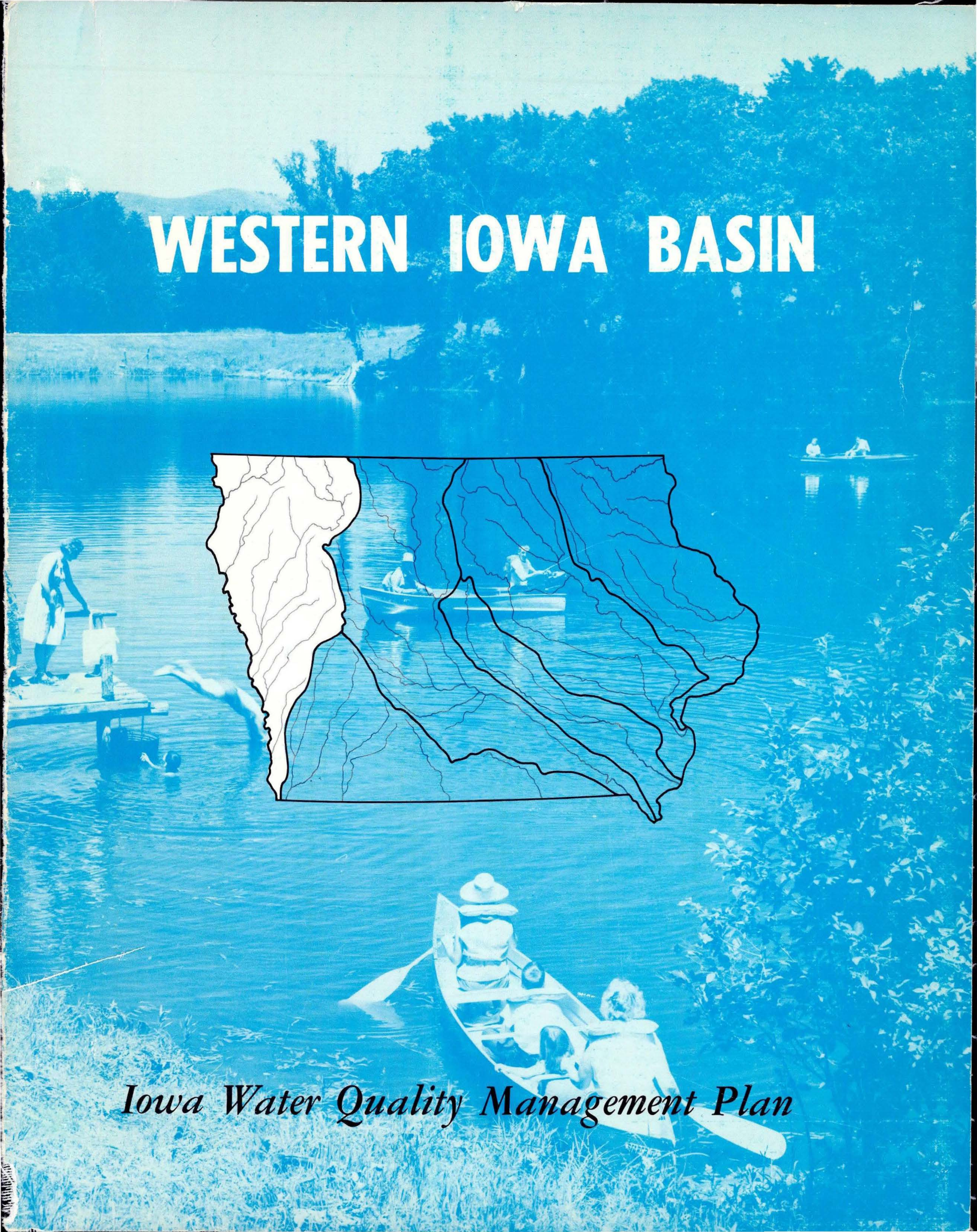
WESTERN IOWA BASIN



Iowa Water Quality Management Plan

WATER QUALITY MANAGEMENT PLAN

WESTERN IOWA BASIN

July, 1976

PLANNING AND ANALYSIS SECTION
WATER QUALITY MANAGEMENT DIVISION
IOWA DEPARTMENT OF ENVIRONMENTAL QUALITY

A C K N O W L E D G M E N T

Water Quality Management Plans for the State of Iowa were prepared by the Department of Environmental Quality, Water Quality Management Division, Planning and Analysis Section. We gratefully acknowledge the assistance of the many State and Federal agencies and individuals that have provided data, reviewed drafts, and helped in other ways during the formulation and preparation of this plan. We also acknowledge the work of E. A. Hickok and Associates in the compilation of this plan, and of Stanley Consultants, Inc. in the development of a portion of the preliminary waste load allocations, both under contract to the Department of Environmental Quality.

FOREWORD

Under section 455B.31, Code of Iowa, 1973, the Iowa Department of Environmental Quality (DEQ) is charged with the responsibility of protecting and maintaining surface and groundwater quality throughout the State. To assist the Department in this task, this basin plan has been prepared to coordinate and direct the State's water quality management decisions on a river basin scale.

The national goal, established in the Federal Water Pollution Control Act Amendments of 1972, (the Act), provides for water quality suitable for the protection and propagation of fish and wildlife, as well as for recreational activities in all surface waters by July 1, 1983. The Amendments define basin planning (Section 303(e)) as a key element for the determination and implementation of the necessary requirements to achieve national water quality goals.

Six major river basins, as defined by the Department of Environmental Quality, are partially located in the State of Iowa. Basin boundary lines are drawn to separate hydrological drainage areas (Figure 1). Any minor deviation from this is done only to be consistent with the boundaries of the six Iowa Conservancy Districts, as established by Chapter 467D.3 of the Code of Iowa. This provides the most compatible use of data among different State agencies.

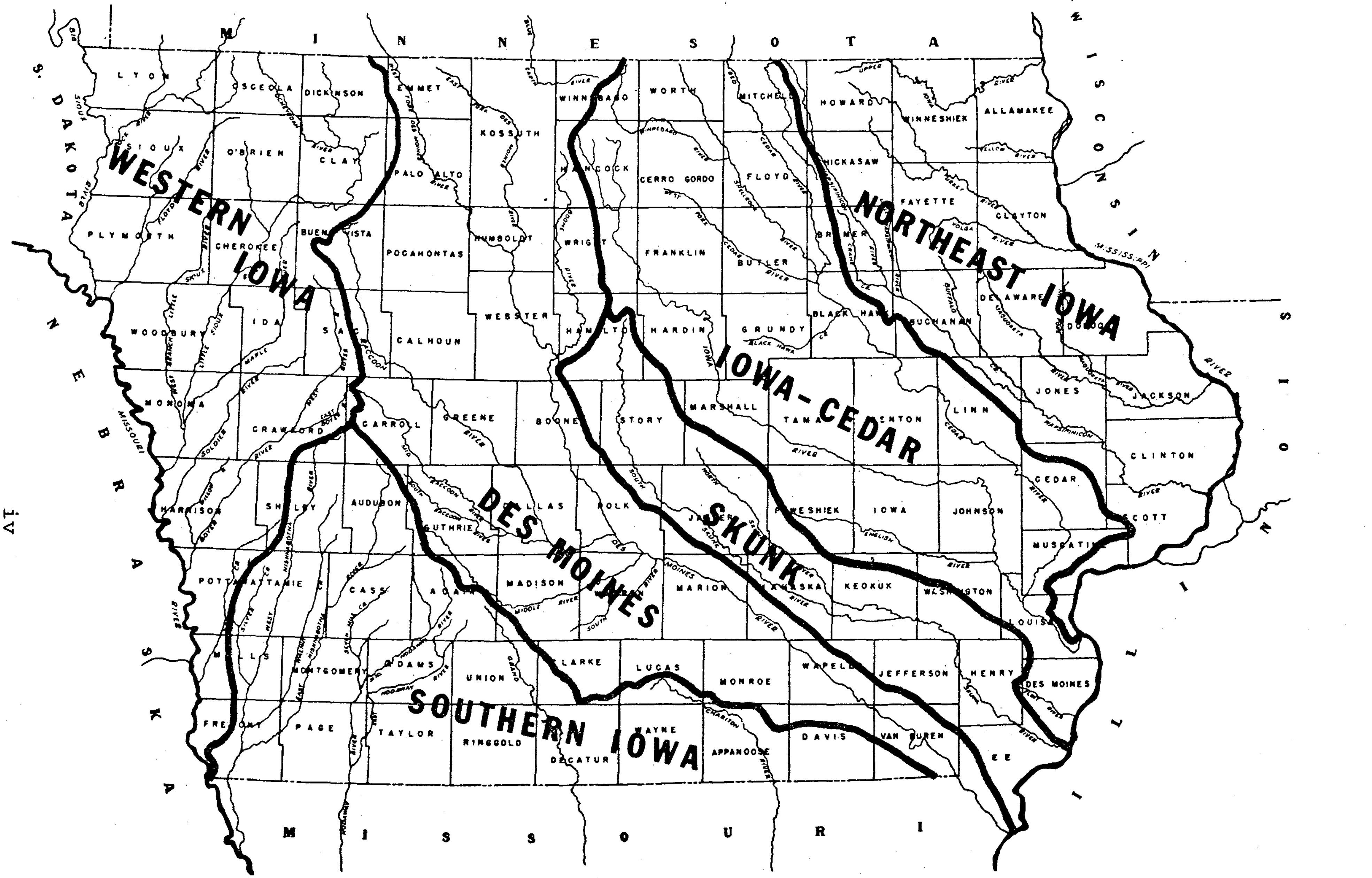


FIGURE 1

IOWA RIVER BASINS

This basin plan is one of a series for the six major river basins in Iowa. These plans are supplemented by the Supporting Document for Iowa Water Quality Management Plans which contains general information of a supporting or background nature applicable to all six basins. The planning documents will be prepared by the Water Quality Management Division of DEQ. The planning information contained herein is part of a continuing planning process. Changes will occur since this plan describes a dynamic process. Basin plans will be reviewed at least every five years with interim revisions as significant changes occur.

This plan includes a determination of existing water quality, applicable standards, and significant point and nonpoint sources of pollution in the Western Iowa Basin. The plan then identifies and sets forth measures to correct the basin's water quality problems. Authority for this basin plan is derived from Section 455B.32, of the Code of Iowa.

This basin plan is specifically directed towards satisfying requirements of section 303(e) of the Federal Water Pollution Control Act, as amended; Public Law 92-500, 86 Statute 816 (1972); (33 United States Congress 1251 *et sequens*). The plan will serve local and regional governments as well as State and Federal agencies.

SCOPE

This basin plan addresses the Western Iowa Basin. The basin includes the Iowa portion of the Big Sioux, Little Sioux, Rock, and Floyd River Basins, all of the Soldier and Boyer River Basins, and a number of smaller streams which are tributaries to the Missouri River, including Mosquito Creek and Keg Creek.

The scope of this plan entails the study of the following items: (1) Water Quality Management Programs, (2) Existing Development Patterns and Basin Characteristics, (3) Existing Water Quality, (4) Inventories of all Point Sources of Wastewater Discharge, (5) Assessment of Nonpoint Pollution Sources, (6) Stream Segment Analyses and Waste Load Allocations, and (7) Assessment of Needs and Compliance Schedules. The detail of study of this document is as follows:

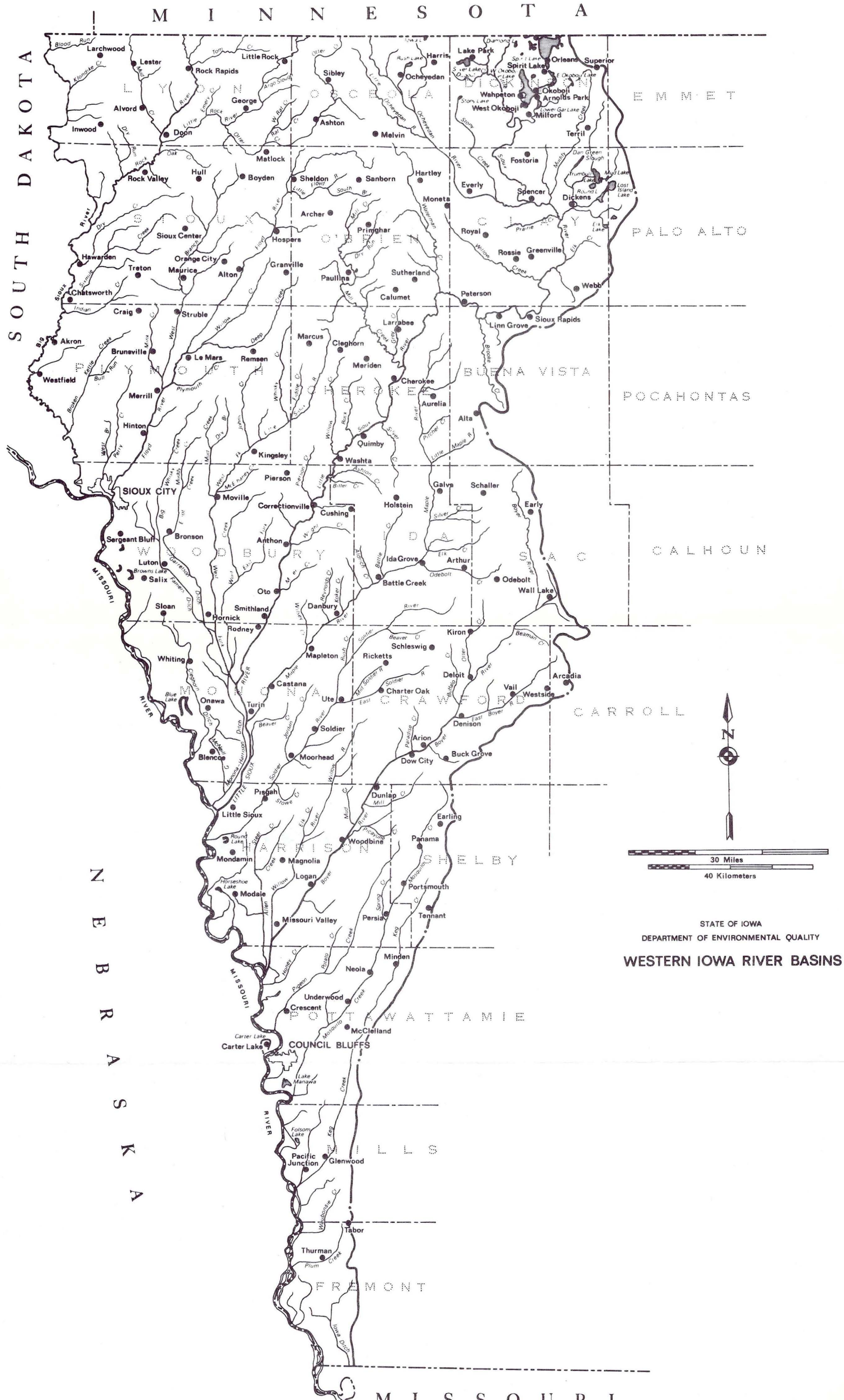
Chapter

I. Iowa's Water Quality Management Program

A synopsis of the basin planning process is presented along with a brief description of the DEQ's water quality management program and strategy.

II. Existing Development Patterns

Information concerning population, land use economics and recreational activities within the basin is presented.



MINNESOTA
SOUTH DAKOTA
NEBRASKA
MISSOURI
LYON
OSCEOLA
DICKINSON
EMMET
SIOUX
O'BRIEN
CLAY
PALO ALTO
PLYMOUTH
CHEROKEE
BUENA VISTA
POCAHONTAS
WOODBURY
IDA
SAC
CALHOUN
MONONA
CRAWFORD
CARROLL
HARRISON
SHELBY
POTTAWATTAMIE
MILLS
FREMONT
Larchwood
Lester
Little Rock
Rock Rapids
Alvord
George
Inwood
Doon
Sibley
Ashton
Ocheyedan
Harris
Lake Park
Spirit Lake
Orleans
Superior
Okoboji
Wahpeton
Arnolds Park
West Okoboji
Milford
Terril
Melvin
Matlock
Hull
Boyden
Rock Valley
Sheldon
Sanborn
Hartley
Moneta
Fostoria
Everly
Spencer
Dickens
Archer
Sioux Center
Primghar
Royal
Hawarden
Orange City
Hospers
Granville
Rossie
Greenville
Treton
Maurice
Alton
Paullina
Sutherland
Webb
Chatsworth
Calumet
Peterson
Craig
Struble
Larrabee
Sioux Rapids
Linn Grove
Akron
Marcus
Cleghorn
Brunsville
Le Mars
Remsen
Meriden
Westfield
Cherokee
Merrill
Aurelia
Alta
Hinton
Quimby
Kingsley
Washta
Pierson
Galva
Schaller
SIOUX CITY
Moville
Correctionville
Holstein
Cushing
Early
Sergeant Bluff
Bronson
Anthon
Luton
Salix
Ida Grove
Arthur
Battle Creek
Odebolt
Wall Lake
Oto
Sloan
Smithland
Danbury
Hornick
Rodney
Kiron
Schleswig
Whiting
Mapleton
Ricketts
Deloit
Arcadia
Castana
Vail
Westside
Onawa
Ute
Charter Oak
Turin
Denison
Soldier
Arion
Blencoe
Moorhead
Dow City
Buck Grove
Pisgah
Dunlap
Little Sioux
Earling
Panama
Woodbine
Mondamin
Magnolia
Logan
Modale
Portsmouth
Missouri Valley
Persia
Tennant
Minden
Neola
Underwood
Crescent
McClelland
Carter Lake
COUNCIL BLUFFS
Pacific Junction
Glenwood
Tabor
Thurman
MISSOURI RIVER
N
30 Miles
40 Kilometers
STATE OF IOWA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WESTERN IOWA RIVER BASINS

FIGURE 2

III. Basin Characteristics

The physical characteristics of the basin, including topography, climatology, physiography, geology, hydrogeology, hydrology, and ground water quality are discussed.

IV. Water Quality

Iowa Water Quality Standards and Stream Classifications are delineated. Available water quality data have been accumulated and evaluated to present the best possible picture of the recent history of basin water quality. Existing water quality is described and then compared with the Iowa Water Quality Standards.

V. Point Source Discharge Inventory

Available records have been reviewed to determine the location and characteristics of point source wastewater discharges. This information is tabulated and summarized.

VI. Waste Load Allocations and Ranking

The results of the waste load allocation analyses for the basin are listed. Waste load reductions for each point source waste dischargers are given. Segments are classified and ranked. Dischargers are ranked.

VII. Nonpoint Pollution Sources

The problems of nonpoint pollution sources are addressed. Combined sewer overflows, urban runoffs, and rural sources of pollution from animal feeding operations and general agricultural activities are characterized. Based upon information extrapolated from other areas, the potential pollution from typical sources is identified.

VIII. Needs and Compliance Schedules

An evaluation of the needs for improved wastewater treatment in the basin is presented. A summary of the estimated costs associated with these needs is also given.

IX. Conclusions and Recommendations

Conclusions drawn from the plan are presented along with several recommendations that would aid in attaining the goal of improved water quality.

X. Review and Revision

The procedures for review and revision of this plan are briefly described.

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CHAPTER I

IOWA'S WATER QUALITY MANAGEMENT PROGRAM

WESTERN IOWA BASIN

The main objective of water quality management is protection and enhancement of water resources to ensure acceptable conditions for designated uses. The establishment of a realistic management program requires a comparison of existing water quality with the desired water quality.

The Iowa Water Quality Standards, as adopted by the Iowa Water Quality Commission, establish a baseline for desired water quality and stream uses. The National Water Quality Criteria, as proposed by the U.S. Environmental Protection Agency (EPA), provides an additional measure of desirable water quality.

WATER QUALITY STANDARDS

Iowa's Water Quality Standards and accompanying use classifications were established by the Water Quality Commission. They were adopted by the State on February 12, 1974 and approved by the U.S. Environmental Protection Agency on March 12, 1974. When a water quality standard is violated the water, according to law, is polluted and its quality must be improved.

Water Use Classifications

The Department of Environmental Quality has responsibility for establishment of water use classifications for the surface waters of the State. Assistance in this task has been provided by the State Conservation Commission which has the major responsibility for fish and wildlife protection. Accordingly, the DEQ has defined four surface water-use classifications and has placed all surface waters of the State into one or more of these classifications. These classifications are:

Class A - Primary Contact Recreation; Class B - Wildlife, Secondary Contact Recreation and Aquatic Life (with subclasses for cold and warm waters); Class C - Potable Water Supply; and a General Water Quality Criteria. All surface waters are designated under the General Water Quality Criteria. In addition, many streams are also designated for one or more of the Class A, Class B, or Class C uses. Each of the use classifications imply specific water quality standards.

Surface Water Quality Standards

Iowa Water Quality Standards define the constituent levels which may be present in the surface waters of the State. Specific concentrations of various constituents which should not be violated are assigned to each water use, in order to protect the water for that particular use.

The water quality standards shall be met at all times when the flow of the receiving stream equals or exceeds the seven day, 1-in-10 year low flow (7Q10). Exceptions may be made for intermittent or extremely low flow streams. When intermittent streams are classified for aquatic life protection, the Water Quality Commission may waive the (7Q10) low flow requirement and establish a minimum flow in lieu thereof. Such a waiver shall be granted by the Commission only when it has been determined that the aquatic resources of the receiving waters are of little significance at flows less than the established minimum.

The specific criteria which apply to A, B, C, or General classifications are detailed in Chapter II of the Supporting Document For Iowa Water Quality Management Plans (1).

Revision of Water Quality Standards

The Act requires that the State shall from time to time, but at least once every three years, hold public hearings to review water quality standards and, if appropriate, modify and adopt new standards.

Some of the most likely changes in the Standards will be revisions of the use classifications. Since the National water quality goal is swimmable-fishable waters by 1983, most anticipated changes will be to upgrade existing Class B waters to include the current Class A usage. There will also be cases of upgrading waters, to which only general criteria apply, Classes A and B. Other revisions that may take place are changes in the criteria of the current Water Quality Standards. Any revisions in the Standards will be subject to public hearings and approval by the EPA before they may become law.

IMPLEMENTATION STRATEGY

If a management plan is to be effective, it must include a strategy for implementation of its proposals. This section gives a brief description of the DEQ's strategy for the implementation of its basin plans.

Strategy Summary

In most cases, water quality violations are the result of man's activities. Typical sources of pollution can include municipal discharges, industrial discharges, and runoff or nonpoint discharges associated with agricultural practices. The solution to water pollution is to identify the contributing sources and either eliminate or control them to the extent necessary to assure that water quality standards will not be violated.

Waste load allocation studies are performed to estimate the quantities of pollutants which may be discharged to receiving waters without exceeding the limits allowed by the water quality standards. Through the use of the water load allocations, effluent limitations are established for municipal and industrial wastewater point source discharges. Only point sources of pollution are addressed in the waste load allocations in the initial version of the basin plans. This is because point sources of pollution are easier to identify and control. Nonpoint sources of pollution will receive further considerations in subsequent revisions to the plans.

Regardless of what the waste load allocation study indicates, to be allowable, the Federal Water Pollution Control Act Amendments of 1972 (the Act), Public Law 92-500, requires publicly owned treatment plants to provide as a minimum, "secondary treatment", and industrial plants to provide, as a minimum, "best practicable control technology currently available" (B.P.T.) by July 1, 1977. The actual effluent limitations required under these degrees of treatment are described in Chapter VI.

The principal mechanism for attaining and maintaining compliance with the water quality standards is through the issuance of operation permits to all point sources of wastewater discharge. The permits contain either minimum allowable effluent limitations or limitations more stringent as necessary to assure compliance with water quality standards. Where existing sources are not in compliance with the effluent limitations, the operation permit will include an implementation schedule to assure compliance within a reasonable time period.

An additional step in the implementation of remedial measures to abate water pollution exists in the case of municipal wastewater treatment plants. Public Law 92-500, the Act, has established a program for assisting publicly owned waste treatment works with funding for improvements necessary to meet the goals of the Act. The DEQ, as the state water pollution control agency, has responsibility for administering the program. The final step, then, in the DEQ's strategy for implementation of the plan is to allocate the federal funds available for improvement of Iowa municipal treatment facilities.

Monitoring and Surveillance

Stream Sampling Station Network - The present Iowa stream sampling station network is a series of sampling points distributed throughout the State. These are permanent stations, sampled at the same location and on a quarterly frequency. The samples are normally analyzed for the same parameters every quarter. The objective of the sampling network is to give a general indication of water quality. The network is effective for measuring trends of either improvement or degradation of water quality. Although only minimal assistance is obtained in the area of enforcement, the network provides some background data for planning and assessing the effectiveness of the program.

The present network consists of thirty-six (36) stations across Iowa, each sampled quarterly. Seven of these stations are in the Western Iowa Basin. Two of the stations are located on the Missouri River; one at Sioux City and the other at the Council Bluffs Water Treatment Plant Intake. The other stations are located on the Big Sioux River at Akron, the Boyer River near Missouri Valley, the Floyd River near Sioux City and two stations on the Little Sioux River; one near Spencer and the other near Onawa. All stations are sampled by the

State Hygienic Laboratory of the University of Iowa, under contract to the DEQ. The State Hygienic Laboratory also does the analyses.

In order to be more effective as a trend indicator, the monitoring network should be expanded. To be most effective, stations should be located below major point source discharges, and at points on the stream of distinct change in characteristic. These locations would be at points of confluence of major tributaries, above and below impoundments, and at points of change of water quality standards designation.

Intensive Stream Water Quality Surveys - The limiting factor in the effectiveness of the stream sampling network is its inability to detect cause and effect relationships. The DEQ's water quality monitoring program therefore includes a complementary program of intensive stream water quality surveys. The intensive surveys are in-depth studies of water quality in a specific area or segment of a stream, over a finite time period. The purpose of the survey is to provide a detailed determination of the biological, physical, and chemical qualities of the stream water. Information obtained is used to determine the effects of a specific point source or combination of point sources upon the receiving stream. The surveys provide documentation for enforcement actions and determine the effectiveness of any corrective measures initiated. Such surveys are also used for evaluating priorities, verifying waste load allocations, and as aids for planning.

The bulk of the intensive surveys program is conducted by the State Hygienic Laboratory. The lab usually performs both sampling and sample analyses. Intensive surveys are also conducted by the DEQ office to obtain answers to specific questions. For example, limited surveys are occasionally conducted by DEQ Regional staff in connection with point source discharge compliance inspections.

All survey data storage and analysis are performed using computer data processing. The stream water quality data is also stored in the U.S. Environmental Protection Agency computer storage system, STORET. The STORET system includes a variety of report and anlysis formats for evaluating and using the data.

Point Source Discharge Self-Monitoring - The principal tool for the management of point source discharge monitoring and enforcement of effluent limitations is the State Operation Permit Program, in coordination with the National Pollutant Discharge Elimination System (NPDES Discharge Permit Program). The permits not only set discharge effluent limitations and prescribe compliance schedules for bringing about corrections, but also specify a program for effluent monitoring and recording by the permit holder.

Dischargers are currently required to report to the DEQ each month. Report contents are specified and are tailored to the size and complexity of the plant and to the effluent limitations specified in the permit. Plant flows are required to be recorded as well as certain laboratory test results.

The self-monitoring reports are used as a screening mechanism to point out operation problems and existing or impending effluent limit violations. The reports are used as a guide to direct the DEQ resources to the needs for more detailed monitoring and possible enforcement action.

More importantly, however, the reports serve as an aid to the operator in evaluating his own operation. The requirements in effect mandate the availability of operational data which the operator can then use to improve his operation.

Another self-monitoring program is the State initiated Effluent Quality Analysis Program (EQAP). This is a program where the State Hygienic Laboratory mails specially prepared sample bottles to each discharger. The plant operator collects a sample at times and locations recommended by the DEQ, and mails the sample back to the State Hygienic Laboratory for analysis. Samples are analyzed monthly for Biochemical Oxygen Demand (BOD) and, in some cases, ammonia. Other water quality parameters compatible with acid fixing can also be analyzed from the EQAP sample. Occasionally, heavy metal or phosphorus analyses are performed at the request of the DEQ.

Plant Inspection - The DEQ also conducts on-site plant inspections. The purpose of the inspection is to provide an in-depth analysis of the operation, maintenance, and effectiveness of the treatment plant. The inspections provide verification of self-monitoring reports and determination of whether the plant is in compliance with permit stipulations.

Influent and effluent samples are collected and analyzed when possible, but in many cases visual observations of the effluent by the inspector can satisfactorily make the determination. The inspection also includes an evaluation of the effects of the effluent on the receiving stream, occasionally by sampling, but more often by visual observation.

The advantage of the on-site inspection over the other monitoring programs is the opportunity to make cause and effect evaluations. The inspector can observe the raw waste load and the operation and maintenance factors which determine the efficiency and effectiveness of the treatment process.

The value of the inspections is twofold; first, they provide a valuable tool for evaluating permit compliance and documenting the need for enforcement actions, and secondly, and equally important, they provide a vehicle for assistance to the operator. The inspectors can provide counsel and advice to the local officials on meeting permit requirements as well as operation and maintenance methods to improve plant operation and efficiency.

Plant inspections are normally made by the DEQ regional staff. The regional staff make the inspections when minimal or no sampling is needed in conjunction with the inspection. Central office staff make inspections when intensive composite sampling is required. The number of inspections conducted each year is limited by the availability of fiscal and personnel resources. Approximately three to four hundred municipal and industrial inspections are made each year, along with a similar number of quick stop visits. All municipal and major industrial plants should be inspected each year. The number of inspections will be increased as staff is added to the Regional offices.

Waste Load Allocations

Waste load allocations have been made for point sources of wastewater discharge in order to maintain water quality standards. The scope of the allocations was limited to evaluation of effluent limitations necessary to meet the dissolved oxygen (DO) and ammonia-nitrogen (NH_3-N) standards, at the 7-day, 1-in-10 year low stream flow.

The DO and NH_3-N parameters were selected for evaluation because they are generally the most critical criteria of the water quality standards. Data from five years of municipal treatment plant effluent sampling are available on these parameters and are readily adaptable to data processing. Other criteria within the water quality standards can normally be met with secondary treatment.

It is recognized that other parameters could be considered in the waste load allocation analyses. An analysis of historical water quality data shows that other water quality criteria have been violated and that critical conditions may also exist for some parameters during high stream flow periods. Some other parameters of particular concern include heavy metals, toxic elements, fecal coliform and thermal discharges. Where standards violations are apparent for parameters other than DO and NH_3-N they are studied on an individual basis and effluent limits incorporated into the operation permits. A more detailed waste load allocation analysis, however, will have to be left until subsequent revisions of this plan when additional data and information become available.

To predict the variation in DO and ammonia concentrations in the streams, a computer-based mathematical model was used. Input data for the model was developed from existing information and cursory field investigations of the streams. When necessary, conservative assumptions have been made that tend to assure a high degree of protection for water quality without necessitating unrealistically stringent effluent limitations. Future stream surveillance should help to verify particular constants and assumptions used, and improve the validity of the model. Based upon existing data, prediction of the impact of different wastewater loads upon the DO and ammonia concentrations may be performed.

A detailed discussion of the mathematical model, methodology, and assumptions used in the waste load allocation analysis is included in Chapter IV of the Supporting Document (1). The final allocations for the Western Iowa River Basin are contained in Chapter VI of this report.

Permit System

The major mechanism by which the water quality management plan will be implemented is the wastewater construction and operation permit program conducted by the DEQ, under authority of Chapter 19, of the rules of the Department (1973 IDR). Any person intending to construct, modify or extend any wastewater disposal system in the State of Iowa must first obtain a construction permit from the Executive Director of DEQ. An operation permit is also required prior to the operation of any disposal system, or the discharge of sewage, industrial waste, or other wastes from any discharge source. Chapter 455B of the Code also has provisions included for correcting violations of any permit, rule, standard, or order issued under Part 1 of Division III of the Chapter.

NPDES - The Federal Water Pollution Control Act Amendments of 1972 (the Act) established a National Pollutant Discharge Elimination System (NPDES) permit program. Any person presently discharging wastewater to public waters is required to obtain an NPDES permit. Any person proposing a disposal system which will result in a wastewater discharge is required to apply for an NPDES permit at least 180 days before such discharge is to commence.

The Act also established a procedure whereby the EPA can delegate permit authority to those States that desire to administer the NPDES program. The State must demonstrate ability to conduct the program and must have adequate legal authority to enforce the permits. The DEQ is currently preparing a delegation request to EPA for issuance of NPDES permits in Iowa.

Operation Permits - An operation permit is a legally enforceable document which specifies the type of waste water which may be discharged, as well as the allowable quantities, concentrations, and rates of discharge. As a minimum, the effluent limitations are equivalent to secondary treatment for municipalities or BPT for industries, but, more stringent limits may be required as needed to meet water quality standards.

The permits also contain self-monitoring and reporting provisions that require dischargers to monitor their effluents and report the results to the DEQ. The DEQ data processing system stores and reports the water quality and compliance schedule data in formats designed to point out violations and problem areas. Fiscal and personnel constraints limit the number of violations and problem areas that can be effectively pursued. Staff resources are, therefore, directed to those discharges which are determined to be of sufficient importance by the priority ranking formula.

Provisions of the State construction and operation permit program also require that certain agricultural operations also obtain a permit for wastewater disposal. This subject is discussed in Chapter VII. Industries which discharge their wastewater to municipal plants do not need an operation permit, but must follow certain pre-treatment standards as published by EPA.

Operation permits are written for a maximum of five years, with renewal application required prior to expiration. A permit can be modified at any time if there is a violation of any terms or condition of the permit, a change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge, or if it is found that the permit was obtained under any type of misrepresentation of fact.

Many dischargers are not currently treating their wastewaters to a sufficient degree to comply with the final effluent limitations of their permit. In these cases the permits are written with interim and final effluent limitations and legally enforceable compliance schedules. These compliance schedules usually specify a series of interim dates so as to assure steady progress on the remedial efforts. The final compliance date, however, is not later than July 1, 1977.

Iowa water pollution control law provides for stiff penalties for violations of permit and other rules or standards. A large bulk of the DEQ compliance action work load is directed toward negotiating corrections. Negotiations are aimed at identifying practical remedial measures. Legal enforcement actions follow only where negotiations are not effective.

Water Quality Management Deadlines

As already mentioned, this document will help to direct the water quality management strategies necessary to implement a remedial program needed to meet the goals of the Act. The Act and the DEQ specify several deadlines that must be met in the implementation of this management program. Several key dates which have been established both by the EPA and the DEQ for improving wastewater treatment to protect National and State water quality follow. These dates are used to establish implementation schedules for the remedial measures defined by this plan.

Date	Action
December 31, 1974	National Pollutant Discharge Elimination System Permits issued.
June 30, 1975	Section 303(e) basin plans completed.
July 1, 1977	Secondary treatment required for all publicly-owned treatment works.
July 1, 1977	Best practicable waste treatment technology for all industrial discharges.

July 1, 1977	More stringent effluent limits to meet Iowa water quality standards.
July 1, 1983	Best practicable waste treatment technology for all publicly-owned treatment works.
July 1, 1983	Best available technology for all industrial discharges.
July 1, 1985	Zero pollutant discharge.

Construction Grants

If all point source dischargers are to meet the effluent limitations imposed by the waste load allocations, considerable monetary expenditures will be required on behalf of municipalities and industries. Industrial dischargers must provide their own waste treatment financing. The Federal Water Pollution Control Act Amendments of 1972, under Title II - "Grants for Construction of Treatment Works" provide for federal grants for publicly owned waste water treatment facilities. Municipalities may apply to the EPA through the DEQ for federal grants of 75% of eligible costs of their wastewater treatment works improvements. Municipalities must then provide from other sources, the remaining 25% of the cost. Eligible project costs include those for treatment, interceptors, and collection facilities. Collection facilities have been assigned lowest priority.

In the past, federal funds allocated to Iowa had been sufficient to cover the grant funding of all needed treatment facilities, however, during the past two years the needs have outgrown the availability of federal funds. Nationwide federal allotments for fiscal years 1974 and 1975 were $3 billion and $4 billion, respectively. Of the national allotment, Iowa's shares were $34.7 million and $39.3 million respectively. Current needs for the State for all eligible facilities excluding storm sewers, based on 1973 dollars is $989,584,000, as contained in the 1974 "Needs Survey" for the State of Iowa. These needs will continue to increase as better information is developed through the waste load allocations and basin planning processes. Inflation is also having a significant influence on treatment facility costs.

Priorities for Funding - To receive grant funding a municipality must proceed through certain requirements. The DEQ is responsible for establishing an orderly priority process for the administration and obligation of federal grant funds. All municipalities are placed on the state discharge inventory and assigned a discharge priority. Should a municipality have a need for improvement or construction of wastewater treatment facilities and apply for federal grant funds, it is then placed in the construction grant priority listing according to its discharge priority rank. The construction grant priority list is revised annually. After determination of the available federal grant money for the year, the annual project list can be established based upon the number of projects from the priority list that can be funded.

Prior to adoption of the annual "priority list" and "project list" for each fiscal year, a public hearing is held where interested persons may voice objections to the proposed lists. Following consideration of public hearing comments the final lists are prepared and approved by the Water Quality Commission and the EPA.

Types of Grants - Once a municipality has been placed upon the "project list" and has been found to be eligible for grant funding, a three-step grant process is initiated in accordance with Federal Regulations 40 CFR 35, promulgated by EPA to implement Title II of the Federal Act.

Step one, known as the facility plan, contains an evaluation of the water pollution control problem; explores a number of alternatives to eliminate the problem; conducts a cost-effectiveness study for each alternative; evaluates the environmental impact of each alternative; and finally, chooses the specific alternatives which seem to have the most environmental, economic, and social benefits. The facility plan must be submitted to the DEQ and the EPA for approval before the second step can be considered.

Step two covers the preparation of construction plans and specifications which are based on the alternative chosen in the facility plan. After approval of the plans and specifications by the DEQ and the EPA, step three, which is the actual construction of the required facilities, can be initiated. Grants are made to applicants for each of the three steps.

Before the facility planning (Step 1) process is begun, the DEQ will inform the applicant of the minimum quality of effluent which can be discharged to the receiving waters. The facility planning for a specific discharge is then directed at meeting these effluent limitations.

Priority System

Application of the waste load allocations and effluent limitations results in considerable needs to upgrade or expand existing wastewater treatment facilities. Although there is considerable expense involved to meet State and Federal water quality goals, the financial resources available each year for publicly owned facilities are limited. Not all needed projects can be funded at once. To solve this problem, a system of priorities has been established. This section describes a portion of the system proposed for use by the State of Iowa.

Stream Segment Priority Ranking - Each major river basin is first divided into various stream segments. Each stream segment consists of surface waters that have common hydrologic characteristics and natural, physical, chemical, and biological processes. In accordance with EPA guidelines, the stream segments must be classified either effluent limited (EL) or water quality limited (WQ).

Segment classification is a contributing factor in the determination of the segment ranking, discharger ranking, and compliance scheduling. The two segment types are described as follows:

1. An effluent limited (EL) segment is any segment where it is known that water quality is meeting and will continue to meet standards, or where there is adequate demonstration that standards will be met after application of secondary treatment or BPT to all point discharges to the segment.
2. A water quality limited (WQ) segment is any segment where it is known that water quality does not currently meet applicable standards and it is not expected that standards would be met even after application of secondary treatment or BPT to all point discharges to the segment.

All segments are next ranked in order of abatement priority. The ranking methodology attempts to take into account: (1) severity of pollution problems, (2) population affected, (3) need for preservation of high quality waters, and (4) national priorities.

Two major concepts were considered necessary and sufficient to distinguish any segment from other segments of the basin. These are: (1) the degree of usefulness of the segment, assuming water quality standards are met, and (2) the number of discharges required to meet effluent limitations in order to bring the segment into compliance with water quality standards. These concepts, thus, form the basis of the ranking methodology.

The specific formula used to calculate the total points for a segment is as follows:

$$\text{TOTAL SEGMENT POINTS} = (0.5 + B_C + B_W + C + BC + AES + POP) \times SQ$$

Where: A = 2 if the segment contains any designated class A waters and 0 otherwise.

B_C = 2 if the segment contains any designated class B cold waters and 0 otherwise.

B_W = 1 if the segment is designated as a class B warm waters and 0 otherwise.

C = 2 if the segment contains any designated class C waters and 0 otherwise.

BC = 1 if the segment is designated as being useful for either boating and/or canoeing and 0 otherwise.

AES = 1 if the segment is considered to include an area of significant aesthetic value and 0 otherwise.

$$POP = \begin{bmatrix} 2.0 \\ 1.5 \\ 1.0 \\ 0.5 \\ 0 \end{bmatrix} \text{ if } \begin{bmatrix} \text{30 or more} \\ \text{15 to 30} \\ \text{5 to 15} \\ \text{0.5 to 5} \\ \text{0 to 0.5} \end{bmatrix} \text{ thousand people reside}$$

within a 10 mile wide corridor adjacent to either side of the segment and at least one of the above terms (A, B_C, B_W, C, BC, or AES) is nonzero.

SQ = 6 if the segment is designated as water quality limited and more than four dischargers have a waste load allocation more stringent than secondary treatment.

SQ = 5 if the segment is designated as water quality limited and three or four dischargers in the segment have a waste load allocation more stringent than secondary treatment.

SQ = 4 if the segment is designated as water quality limited and one or two dischargers in the segment have a waste load allocation more stringent than secondary treatment.

SQ = 3 if the segment is designated as effluent limited with water quality standards violated.

SQ = 2.5 if the segment is designated as effluent limited with water quality standards met.

SQ = 2 if the pollution load to the segment at low flow is contributed equally by point and non-point sources.

SQ = 1 if the pollution load to the segment at low flow is predominantly from nonpoint sources.

The formula for total segment points contains two factors. The first factor allocates points for the degree of usefulness of the segment. It is felt that the population that uses, or would use, the waters of a segment are those most affected by any pollution problems in the segment and further, that this population increases in direct proportion to the potential usefulness of the segment.

The intent of allowing the points of terms A, B_C, B_W, C, BC, and AES, which designate specific water uses, is obvious.

The term POP is included to provide additional points when a segment has any of the above uses, since any usefulness is considered to be of somewhat greater value if a large population resides nearby. The constant term of .5 is included so the product of factors cannot be zero.

The second factor allocates a varying number of points based on whether the segment is designated as effluent limited or water quality limited. The highest level of points is given to segments which have a large number of discharges required to meet waste load allocations more stringent than secondary treatment or BPT to bring the segment into compliance with water quality standards. The scale of points for this factor basically gives an increasing amount of points in those areas where the greatest degree of point source pollution exists.

The total points for a segment are determined from a product of the points earned in each of the two factors. The formula was written in the form of a product so as to give low total points if either factor was low, and high points only if both factors are high. In this manner the formula weighs both the degree of usefulness of a segment and the severity of the pollution problem.

After the total points are determined for each segment in the basin, the segments are then ranked in decreasing order of points. The number one ranked segment is the segment receiving the most total points.

Following the segment ranking, abatement priority points are assigned to each segment. The abatement points are used as a factor in the municipal discharger ranking which is discussed later. The abatement priority points are determined as follows:

ABATEMENT PRIORITY POINTS = Total number of segments in the basin + 1 - Segment Rank

The selected stream segments, for the Western Iowa Basin are detailed in Chapter VI. Total segment points, segment rank, and abatement priority points are also presented in the chapter.

Municipal Discharger Ranking Methodology - In compliance with 40 CFR 130.43, which states that significant municipal dischargers shall be ranked to be subsequently used in establishing priorities and output estimates for municipal facilities construction, the following discharger ranking methodology has been promulgated for the basin plans. This ranking methodology is also in collaboration with current EPA Basin Plan Guidelines (Part IV, para. c) which states that significant municipal dischargers should be ranked in order of abatement priority.

This methodology ranks the municipal discharges in order of significance based on the following criteria:

1. A means of indicating the relative magnitude of one discharger with respect to all other dischargers.

2. A means of accounting for the present effluent quality of the dischargers.
3. A means of indicating the relative magnitude of the discharger in comparison to the capacity of the stream segment at the point of discharge.
4. A means of indicating the relative magnitude of the discharger in comparison to the total waste load of all other dischargers to the stream segment.
5. A means of comparison of the relative merit of the stream segment, to which the municipality discharges, to other segments in the basin.

To incorporate these criteria in the ranking methodology, the following factors were considered and evaluated. It should be noted that the numbering of the factors corresponds to that of the preceding criteria.

1. Total pounds of BOD_5 and ammonia-N presently being discharged, using average reported flows.
2. Discharger's present BOD_5 and ammonia-N concentrations as reported through EQAP.
3. Discharger's present BOD_5 and ammonia-N waste load compared to the stream capacity.
4. Discharger's present BOD_5 and ammonia-N waste load compared to the total waste load from all dischargers to the stream segment.
5. Stream segment abatement priority points into which the municipality discharges.

Sufficient data is readily available to assess the degree of significance of a municipal discharger in terms of factors 1, 2, and 3. Likewise the stream segment abatement priority points, as indicated in factor 5, has previously been determined, however, the selection and manipulation of required data needed to comply with factor 4 is considerably more difficult due to the non-coincidental cause and effect nature of certain discharged pollutant materials. Thus a blending of factors 3 and 4 was deemed the most feasible alternative. This was accomplished by comparing the discharger's present BOD_5 and ammonia-N waste load to the respective values allowed for the discharger under its waste load allocation. This comparison was felt reasonable and justified since the calculations performed in determining waste load allocations take into account both stream capacities and other discharger's waste loads.

This methodology thus ranks a discharge with respect to its relative share of the waste load to the segment, as well as to the waste load the discharger contributes at its present degree of treatment. This rationale also takes into account population equivalency in lieu of just the contributing population, the relative overloading of the stream segment as determined by waste load allocations analysis, and the relative ranking of the stream segments as determined by the segment ranking methodology.

The specific formula used to rank dischargers is as follows:

$(A_1 + D_1) B_1 + (A_2 + D_2) B_2 + C$ = Discharger priority points

The discharger ranking formula consists of four elements which attempt to incorporate the criteria described above. The four elements are as follows:

Element A: Present Effluent Discharge;

$$A_1 = \begin{bmatrix} 60 \\ 50 \\ 40 \\ 30 \\ 20 \\ 10 \\ 0 \end{bmatrix} \text{ if the present } BOD_5 = \begin{bmatrix} >60 \text{ mg/l} \\ 60-50.1 \\ 50-40.1 \\ 40-30.1 \\ 30-20.1 \\ 20-10.1 \\ 10-0 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} 60 \\ 50 \\ 40 \\ 30 \\ 20 \\ 10 \\ 1 \end{bmatrix} \text{ if the present } NH_3\text{-N} = \begin{bmatrix} >40 \text{ mg/l} \\ 40-30.1 \\ 30-23.1 \\ 23-15.1 \\ 15-8.1 \\ 8-2.1 \\ 2-0 \end{bmatrix}$$

This element uses the present average reported BOD_5 and ammonia-N values as representative effluent values (where possible).

Element B: Degree of stream overloading;

a. BOD Overloading Factor:

$$1 - \frac{\text{lb. W.L.A.}}{\text{lb. PRES}} = B_1$$

where: lb. W.L.A. is the total lbs/day of BOD_5 allowed, as determined by the waste load allocation.

lb. PRES is the average lbs/day of BOD_5 which is currently being discharged.

2. Ammonia-N Overloading Factor:

$$1 - \frac{\text{lbs. W.L.A.}}{\text{lbs. PRES}} = B_2$$

where: lbs. W.L.A. is the total lbs/day of NH_3-N allowed as determined by the waste load allocations.

lbs. PRES is the average lbs/day of NH_3-N which is currently being discharged.

Note: B_1 and B_2 are only allowed to vary from zero to 1.00 in this methodology. All other values are set equal to zero.

Element C: The segment abatement priority points are used for element C.

Element D: Total contributing lbs. of BOD_5, and NH_3-N:

$$D_1 = \begin{bmatrix} 0 \\ 1 \\ 3 \\ 5 \\ 7 \\ 9 \\ 12 \\ 14 \\ 16 \\ 18 \\ 21 \\ 25 \end{bmatrix} \text{ if the present } BOD_5 = \begin{bmatrix} \text{1.5 or less} \\ 1.5-3 \\ 3-5 \\ 5-10 \\ 10-20 \\ 20-50 \\ 50-100 \\ 100-250 \\ 250-750 \\ 750-1500 \\ 1500-2500 \\ \text{2500 or more} \end{bmatrix} \text{ lbs.}$$

$$D_2 = \begin{bmatrix} 0 \\ 1 \\ 3 \\ 5 \\ 7 \\ 9 \\ 12 \\ 14 \\ 16 \\ 18 \\ 21 \\ 25 \end{bmatrix} \text{ if the present } NH_3\text{-N} = \begin{bmatrix} \text{.75 or less} \\ .75-1.5 \\ 1.5-2.5 \\ 2.5-5 \\ 5-10 \\ 10-25 \\ 25-50 \\ 50-125 \\ 125-375 \\ 375-750 \\ 750-1250 \\ \text{1250 or more} \end{bmatrix} \text{ lbs.}$$

This element takes into account the actual waste load which the stream receives, instead of a representation of the actual population.

The relative position of each discharger is determined by its total points as calculated by the discharger ranking formula. The dischargers are finally ranked in decreasing order of discharger priority points. The ranking of municipal dischargers in the Western Iowa Basin, as well as the priority points for each discharger, is presented in Chapter VI.

REFERENCES

1. Supporting Document For Iowa Water Quality Management Plans, Iowa Department of Environmental Quality, Water Quality Management Division, Des Moines, Iowa, 1976.

CHAPTER II

EXISTING DEVELOPMENT PATTERNS

WESTERN IOWA BASIN

POLITICAL SUBDIVISION

The Western Iowa Basin includes twenty-two counties or parts thereof. Table II-1 lists those counties, or their respective subdivisions, within the basin. One hundred forty-eight incorporated communities are included within the basin boundaries. The 1970 total population of these incorporated municipalities was 292,214 people. Forty cities had populations greater than 1,000. Six cities had populations in excess of 5,000. Only two had a population over 50,000, Sioux City at 85,925 and Council Bluffs at 60,348. Figure II-1 shows the incorporated municipalities in the basin and Table II-2 summarizes their 1970 and projected 1990 populations.

POPULATION PROJECTION

The DEQ has made population projections for those cities for the year 1990, based on the projections of Taylor (1). For those individual municipal projections not estimated by Taylor, the 1990 population of the community was estimated by multiplying its 1970 population by the ratio of the projected 1990 county population to the 1970 county population. The population projections for 1990 that were used for this study are indicated in Table II-2.

TABLE II-1

PORTION OF COUNTIES WITHIN

THE WESTERN IOWA BASIN

COUNTY	PERCENT
Buena Vista	37.2
Carroll	7.2
Cherokee	100.0
Clay	95.4
Crawford	83.8
Dickinson	92.6
Emmet	4.1
Fremont	21.8
Harrison	100.0
Ida	100.0
Lyon	100.0
Mills	37.9
Monona	100.0
O'Brien	100.0
Osceola	100.0
Palo Alto	7.0
Plymouth	100.0
Pottawattamie	43.7
Sac	52.2
Shelby	27.1
Sioux	100.0
Woodbury	100.0

TABLE II-2

EXISTING AND PROJECTED POPULATIONS (AFTER TAYLOR (1))

WESTERN IOWA BASIN

TOWN	COUNTY	POP. 1970	POP. 1990
Akron	Plymouth	1,324	1,424
Alta	Buena Vista	1,717	2,726
Alton	Sioux	1,018	1,018
Alvord	Lyon	204	239
Anthon	Woodbury	711	797
Arcadia	Carroll	414	414
Archer	O'Brien	134	146
Arion	Carroll	199	234
Arnolds Park	Dickinson	970	1,119
Arthur	Ida	273	273
Ashton	Osceola	483	498
Aurelia	Cherokee	1,065	1,645
Battle Creek	Ida	837	837
Blencoe	Monona	225	234
Boyden	Sioux	670	670
Bronson	Woodbury	193	216
Brunsville	Plymouth	125	127
Buck Grove	Crawford	41	41
Calumet	O'Brien	219	239
Carter Lake	Pottawattamie	3,268	6,434
Castana	Monona	211	219
Charter Oak	Crawford	715	715
Chatsworth	Sioux	90	90
Cherokee	Cherokee	7,272	8,064
Cleghorn	Cherokee	274	302
Correctionville	Woodbury	870	975
Council Bluffs	Pottawattamie	60,348	66,201
Craig	Plymouth	98	99
Crescent	Pottawattamie	284	487
Cushing	Woodbury	204	228
Danbury	Woodbury	527	590
Deloit	Crawford	279	279
Denison	Crawford	6,213	7,455
Dickens	Clay	240	240
Doon	Lyon	437	513

TABLE II-2 (cont.)

TOWN	COUNTY	POP. 1970	POP. 1990
Dow City	Crawford	571	571
Dunlap	Harrison	1,292	2,086
Earling	Shelby	573	660
Early	Sac	727	808
Everly	Clay	699	699
Fostoria	Clay	219	219
Galva	Ida	412	412
George	Lyon	1,194	1,591
Glenwood	Mills	4,421	5,367
Granville	Sioux	383	383
Greenville	Clay	117	117
Harris	Osceola	195	201
Hartley	O'Brien	1,694	2,092
Hawarden	Sioux	2,789	3,185
Hinton	Plymouth	488	495
Holstein	Ida	1,445	1,830
Hornick	Woodbury	250	280
Hospers	Sioux	646	646
Hull	Sioux	1,523	1,928
Ida Grove	Ida	2,261	2,751
Inwood	Lyon	644	756
Ireton	Sioux	582	605
Kingsley	Plymouth	1,097	1,295
Kiron	Crawford	275	275
Lake Park	Dickinson	918	1,059
Larchwood	Lyon	611	717
Larrabee	Cherokee	167	184
Lawton	Woodbury	406	455
Le Mars	Plymouth	8,159	10,982
Lester	Lyon	238	279
Linn Grove	Buena Vista	240	240
Little Rock	Lyon	531	623
Little Sioux	Harrison	239	299
Logan	Harrison	1,526	2,238
Magnolia	Harrison	206	258

TABLE II-2 (cont.)

TOWN	COUNTY	POP. 1970	POP. 1990
Mapleton	Monona	1,647	2,226
Marcus	Cherokee	1,272	1,564
Matlock	Sioux	89	89
Maurice	Sioux	266	266
McClelland	Pottawattamie	146	250
Melvin	Osceola	325	335
Meriden	Cherokee	167	184
Merrill	Plymouth	790	802
Milford	Dickinson	1,668	2,605
Minden	Pottawattamie	433	743
Missouri Valley	Harrison	3,519	5,179
Modale	Harrison	297	372
Mondamin	Harrison	420	527
Moneta	O'Brien	41	44
Moorhead	Monona	271	281
Moville	Woodbury	1,198	1,596
Neola	Pottawattamie	968	1,662
Ocheyeden	Osceola	545	562
Odebolt	Sac	1,323	1,831
Okoboji	Dickinson	361	416
Onawa	Monona	3,154	4,434
Orange City	Sioux	3,572	5,157
Orleans	Dickinson	396	456
Oto	Woodbury	203	227
Oyens	Plymouth	145	147
Pacific Junction	Mills	505	613
Panama	Shelby	221	254
Paullina	O'Brien	1,257	1,571
Persia	Harrison	316	396
Peterson	Clay	469	469
Pierson	Woodbury	421	471
Pisgah	Harrison	286	358
Portsmouth	Shelby	239	275
Primghar	O'Brien	995	1,088
Quimby	Cherokee	395	435

TABLE II-2 (cont.)

TOWN	COUNTY	POP. 1970	POP. 1990
Remsen	Plymouth	1,367	1,464
Ricketts	Crawford	141	141
Rock Rapids	Lyon	2,632	3,313
Rock Valley	Sioux	2,205	3,206
Rodney	Monona	66	68
Rossie	Clay	91	91
Royal	Clay	469	469
Ruthven	Palo Alto	708	708
Salix	Woodbury	387	433
Sanborn	O'Brien	1,465	2,197
Schaller	Sac	835	928
Schleswig	Crawford	875	875
Sergeant Bluff	Woodbury	2,054	4,108
Sheldon	O'Brien	4,535	6,045
Sibley	Osceola	2,749	3,535
Sioux Center	Sioux	3,450	6,009
Sioux City	Woodbury	85,925	105,700
Sioux Rapids	Buena Vista	813	813
Sloan	Woodbury	799	895
Smithland	Woodbury	293	328
Soldier	Monona	242	251
Spencer	Clay	10,278	14,348
Spirit Lake	Dickinson	3,014	4,319
Struble	Plymouth	59	59
Superior	Dickinson	139	160
Sutherland	O'Brien	875	957
Tabor	Fremont	957	1,162
Tennant	Shelby	93	107
Terril	Dickinson	397	458
Thurman	Fremont	230	279
Turin	Monona	115	119
Underwood	Pottawattamie	424	728
Ute	Monona	512	532
Vail	Crawford	486	486
Wahpeton	Dickinson	149	171

TABLE II-2 (cont.)

TOWN	COUNTY	POP. 1970	POP. 1990
Wall Lake	Sac	936	1,040
Washta	Cherokee	319	351
Webb	Clay	234	234
West Okoboji	Dickinson	210	242
Westfield	Plymouth	148	150
Westside	Crawford	389	389
Whiting	Monona	590	613
Woodbine	Harrison	1,349	2,119

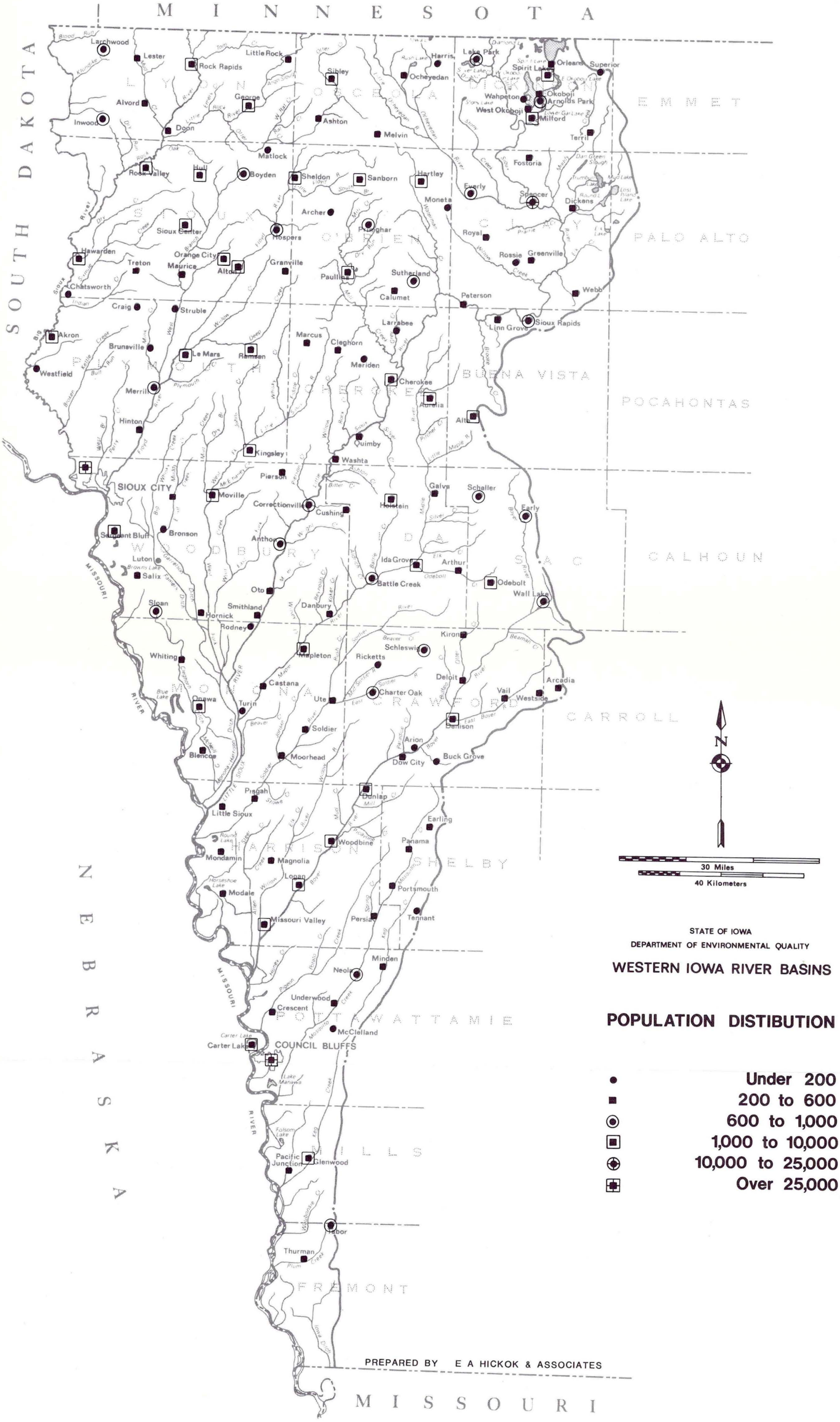

MINNESOTA
SOUTH DAKOTA
NEBRASKA
MISSOURI
EMMET
PALO ALTO
POCAHONTAS
CALHOUN
CARROLL
BUENA VISTA
LYON
OSCEOLA
DICKINSON
O'BRIEN
CLAY
SIOUX
PLYMOUTH
CHEROKEE
WOODBURY
IDA
SAC
MONONA
CRAWFORD
HARRISON
SHELBY
POTTAWATTAMIE
MILLS
FREMONT
SIOUX CITY
COUNCIL BLUFFS
Larchwood
Lester
Rock Rapids
Little Rock
Sibley
Harris
Ocheyedan
Lake Park
Spirit Lake
Orleans
Superior
Okoboji
Arnolds Park
Wahpeton
West Okoboji
Milford
Terril
Alvord
Inwood
George
Doon
Ashton
Melvin
Matlock
Rock Valley
Hull
Boyden
Sheldon
Sanborn
Hartley
Fostoria
Everly
Spencer
Dickens
Moneta
Archer
Primghar
Hospers
Sioux Center
Royal
Rossie
Greenville
Hawarden
Treton
Orange City
Maurice
Alton
Granville
Paullina
Sutherland
Calumet
Chatsworth
Craig
Struble
Webb
Peterson
Linn Grove
Sioux Rapids
Akron
Brunsville
Le Mars
Remsen
Marcus
Cleghorn
Meriden
Larrabee
Westfield
Merrill
Cherokee
Aurelia
Alta
Hinton
Quimby
Kingsley
Washta
Pierson
Moville
Galva
Schaller
Correctionville
Cushing
Holstein
Early
Sergeant Bluff
Bronson
Anthon
Luton
Salix
Ida Grove
Arthur
Battle Creek
Odebolt
Wall Lake
Oto
Sloan
Smithland
Hornick
Rodney
Danbury
Kiron
Mapleton
Schleswig
Ricketts
Whiting
Castana
Deloit
Charter Oak
Ute
Vail
Westside
Arcadia
Onawa
Turin
Denison
Soldier
Arion
Moorhead
Dow City
Buck Grove
Blencoe
Pisgah
Dunlap
Little Sioux
Earling
Woodbine
Panama
Mondamin
Magnolia
Logan
Portsmouth
Modale
Missouri Valley
Persia
Tennant
Minden
Neola
Underwood
Crescent
McClelland
Carter Lake
Pacific Junction
Glenwood
Tabor
Thurman
N
30 Miles
40 Kilometers
STATE OF IOWA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WESTERN IOWA RIVER BASINS
POPULATION DISTIBUTION
Under 200
200 to 600
600 to 1,000
1,000 to 10,000
10,000 to 25,000
Over 25,000
PREPARED BY E A HICKOK & ASSOCIATES

FIGURE II-1

ECONOMICS

Information for this section was obtained from the Missouri River Basin Comprehensive Framework Study (2). Table II-3 presents data for the region depicted in Figure II-2. This region includes virtually all of the Western Iowa Basin and parts of Nebraska, Missouri, and Kansas. The larger cities in the region are Omaha-Council Bluffs, Sioux City and St. Joseph, Missouri.

Labor Force

The labor force is projected to nearly double between 1960 and 2020. As is true for agricultural areas in general, a relatively high proportion of men to women characterize the labor force. Maintenance of the ratio with respect to the nation as a whole is expected to continue into the early part of the 21st century.

Personal Income

Personal per capita income is expected to increase rather rapidly from 1960 to 1980, recovering from a decline in comparison to the national average between 1950 and 1960. From 1980 to 2020, a growth in per capita personal income is expected to keep pace with the rest of the nation, but actual absolute percentages will be a shade (around 2%) below the national average.

TABLE II-3

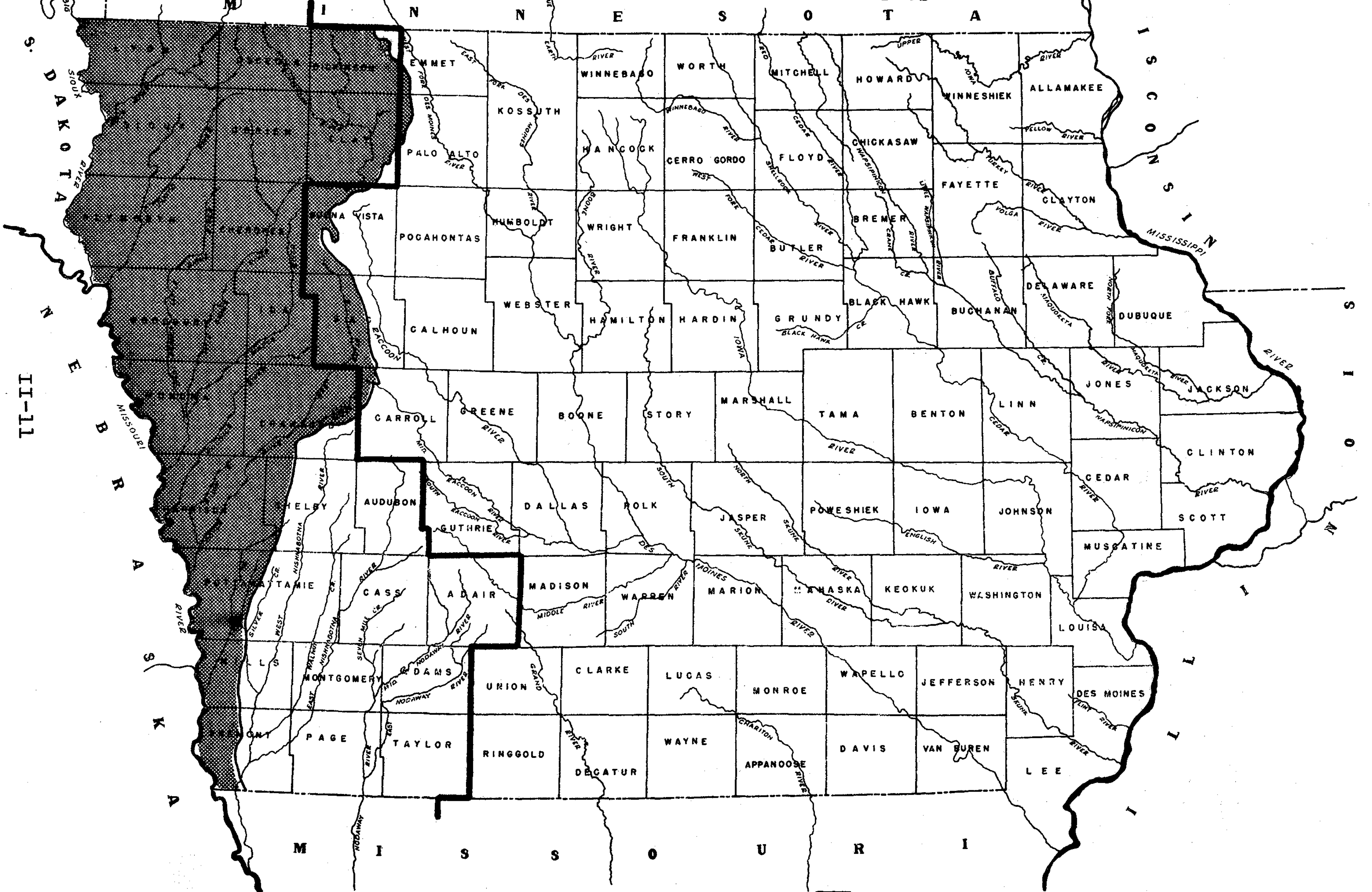
SUMMARY ECONOMIC DATA (2) FOR SELECTED AREA SHOWN IN FIGURE II-2

INCOME, POPULATION, AND EMPLOYMENT - HISTORIC AND PROJECTED MIDDLE MISSOURI SUBREGION

Item	1940	1950	1960	1980	2000	2020
Total personal income (000,000) (54$)	a/	2,069	2,367	4,612	9,071	18,531
Per capita personal income 1/ (54$)	a/	1,665	1,830	3,144	4,890	7,626
Total earnings (000,000) (54$)	a/	1,723	1,873	3,694	7,057	14,231
Earnings per employee 1/ (54$)	a/	3,603	3,878	6,504	9,815	15,091
Population	1,247,064	1,242,428	1,293,481	1,467,000	1,855,000	2,430,000
Urban	565,415	634,475	740,373	988,000	1,371,600	1,926,200
Rural	681,649	607,953	553,108	479,000	483,400	503,800
Non-farm	256,812	258,484	273,058	294,800	326,700	356,500
Farm	424,837	349,469	280,050	184,200	156,700	147,300
Employment	416,760	478,245	482,999	568,000	719,000	943,000
Agriculture	143,630	132,570	92,929	60,700	51,600	48,300
Manufacturing	39,551	58,499	75,611	99,000	124,500	162,400
Petroleum refining	a/	a/	a/	a/	a/	a/
Paper and allied products	a/	a/	a/	2,000	3,000	4,000
Primary metals	a/	a/	a/	2,000	3,000	3,000
Chemical products	1,095	1,867	2,438	5,100	8,500	15,300
Food products	21,320	30,298	35,017	36,600	41,800	41,600
Textile mill products	126	227	164	a/	a/	a/
Other commodity-producing industries	18,776	29,567	29,377	37,600	49,900	72,400
Noncommodity-producing industries	214,803	257,609	285,082	370,700	493,000	659,900

1/ Per capita income and earnings per employee computed from unrounded data.
a/ Not available or not projected.

FIGURE II-2
DATA BASE AREA FOR EMPLOYMENT STATISTICS



Approx. Scale
1:2,340,000

Western Iowa Basin
Major Rivers

Employment

As indicated in Table II-3, civilian employment in the region is projected to increase from nearly 483,000 in 1960 to 943,000 in 2020. This is substantially less than the national average.

Services and industries that do not produce goods are projected to grow to increasingly dominate the employment picture in the region. In 1940, only one-half of employees in the region were engaged in noncommodity-producing industries. The year 2020 is expected to see over two-thirds of workers so-employed.

Manufacturing employment is projected to show vigorous growth. Only recently manufacturing passed agriculture as the largest commodity-producing employer. In 1960, there were 75,611 employed in manufacturing, as contrasted with 162,000 expected in 2020. Over half of the manufacturing employment is concentrated in the Omaha-Council Bluffs area, which is expected to triple its manufacturing employment from 37,000 in 1960 to 104,000 in 2020. In the region outside Omaha-Council Bluffs, manufacturing employment is projected to grow from 38,000 to around 60,400 over the period.

Food products form a substantial part of the manufacturing industry. This industry should have a slow but sustained growth, although its percentage share of the total labor force will decline.

Agricultural employment is projected to continue its historic declines in absolute numbers, dropping by about 50 percent from 1960 to 2020. By 2020, only 6,700 more persons are expected to be in agriculture than in food products manufacturing.

Feed grain production and livestock raising and fattening are important in the agricultural economy of the region. In 1959 about 78 percent of the value of farm products sold was from livestock and livestock products.

Employment in minerals is mostly in non-metallics, and it is dispersed over the region. Most of those employed in minerals are in the construction-related sector, with a minor number of persons employed in petroleum and coal mining. The petroleum region is outside of Iowa, but the southern part of the western Iowa basins overlies bituminous coal fields.

The tiny timber industry is confined mainly to floodplain areas and placed along streams. In 1962, an estimated $3 million products-output value was harvested. Most of the wood is from hardwood stands.

Recreation, fish,and wildlife industries are not significant to total employment. The region is deficient in facilities for such, although a latent demand exists.

Employment in the construction industry is projected to increase through the period, both in terms of actual numbers and percentage of the work force.

RECREATIONAL ACTIVITIES

The Western Iowa River Basin provides numerous water-related recreational activities. The following areas are suitable for recreational sites.

1. Hills with trees for nature observation, hiking, and camping.

2. Lakes or streams for swimming, boating, water-skiing, and fishing.

3. Flood plains and plateaus for organized sport activities.

4. A combination of the above as a game habitat.

A common consideration of all available county and city plans reviewed for the study was the concept of retaining land along rivers for conservancy belts. These are to be left in a natural state for recreational pursuits, such as hiking, and stream access.

From a recreational standpoint, water must be of sufficient quality to support the propagation of desirable forms of fish and wildlife. Iowa "Class B" warm water standards should be adequate to satisfy this requirement (see Chapter IV, Water Quality). In areas where human body contact with the water is permitted, "Class A" standards are required for public health reasons. Maintenance of either Class A or Class B standards are required to retain an aesthetically acceptable water condition.

Figure II-3 shows the location of areas for boating activities in the Western Iowa Basin. In areas allowing power boats in excess of 10 horsepower, it is assumed that waterskiing (and swimming) would occur and that Class A standards should apply even though they may not now be in effect. Total or partial body contact with water would probably occur in areas not specifically designated. For example, body contact would generally occur in the canoeing regions. However, only those areas designated as body contact area need to meet Class A standards.

Figure II-3 also shows the location of existing and proposed recreational sites in the basin. Table II-4 lists data relative to each site. Average peak daily attendance at parks was assumed to be 3 percent of the total yearly attendance. Total yearly

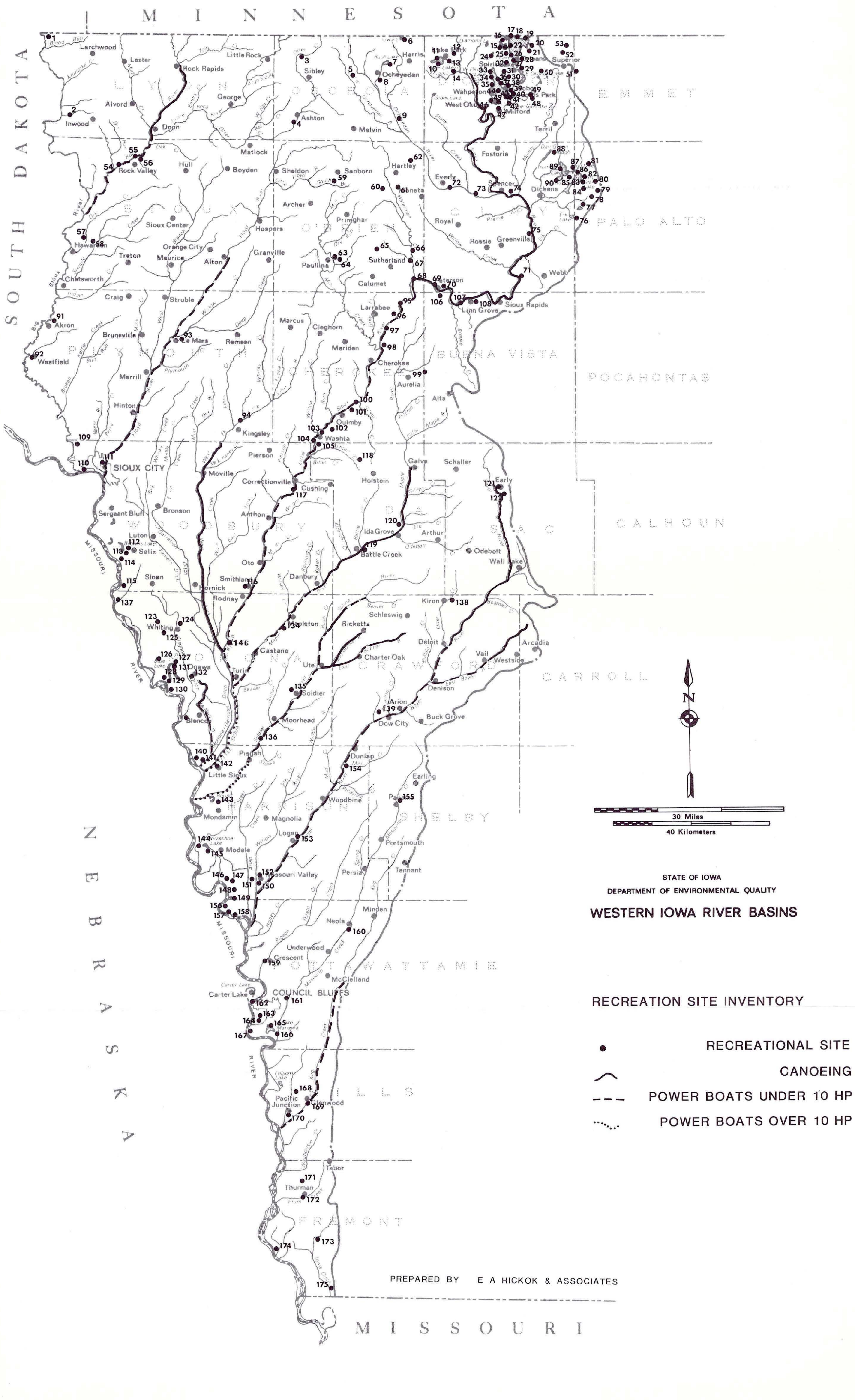

MINNESOTA
SOUTH DAKOTA
NEBRASKA
MISSOURI
LYON
OSCEOLA
DICKINSON
EMMET
SIOUX
O'BRIEN
CLAY
PALO ALTO
PLYMOUTH
CHEROKEE
BUENA VISTA
POCAHONTAS
WOODBURY
IDA
SAC
CALHOUN
MONONA
CRAWFORD
CARROLL
HARRISON
SHELBY
POTTAWATTAMIE
MILLS
FREMONT
SIOUX CITY
COUNCIL BLUFFS
MISSOURI RIVER
N
30 Miles
40 Kilometers
STATE OF IOWA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WESTERN IOWA RIVER BASINS
RECREATION SITE INVENTORY
RECREATIONAL SITE
CANOEING
POWER BOATS UNDER 10 HP
POWER BOATS OVER 10 HP
PREPARED BY E A HICKOK & ASSOCIATES

FIGURE II-3

TABLE II-4

EXISTING AND PROPOSED RECREATION FACILITIES

WESTERN IOWA BASIN

NO.	NAME OF AREA	OWNERSHIP	USAGE	ACRES TOTAL AREA	ACRES LAND AREA	ACRES WATER AREA	ARCHERY/GUN CLUB	BOATING	BOATING ACCESS	CAMPING	FISHING	GOLF COURSE	HIKING TRAILS	HUNTING	PICNICKING	SWIMMING
1	Gitchie Manitou Monument	State	1	91	90	1					*				*	
2	Wildlife Area	State	1	435	435									*		
3	Peters Pit Area	County	1	19	16	3								*		
4	Ashton Pits	State	1	33	22	11								*		
5	Johnson Wilderness	County	1	6	6									*		
6	Iowa Lake	State	1	114		114					*			*		
7	Rush Lake	State	1	336	22	314					*			*		
8	Ocheyedon Pit Area	County	1	18	16	2								*		
9	May City Pit Area	County	1	6	5	1					*					
10	Silver Lake	State	2	1141	83	1058		*	*	*	*			*		
11	Trappers Bay	State	2	65	65			*	*	*	*			*		
12	Cory Marsh	State	1	38	8	30								*		
13	Yager Slough	State	1	56	56									*		
14	Gaylor Prairie	State	1	160	160									*		
15	Diamond Lake	State	1	563	397	166					*			*		
16	Hotters Lake	State	1	378	378						*			*		
17	Little Spirit Lake	State	2	214		214		*	*		*			*		
18	Mini-Wakon State	State	1	20	20			*	*		*					*
19	Private Boat Landing	Private	1					*								
20	Spirit Lake	State	3	5685	1	5684		*	*		*					*
21	Hales Slough	State	1	85	26	59		*	*	*	*		*	*		*
22	Marble Beach	State	1	64	64			*	*	*	*		*	*		
23	Marble Beach	State	2	183		183		*	*	*			*			
24	Welch Lake	State	2	75		75							*			
25	Hogsback Area	State	2	262	262											
26	Crandalls Beach	State	1	6	6					*			*			
27	Spirit Lake Fish Hatchery	State	1	31	21	10		*	*	*	*				*	
28	Orleans Beach	State	1	2	2			*	*		*			*	*	
29	Narrows Access	State	2	1		1										
30	Center Lake	State	2	342	13	329		*	*		*			*	*	

TABLE II-4 (cont.)

EXISTING AND PROPOSED RECREATION FACILITIES

WESTERN IOWA BASIN

NO.	NAME OF AREA	OWNERSHIP	USAGE	ACRES TOTAL AREA	ACRES LAND AREA	ACRES WATER AREA	ARCHERY/GUN CLUB	BOATING	BOATING ACCESS	CAMPING	FISHING	GOLF COURSE	HIKING TRAILS	HUNTING	PICNICKING	SWIMMING
31	Jemmerson Slough	State	1	243	255	88								*		
32	Sunken Lake	State	1	62		62					*					
33	Lazy Lagoon	State	1	1		1		*	*						*	
34	Pikes Point	State	3	15	15			*	*	*	*			*	*	*
35	Private Boat Landing	Private	1					*								
36	West Okoboji Lake	State	4	3939		3939		*			*				*	*
37	Gull Point State Park	State	3	65	65			*	*	*	*		*	*		
38	East Okoboji Area	State	3	1897	24	1897		*	*		*			*		*
39	Private Boat Landing; Arnolds Park	Private	1													
40	Abby Gardner Shop Arnolds Park	State	1	1	1											
41	Arnolds Park Station	State	1	1	1			*	*		*					
42	Upper Gar Lake	State	2	43		43		*			*					
43	Lower Gar Lake	State	2	273	21	252		*	*		*					
44	Minnewashta Lake	State	2	122		122		*	*		*					
45	Pillsbury Point	State	2	6	6						*		*		*	
46	Garwood Slough	State	1	222	122	100		*	*	*	*		*	*	*	*
47	Private Boat Landing; Wilford	Private	1					*								
48	Spring Run	State	1	769	399	370									*	
49	Prairie Lake	State	1	109	9	100										
50	Pleasant Lake	State	1	84	7	77					*					
51	Four Mile Lake	State	1	5	5											
52	Swan Lake	State	1	380	9	371		*	*		*			*		
53	Christopherson Slough	State	1	335	164	171								*		
54	Rock-Sioux Access	State	1	30	30			*	*		*			*		
55	Winterfield Access	County	1	22	22			*	*		*			*	*	
56	Rock Valley Access	County	1	52	48	4					*					
57	Oak Grove	State	1	102	97	5				*	*		*		*	
58	Big Sioux Park	County	1	57	57			*	*	*	*		*		*	
59	Douma Park	County	1	21	11	10				*	*				*	*
60	Porter Wildlife Area	County	1	1	1					*					*	

TABLE II-4 (cont.)

