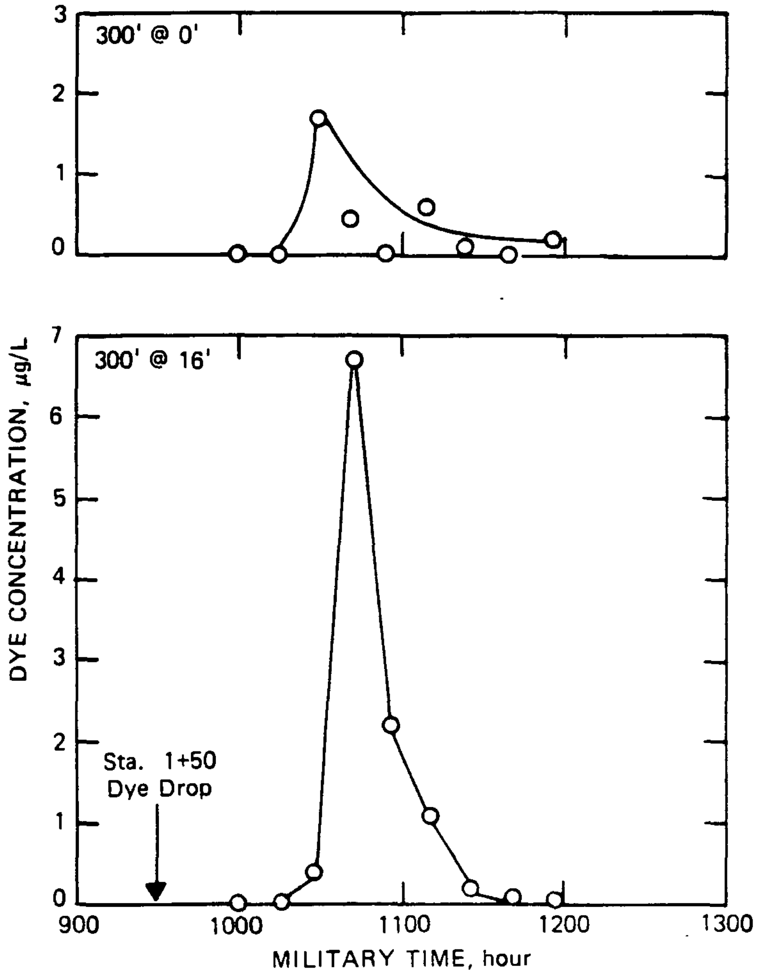


Figure 11. Concluded

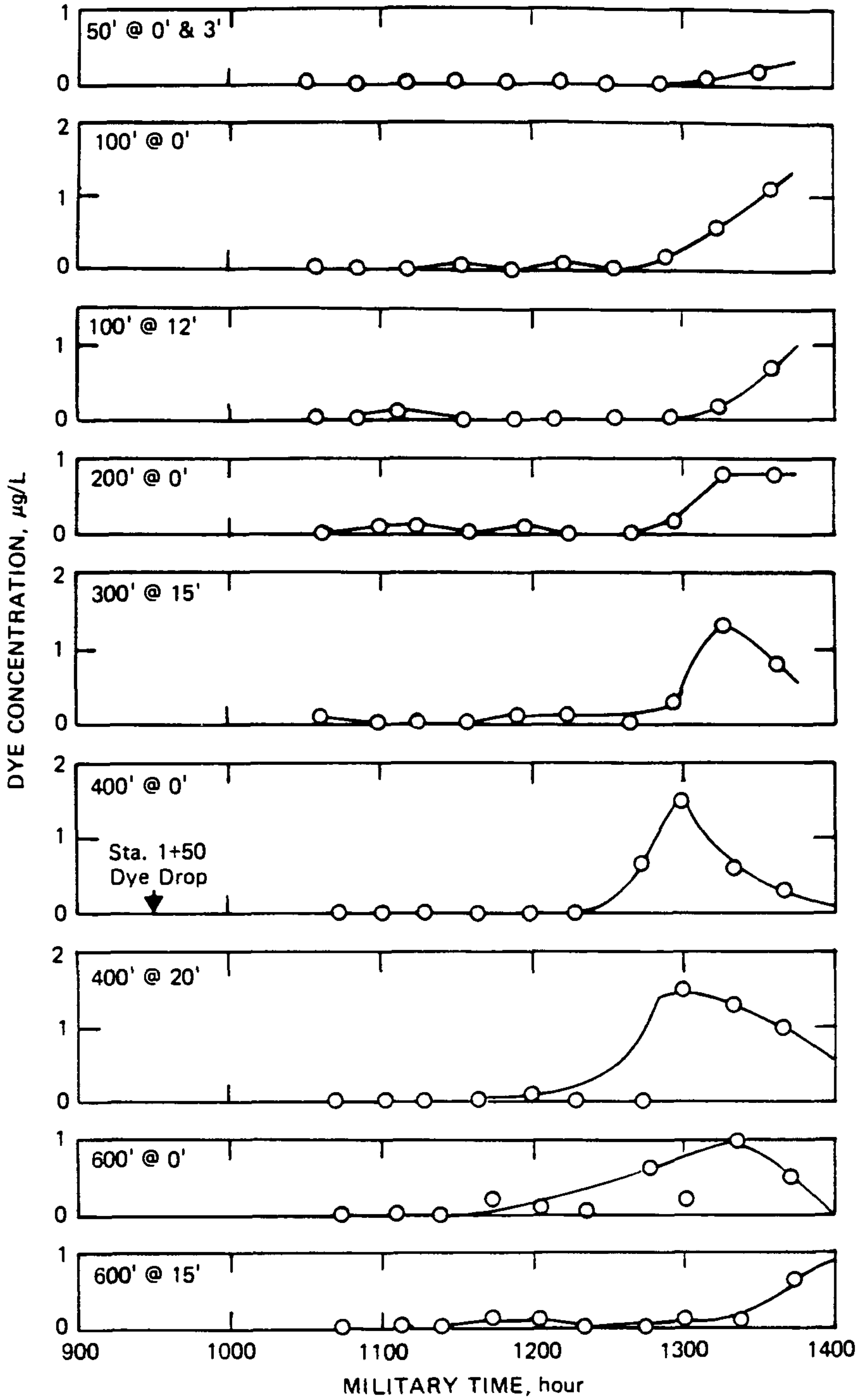


Figure 12. Time of travel between stations 1+50 and 104+00; river flow = 9307 cfs; 50' = distance from right bank looking downstream; @ 0' - depth

injected at a steady rate over eight hours to achieve the desired results. To make this injection practical, the 20 percent dye solution had to be diluted manyfold. For the first run, the micrometer on the metering pump was set at 0.400 or 8 ml/sec (see rating table at 40 inches in Appendix A). This rate requires 230,000 ml of diluted dye for an 8-hour injection period. Table 1 lists the injection criteria used for all 10 runs made over the course of the study.

The first run took slightly less than 7-1/2 hours to complete, and the dye was drawn down to 32,000 ml in the dilution tank. With only 32,000 ml of dye solution left, the metering pump was still functioning satisfactorily. However, to increase the factor of safety of not draining the tank down to a level where the metering pump would not function properly, the micrometer setting was reduced to 0.375 for the second run. However, as table 1 shows, this run took longer and the tank was again drawn down to the 32,000-ml level.

An ideal micrometer setting of 0.325 was arrived at during the third run. As shown in table 1 the safety factor was increased by reducing the injection rate and increasing the dilution volume. However, this refined operating procedure lasted only for one more run, as the pump failed after the fourth run. A new pump was installed, and only one run was needed to refine its operating procedure. Note in table 1 that a 0.400 micrometer setting was used for the last five runs, and the dilution tank level never fell below 52,000 ml.

The dye solution with proper amounts of dye and dilution water was made up on the day prior to the scheduled run. The residual diluted dye volumes which remained after each run are listed in table 1. The volume of 20 percent dye needed to be added to this residual was computed on a proportional basis.

Table 1. Dye Injection Criteria

Date	Run Time (hours)	Vol. of 20% Dye (1)	% Dye Start	Diluted vol. (liters)		Micrometer Setting	Injection Rate (ml/sec)	
				Start	Stop		Lab Calibrated	Calculated
7/12/84	7.42	16	6.95	230	32	0.400	8.00	7.33
7/19	7.92	20	8.70	230	32	0.375	7.50	6.88
7/31	8.50	24	9.60	250	64	0.325	6.50	6.08
8/7	9.75	27	10.89	248	64	0.325	6.50	6.08
8/14	8.58	27	10.89	248	36	0.455	6.69	7.36
8/21	8.50	27	10.89	248	52	0.400	5.82	6.41
8/28	8.15	27	10.89	248	56	0.400	5.82	6.56
9/11	8.00	27	10.89	248	64	0.400	5.82	6.39
9/18	8.15	27	10.89	248	52	0.400	5.82	6.39
10/23	8.72	27	11.74	230	52	0.400	5.82	5.67

Starting with the fourth run, 27,000 ml of the 20 percent commercial solution was used at the start of each run. Since the flows for runs 2 through 10 were lower than those for the first run and the 20 percent dye volume was increased, higher downstream concentrations were maintained. Equation 1 shows that decreasing stream flows require less dye to maintain a given downstream residual concentration.

A weather station was established on the top of the levee near the dye metering house as shown in figure 6. It was activated late in the afternoon before a scheduled run. The station provided continuous recorded information on wind speed and direction and on air temperature. This provided valuable information for ascertaining the effects of wind speed and direction on the dye movement during a run.

Special field sheets were prepared for the study (see Appendix B). The first sheet presented in Appendix B is a blank, the second is an example of a sampling schedule prepared the day before a run, and the third is the form filled in by the boat sampling crew during a run. The sampling locations changed from run to run with the degree of change being dependent upon the results of the previous run, significant changes in flows, and barge fleeting activities along the west bank. The day before each run a scouting boat was sent out to record the exact location of each parked barge along the west shore which would hinder sampling or obscure station stakes. The position and location of the parked barges largely dictated sampling locations below station 48+00. The position of parked barges, however, could change significantly over a 24-hour period, and the field crews manning boats 3 and 4 below station 48+00 usually had to modify the preselected sampling scheme somewhat during each run.

The sanitary district personnel also had to perform some prerun preparations. Chlorination injection into the effluent channel was shut off an hour before dye injection commenced. This was necessitated by the fact that chlorine directly interferes with fluorescence, and the fluorescence-detecting instrumentation used during this study was especially sensitive to such interference. Immediately upon completion of a run, chlorination was resumed. Run durations ranged from a minimum of 8 hours to a maximum of approximately 10.5 hours. Also, predetermined plant flow rates had to be set and maintained throughout a run. During dry weather, plant flows less than 30 mgd could be maintained over an 8- to 10-hour period without making a special allowance for storage. However, at flows 30 mgd or greater, some flow had to be accumulated and stored in the plant diurnal storage basin. This meant that no effluent was allowed to be discharged for varying periods of time prior to the start of runs scheduled for discharges greater than 30 mgd. This procedure, which was unknown to ISWS personnel during the early stages of the study, affected the results of two of the early river water quality sampling runs. The results for these two early water quality sampling runs made in conjunction with dye runs for GPSD discharges of 40 mgd and 35 mgd reflect ambient river conditions since the river water quality sampling was done the day before the dye run at a time when the GPSD was storing all of the incoming flow. When ISWS personnel became aware of this, river water quality sampling was performed two days after the mixing zone run was completed.

Dye Analytical Measurement Procedures

The river dye samples were returned to the laboratory by each boat crew immediately after their individual assignment was completed. The sample containers were opened, and the samples were left undisturbed for a period sufficient for all the containers to reach uniform ambient room temperature. During the analyses sample and standard Rhodamine WT solution temperatures were continuously monitored using a standard mercury-filled glass thermometer.

Rhodamine WT dye standard solutions were prepared with double deionized water to cover concentrations ranging from 0.2 µg/l to 75 µg/l. The standards were read hourly or at any time when a fluorometer aperture (light opening) change was needed.

Before a run was made, samples from the GPSD effluent and from various points in the river study reach were collected and analyzed for background fluorescence. The dye samples were then corrected using the proper background value.

A Turner Model 110 fluorometer equipped with a 546-nanometer primary filter and 590-nanometer narrow bandpass secondary filter was used to analyze samples through August 21, 1984. This fluorometer ceased to function properly thereafter and was replaced with an Aminco fluoro-colorimeter equipped with a 546-nanometer primary filter and a combination 497 blue and 3-66 red secondary filter.

Dye concentrations were calculated using concentration versus fluorometer dial reading curves developed through least squares linear regression curve fitting techniques. All values were corrected to a standard temperature of 29°C using the correction coefficients presented by Cobb and Bailey (1965).

Other Data Collection Procedures

River discharge measurements were made on seven dates using standard USGS procedures. Four measurements were made at station 104+00, two at 9+00, and one at 4+00. Horizontal distances were measured by lining up -on the stakes (see figure 4) and sighting the water edge stake with a range finder. Vertical depths were measured using a downrigger equipped with a depth counter as shown on figure 8. Velocity measurements were taken at the 0.2-fractional and 0.8-fractional depths using a Price current meter. Vertical measurements were taken every 25 feet on a cross section.

The primary purpose of taking the flow measurements was to determine, for a range of flows, the percentage contribution of flow at a given point or between two given points on a typical cross section as shown by figure 13. The results at stations 4+00 and 9+00 were used to help develop or delineate a mixing zone while the results of the measurements taken at 104+00 were used to develop mass-diagram curves.

On September 18, the GPSO effluent flow rate was checked using a current meter. The measurement was made at a box culvert passing over the effluent channel several hundred feet above the dye injection point. On this date, the plant flow meter registered 50 mgd while the computed direct channel measurement was 46 mgd. The field flow measuring procedure produces flow rates within plus or minus 10 percent of actual values; consequently, the plant flow measuring system appears to be well calibrated and accurate.

Because of the great effort expended to accurately gage and meter the dye injection, coupled with very difficult access to the effluent delta channels, direct measurement of the dye concentration in the effluent channels was not considered necessary early in the study. The computed effluent dye concentration was to be used to evaluate mixing and dispersion in the river. On August 28, 1984, however, a casual check of the effluent dye concentration in the concrete effluent overflow box on the river-side of the levee and at the mouth of the most upstream delta channel produced unexpected results. Both samples exhibited similar concentrations (117.6 µg/l at the box versus 120.4 µg/l at the mouth of the channel); however, these values were about 136 to 139 percent above the theoretical injection concentration. Similar results were observed during the next run on September 11.

Consequently, a detailed sampling program was developed to investigate this phenomenon. On eleven dates, effluent samples were collected at 10 locations in the discharge area: five in the overflow box and five in the three main delta

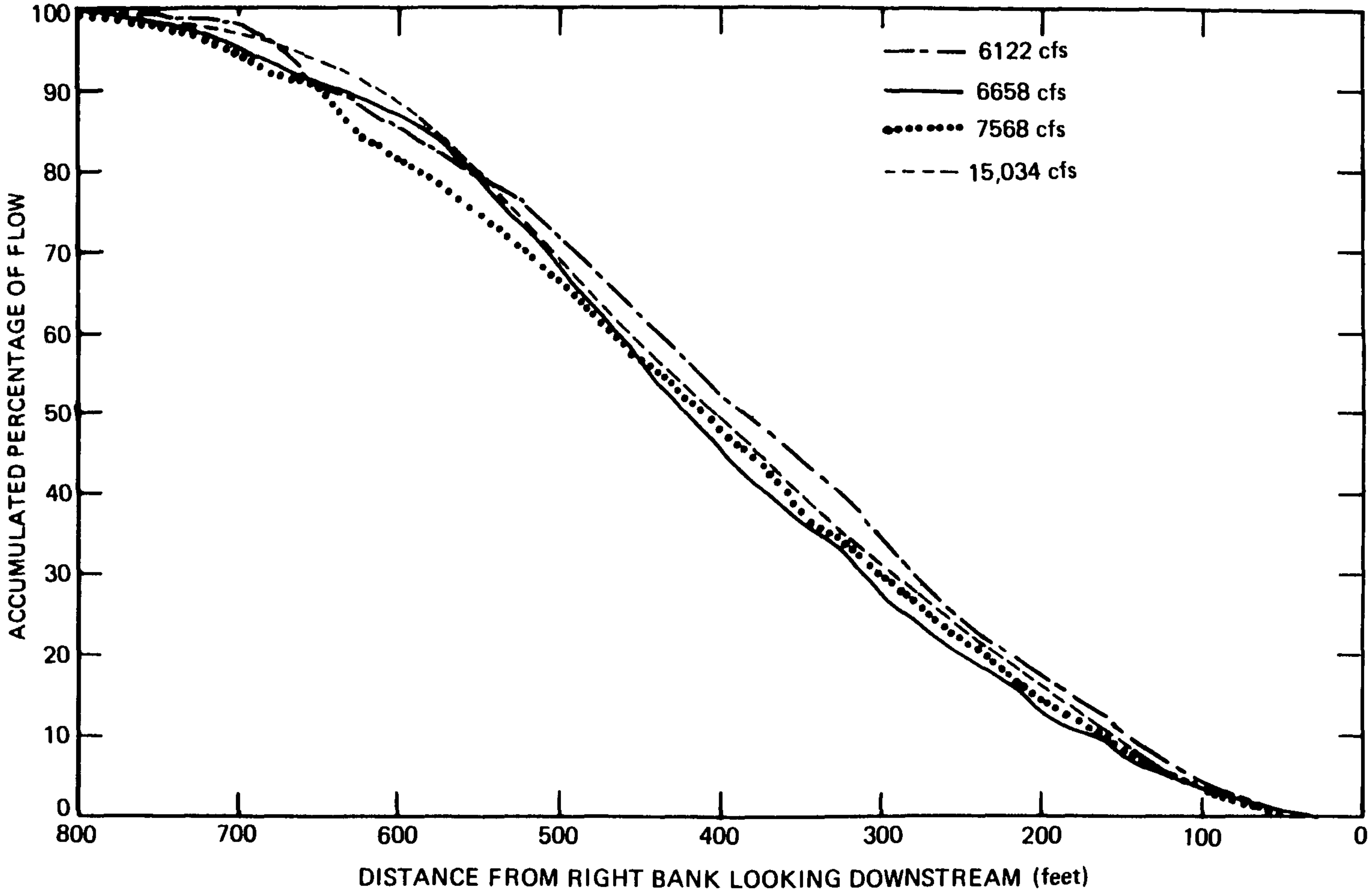


Figure 13. Accumulated percentage of flow in a transverse direction at station 104+00

channels as shown on figure 14. Only two of the samplings coincided with regular mixing zone runs (September 18 and October 23), while the other nine were special events (see table 3). For the special events the dye injection pump was operated just long enough for the dye to reach steady state conditions within the effluent delta area. After the ten samples were collected the injection pump was turned off.

Data Preparation and Reduction Procedures

Presenting the results of a mixing zone and dispersion study in a concise and meaningful way is difficult because so many variables exist that modify basic natural mixing phenomena in a large river system. To date, no conceptual models have been developed and verified to aid in the task. Butts et al. (1984) discussed this fact in detail in their report on the study of Peoria combined sewer overflow mixing and dispersion. Theoretical models certainly do not appear to be applicable to the data generated during this study. Consequently, simple, rational approaches will be utilized to reduce and display the results.

The primary methods of data display used in this report are iso-plots of dye concentration percentages, hereafter referred to simply as dye contour plots. Contour plots were developed for surface, 1-, 3-, and 8-foot depths down to station 12+00 for all ten sampling dates. Plots were developed for surface, 3-, and 8-foot depths down to station 108+00 for two selected dates. The plots developed down to station 12+00 are more detailed and are drawn to a scale double that to which the full-length plots were drawn. They reflect a clearer picture of mixing variability in the immediate area of the outfall, while the plots covering the whole study area present a good picture of overall dispersion.

To enable the development of contours at a given depth, straight line extrapolation was used to estimate dye concentrations at 1-foot depth increments between measured values. Table 2 illustrates the expansion of the observed data base using extrapolation. In almost all cases, the extrapolated results appeared reasonable and logical.

The plots are all in terms of percentages that reflect the concentration of dye detected in a certain spot in the river relative to the concentration in the GPSD effluent. These percentages can be used to estimate the residual concentration of any relatively stable effluent contaminant.

As discussed in the last section, the effluent dye concentrations were not sampled prior to August 28, 1984.

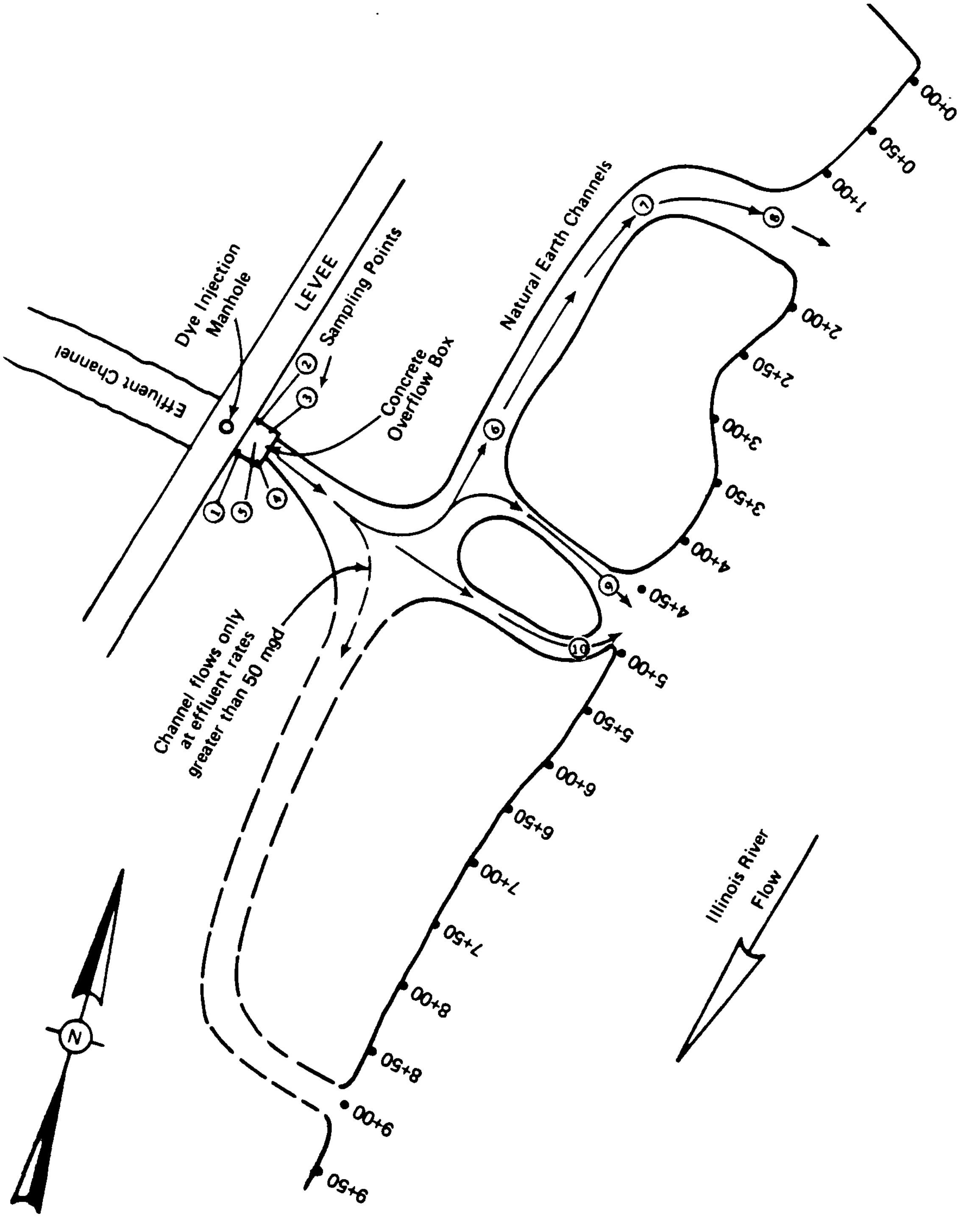


Figure 14. Schematic of GPSD outfall delta, showing dye sampling voints

Table 2. Typical Vertical Extrapolated Dye Percentages
Exemplified by Two August 28, 1984 Locations

		Dye Percentages at a Civon Distance from Shore in Feet									
Station	Depth (ft)	0	12	50	100	150	250	300	400	500	600
2+50	0	(15.0)	(35.3)	(18.6)	(31.4)	(8.6)	(0)				
	1			(15. 3)	27.3	10.9	2.7				
	2				23.3	13.2	5.4				
	3				19.2	15.5	8.2				
	4				(15.1)	(20.1)	10.9				
	5				18.7	20.6	(13.6)				
	6				22.2	21.6	(13.6)				
	7				(25.8)	(22.1)	14.7				
	a						15.9				
	9						17.0				
	10						(18.1)				
42+00	0	(0.1)	(0.3)	(0. 6)	(0.5)	(0.8)	(0.7)	(0.3)	(0.2)	(0.1)	(0.2)
	1				0.6	0.8	0.7	0.3	0.3	0.3	0.5
	2				0.7	0.8	0.7	0.4	0.5	0.5	0.8
	3				0.8	0.9	0.8	0.5	0.7	0.7	1.1
	4				(0.8)	0.9	0.8	0.6	0.8	0.9	1.4
	5					1.0	0.9	0.7	1.1	1.1	1.7
	6					1.0	0.9	0.8	1.3	1.3	2.0
	7					(1.0)	1.0	0.9	1.4	1.5	(2.3)
	8						1.0	1.0	(1.5)	(1.8)	2.3
	9						1.1	1.1	1.5	1.8	2.2
	10						1.1	1.2	1.5	1.9	2.1
	11						(1.1)	1.3	1.6	1.9	2.0
	12							1.4	1.6	2.0	1.9
	13							(1.4)	1.7	2.0	1.8
	14								1.7	2.1	1.7
	15								1.8	2.1	(1.7)
	16								1.8	2.2	
	17								(1.3)	(2.3)	

Note: Measured values are in parentheses

Consequently, for six of the ten mixing and dispersion runs no directly measured effluent dye concentrations were available to develop river percentage values. Table 3 summarizes the measured values obtained at sampling points 8, 9, and 10 (see figure 14) from August 28 through October 23, 1984. Also included in the table are the theoretical calculated concentrations. The data include information for both the mixing zone run dates and the special event dates for which only the effluent delta channels were sampled.

The ratio of the measured concentrations to the theoretical calculated values varied considerably over the course of the measurements. However some periodic consistency was evident. The ratios from August 28 through September 21

Table 3. Summary of Effluent Dye Concentration Values

Date	Calculated Conc. (µg/l)	Measured Conc. (µg/l) @ Station			Weighted Mean of 8, 9, and 10 values**	Weighted Mean Corrected to 29°C	Ratio - Weighted Mean @ 29°C to Calculated Value
		8	9	10			
7/12	80.5	—	—	—	—	(98.2)	—
7/19	108.3	—	—	—	—	(132.1)	—
7/31	126.9	—	—	—	—	(154.8)	—
8/07	179.9	—	—	—	—	(219.4)	—
8/14	108.8	—	—	—	—	(132.7)	—
8/21	108.2	—	—	—	—	(132.0)	—
8/28	86.2	120.4	—	—	120.4	108.5	1.26
9/11	68.7	89.0	—	—	89.0	80.2	1.17
9/18	73.2	96.5	90.5	92.0	94.4	85.0	1.16
9/21*	188.9	253.6	253.6	260.9	255.7	230.4	1.22
9/24*	150.8	249.6	249.6	249.6	249.6	224.9	1.49
9/27*	178.0	186.5	189.0	191.5	188.3	169.7	0.95
10/01*	170.3	201.2	203.9	203.9	202.4	182.4	1.07
10/04*	163.4	191.7	195.0	191.7	192.2	173.2	1.06
10/08*	170.6	143.6	146.6	143.6	144.0	129.7	0.76
10/11*	102.6	88.3	88.3	85.4	87.5	78.8	0.77
10/15*	151.6	123.1	118.9	121.0	121.9	109.8	0.72
10/18*	119.7	195.1	191.6	191.6	193.6	174.4	1.46
10/23	97.5	155.2	155.2	155.2	155.2	139.8	1.43

* Special effluent sampling events

** Based on relative channel flow ratios of 4, 1, and 2 for stations 8, 9, and 10, respectively

Note: Values in parentheses represent the calculated concentrations multiplied by 1.22, the 9/21/84 weighted mean to calculated value ratio

were all roughly 120 percent of unity, those from September 27 through October 4 approximated unity, those between October 8 and October 15 were equal to about 75 percent of unity, and those for the last two dates approached 150 percent of unity. No full explanation is available for this pattern. The fact that Archer Daniels Midland Company started up operations and began discharging a large mass of wastes on September 25, 1984 may have caused the abrupt change that occurred between the September 24 and September 27 sampling dates. A dramatic change in the quality of effluent was visually discernible during the September 27 sample collection run from that which had been observed up to that date.

The ratios for the five dates from August 28 through September 24 are probably more representative of the conditions which existed for the dates July 12 through August 21, for which no effluent sampling was done, than are the ratios for the eight dates from September 27 through October 23. The mean and median of the five values is basically represented by the 1.22 ratio observed for September 21;

consequently, this value was used to generate estimated "observed" weighted mean values for the six missing dates. The "observed" values were computed by multiplying the computed concentration for each of these dates by 1.22. The resultant values are included in parentheses in table 3 and were used to compute the percentages used in deriving the contour plots for these dates.

The Water Quality Section of the Illinois State Water Survey has over 20 years of Illinois River water quality data obtained from weekly grab samples collected approximately 1.5 miles above the GPSD outfall. Included in these historical data are parameters such as pH, temperature, and ammonia-N, which are important in assessing the effects of ammonia-N on the aquatic environment. The information obtained for pH, temperature, and ammonia-N was tabulated for the years 1978 through 1983 and for the first nine months of 1984. An assessment was then made as to the frequency of violation of IEPA ammonia-N standards before and after GPSO ammonia-N inputs. The GPSO discharge effects on river ammonia-N values were evaluated in terms of concentration additions in mg/l. River loads were computed using estimated river flows at Peoria derived by subtracting USGS Mackinaw River discharges from those recorded by the USGS at Kingston Mines on the Illinois River below Peoria. The mixing zone-dispersion portion of the study provided information on the localized and short-term effects of the GPSD effluent on river water quality. To determine the effects of GPSD ammonia discharges downstream of the outfall, DO sag curve simulations were performed for various waste discharge scenarios using the water quality model developed by Butts et al. C1973) and recently applied to the Illinois Waterway by Butts et al. (1983).

RESULTS

The basic accomplishments and objectives that were achieved in the study are reported in this section. The water quality sampling results are presented first, after which the mixing zone dispersion study results are given. The relationships between the two independently collected data bases will be presented later under the "Discussion" section.

Water Quality Sampling Results

River water quality sampling was performed on 16 dates from July 11 through October 25, 1984. The dates sampled and the hydraulic and hydrologic conditions which existed during these sampling dates are presented in table 4.

Table 4. Water Quality Sampling Dates and River Hydraulic and Hydrologic Conditions

Water Quality Sampling Date	Discharge		Pool Stage (msl)	Peoria Dam Operation		
	GPSD (mgd)	River (cfs)		Wickets Down	Valves Open	Needles In
7/11/84	27	9,975	440.36	0	6	0
7/18	21	9,216	440.53	0	6	0
7/24	25	8,840	440.35	0	6	0
7/30	21	8,204	440.14	0	6	0
8/06	23	7,294	439.25	0	0	0
8/13	0	8,250	440.51	0	6	0
8/20	0	8,117	440.04	0	6	0
8/23	21	7,397	439.87	0	0	0
8/30	21	6,857	440.08	0	0	107
9/04	20	7,921	440.90	0	6	107
9/13	21	5,525	440.11	0	0	63
9/27	20	10,346	440.54	8	6	12
10/04	20	5,518	440.20	0	0	42
10/11	26	6,751	440.27	0	6	40
10/15	24	6,554	440.32	0	6	40
10/25	23	8,257	440.20	6	6	28

Note that the GPSD was not discharging during the August 13 and 20 sampling runs. During the river sampling period on these dates, all incoming flow was being stored in anticipation of mixing zone runs at flows of 40 mgd and 35 mgd on the following days. After August 20, all water quality sampling was performed two days following a "dye" run. Hence, two sets of water quality sampling results are associated with the August 21 mixing zone run.

The river hydraulic conditions in the study area are greatly affected by the operation of the Peoria lock and dam located slightly more than two miles below the outfall (see figure 1). The mixing and dispersion and hence the impacts of the GPSD discharges are greatly affected by the dam operation. Figure 15 shows the details of the lock and dam. Flow release is controlled primarily by the manipulation of collapsible weirs known as Chanoine wickets. During periods of sustained high flows, all the wicket sections are lowered to the river bottom on a hinge, allowing unrestricted travel across the structure without locking. An individual wicket is 16.5 feet deep, 4 feet wide, and 1 foot thick; each is separated by a space slightly less than 4 inches wide. During intermediate flows the major portion of the river flow is allowed to discharge through the spaces between the wickets; a minimal amount of water passes over the top. At times, a

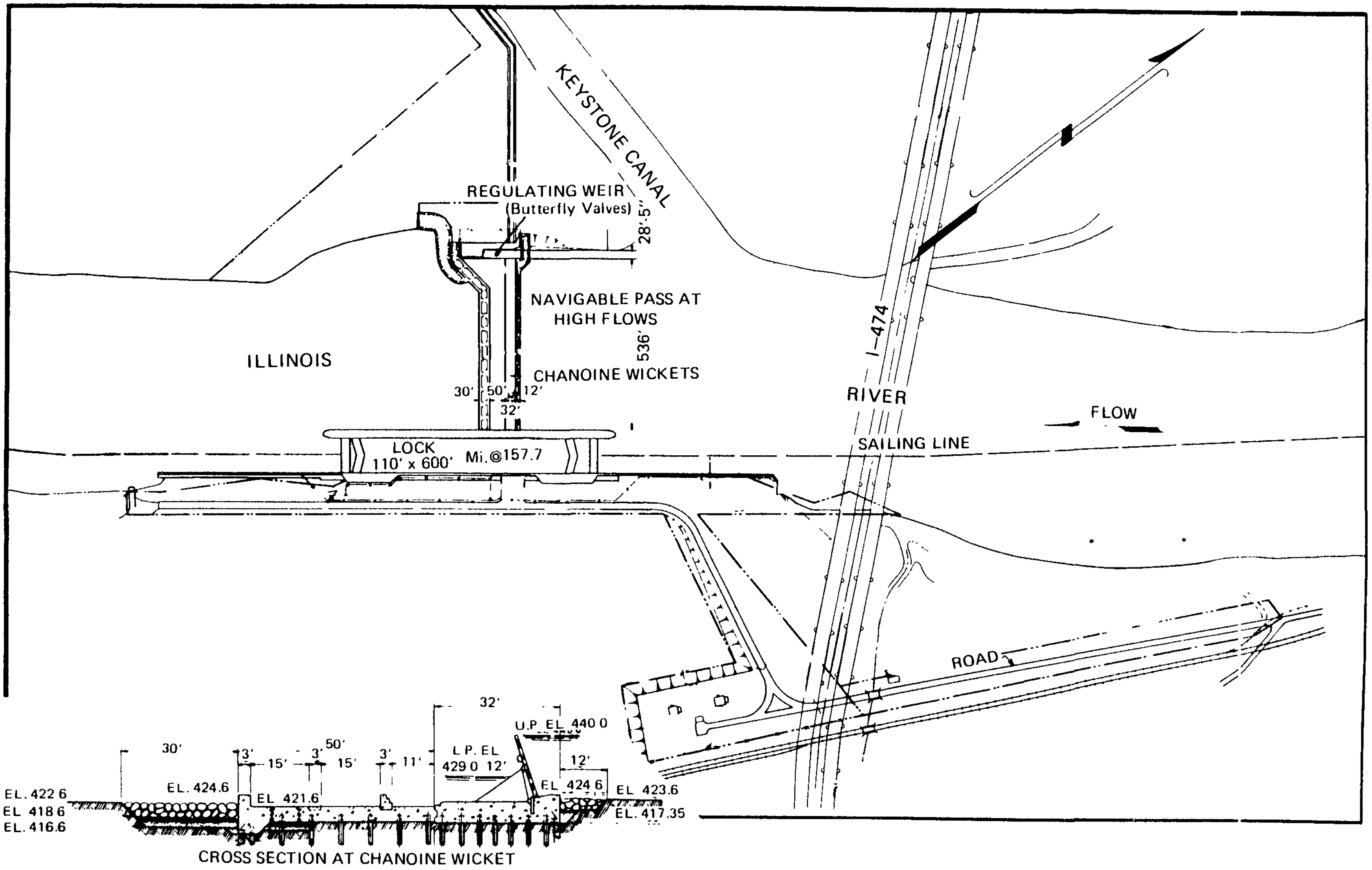


Figure 15. Details of Peoria look and dam

limited number of wickets are lowered as a means of finite flow control. When very low flows occur, 4" by 4" timber "needles" are inserted in the spaces as needed to create or maintain the desired pool level. Additional flow control can be achieved by opening or closing a number of 6-foot butterfly valves located along the west side of the dam.

The information presented in table 4 shows that water quality sampling was achieved during a wide variety of dam operating conditions. For example, on two dates some of the wickets were down, and on one date all the wickets were up with most of the needles in place and no butterfly valves open.

Sampling was achieved over almost a twofold range in river flow. A relatively low flow of 5518 cfs occurred on October 4, 1984 while a relatively high flow of 10,346 cfs occurred only one week prior to that. Note that when the flow reached approximately 10,000 cfs, some wickets were lowered to allow the excess flow to pass.

Normal or flat pool stage above the dam is 440.0 feet above mean sea level (msl). Generally the pool was within about one-half foot of this, level during the course of the study. On two occasions, it was allowed to drop slightly below the desirable 440.0-foot elevation.

The water quality sampling results are summarized in tables 5, 6, and 7 and the individual results used to develop these summaries are presented in Appendix C. The daily tabular values for temperature, pH, ammonia-N, turbidity, and DO represent averages of samples taken at the surface, 3-foot, mid-depth, and bottom levels on a vertical. Nitrate-N and total Kjeldahl-N (TKN) values represent one sample collected at mid-depth.

Ammonia-N was the parameter of primary interest, and some statistical evaluations using analysis of variance (ANOVA) tests were used to determine if differences observed between mean concentrations of various sample groupings were statistically significant. The individual concentration values were corrected to flow-weighted values using the October 4 low flow of 5518 cfs as the base. This minimized the influence of flow on the relative variability of the data collected on the 16 dates.

As a first step in the statistical analyses the data were grouped according to those collected during the two days when no GPSO effluent was being discharged and the 14 days during which it was (see table 4). The results of this test, along with several others, are summarized in table 8. The mean value of 0.414 mg/l for the 48 samples collected during no GPSD discharge was higher than the mean value of 0.375 mg/l for the

Table 5. Summary of River Water Quality Results
at River Mile 160.95

	Depth Averaged Values at 150 and 550 feet from Right Bank LDS*											
	Temperature (°C)		pH		NH_3 -N (mg/l)		NH_3 -N (mg/l)		TKN (mg/l)		Turbidity (NTU's)	
Date	150'	550'	150'	550'	150'	550'	100'	550'	100'	550'	100'	550'
7/11/84	27.0	27.0	8.31	8.30	0.19	0.15	_	_	_	_	_	_
7/18	26.5	26.0	8.76	8.85	0.08	0.07	-	-	-	-	-	-
7/24	29.6	30.9	8.51	8.51	0.25	0.21	-	1.15	-	2.26	-	-
7/30	26.0	26.1	8.50	8.52	0.06	0.06	-	1.50	-	1.70	-	-
8/06	29.0	29.1	8.13	8.15	0.20	0.21	-	1.91	-	1.62	-	-
8/13	27.0	26.6	8.23	8.31	0.33	0.25	-	1.65	-	1.60	-	-
8/20	26.0	25.5	8.01	8.08	0.34	0.24	-	1.61	-	1.54	71	69
8/23	25.0	24.6	8.23	8.30	0.19	0.14	-	1.51	-	2.00	76	68
8/30	27.8	27.4	8.16	8.13	0.25	0.29	-	1.64	-	1.67	56	63
9/04	23.0	22.8	8.25	8.23	0.16	0.24	-	1.48	-	1.68	90	77
9/13	24.0	24.2	8.09	8.10	0.44	0.35	-	2.59	-	1.43	81	80
9/27	16.3	16.0	8.39	8.39	0.17	0.19	-	-	-	2.31	77	77
10/04	16.5	16.4	8.18	8.19	0.26	0.28	-	3.16	-	1.06	60	71
10/11	19.6	19.5	8.04	8.04	0.18	0.19	-	2.75	-	1.03	74	81
10/15	21.0	20.0	8.00	8.03	0.20	0.19	-	2.92	-	1.29	62	70
10/25	13.5	13.0	7.96	8.00	0.31	0.26	-	3.00	-	1.18	72	60
Avg.	23.6	23.4	8.23	8.26	0.23	0.21	-	1.86	-	160.0	72	72

* LDS = Looking Downstream

336 samples collected during the discharging dates. However, this difference was found to be statistically insignificant at the 5 percent level of significance. To be able to reject the hypothesis that the means of various data sets are equal, the computed F-values in table 8 must exceed the theoretical values from a standard statistical F-table. Superficially the means are different for test 1, but the extreme variability of the data within each grouping prevents this difference from showing up statistically.

A second ANOVA evaluation was performed on data grouped according to near shore (100 to 150 feet from shore) and centerline of channel (400 to 550 feet from shore). In this case, the near shore average of 0.426 mg/l was found to be significantly higher than the centerline of channel average of 0.333 mg/l. This leads to the suspicion that the ammonia concentration in the effluent may possibly be influencing the ammonia concentration in the river in the outfall area and downstream. The results in table 8 reveal this to be true. The differences between the outfall average (station 160.01)

Table 6. Summary of River Water Quality Results at River Mile 160.01

Date	Depth Averaged Values at 100 and 400 feet from Right Bank LDS*											
	Temperature (°C)		pH		NH_3 -N (mg/l)		NO_3 -N (mg/l)		TKN (mg/l)		Turbidity (NTU's)	
	100'	400'	100'	400'	100'	400'	100'	400'	100'	400'	100'	400'
7/11/84	27.0	27.1	8.30	8.30	0.16	0.23	—	—	—	—	—	—
7/18	26.0	26.5	8.74	8.80	0.14	0.11	-	-	-	-	-	_
7/24	32.1	32.0	8.55	8.56	0.22	0.16	1.24	1.16	2.10	1.42	-	_
7/30	26.0	25.9	8.48	8.49	0.11	0.12	1.85	1.56	1.67	1.45	-	_
8/06	29.0	28.8	8.05	8.18	0.25	0.26	1.79	1.80	1.88	1.87	-	_
8/13	27.0	27.0	8.26	8.30	0.27	0.21	1.68	2.16	1.63	1.73	-	_
8/20	26.0	25.5	8.04	8.04	0.25	0.38	1.84	1.66	1.69	1.56	55	65
8/23	25.0	24.8	8.19	8.29	0.25	0.13	1.66	1.86	1.58	1.57	94	61
8/30	27.1	27.0	8.08	8.05	0.37	0.39	1.69	1.69	1.76	1.90	53	77
9/04	23.1	23.1	8.21	8.23	0.30	0.30	1.64	1.46	1.88	1.76	93	102
9/13	24.0	24.0	7.90	8.09	0.52	0.44	3.04	2.62	1.53	1.48	62	83
9/27	15.9	16.1	8.24	8.41	0.27	0.23	-	-	2.46	2.37	69	75
10/04	16.9	16.5	8.08	8.14	0.31	0.30	3.12	3.24	1.33	1.24	62	59
10/11	19.9	19.4	7.63	8.05	0.96	0.20	2.32	2.72	2.23	1.10	74	87
10/15	21.0	20.5	7.78	8.01	2.68	0.19	2.82	2.96	4.31	0.95	49	57
10/25	13.8	13.0	8.00	8.00	0.53	0.29	3.15	3.17	1.34	0.78	72	70
Avg.	23.7	23.6	8.16	8.25	0.47	0.25	2.14	2.16	1.96	1.51	68	74

* LDS = Looking Downstream

and those upstream (station 160.95) and downstream (station 158.01) are highly significant. The outfall average is exactly twice that of the upstream value and 75 percent greater than the downstream mean.

A fourth test run, grouping the centerline of channel data by stations, revealed statistically significant differences between the three means. In this case, the means increased in a downstream direction. The influence of the QPSD ammonia-N discharge is somewhat evident in the channel centerline near the outfall; however, it becomes clearly evident in the channel about two miles downstream.

Another statistical evaluation was made using the data for the 14 dates during which GPSD effluent was being discharged. Stepwise regression techniques were used to determine the factors which significantly affect the river ammonia-N concentration at various sampling depths. The surface, 3-foot, mid-depth, and bottom river ammonia-N concentrations at both the near shore and channel verticals in the outfall area were correlated with the GPSD effluent

Table 7. Summary of River Water Quality Results at River Mile 158.01

	Depth Averaged Values at 100 and 400 feet from Right Bank LDS*									
	Temperature (°C)		pH		NH_3 -N (mg/l)		DO (mg/l)		Turbidity (NTU's)	
Date	100'	400'	100'	400'	100'	400'	100'	400'	100'	400'
7/11/84	27.0	27.0	8.31	8.30	0.19	0.16	—	—	—	—
7/18	26.5	26.4	8.70	8.75	0.12	0.11	-	-	-	-
7/24	29.6	29.6	8.46	8.53	0.23	0.24	-	6.50	—	—
7/30	26.3	25.8	8.44	8.44	0.12	0.15	-	8.88	—	—
8/06	28.4	28.5	8.00	8.00	0.29	0.30	-	4.97	—	—
8/13	27.4	27.3	8.33	8.33	0.21	0.29	-	5.40	—	—
8/20	26.0	26.1	8.04	8.05	0.31	0.23	-	5.28	67	65
8/23	25.4	25.0	8.05	8.11	0.24	0.30	-	6.06	56	68
8/30	27.4	27.3	8.02	8.02	0.31	0.27	-	4.95	94	65
9/04	23.1	23.1	8.10	8.20	0.28	0.27	-	5.33	80	73
9/13	23.6	23.8	8.08	8.10	0.48	0.48	-	6.86	67	66
9/27	16.3	16.0	8.43	8.41	0.23	0.23	-	8.38	130	78
10/04	16.9	16.6	8.09	8.14	0.36	0.35	-	8.74	124	57
10/11	19.5	19.5	8.05	8.08	0.22	0.29	-	7.46	77	69
10/15	20.3	20.1	7.99	7.98	0.24	0.32	-	7.06	57	53
10/25	13.0	13.0	8.03	8.04	0.31	0.36	-	9.49	78	61
Avg.	23.5	23.4	8.20	8.22	0.26	0.27	—	6.03	83	66

* LDS = Looking Downstream

ammonia-N concentration, flow rate, and temperature and the river discharge and temperature. The specific parametric values used in the analyses are presented in table 9. The results are summarized in table 10.

The concentrations at all points on the near shore vertical were influenced to the greatest degree by the effluent ammonia-N concentration as evidenced by the singularly high correlations shown in table 10. The surface and 3-foot values are almost exclusively governed by effluent ammonia-N levels. However, at the 5- and 9-foot sampling points, the effluent flow rates and river temperatures come into play and significantly increase the correlations above the singular effluent ammonia-N values.

The channel ammonia-N concentrations are considerably less predictable when the five independent variables are used. The correlations between river channel ammonia-N concentrations and any given parameter are not very high. Also, the multiple correlations, taking into account all five independent variables, are not nearly as high as those for the

Table 8. Summary of Results Derived Using Analysis of Variance (ANOVA) Statistical Tests on the Variability of Ammonia-N

Test No.	Data Groupings	Number of Samples (n)	Mean (mg/l)	Degrees of Freedom f_1	f_2	F-values @ 5% Level Computed	Theoretical*
1	No GPSD Effluent	48	0.414	1	382	0.57	5.02
	GPSD Effluent	336	0.375				
2	Near Shore	192	0.426	1	382	7.41	5.02
	Center of Channel	192	0.333				
3	Near Shore Stations						
	Downstream 158.01	64	0.352	2	189	9.11	3.69
	Outfall 160.01	64	0.618				
	Upstream 160.95	64	0.309				
4	Centerline Channel Stations						
	Downstream 158.01	64	0.368	2	189	7.12	3.69
	Outfall 160.01	64	0.339				
	Upstream 160.95	64	0.290				

* Theoretical value from standard statistical F-table

Table 9. Parametric Value Inputs to Stepwise
Regression Analyses at Station 160.01

Date	NH_3-N Conc. (mg/l) at Depths in Feet								GPSD NH_3-N Conc. (mg/l)	GPSD Flow (mgd)	River Flow (cfs)	GPSD Temp (°C)	River Temp (°C)	
	At 100' From Shore				At 400' From Shore									
	0	3	5	9	0	3	8	15					100'	400'
7/11	0.10	0.15	0.18	0.19	0.22	0.25	0.23	0.22	0.6	26.9	9,975	23	27.0	27.1
7/18	0.12	0.09	0.16	0.18	0.12	0.19	0.16	0.18	1.3	20.9	9,216	24	26.0	26.5
7/24	0.23	0.18	0.26	0.20	0.08	0.14	0.19	0.21	1.2	24.7	8.840	25	32.0	32.0
7/30	0.09	0.09	0.12	0.14	0.09	0.14	0.13	0.11	0.7	20.7	8.204	25	26.0	26.0
8/06	0.25	0.24	0.23	0.28	0.28	0.26	0.27	0.24	0.4	23.1	7.294	25	29.0	29.0
8/23	0.21	0.14	0.30	0.36	0.12	0.08	0.09	0.23	0.4	20.7	9.397	24	25.0	25.0
8/30	0.39	0.34	0.38	0.38	0.33	0.35	0.37	0.49	1.0	20.9	6.857	26	27.0	27.0
9/04	0.32	0.25	0.33	0.31	0.32	0.30	0.29	0.30	0.3	20.3	7.921	24	23.0	23.0
9/13	0.44	0.58	0.53	0.51	0.37	0.45	0.48	0.46	0.1	21.5	5.525	24	24.0	24.0
9/27	0.23	0.31	0.24	0.31	0.18	0.22	0.19	0.34	0.3	19.9	10,346	20	16.0	16.0
10/04	0.32	0.32	0.30	0.30	0.34	0.29	0.28	0.27	0.2	20.4	5,518	25	17.0	16.5
10/11	1.18	1.07	1.02	0.57	0.18	0.19	0.21	0.20	6.4	25.8	6,751	24	20.0	19.6
10/15	2.99	1.52	3.23	2.97	0.22	0.21	0.20	0.14	8.0	24.0	6,554	24	21.0	20.5
10/25	0.95	0.42	0.33	0.41	0.28	0.28	0.28	0.31	2.8	23.2	8,257	22	13.8	13.0
No.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)

Table 10. Summary of Results of River Ammonia-N Stepwise Regression Analyses at Station 160.01

(a.)

	Depth in Feet at 100' From Shore											
	0			3			5			9		
Parameter	Rank	R	SE	Rank	R	SE	Rank	R	SE	Rank	R	SE
GPSD NH_3-N	1	.911	0.330	1	.906	0.180	1	.857	0.431	1	.790	0.459
GPSD Flow	2	.923	0.322	5	.982	0.097	2	.872	0.427	2	.817	0.451
River Flow	3	.929	0.325	2	.945	0.146	4	.886	0.447	5	.857	0.471
GPSD Temp.	4	.934	0.329	3	.968	0.118	5	.910	0.425	4	.829	0.484
River Temp.	5	.940	0.335	4	.978	0.100	3	.881	0.434	3	.824	0.464

(b.)

	Depth in Feet at 400' From Shore											
	0			3			8			15		
GPSD NH_3-N	2	.717	0.075	2	.675	0.076	2	.723	0.075	1	.380	0.105
GPSD Flow	4	.826	0.067	5	.833	0.067	5	.859	0.065	5	.673	0.103
River Flow	1	.643	0.078	1	.571	0.081	1	.630	0.081	2	.549	0.099
GPSD Temp.	3	.816	0.065	3	.789	0.066	3	.788	0.070	3	.658	0.094
River Temp.	5	.828	0.070	4	.828	0.064	4	.847	0.064	4	.670	0.098

R = Multiple Correlation Coefficient
SE = Standard Error of Estimate

corresponding near shore values. River flow rate appears to be the single most influential factor down to mid-depth in the channel. At the bottom, the effluent ammonia concentration shows up first in the stepwise regression analyses sequence; however, the correlation is relatively low, thereby diminishing its singular importance.

The portion of the variability explained by a given parameter or combination of parameters can be ascertained by squaring the correlation coefficient. As an example, about 83 percent (0.911^2) of the variation in the near shore surface ammonia-N concentrations can be explained by the variability of the effluent ammonia-N levels. In contrast, the effluent ammonia-N level variability explains only about 62 percent (0.790^2) of the variability observed for the near shore bottom samples, and only about 73 percent (0.857) of the variation at this location is explained by all five independent variables. In the channel, the percentages for the analyses incorporating the five factors range from a low of 45 percent at the bottom to a high of 74 percent at the 8-foot depth.

Regression or empirical predictive equations were developed using the stepwise regression techniques. The equations are in the linear form:

$$Y = A + BX_1 + CX_2 + DX_3 + EX_4 + FX_5 \text{. . . . .} (2)$$

Table 11. Tabular Values of the Regression
Coefficients Derived for Equation 2
For the Near Shore Sampling Vertical
at the Outfall

	Regression Coefficients					
On Vertical	A	B	C	5	E	F
0	5.89	0.302	-0.0618	-0.00154	-0.166	0.0313
3	5.09	0.146	-0.0204	-0.00165	-0.160	0.0284
5	8.28	0.337	-0.1086	-0.00204	-0.253	0.0764
9	8.33	0.293	-0.1172	-0.00181	-0.249	0.0722

where Y = the ammonia-N concentration at a given point in the river; A, B, C, D, E, and F are regression coefficients; X_1 = the GPSO effluent ammonia-N concentration in mg/l; X_2 = the GPSD effluent flow rate in mgd; X_3 = the river flow rate in cfs; X_4 = the GPSD effluent temperature in °C; and X_5 = the river water temperature in °C. The coefficient values for the points on the near shore sampling vertical are presented in table 11. These coefficients can be used in conjunction with equation 2 to predict, with a high degree of accuracy, the expected ammonia-N concentration at points on a vertical approximately 100 feet out from the shore in the area of the effluent discharge. The coefficients derived for the centerline of channel vertical are not presented because of the relatively poor predictive quality of the results as evidenced by aforementioned high percentages of unexplained variability.

The ISWS Illinois River ammonia-N data extracted from long-term weekly sampling results and the corresponding GPSO effluent ammonia content for the years 1978 through 1983 are presented in Appendix D. The corresponding data for the first 9 months of 1984 are presented in table 12. A summary of the minimum, average, and maximum daily GPSO effluent ammonia-N concentrations and loads is given in Appendix E on a monthly basis for the period from January 1978 through November 1984. Temperature and pH values are included in table 12 and Appendix D since these parameters were used to establish allowable ammonia-N standards according to the criteria contained in paragraph e) of Section 302.212 of the IPCB's rules and regulations pertaining to water quality standards.

Table 13 presents the maximum ammonia-N concentrations observed in the river during the study at points at or below the outfall. Included are observed temperature and pH values which were used to obtain "standard" values.

Table 12, Summary of River and Greater Peoria Sanitary-District (GPSD) 1984 Ammonia-Nitrogen Conditions

	River Values							
Date	pH	Temp (°C)	NH_3-N (mg/l)	IEPA NH_3 -N standard for given pH & temp (mg/l)	River flow (cfs)	River NH_3-N loads (lbs/day)	GPSD NH_3-N loads (lbs/day)	GPSD Contribution to river (mg/l)
1/3/84	8.00	0.0	0.67	3.1	15,810	57,201	186	0.002
1/9	7.94	0.0	0.98	4.4	14,800	78,322	205	0.003
1/16	7.98	0.0	1.19	3.1	12,830	82,446	218	0.003
1/23	7.90	0.0	1.34	4.4	10,840	78,438	254	0.004
1/30	7.86	0.0	1.76	4.4	9,835	93,472	229	0.004
2/6	7.86	0.0	1.87	4.4	9,440	95,325	188	0.004
2/13	7.91	0.5	1.53	4.4	11,440	94,517	401	0.007
2/20	7.78	2.5	0.06	5.7	54,330	17,603	270	0.001
2/27	7.90	5.0	0.53	4.4	45,770	130,994	198	0.001
3/5	8.17	2.9	0.41	2.5	30,565	67,671	311	0.002
3/12	8.21	0.1	0.54	2.5	23,230	67,739	218	0.002
3/19	7.89	2.5	1.01	4.4	32,230	175,782	384	0.002
3/26	7.98	4.0	0.43	3.1	52,370	121,603	499	0.002
4/2	7.95	7.0	0.34	2.7	47,760	87,687	204	0.001
4/9	8.16	8.5	0.28	2.0	40,780	61,659	277	0.001
4/16	8.25	10.5	0.31	1.7	33,310	55,761	226	0.001
4/23	8.14	9.2	0.57	2.1	30,710	94,525	607	0.004
4/30	8.09	14.0	0.26	1.6	34,850	48,929	270	0.001
5/8	8.00	15.0	0.21	1.5	35,530	38,023	249	0.001
5/14	8.23	17.5	0.13	1.5	24,490	17,192	110	0.001
5/21	8.60	21.5	0.08	1.5	12,000	5,184	341	0.005
5/29	8.00	16.0	0.42	1.5	43,530	98,726	420	0.002
6/4	8.10	20.0	0.21	1.5	40,500	45,927	212	0.001
6/11	8.15	24.4	0.11	1.5	30,620	18,188	140	0.001
6/18	8.29	26.6	0.08	1.5	23,470	10,139	108	0.001
6/25	7.92	26.0	0.16	1.6	20,845	18,010	102	0.001
7/2	8.09	24.9	0.08	1.5	11,380	4,916	114	0.002
7/9	8.19	24.0	0.08	1.5	8,920	3,853	76	0.002
7/16	8.54	27.9	0.07	1.5	9,770	3,693	191	0.004
7/23	8.39	28.5	0.12	1.5	8,835	5,725	212	0.005
7/30	8.48	25.8	0.06	1.5	8,425	2,730	121	0.003
8/6	8.20	28.9	0.17	1.5	7,545	6,926	77	0.002
8/13	8.15	27.0	0.20	1.5	8,286	8,949	89	0.002
8/20	8.05	25.5	0.27	1.5	8,340	12,160	137	0.003
8/27	8.00	24.1	0.11	1.5	7,035	4,179	151	0.004
9/4	8.06	22.5	0.23	1.5	7,810	9,700	51	0.001
9/10	8.09	21.0	0.35	1.5	7,590	14,345	190	0.005
9/17	8.05	18.1	0.36	1.5	4,790	9,312	48	0.002
9/24	8.01	22.0	0.10	1.5	6,875	3,713	54	0.002

Table 13. Maximum Ammonia-N Concentrations
Observed at or below the GPSD Outfall
Compared to IEPA Standards

Date	River Mile	Distance from Shore (ft)	Depth (ft)	Temp. (°C)	pH	Maximum Observed Conc. (mg/l)	IEPA Standard For Given Temp. & pH
7/11/84	158.01	100	0	27.0	8.35	0.32	1.5
7/18	160.01	100	5.0	26.0	8.70	0.16	1.5
7/24	158.01	400	9.5	29.5	8.50	0.31	1.5
7/30	158.01	400	9.5	25.5	8.40	0.18	1.5
8/06	158.01	400	9.5	28.5	8.00	0.31	1.5
8/13	160.01	100	5.0	27.0	8.25	0.33	1.5
8/20	158.01	100	0	26.0	8.10	0.37	1.5
8/23	160.01	400	3.0	25.5	8.05	0.40	1.5
8/30	160.01	400	15.0	27.0	7.95	0.49	1.6
9/04	160.01	100	5.0	23.0	8.20	0.33	1.5
9/13	160.01	100	3.0	24.0	7.90	0.58	1.6
9/27	160.01	400	15.0	16.0	8.40	0.34	1.5
10/04	158.01	100	12	17.0	8.05	0.40	1.5
10/11	160.01	100	0	20.0	7.55	1.18	2.9
10/15	160.01	100	5.0	21.0	7.75	3.23	2.2
10/25	160.01	100	0	14.5	8.00	0.95	1.5

Dye Mixing and Dispersion

Ten mixing zone and dispersion runs were completed. The dates of the runs and the conditions under which they were conducted are summarized in table 14. All the runs produced good useable data. Two runs at an effluent discharge rate of 30 mgd were made: one on July 19 and the other on October 23. River flow and stage were almost identical on these two dates; however, water temperatures were significantly different, and the dam operating mode was slightly different.

Appendix F contains surface dye percentage values for all ten dates. The specific dye concentration at points in the river can be obtained by multiplying the percentage figures given in Appendix F by the appropriate discharge concentrations given in table 3. For instance, the July 12 river dye concentration 75 feet out on the surface at station 2+00 corrected to 29°C was 13.7 ug/l C98.2 x 14.0/100) while downstream, out 50 feet at station 104+00, it was only 0.9 ug/l (98.2 x 0.9/100). The percentage values are useful in estimating the diluted value of any given point in the outfall area or downstream of the outfall.

A better overall perspective of the generalized results is displayed by the iso-dye or "contour" plots of the percentages which are presented as figures 16 through 55. These plots are for surface and 1-, 3-, and 8-foot depths in

Table 14. Mixing Zone and Dispersion Run Dates and Physical Conditions That Existed on Those Dates

Date	Discilarge		Pool Stage (msl)	Dam Operation			Temperature (°C)				Wind		Air Temp. (°C)	
	GPSD (mgd)	River (cfs)		Wickets Down	Valves Open	Needles In	GPSD Begin	GPSD End	River Begin	River End	Speed (mph)	Direction	Begin	End
7/12/84	37	10,156	440.48	0	6	0	-	24.0	27.0	29.5	10	W, SW	26	28
7/19	30	8,661	440.22	0	6	0	-	24.0	26.5	29.5	6	S, SW	26	28
7/31	25	7,820	440.12	0	6	0	24.0	25.0	27.0	30.5	1	SE, SW	24	31
8/07	20	7,106	439.98	0	0	0	26.1	28.0	30.5	31.0	5	S, SW	29	33
8/14	40	8,394	440.38	0	6	0	24.5	25.5	28.0	29.5	3	S, SW	31	31
8/21	35	7,848	439.68	0	6	0	24.1	25.0	25.5	26.0	6	S, SW	24	28
8/28	45	6,088	439.47	0	0	51	24.1	26.1	25.7	25.8	5	S, SE	28	33
9/11	55	7,572	440.41	0	0	0	23.0	24.0	22.5	24.5	3	S, SE	20	27
9/18	50	5,224	440.56	0	0	63	22.0	22.5	20.0	21.0	7	SE, SW	17	22
10/23	30	8,837	440.43	6	6	40	19.8	21.0	15.0	15.0	3	N, NE	11	16

the outfall area and downstream to station 12+00 for all ten dye runs. Figures 56 through 61 exhibit dye distributions throughout the study reach for the surface and 3- and 8-foot depths. Figures 16 through 55 are plotted to a scale double that of figures 56 through 61 to show more detail since basically they represent the mixing zone conditions. Figures 56 through 61 represent both the mixing zone area and downstream dispersion for August 21 and September 11. The GPSD effluent discharge on August 21 was 35 mgd, approximately equal to the 37-mgd design average flow of the plant, and the September 11 discharge was 55 mgd, approximately equal to the greatest hydraulic load the plant is capable of handling without bypassing some flow around the secondary treatment units. River flow and other physical factors were essentially equal on both dates except for the fact that during the 35-mgd run six butterfly valves were open and the pool level was drawn down below the 440.0-foot flat pool elevation.

Plots of iso-dye contours were also developed on a transect basis at two locations. Figures 62 through 71 show these plots at station 12+00, while figures 72 through 81 show them at station 104+00. Useful information can be gleaned from these plots, particularly regarding transverse and vertical dispersion and mixing. Figures 62 through 66 reveal that sampling was not extended sufficiently in a transverse direction during the first five runs to "catch" the outer extension of the dye plume. This fact became evident early in the study after the results of a given run were examined. Compensations in sampling locations were made to include the total plume in the succeeding runs, as is evidenced by the continous shift outward of the plots. However, changing river hydraulic conditions and GPSD effluent discharge rates stymied this effort somewhat. An ongoing game of catch-up developed. The total plume was not captured until the sixth run. Note, though, that the dispersion patterns for all runs were virtually dissimilar and that the plume for the first run on July 12 would probably never have extended as far out as any of the successive ones. Generally, sampling results were adequate to satisfactorily describe the dye distribution patterns at station 104+00. Complete or nearly complete mixing was evident at 104+00 on a few dates; the August 14 results particularly exhibited relatively complete mixing (see figure 76).

The maximum dye percentages observed on each transect sampled during each run are presented in Appendix G. The points are located by station, transverse distance from shore, and depth. These tabulations can be useful in quickly determining possible maximum effluent residual waste parameter concentrations in the river at many points in the mixing area or downstream. For example, on July 12 the percentage dye residual at station 108+00 was 1.4 in 7 to 9 feet of water 100 feet from shore. If the GPSD had been discharging 20 mg/l of ammonia on this date, this would have resulted in an effluent residual effect of only 0.03 mg/l.

DO-BOD Model Simulations

The State Water Survey's DO-BOD model was used to investigate and evaluate the effects of GPSD effluent ammonia-N loads on downstream LaGrange pool DO resources. Simulations were run for four river flow regimes. One was for 7-day, 10-year low flow conditions, a somewhat artificial or contrived situation. The other three analyses were made using more realistic observed river hydrologic and hydraulic conditions. Data from a 1982 ISWS study of the water quality conditions of the upper Illinois Waterway were used to evaluate the effects of GPSD effluent ammonia-N loads on river dissolved oxygen concentrations during intermediate river discharges. Evaluations were made for flows between the very low 7-day, 10-year low flow and the 1982 intermediate flow using information extracted from a report by Butts et al. (1981) in which water quality of the LaGrange pool was assessed. Two dates were selected: one from a period in which the pool flow was constantly low throughout, and the other from a period in which the pool flow varied from low to high in a downstream direction. DO standard violations were observed during the former but not during the latter situation. The conditions under which the model runs were performed are summarized in table 15.

The BOD and DO values specified at Peoria for the 7-day, 10-year low flow and the intermediate flow conditions are upstream residuals from Chicago and point sources between Lockport and Peoria. The information used to derive the 7-day, 10-year values is the same as that used by Butts et al. (1983) in their report on Lake Michigan diversion effects on

Table 15. BOD-DO Model Simulation Input Criteria and River Hydraulic and Hydrologic Conditions

Generalized River Flow Conditions	Illinois River Flow (cfs)		Travel Time (days)		Ultimate BOD At Peoria (lb/day)		DO Below Peoria Dam (mg/l)
	Peoria	LaGrange	Lockport-Peoria	Peoria-LaGrange	Carb.	Nit.	
Very Low (7-day, 10-yr)	3,088	3,479	24.638	9.878	27,968	21,873	7.25
Low (7/24/79)	6,151	10,026	-	4.687	151,200	146,540	6.50
Low to High (6/26/79)	6,327	15,220	-	4.210	146,982	155,849	7.90
Intermediate (8/30/82)	8,812	11,341	11.859	3.644	183,996	266,438	8.05

Illinois Waterway DO resources. The loads from Chicago for intermediate conditions were derived from actual long-term BOD measurements performed on samples collected in the Chicago Sanitary and Ship Channel at Lockport on September 30, 1982. Point sources between Lockport and Peoria are those identified by Butts et al. (1983).

The BOD and DO values specified at Peoria for the low and low to high flow conditions are actual measured values taken during stream sampling by Butts et al. (1981) on July 24, 1979 and June 26, 1979, respectively. Dissolved oxygen and temperature profiles of the LaGrange pool were also taken on these two dates and this information was used to verify the modeling procedure.

The objective of the modeling procedures was to determine the maximum ammonia-N loads which could be discharged from the GPSD treatment facilities, in combination with ambient river loads, without depressing DO levels in the LaGrange pool below the minimum standards. A direct modeling solution is not available for making this determination, so an iterative process must be employed. Incremental increases in GPSD ammonia-N loads were superimposed upon the ambient river nitrogenous BOD loads presented in table 15, and model runs were made to determine the effects on pool DO concentrations. The final results for the four different river conditions are summarized in table 16. The GPSD nitrogenous BOD load additions presented in table 16 were converted to equivalent ammonia-N concentrations for three effluent and three river discharge rates (see table 17). Note that a GPSD effluent ammonia-N concentration of 172.6 mg/l in a 20-mgd discharge rate would add 131,594 lbs/day of ultimate nitrogenous BOD but would increase the river ammonia concentration level by only 0.59 mg/l for a discharge of 9000 cfs.

Figure 82 shows the June 26, 1979 observed DO sag curve, a curve simulated using BOD loads derived from water samples collected on June 26, 1979 at the head end of the pool, and a

Table 16. Results of BOD-DO Model Runs

Generalized River Flow Conditions	Ultimate GPSD NBOD Load Addition (lb/day)	Minimum Pool DO mg/l For Ambient Conditions	Minimum Pool DO mg/l For GPSD Load Additions
7-day, 10-yr low	20,963		5.88
	31,444	-	5.77
	62,888	-	5.58
	94,332	-	5.33
	125,776	-	5.07
Low (7/24/79)	0	4.77	4.81
	33,716	4.77	4.72
Low to High (6/26/79)	131,594	5.89	5.33
Intermediate (8/30/82)	62,888	-	6.08
	125,776	-	5.86

Table 17. GPSD Effluent Ammonia-N Concentrations (mg/l)
For Table 16 Loads and Various Discharge Rates

Ultimate GPSD NBOD Load (lb/day)	Equivalent Ammonia-N Concentrations (mg/l) in GPSD Discharges (mgd) of 20	40	60	River Flows (cfs) of 3000	6000	9000
20,963	27.5	13.8	9.2	0.28	0.14	0.09
31,444	41.3	20.6	13.8	0.39	0.20	0.13
33,716	44.2	22.1	14.7	0.46	0.23	0.15
62,888	82.5	41.3	27.5	0.85	0.43	0.28
94,332	123.8	61.9	41.3	1.28	0.63	0.43
125,776	165.0	82.5	55.0	1.70	0.85	0.57
131,594	172.6	86.3	57.5	1.78	0.89	0.59

simulated curve showing what effects a sizeable increase in GPSD nitrogenous BOO (NBOD) loading would have on ambient conditions as they existed on that date. Even a cursory examination of the plots reveals that the very sizeable increase in GPSD ammonia discharge loading had minimal effects on the DO resources throughout the pool. Increasing the NBOD at river mile 157.6 by over 125,000 lbs/day (an 81 percent increase over ambient) did not lower the predicted DO sag concentration below the minimum 5.0 mg/l standard.

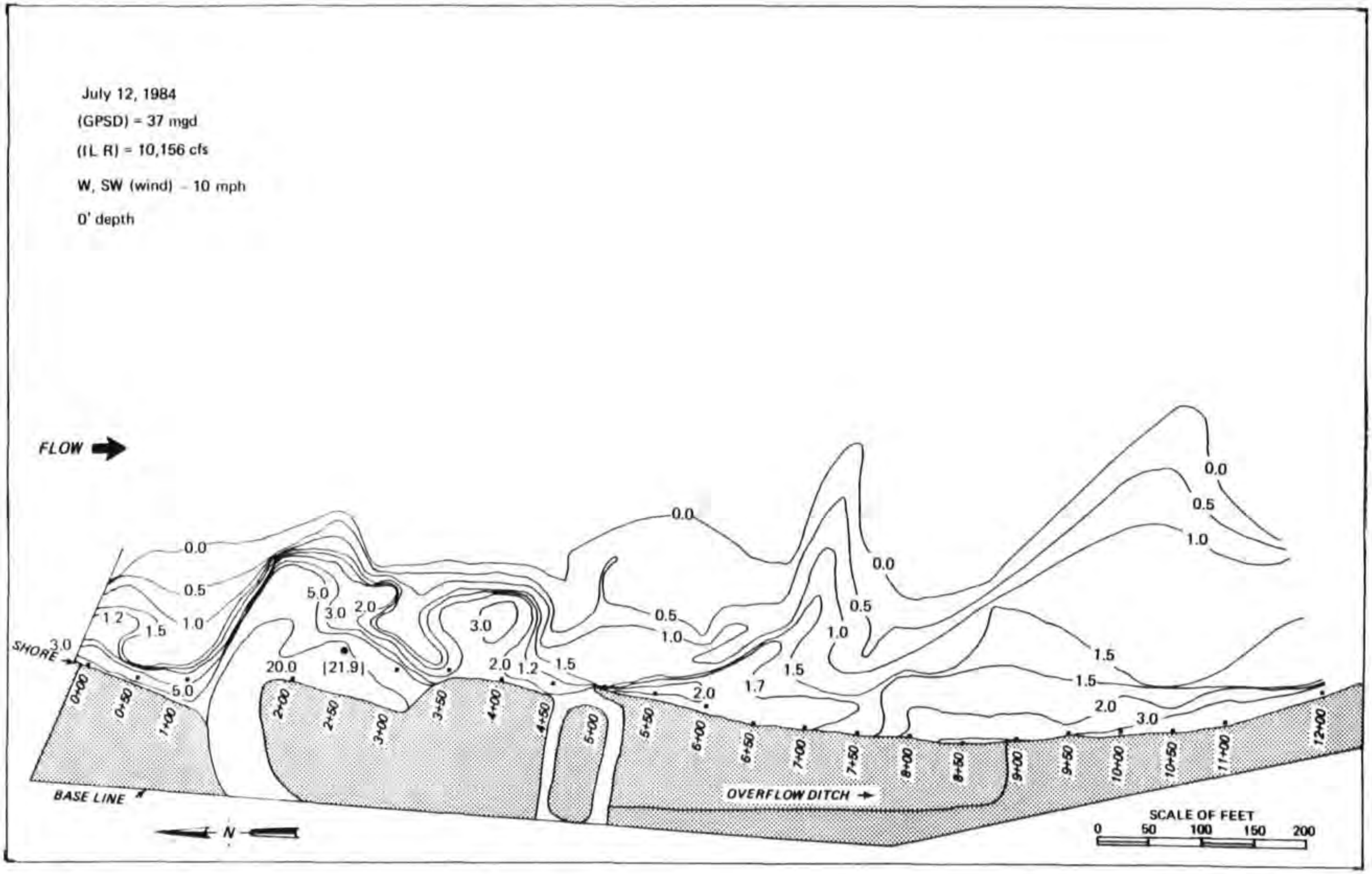


Figure 16. Surface percents of effluent dye concentration in mixing zone area, July 12, 1984

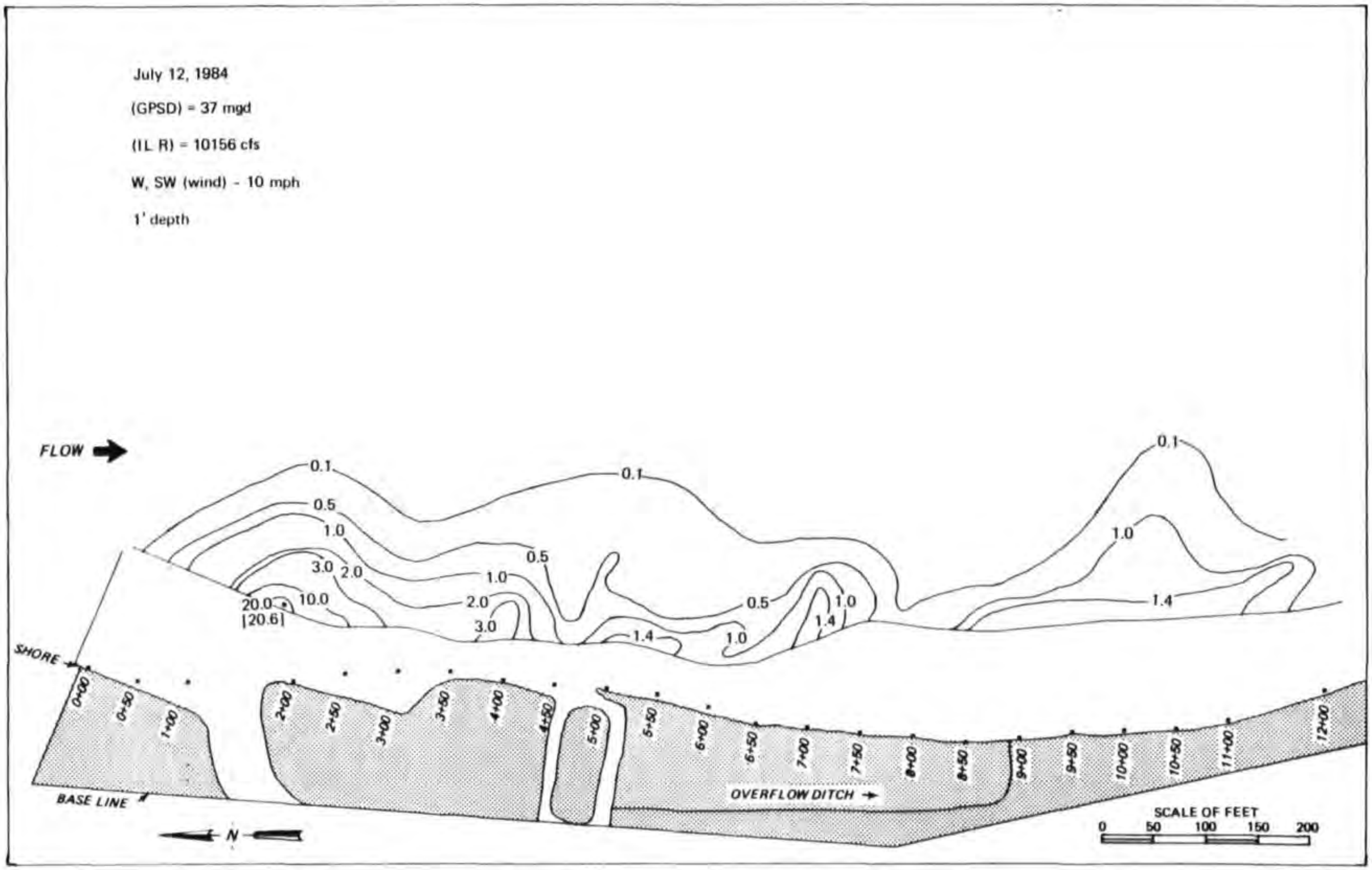


Figure 17. 1' depth, percents of effluent dye concentration in mixing zone area, July 12, 1984

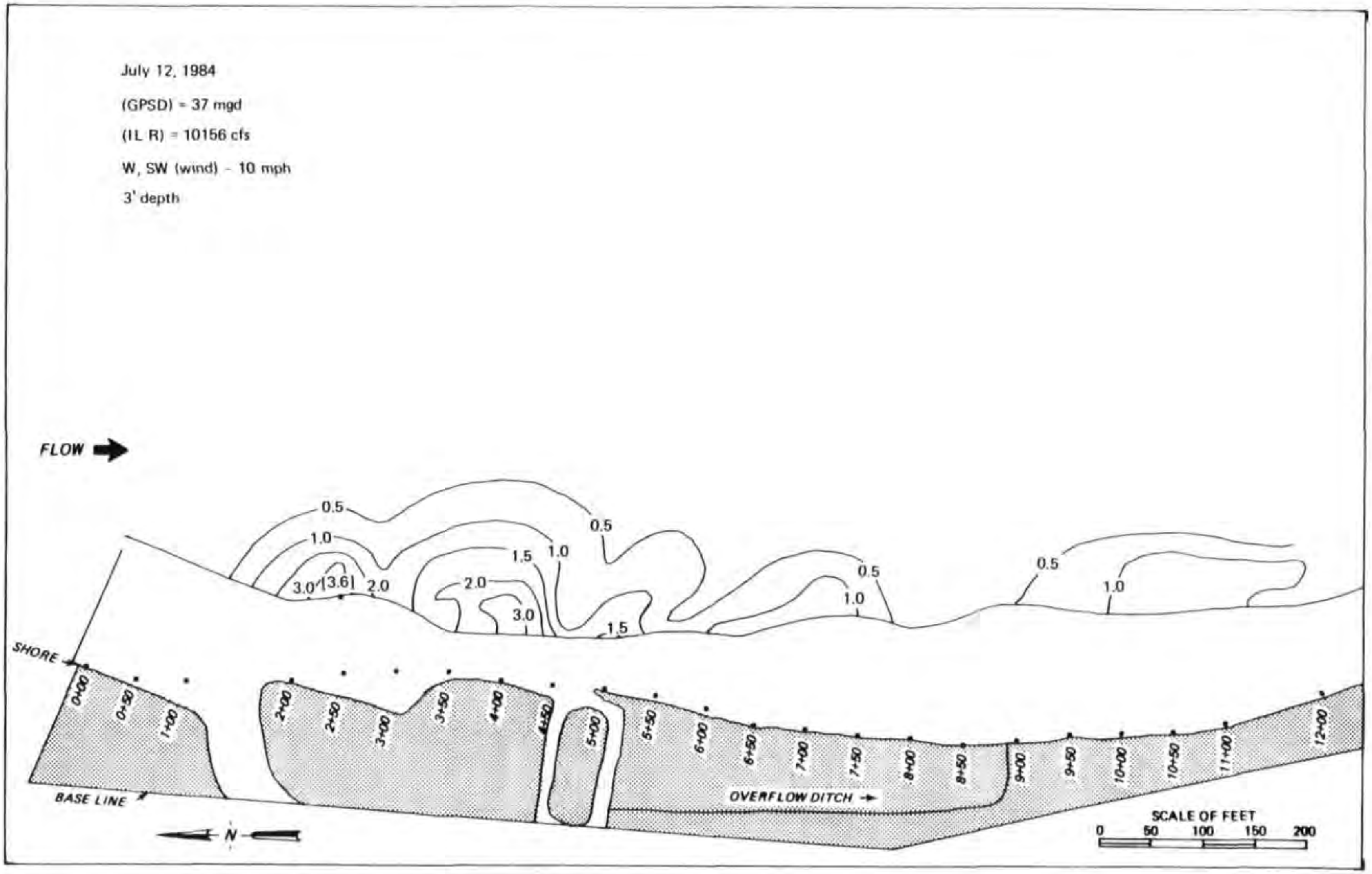


Figure 18. 3' depth, percents of effluent dye concentration in mixing zone area, July 12, 1984

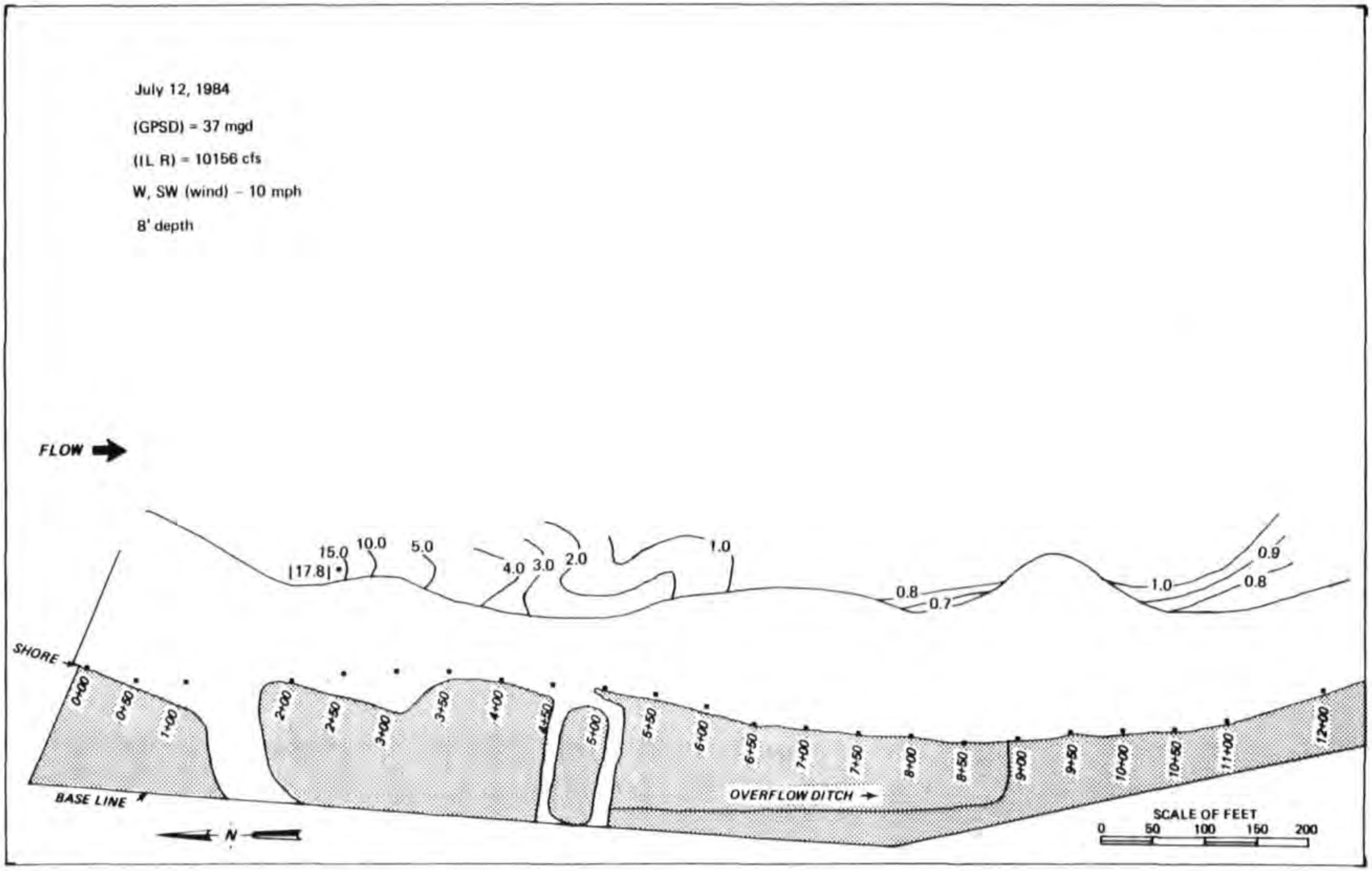


Figure 19. 8' depth, percents of effluent dye concentration in mixing zone area, July 12, 1984

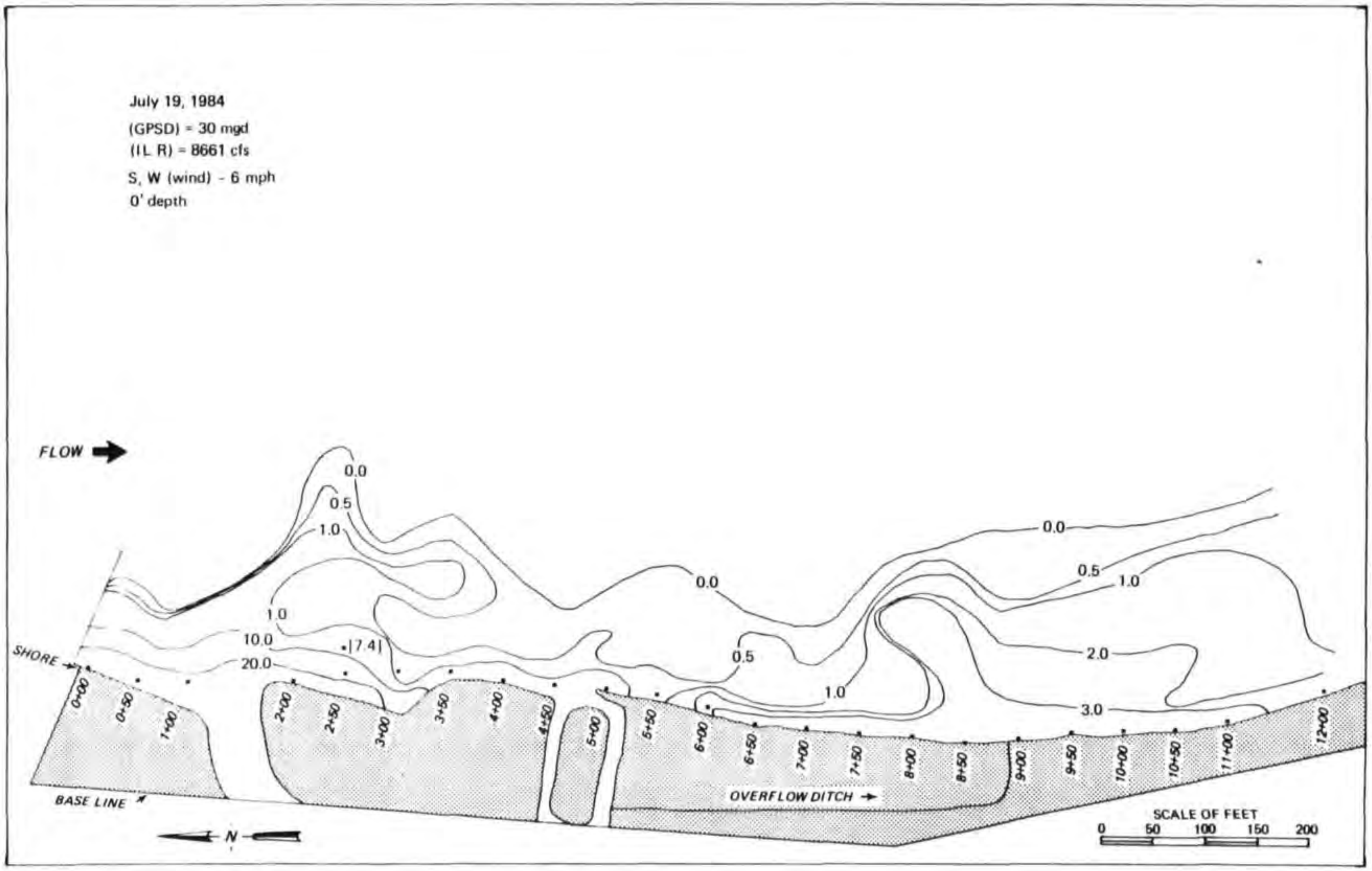


Figure 20. Surface percents of effluent dye concentration in mixing zone area, July 19, 1984

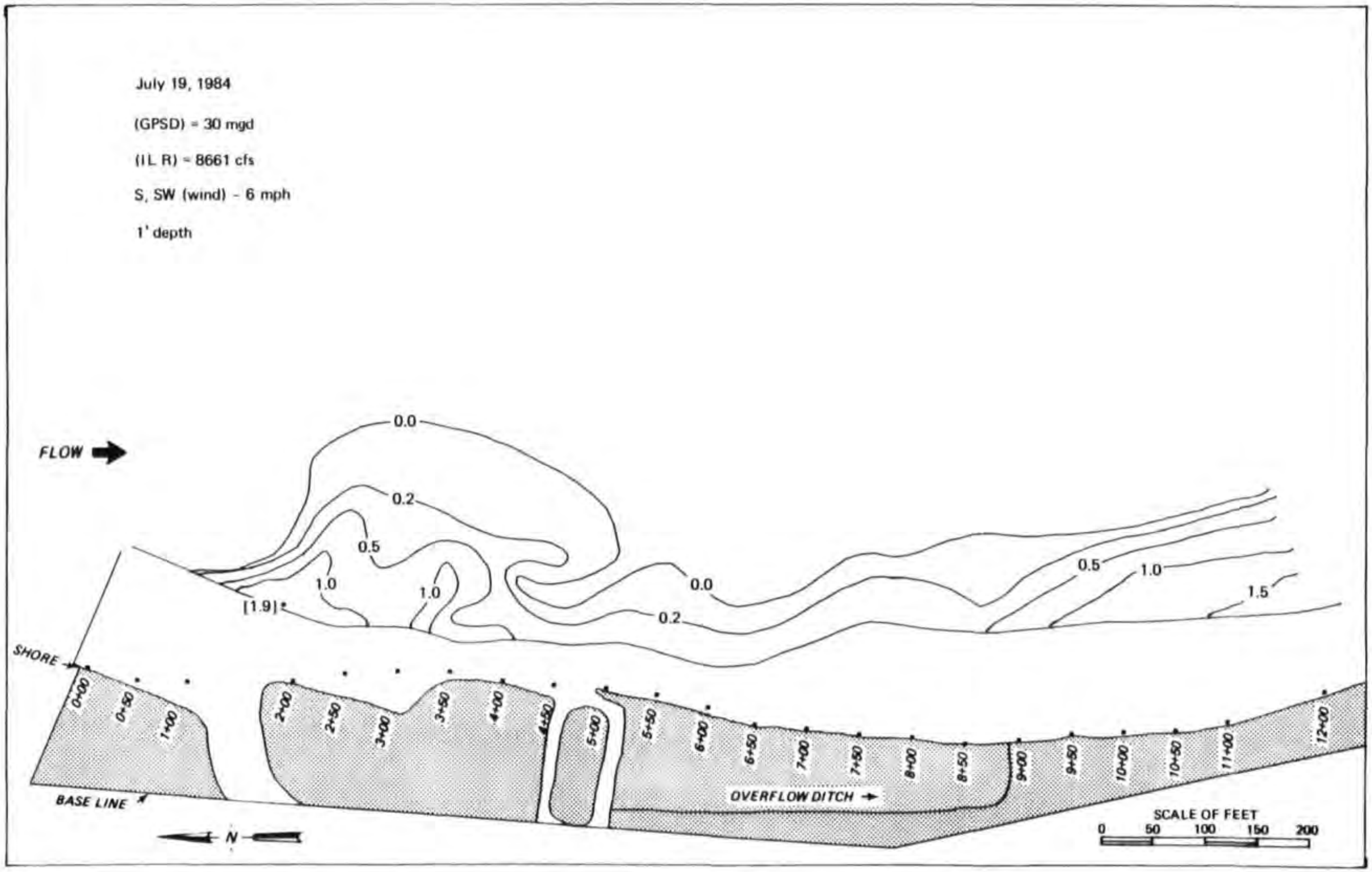


Figure 21. 1' depth, percents of effluent dye concentration in mixing zone area, July 19, 1984

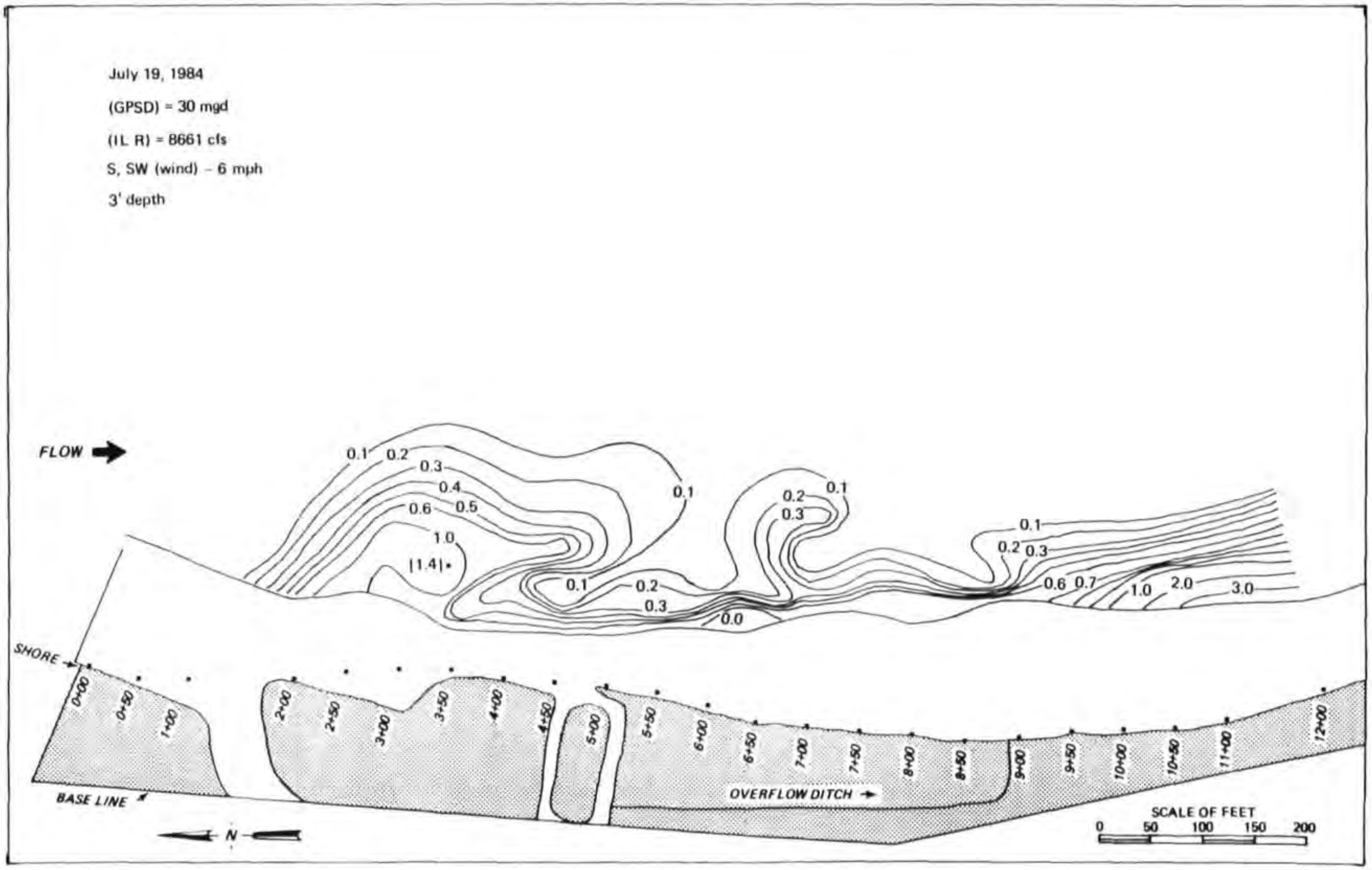


Figure 22. 3' depth, percents of effluent dye concentration in mixing zone area, July 19, 1984

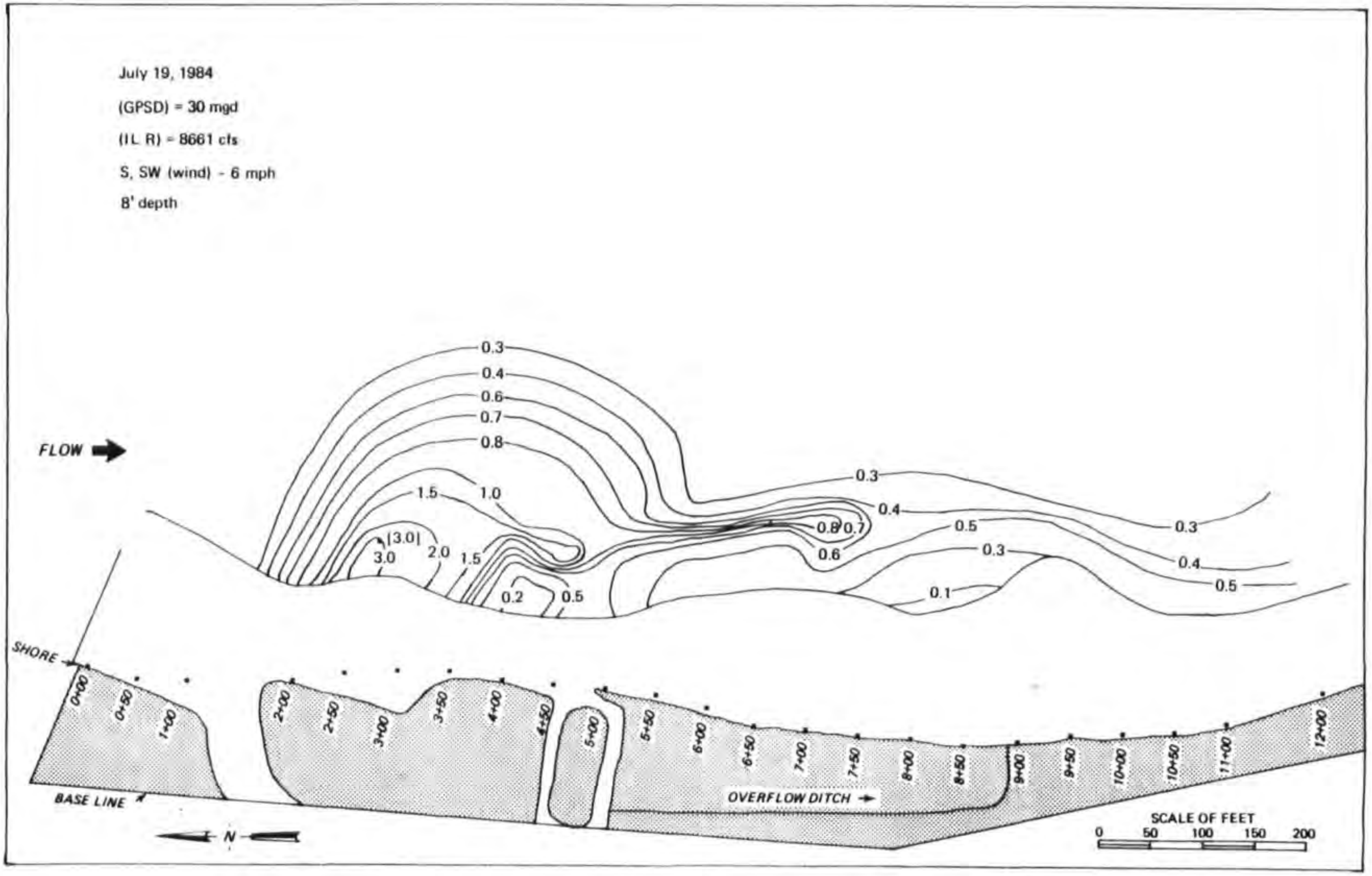


Figure 23. 8' depth, percents of effluent dye concentration in mixing zone area, July 19, 1984

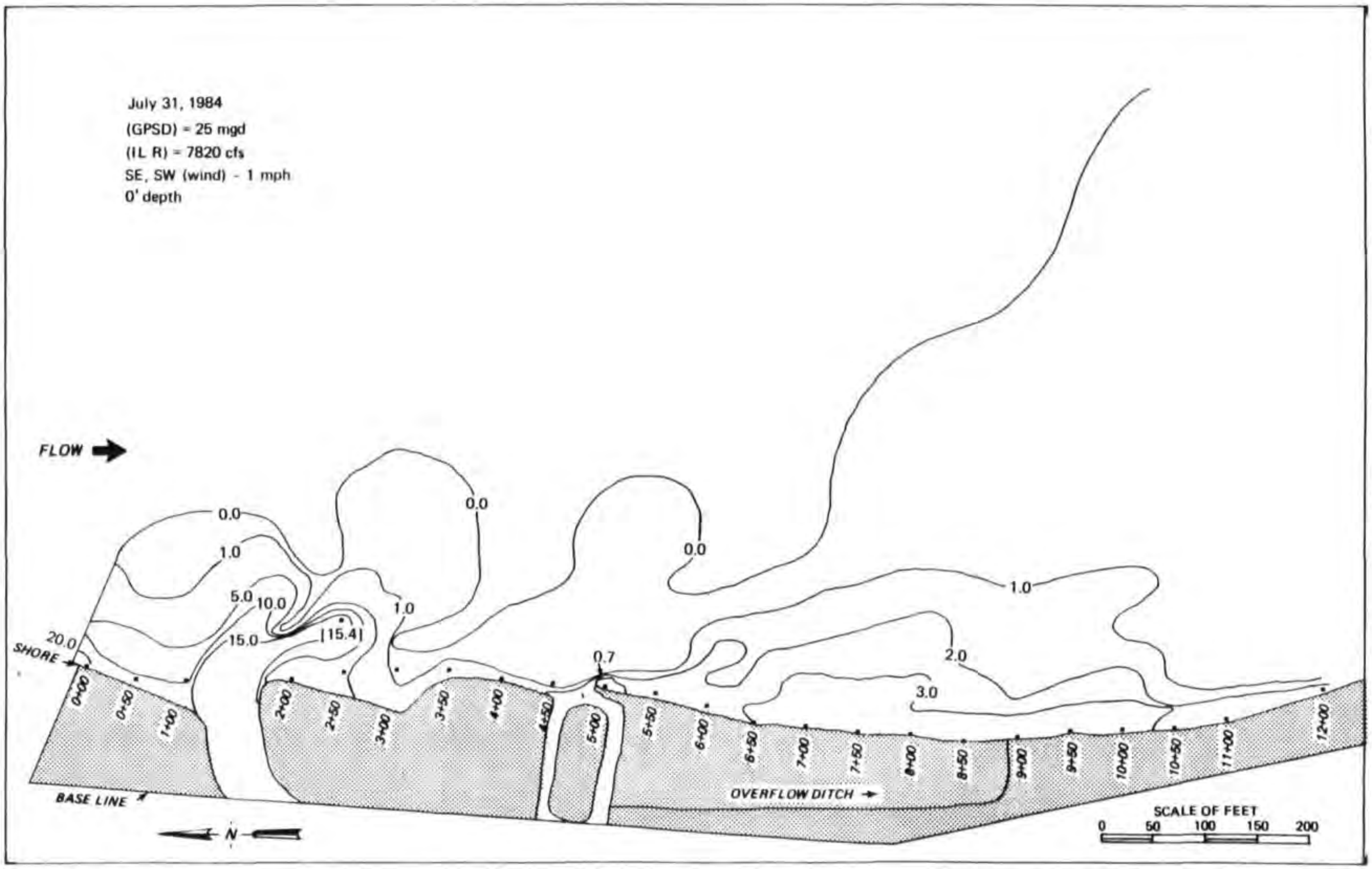


Figure 24. Surface pereents of effluent dye concentration in mixing zone area, July 31, 1984

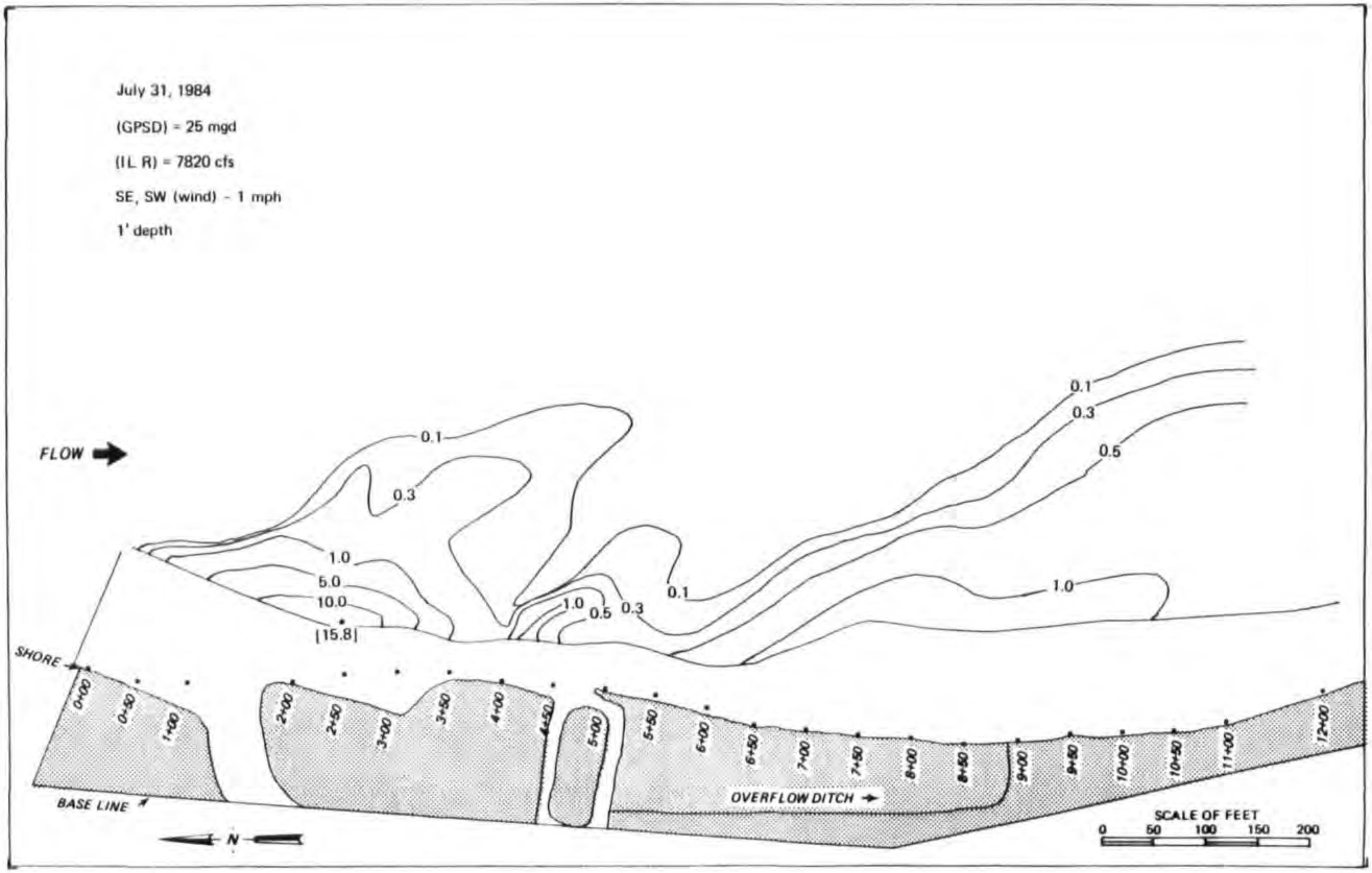


Figure 25. 1' depth, percents of effluent dye concentration in mixing zone area, July 31, 1984

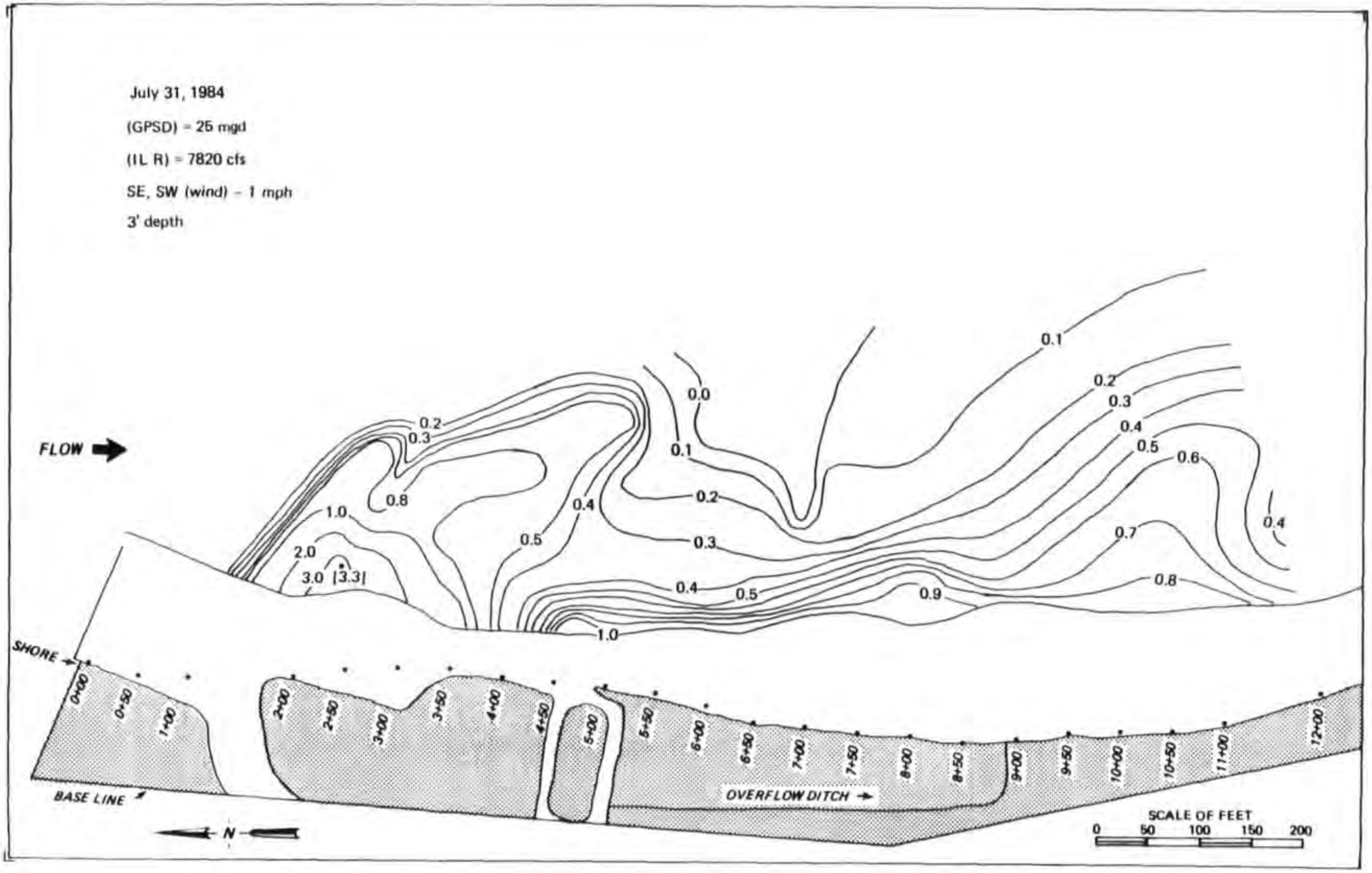


Figure 26. 3' depth, percents of effluent dye concentration in mixing zone area, July 31, 1984

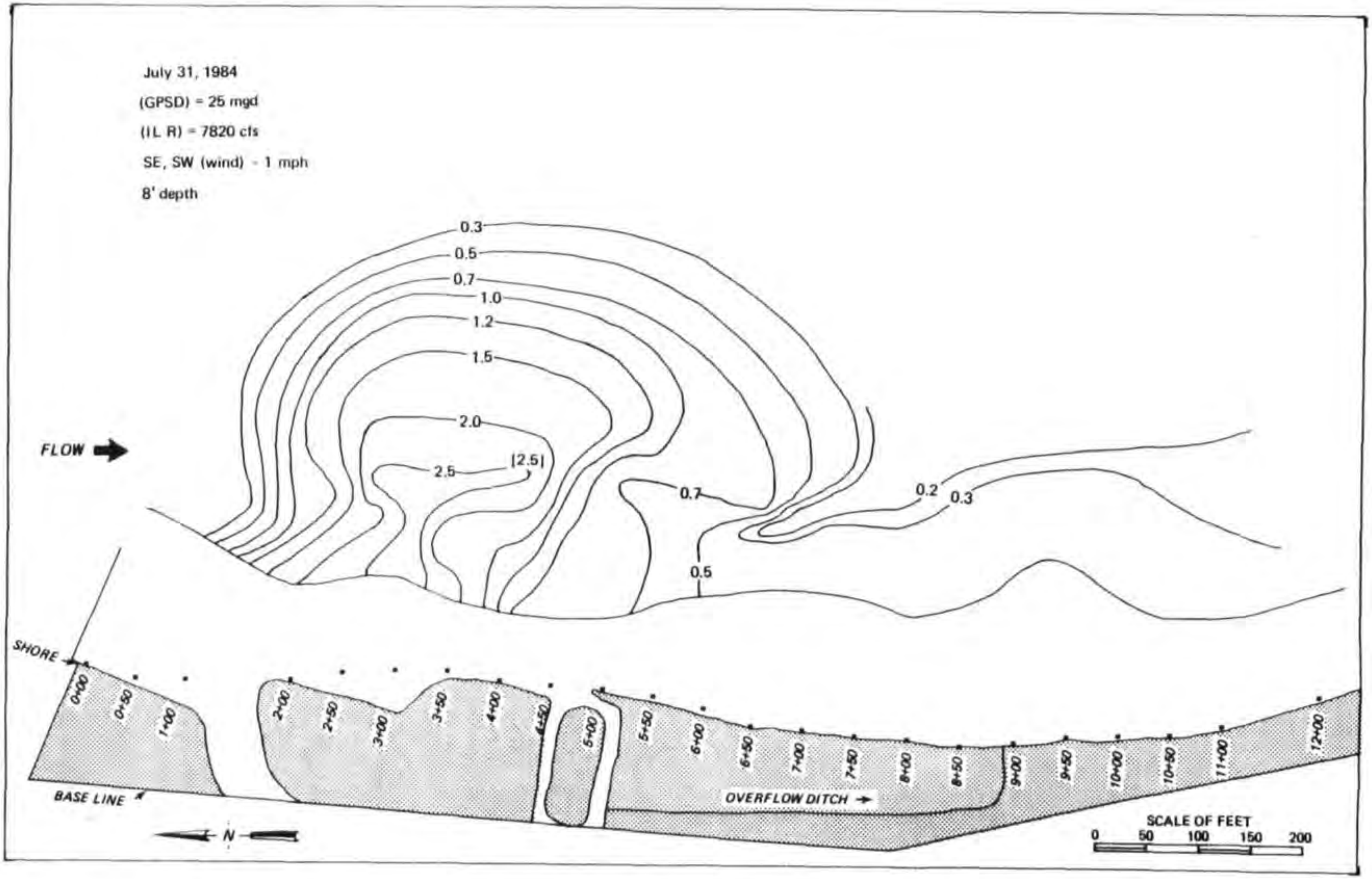


Figure 27. 8' depth, percents of effluent dye concentration in mixing zone area, July 31, 1984

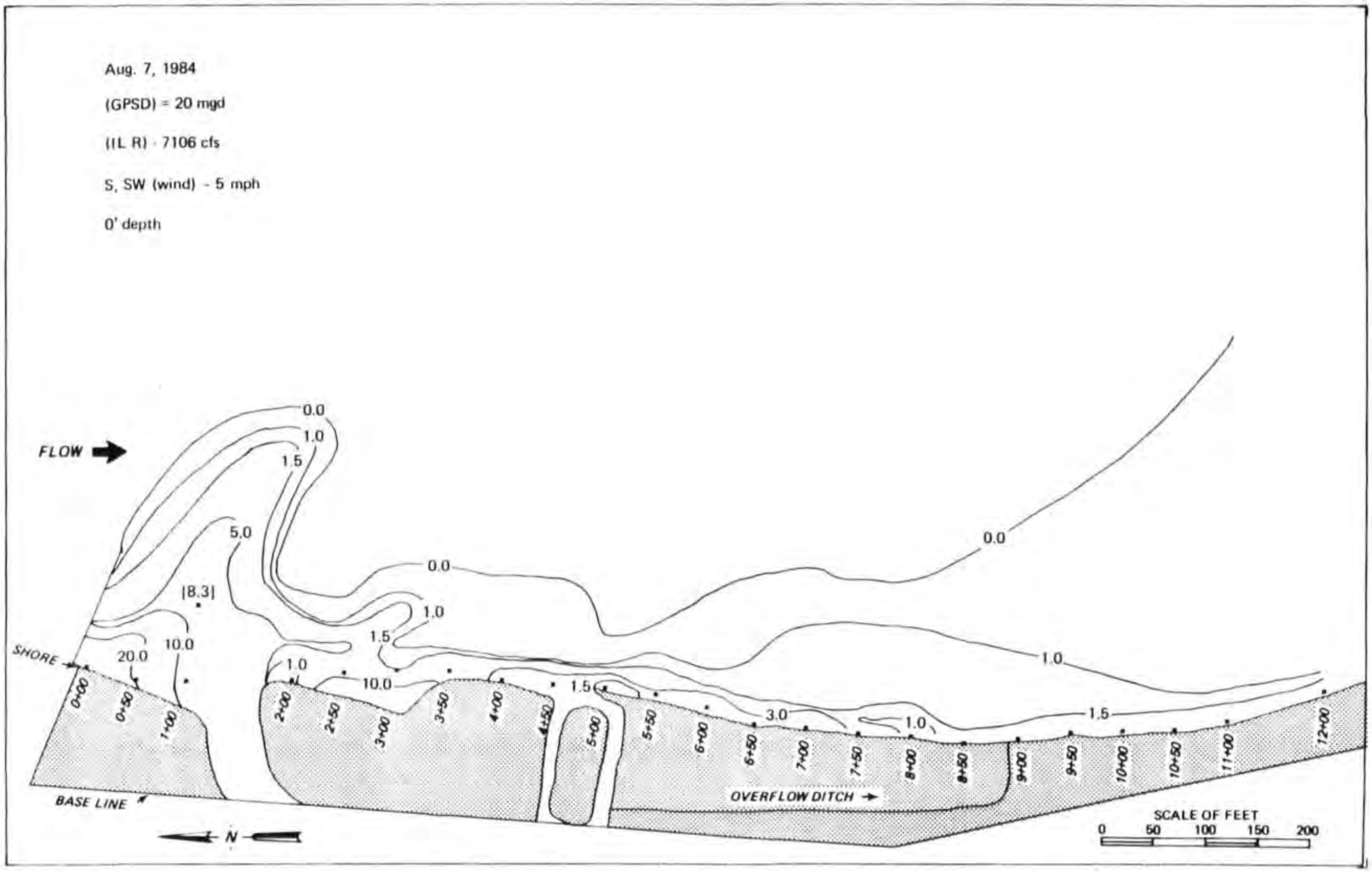


Figure 28. Surface percents of effluent dye concentration in mixing zone area, August 7, 1984

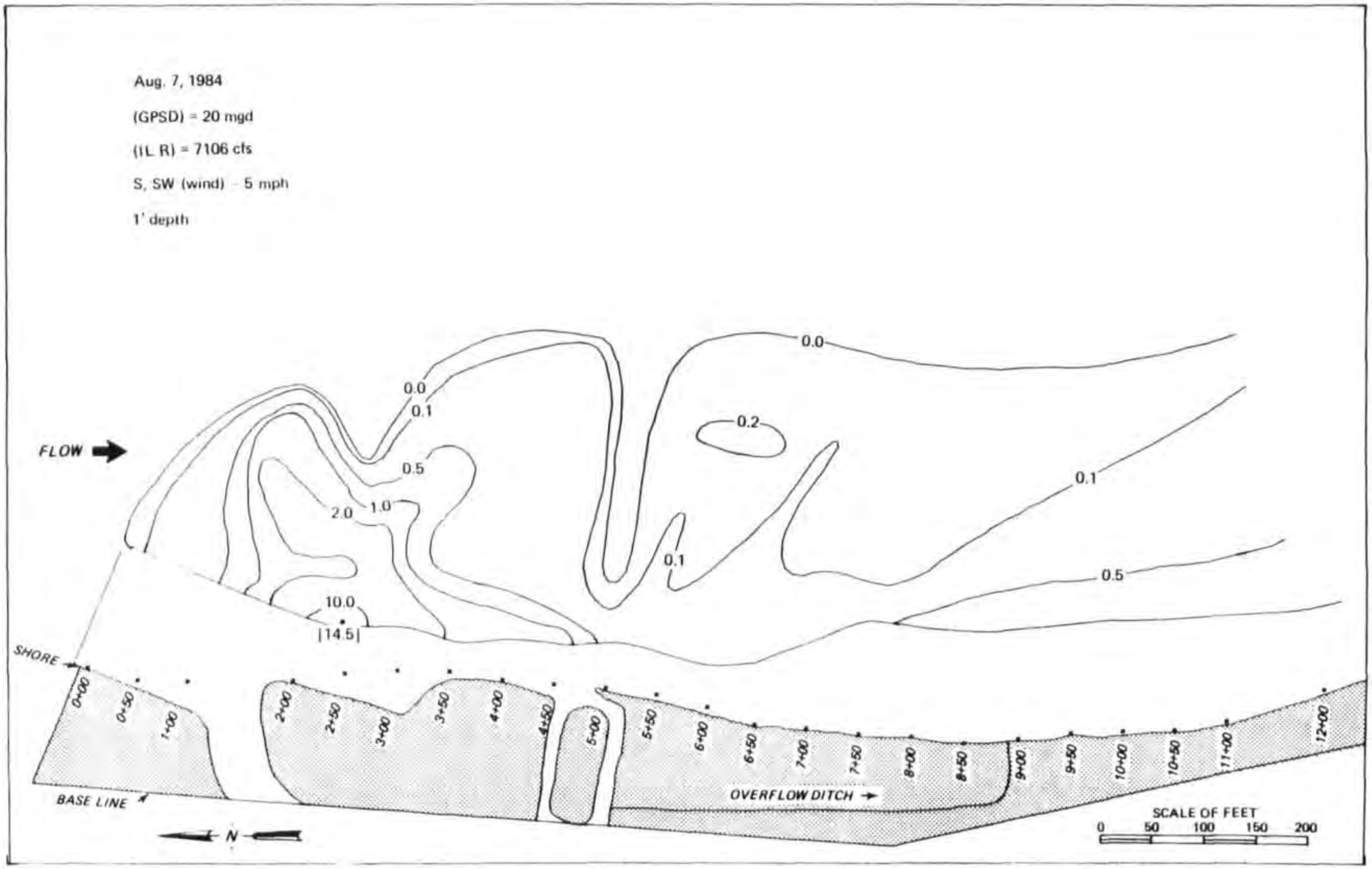


Figure 29. 1' depth, percents of effluent dye concentration in mixing zone area, August 7, 1984

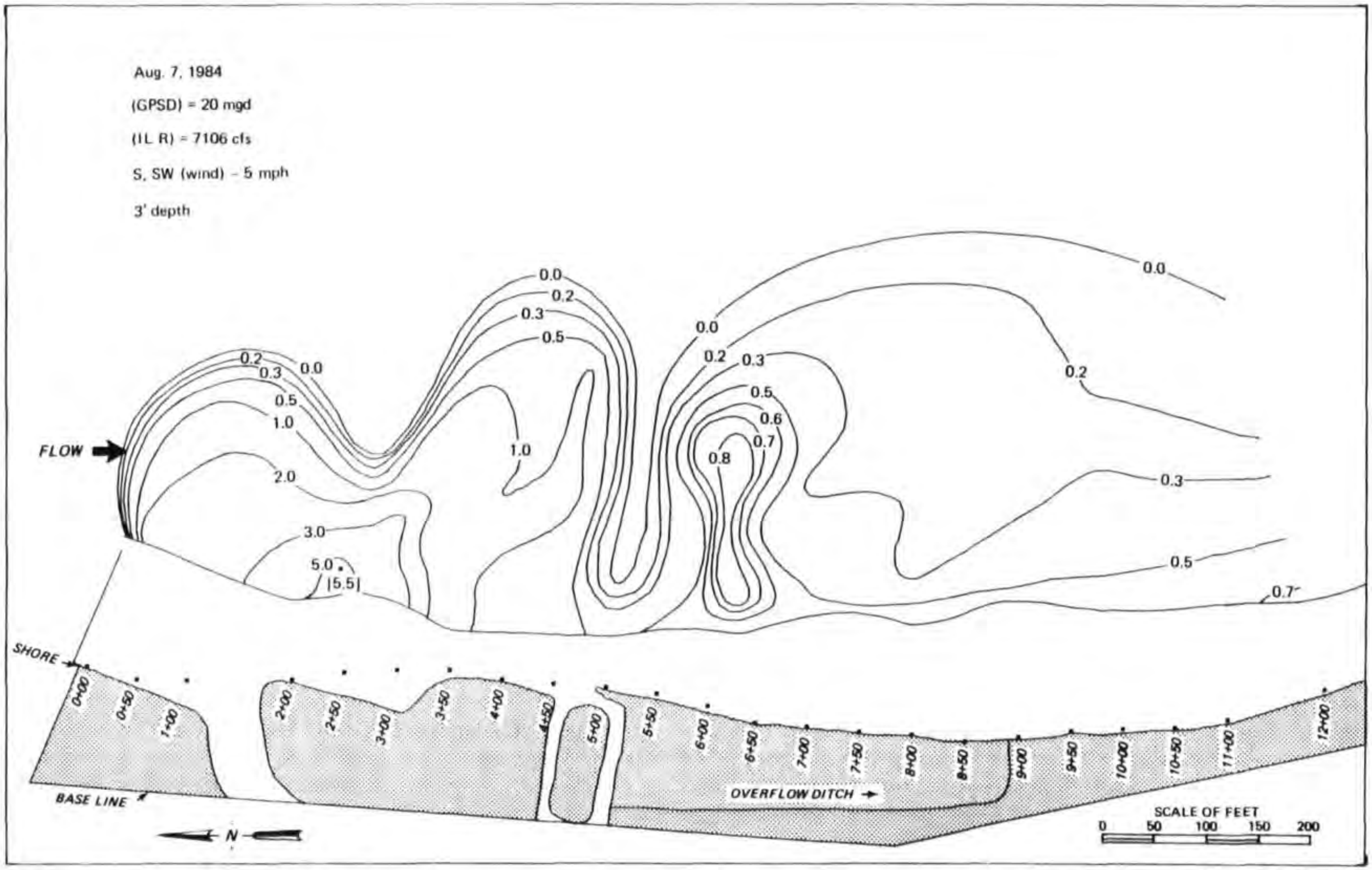


Figure 30. 3' depth, peroents of effluent dye concentration in mixing zone area, August 7, 1984

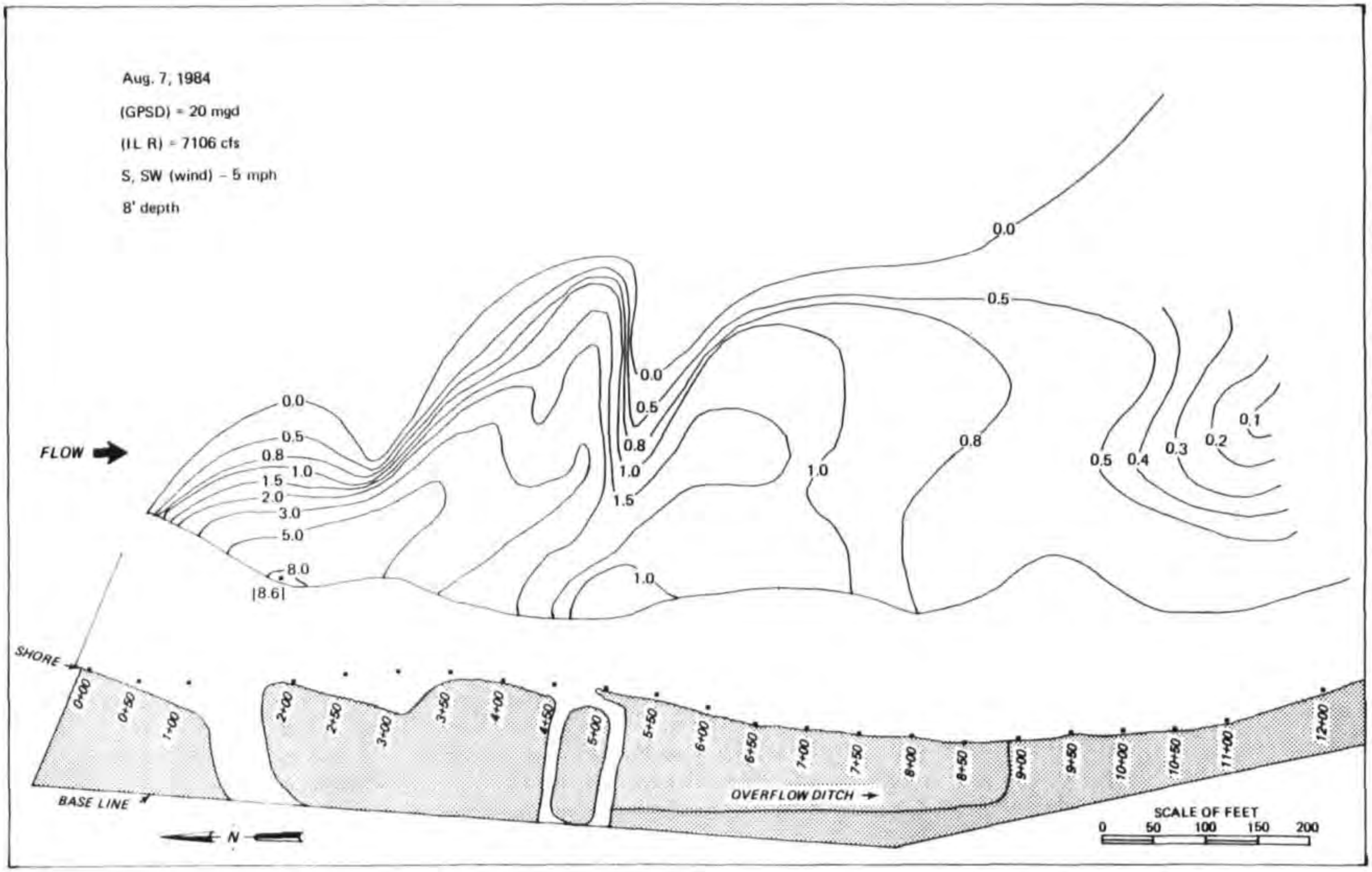


Figure 31. 8' depth, percents of effluent dye concentration in mixing zone area, August 7, 1984

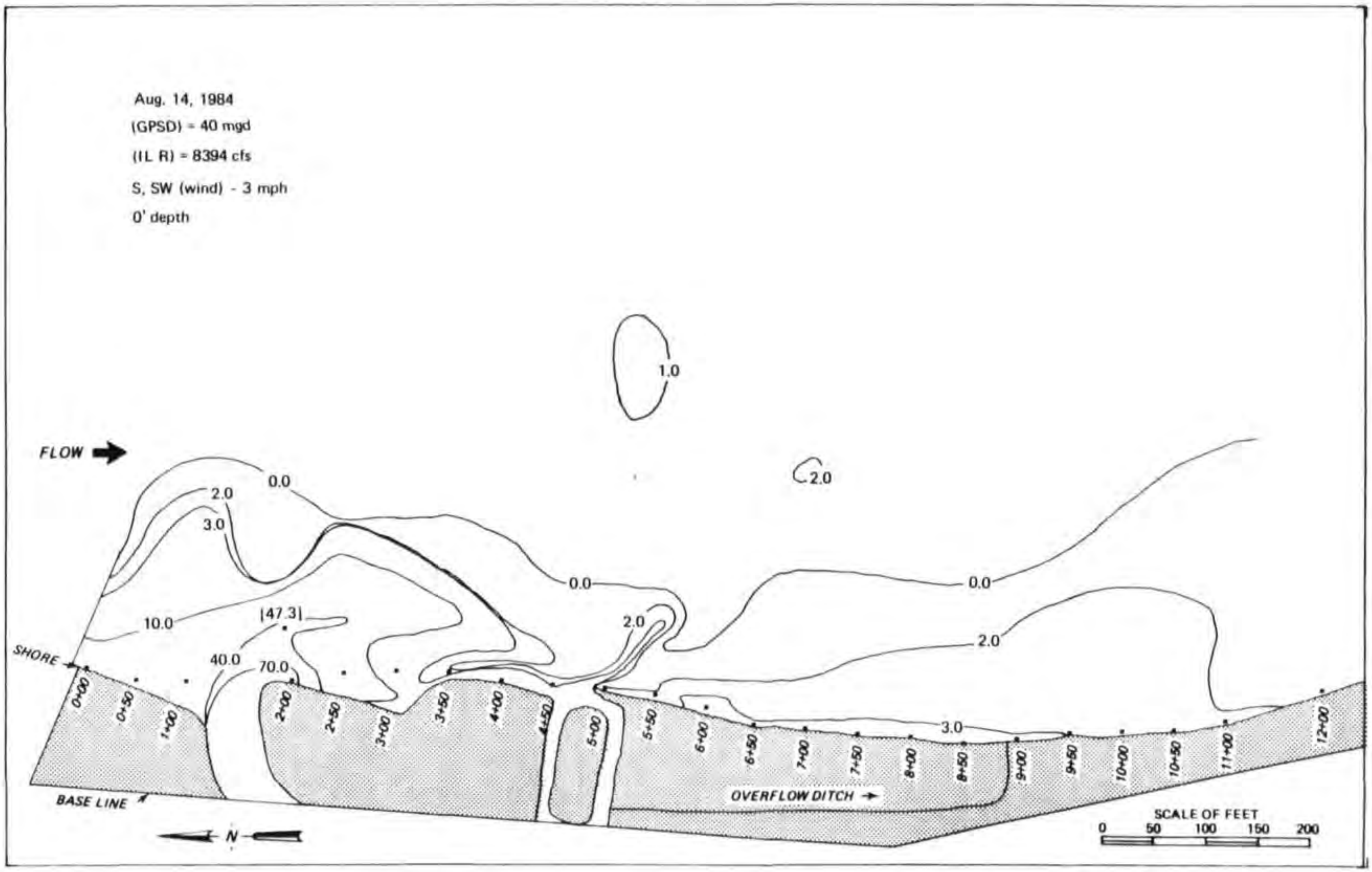


Figure 32. Surface percents of effluent dye concentration in mixing zone area, August 14, 1984

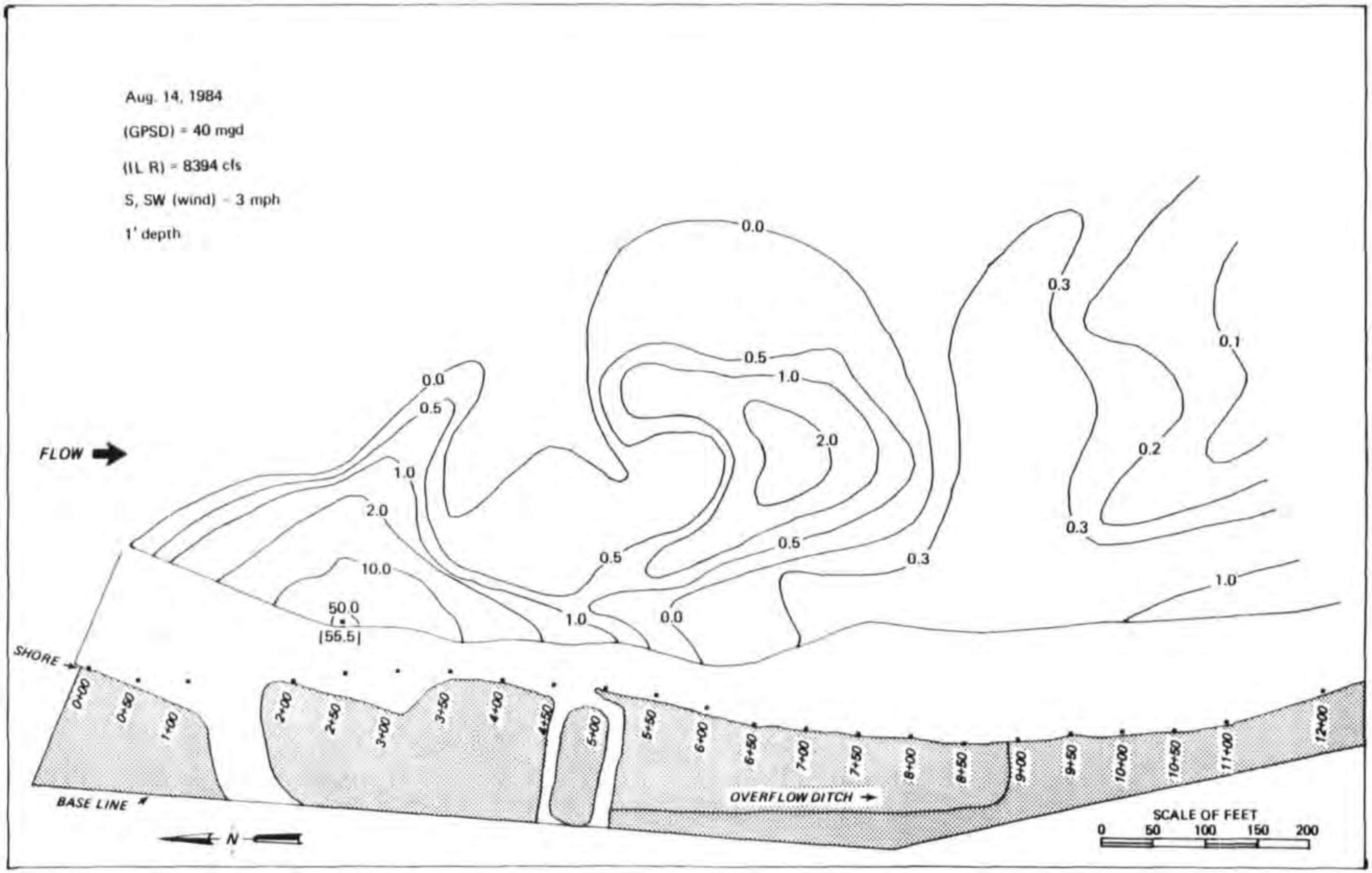


Figure 33. 1' depth, percents of effluent dye concentration in mixing zone area, August 14, 1984

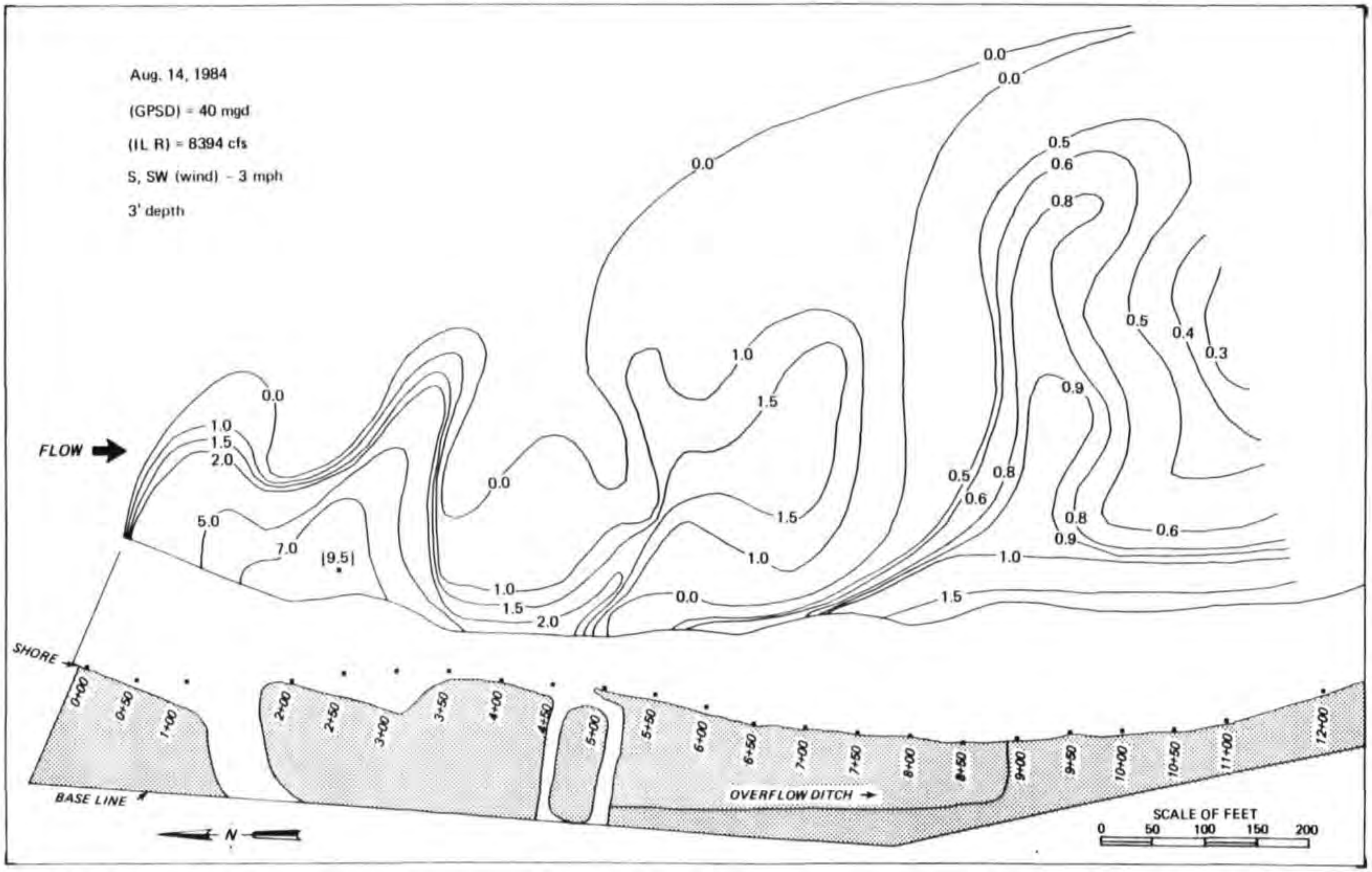


Figure 34. 3' depth, percents of effluent dye concentration in mixing zone area, August 14, 1984

