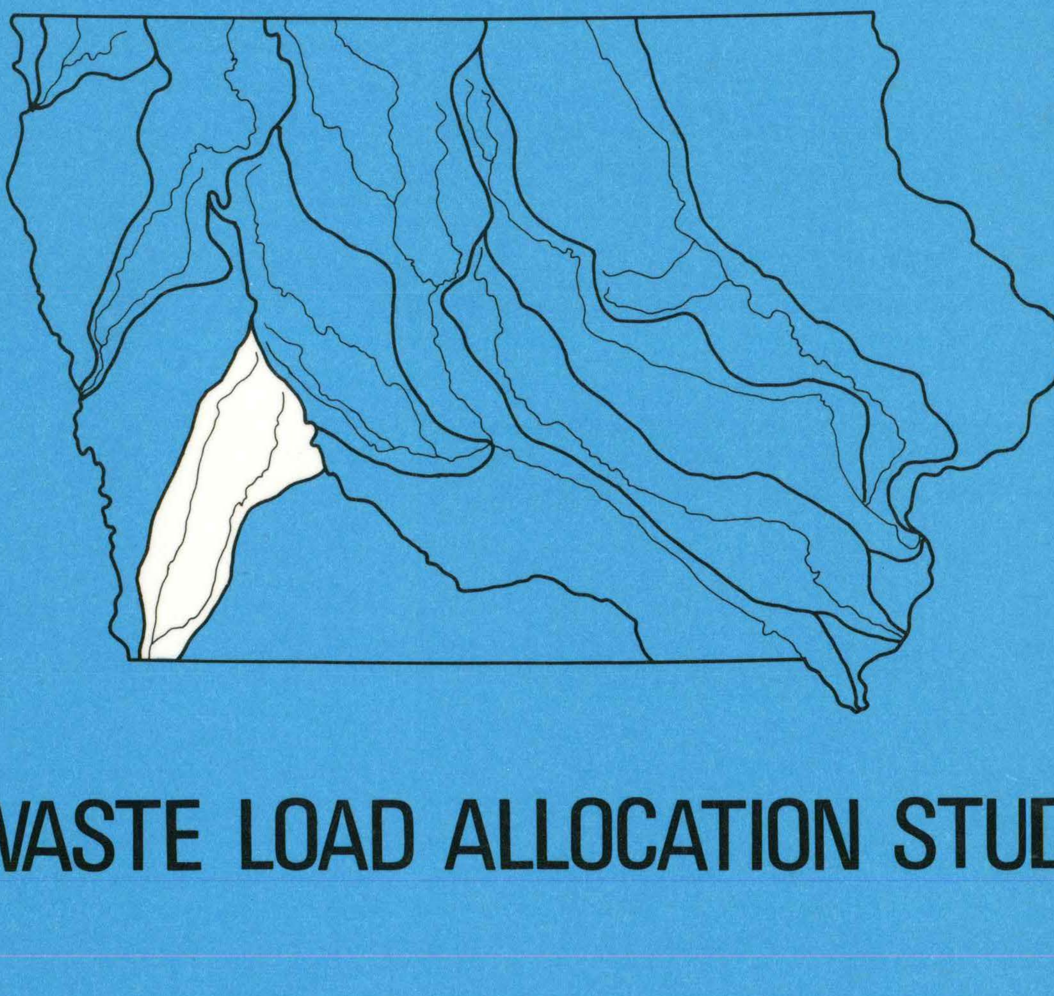
iowa department of environmental quality
Water Quality Management Division

NISHNABOTNA RIVER BASIN



WASTE LOAD ALLOCATION STUDY

STANLEY CONSULTANTS
INTERNATIONAL CONSULTANTS IN ENGINEERING, ARCHITECTURE, PLANNING, AND MANAGEMENT

NISHNABOTNA RIVER BASIN

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November 1, 1974

Iowa Department of Environmental
Quality
3920 Delaware Avenue
P. O. Box 3326
Des Moines, Iowa 50316

Gentlemen:

We are pleased to submit our report entitled "Nishnabotna River Basin - Waste Load Allocation Study." This report has been prepared in accordance with our contract dated November 12, 1973, and Amendment No. 1 dated April 8, 1974, with the Iowa Department of Environmental Quality for a series of waste load allocation studies.

Respectfully submitted,

STANLEY CONSULTANTS, INC.