EXISTING AND PROPOSED RECREATION FACILITIES

WESTERN IOWA BASIN

NO.	NAME OF AREA	OWNERSHIP	USAGE	ACRES			ARCHERY/GUN CLUB	BOATING	BOATING ACCESS	CAMPING	FISHING	GOLF COURSE	HIKING TRAILS	HUNTING	PICNICKING	SWIMMING
				TOTAL AREA	LAND AREA	WATER AREA										
61	Covey Church Park	County	1	1	1					*					*	
62	Bruegman Area	County	1	20	10	10					*				*	*
63	Private Clubs	Private	1													
64	Mill Creek	State	1	158	133	25		*	*	*	*	*			*	*
65	Wall Park	County	1	1	1					*					*	
66	Little Park	County	1	4	4										*	
67	Wittrock Indian Village	State	1	5	5											
68	Dog Creek Park	County	1	110	75	35				*	*				*	*
69	Witherell Area	County	1	3	3											
70	Boy Scout Campground	Boy Scouts	1													
71	Kindlespire Park	County	1	160	155	5										
72	Scharnberg Park	County	2	36	26	10				*					*	*
73	Ocheyedan Area	State	2	100	75	25					*			*		
74	Oneta Park	County	1	8	8											
75	Little Sioux Wildlife	State	1	160	160						*			*		
76	Elk Lake	State	1	261		261								*		
77	Private Boat Landing	Private	1													
78	Wapsi Marsh	State	1	80	80									*		
79	Private Boat Landing; Ruthven	Private	1	160	40	120										
80	Blue Wing Marsh	State	1											*		
81	Opedahl Area	State	1	184	77	107								*		
82	Grandview Park	County	1	1	1											
83	Lost Island Lake	State	3	1332	72	1260		*	*	*	*		*	*	*	
84	Barringer Slough	State	2	1071	293	778					*			*		
85	Smith Area	State	1	292	56	236		*	*		*			*		
86	Mud Lake	State	1	252		252								*		
87	Deweys Pasture	State	1	401	240	161								*		
88	Dan Green Slough	State	1	311		311								*		
89	Trumbell Lake Area	State	2	1224	39	1185		*	*		*			*		
90	Round Lake	State	1	438		438								*		

TABLE II-4 (cont.)

EXISTING AND PROPOSED RECREATION FACILITIES

NO.	NAME OF AREA	OWNERSHIP	USAGE	ACRES TOTAL AREA	ACRES LAND AREA	ACRES WATER AREA	ARCHERY/GUN CLUB	BOATING	BOATING ACCESS	CAMPING	FISHING	GOLF COURSE	HIKING TRAILS	HUNTING	PICNICKING	SWIMMING
	WESTERN IOWA BASIN															
91	Big Sioux Park	County	1	33	33											
92	Millsite Access	State	1	16	16			*	*		*			*		
93	Private Clubs	Private	1													
94	S. E. Wildwood Park	County	1	36	36											
95	Soo Access	State	1	17	16	1					*			*		
96	Nelson Access	County	1	9	9					*	*			*	*	
97	Martin Access	County	1	164	164			*	*	*	*			*	*	
98	Barnes Access	County	1	9	5	4		*	*		*			*	*	
99	Larson Lake	County	1	11	7	4				*	*			*	*	
100	Little Sioux Wildlife Association	Private	1								*			*	*	
101	Pearse Access	County	1	14	14						*			*	*	
102	Stieneke	County	1	16	15	1				*	*			*	*	
103	Ritts Access	County	1	9	9			*	*		*			*	*	
104	Ranney Knob Area	County	1	73	73			*	*	*	*			*	*	
105	Washta Access	State	1	52	52					*	*			*		
106	Wanata Reserve	State	1	160	160								*		*	
107	Buena Vista Co. Park	County	1	292	292					*			*	*	*	
108	Linn Grove Park	County	1	18	16	2			*	*	*				*	
109	Stone Park	State	4	865	865					*	*		*		*	
110	Private Boat Landing	Private	1													
111	War Eagle Park	Muni-cipal	1	24	24								*		*	
112	Bigelow Park	State	3	17	17			*	*	*	*				*	
113	Browns Lake	State	3	784	459	325		*	*		*			*		
114	Snyder Bend	County	1	34	34			*	*	*	*		*	*	*	
115	Winnebago Bend	State	2	29	29						*					
116	Smithland Forest	County	1	50	50								*		*	
117	Little Sioux Park	County	3	448	445	3		*	*		*		*	*	*	
118	Sherman Park	County	1	4	4										*	
119	Heiber Access	Private	1	5	5						*				*	
120	Moorhead Park	County	2	260	248	12				*	*		*		*	

EXISTING AND PROPOSED RECREATION FACILITIES

WESTERN IOWA BASIN

NO.	NAME OF AREA	OWNERSHIP	USAGE	ACRES TOTAL AREA	ACRES LAND AREA	ACRES WATER AREA	ARCHERY/GUN CLUB	BOATING	BOATING ACCESS	CAMPING	FISHING	GOLF COURSE	HIKING TRAILS	HUNTING	PICNICKING	SWIMMING
121	Goodman Pits	Private	1													
122	Reiff Park	County	1	80	80					*	*				*	
123	Badger Lake	State	1	444	429	15								*		
124	Private Boat Landing	Private	1	10	10					*						
125	I-29 Wildlife Area	State	1	253	253									*		
126	Onawa Storage Yard	State	1	3	3			*	*		*			*		
127	Blue Lake	State	1	989	983	6								*		
128	Decatur Bend Access	State	2	6	6			*	*	*	*		*	*		
129	Middle Decatur Access	State	2	22	22			*	*		*			*	*	
130	Abandoned River Channel	State	1								*			*		
131	Lewis and Clark Reserve	State	4	286	286			*	*	*	*		*	*	*	
132	Onawa KOA	Private	1	10	10				*							
133	Huff Access	County	2	5	5			*	*	*	*				*	
134	Whiting Wood	County	2	81	78	3					*		*		*	
135	Oldham Recreation Area	County	1	13	13			*	*	*	*		*	*	*	
136	Preparation Canyon	State	1	187	187											
137	Winnebago Bend	State	1	36	36								*		*	
138	Right-of-Way Area Wildlife	State	1	15	15						*					
139	Nelson Park	County	1	165	153	12		*	*	*	*				*	
140	I-29 Area Wildlife	State	1	300	300										*	
141	Deer Island	State	1	600	600										*	
142	E. Peterson Marina	Private	1													
143	Round Lake	State	1	393	262	131					*			*		
144	California Bend	State	1	550	190	360					*			*		
145	Tyson Island	State	1	84	84									*		
146	Round Access	State	1	5	5			*	*		*			*		
147	Rand Bar	State	1	60	60									*		
148	De Soto National Wildlife Refuge	Federal	1	3749	3185	564		*	*		*		*	*	*	
149	Nobles Lake	State	1	192	28	164				*			*	*		
150	Missouri Valley Boy Scouts	Boy Scouts	1													

TABLE II-4 (cont.)

EXISTING AND PROPOSED RECREATION FACILITIES

WESTERN IOWA BASIN

NO.	NAME OF AREA	OWNERSHIP	USAGE	ACRES TOTAL AREA	ACRES LAND AREA	ACRES WATER AREA	ARCHERY/GUN CLUB	BOATING	BOATING ACCESS	CAMPING	FISHING	GOLF COURSE	HIKING TRAILS	HUNTING	PICNICKING	SWIMMING
151	West Iowa Fishing & Wildlife Club	Private	1													
152	Niles History Museum	County	1	1	1											
153	Boy Scouts; Logan	Boy Scouts	1													
154	County Recreation Area	County	1	50	50											
155	Niles History Museum	County	1	1	1											
156	E. Peterson Private	Private	1													
157	Nobles Island	State	1	37	37											
158	Wilson Island	State	2	498	488	10		*	*	*	*		*	*	*	*
159	Big Timber KOA	Private	1	12	12											
160	Arrowhead Park	County		147	131	16				*	*				*	
161	Smith Area	State	1	201	201						*					
162	Private Clubs; Council Bluffs	Private	1													
163	Gifford Sanctuary	State	1	40	40											
164	Gifford Site 18	Federal	1	50	50											
165	Lake Manawa	State	6	925	265	660		*	*	*	*		*	*	*	*
166	Lake Manawa Private Boat	Private	1													
167	Longs Landing-County Mngt.	State	3	24	24			*	*	*	*				*	
168	Pony Creek Park	County	1	50	50					*			*		*	
169	Private Boat Launching; Glenwood	Private	1													
170	Mills County Boat Club	Private	1					*	*		*			*		
171	Forney Slough	State	1	1071	721	35										
172	Private Boat Landing	Private	1													
173	Waubonsie State Park	State	4	1209	1209					*			*		*	
174	River Access	State	2	53	53						*			*		
175	Private Landing	Private	1													
176	Loess Hills	State	1	2452	2452											

*APPROXIMATE PROBABLE USAGE

Visitors Per Average Peak Day	Usage Class
0-500	1
501-1,000	2
1,001-5,000	3
5,001-10,000	4
10,001-15,000	5
Over-15,000	6

attendance figures were obtained from state and county parks records, when available, or from estimates by park personnel. All wildlife areas were assumed to have less than 500 persons per peak day.

At specific lakes and recreation sites in the basin, high user densities can impart a high pollution load on nearby groundwater and surface water. This can only be avoided if wastes are properly handled. The Iowa Great Lakes region in Dickinson County furnish an example of how water quality problems can hurt traditional uses of recreational waters when intense development takes place around lakes without the proper safeguards. Fortunately, they are currently furnishing an example of how proper planning and implementation of waste water handling and care for the surrounding land can stop and reverse water quality problems.

The Iowa Great Lakes of Dickinson County have appreciable importance to recreation in Iowa. These waters constitute the single greatest water recreation site in the state. The lakes are used for boating, waterskiing, fishing, swimming and other water sports. Many auxiliary recreation facilities have developed around the region. The lakes are generally ringed by resorts which draw vacationers for stays of a week or more in addition to weekenders. Visitors to the lakes include people from Minnesota and other states in addition to Iowans. It has been estimated that the summer population of the area reaches as high as 100,000.

REFERENCES

1. J. R. Taylor, Provisional Projections of the Population of Iowa Counties and Cities: 1975 to 1990, Iowa State Department of Health, June 1972.

2. The Missouri River Basin Comprehensive Framework Study, Vol. 4, appendix: Economic Analysis and Projections, prepared by the Missouri Basin Inter-Agency Committee, 1969.

3. Outdoor Recreation in Iowa, Vol. V(b), Iowa Outdoor Recreation Guide, prepared by Planning and Coordination Section, Iowa Conservation Commission, July 1972.

CHAPTER III

BASIN CHARACTERISTICS

WESTERN IOWA BASIN

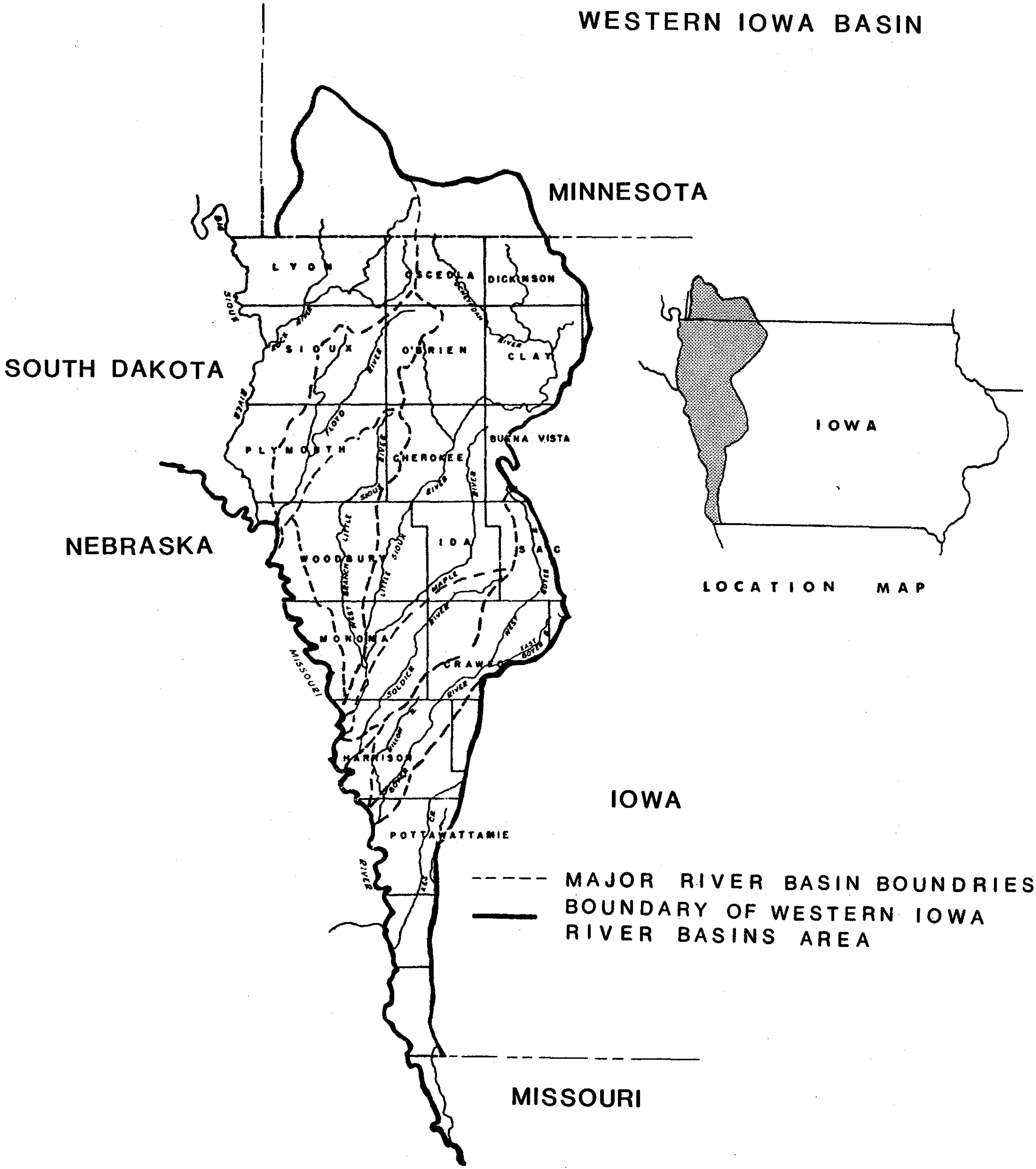
The Western Iowa Basin consists of those basins that drain into the Missouri and Big Sioux Rivers between the Missouri and Minnesota State lines. The eastern boundary of the Western Iowa Basin is the height-of-land between the Des Moines and Nishnabotna Basins.

Two of the sub-basins of the Western Iowa Basin are partly in Minnesota. They are the Rock River and the Little Sioux River. Except for the western boundary rivers, the rest are entirely in Iowa. The general direction of stream flow of rivers within the borders of the basin is from northeast to southwest, while the boundary rivers, the Big Sioux and the Missouri, flow essentially from north to south.

The major sub-basins of the Western Iowa Basin are those of the Rock, Floyd, Little Sioux and Boyer Rivers, and the West Branch of the Little Sioux-Monona-Harrison Drainage Ditch Complex. Minor sub-basins include those of the Soldier River, Mosquito Creek, and Keg Creek, as well as numerous other small creeks that drain into the Big Sioux and Missouri Rivers. Figure III-1 shows the streams and drainage areas of the Basin.

FIGURE III-1

WESTERN IOWA BASIN



The total area of the Western Iowa Basin is 9,313 square miles. This area comprises 16.5 percent of the total area of the State. Table III-1 lists the drainage areas of streams in the basin.

LAKES AND IMPOUNDMENTS

The Western Iowa Basins contain most of the lakes found in the State of Iowa, exclusive of reservoirs recently built in basins to the east.

The major lakes are in Dickinson County which is part of the Little Sioux River Basin. These lakes, collectively called the Iowa Great Lakes, form a major water recreation center for Iowans and attract appreciable numbers from other states. The principle lakes, in order of size by volume, are Lake West Okoboji, Big Spirit Lake, Lake East Okoboji, and Lower Gar Lake. Valuable to Iowans, these lakes have been the object of considerable study and preservation efforts in recent years.

There are also numerous lakes in counties surrounding Dickinson County, as well as numerous small ponds and impoundments scattered throughout western Iowa.

A total of 95 lakes, or impoundments, varying in size from around an acre to 5,684 acres surface area, are located in the Western Iowa Basin. Of these, 24 are designated as Class A, 66 as Class B, and 4 as Class C (see Chapter IV on water quality classifications). The lakes are listed in Table III-2.

TABLE III-1

DRAINAGE AREAS OF STREAMS IN THE WESTERN IOWA BASIN

Stream	Area (Square Miles)	Source*
Big Sioux River Basin		
Rock River		
at Rock Rapids	788	a
near Rock Valley	1,600	b
Dry Creek		
at Hawarden	48.4	c
Big Sioux River		
at Akron	9,030	a
Perry Creek		
at Sioux City	65.1	c
Floyd River		
at Alton	265	a
West Branch Floyd River		
near Struble	181	a
Floyd River		
at James	882	a
Monona-Harrison Ditch Basin		
Monona-Harrison Ditch		
near Turin	900	a
Little Sioux River Basin		
Spirit Lake		
near Orleans	75.6	a
West Okoboji Lake		
near Lakeside Laboratory	125	a
Milford Creek		
at Milford	146	a
Little Sioux River		
at Gillett Grove	1,334	a
at Linn Grove	1,548	a
at Correctionville	2,500	a
Maple River		
at Mapleton	669	b

Little Sioux River near Turin	3,526	a
Soldier River Basin		
Soldier River at Pisgah	407	b
Boyer River Basin		
Boyer River at Logan	871	b
Indian Creek Basin		
Indian Creek at Council Bluffs	7.99	a
Mosquito Creek Basin		
Mosquito Creek near Earling	32	a
Missouri River Basin		
Missouri River		
at Sioux City	314,600	b
at Omaha	322,800	b
at Nebraska City	414,400	b

* a - Water Resources Data for Iowa - United States Geological Survey
  b - Water Supply Papers of the United States Geological Survey
  c - An Inventory of Water Resources and Water Problems - Floyd - Big Sioux River Basins, Iowa Bulletin No. 4

TABLE III-2

LAKES AND IMPOUNDMENTS

WESTERN IOWA BASIN

LAKE OR IMPOUNDMENT	COUNTY	SURFACE ACRES	LOCATION*	OWNERSHIP	TYPE OF WATER**	SURFACE WATER CLASSIFICATION A	B	C
Larson Pond	Cherokee			Private	GP			
Spring Lake	Cherokee	17.5	40-92-28	City			X	
Barringer Slough	Clay	778	35-96-14	State	NL		X	
Brugeman Park	Clay	8.5	38-97-30	C.C.B.	GP	X	X	
Dan Greene Slough	Clay	311	35-97-9	State	NL		X	
Elk Lake	Clay	261	35-97-36	State	NL		X	
Round Lake	Clay	438	35-97-34	State	NL			
Scharnberg Pond	Clay	10	38-96-11	C.C.B.	GP	X	X	
Smith Slough	Clay	125	35-97-26	State	NL			
Trumbull Lake	Clay	1,190	35-97-27	State	NL		X	
Nelson Park Lake	Crawford	15	41-82-2	C.C.B.	GP	X	X	
Sunset Lake	Crawford		39-83-16	C.C.B.	GP		X	
Arnold's Pond	Dickinson	14	38-100-31	Private	OSI			

TABLE III-2 (continued)

LAKES AND IMPOUNDMENTS

WESTERN IOWA BASIN

LAKE OR IMPOUNDMENT	COUNTY	SURFACE ACRES	LOCATION*	OWNERSHIP	TYPE OF WATER	SURFACE WATER CLASSIFICATION A	B	C
Big Spirit Lake	Dickinson	5,684	36-100-23	State	NL	X	X	X
Center Lake	Dickinson	329	36-99-12	State	NL	X	X	
Diamond Lake	Dickinson	166	37-100-15	State	NL		X	
East Okoboji Lake	Dickinson	1,875	36-99-29	State	NL	X	X	
Garlock Slough	Dickinson	90	37-99-35	State	NL		X	
Hale Slough	Dickinson	42	36-100-23	State	NL		X	
Hottes Lake	Dickinson	378	36-100-18	State	NL		X	
Jemmerson Slough	Dickinson	88	36-100-31	State	NL			
Lake Park Pond	Dickinson	5	38-100-32	State	NL		X	
Little Spirit Lake	Dickinson	214	36-100-8	State	NL	X	X	
Lily Lake	Dickinson	-	35-99-18	State	NL			
Lower Gar Slough	Dickinson	273	36-99-32	State	NL		X	
Marble Lake	Dickinson	184	36-100-29	State	NL		X	
McClelland Slough	Dickinson	-	36-100-10	Private	NL			
Minnewashta Lake	Dickinson	126	36-99-30	State	NL	X	X	

TABLE III-2 (continued)

LAKES AND IMPOUNDMENTS

WESTERN IOWA BASIN

LAKE OR IMPOUNDMENT	COUNTY	SURFACE ACRES	LOCATION*	OWNERSHIP	TYPE OF WATER	SURFACE WATER CLASSIFICATION A	B	C
Pleasant Lake	Dickinson	77	35-99-7	State	NL		X	
Sandbar Slough	Dickinson	30	36-100-14	State	NL		X	
Prairie Lake	Dickinson	100	36-99-23	State	NL		X	
Silver Lake	Dickinson	1,058	38-100-33	State	NL	X	X	X
Sunken Lake	Dickinson	15	36-100-17	State	NL		X	
Upper Gar Lake	Dickinson	37	36-99-29	State	NL		X	
Welsh Lake	Dickinson	75	37-100-24	State	NL		X	
West Okoboji Lake	Dickinson	3,939	36-99-22	State	NL	X	X	X
Cheever Lake	Emmett	282	34-99-20	State	NL			
Four Mile Lake	Emmett	213	34-99-18	State	NL			
Twelve Mile Lake	Emmett	290	34-98-21	State	NL		X	
Tabor Pond	Fremont	3	42-70-5	C.C.B.	OSI		X	
California Bend	Harrison	90	45-78-7	State	OX LK		X	
DeSoto Bend	Harrison	850	45-78-20	Federal	OX LK	X	X	
DeSoto Bend Pond	Harrison	3.5	45-78-29	Federal	OX LK		X	

TABLE III-2 (continued)

LAKES AND IMPOUNDMENTS

WESTERN IOWA BASIN

LAKE OR IMPOUNDMENT	COUNTY	SURFACE ACRES	LOCATION*	OWNERSHIP	TYPE OF WATER	SURFACE WATER CLASSIFICATION A	B	C
Dunlap Pond	Harrison	9	41-81-2	C.C.B	OSI		X	
Dunlap Pit	Harrison	2	41-81-9	Private	GP			
Nobles Lake	Harrison	80	45-78-35	State	OX LK			
Tyson Bend	Harrison	75	45-79-28	State	OX LK		X	
Moorehead Park	Ida	12		C.C.B.	OSI	X	X	
School Pond	Ida	3	41-87-26	State	FP		X	
Town and Country	Ida	12	39-89-35	Private	OSI			
Glenwood Lake	Mills	15	43-72-12	City	OSI	X	X	X
Institutional Pond	Mills	3	42-72-17	State	OSI		X	
Pony Creek	Mills	83	43-72-4	Private, CCB & County	OSI		X	
Badger Lake	Monona	-	46-85-28	State & Private	OX LK			
Blackbird Bend	Monona	490	47-84-24	State	OX LK		X	
Blue Lake	Monona	240	46-83-24	State	OX LK	X	X	
Decatur Lake	Monona	800	46-88-17	State	OX LK	X	X	
Louisville Bend	Monona	1,180	46-83-7	State	OX LK		X	

TABLE III-2 (continued)

LAKES AND IMPOUNDMENTS

WESTERN IOWA BASINS

LAKE OR IMPOUNDMENT	COUNTY	SURFACE ACRES	LOCATION*	OWNERSHIP	TYPE OF WATER	SURFACE WATER CLASSIFICATION		
						A	B	C
Middle Decatur	Monona		46-83-16	State	OX LK		X	
North Decatur	Monona	690	46-83-17	State	OX LK		X	
Whiting Woods	Monona	3	43-85-30	C.C.B.	OSI		X	
Dog Creek	O'Brien	30	39-94-24	C.C.B.	OSI	X	X	
Douma Area	O'Brien	7	41-96-5	C.C.B.	GP	X	X	
Mill Creek	O'Brien	28	41-95-3	State	OSI	X	X	
Van Nyhuis #1	O'Brien	315	42-97-21	Private	GP			
Van Nyhuis #2	O'Brien	4	42-97-11	Private	GP			
Ashton Pits	Osceola		42-98-11	-	GP		X	
Hallett Pits	Osceola			-	GP		X	
Iowa Lake	Osceola	116	39-100-9	State	NL		X	
Ylosterman Pond	Osceola			Private				
May City Pit	Osceola		39-98-6	C.C.B.	GP	X	X	
Ocheyedan Pits	Osceola	3.5	40-99-23	C.C.B.	GP	X	X	
Peters Pit	Osceola		42-100-19	C.C.B.	GP		X	

TABLE III-2 (continued)

LAKES AND IMPOUNDMENTS

WESTERN IOWA BASINS

LAKE OR IMPOUNDMENT	COUNTY	SURFACE ACRES	LOCATION*	OWNERSHIP	TYPE OF WATER	SURFACE WATER CLASSIFICATION A	B	C
Rush Lake	Osceola	314	39-100-36	State	NL			
Sibley Pit	Osceola	2	42-99-13	Private	GP			
Blue Wing Marsh	Palo Alto	120	34-96-4	State	NL			
Virgin Lake	Palo Alto	200	34-96-30	State	NL		X	
Le Mars Pit	Plymouth	3	45-92-25	C.C.B.	GP		X	
Arrowhead Pond	Pottawattamie	5	41-77-29	C.C.B.	OSI		X	
Gilberts Pond	Pottawattamie	6	44-75-	Private	FP			
Lake Manawa	Pottawattamie	660	44-74-13	State	OX LK	X	X	
Nobles Lake	Pottawattamie	40	45-77-2	State	OX LK			
Manteno Park	Shelby	11	40-81-2	C.C.B.	OSI		X	
Schimerowski Pond	Shelby	1	39-80-5	Private	FP			
American Legion Pit	Sioux	8		Private	GP			
County Hiway Pond	Sioux	15	46-97-21	State	GP			
Floyd Park Pit	Sioux	2	44-94-11	C.C.B.	GP	X	X	
Haywarden Pit	Sioux		48-94-3	Private	GP			

TABLE III-2 (continued)

LAKES AND IMPOUNDMENTS

WESTERN IOWA BASIN

LAKE OR IMPOUNDMENT	COUNTY	SURFACE ACRES	LOCATION*	OWNERSHIP	TYPE OF WATER	SURFACE WATER CLASSIFICATION A	B	C
Sioux Center Pit	Sioux	5	45-95-8	C.C.B.	GP		X	
Van Zee Pit	Sioux	7	46-97-19	C.C.B.	GP	X	X	
Brown Lake	Woodbury	200	46-87-28	State	Ox Lk	X	X	
Midway Park	Woodbury	2.5	44-89-10	State	Ox Lk			
Park Pits	Woodbury	14	42-89-12	C.C.B.	OSI			
Snyder Bend	Woodbury	375	47-86-16	State	Ox Lk			
Winnebago Bend	Woodbury	555	47-86-28	State	Ox Lk			

*Range-Township-Section

Type of Water -

FP--- Farm Pond
GP--- Gravel Pit
NL--- Natural Lake
OnSi- On Stream Impoundment
OSI-- Off Stream Impoundment

OX LK --- Oxbow Lake

PHYSIOGRAPHIC FEATURES

The physiographic features of the Western Iowa Basin are the result of an erosional topography modified by several advances of continental glaciers, and subsequent erosion.

Prior to glaciation, a complex and varying thickness of sediments were deposited chiefly by shallow seas that intermittently covered the area. These sediments are represented by sandstone, shale, limestone, and dolomite.

The Iowa Geological Survey (1) has prepared a sketch of the nature and approximate thickness of these deposits and indicated the geologic age of each.

Subsequent to Cretaceous time, the consolidated rocks were eroded and differentially uplifted one or more times so that the topography prior to glaciation consisted of a moderate sloped and well-developed drainage system.

Four major intervals of glaciation, including some minor re-advances, separated by periods of erosion, subsequently modified the surface. Streams were diverted to new courses, some probably several times, and locally deep channels were cut into the bedrock surface. Glacial deposits were laid down by the ice or by water and wind associated with each glaciation, and these were in turn changed by subsequent periods of erosion and glaciation. The topography of the bedrock surface, the mantling effect of glacial deposits, and erosion during and subsequent to glaciation all contribute to the physiography of the Western Iowa Basin.

The Kansan and the Wisconsin ice advances were of particular significance in shaping the region. The region from Plymouth County south, however, was never covered by the latter glacial deposits.

The maturely dissected Kansan drift plain of northwestern Iowa was covered by the earlier substage of the Wisconsin ice advance, the Iowan. The Iowan drift is present at the surface or beneath wind-blown deposits in the western part of the basin.

Much of the basin was covered with loess during the melting of the Iowan ice sheet and the interval before the advance of the Tazewell substage of the Wisconsin advance. The last advance of the Wisconsin stage affecting a large area of the basin was the Tazewell, which covered what are now the headwater areas of the Floyd River and the eastern tributaries of the Rock River. A small part of the region in the extreme northeast was covered by the Cary substage of the Wisconsin stage.

The topography resulting from glacial activity, loess deposition, and erosion is a plain sloping from northeast to southwest. The Cary region of the extreme northeast is marked by youthful glacial moraine country. Present are isolated steep-sided hills, undrained basins, and land virtually unaltered by erosion. The Tazewell drift is better drained, but still fairly youthful. In the Iowan drift area drainage systems are better developed.

The erosion over much of the uplands has been so uniform that there are few gullies, and the loess cover has been cut through in only a few places. Incision increases toward the Big Sioux and Missouri Rivers, however, with the valleys of these rivers located over 200 feet below the general plain.

From the vicinity of Sioux City southward, there are steep bluffs which is the result of a deep accumulation of loess modified by stream erosion. Here the bluffs drop sharply 200 feet and more toward the rivers.

SOILS

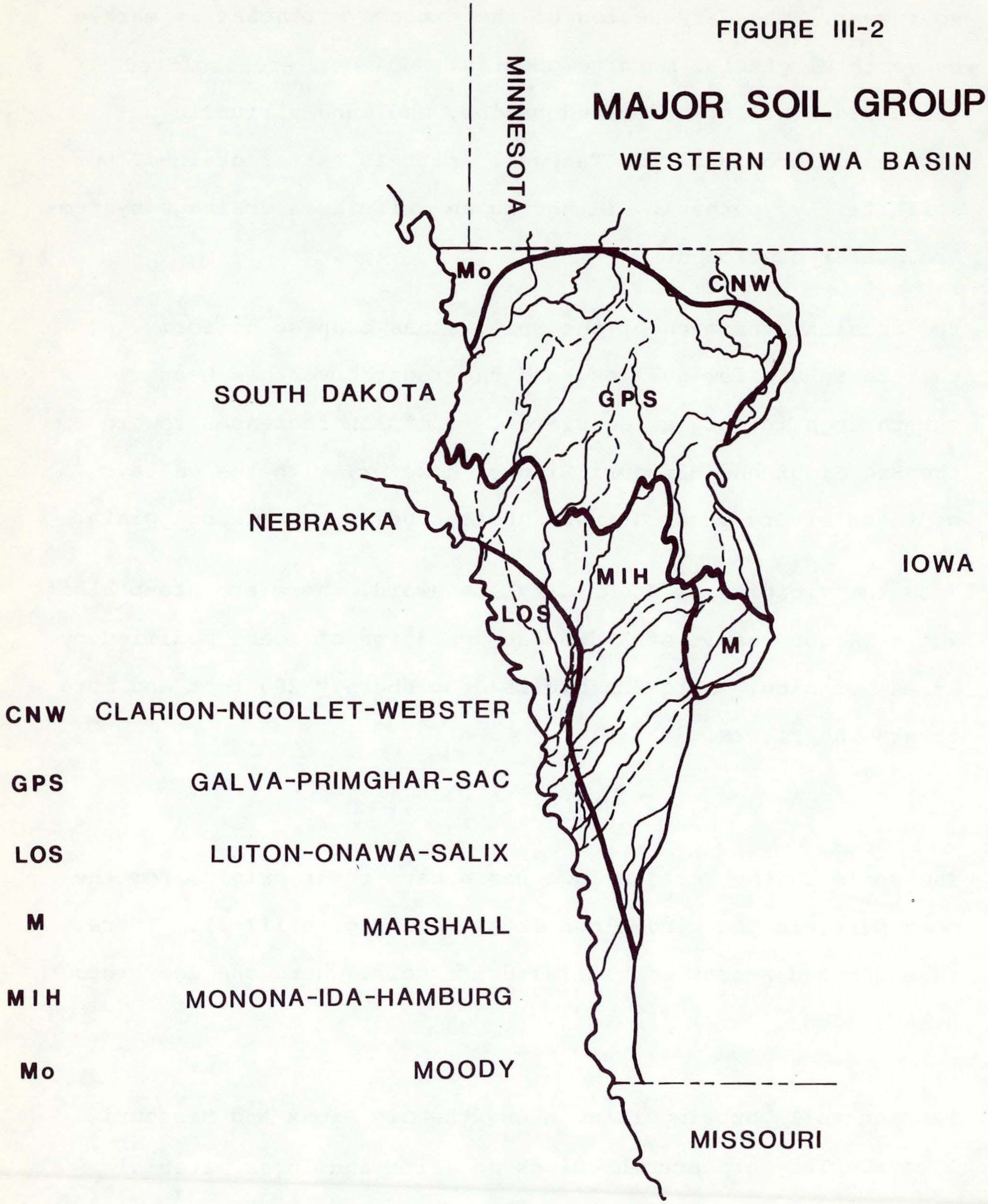
The soils in the Western Iowa Basin have their origin, for the most part, in the wind-blown loess (see Figure III-2). There is a limited amount of glacial drift soil, where the loess has been eroded.

Terrace soils are important along the Big Sioux and Missouri Rivers. They are accumulations of drift and loess material

FIGURE III-2

MAJOR SOIL GROUPS

WESTERN IOWA BASIN



deposited on the floodplain by the rivers during periods of overflow. Because of stream entrenchment, terraces are now located high above the rivers and thus no longer subject to overflow.

Bottomland soils lie along the streams and are subject to occasional flooding. Here the soil is from material eroded from upland areas and deposited as sediment on the flood plain. Terrace and bottomland soils are second in importance in the basin.

In the north, where the Cary and Tazewell glacial-related soils exist at the surface, and in areas only thinly covered by loess, the land is underlain by relatively impermeable materials inhibiting downward movement of water.

In the thicker loess regions, drainage varies from good to excessive in many places, due to poor water-holding capability and steep slopes.

Erosion problems are severe in many parts of the basin due to low moisture-holding capacity and steepness of slope. Soils having low moisture-holding capacity are the Monona-Ida-Hamburg association. Many of the other soil types are subject to severe erosion where steep slopes exist, but are not particularly vulnerable where the land is more level.

The Marcus-Primghar-Sac association and the Clarion-Webster association in the northeast portion of the basin is not subject to any severe erosion hazard, and, indeed, requires drainage for satisfactory cultivation.

CLIMATE

The Supporting Document (2) presents a general climatic discussion for the entire State of Iowa. Information in this section is from References 2 to 10.

Since rainfall is variable over the years and within each year, its distribution is of vital importance to water quality management. Further, climate factors such as temperature, humidity, sunshine and cloudiness, which affect evaporation, are also of vital importance since they also vary over the years and within the year.

The key factor that influences the climate of the Western Iowa Basin is its location not far from the center of the North American Continent. This positioning midway between the equator and the pole gives the basin a definite warm and a definite cold season both of which are enhanced by the basin's remoteness from the tempering effects of the oceans. During the summer and winter months, there is not a great deal of variation in temperatures, while spring and fall are times of strong transition of temperature. By comparison, the onset of the wet time of the year is rather sudden, as is the ceasing of the wet season. Some variables, such as water content of the air, (absolute humidity), dew point, density, and barometric pressure vary similar to temperature with regard to season.

However, other key variables of Iowa weather do not follow such a regular curve. Sunshine, cloudiness, wind velocity, relative humidity, fog, sleet, freezing rain, hail, and chance of precipitation on a given day follow curves that reach maximum and minimum values at times other than summer and winter. Changes in these variables result in enhancement of temperature and rainfall influences at some times of the year.

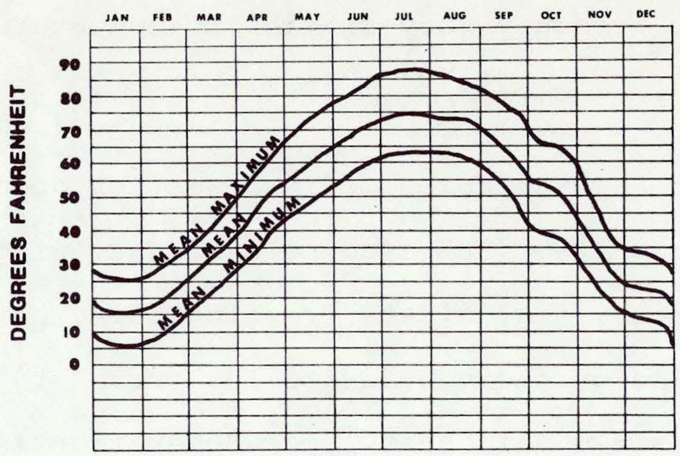
Temperature

The average temperature over the extent of the basin, based on maps by Shaw and Waite (3), ranges from about 45 degrees in the north along the Minnesota border to over 52 degrees in the south. In the small scale, actual averages are enhanced about 1 or 2 degrees along the deep floodplain of the Missouri River.

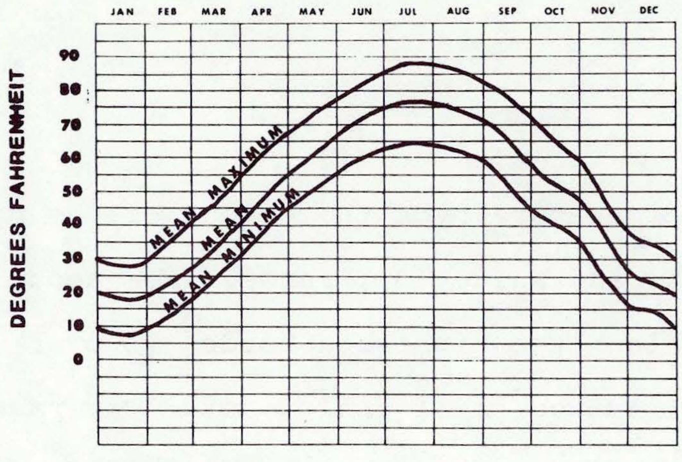
Deeper insight into the temperature distribution can be obtained from Figure III-3, which give curves (derived from National Weather Service Summaries, references 4, 5, 6, 7, 8 and 9) on the mean maximum, mean, and mean minimum temperatures over the year at Rock Rapids, Sioux City, and Council Bluffs. The strong slope of the curves during the spring and fall transition is easily seen, as well as the relative flatness of the curves in winter and summer. Also apparent is the relative coolness

FIGURE III-3

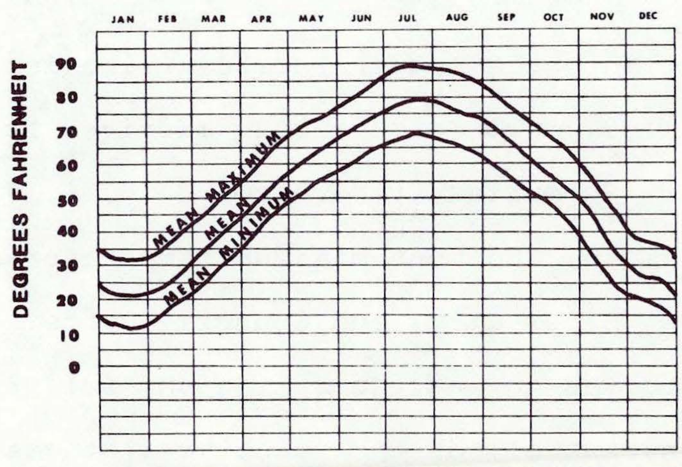
TEMPEPATURE DISTRIBUTION AT SELECTED STATIONS



ROCK RAPIDS



SIOUX CITY



OMAHA-COUNCIL BLUFFS

PREPARED BY E A HICKOK & ASSOCIATES

of the northern part of the basin as represented by Rock Rapids as compared to the relative warmth of the southern part as represented by Council Bluffs.

In terms of temperatures critical to plant life, the mean daily temperature is below 40 degrees (where dormancy of most plants occur) from November 6 to April 3 at Rock Rapids, from November 9 to March 30 at Sioux City, and from November 18 to March 20 at Omaha - Council Bluffs.

The summer season, if defined in terms of mean daily temperature in excess of 60 degrees, lasts from May 18 to September 28 at Sioux City, and from May 8 to October 3 at Omaha - Council Bluffs.

Throughout the basin, the temperature is warmest around the third week of July, and the coolest during the latter part of January. Temperature increase is greatest in March and April, the decrease the greatest in November.

The average length of the frost-free season in the basin varies from around 135 days in the north to about 165 days in the south. The length of the growing season in the north is somewhat shortened by the high elevation of the Coteau des Prairies in addition to latitude.

Temperatures as high as 117 degrees have been observed at Logan and it has been as cold as 46 degrees below zero at Inwood.

Precipitation

The mean annual precipitation over Iowa is shown in the Supporting Document (2). The basin represents the driest part of the state, with minimum occurring along the Missouri and Big Sioux Rivers in the northwest.

Precipitation over the basin is characterized by a maximum of rainfall in June and a minimum in January, with orderly monthly increases and decreases between. The only exception is that July and August are roughly the same in total precipitation amounts. Throughout most of the region, May is the second wettest month. The apparent relative dryness of Sioux City and Omaha - Council Bluffs in May comes about from the short, 30-year normalizing period (1921-1950) used. The data from most of the other stations are from more reliable 50 to 100 year, averaging periods.

The wet season lasts from about April 20th to September 25th. The peak is reached just before the middle of June, when air from the Gulf of Mexico is carried deep into the heart of the North American continent.

A general dry period exists from mid-July to a few days after mid-August, interrupted by a wet period that often occurs between July 28th and August 9th. The period from August 20th to September 25th can be expected to yield more rain than any time of the year except for the late-April to mid-July precipitation maximum. The peak of this second rainfall maximum occurs about September 14th. These patterns clearly and strongly show up in stations having 60 to 155 years of record. They can be masked in 30-year normal periods by a few unusual heavy rains at intermediate times.

December, January, and February have nearly equal wetness, with February values principally affected by the shortness of the month.

There are minor variations in precipitation patterns during the transitional months, but they are of no major significance.

Table III-3 presents information on extreme annual totals of precipitation through the present as compared to the average over the period of record noted.

At the average station in the basin, the wettest year has between 3 and 4 times as much rain as the driest year. In the basin, rainfall can be much "spottier" than in other parts of Iowa.

In western Iowa, a dry year at one place may be a wet year at another place 100 miles or so away. However, dryness or wetness does tend to be somewhat general, and evidence indicates dry "cycles" may tend to come about once every 20 years.

Certain stations tend to run wetter than others over the years because of topographical influences, which create

TABLE III-3

PRECIPITATION DATA FOR LONG-TERM STATIONS
WESTERN IOWA BASIN

Station	Annual Normal Inches	Maximum Annual Inches	Recorded Date	Minimum Annual Inches	Recorded Date
Akron	25.74	42.95	1951	15.13	1939
Alton	26.04	38.25	1944	13.29	1958
Hawarden	25.18	39.34	1951	14.56	1939
Inwood	25.25	37.61	1944	12.65	1958
Le Mars	27.25	42.35	1951	13.93	1956
Rock Rapids	26.59	41.69	1944	11.53	1910
Sanborn	28.37	46.02	1951	13.77	1925
Sheldon	26.94	46.02	1951	15.41	1958
Sibley	27.44	40.74	1908	15.43	1887
Sioux City	24.77	56.37	1881	14.72	1955
Spencer	27.94	44.15	1951	14.41	1958
Storm Lake	28.27	45.94	1951	15.76	1955
Cherokee	27.27	42.86	1938	12.11	1958
Onawa	28.27	41.73	1951	20.88	1966
Denison	28.62	46.88	1951	15.16	1936
Logan	30.49	44.12	1951	13.83	1936
Council Bluffs(Omaha)	28.85	64.52	1869	14.90	1934
Glenwood	30.97	47.29	1965	16.77	1934

Periods of Record

Akron 1926-1974
Alton 1903-1974
Hawarden 1926-1974
Inwood 1901-1973
Le Mars 1875-1885; 1896-1974
Omaha 1857-1974
Rock Rapids 1892-1900; 1903-1974
Sanborn 1881-1883; 1912-1974
Sheldon 1895-1913; 1925-1974
Sibley 1879-1888; 1892-1920; 1930-1974
Sioux City 1858-1859; 1861-1865; 1875-1881; 1887-1974
Others 1931-1973

favored locations for heavier rainfall. A much denser rain gage network than that maintained by the National Weather Service is needed to identify such locations.

About only once in 100 years will a given station in the basin experience a 24-hour rain in excess of 7 inches. However, a rain of double that amount is likely somewhere over the basin once every dozen years or so. Such a storm is illustrated by that of July 16-17, 1968, (Figure III-4) where over 14 inches fell at locations in Buchanan, Black Hawk, Bremer, and Butler Counties. Over 16 inches fell in places in Bremer and Black Hawk Counties. Most of the rain occurred in less than 12 hours with 11.5 inches at one station occurring in 4 hours, 35 minutes. Although this storm occurred outside the basin, such storms will occur from time to time anywhere in Iowa.

Figures III-5 and III-6 present monthly normal values of precipitation for twelve stations in the basin.

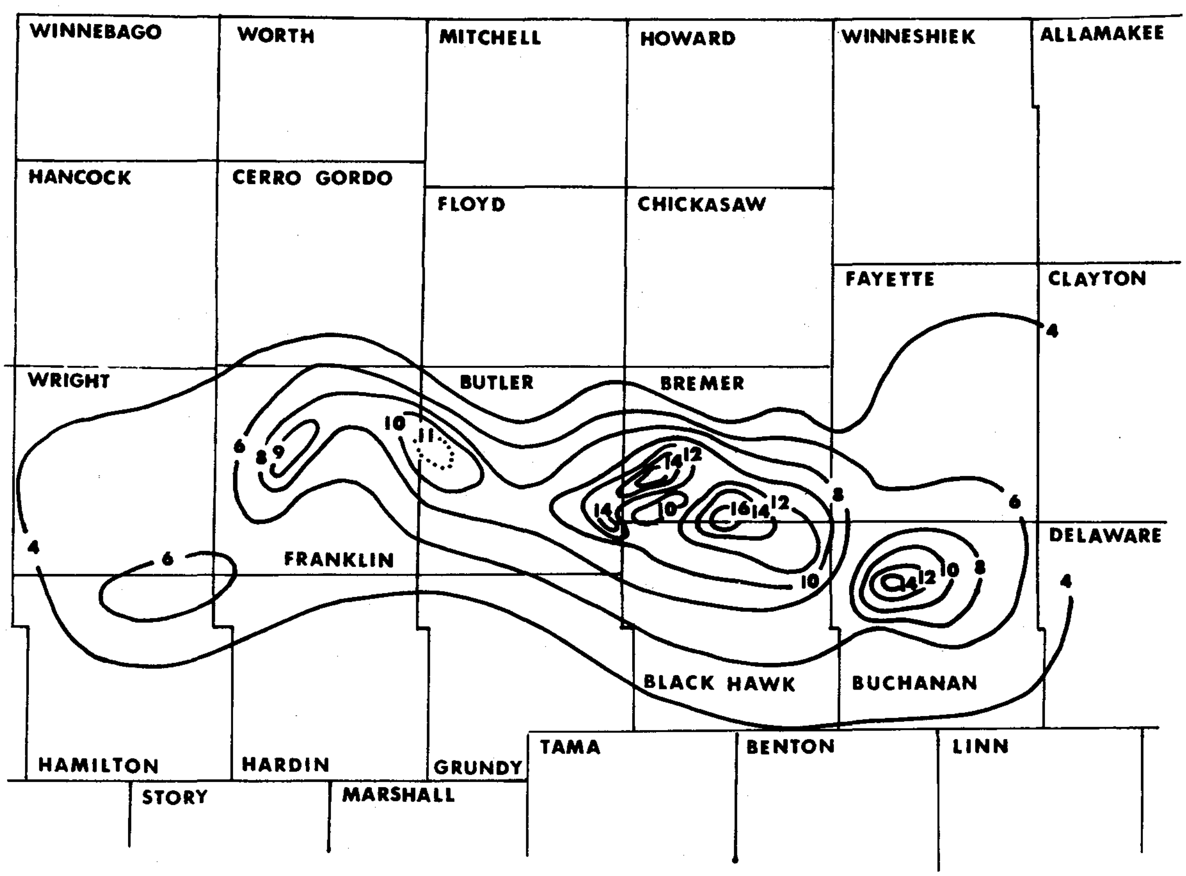
Sunshine and Cloudiness

The Western Iowa Basin is the sunniest and least cloudy part of Iowa.

The sunniest and least cloudy time occurs during the long summer days in July, with the cloudiest time in the latter part of November and earlier part of December. Monthly values

FIGURE III-4

PRECIPITATION DISTRIBUTION OF A RARE STORM



RAINFALL OCCURED DURING A 24 HOUR PERIOD JULY 16-17,1968

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FIGURE III-5
PRECIPITATION DISTRIBUTION AT SELECTED STATIONS

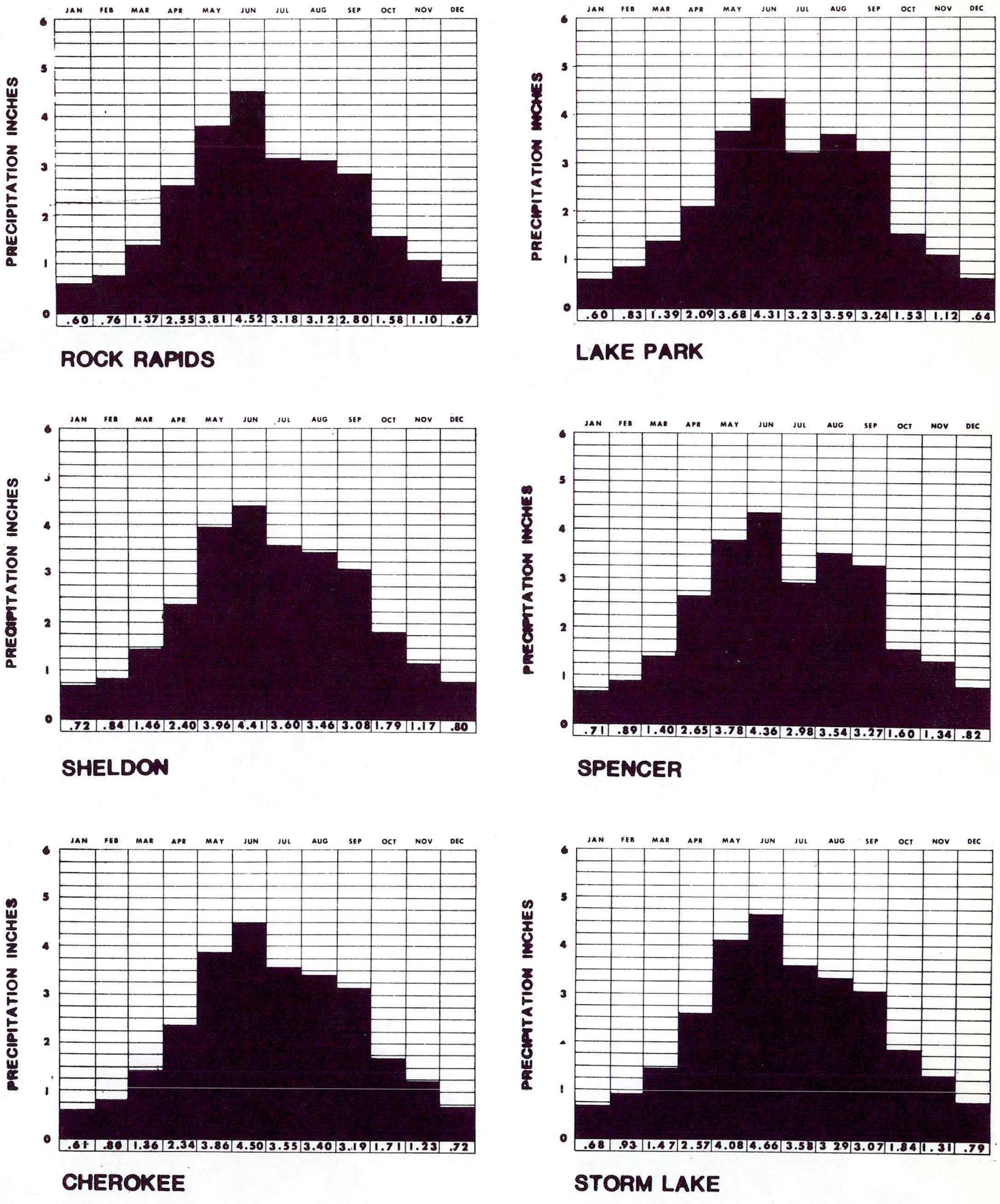

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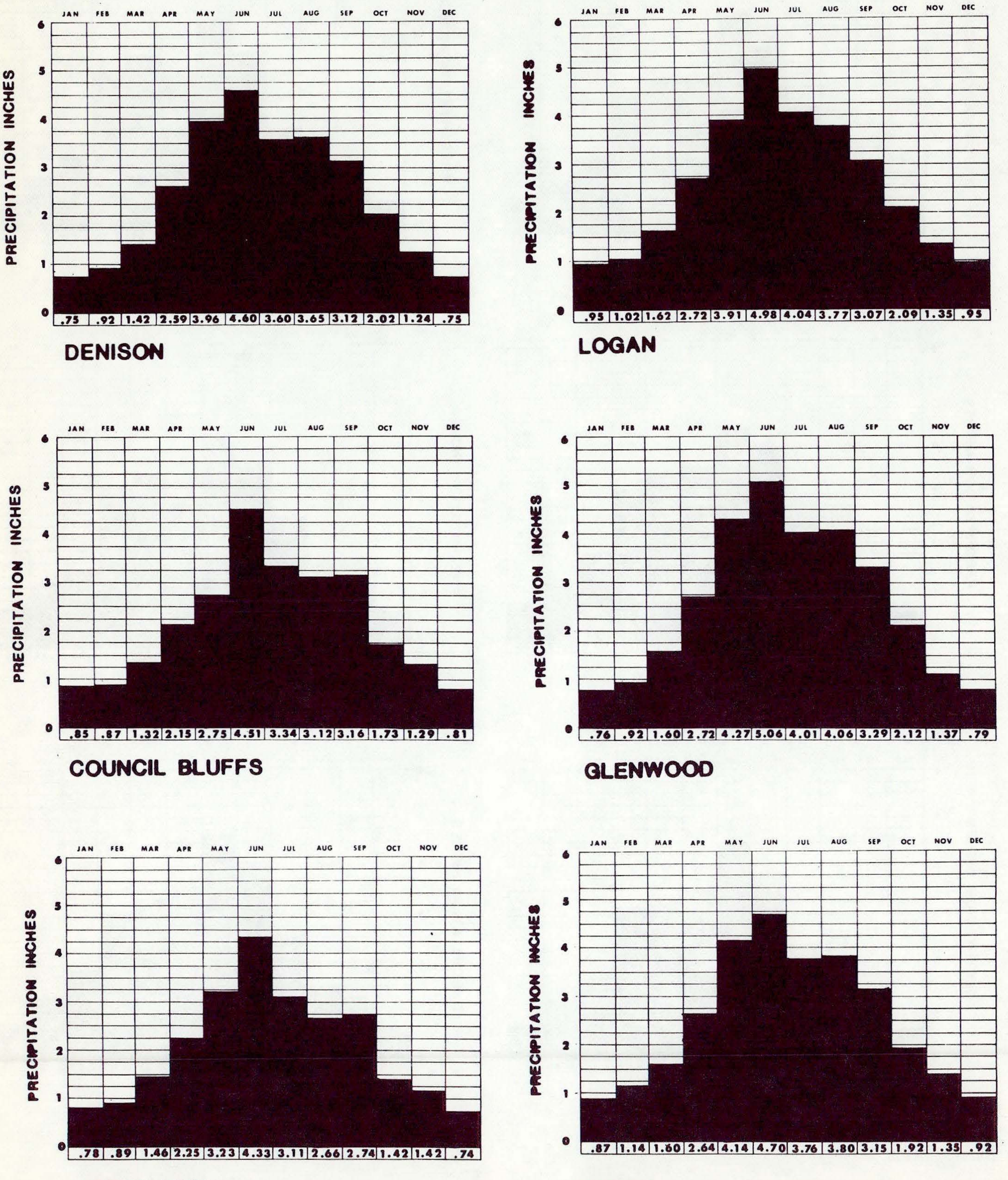
FIGURE III-6

PRECIPITATION DISTRIBUTION AT SELECTED STATIONS



of percent of possible sunshine vary from 44 percent in the north to 50 percent in the south in December, to over 74 percent throughout the basin in July.

The average day has 340 Langleys of solar radiation in the north, and 360 Langleys in the south.

Evaporation

The average pan evaporation over the basin is 55 inches per year. The basin occupies that part of Iowa with the highest rate of evaporation.

Snowfall

The average annual snowfall over the basin varies from 25 inches per year in the south to 40 inches per year in the north. The snowiest months are January and March.

Humidity

Relative humidity (which is the ratio of the amount of water the air holds to the amount it could hold) varies from a maximum in December to a minimum in late April and early May. These data are based on the Local Climatological Data publications of the National Weather Service and the U.S. Air Force Worldwide Airfield Summaries (10).

The spring relative humidity minimum is largely caused by deep mixing of dry air aloft with surface air. A secondary minimum in October is due to the presence of generally dry surface air.

Absolute humidity, the actual amount of water in the air, varies over the year similar to the variation in temperature, with a minimum in late January and a maximum in July. Average monthly values vary from 2.5 grams per cubic meter in the north in January to 17 grams per cubic meter in the south in July.

Wind

Southerly winds prevail from April to October with northwesterlies prevailing from November to March. Average wind speed varies from 12 miles per hour along the Missouri floodplain in the north of the basin. The reduced values along the floodplain result from the protective effects of the high bluffs.

SURFACE WATERS

Stream Flow

That portion of the original precipitation which flows across the land surface and escapes into artificial and natural drainage channels is often referred to as storm runoff. It is the runoff supplemented by discharge from groundwater sources that constitutes the flow observed in streams. Streamflow is highly correlated to precipitation, which varies from year to year and from area to area.

The average annual runoff in the basin ranges from about two inches in extreme northwestern Iowa to more than four inches in the southeast (11). Runoff follows, in general, the pattern of the mean annual precipitation which ranges from less than 26 to more than 34 inches from the northwestern to the eastern parts of the State and from 25 to 32 inches from the north to the south of the Basin. Runoff is modified by evaporation, which is greatest in the southern part of this basin. Runoff tends to be above, or below, average for periods longer than one year. The longest stream flow period on the Cedar River at Cedar Rapids when runoff was above average were the two six-year periods 1915-20 and 1942-47. Also at the same site, the longest below average period was the seven years from 1953 to 1959. Statistics on the extremes of annual runoff at selected stations in the basin are listed in Table III-4, based on an article by S. W. Wiitala in the 1970 Water Resources of Iowa publication (11), and Low Flow Characteristics of Iowa Streams by Heinitz (12).

The stations included in Table III-4 are those measuring the flow from drainage areas of moderate size, and those whose records included the drought of the mid-1950's. The smallest drainage areas are too sensitive to indicate hydrologic conditions; whereas, large drainage areas, which integrate widespread meteorologic and physical regimes, are too insensitive to be truly representative of areal conditions.

Streamflow is characteristically variable. Knowledge of average flow alone, is insufficient for careful planning and

TABLE III-4

ANNUAL RUNOFF AND INDICATORS OF FLOW VARIABILITY FOR SELECTED STATIONS IN WESTERN IOWA BASIN

Station Name	Period of Record	Drainage area sq. mi.	Mean flow cfs.	Annual runoff in inches					Q2.33* / Qmean	Q90** / Qmean
				Mean	Max.	Year	Min.	Year		
Floyd River at James	1934-67	882	174	2.72	10.00	1951	.29	1956	24.6	.05
Maple River at Mapleton	1941-67	669	226	4.62	12.18	1951	.50	1956	39.3	.09

Note: Minimum annual runoff for period through 1968.

* Q2.33 is mean annual flood; Qmean is mean flow.

** Q90 is flow equaled or exceeded 90 percent of time; Qmean is mean flow.

management. In Iowa, it is common for peak flows to be 10,000 or more times the minimum flows. As an indicator of the variability of high flows, the ratio of the mean annual flood to the mean discharge for selected stations in the basin is listed in Table III-4. The mean annual flood is a fairly stable statistic which is unaffected, for the most part, by the chance occurrence of a very large flood. It is the peak flow that is equaled or exceeded once on an average of about every other year (recurrence interval, 2.33 years). The values for the mean annual flood, for the two stations listed in Table III-4, varied from 24.6 to 39.3.

As an index of the variability of low flows, the ratio of the flow at the 90 percent duration level (Q90) to the mean flow is also listed in Table III-4. The variation of this ratio, from .05 to .09, is much less than that for the ratio defining high flows.

From this brief analysis, it is obvious that streamflow is highly variable. On the average, every other year a peak flow is reached that is about 30 or more times the mean flow. During 10 percent of the time, low flows are at or lower than about 7 percent of the mean flow.

Low Flow Characteristics

Water quality criteria of the State of Iowa must be met at all times when the flow of the stream equals or exceeds the statistical 7-day, 1-in-10 year low flow. Information on this flow and the physical characteristics of the stream is needed if the assimilative capacity is to be analyzed and allowable discharges determined.

The United States Geological Survey (USGS) maintains an extensive statewide network of stream gaging stations. Stream flow is monitored continuously at some stations and periodically at others. By extrapolation of data from this established gage network and review of partial-record stations, additional flow information may be determined for streams where continuously recording gaging stations are not provided. Not all gages in a river basin are of the same period of record; therefore, published values of statistical flows such as Q90 (the flow equaled or exceeded 90% of the time) or the 7-day, 1-in-10 year low flow cannot be expected to correlate exactly at different gages.

Specific USGS gaging station locations are shown on Figure III-7. Both partial-record and continuous recording gaging stations are identified. Table III-5 lists the specific station number, tributary drainage areas above the station, and the 7-day, 1-in-10 year low flow, where available, for each station.

As indicated in the tables, insufficient data are available for identification of low flow at each gaging station. In order to conduct waste load allocation analysis, determination of 7-day, 1-in-10 year low flows was made for specific gaging stations. These values were obtained using the same

MINNESOTA
SOUTH DAKOTA
NEBRASKA
MISSOURI
STATE OF IOWA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WESTERN IOWA RIVER BASINS
U.S.G.S. GAGING STATIONS
CONTINUOUS RECORDING STATION
PARTIAL RECORDING STATION
30 Miles
40 Kilometers
N
PREPARED BY E A HICKOK & ASSOCIATES

FIGURE III-7

TABLE III-5

U.S.G.S. GAGING STATION INFORMATION (12)
WESTERN IOWA BASIN

Station No.	Stream	Location	Drainage Area (Mi^2)	7Q10 cfs	7Q10 (cfs/mi^2)
4831	Rock River	Near Rock Rapids	558.		
4832.6	Kanaranzi Creek	Near Rock Rapids	203.	<.1	
4832.7	Rock River	Rock Rapids	788.	1.14*	.006
4832.8	Tom Creek	Rock Rapids	61.9	0	
4833	Rock River	Below Rock Rapids	859.		
4833.2	Mud Creek	Lester	63.7		
4833.3	Mud Creek	Near Doon	138.	<.1	
4833.4	Rock River	Near Doon	1,050.		
4833.6	Little Rock R.	Near Little Rock	92.	0	
4833.8	Little Rock R.	Little Rock	134.	<.1	
4834	Little Rock R.	Near George	199.		
4834.1*	Otter Creek	North of Sibley	11.9		
4834.2*	Schutte Creek	Near Sibley	1.4		
4834.3*	Otter Creek	Sibley	29.9		
4834.4*	Dawson Creek	Near Sibley	4.4		
4834.5*	Wagner Creek	Near Ashton	7.1		
4834.6	Otter Creek	Near Ashton	88.	<.1	
4834.7	Otter Creek	Near Matlock	129.	<.1	
4834.8	Otter Creek	Near George	208.		
4834.9	Little Rock R.	Near Doon	474.		
4834.95*	Burr Oak Creek	Near Perkins	30.9		
4835	Rock River	Near Rock Valley	1,600.0	1.0*	.0006

* Computed Values from Missouri River Tributaries, Waste Load Allocation Study

TABLE III-5 (continued)

U.S.G.S. GAGING STATION INFORMATION (12)
WESTERN IOWA BASIN

Station No.	Stream	Location	Drainage Area (Mi^2)	7Q10 cfs	7Q10 (cfs/mi^2)
4841	Sixmile Creek	Near Hawarden	68.8		
4841.5	Sixmile Creek	Near Chatsworth	104.		
4842	Indian Creek	Near Chatsworth	62.2		
4855	Big Sioux River	Akron	9,030.		
4858	Broken Kettle C.	Near Adaville	60.7		
4859	Broken Kettle C.	Near Sioux City	97.4		
4860	Missouri River	Sioux City	314,600.		
5998*	Perry Creek	Near Merrill	7.9		
5999.5*	Perry Creek	Near Hinton	30.7		
6000.2	Floyd River	Near Sheldon	64.		
6000.3*	Floyd River	Near Sanborn	8.4		
6000.4	Floyd River	Near Sheldon	59.3		
6000.6	Floyd River	Below Sheldon	165.	<.1	
6000.8*	Willow Creek	Hospers	37.9		
6001	Floyd River	Alton	265.		
6001.2	Deep Creek	Near Oyens	82.7		
6001.4	Willow Creek	Near Oyens	65.2	0	
6001.6	Deep Creek	Le Mars	156.	<.1	
6001.8	Floyd River	Le Mars	478.		
6002	Floyd River	Near Merrill	489.		
6002.5	W.B. Floyd River	Near Middleburg	59.7	0	
6003	W.B. Floyd River	Near Struble	181.		

TABLE III-5 (continued)

U.S.G.S. GAGING STATION INFORMATION (12)
WESTERN IOWA BASIN

Station No.	Stream	Location	Drainage Area (Mi^2)	7Q10 cfs	7Q10 (cfs/mi^2)
6004	W.B. Floyd River	Near Merrill	232.		
6005	Floyd River	James	882.	2.5	
6014.8*	Big Whiskey Slough	Near Remsen	12.9		
6015	Big Whiskey Slough	Near Kingsley	55.3		
6016	W.F. Little Sioux	Near Fielding	135.		
6017	W.F. Little Sioux	Near Kingsley	219.		
6018	Mud Creek	Moville	68.7		
6019	W.F. Little Sioux	Moville	344.		
6020	W. Fork Ditch	Holly Springs	399.	1.4	
6021.9*	Elliot Creek	Lawton	34.8		
6022	Elliot Creek	Near Bronson	58.6		
6022.4*	Big Whiskey Creek	Near Lawton	51.3		
6022.5	Big Whiskey Creek	Near Bronson	62.4		
6023	Wolf Creek	Near Holly Springs	99.2		
6024	Monona-Harrison D.	Near Turin	900.		
6036	L. Sioux River	Near Montgomery	118.		
6037	W.F. Little Sioux	Near Lake Park	116.	0	
6038	W.F. Little Sioux	Near Montgomery	173.		
6039	L. Sioux River	Near Milford	333.		
6040	Spirit Lake	Near Orleans	75.6		
6041	Spirit Lake Out.	Orleans	75.6	0	
6042	West Okoboji Lake	Near Milford	125.		
6043	Okoboji Lake Out.	Arnolds Park	125		

TABLE III-5 (continued)

U.S.G.S. GAGING STATION INFORMATION (12)
WESTERN IOWA BASIN

Station No.	Stream	Location	Drainage Area (Mi^2)	$7Q_{10}$	
				cfs	(cfs/mi^2)
6044	Okoboji Lake Out.	Near Milford	151.		
6045	Ocheyedan River	Near Bigelow, MN	68.7		
6045.1*	Ocheyėdan River	Near Ochėyedan	73.5		
6046	L. Ocheyeden River	Near May City	54.2		
6047	Ocheyedan River	Near May City	226.		
6048	Stoney Creek	Near Fostoria	65.4		
6049	Stoney Creek	Near Everly	81.6		
6050	Ocheyedan River	Near Spencer	426.		
6051	L. Sioux River	Spencer	990.		
6052	Big Muddy Creek	Near Langdon	59.7		
6053	Big Muddy Creek	Near Spencer	102.		
6053.4*	Prairie Creek	Near Spencer	22.3		
6054	Pickerel Run	Near Spencer	75.7	0	
6055	Lost Island Out.	Near Dickens	151.		
6056	L. Sioux River	Gillett	1,334.	4.0	.005
6057	Willow Creek	Near Rossi	62.6	0	
6057.5*	Willow Creek	Near Cornell	78.6		
6058	Willow Creek	Near Greenville	90.3		
6058.9*	Waterman Creek	Hartley	28.7		
6059	Waterman Creek	Near Hartley	58.4		
6060	Waterman Creek	Near Sutherland	139.	<.1	
6061	L. Sioux River	Near Sutherland	1,803.		

TABLE III-5 (continued)

U.S.G.S. GAGING STATION INFORMATION (12)
WESTERN IOWA BASIN

Station No.	Stream	Location	Drainage Area (Mi^2)	$7Q10$ cfs	$7Q10$ (cfs/mi^2)
6062	Mill Creek	Near Paulina	61.6		
6063	Mill Creek	Near Cherokee	292.		
6064	L. Sioux River	Cherokee	2,173.		
6065	Pierson Creek	Near Correctionville	55.1	<.1	
6066	L. Sioux River	Correctionville	2,500.	10.0*	.004
6067	L. Soiux River	Near Kennebec	2,738.	23.0*	.008
6067.9*	Maple Creek	Near Alta	15.5		
6068	Maple River	Near Aurelia	85.2		
6069	Maple River	Near Ida Grove	364.		
6070	Odebolt	Near Arthur	39.3		
6071	Odebolt Creek	Ida Grove	61.1		
6071.97*	Wilsey Creek	Mapleton	18.4		
6072	Maple River	Mapleton	669.	5.8*	.009
6074	Maple River	Near Turin	741.	6.4	.009
6075	L. Sioux River	Near Turin	3,526.		
6083	Soldier River	Near Ricketts	90.5		
6083.5	Soldier River	Near Ute	155.		
6084	E. Soldier River	Near Ute	97.8		
6084.5	Jordan Creek	Moorhead	30.1		
6085	Soldier River	Pisgah	407.	3.0	
6092.2	Allen Ditch	Near Loveland	92.1		
6092.6	Boyer River	Near Early	67.5		
6093	E. Boyer River	Vail	65.4		

TABLE III-5 (continued)

U.S.G.S. GAGING STATION INFORMATION (12)
WESTERN IOWA BASIN

Station No.	Stream	Location	Drainage Area (Mi²)	7Q10 cfs	7Q10 (cfs/mi²)
6093.5	E. Boyer River	Denison	130.		
6094	Boyer River	Near Denison	517.		
6095	Boyer River	Logan	871.	4.9	.0056
6095.5	Boyer River	Near Missouri Valley	1,081.		
6095.6*	Willow Creek	Near Soldier	29.1		
6095.8	Willow Creek	Near Woodbine	67.		
6096	Willow Creek	Near Logan	129.		
6096.2	Willow Creek	Near Missouri Valley	146.		
6096.7	Boyer River	Near Loveland	1,084.		
6099	Pigeon Creek	East of Loveland	66.6		
6099.5	Pigeon Creek	Near Crescent	163.		
6100	Missouri River	Omaha	322,800.		
6105	Indian Creek	Council Bluffs	8.	0	
6105.1*	Moser Creek	Near Earling	21.6		
6105.2	Mosquito Creek	Near Earling	32.		
6105.5	Mosquito Creek	Portsmouth	63.9		
6106	Mosquito Creek	Neola	131.		
6106.5	Mosquito Creek	Near Council Bluffs	211.		
8057	Keg Creek	Minden	59.6		
8058	Keg Creek	Near Dumfries	131.		
8059	Keg Creek	Near Glenwood	190.		
8060	Wabonsie Cr.	Near Bartlett	30.4	0.1	
8070	Missouri River	Nebraska City	414,400.		

*High-flow partial-record stations

TABLE III-6

FLOW COMPARISONS (12)*

WESTERN IOWA BASIN

Flow, in cfs/sq mi, Equaled or Exceeded, for Percentage of Time Indicated in Column Headings

	50	90	95	98	99
State of Iowa Average	.150	.033	.024	.018	.015
Rock River near Rock Valley	.043	.006	.002	.0009	.0004
Floyd River at Alton	.019	.001	.0006	.0004	-
Floyd River at James	.052	.010	.007	.004	.003
West Fork Monona-Harrison Ditch near Healy Spring	.075	.017	.011	.006	.004
Little Sioux River at Gillett Grove	.063	.016	.007	.002	.0009
Little Sioux River at Cor-rectionville	.006	.017	.010	.006	.004
Little Sioux River near Kennebec	.115	.022	.014	.009	.008
Little Sioux River near Torin	.119	.040	.016	.008	.007
Maple River at Mapleton	.135	.031	.021	.010	.007
Soldier River at Pisgah	.125	.032	.021	.014	.106
Boyer River at Logan	.149	.031	.018	.010	.007

*Based on record through 1966

Procedure used by the USGS, but based upon less than 10 years of recorded data. For these reasons, verification of these values, as additional flow information is collected, is required.

Due to the climatological and geological characteristics of the basin, low flows tend to occur either during August and September or during January and February of any given year. For this reason, analyses of critical conditions for defining waste load allocations must be conducted for both warm and cold water temperatures.

Table III-6 gives averages from longer-term means derived from continuous-recording gaging stations within the Western Iowa Basin. A comparison with the State of Iowa average is included.

HYDROGEOLOGY

The major aquifers found in the State of Iowa subcrop beneath the Dakota sandstone in the northern half of the Western Iowa Basin, in three continuous counties along the western border of the state: Monona and Woodbury Counties, where (proceeding from south north) Pennsylvanian Rocks in the south give way to the Mississippian aquifer, and the Silurian-Devonian aquifer; and Plymouth County, where the Silurian-Devonian gives way to the Cambrian-Ordovician, and the Dresbach. In extreme northwest Plymouth County, and to the north, Pre-Cambrian bedrock subcrops.

The Dakota aquifer is found, in addition, over parts of the entire basin from Monona and Crawford Counties northward.

The Supporting Document describes the hydrogeology of Iowa on a broader scope. Here the aquifers are sketched as they pertain to the Western Iowa Basin.

The surficial aquifers are those directly underlying the basin. The most important, the alluvial aquifers, are in hydrologic connection with the principal streams. These aquifers have a close time-and-space connection to the streams. Therefore, under certain conditions, most of the water withdrawn from them is induced surface water.

Movement of water in the deeper aquifers is slow, but the amount of water in them is great, so that large groundwater withdrawals do not generally deplete the supply.

Surficial Aquifers

The surficial aquifers of the basin comprise fluvio-glacial outwash deposits and fluvial deposits of Quarternary age (called alluvial deposits or alluvium) found along the present watercourses; outwash sands occupying buried bedrock channels; and thin discontinuous sand bodies in the glacial Drift. The alluvial and buried valley deposits are important sources of moderate to large water supplies, but are restricted in occurrence to river valleys and preglacial drainageways. The glacial drift is a source of small supplies only, but is important as a source of rural water supplies due to its widespread occurrence.

Alluvial deposits underlying the plains and river terraces of Iowa's principal rivers constitute productive aquifers that are currently important sources of water with an additional unevaluated potential. Aquifers of appreciable areal extent occur along the Big Sioux and Missouri Rivers. These groundwater reservoirs have fairly large storage characteristics and are recharged normally at rather frequent intervals. Recharge occurs from local precipitation and seepage from adjacent streams where groundwater withdrawals are large. Therefore, they, to a degree, reflect surface water quality and availability.

The water-bearing materials underlying the Big Sioux and Missouri valleys consist mainly of fine-to-coarse sand and gravel and some interstratified clay and silt sorted and deposited by glacial melt waters. The coarser and more permeable deposits occur along the major valleys, where stream velocities were highest. The thickness of these alluvial deposits is from 100 to 160 feet at most places along the Missouri River and from 30 to 70 feet along the principal interior streams. Appreciable decrease in thickness occurs in areas where local bedrock highs underlie the present valleys.

Enormous quantities of water are stored in the porous alluvial deposits of the Missouri Valley. The Iowa side of the Missouri River alluvium contains an estimated 6 trillion gallons of water in storage.

The thinner and narrower alluvial aquifers along the interior streams contain smaller, but appreciable amounts of water in storage. Of more importance than storage, however, is the induced infiltration of river water that sustains the yield from these aquifers when they are developed for water supplies. Sustained yields, many of them high, have been developed at some localities from the alluvial aquifers. Additional large sustained yields should be readily available at many other localities.

Individual wells constructed in the alluvium along the Missouri River are capable of pumping large quantities of water. In the Missouri Valley numerous wells pump from 1,000 to 1,500 gallons per minute for supplemental irrigation. A well completed in the alluvium of the interior streams commonly yields 200 to 300 gallons per minute.

Glacial drift is a source of water supply for stock and domestic supply and for small towns, except in the portions of the basin where the drift is largely absent. The drift consists principally of pebbly and sandy boulder clay containing lenticular or shoestring bodies of sorted sand and some poorly sorted sand and gravel. The producing zones are the sand bodies within or at the base of the drift.

Wells may range from 15 to 20 to as much as 400 feet deep or more. Generally, these wells yield only a few gallons per minute, but with favorable conditions and proper well design as much as 10 to 20 gpm may be obtained. However, rural residents depend heavily on the drift aquifers in much of the basin where bedrock formations are deeply buried and yield only small supplies of poor quality water. In many places in the basin, the drift sands are the only sources available for acceptable quality water at a reasonable depth.

Bedrock Aquifers

Major portions of the basin are underlain by bedrock formations that yield large amounts of water to wells. Much of the area is underlain by more than one of these aquifers, separated by relatively impermeable aquicludes. In such areas the developer of groundwater may choose between the aquifers on the basis of depth, yield, pumping lift, water quality, or other considerations. In most of the basin these aquifers are not fully developed, however, in a few small areas of concentrated pumping, water levels have declined noticeably but not alarmingly.

The important aquifers are the Dakota Sandstone, lower Pennsylvanian Sandstone, Mississippian Limestone, Jordan Sandstone, and Dresbach Sandstone. The Dakota Sandstone yields moderate to large quantities of somewhat mineralized water in the upper part of the basin. Pennsylvanian sandstone occurs beneath much of the southern part of the basin, but commonly yields only small supplies because of the low permeability. Moreover, this water may be rather highly mineralized.

Dakota Sandstone

Strata of Cretaceous age, principally the Dakota Sandstone, comprise the chief bedrock aquifer in the northern part of the basin. Maximum thickness of the full Cretaceous System is somewhat more than 400 feet in central Sioux and Osceola Counties, from where it thins northwestward and southeastward.

The upper part of the Cretaceous consists of a thick succession of shales representing the Carlisle and Graneros Formations. These shales attain a maximum thickness of 250 to 300 feet in Lyon, Sioux, and Plymouth Counties, thinning to the east and south. The underlying Dakota Sandstone also contains considerable shale, but has water-bearing sandstones in both the upper and lower parts. At Sioux City, the thickness of the Dakota Sandstone reaches 260 feet. Usually the Dakota Sandstone is rather fine-grained and poorly cemented, which frequently causes sand-pumping troubles. Proper well construction and aquifer development can minimize this problem.

Yields from the sandstone aquifer are somewhat erratic, varying from a few ten to a few hundred gallons per minute. The aquifer generally can be counted on to produce sufficient water for rural and many municipal requirements. Even where the aquifer is only moderately thick, many wells have been developed to yield 50 to 100 gpm. However, municipal wells in Osceola, O'Brien, Sioux and Cherokee Counties have been tested at 350 to 750 gallons per minute. At Sioux City, where the Dakota Sandstone is recharged by water from the overlying alluvial sands and gravels, yields in excess of 1,500 gallons per minute have been obtained.

Mississippian Aquifer

The Mississippian Aquifer consists of a thick sequence of limestones and dolomites between the overlying shales of Pennsylvanian age and the underlying Maple Mill-Sheffield shales of Devonian age. These rocks underlie the Dakota Aquifer that is part of the basin south of a line that passes through Woodbury County.

Silurian-Devonian

The Silurian-Devonian aquifer, comprising the Niagran and Alexandrian Series of Silurian age and the Cedar Valley and Wapsipinicon Formations of the Devonian age, underlies the entire basin except for the portion northwest of a line from southwest Plymouth County to east-central Clay County. The aquifer subcrops immediately beneath the glacial drift and cretaceous rocks in a narrow belt from Palo Alto County through southern Clay, most of Buena Vista and Cherokee Counties, southern Plymouth to northwestern Woodbury County. Southeast of the subcrop area, it dips beneath the Devonian aquiclude and other younger Paleozoic rocks. The Silurian-Devonian aquifer's thickness rnages from zero to 650 feet and generally is between 200 and 350 feet throughout its area of occurrence.

The aquifer is composed of relatively dense limestone and dolomite, whose porosity and permeability are dependent principally on secondary rock openings -- fractures, joints, brecciated zones, and solution tubules. The anisotropic aquifer makes it difficult to predict yields. The aquifer is utilized much less in that portion of the basin where it is overlain by the Devonian aquiclude.

Cambrian-Ordovician Aquifer

The Cambrian-Ordovician Aquifer subcrops beneath the Cretaceous rocks in the basin from northwestern Plymouth County to Emmet County, and includes most of southeastern Sioux, southeastern Osceola, northern and central O'Brien, northern Clay, and most of Dickinson counties. The aquifer is present beneath younger Paleozoic rocks at progressively greater depths to the south. The depth of wells necessary to penetrate it increases to about 3,200 feet in the southern parts of the basin. The total thickness of the water-bearing unit in the basin ranges from zero to 400 feet.

The aquifer consists of three water-bearing formations. They are the St. Peter Sandstone, the Prairie Du Chien Formation or Ordovician age, and the Jordan Sandstone of Cambrian age.

The St. Peter is a friable medium-grained, almost pure sandstone that is rarely more than 50 feet thick. It is generally cased off in wells drilled to the Cambrian-Ordovician aquifer to prevent caving of the sandstone or to shut off poor-quality water.

The Prairie du Chien Formation consists principally of dolomite but includes some sandstone beds. In the northern part of the basin the formation wedges out. The formation is believed to yield significant amounts of water to wells penetrating the Cambrian-Ordovician aquifer. However, its performance is generally masked by that of the underlying Jordan sandstone.