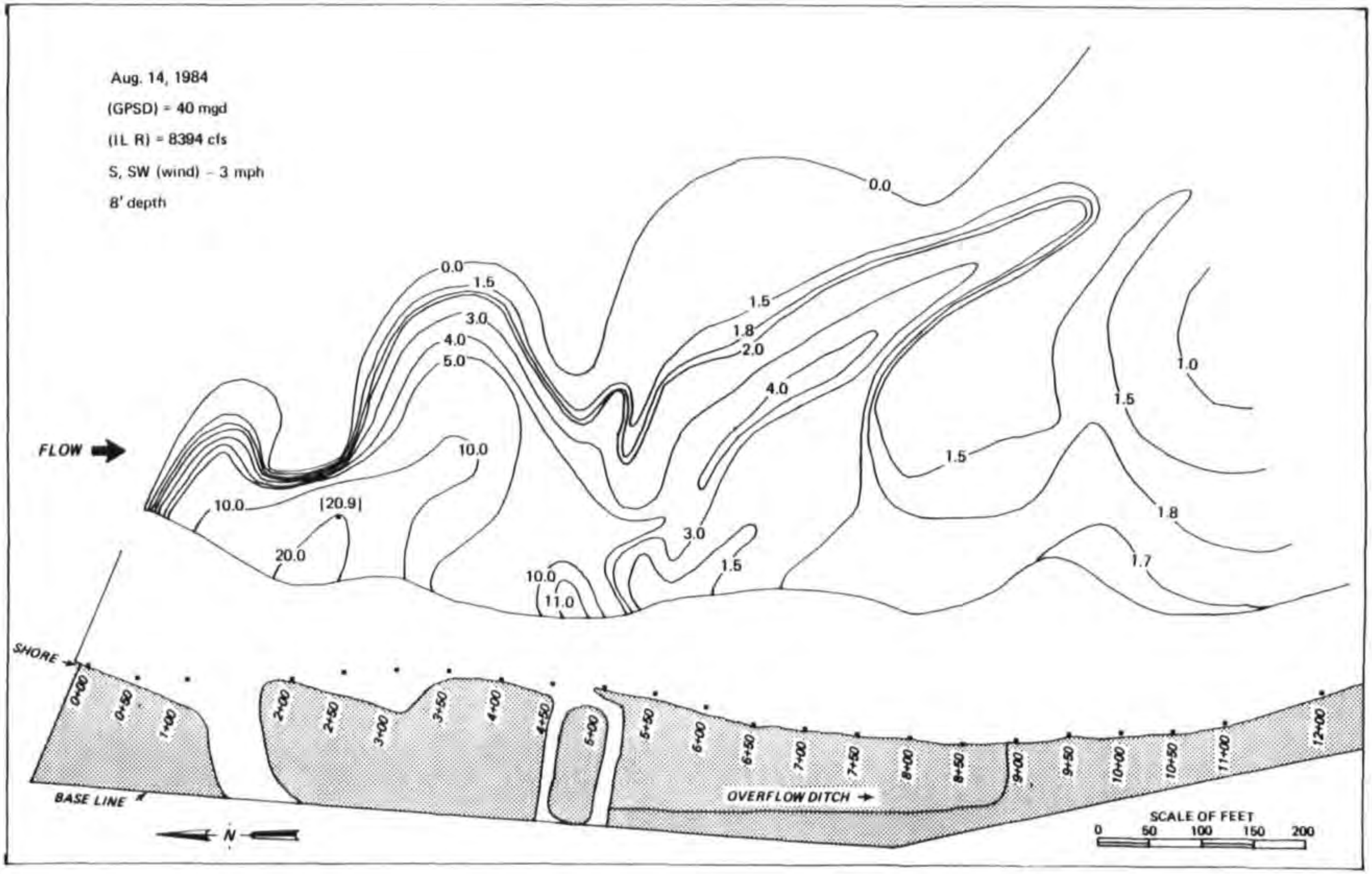


Figure 35. 8' depth, peroents of effluent dye concentration in mixing zone area, August 14, 1984

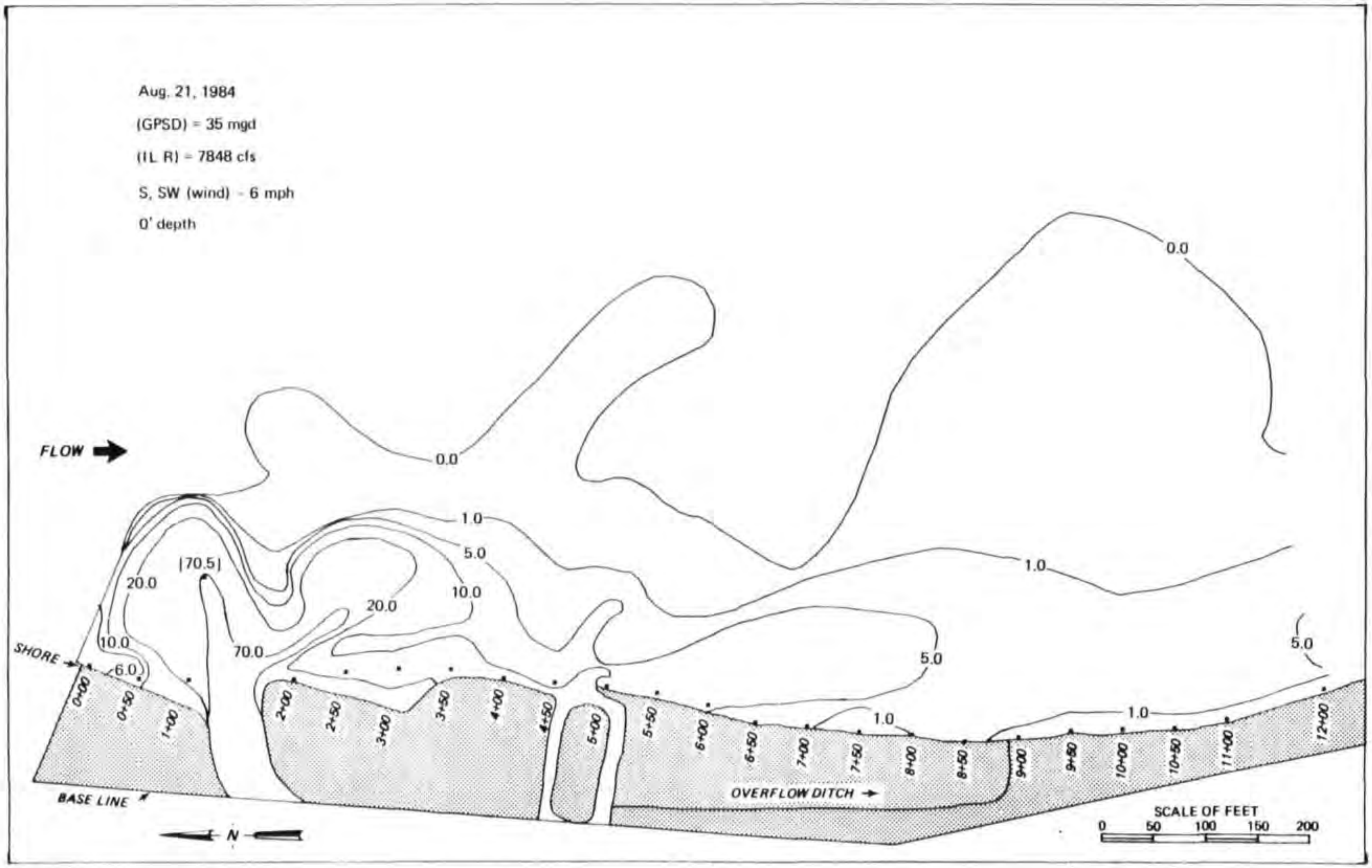


Figure 36. Surface percents of effluent dye concentration in mixing zone area, August 21, 1984

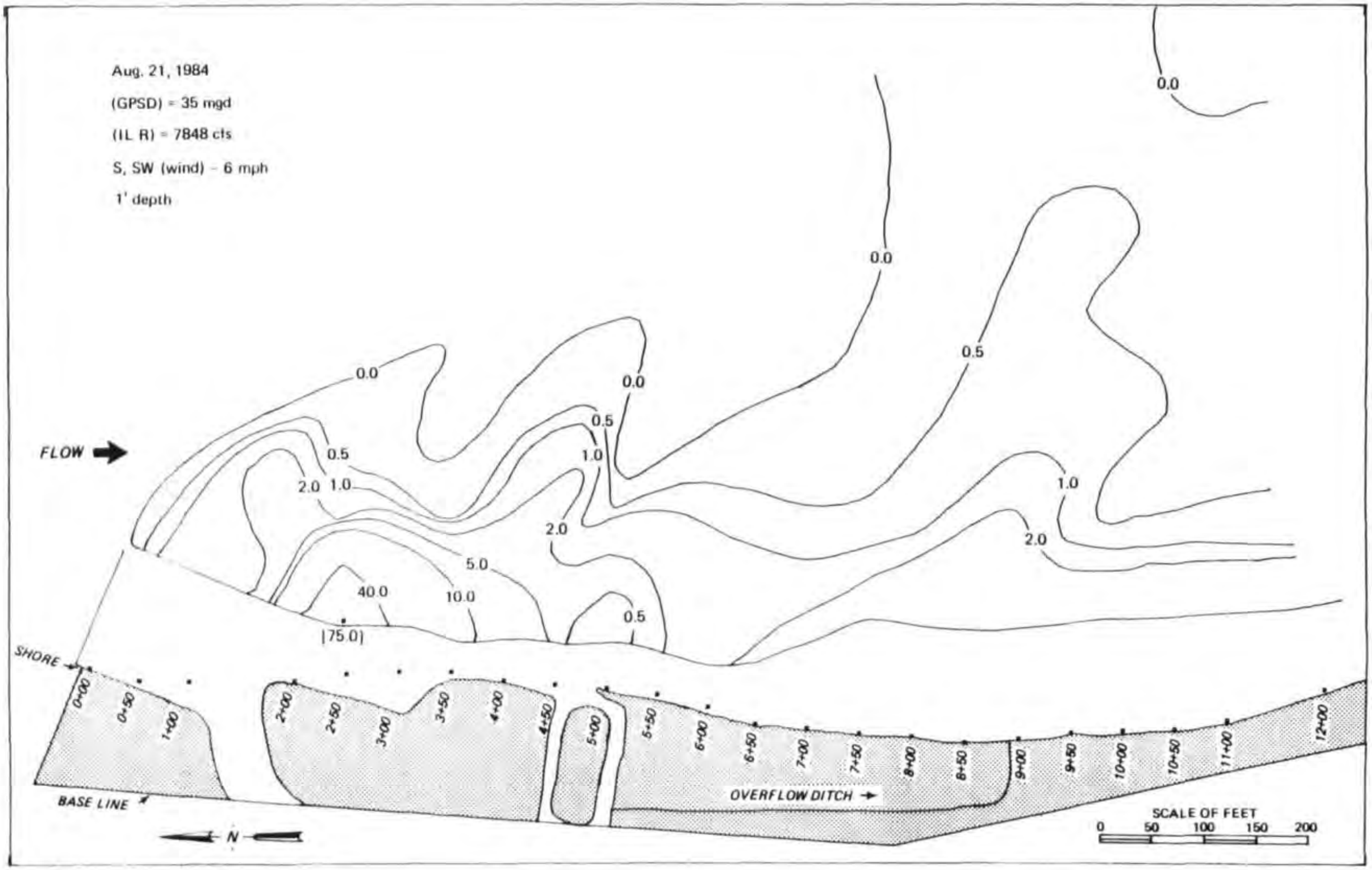


Figure 37. 1' depth, percents of effluent dye concentration in mixing zone area, August 21, 1984

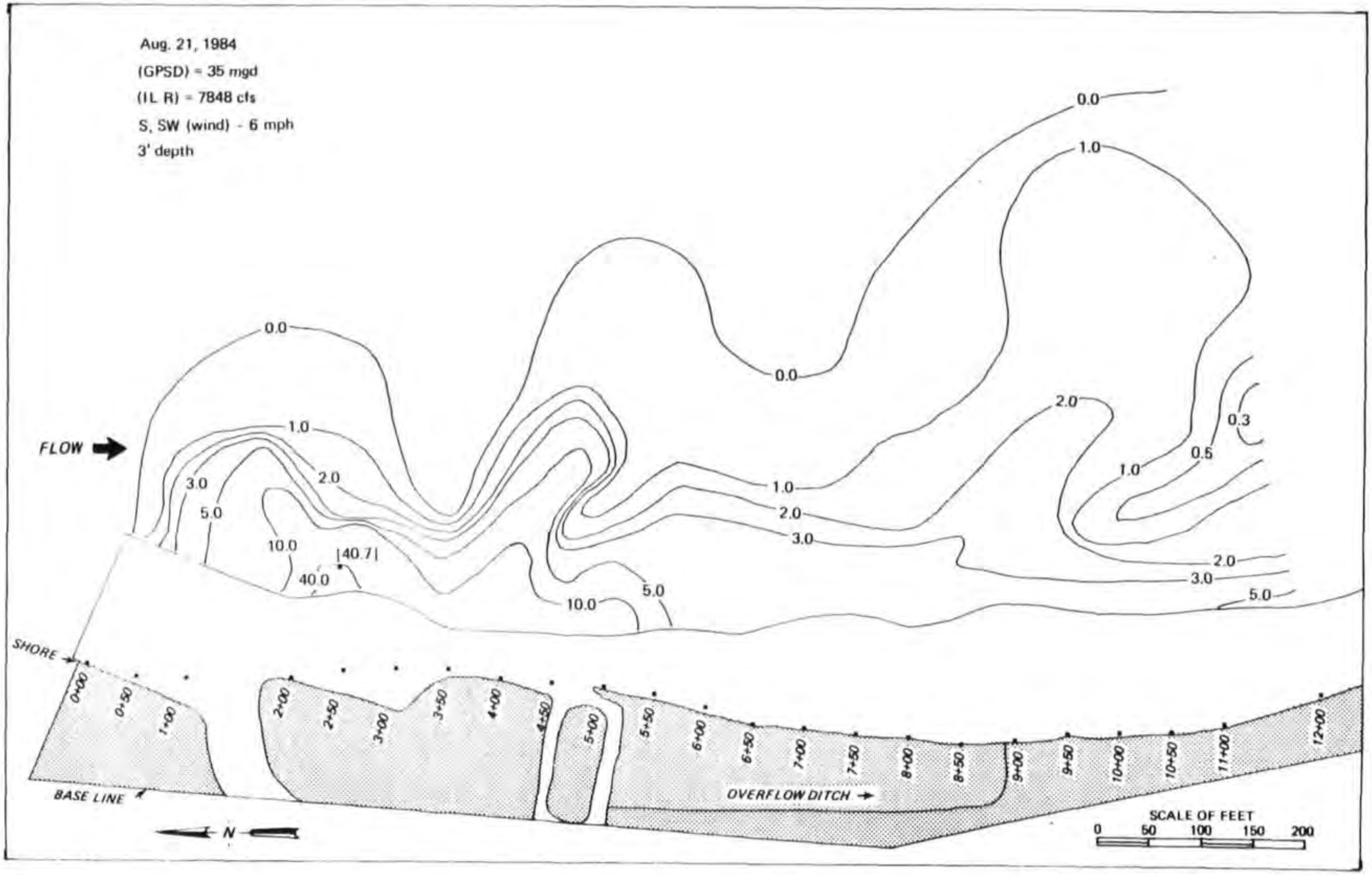


Figure 38. 3' depth, percents of effluent dye concentration in mixing zone area, August 21, 1984

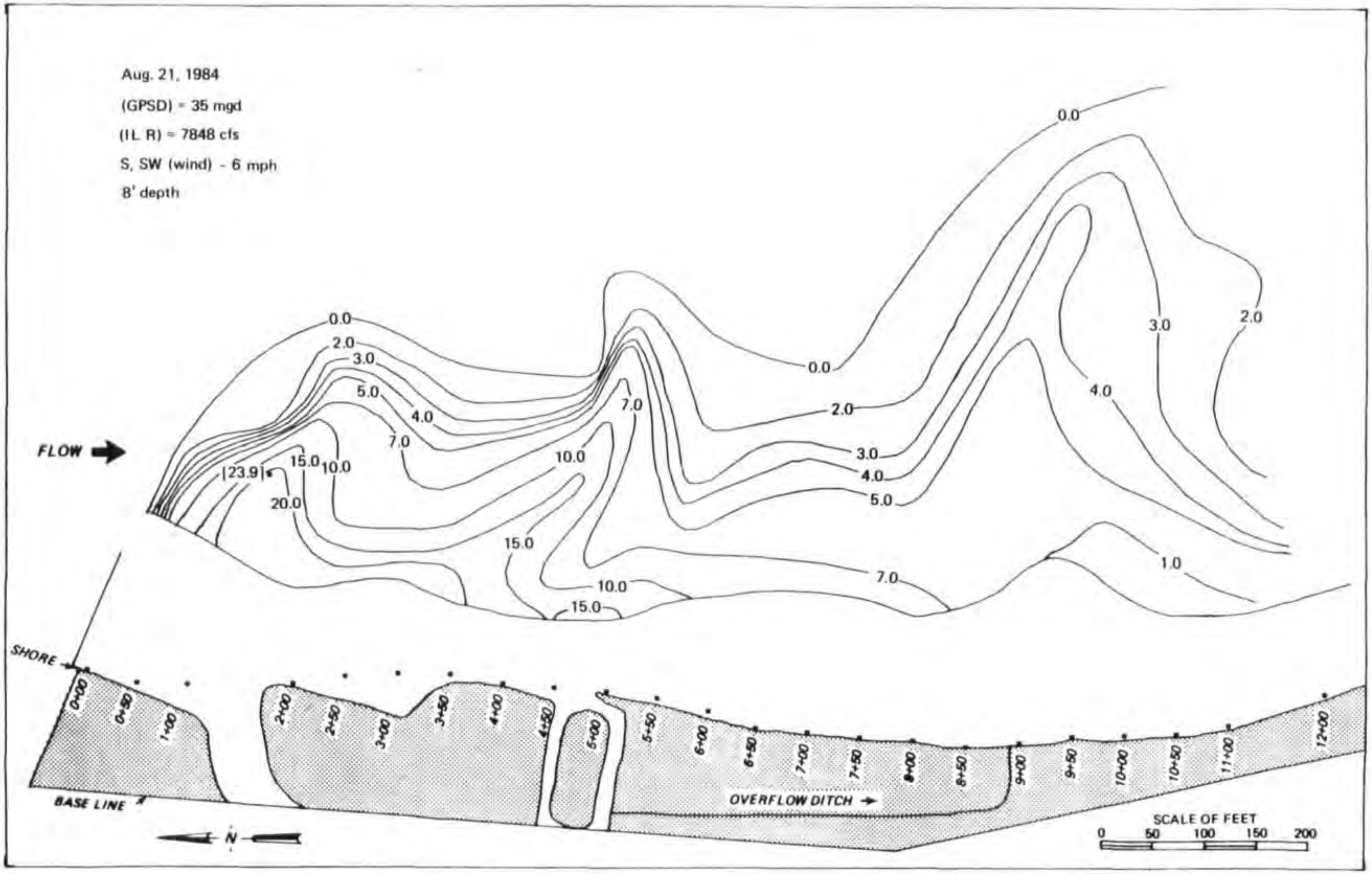


Figure 39. 8' depth, percents of effluent dye concentration in mixing zone area, August 21, 1984

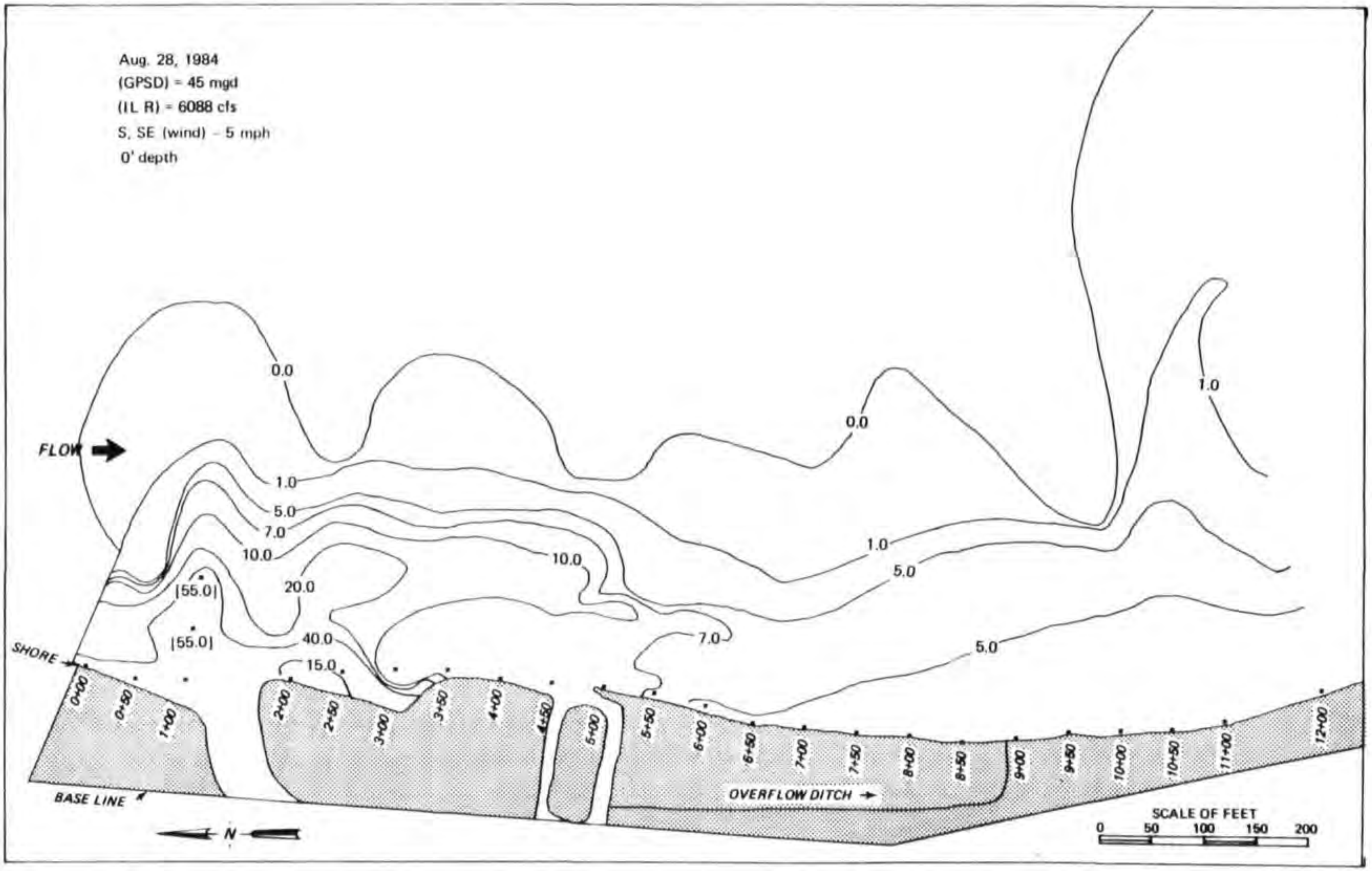


Figure 40. Surface percents of effluent dye concentration in mixing zone area, August 28, 1984

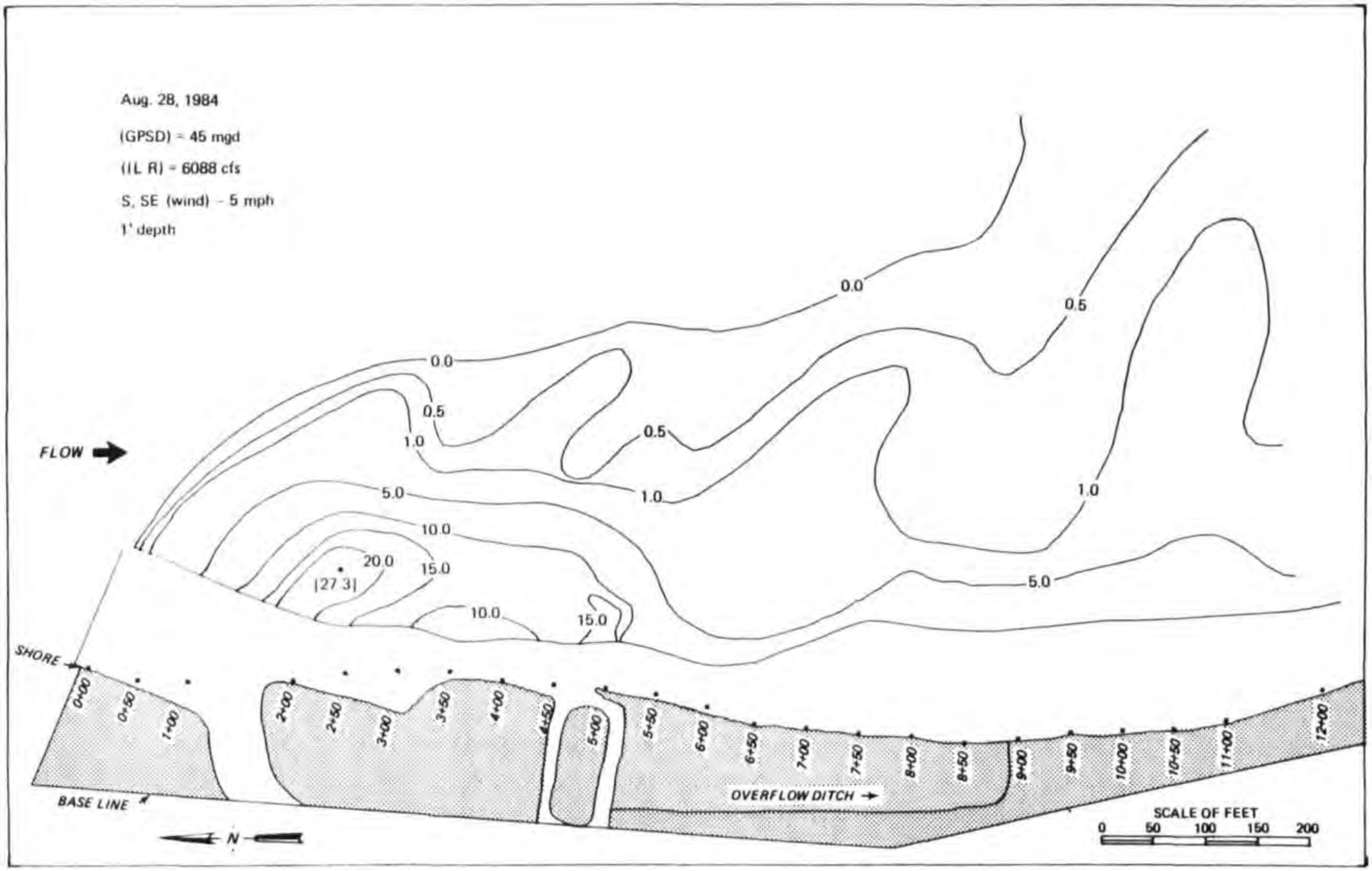


Figure 41. 1' depth, percents of effluent dye concentration in mixing zone area, August 28, 1984

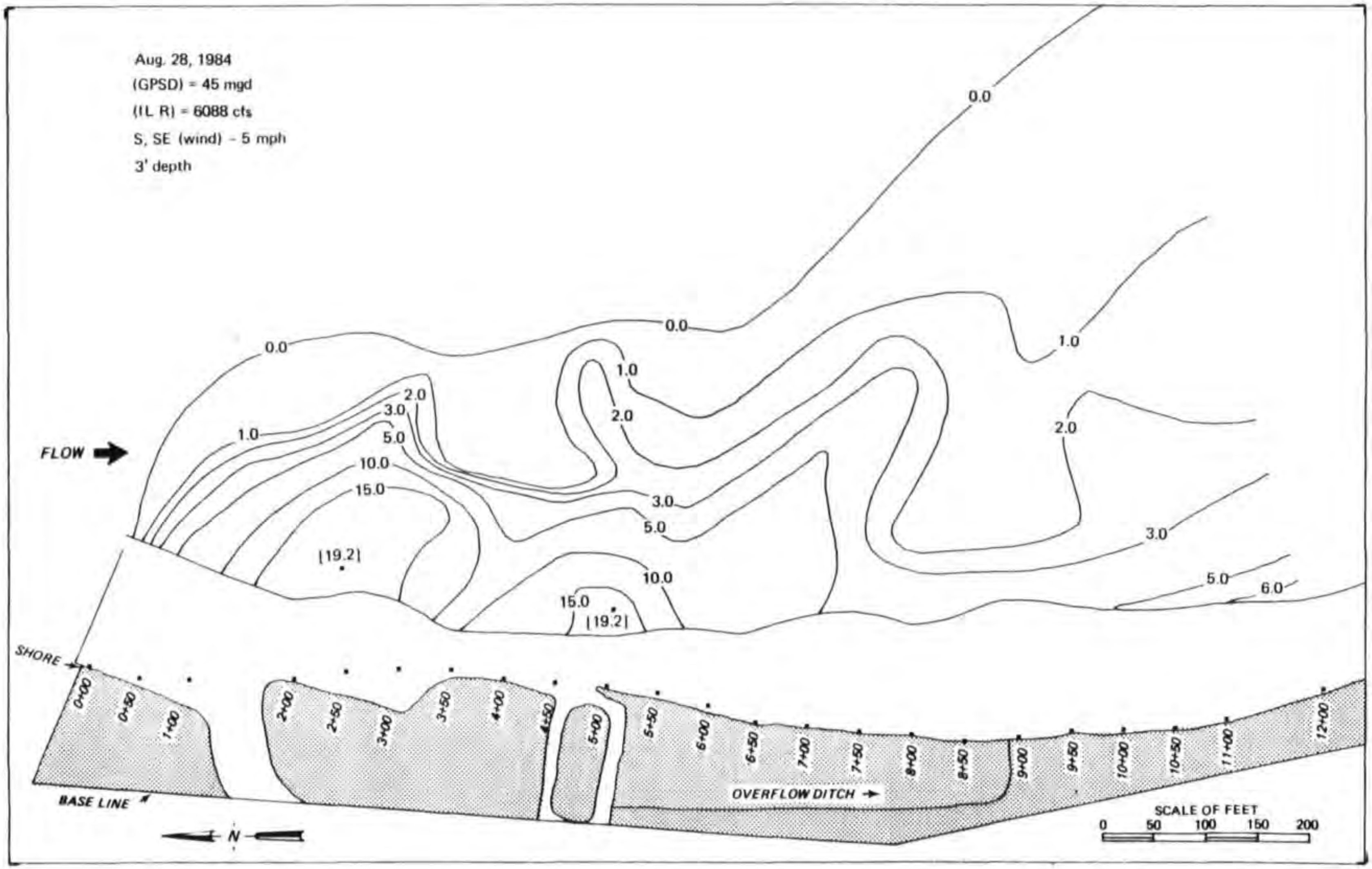


Figure 42. 3' depth, percents of effluent dye concentration in mixing zone area, August 28, 1984

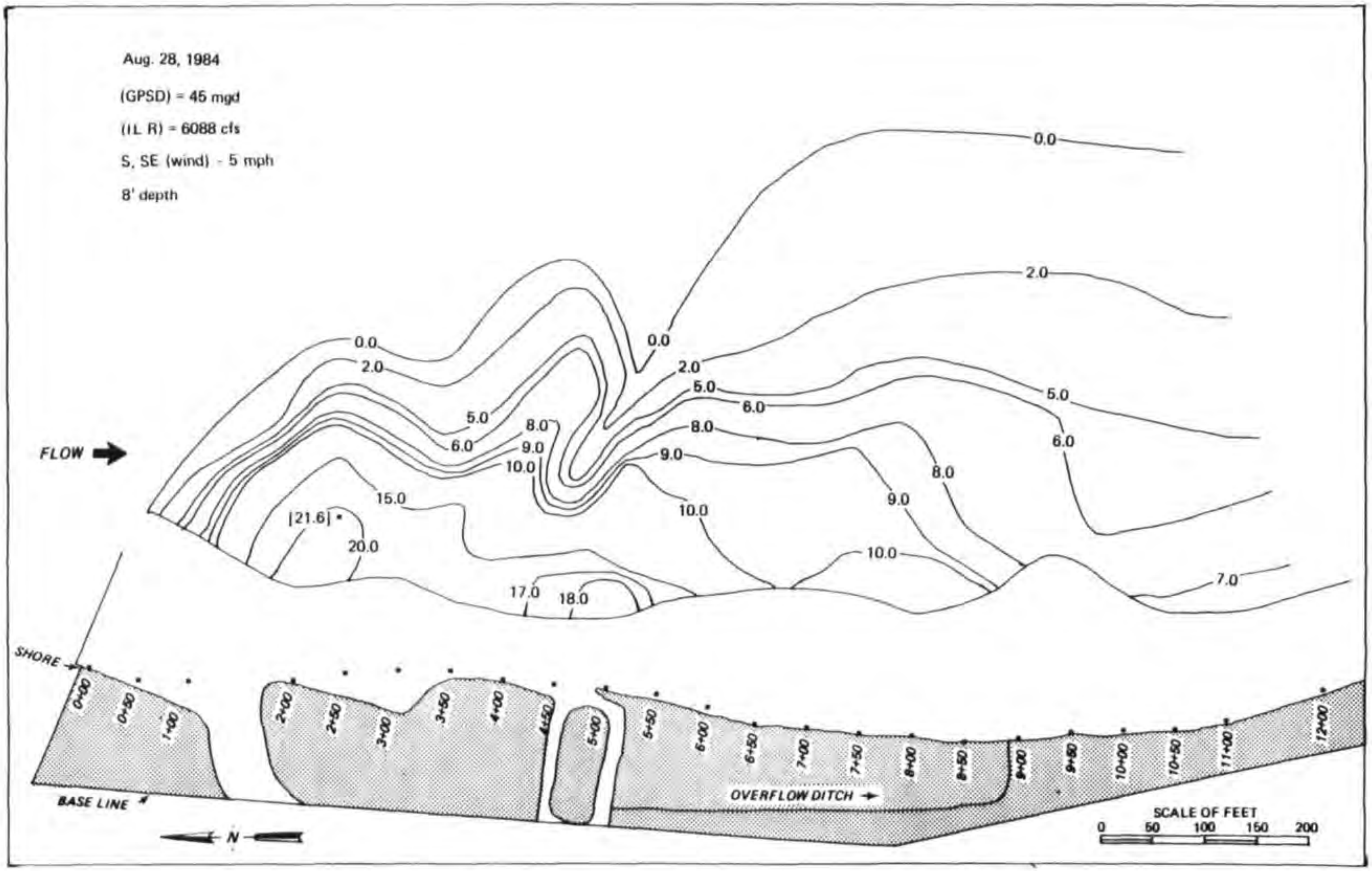


Figure 43. 8' depth, percents of effluent dye concentration in mixing zone area, August 28, 1984

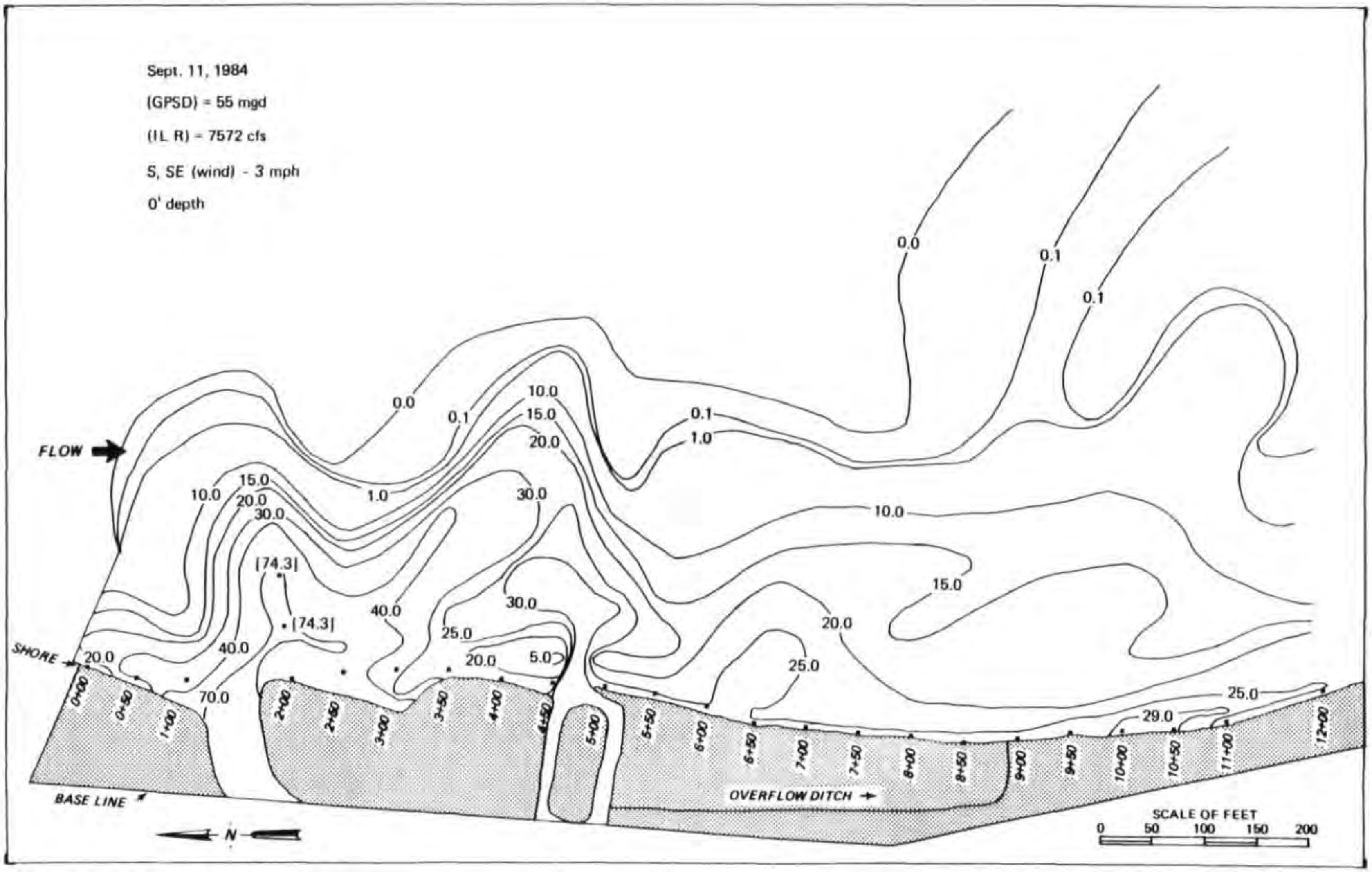


Figure 44, Surface percents of effluent dye concentration in mixing zone area, September 11, 1984

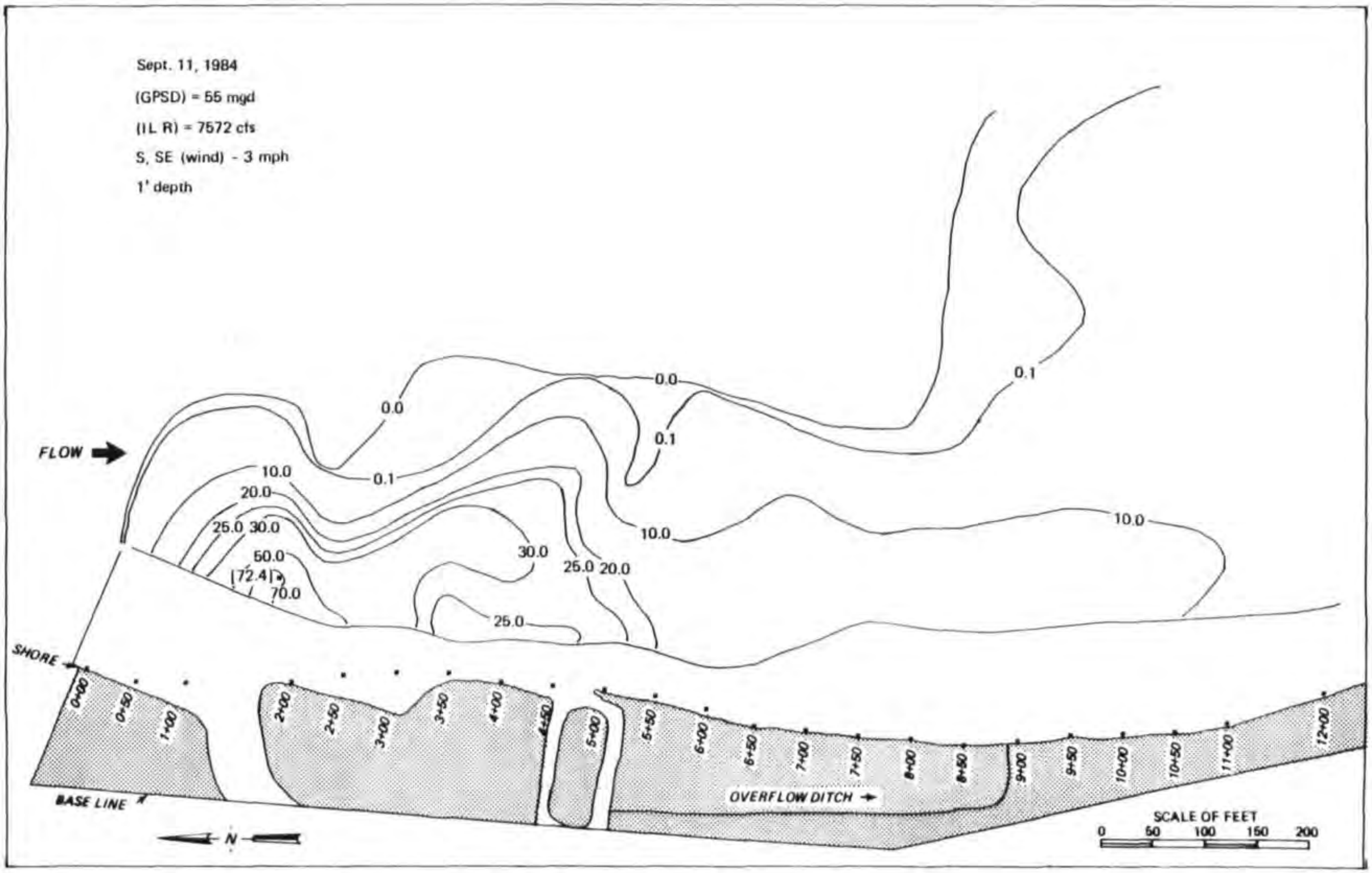
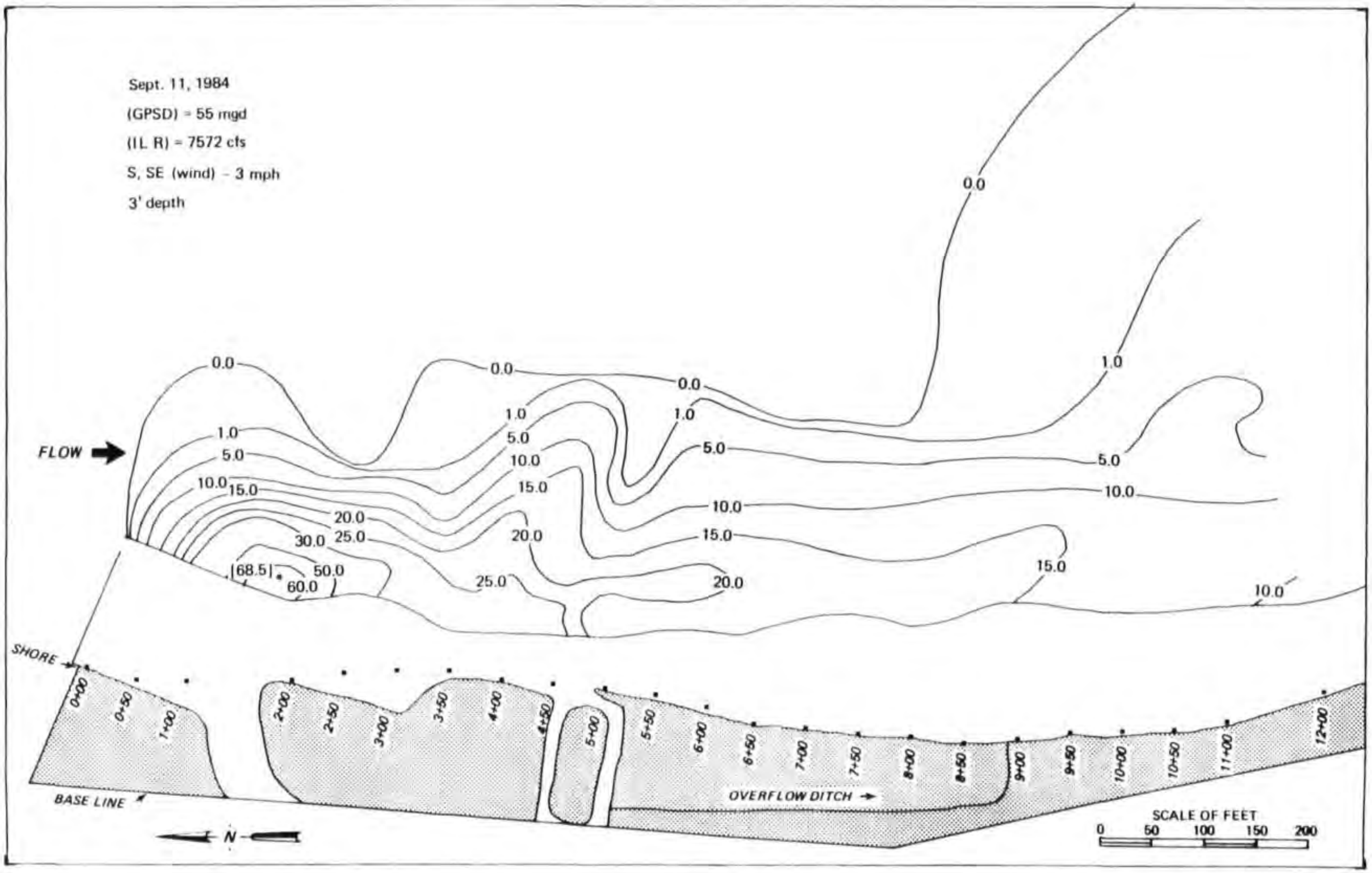


Figure 45. 1' depth, peroents of effluent dye concentration in mixing zone area, September 11, 1984



Sept. 11, 1984
(GPSD) = 55 mgd
(IL R) = 7572 cfs
S, SE (wind) - 3 mph
3' depth

Figure 46. 3' depth, percents of effluent dye concentration in mixing zone area, September 11, 1984

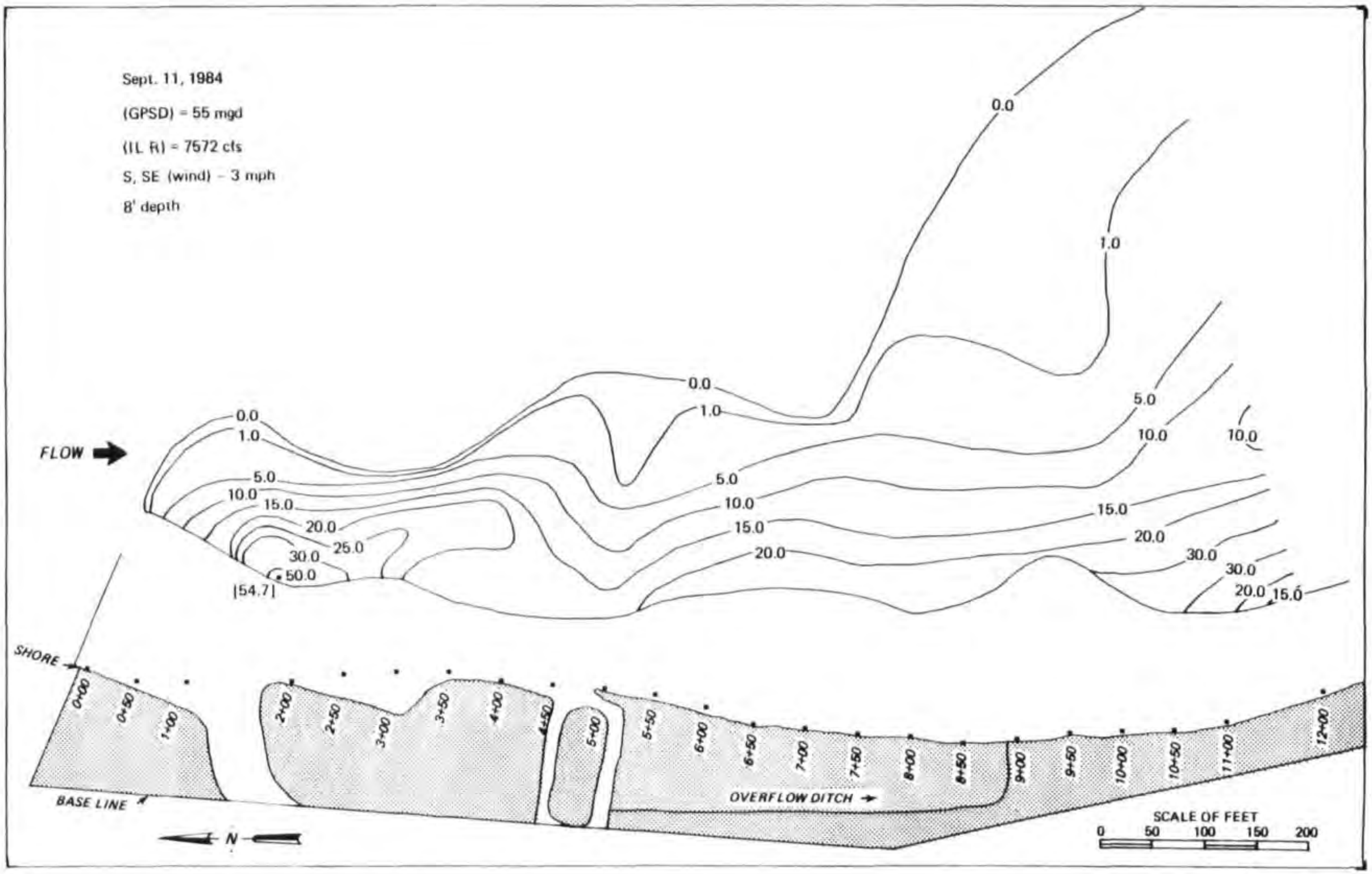


Figure 47. 8' depth, percents of effluent dye concentration in mixing zone area, September 11, 1984

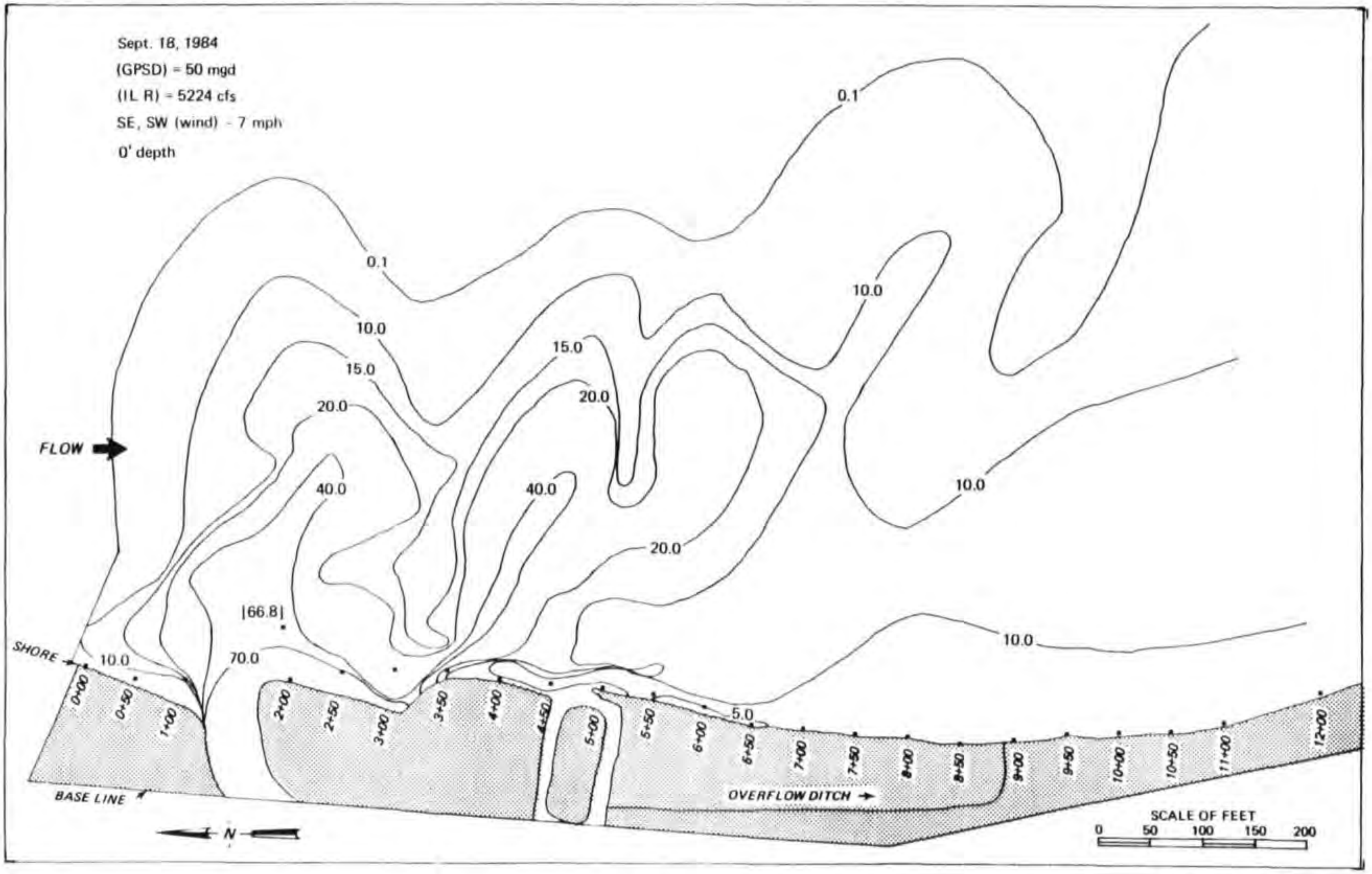


Figure 48. Surface percents of effluent dye concentration in mixing zone area, September 18, 1984

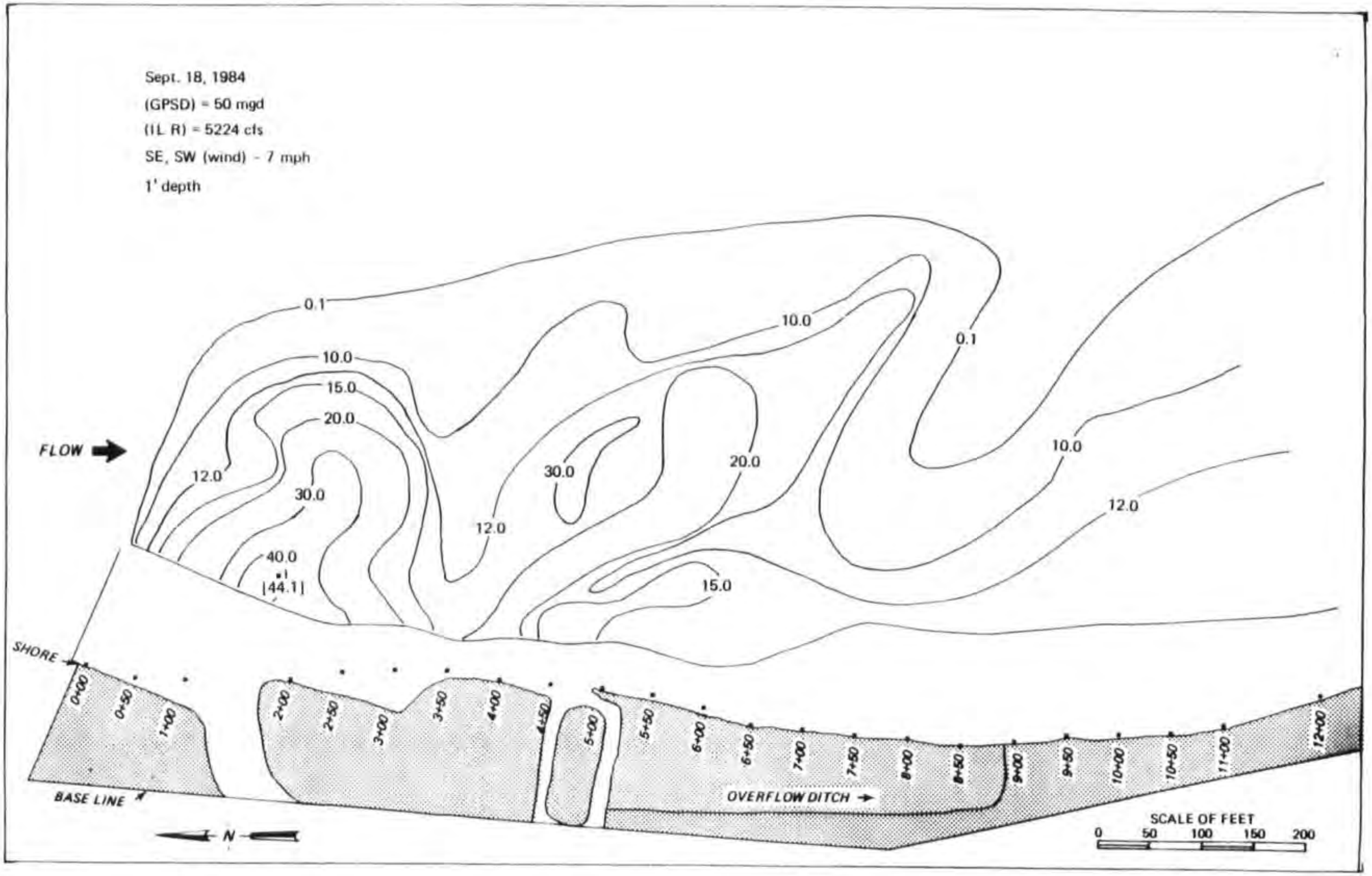


Figure 49. 1' depth, percents of effluent dye concentration in mixing zone area, September 18, 1984

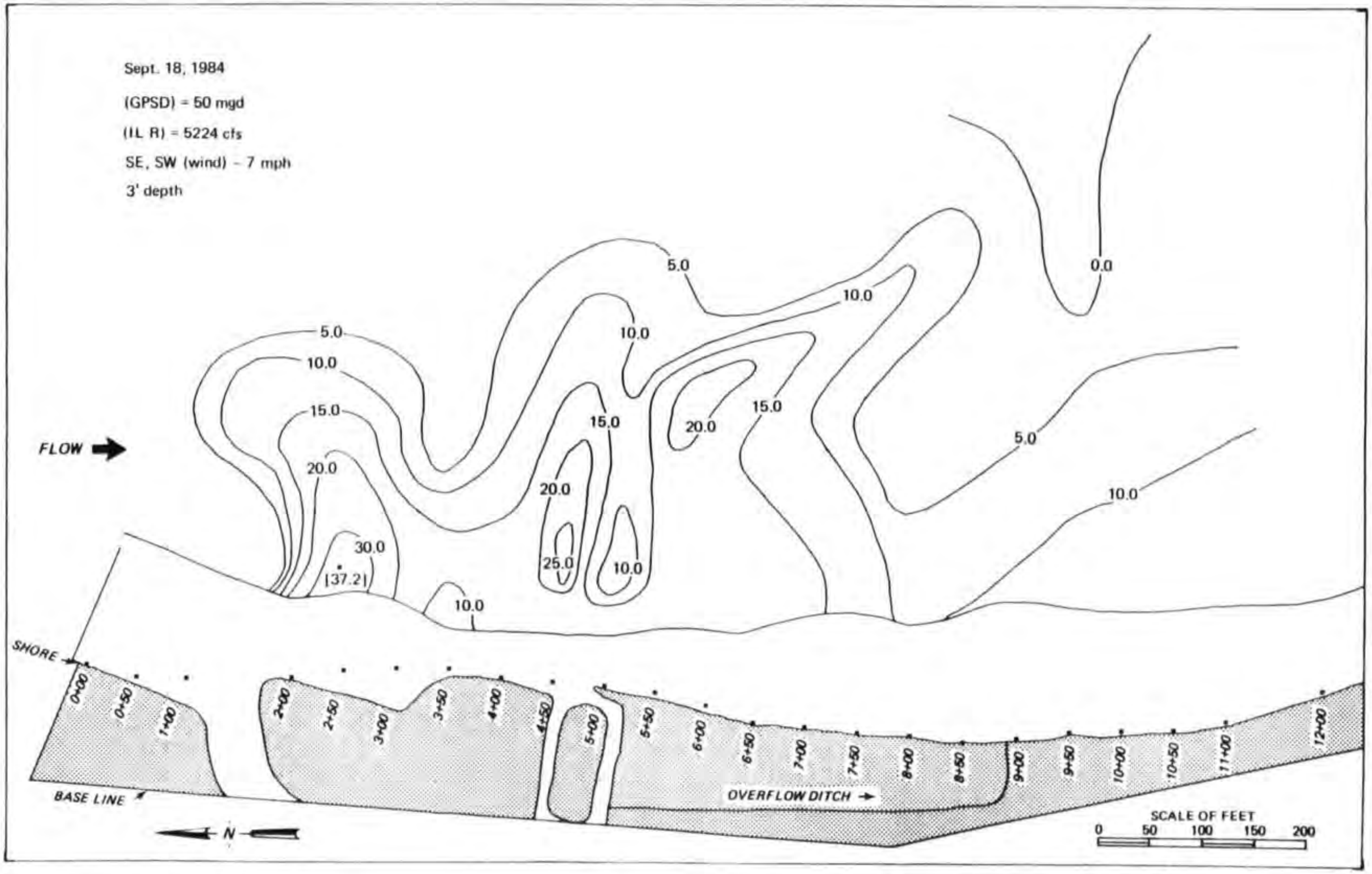


Figure 50. 3' depth, percents of effluent dye concentration in mixing zone area, September 18, 1984

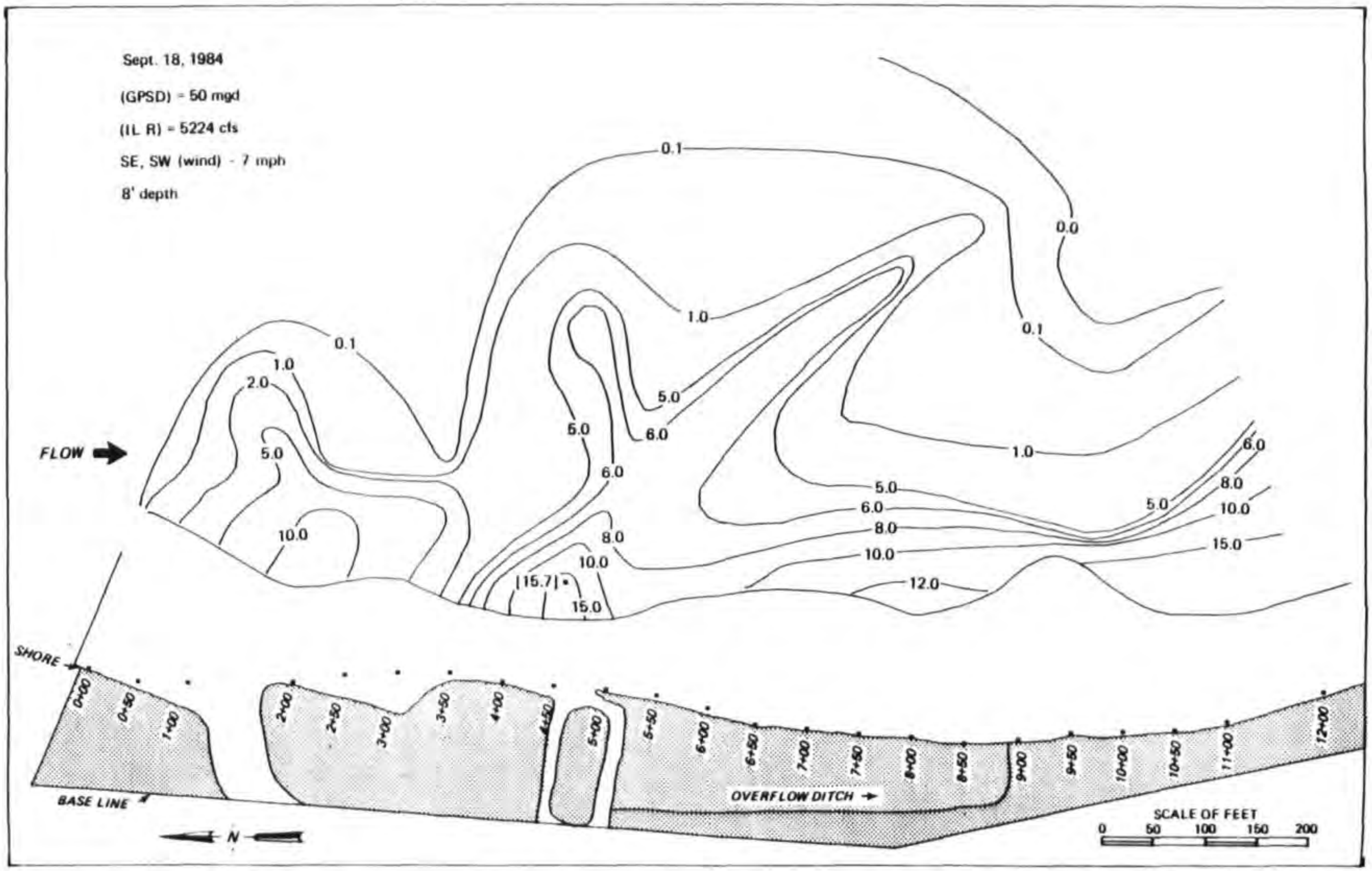


Figure 51. 8' depth, percents of effluent dye concentration in mixing zone area, September 18, 1984

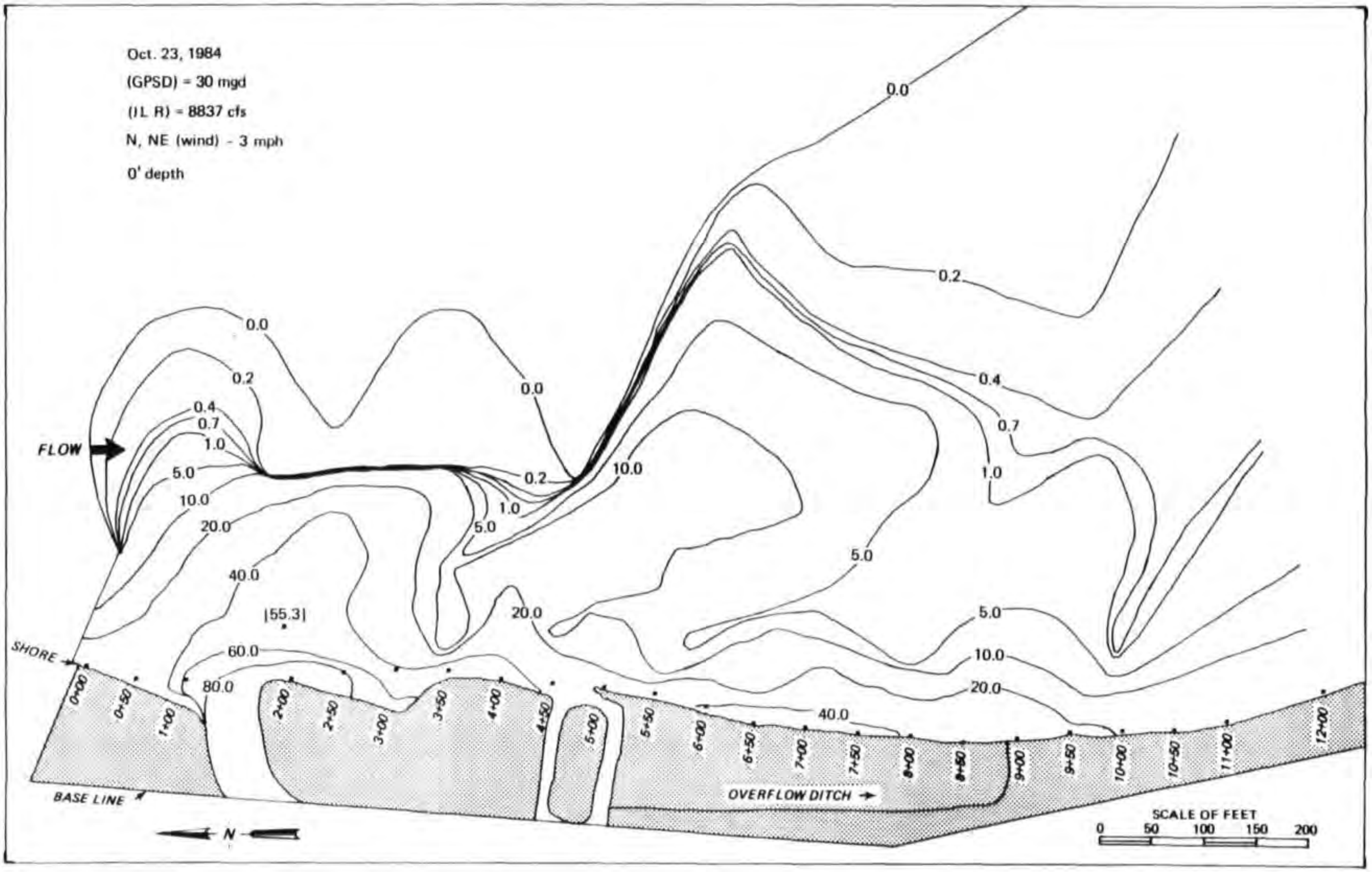


Figure 52. Surface percents of effluent dye concentration in mixing zone area, October 23, 1984

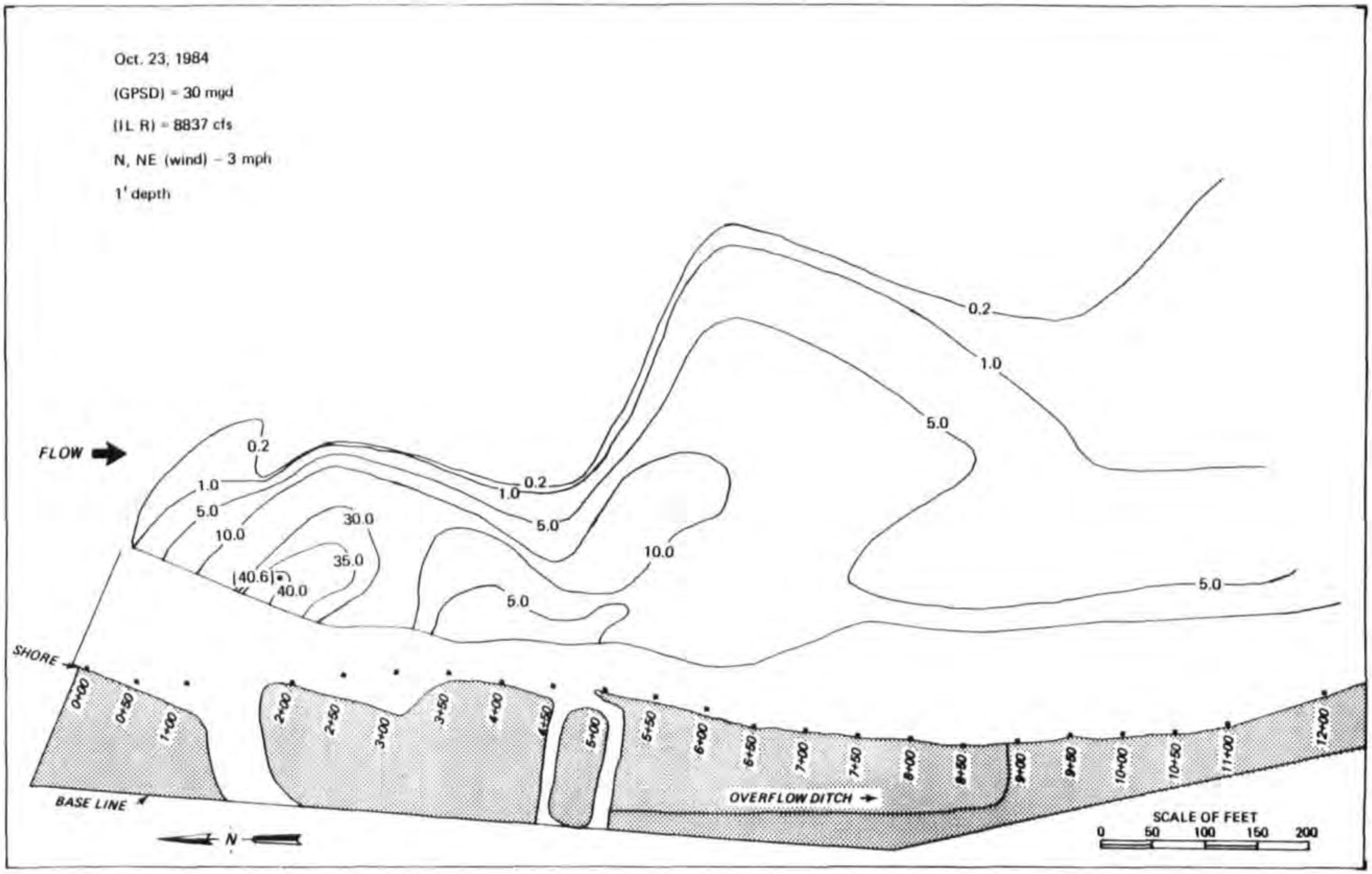


Figure 53. 1' depth, percents of effluent dye concentration in mixing zone area, October 23, 1984

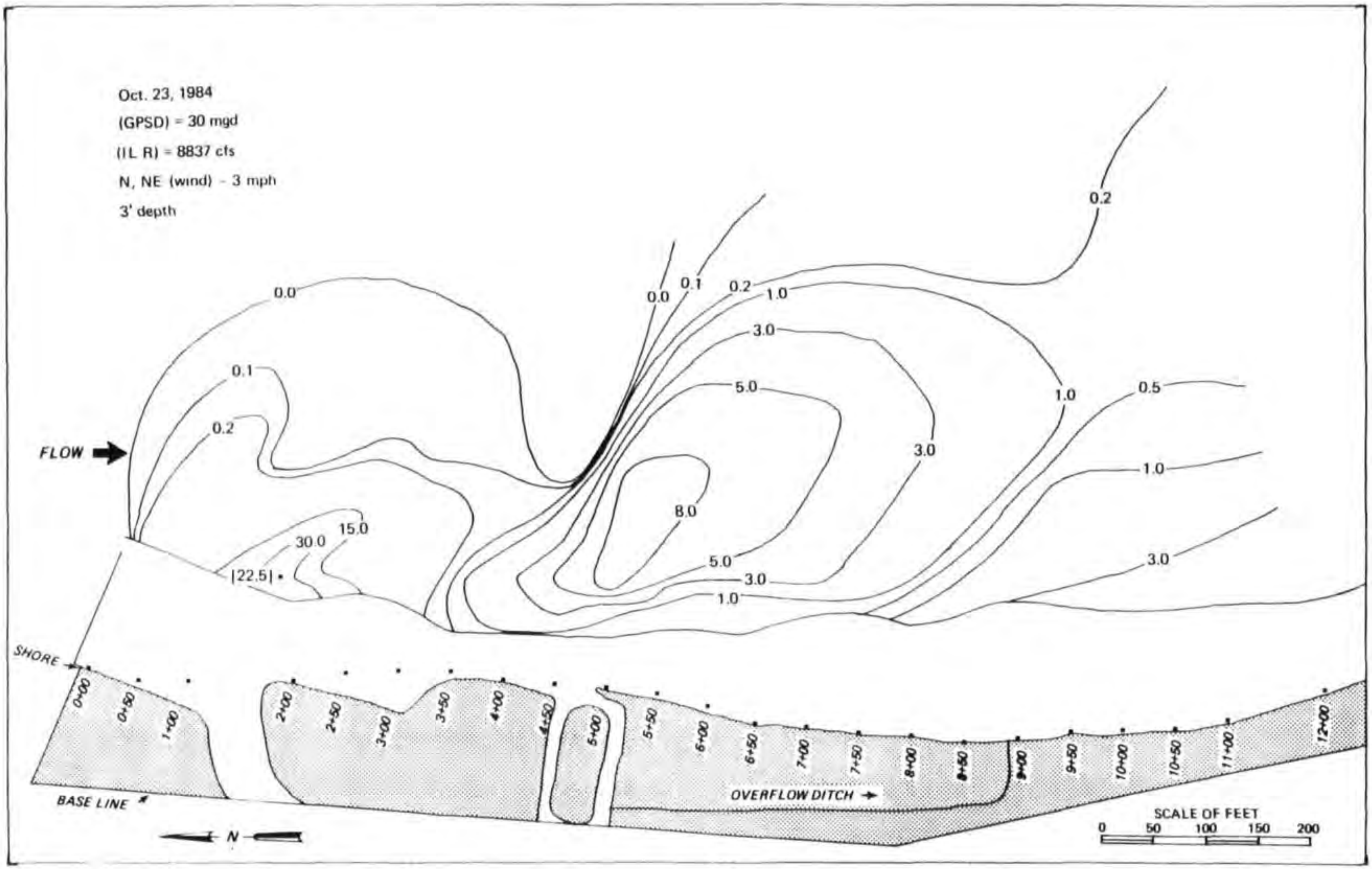
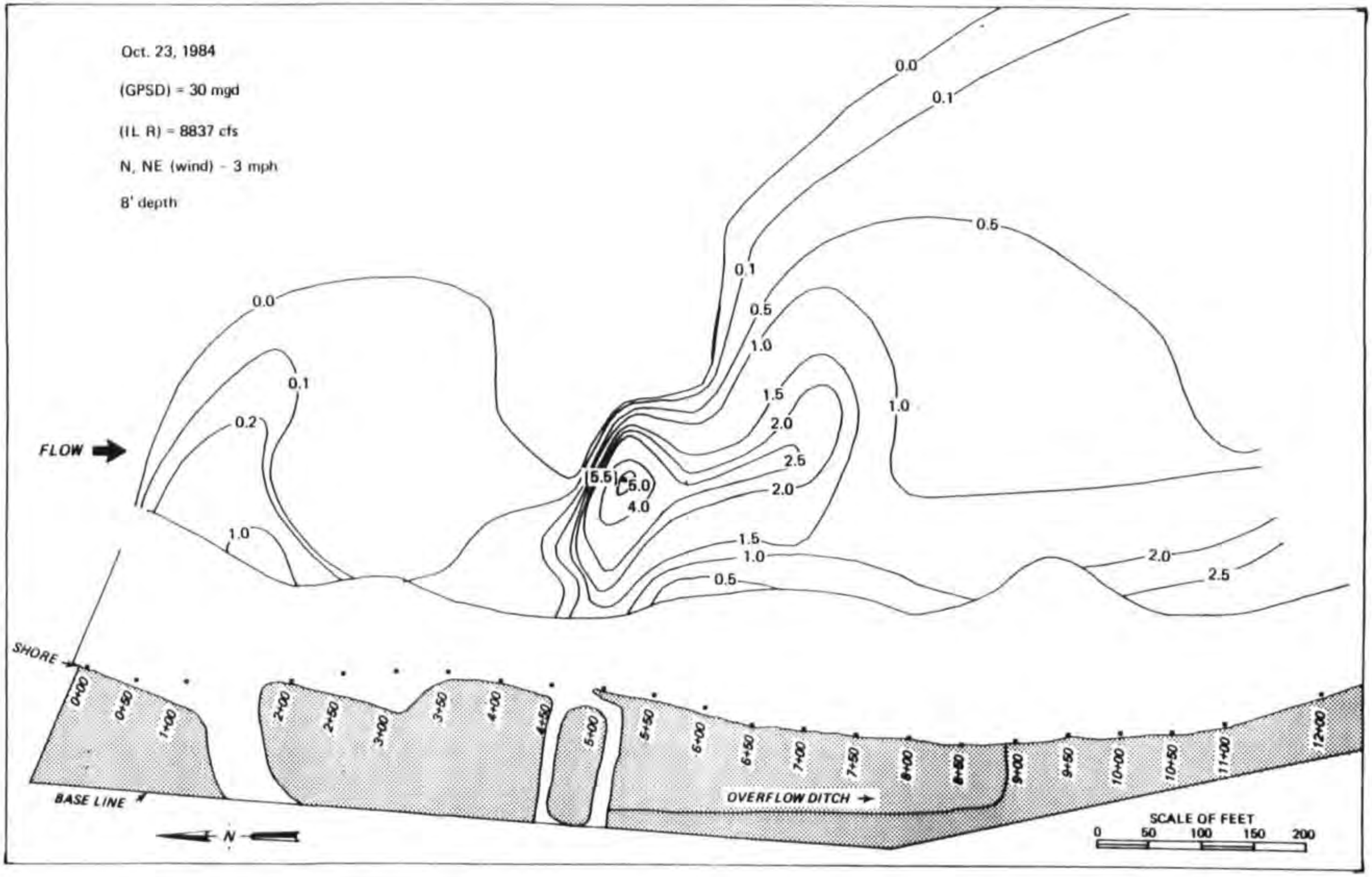


Figure 54. 3' depth, percents of effluent dye concentration in mixing zone area, October 23, 1984



Oct. 23, 1984

(GPSD) = 30 mgd

(IL R) = 8837 cfs

N, NE (wind) - 3 mph

8' depth

Figure 55. 8' depth, percents of effluent dye concentration in mixing zone area, October 23, 1984

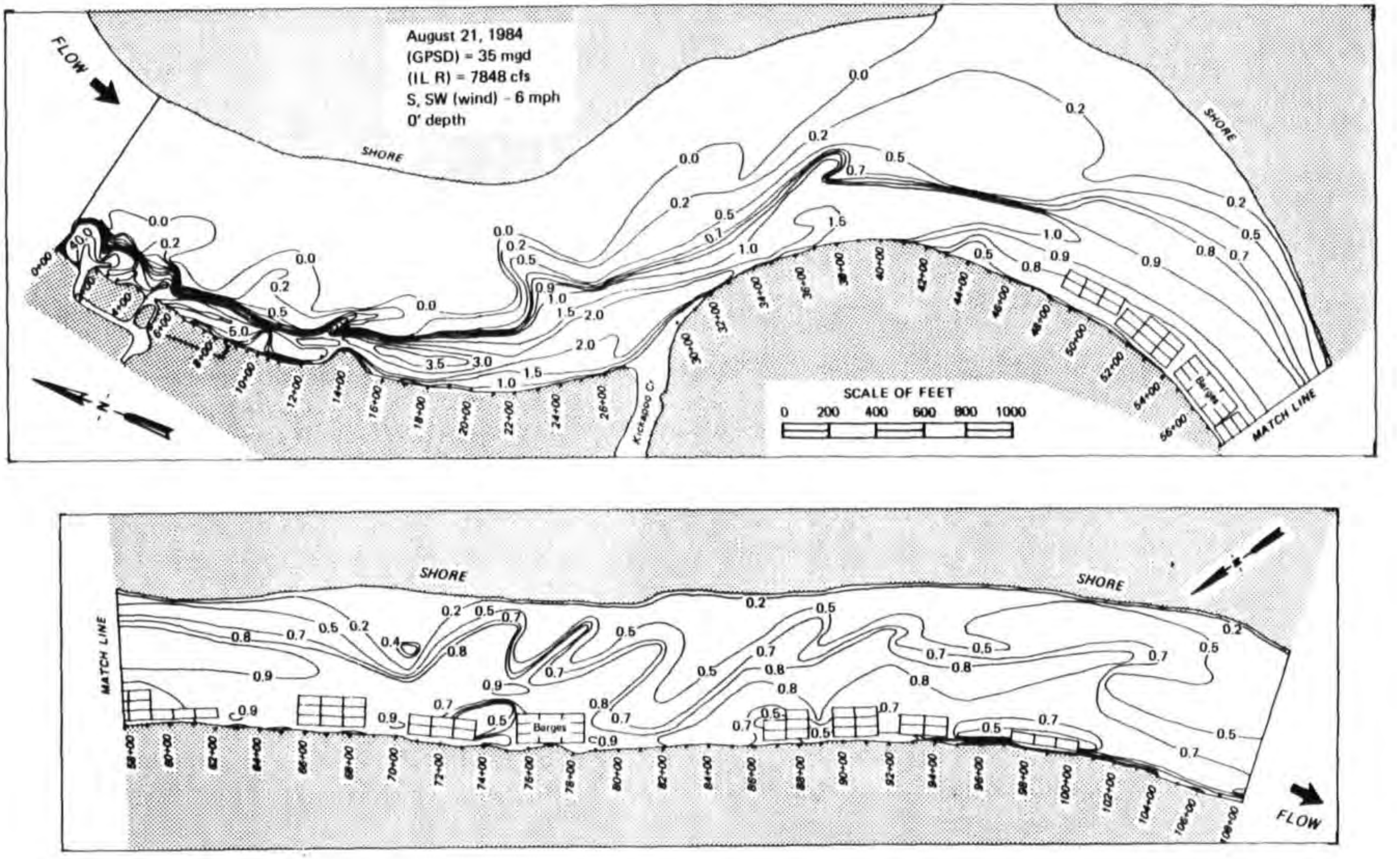


Figure 56. Surface percents of effluent dye concentration throughout study reach, August 21, 1984

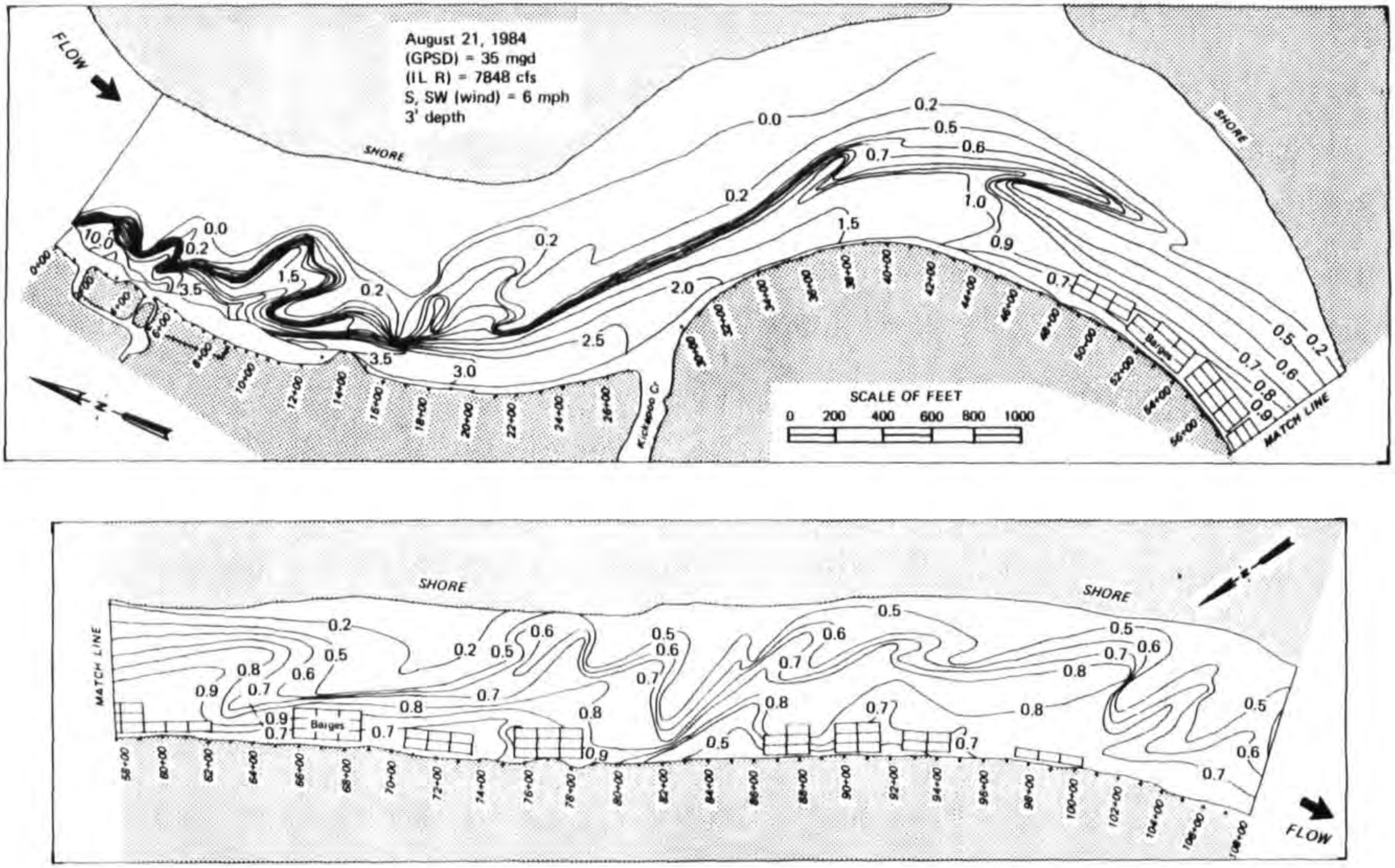


Figure 57. 3' depth, percents of effluent dye concentration throughout study reach, August 21, 1984

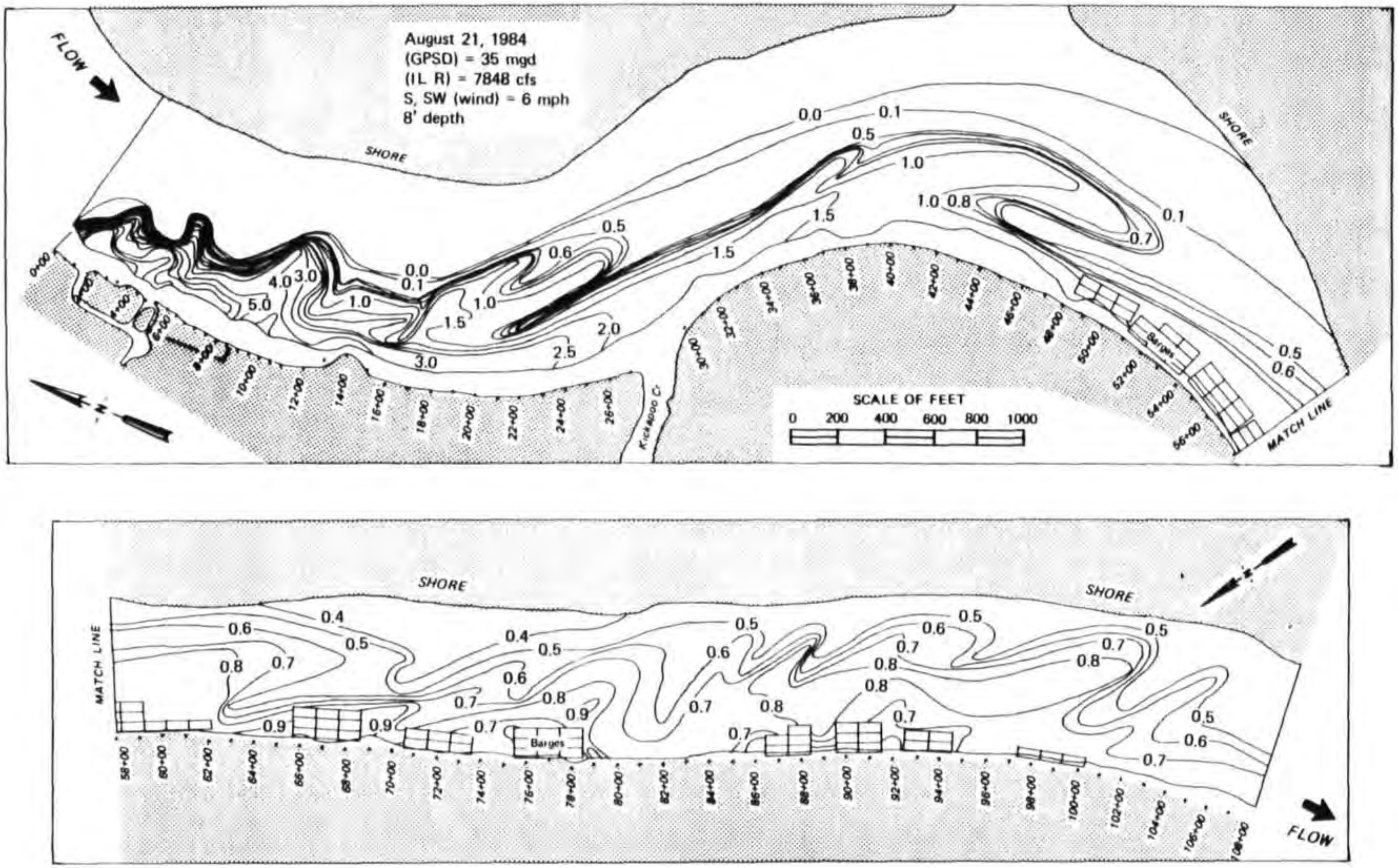


Figure 58. 8' depth, percents of effluent dye concentration throughout study reach, August 21, 1984

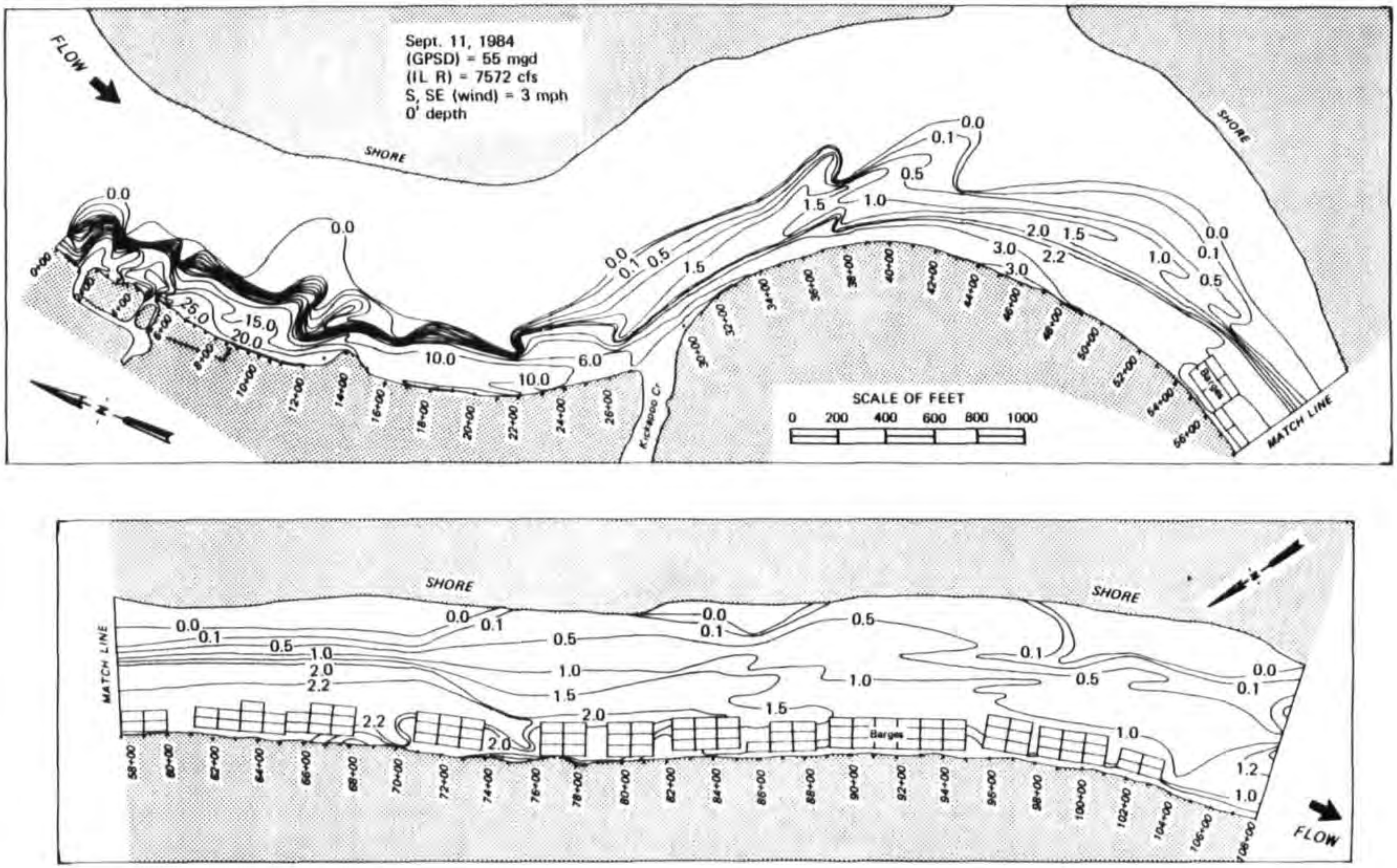


Figure 59. Surface percents of effluent dye concentration throughout study reach, September 11, 1984

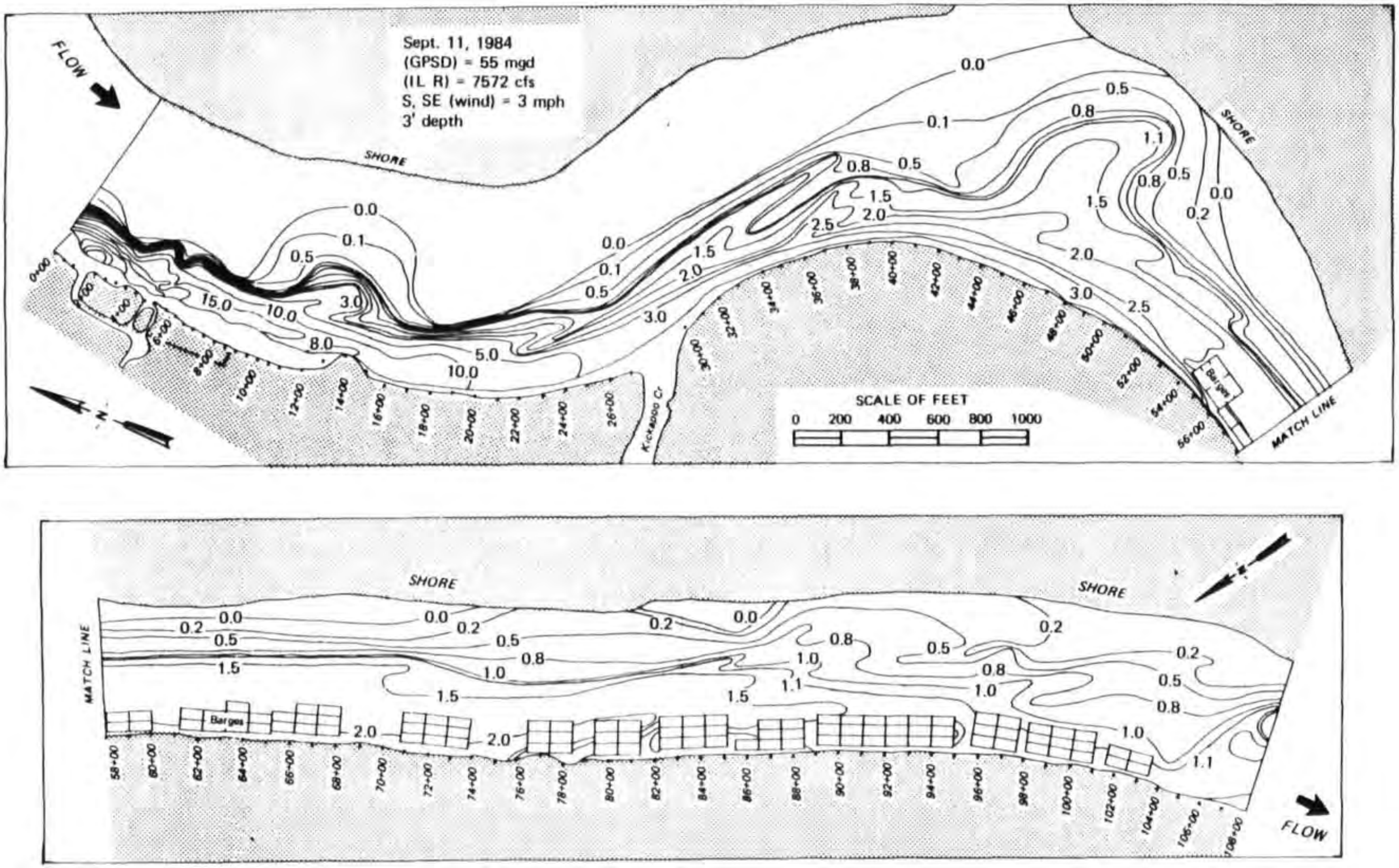
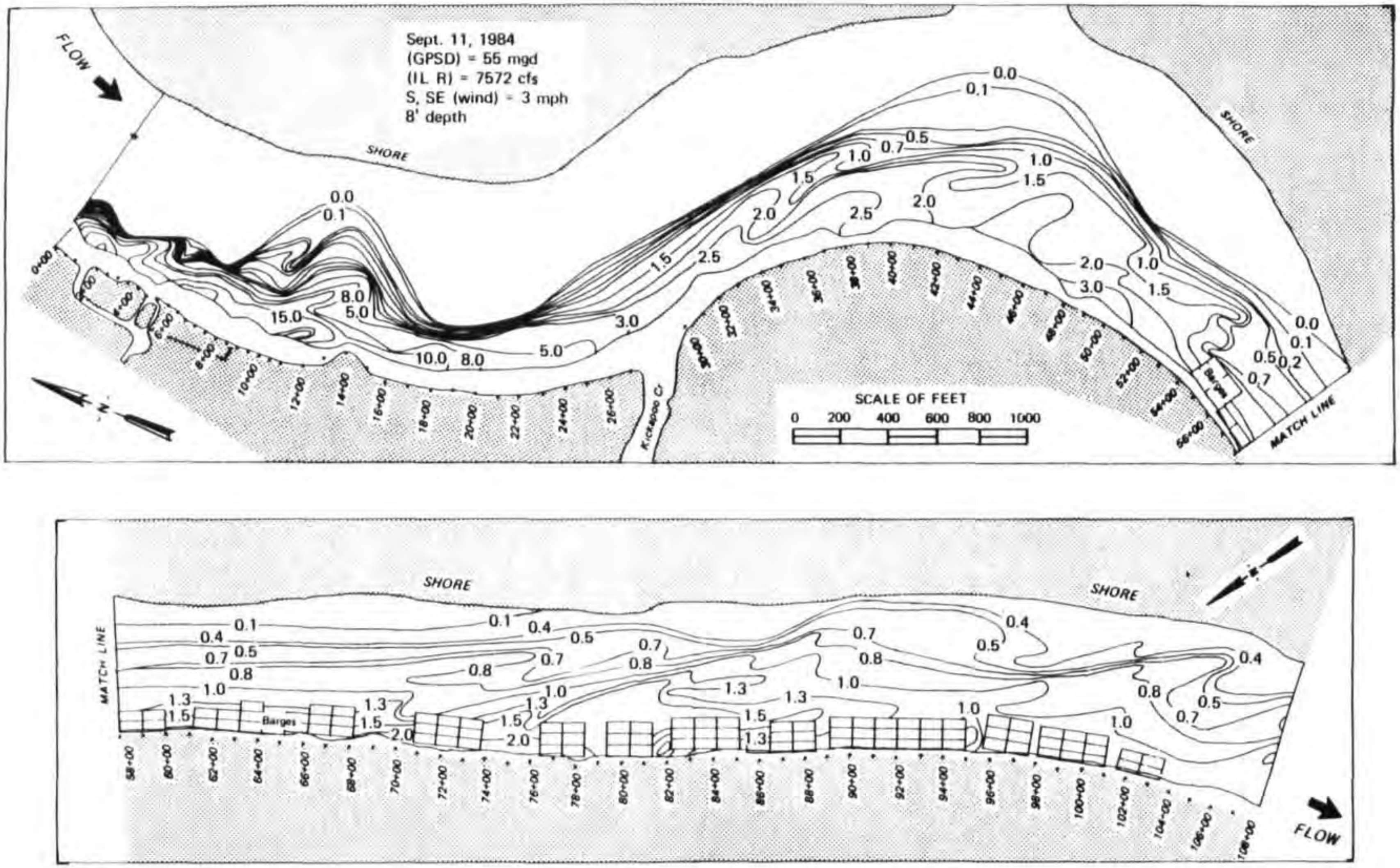


Figure 60. 3' depth, percents of effluent dye concentration throughout study reach, September 11, 1984



Sept. 11, 1984
(GPSD) = 55 mgd
(IL R) = 7572 cfs
S, SE (wind) = 3 mph
8' depth

Figure 61. 8' depth, percents of effluent dye concentration throughout study reach, September 11, 1984

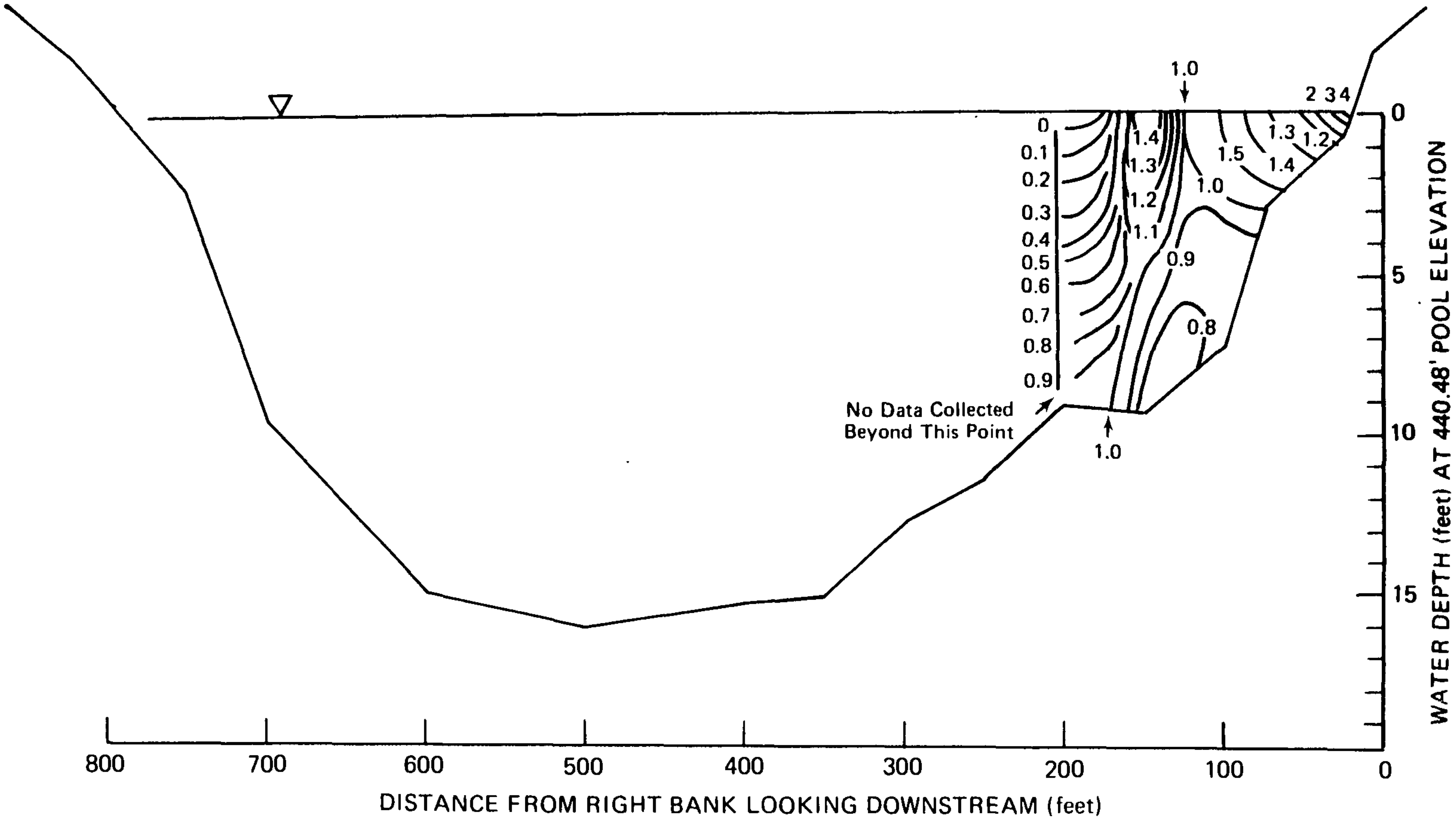


Figure 62. Percents of effluent dye concentration at station 12+00, July 12, 1984

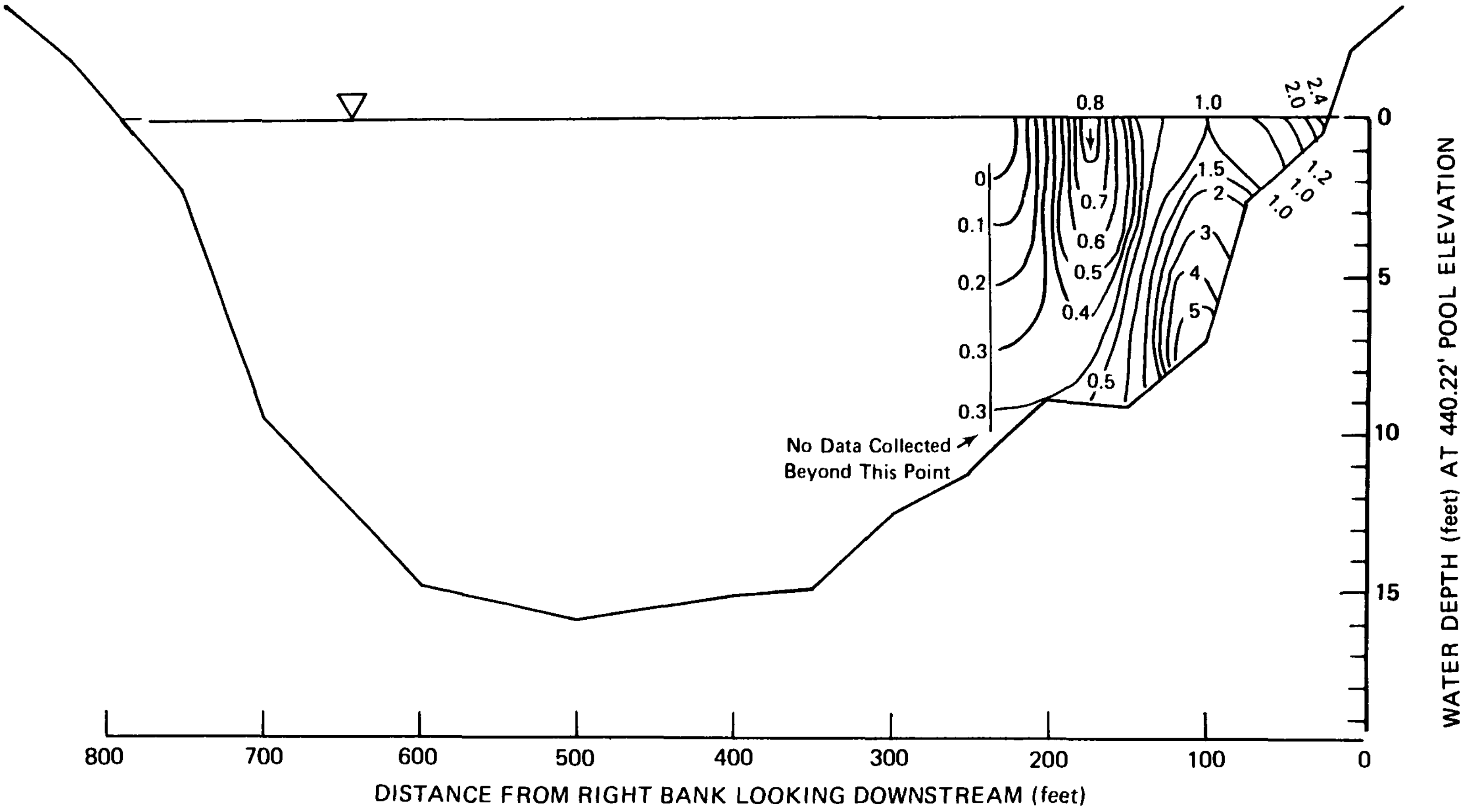


Figure 63. Percents of effluent dye concentration at station 12+00, July 19, 1984

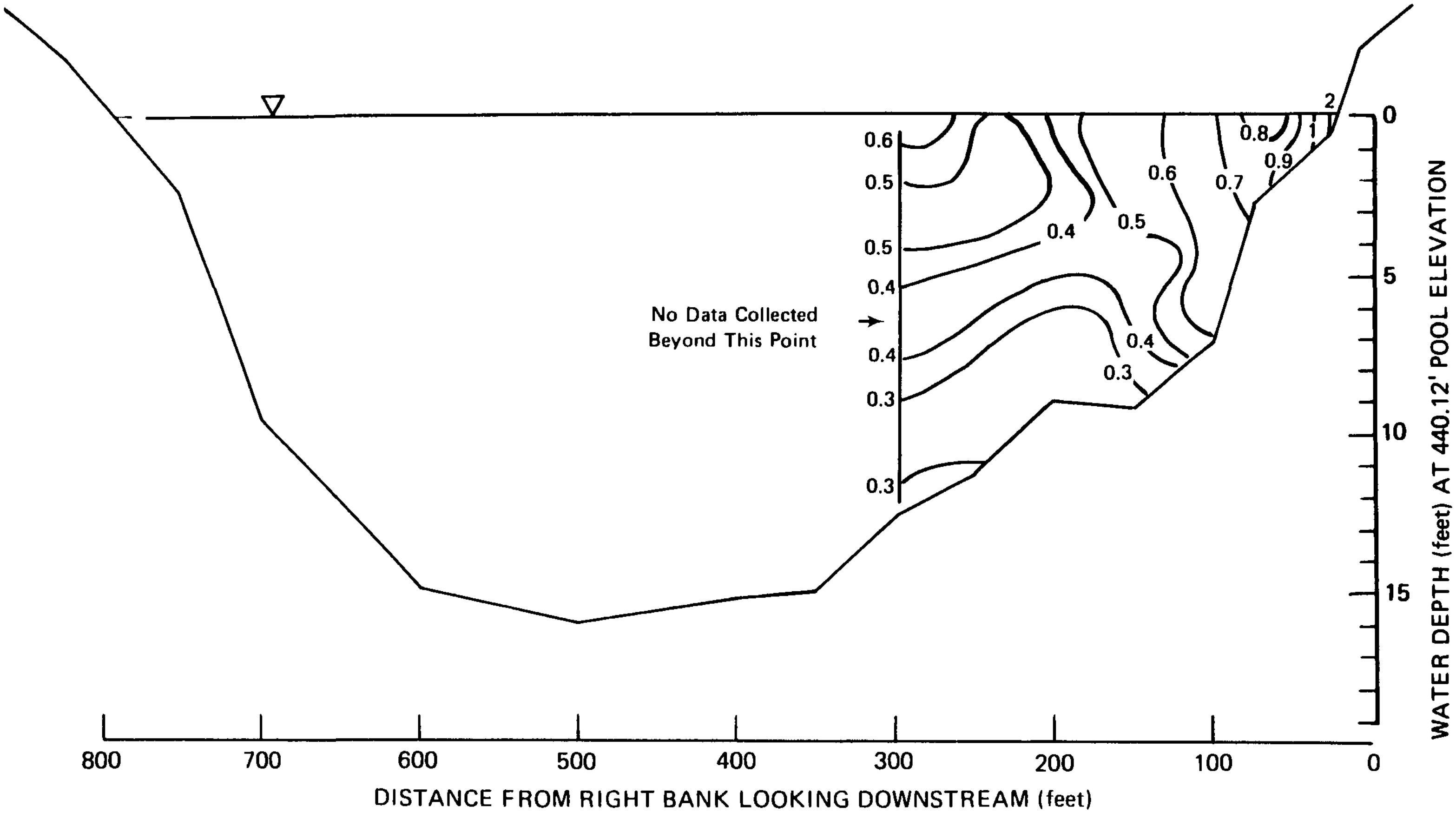


Figure 64. Percents of effluent dye concentration at station 12+00, July 31, 1984

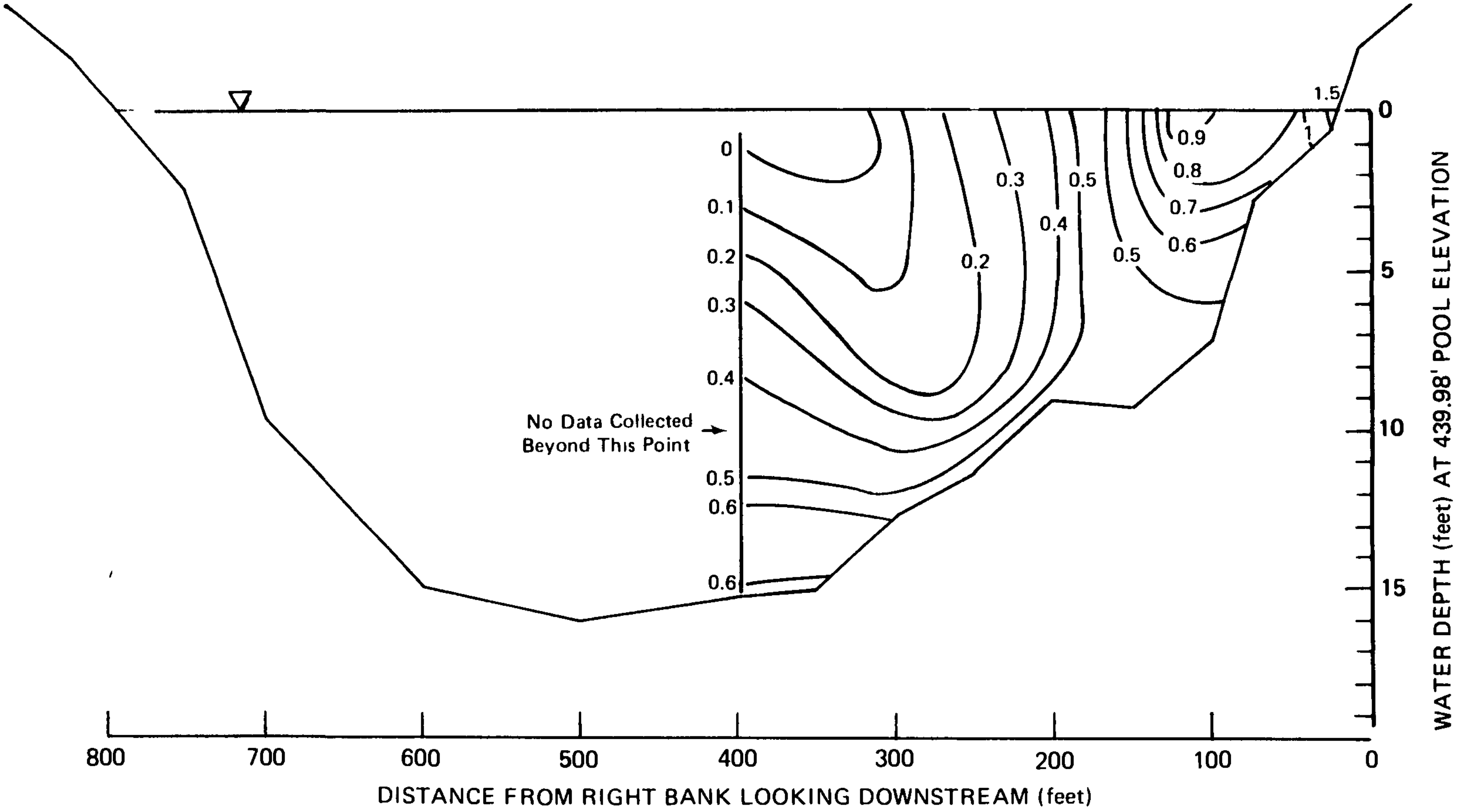


Figure 65. Percents of effluent dye concentration at station 12+00, August 7, 1984

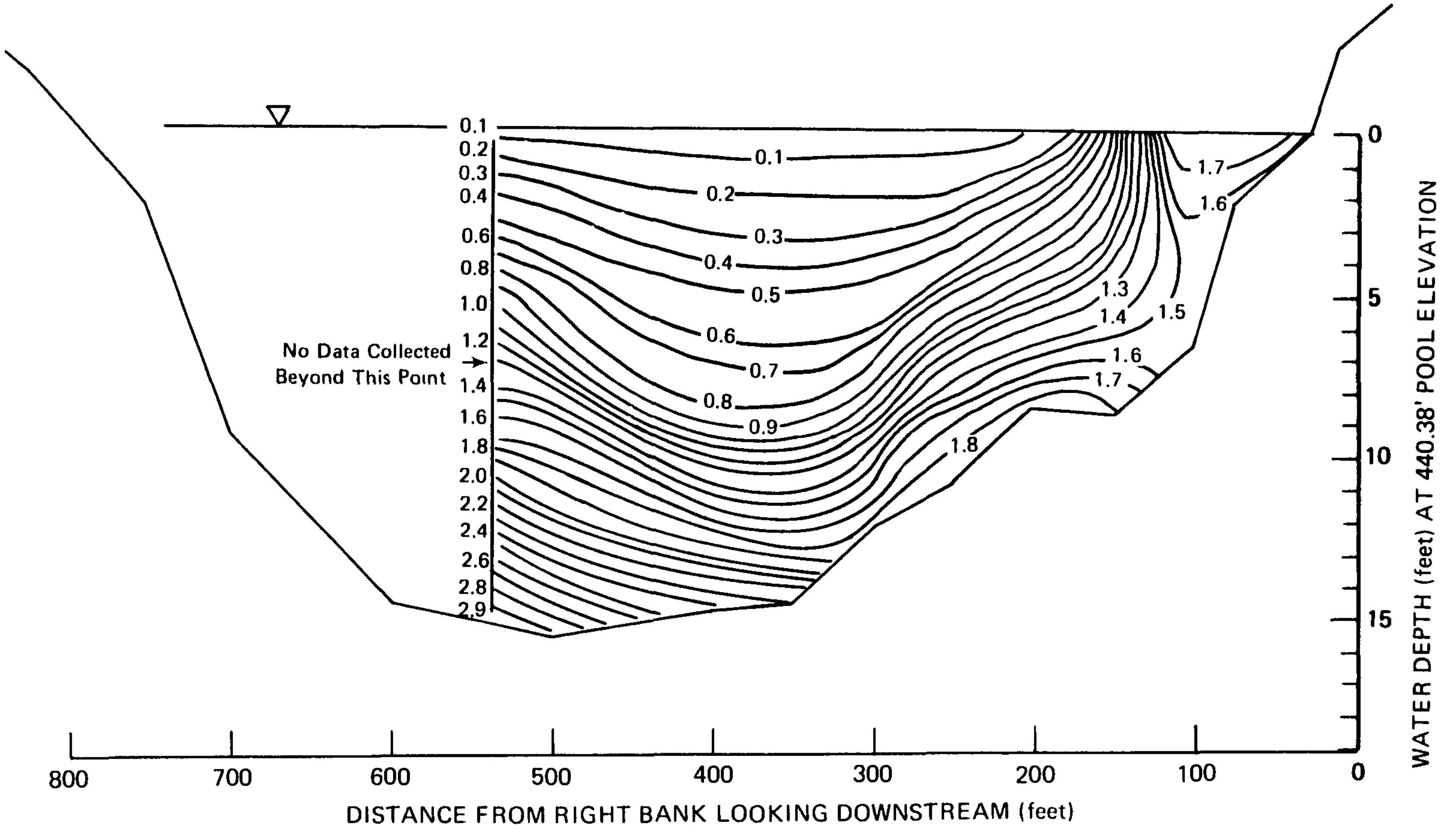


Figure 66. Percents of effluent dye concentration at station 12+00, August 14, 1984

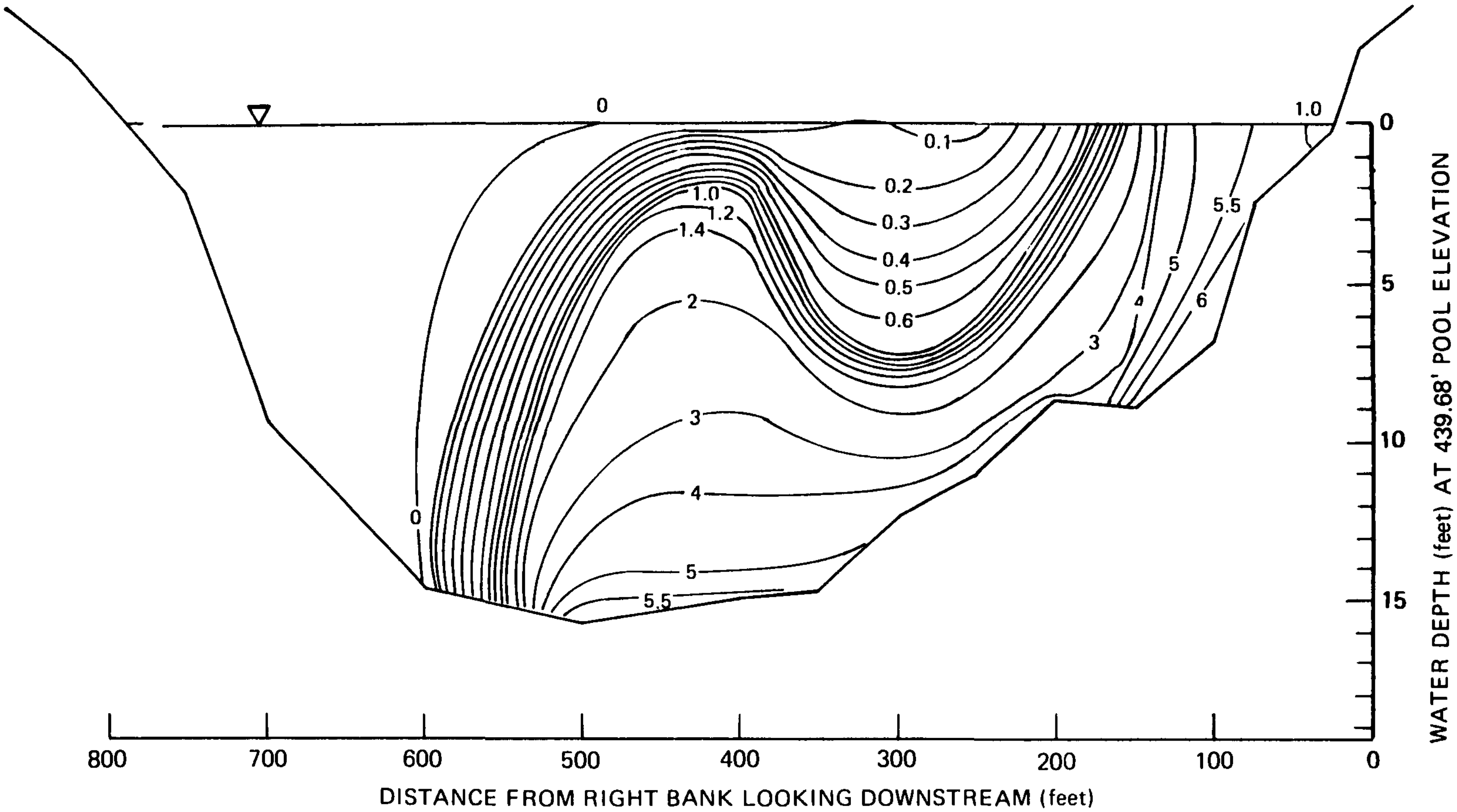


Figure 67. Percents of effluent dye concentration at station 12+00, August 21, 1984

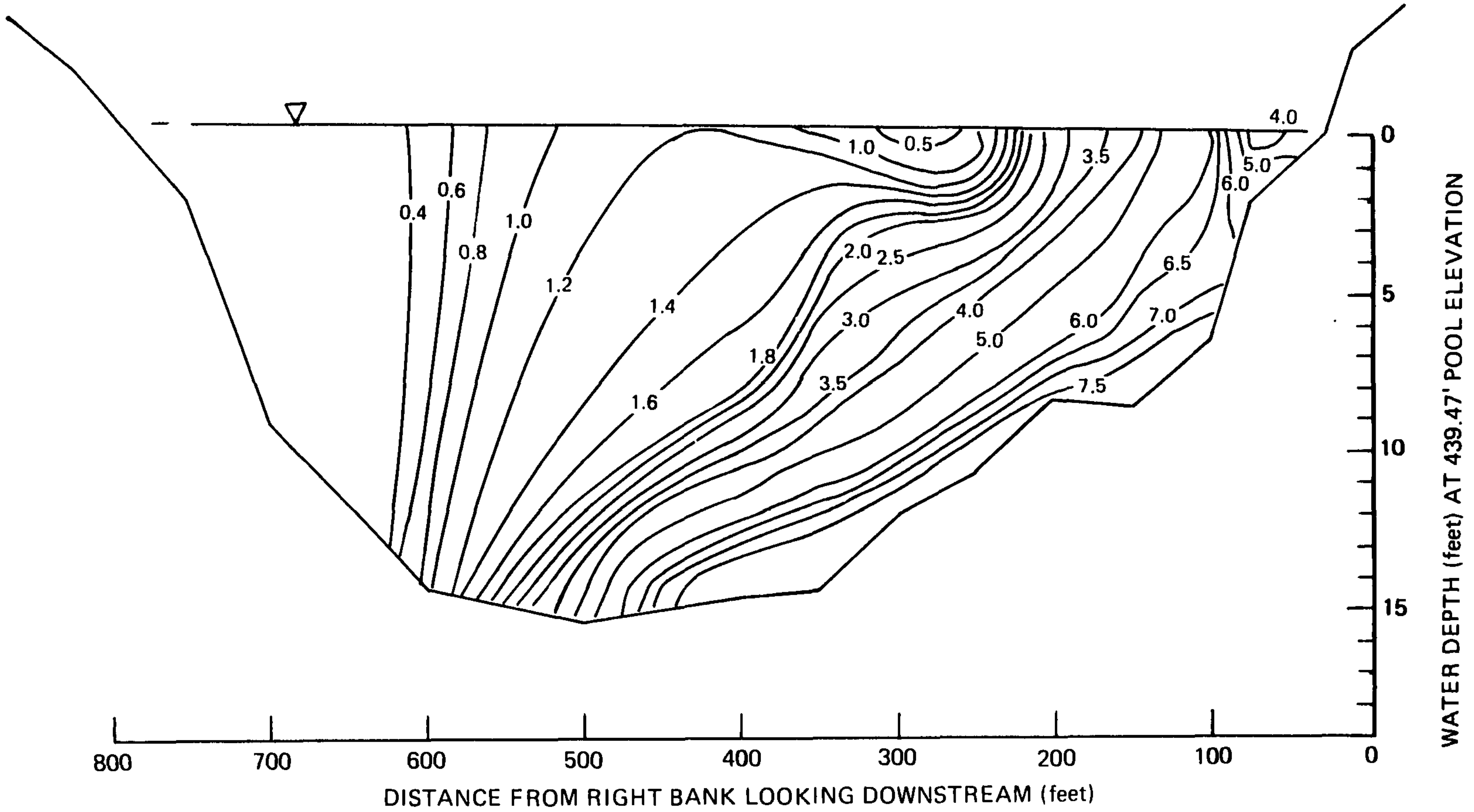


Figure 68. Percents of effluent dye concentration at station 12+00, August 28, 1984

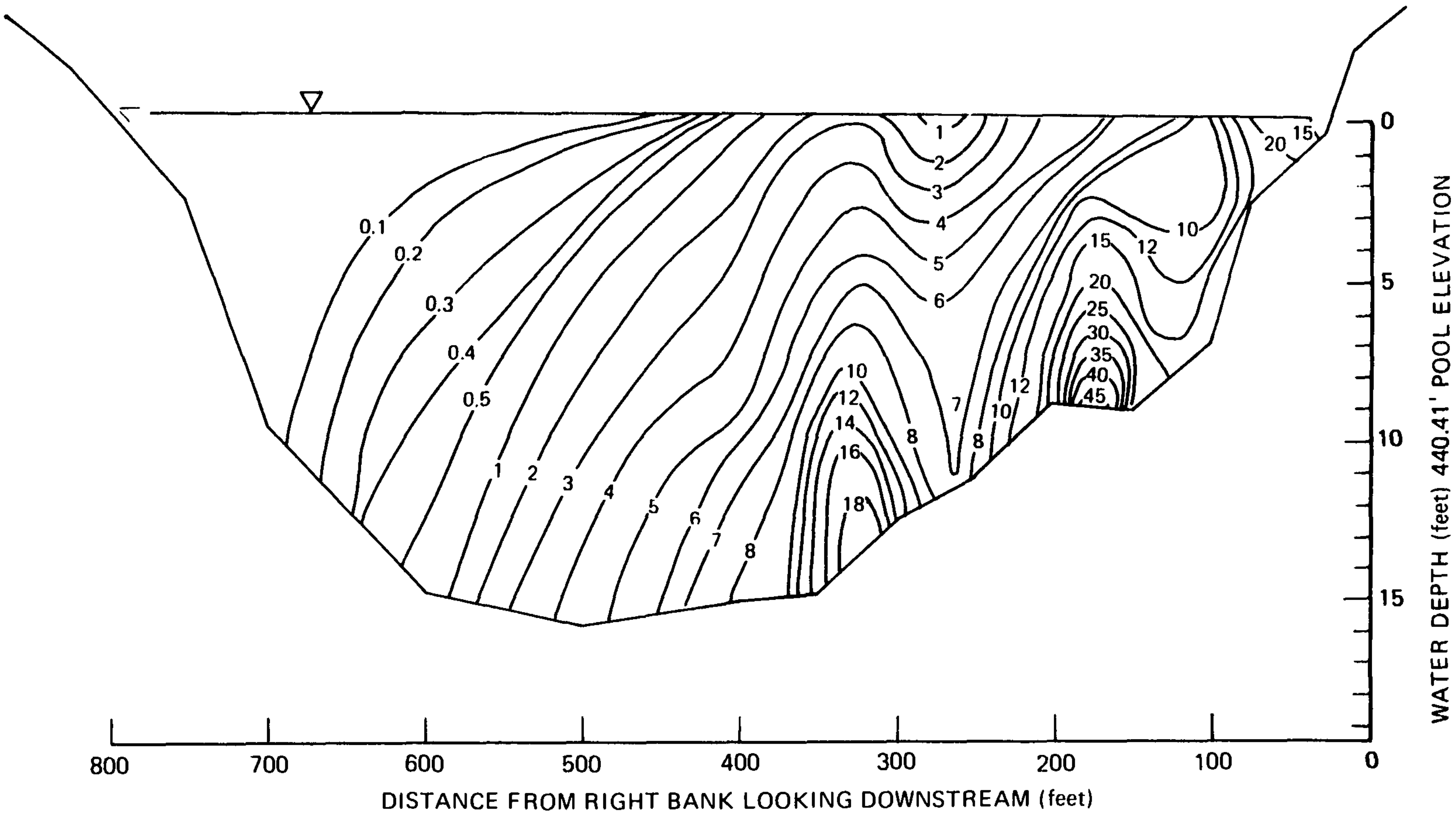


Figure 69. Percents of effluent dye concentration at station 12+00, September 11, 1984

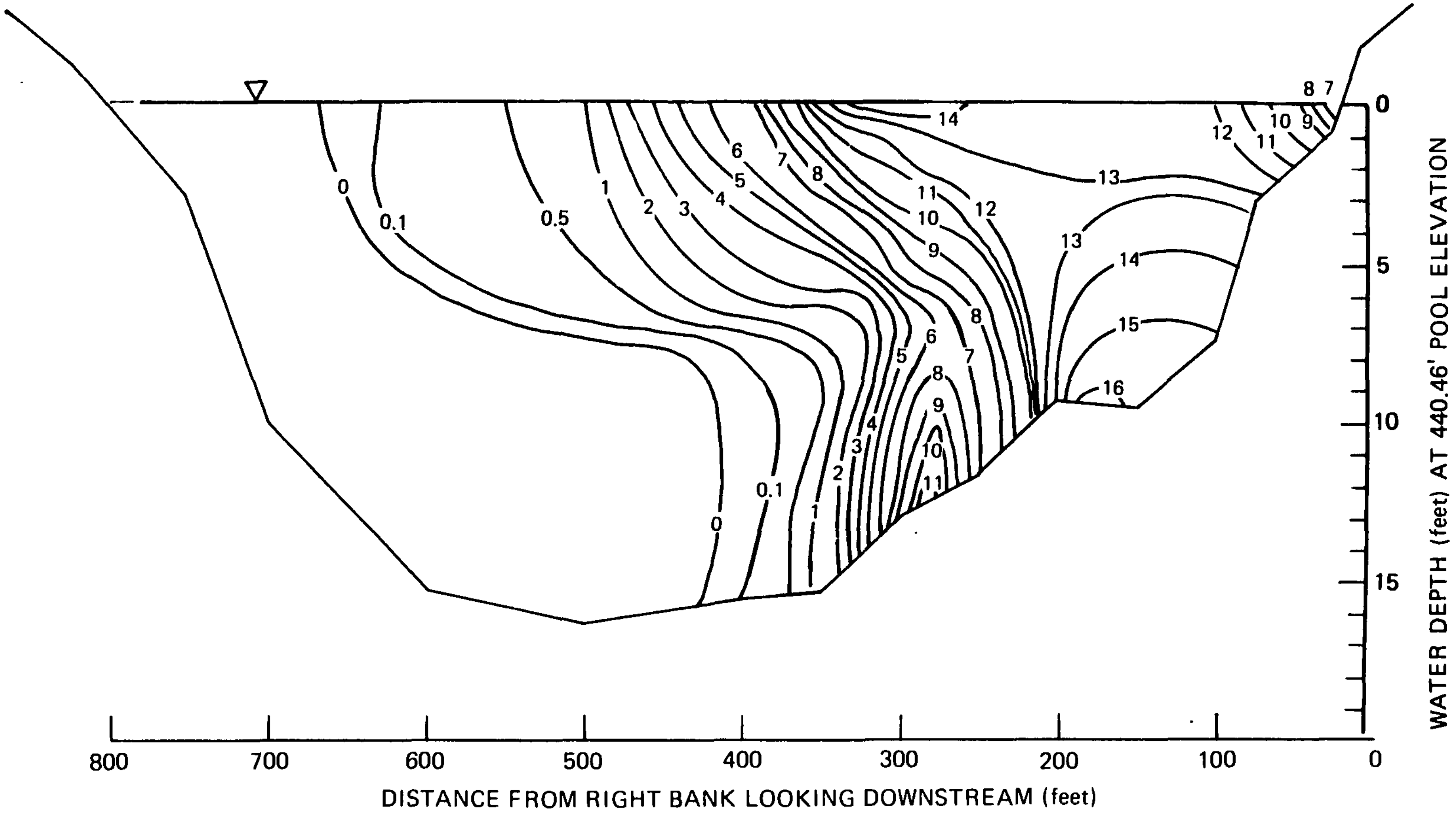


Figure 70. Percents of effluent dye concentration at station 12+00, September 18, 1984

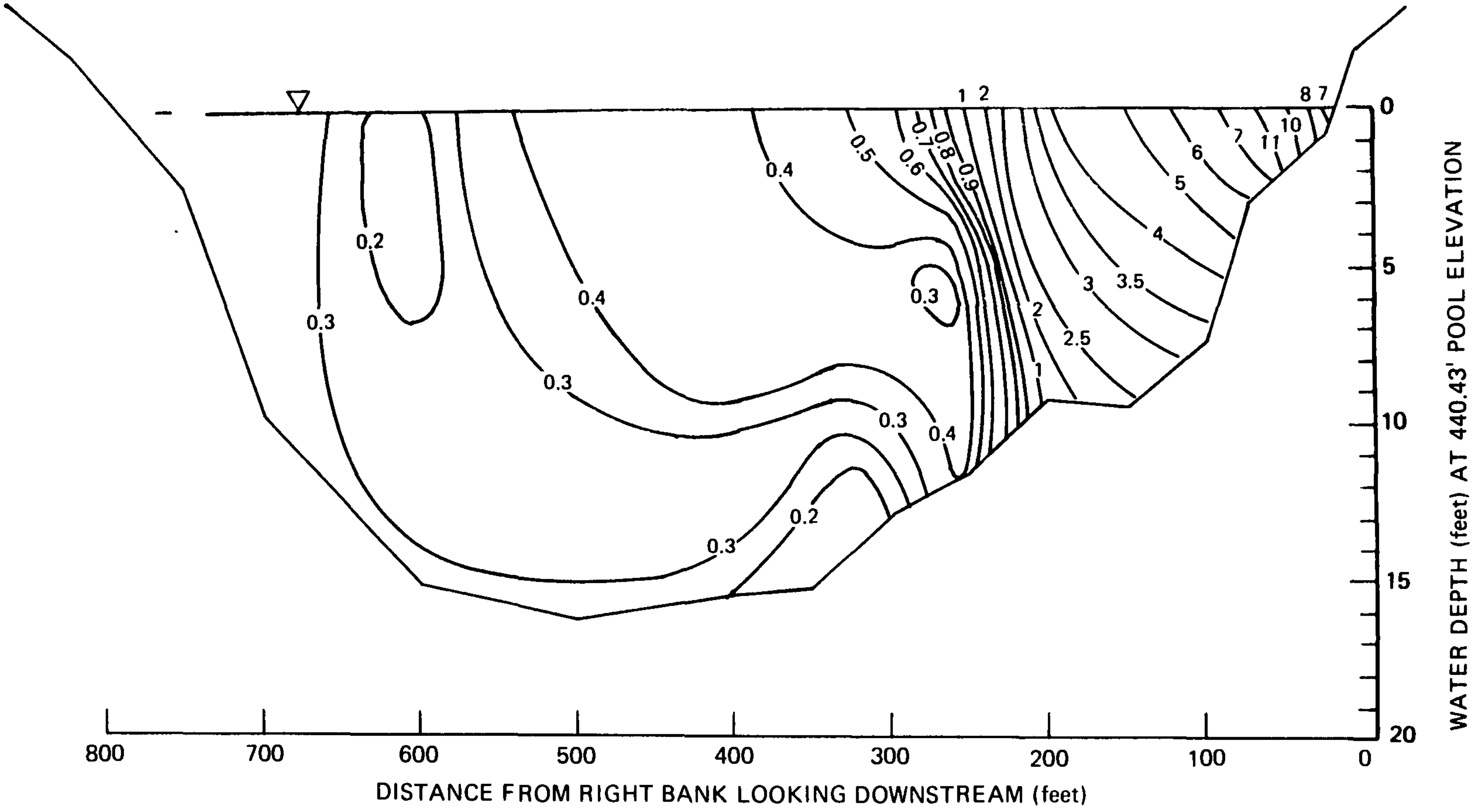


Figure 71. Percents of effluent dye concentration at station 12+00, October 23, 1984

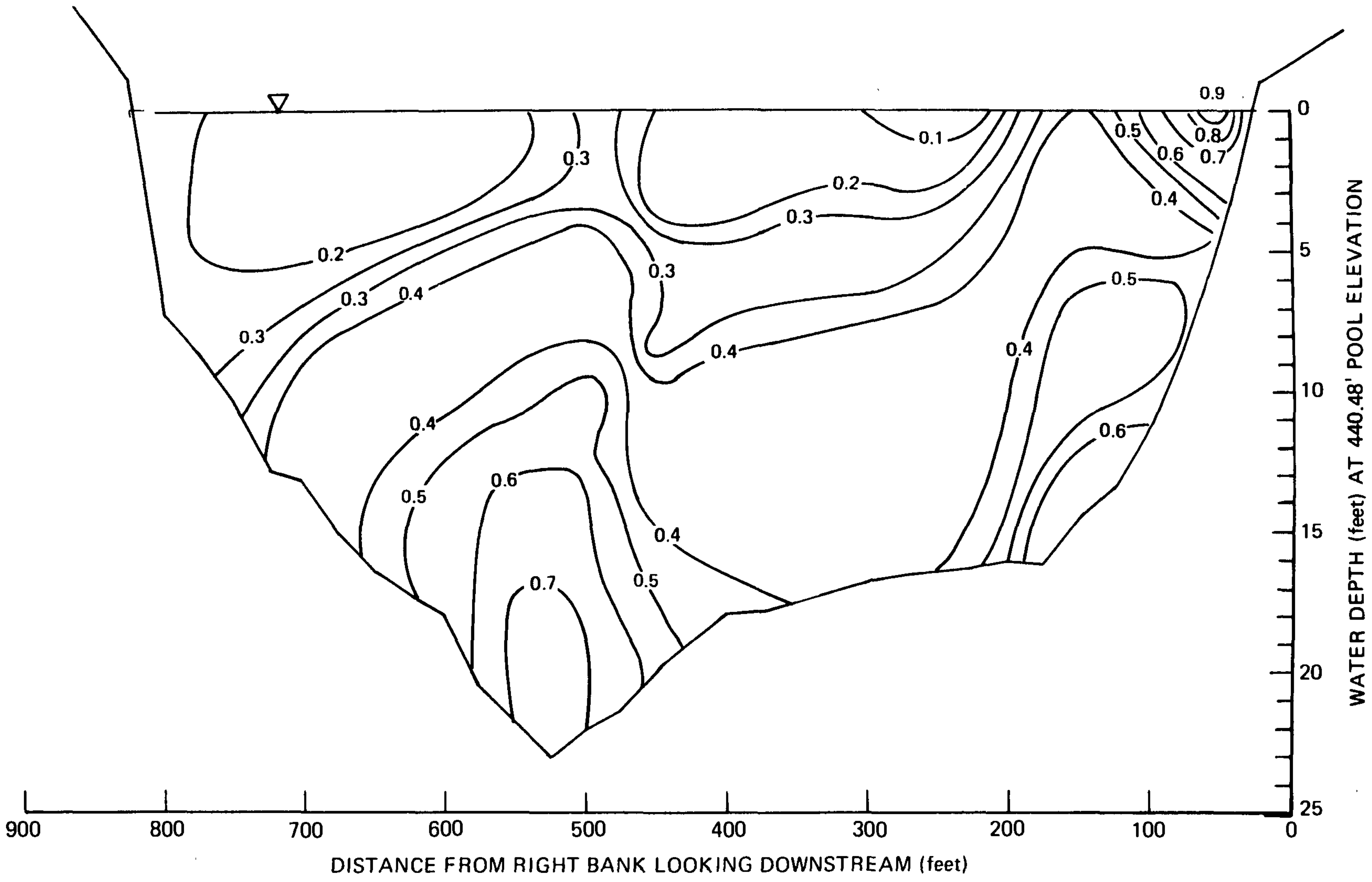


Figure 72. Percents of effluent dye concentration at station 104+00, July 12, 1984

