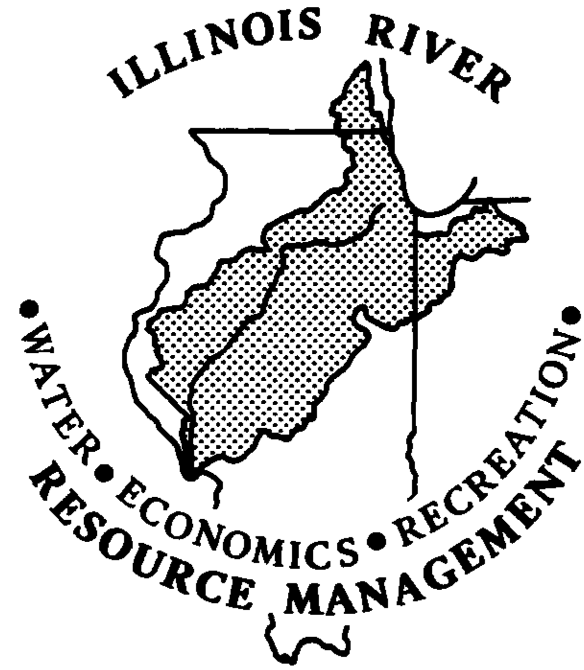
PROCEEDINGS

MANAGEMENT OF THE ILLINOIS RIVER SYSTEM: THE 1990'S AND BEYOND



A Governor's Conference
April 1-3, 1987
at Peoria, Illinois
for Citizens, Organizations,
Industry, and Government
Representatives and
Resources Management
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Approximately 200 people registered for the Governor's Illinois River Management Conference on April 1-3, 1987. Participants included conservationists, resource managers, elected officials, private citizens, university personnel and representatives of state agencies. The format of the conference was designed to allow considerable input from individuals attending the meeting. After presentations of papers, group discussions were held in order to obtain suggestions for solutions to the economic and environmental issues in the Illinois River basin. Each discussion group was directed by a discussion leader, and a recorder kept records of discussions. These were summarized and presented to those in attendance at the close of the conference.

Participants were asked to focus on four different areas. These were: 1) problems dealing with management of the Illinois River, 2) prioritization of those problems with an indication of whether the problems were local or statewide, 3) which problems needed immediate action, and 4) identification of ways to solve these problems.

A large number of issues facing the management of the Illinois River system were discussed. From the outset, participants agreed that the river basin should be examined as a system. Most of the problems uppermost on the mind of participants included significant problems with soil erosion and siltation. All groups recognized that soil erosion and siltation from land use practices threatened the Illinois River, its backwater lakes and associated biota. Additionally, flooding brought on by increased siltation and subsequent loss of storage in the stream and backwater lakes was thought by many to be a problem and a number of participants indicated that there was a great lack of public awareness concerning the impact of siltation of the Illinois River. Some were also concerned about the diversion of water from Lake Michigan and the effect that increased flow would have on downstream flooding and destruction of forested areas along the river. In addition, participants discussed a number of other secondary problems. Some of the more prominent secondary problems were: 1) the lack of a comprehensive management plan for the Illinois River system, 2) the lack of coordination among local, state, and federal agencies, 3) the loss of wetlands and wildlife habitat along the river, 4) the lack of a central organization to deal with the entire Illinois river watershed, and 5) a general feeling of apathy about the Illinois river basin from state officials and the general public. There were also a number of other secondary problems and these are listed in the attached detailed list.

Insofar as which of the problems discussed by participants needed immediate action, there was almost unanimous agreement that the problems were of such magnitude that all major ones should be attacked simultaneously. Many groups felt that the system had deteriorated to such a state that it would be impossible to focus on only one problem at a time. To effect action, it was suggested that: 1) a State of Illinois program to oversee the entire Illinois river watershed be formed, 2) long-term changes in agricultural practices receive attention, and 3) focus media attention on the history, economic importance, and recreational uses of the river. The problems we face are similar to problems in other large river systems. In Illinois, however, a large population base, coupled with extensive row crop farming has exacerbated the problem. Consequently, siltation in the Illinois River has become exceedingly evident in recent years.

Clearly, those attending the conference felt the need to have governmental support in attempting to curb siltation problems in the Illinois river basin. Thus, a number of discussion groups suggested the establishment of an Illinois River Basin Task Force or Steering committee composed of representatives of various interest groups and governmental agencies. To this end, a draft of a possible plan has been formulated. It includes the involvement of various state committees, and the formation of new committees with strong input from the Governor. Most groups felt that the Governor's input was vital to the success of any plan to reverse the present trend in the river system.

Participants had little trouble deciding who should pay the bill. They unanimously agreed that all taxpayers and levels of supporting institutions should bear the burden of solving the problems. Others suggested user fees, tax incentives, and taxes on commodities such as food material, etc.

Other areas that need attention included the development of demonstration projects on the river and its tributaries as a means of controlling sedimentation. Secondary suggestions on resolving the problems included: 1) the development of a scenic river road or heritage trail to focus attention on the river, 2) the development of linear river park corridors, 3) the promotion of the French heritage associated with the river, and 4) establishing an Illinois river natural resources committee.

In summary, discussion participants clearly perceived the problems and made a number of important suggestions on how to begin solving some of the problems. The major importance of this conference appears to have been: 1) it focused local and state attention on a system that will need to be managed from now on if we are to retain any semblance of the productive river it once was, and 2) the conference helped to identify those individuals and agencies that have the expertise to help direct the salvaging of a very important natural resource.

The conference served as an important step in focusing media attention on the neglect that the Illinois River basin has received over the last 170 years. While we recognize the magnitude of the problems we face, it is not yet too late to begin a process of rehabilitation of the Illinois River. We should not, however, raise the expectations of the public too high before we have established what we are about and what can effectively be accomplished within a reasonable time frame. If we fail to act now to reverse the trend toward complete degradation of the river, we can expect to have a barge canal instead of a river with multiple uses for our children and grandchildren. We believe this is our last opportunity to face these problems. In twenty years, if appropriate action is not taken, the Illinois River will be little more than a barge canal surrounded by mud flats.

RECOMMENDATIONS

While a number of recommendations were discussed at the meeting, we recommend the following for consideration: 1) the formation of a post-conference advocacy committee to set goals, objectives, determine a time frame for action, and attempt to estimate costs. This committee would also maintain contact with regional planning commissions and with those legislators that were present at the conference and offer suggestions for legislative action through them, 2) interact closely with state and federal agencies that deal with the management of the Illinois River Systems and its environmental condition, e.g. Illinois Environmental Protection Agency, Department of Energy and Natural Resources, Department of Conservation, Department of Agriculture, Department of Transportation, Corps of Engineers, U.S. Geological Survey, etc. 3) organize an annual event to exchange information on solving problems, but choosing the site of the meeting at other prominent cities or places along the river, e.g. Joliet, Starved Rock, Havana, Beardstown, Pere Marquette State Park, etc., and 4) continue to focus media attention on the Illinois River system.

AFTERNOON SESSION ON APRIL 1, 1987 -- PERE MARQUETTE BALLROOM

OPENING COMMENTS

Glenn E. Stout
Director
Water Resources Center
University of Illinois, Champaign, Illinois

It is my pleasure to welcome this diverse group of people interested in the water resources in Illinois, at the first of probably several annual conferences, in order to define the problems involving the future management of the Illinois River System. I mean system because I am referring to the river as well as the watershed, and the people therein. This river is a complex system which has existed for thousands of years. The river is constantly changing through erosion, a natural phenomena which results from variable precipitation conditions. During the last one hundred-fifty years, increased population and intense agricultural practices have enhanced the erosion and sedimentation accumulation in the river channel and backwater lakes. Based upon the multiple interest groups, that is, there are at least fifty or more co-sponsors of this meeting which suggests that there are many groups interested in the future cultural and economic growth of Illinois, as well as maintaining a satisfactory environment.

The state of Illinois is blessed in that most of this river lies within the boundary of Illinois and its destiny depends upon us, as it has for the last one hundred-fifty years. About one hundred years ago our forefathers initiated the diversion from the Great Lakes into the Illinois River and subsequently into the Mississippi. As a result, Illinois grew because of the commercial aspects of a water connection between the Great Lakes and the Gulf of Mexico. Eleven million or more people live in Illinois because of the Illinois River and its valuable land resource used for agriculture, industry, and other purposes. What are the current problems that require action in the near future and in the long-range?

Planning for the future means many different things. However, it is interesting to note that Michigan, with its great water resources, has intensive efforts to map its future water resources strategy. Likewise, there are major efforts in many states in the midwest and throughout the United States, as well as throughout the world. Many states organized an annual meeting to exchange information, review and evaluate various aspects of water resources planning, development, and management.

During the past year I have had the opportunity of seeing some of the greatest rivers of the world. It is worthy to note that the Illinois River is a part of the largest river system in the world. We are fortunate that the Illinois River is not like the Yangtze River, the Yellow River, the Ganges River or the Nile River in Egypt and Sudan.

The format for our conference during the next two and a half days will be:

A series of state of the art reports will be presented by a number of speakers. The first day will concentrate on the physical aspects of the system, the second day on the natural resources aspects, and the third day on the economic aspects of the importance of this river system.

Following each technical session, we will break up into eleven workshop groups. You will meet the workshop moderator and reporter for your group at noon today. Please sit at a table marked with the same number as on your name tag. Workshop groups will further define the problems, try to establish priorities through a consensus process, and look toward solutions for these problems and issues. For example, is the current management strategy of multiple state agencies involved in various aspects of the river the most appropriate way to manage the system in the future? Currently, based upon the efforts of the Governor's Task Force for state water planning, we have a very amiable group of people working together as a team looking at problems, issues, and developing solutions. On behalf of the agencies, I am safe in saying that it appears to be a satisfactory system. But, is this the appropriate thing for the future?

Governor Thompson will arrive this afternoon at 3:00 pm for a brief presentation to the citizens in Peoria and a boat trip on Lake Peoria.

This conference is the result of several interest groups who collectively felt the need to maintain and possibly restore the economic benefit in an environmentally sound scheme of the total Illinois River Watershed System. The Water Resources Center was able to coordinate the effort. The first meeting of representatives from 34 organizations met on September 12, 1986. Forty-six persons attended this meeting. A planning committee of 22 people met on several occasions to formalize the program. The major portion of the actual program was organized by Harry Hendrickson of ASWCD, Gary Clark of IDOT-WRD, Jim Hart and Bill White of IDOC, and Mike Bowling of DCAA. Local arrangements were coordinated by Jim Miller of the City of Peoria, Don Clem of CILCORP, and Don Meinen of the Tri County Regional Planning Commission. Special credit goes to Bob Frazee from CES who organized the workshop sessions. He joined the program committee late in the planning due to the sudden illness of Robert Walker.

We have all heard about the increasing roles of state in our water management. The current administration has repeatedly reminded the states that they are responsible for the prudent use of their water resources. Today, one of our speakers will be from the federal agencies and she will try to define those areas that should be of interest to our audience today. Likewise, we have a representative from another big state who not only is a professor and teaches water management, but has been deeply involved in water issues in Texas. The Dean of water resources in Illinois, William C. Ackermann, will bring us up to date on the current Illinois situation. However, before proceeding with our three keynote speakers, we will be formally welcomed by Mayor Maloof of Peoria and Betty A. Menold, Chairman of the Peoria County Board.

WELCOME

Betty A. Menold
Peoria County Board Chairman

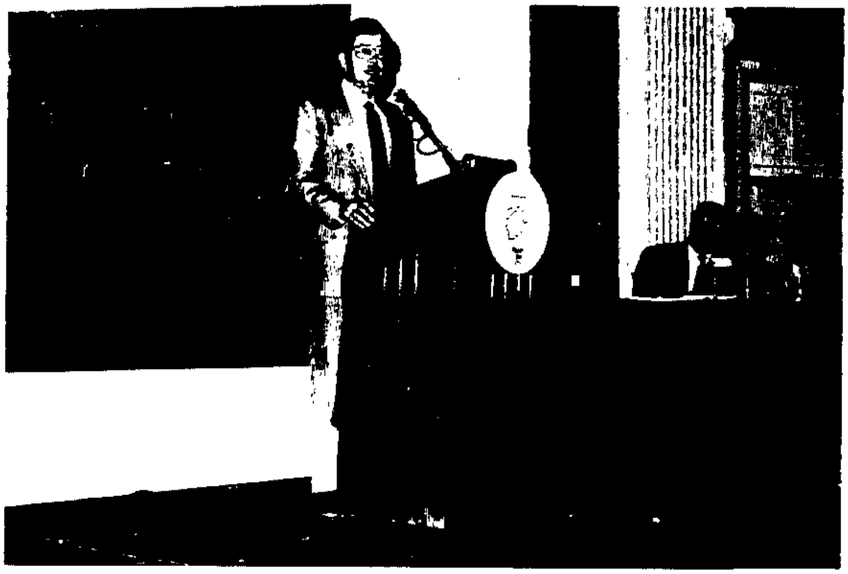
Good morning everyone.

It's my pleasure to welcome all of you to the Governor's Conference. During this conference it is our aim to investigate possible information and proposals for improving the management of our river system. By being here you show a genuine interest to help find solutions to an important problem that not only affects our immediate area, but also the state of Illinois and the Nation. On behalf of Peoria County, I thank you for your honest concern and eagerness to help with these challenges.

I have taken a look at the agenda for the conference and am impressed by the knowledge and insight that the invited speakers have. I am also excited about the kinds of information that is being offered to all of us - information that will help us better understand the problems facing our river system and that also encourages innovative ideas on ways to solve these problems.

One of the most important things that we can do in our search for answers is to make people aware of our sincerity and dedication to the project at hand. This is achieved by working together and showing that our concern is not near-sighted, but stretches far beyond the immediate area. As Peoria County Board Chairman I offer the support of the county in helping to study possible solutions and at working toward these solutions, once they are established.

Again, I welcome all of you and thank you for your participation in a conference that is indeed very important to all of us.



Ernest Smerdon

W. C. Ackermann

Nancy Lopez

Glenn Stout

Mayor Maloof

THE ILLINOIS RIVER INTO THE 1990'S

William C. Ackermann
Emeritus Professor, University of Illinois

I would like you to join me on an imaginary trip this morning. Our destination is the country of Turkey which, you will recall, is on the eastern end of the Mediterranean Sea. Where Turkey projects furthest out into the Sea, there is a little town named Kusadose. Located on the coast, but without a natural harbor, they have constructed a long wooden pier; so that when the waves and wind are not too great, a ship can tie up there.

From the dock we ride a short distance up a hill to a promontory. Up on that elevation is a little cemetery containing the grave of John, one of the disciples. Nearby is the grave of Mary, mother of Jesus.

But if we turn our attention to the westward toward the Sea, we find ourselves at the base of a U-shaped ridge with its open end to the west at the sea, and within this horseshoe-shaped area below us is a flat agricultural area consisting of small farms extending more than a mile.

This area of farms has long ago replaced what was a great harbor some 2000 years ago. It supported a bustling city called Ephesus, to whose citizens Paul wrote one of his letters. Ephesus was a thriving Roman city of some 75,000 people which was there because of the harbor. It had a great ampitheater and running water in its public baths. But most of the running waters in the vicinity were streams which carried a heavy burden of silt from the wheat fields up on the surrounding hills. Eventually the harbor was filled with sediment, and without the shipping, Ephesus gradually ceased to exist. It was replaced by the flat area of subsistence farming that we see today. I would say that the harbor at Ephesus was about the size of Lake Peoria.

I don't know if the Romans ever knew what was happening to them. Perhaps not, at least not until it was too late.

We are in the process of losing a valuable Lake Peoria as well as numerous backwater lakes and an Illinois River. Here, too, there are many people who don't know what is happening. But there is a difference. Our technical people - scientists and engineers - know what is happening. Our political leadership, I believe, also knows what is happening, but they are having trouble with priorities. Priorities are very important, because the silting of Lake Peoria is only one of many problems demanding attention within a limited budget. Their priorities will largely be determined by the strength and persistence of citizen demands.

There was a time - 50 years ago, or even 20 years ago - when our circumstance of a multi-state river basin in trouble with multiple problems might lead to formation of an Illinois Valley Authority similar to the TVA. Such an organization with a big bag of federal money, a lot of state-of-the-art ideas, and energetic staff is not going to happen today. The present administration is trying to sell off the existing TVA, and as we all know, is seeking every opportunity to reduce federal spending.

Recognizing that the Illinois River basin has many problems, and has many governmental and private programs which are addressing them, let me expand on the erosion and resulting sediment situation for a few more minutes. I see this as our central and overriding problem. If we lose that battle, the others won't make any difference.

The Tuesday Letter, as many of you know, is a weekly newsletter of the National Association of Conservation Districts. In the recent, March 3, 1987 issue the Association President Clarence Durban had this to say regarding the budgetary prospects of our soil conservation program:

> "As your National President, I am becoming more concerned each day about the real possibility of losing our federal partners - the Soil Conservation Service - at the district level.
>
> In testimony before the Senate Appropriations Subcommittee on Agriculture last week, Assistant Secretary of Agriculture George Dunlop again promoted the Administration's plan for abandoning federal support of our basic conservation programs.
>
> He told Congress that most farmers have not taken enough responsibility for conservation and implied that those that have, did so because free government services were provided to them. He told the Senators that the federal government cannot afford to fund our programs anymore. He suggested that SCS can solve the nation's conservation problems with less, not more funding.
>
> As a farmer and district official for over 25 years, to me these statements demonstrate just how little some Administration officials know, and perhaps care, about conservation.
>
> Unfortunately, the Administration is so obsessed with reducing the federal deficit that they fail to see the long-term consequences of their actions.
>
> Fellow district officials, I fear for the future of our programs. Someone recently observed that the Administration was using blue smoke and mirrors to solve many of this nation's problems. I suggest to you that they are trying to do the same thing with our conservation problems. Will Congress believe what Mr. Dunlop is telling them? They will, unless you make sure they know the facts."

I think the Congress will restore full or partial funding for the the SCS, but you may be surprised to know how many ways any administration has to delay and frustrate a national program which it doesn't favor.

Taking a look at the soil conservation program from the closer perspective of Illinois, we have both good news and bad news. The good news is that the State is putting substantial additional funds into the activity through the "Build Illinois" program. And we should be proud of that. The bad news is that we are not on target toward meeting our goal of tolerable soil losses by the year 2000. The May 1986 report "Agriculture and the Water Quality Management Plan" is a midcourse review of the soil erosion and sediment control component. Its conclusions state "On review of the effectiveness of the program to achieve its objectivers, current trends indicate we will not be able to meet our goal of T by 2000."

I started out by illustrating a land-use disaster in Turkey. But examples could equally well have been drawn from all the countries which front on the Mediterranean, as well as numerous other countries in Europe and Asia. But there is at least one country which seems to have avoided this problem. It is Switzerland. That country is about the same size and roughly of equal population with the Illinois Basin. It is certainly much steeper, on the average, than our Illinois landscape. Yet there is no visible erosion. In traveling from one end of that country to the other it is green forests and green pastures. The land use is productive as well as protective. Homes have well-tended gardens, but if the country competes in world trade of food it is with Swiss cheese, not field crops. The land use is determined by what will hold the soil, rather than world prices for crops which are destructive of the soil. The Swiss make a living by banking and making watches, including enough to subsidize the farmers for planting perennial grass instead of wheat. Some mix of technological and political/economic means are available to us, too, if we choose.

I certainly want to commend the organizing committee of this meeting on Management of the Illinois River System, in the first place for calling a grass roots meeting to consider the problems and opportunities of the Illinois basin. But I also commend them for the way in which they have organized it. Dr. Ernest Smerdon, the next keynote speaker, is not only an internationally-prominent agricultural and water resources engineer, but he represents Texas which has shown great innovation in organizing itself in the water area. His observations will be valuable to us. Nancy Lopez is one of the rising stars in Washington who has come from the U.S. Geological Survey, and is now in one of the front offices in the U.S. Department of the Interior, with its widespread interest and competence in all aspects of land and water resources. What I am sure will be stimulating talks by these visitors will be followed by sessions on physical aspects, living resources, and economic opportunities.

The resources and opportunities will be described, as will be the problems and various approaches. This 3-day meeting could be the start of something important if you decide that the problems and opportunities are important to your future and to the future of the basin, to Illinois and the midwest, and if you decide to do something about it.

INSTITUTIONAL ISSUES IN RIVER SYSTEM MANAGEMENT

Ernest T. Smerdon
Director
Center for Research in Water Resources

The University of Texas at Austin

INTRODUCTION

It is a distinct pleasure to be in Peoria and on the same program with Bill Ackermann. As far as I am concerned, Bill is "Mr. Water." I question if I can add much to the insights he has shared with you. Nonetheless, I am grateful to Glenn Stout for inviting me to be a part of this important conference.

I must confess that I knew little about the Illinois River and the complexities of its management until I started to prepare these remarks. I read the material that Glenn sent me, and I went to our Center library to see if it might help educate me. I found Special Report No. 6 of the Illinois Water Resources Center dated June 1977. That 212-page report, which dealt with the Illinois River System, was very helpful. It confirmed that the issues to be confronted are very challenging. My remarks focus on the institutional aspects of river system management and some of the things that have been learned from recent activities in Texas.

I note seven agencies, besides representatives of the Governor's Office and the Water Resources Center, were represented on the task force that prepared the 1986 Illinois State Water Plan. Presumably these seven agencies are integrally involved in statewide water-related activities, to say nothing of the many local water districts that will be involved. It is important that these agencies be coordinated in the implementation of any plan for management of the River.

In Texas, we have had grandiose dreams of importing water from outside the state to meet the needs of West Texas with its declining ground water supply. A proposal for transfer of water to West Texas was a part of the Texas Water Plan of the late 1960s. A 1968 referendum on the plan and its financing was narrowly defeated (50.5% opposed, 49.5% for) despite strong support of the Governor and key political leaders. Since then, such a water transfer scheme has had little chance of success because West Texas does not have the population base and necessary political clout to get it done. Also, and this is very important, economic analyses repeatedly show such transfers to be very costly and difficult to justify for irrigation of local cotton and grain sorghum crops.

People realize the federal government will not underwrite such public works projects. Because of these factors, the approach to water management in Texas is undergoing a renaissance.

Today, Texans are looking at ways to improve management of water resources. Little attention is given to getting water from other states. The latest legislative initiative on water focused on other issues and omitted mention of water importation. Water institutions are being scrutinized for ways to improve water management. Moreover, sensitive issues, such as realistically allocating water to the bays and estuaries, even if water is taken from upstream development, are now receiving more attention.

The Texas Legislature in 1985 approved a state-backed loan program for local water projects emphasizing conservation. In the required referendum, 70% supported the proposals. Of 256 counties, ranging from desert areas with less than 10 inches annual rainfall to counties with about 60 inches annually, only 24 opposed the propositions. No vote on a water financing referendum since 1897 received such support, save the water bond issue of 1957 following the most severe drought of record. The water financing provisions of the referendum are summarized in Table 1.

Texans are speaking out on water issues. The message is that better management of water, including environmental protection, is the prudent approach. We must address our own problems before they get worse and not wait for federal programs to help us.

TABLE 1. PROPOSED USE OF BOND FUNDS

BONDING	QUANTITY
Proposition No. 1	
Water supply	$190 million
Water quality	190
Flood control	200
State participation in regional sewer, water and reservoir systems	400
Subtotal	$980 million
Bond insurance	250
Total of proposition no. 1	$1,230 million
Proposition No. 2	
Agricultural soil and water conservation	200
Total of proposition no. 2	$200 million

INSTITUTIONAL ISSUES

The nationwide reexamination of water problems now underway will continue for some time. Some issues are:

(1) more emphasis on management and less on capital projects;

(2) greater attention to social and environmental concerns; and
(3) payment of most costs by local beneficiaries.

These changes will require streamlining of traditional water institutions. Technical problems will require continued attention, but the most difficult questions will concern the water institutions. Texas's experiences regarding institutions may be of interest.

Statewide Water Agencies

Texans prefer to keep power and authority at home, in local units of government. As a result, most of the water management facilities in Texas are operated by local institutions. Texas's approach to state water agencies has undergone numerous changes since the Board of Water Engineers was approved in 1913. (See Figure 1 for a summary of water agencies through the years.) The Board was a data collection agency which cooperated with the USGS and issued surface water permits (surface water usually requires a permit, but ground water does not; it belongs to the owner of the land). After the 1950s drought, the state authorized assistance to local entities for financing projects through a revolving loan fund. The Texas Water Development Board was then created to manage that fund and to be the state water planning agency. At about the same time, pollution became a serious concern and the Texas Water Pollution Advisory Council was established. Three separate water agencies emerged in the early 1960s. One handled water rights and legal questions, another was a planning agency which managed loan funds, and the third was responsible for pollution and water quality.

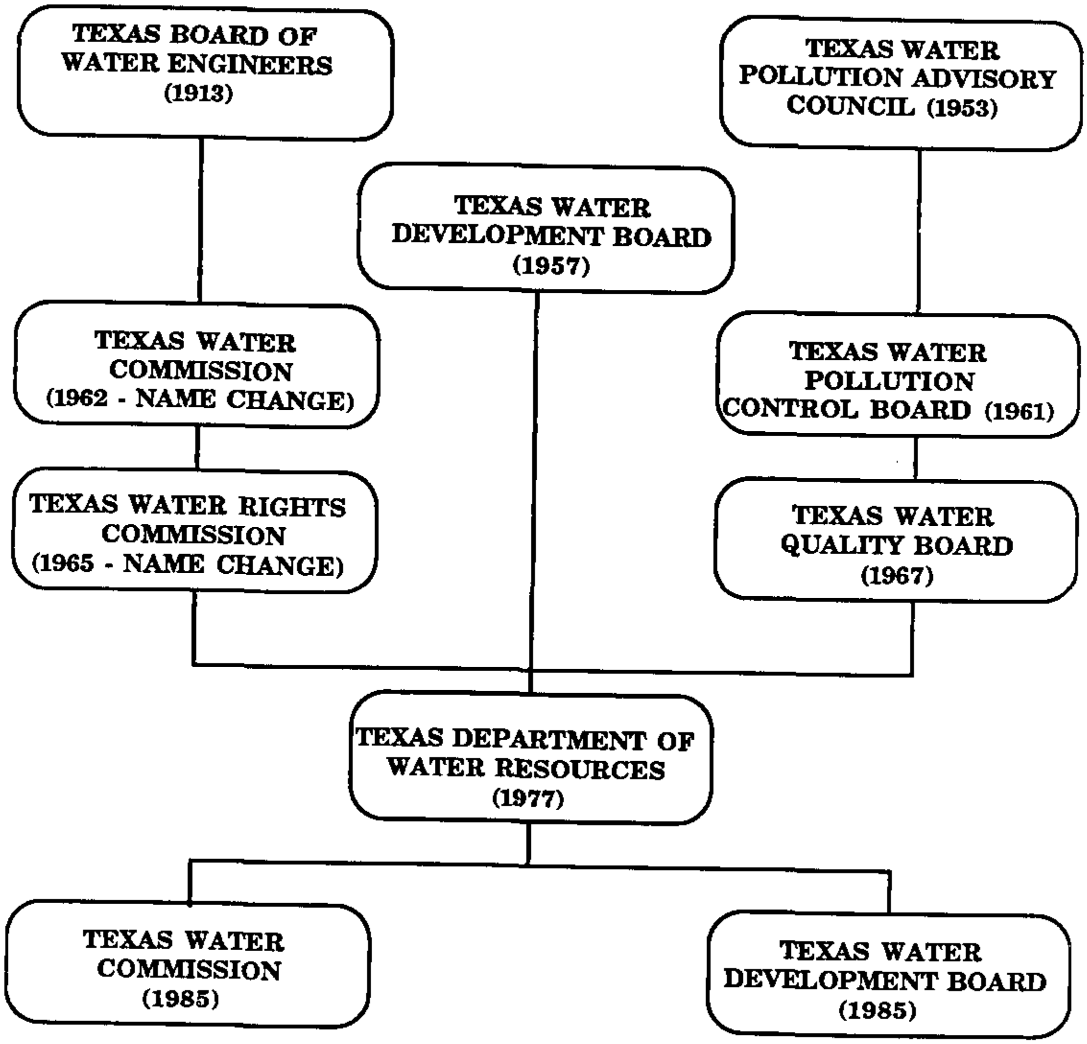
The three agencies existed from 1961 until 1977, when they were combined to form the Texas Department of Water Resources (TDWR). This single water agency continued until 1985 when another reorganization divided it into two agencies--the Texas Water Development Board, responsible for planning and loan fund management, and the Texas Water Commission, responsible for other water activities. None of the state agencies operate water facilities--that is left up to local or regional districts and authorities.

Why so many changes? Some say it has been because of serious legislative concerns regarding the management of the state's water resources. The last change occurred as a result of a routine statutory sunset review of TDWR. Several legislators felt that TDWR had not been sufficiently aggressive in pursuing and correcting serious pollution violations, and the sunset review opened the door to change.

Local and Regional Water Agencies

Historically, local water institutions have been created under general law authorization or by a specific act of the legislature to address problems as they emerged. These entities, whose power and operating authority vary widely, were created on an ad hoc basis to address specific problems, not as a result of a master plan for water management.

FIGURE 1. EVOLUTION OF TEXAS WATER AGENCIES



Source: Texas Water Commission (1986)

Texas now has over 1,200 water districts and authorities ranging from major river authorities to small local special purpose districts, some of which may not be functioning. There are 20 river authorities and several larger municipal water supply districts among these agencies. In several cases, there is more than one river authority or district operating in different segments of the same river basin, as a result providing the seeds for conflict and misunderstanding. It is generally agreed that these local entities have done a good job in carrying out their assigned functions. Nonetheless, there have been recent cases of serious conflict leading to litigation.

Two examples of the conflicts which can occur illustrate the problem. One concerns surface water rights when two entities operate on the same basin and both aspire to develop and market additional supplies. Such a case occurred in the dispute on the proposed Stacy Reservoir between the Lower Colorado River Authority (with jurisdiction on the lower portion of the Colorado River) and the Colorado River Municipal Water District (operating on the upper reaches). Another example is potential dispute between a ground water management district and a river authority with overlapping service areas. The district's functions may include augmenting ground water recharge, and it may want to build structures to facilitate recharge of surface water. The river authority wants to capture that water in its reservoirs. The potential conflict is evident and, too often, costly, time-consuming litigation is the result.

Action in Texas to Improve District-Authority Coordination

The Stacy case was creating political problems, potentially polarizing groups, and resulting in a contentious situation which could destroy the political ground work for the broad state financing program discussed earlier. As a result, the legislature decided that the matter of how Texas water resources were managed and how facilities were operated needed detailed study. The Stacy Reservoir conflict appeared to be the catalyst for this action. As a result in 1985 a Water District and River Authority Study Committee was authorized to determine if the powers of water districts and authorities were too great and if changes in their operations were needed. Members of the study committee were appointed by the Governor, Lieutenant Governor, and Speaker of the House. One issue was whether water organizations in Texas were working together or operating independently. Also of concern was whether conservation was being encouraged and sufficient attention being given to environmental issues. The committee was to report to the legislature before the 70th session in 1987 with its recommendations including needed changes in state law. The LBJ School of Public Affairs at The University of Texas at Austin was contracted to help the committee in its work, a project which I codirected.

THE WATER MANAGEMENT ISSUES

The Water District and River Authority Study Committee worked for more than a year prior to submitting its report to the

70th Texas Legislature in December, 1986. It held numerous hearings throughout the state and received testimony and input from most of the major water districts and river authorities, as well as interested citizens. The seven committee recommendations are summarized as follows:

(1) water conservation is a critical part of the state program and uniform regulations regarding conservation should be adopted;

(2) projects should be implemented at the lowest practical level of government (this reinforces the current Texas approach where local entities operate the water facilities);

(3) all districts and authorities should be subject to uniform rules and regulations by the state;

(4) regional coordinating mechanisms should be established under a state agency to facilitate water resources planning and coordination of programs and projects by local entities [note, many judge this to be a key recommendation of the committee and it relates to recommendation (6) below];

(5) the state should seek authority to impose minimum criteria for regulation of ground water;

(6) a mechanism for continuing oversight of the districts and authorities should be provided (this is judged to be a message that, if coordination does not occur, the state will take firmer action in the future); and

(7) procedures to make districts and authorities accountable to the people of Texas should be established.

When changes in law were deemed necessary, the committee prepared draft bills. The 70th Texas Legislature is in session at the time of this writing, and six bills (S.B. 670 - S.B. 675) have been introduced incorporating all of the committee recommendations. Although the outcome will not be known for some time, it is generally believed that the bills have a good chance to pass.

LESSONS LEARNED

Texas has learned to give more attention to improved management of its existing water supplies. It is apparent that more benefit can accrue from existing water resources than many have thought possible. The state had tended to look at its water resources in isolated parts and not as a system to be managed for maximum benefit.

Texas laws governing ground water and surface water are different, and the state largely manages them independently with separate institutions. River basins are frequently divided in parts and each is managed in isolation. Although this has not created major problems in the past because the limit of the resources in terms of development had not been reached, that approach is no longer adequate.

The challenge facing Texas is to effectively incorporate the many diverse factors in analyses of its water systems. The same problem faces Illinoisans in regard to the Illinois River. There will be differences of opinion and conflicts which must be expeditiously and fairly resolved. Doing this poses a challenge requiring cooperative research among water planners, hydraulic engineers, hydrologists, environmentalists, sociologists, economists, lawyers, and political scientists. It will not be easy, but there is much to be gained.

Great strides have been made the last three decades in improving operations models for physical systems of all types. Large firms routinely use complex systems analysis approaches to increase the efficiency of their business operations and reduce costs. A state-of-the-art review of the approaches applied to water reservoir operations and water management issues was recently published (Yeh 1985). This analysis, citing 224 references, covers everything from linear programming to simulation models and real-time operations. The data suggest that although much has been accomplished, there are still gaps that need attention, particularly in the area of real-time reservoir operations. Three reasons are given for the reluctance of reservoir operators to use optimization models in their day-to-day operations. First, they have not been directly involved in the formulation of the models and are not comfortable with them. Second, published reports often deal with simplified versions and not the real system, and they are sometimes poorly documented. Finally, of considerable importance are the institutional constraints that impede user-researcher interaction.

More recently, another comprehensive review of the use of systems analysis in water management was published (Rogers and Fiering 1986). These writers state,

> It is the authors' experience, supported by a survey of agencies, practitioners, and literature, that there is strong resistance to the use of systems analysis by many government agencies involved in water management both in developed and developing countries.

Water resources problems in the U.S. are becoming more critical, and it is essential that the powerful systems analysis tools be more widely adopted. We must assure that institutional constraints do not impede progress. Coordination of operations among the institutions operating in a basin is essential because system analysis can benefit all parties.

An important question is whether social and environmental objectives can be incorporated into applications of systems analysis. While the procedures are not as simple and straightforward as are the more easily quantifiable factors, they can be considered. Invariably, judgments must be made involving authorities and interested parties (Loucks 1986). Procedures to equitably resolve conflicts are essential.

The potential merit of applying systems analysis methods to Texas problems is illustrated in a preliminary analysis of the water supply for the City of Houston performed by Daniel P. Sheer (Sheer 1986). The possible joint operation of three lakes near the city of Houston, Lake Conroe, Lake Livingston, and Lake Houston, was analyzed. The annual yield of jointly operated surface water reservoirs is 8.3 percent greater than the sum of the independent safe yields. By including the safe average ground water yield in the analysis, the total joint annual yield of surface plus ground water is 18.7 percent greater than the independent safe yields of these sources. These figures are summarized in Table 2. Although the facilities necessary for joint operation do not now exist, the cost of these facilities would be much less than the cost of additional reservoirs. The greatest constraint to achieving the potential increase in water supply may be the several institutions involved.

TABLE 2. SAN JACINTO PROJECT ANALYSIS*

INDEPENDENT SAFE YIELD SUMMARY
Acre-feet per Year

Lake Houston	145,000
Lake Conroe	98,000
Lake Livingston	1,290,000
Surface Subtotal	1,533,000
Groundwater	337,000
Sum of Safe Yields	1,870,000

JOINT YIELD SUMMARY

	Total	Increase	% Increase
Surface Yield (Houston, Conroe, Livingston)	1,660,000	127,000	8.3
Surface plus Groundwater	2,220,000	350,000	18.7
Yield from New Storage	approx. 1,000 ac ft/yr per 4,000 ac ft storage		
Yield from Pumping Brazos	50-75% of pipe size for yields to approximately 200,000 ac ft/yr		

*From work by Dan Sheer

The American Society of Civil Engineers is looking into the problems of application of systems analysis, with special attention to issues which have not had sufficient consideration.

The opening plenary session of the annual conference of the Water Resources Planning and Management Division of ASCE on March 16-18, 1987, was devoted to this topic. Numerous papers dealt with this issue, including one session on incorporating social and environmental objectives in water resources planning and management.

CONSIDERATIONS FOR THE ILLINOIS RIVER SYSTEM

How does this apply to the topic of this conference which is the Illinois River system? The Illinois River is both similar to and different from any Texas river. A difference is that it is a major transportation waterway and a possible means of drainage to presently over-supplied Lake Michigan. It is similar to Texas rivers in that sedimentation and other nonpoint source pollution are a major concern, making land-use policy on the watershed a vital issue. The recreation potential and value for fish and wildlife are matters of serious concern. Also, significant return flow of treated municipal and industrial wastes from the urbanized portions of the basin occurs on the Illinois River as in rivers in Texas.

The Water District and River Authority Study Committee in Texas concluded that highly centralized institutions to manage water resources are not necessarily required. There is value in local control as long as it does not produce bottlenecks to progress and needed decisions. However, close cooperation among the local institutions (which are political entities) is essential because river basins or ground water aquifers do not respect political boundaries. In Texas, that cooperation has not always been adequate, although agencies generally give lip service to it. The awareness is building that the state must exhibit stronger leadership and assure that meaningful cooperation occurs in the future. One plan suggests that additional power over local programs and plans be given to the state agencies, along with establishment of an independent oversight committee, to provide feedback to the legislature. In fact, it is not beyond imagination that the sunset review process might also be used to assure that the major river authorities and districts cooperate.

A question to be asked is whether the institution responsible for the management of water quality and water supply (quantity) should be the same. While there is no single answer to this, our experience is that management of the two cannot be separated. If the same agency does not handle both, the two agencies must closely cooperate. Recent Texas experience when only one state water agency existed (the TDWR) was that the agency found itself concentrating on the supply aspects and not enough on pursuing polluters and correcting the problem. At least that was reportedly the view of the legislature when it divided the TDWR functions into two separate agencies with the clear message being given that pollution must have more attention. Either way will work.

My personal view is that the management of water resources in the decades ahead will involve many considerations, and that it is unlikely that a single agency can be sufficiently comprehensive to cover all aspects of the issue. If so, several agencies at the state level will be involved, each having its own clientele to assure that its interests are given a fair hearing. Numerous local agencies likely will be involved, and, as in Texas, these may be the operators of the water facilities.

It is not necessary or even desirable that there be a single water agency to handle these matters. However, if operations are to be improved and the systems made as efficient as possible, it is essential that meaningful cooperation among the agency actors in the water drama be assured. Texas has learned that lesson, and the current 70th Legislature is considering the data supplied to it by water experts. With modern computers, it is possible to make the operations of large-scale, complex water systems more effective to better serve all. This potential will not be realized without the joint efforts of many parties, with each making compromises as necessary to achieve the larger benefit for all. This is the necessary fine tuning of river system management which will be essential in the decades ahead.

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The Federal Perspective on Water Resources Management

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INTRODUCTION

Citizens of the Illinois River Basin are probably much more familiar with the water resources activities of the U.S. Army Corps of Engineers and the Environmental Protection Agency (EPA) than they are with the U.S. Department of the Interior (DOI). Before discussing Federal Perspectives, I want to report on some recent developments and activities at DOI which I hope will interest you.

A major reorganization of the water resources bureaus of DOI occurred in December 1983. At Christmas time that year, then Secretary William Clark created the Office of the Assistant Secretary for Water and Science. This new Assistant Secretariat brought together in one organizational unit the three major water resources and scientific research bureaus of the DOI -- the U.S. Geological Survey (USGS), Bureau of Reclamation and Bureau of Mines.

In March 1987, the Senate confirmed Mr. James Ziglar as the new Assistant Secretary for Water and Science. Mr. Ziglar replaces the first Assistant Secretary, Mr. Robert Broadbent who resigned in 1986 to return home to Nevada.

Mr. Ziglar brings outstanding credentials and leadership qualities to DOI. He is a lawyer and investment banker with significant water resources experience. His experience as a financial banker is particularly relevant because his specialty is public finance. Mr. Ziglar's expertise will be especially helpful in identifying innovative approaches for financing and cost sharing water resources activities during his term as Assistant Secretary.

I also want to mention two activities of DOI that are directly related to water resources in the Illinois Basin. The first is the National Water Quality Assessment Program of the USGS. Congressman Sidney Yates, from Illinois, is the chairman of the House Appropriations Subcommittee on Interior and Related Agencies, and he has a personal interest in national water quality issues. In 1986, through his leadership, the Congress directed the USGS to initiate a National Water Quality Assessment (NAWQA). The objective of the program is threefold: 1) to define current water quality conditions on a nationwide basis, 2) to identify and describe changes in water quality over time and 3) to characterize both natural and man-made factors related to changes in water quality.

Right now, the USGS is conducting seven pilot studies to develop and test the NAWQA concept -- four surface water and three ground-water studies located across the Nation from Washington State to the Delmarva Peninsula.

One of the four surface water studies is the Upper Illinois River Basin. The USGS chose the Upper Illinois as a pilot study basin for several important reasons. It has complex water quality problems associated with diverse land use including part of the Chicago metropolitan area and major agricultural lands. Equally important, it has a strong existing water quality data base on which to build. But most important, the Illinois Basin has an outstanding cadre of State and local water resources experts who can help shape the pilot study and contribute to its success.

The Upper Illinois and other pilot study results -- both technical and institutional -- will provide the basis for evaluating whether or not the NAWQA program should be expanded to a perennial, nationwide program estimated to cost about $50 million dollars a year. We in DOI appreciate the help of Illinois water resource interests in conducting this pilot effort, which is important to the entire Nation.

Also, DOI is studying the water levels of the Great Lakes. USGS is working cooperatively with the State of Illinois Geological Survey to reconstruct a prehistoric record of lake levels. Officials of the USGS testified on this issue before a congressional hearing March 31, 1987, in Washington, D.C.

In summary, the preliminary findings indicate that over the last 86-year period for which we have measured levels of the lakes, the lakes have been lower than normal. Information developed by USGS and the State Survey reveal that during a period going back approximately 2,000 years, Lake Michigan has been as much as 5 feet higher than we are observing now. Those of you from this area know the importance of that scientific finding to the future of the Great Lakes region. My purpose in mentioning it is to demonstrate the relevance of DOI activities to challenges facing you.

FEDERAL PERSPECTIVES

Having touched on some selected activities of DOI that involve water issues in Illinois, I want to move to the primary subject of my speech -- Federal Perspectives on Water Resources Management. The perspectives will be my personal observations and ideas on where we are going as a nation in water resources. Five basic topics will be highlighted. They are: 1) Federalism, 2) Cost-sharing and financing, 3) Innovative water management, 4) Integrated systems management, and 5) Cooperation and negotiation. In discussing the five themes, I will be using three recently passed Federal laws to make some points. These three laws are P.L. 99-339, the Safe Drinking Water Act Amendments (SDWAA) of 1986; P.L. 99-662, the Water Resources Development Act of 1986, which has sometimes been called the Corps Omnibus Bill although it is actually much broader than that; and P.L. 100-1, the Water Quality Act (WQA) of 1987. The WQA reauthorizes and amends the Clean Water Act (CWA).

Federalism

We are aware of the trend away from centralized government in Washington, D.C., toward increased emphasis on State and local authority and responsibility or "federalism". Instead of dwelling on the obvious, I want to cite two recent examples of the continuing commitment in the Congress to federalism using the wellhead protection provisions of the SDWAA and the nonpoint source provisions of the WQA.

The SDWAA established a State program to protect public drinking water wells from contamination detrimental to human health. Under the wellhead program, States will define wellhead protection areas, identify potential sources of anthropogenic contamination to the wells and define a protection program. The bill authorizes some Federal money to help initiate the program -- $20 million per year in FY 1987 and 1988 and $35 million per year from FY 1989 through FY 1991. The law does not penalize States that do not want to participate, except wellhead protection funds will not be available to those States. Unlike some other environmental programs, EPA is not mandated to conduct the wellhead protection program if a State doesn't. The Congress intends a voluntary, flexible approach to wellhead protection. In addition, Congress waived Federal sovereignty in favor of State authority as part of the wellhead protection program. States can regulate Federal lands and Federal activities to protect wellheads. Needless to say, the DOI is interested in working with States as they develop and implement wellhead protection programs. We need to assure that existing DOI ground-water protection activities and national interests are considered.

Turning to the second example of federalism in recent legislation, the nonpoint source provisions of the CWA establish a State nonpoint source pollution program. Under the CWA, States are to assess their nonpoint source pollution problems and develop a management program tailored to address the problems they have. Under this Act, if a State chooses not to perform an assessment, then EPA is to prepare it and report to Congress. However, EPA is not authorized to develop and implement a management program if the State doesn't prepare one or if EPA doesn't approve the State proposal. The Congress established an innovative alternative for these cases. A local public agency or organization can step in with State approval and EPA technical assistance to prepare a nonpoint source management program. Further, if EPA approves the local program, then the alternative organization can be funded as if it were a State. Thus, the fall back in the absence of State action is local government, not Uncle Sam.

You may be wondering who pays and how much. Final answers to those questions can't be provided just yet, but the WQA authorizes four new sources of funding for nonpoint source pollution programs. Over 4 years $400 million is authorized in direct grant funds. For ground-water nonpoint source programs, $7.5 million per year is authorized. In addition, funds are set aside in the Construction Grants Program and in newly authorized State revolving funds, which will be discussed later. Actual amounts of funding available for both wellhead protection and nonpoint source will depend on future budget decisions made at both the national and State levels.

In summary then, these two examples demonstrate a continuing desire to solve local problems at the local level. The role of the Federal Government is limited in both of these examples and States are in the driver's seat -- where they should be.

Cost Sharing and Financing

There seem to be two groups of people in the country right now -- those who want to check Federal spending, and those who want to spend Federal checks! The first group has been most influential until just recently in stopping new water project starts. The trend in water resources is to shift more of the financial burden from Federal taxpayers to local beneficiaries of the projects. This trend is reflected in the Omnibus Bill. To demonstrate this point, some quick highlights of cost-sharing percentages for non-Federal project sponsors in the bill follow:

1.	Inland Waterway Construction	50
2.	Hydropower	100
3.	Municipal and Industrial Supply	100
4.	Agricultural Supply	35
5.	Recreation	50
6.	Flood Control	between 25-50

Other examples of this trend can be drawn from the Bureau of Reclamation program of DOI. Regarding cost-sharing for irrigation projects, local water users have always been required to pay back 100 percent of the costs but, by law, no interest is charged. However, DOI recently has entered into agreements which require users to help finance their projects. For example, the State of Wyoming is financing 39 percent, or $47 million, of the costs for Buffalo Bill Dam. Ten entities are financing 31 percent, or $349 million, of the costs of the Central Arizona Project's Plan 6 construction. Last, five entities have agreed to finance 39 percent, or $202 million, for the Animas-La Plata Project in Colorado and New Mexico (Starler and Maxey 1987). That's real money.

Within EPA, the new WQA phases out the Construction Grants Program for waste water treatment and phases in State Revolving Funds (SRF). Federal dollars are provided over a period of years to help capitalize the revolving funds. No construction grants are authorized after 1990, but $8.4 billion are authorized for SRF's between 1989 and 1994. States must match 20 percent of the Federal contributions for SRF's. These trends in cost-sharing and financing are very significant to those of you seeking solutions for the problems of the Illinois Waterway. As part of the overall planning effort, you need to consider not only what needs to be done, but how you can help pay for it. The Federal Government has not cut off all money for water resources projects, but more cost-sharing and financing from State and local interests is essential. Competition for Federal dollars for water projects is fierce, and local sponsors need to put their money where their project is.

Innovative Water Management

Innovation is another trend in contemporary water resources management. Old approaches to long-standing problems limit consideration of workable solutions. A good example of innovation is the water supply system for the Washington, D.C., metropolitan area. For three decades before 1982, the Nation's Capitol faced the threat of severe water shortages during droughts. But, in 1982, the jurisdictions involved agreed to a solution to the problem which exemplifies not only innovation, but most of the other themes we are considering today.

By making innovative use of their total existing water supply system through institutional cooperation, the Washington metropolitan jurisdictions increased their water yield by almost 30 percent. Also, they did it without incurring major new capital costs. The innovative approach they ultimately adopted saved between $200 million and $1 billion compared to other solutions that had been considered over the years. This achievement is not a miracle; it is an example of how common sense and cooperation can work.

A few facts will demonstrate the point (Sheer 1986). The Washington area has three main sources of raw water. The Potomac River is available to Maryland, Virginia, and the District of Columbia. The Patuxent River serves the Maryland suburbs, and the Occoquan River flows through Northern Virginia. These three basic sources of raw water are managed by three major water suppliers in the region. The Washington Aqueduct Division of the U.S. Army Corps of Engineers is responsible by Federal law for water supply for D.C. The Washington Suburban Sanitary Commission serves the Maryland suburbs, and the Fairfax County Water Authority serves Northern Virginia. Within the existing infrastructure, the Corps operates Bloomington Reservoir which is about 200 miles upstream from D.C. and stores water for the city. The Corps also operates diversion and treatment facilities. The States of Maryland and Virginia have a total of three small water supply reservoirs within the metropolitan region -- two on the Patuxent in Maryland and one on the Occoquan in Virginia.

These system assets were operated independently during the drought in the late seventies, and Bloomington Dam was still under construction. However, the total yield of all four reservoirs in 1977 (after deducting 100 million gallons a day (mgd) for instream flow) was just over 500 mgd. Average demand during the drought of 1977 was between 450 and 470 mgd. Peak demand at the time exceeded the yield even counting the projected Bloomington contribution. The Corps predicted regional shortages as large as 80 mgd by 1980. Faced with this severe threat, necessity became the mother of innovation.

An independent regional organization, the Interstate Commission on the Potomac River Basin (ICPRB), started looking at the problem from a systems perspective without regard to historical institutional constraints. Using the extensive data base that had been developed by the Corps and others over the years, ICPRB realized that the total storage capacity of the local reservoirs was adequate to overcome the shortage in the Potomac River. The Washington area would not be short of water if the jurisdictions operated as one system. As you probably have already guessed, figuring out the technical innovation was easy compared to breaking down the institutional barriers blocking coordinated reservoir operations. That took 5 years but, in 1982, all the jurisdictions involved signed the agreements which implement the cooperative procedures.

Today, during normal conditions, the Washington metropolitan area takes most of its water from the Potomac and saves the water in the local reservoirs. During droughts, the jurisdictions operate jointly every day using modern forecasting techniques. Uncertainties in the forecasting capability and rest of the system are compensated using releases from a small new regulation dam in the Maryland suburbs close to D.C. This innovative approach improved the system yield enough to meet demands through the year 2030. For more details on this case study, see the article by Daniel Sheer in the <u>1985 National Water Summary</u> published by the USGS.

Integrated Systems Management

The Washington water supply story is a good example of how integrated systems management can result in innovative solutions to local problems. However, on a more fundamental level, the United States has come a long way toward integrated water management. When the Clean Water Act first passed in 1972, we focused on point sources of pollution in streams primarily to protect fisheries and recreation. Now, 15 years later, Federal laws on the books address surface and ground water, point and nonpoint sources of pollution, streams, lakes, estuaries and atmospheric deposition. The goals have shifted primary emphasis from "fishable and swimmable" to human health.

The suite of constituents we are concerned about has expanded drastically. Just a decade ago we worried mostly about oxygen, nutrients, microorganisms and sediments. Today, toxics are the major concern. Tens of thousands of materials are potential environmental contaminants. The list includes man-made and natural constituents. Also, as more chemicals and processes are developed each year, the potential problem gets bigger.

One of the lessons we seem to learn over and over is that we cannot remove a piece of the puzzle from the environmental management game board and address it effectively by itself. We have to consider interactions among different parts of the environment. For example, we cannot ignore ground-water impacts when we seek solutions to surface water or erosion problems. Atmospheric sources of contaminants need to be considered as we address both surface- and ground-water quality problems. Clean lakes, rivers, streams, estuaries and aquifers will depend on our success in focusing on both point and nonpoint sources of pollution. To maintain adequate supplies of high quality water for many different uses, we must face the challenge of comprehensive and integrated resource management and protection.

Negotiation and Cooperation

Achieving environmental goals in a cost effective manner is going to require the cooperation not only among scientists, the public and private sectors, but also from each of us as affected citizens. Thus, the final perspective is cooperation. A common thread among many of the successful approaches to solving water resources (and other problems) in a cost effective, innovative manner is cooperation among the affected parties. The Washington metropolitan area water supply success story is the example we have considered in some detail. We can cite other examples all over the Nation, but let me use one from DOI. We see this trend in some unexpected areas. Indian water rights settlements are good examples. Traditionally, Indian and non-Indian water users have fought through years of litigation and animosity. Often, after decades of battling in the courts, none of the parties really win. The Indians end up with perfected rights, but not "wet" water. The non-Indians' long-term available supply is less certain. Recently, these traditionally bitter rivals have started sitting down at the negotiation table to cooperatively work through mutual problems. They are not negotiating because they are suddenly friends. They are negotiating because more advantageous and cheaper settlements for the involved parties can be found at the bargaining table.

CONCLUSION

This conference on the Illinois River is a positive step in reaching innovative, collaborative solutions to the problems you face. It is especially auspicious that leadership for this cooperative effort is at the local level. No one cares more about the Illinois River than those of you attending this conference. Looking over the list of participants, it is heartening to see all levels of government, private industry and non-profit groups represented. The politicians, technical experts and other citizens who are here to work together can develop and implement innovative solutions. Together, you can solve the major problems of the Illinois River.

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Session I

Physical Aspects of the Illinois River and Its Basin

PORTS AND WATERWAYS TRANSPORTATION IN THE ILLINOIS BASIN

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Introduction

The State of Illinois offers a distinct geographic and economic advantage to shippers due to its Midwest location at the confluence of the Great Lakes and the inland waterway system. Ocean-going vessels provide direct service to the Port of Chicago from the Atlantic Ocean via the Great Lakes/St. Lawrence Seaway system, and barges operating on the inland waterway system provide service between Illinois and 17 other Midwest and Southern states.

The purpose of this paper is to provide an overview of the importance of barge shipping on the inland waterway system to the Illinois economy, the role of the Illinois Department of Transportation (IDOT) in developing a water transportation database for future planning and investment decision-making, and to discuss the creation of and the powers, duties and development activities of Illinois port districts.

Comparison of Freight Transport Modes

1. Barges On Inland Waterways

The typical barge operating on the inland waterway system measures 195 feet in length, 35 feet in width and is 12 feet high. On the Illinois River, the size of tows is limited to 15 barges due to the size of the locks. A single barge has a surface area of 6,825 square feet, and a tow consisting of 15 barges covers 102,375 square feet of water surface. This means that the pilot of the towboat is pushing a group of barges covering nearly 2.4 acres of water surface. Another way to envision a tow of 15 barges, arranged in 5 tiers of 3 barges each, is to imagine a boat pushing 3 football fields down the river. This gives some idea of the skill of the towboat operators in navigating up and down the inland waterways, guiding the barges around bends in the river, into and out of locks and to and from docks and mooring facilities. On the lower Mississippi River, which is unconstrained by locks, tows can have 30 to 45 barges and more, and a single tow can cover 5 to 7 acres of water surface.

A typical barge carries a maximum load of 1,500 tons of cargo and has about 69,000 cubic feet of cargo space. In contrast, the Cotillion Ballroom, in which this conference is being held here at the Pere Marquette Hotel in Peoria, measures 100 feet long, 40 feet wide and 25 feet high, a total of 100,000 cubic feet of space. For this ballroom to hold the same amount of grain or coal as one fully loaded barge, the cargo would fill the room to a height of 17 feet.

If a tow of 15 barges operating on the Illinois River is carrying a load of corn, the maximum load totals 22,500 tons or 803,250 bushels of corn. Were this corn to be stored in Peoria before being loaded to barges, then equivalent storage space amounting to 15 Cotillion Ballrooms filled to 17 feet high, or 10.4 Cotillion Ballrooms loaded to the ceiling, would be needed.

2. Railroad And Truck Capacity

What would be done if the grain being stored in Peoria in 10 Cotillion Ballrooms had to be shipped immediately to New Orleans to meet an ocean-going ship, but a large tow of 15 barges was not available? One alternative might be to use railroad hopper cars. Such a rail car can carry a maximum load of 100 tons. Thus, to transport the same amount of grain as a single tow with 15 barges, a total of 225 rail cars would be needed. This is the equivalent of 2-1/4 unit trains or 3 trains each with 75 cars.

Another alternative would be to load the grain into trucks. A large trailer can carry about 25 tons, so 900 trucks would be needed to ship the same amount of corn to New Orleans.

A tow of 15 barges and a towboat is about one-quarter of a mile long, and it travels down the river relatively unnoticed by the general population. However, if that load of corn had to be shipped by rail, the 225 cars, locomotives and cabooses would reach a length of more than 3 miles, while the 900 trucks, spaced 250 feet apart traveling down the highway, would stretch over a distance of 50 miles. This indicates that a severe capacity problem could occur for our transportation system if, all of a sudden, there were no waterways to carry significant amounts of our grain, coal and other bulk commodities.

3. Comparison of Shipping Rates

In 1985, about 14 million tons of grain were loaded to barges in Illinois, most of which was shipped to New Orleans for export. The extensive use of barges for the shipments of grain from Illinois to export markets is attributed to the strategic location of Illinois relative to the inland waterway system and to the cost savings from use of barge transportaton.

In 1985, the spot-market, non-contract rate on a shipment of corn by barge from Peoria to New Orleans ranged from a low of 12 cents per bushel to a high of 27 cents per bushel. In comparison, the rate to ship all types of grains by rail averaged around 26 cents per bushel, and, at the present time, the rate would be about $1.19 per bushel to ship the grain by truck to New Orleans.

Following is an analysis of barge rates and rail rates in 1985 and current truck rates, based upon non-contract, spot-market rates which are generally higher than negotiated, contract rates.

a. Barge Rates

An IDOT analysis of monthly spot-market barge rates, for the year 1985, indicates a range of between $4.33 per ton and $9.62 per ton for grain shipped from Peoria to New Orleans. These spot-market rates were derived from barge trades negotiated throughout the year at the St. Louis Merchants Exchange.

The Merchants Exchange conducts daily barge trading sessions, where shippers in need of barge transport services make "bids" on the rate they are willing to pay and barge lines make "offers" on the rates they will charge for service on particular waterways. Most trading involves shipments of grain to New Orleans. When there is agreement between the price a barge line will charge and what a shipper is willing to pay, a barge or a number of barges are "traded".

The bid and offer prices are expressed in percentage terms, based on tariffs on grain shipments that had been filed by barge lines with the Interstate Commerce Commission until 1975. At that time, barge rates on most bulk commodities were deregulated, and barge lines were free to negotiate contract rates with shippers. However, the former tariff rates continue to serve as a pricing standard for the barge industry.

The rates for the shipment of grain to New Orleans are highest during the fall and early winter months following the harvest and are at their lowest during the summer months. Following is an approximation of average percent-of-tariff trades on barge shipments from the Illinois River to New Orleans in 1985, arranged at the St. Louis Merchants Exchange. The column for barge rates represents the price at which the barge would have traded for delivery to Peoria for loading and transport to New Orleans.

Month	Barge Rate (In Percent of 1975 Tariff)	Barge Rate (Dollars Per Ton)
January	155%	$7.46
February	140	6.73
March	120	5.77
April	100	4.81
May	90	4.33
June	100	4.81
July	100	4.81
August	100	4.81
September	120	5.77
October	200	9.62
November	200	9.62
December	195	9.38

Most of the barges traded at the Merchants Exchange for shipment of grain from the Illinois River involve shipments of corn. A bushel of corn weighs about 56 pounds, and there are about 35.7 bushels per ton. Using these conversion factors, the spot-market barge rate for shipments of corn to New Orleans in 1985 would have ranged from a low of 12 cents per bushel to a high of 27 cents per bushel.

b. Rail Rates

A study completed early this year by the General Accounting Office (GAO), entitled "Grain Shipments, Agriculture Can Reduce Costs By Increased Use of Negotiated Rail Rates," analyzed railroad rates paid by the U.S. Department of Agriculture (USDA) in 1985 on shipments of government grain. The GAO found that USDA shipped 215.5 million bushels of grain (about 6.25 million tons), most from inland points to coastal ports, at a cost of $55.5 million, an average of 25.75 cents per bushel. The study reported that only 21 percent of the grain was shipped under negotiated rates; 79 percent was shipped at published tariff rates. In contrast, the study found that large grain companies, such as Cargill and Bunge, shipped up to 95 percent of their export grain under negotiated rail rates.

c. Truck Rates

The highway distance from Peoria to New Orleans is about 850 miles. At the present time, a grain shipper would be charged a rate of about $1.25 per truck-mile, for a total charge of $1,062.50 per truck. For a maximum load of 50,000 pounds or 25 tons of grain in a semi-tractor trailer, the rate would be $42.50 per ton or $1.19 per bushel.

Inland Waterways In Illinois

1. Miles of Inland Waterways

Illinois has 1,116 miles of inland waterways, which represents about 14% of the nation's total of 7,000 miles of inland waterways with a depth of 9 to 12 feet. The Mississippi River forms the western border of the State for a distance of 581 miles, the Ohio River forms the southern border for 134 miles, and the Illinois Waterway, which includes the Illinois River and waterways in the Chicago area, bisects the state with 365 miles of waterway and provides the water link between the Great Lakes and the inland waterway system. In addition to these more well-known waterways, the Kaskaskia River in southwestern Illinois is navigable for a distance of 36 miles from the Mississippi River.

2. Locks and Dams

The entire length of the Ohio River from Pittsburgh to its confluence with the Mississippi River, the Illinois Waterway and the Mississippi River north of St. Louis are regulated by a series of locks and dams. The dams serve to maintain the depth of the water in the segment of the waterway behind the dams, and the locks form a passage through the dams to allow barges to be raised or lowered from one level to the next.

While the locks and dams are responsible for creating the pools that allow for commercial navigation, the locks can cause bottlenecks that delay barge operations. Only the Mississippi River, from Locks 27 at Granite City south to the Gulf of Mexico, is unconstrained by locks and dams.

Role of IDOT

The Illinois Department of Transportation has taken an active role in development of a coordinated inter-modal freight transportation system serving the needs of manufacturing companies, farmers, mining operations, commercial enterprizes and other users of railroad, truck and waterway shipping. This section of the paper discusses several of IDOT's responsibilities in furthering the development of the inland waterway transportation system serving Illinois shippers. These include the preparation of a directory that lists and describes each of the 344 water terminals in the state, the development of an historic database on water transportation in Illinois and the development of forecasts of future commodity shipments to and from Illinois on the inland waterway system. The next section of the paper discusses IDOT's assistance to Illinois port districts in their development activities.

1. Directory of Water Terminals

The initial step in the development of a database on water transportation involved an inventory of existing terminals. A terminal is defined as a cargo handling facility which may include a dock, transfer equipment, storage area, landside access and other related cargo facilities. As of 1982, when IDOT completed a survey of the waterway terminals, there were 344 terminals in operation on the waterway system in Illinois. Of this total, 317 terminals mainly handle barge traffic on the inland waterway system while 27 terminals handle overseas and Great Lakes vessels.

The results of the IDOT survey were published in the Directory of Lake and River Terminals in Illinois. For each of the terminals, the Directory includes such information as the terminal name, location, telephone, owners, contact person, tons of commodities handled, vessel loading/unloading capacity, storage capacity and railroad and/or truck access. The purpose of the Directory is to assist shippers in contacting terminals for the shipment of cargoes to and from Illinois.

An analysis of the waterway terminals in Illinois indicates that 87 of the terminals or 25 percent handle grain, 58 terminals or 17 percent handle petroleum products, 41 terminals or 12 percent handle sand and gravel, and 39 terminals or 11 percent handle coal. Most of the water terminal facilities are inter-modal transfer operations where bulk cargoes are transferred between landside modes and barges or deep-draft ocean-going ships and Great Lakes vessels. Analysis of inland access modes to 271 of the water terminals indicates that 47 percent have railroad and highway access, 38 percent have highway access only, 15 percent have rail access only.