The Jordan sandstone is the principal water-producing unit and is penetrated by practically all wells drilled to the Cambrian-Ordovician aquifer. This formation is a medium-to-coarse grained, pure quartzose sandstone whose thickness ranges from 75 to 125 feet in the northern part of the basin to less than 25 feet in southwestern Iowa.

The piezometric high in the Jordan sandstone in northwest Iowa is attributed to recharge by seepage from the Dakota aquifer, which has a slightly higher pressure head than the underlying Paleozoic aquifers. Recharge is enhanced in this area by the absence of the Paleozoic aquicludes, which either wedge out or undergo facies changes to dolomites.

Specific capacities of wells finished in the aquifer commonly range from 5 to 25 gallons per minute per foot of drawdown in the north to 1 to 3 in the south.

Dresbach Aquifer

The Dresbach aquifer is a sequence of coarse-to-fine grained sandstones between the overlying Franconian Formation of Cambrian age and the underlying crystalline rocks of quartzites of Pre-Cambrian age. Throughout much of the Basin, it occurs so deeply buried that the cost of development is prohibitive. Although it subcrops in the extreme north, it is about 3500 feet deep in Fremont County in the south of the Basin.

GROUNDWATER QUALITY

Dissolved solids concentration of water from most aquifers are high in the Western Iowa Basin. In general, excluding some limited bedrock areas, other than the Dakota sandstone, the only aquifers yielding waters of less than 500 milligrams per liter (mg/l) of total dissolved solids are the alluvial aquifers and those of the Dakota aquifer. Alluvial aquifers in five of the six northernmost counties yield waters well over 1000 mg/l of total dissolved solids.

Water with dossolved solids of less than 500 mg/l is found in the Dakota aquifer in parts of Woodbury, Monona, Clay, Buena Vista, and Cherokee counties. The Dakota aquifer in Woodbury, Monona, Harrison, Clay, and Buena Vista Counties in the basin have dissolved solids concentrations under 500, but the water of the bedrock aquifers in these counties and elsewhere is generally hard.

The Supporting Document describes in detail the characteristics of the aquifers underlying Iowa. The alluvial waters of the Western Iowa Basin are of the calcium bicarbonate or calcium magnesium bicarbonate type except in Dickinson and Osceola counties, and in parts of O'Brien, Clay and Lynn counties, where they are of the calcium sulfate type.

Iron in troublesome amounts is commonly found in water from the alluvial aquifers, in sand aquifers beneath glacial drift, and in near-surface bedrock aquifers.

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CHAPTER IV

WATER QUALITY

WESTERN IOWA BASIN

The main objective of water quality management is to protect and enhance the water resources to ensure acceptable conditions for designated uses. Sound management first requires knowledge of the existing water quality. Existing water quality for the Western Iowa Basin has been identified from available data including State Hygienic Laboratory reports, STORET data, the DEQ files and the Iowa Water Quality Report (305). The data indicate some areas of degraded water quality. It is the purpose of water quality standards to limit waste inputs to streams so that designated water uses will not be impaired.

The Iowa Water Quality Commission has classified streams into four classifications, A, B, C, and General. Class A Waters are those which are to be preserved for whole body contact. Class B Waters are those which are to be preserved for wildlife, aquatic life, and non-body contact recreation. Class C Waters are those which must be of a quality to meet requirements for use as a potable water supply. The General classification which applies to all waters, provides for generally acceptable physical conditions and elimination of toxic substances. The Supporting Document for Iowa Water Quality Management Plans (1) lists the standards in detail for each class. In addition to material contamination, thermal discharges are important to water quality, since many life forms cannot adapt to a wide range of temperature. Temperature variation within a stream can result in different proportions of species and may even result in the disappearance of some forms and the appearance of others. Standards have been set for thermal discharges and streams have been further classified as to being "cold water" or "warm water".

Table VI-1, from the Water Quality Standards, Chapter 16, (2) Iowa Departmental Rules, presents the classifications of the various streams in the Western Iowa Basin, and Figure IV-1, shows those streams classified A, B, or C.

EXISTING WATER QUALITY

Information on water quality in the Western Iowa Basin consists mainly of data gathered quarterly by the State Hygienic Laboratory, special surveys made by the laboratory and the DEQ, and of data from special samplings and surveys taken by the academic community.

In the Western Iowa Basin, data have been collected by the State in the Missouri, Big Sioux, Rock, Floyd, Little Sioux, and Boyer basins, as well as in the basin of the West Branch Little Sioux-Monona-Harrison Drainage Ditch System. Figure IV-2 presents the sampling locations in the basin.

The remainder of this chapter describes the water quality in each of the basins over the period from 1970 to 1975. Many materials are samples during surveys and special studies, but here only four key measurements are described: temperature, dissolved oxygen level, ammonia nitrogen, and fecal coliforms.

Data taken earlier than 1970 were excluded because of the changes that take place with time. Data from the last five years was

TABLE IV-1

SURFACE WATER CLASSIFICATION

WESTERN IOWA BASIN

Stream	Classification A	B Warm water	C
A. Missouri River - Main Stem Mo. State line to South Dakota State line	X	X	X (Above Council Bluffs)
1. Big Sioux River mouth to Minn. State line		X	
a. Rock R. mouth to Minn. State line		X	
2. Floyd River mouth to Hwy. 10		X	
3. Little Sioux River mouth to Minn. State line		X	
a. Maple River mouth to Hwy. 3		X	
(1) Battle Cr. mouth to Hwy. 20		X	
(2) Odebolt Cr. mouth to Ida Co. Road M31		X	
(3) Little Maple R. mouth to Buena Vista Co. Road C65		X	
b. W. Fork Little Sioux R. mouth to Plymouth Co. Road L14		X	
c. Mill Cr. mouth to Hwy. 59		X	
d. Waterman Cr. mouth to Hwy. 18		X	
e. Lost Island Outlet mouth to Lost Island Lake		X	
f. Ocheyedan R. mouth to Minn. State line		X	
(1) Stony Cr. mouth to Stony Lake		X	

TABLE IV-1 (cont.)

SURFACE WATER CLASSIFICATION

WESTERN IOWA BASIN

Stream	Classification A	Classification B Warm water	Classification C
4. Soldier River mouth to confl. with E. Soldier R.		X	
5. Boyer River mouth to Sac Co. line		X	
6. Mosquito Creek mouth to Hwy. 275		X	
7. Keg Creek mouth to Hwy. 34/275		X	x (Above Glenwood)


MINNESOTA
SOUTH DAKOTA
NEBRASKA
MISSOURI
LYON
OSCEOLA
DICKINSON
EMMET
SIOUX
O'BRIEN
CLAY
PALO ALTO
PLYMOUTH
CHEROKEE
BUENA VISTA
POCAHONTAS
WOODBURY
IDA
SAC
CALHOUN
MONONA
CRAWFORD
CARROLL
HARRISON
SHELBY
POTTAWATTAMIE
MILLS
FREMONT
SIOUX CITY
COUNCIL BLUFFS
MISSOURI RIVER
N
30 Miles
40 Kilometers
STATE OF IOWA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WESTERN IOWA RIVER BASINS
SURFACE WATER CLASSIFICATION
CLASS A AND CLASS B (WARM WATER)
CLASS B (WARM WATER)
CLASS C
PREPARED BY E A HICKOK & ASSOCIATES

FIGURE IV-1

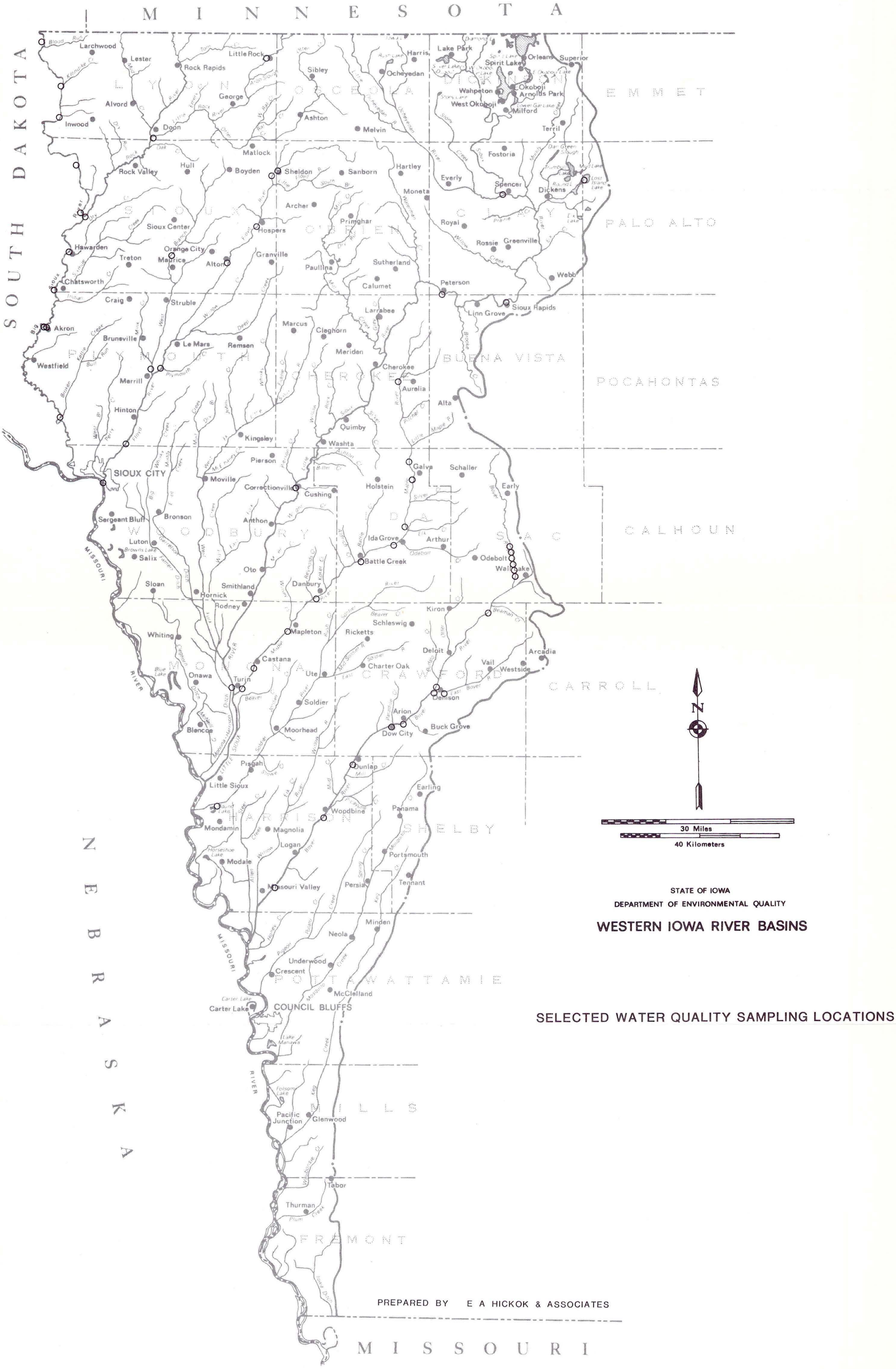

MINNESOTA
SOUTH DAKOTA
NEBRASKA
MISSOURI
LYON
OSCEOLA
DICKINSON
EMMET
SIOUX
O'BRIEN
CLAY
PALO ALTO
PLYMOUTH
CHEROKEE
BUENA VISTA
POCAHONTAS
WOODBURY
IDA
SAC
CALHOUN
MONONA
CRAWFORD
CARROLL
HARRISON
SHELBY
POTTAWATTAMIE
MILLS
FREMONT
SIOUX CITY
COUNCIL BLUFFS
MISSOURI RIVER
N
30 Miles
40 Kilometers
STATE OF IOWA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WESTERN IOWA RIVER BASINS
SELECTED WATER QUALITY SAMPLING LOCATIONS
PREPARED BY E A HICKOK & ASSOCIATES

FIGURE IV-2

used and assumed to be most representative of existing conditions, however, changes over even such a short period occur and have occurred due to the installation of new sources and/or control systems.

Of the many variables sampled during the quarterly surveys and special surveys, the key parameters, temperatures, dissolved oxygen, ammonia nitrogen and fecal coliform count are presented in this report. As discussed in Chapter I of this report, these standards are among the most difficult to meet. Further, along with temperature, they provide an index to general water quality.

Temperature is especially important to the percentage distribution of the various life forms. Ambient water temperatures of Class B "warm water" lakes, streams or reservoirs may not exceed 90°F (32.2°C) while they may not exceed 68°F (20°C) in Class B "cold water" streams. There is no limit for Class A or C waters.

Dissolved oxygen is an index of the capacity of the water to sustain fish and other aquatic life forms. Values of less than 4.0 mg/l at any time violate the DEQ Class B standard, while a value of at least 5.0 mg/l must be met for at least 16 hours of a 24-hour period. If the stream is designated as a cold water stream, the dissolved oxygen level must never drop below 5.0 mg/l, and must be 7.0 mg/l for at least 16 hours of a 24-hour period.

Ammonia nitrogen values over 2.0 mg/l violate Iowa standards for Class B streams. There is no ammonia standard for Class A or C streams.

Increases in fecal coliforms of greater than 200 organisms per 100 milliliters (ml) in the receiving water violate Iowa standards for Class A streams, between April 1 and October 31. Concentrations higher than 2000 per 100 ml violate Iowa standards for Class B streams. However, if the waters are "materially affected by surface runoff", the value of 2000 per ml may be exceeded. There is no limit to fecal coliform concentration in Class C waters.

Quality of Specific Waters

Each major stream in the basin is sampled quarterly. Special surveys are made on these streams and on minor streams as needs arise. Following is a discussion of the information from these samples and surveys.

BIG SIOUX RIVER

The Big Sioux River forms the boundary between Iowa and South Dakota from the northwest corner of Iowa to Sioux City. Originating in northeast South Dakota, it flows for about 100 miles from the northwest corner to Sioux City. The river flows essentially from north to south.

The principal tributary of the Big Sioux River is the Rock River, discussed separately in this section. Both the Big

Sioux River and the Rock River are Class B (warm water) streams. No other Big Sioux River tributaries in Iowa are classified other than under the General criteria.

Several communities lie along this boundary river. Both Sioux City (pop. 89,925) and Sioux Falls, South Dakota, (pop. 72,488) are on the Big Sioux. These cities are much larger than other Iowa communities in the basin: Hawarden (pop. 2,789) and Akron (pop. 1,324), on the Big Sioux, and Rock Valley (pop. 2,205) and Rock Rapids (pop. 2,632) on the tributary Rock River.

Chemical and physical data indicate several significant pollution problems in the Big Sioux River. Dissolved oxygen, BOD, and ammonia concentrations cause serious problems particularly during the winter. Dissolved solids are also in higher concentrations than most other Iowa streams. Significant pesticide residues have also been identified. Dieldrin has been found in concentrations exceeding levels recommended by the National Academy of Science in over 50% of the samples analyzed. Aldrin and DDT have also been found.

Water Quality Conditions

Harmful Substances - Limited data are available on heavy metals, pesticides and herbicides in the Big Sioux River. All metals found in the Big Sioux have been within the limitations of the applicable Iowa Water Quality Standards (see Table IV-2). While no standards are established by Iowa for manganese, the EPA has established suggested drinking

TABLE IV-2

HEAVY METALS IN BIG SIOUX RIVER

PARAMETER	TOTAL SAMPLES	NUMBER OF SAMPLES WITH DETECTABLE LEVELS	MEAN OF THOSE WITH DETECTABLE LEVELS (μg/l)	MAXIMUM (μg/l)
As	12	0		
Ba	9	8	137	200
Cd	11	0		
Cr	13	0		
Cu	11	4	12	20
Pb	11	0		
Mn	13	12	423	2400
Hg	2	0		
Ni	9	0		
Ag	6	0		
Zn	11	9	39	60

water criteria. On the basis of the EPA criteria of 50 ppb, manganese in the Big Sioux River was in violation in over 40% of the samples analyzed. These concentrations are most likely the result of chemical characteristics of the drainage area rather than the result of point source pollution.

A variety of pesticides have been detected in the Big Sioux River (Table IV-3). Concentrations of aldrin, DDT, and dieldrin have exceeded recommended maximum concentrations established by the National Academy of Science (1972). Pesticide concentrations indicate the need for increased control of nonpoint source runoff.

Physical Modification - Turbidity and suspended solids increase during runoff periods. These increases are smaller than those for many other Iowa streams in the northwest part of the State. Temperature changes generally reflect air temperature conditions. There is no known thermal pollution on the Iowa portion of the Big Sioux River.

Eutrophication Potential - High levels of both nitrogen and phosphorus are characteristic of the Big Sioux River (see Figure IV-3). Neither nutrient appears to be limiting to algal growth. The Sioux Falls, South Dakota sewage treatment plant discharges considerable amounts of nutrients.

Salinity, Acidity, and Alkalinity - Total dissolved solids concentrations in the Big Sioux River are among the highest of any stream in the State. Total dissolved solids have averaged

TABLE IV-3

PESTICIDES IN THE BIG SIOUX RIVER

PARAMETER	TOTAL SAMPLES	NUMBER OF SAMPLES WITH DETECTABLE LEVELS	MEAN OF THOSE WITH DETECTABLE LEVELS (ng/l)	MAXIMUM (ng/l)
Aldrin	15	1	20	20
Chlordane	13			
DDD	15			
DDE	15			
DDT	15	1	20	20
Dieldrin	15	9	20	50
Endrin	15			
Heptachlor Epoxide	15	1	10	10
Lindane	15	1	10	10
2, 4,-D	14	8	290	940
2, 4, 5-T	14	2	10	10
Silvex	14			
PCB	4			
Parathion	4			
Methyl Parathion	4			
Malathion	4			
Diazinon	4			
Atrazine	15			

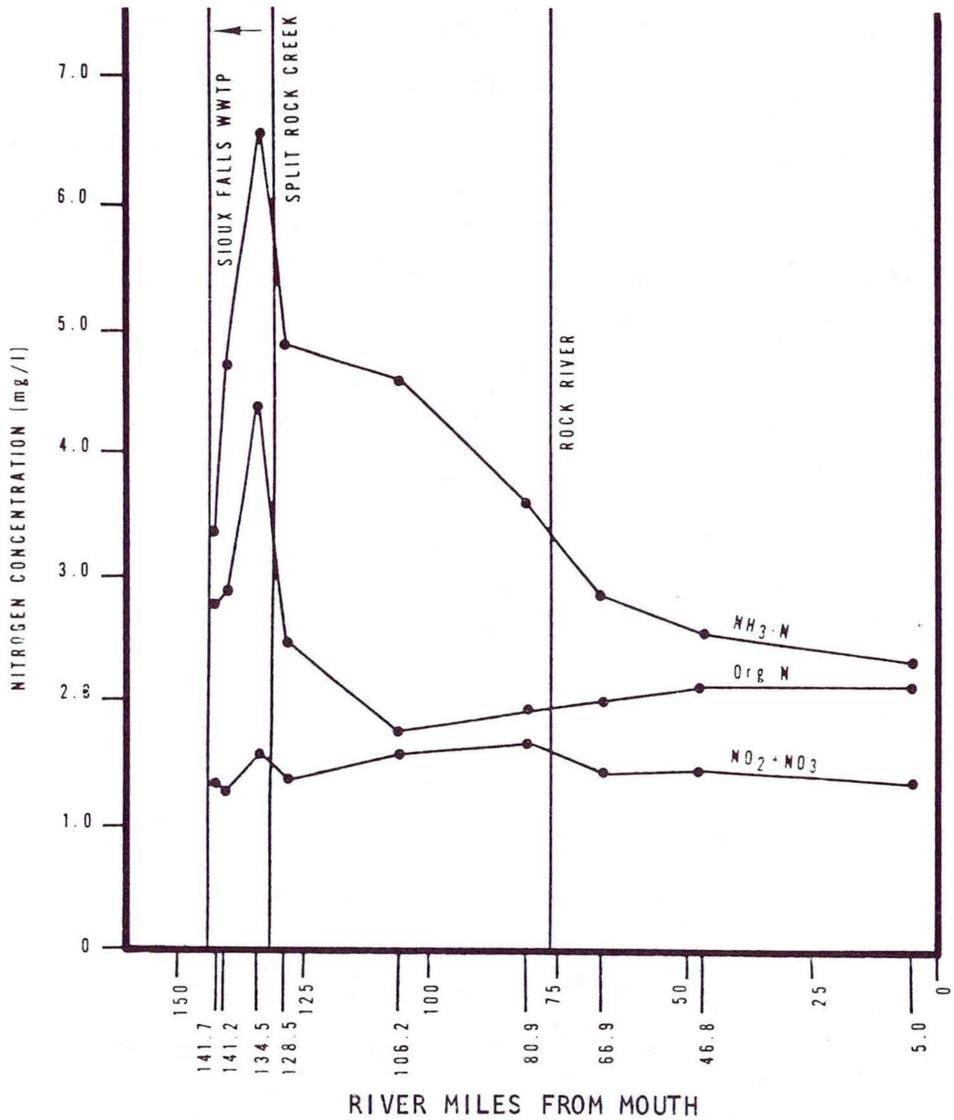


FIGURE IV-3

NITROGEN PROFILE, BIG SIOUX RIVER, ESTELLINE, SOUTH DAKOTA TO SIOUX CITY, IOWA
1-10 FEBRUARY 1973
(ENVIRONMENTAL PROTECTION AGENCY 1973)

greater than 750 mg/l (the Iowa Water Quality Standards) and have been found as high as 1300 mg/l. Concentrations tend to decrease toward the mouth of the river. This is probably the result of dilution as the solids concentration in tributary streams is considerably lower than the solids concentration in the main stem. Chloride concentrations are the highest of any Iowa stream, and follow the same pattern as total dissolved solids. The average chloride concentration in the Big Sioux River is over 125 mg/l, with maximum well over 150 mg/l. While total dissolved solids concentrations are not necessarily detrimental to aquatic life, additional study on the complex problems in the Big Sioux River is needed to determine the effect of these salts on aquatic life.

<u>Oxygen Depletion</u> - As stated earlier, dissolved oxygen and ammonia concentrations in the Big Sioux are currently the most critical pollution parameters. Oxygen concentrations in the summer during the day are at or above saturation (see Figure IV-4 & 5). No oxygen studies have been undertaken to determine the impact from algal respiration at night.

During the winter period of near complete ice cover dissolved oxygen often violates Iowa Water Quality Standards along the entire stream. Ammonia violations also occur.

<u>Health Hazards and Aesthetic Degradation</u> - Fecal coliform concentrations in the Big Sioux are generally acceptable (see Figure IV-6). Fecal coliform from the Sioux Falls, South Dakota treatment plant are diluted sufficiently below the

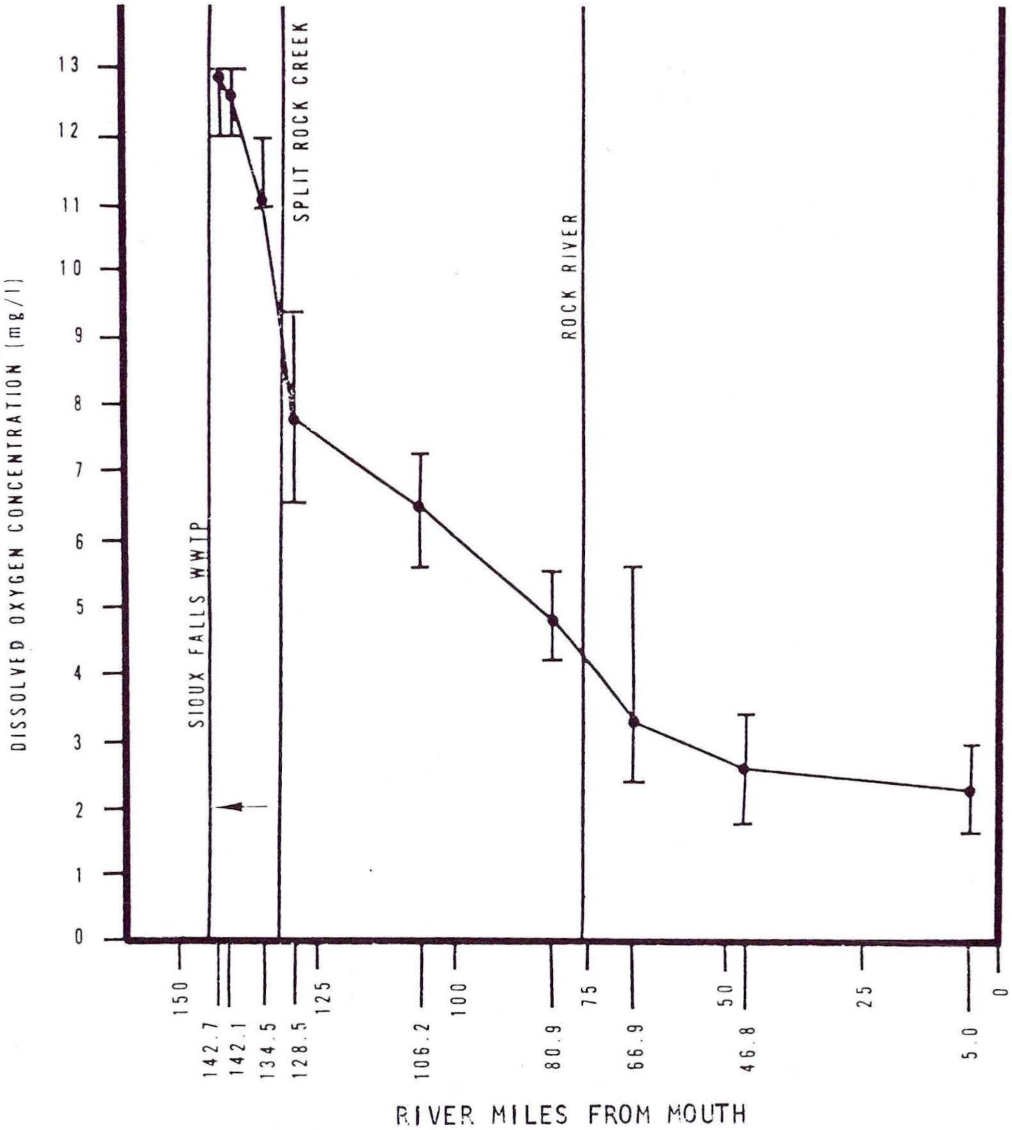


FIGURE IV-4

DISSOLVED OXYGEN PROFILE,
BIG SIOUX RIVER, ESTELLINE,
SOUTH DAKOTA TO SIOUX CITY, IOWA
1-10 FEBRUARY 1973

(ENVIRONMENTAL PROTECTION AGENCY 1973)

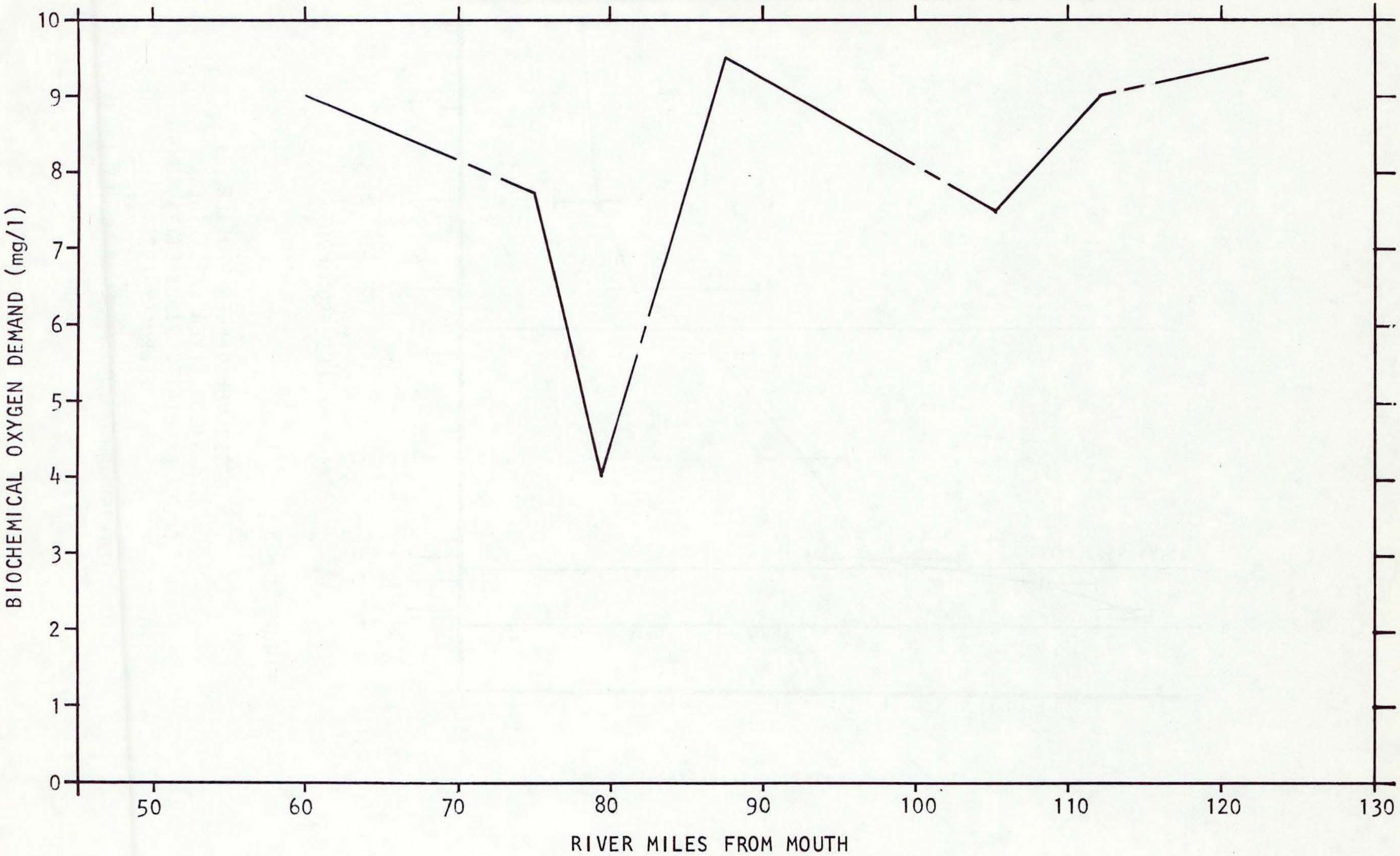


FIGURE IV-5 MEAN BIOCHEMICAL OXYGEN DEMAND CONCENTRATIONS FOR THE BIG SIOUX RIVER, 1970-1974

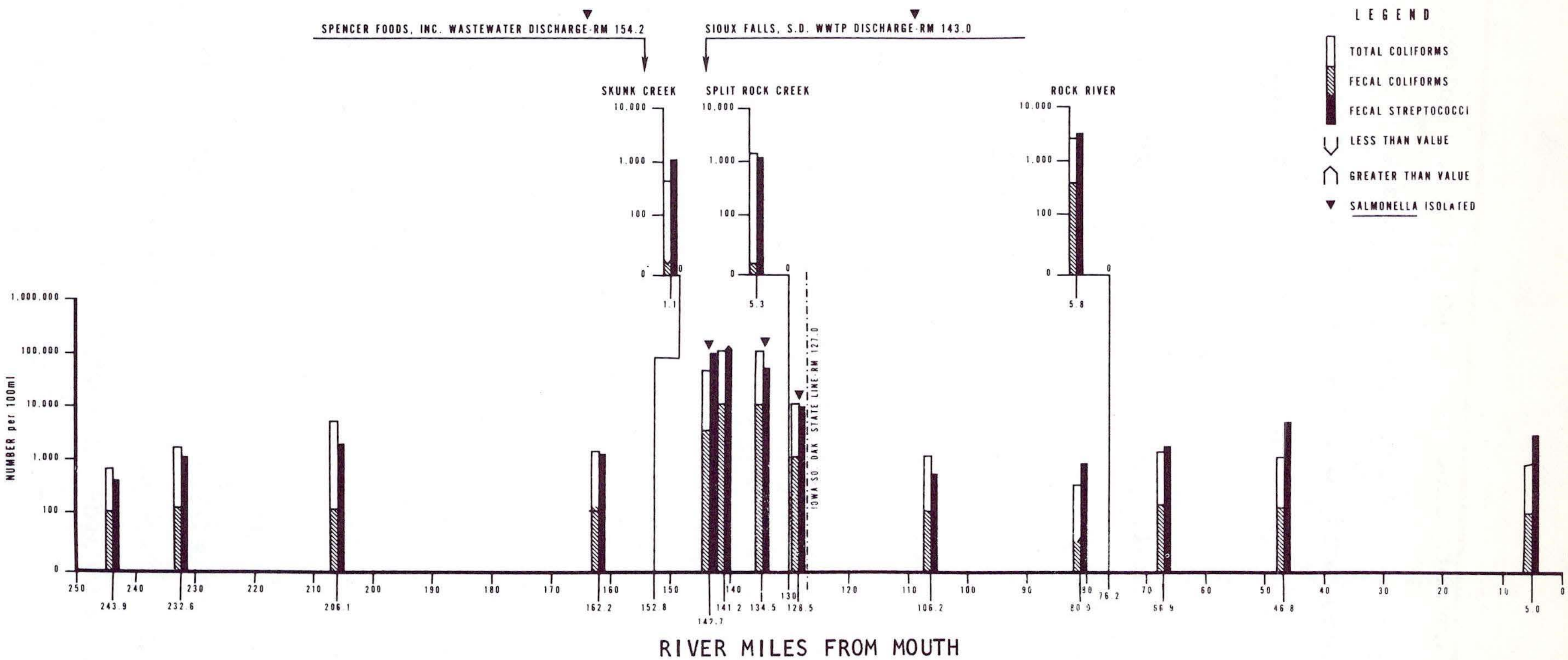


FIGURE IV-6 BACTERIAL DENSITIES (LOGARITHMIC MEAN) BIG SIOUX RIVER, SOUTH DAKOTA, FEBRUARY 1973

(ENVIRONMENTAL PROTECTION AGENCY 1973)

Iowa-Minnesota line to be near federal guidelines (200 bacteria per 100 ml). Concentrations on the Rock River are generally higher and tend to increase in the Big Sioux below the confluence. No violations of Iowa Water Quality Standards have been noted.

The water quality data for the Big Sioux River are summarized on Figure IV-7.

ROCK RIVER

The Rock River originates in Pipestone County, Minnesota, entering Iowa in Lyon County just north of Rock Rapids. The Rock flows about 40 miles from the Minnesota boundary to its confluence with the Big Sioux River in west-central Sioux County.

It has no important tributaries in Iowa. The largest tributary is the Little Rock River, which originates in western Osceola County. Rock Rapids, on the river in north-central Lyon County, is the only Iowa community of significant size, with 2,632 population. The Minnesota communities of Luverne (pop. 4,703) and Edgerton (pop. 1,119) are also on the Rock River.

The water quality of the Rock River is summarized on Figure IV-8. Quarterly sampling of the stream has been made near Sioux Center. None of the samples have indicated violation of DEQ standards, however, relatively high winter ammonia concentration indicate that violation might occur under low flow conditions. Summertime water quality has been found to

DATE	TIME	TEMP	D.O.	NH_3	F.C.
28 Feb 72	12:30	0°C	1.1	16.0	--
19 Sep 72	16:30	28°C	13.7	.01	300

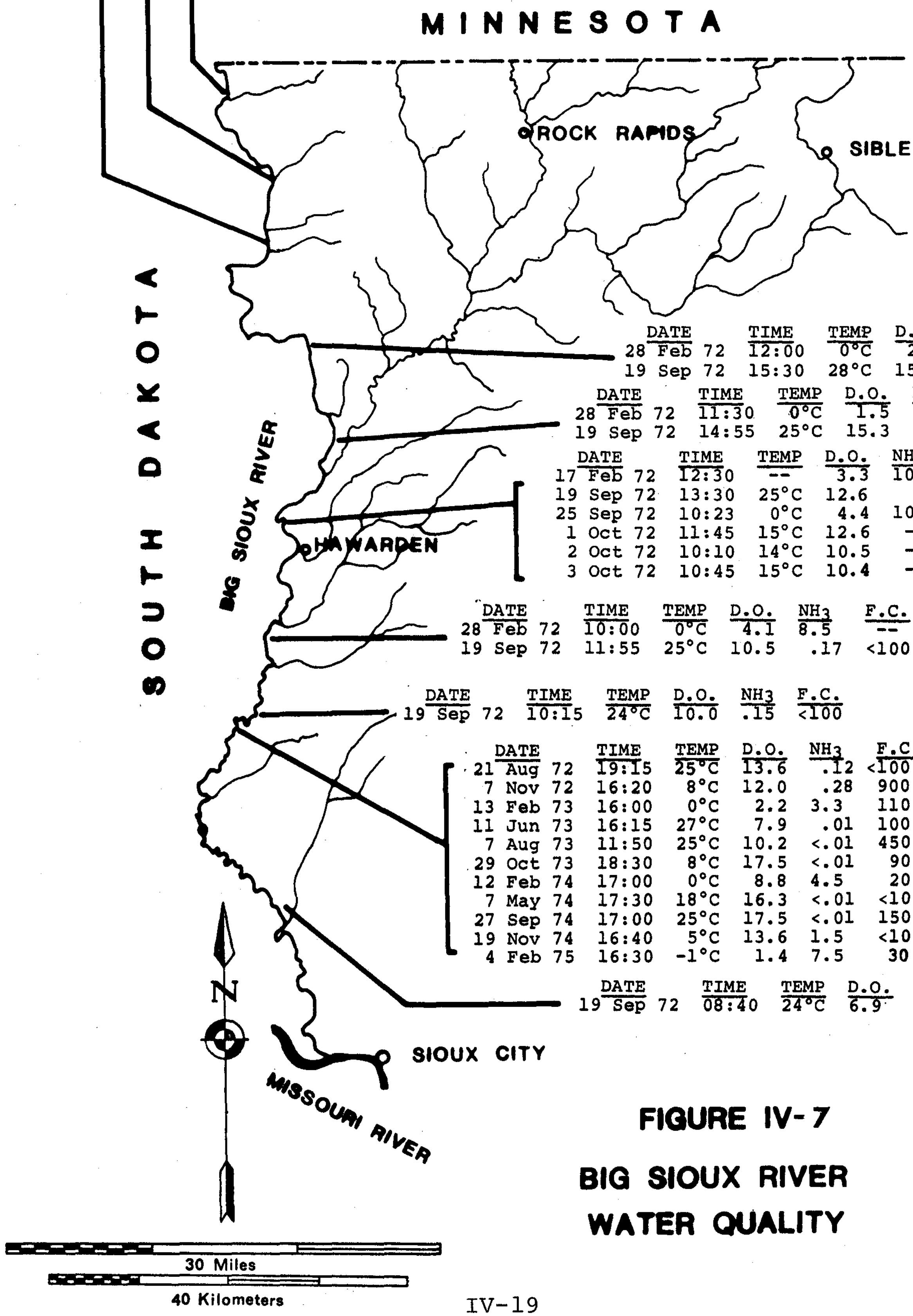
DATE	TIME	TEMP	D.O.	NH_3	F.C.
19 Sep 72	17:15	25°C	12.9	.04	1400
19 Sep 72	17:40	23°C	5.6	--	--

DATE	TIME	TEMP	D.O.	NH_3	F.C.
28 Feb 72	--	0°C	0.2	.25	--
19 Sep 72	18:00	23°C	5.9	--	--
19 Sep 72	18:10	25°C	9.6	.12	400

DEQ WATER QUALITY STANDARDS

	CLASS A&B WATERS COLD	CLASS A&B WATERS WARM	CLASS C WATERS
TEMPERATURE degrees celsius	20	32.2	...
DISSOLVED OXYGEN milligrams per liter	5.0(1)	4.0(2)	...
AMMONIA NITROGEN milligrams per liter	2.0(3)	2.0(3)	...
	CLASS A	CLASS B	
FECAL COLIFORMS colonies per 100 milliliters	200(4)	2000	...

(1) Must be at least 7.0 for 16 hours of a 24-hour period
(2) Must be at least 5.0 for 16 hours of a 24-hour period
(3) Except if flow equals or exceeds the 7-day/10-year low flow or if material is from uncontrollable non-point sources
(4) Between April 1st and October 31st only



DATE	TIME	TEMP	D.O.	NH_3	F.C.
28 Feb 72	12:00	0°C	2.0	20	--
19 Sep 72	15:30	28°C	15.3	.01	<100

DATE	TIME	TEMP	D.O.	NH_3	F.C.
28 Feb 72	11:30	0°C	1.5	17	--
19 Sep 72	14:55	25°C	15.3	.01	200

DATE	TIME	TEMP	D.O.	NH_3	F.C.
17 Feb 72	12:30	--	3.3	10.0	--
19 Sep 72	13:30	25°C	12.6	.01	<100
25 Sep 72	10:23	0°C	4.4	10.0	--
1 Oct 72	11:45	15°C	12.6	--	--
2 Oct 72	10:10	14°C	10.5	--	--
3 Oct 72	10:45	15°C	10.4	--	--

DATE	TIME	TEMP	D.O.	NH_3	F.C.
28 Feb 72	10:00	0°C	4.1	8.5	--
19 Sep 72	11:55	25°C	10.5	.17	<100

DATE	TIME	TEMP	D.O.	NH_3	F.C.
19 Sep 72	10:15	24°C	10.0	.15	<100

DATE	TIME	TEMP	D.O.	NH_3	F.C.
21 Aug 72	19:15	25°C	13.6	.12	<100
7 Nov 72	16:20	8°C	12.0	.28	900
13 Feb 73	16:00	0°C	2.2	3.3	110
11 Jun 73	16:15	27°C	7.9	.01	100
7 Aug 73	11:50	25°C	10.2	<.01	450
29 Oct 73	18:30	8°C	17.5	<.01	90
12 Feb 74	17:00	0°C	8.8	4.5	20
7 May 74	17:30	18°C	16.3	<.01	<10
27 Sep 74	17:00	25°C	17.5	<.01	150
19 Nov 74	16:40	5°C	13.6	1.5	<10
4 Feb 75	16:30	-1°C	1.4	7.5	30

DATE	TIME	TEMP	D.O.	NH_3	F.C.
19 Sep 72	08:40	24°C	6.9	.08	<100

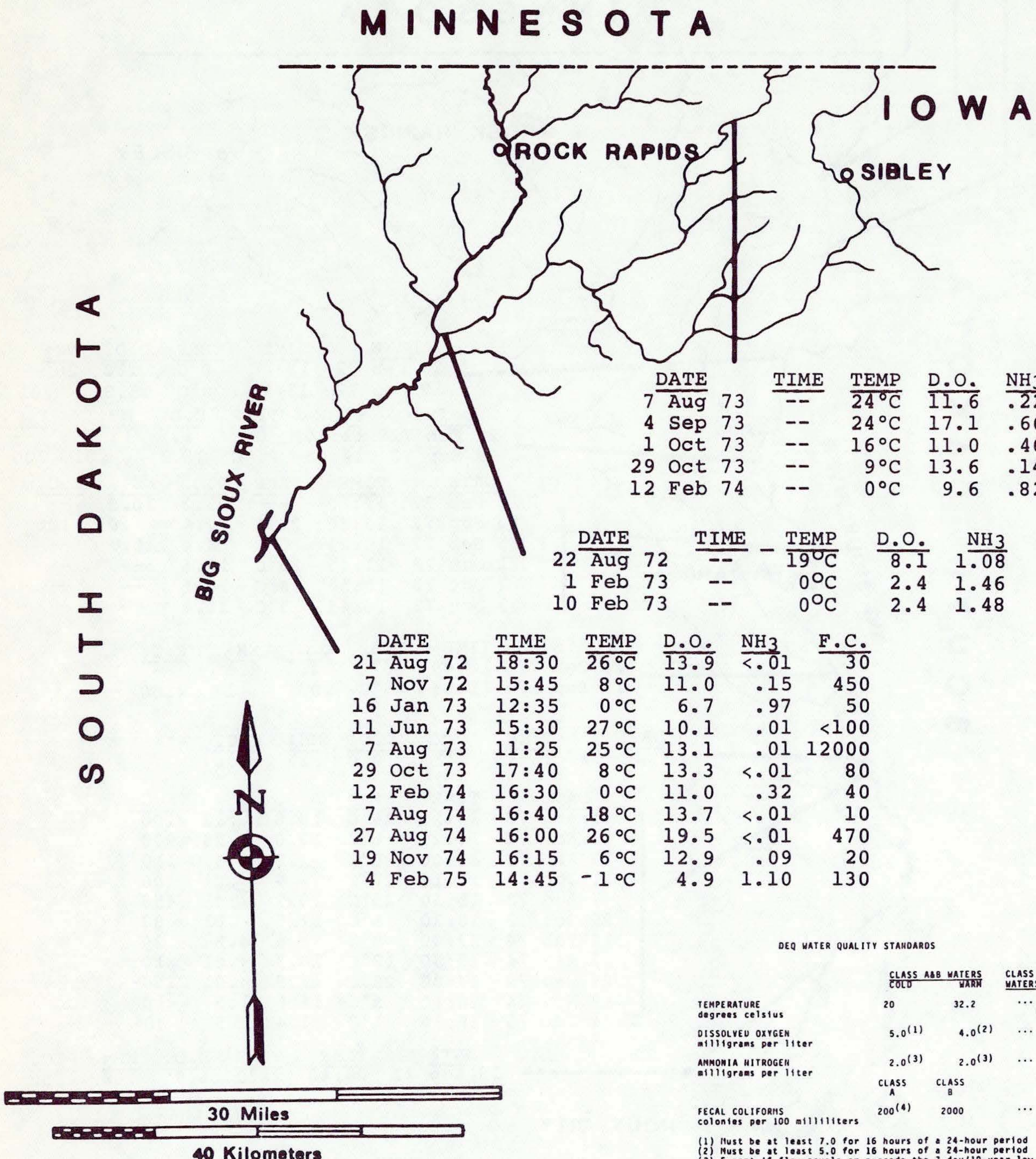
FIGURE IV-7

BIG SIOUX RIVER WATER QUALITY

PREPARED BY E A HICKOK & ASSOCIATES

FIGURE IV- 8

ROCK RIVER WATER QUALITY



DATE	TIME	TEMP	D.O.	NH_3	F.C.
7 Aug 73	--	24°C	11.6	.22	1000
4 Sep 73	--	24°C	17.1	.66	660
1 Oct 73	--	16°C	11.0	.46	3300
29 Oct 73	--	9°C	13.6	.14	100
12 Feb 74	--	0°C	9.6	.82	--

DATE	TIME	TEMP	D.O.	NH_3	F.C.
22 Aug 72	--	19°C	8.1	1.08	200
1 Feb 73	--	0°C	2.4	1.46	--
10 Feb 73	--	0°C	2.4	1.48	--

DATE	TIME	TEMP	D.O.	NH_3	F.C.
21 Aug 72	18:30	26°C	13.9	<.01	30
7 Nov 72	15:45	8°C	11.0	.15	450
16 Jan 73	12:35	0°C	6.7	.97	50
11 Jun 73	15:30	27°C	10.1	.01	<100
7 Aug 73	11:25	25°C	13.1	.01	12000
29 Oct 73	17:40	8°C	13.3	<.01	80
12 Feb 74	16:30	0°C	11.0	.32	40
7 Aug 74	16:40	18°C	13.7	<.01	10
27 Aug 74	16:00	26°C	19.5	<.01	470
19 Nov 74	16:15	6°C	12.9	.09	20
4 Feb 75	14:45	-1°C	4.9	1.10	130

DEQ WATER QUALITY STANDARDS

	CLASS A&B WATERS COLD	CLASS A&B WATERS WARM	CLASS C WATERS
TEMPERATURE degrees celsius	20	32.2	...
DISSOLVED OXYGEN milligrams per liter	5.0 (1)	4.0 (2)	...
AMMONIA NITROGEN milligrams per liter	2.0 (3)	2.0 (3)	...
	CLASS A	CLASS B	
FECAL COLIFORMS colonies per 100 milliliters	200 (4)	2000	...

(1) Must be at least 7.0 for 16 hours of a 24-hour period
(2) Must be at least 5.0 for 16 hours of a 24-hour period
(3) Except if flow equals or exceeds the 7-day/10-year low flow or if material is from uncontrollable non-point sources
(4) Between April 1st and October 31st only

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be good, but with some occasionally high values of fecal coliforms. In the late summer and early autumn of 1973, sampling was performed near Rock Rapids on four separate dates. Ammonia nitrogen values were surprisingly high on September 4th and October 1st. The fecal coliforms violated DEQ standards. The September 4th sampling was under relatively low flow, while the October 1st sampling was apparently associated with runoff conditions. Fecal coliforms on October 1st were found to be 330 per 100 ml, while the August 7, 1973 sample had a value of 1000 per 100 ml. The high values of fecal coliforms, probably due to agricultural runoff, can be expected to rise above 2000 per 100 ml during some rainy periods or during snowmelt.

FLOYD RIVER

Ammonia nitrogen, dissolved oxygen, and BOD concentrations seem to be the most serious pollution problems on the Floyd River. Numerous point sources with inadequate waste treatment have repeatedly been shown to be sources of high BOD and ammonia concentrations. Because of the high BOD values numerous violations of Iowa dissolved oxygen standards have occurred.

Water Quality Conditions

Harmful Substances - Pesticide concentrates found in the Floyd River have sometimes exceeded recommended maximum levels established by the National Academy of Science. While none of the pesticides are consistently found, as in some Iowa streams, dieldrin and 2,4-D have been found in over 50% of the samples collected (see Table IV-4). Dieldrin, DDT, aldrin, and heptachlor epoxide are the pesticides with concentrations above recommended levels. DDT, heptachlor epoxide, and aldrin have only occasionally been found in the Floyd River.

To date, no metals have been found exceeding Iowa standards, however, only limited data is available. Barium, manganese, and zinc have been identified. (See Table IV-5.)

Physical Modification - Turbidity and suspended solids create the biggest problem regarding physical modification. This problem is somewhat related to stream channelization and straightening. Turbidity concentrations as high as 850 JTU have been found in the Floyd. Suspended sediment loads on the Floyd River at James have been measured by the U.S. Geological Survey. Suspended sediment loading since 1970 has been about 450,000 tons per year with a maximum of nearly 800,000 tons per year in 1970-1971.

Salinity, Acidity, and Alkalinity - Acidity and alkalinity are not problems in the Floyd River. Alkalinity data has averaged slightly over 300 mg/l in the winter and dropped below 200 mg/l in the summer. Values for pH have ranged between 6.9 and 9.1. Most values are between 7.5 and 8.5 with only occasional samples approaching the extremes.

Chloride concentrations in the Floyd River are higher than most Iowa rivers, but are not found at the extremely high levels as in the Big Sioux or Maquoketa River.

TABLE IV-4

PESTICIDES IN THE FLOYD RIVER

PARAMETER	TOTAL SAMPLES	NUMBER OF SAMPLES WITH DETECTABLE LEVELS	MEAN OF THOSE WITH DETECTABLE LEVELS (ng/l)	MAXIMUM (ng/l)
Aldrin	15	1	20	20
Chlordane	13			
DDD	15			
DDE	15			
DDT	15	2	10	10
Dieldrin	15	12	20	50
Endrin	15			
Heptachlor Epoxide	15	2	20	20
Lindane	15	2	10	10
2, 4-D	13	7	340	1100
2, 4, 5-T	13	4	10	20
Silvex	13			
PCB	4			
Parathion	4			
Methyl Parathion	4			
Malathion	4			
Diazinon	4			
Heptachlor	15			

TABLE IV-5

HEAVY METALS IN THE FLOYD RIVER

PARAMETER	TOTAL SAMPLES	NUMBER OF SAMPLES WITH DETECTABLE LEVELS	MEAN OF THOSE WITH DETECTABLE LEVELS (μg/l)	MAXIMUM (μg/l)
As	4	0		
Ba	4	4	125	200
Cd	5	0		
Cr	5	0		
Cu	5	0		
Pb	5	0		
Mn	6	5	174	390
Hg	0	0		
Ni	5	0		
Ag	3	0		
Zn	5	4	40	70

Eutrophication Potential - Nitrate and phosphate data on the Floyd River are limited. Nitrate samples collected in the 1950's were generally lower than those found in the last few years. Limited sampling makes any conclusions concerning trends very questionable. It is suspected that runoff may be a main source of these nutrients. Algal mats have been reported at James on several occasions since 1970.

Oxygen Depletion - Significant improvement in dissolved oxygen and ammonia concentrations have been seen since the 1950's (see Figures IV-9 & 10). Considerable improvement is still necessary. Numerous violations of dissolved oxygen and ammonia standards have occurred in the last year.

Biochemical oxygen demand (BOD) concentrations for the 1970's have generally decreased below Hospers, Orange City, Alton, and Le Mars, since the 1950's. BOD has increased below Sheldon (see Figure IV-10). The decreases are due to improved waste treatment by these municipalities. Still many of these treatment facilities are now inadequate to handle the current load and need to be expanded or replaced. Considerable improvement in BOD, dissolved oxygen, and ammonia concentrations can be expected as adequate treatment facilities are constructed in the Floyd River Basin.

Health Hazards and Aesthetic Degradation - Fecal coliform concentrations are generally above the 200/100 ml criteria of the EPA. (3) During runoff periods nonpoint sources predominate and create high levels throughout the river. During

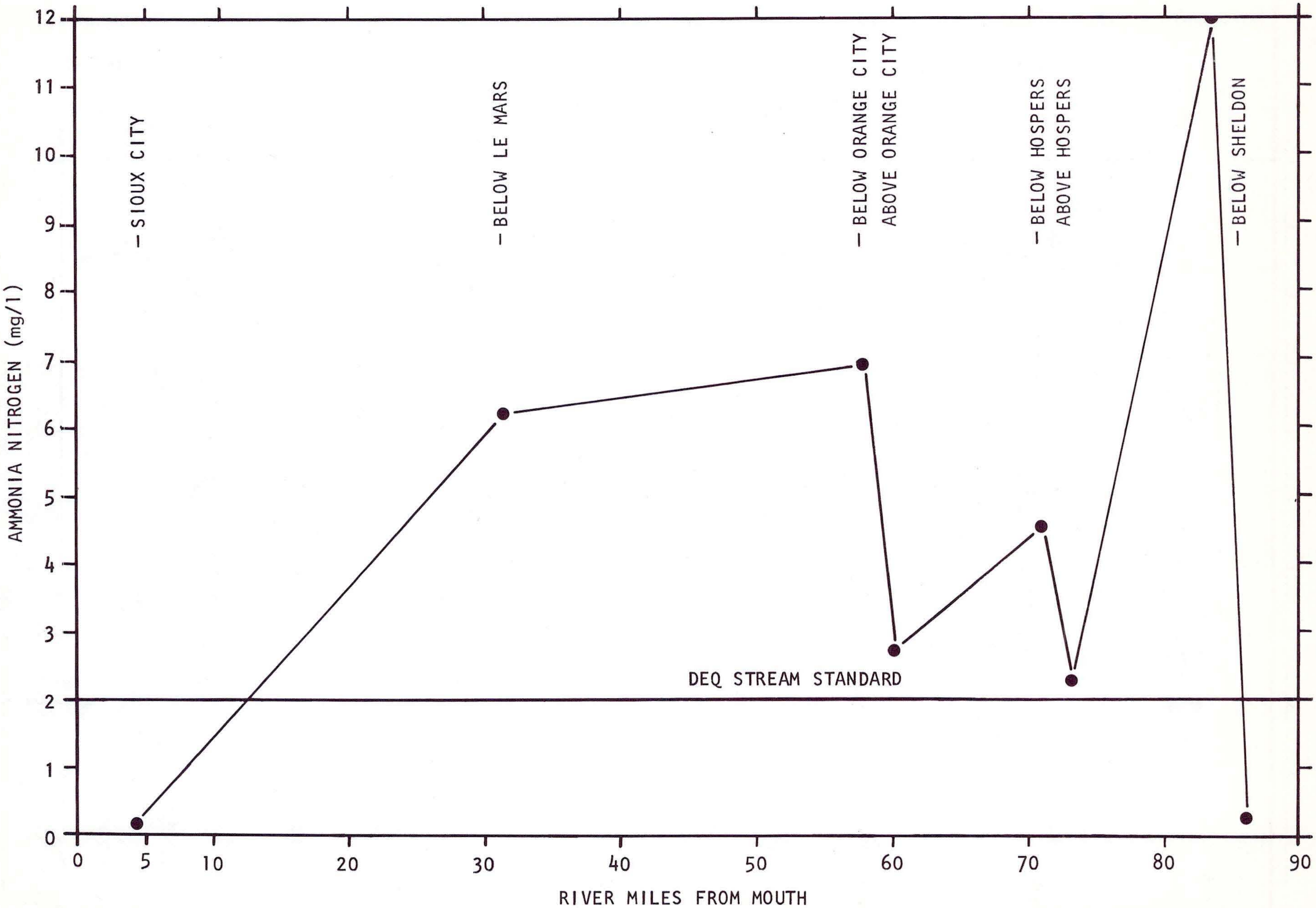


FIGURE IV-9 MEAN AMMONIA NITROGEN CONCENTRATIONS IN THE FLOYD RIVER 1970-1974

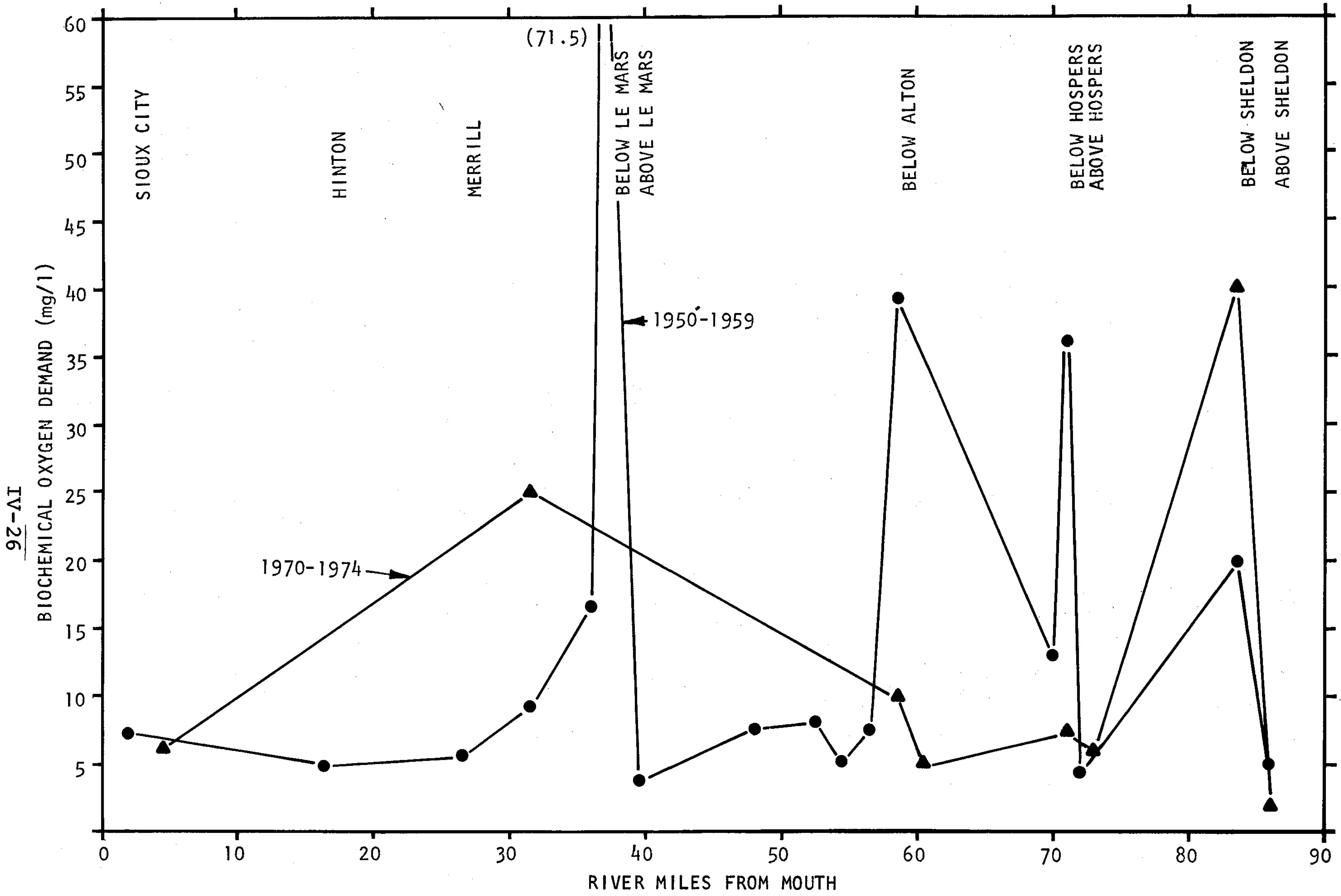


FIGURE IV-10 COMPARISON OF MEAN BOD CONCENTRATIONS IN THE FLOYD RIVER; 1950's-vs-1970's lower flows increased fecal coliform concentrations occur for several miles below the municipal discharges.

Summary

The water quality of the Floyd River is summarized on Figure IV-11.

LITTLE SIOUX

The Little Sioux River has its source in Jackson County, Minnesota. It enters Iowa in northwestern Dickinson County. From the Iowa border to its mouth on the Missouri near Little Sioux in Harrison County, it flows for a distance of about 200 river miles.

Principal tributaries are the Ocheyedan, Maple, and Little Maple Rivers and Stony mill, Battle, Odebon, Waterman, and Muddy Creeks. All of these except Muddy Creek are Class B (warm water) streams. In addition, the waters of Spirit Lake, West Okoboji Lake, East Okoboji Lake, Gar Lake, and Lost Island Lake drain into the Little Sioux system.

The largest communities in the basin are Cherokee (pop. 7,272) and Spencer (pop. 10,278) on the Little Sioux, Mapleton (pop. 1,647) and Ida Grove (pop. 2,261) on the Maple; and Spirit Lake (pop. 3,014), Milford (pop. 1,668), Hartley (pop. 1,694), Paullina (pop. 1,257), Holstein (pop. 1,445), Odeboldt (pop. 1,323), and Alta (pop. 1,717), none of which are on the major rivers.

DEQ WATER QUALITY STANDARDS

	CLASS A&B WATERS COLD	CLASS A&B WATERS WARM	CLASS C WATERS
TEMPERATURE degrees celsius	20	32.2	...
DISSOLVED OXYGEN milligrams per liter	5.0(1)	4.0(2)	...
AMMONIA NITROGEN milligrams per liter	2.0(3)	2.0(3)	...
	CLASS A	CLASS B	
FECAL COLIFORMS colonies per 100 milliliters	200(4)	2000	...

(1) Must be at least 7.0 for 16 hours of a 24-hour period
(2) Must be at least 5.0 for 16 hours of a 24-hour period
(3) Except if flow equals or exceeds the 7-day/10-year low flow or if material is from uncontrollable non-point sources
(4) Between April 1st and October 31st only

DATE	TIME	TEMP	D.O.	NH_3	F.C.
21 Nov 74	16:15	5°C	11.8	.08	510

DATE	TIME	TEMP	D.O.	NH_3	F.C.
21 Nov 74	16:45	7°C	13.1	3.2	3000

DATE	TIME	TEMP	D.O.	NH_3	F.C.
17 Feb 72	16:00	--	--	2.1	70

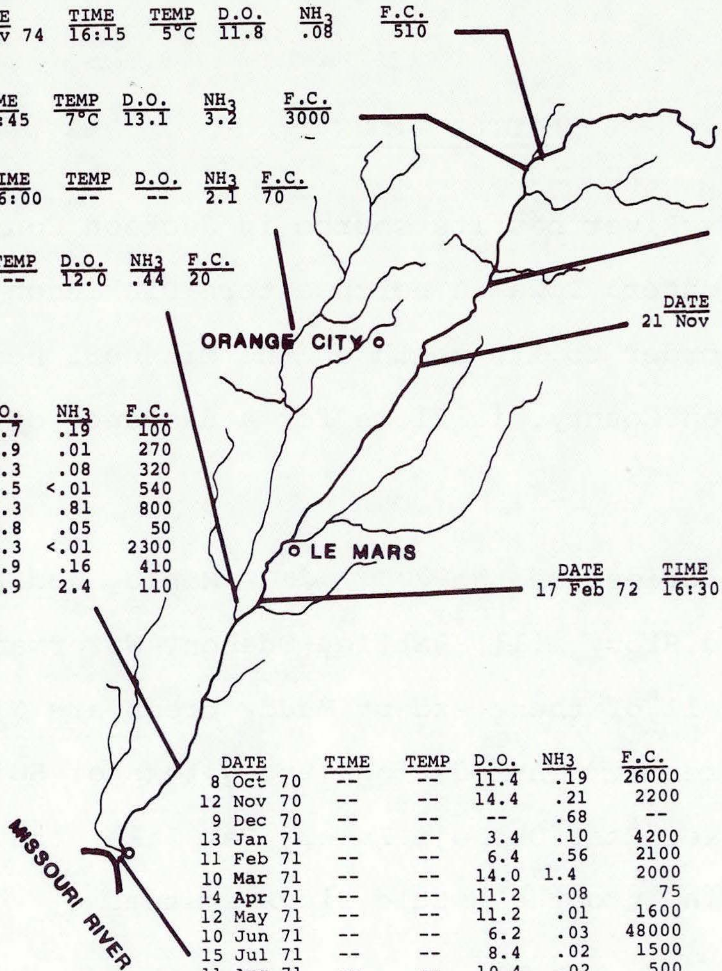
DATE	TIME	TEMP	D.O.	NH_3	F.C.
21 Nov 74	15:00	5°C	14.6	.64	1000

DATE	TIME	TEMP	D.O.	NH_3	F.C.
17 Feb 72	17:00	--	12.0	.44	20

DATE	TIME	TEMP	D.O.	NH_3	F.C.
21 Nov 74	15:15	5°C	14.9	.80	70

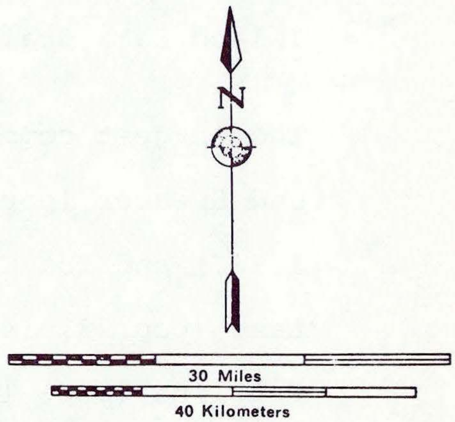
DATE	TIME	TEMP	D.O.	NH_3	F.C.
22 Aug 72	10:00	12°C	9.7	.19	100
11 Jun 73	17:30	26°C	13.9	.01	270
7 Aug 73	13:00	26°C	18.3	.08	320
30 Oct 73	10:00	7°C	11.5	<.01	540
12 Feb 74	18:30	0°C	7.3	.81	800
7 May 74	18:45	17°C	9.8	.05	50
27 Aug 74	18:30	24°C	8.3	<.01	2300
19 Nov 74	17:45	6°C	11.9	.16	410
4 Feb 75	17:30	-1°C	4.9	2.4	110

DATE	TIME	TEMP	D.O.	NH_3	F.C.
17 Feb 72	16:30	--	1.4	6.1	3000



DATE	TIME	TEMP	D.O.	NH_3	F.C.
8 Oct 70	--	--	11.4	.19	26000
12 Nov 70	--	--	14.4	.21	2200
9 Dec 70	--	--	--	.68	--
13 Jan 71	--	--	3.4	.10	4200
11 Feb 71	--	--	6.4	.56	2100
10 Mar 71	--	--	14.0	1.4	2000
14 Apr 71	--	--	11.2	.08	75
12 May 71	--	--	11.2	.01	1600
10 Jun 71	--	--	6.2	.03	48000
15 Jul 71	--	--	8.4	.02	1500
11 Aug 71	--	--	10.4	.02	500
8 Sep 71	--	--	6.2	.02	1200
14 Oct 71	--	--	11.4	.42	750
11 Nov 71	--	--	15.6	.17	120
8 Dec 71	--	--	12.4	.72	640
6 Jan 72	--	--	13.0	.47	180
8 Feb 72	--	--	3.2	1.3	580
8 Mar 72	--	--	11.2	.37	2600
11 Apr 72	--	--	13.6	.38	3100
9 May 72	--	--	10.2	.11	1200
6 Jun 72	--	--	8.7	.09	6200
18 Jul 72	--	--	8.2	.13	34000
10 Aug 72	--	--	9.4	.37	10000
26 Sep 72	--	--	10.1	.21	11000
25 Oct 72	--	--	13.2	.39	650
3 Dec 72	--	--	11.1	.54	103000
5 Dec 72	--	--	9.4	.32	2400
9 Jan 73	--	--	6.4	1.8	680
27 Feb 73	--	--	12.2	4.7	3400
15 Mar 73	--	--	7.6	3.3	28000
25 Apr 73	--	--	10.0	1.1	460
30 May 73	--	--	8.5	.70	38000
19 Jun 73	--	--	5.9	.76	310000
10 Jul 73	--	--	5.5	.42	56000
27 Aug 73	--	--	7.6	.02	8000

FIGURE IV-11
FLOYD RIVER
WATER QUALITY



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Little information on water quality in the Little Sioux River is available. Available data indicate various problems with dissolved oxygen, ammonia and total dissolved solids. These problems have mainly been found below point sources. High concentrations of turbidity and ammonia have been found in the lower portion of the river. Turbidity and suspended matter in the lower Little Sioux basin have been described as among the worst in the State (Iowa Natural Resources Council, 1959).

Water Quality Conditions

Harmful Substances - Pesticides have been found in excess of the maximum concentrations recommended by the Natural Academy of Science. Aldrin, DDT, dieldrin, and heptachlor epoxide have exceeded these criteria. The pesticide concentrations are believed to result from nonpoint runoff from agricultural land.

Heavy metals found in the Little Sioux River include barium, copper, manganese and zinc (see Table IV-7). None of these metals have violated Iowa Water Quality Standards.

Physical Modification (16) - Erosion and sedimentation contribute to the water quality problems of the Little Sioux River, particularly in the southern part where topography and soils are conducive to rapid erosion under both natural and man-induced conditions. Turbidity levels found in the little Sioux River have been as high as 850 JTU. The Little Sioux probably has always carried heavier sediment loads than streams to the east because of the nature of the loessial silts of the watershed.

TABLE IV-6

PESTICIDES IN THE LITTLE SIOUX RIVER

PARAMETER	TOTAL SAMPLES	NUMBER OF SAMPLES WITH DETECTABLE LEVELS	MEAN OF THOSE WITH DETECTABLE LEVELS (ng/l)	MAXIMUM (ng/l)
Aldrin	15	1	20	20
Chlordane	13			
DDD	15			
DDE	32	1	3	3
DDT	27	12	11	20
Dieldrin	24	9	20	50
Endrin	15			
Heptachlor Epoxide	15	1	20	20
Lindane	15	1	10	10
2, 4-D	14	8	240	650
2, 4, 5-T	14	6	30	70
Silvex	14			
PCB	4			
Parathion	1			
Methyl	1			
Malathion	1			
Diazinon	1			
Heptachlor	15			

TABLE IV-7

HEAVY METALS IN THE LITTLE SIOUX RIVER

PARAMETER	TOTAL SAMPLES	NUMBER OF SAMPLES WITH DETECTABLE LEVELS	MEAN OF THOSE WITH DETECTABLE LEVELS (μg/l)	MAXIMUM (μg/l)
As	24	0		
Ba	26	18	189	300
Cd	29	0		
Cr	37	0		
Cu	30	5	12	20
Pb	30	0		
Mn	22	18	175	610
Hg	6	0		
Ni	24	0		
Ag	17	0		
Zn	30	21	78	360

In the northern part of the Little Sioux Basin, where the loess is thin or absent and slopes are not as steep, the erosion problem is classified as "moderate" to "slight".

In compliance with the Flood Control Act of 1936, the Little Sioux River Basin was selected along with problem areas in other states as test areas in which to develop flood prevention programs by land treatment and gully control works.

The program being installed includes: (1) The treatment of farmlands in the Loess-covered part of the watershed to reduce runoff and erosion at the source, and (2) the building of structures to control major gully erosion which cannot be stopped by individual action. Authority for use of program funds is generally limited to that portion of the Little Sioux Watershed lying south of the Clay and Osceola County Soil Conservation Districts. The program is twofold; (1) proper use of land and the application of terraces, grassed waterways, contouring, and other conservation measures which tend to retard runoff, and (2) the installation of dams and other measures designed to stabilize major gullies as well as to reduce peak flood flows and sediment production from small watersheds.

Eutrophication Potential - Nitrate and phosphate levels in the Little Sioux River are similar to those in other Iowa streams. Total phosphate data have averaged about 0.5 mg/l for samples collected since 1970. Phosphates and nitrates tend to increase as flow increases. This would seem to indicate a nonpoint origin of these parameters. Limited nitrate data available from the 1950's indicate that nutrient levels may be increasing in the stream. This is comparable with data available on the Missouri River bordering Iowa. Algal mats in the river have been observed at times, indicating that large algal populations have developed.

Salinity, Acidity, and Alkalinity - Total dissolved solids concentrations in the Little Sioux River have exceeded the Iowa Water Quality Standards (see Figure IV-12). Studies conducted on the Little Sioux River in 1974 showed that the City of Spencer discharged large quantities of dissolved solids and chlorides to the river, and that during low flow conditions stream violations occurred.

Oxygen Depletion - No information is available on water quality in much of the river. Data is available in a small area near Spencer, which is the largest point source on the stream. This data has shown violations of the D.O. standard. The most severe violations found were at night, apparently when nocturnal algal respiration was adding to an already high oxygen demand.

Recent data available from USGS near the mouth of the Little Sioux show some ammonia violations. These violations have occurred at high flows, distant from point sources, during late February or early March. This seems to indicate that during spring thaw ammonia nitrogen runoff from nonpoint sources is causing elevated concentrations in the stream. This is similar to findings on the Skunk, Floyd, Soldier, and Platte Rivers in Iowa. Since no other ammonia violations have been found

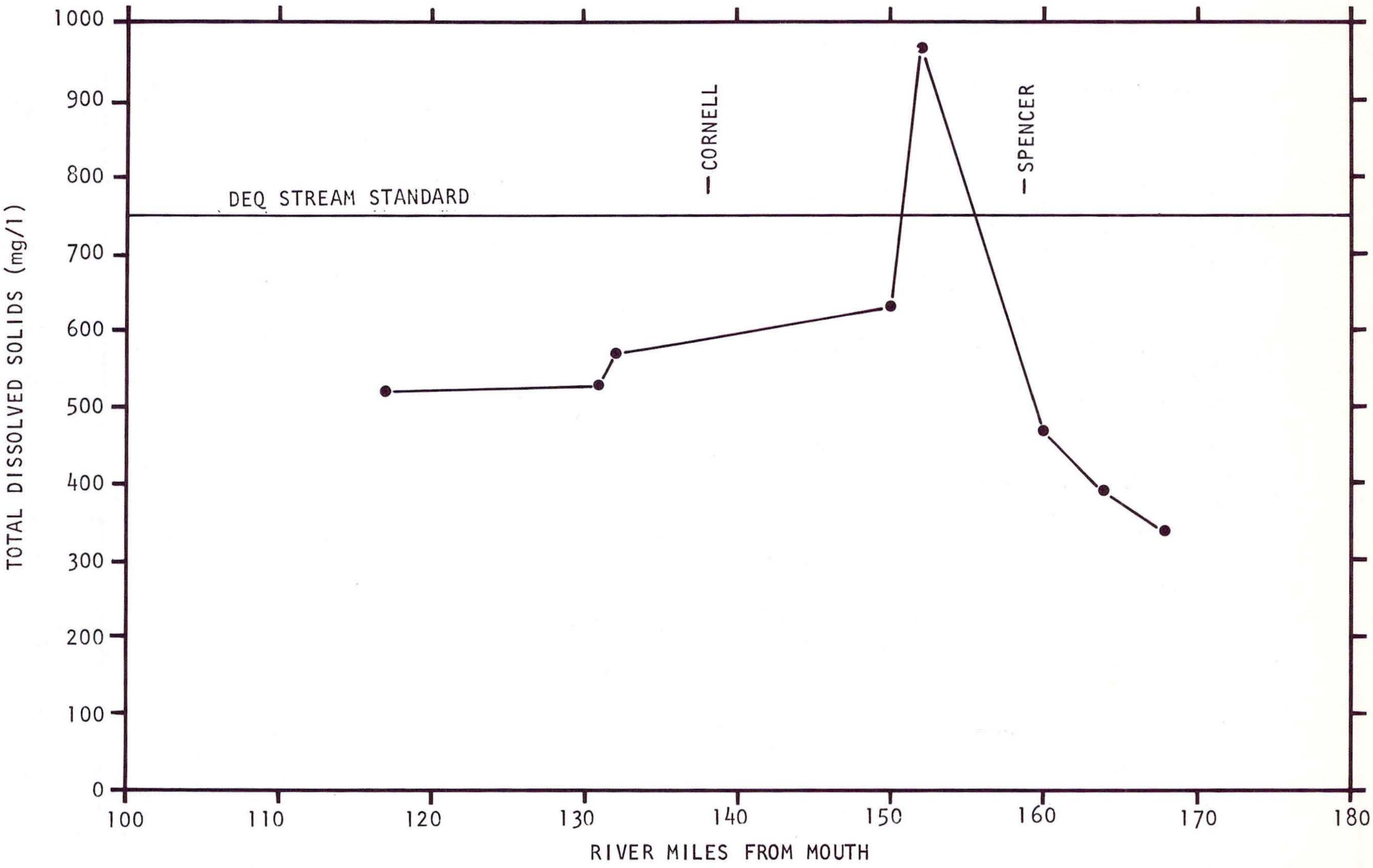


FIGURE IV-12 TOTAL DISSOLVED SOLIDS CONCENTRATIONS IN THE LITTLE SIOUX RIVER, JULY 16, 1974

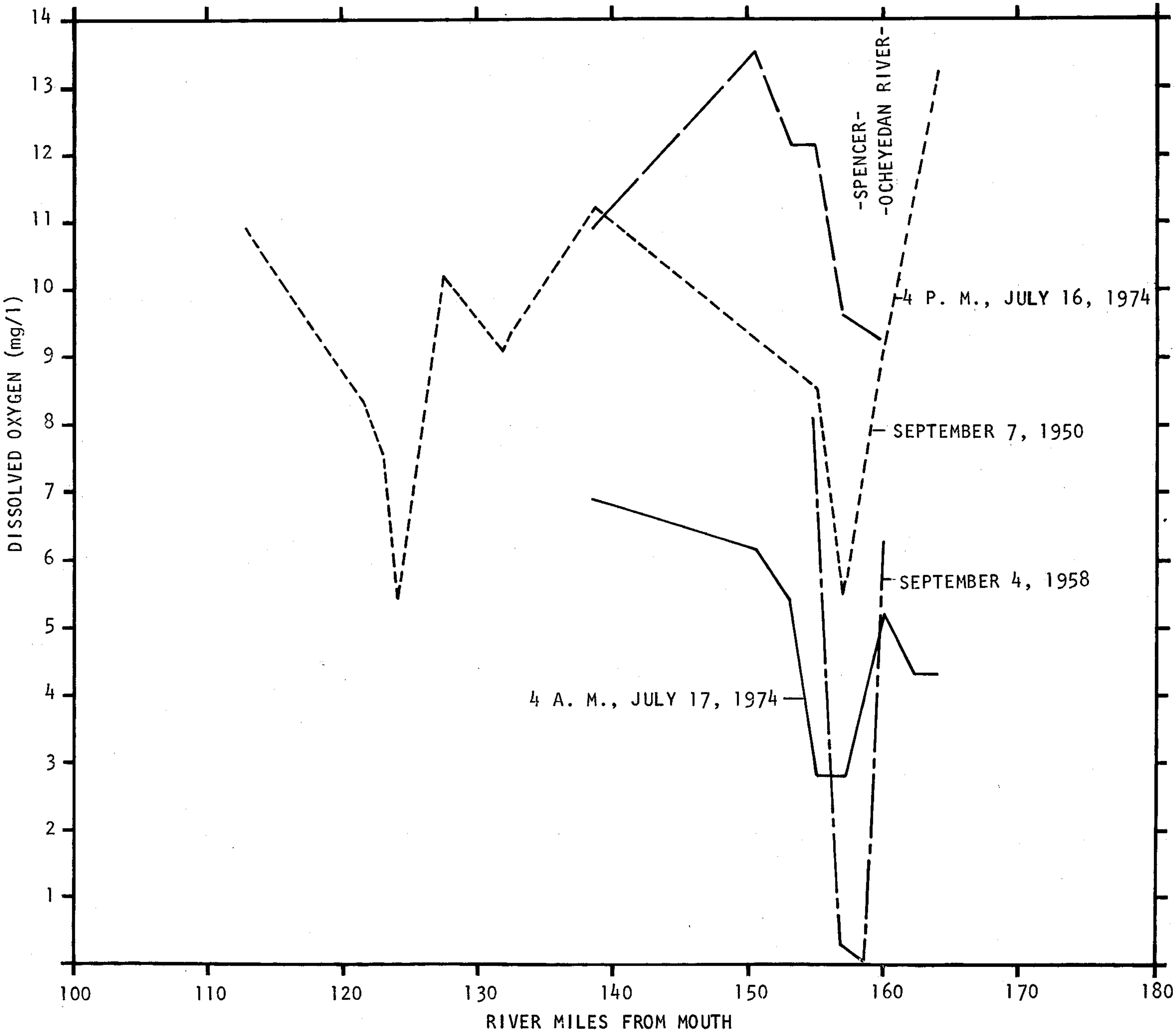


FIGURE IV-13 COMPARISON OF DISSOLVED OXYGEN CONCENTRATIONS IN THE LITTLE SIOUX RIVER NEAR SPENCER, IOWA, 1950-1974 from point sources since 1970, this nonpoint runoff may be the most important source of ammonia in the Little Sioux River. Clearly, more study is necessary to establish a water quality baseline in the Little Sioux and further studies on ammonia runoff at spring thaw is necessary.

Health Hazards and Aesthetic Degradation - Fecal coliform concentrations are generally high in the Little Sioux River. Concentrations normally exceed the 200/100 ml. criteria. Data since 1970 has averaged over 2000/100 ml. Concentrations below point sources are higher than background concentrations and are gradually diluted downstream. During periods of runoff, point source contributions are virtually masked by concentrations from nonpoint source runoff. At these times concentrations near 100,000 fecal coliform per 100 ml are not uncommon.

Tributaries

Little information is available on most tributaries to the Little Sioux River. Only a few isolated samples have been taken on the Ocheyedan River. No sample data is available on the West Fork, and only recently have samples been collected on the Maple River. Based on this recent sampling, it appears that some pollution from point sources is present. Ammonia samples have been found which exceeded Iowa standards and dissolved oxygen concentrations, while not critical, appeared generally below saturation. Water quality data available for the Maple River are summarized in Figure IV-14. Hardness and total dissolved solids generally increase toward the mouth.