R. J. Gear

Ronald J. Gear
Vice President

SYNOPSIS

The Nishnabotna River Basin encompasses an area of approximately 2,819 square miles in the southwest section of Iowa. Topography is rolling and the drainage pattern of the basin is tree-shaped (dendritic). Stream flows per square mile in the Nishnabotna River Basin are generally less than those of the state of Iowa as a whole, especially for the 7-day, 1-in-10 year low flow.

Most of the main streams in the basin have a Class B (warm water fisheries) water quality criteria classification. There is a lack of comprehensive water quality data on existing conditions within the basin. The limited data available show, under winter conditions and low flows, lowered water quality within the streams. Under these conditions, the water quality within the West Nishnabotna River falls below the applicable water quality criteria. This decrease in water quality is directly related to the impact of treated wastewater discharges upon the stream.

Within the basin, 44 communities are incorporated. Of these, 33 have wastewater treatment facilities. Also, there are 8 industrial and one semipublic wastewater dischargers. Only 10 municipalities maintain wastewater treatment facilities which will not be required to adopt a controlled discharge mode of operation under the National Pollutant Discharge Elimination System (NPDES).

To determine allowable waste load allocations for these ten dischargers, a computer model based upon a modified Streeter-Phelps equation was utilized. Input data to the model included such physical characteristics as length of reach, water temperature, channel slope, river width, roughness coefficient, deoxygenation rate constants, wastewater discharge characteristics, and flow and characteristics of groundwater and tributaries. The model approximates the impact of dischargers on stream quality for the specified winter and summer low flow conditions. Wherever stream quality criteria were not met by secondary treatment, reductions were made in the allowable wastewater discharges until satisfactory conditions prevailed.

Under summer conditions, only the communities of Atlantic and Harlan must provide better than secondary treatment to meet stream quality criteria. However, under winter conditions, better than secondary treatment is required by the communities of Atlantic, Audubon, Carson, Harlan, Manning, and Shenandoah to meet stream quality criteria.

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PART I

INTRODUCTION

Purpose

The Iowa Department of Environmental Quality (IDEQ) is charged with the responsibility of protecting and maintaining surface and underground water quality throughout the state. This report on the Nishnabotna River Basin (that portion of the basin within the state of Iowa) has been prepared for IDEQ to provide waste load allocations.

This report provides basic inventory information relative to comprehensive river basin planning and meets some of the objectives specified for Section 303 (e) plans. Waste load allocations are necessary to facilitate issuance of permits under the National Pollutant Discharge Elimination System (NPDES). All material presented herein is relevant to Section 303 (e) plans, but it is anticipated that additional effort is required to develop a complete river basin plan as now defined. In addition, as with any planning tool, periodic revisions are necessary to assure that the data base and subsequent extrapolations are current and valid. Each expansion of a planning report should build upon previous efforts in order to meet current planning objectives.

The specific purposes of the study and resulting report, as specified by IDEQ, are:

1. To inventory point source wastewater discharges.
2. To define stream low flow characteristics for the study area.
3. To determine waste load allocations for all uncontrolled wastewater discharges to streams within the basin boundary.

Scope

The scope of the completed investigation is summarized below. Topics described relate to major parts of the report.

1. Background Data. Significant physical features in the Nishnabotna River Basin are identified for future reference. These include such factors as geology, soil type, and stream and groundwater characteristics.

2. Water Quality. Water quality data pertinent to the study have been tabulated and evaluated to present the most accurate possible picture of water quality throughout the basin.
3. Point Source Wastewater Discharges. Available records have been reviewed to determine the location and characteristics of point source wastewater discharges. This information forms the basis for waste load allocation investigations.
4. Waste Load Allocation Investigations. Water quality modeling techniques have been utilized to evaluate the impact of wastewater discharges upon stream quality characteristics under both summer and winter critical low flow conditions. Reductions in allowable waste load discharges from various point sources have been identified, as required to maintain water quality within the streams at a level consistent with adopted stream standards.

Water Quality Management Deadlines

As indicated, this report will provide the waste load allocations for utilization in water quality management programs. The 1972 Federal Water Pollution Control Act Amendment and Iowa Pollution Abatement Schedule specifies several deadlines that must be met in the implementation of a management program. Following are several key dates which have been established:

Date	Action
December 31, 1974	NPDES 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 practical waste treatment technology for all industrial discharges.
January 1, 1978	Ammonia removal to meet IDEQ water quality standards.
July 1, 1983	Best practical 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.