Of a total of 102 counties in the State of Illinois, 43 counties are located on commercially navigable waterways, and 37 of these counties have one or more water terminals. Outside of Cook County, in which there are 111 terminals or nearly one-third the State's total, the Peoria-Tazewell County border formed by the Illinois River has the largest concentration of terminal facilities on the inland waterway system in the State. A total of 35 terminal facilities are located in the two counties, 18 in Tazewell and 17 in Peoria. Other major concentrations of river terminals are found in Will County with 25 terminals; LaSalle County, 24; and on the Mississippi River, in Madison County with 19 terminals and St. Clair County with 13.

The Directory is presently being updated by IDOT and should be ready for public distribution by September.

2. Historic Database on Water Transportation

Recently, IDOT published a report entitled Illinois Waterborne Transportation Database, 1970-1983. The report contains 55 tables that indicate the commodities and tonnages of waterborne shipments to and from the State of Illinois during the 14-year period, and, in addition, includes tables on historic shipments for ports and waterways throughout the United States. For many types of shipping data, 1983 was the most recent year for which tonnage statistics were available as of the date the report was published.

The tables on the following two pages are from the Database report. The first table compares annual barge shipments to and from Illinois to total U.S. barge shipments during the years 1970 to 1983. Overall, barge shipments to and from Illinois increased from 70.3 million tons (2,000 pounds) in 1970 to a peak of 90.7 million tons in 1975, reached a second peak of 89.4 million tons in 1980, but fell to 81.6 million tons in 1983. It is observed that Illinois barge shipments each year have maintained a fairly constant percentage of total U.S. barge traffic, averaging between 14 percent and 16 percent of the annual U.S. total.

While Illinois shipments peaked in the mid-1970's and have since declined, U.S. barge shipments reached a peak in the late-1970's. For U.S. barge shipments, the traffic peak was reached in 1979/1980 following years of rapid growth in U.S. grain exports, in which most of the grain moved by barge from the Midwest states to the Gulf ports where it was loaded to ocean vessels. However, shipments of grain by barge declined sharply following imposition of the embargo on grain sales to the USSR, the growth in exports from other world grain producing countries and rising levels of grain production in developing countries that had previously been highly dependent upon foreign sources to sustain their populations.

The second table indicates annual barge shipments by commodity groups to and from the State of Illinois during the years 1970 to 1983. The two-digit "group" numbers along the left margin correspond to the following commodity groups:

ILLINOIS INLAND WATERWAY BARGE SHIPMENTS
AS A PERCENT OF
TOTAL U.S. BARGE SHIPMENTS ON INLAND AND INTRACOASTAL WATERWAYS
Calendar Years 1970-1983
(Thousands of Tons)

Year	Illinois	U.S.	Illinois % of U.S.
1970	70,297.0	511,602.4	13.7
1971	69,599.4	521,997.1	13.3
1972	82,971.4	558,658.0	14.9
1973	81,123.5	559,474.9	14.5
1974	85,208.4	556,830.3	15.3
1975	90,675.1	542,326.4	16.7
1976	89,997.6	564,966.0	15.9
1977	84,811.7	567,847.9	14.9
1978	78,753.3	581,602.0	13.5
1979	78,918.7	583,967.0	13.5
1980	89,447.6	583,331.9	15.3
1981	80,200.7	573,516.5	14.0
1982	79,267.2	538,140.3	14.7
1983	81,572.2	530,383.8	15.4

TOTAL ILLINOIS BARGE SHIPMENTS BY COMMODITY GROUP
Calendar Years 1970-1983
(Thousands of Tons)

Group	1970	1971	1972	1973	1974	1975	1976
01	9,959.5	10,229.2	14,427.0	13,867.7	12,674.3	16,731.7	19,386.4
09	2.0	457.6	453.6	330.0	0.1	0.3	237.3
10	225.4	102.4	24.8	64.5	138.4	157.0	179.7
11	22,361.5	19,212.4	24,951.9	24,051.9	24,639.9	28,122.4	23,402.7
13	19.7	0.0	158.4	0.0	448.1	98.0	287.9
14	12,215.9	12,774.7	12,355.8	13,442.3	12,439.5	12,246.8	11,222.5
20	1,503.2	1,549.0	1,502.0	1,643.7	1,908.7	1,995.6	3,373.3
22	0.0	0.3	1.0	0.8	0.0	0.0	0.0
24	53.4	67.9	78.8	48.9	79.4	66.1	114.5
26	54.4	66.8	38.8	27.4	39.8	69.9	32.8
28	3,869.2	4,252.7	4,466.0	3,853.6	4,362.9	4,405.4	4,947.2
29	16,291.4	15,654.6	15,189.0	15,266.3	16,690.3	15,784.6	16,352.0
30	0.2	0.1	0.1	0.3	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	1,410.3	1,947.4	2,607.7	1,391.3	1,235.0	1,091.1	1,539.0
33	1,431.8	1,394.1	1,380.6	1,539.3	2,656.8	1,955.4	2,252.0
34	39.0	178.8	50.6	37.1	35.8	30.2	31.9
35	55.4	16.6	11.7	8.7	9.2	18.1	18.8
36	0.5	1.7	0.1	1.2	0.8	2.3	4.2
37	50.4	27.4	6.4	5.1	10.8	11.1	11.5
38	0.0	0.0	0.0	0.0	0.3	0.0	0.0
39	0.3	0.0	0.0	0.0	0.0	0.0	0.0
40	416.1	1,342.4	5,232.9	5,214.0	7,809.4	7,715.6	4,368.8
41	337.4	323.3	34.2	329.4	28.9	173.5	2,235.1
Total	70,297.0	69,599.4	82,971.4	81,123.5	85,208.4	90,675.1	89,997.6

Group	1977	1978	1979	1980	1981	1982	1983
01	18,889.9	17,622.6	16,889.8	19,782.1	19,715.8	23,283.9	21,898.6
09	0.5	0.1	1.6	1.6	0.3	0.1	1.3
10	230.3	196.2	125.3	72.1	73.4	69.5	50.2
11	24,058.5	20,799.0	22,233.2	29,823.2	25,787.8	19,585.2	21,007.2
13	174.2	204.1	172.9	48.0	375.6	1,046.6	2,086.7
14	11,218.7	10,940.9	11,335.0	10,566.1	8,566.1	9,924.1	9,811.5
20	3,162.0	3,819.0	4,398.3	5,569.0	4,876.5	5,593.0	6,622.8
22	0.0	0.0	0.7	0.0	0.0	0.0	0.4
24	110.7	38.1	57.6	47.6	43.0	29.7	32.0
26	29.0	22.6	36.2	33.5	23.6	35.8	35.4
28	4,831.1	4,650.7	4,277.8	4,607.9	4,165.9	3,664.8	4,550.9
29	16,096.4	15,662.8	14,774.2	13,752.5	11,652.4	11,996.2	11,453.9
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	1,653.6	1,186.0	1,657.6	1,255.9	1,402.9	1,479.2	1,531.3
33	2,157.0	1,707.2	1,985.5	1,176.8	1,017.5	628.7	843.7
34	41.2	32.7	28.8	31.3	19.4	28.5	12.1
35	46.6	8.6	30.2	38.9	10.6	4.5	18.3
36	2.0	2.1	0.5	0.2	0.0	1.1	0.0
37	15.5	13.8	4.2	5.1	0.1	1.2	0.0
38	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	1,865.6	1,686.3	902.5	2,630.2	2,468.0	1,662.8	1,022.3
41	228.9	160.5	6.8	5.6	1.8	232.3	593.6
Total	84,811.7	78,753.3	78,918.7	89,447.6	80,200.7	79,267.2	81,572.2

01 - Agricultural Products	29 - Petroleum and Coal Products
09 - Fish Products	32 - Stone, Clay, Glass and Concrete Products
10 - Metallic Ores	33 - Primary Metal Products
11 - Coal	34 - Fabricated Metal Products
13 - Crude Petroleum	35 - Machinery (Except Electrical)
14 - Sand and Gravel	36 - Electrical Machinery and Equipment
20 - Food Products	37 - Transportation Equipment
24 - Lumber and Wood	40 - Waste and Scrap
26 - Pulp, Paper and Allied Products	41 - Special Items, Mainly Waterway Improvement Materials
28 - Chemicals and Fertilizer	

The table indicates that a sharp increase in barge shipments of grain (group 01) from Illinois in the years 1970 to 1976, with further smaller increases to 1982, was offset by a decline in barge shipments of coal (group 11) and petroleum products (group 29). Grain shipments increased from 10.0 million tons in 1970, to 19.4 million tons in 1976, and then to 23.3 million tons in 1982 and fell to 21.9 million tons in 1983. Despite this overall 54 percent increase in grain shipments, coal shipments by barge fell from a peak of 28.1 million tons in 1975 to 21.0 million tons in 1983 and petroleum products fell from a peak of 16.7 million tons in 1974 to 11.5 million tons. Combined, these two commodities fell by 12.3 million tons from their peak years in the mid-1970's to 1983.

The decline in coal shipments by barge to and from Illinois is primarily attributed to a shift by utilities from the use of high sulphur coal mined in the Illinois basin to low sulfur western coal, which changed the delivery system from barges to railroads. The decline in barge shipments of petroleum products is the result of reduced refining capacity in Illinois and increased shipments of refined products by railroad and truck.

As the next step in development of a comprehensive database on water transportation, IDOT is presently developing a series of projections of future shipments on the inland waterway system. The methodology being used to develop barge forecasts will involve three major steps: 1) Identification of international, national and state production and consumption factors that will affect the need for water transport of coal, grain, fertilizer, petroleum products, sand and gravel and other commodities shipped by the river system; 2) Development of commodity forecasts specific to Illinois for those major commodity groups handled on the inland waterway system; and 3) Development of barge tonnage forecasts to and from the state for major commodities. When completed, the database will assist the state, port districts and the maritime industry in planning for needed port facilities and will provide an immediate source of comprehensive, timely and readily accesible data for investment decision-making and for responding to short-term economic development opportunities.

Role of Illinois Port Districts

Some interest has been indicated by local communities and government agencies in the Peoria area in the creation of a port district. This section of the paper presents an overview of the organization and activities of existing port districts in Illinois.

1. Duties of Port Districts

A port district is a public body created by an act of the Illinois General Assembly to engage in the planning, development, operation, and promotion of water ports, marinas and other facilities. Acting in accordance with designated powers and duties, a port district can engate in activities to attract industrial, commercial and recreational developments, thereby functioning to enhance the economy of the area encompassed by the port district.

2. Creation of Port Districts

Since 1951, the Illinois General Assembly has created 13 port districts, of which 11 are located on commercially navigable waterways. The figure on the following page indicates the locations of the 13 port districts. The two port districts located on the Wabash River, which is not navigable by barges, are inactive. All 11 of the port districts located on navigable waterways are empowered to develop water port facilities, and 9 port districts have the authority to develop airport facilities.

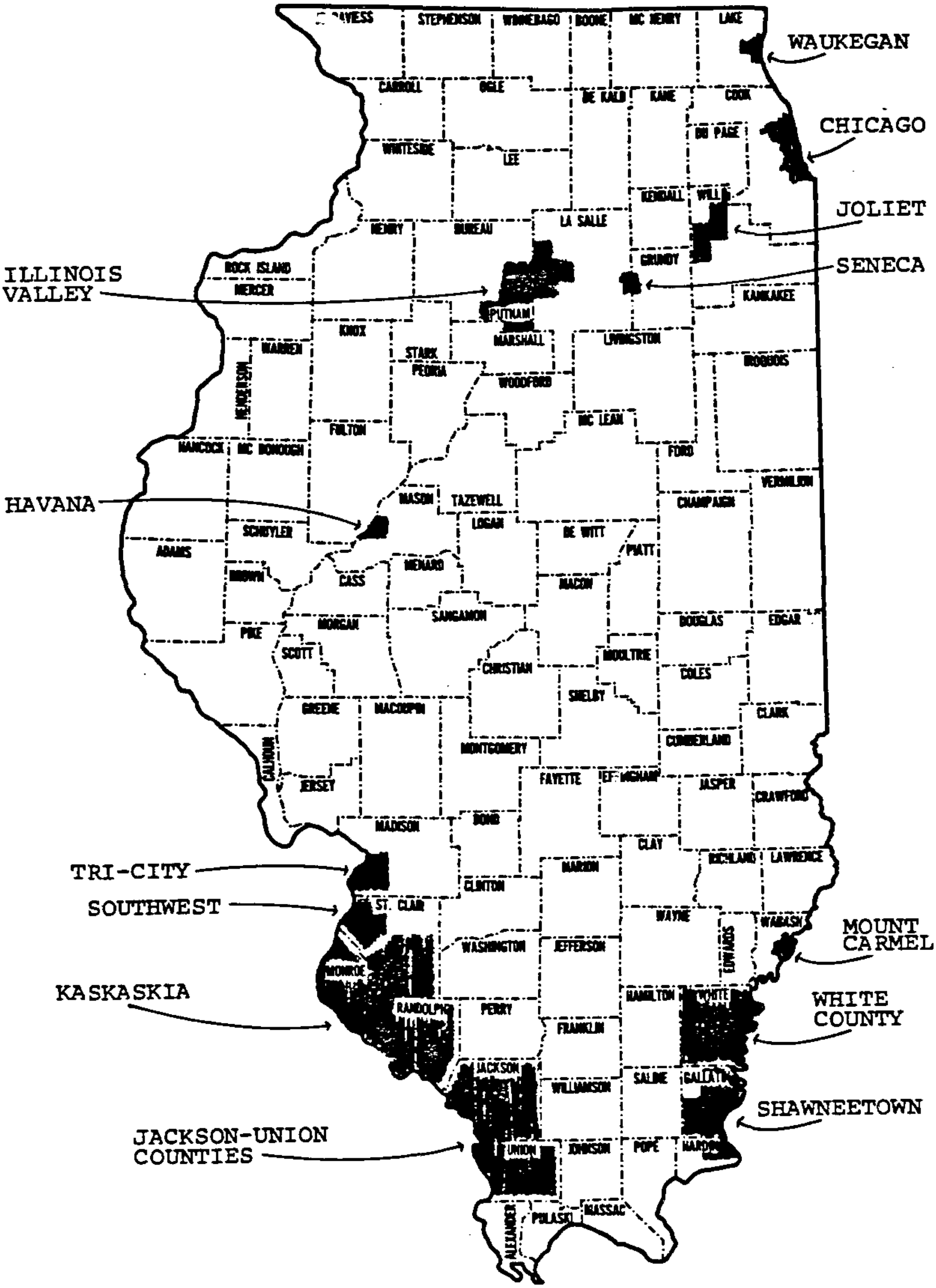
3. Governing Boards

Each port district is governed by a board which is responsible for the conduct of the duties and powers granted to the port district in the enabling legislation. The number of board members ranges from 3 to 23 persons, all of whom are required to be residents of the area encompassed within the legal borders of the port district.

The enabling legislation for each port district designates who is responsible for the selection of board members. In 3 port districts, the Governor has sole responsibility for the selection of board members, and in the remaining 8 port districts the responsibility is shared by the Governor with either or both municipalities and county boards. Board members are appointed for terms of 3 years in eight of the port districts, 5 years in one port district and 6 years in two port districts.

4. State Funding of Port District Projects

Although the State of Illinois does not have a port project development budget, a total of $28.8 million has been appropriated for individual port district projects by the General Assembly from the Capital Development



Illinois Port Districts

FIGURE 1

Bond Fund and from the Build Illinois Program. The State has funded six port district projects, including $1.8 million to the Shawneetown Regional Port District for construction of a coal terminal, $2.75 million to the Tri-City Regional Port District for construction of a grain and dry bulk terminal, $15 million to the Illinois International (Chicago) Port District for construction of a general cargo terminal for ocean shipments, $8 million to the Waukegan Port District for construction of a new marina, $750,000 to the Joliet Port District to purchase an airport, and $500,000 to rehabilitate rail tracks in the Illinois International Port District.

5. Port District Capital Development Plan

IDOT prepares a five-year Illinois Port District Capital Development Plan for the purpose of consolidating the short-range development plans of the Illinois port districts, which provides the State with a tool to budget for the investment of State funds in needed public port facilities. The Plan uses three major categories of port project investments: terminal improvement, terminal expansion and new terminal construction. These investment categories provide a mechanism to allocate available financial resources to a number of projects that are competing for public funds.

The most recent Capital Development Plan, for fiscal years 1985 to 1989, identifies total proposed expenditures of $41.6 million by port districts including $2.1 million to improve existing terminals, $11.9 million to expand existing terminals and $27.6 million to construct new terminals. The Plan is updated and revised every other year to reflect port district accomplishments, shifts in the economy that may cause changes in commodity demand, availability of public monies to undertake capital projects, and other factors that may impact upon port district development.

6. Port District Assistance to Private Industry

During the years 1955 to 1981, Illinois port districts issued $92,500,000 in revenue bonds for the construction of terminals which are used or operated by private companies. Of this total, $60 million in bonds were issued for facilities in which the private company will retain ownership, while $38.3 million in bonds was spent on public use terminals which will be operated by private companies. Several of the major companies involved in these cooperative ventures with Illinois port districts include E.I. duPont, C.F. Industries, Conti-Carriers & Terminals, Apex Oil, Triple T, Houston Natural Gas, Dow Chemical and Associated Electric Cooperative. This example of the financial cooperation between public port districts and the private sector demonstrates the benefits to be derived from cooperation in the interests of the shippers in the State of Illinois.

ILLINOIS WATERWAY SYSTEM

TODAY AND TOMORROW

Paul D. Soyke
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Rock Island, Illinois

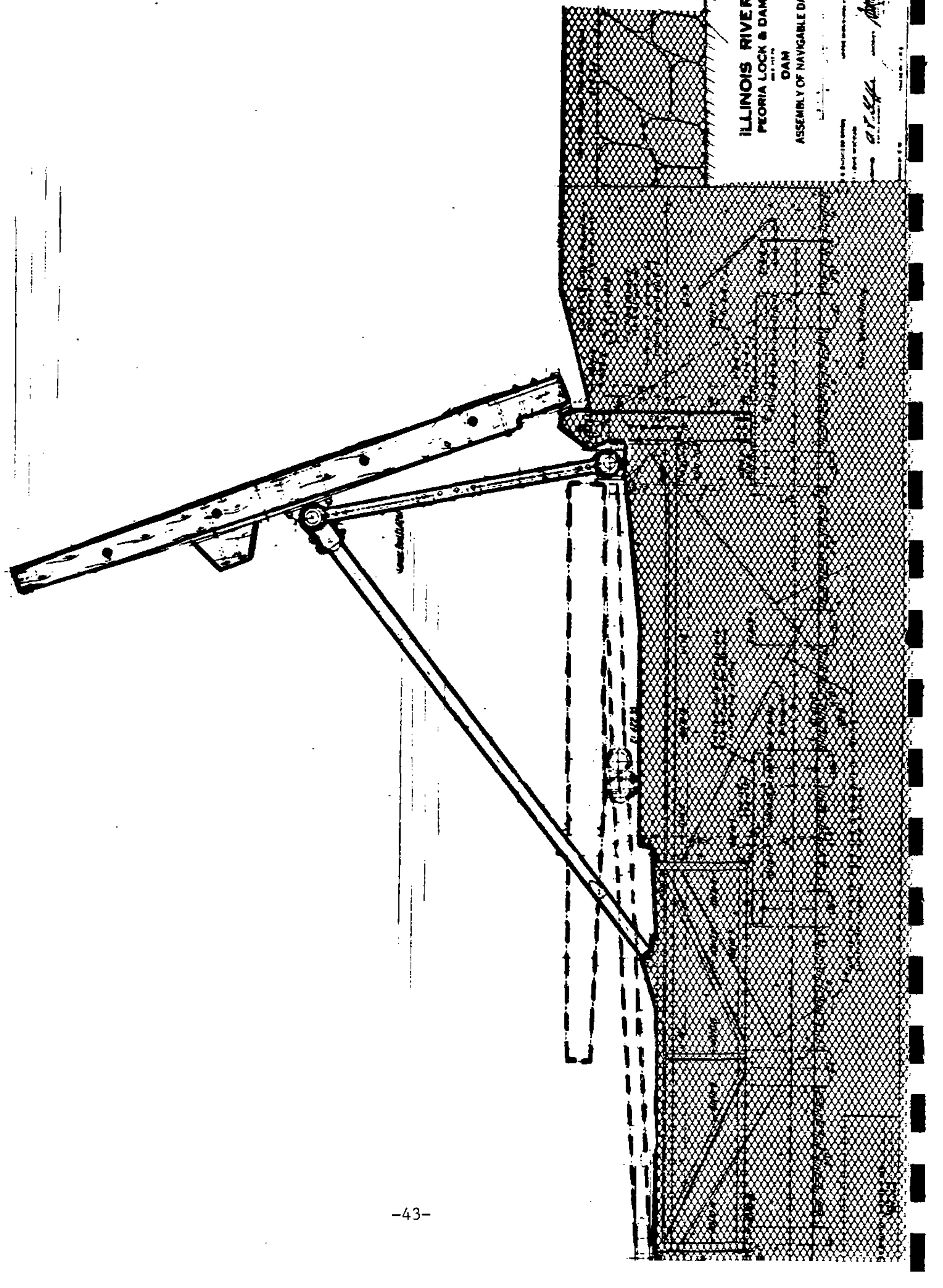
The Illinois River has a history of navigation dating back to 1803. The construction of locks and dams began in 1871 and continued until the system, as we know it today, was completed in 1939.

The Illinois Waterway has been in operation for over 50 years. It consists of 345 miles of channel and 7 locks and dams. All of the locks are 110 x 600 feet. Peoria and LaGrange have two of the four remaining wicket dams in the United States.

(The total tonnage on the waterway has increased at an annual rate of 6 percent since 1940 and 3 percent annually during the past 10 years. 1986 was a record year with total tons exceeding 59 million.) Although tonnage at LaGrange has declined somewhat during the past few years due to the reduction in grain export, Intradistrict tonnage has continued to increase. This is due primarily to coal shipments from Havanna and the transport of sand and gravel in the Chicago area.

The Illinois' physical features vary considerably from upper to lower. The upper reach from Lockport to Starved Rock has a narrow channel and a relatively steep slope. The drop between Lockport and Starved Rock is 2.3 feet per mile. From Starved Rock to the mouth of the Illinois, the channel is wider and much flatter. The drop from Starved Rock to LaGrange is only about 1.6 inches per mile. These physical features impact tow traffic. The upper reaches have smaller tows than the lower reaches, although this is not always due only to channel constraints.

I mentioned the wicket dams at the Peoria and LaGrange Locks. These wickets are made of large timbers that lay on the bottom of the river when flows are great enough to provide for a 9-foot channel. When the flows get low, the wickets are raised to create a dam (see illustration). These wickets allow tows to by-pass the locks almost 50 percent of the time. Even though they are costly to maintain, they create significant


ILLINOIS RIVER
PEORIA LOCK & DAM
DAM
ASSEMBLY OF NAVIGABLE DAM

efficiencies in transportation costs. In 1986 the wickets at Peoria were down 60 percent of the time. This allowed over 2,000 tows to pass by the lock saving a total of more than 2,700 hours in processing time. The rehabilitation of the two locks will replace some of the wickets with a gate that will allow better control of the pool and allow ice to pass. This will relieve a dangerous condition when wickets must be lowered in the winter. Several times, boats have been upset and workers forced into the water when ice upstream has broken loose as the wickets were being raised or lowered. The gates will help to avoid this extremely dangerous situation.

At Marseilles, the lock is about 2 miles downstream from the dam. The canal between the two is only 200 feet wide. This is too narrow to allow the passing of tows, so one must wait while another is in transit on the canal. About 65 percent of all tows encounter delays at Marseilles with an average delay of over 3 hours. These delays will continue to increase in the future. Any solution to this problem will require not only efficiency studies, but environmental studies as well.

Above Lockport, the Sanitary and Ship Canal serves as the navigation channel. This canal is very narrow and it is congested in many places. Last improved 80 years ago, the canal was not designed for the type of equipment that uses it today. The Metropolitan Sanitary District of Greater Chicago built and maintained the canal until 1984. Congress then transferred maintenance responsibility to the Corps of Engineers for navigation purposes.

Dredging on the Illinois is not a major problem. The average dredging is 169,000 cubic yards annually. The major problem area is at the mouth of the Mackinaw River. This area accounts for 25 percent of the average volume. Although small in volume, the location of disposal sites is a sensitive environmental problem that requires resolution.

Although each succeeding year was not always greater than the next, tonnage on the river showed a consistent upward trend until 1975. For the next four years, the tonnage decreased from 41 to 36 million tons annually. However, as the general economy improved, the commodities moved on the river increased back to 41 million tons in 1980 and shot up to 56 million tons in 1981. That remained the record year as tonnage bounced between 50 and 55 million tons through 1985. Then last year it bounced up to 59 million tons. In spite of the cycles of the past 10 years, the long-term trend is definitely upward (see chart).

The previous paper, by Norman Wolfe, presented detailed information on each commodity. It is obvious that there is a wide diversity on the Illinois River. Coal, grain, petroleum, and sand and gravel have been the principal commodities. More recently chemicals and iron and steel products have grown to become of equal importance. The diversity on the waterway is also obvious by the way the commodities are distributed. Grain is the primary commodity downstream of Starved Rock, while miscellaneous products are important upstream. (see chart) These miscellaneous commodities consist of a wide variety of products, but are primarily iron, steel, mineral, and chemicals. The following table shows a distribution of these miscellaneous commodities at Marseilles.

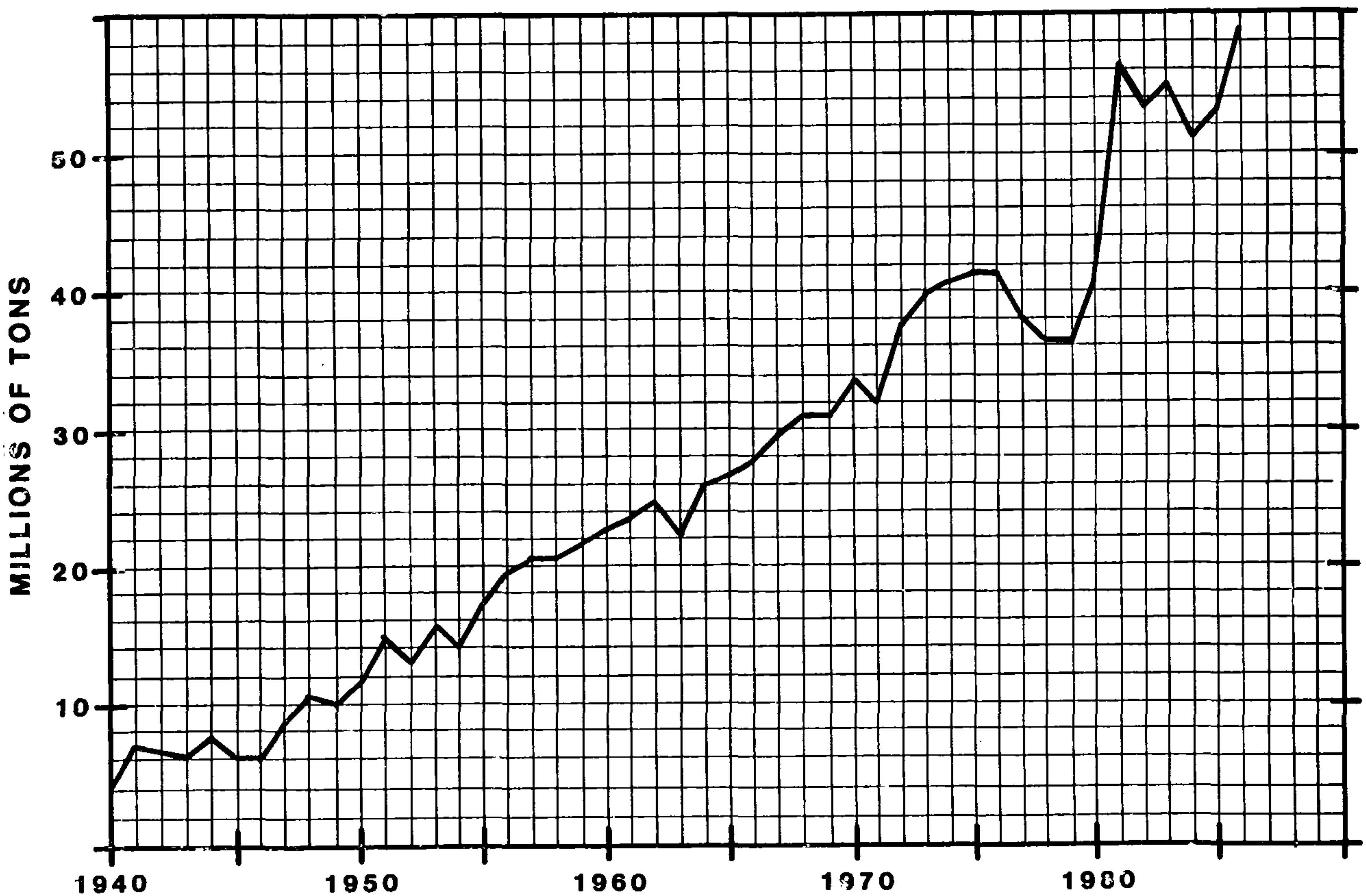
Chemicals	45%
Metallic ores & Products	29%
Non-Metallic Minerals	14%
Stone, Cement, Etc.	10%
Other	4%

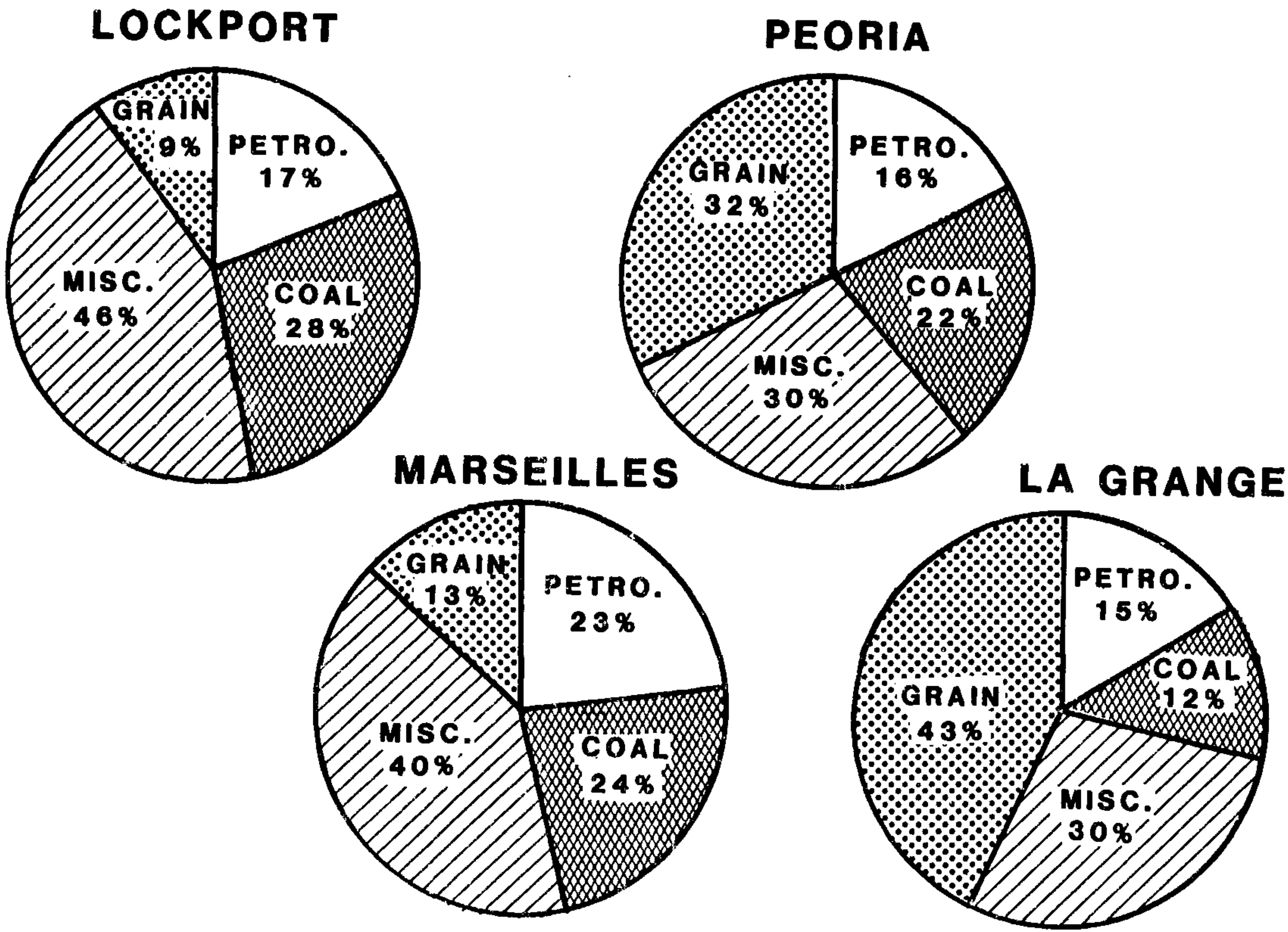
As the Illinois economy continues to improve and diversify, the types and quantities of materials are expected to continue to increase.

Future traffic on the waterway will be limited by several constraints: the major one is the narrow canal at Marseilles. The existing delays which now average 2 hours per tow will continue to increase. The LaGrange Lock has the greatest traffic, however, since the wickets are down a large percent of the time average delays are not excessive. There is a possibility though that, if we have some very dry years, this lock could then be a major constraint. Past studies have identified major constraints at the locks as early as 1990. This can be extended to the year 2000 by use of non-structural measures. However, in order to handle traffic after that, decisions will have to be made on either restricting traffic or building new locks.

These potential problems require a great deal of study. First, better information needs to be developed on the real capacity of the system. Studies are also required to determine the needs of the system. What is the future demand and how can it best be met? With this

ILLINOIS WATERWAY TONNAGE




LOCKPORT
GRAIN 9%
PETRO. 17%
COAL 28%
MISC. 46%
PEORIA
GRAIN 32%
PETRO. 16%
COAL 22%
MISC. 30%
MARSEILLES
GRAIN 13%
PETRO. 23%
COAL 24%
MISC. 40%
LA GRANGE
PETRO. 15%
COAL 12%
GRAIN 43%
MISC. 30%

information, we can then determine when and where problems will develop and make plans to solve them.

There is also a need to obtain better environmental data. As future traffic makes more demands on the system, we must have a better understanding of the impacts. Commercial navigation is important to Illinois, but so is the natural environment of the river.

Several studies are now beginning or underway that have the potential to provide some answers. The first of these is the Rehabilitation effort and its related environmental document. That should result in a better understanding of the existing conditions and provide short-term answers to some problems.

The Environmental Management Program is looking at a number of river related issues; including habitat rehabilitation and enhancement, a long-term resource monitoring program, a computerized inventory and analysis system, a traffic monitoring program and program of recreation projects. An Inland Waterways Review will update the data in the 1982 National Waterways Study to determine if any changes are required in its recommendations. Finally, the states of Illinois, Iowa, Wisconsin, Missouri, and Minnesota have a study of commercial navigation efficiencies underway. Although this study is on the Mississippi River some of the findings may be transferable to the Illinois.

I believe that all of these studies indicate the river is very important and many people and organizations are concerned that it continue to be preserved as an important resource.

PL 99-662, which was passed in October, will have a significant long-term impact on the navigation system. It created a Waterway User's Board composed of 11 shippers and users which will make recommendations regarding construction and rehabilitation priorities and spending levels for features and components of inland waterways and harbors.

The law also authorized the Upper Mississippi River Management Act of 1986. Its purpose is to assure the coordinated development and enhancement of the Upper Mississippi River System of which the Illinois River is a part. It authorized a total of $191,415,000 over a ten-year period to plan, construct and evaluate measures for fish and wildlife habitat, implement a long-term resource monitoring program, implement a computerized inventory and analysis system, implement a program of recreational projects, and conduct an assessment of economic benefits generated by recreational activities. It also adopted the remaining recommendations of the Master Plan. The law amended the fuel tax to be increased from 10 cents to 20 cents in steps to 1995. These funds will be put into a trust fund to be used for capital improvements.

The ongoing and future studies will concentrate on defining the capacity of the navigation system; not only as it relates to navigation, but to the ecology as well. One of the important issues here is to define what capacity means. There are at least nine definitions that have been published.

There are minor modifications which can be done to more efficiently move traffic through the lock. There are also things that the towing industry can do to be more efficient. It is important to analyze these various measures in order to predict when the capacity of the various locks will be reached. It is also important to evaluate the impacts of this future traffic. Both the economic and natural environment are affected by what happens on the river. We cannot afford to simply sit back and try to solve problems as they occur. We need to plan for the future.

In summary, the Illinois River is important to this state and it is important as a national resource as well. We need to maintain commercial navigation on the river as a major economic resource and we need to maintain the river as a major environmental resource. We do not view this as an impossible task. It will, however, require considerable effort in doing further studies and in planning. Through the efforts of all concerned, we can plan for the future of the Illinois River and assure its use as a balanced resource into the 21st century.

BARGE FLEETING IN IOWA - AN INTERGOVERNMENTAL EXPERIENCE

DON McMULLEN/CHRIS BUCKLEITNER
East Central Intergovernmental Association and the
Dubuque Metropolitan Area Transportation Study

INTRODUCTION

Inland waterways provide bulk-break functions for greater efficiency in transportation. A standard fifteen barge tow on the upper Mississippi carries the equivalent of nine hundred semi-truckload of grain. Other benefits translate into jobs and the development of other sectors of the regional transportation network. For example, trucking services benefit from being able to backhaul coal, or other commodities once they deliver corn to the river. Between three terminal operators and two harbor service operators there are 120 jobs tied directly to the loading and shipping of commodities aboard barges.

The two major grain shippers in Dubuque shipped 2.4 million tons of corn and soybeans in 1983, which represented 3.16% of the total U.S. grain export for that year. We realize that market conditions could return to that level. Dubuque grain shipments that year were 8.4% of total Iowa grain production, and this was the year that brought the issue of barge fleeting to the fore.

The harbor service operators called for more fleeting space, and other waterway interest groups opposed the designation of almost all potential fleeting as such because aspects of fleeting that detracted from their interests. This set the stage for the formation of an intergovernmental ad-hoc fleeting committee in August, 1985.

ISSUES AND INTERESTS IN FLEETING

Local economic interests in barge fleeting are job creation and retention, the development of intermodal systems, and support of ancillary activities such as processing, grading and storage that add value to the commodities handled.

The negative aspects of fleeting occur within and outside the industry. External problems can be related to the potential negative environmental impacts of fleeting activity. These include degradation of fish and wildlife habitat and the aesthetic considerations of natural river settings considered important for tourism and recreational waterway users. Fleeting and commercial navigation in general also compete with recreational users, representing potential safety problems. Although the pros and cons of fleeting are not limited to these areas, these are the problems associated with fleeting in the Dubuque tri-state area.

Problems within the industry itself are not the result of any individuals or corporate philosophies. They are related to the external problems described because fleeting sites must be near terminals for efficient operation, and site locations <u>and</u> *capacities are limited physically by channel width*, depth and operational safety. In the Dubuque experience, competing companies provide a high quality harbor service. Unfortunately, they must also compete for a limited number of closely regulated fleeting spaces.

In 1983, with a shortage of fleeting space impeding the Dubuque transshipment process, the City of Dubuque initiated the organization of an ad hoc committee to study the problem. The overall goal of the committee was to promote Dubuque as an efficient transshipment point.

It is important to note that there are public agencies, on different levels of government and with different regulatory responsibilities, that are involved in commercial navigation. To sort out the advantages and drawbacks of respective fleeting sites near Dubuque these organizations, such as the U.S. Fish and Wildlife Service, state departments of conservation and the Corps of Engineers were asked to participate or monitor the activities of the committee. The question at this point was one of practicality. Who or which organization had the political representation and staff resources to energize and maintain the activities of such an issue-oriented committee.

THE DUBUQUE METROPOLITAN AREA TRANSPORTATION STUDY (DMATS)

The Dubuque urbanized area, 1980 population 79,000, participates in federal transportation planning known as the '3-C' process. This stands for continuing, coordinated and comprehensive planning under the auspices of a locally organized and staffed Metropolitan Planning Organization (MPO). In Dubuque the MPO function is directly under the East Central Intergovernmental Association, which is a five-county umbrella organization for provision of planning and management services to local governments. The D-M-A-T-S-performs the MPO function and operates with a policy committee, comprised of elected officials from governments in the urbanized area, a technical committee, which reviews the planning staff activities and monitors local planning needs, and a citizens advisory committee which provides input from interested citizens.

It is this organization, which is based on the active participation of local units of government that was given the task of finding solutions to the fleeting shortage.

The Ad-hoc Fleeting Committee

An ad-hoc committee was formed that eventually had 31 members. About 17-20 members were active in the committee and the others were kept informed through mailings of meeting proceedings. The committee was authorized by the DMATS policy committee and functioned according to the by-laws of the DMATS organization.

The committee was given six months to establish short and long range plans for barge fleeting with the overall goal of maximizing the advantages of the navigable waterway in the Dubuque Metropolitan area. Proceedings of the fleeting committee were reported to the technical committee. Position statements and policy initiatives were reviewed for approval by the policy committee.

Objectives for the ad-hoc committee were as follows:

"BARGE FLEETING COMMITTEE"

1. To establish the short and long term needs of barge fleeting.

2. To determine the economic aspects of barge fleeting, i.e. locations, shipping points.

3. To develop barge fleeting locations that will be conductive to the industrial and commercial growth of the community.

4. To integrate barge fleeting needs with other modes of transportation so there can be a complete interrelationship of all forms of transportation.

5. To establish long term contracts with governmental agencies for barge fleeting in order that appropriate long term planning can be conducted by barge fleeting companies.

6. To establish fleeting areas in locations that are compatible with the environmental concerns of the community.

7. To determine legislation that may or may not be necessary and advantageous to enhance the utilization of the waterways for barge fleeting and water shipments.

8. To decide what is the appropriate state agency for promoting and monitoring the utilization of the waterway, i.e, Iowa Conservation Commission or the Iowa Department of Transportation.

The group spent a moderate amount of time in self-education as it discussed the eight objectives. Two of the more critical areas studied were how fleeting is regulated and secondly, what type of area qualifies as a generally satisfactory fleeting site. This common knowledge gained was important in forming consensus in key areas. This proved to be valuable in presenting an informed local opinion to state and federal regulatory agencies.

As issues were discussed, a list of potential fleeting sites was compiled. Through ranking by respective site strengths and weaknesses, the committee produced a summary report describing how potential sites could help solve fleeting problem. This report contains an executive summary with six major points:

1. Highest priority be given to retention of existing sites through provision of input to the U.S.Fish and Wildlife Service in the development of its master plan for the Upper Mississippi Refuge Complex.

2. That the City of Dubuque begin immediately to develop one of the two largest potential sites in Dubuque Harbor.

3. That a fleeting ordinance be developed by the City using the Iowa Administrative Code, Chapter 54, as a format.

4. That DMATS continue to monitor Fish and Wildlife Service and Army Corps of Engineers' planning activities, and that a permanent committee be established under DMATS for this purpose.

5. That the City of Dubuque and others interested work to promote public awareness of the economic impact commercial navigation has on the tri-state area.

6. That the committee concludes that the sites identified will meet long term projections for sites if they can be developed when needed.

This work laid the groundwork for the establishment of a smaller, permanent DMATS committee. The work and influence of this committee continues to date.

The DMATS Fleeting Committee

The smaller committee continued as a part of DMATS and was now incorporated into the by-laws as a permanent working committee that reported directly to the technical committee. Its composition was important in working to promote a balanced local viewpoint to state and federal organizations. Membership was established as follows:

Dubuque City Council	2 persons
Dubuque County Supervisors	1 person
Grant County, Wisconsin	1 person
Jo Daviess County, Illinois	1 person
Iowa DOT	1 person
Dubuque Dock Commission	1 person
DMATS Technical Committee	1 person
East Central Intergov. Assoc.	1 person
Dubuque Chamber of Commerce	1 person
Chair, Ad-hoc Committee	1 person
Local Shippers	1 person
Local Fleeters	1 person
Superintendent of Waters	1 person
Iowa conservation Commission	
Total	14 members

The first act of this group was to refine the recommendations of the ad-hoc committee to develop even more clearly a local viewpoint on fleeting and to develop clear responses to needs for additional fleeting space.

The objectives of the committee are listed, with a brief description of work accomplished to date.

1. Develop a short term contingency plan enabling a response in event of a fleeting space emergency.

   Several of the larger fleeting sites in the Dubuque area--- are on land managed by U.S. Fish and Wildlife Service. A position paper was drafted requesting these sites be expanded when a bonafide fleeting space emergency was deemed to exist. It should be noted this was approved by the DMATS policy committee but never submitted to F & W because of land use findings by the Fish and Wildlife Service.

2. Review status of leases with Fish and Wildlife and the Corps of Engineers, Iowa Conservation Commission, City of Dubuque and private entities.

   Copies of all lease agreements were obtained by DMATS staff to be indexed.

3. Ascertain tonnage totals

   To monitor shipping volume, locking reports are monitored by DMATS staff as part of data base information gathering.

4. Maximize intermodal systems, i.e. rail to barge.

   This is an objective intended to assure that the intermodal network continues to grow evenly, thereby reducing potential for bottlenecks in its operation.

5. To promote public awareness of the economic impact that the transportation industry, and barge fleeting, leave on Dubuque and the tri-state area.

   Associated with this objective has been an effort to develop interpretive panels or information kiosks that illustrate the past and present role of waterway commerce in Dubuque's development.

6. Ensure long term competition among fleeters through long-term leases and to ensure that long term site development will sustain competition.

   This is a primary concern of the fleeting committee because of expected long term growth in fleeting and a local desire to allow competition to continue without public regulation unfairly promoting individual interests.

7. Expand long term fleeting capacity as needed.

   This objective was centered primarily on two sites managed by U.S. Fish and Wildlife. They had the potential for double present capacity. A Fish and Wildlife land use plan draft recently concluded that fleeting is incompatible with objectives of refuge complex management. Realizing the value of the fleeting sites to local shipping, Fish and Wildlife is offering to consider land trades for these sites, which will no longer be part of the refuge complex.

8. That ordinances or regulations for fleeting will be implemented and enforced by respective regulatory government agencies, using Iowa Administrative Code, Chp. 54 as a format.

   A local entity conceivably could manage barge fleeting sites along the River near Dubuque. Such an opportunity was near when the Fish and Wildlife Service offered the land exchange for the fleeting sites near Dubuque.

CONCLUSION

One of the key ingredients in the success of a fleeting committee is that committee members have vital interests in the local economy. This requires a cross section of committee members, from different levels of government, from relevant areas of expertise, from shippers, fleeters and the business community at large. This type of committee does not need to confine itself strictly to a single narrow issue. Caution is advised in diffusing its objectives, however.

Perhaps the most valuable function of the committee was its key role in presenting a united voice from the local level to state and federal officials involved in waterway management. Awareness by the appropriate federal officials of Dubuque's concerns have resulted in favorable consideration, for long term fleeting space in the Dubuque area, in land use master plans for the Mississippi River Valley.

The Fleeting committee will continue its work, with the approval of the DMATS Policy Committee, and at this point will monitor the land use plan review process underway with the U.S. Fish and Wildlife Service.

ILLINOIS' LAKE MICHIGAN WATER DIVERSION

Daniel Injerd
Illinois Department of Transportation

INTRODUCTION

Water levels on the Great Lakes have been abnormally high for over two years. By the end of January 1987, Lakes Michigan/Huron had set new record monthly highs for 16 consecutive months. Flooding on Chicago's famed Lake Shore Drive has become an all too frequent occurrence. Throughout the Great Lakes, widespread flooding and shoreline erosion, destruction of lakefront homes and coastal property and loss of valuable recreational facilities has again renewed interest in taking whatever measures are available to better control high water levels. Last August, the two federal governments asked the International Joint Commission, a bi-national commission formed to resolve disputes over boundary waters between the U.S. and Canada, to undertake a one year study of all existing control measures that could be implemented to provide some relief from high water levels. This includes increasing Illinois' diversion of Lake Michigan water.

Increasing Illinois' diversion of Lake Michigan water is a subject that generates strong opinions by both proponents and opponents. Its role in lake level management is often misundertood. The purpose of this paper is to briefly review the history of Illinois' diversion, the legal status of the diversion, the primary uses of our Lake Michigan diversion and finally, a discussion of the issues surrounding the potential for increasing the diversion.

HISTORY

Illinois' diversion of Lake Michigan water actually began back when the Illinois and Michigan Canal was opened to traffic in 1848. At that time, annual diversion from Lake Michigan was in the order of 100 cubic feet per second (cfs). In 1854 and 1885, major storms caused massive amounts of untreated sewage to be carried far out into Lake Michigan. This contaminated water found its way into the City of Chicago's water intakes, and caused an outbreak of two waterborne diseases, typhoid and cholera. In the 1885 epidemic, 90,000 people were killed. To correct this dangerous situation, the Sanitary District of Chicago (predecessor of the Metropolitan Sanitary District of Greater Chicago) was created and immediately began a major construction project to change the direction of flow of the Chicago and Calumet Rivers so that water from Lake Michigan and sewage from Chicago flowed into the Illinois River, which drains into the Mississippi River (Figure 1). Flow through the Sanitary and Ship Canal began in 1900 under permits issued by the Secretary of War. The North Shore Channel was completed in 1910, and the last leg, the Calumet-Sag Channel, was completed in 1922.

A 1910 Corps of Engineers permit limited diversion through all channels to a combined total of 4,167 cfs. However, the design capacity of the system was 10,000 cfs, and during the late 1920's annual diversion at times approached 10,000 cfs.

There is no question that the diversion project played an extremely important role in the continued development of the Chicago metropolitan area. Not only did it help to ensure a safe, dependable source of water supply for the area, but it also created a greatly improved transportation link between the Illinois/Mississippi River system and the Great Lakes.

LEGAL STATUS

Illinois' diversion of Lake Michigan water has generated sufficient controversy among the Great Lakes states and lower Mississippi River states such that the issue has come before the U.S. Supreme Court on several occasions. The possible health threat to St. Louis when the Sanitary and Ship Canal was first opened in 1900 prompted the first of many U.S. Supreme Court decisions in 1906. Concern over the possible adverse impact on water levels of the Great Lakes from the increasing diversion led the states of Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin to sue Illinois to stop its diversion. Having been convinced earlier that the diversion did not degrade water quality in the Mississippi River, the states of Missouri, Kentucky, Tennessee, Louisiana, Arkansas and Mississippi joined Illinois' defense. In a 1930 Supreme Court decree, Illinois was directed to reduce its diversion to no more than 6,500 cfs, by 1935 to 5,000 cfs and by 1938 to only 1,500 cfs. At that time, water withdrawn for domestic purposes was not subject to any limitation, even though most of it was also diverted. The reduction in diversion into the Sanitary and Ship Canal system coincided with ordered completion of sewage treatment facilities.

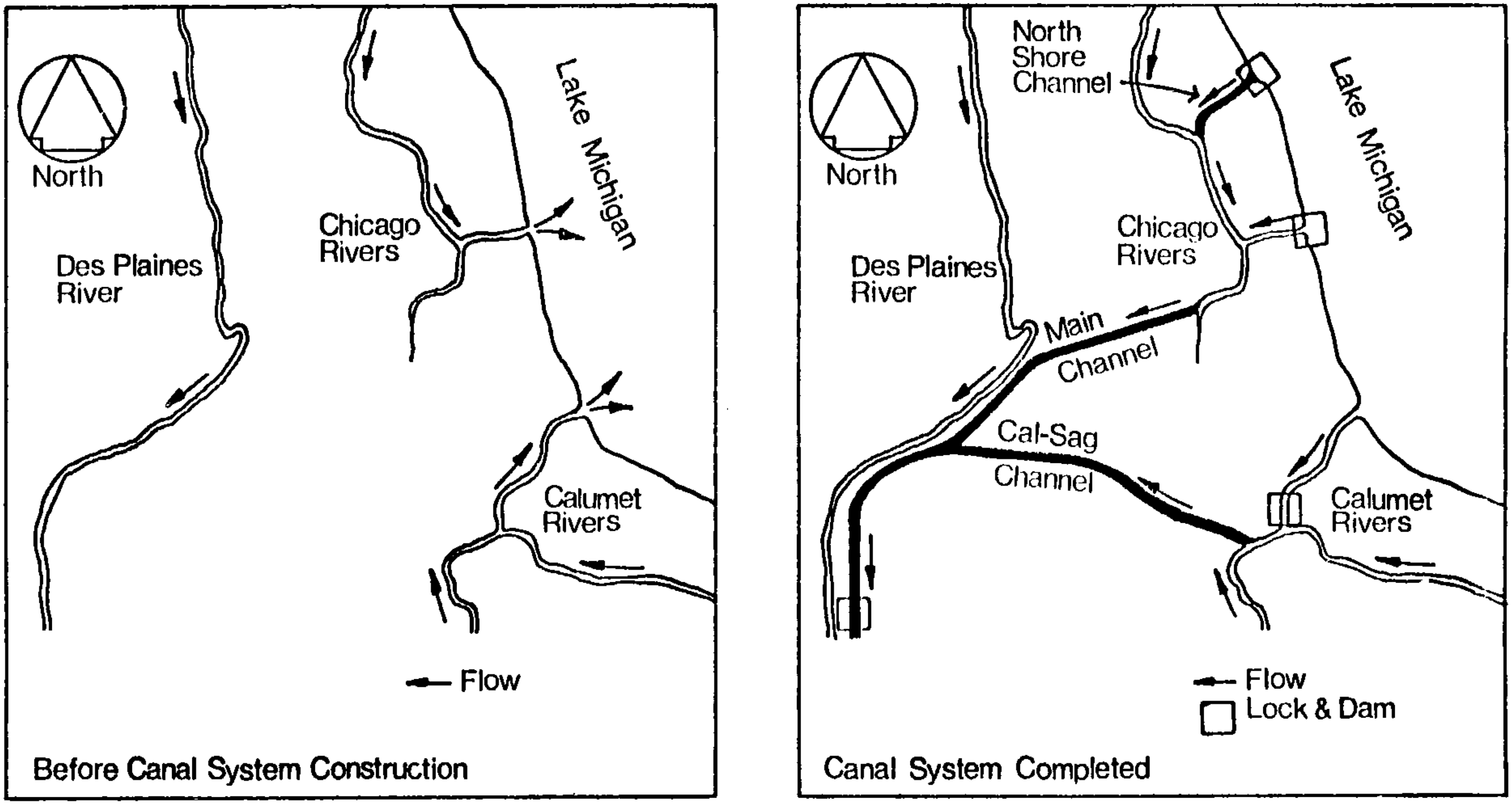

North
Des Plaines
River
Chicago
Rivers
Lake Michigan
Calumet
Rivers
Flow
Before Canal System Construction
North
North
Shore
Channel
Des Plaines
River
Chicago
Rivers
Lake Michigan
Main
Channel
Cal-Sag
Channel
Calumet
Rivers
Flow
Lock & Dam
Canal System Completed

FIGURE 1

In 1958, a suit was again brought before the U.S. Supreme Court by the Great Lakes states asking that Illinois be directed to return its treated sewage effluent to the lake. After an extended period of collecting testimony by the Court's appointed Special Master, the Court approved a new decree in 1967 that limited Illinois' diversion to 3,200 cfs, including domestic pumpage. A 5-year running average was to be used to determine compliance with the 3,200 cfs limitation. In 1980, the Court amended the 1967 Decree to extend the averaging period from 5 to 40 years to allow Illinois to use its diversion more efficiently.

The 1967 U.S. Supreme Court Decree, as amended in1980, allows Illinois to determine how the diversion should be apportioned among various competing interests. The General Assembly has directed the Department of Transportation to develop a continuing program for the apportionment of water to be diverted from Lake Michigan among regional organizations, municipalities, etc. for domestic purposes or for direct diversion into the Sanitary and Ship Canal.

ILLINOIS' DIVERSION TODAY

Illinois' diversion can be broken down into 3 primary categories: domestic water supply, direct diversion and stormwater runoff.

Domestic water supply is by far the largest category, and currently accounts for about 52% of our allowable 3,200 cfs diversion. Withdrawals occur along the Illinois shoreline at 15 separate water treatment plants. Chicago's two water treatment plants alone average 1,500 cfs, serving Chicago and its suburban customers. Currently, about 5 million people in northeastern Illinois use Lake Michigan water. By the year 2000, this number will grow an additional 1.7 million, due to regional growth in the area and the expansion of the Lake Michigan service area westward in DuPage and northwestern Cook Counties. The growth in domestic use of Lake Michigan water is due to the 1980 amended Decree which allows a more efficient allocation of our diversion for domestic use, to a reduction in the direct diversion of Lake Michigan water into the Chicago Sanitary and Ship Canal system and to the water conservation requirements that must be adopted by all users of Lake Michigan water.

Direct diversion of Lake Michigan water into the Sanitary and Ship Canal system occurs for two primary reasons: 1) to provide for safe navigation, and 2) to improve water quality in the canal system upstream of Lockport. Direct diversion occurs at three separate locations: at the mouth of the North Shore Channel at Wilmette, at the mouth of the Chicago River, and at the mouth of the Calumet River. There are navigation locks and controlling works on both the Chicago River and Calumet River; at Wilmette, there is only a controlling structure to allow lake water to enter the North Shore Channel.

Direct diversion for navigation purposes currently requires approximately 215 cfs, and includes water used in lockages, leakages, and to restore adequate depths in the canal after the threat of a storm event has passed. This component of diversion has been decreased in recent years due to the improvements in management of the canal system made possible by the implementation of the Metropolitan Sanitary District of Greater Chicago's Tunnel and Reservoir Plan.

The diversion of lake water into the canal system for water quality enhancement is called discretionary diversion, and has been set by state law at 320 cfs through the year 2000. After 2000, it will be reduced to 101 cfs. This component of diversion is used during the warm weather months only to improve water quality in the canal when most needed. Discretionary diversion occurs at all 3 locations.

The last category of Illinois' diversion is stormwater runoff from the 673 square mile watershed that was diverted by the reversal of the Chicago and Calumet Rivers. Under the provisions of the Supreme Court decree, this component of flow must be included in Illinois' allowable 3,200 cfs diversion. Although it is impossible to accurately measure this flow component, it probably is in the range of 680-700 cfs. This flow component is expected to increase as the Chicago metropolitan area becomes more developed, since stormwater runoff is higher from urbanized areas versus less developed areas.

Most of the dry weather flow at Lockport consists of wastewater treatment plant effluent from 3 large plants operated by the Metropolitan Sanitary District. The remainder consists of natural flows of the Chicago River, Little Calumet River and Grand Calumet River and direct diversion for lockages and leakages and, depending on the time of year, discretionary diversion. During significant storm events, stormwater runoff from the diverted watershed is discharged to the Chicago Sanitary and Ship Canal system through combined sewer overflows and storm outfalls. Discharges in excess of 20,000 cfs at Lockport can occur. On rare occasions, backflows to Lake

Michigan are allowed to prevent serious flooding in the Chicago metropolitan area.

ISSUES SURROUNDING AN INCREASED DIVERSION

The diversion of water from Lake Michigan by Illinois has stirred controversy ever since its inception. More recently, discussions about an increase in Illinois' diversion has similarly stirred strong feelings on both sides of the issue.

Table 1 is a listing of the monthly and annual mean diversions from Lake Michigan from 1900 through 1970. It is interesting to note that from 1900 through the late 1920s, diversion steadily increased, reaching a maximum in the late 1920s. Diversion then began decreasing in the early 1930s (in response to a 1930 U.S. Supreme Court Decree) and took an abrupt decrease after 1938 and has remained at approximately 3,200 cfs ever since. During a 2-1/2 month period in 1956/1957, an increased diversion to 8,500 cfs was authorized by the Supreme Court to be used to alleviate extremely low flow conditions on the Illinois and Mississippi waterway systems due to a prolonged drought.

In 1976, Congress authorized the Corps of Engineers to conduct a 5-year demonstration and study program of increasing Illinois' Lake Michigan diversion from 3,200 cfs up to 10,000 cfs. Although an actual increase in diversion was never implemented, the Corps of Engineers did complete an information report to the Congress in April 1981 which summarized their study findings. While a detailed review of that report is beyond the scope of this paper, of particular interest is their finding that since one of the constraints of an increased diversion was that no increased flow would be allowed during periods of heavy rainfall (to avoid the possibility of any increased risk of flooding), an annual increased diversion of 10,000 cfs could not be achieved. The Corps found that during a dry year, diversion could be increased to approximately 8,700 cfs on an annual average basis while during a wet year the increased diversion would only be about 5,000 cfs.