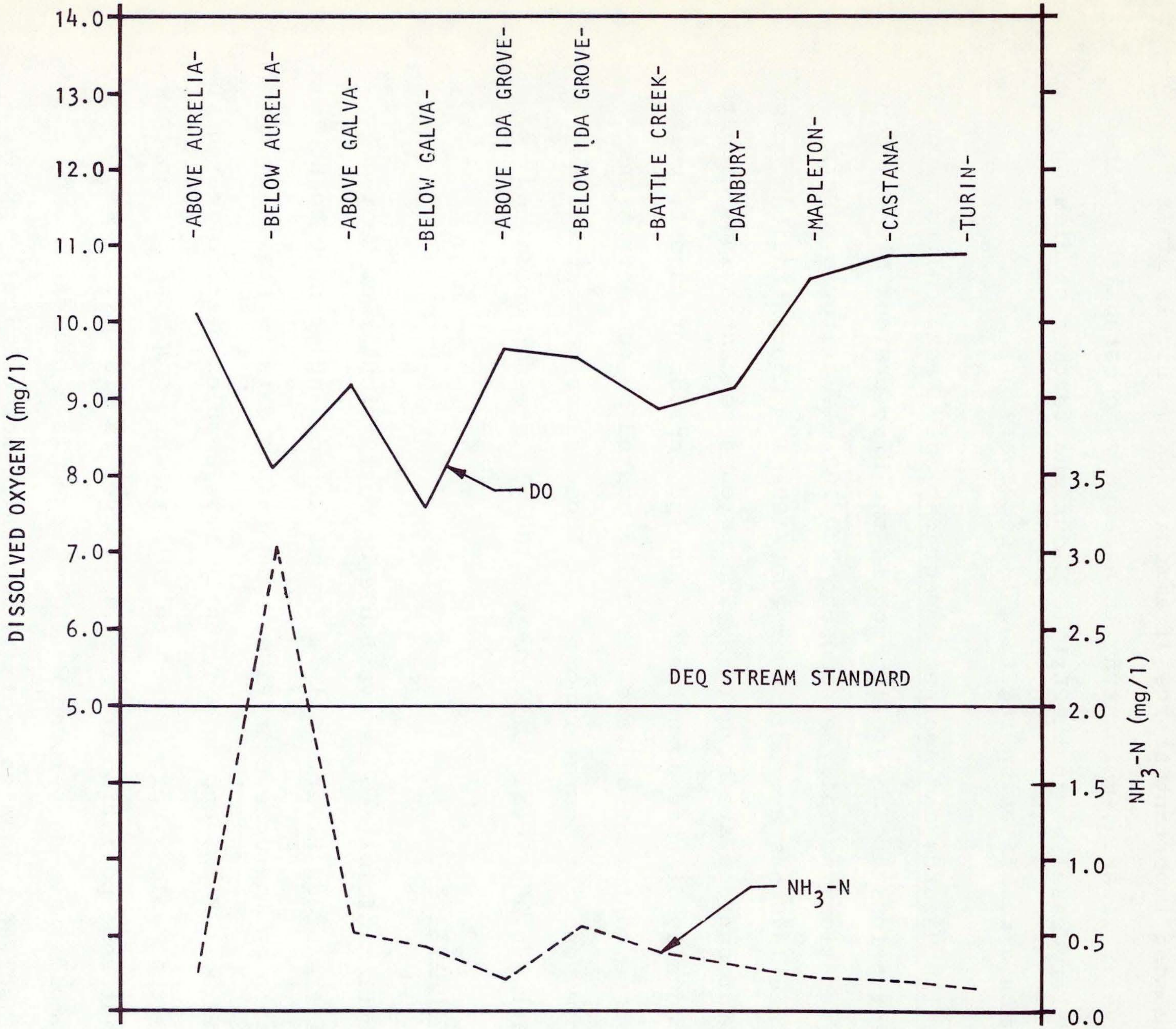


FIGURE IV-14 DISSOLVED OXYGEN AND AMMONIA NITROGEN CONCENTRATIONS IN THE MAPLE RIVER, 1974-1975

(Figures IV-15 and IV-16)

The water quality data for the Little Sioux River is summarized on Figure IV-17.

Iowa Great Lakes Area

The Iowa Great Lakes area in Dickinson County forms part of the drainage system of the Little Sioux River via a tributary from Lower Gar Lake. The Iowa Great Lakes include Big Spirit Lake, Lake West Okoboji, Lake East Okoboji, Upper Gar Lake, Lower Gar Lake and Lake Minnewashta. They are all located in Dickinson County and comprise the only true lake district in Iowa. Lake West Okoboji is the deepest natural lake in the state (over 120 ft. deep) and Big Spirit is the largest natural lake in the State (5357 acres). Extensive water quality data on these lakes have been collected by Bachmann (1974) (4). He has found Lake West Okoboji to be the least eutrophic of these lakes, and Lower Gar Lake the most eutrophic. He has ranked these lakes in order of decreasing water quality; Lake West Okoboji, Big Spirit Lake, Lake East Okoboji, and Lower Gar Lake.

Algal problems have been reported in all of these lakes. Because of the low algal densities in Lake West Okoboji, it probably has the clearest water of any major natural lake in Iowa. (4)

The most dramatic changes noted in the lakes are the decrease in the number of species of aquatic plant life in East Okoboji,

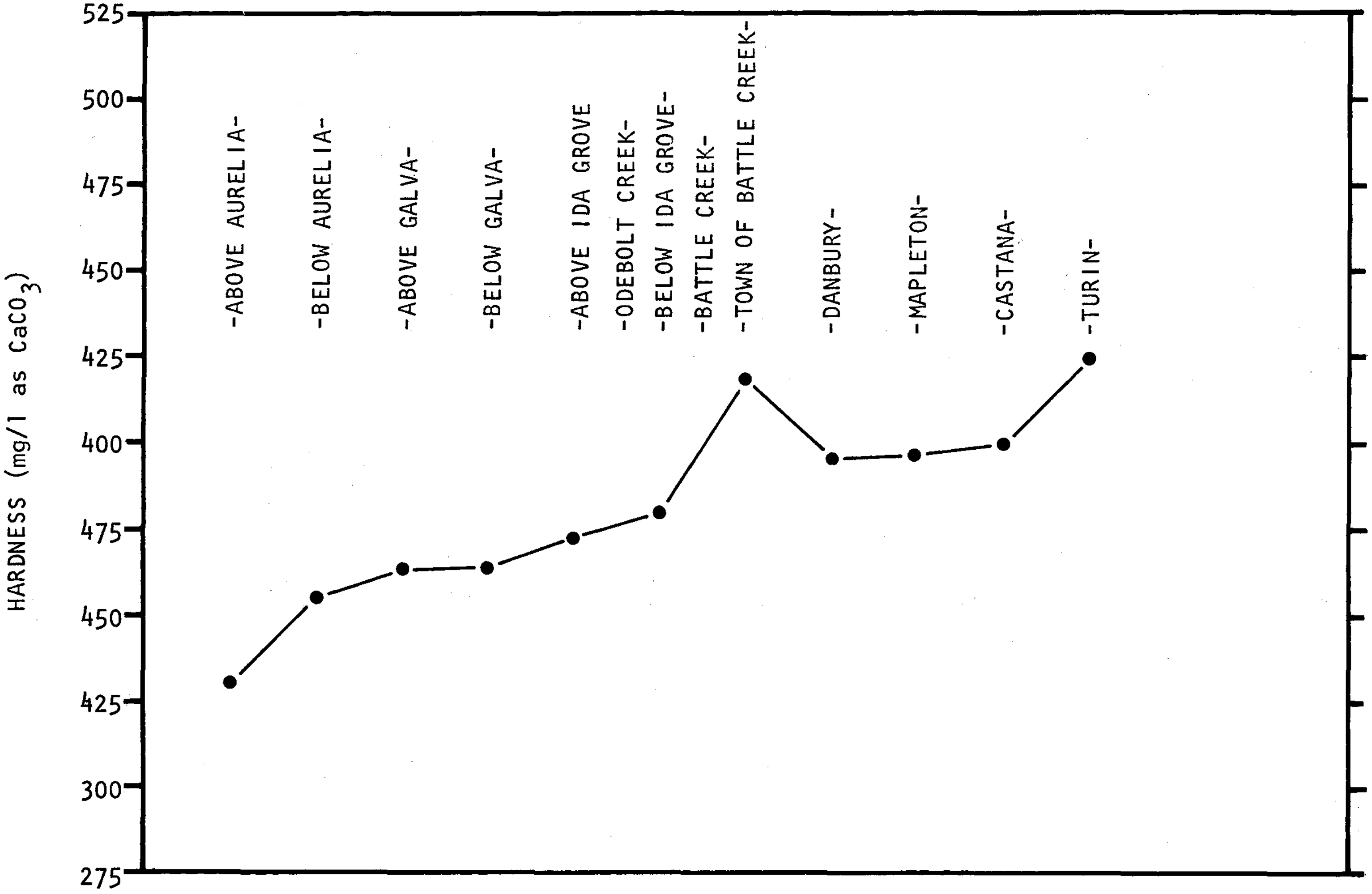


FIGURE IV-15 TOTAL HARDNESS CONCENTRATIONS IN THE MAPLE RIVER, JANUARY 6, 1975

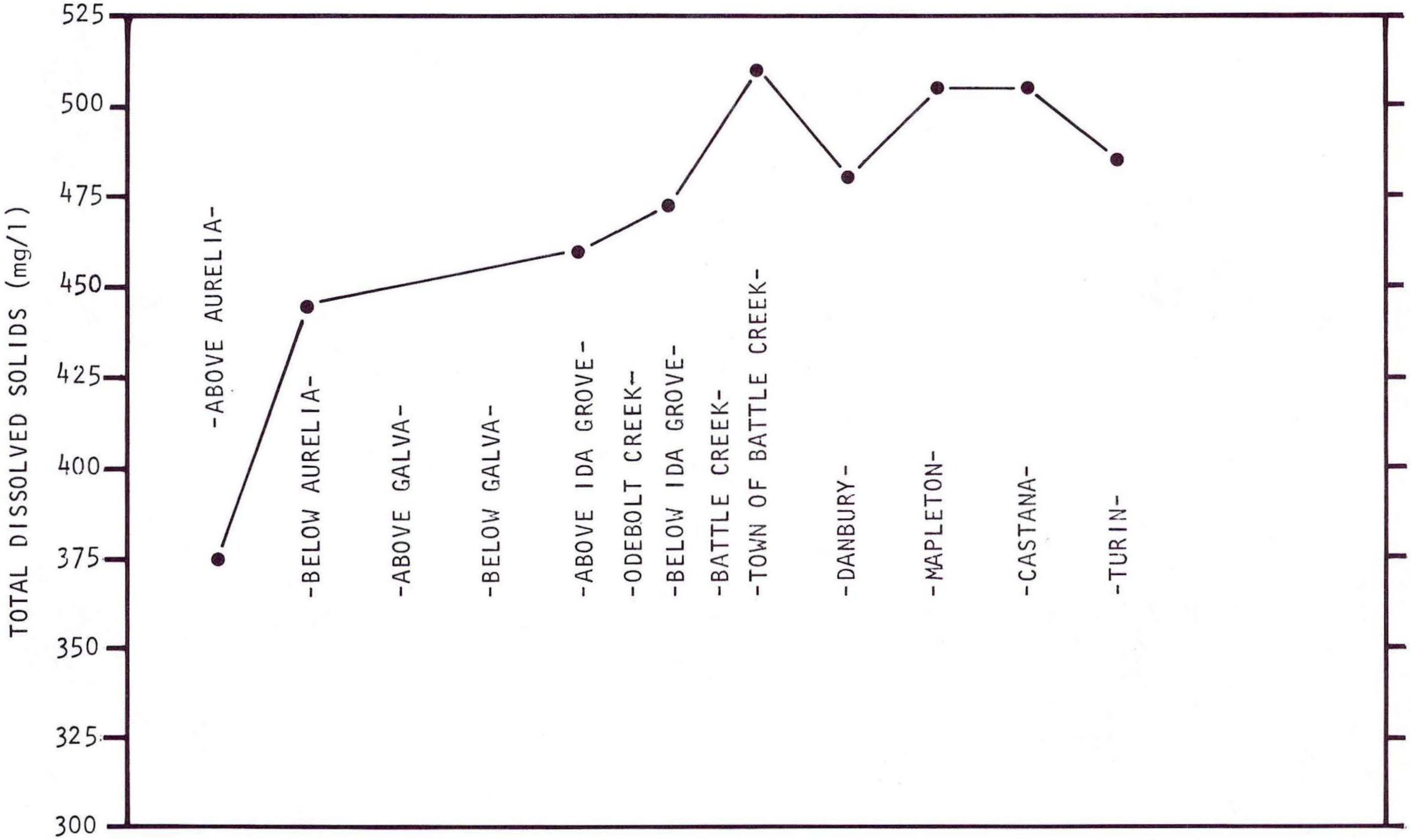
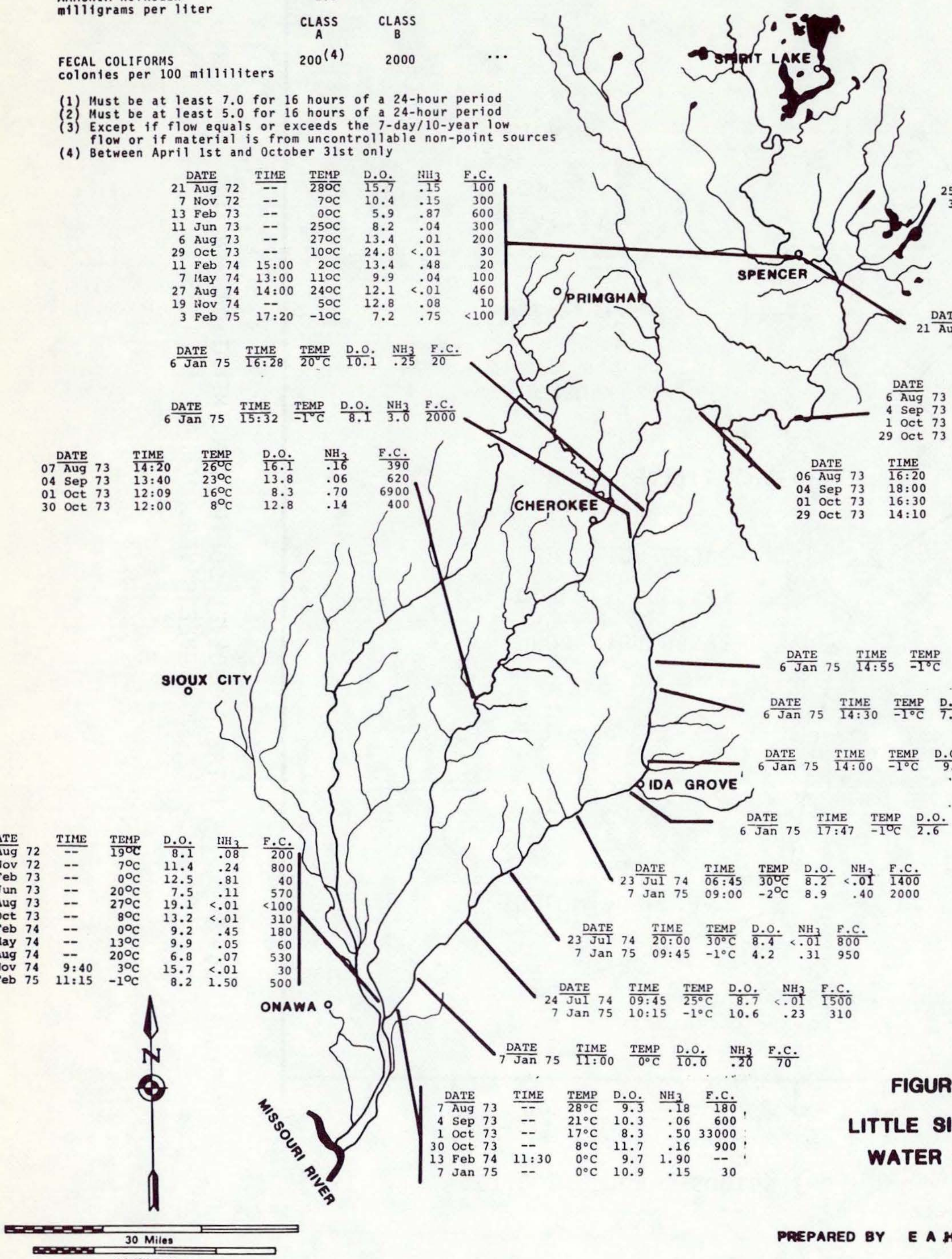


FIGURE IV-16 TOTAL DISSOLVED SOLIDS CONCENTRATIONS IN THE MAPLE RIVER, JANUARY 6, 1975

DEQ WATER QUALITY STANDARDS

	CLASS A&B WATERS COLD	CLASS A&B WATERS WARM	CLASS C WATERS
TEMPERATURE degrees celsius	20	32.2	...
DISSOLVED OXYGEN milligrams per liter	5.0(1)	4.0(2)	...
AMMONIA NITROGEN milligrams per liter	2.0(3)	2.0(3)	...
	CLASS A	CLASS B	
FECAL COLIFORMS colonies per 100 milliliters	200(4)	2000	...

(1) Must be at least 7.0 for 16 hours of a 24-hour period
(2) Must be at least 5.0 for 16 hours of a 24-hour period
(3) Except if flow equals or exceeds the 7-day/10-year low flow or if material is from uncontrollable non-point sources
(4) Between April 1st and October 31st only



DATE	TIME	TEMP	D.O.	NH_3	F.C.
25 Sep 73	10:00	17°C	11.7	.01	<10
3 Feb 75	15:30	1°C	--	.67	<10

DATE	TIME	TEMP	D.O.	NH_3	F.C.
21 Aug 72	--	28°C	15.7	.15	100
7 Nov 72	--	7°C	10.4	.15	300
13 Feb 73	--	0°C	5.9	.87	600
11 Jun 73	--	25°C	8.2	.04	300
6 Aug 73	--	27°C	13.4	.01	200
29 Oct 73	--	10°C	24.8	<.01	30
11 Feb 74	15:00	2°C	13.4	.48	20
7 May 74	13:00	11°C	9.9	.04	100
27 Aug 74	14:00	24°C	12.1	<.01	460
19 Nov 74	--	5°C	12.8	.08	10
3 Feb 75	17:20	-1°C	7.2	.75	<100

DATE	TIME	TEMP	D.O.	NH_3	F.C.
21 Aug 72	15:50	28°C	15.7	.15	<100

DATE	TIME	TEMP	D.O.	NH_3	F.C.
6 Jan 75	16:28	20°C	10.1	.25	20

DATE	TIME	TEMP	D.O.	NH_3	F.C.
6 Aug 73	--	25°C	16.4	.16	< 10
4 Sep 73	--	24°C	14.8	.14	170
1 Oct 73	--	16°C	7.8	1.80	12000
29 Oct 73	--	8°C	14.6	.18	130

DATE	TIME	TEMP	D.O.	NH_3	F.C.
6 Jan 75	15:32	-1°C	8.1	3.0	2000

DATE	TIME	TEMP	D.O.	NH_3	F.C.
07 Aug 73	14:20	26°C	16.1	.16	390
04 Sep 73	13:40	23°C	13.8	.06	620
01 Oct 73	12:09	16°C	8.3	.70	6900
30 Oct 73	12:00	8°C	12.8	.14	400

DATE	TIME	TEMP	D.O.	NH_3	F.C.
06 Aug 73	16:20	25°C	15.2	.20	840
04 Sep 73	18:00	23°C	9.8	.16	920
01 Oct 73	16:30	17°C	8.4	1.50	2400
29 Oct 73	14:10	9°C	15.8	.14	220

DATE	TIME	TEMP	D.O.	NH_3	F.C.
6 Jan 75	14:55	-1°C	9.2	.51	530

DATE	TIME	TEMP	D.O.	NH_3	F.C.
6 Jan 75	14:30	-1°C	7.7	.41	240

DATE	TIME	TEMP	D.O.	NH_3	F.C.
6 Jan 75	14:00	-1°C	9.7	.20	10

DATE	TIME	TEMP	D.O.	NH_3	F.C.
6 Jan 75	17:47	-1°C	2.6	.55	5700

DATE	TIME	TEMP	D.O.	NH_3	F.C.
22 Aug 72	--	19°C	8.1	.08	200
8 Nov 72	--	7°C	11.4	.24	800
14 Feb 73	--	0°C	12.5	.81	40
12 Jun 73	--	20°C	7.5	.11	570
7 Aug 73	--	27°C	19.1	<.01	<100
30 Oct 73	--	8°C	13.2	<.01	310
13 Feb 74	--	0°C	9.2	.45	180
8 May 74	--	13°C	9.9	.05	60
28 Aug 74	--	20°C	6.8	.07	530
20 Nov 74	9:40	3°C	15.7	<.01	30
5 Feb 75	11:15	-1°C	8.2	1.50	500

DATE	TIME	TEMP	D.O.	NH_3	F.C.
23 Jul 74	06:45	30°C	8.2	<.01	1400
7 Jan 75	09:00	-2°C	8.9	.40	2000

DATE	TIME	TEMP	D.O.	NH_3	F.C.
23 Jul 74	20:00	30°C	8.4	<.01	800
7 Jan 75	09:45	-1°C	4.2	.31	950

DATE	TIME	TEMP	D.O.	NH_3	F.C.
24 Jul 74	09:45	25°C	8.7	<.01	1500
7 Jan 75	10:15	-1°C	10.6	.23	310

DATE	TIME	TEMP	D.O.	NH_3	F.C.
7 Jan 75	11:00	0°C	10.0	.20	70

DATE	TIME	TEMP	D.O.	NH_3	F.C.
7 Aug 73	--	28°C	9.3	.18	180
4 Sep 73	--	21°C	10.3	.06	600
1 Oct 73	--	17°C	8.3	.50	33000
30 Oct 73	--	8°C	11.7	.16	900
13 Feb 74	11:30	0°C	9.7	1.90	--
7 Jan 75	--	0°C	10.9	.15	30

FIGURE IV-17

LITTLE SIOUX RIVER WATER QUALITY

PREPARED BY E A HICKOK & ASSOCIATES

Lake Minnewashta and Gar Lakes, and their replacement by blue-green algae. The number of shellfish species has also dropped in West Okoboji (4).

Dissolved oxygen sampling indicates that oxygen deficiencies in the lower depths of West Okoboji have increased 50% since the 1920's (4). Most of the recent changes in lake quality can be attributed directly or indirectly to man's activities. During the past fifty years increased row cropping, increased tiling for agricultural drainage, increased confined livestock activity, urban development, canal dredging, shoreline filling, construction of outlet structures, and introduction of sewage have all contributed to the increased eutrophication. Although eutrophic conditions occur in the lakes, there is reason to believe that they have been eutrophic for several thousand years (4). Man's activitiy has merely accelerated the process. It is not the objective of environmental control to eliminate eutrophication. The concern instead, is to limit eutrophication to a "natural" rate.

Because West Okoboji is the deepest lake, it is likely to be severely altered eutrophically. Efforts to reduce nonpoint pollution will maintain water quality in the Iowa Great Lakes and perhaps reduce the rate of eutrophication in these lakes.

The main problem in the lakes is the high phosphorus content that causes copious growth of blue-green algae, restricting recreational uses. Of the chain, Lower Gar Lake has undergone the greatest eutrophication, while West Okoboji Lake, the deepest by far, has suffered the least.

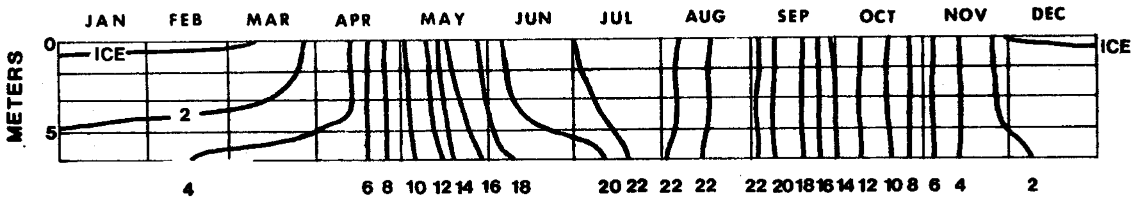
Most of the phosphorus is contributed by streams. Bachmann and Jones (4) have estimated that four-fifths of the phosphorus comes into the lakes from this source and that about one-quarter of the stream phosphorus is due to animal feedlots, which are the largest single source. Very little (about 3%) of the phosphorus is from urban drainage.

Largely through the efforts of local groups, a plan has been devised to improve the water quality of the lakes. The plan calls for the formation of a reciprocal intergovernmental agency to implement a water quality management plan, the construction of feedlot and barnlot runoff collection facilities, management of livestock, the construction of erosion control structures, terraces and waterways, municipal drainage plans for new construction, formation of storm water policies, proper zoning, expansion of sanitary sewer service, a land and water management program, equipping marinas and recreation areas with proper waste facilities, continuous monitoring of the waters, monitoring of agricultural drainage system, and education of the public in their various yard-care and land use activities.

Figures IV-18 to IV-21 are water quality time cross-sections of three of the lakes, West Okoboji, Spirit, and East Okoboji, for temperature, dissolved oxygen, ammonia-nitrogen, and total phosphorus (4).

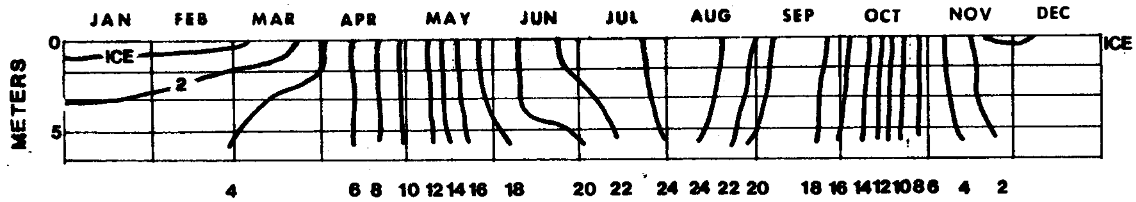
FIGURE IV- 18
TEMPERATURE DISTRIBUTION
IOWA GREAT LAKES (4)

SPIRIT LAKE



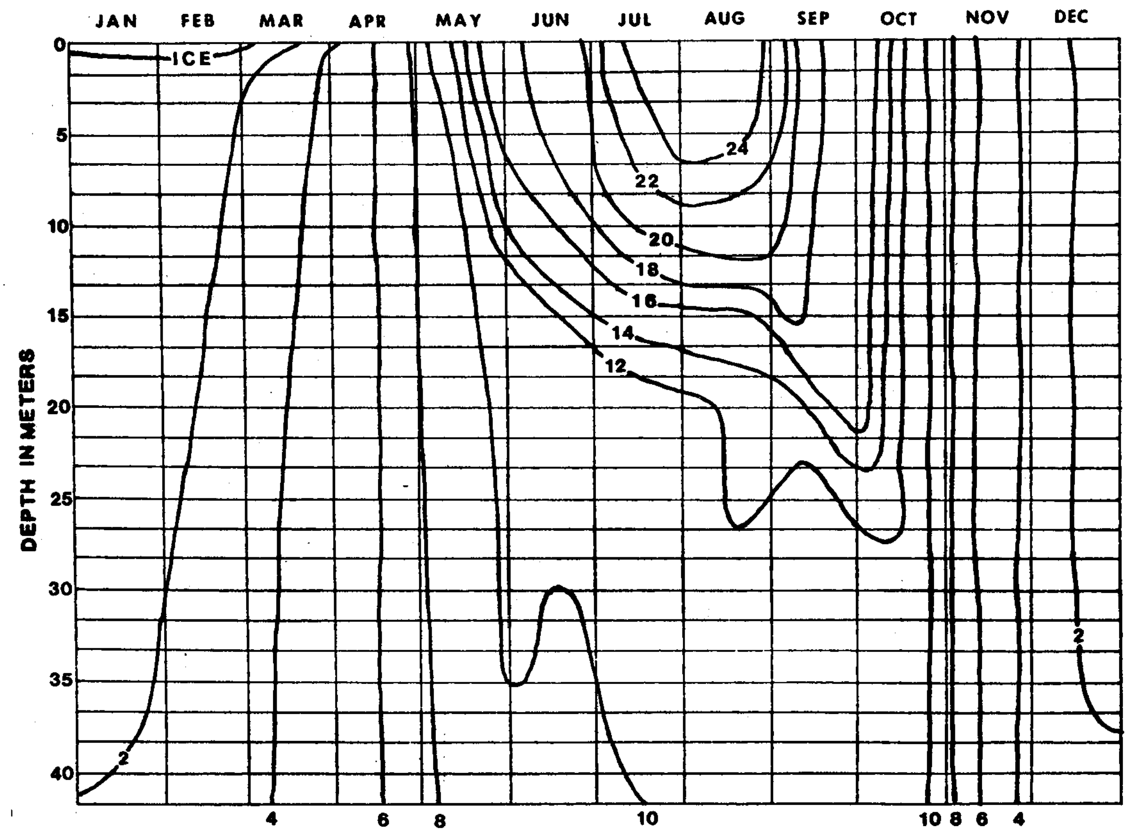
TEMPERATURE DEGREES CENTIGRADE

EAST OKOBOJI



TEMPERATURE DEGREES CENTIGRADE

WEST OKOBOJI



TEMPERATURE DEGREES CENTIGRADE

FIGURE IV-19
OXYGEN DISTRIBUTION
IOWA GREAT LAKES (4)

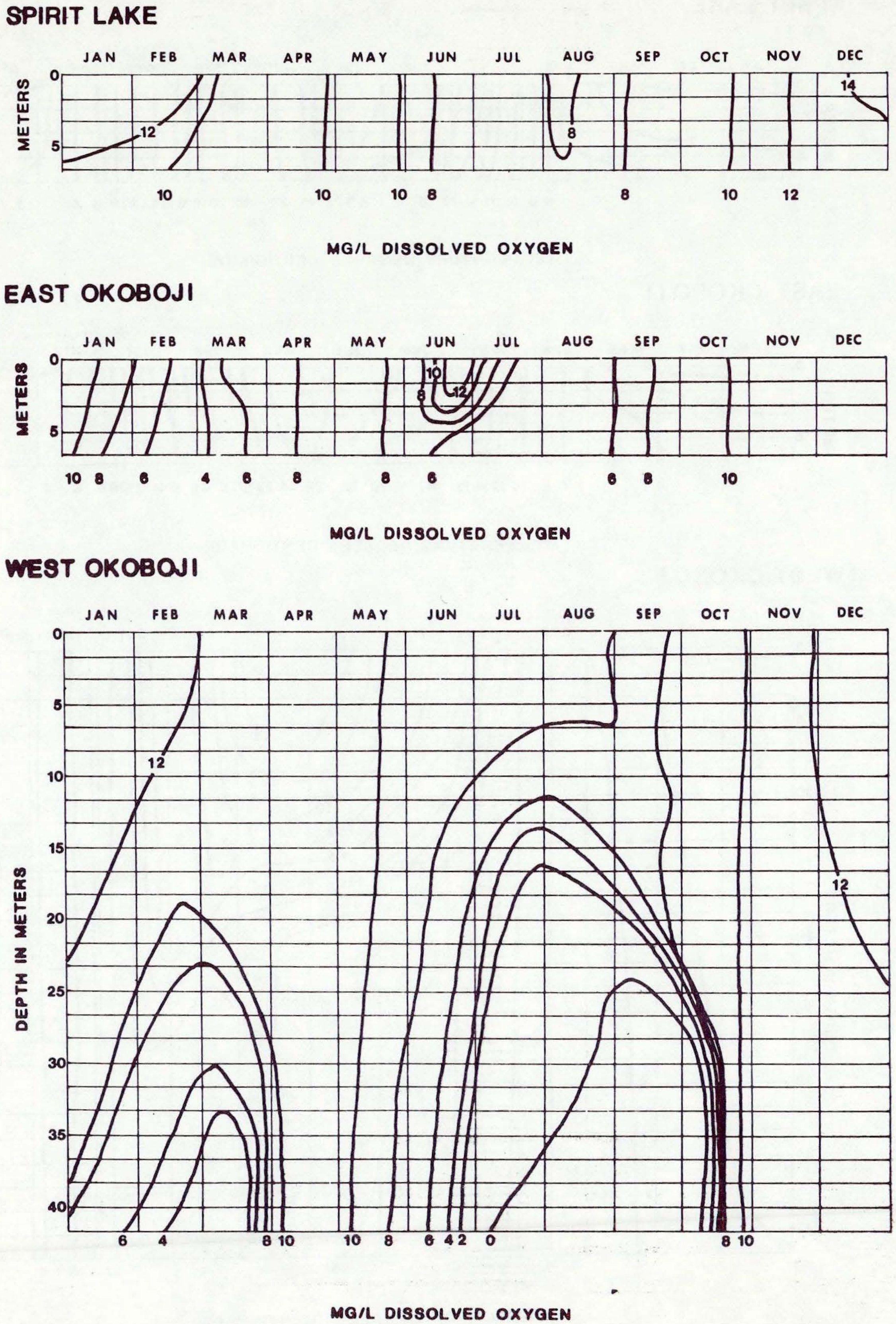


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FIGURE IV-20
AMMONIA-NITROGEN DISTIBUTION
IOWA GREAT LAKES (4)

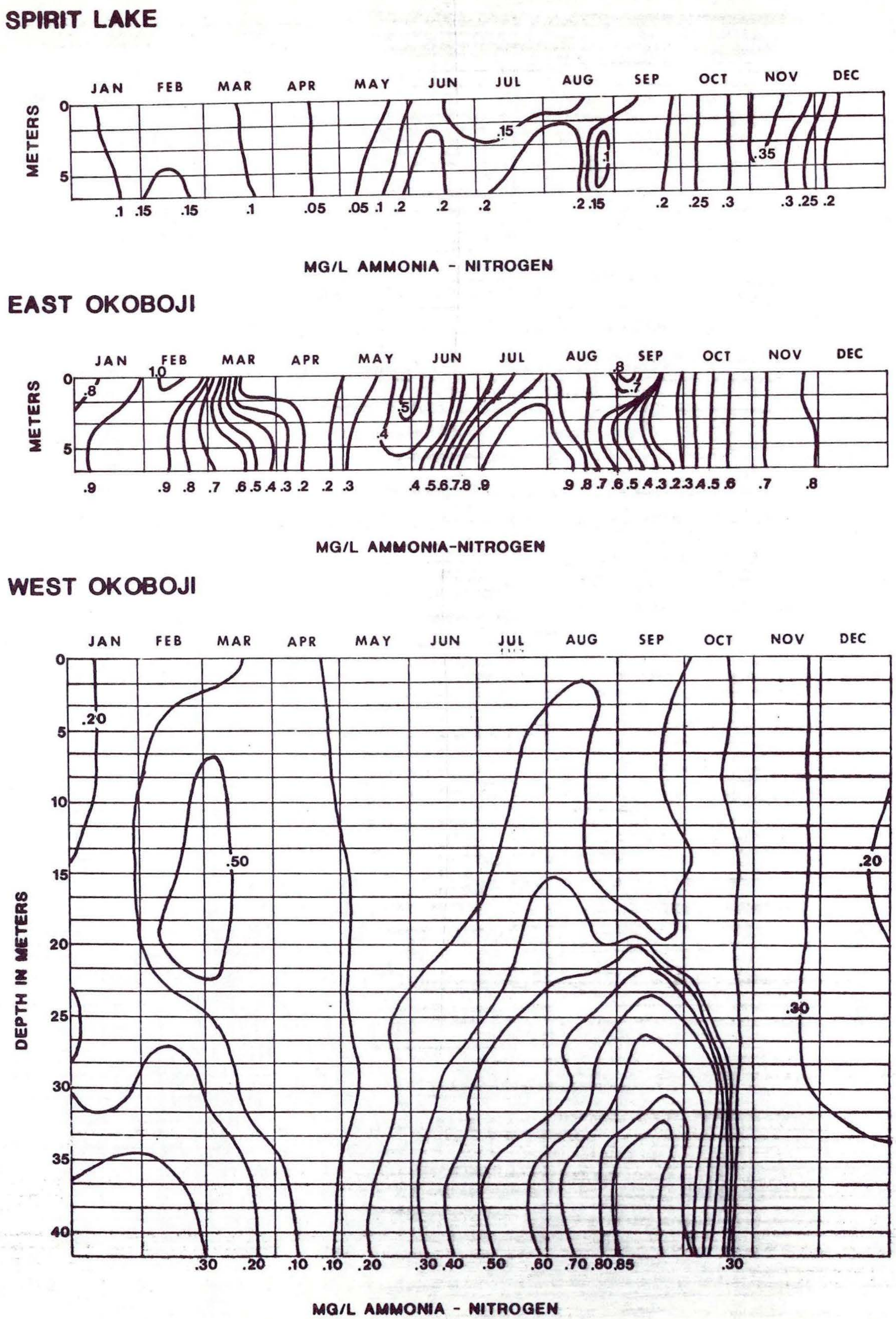

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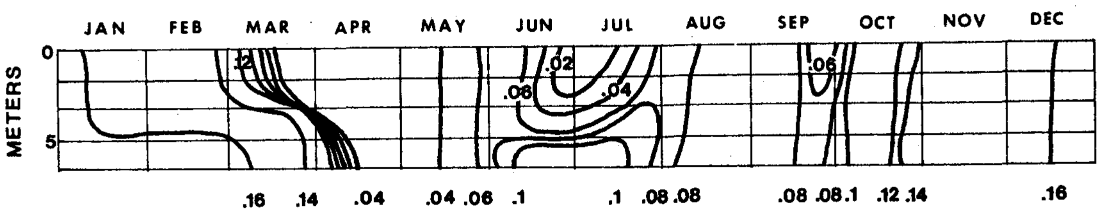
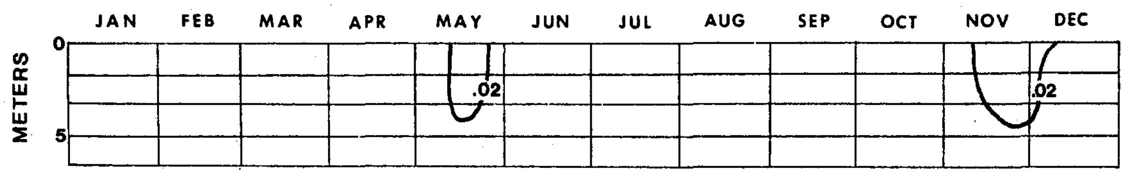
FIGURE IV-21
PHOSPHORUS DISTRIBUTION
IOWA GREAT LAKES (4)

SPIRIT LAKE



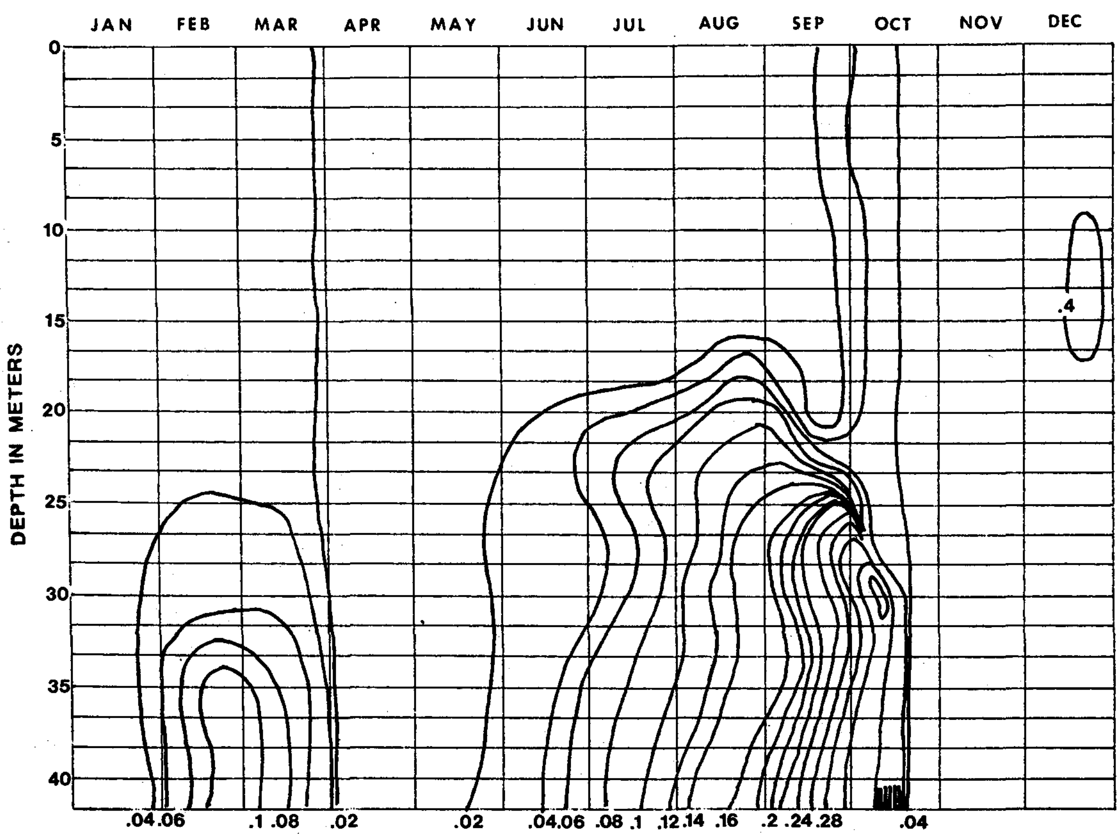
MG/L TOTAL PHOSPHORUS

EAST OKOBOJI



MG/L TOTAL PHOSPHORUS

WEST OKOBOJI



MG/L TOTAL PHOSPHORUS

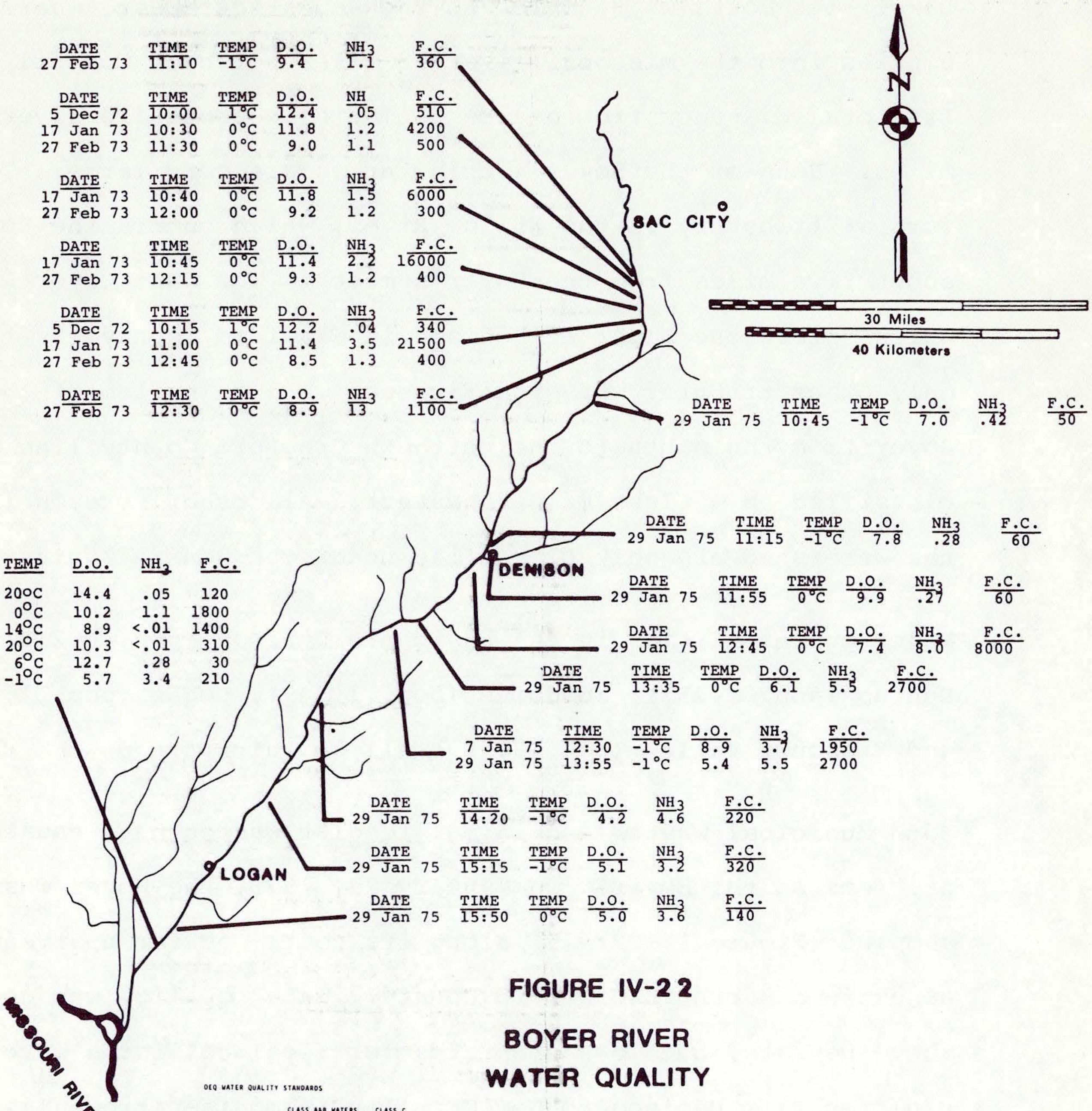
PREPARED BY E A HICKOK & ASSOCIATES

BOYER RIVER

The Boyer River (Figure IV-22) rises in extreme northern Sac County, 6 miles south-southeast of the city of Storm Lake. Its mouth is 86 miles to the south-southwest, where it empties into the Missouri river 13 miles north of Council Bluffs. Its total distance from source to mouth is about 120 river miles. None of the Boyer's tributaries are very large. The largest tributary is the Willow River, which enters the Boyer about five miles from the Boyer's mouth. The East Boyer River, which enters the Boyer at Denison in Crawford County, is the only other tributary of significance. The main stem of the Boyer from the mouth to the northern Crawford County line is classified as a Class B (warm water). All other streams in the watershed are only classified under the General Criteria.

Major municipalities in the basin are Denison (pop. 6,213), Dunlap (pop. 1,292), Woodbine (pop. 1,349), Logan (pop. 1,526), and Missouri Valley (pop. 3,519), all of which are on the river.

Both municipal wastes and animal feedlot wastes have caused problems on the Boyer. On January 29, 1975, the Boyer was sampled (Figure IV-22) (9) along its course as far upstream as extreme northern Crawford County. Water quality was good above Denison, but Iowa standards for fecal coliforms were violated from Denison to Dow City, and ammonia-nitrogen standards were violated from Denison to the mouth. Dissolved oxygen was poor in the vicinity of Dunlap, where a value of 4.2 mg/l was observed. The sewage treatment plant at Denison



DATE	TIME	TEMP	D.O.	NH_3	F.C.
27 Feb 73	11:10	-1°C	9.4	1.1	360

DATE	TIME	TEMP	D.O.	NH	F.C.
5 Dec 72	10:00	1°C	12.4	.05	510
17 Jan 73	10:30	0°C	11.8	1.2	4200
27 Feb 73	11:30	0°C	9.0	1.1	500

DATE	TIME	TEMP	D.O.	NH_3	F.C.
17 Jan 73	10:40	0°C	11.8	1.5	6000
27 Feb 73	12:00	0°C	9.2	1.2	300

DATE	TIME	TEMP	D.O.	NH_3	F.C.
17 Jan 73	10:45	0°C	11.4	2.2	16000
27 Feb 73	12:15	0°C	9.3	1.2	400

DATE	TIME	TEMP	D.O.	NH_3	F.C.
5 Dec 72	10:15	1°C	12.2	.04	340
17 Jan 73	11:00	0°C	11.4	3.5	21500
27 Feb 73	12:45	0°C	8.5	1.3	400

DATE	TIME	TEMP	D.O.	NH_3	F.C.
27 Feb 73	12:30	0°C	8.9	13	1100

DATE	TIME	TEMP	D.O.	NH_3	F.C.
29 Jan 75	10:45	-1°C	7.0	.42	50

DATE	TIME	TEMP	D.O.	NH_3	F.C.
29 Jan 75	11:15	-1°C	7.8	.28	60

DATE	TIME	TEMP	D.O.	NH_3	F.C.
29 Jan 75	11:55	0°C	9.9	.27	60

DATE	TIME	TEMP	D.O.	NH_3	F.C.
29 Jan 75	12:45	0°C	7.4	8.0	8000

DATE	TIME	TEMP	D.O.	NH_3	F.C.
29 Jan 75	13:35	0°C	6.1	5.5	2700

DATE	TIME	TEMP	D.O.	NH_3	F.C.
7 Jan 75	12:30	-1°C	8.9	3.7	1950
29 Jan 75	13:55	-1°C	5.4	5.5	2700

DATE	TIME	TEMP	D.O.	NH_3	F.C.
29 Jan 75	14:20	-1°C	4.2	4.6	220

DATE	TIME	TEMP	D.O.	NH_3	F.C.
29 Jan 75	15:15	-1°C	5.1	3.2	320

DATE	TIME	TEMP	D.O.	NH_3	F.C.
29 Jan 75	15:50	0°C	5.0	3.6	140

DATE	TIME	TEMP	D.O.	NH_3	F.C.
22 Aug 72	12:45	20oC	14.4	.05	120
13 Feb 74	13:15	0°C	10.2	1.1	1800
8 May 74	12:00	14°C	8.9	<.01	1400
28 Aug 74	11:30	20°C	10.3	<.01	310
20 Nov 74	13:00	6°C	12.7	.28	30
5 Feb 75	12:15	-1°C	5.7	3.4	210

DEQ WATER QUALITY STANDARDS

	CLASS A&B WATERS COLD	CLASS A&B WATERS WARM	CLASS C WATERS
TEMPERATURE degrees celsius	20	32.2	...
DISSOLVED OXYGEN milligrams per liter	5.0(1)	4.0(2)	...
AMMONIA NITROGEN milligrams per liter	2.0(3)	2.0(3)	...
	CLASS A	CLASS B	
FECAL COLIFORMS colonies per 100 milliliters	200(4)	2000	...

(1) Must be at least 7.0 for 16 hours of a 24-hour period
(2) Must be at least 5.0 for 16 hours of a 24-hour period
(3) Except if flow equals or exceeds the 7-day/10-year low flow or if material is from uncontrollable non-point sources
(4) Between April 1st and October 31st only

FIGURE IV-22
BOYER RIVER
WATER QUALITY

PREPARED BY E A HICKOK & ASSOCIATES

was found to be a source of the high levels of ammonia and fecal coliforms found during the survey. The Denison effluent was found to have an ammonia nitrogen concentration of 25 mg/l and a fecal coliform concentration of 710,000 per 100 ml.

Animal feedlots are a serious known source of fecal coliform and ammonia-nitrogen problems on the river. A sampling program (13) was made in December 1972 and in January and February 1973 in the upper reaches of the Boyer in Sac County. Here the Boyer is only 15 to 20 feet wide and ½ to 3 feet deep. The December 1972 sampling was done on the 5th of that month, during the memorable cold snap that occurred over Iowa at the time, causing the Boyer to freeze to a depth of 12 to 14 inches. Levels of fecal coliform and ammonia were fair, with a maximum value of fecal coliform (for two samples) of 510 per 100 ml, and a maximum ammonia value of .05 mg/l. The river discharge near Logan was not far from the average for the time of the year.

A warm spell on January 17, 1973 caused a rapid snow melt. Fecal coliform concentrations were as high as 4,200 per 100 ml at the downstream end of the sampling area. Ammonia nitrogen levels ranged between 1.2 and 3.5 mg/l from the upstream end to the downstream end, respectively. A third set of samples were taken on February 27, 1973 during a minor runoff situation. Concentrations of fecal coniform ranged from 360 per 100 ml upstream to 1100 per 100 ml downstream, while ammonia nitrogen varied from 1.1 to 1.2 mg/l from upstream to downstream. On all three dates, dissolved oxygen levels were satisfactory.

The poor water quality with regard to ammonia nitrogen and fecal coliforms shows the impact of animal feedlot runoff on small streams. Other winter samples near the mouth of the Boyer in the mid-1970's also show problems.

Figure IV-22 summarizes available water quality for the Boyer river.

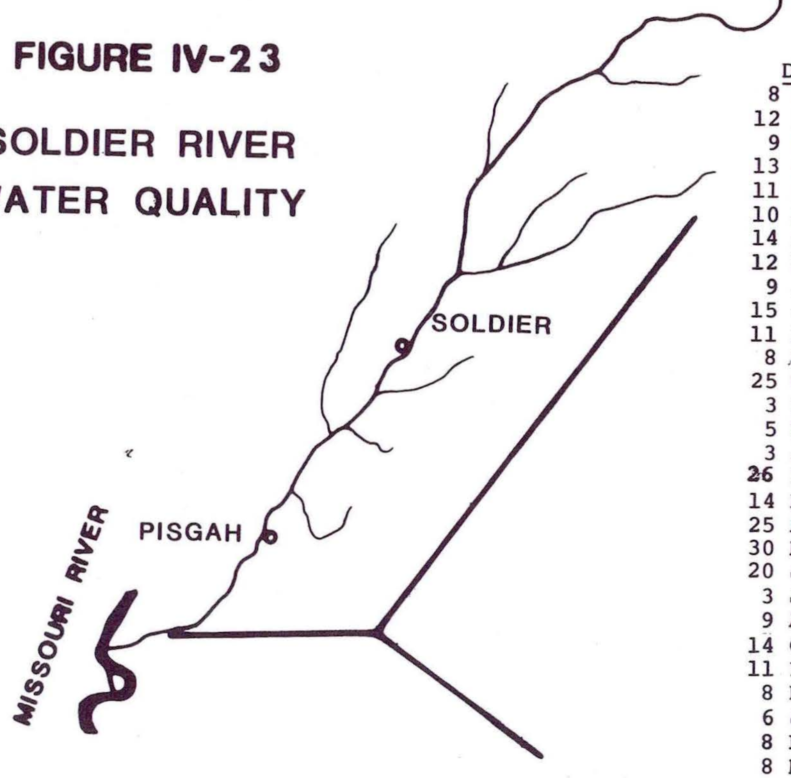
SOLDIER RIVER

The Soldier River is a small stream originating in southeastern Ida County at an elevation of about 1,500 feet. The mouth is about 70 river miles from the source. The Soldier flows into the Missouri river near Mondamin in Harrison County. There are several small tributaries, none of them very large. There are no communities of significant size on streams that flow into the Soldier. The Soldier is a Class B (warm water) stream from Ute in Nonova County to the mouth.

Waste loads to the stream are principally from agricultrual sources, which can cause problems during runoff periods. A monthly monitoring station near the mouth of the Soldier (see Figure IV-23) near Mondamin shows high levels of fecal coliforms, often far in excess of standards, (5,6,7). High concentrations are generally associated with high stream flows, indicating associations with agricultural runoff. Values as high as 350,000/100 ml have been observed on October 25, 1972 after a period of heavy rains following a considerable period of dry weather.

FIGURE IV-23

SOLDIER RIVER WATER QUALITY

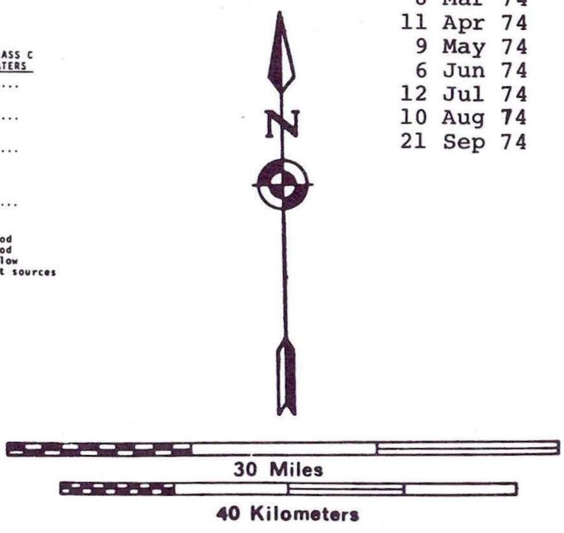


DATE	TIME	TEMP	D.O.	NH_3	F.C.
8 Oct 70	--	--	11.2	.01	9600
12 Nov 70	--	--	12.8	.19	---
9 Dec 70	--	--	--	.02	---
13 Jan 71	--	--	5.7	.02	590
11 Feb 71	--	--	5.2	.12	370
10 Mar 71	--	--	12.8	1.2	450
14 Apr 71	--	--	11.4	.01	110
12 May 71	--	--	10.8	.01	2000
9 Jun 71	--	--	7.6	.52	32000
15 Jul 71	--	--	8.6	.02	750
11 Aug 71	--	--	9.6	.02	190
8 Sep 71	--	--	9.6	.01	1600
25 Oct 72	--	--	11.6	--	350000
3 Nov 72	--	--	10.8	1.5	146000
5 Dec 72	--	--	11.8	.11	480
3 Jan 73	--	--	10.4	1.0	1400
26 Feb 73	--	--	12.4	3.5	5400
14 Mar 73	--	--	9.4	65	3000
25 Apr 73	--	--	9.3	.32	760
30 May 73	--	--	9.0	.27	110000
20 Jun 73	--	--	8.2	.37	41000
3 Jul 73	--	--	5.2	.45	150000
9 Aug 73	--	--	3.4	.72	78000
14 Oct 73	--	--	11.0	.01	120
11 Nov 73	--	--	12.8	.37	380
8 Dec 73	--	--	15.8	.02	630
6 Jan 74	--	--	21.6	.05	20
8 Feb 74	--	--	6.8	.09	50
8 Mar 74	--	--	11.8	3.2	2600
11 Apr 74	--	--	12.4	.03	15
9 May 74	--	--	10.4	.49	12000
6 Jun 74	--	--	9.4	.15	800
12 Jul 74	--	--	5.4	.44	85000
10 Aug 74	--	--	9.4	.13	6800
21 Sep 74	--	--	9.0	.17	13000

DEQ WATER QUALITY STANDARDS

	CLASS A&B WATERS COLD	CLASS A&B WATERS WARM	CLASS C WATERS
TEMPERATURE degrees celsius	20	32.2	...
DISSOLVED OXYGEN milligrams per liter	5.0 (1)	4.0 (2)	...
AMMONIA NITROGEN milligrams per liter	2.0 (3)	2.0 (3)	...
	CLASS A	CLASS B	
FECAL COLIFORMS colonies per 100 milliliters	200 (4)	2000	...

(1) Must be at least 7.0 for 16 hours of a 24-hour period
(2) Must be at least 5.0 for 16 hours of a 24-hour period
(3) Except if flow equals or exceeds the 7-day/10-year low flow or if material is from uncontrollable non-point sources
(4) Between April 1st and October 31st only



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Ammonia-nitrogen values have exceeded standards during spring runoff. On occasion, dissolved oxygen will dip below or come close to standards. In one case, a value of 65 mg/l of ammonia-nitrogen was observed in March 1973.

Water quality data on the Soldier river is summarized in Figure IV-23.

SMALL MISSOURI RIVER TRIBUTARIES

A number of small streams empty into the Missouri river. Mosquito Creek, which originates in Crawford County and empties into the Missouri near Council Bluffs, and Key Creek, a short stream originating in Shelby County and emptying into the Missouri near Glenwood, are both classified as Class B (warm water) streams for approximately their lower five miles.

No quarterly sampling data were available from State records for Mosquito Creek. However, two years of information has been summarized in a report to the Omaha-Council Bluffs Metropolitan Area Planning Agency (MAPA) (8).

Mosquito creek has six small communities along it, three of which have sewage systems, all providing secondary treatment. According to the MAPA report, Mosquito Creek has consistently been observed to have water equal to or better than state standards. The creek was characterized as a generally clean stream with no known significant sources of pollution. Data presented show generally low levels of ammonia nitrogen and excellent levels of dissolved oxygen, and acceptable levels of fecal coliforms.

The results of quarterly sampling on Keg Creek was also mentioned in the MAPA report. Sampling was done at two points in Pottawattamie County, one was at Minden and the other along County Road 92 east of Council Bluffs. Water quality in Keg Creek was generally good, but high fecal coliform counts were occasionally observed. The source of this pollution is unknown (counts as high as 140,000 per 100 ml were observed).

MISSOURI RIVER

This presentation on the Missouri River is admittedly brief in relation to other basins that are addressed within this report. It was the decision of staff of the Department of Environmental Quality that this topic would not receive equal attention since there are existing reports on Missouri river water quality. Data from special studies performed during 1968-70 and reported in the EPA Region's report, Everyone Can't Live Upstream - A Contemporary History of Water Quality Programs on the Missouri River, Sioux City, Iowa, to Hermann, Missouri appear to be one of the more recent comprehensive studies on the Missouri River. Due to the stringent time constraints placed upon this Department for the presentation of this document it was felt that the wiser choice of time expenditure should be devoted to Iowa's interior streams and rivers.

The Missouri River into which all of the preceding rivers flow, generally forms the western boundary of Iowa between Sioux City and the southwestern corner of the State. Changes in course since the establishment of boundaries in the 19th century result in the current bed of the river flowing through some parts of the state.

From Sioux City to the southwest corner, the Missouri's length is about 200 miles. The Missouri is classified as a Class A and B (warm water) stream throughout its Iowa reach. Despite the rather considerable length along the western part of the state, only three Iowa cities of size lie on the river - Sioux City (pop. 89,925), Council Bluffs (pop. 60,348), and Carter Lake (pop. 3,268). The city of Carter Lake is west of the Missouri River.

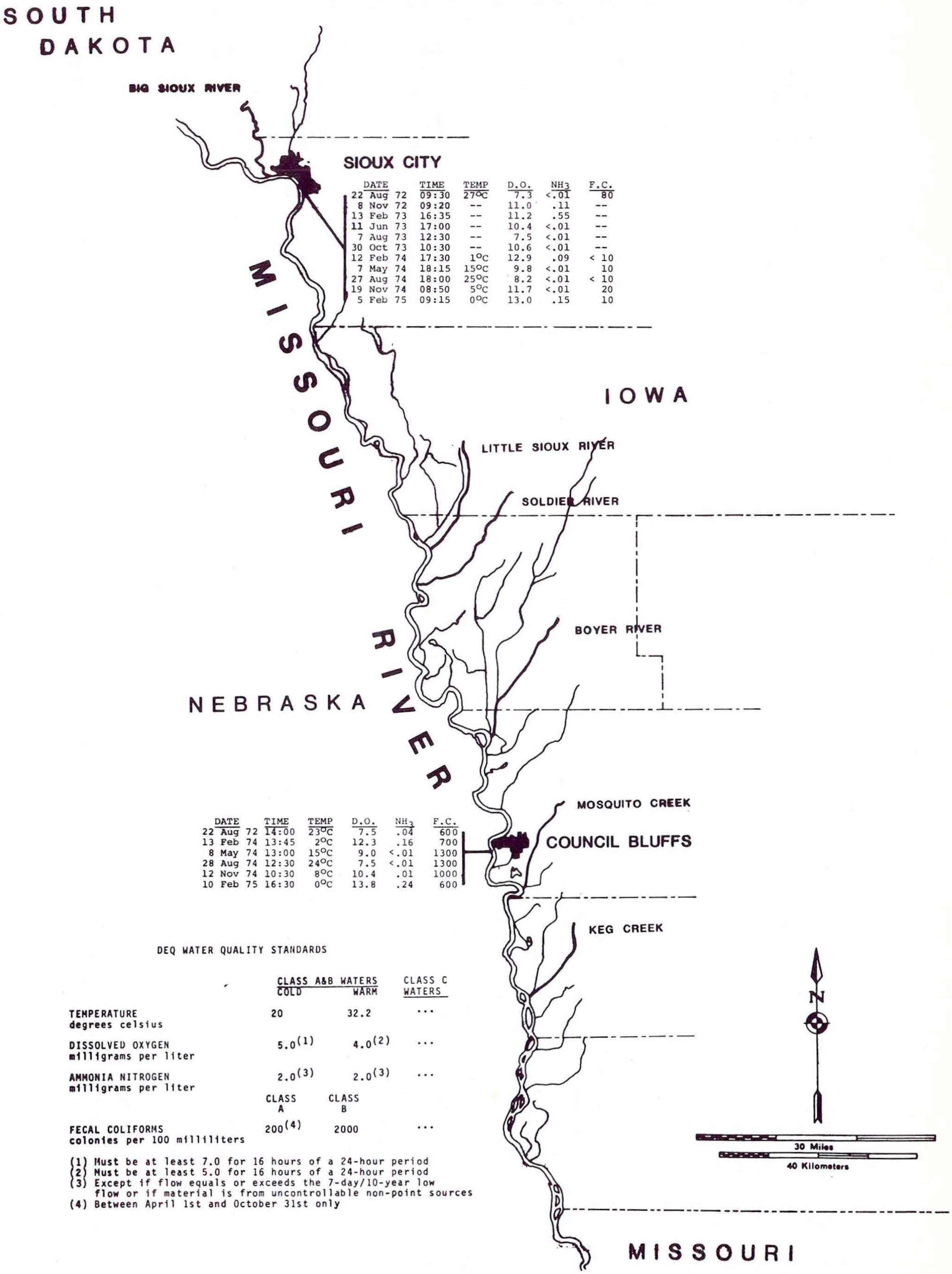
All of the major river basins of western Iowa drain directly into the Missouri, except the Rock, which flows into the Big Sioux. No data are available along the length of the Missouri on single dates.

Data is taken at the Council Bluffs water intake as a part of the quarterly survey (se Figure IV-24). At this location, through 1974 and into 1975, fecal coliform counts have varied between 600 and 1,300 per 100 ml. Ammonia-nitrogen has never exceeded 0.2 (in February) and has been .01 mg/l or less outside of February readings. These levels are quite satisfactory and are indeed more satisfactory than nearly any smaller stream within the Basin. Dissolved oxygen levels are generally satisfactory in the Missouri River.

FIGURE IV-24

MISSOURI RIVER

WATER QUALITY



SIOUX CITY

DATE	TIME	TEMP	D.O.	NH_3	F.C.
22 Aug 72	09:30	27°C	7.3	<.01	80
8 Nov 72	09:20	--	11.0	.11	--
13 Feb 73	16:35	--	11.2	.55	--
11 Jun 73	17:00	--	10.4	<.01	--
7 Aug 73	12:30	--	7.5	<.01	--
30 Oct 73	10:30	--	10.6	<.01	--
12 Feb 74	17:30	1°C	12.9	.09	< 10
7 May 74	18:15	15°C	9.8	<.01	10
27 Aug 74	18:00	25°C	8.2	<.01	< 10
19 Nov 74	08:50	5°C	11.7	<.01	20
5 Feb 75	09:15	0°C	13.0	.15	10

COUNCIL BLUFFS

DATE	TIME	TEMP	D.O.	NH_3	F.C.
22 Aug 72	14:00	23°C	7.5	.04	600
13 Feb 74	13:45	2°C	12.3	.16	700
8 May 74	13:00	15°C	9.0	<.01	1300
28 Aug 74	12:30	24°C	7.5	<.01	1300
12 Nov 74	10:30	8°C	10.4	.01	1000
10 Feb 75	16:30	0°C	13.8	.24	600

DEQ WATER QUALITY STANDARDS

	CLASS A&B WATERS COLD	CLASS A&B WATERS WARM	CLASS C WATERS
TEMPERATURE degrees celsius	20	32.2	...
DISSOLVED OXYGEN milligrams per liter	5.0 (1)	4.0 (2)	...
AMMONIA NITROGEN milligrams per liter	2.0 (3)	2.0 (3)	...
	CLASS A	CLASS B	
FECAL COLIFORMS colonies per 100 milliliters	200 (4)	2000	...

(1) Must be at least 7.0 for 16 hours of a 24-hour period
(2) Must be at least 5.0 for 16 hours of a 24-hour period
(3) Except if flow equals or exceeds the 7-day/10-year low flow or if material is from uncontrollable non-point sources
(4) Between April 1st and October 31st only

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Quarterly survey data taken at Sioux City off a pier at the U.S. Highway 77 Bridge at Sioux City indicate levels of dissolved oxygen, ammonia-nitrogen, and fecal coliform all well within DEQ standards. The quality of the water of this sampling point is generally superior to that sampled in Council Bluffs.

REFERENCES

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4. Water Quality in the Iowa Great Lakes, A report to the Iowa Great Lakes Water Quality Control Plan, Roger W. BAchmann and John R. Jones, Department of Zoology and Entomology, Iowa State University, Ames, Iowa, May 1974.

5. Water Resources Data for Iowa, 1973. U.S. Department of the Interior, Geological Survey, Iowa City, Iowa, 1974.

6. Water Resources Data for Iowa, 1972. U.S. Department of the Interior, Geological Survey, Iowa City, Iowas, 1973.

7. Water Resources Data for Iowa, 1971. U.S. Department of the Interior, Geological Survey, Iowa City, Iowa, 1972.

8. Area Water Quality Sutdies, Technical Supplement No. 3 to Comprehensive Water Pollution Control Plan, MAPA. Henningson, Durham, Richardson and Stanley Consultants report to Omaha-Council Bluffs Metropolitan Area Planning Agency, June 1972.

9. Management Plan for Water Quality Iowa Great Lakes, a report to the Dickinson County Board of Supervisors, Eugene A. Hickok Associates, Wayzata, Minnesota, February, 1974.

10. Missouri River Tributaries Wasteload Allocation Study, A report to the Iowa Department of Environmental Quality. Stanley Consultants, Muscatine, Iowa, January 1975.

11. Water Pollution Report for the Iowa Reach of the Big Sioux River. Report No. 72-40. State Hygienic Laboratory, the University of Iowa, Iowa City, Iowa, 1972.

12. Water Pollution Report for the Iowa Reach at the Big Sioux River. Report No. 73-35. State Hygienic Laboratory, the University of Iowa, Iowa City, Iowa, 1973.

13. Stream Water Quality as Affected by Cattle Feedlot Runoff, A Prelinimary Report, State Hygienic Laboratory, The University of Iowa, Iowa City, Iowa, 1973.

14. Maple River Water Quality Survey, Report #75-20, State Hygienic Laboratory, the University of Iowa, Iowa City, Iowa, 1975.

15. Iowa Water Quality Report (3056) Iowa Department of Environmental Quality, April, 1975.

16. An Inventory of Water Resources And Water Problems - Western Iowa River Basins, Bul. 8, Iowa Natural Resources Council, State of Iowa, Des Moines, Iowa 1959.

CHAPTER V

POINT SOURCE DISCHARGE INVENTORY

WESTERN IOWA BASIN

Point sources are places where volumes of wastes are discharged to surface waters at a given point or at closely-spaced points. This chapter presents an inventory of such sources in the basin originating from municipalities, semi-public and industries installations.

Tables V-1, V-2 and V-3 present an alphabetical listing of municipal, semi-public and industrial wastewater dischargers respectively. Included in the tables is information concerning the location of each discharge by county and an identification of the receiving stream for each discharge.

A coding system is given in the tables, which assigns a reference number to each discharge. Reference numbers for municipal sources are prefixed by an M, industrial sources by an I and semi-public sources by an S. All incorporated municipalities have been assigned reference numbers without consideration as to whether a municipality has a discharge. The reference numbers are used to identify specific discharges in Figure V-1, which shows the location of point source discharge in the basin. Note that a consecutive sequence of reference numbers for the municipalities does not appear

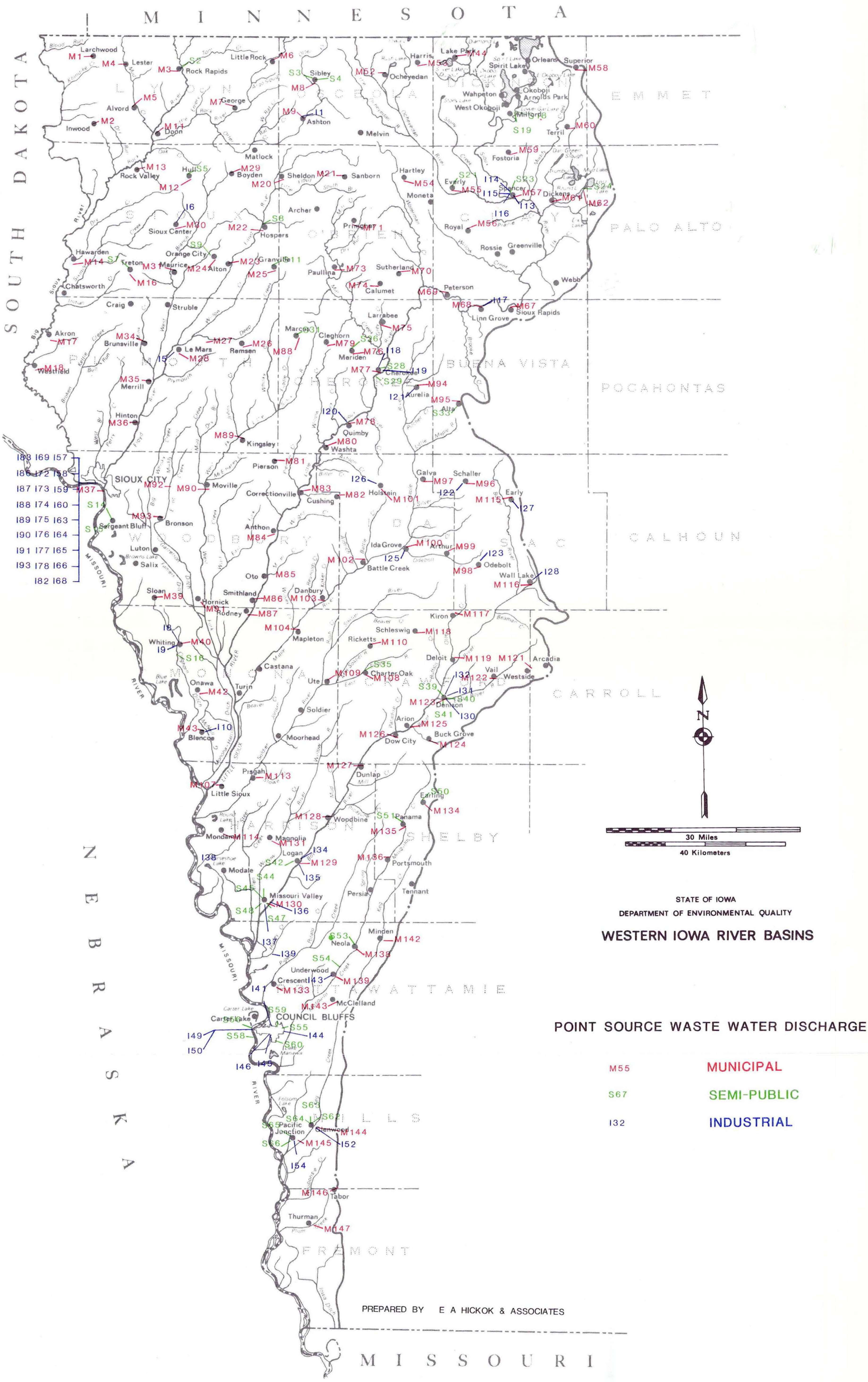

STATE OF IOWA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WESTERN IOWA RIVER BASINS
POINT SOURCE WASTE WATER DISCHARGE
M55 MUNICIPAL
S67 SEMI-PUBLIC
I32 INDUSTRIAL
30 Miles
40 Kilometers
PREPARED BY E A HICKOK & ASSOCIATES
MINNESOTA
SOUTH DAKOTA
NEBRASKA
MISSOURI

FIGURE V-1
V-2

in Figure V-1 since all incorporated municipalities in the basin were assigned reference numbers, but only those with existing discharges are shown on the figure.

Table V-4 identifies the characteristics of each point wastewater discharge from municipal, industrial and semi-public sources. Discharges are listed in the order that the major streams in the Western Iowa Basin empty into the Missouri, from north to south, and within each basin, are listed in downstream order.

Table V-4 lists, for each discharger, present design capacity, present daily flow, BOD_5 and ammonia-nitrogen effluent concentrations, type of treatment processes, method of sludge handling, and comments. Treatment processes are identified in general terms. Specific process descriptions can be obtained from the DEQ. The comments may include information obtained by DEQ personnel concerning existing operation, age of existing facilities, specific DEQ operation permit requirements, DEQ orders for additional treatment, or a delineation of proposed facilities.

A total of 104 municipal treatment facilities have been identified in the basin. In addition, there are 35 small communities presently without municipal collection or treatment systems.

MUNICIPAL

Municipal sewage flow and operational data for municipalities were extracted from DEQ records and files. Average flow values contained in reports submitted by treatment plant operators have been used. Flow values shown in Table V-4 are the averages obtained for the last full year of record; in most instances 1972.

Most effluent quality data were collected from the DEQ's Effluent Quality Analysis Program (EQAP). These data were supplemented by review of treatment facility operation reports. Data reported through EQAP are the results of tests conducted by the Iowa State Hygienic Laboratory on wastewater samples supplied by the individual dischargers. In most instances, no more than four BOD_5 values and two ammonia-nitrogen values are reported each year. This is due to the fact that a significant portion of the facilities are lagoons that only discharge a few times each year. No samples were required when the facilities are not discharging.

The results of BOD_5 analyses performed by the Iowa State Hygienic Laboratory (reported in EQAP) are reported as being between 25 mg/l and 150 mg/l. For some communities, a large percentage of the values reported are 25 or "25-" mg/l. Values designated "25-" are believed to be less than 25 mg/l, but were assumed to be equal to 25 mg/l for this study.

Thus, the actual average effluent BOD_5 concentration may in some cases be lower than that obtained from EQAP information. The adequacy of the program will be reviewed since some dischargers are, or soon will be, required to provide BOD_5 removals to less than 25 mg/l. In some instances, due to a sparsity and scattering of data, engineering judgement was applied to arrive at representative values rather than taking strict averages of the available data.

SEMI-PUBLIC

Information identifying semi-public treatment facilities in the study area was obtained from the DEQ files. Description of wastewater discharges from semi-public facilities was difficult due to the minimal surveillance provided. Quantitative and qualitative data was obtained from EQAP reports or design information from the DEQ files. Values in Table V-4 are thus based on both limited operational data and design characteristics and may not accurately reflect present operating conditions.

INDUSTRIAL

Information on industries discharging wastewater to streams within the study area was obtained from the U.S. Army Corps of Engineers discharge permit applications (Discharge Permit Program, River and Harbors Act of 1899), DEQ industrial files, and the National Pollutant Discharge Elimination System (NPDES) permit applications. Although these sources provide the best available discharge information, caution must be exercised in its interpretation since it represents data that has been submitted by the individual industries with very little verification.

SUMMARY

The distribution of hydraulic and organic loads upon the streams in the basin from municipal, industrial, and semi-public point sources, is summarized in Table V-5. The relatively small quantity of BOD_5 and ammonia-nitrogen discharged by industries and semi-public facilities compared to their flow is due to the following:

1. Several quarries discharge large volumes of water, but add very little BOD_5 to the stream.
2. Several industrial discharges consist only of cooling water; which adds negligible amounts of BOD_5 to the stream.
3. Insufficient monitoring data exists for many of the semi-public and industrial facilities to detect actual quantities.

Table V-6 summarized the various types of municipal wastewater treatment facilities, the number of communities served, and the population served, for each sub-basin. Table V-7 is a composite of Table V-5 for the entire basin.