PART II

BACKGROUND DATA

General

The Nishnabotna River Basin area, for purposes of this study, comprises an area from southwest Carroll and southeast Crawford Counties southwest to the Iowa-Missouri state line. The rivers tributary to the Nishnabotna River within the study area are the East Nishnabotna River and the West Nishnabotna River with the following major tributary streams: Silver Creek, East Branch West Nishnabotna River, and Walnut Creek. The Nishnabotna River Basin encompasses portions of the following counties and are represented as a percent of the total county in the following tabulation.

Audubon	91%	Mills	59%
Carroll	15%	Montgomery	50%
Cass	60%	Page	16%
Crawford	15%	Pottawattamie	57%
Fremont	59%	Shelby	71%
Guthrie	5%		

The relatively long and narrow drainage area of the Nishnabotna River Basin within Iowa flows from the northeast to the southwest encompassing approximately 2,819 square miles (1.805 million acres). The major branches of the river, approximate stream lengths, and drainage areas are tabulated below.

Stream	Stream Length (miles)	Drainage Area (1,000 acres)	Drainage Area (square miles)
East Nishnabotna River	117	735	1,148
West Nishnabotna River	115	587	917
Silver Creek	60	181	282
East Branch West Nishnabotna River	37	145	227
Walnut Creek	62	143	223
Nishnabotna River	5.6	14	22

Average annual precipitation within the basin is approximately 33.7 inches; of this total, 22.56 inches fall during the April through September growing season.

Political Subdivisions

Within the study area are 44 incorporated communities with a total population of 50,993 according to the "1970 Census of Population." Of these, 13 communities have populations greater than 1,000, comprising about 75 percent of the total population. Only 4 municipalities have a population greater than 5,000 and account for 48 percent of the population. Populations are summarized for each county and city in Table 1.

Population projections for 1990, Table 1, have been made by the Iowa State Department of Health (Provisional Projections of the Population of Iowa Counties and Cities: 1975 to 1990, by James R. Taylor, June, 1972). These projections were utilized in determining future waste loads.

Physiography

The topography of the study area is rolling to gently rolling on the upland areas with long, steep, uniform slopes descending to flat river bottoms. The uplands are disected by numerous small valleys. The hills and ridges between these valleys are usually smooth and rounded. In some instances, erosion has produced unusually shaped hills. Ridges and valleys are generally situated in a slightly northeast-southwest direction. The bottoms of stream valleys are approximately 100 feet to 200 feet below the general upland elevation.

The drainage pattern of the basin is dendritic. Numerous intermittent drainageways reach into the uplands to provide good surface drainage throughout the basin. Only on some bottomlands is artificial drainage provided by tile fields and surface drainage ditches. Channel straightening and enlarging has reduced flooding. Occasionally the narrow bottoms of the small valleys are flooded.

Upland soils in the study area have been formed primarily from loess which was deposited over Nebraskan and Kansan till. Although the depth of the loess mantle varies, it is generally greater than 200 inches thick on upland