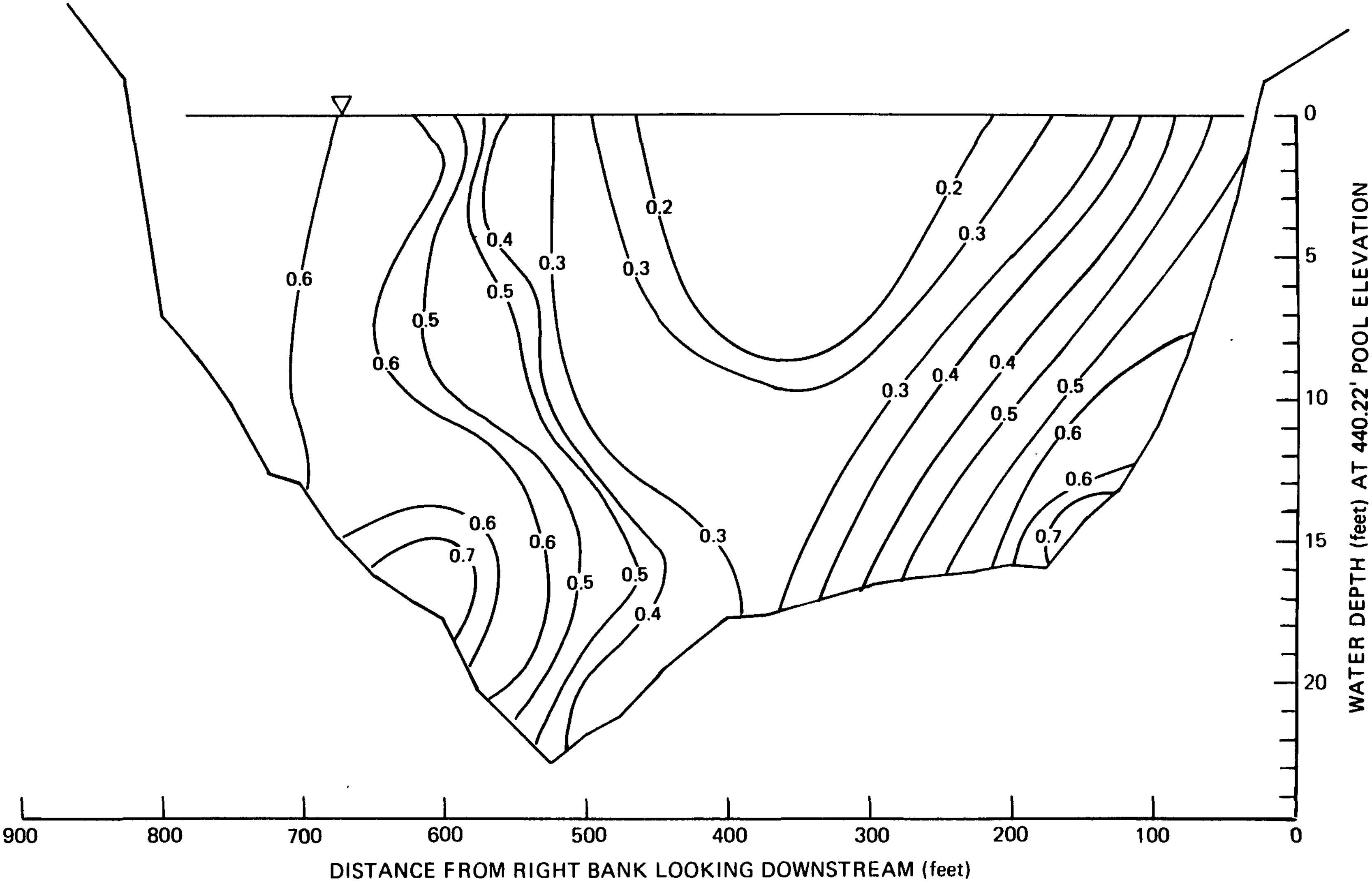


Figure 73. Percents of effluent dye concentration at station 104+00, July 19, 1984

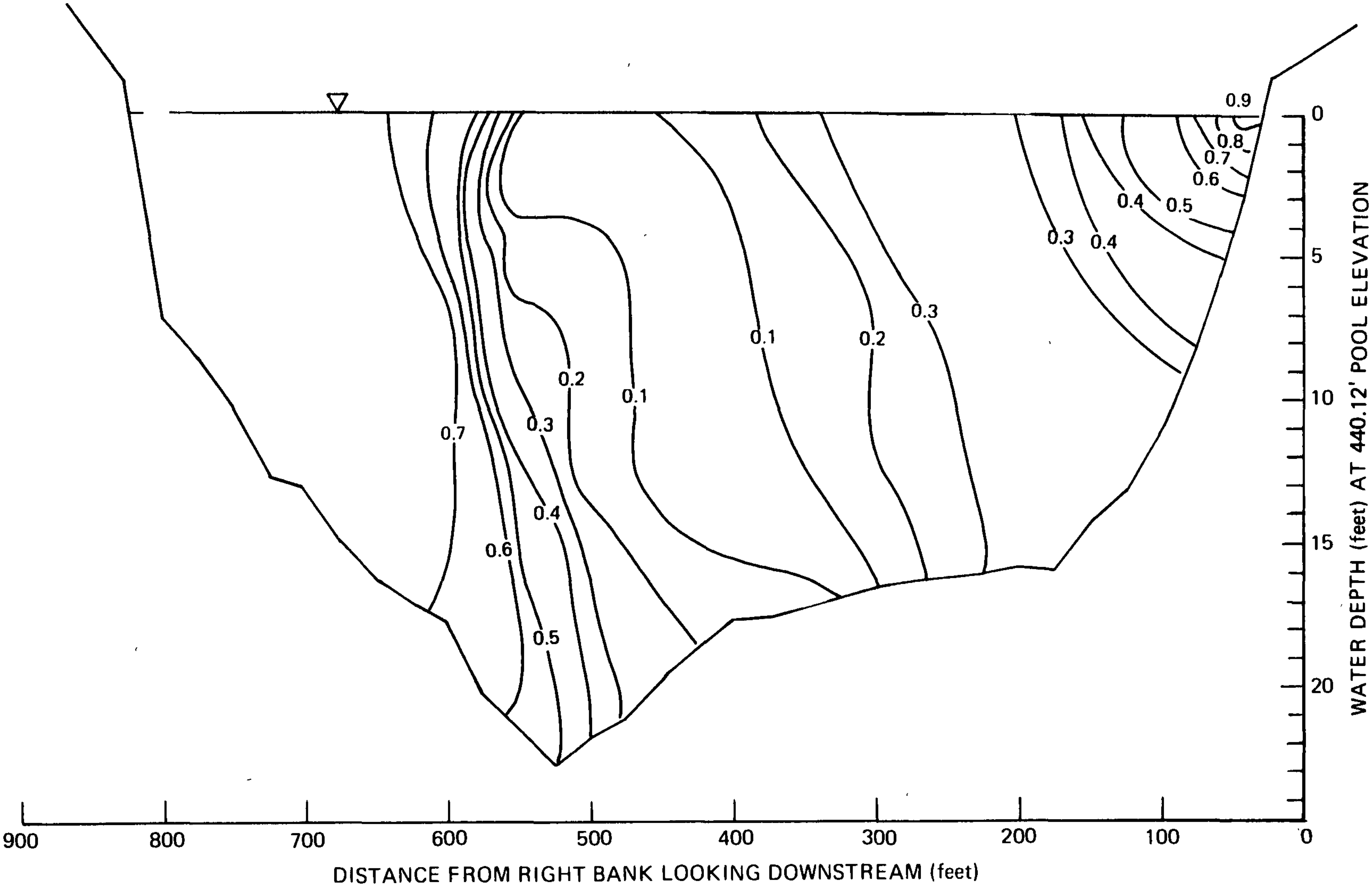


Figure 74. Percents of effluent dye concentration at station 104+00, July 31, 1984

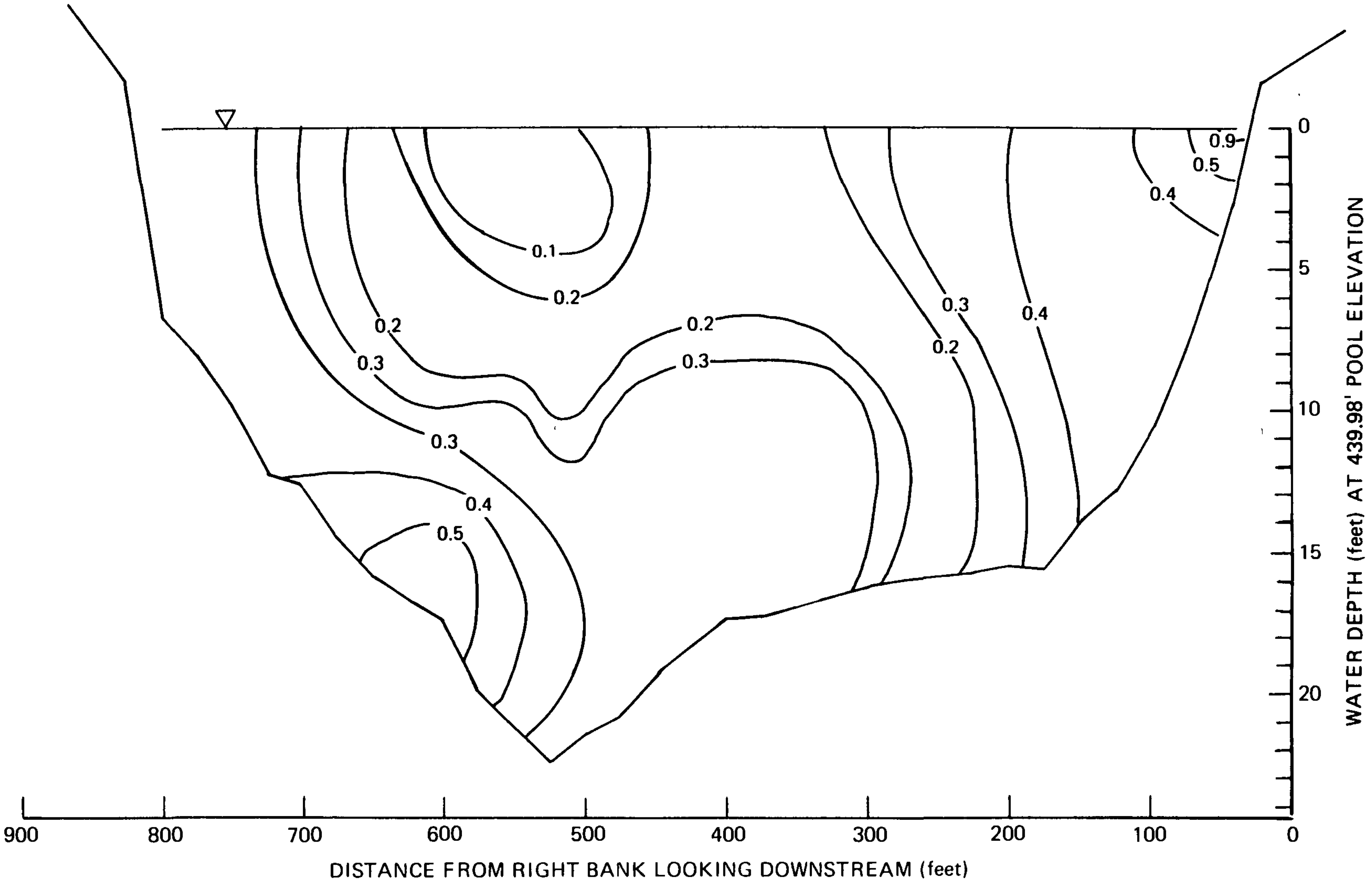


Figure 75. Pevoents of effluent dye concentration at station 104+00, August 7, 1984

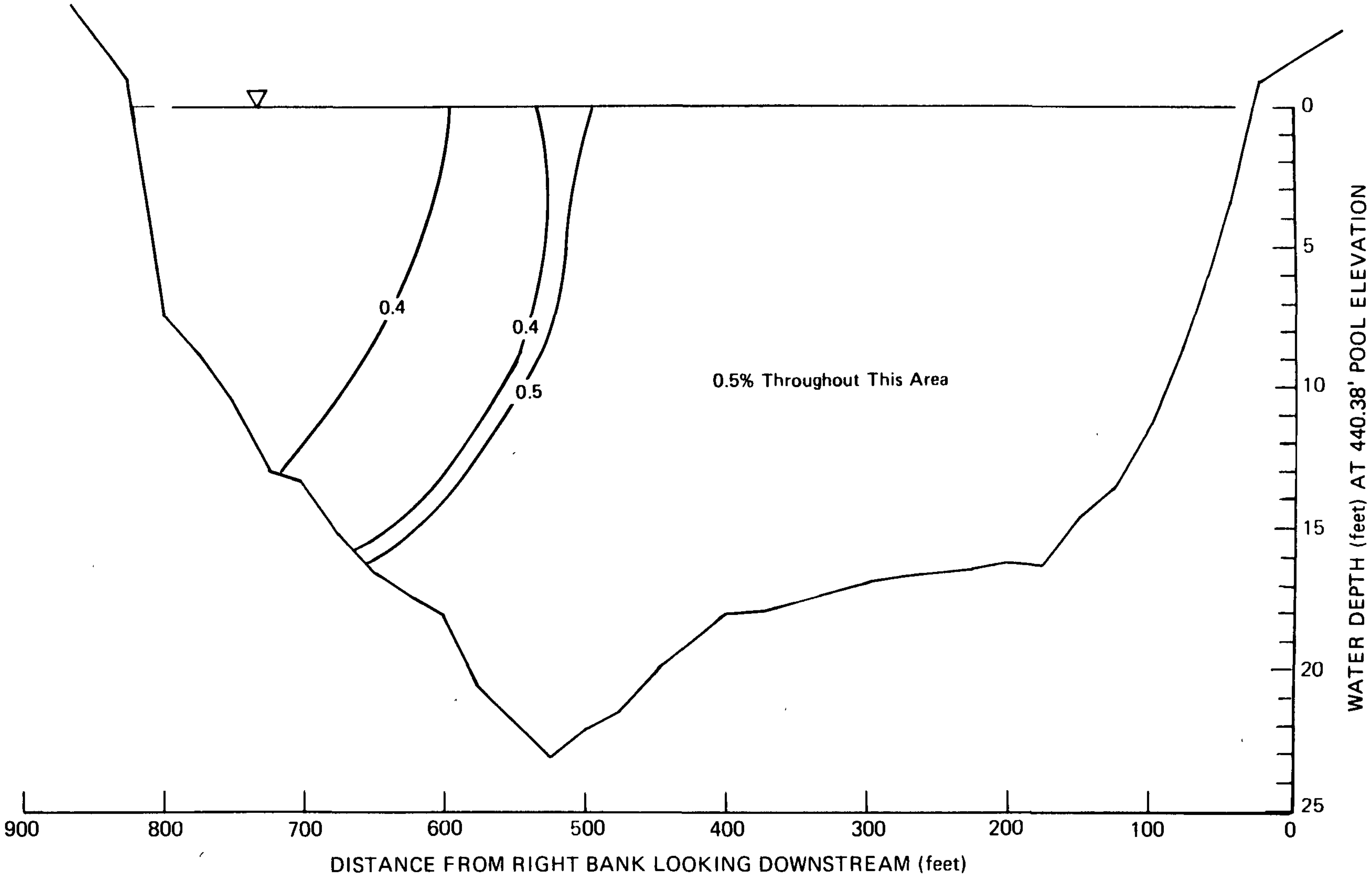


Figure 76. Percents of effluent dye concentration at station 104+00, August 14, 1984

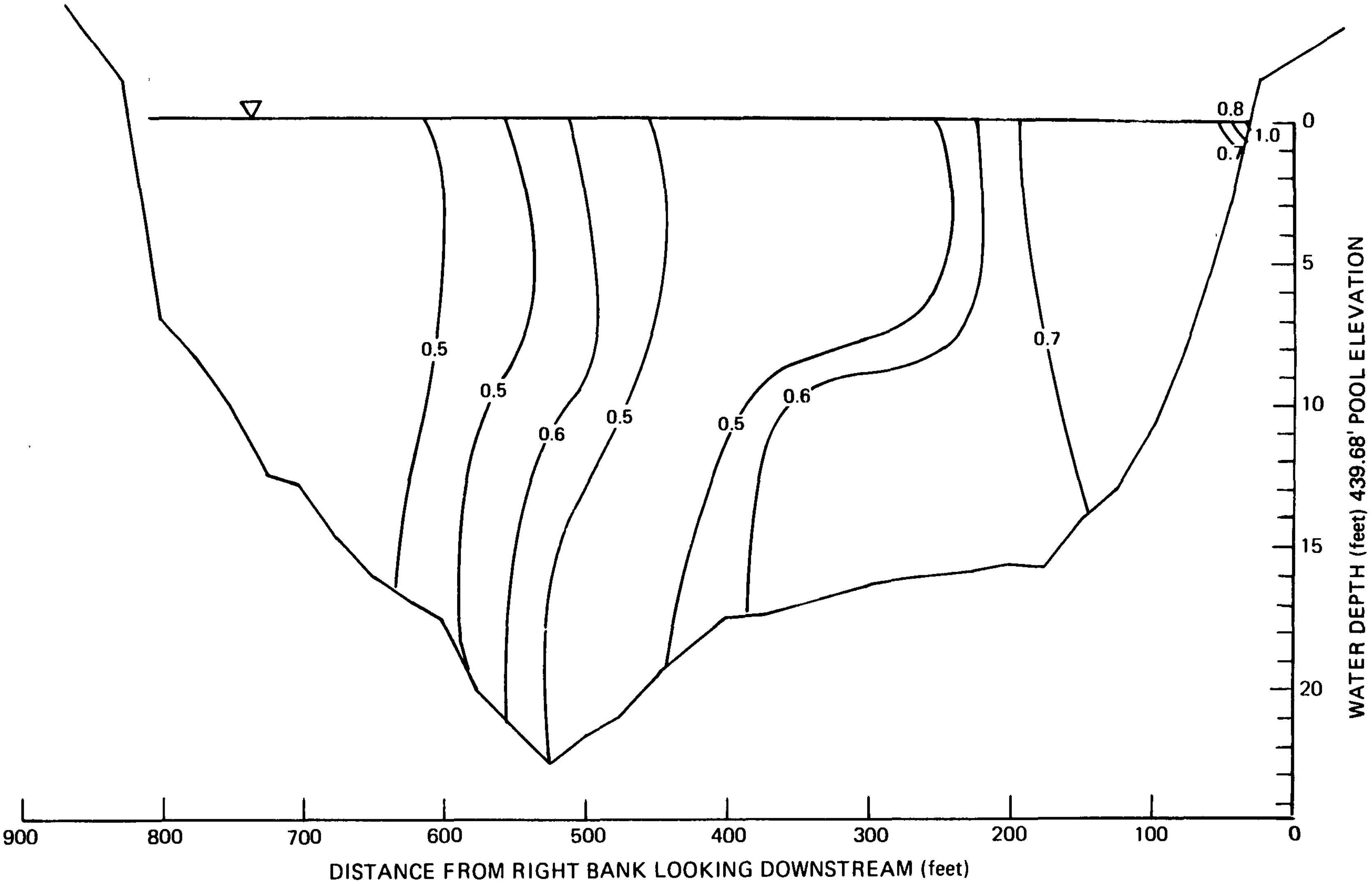


Figure 77. Percents of effluent dye concentration at station 104+00, August 21, 1984

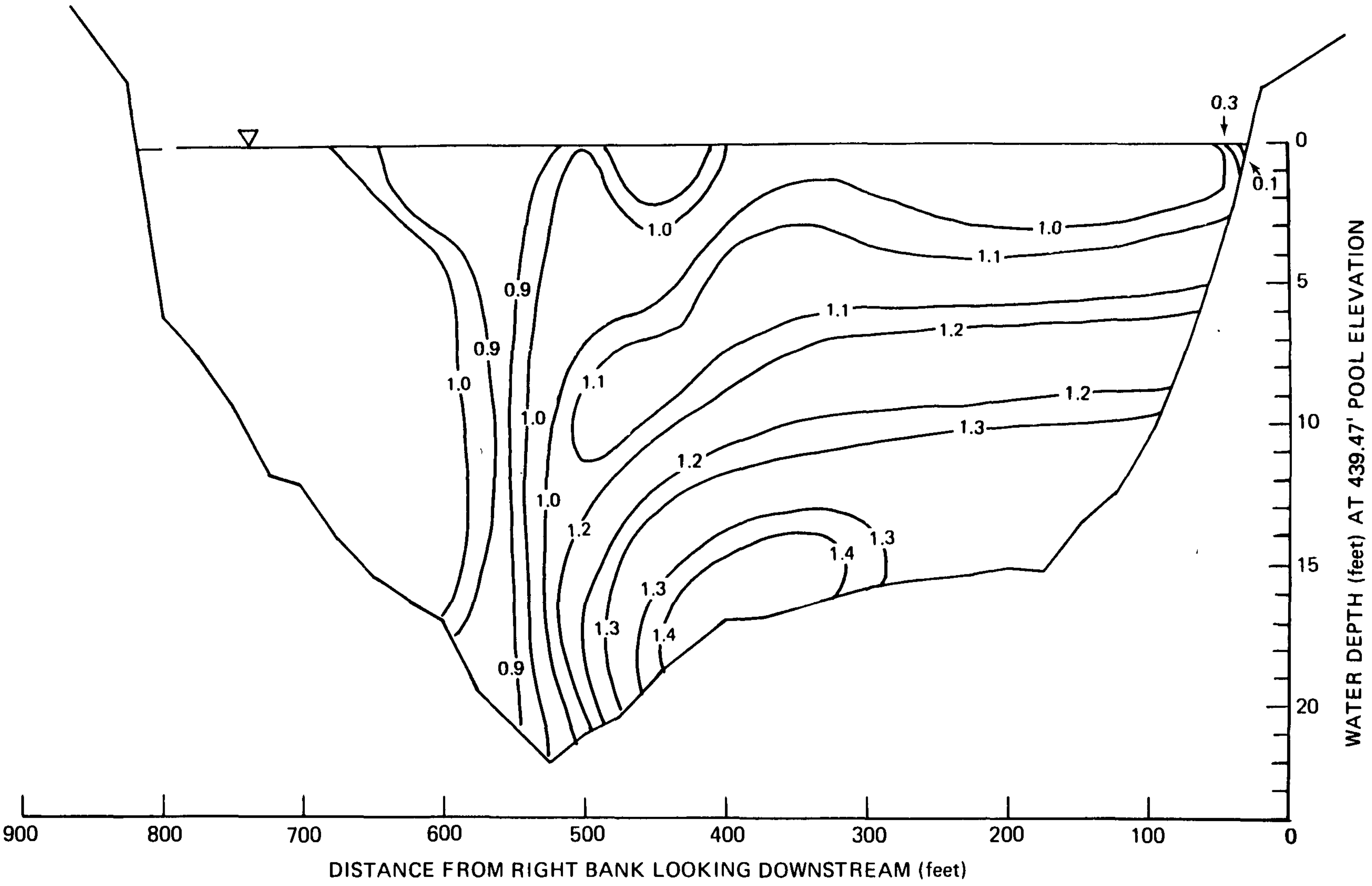


Figure 78. Percents of effluent dye concentration at station 104+00, August 28, 1984

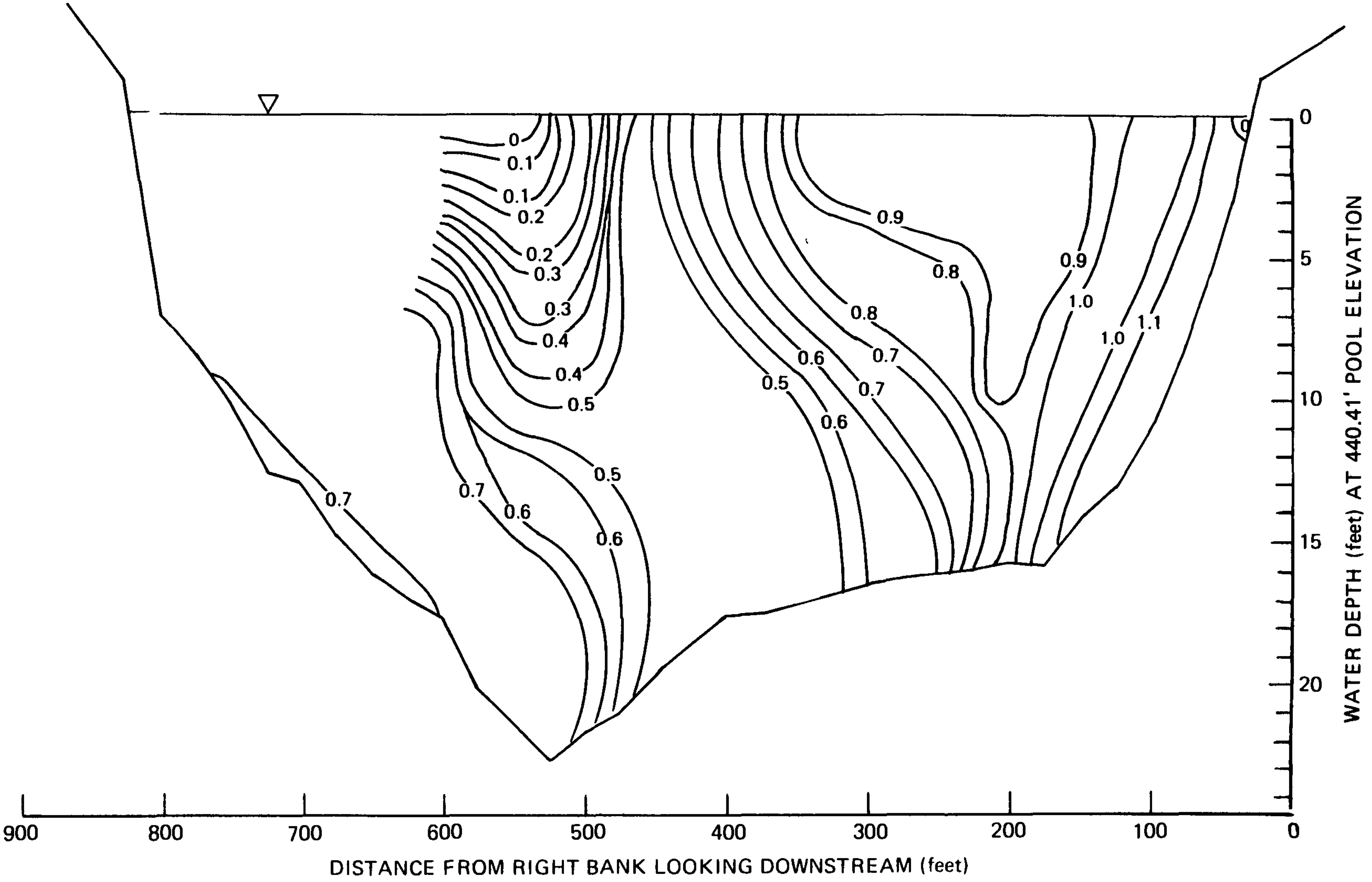


Figure 79. Percents of effluent dye concentration at station 104+00, September 11, 1984

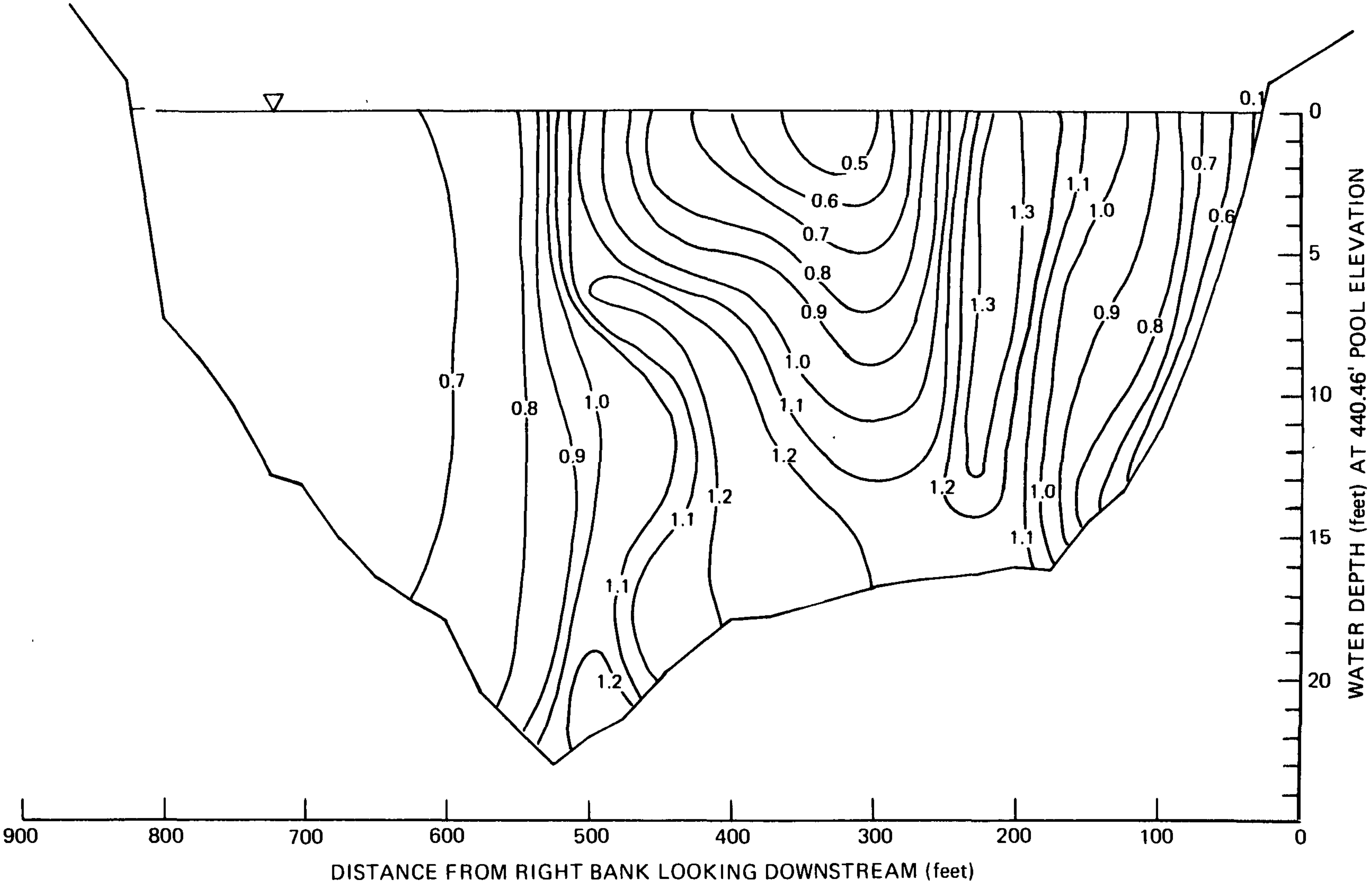


Figure 80. Percents of effluent dye concentration at station 104+00, September 18, 1984

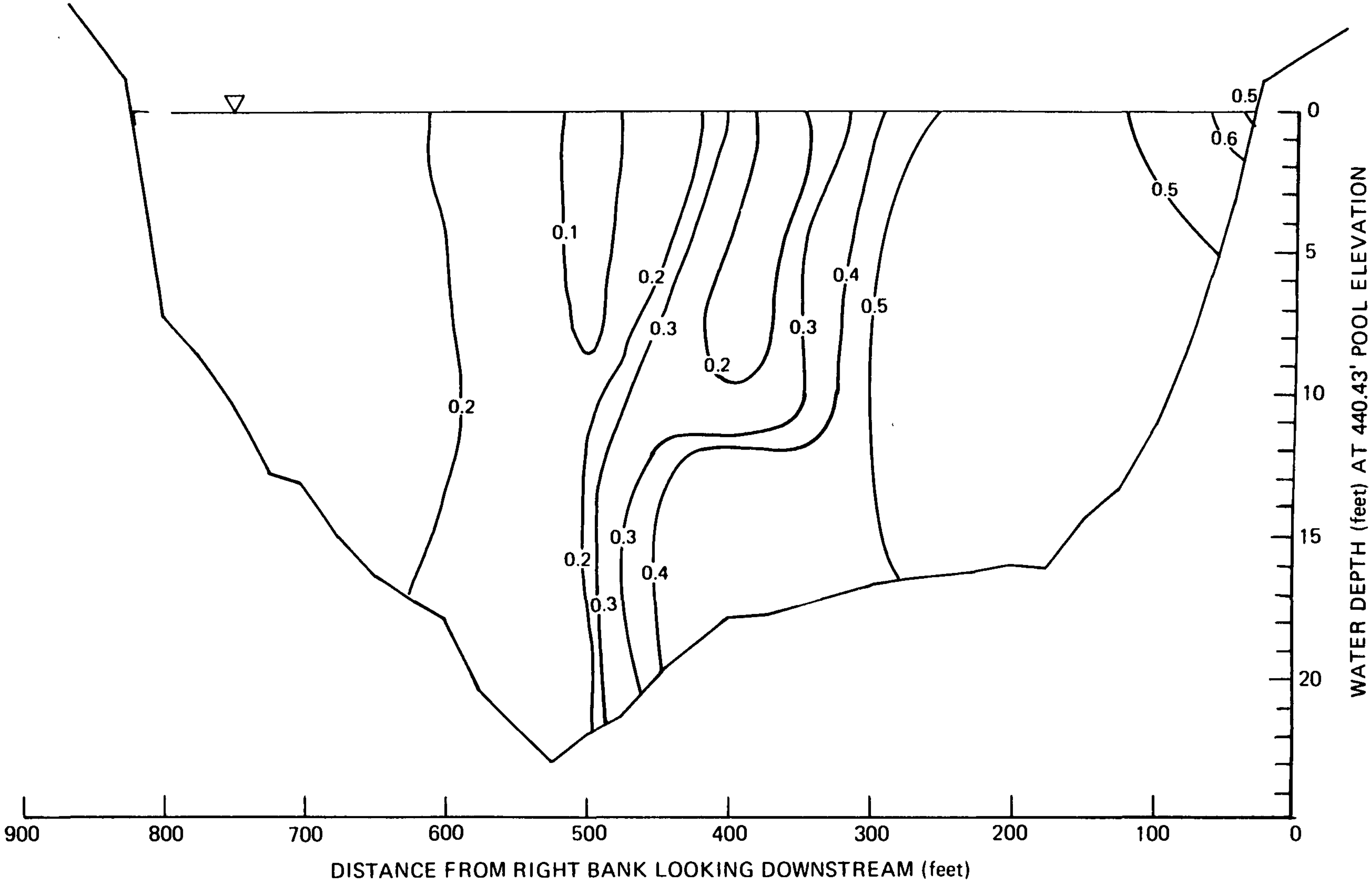


Figure 81. Percents of effluent dye concentration at station 104+00, October 23, 1984

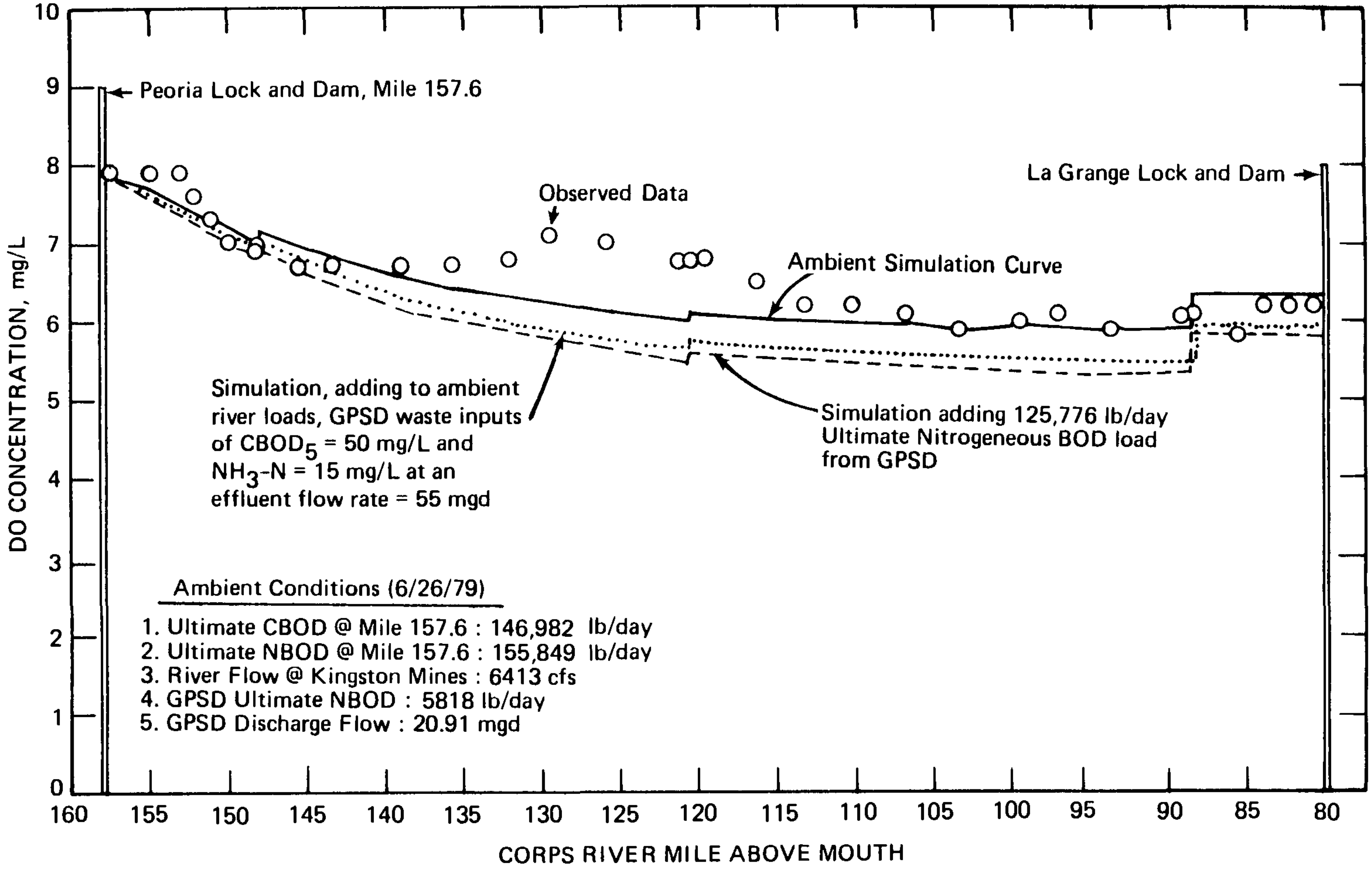


Figure 82. DO simulations, showing the potential effects of a large increase in GPSD ammonia loads for river conditions observed on June 26, 1979

DISCUSSION

Nitrogenous compounds in water can create a number of environmental and ecological problems. Such compounds can be acutely toxic to aquatic fauna and flora, can depress dissolved oxygen through ammonia oxidation, can cause public health problems, can stimulate algae growths, and can reduce disinfection efficiencies during the chlorination of potable water. Only the first two are of importance to this study since these are the only two factors which are governed or limited by standards set forth in the IPCB's Rules and Regulations as administered by the IEPA.

The following discussions concern three basic topics: (1) the acute toxicity implications of ammonia-N discharges, or direct water quality effects, (2) dissolved oxygen depletion associated with ammonia-N oxidation, or indirect water quality effects, and (3) mixing and dispersion phenomena associated with direct water quality effects. Criteria are presented whereby mixing zones can be readily defined and pollutant dispersion analyzed.

Toxicity Implications

Total ammonia-N exists in an aqueous solution in two distinct forms: (1) a molecular gas or un-ionized fraction (NH_3-N) in equilibrium with (2) an ammonium ton fraction (NH_4^+-N). The percent composition of each fraction is a function of temperature and pH. This fact is reflected in the IPCB's ammonia-N standards, which are weighted in favor of regulating the NH_3-N (un-ionized ammonia-N levels) in surface waters. This is because NH_3-N has been found to be much more toxic to aquatic organisms over a wide range of pH and temperature conditions than is NH_4^+-N. Compared to dissolved ammonia gas the ammonium ion is relatively innocuous.

Paragraph d) of Section 302.212 (Ammonia Nitrogen and Un-ionized Ammonia) of the IPCB Rules and Regulations contains two equations used to calculate the un-ionized components of the total ammonia-N content in water. These equations are:

$$U = \frac{N}{(0.94412)(1+10^{X}) + 0.0559} \quad \ldots\ldots\ldots\ldots \quad (3)$$

where U = un-ionized ammonia concentration as N in mg/l, and N = total ammonia concentration as N in mg/l.

$$X = 0.09018 + \frac{2729.92}{T + 273.16} - pH \quad \ldots\ldots\ldots\ldots \quad (4)$$

where T = temperature in degrees Celsius, and pH = pH in pH units.

These equations were used to develop a table of ammonia-N water quality standards set forth in paragraph e) of Section 302.212. This table has been reproduced in this report as table 18. The IEPA standard values listed in table 12 and Appendix D were obtained from this table.

Note that as given combinations of pH and temperatures rise the allowable total ammonia-N value becomes smaller up to a point where it remains constant at 1.5 mg/l regardless of increases in temperature and pH. The "breakpoints" are at temperature (T) and pH values, which, in combination with total ammonia-N (N) equal to 1.5 mg/l, yield "U" values of approximately 0.04 mg/l in equation 3. This in turn must reflect the toxicity criterion set forth in Section 302.210, "Substances Toxic to Aquatic Life," which states that any substance toxic to aquatic life shall not exceed one-tenth of the 96-hour median tolerance limit (96-hr TL_m) for native fish or essential fish food organisms. In other words, the IPCB and the IEPA must consider 0.40 mg/l of NH_3-N to be the minimum level which is toxic to native fishes. This contention is supported by work done by Roseboom and Richey (1977). They found that the most NH_3-N-sensitive common Illinois fish was the bluegill, and its 96-hr TL could be as low as 0.40 mg/l of NH_3-N. Consequently, the allowable ammonia-N concentration in the GPSD effluent has to be evaluated on the basis of permitting 1.5 mg/l ammonia-N in the river outside the mixing zone.

To put the relationship between river and GPSD ammonia-N levels in proper perspective, historical conditions must be

Table 18. IPCB Ammonia-Nitrogen Water Quality Standard Table*

Water Temp.		Allowable Total Ammonia-N Concentration in mg/l at pH values of						
°C	°F	6.0	6.5	7.0	7.5	8.0	8.5	9.0
5	41	15	15	15	9.6	3.1	1.5	1.5
10	50	15	15	15	6.5	2.1	1.5	1.5
15	59	15	15	13.9	4.4	1.5	1.5	1.5
20	68	15	15	9.6	3.1	1.5	1.5	1.5
25	77	15	15	6.7	2.1	1.5	1.5	1.5
30	86	15	14.9	4.7	1.5	1.5	1.5	1.5
35	95	15	10.7	3.4	1.5	1.5	1.5	1.5

* From IPCB Rules and Regulations, Section 302.212, Paragraph e)

looked at and evaluated. On October 10, 1979, rotating biological contactors (RBCs) were put into operation to remove ammonia-N so that the discharge standard of 2.5 mg/L contained in paragraph a) of Section 304.122 of the IPCB's Rules and Regulations could be met. The RBCs proved to be very effective in removing ammonia-N from the effluent. For 92 river sampling dates (January 1, 1978 through October 10, 1979) before the RBCs went on line, the average GPSD ammonia-N effluent load was approximately 2000 lbs/day. For the sampling period between January 1, 1983 and October 1, 1984 the average effluent load was only about 450 lbs/day. This is a significant reduction, showing the effectiveness of the RBCs in removing ammonia-N. However, the worth of this reduction in improving river conditions is questionable. In terms of concentrations, the GPSD was, on the average, elevating the total ammonia-N in the river by about 0.037 mg/l. For any given sampling date the ambient river concentration was never raised more than 0.090 mg/l during the 21-month period just prior to the start-up of the RBCs Csee Appendix D). The 0.090 mg/l figure barely fits within the detection limits for the ammonia-N tests presented in the 16th edition of Standard Methods for the Examination of Water and Wastewater. The most precise and accurate method listed for analyzing water samples with concentrations in the range of those detected in the Illinois River produces results with standard deviations ranging from 0.076 mg/l at 0.20-mg/l ammonia-N concentrations to 0.174 mg/l at 1.50-mg/l ammonia-N concentrations.

The systematic river sampling carried out during this study revealed the direct influence of the GPSD ammonia-N discharges on the river under present operations. The maximum values observed for each sampling date at each sampling station have been extracted from the results contained in Appendix C and are presented in table 19 for comparisons with the IPCB and/or IEPA standards. Note that the standard is the minimal 1.5 mg/l value for all dates but the last. The observed values were well below the standards in all cases but one. On October 15, 100 feet from shore at mile 160.01 (the outfall location) a value of 3.23 mg/l was observed. However, 300 feet farther out at the same location a maximum of only 0.22 mg/l was detected. Also, downstream at mile 158.01, near shore and channel minimum values of only 0.30 and 0.35 mg/l, respectively, were observed. At this time, the GPSD was discharging 8.0 mg/l of ammonia-N in an effluent flow of 24 mgd; the river flow was a low 6554 cfs. The combination of high effluent ammonia-N concentration and low river flow did not produce any standard violations except in the immediate area of the outfall. As will become evident later, this high value clearly falls well within the confines of any stringently defined mixing zone.

Table 19. Comparison between Maximum Observed (Obs)
Ammonia-N Concentrations and
IEPA Standards (Std) for Given Temperature and pH

	Ammonia-N Concentrations (mg/l) at Stations											
	160.95				160.01				158.01			
	150'		550'		100'		400'		100'		400'	
Date	Obs	Std	Obs	Std	Obs	Std	Obs	Std	Obs	Std	Obs	Std
7/11/84	0.32	1.5	0.24	1.5	0.19	1.5	0.25	1.5	0.32	1.5	0.27	1.5
7/18	0.11	1.5	0.09	1.5	0.18	1.5	0.13	1.5	0.12	1.5	0.14	1.5
7/24	0.29	1.5	0.22	1.5	0.26	1.5	0.21	1.5	0.29	1.5	0.31	1.5
7/30	0.06	1.5	0.08	1.5	0.14	1.5	0.14	1.5	0.16	1.5	0.18	1.5
8/06	0.21	1.5	0.24	1.5	0.28	1.5	0.28	1.5	0.28	1.5	0.31	1.5
8/13	0.47	1.5	0.31	1.5	0.33	1.5	0.25	1.5	0.26	1.5	0.30	1.5
8/20	0.39	1.5	0.30	1.5	0.28	1.5	0.44	1.5	0.37	1.5	0.39	1.5
8/23	0.22	1.5	0.18	1.5	0.36	1.5	0.23	1.5	0.27	1.5	0.27	1.5
8/30	0.32	1.5	0.39	1.5	0.39	1.5	0.49	1.5	0.38	1.5	0.32	1.5
9/04	0.24	1.5	0.31	1.5	0.33	1.5	0.32	1.5	0.29	1.5	0.30	1.5
9/13	0.47	1.5	0.47	1.5	0.58	1.5	0.48	1.5	0.57	1.5	0.48	1.5
9/27	0.22	1.5	0.21	1.5	0.31	1.5	0.34	1.5	0.28	1.5	0.28	1.5
10/04	0.29	1.5	0.35	1.5	0.32	1.5	0.34	1.5	0.40	1.5	0.39	1.5
10/11	0.20	1.5	0.21	1.5	1.18	1.5	0.21	1.5	0.31	1.5	0.32	1.5
10/15	0.26	1.5	0.24	1.5	3.23	1.5	0.22	1.5	0.30	1.5	0.35	1.5
10/25	0.37	1.8	0.38	1.7	0.95	1.5	0.31	1.7	0.36	1.5	0.42	1.7

Ammonia Qxidation Implication

Ammonia-N discharges have an indirect effect on water quality through biological oxidation processes. Oxygen depletion in streams can result from the biochemical utilization of ammonia by autotrophic bacteria as a source of energy to convert carbon dioxide to cellular material. Two very specialized chemolithotrophic bacteria, *Nitrosomonas* sp. and *Nitrobacter* sp., are the dominant genera involved in nitrification. Stoichiometrically, 4.57 mg/l of oxygen is required to completely oxidize 1.0 mg/l of ammonia-N to nitrate-N, a stable end product under aerobic conditions.

Nitrification can be a slow process either in normal waste treatment processes or in natural waters. The generation time for nitrifying bacteria ranges between 30 and 40 hours, compared to minutes for carbonaceous bacteria. The Illinois River in the vicinity of Peoria, however, generally contains a large, viable nitrifying bacterial population during warm weather due to the large upstream ammonia discharges from the Chicago area. The time of travel between Chicago and Peoria under low to normal flow conditions is sufficient for a large viable nitrifying bacteria population to develop (see table 15). Consequently, any ammonia loads discharged at Peoria should have an immediate impact on the DO resources downstream, particularly those in the LaGrange pool.

Nitrification occurs in unison with other stream oxidation processes. Carbonaceous bacterial biochemical oxygen (CBOD) usage, sediment oxygen consumption, and algal oxidation-reduction reactions all act as sinks to deplete the DO resources in surface waters. One of the objectives of this study was to isolate effects of GPSD ammonia-N loads on the DO resources in the LaGrange pool. This was done indirectly by using the modeling techniques described in the "Results" section of this report. The results indicated that tremendous ammonia-N loads would have to be discharged at Peoria to cause a significant change in the DO sag curves observed in the LaGrange pool.

The information presented in table 16 shows that over 125,000 lbs/day of ultimate nitrogenous biochemical oxygen demand CNBOD) would have to be added at Peoria to cause the downstream DO concentration to fall near 5.0 mg/l (the minimum standard) during 7-day, 10-year low flow conditions. The 125,000 lbs/day value is about equivalent to the present-day Chicago area input. The information presented in table 17 shows that such a large load will raise the river ammonia-N concentrations above the minimal acceptable 1.5 mg/l value only during extremely low flow conditions. As evidenced in table 17, this would require unrealistically high ammonia-N concentrations in the GPSD effluent. Therefore, the permissible GPSD ammonia-N discharge loads appear to be governed or limited by toxicity considerations rather than indirect water quality implications such as oxygen depletion.

Mixing Zone and Dispersion Considerations

The study results have shown that past and present ammonia-N discharges from the GPSD treatment facilities have rarely caused violations of water quality standards or water quality problems in general. In instances where GPSD ammonia-N discharges have raised river concentrations above desirable levels, the locations have been close to the outfall points. These locations appear to fall within what would have to be considered a mixing zone even under the most stringent definition of a mixing zone. The purpose of this portion of the discussion is to provide some direction in formulating or delineating a mixing zone specific to GPSD outfall conditions. The mixing zone, as defined, will apply only to GPSD outfall conditions; it will not be applicable to generalized situations.

The establishment of any definitive mixing zone has to be guided by the "Mixing Zone" specifications set forth in Section 302.102 in the IPCBs Rules and Regulations. This section is quoted below:

Section 302.102 Mixing Zones

a) In the application of this Chapter, whenever a water quality standard is more restrictive than its corresponding effluent standard then an opportunity shall be allowed for the mixture of an effluent with its receiving waters. Water quality standards must be met at every point outside of the mixing zone. The size of the mixing zone cannot be uniformly prescribed. The governing principle is that the proportion of any body of water or segment thereof within mixing zones must be quite small if the water quality standards are to have any meaning. This principle shall be applied on a case-by-case basis to ensure that neither any individual source nor the aggregate of sources shall cause excessive zones to exceed the standards. The water quality standards must be met in the bulk of the body of water, and no body of water may be used totally as a mixing zone for a single outfall or combination of outfalls. Moreover, except as otherwise provided in this Chapter, no single mixing zone shall exceed the area of a circle with a radius of I83 m C600 feet). Single sources of effluents which have more than one outfall shall be limited to a total mixing area no larger than that allowable if a single outfall were used.

b) In determining the size of the mixing zone for any discharge, the following must be considered:

1) The character of the body of water,

2) the present and anticipated future use of the body of water,

3) the present and anticipated water quality of the body of water,

4) the effect of the discharge on the present and anticipated future water quality,

5) the dilution ratio, and

6) the nature of the contaminant.

c) In addition to the above, the mixing zone shall be so designed as to assure a reasonable zone of passage for aquatic life in which the water quality standards are met. The mixing zone shall not intersect any area of any such waters in such a manner that the maintenance of aquatic life in the body of water as a whole would be adversely affected, nor shall any mixing zone contain more than 25% of the cross-sectional area or volume of flow of a stream except for those streams where the dilution ratio is less than 3:1.

Two physical concepts are specified which constrain the boundaries of any mixing zone. The first is the area factor outlined in paragraph a); i.e., the mixing area is limited to 1,130,973 square feet, the equivalent area of a 600-foot-radius circle. The second is the fact that a mixing zone cannot encompass more than 25 percent of the stream flow or cross-sectional area. The development of the GPSD mixing zone as presented here will be dictated primarily by these two constraints.

Even a cursory examination of the dye distribution patterns depicted by figures 16 through 81 reveals that all ten dye runs produced different mixing and dispersion configurations. This was anticipated somewhat in the study plan. The overall sampling scheme was designed to ferret out or isolate certain factors which could potentially cause significant variability.

The mixing zone or dye dispersion study was designed to produce data for use in a statistical procedure known as stepwise regression analysis. Put succinctly, this is a procedure whereby a variety of independent variables are statistically correlated to a dependent variable producing parameter coefficients and formulations which relate the independent variables to the dependent variable in a decreasing order of importance. It is this technique that was used, in conjunction with the observed data contained in table 9, to develop the water quality statistical information presented in tables 10 and 11.

In developing a methodology for defining a mixing zone in the area of the GPSD outfall, two separate formulations were utilized. One set of equations was developed to relate the maximum transverse projection of a given dye percentage to various influencing factors, while another set was developed to relate the maximum longitudinal (downstream) projection of the same given dye percentages to the same factors. Five independent variables were selected. They were: (1) GPSD effluent flow in mgd, (2) river discharge in cfs, (3) GPSD effluent temperature in °C, (4) river temperature in C, and (5) river pool elevation in mean sea level (msl). The transverse and longitudinal distances were expressed in feet and are presented as Parts a and b of Appendix H. The independent variable values used in the statistical analyses are presented as Part c of Appendix H. All values were used in a linear form; however, the river pool elevations were transformed from absolute msl values to smaller figures by subtracting 400 feet from each value. In other words, the msl value for July 12 was actually 440.48 feet. Normal or flat pool elevation is 440.00 feet.

The outfall is not a point discharge; it consists of a delta area as shown by figures 1, 3, and 14. Consequently, the maximum transverse projection point varies somewhat in a longitudinal direction. For this reason, the transverse projection was selected on the basis that the maximum observed on a given date occurred between stations 1+00 and 5+50. Also, the maximum transverse and longitudinal projections were selected regardless of location on the vertical. On a number of dates, they occurred at the surface while on others they occurred in the middle or near the bottom. The factors influencing this variability were not investigated since they were not particularly relevant to the formulation of the mixing zone. In the end, however, this does put a slight constraint on monitoring for violations, since multiple points have to be sampled on verticals to fully cover the mixing zone configuration as defined by its development. The longitudinal distances were somewhat influenced by the diversion of some effluent into the channel (shown by dashed lines on figure 14 and by solid singular lines on figures 16 through 61) when flow rates reached approximately 40 to 45 mgd. The flow in this channel, when it occurred, was small and the relative transverse projection in the vicinity of station 9+00 was always significantly less than that between stations 1+00 and 5+50 (see figures 16 through 61).

Transverse and longitudinal projections were made for iso-dye contours of 1, 2, 3, 5, 7, 10, 15, and 20 percent. These specific contour designations may or may not be shown on figures 16 through 61. Transverse, longitudinal, and vertical distances relative to these designated contour values were extrapolated from large-scale, detailed working drawings and from tabular information covering the entire study reach. The distances used in the statistical analysis are the untransformed and linear values presented in Parts a and b of Appendix H. The transverse distances are all referenced to an approximate shoreline which would occur at flat pool elevation. The most appropriate transverse monitoring reference point would be station 5+00. The longitudinal distances are all referenced to the centerline of the outfall channel farthest upstream, 50 feet down from station 1+00. A station 1+50 was not actually established in the field and is therefore not shown on the maps and figures. However, for convenience the reference point for the longitudinal distance will be referred to hereafter as station 1+50.

The results of the stepwise regression analyses are summarized in table 20. Considering the limited number of runs, the overall results were exceptionally good. The end products were rational and consistent. Both transverse and longitudinal dispersion could be explained to a great degree by using only two parameters. Note that in the transverse direction the 1, 2, 3, and 5 percent contour distances are basically explained by changes in the river temperature and river flow; whereas, for 7, 10, 15, and 20 percent contour distances, the river temperature remained important but the GPSD effluent flow replaced river flow as the second pertinent variable. Overall, the combination of two variables explained from 62 percent (0.784^2) of the observed variation for the 1 percent contour distance to over 85 percent for the 15 percent contour distance. If all variables are considered, over 89 percent of the variation can be explained for the 15 percent contour .

The fact that the higher contour points show more correlation with the prescribed variables is appropriate and logical since the lower values project much farther from the outfall area and hence are influenced by a number of additional factors such as river traffic, dam operation, and wind. Wind direction and speed, incidentally, had been considered in the original design of the study and were to be incorporated in the statistical analyses. The summer of 1984, however, turned out to be a relatively windless one (see wind data in table 14), and the range of speeds encountered were not of sufficient magnitude to be incorporated in the analyses. Essentially then the results, as presented, are principally applicable to periods having wind speeds of 10 mph or less.

The correlation coefficients relative to establishing two-variable prediction equations for longitudinal distances are comparable to those encountered for the transverse direction (see table 20). Only 44 percent of the variation can be explained for the 1 percent value; however, the explained variation jumps dramatically to 83 percent for the 2 percent value and reaches a maximum of 85 percent for the 15 percent value. All five variables explain a high 91 percent of the observed variation for the 7 percent contour maximum penetration point. The river temperature and the GPSD effluent flow show up as the two elements most pertinent for predicting the maximum dispersion distances for all contour percentages in the longitudinal direction.

Table 20. Summary of Results of the
Mixing Zone Stepwise Regression Analyses

		Transverse Direction					Longitudinal Direction				
Contour %	Statistic	GPSD Flow (mgd)	River Flow (cfs)	GPSD Temp. (°C)	River Temp. (°C)	Pool Elev. (msl)	GPSD Flow (mgd)	River Flow (cfs)	GPSD Temp. (°C)	River Temp. (°C)	Pool Elev. (msl)
1	Rank	5	2	4	1	3	1	3	4	2	5
	R	0.790	0.784	0.790	0.640	0.789	0.633	0.676	0.683	0.664	0.703
2	Rank	4	2	3	1	5	1	3	5	2	4
	R	0.899	0.879	0.887	0.759	0.899	0.884	0.925	0.925	0.911	0.924
3	Rank	3	2	4	1	5	1	3	5	2	4
	R	0.899	0.873	0.931	0.783	0.931	0.835	0.901	0.911	0.890	0.909
5	Rank	3	2	4	1	5	1	3	5	2	4
	R	0.896	0.857	0.929	0.760	0.929	0.761	0.899	0.916	0.881	0.915
7	Rank	2	3	5	1	4	1	3	5	2	4
	R	0.919	0.951	0.955	0.848	0.955	0.794	0.925	0.954	0.911	0.953
10	Rank	2	3	4	1	5	1	4	5	2	3
	R	0.914	0.935	0.937	0.757	0.938	0.799	0.941	0.946	0.901	0.919
15	Rank	1	3	4	2	5	2	4	5	1	3
	R	0.822	0.942	0.944	0.923	0.944	0.921	0.942	0.944	0.793	0.932
20	Rank	1	5	3	2	4	2	4	4	1	3
	R	0.808	0.932	0.931	0.846	0.932	0.879	0.940	0.941	0.742	0.922

The prediction equations derived as a result of the statistical analyses are presented in table 21. Included are the maximum and minimum predicted distances and the maximum and minimum observed distances. Good agreement occurs between the values. The maximum predicted distances for both transverse and longitudinal directions are consistently greater than the observed ones because the observed low temperature did not occur in association with either the low river flow or high effluent flow. The results merely demonstrate what is likely to happen if this temperature-flow combination should occur. The minimum predicted and observed values show good agreement since the observed minimum values were recorded during conditions close to those for which the minimum predicted values were calculated.

These prediction equations are somewhat stochastic in nature due to their "black box" statistical derivation. Consequently, uses should be confined to conditions in which the independent variable inputs fall within the range of values used to develop the equations. These limits are: T = 15 to 31°C, Q = 5,000 to 11,000 cfs, and q = 20 to 55 mgd.

As evidenced by the array of equations developed and the variable output produced, the mixing zone cannot be considered a singular entity. It is a constantly changing phenomenon, with the degree of change governed by fluctuations in the independent variables within the prescribed limits.

Table 21. Summary of Mixing Zone Prediction Equations

a. Transverse Channel Direction

Contour Percentage	Prediction Equation	Max. D or L T=15, q=55 or Q=5,000	Min. D or L T=31, q=20 or Q=11,000	Observed D or L Max.	Observed D or L Min.
1	D — 930 - 12.1T - 0.035Q	574	170	460	145
2	D = 970 - 15.0T - 0.036Q	545	109	455	140
3	D = 990 - 17.3T - 0.035Q	556	69	450	112
5	D = 970 - 17.0T - 0.036Q	535	58	430	70
7	D = 368 - 14.3T + 6.1q	489	47	410	60
10	D = 330 - 13.0T + 5.5q	441	37	390	50
15	D = 170 - 8.7T + 6.0q	370	20	330	35
20	D 165 - 8.8T + 5.9q	358	10	260	10
	b. Longitudinal Channel Direction				
1	L = 5485 - 163T + 198q	13,930	4,392	13,000	3,600
2	L = 620 - 120T + 190q	9,270	700	8,200	650
3	L = 1770 - 108T + 109q	6,145	602	5,550	600
5	L = 2380 - 104T + 61q	4,175	376	3,500	370
7	L = 1910 - 96T + 59q	3,715	114	2,850	105
10	L = 1345 = 73T + 47q	2,835	22	2,300	20
15	L = 1615 - 67T + 24q	1,930	18	1,450	15
20	L = 1245 - 54T + 22q	1,645	11	1,250	10

D = transverse distance (ft) from shore stake
L = longitudinal distance (ft) from station 1+50
T = river temperature (C)
Q = river flow (cfs)
q = GPSD effluent flow (mgd)

The areal extent of the mixing zone must fall within the prescribed area of an equivalent 600-foot-radius circle. The mixing zone configuration can take various arbitrary geometric forms to include this area. An ultraconservative example would be to define the zone as a rectangle with the short side being the transverse projections and the long side the longitudinal projections for given contour percentages as derived using the equations presented in table 21. The rectangular concept would reduce the longitudinal extent of the zone, but it would extend the transverse projection uniformly along the longitudinal axis.

A second, somewhat liberal concept would be to figure the area in terms of a triangle similar to that proposed by Butts et al. (1984). The triangular area concept probably fits the theoretical configuration more closely than any other geometric design for the higher percentage contours.

Examination of the contour figures 16 through 81 reveals that in almost all instances the high value iso-dye line outward extensions decrease relatively uniformly downstream with gradual termination at the shore. This is demonstrated fairly well by the surface contours which were developed for the data collected on September 11, 1984 (see figure 59). Note how the 25, 20, 15, 10, 6, and 5 percent contours tend to tail off downstream and eventually terminate directly at a shore location. The contours for percentages below 5 appear to fit a rectangular model better as they tend to fan out downstream because of dispersion and dilution.

Note, as evidenced by the contour figures 16 through 61, that the upstream mixing zone terminus is well defined. A large water intake conduit projects several feet above the normal pool water level at station 0+00 and acts as a barrier to excess mixing movement in an upstream direction. Consequently, a mixing zone incorporating a downstream triangular dispersion pattern should include a small rectangular areal section in the immediate area of the outfall. The longitudinal base should run between stations 0+00 and 5+00. The triangular area should be computed on the basis of a right triangle with the base starting at station 5+00 and terminating at points dictated by the equations provided in table 21b.

A compromise between the two extreme areal concepts explained above would be to consider the zone as a trapezoid having an average end height equal to 75 percent of the transverse projections derived using the equations presented in table 21a. The 75 percent figure is derived on the basis that the downstream transverse projection is 50 percent of the transverse projection at the outfall calculated using the table 21a equations. The trapezoid, like the triangle, would start at station 5+00 with the zone between stations 0+00 and 5+00 being considered a rectangle.

Recognition is given at this time to the fact that the shoreline immediately below the outfall is not straight but forms a large-radius, convex arc. Essentially then the straight line longitudinal bases assigned to either the rectangular, triangular, or trapezoidal concepts act as cords across this arc. This introduces some error in the total mixing zone area -- the total is slightly understated since the area between the cord and arc is not included. However, because the arc is so large this area is relatively small and encompasses a very shallow near-shore volume. For the sake of simplicity and applicability, a straight-sided geometric configuration should be used to define the mixing zone since it does not significantly exaggerate the acceptable zone in this specific situation.

The maximum areas encompassed by the various contour percentage elements for the three suggested geometric shapes are presented in table 22. In reviewing the tabulated results, the fact thai a 600-foot-radius circle has an area equal to 1,130,973 ft^2 should be kept in mind; the values under the dashed lines in the table indicate areas less than this value. A triangular model fits the areal specifications for percentages of approximately 5 or greater; a trapezoidal model fits for values starting somewhere between 8 and 10 percent, and a rectangular model fits for values slightly greater than 10 percent.

The second physical criterion that has to be met is the specification that no more than 25 percent of the stream flow or cross-sectional area is to be contained within the mixing zone. Figure 83 has been prepared to help evaluate the influence this factor has in delineating a mixing zone in the area of the GPSD outfall. Flow measurements were taken at station 4+00 in the midsection of the outfall area and at station 9+00 near the intermittent overflow channel discharges. The figure is a plot of accumulated flow percentages versus distance from the right bank looking downstream. Plots of accumulated areas versus distances produce similar curves at these two stations. Note that a 25 percent accumulated flow value falls at a point approximately 250 feet from shore. This is significantly less than the maximum transverse distance predicted to occur during conditions similar to those encountered during this study Csee table 21a). Conversely, it is significantly greater than the minimum predicted transverse projections.

Table 22. Areal Extent of Mixing Zones
for Various Iso-dye Percentage Contours

Contour	Maximum Area (ft^2) Encompassed			Maximum Area Adjusted to Meet 25% Stream Flow/Area Requirement		
Percentages	Rectangle	Trapezoid	Triangle	Rectangle	Trapezoid	Triangle
1	7,995,820	5,996,865	3,997,910	—	-	-
2	5,237,550	3,928,163	2,618,775	-	-	-
3	3,416,620	2,562,465	1,708,310	-	-	-
5	2,233,625	1,675,219	1,116,813	-	-	-
7	1,786,915	1,340,186	893,458	515,250	386,438	257,625
10	1,250,235	937,676	625,118	463,750	347,813	231,875
15	714,100	535,575	357,050	232,500	174,375	116,250
20	588,910	441,683	294,455	233,750	175,313	116,875

Note: Values under dashed line meet the area requirements imposed by IWPCB Standards

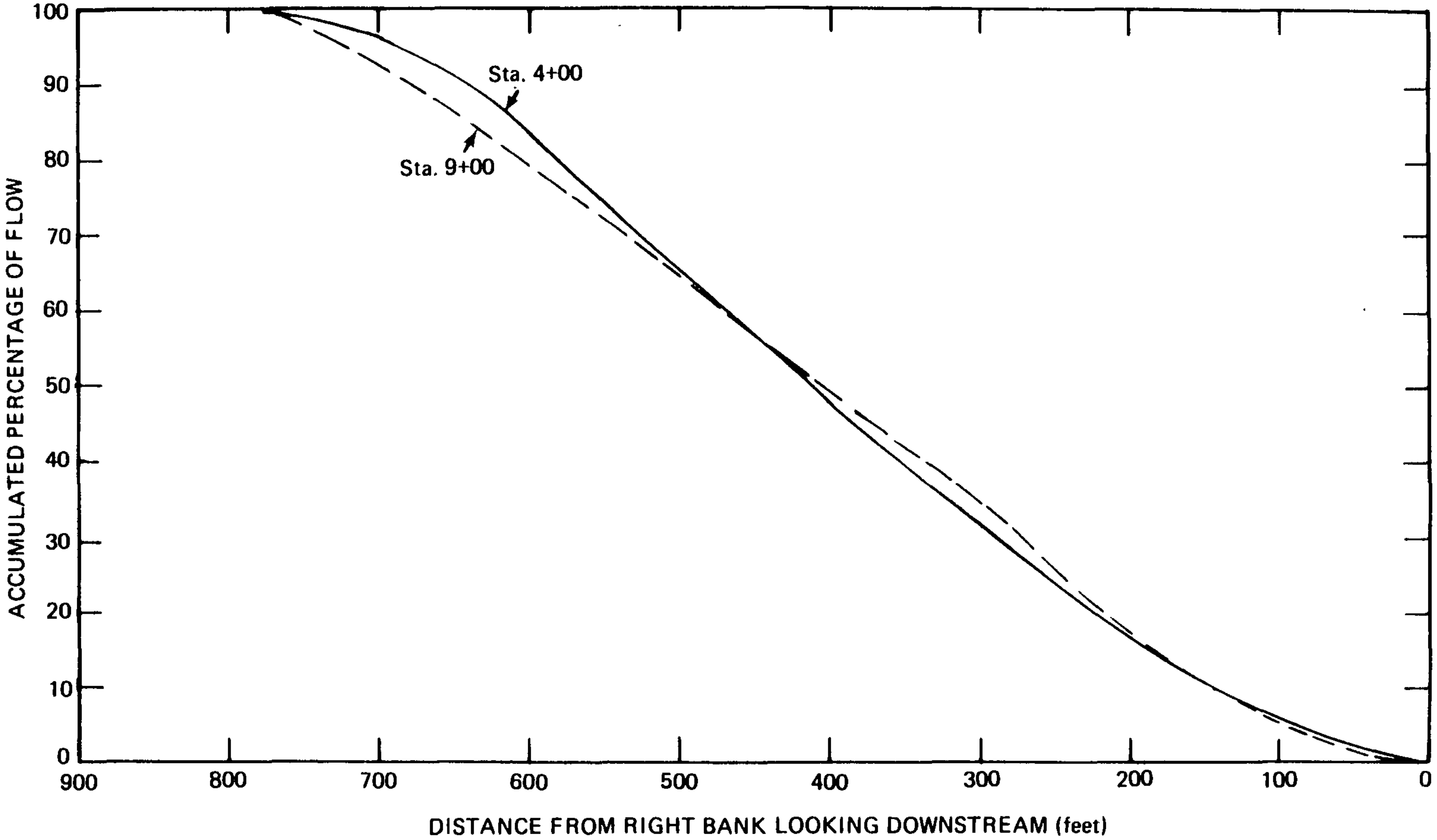


Figure 86. Accumulated percentage of flow in a transverse direction at stations 4+00 and 9+00

Table 23 has been prepared to show the optimum paired conditions (river temperature and river flow or river temperature and effluent flow) at which an estimated outward projection of 250 feet would be produced. The values presented in the table for contours of 1, 2, 3, and 5 percent can be interpreted or used so that a given tabular value of river flow CO) paired with any temperature less than the given line value will produce a transverse projection greater than 25 percent, and any given temperature value paired with a 0 less than the line value will produce a projection greater than 25 percent. For example, a river temperature of 25°C coupled with a river flow of 10,786 cfs will result in an estimated 250-foot projection of the 1 percent contour. If the temperature drops to 24°C but the flow remains unchanged, the 1 percent projection is increased to 262 feet. Similarly, if the temperature remains 25°C but the flow decreases to 10,000 cfs the projection is increased to 278 feet. Conversely, any increase in flow associated with a given tabular temperature will produce reduced projection distances, and any increase in temperatures associated with a given tabular flow will also produce reduced distances.

Table 23. Paired T-Q and T-q Values Which Produce A 250 Ft. Transverse Projection Using Table 21a Equations

River Temp. T(° C)	Flows Producing 250 ft. Projections at Given Line Temperatures For Contour %'s							
	River Flow (Q) cfs				Effluent Flow (q) mgd			
	1%	2%	3%	5%	7%	10%	15%	20%
15	14,243	13,750	13,729	12,917	16	21	35	37
16	13,897	13,333	13,234	12,444	18	23	37	38
17	13,551	12,917	12,386	11,973	21	26	38	40
18	13,205	12,500	12,246	11,500	23	28	39	41
19	12,860	12,083	11,425	11,028	25	30	41	43
20	12,514	11,667	11,257	10,556	28	33	42	44
21	12,169	11,250	10,763	10,083	30	35	44	46
22	11,823	10,833	10,269	9,611	32	37	45	47
23	11,477	10,417	9,774	9,139	35	39	47	49
24	11,131	10,000	9,280	8,667	37	42	48	50
25	10,786	9,583	8,786	8,194	39	45	50	52
26	10,440	9,617	8,291	7,722	42	47	51	53
27	10,094	8,750	7,797	7,250	44	49	52	56
28	9,749	8,333	7,303	6,778	46	52	54	58
29	9,403	7,917	6,809	6,306	49	54	55	59
30	9,057	7,500	6,314	5,833	51	56	57	61
31	8,711	7,083	5,820	5,361	53	59	58	62

The projections for the 7, 10, 15, and 20 percent contours are negatively related to river temperature and positively related to effluent discharge rates. Consequently, any effluent flow greater than that associated with a given line temperature in table 23 will produce transverse distances greater than 250 feet. For example, a river temperature of 25°C coupled with an effluent flow of 39 mgd will result in an estimated 250-foot projection of the 7 percent contour. If the temperature drops to 24°C but the effluent flow remains equal to 39 mgd, the projection is increased to 263 feet. Similarly, if the temperature remains equal to 25°C but the effluent flow increases to 40 mgd, the projection will increase to 255 feet. Conversely, any decrease in flow associated with a given tabular temperature or any increase in temperature associated with a given tabular flow will result in projections of less than 250 feet.

A noteworthy fact is that the areal extent of the mixing zone is greatly reduced as a consequence of meeting the 25 percent flow/area standard (see table 22).

Sufficient information has now been presented for prudently selecting a contour element and geometric shape to define the mixing zone. Contour elements up to 5 percent are not practical to use, principally because these low percentages do not even meet the basic area requirement as illustrated by the data presented in table 22. While contour percentages of 7 or greater meet the area requirement for one or more model shapes, none meets the 25 percent flow/area requirement. Consequently, only restrictive use of these percentages is appropriate. The use of the 7 percent contour is too restrictive and the use of the 10 percent one may also be too restrictive. GPSD effluent flows would have to be limited to rates less than 16 mgd for the 7 percent contour to fall within the 25 percent flow/area requirement during cool river temperature periods, and less than 21 mgd for the 10 percent contour to fall within that requirement Csee 15°C line in table 23). Presently normal daily flows range between 20 and 25 mgd.

Selection of either the 15 or 20 percent contours appears to have considerable merit. Preference probably should be placed on using the 15 percent one since it would liberalize the discharge requirements relative to the 10 percent contour, while imposing minimal additional restrictions. Note that a discharge rate of 37 mgd or less would be required at 15°C to meet all requirements for the 20 percent element, whereas only a slightly lower figure of 35 mgd would be needed for the 15 percent element.

The fact has been established early in this section that toxicity considerations dictate the allowable ammonia-N concentration in the river. The minimal value as presented in table 18 is 1.5 mg/l of total ammonia-N. Selection of the 15 percent contour would, therefore, allow the GPSD to routinely discharge 10 mg/l of ammonia while adhering to the 15 percent effluent flow rate schedule presented in table 23. This should not be hard to do since, presently, daily flow usually ranges from 10 to 15 mgd below the maximum 35 mgd set for 15°C river temperatures. In general during cool weather the GPSD could discharge up to 35 mgd of effluent containing 10 mg/l of ammonia-N. In contrast, during very warm periods discharges well over 50 mgd could be tolerated when the ammonia-N content is 10 mg/l.

Adherence to the 10 percent contour restrictions may be manageable or even desirable. This would allow an ammonia-N concentration of 15 mg/l to be discharged, but it would require the institution of a structured management scheme whereby plant discharge rates were tailored to meet seasonal conditions. Considerable flow storage is available at the plant, which means that portions of cool weather high flows could be retained and "bled off" at later dates to meet either the discharge schedule requirements presented in the 10 percent column in table 23 or the less restrictive cool weather river standards presented in table 18.

The restrictive nature of the 25 percent flow/area requirement obviates the need to define a specific geometric form of the mixing zone. Even the rectangular model produces areas much less than the maximum allowable when the area is computed on the basis of a 250-foot transverse projection as presented in table 22.

Some brief comments and discussion will be advanced in reference to downstream dispersion and dilution. The graphs in Appendix I show the observed distributions of dye percentages and the relative amounts of dye carried within 25-foot segments of channel sections at stations 12+00 and 104+00 for dates on which flows were either measured or extrapolated. As was the case with the areal and cross-sectional iso-dye contour plots, these figures, particularly those at station 12+00, show little or no uniformity from date to date. As would be expected, the variability within a cross section on given dates at 12+00 is significantly greater than that at 104+00. Significantly higher concentrations usually occur near shore, but the bulk of the material is carried in the channel. This is illustrated clearly by the September 11, 1984 plot for station 12+00.

The distribution configurations at station 104+00 may have been influenced somewhat by the dam operation (or, as the case may be, the lack of operation). Up through July 31, 1984, the 104+00 plots reveal that the higher dye percentages and the bulk of the mass transfer occurred near the east side of the river. At this time, heavy river traffic was occurring, with constant lockages being performed in anticipation of an extended shutdown of up-river lock facilities for repair. The Peoria lock is located on the east bank as shown by figure 15. The plots presented for dates after the end of July reflect the greatly reduced use of the Peoria locks during the actual shutdown of the upstream facilities. Most of these plots show a more uniform distribution of both dye percentages and mass bulk within the confines of the channel. The bulk of the dye did not seem to gravitate toward the locks.

The downstream dispersion is also greatly influenced by such unquantifiable factors as barge tow movement and idling, barge fleeting, barge parking along the west bank (see figures 56-61), pool manipulation at the dam, and the inflow of Kickapoo Creek. Such factors almost completely negate the possibility of employing theoretical concepts to mixing, dispersion, and dilution in this area of the river.

The fact has been established that as much as 15 mg/l of ammonia-N could be discharged in a GPSD effluent flow of about 55 mgd in concert with $CBOD_5$ concentrations which meet present-day effluent standards without violating stream water quality standards. A natural question that arises corollary to this is: "What carbonaceous BOD_5 effluent concentration could be tolerated in association with a 15-mg/l ammonia-N concentration without significantly affecting the DO resources in the LaGrange pool?" To answer this the State Water Survey's DO-BOD model was again employed using river physical and biological conditions as observed on June 26, 1979 (see ambient conditions note on figure 82). Two simulations were run -- one for an effluent $CBOD_5$ of 40 mg/l and the other for 50 mg/l, with each occurring in a 55-mgd effluent flow having an ammonia-N concentration of 15 mg/l.

The actual minimum observed DO on this date was approximately 5.80 mg/l (see figure 82). The allowance of a $CBOD_5$ of 40 mg/l would lower this to 5.54 mg/l while a $CBOD_5$ of 50 mg/l would lower it only slightly more to 4.48 mg/l. The complete DO sag curve generated using the 50 mg/l $CBOD_5$ concentration is presented by the dotted line in figure 82. The sag curve throughout the length of the pool falls well above the minimum acceptable standard of 5.0 mg/l in spite of the fact that the 55-mgd effluent flow rate used is an extreme value which is not normally experienced during dry weather conditions.

SUMMARY AND CONCLUSIONS

Field studies were performed between July 11, 1984 and October 25, 1984 to quantify the effects Greater Peoria Sanitary District (GPSD) treatment plant effluent ammonia-N discharges have on downstream Illinois River water quality. The basic objective of the study was to determine if the ammonia-N effluent standard of 2.5 mg/l imposed upon the GPSD is too restrictive or is unjustified environmentally or ecologically.

River water samples were collected and analyzed for ammonia-N, Nitrate-N, Kjeldahl-N, temperature, pH, DO, and turbidity. Collections were made at near shore and channel locations at stations above the outfall, at the outfall, and below it over a wide range of river flows and temperatures. The data were used to evaluate both direct and indirect river water quality implications of permitting higher ammonia-N concentrations to be discharged in the effluent. Direct water quality implications are reflected primarily through toxicity effects and the necessity of meeting stream standards to minimize these effects. Indirect implications are reflected in the process of nitrification whereby ammonia oxidation depletes oxygen in surface waters. Assurances were needed that ammonia-N oxidation does not impose a serious threat to Illinois River dissolved oxygen CDO) resources.

Illinois Pollution Control Board Rules and Regulations permit a mixing zone between a receiving stream and the effluent discharge in which water quality standards can be violated. Considerable effort was expended both in the field and in the office gathering and extracting information which could be used to define a mixing zone in the area of the GPSD outfall. Mixing of the effluent with the river was traced using fluorescent dye techniques. Dye was injected into the effluent on 10 different dates. River flow during these dates ranged from approximately 5000 to 11,000 cfs and river temperatures ranged between 15 and 31 C. Plant flows were controlled and the flows were varied in 5-mgd increments between rates of 20 to 50 mgd. Eight hundred dye samples per run were collected from the river at various transects extending almost two miles below the outfall. The longitudinal and transverse sampling distances were referenced to a surveyed baseline laid out following the outline of the shore. Transverse distances were measured using high quality split-image range finders; sample depths were gaged using a depth counter attached to fishing downriggers. Sampling was done using four boats equipped with a unique pumping system designed to expedite the sampling process and to minimize contamination errors.

Historical information was gathered and tabulated to determine the relationship between ammonia-N concentrations observed in the river and those discharged in the GPSD effluent. The Illinois State Water Survey (ISWS) has compiled a long record of river ammonia-N data via weekly water quality sampling in the river about 1.5 miles above the GPSD outfall. Comparisons were made between the river values and those in the effluent for the years 1978 through 1984.

Conclusions reached as a result of this study are:

1. The reguirement that the GPSD meet a 2.5 mq/l ammonia-N effiuent Standard is unjustified and severely restrictive. Direct river sampling conducted during the study showed that the effluent produced a detectable but insignificant rise in the river ammonia-N concentration even during periods when the GPSD failed to comply with the 2.5 mg/l effluent requirement. On October 15, 1984, the effluent contained 8.0 mg/l of ammonia-N, but in the center of the channel at the outfall, the vertically averaged concentration was only 0.19 mg/l; two miles downstream the channel average was a slightly but insignificantly higher 0.29 mg/l. The comparisons of the historical data produced similar conclusions. Even prior to the implementation of ammonia-N removal the maximum effect the GPSD effluent ammonia-N had was to raise the river concentration by less than 0.09 mg/l (assuming complete mixing).

2. Ammonia-N loads in the nange between those historically and presently discharged by the GPSD affect Illinois River DO resources very little. Mathematical modeling revealed that approximately 131,000 lbs/day of ultimate nitrogenous BOD (NBOD) input by the GPSD would cause only a 0.56 mg/l drop in the LaGrange pool DO resources during low to intermediate river flows. This is equivalent to having a GPSD effluent discharge rate of 60 mgd that contains 57.5 mg/l of ammonia-N. This is a very unlikely scenario. Presently GPSD NBOD loads routinely fall below 1000 lbs/day.

3. A permissible increase in GPSD effluent ammonia-N concentration is limited to a maximum value dictated by toxicity and mixing zone standard requirements as set forth in the IPCB Rules and Regulations. Only a 1.5 mg/l ammonia-N concentration is permissible in the river during critical periods dictated by river temperature and pH conditions. Higher values can fall within a mixing zone which meets prescribed cross-sectional and longitudinal area requirements.

4. The dye injection study provided excellent information by which mixing zones could be delineated over a wide range of physical conditions. River dye concentrations were presented in terms of percentages of effluent concentrations. Iso-dye contour plots were then developed and the extents of certain percentage contours were used to formulate mixing zones according to the IPCB specifications, namely that the mixing zone is not to exceed over 25 percent of the cross-sectional flow or area or the areal extent is not to exceed the area equivalent to a 600-foot-radius circle. Stepwise regression techniques were used to develop formulations relating certain physical factors to transverse and longitudinal projection distances of the 1, 2, 3. 5, 7, 10, 15, and 20 percent contours.

5. The transverse mixing distance is constrained by the 25 percent flow/area requirement. On the basis of this constraint, the 15 percent projection distance was selected as being the most manageable limit. Consequently, a 10 mg/l ammonia-N concentration could be allowed in the effluent. The 7 percent through 20 percent contour transverse and longitudinal projection distances were found to be variable depending upon river temperatures and effluent discharge rates. As river temperatures cool in relation to effluent temperatures and as the effluent discharge rates increase, the transverse projection distances increase to a point where over 25 percent of the cross-sectional area and/or flow rate is exceeded. At a river temperature of 15 C, the GPSD would be limited to a discharge rate of 35 mgd. This is manageable since current daily flows range between only 20 and 25 mgd. The permissible effluent concentration could be raised to 15 mg/l by expanding the mixing zone to include areas bounded by the 10 percent contour. However, under these circumstances, the GPSD would be limited to effluent discharge rates in the range of 20 to 25 mgd during cool weather conditions.

6. The mixing zone prediction equations that were developed are not applicable to conditions when the river water temperature drops below 15°C. The equations are statistical formulations and provide reliable estimates only when used with input information within the value limits of the variables for which they were derived. A fact that must be kept in mind, however, is that the constraints imposed upon the mixing zone during low river temperatures are partially offset by the fact that the IPCB ammonia-N standards become more liberal at lower temperatures. That is, higher ammonia-N concentrations are tolerated as the river water temperature falls. For instance, at a pH of 8.0 (the normal river value), the

allowable ammonia-N stream standards at 15, 10, and 5°C are, respectively, 1.5, 2.1, and 3.1 mg/l. This means that if the area within the 15 percent contour limits constituted the mixing zone, an ammonia-N concentration of over 20 mg/l could be discharged in the effluent when the river temperature is 5°C or less. At this point, though, sufficient information is not available to define mixing zone limitations at river temperatures below 15 C. Additional studies are needed to do this.

7. Higher 5-day carbonaceous biochemical oxygen demand ($CBOD_5$) effluent concentrations could be discharged than are presently permitted even in association with potentially liberalized ammonia-N requirements without significantly affecting LaGrange pool DO resources. Mathematical modeling showed that a $CBOD_5$ concentration of 50 mg/l and an ammonia-N concentration of 15 mg/l in an effluent flow rate of 55 mgd would lower the DO only about 0.3 mg/l below the minimum observed in the pool during moderately low flow conditions.

REFERENCES

American Public Health Association. 1985. Standard Methods for the Examination of Water and Wastewater 16th Edition, Washington D.C., 1268 p.

Anderson, D.D. 1949. The Illinois State Coordinate System Proceedings Paper, The Seventh Annual Conference on Surveying and Mapping, University of Illinois, Urbana, May 27-28.

Bencala, Kenneth E., R.E. Rathbun, A.P. Jackson, V.C. Kennedy, G.W. Zellweyer, and R.V. Avanzino. 1983. "Rhodamine WT Dye Losses in a Mountain Stream Environment." Water Resources Bulletin, Vol. 19, No. 6, pp. 943-950.

Butts, T.A., V. Kothandaraman, and R.L. Evans. 1973. Practical Considerations for Assessing the Waste Assimilative Capacity of Illinois Streams. Illinois State Water Survey Circular 110, 49 p.

Butts, T.A., R.L. Evans, and S.D. Lin. 1975. Water Quality Features of the Upper Illinois Waterway. Illinois State Water Survey Report of Investigation 79, 60 p.

Butts, T., D. Roseboom, T. Hill, S. Lin, D. Beuscher, R, Twait. and R. Evans. 1981. Water Quality Assessment and Waste Assimilative Analysis of the LaGrange Pool, Illinois River. Illinois State Water Survey Contract Report 260, 116 p.

Butts, T.A., D.H. Schnepper, and K.P. Singh. 1983. The Effects of Lake Michigan Discretionary Diversion, Strategles on Illinois Waterway Dissolved Oxvgen Resources. Illinois State Water Survey Contract Report 324, 53 p.

Butts, T.A., R.L. Evans, D.B. Shackleford, and D.H. Schnepper. 1984. The Procedures. Observations, and Results of a Mixing Zone Study for Combined Sewer Overflows at Peoria. Illinois. Illinois State Water Survey Contract Report 34, 119 p.

Cobb, E.D., and J.F. Bailey. 1965. "Measurement of Discharge by Dye-Dilution Methods." Book 1, Chapter 14, Surface Water Techniques-Hydraulic Measurement and Comoutation. USGS.

Illinois Pollution Control Board. 1984. State of Illinois Rules and Regulations, Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, including Amendments through April 1, 1984, 40 p.

Roseboom, D.P., and D.L. Richey. 1977. Acute Toxicity of Residual Chlorine and Ammonia to Some Native Illinois Fishes. Illinois State Water Survey, Report of Investigation 85, 42 p.

Appendix A

Equipment and Material Specifications

Range Finder (used by boats 2, 3, & 4)

- Manufacturer: Lietz
- Model: 8026-15; Mfr. No. SD-5F
- Type: Lens-displacing (split image)
- Measurable Range: 29 to 1000 feet

Accuracy: ± 1% up to 300 ft.
± 2% 300 to 500 ft.
± 5% 500 to 1000 ft.

- Magnification: 4X
- Viewing Angle: 6.5°

Base Line Length: 19.7 in.

- Total Length 23"
- Weigh: 2.8 pounds
- Range Scale:

Distance (ft.)	Increment (ft.)	Interpolation (ft.)
29-40	1	0.1
40-80	2	0.2
80-150	5	0.5
150-200	10	1.0
200-300	20	2.0
300-500	50	5.0
600,750,1000,00		

Range Finder (used by boat 1)

- Manufacturer: Lietz
- Model: 6630 Duo-Site Range, Height Finder
- Type: Split Image
- Measurable Range: 15 to 300 feet

Fluorescent Dye

- Supplier: Crompton & Knowles Corp.
- Appearance: clear, very dark red aqueous solution
- Commercial concentration: 20% of aqueous solution
- Specific gravity: 1.15 at 20/20°C
- Optimum excitation wavelength: about 556 run
- Optimum analyzing wavelength: about 580 nm
- pH sensitivity: insigifnicant fluorescence change between 5.5 and 11.0
- Shipping quantity: 250 pound drums

Dye Injection Metering Pump

- Manufacturer: Fluid Metering, inc.
- Model: RP-B-1-CSY
- Power: 12V, 4a D.C.
- Type: reciprocating RR piston (1/4 in. dia.) positive displacement
- Strokes: 2800 per min. maximum
- Pressure: 70 psig
- Displacement: variable to a maximum 750 ml/min.
- Weight: 8 lbs.
- Size: 11.3 in. x 3.4 in.
- Micrometer: 0.1% settings
- Calibration data

		Observed Flows (ml/min) at Positive Heads of					
Micrometer Setting	Rate Flow (ml/min)	8"		20"		40"	
		Old	New	Old	New	Old	New
0.1	75	122	54	126	60	132	54
0.2	150	236	157	242	157	245	158
0.3	225	354	254	360	252	364	250
0.4	300	471	349	478	340	480	343
0.5	375	579	444	595	427	599	429
0.6	450	689	530	707	515	714	513
0.7	525	706	590	747	599	795	598
0.8	600	717	671	763	677	805	677
0.9	675	743	741	787	750	822	750
1.0	750	759	820	790	829	842	831

Sampling Pump

- Manufacturer: Proven Pumps Corp.
- Model: 365
- Type: Self Priming (up to 7 ft. of lift) to volute
- Power: 12 - volts D.C.
- Ports: Dual threaded - 3/4 in. external garden hose thread - 3/8 in. NPT internal thread - both suction and discharge
- Size: Length = 6 1/8 in., Width - 3 3/8 in., Height = 2 3/4 in.
- Impeller: rubber
- Pumping rates in gph:

Total Head (ft.)						
1	5	10	15	20	30	40
300	258	240	222	202	150	90

Trolling Motors

- Manufacturer: Minn Kota
- Model: 65C (4 units), 95W (1 unit)
- Power: 12 Volt D.C.
- Controls: 5 - speed twist grip, forward - reverse switch
- Shaft length: 65C - 30 in., 95W - 36 in.
  - Power Specifications for 65C:

Speed Setting	Thrust (lbs.)	Amp Draw
1	5	8
2	10	11
3	15	14
4	20	20
5	26	25

- Power Specification for 95W: Maximum 36 pounds of thrust at setting 5.

Appendix B

Field Data Forms

Project ______________ Sewer Flow ______________ Crew ________________

Date ________________ River Flow ______________ Sheet _______ of _____

No.	Sta.	Dist	Depth	Conc	No	Sta	Dist	Depth	Conc.	No.	Sta	Dist	Depth	Conc	No	Sta	Dist	Depth	Conc
901					939					977					1015				
902					940					978					1016				
903					941					979					1017				
904					942					980					1018				
905					943					981					1019				
906					944					982					1020				
907					945					983					1021				
908					946					984					1022				
909					947					985					1023				
910					948					986					1024				
911					949					987					1025				
912					950					988					1026				
913					951					989					1027				
914					952					990					1028				
915					953					991					1029				
916					954					992					1030				
917					955					993					1031				
918					956					994					1032				
919					957					995					1033				
920					958					996					1034				
921					959					997					1035				
922					960					998					1036				
923					961					999					1037				
924					962					1000					1038				
925					963					1001					1039				
926					964					1002					1040				
927					965					1003					1041				
928					966					1004					1042				
929					967					1005					1043				
930					968					1006					1044				
931					969					1007					1045				
932					970					1008					1046				
933					971					1009					1047				
934					972					1010					1048				
935					973					1011					1049				
936					974					1012					1050				
937					975					1013									
938					976					1014									

Project GPSD Sewer Flow 55 mgd Crew Schnepper, Brumitt

Date 9/11/84 River Flow 6020 cfs Sheet 4 of 4

Time Start 12:30 End ______

No.	Sta.	Dist	Depth	Conc	No	Sta	Dist	Depth	Conc	No.	Sta	Dist	Depth	Conc	No	Sta	Dist	Depth	Conc
901	82	500	0		939					977		500	0		1015	104	600	0	
902					940		500	0		978					1016				
903					941					979		450	0		1017				
904		450	0		942					980					1018		550	0	
905					943		450	0		981		400	0		1019				
906					944					982					1020		500	0	
907		400	0		945					983		350	0		1021				
908					946		400	0		984					1022		450	0	
909		350	0		947					985		300	0		1023				
910					948		350	0		986					1024		350	0	
911		300	0		949					987		250	0		1025				
912					956		300	0		988					1026				
913					951					989		200	0		1027		250	0	
914		200	0		952					990					1028				
915					953		200	0		991		150	0		1029		150	0	
916		100	0		954					992					1030				
917					955		100	0		993		100	0		1031		50	0	
918		50	0		956					994					1032	108	600	0	
919					957		50	0		995		50	0		1033				
920	86	550	0		958	95	550	0		996	101	600	0		1034				
921					959					997					1035		550	0	
922		500	0		960		500	0		998		550	0		1036				
923					961					999					1037				
924		450	0		962		450	0		1000		500	0		1038		500	0	
925					963					1001					1039				
926		400	0		964		400	0		1002					1040		450	0	
927					965					1003		450	0		1041				
928		350	0		966		300	0		1004					1042		400	0	
929					967					1005		400	0		1043				
930		250	0		968		250	0		1006					1044		300	0	
931					969					1007					1045				
932		150	0		970		150	0		1008		300	0		1046		200	0	
933					971					1009					1047				
934		100	0		972		100	0		1010		200	0		1048		100	0	
935					973					1011					1049				
936		50	0		974		50	0		1012		100	0		1050		50	0	
937	89	550	0		975	98	550	0		1013					Temp. Begin			______	
938					976					1014		50	0				End	______	

Project GPSD Sewer Flow 55 mgd Crew Schnepper Brumitt

Date 9/11/84 River Flow 6020 cfs Sheet 4 of 4

Time Start 12:30 End 15:10

No.	Sta.	Dist	Depth	Conc	No	Sta	Dist	Depth	Conc	No.	Sta	Dist	Depth	Conc	No	Sta	Dist	Depth	Conc
901	82	500	0	0.5	939			24.0	0.6	977		500	0	0.2	1015	104	600	0	0.0
902			8.0	0.6	940		500	0	0.6	978			19.0	0.5	1016			9.0	0.6
903			16.0	0.6	941			14.0	0.7	979		450	0	0.1	1017			17.0	0.6
904		450	0	0.6	942			22.0	0.5	980			23.0	0.6	1018		550	0	0.0
905			9.0	0.6	943		450	0	0.7	981		400	0	0.3	1019			17.0	0.6
906			18.0	0.7	944			14.0	0.8	982			24.0	0.7	1020		500	0	0.2
907		400	0	0.7	945			27.0	1.1	983		350	0	0.8	1021			20.0	0.6
908			20.0	0.7	946		400	0	0.8	984			23.0	0.8	1022		450	0	0.4
909		350	0	1.5	947			22.0	0.5	985		300	0	0.7	1023			22.0	0.4
910			25.0	0.8	948		350	0	0.8	986			22.0	0.9	1024		350	0	0.7
911		300	0	1.4	949			27.0	0.9	987		250	0	0.6	1025			11.0	0.4
912			13.0	0.9	950		300	0	0.9	988			23.0	1.0	1026			21.0	0.4
913			26.0	1.0	951			13.0	1.0	989		200	0	0.8	1027		250	0	0.7
914		200	0	1.7	952			26.0	1.0	990			23.0	0.9	1028			19.0	0.5
915			23.0	1.0	953		200	0	1.3	991		150	0	0.9	1029		150	0	0.7
916		100	0	0.2	954			26.0	1.0	992			22.0	0.9	1030			17.0	0.9
917			22.0	0.8	955		100	0	1.1	993		100	0	0.9	1031		50	0	0.9
918		50	0	0.2	956			20.0	0.9	994			21.0	0.9	1032	108	600	0	0.2
919			9.0	0.6	957		50	0	0.6	995		50	0	1.0	1033			8.0	0.2
920	86	550	0	0.1	958	95	550	0	0.3	996	101	600	0	0.0	1034			15.0	0.4
921			16.0	0.3	959			15.0	5.3	997			19.0	0.7	1035		550	0	0.6
922		500	0	0.4	960		500	0	0.4	998		550	0	0.0	1036			11.0	0.5
923			24.0	0.4	961			16.0	0.5	999			20.0	0.6	1037			22.0	0.6
924		450	0	0.8	962		450	0	0.1	1000		500	0	0.3	1038		500	0	0.9
925			28.0	0.7	963			17.0	0.7	1001			10.0	0.7	1039			22.0	0.7
926		400	0	0.7	964		400	0	0.4	1002			13.0	0.7	1040		450	0	0.6
927			29.0	0.8	965			18.0	0.8	1003		450	0	0.6	1041			20.0	0.7
928		350	0	1.4	966		300	0	0.8	1004			18.0	0.8	1042		400	0	0.4
929			22.0	0.8	967			24.0	0.9	1005		400	0	0.4	1043			19.0	0.8
930		250	0	1.1	968		250	0	0.9	1006			10.0	0.8	1044		300	0	1.2
931			23.0	0.9	969			23.0	0.9	1007			20.0	0.6	1045			17.0	0.9
932		150	0	1.4	970		150	0	0.9	1008		300	0	0.7	1046		200	0	1.0
933			23.0	1.1	971			23.0	0.3	1009			24.0	0.9	1047			16.0	0.9
934		100	0	0.9	972		100	0	0.4	1010		200	0	0.8	1048		100	0	0.9
935			17.0	1.1	973			22.0	0.7	1011			22.0	0.9	1049			9.0	0.9
936		50	0	0.4	974		50	0	0.1	1012		100	0	0.9	1050		50	0	0.7
937	89	550	0	0.7	975	98	550	0	0.3	1013			19.0	0.9	Temp. Begin 21.5				
938			12.0	0.6	976			17.0	0.3	1014		50	0	0.9	End 23.0				

Appendix C

River Water Quality Results

RIVER MILE 160.95

150 Feet From RBLDS

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
							Temperature (°C)									
0	27.0	26.5	29.5	26.0	29.0	27.0	26.0	25.0	27.5	23.0	24.0	16.5	16.5	19.5	21.0	13.5
2	27.0	26.5	29.5	26.0	29.0	27.0	26.0	25.0	27.5	23.0	24.0	16.5	16.5	19.5	21.0	13.5
3	27.0	26.5	29.5	26.0	29.0	27.0	26.0	25.0	28.0	23.0	24.0	16.0	16.5	19.5	21.0	13.5
6	27.0	26.5	30.0	26.0	29.0	27.0	26.0	25.0	28.0	23.0	24.0	16.0	16.5	20.0	21.0	13.5
								pH								
0	8.35	8.80	8.55	8.50	8.20	8.30	8.05	8.35	8.20	8.25	8.10	8.40	8.20	8.05	8.00	7.95
2	8.30	8.75	8.50	8.50	8.10	8.20	8.00	8.20	8.18	8.25	8.10	8.40	8.20	8.05	8.00	7.95
3	8.30	8.75	8.50	8.50	8.10	8.20	8.00	8.20	8.16	8.20	8.10	8.40	8.15	8.00	8.00	8.00
6	8.30	8.75	8.50	8.50	8.10	8.20	8.00	8.15	8.08	8.20	8.05	8.35	8.15	8.05	8.00	7.95
							Ammonia Nitrogen, NH_3-N (mg/1)									
0	0.32	0.10	0.23	0.04	0.20	0.38	0.33	0.22	0.13	0.10	0.40	0.21	0.29	0.20	0.18	0.24
2	0.19	0.07	0.29	0.06	0.18	0.23	0.28	0.22	0.28	0.24	0.44	0.15	0.20	0.18	0.15	0.37
3	0.13	0.11	0.25	0.06	0.20	0.24	0.39	0.15	0.26	0.16	0.45	0.11	0.25	0.18	0.26	0.30
6	0.11	0.04	0.24	0.05	0.21	0.47	0.34	0.15	0.32	0.15	0.47	0.22	0.28	0.17	0.19	0.33
								Turbidity (NTUs)								
0	_	_	38	55	38	52	59	57	51	72	60	68	62	66	49	58
2	-	-	-	-	-	-	69	82	54	90	75	76	61	85	59	70
3	-	-	-	-	-	-	60	78	55	88	82	79	64	72	55	72
6	-	-	-	-	-	-	94	87	63	110	108	84	54	71	86	87

RIVER MILE 160.95

550 Feet From Right Bank Looking Downstream (RBLDS)

Temperature (°C)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	27.0	26.0	31.0	26.0	29.5	26.5	25.5	25.0	27.2	23.0	24.5	16.0	16.5	19.5	20.0	13.0
3	27.0	26.0	30.5	26.0	29.0	26.5	25.5	24.5	27.5	22.5	24.0	16.0	16.5	19.5	20.0	13.0
9	27.0	26.0	31.0	26.5	29.0	26.5	25.5	24.5	27.5	22.5	24.0	16.0	16.0	19.5	20.0	13.0
18	27.0	26.0	31.0	26.0	29.0	27.0	25.5	24.5	27.5	23.0	24.5	16.0	16.5	19.5	20.0	13.0

pH

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	8.30	8.85	8.55	8.60	8.20	8.35	8.10	8.40	8.20	8.25	8.10	8.45	8.25	8.00	8.00	8.00
3	8.30	8.85	8.50	8.50	8.20	8.30	8.10	8.30	8.18	8.25	8.10	8.40	8.20	8.05	8.00	8.00
9	8.30	8.85	8.50	8.50	8.10	8.30	8.05	8.25	8.09	8.20	8.10	8.35	8.15	8.05	8.05	8.00
18	8.30	8.85	8.50	8.50	8.10	8.30	8.00	8.25	8.05	8.20	8.10	8.35	8.15	8.05	8.05	8.00

Ammonia Nitrogen, NH_3 -N (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	0.10	0.06	0.19	0.01	0.22	0.31	0.24	0.15	0.32	0.13	0.47	0.21	0.35	0.18	0.24	0.28
3	0.10	0.04	0.20	0.08	0.24	0.17	0.30	0.18	0.39	0.25	0.43	0.16	0.27	0.20	0.22	0.38
9	0.15	0.07	0.21	0.08	0.19	0.24	0.16	0.15	0.15	0.27	0.43	0.20	0.23	0.17	0.15	0.18
18	0.24	0.09	0.22	0.06	0.20	0.26	0.25	0.07	0.28	0.31	0.46	0.19	0.28	0.21	0.16	0.19

Nitrate Nitrogen, NO_3 -N (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
9	-	-	1.15	1.50	1.91	1.65	1.61	1.51	1.64	1.48	2.59	-	3.16	2.75	2.92	3.0

Total Kjeldahl Nitrogen (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
9	-	-	2.26	1.70	1.62	1.60	1.54	2.00	1.67	1.68	1.43	2.31	1.06	1.03	1.29	1.18

Turbidity (NTUs)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	-	-	-	-	-	-	54	52	48	58	67	69	55	82	65	46
3	-	-	-	-	-	-	59	58	50	68	77	77	76	83	66	55
9	-	-	58	68	-	-	65	71	79	84	91	79	68	79	70	66
18	-	-	-	-	-	-	98	89	76	97	83	84	84	79	79	71

RIVER MILE 160.01

100 Feet From RBLDS

Temperature (°C)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	27.0	26.0	32.5	26.0	29.0	27.0	26.0	25.0	27.0	23.0	24.0	15.5	16.5	20.0	21.0	14.5
3	27.0	26.0	32.0	26.0	29.0	27.0	26.0	25.0	27.0	23.0	24.0	16.0	17.0	20.0	21.0	13.5
5	27.0	26.0	32.0	26.0	29.0	27.0	26.0	25.0	27.0	23.0	24.0	16.0	17.0	20.0	21.0	13.5
9	27.0	26.0	32.0	26.0	29.0	27.0	26.0	25.0	27.5	23.5	24.0	16.0	17.0	19.5	21.0	13.5

pH

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	8.30	8.80	8.60	8.55	8.00	8.30	8.10	8.30	8.13	8.30	7.95	8.30	8.00	7.55	7.75	8.00
3	8.30	8.75	8.55	8.50	8.00	8.30	8.05	8.20	8.10	8.25	7.90	8.25	8.10	7.55	7.85	8.00
5	8.30	8.70	8.55	8.45	8.10	8.25	8.00	8.15	8.07	8.20	7.90	8.20	8.10	7.60	7.75	8.00
9	8.30	8.70	8.50	8.40	8.10	8.20	8.00	8.10	8.00	8.10	7.85	8.20	8.10	7.80	7.75	8.00

Ammonia Nitrogen, NH_3-N (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	0.10	0.12	0.23	0.09	0.25	0.26	0.25	0.21	0.39	0.32	0.44	0.23	0.32	1.18	2.99	0.95
3	0.15	0.09	0.18	0.09	0.24	0.29	0.23	0.14	0.34	0.25	0.58	0.31	0.32	1.07	1.52	0.42
5	0.18	0.16	0.26	0.12	0.23	0.33	0.25	0.30	0.38	0.33	0.53	C.24	0.30	1.02	3.23	0.33
9	0.19	0.18	0.20	0.14	0.28	0.21	0.28	0.36	0.38	0.31	0.51	0.31	0.30	0.57	2.97	0.41

Nitrate Nitrogen NO -N (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
5	-	-	1.24	1.85	1.79	1.68	1.84	1.66	1.69	1.64	3.04	-	3.12	2.32	2.82	3.15

Total Kjeldahl Nitrogen (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
S	-	-	2.10	1.67	1.88	1.63	1.69	1.58	1.76	1.88	1.53	2.46	1.33	2.23	4.31	1.34

Turbidity (NTUs)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	-	-	-	-	38	38	47	50	51	76	56	68	46	59	40	46
3	-	-	-	-	-	-	57	70	49	92	66	67	63	65	54	73
5	-	-	50	50	-	-	57	107	54	112	63	66	59	69	43	80
9	-	-	-	-	-	-	57	149	56	93	64	74	81	101	59	88

RIVER MILE 160.01

400 Feet From RBLDS

Temperature (°C)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	27.5	26.5	32.5	26.0	29.0	27.0	25.5	25.0	27.0	23.0	24.0	16.0	16.5	19.0	20.5	13.0
3	27.0	26.5	31.5	26.0	28.5	27.0	25.5	25.0	27.0	23.0	24.0	16.5	16.5	19.5	21.0	13.0
8	27.0	26.0	31.5	25.5	28.5	27.0	25.5	24.5	27.0	23.0	24.0	16.0	16.5	19.5	20.5	13.0
15	27.0	26.5	32.5	26.0	29.0	27.0	25.5	24.5	27.0	23.5	24.0	16.0	16.5	19.5	20.0	13.0

pH

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	8.30	8.80	8.60	8.55	8.20	8.30	8.10	8.40	8.10	8.25	8.15	8.40	8.10	8.05	7.95	8.00
3	8.30	8.80	8.55	8.50	8.20	8.30	8.05	8.30	8.08	8.25	8.10	8.45	8.15	8.05	8.00	8.00
8	8.30	8.80	8.55	8.45	8.20	8.30	8.00	8.25	8.05	8.20	8.05	8.40	8.15	8.05	8.05	8.00
15	8.30	8.80	8.55	8.45	8.10	8.30	8.00	8.20	7.95	8.20	8.05	8.40	8.15	8.05	8.05	8.00

Ammonia Nitrogen, NH_3-N (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	0.22	0.11	0.08	0.09	0.28	0.19	0.32	0.12	0.33	0.32	0.37	0.18	0.34	0.18	0.22	0.28
3	0.25	0.13	0.14	0.14	0.26	0.16	0.40	0.08	0.35	0.30	0.45	0.22	0.29	0.19	0.21	0.28
8	0.23	0.09	0.19	0.13	0.27	0.25	0.35	0.09	0.37	0.29	0.48	0.19	0.28	0.21	0.20	0.28
15	0.22	0.10	0.21	0.11	0.24	0.23	0.44	0.23	0.49	0.30	0.46	0.34	0.27	0.20	0.14	0.31

Nitrate Nitrogen, NO_3-N (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
8	-	-	1.16	1.56	1.80	2.16	1.66	1.86	1.69	1.46	2.62	-	3.24	2.72	2.96	3.18

Total Kjeldahl Nitrogen (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
8	-	-	1.42	1.45	1.87	1.73	1.56	1.57	1.90	1.76	1.48	2.37	1.24	1.10	0.95	0.78

Turbidity (NTUs)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	-	-	-	-	-	-	47	54	55	88	62	61	55	82	52	52
3	-	-	-	-	-	-	55	58	75	116	72	77	56	92	57	57
8	-	-	54	62	-	-	65	60	78	106	84	80	60	88	59	66
15	-	-	-	-	-	-	93	73	100	98	115	82	64	86	61	79

RIVER MILE 158.01

100 Feet From RBLDS

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
Temperature <°C)																
0	27.0	26.5	29.5	26.0	28.5	27.5	26.0	25.5	27.2	23.5	24.0	16.0	16.5	19.5	20.0	13.0
3	27.0	26.5	29.5	26.0	28.0	27.5	26.0	25.5	27.5	23.0	23.5	16.5	17.0	19.5	20.5	13.0
6	27.0	26.5	29.5	26.5	28.5	27.5	26.0	25.5	27.5	23.0	23.5	16.5	17.0	19.5	20.5	13.0
12	27.0	26.5	30.0	26.5	28.5	27.0	26.0	25.0	27.5	23.0	23.5	16.0	17.0	19.5	20.0	13.0
pH																
0	8.35	8.75	8.50	8.45	8.00	8.40	8.10	8.10	8.15	8.10	8.15	8.40	8.10	8.05	8.00	8.05
3	8.30	8.65	8.45	8.45	8.00	8.30	8.05	8.05	8.05	8.10	8.10	8.45	8.10	8.05	8.00	8.05
6	8.30	8.70	8.45	8.45	8.00	8.30	8.00	8.05	8.00	8.10	8.10	8.40	8.10	8.05	8.00	8.00
12	8.30	8.70	8.45	8.40	8.00	8.30	8.00	8.00	7.87	8.10	8.05	8.40	8.05	8.05	7.95	8.00
Ammonia Nitrogen, NH_3-N (mg/l)																
0	0.32	0.11	0.23	0.11	0.28	0.12	0.37	0.27	0.30	0.29	0.49	0.21	0.40	0.16	0.20	0.24
3	0.19	0.09	0.29	0.09	0.28	0.24	0.28	0.26	0.29	0.29	0.43	0.17	0.35	0.20	0.20	0.36
6	0.13	0.15	0.14	0.12	0.23	0.21	0.28	0.19	0.28	0.27	0.43	0.26	0.30	0.20	0.26	0.30
12	0.11	0.12	0.26	0.16	0.27	0.26	0.30	0.23	0.38	0.25	0.57	0.28	0.40	0.31	0.30	0.35
Turbidity (NTUs)																
0	-	-	-	-	-	-	47	43	42	58	52	69	102	63	45	60
3	-	-	-	-	-	-	58	53	180	77	61	102	117	85	52	67
6	-	-	-	-	-	-	68	58	76	72	73	109	138	80	57	67
12	-	-	-	-	-	-	95	71	78	112	82	240	137	80	75	118

RIVER MILE 158.01

400 Feet From RBLDS

Temperature <°C)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	27.0	26.0	29.5	26.5	28.5	27.5	26.5	25.0	27.5	23.5	24.0	16.0	17.0	19.5	20.0	13.0
3	27.0	26.5	29.5	25.5	28.5	27.5	26.0	25.0	27.2	23.0	23.5	16.0	16.5	19.5	20.5	13.0
9.5	27.0	26.5	29.5	25.5	28.5	27.0	26.0	25.0	27.2	23.0	23.5	16.0	16.5	19.5	20.0	13.0
18	27.0	26.5	30.0	25.5	28.5	27.0	26.0	25.0	27.2	23.0	24.0	16.0	16.5	19.5	20.0	13.0

pH

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	8.30	8.80	8.55	8.50	8.00	8.40	8.15	8.20	8.10	8.25	8.15	8.50	8.20	8.05	7.95	8.00
3	8.30	8.75	8.55	8.45	8.00	8.30	8.05	8.10	8.07	8.20	8.10	8.40	8.15	8.10	8.00	8.05
9.5	8.30	8.75	8.50	8.40	8.00	8.30	8.00	8.10	8.05	8.20	8.10	8.40	8.10	8.10	8.00	8.05
18	8.30	8.70	8.50	8.40	8.00	8.30	8.00	8.05	8.00	8.15	8.05	8.35	8.10	8.05	7.95	8.05

Ammonia Nitrogen, NH_3-N (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	0.10	0.10	0.20	0.12	0.29	0.29	0.21	0.16	0.32	0.30	0.46	0.28	0.39	0.27	0.29	0.42
3	0.15	0.11	0.25	0.13	0.28	0.30	0.39	0.24	0.20	0.28	0.48	0.22	0.38	0.31	0.30	0.32
9.5	0.27	0.14	0.31	0.18	0.31	0.28	0.33	0.27	0.28	0.27	0.52	0.20	0.30	0.32	0.35	0.37
18	0.11	0.10	0.21	0.15	0.30	0.27	0.28	0.26	0.28	0.21	0.44	0.20	0.32	0.27	0.23	0.33

Dissolved Oxygen (mg/l)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	-	-	7.10	9.80	5.30	6.00	5.40	6.70	5.60	5.90	7.40	8.40	8.40	7.40	7.15	9.50
3	-	-	6.50	8.90	5.10	5.40	5.40	6.35	5.10	5.20	6.80	8.40	8.40	7.45	7.10	9.50
9.5	-	-	6.25	8.50	4.80	5.20	5.20	5.70	4.60	5.10	6.65	8.40	8.55	7.50	7.00	9.45
18	-	-	6.15	8.30	4.70	5.00	5.10	5.50	4.50	5.10	6.60	8.30	9.60	7.50	7.00	9.50

Turbidity (NTUs)

Depth (ft.)	7/11	7/18	7/24	7/30	8/06	8/13	8/20	8/23	8/30	9/04	9/13	9/27	10/04	10/11	10/15	10/25
0	-	-	32	38	10	33	44	45	50	54	53	54	50	59	45	45
3	-	-	-	-	-	-	53	51	54	63	59	69	57	67	50	57
9.5	-	-	-	-	-	-	62	64	73	80	69	76	57	71	58	67
18	-	-	-	-	-	-	102	111	82	94	83	114	62	79	60	76

Appendix D

Illinois State Water Survey 1978 through 1983 Biweekly Ammonia-N, River Temperature, and pH Data Plus GPSD Ammonia-N Data For Corresponding Dates

Summary of River and Greater Peoria Sanitary District (GPSD) 1978 Ammonia-Nitrogen Conditions

	River Values							
Date	PH	Temp (°C)	NH_3-N (mg/l)	IEPA NH_3-N standard for given pH & temp (mg/l)	River flow (cfs)	River NH_3-N loads (lbs/day)	GPSD NH_3-N loads (lbs/day)	GPSD Contribution to river (mg/l)
1/3/78	8.2	1.4	1.18	2.5	11,200	71,366	1993	0.033
1/9	8.2	-1.0	1.27	2.5	9,330	63,985	1796	0.036
1/16	8.0	0.1	1.65	3.1	6,950	61,924	2156	0.058
1/23	7.7	0.0	1.54	7.0	7,300	60,707	2459	0.063
1/30	8.1	0.0	2.94	2.8	6,100	96,844	2709	0.082
2/6	8.3	1.0	1.98	2.1	5,620	60,089	2706	0.089
2/13	7.82	1.0	1.57	5.7	5,450	46,205	2279	0.078
2/20	7.65	-1.0	4.14	7.0	6,000	134,136	2083	0.064
2/27	7.57	2.5	3.67	8.3	6,210	123,070	2508	0.075
3/6	8.08	0.0	2.65	2.8	7,115	101,816	1581	0.041
3/13	8.35	1.8	3.28	1.8	8,210	145,416	2918	0.066
3/20	7.98	2.3	1.50	3.1	24,540	198,774	1979	0.015
3/27	8.26	3.8	0.89	2.1	31,937	153,489	2433	0.014
4/3	8.11	9.0	0.48	2.1	32,110	83,229	1129	0.007
4/11	8.33	11.8	0.18	1.7	42,300	41,116	2458	0.011
4/17	8.27	12.2	0.17	1.7	37,720	34,626	2228	0.011
4/24	8.15	12.5	0.34	1.6	29,370	53,923	2658	0.017
5/1	8.63	13.5	0.15	1.5	19,410	15,722	2256	0.022
5/8	8.42	11.0	0.22	1.6	17,800	21,146	3938	0.041
5/15	8.35	13.2	0.29	1.5	37,200	58,255	2261	0.011
5/22	8.04	17.3	0.26	1.5	33,370	46,851	1258	0.007
5/29	7.86	23.3	0.20	1.7	23,450	25,326	1509	0.012
6/5	8.38	22.9	0.29	1.5	18,200	28,501	2041	0.021
6/12	8.25	24.2	0.31	1.5	11,000	18,414	2294	0.039
6/19	8.34	24.2	0.13	1.5	7,750	5,440	2363	0.057
6/26	8.26	25.6	0.24	1.5	11,200	14,515	1941	0.032
7/3	8.45	26.3	0.13	1.5	27,330	19,186	2172	0.015
7/10	8.20	26.6	0.08	1.5	29;880	12,908	885	0.006
7/17	8.10	28.3	0.09	1.5	23,900	11,615	1536	0.012
7/24	8.02	26.5	0.15	1.5	11,930	9,663	1589	0.025
7/31	8.15	24.2	0.09	1.5	12,860	6,250	2020	0.029
8/7	8.20	26.3	0.09	1.5	9,150	4,447	1464	0.030
8/14	8.22	28.2	0.13	1.5	7,940	5,574	2678	0.063
8/21	8.25	26.2	0.15	1.5	8,290	6,715	1171	0.026
8/28	8.23	25.8	0.12	1.5	9,285	6,017	1833	0.037
9/5	9.07	26.0	0.01	1.5	8,080	436	2028	0.047
9/11	8.62	27.3	0.18	1.5	5,820	5,657	1836	0.059
9/18	8.18	26.6	0.14	1.5	16,485	12,463	1387	0.016
9/25	7.97	22.4	0.28	1.5	17,290	26,143	2224	0.024
10/2	8.27	19.5	0.14	1.5	8,690	6,570	2630	0.056
10/9	8.16	14.0	0.28	1.6	6,990	10,569	2054	0.055
10/16	8.29	13.0	0.26	1.6	4,290	6,023	1896	0.082
10/23	8.18	14.7	0.25	1.5	5,265	7,108	2022	0.071
10/30	8.44	12.5	0.12	1.5	6,390	4,141	1792	0.052
11/6	8.49	14.4	0.29	1.5	6,160	9,647	2996	0.090
11/13	8.26	11.8	0.53	1.7	4,635	13,265	2225	0.089
11/20	8.26	6.9	0.81	2.0	7,230	31,624	2520	0.065
11/27	8.20	4.0	1.16	2.5	8,565	53,651	2453	0.053
12/4	8.23	1.5	1.87	2.5	8,800	88,862	1889	0.040
12/11	8.15	0.8	2.33	2.5	7,310	91,974	1928	0.049
12/18	8.08	1.0	2.54	2.8	9,090	124,678	2225	0.045
12/26	8.20	0.1	1.54	2.5	8,920	74,178	2797	0.058

Summary of River and Greater Peoria Sanitary District (GPSD) 1979 Ammonia-Nitrogen Conditions

	River Values							
Date	PH	Temp (°C)	NH_3-N (mg/l)	IEPA NH_3-N standard for given pH & temp (mg/l)	River flow (cfs)	River NH_3-N loads (lbs/day)	GPSD NH_3-N loads (lbs/day)	GPSD Contribution to river (mg/l)
1/2/79	8.17	0.2	1.62	2.5	9,950	87,043	-	-
1/8	8.01	0.0	3.03	3.1	9,180	150,203	2313	0.047
1/16	7.50	0.1	2.61	9.6	6,880	96,967	1606	0.043
1/22	7.80	0.2	2.17	5.7	6,780	73,448	1664	0.046
1/29	7.79	0.1	2.54	5.7	6,480	88,880	1677	0.048
2/5	7.84	0.1	3.16	5.7	6,580	112,281	408	0.012
2/12	7.97	0.1	2.65	3.1	6,480	92,729	2025	0.058
2/19	7.97	0.1	3.38	3.1	5,780	105,497	1534	0.049
2/26	7.85	0.2	3.39	4.4	9,920	181,595	1401	0.026
3/5	8.04	0.3	4.09	3.1	13,100	289,326	664	0.009
3/12	7.65	0.5	0.68	7.0	66,450	244,004	1601	0.005
3/19	7.84	3.5	0.47	5.7	54,350	137,940	180	0.001
3/26	7.71	5.2	0.52	7.0	70,100	196,841	2117	0.006
4/2	7.97	6.2	0.48	2.9	66,500	172,368	1735	0.005
4/9	7.89	6.8	0.62	3.8	53,650	179,620	1604	0.006
4/16	8.14	9.1	0.67	2.1	59,530	215,380	1761	0.006
4/23	7.95	13.8	0.43	1.6	42,835	99,463	1091	0.005
4/30	8.07	13.1	0.53	1.7	49,100	140,524	1567	0.006
5/7	8.15	14.0	0.31	1.6	49,840	83,342	1092	0.004
5/14	7.98	18.8	0.19	1.5	38,470	39,470	1865	0.009
5/21	8.06	20.3	0.35	1.5	27,115	53,137	1511	0.010
5/29	7.98	19.5	0.22	1.5	16,850	20,018	1695	0.019
6/4	8.07	22.9	0.34	1.5	11,810	21,683	911	0.014
6/11	8.02	22.6	0.49	1.5	16,070	42,521	1244	0.014
6/18	7.96	25.0	0.17	1.5	13,835	12,700	1907	0.026
6/25	8.04	22.0	0.18	1.5	9,900	9,623	1954	0.037
7/2	8.30	25.0	0.10	1.5	11,710	6,323	2374	0.038
7/9	7.95	24.5	0.46	1.5	13,900	34,528	1537	0.021
7/16	7.98	27.5	0.13	1.5	9,700	6,809	1753	0.034
7/23	8.11	28.0	0.20	1.5	7,620	8,230	2815	0.069
7/30	8.10	28.5	0.15	1.5	8,770	7,104	2706	0.057
8/6	8.11	29.0	0.20	1.5	11,980	12,938	1969	0.031
8/13	8.11	24.0	0.43	1.5	12,920	30,000	2199	0.032
8/20	8.15	25.5	0.10	1.5	18,985	10,252	3115	0.030
8/27	7.88	24.0	0.26	1.7	24,900	34,960	2265	0.017
9/4	8.02	26.5	0.43	1.5	18,740	43,514	4343	0.043
9/10	8.22	22.0	0.24	1.5	9,465	12,267	3681	0.072
9/17	8.28	19.5	0.17	1.5	6,175	5,669	2856	0.086
9/24	8.46	18.0	0.11	1.5	7,380	4,384	2446	0.062
10/1	8.38	21.0	0.27	1.5	7,050	10,279	332	0.009
10/8	8.15	13.9	0.30	1.5	6,910	11,194	2656	0.071
10/15	8.28	11.0	0.24	1.7	6,350	8,230	2088	0.061
10/22	8.23	20.0	0.22	1.5	6,515	7,740	2859	0.081
10/29	8.23	10.4	0.51	1.9	6,905	19,016	1777	0.048
11/5	8.21	9.0	-	2.0	6,550	-	1451	-
11/12	8.44	4.5	0.68	1.8	6,485	23,813	2073	0.059
11/19	8.77	7.5	0.18	1.5	6,525	6,342	2155	0.061
11/26	8.31	6.5	0.67	2.0	7,810	28,257	886	0.021
12/3	8.18	0.0	2.20	2.5	9,345	111,019	2061	0.041
12/10	8.24	2.0	0.92	2.5	9,370	46,550	877	0.017
12/17	8.22	-0.3	1.45	2.5	8,325	65,185	1288	0.029
12/24	8.16	3.0	1.22	2.5	10,010	65,946	1091	0.020
12/31	8.00	4.0	1.68	3.1	23,835	216,231	2093	0.016

Summary of River and Greater Peoria Sanitary District (GPSD) 1980 Ammonia-Nitrogen Conditions

	River Values			IEPA NH_3-N standard for given pH & temp		River	GPSD	GPSD
Date	pH	Temp (°C)	NH_3-N (mg/l)	(mg/l)	River flow (cfs)	NH_3-N loads (lbs/day)	NH_3-N loads (lbs/day)	Contribution to river (mg/l)
1/7/80	8.15	0.0	0.93	2.5	14,965	75,154	984	0.012
1/14	8.08	0.5	0.81	2.8	9,255	40,487	1750	0.035
1/21	8.17	1.0	1.35	2.5	8,760	63,860	1227	0.026
1/28	8.19	0.0	1.54	2.5	7,775	64,657	1756	0.042
2/4	8.08	0.0	1.92	2.8	6,285	65,163	2208	0.065
2/11	8.05	0.5	1.88	2.8	5,930	60,201	1794	0.056
2/18	7.94	0.5	2.86	4.4	5,780	89,421	1936	0.062
2/25	8.05	0.0	2.31	2.8	17,060	212,806	2040	0.022
3/3	7.98	0.0	1.95	3.1	11,960	125,939	2430	0.038
3/10	8.32	1.4	1.91	2.1	12,220	126,037	2586	0.039
3/17	8.03	5.0	1.25	3.1	21,770	146,947	2118	0.018
3/24	8.04	6.0	1.10	2.9	28,020	166,439	2943	0.020
3/31	8.13	6.0	0.72	2.6	23,280	90,513	2025	0.016
4/7	8.15	10.5	0.92	1.8	23,750	117,990	1680	0.013
4/14	8.19	7.5	0.93	2.1	29,635	148,827	2412	0.015
4/21	8.40	13.0	0.20	1.5	29,610	31,979	2060	0.013
4/28	8.31	14.5	0.32	1.5	22,215	38,388	1663	0.014
5/5	8.20	19.0	0.21	1.5	20,930	23,735	1791	0.016
5/12	8.14	17.0	0.41	1.5	7,830	17,336	1078	0.026
5/19	8.09	17.5	0.49	1.5	18,700	49,480	225	0.002
5/27	8.18	23.0	0.48	1.5	13,680	35,459	526	0.007
6/2	8.23	24.0	0.30	1.5	9,000	14,580	105	0.002
6/9	8.03	22.5	0.46	1.5	46,430	115,332	187	0.001
6/16	7.96	21.5	0.36	1.5	35,330	68,682	376	0.002
6/23	8.18	24.0	0.15	1.5	22,430	18,168	1102	0.009
6/30	7.81	26.0	0.35	1.7	15,180	28,690	1356	0.017
7/7	7.93	28.0	0.29	1.5	8,315	13,021	576	0.013
7/14	8.01	30.5	0.07	1.5	9,465	3,578	751	0.015
7/21	7.88	29.5	0.24	1.5	7,590	9,837	622	0.015
7/28	7.97	25.0	0.28	1.5	7,505	11,348	1008	0.025
8/4	7.76	27.0	0.08	1.6	7,410	3,201	2410	0.060
8/11	8.08	28.5	0.28	1.5	9,365	12,643	939	0.019
8/18	8.00	24.5	0.20	1.5	12,800	13,824	414	0.006
8/25	7.88	27.0	0.10	1.6	11,480	6,199	840	0.014
9/2	7.94	25.0	0.13	1.6	19,625	13,777	543	0.005
9/8	7.67	25.5	0.10	1.8	18,370	9,920	483	0.005
9/15	7.99	22.0	0.15	1.5	20,980	16,934	685	0.006
9/22	8.30	22.5	0.12	1.5	24,110	15,623	806	0.006
9/29	8.11	19.0	0.12	1.5	18,760	12,156	443	0.004
10/6	8.16	14.0	0.07	1.6	6,757	3,554	213	0.006
10/13	8.69	12.5	0.06	1.5	7,374	2,389	423	0.011
10/20	8.61	13.0	0.07	1.5	12,369	4,675	325	0.005
10/27	8.20	7.9	0.17	2.1	8,680	7,968	373	0.008
11/3	8.42	9.0	0.09	1.7	6,720	3,266	17	0.001
11/10	8.60	10.5	0.06	1.5	6,018	1,950	606	0.019
11/17	8.29	6.0	0.11	2.1	6,238	3,705	395	0.012
11/24	8.62	5.0	0.22	1.5	9,913	11,777	372	0.007
12/1	8.38	4.0	0.96	1.8	6,630	34,370	182	0.005
12/8	8.19	7.5	1.01	2.3	9,336	50,370	680	0.014
12/15	7.84	3.5	0.77	5.7	19,600	81,497	567	0.005
12/22	7.98	0.0	0.38	3.1	7,138	14,647	438	0.011
12/29	7.90	0.1	0.56	4.4	6,750	20,412	176	0.005

Summary of River and Greater Peoria Sanitary District (GPSD) 1981 Ammonia-Nitrogen Conditions

	River Values							
Date	pH	Temp (°C)	NH_3-N (mg/l)	IEPA NH_3-N standard for given pH & temp (mg/l)	River flow (cfs)	River NH_3-N loads (lbs/day)	GPSD NH_3-N loads (lbs/day)	GPSD Contribution to river (mg/l)
1/5/81	7.78	0.0	0.95	5.7	6,830	35,038	181	0.005
1/12	7.90	0.0	1.20	4.4	5,435	35,219	556	0.019
1/19	7.98	0.0	1.52	3.1	4,940	40,549	380	0.014
1/26	7.68	0.5	1.96	7.0	6.320	66,891	141	0.004
2/2	8.03	0.0	1.14	3.1	5,060	31,149	388	0.014
2/9	7.91	0.0	1.30	4.4	4,470	31,379	498	0.021
2/16	8.03	0.5	2.07	3.1	4,850	54,213	1127	0.043
2/23	8.00	5.0	1.74	3.1	19,800	186,041	1122	0.011
3/2	7.91	5.0	0.95	4.4	22,115	113,450	1217	0.010
3/9	8.01	5.5	0.81	2.9	17,490	76,501	628	0.007
3/16	8.23	7.5	0.38	2.1	8,627	17,703	854	0.018
3/23	8.73	7.0	0.06	1.5	6,560	2,125	561	0.016
3/30	8.53	13.0	0.14	1.5	5,860	4,430	1028	0.033
4/6	8.18	11.0	0.61	1.8	7,680	25,297	402	0.010
4/13	8.18	16.0	1.05	1.5	18,380	104,215	608	0.006
4/20	7.95	14.5	0.56	1.5	39,010	117,966	873	0.004
4/27	8.04	15.0	0.26	1.5	32,210	45,223	722	0.004
5/4	8.07	16.0	0.27	1.5	34,400	50,155	1048	0.006
5/11	8.15	12.0	0.14	1.7	25,260	19,096	574	0.004
5/18	8.07	13.0	0.32	1.7	49,620	85,743	879	0.003
5/26	8.12	18.0	0.17	1.5	33,793	31,022	1262	0.007
6/1	8.1	22.0	0.28	1.5	30,040	45,420	670	0.004
6/8	8.07	25.0	0.19	1.5	17,900	18,365	320	0.003
6/15	8.32	25.5	0.16	1.5	29,893	25,827	329	0.002
6/22	7.85	23.5	0.34	1.7	32,840	60,294	650	0.004
6/29	7.98	25.0	0.15	1.5	37,400	30,294	315	0.002
7/6	7.88	25.5	0.10	1.6	22,880	12,355	2059	0.017
7/13	8.15	29.0	0.10	1.5	14,100	7,614	1544	0.020
7/20	7.95	27.5	0.30	1.5	13,290	10,047	515	0.007
7/27	7.97	25.0	0.15	1.5	14,610	11,834	1320	0.017
8/3	7.90	24.5	0.09	1.6	19,230	9,346	880	0.009
8/10	7.98	25.5	0.12	1.5	19,640	12,727	322	0.003
8/17	8.08	24.0	0.08	1.5	26,430	11,418	539	0.004
8/24	7.98	25.0	0.08	1.5	19,782	8,546	405	0.004
8/31	8.05	26.0	0.17	1.5	19,360	17,772	585	0.006
9/8	7.95	22.5	0.09	1.5	19,770	9,608	748	0.007
9/14	8.11	25.5	0.09	1.5	15,148	7,362	1151	0.014
9/21	8.08	19.5	0.07	1.5	8,792	3,304	1193	0.025
9/28	8.18	18.0	0.08	1.5	9,047	3,908	325	0.007
10/5	8.14	16.5	0.18	1.5	15,400	14,969	865	0.010
10/12	8.23	15.5	0.06	1.5	13,954	4,521	295	0.004
10/19	8.27	11.5	0.09	1.7	10,356	5,033	1235	0.022
10/26	8.30	12.5	0.33	1.6	11,328	20,186	143	0.002
11/2	8.47	13.5	0.08	1.5	9,503	4,105	243	0.005
11/9	8.29	11.0	0.14	1.7	9,446	7,141	399	0.008
11/16	8.44	10.0	0.14	1.5	7,369	5,571	380	0.010
11/23	8.38	4.0	0.21	1.8	9,561	10,842	427	0.008
11/30	8.23	4.5	0.96	2.5	16,205	84,006	444	0.005
12/7	8.16	4.0	0.57	2.5	17,283	53,197	352	0.004
12/14	8.25	3.0	0.35	2.1	11,600	21,924	202	0.003
12/21	8.16	0.0	0.46	2.5	8,430	20,940	312	0.007
12/28	8.08	0.5	0.67	2.8	9,930	35,927	132	0.003

Summary of River and Greater Peoria Sanitary-District (GPSD) 1982 Ammonia-Nitrogen Conditions

	River Values			IEPA NH_3-N standard for given pH & temp		River	GPSD	GPSD
Date	PH	Temp (°C)	NH_3-N (mg/l)	(mg/l)	River flow (cfs)	NH_3-N loads (lbs/day)	NH_3-N loads (lbs/day)	Contribution to river (mg/l)
1/4/82	7.98	0.0	1.00	3.1	9,900	53,460	750	0.014
1/11	7.97	0.0	1.54	3.1	15,800	131,393	1317	0.016
1/18	7.68	0.0	1.20	7.0	10,810	70,049	847	0.015
1/25	7.80	0.0	1.29	5.7	9,850	63,532	455	0.009
2/1	7.78	0.0	1.70	5.7	11,700	107,406	538	0.009
2/8	7.90	0.0	1.68	4.4	9,900	89,813	493	0.009
2/15	7.80	0.0	1.61	5.7	9,800	85,201	709	0.013
2/22	7.91	0.5	1.51	4.4	38,000	309,852	774	0.004
3/1	7.55	0.5	0.84	8.3	43,830	198,813	618	0.003
3/8	7.86	0.0	0.73	4.4	35,525	128,213	311	0.002
3/15	8.03	2.0	0.87	3.1	60,720	285,262	639	0.002
3/22	7.82	5.0	0.46	5.7	72,560	180,232	483	0.001
3/29	7.98	6.0	0.55	2.9	53,955	160,246	394	0.001
4/5	8.22	7.0	0.47	2.2	50,350	127,788	738	0.003
4/12	8.22	5.5	0.68	2.3	39,810	146,182	764	0.004
4/19	8.20	11.5	0.35	1.7	53,930	101,909	160	0.001
4/26	8.05	13.5	0.26	1.6	42,930	60,260	456	0.002
5/3	8.18	16.5	0.07	1.5	28,920	10,932	298	0.002
5/10	8.22	20.0	0.15	1.5	19,290	15,625	110	0.001
5/17	7.98	23.5	0.36	1.5	14,475	28,139	64	0.001
5/24	7.92	20.0	0.32	1.8	18,555	32,063	210	0.002
6/1	7.90	20.5	0.15	1.8	25,990	21,052	179	0.001
6/7	8.08	21.0	0.05	1.5	23,255	6,278	235	0.050
6/14	8.17	23.5	0.05	1.5	14,665	3,960	332	0.004
6/21	7.92	22.5	0.18	1.7	13,350	12,976	566	0.008
6/28	8.20	25.0	0.10	1.5	9,210	4,973	945	0.019
7/6	8.10	27.5	0.09	1.5	16,000	7,776	595	0.007
7/12	7.94	25.0	0.18	1.6	18,890	18,361	249	0.002
7/19	8.22	27.0	0.07	1.5	20,610	7,790	485	0.004
7/26	8.02	27.5	0.09	1.5	25,635	12,456	37	<0.001
8/2	8.19	26.5	0.06	1.5	17,245	5,587	334	0.004
8/9	8.10	26.0	0.18	1.5	15,740	15,299	349	0.004
8/16	8.16	25.5	0.16	1.5	12,910	11,154	664	0.010
8/23	8.25	24.5	0.13	1.5	10,935	7,676	535	0.009
8/30	8.21	22.0	0.10	1.5	9,355	5,052	510	0.010
9/7	8.47	23.0	0.12	1.5	7,910	5,126	529	0.012
9/13	7.75	24.0	0.08	1.8	6,940	2,998	40	0.001
9/20	8.51	20.0	0.08	1.5	7,960	3,439	94	0.002
9.27	8.41	16.5	0.06	1.5	8,160	2,644	238	0.005
10/4	8.31	21.0	0.15	1.5	8,640	6,998	201	0.004
10/11	8.30	18.5	0.19	1.5	7,625	7,823	818	0.020
10/18	8.35	13.5	0.06	1.5	7,505	2,432	352	0.009
10/25	8.32	10.0	0.16	1.7	8,430	7,284	346	0.008
11/1	8.40	13.5	0.05	1.5	6,310	1,704	1858	0.055
11/8	8.20	8.0	0.59	2.1	12,415	39,554	701	0.011
11/15	8.10	4.4	0.45	2.8	14,400	34,992	312	0.004
11/22	8.18	9.0	0.63	2.0	14,050	47,798	70	0.001
11/29	8.10	4.5	0.42	2.8	21,200	48,082	575	0.005
12/6	7.90	11.0	0.39	2.8	72,210	152,074	748	0.002
12/13	7.80	4.5	0.19	5.7	56,210	57,672	364	0.001
12/20	8.08	2.5	0.20	2.8	44,010	47,531	1170	0.005
12/27	8.10	5.5	0.30	2.6	44,030	71,329	730	0.003

Summary of River and Greater Peoria Sanitary District (GPSD) 1983 Ammonia-Nitrogen Conditions

	River Values							
Date	pH	Temp (°C)	NH_3-N (mg/l)	IEPA NH_3-N standard for given pH & temp (mg/l)	River flow (cfs)	River NH_3-N loads (lbs/day)	GPSD NH_3-N loads (lbs/day)	GPSD Contribution to river (mg/l)
1/3/83	8.00	3.0	0.36	3.1	41,213	80,118	560	0.003
1/10	8.06	2.0	0.25	2.8	28,000	37,800	1188	0.008
1/17	8.15	0.0	0.45	2.5	20,720	50,350	620	0.006
1/24	8.10	0.5	0.71	2.8	13,760	52,756	1322	0.018
1/31	8.10	0.5	0.76	2.8	10,700	43,913	317	0.006
2/7	7.90	0.0	1.07	4.4	23,600	136,361	1036	0.008
2/14	7.95	2.9	0.47	3.1	13,300	33,755	898	0.013
2/21	8.00	6.0	0.39	2.9	20,855	43,921	142	0.001
2/28	8.12	5.4	0.44	2.8	19,470	46,261	233	0.002
3/7	8.17	12.6	0.44	1.6	10,070	23,926	900	0.017
3/14	8.00	7.1	1.23	2.7	16,360	108,663	61	0.001
3/21	8.10	4.0	0.38	2.8	23,780	48,797	546	0.004
3/28	8.10	5.0	0.46	2.8	23,005	57,144	1574	0.013
4/4	7.90	7.0	0.36	3.8	55,705	108,291	1009	0.003
4/11	7.72	7.0	0.27	6.1	59,760	87,130	768	0.002
4/18	7.90	8.5	0.28	3.3	66,400	100,397	457	0.001
4/25	7.92	11.0	0.22	2.8	45,835	54,452	350	0.001
5/2	8.10	14.5	0.07	1.5	31,740	11,998	985	0.006
5/9	7.70	14.0	0.66	3.5	45,660	162,518	467	0.002
5/16	7.72	16.0	0.17	3.1	40,920	37,565	526	0.002
5/23	7.90	18.0	0.12	1.9	34,470	22,337	957	0.005
5/31	8.13	17.6	0.21	1.5	28,060	31,820	3925	0.026
6/6	8.15	19.5	0.21	1.5	22,455	25,464	1320	0.011
6/13	8.27	24.0	0.10	1.5	16,510	8,915	1121	0.013
6/20	8.09	24.6	0.24	1.5	9,580	12,416	554	0.011
6/27	8.05	28.7	0.25	1.5	8,980	12,123	1034	0,021
7/5	8.45	25.9	0.11	1.5	26,870	15,961	791	0,006
7/11	8.05	27.4	0.08	1.5	20,920	9,037	1588	0.014
7/18	8.17	30.0	0.07	1.5	8,385	3,170	814	0,018
7/25	8.45	29.5	0.10	1.5	8,875	4,793	229	0,005
8/1	8.34	29.0	0.08	1.5	7,720	3,335	1030	0.025
8/8	8.36	30.0	0.12	1.5	7,075	4,585	623	0,016
8/15	8.26	26.0	0.08	1.5	7,445	3,216	261	0.007
8/22	8.18	29.5	0.17	1.5	9,500	8,721	476	0.009
8/29	8.25	28.8	0.16	1.5	9,100	7,862	290	0.006
9/6	8.10	26.0	0.18	1.5	8.355	8,121	123	0.003
9/12	8.22	24.6	0.14	1.5	8,730	6,600	65	0.001
9/19	8.18	27.0	0.12	1.5	10,995	7,125	398	0.007
9/26	8.08	25.5	0.24	1.5	9,875	12,798	177	0.003
10/3	8.18	21.0	0.11	1.5	7,135	4,238	104	0.003
10/10	8.29	15.4	0.09	1.5	6,780	3,295	138	0.004
10/17	8.30	14.1	0.07	1.5	5,985	2,262	133	0.004
10/24	8.25	12.0	0.38	1.7	10,925	22,418	238	0.004
10/31	8.00	12.9	0.71	1.7	7,535	28,889	180	0.004
11/7	7.90	10.6	0.12	2.8	8,495	5,505	218	0.005
11/14	8.25	6.0	0.38	2.1	5,865	12,035	202	0.006
11/21	8.19	9.3	0.34	2.0	8,455	15,523	438	0.010
11/28	8.09	7.5	0.83	2.3	21,080	94,481	480	0.004
12/5	8.15	2.5	0.52	2.5	24,290	68,206	285	0.002
12/12	8.15	2.5	0.45	2.5	21,600	52,488	344	0.003
12/19	7.99	0.0	0.47	3.1	34,150	86,673	225	0.001
12/27	7.88	0.0	0.39	4.4	18,760	39,509	267	0.003

Appendix E

Monthly Summaries of GPSD Ammonia-N Concentrations and Loads for the Years 1978 through 1984

1978

	NH_3-N Conc. (mg/l)			NH_3-N Load (lbs/day)			Temperature (°C)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	2.95	7.41	12.94	761	1626	2709	17	18	19
Feb.	6.23	8.85	12.28	1394	1858	2706	16	17	18
Mar.	2.27	5.87	11.19	718	1493	2918	14	16	17
Apr.	2.03	5.26	9.02	1052	1812	2573	—	—	—
May	0.31	4.62	9.35	111	1507	3938	—	—	—
Jun.	3.41	5.83	10.93	835	1493	2490	—	—	—
Jul.	2.26	6.16	10.30	753	1503	3112	—	—	—
Aug.	2.21	6.18	2.21	459	1412	2844	—	—	—
Sep.	2.82	5.92	10.84	712	1294	2308	—	—	—
Oct.	2.72	7.10	14.06	698	1495	2630	—	—	—
Nov.	0.76	7.06	12.89	215	1525	2996	—	—	—
Dec.	1.51	6.51	13.28	326	1433	2797	—	—	—