TABLE V-1

MUNICIPAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Inventory	Reference Allocation	Needs
MUNICIPAL					Chapter V	Chapter VI	Chapter VIII
Akron	M - 17	Plymouth	Big Sioux River	-	22	(1)	9
Alta	M - 95	Buena Vista	L. Maple R. to Maple R. to L. Sioux R.	- / - / -	41	4	3
Alton	M - 23	Sioux	Floyd River	-	23	(1)	2
Alvord	M - 5	Lyon	Mud Creek to Rock River	- / -	20	(1)	6
Anthon	M - 84	Woodbury	Little Sioux River	54	39	3	5
Arcadia	M - 120	Carroll	E. Boyer River to Boyer River	- / -	46	(2)	10
Archer	M - 72	O'Brien	Mill Creek to Little Sioux R.	- / -	37	(1)	(3)
Arion	M - 125	Carroll	Boyer River	-	48	(1)	10
Arnolds Park	M - 48	Dickinson	Iowa Great Lakes Sanitary District	-	33	(1)	(3)
Arthur	M - 99	Ida	Unnamed Creek to Odebolt Creek to Maple R. to Little Sioux River	- / - / - / -	43	(1)	8
Ashton	M - 9	Osceola	Otter Creek to Little Rock R. to Rock R.	- / - / -	21	(1)	5
Aurelia	M - 94	Cherokee	Dry Creek Bed to Maple R. to L. Sioux R.	- / - / -	41	4	4
Battle Creek	M - 102	Ida	Maple River to Little Sioux River	- / 35	44	(1)	8
Blencoe	M - 43	Monona	McNeil Ditch to Monona-Harrison Ditch	- / -	32	(1)	9
Boyden	M - 29	Sioux	W. Branch Floyd River to Floyd R.	- / -	24	(1)	6
Bronson	M - 93	Woodbury	Elliot Creek to Garretson Ditch to West Fork to Little Sioux R.	- / - / - / -	41	(2)	10
Brunsville	M - 34	Plymouth	Mink Creek to W. Br. Floyd R. to Floyd R.	- / - / -	25	(1)	5
Buck Grove	M - 124	Crawford	Unnamed Tributary to Boyer R.	- / -	48	(1)	(3)
Calumet	M - 74	O'Brien	Mugge Creek to Willow Creek to Mill Creek to Little Sioux Creek	- / - / - / -	37	(2)	9
Carter Lake	M - 148	Pottawattamie	Missouri River	-	53	(1)	(3)
Castana	M - 105	Monona	Maple River to L. Sioux River	- / 8	44	(2)	8
Charter Oak	M - 108	Crawford	E. Soldier R. to Soldier R.	- / -	44	(1)	5
Chatsworth	M - 15	Sioux	Six Mile Creek to Big Sioux River	- / -	22	(1)	(3)
Cherokee	M - 77	Cherokee	Little Sioux River	92	38	3	4
Cleghorn	M - 79	Cherokee	Willow Creek to Little Sioux River	- / -	39	(1)	7
Correctionville	M - 83	Woodbury	Bacon Creek to Little Sioux River	- / -	39	3	5
Council Bluffs	M - 140	Pottawattamie	Missouri River	-	53	(1)	3
Craig	M - 33	Plymouth	Mink Crk. to W. Br. Floyd R. to Floyd R.	- / - / -	25	(1)	(3)

TABLE V-1

MUNICIPAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Inventory Chapter V	Reference Allocation Chapter VI	Needs Chapter VIII
MUNICIPAL							
Crescent	M - 133	Pottawattamie	Pidgeon Creek	-	51	(1)	9
Cushing	M - 82	Woodbury	Bacon Creek to Little Sioux River	- / -	39	3	6
Danbury	M - 103	Woodbury	Maple River to Little Sioux River	- / 25	44	(1)	8
Deloit	M - 119	Crawford	Otter Creek to Boyer River	- / -	46	(1)	8
Denison	M - 123	Crawford	Boyer River	-	47	5	3
Dickens	M - 61	Clay	Lost Island Lake Outlet to L. Sioux R.	- / -	35	(2)	9
Doon	M - 11	Lyon	Little Rock River to Rock River	- / -	21	(1)	5
Dow City	M - 126	Crawford	Boyer River	-	48	(1)	9
Dunlap	M - 127	Harrison	Boyer River	-	48	(1)	10
Earling	M - 134	Shelby	Mosquito Creek	-	51	5	11
Early	M - 115	Sac	Unnamed Tributary to Boyer River	- / -	45	(1)	6
Everly	M - 55	Clay	Ocheyedan R. to Little Sioux R.	- / -	34	(1)	6
Fostoria	M - 59	Clay	L. Muddy Creek to B. Muddy Creek to L. S. R.	- / - / -	35	(1)	9
Galva	M - 97	Ida	Halfway Cr. to Maple R. to L. Sioux R.	- / - / -	42	4	3
George	M - 7	Lyon	Little Rock River to Rock River	- / -	20	(1)	8
Glenwood	M - 144	Mills	Keg Creek	-	55	6	3
Granville	M - 25	Sioux	Willow Creek to Floyd River	- / -	23	(1)	4
Greenville	M - 66	Clay	Willow Creek to Little Sioux River	- / -	36	(1)	(3)
Harris	M - 53	Osceola	Dry Run to Ocheyedan R. to L. Sioux R.	- / - / -	33	(1)	12
Hartley	M - 54	O'Brien	Sewer Creek to Ocheyedan R. to L. Sioux R.	- / - / -	33	4	6
Hawarden	M - 14	Sioux	Dry Creek to Big Sioux R.	- / -	22	(1)	11
Hinton	M - 36	Plymouth	W. Branch Floyd R. to Floyd River	- / -	25	(1)	8
Holstein	M - 101	Ida	Battle Creek to Maple R. to L. Sioux R.	- / - / -	43	(1)	8
Hornick	M - 91	Woodbury	W. Fork to Little Sioux River	- / -	41	(1)	7
Hospers	M - 22	Sioux	Floyd R.	-	23	(1)	4
Hull	M - 12	Sioux	Burr Oak Creek to Rock River	- / -	21	2	4
Ida Grove	M - 100	Ida	Odebolt Creek to Maple R. to L. Sioux R.	- / - / -	43	4	3
Inwood	M - 2	Lyon	Unnamed tributary to Big Sioux River	- / -	20	(1)	7
Ireton	M - 16	Sioux	Spring Creek to Indian Cr. to B. Sioux R.	- / - / -	22	(1)	5
Kingsley	M - 89	Plymouth	West Fork to Little Sioux River	- / -	40	(1)	7
Kiron	M - 117	Crawford	Otter Creek to Boyer R.	- / -	46	5	3

TABLE V-1

MUNICIPAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Inventory Chapter V	Reference Allocation Chapter VI	Needs Chapter VIII
MUNICIPAL							
Lake Park	M - 44	Dickinson	Silver Lake to Little Sioux River	- / -	32	(1)	6
Larchwood	M - 1	Lyon	Blood Run Creek to Big Sioux River	- / -	20	(1)	7
Larrabee	M - 75	Cherokee	Gray Creek to Mill Creek to L. Sioux R.	- / - / -	38	(1)	7
Lawton	M - 92	Woodbury	Elliot Creek to Garretson Ditch to W. Fork to Little Sioux River	- / - / - / -41		(1)	5
Le Mars	M - 28	Plymouth	Floyd River	-	24	2	4
Lester	M - 4	Lyon	Mud Creek to Rock River	- / -	20	(1)	8
Linn Grove	M - 68	Buena Vista	Little Sioux River	142	36	(1)	8
Little Rock	M - 6	Lyon	Little Rock River to Rock River	- / -	20	2	2
Little Sioux	M - 107	Harrison	Little Sioux River	-	44	(2)	11
Logan	M - 129	Harrison	Boyer River	-	48	5	11
Magnolia	M - 131	Harrison	Willow Creek to Boyer R.	- / -	50	(2)	11
Mapleton	M - 104	Monona	Maple River to L. Sioux River	- / 18	44	4	8
Marcus	M - 88	Cherokee	Fiddle Creek to W. Fork to L. Sioux R.	- / - / -	40	4	3
Matlock	M - 10	Sioux	Otter Creek to L. Rock R. to Rock R.	- / - / -	21	(1)	(3)
Maurice	M - 31	Sioux	W. Branch Floyd to Floyd R.	- / -	25	2	2
McClelland	M - 143	Pottawattamie	Keg Creek	-	55	(1)	10
Melvin	M - 19	Osceola	Floyd River	-	22	(2)	8
Meriden	M - 76	Cherokee	Hill Creek to Mill Creek to L. Sioux R.	- / - / -	38	(1)	7
Merrill	M - 35	Plymouth	W. Branch Floyd R. to Floyd R.	- / -	25	(1)	3
Milford	M - 51	Dickinson	Iowa Great Lakes Sanitary District	-	33	(1)	(3)
Minden	M - 142	Pottawattamie	Keg Creek	-	55	(1)	10
Missouri Valley	M - 130	Harrison	Boyer River	-	49	(1)	11
Modale	M - 132	Harrison	Unnamed Tributary to Boyer R.	- / -	50	(2)	11
Mondamin	M - 114	Harrison	Spooner Ditch	-	45	(1)	7
Moneta	M - 64	O'Brien	Willow Creek to Little Sioux River	- / -	36	(1)	(3)
Moorhead	M - 112	Monona	Soldier River	-	45	(1)	11
Moville	M - 90	Woodbury	West Fork to Little Sioux River	- / -	40	(1)	8
Neola	M - 138	Pottawattamie	Mosquito Creek	-	52	5	7
Ocheyedan	M - 52	Osceola	Rush Lake Outlet to Ocheyedan R. to L. S. R.	- / - / -	33	(1)	10
Odebolt	M - 98	Sac	Odebolt Creek to Maple R. to L. Sioux R.	- / - / -	42	4	4

TABLE V-1

MUNICIPAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Inventory	Reference Allocation	Needs
MUNICIPAL					Chapter V	Chapter VI	Chapter VIII
Okoboji	M - 47	Dickinson	Iowa Great Lakes Sanitary District	-	33	(1)	(3)
Onawa	M - 42	Monona	McNeil Ditch to Monona-Harrison Ditch	- / -	32	(1)	7
Orange City	M - 24	Sioux	Unnamed Tributary to W. Branch Floyd R. to Floyd R.	- / - / -	23	2	2
Orleans	M - 45	Dickinson	Iowa Great Lakes Sanitary District	-	32	(1)	(3)
Oto	M - 85	Woodbury	Little Sioux River	45	40	(2)	11
Oyens	M - 27	Plymouth	Deep Creek to Willow Creek to Floyd R.	- / - / -	24	(1)	5
Pacific Junction	M - 145	Mills	Keg Creek	-	56	(2)	10
Panama	M - 135	Shelby	Mosquito Creek	-	51	(1)	12
Paullina	M - 73	O'Brien	Mill Creek to Little Sioux River	- / -	37	(1)	9
Persia	M - 137	Harrison	Mosquito Creek	-	52	(1)	11
Peterson	M - 69	Clay	Little Sioux River	133	37	(1)	3
Pierson	M - 81	Woodbury	Pierson Creek to Little Sioux River	-	39	3	6
Pisgah	M - 113	Harrison	Soldier River	-	45	(1)	10
Portsmouth	M - 136	Shelby	Mosquito Creek	-	52	(1)	10
Primghar	M - 71	O'Brien	Dry Run to Mill Creek to L. Sioux R.	- / - / -	37	(1)	9
Quimby	M - 78	Cherokee	Little Sioux River	80	39	(1)	2
Remsen	M - 26	Plymouth	Deep Creek to Willow Creek to Floyd R.	- / - / -	23	2	2
Ricketts	M - 110	Crawford	M. Soldier R. to Soldier River	- / -	45	(1)	3
Rock Rapids	M - 3	Lyon	Rock River	39	20	2	4
Rock Valley	M - 13	Sioux	Rock River	16	21	2	4
Rodney	M - 87	Monona	Little Sioux River	35	40	(1)	(3)
Rossie	M - 65	Clay	Willow Creek to Little Sioux River	-	36	(1)	(3)
Royal	M - 56	Clay	Prairie Creek to Ocheyedan R. to L. Sioux R.	-	34	(1)	10
Ruthven	M - 62	Palo Alto	Drainage Ditch #60 to Loast Island Lake Outlet to L. Sioux R.	- / - / -	35	(1)	6
Salix	M - 41	Woodbury	Farmers Ditch to Monona-Harrison Ditch	- / -	31	(1)	9
Sandborn	M - 21	O'Brien	Little Floyd R. to Floyd R.	- / -	22	2	4
Schaller	M - 96	Sac	Halfway Creek to Maple R. to L. Sioux R.	- / - / -	42	(1)	6
Schleswig	M - 118	Crawford	Otter Creek to Boyer R.	- / -	46	(1)	7
Sergeant Bluff	M - 38	Woodbury	Missouri River	-	25	(1)	(3)
Sheldon	M - 20	O'Brien	Floyd R.	-	22	2	5

TABLE V-1

MUNICIPAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Reference Inventory Chapter V	Page Reference Allocation Chapter VI	Page Reference Needs Chapter VIII
MUNICIPAL							
Sibley	M - 8	Osceola	Otter Creek to L. Rock River to Rock R.	- / - / -	20	2	2
Sioux Center	M - 30	Sioux	Unnamed Tributary to W. Branch Floyd R. to Floyd R.	- / - / -	24	2	5
Sioux City	M - 37	Woodbury	Missouri River	-	25	(1)	2
Sioux Rapids	M - 67	Buena Vista	Little Sioux River	148	36	3	4
Sloan	M - 39	Woodbury	Boyer Drainage Ditch #1 to Cleghorn Ditch to Missouri R.	- / - / -	31	(1)	4
Smithland	M - 86	Woodbury	Smokey Hollow Creek to L. Sioux R.	- / -	40	(1)	11
Soldier	M - 111	Monona	Soldier River	-	45	(1)	11
Spencer	M - 57	Clay	Little Sioux River	179	34	3	2
Spirit Lake	M - 46	Dickinson	Iowa Great Lakes Sanitary District	-	32	(1)	(3)
Struble	M - 32	Plymouth	W. Branch Floyd R. to Floyd R.	- / -	25	(1)	(3)
Superior	M - 58	Dickinson	Big Muddy Creek to Little Sioux River	- / -	35	(1)	(3)
Sutherland	M - 70	O'Brien	Waterman Creek to Little Sioux River	- / -	37	(1)	9
Tabor	M - 146	Fremont	Plum Creek	-	56	(1)	6
Tennant	M - 141	Shelby	Keg Creek	-	54	(1)	(3)
Terril	M - 60	Dickinson	Drainage Ditch #61c to Lost Island Lake Outlet to Little Sioux River	- / - / -	35	(1)	7
Thurman	M - 147	Fremont	Plum Creek		56	(1)	9
Turin	M - 106	Monona	Maple River to Little Sioux River	- / 1	44	(1)	(3)
Underwood	M - 139	Pottawattamie	Mosquito Creek	-	52	(1)	5
Ute	M - 109	Monona	E. Soldier River to Soldier River	- / -	44	(1)	4
Vail	M - 122	Crawford	E. Boyer River to Boyer River	- / -	47	(1)	10
Wahpeton	M - 49	Dickinson	Iowa Great Lakes Sanitary District	-	33	(1)	(3)
Wall Lake	M - 116	Sac	Drainage Ditch #60 to Lime Creek to Boyer R.	- / - / -	46	(1)	10
Washta	M - 80	Cherokee	Little Sioux River	73	39	(1)	5
Webb	M - 63	Clay	Montgomery Creek to Little Sioux River	- / -	36	(2)	9
West Okoboji	M - 50	Dickinson	Iowa Great Lakes Sanitary District	-	33	(1)	(3)
Westfield	M - 18	Plymouth	Big Sioux River	-	22	(1)	6
Westside	M - 121	Crawford	E. Boyer River to Boyer River	- / -	47	(1)	2
Whiting	M - 40	Monona	Cleghorn Ditch to Missouri River	- / -	31	(1)	7
Woodbine	M - 128	Harrison	Boyer River	-	48	(1)	11

(1) Secondary or controlled discharge

(2) NEMTP

(3) None

TABLE V-2

SEMIPUBLIC POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Reference Inventory Chapter V	Allocation Chapter VI	Needs Chapter VIII
SEMIPUBLIC							
Alta WTP, Alta	S-33	Buena Vista	Little Maple River	-	41	(3)	(4)
Alto Mobile Home Park, Council Bluffs	S-56	Pottawattamie	Pony Cr. to Mosquito Cr.	-	53	(3)	(4)
Charter Oak WTP, Charter Oak	S-35	Crawford	East Soldier R.	-	44	(3)	(4)
Cherokee County Home, Cherokee	S-27	Cherokee	Little Sioux R.	-	38	(3)	(4)
Cherokee Mental Health Institute, Cherokee	S-30	Cherokee	MSTP	-	39	(3)	(4)
Cherokee Rural Water District #1, Cherokee	S-28	Cherokee	Little Sioux R.	-	38	(3)	(4)
College Heights Manor Mobile Home Park, Council Bluffs	S-55	Pottawattamie	Mosquito Cr.	-	53	(3)	(4)
Council Bluffs School For the Deaf, Council Bluffs	S-58	Pottawattamie	Missouri River (2)	-	53	(3)	(4)
Council Bluffs WTP, Council Bluffs	S-57	Pottawattamie	Missouri River	-	53	(3)	(4)
Crawford County Home, Denison	S-40	Crawford	Boyer R.	-	48	(3)	(4)
Denison WTP, Denison	S-39	Crawford	Boyer R.	-	47	(3)	(4)
Desota National Wildlife Refuge, Harrison County	S-37	Harrison	Missouri R.	-	45	(3)	(4)
Earling WTP, Earling	S-50	Shelby	Mosquito Cr.	-	51	(3)	(4)
Everly WTP, Everly	S-21	Clay	Ocheyedan R.	-	34	(3)	(4)
Glenwood Mobile Home Park, Glenwood	S-64	Mills	Keg Creek	-	55	(3)	(4)
Glenwood State School, Glenwood	S-63	Mills	Keg Creek	-	55	(3)	(4)
Glenwood WTP, Glenwood	S-62	Mills	Keg Creek	-	55	(3)	(4)
Granville WTP, Granville	S-11	Sioux	MSTP	-	23	(3)	(4)
Hartley WTP, Hartley	S-20	O'Brien	Sewer Cr. to Ocheyedan R.	-	33	(3)	(4)
Harrison County Home	S-42	Harrison	Boyer R.	-	49	(3)	(4)
Holstein WTP, Holstein	S-34	Ida	MSTP	-	43	(3)	(4)
Hornick WTP, Hornick	S-32	Woodbury	MSTP	-	41	(3)	(4)
Hospers Rural Water, System #1, Hospers	S-8	Sioux	Floyd River	-	23	(3)	(4)
Hull WTP, Hull	S-5	Sioux	Burr Oak Cr. to L. Rock R.	-	21	(3)	(4)
Iowa Electric Light & Power	S-17	Dickenson	IGLSD	-	32	(3)	(4)

TABLE V-2

SEMIPUBLIC POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Reference Inventory Chapter V	Allocation Chapter VII	Needs Chapter VIII
SEMIPUBLIC							
Iowa Great Lakes Sanitary District	S-18	Dickenson	Okojobi Lake Outlet	-	33	4	5
Iowa Great Lakes Water Treatment Plant	S-19	Dickenson	IGLSD	-	33	(3)	(4)
Iowa Hwy. Comm. Rest Area #016R, Sergeant Bluff	S-14	Woodbury	Cleghorn Ditch to Mo. R.	-	31	(3)	(4)
Iowa Hwy. Comm. Rest Area #015R, Sergeant Bluff	S-15	Woodbury	Cleghorn Ditch to Mo. R.	-	31	(3)	(4)
Iowa Hwy. Comm. Rest Area, #25R, Missouri Valley	S-45	Harrison	Euclid Cr. to Boyer R.	-	50	(3)	(4)
Iowa Hwy. Comm. Rest Area, #26R Missouri Valley	S-46	Harrison	Euclid Cr. to Boyer R.	-	50	(3)	(4)
Iowa Hwy. Comm. Rest Area, #029R	S-54	Pottawattamie	Mosquito Cr.	-	52	(3)	(4)
Iowa Hwy. Comm. Rest Area, #035R West, Pacific Junction	S-65	Mills	Keg Creek	-	56	(3)	(4)
Iowa Hwy. Comm. Rest Area, #035R East, Pacific Junction	S-66	Mills	Keg Creek	-	56	(3)	(4)
Ireton WTP, Ireton	S-7	Sioux	Spring Cr. to Indian Cr. to B. Sioux River	-	22	(3)	(4)
Lake Manawa State Park, Council Bluffs	S-61	Pottawattamie	MSTP	-	54	(3)	(4)
Lake Pahoja Rec. Area	S-6	Sioux	Rock River (2)	-	21	(3)	(4)
Louis & Clark State Park, State Conserv. Comm., Onawa	S-16	Monona	Cleghorn Ditch to Mo. R.	-	31	(3)	(4)
Lyon County Home, Rock Rapids	S-2	Lyon	Rock River	-	20	(3)	(4)
Marcus WTP, Marcus	S-31	Cherokee	Fiddle Cr. to W. Frk. L. Sioux River	-	40	(3)	(4)
Meadow Brook Mobile Home Court, Cherokee	S-29	Cherokee	Railroad Cr. to L. Sioux R.	-	38	(3)	(4)
Meriden WTP, Meriden	S-26	Cherokee	MSTP	-	38	(3)	(4)
Meyer Mobile Home Park, Denison	S-41	Crawford	Boyer R.	-	48	(3)	(4)
Missouri Valley WTP, Missouri Valley	S-43	Harrison	MSTP	-	49	(3)	(4)
Mondamin WTP, Mondamin	S-36	Harrison	MSTP	-	45	(3)	(4)

TABLE V-2

SEMIPUBLIC POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Reference Inventory Chapter V	Page Reference Allocation Chapter VI	Page Reference Needs Chapter VIII
SEMIPUBLIC							
Orange City WTP, Orange City	S-9	Sioux	Unnamed Trib. to Floyd R.	-	23	(3)	(4)
Panama WTP, Panama	S-51	Shelby	Mosquito Cr.	-	52	(3)	(4)
Persia WTP, Persia	S-52	Harrison	Mosquito Cr.	-	52	(3)	(4)
Plymouth County Home, Le Mars	S-12	Sioux	MSTP	-	24	(3)	(4)
Pottawattamie County Home, Council Bluffs	S-60	Pottawattamie	Missouri R.	-	54	(3)	(4)
Primghar WTP, Primghar	S-25	O'Brien	Dry Run to Mill Cr. to L. Sioux R.	-	37	(3)	(4)
Royal WTP, Royal	S-22	Clay	Prairie Cr. to Ocheyedan R.	-	34	(3)	(4)
Ruthven WTP, Ruthven	S-24	Palo Alto	Drainage Ditch #60 to Lost Island Lk Outlet to L. Sioux R.	-	36	(3)	(4)
Sibley Mun. Utilities, Sibley	S-4	Osceola	Otter Cr. to L. Rock R. & MSTP (1)	-	21	(3)	(4)
Sibley WTP, Sibley	S-3	Osceola	Otter Cr. to L. Rock R. & MSTP (1)	-	20	(3)	(4)
Sioux Center WTP, Sioux Center	S-13	Sioux	MSTP	-	24	(3)	(4)
Sioux County Home, Orange City	S-10	Sioux	Unnamed Trib. to Floyd R.	-	23	(3)	(4)
Spencer Mun. Power Plant, Spencer	S-23	Clay	L. Sioux R.	-	34	(3)	(4)
Sunny Side Village Mobile Park Home, Missouri Valley	S-47	Harrison	Willow Cr. to Boyer R.	-	50	(3)	(4)
Tonja Mobile Home Park, Council Bluffs	S-59	Pottawattamie	Missouri River (2)	-	54	(3)	(4)
Tri-Center Comm. Home, Neola	S-53	Pottawattamie	Mosquito Cr.	-	52	(3)	(4)
U.S. Air Force Missile Launch Base, Missouri Valley	S-44	Harrison	Euclid Cr. to Boyer R.	-	50	(3)	(4)
Valley View Mobile Home Park, Missouri Valley	S-48	Harrison	Allen Cr. to Boyer R.	-	50	(3)	(4)
Wall Lake County Home, Early	S-38	Sac	Unnamed Trib. to Boyer R.	-	45	(3)	(4)
West Lyons Com. School Dis., Inwood	S-1	Lyon	Unnamed Trib. to Big Sioux River	-	20	(3)	(4)
Wilson Island State Park, Loveland	S-49	Pottawattamie	Boyer River	-	51	(3)	(4)

(1) Sanitary and/or process wastes to Municipal sewage treatment plant

(2) Septic tanks and drainfield

(3) BPT or controlled discharge

(4) None

TABLE V-3

INDUSTRIAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Reference Inventory	Allocation	Needs
INDUSTRIAL					Chapter V	Chapter VI	Chapter VIII
Agricultural Business Co., Inc., Whiting	I-8	Monona	Cleghorn Ditch to Mo. R.	-	31	(1)	(3)
Armour & Co., Sioux City	I-60	Woodbury	Missouri R. & MSTP (4)	-	26	(1)	(3)
Athens Conoco Car Wash, LeMars	I-4	Plymouth	MSTP	-	24	(1)	(3)
Beefland International, Council Bluffs	I-47	Pottawattamie	MSTP	-	53	(1)	(3)
Boyer Valley Co., Denison	I-30	Crawford	Boyer River	-	47	(1)	(3)
Burlington Northern, Inc., Pacific Junction	I-54	Mills	Keg Creek	-	56	(1)	(3)
Camax Inc., Early	I-27	Sax	Sac County Drainage Ditch #68 to Boyer R.	-	46	(1)	(3)
Cargill Inc., Sioux City	I-61	Woodbury	MSTP	-	26	(1)	(3)
Cherokee Industrial Site (Wilson Packing Plant), Cherokee	I-19	Cherokee	Little Sioux River	-	38	(1)	(3)
Chesterman Co., Sioux City	I-62	Woodbury	MSTP	-	27	(1)	(3)
Chicago, Milwaukee, St. Paul & Pacific RR, Council Bluffs	I-46	Pottawattamie	Missouri River	-	53	(1)	(3)
Chicago, Milwaukee, St. Paul & Pacific RR, Sioux City	I-85	Woodbury	Big Sioux River	-	29	(1)	(3)
Chicago & Northwestern RR, Sioux City	I-84	Woodbury	Floyd R. & MSTP (4)	-	29	(1)	(3)
Clark Limestone Co., Logan	I-34	Harrison	Boyer River	-	49	(1)	(3)
Cornbelt Power Co-op, Spencer	I-13	Clay	Ocheyedan River	-	34	(1)	(3)
Crescent Quarry, Crescent	I-40	Pottawattamie	Pidgeon Creek	-	51	(1)	(3)
Culligan Water Cond., Ida Grove	I-24	Ida	MSTP	-	43	(1)	(3)
Deluxe Motel, Ida Grove	I-25	Ida	Odebolt Cr. to L. Maple R.	-	43	(1)	(3)
Dubuque Packing Co., LeMars	I-5	Plymouth	Floyd River	-	24	(1)	(3)
Dwight's Skelly, Blencoe	I-10	Monona	McNeil Ditch	-	32	(1)	(3)
Eaton Corporation, Spencer	I-16	Clay	Little Sioux River	-	35	(1)	(3)
Farmland Foods Inc., Denison	I-31	Crawford	Boyer R.	-	47	(1)	22
Farmland Ind. Soybean Extraction Plant, Sergeant Bluff	I-93	Woodbury	Missouri R.	-	30	(1)	(3)
Flavorland-(Beef Div.) Sioux City	I-57	Woodbury	Abandoned Floyd R. Channel & MSTP (4)	-	26	(1)	22
Flavorland-(Hide Proc. Div.), Sioux City	I-87	Woodbury	Unnamed stream to New Lake-Oxbow to Missouri R.	-	30	(1)	22

TABLE V-3

INDUSTRIAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Reference Inventory Chapter V	Allocation Chapter VI	Needs Chapter VIII
INDUSTRIAL							
Gates Rubber Co., Sioux City	I-79	Woodbury	MSTP	-	29	(1)	(3)
Griffin Pipe Products, Council Bluffs	I-50	Pottawattamie	Missouri R.	-	54	(1)	(3)
Hallett Const. Co., Ashton	I-1	Osceola	Little Rock River	-	21	(1)	(3)
Hallett Const. Co., Cherokee	I-18	Cherokee	Little Sioux River	-	38	(1)	(3)
Hanson Oil Co., Underwood	I-43	Pottawattamie	Mosquito Cr.	-	52	(1)	(3)
Hartley Grain Elevator, Hartley	I-12	O'Brien	Sewer Cr. to Ocheyedan R. (6)	-	34	(1)	(3)
Hilton Inn, Sioux City	I-75	Woodbury	Missouri R.	-	28	(1)	(3)
Hyman's Cons. Co., Sioux Center	I-7	Sioux	Unnamed Trib to W. Br. Floyd R.	-	25	(1)	(3)
Interchange Service Corp., Whiting	I-9	Monona	Cleghorn Ditch to Mo. R.	-	31	(1)	(3)
International Inc., Sioux City	I-92	Woodbury	Missouri R.	-	30	(1)	(3)
Iowa Beef Proc. Inc., Denison	I-32	Crawford	Boyer R.	-	47	(1)	22
Iowa Power & Light Co., Council Bluffs	I-45	Pottawattamie	Pony Creek	-	53	(1)	(3)
Iowa Public Service Co., Sioux City	I-63	Woodbury	Missouri R.	-	27	(1)	(3)
Iowa Public Service Co., Sioux City	I-64	Woodbury	Missouri R.	-	27	(1)	(3)
Iowa Public Service Co., Sioux City	I-89	Woodbury	Missouri R.	-	30	(1)	(3)
Iowa Public Service Co., Sioux City	I-90	Woodbury	Missouri R.	-	30	(1)	(3)
Johnson Biscuit Co., Sioux City	I-65	Woodbury	Floyd R.	-	27	(1)	(3)
Kaser Const. Co., (Glenwood Quarry) Glenwood	I-53	Mills	Keg Creek	-	55	(1)	(3)
Kind & Knox Gelatin, Sioux City	I-88	Woodbury	Oxbow to Missouri R.	-	30	(1)	(3)
Kooima Machine Works, Rock Valley	I-2	Lyon	Rock River	-	21	(1)	(3)
Land O'Lakes, Sheldon	I-3	O'Brien	MSTP	-	22	(1)	(3)
Linn Grove Rendering, Linn Grove	I-17	Buena Vista	Little Sioux River	-	37	3	22
Martin Apartment Bldg., Sioux City	I-86	Woodbury	Missouri R.	-	29	(1)	(3)
Midstate Packers Inc., Sioux City	I-66	Woodbury	Abandoned Floyd R. Channel & MSTP (4)	-	27	(1)	(3)
Midwest Walnut Co., Council Bluffs	I-49	Pottawattamie	Missouri River	-	54	(1)	(3)

TABLE V-3

INDUSTRIAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Reference Inventory	Allocation	Needs
INDUSTRIAL					Chapter V	Chapter VI	Chapter VIII
Myer Beef Inc., Sioux City	I-78	Woodbury	Missouri R. & MSTP (4)	-	28	(1)	(3)
Nat. Coop. Refinery Assoc., Council Bluffs	I-44	Pottawattamie	Pony Cr. to Mosquito Cr.	-	53	(1)	(3)
Nickerson Farms, Honey Creek	I-39	Pottawattamie	Missouri R.	-	51	(1)	(3)
Northwestern Bell Telephone Co., Sioux City	I-77	Woodbury	Missouri R.	-	28	(1)	(3)
Nutra-Flo Chemical Co., Sioux City	I-67	Woodbury	Missouri R. & Floyd R.	-	27	(1)	(3)
Pacific Fruit Express Co., Council Bluffs	I-51	Pottawattamie	Closed	-	54	(1)	(3)
Pampered Beef Inc., Aurelia	I-21	Cherokee	Dry Cr. Bed to Maple R.	-	41	(1)	(3)
Pork Processors Inc. Schaller	I-22	Sac	Halfway Cr. to L. Maple R.	-	42	(1)	(3)
Raskin Packing Co., Inc., Sioux City	I-68	Woodbury	Abandoned Floyd R. Channel	-	27	(1)	(3)
Rath Travelers Inn Motel, Missouri Valley	I-36	Harrison	Boyer R.	-	49	(1)	(3)
Robert Bagenstos Slaughter House Holstein	I-26	Ida	Battle Cr. to L. Maple R.	-	43	(2)	(3)
Roberts Dairy Co., Sioux City	I-69	Woodbury	Perry Cr. to Mo. R.	-	27	(1)	(3)
Roe Dairy Co., Sioux City	I-81	Woodbury	MSTP	-	29	(1)	(3)
Schleswig Locker, Schleswig	I-29	Crawford	MSTP	-	46	(1)	(3)
Selected Casing, Odebolt	I-23	Sac	Odebolt Cr. to L. Maple R.	-	42	(1)	(3)
Simonsen Mill and Rendering Plant, Quimby	I-20	Cherokee	Little Sioux River	-	39	(1)	(3)
Sioux City Cold Storage Co., Sioux City	I-58	Woodbury	Abandoned Floyd R. Channel & MSTP (4)	-	26	(1)	(3)
Sioux City Stock Yards United Stock Yards Corp. Sioux City	I-56	Woodbury	Missouri R. & MSTP (4)	-	26	(1)	(3)
Sioux Preme Packing Co., Sioux Center	I-6	Sioux	W. Br. Floyd R.(5)	-	25	(1)	(3)
Sioux Tools Inc., Sioux City	I-74	Woodbury	Floyd R.	-	28	(1)	(3)

TABLE V-3

INDUSTRIAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Reference Inventory Chapter V	Page Reference Allocation Chapter VI	Page Reference Needs Chapter VIII
INDUSTRIAL							
Skelley Oil Co., Missouri Valley	I-37	Harrison	Boyer River	-	49	(1)	(3)
Skelley Oil Co., Modale	I-38	Harrison	Unnamed Trib. to Boyer R.	-	51	(1)	(3)
Soft Water Service Inc., Sioux City	I-82	Woodbury	Perry Cr. to Missouri R.	-	29	(1)	(3)
South Crawford Rural Electrical Coop., Denison	I-33	Crawford	MSTP	-	48	(1)	(3)
Spencer Rendering Co., Spencer	I-14	Clay	MSTP	-	34	(1)	(3)
Spirit Lake Fish Hatchery, Spirit Lake	I-11	Dickenson	IGLSD	-	33	(1)	(3)
St. Regis Paper Co. - Wheeler Div., Sioux City	I-80	Woodbury	Missouri R.	-	29	(1)	(3)
Standard Ready Mix Co., Sioux City	I-72	Woodbury	Drainage Ditch to Floyd R. & MSTP (4)	-	28	(1)	(3)
Steele's Ice Service, Sioux City	I-83	Woodbury	Perry Cr. & MSTP (4)	-	29	(1)	(3)
Stockyards Service & Supply Co., Sioux City	I-59	Woodbury	Missouri R.	-	26	(1)	(3)
Swift & Co., Sioux City	I-70	Woodbury	Closed	-	28	(1)	(3)
Swift Dairy & Poultry Co., Sioux City	I-71	Woodbury	Closed	-	28	(1)	(3)
Swift Packing Co., Glenwood	I-52	Mills	Keg Creek	-	55	(1)	22
Terra Chemicals, Sioux City	I-91	Woodbury	Missouri R.	-	30	(1)	22
Thurman Quarry, Thurman	I-55	Fremont	Forneys Lake	-	56	(1)	(3)
Toy National Bank, Sioux City	I-76	Woodbury	Missouri River	-	28	(1)	(3)
Twin City Plaza, Council Bluffs	I-48	Pottawattamie	MSTP	-	54	(1)	(3)
Union Pacific RR Co., Council Bluffs	I-41	Pottawattamie	Indian Creek	-	51	(1)	(3)
United Packing of Iowa, Sioux City	I-73	Woodbury	Abandoned Floyd R. Channel	-	28	(1)	(3)

TABLE V-3

INDUSTRIAL POINT SOURCE
WASTEWATER DISCHARGES

WESTERN IOWA BASIN

Discharger	Reference Number	County	Discharge To	River Mile	Page Reference Inventory	Allocation	Needs
INDUSTRIAL					Chapter V	Chapter VI	Chapter VIII
W.A. Schommer, Limestone Quarry, Logan	I-35	Harrison	Boyer	-	49	(1)	(3)
Wall Lake Proc. Corp., Wall Lake	I-28	Sac	Unnamed Trib. to Boyer R.	-	46	(1)	22
Western Electric Co., Underwood	I-42	Pottawattamie	MSTP	-	52	(1)	(3)

LEGEND

(1) BPT or controlled discharge

(2) No discharge data available

(3) None

(4) Sanitary and/or process wastes to Municipal

(5) Spray irrigation system

(6) Septic tank and drainfield

MSTP - Municipal sewage treatment plant

WTP - Water treatment plant

TABLE V-4

DISCHARGE INVENTORY

WESTERN IOWA BASIN

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD_5 (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Big Sioux River — Blood Run Creek							
Larchwood M-1	611	675	.0611/.067	51/ 26	16/ 8	Two cell lagoon / Not applicable	7 acres
Unnamed Tributary							
Inwood M-2	644	657	.0644/ -	56/ 30	7/ 4	Two cell lagoon / Not applicable	2.44 acres
West Lyon Community School District, Inwood S-1	-	-	-	-	-	No Information	
Rock River							
Rock Rapids M-3	2,632	4,220	.181/480	39/59	17/26	Trickling filter / Unknown	2 outfall lines to river
Lyon County Home S-2	-	-	-	-	-	None	Sewers direct to river; last correspondence 1945.
Mud Creek							
Lester M-4	238	300	.028/.030	36/ 8	16/ 4	One cell lagoon / Not applicable	1.9 acres
Alvord M-5	204	245	.016/.023	50/ 6.7	15/ 2	One cell lagoon / Not applicable	2.1 acres
Little Rock River							
Little Rock M-6	531	-	- /.040	100/ -	35/ -	Trickling filter / Unknown	
George M-7	1,194	1,400	.071/.110	27/ 16	4/ 2	Two cell lagoon / Not applicable	9.86 acres
Otter Creek							
Sibley STP M-8	2,749	-	.390/.500	51/166	20/ 65	Trickling filter / Sludge drying beds	
Sibley WTP S-3	-	-	-	-	-	Sanitary wastes to municipal STP	Filter back-wash water to storm sewer

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD$_5$ (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Sibley Municipal Utility S-4	-	-	- /.020	-	-	Sanitary wastes to municipal STP	Cooling tower bleed water to storm sewer.
Ashton M-9	483	-	.031/.045	81/ 21	8/ 2	Two cell lagoon / Not applicable	5.97 acres
Hallett Construction Company, Ashton I-1	-	-	- /1.50	-	-	Two settling basins / Unknown	Sand & gravel wash water.
Matlock M-10	89	-	-	-	-	None	
Little Rock River							
Doon M-11	437	440	.044/.044	75/ 27	10/ 4	Two cell lagoon / Not applicable	7.0 acres
Burr Oak Creek							
Hull STP M-12	1,523	-	.121/.130	39/ 39	20/ 20	Trickling filter / Digester; Unknown	
Hull WTP S-5	-	-	-	-	-	-	Backwash water discharged to storm sewer.
Rock River							
Rock Valley M-13	2,205	2,700	.113/.260	44/ 41	13/ 12	Trickling filter / Digester; Sludge drying beds	
Kooima Machine Works, Rock Valley I-2	-	-	-	-	-	None	
Lake Pahoja Recreation Area S-6	-	-	- /.008	-	-	Three septic tanks with drainfield / Sludge hauled out	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Big Sioux River							
Dry Creek							
Hawarden M-14	2,789	26,000	.168/.501	21/ 29	1/ 1	Activated sludge with polishing lagoon / Unknown	3 acre lagoon with no discharge has large meat packing plant = 22,500 p.e.
Six Mile Creek							
Chatsworth M-15	90	-	-	-	-	Septic tanks / Unknown	
Indian Creek							
Spring Creek							
Ireton STP M-16	582	900	.040/.065	71/ 24	11/ 4	Trickling filter / Unknown	
Ireton WTP S-7	-	-	-	-	-	-	No Information
Big Sioux River							
Akron M-17	1,324	1,500	.134/.150	35/ 39	20/ 22	Activated sludge / Unknown	Contact stabilization
Westfield M-18	148	200	.028/.018	57/ 13	13/ 3	Two cell lagoon / Not applicable	No discharge 2.4 acres
Missouri River							
Floyd River							
Melvin M-19	325	-	-	-	-	No Information	-
Sheldon M-20	4,535	9,400	.217/ -	39/ 71	27/ 49	Trickling filter / Sludge drying beds	Plant being constructed.
Land O'Lakes, Sheldon I-3	-	-	-	-	-	All wastes to municipal STP.	
Little Floyd River							
Sanborn M-21	1,465	5,040	.170/176	50/ 71	14/ 20	Trickling filter / Sludge drying beds	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	BOD$_5$ (mg/l)/(lb/day)	Ammonia-N (mg/l)/(lb/day)	Treatment Type / Sludge Disposal	Comments
Floyd River							
Hospers M-22	646	1,900	.065/ -	79/ 43	9/ 5	Two cell lagoon / Not applicable	16 acres
Hospers Rural Water System #1 S-8	-	-	- /.006	-	-	Soil absorption lagoon	
Alton M-23	1,018	-	.153/.140	125/159	-	Two cell lagoon / Not applicable	11.2 acres
West Branch, Floyd River / Unnamed Tributary							
Orange City STP M-24	3,572	3,000	.357/.235	51/152	26/ 77	Trickling filter / Unknown	
Orange City WTP S-9	-	-	.025/ -	-	-	Filter backwash water to storm sewer and holding pond then to discharge	Twice per week
Sioux County Home Orange City S-10	-	-	-	-	-	No Information	Last correspondence 1960
Willow Creek							
Granville STP M-25	383	-	.020/.050	54/ 9	38/ 6	Two cell lagoon / Not applicable	4.0 acres
Granville WTP S-11	-	-	-	-	-	-	Backwash water to municipal STP.
Deep Creek							
Remsen M-26	1,367	-	.090/.140	58/ 44	26/ 20	Trickling filter / Sludge drying beds	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)/(lb/day)	Effluent: Ammonia-N (mg/l)/(lb/day)	Treatment Type / Sludge Disposal	Comments
Oyens M-27	145	95	.005/.014	85/ 4	6/ 0	One cell lagoon	0.5 acres; lagoon overloaded hydraulically with overflow to adjacent property.
Floyd River							
LeMars M-28	8,159	26,100	.810/1.00	35/236	9/ 61	Two stage Trickling filter / Unknown	
Athens Conoco Car Wash, LeMars I-4	-	-	-	-	-	Unknown	May be connected to STP.
Dubuque Packing Co., LeMars I-5	-	-	-	-	-	2 anaerobic lagoons- 0.7 acres 2 aerobic lagoons -15.2 acres 2 polishing lagoons- 6.6 acres / Not applicable	No discharge;
Plymouth County Home LeMars S-12	-	-	-	-	-	Unknown	Proposed connection to LeMars STP in 1955.
West Branch, Floyd River							
Boyden M-29	670	-	.058/.100	50/ 24	12/ 6	Two cell lagoon / Not applicable	13.29 acres
Unnamed Tributary							
Sioux Center STP M-30	3,450	5,160	.398/.345	51/165	13/ 42	Trickling filter / Unknown	
Sioux Center WTP S-13	-	-	-	-	-	-	All discharges to City STP.

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD_5 (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Sioux Preme Packing Co., Sioux Center I-6	-	-	.575/ -	29/139	14/ 67	2 anaerobic lagoons - 1 acre 2 aerobic lagoons - 15 acres. 160 acres spray irrigation field	
Hyman's Construction Co. Sioux Center I-7	-	-	- /1.50	-	-	None	Quarry water
West Branch, Floyd River							
Maurice M-31	266	260	.0266/.026	196/ 43	48/ 11	Primary only / Unknown	
Struble M-32	59	-	-	-	-	Septic tanks / Unknown	
Mink Creek							
Craig M-33	98	-	-	-	-	Septic tanks / Unknown	
Brunsville M-34	125	-	.005/.015	74/ 3	12/ .5	One cell lagoon / Not applicable	1.5 acres
West Branch, Floyd River							
Merrill M-35	790	800	.058/.082	61/ 30	-	Two cell lagoon / Not applicable	6.8 acres
Hinton M-36	488	2,150	.043/.060	25/ 9	-	Two cell lagoon / Not applicable	9 acres; no discharge
Missouri River							
Sioux City M-37	85,925	-	16.81/20.0	342/47,947	25/4,907	Primary/Sludge lagoons and drying beds	
Sergeant Bluff M-38	2,054	-	-	-	-	To Sioux City STP	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l) (lb/day)	Effluent: Ammonia-N (mg/l) (lb/day)	Treatment Type / Sludge Disposal	Comments
Missouri River							
Sioux City Stockyards, Sioux City, I-56	-	-	-	-	-	To municipal STP	
Abandoned Floyd River Channel							
Flavorland (Beef Div.), Sioux City, I-57	-	-	001=.460	-	-	None	Cooling water
			002= -	-	-	To municipal STP	Storm water runoff from cattle hold-ing pens
			003= -	-	-	To municipal STP	Storm water runoff from cattle holding pens
Sioux City Cold Storage Co., I-58	-	-	.080/ -	-	-	Process waste to municipal STP / Not applicable	Cooling water
Missouri River							
Stockyards Service and Supply Co., Sioux City, I-59	-	-	001=.050	-	-	None	Cooling water and backwash from ion ex-change water softeners
Armour & Co., Sioux City, I-60	-	-	001= -	-	-	To municipal STP	
			002=.170	-	-	None	Cooling water
			003=.864	-	-	None	Clear cooling water and roof drainage
Cargill Inc., Sioux City, I-61	-	-	-	-	-	To municipal STP	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	BOD$_5$ (mg/l)	BOD$_5$ (lb/day)	Ammonia-N (mg/l)	Ammonia-N (lb/day)	Treatment Type Sludge Disposal	Comments
Chesterman Co., Sioux City, I-62	-	-	-	-		-		To municipal STP	
Iowa Public Service Co., Sioux City, I-63	-	-	-	-		-		None	Cooling water
Iowa Public Service Co., Sioux City, I-64	-	-	-	-		-		None	Cooling water; Total for I-63 & I-64=1.064 mgd
Floyd River									
Johnson Biscuit Co., Sioux City, I-65	-	-	.500/ -	-		-		None	Cooling water
Abandoned Floyd River Channel									
Mid-state Packers Inc., Sioux City, I-66	-	-	001=.650	-		-		None	Cooling water
			002=.080	-		-		None	Cooling water
			003=.190	-		-		To municipal STP	Process waste
Missouri River									
Nutra-Flow Chemical Co., Sioux City, I-67	-	-	001=.864	-		-		None	
			002=.864	-		-		None	To Floyd River
Floyd River									
Abandoned Floyd River Channel									
Raskin Packing Co., Inc., Sioux City, I-68	-	-	.300/ -	-		-		None	Cooling water
Perry Creek									
Roberts Dairy Co., Sioux City, I-69	-	-	.250/ -	-		-		None	Cooling water

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l) (lb/day)	Effluent: Ammonia-N (mg/l) (lb/day)	Treatment Type / Sludge Disposal	Comments
Swift and Co., Sioux City, I-70	-	-	-	-	-	-	Closed File
Swift Dairy & Poultry Co., Sioux City, I-71	-	-	-	-	-	-	Closed File
Floyd River Drainage Ditch							
Standard Ready Mix Co., Sioux City, I-72	-	-	.020/ -	-	-	Settling basins / unknown	
			.040/ -	-	-	To municipal STP	
Abandoned Floyd River Channel							
United Packing of Iowa, Sioux City, I-73	-	-	.070/ -	-	-	None	Cooling water
Floyd River							
Sioux Tools Inc., Sioux City, I-74	-	-	001=.035	-	-	None	Cooling water
			002=.035	-	-	None	Cooling water
Missouri River							
Hilton Inn, Sioux City, I-75	-	-	.050/ -	-	-	None	Cooling water
Toy National Bank, Sioux City, I-76	-	-	.050/ -	-	-	None	Cooling water
Northwester Bell Telephone Co., Sioux City, I-77	-	-	.050/ -	-	-	None	Cooling water
Myer Beef Inc., Sioux City, I-78	-	-	-	-	-	Process wastes to municipal STP	Cooling water 1000-5000 G.P.D.

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l) (lb/day)	Effluent: Ammonia-N (mg/l) (lb/day)	Treatment Type / Sludge Disposal	Comments
Gates Rubber Co., Sioux City, I-79	-	-	-	-	-	To municipal STP	
St. Regis Paper Co., Wheeler Div., Sioux City, I-80	-	-	-	-	-	-	-
Roe Dairy Co., Sioux City, I-81	-	-	-	-	-	To municipal STP	
<u>Perry Creek</u>							
Soft Water Service Inc., Sioux City, I-82	-	-	.016/ -	-	-	To municipal STP	Brine waste from water softener regeneration; chlorides 620# ave. 931#max
Steele's Ice Service Sioux City, I-83	-	-	.006/ -	-	-	To municipal STP	Cooling water to storm sewer
<u>Floyd River</u>							
Chicago & Northwestern RR Sioux City, I-84	-	-	001=.020	-	-	Septic tank / Unknown	Has surface discharge
<u>Big Sioux River</u>							
Chicago, Milwaukee, St. Paul & Pacific RR, Sioux City, I-85	-	-	.001/ -	-	-	-	Waste water from engine house
<u>Missouri River</u>							
Martin Apartment Bldg., Sioux City, I-86	-	-	.540/ -	-	-	None	Cooling water

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Oxbow							
New Lake							
Unnamed Stream							
Flavorland (Hide Processing Div.) Sioux City, I-87	-	-	.239/ -	-/36	-/37	Two aerated lagoons Clarifier One polishing lagoon unknown	
Oxbow							
Kind & Knox Gelatin, Sioux City, I-88	-	-	.700/ -	-/800	-/1932	Two cell lagoon unknown	
Missouri River							
Iowa Public Service Co., Sioux City, I-89	-	-	395/ -	-	-	None	Cooling water
Iowa Public Service Co., Sioux City, I-90	-	-	475/ -	-	-	None	Cooling water
Terra Chemicals, Sioux City, I-91	-	-	.810/ -	-/500	-/266	Ammonia stripper & 2 lagoons unknown	
International Inc., Sioux City, I-92	-	-	-	-	-	-	-
Farmland Ind. Soybean Extraction Plant, Sioux City, I-93	-	-	001=.050	-	-	Extended aeration unknown	Sanitary & process water to package waste treatment plant
			002=4.00	-	-	None	Cooling water

TABLE V-4 (cont.)

Discharger (Ref.No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Cleghorn Ditch							
Iowa Hwy. Comm. Rest Area No. 016R, Sergeant Bluff S-14	-	-	.004/ -	-	-	Lagoon / Not applicable	No discharge
Iowa Hwy. Comm. Rest Area No. 015R, Sergeant Bluff S-15	-	-	.005/ -	-	-	Lagoon / Not applicable	No discharge
Boyer Drainage Ditch #1							
Sloan M-39	799	-	.078/.090	65/ 42	27/ 18	Trickling filter / Unknown	
Cleghorn Ditch							
Whiting M-40	590	650	.051/.065	42/ 18	13/5.5	Two cell lagoon / Not applicable	6.7 acres
Agricultural Business Co. Inc., Whiting I-8	-	-	.033/ -	-	-	None	Cooling water
Interchange Service Corp., Whiting I-9	-	294	- /.008	-	-	Activated sludge with polishing lagoon/Unknown	Extended aeration; domestic wastes
Louis & Clark State Park, State Conservation Comm. S-16	-	-	-	-	-	Two cell lagoon / Not applicable	No discharge
Monona-Harrison Ditch Farmers Ditch							
Salix M-41	387	-	-	-	-	Proposing 3-cell lagoon	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
McNeil Ditch							
Onawa M-42	3,154	-	.449/ -	37/139	28/105	Trickling filter / Unknown	
Blencoe M-43	225	300	- /.030	-	-	One cell lagoon / Not applicable	3.0 acres
Dwight's Skelly, Blencoe I-10	-	45	-	-	-	One cell lagoon / Not applicable	No discharge
Little Sioux River							
Silver Lake							
Lake Park M-44	918	1,200	.045/.083	59/22	3/ 1	Two cell lagoon / Not applicable	8.45 acres; seepage is a problem and sealing may be required (per IDEQ,1971)
Spirit Lake							
Orleans M-45	396	-	-	-	-	To Iowa Great Lakes Sanitary District	
Iowa Electric Light & Power S-17	-	-	-	-	-	To Iowa Great Lakes Sanitary District	NPDES File 0.007 mgd boiler blowdown a softener recharge to municipal system
East Okoboji Lake							
Spirit Lake M-46	3,014	-	-	-	-	To Iowa Great Lakes Sanitary District(IGLSD)	-

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD$_5$ (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Spirit Lake Fish Hatchery I-11	-	-	-	-	-	To IGLSD	-
West Okoboji Lake							
Okoboji M-47	361	-	-	-	-	To IGLSD	-
Arnolds Park M-48	970	-	-	-	-	To IGLSD	-
Wahpeton M-49	149	-	-	-	-	To IGISD	-
West Okoboji M-50	210	-	-	-	-	to IGLSD	-
Okojobi Lake Outlet							
Iowa Great Lakes Sanitary District S-18	6,768	-	1.88/2.00	26/408	9/141	Trickling filter	
Iowa Great Lakes Water Treatment Plant S-19	-	-	-	-	-	To IGLSD	
Milford M-51	1,668	-	-	-	-	To IGLSD	
Ocheyedan River							
Rush Lake Outlet							
Ocheyedan M-52	545	-	.039/.036	36/ 12	12/ 4	Two cell lagoon / Not applicable	5.96 acres
Dry Run							
Harris M-53	195	250	-	33/ -	-	One cell lagoon / Not applicable	7.8 acres
Sewer Creek							
Hartley M-54	1,694	-	.205/.193	34/ 58	7/ 12	Trickling filter / Unknown	
Hartley WTP S-20	-	-	.0005/ -	-	-	None	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD5 (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Hartley Grain Elevators, I-12	-	-	-	-	-	Septic tank and drainfield / Unknown	No discharge
Ocheyedan River							
Everly M-55	699	1,006	.076/ -	60/ 38	3/ 2	Two cell lagoon / Not applicable	9 acres
Everly WTP S-21			No Information				
Prairie Creek							
Royal M-56	469	-	.048/.068	37/ 15	-	Two cell lagoon / Not applicable	Some infiltration/inflow from septic tanks
Royal WTP S-22	-	-	-	-	-	None	
Ocheyedan River							
Cornbelt Power Co-op, Spencer I-13	-	-	.034/ -	-	-	Septic tanks / Sludge basin	Water supply from wells 0.372 mgd
Little Sioux River							
Spencer STP M-57	10,278	-	1.87/ 2.4	66/1,029	16/250	Trickling filter / Sludge drying beds	New plant in final design
Spencer Rendering Co., I-14	-	-	- /.025	-	-	To Municipal STP	Corps permit June 30, 1971. Latest information (7-11-74) shows a sump overflow discharge. No information available on this.

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD_5 (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Eaton Corp., Spencer I-16	-	-	- /.016	-	-	Two cell lagoon 1st cell aerated	Sludge hauled out
Spencer Municipal Power Plant S-23	-	-	-	-	-	-	No NPDES information available
Big Muddy Creek							
Superior M-58	139	-	-	-	-	-	No existing municipal treatment facility
Little Muddy Creek							
Fostoria M-59	219	-	-	-	-	-	Site approval 1972. Two cell lagoon, surface area 4.0 acres
Lost Island Lake Outlet Drainage Ditch #61C							
Terrill M-60	397	425	.032/.047	44/ 12	2/ 1	Two cell lagoon / Not applicable	4.12 acres
Lost Island Lake Outlet							
Dickens M-61	240	-	-	-	-	-	No existing municipal treatment facility
Drainage Ditch #60							
Ruthven STP M-62	708	-	.053/.121	51/22	3/ 1	Two cell lagoon / Not applicable	Severe infiltration/inflow problems. Total lagoon area 10 acres.

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD5 (mg/l) (lb/day)	Effluent Ammonia-N (mg/l) (lb/day)	Treatment Type / Sludge Disposal	Comments
Ruthven WTP S-24		No Information					
Montgomery Creek							
Webb M-63	234	-	-	-	-	-	No existing municipal treatment facility
Willow Creek							
Moneta M-64	41	-					No existing municipal treatment facility
Rossie M-65	91	-					No existing municipal treatment facility
Greenville M-66	117	-					No existing municipal treatment facility
Little Sioux River							
Sioux Rapids M-67	813	1,100	.054/.064	74/ 33	30/ 14	Trickling filter / Unknown	
Linn Grove M-68	240	-	.022/.020	31/ 5.7	4/ 0.7		Single cell lagoon made by damming irregular high water channel of Little Sioux River. Flushed during every high water period. Combined sewer system. Plant should be upgraded and protected from high water (per IDEQ 1-22-74) Surface area about 5 acres.

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD_5 (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Linn Grove Rendering, I-17	-	-	001=.018 002=.001	126/ -	5/ -	001=Untreated process water 002=Boiler blowdown	Water supply-well (0.0187 mgd)
Peterson M-69	469	550	- /.065	126/ -	22/ -	Three-cell lagoon / Not applicable	5.26 acres built in 1974
Waterman Creek							
Sutherland M-70	875	-	.059/.090	29/ 14	-	Two cell lagoon / Not applicable	
Mill Creek							
Dry Run							
Primghar STP M-71	995	1,300	.088/.135	29/ 21	2/ 1	Two cell lagoon / Not applicable	13.0 acres
Primghar WTP S-25	-	-	.090/ -	-	-	-	-
Mill Creek							
Archer M-72	134	-	-	-	-	Septic tanks	Last correspondence 1971
Paullina M-73	1,257	1,500	.117/.183	25/ 24	5/ 5	Two cell lagoon / Not applicable	15.0 acres
Willow Creek							
Mugge Creek							
Calumet M-74	219	-	-	-	-	Septic tanks / Unknown	Requested to submit plans 9-1-75, complete construction 12-1-76 Septic tank discharges causing pollution

TABLE V-5 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD5 (mg/l)(lb/day)	Effluent Ammonia -N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Gray Creek							
Larrabee M-75	167	-	.006/.017	36/ 2	-	One cell lagoon / Not applicable	1.5 acres constructed in 1970; no discharge
Hill Creek							
Meriden STP M-76	167	-	.015/.024	40/ 5	8/ 1	One cell lagoon / Not applicable	1.6 acres
Meriden WTP S-26	-	-	-	-	-	-	Iron backwash water to municipal STP
Little Sioux River							
Cherokee M-77	7,272	14,100	.650/1.14	32/173	18/ 98	Activated sludge / Unknown	
Hallet Construction Co., Cherokee I-18	-	-	1.5/ -	-	-	Settling basins / Unknown	Surface water supply. Summer operation only.
Cherokee Industrial Site (Wilson Pkg. Plant) I-19	-	-	.699/1.300	31/180	47/273	Combination anaerobic-aerobic lagoons/Unknown	
Cherokee County Home S-27	-	-	-	-	-	Septic tanks	No correspondence since 1950
Cherokee Rural Water District #1 S-28	-	-	.005/ -	-	-	None	Iron filter backwash water
Railroad Creek							
Meadow Brook Mobile Home Court S-29	-	-	-	-	-	One cell lagoon proposed 8-16-73	65 spaces in court

TABLE V-5 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Little Sioux River							
Cherokee Mental Health Institute S-30	-	-	.150/ -	-	-	To City STP	
Quimby M-78	395	450	.042/.050	132/ 46	35/ 12	Two cell lagoon / Not applicable	
Simonsen Mill and Rendering Plant, Inc., Quimby I-20	-	-	-	-	-	One cell anaerobic lagoon / Not applicable	No discharge
Willow Creek							
Cleghorn M-79	274	280	.010/.021	44/ 4	2/ .2	One cell lagoon / Not applicable	1.5 acres
Little Sioux River							
Washta M-80	319	-	.017/.031	75/ 11	12/ 2	One cell lagoon / Not applicable	2.04 acres
Pierson Creek							
Pierson M-81	421	500	.066/.050	49/ 27	26/ 14	Two cell lagoon / Not applicable	5.0 acres
Bacon Creek							
Cushing M-82	204	200	.026/.025	52/ 11	25/ 5	Community septic tank, dosing tank, filter bed with distributing lines	
Correctionville M-83	870	1,180	.118/.168	88/ 87	15/ 15	Trickling filter / Unknown	
Little Sioux River							
Anthon M-84	711	-	.081/.100	60/ 40	26/ 18	Trickling filter / Unknown	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD5 (mg/l)/(lb/day)	Effluent Ammonia-N (mb/l)/(lb/day)	Treatment Type / Sludge Disposal	Comments
Oto M-85	203	-	-	-	-	Treatment consists of septic tanks, cesspools and privies. A serious health problem has arisen and Oto has submitted for FHA funds for sewage system.	
Smokey Hollow Creek							
Smithland M-86	293	347	- /.035	-	-	Two cell lagoons = 2.4 acres / Not applicable	In the process of building a wastewater collection and treatment system
Little Sioux River							
Rodney M-87	66	-	-	-	-	-	No existing municipal treatment facility
Little Sioux River / West Fork / Fiddle Creek							
Marcus STP M-88	1,272	-	.113/.020	58/ 55	30/ 28	Trickling filter / Digester;unknown	
Marcus WTP S-31	No Data In Files						
West Fork							
Kingsley M-89	1,097	1,350	.130/.090	48/ 52	6/ 7	Two cell lagoon / Not applicable	9.08 acres
Moville M-90	1,198	1,188	.069/.128	46/ 26	16.5/ 9	Two cell lagoon / Not applicable	9.6 acres

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD$_5$ (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Hornick STP M-91	250	275	.028/.033	42/ 10	4/ 1	One cell lagoon / Not applicable	1.82 acres
Hornick WTP S-32	-	-	.030/ -	-	-	All wastes to municipal STP	
Garretson Ditch / Elliot Creek							
Lawton M-92	406	470	.0406/.036	59/ 20	28/ 10	One cell lagoon / Not applicable	
Bronson M-93	193	No Files			NEMTF		
Maple River / Dry Creek Bed							
Aurelia STP M-94	1,065	1,065	.091/.125	42/ 32	12/ 9	Trickling filter / Unknown	Two compartment sludge drying bed has been abandoned. Digested sludge distributed on farmland
Pampered Beef, Inc. Aurelia I-21	-	-	-	-	-	Three cell lagoon / Not applicable	19 acres; 640 acres used to spray liquid manure
Little Maple River							
Alta M-95	1,717	1,945	.180/.161	43/ 65	14/ 21	Trickling filter / Unknown	
Alta WTP S-33	-	-	.017/ -	-	-	None	Ion-exchange backwash water

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD_5 (mg/l) (lb/day)	Effluent Ammonia-N (mg/l) (lb/day)	Treatment Type / Sludge Disposal	Comments
Halfway Creek							
Schaller M-96	835	1,170	.0695/.112	46/ 27	1/ 1	Two cell lagoon / Not applicable	4.8 acres and 4.7 acres; constructed in 1968
Pork Processors, Inc., Schaller I-22	-	-	-	-	-	-	Plans presented to the IDEQ in January, 1974. The processing industrial plant has not been built nor received its permit as yet to build some type of wastewater treatment plant
Galva M-97	412	578	.041/.074	68/ 23	10/ 3	Trickling filter / Sludge drying beds	New plant, 1974
Odebolt Creek							
Odebolt M-98	1,323	-	.113/.187	31/ 29	15/ 14	Trickling filter	Built in 1956
Selected Casing, Odebolt I-23	-	-	-	-	668/ -		Has solids retention tank. Mucasa recovered from tank, spread on fields or sold to rendering. Plant has increased its capacity and is still overloading community sewage plant.

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Unnamed Creek							
Arthur M-99	273	355	.038/.036	33/ 10	11/ 3	Two cell lagoon / Not applicable	3.93 acres
Odebolt Creek							
Ida Grove M-100	2,261	-	.267/.240	75/167	9/ 20	Trickling filter / Sludge lagoon	Old plant. New activated sludge plant proposed in 1972 and is still being constructed.
Culligan Water Conditioning, Ida Grove I-24	-	-	-	-	-	To municipal STP	
Deluxe Motel, Ida Grove I-25	-	-	-	25/ -	-		Permit issued for 1600 gal. septic tank and subsurface sand filter Jan. 31, 1965. 21 units in motel.
Battle Creek							
Holstein STP M-101	1,445	-	.147/.142	40/ 49	4/ 5	Two cell lagoon / Not applicable	6.3 acres east cell and 6.9 acres west cell
Holstein WTP S-34	-	-	-	-	-	To municipal STP	
Robert Bagenstos Slaughter House, Holstein I-26	-	-	-	-	-	-	550-gallon septic tank

TABLE V-4 (cont.)

Discharger (Ref.No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD_5 (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Maple River							
Battle Creek M-102	837	-	.094/.084	28/ 22	-	Two cell lagoon / Not applicable	7.0 acres
Danbury M-103	527	-	.058/.102	28/ 14	1/ 1	Two cell lagoon / Not applicable	5.1 acres
Mapleton M-104	1,647	3,000	.124/.122	26/ 27	4/ 4	Activated sludge with 12-day polishing lagoon / Unknown	New plant 1970
Castana M-105	211	-	-	-	-	None	
Turin M-106	115	-	-	-	-	None	No plant. In the process of building waste stabilization lagoon. Previous method of individual septic tanks will continue until completion.
Little Sioux River							
Little Sioux M-107	239	-	-	-	-	Septic tanks	
Missouri River							
Soldier River							
East Soldier River							
Charter Oak STP M-108	715	-	.040/ -	65/ 22	1/ 0.3	Two cell lagoon / Not applicable	5.7 acres
Charter Oak WTP S-35		No Information					
Ute M-109	512	-	.051/.060	83/ 35	22/ 9	Two cell lagoon / Not applicable	4.8 acres

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD_5 (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Middle Soldier River							
Ricketts M-110	141	125	.015/.008	137/ 17	25/ 3	Imhoff tank / Sludge drying beds	
Soldier River							
Soldier M-111	242	-	-	-	-	Septic tanks / Unknown	Lagoon proposed 4-25-75
Moorhead M-112	271	-	-	-	-	Septic tanks / Unknown	Proposed a lagoon 1973
Pisgah M-113	286	400	.010/.040	-	-	Two cell lagoon / Not applicable	3 acres
Missouri River							
Spooner Ditch							
Mondamin STP M-114	420	-	.038/.060	45/ 14	10/ 3	Lagoon / Not applicable	
Mondamin WTP S-36	-	-	-	-	-	Filter backwash to municipal STP	
Missouri River							
Desoto National Wildlife Refuge, Hanson County S-37	-	-	-	-	-	No discharge lagoon proposed in 1969	
Boyer River							
Unnamed Tributary							
Early M-115	727	-	.064/.109	64/ 34	11/ 6	Two cell lagoon / Not applicable	9 acres
Wall Lake County Home, Early S-38	-	-	-	-	-	Septic tank / Unknown	No correspondence since 1954

TABLE V-4 (cont.)

Discharger (Ref.No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)/(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Sac County Drainage Ditch #68							
Camex, Inc., Early I-27	-	-	001=.015			None	Cooling water
			002= -				Sanitary Wastes & cooling water to municipal STP
Lime Creek / Drainage Ditch #60							
Wall Lake STP M-116	936	-	.121/.107	33/ 33	2/ 2	Two cell lagoon / Not applicable	11.33 acres
Unnamed Tributary							
Wall Lake Processing Corp., Wall Lake I-28	-	770	- /.003	-	-	Septic tanks for sanitary wastes settling basins for process wastes	Collected solids spread on land
Otter Creek							
Kiron M-117	275	400	.053/.030	60/ 27	15/ 7	Trickling filter / Unknown	
Schleswig M-118	875	1,450	.048/.145	46/ 18	10/ 4	Two cell aerated lagoon / Not applicable	7 acres
Schleswig Locker, Schleswig I-29	-	-	-	-	-	To municipal STP	
Deloit M-119	279	250	.061/ -	39/ 20	-	Two cell lagoon / Not applicable	2.2 acres
Boyer River / East Boyer River							
Arcadia M-120	414	-	-	-	-	Septic tanks / Unknown	Proposed 3 cell lagoon 9-20-74

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Westside M-121	389	450	.013/.045	127/ 14	50/5	Two cell lagoon / Not applicable	3.5 acres
Vail M-122	486	505	.066/.050	25/ 14	-	Two cell lagoon / Not applicable	3.88 acres
Boyer River Denison STP M-123	6,213	-	.646/1.05	26/140	28/151	Trickling filter / On land	
Denison WTP S-39	-	-	-	-	-	None at present	Basin for holding filter back wash water scheduled for completion fall 1975
Boyer Valley Co., Denison I-30	-	-	-	-	-	Sanitary wastes to septic tank, industrial wastes to a 2.45 acre, no discharge lagoon	
Farmland Foods, Inc., Denison I-31	-	-	.850/1.00	-	42/292	Two aerobic lagoons= 1.94 acres and 2 trickling filters / Unknown	
Iowa Beef Processors, Inc., Denison I-32	-	75,000	- /1.01	-	1,555/ -	2 anaerobic lagoons, (1.64 acres) 2 aerobic lagoons (25.6 acres) 1 polishing cell (19.2 acres) / Not applicable	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
South Crawford Rural Electrical Coop, Denison I-33	-	-	-	-	-	Proposed a connection to municipal STP in 1969	
Crawford County Home, Denison S-40	-	-	-	-	-	Septic tank / Unknown	No correspondence since 1960
East Boyer River							
Meyer Mobile Home Park, Denison S-41	-	-	-	-	-	One cell lagoon / NOt applicable	58 spaces in park
Unnamed Tributary							
Buck Grove M-124	41	No Information			NEMTF		
Boyer River							
Arion M-125	199	No Files			NEMTF		
Dow City M-126	571	800	.037/ -	33/ 10	2/ 1	Two cell lagoon / Not applicable	6.3 acres
Dunlap M-127	1,292	1,500	.070/.180	45/ 26	11/ 6	Two cell lagoon / Not applicable	12 acres
Woodbine M-128	1,349	1,414	.108/.155	34/ 31	13/ 12	Two cell lagoon / Not applicable	10.8 acres
Logan M-129	1,526	2,040	.118/.200	26/ 26	10/ 10	Activated sludge with polishing lagoon / Unknown	Contact stabilization

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Clark Limestone Co., Logan I-34	-	-	-	-	-	None	Outfall 001= .020 mgd surface water discharge. Outfall 002=.020 mgd process water discharge. Outfall 003= .010 mgd dewatering water discharge
W.A.Schommer Limestone Quarry, Logan I-35	-	-	- /.050	-	-	Settling ponds	
Harrison County Home S-42	-	-	.352/ -	-	-	Reported to have a lagoon in 6/70	
Missouri Valley STP, M-130	3,519	4,590	.165/.432	34/100	9/ 26	3 cell lagoon / Not applicable	38.4 acres
Missouri Valley WTP S-43	-	-	-	-	-	To municipal STP	
Rath Travelers Inn Motel, Missouri Valley I-36	40 units	-	-	-	-	Activated sludge with 10 day polishing lagoon / Unknown	Extended aeration
Skelley Oil Co., Missouri Valley I-37	-	-	-	-	-	Two cell lagoon / Not applicable	0.55 acres; No discharge

TABEL V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l) (lb/day)	Effluent: Ammonia-N (mg/l) (lb/day)	Treatment Type / Sludge Disposal	Comments
Euclid Creek							
U.S.Air Force Missile Launch Base, Missouri Valley S-44	-	135	-	-	-	Two cell lagoon as of 6/70	.308 acres; no correspondence since 1970
Iowa Hwy. Commission Rest Area #25R, Missouri Valley S-45	-	-	- /.002	-	-	Lagoon / Not applicable	
Iowa Hwy. Commission Rest Area #26R, Missouri Valley S-46	-	-	-	-	-	Lagoon / Not applicable	
Willow Creek							
Magnolia M-131	206	-	No Information			NEMTF	
Sunny Side Village Mobile Home Park, Missouri Valley S-47	20 spaces	-	-	-	-	Lagoon / Not applicable	
Allen Creek							
Valley View Mobile Home Park, Missouri Valley S-48	78 spaces	-	- /.015	-	-	Activated sludge with polishing lagoon / Unknown	Extended aeration
Unnamed Tributary							
Modale M-132	297	-	-	-	-	Septic tanks	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD5 (mg/l) (lb/day)	Effluent Ammonia-N (mg/l) (lb/day)	Treatment Type / Sludge Disposal	Comments
Skelley Oil Co., Modale I-38	-	45	-	-	-	Lagoon / Not applicable	0.5 acres; no discharge
Boyer River							
Wilson Island State Park, Loveland S-49	-	-	-	-	-	Unknown	
Missouri River							
Nickerson Farms, Honey Creek I-39	-	-	-	-	-	Lagoon / Not applicable	No discharge
Pidgeon Creek							
Crescent M-133	284	No Information		NEMTF			
Crescent Quarry I-40	-	-	.700/ -	-	-	None	
Missouri River							
Indian Creek							
Union Pacific RR Co., Council Bluffs I-41	-	-	.178/ -	-	-	None	Cooling water
Missouri River							
Mosquito Creek							
Earling STP M-134	573	-	.046/.056	47/ 18	8/ 3	Activated sludge / Unknown	Extended aeration
Earling WTP S-50	-	-	.001/ -	-	-	None	Discharge to storm sewer
Panama STP M-135	221	-	-	-	NEMTF	Septic tanks until 1966; in 1966 two cell lagoon proposed; no record of it having been built.	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent Flow (mgd) Average/Design	Effluent BOD_5 (mg/l)(lb/day)	Effluent Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Panama WTP S-51	-	-	-	-	-	Sanitary wastes to septic tanks 1300 gallon settling tank for filter backwash.	
Portsmouth M-136	239	-	-	-	-	Two cell lagoon / Not applicable	
Persia STP M-137	316	-	-	-	-	None	
Persia WTP S-52	-	-	-	-	-	None	
Neola M-138	968	1,200	- /.100	41/	-	Trickling filter / Unknown	
Tri-Center Community School, Neola S-53	-	-	-	-	-	Lagoon / Not applicable	
Underwood M-139	424	815	.019/.077	77/ 12	4/ 1	Two cell lagoon / Not applicable	6.33 acres
Western Electric Co., Underwood I-42	-	-	-	-	-	Sanitary wastes to municipal STP	
Hanson Oil Co., Underwood I-43	-	-	-	-	-	Two cell lagoon / NOt applicable	Receives sewage from 15 unit motel also
Iowa Hwy. Commission Rest Area #029R S-54	-	-	.025/ -	-	-	Two cell lagoon / Not applicable	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
College Heights Manor M.H.P. Council Bluffs S-55	33 spaces	-	-	-	-	Lagoon / Not applicable	
Pony Creek							
Alto Mobile Home Park, Council Bluffs S-56	180 spaces	-	-	-	-	Lagoon / Not applicable	
National Cooperative Refinery Assoc., Council Bluffs I-44	-	-	-	-	-	None	Surface runoff water
Iowa Power & Light Co., Council Bluffs I-45		No Information					
Chicago, Milwaukee, St. Paul, & Pacific RR, Council Bluffs I-46	-	-	.005/ -	-	-	None	Cooling water
Missouri River							
Council Bluffs STP, M-140	60,348	-	5.55/12.9	205/9,489	4/185	Trickling filter / Unknown	
Council Bluffs WTP S-57	-	-	.500/ -	-	-	Unknown	
Council Bluffs School for the Deaf S-58	-	-	-	-	-	Wet well with overflow to drain-field	
Beefland International, Council Bluffs I-47	-	-	-	-	-	To municipal STP	
Carter Lake, M-148	3,268	-	-	-	-	To Omaha STP	

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l) (lb/day)	Effluent: Ammonia-N (mg/l) (lb/day)	Treatment Type / Sludge Disposal	Comments
Twin City Plaza, Council Bluffs I-48	-	-	-	-	-	To municipal STP	
Midwest Walnut Co., Council Bluffs I-49	-	-	.0005/ -	-	-	None	Company has 3 discharge points; Average COD=86 lbs/day
Tonja Mobile Home Park, Council Bluffs S-59	74 spaces	-	-	-	-	Two cell lagoon / Not applicable	No discharge
Griffin Pipe Products Co., Council Bluffs I-50	-	-	- /.350	-	-	None	Cooling water
Pacific Fruit Express Co., Council Bluffs I-51	-	-	-	-	-	-	Abandoned operations
Pottawattamie Co. Home, Council Bluffs S-60	-	-	-	-	-	Septic tank	No correspondence since 1950
Lake Manawa State Park, Council Bluffs S-61	-	-	-	-	-	Council Bluffs STP	
Missouri River							
Keg Creek							
Tennant M-141	93	-	-	-	-	Septic tanks / Unknown	Awaiting lagoon site approval

TABLE V-4 (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Minden M-142	433	450	.177/.038	51/75	-	Two cell lagoon / Not applicable	3.26 acres
McClelland M-143	146	-	No Information		NEMTF		
Glenwood STP M-144	4,421	8,626	.446/.500	80/298	23/ 86	Trickling filter / Unknown	Two stage digestion
Glenwood WTP S-62	-	-	- /.080	-	-	Lagoon / To land	Lime slurry wastewater
Swift Packing Co., Glenwood I-52	-	-	.490/ -	-	-	Aerobic and anaerobic lagoons / Not applicable	Lagoon area 49.4 acres; lagoons not discharged at flows <5 cfs; 8# NH_3 discharged for each cfs >5 cfs
Glenwood State School, Glenwood S-63	-	2,200	- /.430	-	-	Trickling filter / Sludge digestion; Unknown	
Glenwood Mobile Home Park, Glenwood S-64	72 spaces	-	-	-	-	Aerated lagoon / Not applicable	Only discharge when receiving waters have substantial flow
Unnamed Tributary							
Kaser Construction Co., (Glenwood Quarry) I-53	-	-	.140/ -	-	-	None	Intermittent discharge of quarry water

TABLE V-4. (cont.)

Discharger (Ref. No.)	1970 Pop.	Design P.E.	Effluent: Flow (mgd) Average/Design	Effluent: BOD_5 (mg/l)(lb/day)	Effluent: Ammonia-N (mg/l)(lb/day)	Treatment Type / Sludge Disposal	Comments
Keg Creek							
Pacific Junction M-145	505	No Information			NEMTF		
Burlington Northern, Inc., Pacific Jct. I-54	-	-	.0002/ -	-	-	None	Wastewater from round-house and storm drainage
Iowa Hwy. Commission Rest Area #035R, West Pacific Jct. S-65	-	-	-	-	-	Evaporation lagoon - no discharge	
Iowa Hwy. Commission Rest Area #035R, East Pacific Jct. S-66	-	-	-	-	-	Evaporation lagoon - no discharge	
Plum Creek							
Tabor M-146	957	1,100	.047/.072	34/ 13	28/ 11	Activated sludge / Unknown	Extended aeration
Thurman M-147	230	No Information			NEMTF		
Forneys Lake							
Thurman Quarry I-55		-	.021/ -	-	-	None	Quarry water

Legend

STP - Sewage treatment plant
WTP - Water treatment plant
NEMTF - No existing municipal treatment facility

TABLE V-5

POINT SOURCE WASTEWATER DISCHARGE SUMMARY

WESTERN IOWA BASIN

River Basin	Municipal	Semipublic	Industrial Process Water	Industrial Cooling Water
ROCK RIVER				
Flow (mgd)	1.031	.008	1.50	.020
% Total Flow	40.29	.31	58.62	.78
BOD_5 (lbs/day)	422	*	*	-
% Total BOD_5	100	-	-	-
Ammonia-N (lbs/day)	149	*	*	-
% Total Ammonia-N	100	-	-	-
FLOYD RIVER				
Flow (mgd)	2.218	-	2.075	-
% Total Flow	51.67	-	48.33	-
BOD_5 (lbs/day)	928	-	139	-
% Total BOD_5	87	-	13	-
Ammonia-N (lbs/day)	241	-	67	-
% Total Ammonia-N	78	-	22	-
BIG SIOUX RIVER				
Flow (mgd)	.496	-	-	-
% Total Flow	100	-	-	-
BOD_5 (lbs/day)	161	-	-	-
% Total BOD_5	100	-	-	-
Ammonia-N (lbs/day)	42	-	-	-
% Total Ammonia-N	100	-	-	-
LITTLE SIOUX RIVER				
Flow (mgd)	7.763	.018	2.271	-
% Total Flow	77.22	.18	22.60	-
BOD_5 (lbs/day)	2931	*	180	-
% Total BOD_5	94	-	6	-
Ammonia-N (lbs/day)	859	*	281	-
% Total Ammonia-N	75	-	25	-

TABLE V- 5

POINT SOURCE WASTEWATER DISCHARGE SUMMARY

WESTERN IOWA BASIN

River Basin	Municipal	Semipublic	Industrial Process Water	Industrial Cooling Water
SOLDIER RIVER				
Flow (mgd)	.092	-	-	-
% Total Flow	100	-	-	-
BOD_5 (lbs/day)	46	-	-	-
% Total BOD_5	100	-	-	-
Ammonia-N (lbs/day)	5	-	-	-
% Total Ammonia-N	100	-	-	-
BOYER RIVER				
Flow (mgd)	1.571	.061	1.978	.015
% Total Flow	43.34	1.68	54.57	.41
BOD_5 (lbs/day)	416	*	*	-
% Total BOD_5	100	-	-	-
Ammonia-N (lbs/day)	244	*	292	-
% Total Ammonia-N	45.52	-	54.48	-
MISSOURI RIVER**				
Flow (mgd)	23.615	.987	1.386	.566
% Total Flow	88.93	3.72	5.22	2.13
BOD_5 (lbs/day)	10,622	*	*	-
% Total BOD_5	100	-	-	-
Ammonia-N (lbs/day)	5,140	*	*	-
% Total Ammonia-N	100	-	-	-

* No Data

** Includes: Keg Creek, Mosquito Creek, Plum Creek

TABLE V-6

MUNICIPAL WASTEWATER TREATMENT FACILITY
PROCESS SUMMARY BY SUBBASIN

WESTERN IOWA BASIN

Type Of Plant	No. Of Communities	Population Served
ROCK RIVER		
One Cell Lagoon	2	442
Two Cell Lagoon	3	2,114
Trickling Filter	5	9,640
TOTAL	10	12,196
No Treatment Facilities	1	89
FLOYD RIVER		
One Cell Lagoon	2	270
Two Cell Lagoon	6	3,990
Trickling Filter	7	22,814
Septic Tanks	2	157
TOTAL	17	27,231
No Treatment Facilities	0	0
BIG SIOUX RIVER		
One Cell Lagoon	1	204
Two Cell Lagoon	1	148
Trickling Filter	1	582
Activated Sludge	2	4,113
Septic Tanks	1	90
TOTAL	6	5,137
No Treatment Facilities	0	0

TABLE V- 6 (cont.)

Type Of Plant		No. Of Communities	Population Served
LITTLE SIOUX RIVER			
One Cell Lagoon		9	2,243
Two Cell Lagoon		19	14,184
Three Cell Lagoon		1	469
Trickling Filter		13	32,338
Activated Sludge		2	8,919
Septic Tanks		5	951
	TOTAL	49	59,104
No Treatment Facilities		9	1,358
SOLDIER RIVER			
Two Cell Lagoon		3	1,513
Primary		1	141
Septic Tanks		2	503
	TOTAL	6	2,157
No Treatment Facilities		0	0
BOYER RIVER			
Two Cell Lagoon		9	6,904
Three Cell Lagoon		1	3,519
Trickling Filter		2	6,488
Activated Sludge		1	1,526
Septic Tanks		2	711
	TOTAL	15	19,148
No Treatment Facilities		4	730
MISSOURI RIVER *			
One Cell Lagoon		1	420
Two Cell Lagoon		4	1,686
Trickling Filter		4	66,536
Activated Sludge		2	1,530
Primary		1	89,925
Septic Tanks		2	314
	TOTAL	14	160,411
No Treatment Facilities		3	692

* Includes: Keg Creek; Mosquito Creek; Plum Creek

TABLE V-7

MUNICIPAL WASTEWATER TREATMENT FACILITY
PROCESS SUMMARY

WESTERN IOWA BASIN

Type of Plant	No. of Cummunities	Population Served
One Cell Lagoon	15	3,579
Two Cell Lagoon	45	30,539
Three Cell Lagoon	2	3,988
Trickling Filter	32	138,398
Activated Sludge	7	16,088
Septic Tanks	1	204
Primary	2	90,066
Discharge to Separate Facility	8	3,268
TOTAL	112	286,130
No Treatment Facilities	35	6,974

CHAPTER VI

WASTE LOAD ALLOCATIONS AND RANKING

WESTERN IOWA BASIN

WASTE LOAD ALLOCATIONS

Using a computer methodology, effluent limitations required for dischargers to meet state water quality standards within the Basin were determined. Waste load allocation analyses were performed assuming projected 1990 wastewater discharges at the 7-day, 1-in-10 year low flow under both summer and winter conditions. Analysis was performed on streams classified either A, B, or C with existing wastewater discharges. Some considerations that went into the analysis are discussed below. (A detailed description of the computer methodology and the assumptions used can be found in the Supporting Document (1). The waste load allocations are listed in Table VI-1. The effluent limitation for all dischargers in the Western Iowa Basin not appearing in Table IV-1 is either secondary treatment or BPT.

Considerations

Four basic considerations go into the selection of the specific effluent limitation for any given discharge. These involve secondary treatment, best practicable control technology currently available (BPT), applicable standards, and antidegradation.