The 1981 Corps report found that an increased diversion at Chicago was not economically justified. However, it appears that their operating plan, developed to guide the actual increase in diversion, could be revised so that it is more sensitive to the various interests on the Illinois Waterway. For example, during low flow periods on the Illinois River, an increased diversion is probably beneficial to most, if not all, of the various interests. By developing an operating plan that

TABLE 1 Monthly and Annual Mean Outflow from Lake Michigan Basin through the Chicago Sanitary and Ship Canal in Cubic Feet per Second (Consisting of Diversion from Lake Michigan Watershed and Domestic Pumpage)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1900	1,449	2,315	2,099	2,727	3,228	3,226	3,333	3,576	2,307	3,450	3,813	4,334	2,990
1901	4,917	5,078	5,349	4,371	3,106	2,903	3,139	3,932	3,906	3,841	3,896	4,114	4,046
1902	4,194	4,204	4,233	4,165	4,166	4,071	4,321	4,204	4,291	4,155	4,248	5,352	4,302
1903	6,124	5,749	5,261	4,638	4,569	4,812	4,870	4,533	4,331	4,545	4,686	5,538	4,971
1904	5,457	5,170	5,549	5,311	5,125	4,101	4,553	4,573	4,151	4,004	4,452	5,067	4,793
1905	5,167	5,527	5,546	4,737	4,066	4,153	4,122	4,291	4,341	4,510	3,378	3,919	4,480
1906	4,457	4,626	4,393	4,568	4,719	4,420	3,996	3,426	3,740	5,221	5,198	4,907	4,473
1907	5,304	5,467	4,954	4,959	5,032	5,522	5,597	6,249	4,703	4,205	4,395	5,005	5,116
1908	4,057	4,462	6,781	7,660	7,529	7,466	6,861	6,704	6,533	6,506	6,371	6,389	6,443
1909	6,154	6,117	6,090	6,704	6,813	6,886	7,133	7,014	6,587	6,197	6,072	6,178	6,495
1910	6,830	6,459	7,055	6,964	6,968	7,219	6,870	6,677	6,572	7,061	6,800	6,523	6,833
1911	6,128	6,113	5,943	6,072	6,246	7,154	7,646	7,354	7,578	7,902	7,611	7,001	6,896
1912	6,239	5,968	6,135	6,829	6,344	6,871	7,500	7,766	7,764	7,619	7,411	6,809	6,938
1913	6,822	6,629	6,487	6,768	7,874	8,372	8,567	9,156	9,151	8,662	7,957	7,635	7,839
1914	7,319	7,312	6,858	7,205	8,027	8,168	7,863	8,252	9,000	8,392	7,624	7,703	7,815
1915	7,451	7,661	7,344	6,809	7,587	7,875	7,772	8,470	8,085	7,748	7,986	8,064	7,738
1916	7,926	7,601	7,572	7,491	7,759	8,506	9,569	9,065	8,163	7,972	8,434	8,345	8,200
1917	8,147	7,850	7,746	7,883	8,109	9,190	9,976	9,876	9,703	9,107	8,758	8,361	8,726
1918	7,721	8,492	8,354	8,604	8,962	9,486	9,928	9,348	8,668	8,722	8,726	8,910	8,826
1919	8,537	8,023	8,563	8,780	9,754	9,006	8,586	8,486	8,225	8,615	8,675	7,682	8,595
1920	8,178	8,114	8,528	8,246	7,776	8,046	8,219	8,502	9,061	8,753	8,472	8,258	8,346
1921	7,818	7,795	7,798	8,051	7,771	8,132	8,924	8,581	8,596	8,876	9,121	8,757	8,355
1922[b]	8,115	7,975	8,585	8,035	8,670	8,930	8,675	8,555	8,820	8,595	8,505	7,940	8,450
1923	7,835	7,485	7,720	7,670	8,030	8,140	8,095	8,384	8,445	8,325	8,245	8,080	8,038
1924	7,430	8,080	9,365	9,720	9,535	10,345	9,700	9,975	9,425	9,130	8,410	7,915	9,086
1925	7,460	7,705	8,055	8,335	8,305	8,430	8,460	8,195	8,310	7,990	7,250	7,275	7,981
1926	7,190	7,745	7,960	8,845	8,605	9,150	8,880	8,955	7,830	6,745	8,815	8,690	8,284
1927	8,520	7,870	9,110	7,855	6,790	6,555	7,835	9,115	10,045	9,795	10,245	7,675	8,450
1928	8,455	9,775	10,005	10,185	10,055	10,265	10,235	10,325	10,060	10,045	10,400	10,335	10,010
1929	10,105	10,175	8,280	6,805	5,785	10,035	9,080	9,475	11,015	11,435	11,070	10,135	9,450
1930	7,745	7,910	8,885	9,745	8,200	8,500	8,195	10,370	8,915	7,420	7,160	7,235	8,360
1931	8,120	7,655	7,575	7,565	7,990	8,355	7,945	9,005	8,815	8,770	8,455	7,905	8,180
1932	8,005	7,420	7,155	7,800	8,190	8,140	7,735	8,645	8,865	8,835	8,300	8,105	8,100
1933	7,120	6,820	7,660	8,200	7,750	8,545	8,925	8,750	8,525	7,690	8,095	7,965	8,005
1934	7,281	7,144	7,004	7,955	8,413	8,762	8,710	8,700	8,657	8,239	8,266	8,365	8,125
1935	8,312	8,325	8,235	8,375	8,291	8,214	8,024	7,732	7,217	7,824	8,752	7,734	8,086
1936	6,256	6,597	6,626	6,826	7,593	6,425	7,002	7,086	7,193	5,887	6,495	4,904	6,574
1937	6,257	5,599	5,437	6,305	5,815	6,724	7,303	7,675	6,921	7,172	7,388	7,252	6,654
1938	6,388	7,359	7,582	7,664	6,298	6,673	6,509	6,729	7,222	5,501	5,852	5,460	6,603
1939	2,901	3,949	3,169	2,695	2,605	4,211	2,873	2,899	2,826	3,018	2,816	3,465	3,119
1940	2,930	2,766	3,099	2,960	3,226	2,823	3,571	3,876	3,093	3,159	2,800	4,937[c]	3,270
1941	2,580	2,540	2,832	2,732	3,590	3,958	3,724	3,608	3,379	2,784	2,270	3,279	3,106
1942	2,734	3,447	2,924	2,859	3,077	3,111	3,285	3,547	3,733	2,841	2,750	2,936	3,103
1943	2,478	2,620	2,742	2,672	4,489	3,696	4,095	3,569	3,291	2,973	2,310	2,321	3,105
1944	3,206	2,633	3,179	3,126	3,022	3,330	3,278	3,316	3,081	3,136	3,346	2,993	3,137
1945	2,915	2,852	2,746	3,449	3,907	3,690	3,257	3,322	3,201	2,848	2,496	2,326	3,085
1946	2,846	2,886	3,019	2,598	4,099	3,579	3,774	3,516	3,200	2,653	2,713	2,256	3,095
1947	2,904	2,789	2,877	4,011	3,064	3,474	2,930	3,986	2,967	2,600	2,382	3,406	3,116
1948	2,586	2,506	3,096	2,361	2,896	3,453	3,918	4,446	3,992	3,132	2,475	2,821	3,140
1949	2,474	2,380	2,434	2,480	3,436	4,132	4,244	4,113	3,708	3,007	2,396	2,812	3,134
1950	2,500	2,551	2,601	2,981	2,482	3,930	4,053	3,990	3,750	2,951	2,397	3,088	3,106
1951	2,659	2,731	2,695	2,976	3,185	3,765	3,785	3,862	3,903	3,191	2,437	2,091	3,106
1952	2,377	2,206	2,686	2,719	3,146	3,924	4,077	4,028	3,397	2,749	2,870	3,380	3,130
1953	2,485	2,393	2,790	2,738	3,149	3,533	3,582	4,192	4,446	2,763	3,027	3,195	3,191
1954	2,857	2,622	2,902	3,330	3,153	3,336	3,967	3,998	3,188	4,238	2,106	2,765	3,205
1955	2,731	2,809	2,626	3,525	3,708	3,706	3,661	3,797	3,261	2,825	2,821	3,455	3,244
1956	2,820	2,790	2,725	3,507	3,439	3,586	3,848	4,052	3,260	3,242	2,882	5,834	3,499
1957	9,102[d]	8,009[d]	2,863	3,357	3,352	3,355	4,015	3,427	2,998	3,146	3,045	3,379	4,171
1958	2,877	3,341	2,785	3,245	3,419	3,500	3,640	3,456	3,125	2,962	3,341	3,409	3,258
1959	4,626	2,592	2,814	2,840	2,670	3,357	3,699	4,164	3,242	3,069	2,937	3,478	3,291
1960	3,571	2,905	3,060	3,660	3,457	3,256	3,217	3,187	3,400	2,933	3,021	3,580	3,271
1961	2,915	2,906	3,013	3,530	3,540	3,711	3,671	3,731	4,551	2,292	2,035	2,968	3,239
1962	2,944	2,442	2,538	2,916	3,547	3,668	3,834	4,079	3,707	3,131	3,127	3,527	3,288
1963	2,413	2,662	2,758	3,892	3,929	3,758	3,832	3,565	3,212	2,729	3,117	3,399	3,272
1964	2,488	2,473	2,679	3,222	3,502	3,944	4,098	3,651	3,712	2,747	3,483	3,142	3,262
1965	2,841	2,789	3,018	3,367	2,967	3,181	3,433	4,225	3,642	2,788	2,780	3,390	3,202
1966	2,275	2,638	2,880	3,436	4,058	2,620	3,354	3,973	3,482	2,740	3,308	3,642	3,200
1967	2,296	2,426	2,810	3,553	2,568	3,940	3,235	3,703	3,914	4,008	3,025	3,387	3,239
1968	2,233	2,478	1,803	2,767	3,307	3,726	3,658	4,341	3,415	3,294	3,879	4,445	3,279
1969	2,894	2,026	2,180	3,551	3,644	4,444	4,871	4,267	4,051	3,116	1,951	1,943	3,245
1970	2,865	3,243	2,215	4,320	4,545	4,286	3,669	3,251	3,595	3,106	2,684	2,211	3,333

[a] As reported by the Sanitary District of Chicago.

[b] The first seven months were recomputed in 1928, correcting errors in original computations and adding 12% increased leakage allowance to discharge of turbines in operation.

[c] The U.S. Supreme Court authorized an increase in diversion from Lake Michigan Watershed from 1,500 cfs to 10,000 cfs in addition to domestic pumpage for one continuous period from an appropriate hour on December 2, 1940 to the same hour on December 12, 1940.

[d] The U.S. Supreme Court on December 17, 1956 authorized an increase in diversion from Lake Michigan Watershed from 1,500 cfs to an amount not exceeding an average of 8,500 cfs in addition to domestic pumpage to and including January 31, 1957 and on January 28, 1957 extended this authorized increase to and including February 28, 1957.

Source: Great Lakes Basin Commission Framework Study, Appendix 11, p. 207

is sensitive to the concerns, particularly to the agricultural community and to those subject to flooding, it should be possible to avoid adverse impacts to those groups. We have asked the Corps to begin to update their 1981 report and draft a new operating plan that will provide a high degree of assurance that adverse impacts to particular user groups on the Illinois Waterway resulting from an increased diversion will be minimized, if not prevented.

Proper authorization for an increased diversion at Chicago can only come from an act of Congress or a modification to Illinois' U.S. Supreme Court Decree. Because of the international aspects involved with water level regulation on the Great Lakes, we believe it inappropriate to bring this issue before the Supreme Court. Recently, two Wisconsin Congressmen introduced legislation, both of which calls for an increase in Illinois' diversion. It is the opinion of the Division of Water Resources that any federal legislation calling for an increased diversion at Chicago contain the following key elements:

1. Any authorization for an increased diversion at Chicago should be part of a recommended plan of action between Canada and the U.S.

2. The recommended plan of action should include all existing control measures which can be use to reduce water levels on the Great Lakes. This includes not only an increased diversion at Chicago but also stopping or curtailing the diversion of water into Lake Superior at Long Lake and Ogoki, maximizing flows out of the Niagara River and the Welland Canal, including increasing the flows to the Black Rock Lock during the non-navigation season.

3. The recommended plan of action should be implemented only during periods of high lake levels.

Concerning any authorization to increase the diversion at Chicago, we believe the following conditions would need to be made part of any authorization.

1. The actual implementation of any increased diversion should be under the direct jurisdiction and supervision of the U.S. Army Corps of Engineers.

2. Any increase in diversion should follow an approved operating plan that, while striving to provide maximum lake level relief, will also protect downstate interests on the Illinois such that increased flood damages do not occur,

that safe navigation is ensured, and that minimizes adverse impacts to agricultural interests along the waterway. Prior to any increase in diversion occurring, the Corps of Engineers should prepare an environmental assessment and conduct several hearings in areas most affected by an increased diversion to explain their operating plan and to receive any information that will be helpful in ensuring that a safe operating plan is developed that will protect Illinois interests.

3. An increased diversion for lake level control should be limited to periods of time when the level of Lake Michigan is significantly above its average level.

4. Included with any authorization to increase diversion should be a monitoring program to accurate assess the impacts of an increased diversion, including an analysis of impacts on water quality, flood damage, commercial navigation, fish and wildlife interests, agriculture and the ability of any control structures to safely store or discharge additional water.

It is too early to predict what Congress might do in response to the problem of high water levels on the Great Lakes. The International Joint Commission is expected to complete an interim report this August on existing measures which can be implemented to reduce the adverse consequences of high water levels. Included in their report will be a discussion on increasing Illinois' diversion. One of our most important tasks is to continue to collect information on the potential impacts of an increased diversion and to work with the Corps of Engineers in drafting an revised operating plan so that if an increased diversion is authorized, Illinois' interests are adequately protected.

ILLINOIS RIVER - HYDROLOGIC ISSUES AND TRENDS

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BACKGROUND

The Illinois River Basin lies largely in the state of Illinois as indicated in figure 1. Portions of the basin, however, lie within Wisconsin (including the upper regions of the Fox and Des Plaines Rivers) and Indiana (including portions of the Kankakee and Iroquois Rivers.)

The river basin occupies some 44% of the land area of the state of Illinois. Included within this vast resource are 46% of our agricultural land, 28% of our forest land, and 37% of our surface water and streams. Perhaps more startling is the fact that over 95% of the urban area of the state lies within the Illinois River Basin.

This heavy human occupancy and dependence on the river to meet many conflicting demands are responsible for most of the problems that we see with the river today. It is hard to imagine a river that has had more impact from man than has the Illinois. Prior to 1850 human impacts were relatively insignificant. In the last half of the century, however, a series of events began that would leave the river changed forever.

- Between 1872 and 1893 dams were constructed at Henry, Copperas Creek, LaGrange, and Kampsville. This created a 7-ft navigational channel from the Mississippi River upstream to LaSalle.

- By 1900 flow reversals in the Chicago and Calumet Rivers and diversion of Lake Michigan resulted in an average increase in flow of 7600 cfs in the Illinois River. This flow was accompanied with a large volume of untreated sewage from the rapidly growing Chicago area.

- Between 1900 and 1920 levees were constructed throughout the basin removing 185,000 acres of land from the floodplain.

- In 1938 a Supreme Court decision decreased the diversion from Lake Michigan to an average flow of 3200 cfs.

- In 1939 the 9-ft navigational channel all the way to Lake Michigan was completed and operated essentially as we know it today.

During the same period of time that these significant events occurred, more subtle trends were occurring. These included clearing of forest land, drainage of wetlands, urban development, intensive agriculture, continued levee construction, and increases in the volume of navigation. Superimposed on these trends since 1960 has been an apparent increase in annual precipitation.

Each of these trends produced physical changes that impact the river itself. The more obvious impacts of each of these trends are listed below.

- Clearing forest land
  - Reduced evapotranspiration
  - Reduced infiltration
  - Increased runoff
  - Increased erosion
- Wetland drainage
  - Reduced evapotranspiration
  - Reduced flood storage
  - Increased runoff volume
  - Increased flood peaks
- Urban development
  - Reduced infiltration
  - Accelerated runoff
  - Increased runoff volume
  - Increased flood peaks
  - Increased waste loads
- Intensive agriculture
  - Reduced infiltration
  - Increased runoff volume
  - Increased erosion
  - Increased chemical washoff
- Levee construction
  - Reduced flood storage
  - Increased flood peaks
  - Increased flood stages
- Navigation dams -- short term
  - Creation of deep pools
  - Increased area of backwater lakes
  - Increased low flows
- Navigation dams -- long term
  - Increased sedimentation
  - Increased barge traffic
  - Sediment resuspension
  - Shoreline erosion

It should be noted that most of these trends included an increase in runoff or an increase in erosion or sedimentation. Rather than being offsetting, the impacts of all these events and trends were cumulative with respect to runoff and sedimentation.

TRENDS IN FLOW

The extent to which the construction of the various locks and dams to create the 9-ft waterway impacted the flow regime of the river is clearly illustrated in figure 2. The free-flowing river was replaced with a series of pools that could be manipulated to maintain a 9-ft navigational depth throughout the year.

Flow on the Illinois River at Marseilles since the record began in 1920 is used to illustrate the impact of the Lake Michigan diversion. Figure 3 shows that the mean flow between 1920 and 1938 averaged just under 13,000 cfs. Since the diversion was reduced in 1939, the flow has averaged less than 10,000 cfs. If there were no diversion from Lake Michigan, average flow on the Illinois River at Marseilles would have been approximately 6500 cfs.

The 1920 to 1983 period of record at Marseilles was also used to examine trends in high flows of various durations. Figure 4 shows the 10-year moving average during this period for the 7-, 15-, 31-, and 61-day high flow periods. The 10-year moving average tends to damp out the annual fluctuations so that trends are more easily discernible. An examination of this plot indicates a trend toward increasing high flows since the early to mid-1960s. This is most dramatic for the shorter 7-day high flow period.

Further examination of this same figure indicates that the duration of relatively high flows have also been increasing with time since 1960. In 1965 the duration of a flow of 25,000 cfs, for example, would have been expected to last for about 31 days. By 1975, however, figure 4 shows that a flow of 25,000 cfs would have been expected to continue for 40 to 50 days. These longer-duration high flows can have negative impacts on agricultural drainage and habitat, and can increase sediment resuspension and deposition.

An increase in the high flows and the duration of high flows might be expected to be related to most of the trends previously identified. In this case, however, they seem to be more closely related to the wet years experienced since 1960.

The precipitation records for Aurora and DeKalb from 1903 through 1983 are presented in figure 5. These gages are typical of northeastern Illinois for this period. The 5-year moving average has been plotted to damp out the annual fluctuations and to make it easier to recognize trends. It appears that there has been a trend toward increased precipitation since the early 1960s. It should be noted, however, that although precipitation has increased since 1960, it is not in excess of the amounts experienced in the early 1900s.

Although there appears to be a correlation between the increase in precipitation and the increase in high flows on the Illinois River, the degree to which the higher flows are a direct result of the increased precipitation is not known at this point. The other trends and events identified earlier have also contributed to the higher flows.

Flow duration curves for the periods 1920 through 1939 and 1940 through 1983 for the Illinois River at Marseilles are presented in figure 6. These curves clearly indicate that the reduction of diversion in 1939 resulted in lower low and mean flows. They further illustrate that for approximately 5% of the time, despite the lower diversion, the flow at Marseilles is now higher than it was during the 1920-1939 period.

TRENDS IN SEDIMENT ACCUMULATION

As shown in the case of flow, the development trends have also impacted on erosion and sedimentation. Here too the impacts tend to be cumulative rather than offsetting. The following discussion is based on Peoria Lake because of the data available there. The problems described, however, are typical of other pools and backwater lakes of the Illinois River Basin.

Studies by the Water Survey on Peoria Lake have documented the increasing sedimentation problem (Demissie and Bhowmik, 1986). Figure 7 is a cross section through the center portion of lower Peoria Lake. It clearly illustrates the original valley bottom (1903) as well as the progressively deeper layers of silt for 1965, 1976, and 1985. The continuing loss of volume with time is further illustrated in figure 8. Here it is shown that the upper lake has been losing volume more rapidly than the lower lake during the past 25 years. Between 1903 and 1965 Peoria Lake lost 0.63 percent of its capacity per year. Since 1966 Peoria Lake as a whole has been losing volume at a rate of 1.4% per year. This is nearly three times the volume loss rate at Lake Decatur and five times that of Lake Springfield. The upper lake has lost 73% of its 1903 volume while the lower lake has lost 51% of its 1903 volume.

SUMMARY

Some of the human activities in the Illinois River Basin since the mid-1800s have been identified and discussed. Several of these activities have had similar impacts on parameters such as infiltration and evapotranspiration. As infiltration and evapotranspiration have decreased, runoff has tended to increase. Reduction in flood storage areas with increased runoff has resulted in higher peak flows and higher stages.

Despite a reduction in Lake Michigan diversion in 1939, flood peaks and high flows occurring 5% of the time at Marseilles are greater now than they were prior to that time. There is also evidence that the durations of high flows have increased since 1960. The increased flows are to some degree a result of the development trends described, but increasing precipitation since 1960 is a major factor.

The higher runoff and land use activities associated with intensive agriculture and urban development have resulted in increased erosion from both the uplands and channel banks. The river pools created for navigation have in turn trapped these eroded materials, causing a high sedimentation rate.

REFERENCES

Demissie, Misganaw and Nani G. Bhowmik. 1986. Peoria lake sediment investigation, Illinois State Water Survey, Contract Report 371, Champaign, IL, 88 p.

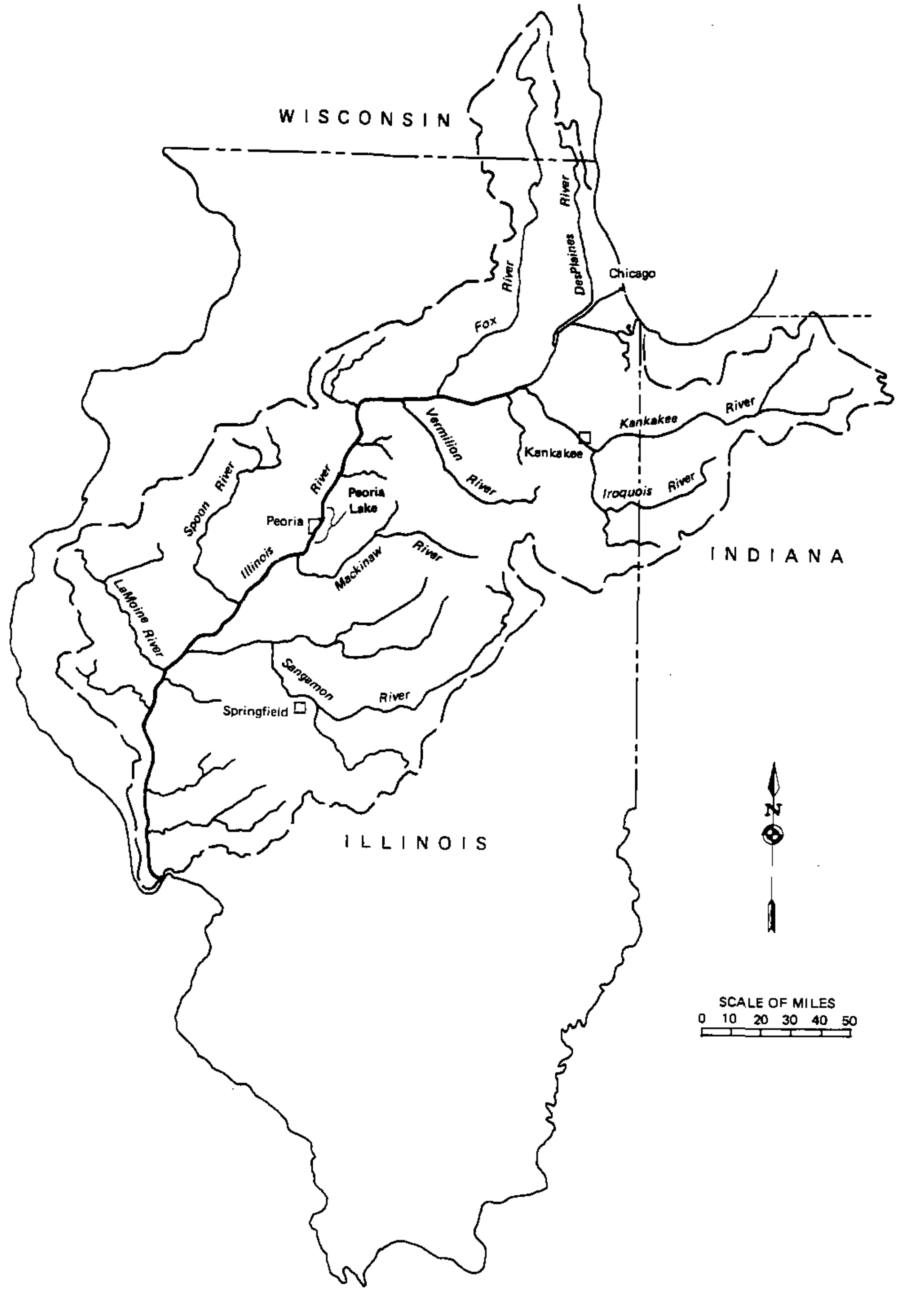

Figure 1. Drainage map of the Illinois River.

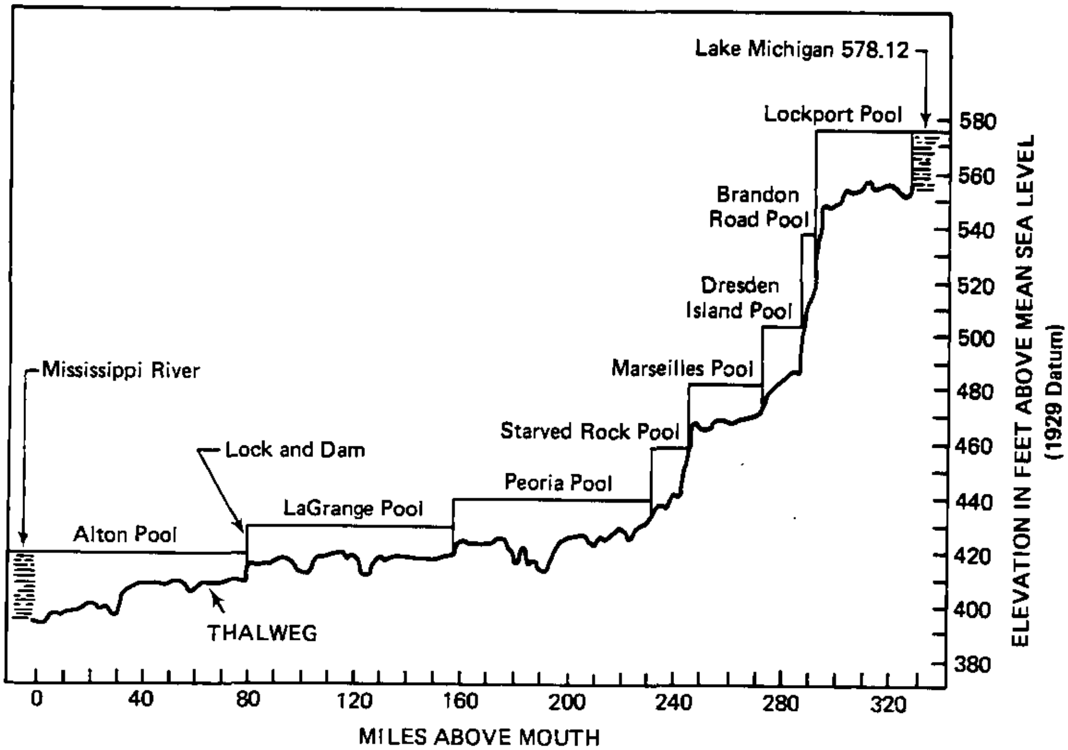

Figure 2. Profile of the Illinois Waterway.

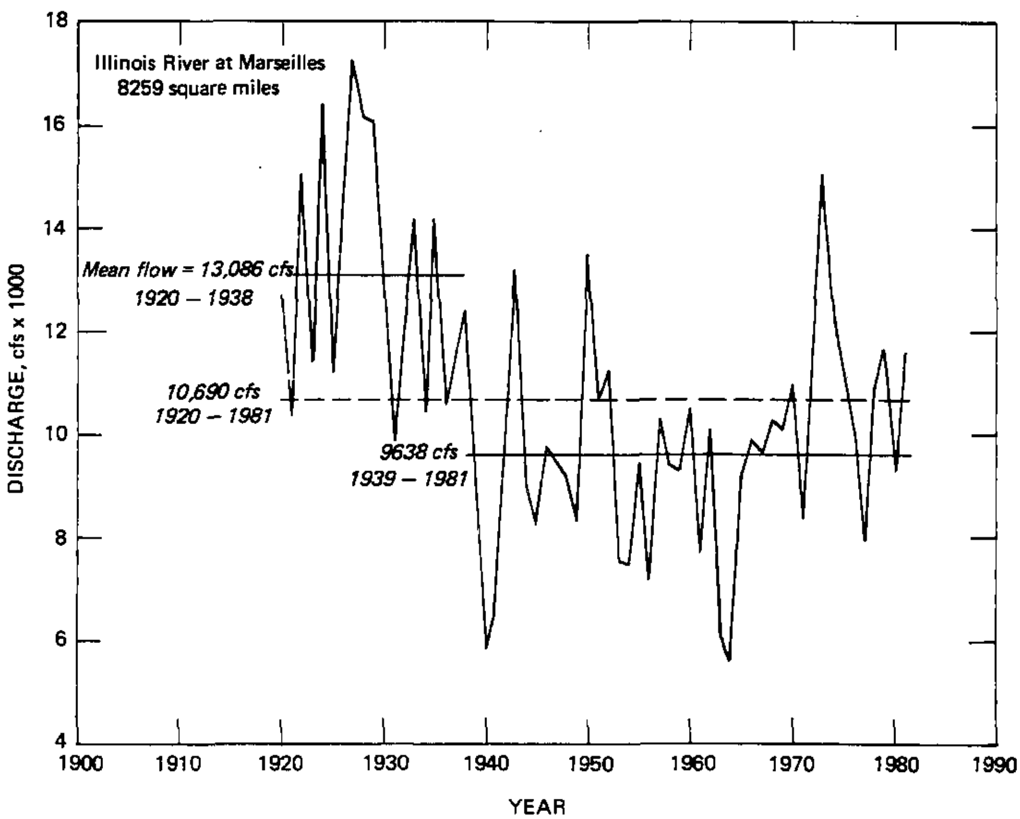

Figure 3. Influence of Lake Michigan diversion on flow in the Illinois River at Marseilles.

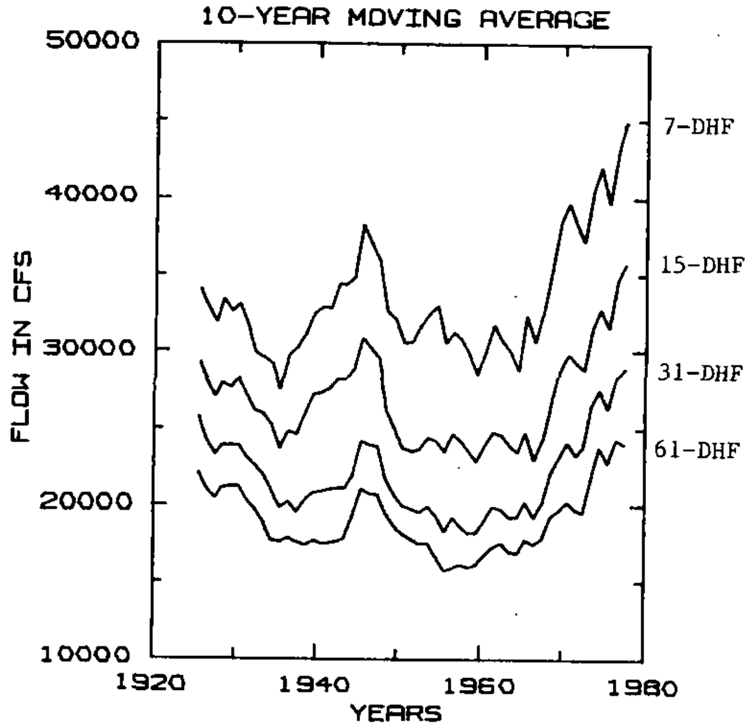

Figure 4. High flows of 7-, 15-, 31-, and 61-day duration on the Illinois River at Marseilles.

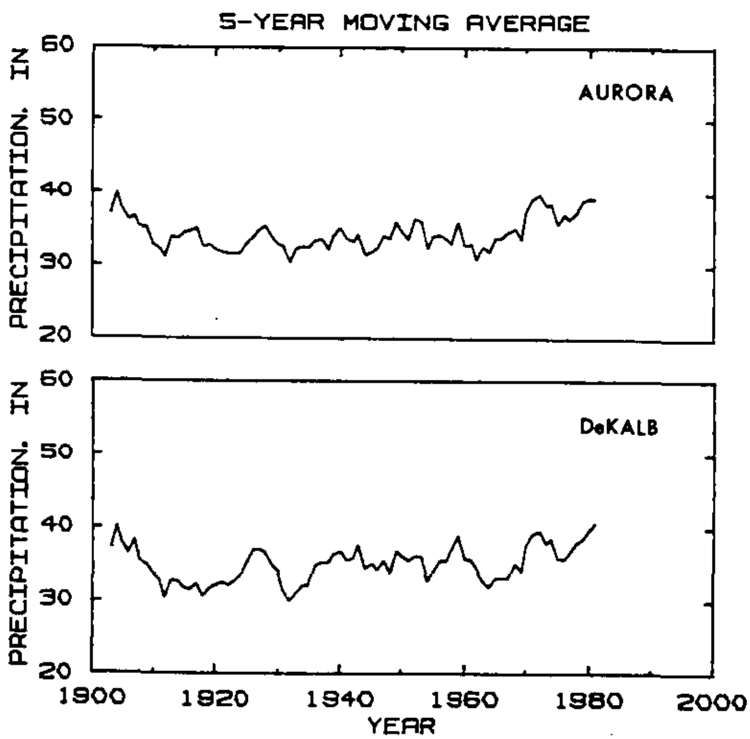

Figure 5. Precipitation at Aurora and DeKalb, Illinois.

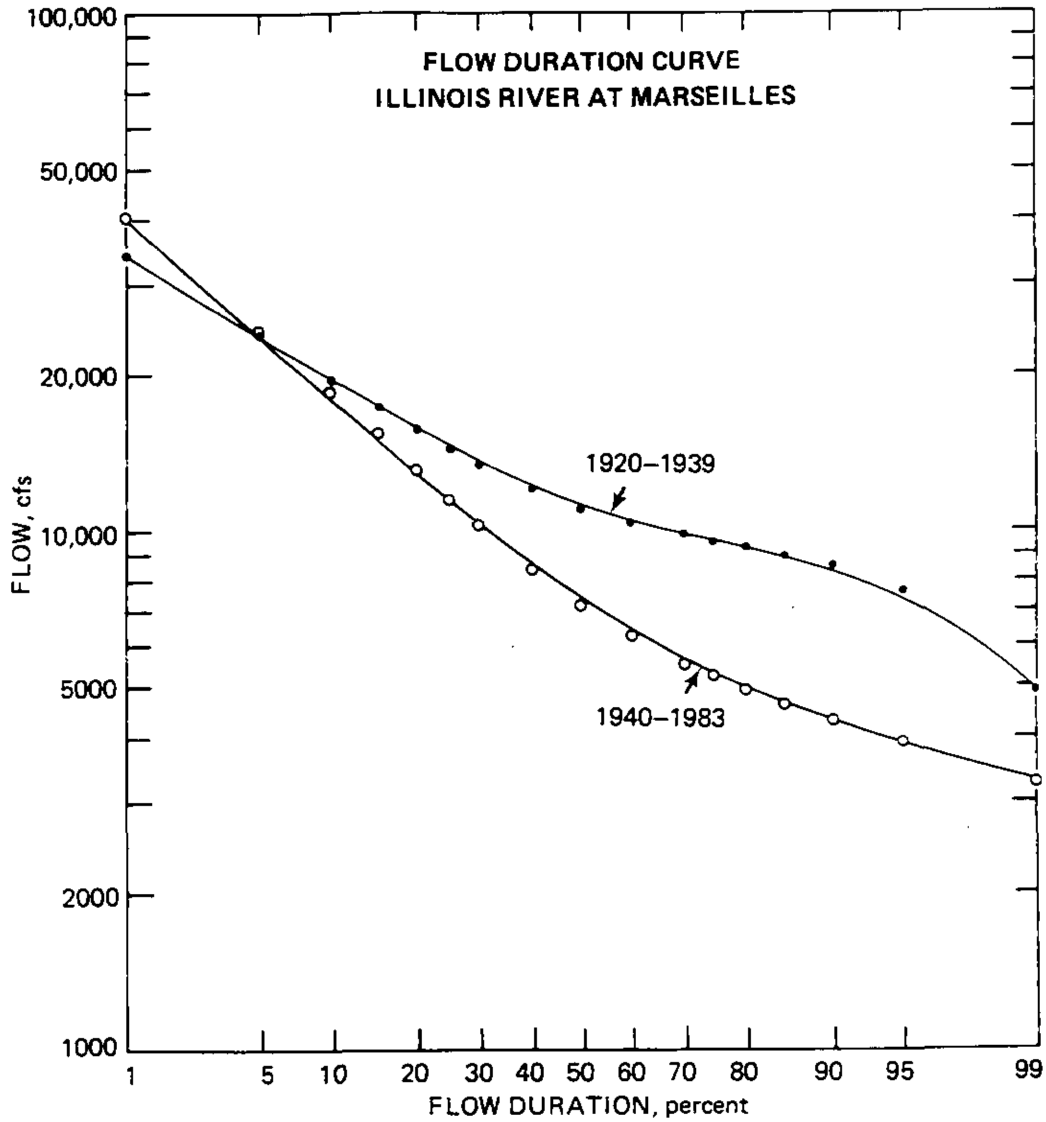

Figure 6. Flow duration curves for the Illinois River at Marseilles 1920-1939 and 1940-1983.

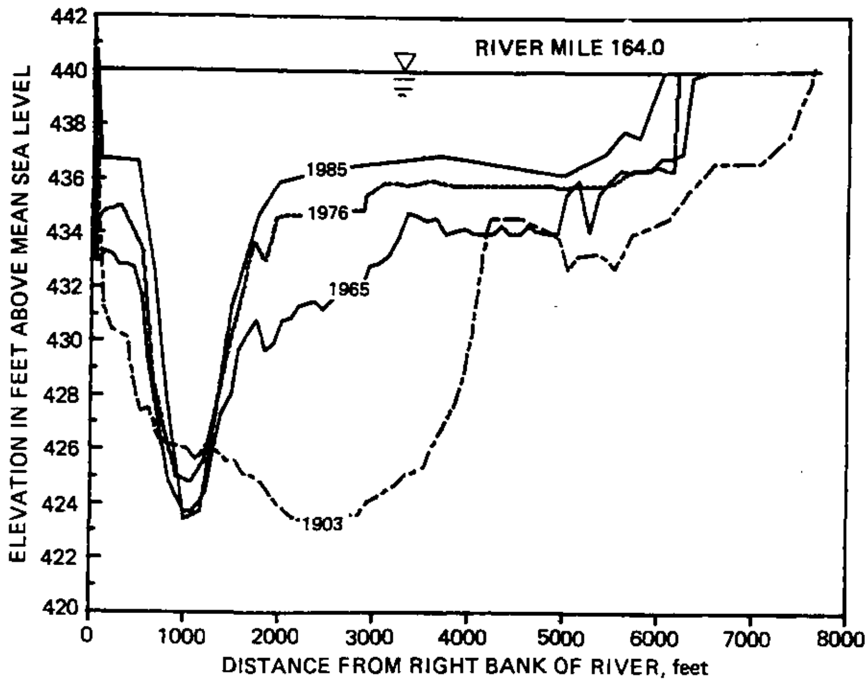

Figure 7. Cross section through lower Peoria Lake at River Mile 164.

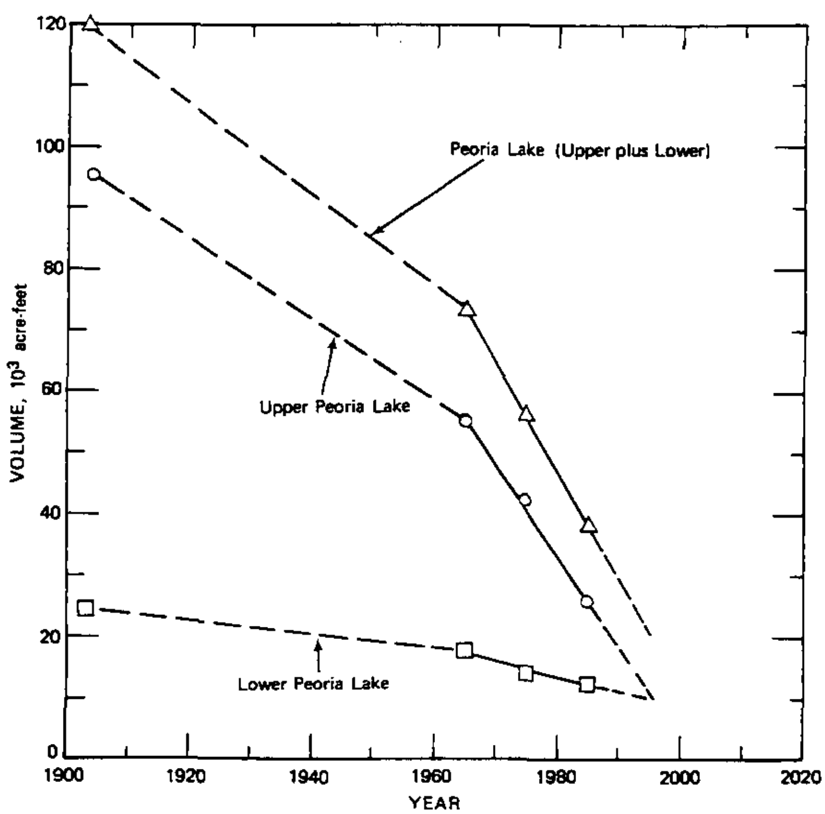

Figure 8. Volume of Peoria Lake 1903-1985.

FLOOD FORECASTING IN THE ILLINOIS RIVER BASIN

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I. Geography

The Illinois River Basin (Figure 1) encompasses a natural drainage area of 28,200 square miles of which approximately 1000 (3.5%) square miles are located in Wisconsin, 3200 (11.5%) in Indiana and 24,000 (85%) in Illinois. The Metropolitan Sanitary District of Chicago, by reversing the flow of the Chicago and Calumet Rivers and intercepting certain drainage areas along the Lake Michigan shore has added to the Illinois River watershed about 673 miles from the Lake Michigan watershed making a total of 28,873 square miles.

The northern-most headwaters of the Illinois River Basin originate with the Des Plaines River in Racine County, Wisconsin, and the Fox River which has its headwaters in Waukesha County, Wisconsin. The eastern-most headwaters of the watershed begin with the Kankakee River in St. Joseph County, Indiana. The Des Plaines and Kankakee Rivers join near Wilmington, Illinois to form the Illinois River (river mile 273).

The entire basin has been glaciated several times. The period of glaciation gave the river its unique river course, roughly running east to west until it reaches the great bend at Hennepin. From Hennepin it flows southwest, joining the Mississippi River at Grafton. As a result of glaciation, the terrain of the Illinois Basin varies from slightly rolling to quite flat. The subbasins within the Illinois basin reflect these variations in topography and each reacts different hydrologically.

Other major rivers in their own right which flow into the Illinois include:

1) Fox River
2) Mazon River
3) Vermilion River
4) Mackinaw River
5) Spoon River
6) Sangamon River
7) LaMoine River

The largest tributary is the Sangamon with a drainage area of over 5200 square miles. This represents about 1/6 of the Illinois basin. The 2nd largest tributary is the Kankakee, with a drainage area of about 5150 square miles.

Because of the large size of the Illinois basin, floods can be occurring in part of the basin, while other parts of the basin remain unaffected. Response of the tributaries also varies widely. For example, the upper reaches of the Fox above McHenry Dam respond very

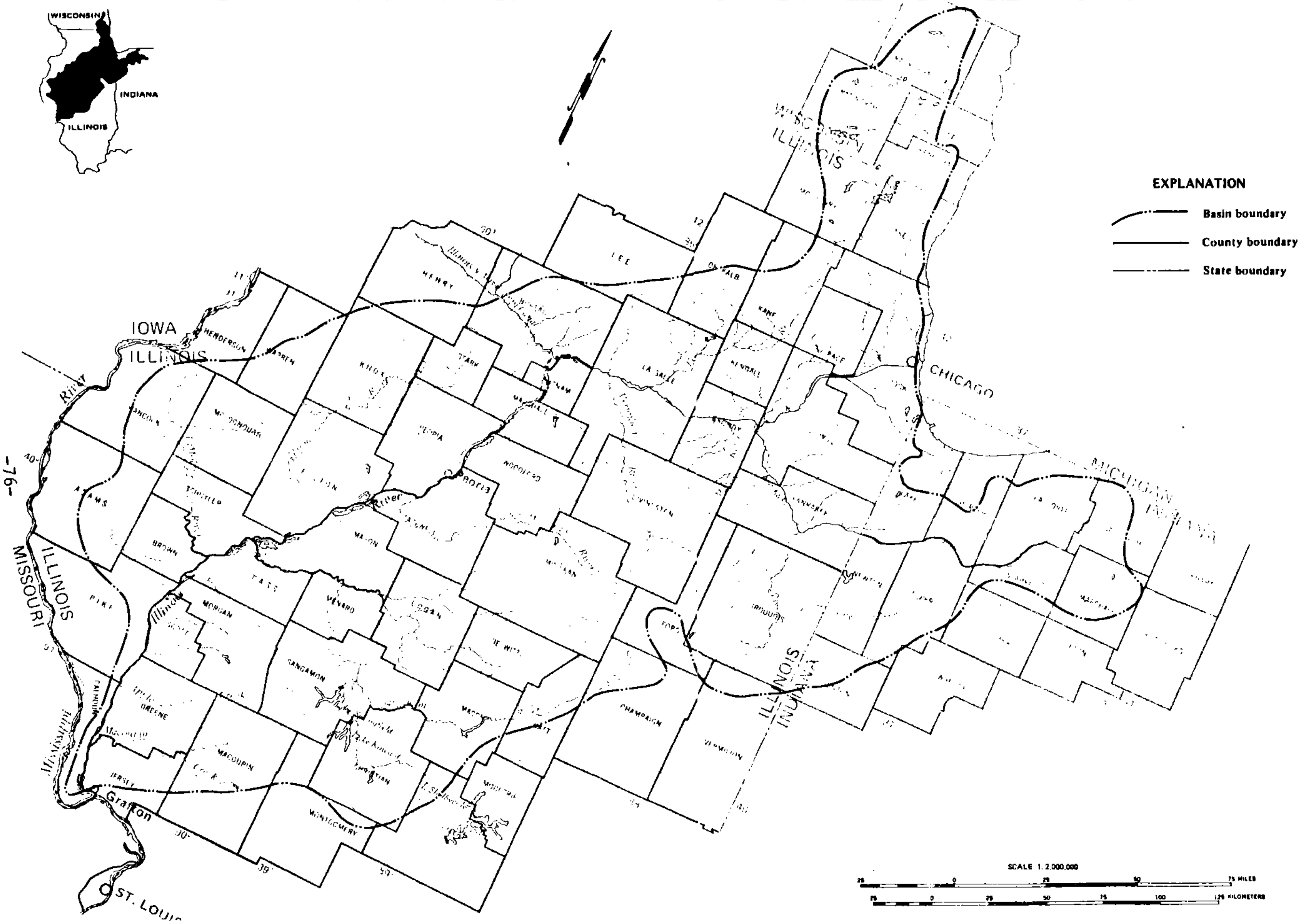

Figure 1. Illinois River Basin

slowly because of extensive marshlands & lakes. The marshlands and lakes act as a large reservoir regulating the rise and fall of the river. On the other hand the Des Plaines which flows parallel to the Fox responds much faster. The topography is a little more rolling and the watershed lacks the extensive marshes and lakes. As a result there is no "natural reservoir" to regulate the flow of the Des Plaines.

The gradient of the Illinois River mainstem changes appreciably below LaSalle. Above LaSalle the gradient is "fairly steep" and "quick rises and falls" at Morris are characteristic (Figure 2). Below LaSalle the slope flattens to such a degree that backwater affects the rate with which the Illinois drains. The "backwater effect" is significant upstream as far as Beardstown. As a result during highwater on the Mississippi a pronounced ponding takes place on the Illinois River. In essence the Mississippi acts as a dam and the Illinois River, as far upstream as Beardstown becomes the reservoir.

In addition there are numerous "lakes" which increase the storage of the lower Illinois. Most notably are the Upper and Lower Peoria Lakes, which serve to attenuate the peak stages at Peoria.

II. Data collection

Because the Illinois basin is so large, forecasting requires a considerable amount of data, both precipitation (rain & snow) and river stages.

Hydrologic and meteorlogical data to forecast the Illinois River is collected by numerous agencies, both state and federal. These include:

1) State of Illinois
    a) Div of Water Resources (IDOT)

2) Federal
    a) U.S. Geological Survey (USGS)
    b) Corps of Engineers (COE)
        1) St. Louis District
        2) Rock Island District
        3) Chicago District
    c) National Weather Service (NWS)

From a National Weather Service standpoint we collect data through our offices in Peoria, Springfield and Chicago. Data is collected at these offices every morning, as well as during the afternoons and evenings when flooding is occurring. This data is then coded in a standardized format for direct input into a computer by hydrologists at the River Forecast Center in Minneapolis.

Most river sites have been automated, with either satellite (GOES DCPs) platforms or telephone interrogable devices (DARDCs, BDTs & Telemarks). The satellite platforms have been installed by the Corps of Engineers, while most telephone interrogable devices have been installed by either IDOT, NWS or the Corps. Even though more and more data sites

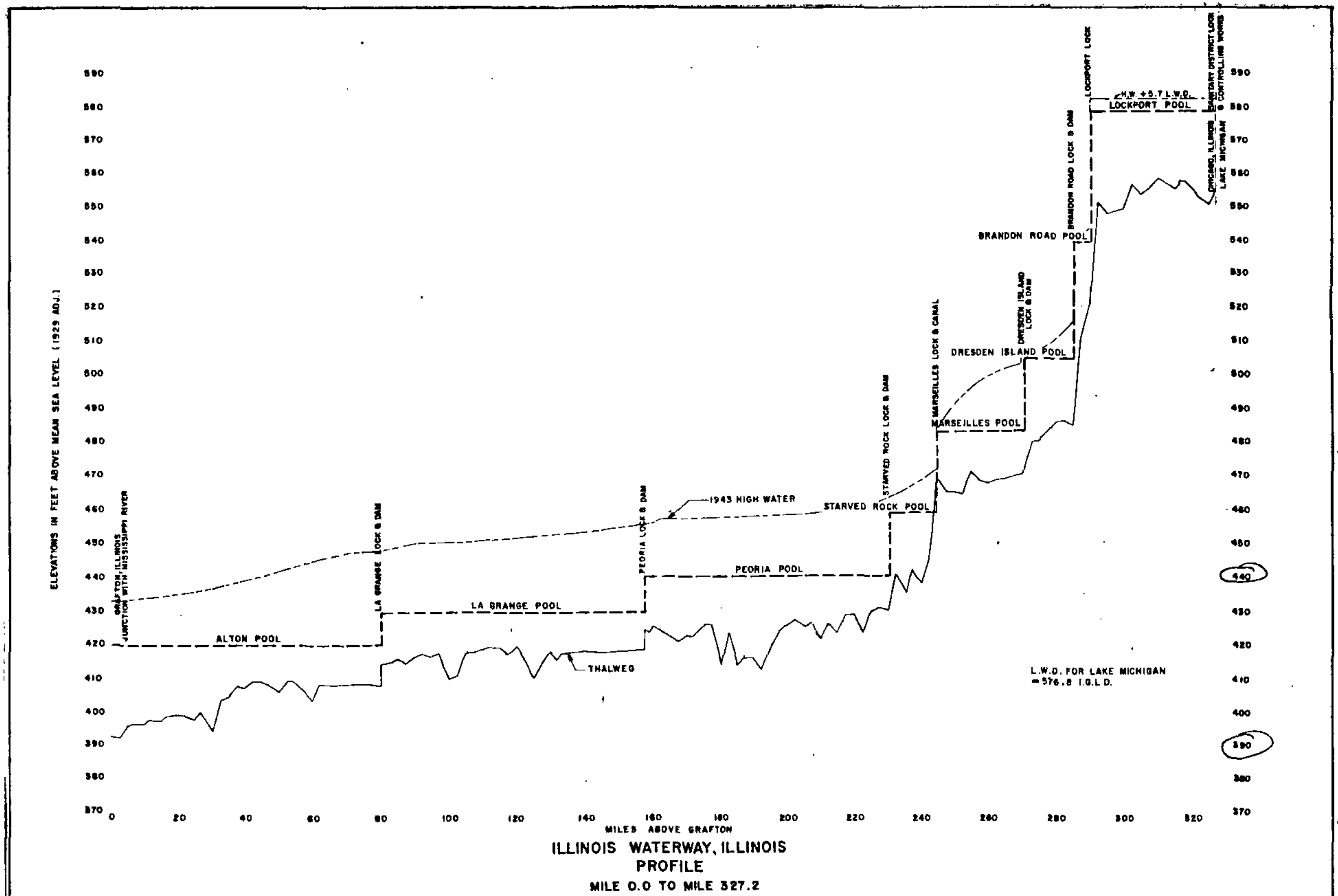

Figure 2. Profile - Illinois River

are being automated, much precipitation data continues to be collected by observers in the National Weather Service cooperative observer network (Figure 3). These reports are phoned to the nearest National Weather Service office for relay to the River Forecast Center at Minneapolis.

Stations collecting data from river (Figure 4), rainfall, and river/rainfall stations have been established to report or be interrogated according to specified criteria. To the extent possible, reporting criteria have been standardized to achieve a uniformity in station operation. For river stations, reporting criteria have standardized reporting to once daily; more often during flooding. At rainfall stations, observers have been instructed to report at 7am/1pm/7pm whenever more than 0.50" of rain has fallen during the preceding 6-hour period; follow-up calls are to be made until the rain ends.

Altogether the National Weather Service operates 98 precipitation stations in the Illinois River basin. While, in cooperation with other agencies, there are a total of about 135 hydrologic data stations. GOES/DARDC data comes in automatically 4x/day. In addition the DARDC data can be either called by telephone or the GOES data can be requested from the National Environmental Satellite Service (NESS) through AFOS, the NWS communication system.

WSFO Chicago also prepares a table of DAILY RIVER STAGES ... ILLINOIS for dissemination on the Illinois Weather Wire. The table lists flood stage and the day's stage reading for major points of interest along the state's rivers and reservoirs, including the Illinois River.

III. Forecasting

While the Weather Service Forecast Office at Chicago is responsible for issuing flood/river stage warnings and statements for public release within the state of Illinois, it receives technical and numeric guidance support from either of two River Forecast Centers; Minneapolis or Cincinnati. The geography of the Illinois is such that the River Forecast Center at Cincinnati handles drainages in the Ohio River basin, while the River Forecast Center at Minneapolis handles drainages in the Mississippi River basin. This includes the Illinois River.

In addition to providing numeric forecasts, the River Forecast Centers are responsible for the development of forecast techniques within the portion of the state for which they provide forecasts. While the River Forecast Center issues hydrologic guidance and forecasts, the Forecast Office in Chicago is responsible for adaptation of that guidance/forecast and the preparation, issuance and dissemination of flood/river stage warnings and statements for the state of Illinois.

Forecasting the Illinois River requires the integration of forecasts for a number of smaller rivers. Each of these smaller rivers presents its own unique set of forecast procedures when it comes to

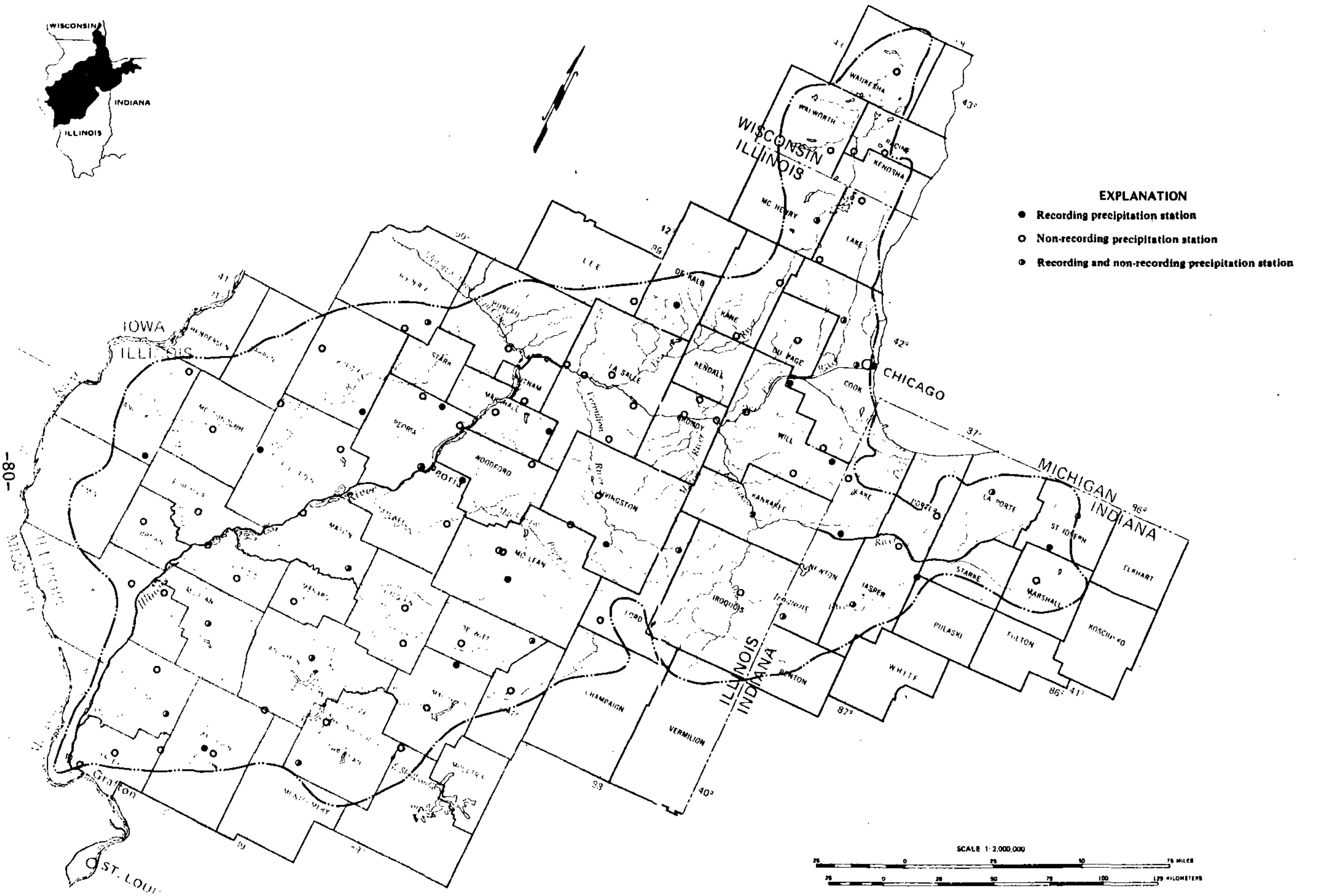

Figure 3. NWS Precipitation Stations in Illinois River Basin

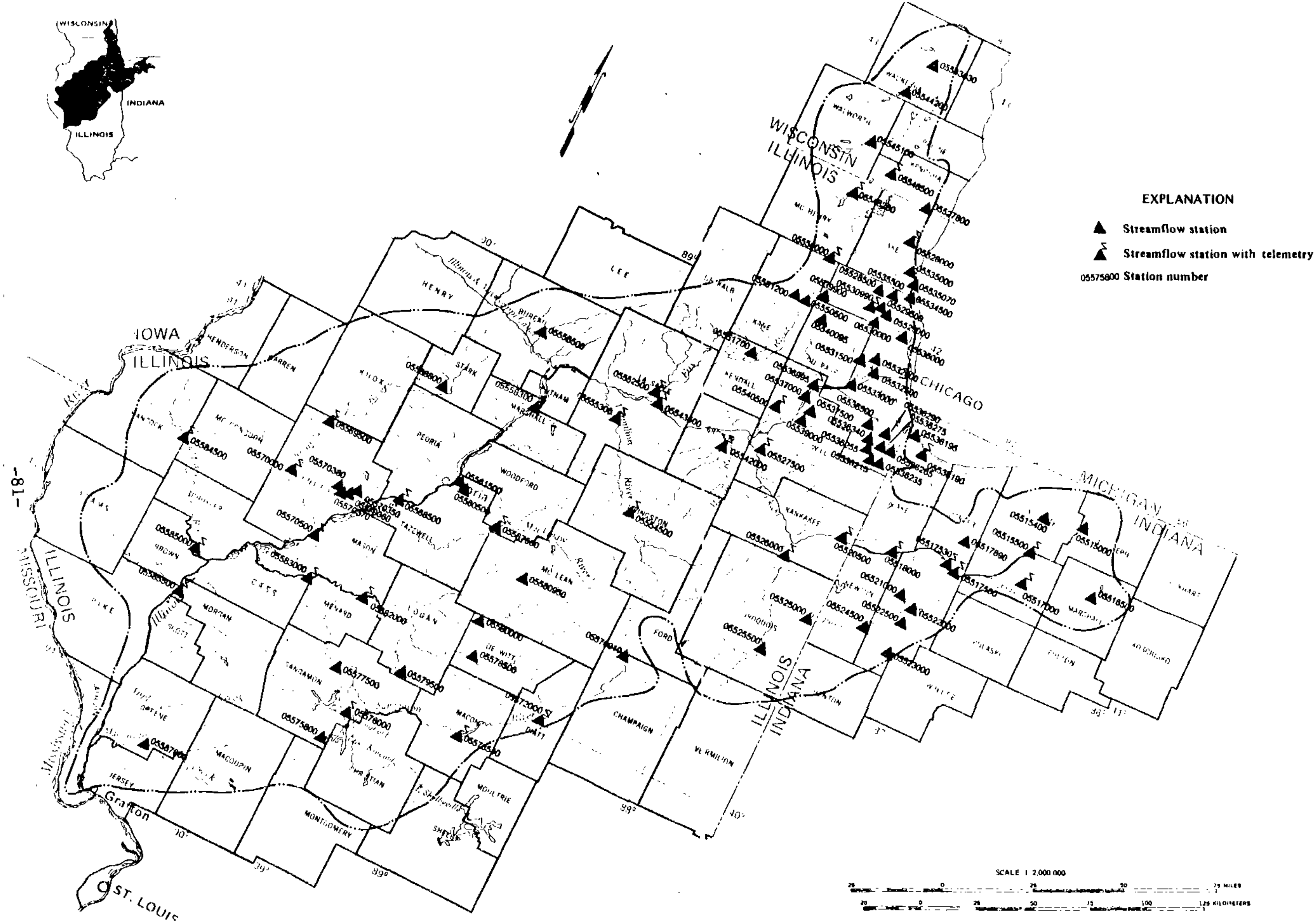

Figure 4. USGS Stream-gaging Stations in Illinois River Basin

predicting the runoff during storm events or during the spring snowmelt.

Factors affecting the runoff in these smaller tributaries includes:

a) Size of basin
b) Snowcover, or lack of
c) Meteorological characteristics of storm
d) Hydrologic/hydraulic characteristics of river & its basin.

The Illinois River below LaSalle is essentially a very flat, sluggish river. But, in addition the Illinois presents another complicating factor in that it becomes a rather large reservoir when the Mississippi River is in flood. This "backwater" effect can determine how high the Illinois River will rise, as well as how fast the lower Illinois will drain. Succeeding storm events will keep building the crest because the lower Illinois is not able to drain fast enough.

The best way to take a look at the Illinois River is to compare two flood events. The first occurred during November-December 1982, while the second occurred during the spring of 1985.

First, a word about procedures. Procedures are empirical, which means that they require a degree of professional input by the hydrologist in order to derive a forecast. The procedure is the result of many years of data on the Illinois, but needs to be revised from time to time to reflect changing conditons in the basin. This procedure takes into account new levees, siltation, etc. These are not taken into account individually, but integrated collectively by the use of U.S. Geological Survey streamflow records. But the model by itself is not capable of being left to run "hands off." It is simply not possible to develop a sophisticated "hands off" model that can be run with limited data in the very short time frame of 2-3 hours in which we need to disseminate flood forecasts. That is basically why an empirical model is used. The model we use is a balance between the incorporation of hydrologic processes and forecasting expedience.

Back to the 2 flood comparisons. These events were used in this report because they represent the variability of forecasting the Illinois River from year to year, which in turn makes forecasting the Illinois River such a challenge.

The first event, November-December 1982 (Figures 5,6 & 7) was a result of a long period of rainfall. No snowmelt was associated with the November-December 1982 flood. November was quite wet, as was early December. On December 2nd, 3-5 inches of rain fell in northeastern Illinois. Before the 2nd of December the Illinois River rose gradually but not spectacularly. After the December 2nd rains, a major flood occurred along the Illinois River. Two items stand out in regards to this particular flood. One is the lack of significant inflow by tributaries below Peoria, and the other item of interest is the large flow at Meredosia, caused by backwater from the Mississippi River. A 2nd large rainfall event occured around the 25th of December producing another, but smaller rise.

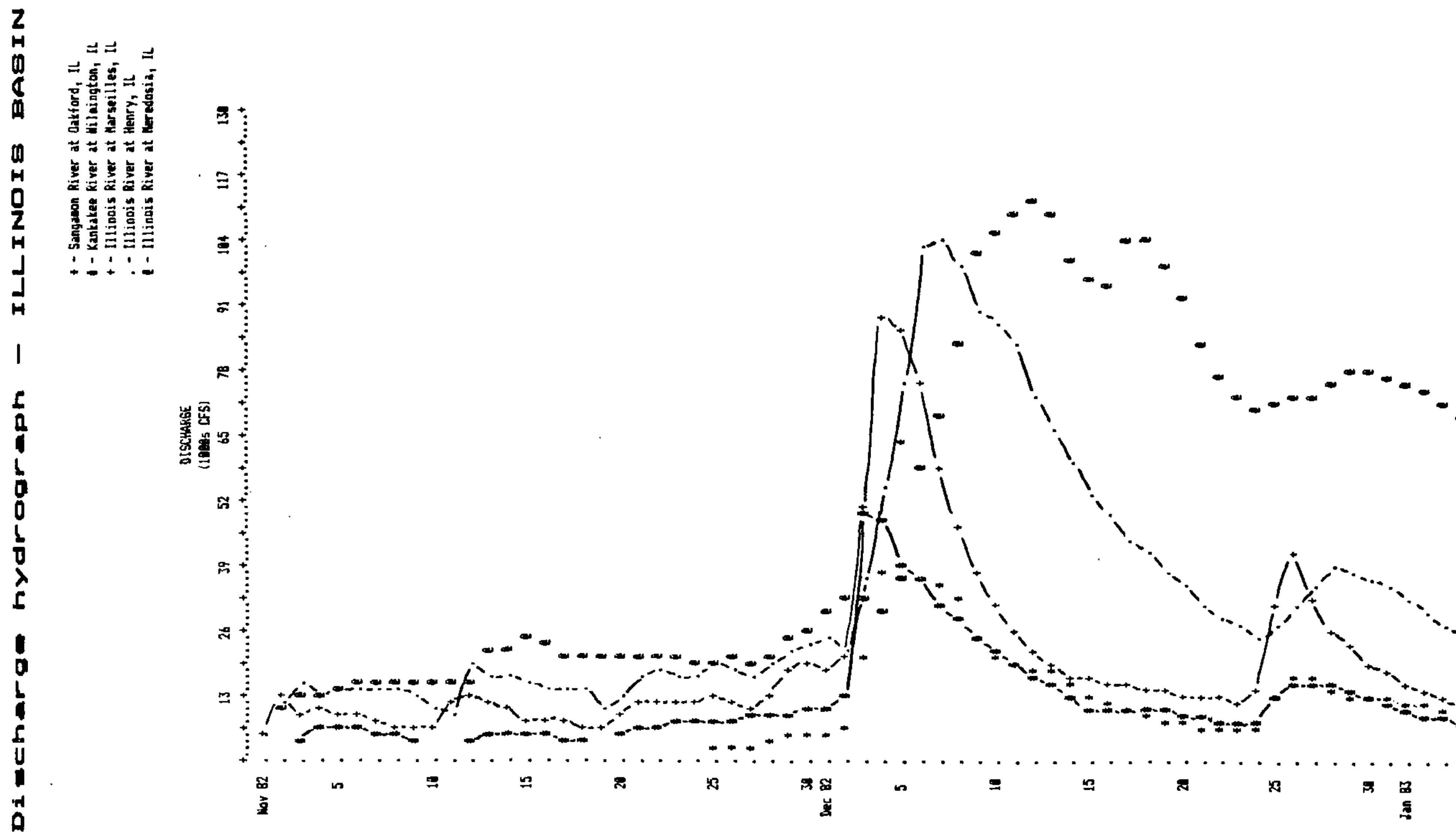

Figure 5. Hydrograph of November-December 1982 Flood along Illinois R.