TABLE 1
EXISTING AND PROJECTED POPULATIONS
FOR WASTE LOAD ALLOCATIONS

	1970	1990
AUDUBON COUNTY	9,595	9,835
Audubon	2,907	3,470
Brayton	151	151
Exira	966	966
Fiscus	--	--
Gardner	--	--
Gray	145	145
Hamlin	--	--
Kimballton	343	343
Larland	--	--
Ross	--	--
Sharon	--	--
CARROLL COUNTY	22,912	27,109
Manning	1,656	1,804
Templeton	312	340
CASS COUNTY	17,007	19,306
Anita	1,101	1,134
Atlantic	7,306	9,313
Griswold	1,181	1,217
Lewis	526	542
Lorah	--	--
Marne	187	193
Wiota	171	176
CRAWFORD COUNTY	19,116	24,314
Aspinwall	81	92
Manilla	943	1,073
FREMONT COUNTY	9,282	9,871
Anderson	--	--
Farragut	521	554
Hamburg	1,649	1,754
Imogene	192	204
Randolph	214	228
Riverton	331	352
Sidney	1,061	1,128
GUTHRIE COUNTY	12,243	12,919
North Branch	--	--
MILLS COUNTY	11,832	12,629
Clark	--	--
Emerson	484	513
Hastings	229	243
Henderson	211	224
Malvern	1,158	1,227
Silver City	272	288
Strahan	--	--
White Cloud	--	--
MONTGOMERY COUNTY	12,781	13,137
Coburg	36	39
Elliott	423	461
Hawthorne	--	--
Red Oak	6,210	6,210
Stennett	--	--
Wales	--	--
PAGE COUNTY	18,537	19,052
Essex	770	770
Shenandoah*	5,968	6,373
POTTAWATTAMIE COUNTY	86,991	112,898
Avoca	1,535	1,928
Carson	756	950
Hancock	228	286
Macedonia	330	414
Oakland	1,603	2,014
Taylor	--	--
Treynor	472	593
Walnut	870	1,093
SHELBY COUNTY	15,528	18,472
Botha	--	--
Corley	--	--
Defiance	392	417
Elk Horn	667	710
Fiscus	--	--
Harlan	5,049	7,318
Irwin	446	475
Jacksonville	--	--
Kirkman	72	77
Poplar	--	--
Shelby**	868	924
Westphalia	--	--

*1970 population includes population for both Fremont and Page Counties.
**Same as (*) except Pottawattamie and Shelby Counties.

areas. Except for a few areas where paleosols or till is exposed, loess covers the slopes and terraces. Loess thickness in stream valleys is less than on upland areas. Marshall, the predominant soil series on uplands in the study area, has moderate permeability. Bedrock has had little or no effect on the soil formation of this area.

Terrace soils consist of outwash sands and gravels covered by loess. Most of these soils are well drained. In some places pits have been excavated to mine the sand and gravel. Waukesha is representative of terrace soils. The Marshall series can also be found on the terrace positions.

Bottomland soils have formed from fine alluvial materials. Such alluvium retains many of the characteristics of the soil from which it has eroded. These areas generally have slow permeability. Zook, Colo, and Wabash soils series are found in bottomland areas.

The surficial aquifer that overlies the bedrock aquifers is formed by alluvium and glacial drift. Although surficial aquifers of glacial drift do not generally produce large enough quantities of water for public or industrial water uses, they do produce water in sufficient quantities for farmsteads and rural residences.

Contamination of groundwater in the glacial drift aquifers on upland areas is not generally a problem. The potential hazards are created by the slow permeability of the soil. Slow permeability can cause septic tank filter fields to fail. Increased surface runoff can carry septic tank effluent, barnyard wastes, fertilizers, and pesticides to streams. Sewage lagoons, except on steep slopes, should not create a pollution problem if properly constructed, but land application of wastewater and construction of septic tank filter fields should be carefully reviewed. All sites for wastewater disposal should be evaluated on an individual basis.

Alluvial aquifers in river bottoms, especially those along major river valleys and on terraces, produce large quantities of water. These aquifers are recharged by local precipitation. Water quality is variable even in local areas, but generally fair to good.

Potential contamination of groundwater in alluvial aquifers is great because of the high permeability of soils in these areas. Polluted surface runoff flowing over these areas infiltrates the soil rapidly. Since these aquifers are located adjacent to streams, contaminated groundwater can transmit pollution to streams. These areas are unsuitable for land wastewater disposal, not only because of high permeability and high groundwater table, but also because they are subject to flooding.

Streams

Water contains oxygen required by microorganisms for degradation of organic material. The quantity of oxygen available for waste assimilation is a direct function of the flow volume. In addition, physical characteristics of the channel establish velocity and turbulence, and determine the reoxygenation capability of a stream. Therefore, physical conditions in a stream influence the available oxygen supply, and the biological degradation of organic matter and ammonia which occurs naturally.

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 seven-day, one-in-ten year (7-day, 1-in-10 year) low flow. Based upon this flow information and the physical characteristics of the stream, the assimilative capacity may be analyzed and allowable discharges determined.

Low Flow Characteristics - The United States Geological Survey (USGS) maintains an extensive nationwide network of stream gaging stations. Stream flow and certain water quality parameters are monitored continuously at some stations and periodically at others. By extrapolation of data from this established network and review of partial-record stations, additional flow information may be determined for streams where continuous-record stations are not provided.