1979

	NH_3-N Conc, (mg/l)			NH_3-N Load (lbs/day)			Temperature (°C)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	2.43	7.17	14.87	567	1580	2930	—	—	—
Feb.	1.74	4.77	10.89	408	1149	2176	17	18	19
Mar.	0.25	2.29	5.63	84	931	2117	—	—	—
Apr.	1.06	3.38	6.71	336	1123	2121	—	—	—
May	1.34	4.47	11.71	291	915	1865	—	—	—
Jun.	1.03	6.02	14.55	266	1081	1954	—	—	—
Jul.	6.08	10.41	16.91	1357	1723	2869	—	—	—
Aug.	6.09	12.14	21.44	1012	2083	3217	—	—	—
Sep.	6.65	16.14	25.18	1550	2481	4343	—	—	—
Oct.	6.00	10.10	14.25	1099	1865	3318	—	—	—
Nov.	2.84	6.91	13.09	632	1298	3530	—	—	—
Dec.	1.92	4.92	11.08	410	1034	2093	—	—	—

1980

	NH_3-N Conc. (mg/l)			NH_3-N Load (lbs/day)			Temperature (°C)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	3.50	6.54	10.00	584	1113	1756	—	—	—
Feb.	3.42	7.03	11.95	683	1299	2359	—	—	—
Mar.	2.95	6.63	12.78	618	1505	2973	15	17	19
Apr.	0.65	4.12	8.78	179	1010	2412	16	18	19
May	0.10	2.44	5.39	20	471	1791	18	21	24
Jun.	0.22	1.74	4.87	103	443	1102	20	23	28
Jul.	0.90	2.94	5.99	186	551	1067	25	27	28
Aug.	0.17	2.86	9.35	34	589	2410	25	27	28
Sep.	0.95	2.20	4.03	226	438	824	24	26	28
Oct.	0.10	0.97	2.46	14	174	611	20	23	25
Nov.	0.10	1.15	3.81	13	183	659	18	20	23
Dec.	0.34	1.37	3.08	56	244	680	13	17	20

1981

	NH_3-N Conc. (mg/l)			NH_3-N Load (lbs /day)			Temperature (°C)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	0.10	1.31	3.98	14	199	627	9	14	17
Feb.	0.22	2.01	5.15	33	408	1194	10	13	18
Mar.	0.10	2.55	5.88	17	457	1217	14	16	18
Apr.	0.40	2.00	3.90	163	479	1003	15	18	20
May	0.60	2.30	4.80	243	609	1262	—	—	—
Jun.	0.20	1.30	3.20	59	314	670	21	24	26
Jul.	0.40	3.80	14.40	141	909	2443	24	26	29
Aug.	0.10	1.20	3.40	23	336	1188	—	—	—
Sep.	0.60	2.70	6.40	115	483	1193	24	25	27
Oct.	0.10	2.70	9.60	14	401	1235	—	—	—
Nov.	0.70	2.00	3.40	112	326	687	16	19	22
Dec.	0.10	1.10	2.80	16	193	548	14	16	1ft

1982

	NH_3-N Conc. (mg/l)			NH_3-N Load (lbs/day)			Temperature (°C)		
	Mint	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	1.2	3.2	9.6	229	602	1731	—	—	—
Feb.	1.5	2.7	4.6	230	652	2141	8	10	12
Mar.	0.4	1.5	3.0	184	459	739	8	9	12
Apr.	0.2	1.7	3.7	104	511	1024	9	12	15
May	0.1	1.0	2.6	20	217	601	14	19	21
Jun.	0.6	2.4	6.2	97	400	991	19	23	25
Jul.	0.2	1.6	3.0	40	332	1051	21	24	26
Aug.	0.6	2.3	4.3	96	389	984	25	26	28
Sep.	0.1	1.6	4.8	21	296	948	23	26	28
Oct.	0.1	2.7	5.2	21	418	818	20	24	26
Nov.	0.2	2.3	5.6	36	520	1858	15	17	24
Dec.	0.4	2.2	5.9	111	674	1324	12	15	18

1983

	NH_3-N Conc. (mg/l)			NH_3-N Load (lbs/day)			Temperature (°C)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	1.2	3.9	7.0	264	808	1416	11	13	16
Feb.	0.6	2.4	5.2	121	513	1138	10	14	16
Mar.	0.3	2.7	6.2	61	732	1961	10	15	18
Apr.	0.3	2.2	7.2	80	840	3205	10	13	18
May	0.2	2.5	17.4	52	715	3925	14	18	20
Jun.	2.5	5.2	9.2	554	1186	2484	20	24	27
Jul.	0.7	4.5	9.1	130	908	1956	26	28	30
Aug.	1.2	2.6	6.5	218	524	1537	25	28	30
Sep.	0.2	0.7	1.5	60	145	397	—	—	—
Oct.	0.5	0.8	1.4	81	152	340	18	20	23
Nov.	0.7	1.3	2.5	118	298	611	14	17	20
Dec.	0.2	0.9	1.5	40	233	467	—	—	—

1984

	NH_3-N Conc. (mg/l)			NH_3-N Load (lbs/day)			Temperature (°C)		
	Mint	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	0.6	1.3	2.2	104	238	429	8	11	14
Feb.	0.6	1.2	2.2	174	311	557	9	10	12
Mar.	0.8	1.2	3.2	160	350	694	9	10	12
Apr.	0.3	0.9	1.4	121	267	607	11	13	15
May	0.5	1.4	5.7	110	394	1674	14	16	19
Jun.	0.3	0.7	1.3	61	155	273	19	21	23
Jul.	0.3	0.9	1.3	54	174	263	21	23	25
Aug.	0.3	0.6	1.1	52	108	206	23	25	27
Sep.	0.1	0.5	1.2	16	85	254	–	–	–
Oct.	0.1	3.8	8.4	16	788	2185	21	23	25
Nov.	1.4	3.0	6.2	247	670	1655	17	19	21
Dec.	–	–	–	–	–	–	–	–	–

Appendix F

Surface Dye Percentage Values for the Ten Dye Run Dates

July 12, 1984 Depth: 0'

Distance in Feet From Right Bank Stake Looking Downstream

Sta.	0	12	25	50	75	100	125	150	200	250	300	350	400	450	500	550	600
0+00	7.0	4.3	2.0														
0+50	5.8	4.1	1.1	1.6													
1+00	6.4	3.5	1.4	1.0	0.7												
2+00	23.5	24.0	20.3	21.5	14.0												
2+50	23.0	23.0	21.9	2.3	2.9	2.0											
3+00	21.4	21.4	2.2	1.3	3.2	0											
3+50	2.5	1.6	1.9	2.3	1.5	0.2											
4+00	2.8	1.9	2.0	3.0	3.0	0.5											
4+50	2.8	2.2	1.4	0.5	0.1	0	0										
5+00	2.0	1.1	1.2	1.3	0.7	0.1	0.5										
5+50	1.9	2.4	1.3	1.3	0.5	0.1	0.2										
6+00	1.3	1.9	1.9	0.7	1.2	0.5	0.2										
6+50	1.7	1.7	1.7	1.6	1.8	0.7	0.4										
7+00	1.7	1.7	1.8	1.4	1.3	1.5	1.5										
7+50	0.9	0.9	1.7	1.2	0.5	0.6	0.4										
8+00	2.5	2.0	2.0	1.9	1.1	0.6	0.1										
9+00	3.0	2.1	2.0	1.7	1.5	1.5	1.5	0.1									
10+50	6.1	4.2	1.7	1.4	1.1	1.2	1.4	1.3									
12+00	4.3	3.9	1.2	1.3	1.5	1.0	1.4	0									
14+00	2.5	1.3	1.9	0.8	0.4	0.1	0										
16+00	2.5	2.0		1.9		1.2	0.8	1.0	0.8								
18+00	1.5	1.0		0.6		0.5		0.7	0.8	0.1							
21+00	1.0	1.1		0.6		0.6		0.6	0.4	0.3							
24+00	1.7	1.8		0.9		0.7		0.5	0.6	0.2	0.1						
27+00	1.7	2.0		0.5		0.5		0.5	0.5	0.6	0.4						
31+00	0.8	0.8		0.4		0.5		0.2	0.3	0.1	0						
33+00	0.8	0.8		0.4		0.4		0.3	0.2	0.1	0	0					
36+00	0.7	0.7		0.4		0		0.1	0	0	0	0					
39+00	0.8	0.6		0.5		0.4		0.1	0.1	0.1	0	0					
42+00	1.2	1.2		0.9		0.6		0.4	0.3	0.2	0.2	0.1	0.2				
45+00	1.4	1.3		1.3		0.9		0.5	0.4	0.3	0.4	0.3	0.3				
47+00	1.3	1.3		1.4		0.8		0.9	0.8	0.9	0.4	0.4	0.4				
49+00	1.3	1.3		0.3		0.3		0.3	0.2	0.1	0	0.1	0				
61+00	0.6	0.6		0.1		0.1		0.1	0	0	0.1	0	0				
63+00	0.6	0.5		0.1		0.1		0.1	0	0	0	0	0				
65+00	0.5	0.6		0.2		0.1		0.1	0.1	0	0.1	0.1	0.1	0			
67+00	0.7	0.5		0.5		0.2		0.2	0.2	0.2	0.1	0.1	0.1	0.1			
70+00	0.7	0.6		0.4		0.3		0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1		
74+00	0.6	0.6															
75+00				1.0		0.5		0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2		
79+00				0.2		0.2		0.2	0.1	0	0.1	0	0	0	0		
82+00	1.2	1.1		0.3		0.2			0.2		0.1	0.1	0.1	0	0		
86+00	0.7	0.7		0.4		0.2		0.2		0		0.1	0	0	0	0	
89+00				0.8		0.5			0.2		0.1	0.1	0	0.1	0	0.1	
92+00	0.9	0.8		0.8		0.8		0.4		0.1		0	0	0	0	0.1	
100+00	0.9	0.9		1.1		0.7			0.2		0		0	0	0	0	0.1
104+00	0.7	0.7		0.9				0.4		0.1		0.2		0.2	0.3	0.2	0.2

July 19, 1984 Depth: 0'

Distance in Feet From Right Bank Stake Looking Downstream

Sta.	0	12	25	50	75	100	125	150	175	200	250	300	350	400	450	475	500	550	600
0+00	25.0	25.4		5.1															
0+50	24.7	26.0			0.2														
2+00	29.0	12.0			0.6		0												
2+50	20.8	16.1	7.4	0.6	0.6		1.1												
3+00	18.5	1.2	0.5	0.5	0.5		0												
3+50	2.0	0.5	0.3	0.5	1.3	1.2		0											
4+00	1.9	1.3	0.5	0.3	0.3	0		0											
4+50	2.1	1.1	0.2	0.2	0	0	0		0										
5+00	2.2	1.2	0.4	0.5	0.2	0	0		0										
5+50	0.8	0.8	0.5	0.3	0.1	0.1	0		0										
6+00	2.8	2.4	0.5	0.2	0.4	0	0		0										
6+50	3.9	2.2	0.8	0.7	0.9		0		0										
7+00	3.9	2.2	0.8	0.6	0.2	0		0		0									
7+50	4.6	3.1	1.5		1.0		0.4		0										
8+00	5.1	3.6	1.8	1.9	1.6	7.5			0										
9+00	3.3		3.1	2.8	2.6	1.9		0.1		0									
10+50	3.1	3.3	1.8	2.1	2.2	1.4		1.2		0									
12+00	2.4	2.1	1.2	1.0		1.0		0.8		0									
14+00	1.3	0.6	1.0	0.6	0	0	0	0											
16+00	1.2	1.3		1.2		1.4		1.7		1.6	0.1								
18+00	1.2	1.4		0.6		0.4		0.3		0.2	0	0	0						
21+00	1.1	1.4		0.8		0.7		0.4		0.2	0.1		0						
24+00	1.1	1.1		0.4		0.4		0.3		0	0.1	0.1	0						
27+00	1.2	1.4		0.4		0.3		0.4		0.2	0.2	0.1		0					
32+00	0.8	0.9		0.4		0.2		0.1		0	0	0	0	0					
35+00	0.7	0.4		0.5		0.2		0.2		0.1	0	0	0	0					
37+00	0.7	0.7		0.2		0.1		0		0	0	0	0	0					
40+00	0.9	0.8		0.7		0.5		0.2		0	0	0	0	0					
43+00	0.5	0.5		0.5		0.8		0.8		0.2	0.2	0.2	0.1	0		0			
46+00	0.6	0.6		0.5		0.5		0.7			0.6	0.4	0.3	0.1		0.4			
47+00	0.5	0.6		0.2		0.2		0.2		0.2	0.2	0.1	0.1	0	0				
50+00	0.6	0.7		0.3		0.2		0.2		0.2	0	0	0.1	0.1	0				
54+00	0.6	0.6		0.2		0.2		0.2		0	0.1	0.2	0.1	0	0.1				
56+00	0.7	0.6		0.1		0.2		0.1		0.1	0.1	0	0.1	0.1	0.1				
66+00	0.5	0.5		0.5		0.4		0.4		0.4	0.4	0.2	0.2	0.3	0.2		0.2		
70+00	0.5	0.5		0.6		0.6		0.5		0.5	0.4	0.4	0.4	0.3	0.3		0.2	0.4	
74+00	0.6	0.5		0.7		0.8		0.8		0.7	0.8	0.8	0.8	0.8	0.7		0.7	0.7	
79+00				0.6		0.7		0.8		0.8	0.8	0.8	0.8	0.8	0.7		0.5		
82+00	0.7	0.5		0.5		0.7				0.8		0.7	0.5	0.5	0.5		0.5		
85+00				0.7		0.7		0.7			0.6		0.3	0.5	0.5		0.5	0.5	
89+00				0.7		0.8				0.7		0.4	0.3	0.2	0.2		0.4	0.6	
92+00	0.6	0.5		0.7		0.5		0.4			0.2		0.1	0.2	0.2		0.4	0.5	
98+00	0.6	0.6		0.4		0.4				0.2		0.2		0.2	0.2		0.3	0.5	0.5
104+00	0.6	0.5		0.5				0.3			0.2		0.2		0.2		0.3	0.4	0.6
108+00	0.7	0.7		0.7		0.4				0.2		0.2		0.2	0.2		0.4	0.5	0.7

July 31, 1984 Depth: 0'

Distance in Feet From Right Bank Stake Looking Downstream

Sta.	0	12	25	50	75	100	125	150	175	200	225	250	300	350	400	450	500	550	600	650	700	800
0+00	20.3	16.6		3.8																		
1+00	9.8	9.8			1.3																	
2+00	0.5	0.3		0.9	9.6			0														
2+50	4.6	4.8		15.4		0			0													
3+00	25.9	1.0	0	1.2		0.8		0.1		0												
3+50	1.1	1.2	0	0	0.1		0.1			0												
4+00	1.2	0.8	0.3	0.3	0		0			0												
4+50	2.1	0.8	0.8	0.2	1.4	0		0		0												
5+00	0.6	0.9	0.6	0.6	0.3	0.3		0.1		0		0										
5+50	3.0	2.5	0.9	0.3	0.1	0		0.1		0												
6+00	2.5	2.8	1.8	2.4	1.7	0.1	0			0												
6+50	3.0	3.5	2.3	2.8	1.9		0.5			0												
7+00	4.1	3.0	3.2	3.0	2.1	1.8		0.5		0		0										
8+00	4.7	4.8	3.0	3.2	2.3	2.4		1.2			0.1											
9+00	5.0	5.0	2.2	1.9	1.7	1.4		1.0				0.2										
10+50	2.8	3.1	1.4	1.0	1.0	0.8		1.0				0.7										
12+00	2.1	1.0	0.8	0.8		0.6		0.5				0.6										
14+00	1.4	0.6	1.0	0.5	0.3	0.3	0.3		0													
16+00	1.6	1.4		1.6		1.6		1.4		1.2		1.0										
18+00	1.5	1.5		0.6		0.3		0.4		0.3		0	0.1	0	0		0		0		0	
22+00	1.6	1.4		0.8		0.9		0.6		0.1			0	0	0.1		0		0		0	
27+00	1.6	1.4		0.5		0.4				0.1			0		0.3		0		0		0	0.1
35+00	0.7	0.4		0.4		0.1				0.1			0.2		0		0.1		0	0		
38+00	0.6	0.6		0.2		0.1		0.1		0		0	0	0	0	0.1	0.1		0.1	0		
42+00	0.8	0.8		0.8		0.8		0.6		0.3		0	0		0		0		0	0		
49+00	0.8	0.8		0.9		1.0		0.6		0.6			0.6		0.3		0.3		0.3			
56+00	0.8	0.8		0.1		0.1		0		0		0	0	0	0	0	0					
61+00	0.7	0.5		0.3		0.1				0		0		0	0	0	0		0			
66+00	0.7	0.6		0.1		0.2		0.3		0.2		0	0.1	0	0	0	0		0			
70+00	1.0	0.9		0.3		0.1		0.3		0.2		0	0	0	0	0						
74+00	1.0	0.9		0.5		0.4		0.3		0.1		0	0	0.1	0.1	0.1	0.1	0.1				
79+00				0.9		0.9		0.6		0.5		0.5	0.4	0.4	0.3	0.4	0.3	0.5				
84+00	0.8	0.7		1.0		0.6				0.5			0.4	0.4	0.5	0.5	0.5					
89+00				0.9		0.8		0.4				0.4		0.5	0.6	0.6	0.6	1.0				
95+00				0.9		0.8				0.3			0.3	0.3	0.6	0.5	0.5	1.0				
98+00	0.9	0.9		1.0		0.8		0.3				0.2		0.2	0.1	0.6	0.9	0.8				
102+00	0.9	0.9		0.8		0.6		0.5		0.5		0.3	0.3	0.2	0.1	0.1	0.3	0.6				
104+00	0.9	0.9		0.5		0.5				0.3			0.3		0.2	0.2	0.1	0.1	0.6			
106+00	0.8	0.9		0.6				0.3				0.3		0.1		0.1	0.3	0.3	0.3			
108+00	0.5	0.6		0.5		0.4				0.3			0.1		0.1	0.1	0.3	0.3	0.5			

August 7, 1984 Depth: 0'

Distance in Feet From Right Bank Stake Looking Downstream

Sta.	0	12	25	50	75	100	150	175	200	225	250	275	300	350	400	450	500	550	600	650
0+00	25.8	26.7		3.4																
1+00	6.2	6.8			8.3															
2+00	0.6	0.2		4.8		0			2.8											
2+50	16.5	3.8	5.5	1.0		0					0									
3+00	27.5	2.4	1.0	0.2		0			0				0							
3+50	1.4	2.6	0.8	0.7		0			0				0							
4+00	3.5	1.7	0.9	0.5		0			0				0							
4+50	2.9	3.5	1.0	0.8	0.1	0			0				0							
5+00	1.5	2.9	0.8	0	0	0			0				0							
5+50	3.7	2.4	1.5	0.3	0	0		0			0									
6+00	4.4	3.6	1.3	0.6	0.1	0.2		0			0									
6+50	5.1	2.3	1.5	1.3	1.3		0			0										
7+00	6.1	4.4	1.3	1.3	1.3	1.0	0		0			0								
8+00	0.6	0.9	1.6	1.3	1.2	1.1	0			0										
10+00	1.5	1.5	1.1	1.0	0.9	0.8	0.5				0			0						
12+00	1.5	1.4	0.8	0.8		0.9	0.5				0.2			0						
14+00	0.7	0.7	0.7	0.4	0.3	0.4	0.2		0											
16+00	0.5	0.6		0.5		0.6	0.6		0.6				0.1		0					
18+00	0.6	0.6		0.4		0.4	0.5		0.5		0.2		0	0	0		0			
22+00	0.3	0.3		0.5		0.4	0.4		0.1		0		0	0	0		0			0
27+00	0.4	0.4		0.5		0.5			0.3				0.2		0.1		0			
35+00	0.3	0.3		0.4		0.4			0.1				0.1		0		0		0	
38+00	0.3	0.3		0.3		0.4	0.1		0.1		0.1		0.1	0	0	0.3	0.1		0	
44+00	0	0		0		0.2	0.2		0.2		0.3		0.2		0.1		0		0.1	
49+00	0.2	0.2		0.2		0.1	0.2		0.2				0.1		0.1		0.2		0.2	
50+00	0.2	0.2		0.2		0.2	0.2		0.2		0.2		0.2		0.5		0.2		0.2	
69+00	0.3	0.3		0.3		0.3	0.1		0.1		0.1		0.1	0.1	0.1	0.2				
74+00	0.3	0.2		0.2		0.2	0.1		0.2		0.3		0.2		0.2	0.2	0.3	0.4		
79+00				0.3		0.3	0.2		0.2		0.1		0.1	0.1	0.1	0.1	0.3	0.3		
82+00	0.5	0.5		0.3		0.2			0.1				0.2	0.4	0.1	0.2	0.6			
86+00	0.2	0.5		0.5		0.4			0.3				0.2	0.2	0.1	0.2	0.3	0.4		
92+00	0.3	0.5		0.4		0.5	0.4				0.3			0.3	0.2	0.2	0.2	0.3		
95+00				0.5		0.2	0.1		0.1		0.1		0.1	0.1	0.2	0.1	0.1	0.2		
100+00	0.3	0.3		0.5		0.5			0.3				0.2		0.1	0.1	0.1	0.2	0.3	
104+00	0.2	0.3		0.5			0.4				0.3			0.2		0.2	0.1	0.1	0.1	
108+00	0.2	0.2		0.4		0.4			0.2				0.1		0.2	0.1	0.1	0.1	0.5	

August 14, 1984 Depth: 0'

Distance in Feet From Right Bank Stake Looking Downstream

Sta.	0	12	25	50	75	100	150	175	200	250	300	350	400	450	500	550	600
0+00	16.5	19.5		5.7													
1+00	29.0	11.1			8.4												
2+00	71.0	74.4		47.3		0.2			0	0							
2+50			12.3	46.0		14.4	0		0								
3+50	2.0	3.0	4.3	13.6		0.6	0		0	0							
4+50	3.2	2.3	2.0	0.9	0.5	0			0		0		0				
5+00	3.3	2.0	1.1	1.1	0.2	0			0		1.7						
5+50	2.9	1.7	0.3	0	2.9	0		0		0		0					
6+50	2.9	3.2	2.8	1.7	0.4		0			2.1		0					
8+00	3.3	3.2	2.3	2.5	2.3	1.4	0		0			0					
10+00	2.6	2.7	2.6	2.6	2.7	2.7			0		0		0		0		
12+00	1.6	1.7	1.7	1.7		1.7	0.2			0	0		0		0		
14+00	1.3	1.5	1.1	1.2	0	0	0		0		0						
16+00	0.8	0.8		1.1		1.4	1.4		0.9		0.4		0		0		
18+00	0.8	0.8		0.5		0.5	1.1		0.9	0.8	0.5	0	0.5		0	0	
22+00	0.5	0.6		0.6		0.7	0.8		0.8	0.8	0.4	0	0		0		0
27+00	0.6	0.6		0.8		0.7	0.8		0.8		0.7		0.2		0	0	
35+00	0.6	0.6		0.5		0			0		0		0		0		
38+00	0.4	0.6		0.7		0.2	0.2		0.2	0	0	0	0	0.6	0		0
44+00	0.2	0.4		0.2		0.3	0.4		0.5	0.3	0.2		0.2		0.6		0.6
47+00	0.4	0.5		0.4		0.4	0.4		0.2		0.2		0.2		0.3		0.4
49+00	0.3	0.5		0.4		0.2	0.2		0.3		0.5		0.3		0.2		
70+00	0.6	0.6		0.7		0.6	0.5		0.5	0.5	0.4	0.1	0.2	0.4			
75+00				0.6		0.5	0.5		0.2	0.3	0.4		0.5	0.5	0.5	0.2	
79+00				0.5		0.5	0.4			0.4		0.2		0.3		0.3	
82+00	0.6	0.7		0.5		0.7			0.6		0.4	0.4	0.5	0.3	0.3		
86+00	0.7	0.3		0.6		0.8	0.5			0.3		0.2	0.3	0.4	0.5	0.4	
89+00				0.3		0.5			0.3		0.2	0.3	0.3	0.3	0.3	0.3	
92+00	0.5	0.5		0.5		0.2	0.2			0.2		0.3	0.4	0.4	0.3	0.4	
95+00				0.5		0.6	0.5		0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.4	
100+00	0.5	0.5		0.6		0.5			0.5		0.5		0.5	0.5	0.5	0.4	0.5
104+00	0.5	0.5		0.5			0.5			0.5		0.5		0.5	0.5	0.4	0.4
108+00	0.5	0.5		0.5		0.5			0.5		0.5		0.5	0.5	0.5	0.5	0.4

August 21, 1984 Depth: 0'

Distance in Feet From Right Bank Stake Looking Downstream

Sta.	0	12	25	50	75	100	150	175	200	250	300	350	400	450	500	550	600
0+00	2.6	4.8		1.2													
1+00	8.3	27.6				70.5											
2+00	21.4	17.4		15.3		1.3			0	0.1							
2+50	18.6	17.0	9.1	78.3		41.6	0.9			0.1							
3+50	6.1	8.2		11.8		10.8	0.2		0		0						
4+50	7.2	10.9	5.1	1.9	1.8	1.1			0		0.1						
5+00	6.9	11.5	3.7	3.9	5.9	1.7			0			0.1					
5+50	6.9	8.4	6.1	2.2	1.0	0.3		0		0		0					
6+50	3.2	3.9	5.2	5.5	7.7		0			0		0					
8+00	1.1	1.4		5.3	5.5	5.9	2.0		0.1			0					
10+00	0.7	1.1	1.1	1.1	1.1	1.2			0.5		0.1		0.2		0		
12+00	0.9	0.9	5.2	5.5		4.5	0.5			0	0.1		0				0
14+00	0.2	3.0	4.4	3.1	2.1	0.2	0.8		0		0		0				
16+00	1.4	1.1		2.7		3.0	3.5		0.2		0.2		0		0		
18+00	1.0	1.2		2.5		3.5	3.6		1.7	0.2	0.2	0	0		0	0	
22+00	0.7	0.9		1.1		1.5	2.1		1.7	1.1	0.6	0.3	.0		0		0.5
27+00	0.9	0.9		2.1		2.0	1.9		2.7		1.8		0.5		0	0	
35+00	1.1	1.7		1.3		1.2			0.9		0.4		0		0.1		
38+00	1.2	1.4		1.4		1.6	1.8		1.3	1.2	0.8	1.3	0.8	0.3	0.2		0
44+00	0.4	0.5		0.3		0.4	0.8		1.0	1.1	1.0		0.3		0.3		0.5
48+00	0.5	0.5		0.6		0.8	0.8		0.9		1.0		0.8		0.8		0.2
63+00	0.7	0.8		0.9		0.8	0.8		0.8		0.9		0.8		0.6		
70+00	0.8	0.8		0.9		0.8	0.8		0.8	0.8	0.2	0.2	0.4	0.2			
75+00				0.8		0.6	0.5		0.5	0.9	0.9		0.5	0.5	0.5	0.8	
79+00				0.9		0.8	0.8			0.8		0.8		0.3		0.8	
82+00	0.8	0.7		0.7		0.7			0.5		0.5	0.6	0.7	0.8	0.6		
86+00	0.6	0.7		0.7		0.5	0.7			0.7		0.8	0.7	0.5	0.5	0.5	
89+00				0.5		0.8			0.8		0.8	0.8	0.6	0.7	0.7	0.7	
92+00	0.2	0.3		0.5		0.6	0.7			0.7		0.8	0.8	0.7	0.8	0.6	
95+00				0.5		0.7	0.7		0.8	0.8	0.8	0.8	0.7	0.4	0.5	0.5	
101+00				0.5		0.7			0.7		0.5		0.5	0.8	0.8	0.7	0.6
104+00	0.8	1.0		0.7			0.7			0.5		0.5		0.5	0.6	0.5	0.5
108+00	0.8	0.8		0.4		0.7			0.6		0.5		0.5	0.5	0.5	0.5	0.5

August 28, 1984 Depth: 0'

Distance in Feet From Right Bank Stake Looking Downstream

Sta.	0	12	25	50	75	100	150	175	200	250	300	350	400	450	500	550	600
0+00	46.8	28.9		23.5													
0+50	47.2	43.8				2.9											
1+00	45.4	46.8		55.0		55.0											
2+00	12.7	10.5		16.1		12.3			0.3	0.2							
2+50	15.0	35.3		18.6		31.4	8.6		0								
3+50	7.4	7.9	8.7	7.5		14.6	5.1		0.8		0						
4+50	7.1	7.4	7.5	8.3	10.9	15.0			0		0						
5+00	7.1	7.4	7.8	7.3	12.8	5.4			0		0						
5+50	6.5	7.4	6.5	6.8	7.9	2.3		0.1		0		0					
6+50	4.4	5.3	5.3	6.5	6.7		0.1			0							
8+00	3.9	4.4			5.1	5.6	6.3		0.3			0					
10+00	3.6	3.6	3.6	3.6	3.6	4.6			0		0		0		0		
12+00	3.3	3.3	4.0	3.7		5.3	3.1			0.3	0.5		1.2				0.3
14+00	3.3	3.3	4.6	2.9	2.7	2.0	0.4		0.6		0.3		0.6				
16+00	0.9	1.2		1.5		1.8	2.8		2.2		1.0				0		
18+00	3.9	3.9		1.6		1.7	2.4		2.3	2.3		1.6	0.2		0		
22+00	0.7	0.9		1.3		1.4	2.1		2.5	2.8	1.7	1.3	2.2		0		0
27+00	0.8	0.7			1.7	1.7	2.0		2.2		1.8		1.7		1.0	0.6	
35+00	1.4	1.5		1.7		1.8			1.2		1.3		0.9		0		
38+00	0.9	1.4		1.3		1.5	1.2		0.9	0.6	0.7	0.6	0.6	0.3	0.2		0
42+00	0.1	0.3		0.6		0.5	0.8		1.0	0.7	0.3		0.2		0.1		0.2
44+00	0.3	0.3		0.4		0.3	0.5		0.6		0.7		0		0		
46+00	0.4	0.5		0.5		0.6	0.6		0.8		0.8		0.9		0.5		0
63+00	0.6	0.6		1.0		1.3	1.3		1.1	1.1	1.0	0.2	0.8		0.4		
70+00	0.6	0.6		0.6		0.6	0.3		0.5	0.6	0.9	1.1	1.2	0.5	1.1		
76+00	0.6	0.6		0.6		0.6	0.5		0.6			0.6		0.9		0.6	
82+00	0.5	0.6		0.5		0.7			0.6		0.6	0.5	0.5	0.5	0.6		
86+00	0.6	0.6		0.5		0.6	0.6			0.9		0.8	0.9	0.8	0.8	0.6	
89+00				0.6		0.8			0.6		0.8	0.8	1.1	0.9	0.8	0.7	
94+00	0.6	0.6		0.8		0.7	0.8			0.7	0.7		0.7	0.7	0.6	0.6	
98+00	0.6	0.6		1.0		0.9	0.9		0.9	1.0	1.0	0.9	0.9	0.7	0.6	0.6	
101+00				1.0		1.0			1.0		1.0		0.9	1.0	0.9	1.0	1.0
104+00	0.1	0.3		1.0			1.0			1.0		1.0		0.9	1.0	0.9	0.9
108+00	0.1	0.2		0.8		1.0			0.7		1.0		1.0	1.0	1.0	0.9	1.0

September 11, 1984 Depth: 0'

Distance in Feet From Right Bank Stake Looking Downstream

Sta.	0	12	25	50	75	100	150	200	250	300	350	400	450	500	550	600
0+00	18.8	26.7		15.0												
0+50	23.3	31.5				4.4										
1+00	51.7	36.4		11.0		12.2										
2+00	44.9	46.9		74.3		74.3		11.8	0.2							
2+50	45.3	45.6	71.3	48.8		32.7	3.5	0								
3+50	26.7	26.1	24.1	27.6		32.7	45.3	0.1		0						
4+50	26.3	23.1	4.0	23.2	31.4	33.0		24.4		0						
5+00	25.4	25.2	19.8	25.2	33.8	23.7		0.1		0						
5+50	25.2	23.6	18.8	23.4	19.6	11.8		3.1		0			0			
6+50	25.9	24.3	25.6	28.7	26.8		19.1			0			0			
8+00	25.2	21.9			17.1	14.3	16.6			0			0			
10+00	29.4	29.4	22.4	17.0	15.7	18.3		13.5		0.1		0.1		0.1		
12+00	26.3	25.2	24.2	21.8		7.2	1.2		0.1	2.9		0.1				0.1
14+00	21.7	21.7	19.0	7.1	10.1	4.5	0.4	1.7		0		0				
16+00	14.7	12.6		10.2		11.7	9.1	0.1		0		0		0		
18+00	10.8	8.4		12.6		13.2	13.0	6.6	2.2	0	0	0		0	0	
22+00	9.4	11.8		9.1		11.5	7.0	0	2.1	0	0	0		0	0	
27+00	6.9	6.5		8.4		5.4	1.5	2.1		0.7		0		0	0	
35+00	4.9	4.9		4.1		1.6		1.6		0		0		0		
38+00	4.5	3.6		3.1		1.5	2.1	1.0	1.7	0	0.7	1.1	0	0		0
42+00	3.9	3.9		3.6		3.2	2.2	1.0	0.7	0		0		0.1		0
46+00	2.0	2.1		3.5		3.1	2.7	2.2		1.7		0.2		0		0
50+00	1.9	2.7		2.7		2.7	2.5	2.6		1.1		1.4		0.3		
54+00	2.5	2.9		3.0		3.0	2.6	2.2	2.5	2.0	0.1	0.7		0		
70+00	1.7	2.4		2.2		1.7	2.2	2.2	2.2	2.2	2.1	0.9	0.1	0		
76+00	0.1	1.0		2.2		2.0	2.2	1.9			1.2		0.7		0.4	
82+00	0.1	0.5		0.2		0.2		2.1		1.7	1.9	0.9	0.7	0.6		
86+00	0.1	0.4				1.1	1.7		1.4		1.7	0.9	1.0	0.5	0	
89+00				0.7		1.4		1.6		1.1	1.0	1.0	0.9	0.7	0.9	
95+00				0.1		0.5	1.1		1.1	1.0		0.5	0.1	0.5	0.4	
98+00	0	0		1.2		1.1	1.1	1.0	0.7	0.9	1.0	0.4	0.1	0.2	0.4	
101+00				1.1		1.1		1.0		0.9		0.5	0.7	0.4	0	0
104+00	0	0		1.1		0.9			0.9		0.9		0.5	0.2	0	0
108+00	0	0		0.9		1.1		1.2		1.5		0.5	0.7	1.1	0.7	0.2

September 18, 1984 Depth: 0'

	Distance in Feet From Right Bank Stake Looking Downstream															
Sta.	0	12	25	50	75	100	150	200	250	300	350	400	450	500	550	600
0+00	4.5	10.2		9.8												
0+50	3.5	4.1				6.9										
1+00	6.1	8.1		24.7		43.1										
2+00	75.8	76.1				64.5		13.8	16.8							
2+50	80.6	77.6	37.4	35.3		17.2	38.4	41.4								
3+50	14.5	14.6	15.5	16.6		11.3	12.8	16.8		2.1						
4+50	14.6	8.0	17.3	16.8	17.3	23.1		40.1			14.2					
5+00	14.6	6.6	12.4	13.2	13.8	12.9		14.7		12.4						
5+50	5.1	6.8	15.1	14.7	13.8	17.5		24.8		28.7			0.1			
6+50	4.4	6.8	10.7	11.2	12.7		19.0			15.5			2.8			
8+00	7.8	8.8			7.5	9.3	11.5			0.2			12.8			
10+00	6.5	6.2	5.1	5.9	9.2	15.3		14.2		11.9		0		0		
12+00	5.5	7.5	5.9	9.3		12.2	12.2		14.7	14.2		5.9				0.1
14+00	3.5	2.5	1.4	2.9	3.2	8.0	8.9	1.3		1.5		0				
16+00	1.4	2.1		6.4		6.1	8.1	8.9		11.1		4.1		0.5		
18+00	3.4	2.4		6.7		2.9	8.5	10.4	10.5	11.9	11.5	11.5		11.5	6.4	
22+00	0.6	0.6		3.2		6.9	8.0	6.5	7.8	6.4	4.2	4.1		1.8		1.6
27+00	1.6	2.1		8.8		9.3	9.6	8.2		8.2		7.9		6.6	6.1	
35+00	3.6	3.5		2.2		2.4		2.0		1.4		1.4		1.5		
38+00	2.1	3.9		2.8		2.5	3.1	0.2	0.5	1.3	1.6	2.7	2.5	2.8		0
41+00	0.2	0.5		0.5		3.5	3.8	1.1	0.4	1.3		0.9		0.4		0.4
44+00	0.1	0.2		0.6		0.7	1.5	1.6		0.1		1.9		1.3		2.2
61+00	0.4	0.5		0.6		1.5	1.3	1.6	1.6	1.4	1.3	1.2		1.1		
70+00	0.4	0.4		0.4		1.4	1.4	1.3	1.4	1.4	1.4	1.3	1.3	1.1		
74+00	0.2	0.2				0.7	1.2	1.3			1.5		1.5		0.7	
78+00	0.1	0.2		0.6		1.1	1.4	1.4			1.6		1.5		1.2	
82+00	0.2	0.2		0.5		0.5		1.2		1.4	1.4	1.4	1.3	0.9		
86+00	0.1	0.1		0.5		0.6	0.6		1.3		1.3	1.3	1.2	0.9	0.4	
90+00	0.1	0.2		0.4		0.5		0.7		1.5	1.4	1.3	1.3	1.3	1.3	
94+00	0.1	0.1		0.7		0.9	1.2		1.5	1.5		0.6	0.8	0.8	0.8	
98+00	0.1	0.2		0.6		0.6	1.2	1.5	0.6	0.6	1.5	0.9	0.7	0.6	0.6	
104+00	0.1	0.1		0.6		1.1		1.3		0.5		0.6	0.8	1.1	0.8	0.7
106+00	0.1	0.1		0.6			0.8		1.1		1.0		1.6	1.6	1.3	0.6
108+00	0.1	0.1		0.6		0.7		1.1		1.3		1.5	1.6	1.6	1.4	1.2

October 23, 1984 Depth: 0'

Sta.	0	12	25	50	75	100	150	200	250	300	350	400	450	500	550	600
					Distance in Feet From Right Bank Stake Looking Downstream											
0+00	17.4	25.2		10.2												
0+50	25.8	33.5				13.2										
1+00	33.9	62.9			31.5	29.5										
2+00	81.8	81.8		55.3		.49.6		0.1	0.2							
2+50	81.8	81.8	53.4		41.8	49.6	41.8	0.1								
3+50	45.3	41.0	8.9	6.2		9.9	14.9	0.1		0.1						
4+50	39.7	39.7		7.4	12.7	13.7		0			0					
5+00	23.0	24.0	14.9	16.8	7.2	14.9		11.6		0						
5+50	24.6	27.8	7.0	5.5	8.4	8.4		12.7		9.0			0.4			
6+50	45.5	44.6	21.4	13.2	10.7		8.5			7.6			0.2			
8+00	37.8	35.5			3.8	3.2	2.0			6.7			0.2			
10+00	18.8	14.6	15.9	5.3	0.7	0.7		2.1		0.4		0.2		0.2		
12+00	6.7	7.6	11.7	10.8		5.8	4.5		0.7	0.5		0.4				0.2
14+00	4.1	3.7	1.9	1.9	2.1	2.1	1.0	1.2		0.6		0.7				
16+00	2.4	2.3		4.5		5.3	6.6	0.7		0.2		0		0.1		
18+00	2.3	2.4		5.3		4.3	8.8	3.1	1.8	1.4	2.9	0.1		0.1	0.5	
22+00	1.9	2.0		4.6		4.6	4.5	0.1	0.1	0	0.1	0.1		0.1		0
27+00	1.9	1.9		2.1		2.0	1.9	1.7		1.1		0.8		0	0.1	
35+00	1.4	1.4		0.4		1.7		0.2		0.1		0.1		0		
38+00	1.5	1.1		1.7		1.3	1.6	1.5	1.6	0.7	0.4	0.3	0.1	0.5	0.8	
41+00	1.2	1.1		1.4		1.2	1.1	0.6	0.1	0.1		0.4		0.1	0.1	
43+00	1.1	1.1		1.4		1.6	0.9	1.3	0.4			0.1		0.1	0.1	
47+00	0.7	0.9		1.1		1.8	1.8	1.3	0.2	0.7	0.1	0.5		0.7		
48+00	0.8	0.8		1.1		0.7	1.1	0.2	0.2	0.2	0.1	0.1	0.1		0.1	
58+00	0.8	0.9		0.5		0.5	0.4	0.6			0.7		0.1			
61+00	1.0	1.0		0.6		0.5	0.8	0.8			1.1		0.8		0.1	
78+00	0.8	0.7		0.9		0.9		0.6		0.6	0.2	0.2	0.5	0.3		
84+00	0.8	0.8		0.8		0.8	0.7		1.1		0.4	0.5	0.4	0.5	0.6	
89+00				0.8		0.8		0.7		0.5	0.6	0.4	0.3	0.3	0.4	
92+00	0.6	0.6		0.6		0.8	0.6		0.4	0.4		0.5	0.6	0.4	0.4	
95+00				0.6		0.8	0.6		0.4	0.4		0.5	0.6	0.4	0.4	
99+00				0.6		0.6		0.4		0.4		0.2	0.2	0.1	0.3	0.3
104+00	0.4	0.5		0.6			0.5		0.5		0.2		0.2	0.1	0.2	0.2
108+00	0.4	0.5		0.5		0.6		0.5		0.4		0.4	0.3	0.4	0.4	0.4

Appendix G

Locations of the Maximum Dye Percent at Each Transect Sampled During the Ten Dye Run Dates

July 12, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	0	0	7.0	9+00	0	0	3.0	49+00	0	0	1.3
0+50	0	0	5.8	10+50	0	0	6.1	49+00	12	0	1.3
1+00	0	0	6.4	12+00	0	0	4.3	61+00	0	0	0.6
2+00	12	0	24.0	14+00	0	0	2.5	61+00	12	0	0.6
2+50	0	0	23.0	16+00	0	0	2.5	63+00	0	0	0.6
2+50	12	0	23.0	18+00	0	0	3.0	65+00	12	0	0.6
3+00	0	0	21.4	21+00	0	0	6.1	67+00	0	0	0.7
3+00	12	0	21.4	24+00	12	0	3.8	70+00	0	0	0.7
3+50	100	9	4.8	27+00	0	0	1.8	75+00	50	0-1	1.0
4+00	75	6	4.4	31+00	0	0	0.9	79+00	0	0	1.0
4+50	125	10	2.9	33+00	0	0	1.4	82+00	0	0	1.2
5+00	0	0	2.0	33+00	12	0	1.4	86+00	0	0	0.7
5+50	12	0	2.4	36+00	0	0	0.7	86+00	12	0	0.7
6+00	12	0	1.9	36+00	12	0	0.7	89+00	0	0	1.0
6+00	25	0	1.9	39+00	0	0	0.8	89+00	12	0	1.0
6+50	75	0	1.8	42+00	0	0	1.2	92+00	0	0	0.9
7+00	125	6	2.0	42+00	12	0	1.2	98+00	0	0	1.1
7+50	25	0	1.7	45+00	50	0	1.3	104+00	50	0	0.9
8+00	0	0	2.5	47+00	50	0	1.4	108+00	100	7-9	1.4

July 19, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	12	0	25.4	21+00	12	0	1.4	74+00	150	10-19	0.9
0+50	12	0	26.0	24+00	0	0	1.1	79+00	150	0-22	0.8
2+00	0	0	29.0	24+00	12	0	1.1	79+00	200	0-23	0.8
2+50	0	0	20.8	27+00	12	0	1.4	79+00	250	0-23	0.8
3+00	0	0	18.5	32+00	12	0	0.9	79+00	300	0-21	0.8
3+50	150	11	2.2	35+00	0	0	0.7	79+00	350	0-8	0.8
4+00	0	0	1.9	37+00	0	0	0.7	79+00	400	0-17	0.8
4+50	0	0	2.1	37+00	12	0	0.7	82+00	200	0-24	0.8
5+00	0	0	2.2	40+00	0	0	0.9	82+00	300	13-25	0.8
5+50	0	0	0.8	43+00	100	0	0.8	82+00	350	17-22	0.8
5+50	12	0	0.8	43+00	150	1	0.8	85+00	100	11-21	0.8
6+00	0	0	2.8	46+00	400	10-13	0.9	85+00	150	12-24	0.8
6+50	0	0	3.9	47+00	12	0	0.6	89+00	100	0-10	0.8
7+00	0	0	3.9	50+00	12	0	0.7	92+00	50	0	0.7
7+50	0	0	4.6	54+00	0	0	0.6	98+00	100	17-20	0.8
8+00	0	0	5.1	54+00	12	0	0.6	104+00	150	14-17	0.7
9+00	0	0	3.3	56+00	0	0	0.7	104+00	600	14-16	0.7
10+50	12	0	3.3	66+00	0	0	0.5	108+00	0	0	0.7
12+00	100	6	5.0	66+00	12	0	0.5	108+00	12	0	0.7
14+00	0	0	1.3	66+00	50	0-9	0.5	108+00	50	0	0.7
16+00	150	0-2	1.7	70+00	50	4-6	0.8	108+00	600	0-4	0.7
18+00	12	0	1.4								

August 14, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	12	0	19.5	47+00	500	3-13	0.6	100+00	50	0	0.6
1+00	0	0	29.0	49+00	300	15-20	0.6	104+00	0	0	0.5
2+00	12	0	74.4	49+00	400	7-22	0.6	104+00	12	0	0.5
2+50	50	2	65.0	70+00	50	0-6	0.7	104+00	50	0	0.5
3+50	200	11	22.8	70+00	150	4-7	0.7	104+00	150	0-18	0.5
4+50	200	12	15.7	70+00	200	20-22	0.7	104+00	250	0-18	0.5
5+00	200	12	10.6	75+00	50	0-2	0.6	104+00	350	0-19	0.5
5+50	250	13	6.6	75+00	200	18-20	0.6	104+00	450	0-21	0.5
6+50	350	13	7.5	79+00	50	0-15	0.5	104+00	500	0-21	0.5
8+00	200	8	1.9	79+00	100	0-20	0.5	104+00	550	10-20	0.5
10+00	500	16	4.0	79+00	150	5-20	0.5	104+00	600	14-18	0.5
12+00	500	16	2.9	82+00	100	10-20	0.8	108+00	0	0	0.5
14+00	300	17	1.9	86+00	100	0-9	0.8	108+00	12	0	0.5
16+00	100	0	1.4	89+00	100	12-18	0.7	108+00	50	0	0.5
16+00	150	0	1.4	92+00	100	16-20	0.6	108+00	100	0-10	0.5
18+00	150	0,1	1.1	92+00	150	19-23	0.6	108+00	200	0-15	0.5
22+00	200	4,5	1.1	92+00	250	21-26	0.6	108+00	300	0-17	0.5
27+00	150	2,3	1.0	92+00	350	20-25	0.6	108+00	400	0-18	0.5
35+00	500	14,15	1.1	92+00	400	17-25	0.6	108+00	450	0-18	0.5
38+00	450	13-17	0.9	92+00	500	14-18	0.6	108+00	500	0-19	0.5
44+00	400	17-20	0.8	92+00	550	12-17	0.6	108+00	550	0-21	0.5
44+00	500	7-12	0.8	95+00	100	0-22	0.6	108+00	600	5-20	0.5
47+00	400	9-24	0.6	95+00	150	12-24	0.6				

August 21, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	12	0	4.8	35+00	100	6	2.0	89+00	300	0-25	0.8
1+00	100	0	70.5	38+00	150	0,1	1.8	89+00	350	0-25	0.8
2+00	200	9	26.7	44+00	400	19,20	1.7	89+00	500	5-9	0.8
2+50	50	0	75.0	48+00	300	19	1.4	92+00	250	12-25	0.8
3+50	100	9	22.6	63+00	50	0	0.9	92+00	350	0-11	0.8
4+50	200	10	18.3	63+00	300	0-7	0.9	92+00	400	0-10	0.8
5+00	200	11	15.6	70+00	50	0	0.9	92+00	500	0-5	0.8
5+50	12	0	8.4	70+00	250	17-22	0.9	95+00	150	11-22	0.8
6+50	250	11	10.2	75+00	250	0-7	0.9	95+00	200	0-22	0.8
8+00	200	9	6.7	75+00	300	0-7	0.9	95+00	250	0-10	0.8
10+00	500	15	8.4	79+00	50	0-12	0.9	95+00	300	0-20	0.8
12+00	100	7	6.0	79+00	250	6-16	0.9	95+00	350	0-17	0.8
14+00	50	9	4.9	82+00	0	0	0.8	101+00	200	10-20	0.8
16+00	150	8,9	3.7	82+00	450	0-2	0.8	101+00	450	0-4	0.8
18+00	150	0,1	3.6	86+00	150	11-22	0.8	101+00	500	0-17	0.8
22+00	200	9,10	2.9	86+00	350	0-12	0.8	104+00	0	0	0.8
27+00	150	2	2.8	89+00	100	0-19	0.8	108+00	0	0	0.8
35+00	50	5	2.0	89+00	200	0-24	0.8	108+00	12	0	0.8

July 31, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	0	0	20.3	12+00	0	0	2.1	61+00	0	0	0.7
1+00	0	0	9.8	14+00	0	0	1.4	66+00	0	0	0.7
1+00	12	0	9.8	16+00	0	0	1.6	70+00	0	0	1.0
2+00	75	2	13.2	16+00	100	1	1.6	74+00	0	0	1.0
2+50	50	2	16.1	18+00	0	0	1.5	79+00	50	8-15	1.0
3+00	0	0	25.9	18+00	12	0	1.5	84+00	50	5-9	1.1
3+50	200	12	3.2	22+00	0	0	1.6	89+00	500	13-16	1.0
4+00	200	11	3.4	27+00	0	0	1.6	89+00	550	0-7	1.0
4+50	0	0	2.1	35+00	0	0	0.7	95+00	100	15-22	1.0
5+00	250	13	2.1	38+00	0	0	0.6	95+00	550	0,1	1.0
5+50	0	0	3.0	38+00	12	0	0.6	98+00	50	0	1.0
6+00	12	0	2.8	42+00	0	0	0.8	102+00	0	0	0.9
6+50	12	0	3.5	42+00	12	0	0.8	102+00	12	0	0.9
7+00	0	0	4.1	42+00	100	0,1	0.8	104+00	0	0	0.9
8+00	12	0	4.8	49+00	100	0-9	1.0	104+00	12	0	0.9
9+00	0	0	5.0	56+00	0	0	0.8	106+00	12	0	0.9
9+00	12	0	5.0	56+00	12	0	0.8	108+00	12	0	0.6
10+50	12	0	3.1								

August 7, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	12	0	26.7	12+00	0	0	1.5	50+00	300	22	0.8
1+00	12	0	6.8	14+00	0	0	0.7	50+00	400	13-15	0.8
2+00	100	8	8.6	14+00	12	0	0.7	69+00	300	19,20	0.9
2+50	0	0	16.5	14+00	25	0	0.7	74+00	550	12-14	0.7
3+00	0	0	27.5	16+00	100	4,5	0.8	79+00	150	18-22	0.6
3+50	200	12	7.2	16+00	400	15,16	0.8	82+00	300	20-22	0.9
4+00	200	12	4.7	18+00	0	0	0.6	82+00	400	15-20	0.9
4+50	200	12	4.7	18+00	12	0	0.6	86+00	550	11-14	0.8
5+00	12	0	2.9	22+00	50	0	0.5	92+00	550	10-12	0.8
5+50	0	0	3.7	27+00	50	0	0.5	95+00	550	11-13	0.6
6+00	0	0	4.4	27+00	100	0	0.5	100+00	550	12-14	0.6
6+50	0	0	5.1	35+00	50	0-2	0.4	100+00	600	10-13	0.6
7+00	0	0	6.1	35+00	100	0,1	0.4	104+00	50	0	0.5
8+00	25	0	1.6	38+00	600	10,11	0.5	104+00	600	14-16	0.5
10+00	0	0	1.5	44+00	500	20,21	1.5	108+00	550	17-20	0.5
10+00	12	0	1.5	49+00	300	18-24	1.2	108+00	600	0-10	0.5

August 28, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	0	0	46.8	22+00	150	4	3.8	86+00	250	19-23	1.3
0+50	0	0	47.2	27+00	500	8	3.7	86+00	350	22-25	1.3
1+00	50	0	55.0	35+00	400	14,15	2.0	86+00	400	22-27	1.3
1+00	100	0	55.0	38+00	500	14	2.9	86+00	450	22-26	1.3
2+00	100	7	20.3	42+00	500	17	2.3	89+00	300	24-26	1.4
2+50	12	0	35.3	42+00	600	7,8	2.3	89+00	400	20-26	1.4
3+50	100	5	17.1	44+00	500	21	2.0	94+00	250	19-22	1.3
4+50	100	8	17.5	46+00	400	17-20	1.8	98+00	250	17-20	1.4
5+00	75	3	19.2	63+00	100	10-15	1.6	98+00	300	17-21	1.4
5+50	250	11	17.5	63+00	200	7-18	1.6	98+00	350	18-21	1.4
6+50	250	10	10.3	63+00	300	7-9	1.6	101+00	200	17-21	1.4
8+00	150	8	11.7	63+00	300	18,19	1.6	101+00	300	17-21	1.4
10+00	200	9	6.5	70+00	150	13-19	1.7	104+00	350	14-16	1.4
10+00	300	11,12	6.5	70+00	200	10-20	1.7	104+00	450	16-19	1.4
12+00	400	16	7.7	70+00	250	18-21	1.7	108+00	300	12-14	1.4
14+00	300	16	25.9	76+00	150	14-19	1.6	108+00	400	12-15	1.4
16+00	150	4,5	4.7	76+00	200	17-19	1.6	108+00	450	12-15	1.4
18+00	100	6	5.2	82+00	300	11-17	1.3				

September 11, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	12	0	26.7	14+00	12	0	21.7	82+00	200	0,1	2.1
0+50	12	0	31.5	16+00	0	0	14.7	86+00	150	0-4	1.7
1+00	0	0	51.7	18+00	100	5	13.7	86+00	350	0,1	1.7
2+00	50	0	74.3	22+00	12	0	11.8	89+00	200	0-5	1.6
2+00	100	0	74.3	27+00	50	0	8.4	95+00	150	0-2	1.1
2+50	25	0	71.3	35+00	0	0	4.9	95+00	250	0-23	1.1
3+50	150	0	45.3	35+00	12	0	4.9	95+00	300	12-23	1.1
4+50	100	0	33.0	38+00	0	0	4.5	98+00	50	0	1.2
5+00	75	0	33.8	42+00	0	0	3.9	98+00	250	15-22	1.2
5+50	0	0	25.2	42+00	12	0	3.9	101+00	50	0	1.1
6+50	50	0	28.7	46+00	100	6,7	3.7	101+00	100	0-19	1.1
8+00	0	0	25.2	50+00	100	8-10	3.2	101+00	200	11-22	1.1
10+00	0	0	29.4	54+00	50	4,5	3.2	101+00	300	16-24	1.1
10+00	12	0	29.4	70+00	12	0	2.4	104+00	50	0	1.1
12+00	150	10	44.9	76+00	50	0-14	2.2	104+00	150	12-17	1.1
14+00	0	0	21.7	76+00	150	0	2.2	108+00	300	0-3	1.5

September 18, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	12	0	10.2	16+00	300	0	11.1	74+00	350	9-17	1.8
0+50	100	0	6.9	18+00	300	0	11.9	74+00	450	6-9	1.8
1+00	100	0	43.1	22+00	150	10	8.4	78+00	200	18-20	1.9
2+00	12	0	76.7	27+00	150	0,1	9.6	82+00	300	11-16	1.8
2+50	0	0	80.6	35+00	0	0	3.6	86+00	250	20-26	1.6
3+50	200	0	16.8	38+00	12	0	3.9	86+00	300	21-28	1.6
4+50	200	0	40.1	41+00	150	0	3.8	90+00	400	21-27	1.6
5+00	75	3	17.8	44+00	150	7,8	2.9	90+00	450	10-24	1.6
5+50	300	0	28.7	61+00	100	12,13	2.2	94+00	150	21-26	1.6
6+50	150	4,5	18.7	61+00	150	8-12	2.2	98+00	250	21-23	1.6
8+00	450	0	12.8	70+00	150	9-12	2.0	104+00	200	0-8	1.3
10+00	100	0	15.3	70+00	200	8-10	2.0	106+00	350	8-11	1.8
12+00	150	10	15.9	74+00	150	8-18	1.8	108+00	450	0-17	1.6
14+00	100	11	11.4	74+00	200	9-19	1.8	108+00	500	0-5	1.6

October 23, 1984

Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)	Sta.	Dist. (feet)	Depth (feet)	Max. Dye (%)
0+00	12	0	25.2	12+00	25	0	11.7	48+00	50	8,9	1.5
0+50	12	0	33.5	14+00	0	0	4.1	58+00	12	0	0.9
1+00	12	0	62.9	16+00	150	0	6.6	61+00	350	0	1.1
2+00	0	0	81.8	18+00	150	0	8.8	78+00	50	0-17	0.9
2+00	12	0	81.8	22+00	50	0	4.6	78+00	100	0-22	0.9
2+50	0	0	81.8	22+00	100	0	4.6	84+00	250	0,1	1.1
2+50	12	0	81.8	27+00	50	0	2.1	89+00	50	0	0.8
3+50	0	0	45.3	35+00	50	7	1.7	89+00	100	0-18	0.8
4+50	0	0	39.7	35+00	100	0	1.7	92+00	100	0-2	0.8
4+50	12	0	39.7	38+00	50	0-2	1.7	95+00	100	0-9	0.8
5+00	12	0	24.0	41+00	50	0	1.4	99+00	50	0	0.6
5+50	12	0	27.8	43+00	100	0,1	1.6	99+00	100	0-18	0.6
6+50	0	0	45.5	47+00	100	0-2	1.8	104+00	50	0	0.6
8+00	0	0	37.8	47+00	150	0,1	1.8	108+00	100	0-4	0.6
10+00	0	0	18.8								

Appendix H

Data Used to Develop Mixing Zone Criteria

a. Transverse Distances From Shore At Flat Pool Elevation of 440.0

Date	Distance in Feet for Dye Percentages of							
	1	2	3	5	7	10	15	20
7/12/84	160	145	140	130	125	120	115	80
7/19	145	140	130	70	60	50	35	20
7/31	360	240	112	105	87	80	55	20
8/07	240	210	190	160	90	70	47	10
8/14	380	340	325	295	120	220	165	150
8/21	380	365	335	325	295	260	225	215
8/28	395	380	365	335	260	235	205	160
9/11	315	313	307	397	287	280	260	245
9/18	460	455	450	430	410	390	330	260
10/23	440	425	410	370	335	280	195	180

b. Longitudinal Distances Below Station 1+50

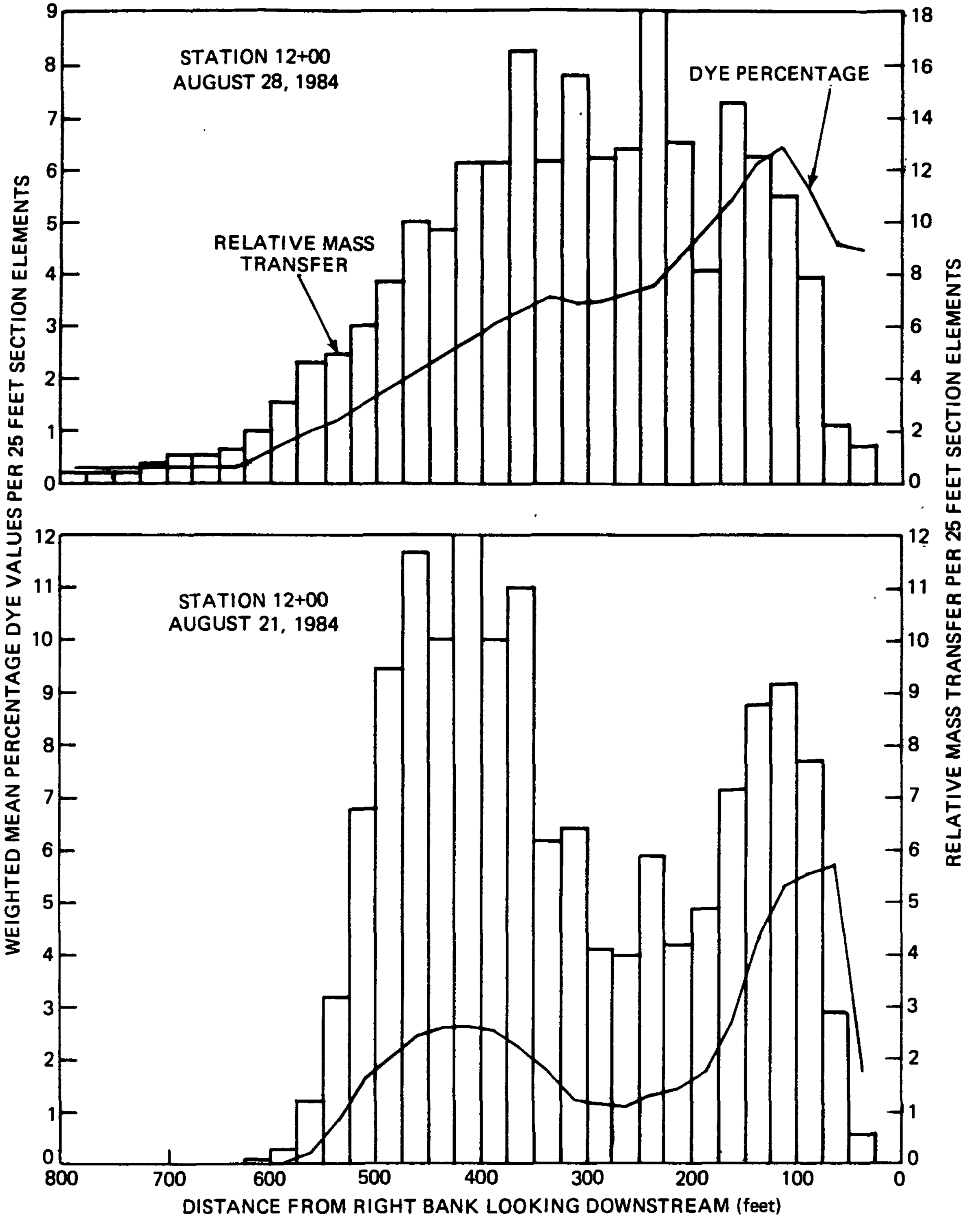
7/12/84	11,000	2,500	1,300	925	500	177	167	160
7/19	2,850	1,150	1,000	650	340	170	150	130
7/31	9,800	1,550	900	725	105	30	25	10
8/07	4,750	650	600	575	185	20	15	;-
8/14	3,600	1,200	800	370	360	355	130	120
8/21	6,100	3,350	1,250	1,000	625	420	360	215
8/28	12,000	4,250	2,750	1,650	1,100	700	430	180
9/11	13,000	8,200	5,550	3,500	2,850	2,300	1,450	1,250
9/18	13,000	6,850	4,200	3,200	2,750	1,900	1,250	1,150
10/23	8,500	2,700	2,400	2,000	1,550	1,150	1,050	825

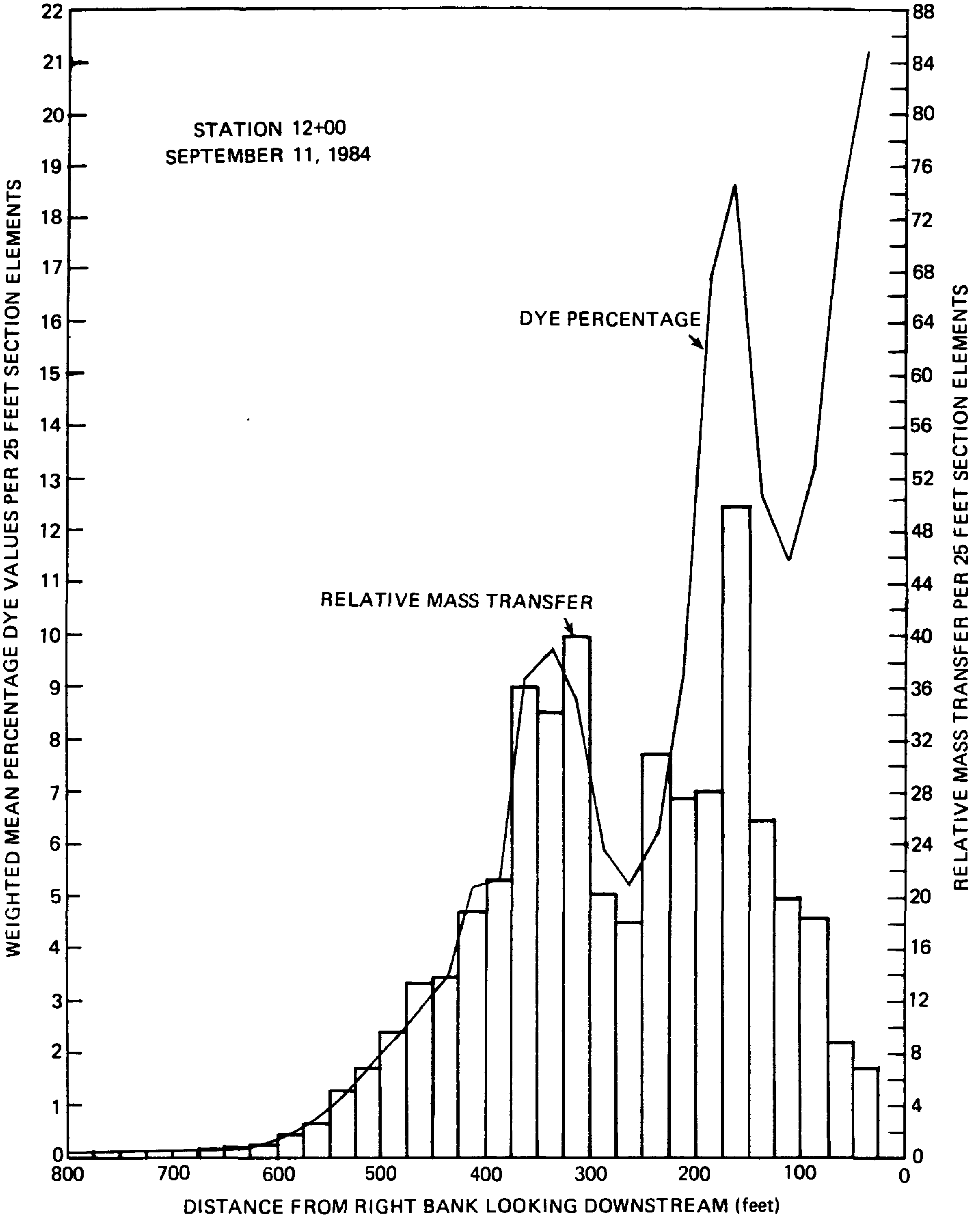
c. Independent Parameters Related to Distances

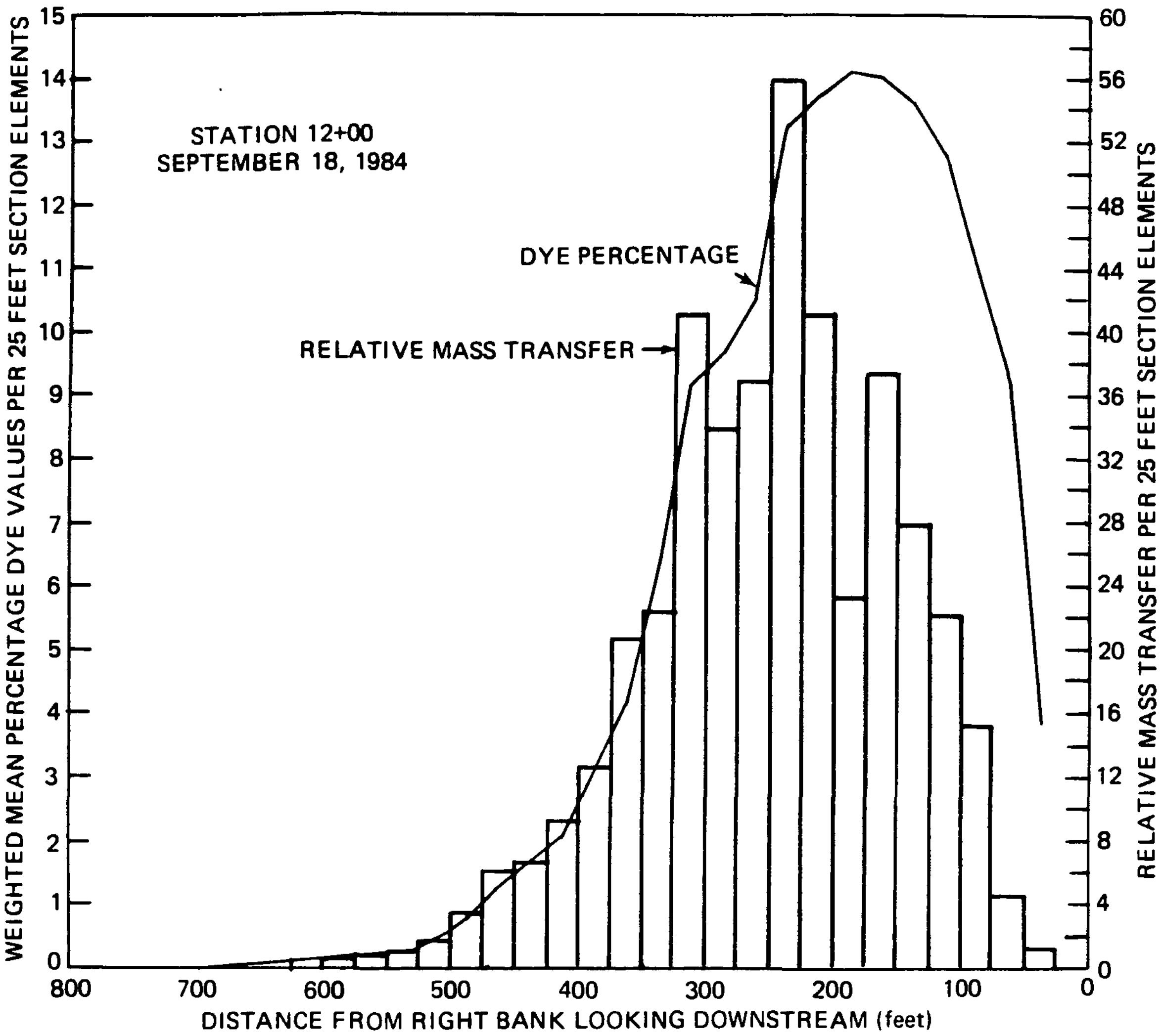
Date	GPSD Flow (mgd)	River Flow (cfs)	GPSD Temp (°C)	River Temp (°C)	River Elev. (msl-400)
7/12/84	37	10,156	24.0	29.5	40.48
7/19	30	8,661	24.0	29.5	40.22
7/31	25	7,820	25.0	30.5	40.12
8/07	20	7,106	28.0	21.0	39.98
8/14	40	8,394	25.5	29.5	40.38
8/21	35	7,848	25.0	26.0	39.68
8/28	45	6,088	26.1	25.8	39.47
9/11	55	7,572	24.0	24.5	40.41
9/18	50	5,224	22.5	21.0	40.56
10/23	30	8,837	21.0	15.0	40.43

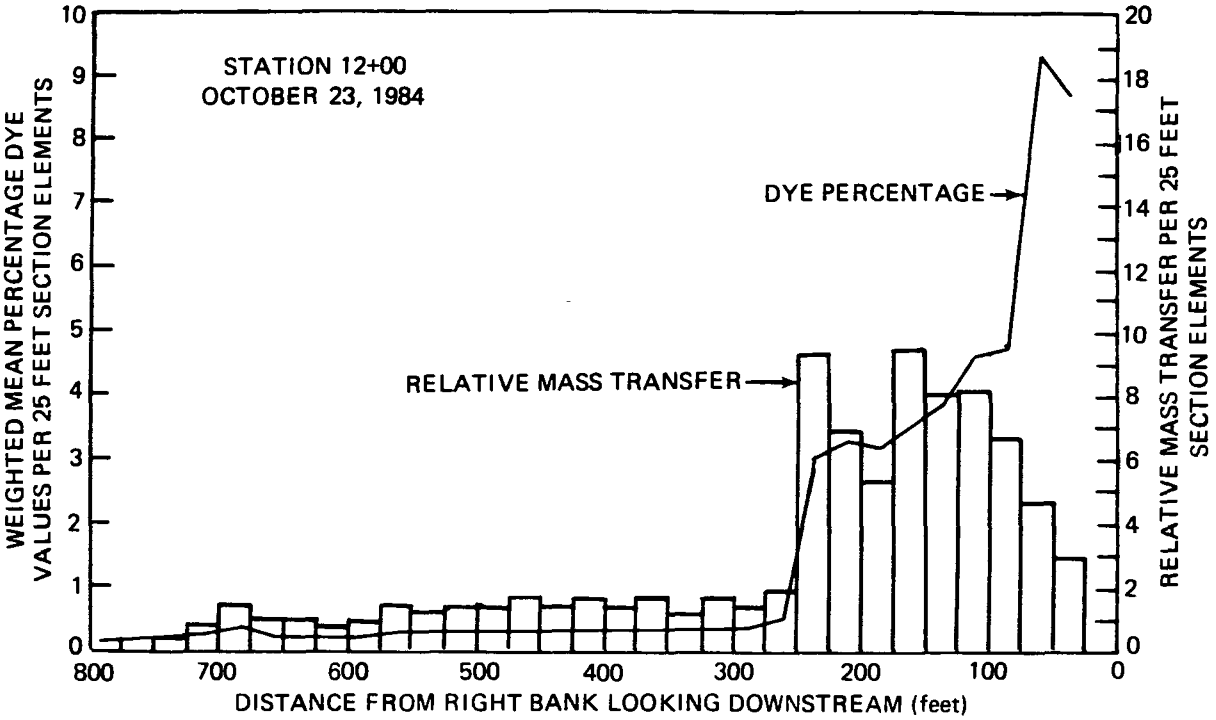
Appendix I

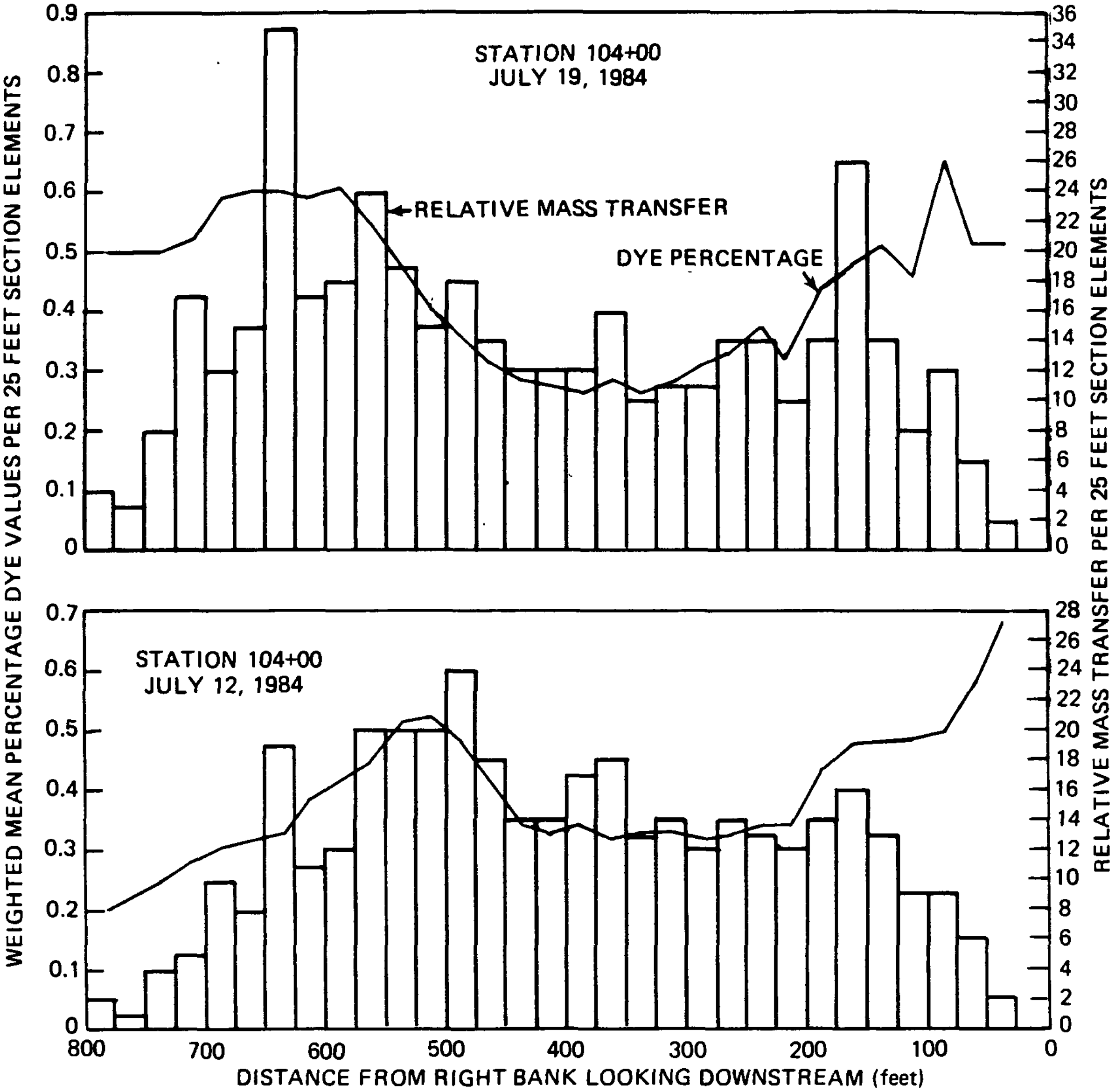
Figures Showing the Transverse Distribution of the Tracer Dye

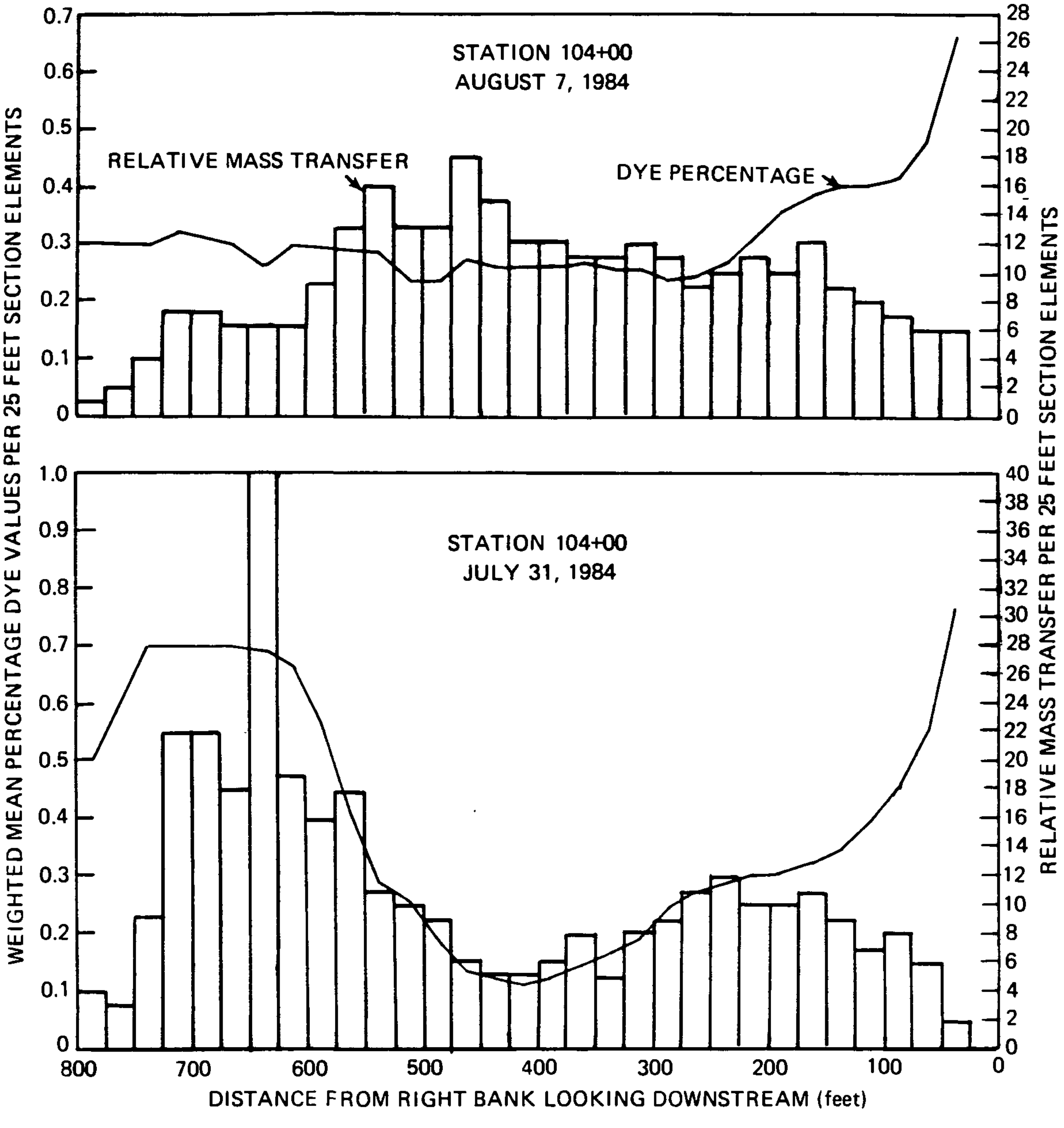

STATION 12+00
AUGUST 28, 1984
DYE PERCENTAGE
RELATIVE MASS TRANSFER
STATION 12+00
AUGUST 21, 1984
WEIGHTED MEAN PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)
0
1
2
3
4
5
6
7
8
9
10
11
12
14
16
18
800
700
600
500
400
300
200
100
0

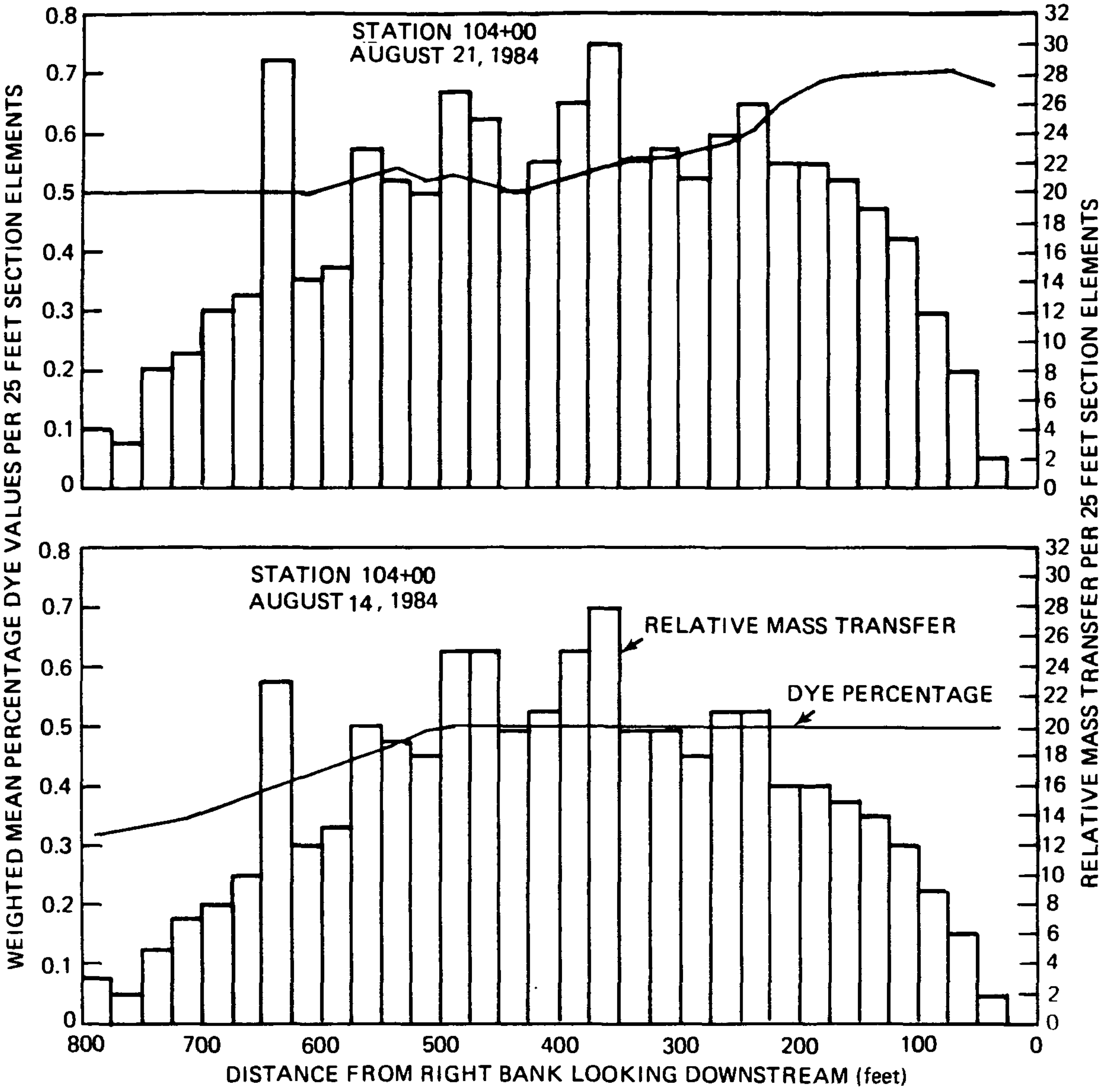

STATION 12+00
SEPTEMBER 11, 1984
DYE PERCENTAGE
RELATIVE MASS TRANSFER
WEIGHTED MEAN PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
800
700
600
500
400
300
200
100
0

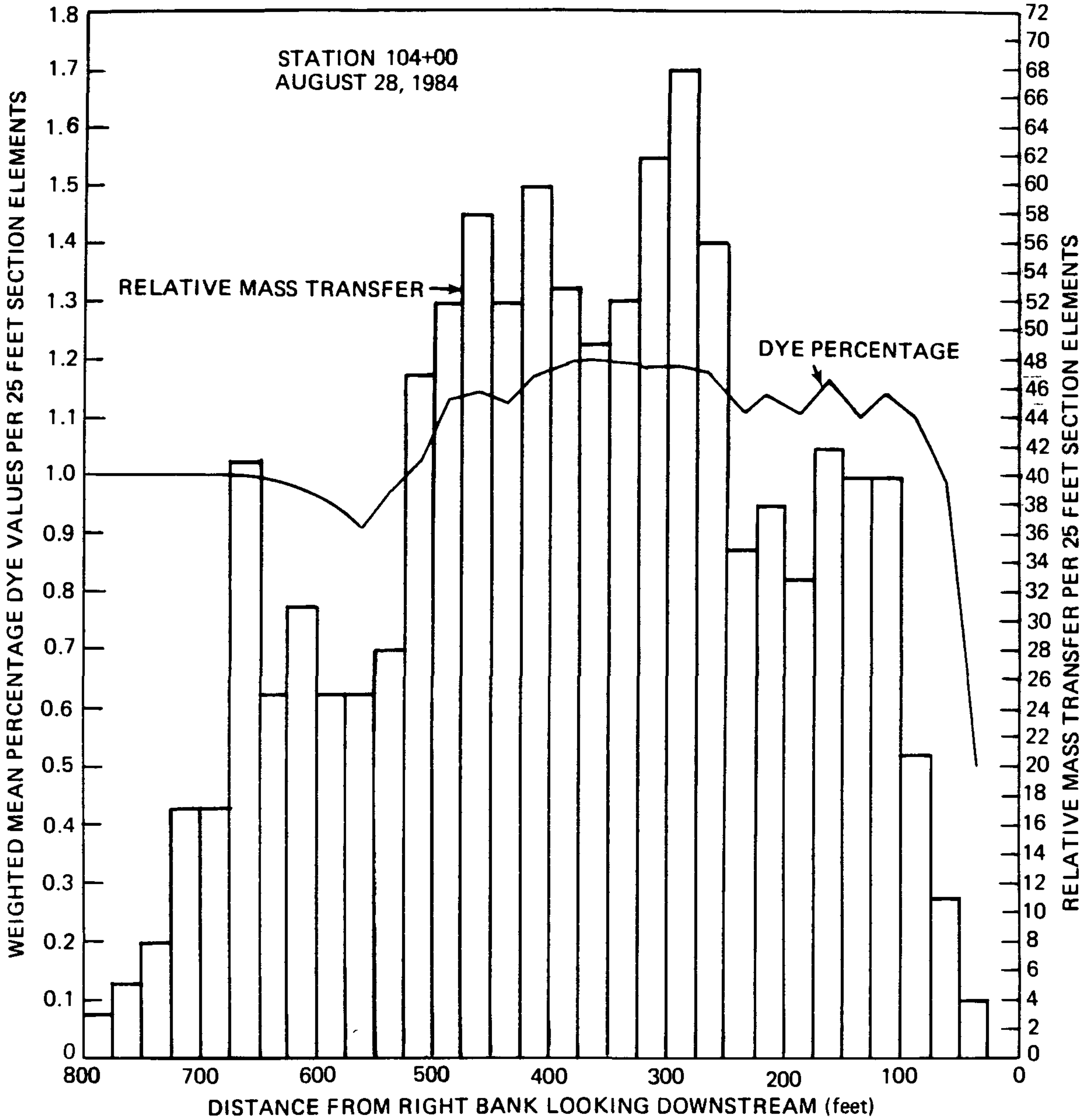

STATION 12+00
SEPTEMBER 18, 1984
DYE PERCENTAGE
RELATIVE MASS TRANSFER
WEIGHTED MEAN PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
800
700
600
500
400
300
200
100
0

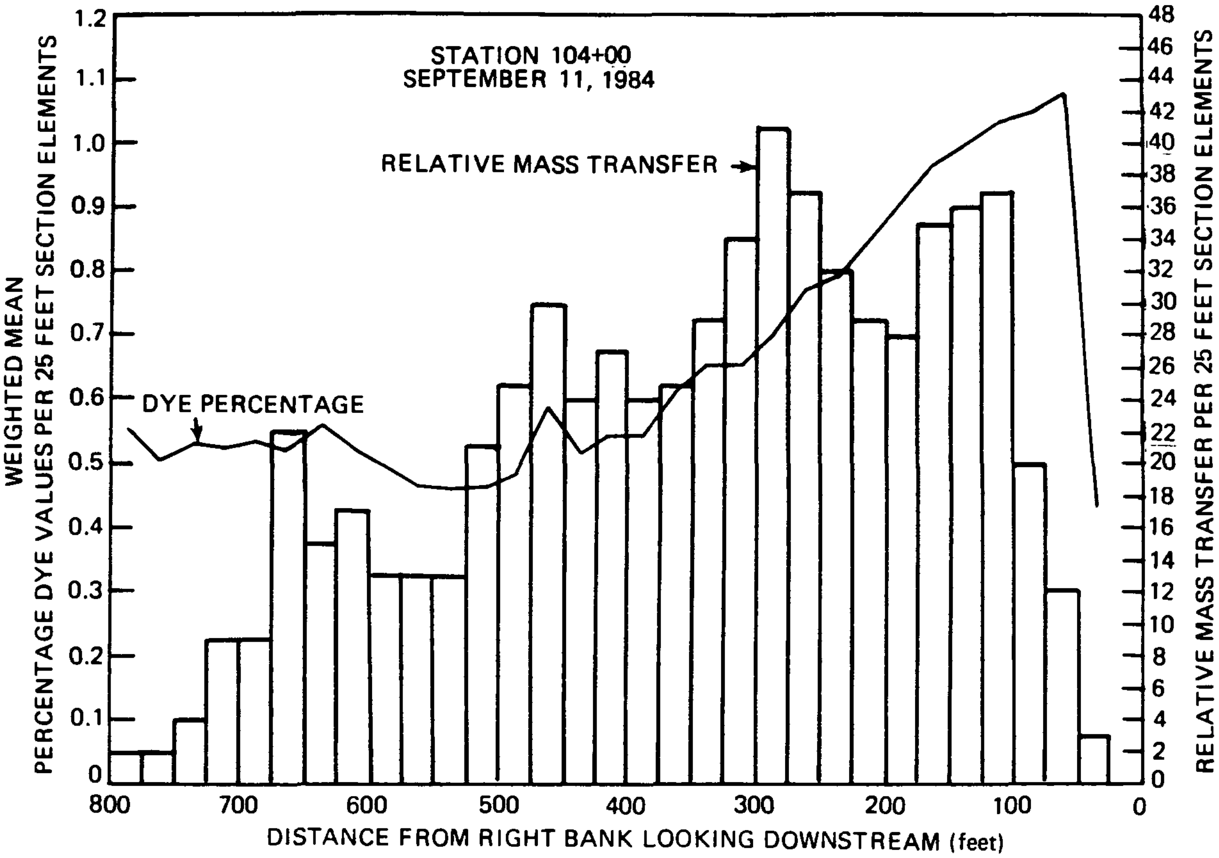

STATION 12+00
OCTOBER 23, 1984
DYE PERCENTAGE
RELATIVE MASS TRANSFER
WEIGHTED MEAN PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)
0
1
2
3
4
5
6
7
8
9
10
0
2
4
6
8
10
12
14
16
18
20
800
700
600
500
400
300
200
100
0

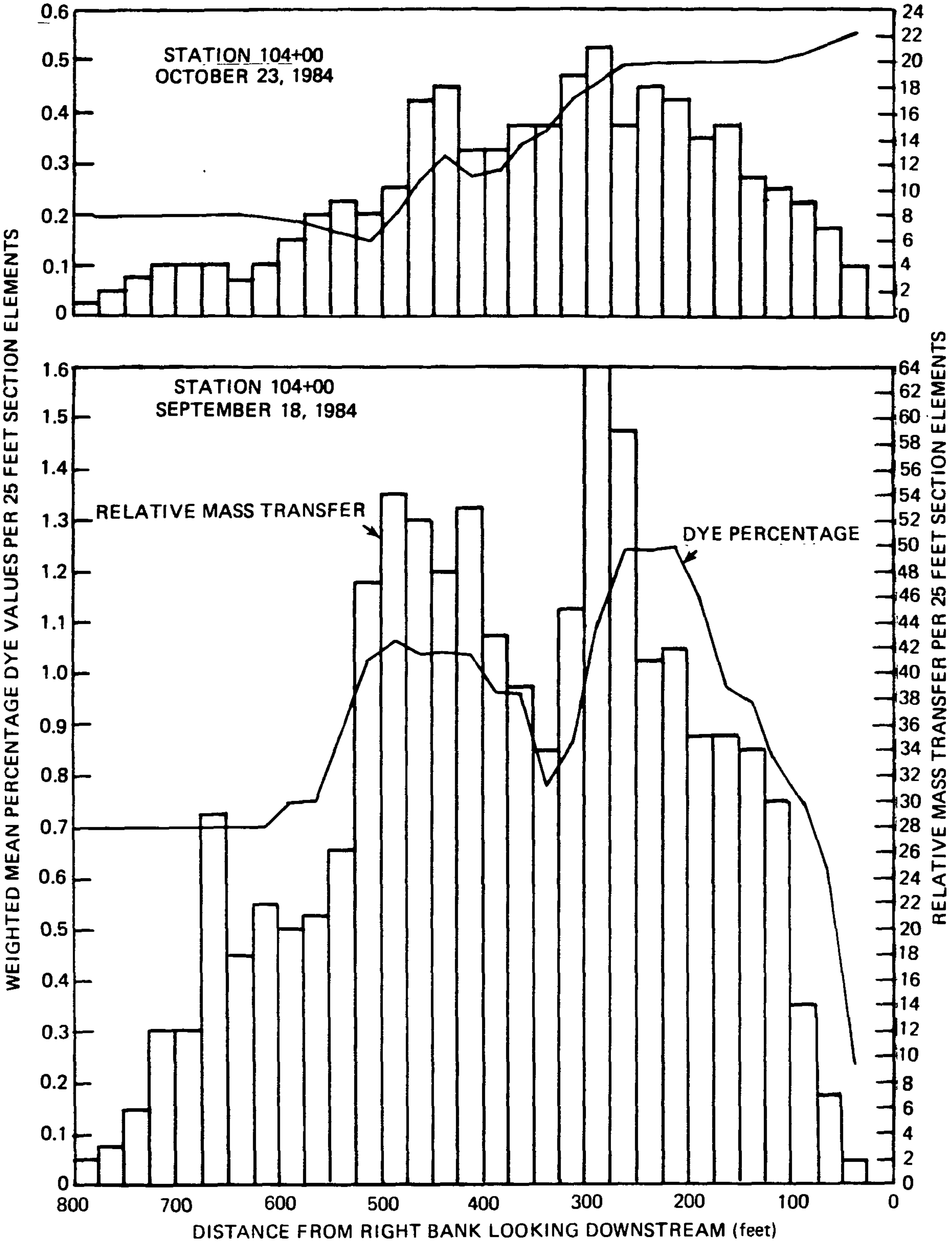

STATION 104+00
JULY 19, 1984
RELATIVE MASS TRANSFER
DYE PERCENTAGE
STATION 104+00
JULY 12, 1984
WEIGHTED MEAN PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
800
700
600
500
400
300
200
100
0
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)


STATION 104+00
AUGUST 7, 1984
RELATIVE MASS TRANSFER
DYE PERCENTAGE
STATION 104+00
JULY 31, 1984
WEIGHTED MEAN PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
800
700
600
500
400
300
200
100
0


STATION 104+00
AUGUST 21, 1984
STATION 104+00
AUGUST 14, 1984
RELATIVE MASS TRANSFER
DYE PERCENTAGE
WEIGHTED MEAN PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
800
700
600
500
400
300
200
100
0
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)


STATION 104+00
AUGUST 28, 1984
RELATIVE MASS TRANSFER
DYE PERCENTAGE
WEIGHTED MEAN PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
800
700
600
500
400
300
200
100
0


STATION 104+00
SEPTEMBER 11, 1984
RELATIVE MASS TRANSFER
DYE PERCENTAGE
WEIGHTED MEAN
PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
800
700
600
500
400
300
200
100
0


STATION 104+00
OCTOBER 23, 1984
STATION 104+00
SEPTEMBER 18, 1984
RELATIVE MASS TRANSFER
DYE PERCENTAGE
WEIGHTED MEAN PERCENTAGE DYE VALUES PER 25 FEET SECTION ELEMENTS
RELATIVE MASS TRANSFER PER 25 FEET SECTION ELEMENTS
DISTANCE FROM RIGHT BANK LOOKING DOWNSTREAM (feet)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
0
2
4
6
8
10
12
14
16
18
20
22
24
800
700
600
500
400
300
200
100
0

Illinois State Water Survey Division
WATER QUALITY SECTION
AT
PEORIA, ILLINOIS

SWS Contract Report 406

THE IMPACT OF GREATER PEORIA SANITARY DISTRICT AMMONIA DISCHARGES ON ILLINOIS RIVER WATER QUALITY:

PART 2

by

Thomas A. Butts and Dana B. Shackleford

Prepared for the
Greater Peoria Sanitary District

November 1986

Illinois Department of Energy and Natural Resources

CONTENTS

THE IMPACT OF GREATER PEORIA SANITARY DISTRICT AMMONIA DISCHARGES ON ILLINOIS RIVER WATER QUALITY:
PART 2

by Thomas A. Butts and Dana B. Shackleford

INTRODUCTION

The Illinois Pollution Control Board (IPCB) and the Illinois Environmental Protection Agency (IEPA) are concerned about ammonia-nitrogen (ammonia-N) in surface water because it can be toxic to fish under certain conditions and because its bio-oxidation can depress dissolved oxygen (DO) concentrations. The IPCB and IEPA have formulated and published rules and regulations to control ammonia-N concentrations in wastewater effluents and surface waters of the state. Generally, these rules and regulations are designed to directly safeguard the water quality of receiving streams. However, one special rule somewhat arbitrarily limits ammonia-N concentrations in effluents from treatment plants handling 50,000 or more raw population equivalents (PE) discharging to the Illinois Waterway to 2.5 mg/l during April through October, and to 4 mg/l at other times.

The Greater Peoria Sanitary District (GPSD) treats a raw PE considerably in excess of 50,000. Consequently, the GPSD approach to ammonia-N removal is predicated on and dictated by this restriction. However, GPSD officials question whether adherence to this rule is essential for achieving or maintaining stream water quality standards below the plant outfall. A study (Butts et al., 1985) was conducted by the Water Quality Section (WQS) of the Illinois State Water Survey (ISWS) during the summer and fall of 1984 to study the relationship between GPSD ammonia-N discharges and possible violations of IPCB standards outside an allowable mixing zone defined through use of a fluorescent tracer dye. This study showed that the effluent standard of 2.5 mg/l, as applied to the GPSD effluent during warm summer periods, is unjustified and severely restrictive. Effluent concentrations of 10 mg/l of ammonia-N could be routinely discharged during periods when the water temperatures are above 15°C, the lowest temperature encountered during the 1984 study. However, nothing was known about mixing and dispersion of the effluent with the river at water temperatures below 15°C.

Consequently, a cold weather study was conducted by the WQS of the ISWS between November 1985 and April 1986 to gather data for developing criteria for defining a cold weather mixing zone and for assessing the impact of GPSD effluent ammonia discharges outside the prescribed mixing area. This report describes the findings and conclusions of the cold weather study and supplements and expands on the detailed information presented in the warm weather report.

General Information

The Greater Peoria Sanitary District sewage treatment plant is located south of Peoria with the effluent discharging to the Illinois Waterway at river mile 160.1 (see figure 1). It is a high-rate activated sludge plant that uses the Kraus process of returning digested sludge to the aeration system. Special treatment is provided for ammonia-N removal: the secondary effluent is passed through 84 rotating biological contactors which support a large population of nitrifying bacteria. Deep tertiary sewage ponds are used to remove suspended solids (SS) and some biochemical oxygen demand (BOD). The effluent is chlorinated.

The plant is designed to handle an average hydraulic load of 37 million gallons per day (mgd). The preliminary and primary treatment facilities can handle a maximum flow of 154 mgd, of which 60 mgd can be routed through the secondary treatment phase. The average annual dry weather flow is about 25 mgd. The average design waste loading is approximately 120,000 pounds per day of 5-day BOD (approximately 706,000 PE) and 132,000 pounds per day of suspended solids.

In the past, the plant received heavy industrial waste loads from three major industries: Pabst Brewing Company, Hiram Walker Distillery, and Bemis Bag Company. These wastes were highly organic and were composed mostly of carbonaceous material. Presently only Bemis is operating. Pabst Brewing has shut down, and the Hiram Walker Distillery has been taken over by Archer Daniels Midland (ADM) for the production of commercial grade alcohol.

Regulatory Implications

IEPA rules and regulations pertaining to effluent discharge and stream water quality standards are contained in State of Illinois Rules and Regulations. Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter 1: Pollution Control Board, dated February 1, 1986. Five sections within these rules and regulations are pertinent to ammonia-N relative to general water use. These are:

Section number	Subject
302.210	Substances Toxic to Aquatic Life
302.212	Ammonia Nitrogen and Un-ionized Ammonia
304.105	Violation of Water Quality Standards
304.122	Nitrogen
304.301	Exceptions for Ammonia Nitrogen Water Quality Violations

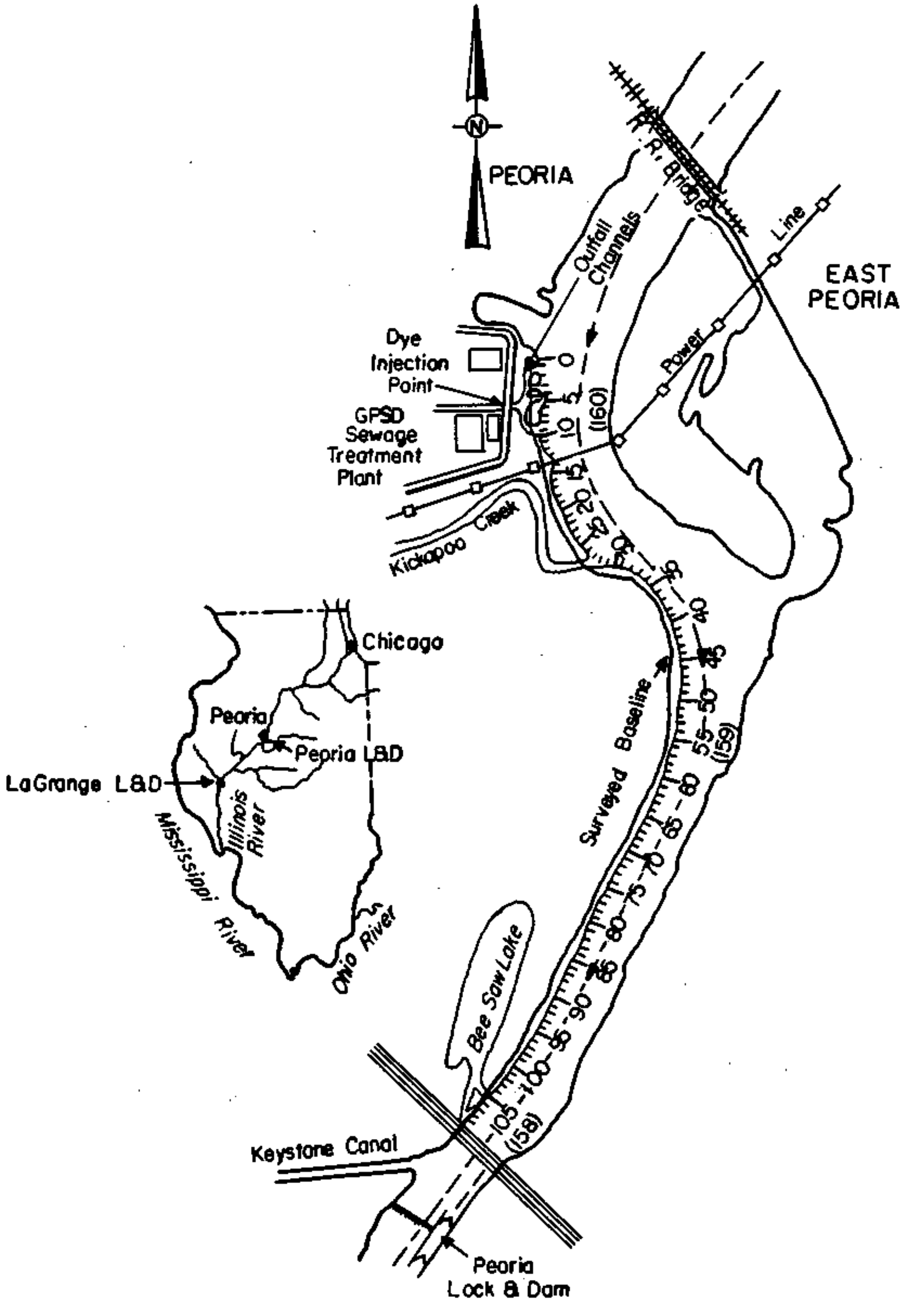


Figure 1. Study area and vicinity map

Four of the five sections are related to stream water quality standards; the exception is rule 304.122, which arbitrarily limits ammonia discharge concentrations irrespective of receiving stream water quality conditions. The four general rules are designed to limit effluent ammonia discharges only to the degree needed to meet stream standards. In contrast, paragraph a) of Section 304.122 stipulates:

> No effluent from any source which discharges to the Illinois River, the Des Plaines River downstream of its confluence with the Chicago River System or the Calumet River System, and whose untreated waste load is 50,000 or more population equivalents shall contain more than 2.5 mg/l of ammonia-nitrogen as N during the months of April through October, or 4 mg/l at other times.

Only three governmental agencies operating sewerage works fall under this rule. They are the Metropolitan Sanitary District of Greater Chicago (MSD), the City of Joliet, and the Greater Peoria Sanitary District. These three agencies must comply with the above regulation even in the absence of evidence that stream water standards are being violated.

Some justification exists for limiting ammonia-N concentrations in the effluents from the various MSD plants and Joliet. Butts et al. (1975) showed that ammonia-N loads originating above river mile 273, near the junction of the Des Plaines and Kankakee Rivers, must be reduced significantly if dissolved oxygen levels are to be improved down to Chillicothe (mile 179). Oxygen suppression also occurs in the LaGrange pool below Peoria, but two recent studies (Butts et al. [1981] and Butts et al. [1983]) indicate somewhat indirectly that present GPSD ammonia-N discharges probably have minimal effect on the DO resources of the LaGrange pool. Butts et al. (1981) showed that during dry, warm 7-day, 10-year low flows the oxygen demand was 57 percent carbonaceous, 13 percent nitrogenous (ammonia-N oxidation), and 30 percent sediment oxygen demand. A BOD-DO model study conducted by Butts et al. (1983) reveals that, for 7-day, 10-year low flows, the time of travel between Chicago and Peoria is so great that most of the carbonaceous and nitrogenous demand would be exerted before it reaches the Peoria area. Consequently, the residual Chicago area loads combined with the GPSD inputs are so small that they have very little impact on LaGrange pool DO resources.

The question that needs to be resolved, based on the facts presented above, is whether the restrictive limitations imposed upon the GPSD treatment plant as set forth in paragraph a) of Section 304.122 are essential in preventing water quality standard violations in the Illinois River below Peoria during the months of November through March. This study was designed and implemented to answer this question. The 1984 warm weather study (Butts et al., 1985) answered this question for the months of April through October.

Scope and Purpose of Study

The primary purpose of this study was to determine the maximum ammonia concentrations which would be permissible in the GPSD-treated effluent for the months November through March to ensure that:

1. Illinois River water ammonia-N levels are not raised to levels which are toxic to native fish as specified in Section 302.210.

2. Illinois River ammonia-N water quality standards are not violated as specified in Section 302.212.

To achieve these two goals, mixing zones had to be defined as dictated by the IPCB's Rules and Regulations (1986). During the warm weather study, fluorescent dye was used to trace the mixing and dispersion characteristics of the effluent with the river. The use of the dye was precluded during this study because of potential freezing conditions. The dye injection pump and dye storage tank would probably freeze during winter operations. Consequently, two alternative methods were selected for use in characterizing mixing. One was to take advantage of the significant differences between the effluent and river temperatures during cold weather. An examination of historical data showed that temperature differentials during the coldest parts of January and February often exceed 13°C. The occurrence of temperature differentials in the area of the outfall would therefore appear to be useful in defining mixing zones.

Temperature, however, can change in an open environment by means other than mixing and dispersion, for example through heat transfer and convection. A conservative substance was needed to back up and substantiate the temperature data. An additional examination of historical data showed that a significant difference usually exists between river and effluent chloride concentrations. During the winter these differences usually range between 200 and 600 mg/l. Therefore, conservative chlorides were measured and compared with field-measured river water temperatures. If the temperature data appeared inadequate or misleading, the chloride information would be used to define or characterize effluent mixing during the winter.

The ultimate goal was to integrate the cold and warm weather data into one complete data base for developing mixing zone prediction equations which would be applicable over a wide range of physical conditions.

Acknowledgments

This study was sponsored and partially funded by the Greater Peoria Sanitary District. The work was performed under the general supervision of the acting Chief of the Illinois State

Water Survey, Richard Schicht. Sampling was conducted under very adverse physical conditions. Field crews had to contend with freezing and windy weather, ice floes, and hazardous barge traffic. Those who deserve extra special mention for doing this are: Harvey Adkins, Dave Green, Dave Beuscher, Jud Williams, and John Mathis.

Jim Kelton did the art and graphics work. Linda Johnson typed the original manuscript, Gail Taylor edited the report, and Dave Hullinger supervised and/or performed laboratory analyses.

Special thanks are extended to the staff of the GPSD who coordinated GPSD and ISWS activities and obligations needed to make the study a success.

METHODS AND PROCEDURES

Water quality and mixing zone sampling runs were scheduled to take place simultaneously during the cold weather period extending from November 1, 1985 through March 31, 1986. However, because favorable river flows and temperatures continued past March 31, the sampling period was extended to April 22, 1986. Using temperature and/or chlorides as a tracer in place of the fluorescent dye reduced laboratory work significantly and permitted the ammonia samples to be collected during mixing zone sampling. In contrast, during the warm weather study water quality sampling had to be delayed until a day or two after the mixing zone data were collected.

Runs were contemplated for GPSD effluent discharge rates of 20, 25, 30, 35, 40, 45, 50, and 55 mgd. All sampling was to take place during periods when the river temperatures were 13°C or less; the goal was to concentrate on grouping the runs into an 8°C to 13°C range and a 0°C to 5°C range. The maximum desirable river flow was 10,000 cfs.

Field Sampling

Sampling locations were determined and water samples were collected by using the procedures developed and employed during the warm weather dye tracer study. Since the warm weather results clearly showed that the mixing zone extension was limited by the IPCB's requirement that no mixing zone shall contain more than 25 percent of the stream cross-sectional area or flow volume, sampling was limited to points approximately 1000 feet downstream of the outfall area. As it turned out, ice floes and adverse weather conditions would have prevented longitudinal sampling much farther downstream than this even if it would have been needed.

Figure 1 shows the study location and the extent of the warm weather study. This figure is a slight modification of figure 1 presented in the report on the warm weather results (Butts et al., 1985); the new revised figure shows the outfall configuration and discharge locations more accurately. Figure 2 shows the immediate cold weather sampling area in more detail; this figure supersedes figure 14 presented in the warm weather report. The original figure showed an incorrect positioning of the second and third outlet channels: they were shown approximately 150 feet too far downstream. This error did not affect the reported results because all the data collections and results were referenced to the bank stationing, which was correct. Shore and offset stakes were reestablished downstream to station 10+50. Periodically, many of the shore stakes were destroyed by ice and had to be replaced.

The sampling routine consisted of: (1) collecting samples and making temperature measurements in the three main effluent channels, (2) collecting river ammonia and chloride background samples and making temperature measurements upstream of the outfall, and (3) making measurements and collecting samples in the mixing zone area. Temperature measurements were taken again midway through and at the end of the run in the three effluent channels and at the end of the run at the background stations. Chloride and ammonia samples were also taken at the end of the runs in the effluent channels and background stations after the initial two runs were completed in November. Unlike in the dye tracer study, predetermined mixing zone sampling locations were not used. The warm effluent provided an easily detectable mixing pattern which could be followed and used to efficiently establish appropriate sampling and measuring points.

Figure 3 shows the boat, equipment, and crew prepared to start a run. The boat was secured in the outfall channel between most runs since boat launching was impossible at the local boat ramps during the cold weather. Some damage occurred to the boat and equipment over the course of the study as a result of vandalism and ice floes. A winch was placed on a boat on the bank near location 4 (figure 2) for use in pulling the boat upstream against very strong effluent currents.

Figure 4 shows sampling in progress at station 0+50. Water samples were collected by using the downrigger-pumping system developed for use during the dye tracer study. For this study, the intake line was shortened so that flushing time was reduced to about 10 seconds; 20 to 30 seconds were allowed to elapse before a sample was taken. Samples were collected in 250-ml plastic bottles. Collection points were selected on the basis of temperature readings. Approximately 178 chloride and 25 to 28 ammonia-N samples could be handled and analyzed in the laboratory per run. Initially only about 60 chloride samples could be handled, but after the first run this number appeared insufficient, and laboratory facilities were streamlined and laboratory help added so the output could be tripled.

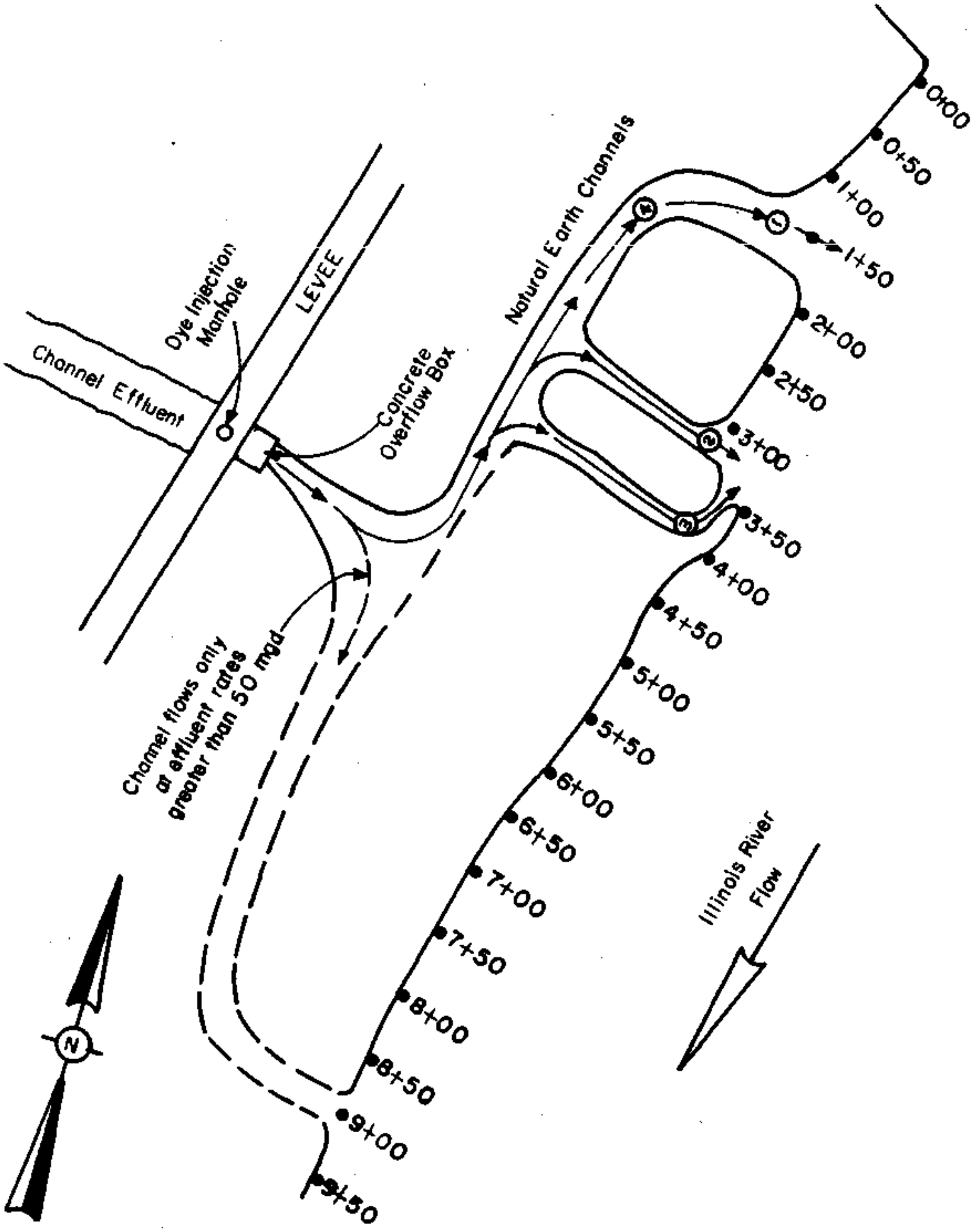


Figure 2. Schematic of GPSD outfall delta showing sampling points

Figure 3. Sampling crew preparing to make run

Figure 4. Winter sampling in river

Temperature measurements were made by using a YSI model 5739 temperature-oxygen probe attached to a YSI model 58 temperature-DO meter. The accuracy of the temperature probe was checked in the laboratory over a range of 5°C to 20°C against a Bureau of Standards-quality mercury thermometer and found to be within 0.1°C over this temperature range.

Ice floes and, at times, barge traffic greatly interfered with sampling. Note that the scene depicted in figure 4 exhibits little ice on the river in the study area. However, massive ice jams could build up in a matter of 10 to 15 minutes. Figures 5 and 6 show massive ice floes which showed up almost instantly as sampling was being completed at station 10+00. Figures 4, 5, and 6 are photographs taken on the same day.

The United States Geological Survey (USGS) flow gage at Kingston Mines (river mile 145.5) was read early each morning before a run was made. The readings in feet were converted to flow with a flow rating table supplied by the USGS. Official flow data will not be available from the USGS until November or December 1986; consequently, in some instances the flow rates used in this report will differ slightly from those which will eventually be published.

When runs required effluent flows in excess of 30 mgd, the GPSD had to store sufficient effluent in their retention lagoons so that a prescribed flow rate could be maintained from 8:00 a.m. to 3:00 p.m. Sampling usually started around 10:00 a.m. and ended between 2:00 and 3:00 p.m. Sampling schedules were coordinated with storage arrangements so that storage time would be minimal to prevent significant cooling of the effluent during very cold conditions. An effort was made to provide as great a temperature differential as practical between the effluent and the river.

Laboratory Analyses

After arrival at the laboratory, the 250-ml water samples were iced overnight and analyzed immediately the next morning for ammonia-N and chlorides. Chloride determinations were made by using the argentometric method (Standard Methods) whereby potassium chromate is added to the samples and titrated with 0.0141-normal silver nitrate.

The determination of permissible ammonia-N levels in the river requires a knowledge of both ambient temperatures and pH. Because of freezing conditions, field determination of pH was impractical and was not attempted. To fulfill the needs of this study, pH readings taken on river samples collected twice a week by ISWS personnel at river mile 161.6 were used.

Samples for ammonia-N determination were distilled with sodium hydroxide by using a Buchi model 320 steam generator with

Figure 5. Sampling boat at station 10+00 hemmed in by ice

Figure 6. Two winter sampling hazards - ice floes and barge traffic

the distillate collected in a boric acid solution. A portion of the distillate was retained for colorimetric analyses using the Harwood and Kuhn phenol-hypochlorate method.

Data Preparation and Reduction

Presenting the results of a mixing zone and dispersion study in a concise and meaningful way is difficult because so many variables exist that modify basic natural mixing phenomena in a large river system. Theoretical models do not appear to be any more applicable to the data generated during the cold weather study than they did for the data generated during the warm weather study.

The primary method of data display used in this report is the use of areal iso-plots (contours) that show effluent temperature residuals (in terms of percentages) in the sampling area, and the use of ammonia-N and chloride residual percentages in statistical regression analyses. The "contouring" procedure is the same as the one developed for depicting mixing zones using the fluorescent dye tracer. Contour plots were developed for surface, 1-, 3-, and 8-foot depths down to station 10+50 for all completed sampling dates. To enable the development of contours at any depth based on the observed temperature measurements, straight-line extrapolation was used to estimate the temperatures at 1-foot depth increments between measured values. However, very few interpolated data were required for completing the cold weather plots since temperature readings were taken at 1- to 2-foot depth intervals throughout most of the study area.

The plots are all in terms of percentages computed on the basis of the relationship of ambient temperatures measured within the mixing zone to those measured in the effluent channels. The change in effluent and background temperature and chemical values over the period of time required to complete a run was compensated for by using straight line interpolation. This was done on a computer by using the following algorithm:

$$P_t = \frac{T_t - (T_{bi} + T_b^{1})}{T_{ei} + T_e^{1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where P_t = the fraction observed in the mixing zone at the time t

T_t = the temperature, ammonia, or chlorine (parameter) value observed in the mixing zone at time t

T_{bi} = the initial background parameter value observed at time t_{bi}

T_b^1 = the incremental change in the background parameter values =

$$\frac{(t_{bi} - t)\,(T_{bi} - T_{be})}{t_{bi} - t_{be}}$$

where T_{be} = the end background parameter value observed at time t_{be}

T_{ei} = the initial weighted average effluent parameter values =

$$\frac{f_1T_{e1i} + f_2T_{e2i} + f_3T_{e3i}}{f_1 + f_2 + f_3}$$

where f_1 , f_2, f_3 = flow weighting factors given in table 1 for effluent channels 1, 2, and 3 Cfigure 2)

T_{e1i}, T_{e2i}, T_{e3i} = the initial effluent parameter values observed at time t_{ei}

T_e^1 = the incremental change in the effluent parameter values =

$$\frac{(t_{ei} - t)\ (T_{ei} - T_{ee})}{t_{ei} - t_{ee}}$$

where T_{ee} = the end weighted average effluent parameter values =

$$\frac{f_1T_{e1e} + f_2T_{e2e} + f_3T_{e3e}}{f_1 + f_2 + f_3}$$

where T_{e1e}, T_{e2e}, T_{e3e} = the end effluent parameter values observed at time t_{ee}

The weighting factors f_1, f_2, and f_3 used are listed in table 1. They are rough estimates based on channel width and depths and surface velocities measured for 20-, 35-, and 50-mgd flows. These weighting factors, albeit somewhat crudely devised, are sufficiently accurate for use in this study since the temperature, ammonia-N, and chloride values varied little between the channels on most dates.

RESULTS

Ten successful runs were completed between early November 1985 and mid-April 1986. An additional run was attempted on January 20, 1986, but with about one-third of the sampling completed, the crew was forced off the river by an ice jam. The physical conditions under which the ten successful runs were made are summarized in table 2. The warm weather conditions are included in the table for comparative purposes. Note that the river flows were considerably lower during the warm weather study. The warm weather average and median flow values were 7,771 cfs and 7,834 cfs, respectively, whereas the cold weather values were 12,625 cfs and 10,745 cfs, respectively. During the

Table 1. Effluent Channel Flow Weighting Factors

Effluent Flow Rate (mgd)	Channel 1 (f_1)	Channel 2 (f_2)	Channel 3 (f_3)
20	15	1	5
25	14	1	5
30	14	1	4
35	12	1	4
40	10	1	3
45	8	1	3
50	6	1	2
55	4	1	2

Table 2. Mixing Zone and Dispersion Run Dates and Physical Conditions on Those Dates

	Discharge		Pool	Peoria Dam Operation		
Date	GPSD (mod)	River (cfs)	Stage (msl)	Wickets Down	Valves Open	Needles In
Warm Weather Data (From Table 14 [Butts et al., 1985])						
7/12/84	37	10,156	440.48	0	6	0
7/19	30	8,661	440.22	0	6	0
7/31	25	7,820	440.12	0	6	0
8/07	20	7,106	439.98	0	0	0
8/14	40	8,394	440.38	0	6	0
8/21	35	7,848	439.68	0	6	0
8/28	45	6,088	439.47	0	0	51
9/11	55	7,572	440.81	0	0	0
9/18	50	5,224	440.56	0	0	63
10/23	30	8,837	440.43	6	6	40
Cold Weather Data (new)						
11/05/85	40	17,540	439.98	134	0	0
11/13	35	21,060	441.11	134	0	0
1/09/86	25	10,920	440.38	0	6	0
1/13	20	10,570	440.29	0	6	0
1/16	45	9,446	440.35	0	6	0
1/21	55	11,320	440.73	0	6	0
1/23	30	18,430	439.81	117	6	0
2/18	50	10,020	440.55	0	6	0
4/16	35	8,535	440.56	0	6	0
4/22	40	8,411	440.49	0	6	0

Note: Maximum number of wickets is 134

cold weather study all 134 Peoria dam wickets were down on two dates and 117 were down on another. No winter flows were low enough to warrant needle placement between raised wickets. Although the overall winter flow conditions were not ideal, the winter results were satisfactorily melded with the warm weather data by using only the winter data that were collected within the summer data flow range. This selective process will be addressed in detail later.

Over 4100 temperature readings were taken. Along with these readings, 1402 chloride and 277 ammonia-N samples were collected and analyzed in the laboratory. The daily reading and collection totals are presented in table 3 and are summarized as to location.

The mixing zone ammonia-N results in terms of concentration and residual percentages are given in Appendix A. The river background and effluent results are detailed in table 4. A good range and satisfactory blend of river water temperatures were achieved. Good to excellent effluent-river temperature differentials occurred during eight of the ten sampling dates. The differentials during the two April runs were only fair, but they were adequate to satisfactorily define the mixing zone. The minimum, average, and maximum differences were 3.22°C, 9.36°C, and 13.20°C, respectively. The greatest differences were observed during January.

River ammonia-N background levels increased significantly as water temperatures decreased (table 4). On November 5, 1985, the level was only 0.18 mg/l at a river water temperature of 9.6°C, while on January 13, 1986 the river ammonia-N background level increased to 1.47 mg/l when the water temperature dropped to about 0.2°C. The river background chloride levels also increased seasonally but only moderately. The effluent ammonia-N levels also increased significantly during the height of the cold weather. The effluent chloride levels remained fairly uniform throughout with the exception of those observed on February 18, 1986. The chloride value ballooned to 712 mg/l after having consistently been in the mid-200 mg/l range. This value reflected increased street runoff due to the use of salt for snow removal the previous day.

The contour percent plots based on residual temperature values computed by using equation 1 are presented in Appendix B. Plots are presented for surface, 1-, 3-, and 8-foot depths for each of the ten runs, resulting in a total of 40 figures. The plots are grouped by date.

These plots are very effective in showing the effects of high river flows on mixing. On both November 5, 1985, and April 22, 1986, the effluent discharges were 40 mgd; however, the November run was made at a time when the wickets were down (table 2) and the flow was over twice as great as the flow during the April run when the wickets were up. The high November river flow

Table 3. Number of Samples Collected and Number of In-situ Readings Taken

	Temperature Readings			Chloride Samples			Ammonia-N Samples		
Date	B.G.	Eff.	Mix.	B.G.	Eff.	Mix.	B.G.	Eff.	Mix.
11/05/86	16	6	300	11	3	74	2	3	20
11/13	16	6	350	4	3	81	2	3	20
1/09/86	30	6	350	4	6	139	2	6	16
1/13	6	6	350	4	6	148	2	6	19
1/16	8	9	400	5	6	139	1	6	18
1/20*	3	6	100	3	3	50	1	1	12
1/21	8	9	350	6	6	112	2	6	19
1/23	8	9	400	6	6	138	2	6	19
2/18	8	9	350	3	6	94	1	6	21
4/16	16	9	450	16	6	150	3	6	18
4/22	16	9	500	16	6	142	4	6	18
Totals	135	84	3900	78	57	1267	22	55	200

* Partial Run - Forced off river due to ice floe

B.G. = River background
Eff . = Effluent
Mix. = River mixing zone area

Table 4. River and Effluent Conditions
Observed during Cold Weather Sampling

Parameter	Sampling Dates									
	11/5/85	11/13	1/9/86	1/13	1/16	1/21	1/23	2/18	4/16	4/22
	River Conditions									
Flow, Q (cfs)	17,540	21,060	10,820	10,570	9,446	11,320	18,430	10,020	8,535	8,411
Temp, T (°C) Begin	9.60	8.97	0.25	0.20	0.20	0.20	1.10	0.10	10.04	11.40
End	9.66	9.10	0.40	0.68	0.50	0.48	1.40	0.40	9.85	11.69
Chlorides (mg/l) Begin	49.0	48.0	70.0	79.0	77.3	86.0	76.3	73.3	71.1	74.9
End	50.3	48.0	70.5	81.0	78.0	87.0	75.3	73.3	73.9	74.6
Ammonia-N (mg/l) Begin	0.18	0.37	1.12	1.47	1.11	1.05	0.83	1.27	0.17	0.21
End	0.18	0.37	0.94	0.83	1.11	1.32	1.29	1.27	0.37	0.29
	Effluent Conditions									
Flow (mgd) Channel 1	29	25	18	14	30	31	22	33	25	29
Channel 2	2	2	1	1	4	8	2	6	2	2
Channel 3	9	8	6	5	11	16	6	11	8	9
Total, q	40	35	25	20	45	55	30	50	35	40
Temp, t (°C) Ch. 1 Begin	16.3	16.7	10.3	11.1	13.1	13.2	12.2	12.5	13.5	14.1
Mid	-	-	-	-	14.2	14.6	14.2	14.5	14.0	16.5
End	18.4	17.0	11.3	12.4	13.9	13.8	12.8	13.0	13.8	15.4
Ch. 2 Begin	16.2	16.7	9.5	9.9	13.1	13.2	11.8	12.5	13.3	13.9
Mid	-	-	-	-	14.2	14.5	14.0	14.5	13.9	16.7
End	18.3	16.9	9.9	10.0	14.2	13.6	12.7	13.0	13.8	15.6
Ch. 3 Begin	16.4	16.8	10.1	11.1	13.1	13.1	12.1	12.5	13.4	14.0
Mid	-	-	-	-	14.2	14.5	14.2	14.5	13.9	16.7
End	18.4	17.0	9.3	12.2	14.2	13.8	12.8	13.0	13.9	15.6
Chlorides (mg/l) Ch. 1 Begin	184	184	265	266	283	264	249	712	249	272
End	-	-	267	225	275	250	249	668	253	230
Ch. 2 Begin	184	181	259	280	283	283	248	714	254	269
End	-	-	273	258	271	256	251	670	239	236
Ch. 3 Begin	184	180	264	264	283	260	248	708	249	269
End	-	-	260	260	270	257	249	674	249	240
Ammonia-N (mg/l) Ch. 1 Begin	5.47	7.27	11.44	12.85	14.59	11.33	10.18	7.95	8.76	2.51
End	-	-	11.26	13.35	16.57	10.25	12.93	6.78	9.29	2.46
Ch. 2 Begin	5.69	7.28	11.64	12.75	14.46	11.36	9.77	8.36	8.96	2.10
End	-	-	11.49	13.39	15.77	10.81	13.26	6.72	9.26	2.60
Ch. 3 Begin	5.36	7.32	11.69	12.69	14.34	11.21	8.03	8.21	9.04	2.34
End	-	-	11.38	14.00	15.60	10.64	12.59	7.12	9.55	2.68
Time (Military) Begin	950	919	1030	1052	1014	1036	1000	941	816	807
End	1410	1349	1600	1549	1542	1510	1445	1413	1345	1322

appears to have sheared the effluent's transverse movement, preventing significant mixing in the study area (see 0-foot plots for both dates). The November figure shows essentially parallel contour lines which hug and follow the shoreline, while the April 22 lines project much farther outward in a bubble-like fashion. The 20 percent contour line extended past station 9+50 on November 5, but this same percent contour extended only to station 3+50 on April 22.

The figures given in Appendix B were used to determine the maximum transverse extent of the 1, 2, 3, 5, 7, 10, 15, and 20 percent contours within the study area. The distances derived from the contour plots for both the warm and cold weather studies are tabulated in table 5. These distances represent the maximums observed, independent of depth. Most occurred at the surface, but some occurred at each of the other three depths represented by the plots. The river temperatures listed in table 5 represent the average of the beginning and ending values, and those for the effluent are averages of the flow-weighted beginning and ending values. The information in table 5 was used to statisically generate the regression (prediction) equations used in evaluating and defining the transverse extent of the mixing zone.

The results of the cold weather regression analyses are given in table 6. For contour percentages 1 through 5, only the effluent (q) and river (Q) flows were significantly correlated to the maximum transverse distances listed in table 5. However, the multiple correlation coefficients were only moderately high. The formulation is theoretically correct in that the distances are directly related to the effluent discharge rate and inversely related to the river flow rate. The equations listed in table 21 of the warm weather report (table 7 of this report) show that river temperature and river flow are the two most significant independent variables for contour percentages 1 through 5 for river temperatures above 15°C.

For the 7, 10, 15, and 20 percent contours, the maximum transverse distances are shown to be directly related to effluent discharge rates and indirectly to river temperature (T). This is the same general relationship found to represent the warm weather conditions for these same percentages (see table 21a of the warm weather report, table 7a of this report). The correlations for the 7 through 20 percent contours are high, as shown by the values given in table 6. Note, from table 5, that the extreme observed values can be closely predicted by using the equations representing contour percents 7 through 20. However, the use of these prediction equations is limited by the extreme conditions under which they were developed, as was the case for the warm weather equations.

To achieve more flexible and encompassing expressions all the cold and warm water data presented in table 5 were combined to form prediction equations applicable for river temperatures from 0°C to 31°C. Combining all these data, however, produced

Table 5. Transverse Distances (D) of Contour Percentages from Shore Stakes,and Effluent and River Flows and Temperatures, for Warm and Cold Weather Sampling Dates

	Transverse Distances, D (ft) for Contour Percentages of								Average Conditions during Sampling			
									River		Effluent	
Date	1	2	3	5	7	10	15	20	Temp T(°C)	Flow Q(cfs)	Temp t(°C)	Flow q(mgd)
7/12/84	160	145	140	130	125	120	115	80	29.5	10,156	24.00	37
7/19	145	140	130	70	60	50	35	20	29.5	8,661	24.00	30
7/31	360	240	112	105	87	80	55	20	30.5	7,820	25.00	25
8/07	240	210	190	160	90	70	47	10	31.0	7,106	28.00	20
8/14	380	340	325	295	120	220	165	150	29.5	8,391	25.50	40
8/21	380	365	335	325	295	260	225	215	26.0	7,848	25.00	35
8/28	395	380	365	335	260	235	205	160	25.8	6,088	26.10	45
9/11	315	313	307	297	287	280	260	245	24.5	7,572	24.00	55
9/18	460	455	450	430	410	390	330	260	21.0	5,224	22.56	50
10/23	440	425	410	370	335	280	195	180	15.0	8,837	21.00	30
11/05/85	225	200	175	155	150	125	85	75	9.83	17,540	17.35	40
11/3	200	195	190	150	140	90	80	75	9.03	21,060	16.86	35
1/09/86	180	170	160	150	145	135	125	120	0.33	10,920	10.47	25
1/13	220	195	190	170	160	155	135	120	0.44	10,570	11.87	20
1/16	350	325	300	275	250	200	150	105	0.35	9,448	13.55	45
1/21	272	260	215	200	185	175	150	135	0.34	11,320	13.49	55
1/23	265	260	230	205	200	155	135	125	1.25	18,430	12.48	30
2/18	525	510	495	320	250	225	200	120	0.25	10,020	12.75	50
4/16	345	315	310	270	130	115	105	95	9.95	8,535	13.64	35
4/22	450	375	340	300	210	120	110	85	11.54	8,411	14.76	40

Table 6. Summary of Cold Weather Mixing Zone Equations

Contour Percent	Prediction Equations. D=	Corr. Coeff. R	Extreme D-values (ft) Computed Max.	Min.	Observed Max.	Min.
1	262 + 5.0q - 0.012Q	0.724	436	109	525	180
2	208 + 5.0q - 0.009Q	0.711	407	118	510	170
3	221 + 4.2q - 0.009Q	0.659	376	115	495	160
5	229 + 2.5q - 0.0080	0.754	299	111	320	150
7	130 + 1.8q - 5.7T	0.860	228	100	250	130
10	110 + 1.8q - 6.3T	0.892	207	73	225	90
15	105 + 1.2q - 5.4T	0.858	170	67	200	80
20	120 + O.lq - 3.9T	0.883	124	77	135	75
		q =	55	20		
		Q =	8411	21060		
		T =	0.25	11.54		

D = Contour projection distance from shore stake (ft)
q = GPSD effluent flow rate (mgd)
Q = River flow rate (cfs)
T = River temperature (°C)

Table 7. Summary of Warm Weather Mixing Zone Prediction Equations (Table 21 of warm weather report [Butts et al., 1985])

Contour Percentage	Prediction Equation	Max. D or L T=15, q=55 or Q=5,000	Min. D or L T=31, q=20 or Q=11,000	Observed D or L Max.	Observed D or L Min.
	a. Transverse Channel Direction				
1	$D = 930 - 12.1T - 0.035Q$	574	170	460	145
2	$D = 970 - 15.0T - 0.036Q$	565	109	455	140
3	$D = 990 - 17.3T - 0.035Q$	556	69	450	112
5	$D = 970 - 17.0T - 0.036Q$	535	58	430	70
7	$D = 368 - 14.3T + 6.1q$	489	47	410	60
10	$D = 330 - 13.0T + 5.5q$	441	37	390	50
15	$D = 170 - 8.7T + 6.0q$	370	20	330	35
20	$D = 165 - 8.8T + 5.9q$	358	10	260	10
	b. Longitudinal Channel Direction				
1	$L = 5485 - 163T + 198q$	13,930	4,392	13,000	3,600
2	$L = 620 - 120T + 190q$	9,270	700	8,200	650
3	$L = 1770 - 108T + 109q$	6,145	602	5,550	800
5	$L = 2380 - 104T + 61q$	4,175	376	3,500	370
7	$L = 1910 - 96T + 59q$	3,715	114	2,850	105
10	$L = 1345 - 73T + 47q$	2,835	22	2,300	20
15	$L = 1615 - 67T + 24q$	1,930	18	1,450	15
20	$L = 1245 - 54T + 22q$	1,645	11	1,250	10

D = transverse distance (ft) from shore stake
L = longitudinal distance (ft) from station 1+50
T = river temperature (°C)
Q = river flow (cfs)
q = GPSD effluent flow (mgd)

poor quality prediction equations. Correlation coefficients relating D to q, t, Q and T were very low, ranging from about 0.4 to 0.6. A close examination of the cold weather data revealed the reason for this: four of the ten cold weather river flows were significantly higher than the maximum summer flow, and two of the remaining six were slightly greater. Consequently, the unabridged winter data, when included with the summer data, produced distorted and misleading results when subjected to statistical analyses.

To achieve meaningful results, only the five sets of winter data which included river flows which fell below or slightly above the summer extreme high value were included in the analyses. The January 13, 1986, flow of 10,570 cfs was included but the January 9, 1986, flow of 10,920 cfs was not so as to avoid weighting the overall data too heavily at the higher end of the flow spectrum. The February 18, 1986, flow of 10,020 cfs was only slightly less than the maximum warm weather value of 10,156 cfs, and was included. The other data sets selected were those for January 16, April 16, and April 22, 1986. Since low flows are most critical, i.e., low flows permit greater transverse mixing, preventing distortions at low flows is critical to this analysis.

The prediction equations developed by combining the five winter data sets containing the lowest river flows with all ten summer data sets are summarized in table 8. The results indicate that all four independent variables are significant under extreme temperature conditions. Good correlations were produced overall, and maximum and minimum observed conditions could be satisfactorily simulated. In fact, the extreme observed values for the three most important percents (10, 15, and 20) were matched extremely well by using the equations. Of equal importance is the fact that the equations appear to provide reasonable estimates for 7-day, 10-year low flow conditions (2,964 cfs), although this flow value is significantly lower than the minimum observed value of 5,224 cfs.

DISCUSSION

The equations listed in tables 7b and 8 play a critical role in arriving at solutions for use in meeting the two principal objectives of this study. The results of combining the warm and cold weather data can be used to establish transverse limits of a mixing zone based upon certain constraints. Once those limits have been ascertained, maximum effluent ammonia-N concentrations can be determined which will not cause standard violations outside the mixing zone as limited by the 25 percent flow/area requirement, and which will not be toxic to fish. The following section discusses transverse distance limitations. Additional discussion on longitudinal distances and areal limitations of mixing zones is then presented. This discussion is based on criteria developed from data collected during the warm weather study.

Table 8. Summary of Mixing Zone Equations Derived by Using
Ten Warm Weather Data Sets and Five Cold Weather Data Sets

		Corr.	Extreme D-Values (feet)					
Contour		Coeff.	Computed		Observed		7-day, 10-year Q	
Percent	Prediction Equation, D =	R	Max.	Min.	Max.	Min.	Max.	WW Max*
1	$2.9q+6.7t-0.035Q-8.3T+547$	0.710	606	145	525	145	704	546
2	$4.0q+14.4t-0.030Q-11.7T+339$	0.804	602	99	510	140	669	539
3	$4.9q+16.9t-0.026Q-13.1T+229$	0.833	597	69	495	112	655	522
5	$3.9q+14.9t-0.034Q-11.2T+297$	0.833	540	41	430	70	616	511
7	$3.6q+23.4t-0.026Q-14.6T+104$	0.833	490	34	410	60	549	474
10	$4.2q+24.2t-0.015Q-12.9T-99$	0.820	389	32	390	50	423	414
15	$4.3q+15.9t-0.013Q-8.7T-56$	0.827	349	21	330	35	362	349
20	$3.7q+13.3t-0.010Q-7.0T-74$	0.724	262	10	260	10	280	281
		q =	55	20			55	55
		t =	14	25			14	30
		Q =	5224	10570			2964	2964
		T =	0.25	31			0.25	31

D = Contour projection distance from shore stake (ft)
q = GPSD effluent flow rate (mgd)
t = GPSD effluent temperature (°C)
Q = River flow rate (cfs)
T = River temperature (°C)

* WW designates warm weather

Transverse Distance Limitations

The equations listed in table 8 represent linear relationships between river temperature, effluent temperature, effluent flow, and river flow and the maximum transverse projection of a certain residual effluent percent. These types of statistically derived equations are generally limited to use within the parametric value range in which they were derived. However, in this case, an additional constraint appears -- the relationship between river and effluent temperature has to be considered. Average effluent temperatures during sampling ranged from 10.47°C to 28.0°C, and average river temperatures ranged from 0.33°C to 31.0°C (table 5). While mathematically correct, the solutions to equations using an effluent temperature of 10.47°C in combination with a river temperature of 31°C are not rational. Therefore, to provide rational input combinations of effluent-river temperatures, a regression equation was developed relating effluent temperature to river temperature, based on the 20 data sets generated during both the warm and cold weather studies. The expression is:

$$t = 0.464T + 12.02 \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (2)$$

where t = effluent temperature in °C
T = river temperature in °C

The correlation coefficient for the 20 data sets is 0.97; therefore the equations will give good logical matchups of temperatures. Note that when the river temperature is 0°C the effluent temperature will probably be around 12°C.