Secondary Treatment - The Act requires that all publicly owned treatment works shall, by July 1, 1977, achieve, as a

TABLE VI-1

WASTE LOAD ALLOCATIONS

WESTERN IOWA BASIN

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Summer BOD$_5$ (mg/l)	Summer BOD$_5$ (lbs/day)	Summer NH$_3$ (mg/l)	Summer NH$_3$ (lbs/day)	Winter BOD$_5$ (mg/l)	Winter BOD$_5$ (lbs/day)	Winter NH$_3$ (mg/l)	Winter NH$_3$ (lbs/day)
Rock River										
Entire Length										
Rock Valley (M-13)	.63	.130	10	10	4	4	10	11	4	4
Hull (M-12)	.69	.108	18	16	10	9	12	11	4	4
Doon (M-11)	--	0		Controlled		Discharge				
Ashton (M-9)	--	0		Controlled		Discharge				
Sibley (M-8)	.74	.356	30	90	10	30	13	40	3	9
George (M-7)	--	0		Controlled		Discharge				
Little Rock (M-6)	.74	.040	30	10	10	3	10	3	4	1
Alvord (M-5)	--	0		Controlled		Discharge				
Lester (M-4)	--	0		Controlled		Discharge				
Rock Rapids (M-3)	.70	.295	10	24	3	7	10	24	2	5
Floyd River										
Entire Length										
Hinton (M-36)	--	0		Controlled		Discharge				
Merrill (M-35)	--	0		Controlled		Discharge				
Brunsville (M-34)	--	0		Controlled		Discharge				
Maurice (M-31)	4.65	.027	20	5	5	1	20	5	5	1
Sioux Center (M-30)	4.65	.695	20	116	5	29	20	116	5	29
Boyden (M-29)	--	0		Controlled		Discharge				
LeMars (M-28)	3.39	1.09	10	91	2	18	10	91	2	18
Oyens (M-27)	--	0		Controlled		Discharge				
Remsen (M-26)	2.24	.146	15	18	4	5	15	18	4	5
Granville (M-25)	--	0		Controlled		Discharge				
Orange City (M-24)	1.04	.516	10	43	2	9	10	43	2	9
Alton (M-23)	--	0		Controlled		Discharge				
Hospers (M-22)	--	0		Controlled		Discharge				
Sanborn (M-21)	1.04	.255	15	32	4	9	15	32	4	9
Sheldon (M-20)	1.04	.605	15	76	4	20	15	76	4	20
Melvin (M-19)		N E M T P								

TABLE VI-1

WASTE LOAD ALLOCATIONS

WESTERN IOWA BASIN

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Summer BOD$_5$ (mg/l)	Summer BOD$_5$ (lbs/day)	Summer NH$_3$ (mg/l)	Summer NH$_3$ (lbs/day)	Winter BOD$_5$ (mg/l)	Winter BOD$_5$ (lbs/day)	Winter NH$_3$ (mg/l)	Winter NH$_3$ (lbs/day)
Little Sioux River										
Missouri River to Quimby										
Little Sioux (M-107)		.0299[E]	N E M T P							
Smithland (M-86)	--	0		Controlled Discharge						
Oto (M-85)			N E M T P							
Anthon (M-84)	10.14	.085	30	21	10	7	30	21	15	11
Correctionville (M-83)	7.61	.163	30	40	10	14	30	40	15	20
Cushing (M-82)	7.61	.039	30	10	10	3	30	10	15	5
Pierson (M-81)	7.27	.074	30	18	10	6	30	18	15	9
Washta (M-80)	--	0		Controlled Discharge						
Cleghorn (M-79)	--	0		Controlled Discharge						
Quimby (M-78)	--	0		Controlled Discharge						
Quimby to Spencer										
Cherokee (M-77)	5.57	.756	10	63	5	32	10	63	4	25
Meriden (M-76)	--	0		Controlled Discharge						
Larrabee (M-75)	--	0		Controlled Discharge						
Calumet (M-74)			N E M T P							
Paullina (M-73)	--	0		Controlled Discharge						
Pringhar (M-71)	--	0		Controlled Discharge						
Sutherland (M-70)	--	0		Controlled Discharge						
Peterson (M-69)	--	0		Controlled Discharge						
Linn Grove (M-68)	--	0		Controlled Discharge						
Linn Grove Rendering (I-17)	4.60	.014	30	3	20	2	30	3	20	2
Sioux Rapids (M-67)	4.75	.054	30	13	10	5	30	13	15	7
Webb (M-63)			N E M T P							
Ruthven (M-62)	--	0		Controlled Discharge						
Dickens (M-61)			N E M T P							
Terril (M-60)	--	0		Controlled Discharge						
Spencer (M-57)	2.40	2.56	4	96	2	43	4	96	2	43

TABLE VI-1

WASTE LOAD ALLOCATIONS

WESTERN IOWA BASIN

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Summer BOD_5 (mg/l)	Summer BOD_5 (lbs/day)	Summer NH_3 (mg/l)	Summer NH_3 (lbs/day)	Winter BOD_5 (mg/l)	Winter BOD_5 (lbs/day)	Winter NH_3 (mg/l)	Winter NH_3 (lbs/day)
Spencer to Source										
IGLSD (S-18)	0	2.146	4	80	2	36	6	120	2	36
Fostoria (M-59)	--	0		Controlled Discharge						
Lake Park (M-44)	--	0		Controlled Discharge						
Ocheyedan River										
Entire Length										
Royal (M-56)	--	0		Controlled Discharge						
Everly (M-55)	--	0		Controlled Discharge						
Hartley (M-54)	.40	.181	7	10	10	15	30	45	5	7.5
Harris (M-53)	--	0		Controlled Discharge						
Ocheyeden (M-52)	--	0		Controlled Discharge						
West Br. Little Sioux										
Entire Length										
Bronson (M-93)			NEMTP							
Lawton (M-92)	--	0		Controlled Discharge						
Hornick (M-91)	--	0		Controlled Discharge						
Moville (M-90)	--	0		Controlled Discharge						
Kingsley (M-89)	--	0		Controlled Discharge						
Marcus (M-88)	.549	.139	23	27	8	9	23	27	6	7
Maple River										
Entire Length										
Robert Bagenstos Slaughter House (I-26)	--	--	No Discharge Data Available							
Pork Processors (I-22)	--	0		Controlled Discharge						
Castana (M-105)			NEMTP							
Mapleton (M-104)	3.61	.116	30	29	10	10	30	29	15	15
Danbury (M-103)	--	0		Controlled Discharge						
Battle Creek (M-102)	--	0		Controlled Discharge						
Holstein (M-101)	--	0		Controlled Discharge						
Ida Grove (M-100)	1.16	.22	30	55	10	18	20	37	7	13
Arthur (M-99)	--	0		Controlled Discharge						
Odebolt (M-98)	.24	.149	30	37	5	6	3	4	1	1
Galva (M-97)	.23	.02	30	5	10	2	8	1	7	1
Schaller (M-96)	--	0		Controlled Discharge						
Alta (M-95)	0	.229	3	6	1	2	1	2	2	4
Aurelia (M-94)	0	.128	5	5	2.5	3	8	9	1.5	2

TABLE VI-1

WASTE LOAD ALLOCATIONS

WESTERN IOWA BASIN

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Summer BOD$_5$ (mg/l)	Summer BOD$_5$ (lbs/day)	Summer NH$_3$ (mg/l)	Summer NH$_3$ (lbs/day)	Winter BOD$_5$ (mg/l)	Winter BOD$_5$ (lbs/day)	Winter NH$_3$ (mg/l)	Winter NH$_3$ (lbs/day)
Boyer River										
Missouri River to Woodbine										
Modale (M-132)			NEMTP							
Magnolia (M-131)			NEMTP							
Missouri Valley (M-130)	--	0	Controlled Discharge							
Logan (M-129)		.224	30	56	10	19	30	56	15	28
Woodbine (M-128)	--	--	Controlled Discharge							
Woodbine to Source										
Dunlap (M-127)	--	0	Controlled Discharge							
Dow City (M-126)	--	0	Controlled Discharge							
Arion (M-125)	--	0	Controlled Discharge							
Denison (M-123)		3.30	4	110	2	55	4	110	2	55
Vail (M-122)	--	0	Controlled Discharge							
Westside (M-121)	--	0	Controlled Discharge							
Arcadia (M-120)			NEMTP							
Deloit (M-119)	--	0	Controlled Discharge							
Schleswig (M-118)	--	0	Controlled Discharge							
Kiron (M-117)		.028	30	7	10	2	30	7	15	4
Wall Lake (M-116)	--	0	Controlled Discharge							
Early (M-115)	--	0	Controlled Discharge							
Mosquito River										
Source to Above Council Bluffs										
Underwood (M-139)	--	0	Controlled Discharge							
Neola (M-138)	1.65	.166	30	42	15	21	30	42	15	21
Persia (M-137)	--	0	Controlled Discharge							
Portsmouth (M-136)	--	0	Controlled Discharge							
Panama (M-135)	--	0	Controlled Discharge							
Earling (M-134)	1.65	.066	30	17	10	6	30	17	15	8

TABLE VI-1

WASTE LOAD ALLOCATIONS

WESTERN IOWA BASIN

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Summer BOD_5 (mg/l)	Summer BOD_5 (lbs/day)	Summer NH_3 (mg/l)	Summer NH_3 (lbs/day)	Winter BOD_5 (mg/l)	Winter BOD_5 (lbs/day)	Winter NH_3 (mg/l)	Winter NH_3 (lbs/day)
Keg Creek										
Missouri River to Glenwood										
Pacific Junction (M-145)			N E M T P							
Glenwood (M-144)	1.94	.82	20	137	5	34	20	137	5	34

minimum, secondary treatment. No municipal discharge is, therefore, allowed an effluent limitation less stringent than secondary treatment. Secondary treatment has been defined by EPA and DEQ as having the following concentrations in the effluent: 30 mg/l BOD_5, 30 mg/l suspended solids; or not less than 85 percent removal of BOD_5 and suspended solids; and 200 most probable number/100 ml fecal coliforms.

BPT - The Act requires that all point sources other than publically owned treatment works shall, by July 1, 1977, achieve as a minimum, "best practicable control technology currently available" (BPT). No industrial discharge is, therefore, allowed an effluent limitation less stringent than secondary treatment. BPT for various industrial processes is defined by the EPA in their industrial development documents.

Applicable Standards - The ultimate reason for requiring any effluent limitation is the protection of water quality. The Iowa Water Quality Standards are designed to insure a reasonable degree of protection. All discharges are, therefore, required to meet effluent limitations stringent enough to assure that water quality standards will be met. If secondary treatment for BPT is not sufficient to meet the applicable water quality standards, a higher level of treatment is required.

Antidegradation - A policy on antidegradation has been adopted by the DEQ to assure that in those places where water quality significantly exceeds that of the standards, this condition shall be maintained. New dischargers locating in areas of high quality water may, therefore, be required to meet effluent limitations more stringent than secondary treatment or BPT, even though a lesser degree of treatment might be sufficient to meet water quality standards.

Modeling was conducted for the Rock River, Little Rock River, Otter Creek, the Little Sioux River, the Maple River, the Ocheyedan River, Odebolt Creek, and the Little Maple River by Stanley Consultants and on the Floyd River and the Boyer River by the DEQ.

Evaluation Assumptions

In order to define waste load allocations for dischargers within the study area, specific assumptions are required. Identification of the major items required to evaluate and determine waste load allocations are identified in the following list:

1. The major objective of the present investigation is to satisfy Iowa Water Quality Standards with future effluent discharges. Determination of allowable effluent concentrations was based upon varying the effluent quality from point source discharges until the model maintained dissolved oxygen concentrations above 5.0 mg/l and ammonia nitrogen concentrations below 2.0 mg/l in all water quality classified sections of the stream. Because NPDES permits are

requiring discharges with stabilization ponds to utilize controlled discharge of the effluent, no discharge from stabilization pond treatment facilities to the stream was assumed for the low flow conditions.

2. Definition of 7-day, 1-in-10 year low flow was required for each stream modeled. Where the low flow is exceeded by wastewater discharges, two possible explanations are:

   a. During extreme dry periods (7-day, 1-in-10 year low flow), evaporation and exfiltration exceed any infiltration taking place with the result being a net loss of natural flow from the river. Some flow is maintained as a result of wastewater discharges from communities and industries.

   b. The 7-day, 1-in-10 year low flow is a statistical number based upon the flow in the river for the number of years of record at the various gaging stations. Most present point source discharge quantities are higher than they were in past years, and this accounts (at least in part) for the higher flows based upon present discharges.

   Sufficient information is not available in the Rock River Basin or the upper portion of the Little Sioux River Basin to establish the exact water balance during low flow conditions and, in reality, some combination of these two factors probably causes the point source discharges to exceed the 7-day, 1-in-10 year low flow.

In order to obtain river flows for use in the stream model which approximate the 1990, 7-day, 1-in-10 year low flow, the following assumptions were made regarding the groundwater inflow and groundwater recharge:

a. For the Rock River, the present flow from point source discharges and tributaries upstream of USGS Gaging Station 6-4835 near Rock Valley is greater than the calculated 7-day, 1-in-10 year low flow. Uniform exfiltration from the Rock River is assumed to take place from the furthest upstream discharger to the gage to meet the 7-day, 1-in-10 year low flow. Between the present time and 1990, the flow from upstream point source dischargers is expected to increase slightly. For purposes of the computer model, the percent of groundwater recharge due to the incremental increase in flow from point dischargers was assumed to equal the percent of groundwater recharge under existing conditions. This results in an increase in the 7-day, 1-in-10 year low flow at the gage near Rock Valley from 1.0 to 1.06 cfs. The rate of groundwater recharge from the furthest upstream discharger to gage 6-4835 has been assumed to apply to the reach of stream from the gage to the confluence with the Big Sioux River.

b. For sections of the Little Sioux River above Cherokee, the 7-day, 1-in-10 year low flow does not equal the sum of present upstream wastewater discharges, or the 7-day, 1-in-10 year low flow of a downstream gage will be less than the upstream gage. Because there are few continuous-record gages on the upper portion of the Little Sioux River, there is a higher degree of uncertainty associated with the 7-day, 1-in-10 year low flows at the gages. The same procedure is utilized as in the Rock River Basin above for those sections of the Little Sioux River where there is a net outflow of water to groundwater. For sections of the stream where flow exceeds upstream discharges or the upstream gage 7-day, 1-in-10 year low flow, the groundwater contribution was determined by the method given in "c" below.

c. For portions of the Little Sioux River the excess stream flow above the sum of present wastewater discharges was assumed to be the result of groundwater inflow to the stream. This amount of groundwater inflow was assumed to remain constant over the planning period. Since most wastewater discharges will increase during this time, the 7-day, 1-in-10 year low flow in 1990 will be greater by the amount of the increase. Groundwater contribution to the stream flow was distributed throughout the drainage area in relationship to the area contributing to the stream along the length of the channel. Values of 4.0 mg/l BOD_5, 0.0 mg/l ammonia nitrogen, and 2.0 mg/l dissolved oxygen concentration were assumed as water quality of the groundwater contribution.

3. Ultimate carbonaceous BOD was assumed to 1.5 times the BOD_5.

4. Since no data are available describing effluent dissolved oxygen concentrations or temperatures, the following values were assumed for each class of wastewater discharge.

	Summer Condition			Winter Condition		
Discharger	Dissolved Oxygen (mg/l)	Temperature (^oC)	Temperature (^oF)	Dissolved Oxygen (mg/l)	Temperature (^oC)	Temperature (^oF)
Trickling Filter	3.0	20	68	4.0	9	48
Activated Sludge	3.0	20	68	4.0	9	48
Industrial	Each Discharger Handled Individually					

5. In order to assess the reaeration rate constants under wintertime conditions, the amount of ice cover on the stream was estimated. Then the winter reaeration rate constant for each reach of the stream was determined by multiplying the predicted constant by the percentage of open water in the reach. Ice cover estimates were based upon general climatological conditions for the basin and upon personal observations

of persons familiar with the area. Complete ice cover was assumed to be noncoincidental with the 7-day, 1-in-10 year low flow.

6. Deoxygenation rate coefficients were assumed to be 0.2/day for carbonaceous demand and 0.3/day for nitrogenous demand.

7. Best practicable waste treatment technology (BPT) effluent limitations described by the EPA guidelines were utilized for industrial discharges when available. Otherwise, the actual allowable waste load which could be discharged into the stream was determined and identified as the waste load allocation for that discharger.

8. Tributaries (without wastewater sources) discharging to the streams being modeled were assumed to have saturated dissolved oxygen concentrations, an ultimate BOD of 6.0, and ammonia nitrogen concentrations of 0.0 mg/l in the summer and 0.5 mg/l in the winter.

9. The Little Sioux River, Rock River, Little Rock River, and some small tributaries originate in Minnesota. A lack of water quality data does not permit identification of stream water quality as it enters the study area. Water quality of the streams entering the study area is assumed to be the same as that of tributaries without wastewater sources, as given below.

10. The impoundment above Linn Grove is shallow, and the model has been carried through the impoundment and over the dam. Through the impoundment reach of the Little Sioux River, the actual water surface slope is estimated. Stream width is also increased through the impoundment area. The dam is assumed to take a reach of stream equal to 0.001 miles with a change in head equal to the height of the dam. This results in a high reaeration rate constant for the stream flow over the dam.

ALLOCATION RESULTS

For the initial run, all discharges were assumed to meet either secondary treatment (municipalities) or best practicable treatment (BPT) (industries). Where the model indicated violation of the Iowa Water Quality Standards, more stringent effluent requirements were imposed until standards were met. Both winter and summer conditions were evaluated in determining the waste load allocations for the study areas.

The upper limit for wastewater discharges is secondary treatment from municipal discharges and BPT for industrial discharges. The DEQ has set the allowable ammonia nitrogen level for secondary treatment as 10 mg/l in summer and 15 mg/l in winter.

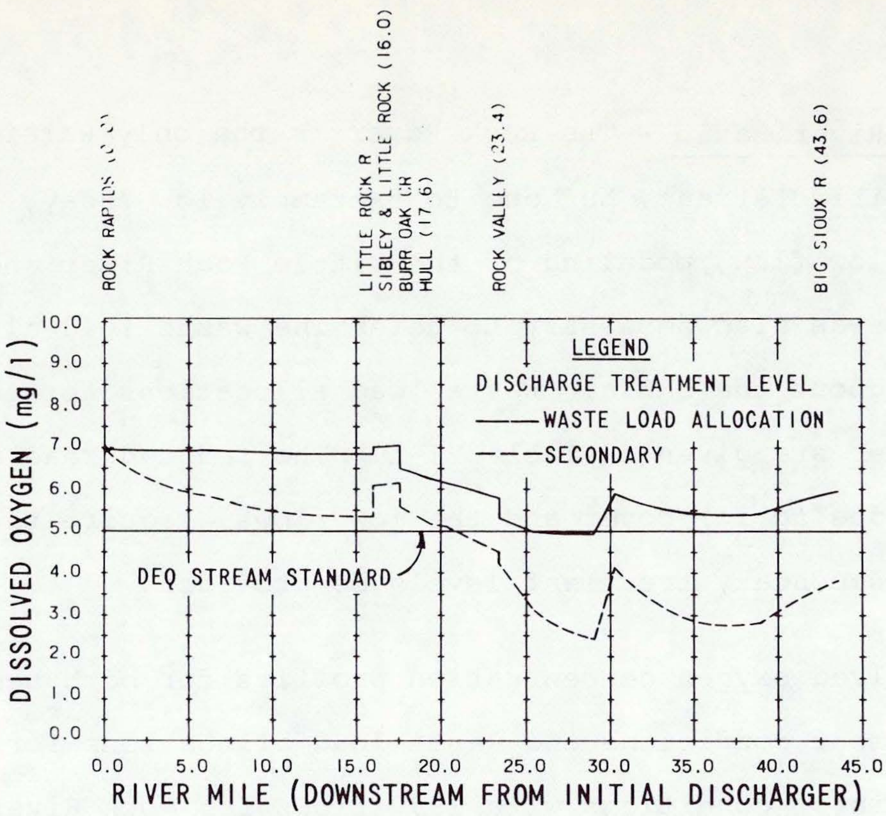
Rock River Basin - The Rock River is the only water quality classified stream, but due to extremely low 7-day, 1-in-10 year low flow, modeling of the Little Rock River and Otter Creek was also necessary to determine waste load allocations throughout the basin. Waste load allocations for each discharger are given in Table VI-1. The reduced reaeration rate due to ice cover and the low flows, require that better than secondary treatment levels be provided.

Dissolved oxygen concentration profiles for both secondary treatment conditions and waste load allocations for summer and winter conditions with 1990 flows for Rock River, Little Rock River, and Otter Creek are shown on Figures VI-1 through VI-6.

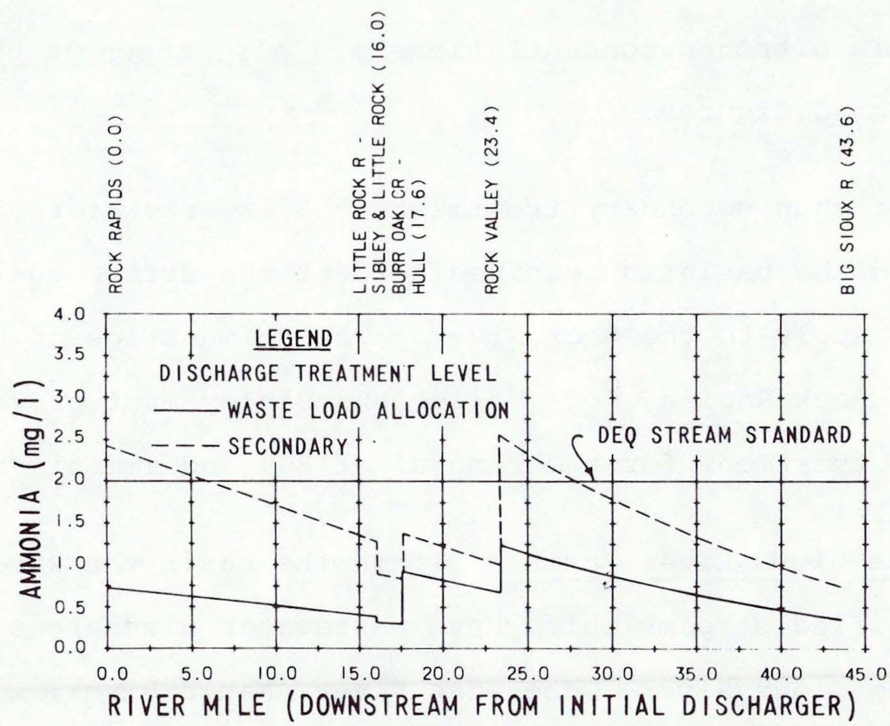
Ammonia nitrogen concentrations are also shown on the above mentioned figures.

Better than secondary treatment of all wastewater discharges within the basin is required to meet the stream quality criteria which apply to the Rock River. The communities of Hull, Little Rock, Rock Rapids, Rock Valley and Sibley must provide advanced waste treatment for the removal of BOD and ammonia nitrogen.

Little Sioux River Basin - Within the basin the water quality classified streams which have wastewater discharges are the Little Sioux River, Ocheyedan River, Maple River, Little Maple River and Odebolt Creek. Waste load allocations were necessary for some dischargers to unclassified streams which have

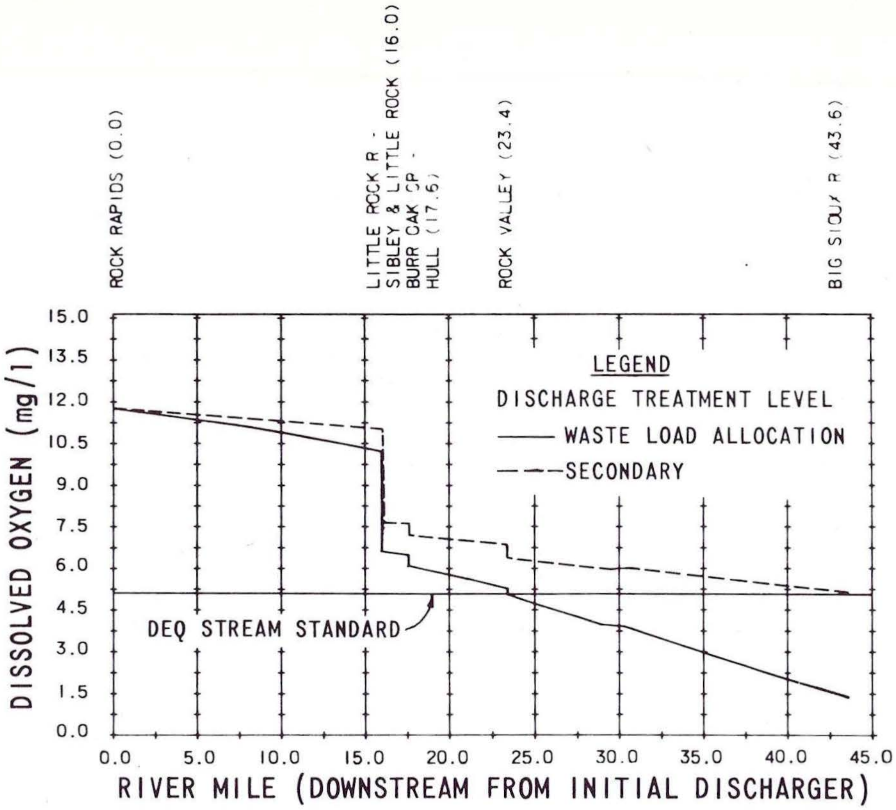


DISSOLVED OXYGEN CONCENTRATIONS

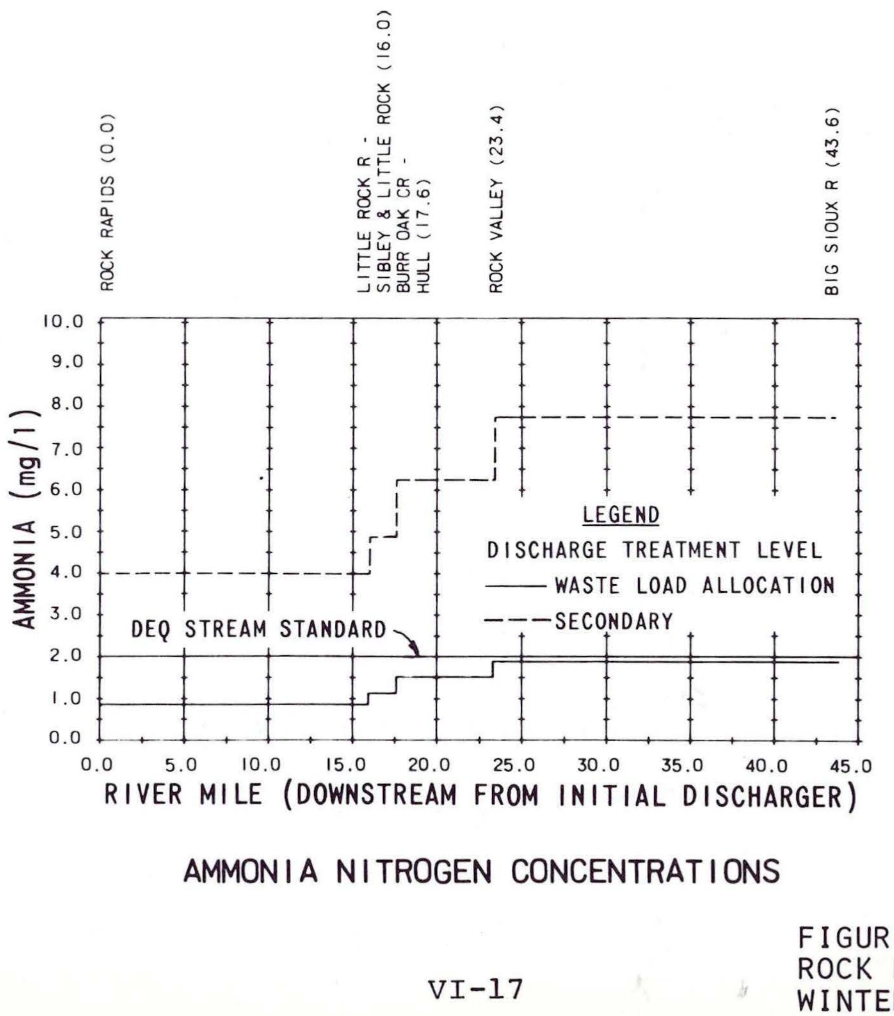


AMMONIA NITROGEN CONCENTRATIONS

FIGURE VI-1
ROCK RIVER
SUMMER CONDITIONS

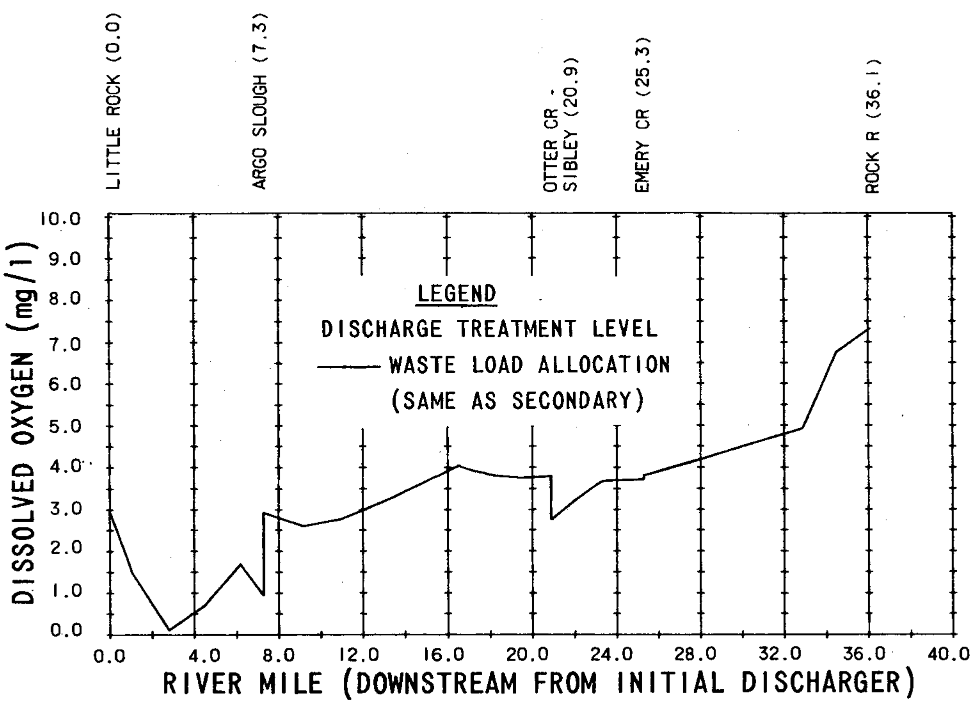


DISSOLVED OXYGEN CONCENTRATIONS

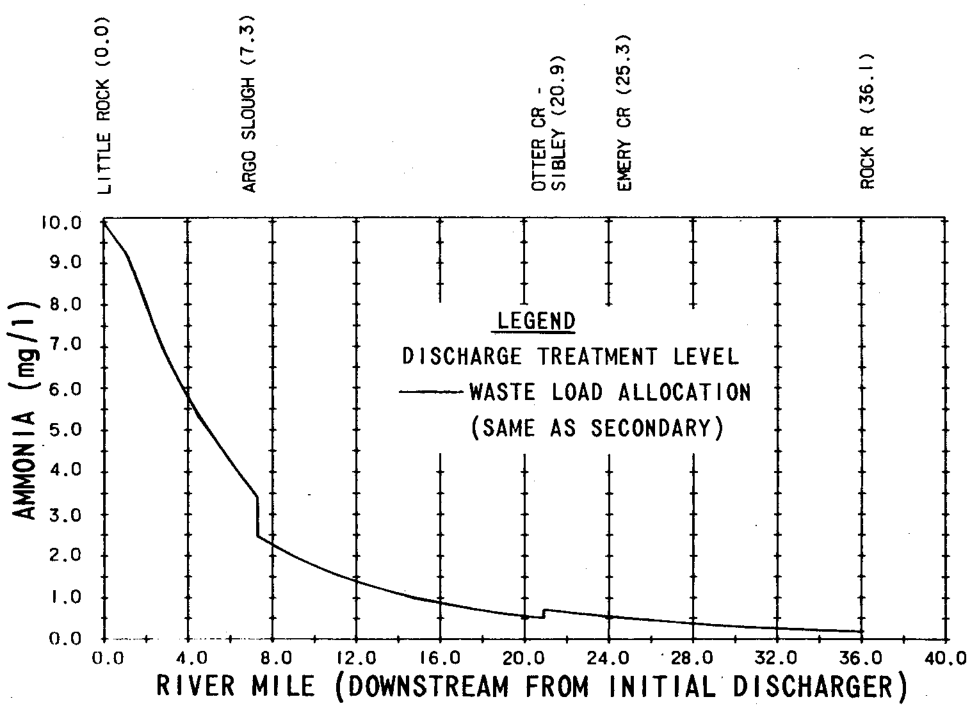


AMMONIA NITROGEN CONCENTRATIONS

FIGURE VI-2
ROCK RIVER
WINTER CONDITIONS

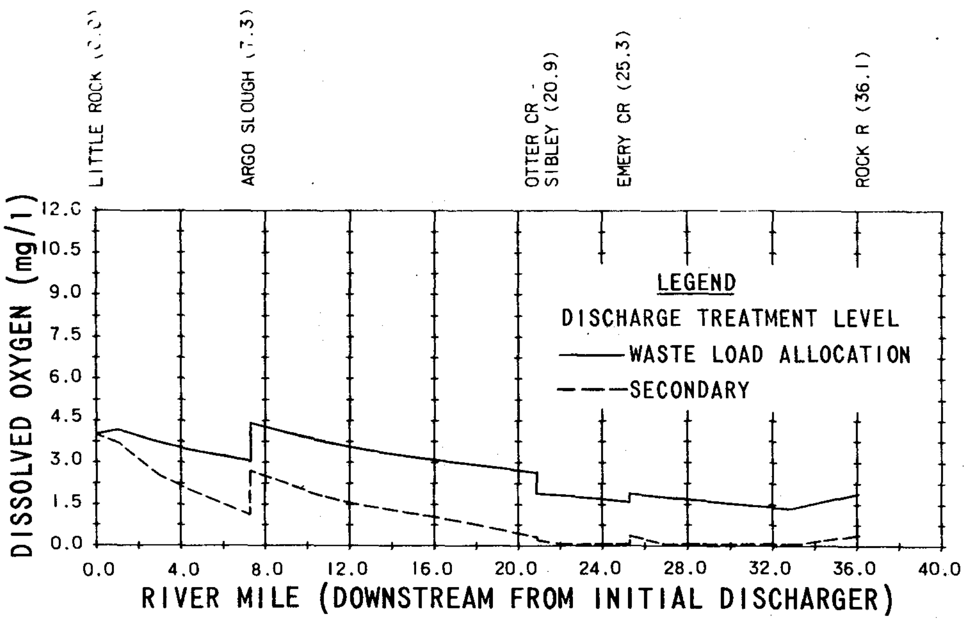


DISSOLVED OXYGEN CONCENTRATIONS

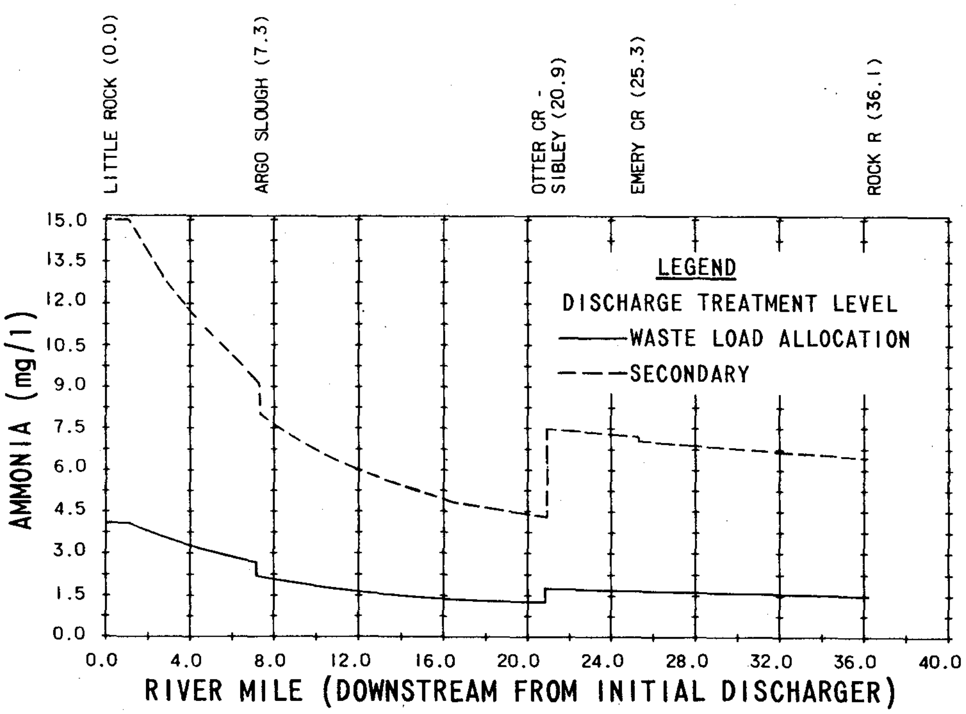


AMMONIA NITROGEN CONCENTRATIONS

FIGURE VI-3
LITTLE ROCK RIVER
SUMMER CONDITIONS

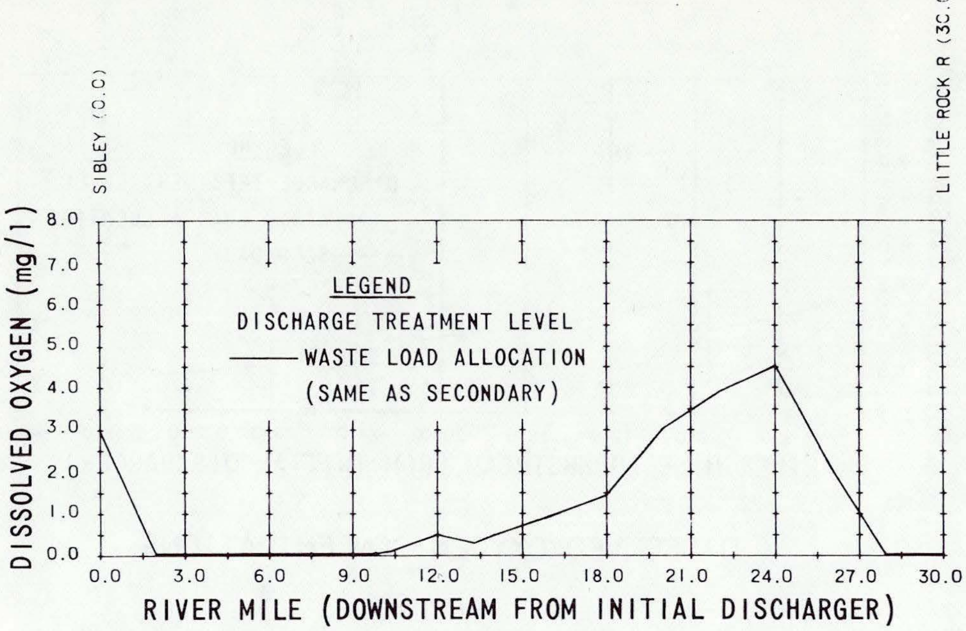


DISSOLVED OXYGEN CONCENTRATIONS

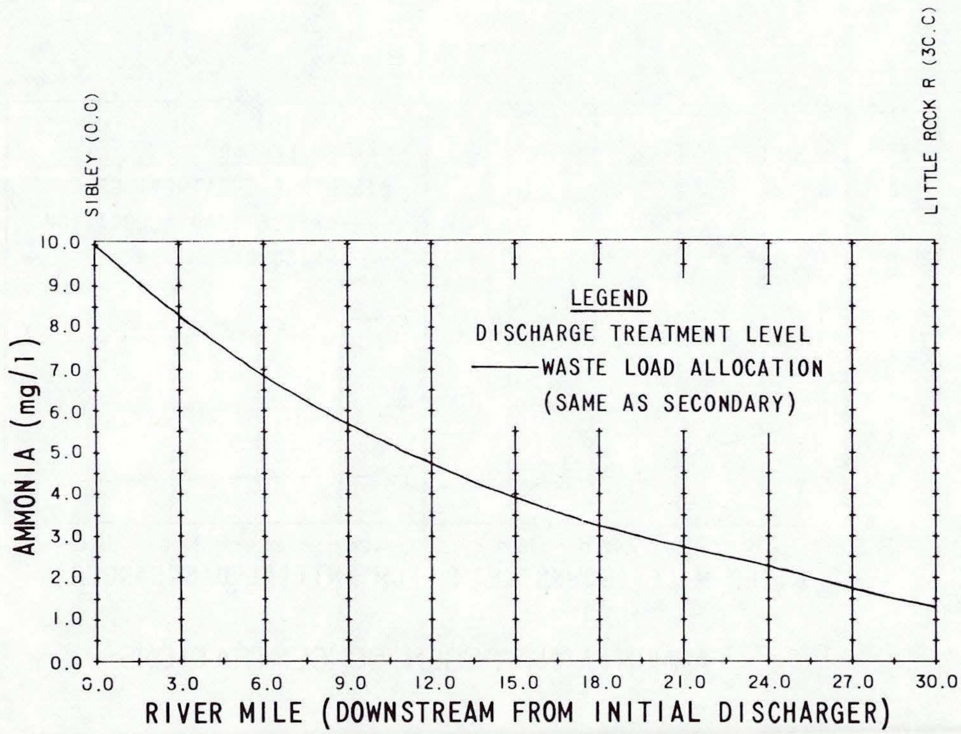


AMMONIA NITROGEN CONCENTRATIONS

FIGURE VI-4
LITTLE ROCK RIVER
WINTER CONDITIONS

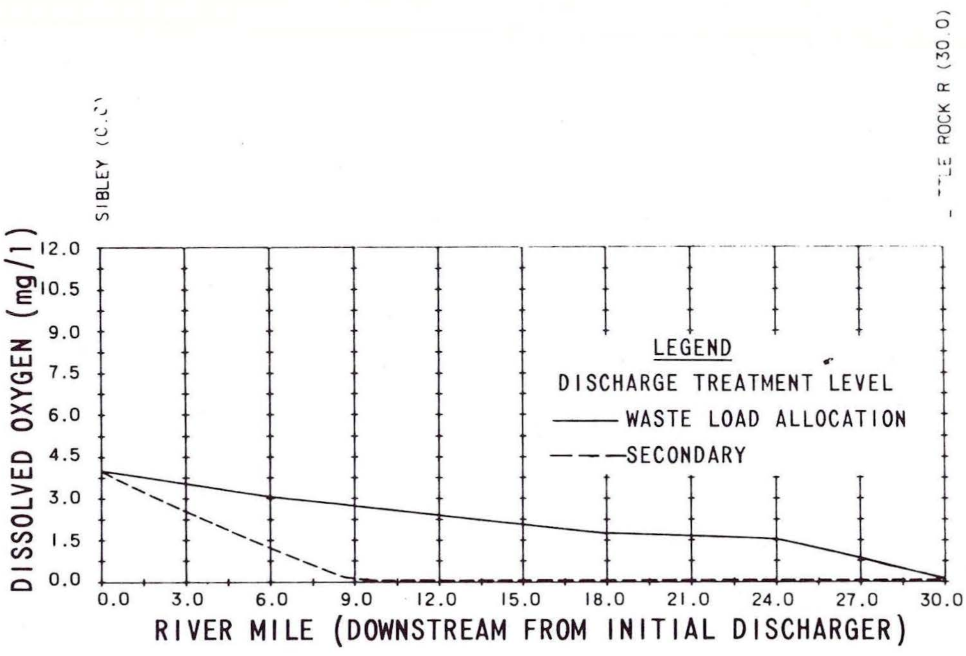


DISSOLVED OXYGEN CONCENTRATIONS



AMMONIA NITROGEN CONCENTRATIONS

FIGURE VI-5
OTTER CREEK
SUMMER CONDITIONS



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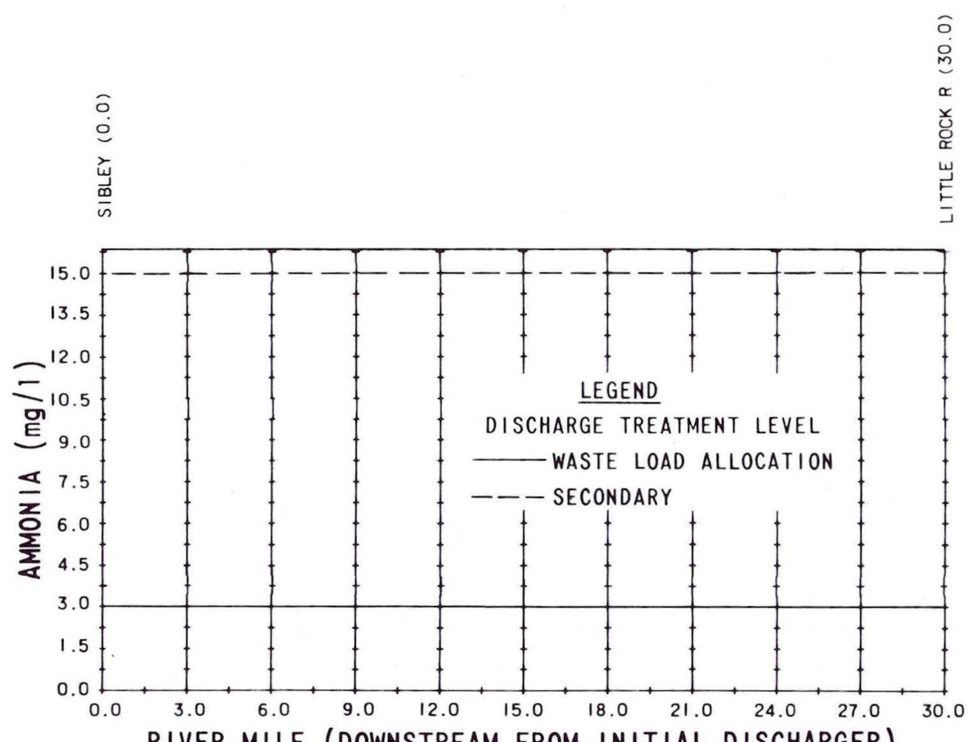
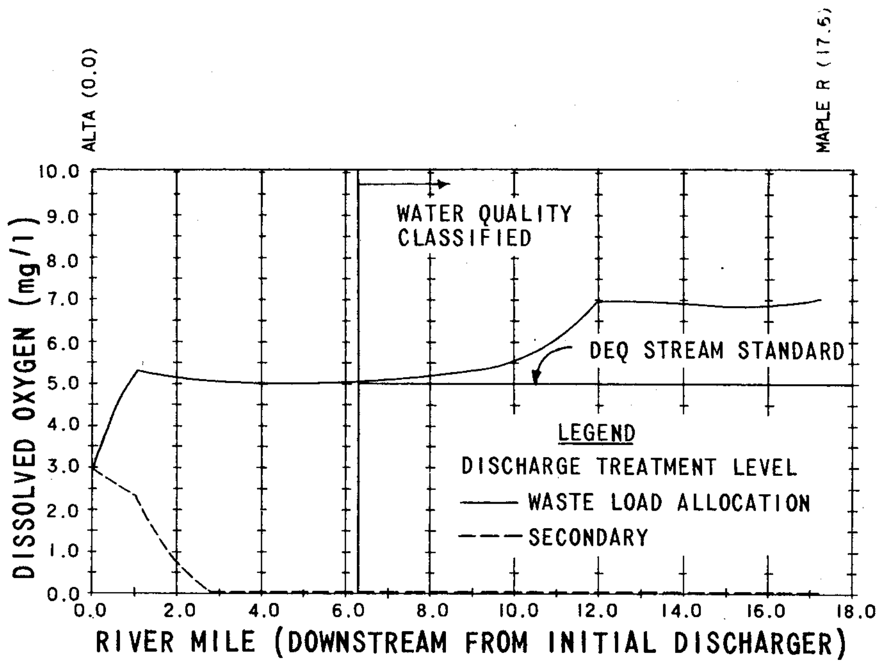


AMMONIA NITROGEN CONCENTRATIONS

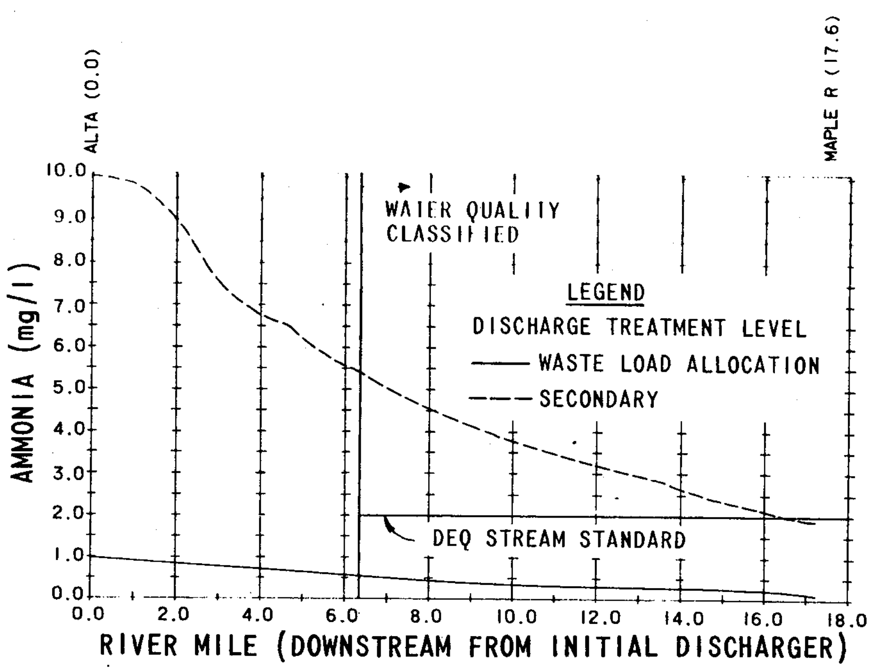
FIGURE VI-6
OTTER CREEK
WINTER CONDITIONS

an impact upon the water quality of classified streams. Waste load allocations for each discharger are given in Table VI-1.

Dissolved oxygen and ammonia nitrogen concentration profiles for both secondary treatment conditions and the waste load allocations for summer and winter conditions for 1990 dischargers are shown on Figure VI-7 and VI-8 for the Little Maple River respectively. Dissolved oxygen and ammonia nitrogen concentration profiles for both secondary treatment conditions and the waste load allocations for summer and winter conditions for 1990 dischargers are shown on Figure VI-9 and VI-10 for Odebolt Creek respectively. Dissolved oxygen and ammonia nitrogen concentration profiles for both secondary treatment conditions and the waste load allocations for summer and winter conditions for 1990 dischargers are shown on Figure VI-11 and VI-12 for the Ocheyedan River respectively. Dissolved oxygen and ammonia nitrogen concentration profiles for both secondary treatment conditions and the waste load allocations for summer and winter conditions for 1990 dischargers are shown on Figure VI-13 and VI-14 for the Maple River respectively. Dissolved oxygen and ammonia nitrogen concentration profiles for both secondary treatment conditions and the waste load allocations for summer and winter conditions for 1990 dischargers are shown on Figure VI-15, VI-16, VI-17 and VI-18 for the Little Sioux River respectively. The upper reaches of the Little Sioux River and the Maple River require better

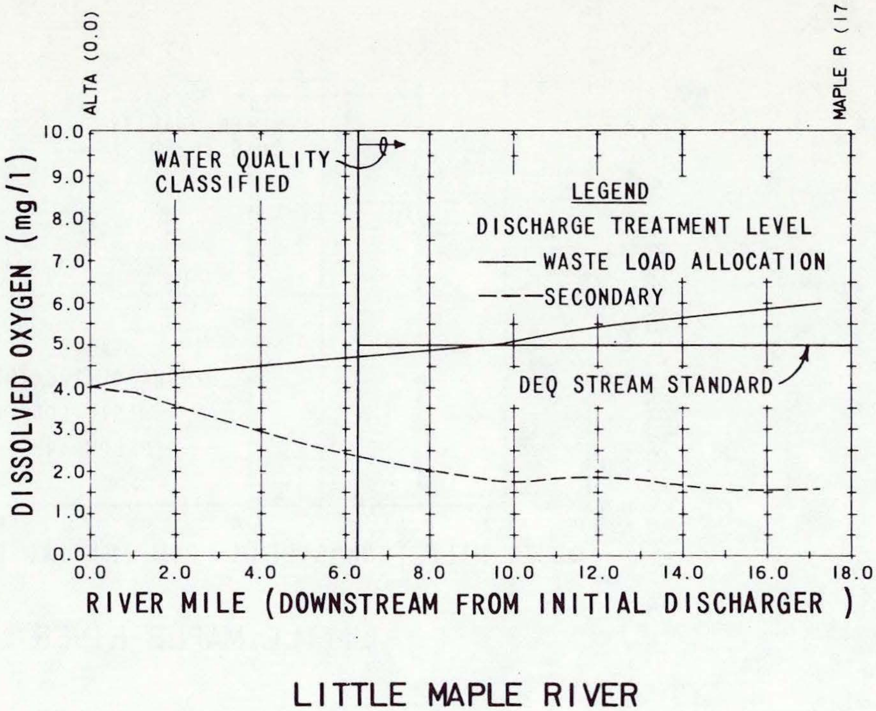


LITTLE MAPLE RIVER



LITTLE MAPLE RIVER

FIGURE VI-7
LITTLE MAPLE RIVER
SUMMER CONDITIONS



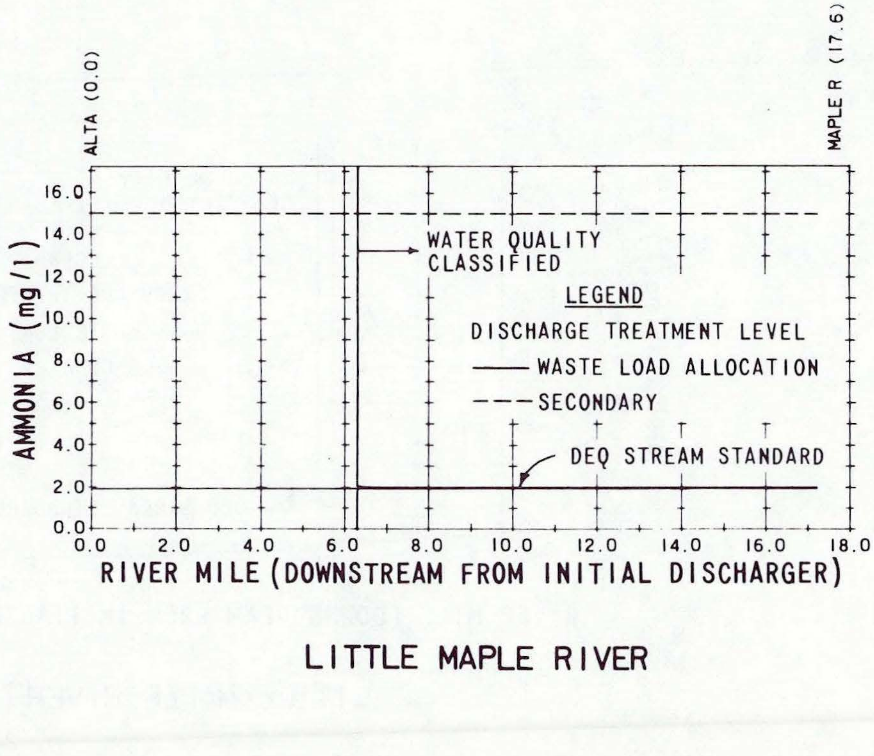
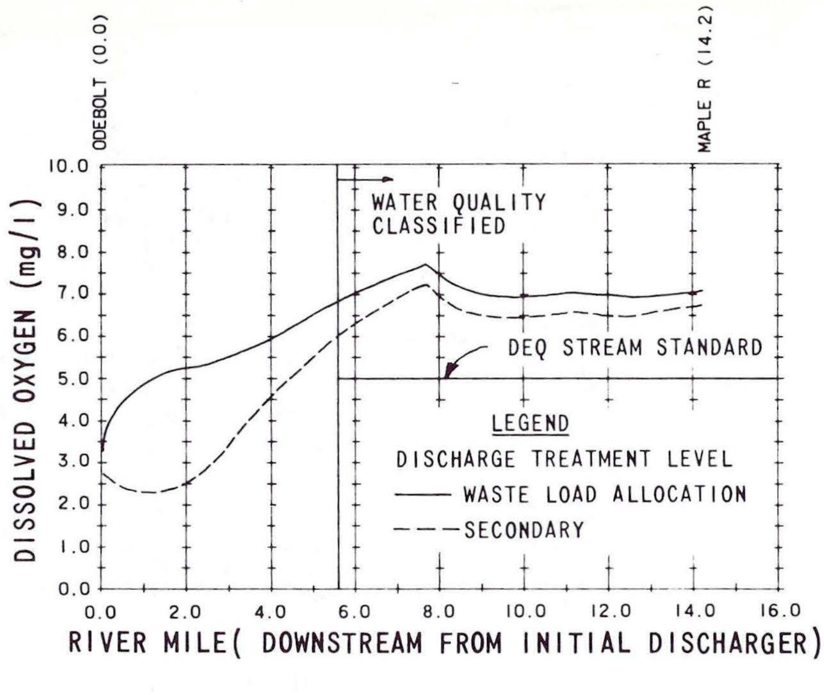
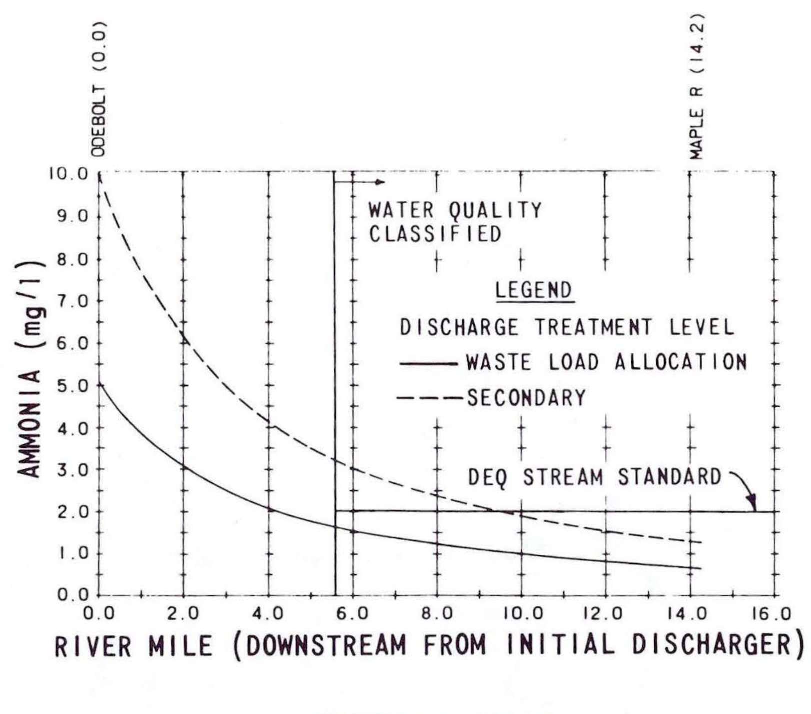