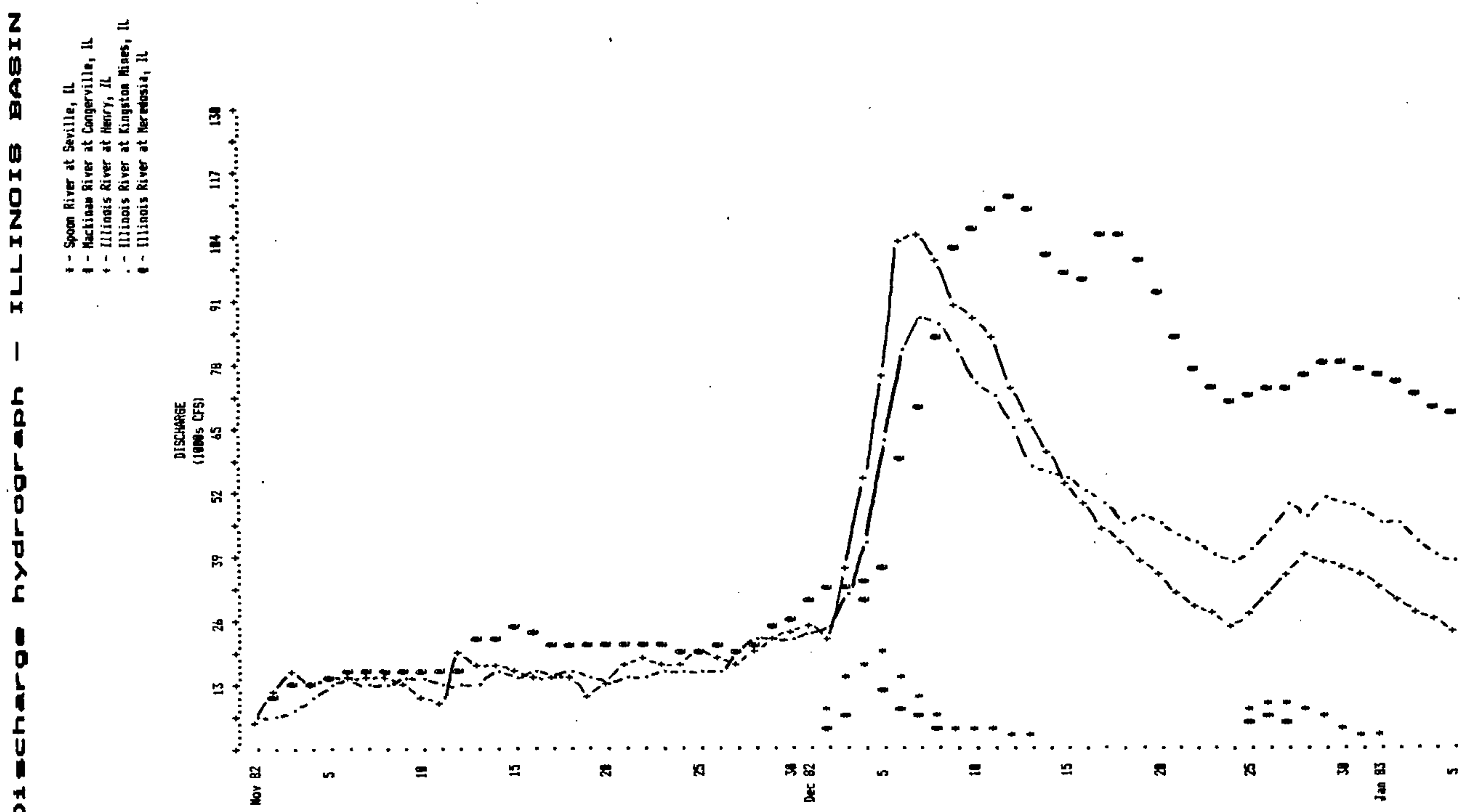

Figure 6. Hydrograph of November-December 1982 Flood along Illinois R.

Discharge hydrograph — ILLINOIS BASIN

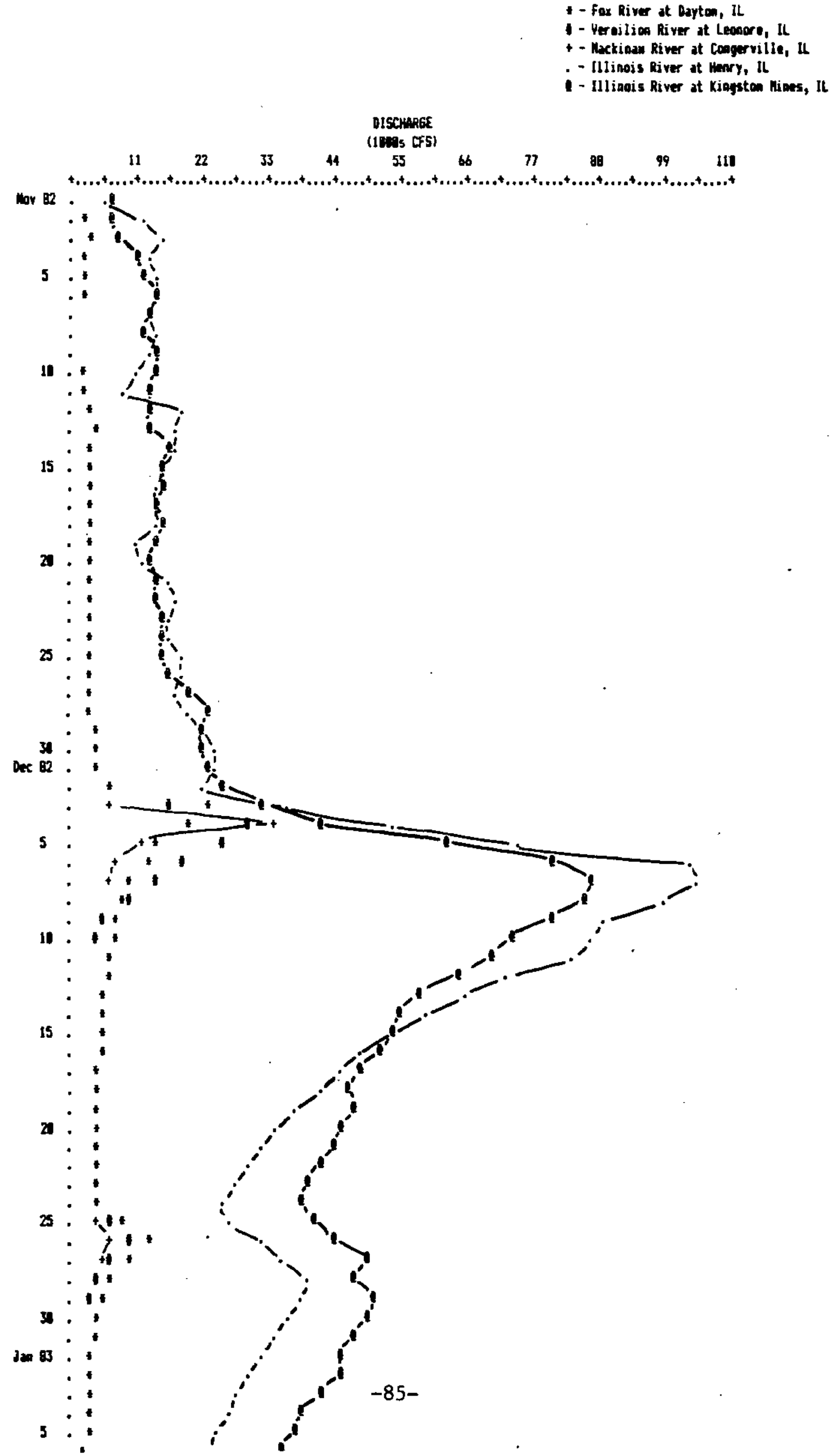

Figure 7. Hydrograph of November - December 1982 Flood along Illinois R.

It is an interesting exercise to follow the November-December '82 flood crest downriver. The Kankakee at Wilmington crests on December 3rd. The crest moves into the Illinois, continues to build and crests on the 4th. Several tributaries, the Fox River at Dayton and the Mackinaw at Congerville crest on the 4th as well. The crest continues to move downstream to Henry when the Illinois discharge crests on the 7th. The really interesting point is that the discharge at Kingston Mines which lies below Peoria also crests on the same day, December 7th. The peak stage, though, occurs on December 8th at Henry and on December 9th at Kingston Mines. The lower Illinois River is acting like a giant reservoir with an initial surge of water, followed by a gradual rise in the stages to a crest elevation. Another point to make is that, all things considered though the November-December '82 flood involved one major rise followed by a slow recession.

The 2nd flood event (Figures 8 & 9) occurred in late February and early March of 1985. The initial rise was the result of snowmelt accompanied by some rainfall. A week later a very heavy rainfall event occurred dumping anywhere from 4-7 inches of rain. A third rainfall event occurred towards the end of March, but only produced a minor rise on the Illinois. As a result of the snowmelt, followed a week later by heavy rainfall, a near record crest was generated at Peoria. As in the case of the November-December 1982 flood event, a large backwater was caused by high stages on the Mississippi. This is evidenced by the large discharge at Meredosia. The February-March '85 flood resulted in two distinct crests. The magnitude of the second crest was augmented by the first snowmelt-generated crest. Because the Illinois River below LaSalle is so flat multiple rainfall events will continue "ponding" floodwaters along the lower Illinois. This is especially true when the Mississippi is also in flood.

In comparing the '82 flood with the '85 flood, the main difference is the shape of the hydrographs. The first event (Nov-Dec '82) results in a fairly classic rise and recession, while the second event results in hydrographs that rise and fall several times. But this is a significant difference. Each and every runoff event in the Illinois basin is unique. The basin is large. Runoff can be generated in a number of ways; snowmelt, rain on snow and by just rain. To compound the forecasting problem there is the backwater effect from the Mississippi River, as well as the extremely flat slope of the lower Illinois.

Discharge hydrograph — ILLINOIS BASIN

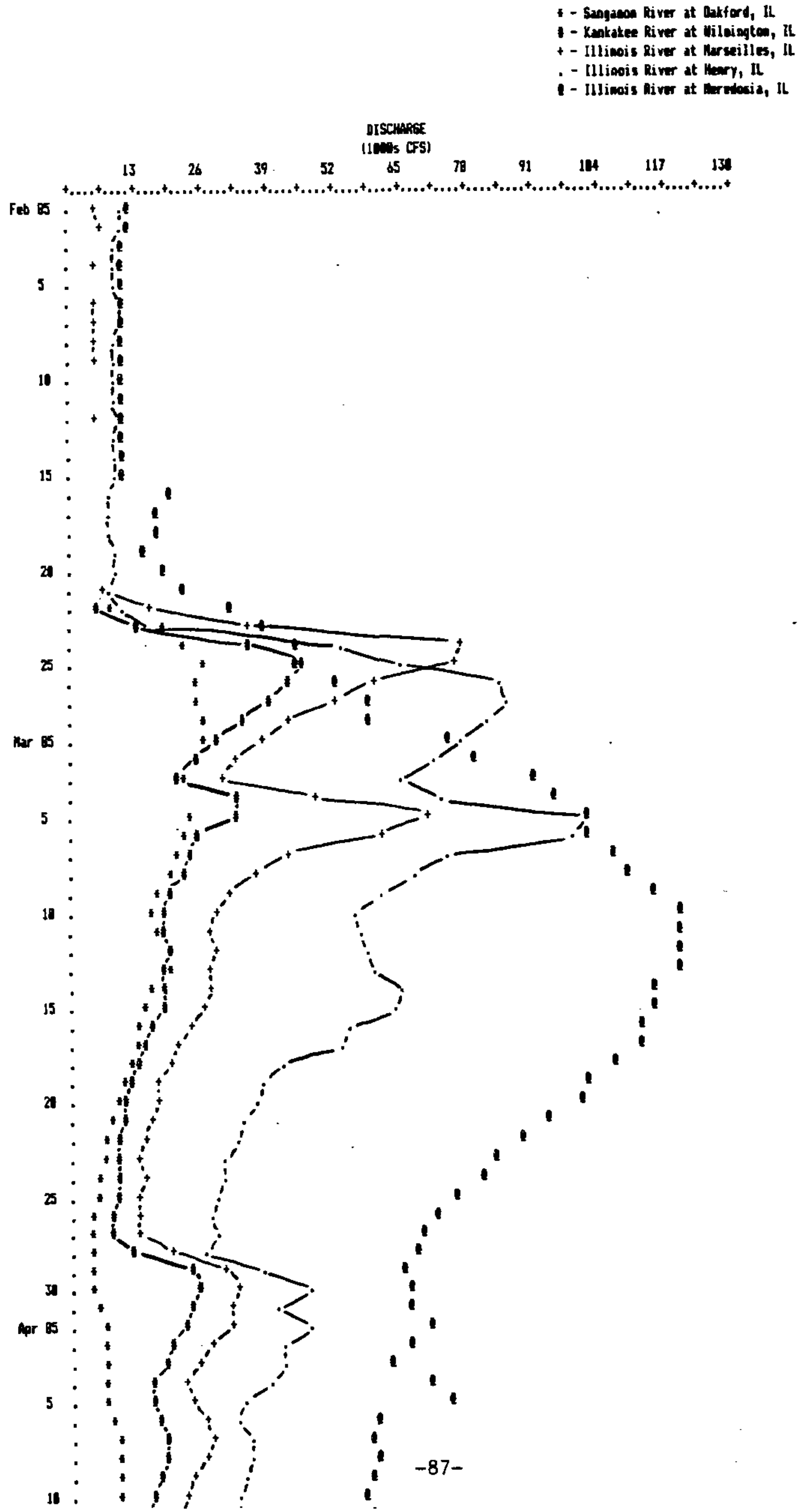

Figure 8. Hydrograph of February-March 1985 Flood along Illinois R.

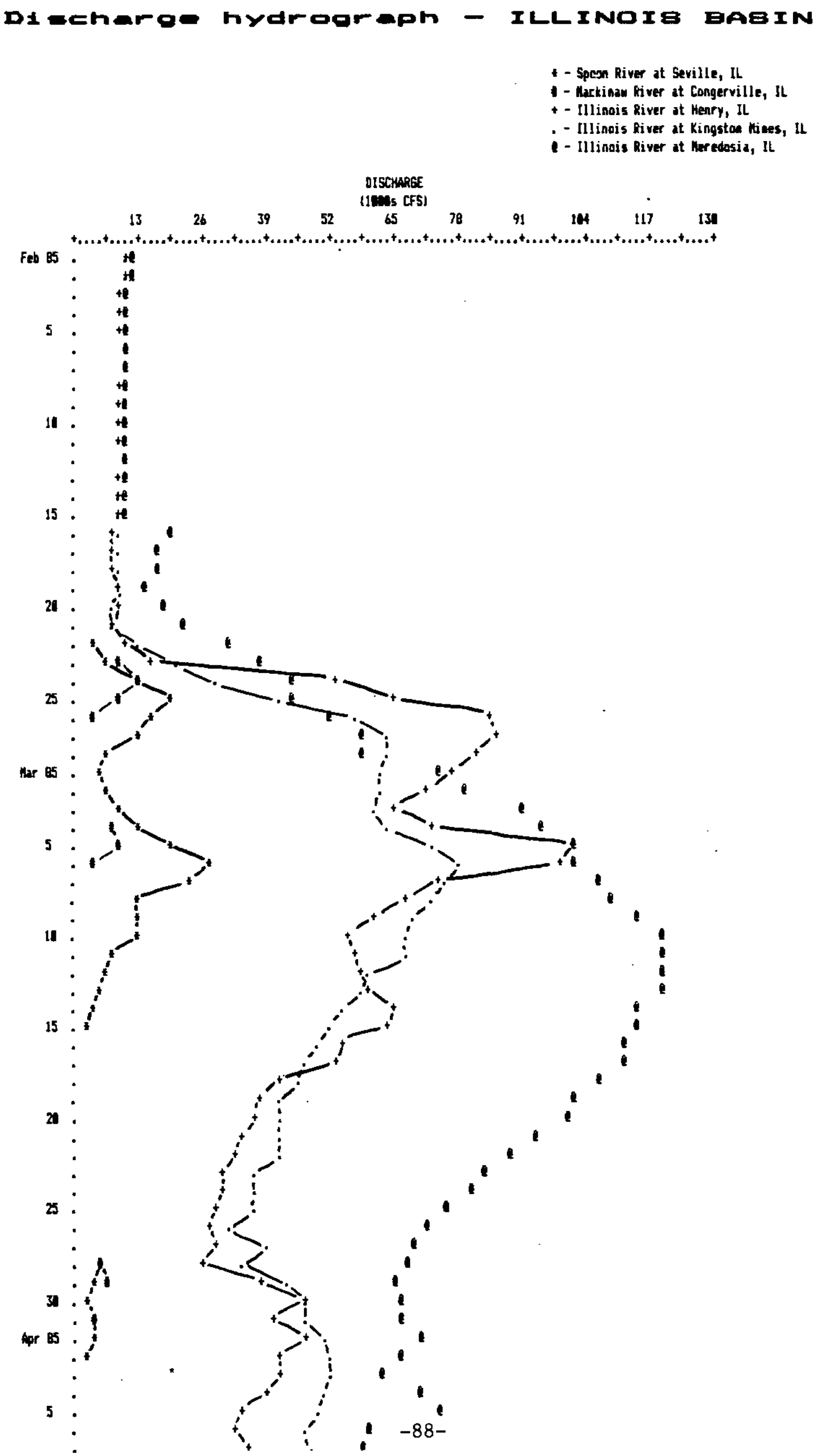

Figure 9. Hydrograph of February-December 1985 Flood along Illinois R.

FLOOD DAMAGE PROTECTION PROGRAMS

French Wetmore
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Illinois Department of Transportation
Division of Water Resources

THE FLOOD PROBLEM

From its beginning at the confluence of the Kankakee and Des Plaines Rivers, the Illinois River travels 270 miles to its mouth at the Mississippi. On its way, it travels next to 19 counties and 36 cities and villages. Periodically the river leaves its banks and flows through those communities.

Since 1978, the Illinois River has flooded at least once a year. Floods were so bad that two or more counties along the river were declared disaster areas by the President in 1979, 1982, 1983, 1985, and 1986.

As shown in Figure 1, flood insurance claims paid since 1978 exceed $26 million, one-half of all the flood insurance claims paid in the entire state. This number can be doubled to estimate total state and federal disaster assistance of $50 million. State and federal disaster expenditures represent only 1/4 to 1/3 of the total property damages suffered. Adding the cost of lost business and other expenses brings the cost of Illinois River flooding during the period 1978-1985 to over $200 million or more than $25 million per year.

POSSIBLE SOLUTIONS

The traditional response to Illinois River floods has been to build levees. A trip along the river will show a substantial investment in levee systems protecting urban, industrial, and agricultural areas. Most of these were built with the advice and financial assistance of the U.S. Army Corps of Engineers. However, as seen in Figure 1, there are still a tremendous number of properties left unprotected.

Accordingly, we need to look at other solutions. Rather than focus on only keeping the river off of

ILLINOIS RIVER FLOOD INSURANCE CLAIMS PAID : 1978-1985

Grundy County Unincorporated	69	$ 724,573
Morris	20	112,865
LaSalle County Unincorporated	0	0
Seneca	3	7,021
Marseilles	0	0
Ottawa	65	616,230
North Utica	0	0
LaSalle	11	14,320
Peru	18	10,213
Bureau County Unincorporated	0	0
Spring Valley	9	20,214
Bureau Junction	0	0
Putnam County Unincorporated	42	13,756
Hennepin	0	0
Marshall County Unincorporated	0	0
Henry	15	57,447
Sparland	18	6,454
Lacon	0	0
Woodford County Unincorporated	211	1,067,342
Spring Bay	78	250,271
Peoria County Unincorporated	1,125	7,077,165
Chillicothe	123	809,135
Peoria Heights	197	1,277,117
Peoria	288	1,546,864
Bartonville	6	7,044
Tazewell County Unincorporated	153	725,281
East Peoria	89	365,410
Greve Coeur	0	0
North Pekin	17	105,828
Pekin	51	124,989
Fulton County Unincorporated	51	$ 171,531
Banner	18	114,156
Liverpool	288	1,472,561
Mason County Unincorporated	186	700,267
Havana	0	0
Bath	30	70,066
Schuyler County Unincorporated	31	78,634
Browning	88	169,359
Cass County Unincorporated	57	517,818
Beardstown	26	61,559
Brown County Unincorporated	13	65,736
Morgan County Unincorporated	123	271,573
Meredosia	73	177,958
Scott County Unincorporated	6	5,945
Naples	10	103,641
Pike County Unincorporated	166	540,435
Valley City	9	14,633
Florence	9	23,587
Pearl	3	9,038
Greene County Unincorporated	14	146,431
Calhoun County Unincorporated	720	1,746,192
Kampsville	228	772,421
Hardin	223	825,359
Jersey County Unincorporated	920	2,743,207
Grafton	324	712,081
Total	6,324	$ 26,983,727

people's property, we need to think in terms of all the possible ways we can protect property from flood damage. The following pages will briefly review the various measures, where they are appropriate, and what kinds of problems or shortcomings they have. They are categorized in four general areas: flood control, property protection, emergency services, and floodplain management.

FLOOD CONTROL

Flood control measures keep water from getting to damageable property. They are also call "structural" measures because they involve construction of man-made structures to affect the flow of surface water. Because of the size and cost of structural projects, they are typically implemented by government agencies, usually with the help of the Division of Water Resources, the Corps of Engineers, or the Soil Conservation Service.

<u>Levees and floodwalls.</u> Probably the most common flood control measure is to erect a wall of dirt (levee) or concrete (floodwall) between the river and the property to be protected. Levees and walls must be well designed to account for large floods, underground seepage, pumping of internal drainage, and erosion and scour.

Appropriate for: protecting existing development without disrupting it. Where they protect more than one property, they should be publicly owned. Levees need a lot of room to fit between the river and the area to be protected levees. If space is a constraint, more expensive floodwalls are used. Both must be set back out of the floodway so they will not push floodwater onto other properties.

Problems: Levees or floodwalls can be overtopped and suddenly flood many people who thought they were protected. They may restrict access and view. There are continued operation and maintenance costs to insure the pumps work and that they do not slump or develop holes from animals or roots.

Larger levees or floodwalls usually cost so much that they cannot be built without government aid. We can afford to spend a lot of money to protect the major concentrations of flooded property like East Peoria and Beardstown. But when the properties are scattered or aligned in narrow strips along the river as in Rome, we cannot afford to build 15 foot high levees to protect them. In fact there is only one more levee project expected on the main stem of the Illinois River and that will only construct a 44 year levee for the Village of Liverpool.

Reservoirs and detention basins. These measures control flooding by holding high flows behind dams or in basins. After the flood peaks, water is let out slowly in small amounts that the river can handle. The lake created may provide recreational or water supply benefits and dry basins can double as parks or other open space uses.

Appropriate for: protecting existing development without disrupting it. Reservoirs are most efficient in deeper valleys where there is more room to store water or on smaller rivers where there is less water to store. They are often infeasible in flat areas of Illinois because so much land would have to be purchased.

Problems: They take up a lot of ground. Higher dams create safety hazards when upstream flood flows exceed design capacity. Reservoirs usually cost so much that they cannot be built without goverment aid. There are also continued operation and maintenance costs. Sometimes costs can be reduced by utilitzing existing features such as quarries to hold water.

Channel improvements. A channel can be made wider, deeper, or straighter so it will carry more water and/or carry it downstream faster. Some smaller channels can be lined with concrete or even put in underground pipes. In a few locations, a diversion or overflow channel can speed floodwaters to another, bigger river.

Appropriate for: smaller streams and ditches in developed areas, particularly if there is no room for a levee. Dredging of larger rivers is usually cost prohibitive because the dredged material must be disposed somewhere and the river will usually fill back in with sediment in a few years. Dredging is usually only conducted to maintain a navigation channel.

Problems: Channel improvements and their continual maintenance can be expensive. They can damage or destroy wildlife habitats and create new erosion problems. Straightening a stream is only temporary because it tries to eliminate meanders and other features that nature will continually work to recreate. Sending water faster downstream is sending the flood problem downstream.

Control gates and back-up valves. Many smaller ditches and pipes can have gates or valves installed to keep water from backing up. Some are operated manually but others, such as "flap gates", can be automatic. This prevents a larger river above flood stage from backing floodwater into tributaries or sewer lines.

Appropriate for: smaller channels and at storm sewer outfall pipes. Communities and property owners can install sanitary sewer back-up valves to prevent backflow into low areas and basements.

Problems: Unless thereis a pump system installed, the ditch or pipe will not be able to drain. Local rains could then cause upstream flooding.

Terracing and run-off controls. The run-off of rain water can be slowed down on the ground by vegetation, terraces, contour plowing, no-till farm practices, and other measures. Delaying surface water on its way to the channel also controls erosion and loss of topsoil.

Appropriate for: steeper slopes, especially in agricultural watersheds.

Problems: Must be implemented by owners of property far from the flood problem, usually at their expense. Must be done by many over a wide area to have an impact.

PROPERTY PROTECTION

Rather than keep water off of the land, property protection measures modify the buildings exposed to damage. They are also appropriate where the buildings are scattered or a flood study has concluded that a structural flood control project will not be built. For more information, see Protect Your Home from Flood Damage, available free from the Division of Water Resources.

Building relocation or acquisition. The surest and safest way to protect a building from flooding is to move it to high ground. Vacant riverfront property can be converted to public park or open space. Because this is expensive and because many people do not want to own vacant flood-prone lots, there are several government programs that can provide financial assistance or even purchase the building and lot. For more information, see Elevating or Relocating Your House to Reduce Flood Damage, available free from the Division of Water Resources.

Appropriate for: where the flood hazard is very high, such as in areas subject to ice jams, flash flooding, or deep waters and/or where the community wants to clear or redevelop. Relocation is appropriate for smaller buildings that are easier to move and where the owner has a new lot available. Acquisition and demolition is done more often for larger, slab, or masonry buildings that are too expensive to move and for dilapidated structures that are not worth protecting.

Problems: Expensive for the individual property owner, although there are some government loans or grants available. If a large area is affected, some smaller towns are concerned about loosing residents or businesses.

Building elevation. Raising a building above the flood level is cheaper than moving it and can be less disruptive to a neighborhood. For more information, see Elevating or Relocating Your House to Reduce Flood Damage, available free from the Division of Water Resources.

Appropriate for: smaller, wood frame buildings on crawlspaces. Where flood depths are under nine feet and velocities are slow, elevation can be more appropriate than relocation.

Problems: The building may be isolated and without utilities and therefore unusable during flooding.

Floodproofing. Some buildings can be made floodproofed by sealing the walls and closing all openings. When water reaches the building, it is kept out. Another technique, wet floodproofing, works for garages and unfinished areas; water is let in the building but all damageable property is removed or protected. Unlike acquisition or elevation, floodproofing is relatively inexpensive and does not involve moving or making major changes to the building.

Appropriate for: areas of shallow, short term flooding. Masonry buildings on slab are easiest to waterproof. Garages and basements with block or concrete walls are easiest to wet floodproof.

Problems: Some buildings are tricky to waterproof. Water pressures from deeper flooding can cause structural damage, especially to basement walls and floors. The building may be isolated and without utilities and therefore unusable during flooding.

Self-help advice and assistance. Some communities provide help in the form of manuals, "open houses", and direct consultation to property owners. Much property can be protected with inexpensive steps taken by the owner such as installing a sewer back-up valve, moving appliances out of the basement, and considering the flood hazard in remodelling projects. Lives and property can be protected when people know the flood warning signals, evacuation procedures, where to get sandbags, how to clean up, etc.

Technical advice is one of the least expensive measures a community can undertake. Every little step taken by a property owner will reduce flood damages. Manuals and technical assistance, including slide presentations, are available from the Division of Water Resources.

Appropriate for: everywhere.

Flood insurance. Although it does not reduce flooding or flood damages, insurance does help the flood victim. The National Flood Insurance Program is administered by the Federal Emergency Management Agency (FEMA). It makes federally subsidized insurance available for properties affected by surface water problems in communities that have enacted floodplain regulations. Some commercial companies sell sewer backup and sump pump failure policies. All are available through property insurance agents.

Appropriate for: it depends on the type of flooding and the property affected. Most buildings subject to overbank flooding or ponding can benefit from the National Flood Insurance Program. It is available in most flood-prone Illinois communities.

Problems: National Flood Insurance will not cover finished portions of a basement nor will it cover property outside a building such as landscaping, driveways, or seawalls. It will not reduce flood damages, it will only pay part of the cost of repairs.

EMERGENCY SERVICES

While property protection measures protect buildings when the flood comes, emergency services measures protect people. All counties and many communities have Emergency Services and Disaster Agencies (ESDAs) to coordinate warning, response, and recovery during a disaster. The manual, Flood Fighting, available from the Division of Water Resources or the Illinois Emergency Services and Disaster Agency covers these measures in more detail.

Flood Warning. Providing an adequate warning is the number one way to save lives. Furthermore, much moveable property, particularly vehicles, can be protected, even on very short notice. With a well-prepared response plan, critical facilties such as hospitals and water works, can take protection measures and the limited work force can be used most efficiently. Warning systems are relatively inexpensive, especially on the bigger rivers.

Appropriate for: all but the smallest watersheds. The bigger the river, the easier it is to set up a system, the predictions will be more accurate and there will be more lead time. In smaller watersheds or hilly areas, adquate warning time may only be given if a more expensive, automated system is established.

Problems: Giving a warning does not mean people will react properly. It is important that people are advised of what the warnings mean and what they should do or the warnings will not be heeded.

Sandbagging. This term includes all emergency barriers that can be erected on short notice to stop flood waters. Generally, emergency barriers are not as effective, and may even cost more than, permanent flood control facilities. Sandbagging does work well as a back-up system to other flood protection measures. It can be a very flexible way to provide protection on short notice.

Appropriate for: blocking rising floodwaters at low spots or to fill small openings in levees or floodwalls. Larger sandbag walls can be built if time, labor, and supplies are available.

Problems: If not properly planned or keyed to the flood threat, it can be a wasted effort when a sandbag wall is not built fast enough or high enough. Careful planning and stockpiling is necessary to ensure the availability of supplies on short notice. The wages, health and safety of the labor force must be accounted for.

Evacuation and rescue. Removing people from the flooded area, either before the flood (evacuation) or during (rescue), are vital measures to protect lives. A related measure that must be considered is sheltering and feeding those who are forced from their homes.

Appropriate for: high flood hazards such as deep or fast moving waters or where there is a threat of a dam or levee break.

Problems: Property owners may resist evacuation in order to protect their belongings. Rescue operations, especially at night or in fast currents, can pose a danger to the rescuers.

Public health and safety maintenance. Numerous measures must be taken during a flood to prevent dangers to health and safety. These include patrolling evacuated areas to prevent looting, providing safe drinking water, vaccinating residents for tetanus, clearing the streets, and cleaning up debris and garbage.

Appropriate for: everywhere the community can afford to provide protection. Advanced flood response planning can identify needs, resources, and where attention should be focused first.

FLOODPLAIN MANAGEMENT

While the three previous categories of mitigation measures are oriented toward dealing with the existing flood problem, floodplain management projects focus on the future. Floodplain management projects are designed to keep the problem from getting worse by ensuring that future development in the floodplain does not increase flood damages and by maintaining the river system's capacity.

Planning and Zoning. Advance planning can match the land use with the land's hazards, typically by reserving flood hazard areas for open space, parking lots, backyards, or similar low-damage activities. A land use plan that proposes appropriate uses can be implemented by a zoning ordinance that regulates private development and by the community's capital improvements plan that directs extension of roads and utilities, the location of future parks, etc.

Appropriate for: communities that can expect any growth or land development and are willing to guide it.

Problems: Zoning can be controversial to those who want complete freedom to build on their property without government interference.

Floodplain development regulations. Subdivision ordinances and building codes come into effect after the plans and zoning ordinances have identified where various land uses are appropriate. If buildings are allowed, these regulations ensure that they will not be subject to flood damage and that the development will not aggravate the flood problem.

Building codes also require that when existing buildings are substantially damaged, they are rebuilt protected from flood damage. In addition to preventing flood problems from getting worse, these regulations qualify a community for participation in the National Flood Insurance Progam. For more information, see the Division of Water Resource's manual, Floodplain Regulations.

Appropriate for: every community with a floodplain.

Problems: Can be controversial to those who want complete freedom to build on their property without government interference.

Open space acquisition or easements. Rather than regulate future development, many communities purchase vacant flood-prone lands to prevent hazardous development and/or to obtain attractive sites for parks. While this can be expensive, there are sources of financial assistance for park acquisition or development. Some Illinois communities have been successful in getting owners to donate land for tax purposes or to ensure it is kept open for future generations to enjoy.

As an alternative to public ownership, an easement can be purchased. With an easement, the owner is able to develop the flood-free portion but he is paid to not develop the flood-prone part. In some cases, the owner is allowed to develop his ground for low hazard uses or he can transfer his right to develop other flood-free parcels.

Appropriate for: wherever there is vacant flooplain land. Where lots are large and the floodplain is relatively small, purchasing an easement can be cheaper and more appropriate.

Problems: Can be expensive. A community with a large portion of its area in the floodplain cannot afford to convert its tax base into public open space.

Stormwater management. In the past, developers and communities built gutters, sewers, and ditches to move surface water as fast as possible downhill to the river channels. Not only did this aggravate downstream flooding, it often overloaded the community's drainage system. The alternative, stormwater management, looks at the whole system and identifies where water should be held on-site, in detention basins, or allowed to flow to the river quickly.

Requirements for detention are generally included in ordinances governing subdivisions and new developments. This insures that new developments pay their share of the cost of using the drainage and river system. Many developments utilize wet or dry basins as landscaping amenities.

Appropriate for: usually required for the larger new developments such as those greater than 2 acres.

Problems: If not properly planned, many small on-site basins will not help, and may even aggravate, the problem. Continued maintenance is needed after the developer leaves.

Erosion and sediment control. Many Illinois rivers are loosing their capacity to carry floodwaters to sedimentation. As rain hits the ground, especially where there is bare dirt as on farm fields and construction sites, soil is picked up and washed downstream. Sediment tends to settle where the river slows down and will gradually fill in the channel. Farm practices such as terracing and no-till will help reduce agricultural erosion and keep topsoil where it is needed. Catch basins can be installed downstream of construction sites to slow run-off so sediment will be dropped on-site before it gets to the river.

Appropriate for: all watersheds. In urbanizing areas, many communities require developers to build and maintain sediment catch basins.

Stream maintenance. Sediment is not the only thing that restricts a river's ability to carry floodwaters. A stream maintenance program works to clean out blockages of a channel caused by overgrowth and debris. This work is usually done by a community's public works crew. Communities also pass ordinances prohibiting dumping and making riverfront owners responsible for maintaining their areas. For more information, see the Division of Water Resource's manual, Stream Maintenance.

Appropriate for: smaller streams. Annual clean-outs should be conducted in late winter, before spring flows and when there are no leaves restricting visibility.

Problems: If not done properly, channel clearance can allow bank erosion and destroy natural habitats.

PICKING THE BEST MEASURES

While some of these measures may appear attractive, we recommend a careful planning process to ensure that the flood damage protection methods chosen are feasible and appropriate to the hazard. Assistance is available from the Division of Water Resources for a three-step planning approach:

1. *Reconnaissance. The first step is to collect* available data on flooding and survey the affected properties. This may include a detailed building-by-building survey to identify appropriate property protection measures and draw preliminary recommendations. This work is usually done completely at state or federal expense.

2. Detailed plan. The results of the reconnaissance and preliminary recommendations are reviewed with local officials. If there is an interest in pursuing the projects, an intergovernmental agreement will be signed. Typically it will include a requirement that since the state or federal government is going to help pay for reducing flood damages, the community will properly regulate development to ensure damages do not increase.

   If the projects will be primarily structural, the state may request cost- sharing on preparing the plans. If the projects are going to be primarily non-structural, a citizens planning committee will be formed and the community will assign a staff person as liaison and floodplain planner. The result of this phase is a detailed plan that is reviewed at one or more public hearings, is adopted by the city council, and forms the basis for applications for state or federal financial assistance.

3. *Implementation. At this phase, applications for* needed outside funds are submitted. The community will be expected to administer the locally funded projects such as developing a flood warning system or amending its zoning ordinance. There is likely to be cost-sharing on the major projects. It is recommended that the planning committee be used to monitor and evaluate progress.

STATUS OF ILLINOIS RIVER PROJECTS

As mentioned earlier, most of the Illinois River flood control projects have been completed. Overall basin planning has concluded that reservoirs are not feasible. Channel dredging is still being looked at in the Peoria Lake area, but if it is funded it will probably be for recreational purposes and may not affect flood levels.

Since we cannot control the river, the current approach is to look at each community. Many communities on the Illinois and its tributaries have had reconnaissance studies. Where structural projects are shown to be appropriate, the state or federal agency has proceeded on to steps 2 and 3. Two examples of this are Pontiac and Liverpool, both of which are having their detailed plans for levees finalized by the Corps of Engineers.

We have found that structural flood control projects will not be feasible in most of the remaining communities. Accordingly, we are proceeding with non-structural planning for the rest. Initially, we started with those towns who asked for help. The first town was Grafton. With the help of the regional planning commission and a citizens committee, a non-structural plan was prepared. Due to local concerns and needs, it focuses primarily on emergency services or flood fighting activities.

In 1984 we conducted the reconnaissance study for Kampsville. A citizens planning committee worked with state and village staff to develop a comprehensive flood hazard mitigation plan that includes raising the ferry road to ensure access during high water, floodproofing the water plan, elevating three buildings, acquiring 50 parcels of land, and converting the flood-prone target area into a community park and village asset. Funding for the work has come from the Division of Water Resources, the Federal Emergency Management Agency (FEMA), the Department of Commerce and Community Affairs, and the Division of Highways.

The next community was the Rome area of unincorporated Peoria County. With funding support from FEMA, the county conducted the phase 1 reconnaissance with in-house staff and a surveyor. The resulting recommendations could cost over $5 million and would involve purchasing over 100 homes. Rather than wait to do a detailed plan for the hardest hit area, the County is preparing the detailed plan for only one of the potential target areas. Over $2.7 million has been committed to purchase and clear that area with funds from the Division of Water Resources, the Federal Emergency Management Agency (FEMA), and the Department of Commerce and Community Affairs.

We have developed a preliminary priority list of who to help next. Because non-structural projects require a high degree of local interest and potential for FEMA funding, we are using flood insurance claims as a measure of where attention is both needed and likely to bring results (see figure 1.). During this fiscal year we will be conducting the reconnaissance surveying in Hardin, Calhoun County, Jersey County, Woodford County and Spring Bay. We have helped the City of Peoria obtain FEMA funding to prepare a mitigation plan for Peoria and Peoria Heights.

Communities, both on or off the Illinois River, can obtain copies of the references and assistance in flood protection by contacting the Division of Water Resources at 310 South Michigan Ave, Rm 1606, Chicago, Illinois 60466.

MSDGC ACTIVITIES IN THE UPPER ILLINOIS BASIN

Richard Lanyon
Assistant Director of Research and Development
and
Cecil Lue-Hing
Director of Research and Development

INTRODUCTION

The greater Chicago area represents one of the largest urban centers in the United States, with a population of over five million people in an area of approximately 900 square miles. Obviously, such a population concentration and the attendant industrial and commercial enterprises require a complex and extensive water quality management program.

This paper describes the major aspects of water quality management in the greater Chicago area and the role played by the Metropolitan Sanitary District of Greater Chicago (District), the principal water quality management agency in this area having responsibility for wastewater treatment and water pollution control. A description of the current activities of the District would not be adequate unless one understands how and why this agency was created and what has been its past accomplishments. The history of the District is representative of how our nation has solved its water quality management problems.

CANAL BUILDING

The enabling legislation for creation of the District was adopted on May 29, 1889 by an act of the Illinois General Assembly. This legislation came about as a result of a series of waterborne communicable disease epidemics and continuing drainage-related public health problems occurring over the prior fifty years.

In the mid-1800s, sewage disposal in Chicago consisted mainly of pit privies and open drainage ditches which discharged directly to the Chicago River and which, in turn, discharged to Lake Michigan. This lake, as it does today, served as the main supply of drinking water for the city of Chicago. Because of the lack of understanding at the time about the mode of disease transmission, a major drinking water intake in Lake Michigan was within close proximity of the mouth of the Chicago River.

In 1857, the Chicago Board of Sewage Commissioners chose a plan to build a system of sewers to convey drainage and sewage to the Chicago River to relieve the poor drainage conditions, to eliminate open drains, and to allow for the discontinuation of pit privies. Oddly enough, an alternative plan to convey drainage and sewage away from Lake Michigan to the Illinois River Basin was rejected as infeasible. This alternative was considered because a continental drainage divide between the Great Lakes and Mississippi River Basins occurs in the Chicago area and is only 15 feet above the level of Lake Michigan and 10 miles west of the shoreline. The Illinois and Michigan canal was completed in 1848 for the purpose of navigation between the Great Lakes and the Illinois River. It did not have sufficient hydraulic capacity to provide relief for the drainage and sanitation problems.

Because of the growth in population and industry, pollution of the Chicago River and the Lake Michigan water supply increased. Water intakes were moved further and further offshore in an attempt to obtain nonpolluted water. In 1867, a two-mile water intake tunnel nine feet in diameter was constructed out into Lake Michigan.

In 1879, the Chicago River so fouled the city's drinking water supply that a citizen's committee was formed and they soon recommended a new canal be constructed to convey the city's sewage over the divide and away from Lake Michigan. Figure 1 illustrates the Chicago area drainage system prior to the turn of the century.

A heavy storm in August 1885 flushed the city's wastewater into the lake beyond the water supply intake. The resultant outbreak of cholera, typhoid, and other waterborne diseases caused the death of about 12 percent of the city's population. Another commission was formed and eventually recommended that a canal of sufficient size be constructed to divert 10,000 cfs from Lake Michigan into the Des Plaines River. The diversion was to be complete, and all sewage was to be kept out of Lake Michigan. The catastrophic storm of 1885 and the Commission's recommendation led to the enabling act of 1889.

Construction of the original man-made drainage system for the Chicago area, including canals and three controlling works, as shown on Figure 2, occurred over the period 1892 through 1922. The lock and control at the mouth of the Chicago River were built in 1938. The original lock at Blue Island was replaced by the O'Brien Lock in 1965. The three controls on the Lake Michigan end of the system allow for the passage of navigation and introduction of dilution flows to the canal system. The structures at Lockport include a hydroelectric powerhouse and navigation lock and these allow water to be released from the system in controlled amounts.

Construction of this canal system has provided for proper drainage and protection of Lake Michigan water quality. It, together with chlorination of public water supplies, resulted in the control of waterborne communicable diseases to the point that in 1917, Chicago had the lowest mortality rate from typhoid fever among United States cities.

SEWAGE TREATMENT

To avoid having the District's canal system turning into an open sewer, Lake Michigan water was to be drawn into the system for dilution in large quantities. This gave rise to opposition from other Great Lakes states, Canada, and the federal government. Their arguments, predicated upon the assumption that the District's diversion would reduce the levels of the Great Lakes and create dangerous harbor conditions, led to litigation which, together with continued population growth and increasing industrial waste loads worked against the District's sole reliance on the dilution method for sewage treatment.

As early as 1908, the District began experimenting with various sewage treatment processes. The District's first full-scale plants were aimed at prototype testing of various treatment methods. An Imhoff plant was constructed at Morton Grove in 1914, and a trickling filter was added in 1920. In Des Plaines, an activated sludge plant was placed into operation in 1922, the first full-scale activated sludge facility built by the District. The District's major sewage treatment works, Calumet, North Side, and West-Southwest, were constructed in the 1920s and 30s. Thus, the District was providing full secondary treatment for all wastewater flows by 1940, more than a generation prior to this becoming a federal requirement. The District's taxpayers paid for this without federal subsidies.

From 1940 through 1960, the District kept abreast of increasing sewage flows due to population growth and increases in its service area. By 1960, it became increasingly obvious to the District that secondary treatment alone would not be sufficient to meet the new regulatory concerns about water quality. It was becoming apparent that effluent BOD and SS standards would be more stringent than the accepted secondary treatment standards for facilities discharging to natural streams. In addition, the greatly expanded service area necessitated that the District investigate new sites for its sewage treatment facilities. Following further research in advanced wastewater treatment, the District constructed new advanced waste treatment facilities in northwest Cook County in the 1970's and 80's.

The District's seven treatment facilities have a total capacity of 2 billion gallons per day, ranging in size from 2 to 1,200 million gallons per day. These facilities are shown on Figure 3. The District has maintained an outstanding record of compliance with the NPDES permit limits. Each year, the District's record of compliance for all pollutant limits in all permits exceeds 99 percent.

At present, dissolved oxygen (DO) levels in some segments of the District's waterways do not consistently meet the IPCB secondary waters standard of 4.0 mg/L. The District has determined that the applicable standard cannot be met exclusively by upgrading its secondary waste treatment process to tertiary levels. Sediment oxygen demand of benthic deposits and sluggish flows during the critical summer period contribute to the inability of these waterways to meet the DO standard. Accordingly, the District has initiated construction of an artificial instream aeration system to increase directly the DO levels in the waterways.

A water quality model was used to size and locate the aeration stations. Based on historical water quality data and computer simulations of DO profiles, ten aeration stations having a total design capacity of 167,300 pounds of oxygen per day were selected for District waterways in the Chicago area locations are shown on Figure 4. Individual station capacity will vary from 5,000 to 40,000 pounds of oxygen per day. Construction of the first stations at Devon and Webster Avenues were completed in 1979 and 1982, respectively. Additional construction will be accomplished as funds are available. Stations on the

Calumet Sag Channel will be off-channel basins with cascade aerators to also allow for recreation.

SOLIDS MANAGEMENT

The District, like other municipal agencies, has found that the processing and disposal of sewage treatment solids is a major technical and economic problem. Many of the solids management technologies practiced today at the District and elsewhere in the United States were developed in the first three decades of this century.

The District has moved away from older energy-intensive operations to operations with low energy utilization such as land application. A brief chronology of solids management at the District is shown on Table 1. The District has learned that one of the keys to efficient and economical solids management is volume reduction through the use of dewatering and drying processes. The District's current solids management schemes all include anaerobic digestion, followed by processes designed to remove water, including centrifugation, lagooning, and air drying.

Final disposition of District solids follows the practices outlined below. The quantity of solids disposed and the percent of total for 1984 are also indicated. All of these practices are in compliance with federal and state regulations.

1. Sludge Application to land in Fulton County and at Hanover Park, 48,000 dry tons, 11 percent of total.

2. Landfilling at privately-owned sites under contract to the District, 30,000 dry tons, 7 percent of total.

3. Final closure of a City of Chicago landfill site, 260,000 dry tons, 62 percent of total.

4. Controlled Distributions to Large-Scale Users, such as sod farms, nurseries, golf courses, etc, 84,000 tons, 20 percent of total.

5. Landscaping Purposes at District Facilities, incidental volume.

INDUSTRIAL WASTE CONTROL PROGRAM

The District is one of the few municipal sewage treatment agencies with a long and effective record of enforcement regarding discharge of industrial wastes to the public sewer system and of discharge to the waterways. This record dates back to 1946 when the Board of Trustees of the District adopted its first ordinance for the control and abatement of pollution to waters within its jurisdiction. This ordinance required all discharges to a waterway not to exceed in quantity an amount of pollutants contained in an equal volume of the effluent discharged from the sewage treatment works of the District.

Later, in 1962, the Board of Trustees of the District adopted an ordinance that set forth certain limiting conditions for the discharge of liquid industrial wastes into the sanitary sewer system, including a pH range between 4.5 and 10.0 and a limit on total fats, oils, and greases of 100 mg/l.

Subsequent to the passage of State of Illinois regulations on waterway and effluent quality, the District determined that a new industrial waste ordinance was needed to further control the discharge of industrial waste into the sewer system so that District treatment plants would meet the new standards for discharge to the waters of the state. In 1969, the District adopted the Sewage and Waste Control Ordinance which set specific limits on 22 contaminants for discharges to waterways as shown in Table 2 and limits for 13 contaminants and 11 limiting conditions on discharges to sewers as shown in Table 3.

Direct Discharges To Waterways

The ordinance incorporates Illinois effluent standards for enforcement of direct dischargers to Lake Michigan and to waterways. In addition, with respect to Lake Michigan, Appendix A of the ordinance states: "there shall be no discharge of any sewage, industrial waste, or other wastes of any kind into the waters of lake michigan." with this authority, the district has proceeded to enforce the terms of this ordinance against industries which discharge wastes to waterways and to lake Michigan. Upon issuance of a Notice of Violation, dischargers must appear at a conciliation meeting. Compliance schedules and agreements for abatement are worked out with the violators. For the most part, compliance with these waterway effluent standards has not been a problem.

Upon occasion, in order to carry out the District's mandate to protect the quality of Lake Michigan, the District has proceeded through petitions for injunctive relief in the Circuit Court of Cook County, Illinois, against those outside its jurisdiction who discharge waste to Lake Michigan. With such action, the District sought to force dischargers in areas outside of the District's jurisdiction to cease and desist and otherwise control the discharge of waste into Lake Michigan.

Several of the dischargers against which the District proceeded were industries located in neighboring Lake County, Indiana, southeast of Chicago. These industries included three major steel-making facilities, three petroleum refineries, two petroleum products storage facilities, two chemical manufacturers, and one food processor. The District filed suit against these industries in 1970 as a result of studies undertaken by the District and by other organizations. In 1972, the Attorney General of the State of Illinois also filed suit against these industries. The suits of the District and the Attorney General were consolidated for litigation. As a result, court-ordered stipulations which provide for the control of pollution of the Illinois waters of Lake Michigan were entered into with each of the several industries. These stipulations included a compliance schedule for the construction of water pollution control facilities and the establishment of effluent criteria.

Indirect Dischargers To The Sewer System

In November, 1985, the Regional Administrator for USEPA Region 5, approved the District's pretreatment program making the District the control authority under the USEPA regulations for administration of the general pretreatment regulations, including the industrial categorical standards. The limitations on Table 3 comprise the local limits under the regulations, and the District has adopted by reference the categorical standards.

Because of the District's history in enforcement of the Appendix B limitations, the addition of the USEPA requirements will have little effect insofar as protection of the treatment process and the environment is concerned. The District normally issues between 500 to 600 violations of the ordinance each year, and this is not expected to change, except for failure of dischargers to submit the proper USEPA self-monitoring reports.

The District has catalogued approximately 3,450 industrial dischargers in its jurisdiction of which nearly 2,200 come under USEPA regulated industrial categories. Discharge limits have been published for 19 categories and these apply to 530 dischargers. Therefore, published USEPA categorical standards apply to only about 15 percent of the industrial dischargers. The District has notified each of these regulated dischargers regarding their obligations under the regulations, and the self-reporting requirements have been initiated.

Some of the regulated categories are subject to limits for organic priority pollutants, and the District has begun the analysis of samples from these industries for these pollutants. The District has also applied for removal credits under the regulations; however, due to litigation and legislative changes, action on our application has been delayed.

TUNNEL AND RESERVOIR PLAN TO CONTROL COMBINED SEWER OVERFLOWS

Combined sewer overflows (CSOs) in the Chicago area discharge the equivalent of raw waste from one million people per day into the waterways. Besides being unsightly, continuation of this pollution is a violation of NPDES permits and contributes to lack of attainment of water quality standards. After extensive studies of 23 alternatives by a committee of state and local officials in the early 1970s, the committee recommended the Tunnel and Reservoir Plan (TARP) as the most economical and environmentally acceptable way to solve the regional problem of CSOs.

TARP is designed to capture CSOs from the 375 square miles of combined sewer area within the District. In addition to being a pollution problem, the quantity of discharge to the waterways during heavy storm periods exceeds the capacity of the waterways to transport the flow away from the area, causing both basement and local street flooding. Excessive storm flows require the release of polluted waters to Lake Michigan, thereby polluting the area's drinking water source and nearby public bathing beaches. The objectives of TARP are therefore as follows:

1. To prevent backflows to Lake Michigan,

2. To eliminate waterway pollution caused by CSOs, and

3. To provide for flood control.

Implementation

TARP was divided into two phases to accommodate federal funding. Phase I consists of four different tunnel systems (Calumet, Des Plaines, Mainstream, and Upper Des Plaines) totalling 110 miles in length. Phase I is primarily meant to control pollution, and will eliminate 85 percent of the CSO pollution load. Of the 110 miles, the largest is the Mainstream Tunnel, the completed portion of which consists of 31 miles of tunnels, 13 to 33 feet in diameter and 240 to 300 feet below ground. It extends from the northeastern to the southwestern parts of the District's service area, as shown on Figure 5. Sewage and stormwater entering the tunnels through 116 drop shafts are carried to the Mainstream Pumping Station (MSPS), where the flow is subsequently pumped to the West-Southwest facility for treatment.

The TARP MSPS is one of the largest underground pumping facilities. It is designed to handle not only the presently completed portion of the Mainstream System, but has the capacity for those portions of the system not yet constructed. The MSPS provides space for eight pumps, with 1,100 cfs of total capacity. These pumps together are able to empty the 31 miles of the Mainstream Tunnel in less than two days.

Phase II of TARP will consist of an additional 21 miles of rock tunnels and three reservoirs with a total storage capacity of 128,000 acre-ft. Two of the proposed reservoirs will be located in existing rock quarries. During major storms, the discharge from the tunnels will be directed into the reservoirs for temporary storage and preliminary treatment. Following temporary storage, the reservoir contents will be pumped to existing facilities for treatment. Phase II was designed primarily for flood control, though it will eliminate the remaining 15 percent of pollution from CSO's. In 1976, Congress authorized the U.S. Army Corps of Engineers to take responsibility for Phase II of TARP.

The estimated construction cost of Phase I is $2.24 billion as shown in Table 4 and, as this phase is primarily a pollution control project, the USEPA is providing grant funds for approximately 75 percent of the project costs. The cost of the projects completed or under construction as of 1985 was $1.215 billion. The remaining, unawarded portion of TARP Phase I, now estimated to cost $1.028 billion, has been designed, and is awaiting further appropriations of USEPA funds. The District has estimated that Phase II will have a construction cost of $1.6 billion.

Benefits of TARP

Approximately 43 million pounds of BOD is spilled to the area's waterways from combined sewers annually. The first phase of the TARP system will reduce this BOD load by approximately 85 percent. Phase II will reduce the BOD spillage by about 99.8 percent. It is also estimated that Phase I TARP will reduce floodwater damage by 10 to 15 percent and that Phase II TARP will reduce the flood damage costs by approximately 65 percent. Municipal sewer improvements added to Phase II TARP will substantially eliminate all flood damage in the combined sewer area.

There are several regional benefits that will be achieved by TARP. Approximately $1 billion in costs for plant expansion and $20 million in high-level sewer construction by the District will be offset. Also, municipal sewer construction of $66 million will be offset. The quality of the waterways in the combined sewer area of metropolitan Chicago will be greatly improved and flooding significantly reduced after both phases of TARP become operational. Moreover, the incidences of backflows to Lake Michigan will be greatly reduced and enhancements will accrue to the recreational potential of the waterways and the value of property along the waterways.

STORMWATER MANAGEMENT

The District's historic responsibilities for drainage have led to its involvement in flood control or stormwater management. Aside from the drainage improvements in the first half of the of this century, the District began its first direct involvement in flood Control in the 1950s with the design and construction of waterway improvements. Drainage ditch construction and waterway widening was accomplished up until the early 1960s when it was realized that these types of projects did not solve problems, but merely moved them downstream.

Therein began the District's role in stormwater management. In 1967, funding was programmed for a series of stormwater retarding reservoirs in the separate sewered and nonsewered areas of the District. Funding for these projects was to be cooperative in nature with local governments picking up costs for engineering and maintenance. Although slow to take root, the programs' early and notable projects were the Melvina Reservoir in Berkeley and the Middle Fork Reservoir in Northbrook.

To prevent the flooding problem from getting worse, the District amended its Sewer Permit Ordinance in 1972 to require municipalities to adopt comprehensive stormwater management plans or in the absence thereof, to require developers to install on-site detention for excess stormwater flows. As a result of this amendment, no communities have adopted the required plans, but developers have installed on-site detention reservoirs with a total capacity of 7,753 acre-feet through 1986.

The need for comprehensive stormwater management planning for the entire area was addressed with the District entering into a cooperative agreement with the Soil Conservation Service (SCS) in June, 1971. The resulting Chicago Metropolitan Area River Basin Plan (CMARBP) was completed by July, 1976, at a total cost of 2.9 million dollars, 1.6 million coming from District resources and the balance from the SCS.

The CMARBP was a cooperative undertaking involving all levels of government including forest preserve districts and soil conservation districts. The CMARBP consists of seven separate plans for the seven watersheds in the metropolitan area as shown in Figure 6. The total area affected includes portions of Wisconsin and Cook, DuPage, Lake, and Will Counties in Illinois. A steering committee, consisting of citizens and representatives from local governments and organizations was established in each watershed to guide the planning effort. The SCS staff directed the surveys and technical studies of alternatives.

Implementation of the CMARBP is being handled in a variety of ways. In some watersheds, implementation is handled by the SCS watershed program under Public Law 566, in others the District has utilized its cooperative program with local governments, and in one basin, Congressional authorization has been received for the U.S. Army Corps of Engineers to assume responsibility. A summary of the projects included in the CMARBP is shown in Table 5.

Both the Poplar Creek and Upper Des Plaines River watersheds are relatively undeveloped and proper on-site detention and flood plain preservation and control are thought to be sufficient to avoid future flood problems as development occurs. Another small watershed, West Branch of the DuPage River, had flood control projects identified and installed as part of the District's Hanover Park Solids Management Plan implementation.

HAZARDOUS MATERIALS EMERGENCY RESPONSE

In the summer of 1978, explosions and fires occurred at two chemical plants in the southern suburbs of Cook County. One plant manufactured pesticides and large quantities of toxic materials were released to the environment. In both situations, hazardous or toxic materials posed a severe threat to the local air and water resources. As a result of these incidents, and a rising awareness of hazardous waste landfill problems, the IEPA and Illinois Emergency Service and Disaster Agency convened a meeting of local, state and federal Chicago area agencies to form a Hazardous and Toxic Materials Emergency Response Plan.

The Plan was not an attempt to redefine authorities, responsibilities or methods, but simply to identify levels of responsibility and to provide a coordinating mechanism. The coordinating machanism is presently handled by the Emergency Response Coordinating Committee. Activities include updating agency personnel and equipment rosters, improving communications, cross-training of personnel and analyzing past response activities for the purpose of improving future operations.

Responsibilities for incidents are as follows:

- Waterway spills: Primary response, U.S. Coast Guard
  First support, District

- Hazardous spills and/or toxic gas release in the City of Chicago: Primary response, Chicago Fire Department
  First support, District

- Hazardous spills in Cook County outside Chicago:
  Primary response, District
  First support, local fire department.

- Toxic gas releases in Cook County outside Chicago:
  Primary response, Cook County Department of Environmental Control.
  First support, District
  Second support, local fire department.

ENVIRONMENTAL MONITORING ACTIVITIES

Lake Michigan

The District was created in 1889 to protect the source of the city of Chicago's drinking water-Lake Michigan. The District has continued to safeguard this valuable water resource through capital improvements such as TARP, and by continuing extensive water quality monitoring programs for this great lake.

There are, at present, seven ongoing water quality monitoring programs for Lake Michigan. These programs are briefly described in Table 6. Figure 7 is a map of the southwestern portion of Lake Michigan indicating the sampling locations for the seven water quality monitoring programs described.

Chicago Area Waterways Ambient Monitoring

The District conducts a program to monitor the water quality of the waterways within its jurisdiction by taking monthly grab samples at 48 locations. These sampling locations are upstream and downstream of the outfalls of the seven treatment facilities, at locations where waterways enter or leave the District, at or near USGS flow measurement stations and at other critical locations as shown in Figure 8.

The monthly samples from these 48 locations are analyzed at District laboratories for 48 separate biological, chemical, physical, or radiological constituents. The data from these 48 locations are used to evaluate compliance with water quality standards, to determine trends and to determine the impact of operations and the construction of major improvements. Data resulting from this waterway monitoring is provided to other agencies at their request.

Illinois Waterway Monitoring

In 1977, the District initiated an extensive water quality survey of the 133 mile reach of the Illinois Waterway from the Lockport Lock and Dam to the Peoria Lock and Dam as shown in Figure 9. Included in his survey are 49 locations from which grab samples were taken and analyzed for biological, chemical, and physical constituents. This survey was performed in 1977 and since 1983 has been performed annually. Since 1983, the survey has included the collection and analysis of sediments from selected locations. Dissolved oxygen concentrations measured in 1977 and 1983 are shown on Figure 10.

SUMMARY AND CONCLUSIONS

This presentation has described the activities of the District to show its role as the principal water quality management agency in the Chicago area. As a result of the District's history and development its current and ongoing activities accomplish the following:

1. Eliminating discharges of raw sewage to Lake Michigan thereby protecting this resource as a supply of drinking water and protecting the public health of the community.

2. Providing full secondary treatment of sewage for a population of 5,000,000 thereby protecting water quality for downstream users.

3. Processing and disposing of municipal wastewater treatment solids in an environmentally safe manner resulting in the recycle of these solids to land.

4. Controlling industrial waste to protect the wastewater treatment process, insure compliance with waterway effluent standards and protect the public from industrial toxic discharges to waterways or sewers.

5. Implementing a cost-effective control program for combined sewer overflows to reduce waterway pollution loading and provide treatment for polluted urban storm water runoff.

6. Implementing a master drainage plan for the greater Chicago area involving the resources of federal, state, and local governments in planning, design, construction and operation of facilities to reduce storm water flooding and provide multiuse activities at project sites.

7. Cooperating with other local and state agencies in the operation of a hazardous materials emergency response plan to protect the public health and welfare from accidental spills of toxic pollutants to the environment.

8. Cooperating with other local and state agencies in the operation of environmental monitoring programs to assess compliance with environmental regulations and to identify need for changes or new regulatory programs.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 1

CHRONOLOGY OF SOLIDS MANAGEMENT AT THE DISTRICT

1922	-	Heat-dried solids sold at Des Plaines Treatment Works
1932	-	Heat drying at the West-Southwest Sewage Treatment Works - Experimental Scale
1937	-	Full-scale drying at the Calumet Sewage Treatment Works
1939	-	Full-scale heat drying at the West-Southwest Sewage Treatment Works
1969	-	Research plots started by University of Illinois at Elwood for studies on agricultural use of digested solids
1970	-	First District land purchase at Fulton County for solids utilization in reclamation of strip mined land.
1972	-	Solids application begins at Fulton County
1974	-	Nu Earth program begins for free distribution of aged solids
1978	-	Nu Earth program restricted to controlled free distribution for non-food-chain uses
1978	-	Full-scale 140 acre farm at Hanover Park Water Reclamation Plant.
1981	-	Air-dried digested solids used in closure plan for City of Chicago landfill

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

Table 2

APPENDIX A OF THE SEWAGE AND WASTE CONTROL ORDINANCE
FOR DISCHARGES TO WATERWAYS

Constituent	Units	Not to Exceed Limits[1,4,5]
Arsenic	mg/l	0.25
Barium	mg/l	2.0
Biochemical Oxygen Demand		-[2]
Cadmium	mg/l	0.15
Chromium (Hexavalent)	mg/l	0.1
Chromium (Total)	mg/l	1.0
Copper	mg/l	0.5
Cyanide	mg/l	0.1
Fats, Oils or Greases	mg/l	15.0[3]
Fecal Coliform	counts/100 ml	400.0
Fluoride	mg/l	15.0
Iron	mg/l	2.0
Lead	mg/l	0.2
Manganese	mg/l	1.0
Mercury	mg/l	0.0005
Nickel	mg/l	1.0
pH range	Units	not>10.0 nor< 5.0
Phenols	mg/l	0.3
Phosphorus (Calumet River only)	mg/l	1.0
Silver	mg/l	0.1
Suspended Solids		-[2]
Zinc	mg/l	1.0

[1]Compliance with these numerical standards shall be determined on the basis of 24-hour composite samples, averaged over any monthly period. However, no single 24-hour composite shall be greater than 2 times the standard and no grab sample shall be greater than 5 times the standard.