Transverse projection distances were computed on the basis of seven temperature data sets: (t=30, T=31), (t=24, T=25), (t=21, T=20). (t=20, T=15), (t=17, T=10), (t=14. T=5), and (t=12. T=0); four river flows (Q): 2964 (7-day, 10-year low flow), 5000, 7500, and 10,000 cfs; and eight effluent flows: 20, 25, 30, 35, 40, 45, 50, and 55 mgd. The temperature set values were derived by using equation 2, with the exception of the (30,31) combination and the (20, 15) combination. An examination of the GPSD treatment plant operating records from 1978 through 1985 revealed that the maximum effluent temperature was 30°C and that this peak value occurred only once, on July 28, 1983. The maximum river temperature recorded during the ISWS twice-weekly sampling over many years is 31°C. Consequently, to examine the extreme condition the (30,31) combination was included in the analyses. The (20,15) combination resulted from a slight computational error using equation 2; t should equal 19 when using a T of 15 in equation 2. However, the (20,15) combination is realistic and representative since its probability of occurrence is high. The results are presented in tables 9, 10, 11, and 12 for the four river flow conditions. The computations were terminated when the computed D-values greatly exceeded the 250-foot distance which has been established as the point in the river cross section, at the effluent location, which represents 25 percent of the river flow.

The information presented in tables 9 through 12 provides a good basis around which a flexible management scheme can be devised and implemented. For instance, the most critical or limiting situation occurs when an effluent with a temperature of 30 C discharges to the river during a 7-day, 10-year low flow situation (table 9). To prevent possible standard violations outside the mixing zone, effluent discharge rates of 45 mgd or less would have to be adhered to if the 20 percent contour is accepted as the outermost mixing zone boundary. If the 15 percent contour is accepted as the outer limit, the GPSO would be limited to a discharge rate in the range of 30 to 35 mgd. Generally, during extremely low flows, such as the 7-day, 10-year value, the effluent-river temperature combinations have only a moderate effect on the variability of "D."

During higher river flows, the effluent limitation can be liberalized greatly Ctable 12). Effluent flow rates of 55 mgd could be tolerated at the (30,31) combination if a 15 or 20 percent mixing limitation is accepted. By limiting the effluent flow rate to 35 mgd and assuming a 1.5 mg/l standard [paragraphs d) and e) of Section 302.212 of the IPCB's Rules and Reaulat ions], the mixing zone could be expanded to the 3 percent contour, which would allow an effluent ammonia-N concentration of 50 mg/l. At an effluent flow rate of 55 mgd, the effluent ammonia-N concentration would be limited to approximately 10 mg/l.

Tables 9 through 12 can be viewed as a type of quality control chart, and management of the ammonia-N effluent quantity can be dictated by their use as such. For example, suppose on a given day the GPSD is discharging 17 mg/l of ammonia-N at a rate of 40 mgd and at a temperature of 24°C. The probable river temperature is 25°C according to equation 2 (a direct river measurement would be better). The flow at Peoria, estimated from the Kingston Mines rating curve, is 8000 cfs. Reference to the (24,25), 40 mgd row in table 11 indicates that an effluent concentration of 21.4 mg/l ammonia-N could be tolerated without violating the 1.5 mg/l standard [paragraphs d) and e) of Section 302.212 of the IPCB's Rules and Regulations]. Since only 17 mg/l are being discharged the system could be considered under control.

Table 13 contains information on observed effluent ammonia-N conditions and their relationship to stream standards for conditions specific to both warm and cold weather study dates. High to extremely high effluent levels could have been tolerated during the cold weather periods without violating stream standards. On January 16, 1986, a relatively high concentration of 15.06 mg/l of ammonia-N was being discharged, but considering all factors it was not even close to the theoretical tolerable level of 250.39 mg/l.

Table 9. Computed Effluent Transverse Projections Using Equations Presented in Table 7
Q = 2964 cfs

Temp.	(°C)	Effluent Flow (mgd)	Distance, D, in Feet to Contour Percentages of							
t	T	q	1	2	3	5	7	10	15	20
30	31	55							349	283
		50							327	264
		45							305	246
		40						351	284	227
		35						330	263	209
		30						309	241	190
		25						288	220	172
		20					348	267	198	153
24	25	55							306	245
		50							284	226
		45							263	208
		40						283	241	189
		35						262	220	171
		30					332	241	198	152
		25					314	220	177	134
		20					296	199	155	115
21	20	55							301	240
		50							280	221
		45							258	203
		40						275	237	184
		35						254	215	166
		30					334	233	194	147
		25					316	212	172	129
		20					298	191	151	110
20	15	55							329	262
		50							307	243
		45							286	225
		40						316	265	206
		35						295	243	188
		30					384	274	222	169
		25					366	253	200	151
		20					348	232	179	132

Table 9. (Concluded)

Temp. (°C)		Effluent Flow (mgd)	Distance, D, in Feet to Contour Percentages of							
t	T	q	1	2	3	5	7	10	15	20
17	10	55							325	257
		50							303	238
		45							282	220
		40						307	260	201
		35						286	239	183
		30					387	265	217	164
		25					369	244	196	146
		20					349	223	174	127
14	5	55							321	252
		50							299	233
		45							278	215
		40						299	256	196
		35						278	235	178
		30					390	257	213	159
		25					273	236	192	141
		20					354	215	170	122
12	0	55							332	260
		50							311	242
		45							289	223
		40						315	268	205
		35						294	246	186
		30					416	273'	225	168
		25					398	252	203	149
		20					380	231	182	131

t = GPSD effluent temperature (°C)
T = River temperature (°C)

Table 10. Computed Effluent Transverse Projections Using Equations Presented in Table 7
Q = 5000 cfs

Temp (°C)		Effluent Flow(mgd)	Distance, D, in Feet to Contour Percentages of							
t	T	q	1	2	3	5	7	10	15	20
30	31	55							323	262
		50							301	243
		45						341	280	225
		40						320	258	206
		35						299	237	188
		30					331	278	215	169
		25					313	257	194	151
		20					295	236	172	132
24	25	55							280	224
		50							258	205
		45						273	237	187
		40						252	215	168
		35					297	231	194	150
		30					279	210	172	131
		25					261	189	151	113
		20				282	243	168	129	94
21	20	55							275	219
		50							254	200
		45						265	232	182
		40					317	244	211	163
		35					299	223	189	145
		30					281	202	167	126
		25					263	181	146	108
		20				294	245	160	125	89
20	15	55							303	241
		50							282	222
		45						306	260	204
		40						285	239	185
		35					349	264	217	167
		30					331	243	196	148
		25					313	222	174	130
		20					295	201	153	111

Table 10. (Concluded)

Temp (°C)		Effluent Flow (mgd)	Distance, D, in Feet to Contour Percentages of							
t	T	q	1	2	3	5	7	10	15	20
17	10	55							299	236
		50							277	217
		45						297	256	199
		40						276	234	180
		35					352	255	213	162
		30					334	234	191	143
		25					216	213	170	125
		20					298	192	148	106
14	5	55							295	231
		50							273	212
		45						289	252	194
		40						268	230	175
		35					355	247	209	157
		30					337	226	187	138
		25					319	205	166	120
		20					301	184	144	101
12	0	55							306	239
		50							285	221
		45						305	263	202
		40						284	242	184
		35					381	263	220	165
		30					363	242	199	147
		25					345	221	177	128
		20					327	200	156	110

t = GPSD effluent temperature (°C)
T = River temperature (°C)

Table 11. Computed Effluent Transverse Projections Using Equations Presented in Table 7

Q = 7500 cfs

Temp	(°C)	Effluent Flow (mgd)	Distance, D, in Feet to Contour Percentages of							
t	T	q	1	2	3	5	7	10	15	20
30	31	55							290	237
		50						325	269	218
		45					320	304	247	200
		40				298	302	283	226	181
		35				278	294	262	204	163
		30			282	259	266	241	183	144
		25		283	257	239	248	220	161	126
		20	286	263	233	220	230	199	140	107
24	25	55						278	247	199
		50						257	226	180
		45					268	236	204	162
		40				276	250	215	183	143
		35				256	232	194	161	125
		30			259	237	214	173	140	106
		25		267	235	217	196	152	118	88
		20	296	247	210	198	178	131	97	69
21	20	55						270	243	194
		50						249	221	175
		45					270	248	200	157
		40				287	252	207	178	138
		35				267	234	186	157	120
		30			274	248	216	165	135	101
		25		282	249	228	198	144	114	83
		20	317	262	225	209	180	123	92	64
20	15	55						310	271	216
		50						289	249	197
		45					320	268	228	179
		40					302	268	228	179
		35					284	226	185	142
		30				289	266	205	163	123
		25			298	270	248	184	142	105
		20			274	250	230	163	120	86

Table 11. (Concluded)

Temp (°C)		Effluent Flow (mgd)	Distance, D, in Feet to Contour Percentages of							
t	T	q	1	2	3	5	7	10	15	20
17	10	55						302	266	210
		50						281	245	192
		45					323	260	223	174
		40					305	239	202	155
		35					287	218	180	137
		30				300	269	197	159	118
		25				281	251	176	137	100
		20			288	261	232	155	116	81
14	5	55						294	262	206
		50						274	240	187
		45					326	252	219	169
		40					308	231	198	150
		35					290	210	176	132
		30				312	272	189	155	113
		25				292	254	168	133	95
		20			303	273	236	147	112	76
12	0	55						310	274	214
		50						289	252	196
		45					352	268	231	177
		40					334	247	209	159
		35					316	226	188	140
		30					298	205	166	122
		25				318	280	184	145	103
		20				299	262	163	123	85

t = GPSO effluent temperature (°C)
T = River temperature (°C)

Table 12. Computed Effluent Transverse Projections Using Equations Presented in Table 7
Q = 10,000 cfs

Temp.	(°C)	Effluent Flow (mgd)	Distance, D, in Feet to Contour Percentages of							
t	T	q	1	2	3	5	7	10	15	20
an	31	55						308	258	212
		50					273	287	236	193
		45					255	266	215	175
		40			265	213	237	245	193	156
		35		348	241	193	219	224	172	138
		30		328	217	193	219	224	172	138
		25		308	192	154	183	182	129	101
		20		288	168	134	165	161	107	82
24	25	55			317	249	239	240	215	174
		50			292	230	221	219	193	155
		45			268	210	203	198	172	137
		40		352	243	191	185	177	150	118
		35		332	219	171	167	156	129	100
		30		312	194	152	149	135	107	81
		25		292	170	132	131	114	86	63
		20		272	145	113	112	93	64	44
21	20	55			331	260	241	232	210	169
		50			307	241	223	211	189	140
		45			282	221	205	190	167	132
		40		367	258	202	187	169	146	113
		35		347	233	182	169	148	124	95
		30		327	209	163	151	127	103	76
		25		307	184	143	133	106	81	58
		20		287	160	124	115	85	60	39
20	15	55					291	273	238	191
		50				282	273	252	217	172
		45			331	263	255	231	195	154
		40			306	243	237	210	174	135
		35			282	224	219	189	152	117
		30		372	258	204	201	168	131	98
		25		352	233	185	183	147	109	80
		20		332	209	165	164	126	88	61

Table 12. (Concluded)

Temp. (°C)		Effluent Flow (mgd)	Distance, D, in Feet to Contour Percentages of							
t	T	q	1	2	3	5	7	10	15	20
17	10	55					294	264	234	186
		50					276	243	212	167
		45				274	258	222	191	149
		40			321	254	240	201	169	130
		35			297	235	222	180	148	112
		30			272	215	204	159	126	93
		25		367	248	196	186	138	105	75
		20		347	223	176	168	117	83	56
14	5	55					297	256	230	181
		50				305	279	235	208	162
		45				285	261	214	187	144
		40			336	266	243	193	165	125
		35			312	246	225	172	144	107
		30			287	227	207	151	122	88
		25		382	263	207	189	130	101	70
		20		362	238	188	171	109	79	51
12	0	55					323	272	241	189
		50					305	251	220	171
		45				311	287	230	198	152
		40				292	269	209	177	134
		35			343	272	251	188	155	115
		30			219	253	233	167	134	97
		25			294	233	215	146	112	78
		20		392	270	214	197	125	91	60

t = GPSD effluent temperature (°C)
T = River temperature (°C)

Table 13. Relationship between Mixing Zone Limits And Ammonia-N Standards during Mixing Zone Sampling Dates

Date	River Temp ($^{\circ}$C)	River pH	IEPA (or IPCB) Ammonia-N Standards (mg/l)	Contour Percent at 250'	Back-ground NH_3-N (mg/l)	Effluent NH_3-N Conc. (mg/l) Theoretical Limit	Effluent NH_3-N Conc. (mg/l) Observed	Margins: Theor. minus Obs (mg/l)
7/12/84	29.50	8.37	1.50	1	0.17	149.83	0.80	149.03
7/19	29.50	8.47	1.50	1	0.08	149.92	1.10	148.82
7/31	30.50	8.48	1.50	2	0.06	74.94	0.30	74.64
8/07	31.00	8.20	1.50	1	0.21	149.79	0.30	149.49
8/14	29.50	8.15	1.50	6	0.29	24.71	0.70	24.01
8/21	26.00	8.05	1.50	12	0.17	12.33	0.80	11.53
8/28	25.80	8.00	1.50	8	0.27	18.48	0.50	17.98
9/11	24.50	8.09	1.50	18	0.40	7.93	1.20	6.73
9/18	21.00	8.05	1.50	20	0.36	7.14	0.20	6.94
10/23	15.00	8.04	1.50	12	0.29	12.21	3.40	8.81
		Cold Weather Data (New)						
11/05/85	9.63	8.17	1.50	6	0.18	24.82	5.51	19.31
11/13	9.03	8.06	1.95	5	0.37	38.63	7.29	31.34
11/09	0.33	7.93	5.28	7	1.03	74.40	11.52	62.88
1/13	0.44	7.95	5.00	2	1.15	248.85	13.17	235.68
1/16	0.35	7.95	5.03	2	1.11	250.39	15.06	235.33
1/21	0.34	7.89	5.78	7	1.19	81.38	10.94	70.44
1/23	1.25	7.89	5.36	1	1.06	534.94	11.13	523.81
2/18	0.25	7.75	8.02	1	1.27	800.73	7.52	793.21
4/18	9.95	8.55	1.50	1	0.27	149.73	10.50	139.23
4/22	11.54	8.43	1.50	1	0.25	149.25	2.45	146.80

Note: Theoretical limit = ((100) (Standard Concentration/contour %) minus the background concentration.

Warm weather observed NH_3-N concentrations are GPSD data; cold weather observed NH_3-N concentrations are SWS data.

The standards were not closely tested during either the warm or cold weather dates. However, table 13 indicates that single digit margins did occur on the warm weather dates of September 11, September 18, and October 23, 1984, whereas double- and triple-digit margins occurred for the remaining 17 dates. The smallest margins of 6.73 mg/l and 6.94 mg/l, which occurred on September 11 and September 18, 1984, respectively, are substantial but nevertheless are dwarfed by the respective maximum warm and cold weather margins of 149.49 mg/l and 793.21 mg/l. The effluent discharge rates were 55 and 50 mgd on the two respective September dates Ctable 5). Cutting the September 11 rate back to 40 mgd would have permitted an effluent ammonia-N concentration of over 21 mg/l to be discharged. A similar case could be made for the September 18 situation; i.e., effecting a reduction in the effluent flow rate would increase the tolerable effluent ammonia-N level.

The implementation of one of several management strategies could provide assurances that stream ammonia-N standards are not violated if GPSD effluent standards are relaxed significantly.

The simplest and most easily administered management strategy would be an across-the-board adoption of the 20 percent contour as the mixing zone limitation for all situations and conditions. Such an adoption would limit summer effluent ammonia-N concentrations to approximately 7.5 mg/l; winter limitations would range from about 7.5 mg/l to 40 mg/l. This would essentially provide a 99.99 percent probability that water quality standards would not be violated under any circumstances (see the 20 percent columns in tables 9 through 12). This plan could allow increased discharge rates to be effected during wet weather conditions.

Another relatively simple and easily administered scheme would be to limit the effluent discharge rate to a maximum value and to store volumes generated by excessive flows. For example, the stipulation could be made that the maximum discharge rate would be 40 mgd. An examination of tables 9 through 12 reveals that the 15 percent contour would assure compliances under most conditions when associated with an effluent discharge rate of 40 mgd. This would permit a summer effluent concentration of about 10 mg/l and a winter range of about 10 to 53 mg/l.

The most comprehensive plan, but the one most difficult to administer, would be to adopt a flexible quality control program whereby daily discharge rates could be adjusted to match the t, T, q, and Q values to prevent standard violations for effluent ammonia-N concentration. For example, on a given date, assume that the following conditions prevail: t = 24°C, T = 25°C, q = 40 mgd, Q = 3000 cfs, and effluent ammonia-N = 14 mg/l. From the IPCB's Rules and Regulations the river standard is shown to be 1.5 mg/l. From table 9, row (24,25)-40 and the 15 percent residual column, the permissible effluent concentration is determined to be 10 mg/l (1.5/0.15 = 10 mg/l). Since the ambient level is 14, the stream standards would clearly be violated. By immediately reducing the discharge rate to 30 mgd the permissible effluent concentration could be increased to 15 mg/l (1.5/0.10 = 15 mg/l) as referenced to row (24,25)-30 and the 10 percent residual column of table 9.

For this scheme to be manageable, daily river flow and temperature information would have to be readily available. Routine field determinations of river temperatures could be circumvented by developing a prediction equation similar to equation 2 from long-term records. This could be done by matching the 20 years of twice-weekly river readings taken by the ISWS with those recorded on the GPSD operating reports over the same period. River flow information would have to be obtained from the USGS or the Corps of Engineers. Control charts, similar to those presented as tables 9 through 12, would have to be prepared for 1000-cfs river flow increments from 3000 to 10,000 cfs, and for 1°C effluent temperature changes.

At this point, a discussion is needed of the ambiguities that appear when the D-equations presented in table 8 are used under certain conditions. Certain extreme combinations of data cause some overlapping of the results. As an example, in table 12 in the (30,31) rows for q-values equal to or greater than 40 mgd, inconsistencies occur in the continuity of distances for the respective contour percents. This fact should not be considered a serious flaw in the use of these equations, in that the point has already been made that some anomalies may occur when making predictions based on peripheral data used in the development of regression equations, or when using data outside the development boundaries. In any event, the inconsistencies generally appear for conditions which would not normally be included in any of the general management schemes presented.

Some discussion should be given on the use of temperature differences as a means of defining the mixing zone during the winter. Table 14 has been prepared to aid in this discussion. Correlation and regression coefficients have been generated for each date. Good to excellent correlations exist between the temperature and chloride percentages, indicating that each of these parameters can be used reliably to predict the other. However, the regression coefficients indicate that the temperature percentages are always lower than the chloride ones. This is not unexpected since chlorides are conservative substances while temperature is dissipated in the open environment in ways other than by mixing. However, the fact that a great many temperature points were available for developing the percentage contour plots appeared to be an advantage when compared to using the more accurate but much less numerous chloride data. Over three times as many temperature readings as chloride analyses were available (table 3). This required less data extrapolation and plotting interpretation in generating the contour plots presented in Appendix B.

Table 14. Regression Relationships between Chlorides (CI), Ammonia-N (NH_3), and Temperature (T) (Residual Percentages)

	CI = A + B(T)				NH_3 = A + B(T)				NH_3 = A + B(CI)			
	n	r	A	B	n	r	A	B	n	r	A	B
11/05/85	55	0.935	0.974	0.503	20	0.979	-0.758	2.204	20	0.995	-0.700	1.265
11/13	77	0.954	0.457	0.718	20	0.957	0.716	1.788	20	0.985	-3.149	1.617
1/09/86	139	0.928	3.124	1.303	16	0.975	-3.902	1.004	16	0.998	0.684	1.313
1/13	148	0.784	3.630	1.084	19	0.674	9.250	0.774	19	0.790	5.997	1.198
1/16	139	0.924	3.469	1.228	18	0.969	-0.586	0.909	18	0.994	0.384	1.325
1/21	112	0.975	2.436	1.423	19	0.902	1.867	0.892	19	0.981	0.343	1.405
1/23	138	0.943	5.212	1.117	19	0.902	-2.045	0.776	19	0.958	1.516	1.011
2/18	93	0.873	5.387	0.963	21	0.840	-3.555	0.766	21	0.872	-0.779	0.823
4/16	150	0.888	9.007	1.226	18	0.883	-6.749	0.843	18	0.864	2.620	1.202
4/22	142	0.874	2.618	0.336	18	0.942	-7.491	4.609	18	0.987	1.050	1.624
								Total*	188	0.922	1.117	1.278

r = the linear corrlation coefficient
A = the Y-intercept
B = slope of the line

* An overall regression equation (Total) was developed only for the paired ammonia-N and chloride data

Table 14 also contains regression relationships developed between ammonia-N and temperature, and ammonia-N and chlorides. The correlations between the ammonia and temperature percentages are high, and those between ammonia and chlorides are even higher. The expression developed from all 188 ammonia-N and chloride data sets can be used with great reliability to predict ammonia-N concentrations by running quick, inexpensive, and reliable chloride tests on river water. Any monitoring program associated with a relaxation of the ammonia-N effluent standards should consider this fact.

Longitudinal Distance and Areal Limitations

Since the collection of data for use in defining the longitudinal extent of mixing was not feasible during cold weather, the longitudinal and areal criteria developed for warm weather periods will be reviewed, and their relevance and applicability to cold weather conditions will be discussed. The equations pertinent to this discussion are presented in table 7b (table 21b of the warm weather report). Two typographical errors which occurred in table 21 of the warm weather report have been corrected in table 7 of this report: the maximum D for the 2 percent contour has been changed from 545 to 565, and the equal sign between 1345 and 73T in the 10 percent contour equation for L has been changed to a minus sign.

Both the transverse (D-value) and the longitudinal CL-value) distance prediction equations, derived from the statistical analyses of the warm weather data, are presented in table 7. Included are the maximum and minimum predicted distances and the maximum and minimum observed distances. Good agreement occurs between the values. The maximum predicted distances for both transverse and longitudinal directions are consistently greater than the observed ones because the observed low temperature did not occur in association with either the low river flow or high effluent flow. The results merely demonstrate what is likely to happen if this temperature-flow combination should occur. The minimum predicted and observed values show good agreement since the observed minimum values were recorded during conditions close to those for which the minimum predicted values were calculated. The approximate limits of their usage are: $T = 15$ to 31°C, $Q=$ 5000 to 11,000 cfs, and $q = 20$ to 55 mgd.

As evidenced by the array of equations developed and the variable output produced, the mixing zone cannot be considered a singular entity. It is a constantly changing phenomenon, with the degree of change governed by fluctuations in the independent variables within the prescribed limits.

The areal extent of the mixing zone must fall within the prescribed area of an equivalent 600-foot-radius circle. The mixing zone configuration can take various arbitrary geometric forms to include this area. An ultraconservative example would be to define the zone as a rectangle with the short side being the transverse projections and the long side the longitudinal projections for given contour percentages as derived by using the equations presented in table 7. The rectangular concept would reduce the longitudinal extent of the zone, but it would extend the transverse projection uniformly along the longitudinal axis.

A second, somewhat liberal concept would be to figure the area in terms of a triangle similar to that proposed by Butts et al. (1984). The triangular area concept probably fits the theoretical configuration more closely than any other geometric design for the higher percentage contours. The warm weather contour plots revealed that contours 5 percent or greater fit a triangular model best. The contour lines for these percentages generally tended to tail off downstream, eventually terminating directly at the shoreline. The contours for percentages below 5 appear to fit a rectangular model better as they tend to fan out downstream because of dispersion and dilution.

A compromise between the two extreme areal concepts explained above would be to consider the zone as a trapezoid having an average end height equal to 75 percent of the transverse projections derived by using the equations presented in table 7a. The 75 percent figure is derived on the basis that the downstream transverse projection is 50 percent of the transverse projection at the outfall calculated by using the table 7a equations.

Note, as evidenced by the contours presented in Appendix B, that the upstream mixing zone terminus is well defined. A large water intake conduit projects several feet above the normal pool water level at station 0+00 and acts as a barrier to excess mixing movement in an upstream direction. Consequently, a mixing zone incorporating a downstream triangular or trapezoidal dispersion pattern should include a small rectangular areal section in the immediate area of the outfall. The longitudinal base should run between stations 0+00 and 5+00. The triangular or trapezoidal area should be computed on the basis of a right triangle with the base starting at station 5+00 and terminating at points dictated by the equations provided in table 7b. Although this fact was presented in the warm weather report, the actual mixing zone areas presented in table 22 of that report did not include this consideration. The mixing zone areas presented in this report do take this fact into consideration.

Recognition was given to the fact that the shoreline immediately below the outfall is not straight but forms a large-radius, convex arc. Essentially then the straight line longitudinal bases assigned to either the rectangular, triangular, or trapezoidal concepts act as cords across this arc. This introduces some error in the total mixing zone area -- the total is slightly understated since the area between the cord and arc is not included. However, because the arc is so large this area is relatively small and encompasses a very shallow near-shore volume. For the sake of simplicity and applicability, a straight-sided geometric configuration should be used to define the mixing zone since it does not significantly exaggerate the acceptable zone in this specific situation.

The maximum areas encompassed by the various contour percentage elements for the three suggested geometric shapes are presented in table 15. In reviewing the tabulated results. the fact that a 600-foot-radius circle has an area equal to 1,130,973 ft should be kept in mind; the values under the dashed lines in the table indicate areas less than this value. A triangular model fits the areal specifications for percentages of slightly above 5 or greater; a trapezoidal model fits for values starting somewhere between 8 and 10 percent; and a rectangular model fits for values starting slightly above 10 percent.

The geometric areas below station 5+00 are computed on the basis of a longitudinal distance equal to L = 350' since L is referenced to station 1+50. To each geometric area below 5+00 the rectangular area equal to D x 500' is added.

The maximum areas resulting from adherence to the 25 percent stream flow or stream cross-sectional area requirement for the 7 to 20 percent contours have also been revised and presented in table 15. These values were obtained by setting the appropriate D-equations in table 7a equal to 250 feet for a temperature, T, of 31°C and solving for the effluent flow, q. These q-values, along with T = 31°C, were used to solve for the appropriate L-value by using the equations in table 7b. The computed q-values for the 7, 10, 15, and 20 percent contours were, respectively, 53, 59, 58, and 62 mgd. The effluent flow rate is a manageable variable whereas river flow, Q, is not, nor does it appear in the L-equations in table 7b. Therefore, the determination of L-values and subsequent maximum areas for D = 250' is not practical for contour iso-percents of 1 through 5.

Table 16 has been prepared to provide an idea of the magnitude of the mixing zone areas being dealt with during cold weather conditions when river flows are compatible with the warm weather river flows. For three of the five compatible dates, the downstream or longitudinal distance, L, could be determined from the appropriate plot in Appendix B for all eight contour designations. Even the 1 percent limitation for these dates fell well within the 1,130,973 ft^2 limitation of the 600-foot radius circle. The critical 10, 15, and 20 percent limitations for all five dates included only a small fraction of the permissible area. The maximum area of 196,000 ft^2, which occurred on January 16, 1986 for the 10 percent contour, included only about 17 percent of the permissible mixing zone area. Consequently, the conclusion can be reached from these facts that the cold weather mixing zone is constrained almost entirely by the 25 percent area/flow limitation as set forth in paragraph c) of Section 302.102 of the IPCB Rules and Regulations.

Table 15. Areal Extent of Mixing Zones for Various Warm-weather Iso-dye Percentage Contours

Contour Percentages	Maximum Area(ft^2) Encompassed			Maximum Area (ft^2) Resulting from Adherence to the 25% Stream Flow/Area Requirement		
	Rectangle	Trapezoid	Triangle	Rectangle	Trapezoid	Triangle
1	8,086,512	6,136,834	4,186,756	*	*	*
2	5,322,300	4,062,350	2,802,400	*	*	*
3	3,500,020	2,694,515	1,889,010	*	*	*
5	2,313,875	1,802,281	1,290,688	*	*	*
7	1,889,985	1,478,614	1,067,243	552,750	445,813	338,875
10	1,316,385	1,042,414	768,443	501,250	407,188	313,125
15	769,800	623,450	477,300	270,000	233,750	197,500
20	642,810	526,708	410,805	271,250	234,688	198,125

* Values cannot be directly calculated by using the D-equations in conjunction with the L-equations presented in table 7

Table 16. Observed Mixing Zone Dimensions for the Five Cold Weather Dates That Have Flows Compatible with Warm Weather Flows

	Date														
	1/13/86			1/16/86			2/18/86			4/16/86			4/22/86		
Contour Percentages	Observed Maximum Dist (ft) D	L	Max. Mixing Area (ft^2)	Observed Maximum Dist (ft) D	L	Max. Mixing Area (ft^2)	Observed Maximum Dist (ft) D	L	Max. Mixing Area (ft^2)	Observed Maximum Dist (ft) D	L	Max. Mixing Area (ft^2)	Observed Maximum Dist (ft) D	L	Max. Mixing Area (ft^2)
1	220	1000	253,000	350	940	381,500	525	900	551,250	345	*	*	450	*	*
2	195	970	218,400	325	900	341,250	510	820	494,700	315	*	*	375	*	*
3	190	960	210,900	300	880	309,000	495	800	470,250	310	*	*	340	*	*
5	170	930	183,600	275	870	280,500	320	550	224,000	270	*	*	300	*	*
7	160	900	168,000	250	860	252,500	225	400	123,750	130	*	*	110	*	*
10	155	830	151,900	200	830	196,000	215	350	107,500	115	900	120,750	120	1050	144,000
15	135	750	121,500	150	820	145,500	200	300	90,000	105	230	39,900	110	260	45,100
20	120	260	49,200	105	800	99,750	120	200	4,200	95	210	34,200	85	200	29,750

* Indeterminate from data

Note: The maximum mixing area has been computed on the basis of a rectangular area

CONCLUSIONS

The results of the cold weather study and of the combined cold and warm weather studies lead to the following conclusions:

1. Temperature can be used as a reliable mixing zone tracer when the effluent and river water temperature differential is at least 3°C. A slight error in accuracy results from the use of temperature due to the dissipation of heat by means other than mixing. However, the loss in accuracy is more than made up for by an increase in precision. More precise locations of iso-temperature percent contours are made possible because many more temperature measurements can be recorded than analyses made for other tracers such as chlorides and fluorescent dyes.

2. The maximum transverse distance (D) of the mixing zone in the vicinity of the Greater Peoria Sanitary District (GPSD) outfall is dependent upon four factors: the effluent temperature (t) and effluent flow rate (q) and the river temperature (T) and river flow rate (Q). Prediction equations were developed equating these four factors to the 1, 2, 3, 5, 7, 10, 15, and 20 percent effluent residual percent distances on the basis of five of the ten cold weather data sets and all ten warm weather data sets. Five of the cold weather data sets were not used because the data were obtained during excessive river flows.

3. The prediction equations form a reliable basis for assessing transverse mixing distances. Mixing in the vicinity of the GPSD outfall is limited by the 25 percent cross-sectional area or flow volume requirement contained in the mixing zone definition outlined in the Illinois Pollution Control Board's (IPCB) Rules and Regulations. Limits under which the prediction equations were developed are: t = 10.47°-28°C, T = 0.33°-31°C, q = 20-55 mgd, and Q = 5,224-10,570 cfs.

4. The prediction equations appear to produce reasonable results for 7-day. 10-year low flow river conditions (2964 cfs) in conjunction with critically high river and effluent temperatures of 31°C and 30°C. respectively, although these values fall outside the limits under which the equations were statistically derived. For this extreme condition, effluent ammonia-N concentrations of 10 mg/l could be tolerated if the effluent discharge flow rate was limited to 35 mgd or less.

5. At no time during the warm or cold weather study were the IPCB's river water quality standards violated outside the mixing zone (as defined by this study) even though effluent ammonia-N levels as high as 15.06 mg/l were observed. Under the study conditions, summer discharge concentrations ranging from 7.14 mg/l to 149.92 mg/l could have been

tolerated without violating standards; during winter conditions, discharge concentrations ranging from 24.82 mg/l to 800.73 mg/l could have been tolerated. The 7.14 mg/l minimum summer level occurred during a 50-mgd discharge rate. If this discharge rate were reduced to 40 mgd, a 15.0-mg/l effluent ammonia-N concentration could be tolerated without violating stream standards. A 21.5 mg/l effluent concentration would havs bee acceptable at q = 20 mgd .

6. The effluent ammonia-N standards can be liberalized significantly without violating stream ammonia-N standards during either the summer or winter months. Three management schemes are proposed which would ensure that stream standards are met at all times. One is a rigid across-the-board plan which specifies that the mixing zone be limited by the 20 percent contour and that would set summer discharges at 7.5 mg/l and would allow winter discharge to range from 7.5 to 40 mg/l. The second scheme would limit the GPSO effluent discharge rate to 40 mgd, thereby setting the summer effluent limit at 10 mg/l and allowing winter limits to range from 10 to 53 mg/l. The third scheme is a flexible plan using daily river and effluent conditions to dictate specific acceptable ammonia-N level at a given time. It would involve the development of extensive quality control charts. If properly administered it would allow up to 15 mg/l of ammonia-N to be discharged during warm weather periods.

7. The cold weather mixing zone areas appear to be limited by the 25 percent stream cross-sectional area-flow volume requirement presented in the IPCB's Rules and Regulations. Sufficient information was contained on the cold weather percentage contour plots to determine longitudinal distances for developing mixing areas. The maximum area for the 10 percent contour constituted only about 17 percent of the permissible mixing zone area.

REFERENCES

Butts, T.A., R.L. Evans, and S.D. Lin. 1975. Water Quality Features of the Upper Illinois Waterway. Illinois State Water Survey Report of Investigation 79, 60 p.

Butts, T.A., R.L. Evans, D.B. Shackleford, and D.H. Schnepper. 1984. The Procedures. Observations, and Results of a Mixing Zone Study for Combined Sewer Overflows at Peoria. Illinois. Illinois State Water Survey Contract Report 349,119 p.

Butts, T., D. Roseboom, T. Hill, S. Lin, D. Beuscher, R. Twait, and R. Evans. 1981. Water Quality Assessment and Waste Assimilative Analysis of the LaGrange Pool. Illinois River. Illinois State Water Survey Contract Report 260, 116 p.

Butts, T.A., D.H. Schnepper, and K.P. Singh. 1983. The Effects of Lake Michigan Discretionary Diversion Strategies on Illinois Waterway Dissolved Oxygen Resources. Illinois State Water Survey Contract Report 324, 53 p.

Butts, T.A., D.B. Shackleford, T.E. Hill, and R.L. Evans. 1985. The Impact of Greater Peoria Sanitary District Ammonia Discharges on Illinois River Water Quality. Illinois State Water Survey Contract Report 373, 199 p.

Illinois Pollution Control Board. 1986. State of Illinois Rules and Regultions. Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter 1: Pollution Control Board, February 1, 1986, 44 p.

Standard Methods for the Examination of Water and Wastewater. 1985. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 16th edition, 1268 p.

Appendix A. Ammonia-N (NH_3-N) Concentrations and Residual Percentages Observed in the Illinois River between November 1, 1985 and April 30, 1986 in the Mixing Zone Area of the Greater Peoria Sanitary District's Treatment Plant Outfall

November 5, 1985						November 13, 1985					
Sta (ft)	Dist (ft)	Depth (ft)	Temp (ºC)	Observed NH_3-N (mg/l)	(%)	Sta (ft)	Dist (ft)	Depth (ft)	Temp (ºC)	Observed NH_3-N (mg/l)	(%)
0+00	50	0	13.4	2.63	44.9	1+00	50	0	9.2	0.15	0
0+50	0	0	11.0	3.60	62.6	1+50	50	0	9.4	0.10	0
1+50	50	0	16.6	1.30	20.5		0	0	15.5	6.56	85.0
	100	0	10.8	0.75	10.4	2+50	50	0	9.3	0.47	1.37
	150	0	10.1	0.03	0		30	0	16.1	4.20	52.6
2+50	0	0	16.2	4.69	82.6	3+50	75	0	11.5	0.63	3.6
	30	0	10.5	0.56	6.9		50	1	15.8	5.68	72.9
	100	0	9.9	1.05	15.9		0	0	11.5	2.47	28.8
3+50	30	0	15.7	4.88	86.1	4+50	75	0	9.3	0.42	0.7
	50	0	16.4	4.41	77.4		50	0	12.0	2.41	27.0
	100	0	10.0	0.10	0		30	0	11.8	2.91	34.9
5+00	0	0	14.0	3.10	53.5	5+00	75	0	9.3	0.30	0
	50	0	14.9	4.11	71.9		0	0	11.6	2.71	32.1
	100	0	11.8	1.90	31.5	6+00	100	0	9.6	0.52	2.1
6+50	30	0	12.5	1.91	31.7		46	0	11.0	2.16	24.6
	75	0	11.6	1.27	19.9	8+00	50	0	10.9	1.99	22.3
8+50	100	0	11.8	1.33	21.1	8+50	160	0	9.2	0.49	1.7
	150	0	9.9	0.12	0		0	0	10.9	1.99	22.3
9+50	30	0	13.4	2.69	45.9	9+00	30	0	11.0	2.12	24.0
	125	1.5	11.0	0.74	10.3	10+00	30	0	11.0	2.12	24.0

January 9, 1986						January 13, 1986					
0+00	50	0	0.4	1.15	0.4	0+00	25	0	4.4	4.92	27.0
0+50	75	0	1.0	1.14	5.7	0+50	75	0	2.6	4.06	20.7
	25	0	2.0	2.96	16.3	1+00	50	0	8.0	9.95	66.2
1+00	0	0	1.2	2.07	8.6		125	0	1.8	3.26	14.6
	115	0	6.1	5.02	34.4	1+50	25	1	4.7	7.50	47.6
1+50	20	0	7.2	8.29	63.1		25	0	2.8	1.33	0.2
2+00	25	0	10.6	12.14	96.7	2+00	45	0	11.3	11.74	80.2
2+60	60	0	5.0	5.25	36.9	2+50	75	4	2.5	4.66	26.2
	0	0	10.9	12.93	100.0		75	0	0.9	15.88	100.
3+00	0	0	8.6	11.53	92.0		25	0	2.7	7.53	48.1
	60	0	3.4	3.49	21.7	3+00	0	0	1.5	13.63	94.8
3+60	100	11	3.8	2.47	12.9		50	0	2.5	4.54	25.4
	100	0	0.6	0.67	0		125	10	2.9	1.40	1.7
4+50	50	0	0.5	1.19	1.9		125	0	0.7	0.51	0
5+50	50	0	0.6	1.00	0.2	4+00	50	0	2.6	2.41	9.9
8+00	25	0	1.1	1.52	5.0	5+00	60	3	1.5	1.40	2.8
						6+50	65	0	1.1	0.50	0
						9+00	25	0	2.2	1.66	5.6
						10+50	100	0	1.5	1.71	6.1

January 16, 1986

Sta (ft)	Dist (ft)	Depth (ft)	Temp (°C)	Observed NH_3-N (mg/l)	(%)
1+00	25	0	5.3	6.92	39.0
1+50	25	0	8.6	9.15	53.8
	50	0	0.9	1.56	3.01
2+00	50	0	13.7	14.88	89.5
2+50	75	7	4.0	2.74	10.69
	75	0	7.8	7.24	40.1
3+00	50	0	12.5	14.86	88.7
3+50	72	9	6.8	8.74	48.9
	72	0	4.1	4.87	24.0
	128	12	2.5	3.63	16.1
	128	0	0.7	1.25	0.9
4+50	115	11	5.6	5.24	25.7
	115	0	0.7	1.28	1.1
5+50	100	8	5.6	5.50	27.0
	100	0	1.0	2.16	8.5
6+50	220	13	3.8	4.71	21.9
9+50	200	11	1.9	2.08	3.8
	200	0	0.5	0.75	2.2

January 21, 1986

Sta (ft)	Dist (ft)	Depth (ft)	Temp (°C)	Observed NH_3-N (mg/l)	(%)
1+00	25	0	0.7	1.38	2.8
1+50	0	0	0.8	1.13	0.4
2+00	50	2.5	1.6	2.89	16.7
	50	0	0.9	1.13	0.3
2+50	65	4	5.5	4.22	29.2
	65	0	0.7	1.24	1.2
3+00	42	2	10.5	8.39	69.8
	42	0	4.1	3.58	23.5
	90	0	8.8	7.01	53.9
3+50	110	11	3.7	3.65	24.5
	110	0	0.9	4.08	28.8
4+00	100	0	5.7	4.15	30.0
5+00	115	0	3.0	2.30	11.2
6+00	180	11	2.4	2.37	11.9
	180	0	0.3	1.38	1.4
7+50	0	0	3.8	2.94	18.2
8+00	120	8	1.8	1.98	7.7
	0	0	0.8	1.24	0
9+00	0	0	5.2	6.25	55.1

January 23, 1986

0+00	25	0	5.8	4.45	34.6
1+00	125	0	1.8	1.48	5.2
1+50	125	0	1.5	2.56	14.5
	95	0	3.6	2.13	10.7
2+00	75	0	2.4	1.46	4.4
3+00	85	8	1.7	1.18	1.2
	85	0	5.0	1.77	5.7
3+50	56	3	7.9	6.25	37.9
	56	0	11.3	10.28	66.8
4+50	100	8	4.1	3.08	18.15
	100	0	2.1	1.32	1.6
5+50	110	7	3.5	2.81	9.9
	110	0	1.8	1.54	2.7
6+00	90	0	4.0	3.07	12.3
8+00	75	0	4.7	4.02	17.7
9+00	120	0	4.1	3.72	15.2
	25	0	4.3	3.21	11.9
10+00	25	0	5.9	2.92	10.2
10+50	50	0	4.9	3.00	10.6

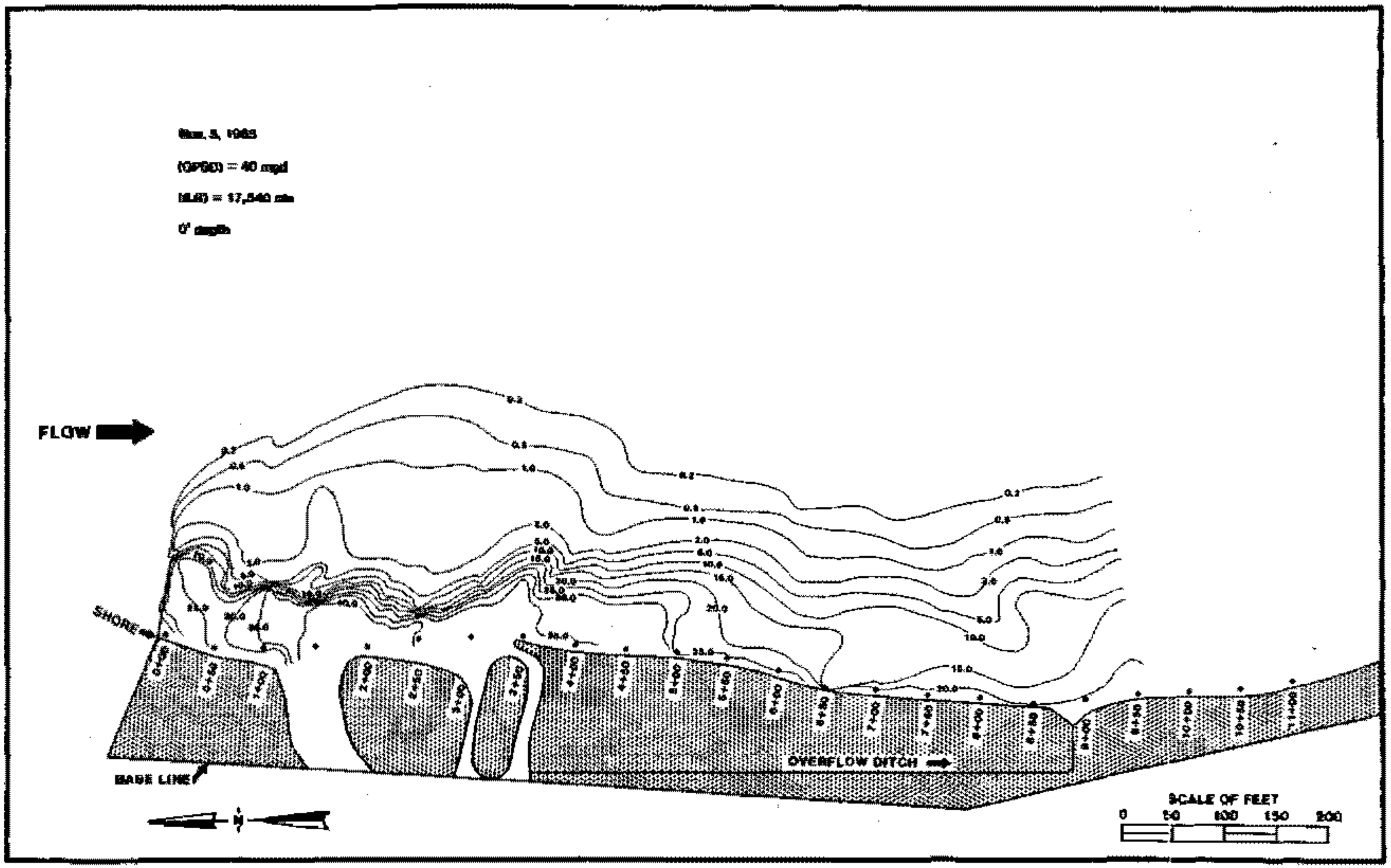
February 18, 1986

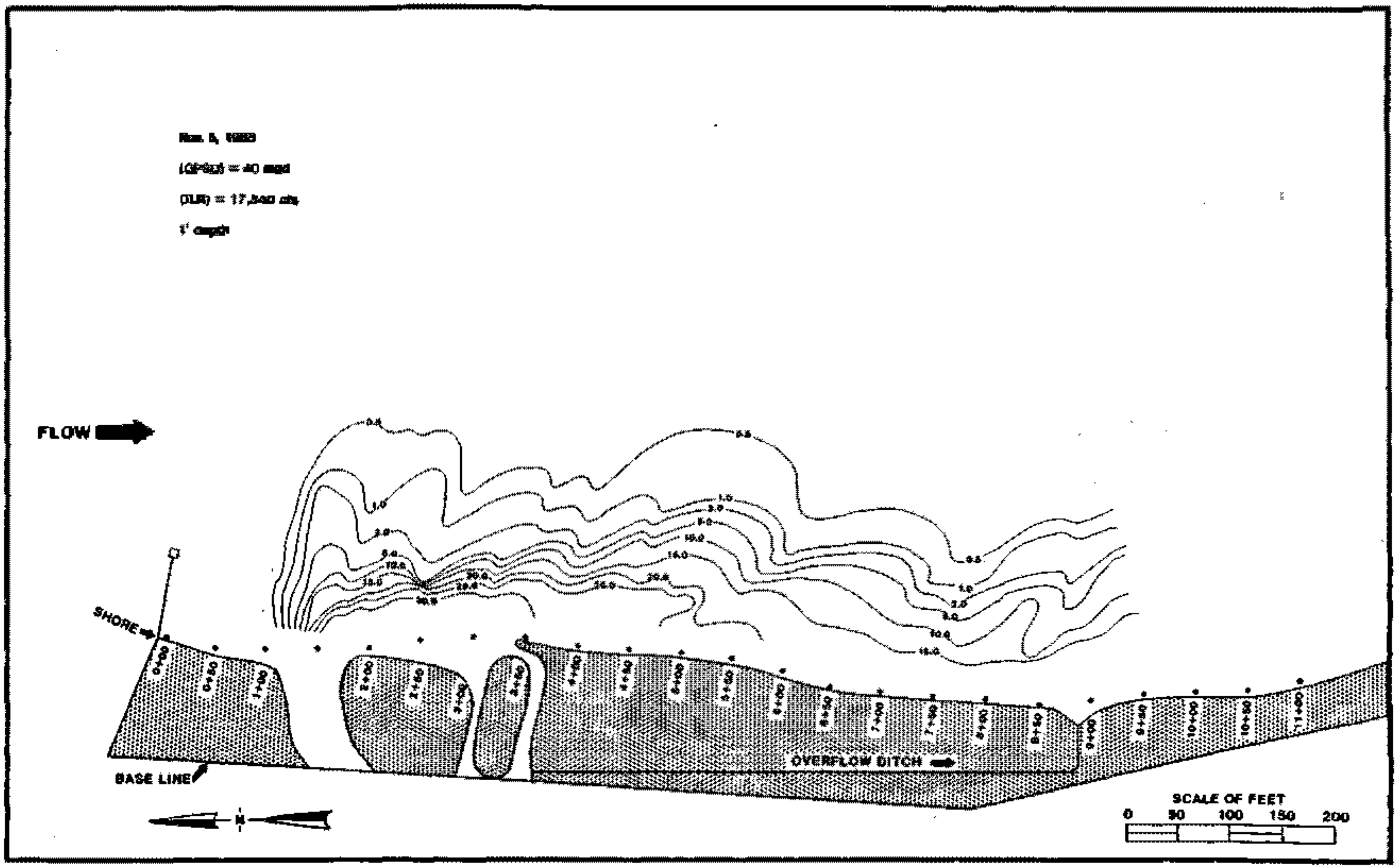
0+50	50	0	2.0	1.29	0.3
1+00	100	0	1.0	0.99	0
1+50	0	0	7.0	2.00	9.6
	160	0	0.7	1.27	0
2+00	90	5	1.1	1.45	2.4
	90	0	0.7	1.27	0
2+50	0	0	11.8	7.39	84.8
	115	9	5.2	4.68	47.8
		0	0.8	0.93	0
3+00	117	9	2.8	1.41	2.0
		5	5.0	1.40	1.9
		0	0.6	1.08	0
3+50	74	6	6.4	3.53	38.5
		0	0.9	2.19	15.7
4+50	180	10	2.4	2.01	12.9
		0	0.5	0.92	0
7+00	350	12	0.8	1.33	1.1
		0	0.9	1.04	0
8+00	50	0	0.9	1.06	0
9+00	300	0	0.5	1.20	0

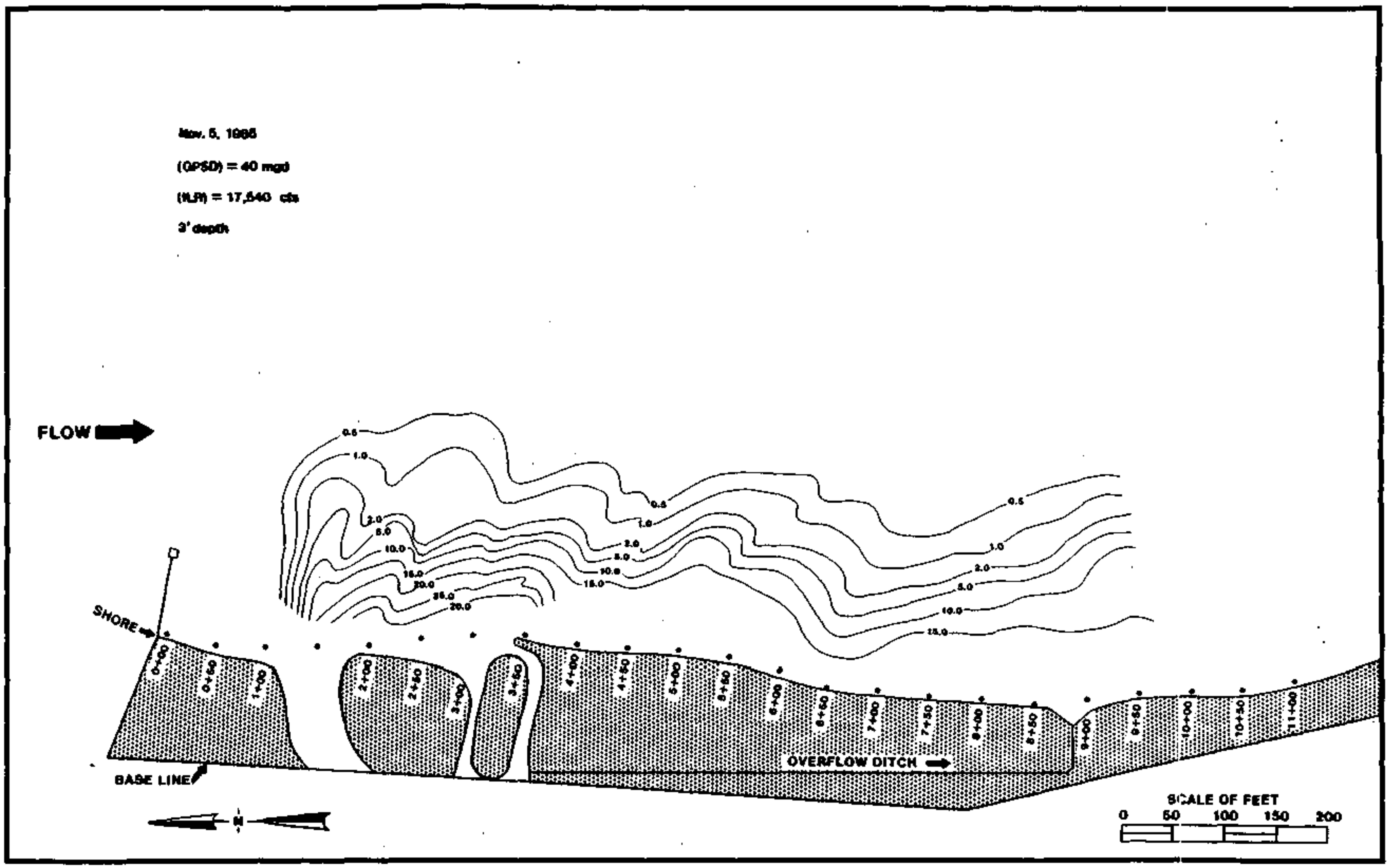
April 16, 1986					
0+00	100	0	10.3	0.11	0
0+50	25	0	9.3	0.19	0.1
	200	0	10.5	0.21	0.3
1+00	170	0	10.5	0.13	0
	50	0	10.3	0.11	0
1+50	0	0	12.4	2.40	24.4
	125	0	10.5	0.08	0
2+00	50	2	12.6	6.33	66.9
	50	0	11.1	2.23	21.9
2+50	95	0	13.4	5.76	60.0
3+00	65	8	13.3	6.39	66.3
	65	0	11.6	3.24	32.2
3+50	115	0	11.9	7.61	78.9
4+00	56	0	11.7	4.13	41.0
6+00	25	0	11.0	1.78	15.6
8+00	115	0	11.1	2.41	21.7
10+50	125	0	10.5	1.04	7.2
	45	0	11.2	2.32	20.4

April 22, 1986					
0+00	50	0	12.2	0.05	0
1+00	65	0	11.9	0.23	0.4
1+50	55	0	14.5	2.95	100
	110	0	11.9	0.29	2.7
2+00	60	0	14.0	1.53	52.5
	25	0	14.6	2.09	100
2+50	100	0	14.0	2.14	76.5
3+00	100	0	12.8	1.54	52.0
	25	0	15.3	2.79	100
3+50	95	0	13.9	1.60	61.7
4+00	110	11	12.0	0.78	21.1
	110	0	13.9	1.66	56.9
4+50	150	0	13.0	1.29	40.8
5+50	70	0	12.7	0.96	26.2
6+50	50	0	12.4	0.87	23.8
8+50	110	0	12.6	0.84	21.9
10+50	25	0	13.3	0.74	17.9
10+50	170	0	12.4	0.49	8.2

Appendix B. Contour Plots of Residual Effluent Temperature Percents for Surface, 1-, 3-, and 8-Foot Depths for the Ten Cold Weather Sampling Dates


Dec. 5, 1985
(OPSD) = 40 mgd
(ILR) = 17,540 cfs
0' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
N
SCALE OF FEET
0 50 100 150 200
0.2
0.5
1.0
2.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00


= 40 mgd
(ILR) = 17,540 cfs
1' depth
FLOW
SHORE
BASE LINE
N
0.5
1.0
2.0
5.0
10.0
15.0
20.0
25.0
30.0
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
SCALE OF FEET
0
50
100
150
200

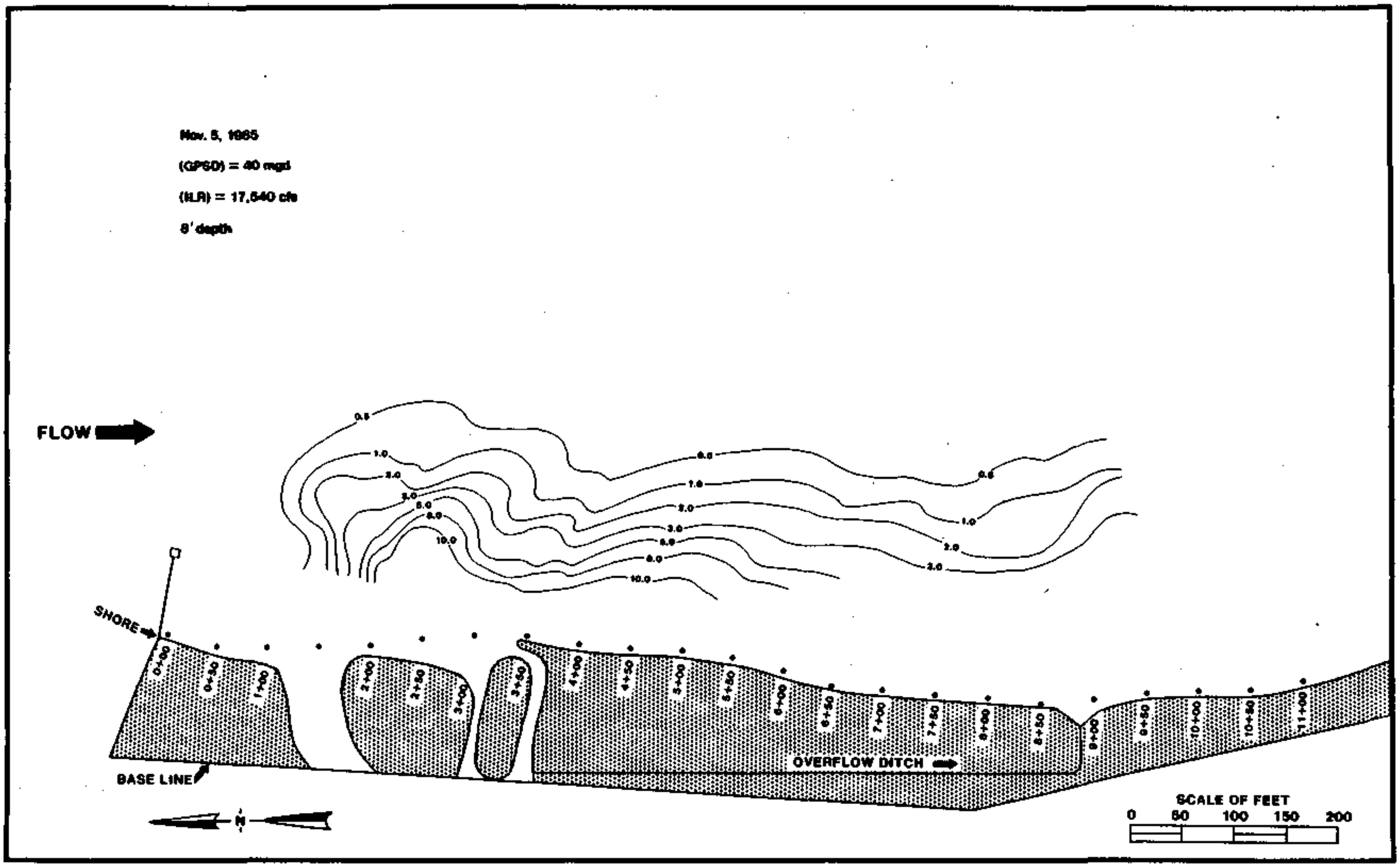


Nov. 5, 1985

(GPSD) = 40 mgd

(ILR) = 17,540 cfs

3' depth

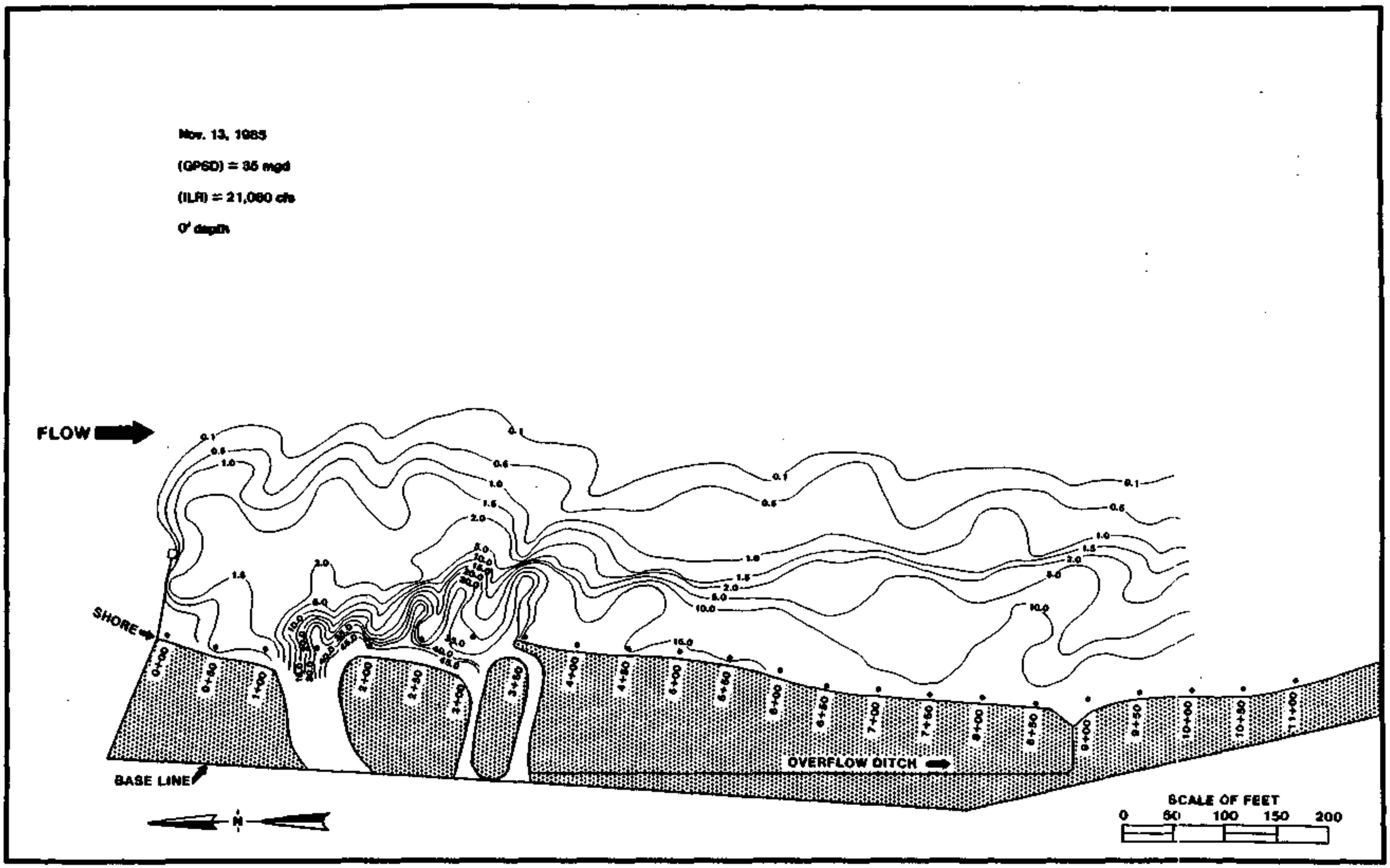


Nov. 5, 1985

(GPSD) = 40 mgd

(ILR) = 17,540 cfs

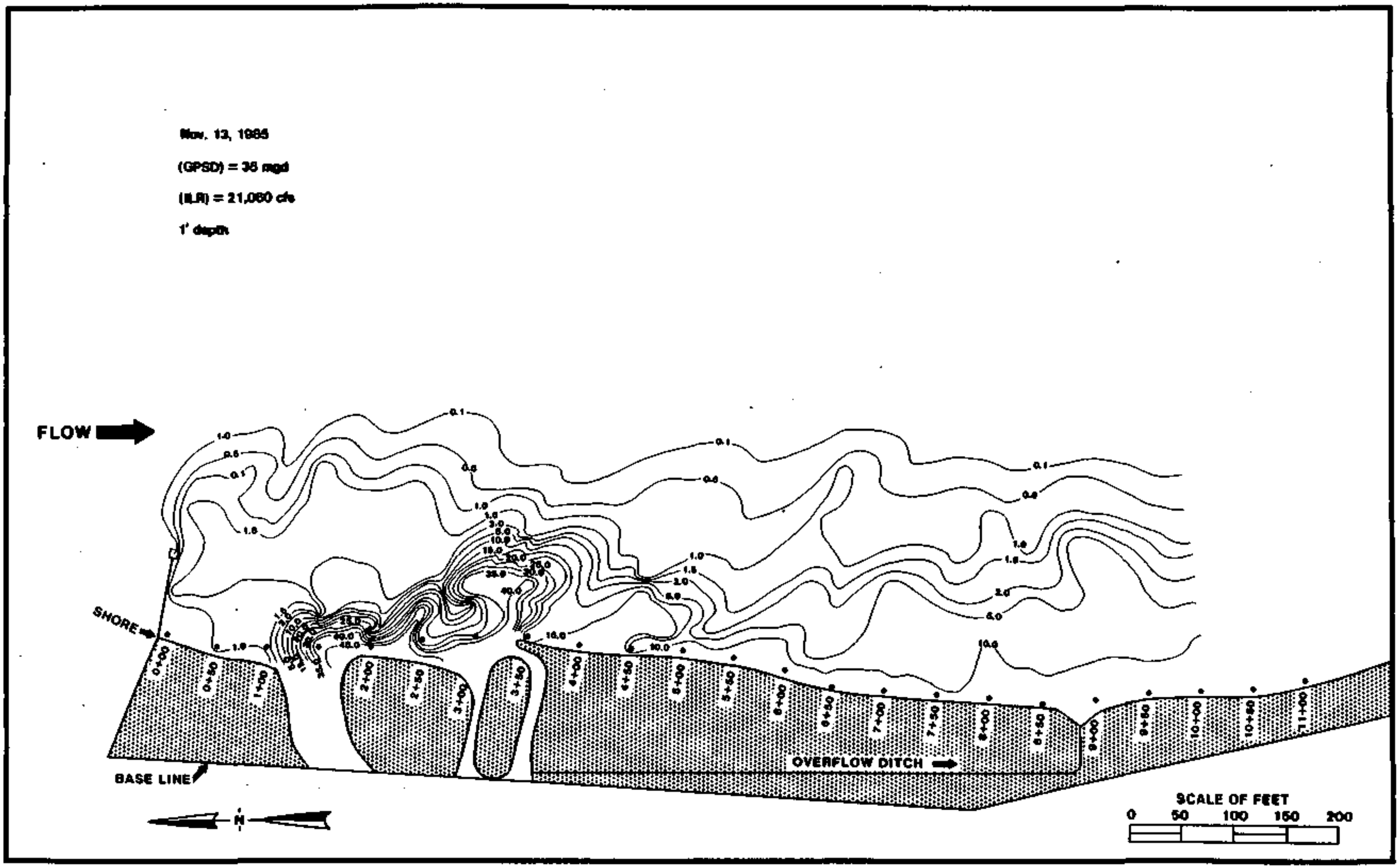
8' depth

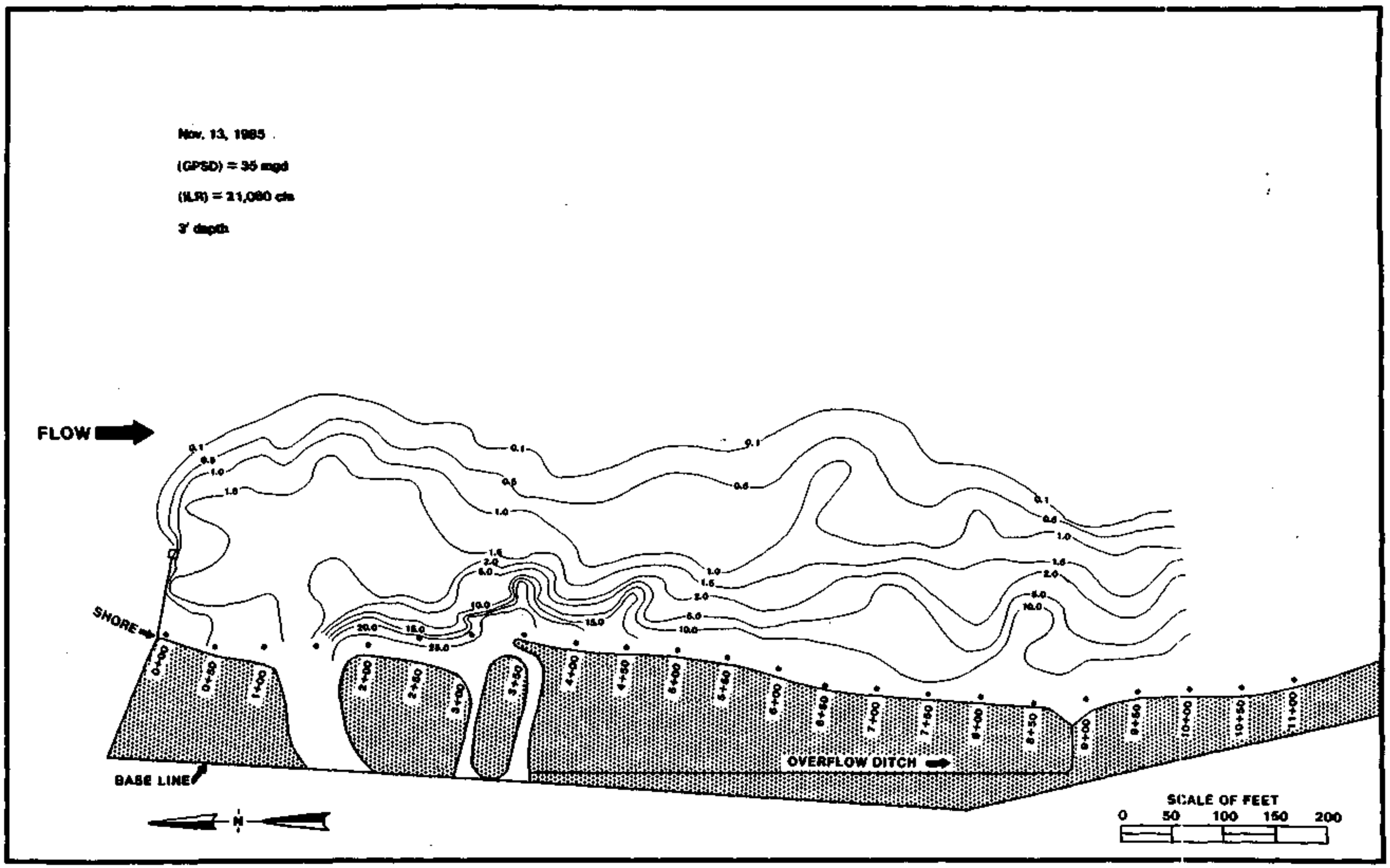

Nov. 13, 1985

(GPSD) = 35 mgd

(ILR) = 21,060 cfs

0' depth


Nov. 13, 1985
(GPSD) = 36 mgd
(ILR) = 21,060 cfs
1' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
0.1
0.5
1.0
1.5
2.0
3.0
5.0
10.0
15.0
20.0
25.0
35.0
40.0

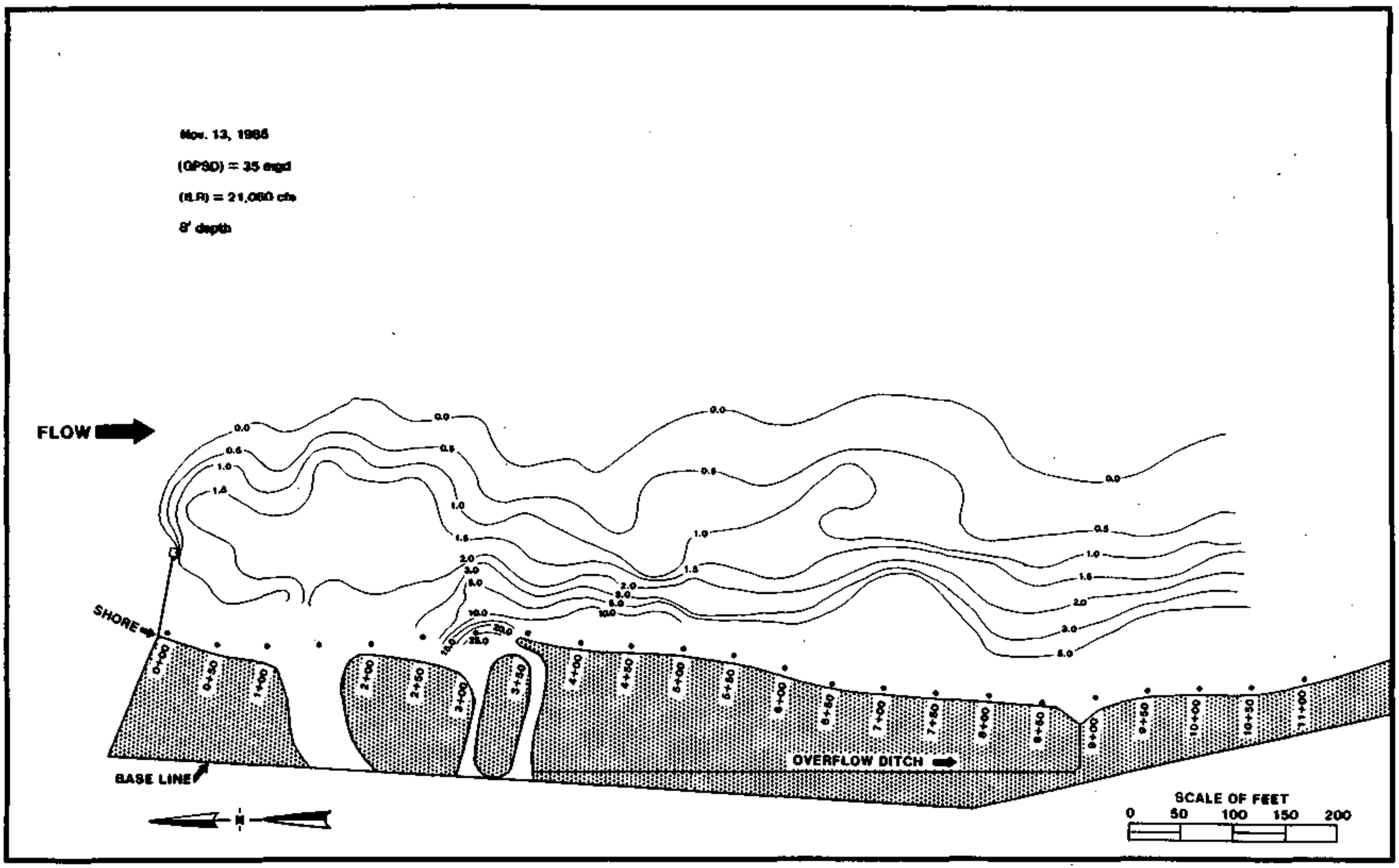


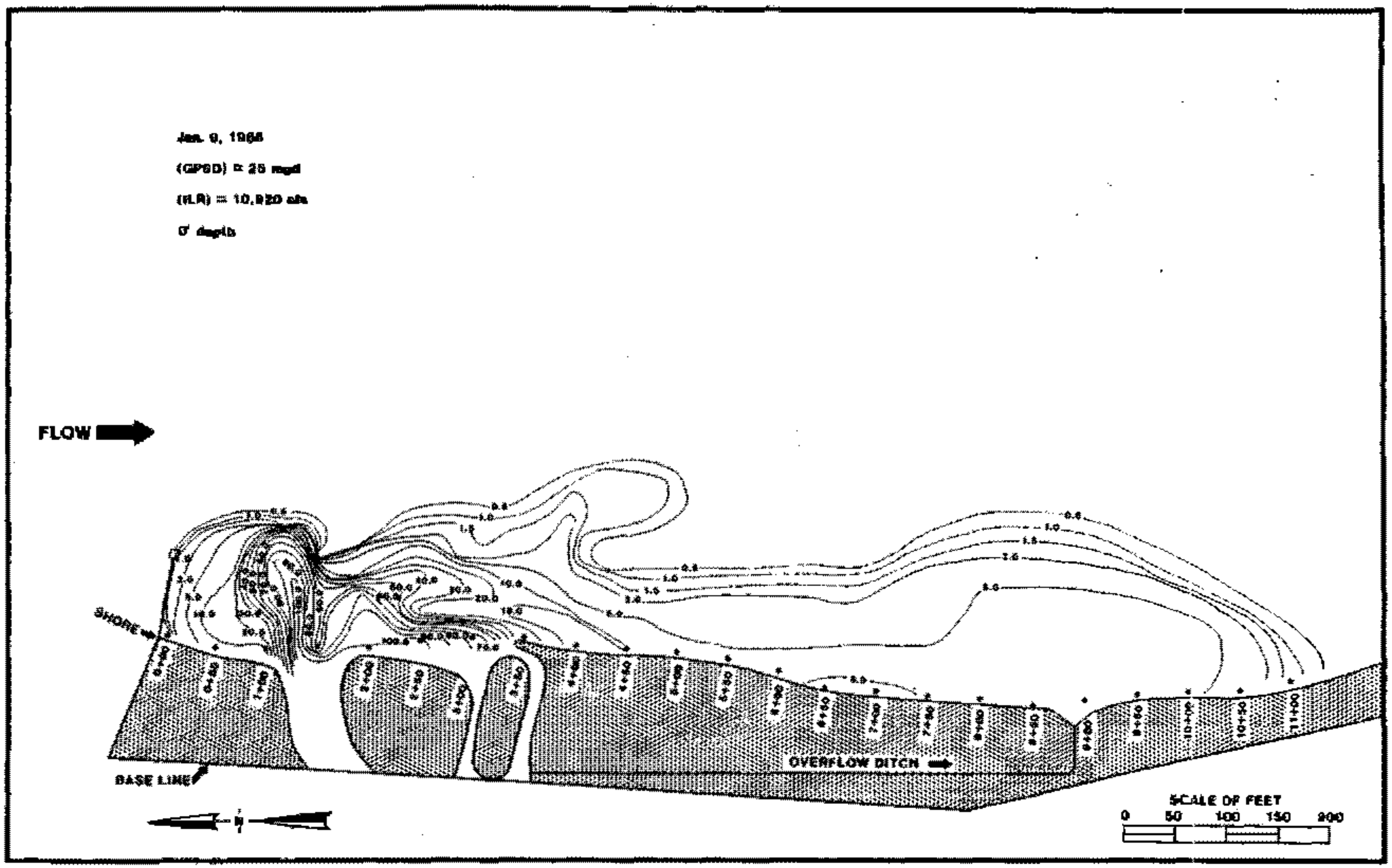
Nov. 13, 1985

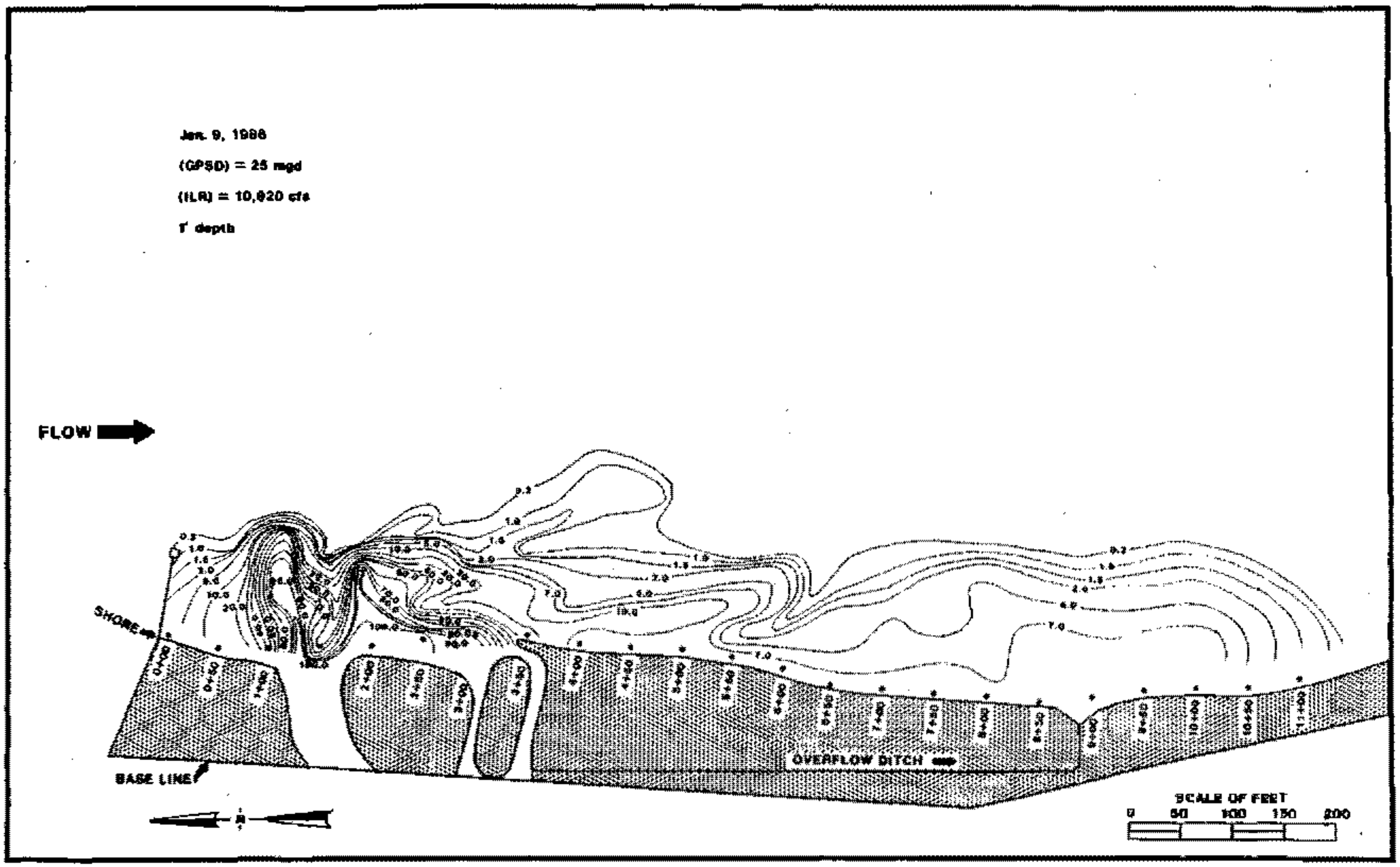
(GPSD) = 35 mgd

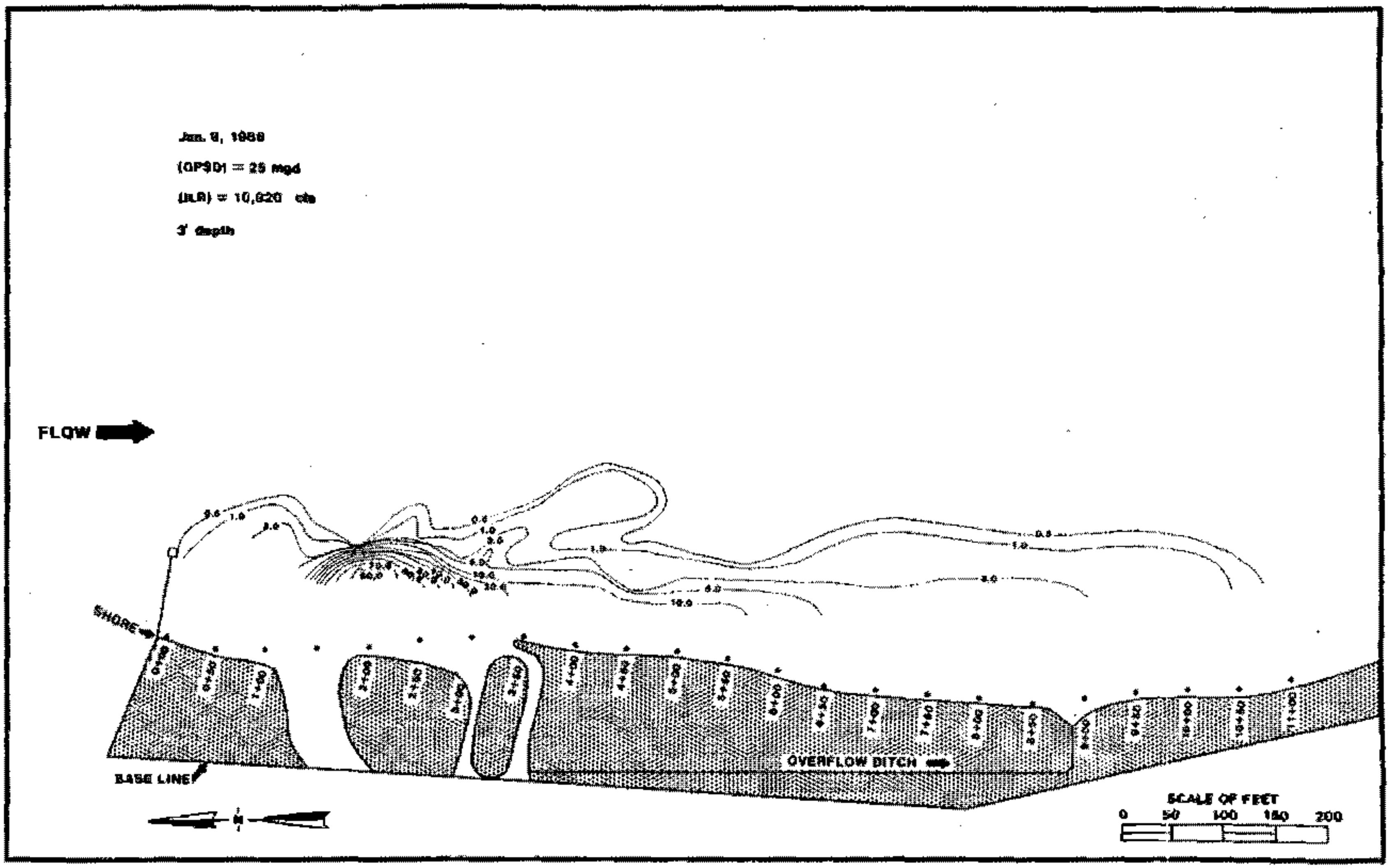
(ILR) = 21,080 cfs

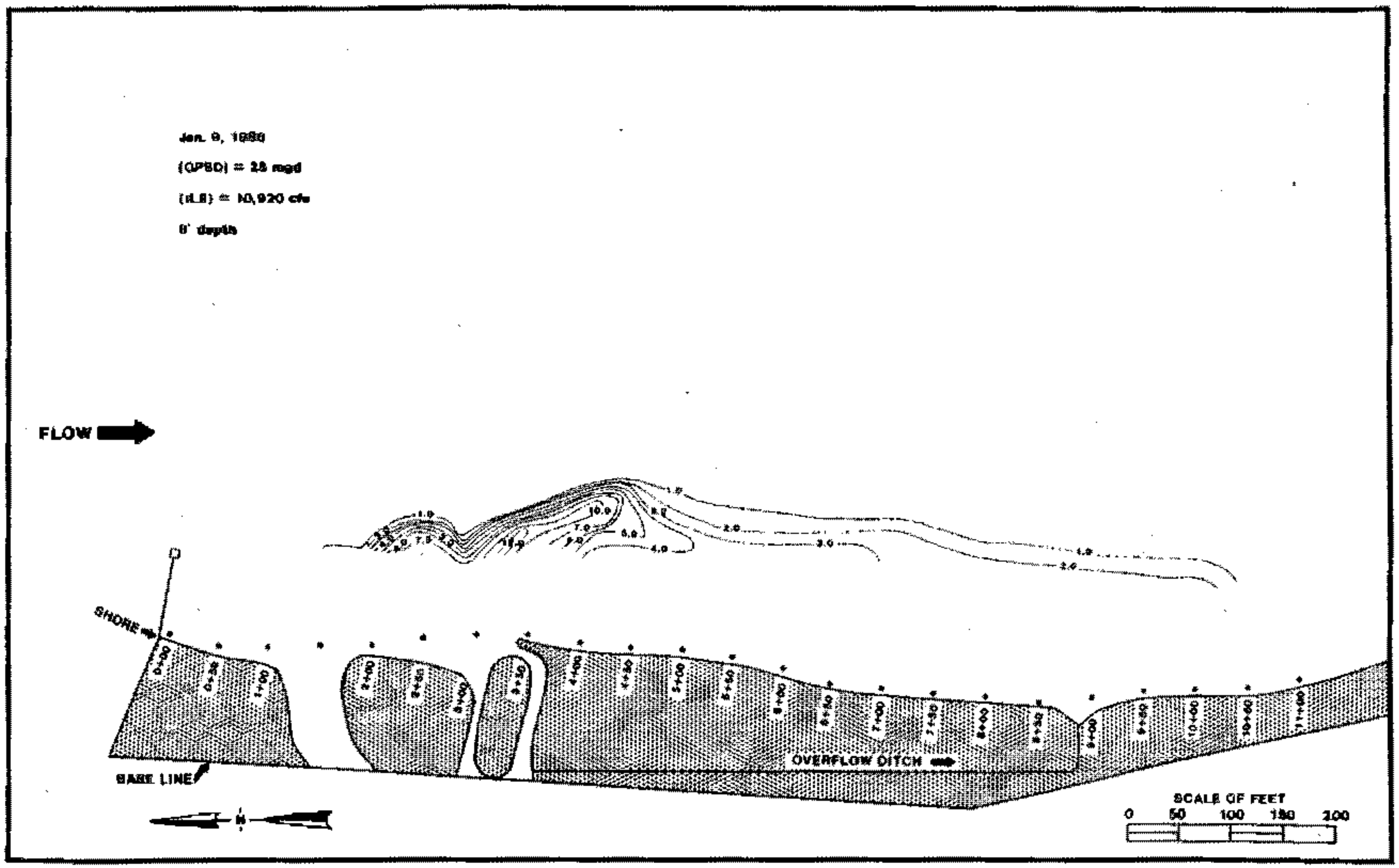
3' depth

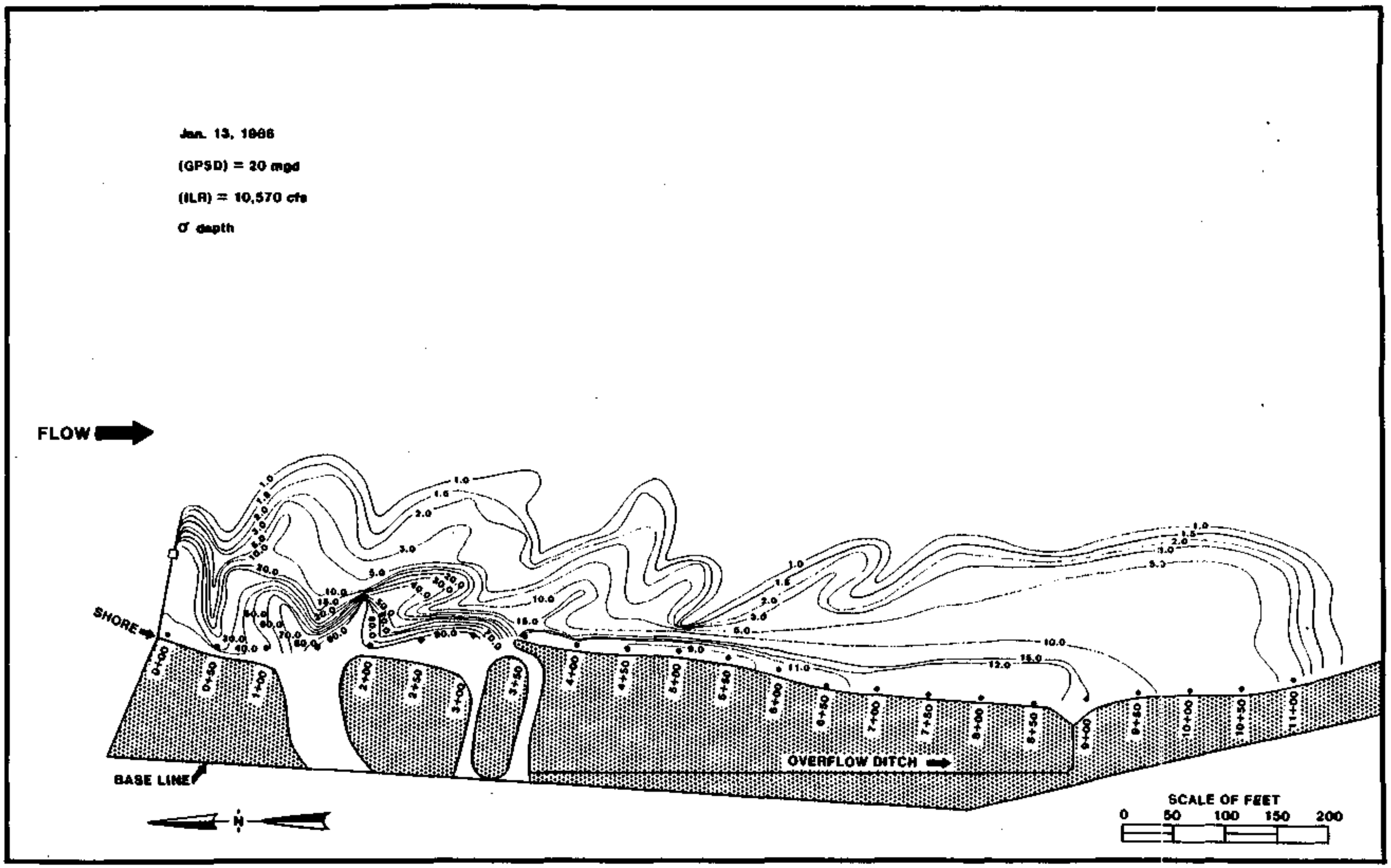

Nov. 13, 1986
(GPSD) = 35 mgd
(ILR) = 21,080 cfs
8' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200
0.0
0.5
1.0
1.5
2.0
3.0
5.0
10.0
15.0
20.0
25.0
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00


Jan. 9, 1968
(GPSD) = 25 mgd
(ILR) = 10,920 cfs
0' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
SCALE OF FEET
0
50
100
150
200


Jan. 9, 1986
(GPSD) = 25 mgd
(ILR) = 10,920 cfs
1' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
SCALE OF FEET
0
50
100
150
200


Jan. 8, 1988
(GPSD) = 25 mgd
(ILR) = 10,820 cfs
3' depth
FLOW
0.5
1.0
3.0
5.0
10.0
20.0
40.0
SHORE
BASE LINE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200


Jan. 9, 1986
(QPSD) = 28 mgd
(ILR) = 10,920 cfs
8' depth
FLOW
1.0
10.0
8.0
7.5
5.0
12.0
7.0
9.0
6.0
4.0
2.0
3.0
SHORE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
BASE LINE
N
SCALE OF FEET
0
50
100
150
200

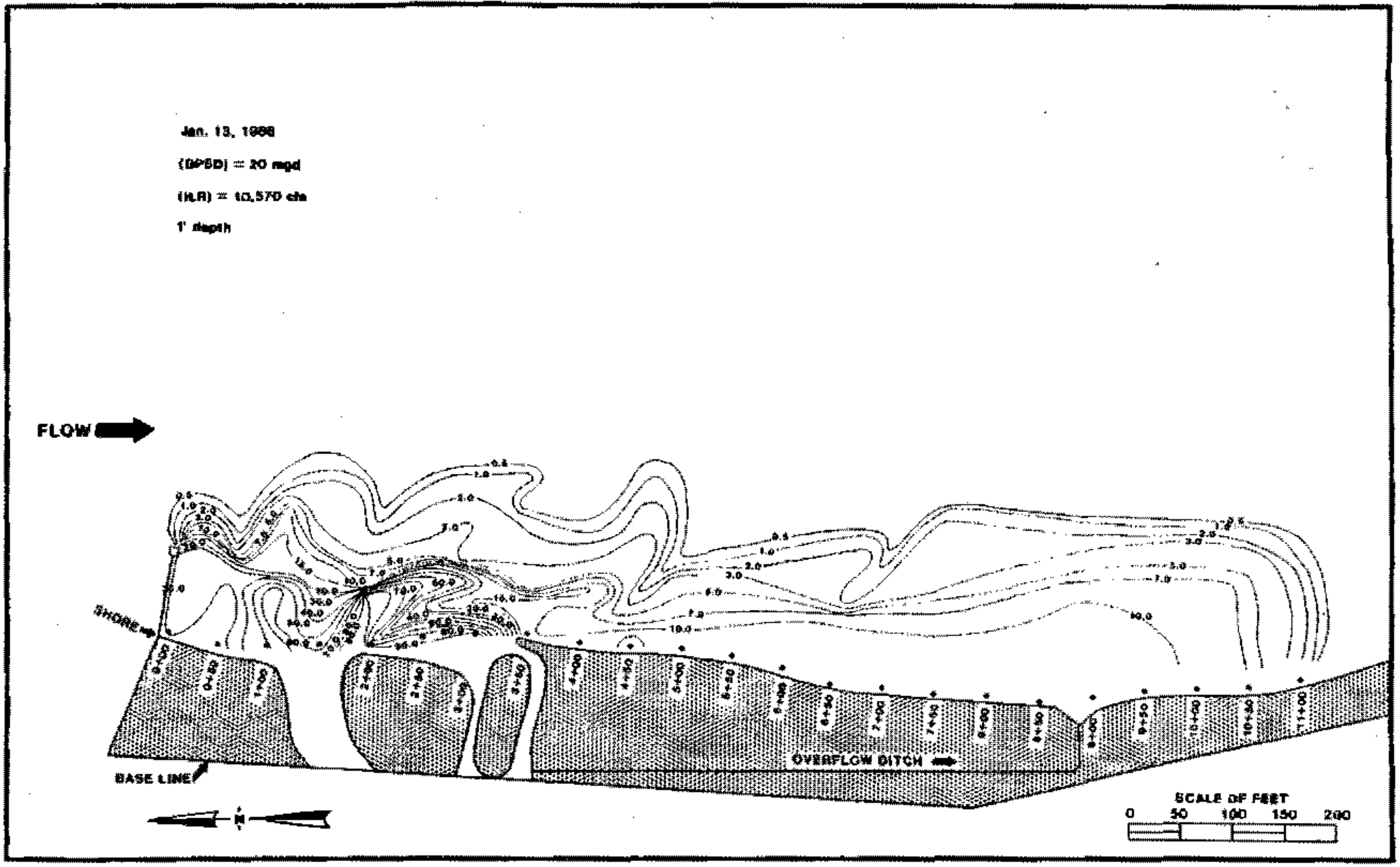


Jan. 13, 1986

(GPSD) = 20 mgd

(ILR) = 10,570 cfs

σ depth

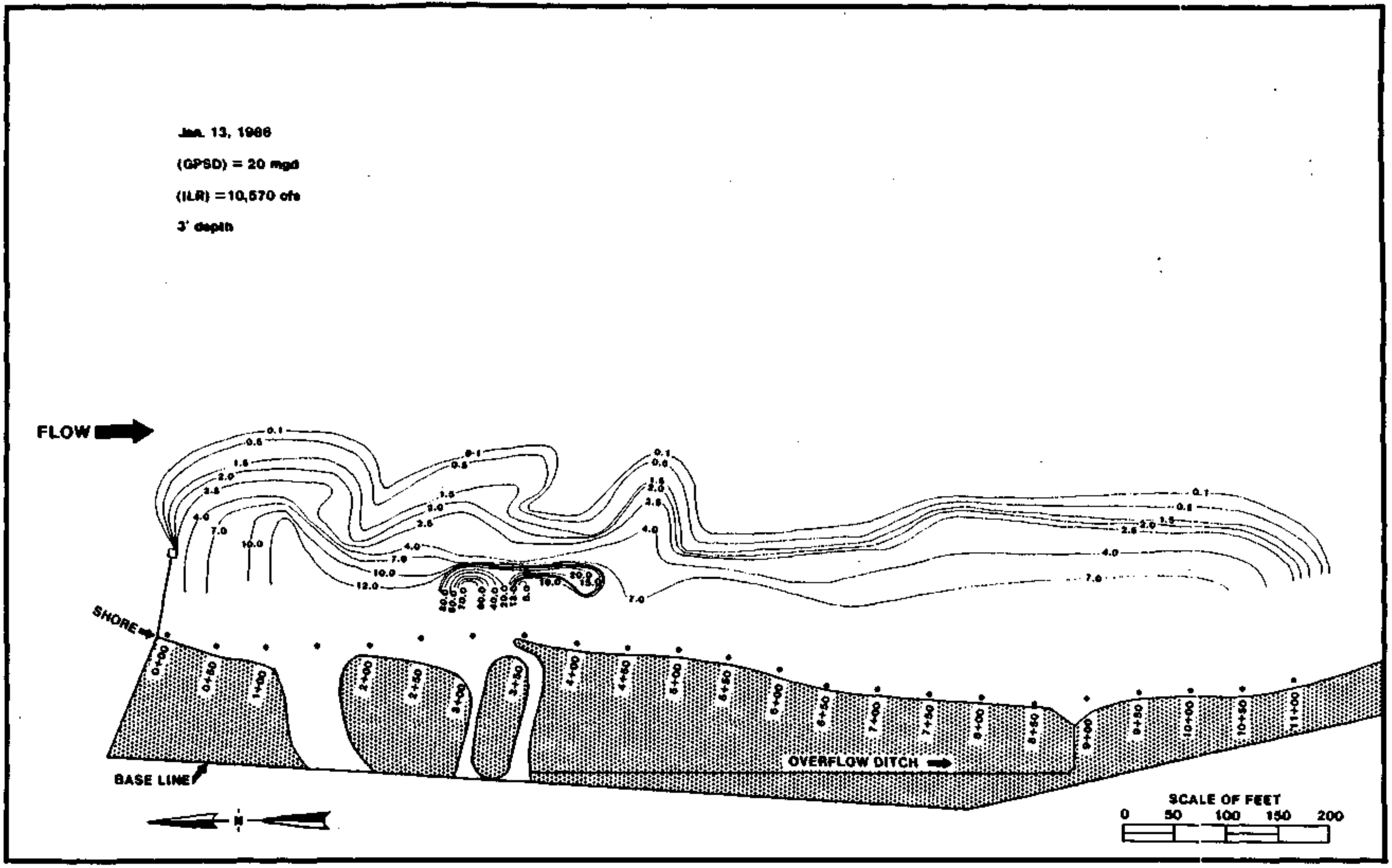


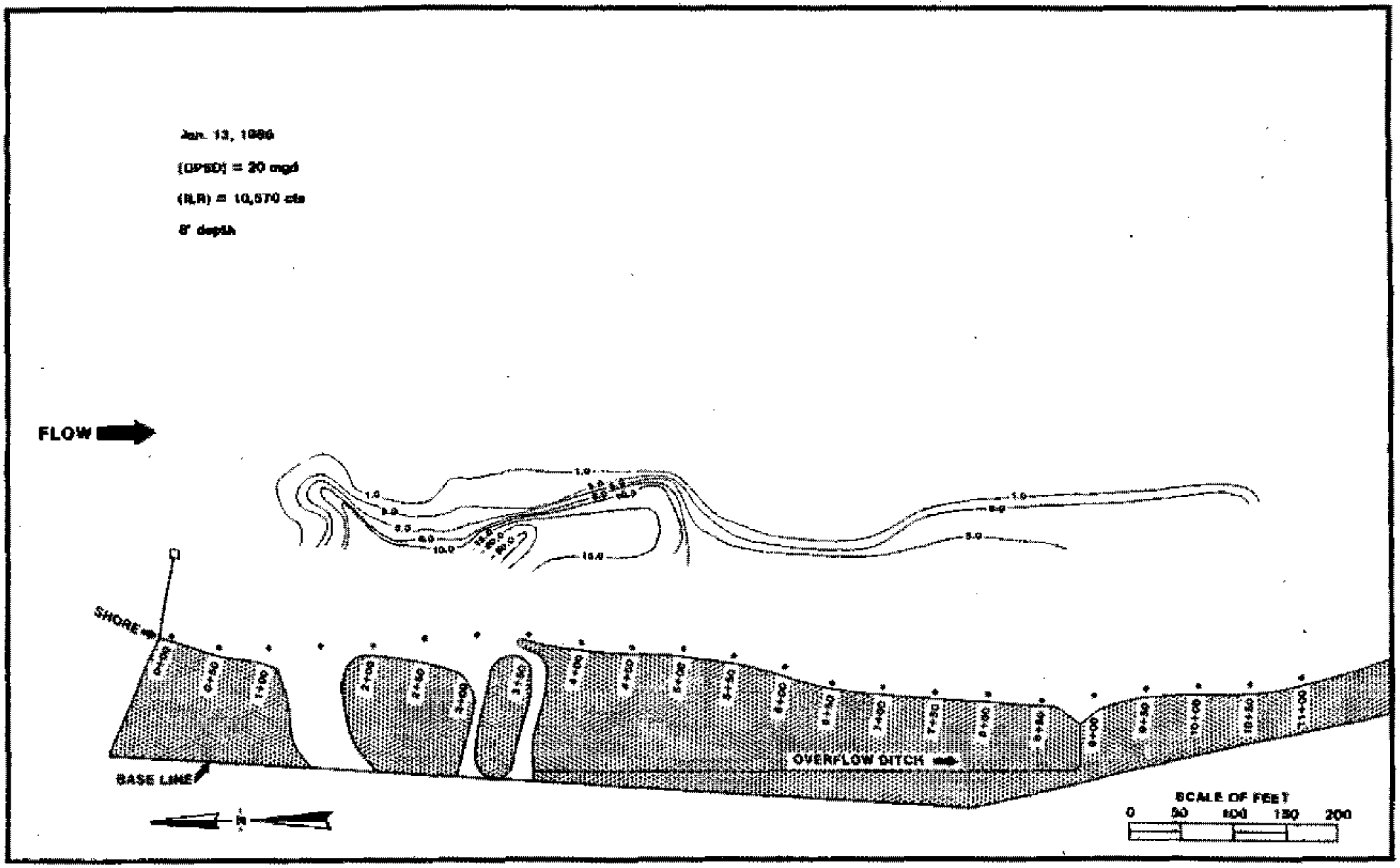
Jan. 13, 1968

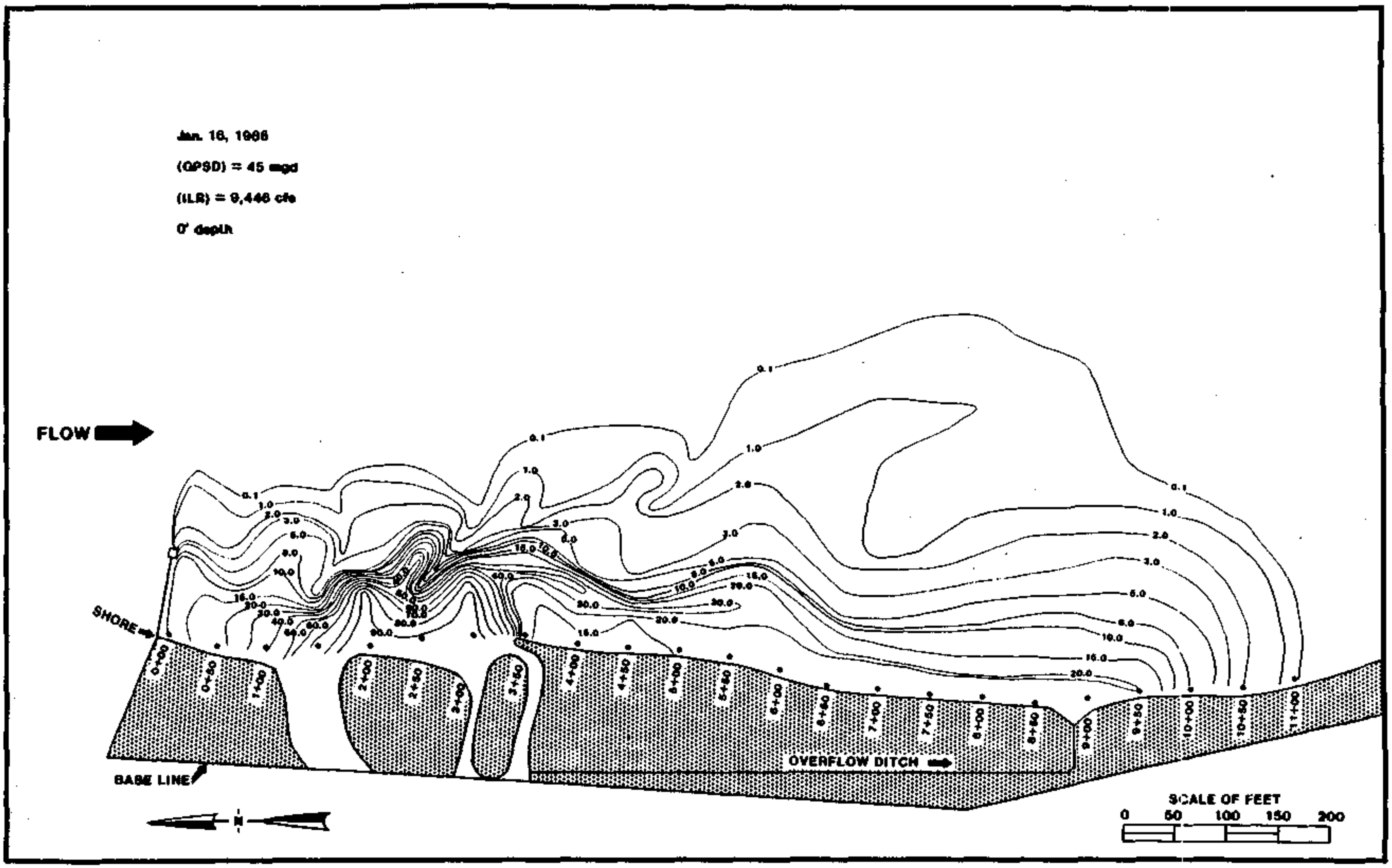
(DPSD) = 20 mgd

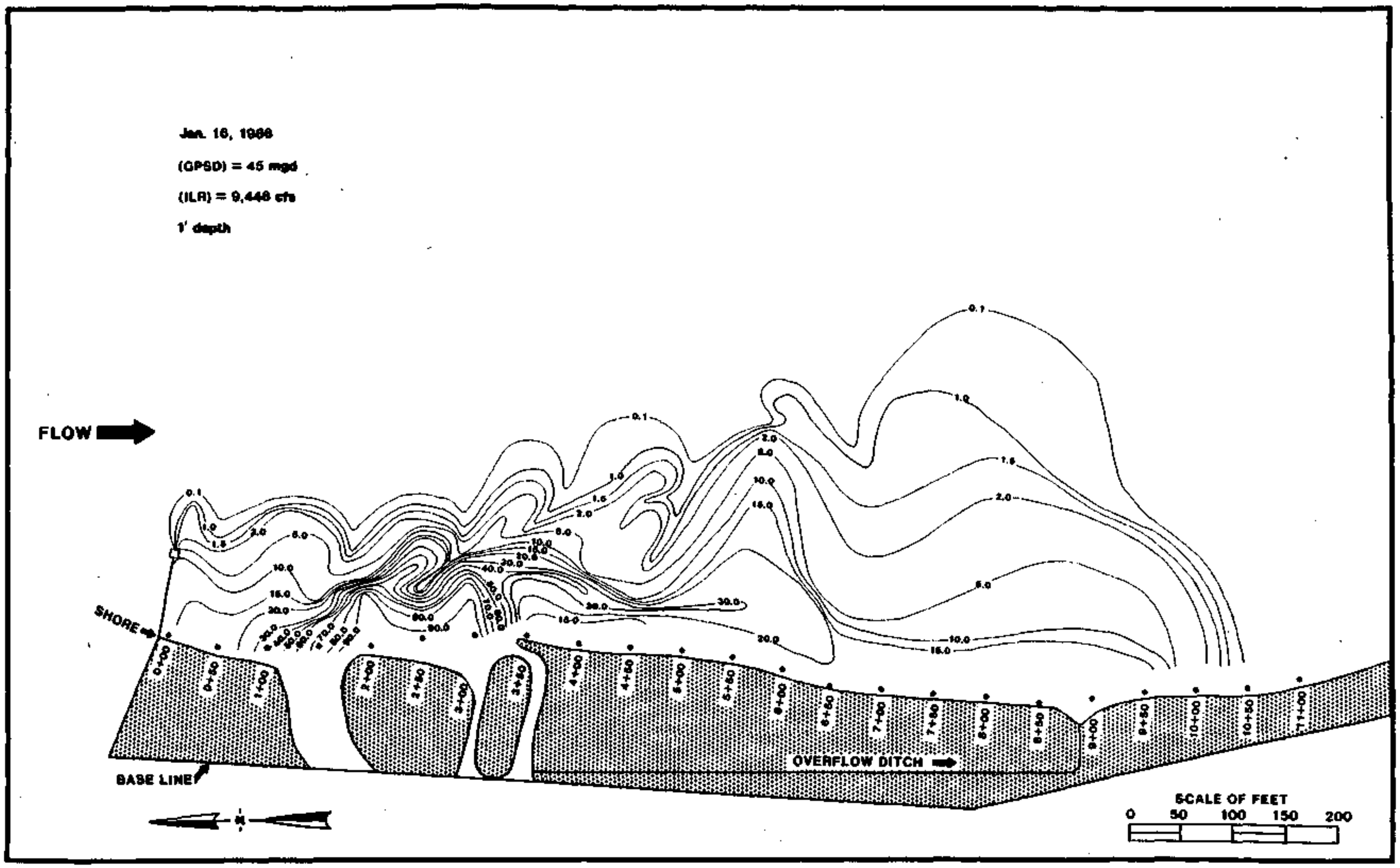
(ILR) = 10,570 cfs

1' depth


Jan. 13, 1986
(GPSD) = 20 mgd
(ILR) =10,570 cfs
3' depth
FLOW
0.1
0.5
1.5
2.0
2.5
4.0
7.0
10.0
12.0
20.0
15.0
80.0
60.0
70.0
50.0
40.0
30.0
SHORE
BASE LINE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200


Jan. 13, 1986
(DPSD) = 20 mgd
(I,R) = 10,670 cfs
8' depth
FLOW
1.0
3.0
5.0
10.0
15.0
SHORE
BASE LINE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200


Jan. 16, 1986
(QPSD) = 45 mgd
(ILR) = 9,446 cfs
0' depth
FLOW
SHORE
BASE LINE
N
0.1
1.0
2.0
3.0
5.0
8.0
10.0
15.0
20.0
30.0
40.0
50.0
60.0
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
SCALE OF FEET
0
50
100
150
200

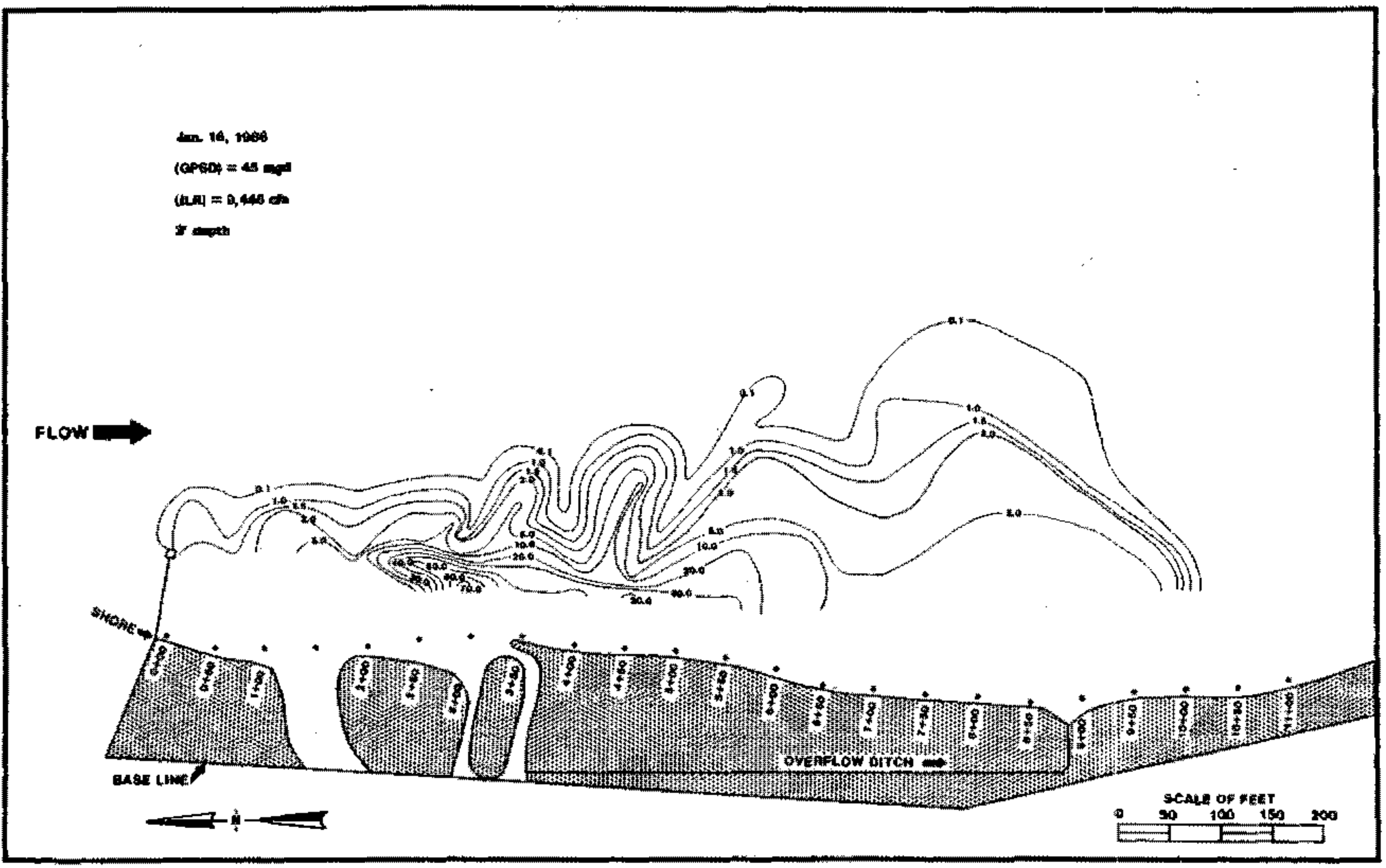


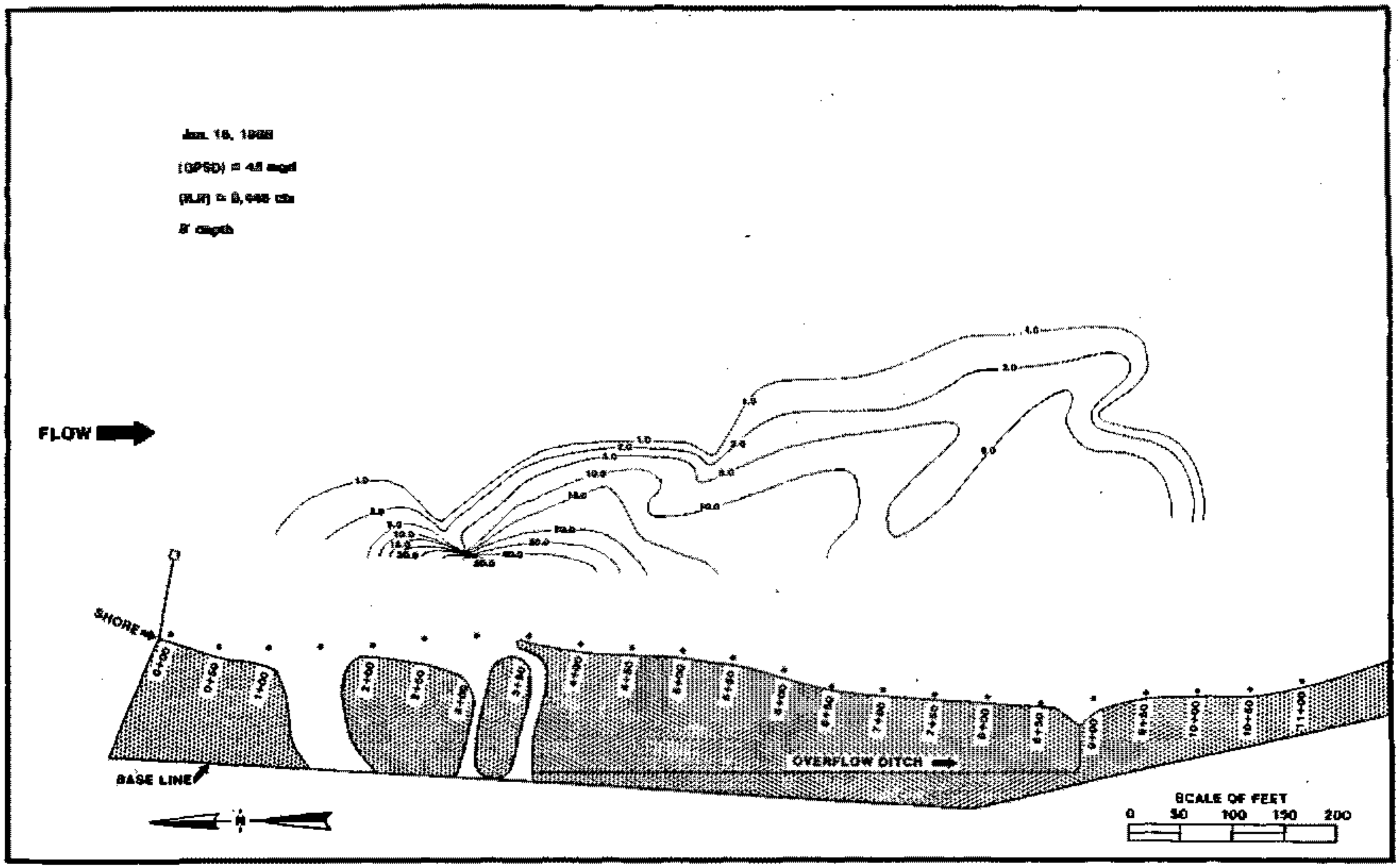
Jan. 16, 1986

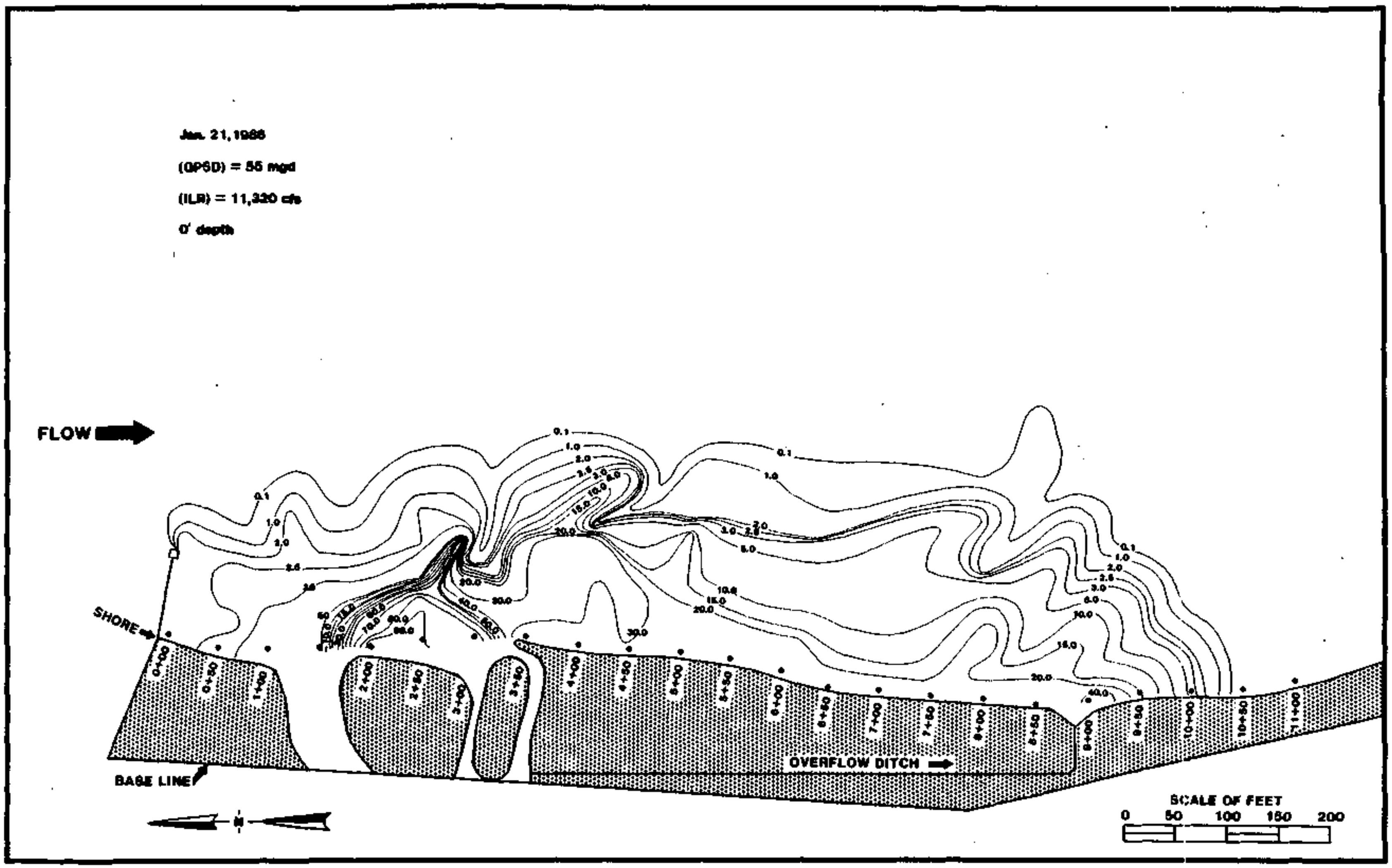
(GPSD) = 45 mgd

(ILR) = 9,448 cfs

1' depth


Jan. 16, 1986
(GPSD) = 45 mgd
(ILR) = 9,446 cfs
3' depth
FLOW
0.1
1.0
1.5
2.0
5.0
10.0
20.0
30.0
40.0
50.0
70.0
SHORE
BASE LINE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200


Jan. 16, 1968
(GPSD) = 45 mgd
(ILR) = 8,048 cfs
5' depth
FLOW
1.0
2.0
5.0
10.0
15.0
20.0
30.0
SHORE
BASE LINE
N
OVERFLOW DITCH
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
SCALE OF FEET
0
50
100
150
200

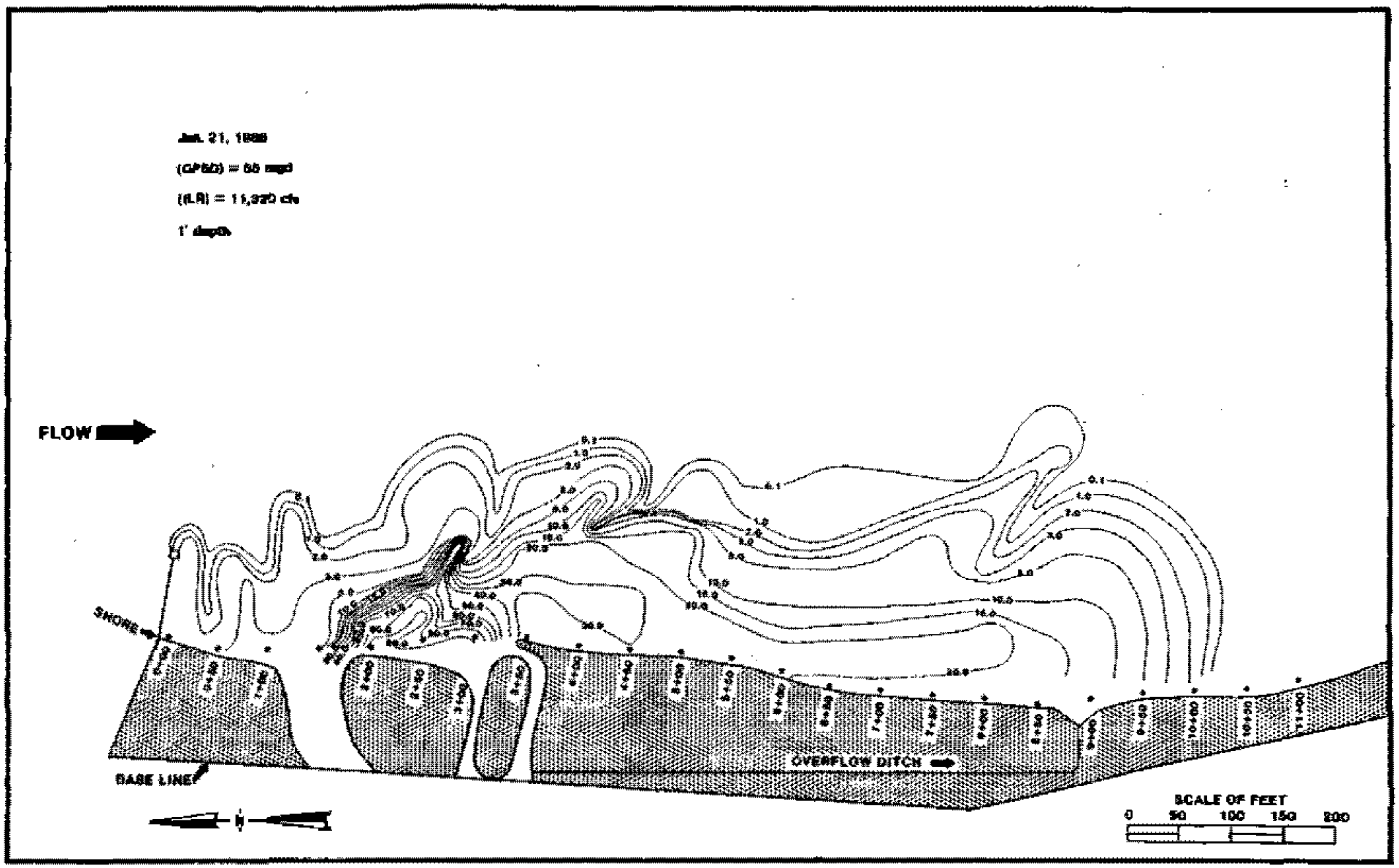


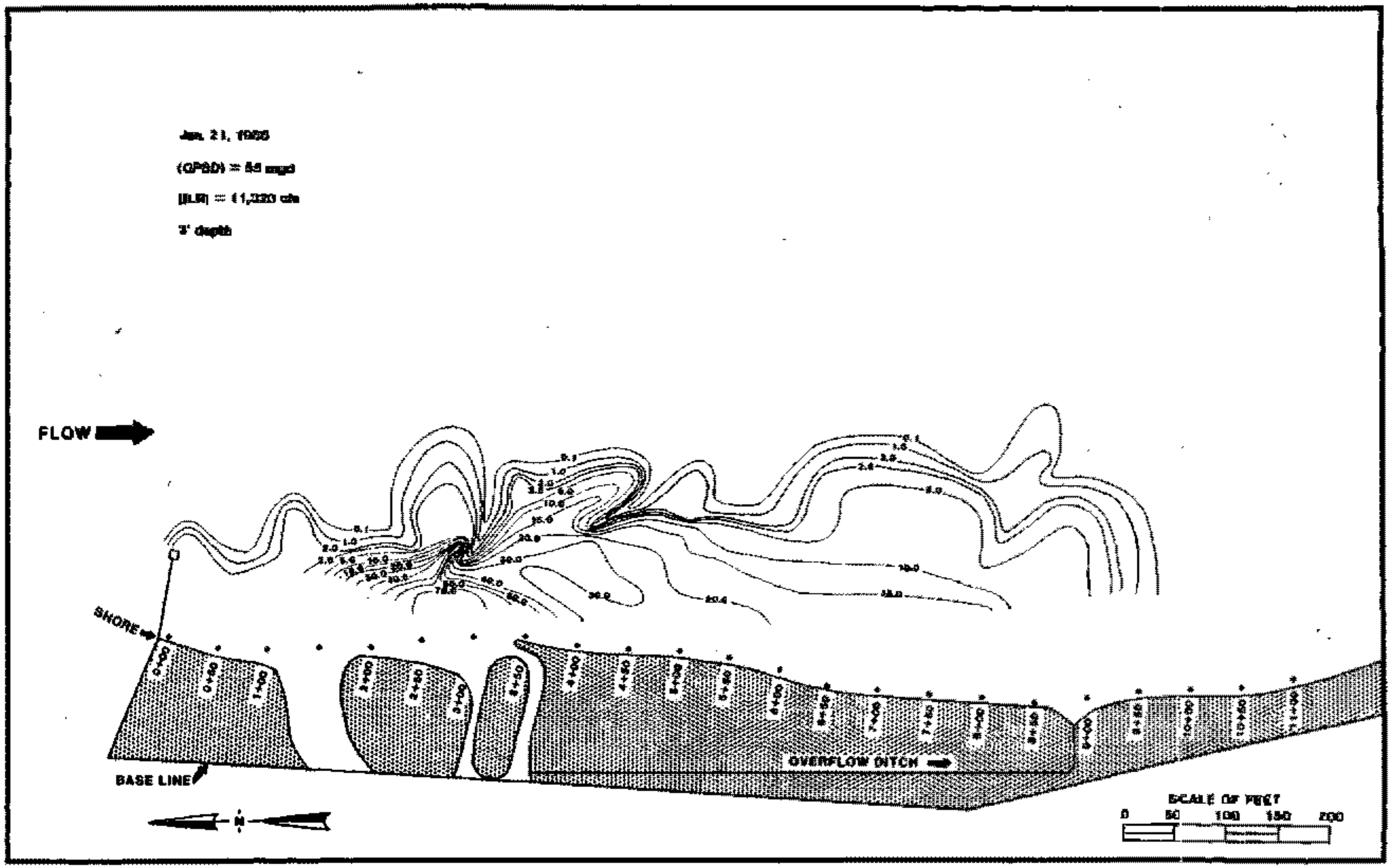
Jan. 21, 1986

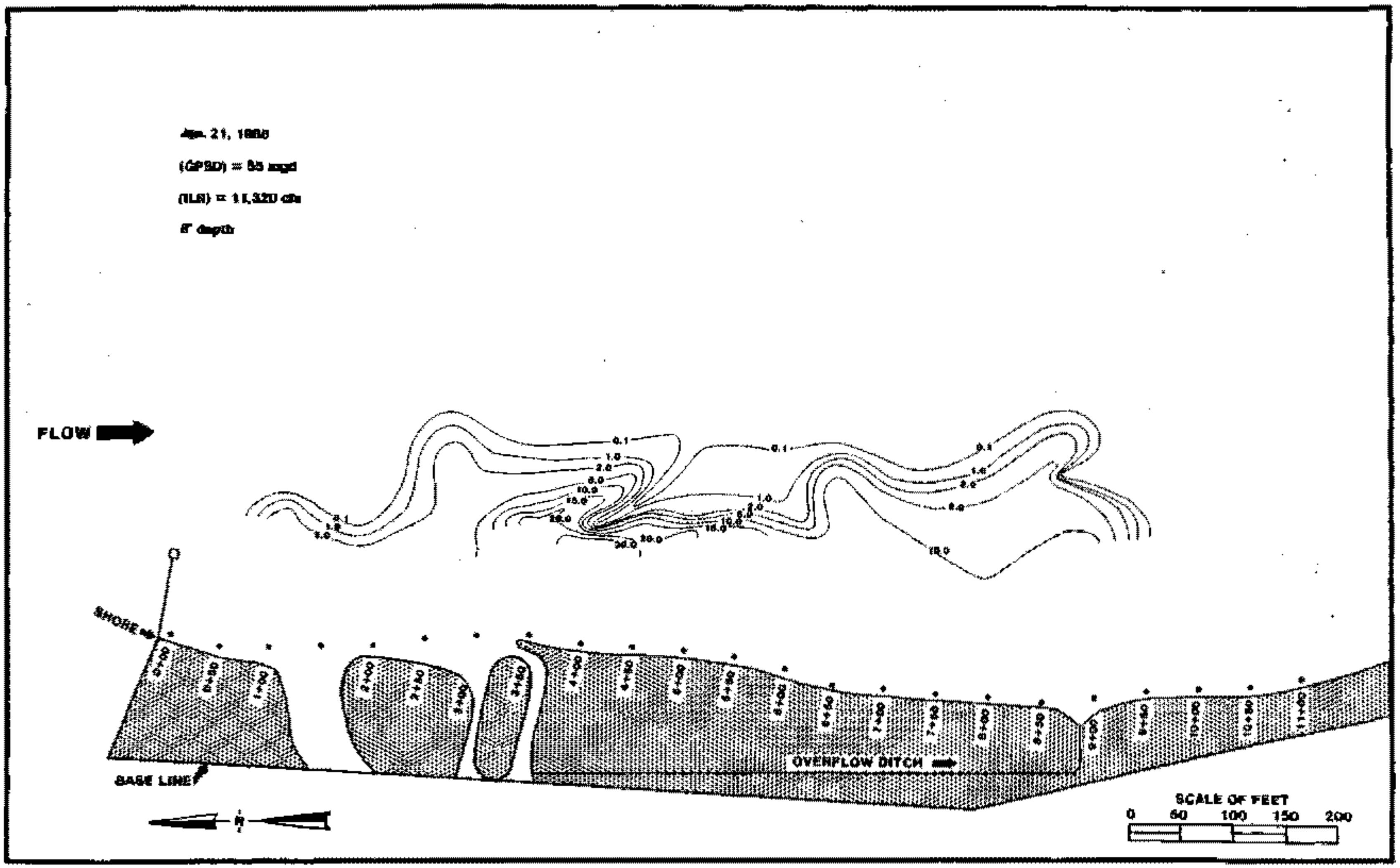
(GPSD) = 55 mgd

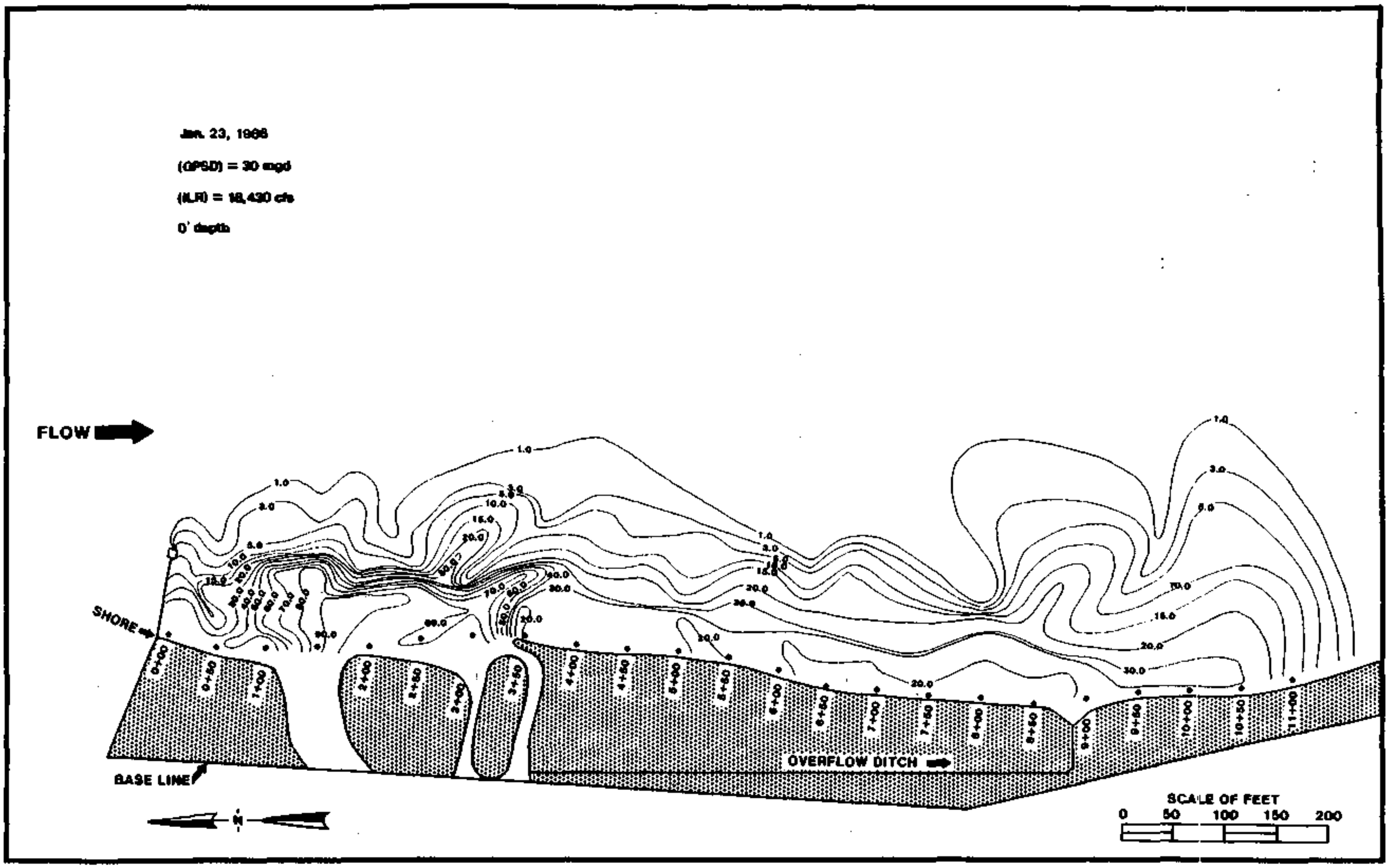
(ILR) = 11,320 cfs

0' depth


Jan. 21, 1986
(GPSD) = 55 mgd
(ILR) = 11,320 cfs
1' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
0.1
1.0
2.0
5.0
10.0
15.0
20.0
25.0
30.0
40.0
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
SCALE OF FEET
0
50
100
150
200
N


Jan. 21, 1986
(QPSD) = 55 mgd
(ILR) = 11,320 cfs
3' depth
FLOW
0.1
1.0
2.0
2.5
5.0
10.0
15.0
20.0
30.0
40.0
50.0
60.0
70.0
SHORE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
BASE LINE
N
SCALE OF FEET
0
50
100
150
200


Jan. 21, 1986
(GPSD) = 55 mgd
(ILR) = 11,320 cfs
5' depth
FLOW
0.1
1.0
2.0
5.0
10.0
15.0
20.0
30.0
SHORE
BASE LINE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200