FIGURE VI-8
LITTLE MAPLE RIVER
WINTER CONDITIONS

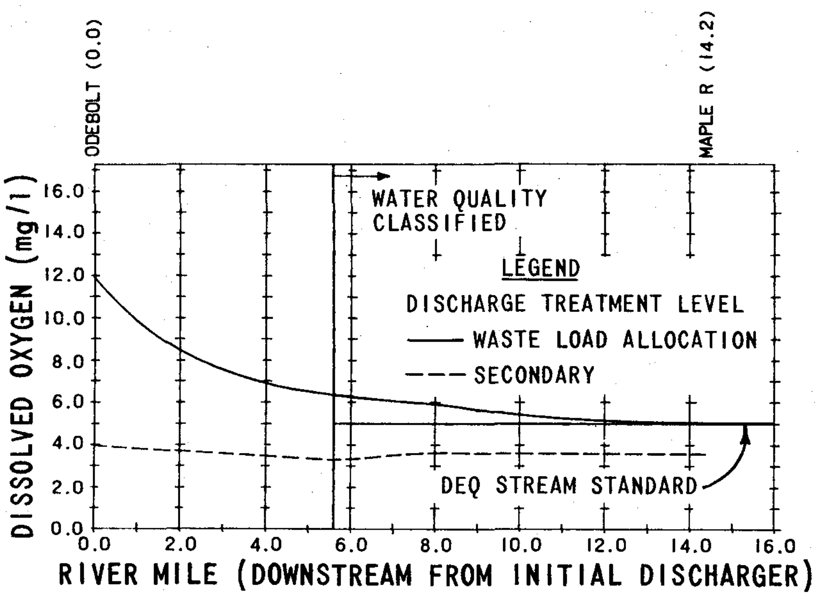


ODEBOLT CREEK

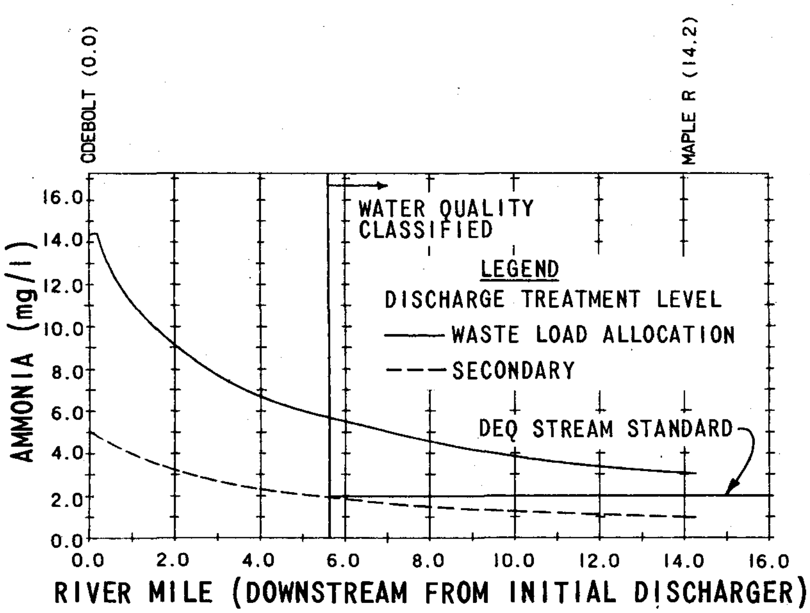


ODEBOLT CREEK

FIGURE VI-9
ODEBOLT CREEK
SUMMER CONDITIONS

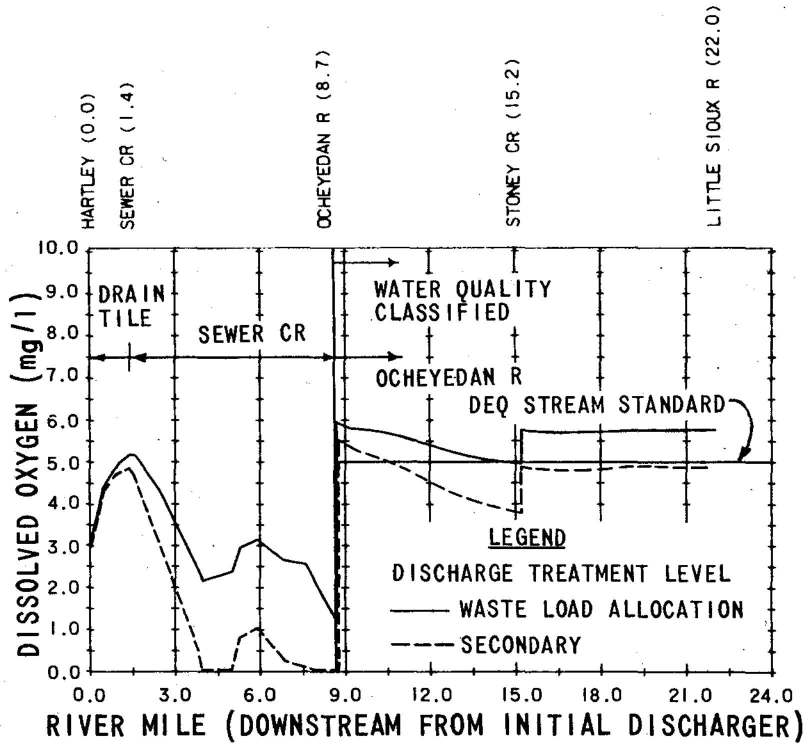


ODEBOLT CREEK

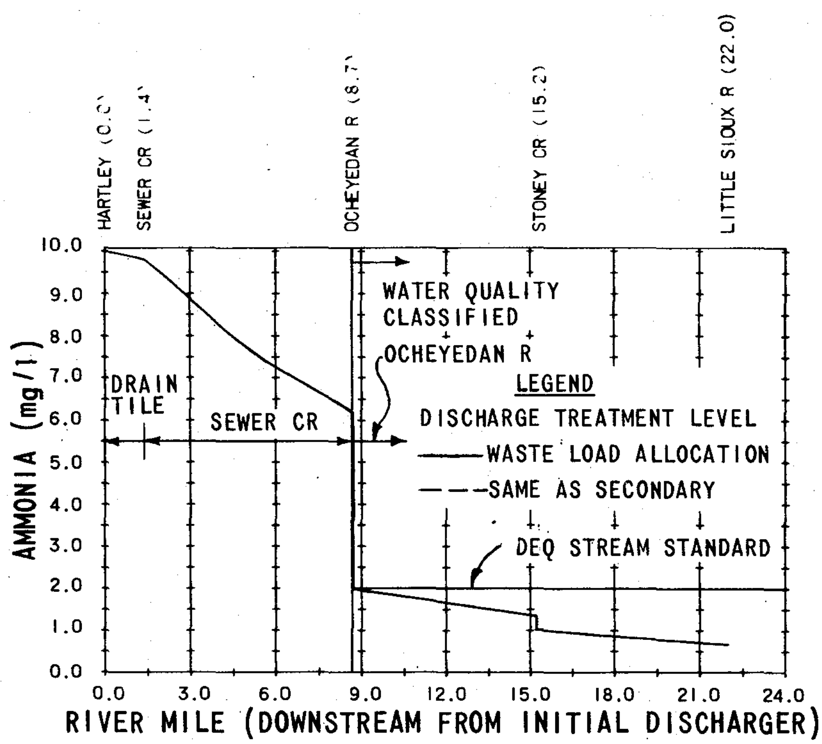


ODEBOLT CREEK

FIBURE VI-10
ODEBOLT CREEK
WINTER CONDITIONS

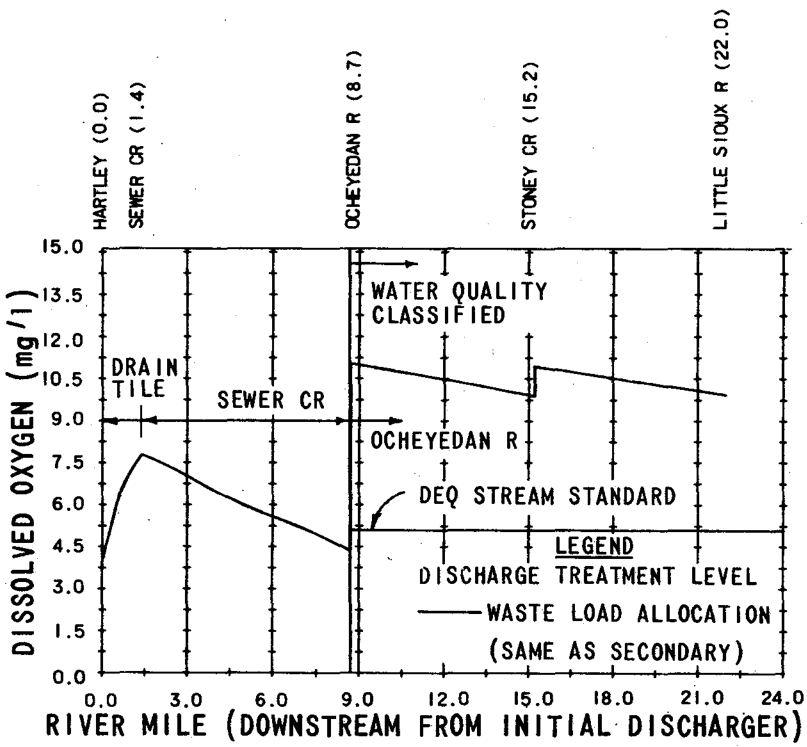


OCHEYEDAN RIVER

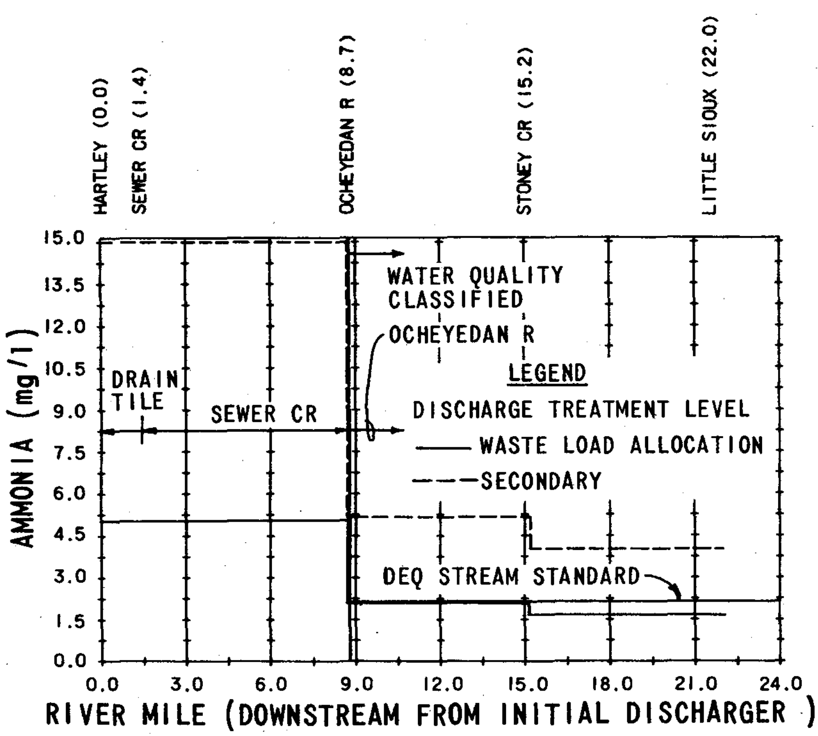


OCHEYEDAN RIVER

FIGURE VI-11
OCHEYEDAN RIVER
SUMMER CONDITIONS

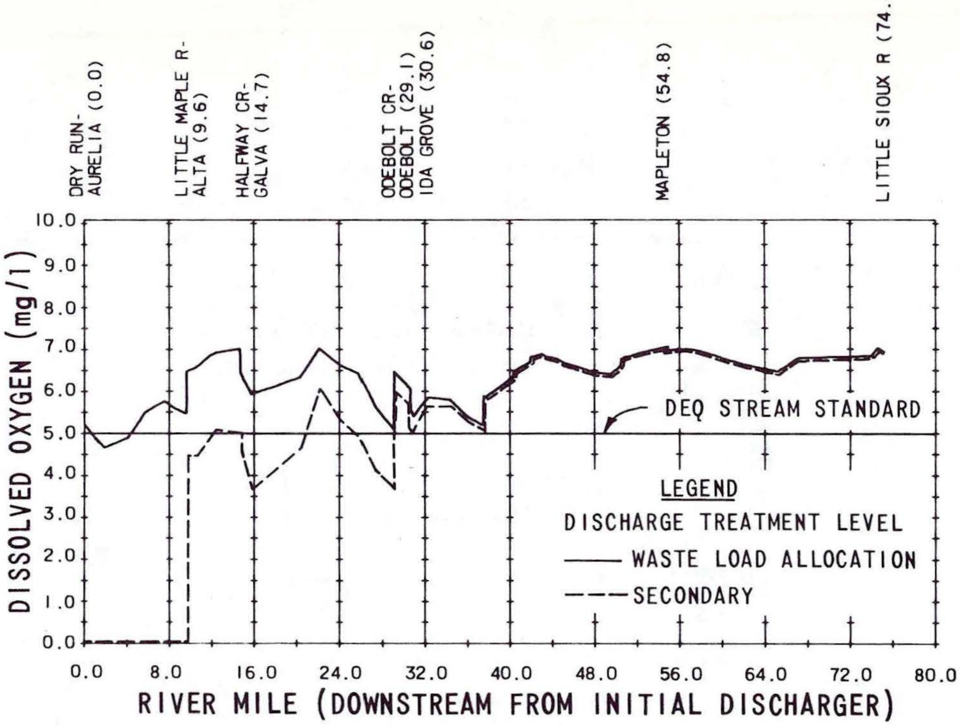


OCHEYEDAN RIVER

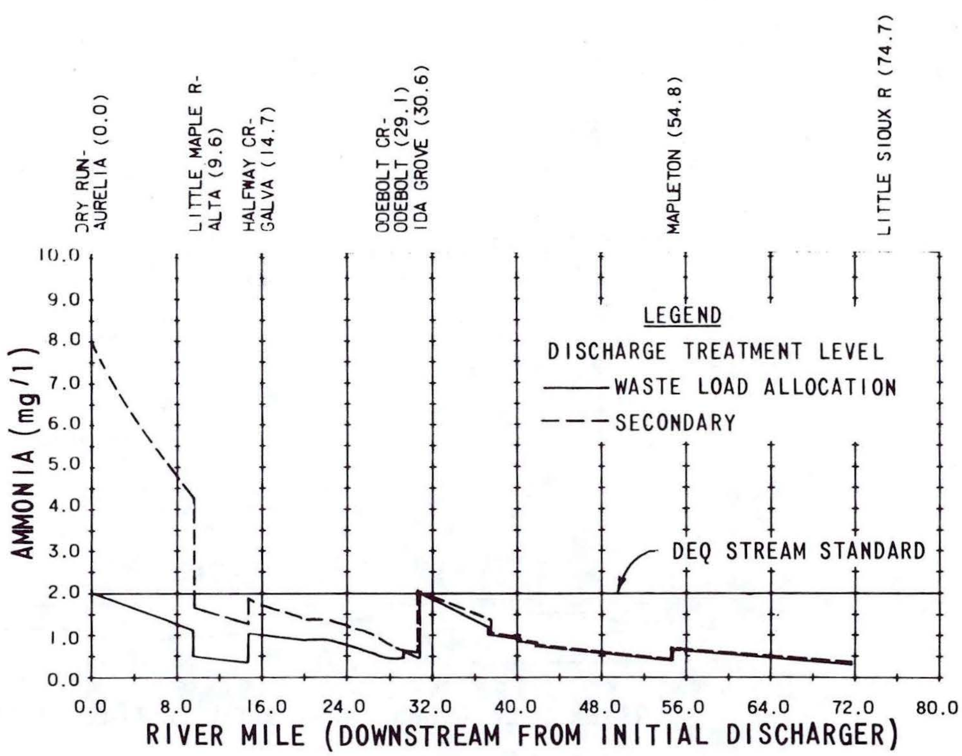


OCHEYEDAN RIVER

FIGURE VI-12
OCHEYEDAN RIVER
WINTER CONDITIONS

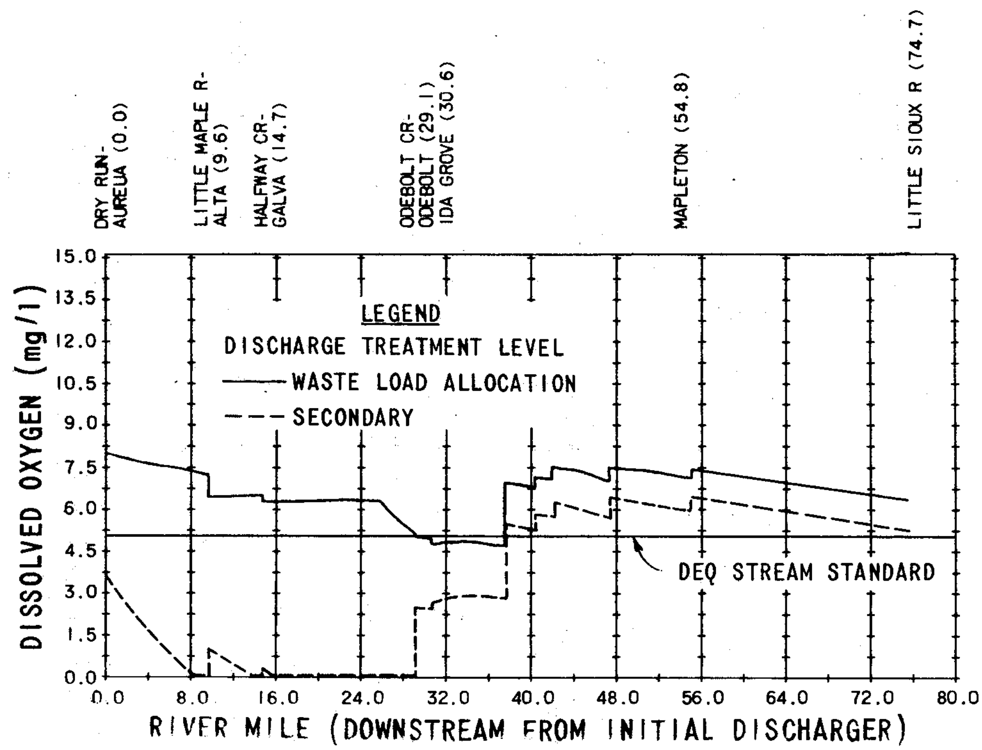


MAPLE RIVER

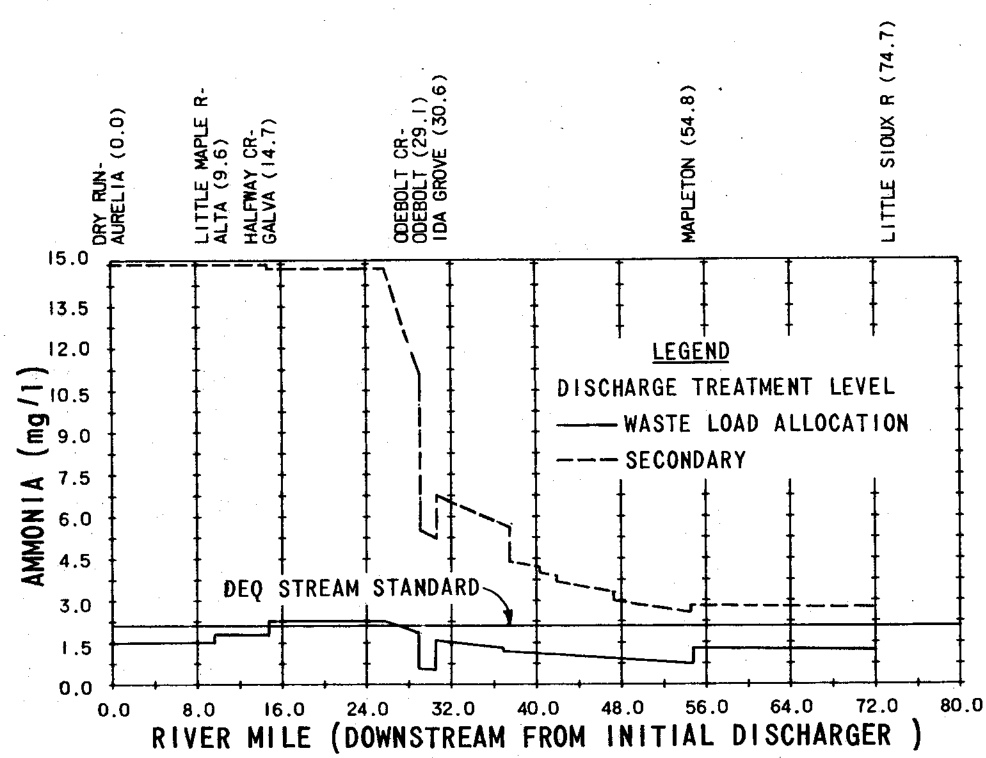


MAPLE RIVER

FIGURE VI-13
MAPLE RIVER
SUMMER CONDITIONS

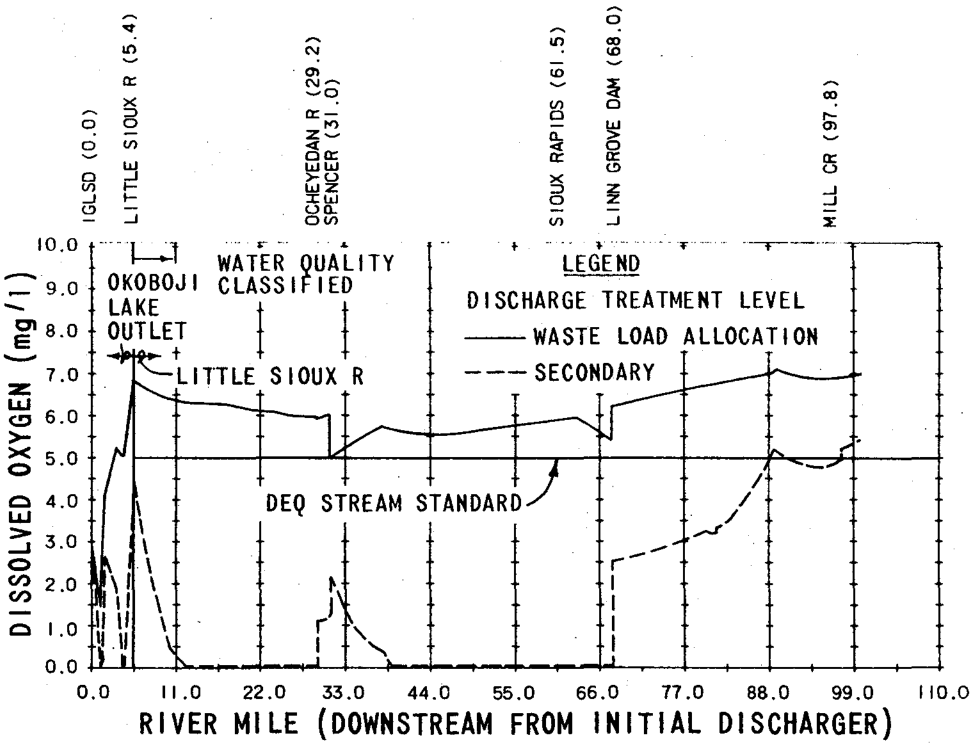


MAPLE RIVER

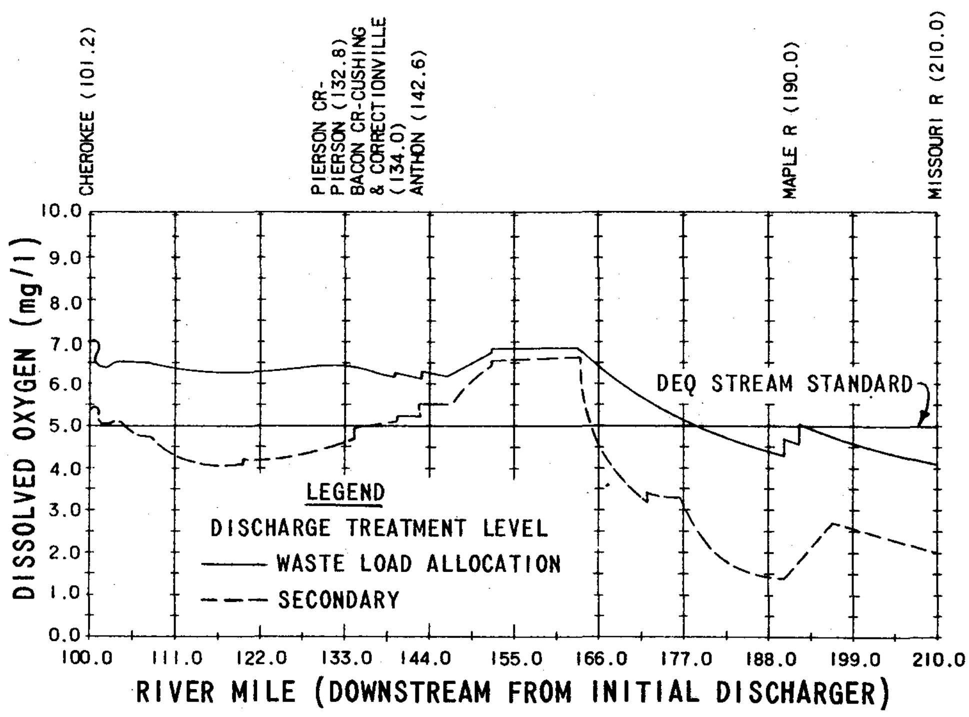


MAPLE RIVER

FIGURE VI-14
MAPLE RIVER
WINTER CONDITIONS

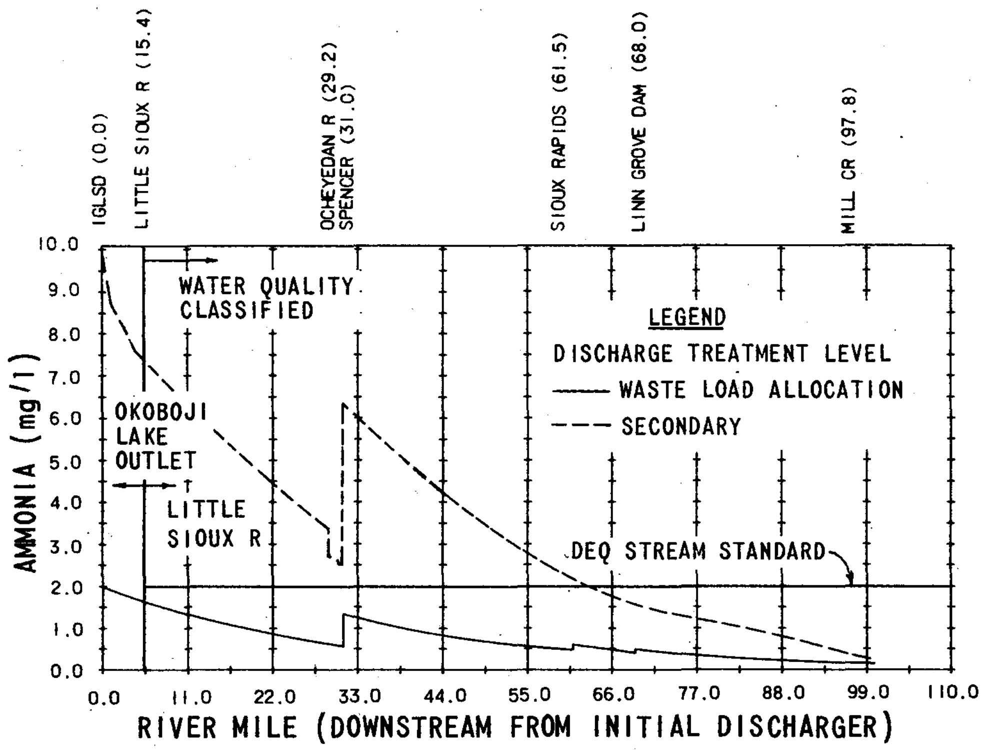


LITTLE SIOUX RIVER

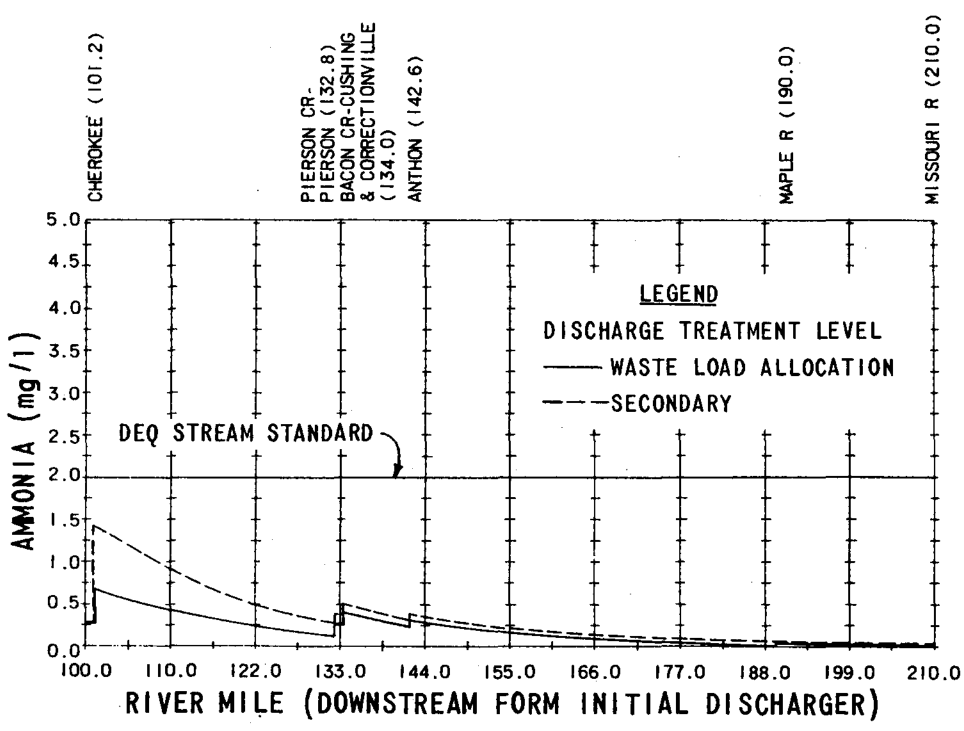


LITTLE SIOUX RIVER

FIGURE VI-15
DISSOLVED OXYGEN CONCENTRATIONS
LITTLE SIOUX RIVER
SUMMER CONDITIONS

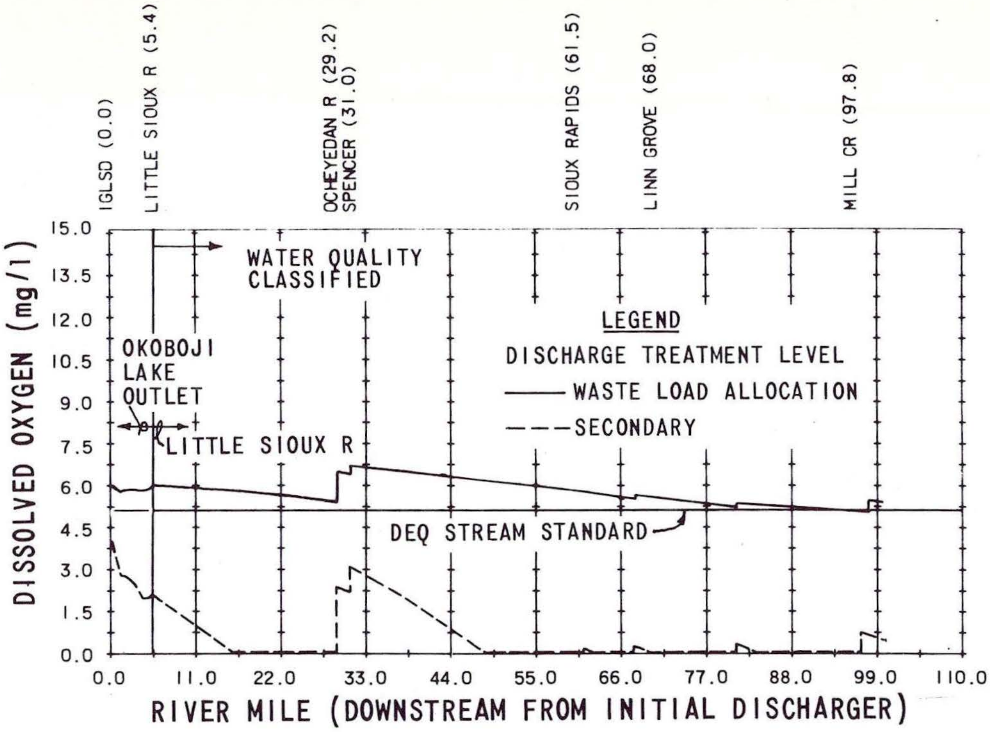


LITTLE SIOUX RIVER

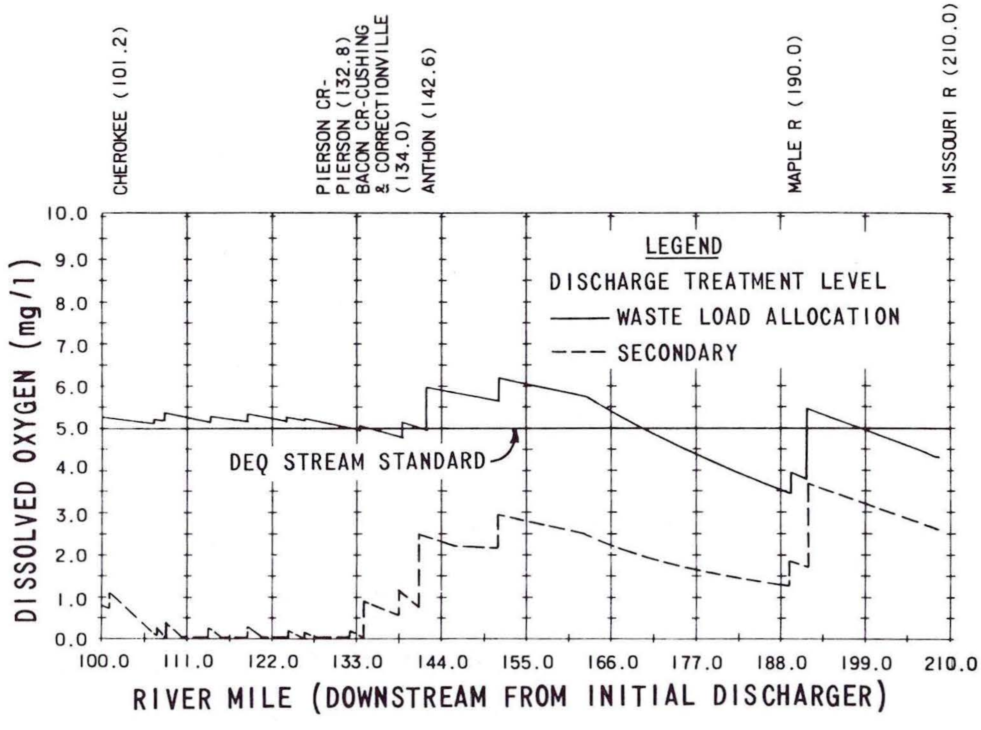


LITTLE SIOUX RIVER

FIGURE VI-16
AMMONIA NITROGEN CONCENTRATIONS
LITTLE SIOUX RIVER
SUMMER CONDITIONS

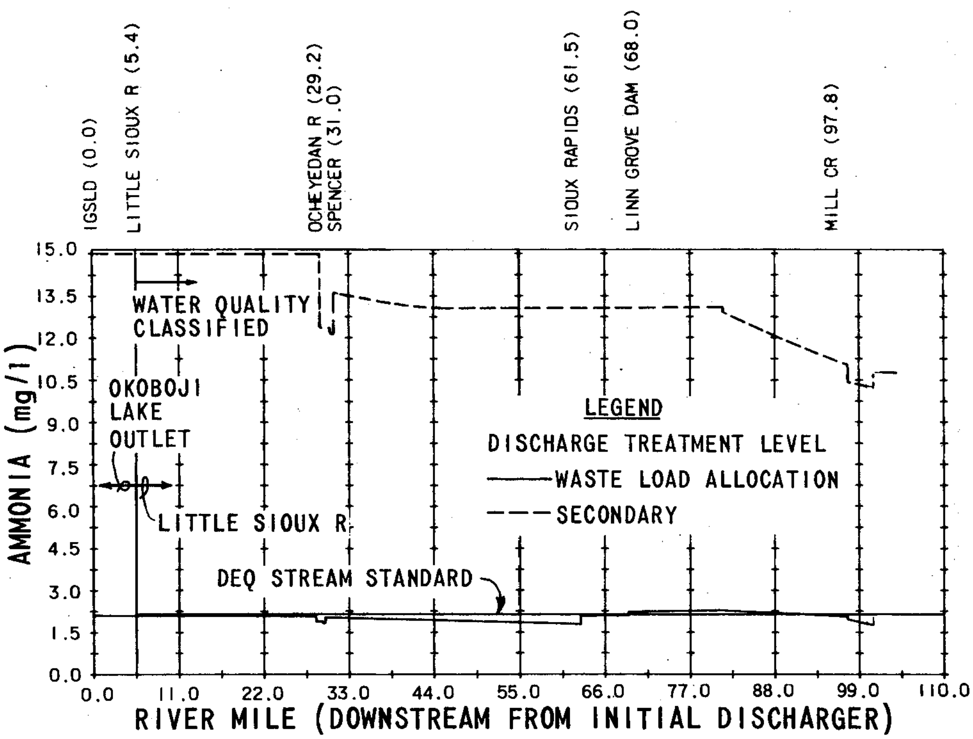


LITTLE SIOUX RIVER

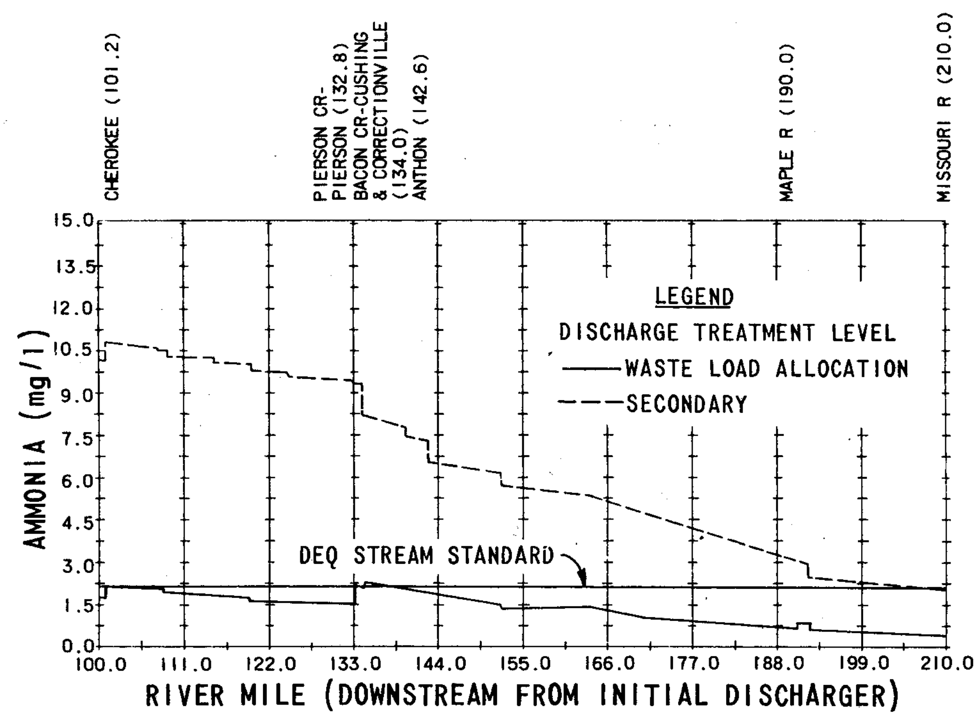


LITTLE SIOUX RIVER

FIGURE VI-17
DISSOLVED OXYGEN
CONCENTRATIONS
LITTLE SIOUX RIVER
WINTER CONDITIONS



LITTLE SIOUX RIVER



LITTLE SIOUX RIVER

FIGURE VI-18
AMMONIA NITROGEN CONCENTRATIONS
LITTLE SIOUX RIVER
WINTER CONDITIONS

than secondary treatment level removals of BOD to maintain DO stream quality criteria. In the upper reaches of the Little Sioux River, removal of ammonia nitrogen to decrease oxygen demand in the stream and increases in the DO content of wastewater effluents are necessary to maintain the stream standards for DO. Because of the extremely high levels of BOD removal required, further study of the upper reaches of the Little Sioux River is recommended. To meet water quality criteria in the classified portions of the Little Maple River, very stringent waste load allocations for both BOD and ammonia nitrogen removal must be assigned to Alta. Further study of the stream is recommended.

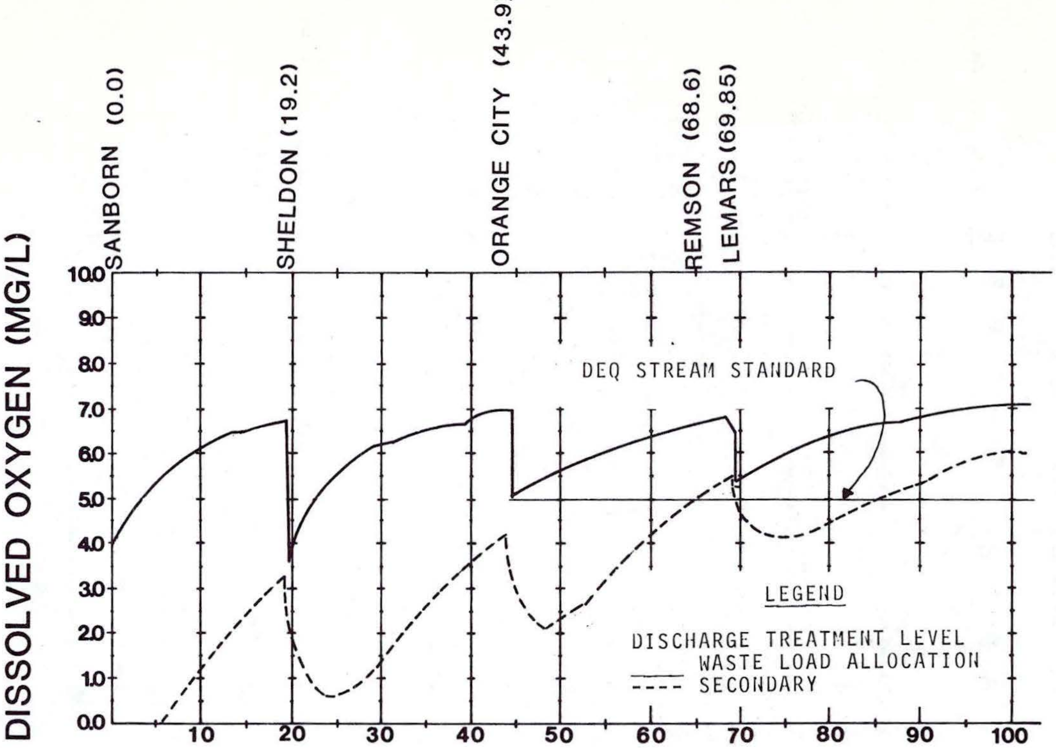
In addition to the critical stream reaches above, Odebolt Creek requires better than secondary treatment level removal of ammonia nitrogen to meet the stream quality criteria of 2.0 mg/l.

To meet water quality criteria, the Iowa Great Lakes Sanitary District (IGLSD) and the communities of Alta, Aurelia, Cherokee, Galva, Hartley, Odebolt, Ida Grove and Spencer must provide better than secondary treatment levels. In addition to BOD and ammonia nitrogen removal, the community of Odebolt must maintain a DO effluent concentration of 12.0 mg/l. Spencer, Sioux Rapids and IGLSD must meet extremely stringent allocations and provide the specified post-aeration levels given in Table VI-1. All industrial wastewater dischargers are assumed o be controlled discharges except for Linn Grove Rendering, which needs only to meet BPT.

Floyd River Basin - The lower portion of the Floyd River is classified, however, several upstream dischargers have a significant effect on the classified segment. Due to extremely low 7-day, 1-in-10 year low flow modeling of the entire system was required. Waste load allocation for each discharger are given in Table VI-1. Dissolved oxygen and ammonia nitrogen concentration profiles for the Floyd River for both secondary treatment conditions and waste load allocations with 1990 flows for summer and winter conditions are shown on Figures VI-19 and VI-20 respectively. Better than secondary treatment of all wastewater discharges within the basin is required to meet the stream quality criteria.

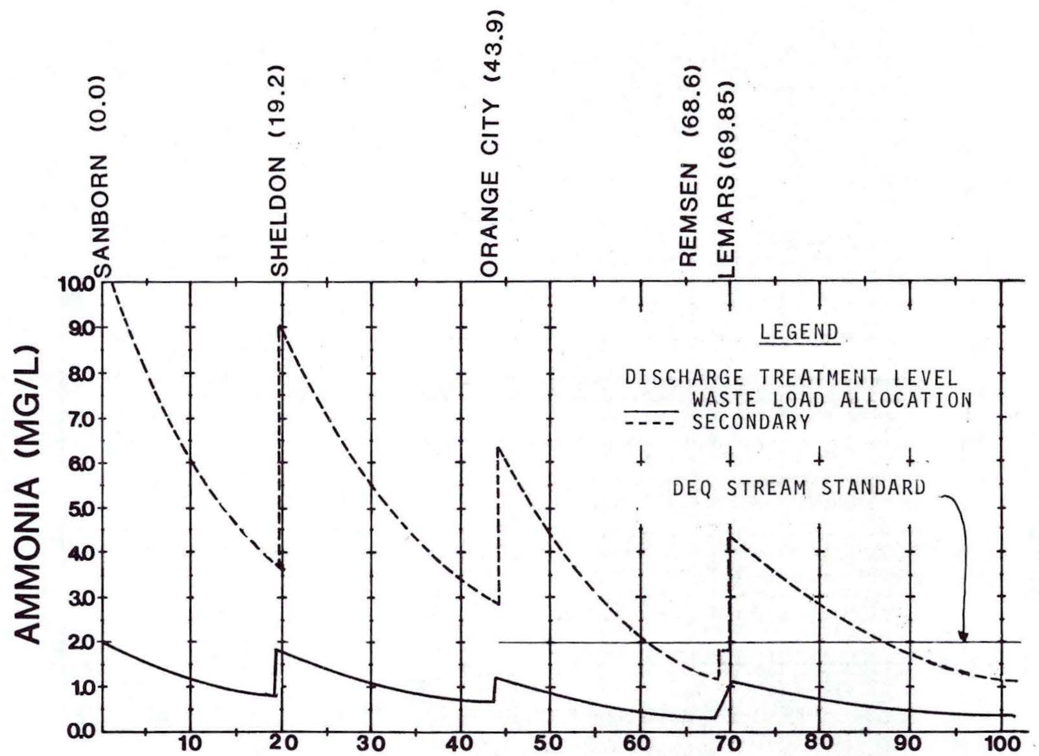
The communities of Sheldon, Sanborn, Orange City, Remsen, Le Mars, Sioux Center and Maurice must provide advanced waste treatment for the removal of BOD and ammonia nitrogen.

Boyer River Basin - The Boyer River is classified from Deloit to the mouth. One dischager (Kiron) on an unclassified segment required a waste load allocation. The impact of the large load discharged at Denison has the greatest impact of any dischargers to the river. The waste load allocations are given in Table VI-1. Dissolved oxygen and ammonia nitrogen concentration profiles for the Boyer River for both secondary treatment conditions and waste load allocations with 1990



RIVER MILE (DOWNSTREAM FROM INITIAL DISCHARGER)

DISSOLVED OXYGEN CONCENTRATIONS



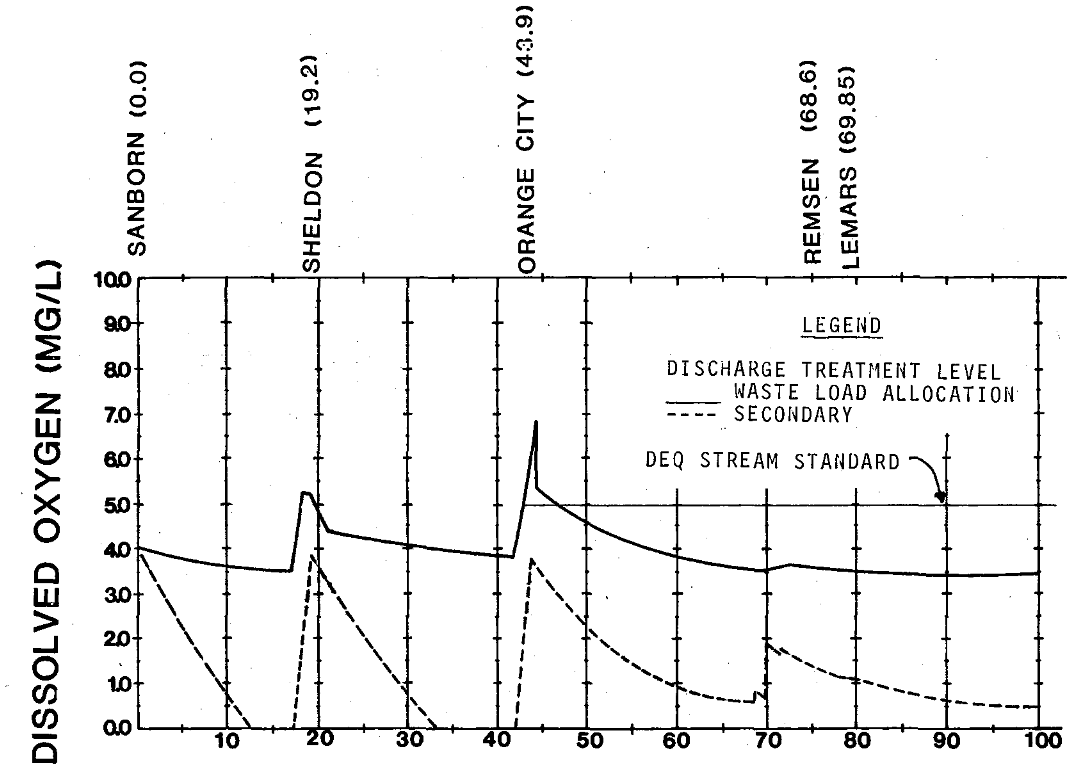
RIVER MILE (DOWNSTREAM FROM INITIAL DISCHARGER)

AMMONIA NITROGEN CONCENTRATIONS

FIGURE VI-19

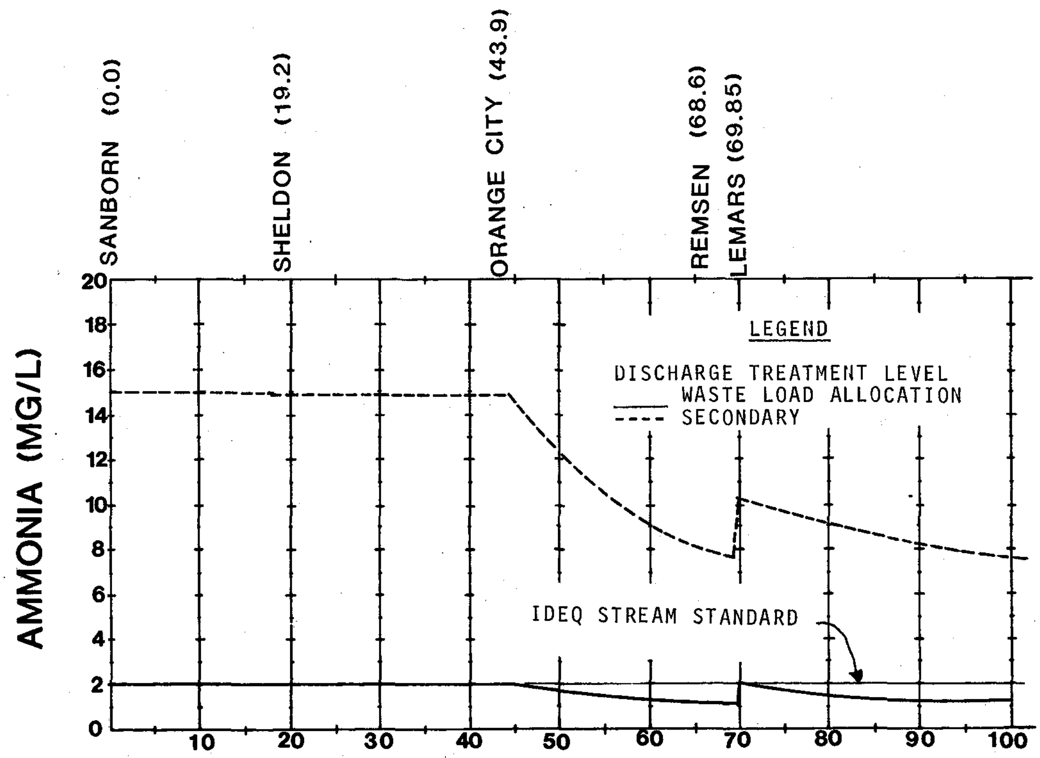
FLOYD RIVER

SUMMER CONDITIONS



RIVER MILE (DOWNSTREAM FROM INITIAL DISCHARGER)

DISSOLVED OXYGEN CONCENTRATIONS



RIVER MILE (DOWNSTREAM FROM INITIAL DISCHARGER)

AMMONIA NITROGEN CONCENTRATIONS

FIGURE VI-20

FLOYD RIVER

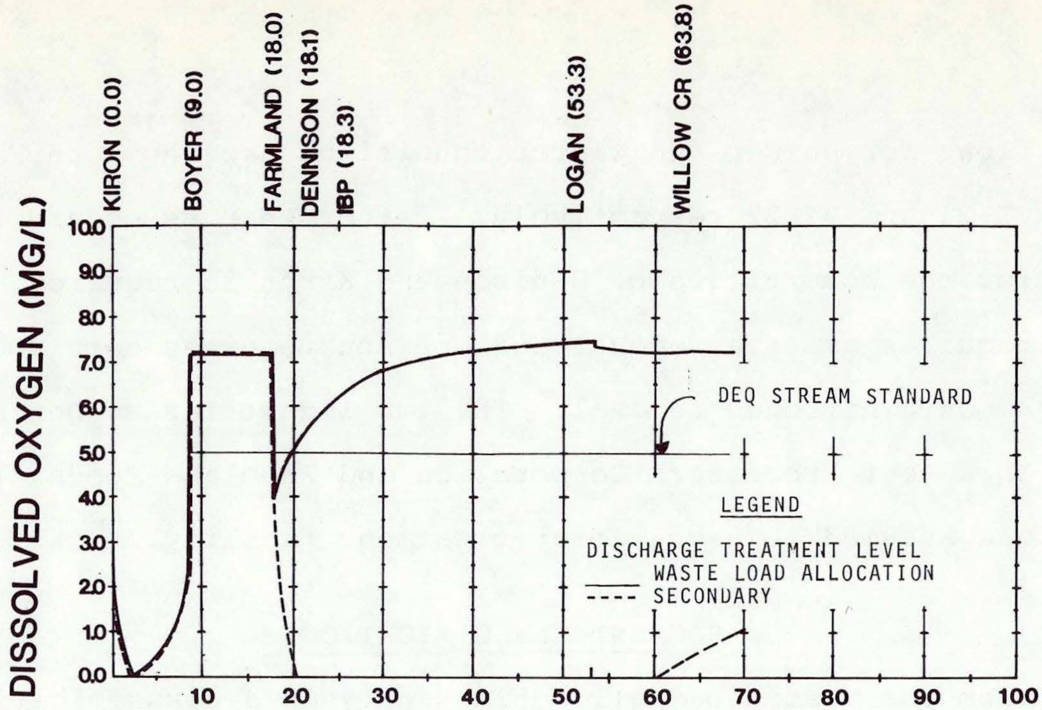
WINTER CONDITIONS

flows for summer and winter conditions are shown on Figures VI-21 and VI-22 respectively. Better than secondary treatment for the communities of Denison and Kiron is required. Kiron requires ammonia removal and Denison requires both BOD and ammonia nitrogen removal. The two industries at Denison, Iowa Beef Processors Corporation and Farmland Foods, Inc. are assumed to use a joint treatment facility.

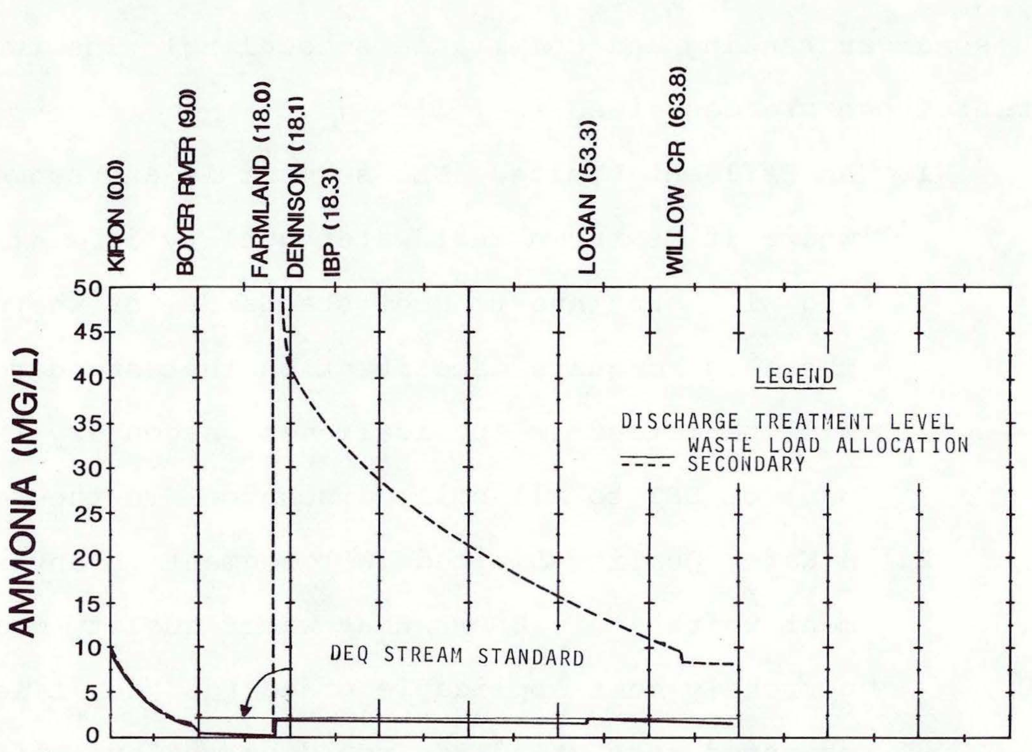
SEGMENT CLASSIFICATION

From the waste load allocation analyses a classification of stream segments is possible. Segment classification is a contributing factor in the determination of the segment ranking, discharger ranking and compliance scheduling. The two segment types are described as follows:

1. An Effluent Limited (EL) segment is any segment where it is known that water quality is meeting and will continue to meet standards, or where there is adequate demonstration that standards will be met after application of secondary treatment or BPT to all point discharges to the segment.
2. A Water Quality Limited (WQ) segment is any segment where it is known that water quality does not currently meet applicable standards and it is not expected that standards would be met even after application of secondary treatment or BPT to all point discharges to the segment.



RIVER MILE (DOWNSTREAM FROM INITIAL DISCHARGER)
DISSOLVED OXYGEN CONCENTRATIONS

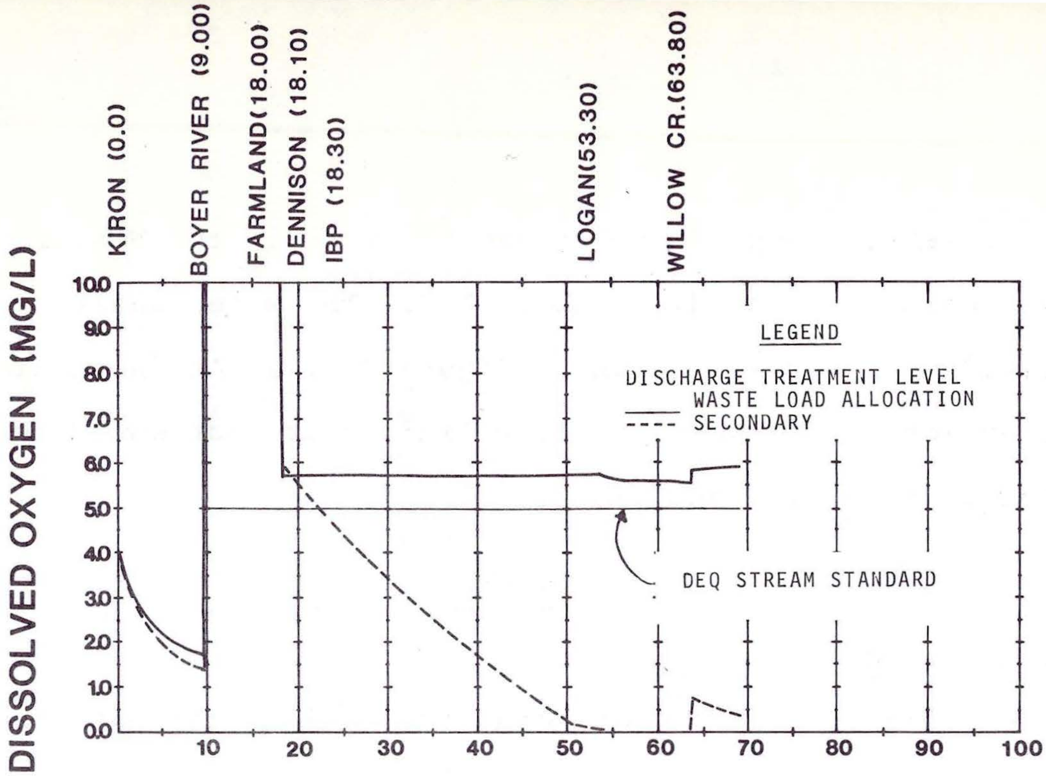


RIVER MILE (DOWNSTREAM FROM INITIAL DISCHARGER)
AMMONIA NITROGEN CONCENTRATIONS

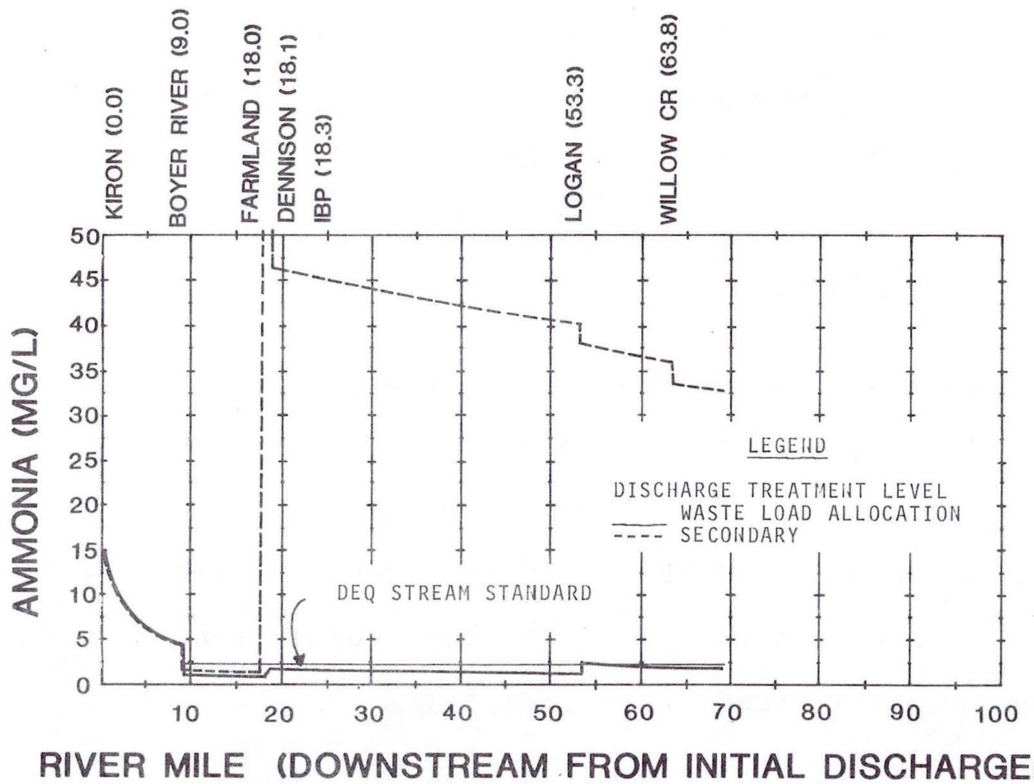
FIGURE VI-21

BOYER RIVER

SUMMER CONDITIONS



RIVER MILE (DOWNSTREAM FROM INITIAL DISCHARGER)
DISSOLVED OXYGEN CONCENTRATIONS



RIVER MILE (DOWNSTREAM FROM INITIAL DISCHARGER)
AMMONIA NITROGEN CONCENTRATIONS

FIGURE VI-22

BOYER RIVER

WINTER CONDITIONS

The classification of the stream segments in the Western Iowa Basin are listed in Table VI-2. The water quality limited segments are shown in Figure VI-23. All segments not designated as water quality limited are currently considered to be effluent limited.

PRIORITY RANKINGS

Stream Segment Ranking

The Western Iowa Basin has been divided into various stream segments. Each stream segment consists of surface waters that have common hydrologic characteristics and natural, physical, chemical, and biological processes. The segments have been ranked in order of abatement priority. The ranking methodology has attempted to take into account: (1) severity of pollution problems, (2) population affected, (3) need for preservation of high quality waters, and (4) national priorities.

The total points for a segment are determined from a product of the points earned in each of two factors. The formula weighs both the degree of usefulness of a segment and the severity of the pollution problem. The specific details and rationale used for the segment ranking methodology have been described in Chapter I.

Table VI-2 lists the stream segments selected, their respective priority points, and their final ranking. Figure VI-23 shows the stream segments.

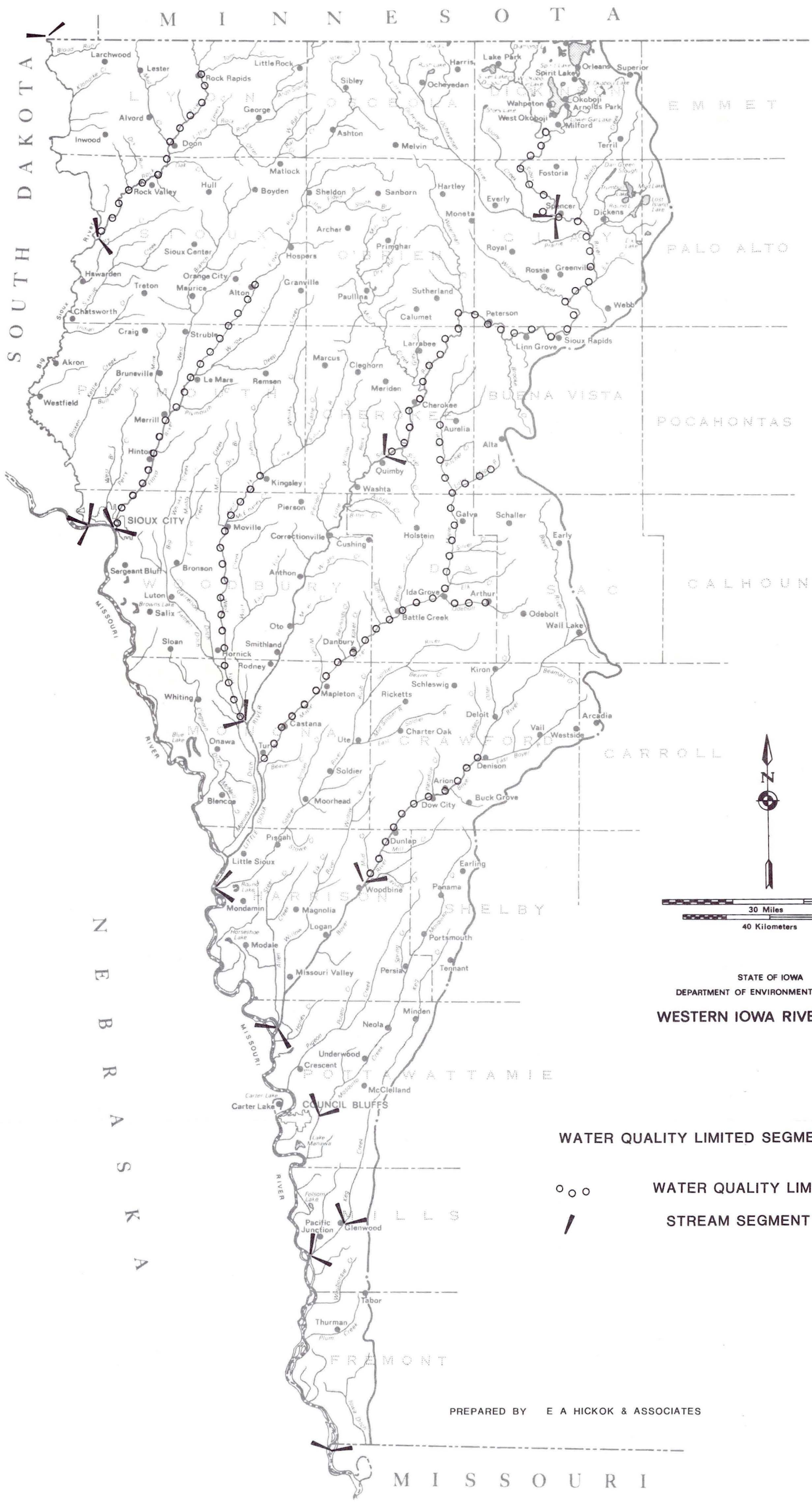
TABLE VI-2

Stream Segment Ranking

Western Iowa Basin

Rank	River	Stream Segment	WQ/ EL*	A	B C	B W	C	BC	AES	POP	SQ	Total Points	Priority Points
						Priority Criteria							
1	Floyd River	Entire Length	WQ	0	0	1	0	1	0	2.0	6.0	27.00	16
2	Maple River	Entire Length	WQ	0	0	1	0	1	0	1.5	6.0	24.00	15
3	Rock River	Big Sioux River to Minn. Line	WQ	0	0	1	0	1	0	1.5	6.0	24.00	14
4	Missouri River	Entire Length	EL	2	0	1	2	1	0	2.0	2.5	21.25	13
5	Little Sioux River	Spencer to Source	WQ	0	0	1	0	1	1	1.0	4.0	18.00	12
6	Little Sioux River	Quimby to Spencer	WQ	0	0	0	0	1	0	2.0	5.0	17.50	11
7	W. Branch Little Sioux River	Entire Length	WQ	0	0	1	0	1	0	1.0	4.0	14.00	10
8	Keg Creek	Missouri River to Glenwood	WQ	0	0	1	0	1	0	1.0	4.0	14.00	9
9	Big Sioux River	Minnesota Line to Missouri River	EL	0	0	1	0	1	0	2.0	3.0	13.50	8
10	Keg Creek	Glenwood to Source	EL	0	0	1	2	1	0	0.5	2.5	12.50	7
11	Boyer River	Woodbine to Source	WQ	0	0	0	0	1	0	1.0	4.0	10.00	6
12	Soldier River	Entire Length	EL	0	0	1	0	1	0	0.5	3.0	9.00	5
13	Boyer River	Missouri River to Woodbine	EL	0	0	1	0	1	0	1.0	2.5	8.75	4
14	Little Sioux River	Missouri River to Quimby	EL	0	0	1	0	1	0	0.5	2.5	7.50	3
15	Mosquito Creek	Source to above Council Bluffs	EL	0	0	1	0	0	0	0.5	2.5	5.00	2
16	Ocheyedan River	Spencer to Minnesota Line	EL	0	0	1	0	0	0	0.5	2.5	5.00	1

*Water Quality or Effluent Limited



STATE OF IOWA

DEPARTMENT OF ENVIRONMENTAL QUALITY

WESTERN IOWA RIVER BASINS

WATER QUALITY LIMITED SEGMENTS

o o o WATER QUALITY LIMITED

/ STREAM SEGMENT END

PREPARED BY E A HICKOK & ASSOCIATES

FIGURE VI-23

Municipal Discharger Ranking Methodology

The significant municipal dischargers in the basin have been ranked to be consistent with the segment priority ranking and to be subsequently used in establishing priorities and output estimates for municipal facilities construction. The relative significance of each discharger is determined by its total points as calculated by the discharger ranking formula. The specific details and rationale used for the municipal discharger ranking methodology have been described in Chapter I.

Table VI-3 lists the municipalities in the basin, their priority points and their final ranking.

Waste Load Reduction

The waste load reduction to be acheived by the waste load allocation and providing secondary treatment is shown on Table VI-4. The waste load reductions are tabulated by stream segment. It is interesting to note that by far greatest load reduction takes place on the Missouri River with its more densely populated cities.

Due to a lack of data, the BOD_5 and ammonia nitrogen values listed as being in the present discharge at critical periods have in some cases been estimated. Such estimations are noted in Table VI-4 and are designated as engineering estimates.

These estimates may differ from the operational data shown in Table V-4 because all BOD_5 and ammonia nitrogen values shown in Table V-4 are yearly averages computed from operation reports of the Effluent Quality Analysis Program (EQAP) data.

As can be seen, some municipalities do not show a reduction. This may be caused by one of the following:

1. A town presently not having a discharge (e.g. individual septic systems) is projected to construct a sewer system and treatment plant.
2. A substantial increase in population or industrial flow is forecasted which would increase the present discharge.

Any of these factors could cause an increase in the BOD_5 and/or ammonia nitrogen in the projected plant effluent.

TABLE VI-3

Municipal Discharger Ranking

Western Iowa Basin

Rank	Municipality	Discharge Criteria A_1	D_1	B_1	$(A_1+D_1)B_1$	A_2	D_2	B_2	$(A_2+D_2)B_2$	Segment Points	Priority Points
1	Maurice	60	9	.895	61.76	60	9	.897	61.89	16	139.65
2	Little Rock	60	9	.924	63.76	50	9	.933	55.07	14	132.83
3	Sioux City	60	25	.892	75.84	50	25	.473	35.51	13	124.35
4	Spencer	60	18	.793	61.85	30	16	.828	38.09	11	110.94
5	Orange City	50	14	.717	45.89	40	14	.883	47.69	16	109.58
6	Alton	60	14	.761	56.31	50	12	.596	36.94	16	109.25
7	Westside	60	7	.771	51.69	60	7	.680	45.56	7	104.25
8	Sibley	50	14	.765	41.31	30	14	.862	37.91	14	93.22
9	Remsen	50	9	.591	34.87	40	9	.750	36.75	16	87.62
10	Quimby	60	9	.739	51.00	50	9	.500	29.50	4	84.50
11	Council Bluffs	60	25	.825	70.17	10	16	.00	.00	13	83.17
12	Ida Grove	60	14	.778	57.60	20	9	.350	10.15	15	82.75
13	Marcus	50	12	.509	31.56	40	12	.750	39.00	10	80.56
14	Denison	20	14	.615	20.90	40	16	.929	52.00	7	79.90
15	Galva	60	9	.852	58.80	20	5	.200	5.00	15	78.80
16	Ricketts	60	7	.794	53.21	40	5	.417	18.75	6	77.96
17	Merrill	60	9	.500	34.50	30	9	.700	27.30	16	77.80
18	Glenwood	60	16	.544	41.34	30	14	.593	26.09	9	76.43
19	Peterson	60	9	.755	52.10	30	7	.333	12.33	11	75.43
20	Alta	40	12	.708	36.80	20	9	.810	23.48	15	75.28
21	Rock Rapids	30	12	.642	27.58	30	9	.826	32.20	14	73.78
22	Granville	50	5	.444	24.44	50	7	.583	33.25	16	73.69
23	Hull	30	9	.718	28.00	30	9	.800	31.20	14	73.20
24	Cherokee	30	14	.636	27.98	30	14	.745	32.78	11	71.76
25	Aurelia	40	9	.688	33.69	20	7	.778	21.00	15	69.69
26	Kiron	60	9	.741	51.11	20	7	.429	11.57	7	69.68
27	Rock Valley	40	9	.732	35.85	20	9	.667	19.33	14	69.18
28	LeMars	30	14	.614	27.02	20	14	.705	23.97	16	66.99
29	Sioux Rapids	60	9	.606	41.82	40	9	.286	14.01	11	66.83
30	Sanborn	50	12	.549	34.04	20	9	.575	16.68	16	66.72

TABLE VI-3

Municipal Discharger Ranking

Western Iowa Basin

Rank	Municipality	Discharge Criteria A_1	D_1	B_1	$(A_1+D_1)B_1$	A_2	D_2	B_2	$(A_2+D_2)B_2$	Segment Points	Priority Points
31	Sloan	60	9	.476	32.86	40	9	.389	19.06	13	64.92
32	Ute	60	9	.629	43.37	30	7	.278	10.28	6	59.65
33	Hospers	60	9	.628	43.33	20	7	.00	.00	16	59.33
34	Odebolt	30	9	.552	21.52	20	9	.786	22.79	15	59.31
35	Oyens	60	3	.688	43.12	10	0	.00	.00	16	59.12
36	IGLSD	20	16	.561	20.21	20	16	.745	26.81	12	59.02
37	Lawton	50	9	.45	26.55	40	9	.45	22.05	10	58.60
38	Ashton	60	9	.619	42.71	10	3	.00	.00	14	56.71
39	Brunsville	60	3	.60	37.80	20	0	.00	.00	16	53.80
40	Doon	60	9	.519	35.78	20	5	.00	.00	14	49.78
41	Anthon	60	9	.425	29.33	40	9	.333	16.32	4	49.65
42	Sheldon	30	12	.00	.00	40	12	.592	30.78	16	46.78
43	Sioux Center	50	14	.299	19.14	20	12	.312	9.98	16	45.12
44	Underwood	60	7	.642	42.99	10	1	.00	.00	2	44.99
45	Charter Oak	60	9	.545	37.64	1	0	.00	.00	6	43.64
46	Ireton	60	9	.583	40.25	20	5	.00	.00	3	43.25
47	Washta	60	7	.573	38.37	20	3	.00	.00	4	42.37
48	Correction-ville	60	12	.529	38.07	20	9	.00	.00	4	42.07
49	Early	60	9	.471	32.47	20	7	.00	.00	7	39.47
50	Pierson	40	9	.333	16.33	40	9	.357	17.50	4	37.83
51	Lake Park	50	9	.409	24.14	10	1	.00	.00	12	36.14
52	Everly	60	9	.50	34.50	10	3	.00	.00	1	35.50
53	Ruthven	50	9	.409	24.14	10	1	.00	.00	11	35.14
54	Boyden	40	9	.375	18.38	20	7	.00	.00	16	34.38
55	Tabor	30	7	.00	.00	40	7	.364	17.09	13	30.09
56	Schaller	40	9	.296	14.52	1	1	.00	.00	15	29.52
57	Hartley	20	12	.638	26.79	10	9	.0833	1.58	1	29.37
58	Westfield	50	7	.462	26.31	20	5	.00	.00	3	29.31
59	Alvord	40	5	.313	14.10	20	3	.00	.00	14	28.10
60	Cushing	50	7	.091	5.18	40	7	.40	18.80	4	27.98

TABLE VI-3

Municipal Discharger Ranking

Western Iowa Basin

Rank	Municipality	Discharge Criteria A_1	D_1	B_1	$(A_1+D_1)B_1$	A_2	D_2	B_2	$(A_2+D_2)B_2$	Segment Points	Priority Points
61	Onawa	30	14	.00	.00	40	14	.240	13.37	13	26.37
62	Whiting	40	7	.278	13.06	20	7	.00	.00	13	26.06
63	Schleswig	50	7	.333	19.00	20	5	.00	.00	7	26.00
64	Inwood	50	9	.367	21.63	10	3	.00	.00	3	24.63
65	Kingsley	40	12	.269	14.00	10	7	.00	.00	10	24.00
66	Terril	40	7	.25	11.75	1	1	.00	.00	11	22.75
67	Larrabee	30	1	.175	5.43	20	1	.175	3.68	11	20.11
68	Mondamin	40	7	.143	6.71	20	5	.00	.00	13	19.71
69	Hornick	40	7	.20	9.40	10	1	.00	.00	10	19.40
70	Larchwood	50	9	.267	15.70	30	5	.00	.00	3	18.73
71	Meriden	30	5	.20	7.00	10	1	.00	.00	11	18.00
72	Neola	60	9	.134	9.25	40	9	.134	6,57	2	17.82
73	Cleghorn	40	3	.30	12.90	1	0	.00	.00	4	16.90
74	Arthur	30	7	.05	1.85	20	5	.00	.00	15	16.85
75	Deloit	30	9	.25	9.75	20	7	.00	.00	7	16.75
76	Holstein	30	9	.041	1.59	10	7	.00	.00	15	16.59
77	Hinton	20	5	.00	.00	10	5	.00	.00	16	16.00
78	Melvin	0	0	.00	.00	0	0	.00	.00	16	16.00
79	Moville	40	9	.115	5.65	30	7	.00	.00	10	15.65
80	Mapleton	20	9	.00	.00	10	5	.00	.00	15	15.00
81	Battle Creek	20	9	.00	.00	20	7	.00	.00	15	15.00
82	Danbury	20	7	.00	.00	1	1	.00	.00	15	15.00
83	Castana	0	0	.00	.00	0	0	.00	.00	15	15.00
84	George	20	7	.00	.00	10	3	.00	.00	14	14.00
85	Lester	30	7	.00	.00	10	5	.00	.00	14	14.00
86	Linn Grove	30	5	.083	2.92	10	1	.00	.00	11	13.92
87	Akron	30	9	.077	3.00	30	9	.182	7.09	3	13.09
88	Crescent	0	0	.00	.00	0	0	.00	.00	13	13.00
89	Salix	0	0	.00	.00	0	0	.00	.00	13	13.00
90	Thurman	0	0	.00	.00	0	0	.00	.00	13	13.00

TABLE VI-3 (cont)

Municipal Discharger Ranking

Western Iowa Basin

Rank	Municipality	A_1	D_1	B_1	$(A_1+D_1)B_1$	A_2	D_2	B_2	$(A_2+D_2)B_2$	Segment Points	Priority Points
91	Blencoe	0	0	.00	.00	0	0	.00	.00	13	13.00
92	Fostoria	0	0	.00	.00	0	0	.00	.00	12	12.00
93	Paullina	20	9	.00	.00	20	7	.00	.00	11	11.00
94	Primghar	20	9	.00	.00	1	1	.00	.00	11	11.00
95	Sutherland	20	9	.00	.00	20	7	.00	.00	11	11.00
96	Dickens	0	0	.00	.00	0	0	.00	.00	11	11.00
97	Calumet	0	0	.00	.00	0	0	.00	.00	11	11.00
98	Webb	0	0	.00	.00	0	0	.00	.00	11	11.00
99	Dow City	30	7	.1	3.70	1	1	.00	.00	7	10.70
100	Bronson	0	0	.00	.00	0	0	.00	.00	10	10.00
101	Pacific Jct.	0	0	.00	.00	0	0	.00	.00	9	9.00
102	Royal	30	7	.2	7.40	20	7	.00	.00	1	8.40
103	Minden	30	7	.00	.00	10	5	.00	.00	8	8.00
104	McClelland	0	0	.00	.00	0	0	.00	.00	8	8.00
105	Ocheyedan	30	7	.167	6.17	20	5	.00	.00	1	7.17
106	Dunlap	40	9	.00	.00	20	7	.00	.00	7	7.00
107	Wall Lake	30	9	.00	.00	1	3	.00	.00	7	7.00
108	Vail	20	7	.00	.00	10	5	.00	.00	7	7.00
109	Arcadia	0	0	.00	.00	0	0	.00	.00	7	7.00
110	Arion	0	0	.00	.00	0	0	.00	.00	7	7.00
111	Portsmouth	30	5	.125	4.38	10	3	.00	.00	2	6.38
112	Pisgah	30	3	.00	.00	10	1	.00	.00	6	6.00
113	Moorhead	0	0	.00	.00	0	0	.00	.00	6	6.00
114	Soldier	0	0	.00	.00	0	0	.00	.00	6	6.00
115	Smithland	30	5	.0465	1.63	10	3	.00	.00	4	5.63
116	Missouri Valley	30	14	.00	.00	20	12	.00	.00	5	5.00
117	Logan	20	9	.00	.00	20	9	.00	.00	5	5.00
118	Woodbine	30	9	.00	.00	20	9	.00	.00	5	5.00
119	Modale	0	0	.00	.00	0	0	.00	.00	5	5.00
120	Magnolia	0	0	.00	.00	0	0	.00	.00	5	5.00

TABLE VI-3 (cont.)

Municipal Discharger Ranking

Western Iowa Basin

Rank	Municipality	Discharge Criteria								Segment Points	Priority Points
		A_1	D_1	B_1	$(A_1+D_1)B_1$	A_2	D_2	B_2	$(A_2+D_2)B_2$		
121	Earling	40	7	.060	2.82	10	5	.00	.00	2	4.82
122	Little Sioux	0	0	.00	.00	0	0	.00	.00	4	4.00
123	Oto	0	0	.00	.00	0	0	.00	.00	4	4.00
124	Hawarden	20	9	.00	.00	1	1	.00	.00	3	3.00
125	Persia	0	0	.00	.00	0	0	.00	.00	2	2.00
126	Panama	0	0	.00	.00	0	0	.00	.00	2	2.00
127	Harris	30	3	.00	.00	20	1	.00	.00	1	1.00

TABLE VI-4

WASTE LOAD REDUCTIONS

WESTERN IOWA BASIN

Dischargers	Reference Number	Present		Projected (1990)		Load Reduction
		Flow (mgd)	Lbs.Eff. BOD_5/NH_3	Flow (mgd)	Lbs.Eff. BOD_5/NH_3	BOD_5/NH_3
-Big Sioux River						
Entire Length						
Westfield	M-18	.028	13/3	.028	CD	--/--
Akron	M-17	.134	39/22	.144	36/18	3/4
Ireton	M-16	.040	24/4	.042	11/6.5	13/A
Hawarden	M-14	.168	29/1	.192	48/24	A/A
Inwood	M-2	.0644	30/4	.0235	CD	--/--
Larchwood	M-1	.0611	26/8	.0352	CD	--/--
Total:						16*/4*
-Missouri River						
Entire Length						
Thurman	M-147		No Plant	.028^E	CD	--/--
Tabor	M-146	.047	13/11	.0571	14/7	A/A
Council Bluffs	M-140	5.55	9,489/185	6.62	1,656/828	7,833/A
Crescent	M-133		No Plant	.0487^E	CD	--/--
Mondamin	M-114	.038	14/3	.048	CD	--/--
Blencoe	M-43	.0225^E	6^E/3^E	.0234^E	CD	--/--
Onawa	M-42	.449	139/105	.593	158/79	A/26
Salix	M-41		No Plant	.043^E	CD	--/--
Whiting	M-40	.051	18/5.5	.0613	CD	--/--
Sloan	M-39	.078	42/18	.0874	22/11	20/7
Sioux City	M-37	16.81	47,947/4,907	20.66	5,169/2,584	42,778/2,323
Total:						50,631*/2,360*
-Rock River						
Entire Length						
Rock Valley	M-13	.113	41/12	.321	11/4	30/8
Hull	M-12	.121	39/20	.193	11/4	28/16
Doon	M-11	.044	27/4	.052	CD	--/--
Ashton	M-9	.031	21/2	.032	CD	--/--
Sibley	M-8	.390	166/65	.354	39/9	114/51
George	M-7	.071	16/2	.0946	CD	--/--
Little Rock	M-6	.0531	44/15	.0623	3/1	41/14
Alvord	M-5	.016	6.7/2	.01835	CD	--/--
Lester	M-4	.028	8/4	.0279	CD	--/--
Rock Rapids	M-3	.164	53/23	.331	19/4	34/19
Total:						247/108
-Floyd River						
Entire Length						
Hinton	M-36	.043	9/--	.044	CD	--/--
Merrill	M-35	.058	30/--	.0589	CD	--/--
Brunsville	M-34	.005	3/.5	.0051	CD	--/--
Maurice	M-31	.0266	43/11	.027	5/1	38/10
Sioux Center	M-30	.398	165/42	.695	116/29	49/13
Boyden	M-29	.058	24/6	.058	CD	--/--
LeMars	M-28	.810	236/61	1.09	91/18	145/43
Oyens	M-27	.005	4/0	.0147	CD	--/--
Remsen	M-26	.090	44/20	.146	18/5	26/15
Granville	M-25	.020	9/6	.02	CD	--/--
Orange City	M-24	.357	152/77	.516	43/9	109/68
Alton	M-23	.153	159/--	.153	CD	--/--
Hospers	M-22	.065	43/5	.065	CD	--/--
Sanborn	M-21	.170	71/20	.255	32/9	39/11
Sheldon	M-20	.217	71/49	.605	76/20	A/A
Melvin	M-19		No Plant	.0335^E	CD	--/--
Total:						406*/160*

TABLE VI-4 (cont.)

Dischargers	Reference Number	Present Flow (mgd)	Present Lbs.Eff. BOD_5/NH_3	Projected (1990) Flow (mgd)	Projected (1990) Lbs.Eff. BOD_5/NH_3	Load Reduction BOD_5/NH_3
-Little Sioux River						
Missouri River to Quimby						
Little Sioux	M-107	No Plant		.0299^{E}	CD	--/--
Smithland	M-86	No Data		.033^{E}	CD	--/--
Oto	M-85	No Data		.0227^{E}	CD	--/--
Anthon	M-84	.081	40/18	.091	23/12	17/6
Correctionville	M-83	.118	87/15	.132	41/20	46/A
Cushing	M-82	.026	11/5	.0291	CD	--/--
Pierson	M-81	.066	27/14	.047	CD	--/--
Washta	M-80	.017	11/2	.0187	CD	--/--
Cleghorn	M-79	.010	4/.2	.011	CD	--/--
Quimby	M-78	.042	46/12	.044	CD	--/--
Total:						63/6*
Quimby to Spencer						
Cherokee	M-77	.650	173/98	.721	63/25	110/73
Meriden	M-76	.015	5/1	.0165	CD	--/--
Larrabee	M-75	.006	2/--	.0066	CD	--/--
Calumet	M-74	No Plant		.023^{E}	CD	--/--
Paullina	M-73	.117	24/5	.146	CD	--/--
Primghar	M-71	.088	21/1	.096	CD	--/--
Sutherland	M-70	No Data		.096^{E}	CD	--/--
Peterson	M-69	.047^{E}	49/9	.047	CD	--/--
Linn Grove	M-68	.022	6/1	.022	CD	--/--
Sioux Rapids	M-67	.054	33/14	.054	20/10	13/4
Webb	M-63	No Plant		.0234^{E}	CD	--/--
Ruthven	M-62	.053	22/1	.053	CD	--/--
Dickens	M-61	No Plant		.024^{E}	CD	--/--
Terril	M-60	.032	12/1	.037	CD	--/--
Spencer	M-57	1.87	1,029/250	2.56	213/43	816/207
Total:						939/284
Spencer to Source						
Fostoria	M-59	No Data		.0219^{E}	CD	--/--
Lake Park	M-44	.045	22/1	.0519	CD	--/--
IGLSD	S-18	1.88	408/141	2.146	179/36	229/105
Total:						229/105
-Ocheyeden River						
Entire Length						
Royal	M-56	.048	15/--	.048	CD	--/--
Everly	M-55	.076	38/2	.109	CD	--/--
Hartley	M-54	.205	58/12	.253	21/11	37/1
Harris	M-53	No Data		.0155^{E}	CD	--/--
Ocheyedan	M-52	.039	12/4	.040	CD	--/--
Total:						37/1
-West Branch Little Sioux						
Entire Length						
Bronson	M-93	No Plant		.022^{E}	CD	--/--
Lawton	M-92	.0406	20/10	.046	CD	--/--
Hornick	M-91	.028	10/1	.0314	CD	--/--
Moville	M-90	.069	26/9	.160	CD	--/--
Kingsley	M-89	.130	52/7	.153	CD	--/--
Marcus	M-88	.113	55/28	.134	26/7	29/21
Total:						29/21

TABLE VI-4 (cont.)

Dischargers	Reference Number	Present Flow (mgd)	Present Lbs.Eff. BOD_5/NH_3	Projected (1990) Flow (mgd)	Projected (1990) Lbs.Eff. BOD_5/NH_3	Load Reduction BOD_5/NH_3
-Soldier River Entire Length						
Pisgah	M-113	.029^E	7^E/4^E	.036^E	CD	--/--
Moorhead	M-112	No Plant		.028^E	CD	--/--
Soldier	M-111	No Plant		.025^E	CD	--/--
Ricketts	M-110	.015	17/3	.015	CD	--/--
Ute	M-109	No Data		.053^E	CD	--/--
Charter Oak	M-108	.040	22/0	.04	CD	--/--
Total:						0/0
-Boyer River Missouri River to Woodbine						
Modale	M-132	No Plant		.037^E	CD	--/--
Magnolia	M-131	No Plant		.0258^E	CD	--/--
Missouri Valley	M-130	.165	100/26	.518	CD	--/--
Logan	M-129	.118	26/10	.224	56/28	A/A
Woodbine	M-128	.108	31/12	.113	CD	--/--
Total:						0*/0*
Woodbine to Source						
Dunlap	M-127	.070	26/6	.209	CD	--/--
Dow City	M-126	.037	10/1	.057	CD	--/--
Arion	M-125	No Plant		.023^E	CD	--/--
Denison	M-123	3.3**	714**/751**	3.30**	275**/55**	439/696
Vail	M-122	.066	14/--	.066	CD	--/--
Westside	M-121	.013	14/5	.0389	CD	--/--
Arcadia	M-120	No Plant		.041^E	CD	--/--
Deloit	M-119	.061	20/--	.028	CD	--/--
Schleswig	M-118	.048	18/4	.088	CD	--/--
Kiron	M-117	.053	27/7	.03	7/4	20/3
Wall Lake	M-116	.121	33/2	.1333	CD	--/--
Early	M-115	.064	34/6	.071	CD	--/--
Total:						459/699
-Mosquito River Source to above Council Bluffs						
Underwood	M-139	.019	12/1	.0728	CD	--/--
Neola	M-138	.097^E	49^E/25^E	.166	42/21	7/4
Persia	M-137	No Data		.04	CD	--/--
Portsmouth	M-136	.024	6/3	.028	CD	--/--
Panama	M-135	No Data		.025	CD	--/--
Earling	M-134	.046	18/3	.066	17/8	1/A
Total:						8/4*
-Keg Creek Missouri River to Glenwood						
Pacific Junction	M-145	No Plant		.0616^E	CD	--/--
Glenwood	M-144	.446	298/86	.820	136/35	162/51
Total:						162/51
Glenwood to Source						
McClelland	M-143	No Plant		.025^E	CD	--/--
Minden	M-142	No Data		.0743^E	CD	--/--
Total:						0/0

TABLE VI-4 (cont.)

Dischargers	Reference Number	Present Flow (mgd)	Present Lbs.Eff. BOD_5/NH_3	Projected (1990) Flow (mgd)	Projected (1990) Lbs.Eff. BOD_5/NH_3	Load Reduction BOD_5/NH_3
-Maple River						
Entire Length						
Castana	M-105	No Plant		.0219[E]	CD	--/--
Mapleton	M-104	.124	27/4	.223	29/15	A/A
Danbury	M-103	.058	14/1[E]	.0649	CD	--/--
Battle Creek	M-102	.094	22/7[E]	.094	CD	--/--
Holstein	M-101	.147	49/5	.186	CD	--/--
Ida Grove	M-100	.267	167/20	.275	37/13	130/7
Arthur	M-99	.038	10/3	.038	CD	--/--
Odebolt	M-98	.113	29/14	.156	13/3	16/11
Galva	M-97	.041	23/3	.041	3/2	20/1
Schaller	M-96	.0695	27/1	.0772	CD	--/--
Alta	M-95	.180	65/21	.229	19/4	46/17
Aurelia	M-94	.091	32/9	.116	10/2	22/7
Total:						234*/43*

LEGEND

"A" Minor load increase due to increased population growth or new STP being constructed with increased flows, or due to unreliable operating data being reported

"CD" Controlled discharge

"E" Engineering estimate

"*" Apparent load reduction based on available information

"**" Includes industries

"IGLSD" Iowa Great Lakes Sanitary District

REFERENCES

1. Supporting Document For Iowa Water Quality Management Plans, Iowa Department of Environmental Quality, Water Quality Management Division, Des Moines, Iowa, 1976.

CHAPTER VII

NONPOINT POLLUTION SOURCES

WESTERN IOWA BASIN

Wastes from nonpoint (area) sources, mainly the fields and other lands of the basin, vary tremendously with respect to time and place of flow into the basin's rivers.

During times of dry weather, the contribution of area sources to streams and other water bodies is minimal. At such times wastes accumulate on the land. A light rain will carry some of these wastes into streams, while a heavier rain will generally carry heavier amounts. Further, variation of the location of input waste and total amount injected will occur with the distribution of rainfall over an area. Simply stated, contamination of waters from area sources is a function of the weather.

Area source impact is a function of the amount of material that has been accumulated on the land as a function of the duration of dry weather, the amount and intensity of rain, and the distribution of rain. A light, spotty rain after a long wet period will inject only small amounts of wastes at a few spots along a stream, while heavy, widespread downpours occurring after a long drought, especially in certain soil types, can inject massive amounts of wastes over the entire lengths of streams, completely overtaxing the streams assimilative capacity. This happens in spite of the increased quantities of water from the heavy rains.

At such rainy times, the problems of agricultural wastes may be compounded by discharges of combined storm and sewer systems and runoff from urban streets and lots.

There is much less information on area sources than there is on point sources. Data are lacking on such because of difficulties in monitoring relatively small concentrations over expansive areas, economic factors, and probably cultural attitudes.

Area sources can be grouped into three major categories: general rural fields and woodlands, animal feedlots and operations, and urban area sources. Feedlots in some cases approach being point sources. However, it is often difficult to draw a distinct line between a feedlot and general feeding operations of middle- and smaller-sized farms. Even large feedlots can be uncharacteristic of point sources, When remote from streams, waste materials from large feedlots may be altered or spread over a large area before reaching a water body.

Land Use

About 96 percent of the land in the Western Iowa Basin is rural. This rural land, for purposes here, is divided into four general categories: cropland, pasture, forest and "other" land.

Cropland consists of tilled land or land being prepared for tillage, temporarily idle land that is usually used to raise crops, land in "soil improvement", land in cover crops not harvested or pastured, and hay land permanently used for forage.

Pasture is grassland or other lands primarily used for grazing.

Forest is land that has at least 10% tree cover and is capable of producing timber or other forest products.

Lands other than these (in the "other" category) consist of such regions as farmsteads, roads, animal feeding operations, ditch banks, hedge and fence rows, rural residences, investment tracts, marshes not used for grazing, borrow pits, and gravel pits.

Estimates of land use in each of the basins and hydrological units were made using information from the "Iowa Conservation Needs Committee"(1).

Table VII-1 lists the acreages of land use in the Western Iowa Basin by hydrologic unit. Note that in each unit, the nearly overwhelming land use is cropland. Pasture, although a poor second, ranks far above forest land, and well ahead of the "other" uses.

TABLE VII-1

LAND USE CLASSIFICATION

WESTERN IOWA BASIN

Hydrologic Unit	Land Use in Acres							
	Cropland	Pasture	Forest	Federal	Urban	Smaller Water	Other	Total
Rock	468,842	52,851	5,073	0	18,369	463	17,841	563,439
Floyd	532,176	63,692	9,799	0	22,849	912	20,065	649,493
Maple	398,507	53,382	17,299	0	19,044	421	16,626	496,279
Little Sioux	1,608,763	198,494	46,575	131	17,999	899	67,324	2,000,185
Other	1,852,544	227,325	122,218	3,504	93,645	5,335	71,536	1,921,457
Total	4,860,832	595,744	200,964	3,635	231,906	8,030	193,392	6,094,503

CONTAMINANTS FROM AREA SOURCES

The most serious contaminants of water bodies in the western basins are phosphorus and nitrogen, sediments, ammonia nitrogen, suspended organic solids, BOD, and COD materials. Potentially, pesticides and herbicides could someday be a problem. Plant materials may pose a special problem in the case of reservoir creation.

Phosphorus and Nitrogen

Phosphorus is especially important to water bodies because it is usually the critical nutrient element for algal growth. The impact of phosphorus is especially severe on lakes, such as the Iowa Great Lakes in Dickinson County, where recreational activities have been somewhat restricted by algae blooms. The problem with such blooms has led to continuing studies on these lakes. The studies that have been conducted provide excellent insight into some of the problems that exist with regard to agricultural activities in the Western Iowa Basin.

Determination of the nutrient budgets for the lakes, taken together over the entire period of study, revealed that 80 percent of the phosphorus in the lakes come from the streams draining the watersheds surrounding the lakes. Investigation was made of the relative variation of phosphorus in tributary streams. No difference was found with variation in the percentage of the watersheds in pasture, raw crops, or marshlands, although very little land was devoted to non-agriculture usage.

However, a significant correlation was found with the number of animal units confined in feedlots having surface drainage to a stream or tile drain. Approximately 19% of the estimated phosphorus inflows from agricultural watersheds (rainfall excepted) were from feedlot livestock units. Further, years with the greatest rainfall and spring runoff were years with the greatest increase in phosphorus input.

It would appear that application of phosphate fertilizers do not grossly raise the input of phosphorus to the streams since the input of phosphorus from other land types was not significantly greater or less. This does not necessarily mean that phosphorus from fertilizer applications is not significant. Marshland waters, for example, may be rather high in phosphorus content due to higher inputs from the many animals that are attracted to it. Further, land types that might yield lesser amounts of phosphates may not be present in the Iowa Great Lakes drainage area.

Damage to full recreational enjoyment of the lakes is only part of the problems that phosphorus in water raises. Ultimately, it could destroy the lakes completely through eutrophication.

Through increase of the algal population, phosphorus leads to increases in carbonaceous biological oxygen demand (BOD) due to decomposition of the cells that die. During the night, algal respiration significantly lowers the amount of dissolved oxygen in the water. The growth of the algae increases the turbidity and suspended solids levels, causing other variations such as alternation of temperature structure--which in turn may affect other life forms and physical processes. Further, algae often import tastes and odors to the water which makes it obnoxious for recreation; and, for some persons, undrinkable even when treated.

Nitrogen can be, in some instances, the limiting element to the production of algae blooms. It then takes over the role played by phosphorus. However, in the Western Iowa Basin, phosphorus is the key element to algal problems.

Sediments

Sediments have a negative effect on water quality since they fill stream beds, and increase turbidity, which in turn alters temperature structure and thus the biological composition of the water body. They also serve as carriers of phosphates, and organic materials.

Sediments mainly enter streams during the short, intense showers that occur throughout the Western Iowa Basin during the warm season.

Ammonia Nitrogen

Animals are rich sources of ammonia nitrogen, which results from the hydrolysis of urea. The impact of ammonia is severe where cattle or other farm animals have direct access to a stream, enabling direct injection of the material into the waters. Ammonia problems are dramatically lessened where a good distance exists between animals and streams. Where adequate distance and erosion control methods are implemented, ammonia has little impact.

Since ammonia has high affinity for soil particles, its injection to streams occurs most strongly at times of heavy rain and surface runoff.

Pesticides and Herbicides

Pesticides and herbicides constitute a potential hazard to water quality. Massive rains after widespread applications of pesticides and herbicides could easily result in the injection of vast quantities of this material to streams. Forfunately, pesticides and herbicides quickly dissipate as a threat to water quality, so that within a few days after application they no longer constitute a major threat to contamination. Moveover, even a moderate rainfall soon after application of these materials renders them virtually useless as killers of pests and unwanted plants. Thus, farmers and sprayers, in their own economic interest, seek to avoid application when rain threatens. Research projects, such as the Buffalo Bill Watershed Study (2), have failed to gather data on pesticides and herbicides following rain because of the care that is taken by applicators.

Suspended Solids

Organic suspended solids from animal feedlots are responsible for the formation of sludge along the banks of streams and lakes. Unlike sediment from sheet erosion, they cause odor problems and are a repulsive element in the waters. Organic solids deprive the water bodies of oxygen, and often are responsible for killing desirable organisms and bringing about increases in undesirable life forms.

BOD and COD

Miscellaneous other animal waste ingredients producing high biological oxygen demand (BOD) and chemical oxygen demand (COD) are a further serious source of damage to water quality. Impact of these materials may also be especially great after heavy rains.

Special Reservoir Problems

When reservoir sites are flooded, land plants die and organic residues begin to decompose below the rising waters. Nutrients are released and algae and other micro-organisms flourish in the nutrient enriched environment. Ten to fifteen years are normally required before biodegradable substances are decomposed and the reservoir becomes stabilized.

Although much research has been conducted dealing with the limnology of impoundments, a great deal of uncertainty still exists in predicting the influence of reservoirs and reservoir operation on water quality. The interrelationships between the various chemical and biological factors within a large body of water are extremely complex. Climatic changes, variations in the terrestrial environment, and other special conditions unique to each individual impoundment make it extremely difficult to determine the exact conditions that will occur in a given reservoir. Normally reservoirs with extensive shallow areas tend to support algae populations and are prone to develop taste and odor problems. Where reservoirs are used to store flood waters, the level is normally lowered during the summer, thus destroying stratification during the most critical period of the year when rates of decomposition are high and algae blooms are common. This is very helpful in preventing the development of extensive algae blooms in the shallow areas.

GENERAL RURAL RUNOFF

In the basin one of the major causes of eutrophication is runoff from agricultural lands. Extensive use of artificial fertilizers containing large amounts of nitrates and phosphates has contributed to the high concentrations of these substances in many of the Basin's surface waters. Over three-fourths of the phosphorus content of the Iowa Great Lakes in Dickinson County has been attributed to drainage off the lands of the watersheds. The watersheds of these lakes are 90% in agricultural use. It is estimated that animal feedlots alone contribute nearly one-fifth of the total phosphorus imported into the lakes.

It is very difficult to predict the amount of nutrients which can enter a lake without causing nuisance conditions. The nutritional status of certain species of algae can vary from lake to lake, or even from different areas or depths of the same lake, as well as over time. Subsurface samples of some algae have been shown to have surplus nitrogen or phosphorus at times when the same species in surface waters were nitrogen or phosphorus limited. No simple relationship can be expected among nutrient loading, nutrient concentration, and production, because of the variety of other influential factors such as depth, extent of shoreline, flow-through and detention times. Lake West Okoboji, which has the largest water volume and a small drainage area, is in the best condition of the Iowa Great Lakes, while Little Lower Gar Lake, shallow and draining a relatively larger area, has very serious algae problems.

Method of Analysis

An estimate of nutrient pollution from phosphorus and nitrogen has been made based on techniques detailed in the Supporting Document (3). A total of 729 tons of nitrogen and 24,304 tons of phosphorus are estimated to enter streams in the basin each year. Table VII-2 delineates the estimates by hydrologic units. The Little Sioux River Basin contributes the heaviest single load of nutrients, followed by the Floyd River Basin.

TABLE VII-2

POTENTIAL NUTRIENT POLLUTION

Hydrologic Unit	Cropland (acre)	Potential Pollution Nitrogen (ton/year)	Potential Pollution Phosphorus (ton/year)
Rock River	468,842	2,344	70
Floyd River	532,176	2,661	80
Maple River	398,507	1,992	60
Little Sioux River	1,608,763	8,044	241
Other	1,852,544	9,263	278
TOTAL	4,860,832	24,304	729

The Supporting Document recommends remedial procedures to reduce wasteloads from agricultural cropland. Basically, the Supporting Document recommends that the soundest approach to pollution reduction involves soil conservation and sound management of fertilizers. The 1970 Conservation Needs Inventory was used to summarize treatment measures necessary to reduce surface runoff and limit soil losses to levels established by the Soil Conservation Districts (Table VII-3). The associated implementation costs were then developed based on these needs and cost estimates provided by the Soil Conservation Service (Table VII-4). The cost of treatment measures to reduce runoff from cropland was by far the largest cost segment since cropland would be more susceptible to runoff due to limited soil cover. Annual costs for the various types of treatment are also listed in Table VII-4. Total capital costs are shown in Table VII-5 and summarized on Table VII-6. The annual cost of the runoff control measures for the Western Iowa Basin is almost 358 million.