Low flow in the Nishnabotna River Basin above the gaging station near Hamburg is significantly less than the state average when results are reduced to the common basis of discharge per square mile. The flow at Hamburg represents almost the entire basin flow within Iowa. The following tabulation gives a comparison of the flow at the gaging station near

Hamburg to the average of 84 continuous-record stations within the state of Iowa.

	Percentage of Time Flow Equaled or Exceeded[1]				
	50	90	95	98	99
State of Iowa Average (cfs/sq mi)	0.150	0.033	0.024	0.018	0.015
Nishnabotna River Basin (cfs/sq mi)	0.153	0.030	0.019	0.012	0.009

[1] Iowa Natural Resources Council, Low-Flow Characteristics of Iowa Streams Through 1966, Bulletin No. 10, 1970.

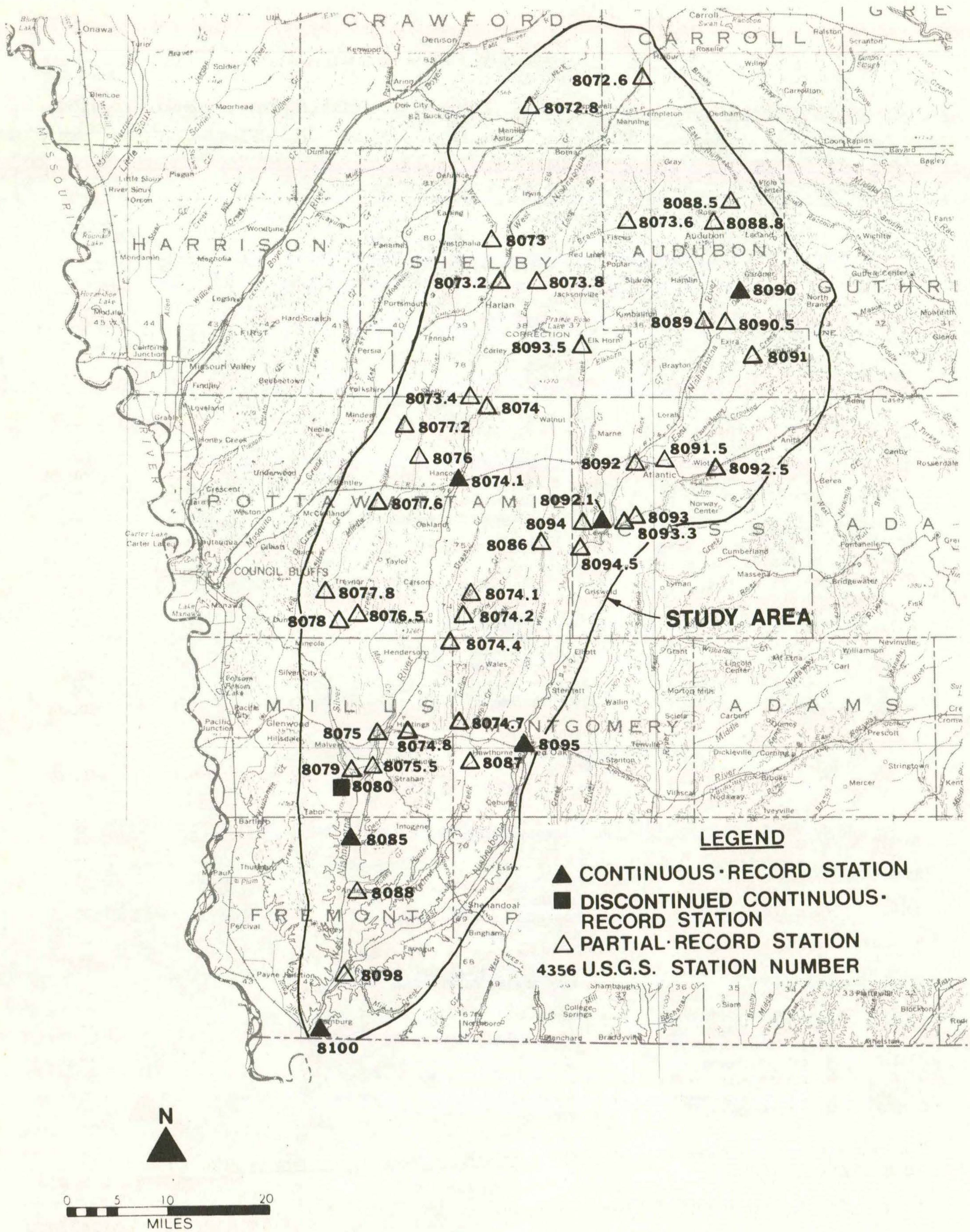
The above table refers to daily average discharges recorded at each gaging station regardless of chronological sequence. The period of record for the Nishnabotna gaging station near Hamburg is 47 years beginning in 1922.