[2]Biochemical oxygen demand and suspended solids in all effluents shall meet the following limits:

a. No effluent from any source discharging into the Chicago River System or into the Calumet River System, shall exceed 20 mg/l of biochemical oxygen demand or 25 mg/l of suspended solids.

b. No effluent whose dilution ratio is less than 5 to 1 shall exceed 10 mg/l of biochemical oxygen demand or 12 mg/l of suspended solids.

c. No effluent whose dilution ratio is less than 1 to 1 shall exceed 4 mg/l of biochemical oxygen demand or 5 mg/l of suspended solids.

[3]Fats, oils or greases may be analytically separated into polar and nonpolar components. If such separation is done, neither of the components may exceed 15 mg/l.

[4]In addition to the other requirements, no effluent shall contain settleable solids, floating debris, visible oil, grease, scum, or sludge solids. Color, odor, and turbidity must be reduced to below obvious levels.

[5]There shall be no discharge of any sewage, industrial wastes, or other wastes into the waters of Lake Michigan.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

Table 3

APPENDIX B OF THE SEWAGE AND WASTE CONTROL ORDINANCE FOR DISCHARGES TO SEWERS

Constituent	Units	Not to Exceed Limits
Cadmium	mg/l	2.0
Chromium (Total)	mg/l	25.0
Chromium (Hexavalent)	mg/l	10.0
Copper	mg/l	3.0
Cyanide (Total)	mg/l	10.0
Cyanide (Readily released at 68.3°C and pH = 4.5)	mg/l	2.0
Fats, Oils or Greases	mg/l	250.0
Iron	mg/l	50.0
Lead	mg/l	0.5
Nickel	mg/l	10.0
pH	units	not>10.0 nor< 5.0
Zinc	mg/l	15.0
Temperature	°C	68.3

NOTE: Any discharge of wastes or waters into a sewer which terminates in or is a part of the sewerage system of the District, must not contain the following:

1. Volatiles sufficient to cause fire or explosion.
2. Noxious or malodorous liquids, gases or substances.
3. Water or wastes containing toxic substances.
4. Garbage that has not been ground or comminuted.
5. Radioactive wastes unless they comply with the Atomic Energy Commission Act of 1954.
6. Solid or viscous wastes which cause obstruction to the flow.
7. Waters or waste containing substances which are not amenable to treatment.
8. Excessive discoloration.
9. Mercury in excess of 0.0005 mg/l, with certain exemptions provided.
10. Pollutants which will cause corrosive structural damage.
11. Pollutants which will cause interference to or pass through the treatment process.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 4

FUNDED AND UNFUNDED PORTIONS OF TARP PHASE I

FUNDED

Segment	Construction Cost (Million $)	Length (Miles)
Mainstream	975	31.2
Calumet	153	9.2
O'Hare	64	6.6
Des Plaines	23	3.5
Totals:	1,215	50.5

UNFUNDED

Segment	Construction Cost (Million $)	Length (Miles)
Mainstream	197	9.1
Calumet	400	27.1
O'Hare	0	0
Des Plaines	431	22.9
Totals:	1,028	59.1

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 5

FLOOD CONTROL PROJECTS INCLUDED IN THE
CHICAGO METROPOLITAN AREA RIVER BASIN PLAN
AND OTHER DISTRICT PROGRAMS

Project Type	Number	Storage Capacity (acre-feet)
Calumet-Sag Channel Watershed		
Reservoirs	3	290
Bridge Replacements	1	--
Little Calumet River Watershed		
Reservoirs	5	12,500
Channel Improvements	1	--
Lower Des Plaines River Watershed		
Reservoirs	11	1,960
Channel Improvements	3	--
Bridge Replacements	1	--
North Branch Chicago River Watershed		
Reservoirs	7	2,000
Poplar Creek Watershed		
Reservoirs	3	210
Channel Improvement	1	--
Bridge Replacement	1	--
Upper Des Plaines Watershed		
No projects designated	--	--
Upper Salt Creek Watershed		
Reservoirs	6	6,370
Channel Improvements	1	--
West Branch DuPage River Watershed		
Reservoirs	1	230
Channel Improvements	1	--
Bridge Replacement	1	--

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE 6

LAKE MICHIGAN MONITORING PROGRAMS OF THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

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1. Sampling of Wilmette, Chicago, and Calumet Harbors for toxic organic compounds, bacteria and conventional constituents during bypassing by the District from the Wilmette, Chicago, and O'Brien Locks to Lake Michigan during heavy rains.

2. Sampling near the Zion Nuclear Power Station of Commonwealth Edison for radioactivity content and toxic organic compounds.

3. Sampling of the Calumet and Indiana Harbor areas and the water intakes for Waukegan, Winnetka, and Evanston for polychlorinated biphenyls and pesticides.

4. Determination of the fish, bacterial, algae, and benthos populations of the Wilmette, Chicago, and Calumet Harbor areas.

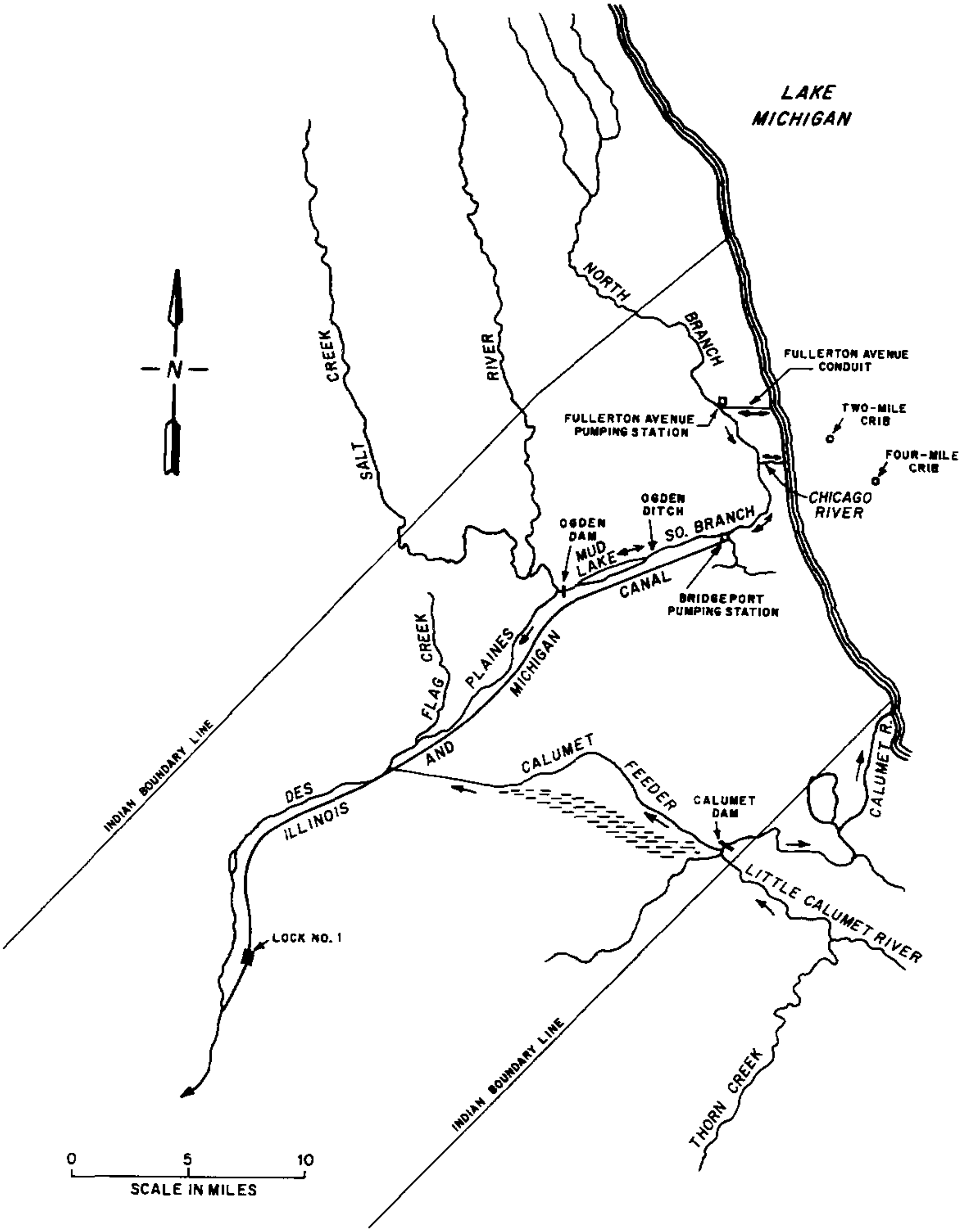
5. Sampling of the inshore open waters for bacteria and conventional constituents at seven locations between the Cook-Lake County Line and Indiana Harbor.

6. Sampling near the Robertsdale Pumping Station of the Hammond-Munster, Indiana, Sanitary District.

7. Sampling near Navy Pier and in Monroe Harbor before, during, and after public lakefront entertainment events for bacteria and conventional constituents.

FIGURE 1

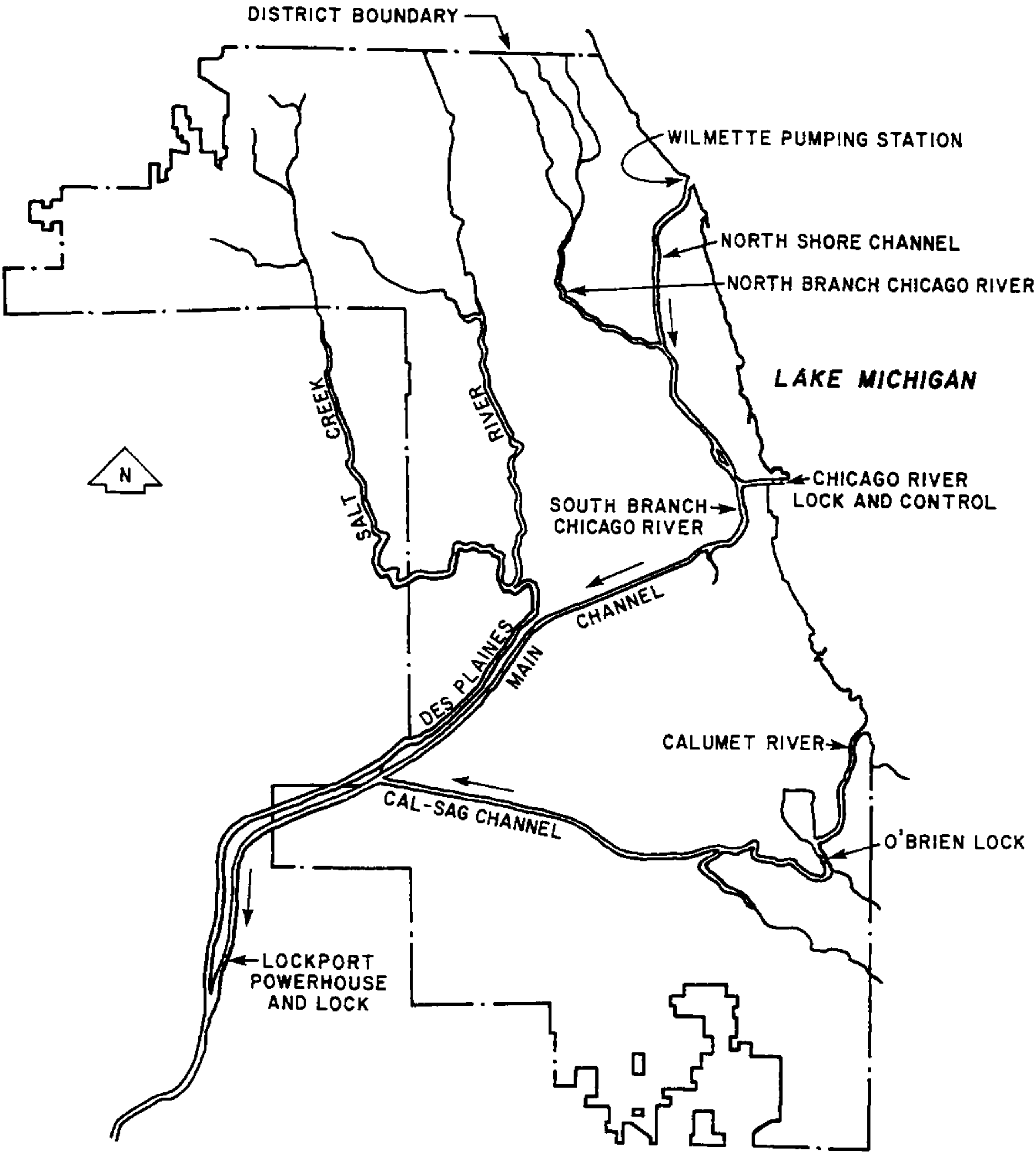
CHICAGO AREA WATERWAY SYSTEM
PRIOR TO 1900



THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

FIGURE 2

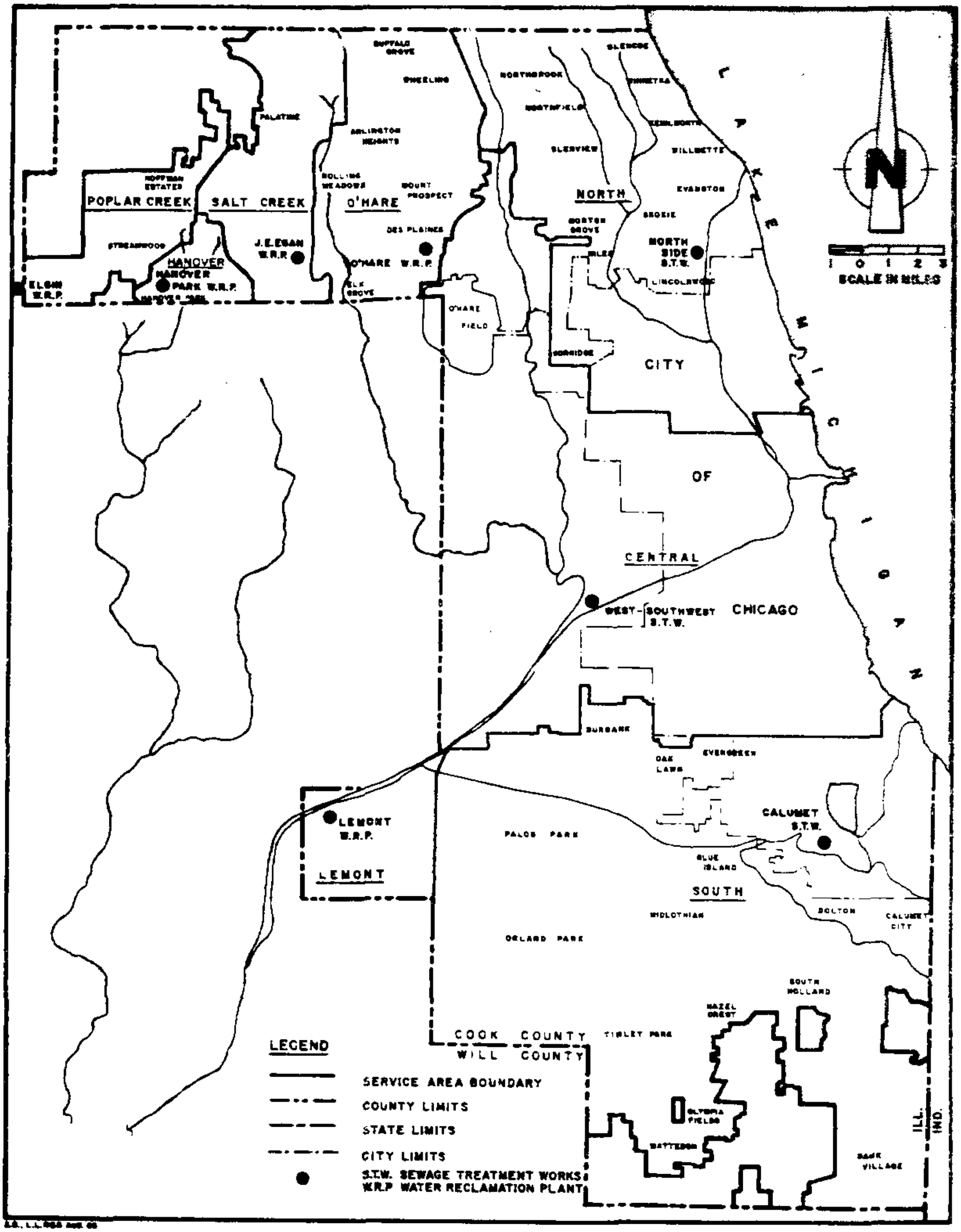
CANAL SYSTEM OF THE DISTRICT



THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

FIGURE 3

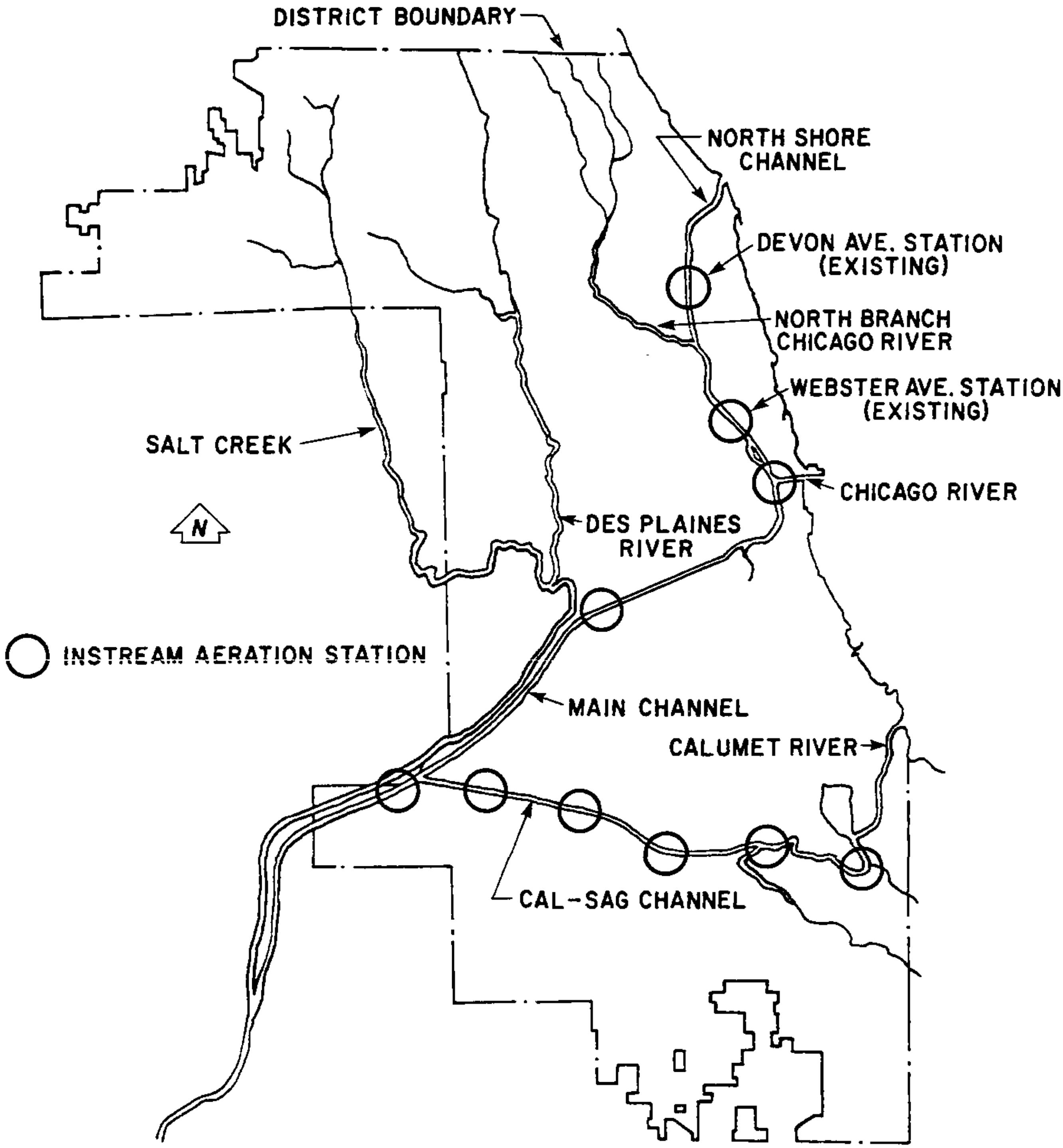
TREATMENT FACILITY AND SERVICE AREAS MAP



THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

FIGURE 4

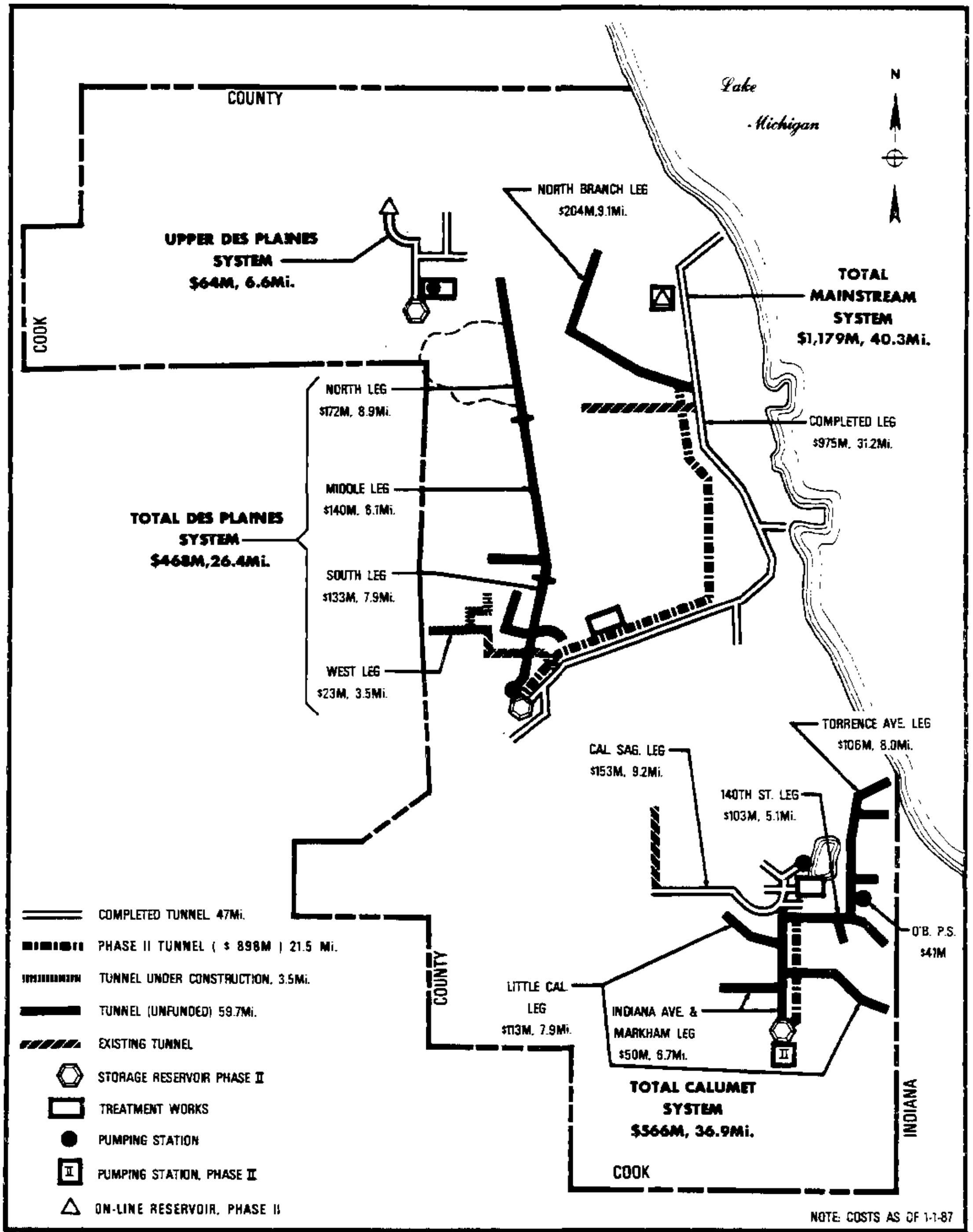
EXISTING AND PLANNED INSTREAM AERATION STATIONS



THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

FIGURE 5

TUNNEL AND RESERVOIR PLAN SYSTEM



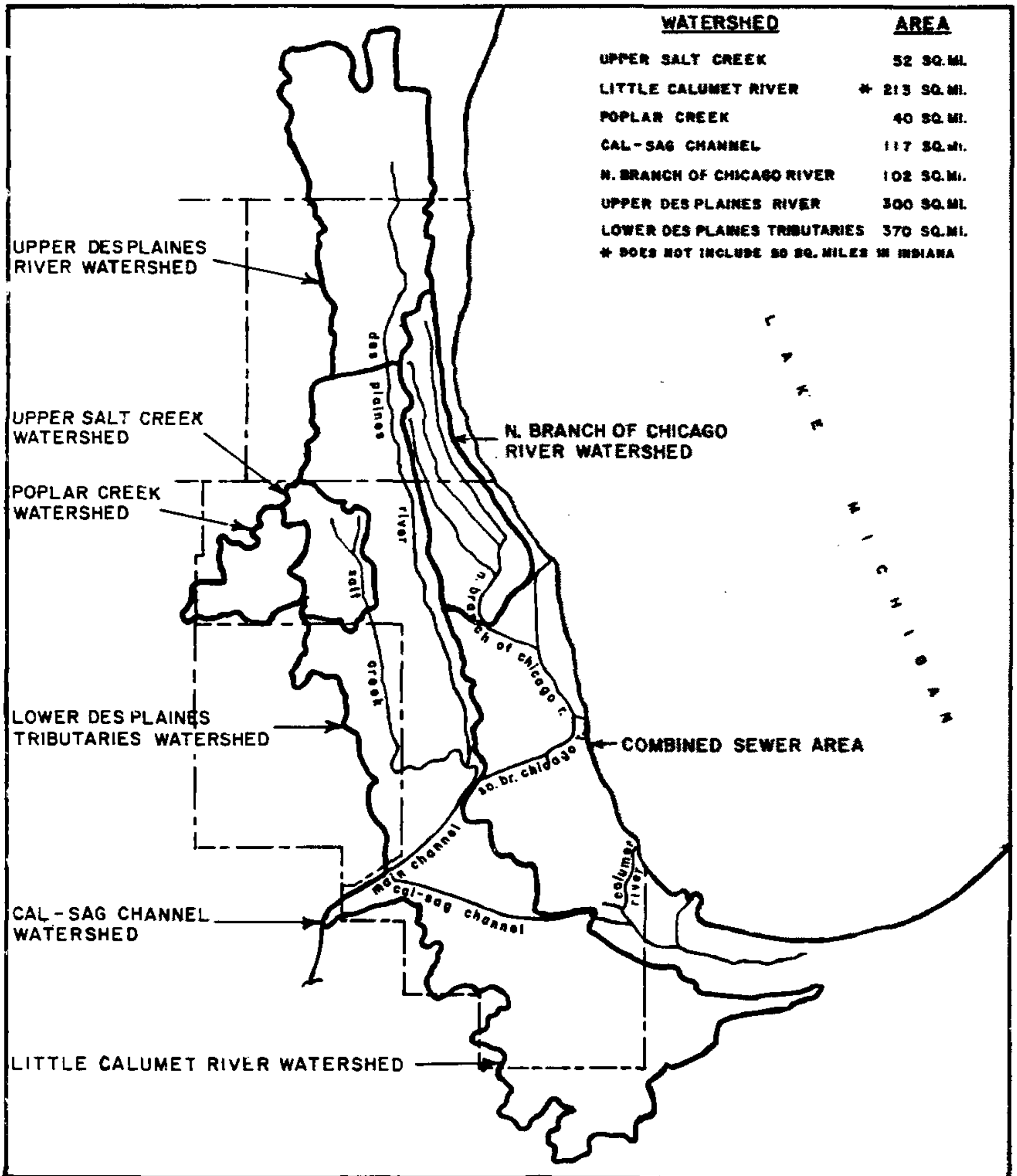
TUNNEL AND RESERVOIR PLAN
PROJECT STATUS

THE METROPOLITAN SANITARY DISTRICT
OF GREATER CHICAGO
ENGINEERING DEPARTMENT
1-87 TUNNEL AND RESERVOIR JP:HP

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

FIGURE 6

CHICAGO METROPOLITAN AREA RIVER BASIN PLAN WATERSHEDS

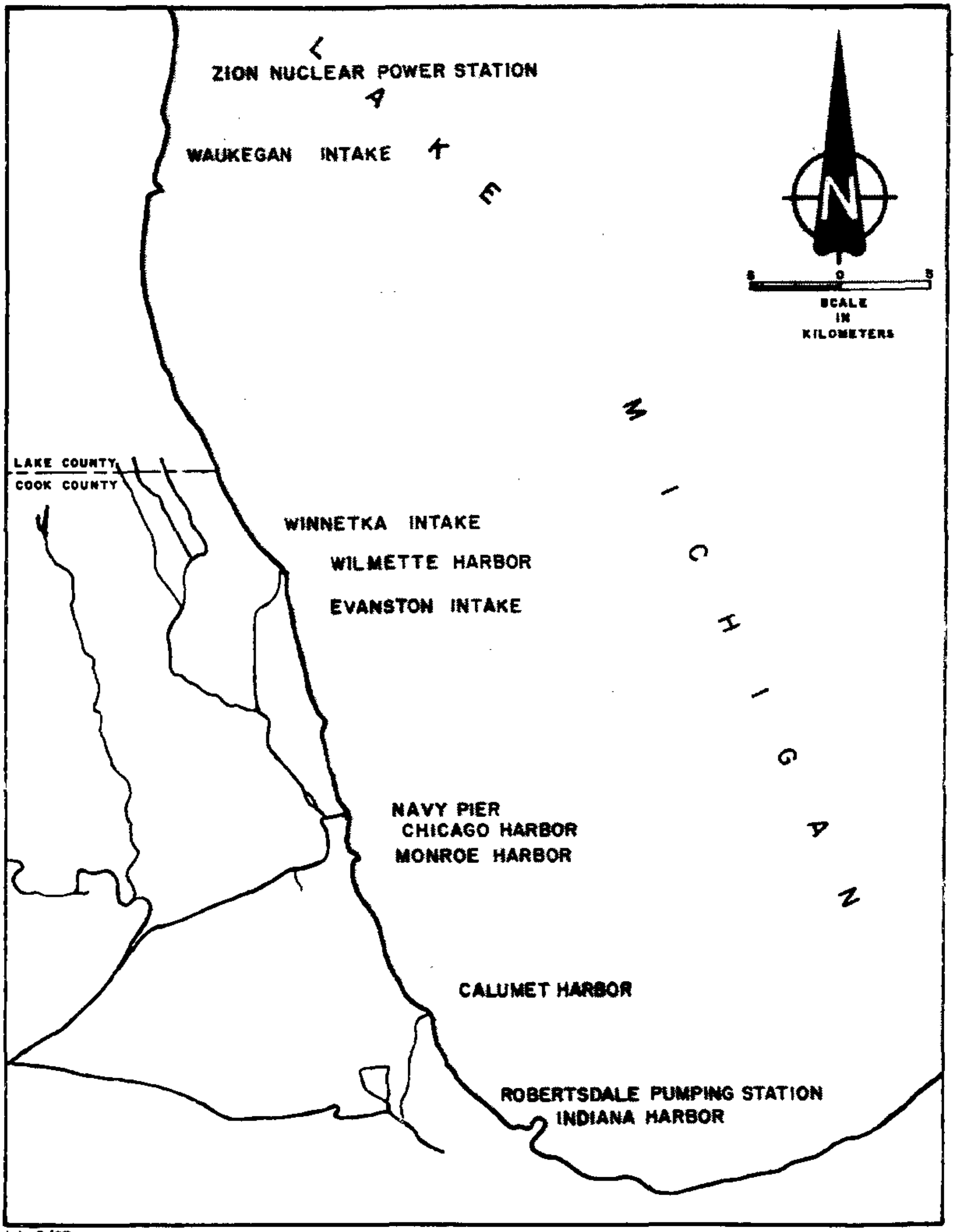


L.L., 3/87

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

FIGURE 7

LAKE MICHIGAN SAMPLING PROGRAM AREAS

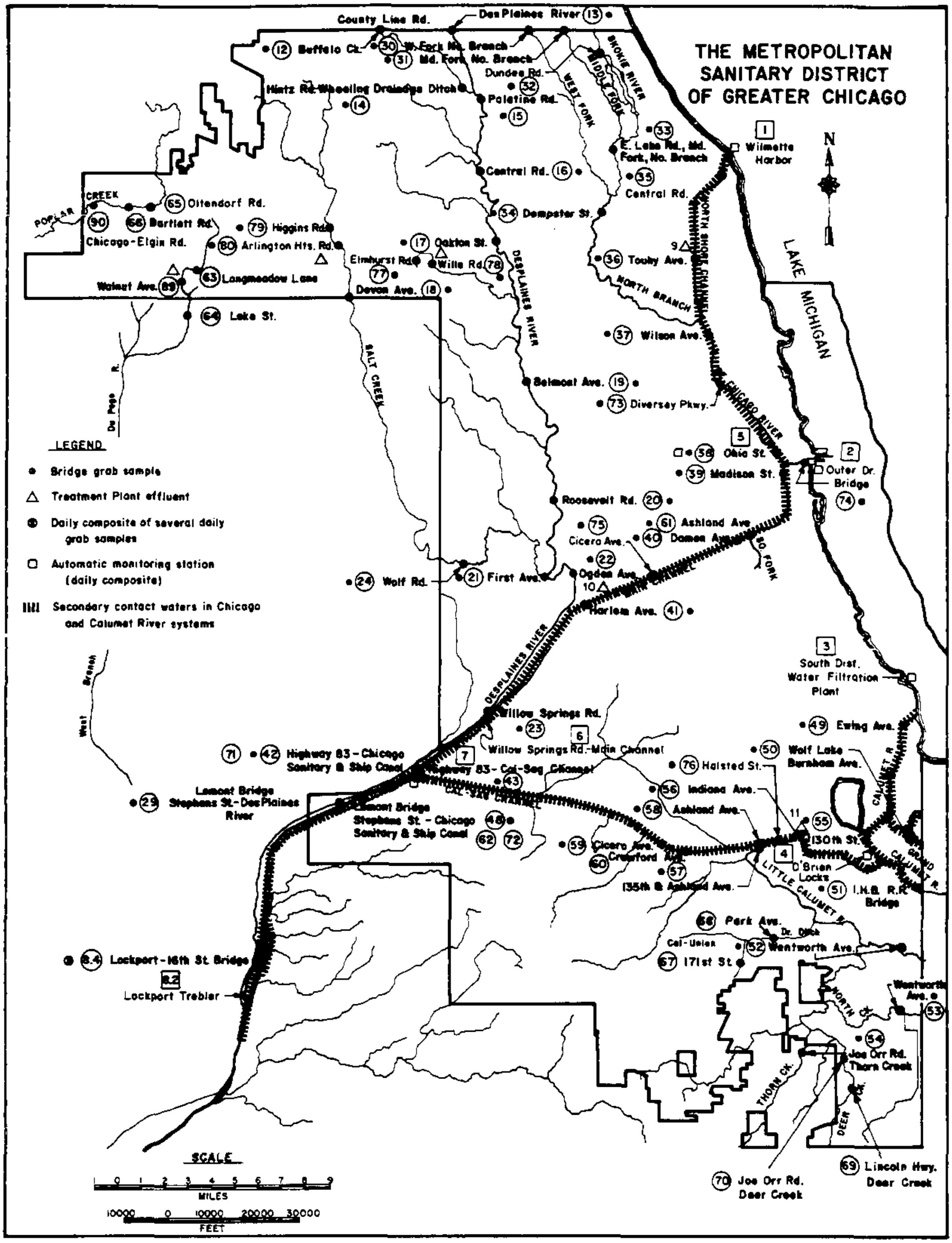


L.L.,3/87

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

FIGURE 8

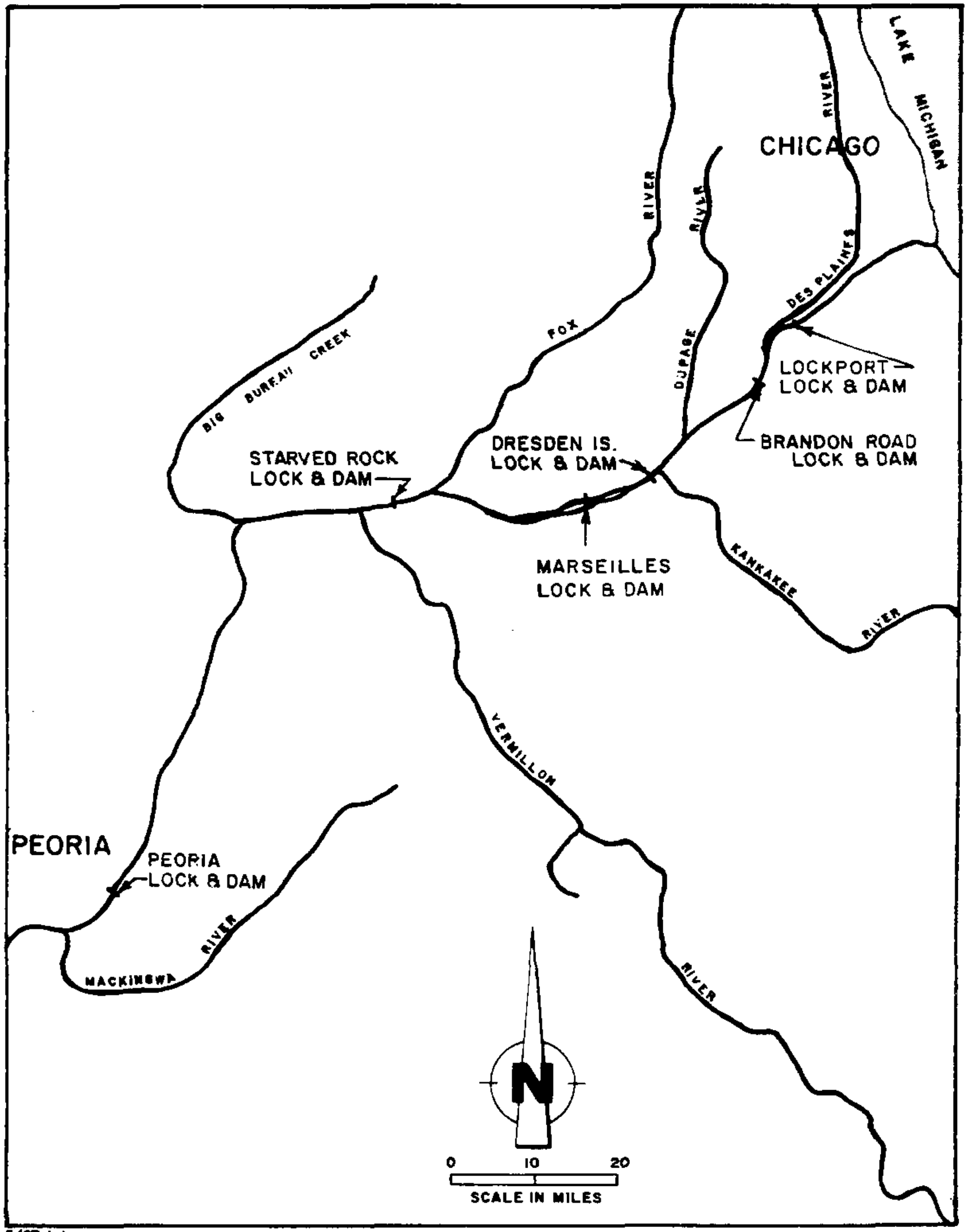
WATERWAY SAMPLING LOCATION POINTS



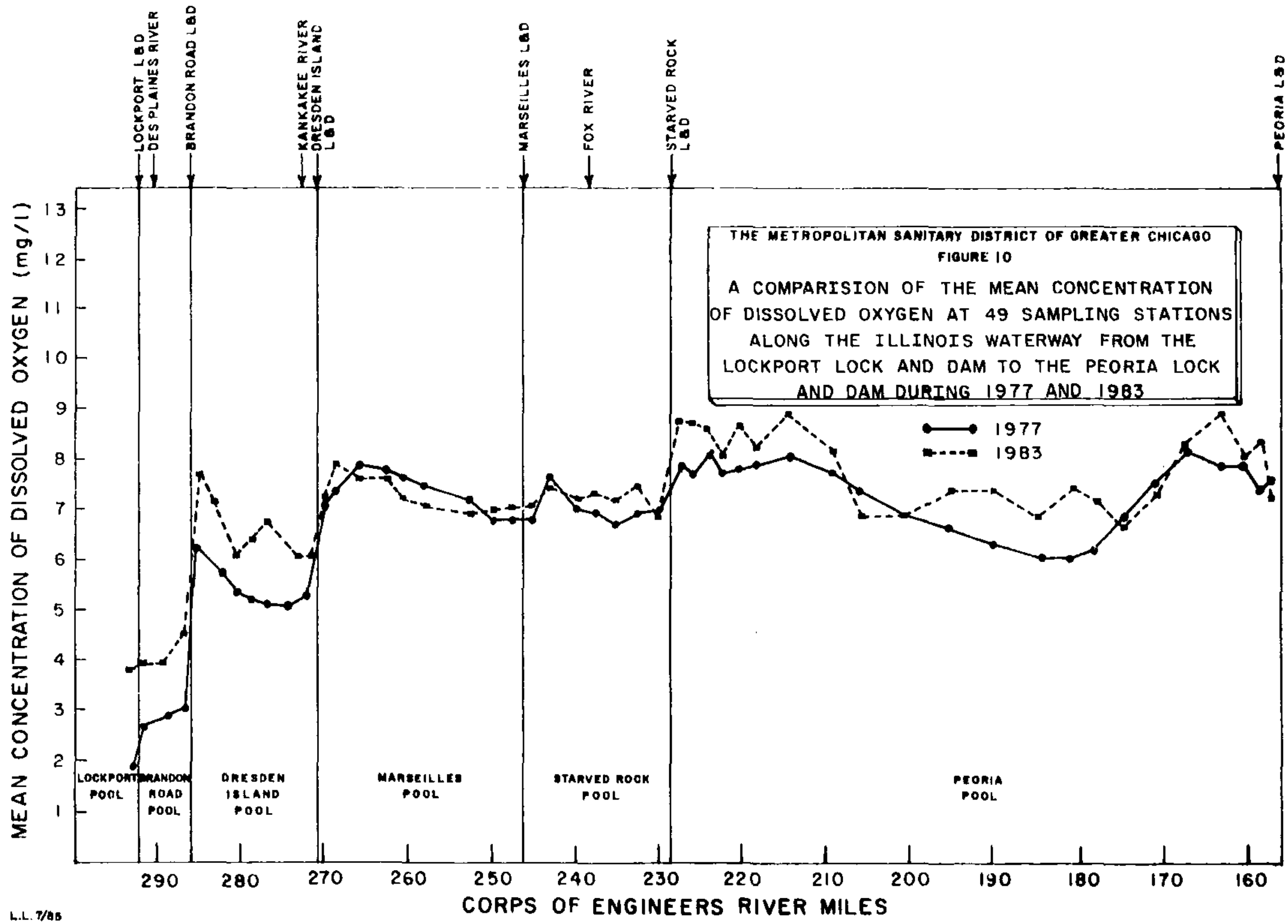
THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

FIGURE 9

ILLINOIS WATERWAY FROM LOCKPORT TO PEORIA



3/87, L.L.


THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO
FIGURE 10
A COMPARISION OF THE MEAN CONCENTRATION OF DISSOLVED OXYGEN AT 49 SAMPLING STATIONS ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT LOCK AND DAM TO THE PEORIA LOCK AND DAM DURING 1977 AND 1983
1977
1983
LOCKPORT L&D
DES PLAINES RIVER
BRANDON ROAD L&D
KANKAKEE RIVER
DRESDEN ISLAND L&D
MARSEILLES L&D
FOX RIVER
STARVED ROCK L&D
PEORIA L&D
LOCKPORT POOL
BRANDON ROAD POOL
DRESDEN ISLAND POOL
MARSEILLES POOL
STARVED ROCK POOL
PEORIA POOL
MEAN CONCENTRATION OF DISSOLVED OXYGEN (mg/l)
13
12
11
10
9
8
7
6
5
4
3
2
1
290
280
270
260
250
240
230
220
210
200
190
180
170
160
CORPS OF ENGINEERS RIVER MILES
L.L. 7/85

Session II

Natural Resources of the Illinois River and Its Basin

OPENING REMARKS FOR THE NATURAL RESOURCE SESSION

John W. Comerio
Director, Office of Planning and Development

Illinois Department of Conservation

Good morning and welcome to today's session on the Natural Resources of the Illinois River and its basin. I am John W. Comerio of the Illinois Department of Conservation. I am very happy to participate in this important conference. I wish to extend to you a sincere apology from Director Mark Frech who is unable to be here today.

The Department of Conservation's mission is to protect and manage the state's natural resources and provide outdoor recreation opportunities. The Department meets these objectives while recognizing their relationship to other state goals and incorporating these objectives with environmental protection and economic development. In this way the Department helps in a large measure to upgrade the quality of life in Illinois.

The Department is a governmental agency, and as such, must operate within a broad, statewide context while recognizing local attributes, needs, and desires.

The Department of Conservation has a major interest in the Illinois River Basin which contains some of the state's most productive fish and wildlife habitats and important outdoor recreation assets. The Agency manages 29 separate properties along the Illinois River encompassing over 70,000 acres of land.

Recent capital improvements have upgraded 13 of these Department sites between fiscal years 1985 through 1987. In this period, over 20 million dollars have been spent on these Illinois River sites alone. The Build Illinois Wildlife Habitat Acquisition Program has provided 6.5 million dollars in FY86 and FY87 for areas along the Illinois River. Department assistance to municipalities along the Illinois River has been considerable in the last 2 years. Approximately $460,000 of Build Illinois Open Space Land Acquisition and Development funds have been provided to municipalities. As many of you know, Governor Thompson presented a $200,000 check of the Department of Conservation-administered federal Land & Water Conservation Funds to the City of Peoria and Peoria Park District officials for the 36 acre park along the Development. Since 1985, $405,000 of Land and Water Conservation Fund dollars have been spent in Peoria. Approximately $151,000 of State Boat Access money has been spent in FY86 for communities along the Illinois River at Creve Coeur, Grafton, and Spring Valley.

For those not familiar with the Department, some of the major sites owned and managed by the Department of Conservation in the area of Peoria Lake include Woodford County State Fish and Wildlife Area, Marshall County State Fish and Wildlife Area, Banner Marsh State Wildlife Area, Rice Lake State Fish and Wildlife Area, Spring Lake Conservation Area and Sparland County Conservation Area. We have strong commitments to these and other sites along the Illinois River and sedimentation of backwater areas is of major concern.

I would like to briefly outline a few projects undertaken by the Department of Conservation in the Peoria Lake area.

The Department has recently initiated a Watershed Planning Program to address soil erosion and sedimentation problems in Illinois, particularly those associated with Department land and water areas. Environmentally sound and economically affordable techniques for streambank erosion control are currently being tested and will be promoted on public and private property. Court Creek is located in Knox County and empties into the Spoon River and eventually into the Illinois River near Havana. Court Creek is currently the site of one of our research/demonstration projects. Crow Creek empties into Sparland Conservation Area just north of us here along the river. Crow Creek may be the next site selected for streambank erosion control evaluations. A brochure for the Illinois River Soil Conservation Task Force has been published by the Watershed Planning Program in cooperation with other agencies and groups. The brochure essentially outlines the Illinois River Basin soil erosion and sedimentation problem.

The Department of Conservation is funding a project to restore aquatic vegetation in Peoria Lake. Thousands of arrowhead and pondweed tubers are being planted in a bay in Lower Peoria Lake, and protective measures will be tested to see if they help the plants to become established. Depletion of these aquatic plants in the past has led to severe reductions in the numbers of waterfowl and game fish in Peoria Lake. These losses of aquatic life have decreased fishing and hunting opportunities at the lake. The vegetated areas may decrease wave fetch and, in turn, decrease the rate of shoreline erosion while upgrading the aquatic and wetland habitat and water quality.

Conservation currently maintains fish monitoring stations in Peoria Lake and conducts fish surveys each year. The fish survey data is generally used for habitat management. Contamination of fish species is checked from surveys conducted near the Peoria water intake system in Peoria Lake.

The Department is also currently compiling information for the National Wetland Inventory. This effort is being conducted by the Department's Wetlands Program and will offer an automated data base for further investigations associated with the Peoria Lake problem.

The agency has provided a great deal of management, assistance and information specific to the Illinois River Basin and to the Peoria area. We feel the Department, on the whole, is doing a good job managing the natural resources and outdoor recreational assets of the Illinois River Basin and is addressing in a meaningful way the real resource management issues of the Basin.

Our speakers in the Natural Resources Session will provide us with futher Basin information and will help to set the stage for the discussion groups that follow at 3:30 p.m. this afternoon. The speakers will briefly refresh your memory on pertinent Illinois River Basin considerations which include

1) Basin evolution and dynamics,
2) Fish and wildlife considerations,
3) Watershed modifications and treatments,
4) Water quality and water-use management issues, and
5) Soil and habitat conservation programs.

Other key issues, like the effects of Lake Michigan Diversion on fish and other wildlife along the Illinois River, will not be ignored. Please raise pertinent questions and offer recommendations for solving these problems during the discussion groups.

I'm sure you will enjoy the day's session and please feel free to participate in the discussion groups.

Bob Walker

Jim Hart

Tom Butts

Marvin Hubball

Bill Mathis

Raman Raman

Richard Sparks

Kay Harmon

Dorothy Sinclair

RIVER BASIN EVOLUTION AND STREAM DYNAMICS

Lawson M. Smith
Chief, Engineering Geology Group
U.S.A.E. Waterways Experiment Station

River basins are complex environmental systems which require multidisciplinary approaches to develop comprehensive basin plans and programs. Development of a coordinated river and river basin management plan for the Illinois River System will require an understanding of the natural evolution of the Illinois River in order to analyze the impact of man's activities and changing natural factors on the river system.

In the following paragraphs, a discussion will be given of the general evolution of river basins and stream dynamics in terms of an understanding of the mechanics of fluvial systems. Upon establishing a basic background in fluvial systems, the general evolution of the Illinois River Basin will be outlined, including a consideration of the future development of the river.

RIVER BASINS AS ENVIRONMENTAL SYSTEMS

Like all environmental systems, river (or fluvial) systems are characterized by a number of important qualities. These qualities are: (1) the limits of the fluvial system are environmental; (2) the elements of the system interact; (3) the fluvial system is controlled by previous actions; (4) a single element usually dominates the fluvial system; (5) the system evolves through time; (6) energy and matter flow through the system; and (7) the dynamics of the system are influenced by thresholds.

The limits of a fluvial system are the drainage divide of its drainage basin and the mouth of the river. Elements of the fluvial system, such as the tributary channels and the main channel interact; that is, a change in the tributary network will impact the character of the main channel, and vice-versa. Fluvial systems are controlled by the dominant element of climate, which through precipitation and temperature control the amount of water flowing through the system. A river system is also controlled by previous actions, such as a long-term response to the processing of large amounts of glacial meltwater, a condition which still influences the Illinois River today. River systems evolve over time geomorphically, as they adjust their physical character to the influence of major internal and external parameters. Fluvial systems transfer energy through raindrop impact on hillslopes to the exertion of fluid shear on the streambanks. Mass, primarily in the form of water and sediment, is transported from the farthest drainage divide to the channel mouth through the expenditure of energy in the system. Thresholds, such as critical discharge levels or channel slopes influence system dynamics by changing the importance of certain processes, such as channel bed or streambank erosion.

Subsystems exist within an overall fluvial system that may be considered as important and separate elements of the system. The major subsystems of a fluvial system are the main channel and its floodplain, the tributary network, and the hillslopes. These subsystems are characterized by energy and mass transfer through them and interaction between them. The hillslope subsystem transfers water and sediment overland during precipitation through the generation of sheet flow and the eventual erosional development of rills and gullies. Water and sediment in the gullies then enter the tributary drainage network and are transported downstream, modifying the tributary channels progressively downstream. Upon entering the main channel, the collective influence of the many tributaries on the main channel is expressed by the rate and type of sediment production from the tributary and hillslope subsystems and the hydrologic smoothing of the processing of precipitation and consequent streamflow to the main channel. The resulting mainstream reflects an adjustment to the tributary and hillslope subsystems, in terms of process and form.

Fluvial systems are controlled by a number of external and internal factors. Major external factors influencing the evolution and character of fluvial systems are time, geology, initial relief, geology, climate, and of course, man. Factors within the fluvial system, products of the external factors, are vegetation, local relief of the basin, hydrology, drainage network morphology, and hillslope morphology. As external variables, geology and initial relief are established at the onset of river basin evolution. The influence of climate changes as the river system evolves through time, or as the climate changes. The Illinois River has been profoundly influenced by a large scale climatic change during the last 18,000 years, and probably by several smaller scale changes and variations in climate over the last 10,000 years.

Time is a useful yardstick by which to estimate the evolution of a river system. In terms of fluvial systems, time is usually considered as having four scales, cyclic, graded, steady, and instantaneous. These timescales will be discussed below as they relate to equilibrium conditions in fluvial systems.

As products of the external factors, the internal factors of vegetation, local relief of the basin (maximum elevation minus minimum elevation), hydrology (water and sediment discharge), drainage network morphology (tributary network subsystem), and hillslope morphology (hillslope subsystem), the internal factors evolve through time and as external factors (primarily climate) change. The significance of cyclic, graded, and steady timescales on the role of the external and internal factors of fluvial systems evolution is illustrated in Table 1 (Schumm and Lichty, 1965). The role of climate as a dynamic variable in influencing the internal variables of a fluvial system is illustrated in Figure 1.

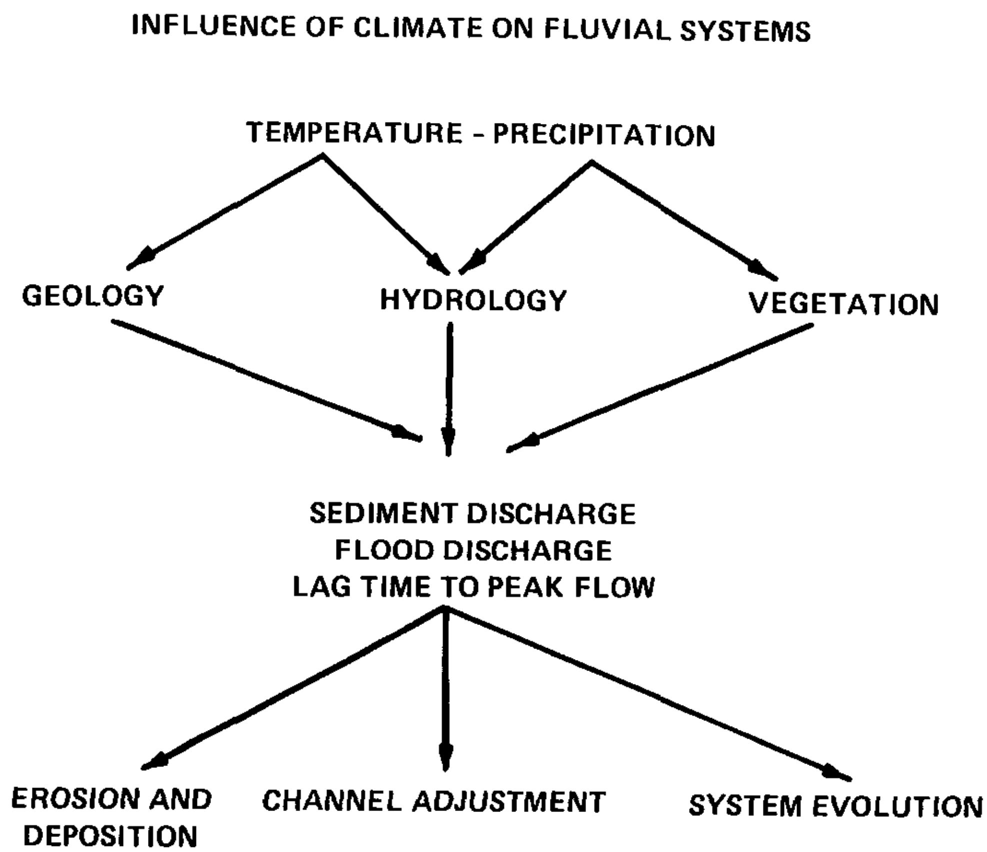


Figure 1. Influence of climate on fluvial systems.

Table 1. Significance of drainage basin variables during various timescales

Drainage basin variables	Status of variables during designated timespans		
	Cyclic	Graded	Steady
1 Time	Independent	Not relevant	Not relevant
2 Initial relief	Independent	Not relevant	Not relevant
3 Geology (lithology, structure)	Independent	Independent	Independent
4 Climate	Independent	Independent	Independent
5 Vegetation (type and density)	Dependent	Independent	Independent
6 Relief or volume of system above baselevel	Dependent	Independent	Independent
7 Hydrology (runoff and sediment yield per unit area within system)	Dependent	Independent	Independent
8 Drainage network morphology	Dependent	Dependent	Independent
9 Hillslope morphology	Dependent	Dependent	Independent
10 Hydrology (discharge of water and sediment from system)	Dependent	Dependent	Dependent

Source: Schumm and Lichty, 1965, table 1, p. 112.

Several salient concepts of "systems analysis" are especially appropriate to the consideration of the mechanics of fluvial systems. These concepts include equilibrium conditions, equifinality, feedback, relaxation time, and thresholds. A number of equilibrium conditions exist in fluvial systems at any instant, including decay, steady state, dynamic, and dynamic metastable equilibrium. These various equilibrium states will be described in terms of time scales below.

Equifinality, the accomplishment of a similar result from various ways and origins, is an interesting concept in view of the Illinois River. As will be discussed in a later section, several reaches of the Illinois River have a similar appearance, even though these reaches have been profoundly influenced by different factors and have substantially different histories. In the complex evolution of the Illinois River various processes acting on different materials have resulted in some features of the Illinois River system which, upon casual observance, would appear to have a similar origin and history.

Feedback occurs in the Illinois River system through the impact of the output of the tributary system on the main channel, which in turn may become locally regulated by a tributary influence and change the direction of the evolution of the main channel. An example is the growth of large alluvial fans in the Illinois River valley at the confluence of major tributaries, such as Ackerman Creek at East Peoria. These large bodies of sediment deflect the channel of the Illinois River and provide a substantial increase in local sediment available for transport. Since the Illinois River cannot transport the sediment produced to it by Ackerman Creek, positive feedback occurs and the channel of the river is changed.

Relaxation time is the period that a fluvial system requires to re-adjust its system operation to a new state of equilibrium following a change in equilibrium. Since there are various time scales for different equilibrium states, the relaxation time between each equilibrium state is also variable. The Illinois River has been profoundly influenced by large scale influences (glaciation) that still substantially control its character. That is, the relaxation time required for the Illinois River to adjust to a new state of equilibrium as a stream not presently being influenced by glaciation has not been reached since the cessation of direct influence of glaciation over 10,000 years ago. Consequently, many of the features of the Illinois River Valley, which are directly influencing the character of the Illinois River, are relict features of a time when the Illinois River Basin was considerably different from today.

Change in equilibrium states of fluvial systems usually involve a change in the influence of an external or internal factor or the passage of a threshold. Examples of thresholds include the form of a river channel, for instance, width-depth ratio as it adjusts to increased or decreased sediment transport. When sediment transport decreases due to a reduction of sediment availability, the width-depth ratio of the channel may decrease due to scouring of the channel bed. As the streambanks increase in heighth, a critical (threshold) bank heighth is reached which may initiate mass failure of the streambank, increase in channel width, and the width-depth ratio, and a local increase in the amount of sediment available for transport. In terms of systems mechanics, a threshold was passed interrupting an equilibrium state, and positive feedback in the form of increased sediment production from streambank erosion returned the system to a new equilibrium state after a given relaxation time.

The concept of equilibrium states in fluvial systems has been recognized since the time of Leonardo da Vinci, who described the apparent natural adjustment of rivers and valleys. Over 100 years ago, G. K. Gilbert (1877) outlined the basic tenets of the concept of "dynamic equilibrium," later developed by Hack (1964). Most fluvial geomorphologists today recognize four separate equilibrium states that may be seen over various time scales in a fluvial system. These equilibrium states are (1) decay, (2) steady state, (3) dynamic, and (4) dynamic metastable equilibrium (Figure 2). Decay equilibrium occurs over the longest time (cyclic period, reflecting the entire history of the

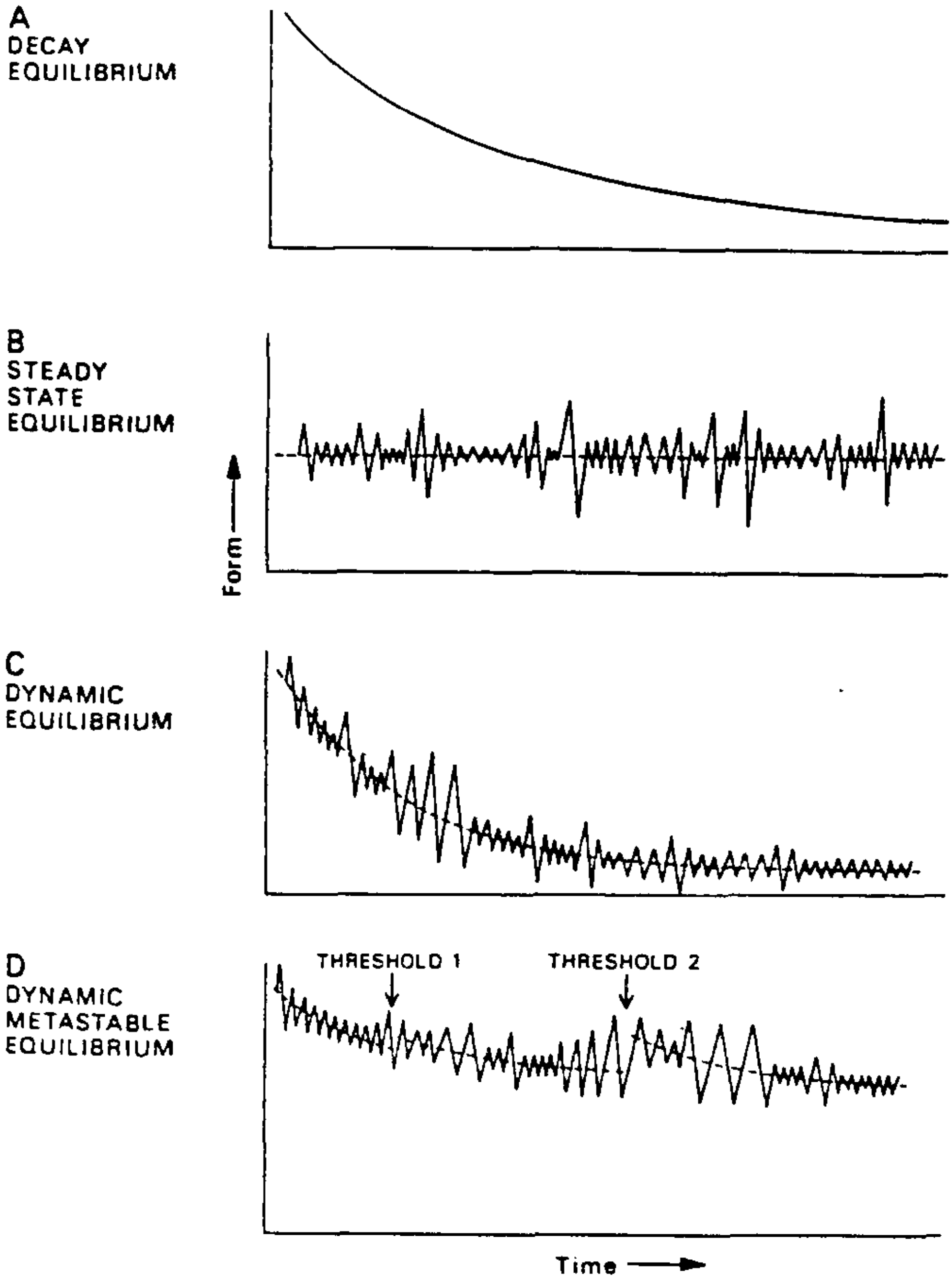


Figure 2. Equilibrium conditions of fluvial systems (after Chorley, Schumm, and Sugden, 1984).

evolution of the drainage basin (10^4 - 10^5 years). Decay equilibrium conditions are the product of the long-term erosional development of the drainage basin, and exist when the rate of change of form decays through time from relatively fast to slow change (Chorley, Schumm,, and Sugden, 1984). The Illinois River Basin has undergone a drastic influence from continental glaciation which has caused its decay equilibrium condition to rapidly accelerate to a present situation of very slow decay.