ANIMAL FEEDING OPERATIONS

Livestock constitute another important source of stream contamination. For the most part, farm animals are mostly mammals, which, like people, have vastly expanded in total number far beyond the balance they had with other life forms in prehistoric times. Mammals, unfortunately, have a general characteristic of being large contributors of wastes

TABLE VII-3

RUNOFF CONTROL MEASURES REQUIRED

WESTERN IOWA BASIN

Hydrologic Unit	Cropland Acres		Pasture Acres				Acres
	Terracing Stripcropping	Grade Stabilization	Diversions	Land Conversions	Critical Area Planting	Grassland Management	Woodland Management
Rock	103,361	22,427	5,554	0	1,183	1,205	3,078
Floyd	274,700	15,988	27,549	0	2,535	2,125	6,387
Maple	148,647	35,596	25,096	335	1,906	2,466	10,527
Little Sioux	410,642	146,719	50,572	0	13,371	14,934	40,245
Sub Total	937,350	220,730	108,771	335	18,995	20,730	60,237
Other	969,048	144,324	108,438	983	16,724	16,336	304,700
Total	1,906,398	365,054	217,209	1,318	35,719	37,066	364,937

TABLE VII-4

ANNUAL UNIT COSTS FOR STATEWIDE CONTROLS

WESTERN IOWA BASIN

Land Use	Total Cost	Total Acres	Capital Cost/Acre	Annual Cost/Acre
Cropland				
Stripcropping and Terracing	$824,677,000	7,932,499	$ 103.96	$5.00
Grade Stabilization	$638,440,000	1,873,037	$ 340.86	$1.50
Pasture				
Diversions	$ 7,003,000	610,660	$ 11.47	$5.00
Land Conversions	$ 29,647,000	16,682	$1,777.18	$2.00
Critical Area Planting	$ 8,002,000	715,003	$ 11.19	$1.00
Grassland Management	$ 9,296,000	229,332	$ 40.54	$1.00
Woodland				
Woodland Management	$160,080,000	2,055,435	$ 77.88	$2.00

TABLE VII-5

CAPITAL RUNOFF CONTROL COSTS BY SUBBASIN

WESTERN IOWA BASIN

	Cropland		Pasture					
Hydrologic Unit	Terracing Stripcropping	Grade Stabilization	Diversions	Land Conversions	Critical Area Planting	Grassland Management	Woodland Management	Total
Rock	$ 10,745,597	$ 7,644,426	$ 63,693	$ 0	$ 13,240	$ 48,845	$ 239,719	$ 18,755,520
Floyd	$ 28,558,309	$ 5,449,641	$ 315,930	$ 0	$ 28,371	$ 86,137	$ 497,428	$ 34,935,816
Maple	$ 15,453,611	$ 12,133,188	$ 287,799	$ 595,357	$ 21,331	$ 99,960	$ 819,857	$ 29,411.103
Little Sioux	$ 42,691,086	$ 50,010,371	$ 579,956	$ 0	$149,642	$ 605,351	$ 3,134,334	$ 97,170,740
Other	$100,743,984	$ 49,194,016	$ 1,243,558	$1,746,973	$187,168	$ 662,182	$23,730,439	$177,508,320
Total	$198,192,587	$124,431,642	$ 2,490,936	$2,342,330	$399,752	$1,502,475	$28,421,777	$357,381,499

TABLE VII-6

GENERAL RUNOFF TREATMENT COSTS*

WESTERN IOWA BASIN

Hydrologic Unit	Total Costs		
	Capital	Annual Operation and Maintenance	Annual**
Rock River	$ 18,756,000	$ 567,000	$ 2,338,000
Floyd River	$ 34,936,000	$1,553,000	$ 4,851,000
Maple River	$ 29,411,000	$ 948,000	$ 3,724,000
Little Sioux River	$ 97,171,000	$2,635,000	$11,808.000
Other	$177,508,000	$6,247,000	$23,004,000
Total	$357,782,000	$11,950,000	$45,725,000

* 1974 Dollars

** Annual O & M cost and capital cost amortized @ 7% for 20 years.

relative to other animal forms. Because of the large mammal population now present in the Western Iowa Basin, mostly swine, cattle and sheep, a pollution problem is present that did not exist a century or so ago. As stated in the introduction, animal wastes enter streams mainly in times of runoff.

Table VII-7 gives estimates of the population of cattle, swine, sheep and also poultry in the various hydrological units in 1971. Swine constitute, by far, the greatest number of animals in the basin.

Animal feedlots are the most easily identified of all sources of stream contamination by farm livestock. This is because they are relatively large and concentrated, and thus, highly visible and monitorable. Figure VII-1 gives the location of registered animal feedlots in the basin, and Table VII-8 gives a list of the feedlots. The table also lists the type of controls that each feedlot had effected.

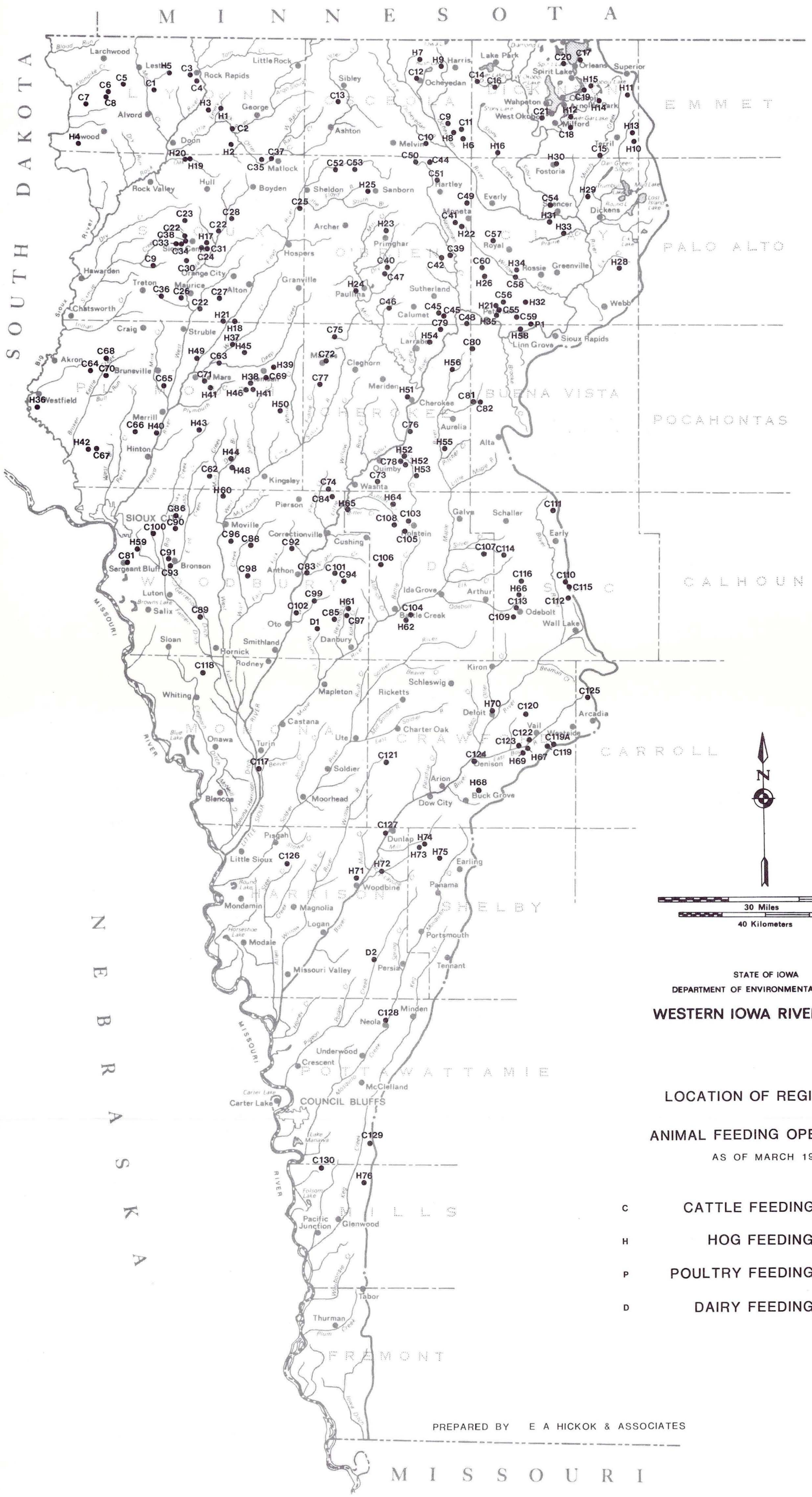
Supporting Document gives details on the pollution waste characteristics of animals. According to the Document, the example is given that 300 cattle will produce about 300 pounds of BOD_5 (a measure of impact on dissolved oxygen in waters) per day. That amount, according to the Document, is 5 times that produced by a person. However, animal feedlots do not discharge their wastes to streams directly or continuously. Periods of high runoff move the contaminants from their deposition site

TABLE VII-7

ANIMAL DISTRIBUTION

WESTERN IOWA BASIN

Hydrologic Unit	Cattle	Swine	Sheep	Poultry
Rock River	135,320	273,645	16,524	216,474
Floyd River	195,288	459,891	4,158	249,200
Maple River	104,160	271,921	6,520	201,296
Little Sioux River	335,717	936,569	32,381	884,593
Other	940,637	1,148,761	18,288	653,228
Total	1,711,122	3,090,787	77,871	2,204,791



STATE OF IOWA
DEPARTMENT OF ENVIRONMENTAL QUALITY

WESTERN IOWA RIVER BASINS

LOCATION OF REGISTERED

ANIMAL FEEDING OPERATIONS

AS OF MARCH 1975

C CATTLE FEEDING OPERATION

H HOG FEEDING OPERATION

P POULTRY FEEDING OPERATION

D DAIRY FEEDING OPERATION

PREPARED BY E A HICKOK & ASSOCIATES

FIGURE VII-1

TABLE VII-8

ANIMAL FEEDING OPERATIONS

WESTERN IOWA BASIN

Registration No.	County	No. Of Animals	Ref. No.	Type Controls*
	HOG FEEDING OPERATIONS			
2-11-00-4-01	Buena Vista	600	H-58	RC
2-18-00-4-01	Cherokee	NA	H-51	SB
" 02		1,200	H-52	SB
" 03		2,800	H-53	SB
" 04		500	H-54	SL
" 05		500	H-55	RC
" 06		400	H-56	ST
" 07		600	H-57	SB
2-21-00-4-01	Clay	720	H-26	SL
" 02		600	H-27	RC
" 03		320	H-28	ST
" 04		19	H-29	ST
" 05		600	H-30	ST
" 06		960	H-31	ST
" 07		500	H-32	ST
" 08		200	H-33	ST
" 09		500	H-34	ST
" 10		600	H-35	ST
2-24-00-4-01	Crawford	NA	H-67	NC
" 02		5,100	H-68	SL
" 03		4,480	H-69	SB
" 04		800	H-70	SL
2-30-00-4-01	Dickinson	500	H-10	ST
" 02		400	H-11	ST
" 03		10	H-12	ST
" 04		480	H-13	ST
" 05		1,380	H-14	ST
" 06		350	H-15	ST
" 07		800	H-16	ST
2-43-00-4-01	Harrison	360	H-71	RC
" 03		1,440	H-72	SB

TABLE VII-8 (cont.)

Registration No.	County	No. Of Animals	Ref. No.	Type Controls*
2-47-00-4-01	Ida	270	H-62	RC
" 02		500	H-63	ST
" 03		3,000	H-64	ST
" 04		1,600	H-65	SL
2-60-00-4-01	Lyon	800	H- 1	ST
" 02		400	H- 2	ST
" 03		800	H- 3	ST
" 05		800	H- 4	SB
" 07		400	H- 5	SL
2-65-00-4-01	Mills	480	H-76	ST
2-71-00-4-01	O'Brien	250	H-22	NC
" 02		500	H-23	NC
" 03		1,000	H-24	ST
" 04		240	H-25	ST
2-72-00-4-01	Osceola	200	H- 6	ST
" 02		360	H- 7	ST
" 03		1,100	H- 8	ST
" 04		1,050	H- 9	ST
2-75-00-4-01	Plymouth	300	H-36	ST
" 02		300	H-37	ST
" 03		475	H-38	ST
" 04		24	H-39	ST
" 05		560	H-40	ST
" 06		320	H-41	RC
" 07		720	H-42	ST
" 08		300	H-43	RC
" 09		360	H-44	NC
" 10		360	H-45	ST
" 11		560	H-46	ST
" 12		300	H-47	RC
" 13		240	H-48	RC
" 14		960	H-49	RC
" 15		250	H-50	ST
2-81-00-4-06	Sac	600	H-66	SL

TABLE VII-8 (cont.)

Registration No.	County	No. Of Animals	Ref. No.	Type Controls*
2-83-00-4-01	Shelby	20	H-73	ST
" 02		320	H-74	ST
" 03		360	H-75	RC
2-84-00-4-01	Sioux	350	H-17	ST
" 02		800	H-18	SB
" 03		480	H-19	SL
" 04		800	H-20	SB
" 05		700	H-21	ST
2-97-00-4-01	Woodbury	2,500	H-59	RC
" 02		480	H-60	RC
" 03		480	H-61	ST
	CATTLE FEEDING OPERATIONS			
2-11-00-0-03	Buena Vista	400	C-80	RC
" 05		275	C-81	RC
" 09		375	C-82	RC
2-14-00-0-02	Carroll	NA	C-125	NA
2-18-00-0-02	Cherokee	4,000	C-72	NC
" 04		5,000	C-73	SL
" 05		750	C-74	RC
" 06		NA	C-75	RC
" 07		300	C-76	ST
" 08		5,000	C-77	SL
" 09		180	C-78	ST
" 10		1,325	C-79	NC
2-21-00-0-01	Clay	NA	C-54	NA
" 02		350	C-55	RC
" 03		600	C-56	SL
" 04		500	C-57	ST
" 05		NA	C-58	NC
" 07		1,500	C-59	RC
" 08		900	C-60	NC
2-24-00-0-01	Crawford	500	C-119	RC
" 02		NA	C-120	RC
" 03		200	C-121	NC
" 04		4,000	C-122	RC
" 05		NA	C-123	NA
" 06		5,000	C-124	SL

TABLE VII-8 (cont.)

Registration No.	County	No. Of Animals	Ref. No.	Type Controls*
2-30-00-0-01	Dickinson	NA	C-14	RC
" 02		1,500	C-15	RC
" 03		1,500	C-16	RC
" 04		80	C-17	NC
" 05		400	C-18	NC
" 06		125	C-19	RC
" 07		600	C-20	RC
" 08		150	C-21	RC
2-43-00-0-01	Harrison	200	C-126	RC
" 02		1,500	C-127	RC
2-47-00-0-01	Ida	NA	C-103	NA
" 02		400	C-104	RC
" 04		400	C-105	RC
" 05		500	C-106	RC
" 06		400	C-107	RC
" 07		200	C-108	RC
2-60-00-0-01	Lyon	3,500	C- 1	NC
" 02		3,000	C- 2	RC
" 03		1,500	C- 3	NC
" 04		1,000	C- 4	RC
" 05		800	C- 5	ST
" 06		400	C- 6	RC
" 07		500	C- 7	RC
" 08		650	C- 8	RC
2-65-00-0-05	Mills	1,500	C-130	RC
2-67-00-0-01	Monona	1,000	C-117	RC
" 02		1,000	C-118	SL
2-71-00-0-01	O'Brien	10,000	C-39	RC
" 02		800	C-40	RC
" 03		2,000	C-41	RC
" 04		500	C-42	RC
" 05		250	C-43	RC
" 06		300	C-44	RC
" 07		500	C-45	RC
" 08		1,000	C-46	RC
" 09		450	C-47	RC

TABLE VII-8 (cont.)

Registration No.	County	No. Of Animals	Ref. No.	Type Controls*
2-71-00-0-10	O'Brien (cont)	400	C-48	RC
" 11		500	C-49	RC
" 13		300	C-50	RC
" 14		350	C-51	ST
" 15		3,300	C-52	SL
" 16		1,100	C-53	NC
2-72-00-4-01	Osceola	600	C- 9	RC
" 02		700	C-10	RC
" 03		700	C-11	RC
" 04		300	C-12	RC
" 05		2,000	C-13	RC
2-75-00-0-01	Plymouth	1,500	C-61	RC
" 03		NA	C-62	NA
" 04		150	C-63	RC
" 05		600	C-64	RC
" 06		200	C-65	RC
" 07		800	C-66	RC
" 08		30	C-67	RC
" 09		4,000	C-68	SL
" 10		800	C-69	RC
" 11		600	C-70	RC
" 12		250	C-71	RC
2-78-00-0-03	Pottawattamie	300	C-128	RC
" 04		NA	C-129	NA
2-81-00-0-01	Sac	9,000	C-109	RC
" 02		1,500	C-110	RC
" 03		1,200	C-111	RC
" 04		600	C-112	NC
" 06		500	C-113	RC
" 08		600	C-114	RC
" 10		300	C-115	NC
" 11		700	C-116	RC
2-84-00-0-01	Sioux	1,000	C-22	RC
" 02		2,500	C-23	RC
" 03		1,200	C-24	NC
" 04		500	C-25	NC

TABLE VII-8 (cont.)

Registration No.	County	No. Of Animals	Ref. No.	Type Controls*
2-84-00-0-05	Sioux	1,600	C-26	RC
" 06		1,500	C-27	NC
" 07		750	C-28	RC
" 08		1,650	C-29	NC
" 09		3,700	C-30	ST
" 10		850	C-31	RC
" 11		2,000	C-32	RC
" 12		10,500	C-33	SL
" 13		1,500	C-34	NC
" 15		NA	C-35	NA
" 16		650	C-36	NC
" 17		300	C-37	RC
" 18		1,153	C-38	NC
2-97-00-0-01	Woodbury	1,500	C-83	RC
" 02		950	C-84	SL
" 03		450	C-85	RC
" 04		200	C-86	RC
" 05		5,000	C-87	NC
" 06		450	C-88	RC
" 07		700	C-89	RC
" 08		300	C-90	RC
" 09		800	C-91	RC
" 10		200	C-92	RC
" 11		1,500	C-93	ST
" 12		600	C-94	RC
" 13		400	C-95	RC
" 14		150	C-96	RC
" 15		500	C-97	RC
" 16		550	C-98	RC
" 17		300	C-99	RC
" 18		120	C-100	SL
" 19		900	C-101	NC
" 20		900	C-102	RC
	DAIRY FEEDING OPERATIONS			
2-43-00-3-01	Harrison	120	D- 2	RC
2-97-00-3-01	Woodbury	100	D- 1	RC

TABLE VII-8 (cont.)

Registration No.	County	No. Of Animals	Ref. No.	Type Controls*
		POULTRY FEEDING OPERATIONS		
2-21-00-8-01	Clay	30,000	P-1	ST

* SB - Storage Basin
ST - Below Building Storage-or Tank
NA - Not Available
RC - Runoff Controls
SL - Lagoon
NC - No Control

to receiving waters, and at these times the load on the stream can exceed that of 1,500 people.

The quality of contaminant load actually reaching different streams from different livestock operations is quite variable. Type of lot surface, slope, precipitation, amount and distribution soil condition, distance to stream, terrain, concentration of animals all influence the impact of waste discharges.

Cattle densities in the Western Iowa Basin range from a low of 0.05 head per acre in the basins south of the Little Sioux River to a high of 0.30 in the Floyd River drainage area. Swine densities vary between 0.47 head per acre in the Little Sioux drainage area to 0.71 in the Floyd River drainage area.

With the small animal densities in the basin, quantitative calculations of contaminant loads from feeding operations were not warranted. As indicated in Table VII-8, registered feeding operations with a cumulative capacity for 146,363 cattle are designated at 129 locations. The remaining cattle in the study area are spread over about 5,850,000 acres of agricultural land. Similar dispersion of the swine, sheep, and poultry populations occurs in the basin.

The Supporting Document gives detailed pollution abatement methods for feeding operations. Generally, for swine and cattle operations, recommendations are made to design or re-design the feedlot or operation to isolate it from runoff waters to streams. Disposal of the wastes into debris basins and retention basins is recommended in the Document, with ultimate disposal on agricultural land. Disposal of poultry wastes in dry form onto agricultural land is also recommended.

Table VII-9 gives the estimated capital costs, in 1974 dollars, for treatment of cattle and swine operations in each hydrological unit of the basin. The Supporting Document details the methods used in arriving at these costs.

URBAN NONPOINT WASTES

Although runoff from different urban areas has certain common features, such runoff often has characteristics that are unique to different communities, or portions of communities. One common feature of urban runoff is that it differs substantially from rural runoff. The Supporting Document describes urban runoff characteristics and problems in detail.

Wastes from sources such as, for example, automobiles, occur in every community, although the size, traffic, and physical features of the community may cause wide variation in the nature of the wastes reaching streams. Certain communities may have unique industries that result in special urban runoff characteristics. Unusual contaminants may enter streams via deposition from airborne emissions and spillage from loading and unloading processes.

TABLE VII-9

LIVESTOCK TREATMENT COST*

Hydrologic Unit	Capital Cost Cattle	Swine	Total
Rock River	$ 527,380	722,240	1,249,620
Floyd River	761,095	1,213,810	1,974,905
Maple River	405,940	717,690	1,123,630
Little Sioux River	1,308,390	2,471,920	3,780,310
Other Basins	3,665,940	3,032,000	6,647,940
Total	6,668,745	8,157,660	14,826,405

* 1974 Dollars

Estimates of cost of treatment of urban runoff wastes have been made for this basin. These costs are given for this basin in Table VII-10. The urban storm water treatment costs were determined from a model considering dollars as a function of population and acreage. Values for each basin were determined by summing values for all communities located in each basin. The annual recurring costs were calculated at an annualized capital cost of 7% over 20 years, plus operating and maintenance cost of 12¢ per 1000 gallons per year.

COST SUMMARY

The Supporting Document gives a generally complete statement on the problem of nonpoint source runoff and the rationale behind the pollution abatement methodology recommended. Table VII-11 gives a summary of treatment capital costs needed to implement nonpoint pollution abatement in the Western Iowa Basin. Although urban areas are but a tiny fraction of the total land area of the basin, well over half the cost of runoff pollution abatement in the basin must be borne by urban runoff treatment programs.

Note, however, that treatment of rural runoff is greater in all basins except "other", while in the "other" category urban treatment ranks far ahead of monies needed for pollution abatement. The "other" category does include most of the larger cities in the basin, which are generally on the Missouri River, e.g., Sioux City and Council Bluffs.

TABLE VII-10

URBAN STORMWATER TREATMENT COSTS*

WESTERN IOWA BASIN

Hydrologic Unit	Capital Cost	Annual** Operation and Maintenance Cost	Total*** Annual Cost
Rock River	$ 17,310,000	$ 1,039,000	$ 2,673,000
Floyd River	40,480,000	2,429,000	6,250,00
Maple River	18,150,00	1,089,000	2,802,000
Little Sioux River	61,600,000	3,696,000	9,511,000
Other	254,600,000	15,276,000	39,310,000
Total:	$392,140,000	$23,529,000	$60,546,000

*1974 Dollars
** 6% of total capital cost
***Annual operation and maintenance cost and capital cost amortized at 7% for 20 years.

TABLE VII-11

SUMMARY NON-POINT TREATMENT CAPITAL COSTS

WESTERN IOWA BASIN

Hydrologic Unit	General Runoff	Livestock	Urban
Rock River	$ 18,756,000	$ 1,249,620	$ 17,310,000
Floyd	34,936,000	1,974,905	40,480,000
Maple	29,411,000	1,123,630	18,150,000
Little Sioux	97,171,000	3,780,310	61,600,000
Other	177,508,000	6,697,940	254,600,000
Total	357,782,000	14,826,405	392,140,000
Grand Total			764,748,405

SUMMARY AND CONCLUSIONS

Non-area sources contribute to stream contamination through discharge of their materials during times of runoff. This occurs with the more significant rains and seasonally during the spring snowmelt.

Three principal area sources of contaminants in runoff waters are agricultural croplands, animal feedlots, and urban lands. The Supporting Document recommends procedures for abating pollution from these three sources.

REFERENCES

1. Conservation Needs Inventory, Iowa Conservation Needs Committee, 1970.

2. Buffalo Bill Watershed Agricultural Runoff and Wasteland Allocation Study, Limnology Division, State Hygienic Laboratory, University of Iowa, Iowa City, Iowa, 1974.

3. Supporting Document for Iowa Water Quality Management Plan, Iowa Department of Environmental Quality, Water Quality Management Division, Des Moines, Iowa, 1976.

4. Iowa Annual Farm Census, 1971, compiled by the Iowa Crop and Livestock Reporting Service, published by State of Iowa, Des Moines, Iowa.

5. Management Plan for Water Quality Iowa Great Lakes, A report to the Dickinson County Board of Supervisors, Eugene A. Hickok and Associates, Wayzata, Minnesota, February, 1974.

6. Code of Iowa, Rules of Civil Procedure. 1973. Vol. II, Section 421.1 to 795.5.

7. Drainage Areas of Iowa Streams. United States Geological Survey, Des Moines, Iowa, 1974. Bulletin #7. 440pp.

8. Iowa Annual Farm Census. Department of Agriculture (Iowa), Des Moines, Iowa, 1971. Bulletin #92-AG.

9. Iowa Annual Farm Census. Department of Agriculture (Iowa), Des Moines, Iowa, 1972. Bulletin #92-AH.

10. Iowa Conservation Needs Inventory. Iowa Conservancy Needs Committee, United States Department of Agriculture, Des Moines, Iowa, 1970. 229 pp.

11. Low Flow Characteristics of Iowa Streams Through 1966. State of Iowa. Iowa Natural Resources Council, Des Moines, Iowa, 1970. Bulletin #10.

12. Report on the Investigation of Pollution of the Iowa River from Iowa Falls to Columbus Junction 1930-1935. State Department of Health (Iowa). Des Moines, Iowa, 1935. 74pp.

13. Stream Water Quality as Affected by Cattle Feedlot Runoff. State Hygienic Laboratory (Iowa), Iowa City, Iowa, 1973.

CHAPTER VIII

NEEDS AND COMPLIANCE SCHEDULES

WESTERN IOWA BASIN

ASSESSMENT OF NEEDS

Municipal Needs

The waste load allocation from Table VI-1 were compared to the present discharges (Table V-4). Facilities which could not meet their waste load allocation were evaluated as to their need for additional treatment capacity. Physical needs for effective municipal sewage control can be classified into:

1. New sewer systems and treatment facilities for certain unsewered communities.
2. Upgrading to adequate secondary treatment where the present treatment level is either primary or inadequate secondary.
3. Infiltration and/or inflow (I/I) removal.
4. Advanced treatment under selective circumstances.
5. Adequate sludge disposal.

An estimation of these needs and their associated cost has been developed for the municipalities in the Western Iowa Basin as shown on Table VIII-1. Several sources have been used to estimate costs. Some of these are listed below in order of priority.

1. Grant applications, based on preliminary engineering estimates or final construction costs.

TABLE VIII-1

MUNICIPAL

ASSESSMENT OF NEEDS

AND

SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	1990 Flow	Waste Load Allocation: Concentration BOD_5/NH_3	Waste Load Allocation: lbs.Eff. BOD_5/NH_3	Needs: Treatment	Needs: 1974 Dollars	Needs: Collection	Needs: 1974 Dollars	Schedule of Compliance: Facility Plans	Schedule of Compliance: Final Plans	Schedule of Compliance: Completion Date
1	Maurice M-31	.027	20/5	5/1	advanced waste treatment	E/ 173,000	---	---	11/1/76	9/1/77	1/1/79
2	Little Rock M-6	.04	10/4	3/1	advanced waste treatment	E/ 359,000	---	---	10/1/76	10/1/77	5/1/79
3	Sioux City M-37	20.66E	30/15	5170/2585	upgrade to secondary	GA/ 19,667,600	---	---	---	---	6/1/78 (1)
4	Spencer M-57	2.56	10/2	213/43	advanced waste treatment	NS/ 4,420,000	Improvement	NS/ 1,337,000	---	---	1/1/77 (1)
5	Orange City M-24	.516E	10/2	43/9	advanced waste treatment	E/ 717,000	---	---	4/1/77	4/1/78	1/1/80
6	Alton M-23	.153	---	C.D.	add 1 cell	E/ 118,000	---	---	---	---	---
7	Westside M-121	.039E	---	C.D.	add 1 cell	E/ 73,000	---	---	---	---	---
8	Sibley M-8	.356	13/3	40/9	advanced waste treatment	GA/ 1,280,000	---	---	9/1/75	3/1/76	11/1/77
9	Remsen M-26	.146	15/4	18/5	advanced waste treatment	E/ 544,000	---	---	7/1/75	1/1/76	7/7/77
10	Quimby M-78	.044E	---	C.D.	2 cell lagoon	C/ 107,000	---	---	---	---	---

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	1990 Flow	Waste Load Allocation: Concentration BOD_5/NH_3	Waste Load Allocation: lbs.Eff. BOD_5/NH_3	Treatment	Needs: 1974 Dollars	Needs: Collection	Needs: 1974 Dollars	Schedule of Compliance: Facility Plans	Schedule of Compliance: Final Plans	Schedule of Compliance: Completion Date
11	Council Bluffs M-140	6.62E	30/15	1656/828	no needs	---	---	---	---	---	---
12	Ida Grove M-100	.22	20/7	37/13	advanced waste treatment	C/ 1,413,800	---	---	---	4/1/76	11/1/77
13	Marcus M-88	.139	23/6	26/7	advanced waste treatment	E/ 526,000	---	---	4/1/76	4/1/77	11/1/78
14	Denison M-123	3.30	10/2	275/55	advanced waste treatment	NS/ 2,819,000	Interceptors, collectors & I/I analysis	NS/ 900,000	---	3/1/76	9/1/77
15	Galva M-97	.041E	10/7	3/2	advanced waste treatment	C/ 150,000	---	---	4/1/77	2/1/78	1/1/80
16	Ricketts M-110	.015	30/15	4/2	upgrade to secondary	E/ 79,000	---	---	2/1/77	11/1/77	11/1/78
17	Merrill M-35	.080E	---	C.D.	upgrade to secondary	C/ 46,900	---	---	---	---	---
18	Glenwood M-144	.820	20/5	137/34	advanced waste treatment	E/ 765,000	---	---	6/1/76	11/1/76	1/1/78 3/
19	Peterson M-69	.047E	---	C.D.	no needs	---	---	---	---	---	---
20	Alta M-95	.229	10/2	19/4	advanced waste treatment	E/ 1,004,000	---	---	8/1/76	6/1/77	10/1/78
21	Rock Rapids M-3	.290	10/2	24/5	advanced waste treatment	GA/ 2,215,700	---	---	---	3/1/76	3/1/78
22	Granville M-25	.038E	---	C.D.	add 1 cell	E/ 70,000	---	---	---	---	---

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	Waste Load Allocation: 1990 Flow	Waste Load Allocation: Concentration BOD_5/NH_3	Waste Load Allocation: lbs.Eff. BOD_5/NH_3	Treatment	Needs: 1974 Dollars	Needs: Collection	Needs: 1974 Dollars	Schedule of Compliance: Facility Plans	Schedule of Compliance: Final Plans	Schedule of Compliance: Completion Date
23	Hull M-12	.108	12/4	11/4	advanced waste treatment	GA/ 70,200	---	---	9/1/76	5/1/77	3/1/79
24	Cherokee M-77	.756	10/4	63/25	no needs	---	---	---	---	---	---
25	Aurelia M-94	.116	10/2	10/2	advanced waste treatment	E/ 556,000	---	---	1/1/76	10/1/76	9/1/78
26	Kiron M-117	.028	30/15	7/4	upgrade to secondary	E/ 120,000	---	---	---	---	---
27	Rock Valley M-13	.130	10/4	11/4	advanced waste treatment	E/ 1,100,000	---	---	9/1/76	6/1/77	7/1/79
28	LeMars M-28	1.09	10/2	91/18	advanced waste treatment	E/ 1,339,000	---	---	8/1/76	7/1/77	9/1/79
29	Sioux Rapids M-67	.081E	30/15	20/10	upgrade to secondary	E/ 319,000	---	---	11/1/76	10/1/77	5/1/79
30	Sanborn M-21	.255	15/4	32/9	advanced waste treatment	E/ 801,000	---	---	8/1/76	5/1/77	12/1/78
31	Sloan M-39	.087	30/15	22/11	upgrade to secondary	E/ 263,000	Interceptor & I/I analysis	NS/ 85,000	2/1/77	2/1/78	4/1/79
32	Ute M-109	.053	---	C.D.	add 1 cell	E/ 76,000	I/I analysis	NS/ 6,000	---	---	---
33	Hospers M-22	.065	---	C.D.	upgrade overloaded lagoons	E/ 312,000	---	---	---	5/1/76	9/1/77
34	Odebolt M-98	.156	10/2	13/3	advanced waste treatment	E/ 945,000	---	---	5/1/77	3/1/78	8/1/79
35	Oyens M-27	.015E	---	C.D.	add 2 cells	E/ 70,000	I/I analysis	NS/ 8,000	4/1/76	12/1/76	2/1/78

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	1990 Flow	Waste Load Allocation: Concentration BOD_5/NH_3	Waste Load Allocation: lbs.Eff. BOD_5/NH_3	Treatment	Needs: 1974 Dollars	Needs: Collection	Needs: 1974 Dollars	Schedule of Compliance: Facility Plans	Schedule of Compliance: Final Plans	Schedule of Compliance: Completion Date
36	IGLSD S-18	2.146	10/2	179/36	advanced waste treatment	E/ 3,300,000	---	---	---	10/1/76	5/1/79
37	Lawton M-92	.046E	---	C.D.	add 1 cell	E/ 76,000	---	---	2/1/77	9/1/77	2/1/79
38	Ashton M-9	.032	---	C.D.	none	---	---	---	---	---	---
39	Brunsville M-34	.013E	---	C.D.	add 1 cell	E/ 63,000	---	---	1/1/77	11/1/77	12/1/78
40	Doon M-11	.052	---	C.D.	add 1 cell	E/ 63,000	---	---	11/1/76	8/1/77	12/1/78
41	Anthon M-84	.091	30/15	23/12	upgrade to secondary	E/ 341,000	New collectors & I/I analysis	NS/ 32,000	---	---	---
42	Sheldon M-20	.605E	15/4	76/20	advanced waste treatment	GA/ 2,452,600	---	---	---	11/1/75	8/1/77
43	Sioux Center M-30	.695E	20/5	116/29	advanced waste treatment	GA/ 2,173,900	---	---	11/1/75	8/1/76	7/1/78
44	Underwood M-139	.073E	---	C.D.	add 1 cell	NS/ 159,000	I/I analysis	NS/ 23,000	5/1/77	4/1/78	9/1/79
45	Charter Oak M-108	.072E	---	C.D.	add 1 cell	E/ 85,000	New collectors & I/I analysis	NS/ 112,000	---	---	---
46	Ireton M-16	.042	30/15	10/5	upgrade to secondary	E/ 161,000	---	---	1/1/77	11/1/77	4/1/79
47	Washta M-80	.035E	---	C.D.	add 2 cells	E/ 78,000	---	---	7/1/77	1/1/78	5/1/79
48	Correctionville M-83	.163	30/15	41/20	upgrade to secondary	E/ 466,000	New collectors & I/I analysis	NS/ 41,000	---	---	---

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	1990 Flow	Waste Load Allocation: Concentration BOD_5/NH_3	Waste Load Allocation: lbs.Eff. BOD_5/NH_3	Treatment	Needs: 1974 Dollars	Collection	1974 Dollars	Schedule of Compliance: Facility Plans	Schedule of Compliance: Final Plans	Schedule of Compliance: Completion Date
49	Early M-115	.071	---	C.D.	add 1 cell	E/ 66,000	---	---	---	---	---
50	Pierson M-81	.047E	---	C.D.	add 1 cell	E/ 82,000	---	---	---	---	---
51	Lake Park M-44	.106E	---	C.D.	add 1 cell	E/ 97,000	---	---	5/1/76	2/1/77	11/1/77
52	Everly M-55	.109	---	C.D.	add 1 cell	E/ 97,000	---	---	---	---	---
53	Ruthven M-62	.053	---	C.D.	add 1 cell	E/ 93,000	---	---	---	---	---
54	Boyden M-29	.058	---	C.D.	add 1 cell	E/ 91,000	---	---	10/1/76	10/1/77	12/1/78
55	Tabor M-146	.0571	30/15	14/7	upgrade to secondary	E/ 323,000	Interceptor & I/I analysis	NS/ 69,000	---	---	---
56	Schaller M-96	.077	---	C.D.	add 1 cell	NS/ 96,000	Interceptor, collectors & I/I analysis	NS/ 170,000	---	---	---
57	Hartley M-54	.181	10/5	15/7.5	advanced waste treatment	E/ 950,000	---	---	11/1/76	9/1/77	12/1/78
58	Westfield M-18	.028	---	C.D.	add 1 cell	E/ 71,000	---	---	---	---	---
59	Alvord M-5	.018	---	C.D.	add 2 cells	E/ 65,000	---	---	9/1/76	6/1/77	12/1/78
60	Cushing M-82	.029	---	C.D.	construct lagoons	E/ 148,000	Interceptors & I/I analysis	NS/ 23,000	9/1/76	9/1/77	2/1/79

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	Waste Load Allocation 1990 Flow	Concentration BOD_5/NH_3	lbs.Eff. BOD_5/NH_3	Treatment	Needs 1974 Dollars	Collection	1974 Dollars	Schedule of Compliance Facility Plans	Final Plans	Completion Date
61	Onawa M-42	.593	30/15	148/74	upgrade to secondary	GA/ 500,000	---	---	3/1/76	2/1/77	9/1/78
62	Whiting M-40	.061E	---	C.D.	add 1 cell	E/ 72,000	---	---	---	---	---
63	Schleswig M-118	.088E	---	C.D.	add 1 cell	C/ 35,200	---	---	---	---	---
64	Inwood M-2	.076E	---	C.D.	add 1 cell	E/ 108,000	---	---	---	---	---
65	Kingsley M-89	.153	---	C.D.	add 1 cell	E/ 130,000	I/I analysis	NS/ 54,000	---	---	---
66	Terril M-60	.037	---	C.D.	add 1 cell	E/ 68,000	---	---	---	---	---
67	Larrabee M-75	.018E	---	C.D.	add 2 cell	E/ 69,000	---	---	2/1/77	9/1/77	2/1/79
68	Mondamin M-114	.048	---	C.D.	add 1 cell	E/ 74,000	---	---	---	---	---
69	Hornick M-91	.031	---	C.D.	add 2 cells	E/ 77,000	Collectors & I/I analysis	NS/ 20,000	8/1/76	6/1/77	1/1/79
70	Larchwood M-1	.072E	---	C.D.	add 1 cell	E/ 80,000	---	---	2/1/77	11/1/77	4/1/79
71	Meriden M-76	.016	---	C.D.	add 2 cells	E/ 65,000	---	---	12/1/76	10/1/77	6/1/79
72	Neola M-138	.166	30/15	42/21	upgrade to secondary	E/ 418,000	I/I analysis	NS/ 35,000	---	---	---
73	Cleghorn M-79	.030E	---	C.D.	add 2 cells	E/ 148,000	---	---	9/1/76	6/1/77	10/1/78

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	1990 Flow	Waste Load Allocation: Concentration BOD_5/NH_3	Waste Load Allocation: lbs. Eff. BOD_5/NH_3	Treatment	Needs: 1974 Dollars	Collection	1974 Dollars	Schedule of Compliance: Facility Plans	Final Plans	Completion Date
74	Arthur M-99	.038	---	C.D.	add 1 cell	E/ 70,000	---	---	---	---	---
75	Deloit M-119	.028E	---	C.D.	add 1 cell	E/ 72,000	---	---	---	---	---
76	Holstein M-101	.186	---	C.D.	add 1 cell	E/ 133,000	---	---	---	---	---
77	Hinton M-36	.044	---	C.D.	seal lagoons add 1 cell	3/ 84,000	---	---	---	---	---
78	Melvin M-19	.034	---	C.D.	construct lagoons	E/ 152,000	New system	E/ 359,000	---	---	---
79	Moville M-90	.160E	---	C.D.	construct lagoons	E/ 198,000	New collectors	NS/ 8,000	---	---	---
80	Mapleton M-104	.223E	30/15	29/15	none	---	---	---	---	---	---
81	Battle Creek M-102	.094	---	C.D.	add 1 cell	E/ 96,000	---	---	---	---	---
82	Danbury M-103	.065	---	C.D.	add 1 cell	E/ 83,000	I/I analysis	NS/ 4,000	---	---	---
83	Castana M-105	.022	---	C.D.	construct lagoons	E/ 142,000	New system	E/ 275,000	---	---	---
84	George M-7	.095	---	C.D.	add 1 cell	E/ 80,000	---	---	---	---	---
85	Lester M-4	.028	---	C.D.	construct lagoons	E/ 149,000	New system	E/ 323,000	4/1/77	1/1/78	5/1/79
86	Linn Grove M-68	.022	---	C.D.	construct lagoons	E/ 154,000	Interceptor, collectors, repairs & I/I analysis	NS/ 256,000	---	---	---

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	Waste Load Allocation 1990 Flow	Waste Load Allocation Concentration BOD_5/NH_3	Waste Load Allocation lbs.Eff. BOD_5/NH_3	Treatment	Needs 1974 Dollars	Collection	1974 Dollars	Schedule of Compliance Facility Plans	Schedule of Compliance Final Plans	Schedule of Compliance Completion Date
87	Akron M-17	.144	30/15	36/18	upgrade to secondary	E/ 383,000	---	---	1/1/77	9/1/77	1/1/79
88	Crescent M-133	.049	---	C.D.	construct lagoons	E/ 165,500	New system	NS/ 330,000	---	---	---
89	Salix M-41	.043E	---	C.D.	construct lagoons	GA/ 152,500	New collectors	NS/ 131,000	---	---	---
90	Thurman M-147	.028E	---	C.D.	construct lagoons	GA/ 213,000	---	---	---	---	---
91	Blencoe M-43	.023E	---	C.D.	construct lagoons	E/ 145,000	I/I analysis	NS/ 6,000	---	---	---
92	Fostoria M-59	.023E	---	C.D.	add 2 cells	GA/ 144,700	New collectors	NS/ 208,000	---	---	---
93	Paullina M-73	.146	---	C.D.	add 1 cell	E/ 91,000	---	---	---	---	---
94	Primghar M-71	.096	---	C.D.	none	---	---	---	---	---	---
95	Sutherland M-70	.096E	---	C.D.	add 2 cells	GA/ 97,400	---	---	---	---	---
96	Dickens M-61	.024	---	C.D.	construct lagoons	E/ 157,000	New system	NS/ 597,000	---	---	---
97	Calumet M-74	.023E	---	C.D.	construct lagoons	GA/ 166,200	New system	E/ 299,000	---	11/1/75	1/1/77
98	Webb M-63	.023	---	C.D.	construct lagoons	E/ 144,000	New system	E/ 263,000	---	---	---
99	Dow City M-126	.057E	---	C.D.	add 1 cell	NS/ 93,000	I/I analysis	NS/ 31,000	---	---	---

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	1990 Flow	Waste Load Allocation: Concentration BOD_5/NH_3	Waste Load Allocation: lbs.Eff. BOD_5/NH_3	Treatment	Needs: 1974 Dollars	Needs: Collection	Needs: 1974 Dollars	Schedule of Compliance: Facility Plans	Schedule of Compliance: Final Plans	Schedule of Compliance: Completion Date
100	Bronson M-93	.022E	---	C.D.	construct lagoons	GA/ 100,500	New system	NS/ 164,000	---	---	---
101	Pacific Jct. M-145	.062	---	C.D.	construct lagoons	E/ 177,000	New system	NS/ 1,027,000	---	---	---
102	Royal M-56	.048	---	C.D.	add 2 cells	E/ 77,000	---	---	---	---	---
103	Minden M-142	.074	---	C.D.	add 2 cells	E/ 185,000	New collectors &I/I analysis	NS/ 54,000	6/1/77	4/1/78	10/1/79
104	McClelland M-143	.025	---	C.D.	construct lagoons	E/ 146,000	New system	NS/ 143,000	---	---	---
105	Ocheyedan M-52	.040	---	C.D.	no needs	---	---	---	---	---	---
106	Dunlap M-127	.209E	---	C.D.	expand lagoons	E/ 225,000	---	---	12/1/76	12/1/77	11/1/78
107	Wall Lake M-116	.133	---	C.D.	add 1 cell	E/ 104,000	---	---	---	---	---
108	Vail M-122	.066	---	C.D.	add 1 cell	E/ 92,000	---	---	---	---	---
109	Arcadia M-120	.041E	---	C.D.	construct lagoons	GA/ 160,100	---	---	---	---	--- (1)
110	Arion M-125	.023	---	C.D.	construct lagoons	E/ 145,000	New system	E/ 299,000	---	---	---
111	Portsmouth M-136	.028	---	C.D.	add 1 cell	E/ 67,000	---	---	---	---	---
112	Pisgah M-113	.036E	---	C.D.	add 1 cell	E/ 79,000	---	---	---	---	---

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLIANCE

Rank	Discharger Ref. #	1990 Flow	Waste Load Allocation: Concentration BOD_5/NH_3	Waste Load Allocation: lbs.Eff. BOD_5/NH_3	Treatment	Needs: Treatment 1974 Dollars	Needs: Collection	Needs: Collection 1974 Dollars	Schedule of Compliance: Facility Plans	Schedule of Compliance: Final Plans	Schedule of Compliance: Completion Date
113	Moorhead M-112	.028E	---	C.D.	construct lagoons	C/ 300,400	---	---	---	---	---
114	Soldier M-111	.025E	---	C.D.	construct lagoons	GA/ 126,900	New system	GA/ 153,500	---	---	---
115	Smithland M-86	.033E	---	C.D.	add 2 cells	C/ 97,400	---	---	---	---	---
116	Missouri Valley M-130	.518E	---	C.D.	add 2 cells	E/ 315,000	---	---	---	---	---
117	Logan M-129	.224	30/15	56/28	upgrade to secondary	E/ 143,000	---	---	---	---	---
118	Woodbine M-128	.113	---	C.D.	add 1 cell	E/ 92,000	---	---	---	---	---
119	Modale M-132	.037E	---	C.D.	construct lagoons	GA/ 318,200	Interceptor & collectors	NS/ 401,000	---	---	---
120	Magnolia M-131	.026	---	C.D.	construct lagoons	E/ 146,000	New system	E/ 263,000	---	---	---
121	Earling M-134	.066	30/15	17/8	upgrade to secondary	E/ 221,000	---	---	12/1/76	1/1/78	2/1/79
122	Little Sioux M-107	.030	---	C.D.	construct lagoons	E/ 150,000	New system	E/ 287,000	---	---	---
123	Oto M-85	.023	---	C.D.	construct lagoons	E/ 144,000	New system	NS/ 251,000	---	---	---
124	Hawarden M-14	.192	30/15	48/24	none	---	---	---	---	---	---
125	Persia M-137	.040	---	C.D.	construct lagoons	E/ 160,000	Interceptor & collectors	NS/ 507,000	---	---	---

TABLE VIII-1
MUNICIPAL
ASSESSMENT OF NEEDS
AND
SCHEDULE OF COMPLAINCE

Rank	Discharger Ref. #	Waste Load Allocation: 1990 Flow*	Waste Load Allocation: Concentration BOD_5/NH_3	Waste Load Allocation: Lbs.Eff. BOD_5/NH_3	Needs: Treatment	Needs: 1974 Dollars	Needs: Collection	Needs: 1974 Dollars	Schedule of Compliance: Facility Plans	Schedule of Compliance: Final Plans	Schedule of Compliance: Completion Date
126	Panama M-135	.025E	---	C.D.	construct lagoons	(2)GA/ 200,600	---	---	---	---	---
127	Harris M-53	.016	---	C.D.	none	---	---	---	2/1/77	12/1/77	10/1/78

LEGEND

"C" Construction cost from Federal Grant records

"CD" Controlled discharge

"E" Engineering estimate

"GA" Cost from Federal Grant Applications

"NS" Cost from 1974 Municipal Needs Survey

(1) Construction of facility may be completed by publication of this plan

(2) includes collection system

Facilities presently without compliance schedule will be given dates as deemed necessary.

2. 1974 Needs Survey

3. EPA cost curves supplied for the 1974 Needs Survey.

4. State cost curves based on comparable construction costs.

All of the costs were updated to September, 1974, dollars based on EPA construction indices (1).

New Systems - Of the 148 incorporated municipalities in the basin, 17 do not have a sewage system. These communities are presently served by individual residence septic tanks and tile drain fields. Some of these communities have a disposal problem causing either water pollution, or a health hazard, or both. This may be caused either by old systems in need of repair or replacement, or because of unsuitable site conditions such as a high ground water table, local limestone deposits, or poor soil conditions.

Most unsewered communities have a waste water disposal problem, but whether it is cost effective to construct a sewer system and treatment plant or to replace or repair existing individual septic tank systems is difficult to estimate without a detailed engineering report.

For the purpose of this study it was assumed to be cost effective to continue using individual residence septic tank systems in those communities with projected 1990 populations of less than 200. It may also be cost-effective for certain towns with populations somewhat greater than 200 to continue the use of individual septic systems. However, increased potential for possible groundwater contamination and related health problems from the use of individual septic systems by larger communities must also be weighed in a cost-effectiveness evaluation. As a result, communities with projected 1990 populations greater than 200 were assumed to have a need for a sewer system and treatment facilities while communities with projected populations of less than 200 were assumed to have no needs.

Upgrade to Secondary Treatment - Two communities in the Western Iowa Basin have only primary treatment. All other municipal facilities provide what is commonly referred to as secondary treatment. The Act requires that all municipal treatment facilities shall, by July 1, 1977, have treatment equivalent to secondary treatment. Many municipal secondary plants, however, cannot presently, or with projected 1990 flow, meet the new EPA and the DEQ definition of secondary treatment. When compared with the quantitative definition. thirteen municipalities are estimated to have a need to upgrade their facilities to secondary treatment.

Upgrade to Advanced Treatment - The waste load allocations analyses have pointed out several locations where treatment more stringent than secondary will be required if water quality standards are to be met. Because the new waste load allocations will be incorporated into discharge permits, twenty-six municipalities now have the need for advanced treatment facilities.

Infiltration and/or Inflow Removal - Many municipalities have infiltration and/or inflow (I/I) problems. To estimate the cost to correct I/I problems in an individual case requires detailed information concerning the systems. Without such information an accurate cost estimation is difficult. Some municipalities have been studied by consulting engineers and correction costs estimated. In addition, the 1974 Needs Survey of Municipal Wastewater Treatment Plants provides the estimated cost to study and correct I/I for a 20 percent random sampling of Iowa municipalities. For those municipalities for which an I/I correction cost estimate was available, the cost for study and correction was updated and included in the costs column of the table of needs. For those municipalities where no estimate was available for I/I correction, no costs are included because of the difficulty in making an accurate estimate without detailed information about the system. It should be realized, therefore, that the total municipal needs for the basin will be greater than what is predicted in Table VIII-1.

Most cost estimates assume that, for a given facility, it is cost effective to remove I/I rather than treat it. If it is known from engineering studies that it is cost-effective to treat I/I, those costs are included with treatment plant costs.

Sludge Disposal - Sludge disposal is a major concern at any wastewater treatment plant. A secondary municipal treatment plant produces approximately 1726 lbs. of dry solids per million gallons of water treated, or approximately 173 lbs. per 1000 people per day. When an additional contribution comes from industrial wastes, sewage sludge can become the second largest disposal problem facing a municipality, next only to garbage disposal.

Unfortunately, the job of designing a sludge disposal system, historically, seems to have been done backwards (2). The conditioning and handling design was often completed before much thought was given to actual method and site of final disposal. A more logical method of design is to first choose the final disposal method and location and then work back from that point to the most cost-effective process for getting the sludge in the best condition to accommodate the mechanics of actual disposal.

Most municipal treatment facilities in the basin handle their sludge in similar manners. After settling to concentrate solids the sludge is stabilized either by aerobic or anaerobic digestion. Digested sludge is then usually either dried mechanically or on drying beds and finally hauled either to a landfill or farmland.

Farmland is the more common disposal location since many landfills, because of their location or equipment, cannot accept sewage sludge either wet or dry. Currently there are eight approved landfills in the Western Iowa Basin. Greater effort must be made to educate the farmer to the benefits of accepting treated sewage sludge for land application. Even though some sludges contain traces of toxic metals from plating industries making them undesirable for application to certain crops, most grain crops are not influenced by these metals and with proper controls can serve as application sites.

If weather is conducive for equipment to get into the fields wet digested sludge is often applied directly to farmlands. In fact, nearly all municipalities have sludge treatment equipment although most presently apply wet digested sludge directly to farmland allowing the sludge treatment equipment to lie idle. Drying beds, for example, often become relegated to a backup status as a method of sludge handling. This is done so as to reserve their entire capacity for the wet spring season when farm fields become inaccessible.

Land disposal of sludge has the advantage of being one of the simplest methods during winter months. It is also generally one of the most cost-effective methods.

Table VIII-2 gives an indication of sludge disposal costs found in Ohio.

One community in the state is presently experimenting with a method of combined sludge and garbage composting. In this process the ultimate disposal of the sludge would be as a salable soil conditioning agent. No conclusive results are as yet available from the project.

TABLE VIII-2

AVERAGE DISPOSAL COSTS (PER TON OF DRY SOLIDS)

Sludge Handling Method	Costs*
Vacuum filters, centrifuges	$34.41
Direct land application of liquid (Hauling by contract)	31.93
Drying beds (On-site storage for private individual hauling may reduce cost)	14.34
Direct land application of liquid (By city-owned trucks)	7.73

*Costs do not include digestion.

Costs to upgrade or to add additional sludge handling capacity that may be required under the basin plan have not been estimated for the municipalities in the basin. This is because a detailed knowledge of the existing facilities, not presently available, is needed for an accurate estimate. Also in many cases, the cost should be small when compared with that to upgrade the existing treatment. This is therefore another reason why the total municipal need for the basin will be greater than what is predicted in Table VIII-1.

TABLE VIII-3

SUMMARY OF MUNICIPAL TREATMENT NEEDS

WESTERN IOWA BASIN

Treatment Type Need	Number of Municipalities	1974 Dollars
Three cell lagoon	27	$ 4,505,600
Add 2 lagoon cells	12	1,369,800
Add 1 lagoon cell	46	3,895,200
Advanced Waste Treatment	22	18,829,500
Upgrade to Secondary	16	34,695,400
Maintain septic tanks	13	0
No need	9	0
Collection System needs	40	8,554,500
TOTAL		$71,850,000

Summary of Municipal Needs - Table VIII-1 is a compilation of municipal treatment facility needs for the Western Iowa Basin. In this table, projected 1990 flows are listed along with concentrations and pounds of BOD_5 and ammonia nitrogen allowed in the effluent at critical periods for the 1990 discharge, the treatment and collection needs and a compliance schedule for meeting the waste load allocations. A permit will be issued by the DEQ to the municipalities which will assure compliance with the basin plan. Table VIII-1 is arranged by rank, i.e., the highest ranking discharger to the lowest.

Table VIII-3 summarized the basin municipal treatment facility needs and the related investment requirements for the Basin. The estimated municipal treatment needs total over $85 million dollars.

Industrial Needs

Iowa has become increasingly more industrialized. Many industries are agriculturally oriented, such as meat packing and processing, dairy and cheese processing, fertilizer and pesticide production, wet grain milling, and rendering. All of these are "wet" industries (using large quantities of water) and produce inordinately large amounts of waste which are difficult to treat by conventional methods. In the Western Iowa Basin most of the industries discharge to municipal treatment facilities. Sometimes they cause an overload condition upon the municipal plant.

Some industries have their own treatment facilities such as Farmland Foods Inc. and Iowa Beef Processors at Denison; Terra Chemicals and Flavorland-Hide Division at Sioux City; Swift Packing Company at Glenwood; Linn Grove Rendering at Linn Grove; and Wall Lake Processing at Wall Lake. All of the above with the exception of Linn Grove Rendering and Wall Lake Processing have lagoon systems and relatively high amounts of ammonia. These industries have been identified as significant dischargers and have treatment needs.

The DEQ, through the State Operation Permit Program, in coordination with the Federal NPDES Discharge Program will regulate industrial dischargers. Effluent limits are set according to the waste load allocations. BPT is the minimum allowable allocation.

Table VIII-4 lists the significant industrial discharges in the basin, their present discharge, waste load allocation, projected need, and a compliance schedule. A permit will be issued by the DEQ to the industry, which will assure compliance with the basin plan.

According to the schedules of compliance for the significant industrial dischargers, reduction of industrial waste loads of 71% and 81% of BOD_5 and ammonia nitrogen, respectively, is expected. This reduction is estimated to cost the industries approximately 2.5 million dollars. This cost estimation was derived from a DEQ survey of the significant industries where available, or by the use of the municipal treatment cost curves.

TABLE VIII-4

TREATMENT NEEDS AND SCHEDULE OF COMPLIANCE
FOR
MAJOR INDUSTRIAL DISCHARGERS*
WESTERN IOWA BASIN

Industrial Discharger	Present Flow (mgd)	Present BOD_5	Eff.Lbs. NH_3	7-1-77 BOD_5	Eff.Lbs. NH_3	Treatment Needs	Schedule of Compliance Facility Plan	Final Plan	Completion Date
Linn Grove Rendering Linn Grove I-17	.018	19	1	3	2	Additional BOD_5 and NH_3 removal	-	-	-
Wall Lake Processing Corp., Wall Lake I-28	.003	129	19	5	1	Additional BOD_5 and NH_3 removal	-	3/31/76	9/1/76
Farmland Foods Inc., Denison I-31	1.00	542	834	33	25	Additional BOD_5 and NH_3 removal	-	-	7/1/77
Iowa Beef Processors, Inc., Denison I-32	.477 (1)	267	-	33	25	Additional BOD_5 and NH_3 removal	-	6/1/75	7/1/77
Terra Chemicals, Sioux City I-92	1.02	500	152	255	84	Additional BOD_5 and NH_3 removal	6/1/75	4/1/77	10/29/79
Flavorland-Hide Div., Sioux City I-88	.242 (2)	115	-	120	60	Additional NH_3 removal	6/1/75	12/1/75	1/1/77
Flavorland-Beef Div., Sioux City I-57	.46	400	41			Connect to municipal STP	-	-	-
Swift Packing Co., Glenwood I-52	.49 (3)	102	49	158	8	Provide controlled discharge for effluent	-	-	7/1/77

"*" as defined by DEQ

(1) Future waste flow expected to increase by factor of 2

(2) Future waste flow expected to increase by factor of 3

(3) Future waste flow expected to increase by factor of 1.7; no discharge at flows less than 5 cfs in Keg Creek. 20# BOD_5 and 8# NH_3 allowed per cfs greater than 5 cfs

Semipublic

The major semipublic wastewater disposal problem is water treatment plants. Many of these plants use lime (calcium hydroxide) to soften the water before distribution. The sludge created poses a significant disposal problem.

Most facilities lagoon the sludge, but this does not answer the final disposal problem of what to do when the lagoons are full. Some plants discharge their lime sludge directly to the river. These plants are currently studying methods to eliminate such discharges.

Lime sludge does have an economic value if handling problems can be overcome. The sludge can be used for landfill, or as a pH buffer on farmland which has acidic soil. Recently concrete manufacturers have expressed an interest in the material, since it is one of the major ingredients in their product.

As pressure is brought to bear on water treatment plants from Government agencies and landowners located adjacent to sludge lagoons, lime sludge disposal will receive greater attention.

An estimate of semipublic needs and related costs to meet the Basin's plan has not been performed due to a lack of information detailing the facilities.

Non-Point Source Needs

Non-point source of pollution have been divided into the three main areas of general rural runoff, animal feeding operations, and urban nonpoint sources. Each of the three areas has been discussed in Chapter VII and in the Supporting Document (3).

General Rural Runoff - The major pollution parameters in general rural runoff have been classified as sediment, nutrients, and organics. Sediment is usually the parameter of most significance.

Nutrients can also be of major significance especially if they will affect near-by lakes or impoundments. Runoff from cropland is a major source of nutrients. Nutrient pollution abatement is accomplished through improved methods of fertilizer application and implementation of the same measures used to control soil loss.

Except where runoff occurs from animal feeding operations, organics are usually of relatively minor importance, especially when compared with the contribution from municipalities.

Physical needs for abating general rural runoff pollution reduce to those methods employed for controlling soil loss. These methods have been discussed in some detail in Chapter VII of the plan. An estimate to implement such control measures in the Western Iowa Basin was presented. The estimated capital investments amounted to approximately 358 million dollars.

Animal Feeding Operations - The major pollutants from animal feeding operations are suspended solids, nutrients, and organics. Physical needs to control these sources of pollution have been summarized as including debris basins and retention basins, with land application for final disposal. These methods have been discussed in some detail in Chapter VII of this plan. An estimate to implement such control measures in the Western Iowa Basin was presented. The estimated capital investments amounted to approximately $14.8 million dollars.

Urban Nonpoint Sources - An estimate of the physical needs and costs involved in the correction, containment, and/or treatment of urban runoff was prepared on a general basis for each municipality and presented by hydrologic units. The estimated capital investments are approximately $392 million dollars. These estimates are approximations but they do reflect the magnitude of the problem. This is an area of the basin plan that will receive greater emphasis in future revisions.

Summary of Needs

The total dollar need to meet the objectives of this basin plan for the Western Iowa Basin is estimated to exceed 852 million dollars. This amount is broken down in Table VIII-5.

TABLE VIII-5

SUMMARY OF NEEDS

WESTERN IOWA BASIN

Need	Approximate Dollars*
Municipal Treatment	$ 63,295,500
Municipal Collection and Combined Sewer Overflow Correction	8,554,500
Industrial Treatment (Significant Industries)	2,470,000
Animal Feeding Operation Controls	14,826,000
Soil Loss Controls	357,782,000
Urban Storm Water Runoff Controls	392,140,000
TOTAL	$839,068,000

REFERENCES

1. Sewage Treatment Plant and Sewer Construction Cost Index, U.S. EPA Office of Water Program Operations, Municipal Construction Division.

2. Manson, R.J. and Merrit, C.A., "Land Application of Liquid Municipal Wastewater Sludge", Water Pollution Control Federation Journal, Vol. 47, No. 1, January 1975.

3. Supporting Document For Iowa Water Quality Management Plans, Iowa Department of Environmental Quality, Water Quality Management Division, Des Moines, Iowa, 1976.

CHAPTER IX

CONCLUSIONS AND RECOMMENDATIONS

WESTERN IOWA BASIN

As stated in the introduction, the objective of this basin plan is to provide the framework for achieving the protection and maintenance of surface and ground water quality in the Western Iowa Basin. Its implementation will help in attaining that objective.

CONCLUSIONS

Several significant conclusions have been identified during the development of this plan.

These include:

1. The Western Iowa Basin currently has 148 incorporated municipalities with a total population of 292,214. The population of these municipalities is projected to increase by 23 percent to 360,859 by 1990.
2. Of the incorporated municipalities, 131 currently have collection and treatment facilities and 17 communities have no central sewage system. Many of the treatment facilities are presently not achieving secondary treatment standards.
3. The waste stabilization lagoons serve 47 percent of the municipalities and a large number of

industries within the basin.

4. A number of water pollution instances have been documented in the basin due to point source discharges. Most of these instances have occurred at stream flows well above the 7-day, 1-in-10 year low flow.
5. Waste load allocations have shown that a significant number of dischargers will be required to provide advanced waste treatment to meet water quality standards at the 7-day, 1-in-10 year low streamflow. Waste load allocations have been made on the Rock, Floyd, Little Sioux, Boyer, and Maple Rivers, and Keg Creek.
6. Most industries should be able to meet the July 1, 1977 requirements of the Act. A high percentage of municipalities will also meet this deadline. Extended construction schedules and lack of adequate grant funding will undoubtedly result in some municipalities not meeting the deadline. The 1983 goal requiring all streams to be of suitable water quality to be fishable and swimmable can be met if Federal funding is continued.
7. The water quality strategy for point sources, as outlined in the plan, should result in maintaining acceptable surface water quality for designated uses.

8. The basin plan has demonstrated (Chapter VIII) a need in the Western Iowa Basin for municipal treatment and collection facilities which may exceed a cost of 85 million dollars.

9. The evaluation of adequacy and improvement needs for municipal wastewater treatment facilities has been hampered by a current lack of available information on the status of combined sanitary/ storm sewers and on the extent of sewer infiltration. It would appear, in several instances, that treatment facilities are either overloaded or overdesigned because of basic sewerage problems which deserve more direct attention.

10. At present, there is no organized information available as a base for evaluating the sewer and treatment needs of unsewered communities or private point source dischargers. In cases where obvious water quality problems are identified, sewer and treatment facilities are recommended to replace individual on-site disposal systems. But, for planning purposes, information should be developed regarding soil characteristics, ground water pollution potential, etc. to screen out those communities or point source dischargers with definable needs for municipal sewage treatment systems.

11. Current methods for estimating municipal project costs are non-systematic. An adequate basis of historical cost data and other correlary information with which to develop a much improved method for project cost estimation should be established.

12. There are several planning areas where currently available information is inadequate. In many instances, the basic data are available in one form or another, but manpower and/or time limitations did not allow for their proper processing or application to the planning study. In other instances, the required data base is simply lacking and must be built up over a period of time.

The more significant areas of planning information deficiency are briefly described below:

a. Current information appears, in several instances, to be incomplete, out-dated and lacking in important descriptive details. A comprehensive state-wide survey of industrial wastewater sources may be invaluable to support both basin planning and routine water pollution control activities.

b. Comprehensive, up-to-date estimates of 5-day BOD loading and discharge volume for all municipal and industrial sources within each basin is inadequate for planning purposes. Some of the required information is potentially available from the DEQ's EQAP files, but should be augmented and up-dated by new data. A screening process for data should be instituted to mimimize erroneous entries or obviously inconsistent data.

c. Complete, authoritative estimates of nutrient loading (i.e., phosphorous and nitrogen) into streams and lakes from point and area sources within each basin would be valuable.

d. Estimates of low-flow probabilities and assimilative capacities for minor streams in the basin do not exist. The flow characteristics along selected reaches of larger rivers and tributaries have been measured, and modeled in terms of assimilative capacity. More extensive modeling of Iowa's major river systems is required for use as a base in estimating future waste loads within all basins and watersheds. Also, for the minor streams there is a definite need for authoritative estimates of low-flow probability and assimilative capacity; otherwise, there is no quantitative basis for evaluating significance of waste loadings into local receiving waters.

13. Sediment, which often carries other pollutants with it, is a significant pollution parameter in Iowa. Proper land and water management can minimize soil erosion. Effort should be made to continue and increase the use of established soil conservation practices. A few of these practices involve only alternate land management with greater benefit resulting from the same monetary outlay. This can also be true for certain pollutants carried with sediment.

    Pesticides in the environment can be reduced by using soil conservation practices and fertilizer loss can be minimized by application methods which assure efficient uptake by crops. Farmers, developers, communities, counties, and individuals can all help in these and many other ways.

14. All lakes and reservoirs in the basin are subject to potential eutrophication from rural and urban runoff. This problem is intensified in the Iowa Great Lakes area because of its regional and recreational value.

15. Land disposal of digested municipal sewage sludge is the most economical ultimate disposal method

currently utilized in the planning area. However, problems have arisen as a result of the unpermitted practice of disposing of sludge in sanitary landfills, and careless practices in farmland disposal.

RECOMMENDATIONS

The following recommendations are made for further consideration and study:

1. Additional qualitative stream monitoring (BOD_5, dissolved oxygen, ammonia) during low flow conditions should be undertaken to refine the waste load allocation program. For minor streams, low flow probabilities and determinations of assimilative capacity should be made. Also, additional data concerning physical stream characteristics, such as stream width, depth, slope, roughness, coefficients, etc. should be established.
2. Those communities faced with advanced waste treatment requirements should include, where soil and other conditions permit, as part of their Step 1 Facilities Plan, an evaluation of land application techniques, oriented toward utilization of the treated wastewater as a valuable agricultural resource.
3. Complete retention lagoons rather than small mechanical treatment plants should be considered for fulfilling waste treatment facility needs where

applicable, in view of the national goal of zero discharge of pollutants by 1985. In Step 1, Facilities Plans, appropriate considerations should be given to joint treatment possibilities for municipalities and industries. In addition, the Facilities Plan should include an evaluation of upgraded treatment alternatives versus other alternatives such as relocating discharge points and flow regulation. The communities, assisted by the Department of Environmental Quality are responsible for considering this in their plan alternatives.

4. There is a definite need to make waste load allocation studies during other than low flow conditions, at such times when contributions from non-point sources could be relatively large compared to point sources.

   Agricultural and natural pollution loadings should be systematically estimated on a watershed unit basis for each basin. Concentrated analysis should be directed toward specific water quality problem areas where eutrophication and high bacterial concentrations are associated with such similar non-point sources.

An expanded pilot study similar to that done in the Buffalo Bill Creek Watershed, for assessing nonpoint source pollutant contributions should be undertaken. This study should evaluate the contributions of sediments,nutrients and pesticides from agricultural areas, compare the relative contributions from various conservation practices, and suggest remedial measures.

5. Each basin plan should devote attention to non-conventional waste source problems such as radio-active wastes, thermal pollution and potential pollution problems from stored liquids
6. Consideration should be given toward designating two new 208 area-wide planning regions, one for Sioux City and environs, and the other for the Council Bluffs-Omaha region.
7. The formation of an intergovernmental water quality management agency for the Iowa Great Lakes region is recommended, for the purpose to protect the lakes from future enrichment of pollutants, especially phosphorus.
8. Establishment of specific waste load allocations has indicated certain areas where regionalization of facilities should be considered. It is recommended that detailed evaluations should be performed as an

element of the Section 201, Step 1 Facilities Planning for regionalization of waste treatment facilities in the Denison area, to include the City of Denison, Iowa Beef Processors, Inc. of Denison and Farmland Foods, Inc. of Denison.

9. Additional monitoring stations for measuring sediment loads should be chosen and additional data gathered to further quantify the magnitude of this problem.

10. Non-structural management measures that can enhance and protect water quality should be given careful consideration by all levels of government, business interests and private citizens. Some such measures include:

    a. Improved operation and maintenance of all waste treatment systems. Small communities may be able to accomplish this goal by sharing qualified operators and laboratory facilities. In addition, wastewater plant operator training should receive emphasis.

    b. Land use planning and zoning decisions should include considerations of water quality. This is particularly important where lake shore development occurs.

    c. Local government should consider the impact on water quality before making commitments for new development or industry.

d. Tillage practices should be selected that will minimize soil erosion.

e. Woodland management practices should be selected that will minimize soil erosion.

f. Agricultural chemicals should be applied at rates and times that will minimize runoff of fertilizers and herbicides.

g. The design of any new or expanded industrial or commercial facilities should give careful consideration to minimize the amount of waste products that will be discharged from that facility.

h. Recycling should be encouraged and selected even when marginally cost-effective on the assumption that the cost of all natural resources will increase in the future.

i. Strict enforcement of local ordinances should be practiced. Such ordinances should include provision for rigid inspection of all new sewer construction and connections.

j. County Boards of Health should adopt and enforce individual waste disposal system regulations promulgated by the State Health Department.

k. Sanitary districts should be established to provide sewerage services to unincorporated areas.

l. It is known that urban runoff contains metals and other pollutants, but their impact on downstream water uses needs further studies. Urban runoff can be controlled by storage and treatment. Economic feasibility studies should be performed for all major municipalities.

m. Land disposal of digested municipal sewage sludge is the most economical ultimate disposal method presently used. Departmental policy should address this disposal problem. A program could be mounted to educate the rural community of the economic advantages of accepting this material.

n. At the community and county level, zoning and land use planning should be used to assure an orderly and efficient development of unsewered areas.

11. Structural measures will, of course, also help to protect water quality. Many of the structural measures required in the basin are outlined in the needs table.

12. The State Water Plan, which is currently under development, should give careful consideration to water quality. Consideration should also be given to limiting use classifications in water quality limited segments.

CHAPTER X - REVIEW AND REVISION

PUBLIC HEARING PROCEDURE

Public hearings are specified by the Federal Water Pollution Control Act Amendments of 1972 as part of the procedure for establishing a water quality management plan for river basins. In accordance with Section 101(e) of the Act, public participation was required on significant elements of the planning process.

Statements or presentations given at public hearings were required to be retained in writing for the record. Verbal comments and written statements were specified to be limited to the Water Quality Management Plan. Written statements were requested to be submitted to DEQ at least one week prior to the hearing. Additional statements, filed within ten days after the scheduled hearing, were also considered part of the record.

"Reasonable Notice" was given to the public by prominent advertisement, indicating time, date, place, and availability of proposed plan, 30 days prior to the date of each hearing. Complete records of such hearings are kept and a transcript made available on payment of fee.

WATER QUALITY STANDARDS REVIEW

The Federal Act specifies that at least every three years, starting from date of enactment of the 1972 Amendments, the Iowa Water Quality Commission hold public hearings for purpose of review, and/or revision, of the Iowa Water Quality Standards. The 303(e) process, including this basin plan developed as part of the process, is used to assist in making any necessary revisions of Iowa Water Quality Standards. The Iowa Water Quality Standards are scheduled for revision in 1976.

BASIN PLAN REVISION

This Basin Plan is Phase I of the annual continuing planning process as required by section 303(3) of the Act. This basin plan will be revised under Phase II in such manner as is necessary to maintain its viability. Thereafter, this Basin Plan will be reviewed annually and revision will be made if warranted. Revision to the wasteload allocations, compliance schedules, or construction grant needs and priorities will be based on the most current and accurate data available.

BASIN PLAN HEARING

A public hearing concerning the adoption of the proposed Western Iowa Basin Water Quality Management Plan was conducted by the Department of Environmental Quality. The hearing was held January 13, 1976, at 7:30 p.m. at the Morningside College Commons, Morningside College, 3609 Peters Street, Sioux City, Iowa. A copy of the public notice announcing the hearing appears in this chapter.

Identified in the following list are persons who attended the hearing:

Name	Representing
Don Meisner	SIMPCO
Ronald L. McIntosh	Terra Chemicals International
Jerry Cole	Otto Engr. Co.
Charles R. Trautman	Self
Wm. J. Rush	City of Sheldon
Richard A. Wilford	City of Sioux City
Bernard E. Poppenga, P.E.	DeWild, Grant, Reckert & Assoc. Co.
David Stoklasa	Howard R. Green Co.
Richard W. Hall	SCS
Tom Weeks	Consulting Engineer
Calvin Tininenko	Farmland Foods, Inc.
Steven Jm. Saufley	Farmland Foods, Inc.
Neal R. Kuehl	Otto Engineering Co.
Mrs. Bob Zimmerman	Self
Bob Zimmerman	Self
Steve Jauron	ICC
Richard L. King	Brice, Petrides & Assoc.
Larry E. Thompson	Terra Chemicals Int. Inc.
Ken Baldwin	Briar Cliff College
Ronald Tague	City of Hinton
Steve Sundquist	H. Gene McKeown & Assoc., Inc.
Jane Hey	Briar Cliff College
W. S. Kane	Iowa Public Service
J. Thomas Kenny	SCS
Richard C. Engle	Iowa Public Service Co.

Name	Representing
L. V. Kuhl	Sioux City Stockyards
Bill Persinger	Wilson Trailer Co.
Les Vanderlugt	DeWild, Grant, Reckert & Assoc.
Allen Jay Marshall	City of Missouri Valley
Ross Sorensen	Self

NOTICE OF PUBLIC HEARING

The Iowa Department of Environmental Quality (DEQ) will hold public hearing concerning the adoption of the proposed Water Quality Management Plan for the Northeastern Iowa Basin on December 30, 1975 at 7:30 p.m. at the 9th St. Fire Station 9th St & Central, Dubuque, Iowa. In event of inclement weather condition, the hearing will be held one week later, on January 6, 1976, same time, same place.

The Water Quality Management Plan is specifically directed toward satisfying the requirements of Section 303(e) of the Federal Water Pollution Control Act, as amended, Public Law 92-500, 86 Statute 849 (1972); (33 United States Code Annotated 1313(e). The purpose of the Water Quality Management Plan is to identify the water quality problems of the Northeastern Iowa Basin and to set forth a program to correct the problems.

The public hearing (held pursuant to Subsection 455B.32(7) of the Code of Iowa and 40 Code of Federal Regulation Part 131.502 (Federal Register, Volume 39, 19643, June 3, 1974) will give the public opportunities for expression of views to DEQ as well as provide for total public disclosure of the Water Quality Management Plan.

Oral and written statements presented at the hearing will be retained in the written record of the hearing. Statements should be limited to the subject matter of the Water Quality Management Plan for the Northeastern Iowa Basin. Time limits may be set on oral presentations at the discretion of the hearing officer so that all wishing to speak may be heard. Written statements may be submitted to DEQ prior to the hearing and at the hearing. Written statements received within ten days after the hearing will also be considered part of the hearing record. Complete records of the hearing will be kept and transcripts will be available upon payment of a duplication fee. The final Water Quality Management Plan will include a description of any major objections raised during the period for public comment and the disposition of such objections. The plan will become effective after approval by the Iowa Water Quality Commission, the Governor of Iowa and the U.S. Environmental Protection Agency.

A copy of the proposed plan will be available for inspection in the City Clerk's Office in the county seat of each county located in, or partially in, the Northeastern Iowa Basin. Copies will also be available for inspection in the DEQ regional offices located in Manchester, Mason City, Spencer, Washington and Council Bluffs, and in the main office in Des Moines. Written statements and requests for additional information should be addressed to the Water Quality Management Division, Iowa Department of Environmental Quality, 3920 Delaware, P.O. Box 3326, Des Moines, Iowa 50316, telephone 515/265-8134.

WATER QUALITY MANAGEMENT DIVISION

Joseph E. Obr, P.E., Director

3920 Delaware Ave., P.O. Box 3326, Des Moines, Iowa 50316 • 515/265-8134

The substantive comments (both written and oral) for all six basin plans presented at the hearings and/or directly submitted to the DEQ office in Des Moines, have been compiled. Responses made by the DEQ staff were then presented to the Iowa Water Quality Commission. Those commenting on the plan included federal and state agencies, county and local governments and agencies, industrial organizations, local citizens and special interest groups. Many of these comments have been adopted or substantially justified by change, deletion from, or additions to the basin plans. The Commission approved the plans and copies along with the comments and responses were sent to the Region VII office for EPA's approval. Oral and written statements presented at the hearings are available at the DEQ office for inspection. Copies may be obtained from the DEQ for a reproduction fee.

The DEQ has revised the plans in responses to issues raised, which could be resolved easily and not slow the progress of the study. If, however, it cannot readily be resolved and is a major issue, the issue will be addressed in Phase II of the planning process.

The water quality standards and the stream classifications will be reviewed in 1976. The DEQ, in cooperation with the Iowa Conservation Commission, will evaluate stream use and classification. The chemical and physical parameters listed in the standards will also be subject to review. Public hearings will be held prior to commission approval.

The stream segment and discharger ranking methodology, as required by Sec. 303(e) of the Act, may be the basis for future construction grant funding. Before any future grant priority list is compiled, which may be based on new priority formulas, the methodology will be reviewed and public hearings held. The discharger ranking used in the basin plans basically assumes that dischargers creating the greatest impact on water quality will be addressed more quickly than dischargers with less impact. This methodology will be expanded before it is used for the construction grant ranking.

New data regarding the seven-day ten-year low flow is now available and new population projections are expected. This will necessitate updating many waste load allocations in the Phase II planning program.

As stated earlier, 303(e) basin planning, or Phase I, mainly addressed point source pollution abatement. Under EPA (Phase II) guidelines, states are required to fully address nonpoint source pollution and to develop abatement programs to handle the problem. Phase II planning will continue to include point source waste load allocations and time schedules, and will update the municipal needs tables. Much of this will concern locating errors, or be tied to stream reclassification, new low flow data or standards revision.

The goal of Phase II planning is to reassess controls and needs of combined sewer replacement, feedlot control, urban runoff, and rural nonpoint pollution and to assign implementation programs.

GLOSSARY

Activated sludge is a completely aerobic treatment process by which wastewater is fed continuously into an aerated tank where microorganisms metabolize the organic material. The biological floc is settled in a final clarifier and may be recirculated to the aeration basin. Ninety to ninety-five percent BOD removal can be achieved.

Aerobic denotes biological processes in which oxygen is used for the decomposition of organic material.

Anaerobic denotes biological processes in which organic matter is decomposed in an environment devoid of free oxygen.

Biochemical oxygen demand (BOD) is the quantity of oxygen utilized in the biochemical oxidation of organic matter in a specified time and at a specified temperature.

Combined sewer is designed to carry sanitary sewage, industrial wastes, and storm runoff in a single conduit.

Disinfection of water or wastewater is a method of reducing pathogens or objectionable microorganisms by means of chemicals or other acceptable means.

Dissolved oxygen is the concentration of oxygen dissolved in a liquid. If affects biological changes brought about by aerobic or anaerobic organisms, and is an important environmental factor for growth and reproduction of fish and other aquatic organisms. Determination of dissolved oxygen also serves as the basis of the BOD test.

Gaging station is a particular site on a stream, canal, lake, or reservoir where systematic observations of gage height or discharge are obtained.

Holding or storage pit is a covered container into which wastewater flows until it can be pumped out and taken to a treatment facility.

Industrial wastewater is the wastewater which originates in industrial processing, cooling, or washing operations.

Infiltration is the groundwater which gains entrance to sewers through joints or improper connections.

Intermediate treatment involves additional settling of the wastewater and may incorporate chemicals to aid the settling process. Normally 50 percent BOD removal may be obtained through this process.

Intermittent stream is a stream with 7-day, 10-year low flow less than 0.1 cubic feet per second.

Lagoon or stabilization pond is generally a shallow geometrical pond which treats pretreated or untreated sewage biologically. Wastewater is retained in the pond for treatment and a clarified effluent is discharged after a specific detention time.

Main sewer is a conduit to which one or more branch sewers are tributary.

Outfall sewer receives the wastewater from a collection system and carries it to a point of final discharge.

pH is the negative logarithm of the hydrogen ion concentration. A pH below 7 indicates an acid condition and a pH above 7 indicates an alkaline condition.

Population equivalent measures the strength of a wastewater in terms of an equivalent number of persons, using an average 0.17 pounds of oxygen demand per person per day in domestic wastewater.

Pretreatment of industrial waste refers to treatment, usually primary, given to the wastewater before it is discharged into a sanitary sewer for secondary treatment.

Primary treatment involves only screening and physical settling of the wastewater. Approximately 30 percent of the BOD can be removed through this process.

Sampling station is a particular site on a stream, lake, canal, or reservoir where systematic samples of water are taken for analysis for physical, chemical, or biological parameters.

Sanitary sewer is a conduit designed to carry sanitary sewage. However, in many cases, it will also carry industrial wastes produced in the area it serves.

Secondary treatment conventionally involves biological treatment of wastewater to reduce the BOD by 85 percent or more. These biological processes usually involve trickling filters, stabilization ponds, or activated sludge processes. Recently, straight physical-chemical processes have been considered secondary treatment on the basis of their BOD removal efficiency.

Septic tank allows solids to settle out of a waste and permits a clarified effluent to be discharged to a ground seepage system. The solids are broken down anaerobically, and the residue must be pumped out periodically.

Sewage disposal applies to the act of disposing of sewage by any method. It may be done with or without any previous treatment of the wastewater.

Sewage treatment refers to any artificial process to which wastewater is subjected in order to remove or alter its objectionable constituents so as to render it less dangerous or offensive.

Sewage treatment plant is a comprehensive term encompassing an arrangement of devices and structures for treatment domestic and industrial wastewater and sludge.

Sewerage is a system of sewers and appurtenances for the collection, transportation, pumping, and treatment of domestic and industrial wastewaters.

Solids are all matter except water contained in a liquid. They may be suspended or dissolved solids.

Storm runoff is the wastewater flowing due to rain water, snowmelt, or other surface runoff.

Trickling filter systems consist of a bed of crushed rock, or other media, coated with biological films, through which primary effluent is passed for secondary treatment. The filter may be followed by a final settling basin, and recirculation through the filter may be employed for better removal. Up to 90 percent BOD removal can be achieved through trickling filter systems in ideal situations.

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