As with the daily flow data presented, the average 7-day, 1-in-10 year low flow for the basin is considerably lower than that for the entire state. The Nishnabotna River Basin averages 0.00677 cfs/sq mi, while the state of Iowa averages 0.020 cfs/sq mi. The lowest recorded average daily flow for time periods ranging from 1 to 183 days have occurred at the gaging station near Hamburg in the 1930's.

Specific USGS gaging station locations are identified on Figure 1. Both partial-record and continuous record stations are identified. Table 2 identifies 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 Table 2, insufficient data are available for identification of low flow at each gaging station. In order to conduct the waste load allocation analysis, determination of 7-day, 1-in-10 year low flow was conducted for specific gaging stations. These values were obtained utilizing the same procedure conducted by the USGS, but based upon less than 10 years of recorded data in some instances. For these reasons, verification of these values, as additional flow information becomes available, is required.

The frequency of extreme low flows is cyclic within the basin. Due to the climatological and geological characteristics of the basin, low flows can occur either during August and September or during January and



U.S.G.S. GAGING STATIONS

FIG. 1

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TABLE I-2

USGS GAGING STATION INFORMATION

Station No.	Stream[1]	Location	Drainage Area (sq mi)	7-Day, 1-in-10 Year Low Flow (cfs)	7-Day, 1-in-10 Year Low Flow (mgd)
8100	Nishnabotna	North of (upstream) Hamburg	2,806	19	12.28
8098	E. Nishnabotna	Above Hamburg near confluence with Fisher Creek	1,082	--	--
8095	E. Nishnabotna	Near Red Oak	894	12	7.76
8094.5	E. Nishnabotna	Near confluence with Indian Creek	778	--	--
8094	Indian Creek	Near confluence with East Nishnabotna	183	--	--
8093.5	Indian Creek	Midway between Elkhorn Creek and Buck Creek	67.4	--	--
8093.3	E. Nishnabotna	Near Lewis	574	--	--
8093	Turkey Creek	Near confluence with East Nishnabotna	133	--	--
8092.5	Turkey Creek	Near Wiota	69.5	--	--
8092.1	E. Nishnabotna	Near Atlantic midway between Buck Creek and Turkey Creek	432	3.6[2]	--
8092	E. Nishnabotna	Near confluence with Buck Creek	382	--	--
8091.5	Troublesome Creek	Near Atlantic	128	--	--
8091	Troublesome Creek	Near Brayton	68.4	<0.1	<0.065
8089	E. Nishnabotna	Near Brayton	195	1.0[2]	--
8090.5	Davids Creek	Near confluence with East Nishnabotna and also near Exira	56.7	--	--
8090	Davids Creek	Near Hamlin	26	<0.1	<0.065
8088.5	E. Nishnabotna	Near Audubon	66.7	0.32[2]	--
8088	Walnut Creek	Near confluence with West Nishnabotna	222	--	--
8087	Walnut Creek	Near Hawthorne	140	--	--
8086	Walnut Creek	Near Lewis	61.3	--	--
8085	W. Nishnabotna	Near Randolph near confluence with Deer Creek	1,326	17	10.99
8082	Spring Valley Creek	Near confluence with West Nishnabotna	7.65	<0.1	<0.065
8079	Silver Creek	Near confluence with West Nishnabotna	282	--	--
8080	Mule Creek	Near confluence with Silver Creek	10.6	<0.1	<0.065
8078	Middle Silver Creek	Near confluence with Silver Creek	74.3	--	--
8076.5	Silver Creek	Near Treynor	115	--	--
8076	Silver Creek	Near Shelby	59.2	--	--
8075.5	W. Nishnabotna	Near Clark	974	10[2]	--
8075	W. Nishnabotna	Near White Cloud	967	--	--
8074.8	Indian Creek	Near confluence with West Nishnabotna	67.9	--	--
8074.4	Farm Creek	Near confluence with Jordan Creek	104	--	--
8074.2	Graybill Creek	Near confluence with Farm Creek	52.1	--	--
8074.1	W. Nishnabotna	Near Hancock near downstream end of Shelby County line	609	4.8[2]	--
8074	E.B. West Nishnabotna	Avoca	223	--	--
8073.8	E.B. West Nishnabotna	Near Jacksonville	151	--	--
8073.6	E.B. West Nishnabotna	Near Red Line	70.3	--	--
8073.4	West Nishnabotna	Avoca	357	3.1[2]	--
8073.2	West Nishnabotna	Harlan	316	--	--
8073	W.F. West Nishnabotna	Harlan	146	--	--
8072.8	W.F. West Nishnabotna	Near Manilla	64.2	--	--
8072.6	West Nishnabotna	Near Manning	58.6	0.06[2]	--