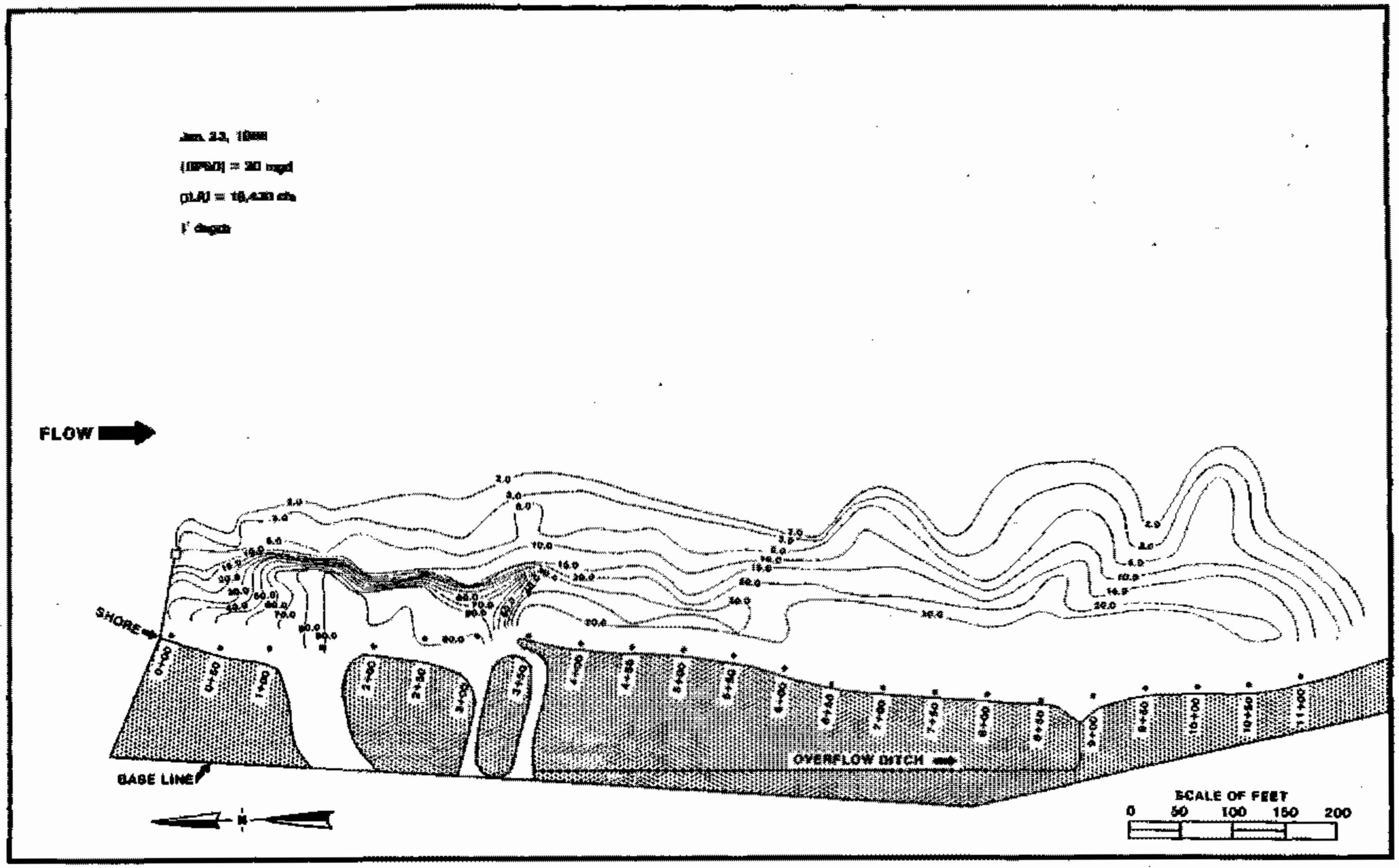


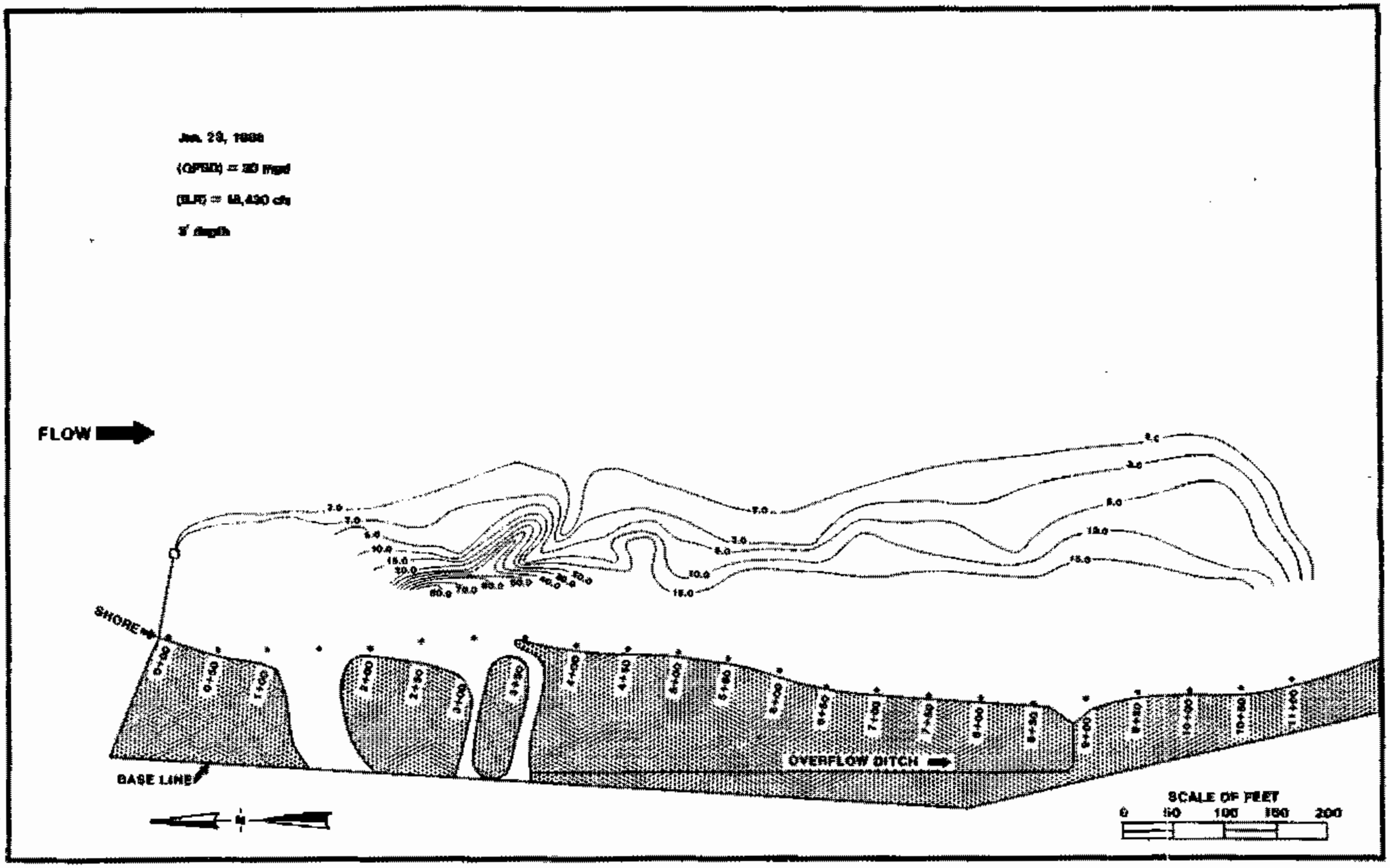
Jan. 23, 1988

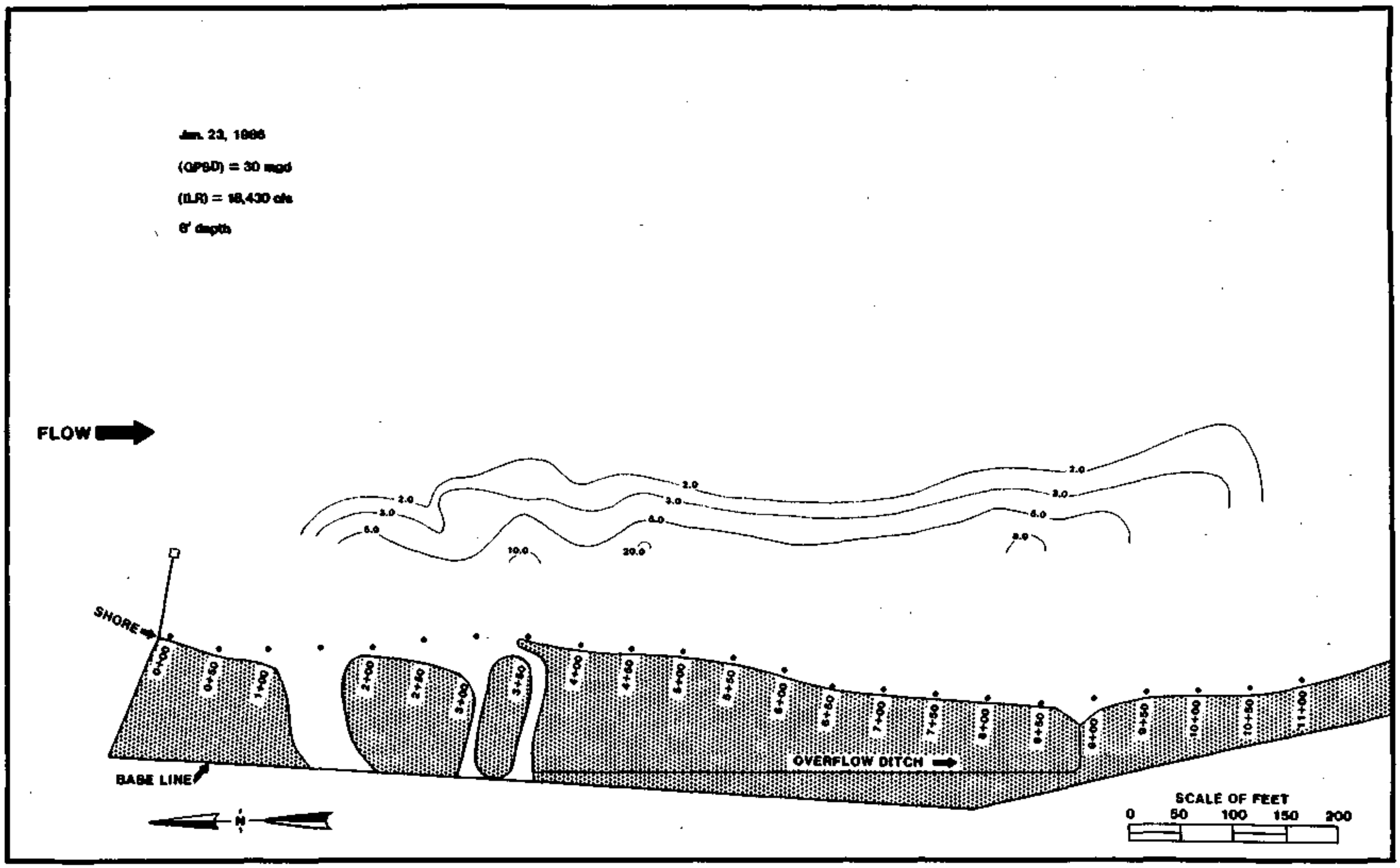
(QPSD) = 30 mgd

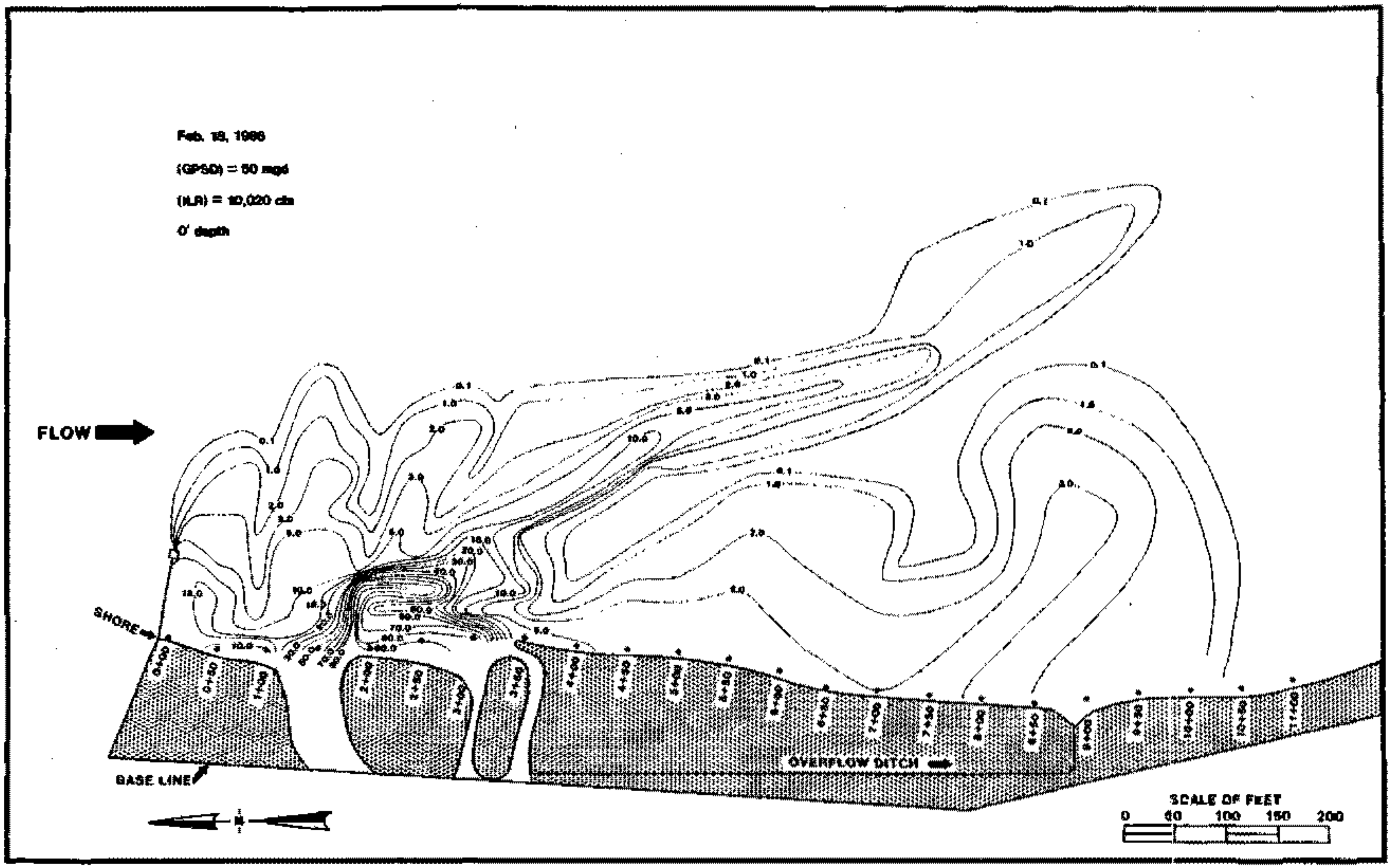
(ILR) = 18,430 cfs

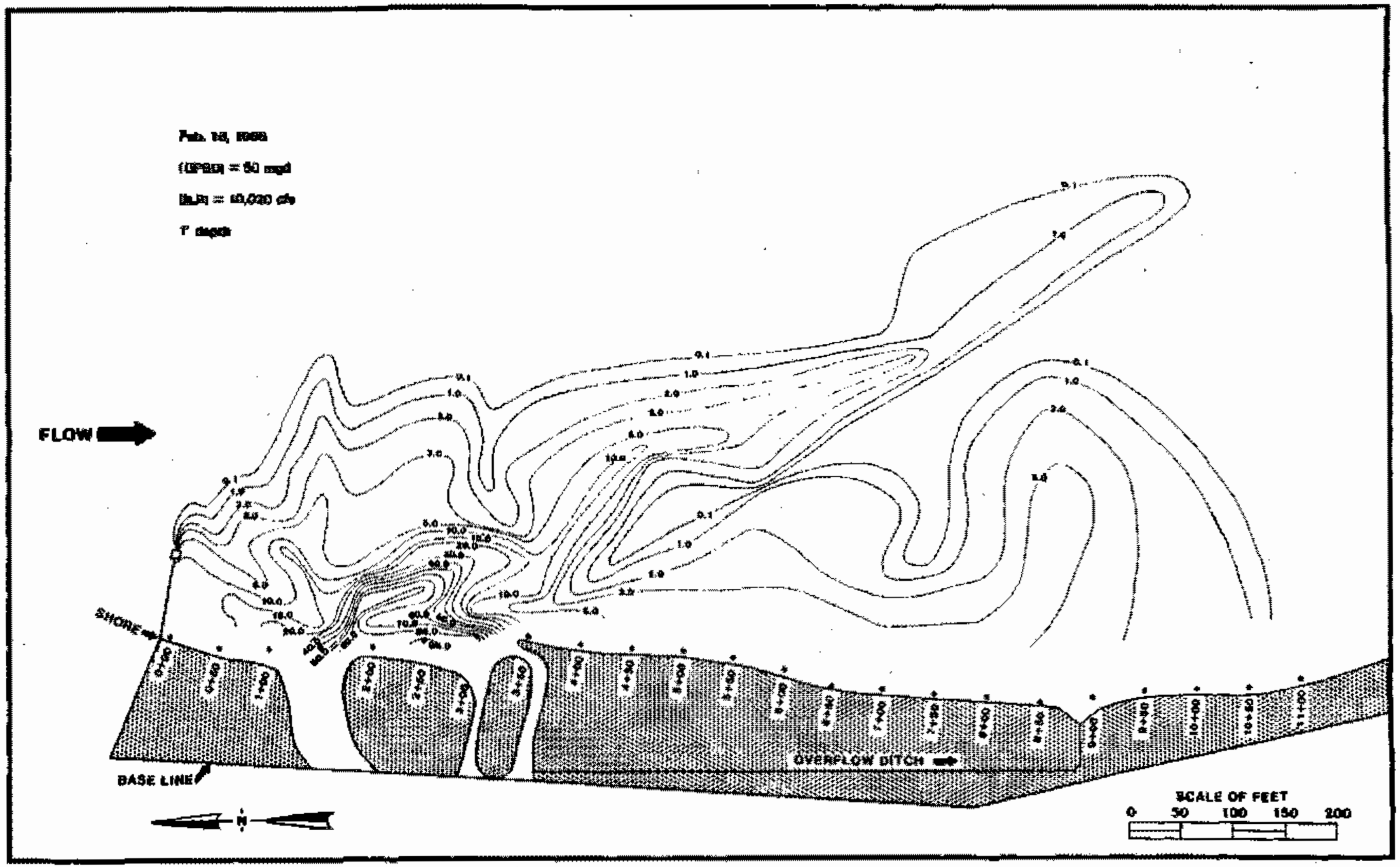
0' depth

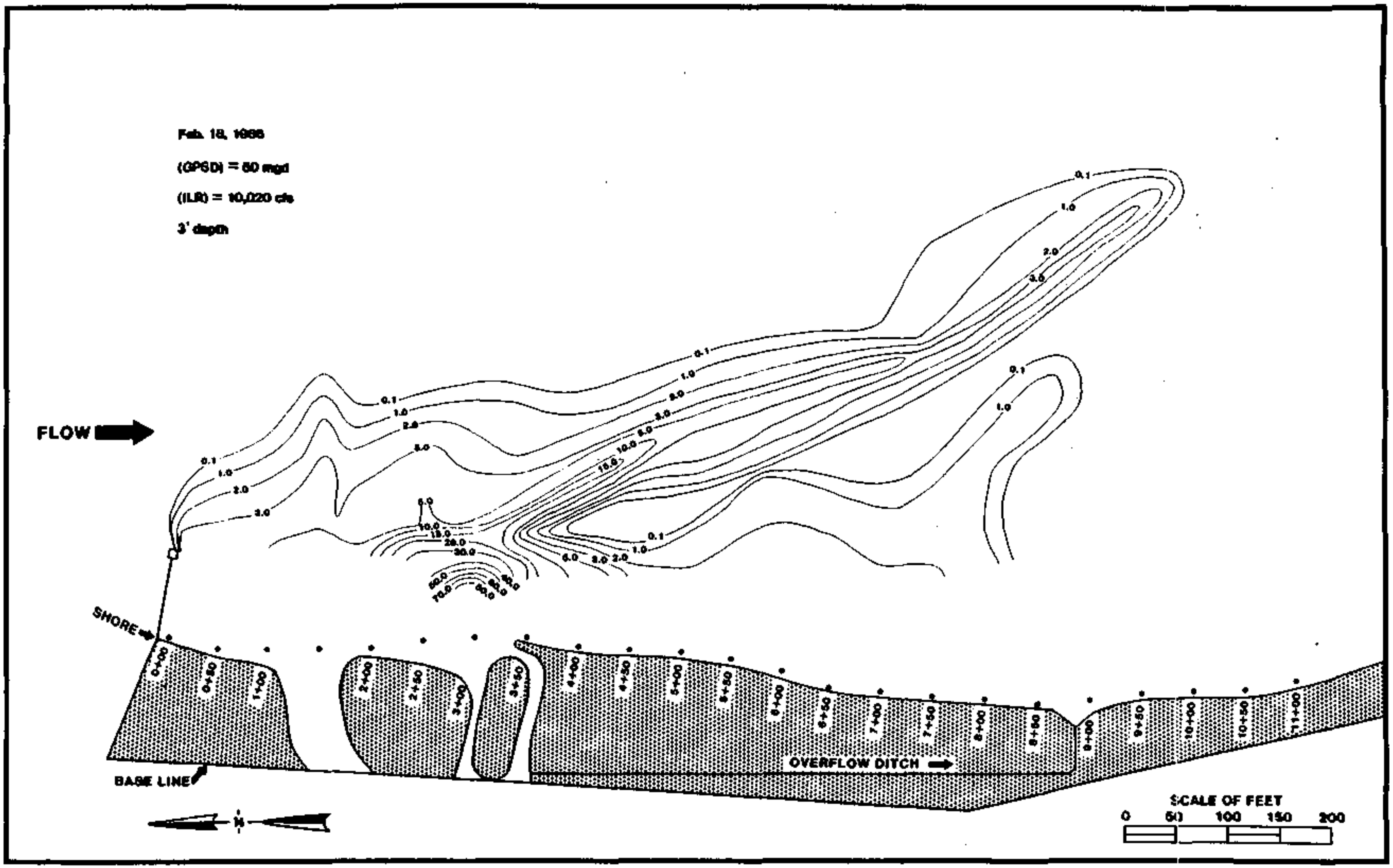

Jan. 23, 1988
(QPSO) = 30 mgd
(Q.R) = 18,430 cfs
1' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
2.0
3.0
5.0
10.0
15.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0

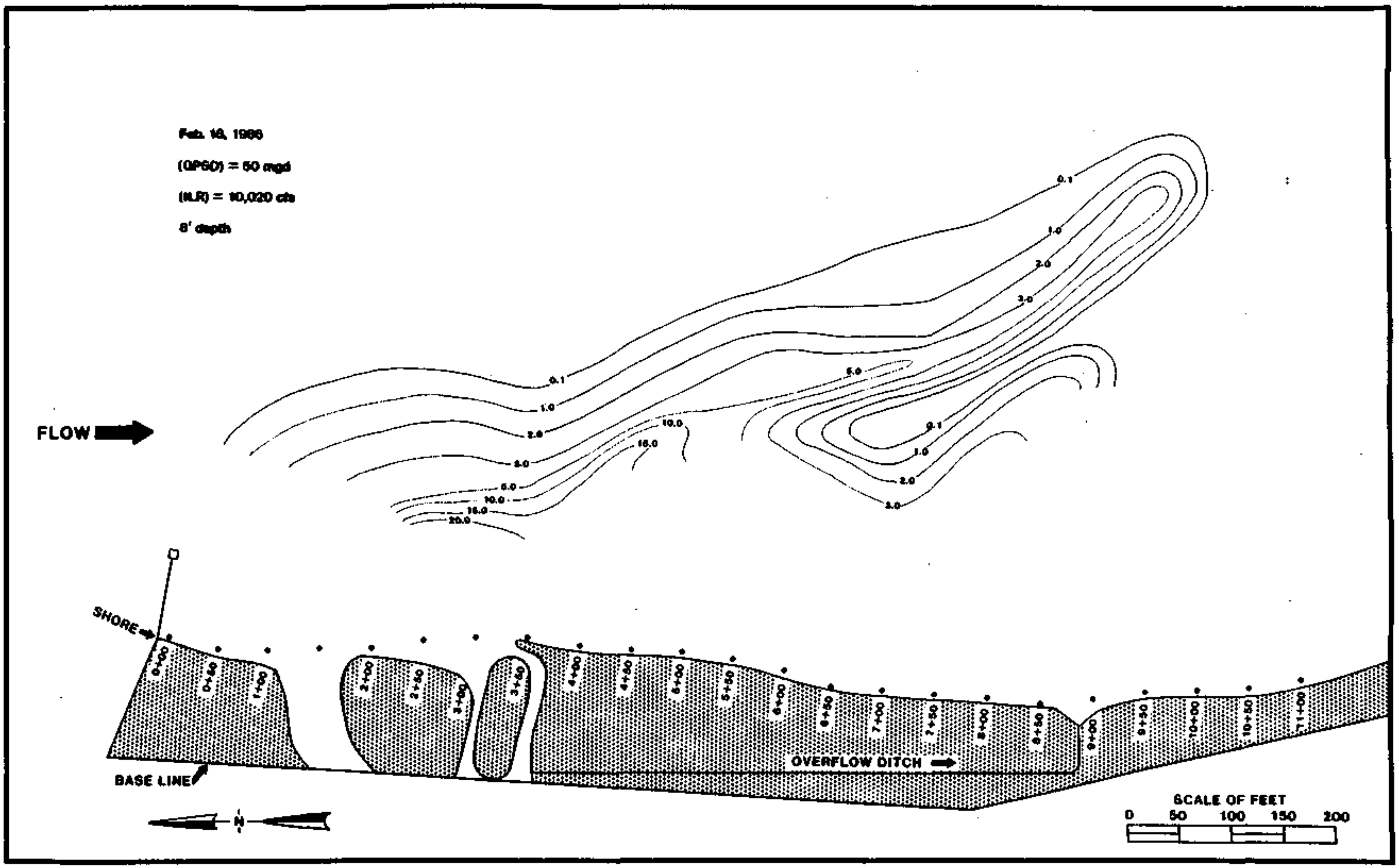

Jan. 23, 1986
(QPSD) = 20 mgd
(ILR) = 18,430 cfs
3' depth
FLOW
2.0
3.0
5.0
10.0
15.0
20.0
80.0
70.0
60.0
50.0
40.0
30.0
SHORE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
BASE LINE
N
SCALE OF FEET
0 50 100 150 200

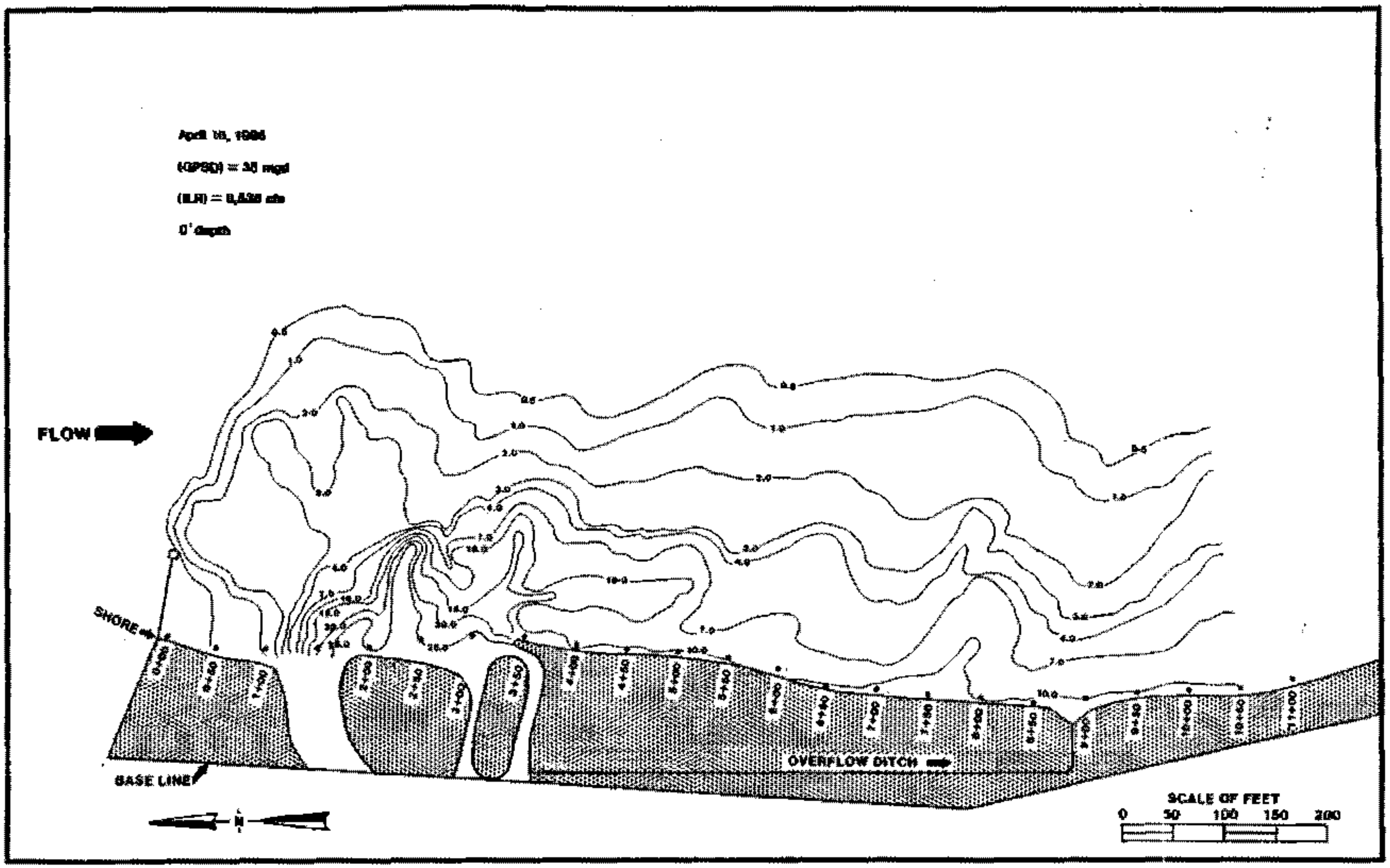

Jan. 23, 1986
(QPSD) = 30 mgd
(ILR) = 18,430 cfs
6' depth
FLOW
2.0
3.0
5.0
10.0
20.0
2.0
3.0
5.0
8.0
2.0
3.0
SHORE
BASE LINE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200

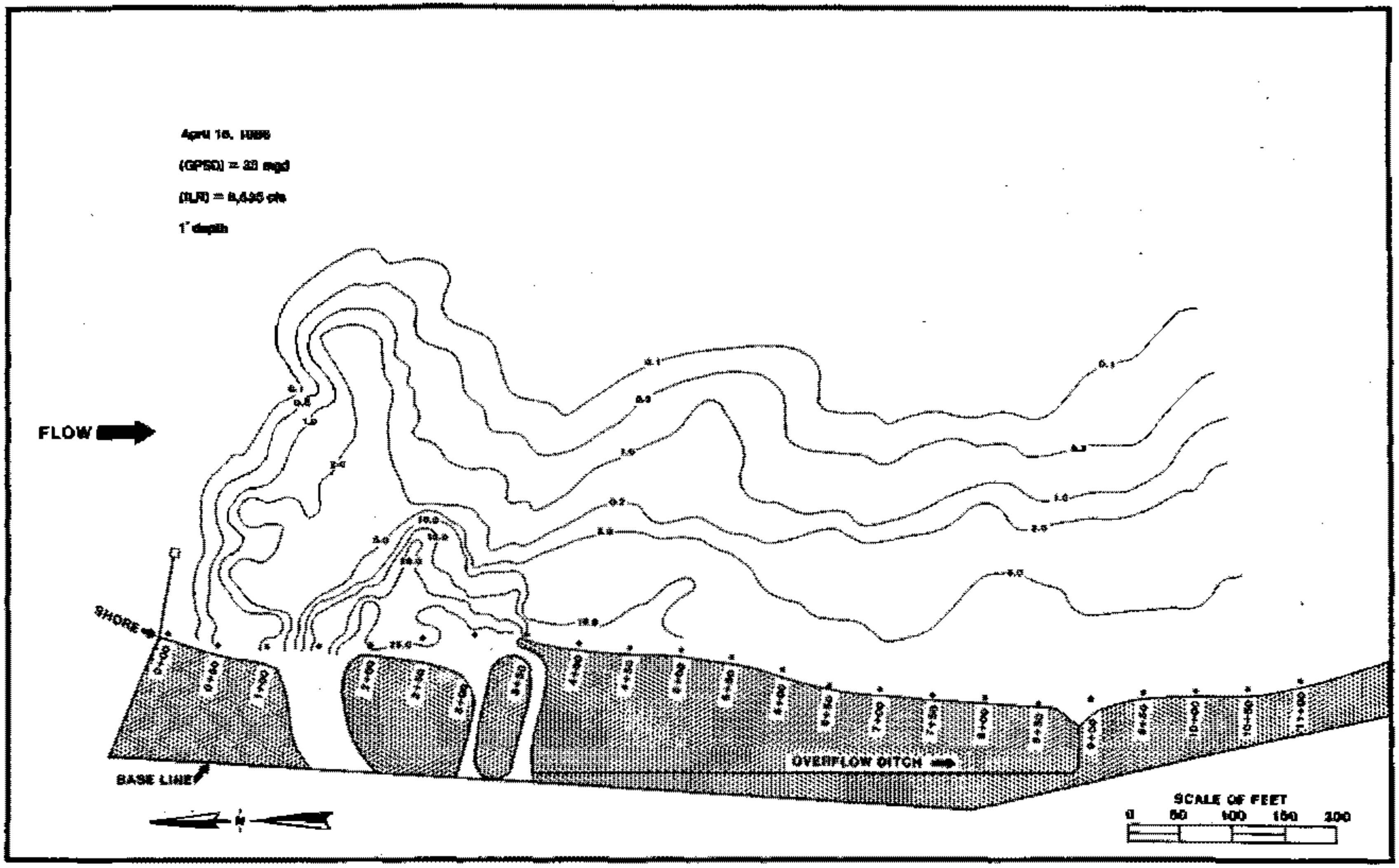

Feb. 18, 1986
(GPSD) = 50 mgd
(ILR) = 10,020 cfs
0' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
0.1
1.0
2.0
3.0
5.0
10.0
15.0
20.0
30.0
50.0
60.0
70.0
80.0
90.0
N
SCALE OF FEET
0
50
100
150
200

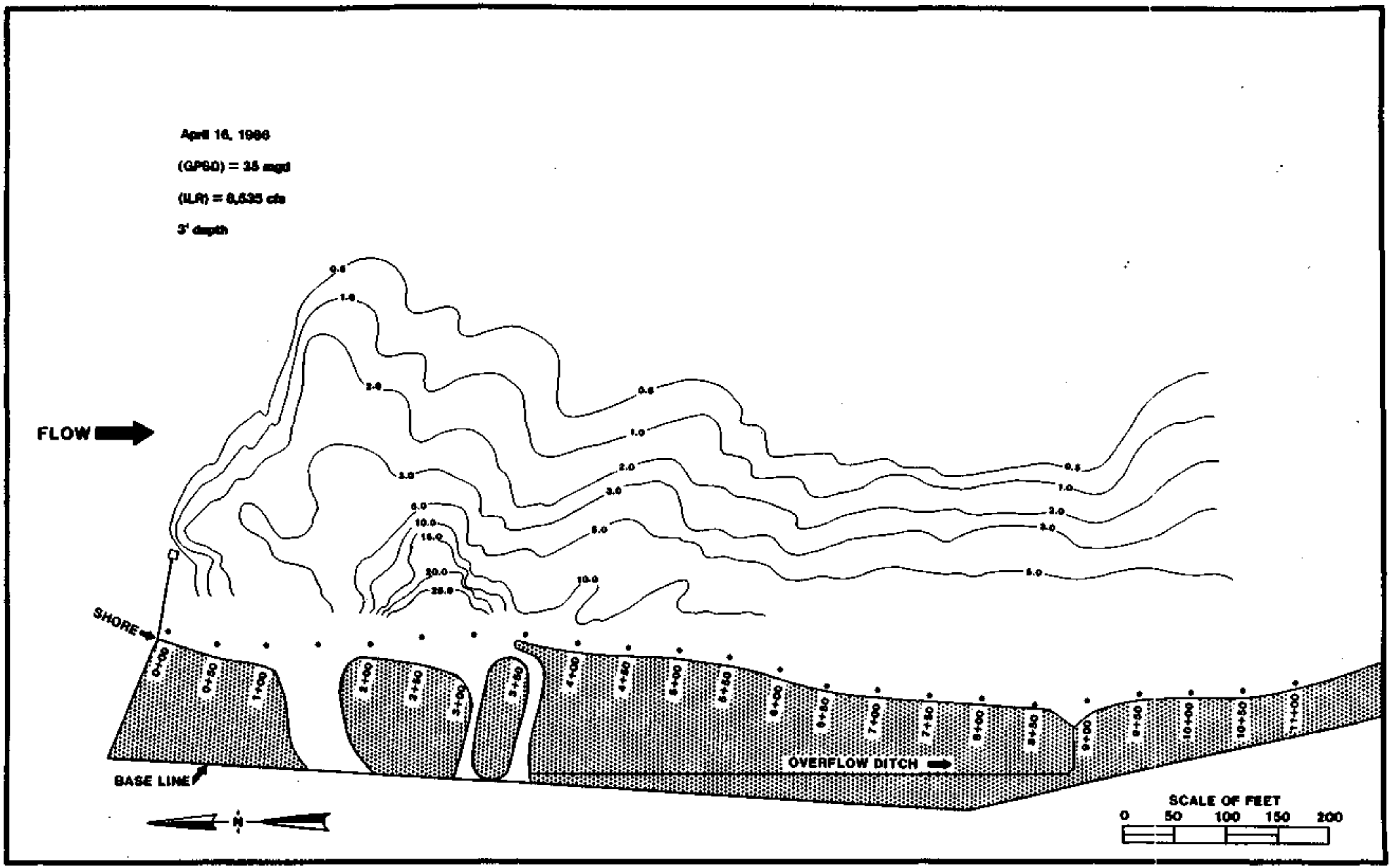

Feb. 16, 1968
= 50 mgd
= 10,020 cfs
1' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
0.1
1.0
2.0
3.0
5.0
10.0
20.0
30.0
40.0
50.0


Feb. 18, 1986
(GPSD) = 60 mgd
(ILR) = 10,020 cfs
3' depth
FLOW
0.1
1.0
2.0
3.0
5.0
10.0
15.0
20.0
30.0
40.0
50.0
60.0
70.0
SHORE
BASE LINE
OVERFLOW DITCH
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
N
SCALE OF FEET
0
50
100
150
200


Feb. 18, 1986
(GPSD) = 50 mgd
(ILR) = 10,020 cfs
8' depth
FLOW
0.1
1.0
2.0
3.0
5.0
10.0
15.0
20.0
SHORE
BASE LINE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200


April 16, 1986
(GPSD) = 35 mgd
(ILR) = 8,530 cfs
0' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
N
0.5
1.0
2.0
3.0
4.0
7.0
10.0
15.0
20.0
25.0
30.0
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
SCALE OF FEET
0
50
100
150
200

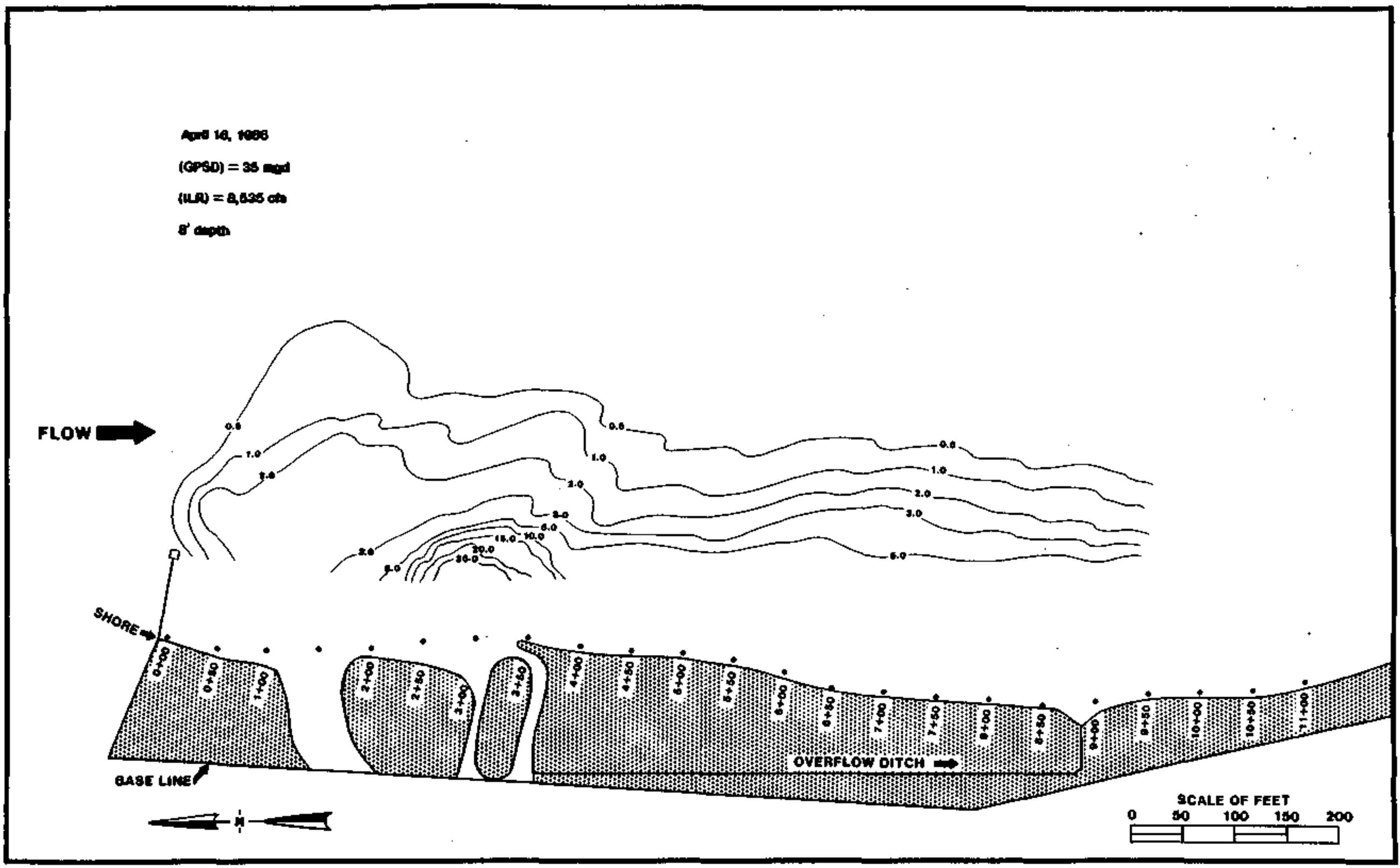

April 16, 1986
(GPSD) = 33 mgd
(ILR) = 8,436 cfs
1' depth
FLOW
SHORE
BASE LINE
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00


April 16, 1986

(GPSD) = 35 mgd

(ILR) = 8,635 cfs

3' depth

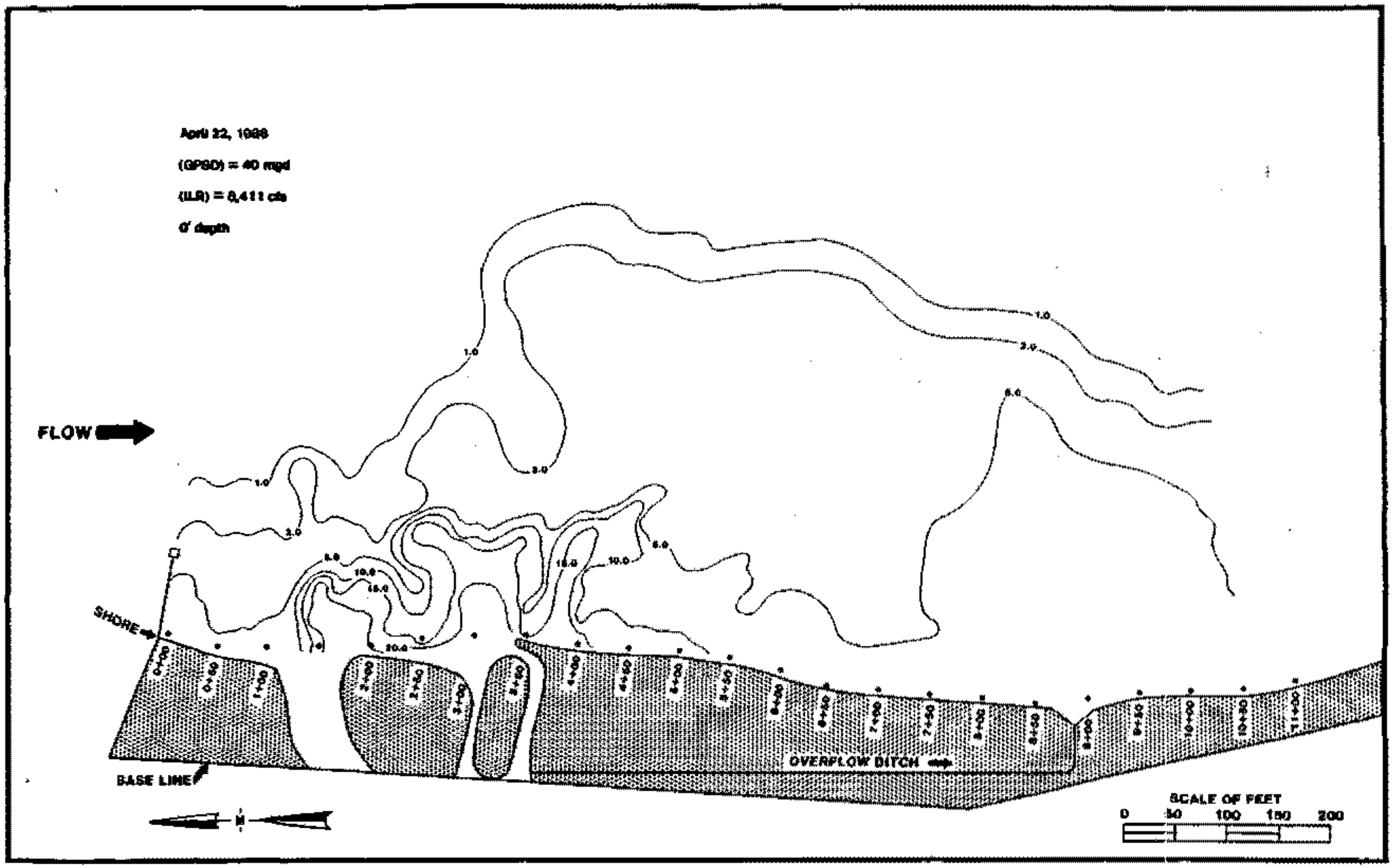


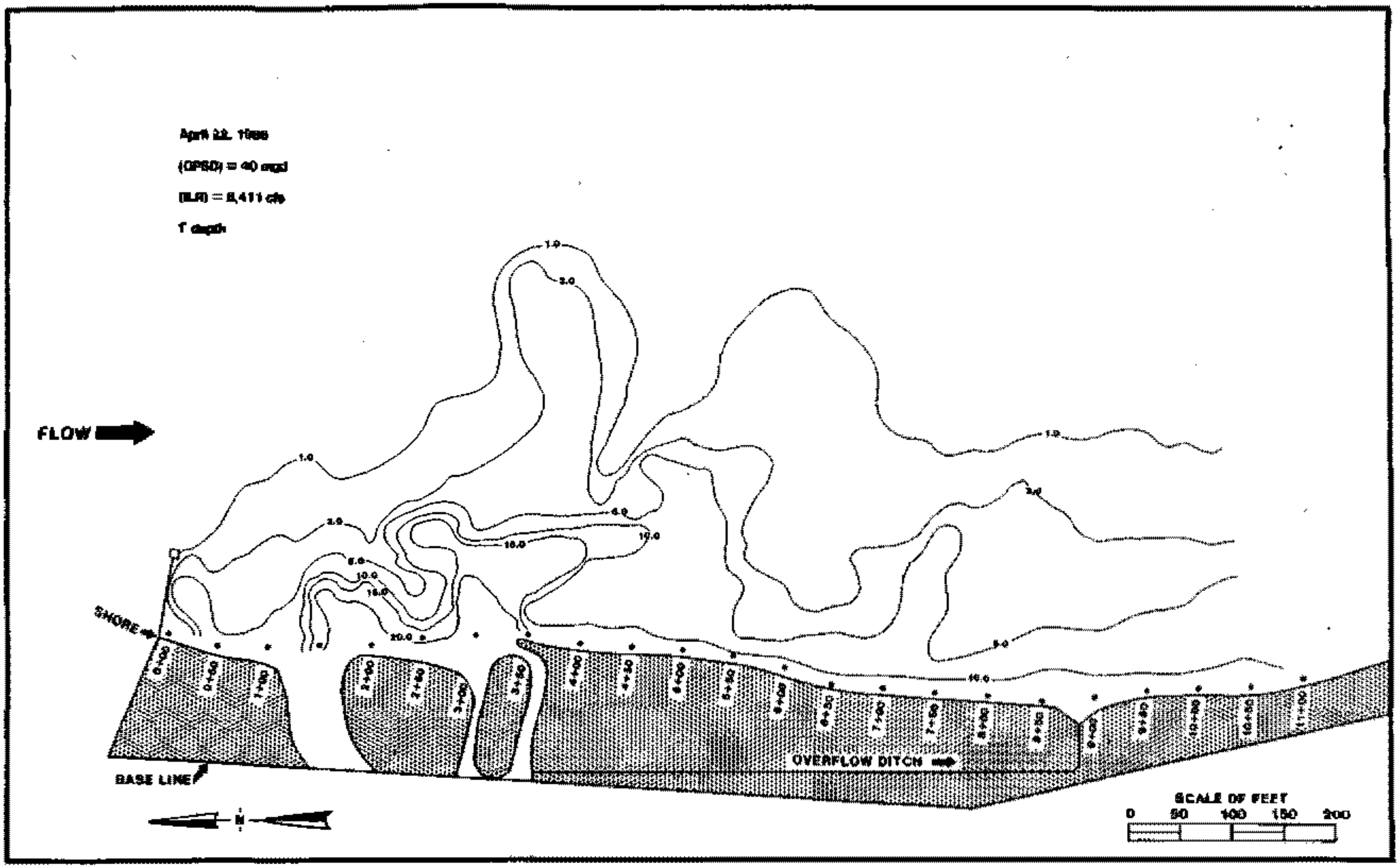
April 16, 1986

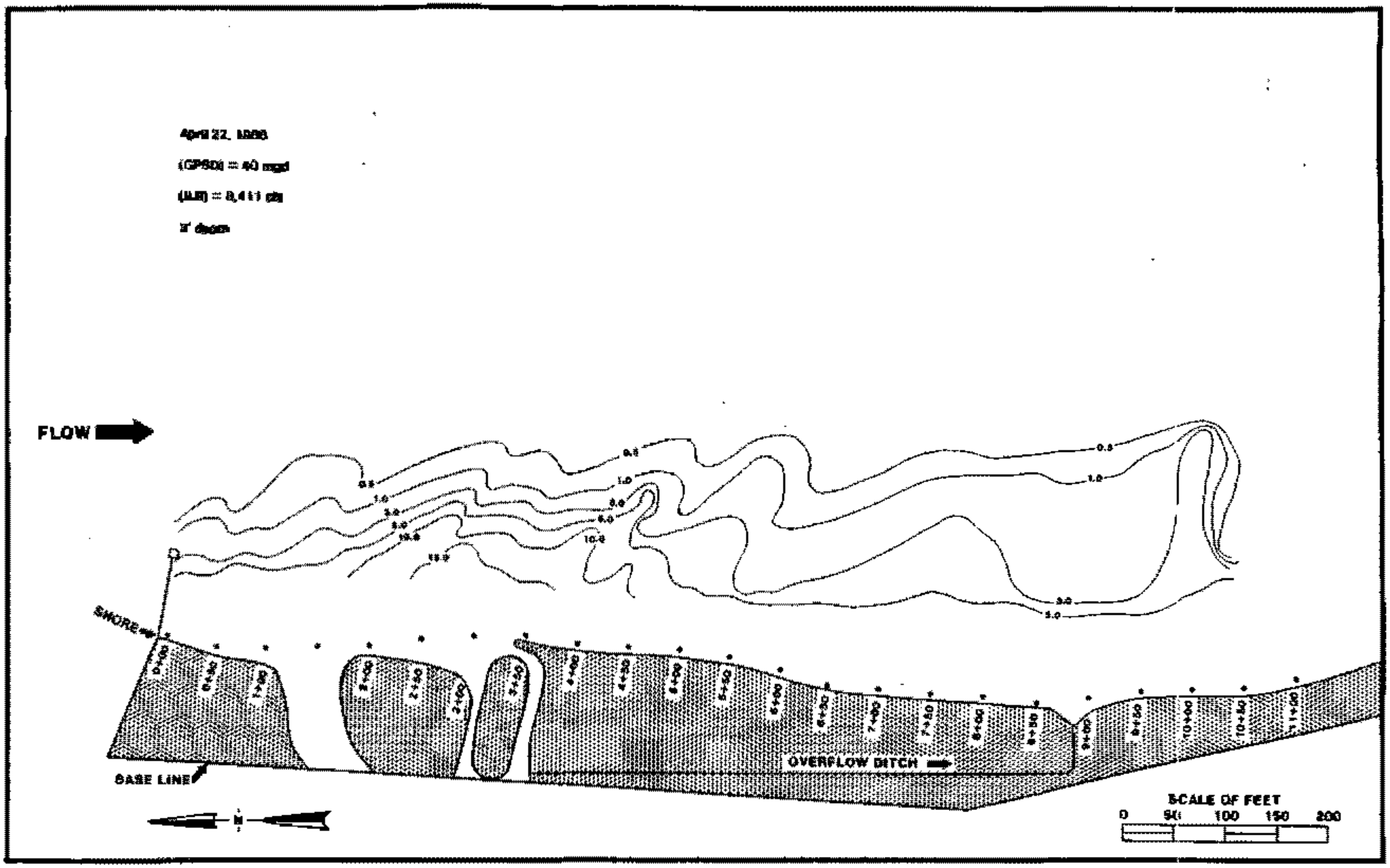
(GPSD) = 35 mgd

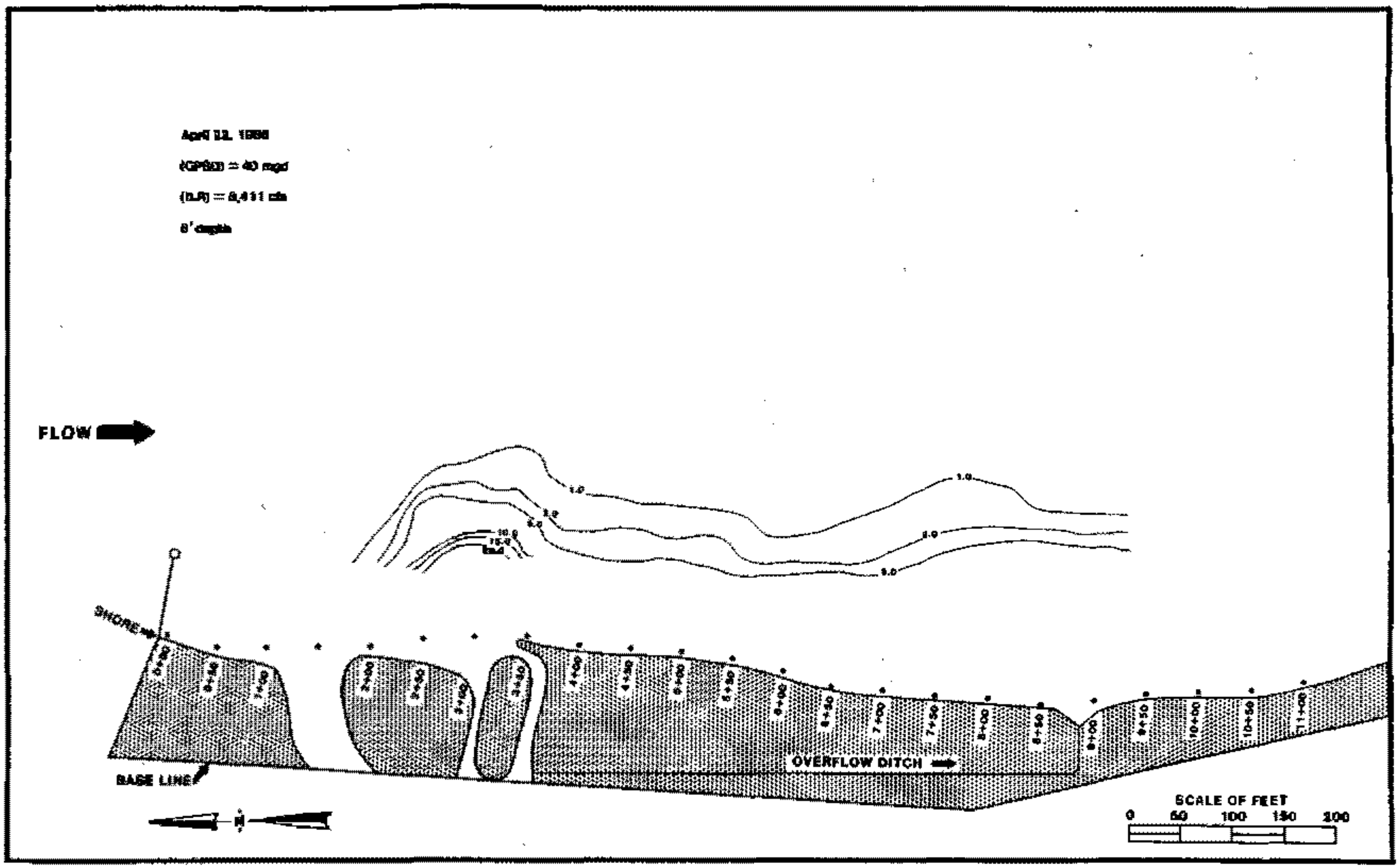
(ILR) = 8,535 cfs

8' depth


April 22, 1998
(GPSD) = 40 mgd
(ILR) = 6,411 cfs
0' depth
FLOW
1.0
2.0
5.0
10.0
15.0
20.0
SHORE
BASE LINE
OVERFLOW DITCH
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
N
SCALE OF FEET
0
50
100
150
200


April 22, 1988
(OPSD) = 40 mgd
(ILR) = 8,411 cfs
1' depth
FLOW
1.0
2.0
5.0
10.0
15.0
20.0
SHORE
BASE LINE
OVERFLOW DITCH
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
N
SCALE OF FEET
0
50
100
150
200


April 22, 1988
(GPSD) = 40 mgd
(ILR) = 8,411 cfs
3' down
FLOW
0.5
1.0
3.0
5.0
10.0
15.0
SHORE
BASE LINE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
N
SCALE OF FEET
0
50
100
150
200


April 11, 1986
(CPS3) = 40 mgd
(I.R.) = 8,411 cfs
8' depth
FLOW
1.0
2.0
3.0
5.0
10.0
15.0
SHORE
0+00
0+50
1+00
2+00
2+50
3+00
3+50
4+00
4+50
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
OVERFLOW DITCH
BASE LINE
N
SCALE OF FEET
0
50
100
150
200

Appendix B-2. Specific Assessment Information for Streams, 2012.

Legend

Support Code	Use Support Level
F	Fully Supporting
N	Not Supporting
I	Insufficient Information
X	Not Assessed

Use ID	Use Description
582	Aquatic Life
583	Fish Consumption
584	Public and Food Processing Water Supplies
585	Primary Contact
586	Secondary Contact
587	Indigenous Aquatic Life
590	Aesthetic Quality

Cause ID	Description
N/A	No Cause Identified
1	.alpha.-BHC
34	2,4-D
79	Aldrin
84	Alteration in stream-side or littoral vegetative covers
91	Ammonia (Un-ionized)
96	Arsenic
99	Atrazine
104	Barium
123	Boron
127	Cadmium
137	Chlordane
138	Chloride
139	Chlorine
154	Chromium (total)
160	Color
163	Copper
168	Cyanide
177	DDT
198	Dieldrin
203	Dioxin (including 2,3,7,8-TCDD)
213	Endrin
228	Fish-Passage Barrier
229	Fish Kills
234	Fluoride
244	Heptachlor
246	Hexachlorobenzene
260	Iron
267	Lead
268	Lindane
270	Low flow alterations
273	Manganese
274	Mercury

Cause ID	Description
277	Methoxychlor
301	Nickel
308	Ammonia (Total)
313	Nonnative Fish, Shellfish, or Zooplankton
317	Oil and Grease
319	Other flow regime alterations
322	Oxygen, Dissolved
339	Phenols
348	Polychlorinated biphenyls
371	Sedimentation/Siltation
375	Silver
385	Sulfates
388	Temperature, water
390	Terbufos
399	Total Dissolved Solids
400	Fecal Coliform
403	Total Suspended Solids (TSS)
413	Turbidity
423	Zinc
441	pH
452	Nitrogen, Nitrate
462	Phosphorus (Total)
463	Cause Unknown
471	Bottom Deposits
478	Aquatic Plants (Macrophytes)
479	Aquatic Algae
500	Changes in Stream Depth and Velocity Patterns
501	Loss of Instream Cover
502	Sludge
519	Visible Oil
520	Odor
521	Ethanol

Appendix B-2. Specific Assessment Information for Streams, 2012.

Legend

Source ID	Description
N/A	No Source Identified
2	Acid Mine Drainage
4	Animal Feeding Operations (NPS)
10	Atmospheric Deposition - Toxics
20	Channelization
23	Combined Sewer Overflows
28	Contaminated Sediments
36	Drainage/Filling/Loss of Wetlands
37	Dredge Mining
38	Dredging (E.g., for Navigation Channels)
45	Golf Courses
49	Highway/Road/Bridge Runoff (Non-construction Related)
50	Highways, Roads, Bridges, Infrastructure (New Construction)
56	Impacts from Abandoned Mine Lands (Inactive)
58	Impacts from Hydrostructure Flow Regulation/modification
61	Industrial Land Treatment
62	Industrial Point Source Discharge
66	Irrigated Crop Production
69	Landfills
72	Loss of Riparian Habitat
73	Managed Pasture Grazing
82	Mine Tailings
84	Municipal (Urbanized High Density Area)
85	Municipal Point Source Discharges

Source ID	Description
87	Non-irrigated Crop Production
92	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)
95	Other Recreational Pollution Sources
102	Petroleum/natural Gas Activities
115	Sanitary Sewer Overflows (Collection System Failures)
122	Site Clearance (Land Development or Redevelopment)
124	Spills from Trucks or Trains
125	Streambank Modifications/destabilization
126	Subsurface (Hardrock) Mining
127	Surface Mining
130	Unpermitted Discharge (Domestic Wastes)
132	Upstream Impoundments (e.g., Pl-566 NRCS Structures)
135	Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO)
140	Source Unknown
142	Dam or Impoundment
143	Livestock (Grazing or Feeding Operations)
144	Crop Production (Crop Land or Dry Land)
155	Natural Sources
156	Agriculture
157	Habitat Modification - other than Hydromodification
161	Pesticide Application
177	Urban Runoff/Storm Sewers
178	Coal Mining (Subsurface)
181	Runoff from Forest/Grassland/Parkland

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Ackerman Cr.	IL_DZZPC	0713000116	11	3	7.32	X582, X583, X585, X586, X590	N/A	N/A
Adams Branch	IL_DAHA	0713001201	18	3	6.17	X582, X583, X585, X586, X590	N/A	N/A
Addison Cr.	IL_GLA-02	0712000404	2	5	6.72	N582, X583, N585, X586, X590	79, 84, 138, 154, 177, 246, 301, 319, 462, 500, 400	28, 20, 72, 23, 85, 177, 132, 142
Addison Cr.	IL_GLA-04	0712000404	2	5	3.43	N582, X583, X585, X586, N590	1, 84, 163, 246, 317, 319, 322, 348, 371, 403, 462, 519, 471, 479	28, 20, 72, 125, 132, 85, 58, 177, 142
Adds Branch	IL_IXMA	0714010801	33	3	5.16	X582, X583, X585, X586, X590	N/A	N/A
Akin Cr.	IL_NHG	0714010604	26	3	9.23	X582, X583, X585, X586, X590	N/A	N/A
Akward Cr.	IL_NJCC	0714010601	26	3	2.82	X582, X583, X585, X586, X590	N/A	N/A
Alcorn Cr.	IL_AHA	0514020309	32	3	5.77	X582, X583, X585, X586, X590	N/A	N/A
Allen Branch	IL_ATHDC	0514020403	32	3	2.6	X582, X583, X585, X586, X590	N/A	N/A
Allen Cr.	IL_PBPB	0709000702	8	3	3.18	X582, X583, X585, X586, X590	N/A	N/A
Allforks Cr.	IL_DZN	0713000108	11	3	11.84	X582, X583, X585, X586, X590	N/A	N/A
Allison Ditch	IL_BEZF-01	0512011215	30	3	18.71	X582, X583, X585, X586, X590	N/A	N/A
Alloway Cr.	IL_DKH-01	0713000407	14	3	6.48	X582, X583, X585, X586, X590	N/A	N/A
Ambeer Cr.	IL_IXDBA	0714010802	33	3	2.4	X582, X583, X585, X586, X590	N/A	N/A
Anderson Branch	IL_DAJ	0713001201	18	3	6.38	X582, X583, X585, X586, X590	N/A	N/A
Anderson Cr.	IL_ATHN	0514020401	32	3	2.24	X582, X583, X585, X586, X590	N/A	N/A
Andy Cr.	IL_NZN-13	0714010607	26	5	11.68	N582, X583, X585, X586, X590	260, 273, 322, 500	20, 72, 144, 156, 140
Andys Run	IL_JHC	0714010107	27	3	5.11	X582, X583, X585, X586, X590	N/A	N/A
Angel Branch	IL_OSCA	0714020108	23	3	3.75	X582, X583, X585, X586, X590	N/A	N/A
Apple Cr.	IL_DB-01	0713001107	18	5	21.88	F582, X583, N585, X586, X590	400	140
Apple Cr.	IL_DB-04	0713001106	18	2	47.68	F582, X583, X585, X586, X590	N/A	N/A
Apple R.	IL_MN-01	0706000506	9	3	17.29	X582, X583, X586, X590	N/A	N/A
Apple R.	IL_MN-03	0706000506	9	5	8.99	F582, X583, N585, X586, F590	400	140
Apple R.	IL_MN-04	0706000505	9	2	11.74	F582, X583, X585, X586, F590	N/A	N/A
Apple R.	IL_MN-07	0706000505	9	2	4.29	F582, X583, X585, X586, F590	N/A	N/A
Apple R.	IL_MN-08	0706000505	9	2	3.39	F582, X583, X585, X586, F590	N/A	N/A
Apple RIver	IL_MN-19	0706000506	9	2	7.16	F582, X583, X585, X586, F590	N/A	N/A
Archer Cr.	IL_ELE	0713000802	20	3	10.49	X582, X583, X585, X586, X590	N/A	N/A
Archie Cr.	IL_BOG	0512010810	29	3	4.77	X582, X583, X585, X586, X590	N/A	N/A
Archie Cr.	IL_OEC	0714020403	25	3	6.61	X582, X583, X585, X586, X590	N/A	N/A
Arlington Heights Branch	IL_GLC	0712000404	2	3	6.83	X582, X583, X585, X586, X590	N/A	N/A
Armitage Ditch	IL_GBLG	0712000410	2	3	1.2	X582, X583, X585, X586, X590	N/A	N/A
Armstrong Run	IL_DZU	0712000508	11	3	10.45	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Asa Cr.	IL_OZZT-01	0714020107	23	5	9.22	N582, X583, X586, X590	371, 441	140
Ash Cr.	IL_ODEB	0714020405	25	3	5.92	X582, X583, X585, X586, X590	N/A	N/A
Ash Cr.	IL_OZZD-02	0714020206	24	3	13.54	X582, X583, X585, X586, X590	N/A	N/A
Ashkum Cr.	IL_FLGB-C1	0712000209	10	5	2.84	N582, X583, X585, X586, X590	123, 308, 322, 462	62
Ashkum Cr.	IL_FLGB-C4	0712000209	10	5	2.61	N582, X583, X585, X586, X590	84, 123, 371	20, 62, 130
Ashmore Cr.	IL_BK	0512011109	30	3	8.3	X582, X583, X585, X586, X590	N/A	N/A
Askew Branch	IL_JVAB	0711000902	27	3	2.05	X582, X583, X585, X586, X590	N/A	N/A
Atchison Cr.	IL_NJA	0714010603	26	3	12.38	X582, X583, X585, X586, X590	N/A	N/A
Atlas Cr.	IL_KCO	0711000408	19	3	4.59	X582, X583, X585, X586, X590	N/A	N/A
Auburn Branch	IL_BHE	0512011110	30	3	6.44	X582, X583, X585, X586, X590	N/A	N/A
Aux Sable Cr.	IL_DW-01	0712000501	11	5	21.06	F582, X583, N585, X586, F590	400	140
Auxier Ditch	IL_CAGC-01	0512011504	31	4C	28.57	N582, X583, X585, X586, X590	84, 501	20
Avery Branch	IL_DED	0713001102	18	3	7.04	X582, X583, X585, X586, X590	N/A	N/A
Avery Branch	IL_OLB	0714020204	24	3	5.72	X582, X583, X585, X586, X590	N/A	N/A
Aylesworth Branch	IL_DJZI	0713000512	15	3	6.26	X582, X583, X585, X586, X590	N/A	N/A
B. Grand Pierre Cr.	IL_AL-01	0514020307	32	2	16.2	F582, X583, X585, X586, F590	N/A	N/A
Back Branch	IL_NKD	0714010602	26	3	4.82	X582, X583, X585, X586, X590	N/A	N/A
Back Cr.	IL_NCR	0714010610	26	3	4.87	X582, X583, X585, X586, X590	N/A	N/A
Bacon Branch	IL_OZZFA	0714020111	23	3	3.2	X582, X583, X585, X586, X590	N/A	N/A
Badger Cr.	IL_DJZE	0713000514	15	3	8.53	X582, X583, X585, X586, X590	N/A	N/A
Bailey Branch	IL_OODA	0714020202	24	3	5.73	X582, X583, X585, X586, X590	N/A	N/A
Bailey Cr.	IL_DSA-02	0713000209	12	2	14.68	F582, X583, X585, X586, F590	N/A	N/A
Baitter Branch	IL_DBN	0713001106	18	3	2.61	X582, X583, X585, X586, X590	N/A	N/A
Baker Run	IL_DSK-01	0713000206	12	2	9.77	F582, X583, X585, X586, F590	N/A	N/A
Bald Hill Cr.	IL_NEK	0714010606	26	3	6.48	X582, X583, X585, X586, X590	N/A	N/A
Balmoral Track Cr.	IL_HBEC	0712000303	1	3	1.83	X582, X583, X585, X586, X590	N/A	N/A
Bankston Fk.	IL_ATGC-01	0514020402	32	4A	4.38	N582, X583, N585, X586, X590	273, 375, 385, 400	2, 56, 127, 140
Bankston Fk.	IL_ATGC-02	0514020402	32	4C	4.76	N582, X583, X585, X586, X590	84	20
Bankston Fk.	IL_ATGC-11	0514020402	32	5	7.19	N582, X583, X585, X586, X590	375	127
Bankston Spring Grove	IL_ATGI-01	0514020402	32	3	4.37	X582, X583, X585, X586, X590	N/A	N/A
Baptist Cr.	IL_DGPC-01	0713001001	17	5	14.29	N582, X583, X585, X586, X590	273	140
Barden Cr.	IL_OKBA	0714020205	24	3	4.62	X582, X583, X585, X586, X590	N/A	N/A
Bare Cr.	IL_CGC	0512011408	31	3	2.46	X582, X583, X585, X586, X590	N/A	N/A
Barker Cr.	IL_DJZF-01	0713000514	15	4C	10.66	N582, X583, X585, X586, F590	84	20
Barnes Cr.	IL_AEB	0514020602	33	3	6.87	X582, X583, X585, X586, X590	N/A	N/A
Barren Cr.	IL_AI	0514020309	32	2	7.65	F582, X583, X585, X586, X590	N/A	N/A
Battle Creek	IL_DTCE	0712000703	4	3	9.67	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Battle Ford Cr.	IL_ATHC-01	0514020403	32	5	7.22	N582, X583, X585, X586, F590	84, 322, 500, 501	20, 72, 144, 156
Baughman Branch	IL_DJZG	0713000514	15	3	3.34	X582, X583, X585, X586, X590	N/A	N/A
Baum Branch	IL_BOH	0512010810	29	3	6.74	X582, X583, X585, X586, X590	N/A	N/A
Bay Cr.	IL_AJ-08	0514020308	32	2	11.29	F582, X583, X585, X586, X590	N/A	N/A
Bay Cr.	IL_AJ-09	0514020308	32	2	15.2	F582, X583, X585, X586, F590	N/A	N/A
Bay Cr.	IL_AJ-10	0514020308	32	2	12.6	F582, X583, X585, X586, X590	N/A	N/A
Bay Cr.	IL_AJ-11	0514020308	32	2	17.11	F582, X583, X585, X586, X590	N/A	N/A
Bay Cr.	IL_KCA-01	0711000409	19	5	19	F582, X583, N585, X586, F590	400	140
Bay Cr.	IL_KCA-02	0711000409	19	2	7.54	F582, X583, X585, X586, X590	N/A	N/A
Bay Cr.	IL_KCA-03	0711000409	19	2	3.78	F582, X583, X585, X586, F590	N/A	N/A
Bay Cr.	IL_KCA-04	0711000409	19	2	17.13	F582, X583, X585, X586, X590	N/A	N/A
Bay Cr. Ditch	IL_AJK-01	0514020308	32	2	8.51	F582, X583, X585, X586, F590	N/A	N/A
Beach Cr.	IL_PLB-03	0709000503	6	2	3.33	F582, X583, X585, X586, X590	N/A	N/A
Beach Cr.	IL_PLB-C1	0709000503	6	5	1.95	N582, X583, X585, X586, X590	322, 371, 462	85
Beach Cr.	IL_PLB-C3	0709000503	6	5	3.04	N582, X583, X585, X586, X590	463	N/A
Bean Cr.	IL_BPKG-01	0512010905	29	3	8.83	X582, X583, X585, X586, X590	N/A	N/A
Bear Branch	IL_AKK	0514020306	32	3	3.56	X582, X583, X585, X586, X590	N/A	N/A
Bear Branch	IL_CAWB	0512011502	31	3	3.03	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_ATFIA	0514020404	32	3	0.86	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_ATFIA-MC-A2	0514020404	32	4C	1.3	N582, X583, X585, X586, X590	84, 319, 500	20, 132
Bear Cr.	IL_ATFIA-MC-C1	0514020404	32	5	1.15	N582, X583, X585, X586, X590	84, 319, 462	20, 132, 85, 144, 177
Bear Cr.	IL_ATFJC-01	0514020405	32	5	19.86	N582, X583, X585, X586, F590	322	102, 127, 144, 156
Bear Cr.	IL_BEJH-01	0512011207	30	3	8.34	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_CANBC	0512011501	31	3	4.36	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_CDFB	0512011407	31	3	13.63	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_CZZC	0512011408	31	3	5.95	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_DAD	0713001206	18	3	11.65	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_DAGB	0713001202	18	4C	20.03	N582, X583, X585, X586, X590	501	20
Bear Cr.	IL_DBG	0713001106	18	3	11.92	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_EOF-05	0713000703	20	2	23.67	F582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_JQK	0714010101	27	3	5.09	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_KI-02	0711000105	19	5	10.98	F582, X583, N585, X586, F590	400	140
Bear Cr.	IL_KI-03	0711000105	19	2	1.7	F582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_KI-04	0711000105	19	3	5.92	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_KI-05	0711000105	19	5	12.69	N582, X583, X585, X586, F590	322	140
Bear Cr.	IL_KI-06	0711000105	19	2	11.75	F582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_NAB	0714010612	26	3	3.75	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Bear Cr.	IL_NGAA	0714010605	26	3	7.04	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_OMA	0714020206	24	3	6.07	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_OWA	0714020101	23	3	6.93	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr.	IL_OZX	0714020206	24	3	9	X582, X583, X585, X586, X590	N/A	N/A
Bear Cr. Ditch	IL_ADCDA	0514020605	33	5	14.16	N582, X583, X585, X586, F590	84, 322, 441, 500, 501	20, 66, 72, 144, 156
Bearcat Cr.	IL_OILD	0714020304	24	3	11.84	X582, X583, X585, X586, X590	N/A	N/A
Beatty Br.	IL_AKE	0514020306	32	3	4.44	X582, X583, X585, X586, X590	N/A	N/A
Beaucoup Cr.	IL_NC-03	0714010610	26	5	8.21	N582, X583, X585, X586, X590	322, 385	85, 127
Beaucoup Cr.	IL_NC-04	0714010610	26	3	5.47	X582, X583, X585, X586, X590	N/A	N/A
Beaucoup Cr.	IL_NC-07	0714010610	26	5	27.65	N582, X583, N585, X586, X590	322, 371, 403, 462, 400	155, 127, 156, 140
Beaucoup Cr.	IL_NC-09	0714010610	26	2	30.56	F582, X583, X585, X586, X590	N/A	N/A
Beaucoup Cr.	IL_NC-10	0714010610	26	2	10.29	F582, X583, X585, X586, X590	N/A	N/A
Beaver Cr.	IL_FLD-03	0712000213	10	4A	21.56	F582, X583, N585, X586, F590	400	140
Beaver Cr.	IL_NGAZ-JC-D1	0714010605	26	5	1.7	N582, X583, X585, X586, X590	273, 500, 501	72, 85, 144, 156, 177, 181
Beaver Cr.	IL_OIB-01	0714020305	24	2	22.06	F582, X583, X585, X586, X590	N/A	N/A
Beaver Cr.	IL_OIB-02	0714020305	24	2	21.37	F582, X583, X585, X586, X590	N/A	N/A
Beaver Cr.	IL_PQD-05	0709000604	5	2	10.22	F582, X583, X585, X586, X590	N/A	N/A
Beaver Cr.	IL_PQD-06	0709000604	5	2	7.85	F582, X583, X585, X586, X590	N/A	N/A
Beaver Cr.	IL_PQD-07	0709000604	5	2	13.14	F582, X583, X585, X586, X590	N/A	N/A
Beaver Pond Cr.	IL_OJAB	0714020207	24	3	7.42	X582, X583, X585, X586, X590	N/A	N/A
Beaver Pond Ditch	IL_BEZA-01	0512011215	30	3	10.73	X582, X583, X585, X586, X590	N/A	N/A
Beck Cr.	IL_OQ-01	0714020110	23	5	29.8	F582, X583, N585, X586, X590	400	140
Beckford Branch	IL_DGZK	0713001007	17	3	4.94	X582, X583, X585, X586, X590	N/A	N/A
Bee Branch	IL_CAWD	0512011502	31	3	6.71	X582, X583, X585, X586, X590	N/A	N/A
Bee Cr.	IL_DZ3I	0713001108	18	3	5.58	X582, X583, X585, X586, X590	N/A	N/A
Beebe Cr.	IL_KCHA	0711000404	19	3	10.74	X582, X583, X585, X586, X590	N/A	N/A
Bell Branch	IL_BEZP	0512011208	30	3	3.32	X582, X583, X585, X586, X590	N/A	N/A
Bennett Cr.	IL_BEDC	0512011211	30	3	9.47	X582, X583, X585, X586, X590	N/A	N/A
Bertrand Branch	IL_FCCCA	0712000116	10	3	4.81	X582, X583, X585, X586, X590	N/A	N/A
Bettell Cr.	IL_DZ3J	0713001108	18	3	4.17	X582, X583, X585, X586, X590	N/A	N/A
Big Bayou	IL_NZA	0714010612	26	3	2.66	X582, X583, X585, X586, X590	N/A	N/A
Big Branch	IL_BCJ	0512011304	31	3	6.02	X582, X583, X585, X586, X590	N/A	N/A
Big Branch	IL_DCC	0713001105	18	3	6.8	X582, X583, X585, X586, X590	N/A	N/A
Big Branch	IL_JQH	0714010101	27	3	8.19	X582, X583, X585, X586, X590	N/A	N/A
Big Branch	IL_MZM	0708010105	9	3	5.21	X582, X583, X585, X586, X590	N/A	N/A
Big Bureau Cr.	IL_DQ-01	0713000107	11	5	9.61	F582, N583, X585, X586, F590	274, 348	10, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Big Bureau Cr.	IL_DQ-02	0713000105	11	5	16.4	F582, N583, X585, X586, X590	274, 348	140
Big Bureau Cr.	IL_DQ-03	0713000105	11	5	5.4	F582, N583, N585, X586, F590	274, 348, 400	140
Big Bureau Cr.	IL_DQ-04	0713000107	11	5	4.68	F582, N583, N585, X586, F590	274, 348, 400	140
Big Bureau Cr.	IL_DQ-05	0713000105	11	5	37.67	F582, N583, X585, X586, F590	274, 348	140
Big Cr.	IL_AO-02	0514020305	32	2	9.55	F582, X583, X585, X586, X590	N/A	N/A
Big Cr.	IL_AO-03	0514020305	32	2	9.2	F582, X583, X585, X586, F590	N/A	N/A
Big Cr.	IL_BED-01	0512011211	30	2	25.72	F582, X583, X585, X586, X590	N/A	N/A
Big Cr.	IL_BJ-01	0512011108	30	2	26.45	F582, X583, X585, X586, X590	N/A	N/A
Big Cr.	IL_CAGB	0512011504	31	5	19.58	N582, X583, X585, X586, X590	463, 479	20, 72, 140
Big Cr.	IL_CHEA-11	0512011406	31	5	11.77	N582, X583, X585, X586, X590	163, 463	140
Big Cr.	IL_DJB-18	0713000513	15	2	33.91	F582, X583, X586, F590	N/A	N/A
Big Cr.	IL_DJED	0713000510	15	3	8.12	X582, X583, X585, X586, X590	N/A	N/A
Big Cr.	IL_EU-01	0713000604	21	3	11.62	X582, X583, X585, X586, X590	N/A	N/A
Big Cr.	IL_IXJ-01	0714010801	33	4C	8.18	N582, X583, X585, X586, X590	84, 500, 501	20, 125
Big Cr.	IL_IXJ-02	0714010801	33	2	10.02	F582, X583, X585, X586, X590	N/A	N/A
Big Cr.	IL_OP-01	0714020201	24	2	12.64	F582, X583, X585, X586, X590	N/A	N/A
Big Cr. Drainage Ditch	IL_CAG	0512011504	31	3	5.28	X582, X583, X585, X586, X590	N/A	N/A
Big Cr. North	IL_CR	0512011404	31	3	13.42	X582, X583, X585, X586, X590	N/A	N/A
Big Cr. South	IL_CB	0512011409	31	3	5.48	X582, X583, X585, X586, X590	N/A	N/A
Big Ditch	IL_EZU-01	0713000602	21	5	18.23	N582, X583, X585, X586, X590	322, 441, 501	140, 20
Big Four Ditch	IL_BPKP-01	0512010901	29	4C	10.38	N582, X583, X585, X586, X590	84	20
Big Four Ditch	IL_BPKP-02	0512010901	29	4C	18.68	N582, X583, X585, X586, X590	84	20
Big Four Ditch trib.	IL_BPKQ-01	0512010901	29	3	3.9	X582, X583, X585, X586, X590	N/A	N/A
Big George Branch	IL_EOHI	0713000701	20	3	13.84	X582, X583, X585, X586, X590	N/A	N/A
Big Hill Branch	IL_CZD	0512011410	31	3	3.13	X582, X583, X585, X586, X590	N/A	N/A
Big Hollow Cr.	IL_DLB	0713000302	13	3	7.4	X582, X583, X585, X586, X590	N/A	N/A
Big Muddy Cr.	IL_CJ-04	0512011405	31	5	17.15	N582, N583, X585, X586, X590	273, 319, 322, 371, 478, 500, 274	102, 58, 140, 144, 142
Big Muddy Cr.	IL_CJ-06	0512011405	31	5	34.4	N582, N583, X585, X586, X590	84, 322, 371, 403, 462, 274	20, 4, 144, 10, 140
Big Muddy Diversion Ditch	IL_CJAE-01	0512011405	31	2	8.74	F582, X583, X585, X586, X590	N/A	N/A
Big Muddy R.	IL_N-06	0714010607	26	5	15.13	N582, N583, F585, F586, X590	371, 501, 274, 348	144, 155, 142, 156, 10, 140
Big Muddy R.	IL_N-08	0714010602	26	5	40.04	N582, N583, X586, X590	273, 322, 371, 441, 462, 274	140, 155, 156, 72, 10
Big Muddy R.	IL_N-11	0714010607	26	5	11.48	N582, N583, N585, X586, X590	371, 385, 403, 274, 348, 400	87, 140, 10

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Big Muddy R.	IL_N-12	0714010612	26	5	15.19	N582, N583, F585, F586, X590	273, 322, 403, 274	140, 155, 85, 87, 144, 10
Big Muddy R.	IL_N-16	0714010612	26	5	11.79	N582, N583, X585, X586, X590	322, 371, 274	87, 155, 10, 140
Big Muddy R.	IL_N-17	0714010607	26	5	21.48	N582, N583, X585, X586, X590	322, 371, 403, 274	85, 87, 155, 144, 10, 140
Big Muddy R.	IL_N-99	0714010612	26	5	29.22	N582, N583, X585, X586, X590	273, 322, 403, 441, 462, 274	155, 140, 144, 10
Big Negro Cr.	IL_DJFBBC	0713000509	15	3	13.24	X582, X583, X585, X586, X590	N/A	N/A
Big Rock Cr.	IL_DTC-03	0712000703	4	2	3.59	F582, X583, X585, X586, X590	N/A	N/A
Big Rock Cr.	IL_DTC-06	0712000703	4	2	10.47	F582, X583, X585, X586, X590	N/A	N/A
Big Sister Cr.	IL_DZZK	0713000306	13	3	11.58	X582, X583, X585, X586, X590	N/A	N/A
Big Slough	IL_BZKA	0512011302	31	3	9.51	X582, X583, X585, X586, X590	N/A	N/A
Big Slough Ditch	IL_PBG-10	0709000705	8	5	4.49	N582, X583, X585, X586, F590	79, 84, 246, 319, 500	28, 20, 58
Big Slough Ditch	IL_PBG-12	0709000705	8	5	0.88	N582, X583, X585, X586, X590	84, 104	4, 20, 144, 28
Bigneck Cr.	IL_KIFB	0711000104	19	3	16.44	X582, X583, X585, X586, X590	N/A	N/A
Bills Cr.	IL_CTBA	0512011401	31	3	6.82	X582, X583, X585, X586, X590	N/A	N/A
Bills Run	IL_DZW	0712000507	11	3	14.45	X582, X583, X585, X586, X590	N/A	N/A
Birch Branch	IL_MNIB	0706000505	9	3	4.22	X582, X583, X585, X586, X590	N/A	N/A
Birch Cr.	IL_BEBC	0512011214	30	3	6.71	X582, X583, X585, X586, X590	N/A	N/A
Birch Cr.	IL_BEIC	0512011208	30	3	5.39	X582, X583, X585, X586, X590	N/A	N/A
Birch Cr.	IL_DBH	0713001106	18	3	11.04	X582, X583, X585, X586, X590	N/A	N/A
Bishop Cr.	IL_CO-01	0512011403	31	2	20.89	F582, X583, X585, X586, X590	N/A	N/A
Black Branch	IL_ATEB	0514020407	32	3	5.53	X582, X583, X585, X586, X590	N/A	N/A
Black Branch	IL_EOB	0713000708	20	3	5.96	X582, X583, X585, X586, X590	N/A	N/A
Black Cr.	IL_JRBA	0711000903	27	3	3.45	X582, X583, X585, X586, X590	N/A	N/A
Black Cr.	IL_OCA	0714020406	25	2	6.92	F582, X583, X585, X586, X590	N/A	N/A
Black Slough	IL_BETA	0512011201	30	3	7.1	X582, X583, X585, X586, X590	N/A	N/A
Black Walnut Cr.	IL_FFBA	0712000115	10	5	13.87	N582, X583, X585, X586, F590	84, 139, 319, 462, 500	20, 157, 85, 156
Black Walnut Cr.	IL_PPA-01	0709000504	6	2	10.44	F582, X583, X585, X586, X590	N/A	N/A
Blackberry Cr.	IL_DTD-02	0712000702	4	5	16.79	F582, X583, N585, X586, X590	400	140
Blackberry Cr.	IL_DTD-03	0712000702	4	2	17.14	F582, X583, X585, X586, X590	N/A	N/A
Blackburn Branch	IL_BHCA	0512011110	30	3	6.43	X582, X583, X585, X586, X590	N/A	N/A
Blackman Cr.	IL_ATHB	0514020403	32	3	6.58	X582, X583, X585, X586, X590	N/A	N/A
Blacksop Cr.	IL_NEBA	0714010606	26	3	4.01	X582, X583, X585, X586, X590	N/A	N/A
Blackston Branch	IL_FLZA	0712000205	10	3	5.79	X582, X583, X585, X586, X590	N/A	N/A
Blalock Cr.	IL_DZ4N	0713000117	11	3	3.48	X582, X583, X585, X586, X590	N/A	N/A
Blue Cr.	IL_DZC	0713001108	18	5	17.25	N582, X583, X585, X586, X590	371, 501	142, 156, 157

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Blue Cr.	IL_DZZL	0713000117	11	3	8.68	X582, X583, X585, X586, X590	N/A	N/A
Blue Grass Cr.	IL_OIMD	0714020301	24	3	9.63	X582, X583, X585, X586, X590	N/A	N/A
Blue Point Cr.	IL_CZS	0512011401	31	3	3.19	X582, X583, X585, X586, X590	N/A	N/A
Blue Point Cr.	IL_CZS-01	0512011401	31	3	1.84	X582, X583, X585, X586, X590	N/A	N/A
Blue Ridge Special Cr.	IL_EIMA	0713000901	22	3	7.05	X582, X583, X585, X586, X590	N/A	N/A
Bluegrass Cr.	IL_BEFJ	0512011210	30	3	5.17	X582, X583, X585, X586, X590	N/A	N/A
Bluegrass Cr.	IL_BPKI-01	0512010905	29	2	14.37	F582, X583, X585, X586, X590	N/A	N/A
Boar Cr.	IL_IXC	0714010803	33	5	7.69	N582, X583, X585, X586, N590	84, 322, 500, 501, 160, 413, 471	20, 72, 144, 156, 157
Board Tree Branch	IL_NCKB	0714010610	26	3	4.74	X582, X583, X585, X586, X590	N/A	N/A
Bob Branch	IL_CARB	0512011502	31	3	2.39	X582, X583, X585, X586, X590	N/A	N/A
Bobbies Branch	IL_CAZK	0512011502	31	3	3.65	X582, X583, X585, X586, X590	N/A	N/A
Boeur Branch	IL_DHJ	0713000309	13	3	7.99	X582, X583, X585, X586, X590	N/A	N/A
Bolin Branch	IL_OUB	0714020103	23	3	6.47	X582, X583, X585, X586, X590	N/A	N/A
Bolt Cr.	IL_OZZDA	0714020206	24	3	7.5	X582, X583, X585, X586, X590	N/A	N/A
Bond Cr.	IL_JHB	0714010107	27	3	8.46	X582, X583, X585, X586, X590	N/A	N/A
Boneyard Cr.	IL_BPJCA	0512010902	29	5	3.28	N582, X583, X585, X586, X590	84, 163, 322, 462	20, 177
Bonnie Cr.	IL_NCDC-01	0714010609	26	4A	11.16	N582, X583, X585, X586, X590	84, 385	72, 127
Bonpas Cr.	IL_BC-02	0512011304	31	5	28.95	N582, X583, N585, X586, X590	99, 273, 322, 371, 400	144, 140
Bonpas Cr.	IL_BC-04	0512011304	31	5	26.2	N582, X583, X585, X586, X590	371	144
Bonwell Branch	IL_BNBBB	0512011101	30	3	3.72	X582, X583, X585, X586, X590	N/A	N/A
Boone Branch	IL_PWNBA	0709000313	7	3	3.68	X582, X583, X585, X586, X590	N/A	N/A
Boone Cr.	IL_DTZT-02	0712000611	3	5	11.81	N582, X583, X585, X586, X590	84, 319, 441	72, 122, 58, 140
Bower Cr.	IL_DEAAA	0713001102	18	3	7.21	X582, X583, X585, X586, X590	N/A	N/A
Boyd Cr.	IL_CAZH	0512011505	31	3	5.82	X582, X583, X585, X586, X590	N/A	N/A
Boyer Cr.	IL_DAZB	0713001206	18	3	7.61	X582, X583, X585, X586, X590	N/A	N/A
Bradley Branch	IL_OBD	0714020408	25	3	4.17	X582, X583, X585, X586, X590	N/A	N/A
Bradshaw Cr.	IL_ADP-01	0514020605	33	4C	15.41	N582, X583, X585, X586, X590	84, 501	20
Branch Cr.	IL_IIHB	0714010502	28	3	5.07	X582, X583, X585, X586, X590	N/A	N/A
Brandywine Cr.	IL_DJZP	0713000507	15	3	9.21	X582, X583, X585, X586, X590	N/A	N/A
Brewer Branch	IL_CAUD	0512011502	31	3	2.08	X582, X583, X585, X586, X590	N/A	N/A
Brewster Cr.	IL_DTZO-01	0712000701	4	3	5.44	X582, X583, X585, X586, X590	N/A	N/A
Briar Branch	IL_CZZG	0512011409	31	3	1.83	X582, X583, X585, X586, X590	N/A	N/A
Briar Cr.	IL_DAZN	0713001201	18	5	4.44	N582, X583, X585, X586, X590	84, 322, 462	20, 72, 85
Brickyard Branch	IL_OPAC	0714020201	24	3	6.86	X582, X583, X585, X586, X590	N/A	N/A
Brier Cr.	IL_ATGA	0514020402	32	3	6.37	X582, X583, X585, X586, X590	N/A	N/A
Brier Cr.	IL_ATHS-01	0514020401	32	5	3.47	N582, X583, X585, X586, X590	260, 273, 322, 385, 403	2, 127, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Broad Run	IL_CAZF	0512011505	31	3	3.77	X582, X583, X585, X586, X590	N/A	N/A
Brockett Cr.	IL_CRA	0512011404	31	3	7.08	X582, X583, X585, X586, X590	N/A	N/A
Bronson Cr.	IL_DGK-01	0713001004	17	3	17.85	X582, X583, X585, X586, X590	N/A	N/A
Broughton Cr.	IL_DVFC	0712000502	11	3	13.35	X582, X583, X585, X586, X590	N/A	N/A
Brouilletts Cr.	IL_BN-01	0512011102	30	5	39.42	F582, X583, N585, X586, X590	400	140
Brown Branch	IL_EOHD	0713000701	20	3	6.14	X582, X583, X585, X586, X590	N/A	N/A
Brown Cr.	IL_PWIC	0709000314	7	3	8.14	X582, X583, X585, X586, X590	N/A	N/A
Brown Creek	IL_CIA	0512011408	31	3	4.17	X582, X583, X585, X586, X590	N/A	N/A
Brown Run	IL_DZ4I	0713000113	11	3	8.59	X582, X583, X585, X586, X590	N/A	N/A
Brownsville Cr.	IL_IBAB	0714010507	28	3	3.35	X582, X583, X585, X586, X590	N/A	N/A
Brubaker Cr.	IL_OJJ	0714020208	24	3	7.57	X582, X583, X585, X586, X590	N/A	N/A
Brumbach Cr.	IL_DTZC	0712000706	4	3	8.89	X582, X583, X585, X586, X590	N/A	N/A
Brunk Cr.	IL_DJHDA	0713000508	15	3	5.14	X582, X583, X585, X586, X590	N/A	N/A
Brush Branch	IL_NCKA	0714010610	26	3	3.24	X582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_BEDBA	0512011211	30	3	7.56	X582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_BEPB	0512011204	30	3	1.99	X582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_CAR-01	0512011502	31	5	23.05	N582, X583, X585, X586, X590	322	4, 140
Brush Cr.	IL_CPB	0512011402	31	3	4.5	X582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_CTB	0512011401	31	3	5.96	X582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_DJHD-01	0713000508	15	2	12.21	F582, X583, X585, X586, F590	N/A	N/A
Brush Cr.	IL_EOCA-02	0713000706	20	2	13.56	F582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_EOCA-04	0713000706	20	2	8.74	F582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_OIMB	0714020301	24	3	8.28	X582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_ORA-01	0714020109	23	3	13.17	X582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_OTBA	0714020106	23	3	8.82	X582, X583, X585, X586, X590	N/A	N/A
Brush Cr.	IL_PWPB	0709000311	7	2	7.61	F582, X583, X585, X586, X590	N/A	N/A
Brush Creek	IL_ATFD-01	0514020406	32	5	6.2	N582, X583, X585, X586, N590	84, 322, 501	20, 72, 144, 156
Brushy Branch	IL_DHFA	0713000309	13	3	1.45	X582, X583, X585, X586, X590	N/A	N/A
Brushy Branch	IL_EOHC	0713000701	20	3	11.63	X582, X583, X585, X586, X590	N/A	N/A
Brushy Cr.	IL_ATGH-04	0514020402	32	5	7.82	N582, X583, X585, X586, X590	84, 371, 403, 462	20, 72, 127, 144
Brushy Cr.	IL_ATGH-09	0514020402	32	4C	1.33	N582, X583, X585, X586, X590	84	20
Brushy Cr.	IL_ATGH-10	0514020402	32	5	3.19	N582, X583, X585, X586, X590	273	2, 144, 155, 156
Brushy Cr.	IL_ATHGB	0514020401	32	3	3.28	X582, X583, X585, X586, X590	N/A	N/A
Brushy Cr.	IL_BEB-01	0512011214	30	5	8.15	N582, X583, X585, X586, X590	273	155
Brushy Cr.	IL_BEB-02	0512011214	30	3	7.3	X582, X583, X585, X586, X590	N/A	N/A
Brushy Cr.	IL_DCD	0713001105	18	3	14.74	X582, X583, X585, X586, X590	N/A	N/A
Brushy Cr.	IL_DGFA	0713001010	17	3	10.01	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Brushy Cr.	IL_OGC	0714020402	25	3	4.18	X582, X583, X585, X586, X590	N/A	N/A
Brushy Fk.	IL_BEZZ-05	0512011203	30	2	27.29	F582, X583, X585, X586, X590	N/A	N/A
Buck Branch	IL_ADLA	0514020605	33	2	7.36	F582, X583, X585, X586, F590	N/A	N/A
Buck Branch	IL_DTBA	0712000704	4	3	5.77	X582, X583, X585, X586, X590	N/A	N/A
Buck Branch	IL_KCAD	0711000409	19	3	5.1	X582, X583, X585, X586, X590	N/A	N/A
Buck Cr.	IL_ALC	0514020307	32	3	4.11	X582, X583, X585, X586, X590	N/A	N/A
Buck Cr.	IL_BCF	0512011304	31	3	5.94	X582, X583, X585, X586, X590	N/A	N/A
Buck Cr.	IL_BPKJ-01	0512010905	29	3	10.23	X582, X583, X585, X586, X590	N/A	N/A
Buck Cr.	IL_CZN	0512011408	31	3	20.83	X582, X583, X585, X586, X590	N/A	N/A
Buck Cr.	IL_DKR-01	0713000403	14	2	12.21	F582, X583, X585, X586, X590	N/A	N/A
Buck Cr.	IL_DTZB-02	0712000706	4	2	15.92	F582, X583, X585, X586, X590	N/A	N/A
Buck Cr.	IL_NZU	0714010602	26	3	4.77	X582, X583, X585, X586, X590	N/A	N/A
Buck Cr.	IL_OZR	0714020206	24	3	3.99	X582, X583, X585, X586, X590	N/A	N/A
Buck Run	IL_ADK	0514020605	33	3	5.95	X582, X583, X585, X586, X590	N/A	N/A
Buckeye Branch	IL_OHG	0714020401	25	3	6.06	X582, X583, X585, X586, X590	N/A	N/A
Buckeye Cr.	IL_KCAZ-01	0711000409	19	3	6.96	X582, X583, X585, X586, X590	N/A	N/A
Buckhart Cr.	IL_EZM-02	0713000607	21	5	26.86	N582, X583, X585, X586, X590	84, 322, 371	20, 144
Buckhorn Cr.	IL_DZ3K	0713001108	18	3	5.37	X582, X583, X585, X586, X590	N/A	N/A
Buckingham Branch	IL_OZI	0714020209	24	3	3.19	X582, X583, X585, X586, X590	N/A	N/A
Bucks Branch	IL_DBLA	0713001106	18	3	3.4	X582, X583, X585, X586, X590	N/A	N/A
Bucks Branch	IL_DZ3V	0713001108	18	3	8.15	X582, X583, X585, X586, X590	N/A	N/A
Buffalo Cr.	IL_GST	0712000405	2	5	8.94	N582, X583, N585, X586, X590	138, 322, 403, 400	177, 140
Buffalo Cr.	IL_PHE-01	0709000507	6	2	8.13	F582, X583, X585, X586, X590	N/A	N/A
Buffalo Cr.	IL_PHE-A1	0709000507	6	2	4.18	F582, X583, X585, X586, X590	N/A	N/A
Buffalo Cr.	IL_PHE-C1	0709000507	6	5	2.07	N582, X583, X585, X586, X590	462	85
Bugaboo Cr.	IL_BEABA	0512011213	30	3	8.33	X582, X583, X585, X586, X590	N/A	N/A
Bull Branch	IL_OHAA-07	0714020401	25	5	4.04	N582, X583, X585, X586, X590	322, 371, 403, 462	4, 144
Bull Cr.	IL_FRA	0712000113	10	3	10.31	X582, X583, X585, X586, X590	N/A	N/A
Bull Cr.	IL_GV-01	0712000403	2	5	2.33	N582, X583, X585, X586, X590	96, 273, 277	28
Bull Cr.	IL_QG	0404000201	1	5	5.05	N582, X583, X585, X586, X590	79, 213, 322	28, 140
Bull Run	IL_KXB	0711000406	19	3	5.53	X582, X583, X585, X586, X590	N/A	N/A
Bull Run	IL_PQCD	0709000606	5	3	4.8	X582, X583, X585, X586, X590	N/A	N/A
Burdick Branch	IL_JNC	0714010103	27	3	5.04	X582, X583, X585, X586, X590	N/A	N/A
Burlington Cr.	IL_PQFC	0709000601	5	2	10.78	F582, X583, X585, X586, X590	N/A	N/A
Burlison Cr.	IL_EIEH	0713000905	22	3	4.23	X582, X583, X585, X586, X590	N/A	N/A
Burroughs Branch	IL_JQB	0714010102	27	3	5.36	X582, X583, X585, X586, X590	N/A	N/A
Burton Cr.	IL_KDA	0711000402	19	2	15	F582, X583, X585, X586, F590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Butler Branch	IL_BPI-01	0512010909	29	2	4.78	F582, X583, X585, X586, X590	N/A	N/A
Butter Cr.	IL_CBB	0512011409	31	3	6.09	X582, X583, X585, X586, X590	N/A	N/A
Butter Cr.	IL_OAB	0714020409	25	3	6.03	X582, X583, X585, X586, X590	N/A	N/A
Butterfield Cr.	IL_HBDB-03	0712000302	1	5	15.24	N582, X583, N585, X586, X590	246, 319, 322, 400	28, 58, 177
Cabiness Cr.	IL_EIA	0713000908	22	3	11.02	X582, X583, X585, X586, X590	N/A	N/A
Cache Cr	IL_ADX	0514020605	33	3	1.19	X582, X583, X585, X586, X590	N/A	N/A
Cache Cr.	IL_ADX-01	0514020605	33	5	2.48	N582, X583, X585, X586, X590	462	85, 177
Cache R.	IL_AD-02	0514020605	33	5	7.55	F582, X583, N585, X586, F590	400	N/A
Cache R.	IL_AD-04	0514020605	33	2	22.33	F582, X583, X585, X586, F590	N/A	N/A
Cache R.	IL_AD-05	0514020605	33	2	11.16	F582, X583, X585, X586, F590	N/A	N/A
Cache R.	IL_AD-06	0514020605	33	2	6.55	F582, X583, X585, X586, X590	N/A	N/A
Cache R.	IL_AD-11	0514020605	33	2	6.55	F582, X583, X585, X586, F590	N/A	N/A
Cache R.	IL_IX-03	0714010802	33	5	3.97	N582, X583, X585, X586, X590	84, 371, 501	20, 144
Cache R.	IL_IX-04	0714010802	33	2	7.32	F582, X583, X586, F590	N/A	N/A
Cache R.	IL_IX-05	0714010801	33	5	7.77	N582, X583, X585, X586, F590	84, 319, 322, 371, 500	36, 58, 140, 144, 20, 72, 156
Cache R.	IL_IX-06	0714010803	33	5	10.4	N582, N583, X585, X586, F590	273, 322, 371, 501, 274	140, 144
Cache R.	IL_IX-08	0714010803	33	5	2.85	F582, N583, X585, X586, F590	274	140
Cache R. Old Channel	IL_AA-01	0514020607	33	3	7.32	X582, X583, X585, X586, X590	N/A	N/A
Cache R-Old Channel	IL_IX	0714010802	33	3	5.1	X582, X583, X585, X586, X590	N/A	N/A
Caesar Cr.	IL_OOB	0714020202	24	3	10.46	X582, X583, X585, X586, X590	N/A	N/A
Cahokia Canal	IL_JN-02	0714010104	27	5	12.39	N582, X583, X586, N590	84, 260, 273, 322, 371, 403, 462, 500, 501	20, 177, 23, 72, 85, 115, 144, 156, 122
Cahokia Canal No.1	IL_JMA-01	0714010105	27	5	7.07	N582, X583, X585, X586, X590	84, 462, 500, 501	20, 72, 85
Cahokia Chute	IL_JM	0714010105	27	3	1.95	X582, X583, X585, X586, X590	N/A	N/A
Cahokia Cr.	IL_JQ-03	0714010102	27	2	20.09	F582, X583, X585, X586, X590	N/A	N/A
Cahokia Cr.	IL_JQ-04	0714010101	27	2	15.9	F582, X583, X585, X586, F590	N/A	N/A
Cahokia Cr.	IL_JQ-05	0714010102	27	5	10.69	N582, X583, N585, X586, F590	273, 322, 400	20, 85, 144, 156, 177, 140
Cahokia Div. Channel	IL_JQ-07	0714010102	27	5	5.23	N582, X583, X585, X586, X590	84, 228, 322, 462, 500, 501	20, 125, 142, 156, 177
Calfkiller Cr.	IL_BEE-01	0512011212	30	3	8.84	X582, X583, X585, X586, X590	N/A	N/A
Calumet R.	IL_HAA-01	0404000106	1	5	6.2	N582, N583, N585, X586, X590	375, 441, 462, 274, 348, 400	23, 62, 177, 10, 140
Calumet Union Drain N.	IL_HBB	0712000304	1	3	3.6	X582, X583, X585, X586, X590	N/A	N/A
Calumet-Sag Channel	IL_H-01	0712000407	2	5	5.74	N583, X586, N587	274, 348, 260, 322, 403, 462	10, 140, 23, 62, 85, 177, 58

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Calumet-Sag Channel	IL_H-02	0712000304	1	5	10.35	N583, X586, F587	274, 348	10, 140
Camel Cr.	IL_CDFA	0512011407	31	3	6.85	X582, X583, X585, X586, X590	N/A	N/A
Camfield Branch	IL_OZZZC	0714020107	23	3	2.93	X582, X583, X585, X586, X590	N/A	N/A
Camp Branch	IL_CHI	0512011406	31	3	3.43	X582, X583, X585, X586, X590	N/A	N/A
Camp Cr.	IL_CZZF	0512011409	31	3	3.75	X582, X583, X585, X586, X590	N/A	N/A
Camp Cr.	IL_DGI-01	0713001006	17	2	33.77	F582, X583, X585, X586, X590	N/A	N/A
Camp Cr.	IL_DJMB	0713000502	15	3	7.97	X582, X583, X585, X586, X590	N/A	N/A
Camp Cr.	IL_DZ3L	0713001103	18	3	13.79	X582, X583, X585, X586, X590	N/A	N/A
Camp Cr.	IL_EW-01	0713000604	21	2	16.58	F582, X583, X585, X586, X590	N/A	N/A
Camp Cr.	IL_LB-01	0708010416	16	2	18.08	F582, X583, X585, X586, F590	N/A	N/A
Camp Cr.	IL_MJA-02	0706000510	9	3	18.35	X582, X583, X585, X586, X590	N/A	N/A
Camp Cr.	IL_NCAA	0714010610	26	3	7.46	X582, X583, X585, X586, X590	N/A	N/A
Camp Cr.	IL_OZB	0714020409	25	3	9.12	X582, X583, X585, X586, X590	N/A	N/A
Camp Cr. East	IL_LFD-01	0708010402	16	3	21.71	X582, X583, X585, X586, X590	N/A	N/A
Camp Cr. North	IL_ONEC-01	0714020203	24	3	12.44	X582, X583, X585, X586, X590	N/A	N/A
Camp Cr. West	IL_LFB-01	0708010403	16	3	25.71	X582, X583, X585, X586, X590	N/A	N/A
Camp Run	IL_DJM-01	0713000502	15	2	14.11	F582, X583, X585, X586, F590	N/A	N/A
Cana Cr.	IL_ATHH	0514020401	32	3	6.55	X582, X583, X585, X586, X590	N/A	N/A
Canavan Cr.	IL_FKAA	0712000118	10	3	3.86	X582, X583, X585, X586, X590	N/A	N/A
Cane Cr.	IL_AS	0514020303	32	3	3.27	X582, X583, X585, X586, X590	N/A	N/A
Cane Cr.	IL_ATFJ-01	0514020405	32	5	2.76	N582, X583, X585, X586, X590	84, 371, 501	20, 144
Cane Cr.	IL_ATFJ-02	0514020405	32	4C	13.64	N582, X583, X585, X586, X590	84, 500, 501	20, 72
Cane Cr.	IL_NEO	0714010606	26	3	5.02	X582, X583, X585, X586, X590	N/A	N/A
Caney Br.	IL_NDDB	0714010608	26	3	3.33	X582, X583, X585, X586, X590	N/A	N/A
Caney Branch	IL_ATHDD	0514020403	32	3	2.26	X582, X583, X585, X586, X590	N/A	N/A
Caney Cr.	IL_AIA	0514020309	32	3	3.91	X582, X583, X585, X586, X590	N/A	N/A
Caney Cr.	IL_ATHGA	0514020401	32	3	3.03	X582, X583, X585, X586, X590	N/A	N/A
Caney Cr.	IL_ICDA	0714010506	28	3	5.04	X582, X583, X585, X586, X590	N/A	N/A
Caney Cr.	IL_NAA	0714010612	26	3	2.69	X582, X583, X585, X586, X590	N/A	N/A
Canoe Cr.	IL_PZG	0709000511	6	3	7.54	X582, X583, X585, X586, X590	N/A	N/A
Canteen Cr.	IL_JNA-01	0714010103	27	5	4.52	N582, X583, X586, F590	84, 104, 273, 403, 462, 500, 501	20, 177, 122, 144, 85
Canteen Cr.	IL_JNA-02	0714010103	27	5	10.28	N582, X583, X585, X586, X590	84, 104, 500	20, 72, 125, 177
Cantrall Cr.	IL_EZK	0713000804	20	3	11.29	X582, X583, X585, X586, X590	N/A	N/A
Carlton Branch	IL_NHI	0714010604	26	3	4.63	X582, X583, X585, X586, X590	N/A	N/A
Carr Cr.	IL_JI	0714010106	27	2	10.07	F582, X583, X585, X586, F590	N/A	N/A
Carroll Cr.	IL_MJB-01	0706000509	9	2	10.01	F582, X583, X585, X586, F590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Carroll Cr.	IL_MJB-02	0706000509	9	2	6.48	F582, X583, X585, X586, X590	N/A	N/A
Carson Branch	IL_NCKF	0714010610	26	3	1.49	X582, X583, X585, X586, X590	N/A	N/A
Carson Cr.	IL_DXA	0712000507	11	3	1.86	X582, X583, X585, X586, X590	N/A	N/A
Carter Cr.	IL_BEZZZA	0512011212	30	3	4.84	X582, X583, X585, X586, X590	N/A	N/A
Cary Branch	IL_ORAA	0714020109	23	3	1.65	X582, X583, X585, X586, X590	N/A	N/A
Case Cr.	IL_PZA	0709000513	6	3	10.81	X582, X583, X585, X586, X590	N/A	N/A
Casey Fk.	IL_NJ-07	0714010603	26	5	17.88	N582, N583, N585, X586, X590	322, 403, 348, 400	140, 144, 156
Casey Fk.	IL_NJ-10	0714010601	26	5	15.69	N582, N583, X585, X586, X590	273, 348	140
Cash Cr.	IL_LFBA	0708010403	16	3	4.23	X582, X583, X585, X586, X590	N/A	N/A
Cassel Cr.	IL_BENC-01	0512011206	30	2	8.64	F582, X583, X585, X586, X590	N/A	N/A
Catfish Cr.	IL_BEPD-01	0512011204	30	3	11.26	X582, X583, X585, X586, X590	N/A	N/A
Cattail Cr.	IL_MG	0708010102	9	3	12.98	X582, X583, X585, X586, X590	N/A	N/A
Cattle Cr.	IL_OIP-10	0714020306	24	5	3.08	N582, X583, X585, X586, X590	163, 308, 322, 371, 403, 462	140, 143, 144
Cave Cr.	IL_ADDA	0514020604	33	5	7	N582, X583, X585, X586, F590	273, 322	143, 155
Cave Cr.	IL_AIB	0514020309	33	3	4.35	X582, X583, X585, X586, X590	N/A	N/A
Cave Cr.	IL_NAC-01	0714010612	26	4A	9.96	N582, X583, X585, X586, X590	322	140
Cedar Cr.	IL_AJF-02	0514020308	32	5	1.95	N582, X583, X585, X586, X590	273, 322, 371, 500, 501	140, 155, 20, 144
Cedar Cr.	IL_AJF-16	0514020308	32	2	10.98	F582, X583, X585, X586, X590	N/A	N/A
Cedar Cr.	IL_DGG-01	0713001009	17	2	2.56	F582, X583, X585, X586, X590	N/A	N/A
Cedar Cr.	IL_DGG-02	0713001009	17	2	21.52	F582, X583, X585, X586, X590	N/A	N/A
Cedar Cr.	IL_DJF-02	0713000509	15	2	20.09	F582, X583, X585, X586, F590	N/A	N/A
Cedar Cr.	IL_DJF-04	0713000509	15	2	28	F582, X583, X585, X586, F590	N/A	N/A
Cedar Cr.	IL_DZQ	0713000108	11	3	16.61	X582, X583, X585, X586, X590	N/A	N/A
Cedar Cr.	IL_GD	0712000409	2	3	8.03	X582, X583, X585, X586, X590	N/A	N/A
Cedar Cr.	IL_LDD-11	0708010408	16	5	9.78	F582, N583, X585, X586, X590	348	140
Cedar Cr.	IL_LDD-14	0708010408	16	5	9.09	F582, N583, X585, X586, F590	274, 348	10, 140
Cedar Cr.	IL_LDD-23	0708010408	16	5	6.44	N582, N583, X585, X586, F590	348, 371, 403, 462	28, 20, 144, 156, 140
Cedar Cr.	IL_LDD-A1	0708010408	16	5	0.96	N582, N583, X585, X586, X590	84, 348	20, 28, 140
Cedar Cr.	IL_LDD-A3	0708010408	16	5	6.06	N582, N583, X585, X586, X590	84, 348	20, 140
Cedar Cr.	IL_LDD-C1	0708010408	16	5	1.32	N582, N583, X585, X586, X590	348, 371, 462	28, 144, 156, 23, 85, 140
Cedar Cr.	IL_LDD-C2	0708010408	16	5	1.37	N582, N583, X585, X586, X590	322, 348, 371, 462	140, 28, 144, 156, 23, 85
Cedar Cr.	IL_LDD-C3	0708010408	16	5	3.02	N582, N583, X585, X586, X590	348, 462	28, 23, 85, 144, 156, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Cedar Cr.	IL_LDD-C6	0708010408	16	5	8.17	N582, N583, X585, X586, X590	84, 371, 462, 348	20, 23, 144, 156, 85, 140
Cedar Cr.	IL_ME	0708010102	9	3	3.38	X582, X583, X585, X586, X590	N/A	N/A
Cedar Cr.	IL_NA-01	0714010612	26	5	4.38	N582, X583, F585, F586, X590	228, 270, 273, 319, 322, 371, 403	142, 155, 58, 72
Cedar Cr.	IL_NA-02	0714010612	26	5	9.55	N582, X583, X585, X586, X590	322, 371	140, 155, 20
Cedar Cr.	IL_NA-04	0714010612	26	2	3.78	F582, X583, X585, X586, X590	N/A	N/A
Cedar Cr.	IL_PWPA-01	0709000311	7	2	17.41	F582, X583, X585, X586, X590	N/A	N/A
Cedar Cr.	IL_PWT	0709000310	7	3	4.97	X582, X583, X585, X586, X590	N/A	N/A
Cedar Cr. North	IL_DGN-01	0713001007	17	3	14.23	X582, X583, X585, X586, X590	N/A	N/A
Cedar Creek	IL_OPCDB	0714020201	24	3	5.48	X582, X583, X585, X586, X590	N/A	N/A
Cedar Fork	IL_DJFD-01	0713000509	15	2	17.04	F582, X583, X585, X586, F590	N/A	N/A
Cedar Glen Cr.	IL_LZU	0708010418	16	3	5.39	X582, X583, X585, X586, X590	N/A	N/A
Chain o Rocks Canal	IL_JO	0714010104	27	5	9.43	X590	348, 273	140
Chaney Cr.	IL_LZS-01	0708010418	16	3	11.7	X582, X583, X585, X586, X590	N/A	N/A
Chic. San. & Ship Canal	IL_GI-02	0712000407	2	5	13.53	N583, X586, N587	348, 260, 317, 322, 462	140, 23, 177, 58, 85
Chic. San. & Ship Canal	IL_GI-03	0712000301	1	5	5.91	N583, X586, N587	274, 348, 91, 322, 462	10, 140, 23, 85, 20, 58, 177
Chic. San. & Ship Canal	IL_GI-06	0712000407	2	5	12.4	N583, X586, N587	348, 322, 462	140, 23, 58, 177, 85
Chicago R.	IL_HCB-01	0712000301	1	5	1.29	N582, N583, N585, X586, X590	375, 462, 274, 348, 400	23, 85, 95, 177, 10, 140
Chicken Cr.	IL_NCF	0714010610	26	3	6.95	X582, X583, X585, X586, X590	N/A	N/A
Chicken Cr.	IL_OIO-09	0714020306	24	5	1.54	N582, X583, X585, X586, X590	322, 371, 375, 403, 462	4, 143, 144, 140
Chivler Cr.	IL_BEIA	0512011208	30	3	6.93	X582, X583, X585, X586, X590	N/A	N/A
Clair Cr.	IL_JMACBA-C1	0714010105	27	2	2.39	F582, X583, X585, X586, X590	N/A	N/A
Clark Branch	IL_DGEA	0713001012	17	3	7.72	X582, X583, X585, X586, X590	N/A	N/A
Clark Branch	IL_DLFA	0713000302	13	3	7.93	X582, X583, X585, X586, X590	N/A	N/A
Clark Run	IL_DZZT	0713000102	11	3	9.82	X582, X583, X585, X586, X590	N/A	N/A
Clary Cr.	IL_EG-01	0713000806	20	5	19.63	N582, X583, X585, X586, X590	441	140
Clay Cr.	IL_CZZB-CC-C1	0512011408	31	5	2.35	N582, X583, X585, X586, X590	84, 308, 462, 502	20, 85
Clay Cr.	IL_CZZB-CC-C2	0512011408	31	5	1.25	N582, X583, X585, X586, X590	308, 322, 462, 502	85
Clear Cr.	IL_BEJL	0512011207	30	3	7.79	X582, X583, X585, X586, X590	N/A	N/A
Clear Cr.	IL_BEZR	0512011208	30	3	5.87	X582, X583, X585, X586, X590	N/A	N/A
Clear Cr.	IL_BL	0512011109	30	2	17.17	F582, X583, X585, X586, X590	N/A	N/A
Clear Cr.	IL_CZW	0512011401	31	3	4.82	X582, X583, X585, X586, X590	N/A	N/A
Clear Cr.	IL_DFD	0713001101	18	3	19.01	X582, X583, X585, X586, X590	N/A	N/A
Clear Cr.	IL_DTZF-01	0712000706	4	2	5.5	F582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Clear Cr.	IL_EIEB	0713000905	22	3	6.86	X582, X583, X585, X586, X590	N/A	N/A
Clear Cr.	IL_EOD-01	0713000704	20	2	12.08	F582, X583, F585, F586, X590	N/A	N/A
Clear Cr.	IL_EP-02	0713000608	21	3	13.65	X582, X583, X585, X586, X590	N/A	N/A
Clear Cr.	IL_IC-02	0714010506	28	2	8.08	F582, X583, X585, X586, F590	N/A	N/A
Clear Cr.	IL_IC-03	0714010506	28	2	4.44	F582, X583, X585, X586, X590	N/A	N/A
Clear Cr.	IL_IC-05	0714010507	28	5	15.77	N582, N583, X585, X586, F590	84, 273, 313, 322, 371, 500, 501, 274	20, 28, 36, 72, 144, 156, 140
Clear Cr.	IL_MNIA-11	0706000505	9	2	6.53	F582, X583, X585, X586, F590	N/A	N/A
Clear Cr.	IL_PZU	0709000506	6	3	8.89	X582, X583, X585, X586, X590	N/A	N/A
Clear Lake Ave Cr.	IL_EOAF-01	0713000707	20	4C	1.12	N582, X583, X585, X586, X590	84	72
Clear Pond Ditch	IL_CZZJC	0512011408	31	3	7.36	X582, X583, X585, X586, X590	N/A	N/A
Clifton N	IL_FLEA-C1	0712000212	10	5	1.31	N582, X583, X585, X586, X590	123, 163, 308, 322, 371, 462	130
Clifton South Cr	IL_FLGZ-C1	0712000209	10	5	2.18	N582, X583, X585, X586, X590	123, 308, 322, 371, 462	130
Clifty Cr.	IL_ATHDB	0514020403	32	3	3.82	X582, X583, X585, X586, X590	N/A	N/A
Clifty Cr.	IL_ATHK	0514020401	32	3	2.02	X582, X583, X585, X586, X590	N/A	N/A
Clifty Cr. Ditch	IL_ADCA	0514020605	33	3	8.01	X582, X583, X585, X586, X590	N/A	N/A
Coal Bank Cr.	IL_CAND	0512011501	31	3	4.88	X582, X583, X585, X586, X590	N/A	N/A
Coal Cr.	IL_BNA	0512011103	30	3	8.19	X582, X583, X585, X586, X590	N/A	N/A
Coal Cr.	IL_BZU	0512011106	30	3	3.52	X582, X583, X585, X586, X590	N/A	N/A
Coal Cr.	IL_DJE-02	0713000510	15	2	16.93	F582, X583, X585, X586, F590	N/A	N/A
Coal Cr.	IL_DZ3XA	0713000306	13	3	7.06	X582, X583, X585, X586, X590	N/A	N/A
Coal Cr.	IL_DZZPA	0713000116	11	3	3.17	X582, X583, X585, X586, X590	N/A	N/A
Coal Cr.	IL_LFJ	0708010404	16	3	2.52	X582, X583, X585, X586, X590	N/A	N/A
Coal Cr.	IL_MZN	0708010105	9	3	3.95	X582, X583, X585, X586, X590	N/A	N/A
Coal Cr.	IL_OQCA	0714020110	23	3	1.8	X582, X583, X585, X586, X590	N/A	N/A
Coal Cr.	IL_OQCA-01	0714020110	23	5	1.33	N582, X583, X585, X586, X590	462	85
Coal Cr.	IL_OQCA-02	0714020110	23	3	5.11	X582, X583, X585, X586, X590	N/A	N/A
Coal Cr.	IL_PBJA-02	0709000703	8	2	10.63	F582, X583, X585, X586, F590	N/A	N/A
Coal Cr.	IL_PBJA-03	0709000703	8	2	2.95	F582, X583, X585, X586, F590	N/A	N/A
Coal Cr.	IL_PBJA-04	0709000703	8	5	4.56	N582, X583, X585, X586, X590	84, 463	20
Coal Cr.	IL_PBJA-05	0709000703	8	2	8.11	F582, X583, X585, X586, F590	N/A	N/A
Coal Cr.	IL_PZB-01	0709000513	6	5	14.01	N582, X583, X585, X586, X590	463	N/A
Coates Cr.	IL_DBB	0713001107	18	3	7.53	X582, X583, X585, X586, X590	N/A	N/A
Coffee Cr.	IL_BD	0512011303	31	4C	7.95	N582, X583, X585, X586, X590	501	20
Coffee Cr.	IL_DZ4J	0713000110	11	3	9.9	X582, X583, X585, X586, X590	N/A	N/A
Cold Run	IL_KCAF	0711000409	19	3	7.68	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Cole Branch	IL_DBIA	0713001106	18	3	4.01	X582, X583, X585, X586, X590	N/A	N/A
Cole Cr.	IL_DAA	0713001206	18	3	9.9	X582, X583, X585, X586, X590	N/A	N/A
Collier Cr.	IL_NEH	0714010606	26	3	7.37	X582, X583, X585, X586, X590	N/A	N/A
Collins Run	IL_DWB	0712000501	11	3	3.02	X582, X583, X585, X586, X590	N/A	N/A
Collison Br.	IL_BPKE-01	0512010905	29	3	6.87	X582, X583, X585, X586, X590	N/A	N/A
Concord Cr.	IL_EZF	0713000806	20	3	9.17	X582, X583, X585, X586, X590	N/A	N/A
Conkey Branch	IL_BPJN	0512010906	29	3	4.89	X582, X583, X585, X586, X590	N/A	N/A
Conners Branch	IL_CAX	0512011502	31	3	10.48	X582, X583, X585, X586, X590	N/A	N/A
Conover Branch	IL_DFL	0713001101	18	3	9.28	X582, X583, X585, X586, X590	N/A	N/A
Contrary Cr.	IL_ATFF-02	0514020404	32	4C	16.12	N582, X583, X585, X586, X590	84, 500, 501	20, 72, 125
Coolidge Cr.	IL_PWF-L-C1	0709000316	7	5	3.67	N582, X583, X585, X586, X590	319, 463, 479	58, 132
Coolidge Cr.	IL_PWF-L-C2	0709000316	7	2	4.07	F582, X583, X585, X586, X590	N/A	N/A
Coolidge Cr.	IL_PWF-W-C1	0709000316	7	5	2.56	N582, X583, X585, X586, X590	319, 371, 462	85
Coolidge Cr.	IL_PWF-W-C4	0709000316	7	2	2.41	F582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_CHJ	0512011406	31	3	5.91	X582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_CZP	0512011404	31	3	5.6	X582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_DZ3W	0713001110	18	3	10.53	X582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_DZ4K	0713000113	11	3	3.24	X582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_DZKB	0713000115	11	3	4.79	X582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_EII-01	0713000904	22	2	14.31	F582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_FLIA-01	0712000207	10	4C	17.21	N582, X583, X585, X586, F590	500, 501	20
Coon Cr.	IL_MNG	0706000505	9	3	6.3	X582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_OJAA	0714020207	24	3	8.7	X582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_PJB-C4	0709000505	6	2	6.08	F582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_PQF-06	0709000601	5	5	6.44	N582, X583, X585, X586, X590	371	140, 144
Coon Cr.	IL_PQF-07	0709000601	5	5	23.17	F582, X583, N585, X586, X590	400	140
Coon Cr.	IL_PWPAA	0709000311	7	3	4.71	X582, X583, X585, X586, X590	N/A	N/A
Coon Cr.	IL_PZZO	0709000508	6	3	25.85	X582, X583, X585, X586, X590	N/A	N/A
Coon Cr. North	IL_OZZU	0714020104	23	5	4.93	N582, X583, X585, X586, X590	463	N/A
Coon Creek South	IL_OZZM	0714020107	23	3	2.28	X582, X583, X585, X586, X590	N/A	N/A
Coon Run	IL_DZD	0713001103	18	3	19.74	X582, X583, X585, X586, X590	N/A	N/A
Cooney Cr.	IL_AIC	0514020309	32	3	3.59	X582, X583, X585, X586, X590	N/A	N/A
Coop Branch	IL_DAZI	0713001204	18	4C	20.26	N582, X583, X585, X586, X590	84	20
Cooper Cr.	IL_IXFC	0714010802	33	5	5.37	N582, X583, X585, X586, F590	463	4, 72, 143, 144, 156
Coopers Defeat Cr.	IL_DJNA	0713000501	15	2	11.98	F582, X583, X585, X586, F590	N/A	N/A
Copper Slough	IL_OZYA	0714020102	23	5	8.73	N582, X583, X585, X586, X590	84, 213, 319	20, 28
Copperas Cr.	IL_CZX	0512011401	31	3	4.72	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Copperas Cr.	IL_DZH-01	0713000304	13	2	6.41	F582, X583, X585, X586, X590	N/A	N/A
Copperas Cr.	IL_MZA	0708010106	9	2	32.21	F582, X583, X585, X586, F590	N/A	N/A
Copperous Branch	IL_AKG	0514020306	32	3	3.71	X582, X583, X585, X586, X590	N/A	N/A
Corlock Branch	IL_ODLB	0714020404	25	3	4.3	X582, X583, X585, X586, X590	N/A	N/A
Corn Valley Cr	IL_EZZP-01	0713000601	21	5	6.16	N582, X583, X585, X586, X590	463	140
Corwin Branch	IL_OPCA	0714020201	24	3	3.29	X582, X583, X585, X586, X590	N/A	N/A
Cotton Cr.	IL_DTI	0712000611	3	3	1.7	X582, X583, X585, X586, X590	N/A	N/A
Cotton Cr.	IL_EOJ	0713000702	20	3	10.88	X582, X583, X585, X586, X590	N/A	N/A
Cottonwood Cr.	IL_BEJC-01	0512011207	30	3	17.69	X582, X583, X585, X586, X590	N/A	N/A
Cottonwood Cr.	IL_DAKA	0713001201	18	3	5.42	X582, X583, X585, X586, X590	N/A	N/A
Cottonwood Cr.	IL_EOIA	0713000702	20	3	8.48	X582, X583, X585, X586, X590	N/A	N/A
Court Cr.	IL_DJJ-03	0713000505	15	2	15.48	F582, X583, X585, X586, F590	N/A	N/A
Covel Cr.	IL_DZS	0713000101	11	5	18.49	F582, N583, X585, X586, F590	274	140
Cox Cr.	IL_EEA-01	0713000807	20	2	12.16	F582, X583, X585, X586, X590	N/A	N/A
Cox Cr.	IL_IIH-36	0714010502	28	5	12.08	N582, X583, X585, X586, F590	84, 371, 403, 500, 501	20, 125, 144, 72, 127, 156
Cox Cr.	IL_IIH-ST-C2	0714010502	28	5	3.76	N582, X583, X585, X586, X590	322, 371, 462	4, 85, 177, 144
Crab Orchard Cr.	IL_ND-01	0714010608	26	5	10.41	F582, N583, N585, X586, X590	274, 400	10, 140, 177
Crab Orchard Cr.	IL_ND-02	0714010608	26	4A	2.11	N582, X583, X586, X590	273, 319, 322	140, 58, 132
Crab Orchard Cr.	IL_ND-04	0714010608	26	5	14.77	N582, X583, X586, X590	228, 273, 322, 371, 501	142, 127, 143, 20, 156, 82
Crab Orchard Cr.	IL_ND-11	0714010608	26	4A	1.01	N582, X583, X585, X586, X590	322	140
Crab Orchard Cr.	IL_ND-12	0714010608	26	2	1.2	F582, X583, X585, X586, X590	N/A	N/A
Crab Orchard Cr.	IL_ND-13	0714010608	26	2	1.6	F582, X583, X585, X586, X590	N/A	N/A
Crab Orchard Cr.	IL_ND-14	0714010608	26	2	5.69	F582, X583, X585, X586, X590	N/A	N/A
Crabapple Branch	IL_CAZI	0512011502	31	3	5.76	X582, X583, X585, X586, X590	N/A	N/A
Crabapple Cr.	IL_BNB	0512011101	30	2	18.89	F582, X583, X585, X586, X590	N/A	N/A
Crabapple Cr.	IL_CJH	0512011405	31	3	5.71	X582, X583, X585, X586, X590	N/A	N/A
Crabapple Cr.	IL_DEI	0713001102	18	3	2.19	X582, X583, X585, X586, X590	N/A	N/A
Crabtree Cr.	IL_DZ3X	0713000306	13	3	2.1	X582, X583, X585, X586, X590	N/A	N/A
Crane Cr.	IL_DZGBA	0713000305	13	3	12.71	X582, X583, X585, X586, X590	N/A	N/A
Crane Cr.	IL_DZZE	0713000311	13	3	12.89	X582, X583, X585, X586, X590	N/A	N/A
Crane Cr.	IL_EH-01	0713000805	20	5	15.31	N582, X583, X585, X586, X590	322	140
Crane Grove Cr.	IL_PWNA	0709000313	7	2	9.36	F582, X583, X585, X586, X590	N/A	N/A
Crater Cr.	IL_DZ3M	0713001110	18	3	3.64	X582, X583, X585, X586, X590	N/A	N/A
Crawfish Cr.	IL_BZJ	0512011302	31	5	11.81	N582, X583, X585, X586, X590	463	140
Crawford Cr.	IL_ATFA-01	0514020406	32	5	9.91	N582, X583, X585, X586, X590	84, 462, 500, 501	20, 85, 177

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Crawford Cr.	IL_DZ3N	0713001110	18	3	4.73	X582, X583, X585, X586, X590	N/A	N/A
Crenshaw Cr.	IL_AGB	0514020601	33	3	7.59	X582, X583, X585, X586, X590	N/A	N/A
Cress Cr.	IL_OILB-01	0714020302	24	3	6.4	X582, X583, X585, X586, X590	N/A	N/A
Crileys Branch	IL_OJD	0714020208	24	3	2.52	X582, X583, X585, X586, X590	N/A	N/A
Croked Cr.	IL_GIBG	0712000407	2	3	4.67	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_BCD	0512011304	31	3	7.28	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_BEG-01	0512011209	30	3	6.6	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_BEJD	0512011207	30	3	4.74	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_BZS	0512011109	30	3	13.69	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_CAO	0512011502	31	3	6.2	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_CAUC	0512011502	31	3	2.59	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_CL	0512011404	31	3	21.29	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_CZG	0512011409	31	3	8.23	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_DBA	0713001107	18	3	4.77	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_DKT-01	0713000403	14	2	10.41	F582, X583, X585, X586, F590	N/A	N/A
Crooked Cr.	IL_KCP	0711000410	19	3	2.13	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_OJ-07	0714020208	24	5	34.46	N582, X583, X586, X590	273, 462	85, 144
Crooked Cr.	IL_OJ-08	0714020208	24	5	24.34	N582, X583, X586, X590	322, 403, 462	72, 85, 177, 144
Crooked Cr.	IL_OJ-11	0714020208	24	5	15.72	N582, X583, X585, X586, X590	322	140
Crooked Cr.	IL_OZZZA	0714020409	25	3	3.12	X582, X583, X585, X586, X590	N/A	N/A
Crooked Cr.	IL_PBPA	0709000702	8	3	5.35	X582, X583, X585, X586, X590	N/A	N/A
Crooked Creek	IL_IXJAA	0714010801	33	5	6.05	N582, X583, X585, X586, F590	322, 501	20, 125, 144, 156, 157
Crooked Run	IL_DBE	0713001107	18	3	6.3	X582, X583, X585, X586, X590	N/A	N/A
Croookedleg Cr.	IL_DTAA	0712000705	4	3	16.1	X582, X583, X585, X586, X590	N/A	N/A
Crow Cr. E.	IL_DO-01	0713000112	11	5	17.98	F582, X583, N585, X586, F590	400	140
Crow Cr. W.	IL_DN	0713000111	11	2	32.94	F582, X583, X585, X586, F590	N/A	N/A
Crystal Cr.	IL_GN-01	0712000405	2	3	2.57	X582, X583, X585, X586, X590	N/A	N/A
Crystal Glen Cr.	IL_LZV	0708010418	16	3	7.09	X582, X583, X585, X586, X590	N/A	N/A
Crystal Lake Outlet	IL_DTZR-01	0712000612	3	5	6.54	X582, X583, N585, X586, X590	400	177
Cub Branch	IL_CANBCA	0512011501	31	3	1.73	X582, X583, X585, X586, X590	N/A	N/A
Curl Cr.	IL_DEO	0713001102	18	3	10.87	X582, X583, X585, X586, X590	N/A	N/A
Curtis Cr.	IL_KE	0711000110	19	3	7.34	X582, X583, X585, X586, X590	N/A	N/A
Cuttington Cr.	IL_EGC	0713000806	20	3	3.76	X582, X583, X585, X586, X590	N/A	N/A
Cypress Cr.	IL_IXM-01	0714010801	33	2	7.13	F582, X583, X585, X586, X590	N/A	N/A
Cypress Cr.	IL_IXM-04	0714010801	33	2	5.35	F582, X583, X585, X586, X590	N/A	N/A
Cypress Cr.	IL_IXM-05	0714010801	33	2	13.65	F582, X583, X585, X586, X590	N/A	N/A
Cypress Ditch	IL_ATZM-02	0514020407	32	4C	9.16	N582, X583, X585, X586, F590	84, 500, 501	20, 72, 144, 156