During the long-term decay (erosional development) of a fluvial system, there are smaller scale fluctuations in the system which collectively result in the overall decay of the system. Consequently, the fluvial system is dynamic about a mean trend, and the condition is termed as dynamic equilibrium. An example of dynamic equilibrium in the Illinois River would be the response of the Illinois River to the introduction of sediment and meltwater during periodic melting of the Late-Pleistocene glaciers of northeastern Illinois. Dynamic equilibrium is equivalent to the graded condition in terms of time scales.

Within the dynamic equilibrium time period or condition, thresholds are surpassed which cause interruptions in the stability of the fluvial system. The dynamic equilibrium condition is then interrupted until a new stability condition is reached. Collectively, these multiple stability conditions within the longer term dynamic equilibrium is termed as dynamic metastable equilibrium (Chorley and Kennedy, 1971). The previous example of a channel form threshold causing a change in local equilibrium states is appropriate to the Illinois River. However, a major handicap to the Illinois River in assimilating the impact of thresholds and changes in external and internal factors and he consequent return to a new dynamic metastable equilibrium is the extremely low gradient of the Illinois River below Starved Rock. The low gradient of the river has reduced the power of the river to overcome changes in its character imposed by changes in external and internal factors and thresholds. Dynamic metastable equilibrium occurs in the same time scale as "steady" time, that is, several months to several tens of years.

At any time, the Illinois River is in a state of steady state equilibrium when active processes control present form. Steady state, or instantaneous equilibrium, occurs in the river bed as the depth and velocity of streamflow controls the amount of sediment transport at a given location. Appropriate time scales for steady state equilibrium may be minutes to hours.

EVOLUTION OF FLUVIAL SYSTEMS

The evolution of fluvial systems is a complex phenomena which is largely different for every system, even though the influence of external and internal factors may appear similar. The variable combination of the geological and climatological history of a region integrated over time has produced a wide spectrum of river systems, each with their own special characteristics. Examination of the Illinois River system reveals that it has had a unique history among rivers of North America, and consequently poses unique problems to those who would manage its resources.

A popular concept in river basin evolution is related to the erosional cycle of Davis (1899). During the early stages of basin development, hillslopes are low, streams are small with no floodplains, and the drainage pattern is irregular. This "youthful" stage of drainage basin evolution may be seen throughout northeastern Illinois, where drainage systems are still trying to recover from the impact of widespread continental glaciation. As the drainage network evolves to "maturity" valleys are eroded to maximum depth, the entire basin becomes either hillslope or floodplain, and the principle streams develop a meandering nature. Most of the river systems of non-glaciated areas of North America could be described as being in the "mature" stage of Davis (1899). In some unique regions, however, drainage basin evolution has reached a stage that Davis would refer to as "old age," characterized by broad open valleys, low hillslopes and indistinct drainage divides, and highly meandering streams. Most rivers never reach the "old age" stage because a major change in climatic or geologic influences causes a change in the character of a system and re-starts the evolutionary mechanism at an "earlier" stage.

Glock (1931) proposed an illustrative model of river basin evolution. Glock's model consists of five stages of drainage network evolution, when all of the external variables are held constant over time. In the initial stage, the drainage network is irregular as the first widely spaced poorly connected tributary channels develop. The drainage network elongates during the second stage as the system begins to adjust to its first stage of dynamic equilibrium. During the third stage, the drainage network elaborates, filling in the areas between the principal tributaries. Maximum extension of the tributaries (maximum drainage density) is accomplished in the fourth stage. Drainage density then begins to decrease during the final stage with stream abstraction occurring.

Complications in the climatological and geological history of the Illinois River Basin has resulted in the existence of a wide range of evolutionary stages characterizing the numerous tributary basins of the Illinois River. Consequently, the impact of these diverse tributary basins is highly variable upon the Illinois River.

MAN'S INTERACTION WITH FLUVIAL SYSTEMS

In the previous discussion of the mechanics of fluvial systems, it was mentioned that man acts as an external variable in influencing the evolution of fluvial systems. On many of the major rivers of the United States, man's modification of the fluvial system has been substantial, in many cases equivalent to several thousands of years of adjustment to a major change in climate or geologic history. On many of the principle navigational streams of the United States, the present channel has only a minimal resemblance to the natural river that it was 100 years ago.

Man modifies a fluvial system by changing the character of the internal variables of the system, such as vegetation, hydrology, and drainage network morphology. The result of man's modification of the fluvial system is feedback in the form of system change in process and form.

An appropriate way to illustrate the impact of man upon a fluvial system is to examine the relationship between water and sediment discharge in a river and certain characteristics of the river, such as its width, depth, slope, meander wavelength, sinuosity, and width-depth ratio. Schumm (1969) has shown that water discharge is positively related to channel width, depth and meander wavelength and inversely related to channel slope. With constant water discharge, sediment discharge is positively related to channel width, slope, and meander wavelength and negatively related to channel depth and sinuosity. Under these relationships, an increase in water in the stream, through a diversion of water into the system would result in an increase in the width, depth, and meander wavelength, and a decrease in channel slope. Diversion of water from the river system would cause an opposite effect. When the sediment discharge in a stream is increased through disturbance of the natural vegetative cover (agriculture), the channel width, slope, and meander wavelength increase while the channel depth and sinuosity decrease. Trapping of channel sediment behind reservoirs would result in a decrease in channel width, slope, and meander wavelength and an increase in channel depth and sinuosity. These general relationships are useful in understanding not only the impact of man's works on a fluvial system but also the complex adjustment of fluvial systems to changes in hydrology.

EVOLUTION OF THE ILLINOIS RIVER BASIN

Most rivers are a product of the long-term geomorphological evolution of their drainage basin, and reflect various levels of equilibrium with its basin. The Illinois River, however, is a product of a relatively recent, highly complex, and spatially variable geomorphological history. Consequently, the Illinois River is attempting to erase the relicts of an earlier substantially different fluvial character.

The Illinois River Valley is excavated in Paleozoic dolomite, sandstone, limestone, and shale. Pleistocene glacial advances have modified the drainage network in a profound manner several times over the last 1,000,000 years by scouring the bedrock surface and destroying interglacial drainage (Willman, 1973; Bretz, 1955; Frye, Willman, and Black, 1965; Piskin and Bergstrom, 1967; Willman and Frye, 1970). Glacial advances during the last glacial stage (Wisconsinan) proceeded from northeastern Illinois as far as Peoria in the present Illinois River Basin approximately 20,000 years ago. Approximately 1,000 years earlier, the ancestral Mississippi River was diverted to near its present position by the advancing Wisconsinan (Woodfordian substage) glacier front. The present course of the Illinois River was then established as meltwater from Woodfordian glaciers flowed down the ancestral Mississippi River Valley below Peoria.

By about 14,000-13,500 years ago, the Woodfordian ice front had retreated northeasterly to the Lake Michigan Basin, with a major meltwater channel eroding the present valley of the Illinois River above Peoria. Several large floods caused by the breaching of lakes formed in the Illinois River and Kankakee River Valleys caused wide-spread valley widening, deepening, and subsequent deposition in the Illinois River Valley. Many of the present features of the Illinois River Valley are relicts of the highly dynamic period of time approximately 21,000 to 13,000 years ago in the Illinois River Basin.

Examination of the Illinois River Valley from the confluence of the Kankakee and Des Plaines Rivers to its mouth at the Mississippi River reveals that the Illinois River Valley may be subdivided into seven geomorphologically distinct reaches. The uppermost reach, from the head of the Illinois to a point about four miles downstream of Morris, the Illinois is entrenched in glacial deposits and has a narrow floodplain and shallow channel. In the second reach, extending from the end of reach one to Utica (Starved Rock Dam), the river is entrenched in Paleozoic bedrock, has a shallow channel and almost no floodplain, with the Illinois River Valley consisting primarily of terraces formed by the ancestral Chicago River Outlet. From Utica to Hennepin (reach number three), the Illinois River is shallowly entrenched into glacial outwash, with the initial evidence of Holocene (last 10,000 years) lateral migration and floodplain formation occurring.

As the Illinois River turns southward from Hennepin, it enters an ancestral Mississippi River Valley with the narrow Holocene floodplain bounded by high level late Woodfordian terraces. A number of large alluvial fans protrude into the Illinois Valley at the confluence of tributary channels, deflecting the Illinois River to the opposite bank and forming broad lakes. Reach number four extends to Peoria, where the Illinois River opens up to a width of 17 miles.

In ths reach (number five) from Peoria to Browning, the Holocene floodplain of two to five miles width is bounded by a broad high level terrace on the southeast. Several large lakes occur on the broad Holocene floodplain in reach five. Below Browning to Meredosia, the Holocene floodplains of the Illinois and an Ancestral Sangamon River combine, with broad low-level terraces between them. The Illinois River Valley averages twelve miles wide in reach six. Below Meredosia, the Illinois River turns due south and the valley narrows to an average width of 3.5 miles. Few lakes and terraces occur in this lowermost reach, as the influence of the Mississippi River on sedimentation in the Illinois River Valley becomes significant.

These seven distinct reaches of the Illinois River reflect the complexity of the evolution of the Illinois River Basin during the last several tens of thousands of years. Because of the distinct nature of the various reaches, the ability of the Illinois River to assimilate thresholds, man's influence, and feedback in its system mechanics differs, requiring each of these reaches to be considered discretely.

Future activities in the Illinois River Valley should be planned in cognizance of the variable character of the reaches of the Illinois River. Man's activities in these reaches will obviously not have similar impacts on the river system in different reaches.

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ILLINOIS RIVER
FISH AND WILDLIFE CONSIDERATIONS

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While the Illinois River might be described as "sick", it is by no means "dead". Even though it has suffered from a variety of impacts, and most of them in this century, the river continues to be a valuable resource on many fronts and certainly for fish and wildlife. I would like to share some of the latter with you today.

This conference presents considerable information on physical changes that have occurred in the river and the consequences of the impacts therefrom. And while those changes will not be the focus of this paper, I will not attempt to avoid inclusion of ecological considerations for fish and wildlife for it would indeed be difficult to address their status and importance without mentioning basic life history requirements.

Since the conference also focuses on what can be done to enhance the river's resources, suggestions on habitat protection and improvement will also be included. While we might well want to maintain fish and wildlife because they reflect a picture of environmental health or perhaps because many of us "feel better" knowing wild things are alive and well on the earth, there are economic benefits that should not go unrecognized. Indeed, they often become the center of attention when alternatives are considered relative to habitat changes and resource management proposals.

If we were to build us a river running diagonally southwest from Chicago to St. Louis across some of the richest farm land in the world, what would we want? Smallmouth bass; wood ducks; small pool and riffle feeder streams so the smallmouth could spawn; nesting trees for the wood ducks; cover for the smallmouth fry in the streams and along the river banks to protect them from predation; escape cover for the young wood ducks after they tumble from their tree homes; a good food supply for the young of both and for the intermediates and adults too through all the seasons. How about bluegill and beaver; crappie and cardinals, eels and eagles, spatterdock, coontail, willows and sycamores? Marshes and upland woods? The list would be long and perhaps confusing because where would it lead us? Shall we live along the river? Shall we use it? Shall we harness it for power? Dam it for navigation? Shall we farm the watershed? Log the forests? Can we have consensus on all our plans for the river? Certainly not an easy task.

Before striking off in various directions in building this river, stocking it with fish and game and planting it, perhaps we should look first at what makes up a river's biotic environs. There is the river itself with pools, riffles and side channels, all of which serve as special habitats for aquatic life by providing food, shelter and spawning areas. Various fishes have rather specific habitat requirements. For example:

White bass: "prefers clear water over a firm bottom." (Smith, 1979). "tends to avoid waters that are continuously turbid." (Pflieger, 1975). "firm bottom of sand, gravel, rubble or rock is required for successful spawning." "feed more by sight than by scent" (Becker, 1983).

Largemouth bass: "intolerant of excessive turbidity and siltation." (Pflieger, 1975). "encountered most frequently in clear to slightly turbid water at depths up to 1.5 m, over substrates of sand (31% frequency), gravel (20%), mud (20%), silt (9%), rubble (7%), boulders (6%), clay (4%), and detritus (3%)." "prefers temperatures of 81-86^{o}F and its upper lethal limit is 96^{o}F." "turbidity inhibits mating and adversely affects the survival of eggs and the young rather than the survival of juvenile or adult bass." "generally move into deeper water in winter" (Becker, 1983).

Bluegill: "intolerant of continuous high turbidity and siltation and thrives best in warm, clear waters where aquatic plants or other cover is present." (Pflieger, 1975). "encountered most frequently in clear water . . . at varying depths, over substrates of sand (29% frequency), gravel (20%), mud (17%), silt (11%), rubble (8%), boulders (7%), clay (4%), detritus (2%), hardpan (1%), marl (1%) and bedrock (trace)." "Bluegills and largemouth bass are among the first fish to die off in winterkill lakes." "Bluegills will not tolerate low oxygen nearly as well as northern pike, perch and bullheads" (Becker, 1983).

Black crappie: "much less tolerant of turbidity and silt than the white crappie." (Smith, 1979). "encountered in clear to slightly turbid water" "it is somewhat decimated because of the silt problem in so many Illinois lakes and rivers" (Becker, 1983).

Moving away from the river proper we have the riparian zone which includes the river bank, wetlands, connected backwaters and adjacent terrestrial areas. Here we find a variety of habitats and associated fish, wildlife and plants such as beaver, wood ducks, northern pike, egrets, mallards, muskrats, largemouth bass, whitetail deer, mink, bluegill, marsh hawks, arrowhead, cattail, willows, buttonbush, river birch and sycamore. Several endangered and threatened species, including the Indiana Bat, bald eagle and bobcat inhabit this "edge" zone (Garner, 1987) (Kruse, 1987). These few examples illustrate its importance. Then we move away from the riparian zone to a feeder stream with its associated habitats and on up to smaller ditches and flatland watersheds.

It is in the watershed where many of the problems focused on in this conference lie. Excessive siltation has been termed the number one pollution problem in the loss of Illinois stream species and the reduction in range of others (Smith, 1971). For example, silt affects the ability of black bass, bluegill and crappie to feed. These fishes have large eyes and are sight feeders. Murky water is an impediment to them. Silt also smothers fish eggs, thereby interfering with spawning and can destroy spawning habitat of a species like the northern pike which depends on flooded vegetation in the spring to complete its life cycle.

A problem in the lower part of the Illinois River is lack of sufficient water depth due to sedimentation. During those years when low water coincides with a hard winter (extended snow and ice cover) the shallow backwaters suffer dramatic fish losses from winterkill. Much of the decline in sport fish abundance that occurred in the Illinois River after 1975 appears to be related to winterkill during the low-water winters of 76-77 and 78-79, as well as summerkill during 1976. Certainly the impacts of summer and winter stress would have been much less had the backwater areas not been so shallow from sedimentation. Until we have some deep water areas on the lower Illinois, outside the navigation channel, to shelter the fish in such times of stress, we can never expect to have stability in the sport fishery. No sooner will the fishery rebuild, than some drought or hard winter will devastate it and we will continue to see the wild fluctuations in number and size of sport fish available. The deep water of the navigation channel in the lower river will not suffice, since navigation disrupts and probably causes direct mortality of fishes sheltering there (Bertrand, 1987).

There should be no puzzle as to where silt originates. Forest land holds the soil best with its rooted trees, carpet of leaves and buffering of wind. Our Division of Forest Resources has estimated there were almost 6 million acres of forest in the Illinois River watershed in 1820. However, today there are about 1.6 million acres, a loss of some 73 percent (Roberts, 1987). Pasture land is next best at holding soil and, of course, cultivated soil loses it most rapidly. Other projects such as bridge and highway construction and stream channelization also contribute to the deposition of silt in bottomland lakes and streams.

Silt is by no means the only water quality problem. Industrial pollution has added a variety of contaminants to the Illinois River. As an example, PCB's in carp in the upper river exceed the action level established by the U.S. Food and Drug Administration for interstate sales of fish. A health advisory on carp is now in effect from the Des Plaines River at Lockport downstream to the Starved Rock Lock and Dam. Municipal sewage entering a stream can reduce oxygen levels and cause fish kills. Agriculture chemicals, both fertilizers and insecticides have caused problems in a variety of streams in Illinois. Even household uses of chemicals are implicated in water quality. The recent health advisory on the Mississippi River, in which carp and channel catfish are the target species, is due to chlordane, an insecticide widely used for termite control and past use as an insecticide on farm land (the United States Environmental Protection Agency banned use on farm land in 1976).

Obviously we cannot turn back the clock but I believe we would all agree that if we were to build the river and all its ecosystems today, we would try to improve management of it.

In spite of the problems there is much about the river that is positive. The walleye, sauger, smallmouth bass and white bass fishing from Lacon upstream to Marseilles has attracted a great deal of interest. This has come about only in recent years and suggests improvements in water quality as a result of compliance with effluent standards required of industry and municipalities. I believe we have seen what the lower Illinois can produce when we have a few years of favorable water levels and weather: abundant crappie, largemouth bass, sunfish and channel catfish.

In 1975, the Division of Fisheries' Streams Program established monitoring stations on the Illinois River at which electrofishing collections were taken once each summer to monitor changes in the fishery - particularly the sport fishery. Examination of the 10 years of electrofishing samples, 1975-84, has provided insight into makeup and changes in the Illinois River fishery. Although the numbers of sport fish available have fluctuated over the 10 years, the general trend has been toward improvement of the fishery. This improvement can be best exemplified by comparing goldfish to walleye and sauger collections in ten middle and upper river stations. In 1975, 44 goldfish and only 1 walleye were collected; whereas in 1984, only 1 goldfish and 23 walleye and sauger were taken. Although walleye and sauger still only provide a sport fishery localized in the upper river and are a small part of the total sport fishery available, the development of this fishery over the past ten years is an encouraging illustration that the fisheries can improve if given the opportunity (Bertrand, 1987).

To give a picture of the sport fishery the Illinois provides, so that one can envision various impacts on the fishery, it can be typified as: crappie averaging 1/2 pound; sunfish species averaging 1/4 pound; largemouth bass averaging 1 pound; white bass averaging 3/4 pound; channel catfish averaging 1-1/2 pound; bullhead species averaging 1/2 pound; smallmouth bass averaging 1 pound; and walleye-sauger averaging 1-1/2 pound (Bertrand, 1987).

Crappie, sunfish and largemouth bass are most abundant on the middle and lower river, while smallmouth bass, white bass, walleye and sauger dominate on the upper river; channel catfish are common riverwide. White bass numbers are typically greatest in tailwater and river mouth areas, as are walleye and sauger. Crappie, sunfish, and largemouth bass numbers are greatest in off-channel or backwater areas. Generally these species enter the sport fishery at age three, except for white bass which may contribute to the sport fishery at age two. Since electrofishing is more efficient for harvestable-sized sport fish, monitoring samples often reflect river conditions 3-4 years previous to the samples when the strength of the year classes predominant in the sample were determined (Bertrand, 1987).

In comparing the numbers of harvestable-sized sport fish collected by electrofishing, we find that 1975 and 1984 were the years which provided the greatest numbers of harvestable-sized sport fish - 43.45 per hour electrofishing in 1975 and 42.30 in 1984. The poorest year was 1977 at 12.84. The dramatic decline in 1977 was certainly due in part at least to the record low water experienced from September, 1976 through July, 1977, which no doubt contributed to poor survival of the 1976 year class fish and winterkill of older year classes as well. Winterkill may also have been a factor in 1978-79. These setbacks in the mid and late 70's were just starting to be compensated in 1984, particularly in the lower river, as the favorable water levels of the early 80's resulted in fish just entering the sport fishery in 1984. The upper river sport fishes, i.e., walleye, sauger, smallmouth bass and white bass, are less affected by water levels (Bertrand, 1987).

Aside from aesthetic values of fish and wildlife, there are economic considerations well worth noting. The Illinois River and its backwaters provide about 2.1 million angling days, which is 5.3 percent of the total statewide angling days (Baur and Rogers, 1985). Based on an average of $12.00 spent by fishermen per angling day, this amounts to $25.2 million annually (United States Fish and Wildlife Service, 1982). In 1985, over 1.0 million pounds of carp, buffalo, catfish, drum and other commercial species were harvested from the Illinois River with a wholesale value of $276,000. In addition, 741 tons of mussels worth $402,000 were taken.

Hunting and trapping also contribute to the Illinois River economy. Peak fall migrations often exceed one million ducks on the River. Nearly 50% of the mallards in the Mississippi Flyway, of which the Illinois River is a part, are in Illinois at one time or another and about 25% are associated with the Illinois River (Williamson, 1987). In 1985 over 10,000 waterfowl stamps were sold in counties along the Illinois River. Assuming hunters bought those stamps and spent $462 for waterfowl hunting that year (the statewide average), those hunters expended a total of $4.6 million (Anderson, 1987).

In 1985, 18,658 shotgun deer permits were issued in counties along the Illinois River (Loomis, 1987). The average number of days spent hunting was 3.92 (Ellis and Mahon, 1987). At an average expenditure of $35 per day (USFWS, 1980) the economic value was about $2.6 million dollars.

Small game hunters spent 2.5 million days afield in Illinois in 1985 (Ellis and Mahon, 1987). Sixteen percent of hunting licenses are sold in Illinois River counties. Using those figures and an average daily expenditure of $17 (USFWS, 1980), the expenditures totalled $6.8 million.

The value of furs taken by hunters and trappers in the 1984-85 season in Illinois River counties was about $800,000 (Hubert, G.F., Jr. 1985) (Woolard, 1987).

Those economic values are based on factual information. How much is a trip worth to watch a flock of mallards drop into a marsh just at dusk? Or see a bass leaping after a mayfly at sunrise? Or observe a bald eagle soaring high overhead? What is it worth to help your granddaughter catch her first fish? Or sit around a campfire at night? These experiences may well be far more valuable than the $17.00 spent on a rabbit hunting trip. But just because we cannot put a dollar figure on them is no reason to overlook them when economics are discussed.

Earlier, I mentioned some recommendations would be given to protect and enhance the river's ecosystem. Perhaps these are unnecessary if not redundant, since we all know the basics. And while it is easy to say soil should be kept up on the watershed and we have a number of effective ways to do that, I would like to mentioned a project on an Illinois River tributary, Court Creek. This project, under contract by the Illinois Department of Conservation with the George Palmiter River Consulting Company, the U.S. Soil Conservation Service and the Illinois State Water Survey, is designed to utilize materials immediately available, such as fallen trees and willow plantings, to protect stream and ditch banks from sloughing off and adding to the silt load going downstream. The idea is to redirect the current as well as to slow it down. We believe it is a very positive alternative to channelization that holds much promise. Fencing of streams from the effects of cattle has also been demonstrated to retard erosion. And, certainly, the variety of soil holding practices recommended by the Soil Conservation Service continue to be of critical importance to good stewardship of the land. In the river pools themselves we are attempting, through a cooperative research project with the Illinois State Water Survey, to demonstrate the value of reestablishing aquatic vegetation through plantings protected by breakwaters in Peoria Lake. If successful, projects of this nature could reduce turbidity by retarding wave action and improving habitat for a variety of fish and wildlife.

Dredging of silt may have some application if satisfactory methods of deposition can be worked out. Obviously, in terms of the future, siltation needs to be drastically reduced for dredging to have much promise. Under the present silt load, improvements by dredging would be rapidly offset by a couple of years of heavy flooding.

To improve the Illinois River for benefits now and into the next century will be no easy task and will take a concerted effort from the private sector, public, state and federal agencies. I believe this conference is a very firm step in the right direction and a foundation upon which to build.

Thank you.

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THE HISTORIC ILLINOIS--ONCE CHANGED, ALWAYS CHANGED?

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ABSTRACT

Historically, the Illinois River was one of the most productive rivers in North America, its fish and wildlife populations virtually unequaled. Today, even after experiencing drastic changes brought about by human intervention, the Illinois River remains our state's most important river system. Its basin and tributaries total 32,081 square miles and include over half of the area of Illinois as well as parts of Wisconsin and Indiana. Accordingly, the Illinois River is affected by and affects the majority of our state's citizens.

Five major changes have been imposed by our society on the Illinois River system since the turn of the century. An appreciable volume of water diverted from Lake Michigan entered the Illinois River in 1900 when the Sanitary and Ship Canal was opened at Chicago. Shortly thereafter, vast quantities of untreated domestic sewage and industrial wastes from Chicago were flushed through the Canal into the Illinois River and away from Lake Michigan, a source of the city's water. Thirty-eight organized drainage and levee districts and three private levees were developed for agricultural purposes between 1902 and 1929, and they greatly modified the hydrology and landscape of the valley. Six dams--five along the Illinois and another below its mouth at Alton on the Mississippi--were constructed during the 1930s to create a channel 9 feet in depth for commercial navigation. In recent decades, sedimentation has dramatically affected the river and its adjacent waters.

Sedimentation, today's major pollutant of our nation's agricultural waterways, is the primary obstacle in preserving some semblance of the historic Illinois River for future generations. Restoration of portions of the river valley by reclaiming selected drainage and levee districts is one plausible approach; however, any alternative must be accompanied by a land-use policy that is both economically sound and ecologically intelligent.

INTRODUCTION

The Illinois River flows gently through the heartland of the Prairie State. This unique waterway, whose drainage basin encompasses more than half of Illinois, stretches some 300 miles from Chicago to the Mississippi River just above St. Louis. It is a vital link in the transportation of commodities, principally grain and fuel, between the Great Lakes and the Gulf of Mexico. The Illinois River valley has a remarkable history, from its geologic genesis, through its pristine youth, to its present state, which bears the heavy stamp of human intervention.

GEOLOGIC HISTORY OF THE RIVER

The "Father of Waters," the mighty Mississippi River, once occupied the Illinois Valley from above Henry to Grafton (Willman and Frye 1970). However, with the advancement of the Wisconsinan glaciation approximately 21,000 years ago, the Mississippi River was pushed westward to its present location (Willman 1973). With the ensuing warmer climate and subsequent recession of the glacier, meltwaters formed the Des Plaines and Kankakee rivers, which coalesced into the Illinois River southwest of Chicago. From this merger, the Illinois flowed westward, cutting a new channel until it reached the ancient and deep valley of the Mississippi River above Henry.

As the waters of the Illinois entered this wide basin, their relatively low volume produced a river with a remarkably gentle rate of fall, thus creating a unique floodplain river ecosystem. This low gradient resulted in a sluggish river that had difficulty moving the sediment load contributed by tributary streams. Over the centuries, therefore, sediment was deposited during overflow conditions at the interface between the faster moving water in the river channel and the slower moving waters in the bottomlands. As a result, natural levees rose, pinching off over 300 bottomland lakes and sloughs from the river channel. These lakes were generally connected with the river at their lower ends and, in concert with the fertile Illinois soil, were the principal reason for the profound richness of the Illinois River valley.

PRISTINE CONDITIONS

The fertility of the Illinois River valley with its abundance of game and fish attracted Indians, whose encampments dotted the basin. Explorers used the river as a highway, and settlements were established on its shorelines. After ascending the Illinois River with Louis Joliet in 1673, Pere Marquette wrote, "We have seen nothing like this river that we enter, as regards to its fertility of soil, its prairies and woods; its cattle, elk, deer, wildcats, bustards, swans, ducks, parroquets, and even beaver. There are many small lakes and rivers. That on which we sailed is wide, deep, and still, for 65 leagues." (Kenton 1925). In later accounts, Thomas Jefferson (1787:13) portrayed the Illinois as "a fine river, clear, gentle, and without rapids," and Captain Howard Stansbury (Mulvihill and Cornish 1929:27) described the Illinois Valley as "one to five miles wide, deeply overflowed in every freshet, filled with bayous, ponds, and swamps, and infested with wild beasts."

At the turn of the century, the Illinois River remained relatively unblemished and ran comparatively clear. Kofoid (1903:151-155) described bottomland lakes near Havana on the middle stretch of the river as choked with aquatic vegetation and filled with water that was clear with a brownish tinge from diatoms. At that time, turbidity in the bottomland lakes was generally a result of plankton; turbidity in the river channel, however, was often greater and resulted from both plankton and silt.

The bottomland lakes were extremely productive, and the waters of the Illinois Valley provided the livelihood for many citizens. Alvord and Burdick (1919:64) observed, "It is a fact not generally known that the fishery of the Illinois River is the most important river fishery of the country, excepting only the salmon industry of the Pacific Coast, and this is not strictly speaking, a river fish." Indeed, in 1908, nearly 24 million pounds of fish worth about 3 cents per pound were taken commercially from the Illinois River by 2,500 fishermen who worked its waters. In addition, visiting sports fishermen contributed about as much money to the economies of local communities as the commercial fishery (Alvord and Burdick 1919:64-66). Danglade (1914:8) judged the Illinois to be the most productive mussel stream per mile in the United States, and in 1910, the Illinois accommodated more than 2,600 boats engaged in mussel fishing. During the fall, the Illinois River valley was alive with waterfowl, and market and sport hunters considered it a mecca for hunting. The prolific days of the Illinois River valley were numbered, however.

CHANGES IN THE ILLINOIS RIVER VALLEY

Largely because of the increasing human population in the Illinois basin, the valley was undergoing major physical changes that would greatly affect the river system.

Diversion of Water from Lake Michigan

The Illinois River received an appreciable volume of water diverted from Lake Michigan on 1 January 1900 when the Sanitary and Ship Canal was opened at Chicago. This canal connected the Des Plaines and Illinois rivers to Lake Michigan and thus afforded the city of Chicago a means of flushing vast quantities of untreated domestic sewage and industrial wastes away from Lake Michigan, a source of the city's water supply, and into the Illinois River system. Between 1900 and 1938, an average of 7,200 cubic feet of Lake Michigan water was diverted each second into the Illinois River system through the Chicago Sanitary and Ship Canal. Since 1938, the average amount has been 3,200 cubic feet per second.

Diverted water briefly enhanced the aquatic habitats of the Illinois River valley. Habitat available to fishes increased dramatically as the diverted water essentially doubled the surface area of the bottomland lakes, marshes, and sloughs--from 55,660 acres to approximately 111,325 acres (Bellrose, et al 1983:11). Diverted water not only coalesced and extended water areas but deepened them as well. Low river levels in midsummer increased by more than 3 feet at Havana (Mills, et al 1966:5). A price was to be paid, however, and thousands of hectares of bottomland timber, including such important species for riparian wildlife as pin oak (Quercus palustris) and pecan (Carya illinoiensis), were inundated and eventually succumbed as many small lakes, sloughs, and marshes were united into larger bodies of water.

Sewage and Industrial Wastes

The opening of the Chicago Sanitary and Ship Canal in 1900 dramatically increased the sewage load in the Illinois River. Because it received the wastes from the sprawling Chicago metropolitan area, the upper river was heavily polluted by 1911 (Mills, et al 1966:8). During the World War I years, a burgeoning organic load was delivered to the river, which according to Richardson (1921:33), moved downstream at a rate of 16 miles per year. Consequently, in 1923 the oxygen content of the river from below Chicago nearly to Peoria was negligible (Greenfield 1925:24-25). The construction of massive sewage treatment plants in Chicago that became operational in 1922; the completion in the 1930s of lock and dam systems that slowed the flow of water; and the recent implementation of rigorous water pollution laws have reduced the impact of urban pollution on the Illinois River.

Drainage and Levee Districts

Shortly after the diversion of Lake Michigan water into the Illinois River in 1900, drainage and levee districts began to encroach upon the floodplain of the valley. A few small districts had been organized prior to 1900 in the higher areas of the floodplain, but those that greatly modified the landscape of the valley were initiated between 1902 and 1923 (Mulvihill and Cornish 1929:38-39). By 1929, 38 organized drainage and levee districts and 3 private levees enclosed roughly half of the estimated 400,000 acres of the Illinois Valley subject to overflow between La Salle and the river's mouth (Mulvihill and Cornish 1929:36). These districts also eliminated about 43,450 acres of water surface, 39 percent of the total in the floodplain (Bellrose, et al 1983:24). Thus, the drainage and levee districts removed much of the increase in surface area of water that had resulted from diversion. Today approximately 67,700 acres of water surface remain in addition to the river proper.

Because of the removal for agricultural purposes of nearly half of the terrestrial and aquatic habitat from the floodplain of the Illinois River, the drainage and levee districts influenced the remaining unleveed areas. Mulvihill and Cornish (1929:37) reported that under high-water conditions the districts increased flood stages by reducing the space available for flow and storage. Walraven (1950:39) compared river depths for two years with similar river flows during flood: 1904, before the organization of drainage and levee districts, and 1943, well after their completion. The river at Beardstown was 10 feet higher in 1943 than it had been in 1904.

Navigation Dams

Although the amount of diverted water from Lake Michigan was reduced in 1938, river levels were held in somewhat similar ranges by the construction of navigation dams. Before 1900, five low dams had been built along the Illinois River, but their effects were comparatively minimal and were usually felt only during periods of low water. During the 1930s, however, five higher navigation dams were built along the Illinois; a sixth was built at Alton, just below the mouth of the Illinois on the Mississippi. These "high dams," constructed to create a 9-foot channel for commercial navigation, had a marked impact on the Illinois River. Not only did they maintain the high levels of water established by diversion, but they also created pools along the river, slowing even more the rate of flow of the sluggish Illinois. Starrett (1971:272) reported the water velocity of the Illinois as only 0.6 miles per hour at normal river stages.

Sedimentation

Although large-scale alterations of the Illinois River valley by increased diversion of Lake Michigan water, by navigation dams, and by drainage and levee districts had been completed by 1938, the river remained biologically significant; it continued to support a viable fishery and to host thousands of waterfowl during fall and spring migrations. In more recent decades, however, human activity has had an irreversible effect on the river and its adjacent waters. The current degradation and destruction of the aquatic communities, the lifeblood of the Illinois River valley, are the results of sedimentation associated with intensive land use.

Its fertile prairie soils have placed Illinois at the forefront of the nation as a producer of corn (Zea mays) and soybeans (Glycine max), and the intensive land use practices associated with the production of these row crops have increased since the 1930s. Soils planted to row crops, particularly soybeans, are susceptible to wind and water erosion for much of the year, especially when fields are moldboard plowed soon after harvest. Because past economic policies encouraged maximum production, lands of marginal fertility (pastures, wood lots, waterways, fence rows, windbreaks, and green belts of protective vegetation along streams) have been converted to croplands. Accordingly, soil erosion has increased with agricultural production. The Illinois River valley in particular suffers the consequences of increased agricultural production because its drainage basin encompasses the heartland of the rich prairie soils of the state. In the Illinois River basin, row cropland increased about 67 percent between 1945 and 1976 (Bellrose, et al 1979:34).

The sedimentation problem is further complicated by the sluggishness of the Illinois River. Because the velocities of the tributaries entering the Illinois are much greater than the velocity of the Illinois itself, much of the sediments generated from sheet erosion of agricultural lands and bank erosion of streams are carried by the tributaries and delivered to the Illinois, whose slow flow allows the clay and fine silt particles to settle in the backwater lakes.

Lee and Stall (1976:27) calculated the annual sediment loss in the Illinois River basin at about 27.5 million tons. Of these, approximately 12 million tons were transported to the Mississippi River, leaving around 15.5 million tons to settle out in the bottomland lakes and unleveed areas of the Illinois Valley. These sediments are causing the plant and animal life to disappear from the waters of the Illinois River.

EFFECTS OF SEDIMENTATION

Intensive studies of the surface areas, volumes, depths, and amounts and rates of sedimentation in bottomland lakes of the Illinois River valley have disclosed alarming data. Between 1976 and 1979, Bellrose and his colleagues (1979, 1983) resurveyed the bottom elevations of selected bottomland lakes that had been investigated in 1903. Their studies showed that between 1903 and 1976-1979, sediments had accumulated at a yearly average amount of between 0.10 and 0.75 inches, with an average for all lakes investigated of 0.42 inches. The sedimentation rate has been greater in recent decades, undoubtedly a result of more intensive agricultural practices (Bellrose, et al 1983:24).

Sedimentation has changed the once diverse bottoms of the lakes along the Illinois to uniformly shallow, concave accumulations of loosely coagulated silt. Thus, the structural diversity of the lake bottoms is lost, blanketed with thick and ever increasing layers of sediment. The average depth of the bottomland lakes in the late 1970's was only 2.0 feet (Bellrose, et al 1983:17).

By using the sedimentation rates and current depths in a predictive equation, Bellrose, et al (1983:22) estimated the number of years required for selected bottomland lakes to lose half of their remaining depth--a depth at which they would retain little biological and recreational value. The estimates are dispiriting. Lakes closely associated with the Illinois River were projected to lose half their depths in 24 to 127 years, with the majority of the estimates ranging between 60 and 100 years. Because sedimentation rates have increased in recent years, these estimates may prove conservative, especially if high soil losses continue. Therefore, most of the current biological and recreational values of the Illinois River valley could disappear in 100 years.

The effects of sedimentation, however, are more far reaching than filling in the bottomland water areas. Sedimentation has had a cataclysmic effect on the aquatic plant communities of the Illinois Valley, undoubtedly the keystone of the river's productivity and richness. Mills, et al (1966:13) reported an abundance of vegetation along the central stretches of the river from the late 1930s until the middle 1950s. Since then, aquatic vegetation has disappeared except for scattered remnants. When Mills, et al (1966:7) compared turbidity readings taken in 1963 and 1964 with benchmark values recorded in 1896, they found that turbidity had increased two to three times at low-river stage. They realized that sedimentation decimated aquatic plant communities by generating turbidity, which in turn prevents the penetration of sunlight necessary for photosynthesis, and by creating soft bottom conditions that are unsuitable for anchorage when plants are subjected to wave and fish action.

As plant communities were gradually eliminated from the waters of the Illinois, their departure actually accelerated the turbidity that had caused them to disappear. Jackson and Starrett (1959:162) demonstrated that the effect of wind on turbidity was reduced by rooted aquatic plants. With the disappearance of aquatic plants, wave and fish action were less buffered and more likely to encourage the resuspension of sediment. Thus, aquatic plants are prohibited from reestablishing in bottomland lakes so shallow that their entire depth falls within the euphotic zone.

With the virtual removal of the aquatic plant communities and their functions from the Illinois River valley, the disintegration of the structure of the riverine system accelerated. Aside from curtailing turbidity, aquatic plants had provided a variety of fish species with spawning sites and protection for fry; they had cleansed the water of such toxins as ammonia; and they had provided habitat for a host of invertebrates and zooplankton essential in the food web of higher organisms. The plants themselves along with their fruits had been used as food by waterfowl. Unfortunately, the Illinois River floodplain ecosystem is now in a steadily deteriorating situation dictated by the sediments that precipitate from its turbid waters. It is unable to recover unless the conditions required for the reestablishment of aquatic communities are restored.

THE FUTURE

During the last century, human activity has degraded the Illinois River floodplain ecosystem from a high level of productivity and diversity to a level of subsistence. The river maintained a respectable ecological balance after 40 years of changes, including increased water levels, the construction of drainage and levee districts, navigation dams, and the dumping of domestic and industrial wastes. Since World War II, however, the life functions of the Illinois River have been increasingly eliminated by the accumulation of sediment. Because of its gently sloping floodplain, the Illinois River would, over a long time, have eventually filled in; however, its premature filling with sediment is clearly predicted.

In recent years, an encouraging trend from conventional to conservation tillage practices has appeared. The expansion of conservation tillage programs, whether no-tillage, reduced tillage, or organic farming, will prove important. Amemiya (1982:13) observed that "conservation tillage is the single most effective and least costly means of controlling erosion on row cropped land and erosion can be reduced by as much as 90% with some forms of conservation tillage." Through economic incentive, the 1985 Farm Bill encourages the removal of marginal land from crop production and discourages the conversion of previously untilled fields and wetlands to arable land. A land-use policy that is economically and ecologically sound is of immediate importance, especially in light of our current enormous grain surpluses.

The tons of sediment deposited over the lake bottoms of the Illinois Valley are irretrievable, and restructuring the ecological integrity of the Illinois River valley is virtually impossible. Some of the depth, clarity, and plant life of certain lakes might be reclaimed by draining them and allowing the bottoms to dry and compact or, perhaps, by selective dredging. More water might also be diverted from Lake Michigan to increase the water levels of bottomland lakes; but increased diversion may accentuate flooding problems and would adversely affect terrestrial habitat (Havera, et al 1980; Havera, et al 1983; Kilburn 1981). These remedies are, however, only temporary unless sedimentation is reduced. Walraven (1950) has offered a more long range alternative. He has suggested that selected drainage and levee districts be allowed to revert to aquatic habitat. At the same time, these areas could be used to store flood waters. In other words, give back to the river at least part of the floodplain that was taken from it. Those who would restore the Illinois River must be cognizant of the history of this once fabulous system. The aquatic communities of its numerous bottomland lakes were undoubtedly a primary factor in making this river one of the most productive in North America. These were Nature's ways; perhaps they should be ours.

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PROTECTING STREAM RESOURCES IN URBAN AREAS

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I. INTRODUCTION

This paper presents preliminary conclusions and recommendations derived from a study of stream and wetland protection by the Northeastern Illinois Planning Commission (NIPC). These conclusions and recommendations are included in a draft technical report, (Stream and Wetland Protection: A Natural Resource Management Priority in Northeastern Illinois; February 1987), which has been prepared under NIPC's natural resources and land-use planning programs. The contents of this paper do not necessarily represent the official policy of NIPC or its funding agencies.

II. PROBLEM STATEMENT

The natural drainage systems of northeastern Illinois have been drastically altered over the last 150 years in order to accommodate agricultural and urban uses. That process continues as the economic value of our land resource increases and competition for its use increases. While this activity has major economic benefit to the region, it has also resulted in loss of habitat, recreational opportunities, degradation of water quality and loss of esthetic qualities.

During the last 15 to 20 years, particularly, there has been an increased environmental awareness that has resulted in over $1 billion being invested in water quality improvement in the State of Illinois. Unfortunately, improvements in the chemical qualities of our water have not always led to corresponding benefits in terms of healthy fisheries, increased recreational opportunities and improved esthetics. Waterways that have been physically modified to accommodate urban development and to carry increased stormwater and floodwater flows are limited in their ability to provide these additional benefits which were envisioned in the Clean Water Act.

The complete extent of channel modification, wetland destruction, and construction in floodplains in northeastern Illinois is probably impossible to determine. Much of this activity occurred before regulatory programs imposed record-keeping requirements on land owners and developers. Two facts are clear: the damage has been extensive, and it is continuing at a significant rate. Some statistics will give a sense of the magnitude of the problem.

- Since 1970, there have been nearly 1200 permits issued for significant activities in northeastern Illinois by IDOT/DWR, averaging about 70 per year. Roughly half of the permitted activities involved work in stream channels and the other half involved floodplain construction.

- In the Fox and Des Plaines river basins, 43 percent of the stream miles have been channelized and 58 percent have been disturbed by channelization, levees, vegetation clearing, or reservoirs (Illinois Department of Conservation, 1986).

- By 1981, 99.5 percent of Illinois' original wetlands were eliminated or significantly disturbed and 62 percent of the remaining high quality wetlands in northeastern Illinois were threatened by destruction and modification activities (Bell, 1981). The great irony is that problems which we sought to solve have, in many instrances, been made more severe or have merely been relocated.

Ways need to be found to preserve and restore drainageways that can support aquatic and riparian habitat and enhance recreational opportunities and esthetic benefits. This is difficult to achieve in urban areas where there has been a long history of stream and wetland modification, where urban development has resulted in extraordinary measures to control and prevent flooding, and where pressure for intensive land development continues.

III. STUDY FINDINGS

A. Modification of streams, floodplains and wetlands has altered or destroyed the natural conditions of over half of the streams and the vast majority of wetlands in northeastern Illinois. These modifications continue with 70 to 100 permits approved for modification activities each year. In some instances mitigation of adverse impacts of modification is required by the regulatory agencies.

B. Modifications which reduce or eliminate amenities provided by natural aquatic systems may have an adverse economic development impact on the region because of the loss of recreational opportunities, degraded esthetics, and a generally lowered perception of quality of life in northeastern Illinois.

C. The regulatory activities of the U.S. Army Corps of Engineers and the Illinois Department of Transportation, Division of Water Resources are limited by the types of activities that can be regulated, by the types of water bodies that can be regulated and by small enforcement staffs.

On the other hand, local units of government have substantial authority but lack knowledge, staffing, and political willpower. But there is much that local governments can do to support the protection of streams and wetlands, since they have local authority to regulate land use and deal directly on a day-to-day basis with the land development process. The multiplicity of local governments does hinder water resource management at the drainage basin level and suggests the need for regional and intergovernmental approaches to management, as well as the need for federal and state oversight.

IV. STATE LEVEL INVOLVEMENT

A number of state programs have been examined and they exhibit a range in the degree of involvement with stream and wetland protection measures. These include, in increasing degrees of intervention:

- education of citizens and public officials; promulgation of criteria and guidelines
- mapping, classifying and monitoring of streams and wetland resources and development activities
- incentives or requirements for local-level stream and wetland management, including authorization for local regulatory programs and funding for cost-sharing programs
- direct regulation of development or modification activities and/or mandated local regulation

State-level programs commonly include the following elements:

- establishment of official state policy
- assignment of responsibility to a state agency and creation of a coordination mechanism among state agencies and departments
- development, adoption and implementation of a state-level management program
- support of local-level planning and management
- encouragement of local-level regulation

There are a number of specific actions that could be considered at the state level in Illinois and that would contribute to a positive climate for stream and wetland protection.

a. Development of a statewide, comprehensive stream and wetland protection program which strengthens, coordinates and consolidates, as necessary, the various resource management functions and responsibilities among state departments and agencies.

b. Establishment of more stringent rules, guidelines and criteria under the state regulatory program for stream and floodplain modification, including encouragement of environmentally benign approaches and mitigation in instances where modification is permitted.

c. Establishment, at the state level, conditions on U.S. Corps of Engineers nationwide permits so a more thorough review of riparian and wetland projects is required.

d. Elevation of priority for stream corridor acquisition in the state-administered open space programs.

e. Amendment of enabling legislation for county and municipal zoning in order to specifically authorize and encourage zoning for the protection of streams and stream-related resources.

f. Creation of a shoreland-wetland protection program for cities and villages which mandates local zoning for protection of wetlands along shorelines and which is supported by an official state mapping of regulated wetland.

g. Modification of IEPA requirements for area-wide water quality management plans with specific reference to required content of facility plans and their amendment:

  - delineation of existing and proposed 20-year sewer service areas within facility planning areas.

  - delineation of major areas unsuitable for installation of waste treatment systems because of environmental or physical constraints; where potential exists for adverse impacts on water quality from point and non-point sources because of wetlands, shorelands, floodplains, steep slopes, highly erodable soils and other limiting soil types, ground water recharge areas, and other such physical constraints.

h. Adoption of state guidelines or standards for mandatory best management practices for erosion control which would apply to stream, drainageway and floodplain modification activities.

V. LOCAL INITIATIVES

While the interjurisdictional nature of most streams suggests the need for a strong management framework at the state level, there is much that can be accomplished by villages, cities and counties that contain stream segments.

A. Comprehensive land-use plans can be created or amended to include delineation of stream corridors, including lake and wetland areas, to provide a policy basis for local management programs.

B. Cooperative relationships with adjacent jurisdictions and with water resource management agencies can be developed in order to facilitate improved water resources management at the drainage basin level.

C. A stream, lake and wetland protection ordinance can be adopted in order to regulate land development activities affecting streams and stream corridors.

D. Non-point sources of pollution can be reduced through a soil erosion and sedimentation and other non-point source control programs.

E. Storm and flood water management can be achieved through requirements for on-site detention and through floodplain ordinances.

F. Local open-space programs can give a high priority to the purchase of key public-use parcels along stream corridors and to the multi-use development of detention basins.

G. Stream maintenance programs can help keep streams from deteriorating and can preserve their conveyance capabilities while protecting their natural qualities.

H. Private land owners and developers can be informed of local plans and policies, the benefits to the private owner/developer of maintaining natural drainageways, and the appropriate techniques for site development.

Since floodplain ordinances and other regulations such as erosion and sedimentation control ordinances do not necessarily require the preservation of the natural attributes of drainageways, a stream and wetland protection ordinance may be a very desirable adjunct to the local package of development regulations. The Northeastern Illinois Planning Commission has examined a number of such ordinances that have been developed throughout the country. A model stream and wetland protection ordinance in the form of a lowland protection overlay zoning district is currently being prepared for local-level review in the region. The ordinance contains components typically found within the ordinances surveyed nationwide:

A. statement of rationale and policy for protection
B. requirements that encourage the restoration and rehabilitation of stream
C. definition of the area to be regulated
D. requirements for professionally prepared site plans
E. control of stream relocation
F. criteria encouraging use of natural materials in stabilizing streams relocation
G. requirements for protection of wetlands
H. establishment of setbacks for the purpose of creating a natural vegetation buffer strip along streams and adjacent to wetlands
I. limitations on land modification activities within the setback areas

VI. CONCLUSIONS

In many parts of the region, streams and wetlands have been approached as problems, as impediments to what we wanted to do with the land. We are learning belatedly that these natural features may represent opportunities, that they not only do not necessarily impede our overall development, but may in fact benefit it.

The diversity of drainage and development conditions suggest that simplistic approaches to water resource management must be avoided. Each community and drainage area will need to develop its own response to local conditions in a manner that will ensure a maximum quality of life. Management of stream and wetland resources requires a blend of local, regional and state/federal stewardship.

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NATIONAL RESOURCES INVENTORY AND POTENTIAL STREAM SEDIMENT REDUCTIONS

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I am extremely pleased to be a part of this conference. It is another indication of the strong desire of people to work together to discuss a valuable resource and continue efforts to improve that resource--the Illinois River System.

I have been asked to discuss, with you, the National Resources Inventory (NRI) and potential stream sediment reductions. I will spend a few minutes discussing the National Resources Inventory. Then I will share with you some of the data it provides statewide and for individual river basins or the Water Resource Councils' (WRC) hydrologic units. Finally, I plan to look more closely at one basin, the Peoria Lakes river basin, to discuss sediment sources and potential sediment reductions.

The National Resources Inventory represents the most comprehensive survey of our nation's land resources ever conducted by the Soil Conservation Service. The inventory was conducted in Illinois and in all states to provide the data required for the national appraisal of resources as directed in Public Law 92-419.

The first inventory, NRI-77, collected data on 11 resource data elements. Eleven additional data elements were added for the second inventory, NRI-82, to provide new data and close some data voids. We are currently updating the inventory data with NRI-87, the third inventory.

The second inventory, NRI-82, is what I have primarily used for this paper. I will use NRI-77 data as the base for streambanks, gully and other erosion, as it was not collected in NRI-82.

NRI-82 provided a data set that is accurate at the multi-county level. Whereas, NRI-77 provided statewide level of accuracy. The number of primary sample units (PSU's) increased from about 1525 in 1977 to about 10,000 in 1982. Samples were selected by statisticians at Iowa State University using a random sampling procedure.

The process, once PSU's were located, involved completing two worksheets. The first worksheet provided the base acreage data for each county. These data are: total surface area, census water (water bodies greater than 40 acres and streams wider than 1/8 mile wide), federal land, urban and built-up land, and rural transportation acreages. In 1982, Illinois was determined to consist of 36,061,000 acres--35,137,000 or 97.4 percent is nonfederal; 493,000 or 1.4 percent is federal; and 431,000 or 1.2 percent is census water.

The second worksheet, the Primary Sample Unit (PSU) worksheet, was completed for all PSU's in each county. The data collected included soil type and phase information, soil capability, prime farmland identification, land use, conservation treatment applied, treatment needs, USLE data, potential cropland data, wetland types, flood prone areas, and many more. About 70 individual information bits were collected for each of three sampling sites on each 160 acre PSU.

Land use in 1982 was determined to be 70.4 percent cropland; 9.0 percent pastureland; 9.8 percent forestland; 5.2 percent urban and built-up land; 2.4 percent rural transportation land; 2.2 percent minor uses and about 1 percent small water areas. This equates to 24,727,000 acres of cropland; 3,157,000 acres of pastureland, 3,429,000 acres of forestland, 1,846,000 acres urban and built-up land, 870,000 acres in rural transportation use, 761,000 acres of minor uses and 346,000 acres in small water areas.

Minor use lands include farmsteads, small built-up lands (anything from 0.25-40 acres), active mines, pits and quarries. Small water areas include ponds and perennial streams not included as census water in the base data previously discussed. In the Illinois River System, there were about 10,402,900 acres of cropland, 643,500 acres of pastureland, 379,400 acres of forestland and 217,800 acres of other lands.

Statewide, the soil loss average annual rate for cropland is 7.0 tons per acre per year, about 3.0 for pastureland and about 3.7 for forestland erosion per acre. In the Illinois River System, the average annual erosion rates for cropland, pastureland, and forestland are similar.

The inventory shows us where the soil erosion problems are by capability class and by each land use. We know that the major erosion problems are with the cropland. We also know that 10,227,000 acres of cropland, or about 40 percent, exceeds "T". "T" is the level of soil loss that can be permitted but still maintain long-term productivity of the soil resource. "T" or soil loss tolerance values range from 1 to 5 for Illinois soils. For all land uses, 11,201,000 acres or 32 percent of the land acreage in Illinois is degrading because soil loss rates exceed "T".

In the Illinois River System, there are about 3,498,700 acres of cropland that exceed "T". For all land uses, 3,519,400 acres exceed "T" in the system. Following is a table that provides a comparison of river basins within the Illinois River System of acres that fall into different erosion groups by land use. The state map by Water Resource Councils' hydrologic units provides the location of each. The state map can be found following Table 1.

Table 1. Acres in Soil Loss Groups by Land Use for Each Water Resources Council Hydrologic Unit in the Illinois River System (Acres x 100)

WRC Unit	Soil Loss	Cropland	Pasture	Forest	Minor
07120001	<T	2907	178	102	76
	T-1.5T	688	0	0	0
	1.5T-2T	205	0	0	0
	2T-4T	450	0	0	0
	>4T	89	0	0	0
07120002	<T	4881	293	201	132
	T-1.5T	1410	0	0	14
	1.5T-2T	362	0	0	0
	2T-4T	379	0	0	0
	>4T	63	0	0	13
07120003	<T	178	218	110	39
	T-1.5T	49	0	0	0
	1.5T-2T	25	0	0	0
	2T-4T	64	0	0	0
	>4T	60	0	0	0
07120004	<T	1036	621	224	197
	T-1.5T	244	0	0	0
	1.5T-2T	202	0	0	0
	2T-4T	291	0	0	0
	>4T	232	0	0	0
07120005	<T	4152	181	51	91
	T-1.5T	556	0	0	0
	1.5T-2T	194	0	0	0
	2T-4T	176	0	0	0
	>4T	64	0	0	0
07120006	<T	757	301	106	248
	T-1.5T	173	0	21	0
	1.5T-2T	92	0	0	0
	2T-4T	185	0	0	0
	>4T	52	0	0	0

Table 1. (Continued)

WRC Unit	Soil Loss	Cropland	Pasture	Forest	Minor
07120007	<T	3549	165	133	126
	T-1.5T	734	0	0	0
	1.5T-2T	246	0	0	0
	2T-4T	449	0	0	7
	>4T	67	0	0	0
07130001	<T	4695	366	271	64
	T-1.5T	1855	0	0	0
	1.5T-2T	635	0	0	0
	2T-4T	896	0	0	0
	>4T	93	0	0	0
07130002	<T	5239	261	125	178
	T-1.5T	1526	0	21	0
	1.5T-2T	381	0	0	0
	2T-4T	452	0	0	0
	>4T	174	0	0	0
07130003	<T	3599	469	726	140
	T-1.5T	996	0	0	18
	1.5T-2T	115	0	0	0
	2T-4T	351	0	0	0
	>4T	63	0	0	0
07130004	<T	3266	172	84	57
	T-1.5T	1649	0	0	0
	1.5T-2T	616	0	0	0
	2T-4T	537	0	0	0
	>4T	156	0	0	0
07130005	<T	4710	613	285	135
	T-1.5T	1032	0	0	17
	1.5T-2T	533	0	0	0
	2T-4T	727	0	0	0
	>4T	160	0	0	0
07130006	<T	4508	384	215	58
	T-1.5T	1543	0	0	0
	1.5T-2T	484	0	0	0
	2T-4T	369	0	0	0
	>4T	102	0	0	0
07130007	<T	4955	248	135	132
	T-1.5T	730	0	0	0
	1.5T-2T	148	0	0	0
	2T-4T	332	0	0	0
	>4T	37	0	0	0

Table 1. (Continued)

WRC Unit	Soil Loss	Cropland	Pasture	Forest	Minor
07130008	<T	2865	158	166	26
	T-1.5T	508	0	0	0
	1.5T-2T	196	0	0	0
	2T-4T	165	0	0	0
	>4T	63	0	0	0
07130009	<T	6748	332	60	184
	T-1.5T	2058	19	0	0
	1.5T-2T	508	0	0	0
	2T-4T	802	0	0	0
	>4T	107	0	0	0
07130010	<T	3113	550	198	56
	T-1.5T	920	7	0	0
	1.5T-2T	260	0	0	0
	2T-4T	428	0	0	5
	>4T	55	0	0	0
07130011	<T	4735	567	488	86
	T-1.5T	1557	38	0	0
	1.5T-2T	547	0	0	0
	2T-4T	1058	0	0	0
	>4T	147	0	0	0
07130012	<T	3149	294	72	52
	T-1.5T	536	0	0	27
	1.5T-2T	183	0	0	0
	2T-4T	331	0	0	0
	>4T	65	0	0	0

Let's look closely at the cropland situation since this is clearly the area we must emphasize in Illinois because 91 percent of all acres that exceed "T" are cropland acres.

The National Resources Inventory provides data tables that show erosion problems by land capability class and subclass. There are 8 land capability classes. As one moves from Class 1 to Class 8, the choice of crops decreases, and the degree of limitation or extent of hazard increases. So, Class 1 is the best and Class 8 is the poorest and most difficult to protect.

Within each capability class, except Class 1, three subclasses based on kind of limitation are recognized. They are e, w, and s. Respectively, they indicate that erosion, wetness and droughtiness are the limitations.

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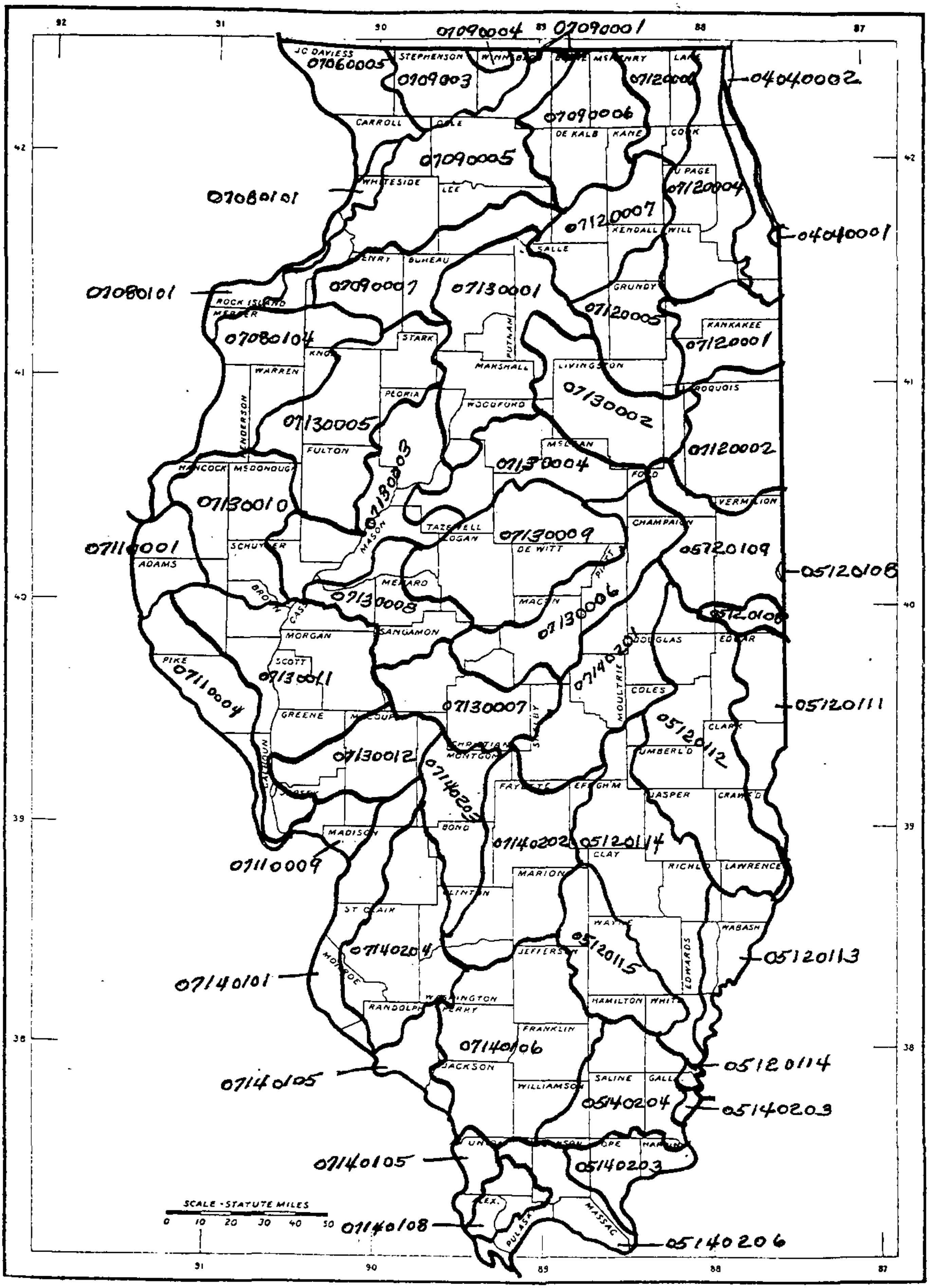
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JO DAVIESS
STEPHENSON
CARROLL
DE KALB
KANE
COOK
WHITESIDE
LEE
KENDALL
WILL
GRUNDY
ROCK ISLAND
STARK
KANKAKEE
PUTNAM
MARSHALL
WARREN
PEORIA
WOODFORD
FULTON
HANCOCK
McDONOUGH
CHAMPAIGN
SCHUYLER
ADAMS
LOGAN
DE WITT
MENARD
MORGAN
SANGAMON
PIKE
SCOTT
COLES
MOULTRIE
GREENE
SHELBY
CLARK
JASPER
BOND
CLAY
MADISON
MARION
ST CLAIR
WABASH
EDWARDS
JEFFERSON
HAMILTON
RANDOLPH
FRANKLIN
JACKSON
WILLIAMSON
SALINE
PULASKI
MASSAC
SCALE - STATUTE MILES
0
10
20
30
40
50
92
91
90
89
88
87
42
41
40
39
38

The following Table 2 shows the relationship of erosion rates (tons/acre/year) to increasing capability class. Except for land capability Class 5, which includes only wet soils in Illinois, and land capability Class 8 (we have none), erosion rates ascend in a regular manner.

Table 2. Soil Erosion Rates for Cropland for the Various Land Capability Classes (Ton/Acre/Year)

Capability Class and Subclass	Soil Erosion Rates Tons/Acre/Year
I	3.8
IIe	8.0
IIw	3.3
IIs	0
IIIe	15.7
IIIw	3.3
IIIs	2.7
IVe	25.0
IVw	3.0
IVs	2.7
V	3.3
VIe	34.3
VIw	1.5
VIs	4.6
VIIe	42.9
VIIw	0
VIIs	13.3
VIII	0

If we look statewide at only the "e" subclass portion of each land capability class we see that the average annual erosion rates are 8.0, 15.7, 25.0, 34.3 and 42.9 ton/acres/year, for capability classes 2, 3, 4, 6 and 7, respectively. The rates for the Illinois River Systems would be similar.

The subclass "e" amounts to 9,545,000 cropland acres in Illinois. Of these, about 75 percent exceed "T".

The following table further refines the magnitude of the cropland erosion problem:

Table 3. Cropland Acres In Each of Three Erosion Groups for the State

Erosion Group	Acres
<T	14,500,000
T-2T	5,506,600
>2T	4,720,800

The first group contains 14.5 million acres of cropland that are adequately protected from excessive sheet and rill erosion. The average soil loss rate for this group is 2.6 ton/acre/year. Looking at the T-2T category one sees a similar relationship in these 5.5 million acres. The average soil loss rate of this group is 6.2 ton/acre/year. The last group, the greater than 2T category, has an average sheet and rill erosion rate of 21.5 ton/acre/year. A dramatic increase in erosion rate!