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Cypress Slough	IL_IXCD	0714010803	33	3	5.56	X582, X583, X585, X586, X590	N/A	N/A
Dago Slough	IL_DJFCA	0713000509	15	5	3.5	N582, X583, X585, X586, X590	84, 371, 462	20, 143, 85
Darkies Cr.	IL_BEJK	0512011207	30	3	4.69	X582, X583, X585, X586, X590	N/A	N/A
Davids Cr.	IL_LDDAA	0708010408	16	3	12.81	X582, X583, X585, X586, X590	N/A	N/A
Davidson Cr.	IL_OKB	0714020205	24	3	11.96	X582, X583, X585, X586, X590	N/A	N/A
Davis Cr.	IL_FH	0712000118	10	3	5.38	X582, X583, X585, X586, X590	N/A	N/A
Davis Cr.	IL_MJD	0706000510	9	3	6.43	X582, X583, X585, X586, X590	N/A	N/A
De Arcy Branch	IL_DAEA	0713001205	18	3	8.75	X582, X583, X585, X586, X590	N/A	N/A
Dead Cr.	IL_JMAF	0714010105	27	3	2.92	X582, X583, X585, X586, X590	N/A	N/A
Dead Dog Creek	IL_QE-01	0404000201	1	5	4.68	N582, X583, X585, X586, X590	79, 463	28, 140
Dead R.	IL_QD	0404000201	1	3	1.77	X582, X583, X585, X586, X590	N/A	N/A
Deadly Run	IL_DZZB	0712000508	11	3	2.97	X582, X583, X585, X586, X590	N/A	N/A
Deep Run	IL_LCD	0708010413	16	3	6.3	X582, X583, X585, X586, X590	N/A	N/A
Deep Run Cr.	IL_GIX-01	0712000407	2	2	3.72	F582, X583, X585, X586, X590	N/A	N/A
Deer Branch	IL_DAZQA	0713001201	18	3	3.5	X582, X583, X585, X586, X590	N/A	N/A
Deer Cr.	IL_BEZY	0512011205	30	3	14.34	X582, X583, X585, X586, X590	N/A	N/A
Deer Cr.	IL_CDB	0512011407	31	5	17.27	N582, X583, X585, X586, X590	84, 273, 322, 479	20, 155
Deer Cr.	IL_DKGB	0713000407	14	3	8.08	X582, X583, X585, X586, X590	N/A	N/A
Deer Cr.	IL_DKGC	0713000407	14	3	6.25	X582, X583, X585, X586, X590	N/A	N/A
Deer Cr.	IL_DMCA	0713000114	11	3	6.44	X582, X583, X585, X586, X590	N/A	N/A
Deer Cr.	IL_DSLB	0713000206	12	5	6.25	N582, X583, X585, X586, F590	322, 501	140, 20
Deer Cr.	IL_EIF-01	0713000904	22	4C	18.74	N582, X583, X585, X586, X590	84	125
Deer Cr.	IL_FLC	0712000214	10	3	5.96	X582, X583, X585, X586, X590	N/A	N/A
Deer Cr.	IL_HBDC	0712000302	1	5	8.2	N582, X583, N585, X586, X590	84, 319, 462, 400	20, 85, 177, 140
Deer Cr.	IL_HBDC-02	0712000302	1	5	10.12	N582, X583, N585, X586, X590	319, 322, 371, 462, 400	58, 85, 177, 140
Deer Cr.	IL_OKAB	0714020205	24	3	6.02	X582, X583, X585, X586, X590	N/A	N/A
Deer Cr.	IL_PQCE	0709000606	5	5	9.66	N582, X583, X585, X586, X590	463	N/A
Deer Cr.	IL_PZN	0709000510	6	3	9.95	X582, X583, X585, X586, X590	N/A	N/A
Deer Lick Cr.	IL_DLJ	0713000302	13	3	3.96	X582, X583, X585, X586, X590	N/A	N/A
Deerlick Branch	IL_MWDC	0708010107	9	3	4.57	X582, X583, X585, X586, X590	N/A	N/A
Degonia Cr.	IL_IH	0714010503	28	3	6.86	X582, X583, X585, X586, X590	N/A	N/A
Delta Cr.	IL_ATGJ-01	0514020402	32	3	6.56	X582, X583, X585, X586, X590	N/A	N/A
DeNeal Branch	IL_ATHZB	0514020403	32	3	4.07	X582, X583, X585, X586, X590	N/A	N/A
Denman Cr.	IL_DKM-01	0713000405	14	2	10.33	F582, X583, X585, X586, F590	N/A	N/A
DesPlaines R.	IL_G-03	0712000407	2	5	8.41	N582, N583, F585, F586, X590	84, 138, 319, 441, 462, 479, 274, 348	20, 23, 85, 177, 58, 10, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
DesPlaines R.	IL_G-07	0712000403	2	5	10.78	N582, N583, N585, X586, X590	84, 96, 138, 462, 274, 348, 400	125, 28, 85, 177, 10, 140
DesPlaines R.	IL_G-08	0712000403	2	5	0.98	N582, N583, N585, X586, X590	138, 260, 403, 479, 274, 400	49, 140, 144, 10
DesPlaines R.	IL_G-11	0712000407	2	5	9.06	N582, N583, F585, F586, X590	79, 96, 138, 277, 319, 322, 441, 462, 479, 274, 348	28, 85, 177, 58, 10, 140
DesPlaines R.	IL_G-12	0712000409	2	5	8.52	N583, X586, F587	274, 348	10, 140, 28
DesPlaines R.	IL_G-15	0712000405	2	5	3.52	N582, N583, N585, X586, X590	138, 322, 371, 462, 274, 348, 400	23, 49, 85, 177, 10, 140
DesPlaines R.	IL_G-22	0712000405	2	5	4.31	N582, N583, N585, X586, X590	96, 138, 277, 319, 403, 462, 500, 274, 348, 400	28, 85, 177, 58, 132, 142, 10, 140
DesPlaines R.	IL_G-23	0712000407	2	5	3.82	N583, X586, F587	274, 348	10, 140
DesPlaines R.	IL_G-24	0712000409	2	5	5.18	F582, N583, N585, X586, X590	274, 348, 400	10, 140, 28, 23, 85
DesPlaines R.	IL_G-25	0712000403	2	5	6.92	N582, N583, X585, X586, X590	96, 371, 403, 274	28, 122, 177, 10, 140
DesPlaines R.	IL_G-26	0712000405	2	5	6.01	F582, N583, X585, X586, X590	274, 348	10, 140
DesPlaines R.	IL_G-28	0712000405	2	5	9.02	N582, N583, N585, X586, X590	84, 138, 319, 462, 274, 348, 400	125, 23, 85, 177, 58, 10, 140
DesPlaines R.	IL_G-30	0712000405	2	5	5.19	N582, N583, N585, X586, X590	138, 403, 462, 274, 348, 400	23, 49, 85, 177, 10, 140
DesPlaines R.	IL_G-32	0712000405	2	5	6.18	N582, N583, N585, X586, X590	138, 462, 274, 348, 400	23, 49, 85, 177, 10, 140
DesPlaines R.	IL_G-35	0712000405	2	5	5	N582, N583, X585, X586, X590	462, 463, 274, 348	85, 140, 10
DesPlaines R.	IL_G-36	0712000405	2	5	7.22	N582, N583, N585, X586, X590	319, 462, 479, 274, 348, 400	58, 142, 85, 10, 140, 177
DesPlaines R.	IL_G-39	0712000407	2	5	11.25	N582, N583, N585, X586, X590	79, 96, 138, 268, 277, 319, 441, 462, 274, 348, 400	28, 23, 85, 177, 58, 142, 10, 140
Diamond Cr.	IL_DSFB	0713000207	12	2	14.04	F582, X583, X585, X586, X590	N/A	N/A
Dickerson Slough	IL_EZZH-01	0713000601	21	2	15.09	F582, X583, X585, X586, X590	N/A	N/A
Dickison Run	IL_DZZR	0713000117	11	3	6.87	X582, X583, X585, X586, X590	N/A	N/A
Dicks Cr.	IL_BEJJ	0512011207	30	3	4.2	X582, X583, X585, X586, X590	N/A	N/A
Dickson Cr.	IL_DZ3XAA	0713000306	13	3	4.63	X582, X583, X585, X586, X590	N/A	N/A
Dieterich Cr.	IL_COC-09	0512011403	31	5	0.99	N582, X583, X585, X586, X590	371, 403, 462	144
Dieterich Cr.	IL_COC-10	0512011403	31	5	8.66	N582, X583, X585, X586, X590	463	140
Dillon Cr.	IL_DKC-01	0713000408	14	5	18	N582, X583, X585, X586, F590	463	140
Discharge, The	IL_JA	0714010109	27	3	8.71	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Dismal Cr.	IL_CM-02	0512011404	31	4C	24.58	N582, X583, X585, X586, X590	84, 500, 501	125, 20
Diversion Canal	IL_KG	0711000110	19	3	15.81	X582, X583, X585, X586, X590	N/A	N/A
Dixson Cr.	IL_LCF	0708010413	16	3	5.96	X582, X583, X585, X586, X590	N/A	N/A
Doby Branch	IL_DEHD	0713001102	18	3	5.21	X582, X583, X585, X586, X590	N/A	N/A
Dodds Branch	IL_NCKD	0714010610	26	3	5.35	X582, X583, X585, X586, X590	N/A	N/A
Dodds Cr.	IL_NJB	0714010603	26	3	10.97	X582, X583, X585, X586, X590	N/A	N/A
Dog Cr.	IL_AH	0514020309	32	5	9.93	N582, X583, X585, X586, F590	322	140
Dogwood Cr.	IL_BEDB-01	0512011211	30	5	15.22	N582, X583, X585, X586, X590	273, 322, 462	155, 140, 144
Donica Cr.	IL_BEPC	0512011204	30	3	3.08	X582, X583, X585, X586, X590	N/A	N/A
Donohue Run	IL_LFC	0708010404	16	3	6.73	X582, X583, X585, X586, X590	N/A	N/A
Dorris Cr.	IL_OIF	0714020304	24	3	12.52	X582, X583, X585, X586, X590	N/A	N/A
DOT Creek	IL_JNGA-PF-A1	0714010104	27	5	0.31	N582, X583, X585, X586, N590	84, 322, 500, 501, 160, 413, 462, 471, 479	20, 36, 49, 72, 177
DOT Creek	IL_JNGA-PF-D1	0714010104	27	5	0.32	N582, X583, X585, X586, N590	84, 500, 501, 160, 413, 462, 471, 479, 520	20, 28, 49, 62, 69, 72, 157, 177
Douglas Cr.	IL_OCE	0714020406	25	2	10.27	F582, X583, X585, X586, F590	N/A	N/A
Douglas Cr.	IL_OCE-ST-C1	0714020406	25	5	1.16	N582, X583, X585, X586, N590	84, 462, 500, 501, 479, 520	20, 72, 125, 177, 85, 144, 156
Doza Cr.	IL_OZD	0714020409	25	5	17.65	N582, X583, X585, X586, X590	273, 322, 371, 462, 478, 502	56, 85, 144, 36
Drain Ditch 7	IL_BEPG-01	0512011204	30	3	8.82	X582, X583, X585, X586, X590	N/A	N/A
Drake Cr.	IL_CTA	0512011401	31	3	5.64	X582, X583, X585, X586, X590	N/A	N/A
Drapper Branch	IL_DAZC	0713001206	18	3	3.43	X582, X583, X585, X586, X590	N/A	N/A
Drowning Fork	IL_DGLC-01	0713001003	17	5	18.83	N582, X583, X585, X586, X590	84, 138, 371, 403, 462	20, 140, 144, 85
Drum Hill Branch	IL_OZF	0714020409	25	3	8.39	X582, X583, X585, X586, X590	N/A	N/A
Drummer Cr.	IL_EY-01	0713000601	21	5	18.97	N582, X583, X585, X586, X590	322, 501	140, 20
Drury Cr.	IL_NDC-01	0714010608	26	5	21.9	N582, X583, X585, X586, X590	84, 322	72, 140
Drury Cr.	IL_NDC-02	0714010608	26	5	1.43	N582, X583, X585, X586, X590	273	127
Dry Branch	IL_BEU	0512011205	30	3	6	X582, X583, X585, X586, X590	N/A	N/A
Dry Branch	IL_DAZF	0713001206	18	3	9.51	X582, X583, X585, X586, X590	N/A	N/A
Dry Branch	IL_EOHFB	0713000701	20	3	6.48	X582, X583, X585, X586, X590	N/A	N/A
Dry Branch	IL_ICG	0714010506	28	3	3.31	X582, X583, X585, X586, X590	N/A	N/A
Dry Cr.	IL_DZGBAA	0713000305	13	3	7.62	X582, X583, X585, X586, X590	N/A	N/A
Dry Cr.	IL_DZKA	0713000115	11	3	12.71	X582, X583, X585, X586, X590	N/A	N/A
Dry Cr.	IL_IID	0714010502	28	3	3.99	X582, X583, X585, X586, X590	N/A	N/A
Dry Cr.	IL_NCL	0714010610	26	3	4.04	X582, X583, X585, X586, X590	N/A	N/A
Dry Cr.	IL_PV-01	0709000501	6	5	9.39	N582, X583, X585, X586, X590	463	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Dry Fork	IL_ATHDA	0514020403	32	3	2.73	X582, X583, X585, X586, X590	N/A	N/A
Dry Fork	IL_CAJ-01	0512011503	31	2	23.13	F582, X583, X585, X586, X590	N/A	N/A
Dry Fork	IL_DAH	0713001201	18	3	9.2	X582, X583, X585, X586, X590	N/A	N/A
Dry Fork	IL_DEF	0713001102	18	3	16.15	X582, X583, X585, X586, X590	N/A	N/A
Dry Fork	IL_OBCA	0714020408	25	3	4.52	X582, X583, X585, X586, X590	N/A	N/A
Dry Fork	IL_OIG	0714020304	24	2	15.97	F582, X583, X585, X586, X590	N/A	N/A
Dry Fork	IL_OLG	0714020204	24	3	15.33	X582, X583, X585, X586, X590	N/A	N/A
Dry Fork	IL_OZZW	0714020102	23	5	12.03	N582, X583, X585, X586, X590	463	N/A
Dry Fork (old chan)	IL_CAJ-OLDCHAN	0512011503	31	3	3.07	X582, X583, X585, X586, X590	N/A	N/A
Dry Fork Cr.	IL_ATHM	0514020401	32	3	3.32	X582, X583, X585, X586, X590	N/A	N/A
Dry Fork Drainage D	IL_CAJ-DRAIND	0512011503	31	3	1.47	X582, X583, X585, X586, X590	N/A	N/A
Dry Run	IL_DLA	0713000302	13	3	5.31	X582, X583, X585, X586, X590	N/A	N/A
Dry RUN	IL_DY	0713000306	13	3	3.05	X582, X583, X585, X586, X590	N/A	N/A
Dry Run	IL_OBE	0714020408	25	3	3.57	X582, X583, X585, X586, X590	N/A	N/A
Dry Run	IL_PBUA	0709000701	8	3	9.1	X582, X583, X585, X586, X590	N/A	N/A
Duck Cr.	IL_LDF	0708010410	16	3	12.21	X582, X583, X585, X586, X590	N/A	N/A
Dudley Branch	IL_BEOA	0512011208	30	3	3.65	X582, X583, X585, X586, X590	N/A	N/A
Dugout Cr.	IL_LFGA	0708010401	16	3	7.8	X582, X583, X585, X586, X590	N/A	N/A
Dugout Cr.	IL_LZE	0708010416	16	3	18.94	X582, X583, X585, X586, X590	N/A	N/A
Dugout Run	IL_LEE	0708010405	16	3	4.28	X582, X583, X585, X586, X590	N/A	N/A
Duke Cr.	IL_MNA	0706000506	9	3	3.06	X582, X583, X585, X586, X590	N/A	N/A
Dums Cr.	IL_CAW-04	0512011502	31	5	27.88	N582, X583, X585, X586, X590	322	4, 143
Dunbar Cr.	IL_DGPA	0713001001	17	3	4.7	X582, X583, X585, X586, X590	N/A	N/A
DuPage R.	IL_GB-01	0712000408	2	5	8.11	N582, N583, X585, X586, X590	319, 462, 500, 274, 348	142, 85, 10, 140
DuPage R.	IL_GB-11	0712000408	2	5	10.11	N582, N583, N585, X586, X590	84, 96, 138, 277, 319, 348, 371, 462, 478, 274, 400	72, 28, 85, 177, 58, 122, 132, 142, 10, 140
DuPage R.	IL_GB-16	0712000408	2	5	11.31	N582, N583, N585, X586, X590	319, 322, 462, 478, 274, 348, 400	58, 85, 122, 177, 10, 140
Durbin Branch	IL_DEHCA	0713001102	18	3	3.4	X582, X583, X585, X586, X590	N/A	N/A
Dutch Cr.	IL_DTN	0712000611	3	3	2.76	X582, X583, X585, X586, X590	N/A	N/A
Dutch Cr.	IL_ICD-02	0714010506	28	2	5.96	F582, X583, X585, X586, F590	N/A	N/A
Dutch Cr.	IL_ICD-JB-C2	0714010506	28	5	1.6	N582, X583, X585, X586, X590	322	85
Dutch Cr.	IL_ICD-JB-D1	0714010506	28	2	3.71	F582, X583, X585, X586, X590	N/A	N/A
Dutch Cr.	IL_KCF	0711000408	19	3	11.56	X582, X583, X585, X586, X590	N/A	N/A
Dutchman Cr.	IL_ADD-01	0514020604	33	2	5.11	F582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Dutchman Cr.	IL_ADD-02	0514020604	33	5	11.52	N582, X583, X585, X586, F590	84, 322, 500, 501	20, 72, 125, 143, 144, 156, 157
Dutchman Cr.	IL_ADD-05	0514020604	33	5	4.7	N582, X583, X585, X586, F590	84, 441	66, 72, 143, 144, 156
Dutchmans Cr.	IL_DZZG	0713000310	13	3	4.96	X582, X583, X585, X586, X590	N/A	N/A
E. Aux Sable Cr.	IL_DWD-01	0712000501	11	2	11.24	F582, X583, X585, X586, X590	N/A	N/A
E. Br. Big Rock Cr.	IL_DTCD	0712000703	4	3	15.22	X582, X583, X585, X586, X590	N/A	N/A
E. Br. Cedar Cr.	IL_AJFB	0514020308	32	3	4.87	X582, X583, X585, X586, X590	N/A	N/A
E. Br. Copperas Cr.	IL_DZHC	0713000304	13	5	20.14	N582, X583, X585, X586, X590	463	140
E. Br. DuPage R.	IL_GBL-02	0712000408	2	5	8.01	N582, N583, X585, X586, X590	96, 277, 319, 322, 462, 348	28, 20, 58, 177, 85, 140
E. Br. DuPage R.	IL_GBL-05	0712000408	2	5	3.18	N582, N583, X585, X586, X590	84, 138, 322, 403, 462, 348	20, 122, 85, 177, 140
E. Br. DuPage R.	IL_GBL-08	0712000408	2	5	4.69	N582, N583, X585, X586, X590	84, 96, 198, 246, 277, 319, 322, 371, 403, 441, 462, 479, 348	20, 122, 132, 28, 58, 142, 177, 50, 85, 140
E. Br. DuPage R.	IL_GBL-10	0712000408	2	5	4.66	N582, N583, N585, X586, X590	84, 96, 138, 198, 246, 277, 322, 441, 462, 348, 400	20, 28, 85, 177, 140
E. Br. DuPage R.	IL_GBL-11	0712000408	2	5	3.45	N582, N583, X585, X586, X590	84, 319, 322, 462, 348	72, 122, 125, 20, 177, 140, 85
E. Br. Embarras R.	IL_BET-01	0512011201	30	3	20.33	X582, X583, X585, X586, X590	N/A	N/A
E. Br. Green Cr.	IL_CSB-07	0512011401	31	5	3.43	N582, X583, X585, X586, X590	322, 462	4, 144
E. Br. Green Cr.	IL_CSB-08	0512011401	31	5	5.98	N582, X583, X585, X586, X590	322, 462	4, 144
E. Br. Horse Cr.	IL_FCC-01	0712000116	10	2	15.15	F582, X583, X585, X586, F590	N/A	N/A
E. Br. Killbuck Cr.	IL_PQBA	0709000607	5	5	14.93	N582, X583, X585, X586, X590	462	144
E. Br. Kiser Cr.	IL_KXC	0711000406	19	3	7.65	X582, X583, X585, X586, X590	N/A	N/A
E. Br. Lamarsh Cr.	IL_DZIB	0713000303	13	3	11.16	X582, X583, X585, X586, X590	N/A	N/A
E. Br. Little Silver Cr	IL_ODGA	0714020405	25	3	6.8	X582, X583, X585, X586, X590	N/A	N/A
E. Br. Panther Cr.	IL_DKKC-02	0713000404	14	5	13.31	N582, X583, X585, X586, F590	322	140
E. Br. Richland Cr.	IL_PWPC-01	0709000311	7	3	2.61	X582, X583, X585, X586, X590	N/A	N/A
E. Br. S. Br. Kishwaukee R.	IL_PQCL-01	0709000605	5	3	3.49	X582, X583, X585, X586, X590	N/A	N/A
E. Br. S. Br. Kishwaukee R.	IL_PQCL-02	0709000605	5	2	7.17	F582, X583, X585, X586, X590	N/A	N/A
E. Crooked Cr.	IL_BEGA	0512011209	30	3	19.89	X582, X583, X585, X586, X590	N/A	N/A
E. Fk Mazon R.	IL_DVF-01	0712000502	11	2	23.75	F582, X583, X585, X586, F590	N/A	N/A
E. Fk. Crane Cr.	IL_DZZEA	0713000311	13	3	8	X582, X583, X585, X586, X590	N/A	N/A
E. Fk. E. Plum R.	IL_MJCB	0706000508	9	3	4.99	X582, X583, X585, X586, X590	N/A	N/A
E. Fk. Galena R.	IL_MQB	0706000503	9	2	11.74	F582, X583, X585, X586, F590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
E. Fk. Kaskaskia R.	IL_OK-01	0714020205	24	4A	20.05	F582, X583, N585, X586, X590	400	140
E. Fk. Kaskaskia R.	IL_OK-02	0714020205	24	5	18.72	N582, X583, X585, X586, X590	322, 462	140, 144
E. Fk. Kaskaskia R.	IL_OK-03	0714020205	24	2	8.76	X582, X583, F584, X585, X586, X590	N/A	N/A
E. Fk. La Moine R.	IL_DGL-02	0713001003	17	2	6.97	F582, X583, X585, X586, X590	N/A	N/A
E. Fk. La Moine R.	IL_DGL-04	0713001003	17	4A	14.82	F582, X583, N584, X585, X586, X590	273	140
E. Fk. La Moine R.	IL_DGL-05	0713001003	17	2	22.27	F582, X583, X585, X586, X590	N/A	N/A
E. Fk. Little Lusk Cr.	IL_AKIA	0514020306	32	3	3.64	X582, X583, X585, X586, X590	N/A	N/A
E. Fk. Mill Cr.	IL_POAA	0709000504	6	3	11.11	X582, X583, X585, X586, X590	N/A	N/A
E. Fk. Nettle Cr.	IL_DUA	0712000506	11	2	13.81	F582, X583, X585, X586, X590	N/A	N/A
E. Fk. Otter Cr.	IL_DAGDA	0713001202	18	3	14.63	X582, X583, X585, X586, X590	N/A	N/A
E. Fk. Raccoon Cr.	IL_PWAD	0709000315	7	3	1.84	X582, X583, X585, X586, X590	N/A	N/A
E. Fk. Shoal Cr	IL_OID-04	0714020303	24	2	33.34	F582, X583, X585, X586, X590	N/A	N/A
E. Fk. Shoal Cr.	IL_OID-05	0714020303	24	2	26.5	F582, X583, X585, X586, X590	N/A	N/A
E. Fk. Silver Cr.	IL_ODL	0714020404	25	3	9.1	X582, X583, X585, X586, X590	N/A	N/A
E. Fk. Silver Cr.	IL_ODL-02	0714020404	25	2	14.97	F582, X583, X585, X586, X590	N/A	N/A
E. Fk. Spoon R.	IL_DJN-02	0713000501	15	2	23.6	F582, X583, X585, X586, F590	N/A	N/A
E. Fk. Wet Weather Cr.	IL_CJDA	0512011405	31	3	10.74	X582, X583, X585, X586, X590	N/A	N/A
E. Fk. Wood R.	IL_JRA-02	0711000903	27	5	21.61	N582, X583, X585, X586, N590	371, 388, 500, 501, 471	72, 144, 177
E. Fk.La Moine R.	IL_DGL-03	0713001003	17	2	7.91	F582, X583, X585, X586, X590	N/A	N/A
E. Fk.La Moine R.	IL_DGL-08	0713001003	17	2	4.48	F582, X583, X585, X586, X590	N/A	N/A
E. Johnson Cr.	IL_MIC	0708010101	9	3	9.01	X582, X583, X585, X586, X590	N/A	N/A
E. Little Cr.	IL_BJD	0512011108	30	3	6.8	X582, X583, X585, X586, X590	N/A	N/A
E. Mill Cr.	IL_BHF	0512011110	30	3	6.97	X582, X583, X585, X586, X590	N/A	N/A
E. Panther Cr.	IL_DZ3O	0713001110	18	3	6.15	X582, X583, X585, X586, X590	N/A	N/A
E. Spafford Branch	IL_PWWA	0709000309	7	3	4.99	X582, X583, X585, X586, X590	N/A	N/A
Eagle Branch	IL_BEZE	0512011212	30	3	4.56	X582, X583, X585, X586, X590	N/A	N/A
Eagle Cr.	IL_ATE-01	0514020407	32	3	3.85	X582, X583, X585, X586, X590	N/A	N/A
Eagle Cr.	IL_ATE-02	0514020407	32	5	3.14	N582, X583, X585, X586, X590	322	56, 140
Eagle Cr.	IL_ATE-03	0514020407	32	5	2.66	N582, X583, X585, X586, X590	273, 322, 385	127, 140
Eagle Cr.	IL_ATE-04	0514020407	32	5	1.6	N582, X583, X585, X586, X590	273, 322, 385, 441	127, 140
Eagle Cr.	IL_ATE-05	0514020407	32	5	1.76	N582, X583, X585, X586, X590	273, 322, 385	127, 140
Eagle Cr.	IL_ATE-06	0514020407	32	3	3.72	X582, X583, X585, X586, X590	N/A	N/A
Eagle Cr.	IL_DSC-01	0713000209	12	2	11.48	F582, X583, X585, X586, X590	N/A	N/A
Eagle Cr.	IL_DTLA-01	0712000610	3	3	4.28	X582, X583, X585, X586, X590	N/A	N/A
Eagle Cr.	IL_PHG	0709000507	6	3	8.77	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Eagle Run	IL_DZDB	0713001103	18	3	6.61	X582, X583, X585, X586, X590	N/A	N/A
Eakin Cr	IL_PQIC	0709000602	5	3	9.63	X582, X583, X585, X586, X590	N/A	N/A
East Bureau Cr.	IL_DQA-01	0713000106	11	5	26.76	N582, X583, X585, X586, F590	463	N/A
East Cr.	IL_DJA	0713000514	15	3	9.17	X582, X583, X585, X586, X590	N/A	N/A
East Cr.	IL_JQI	0714010101	27	3	3.56	X582, X583, X585, X586, X590	N/A	N/A
East Cr.	IL_NLA	0714010602	26	3	5.93	X582, X583, X585, X586, X590	N/A	N/A
East Fork Fox R.	IL_CHG	0512011406	31	3	4.57	X582, X583, X585, X586, X590	N/A	N/A
East Lake Fork	IL_OWB	0714020101	23	3	14.52	X582, X583, X585, X586, X590	N/A	N/A
East Palzo Cr.	IL_ATHV-01	0514020401	32	5	3.26	N582, X583, X585, X586, X590	163, 260, 273, 441	2, 127
East Plum R.	IL_MJC	0706000508	9	3	22.57	X582, X583, X585, X586, X590	N/A	N/A
East Run	IL_DTDA	0712000702	4	3	1.04	X582, X583, X585, X586, X590	N/A	N/A
Eaton Cr.	IL_NEHA	0714010606	26	3	3.42	X582, X583, X585, X586, X590	N/A	N/A
Eaton Hill Branch	IL_CZDA	0512011410	31	3	1.8	X582, X583, X585, X586, X590	N/A	N/A
Edwards R.	IL_LF-01	0708010404	16	5	14.33	F582, X583, N585, X586, X590	400	140
Edwards R.	IL_LF-05	0708010404	16	2	28.61	F582, X583, X585, X586, X590	N/A	N/A
Edwards R.	IL_LF-08	0708010404	16	4C	31.19	N582, X583, X585, X586, F590	84, 501	20
Egg Bag Cr.	IL_DSCA	0713000209	12	2	12.02	F582, X583, X585, X586, X590	N/A	N/A
Eldorado Creek	IL_ATGL-EL-C1	0514020402	32	3	5.49	X582, X583, X585, X586, X590	N/A	N/A
Eldorado Creek	IL_ATGL-HB-D1	0514020402	32	2	3.8	F582, X583, X585, X586, X590	N/A	N/A
Eliza Cr.	IL_MWD	0708010107	9	4C	24.44	N582, X583, X585, X586, F590	501	72
Elkhorn Cr.	IL_OG-02	0714020402	25	5	31.24	N582, X583, X585, X586, X590	273, 322, 371, 403, 462, 479	72, 144, 156
Elkhorn Cr.	IL_PH-01	0709000507	6	5	12.89	F582, N583, X585, X586, X590	348	140
Elkhorn Cr.	IL_PH-14	0709000507	6	5	4.65	F582, N583, X585, X586, X590	348	140
Elkhorn Cr.	IL_PH-16	0709000507	6	5	17.6	F582, N583, X586, X590	348	140
Elkhorn Cr.	IL_PH-17	0709000507	6	5	20.51	N582, N583, X585, X586, X590	403, 348	143, 144, 140
Elliott Cr.	IL_CZZA	0512011409	31	3	6.65	X582, X583, X585, X586, X590	N/A	N/A
Elliott Cr.	IL_OOD	0714020202	24	3	7.87	X582, X583, X585, X586, X590	N/A	N/A
Ellis Br.	IL_BOL	0512010811	29	2	4.73	F582, X583, X585, X586, X590	N/A	N/A
Ellison Cr.	IL_LC-01	0708010413	16	5	31.76	N582, X583, X585, X586, F590	260, 501	155, 20
Ellison Creek Diversion	IL_LCH-01	0708010413	16	3	4.65	X582, X583, X585, X586, X590	N/A	N/A
Ellsworth Cr.	IL_PGA	0709000510	6	3	12.98	X582, X583, X585, X586, X590	N/A	N/A
Elm Cr.	IL_CANC	0512011501	31	3	3.76	X582, X583, X585, X586, X590	N/A	N/A
Elm Cr.	IL_DAZIA	0713001204	18	3	3.24	X582, X583, X585, X586, X590	N/A	N/A
Elm Cr.	IL_DZ3Y	0713000310	13	3	7.52	X582, X583, X585, X586, X590	N/A	N/A
Elm Cr.	IL_KIFE	0711000104	19	3	6.79	X582, X583, X585, X586, X590	N/A	N/A
Elm Point Branch	IL_OIHA	0714020304	24	3	4.87	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Elm R.	IL_CD-01	0512011407	31	5	8.6	N582, N583, N585, X586, X590	99, 273, 322, 462, 274, 400	144, 102, 155, 140
Elm R.	IL_CD-04	0512011407	31	5	36.41	N582, N583, X585, X586, X590	322, 274	4, 140, 10
Embarras R.	IL_BE-01	0512011215	30	5	29.06	F582, X583, N585, X586, X590	400	140
Embarras R.	IL_BE-07	0512011212	30	5	23.7	F582, X583, N585, X586, X590	400	140
Embarras R.	IL_BE-09	0512011208	30	5	39.14	F582, X583, N585, X586, X590	400	140
Embarras R.	IL_BE-14	0512011201	30	5	20.89	F582, X583, N585, X586, X590	400	140
Embarras R.	IL_BE-17	0512011205	30	2	28.43	F582, X583, X585, X586, X590	N/A	N/A
Embarras R.	IL_BE-25	0512011201	30	4C	20.74	N582, X583, X585, X586, X590	84	20, 72
Embarras R.	IL_BE-36	0512011208	30	2	28.2	F582, X583, X585, X586, X590	N/A	N/A
Emmons Cr.	IL_CDC	0512011407	31	3	6.64	X582, X583, X585, X586, X590	N/A	N/A
Endsley Cr.	IL_CDD	0512011407	31	3	9.84	X582, X583, X585, X586, X590	N/A	N/A
Engle Cr.	IL_ODFA	0714020405	25	3	7.07	X582, X583, X585, X586, X590	N/A	N/A
Epperson Run	IL_DQE	0713000105	11	2	7.18	F582, X583, X585, X586, X590	N/A	N/A
Evans Cr.	IL_CZZKA	0512011409	31	3	2.95	X582, X583, X585, X586, X590	N/A	N/A
Evelen Branch	IL_DJBB	0713000513	15	3	4.01	X582, X583, X585, X586, X590	N/A	N/A
Ewing Cr.	IL_NHB-01	0714010604	26	2	18.79	F582, X583, X585, X586, X590	N/A	N/A
Exline Slough	IL_FKA-01	0712000118	10	4C	22.01	N582, X583, X585, X586, F590	84, 500, 501	20, 156, 72
Fairfield Ditch	IL_PBM-11	0709000704	8	5	7.64	N582, X583, X585, X586, F590	79, 84, 319, 322	28, 20, 58
Fairfield Union Sp Dtch	IL_PBO-10	0709000704	8	5	5.65	N582, X583, X585, X586, F590	79, 84, 319, 371	28, 20, 58, 144
Fairview Ditch	IL_BOC	0512010810	29	3	7.94	X582, X583, X585, X586, X590	N/A	N/A
Fall Cr.	IL_KCN	0711000403	19	3	9.64	X582, X583, X585, X586, X590	N/A	N/A
Fall Cr.	IL_LDC	0708010410	16	3	7.84	X582, X583, X585, X586, X590	N/A	N/A
Fallet Branch	IL_NZO	0714010607	26	3	2.12	X582, X583, X585, X586, X590	N/A	N/A
Fancher Cr.	IL_EFA	0713000808	20	3	4.51	X582, X583, X585, X586, X590	N/A	N/A
Fancy Cr.	IL_EM	0713000804	20	2	14.79	F582, X583, X585, X586, X590	N/A	N/A
Fancy Cr.	IL_MZP	0708010105	9	3	5.81	X582, X583, X585, X586, X590	N/A	N/A
Fanny Branch	IL_OZZH	0714020111	23	3	3.98	X582, X583, X585, X586, X590	N/A	N/A
Fargo Run	IL_DLH	0713000301	13	5	9.35	N582, X583, X585, X586, X590	463	140
Farm Cr.	IL_DZZP-03	0713000116	11	5	20.18	N582, X583, X586, X590	84, 138, 403, 441, 462	20, 177, 140, 85
Farmers Fk.	IL_DGLD-01	0713001003	17	4C	13.32	N582, X583, X585, X586, X590	84, 501	20
Farr Cr.	IL_FO	0712000114	10	3	7.53	X582, X583, X585, X586, X590	N/A	N/A
Fawn Cr.	IL_OILE	0714020302	24	3	7.27	X582, X583, X585, X586, X590	N/A	N/A
Fayette Cr.	IL_BOD	0512010810	29	2	8.36	F582, X583, X585, X586, X590	N/A	N/A
Feather Cr.	IL_BPJL-01	0512010904	29	3	7.43	X582, X583, X585, X586, X590	N/A	N/A
Felky Slough	IL_DSQA-01	0713000203	12	2	13.36	F582, X583, X585, X586, X590	N/A	N/A
Ferry Creek	IL_GBKG	0712000408	2	3	3.76	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Ferson Cr.	IL_DTF-02	0712000701	4	5	14.63	F582, X583, N585, X586, X590	400	177, 181
Fiddle Creek	IL_DTRA-W-A1	0712000611	3	3	0.34	X582, X583, X585, X586, X590	N/A	N/A
Fiddle Creek	IL_DTRA-W-C1	0712000611	3	5	2.04	N582, X583, X585, X586, F590	138, 371, 462, 463	85, 122, 140
Fiddyment Cr.	IL_GHC	0712000407	2	5	5.37	N582, X583, X585, X586, F590	371, 462	85
Figley Branch	IL_DEP	0713001102	18	3	7.84	X582, X583, X585, X586, X590	N/A	N/A
Finley Cr.	IL_EZP	0713000604	21	3	16	X582, X583, X585, X586, X590	N/A	N/A
First Salt Cr.	IL_CPC-TU-A1	0512011402	31	2	6.35	F582, X583, X585, X586, X590	N/A	N/A
First Salt Cr.	IL_CPC-TU-C1	0512011402	31	5	1.54	N582, X583, X585, X586, X590	322, 462	85, 144
Fish Slough	IL_OZZZB	0714020209	24	3	1.55	X582, X583, X585, X586, X590	N/A	N/A
Fisher Branch	IL_DENA	0713001102	18	3	4.89	X582, X583, X585, X586, X590	N/A	N/A
Fisher Cr.	IL_DGNA	0713001007	17	3	4.86	X582, X583, X585, X586, X590	N/A	N/A
Fishhook Cr.	IL_DEJ	0713001102	18	2	13.77	F582, X583, X585, X586, X590	N/A	N/A
Fitch Cr.	IL_DJKB	0713000504	15	3	12.95	X582, X583, X585, X586, X590	N/A	N/A
Fitchie Cr.	IL_DTFC	0712000701	4	3	6.34	X582, X583, X585, X586, X590	N/A	N/A
Fivemile Cr.	IL_DSQB-01	0713000203	12	2	16.3	F582, X583, X585, X586, F590	N/A	N/A
Fivemile Cr.	IL_PHI-01	0709000507	6	2	7.27	F582, X583, X585, X586, X590	N/A	N/A
Flag Cr.	IL_GK-03	0712000407	2	5	7.91	N582, X583, X585, X586, X590	84, 96, 177, 246, 277, 462, 479	122, 125, 28, 85
Flanders Cr.	IL_CZC	0512011410	31	3	2.9	X582, X583, X585, X586, X590	N/A	N/A
Flat Br.	IL_EOH-01	0713000701	20	5	14.95	N582, X583, N585, X586, X590	322, 371, 403, 400	140, 144
Flat Br.	IL_EOH-02	0713000701	20	5	22.72	N582, X583, N585, X586, X590	322, 371, 403, 400	140, 144
Flat Br.	IL_OZZV-01	0714020104	23	3	14.16	X582, X583, X585, X586, X590	N/A	N/A
Flat Branch	IL_BEBA	0512011214	30	3	4.73	X582, X583, X585, X586, X590	N/A	N/A
Flat Branch	IL_OIBA-01	0714020305	24	5	12.5	N582, X583, X585, X586, X590	273, 322, 462	4, 72, 144, 156
Flat Cr.	IL_OIGB	0714020304	24	3	3.01	X582, X583, X585, X586, X590	N/A	N/A
Flat Cr.	IL_OMB-01	0714020206	24	3	18.38	X582, X583, X585, X586, X590	N/A	N/A
Flat Lick Branch	IL_AJB	0514020308	32	2	6.23	F582, X583, X585, X586, F590	N/A	N/A
Flatville Br.	IL_BPJI-02	0512010903	29	3	7.89	X582, X583, X585, X586, X590	N/A	N/A
Flea Cr.	IL_DJGA	0713000510	15	3	5.23	X582, X583, X585, X586, X590	N/A	N/A
Flemington Cr.	IL_BJE	0512011108	30	3	7.84	X582, X583, X585, X586, X590	N/A	N/A
Flick Branch	IL_AKB	0514020306	32	3	4.13	X582, X583, X585, X586, X590	N/A	N/A
Flint Cr.	IL_DTZS-01	0712000611	3	5	11	N582, X583, X585, X586, X590	319, 322, 462, 479	132, 142, 177, 85
Flint Cr.	IL_DZ3U	0713001108	18	3	6.82	X582, X583, X585, X586, X590	N/A	N/A
Flour Cr.	IL_DGH-01	0713001008	17	3	24.25	X582, X583, X585, X586, X590	N/A	N/A
Folks Cr.	IL_OJL	0714020208	24	3	4.51	X582, X583, X585, X586, X590	N/A	N/A
Forbes Cr.	IL_ONED	0714020203	24	3	3.7	X582, X583, X585, X586, X590	N/A	N/A
Fordice Cr.	IL_BCB	0512011304	31	3	9	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Fork Cr.	IL_ODKA	0714020405	25	3	4.12	X582, X583, X585, X586, X590	N/A	N/A
Forked Cr.	IL_FB-01	0712000117	10	2	11.74	F582, X583, X585, X586, F590	N/A	N/A
Forked Cr.	IL_FB-02	0712000117	10	2	25.85	F582, X583, X585, X586, X590	N/A	N/A
Forman Cr.	IL_DJKC	0713000504	15	3	12.76	X582, X583, X585, X586, X590	N/A	N/A
Fountain Cr.	IL_FLIDA	0712000206	10	2	20.44	F582, X583, F585, F586, X590	N/A	N/A
Fountain Cr.	IL_JH-03	0714010107	27	2	18.75	F582, X583, X585, X586, X590	N/A	N/A
Fountain Cr.	IL_JH-04	0714010107	27	2	11.39	F582, X583, X585, X586, F590	N/A	N/A
Fourmile Cr.	IL_AFA	0514020602	33	3	6.04	X582, X583, X585, X586, X590	N/A	N/A
Fourmile Cr.	IL_CAK	0512011503	31	3	19.23	X582, X583, X585, X586, X590	N/A	N/A
Fourmile Grove Cr.	IL_DTACA	0712000705	4	3	8.06	X582, X583, X585, X586, X590	N/A	N/A
Fowler Branch	IL_DGZF	0713001010	17	3	7.67	X582, X583, X585, X586, X590	N/A	N/A
Fox Branch	IL_DBIE	0713001106	18	3	3.37	X582, X583, X585, X586, X590	N/A	N/A
Fox Cr.	IL_BHG	0512011110	30	3	3.03	X582, X583, X585, X586, X590	N/A	N/A
Fox Cr.	IL_DJNB	0713000501	15	3	8.5	X582, X583, X585, X586, X590	N/A	N/A
Fox Cr.	IL_KCK	0711000410	19	3	6.27	X582, X583, X585, X586, X590	N/A	N/A
Fox R.	IL_BZG	0512011308	31	3	10.46	X582, X583, X585, X586, X590	N/A	N/A
Fox R.	IL_CH-02	0512011406	31	5	24.46	N582, N583, N585, X586, X590	273, 319, 322, 371, 462, 274, 400	85, 140, 142, 144, 10
Fox R.	IL_CH-03	0512011406	31	5	21.87	N582, N583, N584, X585, X586, X590	228, 273, 319, 322, 500, 274	58, 132, 140, 142, 10
Fox R.	IL_DT-01	0712000706	4	5	3.24	N582, N583, N585, X586, X590	84, 319, 371, 403, 441, 479, 348, 400	125, 58, 144, 177, 95, 142, 140
Fox R.	IL_DT-02	0712000706	4	5	11	F582, N583, X585, X586, X590	348	140
Fox R.	IL_DT-03	0712000701	4	5	7.42	N582, N583, N585, X586, X590	79, 319, 322, 371, 403, 441, 462, 479, 274, 348, 400	28, 58, 142, 156, 177, 85, 10, 140
Fox R.	IL_DT-06	0712000612	3	5	8.06	N582, N583, F585, F586, X590	84, 319, 322, 479, 348	125, 58, 142, 140
Fox R.	IL_DT-09	0712000701	4	5	8.15	N582, N583, F585, F586, X590	84, 246, 277, 319, 462, 479, 348	125, 28, 58, 142, 85, 140
Fox R.	IL_DT-11	0712000706	4	5	4.92	N582, N583, F585, F586, X590	79, 319, 371, 403, 462, 479, 348	28, 58, 142, 177, 85, 140
Fox R.	IL_DT-18	0712000612	3	5	5.9	N582, N583, F584, X585, X586, X590	84, 246, 319, 322, 371, 403, 274, 348	125, 28, 58, 85, 23, 177, 10, 140
Fox R.	IL_DT-20	0712000612	3	5	7.22	N582, N583, X585, X586, X590	84, 319, 322, 348	157, 58, 140
Fox R.	IL_DT-22	0712000611	3	5	7.86	N582, N583, F585, F586, X590	84, 138, 163, 319, 371, 479, 348	58, 157, 49, 177, 142, 140
Fox R.	IL_DT-23	0712000611	3	5	7.77	N582, N583, F585, F586, X590	84, 319, 463, 479, 348	142, 157, 58, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Fox R.	IL_DT-35	0712000610	3	5	5.03	N582, N583, F585, F586, X590	319, 371, 479, 348	58, 144, 140
Fox R.	IL_DT-36	0712000706	4	5	2.63	F582, N583, X585, X586, X590	348	140
Fox R.	IL_DT-38	0712000701	4	5	10.83	N582, N583, F584, N585, X586, X590	84, 319, 403, 441, 462, 479, 274, 348, 400	125, 58, 142, 23, 177, 85, 10, 140
Fox R.	IL_DT-41	0712000706	4	5	11.25	F582, N583, X585, X586, X590	348	140
Fox R.	IL_DT-46	0712000706	4	5	3.71	N582, N583, X585, X586, X590	319, 371, 403, 441, 274, 348	58, 132, 144, 10, 140
Fox R.	IL_DT-58	0712000701	4	5	3.76	N582, N583, X585, X586, X590	84, 319, 322, 274, 348	125, 58, 10, 140
Fox R.	IL_DT-69	0712000701	4	5	4.51	N582, N583, F585, F586, X590	84, 277, 319, 371, 441, 462, 479, 274, 348	125, 28, 58, 142, 85, 10, 140
Fraction Run	IL_GHA	0712000407	2	3	7.6	X582, X583, X585, X586, X590	N/A	N/A
Francis Cr.	IL_DJZD	0713000514	15	2	8.31	F582, X583, X585, X586, X590	N/A	N/A
Frankfort Trib.	IL_GGF	0712000406	2	5	3.92	N582, X583, X585, X586, X590	462	85
Franklin Branch	IL_BEPAA	0512011204	30	3	2.34	X582, X583, X585, X586, X590	N/A	N/A
Franklin Cr.	IL_PK-01	0709000506	6	2	18.37	F582, X583, X585, X586, X590	N/A	N/A
Freds Cr.	IL_CZZLA	0512011409	31	3	4.31	X582, X583, X585, X586, X590	N/A	N/A
Freedwell Branch	IL_BOI	0512010810	29	3	4.32	X582, X583, X585, X586, X590	N/A	N/A
Freeport Cr.	IL_BEDG	0512011211	30	3	6.22	X582, X583, X585, X586, X590	N/A	N/A
French Cr.	IL_BB	0512011306	31	3	11.65	X582, X583, X585, X586, X590	N/A	N/A
French Cr.	IL_DJI-01	0713000506	15	2	24.17	F582, X583, X585, X586, F590	N/A	N/A
French Cr.	IL_PEB	0709000509	6	3	8.72	X582, X583, X585, X586, X590	N/A	N/A
Frickes Branch	IL_IIE	0714010502	28	3	3.42	X582, X583, X585, X586, X590	N/A	N/A
Friddle Branch	IL_DZ4A	0713000310	13	3	5.05	X582, X583, X585, X586, X590	N/A	N/A
Friends Cr.	IL_EV-02	0713000603	21	2	22.03	F582, X583, X585, X586, X590	N/A	N/A
Frieze Branch	IL_AJGB	0514020308	32	3	1.42	X582, X583, X585, X586, X590	N/A	N/A
Frog Slough	IL_OIQ	0714020306	24	3	0.39	X582, X583, X585, X586, X590	N/A	N/A
Fulfer Branch	IL_BEJI	0512011207	30	3	3.85	X582, X583, X585, X586, X590	N/A	N/A
Fulfer Cr.	IL_CQ	0512011404	31	3	18.72	X582, X583, X585, X586, X590	N/A	N/A
Fulton Cr.	IL_CAV	0512011502	31	3	8.61	X582, X583, X585, X586, X590	N/A	N/A
Fults Cr.	IL_JZGA	0714010109	27	3	5.74	X582, X583, X585, X586, X590	N/A	N/A
Fults Creek Ditch	IL_JCA	0714010109	27	3	4.13	X582, X583, X585, X586, X590	N/A	N/A
Funks Branch	IL_DKIA	0713000407	14	3	5.82	X582, X583, X585, X586, X590	N/A	N/A
Funks Run	IL_DZ3F	0713000117	11	3	5.59	X582, X583, X585, X586, X590	N/A	N/A
Furnace Cr.	IL_MND	0706000506	9	2	4.76	F582, X583, X585, X586, X590	N/A	N/A
Gaffield Cr.	IL_FLZB	0712000210	10	3	2.77	X582, X583, X585, X586, X590	N/A	N/A
Gaines Branch	IL_DHE	0713000309	13	3	4.42	X582, X583, X585, X586, X590	N/A	N/A
Gale Cr.	IL_PZV	0709000506	6	3	8.53	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Galena R.	IL_MQ-01	0706000503	9	5	8.64	N582, N583, N585, X586, N590	84, 371, 403, 423, 348, 400, 471	20, 143, 177, 56, 140
Galena R.	IL_MQ-02	0706000503	9	5	8.62	F582, N583, X585, X586, F590	348	140
Gallett Cr.	IL_DJFA	0713000509	15	3	9.95	X582, X583, X585, X586, X590	N/A	N/A
Galum Cr.	IL_NCD-03	0714010609	26	5	23.54	N582, X583, X585, X586, X590	322, 371, 385	87, 144, 155, 127
Galum Cr.	IL_NCD-05	0714010609	26	5	14.55	N582, X583, X585, X586, X590	463	N/A
Gamble Branch	IL_OLJ	0714020204	24	3	1.31	X582, X583, X585, X586, X590	N/A	N/A
Gar Cr.	IL_FJ	0712000118	10	3	13.29	X582, X583, X585, X586, X590	N/A	N/A
Gartside Cr.	IL_JMAAB-C2	0714010105	27	2	2.55	F582, X583, X585, X586, X590	N/A	N/A
Gartside Cr.	IL_JMAAB-D1	0714010105	27	2	2.48	F582, X583, X585, X586, X590	N/A	N/A
Gassaway Branch	IL_ATGD	0514020402	32	3	5.55	X582, X583, X585, X586, X590	N/A	N/A
Gay Cr.	IL_FLIDB	0712000206	10	5	12.97	N582, X583, N585, X586, X590	463, 400	140
Geneseo Cr.	IL_PBE-01	0709000706	8	5	14.17	N582, X583, X585, X586, X590	84, 371	20, 72, 156
Gentry Cr.	IL_CHA	0512011406	31	3	8.77	X582, X583, X585, X586, X590	N/A	N/A
Georgetown Cr.	IL_CJAD	0512011405	31	3	6.75	X582, X583, X585, X586, X590	N/A	N/A
Gerhardt Cr.	IL_OCBD	0714020406	25	3	7.61	X582, X583, X585, X586, X590	N/A	N/A
Geryune Cr.	IL_PQEG	0709000603	5	3	8.97	X582, X583, X585, X586, X590	N/A	N/A
Gibbons Cr.	IL_ALGA	0514020307	32	3	4.45	X582, X583, X585, X586, X590	N/A	N/A
Gilfillan Cr.	IL_DMBA	0713000114	11	3	4.57	X582, X583, X585, X586, X590	N/A	N/A
Gilham Cr.	IL_OLK	0714020204	24	3	9.56	X582, X583, X585, X586, X590	N/A	N/A
Gimlet Br.	IL_BPKD-01	0512010905	29	3	4.18	X582, X583, X585, X586, X590	N/A	N/A
Gimlet Cr.	IL_DZ4L	0713000113	11	3	6.18	X582, X583, X585, X586, X590	N/A	N/A
Ginseng Cr.	IL_JQG	0714010102	27	3	2.39	X582, X583, X585, X586, X590	N/A	N/A
Glenburn Cr.	IL_BPKA-01	0512010905	29	2	5.54	F582, X583, X585, X586, X590	N/A	N/A
Glencrest Creek	IL_GBLF-01	0712000410	2	3	1.23	X582, X583, X585, X586, X590	N/A	N/A
Glenn Cr.	IL_NCS	0714010610	26	3	10.42	X582, X583, X585, X586, X590	N/A	N/A
Goodall Branch	IL_BOJ	0512010810	29	3	4.15	X582, X583, X585, X586, X590	N/A	N/A
Goose Cr.	IL_AOB	0514020305	32	3	4.47	X582, X583, X585, X586, X590	N/A	N/A
Goose Cr.	IL_ATBB	0514020407	32	3	2.64	X582, X583, X585, X586, X590	N/A	N/A
Goose Cr.	IL_BNBA	0512011101	30	3	4.47	X582, X583, X585, X586, X590	N/A	N/A
Goose Cr.	IL_DAGAC	0713001202	18	3	3.9	X582, X583, X585, X586, X590	N/A	N/A
Goose Cr.	IL_EIDD	0713000907	22	4C	1.97	N582, X583, X585, X586, X590	84	20, 125
Goose Cr.	IL_EX-01	0713000602	21	2	20.12	F582, X583, X585, X586, X590	N/A	N/A
Goose Cr.	IL_LFGB	0708010401	16	3	8.63	X582, X583, X585, X586, X590	N/A	N/A
Goose Cr.	IL_NHHA	0714010604	26	3	3.39	X582, X583, X585, X586, X590	N/A	N/A
Goose Run	IL_LDBAA	0708010410	16	3	3.83	X582, X583, X585, X586, X590	N/A	N/A
Goose Run	IL_LDEC	0708010407	16	3	6.07	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Gooseberry Cr.	IL_DVEB	0712000503	11	3	26.37	X582, X583, X585, X586, X590	N/A	N/A
Gossage Branch	IL_OPCB	0714020201	24	3	2.55	X582, X583, X585, X586, X590	N/A	N/A
Gowdy Cr.	IL_CAZEA	0512011505	31	3	3.38	X582, X583, X585, X586, X590	N/A	N/A
Granary Cr.	IL_DVFA	0712000502	11	3	13.57	X582, X583, X585, X586, X590	N/A	N/A
Grand Calumet R.	IL_HAB-41	0712000304	1	5	2.62	X583, X586, N587	91, 96, 104, 127, 154, 163, 177, 260, 267, 301, 322, 348, 371, 375, 423, 462, 479	85, 28, 23, 177, 20
Grand Point Cr.	IL_OJC-01	0714020208	24	5	16.55	N582, X583, X585, X586, X590	322, 371, 479	4, 72, 143, 144, 156
Grand Tower Branch	IL_DGDC	0713001011	17	3	3.96	X582, X583, X585, X586, X590	N/A	N/A
Granny Cr.	IL_NHHC	0714010604	26	3	3.86	X582, X583, X585, X586, X590	N/A	N/A
Grannys Branch	IL_NEAB	0714010606	26	3	4.16	X582, X583, X585, X586, X590	N/A	N/A
Grant Cr.	IL_GA-01	0712000409	2	5	11.4	N582, X583, X585, X586, X590	463	N/A
Grape Cr.	IL_BPE-02	0512010909	29	2	9.73	F582, X583, X585, X586, X590	N/A	N/A
Grassy Branch	IL_OHC	0714020401	25	5	8.2	N582, X583, X585, X586, X590	322, 371, 462	4, 85, 144
Grassy Cr.	IL_ADCAA	0514020605	33	3	3.03	X582, X583, X585, X586, X590	N/A	N/A
Grassy Cr.	IL_ATHEA	0514020403	32	3	8.19	X582, X583, X585, X586, X590	N/A	N/A
Grassy Cr.	IL_NDD-03	0714010608	26	2	6.04	F582, X583, X585, X586, X590	N/A	N/A
Grassy Cr.	IL_NDD-04	0714010608	26	2	6.47	F582, X583, X585, X586, X590	N/A	N/A
Gravel Cr.	IL_IICA-01	0714010502	28	2	9.5	F582, X583, X585, X586, X590	N/A	N/A
Greasy Cr.	IL_ATFFAA	0514020404	32	5	6.35	N582, X583, X585, X586, F590	84, 322, 500, 501	20, 66, 72, 144, 156
Greasy Cr.	IL_BEQ-01	0512011205	30	3	10.82	X582, X583, X585, X586, X590	N/A	N/A
Greathouse Cr.	IL_BZI	0512011303	31	3	6.27	X582, X583, X585, X586, X590	N/A	N/A
Green Cr.	IL_CS-12	0512011401	31	2	13.16	F582, X583, X585, X586, X590	N/A	N/A
Green Cr.	IL_ICDB	0714010506	28	2	5.54	F582, X583, X585, X586, F590	N/A	N/A
Green R.	IL_NHA	0714010604	26	3	3.96	X582, X583, X585, X586, X590	N/A	N/A
Green R.	IL_PB-02	0709000702	8	2	9.58	F582, X583, F585, F586, X590	N/A	N/A
Green R.	IL_PB-04	0709000705	8	5	6.48	F582, X583, N585, X586, X590	400	140
Green R.	IL_PB-05	0709000701	8	4C	8.6	N582, X583, X585, X586, F590	84, 319	20, 58
Green R.	IL_PB-06	0709000702	8	2	6.19	F582, X583, X585, X586, F590	N/A	N/A
Green R.	IL_PB-08	0709000704	8	2	15.97	F582, X583, X585, X586, F590	N/A	N/A
Green R.	IL_PB-09	0709000706	8	5	13.93	N582, X583, X585, X586, X590	463	N/A
Green R.	IL_PB-10	0709000701	8	2	8.71	F582, X583, X585, X586, F590	N/A	N/A
Green R.	IL_PB-19	0709000702	8	2	10.18	F582, X583, X585, X586, X590	N/A	N/A
Green R.	IL_PB-28	0709000705	8	4C	4.38	N582, X583, X585, X586, X590	84	20
Green River	IL_PB-30	0709000704	8	4C	5.74	N582, X583, X585, X586, X590	84	20
Greenwood Branch	IL_CJCA	0512011405	31	3	2.48	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Greenwood Cr.	IL_EGDA-01	0713000806	20	3	2.73	X582, X583, X585, X586, X590	N/A	N/A
Gregory Branch	IL_CANA	0512011501	31	3	3.72	X582, X583, X585, X586, X590	N/A	N/A
Griffith Cr.	IL_EPA	0713000608	21	3	8.17	X582, X583, X585, X586, X590	N/A	N/A
Grindstone Cr.	IL_CZB	0512011410	31	3	4.64	X582, X583, X585, X586, X590	N/A	N/A
Grindstone Cr.	IL_DEK	0713001102	18	3	8.1	X582, X583, X585, X586, X590	N/A	N/A
Grindstone Cr.	IL_DGIA-03	0713001006	17	2	19.97	F582, X583, X585, X586, X590	N/A	N/A
Grindstone Cr.	IL_KID	0711000105	19	3	6.6	X582, X583, X585, X586, X590	N/A	N/A
Grove Branch	IL_OIJA	0714020304	24	3	11.95	X582, X583, X585, X586, X590	N/A	N/A
Grove Cr.	IL_CZO	0512011408	31	3	7.87	X582, X583, X585, X586, X590	N/A	N/A
Grove Cr.	IL_DGQ-01	0713001002	17	3	13.79	X582, X583, X585, X586, X590	N/A	N/A
Grove Cr.	IL_EIAA	0713000908	22	3	13.58	X582, X583, X585, X586, X590	N/A	N/A
Grove Cr.	IL_PWHA	0709000314	7	3	9.51	X582, X583, X585, X586, X590	N/A	N/A
Grove Creek	IL_CZZDA	0512011408	31	3	5.62	X582, X583, X585, X586, X590	N/A	N/A
Gum Branch	IL_CARD	0512011502	31	3	4.91	X582, X583, X585, X586, X590	N/A	N/A
Gum Branch	IL_CZZJA	0512011408	31	3	2.94	X582, X583, X585, X586, X590	N/A	N/A
Gun Cr.	IL_NI-01	0714010603	26	5	12.01	N582, X583, X585, X586, X590	260, 273, 322	140
Hackett Branch	IL_BERB-01	0512011202	30	3	11.74	X582, X583, X585, X586, X590	N/A	N/A
Hackett Branch	IL_BERB-TO-C1	0512011202	30	5	6.79	N582, X583, X585, X586, X590	322, 462	85, 177, 144
Hackett Branch	IL_BERB-TO-C1A	0512011202	30	5	0.59	N582, X583, X585, X586, X590	322, 462	85, 177, 144
Hadley Cr	IL_KCH	0711000404	19	2	4.8	F582, X583, X585, X586, X590	N/A	N/A
Hadley Cr	IL_KCH-01	0711000404	19	2	20.65	F582, X583, X585, X586, F590	N/A	N/A
Hagemann Cr.	IL_ODO	0714020405	25	3	3.72	X582, X583, X585, X586, X590	N/A	N/A
Halfmile Cr.	IL_NEAA	0714010606	26	3	6.58	X582, X583, X585, X586, X590	N/A	N/A
Hallenback Cr.	IL_DOAA	0713000112	11	3	10.92	X582, X583, X585, X586, X590	N/A	N/A
Hallock Cr.	IL_DMA	0713000114	11	3	6.64	X582, X583, X585, X586, X590	N/A	N/A
Halls Branch	IL_EZI	0713000804	20	3	5.75	X582, X583, X585, X586, X590	N/A	N/A
Halltown Cr.	IL_ATGE	0514020402	32	3	6.17	X582, X583, X585, X586, X590	N/A	N/A
Ham Cr.	IL_CBA	0512011409	31	3	2.66	X582, X583, X585, X586, X590	N/A	N/A
Hamilton Branch	IL_NIA	0714010603	26	3	2.3	X582, X583, X585, X586, X590	N/A	N/A
Hammond Branch	IL_MJH	0706000510	9	3	3.33	X582, X583, X585, X586, X590	N/A	N/A
Hammond Mutual Ditch	IL_OTF	0714020106	23	3	15.34	X582, X583, X585, X586, X590	N/A	N/A
Hampshire Cr.	IL_PQFD-H-A1	0709000601	5	2	1.43	F582, X583, X585, X586, X590	N/A	N/A
Hampshire Cr.	IL_PQFD-H-C1	0709000601	5	5	3.47	N582, X583, X585, X586, X590	96, 104, 234, 462	85
Haney Cr.	IL_AR	0514020303	32	2	12.68	F582, X583, X585, X586, X590	N/A	N/A
Harco Br.	IL_ATGM-01	0514020402	32	5	3.34	N582, X583, X585, X586, X590	322	72, 144, 155, 156
Harding Ditch	IL_JMAC-02	0714010105	27	5	10.89	N582, X583, N585, X586, F590	84, 403, 462, 400	20, 49, 72, 125, 177, 122, 156, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Harlow Cr.	IL_NJCB	0714010601	26	3	2.76	X582, X583, X585, X586, X590	N/A	N/A
Harper Cr.	IL_CBC	0512011409	31	3	5.79	X582, X583, X585, X586, X590	N/A	N/A
Harper Cr.	IL_NZV	0714010602	26	3	7.49	X582, X583, X585, X586, X590	N/A	N/A
Harris Branch	IL_DHC	0713000309	13	3	7.22	X582, X583, X585, X586, X590	N/A	N/A
Harris Cr.	IL_ATB	0514020407	32	5	13.01	N582, X583, X585, X586, F590	322	20, 126, 127, 144, 156
Harrison Cr.	IL_DGZJ	0713001010	17	3	8.39	X582, X583, X585, X586, X590	N/A	N/A
Hart Cr.	IL_ALG	0514020307	32	3	4.33	X582, X583, X585, X586, X590	N/A	N/A
Hartline Cr.	IL_IXFB-01	0714010802	33	2	2.94	F582, X583, X585, X586, F590	N/A	N/A
Hartline Cr.	IL_IXFB-02	0714010802	33	4C	4.09	N582, X583, X585, X586, F590	84	20, 72, 144, 156
Hastings Cr.	IL_GWAA	0712000402	2	5	4.04	N582, X583, X585, X586, X590	84, 96, 319, 371, 462	20, 132, 28, 58, 85, 177, 122, 144
Haw Cr.	IL_CAH	0512011503	31	3	6.37	X582, X583, X585, X586, X590	N/A	N/A
Haw Cr.	IL_DJH-01	0713000508	15	2	4.82	F582, X583, X585, X586, F590	N/A	N/A
Haw Cr.	IL_DJH-02	0713000508	15	2	24.4	F582, X583, X585, X586, F590	N/A	N/A
Hawbuck Cr.	IL_BPEA	0512010909	29	3	2.59	X582, X583, X585, X586, X590	N/A	N/A
Hawks Cr.	IL_BZT	0512011109	30	3	9.18	X582, X583, X585, X586, X590	N/A	N/A
Hayes Branch	IL_BERC-01	0512011202	30	2	11.23	F582, X583, X585, X586, X590	N/A	N/A
Hayes Cr.	IL_AJG-18	0514020308	32	5	15.08	N582, X583, X585, X586, F590	273, 322	140, 155
Hazel Branch	IL_CAJBA	0512011503	31	3	2.56	X582, X583, X585, X586, X590	N/A	N/A
Hazel Cr.	IL_ODEA	0714020405	25	3	5.94	X582, X583, X585, X586, X590	N/A	N/A
Heberers Branch	IL_ODC	0714020405	25	3	4.62	X582, X583, X585, X586, X590	N/A	N/A
Hells Branch	IL_MNEA	0706000506	9	3	11.74	X582, X583, X585, X586, X590	N/A	N/A
Henderson R.	IL_LD-02	0708010410	16	5	22.79	F582, X583, N585, X586, X590	400	140
Henderson R.	IL_LD-07	0708010410	16	2	42.53	F582, X583, X585, X586, F590	N/A	N/A
Henkle Branch	IL_EOCB	0713000706	20	3	5.63	X582, X583, X585, X586, X590	N/A	N/A
Henline Cr.	IL_DKV-01	0713000401	14	5	17.71	N582, X583, X585, X586, F590	322	140
Henry Cr.	IL_DMB	0713000114	11	3	8.73	X582, X583, X585, X586, X590	N/A	N/A
Hermon Cr.	IL_DJHA-01	0713000508	15	2	12.41	F582, X583, X585, X586, X590	N/A	N/A
Hess Bayou	IL_AB	0514020607	33	3	8	X582, X583, X585, X586, X590	N/A	N/A
Hesterburg Cr.	IL_JHD	0714010107	27	3	3.57	X582, X583, X585, X586, X590	N/A	N/A
Hickman Cr.	IL_JMAAA	0714010105	27	3	6.68	X582, X583, X585, X586, X590	N/A	N/A
Hickory Cr.	IL_BEFT	0512011210	30	3	10.29	X582, X583, X585, X586, X590	N/A	N/A
Hickory Cr.	IL_DJZK	0713000510	15	3	7.19	X582, X583, X585, X586, X590	N/A	N/A
Hickory Cr.	IL_GG-04	0712000406	2	5	8.11	N582, X583, X585, X586, X590	138, 322, 462	85, 177
Hickory Cr.	IL_GG-06	0712000406	2	5	12.63	N582, X583, X585, X586, X590	96, 138, 322, 462	28, 85, 177
Hickory Cr.	IL_GG-22	0712000406	2	5	2.25	N582, X583, N585, X586, X590	84, 138, 319, 403, 462, 479, 400	20, 72, 23, 85, 177, 58, 122

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Hickory Cr.	IL_NCP	0714010610	26	3	4.57	X582, X583, X585, X586, X590	N/A	N/A
Hickory Cr.	IL_ON-01	0714020203	24	5	23.88	F582, X583, N585, X586, X590	400	140
Hickory Creek	IL_OLL	0714020204	24	3	2.49	X582, X583, X585, X586, X590	N/A	N/A
Hickory Grove Cr.	IL_BEPH-01	0512011204	30	3	10.72	X582, X583, X585, X586, X590	N/A	N/A
Hickory Grove Ditch	IL_DKB-01	0713000408	14	5	2.98	N582, X583, X585, X586, F590	84, 273, 322, 371, 501	20, 28, 140, 144, 156
Hickory Run	IL_DLI	0713000301	13	3	9.76	X582, X583, X585, X586, X590	N/A	N/A
Hicks Branch	IL_ALD	0514020307	32	3	3.86	X582, X583, X585, X586, X590	N/A	N/A
Hicks Cr.	IL_DAGAA	0713001202	18	3	2.55	X582, X583, X585, X586, X590	N/A	N/A
Higgens Creek	IL_GOA-01	0712000405	2	5	1.69	N582, X583, N585, X586, X590	138, 462, 400	85, 177
Higgens Creek	IL_GOA-02	0712000405	2	5	1.36	N582, X583, N585, X586, X590	138, 463, 400	177
Higgins Cr.	IL_BCH	0512011304	31	3	4.75	X582, X583, X585, X586, X590	N/A	N/A
Hill Branch	IL_AJI	0514020308	32	3	2.32	X582, X583, X585, X586, X590	N/A	N/A
Hill Cr.	IL_BEZN	0512011208	30	3	5.94	X582, X583, X585, X586, X590	N/A	N/A
Hill Cr.	IL_DZZU	0713001108	18	3	4.65	X582, X583, X585, X586, X590	N/A	N/A
Hillery Cr.	IL_LFH	0708010404	16	3	5.27	X582, X583, X585, X586, X590	N/A	N/A
Hills Branch	IL_AJDA	0514020308	32	3	4.44	X582, X583, X585, X586, X590	N/A	N/A
Hills Cr.	IL_MZO	0708010105	9	3	5.39	X582, X583, X585, X586, X590	N/A	N/A
Hillsbury Slough	IL_EZZG	0713000601	21	3	8.82	X582, X583, X585, X586, X590	N/A	N/A
Hinkle Branch	IL_DZHB	0713000304	13	3	4.86	X582, X583, X585, X586, X590	N/A	N/A
Hobbs Cr.	IL_ALB	0514020307	32	3	4.77	X582, X583, X585, X586, X590	N/A	N/A
Hodges Cr.	IL_AC	0514020607	33	3	8.37	X582, X583, X585, X586, X590	N/A	N/A
Hodges Cr.	IL_DAG-02	0713001202	18	5	11.37	N582, X583, X585, X586, X590	322	140
Hoffman Cr.	IL_OZZA	0714020206	24	3	9.05	X582, X583, X585, X586, X590	N/A	N/A
Hog Branch	IL_BEZX-01	0512011205	30	3	10.45	X582, X583, X585, X586, X590	N/A	N/A
Hog Cr.	IL_CZY	0512011401	31	3	4.09	X582, X583, X585, X586, X590	N/A	N/A
Hog Cr.	IL_NED	0714010606	26	3	8.75	X582, X583, X585, X586, X590	N/A	N/A
Hog Cr.	IL_OZZF	0714020111	23	3	4.93	X582, X583, X585, X586, X590	N/A	N/A
Hog R.	IL_ODD	0714020405	25	3	3.14	X582, X583, X585, X586, X590	N/A	N/A
Hog Run	IL_DZV	0712000507	11	3	17.52	X582, X583, X585, X586, X590	N/A	N/A
Hog Run Creek	IL_CI	0512011408	31	3	9.61	X582, X583, X585, X586, X590	N/A	N/A
Hogg Cr.	IL_ATFFA	0514020404	32	5	11.02	N582, X583, X585, X586, F590	84, 322, 500, 501	66, 72, 144, 156
Hogskin Cr.	IL_IXR	0714010803	33	3	10.17	X582, X583, X585, X586, X590	N/A	N/A
Hogthief Cr.	IL_AOA-01	0514020305	32	3	7.09	X582, X583, X585, X586, X590	N/A	N/A
Holiday Shores Cr.	IL_JQO-HS-A1	0714010102	27	2	0.85	F582, X583, X585, X586, X590	N/A	N/A
Holiday Shores Cr.	IL_JQO-HS-C1	0714010102	27	5	0.25	N582, X583, X585, X586, X590	462, 479	85, 156
Hollands Cr.	IL_DKZF	0713000407	14	3	3.25	X582, X583, X585, X586, X590	N/A	N/A
Hollenback Cr.	IL_DTZG-01	0712000706	4	3	8.2	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Honey Branch	IL_DGZG	0713001010	17	3	7.67	X582, X583, X585, X586, X590	N/A	N/A
Honey Cr.	IL_BEC	0512011212	30	3	14.45	X582, X583, X585, X586, X590	N/A	N/A
Honey Cr.	IL_DAZM	0713001201	18	3	10.74	X582, X583, X585, X586, X590	N/A	N/A
Honey Cr.	IL_KCAG-01	0711000409	19	2	13.1	F582, X583, X585, X586, F590	N/A	N/A
Honey Cr.	IL_KIFD	0711000104	19	3	10.56	X582, X583, X585, X586, X590	N/A	N/A
Honey Cr.	IL_LZF-01	0708010414	16	2	27.72	F582, X583, X585, X586, F590	N/A	N/A
Honey Cr.	IL_PLD	0709000503	6	3	5.67	X582, X583, X585, X586, X590	N/A	N/A
Honey Cr.	IL_PWV	0709000310	7	3	1.02	X582, X583, X585, X586, X590	N/A	N/A
Honeycut Branch	IL_JRBB-01	0711000903	27	3	12.66	X582, X583, X585, X586, X590	N/A	N/A
Hooper Branch	IL_FLDB	0712000213	10	3	4.14	X582, X583, X585, X586, X590	N/A	N/A
Hoopeston Br.	IL_BPGD	0512010908	29	5	4.8	N582, X583, X585, X586, X590	462	85
Hoover Branch	IL_EOAD-11	0713000707	20	5	2.95	N582, X583, X585, X586, X590	371	144, 177
Hornbostel Branch	IL_IIF	0714010502	28	3	1.89	X582, X583, X585, X586, X590	N/A	N/A
Horney Branch	IL_DGZD-01	0713001012	17	3	11.47	X582, X583, X585, X586, X590	N/A	N/A
Horse Branch	IL_DJFBBA	0713000509	15	3	4.37	X582, X583, X585, X586, X590	N/A	N/A
Horse Cr.	IL_CAN-01	0512011501	31	2	31.04	F582, X583, X585, X586, X590	N/A	N/A
Horse Cr.	IL_EOC-02	0713000706	20	5	35.86	N582, X583, X585, X586, X590	322, 371	140, 20, 144, 155
Horse Cr.	IL_FC-01	0712000116	10	2	7.84	F582, X583, X585, X586, F590	N/A	N/A
Horse Cr.	IL_OB-03	0714020408	25	5	29.57	N582, X583, X585, X586, X590	322, 371	4, 144
Horse Cr. East	IL_DAZQ	0713001201	18	3	13.56	X582, X583, X585, X586, X590	N/A	N/A
Horse Cr. West	IL_DAZR	0713001201	18	3	8.74	X582, X583, X585, X586, X590	N/A	N/A
Horseshoe Cr.	IL_ATZD	0514020403	32	3	5.12	X582, X583, X585, X586, X590	N/A	N/A
Hosick Cr.	IL_AP	0514020303	32	3	4.05	X582, X583, X585, X586, X590	N/A	N/A
Howe Cr.	IL_OZZI	0714020111	23	3	4.31	X582, X583, X585, X586, X590	N/A	N/A
Hughes Creek	IL_CZZE	0512011408	31	3	5.42	X582, X583, X585, X586, X590	N/A	N/A
Hughlett Branch	IL_MQA	0706000503	9	3	4.59	X582, X583, X585, X586, X590	N/A	N/A
Hungry Run	IL_PWE	0709000316	7	3	3.45	X582, X583, X585, X586, X590	N/A	N/A
Hunter Slough	IL_EIGA	0713000903	22	3	7.49	X582, X583, X585, X586, X590	N/A	N/A
Hunting Branch	IL_AJIA	0514020308	32	3	2.73	X582, X583, X585, X586, X590	N/A	N/A
Huntley Ditch	IL_PQIB-H-C1	0709000602	5	5	0.6	N582, X583, X585, X586, X590	84, 104, 138, 163, 246, 371, 423, 462	20, 28, 85, 122, 144, 177
Hurricane Cr.	IL_BEL-01	0512011208	30	2	4.67	F582, X583, X585, X586, X590	N/A	N/A
Hurricane Cr.	IL_BEL-03	0512011208	30	2	12.86	F582, X583, X585, X586, X590	N/A	N/A
Hurricane Cr.	IL_BHC	0512011110	30	3	9.92	X582, X583, X585, X586, X590	N/A	N/A
Hurricane Cr.	IL_CJC	0512011405	31	3	16.5	X582, X583, X585, X586, X590	N/A	N/A
Hurricane Cr.	IL_DAI	0713001201	18	3	17.52	X582, X583, X585, X586, X590	N/A	N/A
Hurricane Cr.	IL_DZB	0713001110	18	3	11.75	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Hurricane Cr.	IL_NEG	0714010606	26	3	7.29	X582, X583, X585, X586, X590	N/A	N/A
Hurricane Cr.	IL_NF-01	0714010607	26	5	10.6	N582, X583, X585, X586, X590	268, 371	144, 156
Hurricane Cr.	IL_OL-02	0714020204	24	5	27.66	F582, X583, N585, X586, X590	400	140
Hurricane Cr.	IL_OL-06	0714020204	24	2	21.21	F582, X583, X585, X586, X590	N/A	N/A
Hurricane Cr. North	IL_DZ3P	0713001108	18	2	15.55	F582, X583, X585, X586, X590	N/A	N/A
Hutchins Cr.	IL_ICE-01	0714010506	28	2	12.04	F582, X583, X585, X586, F590	N/A	N/A
Hutson Cr.	IL_BZO	0512011113	30	3	11.99	X582, X583, X585, X586, X590	N/A	N/A
Hutt Cr.	IL_ATEAA	0514020407	32	3	3.58	X582, X583, X585, X586, X590	N/A	N/A
Ida Creek	IL_DSI	0713000206	12	5	6.11	N582, X583, X585, X586, F590	84, 322	20, 140
Illinois and Michigan Canal	IL_GBA	0712000408	2	5	5.22	X582, N583, X585, X586, X590	274	10, 140
Illinois and Michigan Canal	IL_GH	0712000407	2	3	5.88	X582, X583, X585, X586, X590	N/A	N/A
Illinois R.	IL_D-01	0713001110	18	5	48.08	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Illinois R.	IL_D-05	0713000303	13	5	12.22	F582, N583, F585, F586, X590	274, 348	10, 140
Illinois R.	IL_D-09	0713000113	11	5	19.1	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Illinois R.	IL_D-10	0712000507	11	5	9.38	F582, N583, F585, F586, X590	274, 348	10, 140, 28
Illinois R.	IL_D-16	0713000108	11	5	24.75	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Illinois R.	IL_D-20	0713000102	11	5	13.67	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Illinois R.	IL_D-23	0712000508	11	5	30.1	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Illinois R.	IL_D-30	0713000117	11	5	21.83	F582, N583, N584, F585, F586, X590	274, 348, 99, 399	10, 140
Illinois R.	IL_D-31	0713000310	13	5	66.58	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Illinois R.	IL_D-32	0713001108	18	5	34.01	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Illinois Slough	IL_LFBB	0708010403	16	3	6.24	X582, X583, X585, X586, X590	N/A	N/A
Indian Camp Cr.	IL_IXI	0714010802	33	3	2.76	X582, X583, X585, X586, X590	N/A	N/A
Indian Camp Cr.	IL_IXI-01	0714010802	33	5	1.35	N582, X583, X585, X586, F590	84, 270, 319, 385, 500, 501	20, 50, 58, 72, 92, 125, 157, 177
Indian Cr.	IL_BCA	0512011304	31	3	6.57	X582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_BEM	0512011208	30	3	3	X582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_BEZB-07	0512011215	30	5	15.08	N582, X583, X585, X586, X590	322	177
Indian Cr.	IL_BMC	0512011105	30	3	5.83	X582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_BNDB	0512011102	30	3	3.29	X582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_DF-04	0713001101	18	2	12.32	F582, X583, X586, X590	N/A	N/A
Indian Cr.	IL_DF-05	0713001101	18	2	2.34	F582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_DF-06	0713001101	18	2	24.38	F582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_DJFC	0713000509	15	5	8.92	N582, X583, X585, X586, X590	84, 371, 403, 462	20, 143, 85
Indian Cr.	IL_DJL-01	0713000503	15	2	26.51	F582, X583, X586, F590	N/A	N/A
Indian Cr.	IL_DKD-01	0713000408	14	5	6.38	N582, X583, X585, X586, X590	84, 403, 462	20, 144, 85

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Indian Cr.	IL_DSPA-01	0713000202	12	2	29.62	F582, X583, X585, X586, F590	N/A	N/A
Indian Cr.	IL_DTA-01	0712000705	4	3	10.23	X582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_DTA-05	0712000705	4	2	16.34	F582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_DTA-06	0712000705	4	3	22.4	X582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_EZH	0713000806	20	3	12.93	X582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_GU-02	0712000405	2	2	11.32	F582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_JQA-01	0714010102	27	5	23.34	N582, X583, X585, X586, X590	322, 462	140, 144, 177
Indian Cr.	IL_KZN	0711000411	19	3	3.63	X582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_NDCB-01	0714010608	26	5	4.37	N582, X583, X585, X586, X590	84, 270, 322, 500	125, 157, 72, 144, 156
Indian Cr.	IL_NDCB-02	0714010608	26	2	6.84	F582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_OIE	0714020304	24	3	9.88	X582, X583, X585, X586, X590	N/A	N/A
Indian Cr.	IL_PWU	0709000310	7	3	11.05	X582, X583, X585, X586, X590	N/A	N/A
Indian Run	IL_EZA	0713000808	20	3	11.22	X582, X583, X585, X586, X590	N/A	N/A
Iroquois R.	IL_FL-02	0712000214	10	4A	11.57	F582, X583, N585, X586, F590	400	140
Iroquois R.	IL_FL-04	0712000210	10	4A	22.49	F582, X583, N585, X586, F590	400	140
Iroquois R.	IL_FL-05	0712000210	10	4A	22.57	F582, X583, N585, X586, F590	400	140
Irwin Branch	IL_MWDE	0708010107	9	3	3.95	X582, X583, X585, X586, X590	N/A	N/A
Island Cr.	IL_BEJA	0512011207	30	3	10.01	X582, X583, X585, X586, X590	N/A	N/A
Jack Cr.	IL_DJZS	0713000501	15	2	11.83	F582, X583, X585, X586, X590	N/A	N/A
Jack Oak Cr.	IL_CHHA	0512011406	31	3	2.89	X582, X583, X585, X586, X590	N/A	N/A
Jacks Run	IL_ODB	0714020405	25	3	5.15	X582, X583, X585, X586, X590	N/A	N/A
Jackson Br.	IL_GCB	0712000409	2	5	8.83	N582, X583, X585, X586, X590	322, 423, 462, 478, 500	85, 142
Jackson Cr.	IL_GC-02	0712000409	2	2	10.69	F582, X583, X585, X586, X590	N/A	N/A
Jackson Cr.	IL_GC-03	0712000409	2	2	14.45	F582, X583, X585, X586, X590	N/A	N/A
Jackson Cr.	IL_IXFA	0714010802	33	5	6.6	N582, X583, X585, X586, F590	322	72, 144, 156
Jackson Slough	IL_OF	0714020409	25	3	3.96	X582, X583, X585, X586, X590	N/A	N/A
Jacksonville Branch	IL_ELA-11	0713000802	20	3	5.84	X582, X583, X585, X586, X590	N/A	N/A
Jake Cr.	IL_DIE	0713000307	13	3	5.19	X582, X583, X585, X586, X590	N/A	N/A
Jakes Branch	IL_BEPA	0512011204	30	3	4.65	X582, X583, X585, X586, X590	N/A	N/A
Jamison Cr.	IL_CAWA	0512011502	31	3	7.32	X582, X583, X585, X586, X590	N/A	N/A
Jeclkes Cr.	IL_DTZQ-01	0712000612	3	3	5.47	X582, X583, X585, X586, X590	N/A	N/A
Jefferson Cr.	IL_FLIB	0712000207	10	5	10.57	N582, X583, X585, X586, X590	84, 371, 500	20, 157
Jenkins Cr.	IL_KIB	0711000105	19	3	7.87	X582, X583, X585, X586, X590	N/A	N/A
Jerry Slough	IL_BZF	0512011308	31	3	3.12	X582, X583, X585, X586, X590	N/A	N/A
Jesse Cr.	IL_CJBA	0512011405	31	3	3.3	X582, X583, X585, X586, X590	N/A	N/A
Jim Branch	IL_IXDC	0714010802	33	3	4.98	X582, X583, X585, X586, X590	N/A	N/A
Jims Cr.	IL_OKC	0714020205	24	3	8.43	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Jinks Hollow	IL_LDBA	0708010410	16	5	9.75	N582, X583, X585, X586, F590	260	155
Jobs Cr.	IL_ED	0713000808	20	3	14.61	X582, X583, X585, X586, X590	N/A	N/A
Joe Branch	IL_CAUA	0512011502	31	3	3.3	X582, X583, X585, X586, X590	N/A	N/A
Joes Cr.	IL_DAGA	0713001202	18	3	19.6	X582, X583, X585, X586, X590	N/A	N/A
Joes Fork	IL_BHA	0512011110	30	3	7.59	X582, X583, X585, X586, X590	N/A	N/A
Johnny Run	IL_DVD-01	0712000504	11	2	29.82	F582, X583, X585, X586, F590	N/A	N/A
Johns Branch	IL_CAVA	0512011502	31	3	4.79	X582, X583, X585, X586, X590	N/A	N/A
Johns Cr.	IL_EOAAAA	0713000707	20	3	6.95	X582, X583, X585, X586, X590	N/A	N/A
Johns Cr.	IL_LDDA	0708010408	16	3	9.35	X582, X583, X585, X586, X590	N/A	N/A
Johnson Cr.	IL_AJE	0514020308	32	2	8.93	F582, X583, X585, X586, F590	N/A	N/A
Johnson Cr.	IL_CCA-FF-A1	0512011409	31	5	3.49	N582, X583, X585, X586, X590	463	140, 155
Johnson Cr.	IL_CCA-FF-C1	0512011409	31	4C	2.01	N582, X583, X585, X586, X590	84, 500, 501	20, 72
Johnson Cr.	IL_CGAA	0512011408	31	3	4.09	X582, X583, X585, X586, X590	N/A	N/A
Johnson Cr.	IL_MI	0708010101	9	3	26.52	X582, X583, X585, X586, X590	N/A	N/A
Johnson Fork	IL_CARA	0512011502	31	3	5.07	X582, X583, X585, X586, X590	N/A	N/A
Johnson Run	IL_DLC	0713000302	13	3	5.6	X582, X583, X585, X586, X590	N/A	N/A
Jonathan Branch	IL_OTD	0714020106	23	3	7.25	X582, X583, X585, X586, X590	N/A	N/A
Jonathon Cr.	IL_OU-01	0714020103	23	5	19.25	N582, X583, N585, X586, X590	84, 400	20, 140
Jones Branch	IL_NIB	0714010603	26	3	2.22	X582, X583, X585, X586, X590	N/A	N/A
Jones Quarry Cr.	IL_NZY	0714010612	26	3	2.46	X582, X583, X585, X586, X590	N/A	N/A
Jordan Cr.	IL_BCEA	0512011304	31	3	7.57	X582, X583, X585, X586, X590	N/A	N/A
Jordan Cr.	IL_BPGC-01	0512010907	29	2	7.26	F582, X583, X585, X586, X590	N/A	N/A
Jordan Cr.	IL_BPJA-01	0512010906	29	5	11.63	N582, X583, N585, X586, X590	84, 371, 400	20, 144, 140
Jordan Cr.	IL_FBA	0712000117	10	3	10.2	X582, X583, X585, X586, X590	N/A	N/A
Jordan Cr.	IL_NHF	0714010604	26	3	7.92	X582, X583, X585, X586, X590	N/A	N/A
Jordan Cr.	IL_OZZJ-01	0714020111	23	5	10.39	N582, X583, X585, X586, X590	463	N/A
Jordan Cr.	IL_PHC	0709000507	6	3	6.86	X582, X583, X585, X586, X590	N/A	N/A
Jordan Slough	IL_BES-01	0512011201	30	3	15.55	X582, X583, X585, X586, X590	N/A	N/A
Jubilee Cr.	IL_DLG-01	0713000301	13	2	12.42	F582, X583, X585, X586, X590	N/A	N/A
Judd Cr.	IL_DPC	0713000109	11	3	11.94	X582, X583, X585, X586, X590	N/A	N/A
Judys Branch	IL_JND	0714010103	27	3	6.34	X582, X583, X585, X586, X590	N/A	N/A
Jug Run	IL_DJZR	0713000501	15	3	4.2	X582, X583, X585, X586, X590	N/A	N/A
Kankakee R.	IL_F-01	0712000118	10	5	6.25	F582, N583, F585, F586, F590	274, 348	140
Kankakee R.	IL_F-02	0712000114	10	5	12.43	F582, N583, F585, F586, F590	274	10, 140
Kankakee R.	IL_F-03	0712000114	10	5	7.1	F582, N583, X585, X586, F590	274	10, 140
Kankakee R.	IL_F-04	0712000118	10	5	8.8	F582, N583, X585, X586, F590	274, 348	140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Kankakee R.	IL_F-12	0712000118	10	5	15.48	F582, N583, N584, X585, X586, F590	274, 348, 273	10, 140
Kankakee R.	IL_F-16	0712000118	10	5	8.22	F582, N583, N584, F585, F586, F590	274, 348, 273	10, 140
Kaskaskia R.	IL_O-02	0714020104	23	5	13.53	F582, N583, N585, X586, X590	348, 400	140
Kaskaskia R.	IL_O-03	0714020409	25	5	15.18	N582, N583, N584, X585, X586, X590	84, 228, 270, 322, 371, 500, 501, 274, 99, 273	20, 38, 4, 143, 144, 156, 10, 140
Kaskaskia R.	IL_O-07	0714020209	24	5	17.85	N582, N583, N584, F585, F586, X590	390, 462, 274, 260, 273	144, 156, 10, 140
Kaskaskia R.	IL_O-08	0714020206	24	5	17.74	N582, N583, N584, N585, X586, X590	322, 403, 441, 462, 274, 273, 400	140, 144, 10
Kaskaskia R.	IL_O-10	0714020111	23	5	23.76	F582, N583, N585, X586, X590	274, 400	10, 140
Kaskaskia R.	IL_O-11	0714020111	23	5	8.87	F582, N583, F585, F586, X590	274	10, 140
Kaskaskia R.	IL_O-13	0714020102	23	5	9.27	F582, N583, X585, X586, X590	348	140
Kaskaskia R.	IL_O-15	0714020104	23	5	13.85	F582, N583, N585, X586, X590	348, 400	140
Kaskaskia R.	IL_O-17	0714020104	23	5	10.74	F582, N583, X585, X586, X590	348	140
Kaskaskia R.	IL_O-20	0714020409	25	5	25.25	N582, N583, N584, N585, X586, X590	403, 462, 274, 273, 400	4, 72, 144, 156, 177, 10, 140
Kaskaskia R.	IL_O-25	0714020209	24	5	14.65	F582, N583, N584, X585, X586, X590	274, 99, 273	10, 140
Kaskaskia R.	IL_O-30	0714020409	25	5	13.32	N582, N583, N584, F585, F586, X590	34, 99, 168, 322, 371, 390, 403, 462, 274, 273, 399	144, 140, 156, 10
Kaskaskia R.	IL_O-31	0714020102	23	5	5.25	N582, N583, X586, X590	84, 501, 348	20, 140
Kaskaskia R.	IL_O-32	0714020111	23	5	6.89	F582, N583, X585, X586, X590	274	10, 140
Kaskaskia R.	IL_O-33	0714020206	24	5	15.21	F582, N583, N584, X585, X586, X590	274, 273	10, 140
Kaskaskia R.	IL_O-35	0714020102	23	5	15.25	F582, N583, X585, X586, X590	348	140
Kaskaskia R.	IL_O-37	0714020102	23	5	7.93	N582, N583, X585, X586, X590	84, 319, 348	20, 140
Kaskaskia R.	IL_O-38	0714020206	24	5	21.3	X582, N583, F585, F586, X590	274	10, 140
Kaskaskia R.	IL_O-97	0714020409	25	5	8.91	N582, N583, N584, X585, X586, X590	228, 270, 371, 500, 501, 274, 273	20, 142, 144, 156, 10, 140
Keefer Branch	IL_PBKA	0709000704	8	3	2.82	X582, X583, X585, X586, X590	N/A	N/A
Keg Slough	IL_MZB	0708010107	9	3	1.72	X582, X583, X585, X586, X590	N/A	N/A
Keith Creek	IL_PR-01	0709000501	6	5	10.42	X582, X583, N585, X586, X590	400	177
Keith Creek	IL_PR-99	0709000501	6	5	3.44	N582, X583, N585, X586, X590	84, 96, 277, 423, 441, 500, 400	20, 28, 177

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Kellogg Ravine	IL_QF	0404000201	1	5	6.98	N582, X583, X585, X586, X590	79, 322, 500	28, 140, 20
Kelly Cr.	IL_DSQC-01	0713000201	12	5	11.44	N582, X583, X585, X586, F590	84, 260, 371, 403, 501	20, 155, 144
Kent Branch	IL_DAIA	0713001201	18	3	5.94	X582, X583, X585, X586, X590	N/A	N/A
Kentucky Cr.	IL_MNJ-01	0706000505	9	5	2.45	N582, X583, X585, X586, X590	463	N/A
Kepple Cr.	IL_DGLCA	0713001003	17	3	10.19	X582, X583, X585, X586, X590	N/A	N/A
Kerr Cr.	IL_BPKR-01	0512010905	29	3	6.71	X582, X583, X585, X586, X590	N/A	N/A
Kersey Cr.	IL_DZ3VAA	0713001108	18	3	2.34	X582, X583, X585, X586, X590	N/A	N/A
Kerton Cr.	IL_DIA	0713000307	13	3	7.56	X582, X583, X585, X586, X590	N/A	N/A
Kettering Branch	IL_BEFH	0512011210	30	3	5.51	X582, X583, X585, X586, X590	N/A	N/A
Kickapoo Cr.	IL_BEN-01	0512011206	30	2	5.47	F582, X583, X585, X586, X590	N/A	N/A
Kickapoo Cr.	IL_BEN-02	0512011206	30	2	15.15	F582, X583, X585, X586, X590	N/A	N/A
Kickapoo Cr.	IL_DL-01	0713000302	13	5	20.83	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Kickapoo Cr.	IL_DL-07	0713000301	13	5	25.52	F582, N583, X585, X586, X590	274, 348	10, 140
Kickapoo Cr.	IL_EIE-03	0713000905	22	2	27.15	F582, X583, X586, X590	N/A	N/A
Kickapoo Cr.	IL_EIE-04	0713000905	22	2	15.61	F582, X583, X586, X590	N/A	N/A
Kickapoo Cr.	IL_EIE-05	0713000905	22	4A	20.64	F582, X583, N585, X586, X590	400	140
Kickapoo Cr.	IL_EVA	0713000603	21	3	7.24	X582, X583, X585, X586, X590	N/A	N/A
Kickapoo Slough	IL_MXD	0708010105	9	3	1.65	X582, X583, X585, X586, X590	N/A	N/A
Killbuck Cr.	IL_PQB-02	0709000607	5	5	6.56	F582, X583, N585, X586, X590	400	140
Killbuck Cr.	IL_PQB-03	0709000607	5	2	4.41	F582, X583, X585, X586, X590	N/A	N/A
Killbuck Cr.	IL_PQB-04	0709000607	5	3	10.93	X582, X583, X585, X586, X590	N/A	N/A
Killjordan Cr.	IL_DGJA-01	0713001005	17	2	3.76	F582, X583, X585, X586, X590	N/A	N/A
Killjordan Cr.	IL_DGJA-02	0713001005	17	2	6.42	F582, X583, X585, X586, X590	N/A	N/A
Kings Mill Cr.	IL_EIDEA	0713000906	22	3	12.72	X582, X583, X585, X586, X590	N/A	N/A
Kingsbury Branch	IL_OIDA	0714020303	24	3	7.4	X582, X583, X585, X586, X590	N/A	N/A
Kingsbury Cr.	IL_PQCC	0709000606	5	3	8.07	X582, X583, X585, X586, X590	N/A	N/A
Kinkaid Cr.	IL_NB	0714010611	26	3	9.66	X582, X583, X585, X586, X590	N/A	N/A
Kinkaid Cr.	IL_NB-01	0714010611	26	2	3.38	F582, X583, F585, F586, X590	N/A	N/A
Kinney Branch	IL_OCF	0714020406	25	5	5.53	N582, X583, X585, X586, N590	84, 322, 462, 500, 501, 413, 471, 502, 520	20, 72, 125, 156, 85, 177, 144
Kiser Cr.	IL_KX	0711000406	19	2	21.07	F582, X583, X585, X586, F590	N/A	N/A
Kishwaukee R.	IL_PQ-02	0709000608	5	5	4.75	F582, N583, N585, X586, X590	348, 400	140
Kishwaukee R.	IL_PQ-07	0709000602	5	5	5.14	F582, N583, X585, X586, X590	348	140
Kishwaukee R.	IL_PQ-10	0709000602	5	5	12.87	F582, N583, F585, F586, X590	348	140
Kishwaukee R.	IL_PQ-12	0709000608	5	5	14.12	F582, N583, F585, F586, X590	274, 348	10, 140
Kishwaukee R.	IL_PQ-13	0709000602	5	5	19.84	N582, N583, X585, X586, X590	84, 322, 371, 348	20, 140, 144
Kishwaukee R.	IL_PQ-14	0709000608	5	5	11.6	F582, N583, X585, X586, X590	274, 348	10, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Klein Creek	IL_GBKC-01	0712000408	2	4C	3.38	N582, X583, X585, X586, X590	84, 319, 500	20, 72, 142
Klemme Cr.	IL_HBEF	0712000303	1	3	7.97	X582, X583, X585, X586, X590	N/A	N/A
Knights Br.	IL_BPKF-01	0512010905	29	2	8.3	F582, X583, X585, X586, X590	N/A	N/A
Knob Prairie Cr.	IL_NKB	0714010602	26	3	3.7	X582, X583, X585, X586, X590	N/A	N/A
Kopp Cr.	IL_OCBDA	0714020406	25	3	5.23	X582, X583, X585, X586, X590	N/A	N/A
Kress Cr.	IL_GBKB-01	0712000408	2	5	7.91	N582, X583, X585, X586, X590	84, 322, 501	20, 72
Kyte R.	IL_PL-03	0709000503	6	5	9.22	F582, X583, N585, X586, X590	400	156
Kyte R.	IL_PL-18	0709000503	6	2	11	F582, X583, X585, X586, X590	N/A	N/A
Kyte River	IL_PL-99	0709000503	6	3	10.78	X582, X583, X585, X586, X590	N/A	N/A
L Grassy Cr.	IL_NDDA-01	0714010608	26	5	5.18	N582, X583, X585, X586, X590	84, 270, 319, 322	72, 20, 132, 140
L. Beaver Cr.	IL_PQEF-01	0709000603	5	3	8.45	X582, X583, X585, X586, X590	N/A	N/A
L. Saline Cr.	IL_ATHJ-01	0514020401	32	5	7.16	N582, X583, X585, X586, N590	463, 462, 479	155, 72, 156
L. Saline Cr.	IL_ATHJ-LE-C1A	0514020401	32	5	0.7	N582, X583, X585, X586, F590	463, 500	62, 132
L. Saline R.	IL_ATHD-01	0514020403	32	2	2.94	F582, X583, X585, X586, X590	N/A	N/A
L. Saline R.	IL_ATHD-03	0514020403	32	5	13.63	N582, X583, X585, X586, F590	322	140, 155
La Harpe R.	IL_DGP	0713001001	17	5	19.27	N582, X583, F584, X585, X586, X590	273, 322, 501	140, 157
La Harpe R.	IL_DGP-01	0713001001	17	5	7.52	N582, X583, X585, X586, X590	273, 322, 501	140, 157
La Moine R.	IL_DG-01	0713001012	17	5	22.61	F582, X583, N585, X586, X590	400	140
La Moine R.	IL_DG-02	0713001010	17	2	14.79	F582, X583, X585, X586, X590	N/A	N/A
La Moine R.	IL_DG-04	0713001007	17	5	11.38	F582, X583, N585, X586, X590	400	140
La Moine R.	IL_DG-06	0713001010	17	2	12.99	F582, X583, X585, X586, X590	N/A	N/A
La Moine R.	IL_DG-07	0713001007	17	2	8.08	F582, X583, X585, X586, X590	N/A	N/A
La Moine R.	IL_DG-08	0713001007	17	2	9.27	F582, X583, X585, X586, X590	N/A	N/A
La Moine R.	IL_DG-09	0713001007	17	2	7.63	F582, X583, X585, X586, X590	N/A	N/A
La Moine R.	IL_DG-10	0713001002	17	2	38.58	F582, X583, X585, X586, X590	N/A	N/A
Lacey Cr.	IL_GBLC	0712000410	2	3	3.69	X582, X583, X585, X586, X590	N/A	N/A
Lake Branch	IL_OHA-02	0714020401	25	5	4.52	N582, X583, X585, X586, X590	322, 371, 403, 462	4, 143, 144
Lake Branch	IL_OHA-03	0714020401	25	5	2.25	N582, X583, X585, X586, X590	273, 322, 371, 462	85, 177, 4, 143, 144
Lake Branch	IL_OHA-04	0714020401	25	5	2.08	N582, X583, X585, X586, X590	322, 371, 403, 462	4, 85, 143, 144
Lake Branch	IL_OHA-05	0714020401	25	5	1.39	N582, X583, X585, X586, X590	322, 371, 403, 462	4, 143, 144
Lake Branch	IL_OHA-06	0714020401	25	5	3.79	N582, X583, X585, X586, X590	322, 403, 462	4, 144
Lake Cr.	IL_NGA-02	0714010605	26	5	12.33	N582, X583, X585, X586, X590	322, 462, 500	140, 85, 144, 156, 177
Lake Fk.	IL_EIG-01	0713000903	22	4A	21.4	F582, X583, N585, X586, X590	400	140
Lake Fork	IL_EOHK	0713000701	20	3	17.77	X582, X583, X585, X586, X590	N/A	N/A
Lake Fork	IL_ODK	0714020405	25	3	8.16	X582, X583, X585, X586, X590	N/A	N/A
Lake Fork	IL_OIJ-01	0714020304	24	2	13.51	F582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Lake Fork	IL_OW-01	0714020101	23	5	9.72	N582, N583, X585, X586, X590	84, 371, 274, 348	20, 144, 10, 140
Lake Fork	IL_OW-02	0714020101	23	5	4.91	N582, N583, X585, X586, X590	84, 371, 274, 348	20, 144, 10, 140
Lake Fork	IL_OW-03	0714020101	23	5	19.68	N582, N583, X585, X586, X590	84, 319, 479, 274, 348	20, 140, 10
Lake Run	IL_DTDB	0712000702	4	3	5.79	X582, X583, X585, X586, X590	N/A	N/A
LaMarsh Cr.	IL_DZI	0713000303	13	2	2.15	F582, X583, X585, X586, X590	N/A	N/A
Lamotte Cr.	IL_BFB-09	0512011114	30	2	11.61	F582, X583, X585, X586, X590	N/A	N/A
Lands Branch	IL_DBID	0713001106	18	3	4.3	X582, X583, X585, X586, X590	N/A	N/A
Lanes Branch	IL_DEJA	0713001102	18	3	3.07	X582, X583, X585, X586, X590	N/A	N/A
Lanes Branch	IL_OLGB	0714020204	24	3	4.17	X582, X583, X585, X586, X590	N/A	N/A
Langan Cr	IL_FLE-03	0712000212	10	3	14.07	X582, X583, X585, X586, X590	N/A	N/A
Langan Cr.	IL_FLE-01	0712000212	10	4A	10.06	F582, X583, N585, X586, F590	400	140
Langan Cr.	IL_FLE-02	0712000212	10	5	0.78	N582, X583, X585, X586, X590	123, 308, 322, 462	130
Largent Cr.	IL_DZIAA	0713000303	13	5	4.32	N582, X583, X585, X586, X590	463	140
Larkin Cr.	IL_ATHP	0514020401	32	3	4.01	X582, X583, X585, X586, X590	N/A	N/A
Larry Cr.	IL_LJ-01	0708010418	16	3	4	X582, X583, X585, X586, X590	N/A	N/A
Laswell Branch	IL_DJDA	0713000511	15	3	6.12	X582, X583, X585, X586, X590	N/A	N/A
Latimer Cr.	IL_DJFDA	0713000509	15	3	4.93	X582, X583, X585, X586, X590	N/A	N/A
Latimore Cr.	IL_EZE	0713000806	20	3	4.68	X582, X583, X585, X586, X590	N/A	N/A
Lawhorn Cr.	IL_MLB	0706000507	9	3	5.35	X582, X583, X585, X586, X590	N/A	N/A
Lawrence Cr.	IL_PQEC-A	0709000603	5	5	4.35	N582, X583, X585, X586, X590	463	N/A
Lawrence Cr.	IL_PQEC-C	0709000603	5	5	3.93	N582, X583, X585, X586, X590	462	62
Lawson Cr.	IL_PBJAA	0709000703	8	3	6.31	X582, X583, X585, X586, X590	N/A	N/A
Leaf R.	IL_PN-01	0709000502	6	2	4.32	F582, X583, X585, X586, X590	N/A	N/A
Leaf R.	IL_PN-02	0709000502	6	2	4.06	F582, X583, X585, X586, X590	N/A	N/A
Leaf R.	IL_PN-03	0709000502	6	2	21.49	F582, X583, X585, X586, X590	N/A	N/A
Lee Cr.	IL_OMBA	0714020206	24	3	5.71	X582, X583, X585, X586, X590	N/A	N/A
Left Fork Apple Cr.	IL_DBL	0713001106	18	3	16.01	X582, X583, X585, X586, X590	N/A	N/A
LeHigh Raymond Run	IL_FCCC	0712000116	10	3	8.91	X582, X583, X585, X586, X590	N/A	N/A
Leineke Branch	IL_DEB	0713001102	18	3	6.15	X582, X583, X585, X586, X590	N/A	N/A
Lewis Cr.	IL_DGZI	0713001010	17	3	5.93	X582, X583, X585, X586, X590	N/A	N/A
Lewis Cr.	IL_NZK	0714010612	26	3	4.67	X582, X583, X585, X586, X590	N/A	N/A
Liberty Cr.	IL_OLI	0714020204	24	3	3.34	X582, X583, X585, X586, X590	N/A	N/A
Lick Branch	IL_CAT	0512011502	31	3	3.53	X582, X583, X585, X586, X590	N/A	N/A
Lick Branch	IL_DAZK	0713001201	18	3	4.23	X582, X583, X585, X586, X590	N/A	N/A
Lick Branch	IL_DFI	0713001101	18	3	8.32	X582, X583, X585, X586, X590	N/A	N/A
Lick Branch	IL_IIJ	0714010502	28	3	7.43	X582, X583, X585, X586, X590	N/A	N/A
Lick Branch	IL_JRBC	0711000903	27	3	3.35	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Lick Cr.	IL_ADL-01	0514020605	33	2	16.34	F582, X583, X585, X586, X590	N/A	N/A
Lick Cr.	IL_BPFA-01	0512010909	29	3	7.97	X582, X583, X585, X586, X590	N/A	N/A
Lick Cr.	IL_CZA	0512011410	31	3	9.92	X582, X583, X585, X586, X590	N/A	N/A
Lick Cr.	IL_DAGE	0713001202	18	3	14.59	X582, X583, X585, X586, X590	N/A	N/A
Lick Cr.	IL_DBJA	0713001106	18	3	12.22	X582, X583, X585, X586, X590	N/A	N/A
Lick Cr.	IL_DZZO	0713000303	13	3	8.4	X582, X583, X585, X586, X590	N/A	N/A
Lick Cr.	IL_EOAA-01	0713000707	20	4C	27.55	N582, X583, X585, X586, X590	84	72
Lick Cr.	IL_OLD	0714020204	24	3	6.15	X582, X583, X585, X586, X590	N/A	N/A
Lick Run	IL_BNBBA	0512011101	30	3	4.8	X582, X583, X585, X586, X590	N/A	N/A
Lierle Cr.	IL_DEQ	0713001102	18	3	8.29	X582, X583, X585, X586, X590	N/A	N/A
Lilly Branch	IL_MNH	0706000505	9	3	4.35	X582, X583, X585, X586, X590	N/A	N/A
Lily Cache Cr.	IL_GBE-01	0712000408	2	2	7.89	F582, X583, X585, X586, X590	N/A	N/A
Lily Cache Cr.	IL_GBE-02	0712000408	2	5	10.05	N582, X583, X585, X586, X590	463	N/A
Lily Cr.	IL_CZR	0512011404	31	3	8.37	X582, X583, X585, X586, X590	N/A	N/A
Limb Branch	IL_NDF	0714010608	26	3	6.55	X582, X583, X585, X586, X590	N/A	N/A
Lime Cr.	IL_DQDB	0713000104	11	3	11.23	X582, X583, X585, X586, X590	N/A	N/A
Limekiln Cr.	IL_CAB	0512011505	31	3	5.91	X582, X583, X585, X586, X590	N/A	N/A
Limekiln Slough	IL_IXQ	0714010801	33	3	5.61	X582, X583, X585, X586, X590	N/A	N/A
Limekiln Springs	IL_IXQA-01	0714010801	33	3	0.02	X582, X583, X585, X586, X590	N/A	N/A
Limestone Cr.	IL_CJG	0512011405	31	3	9.32	X582, X583, X585, X586, X590	N/A	N/A
Limestone Cr.	IL_CQA	0512011404	31	3	7.95	X582, X583, X585, X586, X590	N/A	N/A
Limestone Cr.	IL_NJE	0714010601	26	3	3.89	X582, X583, X585, X586, X590	N/A	N/A
Lin Branch	IL_EOHB	0713000701	20	3	2.19	X582, X583, X585, X586, X590	N/A	N/A
Lindsay Branch	IL_BEFL	0512011210	30	3	3.58	X582, X583, X585, X586, X590	N/A	N/A
Lingle Cr.	IL_IXFD	0714010802	33	2	4.74	F582, X583, X585, X586, F590	N/A	N/A
Link Branch	IL_DAZG	0713001206	18	2	7.01	F582, X583, X585, X586, X590	N/A	N/A
Linn Cr.	IL_OZZB	0714020206	24	3	7.4	X582, X583, X585, X586, X590	N/A	N/A
Lisbon Cr.	IL_DWEA	0712000501	11	3	8.63	X582, X583, X585, X586, X590	N/A	N/A
Little Apple Cr.	IL_DBK	0713001106	18	3	13.22	X582, X583, X585, X586, X590	N/A	N/A
Little Bay Cr.	IL_AJH	0514020308	32	3	3.44	X582, X583, X585, X586, X590	N/A	N/A
Little Bear Branch	IL_AKL	0514020306	32	3	1.32	X582, X583, X585, X586, X590	N/A	N/A
Little Bear Cr.	IL_DBGA	0713001106	18	3	6.96	X582, X583, X585, X586, X590	N/A	N/A
Little Bear Cr.	IL_KIK	0711000105	19	3	13.29	X582, X583, X585, X586, X590	N/A	N/A
Little Bear Rough	IL_DADA	0713001206	18	3	4.87	X582, X583, X585, X586, X590	N/A	N/A
Little Beaucoup Cr.	IL_NCEB	0714010610	26	3	9.21	X582, X583, X585, X586, X590	N/A	N/A
Little Beaucoup Cr.	IL_NCI-01	0714010610	26	5	15.46	N582, X583, X585, X586, X590	84, 273, 322, 500, 501	72, 125, 127, 140, 20
Little Beaver Cr.	IL_FLDA-01	0712000213	10	5	12.38	N582, X583, X585, X586, F590	84, 319, 371, 500	20, 156

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Little Beaver Cr.	IL_OIBB	0714020305	24	3	8.68	X582, X583, X585, X586, X590	N/A	N/A
Little Bessie Cr.	IL_NHD	0714010604	26	3	4.89	X582, X583, X585, X586, X590	N/A	N/A
Little Bishop Cr.	IL_COB	0512011403	31	3	10.05	X582, X583, X585, X586, X590	N/A	N/A
Little Blue Cr.	IL_DZZX	0713001108	18	3	10.07	X582, X583, X585, X586, X590	N/A	N/A
Little Bonpas Cr.	IL_BCE	0512011304	31	2	16.35	F582, X583, X585, X586, X590	N/A	N/A
Little Cache Cr.	IL_ADDB-01	0514020604	33	2	12.9	F582, X583, X585, X586, F590	N/A	N/A
Little Cache Cr.	IL_ADDB-02	0514020604	33	5	2.16	N582, X583, X585, X586, F590	319, 322, 371, 500, 501	20, 177
Little Calumet R. N.	IL_HA-04	0712000304	1	5	1.77	N583, X586, F587	274, 348	10, 140
Little Calumet R. N.	IL_HA-05	0712000304	1	5	4.34	N583, X586, N587	274, 348, 79, 260, 313, 319, 322, 375, 462, 479	10, 140, 28, 23, 85, 177, 58, 20, 132
Little Calumet R. S.	IL_HB-01	0712000304	1	5	8.68	N582, X583, N585, X586, X590	84, 137, 213, 234, 246, 317, 322, 371, 462, 400	20, 28, 23, 85, 177
Little Calumet R. S.	IL_HB-42	0712000303	1	5	4.15	N582, X583, N585, X586, X590	84, 234, 322, 371, 462, 400	20, 23, 177
Little Camp Cr.	IL_LFBD	0708010403	16	3	4.8	X582, X583, X585, X586, X590	N/A	N/A
Little Cana Cr.	IL_ATHHA	0514020401	32	3	2.84	X582, X583, X585, X586, X590	N/A	N/A
Little Canteen Cr.	IL_JMACA	0714010103	27	3	5.47	X582, X583, X585, X586, X590	N/A	N/A
Little Carr Cr.	IL_JHAA	0714010107	27	3	5.75	X582, X583, X585, X586, X590	N/A	N/A
Little Cedar Cr.	IL_DGGA	0713001009	17	3	6.52	X582, X583, X585, X586, X590	N/A	N/A
Little Coal Cr.	IL_DJEC	0713000510	15	3	6.97	X582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_BEDA-01	0512011211	30	3	13.62	X582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_BHL	0512011110	30	3	4.79	X582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_BNF	0512011103	30	3	3.05	X582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_DGLG	0713001003	17	3	4.91	X582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_DGMA	0713001007	17	3	9.05	X582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_DGPCA	0713001001	17	2	12.75	F582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_DZ3Q	0713001103	18	3	10.92	X582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_IXJA	0714010801	33	3	8.32	X582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_OPAA	0714020201	24	3	5.98	X582, X583, X585, X586, X590	N/A	N/A
Little Cr.	IL_OQB	0714020110	23	3	7.15	X582, X583, X585, X586, X590	N/A	N/A
Little Cr. North	IL_IXJC-01	0714010801	33	2	7.45	F582, X583, X585, X586, X590	N/A	N/A
Little Crab Orchard Cr.	IL_NDA-01	0714010608	26	5	13.92	N582, X583, X585, X586, X590	84, 273, 277, 322	72, 125, 177, 144, 143
Little Crooked Cr.	IL_OJA-01	0714020207	24	5	17.64	N582, X583, X585, X586, X590	273, 322, 462	4, 20, 72, 156, 85, 144
Little Dry Fork	IL_OIGA	0714020304	24	3	9.35	X582, X583, X585, X586, X590	N/A	N/A
Little Eagle Cr,	IL_ATEA-07	0514020407	32	3	8.71	X582, X583, X585, X586, X590	N/A	N/A
Little Embarras Cr.	IL_BEP-01	0512011204	30	2	19.38	F582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Little Fox Cr.	IL_CHE	0512011406	31	3	9.59	X582, X583, X585, X586, X590	N/A	N/A
Little Fox R.	IL_BZH	0512011308	31	3	3.9	X582, X583, X585, X586, X590	N/A	N/A
Little Galum Cr.	IL_NCDB	0714010609	26	5	16.42	N582, X583, X585, X586, X590	84, 371, 501	72, 125, 20, 144
Little Grand Pierre Cr.	IL_ALA-11	0514020307	32	2	6.4	F582, X583, X585, X586, X590	N/A	N/A
Little Grassy Cr	IL_NDDA-99	0714010608	26	3	2.53	X582, X583, X585, X586, X590	N/A	N/A
Little Grove Cr.	IL_EGA	0713000806	20	3	8.44	X582, X583, X585, X586, X590	N/A	N/A
Little Haw Cr.	IL_DJHC	0713000508	15	3	6.52	X582, X583, X585, X586, X590	N/A	N/A
Little Hickory Cr.	IL_ONB-01	0714020203	24	2	9	F582, X583, X585, X586, X590	N/A	N/A
Little Hurricane Cr.	IL_NFA	0714010607	26	3	3.43	X582, X583, X585, X586, X590	N/A	N/A
Little Indian Cr.	IL_BCAA	0512011304	31	3	1.89	X582, X583, X585, X586, X590	N/A	N/A
Little Indian Cr.	IL_DTAB-01	0712000705	4	2	17.42	F582, X583, X585, X586, X590	N/A	N/A
Little Indian Cr.	IL_DTAB-02	0712000705	4	2	17.57	F582, X583, X585, X586, X590	N/A	N/A
Little Indian Cr.	IL_NEE-01	0714010606	26	5	8.27	N582, X583, X585, X586, X590	84, 385, 462	125, 178, 4, 85, 144
Little Indian Cr. West	IL_DFH-01	0713001101	18	2	17.35	F582, X583, X585, X586, X590	N/A	N/A
Little Jobs Cr.	IL_EDB	0713000808	20	3	7.49	X582, X583, X585, X586, X590	N/A	N/A
Little Kickapoo Cr.	IL_EIEK	0713000905	22	3	9.28	X582, X583, X585, X586, X590	N/A	N/A
Little Kickapoo Cr. N.	IL_EIEI-01	0713000905	22	2	16.9	F582, X583, X585, X586, X590	N/A	N/A
Little Kinkaid Cr.	IL_NBA	0714010611	26	3	6.41	X582, X583, X585, X586, X590	N/A	N/A
Little Lamarsh Cr.	IL_DZZW	0713000306	13	3	6.09	X582, X583, X585, X586, X590	N/A	N/A
Little Lusk Cr.	IL_AKI	0514020306	32	3	10.26	X582, X583, X585, X586, X590	N/A	N/A
Little Mackinaw R.	IL_DKE-03	0713000408	14	2	18.07	F582, X583, X585, X586, F590	N/A	N/A
Little Marys R.	IL_IIC-38	0714010502	28	2	15.07	F582, X583, X585, X586, X590	N/A	N/A
Little Marys R.	IL_IIC-39	0714010502	28	2	9.04	F582, X583, X585, X586, F590	N/A	N/A
Little Menominee R.	IL_MT	0706000502	9	2	8.88	F582, X583, X585, X586, X590	N/A	N/A
Little Mill Cr.	IL_KDB	0711000402	19	3	3.95	X582, X583, X585, X586, X590	N/A	N/A
Little Missouri Cr.	IL_DEH	0713001102	18	3	5.46	X582, X583, X585, X586, X590	N/A	N/A
Little Missouri Cr.	IL_DGDA-01	0713001011	17	5	15	N582, X583, X585, X586, X590	273, 322	56, 127, 144
Little Moccasin Cr.	IL_OPCDA	0714020201	24	3	7.8	X582, X583, X585, X586, X590	N/A	N/A
Little Mooney Cr.	IL_JQCB	0714010102	27	3	3.98	X582, X583, X585, X586, X590	N/A	N/A
Little Mud Cr.	IL_FLIDC	0712000206	10	3	11.98	X582, X583, X585, X586, X590	N/A	N/A
Little Mud Cr.	IL_OEA	0714020403	25	3	15.41	X582, X583, X585, X586, X590	N/A	N/A
Little Muddy Cr.	IL_CJA-02	0512011405	31	5	32.41	N582, N583, X585, X586, X590	84, 273, 322, 371, 462, 274	20, 140, 144, 10
Little Muddy R.	IL_NE-04	0714010606	26	5	25.46	F582, N583, X585, X586, X590	274	10, 140
Little Muddy R.	IL_NE-05	0714010606	26	5	25.9	N582, N583, N585, X586, X590	273, 322, 274	127, 85, 155, 10, 140
Little Muddy R.	IL_NE-06	0714010606	26	5	22.83	N582, N583, X585, X586, X590	322, 274	4, 155, 10, 140
Little Negro Cr.	IL_DJFBBB	0713000509	15	3	7.43	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Little Negro Lick Cr.	IL_DBIF	0713001106	18	3	2.69	X582, X583, X585, X586, X590	N/A	N/A
Little Ninemile Cr.	IL_OAA	0714020409	25	3	7.86	X582, X583, X585, X586, X590	N/A	N/A
Little Panther Cr.	IL_CZZIA	0512011404	31	3	2.61	X582, X583, X585, X586, X590	N/A	N/A
Little Panther Cr.	IL_EEB	0713000807	20	3	3.32	X582, X583, X585, X586, X590	N/A	N/A
Little Piasa Cr. E.	IL_JVC-01	0711000902	27	3	13.26	X582, X583, X585, X586, X590	N/A	N/A
Little Piasa Cr. W.	IL_JVD	0711000902	27	3	8.82	X582, X583, X585, X586, X590	N/A	N/A
Little Plum Cr.	IL_OZCA	0714020407	25	3	7.16	X582, X583, X585, X586, X590	N/A	N/A
Little Pond Cr.	IL_CZZL	0512011409	31	3	9.68	X582, X583, X585, X586, X590	N/A	N/A
Little Rock Cr.	IL_DTCA-01	0712000703	4	2	31.23	F582, X583, X585, X586, X590	N/A	N/A
Little Rock Cr.	IL_PEC	0709000509	6	3	14.45	X582, X583, X585, X586, X590	N/A	N/A
Little Rush Cr.	IL_MLA	0706000507	9	3	12.79	X582, X583, X585, X586, X590	N/A	N/A
Little Salt Cr.	IL_CPA-01	0512011402	31	3	15.44	X582, X583, X585, X586, X590	N/A	N/A
Little Sandy Cr.	IL_DCA	0713001105	18	2	15.86	F582, X583, X585, X586, X590	N/A	N/A
Little Sandy Cr.	IL_DCB	0713001105	18	2	15.92	F582, X583, X585, X586, X590	N/A	N/A
Little Sandy Cr.	IL_DPB	0713000109	11	3	12.92	X582, X583, X585, X586, X590	N/A	N/A
Little Sangamon	IL_EBB	0713000808	20	3	6.78	X582, X583, X585, X586, X590	N/A	N/A
Little Senachwine Cr.	IL_DMC	0713000114	11	3	10.2	X582, X583, X585, X586, X590	N/A	N/A
Little Silver Cr.	IL_ODG-01	0714020405	25	5	15.71	N582, X583, X585, X586, X590	322, 371, 462	4, 85, 144
Little Silver Cr.	IL_ODLC	0714020404	25	3	11.43	X582, X583, X585, X586, X590	N/A	N/A
Little Sister Cr.	IL_DZZKA	0713000306	13	3	9.79	X582, X583, X585, X586, X590	N/A	N/A
Little Spring Cr.	IL_PED	0709000509	6	3	6.29	X582, X583, X585, X586, X590	N/A	N/A
Little Swan Cr.	IL_DJFBA	0713000509	15	3	5.73	X582, X583, X585, X586, X590	N/A	N/A
Little Vermilion R.	IL_BO-07	0512010811	29	4A	10.53	F582, X583, N585, X586, X590	400	140
Little Vermilion R.	IL_BO-08	0512010810	29	2	17.27	F582, X583, X585, X586, X590	N/A	N/A
Little Vermilion R.	IL_BO-09	0512010810	29	2	9.4	F582, X583, X585, X586, X590	N/A	N/A
Little Vermilion R.	IL_DR	0713000103	11	5	4.26	N582, X583, X585, X586, X590	463	N/A
Little Vermilion R.	IL_DR-01	0713000103	11	5	3.79	N582, X583, N585, X586, F590	138, 403, 423, 441, 462, 400	23, 177, 144, 28, 61, 115, 140
Little Vermilion R.	IL_DR-04	0713000103	11	2	26.65	F582, X583, X585, X586, F590	N/A	N/A
Little Wabash R.	IL_C-01	0512011410	31	5	20.96	N582, N583, X585, X586, X590	228, 319, 322, 274	142, 10, 140
Little Wabash R.	IL_C-09	0512011408	31	5	22.21	N582, N583, N584, N585, X586, X590	99, 322, 274, 273, 400	144, 140, 10
Little Wabash R.	IL_C-12	0512011404	31	5	9.62	F582, N583, X585, X586, X590	274	10, 140
Little Wabash R.	IL_C-19	0512011408	31	5	57.81	N582, N583, N584, N585, X586, X590	99, 322, 390, 274, 273, 400	144, 140, 156, 10
Little Wabash R.	IL_C-21	0512011401	31	5	32.14	N582, N583, N584, N585, X586, X590	228, 273, 322, 274, 400	142, 155, 10, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Little Wabash R.	IL_C-22	0512011408	31	5	21.59	F582, N583, N585, X586, X590	274, 400	10, 140
Little Wabash R.	IL_C-23	0512011410	31	5	16.02	N582, N583, N585, X586, X590	228, 319, 322, 403, 462, 274, 400	142, 140, 144, 10
Little Wabash R.	IL_C-24	0512011401	31	5	9.77	N582, N583, X585, X586, X590	463, 274	140, 10
Little Wabash R.	IL_C-33	0512011409	31	5	43.72	N582, N583, N584, X585, X586, X590	99, 322, 388, 274, 273	144, 142, 10, 140
Little Willow Cr.	IL_BEFAA	0512011210	30	3	6.74	X582, X583, X585, X586, X590	N/A	N/A
Little Wolf Cr.	IL_ENA	0713000801	20	3	5.34	X582, X583, X585, X586, X590	N/A	N/A
Little Wolf Cr.	IL_NDJB	0714010608	26	3	4.85	X582, X583, X585, X586, X590	N/A	N/A
Little York Branch	IL_OZZY	0714020209	24	3	3.91	X582, X583, X585, X586, X590	N/A	N/A
Littlers Cr.	IL_DJG-01	0713000510	15	2	22.03	F582, X583, X585, X586, F590	N/A	N/A
Lively Branch	IL_OZE	0714020409	25	3	5.54	X582, X583, X585, X586, X590	N/A	N/A
Livergood Cr.	IL_CAJD	0512011503	31	3	6.7	X582, X583, X585, X586, X590	N/A	N/A
Locust Cr.	IL_EOI-01	0713000702	20	3	11.16	X582, X583, X585, X586, X590	N/A	N/A
Locust Cr.	IL_NCN	0714010610	26	2	15.61	F582, X583, X585, X586, X590	N/A	N/A
Locust Fork	IL_OIC-01	0714020306	24	3	3.27	X582, X583, X585, X586, X590	N/A	N/A
Locust Fork	IL_OIC-02	0714020306	24	2	4.79	F582, X583, X585, X586, X590	N/A	N/A
Logan Cr.	IL_DGZB	0713001012	17	3	12.49	X582, X583, X585, X586, X590	N/A	N/A
Lone Grove Br.	IL_OKE	0714020205	24	3	8.46	X582, X583, X585, X586, X590	N/A	N/A
Lone Tree Cr.	IL_EZW	0713000601	21	2	15.1	F582, X583, X585, X586, X590	N/A	N/A
Long Branch	IL_CHH	0512011406	31	3	6.36	X582, X583, X585, X586, X590	N/A	N/A
Long Branch	IL_CJED	0512011405	31	3	4.15	X582, X583, X585, X586, X590	N/A	N/A
Long Branch	IL_DBIB	0713001106	18	3	4.34	X582, X583, X585, X586, X590	N/A	N/A
Long Branch	IL_OIMA	0714020301	24	3	9.11	X582, X583, X585, X586, X590	N/A	N/A
Long Branch Cr.	IL_ATFEA-01	0514020404	32	5	9.87	N582, X583, X585, X586, F590	84, 322, 500, 501	20, 72, 144, 156
Long Cr.	IL_DGZO-01	0713001002	17	3	14.33	X582, X583, X585, X586, X590	N/A	N/A
Long Cr.	IL_DZ4E	0712000508	11	3	2.84	X582, X583, X585, X586, X590	N/A	N/A
Long Cr.	IL_EUA-01	0713000604	21	3	9.13	X582, X583, X585, X586, X590	N/A	N/A
Long Cr.	IL_NCBA	0714010610	26	3	3.56	X582, X583, X585, X586, X590	N/A	N/A
Long Grove Creek	IL_EOHFA	0713000701	20	3	10.52	X582, X583, X585, X586, X590	N/A	N/A
Long Hollow Creek	IL_MNDA-01	0706000506	9	2	5.91	F582, X583, X585, X586, F590	N/A	N/A
Long Point Cr.	IL_BEJN	0512011207	30	3	10.27	X582, X583, X585, X586, X590	N/A	N/A
Long Point Cr.	IL_DSF-01	0713000207	12	2	28.38	F582, X583, X585, X586, F590	N/A	N/A
Long Point Cr.	IL_DXAA	0712000507	11	3	6.05	X582, X583, X585, X586, X590	N/A	N/A
Long Point Cr.	IL_EIEE	0713000905	22	2	15.82	F582, X583, X585, X586, X590	N/A	N/A
Long Point Slough	IL_BESA	0512011201	30	3	6.3	X582, X583, X585, X586, X590	N/A	N/A
Long Point Slough	IL_ERA-01	0713000608	21	5	10.7	N582, X583, X585, X586, X590	84, 371	20