These 4,721,000 acres or about 20 percent of the cropland base are contributing about 102 million tons of annual erosion or 59 percent of all cropland erosion.

In the Illinois River System, this group contains 1,029,100 acres and makes up about 10 percent of the cropland base. Table 4 provides a comparison of the Illinois River System to the state when compared to Table 3.

Table 4. Cropland Acres In Each of Three Erosion Groups for the Illinois River System

Erosion Group	Acres
<T	6,904,200
T-2T	2,469,600
>2T	1,029,100

The Natural Resources Inventory provides a broad and varied data base. It provides opportunities to better understand the needs of the resources by identifying existing conditions and treatment needs. The Inventory does not supply all the data we need to estimate all types of erosion but does provide good sheet and rill erosion data and some sketchy gully, streambank and roadside estimates. Ephemeral gully erosion must be estimated.

Looking at a single basin within the Illinois River System, the Peoria Lakes basin, we can analyze the erosion problems and discuss sedimentation and how to reduce it.

Table 5 on USLE erosion from all land uses in the Peoria Lakes basin shows that the average soil loss in the basin is 5.8 tons per acre per year. The cropland component is generating more than 90 percent of the total tons eroded.

Table 5. Peoria Lakes - Total USLE Erosion From All Land Uses

Land Use	Acres	USLE Tons (1,000,000)	Tons Per Acre Average
Cropland	875,200	5.672	6.5
Pastureland	49,900	0.091	1.8
Forestland	101,700	0.142	1.4
Other Land	37,600	0.318	8.5
Total	1,064,400	6.223	5.8

Table 6. Peoria Lakes - USLE Erosion >T From All Land Uses

Land Use	Acres	USLE Tons (1,000,000)	Tons Per Acre Average
Cropland	398,500	4.271	10.7
Pastureland	6,800	0.063	9.3
Forestland	7,000	0.083	11.9
Other Land	5,900	0.304	51.5
Total	418,200	4.721	11.3

As seen in Table 6, the average rate for the 418,200 acres that exceed "T" is 11.3. Note that more than 75 percent of the tons eroded comes from about 40 percent of the total area or from the 398,500 acres of cropland that exceeds "T".

Table 7. Peoria Lakes - Total USLE Erosion From Cropland

Slope	Acres	USLE Tons (1,000,000)	Tons Per Acre Average
0-2	522400	1.856	3.6
2.1-5	291700	2.608	8.9
5.1-10	53400	1.049	19.6
10.1-15	6400	0.150	23.4
15.1-20	1300	0.009	6.9
20.1-30	0	0	0
>30	0	0	0
Total	875200	5.672	6.5

Table 8. Peoria Lakes - USLE Erosion >T From Cropland

Slope	Acres	USLE Tons (1,000,000)	Tons Per Acre Average
0.2	107200	0.650	6.1
2.1-5	238500	2.431	10.2
5.1-10	46400	1.035	22.3
10.1-15	5100	0.146	28.6
15.1-20	1300	0.009	6.9
20.1-30	0	0	0
>30	0	0	0
Total	398500	4.271	10.7

Both Tables 7 and 8 point to the fact that it is the gently sloping, 2 to 5 percent slopes, and the sloping, 5 to 10 percent slopes that produce most of the tons that erode from cropland from sheet and rill erosion.

Based on NRI-82 data from sheet and rill erosion it was determined that 6.2 million tons of soil erode each year from all land uses from the 1,064,000 acres of rural land in the Peoria Lakes basin. Using a 75 percent sediment delivery ratio about 4.7 million tons are delivered to the edge of the field and 30 percent of that or 1.4 million tons would be delivered to the Illinois River.

Streambank and gully erosion estimates from the NRI-77 data suggest that about 0.4 million tons would reach the river from these sources. These data are sketchy and likely underestimate the tons delivered from these sources.

Ephemeral gully, or shallow gullies that are annually filled and voided, are estimated to provide another 0.2 million tons of sediment.

Table 9 below provides these estimates and a total tons of sediment annually delivered to the Illinois River.

Table 9. Peoria Lakes - Sediment Delivery Estimates (1,000,000 Tons/Year)

Sheet and Rill	1.4
Streambank and Gully	0.432
Ephemeral Gully	0.238
Total	2.070

Treatment of sheet and rill and ephemeral gully erosion is relatively easy to achieve, but treatment can be expensive if structural measures, like terraces, are needed. Sheet and rill erosion can be reduced with such practices as crop rotations, conservation tillage, contouring or seeding the areas to permanent vegetation or planting trees.

Ephemeral gullies can be controlled but will require grassed waterways, terraces, diversions, or water and sediment control basins. These structural measures are often too costly for individuals to install without cost-share assistance.

Gully erosion is more difficult and expensive to control. Grade stabilization structures, ponds, and sediment basins can stabilize these areas.

Streambank erosion can be reduced by use of rip-rap, vegetative plantings and large structures that control flow rates. In the Peoria Lakes basin the tons of soil eroded from cropland is the major contributor to the sediment in the Illinois River. A full scale treatment program in the uplands which centered on sheet and rill erosion control practices could reduce this erosion by 50-60 percent and treat most soils to "T".

In many areas reduction of erosion rates to "T" may be sufficient to maintain soil productivity and water quality. In other places soil erosion rates may need to be reduced to rates much less than "T" to protect or improve the resources impacted. The Peoria Lakes basin may be one of those areas.

Structural measures, perhaps including large structures that hold or trap water and sediment, will be necessary to impact on all types of erosion and retain sediment at positions outside the Illinois River System.

Data from the Peoria Lakes basin was developed by Dale Benz, Resource Conservationist, with the Soil Conservation Service. This data was developed for the Peoria Lakes Resource Planning Committee, a local committee representing all the counties in the basin, who are working to develop a resource plan.

CASE STUDIES OF STREAM AND RIVER RESTORATION

Don Roseboom
State Water Survey
Peoria, Illinois

The Illinois Department of Conservation (IDOC) is funding demonstration projects by the Illinois State Water Survey (ISWS) in the Illinois River basin, (1) to decrease sediment delivery from Illinois River tributaries and, (2) to lessen the negative effects resulting from the massive amounts of sediment already deposited in river pools as Lake Peoria. The Watershed Planning Program of the Division of Planning has begun stream restoration projects on Court Creek and Crow Creek, which are designed to reduce bank erosion and sediment delivery to the Illinois River through methods which increase the extent of wooded stream corridors. In the Lake Peoria Restoration project, IDOC with Wallop-Breaux funding is testing the effectiveness of breakwaters and aquatic vegetation to stabilize lake sediments and reduce the entry of sediment into the lake water. The Fishery Division is testing methods of river restoration, which will increase fishing and hunting options for Illinois residents while reducing non-point pollution effects.

In the Court Creek watershed, the amount of sediment delivered from the 97.5 square mile watershed was compared with the amount of soil eroded from 10 large bank erosion sites along a 3-mile length of stream. During the 5 major storms of 1986, the bank erosion from 10 sites equalled 20 percent of sediment delivered from the entire watershed (see table 1). On one site 1,960 tons of soil were eroded during one storm. On Crow Creek over 6,000 tons were eroded from a 500 ft. long bank in one storm. If only the clay and silt portions of the bank soils are measured, then bank erosion of silt and clay from the 10 sites equalled 16 percent of the watershed sediment yield during 1986. These major bank erosion sites occurred where streams had been channelized to maximize the size and uniformity of floodplain rowcrop fields. Unfortunately when stream length reduction occurs as the result of channelization, the speed of floodwaters is increased and massive bank erosion often results.

If there are 50 severe bank erosion sites in the entire watershed (a very conservative estimate), then the 10 monitored bank erosion sites would represent 20 percent of the bank erosion in the watershed. An estimate of the bank erosion contribution for the entire watershed can therefore be made by multiplying the contribution of the monitored sites by five. Since eroded bank soil from only 10 sites represents over 20 percent of the sediment yield in a 61,760-acre watershed, bank erosion could contribute all the sediment delivered to the stream from the entire watershed. However, sand represents a large percentage (15 to 40%) of eroding bank soils. Much of the sand transported by a stream is not sampled with a DH-59 sediment sampler. Sand is largely transported along the stream bottom as bedload, which lies below the sampling depth of the DH-59.

TABLE 1

CONTRIBUTION OF ERODED BANK SOILS TO THE STREAM YIELD OF A 62,000 ACRE WATERSHED

	Bank Soil (tons)	Silt and Clay (tons)	Phosphate (lbs)	Ammonia (lbs)	Kjeldahl Nitrogen (lbs)
Watershed Yield - 1986	28,129	28,129	79,555	6,948	109,862
Contribution from 10 Sites	6,424	4,648	9,358	704	8,929
Percent of Yield from 10 Sites	22.8	16.5	11.8	10.1	8.1
Percent of Estimated Yield from Bank Erosion	100	82.5	56.4	50.5	40.5

This sand bedload is responsible for destruction of instream habitat for fish and macroinvertebrates in Illinois River tributaries. Sand fills the deep pools and covers the rock rubble and woody structure, where gamefish as smallmouth bass and channel catfish dwell and feed (Roseboom et al., 1986). The loss of this habitat in most of Court Creek and many other Illinois streams is responsible for decreasing populations of gamefish. Fishery biologists can select sites within any stream that will reflect the effects of good and bad instream habitat on gamefish populations. While point pollution will often destroy the fish populations of entire stream segments, non-point pollution will destroy portions of the stream populations by covering the habitat within segments of the stream. The proportion of poor instream habitat within the stream system determines gamefish populations within the stream, if water quality is not critical and fish populations are in balance.

Particle size analyses of eroding bank soils at the 10 selected sites allows the determination of sand inputs. Over 1770 tons of sand were eroded from only 10 sites. If these 10 sites represent 20 percent of the bank erosion, then bank erosion will contribute 8,800 tons of sand to the bedload. If the stream can not transport these inflows of sand, then the deeper pools will fill and habitat will be buried. This loss of instream habitat is common in central and western Illinois streams with sand beds. Stream channel width at severe bank erosion remains constant while the stream channel erodes into the prime farmland along the floodplain. However, the prime farmland is replaced on the opposite bank with a sand and gravel bar. This process has been observed in the channelized floodplain segments of Court Creek where stream channels have moved 80 ft. in 4 years.

If only the silt and clay portions of eroded bank soils are compared with the 1986 stream sediment yield, the 10 monitored bank erosion sites contribute 16.5 percent of the sediment yield from the entire watershed. If these 10 sites represent 20 percent of the bank erosion in the entire watershed, then bank erosion of silt and clay is equal to 80 percent of the soil transported by Court Creek during 1986. These eroded bank soils of clay and silt are delivered to the stream when high-velocity floodwaters are likely to transport silt and clay long distances offsite. This finding is very important if sediment delivery to the Illinois River is to be reduced from tributaries.

However, the high percentage of eroded bank soil introduced into the stream does not indicate that bank erosion is the only source of sediment in the watershed, only that the process of sedimentation is occurring as the streams overflow their banks onto the floodplain. Observations of sand deposits on stream border regions and silt deposits in floodplain rowcrop fields were always made after overbank streamflows, just as deposits of silt were visible in roadside ditches along row crop fields in the upland plain.

As a result of chemical analyses of the eroding stream bank soils, the contribution of bank erosion to the total phosphorus, total ammonia, and Kjeldahl nitrogen stream yields could be determined. Given the extent of bank instability found during stream surveys of Court Creek and its three tributaries, these 10 sites are not estimated to contribute more than 20 percent of the total bank erosion occurring during major storms. If the 10 monitored bank erosion sites represent 20 percent of the bank erosion in the watershed, bank erosion will contribute 56 percent of the total phosphate yield, 50 percent of the total ammonia yield, and 40 percent of the Kjeldahl nitrogen yield. This finding is extremely important if the eutrophication of Illinois rivers and lakes is to be limited by land management practices.

In Illinois and other midwestern states, the extent and severity of bank erosion on water quality has only recently been discerned. Evans and Schnepper (1977) estimated that over 40 percent of the sediment in Spoon River in western Illinois resulted from bank erosion along the Spoon River. Leedy (1979) estimated that over 50 percent of the annual sediment yield of Illinois streams resulted from stream bed erosion. Using stream cross-sectional data, Lee et al. (1982) estimated that 50 percent of the sediment yield from the Blue Creek watershed in western Illinois came from the eroding stream bed. Through the use of an approved SCS field survey technique, Davenport (1983) estimated that only a small percentage of the sediment yield from the Blue Creek watershed resulted from bank erosion. Vagt (1982) estimated that 50 percent of the annual sediment yield in northern Illinois streams resulted from bank erosion. Hamlett et al. (1982) estimated that stream channel contributions of sediment to an Iowa stream represent between 25 and 50 percent of stream sediment yield. Sharpley and Syers (1979) found that stream bank erosion and resuspension of stream sediment contributed the major portion of annual sediment and phosphate stream yields.

Wilkin and Hebel (1982) estimated that only a small fraction of soil eroded from upland row crop fields actually reached an Illinois stream. The vast majority of instream sediment resulted from floodplain and valley bluff erosion. Only one very broad row-cropped floodplain with pooled floodwaters had evidence of sediment deposition. However, forested floodplain areas had very strong evidence of deposition. The forested floodplain had sedimentation rates of 10 to 20 tons per acre per year. Unfortunately most floodplain areas were row-cropped with no forested areas positioned to decrease sediment levels in runoff. The active floodplain row crop areas had estimated erosion rates of 15 to 60 tons per acre per year.

In Knox County, the floodplains of streams no longer serve only as the sedimentation basins described by Fehrenbacher et al. (1977); instead, the floodplains have become primary sources of stream sediment and nutrients. Fehrenbacher et al. state that the floodplains were forested bottomland during the thousands of years of alluvial soil development from sedimentation. Wilkin and Hebel found sedimentation occurring in forested floodplains and forested stream border bluffs. These conclusions have led to the present Court Creek project, which restores the wooded stream borders as the means of reducing soil erosion, decreasing the delivery of sediment to larger rivers and lakes, and increasing stream habitat.

The Illinois State Water Plan (Illinois State Water Plan Task Force, 1984) has determined that erosion and sediment control, flood damage mitigation, and aquatic and riparian habitat are critical water resource issues to Illinois residents. Lead Illinois agencies for each critical issue are the Illinois Department of Agriculture (erosion and sediment control), the Illinois Department of Transportation - Division of Water Resources (flood damage mitigation), and Illinois Department of Conservation (aquatic and riparian habitat). The State Water Plan describes the unquantified link between soil erosion and water quality as a difficulty in assessing the improvement of water quality by erosion control methodology. The Court Creek study is designed to illustrate the links between water quality and soil erosion in those watersheds, where high-velocity floodwaters destroy floodplain fields and stream habitat. Such watersheds are common in the Illinois River basin.

In the Illinois State Water Plan (Illinois State Water Plan Task Force, 1984), the Illinois Department of Conservation states that the losses of riparian habitat are a major cause in the aquatic resources degradation of Illinois streams. Techniques of stream restoration or renovation have been applied successfully in other states (Nunnally, 1978; Keller, 1976) in place of channelization. These methods promote runoff within the stream channel while retaining much of the woody vegetation and stream meanders. Drainage is enhanced by removal of trees, which are or soon will be large obstructions to floodwaters in the main stream channel.

Stream maintenance includes the removal of large trees on the stream bank, when such trees will soon be eroded into the stream channel. Such trees can be placed as tree retards along the eroding stream bank to divert streamflow into the center of the stream bed. The conversion of a potential flow obstruction into a low-cost tree retarder is an old soil conservation technique (Lester, 1946), which has received added emphasis as a Palmiter river restoration technique (Willeke and Baldwin, 1982). The removal of eroding trees from the bank and from the stream channel should follow guidelines established by the Illinois Department of Conservation (IDOC, 1982) and the American Fisheries Society (1983).

George Palmiter has been hired by IDOC to test the application of tree retards in protecting stream banks along a three mile demonstration area of Court Creek. A series of three floods occurred during the fall construction period. Over that portion of the stream where construction has been completed, little or no bank erosion was observed. A more complete evaluation of the Palmiter techniques will be made during those floods, which occur after Palmiter finishes construction in 1987.

Floodplain farmers on the Palmiter 3-mile Demonstration area of Court Creek have given the Knox County Soil and Water Conservation District the conservation easements for a 30 foot border on both sides of the stream. Once the tree retards have collected sediment in their branches, willow cuttings and bald cypress seedings will be placed in the deposited sediment along the lower bank. Tree retards are viewed as low cost temporary structures, which will reduce erosion so that the willows and cypress can be established along the toe of the eroding bank. Additional trees as walnut, green ash, American plum, and gray dogwood will be planted along the upper banks. In this manner a wooded stream border will increase stream stability and increase game habitat. The tree retards introduce woody structure into the deeper waters along the eroding banks. Such woody structure has been covered by the sand eroded from stream banks. The loss of woody structure in deep waters is the primary cause in the declining gamefish populations of smallmouth bass and channel catfish in Court Creek and many Illinois River tributaries.

In the Court Creek watershed, major bank erosion sites and complete blockages of streamflow resulted when large trees were uprooted and fell into the stream. Even streamflows resulting from a 3-inch rainstorm did not dislodge these trees. Such occurrences are the major reason that floodplain landowners do not readily accept "green belts" of trees along streams. Only with an annual stream maintenance program will stream borders of woody vegetation be accepted by landowners.

The development of a locally supported stream maintenance program is essential to the success of any stream stabilization practice utilizing riparian woody vegetation in agricultural floodplain areas. The effectiveness of the watershed demonstration efforts in promoting widespread application of such practices will largely depend upon the development of methods to foster locally funded stream maintenance programs.

Under the Watershed Planning Program of IDOC, the Knox County Soil and Water Conservation District has formed a stream maintenance crew. The stream crew is working upstream of Palmiter Demonstration area on a 19,000 acre tributary - North Creek. Since the fall of 1986, the crew has selectively removed major logjams along a 4 mile stream segment. In addition, 2000 trees have been planted along the North Creek stream border, after the District received permission from agricultural landowners.

In conjunction with a joint effort between IDOC and the Soil Conservation Service (SCS), the District crew has performed two Conservation *Field Trials* on North Creek. These *Trials* utilize large size cuttings of willow to protect severe bank erosion sites. In one site 130 cuttings were placed with a hand auger along 240 ft. of bank in July of 1986. In the second site this spring, 620 cuttings were placed along 800 ft. of bank with a Caterpillar high-hoe and 6 ft. ram. The ram allowed penetration of a rock layer, so that 6 ft. of the 12 ft. long cuttings could be placed in the bank. The method is more expensive than the Palmiter method, since more trees are required to protect the same length of eroding bank.

The technique, utilizing willow cuttings as bank protection, has been successfully applied by the SCS along major streams and rivers in California and Arizona. During the fall floods of 1986, no erosion was found along the first Trial site on North Creek, although upstream and downstream bank erosion sites lost thousands of tons. The durability of the bank protection should increase with time since dormant cuttings of willow will regrow roots and branches along the bank. Therefore, a wooded stream border is rapidly established at severe erosion sites. At the same time more desirable trees are planted as American plum, ash, walnut, and red cedar have been planted on the upper portions of the banks.

Bank sloping at certain severely eroding sites may be necessary, however, more expensive alterations of the technique will only be attempted if less expensive methods have failed. The purpose of these demonstration projects is the development of low cost methods, which can be widely applied over a region as large as the Illinois River basin. Only in this fashion can local landowners and local government support such projects. Indeed even state and federal agencies do not have the funding necessary if structural techniques are to be applied to such a large area effectively.

The Lake Peoria Restoragion project reduced the effects of sediment already delivered to the Illinois River through low cost restoration practices involving revegetation. The Illinois River and Lake Peoria were the greatest fishing and hunting area in Illinois even before massive federal grants reduced the effects of point pollution sources from Chicago and downstream urban areas. However, nonpoint pollution sources not only destroy water quality but actually destroy the water body within the span of our life, not thousands of years. This process is not confined to Lake Peoria but is occurring in all backwater lakes of the Illinois River and also many reservoirs in central and western Illinois. The Illinois State Water Survey found the greatest stream sediment yields occurred in central and western Illinois. The Soil Conservation Service stated that one third of the "critical sediment producing area" of the upper Mississippi River basin (this includes the Illinois River basin) lies in central and western Illinois. Controlling nonpoint pollution in Illinois is the single most important water quality objective in saving the aquatic recreational resources of this state.

Bellrose et al. (1983) stated that upper Peoria Lake is the most important recreational lake in central Illinois. Sedimentation and the concurrent loss of aquatic vegetation have increased turbidity levels and decreased dissolved oxygen levels during normal river flows in the peak summer recreational period. Starret and Jackson (1959) found it took approximately 11 days for sediment resuspended by wind-generated waves to decline to background levels in Lake Chautauqua, a backwater lake of the Illinois River. Since the average recurrence interval of winds during the growing season is less than 11 days, Lake Chautauqua remained turbid most of the time. Shoreline erosion and resuspension of sediment is greatest in lake areas opposite the prevailing westerly winds, such as northeast Lake Peoria.

Concurrently with increased sedimentation and turbidity, much of the aquatic vegetation in Illinois River backwater lakes disappeared between 1950 and 1965. The reasons for this disappearance and, even more importantly, the subsequent lack of recolonization by aquatic vegetation have never been determined (Mills et al., 1966). Since aquatic plants stabilize bottom sediments and increase the dissolved oxygen content of overlying waters, the colonization of Illinois backwater lakes by aquatic vegetation is especially important to the principle water quality and recreational problems now existing in the Illinois River.

The Lake Peoria Restoration project is an attempt to restore some of the recreational benefits of lakes impacted by sediment in a cost effective manner. The project restores aquatic habitat for gamefish and waterfowl by constructing an artificial reef. The reef also serves as a tire breakwater to protect plantings of aquatic vegetation from wave action of wind or boat generated waves. High rates of sedimentation have buried aquatic vegetation beneath thick layers of fluid sediments. Wave action prevents natural revegetation by uprooting young plants from the fluid sediments. Pilot plantings of arrowhead and pondweed have been partially successful when the plants are driven deeply into the sediment. Improvements of revegetation success will be determined once the breakwater is installed this spring and wave action is decreased at the planting site.

Both the wave energy dissipator and transplanting of aquatic plants are recommended mitigation and enhancement techniques for the upper Mississippi River system, which includes the Illinois River (Schnick et al. 1982). Webb and Dodd (1983) found wave protection to be necessary for transplanting emergent plants. Bonham (1980) also resorted to the use of old tires in order to establish beds of emergent plants in areas with heavy boat traffic. Kelly et al. (1971) utilized 14 different methods to transplant a marine grass (Thalassia testudinum) to areas where tidal currents would erode the buoyant plant free from the sediment.

Aquatic plants can increase sedimentation if placed in locations where water currents transport sediment. This is the reason why the demonstration site is located in shallow bay on the east bank of the Illinois River upstream of the McCluggage Bridge on Rte. 150 (river mile 166.0). This site is well away from strong currents even during flood events. The vegetation is meant to reduce the sediment suspended in the water column by wave action. In fact, the ability of aquatic vegetation to increase sedimentation rates at specific sites is the basis of a new Lake Peoria proposal.

The Illinois Department of Conservation and the U.S. Army Corps of Engineers are considering a proposal to combine check dams, wetland prairie marshes, and breakwaters with aquatic vegetation at the mouths of major Lake Peoria tributaries. Marsh areas near the mouths of tributaries have been buried under the heavy sand inflows, so that the major vegetation is willows, not the marsh plants valuable to wildlife. A series of checkdams will trap sand bedloads before the sand reaches the marsh areas. Sand deposits must be removed periodically from the checkdam areas. Braided stream channels will be formed through the marsh areas before streams enter the lake. Tributary floodwaters will spread and slow so that sedimentation of silt occurs. The combination of breakwaters and aquatic vegetation surrounding the marsh will slow floodwater velocities even more. Both silt and clay sedimentation will occur before the eroded soils are carried further out into the lake. This restoration design reduces the effects of nonpoint pollution by methods which increase fish and waterfowl habitat.

The purpose of both the Court Creek project and the Lake Peoria project is the development of low cost methods to reduce sediment delivery to water bodies like Lake Peoria. Both restoration projects slow water velocities and increase sedimentation in floodplain areas before sediment can enter lakes and rivers. An effective land management program to control nonpoint pollution in the Illinois River basin must include stream and wetland management to reduce stream channel erosion, increase sedimentation along the floodplains of stream valleys, and reduce floodwater velocities. Such methods must be developed before nonpoint pollution can be effectively reduced. Landowners and local agencies in the watershed of Lake Peoria have demonstrated a determined interest to achieving such objectives.

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ILLINOIS RIVER WATER QUALITY
PAST, PRESENT, AND FUTURE

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INTRODUCTION

Significant improvements have occurred in the water quality of the Illinois Waterway on both a short-term and a long-term basis. Presently, the organic waste loadings discharged throughout the system are small compared to those of the recent past and even to those discharged as long ago as 100 years. To appreciate these improvements an understanding of the historical developments, which have occurred in and along the waterway, is needed. Also, the unusual hydrologic and hydraulic characteristics of the waterway drainage system, which makes it somewhat unique, must be understood.

WATERWAY SYSTEM

A plan view of the waterway is shown in figure 1. The waterway runs from Lake Michigan to Grafton, a distance of approximately 327 miles. The watershed drains 29,010 square miles with 1,000 and 3,200 being in Wisconsin and Indiana, respectively, and the remaining 24,810 being in Illinois.

The waterway is no longer a free flowing river as demonstrated by figure 2. It has been levied and dammed and now consists of eight "stepped" navigation pools. These physical alterations have placed serious constraints upon the ability of the system to assimilate organic, oxygen consuming wastes. Water velocities have been reduced and water depths have been increased, both of which are detrimental to natural waste assimilative processes. Sedimentation is also promoted in the slackened water.

Before the dams were built, the hydraulic gradient above Starved Rock was approximately 1.14 feet per mile while below it the gradient averaged only 0.12 feet per mile all the way to Grafton. The lower river, even in an unaltered state, had a low capacity to purify wastes.

Figure 3 shows the intricate makeup of the channels, canals, and rivers which comprise the waterway in the Chicago area. The Illinois River proper officially starts at the junction of the Des Plaines, DuPage, and Kankakee Rivers (known as the three rivers area) shown on figure 3. To fully understand the water quality problems which occur far downstream, a cursory understanding of the history and the nature of the operation of the Chicago area drainage system is needed.

During the early development of Chicago, the Chicago and Calumet river systems flowed easterly and discharged into Lake Michigan. As the population grew, wastes were discharged into these rivers eventually causing public health and pollution problems. Subsequently, the flow of these rivers was reversed and flushing was accomplished by diverting Lake Michigan water; this relieved many of the problems in the immediate Chicago area, but water quality conditions deteriorated downstream as a result.

Today flushing water (discreationary diversion) from Lake Michigan is drawn at the three locations shown by the arrows on figure 3. Total diversion, including that needed for public water supply, is limited by law to 3200 cfs on an annual average basis; discretionary diversion is limited to 320 cfs on an annual average basis.

The three major Metropolitan Sanitary District of Greater Chicago (MSD) wastewater treatment plants, discharging an average dry weather flow of 2042 cfs, are shown on figure 3. Historically, during wet weather, combined sewers have overflowed and discharged dissolved organic wastes and solids throughout the Chicago waterway network. Much of this combined sewer waste load has been eliminated since most of Phase I of the Chicago Tunnel and Reservoir Project (TARP) has been completed.

HISTORICAL OBSERVATIONS

The Illinois River has a long history of being studied. Some authorities consider it to be the most studied stream in the world.

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 water 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 down-river opposition to this plan was encountered, all physical and political obstacles were eventually overcome and on January 16, 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 Illinois State Board of Health from 1886 to 1889 to investigate and study the waste assimilative capacity of the river system from Chicago to Grafton. 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 Pekin 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 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. However, significant improvements started to become evident in the early 1930s after the completion of highly efficient treatment systems at Chicago and Peoria.

The completion of the locks and dams in the late 1930s reduced the organic waste assimilative capacity significantly and accelerated sedimentation. New environmental and ecological problems developed and evolved as a result.

PRESENT DAY WATER QUALITY PROBLEMS

The preceding observations clearly demonstrate that yesteryear problems were much greater and more obvious than those which persist today. However, presently, major problems do exist in certain reaches of the waterway. Basically, these problems are related to:

(1) Sediment transport and sediment deposition

(2) Toxic contaminants of benthic sediments

(3) Low dissolved oxygen (DO) concentrations during warm weather.

Past, present, and future considerations associated with low DOs will be addressed in this paper.

Low DOs are reflective of active biological stabilization of organic wastes. When the DO supply is insufficient to supply the continuous biological demands, stream degradation occurs and oxygen sags occur in a stream. Low DOs still persist because:

(1) The waste assimilative capacity has been reduced due to man's alterations of the natural flow regime.

(2) Significant organic waste loads are still discharged in the form of carbonaceous and nitrogenous compounds.

(3) Bottom (benthic) sediments exert a high oxygen demand in certain locations.

The minimum DO standard for the waterway above the I-55 highway bridge is 4.0 mg/l, whereas, below the bridge it is 5.0 mg/l. The standard above the bridge is routinely violated. Below I-55, the 5.0 mg/l standard is still being violated but much less frequently than it was just a few years ago. A combination of adverse conditions have to exist before persistent low DOs occur below Dresden Island, and the areas of occurrence are normally restricted to the Peoria pool (between Lacon and the Peoria narrows) and in the LaGrange pool below Havana. In any event, extremely depressed DOs are limited to locations above Brandon Road in the far upper reaches of the waterway. Overall, conditions have improved greatly in the last 25 years.

WASTE LOAD REDUCTIONS AND WATER QUALITY IMPROVEMENTS

Since the mid-1800s when the I & M Canal was opened, overall water quality (relative to organic pollutants) has never been better. The "good old days" are now; contrary to what is often espoused, our fathers, grandfathers, and most of our great grandfathers never saw the river in as good as condition as it is now from an organic waste load perspective.

Table 1 shows very vividly what has been accomplished. Carbonaceous waste loads have been reduced 91% since 1922. Since 1971, a 32% reduction alone has occurred although the load in 1971 was actually only 13% of that observed in 1922. The figures specific to the Peoria area are equally amazing. Since 1925, 97% of the organic waste discharges have been elimiated here.

High ammonia concentrations are indicative of organic pollution, especially those associated with domestic waste. As the population increased along the waterway since 1900, a commensurate increase in ammonia occurred. Ammonia is not readily removed in the treatment processes employed up to the early 1970s. Table 2 shows that significant increases occurred in the ammonia load up to that time, then it significantly decreased. Since 1971, over a 50% reduction has occurred. One part ammonia in water requires 4.57 parts of oxygen for stabilization. In terms of population equivalents (based on oxygen usage), approxiamtely 950,000 population equivalents are now being discharged compared to 1,950,000 about ten years ago.

Table 3 shows the large reduction in ammonia levels which have occurred in the Peoria area of the river in the last 15 years. A dramatic drop in concentrations occurred in the decade between 1971-72 and 1981-82. The low concentrations which started appearing in the early 1980's continue to persist.

The DO curves of figure 4 and the DO data in tables 4 and 5 demonstrate the "bottom line" of all the effort that has been exerted over the years to reduce the organic pollution of the Illinois waterway. The DOs in the upper waterway above Peoria have increased steadily from near zero conditions in 1922 to values persistently above 5 mg/l in 1982. Some undesirably low concentrations occasionally occur in localized areas and near zero levels often occur for long time periods above Lockport, but overall, a tremendous improvement has been evident. The average summer DO within the Peoria pool has increased 230 percent since 1964 (table 4). Increases in other pool average DOs below the Dresden Island dam have been only slightly less dramatic. Dresdent Island (188%), Marseilles (170%), and Starved Rock (190%).

At certain locations, such in the Starved Rock pool immediately above the dam, DO levels are now being maintained at or above saturation concentrations (table 5). The 1985 average of 9.9 mg/l above the Starved Rock dam was significantly greater than the saturation average, and the 1986 average of 8.4 mg/l was essentially equal to saturation.

Figure 5 illustrates an interesting fact relative to the relationship between sediment deposition and DO levels within the waterway. Not only do sediments reduce water volume and create physical problem, they also contribute to oxygen depletion in the form of sediment oxygen demand (SOD). The top curve shows that oxygen sags will still occur in the waterway even if all point sources of pollution were completely eliminated. The bottom curve demonstrates what could be expected if the Chicago Calumet treatment plant were upgraded to meet the same effluents now being achieved by the other two Chicago plants. The Calumet plant is basically the last facility along the waterway that could be improved to provide detectable improvements in DO and ammonia levels downstream.

FUTURE CONSIDERATIONS

In the future, physical factors and changes will influence DO resources along the waterway more than biological considerations. As has been noted, the potential for reducing organic waste loads is limited because such great strides have already been made in reducing sources to practical limits. Some additional reductions will come as the final segment of Phase I of TARP is completed and the Calumet treatment plant is upgraded.

Physical considerations which need to be addressed and evaluated relative to their interactions with waterway DO resources are: (1) increased Lake Michigan diversion, (2) hydropower development, (3) increased dam aeration using Tainter gate manipulation, and (4) increased Peoria pool elevations. The Water Quality Section's BOD-DO computer model was used to predict what effects of these four items would have on DO resources if they were to be implemented.

Table 6 lists the modeling results of four diversion scenarios associated with increased diversion. The Corps of Engineers propose diverting an additional 9,000 or 12,000 cfs during low, summer flows. Surprisingly, increased diversion will not be particularly beneficial to the overall DO resources. It will increase concentrations in the upper two pools, but under certain circumstances, it will reduce downstream concentrations significantly, particularly in the lower reaches of the Peoria pool. Lower Peoria pool DO concentrations will result because the higher diversion flows will push or flush Chicago area wastes into the Starved Rock-Peoria pool area where stabilization will become more deliberate. A diversion flow of 9,000 cfs superimposed upon a flow of 50% duration (50% + 9000) will produce lower DOs above the Peoria dam than will an "ambient" flow of 99.8% duration (99.8 w/o P). Also, the higher flows will negate the benefits of photosynthetic oxygen production experienced during low flows (99.8 w/P). High flows produce an unfavorable environment for algal growth.

Hydropower developments are now being seriously considered at the Brandon Road, Dresden Island, and Starved Rock dam sites. Water is not effectively aerated when routed through a hydroelectric power plant as it is when it is released through Tainter gates. Hydroelectric power is now being generated at Lockport and Marseilles. The low DOs still being experienced above the Brandon Road dam appear to limit the exploitation of this site for hydropower development, although, it could possibly be done. Hydropower development at Starved Rock could actually enhance downstream DO levels during much of the summer. Table 7 shows that 59 percent of the time the average DO above the Starved Rock dam equals or exceeds 100 percent saturation. This means that during the majority of the time the water is presently being <u>de</u>aerated as it passes through the Tainter gates. Most of the dissolved oxygen now being "blown out" and lost would be retained for downstream use when passed through a hydropower plant.

Downstream improvements in DO could also be achieved by managing flow releases at the Dresden Island, Marseilles, and Starved Rock dam sites. For example, the Starved Rock dam aeration coefficient has been found to be directly related to the height of the gate opening. A gate open four feet at Starved Rock has been found to have an aeration coefficient four times that of a gate open one foot.

Raising the Peoria dam height to increase the Peoria Lake water depth would negatively impact the DO levels in the pool. It would reduce the reaeration capacity and extend the biochemical oxidation incubation period. Table 8 illustrates what the net effect would be during three summer low-flow conditions for dam height increase of 1, 2, and 3 feet. The reduction in DO levels may appear small but would be equivalent to discharging raw sewage from 29,500 to 66,900 people at Lacon (table 9). One would not be presumptive in assuming that this would be universally unacceptable.

Table 1. Organic Waste Load Reductions

Year	Waste Load Population Equivalents* Discharged to Waterway	Year	Waste Load Population Equivalents Discharged in Peoria Area
1922	6,225,000	1925	1,149,000
1962	1,752,000	1971	80,300
1971	790,000	1980	37,500
1980	537,000		

* 1 Population Equivalent = 0.167 lbs/day of 5-day Biochemical Oxygen Demand

Table 2. Historical and Current Ammonia (NH_3-N) Loads at Lockport (River Mile 290)

	Monthly Average NH_3-N Loads (lbs/day)		
Year	July	August	September
1900	49,860	70,800	67,600
1901	63,800	71,660	79,980
1971	118,000	107,600	91,400
1982	40,200	53,200	61,000

Table 3. Seasonal Variations in Ammonia Concentrations at Peoria

	Average Concentration (mg/l)			
Season	1971-72	1981-82	1982-83	1986-87
Winter	5.13	1.13	0.46	0.61
Spring	2.37	0.47	0.37	0.26
Summer	0.67	0.15	0.11	0.07
Fall	1.99	0.19	0.22	0.22
Yearly Average	2.54	0.49	0.29	0.29

Table 4. Average Pool DOs (mg/l) During Warm Weather

Year	Brandon Road	Dresden Island	Marseilles	Starved Rock	Peoria
1982	2.3	6.2	7.3	7.4	7.6
1971/72	4.3	4.8	5.6	4.8	5.1
1967	-	2.7	4.8	3.8	3.9
1964	-	3.3	4.3	3.9	3.3

Table 5. Average DOs Immediately Above Upper Illinois Waterway Dams at 3-foot Depth

Dam	Do Concentration (mg/l)					
	1971	1972	1978	1982	1985	1986
Lockport	1.2	1.3	1.4	1.1	-	-
Brandon Road	2.4	1.1	2.0	2.6	-	3.4
Dresden Island	5.1	5.3	5.6	6.8	-	6.8
Marseilles	4.8	4.5	5.6	7.0	-	-
Starved Rock	4.9	5.3	7.5	7.7	9.9	8.4
Peoria	-	6.1	7.0	-	-	7.7

Table 6. Above Dam DOs Predicted for Various Possible Diversion Scenarios

Above Dam Location	Dissolved Oxygen Concentration (mg/l)						
	99.8% Duration				50% Duration		
	w/P	w/o P	+9000	+12000	w/o P	+9000	+12000
Lockport	0.5	0.5	1.5	1.5	0.5	1.5	1.5
Brandon Road	0	0	1.5	1.5	0.8	1.6	1.6
Dresden Island	2.0	2.0	6.2	6.4	6.2	6.5	6.6
Marseilles	3.8	2.2	7.2	7.4	6.3	7.4	7.5
Starved Rock	6.3	2.4	7.1	7.5	6.0	7.7	7.8
Peoria	8.2	6.4	5.0	5.0	5.1	4.9	5.2

Note: 99.8% and 50% Duration refer to the percent of times a summer flow is equalled or exceeded; w/P = with photosynthetic (P) oxygen production; w/o P = without P; +9000 and +12000 = increased diversion cfs

Table 7. Percent of Time DO Saturation Percentage Was Exceeded Above Starved Rock Dam During 1986

Saturation (%)	Percent of Time Exceeded For		
	Surface	Depth Avg.	Bottom
70	100	99	98
80	99	95	89
90	92	83	66
100	80	59	34
110	72	46	13
120	64	30	1
130	49	22	0
140	41	10	
150	35	3	
160	32	1	
170	21	0	
180	17		
190	13		
200	10		

Table 8. Minimum DOs Predicted For Peoria Dam Height Increases of 1, 2, and 3 Feet

Increase in Pool Elevation (ft)	Minimum DO (mg/l) For Summer, Low-Flow Durations Percentage Of 99.8	98.0	90.0
0	3.95	3.65	3.4
1	3.8	3.5	3.25
2	3.7	3.45	3.1
3	3.65	3.4	2.95

Table 9. Raw Waste Population Equivalent (PE) Discharges at Lacon (MP 190.0) Needed To Effect DO Drops Equivalent Those Caused By Raising Peoria Dam Heights By 1, 2, and 3 Feet During a 99.8% Summer Low-Flow Duration

Increase In Pool Elevation (ft)	Population Equivalent Discharge At Lacon At 99.8% Duration
1	29,500
2	56,200
3	66,900

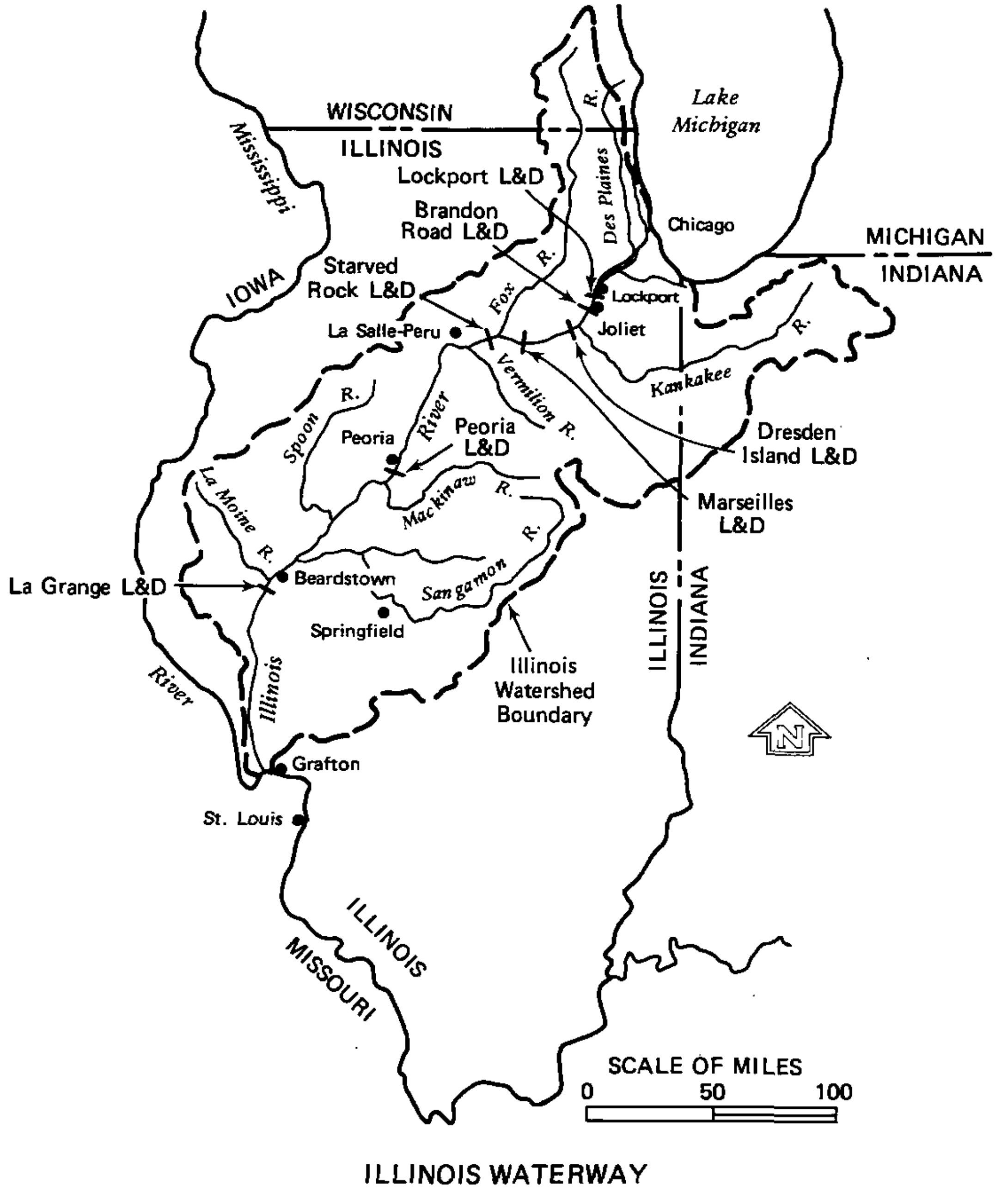


Figure 1. Illinois waterway and drainage area

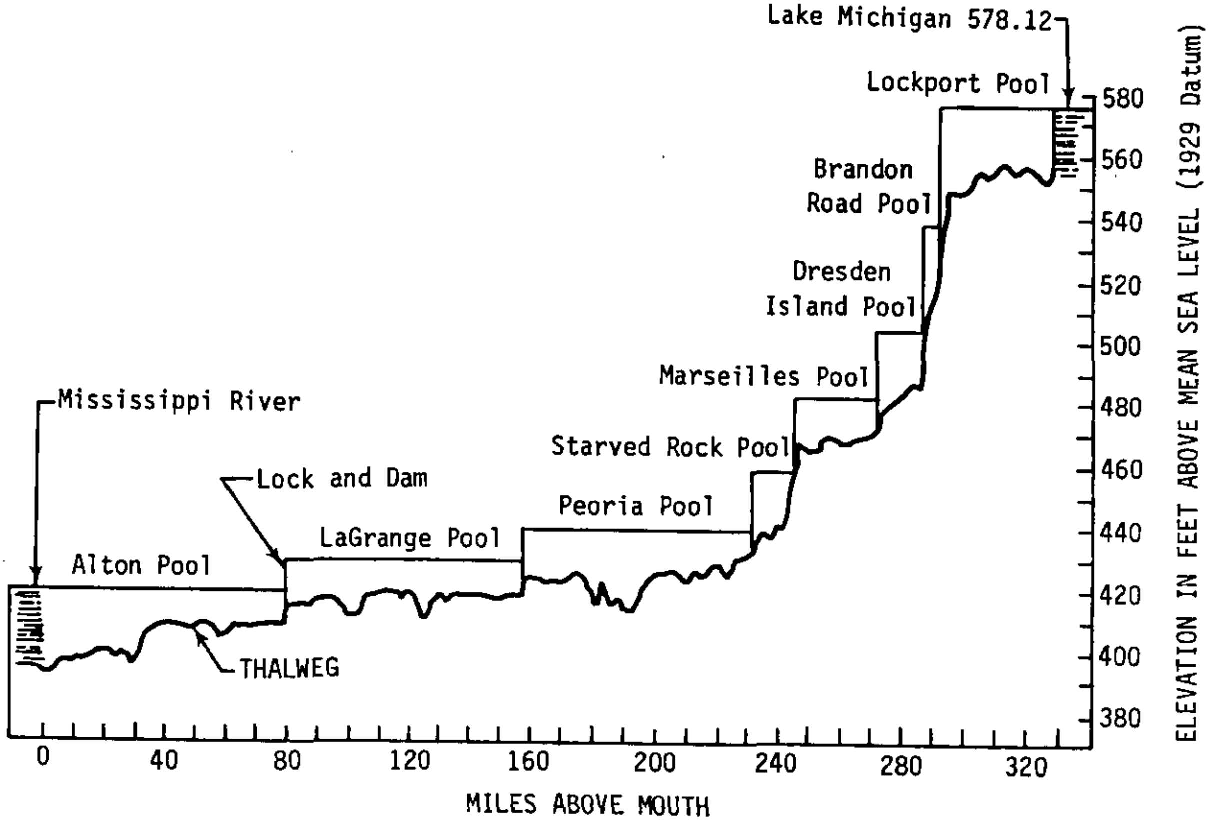


Figure 2. Illinois waterway profile

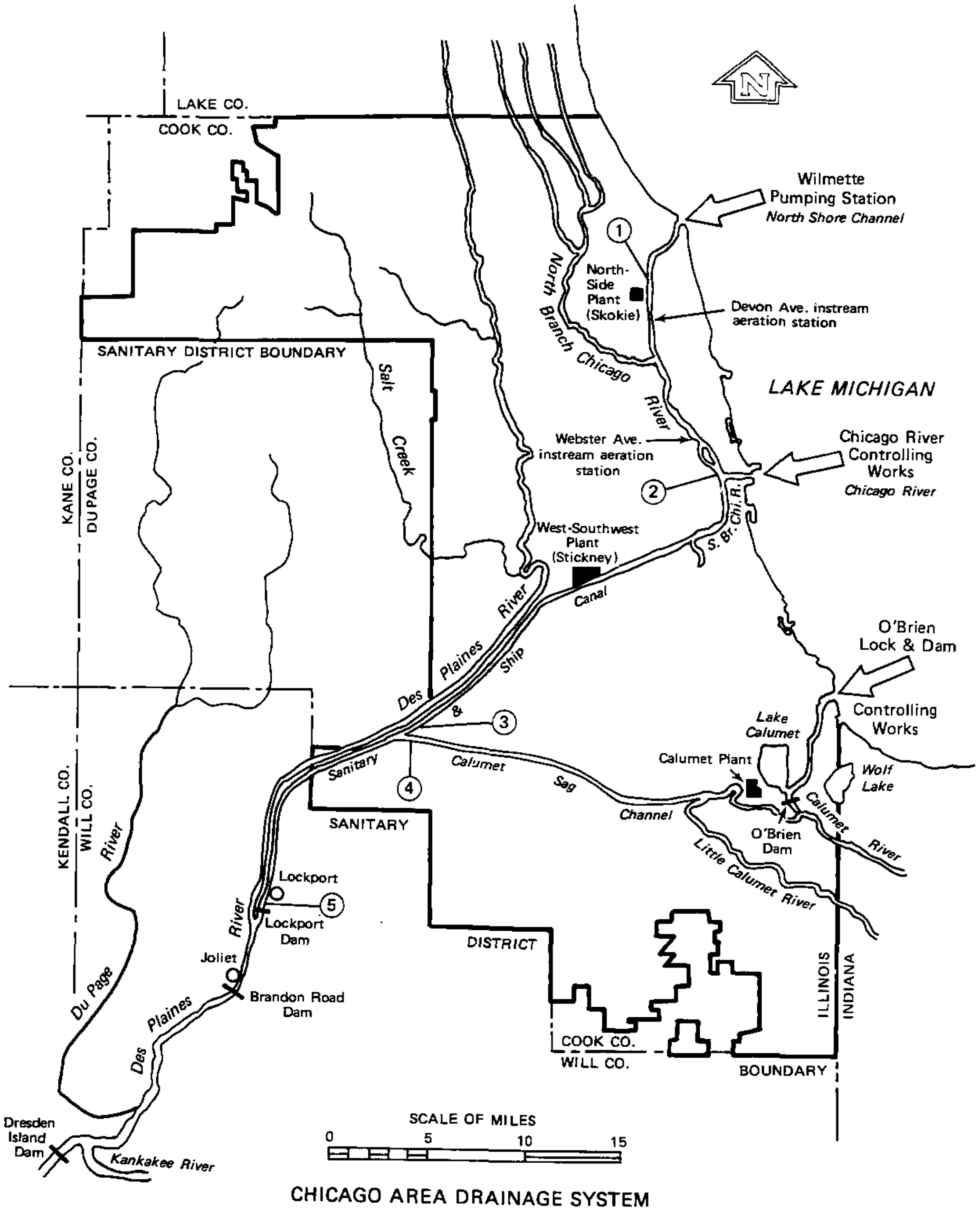
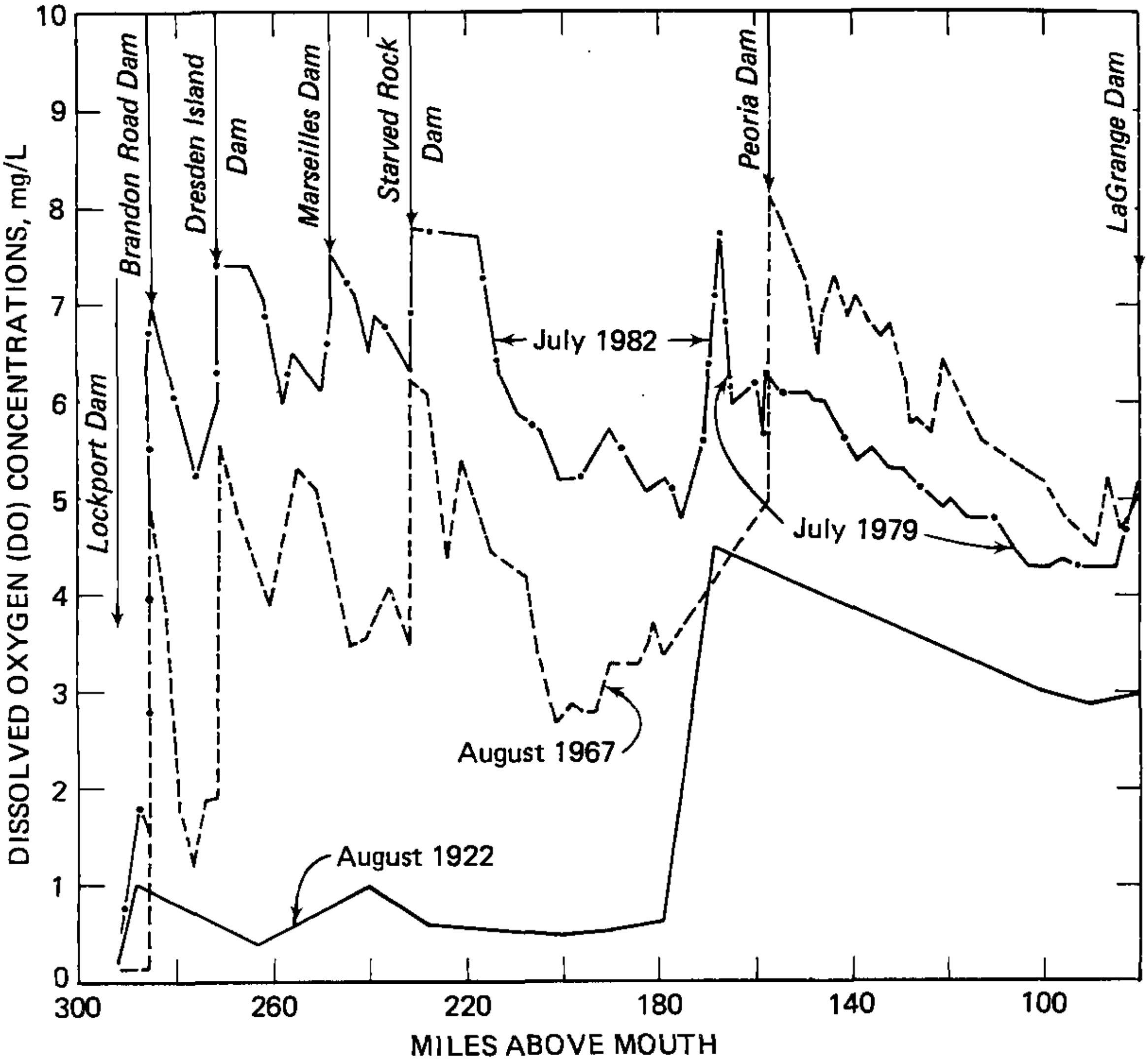


Figure 3. Chicago area drainage system and Lake Michigan diversion inlets



DISSOLVED OXYGEN PROFILES – LAGRANGE DAM TO LOCKPORT DAM

Figure 4. Historical and present dissolved oxygen profiles between the Lockport and LaGrange dams

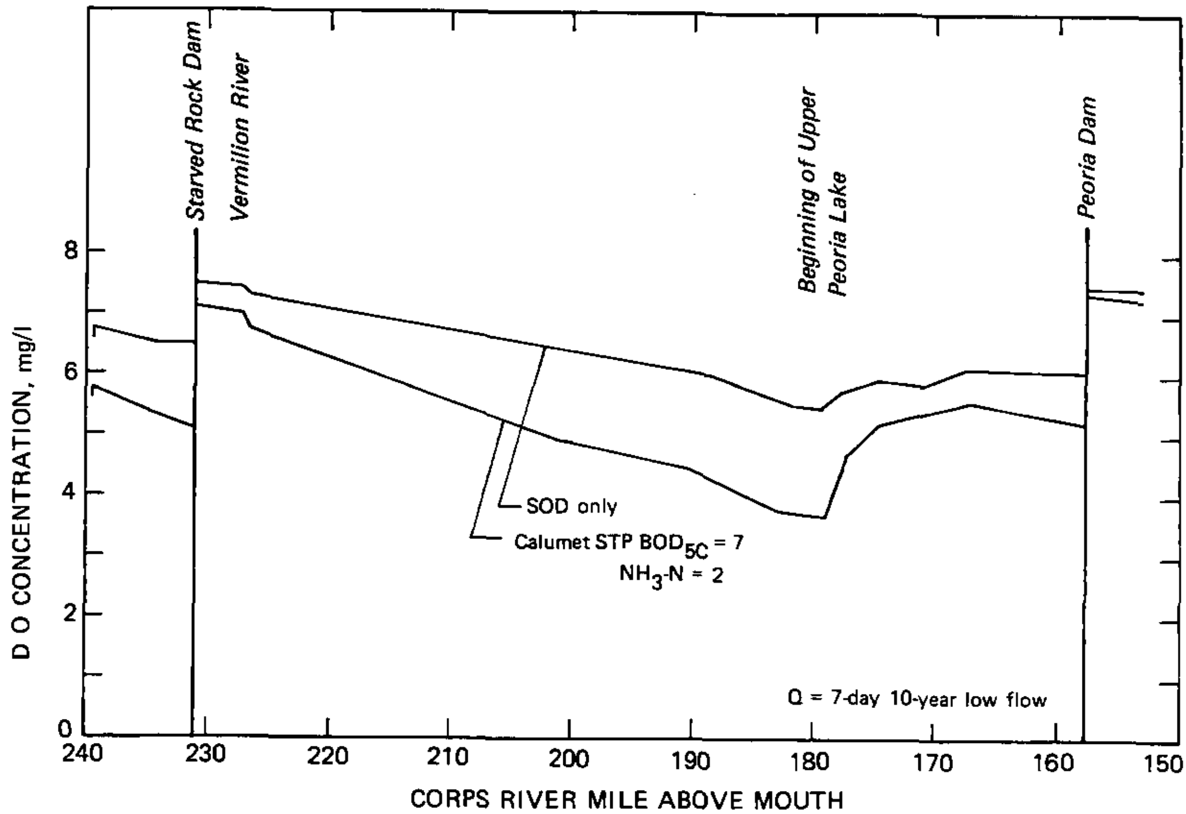


Figure 5. Predicted DO profiles - elimination of all effluents (SOD only) and the upgrading of the MSD Calumet treatment plant

WATER USE MANAGEMENT: INNOVATIVE IDEAS

John R. Sheaffer, Ph.D., President
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There are two basic management concepts which can be applied to The Illinois River System. The first is characterized as linear. Current management of the water resources tends to reflect this concept. To illustrate, runoff from precipitation is shunted into the nearest outlet waterway through a network of storm sewers and drain tiles. The stormwater is treated as a common enemy to be gotten rid of rather than a resource to be managed and used. Ironically, it often is reused to flood subsequent areas as it moves downstream. The irony of the linear approach is that it frequently costs as much to get rid of the stormwater as it does to manage and use it.

With respect to water supply, in the linear approach water is withdrawn from an aquifer, lake, or stream, used, and the used water or wastewater is discharged downstream after partial treatment. Thus the linear approach depletes the water resources and deteriorates the water quality. These subsequent problems are addressed by extending water supply lines and by limiting recreational uses of the polluted waters. There is widespread opportunity for developers and communities to employ circular systems in the management of their water resources. Models or examples of such systems exist in Illinois.

The alternative management concept is circular. In a circular system, stormwater runoff is captured, treated, and used to replenish the water resource. Wastewater is collected, pretreated, stored, disinfected, and used to irrigate and fertilize landscaping and cropland. As the water moves through the living soil filter, it is purified and either recharges or replenishes the aquifers.

Circular systems provide opportunities to achieve synergistic benefits. To illustrate, flood control benefits, water quality benefits, and water supply benefits can be achieved in a project.

This paper presents information on the following circular systems:

- Hamilton Lakes
- The Fields of Long Grove single family homes
- Saddlebrook--a 3,800 unit retirement community

Widespread use of circular systems analogous to these examples will usher in a new era of water management in the Illinois River System.

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THE GREAT DEBATE

The outcome of a heated debate that took place around 1900 significantly influences the manner in which the water resources of the Illinois River system are now managed. On one side of the debate were the linear-system proponents who claimed there was enough water to serve indefinitely, both as water supply and to dilute municipal sewage discharged into streams and other natural bodies of water. Where there was too much wastewater (sewage) for dilution, these people claimed the discharges could be cleaned up enough with technological treatment systems to overcome the problem.

Simply put, the linear-system proponents saw water flowing in a straight line from sources to users to receiving streams, and on out to sea. The same concepts were applied to drainage and flood control problems. The stormwater runoff was a common enemy to be gotten rid of as quickly as possible. The wetland portions of the floodplains were areas that needed to be drained and filled.

Arguing to the contrary were those who can be called the circular-system proponents, who advocated obeying nature's inviolable law of return by sending our used water back to the natural cleansing systems of soil, plants, air and sunshine for reclamation and reuse, over and over again. The circular-system proponents believed that water resource management programs needed to be consistent with the hydrologic and nutritional cycles. They warned that the discharge of wastewater into natural bodies of water disregarded powerful forces of nature and amounted to a grand plan for disaster. They also refused to believe that man-made machinery or mechanical treatment plants would ever match nature's reliable water-cleaning capabilities.

The validity of their cyclical point of view was demonstrated by many remarkable European farms that used nature's purification system to reclaim both the water and the waste it carried from some of the world's largest cities. Such a farm system was considered for Chicago, but was turned down in favor of a far more expensive canal. It at once opened up shipping between the Great Lakes and the Mississippi River and diverted sewage away from the city's Lake Michigan water supply to the Illinois River System to a point on the Mississippi near St. Louis's water-supply intake.

The linear-system proponents, who favored the canal, won the debate, and their philosophy guided the growth of the Illinois River System. For decades the linear proponents seemed to prove the rightness of their case, ending the fear of typhoid fever, and serving the Basin with an abundance of "safe water."

Whenever there appeared to be a water shortage, the linear proponents would reach out to tap a new source of water--frequently Lake Michigan. To the average citizen the inexpensive availability of good water became practically a constitutional right. There was no need to manage the use of water to ensure efficiency.

Unintended Consequences

The linear-system practitioner strives to provide water wherever it is desired. A corollary to such a policy is to allow people to live wherever they want to, even in flood hazard areas regardless of costs sometimes associated with this action. When the problems became evident, the linear-system proponents always looked to the general public to finance a public works program to solve them. The general taxpayer was and still is being asked to subsidize the people who chose not to manage their water resources and to ignore flood hazard areas. By looking for general taxpayer bailouts, these linear proponents abandoned the concept of having the project beneficiaries pay the costs directly. By doing so, they ignored the sage advice of Abraham Lincoln who stated, "When you do something for someone who is capable of doing it himself, you destroy the person."

There is a growing number of people in Illinois who argue that the linear proponents are concentrating on the wrong end of the problem, that the real answers to the water crisis are to be found not in the continued search for new sources but in the efficient management of existing supplies in closed, circular systems, where used water and stormwater runoff are kept and reclaimed along with the wastes they carry.

A NEW ETHIC

The management of the Illinois River System will be enhanced when we confront the ethic condoning the idea that used water and resources are wastes to be disposed of at any cost. We are so caught up by this mentality that we willingly spend hundreds of millions of dollars to try to get rid of plant nutrients and fresh water. Disposal is the trademark of this approach.

The downward spiral will continue until there is a change from our present ethic of linear water use to another, based on the understanding that the pollutants in wastewater are really valuable resources out of place. When this is understood, we can consider wastes as raw materials, and through proper capital investments turn them into valuable resources to enhance the production of food, fiber and energy, all with the incidental by-product of clean water. Seen in this light, wastewater and iron ore are analogous in that both can become valuable resources when proper capital investments are made.

The dividends from reuse of wastewater can be substantial. Besides dealing effectively with the water crisis by preserving and enlarging upon supplies, the returns include a healthier economy through more efficient use of resources, with a practically free bonus of improved environmental quality. Replacing our throw-away mentality with concern for reclaiming and reusing our resources offers not only a practical solution but really the only solution to the water problems of our State.

The Futility of Legislating Changes

This overdue ethic is already backed by federal legislation. The Clean Water Act Amendments passed overwhelmingly by the Congress of the United States in 1972 and strengthened in 1977 ware intended to unshackle the nation's water from the wastes that spoil its purity and diminish potable supplies. But the change from a linear to a circular direction was too much for the powerful forces locked into traditional systems, so the mandate--fought, thwarted and disparaged--was not implemented by succeeding administrations.

Change is virtually a stranger to the granitic world of water management and wastewater treatment. The authors know firsthand this unyielding state of affairs. Three national personalities were quoted on the point in an article in Audubon magazine (November 1981):

> Thomas Jorling, one of the draftsmen of the famous clean water law of 1972 and later the administrator for water at the U.S. Environmental Protection Agency (EPA), explained, "The biggest problem comes from where the program is driven and it is driven by consulting engineers."
>
> David Zwick, director of the Clean Water Action Project, expanded on the explanation: "The conventional industry has gotten so large and gained so much momentum that it just continues, having surrounded itself with this infrastructure of bureaucratic, governmental, academic and business groups all feeding on each other. It is an orthodoxy--and it's backed by billions and billions of dollars, and it just keeps rolling along."
>
> And Andrew Ellicott, director of public affairs for the powerful Water Pollution Control Federation, confirmed, "Engineers tend to go with processes they are most familiar with."