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Long Run Cr.	IL_GHE-01	0712000407	2	2	13.41	F582, X583, X585, X586, X590	N/A	N/A
Long Slash Cr.	IL_JHA	0714010107	27	3	9.95	X582, X583, X585, X586, X590	N/A	N/A
Loop Creek	IL_ODE-LN-A1	0714020405	25	5	2.35	N582, X583, X585, X586, X590	84, 462	125, 177
Loop Creek	IL_ODE-LN-C1	0714020405	25	5	1.18	N582, X583, X585, X586, X590	84, 462	125, 85, 177
Loop Creek	IL_ODE-LN-C3	0714020405	25	5	8.33	N582, X583, X585, X586, X590	84, 371, 462	125, 177, 85
Lost Branch	IL_NCJ	0714010610	26	3	3.69	X582, X583, X585, X586, X590	N/A	N/A
Lost Branch	IL_NDDAA	0714010608	26	3	4.82	X582, X583, X585, X586, X590	N/A	N/A
Lost Cr.	IL_ATFG	0514020404	32	3	4.31	X582, X583, X585, X586, X590	N/A	N/A
Lost Cr.	IL_BEK	0512011208	30	3	13.13	X582, X583, X585, X586, X590	N/A	N/A
Lost Cr.	IL_CAZE	0512011505	31	3	12.13	X582, X583, X585, X586, X590	N/A	N/A
Lost Cr.	IL_DZ4B	0713000808	13	3	13.33	X582, X583, X585, X586, X590	N/A	N/A
Lost Cr.	IL_DZZQ	0713000303	13	3	15.32	X582, X583, X585, X586, X590	N/A	N/A
Lost Cr.	IL_OJB-04	0714020208	24	5	25.75	N582, X583, X585, X586, X590	322, 371, 462, 479	72, 144, 156
Lost Cr.	IL_PWNB	0709000313	7	5	13.21	N582, X583, X585, X586, X590	463	N/A
Lost Fk.	IL_CAY	0512011502	31	3	8.51	X582, X583, X585, X586, X590	N/A	N/A
Lost Grove Cr.	IL_DJDC	0713000511	15	3	11.89	X582, X583, X585, X586, X590	N/A	N/A
Louis Creek	IL_FLHB-01	0712000208	10	5	12	N582, X583, X585, X586, F590	84, 371	20, 156
Louse Run	IL_OKAA	0714020205	24	3	12.79	X582, X583, X585, X586, X590	N/A	N/A
Loving Branch	IL_DKZG	0713000403	14	3	3.01	X582, X583, X585, X586, X590	N/A	N/A
Lucas Cr.	IL_CN	0512011404	31	3	13.59	X582, X583, X585, X586, X590	N/A	N/A
Lucas Ditch	IL_GIBBA	0712000304	1	3	2.4	X582, X583, X585, X586, X590	N/A	N/A
Lunte Cr.	IL_OJACA	0714020207	24	3	4.32	X582, X583, X585, X586, X590	N/A	N/A
Lusk Cr.	IL_AK-02	0514020306	32	5	7.8	F582, N583, F585, F586, F590	274	10, 140
Lusk Cr.	IL_AK-04	0514020306	32	2	12.96	F582, X583, F585, F586, X590	N/A	N/A
Lusk Cr.	IL_AK-07	0514020306	32	2	11.32	F582, X583, X585, X586, X590	N/A	N/A
Lynn Cr.	IL_OZZSA	0714020105	23	3	7.18	X582, X583, X585, X586, X590	N/A	N/A
Lynn Grove Branch	IL_DAZPA	0713001201	18	3	2.88	X582, X583, X585, X586, X590	N/A	N/A
M. Fk. Big Muddy	IL_NH-06	0714010604	26	5	12.52	N582, N583, N585, X586, X590	273, 322, 500, 274, 400	102, 127, 4, 85, 20, 140
M. Fk. Big Muddy	IL_NH-07	0714010604	26	5	19.74	N582, X583, X585, X586, X590	273, 322, 371	102, 127, 4, 155, 144
M. Fk. Big Muddy	IL_NH-26	0714010604	26	2	9.23	F582, X583, X585, X586, X590	N/A	N/A
M. Fk. Saline R.	IL_ATG-03	0514020402	32	5	7.44	N582, X583, X586, X590	84, 138, 322, 371, 403, 462, 478, 500	20, 72, 102, 127, 144, 156, 85
M. Fk. Saline R.	IL_ATG-04	0514020402	32	2	4.84	F582, X583, X585, X586, X590	N/A	N/A
M. Fk. Saline R.	IL_ATG-05	0514020402	32	2	12.83	F582, X583, X585, X586, X590	N/A	N/A
M. Fk. Sugar Cr.	IL_EIDE-01	0713000906	22	2	26.13	F582, X583, X585, X586, X590	N/A	N/A
Mackinaw R.	IL_DK-04	0713000407	14	5	10.42	F582, N583, X585, X586, X590	348	140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Mackinaw R.	IL_DK-12	0713000408	14	5	29.53	F582, N583, N585, X586, F590	348, 400	140
Mackinaw R.	IL_DK-13	0713000407	14	5	11.47	F582, N583, N585, X586, F590	348, 400	140
Mackinaw R.	IL_DK-15	0713000407	14	5	5.22	F582, N583, X585, X586, F590	348	140
Mackinaw R.	IL_DK-17	0713000405	14	5	18.7	F582, N583, F584, X585, X586, F590	348	140
Mackinaw R.	IL_DK-19	0713000408	14	5	9.42	F582, N583, X585, X586, F590	348	140
Mackinaw R.	IL_DK-20	0713000403	14	5	21.68	F582, N583, X585, X586, F590	348	140
Mackinaw R.	IL_DK-21	0713000401	14	5	23.21	F582, N583, X585, X586, F590	348	140
Macoupin Cr.	IL_DA-03	0713001204	18	5	7.98	F582, X583, N585, X586, X590	400	140
Macoupin Cr.	IL_DA-04	0713001204	18	4A	20.62	F582, X583, N585, X586, X590	400	140
Macoupin Cr.	IL_DA-05	0713001201	18	5	45.47	N582, X583, X585, X586, X590	322, 403, 462	85, 82, 144
Macoupin Cr.	IL_DA-06	0713001206	18	5	25.15	F582, X583, N585, X586, X590	400	140
Mad Cr.	IL_BEAAA	0512011213	30	3	4.2	X582, X583, X585, X586, X590	N/A	N/A
Mad R.	IL_LEA	0708010405	16	3	7.58	X582, X583, X585, X586, X590	N/A	N/A
Madden Cr.	IL_CGA	0512011408	31	3	5.02	X582, X583, X585, X586, X590	N/A	N/A
Madden Cr.	IL_EZT-01	0713000602	21	2	17.12	F582, X583, X585, X586, X590	N/A	N/A
Maeystown Cr.	IL_JD-02	0714010109	27	2	12.74	F582, X583, X585, X586, F590	N/A	N/A
Maggot Cr.	IL_OZP	0714020206	24	3	4.56	X582, X583, X585, X586, X590	N/A	N/A
Main Ditch	IL_ADC-01	0514020605	33	5	8.65	N582, X583, X585, X586, F590	84, 322, 500, 501	20, 72, 125, 143, 156, 157
Main Ditch	IL_DZGB-01	0713000305	13	4C	9.26	N582, X583, X585, X586, X590	84	20
Main Union Special Ditch	IL_PBK	0709000704	8	3	12.07	X582, X583, X585, X586, X590	N/A	N/A
Mallard Cr.	IL_AFB	0514020602	33	3	3.04	X582, X583, X585, X586, X590	N/A	N/A
Manhattan Creek	IL_GCA-M-A1	0712000409	2	5	2.52	N582, X583, X585, X586, X590	138, 322, 371, 500	140, 156, 20
Manhatten Cr.	IL_GCA-01	0712000409	2	2	1.38	F582, X583, X585, X586, X590	N/A	N/A
Manhatten Cr.	IL_GCA-M-C1	0712000409	2	5	4.06	N582, X583, X585, X586, X590	84, 371, 462, 463, 500	20, 157, 122, 156, 85, 140
Mannel Branch	IL_DFG	0713001101	18	3	3.96	X582, X583, X585, X586, X590	N/A	N/A
Maple Br.	IL_ATHW-01	0514020401	32	2	5.25	F582, X583, X585, X586, X590	N/A	N/A
Maple Creek	IL_BEFABA	0512011210	30	3	11.53	X582, X583, X585, X586, X590	N/A	N/A
Marathon Cr.	IL_BFCA-22	0512011114	30	5	1.01	N582, X583, X585, X586, X590	463, 501	20
Marine Creek	IL_ODP	0714020405	25	2	5.7	F582, X583, X585, X586, X590	N/A	N/A
Marine Effluent Creek	IL_ODPA-MA-C1	0714020405	25	2	1.05	F582, X583, X585, X586, X590	N/A	N/A
Marine Effluent Creek	IL_ODPA-MA-C2	0714020405	25	2	1.1	F582, X583, X585, X586, X590	N/A	N/A
Markham Cr.	IL_LDDC	0708010408	16	5	6.24	N582, X583, X585, X586, X590	123, 371, 462	85, 177
Marks Cr.	IL_DBJ	0713001106	18	3	10.92	X582, X583, X585, X586, X590	N/A	N/A
Marley Cr.	IL_GGB-01	0712000406	2	3	10.33	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Marrowbone Cr.	IL_OTB-01	0714020106	23	3	15.36	X582, X583, X585, X586, X590	N/A	N/A
Marshall Branch	IL_LCC	0708010413	16	3	3.96	X582, X583, X585, X586, X590	N/A	N/A
Marshall Slough	IL_FFBB	0712000115	10	3	4.8	X582, X583, X585, X586, X590	N/A	N/A
Martin Branch	IL_OJG	0714020208	24	3	5.26	X582, X583, X585, X586, X590	N/A	N/A
Martin Cr.	IL_CDBA	0512011407	31	3	12.53	X582, X583, X585, X586, X590	N/A	N/A
Marys R.	IL_II-02	0714010502	28	5	10.58	N582, X583, X586, X590	273, 322	2, 127
Marys R.	IL_II-03	0714010502	28	5	13.14	N582, N583, X586, F590	84, 273, 322, 403, 500, 274	156, 127, 20, 140
Marys R.	IL_II-05	0714010502	28	2	10.31	F582, X583, X585, X586, X590	N/A	N/A
Marys R.	IL_II-91	0714010502	28	2	8.12	F582, X583, X585, X586, F590	N/A	N/A
Mash Cr.	IL_CHF	0512011406	31	3	6.26	X582, X583, X585, X586, X590	N/A	N/A
Massac Cr.	IL_AE	0514020602	33	5	15.93	N582, X583, X585, X586, F590	84, 322	72, 144, 156
Masters Fork	IL_DQF-01	0713000105	11	2	21.08	F582, X583, X585, X586, X590	N/A	N/A
Matney Branch	IL_OQCB	0714020110	23	3	6.25	X582, X583, X585, X586, X590	N/A	N/A
Matodd Branch	IL_DAGAF	0713001202	18	3	3.08	X582, X583, X585, X586, X590	N/A	N/A
Matthis Branch	IL_AKH	0514020306	32	3	1.94	X582, X583, X585, X586, X590	N/A	N/A
Mauvaise Terre R.	IL_DD-02	0713001104	18	3	10.74	X582, X583, X585, X586, X590	N/A	N/A
Mauvaise Terre R.	IL_DD-04	0713001104	18	4A	36.83	F582, X583, N585, X586, X590	400	140
Max Cr.	IL_AJFA-21	0514020308	32	2	10.88	F582, X583, X585, X586, X590	N/A	N/A
Maxwell Cr.	IL_IIK	0714010502	28	3	0.76	X582, X583, X585, X586, X590	N/A	N/A
Maxwell Cr.	IL_IIK-27	0714010502	28	5	2.91	N582, X583, X585, X586, F590	84, 462	72, 85, 177
Maxwell Cr.	IL_IIK-SP-C1A	0714010502	28	5	2.45	N582, X583, X585, X586, X590	319, 322, 462	85, 177
May Branch	IL_DAZJ	0713001201	18	3	7.46	X582, X583, X585, X586, X590	N/A	N/A
Mayberry Branch	IL_ATFHA	0514020404	32	3	2.69	X582, X583, X585, X586, X590	N/A	N/A
Mazon R.	IL_DV-04	0712000505	11	5	18.74	F582, N583, N585, X586, F590	274, 348, 400	10, 140
Mazon R.	IL_DV-06	0712000502	11	5	8.26	F582, N583, X585, X586, F590	274, 348	10, 140
McCalls Branch	IL_BMD	0512011105	30	3	4.18	X582, X583, X585, X586, X590	N/A	N/A
McCorkle Cr.	IL_ADDBA	0514020604	33	3	5.02	X582, X583, X585, X586, X590	N/A	N/A
McCoy Branch	IL_EOBA	0713000708	20	3	1.58	X582, X583, X585, X586, X590	N/A	N/A
McCrany Cr.	IL_KCI	0711000404	19	2	19.82	F582, X583, X585, X586, F590	N/A	N/A
McDonald Cr.	IL_GR-01	0712000405	2	3	7.9	X582, X583, X585, X586, X590	N/A	N/A
McHenry Slough	IL_CZF	0512011410	31	3	3.81	X582, X583, X585, X586, X590	N/A	N/A
McKee Branch	IL_DHK	0713000309	13	3	8.43	X582, X583, X585, X586, X590	N/A	N/A
McKee Cr.	IL_DE-01	0713001102	18	5	13.73	F582, X583, N585, X586, X590	400	140
McKee Cr.	IL_DE-03	0713001102	18	2	18.51	F582, X583, X585, X586, X590	N/A	N/A
McKee Cr.	IL_DE-05	0713001102	18	2	40.98	F582, X583, X585, X586, X590	N/A	N/A
McNary Branch	IL_BEFO	0512011210	30	3	4.13	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
McNellis Bayou	IL_DZ4F	0712000507	11	3	3.33	X582, X583, X585, X586, X590	N/A	N/A
Meacham Cr.	IL_GLBA	0712000404	2	4A	2.49	N582, X583, X585, X586, X590	319, 322	58, 177
Mendota Cr.	IL_DRD	0713000103	11	5	6.06	N582, X583, X585, X586, X590	84, 319, 322, 462	20, 23, 85, 132, 177
Menominee R.	IL_MU	0706000502	9	2	6.31	F582, X583, X585, X586, F590	N/A	N/A
Meredosia Ditch	IL_PD	0709000511	6	3	4.81	X582, X583, X585, X586, X590	N/A	N/A
Metz Cr.	IL_DZ3R	0713001110	18	3	8.64	X582, X583, X585, X586, X590	N/A	N/A
Michael Cr.	IL_DZ3T	0713001110	18	3	6.87	X582, X583, X585, X586, X590	N/A	N/A
Mid Br S Br Kishwaukee R.	IL_PQCG	0709000606	5	3	5.04	X582, X583, X585, X586, X590	N/A	N/A
Mid Br W Br Copperas Cr	IL_DZHAB	0713000304	13	3	14.07	X582, X583, X585, X586, X590	N/A	N/A
Mid Fk. N. Br. Chic. R.	IL_HCCC-02	0712000301	1	5	18.57	N582, X583, N585, X586, X590	84, 138, 177, 246, 322, 371, 403, 400	20, 72, 125, 177, 28
Mid Fk. N. Br. Chic. R.	IL_HCCC-04	0712000301	1	5	3.51	N582, X583, N585, X586, X590	84, 104, 127, 138, 154, 163, 177, 213, 246, 267, 274, 301, 322, 371, 375, 388, 403, 462, 400	20, 28, 85, 177, 140, 45, 181, 95
Mid. Fk. McKee Cr.	IL_DEAA	0713001102	18	2	19.47	F582, X583, X585, X586, X590	N/A	N/A
Mid. Fk. Shoal Cr.	IL_OIL-01	0714020302	24	3	14.26	X582, X583, X585, X586, X590	N/A	N/A
Mid. Fk. Shoal Cr.	IL_OIL-03	0714020302	24	2	8.41	F582, X583, X585, X586, X590	N/A	N/A
Mid. Fk. Shoal Cr.	IL_OIL-HB-C1	0714020302	24	5	2.32	N582, X583, X585, X586, X590	273, 322, 462	85, 144, 156
Mid. Fk. Vermilion R.	IL_BPK-07	0512010905	29	5	10.74	F582, X583, N585, X586, X590	400	140
Mid. Fk. Vermilion R.	IL_BPK-10	0512010905	29	2	6.22	F582, X583, X585, X586, X590	N/A	N/A
Mid. Fk. Vermilion R.	IL_BPK-11	0512010905	29	2	8.56	F582, X583, X585, X586, X590	N/A	N/A
Mid. Fk. Vermilion R.	IL_BPK-12	0512010905	29	2	6.86	F582, X583, X585, X586, X590	N/A	N/A
Mid. Fk. Vermilion R.	IL_BPK-13	0512010905	29	2	6.71	F582, X583, X585, X586, X590	N/A	N/A
Mid. Fk. Vermilion R.	IL_BPK-14	0512010905	29	2	5.06	F582, X583, X585, X586, X590	N/A	N/A
Mid. Fk. Vermilion R.	IL_BPK-15	0512010905	29	2	3.96	F582, X583, X585, X586, X590	N/A	N/A
Middle Aux Sable Cr.	IL_DWF-01	0712000501	11	2	12.02	F582, X583, X585, X586, X590	N/A	N/A
Middle Br.	IL_BPGE-01	0512010907	29	2	15.96	F582, X583, X585, X586, X590	N/A	N/A
Middle Cr.	IL_CAGBB	0512011504	31	3	4.25	X582, X583, X585, X586, X590	N/A	N/A
Middle Cr.	IL_DGM	0713001007	17	3	12.12	X582, X583, X585, X586, X590	N/A	N/A
Middle Cr.	IL_DJJC-01	0713000505	15	3	11.48	X582, X583, X585, X586, X590	N/A	N/A
Middle Cr.	IL_EF	0713000808	20	3	12.18	X582, X583, X585, X586, X590	N/A	N/A
Middle Cr.	IL_LCG	0708010413	16	3	7.27	X582, X583, X585, X586, X590	N/A	N/A
Middle Cr.	IL_OJAE	0714020207	24	3	14.7	X582, X583, X585, X586, X590	N/A	N/A
Middle Cr.	IL_PHH	0709000507	6	3	8.62	X582, X583, X585, X586, X590	N/A	N/A
Middle Cr.	IL_POA	0709000504	6	2	9.45	F582, X583, X585, X586, X590	N/A	N/A
Middle Fk Plum R.	IL_MJG	0706000510	9	3	4.57	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Middle Henderson Cr.	IL_LDG-01	0708010410	16	2	16.01	F582, X583, X585, X586, X590	N/A	N/A
Middle Wolf Cr.	IL_NDJC	0714010608	26	3	5.44	X582, X583, X585, X586, X590	N/A	N/A
Middleton Branch	IL_CAZL	0512011502	31	3	1.92	X582, X583, X585, X586, X590	N/A	N/A
Midlothian Cr.	IL_HBA-01	0712000304	1	3	13.5	X582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_AJEA	0514020308	32	3	3.87	X582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_BH-01	0512011110	30	2	31.97	F582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_DKJA	0713000406	14	3	6.26	X582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_DTZL-01	0712000701	4	3	3.34	X582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_DTZL-02	0712000701	4	3	11.1	X582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_GIBA	0712000407	2	3	4.07	X582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_GW-02	0712000402	2	2	13.29	F582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_IIB-40	0714010502	28	2	13.25	F582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_IXF-01	0714010802	33	2	7.14	F582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_IXF-02	0714010802	33	2	10.92	F582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_JVA	0711000902	27	2	7.97	F582, X583, X585, X586, F590	N/A	N/A
Mill Cr.	IL_KD	0711000402	19	2	23.86	F582, X583, X585, X586, F590	N/A	N/A
Mill Cr.	IL_MNE	0706000506	9	2	13.24	F582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_NAFA	0714010612	26	3	5.11	X582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_ODJ	0714020405	25	3	8.87	X582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_PA-01	0709000512	6	5	21.53	N582, X583, X585, X586, X590	463	N/A
Mill Cr.	IL_PO-01	0709000504	6	2	14.39	F582, X583, X585, X586, X590	N/A	N/A
Mill Cr.	IL_PO-C1	0709000504	6	5	2.27	N582, X583, X585, X586, X590	322, 462	85
Mill Cr. N.	IL_MX	0708010105	9	3	7.78	X582, X583, X585, X586, X590	N/A	N/A
Mill Spring	IL_AIE	0514020309	32	3	2.18	X582, X583, X585, X586, X590	N/A	N/A
Miller Branch	IL_DAGAB	0713001202	18	3	3.29	X582, X583, X585, X586, X590	N/A	N/A
Miller Cr.	IL_AKA	0514020306	32	3	5.38	X582, X583, X585, X586, X590	N/A	N/A
Miller Cr.	IL_CAL	0512011503	31	3	6.85	X582, X583, X585, X586, X590	N/A	N/A
Miller Cr.	IL_EFB	0713000808	20	3	4.72	X582, X583, X585, X586, X590	N/A	N/A
Miller Cr.	IL_IBA-08	0714010507	28	2	8.25	F582, X583, X585, X586, X590	N/A	N/A
Miller Cr.	IL_OILA	0714020302	24	3	5.4	X582, X583, X585, X586, X590	N/A	N/A
Miller Cr.	IL_PWK	0709000314	7	3	2.62	X582, X583, X585, X586, X590	N/A	N/A
Miller Creek	IL_CZM	0512011408	31	3	4.61	X582, X583, X585, X586, X590	N/A	N/A
Milliken Cr.	IL_DZ4C	0712000508	11	3	6.57	X582, X583, X585, X586, X590	N/A	N/A
Millrace Slough	IL_AU	0514020207	32	3	1.94	X582, X583, X585, X586, X590	N/A	N/A
Milton Branch	IL_CZT	0512011401	31	3	2.74	X582, X583, X585, X586, X590	N/A	N/A
Mineral Cr.	IL_PBD-02	0709000706	8	4C	12.27	N582, X583, X585, X586, F590	84, 319, 501	20, 58, 144, 156
Mineral Spring Cr.	IL_PDA	0709000511	6	3	8.45	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Mink Cr.	IL_GBEA	0712000408	2	3	5.78	X582, X583, X585, X586, X590	N/A	N/A
Minnie Cr.	IL_FLA	0712000214	10	2	9.33	F582, X583, X585, X586, X590	N/A	N/A
Minnow Slough	IL_BFA-10	0512011114	30	3	5.79	X582, X583, X585, X586, X590	N/A	N/A
Mint Cr.	IL_BEH	0512011208	30	3	12.29	X582, X583, X585, X586, X590	N/A	N/A
Mission Cr.	IL_DTZD-01	0712000706	4	3	8.78	X582, X583, X585, X586, X590	N/A	N/A
Mississippi R.	IL_I-84	0714010508	28	5	119.58	F582, N583, N584, N585, X586, X590	274, 348, 273, 400	10, 140
Mississippi R.	IL_J	0714010105	27	5	7.13	F582, N583, N584, X586, X590	274, 348, 273	10, 140
Mississippi R.	IL_J-02	0714010104	27	5	13.1	F582, N583, N584, F585, X586, X590	274, 348, 273	10, 140
Mississippi R.	IL_J-05	0711000904	27	5	43.63	F582, N583, N584, N585, X586, X590	274, 348, 273, 400	10, 140
Mississippi R.	IL_J-36	0714010109	27	5	58.71	F582, N583, N584, F585, F586, X590	274, 348, 273	10, 140
Mississippi R.	IL_K-17	0711000110	19	5	36.83	F582, N583, N584, F585, F586, X590	274, 348, 273	10, 140
Mississippi R.	IL_K-21	0711000411	19	5	88.61	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Mississippi R.	IL_K-22	0708010418	16	5	74.4	F582, N583, N584, F585, F586, X590	274, 348, 99, 273	10, 140
Mississippi R.	IL_M-02	0708010107	9	5	90.69	F582, N583, N584, F585, F586, X590	274, 348, 273	10, 140
Mississippi R.	IL_M-12	0706000512	9	5	59.95	F582, N583, F585, F586, X590	274, 348	10, 140
Missouri Cr.	IL_DGD-01	0713001011	17	5	27.55	N582, X583, X585, X586, X590	273	140
Mitchell Cr.	IL_OQA-01	0714020110	23	2	22.25	F582, X583, X585, X586, X590	N/A	N/A
Moccasin Creek	IL_OPCD	0714020201	24	3	10.44	X582, X583, X585, X586, X590	N/A	N/A
Mokeler Creek	IL_PQEA-01	0709000603	5	2	5.63	F582, X583, X585, X586, X590	N/A	N/A
Mokeler Creek	IL_PQEA-H-A1	0709000603	5	3	3.92	X582, X583, X585, X586, X590	N/A	N/A
Mokeler Creek	IL_PQEA-H-C1	0709000603	5	5	1.24	N582, X583, X585, X586, X590	84, 319, 371, 463	20, 85, 122, 177, 144
Mole Cr.	IL_DSFA	0713000207	12	5	17.82	N582, X583, X585, X586, F590	371, 501	144, 20
Money Cr.	IL_DKP	0713000402	14	3	2.8	X582, X583, X585, X586, X590	N/A	N/A
Money Cr.	IL_DKP-02	0713000402	14	2	28.08	F582, X583, X585, X586, F590	N/A	N/A
Monroe City Cr.	IL_JDBA	0714010109	27	3	9.62	X582, X583, X585, X586, X590	N/A	N/A
Moon Cr.	IL_DSD	0713000208	12	3	13.78	X582, X583, X585, X586, X590	N/A	N/A
Mooney Branch	IL_DBKA	0713001106	18	3	6.57	X582, X583, X585, X586, X590	N/A	N/A
Mooney Cr.	IL_JQC	0714010102	27	3	5.13	X582, X583, X585, X586, X590	N/A	N/A
Moore Cr.	IL_KCAH	0711000409	19	3	4.89	X582, X583, X585, X586, X590	N/A	N/A
Moores Branch	IL_NCKE	0714010610	26	3	3.49	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Moores Cr.	IL_DZ4G	0712000508	11	3	2.01	X582, X583, X585, X586, X590	N/A	N/A
Morehouse Cr.	IL_DSHB-01	0713000205	12	2	13.88	F582, X583, X585, X586, X590	N/A	N/A
Morgan Cr.	IL_DTZJ-01	0712000701	4	3	6.73	X582, X583, X585, X586, X590	N/A	N/A
Morris Cr.	IL_OPCC	0714020201	24	3	5.03	X582, X583, X585, X586, X590	N/A	N/A
Morrison Branch	IL_IICC	0714010502	28	3	2	X582, X583, X585, X586, X590	N/A	N/A
Morrison Spring Branch	IL_PWIB	0709000314	7	3	4.41	X582, X583, X585, X586, X590	N/A	N/A
Mosquito Cr.	IL_EQ-01	0713000606	21	2	22.58	F582, X583, X585, X586, X590	N/A	N/A
Mosquito Cr.	IL_GIBF	0712000304	1	3	2.03	X582, X583, X585, X586, X590	N/A	N/A
Mosquito Cr.	IL_PBA	0709000706	8	3	11.48	X582, X583, X585, X586, X590	N/A	N/A
Mosquito Cr.	IL_PQDA-01	0709000604	5	2	2.39	F582, X583, X585, X586, X590	N/A	N/A
Mosquito Cr.	IL_PQFA	0709000601	5	3	8.58	X582, X583, X585, X586, X590	N/A	N/A
Mount Branch	IL_BEFD	0512011210	30	3	7.46	X582, X583, X585, X586, X590	N/A	N/A
Moutray Slough	IL_CZZD	0512011408	31	3	4.11	X582, X583, X585, X586, X590	N/A	N/A
Mt. Morris Cr. North	IL_PJBA-C1	0709000505	6	5	2.77	N582, X583, X585, X586, X590	462	85
Mt. Morris Cr. North	IL_PJBA-C2	0709000505	6	2	1.14	F582, X583, X585, X586, X590	N/A	N/A
Mt. Morris Cr. South	IL_PJBB	0709000505	6	3	3.31	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_AEC	0514020602	33	3	2.97	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_AG	0514020601	33	3	13.24	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_BCG	0512011304	31	3	4.26	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_BLB	0512011109	30	3	9.81	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_DFF	0713001101	18	3	7.39	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_DKG-01	0713000407	14	2	19.44	F582, X583, X585, X586, F590	N/A	N/A
Mud Cr.	IL_DSG-01	0713000208	12	5	22.75	N582, X583, X585, X586, F590	260, 371, 403, 501	155, 156, 144, 20
Mud Cr.	IL_EIEG	0713000905	22	3	4.58	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_KIH	0711000105	19	3	14.48	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_LFF-01	0708010404	16	3	9.38	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_NZL	0714010612	26	5	9.46	N582, X583, X585, X586, X590	463	N/A
Mud Cr.	IL_OE-02	0714020403	25	5	38.66	N582, X583, X585, X586, X590	84, 273, 322, 371	20, 140, 144
Mud Cr.	IL_OLGAA	0714020204	24	3	3.42	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_OSC	0714020108	23	3	10.35	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_PAA	0709000512	6	3	6.55	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_PBC	0709000706	8	3	10.93	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_PBJ-04	0709000703	8	5	28.34	N582, X583, X585, X586, X590	463	N/A
Mud Cr.	IL_PNA	0709000502	6	2	14	F582, X583, X585, X586, X590	N/A	N/A
Mud Cr.	IL_PQG	0709000602	5	3	4.94	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr. East	IL_FLIC-04	0712000207	10	4A	5.68	F582, X583, N585, X586, F590	400	140
Mud Cr. North	IL_PZZH	0709000501	6	3	4.84	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Mud Cr. South	IL_PZW	0709000504	6	3	4.95	X582, X583, X585, X586, X590	N/A	N/A
Mud Cr. West	IL_FLID-01	0712000206	10	5	9.33	N582, X583, X585, X586, X590	84, 371	72, 144
Mud Cr. West	IL_FLID-02	0712000206	10	5	8.14	N582, X583, N585, X586, F590	322, 400	140
Mud Run	IL_DJKD	0713000504	15	3	9.24	X582, X583, X585, X586, X590	N/A	N/A
Mud Run	IL_DJMA	0713000502	15	3	14.69	X582, X583, X585, X586, X590	N/A	N/A
Mud Run	IL_MNID-C4	0706000505	9	5	4.93	N582, X583, X585, X586, X590	308, 322, 462	85
Mud Run	IL_MNID-C6	0706000505	9	2	3.51	F582, X583, X585, X586, X590	N/A	N/A
Muddy Cr.	IL_BEA-01	0512011213	30	2	15.97	F582, X583, X585, X586, X590	N/A	N/A
Muddy Cr.	IL_BEFAB	0512011210	30	3	15.55	X582, X583, X585, X586, X590	N/A	N/A
Muddy Cr.	IL_BEJ-03	0512011207	30	2	30.91	F582, X583, X585, X586, X590	N/A	N/A
Muddy Cr.	IL_DJZC	0713000514	15	3	4.29	X582, X583, X585, X586, X590	N/A	N/A
Muddy Cr.	IL_PWS	0709000312	7	3	6.58	X582, X583, X585, X586, X590	N/A	N/A
Muddy Plum R.	IL_MJE	0706000510	9	2	10.09	F582, X583, X585, X586, F590	N/A	N/A
Mule Cr.	IL_BEJF-01	0512011207	30	3	12.66	X582, X583, X585, X586, X590	N/A	N/A
Mundinger Cr.	IL_DZJA	0713000117	11	3	5.95	X582, X583, X585, X586, X590	N/A	N/A
Murray Ditch	IL_DST-01	0713000208	12	4C	8.06	N582, X583, X585, X586, F590	501	155
Murray Slough	IL_DVEA	0712000503	11	3	23.6	X582, X583, X585, X586, X590	N/A	N/A
N Br S Br Kishwaukee R	IL_PQCF	0709000606	5	3	6.89	X582, X583, X585, X586, X590	N/A	N/A
N. Br. Chicago R.	IL_HCC-02	0712000301	1	5	2.05	N583, X586, F587	274, 348	10, 140
N. Br. Chicago R.	IL_HCC-07	0712000301	1	5	11.9	N582, N583, N585, X586, X590	79, 84, 138, 177, 246, 322, 403, 462, 348, 400	28, 20, 125, 23, 49, 85, 177, 140
N. Br. Chicago R.	IL_HCC-08	0712000301	1	5	5.73	N583, X586, N587	274, 348, 260, 317, 319, 322, 462	10, 140, 23, 177, 58, 85
N. Br. Crow Cr. E.	IL_DOB	0713000112	11	3	15.53	X582, X583, X585, X586, X590	N/A	N/A
N. Br. Kishwaukee R.	IL_PQJ-01	0709000602	5	2	17.84	F582, X583, X585, X586, X590	N/A	N/A
N. Br. Larry Cr.	IL_LJA	0708010418	16	3	6.86	X582, X583, X585, X586, X590	N/A	N/A
N. Br. Nippersink Cr.	IL_DTKA-04	0712000608	3	2	9.25	F582, X583, X585, X586, X590	N/A	N/A
N. Br. Otter Cr.	IL_DIC	0713000307	13	3	6.19	X582, X583, X585, X586, X590	N/A	N/A
N. Br. Otter Cr.	IL_PWBB-01	0709000408	7	2	11.16	F582, X583, X585, X586, X590	N/A	N/A
N. Fk. Clear Cr.	IL_EPB-01	0713000608	21	3	6.75	X582, X583, X585, X586, X590	N/A	N/A
N. Fk. E. Fk. La Moine R	IL_DGLF	0713001003	17	3	6.76	X582, X583, X585, X586, X590	N/A	N/A
N. Fk. East Fork	IL_PQEE-01	0709000603	5	3	1.59	X582, X583, X585, X586, X590	N/A	N/A
N. Fk. Embarras R.	IL_BEF-02	0512011210	30	2	33.93	F582, X583, X585, X586, X590	N/A	N/A
N. Fk. Embarras R.	IL_BEF-05	0512011210	30	5	29.96	F582, X583, N585, X586, X590	400	140
N. Fk. Hadley Cr.	IL_KCHC	0711000404	19	3	7.13	X582, X583, X585, X586, X590	N/A	N/A
N. Fk. Indian Cr.	IL_BEMB	0512011208	30	3	5.21	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
N. Fk. Kaskaskia R.	IL_OKA-01	0714020205	24	5	11.83	N582, X583, N585, X586, X590	99, 273, 322, 390, 462, 400	156, 127, 140, 144
N. Fk. Kaskaskia R.	IL_OKA-02	0714020205	24	5	18.56	N582, X583, X585, X586, X590	273, 322, 441, 462	56, 127, 140, 144
N. Fk. Mauvaise Terre C	IL_DDC	0713001104	18	4C	14.98	N582, X583, X585, X586, X590	84, 501	20
N. FK. Plum R.	IL_MJF	0706000510	9	3	4.27	X582, X583, X585, X586, X590	N/A	N/A
N. Fk. Raccoon Cr.	IL_BGA	0512011113	30	3	9.47	X582, X583, X585, X586, X590	N/A	N/A
N. Fk. Richland Cr.	IL_EKB	0713000803	20	3	5.61	X582, X583, X585, X586, X590	N/A	N/A
N. Fk. Saline R.	IL_ATF-04	0514020406	32	5	5.21	N582, N583, N585, X586, X590	260, 322, 501, 274, 400	20, 10, 140
N. Fk. Saline R.	IL_ATF-05	0514020404	32	4C	7.95	N582, X583, X585, X586, X590	84, 500, 501	20, 125
N. Fk. Saline R.	IL_ATF-06	0514020407	32	5	14.62	N582, X583, X585, X586, N590	84, 322, 501, 413	20, 156
N. Fk. Saline R.	IL_ATF-07	0514020404	32	5	5.62	N582, X583, X585, X586, X590	84, 138	20, 72, 102
N. Fk. Salt Cr.	IL_EIJ-01	0713000902	22	2	21.39	F582, X583, X585, X586, X590	N/A	N/A
N. Fk. Shelby Cr.	IL_DGC	0713001012	17	3	6.25	X582, X583, X585, X586, X590	N/A	N/A
N. Fk. Vermilion R.	IL_BPG-05	0512010908	29	4A	10.2	F582, X583, N584, X585, X586, X590	452	N/A
N. Fk. Vermilion R.	IL_BPG-09	0512010908	29	4A	10.68	F582, X583, N585, X586, X590	400	140
N. Fk. Vermilion R.	IL_BPG-10	0512010908	29	4C	25.2	N582, X583, X585, X586, X590	501	20
N. Fk. Vermilion R.	IL_DSQ-02	0713000203	12	3	6.35	X582, X583, X585, X586, X590	N/A	N/A
N. Fk. Vermilion R.	IL_DSQ-03	0713000201	12	5	30.63	N582, X583, X585, X586, F590	84, 260, 339, 371, 403, 501	20, 155, 140, 144, 156
N. Fork Kent Cr.	IL_PSB-01	0709000501	6	5	12.63	F582, X583, N585, X586, X590	400	140
N. Henderson Cr.	IL_LDE-03	0708010407	16	5	33.5	N582, X583, X585, X586, F590	84, 260, 501	20, 155
N. Kickapoo Cr.	IL_DZZA	0712000508	11	3	8.52	X582, X583, X585, X586, X590	N/A	N/A
N. Kinnikinnick Cr.	IL_PU	0709000501	6	5	15.28	F582, X583, N585, X586, X590	400	140
N. Lake Fk.	IL_EIGB-01	0713000903	22	4C	27.5	N582, X583, X585, X586, X590	84	20
N. Mill Cr.	IL_GWA	0712000402	2	5	6.62	N582, X583, X585, X586, X590	96, 273, 319, 371, 462, 500	28, 142, 156
N. Pope Cr.	IL_LEG-02	0708010405	16	3	13.75	X582, X583, X585, X586, X590	N/A	N/A
N. Shore Channel	IL_HCCA-04	0712000301	1	5	3.4	N583, X586, F587	274, 348	10, 140
Nashville Cr.	IL_OJAF-NV-A1	0714020207	24	5	6.85	N582, X583, X585, X586, X590	322	140
Nashville Cr.	IL_OJAF-NV-C1	0714020207	24	5	1.1	N582, X583, X585, X586, X590	84, 322, 462, 500	20, 85, 177, 144
Nashville Cr.	IL_OJAF-NV-C3	0714020207	24	5	2.99	N582, X583, X585, X586, X590	84, 462, 500	73, 85, 144, 177
Nassa Cr.	IL_DAGDB	0713001202	18	3	17.74	X582, X583, X585, X586, X590	N/A	N/A
Navajo Cr.	IL_GIBE	0712000304	1	3	2.86	X582, X583, X585, X586, X590	N/A	N/A
Neely Cr.	IL_BZQ	0512011111	30	3	6.6	X582, X583, X585, X586, X590	N/A	N/A
Negro Cr.	IL_BZX	0512011304	31	3	4.93	X582, X583, X585, X586, X590	N/A	N/A
Negro Cr.	IL_DJFBB	0713000509	15	5	14.82	N582, X583, X585, X586, F590	84, 322, 501	20, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Negro Cr.	IL_DZO	0713000108	11	3	15.5	X582, X583, X585, X586, X590	N/A	N/A
Negro Lick Cr.	IL_DBI	0713001106	18	3	11.71	X582, X583, X585, X586, X590	N/A	N/A
Nettle Cr.	IL_DU-01	0712000506	11	2	24.53	F582, X583, X585, X586, F590	N/A	N/A
Nettle Cr.	IL_DU-99	0712000507	11	3	0.36	X582, X583, X585, X586, X590	N/A	N/A
New Columbia Ditch	IL_ADCD-01	0514020605	33	4C	10.12	N582, X583, X585, X586, X590	84, 500, 501	20
Newton Branch	IL_CZZJB	0512011408	31	3	2.6	X582, X583, X585, X586, X590	N/A	N/A
Nichols Run	IL_LCB	0708010413	16	3	5.35	X582, X583, X585, X586, X590	N/A	N/A
Nickolson Cr.	IL_CAZC	0512011502	31	3	12.69	X582, X583, X585, X586, X590	N/A	N/A
Ninemile Cr.	IL_OA-01	0714020409	25	2	18.42	F582, X583, X585, X586, X590	N/A	N/A
Nippersink Cr.	IL_DTK-04	0712000609	3	5	16.71	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Nippersink Cr.	IL_DTK-06	0712000609	3	5	17.02	N582, N583, N585, X586, X590	79, 301, 463, 478, 274, 348, 400	28, 140, 10
Nixon Run	IL_DLE	0713000302	13	3	9.98	X582, X583, X585, X586, X590	N/A	N/A
No Business Cr.	IL_BZN	0512011117	30	3	7.51	X582, X583, X585, X586, X590	N/A	N/A
Norman Drain	IL_GBH-01	0712000408	2	3	7.49	X582, X583, X585, X586, X590	N/A	N/A
North Bonfield Branch	IL_FCCA	0712000116	10	3	9.48	X582, X583, X585, X586, X590	N/A	N/A
North Camp Cr.	IL_LFBC	0708010403	16	3	5.67	X582, X583, X585, X586, X590	N/A	N/A
North Cr.	IL_DJJB-01	0713000505	15	2	13.24	F582, X583, X585, X586, F590	N/A	N/A
North Cr.	IL_DTKAA-03	0712000608	3	3	1.92	X582, X583, X585, X586, X590	N/A	N/A
North Cr.	IL_HBDA-01	0712000302	1	5	4.86	N582, X583, X585, X586, X590	246, 313, 322, 371	28, 58, 177, 181
North Cr.	IL_JMACBAA-D2	0714010105	27	2	2.16	F582, X583, X585, X586, X590	N/A	N/A
North Cr.	IL_OJAD	0714020207	24	3	10.27	X582, X583, X585, X586, X590	N/A	N/A
North Creek	IL_DSLC	0713000206	12	5	5.51	N582, X583, X585, X586, X590	84, 322	20, 23, 140, 177
North Fk. Cox Cr.	IL_IIHA-31	0714010502	28	5	5.11	N582, X583, X585, X586, X590	84, 213, 371, 385	72, 125, 144, 177, 127
North Fk. Cox Cr.	IL_IIHA-ST-C1	0714010502	28	5	0.55	N582, X583, X585, X586, X590	371	85, 127, 144, 177
North Fork Shoal Cr.	IL_CZUA	0512011401	31	3	4.22	X582, X583, X585, X586, X590	N/A	N/A
North Fraction Run	IL_GHAA	0712000407	2	3	1.66	X582, X583, X585, X586, X590	N/A	N/A
North Shore Channel	IL_HCCA-02	0712000301	1	5	4.33	N582, N583, N585, X586, X590	84, 301, 319, 322, 423, 462, 479, 274, 348, 400	20, 23, 58, 132, 85, 177, 10, 140
Norton Branch	IL_DTZN-01	0712000701	4	3	5.46	X582, X583, X585, X586, X590	N/A	N/A
Novak Cr.	IL_NKC	0714010602	26	3	9.21	X582, X583, X585, X586, X590	N/A	N/A
Oak Branch	IL_EOHE	0713000701	20	3	9.26	X582, X583, X585, X586, X590	N/A	N/A
Oat Cr.	IL_PBIA	0709000705	8	3	4.62	X582, X583, X585, X586, X590	N/A	N/A
O'Brien Run	IL_DZ4D	0712000507	11	3	6.16	X582, X583, X585, X586, X590	N/A	N/A
Ogles Cr.	IL_ODI-CE-C1	0714020405	25	5	0.82	N582, X583, X585, X586, X590	84, 462	125, 85, 144, 177
Ogles Cr.	IL_ODI-CE-C2	0714020405	25	2	2.56	F582, X583, X585, X586, X590	N/A	N/A
Ogles Cr.	IL_ODI-CE-C3	0714020405	25	2	6.42	F582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Ogles Cr.	IL_ODI-CE-D1	0714020405	25	5	1.76	N582, X583, X585, X586, X590	463	N/A
Ohio River	IL_A-848-849	0514020207	32	5	1.05	F582, N583, N585, X586, X590	203, 274, 348, 400	140, 10
Ohio River	IL_A-849-862	0514020301	32	5	12.73	F582, N583, N585, X586, X590	203, 274, 348, 400	140, 10, 177
Ohio River	IL_A-862-873	0514020303	32	5	11.24	F582, N583, N585, X586, X590	203, 274, 348, 400	140, 10, 177
Ohio River	IL_A-873-894	0514020305	32	5	19.74	F582, N583, N585, X586, X590	203, 274, 348, 400	140, 10, 177
Ohio River	IL_A-894-910	0514020307	32	5	16.08	F582, N583, N585, X586, X590	203, 274, 348, 400	140, 10
Ohio River	IL_A-910-920	0514020309	32	5	10.19	F582, N583, F585, F586, X590	203, 274, 348	140, 10
Ohio River	IL_A-920-981	0514020607	33	5	60.13	F582, N583, F584, N585, X586, X590	203, 274, 348, 400	140, 10
Old Cache R.	IL_ADY-01	0714010801	33	5	3.94	N582, X583, X585, X586, X590	84, 273, 319, 322, 500	20, 140, 58, 144, 36
Old Camp Cr.	IL_CAVB	0512011502	31	3	3.52	X582, X583, X585, X586, X590	N/A	N/A
Old Channel, Embarras R.	IL_BE	0512011215	30	3	10.38	X582, X583, X585, X586, X590	N/A	N/A
Old Hickory Cr.	IL_ONEA	0714020203	24	3	5.19	X582, X583, X585, X586, X590	N/A	N/A
Old Maeystown Cr.	IL_JZG	0714010109	27	3	10.85	X582, X583, X585, X586, X590	N/A	N/A
Old Prairie Du Pont Cr.	IL_JMAG	0714010105	27	3	1.51	X582, X583, X585, X586, X590	N/A	N/A
Old Wabash R.	IL_B-19	0512011306	31	3	2.06	X582, X583, X585, X586, X590	N/A	N/A
Olive Branch	IL_BPJF-01	0512010906	29	3	11.2	X582, X583, X585, X586, X590	N/A	N/A
Olive Branch	IL_DKKA	0713000404	14	3	4.92	X582, X583, X585, X586, X590	N/A	N/A
Olney Cr.	IL_CHL-OL-C1	0512011406	31	2	0.98	F582, X583, X585, X586, X590	N/A	N/A
O'Neill Branch	IL_DTZA	0712000706	4	3	5.04	X582, X583, X585, X586, X590	N/A	N/A
Onemile Race Cr.	IL_JC	0714010109	27	3	7.88	X582, X583, X585, X586, X590	N/A	N/A
Onion Cr.	IL_BBA	0512011306	31	3	2.69	X582, X583, X585, X586, X590	N/A	N/A
Onion Cr.	IL_BEDD	0512011211	30	3	4.06	X582, X583, X585, X586, X590	N/A	N/A
Opossum Cr.	IL_CAGBA	0512011504	31	3	7.16	X582, X583, X585, X586, X590	N/A	N/A
Opossum Cr.	IL_LAA	0708010416	16	3	2.9	X582, X583, X585, X586, X590	N/A	N/A
Opossum Cr.	IL_NCG	0714010610	26	3	4.24	X582, X583, X585, X586, X590	N/A	N/A
Opossum Cr.	IL_OQC-01	0714020110	23	2	14.35	F582, X583, X585, X586, X590	N/A	N/A
Opossum Cr.	IL_OZZK	0714020111	23	3	3.87	X582, X583, X585, X586, X590	N/A	N/A
Orchard Creek	IL_IA-01	0714010508	28	5	3.79	N582, X583, X585, X586, F590	322	72, 143, 144, 156
Otter Branch	IL_BEJG	0512011207	30	3	4.18	X582, X583, X585, X586, X590	N/A	N/A
Otter Branch	IL_OOC	0714020202	24	3	5.75	X582, X583, X585, X586, X590	N/A	N/A
Otter Cr.	IL_DAGD-01	0713001202	18	3	21.76	X582, X583, X585, X586, X590	N/A	N/A
Otter Cr.	IL_DI-02	0713000307	13	2	31.63	F582, X583, X585, X586, X590	N/A	N/A
Otter Cr.	IL_DSB-01	0713000209	12	2	21.51	F582, X583, X585, X586, F590	N/A	N/A
Otter Cr.	IL_DTFA	0712000701	4	2	6.52	F582, X583, X585, X586, X590	N/A	N/A
Otter Cr.	IL_DZA-02	0713001109	18	2	11.33	F582, X583, X585, X586, X590	N/A	N/A
Otter Cr.	IL_DZA-03	0713001109	18	2	12.25	F582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Otter Cr.	IL_MIA	0708010101	9	3	11.95	X582, X583, X585, X586, X590	N/A	N/A
Otter Cr.	IL_PEE-01	0709000509	6	5	15.33	N582, X583, X585, X586, X590	463	N/A
Otter Cr.	IL_PWBA	0709000408	7	2	6.37	F582, X583, X585, X586, X590	N/A	N/A
Otter Pond Ditch	IL_BEZC	0512011215	30	3	13.96	X582, X583, X585, X586, X590	N/A	N/A
Overcup Cr.	IL_ONA	0714020203	24	3	6.52	X582, X583, X585, X586, X590	N/A	N/A
Owens Cr.	IL_CZZK	0512011409	31	3	5.57	X582, X583, X585, X586, X590	N/A	N/A
Owens Cr.	IL_PQCB-01	0709000606	5	3	16.44	X582, X583, X585, X586, X590	N/A	N/A
Owl Branch	IL_DAZH	0713001205	18	3	6.12	X582, X583, X585, X586, X590	N/A	N/A
Owl Cr.	IL_OLC	0714020204	24	3	5.4	X582, X583, X585, X586, X590	N/A	N/A
Owl Creek	IL_EZV	0713000601	21	4A	6.57	N582, X583, X585, X586, X590	84, 322, 462	20, 72, 144
Ozark Cr.	IL_AJFBA	0514020308	32	3	2.84	X582, X583, X585, X586, X590	N/A	N/A
Paddock Cr.	IL_JQD	0714010102	27	3	19	X582, X583, X585, X586, X590	N/A	N/A
Paddy Cr.	IL_CAQ	0512011502	31	3	7.31	X582, X583, X585, X586, X590	N/A	N/A
Paint Cr.	IL_OBA	0714020408	25	3	4.99	X582, X583, X585, X586, X590	N/A	N/A
Painter Cr.	IL_BPGB-01	0512010908	29	3	4.85	X582, X583, X585, X586, X590	N/A	N/A
Painter Fork	IL_BECB	0512011212	30	3	4.76	X582, X583, X585, X586, X590	N/A	N/A
Paintrock Cr.	IL_CAU	0512011502	31	3	10.48	X582, X583, X585, X586, X590	N/A	N/A
Palmer Cr.	IL_JJ	0714010105	27	3	7.45	X582, X583, X585, X586, X590	N/A	N/A
Pankey Branch	IL_ATGB	0514020402	32	3	6.58	X582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_BEFC	0512011210	30	3	14.48	X582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_CZZI	0512011404	31	3	14.5	X582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_DBO	0713001106	18	3	4.91	X582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_DGKA	0713001004	17	3	11.75	X582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_DKK-01	0713000404	14	2	5.28	F582, X583, X585, X586, F590	N/A	N/A
Panther Cr.	IL_DKK-02	0713000404	14	2	8.23	F582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_DKK-03	0713000404	14	3	12.99	X582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_EE-01	0713000807	20	2	14.92	F582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_EOE-05	0713000705	20	5	4.86	N582, X583, X585, X586, X590	322, 462	177, 85
Panther Cr.	IL_JQM	0714010101	27	3	3.48	X582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_KCAI	0711000409	19	5	6.27	N582, X583, X585, X586, X590	273, 322	140, 155
Panther Cr.	IL_KII	0711000105	19	3	10.5	X582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_NCE-02	0714010610	26	2	12.84	F582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_NCO	0714010610	26	3	7.08	X582, X583, X585, X586, X590	N/A	N/A
Panther Cr.	IL_OLH	0714020204	24	3	4.37	X582, X583, X585, X586, X590	N/A	N/A
Panther Fork	IL_CANE	0512011501	31	3	5.5	X582, X583, X585, X586, X590	N/A	N/A
Parker Branch	IL_DZHAA	0713000304	13	3	2.5	X582, X583, X585, X586, X590	N/A	N/A
Parker Cr.	IL_CGAB	0512011408	31	3	4.86	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Parker Run	IL_LFE	0708010404	16	3	9.41	X582, X583, X585, X586, X590	N/A	N/A
Partridge Cr.	IL_BZR	0512011111	30	3	4.9	X582, X583, X585, X586, X590	N/A	N/A
Partridge Cr.	IL_DZ4H	0713000117	11	3	14.7	X582, X583, X585, X586, X590	N/A	N/A
Patten Br.	IL_IIA	0714010502	28	3	4.2	X582, X583, X585, X586, X590	N/A	N/A
Patterson Branch	IL_ADCG	0514020605	33	3	6.12	X582, X583, X585, X586, X590	N/A	N/A
Patton Cr.	IL_DKU	0713000403	14	2	8.91	F582, X583, X585, X586, X590	N/A	N/A
Paul Cr.	IL_BEAB-01	0512011213	30	3	10.07	X582, X583, X585, X586, X590	N/A	N/A
Paw Paw Run	IL_DTAD	0712000705	4	3	8.23	X582, X583, X585, X586, X590	N/A	N/A
Pecatonica R.	IL_PW-01	0709000316	7	5	7.01	N582, N583, N585, X586, X590	371, 403, 348, 400	144, 140
Pecatonica R.	IL_PW-02	0709000316	7	5	18.75	F582, N583, X585, X586, X590	274, 348	10, 140
Pecatonica R.	IL_PW-04	0709000312	7	5	7.29	N582, N583, X585, X586, X590	371, 403, 348	144, 140
Pecatonica R.	IL_PW-06	0709000314	7	5	22.72	X582, N583, X585, X586, X590	348	140
Pecatonica R.	IL_PW-07	0709000312	7	5	20.7	F582, N583, X585, X586, X590	348	140
Pecatonica R.	IL_PW-08	0709000314	7	5	7.59	N582, N583, N585, X586, X590	371, 403, 348, 400	144, 140
Pecatonica R.	IL_PW-13	0709000316	7	5	8.56	X582, N583, N585, X586, X590	348, 400	140, 156
Pennington Cr.	IL_LDI	0708010410	16	3	3.94	X582, X583, X585, X586, X590	N/A	N/A
Person Cr.	IL_DZ3C	0712000508	11	3	3.24	X582, X583, X585, X586, X590	N/A	N/A
Peters Cr.	IL_AQ	0514020303	32	2	9.67	F582, X583, X585, X586, X590	N/A	N/A
Peters Slough	IL_ATHU-01	0514020403	32	5	5.87	N582, X583, X585, X586, X590	260, 273, 385, 423, 441	2, 127
Pettibone Cr.	IL_QA-C4	0404000201	1	5	0.21	N582, X583, X585, X586, X590	273, 274, 301, 348, 375,	28
Petty Branch	IL_OZZG	0714020111	23	3	2.02	X582, X583, X585, X586, X590	N/A	N/A
Phil Creek	IL_NEBB-DQ-C1A	0714010606	26	5	1.21	N582, X583, X585, X586, F590	322	56, 144, 156, 177
Phils Cr.	IL_DAE	0713001205	18	2	16.71	F582, X583, X585, X586, X590	N/A	N/A
Phinney Branch	IL_OZYB	0714020102	23	3	2.26	X582, X583, X585, X586, X590	N/A	N/A
Piasa Cr.	IL_JV-01	0711000902	27	5	29.74	N582, X583, X585, X586, F590	84, 322, 388	72, 125, 156, 177
Piatt Cr.	IL_OLGA	0714020204	24	3	6	X582, X583, X585, X586, X590	N/A	N/A
Pierce Cr.	IL_NZW	0714010602	26	3	5.53	X582, X583, X585, X586, X590	N/A	N/A
Pig Cr.	IL_DJHB	0713000508	15	3	8.41	X582, X583, X585, X586, X590	N/A	N/A
Pigeon Cr.	IL_CANBA	0512011501	31	3	4.42	X582, X583, X585, X586, X590	N/A	N/A
Pigeon Cr.	IL_DZLA	0713000113	11	3	10.64	X582, X583, X585, X586, X590	N/A	N/A
Pigeon Cr.	IL_FLIDD-01	0712000206	10	5	4.82	N582, X583, N585, X586, X590	463, 400	140
Pigeon Cr.	IL_FLIDD-02	0712000206	10	3	4.16	X582, X583, X585, X586, X590	N/A	N/A
Pigeon Cr.	IL_FLIDD-03	0712000206	10	3	2.59	X582, X583, X585, X586, X590	N/A	N/A
Pigeon Creek	IL_KCG-01	0711000405	19	2	14.65	F582, X583, X585, X586, X590	N/A	N/A
Pike Cr.	IL_DQG	0713000105	11	4C	21.07	N582, X583, X585, X586, X590	84	20
Pike Cr.	IL_DSJA-01	0713000204	12	2	14.34	F582, X583, X585, X586, X590	N/A	N/A
Pike Cr.	IL_EIC	0713000908	22	3	13.66	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Pike Cr.	IL_FLF-01	0712000211	10	5	18.31	N582, X583, N585, X586, F590	84, 322, 371, 500, 501, 400	20, 157, 156, 72, 140
Pike Cr.	IL_FQA	0712000114	10	3	15.06	X582, X583, X585, X586, X590	N/A	N/A
Pike Run	IL_LED	0708010405	16	3	7.56	X582, X583, X585, X586, X590	N/A	N/A
Piles Fk.	IL_NDB-03	0714010608	26	5	7.91	N582, X583, X585, X586, X590	84, 277, 319, 322	125, 177, 132
Pine Cr.	IL_PJ-01	0709000505	6	2	14.76	F582, X583, X585, X586, X590	N/A	N/A
Pine Cr.	IL_PJ-11	0709000505	6	2	8.1	F582, X583, X585, X586, X590	N/A	N/A
Piney Branch	IL_IIBB-01	0714010502	28	2	5.81	F582, X583, X585, X586, F590	N/A	N/A
Pink Cr.	IL_PWIA-01	0709000314	7	3	10.18	X582, X583, X585, X586, X590	N/A	N/A
Pint Cr.	IL_OQAAA	0714020110	23	3	3.13	X582, X583, X585, X586, X590	N/A	N/A
Pipestone Cr.	IL_NCDA-01	0714010609	26	5	14.33	N582, X583, X585, X586, X590	273, 371, 385	127, 20, 72, 125, 144
Piscasaw Cr.	IL_PQE-06	0709000603	5	5	12.65	F582, N583, X585, X586, X590	274	10, 140
Piscasaw Cr.	IL_PQE-07	0709000603	5	5	14.6	X582, N583, X585, X586, X590	274	10, 140
Plum Cr.	IL_DZZJA	0713001108	18	2	14.3	F582, X583, X585, X586, X590	N/A	N/A
Plum Cr.	IL_HBE-02	0712000303	1	2	17.59	F582, X583, X585, X586, X590	N/A	N/A
Plum Cr.	IL_OZC-01	0714020407	25	2	32.74	F582, X583, X586, X590	N/A	N/A
Plum Cr.	IL_OZH-OK-A2	0714020209	24	5	7.23	N582, X583, X585, X586, X590	84, 322, 371, 403, 462	125, 140, 144
Plum Cr.	IL_OZH-OK-C2	0714020209	24	5	2.1	N582, X583, X585, X586, X590	84, 322, 462	125, 85
Plum Cr.	IL_OZH-OK-C3	0714020209	24	5	2.25	N582, X583, X585, X586, X590	84, 322, 371, 462	85, 177
Plum R.	IL_MJ-01	0706000510	9	5	31.39	N582, X583, N585, X586, X590	84, 371, 403, 400	20, 66, 140
Plum R.	IL_MJ-02	0706000510	9	2	19.12	F582, X583, X585, X586, F590	N/A	N/A
Polecat Cr.	IL_BEO-01	0512011208	30	2	19.08	F582, X583, X585, X586, X590	N/A	N/A
Polecat Cr.	IL_EOAE	0713000707	20	3	7.91	X582, X583, X585, X586, X590	N/A	N/A
Polecat Cr.	IL_OQAB	0714020110	23	3	7.99	X582, X583, X585, X586, X590	N/A	N/A
Pond Cr.	IL_ATHE	0514020403	32	5	9.21	N582, X583, X585, X586, F590	322	2, 155
Pond Cr.	IL_CC-FF-C3	0512011409	31	5	7.33	N582, X583, X585, X586, X590	84, 463, 479, 500, 501	20, 72
Pond Cr.	IL_CC-FF-D1	0512011409	31	5	4.64	N582, X583, X585, X586, X590	84, 322	20, 72, 140
Pond Cr.	IL_DQDA	0713000107	11	3	10.21	X582, X583, X585, X586, X590	N/A	N/A
Pond Cr.	IL_NCA	0714010610	26	3	7.08	X582, X583, X585, X586, X590	N/A	N/A
Pond Cr.	IL_NG-02	0714010605	26	5	23.53	N582, X583, F585, F586, X590	84, 138, 322, 371, 500, 501	20, 56, 72, 125, 144, 156, 177, 140
Pond Ditch	IL_ATZN-10	0514020407	32	3	1.8	X582, X583, X585, X586, X590	N/A	N/A
Pond Ditch	IL_ATZN-11	0514020407	32	3	6.45	X582, X583, X585, X586, X590	N/A	N/A
Pond Grove Cr.	IL_BEZG	0512011212	30	3	9.37	X582, X583, X585, X586, X590	N/A	N/A
Poole Cr.	IL_DZ4M	0713000110	11	3	4.85	X582, X583, X585, X586, X590	N/A	N/A
Pope Cr.	IL_LE-03	0708010405	16	2	25.37	F582, X583, X585, X586, X590	N/A	N/A
Pope Cr.	IL_LE-04	0708010405	16	3	7.62	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Pope Cr.	IL_LE-05	0708010405	16	3	25.44	X582, X583, X585, X586, X590	N/A	N/A
Poplar Branch	IL_NIC	0714010603	26	3	3.99	X582, X583, X585, X586, X590	N/A	N/A
Poplar Cr.	IL_CAZJ	0512011502	31	3	8.45	X582, X583, X585, X586, X590	N/A	N/A
Poplar Cr.	IL_DTG-02	0712000612	3	5	15.52	N582, X583, N585, X586, X590	138, 403, 400	49, 177, 140
Poplar Cr.	IL_DTG-03	0712000612	3	3	1.95	X582, X583, X585, X586, X590	N/A	N/A
Porterfield Cr.	IL_IXJB	0714010801	33	3	3.08	X582, X583, X585, X586, X590	N/A	N/A
Possum Cr.	IL_CAP	0512011502	31	3	4.28	X582, X583, X585, X586, X590	N/A	N/A
Possum Cr.	IL_DZ3WA	0713001110	18	3	1.45	X582, X583, X585, X586, X590	N/A	N/A
Post Cr. Cutoff	IL_AD-09	0514020605	33	2	5.22	F582, X583, X585, X586, X590	N/A	N/A
Post Oak Slough	IL_OHH	0714020401	25	3	1.5	X582, X583, X585, X586, X590	N/A	N/A
Prairie Branch	IL_DAGCA	0713001202	18	3	4.15	X582, X583, X585, X586, X590	N/A	N/A
Prairie Cr.	IL_ATGF	0514020402	32	3	8.41	X582, X583, X585, X586, X590	N/A	N/A
Prairie Cr.	IL_BPKL-01	0512010901	29	2	7.51	F582, X583, X585, X586, X590	N/A	N/A
Prairie Cr.	IL_CAE	0512011505	31	3	7.61	X582, X583, X585, X586, X590	N/A	N/A
Prairie Cr.	IL_DFE	0713001101	18	2	15.49	F582, X583, X585, X586, X590	N/A	N/A
Prairie Cr.	IL_DGZN-01	0713001007	17	5	10.18	N582, X583, X585, X586, X590	273, 322, 403, 462	140, 85, 144
Prairie Cr.	IL_DKF-11	0713000408	14	5	14.96	N582, X583, X585, X586, F590	84, 138, 322	20, 85
Prairie Cr.	IL_DSE-01	0713000208	12	2	20.21	F582, X583, X585, X586, F590	N/A	N/A
Prairie Cr.	IL_EIDA-01	0713000907	22	2	20.68	F582, X583, X585, X586, X590	N/A	N/A
Prairie Cr.	IL_EIED	0713000905	22	3	10.47	X582, X583, X585, X586, X590	N/A	N/A
Prairie Cr.	IL_EKA	0713000803	20	3	16.61	X582, X583, X585, X586, X590	N/A	N/A
Prairie Cr.	IL_FA-01	0712000118	10	2	24.93	F582, X583, X585, X586, F590	N/A	N/A
Prairie Cr.	IL_FLG	0712000209	10	5	29.72	N582, X583, N585, X586, N590	84, 322, 500, 501, 400, 471	20, 72, 140
Prairie Cr.	IL_NZM-01	0714010607	26	5	9.06	N582, X583, X585, X586, X590	385	127
Prairie Cr.	IL_OJBA	0714020208	24	5	21.8	N582, X583, X585, X586, X590	322, 462	72, 125, 143, 144, 156, 161, 177
Prairie Cr.	IL_PLE-03	0709000503	6	2	11.6	F582, X583, X585, X586, X590	N/A	N/A
Prairie du Long Cr.	IL_OCB-99	0714020406	25	5	26.39	N582, X583, X585, X586, X590	273, 322	72, 144, 156
Prairie Du Pont Cr.	IL_JMAA-01	0714010105	27	2	14.95	F582, X583, X585, X586, F590	N/A	N/A
Prairie du Rocher Cr.	IL_JB	0714010109	27	3	8.55	X582, X583, X585, X586, X590	N/A	N/A
Prairie Fork	IL_EOFA	0713000703	20	3	13.64	X582, X583, X585, X586, X590	N/A	N/A
Prentiss Cr.	IL_GBLA	0712000408	2	3	3.5	X582, X583, X585, X586, X590	N/A	N/A
Preston Cr.	IL_PWO	0709000312	7	3	7.8	X582, X583, X585, X586, X590	N/A	N/A
Prince Run	IL_DJMAA	0713000502	15	5	8.65	N582, X583, X585, X586, X590	84, 234, 371	20, 140, 144, 156
Pulaski Slough	IL_IXCC-01	0714010803	33	4C	9.64	N582, X583, X585, X586, X590	84, 500, 501	20
Puncheon Cr.	IL_CANB	0512011501	31	3	12.65	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Puncheon Cr.	IL_NEI-01	0714010606	26	5	7.98	N582, X583, X585, X586, X590	463	140
Purpus Cr.	IL_DEHC	0713001102	18	3	7.76	X582, X583, X585, X586, X590	N/A	N/A
Put Cr.	IL_DJD-02	0713000511	15	2	17.38	F582, X583, X585, X586, F590	N/A	N/A
Quail Cr.	IL_BFCB-12	0512011114	30	5	3.79	N582, X583, X585, X586, X590	229, 463	45, 102, 144, 177
Quarrel Cr.	IL_AKF	0514020306	32	3	3.6	X582, X583, X585, X586, X590	N/A	N/A
Quarry Branch	IL_BEFE	0512011210	30	3	9.11	X582, X583, X585, X586, X590	N/A	N/A
Queens Lake Branch	IL_OZG	0714020409	25	3	8.85	X582, X583, X585, X586, X590	N/A	N/A
Quiver Cr.	IL_DZG-02	0713000305	13	2	16.17	F582, X583, X585, X586, X590	N/A	N/A
Raccoon Cr.	IL_BG	0512011113	30	2	12.63	F582, X583, X585, X586, X590	N/A	N/A
Raccoon Cr.	IL_CDF-02	0512011407	31	5	23.71	F582, N583, X585, X586, X590	274	10, 140
Raccoon Cr.	IL_OJF	0714020208	24	3	17.08	X582, X583, X585, X586, X590	N/A	N/A
Raccoon Cr.	IL_OLE	0714020204	24	3	6.92	X582, X583, X585, X586, X590	N/A	N/A
Raccoon Cr.	IL_PWA-01	0709000315	7	5	8.38	F582, X583, N585, X586, X590	400	140
Raccoon Cr. South	IL_BZK-01	0512011301	31	5	21.17	N582, X583, X585, X586, X590	322	4, 155
Railroad Cr.	IL_LZW	0708010418	16	3	7.13	X582, X583, X585, X586, X590	N/A	N/A
Ramsey Branch	IL_AKJ	0514020306	32	3	4.13	X582, X583, X585, X586, X590	N/A	N/A
Ramsey Cr.	IL_COA	0512011403	31	3	11.64	X582, X583, X585, X586, X590	N/A	N/A
Ramsey Cr.	IL_OO-01	0714020202	24	2	15.76	F582, X583, X586, X590	N/A	N/A
Ramsey Cr.	IL_OO-02	0714020202	24	2	15.57	F582, X583, X585, X586, X590	N/A	N/A
Ramsey Slough	IL_PZO	0709000510	6	3	2.48	X582, X583, X585, X586, X590	N/A	N/A
Randy Creek	IL_JDA-MT-A1	0714010109	27	2	2.11	F582, X583, X585, X586, F590	N/A	N/A
Randy Creek	IL_JDA-MT-C1	0714010109	27	2	0.23	X582, X583, X585, X586, F590	N/A	N/A
Range Cr.	IL_BEI-01	0512011208	30	2	24.01	F582, X583, X585, X586, X590	N/A	N/A
Rat Run	IL_DZZC	0712000508	11	3	6.39	X582, X583, X585, X586, X590	N/A	N/A
Rattlesnake Branch	IL_DZZKB	0713000306	13	3	4.6	X582, X583, X585, X586, X590	N/A	N/A
Rattlesnake Cr.	IL_BEZW	0512011208	30	3	3.06	X582, X583, X585, X586, X590	N/A	N/A
Rattlesnake Cr.	IL_CZV	0512011401	31	3	3	X582, X583, X585, X586, X590	N/A	N/A
Rattlesnake Cr.	IL_NCB-01	0714010610	26	2	11.35	F582, X583, X585, X586, X590	N/A	N/A
Rattlesnake Den Cr.	IL_DEG	0713001102	18	3	3.56	X582, X583, X585, X586, X590	N/A	N/A
Rayhill Slough	IL_OFA	0714020409	25	3	9.02	X582, X583, X585, X586, X590	N/A	N/A
Rayns Cr.	IL_FE	0712000118	10	3	6.26	X582, X583, X585, X586, X590	N/A	N/A
Rayse Cr.	IL_NK-01	0714010602	26	2	9.13	F582, X583, X586, X590	N/A	N/A
Rayse Cr.	IL_NK-02	0714010602	26	2	21.18	F582, X583, X585, X586, X590	N/A	N/A
Rector Cr.	IL_ATFE-01	0514020404	32	5	19.74	N582, X583, X585, X586, X590	84, 322, 479, 500, 501	20, 140, 144, 72
Red R.	IL_DKKG	0713000404	14	3	8.17	X582, X583, X585, X586, X590	N/A	N/A
Reese Cr	IL_NEB-DQ-C1	0714010606	26	5	1.31	F582, X583, X585, X586, N590	471	144, 156, 177
Reese Cr.	IL_NEB	0714010606	26	3	4.71	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Reese Cr.	IL_NEB-02	0714010606	26	5	6.59	N582, X583, X585, X586, F590	84, 322, 371, 462, 500, 501	20, 49, 72, 85, 144, 156
Reese Cr.	IL_NEB-DQ-A2	0714010606	26	5	4.15	N582, X583, X585, X586, F590	84, 273, 501	2, 127, 143, 144, 156
Reinhardt Slouth	IL_OFB	0714020409	25	3	7.1	X582, X583, X585, X586, X590	N/A	N/A
Rhule Cr.	IL_PWC-01	0709000316	7	3	1.8	X582, X583, X585, X586, X590	N/A	N/A
Rich Branch	IL_DHGA	0713000309	13	3	5.06	X582, X583, X585, X586, X590	N/A	N/A
Richardson Branch	IL_DAJA	0713001201	18	3	6.21	X582, X583, X585, X586, X590	N/A	N/A
Richie Branch	IL_DHF	0713000309	13	3	7.22	X582, X583, X585, X586, X590	N/A	N/A
Richland Cr.	IL_CHK	0512011406	31	3	6.65	X582, X583, X585, X586, X590	N/A	N/A
Richland Cr.	IL_DZK	0713000115	11	3	15.77	X582, X583, X585, X586, X590	N/A	N/A
Richland Cr.	IL_EK-01	0713000803	20	5	19.28	N582, X583, X585, X586, X590	463	140
Richland Cr.	IL_OZT	0714020206	24	3	10.54	X582, X583, X585, X586, X590	N/A	N/A
Richland Cr.	IL_PWP-06	0709000311	7	2	21.6	F582, X583, X585, X586, X590	N/A	N/A
Richland Cr. North	IL_OR-01	0714020109	23	2	27.62	F582, X583, X585, X586, X590	N/A	N/A
Richland Cr.-South	IL_OC-03	0714020406	25	5	3.81	N582, X583, X585, X586, X590	84, 462	20, 125, 144, 23, 85
Richland Cr.-South	IL_OC-04	0714020406	25	5	9.53	N582, X583, X586, X590	168, 371, 403, 462, 500, 501	23, 85, 177, 127, 144, 20
Richland Cr.-South	IL_OC-86	0714020406	25	5	9.01	N582, X583, X586, X590	462, 500	20, 144, 156
Richland Cr.-South	IL_OC-90	0714020406	25	5	3.05	N582, X583, X585, X586, N590	371, 462, 500, 501, 520	23, 85, 144, 177
Richland Cr.-South	IL_OC-92	0714020406	25	2	3.49	F582, X583, X585, X586, X590	N/A	N/A
Richland Cr.-South	IL_OC-94	0714020406	25	2	1.72	F582, X583, X585, X586, X590	N/A	N/A
Richland Cr.-South	IL_OC-95	0714020406	25	5	2.97	N582, X583, X585, X586, X590	84, 322, 462	20, 85, 177
Richland Cr.-South	IL_OC-97	0714020406	25	3	6.22	X582, X583, X585, X586, X590	N/A	N/A
Riley Cr.	IL_BENA-01	0512011206	30	2	1.38	F582, X583, X585, X586, X590	N/A	N/A
Riley Cr.	IL_BENA-02	0512011206	30	2	8.54	F582, X583, X585, X586, X590	N/A	N/A
Riley Cr.	IL_BENA-03	0512011206	30	2	5.46	F582, X583, X585, X586, X590	N/A	N/A
Riley Run	IL_OPB	0714020201	24	3	2.18	X582, X583, X585, X586, X590	N/A	N/A
Rindesbacher Cr.	IL_MLC	0706000507	9	3	3.61	X582, X583, X585, X586, X590	N/A	N/A
Road Run	IL_IXRA	0714010803	33	3	5.73	X582, X583, X585, X586, X590	N/A	N/A
Rob Roy Cr.	IL_DTZI-01	0712000706	4	3	9.66	X582, X583, X585, X586, X590	N/A	N/A
Robinson Cr.	IL_BFC-10	0512011114	30	5	2.69	N582, X583, X585, X586, X590	462	62, 85, 177
Robinson Cr.	IL_BFC-11	0512011114	30	5	0.92	N582, X583, X585, X586, X590	138, 234, 462	62, 85, 177
Robinson Cr.	IL_BFC-19	0512011114	30	5	0.72	N582, X583, X585, X586, X590	462	85, 177
Robinson Cr.	IL_BFC-20	0512011114	30	5	3.66	N582, X583, X585, X586, X590	322	62, 85, 177
Robinson Cr.	IL_BFC-25	0512011114	30	5	0.22	N582, X583, X585, X586, X590	462	85, 177
Robinson Cr.	IL_BFC-26	0512011114	30	5	1.26	N582, X583, X585, X586, X590	84, 138, 462, 501	20, 62, 85, 177
Robinson Cr.	IL_LZA	0708010416	16	3	6.23	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Robinson Cr.	IL_OAC	0714020409	25	3	4.78	X582, X583, X585, X586, X590	N/A	N/A
Robinson Cr.	IL_OS-03	0714020108	23	2	31.09	F582, X583, X585, X586, X590	N/A	N/A
Rock Branch	IL_CHDA	0512011406	31	3	2.01	X582, X583, X585, X586, X590	N/A	N/A
Rock Branch	IL_NCIA	0714010610	26	3	3.12	X582, X583, X585, X586, X590	N/A	N/A
Rock Cr.	IL_ATBA	0514020407	32	5	10.22	N582, X583, X585, X586, F590	163, 322	N/A
Rock Cr.	IL_DGO-01	0713001002	17	5	13.48	N582, X583, X585, X586, X590	322	140
Rock Cr.	IL_DGPB-01	0713001001	17	3	13.73	X582, X583, X585, X586, X590	N/A	N/A
Rock Cr.	IL_DKI-01	0713000407	14	2	18.09	F582, X583, X585, X586, X590	N/A	N/A
Rock Cr.	IL_EIEC	0713000905	22	3	7.19	X582, X583, X585, X586, X590	N/A	N/A
Rock Cr.	IL_EZZN	0713000804	20	2	12.45	F582, X583, X585, X586, X590	N/A	N/A
Rock Cr.	IL_FF-01	0712000115	10	2	24.69	F582, X583, X585, X586, F590	N/A	N/A
Rock Cr.	IL_IHA	0714010503	28	3	3.43	X582, X583, X585, X586, X590	N/A	N/A
Rock Cr.	IL_JRBAA	0711000903	27	3	1.8	X582, X583, X585, X586, X590	N/A	N/A
Rock Cr.	IL_PE-02	0709000509	6	2	43.3	F582, X583, X585, X586, X590	N/A	N/A
Rock Cr.	IL_PE-05	0709000509	6	5	9.4	F582, X583, N585, X586, X590	400	140
Rock Fork	IL_NCDD	0714010609	26	3	3.08	X582, X583, X585, X586, X590	N/A	N/A
Rock R.	IL_P-04	0709000511	6	5	29.61	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Rock R.	IL_P-06	0709000510	6	5	11.31	N582, N583, F585, F586, X590	229, 521, 274, 348	124, 10, 140
Rock R.	IL_P-09	0709000316	6	5	5.66	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Rock R.	IL_P-14	0709000504	6	5	11.01	F582, N583, F585, F586, X590	274, 348	10, 140
Rock R.	IL_P-15	0709000501	6	5	21.26	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Rock R.	IL_P-20	0709000506	6	5	25.14	N582, N583, F585, F586, X590	229, 521, 274, 348	124, 10, 140
Rock R.	IL_P-21	0709000506	6	5	18.47	N582, N583, X585, X586, X590	229, 521, 274, 348	124, 10, 140
Rock R.	IL_P-23	0709000504	6	5	7.5	F582, N583, F585, F586, X590	274, 348	10, 140
Rock R.	IL_P-24	0709000510	6	5	25.55	N582, N583, X585, X586, X590	229, 521, 274, 348	124, 10, 140
Rock R.	IL_P-25	0709000513	6	5	15.96	N582, N583, X585, X586, X590	463, 274, 348	10, 140
Rock Run	IL_GBAA-01	0712000408	2	5	9.11	N582, X583, X585, X586, X590	463	N/A
Rock Run	IL_PWI-01	0709000314	7	2	22.68	F582, X583, X585, X586, X590	N/A	N/A
Rockcastle Cr.	IL_IIG	0714010502	28	3	5.4	X582, X583, X585, X586, X590	N/A	N/A
Rockhouse Cr.	IL_OCBC	0714020406	25	3	9.46	X582, X583, X585, X586, X590	N/A	N/A
Rocky Branch	IL_AKC	0514020306	32	3	4.08	X582, X583, X585, X586, X590	N/A	N/A
Rocky Branch	IL_ATZB	0514020403	32	3	5.2	X582, X583, X585, X586, X590	N/A	N/A
Rocky Branch	IL_AX	0514020607	33	3	3.91	X582, X583, X585, X586, X590	N/A	N/A
Rocky Branch	IL_CAGCA	0512011504	31	3	6.26	X582, X583, X585, X586, X590	N/A	N/A
Rocky Branch	IL_CAYC	0512011502	31	3	1.75	X582, X583, X585, X586, X590	N/A	N/A
Rocky Branch	IL_EZZM	0713000804	20	3	3.14	X582, X583, X585, X586, X590	N/A	N/A
Rocky Branch	IL_JRAA	0711000903	27	3	7.08	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Rocky Branch	IL_OABA	0714020409	25	3	1.89	X582, X583, X585, X586, X590	N/A	N/A
Rocky Branch	IL_OCBA	0714020406	25	3	4.03	X582, X583, X585, X586, X590	N/A	N/A
Rocky Branch	IL_OSB	0714020108	23	3	7.24	X582, X583, X585, X586, X590	N/A	N/A
Rocky Fork	IL_JVB	0711000902	27	3	6.34	X582, X583, X585, X586, X590	N/A	N/A
Rocky Run	IL_DQC	0713000107	11	3	6.18	X582, X583, X585, X586, X590	N/A	N/A
Roods Cr.	IL_DTZE-01	0712000706	4	3	12.33	X582, X583, X585, X586, X590	N/A	N/A
Rooks Cr.	IL_DSJ-01	0713000204	12	2	34.52	F582, X583, X585, X586, F590	N/A	N/A
Root Lick Branch	IL_AJC	0514020308	32	3	5.13	X582, X583, X585, X586, X590	N/A	N/A
Rose Cr.	IL_ALF	0514020307	32	3	8.95	X582, X583, X585, X586, X590	N/A	N/A
Rose Cr.	IL_ATEE-08	0514020407	32	5	3.14	N582, X583, X585, X586, X590	322, 385	140, 127
Rosetter Cr.	IL_PQCK-01	0709000606	5	3	6.93	X582, X583, X585, X586, X590	N/A	N/A
Rubicon Cr.	IL_DAFA	0713001203	18	3	10.25	X582, X583, X585, X586, X590	N/A	N/A
Ruffner Cr.	IL_BEIB	0512011208	30	3	2.86	X582, X583, X585, X586, X590	N/A	N/A
Running Lake Ditch	IL_ICIA-01	0714010507	28	5	19.62	N582, X583, X585, X586, F590	84, 273, 322, 500, 501	49, 72, 155
Running Slough	IL_AZB	0514020207	32	3	9.72	X582, X583, X585, X586, X590	N/A	N/A
Rupp Run	IL_DLK	0713000302	13	3	2.35	X582, X583, X585, X586, X590	N/A	N/A
Rush Cr.	IL_ML	0706000507	9	3	30.26	X582, X583, X585, X586, X590	N/A	N/A
Rush Cr.	IL_PQH-01	0709000602	5	2	15.54	F582, X583, X585, X586, X590	N/A	N/A
Russett Branch	IL_DES	0713001102	18	3	3.96	X582, X583, X585, X586, X590	N/A	N/A
Russian Branch	IL_NCKC	0714010610	26	3	4.16	X582, X583, X585, X586, X590	N/A	N/A
S. Beach Cr.	IL_PLBA	0709000503	6	5	4.92	N582, X583, X585, X586, X590	463	N/A
S. Br. Chicago R.	IL_HC-01	0712000301	1	5	3.99	N583, X586, F587	348	140
S. Br. Crow Cr. E.	IL_DOA	0713000112	11	3	21.7	X582, X583, X585, X586, X590	N/A	N/A
S. Br. E. Kishwaukee R.	IL_PQI-10	0709000602	5	5	6.76	N582, X583, X585, X586, X590	84, 104, 319, 322, 371, 462, 478, 479	20, 58, 28, 85, 122, 144
S. Br. Fork Cr.	IL_FBC-02	0712000117	10	3	22.26	X582, X583, X585, X586, X590	N/A	N/A
S. Br. Kishwaukee R.	IL_PQC-02	0709000606	5	5	12.37	F582, N583, X585, X586, X590	274, 348	140
S. Br. Kishwaukee R.	IL_PQC-05	0709000606	5	5	15.88	N582, N583, X585, X586, X590	463, 348	140
S. Br. Kishwaukee R.	IL_PQC-06	0709000606	5	5	5.5	N582, N583, N585, X586, X590	322, 441, 479, 348, 400	140
S. Br. Kishwaukee R.	IL_PQC-09	0709000606	5	5	9.18	F582, N583, X585, X586, X590	348	140
S. Br. Kishwaukee R.	IL_PQC-11	0709000606	5	5	7.18	F582, N583, X585, X586, X590	274, 348	140
S. Br. Kishwaukee R.	IL_PQC-13	0709000606	5	5	14.21	N582, N583, X585, X586, X590	84, 371, 479, 348	20, 144, 140
S. Br. Kishwaukee River	IL_PQI-H-D1	0709000602	5	5	5.85	N582, X583, X585, X586, X590	84, 319, 371	20, 58, 122, 144
S. Br. Kishwaukee River (East)	IL_PQI-H-C3	0709000602	5	5	2.68	N582, X583, X585, X586, X590	84, 319, 462	20, 122, 58, 85
S. Br. Kishwaukee River (East)	IL_PQI-H-C5	0709000602	5	5	4.31	N582, X583, X585, X586, X590	138, 163, 322, 462, 478, 479	85, 177

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
S. Br. La Moine R.	IL_DGZR	0713001002	17	5	16.8	N582, X583, F584, X585, X586, X590	273, 308, 322, 462	140, 85
S. Br. Larry Cr.	IL_LJB	0708010418	16	3	5.68	X582, X583, X585, X586, X590	N/A	N/A
S. Br. Otter Cr.	IL_DIF	0713000307	13	3	1.83	X582, X583, X585, X586, X590	N/A	N/A
S. Br. Otter Cr.	IL_PWBC	0709000408	7	5	9.82	N582, X583, X585, X586, X590	463	140
S. Br. Pettibone Cr.	IL_QAA-D1	0404000201	1	5	2.69	N582, X583, X585, X586, X590	1, 213, 244, 348	28
S. Br. Rock Cr.	IL_FFB-01	0712000115	10	5	19.82	N582, X583, X585, X586, F590	84, 319, 441, 462	143, 20
S. Br. Waukegan R.	IL_QCA-01	0404000201	1	5	0.86	N582, X583, X585, X586, X590	79, 154, 177, 246, 301, 319, 375	28, 132, 177
S. Edwards R.	IL_LFG-01	0708010401	16	3	19.21	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Apple R.	IL_MNI-12	0706000505	9	2	11.01	F582, X583, X585, X586, F590	N/A	N/A
S. Fk. Bear Cr.	IL_KIF-01	0711000104	19	2	6.83	F582, X583, X585, X586, F590	N/A	N/A
S. Fk. Bear Cr.	IL_KIF-02	0711000104	19	2	25.01	F582, X583, X585, X586, X590	N/A	N/A
S. Fk. Big Cr.	IL_OPA-01	0714020201	24	3	7.37	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Brouilletts Cr.	IL_BND	0512011102	30	3	18.91	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Horse Cr.	IL_OBC	0714020408	25	3	6.37	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Indian Cr.	IL_BEMA	0512011208	30	3	6.28	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Kent Cr.	IL_PSA	0709000501	6	5	9.6	X582, X583, N585, X586, X590	400	140
S. Fk. Lake Fk.	IL_EIGC	0713000903	22	3	14.88	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Lick Cr.	IL_EOAAA	0713000707	20	3	14.86	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. McKee Cr.	IL_DEA	0713001102	18	2	18.77	F582, X583, X585, X586, X590	N/A	N/A
S. Fk. Mud Cr.	IL_OEB	0714020403	25	3	10.12	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Otter Cr.	IL_DZAF-01	0713001109	18	2	8.88	F582, X583, X585, X586, X590	N/A	N/A
S. Fk. Raccoon Cr.	IL_BGB	0512011113	30	3	7.13	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. S. Br. Chicago R	IL_HCA-01	0712000301	1	5	1.49	X583, X586, N587	322, 441, 462	23
S. Fk. S. Henderson R.	IL_LDAB	0708010409	16	3	10.64	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Saline R.	IL_ATH	0514020403	32	3	12.7	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Saline R.	IL_ATH-02	0514020401	32	5	8.11	N582, X583, N585, X586, X590	84, 127, 322, 400	20, 127, 140
S. Fk. Saline R.	IL_ATH-05	0514020401	32	5	8.67	N582, X583, F585, F586, X590	84, 123, 127, 260, 273, 301, 403, 423, 441, 500, 501	20, 62, 127, 72
S. Fk. Saline R.	IL_ATH-11	0514020401	32	2	8.57	F582, X583, X585, X586, X590	N/A	N/A
S. Fk. Saline R.	IL_ATH-13	0514020403	32	5	12.68	N582, X583, X585, X586, X590	84, 273, 441	20, 125, 127
S. Fk. Saline R.	IL_ATH-14	0514020401	32	5	4.12	N582, X583, X585, X586, F590	463	62, 85
S. Fk. Sangamon R.	IL_EO-01	0713000708	20	5	19.04	N582, N583, F584, N585, X586, X590	441, 462, 137, 400	140, 144

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
S. Fk. Sangamon R.	IL_EO-02	0713000705	20	5	16.26	N582, N583, N585, X586, X590	322, 371, 403, 462, 137, 400	140, 82, 144
S. Fk. Sangamon R.	IL_EO-04	0713000708	20	5	10.55	N582, N583, F585, F586, X590	441, 462, 137	140, 144
S. Fk. Sangamon R.	IL_EO-05	0713000705	20	5	13.78	N582, N583, X585, X586, X590	322, 371, 403, 462, 137	140, 82, 144
S. Fk. Sangamon R.	IL_EO-13	0713000702	20	5	20.73	N582, N583, X585, X586, X590	273, 322, 371, 137	140
S. Fk. Shelby Cr.	IL_DGCA	0713001012	17	3	8.4	X582, X583, X585, X586, X590	N/A	N/A
S. Fk. Vermilion R.	IL_DSP-01	0713000202	12	2	6.02	F582, X583, X585, X586, X590	N/A	N/A
S. Fk. Vermilion R.	IL_DSP-03	0713000202	12	2	22.02	F582, X583, X585, X586, F590	N/A	N/A
S. Henderson Cr.	IL_LDH	0708010410	16	3	13.61	X582, X583, X585, X586, X590	N/A	N/A
S. Henderson R.	IL_LDA-01	0708010409	16	2	5.79	F582, X583, X585, X586, F590	N/A	N/A
S. Henderson R.	IL_LDA-03	0708010409	16	2	22.15	F582, X583, X585, X586, X590	N/A	N/A
S. Kickapoo Cr.	IL_DZ3B	0712000508	11	3	9.36	X582, X583, X585, X586, X590	N/A	N/A
S. Kinnikinnick Cr.	IL_PT	0709000501	6	5	14.43	F582, X583, N585, X586, X590	400	140
S. Prong Spring	IL_KCAEA	0711000409	19	3	3.04	X582, X583, X585, X586, X590	N/A	N/A
Saline Br.	IL_BPJC-06	0512010902	29	2	10.38	F582, X583, X586, X590	N/A	N/A
Saline Br.	IL_BPJC-08	0512010902	29	4C	14.11	N582, X583, X585, X586, X590	84, 501	20
Saline R.	IL_AT-05	0514020403	32	5	9.6	N582, X583, X585, X586, N590	84, 123, 322, 501, 471, 520	20, 72, 85, 127, 156
Saline R.	IL_AT-06	0514020407	32	5	10.44	N582, N583, F585, F586, X590	322, 403, 462, 501, 274	140, 144, 2, 20, 10
Saline R.	IL_AT-07	0514020407	32	5	7.27	N582, N583, X585, X586, X590	84, 273, 322, 371, 385, 403, 441, 462, 274	20, 125, 127, 140, 144, 10
Salt Cr.	IL_CP-04	0512011402	31	5	1.97	N582, X583, X585, X586, X590	371, 403, 462	144
Salt Cr.	IL_CP-05	0512011402	31	2	5.67	F582, X583, X585, X586, X590	N/A	N/A
Salt Cr.	IL_CP-EF-C2	0512011402	31	5	2.4	N582, X583, X585, X586, X590	322, 462	85, 177, 144
Salt Cr.	IL_CP-EF-C4	0512011402	31	5	1.87	N582, X583, X585, X586, X590	462	85, 144, 177
Salt Cr.	IL_CP-EF-C5	0512011402	31	2	3.26	F582, X583, X585, X586, X590	N/A	N/A
Salt Cr.	IL_CP-EF-C6	0512011402	31	2	2.42	F582, X583, X585, X586, X590	N/A	N/A
Salt Cr.	IL_CP-TU-C3	0512011402	31	5	0.89	N582, X583, X585, X586, X590	462	85, 144
Salt Cr.	IL_EI-02	0713000908	22	4A	11.07	F582, X583, N585, X586, X590	400	140
Salt Cr.	IL_EI-03	0713000908	22	2	21.88	F582, X583, X585, X586, X590	N/A	N/A
Salt Cr.	IL_EI-06	0713000904	22	4A	16.1	F582, X583, N585, X586, X590	400	140
Salt Cr.	IL_EI-07	0713000901	22	2	21.59	F582, X583, X585, X586, X590	N/A	N/A
Salt Cr.	IL_EI-18	0713000904	22	2	28.87	F582, X583, X585, X586, X590	N/A	N/A
Salt Cr.	IL_GL	0712000404	2	5	11.9	N582, N583, F585, F586, X590	138, 319, 322, 462, 479, 274, 348	177, 58, 142, 10, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Salt Cr.	IL_GL-03	0712000404	2	5	10.52	N582, N583, X585, X586, X590	84, 177, 244, 322, 348, 371, 403, 462, 500, 274	20, 84, 28, 23, 115, 122, 177, 85, 142, 10, 140
Salt Cr.	IL_GL-09	0712000404	2	5	12.09	N582, N583, N585, X586, X590	79, 138, 277, 319, 322, 371, 403, 462, 274, 348, 400	28, 23, 85, 177, 58, 132, 142, 10, 140
Salt Cr.	IL_GL-10	0712000404	2	5	3.72	N582, N583, N585, X586, X590	84, 96, 138, 246, 277, 301, 319, 322, 441, 478, 479, 274, 348, 400	20, 125, 28, 85, 177, 58, 132, 142, 140, 10
Salt Cr.	IL_GL-19	0712000404	2	5	3.15	N582, N583, N585, X586, X590	84, 138, 319, 403, 462, 274, 348, 400	20, 23, 85, 177, 10, 140
Salt Fk. Vermilion R.	IL_BPJ-03	0512010906	29	4A	10.06	F582, X583, N584, N585, X586, X590	452, 400	140
Salt Fk. Vermilion R.	IL_BPJ-07	0512010903	29	5	3.12	F582, X583, N585, X586, X590	400	140
Salt Fk. Vermilion R.	IL_BPJ-08	0512010906	29	5	3.21	F582, X583, N584, N585, X586, X590	452, 400	140
Salt Fk. Vermilion R.	IL_BPJ-09	0512010903	29	3	13.71	X582, X583, X585, X586, X590	N/A	N/A
Salt Fk. Vermilion R.	IL_BPJ-10	0512010906	29	4A	13.74	F582, X583, N584, X585, X586, X590	452	140
Salt Fk. Vermilion R.	IL_BPJ-12	0512010906	29	2	3.18	F582, X583, X585, X586, X590	N/A	N/A
Salt Fork	IL_BNBB	0512011101	30	3	15.27	X582, X583, X585, X586, X590	N/A	N/A
Salty Branch	IL_CANF	0512011501	31	3	2.4	X582, X583, X585, X586, X590	N/A	N/A
Sam Branch	IL_BEFB	0512011210	30	3	5.27	X582, X583, X585, X586, X590	N/A	N/A
Sammons Cr.	IL_IBAA	0714010507	28	2	4.31	F582, X583, X585, X586, F590	N/A	N/A
Sand Branch	IL_DACA	0713001206	18	3	5.85	X582, X583, X585, X586, X590	N/A	N/A
Sand Branch	IL_DAZAA	0713001206	18	3	1.94	X582, X583, X585, X586, X590	N/A	N/A
Sand Branch	IL_DGAA	0713001012	17	3	3.11	X582, X583, X585, X586, X590	N/A	N/A
Sand Cr.	IL_DAC	0713001206	18	3	5.83	X582, X583, X585, X586, X590	N/A	N/A
Sand Cr.	IL_MIB	0708010101	9	3	6.6	X582, X583, X585, X586, X590	N/A	N/A
Sand Cr.	IL_MXB	0708010105	9	3	4.96	X582, X583, X585, X586, X590	N/A	N/A
Sand Cr.	IL_ODLAA	0714020404	25	3	6.95	X582, X583, X585, X586, X590	N/A	N/A
Sand Cr.	IL_OZZO	0714020107	23	3	10.83	X582, X583, X585, X586, X590	N/A	N/A
Sandy Branch	IL_BHD	0512011110	30	3	2.8	X582, X583, X585, X586, X590	N/A	N/A
Sandy Branch	IL_OKD	0714020205	24	3	2.26	X582, X583, X585, X586, X590	N/A	N/A
Sandy Cr.	IL_DC-01	0713001105	18	2	33.86	F582, X583, X585, X586, X590	N/A	N/A
Sandy Cr.	IL_DP-02	0713000109	11	5	30.22	F582, X583, N585, X586, F590	400	140
Sandy Cr.	IL_DZAG	0713001109	18	5	5.01	N582, X583, X585, X586, X590	462	85

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Sandy Cr.	IL_IXD-01	0714010802	33	5	13.42	N582, X583, X585, X586, F590	322, 441	20, 72, 144, 156
Sandy Run Ditch	IL_ONEB	0714020203	24	3	12.73	X582, X583, X585, X586, X590	N/A	N/A
Sangamon R	IL_E-18	0713000604	21	4A	24.53	F582, X583, N585, X586, X590	400	140
Sangamon R.	IL_E-04	0713000804	20	5	15.78	F582, N583, X585, X586, X590	348	140
Sangamon R.	IL_E-05	0713000608	21	5	13.58	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Sangamon R.	IL_E-06	0713000608	21	5	1.19	F582, N583, N585, X586, X590	348, 400	140
Sangamon R.	IL_E-09	0713000608	21	5	2.52	F582, N583, N585, X586, X590	348, 400	140
Sangamon R.	IL_E-16	0713000608	21	5	27.48	F582, N583, N585, X586, X590	348, 400	140
Sangamon R.	IL_E-24	0713000806	20	5	23.11	F582, N583, N585, X586, X590	348, 400	140
Sangamon R.	IL_E-25	0713000808	20	5	36.42	F582, N583, N585, X586, X590	348, 400	140
Sangamon R.	IL_E-26	0713000804	20	5	10.72	F582, N583, N585, X586, X590	348, 400	140
Sangamon R.	IL_E-29	0713000602	21	4A	41.9	F582, X583, N585, X586, X590	400	140
Sangamon R.	IL_E-33	0713000601	21	2	31.32	F582, X583, X585, X586, X590	N/A	N/A
Sangamon R.	IL_E-95	0713000604	21	5	5.89	F582, N583, X585, X586, X590	274	10, 140
Saratoga Cr.	IL_DWBA	0712000501	11	3	10.83	X582, X583, X585, X586, X590	N/A	N/A
Sargent Slough	IL_DKEA	0713000408	14	3	10.02	X582, X583, X585, X586, X590	N/A	N/A
Sawmill Cr.	IL_GJ-01	0712000407	2	5	6.62	N582, X583, X585, X586, X590	277, 319, 348, 500	28, 142
Scattering Fk.	IL_BER-01	0512011202	30	2	13.7	F582, X583, X585, X586, X590	N/A	N/A
Scattering Point Cr.	IL_DSH-02	0713000205	12	2	18.96	F582, X583, X585, X586, F590	N/A	N/A
Schneider Springs Br.	IL_OKF	0714020205	24	3	4.85	X582, X583, X585, X586, X590	N/A	N/A
Schoenberger Cr. South	IL_JMACB	0714010105	27	3	6.22	X582, X583, X585, X586, X590	N/A	N/A
Schoenberger Creek	IL_JNG	0714010104	27	5	3.82	N582, X583, X585, X586, N590	84, 273, 308, 322, 500, 501, 160, 413, 462, 471, 478, 479, 502, 520	20, 23, 28, 49, 69, 72, 85, 115, 125, 177
Schoenberger Creek	IL_JNG-PF-A3	0714010104	27	5	1.02	N582, X583, X585, X586, F590	273, 322	20, 23, 28, 72, 115, 177
Scholes Branch	IL_DNA	0713000111	11	3	7.94	X582, X583, X585, X586, X590	N/A	N/A
Schoolhouse Branch	IL_JNB	0714010103	27	3	6.42	X582, X583, X585, X586, X590	N/A	N/A
Scrub Cr.	IL_MJAA	0706000510	9	3	4.15	X582, X583, X585, X586, X590	N/A	N/A
Second Cr.	IL_CZQ	0512011404	31	3	10.74	X582, X583, X585, X586, X590	N/A	N/A
Second Salt Cr.	IL_CPD-01	0512011402	31	5	2.9	N582, X583, X585, X586, X590	273, 322, 462	140, 155, 143
Second Salt Cr.	IL_CPD-03	0512011402	31	5	1.46	N582, X583, X585, X586, X590	322, 371, 403, 462	4, 144
Second Salt Cr.	IL_CPD-04	0512011402	31	5	3.08	N582, X583, X585, X586, X590	322, 371, 403, 462	4, 144
Section Cr.	IL_OQAA	0714020110	23	3	9.61	X582, X583, X585, X586, X590	N/A	N/A
Seed Cr.	IL_BZKB	0512011301	31	3	3.84	X582, X583, X585, X586, X590	N/A	N/A
Seminary Cr.	IL_CDG-FL-A1	0512011407	31	5	1.65	N582, X583, X585, X586, X590	322	177
Seminary Cr.	IL_CDG-FL-C1	0512011407	31	5	1.48	N582, X583, X585, X586, X590	463	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Seminary Cr.	IL_CDG-FL-C4	0512011407	31	5	2.15	N582, X583, X585, X586, X590	84, 462	125, 85, 144, 177
Seminary Cr.	IL_CDG-FL-C6	0512011407	31	5	2.36	N582, X583, X585, X586, X590	84, 322, 462	125, 85, 177, 144
Seminary Cr.	IL_DBC	0713001107	18	5	12.49	N582, X583, X585, X586, X590	462	85, 144
Senachwine Cr.	IL_DM	0713000114	11	5	29.08	F582, X583, N585, X586, F590	400	140
Sepo Cr.	IL_DJAA	0713000514	15	3	4.3	X582, X583, X585, X586, X590	N/A	N/A
Sevenmile Branch	IL_PZZN	0709000506	6	3	10.61	X582, X583, X585, X586, X590	N/A	N/A
Sevenmile Cr.	IL_AF	0514020602	33	2	11.8	F582, X583, X585, X586, F590	N/A	N/A
Sevenmile Cr.	IL_CAC-01	0512011505	31	3	17.5	X582, X583, X585, X586, X590	N/A	N/A
Sevenmile Cr.	IL_NJC	0714010601	26	5	10.92	N582, X583, X585, X586, X590	273, 322	140
Sewer Cr.	IL_OHE-HL-A1	0714020401	25	5	3.02	N582, X583, X585, X586, X590	463	N/A
Sewer Cr.	IL_OHE-HL-C1	0714020401	25	5	1.33	N582, X583, X585, X586, X590	462	85, 177
Sewer Cr.	IL_OJCB-19	0714020208	24	5	3.13	N582, X583, X585, X586, X590	371, 462	144, 177, 85
Sewer Cr.	IL_OJCB-20	0714020208	24	2	2.33	F582, X583, X585, X586, X590	N/A	N/A
Sexson Br.	IL_CTC	0512011401	31	3	10.03	X582, X583, X585, X586, X590	N/A	N/A
Sexton Cr.	IL_IB-01	0714010507	28	5	3.09	N582, X583, X585, X586, X590	84, 371, 403, 500, 501	20, 72, 144
Sexton Cr.	IL_IB-07	0714010507	28	5	9.06	N582, X583, X585, X586, F590	322, 441, 500, 501	37, 144, 156, 157
Seymore Branch	IL_DBLAA	0713001106	18	3	2.04	X582, X583, X585, X586, X590	N/A	N/A
Shaffer Cr.	IL_PZC	0709000513	6	3	8.92	X582, X583, X585, X586, X590	N/A	N/A
Shale Cr.	IL_JMACBAB-D1	0714010105	27	2	3.22	F582, X583, X585, X586, X590	N/A	N/A
Shavetail Cr.	IL_FLHA-01	0712000208	10	5	9.01	N582, X583, X585, X586, X590	84, 322, 371, 403	20, 144
Shaw Cr.	IL_DJC-01	0713000512	15	2	15.51	F582, X583, X585, X586, F590	N/A	N/A
Shaw Cr.	IL_DPA	0713000109	11	3	6.9	X582, X583, X585, X586, X590	N/A	N/A
Shaw Point Branch	IL_DAK	0713001201	18	3	11.01	X582, X583, X585, X586, X590	N/A	N/A
Shearles Branch	IL_DAZP	0713001201	18	3	11.3	X582, X583, X585, X586, X590	N/A	N/A
Shelby Cr.	IL_CGB	0512011408	31	3	3.4	X582, X583, X585, X586, X590	N/A	N/A
Sheridan Branch	IL_ARB	0514020303	32	3	2.62	X582, X583, X585, X586, X590	N/A	N/A
Sheridan Cr.	IL_LZY	0708010418	16	3	10.66	X582, X583, X585, X586, X590	N/A	N/A
Sherry Cr.	IL_JQE	0714010102	27	5	13.39	N582, X583, X585, X586, F590	463	140, 144, 155, 156
Shields Branch	IL_JS	0711000904	27	3	4.1	X582, X583, X585, X586, X590	N/A	N/A
Shirley Cr.	IL_BEAC	0512011213	30	3	5.96	X582, X583, X585, X586, X590	N/A	N/A
Shoal Cr.	IL_CZU	0512011401	31	3	6.09	X582, X583, X585, X586, X590	N/A	N/A
Shoal Cr.	IL_DJZH	0713000512	15	3	4.95	X582, X583, X585, X586, X590	N/A	N/A
Shoal Cr.	IL_OI-05	0714020306	24	2	13.37	F582, X583, X585, X586, X590	N/A	N/A
Shoal Cr.	IL_OI-08	0714020306	24	5	14.29	N582, X583, N584, N585, X586, X590	322, 390, 403, 462, 99, 260, 273, 400	144, 156, 140
Shoal Cr.	IL_OI-09	0714020304	24	4A	31.5	F582, X583, N585, X586, X590	400	140
Shoal Cr.	IL_OI-13	0714020306	24	5	11.49	N582, X583, X585, X586, X590	463	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Shoal Cr.	IL_OI-15	0714020306	24	2	11.12	F582, X583, X585, X586, X590	N/A	N/A
Shoe Cr.	IL_CAM	0512011503	31	3	6.94	X582, X583, X585, X586, X590	N/A	N/A
Shop Cr.	IL_OIMC	0714020301	24	3	10.52	X582, X583, X585, X586, X590	N/A	N/A
Short Cr.	IL_DGOA	0713001002	17	3	5.39	X582, X583, X585, X586, X590	N/A	N/A
Short Fork	IL_DGLE	0713001003	17	3	9.01	X582, X583, X585, X586, X590	N/A	N/A
Short Point Cr.	IL_EIEF	0713000905	22	3	6.17	X582, X583, X585, X586, X590	N/A	N/A
Short Point Creek	IL_DSHA	0713000205	12	2	17.02	F582, X583, X585, X586, X590	N/A	N/A
Shuhart Cr.	IL_KZQ	0711000106	19	3	6.45	X582, X583, X585, X586, X590	N/A	N/A
Silver Cr.	IL_DJNBA	0713000501	15	2	8.16	F582, X583, X585, X586, X590	N/A	N/A
Silver Cr.	IL_DZ3S	0713001110	18	3	4.25	X582, X583, X585, X586, X590	N/A	N/A
Silver Cr.	IL_GM-01	0712000405	2	3	4.58	X582, X583, X585, X586, X590	N/A	N/A
Silver Cr.	IL_LZC	0708010416	16	3	3.7	X582, X583, X585, X586, X590	N/A	N/A
Silver Cr.	IL_OD-06	0714020405	25	5	50.74	N582, X583, X586, X590	273, 322, 371, 462	4, 85, 144
Silver Cr.	IL_OD-07	0714020405	25	2	33.65	F582, X583, X586, X590	N/A	N/A
Silver Cr.	IL_PM	0709000504	6	3	7.47	X582, X583, X585, X586, X590	N/A	N/A
Silver Cr.	IL_PWM	0709000314	7	3	6.89	X582, X583, X585, X586, X590	N/A	N/A
Silver Creek Ditch	IL_ODF-OF-C1	0714020405	25	2	7.72	F582, X583, X585, X586, X590	N/A	N/A
Simmons Cr.	IL_BCI	0512011304	31	3	4.49	X582, X583, X585, X586, X590	N/A	N/A
Simmons Creek	IL_ALAA-11	0514020307	32	3	9.37	X582, X583, X585, X586, X590	N/A	N/A
Singleton Ditch	IL_FR	0712000113	10	3	5.59	X582, X583, X585, X586, X590	N/A	N/A
Sinsinawa R.	IL_MS	0706000502	9	5	10.27	N582, X583, X585, X586, F590	371	156
Sixmile Cr.	IL_DKN	0713000405	14	3	1.44	X582, X583, X585, X586, X590	N/A	N/A
Sixmile Cr.	IL_DKN-01	0713000405	14	5	10.14	N582, X583, X585, X586, F590	84, 319, 322, 371, 501	20, 142, 140, 144, 156
Sixmile Cr.	IL_KCB	0711000409	19	2	19.99	F582, X583, X585, X586, F590	N/A	N/A
Sixmile Cr.	IL_NEA-02	0714010606	26	2	11.08	F582, X583, X585, X586, X590	N/A	N/A
Skillet Fk.	IL_CA-02	0512011505	31	5	20.04	N582, N583, X585, X586, X590	403, 501, 274, 348	20, 10, 140
Skillet Fk.	IL_CA-03	0512011505	31	5	7.22	N582, N583, N585, X586, X590	273, 322, 403, 462, 274, 348, 400	140, 144, 10
Skillet Fk.	IL_CA-05	0512011503	31	5	11.08	N582, N583, N584, N585, X586, X590	99, 260, 273, 322, 390, 403, 274, 348, 400	144, 140, 156, 10
Skillet Fk.	IL_CA-06	0512011502	31	5	16.79	N582, N583, N585, X586, X590	138, 163, 322, 274, 348, 400	102, 140
Skillet Fk.	IL_CA-07	0512011502	31	5	11.84	F582, N583, X585, X586, X590	274, 348	10, 140
Skillet Fk.	IL_CA-08	0512011502	31	5	10.92	N582, N583, X585, X586, X590	322, 274, 348	140, 10
Skillet Fk.	IL_CA-09	0512011502	31	5	19.73	N582, N583, X585, X586, X590	273, 322, 462, 274, 348	155, 140, 10
Skokie R.	IL_HCCD-01	0712000301	1	5	13.47	N582, X583, N585, X586, X590	138, 322, 403, 462, 400	135, 177

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Skokie R.	IL_HCCD-09	0712000301	1	5	1.76	N582, X583, N585, X586, X590	84, 137, 138, 319, 322, 371, 462, 479, 500, 400	20, 28, 85, 177, 58, 132, 142, 23
Skull Cr.	IL_OZZN	0714020107	23	3	5.33	X582, X583, X585, X586, X590	N/A	N/A
Skunk Cr.	IL_LFI	0708010404	16	3	4.31	X582, X583, X585, X586, X590	N/A	N/A
Slade Branch	IL_NCM	0714010610	26	3	4.61	X582, X583, X585, X586, X590	N/A	N/A
Slate Cr.	IL_BEHA	0512011208	30	3	4.13	X582, X583, X585, X586, X590	N/A	N/A
Slater Cr.	IL_BEFM	0512011210	30	3	5.79	X582, X583, X585, X586, X590	N/A	N/A
Slater Cr.	IL_KIJ	0711000105	19	3	14.61	X582, X583, X585, X586, X590	N/A	N/A
Sleepy Hollow Ditch	IL_EIB-01	0713000908	22	3	8.56	X582, X583, X585, X586, X590	N/A	N/A
Slocum Lake Drain	IL_DTR-W-C3	0712000611	3	5	1.08	N582, X583, X585, X586, F590	322, 371, 441, 462, 500	140, 177, 20, 142, 85
Slocum Lake Drain	IL_DTR-W-D1	0712000611	3	5	0.92	N582, X583, X585, X586, N590	322, 371, 441, 462, 500, 471	140, 142, 177, 20
Slough, The	IL_DSLA	0713000206	12	3	2.56	X582, X583, X585, X586, X590	N/A	N/A
Slug Run	IL_DJBZ-01	0713000513	15	5	4.12	N582, X583, X586, X590	371	56
Smallpox Cr.	IL_MPA	0706000504	9	2	14.37	F582, X583, X585, X586, F590	N/A	N/A
Smith Cr.	IL_LDB-01	0708010410	16	2	10.94	F582, X583, X585, X586, X590	N/A	N/A
Snag Cr.	IL_DZZV	0713000115	11	2	29.76	F582, X583, X585, X586, X590	N/A	N/A
Snake Cr.	IL_BNC	0512011102	30	3	8.98	X582, X583, X585, X586, X590	N/A	N/A
Snake Cr.	IL_DFK	0713001101	18	3	7.32	X582, X583, X585, X586, X590	N/A	N/A
Snake Cr.	IL_DZZVA	0713000115	11	3	4.71	X582, X583, X585, X586, X590	N/A	N/A
Snake Cr.	IL_LDEA	0708010407	16	3	4.74	X582, X583, X585, X586, X590	N/A	N/A
Snakeden Branch	IL_DHH	0713000309	13	3	4.6	X582, X583, X585, X586, X590	N/A	N/A
Snakeden Hollow	IL_DJZN-01	0713000507	15	2	8.06	F582, X583, X585, X586, X590	N/A	N/A
Snow Cr.	IL_NL-01	0714010602	26	5	10.81	N582, X583, X585, X586, X590	322, 403	140, 144, 156
Snyder Cr.	IL_BZP	0512011111	30	3	14.45	X582, X583, X585, X586, X590	N/A	N/A
Soldier Cr.	IL_FI	0712000118	10	3	8.78	X582, X583, X585, X586, X590	N/A	N/A
Solomon Cr.	IL_DAGC	0713001202	18	3	15.46	X582, X583, X585, X586, X590	N/A	N/A
Somonauk Cr.	IL_DTB-01	0712000704	4	2	9.72	F582, X583, X586, X590	N/A	N/A
Somonauk Cr.	IL_DTB-02	0712000704	4	2	22.9	F582, X583, X585, X586, X590	N/A	N/A
Sorghum Branch	IL_EOHJ	0713000701	20	3	6.53	X582, X583, X585, X586, X590	N/A	N/A
South Bonfield Branch	IL_FCCB	0712000116	10	3	6.08	X582, X583, X585, X586, X590	N/A	N/A
South Br. Cedar Cr. S.	IL_DGGC	0713001009	17	3	4.57	X582, X583, X585, X586, X590	N/A	N/A
South Branch	IL_DGDB	0713001011	17	3	7.42	X582, X583, X585, X586, X590	N/A	N/A
South Fork Cr.	IL_DGGB	0713001009	17	3	9.65	X582, X583, X585, X586, X590	N/A	N/A
South Fork Deer Cr.	IL_CDBB	0512011407	31	3	3.75	X582, X583, X585, X586, X590	N/A	N/A
South Fork Shaw Cr.	IL_DJCA	0713000512	15	3	8.42	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Southern Outlet Drainage Ditch	IL_CAF	0512011505	31	3	11.71	X582, X583, X585, X586, X590	N/A	N/A
Spafford Cr.	IL_PWW	0709000309	7	3	7.58	X582, X583, X585, X586, X590	N/A	N/A
Spanish Needle Cr.	IL_DAZL	0713001201	18	2	10.99	F582, X583, X585, X586, X590	N/A	N/A
Spanker Branch	IL_OHB	0714020401	25	3	7.91	X582, X583, X585, X586, X590	N/A	N/A
Sparrow Cr.	IL_JMAAAA	0714010105	27	3	2.1	X582, X583, X585, X586, X590	N/A	N/A
Sparta Cr.	IL_OZCB-SP-A1	0714020407	25	5	0.66	N582, X583, X585, X586, X590	322	144, 156, 177
Sparta Cr.	IL_OZCB-SP-C1	0714020407	25	5	2.26	N582, X583, X585, X586, X590	462	85, 144
Spider Branch	IL_KCIA	0711000404	19	3	2.62	X582, X583, X585, X586, X590	N/A	N/A
Spillman Cr.	IL_LA	0708010416	16	3	6.42	X582, X583, X585, X586, X590	N/A	N/A
Spoil Bank trib.	IL_BERD-01	0512011202	30	3	10.69	X582, X583, X585, X586, X590	N/A	N/A
Spoon Br.	IL_BPJD-02	0512010903	29	2	13.92	F582, X583, X585, X586, X590	N/A	N/A
Spoon Cr.	IL_DCDA	0713001105	18	3	8.46	X582, X583, X585, X586, X590	N/A	N/A
Spoon R.	IL_DJ-01	0713000514	15	2	28.11	F582, X583, X585, X586, F590	N/A	N/A
Spoon R.	IL_DJ-02	0713000507	15	5	24.55	F582, X583, N585, X586, F590	400	140
Spoon R.	IL_DJ-06	0713000507	15	5	25.62	F582, X583, N585, X586, F590	400	140
Spoon R.	IL_DJ-08	0713000512	15	5	35.07	F582, X583, N585, X586, F590	400	140
Spoon R.	IL_DJ-09	0713000510	15	5	33.77	F582, N583, N585, X586, F590	274, 400	10, 140
Spring Branch	IL_AJJ	0514020308	32	3	1.57	X582, X583, X585, X586, X590	N/A	N/A
Spring Branch	IL_CJAC	0512011405	31	3	1.95	X582, X583, X585, X586, X590	N/A	N/A
Spring Branch	IL_DEAAB	0713001102	18	3	4.47	X582, X583, X585, X586, X590	N/A	N/A
Spring Branch	IL_PWNC	0709000313	7	5	4.7	N582, X583, X585, X586, X590	308, 462	140, 156
Spring Brook	IL_DZ3A	0712000508	11	3	3.05	X582, X583, X585, X586, X590	N/A	N/A
Spring Brook	IL_GBKA	0712000408	2	5	1.74	N582, X583, N585, X586, X590	84, 138, 322, 462, 400	20, 156, 177, 140
Spring Brook	IL_GBKA-01	0712000408	2	5	3.18	N582, X583, N585, X586, X590	84, 163, 462, 501, 400	20, 85, 140
Spring Brook	IL_GLB-01	0712000404	2	5	3.14	N582, X583, X585, X586, X590	84, 177, 213, 246, 319, 322, 371, 403, 462, 479	20, 28, 58, 85, 132, 177
Spring Brook	IL_GLB-07	0712000404	2	5	4.19	N582, X583, X585, X586, X590	463	140
Spring Cr.	IL_DGLA-01	0713001003	17	3	11.02	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_DTH-01	0712000612	3	3	11.85	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_DZAH	0713001109	18	3	2.61	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_DZP	0713000108	11	2	25.94	F582, X583, X585, X586, F590	N/A	N/A
Spring Cr.	IL_DZZSA	0713000117	11	3	4.68	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_EL-01	0713000802	20	5	9.27	N582, N583, N585, X586, X590	371, 348, 400	144, 177, 140
Spring Cr.	IL_EL-03	0713000802	20	5	27.94	F582, N583, F584, X585, X586, X590	348	140
Spring Cr.	IL_EOHA	0713000701	20	3	5.51	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_ESA-12	0713000605	21	3	12.78	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Spring Cr.	IL_ET	0713000608	21	3	6.97	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_FLH-02	0712000208	10	5	63.89	N582, X583, N585, X586, N590	322, 371, 501, 400, 471, 520	144, 156, 140, 58, 125, 157, 72
Spring Cr.	IL_FM	0712000114	10	4C	10.53	N582, X583, X585, X586, F590	501	20
Spring Cr.	IL_GGA-02	0712000406	2	5	15.29	N582, X583, X585, X586, N590	322, 371, 462, 519	140, 142, 156, 177
Spring Cr.	IL_JQL	0714010101	27	3	4.59	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_KCAE	0711000409	19	3	6.73	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_PBI-02	0709000705	8	2	17.85	F582, X583, X585, X586, F590	N/A	N/A
Spring Cr.	IL_PBI-03	0709000705	8	5	2.37	N582, X583, X585, X586, X590	371	20, 156
Spring Cr.	IL_PHA	0709000507	6	3	11.4	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_PQFB	0709000601	5	3	8.41	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_PWR	0709000312	7	3	5.24	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr.	IL_PZZA	0709000504	6	3	6.56	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr. North	IL_DGZQ	0713001002	17	3	9.55	X582, X583, X585, X586, X590	N/A	N/A
Spring Cr. North	IL_PZZG	0709000501	6	5	8.68	X582, X583, N585, X586, X590	400	140
Spring Cr. South	IL_DGZE	0713001010	17	3	4.34	X582, X583, X585, X586, X590	N/A	N/A
Spring Point Cr.	IL_BEJE-01	0512011207	30	3	14.92	X582, X583, X585, X586, X590	N/A	N/A
Spring Point Cr. Trib.	IL_BEJEA-01	0512011207	30	3	3.5	X582, X583, X585, X586, X590	N/A	N/A
Spring Run	IL_DVB	0712000505	11	3	3.86	X582, X583, X585, X586, X590	N/A	N/A
Spring Run	IL_DZDC	0713001103	18	3	6.43	X582, X583, X585, X586, X590	N/A	N/A
Spring Run	IL_PQBE	0709000607	5	3	6.15	X582, X583, X585, X586, X590	N/A	N/A
Spring Valley Cr.	IL_ATHA	0514020403	32	3	8.77	X582, X583, X585, X586, X590	N/A	N/A
Squaw Cr.	IL_DTL-02	0712000610	3	3	13.16	X582, X583, X585, X586, X590	N/A	N/A
Squirrel Cr.	IL_DID	0713000307	13	3	3.75	X582, X583, X585, X586, X590	N/A	N/A
St. Jacob Cr.	IL_ODLD-01	0714020404	25	3	2.19	X582, X583, X585, X586, X590	N/A	N/A
St. Joseph Cr.	IL_GBLB-01	0712000408	2	5	4.29	N582, X583, X585, X586, X590	84, 317, 319, 322, 403, 479	20, 72, 122, 125, 140, 85, 177
Stanton Cr.	IL_DXAB	0712000507	11	3	3.97	X582, X583, X585, X586, X590	N/A	N/A
State St. Ditch A	IL_HBDF-04	0712000302	1	3	0.95	X582, X583, X585, X586, X590	N/A	N/A
State St. Ditch A	IL_HBDF-05	0712000302	1	3	1.55	X582, X583, X585, X586, X590	N/A	N/A
Steer Cr.	IL_DAGAE	0713001202	18	3	5.32	X582, X583, X585, X586, X590	N/A	N/A
Steidley Branch	IL_DAGAD	0713001202	18	3	4.17	X582, X583, X585, X586, X590	N/A	N/A
Steve Cr.	IL_OMC	0714020206	24	3	5.99	X582, X583, X585, X586, X590	N/A	N/A
Stevens Cr.	IL_ES-13	0713000605	21	2	22.73	F582, X583, X585, X586, X590	N/A	N/A
Stevens Cr.	IL_NHBB	0714010604	26	3	4.3	X582, X583, X585, X586, X590	N/A	N/A
Steward Cr.	IL_PLC-01	0709000503	6	2	5.29	F582, X583, X585, X586, X590	N/A	N/A
Stillhouse Cr.	IL_ATHT-01	0514020403	32	5	4.25	N582, X583, X585, X586, X590	260, 273, 322, 385, 441	2, 127, 140

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Stillman Cr.	IL_PP-01	0709000504	6	2	17.99	F582, X583, X585, X586, X590	N/A	N/A
Stinking Cr.	IL_CZH	0512011409	31	3	5.36	X582, X583, X585, X586, X590	N/A	N/A
Stone Cr.	IL_ONC	0714020203	24	3	6.43	X582, X583, X585, X586, X590	N/A	N/A
Stoney Cr.	IL_BPF-01	0512010909	29	2	26.27	F582, X583, X585, X586, X590	N/A	N/A
Stony Cr	IL_BPJB-01	0512010904	29	3	1.24	X582, X583, X585, X586, X590	N/A	N/A
Stony Cr.	IL_BPJB-02	0512010904	29	2	14.72	F582, X583, X585, X586, X590	N/A	N/A
Stony Cr.	IL_DGF	0713001010	17	3	11.19	X582, X583, X585, X586, X590	N/A	N/A
Stony Cr.	IL_DTFB	0712000701	4	3	5.55	X582, X583, X585, X586, X590	N/A	N/A
Stony Cr.	IL_GIBC	0712000304	1	3	4.13	X582, X583, X585, X586, X590	N/A	N/A
Stony Cr. W.	IL_GIBB	0712000304	1	3	5.92	X582, X583, X585, X586, X590	N/A	N/A
Stookey Cr.	IL_JMAABA-C1	0714010105	27	5	1.17	N582, X583, X585, X586, X590	84, 462	125, 85, 144, 177
Storckman Cr.	IL_BZKC	0512011301	31	3	4.25	X582, X583, X585, X586, X590	N/A	N/A
Straddle Cr.	IL_MJBA-01	0706000509	9	5	11.91	N582, X583, X585, X586, X590	84, 462	20, 143, 144
Strawn Cr.	IL_DZLB	0713000113	11	3	15.54	X582, X583, X585, X586, X590	N/A	N/A
Stringtown Branch	IL_OTE	0714020106	23	3	8.43	X582, X583, X585, X586, X590	N/A	N/A
Suck Cr.	IL_OZZC-01	0714020206	24	3	10.87	X582, X583, X585, X586, X590	N/A	N/A
Sugar Camp Cr.	IL_JQIA	0714010101	27	3	2.43	X582, X583, X585, X586, X590	N/A	N/A
Sugar Camp Cr.	IL_NHH	0714010604	26	2	14.87	F582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_AJD-15	0514020308	32	4C	12.12	N582, X583, X585, X586, F590	228	72, 132, 144, 156
Sugar Cr.	IL_ATHG-01	0514020401	32	5	4.24	N582, X583, N585, X586, X590	84, 127, 260, 273, 301, 322, 385, 403, 423, 441, 462	2, 82, 127, 140
Sugar Cr.	IL_ATHG-02	0514020401	32	5	11.86	N582, X583, X585, X586, F590	322	140, 155
Sugar Cr.	IL_ATHG-05	0514020401	32	4A	0.92	F582, X583, N585, X586, X590	400	140
Sugar Cr.	IL_ATHG-07	0514020401	32	2	7.46	F582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_BCEB	0512011304	31	3	2.82	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_BDA	0512011303	31	3	3.32	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_BEBB	0512011214	30	3	6.79	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_BF-01	0512011114	30	5	4.84	N582, X583, N585, X586, X590	138, 234, 273, 403, 462, 400	62, 85, 177, 155, 140
Sugar Cr.	IL_BF-22	0512011114	30	3	9.46	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_BM	0512011105	30	3	4.73	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_BM-02	0512011105	30	2	14.17	F582, X583, X586, X590	N/A	N/A
Sugar Cr.	IL_BM-A1	0512011105	30	3	1.11	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_BM-C2	0512011105	30	5	2.18	N582, X583, X585, X586, X590	319, 322, 371, 462	58, 85
Sugar Cr.	IL_BPKK-01	0512010905	29	3	13.89	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_CG	0512011408	31	2	14.12	F582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Sugar Cr.	IL_CHD	0512011406	31	3	11.2	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_CJB	0512011405	31	3	12.96	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_DAB	0713001206	18	3	4.95	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_DAZO	0713001201	18	3	6.88	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_DH-01	0713000309	13	5	42.55	F582, X583, N585, X586, X590	400	140
Sugar Cr.	IL_DJJA-02	0713000505	15	3	4.82	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_EID-04	0713000907	22	2	9.92	F582, X583, X586, X590	N/A	N/A
Sugar Cr.	IL_EID-07	0713000907	22	5	13.7	N582, X583, X585, X586, X590	322	140
Sugar Cr.	IL_EID-C1	0713000907	22	5	23.91	N582, X583, X585, X586, X590	462, 501	85, 20
Sugar Cr.	IL_EID-C8	0713000907	22	2	12.66	F582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_EOA-01	0713000707	20	5	4.04	N582, X583, X586, X590	123	62
Sugar Cr.	IL_EOA-04	0713000707	20	5	34.28	N582, X583, X585, X586, X590	462	85, 144
Sugar Cr.	IL_EOA-06	0713000707	20	5	3.2	N582, X583, X585, X586, X590	84, 123, 462	132, 144, 62, 85
Sugar Cr.	IL_FLI-02	0712000207	10	5	23.65	F582, N583, N585, X586, F590	274, 400	10, 140
Sugar Cr.	IL_FLI-03	0712000207	10	5	15.11	N582, N583, N585, X586, F590	84, 500, 274, 400	20, 10, 140
Sugar Cr.	IL_JQJ	0714010101	27	3	3.25	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_NAJ	0714010612	26	3	4.2	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_NCNA	0714010610	26	3	3.67	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_NCQ	0714010610	26	3	6.02	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_NDJA	0714010608	26	3	5.51	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_NZP	0714010607	26	3	3.03	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_OCG	0714020406	25	3	5.23	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_OH-01	0714020401	25	5	23.91	N582, X583, N585, X586, X590	84, 273, 322, 462, 500, 400	20, 144, 85, 177, 140
Sugar Cr.	IL_OH-05	0714020401	25	5	5.79	N582, X583, X585, X586, X590	84, 213, 371, 462	20, 85, 144
Sugar Cr.	IL_OH-HL-D1	0714020401	25	5	11.89	N582, X583, X585, X586, X590	322, 462	140, 144
Sugar Cr.	IL_OPABA	0714020201	24	3	6.26	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr.	IL_PHB-01	0709000507	6	2	14.71	F582, X583, X585, X586, X590	N/A	N/A
Sugar Cr. Central	IL_BI	0512011111	30	3	7.61	X582, X583, X585, X586, X590	N/A	N/A
Sugar Cr. South	IL_BZW	0512011117	30	3	7.29	X582, X583, X585, X586, X590	N/A	N/A
Sugar Fk.	IL_ODLA-01	0714020404	25	5	18.56	N582, X583, X585, X586, X590	273, 322	4, 66, 102, 143, 156
Sugar R.	IL_PWB-01	0709000408	7	5	5.65	F582, N583, X585, X586, X590	348	140
Sugar R.	IL_PWB-03	0709000408	7	5	4.57	F582, N583, X585, X586, X590	348	140
Sugar Run	IL_GF-01	0712000409	2	5	7.32	N582, X583, X585, X586, X590	96, 273, 322, 371, 441	28, 177, 122, 144
Sullivan Branch	IL_NHJ	0714010604	26	3	6.56	X582, X583, X585, X586, X590	N/A	N/A
Sulphur Branch	IL_OJFA	0714020208	24	3	2.69	X582, X583, X585, X586, X590	N/A	N/A
Sumner Cr.	IL_PWH-02	0709000314	7	2	12.97	F582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Sunfish Slough	IL_MF	0708010102	9	3	0.98	X582, X583, X585, X586, X590	N/A	N/A
Susan Branch	IL_CHC	0512011406	31	3	2.26	X582, X583, X585, X586, X590	N/A	N/A
Sutphens Run	IL_DTAC	0712000705	4	2	12.98	F582, X583, X585, X586, X590	N/A	N/A
Sutton Cr.	IL_CAZB	0512011502	31	3	7.5	X582, X583, X585, X586, X590	N/A	N/A
Swab Run	IL_DJIA	0713000506	15	4C	11.54	N582, X583, X585, X586, X590	84	20, 125, 144
Swafford Branch	IL_OSA	0714020108	23	3	5.99	X582, X583, X585, X586, X590	N/A	N/A
Swan Cr.	IL_DJFB-01	0713000509	15	2	30.78	F582, X583, X585, X586, F590	N/A	N/A
Swank Cr.	IL_BOE	0512010810	29	3	8.55	X582, X583, X585, X586, X590	N/A	N/A
Swanwick Cr.	IL_NCK-01	0714010610	26	5	20.7	N582, X583, X585, X586, X590	322	140, 143, 156
Sweetwater Cr.	IL_BENB	0512011206	30	3	2.74	X582, X583, X585, X586, X590	N/A	N/A
Swegle Cr.	IL_DJZJ	0713000510	15	3	10.32	X582, X583, X585, X586, X590	N/A	N/A
Sycamore Cr.	IL_CDE	0512011407	31	3	4.57	X582, X583, X585, X586, X590	N/A	N/A
Sycamore Cr.	IL_LZX	0708010416	16	3	3.35	X582, X583, X585, X586, X590	N/A	N/A
Sycamore Cr.	IL_NDCA	0714010608	26	5	5.32	N582, X583, X585, X586, X590	273	127
Tadlock Branch	IL_CAWE	0512011502	31	3	3.67	X582, X583, X585, X586, X590	N/A	N/A
Talbot Cr.	IL_LDDB	0708010408	16	3	10.68	X582, X583, X585, X586, X590	N/A	N/A
Tallula Cr.	IL_EGD	0713000806	20	3	2.86	X582, X583, X585, X586, X590	N/A	N/A
Tar Cr.	IL_EZC	0713000806	20	3	9.8	X582, X583, X585, X586, X590	N/A	N/A
Tar Hollow	IL_DAZA	0713001206	18	3	5.44	X582, X583, X585, X586, X590	N/A	N/A
Tater Cr.	IL_DJZA	0713000514	15	2	14.63	F582, X583, X585, X586, F590	N/A	N/A
Taylor Branch	IL_CZZH	0512011408	31	3	4.25	X582, X583, X585, X586, X590	N/A	N/A
Taylor Branch	IL_NHHB	0714010604	26	3	4.63	X582, X583, X585, X586, X590	N/A	N/A
Taylor Cr.	IL_DAF-01	0713001203	18	5	24.1	N582, X583, X585, X586, X590	273, 403	140, 144
Ten Mile Cr.	IL_EIH-01	0713000904	22	2	18.9	F582, X583, X585, X586, X590	N/A	N/A
Tenmile Cr.	IL_ATFI-MC-C4	0514020404	32	5	3.02	N582, X583, X585, X586, X590	84, 463	20
Tenmile Cr.	IL_ATFI-MC-D1	0514020404	32	5	8.94	N582, X583, X585, X586, X590	273, 322	102, 140
Tenmile Cr.	IL_DZZS	0713000117	11	3	8.28	X582, X583, X585, X586, X590	N/A	N/A
Terry Cr.	IL_FD	0712000118	10	3	6.97	X582, X583, X585, X586, X590	N/A	N/A
The Slough	IL_BEAA-01	0512011213	30	3	15.65	X582, X583, X585, X586, X590	N/A	N/A
The Sny	IL_KC-01	0711000410	19	3	12.81	X582, X583, X585, X586, X590	N/A	N/A
The Sny	IL_KC-02	0711000405	19	3	18.14	X582, X583, X585, X586, X590	N/A	N/A
The Sny	IL_KC-04	0711000408	19	5	19.84	N582, X583, X585, X586, F590	84, 260, 501	20, 155
The Sny	IL_KC-05	0711000406	19	3	6.58	X582, X583, X585, X586, X590	N/A	N/A
Thenius Cr.	IL_DZM	0713000113	11	3	9.48	X582, X583, X585, X586, X590	N/A	N/A
Third Cr.	IL_HBDD-02	0712000302	1	3	2.54	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Thorn Cr.	IL_HBD-02	0712000302	1	5	3.86	N582, X583, N585, X586, X590	79, 84, 137, 177, 198, 213, 234, 246, 322, 348, 375, 403, 423, 462, 400	28, 85, 177
Thorn Cr.	IL_HBD-03	0712000302	1	5	6.52	N582, X583, N585, X586, X590	322, 400	58, 142
Thorn Cr.	IL_HBD-04	0712000302	1	5	4.29	N582, X583, N585, X586, X590	79, 84, 137, 138, 177, 198, 213, 246, 322, 348, 462, 400	28, 20, 125, 85, 177
Thorn Cr.	IL_HBD-05	0712000302	1	5	2.9	N582, X583, N585, X586, X590	246, 319, 322, 462, 400	28, 58, 132, 177, 140
Thorn Cr.	IL_HBD-06	0712000302	1	5	2.22	N582, X583, N585, X586, X590	79, 138, 198, 246, 322, 462, 400	28, 85, 177
Threemile Br.	IL_OIME	0714020301	24	3	9.56	X582, X583, X585, X586, X590	N/A	N/A
Threemile Cr.	IL_AN	0514020305	32	2	8.09	F582, X583, X585, X586, F590	N/A	N/A
Threemile Cr.	IL_PZR-01	0709000506	6	2	22.21	F582, X583, X585, X586, X590	N/A	N/A
Thunder Cr.	IL_DVDA	0712000504	11	3	6.94	X582, X583, X585, X586, X590	N/A	N/A
Thurman Cr.	IL_KIFA	0711000104	19	3	13.89	X582, X583, X585, X586, X590	N/A	N/A
Tiber Cr.	IL_DLFB	0713000304	13	3	9.97	X582, X583, X585, X586, X590	N/A	N/A
Tilley Cr.	IL_NHBA	0714010604	26	3	5.67	X582, X583, X585, X586, X590	N/A	N/A
Tilton Cr.	IL_LBA	0708010416	16	3	6.11	X582, X583, X585, X586, X590	N/A	N/A
Timber Cr.	IL_EIDC-01	0713000907	22	2	15.78	F582, X583, X585, X586, X590	N/A	N/A
Tindall Cr.	IL_IICB	0714010502	28	3	6.07	X582, X583, X585, X586, X590	N/A	N/A
Tinley Cr.	IL_HF-01	0712000304	1	5	9.49	N582, X583, X585, X586, X590	319, 463	177
Tolans Branch	IL_DHGB	0713000309	13	3	4.79	X582, X583, X585, X586, X590	N/A	N/A
Tomahawk Cr.	IL_DRA	0713000103	11	2	14.84	F582, X583, X585, X586, F590	N/A	N/A
Tomahawk Cr.	IL_PBJE	0709000703	8	3	2.62	X582, X583, X585, X586, X590	N/A	N/A
Toms Cr.	IL_LDGA	0708010410	16	3	7.21	X582, X583, X585, X586, X590	N/A	N/A
Toole Branch	IL_OCBB	0714020406	25	3	3.6	X582, X583, X585, X586, X590	N/A	N/A
Tournear Cr.	IL_KDAA	0711000402	19	3	11.42	X582, X583, X585, X586, X590	N/A	N/A
Tower Cr.	IL_FP	0712000114	10	3	10.1	X582, X583, X585, X586, X590	N/A	N/A
Town Branch	IL_DJFBBAA	0713000509	15	3	2.47	X582, X583, X585, X586, X590	N/A	N/A
Town Branch	IL_ELC-01	0713000802	20	3	1.16	X582, X583, X585, X586, X590	N/A	N/A
Town Branch	IL_EZJ	0713000804	20	2	4.47	F582, X583, X585, X586, X590	N/A	N/A
Town Cr.	IL_DGA-01	0713001012	17	2	9.95	F582, X583, X585, X586, X590	N/A	N/A
Town Cr.	IL_NZJ	0714010612	26	3	3.79	X582, X583, X585, X586, X590	N/A	N/A
Town Cr.	IL_OJK-02	0714020208	24	5	7.03	N582, X583, X585, X586, X590	371	144, 177
Town Cr.	IL_OJK-03	0714020208	24	5	2.04	N582, X583, X585, X586, X590	462	85, 95, 177
Town Fork	IL_DGLDA	0713001003	17	3	11.12	X582, X583, X585, X586, X590	N/A	N/A
Trail Cr.	IL_FLB	0712000214	10	3	5.71	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Trenkle Slough	IL_EIM	0713000901	22	3	9.2	X582, X583, X585, X586, X590	N/A	N/A
Trenton Creek	IL_OHF-TR-A1	0714020401	25	5	1.3	N582, X583, X585, X586, X590	322	4
Trenton Creek	IL_OHF-TR-C1	0714020401	25	5	0.97	N582, X583, X585, X586, X590	462, 502	4, 85, 177
Trenton Creek	IL_OHF-TR-C3	0714020401	25	5	2.03	N582, X583, X585, X586, X590	462	4, 85, 144, 177
Trim Cr.	IL_FQ-01	0712000114	10	2	22.03	F582, X583, X585, X586, F590	N/A	N/A
Trimble Run	IL_PQCA	0709000606	5	3	8.05	X582, X583, X585, X586, X590	N/A	N/A
Trimley Cr.	IL_DZ3VA	0713001108	18	3	4.22	X582, X583, X585, X586, X590	N/A	N/A
Troublesome Cr.	IL_DGJ-01	0713001005	17	2	25.56	F582, X583, X585, X586, X590	N/A	N/A
Troy Creek	IL_ODMA-TR-C2	0714020405	25	2	2.95	F582, X583, X585, X586, X590	N/A	N/A
Troy Creek	IL_ODMA-TR-C3	0714020405	25	5	0.3	N582, X583, X585, X586, X590	462	85, 177
Tunnison Cr.	IL_PWD	0709000316	7	3	6.73	X582, X583, X585, X586, X590	N/A	N/A
Turkey Branch	IL_DIB	0713000307	13	3	5.42	X582, X583, X585, X586, X590	N/A	N/A
Turkey Cr.	IL_ATD	0514020407	32	3	2.1	X582, X583, X585, X586, X590	N/A	N/A
Turkey Cr.	IL_BEZK	0512011208	30	3	5.06	X582, X583, X585, X586, X590	N/A	N/A
Turkey Cr.	IL_CHB	0512011406	31	3	3.94	X582, X583, X585, X586, X590	N/A	N/A
Turkey Cr.	IL_DBJAA	0713001106	18	3	3.98	X582, X583, X585, X586, X590	N/A	N/A
Turkey Cr.	IL_DJDB	0713000511	15	2	16.33	F582, X583, X585, X586, F590	N/A	N/A
Turkey Cr.	IL_DKS	0713000403	14	2	11.18	F582, X583, X585, X586, F590	N/A	N/A
Turkey Cr.	IL_OJE	0714020208	24	3	12.31	X582, X583, X585, X586, X590	N/A	N/A
Turkey Hollow Cr.	IL_MZR	0708010105	9	3	6.21	X582, X583, X585, X586, X590	N/A	N/A
Turkey Run	IL_BEFF	0512011210	30	3	7.14	X582, X583, X585, X586, X590	N/A	N/A
Turkey Run	IL_OJEA	0714020208	24	3	5.01	X582, X583, X585, X586, X590	N/A	N/A
Turkey Trail Cr.	IL_NEIA	0714010606	26	3	4.13	X582, X583, X585, X586, X590	N/A	N/A
Turner Cr.	IL_CAS	0512011502	31	3	6.76	X582, X583, X585, X586, X590	N/A	N/A
Turner Cr.	IL_DBQ	0713001106	18	3	4.48	X582, X583, X585, X586, X590	N/A	N/A
Turner Cr.	IL_PBB	0709000706	8	3	9.65	X582, X583, X585, X586, X590	N/A	N/A
Turtle Cr.	IL_DSM	0713000206	12	2	9.25	F582, X583, X585, X586, X590	N/A	N/A
Twomile Branch	IL_OUA	0714020103	23	3	9.14	X582, X583, X585, X586, X590	N/A	N/A
Twomile Cr.	IL_KCOA	0711000408	19	3	4.12	X582, X583, X585, X586, X590	N/A	N/A
Twomile Cr.	IL_NJCA	0714010601	26	3	4.63	X582, X583, X585, X586, X590	N/A	N/A
Twomile Slough	IL_OZZX-01	0714020102	23	2	13.55	F582, X583, X585, X586, X590	N/A	N/A
Tyler Cr.	IL_DTZP-02	0712000612	3	5	14.4	F582, X583, N585, X586, X590	400	177, 181
Tyson Cr.	IL_LZB	0708010416	16	3	5.7	X582, X583, X585, X586, X590	N/A	N/A
U TRIB VERMILION R	IL_BPZA-01	0512010909	29	2	3.25	F582, X583, X585, X586, X590	N/A	N/A
Union Ditch	IL_GGC-FN-A1	0712000406	2	5	4.1	N582, X583, X585, X586, X590	84, 319, 322, 371	20, 58, 122, 177
Union Ditch	IL_GGC-FN-C1	0712000406	2	5	1.21	N582, X583, X585, X586, X590	84, 138, 308, 319, 322, 371, 462	20, 85, 177, 122

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Union Dr. Ditch	IL_BPJM-01	0512010903	29	3	7.35	X582, X583, X585, X586, X590	N/A	N/A
Unnamed trib to Mud Cr.	IL_FLIDE-01	0712000206	10	5	15.5	N582, X583, N585, X586, F590	322, 371, 400	156, 140
Unnamed trib. to Sugar Creek.	IL_FLIE-01	0712000207	10	4A	14.04	N582, X583, N585, X586, X590	84, 400	157, 140
unnamed tributary (Bray Cr.)	IL_DKZD-01	0713000401	14	2	9.55	F582, X583, X585, X586, F590	N/A	N/A
unnamed tributary (Frog Alley)	IL_DKZE-01	0713000401	14	2	6.72	F582, X583, X585, X586, F590	N/A	N/A
Unnamed Tributary To Kishwaukee	IL_PQZB	0709000608	5	5	2.52	N582, X583, X585, X586, N590	521	124
Upper Salt Fork	IL_BPJG-01	0512010903	29	5	24.05	N582, X583, X585, X586, X590	84, 462	20, 85
UT Indian Creek	IL_DSPAA-01	0713000202	12	5	8.3	N582, X583, X585, X586, X590	322	155
UT to N. Fk. Vermillion R.	IL_DSQZA	0713000201	12	5	3.61	N582, X583, X585, X586, X590	123, 322	140
Valley Run	IL_DWBB	0712000501	11	2	12.99	F582, X583, X585, X586, X590	N/A	N/A
Vandalia Ditch	IL_ONE	0714020203	24	3	11.68	X582, X583, X585, X586, X590	N/A	N/A
Vanwinkle Branch	IL_DBLB	0713001106	18	3	2.26	X582, X583, X585, X586, X590	N/A	N/A
Vermilion Cr.	IL_DRC	0713000103	11	3	14.7	X582, X583, X585, X586, X590	N/A	N/A
Vermilion Cr.	IL_OJH	0714020208	24	3	7.68	X582, X583, X585, X586, X590	N/A	N/A
Vermilion R.	IL_BP-01	0512010909	29	5	4.98	F582, N583, N585, X586, X590	274, 400	10, 140
Vermilion R.	IL_BP-03	0512010909	29	2	6.97	F582, X583, X585, X586, X590	N/A	N/A
Vermilion R.	IL_BP-04	0512010909	29	5	5.79	F582, N583, X585, X586, X590	274	10, 140
Vermilion R.	IL_DS-06	0713000203	12	5	14.11	F582, N583, N584, N585, X586, F590	274, 452, 400	10, 140
Vermilion R.	IL_DS-07	0713000209	12	5	26.38	F582, N583, N585, X586, F590	274, 400	10, 140
Vermilion R.	IL_DS-10	0713000208	12	5	16.09	F582, X583, N584, X585, X586, F590	452	140
Vermilion R.	IL_DS-14	0713000206	12	5	18.29	F582, X583, N584, X585, X586, F590	452	N/A
Village Cr.	IL_CE-01	0512011408	31	5	14.53	N582, X583, X585, X586, X590	84, 273, 319, 403, 500, 501	125, 140, 155, 20, 144, 72
Voel Cr.	IL_DGRA	0713001002	17	3	9.13	X582, X583, X585, X586, X590	N/A	N/A
W. Br. Big Rock Cr.	IL_DTCC	0712000703	4	3	13.64	X582, X583, X585, X586, X590	N/A	N/A
W. Br. Copperas Cr.	IL_DZHA	0713000304	13	3	14.33	X582, X583, X585, X586, X590	N/A	N/A
W. Br. Drummer Cr.	IL_EYA	0713000601	21	3	10.15	X582, X583, X585, X586, X590	N/A	N/A
W. Br. DuPage R.	IL_GBK-02	0712000408	2	5	9.43	N582, N583, X585, X586, F590	96, 277, 319, 371, 462, 274	28, 58, 142, 177, 85, 140
W. Br. DuPage R.	IL_GBK-05	0712000408	2	5	10.51	N582, X583, N585, X586, X590	84, 319, 371, 403, 462, 400	20, 58, 122, 142, 177, 85, 140
W. Br. DuPage R.	IL_GBK-09	0712000408	2	5	11.85	N582, X583, N585, X586, X590	138, 371, 462, 400	85, 177, 122
W. Br. DuPage River	IL_GBK-14	0712000408	2	5	3.83	N582, X583, N585, X586, X590	84, 138, 322, 441, 500, 400	20, 84, 177

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
W. Br. Honey Cr.	IL_BECA	0512011212	30	3	3.67	X582, X583, X585, X586, X590	N/A	N/A
W. Br. Horse Cr.	IL_EOCC	0713000706	20	3	13.22	X582, X583, X585, X586, X590	N/A	N/A
W. Br. Horse Cr.	IL_FCB-01	0712000116	10	3	19.54	X582, X583, X585, X586, X590	N/A	N/A
W. Br. Hurricane Cr.	IL_BELB	0512011208	30	3	7.81	X582, X583, X585, X586, X590	N/A	N/A
W. Br. Indian Cr.	IL_DJLA	0713000503	15	3	4.5	X582, X583, X585, X586, X590	N/A	N/A
W. Br. Lamarsh Cr.	IL_DZIA	0713000303	13	2	12.76	F582, X583, X585, X586, X590	N/A	N/A
W. Br. Panther Cr.	IL_DKKB-01	0713000404	14	2	15.57	F582, X583, X585, X586, F590	N/A	N/A
W. Br. Piscasaw Cr.	IL_PQEB	0709000603	5	3	6.13	X582, X583, X585, X586, X590	N/A	N/A
W. Br. Sugar Cr.	IL_DHG	0713000309	13	2	10.54	F582, X583, X585, X586, X590	N/A	N/A
W. Bureau Cr.	IL_DQD-01	0713000104	11	5	23.67	F582, X583, N585, X586, F590	400	140
W. Donica Cr.	IL_BEPF	0512011204	30	3	5.74	X582, X583, X585, X586, X590	N/A	N/A
W. Fk Mazon R.	IL_DVE-03	0712000503	11	2	33.47	F582, X583, X585, X586, F590	N/A	N/A
W. Fk. Apple R.	IL_MNK	0706000505	9	3	8.98	X582, X583, X585, X586, X590	N/A	N/A
W. Fk. Bear Cr.	IL_KIL	0711000105	19	3	10.73	X582, X583, X585, X586, X590	N/A	N/A
W. Fk. Cahokia Cr.	IL_JQF	0714010102	27	3	12.69	X582, X583, X585, X586, X590	N/A	N/A
W. Fk. Elkhorn Cr.	IL_PHJ	0709000507	6	3	6.08	X582, X583, X585, X586, X590	N/A	N/A
W. Fk. Kickapoo Cr.	IL_DLF-01	0713000302	13	2	23.99	F582, X583, X585, X586, X590	N/A	N/A
W. Fk. N. Br. Chic. R.	IL_HCCB-05	0712000301	1	5	14.47	N582, X583, N585, X586, X590	79, 84, 138, 177, 213, 246, 322, 403, 462, 500, 400	28, 20, 72, 122, 49, 85, 177, 140
W. Fk. Richland Cr.	IL_OCC-98	0714020406	25	2	18.29	F582, X583, X585, X586, X590	N/A	N/A
W. Fk. Salt Cr.	IL_EIJA	0713000902	22	3	10.08	X582, X583, X585, X586, X590	N/A	N/A
W. Fk. Shoal Cr.	IL_OIM	0714020301	24	3	11.32	X582, X583, X585, X586, X590	N/A	N/A
W. Fk. Shoal Cr.	IL_OIM-02	0714020301	24	2	10.57	F582, X583, X585, X586, X590	N/A	N/A
W. Fk. Spoon R.	IL_DJO-01	0713000501	15	5	22.48	N582, X583, X585, X586, F590	138, 371	85, 144, 156
W. Fk. Sugar Cr.	IL_EIDB-01	0713000906	22	2	31.13	F582, X583, X585, X586, X590	N/A	N/A
W. FK. Wood R.	IL_JRB	0711000903	27	5	16.36	N582, X583, X585, X586, F590	371, 501	20, 45, 144, 156, 177
W. Mineral Cr.	IL_PBDA	0709000706	8	3	8.1	X582, X583, X585, X586, X590	N/A	N/A
W. Okaw Ditch 3	IL_OTG	0714020106	23	3	10.49	X582, X583, X585, X586, X590	N/A	N/A
W. Okaw Ditch 4	IL_OTH	0714020106	23	3	7.41	X582, X583, X585, X586, X590	N/A	N/A
W. Okaw R.	IL_OT-02	0714020106	23	5	5.39	F582, X583, N585, X586, X590	400	140
W. Okaw R.	IL_OT-03	0714020106	23	2	13.78	F582, X583, X585, X586, X590	N/A	N/A
W. Okaw R.	IL_OT-04	0714020106	23	5	5.07	N582, X583, X585, X586, X590	322, 441, 462	140, 144
W. Okaw R. Trib.	IL_OTI	0714020106	23	3	14.32	X582, X583, X585, X586, X590	N/A	N/A
W. Side Diversion Ditch	IL_CZZJ	0512011408	31	3	7.94	X582, X583, X585, X586, X590	N/A	N/A
W.Crooked Cr.	IL_BEGB	0512011209	30	3	14.05	X582, X583, X585, X586, X590	N/A	N/A
Wabash Levee Ditch	IL_BZE	0512011308	31	3	7.06	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Wabash R (old chan)	IL_B-OLDWAB-01	0512011308	31	3	7.61	X582, X583, X585, X586, X590	N/A	N/A
Wabash R.	IL_B-01	0512011306	31	5	56.59	X582, N583, X585, X586, X590	274, 348	10, 140
Wabash R.	IL_B-03	0512011309	31	5	55.74	F582, N583, X585, X586, X590	274, 348	10, 140
Wabash R.	IL_B-06	0512011119	30	5	78.08	F582, N583, N585, X586, X590	274, 348, 400	10, 140
Waddams Cr.	IL_PWQ-04	0709000312	7	2	10.23	F582, X583, X585, X586, X590	N/A	N/A
Waggoner Cr.	IL_LZT	0708010418	16	3	7.89	X582, X583, X585, X586, X590	N/A	N/A
Wagon Cr.	IL_ATHL	0514020401	32	3	3.37	X582, X583, X585, X586, X590	N/A	N/A
Walker Branch	IL_DEN	0713001102	18	3	5.63	X582, X583, X585, X586, X590	N/A	N/A
Walker Cr.	IL_PBJD	0709000703	8	3	9.05	X582, X583, X585, X586, X590	N/A	N/A
Walkers Cr.	IL_NCC-01	0714010610	26	4A	7.15	N582, X583, X585, X586, X590	84, 273	20, 125, 82, 127
Wall Town Ditch	IL_BPKS-01	0512010901	29	3	19.65	X582, X583, X585, X586, X590	N/A	N/A
Wallace Branch	IL_AM	0514020305	32	3	4.03	X582, X583, X585, X586, X590	N/A	N/A
Walley Run	IL_DWC	0712000501	11	3	6.33	X582, X583, X585, X586, X590	N/A	N/A
Walnut Cr.	IL_DJK	0713000504	15	3	15.02	X582, X583, X585, X586, X590	N/A	N/A
Walnut Cr.	IL_DJK-02	0713000504	15	2	21.36	F582, X583, X585, X586, F590	N/A	N/A
Walnut Cr.	IL_DKJ-01	0713000406	14	2	25.2	F582, X583, X585, X586, F590	N/A	N/A
Walnut Cr.	IL_DLFC	0713000302	13	2	10.44	F582, X583, X585, X586, X590	N/A	N/A
Walnut Cr.	IL_DZZJ	0713001108	18	2	22.37	F582, X583, X585, X586, X590	N/A	N/A
Walnut Cr.	IL_OND	0714020203	24	3	3.98	X582, X583, X585, X586, X590	N/A	N/A
Walnut Cr.	IL_PBQ-01	0709000702	8	3	12.57	X582, X583, X585, X586, X590	N/A	N/A
Walnut Fork	IL_DEM	0713001102	18	2	14.51	F582, X583, X585, X586, X590	N/A	N/A
Walnut Special Ditch	IL_PBP-01	0709000702	8	5	4.39	N582, X583, X585, X586, F590	79, 84, 319, 500	28, 20, 38, 72, 58
Walser Cr.	IL_BCC	0512011304	31	3	7.25	X582, X583, X585, X586, X590	N/A	N/A
Walters Cr.	IL_OCBE	0714020406	25	3	6.73	X582, X583, X585, X586, X590	N/A	N/A
Walton Cr.	IL_CAJA	0512011503	31	3	6.38	X582, X583, X585, X586, X590	N/A	N/A
Warren Branch	IL_OKG	0714020205	24	3	5.04	X582, X583, X585, X586, X590	N/A	N/A
Warsaw Run	IL_DLD	0713000302	13	3	6.45	X582, X583, X585, X586, X590	N/A	N/A
Wash Branch	IL_CAJB	0512011503	31	3	6.15	X582, X583, X585, X586, X590	N/A	N/A
Waterloo Cr.	IL_JHE-C1	0714010107	27	5	1.79	N582, X583, X585, X586, X590	322, 371, 462	85, 177
Waterloo Cr.	IL_JHE-C2	0714010107	27	2	0.87	F582, X583, X585, X586, X590	N/A	N/A
Waterloo Cr.	IL_JHE-C3	0714010107	27	2	0.25	F582, X583, X585, X586, X590	N/A	N/A
Watson Cr.	IL_CAZHA	0512011505	31	3	6.07	X582, X583, X585, X586, X590	N/A	N/A
Watson Cr.	IL_OPAB	0714020201	24	3	3.86	X582, X583, X585, X586, X590	N/A	N/A
Waubansee Cr.	IL_DTE-01	0712000701	4	3	10.72	X582, X583, X585, X586, X590	N/A	N/A
Waukegan R.	IL_QC-03	0404000201	1	5	4.01	N582, X583, X585, X586, X590	79, 177, 246, 348	28
Waukegan R.	IL_QC-05	0404000201	1	5	0.54	N582, X583, X585, X586, X590	177, 348	28
Waupecan Cr.	IL_DZX	0712000507	11	2	29.39	F582, X583, X585, X586, F590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Weather Cr.	IL_CJE	0512011405	31	3	9.61	X582, X583, X585, X586, X590	N/A	N/A
Weaver Branch	IL_LZD	0708010416	16	3	5.55	X582, X583, X585, X586, X590	N/A	N/A
Weaver Cr.	IL_AEA	0514020602	33	5	5.78	N582, X583, X585, X586, F590	84, 322	144, 156
Weaver Cr.	IL_OGA	0714020402	25	3	7.09	X582, X583, X585, X586, X590	N/A	N/A
Webbs Hill Branch	IL_NHL	0714010604	26	3	5.67	X582, X583, X585, X586, X590	N/A	N/A
Webster Branch	IL_BEJB	0512011207	30	3	5.59	X582, X583, X585, X586, X590	N/A	N/A
Webster Cr.	IL_OJCC	0714020208	24	3	9.38	X582, X583, X585, X586, X590	N/A	N/A
Welch Cr.	IL_DTCB	0712000703	4	3	17.57	X582, X583, X585, X586, X590	N/A	N/A
Welge Cr.	IL_IICD-01	0714010502	28	5	9.1	N582, X583, X585, X586, X590	84, 463	20, 72, 125
Wells Fork	IL_DEHB	0713001102	18	3	7.36	X582, X583, X585, X586, X590	N/A	N/A
Welsh Hollow Creek	IL_MNF-01	0706000505	9	2	7.32	F582, X583, X585, X586, X590	N/A	N/A
Wendell Branch	IL_ODM	0714020405	25	2	10.01	F582, X583, X585, X586, X590	N/A	N/A
West Aux Sable Cr.	IL_DWE	0712000501	11	2	14.76	F582, X583, X585, X586, X590	N/A	N/A
West Br. Lake Fk.	IL_OWC	0714020101	23	3	9.12	X582, X583, X585, X586, X590	N/A	N/A
West Br. Sandy Cr.	IL_IXDB	0714010802	33	5	4.64	N582, X583, X585, X586, F590	84, 127, 322, 441	72, 143, 144, 156
West Branch	IL_CT-01	0512011401	31	2	11.6	F582, X583, X585, X586, X590	N/A	N/A
West Cr.	IL_DGB-01	0713001012	17	3	12.59	X582, X583, X585, X586, X590	N/A	N/A
West Cr.	IL_NLB	0714010602	26	3	4.57	X582, X583, X585, X586, X590	N/A	N/A
West Fk, Big Creek	IL_BJB	0512011108	30	3	16.36	X582, X583, X585, X586, X590	N/A	N/A
West Fork	IL_OV-01	0714020104	23	3	11.59	X582, X583, X585, X586, X590	N/A	N/A
West Fork Wetweather Cr	IL_CJDB	0512011405	31	3	8.87	X582, X583, X585, X586, X590	N/A	N/A
West Little Sugar Cr.	IL_BME	0512011105	30	3	3.73	X582, X583, X585, X586, X590	N/A	N/A
West Panther Cr.	IL_KCL	0711000410	19	3	4.71	X582, X583, X585, X586, X590	N/A	N/A
West Point Cr.	IL_KZF	0711000411	19	3	3.44	X582, X583, X585, X586, X590	N/A	N/A
West Village Cr.	IL_CEA	0512011408	31	3	7.44	X582, X583, X585, X586, X590	N/A	N/A
Wet Weather Cr.	IL_CJD	0512011405	31	3	6.47	X582, X583, X585, X586, X590	N/A	N/A
Wheeler Cr.	IL_ATFH-01	0514020404	32	4C	11.73	N582, X583, X585, X586, X590	84, 500, 501	20, 72, 125
Wheeling Ditch	IL_GS-01	0712000405	2	3	1.5	X582, X583, X585, X586, X590	N/A	N/A
Whetstone Cr.	IL_BEZV	0512011208	30	3	8.58	X582, X583, X585, X586, X590	N/A	N/A
Whippoorwill Branch	IL_BPB	0512010909	29	2	3.68	F582, X583, X585, X586, X590	N/A	N/A
Whisky Cr.	IL_FLIDAA	0712000206	10	4A	16.48	F582, X583, N585, X586, X590	400	140
Whitaker Cr.	IL_DBD	0713001107	18	3	13.31	X582, X583, X585, X586, X590	N/A	N/A
White Branch	IL_BPD	0512010909	29	3	3.06	X582, X583, X585, X586, X590	N/A	N/A
White Feather Cr.	IL_CANBB	0512011501	31	3	3.17	X582, X583, X585, X586, X590	N/A	N/A
White Oak Branch	IL_CAWC	0512011502	31	3	3.26	X582, X583, X585, X586, X590	N/A	N/A
White Oak Cr.	IL_ATHI	0514020401	32	3	3.52	X582, X583, X585, X586, X590	N/A	N/A
White Oak Cr.	IL_NEF	0714010606	26	3	7.63	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
White Oak Slough	IL_CZJ	0512011409	31	3	7.19	X582, X583, X585, X586, X590	N/A	N/A
White Walnut Cr.	IL_NCH	0714010610	26	3	9.96	X582, X583, X585, X586, X590	N/A	N/A
Whiteash Br.	IL_NGAB-JC-D2	0714010605	26	3	2.04	X582, X583, X585, X586, X590	N/A	N/A
Whiteoak Cr.	IL_KIC	0711000105	19	3	10.88	X582, X583, X585, X586, X590	N/A	N/A
Whites Cr.	IL_DTP-01	0712000701	4	3	1.52	X582, X583, X585, X586, X590	N/A	N/A
Whiteside Branch	IL_AJGA	0514020308	32	3	3.45	X582, X583, X585, X586, X590	N/A	N/A
Whitley Cr.	IL_OZZS-01	0714020105	23	2	14.35	F582, X583, X585, X586, X590	N/A	N/A
Wickham Cr.	IL_PWJ	0709000314	7	3	6.76	X582, X583, X585, X586, X590	N/A	N/A
Wildcat Cr.	IL_DGQA	0713001002	17	3	4.12	X582, X583, X585, X586, X590	N/A	N/A
Wildcat Cr.	IL_DZHD	0713000304	13	3	4.09	X582, X583, X585, X586, X590	N/A	N/A
Wildcat Cr.	IL_EZS	0713000604	21	5	6.22	N582, X583, X585, X586, X590	463	140
Wildcat Cr.	IL_LEB	0708010405	16	3	6.46	X582, X583, X585, X586, X590	N/A	N/A
Wildcat Ditch	IL_OM	0714020206	24	3	3.54	X582, X583, X585, X586, X590	N/A	N/A
Wildcat Slough	IL_EZZF	0713000602	21	3	14.42	X582, X583, X585, X586, X590	N/A	N/A
Wiley Cr.	IL_FG	0712000118	10	3	5.07	X582, X583, X585, X586, X590	N/A	N/A
William Cr.	IL_NCEA	0714010610	26	3	4.21	X582, X583, X585, X586, X590	N/A	N/A
Williams Cr.	IL_DGHA-01	0713001008	17	2	19.49	F582, X583, X585, X586, X590	N/A	N/A
Williams Cr.	IL_OGB	0714020402	25	3	12.28	X582, X583, X585, X586, X590	N/A	N/A
Willis Branch	IL_BEFI	0512011210	30	3	4.82	X582, X583, X585, X586, X590	N/A	N/A
Willow Br. West	IL_EZL	0713000804	20	3	3.53	X582, X583, X585, X586, X590	N/A	N/A
Willow Branch	IL_CDFBA	0512011407	31	3	6.64	X582, X583, X585, X586, X590	N/A	N/A
Willow Branch	IL_DDA	0713001104	18	3	8.93	X582, X583, X585, X586, X590	N/A	N/A
Willow Branch	IL_EOHF	0713000701	20	3	11.31	X582, X583, X585, X586, X590	N/A	N/A
Willow Branch	IL_OLA	0714020204	24	3	7.6	X582, X583, X585, X586, X590	N/A	N/A
Willow Branch East	IL_EZR	0713000604	21	3	8.66	X582, X583, X585, X586, X590	N/A	N/A
Willow Cr.	IL_BEFA-02	0512011210	30	2	30.07	F582, X583, X585, X586, X590	N/A	N/A
Willow Cr.	IL_BNDA	0512011102	30	3	6.81	X582, X583, X585, X586, X590	N/A	N/A
Willow Cr.	IL_DGZH	0713001010	17	3	7.86	X582, X583, X585, X586, X590	N/A	N/A
Willow Cr.	IL_DKGA	0713000407	14	3	4.02	X582, X583, X585, X586, X590	N/A	N/A
Willow Cr.	IL_DZE	0713001103	18	3	10.75	X582, X583, X585, X586, X590	N/A	N/A
Willow Cr.	IL_GO-01	0712000405	2	5	8.22	N582, X583, X585, X586, X590	84, 462, 501	20, 72, 84, 85
Willow Cr.	IL_OJAC	0714020207	24	3	7.17	X582, X583, X585, X586, X590	N/A	N/A
Willow Cr.	IL_PBU-10	0709000701	8	2	17.92	F582, X583, X585, X586, X590	N/A	N/A
Willow Cr.	IL_PZZI	0709000501	6	3	11.3	X582, X583, X585, X586, X590	N/A	N/A
Willow Pond Cr.	IL_KCM	0711000405	19	3	3	X582, X583, X585, X586, X590	N/A	N/A
Wills Cr.	IL_OKCA	0714020205	24	3	3.85	X582, X583, X585, X586, X590	N/A	N/A
Wilson Cr.	IL_CAA	0512011505	31	3	4.74	X582, X583, X585, X586, X590	N/A	N/A

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Wilson Cr.	IL_DZF	0713000310	13	3	10.59	X582, X583, X585, X586, X590	N/A	N/A
Windfall Cr.	IL_BPKB	0512010905	29	3	6.22	X582, X583, X585, X586, X590	N/A	N/A
Wines Branch	IL_DAZD	0713001206	18	2	8.33	F582, X583, X585, X586, X590	N/A	N/A
Winfield Creek	IL_GBKF-01	0712000408	2	5	6.89	N582, X583, X585, X586, X590	84, 322	20, 72, 142, 177
Winnebago Ditch	IL_PBS-01	0709000702	8	2	4.81	F582, X583, X585, X586, F590	N/A	N/A
Winneshiek Cr.	IL_PWL-01	0709000314	7	5	10.15	N582, X583, X585, X586, X590	371, 403, 462, 463	85
Winters Cr.	IL_LFA	0708010404	16	3	9.18	X582, X583, X585, X586, X590	N/A	N/A
Wolf Branch	IL_DAGDD	0713001202	18	3	3.61	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr	IL_GBI	0712000408	2	3	6.34	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_ATGK	0514020402	32	3	7.75	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_BEZI	0512011212	30	3	1.97	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_CAFA	0512011505	31	3	4.61	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_CJEA	0512011405	31	3	8.45	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_DKO-01	0713000405	14	3	6.18	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_DSL-01	0713000206	12	2	19.11	F582, X583, X585, X586, F590	N/A	N/A
Wolf Cr.	IL_DZZSB	0713000117	11	3	4.03	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_EN-01	0713000801	20	3	15.57	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_IXDA	0714010802	33	5	4.67	N582, X583, X585, X586, F590	322	156
Wolf Cr.	IL_LCE	0708010413	16	3	7.34	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_MNB	0706000506	9	3	6.64	X582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_MNIC	0706000505	9	5	7.74	N582, X583, X585, X586, F590	462, 463	85
Wolf Cr.	IL_NDJ	0714010608	26	2	13.98	F582, X583, X585, X586, X590	N/A	N/A
Wolf Cr.	IL_OPC-01	0714020201	24	2	24.97	F582, X583, X585, X586, X590	N/A	N/A
Wolf Cr. North	IL_BEZM	0512011208	30	3	5.13	X582, X583, X585, X586, X590	N/A	N/A
Wolf Run	IL_DBF	0713001107	18	3	10.35	X582, X583, X585, X586, X590	N/A	N/A
Wolf Run	IL_DZDA	0713001103	18	3	8.35	X582, X583, X585, X586, X590	N/A	N/A
Wood R.	IL_JR-02	0711000903	27	5	2.53	N582, X583, N585, X586, F590	84, 403, 500, 501, 400	20, 49, 72, 177
Woods Cr.	IL_DBP	0713001106	18	3	12.69	X582, X583, X585, X586, X590	N/A	N/A
Woods Run	IL_DVEBA	0712000503	11	3	9.75	X582, X583, X585, X586, X590	N/A	N/A
Woodville Branch	IL_KIFAA	0711000104	19	3	7.67	X582, X583, X585, X586, X590	N/A	N/A
Worthen Bayou	IL_NZH	0714010612	26	3	7.09	X582, X583, X585, X586, X590	N/A	N/A
Yankee Branch	IL_BOB	0512010811	29	2	6.84	F582, X583, X585, X586, X590	N/A	N/A
Yankee Branch	IL_MWDB	0708010107	9	3	4.1	X582, X583, X585, X586, X590	N/A	N/A
Yankee Cr.	IL_OIH	0714020304	24	3	6.29	X582, X583, X585, X586, X590	N/A	N/A
Yellow Cr.	IL_PWN-01	0709000313	7	5	4.19	F582, X583, N585, X586, X590	400	140
Yellow Cr.	IL_PWN-02	0709000313	7	2	30.63	F582, X583, X585, X586, X590	N/A	N/A
Yellow Cr.	IL_PWN-03	0709000313	7	4C	17.1	N582, X583, X585, X586, X590	319	142

Appendix B-2. Specific Assessment Information for Streams, 2012.

Name	Assessment Unit ID	10-Digit HUC	IEPA Basin	Cat.	Size (miles)	Use Attainment	Causes	Sources
Youngs Cr.	IL_NCCA	0714010610	26	3	3.88	X582, X583, X585, X586, X590	N/A	N/A
Zuma Cr.	IL_PZD	0709000511	6	3	13.43	X582, X583, X585, X586, X590	N/A	N/A