Many who might be described as today's circular-system proponents have concluded this orthodoxy will fight to just keep rolling along. If there was ever reason for it to change, the potential was found in the innovative clean water laws of the 1970s. But the motivation was blunted, and billions and billions in federal construction grants and matching funds allowed by the law paid for a lot more of the same linear systems that failed to view wastes as raw materials.

Change must be initiated from other quarters. In the private sector there is a growing awareness that the wastes fouling and diminishing the Illinois River System are really resources out of place. As such they can become raw materials for bankable private ventures that can produce goods, services, and employment; reduce inflationary, nonproductive expenditures of tax dollars on disposal efforts; and produce purified water for reuse. The implementation of circular systems will be accelerated as more people become aware of the potential benefits that can be realized by reusing wastewater and stormwater. An awareness of this subtle move toward circular systems was expressed by Philip Metzger of the Conservation Foundation, when he stated to The Christian Science Monitor that, "The cliche that we're moving from an era of development to an era of managing our water resources is true."

The movement toward circular systems was endorsed by Dr. Jay H. Lehr, Editor of Ground Water. Dr. Lehr made the following statement in an editorial (January/February 1984):

> These examples (of circular systems) clearly prove that our nation's water crisis is not one of too little water, but rather too little common-sense water management. Sheaffer says, and I agree, that the waste crisis will approach an end when we convert from a linear mentality to a circular mentality in the planning and implementation of our water supply and wastewater disposal systems.
>
> Such change will not come easily as the purveyors and disposers of water are entrenched in antiquated techniques that maintain a very unsatisfactory status quo for the public, but an extremely profitable livelihood for the water treatment establishment.
>
> It's time to beat the drum for change, a change which will at last unite man with Mother Nature whom we have been insulting these many years.

THE CIRCULAR APPROACH

Land treatment or regional reuse of wastewater is an example of the circular approach. It is a cost effective means to assure pure, as well as adequate, water supplies. Land treatment breaks away from the traditional linear approach and replaces it with a circular approach.

A circular land treatment system will include the following components:

- Gravity sewer collection system or force main conveyance to the treatment site
- Deep aerated lagoon pretreatment system with up to 20 years of sludge storage
- Storage lagoon to retain treated wastewater during nonirrigation periods (periods of precipitation and harvesting and when the soil temperature one-half inch under the surface is 40 degrees F.)
- Disinfection of the pretreated and filtered wastewater
- Irrigation pumping station and distribution pipeline
- Irrigation system for turf and landscaped areas at the site or for croplands
- Monitoring wells at the irrigation site to record the effectiveness of operations of the land treatment system

Only when all of these components are present, does a complete land treatment system exist.

In the circular method of land treatment, the water supply is pumped from either the surface water or the groundwater, used by the population, pretreated in aerated lagoons, stored during nongrowing seasons, applied to the land to irrigate and fertilize a growing crop, and reclaimed as purified water for groundwater recharge or reuse. The system completes the circle. Purified water is returned to the regional water supply from which it was withdrawn.

When a land treatment system is part of a self-contained development, it is a multiple use system: the same water is used for potable water supply, irrigation, fertilization, recreation, and fire protection. By reusing water, problems of water shortage and costs of new water supplies are mitigated and water pollution is abated.

Many added benefits can accrue from a land treatment system. A well-planned land treatment system is designed in conjunction with comprehensive stormwater management and flood control planning. Stormwater runoff from the area served is detained and retained through on-site storage facilities. Swales or slow-flow channels provide treatment of nonpoint pollution sources. By detaining and retaining stormwater and providing treatment, the water supply of a region is augmented. This augmentation of a water resource coupled with reuse provides for a significant increase in an available regional water supply.

The application of water and nutrients to croplands can multiply the production from that land. This increased production can be used to help pay the costs of the wastewater maqnagement system. Thus, a land treatment system will produce revenues from the production of agricultural, silvicultural (tree farming), and aquacultural (fish farming) products rather than becoming a burden on the taxpayer.

A land treatment system is sometimes referred to by the Illinois Environmental Protection Agency (IEPA) as a zero discharge system. IEPA has stated that systems with no surface discharge do not require amendment of a region's 208 Plan and do not require a National Pollution Discharge Elimination System (NPDES) permit.

The Theory in Action: Models of Circular Systems

Very little implementation of land treatment systems through the Federal Construction Grants Program has occurred, even though there is a growing body of information that shows them to be cost effective. The reluctance on the part of the Grants administrative personnel to change has created a "needs" vacuum that is drawing in private interests. Privately designated, funded, and operated systems are appearing in increasing numbers, and they have demonstrated the following benefits:

- Planning costs of as little as 25% of traditional costs
- Lower design costs
- Construction costs that are 30-60% less than traditional costs
- Planning and design times of just 4 months compared to 24-60 months for traditional systems
- Construction times of just 6 months compared to 24-80 months for traditional systems

There are several examples of circular systems that are located in the Illinois River System. They are discussed briefly in the following passages.

Hamilton Lakes

Hamilton Lakes is a 274-acre office, commercial, and hotel complex in the Village of Itasca, Illinois. The site is located approximately four miles west of O'Hare Airport's western boundary. In 1987, buildings with more than 2,700,000 square feet and the Hamilton Hotel were in use. Ultimately 8,000,000 square feet of office and commercial space will be contained on the site.

The Trammell Crow Co., owners of the development, were faced with three serious problems:

1. Itasca's sewage treatment plant was at capacity and no new connections were permitted.

2. Nearly 30 acres of the site were in the floodplain.

3. The site is in DuPage County, a county with alleged critical water shortages.

To meet these problems head-on, an integrated system of on-site water supply, fire protection, wastewater, stormwater and irrigation management was installed. The system is totally self-contained. There is no dependency on outside sources for water supply or for wastewater treatment, and the stormwater is managed and used on the site.

The components of the integrated circular system are inter-supporting and produce synergistic benefits. They include:

A. An on-site water supply consisting of two shallow wells with chlorination and hydropneumatic storage

B. Wastewater management which consists of two deep aerated lagoons which provide 40 days treatment time and space for approximately 20 years of sludge accumulation. In addition, a storage lagoon allows the treated wastewater to be stored for a 140-day non-growing season. Chlorination facilities are provided to disinfect the pretreated stored wastewater, if necessary. Two intermittent sand filters are included for additional treatment and operate automatically during irrigation periods.

C. An irrigation system which contains a 500 gpm pumping station, a network of force mains through the property and a system of automatic pop-up sprinklers which irrigate and fertilize landscaping.

D. Five interconnected lakes which provide stormwater retention of runoff for the 100-year storm. The runoff is collected and treated in a series of swales and recharge basins which provide grass and soil filtration of the runoff. These lakes also are the water supply for fire protection.

E. A fire protection system which makes use of the irrigation pumps and irrigation force mains. The irrigation force mains are sized to supply sufficient water to meet the high capacity, low frequency irrigation period needs. Thus, they are of sufficient size to meet fire protection requirements. Because the water supply system did not have to provide for fire protection, the storage volume and distribution main sizes are half of what would have been required had the water supply system been used for fire protection.

A comprehensive monitoring program was initiated to verify the effectiveness of the Hamilton Lakes system. The initial test results are summarized as follows:

Parameter	Influent	Aerated Lagoon Effluent	Sand Filter Effluent
BOD5	275 mg/l	8 mg/l	2 mg/l
TSS	213 mg/l	15 mg/l	7 mg/l

The recorded success of the circular approach was reported by Casey Bukro, Environmental Editor of the Chicago Tribune. Mr. Bukro, in an article on Hamilton Lakes System (October 11, 1981), observed that: "Itasca's (the village in which the system is located) recycling creates an oasis." Mr. Bukro went on to say:

> DuPage County is famous for towns haunted by the specter of running dry. The threat is so real that 27 county communities have banded together to build a $300 million pipeline to tap Chicago's water system.
>
> In this scramble for fresh water, Jack Sheaffer has created an oasis in DuPage County where here are no water shortages. Sheaffer is a Chicago consultant who designed the water resource management system at the 274-acre Hamilton Lakes hotel and office complex in Itasca, where the water is recycled. . . . The development is a model for water recycling in an area in danger of going thirsty in the future.

The circular wastewater and stormwater systems at Hamilton Lakes have been operating since December 1980. Planning is underway to expand the system to accommodate a higher density at the site than originally forecast.

The Fields of Long Grove

The Fields of Long Grove is a luxury residential development in the Village of Long Grove. Eighty-eight homes are clustered on a 160-acre site so that most of the area is preserved in natural wetlands, prairies, and farmland.

This project was designed as a no-discharge system. Stormwater and wastewater are managed in self-contained systems on the site. The major features of the system include:

A. A private water supply system which uses the underlying aquifers as the water source.

B. A wastewater management system consisting of an aerated /storage lagoon which provides a 36-day treatment period, space to store 20 years of sludge accumulation, and long-term storage for the 130-day nongrowing season. The treated stored wastewater can be disinfected whenever necessary through the use of gas chlorination facilities.

C. The pretreated, stored, and disinfected wastewater is then used as a resource to irrigate and fertilize a growing crop. The nutrients in the wastewater are recycled by the plants and the living filter of the soil provides purified water for reuse or recharge of the aquifer. The irrigation system consists of a pumping station with two 150 gpm, 5 HP vertical turbine pumps and a low pressure center pivot irrigation machine. Strainers are provided at the pumping station to collect any solids in the lagoon effluent. The center pivot rig irrigates approximately nine acres of cropland.

D. The stormwater runoff is collected through a system of swales and stored in retention basins designed to contain the 100-year storm. Grass filtration provides a degree of treatment for this nonpoint pollution. The retention basins also serve as the water supply or fire protection purposes.

The Fields of Long Grove provides a good working example of the potential to develop environmentally sensitive land without affecting adversely either water quality or stormwater runoff. Through careful planning and engineering the designers of this development have integrated the community into the natural surroundings to preserve the beauty and character of the land.

The self-contained or circular systems at the Fields became operational in early 1987.

Saddlebrook Farms

Saddlebrook Farms, a 685-acre area, is being developed as a retirement village with 3,800 units and a full range of recreation facilities. The development is located in the Village of Round Lake Park. The water supply system, wastewater management facilities, and urban drainage are designed to be self-contained. The circular systems are scheduled to begin operation in July 1987.

The components of the system include:

A. A water supply consisting of four shallow wells, chlorination, and storage.

B. A wastewater management system providing two aerated lagcons with 47.5 days retention time and approximately

20 years of sludge storage. A separate storage lagoon is provided to store the wastewater flows for the 130-day nongrowing season. Disinfection facilities are provided and will be used to assure a pathogen-free irrigation water supply.

C. An irrigation system to deliver the pretreated, stored, and disinfected wastewater to 159 acres of agricultural cropland. The nutrients are recycled by the plants and the purified water recharges the aquifers from which the original water supply was withdrawn.

D. Facilities to detain and/or retain the runoff from the 100-year storm. The stormwater runoff from the development was analyzed during the design of the community and facilities were incorporated into the plan to eliminate any increased runoff. Stormwater will be treated through grass filtration and soil filtration, stored, and reused.

Saddlebrook Farms is an example of how a new development can be designed to be in harmony with its setting. Floodplains are maintained as multipurpose open space areas. The stormwater retention lakes are managed as recreational features. The agricultural areas which are irrigated and fertilized by the treated wastewater help to maintain the area's rural atmosphere and provide a cash crop.

CONCLUSION AND RECOMMENDATIONS

Circular wastewater systems that incorporate stormwater management will be an important option for communities seeking to move from reliance on massive, tax-supported public works projects to an era of environmentally sensitive, privately funded systems. Circular systems draw in private interests that see the profit in managing stormwater, wastewater, drinking water, and recreational water in a common program. The functional divisions between government programs make this type of synergism difficult to achieve in the public sector.

Based on the recorded successes of circular systems, more private interests are implementing such systems. Widespread adoption would improve the management of the Illinois River System. Flood problems would be mitigated and water quality would be improved. Because such systems are being financed privately, i.e., the users pay all the costs; federal construction grants and state assistance would not be necessary. With the circular system, not only does the state achieve natural resource benefits, but also the users pay, thereby freeing the general taxpayers of the state of additional tax burdens.

CONSERVATION FUNDED PROGRAMS

Marvin Hubbell
Department of Conservation

Through-out today's session you have been given a solid overview of the resource issues facing the Illinois River and its Basin. Understanding the complex interaction between rural and urban land use, river management, natural river dynamics and their impacts on the biology of the river and man's use of the river is difficult. As yesterday's session clearly demonstrated, the Illinois River is a multiuse resource, unique for both its biological history and economic significance. Balancing these two objectives is not easy and not always possible.

The last two presentations have begun to focus on solutions or at least programs and activities which may reduce the sedimentation and delivery of non-point pollutants and therefore improve the water quality and usability of the Illinois River System.

Mr. Walker and myself have been asked to focus on "Conservation Programs" which seek to reduce soil erosion, sedimentation and the delivery of other non-point pollutants to water bodies and the improvement of water quality. We have divided the topic into base ongoing programs available to all counties and special program or project assistance currently available.

Mr. Walker will cover the programs which form the foundation of soil and water conservation effort. I'd now like to identify the special and new programs which are available, their current funding status, program objectives, how to apply for assistance and how to increase the attractiveness of your application.

State Programs
Illinois Department of Agriculture

1. Watershed Land Treatment Program (WLTP)

   Established - 1985 Build Illinois Program

   Funding - Proposed 5 year, Total $10 million

   Status - Funding is currently committed to 60 existing projects

   Purpose - Primary - Control sheet and rill erosion to meet T by 2000 objectives
   Secondary - Sediment control and improved water quality

   Program Emphasis - To protect...

   Primary - Multi-purpose public lakes and reservoirs
   Secondary - Important rivers, streams and wetlands

   Assistance - Special application through local Soil and Water Conservation Districts (SWCD) and approved by IDOA.

Illinois Department of Conservation

1. Forestry Development Cost/Share Program

Established - 1983

Funding - 4% tax on timber sales with appropriation from the Illinois General Assembly.

Appropriation has steadily increased
$150,000 FY 86
$225,000 FY 87
$400,000 FY 88

Purpose - Promote the development of the timber industry especially on marginal and/or erosive land.

Provides both cost/share and management assistance. Original 20% cost/share assistance was available to landowners this has been increased to 60%.

Program Emphasis - Technical and cost/share assistance are available on tracts 5 acres or larger.

Assistance - Directly through an IDOC District Forester or by referral from a local office of the:

Soil and Water Conservation District (SWCD)
Soil Conservation Service (SCS)
Agricultural Stabilization and Conservation Service (ASCS)

2. Watershed Planning for Habitat Assistance

Established - 1986

Funding - $100K - $150K

Purpose

a. coordinate soil erosion and sediment control efforts on IDOC facilities.

b. Work to assure that existing soil erosion and sediment control projects and programs maximize habitat benefits.

c. Conduct special research/demonstration projects primarily on streambank stabilization

Program Emphasis - Maximize habitat benefits from soil erosion and sediment control practices.

Assistance - Request to IDOC

3. Wetlands Program

Established - 1984

Purpose

Primary - Development a state wetlands program which will protect existing high value wetlands.

Secondary - To protect, manage and develop wetlands to maintain habitat, flood control recreational and water quality functions and to compliment existing soil erosion and sediment control and water quality improvement programs.

Assistance - Current

1. Providing data and technical assistance for wetland management and program development.

2. Project specific assistance on important wetlands.

Scope - Many program elements are still being developed.

4. Private Lands Program

Established - 1986

Purpose - work with private landowners to establish wild life habitat

Assistance - directly through IDOC private lands biologist or by referral from a local office of the:

Soil and Water District
Soil Conservation Service
Agricultural Stabilization and Conservation Service

Illinois Environmental Protection Agency

1. Clean Lakes 314 Program

Funding - Project specific application
National FY88 funding $4.5 M
Region 5 USEPA - $800,000

Purpose - Evaluate inlake water quality problems and to install corrective management procedures. These projects are frequently carried out in conjunction with soil erosion and sediment control programs (Watershed management).

Assistance - Phase I Diagnostic Feasibility Study
Phase II Implementation

Program Emphasis - Publicly owned recreational lakes.

<u>Soil Conservation Service</u>

1. Watershed Planning and Construction (Popularly known as PL-566)

Established - 1953

Funding - Project specific application
National appropriation
FY 86 $305.2
FY 87 $129.0
Fy 88 $73.9

Purpose - (Illinois) To plan, design and implement practices which will reduce soil erosion, sedimentation, flooding and drainage problems on watershed areas less than 250,000 acres.

Assistance - to local sponsors for both planning and implementation.

Program Emphasis - Agricultural - Soil and water conservation practices designed to maintain soil productivity and to reduce offsite impacts of sedimentation and non-point pollutants water quality, recreation, fish and wildlife habitat and the local economy.

Urban - Structural and non-constructural urban flood control practices and programs

If you decide to apply for assistance under a special program there are three key elements which you must demonstrate and stress:

1. The scope of your problem and tentative solutions. You must demonstrate that your problem can be addressed by a specific program and that the solution is feasible.

2. Strong public and agency support. You must demonstrate that you have the <u>working</u> (not verbal) support of key individuals and/or agencies. Most projects can generate verbal support but it is the working support which demonstrates a concrete commitment to succeed.

3. Local financial backing. If a project is important enough to warrant state or federal funding support, it should also warrant local support. As an example, a municipality should first support, through manpower and funding, the protection of its water supply reservoir from further sedimentation before they can expect strong state or federal support.

CONCLUSION

This paper has outlined a number of base and special programs which can be used to reduce soil erosion and sedimentation and help to improve water quality, fish and wildlife habitat and recreational use of water bodies.

However, none of these programs are capable of solving the associated problems of the entire Illinois River. Therefore other programs are also needed. In addition the basin must be sub-divided into smaller manageable units where work can be coordinated effectively and real improvements are possible.

The problem of soil erosion and sediment control must be approached with a combination of programs which emphasize:

Agricultural - sheet, rill, ephemeral and gully erosion
Urban - construction erosion and runoff control
Streambank - stabilization and riparian habitat establishment
In water management techniques and,
Incentives to maintain natural land uses such as woodlands, wetlands and grasslands.

Rick Mollaham

Gregg Good

Nani Bhowmik

Larry Toler

Irwin Polls

Steve Havera

Dan Injerd

CONSERVATION PROGRAMS AND FUNDING SOURCES

Robert D. Walker,
Professor of Natural Resources,
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Soil erosion was recognized as a major problem in the United States before 1900. However, it was not until 1933 that a national policy of controlling soil erosion was adopted. The first program was carried out by the U.S. Soil Erosion Service. The Soil Erosion Service was transferred from the Department of of Interior to the Department of Agriculture and renamed the Soil Conservation Service in 1935. The Department chose to deliver the program through locally organized Soil Conservation Districts. The Soil Conservation Service agreed to provide technical assistance to any group of land-owners who would organize into a legal district. Illinois Soil and Water Conservation Districts are organized along county lines. Nearly all Illinois Districts were organized from 1937 to 1950.

The early soil erosion control program relied heavily on grass and legumes in the crop rotation. Technological changes adopted by farmers after World War II conflicted with the early soil erosion control program. Legume crops were grown in nearly all Illinois crop rotations to provide nitrogen for growing corn. A typical 1940 crop rotation on nearly level cropland was corn-corn-oats-meadow. More meadow was included as the land became steeper. Most farms had livestock to utilize the meadow crops.

Low cost nitrogen fertilizer available after World War II made it unnecessary to grow legume crops for nitrogen. The change in crop rotation was dramatic from 1940 to 1975. Illinois grew about 10 million acres of row crops, 8 million acres of corn and 2 million acres of soybeans in 1940. By 1975 farmers were growing 20 million acres of row crops; 11 million acres of corn and 9 million acres of soybeans. This crop rotation change nearly trippled the State's soil erosion while crop yields also increase 3 fold.

Increased U.S. population, a higher standard of living for U.S. citizens and increased export demands through the 1970's provide a good market for U.S. feed grains and encourage more grain production.

Section 208 of the Water Pollution Control Act Amendments of 1970 required states to define all sources of water pollution and develop a plan for controlling water pollution. This was the first time that non-point sources of water pollution was studied in depth. As a result of Secion 208 planning Sediment was recognized as the largest contributor to water pollution from Agricultural sources. The State Water Quality Management plan adopted in 1970 set a goal of reducing soil erosion on all soils to the established soil loss tolerance by the year 2000. The soil loss tolerance is defined as the maximum annual soil erosion that can occur and not cause a decline in long term agricultural productivity. Responsibility for meeting the soil erosion goal was placed in the Illinois Department of Agriculture who administers the State Soil and Water Conservation District Law.

The Illinois Soil Conservation Program has many components: research, education, technical assistance, cost-share payments, incentive payments and conservation loans.

Research programs help to define the soil erosion problems and find solutions. Educational programs provide technology transfer to those who need information. Technical assistance provides engineering, practice layout and design need for building practices and assist with developing sound soil conservation farm plans. Cost-share payments aids the land-owner and farmer with financial assistance to speed the adoption of new soil erosion control practices.

Incentive payments are sometimes provided to speed the adoption of new soil erosion control practices. This was used to help introduce conservation tillage. Low interest loans have been made available for applying soil conservation practices through FMHA and the State of Illinois.

Some people may raise the question, why provide cost-share payments? Is it not in the interest of land-owners to control soil erosion on their own land? Land-owners and farmers do not receive all the benefits for applying conservation soil practices. Generally there are two types of benefits for applying conservation practices; on-farm benefits and off-farm benefits. The on-farm benefits include sustained productivity of the land. The amount of damage done by soil erosion depends on the type of soil. Ken Olson, University of Illinois Soil Scientist, has conducted research on several soil types in the state. His work shows that the deep loess soils, found along the Illinois and Mississippi Rivers will only loose about 5% productivity as they erode from moderate erosion to severe erosion. However, productivity on shallow soils like the till soils found in Northeastern Illinois and the claypan and fragipan soils found in Southern Illinois may be reduced by 25% with severe erosion.

The off-farm damages from soil erosion is less well documented. Edwin Clark and others in the book entitled, "Eroding Soils: The Off-Farm Impacts" provides some insite on the magnitude of off-farm damages created by yearly national erosion rates exceeding 6 billion tons. Excluding biological impacts, the authors estimate off-farm damages between 3.2 billion and 13 billion dollars annually in 1980 dollars. Their best guess is 6.1 billion dollars or one dollar for each ton of soil eroded in the U.S. SCS has estimated current soil erosion rates at 200,000 tons annually in Illinois. Using Clark's figures the off site damages for Illinois are about $200,000 dollars annually, excluding biological damages.

Present Illinois cost-share rates are generally for 50 to 75 percent of the cost. This may be in line with the farmers vs. society benefits from applying soil conservation practices.

T-By-2000: Illinois Erosion Control Guidelines

Passed in 1977 by the General Assembly, the Illinois Erosion and Sediment Control Program and Standards law gave the Illinois Department of Agriculture (IDOA) responsibility to draft a set of erosion control guidelines that would bring soil erosion to T (tolerance levels) values by the year 2000. On April 18, 1980, IDOA drafted State Erosion and Sediment Control Guidelines. Over the next two years, local Soil and Water Conservation Districts (SWCD) adopted similar or more stringent guidelines. On January 1, 1983, IDOA published state guidelines.

How does T-by-2000 affect citizens of Illinois? The 1982 National Resource Inventory for Illinois survey furnishes some answers. Excluding federal land, 35,137,200 acres of land in Illinois are devoted to cropland, forest land, pastureland, and other uses. Total rural acreage comprises 31,936,900 acres. For all acres, annual erosion equals 6.3 tons per acre; total yearly erosion equals 200.7 million tons.

To comply with T-by-2000 guidelines, 11.2 million acres require a conservation system that uses one or more conservation practices. Less than two years away, 1988 guidelines suggest that 8,021,488 acres with a slope of less than or equal to 5 percent should be at or below T. Hence, by 1988, 90 percent of Illinois's rural land should be at or below T (IDOA, "T-by-2000"; the remaining 10 percent, no more than 2 T.

One should point out that the Illinois Erosion and Sediment Control Program and Standards guidelines are voluntary. A complaint process exists and any person or group can file a complaint. Your local soil and water conservation district investigates complaints, offers technical assistance if guidelines are violated, and identifies cost-share programs to ease the financial burden. Failure to cooperate within one year can lead to formal local meetings and a formal state meeting conducted by IDOA, with all recommendations being made public. The final step in the complaint process is referral of the case to the Illinois Pollution Control Board. If a link can be made between erosion and water quality, the board may be able to enforce the guidelines. As of June 1986, 114 complaints filed at local SWCD offices never reached the public meeting phase. Land users in all cases agreed to follow conservation plans recommended by the local SWCDS.

Food Security Act of 1985: Public Law 99-198

Three components of the act affecting highly erodible land and relevant to land-owners are the "conservation compliance," "sodbuster," and "swampbuster" provisions. Land-owners who violate any of the provisions are not eligible to receive commodity price support payments, production adjustment payments, farm, storage facility loans, disaster payments, federal crop insurance payments for storage of Commodity Credit Corporation grain, annual payments through the Conservation Reserve Program, and other unmentioned program benefits.

Interim regulations that define highly erodible land and wet lands, discuss exceptions, and outline procedures were published in June 1986. The important definitions and relevant provisions follow.

Highly Erodible Land

Highly erodible land is defined by using parts of the universal soil loss equation (USLE), the wind erosion equation (WEQ), and a soil's assigned T value defined previously.

(1) The water erosion equation is $R \times K \times LS : T = EI$

(2) The wind erosion equation is $C \times I : T = EI$

USLE represents tons of soil loss per acre per year for fallow land. USLE takes into consideration rainfall and runoff (R), a soil's resistance to erosion (K), and slope and length interactions (LS). USLE addresses only sheet and rill erosion. The wind erosion index consists of two factors: C characterizes windspeed and surface soil moisture and I represents the degree to which a soil resists wind erosion.

For either wind or water erosion, and EI greater than or equal to 8 signifies highly erodible land. In other words, land that has an average annual erosion potential equal to or greater than 8 times its T value is highly erodible and must be in compliance. As a general guideline, many soils in central and western Illinois will have an EI or 8 or greater if they have a slope steepness of at least 5 percent and slope length of 200 feet or more. (For specific details about the USLE, T values, and examples, consult Cooperative Extension Service Circular 1220, "Estimating Your Soil Erosion Losses with the Universal Soil Loss Equations".)

A field is classified as high erodible if at least 33.33 percent of the field acreage is identified as highly erodible or a field contains 50 or more acres of highly erodible land. Field boundaries can be modified subject to a written request submitted to and approved by ASCS.

Conservation Compliance

The Conservation Compliance Provision addresses the problem of highly erodible land in the production of annual crops such as corn, soybeans, wheat, cotton, and sorghum grains or land considered planted before December 23, 1985. Compliance can take one of three forms:

1. Land bid into the Conservation Reserve Program (CRP) is in compliance. At the end of the ten-year CRP contract, a producer must fully implement an approved conservation plan or lose government program benefits.

2. For highly erodible land that has a detailed soils map and is

not bid into the CRP, land-owners have until January 1, 1990, to begin implementing an approved conservation plan; otherwise, they lose program eligibility. Landowners must have fully implemented an approved conservation plan by January 1, 1995, or lose government program benefits.

3. For highly erodible land that does not have a detailed soils map, land-owners must begin an approved conservation plan two years after completion of soil survey or lose eligibility for program benefits. Landowners have until January 1, 1995, to complete application of the conservation plan or again face ineligibility.

Sodbuster Provision

This provision applies to highly erodible land that was not planted with an annual crop between 1981 and 1985. Landowners would be disqualified for certain USDA programs if they use this land for annual crops without following a conservation plan approved by the local conservation district.

Land-owners who already have implemented a conservation plan on their lands remain eligible to receive federal program benefits. Furthermore, "conservation compliance" and "sodbuster" provisions are not applicable to land-owners who do not participate in federal government programs. Then you must use environmentally sound practices on land defined as highly erodible.

Highly erodible land under the "sodbuster" program must have an approved plan applied before annual crops are planted to retain eligibility to participate in USDA farm programs.

Wetlands and Converted Wetlands

Wetland is any land that contains a predominance of hydric soils and supports a prevalance of hydrophytic vegetation under normal circumstances. Hydric soils are soils saturated, flooded, or ponded long enough to support growth and regeneration of hydrophytic vegetation during a growing season. Hydrophytic vegetation consists of plants that grow in water or in a soil substrate that is periodically deficient in oxygen because of too much water.

Converted wetland is any wetland drained, dredged, filled, leveled, or otherwise manipulated to make agricultural production possible. Land in this classification is subject to the following conditions: first, production was not possible before conversion and, second, before conversion the land was wetland and not highly erodible land or highly erodible cropland.

Land Retirement and Cost-share Programs

People interested in voluntarily following T-by-2000 guidelines and in participating in federal farm programs can join the Conservation Reserve Program or choose from a variety of cost-share conservation programs. Brief descriptions of major programs follow. For more information, visit your local Soil and

Water Conservation, county Extension, ASCS, and SCS offices.

Conservation Reserve Program (CRP)

During policy deliberations on the Food Security Act of 1985, legislators, environmental groups, soil conservation groups, and farm groups broadly supported a program designed to retire highly erodible land. Reacting to concern about our nation's ability tc maintain productive capacity in the future, to mitigate off-farm damages caused by sediment and related contaminants, and to stabilize the boom-bust cycle in the agricultural sector, these groups successfully lobbied for a comprehensive conservation section. "Conservation compliance", "sodbuster", and "swampbuster" form one component. CRP forms the second half. Subject to funding contstraints, CRP can remove up to 45 million acres from annual production between 1986 and 1990.

CRP is a voluntary program designed to remove highly erodible land from production. The Secretary of Agriculture exercised his right to define highly erodible lands during the first sign-up periods. He used T values and the Land Capability Class System, which divides land into eight capability classes. Capability Class I is prime land with slopes of less than 2 percent. Land assigned in progressively higher number classes becomes progressively more unsuitable for crop production. Class VIII land is unsuitable for any crop production. Class VIII land is unsuitable for any crop production. Future sign-ups, starting February 9-27, 1987 sign-up, will use highly erodible land, EI $\geq$8 and eroding at greater than T.

Under current definitions of eligibility, about 3,000,000 acres of Illinois land qualities for the program. The first sign-up period, from March 3 to 14, 1986, produced disappointing results on the national and state level. Only 828,387 acres were accepted into the program nationwide, far short of USDA's 1986 goal of 5 million acres. Illinois acreage accepted into CRP amounted to only 17,239 acres.

Conservation Practices Program (CPP)

Funded with appropriations from the "Build Illinois" program, the Conservation Practices Program (CPP) receives $10 million over five years beginning in fiscal year 1986. The objectives of CPP are to provide financial assistance to land users who install costly conservation practices and to help meet Illinois's T-by-2000 guidelines. All Soil and Water Conservation Districts receive a share of the money based on the percentage derived from dividing total acres exceeding T in a district, by total acres exceeding T in the State. Every District, receives at least $10,000 in cost-share funds. Maximum state cost-share rates for most conservation practices are 75 percent of average costs. Several exceptions are worth noting: the establishment of contour farming ($5.00 per acre for one year), contour strip cropping ($10.00 per acre for one year), and permanent vegetation (75 percent not to exceed $100.00 per acre). For land classes VI through VII, the state limits use of cost-share funds to practices that convert land to less intensive uses such as permanent vegetative cover. Every SWCD can set lower cost-share rates if local conditions warrant the change.

Land-owners or renters with land-owner approval can apply for and receive state CPP funds, providing they are SWCD cooperators, have a conservation plan on file, and have land with erosion T values. Applications must be made at your local SWCD office. Land-owners or renters can enter into multi-year agreements. Maximum length is five years for contracts signed in 1986. Multi-year agreements signed in 1987 and beyond cannot exceed the number of years remaining in the CPP program.

Land-owners or renters who sign contracts with their local SWCD agree to maintain the installed conservation practices for the life of the contract, ten years after installation of the last practice. In addition, land users agree to continue complementary practices such as conservation tillage if these practices were part of the conservation plan. Land-owners or renters who fail to abide by contract terms must reimburse cost-share funds to the SWCD.

Illinois Watershed Land Treatment Program (WLTP)

Funded from the "Build Illinois" program at $10 million over five years, WLTP focuses soil conservation on critical watershed throughout Illinois. Within a watershed, landowners or renters with landlord approval can apply and receive cost-share funds for lands with at least a 2 percent slope and eroding above T values. Again, a land user must be a SWCD cooperator and have a conservation plan on file before requesting cost-share funds. State cost-share rates, conservation practices, contract life, and penalties are the same as those found in the Conservation Practices Program.

One major difference in WLTP is solicitation of state funds. Soil and Water Conservation Districts must prepare and submit an application to their area land use councils. The application must describe the geographic area, quantify resource concerns and needs, identify necessary conservation practices and costs to achieve T values, and outline a time frame for completing the project. The land use councils then prioritize the applications and make recommendations to the state Watershed Priority Subcommittee, which in turn makes recommendations to the Soil Erosion and Water Quality Advisory Committee. The Illinois Department of Agriculture makes the final selection of priority watersheds on the basis of recommendations from the Advisory Committee.

The selection process is competitive and depends on several related criteria: reduction in erosion and sedimentation per cost-share dollar, achievement of T-by-2000, presence of a lake, municipal water supply, or other impoundment, an educational component, outside funding, willingness and ability of a SWCD to complete a funded watershed resource plan, and land user support. To date, 60 watershed projects have been fully or partly funded with "Build Illinois" funds distributed by IDOA.

Agricultural Conservation Program (ACP)

USDA's Agricultural Stabilization and Conservation Service (ASCS) administers ACP. ACP provides cost-share funds to encourage voluntary compliance with federal and state conservation regulations, to control erosion and sedimentation, to improve water quality, and maintain soil productivity. Each year, county ASCS committees choose eligible practices from an approved state list of acceptable practices and assign cost-share rates to the eligible ones. Land users must file annually for federal assistance if they do not have a long-term agreement (LTA) with ASCS. LTA's cover three to ten years, and applicants file only once for approval and assistance over the life of the agreement. Cost-share rates under the annual and LTA programs are between 30 and 75 percent of average costs. Under special circumstance, low income producers can obtain 80 percent cost-share rates. Yearly payments to a producer cannot exceed $3,500.

Application for cost-shared funds and final payment involve several steps. Any landlord, owner, tenant, or share cropper can file for federal cost-share funds at their ASCS county office. After a land user files for assistance, the Soil Conservation Service (SCS) determines if the practice are feasible and estimate costs. The county ASCS committee then approves or rejects the request and notifies the applicant. Applicants who begin installation before written approval are not eligible to receive cost-share funds. If the application is approved, SCS develops a practice plan in accordance with its technical guide and local regulations. The land user installs or hires a contractor to install the practices. SCS certifies that the installed practices meet technical specifications and local regulations. Finally, the land user submits bills to ASCS for reimbursement according to established cost-share rates. Land users who accept cost-share funds agree to maintain the practices for a specified number of years or refund all federal funds.

Funding

The Illinois Department of Agriculture made estimates of the cost for meeting the State and erosion goals in their T-by-2000 plan. They estimated the cost of installing permanent soil conservation practices at 1,039 million dollars. This did not include any cost for cultural practice such as extra time for farming on the contour, purchasing machinery for conservation tillage or reduced income for substituting forage crops for row crops.

We currently have four major sources of cost-share: ACP, CRP, Illinois Conservation Practice Programs and the Illinois Watershed Land Treatment Program. The funding for ACP has been running at about 6 million dollars annually for Illinois. There is no guarantee that the program will remain at this level but assuming it will the total funding from 1985 to 2000, 15 years, would be 90 million dollars. Our best estimate of Illinois funding for the CRP program is 20 million dollars. The State cost-share funding for both State programs is 20 million for 5 years.

This would provide a total of 130 million dollars for cost sharing through the year 2000. The farmer cost was estimated 1,039 million dollars leaving 909 million dollars for landowners and farmers to pick up if the state goal is to be met.

Session III

Economic Opportunities

RIVERFRONT DEVELOPMENT: PEORIA

Dorothy Sinclair
Peoria City Council

The riverfront along the Peoria Lakes has been the site of development since mankind came to the prairies. The Indians considered the river valley to be good for their hunting and fishing and so built their crude villages here. The French also found the area to be suited to their interests of trading for the abundant furs in the area. Many authorities believe the French expanded their development to include not only trading posts but whole villages with family homes, gardens, and vineyards. With the arrival of the American settlers came boat landings, river boat trade, and diversified businesses.

In fact, life in early American Peoria was oriented toward the Illinois River as settlers from the East arrived here and grain and other products were shipped out. Arrival of the river boat became a social event, as well as a commercial one. Great breweries and distilleries, as well as other industries, prospered by the water.

Between World Wars I and II these businesses continued to develop near the easy transportation link, until within the last 50 years little public access to the water remained to remind us of the fine regattas held years ago in the downtown area or the family picnics and outings at El Fresco and Waterworks Parks. We turned our backs to the river and like other neglected resources, it withdrew from us.

Nationally the 1970's and 80's saw a rebirth of interest in water fronts across the country. Fameuil Hall in Boston was one of the leaders. Others quickly followed. You are familiar with them--Harborplace in Baltimore to Lakeside in Toledo.

Peoria saw little opportunity to join in because our river's edge was occupied by business after business in varying degrees of viability. Although these companies had once relied heavily on the water, few in the 1980's utilized the river as part of their day to day activities. However, since they were there, it was almost impossible to move them.

The unfortunate bankruptcy of one of these businesses and the awareness of former City Councilman Dick Neumiller brought the opportunity to the City. The business was the Rock Island Railroad. Dick Neumiller is a railroad buff. He knew that one of the Rock Island's tracks in downtown Peoria would have to be kept open and that operation on that track would be taken over by another rail line. He knew that the old Rock Island yards in downtown Peoria by the river would no longer be needed because other rail lines, which operated locally, already had yards in the area. He proposed that the City of Peoria approach the Rock about purchasing the property. This was arranged and the City acquired 37 acres of riverfront property near downtown Peoria for slightly over $1 million. The State of Illinois assisted with a $400,000 grant toward the purchase. This came through the Department of Conservation.

This land--after the railroad salvaged the rails--was, for the most part, barren and unappealing. Actually, about 7 acres of the purchase was under the Illinois River and of little use to us at this time. The remainder was covered with cinders and salt and gave little promise of being able to support vegetation. Several badly deteriorated buildings lay to the upstream side of the property.

On the positive side the land was adjacent to about 20 acres already owned by the City. This had been granted to the City by the State of Illinois when the City was chartered. In addition, the City had acquired in the mid-1970's another adjacent property in a land swap. This is now the site of the Riverstation Restaurant.

Thus, the City has control of about 1 1/2 miles of land on the riverfront from Liberty Street in downtown Peoria upstream to Morton Street, and of varying depths from the water's edge of about 300 to 600 feet. How could it best be used? We realized that we needed a plan and so turned to internationally known planner Angelos Demetriou, who had done the original downtown Peoria plan, which led to the Civic Center and other projects that you now see here.

Demetriou's customary method of developing a plan is to listen to the wishes of the community, to study the assets of the planning area, and to devise a plan which best suits these. He walked the area and talked to the people, both in formal hearings and over drinks in corner taverns. He met with the mayor, city council members, park district policy setters and administrators, Peoria City Beautiful officers, EPA authorities, engineers from the Corps of Engineers and the City, joggers, hikers, and neighborhood residents. This is the plan which emerged and which was adopted by the Peoria City Council as a guide for evaluating proposed development.

Basically, the plan is divided into 3 areas. The first of these is a proposed riverfront drive. Demetriou felt this was vital for development because there presently exists little public access to the river. The black-topped parking lot in downtown Peoria is the only area where one can drive or walk now to watch the boats on the river or just to address the fascination that so many people have toward water.

The proposed river drive would be oriented toward the river in the same fashion that Lake Shore Drive in Chicago is oriented toward Lake Michigan. It would be near the water to open up access, but not directly by the water. It is planned to be a 4-lane drive with a center median. Because we need to keep one track in this area operational, the plan suggested that the track should be built in the median strip--this concept has not proven to be practical and we now plan that the rail track will go on one side or the other of the roadway. Savannah, Georgia has turned just such a switching track into an asset by painting the engine bright colors, providing special uniforms for the train crew, and having the steam whistle play tunes as it goes through the waterfront area.

Now Demetriou feels strongly that this "River Shore Drive" should not be a part of the arterial street plan of the City. It should be a roadway whose major role is to open up the river area--not to move vehicles from one place to another not related to the water. The planner believes the "River

Shore Drive" should be available to be a part of riverfront activities. Perhaps for some activities, portions of it could be used for parking; for others one entire side could be the site of events such as street dances, vendor areas, or parades.

As you see the roadway on the map, it would run parallel to the river between buildings marked 2 and 3 and then between 4 and 6, beginning at Spring Street on the northeast side and running to State Street on the downstream side.

The second portion of the plan lies along the river between the two bridges, the Franklin Street Bridge and the Murray Baker Bridge (I-74). This area is ear-marked as a high density usage area with a variety of "people magnets" to pull people into the area. These magnets include potential uses such as office buildings and retail shops. These are numbered 6 and 7 on the map. Number 4 on the map is an existing department/mail order store. Number 5 is the well-known Riverstation Restaurant.

Number 8 is envisioned as an urban plaza, designed to be the site of celebrations and festivals such as our Steam Boat Days in June or the big 4th of July celebration. The landscaping is proposed to be constructed to withstand the potential use and abuse of crowds and could include band shells, terraces for seating, and fountains.

The area at the foot of Liberty Street, marked on the map as a "water park", has been put aside as impractical. Demetriou thought that this could be a cove where little paddleboats would be available for rent along with other "hands-on" water activities. However, the closeness of the river channel with its heavy barge traffic makes this too dangerous to consider at this time.

Now this urban plaza area has one other big problem--it periodically floods, chiefly in the area marked 8. In some years it even floods twice a year. Thus, it would be necessary to waterproof development here. I am told by knowledgeable engineers that this could be done. Any buildings constructed in the area could be elevated so that their working floors are above the flood level, with parking underneath designed to withstand the water. The plaza also could be set up in such a way that landscaping and plants would not be permanently damaged by periods of water. This represents a serious handicap but should be well worth the effort in order to provide waterfront activities in Peoria's downtown district.

The third basic planning area lies upstream--northeast--from the Murray Baker Bridge (I-74). Immediately upstream was planned another commercial node of some type--another people magnet--perhaps a motel or a hotel. When the plan was drawn up, it was anticipated that this might include a large old warehouse called the Beeney Building. However, soon after the plan was adopted, the Beeney Building burned in a tragic and spectacular fire and was lost as a development tool. Conversely, the land is now available for development.

Next to the commercial node, or perhaps as a part of it, was proposed a marina where boats could be tied up while the boaters participate in downtown functions.

And then, still farther upstream is located the traditional green space park that Peorians requested. This is an ideal area for fishing, walking, jogging, bike riding, or just river watching. Perhaps a lagoon for sailing model boats could be included, along with outdoor eateries, a visitor center, or a museum.

This park from Irving Street to Morton Street is partially constructed. The City has received a $200,000 park construction grant from the Illinois Department of Conservation. This was matched by $200,000 from the City of Peoria and a second $200,000 from the Peoria Park District. The park has been an outstanding example of intergovernmental cooperation at its best. The total of $0.6 million has provided for removal of unusable buildings, planning by the Peoria Park District, grading of the park, 19 acres of topsoil, an irrigation system, grass, shrubs and trees, gravel walkways with connections for future lighting, and a hard-top lighted parking area. These improvements are not considered to be the final completed park. Much remains to be done. The old railroad round table must be improved--perhaps as a play area for youngsters or as a revolving stage. The sand beach needs to be cleaned and access to it provided. The pathway surface and lighting will be completed, and the most expensive component, the riverbank stabilization, remains to be done.

In 1982 the anticipated cost to carry out the plan was $75 million of which $15 million was to go for public improvements such as the roadway, the urban plaza, the park, etc. We hoped to be able to finance these public improvements through lease agreements and a tax increment district.

Now I want to mention two other situations which have come to the forefront wince this plan was adopted in 1982. One of these occurred just a few weeks ago with the announcement by Jumers Company that they will utilize the urban plaza area to develop a new facility in the water at the foot of Main Street. This will be made up of a barge with a gift shop, two tug boats--one to be converted to a restaurant and one to be a river museum, an excursion boat, plus a landscaped area on shore where these boats will tie up. This is just the sort of "people magnet" that the City Council believed was needed here. So we see the development beginning and we are pleased that Jumers is the leader. The City will assist with the project by utilizing tax increments financing income and our hotel/restaurant/amusement income from the project.

The second situation is a negative one. Since we began to look carefully at this area for development, we have been alerted to the impending conversion of the Peoria Lakes to mud-flats. It does not require a very imaginative mind to understand that this development could seriously hamper or completely stop our goals for the future. Few developers are attracted by the view of a mud flat. Although our 7 acres of under-river land may come to the surface as siltation continues, this will hardly enhance the park area, as the focus of this park is the river not a boggy unusable stretch of mire.

The City of Peoria is pledged to riverfront development and we are pledged to preserving the Peoria Lakes and other parts of the Illinois River. These pledges go hand-in-hand.

THE ILLINOIS RIVER VALLEY: AN ECONOMIC PROFILE

Steve Selcke
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Twenty-one counties are immediately adjacent to the Illinois River, including Cook County which is directly connected to the river via the Chicago Sanitary and Ship Canal. With Cook County, this collection of counties forms an impressive economic and demographic region.

Population and Education

With Cook County, the region contained 55 percent of the State's population in 1985 (see Table 1). Cook County had 5,212,220 persons, but other counties with more than 100,000 in population include Tazewell, Peoria, LaSalle, and Will counties. Among the smallest counties in population are Calhoun, Scott, Brown, and Putnam.

Not surprisingly, Cook County is the most heavily urbanized of the counties with nearly 100 percent of its population in urban areas in 1980. However, four counties in the valley had no urban population. Between these two extremes were the largely urbanized counties of Morgan, Tazewell, Peoria, LaSalle, and Will counties.

In all but one county, Calhoun, the majority of adults had 12 years of school or more in 1980. The counties with the highest percentages in this regard were Morgan, Tazewell, Peoria, Woodford, Putnam, Bureau, Grundy, and Will counties.

Personal Income

Per capita personal income in the region ranged from a high of $14,328 in Grundy County to a low of $9,409 in Schuyler County (see Table 2). The state average was $13,705. Although most counties in the region were below this average, Cook County, with the bulk of the region's population, exceeded the state average.

The region accounted for 56 percent of the State's total personal income. Cook County had by far the largest share of the region's total personal income, but Peoria, LaSalle, Tazewell, and Will counties each had total personal incomes of more than one billion dollars in 1984.

Agriculture

The region is an important agricultural area (see Table 3). One of the significant measures of agricultural productivity is agricultural receipts. Livestock receipts for the region in 1983 were $419,875,000 or 18 percent of the State's total. Receipts ranged from a high of $54,885,000 in Pike County to a low of $6,184,000 in Putnam. Livestock receipts were also relatively high in Bureau County, and low in Mason and Grundy counties.

Crop receipts for the region in 1983 were $1,001,739,000 or 17 percent of the State's total. Receipts ranged from a high of $152,312,000 in LaSalle County to a low of $6,323,000 in Calhoun County. Crop receipts were also relatively high in Morgan, Tazewell, Woodford, Bureau, and Will counties, and low in Brown County.

Employment and Industry

The region is an important industrial area (see Table 4). With Cook county, the region accounted for a substantial percentage of the State's employment in all major industries in 1984.

In the agricultural services industry, the region had 952 establishments employing approximately 5,800, roughly half of the state's employment in that industry.

While not as important in the Illinois Valley Region as in other parts of Illinois, the mining industry nevertheless employed approximately 3,600, many of them in Cook County in the quarrying of sand and gravel.

Employment in contract construction was over 88,000 at 7,885 establishments. This was 57.8 percent of the state's employment in that industry.

The region's second largest employing industry was manufacturing, with 609,331 employees or 58.1 percent of the State's total. The most important manufacturing areas were in Cook and Peoria counties, with substantial employment also in Tazewell, LaSalle, and Will counties.

The State's transportation and public utilities employment were heavily concentrated in the region, particularly in Cook County. Sixty-four percent of the statewide employment in that industry was found in the region. Will, Peoria, and LaSalle counties also had significant numbers of employees in the industry.

There was a heavy concentration of the state's wholesale trade employment in the region, especially in Cook County. More than 62 percent of statewide employment in wholesale trade was in the 12,497 establishments in the region. Tazewell, Peoria, and Will counties were also important wholesale trade centers.

Retail trade was a significant employing industry in 1984. There were 431,960 employees at 31,156 businesses in the region. Peoria and Will counties also had large numbers of employees in the industry.

The largest share of statewide employment was in the region's finance, insurance, and real estate (FIRE) industry. There were 238,517 employees, or 70.3 percent of the State's total, in the region's 14,184 establishments. Cook County alone accounted for nearly 66 percent of the State's employment in the industry.

The largest regional employer was the services industry with 679,596 employees at 41,674 establishments. This was nearly 65 percent of the State's total employment in the industry.

Travel Expenditures

Although all the counties in the region garner travel expenditures, the spending is most significant in Tazewell, Peoria, LaSalle, and Will counties, and especially Cook County (see Table 5). Several counties receive relatively low, but not inconsiderable, expenditures, including Scott, Brown, and Putnam counties.

In 1983, the region received nearly 62 percent of the statewide total of $5.7 billion spent on travel. Cook County received 55 percent of the state total in that year. Peoria and Will counties received approximately $100 million each.

In 1985, the situation was much the same, although the state received a much larger amount in expenditures, $8.3 billion. The region received nearly 66 percent of the statewide total, with Cook County receiving nearly 60 percent of that total. Will County, however, ranked second in income from travel, followed by Peoria County. Tazewell and LaSalle counties also received nearly the same travel expenditures in 1985 as in 1983, it was estimated that the majority of counties had experienced an increase in travel income.

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Appendix

DISCUSSION GROUP RESPONSES

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Peoria, Illinois

Responses to the questionnaires from each group were categorized and examined for redundancy. In many cases, several groups suggested similar items with a somewhat different wording. I edited these in order to present a cohesive report. The items that are capitalized under each question received the most discussion judging from the reports submitted to me. Those responses listed under Other are presented to give an idea of the wide range of problems we face and some innovative solutions to begin solving some of those problems.

Finally, let me congratulate the discussion groups. You did an excellent job of summarizing.

QUESTION NO. 1

LIST PROBLEMS DEALING WITH THE MANAGEMENT OF THE ILLINOIS RIVER.

SOIL EROSION AND SILTATION

FLOODING

EDUCATING THE PUBLIC (LACK OF PUBLIC AWARENESS)

DIVERSION OF WATER FROM LAKE MICHIGAN

OTHERS

Apathy - lack of understanding on the part of government officials, farmers and the general public

Conflicting uses of the river (commerce and industry versus recreational interests)

Lack of a central organization to deal with the problem of the entire Illinois River watershed

Heavy barge traffic and barge fleeting

Failure to utilize existing state agencies, resources and organizations to promote soil conservation and wise land use practices

Lack of comprehensive management systems for the Illinois River basin

Reduced federal spending

Lack of coordination among local, state, and federal agencies

Toxic compounds and non-point source of pollution

Restoration of wetlands and wildlife habitat

The need to get watershed land owners to participate in the problem given high land taxes and low profitability in agriculture

Leave flood plains alone and let areas that were leveed return to a lake

Damage to wetlands

Channelization of tributaries

Bad use of zoning laws

Lack of consensus on land use

How to get farmers to change their philosophy and farming techniques

Economics - pressure to put more land into crop production

Conflicts in farming practices

Water quality

Floodplain vegetation - lack of stream side vegetation as a buffer

Lack of a consistent and environmentally sound farm bill

Reduced federal and state funding

Need to develop a land use ethic

Need to move forward on tourism and economic development

Need to develop local commitment first before state and federal aid is sought

Need to develop a marketing approach to river related assets

Need to stress creative opportunities for investors

Should have had more farmers present

Need for more public access

Need for excursion boats

Need to change emphasis of extension service programs from production to soil conservation

Lack of maintenance for existing facilities on the river - e.g. public access area, Starved Rock State Park, etc.

QUESTION NO. 2

PRIORITIZE THE PROBLEMS LISTED IN NUMBER 1. (CONSIDER WHETHER IT IS A LOCAL OR STATE-WIDE ISSUE). INDICATE THOSE OF MAJOR SIGNIFICANCE.

ILLINOIS RIVER BASIN SILTATION (STATE-WIDE) (BRUNT OF PROBLEM SHOULD FALL ON RIVER COMMUNITIES)

LAKE MICHIGAN DIVERSION (STATE) - (NEEDS MORE STUDY)

FLOODING ALONG ILLINOIS RIVER (ALL AREAS) ADJACENT TO RIVER AND TRIBUTARIES) (STATE-WIDE)

EROSION CONTROL (STATE)

OTHERS

Water quality (state)

Intergovernmental cooperation (state)

Education (state and local)

Comprehensive management system for the basin (state and local)

Reduced funding at state level

Restoration of wetlands and wildlife habitat (local) (state)

Non-point sources of pollution

Commercial navigation

Drainage of wetlands (state)

Channelization (state)

Land use ethic (state)

Tourism and economic development (state and local)

Marketing approach (state and local)

Creative opportunities for investors (state and local)

Public access (state and local)

Excursion boats (local)

Changing emphasis of extension service (state and local)

Increased maintenance for existing facilities (state)

QUESTION NO. 3

WHICH OF THESE PROBLEMS NEED IMMEDIATE ACTION?

ALL SIMULTANEOUSLY - (SEVERAL GROUPS)

ILLINOIS RIVER BASIN SILTATION (INCLUDING SILTATION IN PEORIA LAKE)

LAKE MICHIGAN DIVERSION

FLOODING PROBLEMS

REDUCED FEDERAL AND STATE FUNDING - NEED TO GET ORGANIZED IN ORDER TO GET STATE AND FEDERAL FUNDS

PUBLIC AWARENESS AND EDUCATION (SEVERAL GROUPS)

OTHERS

This is not an appropriate question. We should not move into a panic mode at this time. Problems that were identified need planned and sustained action

Form an agency to oversee the entire Illinois watershed

Long-term changes in agricultural practices - focus on profitability, not productivity

Build sediment retention areas

Enforce existing laws that protect wetlands and prohibit channelization

Stronger controls on stream channelization

County-wide zoning for stream corridor protection

Wildlife habitat

Promotion of tourism

Focus media attention on the history, economic importance and recreational uses of the river

QUESTION NO. 4

IDENTIFY MEANS TO RESOLVE THESE PROBLEMS

A. ORGANIZATIONAL/AGENCY FRAMEWORK

ESTABLISH AN ILLINOIS RIVER TASK FORCE OR STEERING COMMITTEE COMPOSED OF STATE, LOCAL AND FEDERAL AGENCIES ALONG WITH PRIVATE SECTOR LEADERS

ESTABLISH AN ILLINOIS RIVER BASIN AUTHORITY WITH TAXING AUTHORITY TO IDENTIFY PROBLEMS AND DEAL WITH ISSUES

ENCOURAGE EXISTING AGENCIES TO DEVELOP DEMONSTRATION PROJECTS WITH EXISTING FUNDS

STRONG LEADERSHIP FROM THE GOVERNOR'S OFFICE USING EXISTING STATE AGENCIES

OTHERS

A separate state agency to have an advisory role to the other related agencies

A cooperative group combined from existing state agencies

A think tank organizational group to administer a comprehensive program for the Illinois River basin

SCS districts, Corps of Engineers, IDOT, State Water Survey, Lake Associations and ASCS for erosion

IDOT, USEPA, Corps of Engineers, Great Lakes Joint Commission, Levee and drainage districts for Lake Michigan diversion

DOC, Natural History Survey, Sportsman's groups, Fish and Wildlife for habitat development

One group could not reach a consensus

Establish demonstration projects on back-water lakes, tributaries, mainstream lakes, etc. to control siltation

Develop a scenic river road or heritage trail

Develop transportation and tourism along the river

Promote French heritage associated with the river

Develop linear river park corridors

Focus national attention on Illinois River

Establish a Natural Resources committee

QUESTION NO. 4

B. WHO PAYS THE BILL?

ALL TAXPAYERS (LOCAL, STATE AND FEDERAL)

USER FEES - (NAVIGATOR FEES AND FUEL TAX)

PROVIDE TAX INCENTIVES TO LAND OWNERS FOR INSTALLING UPLAND EROSION CONTROL

COST SHARING IN THE BASIN

OTHERS

All taxpayers in the basin (50%); state tax 50%

Local funding to be decided locally

Sediment loss and run-off tax

State and local river use tax

State tax on commodities

State income tax check-off

Federal grants and funds

Tax on soft drinks

Let an Illinois River Steering committee recommend a solution

PLANNING COMMITTEE

Glenn E. Stout, University of Illinois Water Resources Center, Chairman
Harry Hendrickson, Association of Illinois Soil and Water Conservation Districts, Secretary
Gary Clark, Illinois Department of Transportation
Jim Hart, Illinois Department of Conservation
Bill White, Illinois Department of Conservation
Michael Bowling, Illinois Department of Commerce and Community Affairs
Don Meinen, Tri County Regional Planning Commission
Raman Raman, Illinois Department of Energy and Natural Resources
Don Clem, CILCORP, Inc.
Bill Miller, City of Peoria
Fannie Hills, Illinois Wildlife Federation
Michael Purnell, Illinois House of Representatives
Don Roseboom, Illinois Chapter - American Fisheries Society
Keith Donelson, Soil Conservation Service
Robert Walker, University of Illinois Cooperative Extension Service
Mark Schroeder, U.S. Army Corps of Engineers
Krishan Singh, Illinois Chapter - American Water Resources Association
Richard Mollahan, Illinois Environmental Protection Agency
Gregg Good, Illinois Environmental Protection Agency
Carolyn Raffensperger, Sierra Club
Don Condit, Illinois River Soil Conservation Task Force
Robert Frazee, University of Illinois Cooperative Extension Service

SPECIAL RECOGNITION

CILCORP, Inc.
City of Peoria
Illinois Department of Conservation for printing services
Peoria County
Peoria County Soil and Water Conservation District
Peoria Convention and Visitors Bureau for registration and housing services
Peoria Journal Star
State Water Survey for design of logo

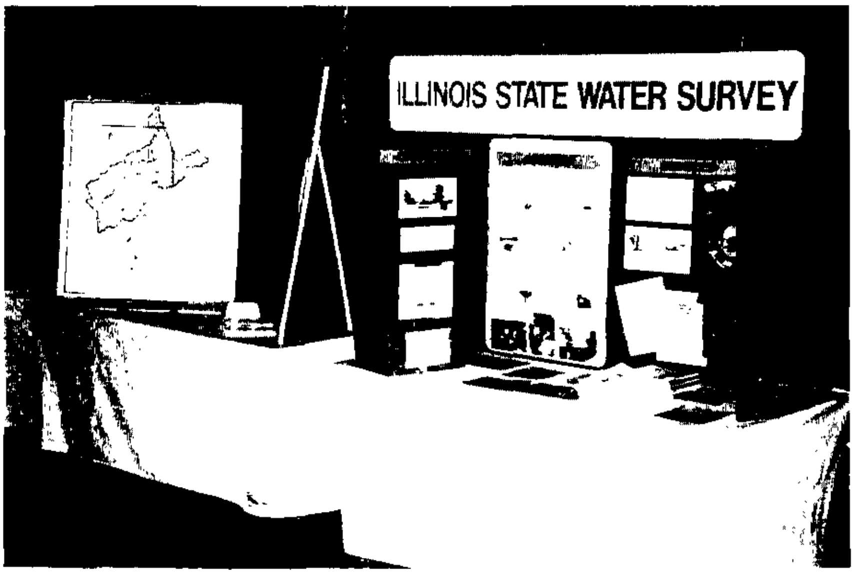
EXHIBITORS

Association of Illinois Soil and Water Conservation Districts
Association of Natural Vegetation in Landscapes
Association of State Flood Plains Managers
Illinois Department of Conservation
Illinois Lake Management Association
Illinois River Soil Conservation Task Force
Illinois State Water Survey
Metropolitan Sanitary District of Greater Chicago
Peoria School of Medicine, U of I River City Toxicology Program
River Science Center
Riverfront Forum and Tri County Planning Commission
Soil Conservation Society of America
U.S. Army Corps of Engineers - Illinois River Visitor Center at Ottawa
Water Resources Center, University of Illinois
Water Resources Division, Illinois Department of Transportation

ADDITIONAL CONFERENCE PLANNING PERSONNEL

Ken Reuter, Association of Illinois Soil and Water Conservation Districts
William C. Ackermann, University of Illinois
Richard Semonin, Illinois State Water Survey
Richard Schicht, Illinois State Water Survey
Walt Brakeman, Tri County Open Space and Recreation Committee
Bill Busch, Illinois Water Pollution Control Association
Mike Miller, Illinois State Geological Survey
Rodell Beaty, Illinois Farmers Union
Pat Burke, U.S. Army Corps of Engineers
Jack Carr, U.S. Army Corps of Engineers
Bill Tanton, Tri-County Riverfront Forum
Russell McHaffey, Illinois River Carriers Association
C. Lawson Corlew, Illinois Department of Commerce and Community Affairs
Wallace Bierman, Illinois Department of Commerce and Community Affairs
Jim Baldwin, Illinois River Valley Association
Mike Foertch, Peoria Area Chamber of Commerce
Lorri Latham, Peoria Convention and Visitors Bureau
Sherri Behrends, Peoria Convention and Visitors Bureau
Mindy McDaniel, Hotel Pere Marquette
Marvin Hubbell, Illinois Chapter Soil Conservation Society of America
Stephen Havera, Illinois Natural History Survey
Al Fleming, Olivet Nazarene University
Robert Pepin, U.S. Environmental Protection Agency
Toby Frevert, Illinois Environmental Protection Agency
Dale Garman, Illinois Association of Aggregate Producers
Bill Macaitis, Metropolitan Sanitary District of Greater Chicago
Roy Mann, Illinois Management Association
Virginia Scott, Illinois Environmental Council
James Beaumont, Illinois State Chamber of Commerce
Rich Nichols, Illinois Department of Agriculture
Joe Spivey, Illinois Coal Association
Clarence Klassen, Illinois Coal Association
James O'Connell, Illinois Association of Port Districts
Larry Toler, U.S. Geological Survey
Dick Neumiller, CILCO, Inc.

WORKSHOP
GROUP
IN
DEEP
THOUGHT



EXAMPLE
OF
EXHIBITS

Don Bell

Otis Michels

Henry Holling

Sponsors

Local and Regional

City of Peoria
Tri County Regional Planning Commission
Metropolitan Sanitary District of Greater Chicago
Northeastern Illinois Planning Commission
Peoria Convention and Visitors Bureau

State

Office of Governor James R. Thompson
Illinois Departments of Conservation, Transportation, Energy and Natural Resources, Commerce and Community Affairs, Agriculture, and Environmental Protection Agency
University of Illinois Water Resources Center and Cooperative Extension Service
Commission on Intergovernmental Cooperation

Federal

Congressman Robert Michel
Congressman Lane Evans
U. S. Army Corps of Engineers
U. S. Department of Agriculture — Soil Conservation Service
U. S. Geological Survey
U. S. Environmental Protection Agency

Organizational

Illinois River Soil Conservation Task Force
Association of Illinois Soil and Water Conservation Districts
Tri-County Riverfront Forum
Illinois Wildlife Federation
Illinois Coal Association
Sierra Club — Great Lakes Chapter
Illinois River Carriers Association
Illinois Lake Management Association
Peoria Area Chamber of Commerce
Illinois State Chamber of Commerce
Illinois Environmental Council
Illinois Association of Park Districts
Illinois Association of Port Districts
Illinois Water Pollution Control Association
Soil Conservation Society of America — Illinois Chapter
Illinois Land Improvement Contractor's Association
Upper Illinois Valley Association
Illinois River Valley Association
American Fisheries Society — Illinois Chapter
American Water Resources Association — Illinois Chapter
League of Women Voters
Illinois Fertilizer and Chemical Association
Illinois Farmer's Union
Illinois State Grange
Illinois Farm Bureau
Izaak Walton League
Illinois Audubon Society
Illinois Sportsmen's Legislative Coalition
Illinois Association of County Zoning Administrators
Illinois Association of Floodplain and Stormwater Management
Open Lands Project

Industry

CILCORP, Inc.
Caterpillar, Inc.
Commercial National Bank

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April 1-3, 1987

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