[1] Iowa Natural Resources Council, Low-Flow Characteristics of Iowa Streams Through 1966, Bulletin No. 10, 1970.

[2] Flow values are those computed for use in this study.

February of any given year. In addition, long-term climatological cycles have an influence upon stream flow. Based upon this information, analyses of critical conditions for defining waste load allocations must be conducted for both warm and cold water temperatures.

Stream Hydrodynamics - The term hydrodynamics refers to the characteristics of motion associated with a body of water. As is discussed in further detail in PART V - WASTE LOAD ALLOCATION METHODOLOGY, stream velocity and slope are of major interest. The relationship between these two characteristics allows definition of reaeration rate constants within particular reaches of streams based upon cross section and slope information. The two physical characteristics which are required to define the reaeration rate constants are the slope of the water surface and time of travel for each reach.

Information on the actual slope of the water surface is not available for this river basin. Surface water slope varies with the amount of flow in the stream and at 7-day, 1-in-10 year low flows, the assumption is made that the slope of the water surface is essentially the same as the slope of the stream bottom. Stream bed slopes have been obtained from the information on USGS topographic maps. Channel slopes in the streams to be modeled range from approximately 1.5 ft/mi to approximately 13.0 ft/mi, with an average slope at approximately 4.0 ft/mi.

Determination of time of travel is dependent only upon distance traveled and stream velocity. Distance is measured from USGS topographic maps. Determination of stream velocity is described in detail in PART V. The two physical characteristics required to calculate stream velocity are the width of stream and value of the Manning coefficient ("n"). Values of both the width and "n" are dependent upon the stream flow, and so these values must be determined at the 7-day, 1-in-10 year low flow. Values for these two characteristics can be obtained at USGS gaging stations, but data available at the stations do not usually include measurements at the 7-day, 1-in-10 year low flows. Available data must be extrapolated to obtain an approximate value for these characteristics under low flow conditions. Since there are few USGS gaging stations at which these characteristics may be obtained, the values of "n" and stream width for other reaches of the stream must be estimated from the approximations available at the gaging stations and from field observations. Field observations of stream widths at low flows (not 7-day, 1-in-10 year low flows) also aid in estimating stream widths under the low flow condition. The approximate "n" values at the gaging stations, visual examination of the stream, and use of the method for estimating "n" presented in Open Channel Hydraulics (by V. T. Chow) are all aids in estimating "n" values for stream reaches which do not have a USGS gaging station.

Approximate values of the Manning coefficient and stream widths at 7-day, 1-in-10 year low flows are given in Table 3.

TABLE 3

ESTIMATED PHYSICAL CHARACTERISTICS AT USGS GAGING STATIONS

Station No.	Stream Width (ft)	"n"
8100	82	0.032
8095	46	0.046
8092.1	26	0.055
8085	54	0.022
8074.1	36	0.037

PART III
WATER QUALITY

General

The main objective of determining allowable waste loads is protection and enhancement of water resources to ensure acceptable conditions for designated uses. Identification of realistic waste load allocations requires knowledge of the existing water quality resulting from the interaction of man with nature throughout the Nishnabotna River Basin.

Iowa Water Quality Standards establish a baseline for evaluating adequate stream quality under existing and projected discharge conditions. The National Water Quality Criteria, as proposed by the Federal Environmental Protection Agency (EPA), provide an additional measure of the adequacy of existing water quality.

Existing water quality for the West Nishnabotna River and East Nishnabotna River has been identified from available data obtained from the State Hygienic Laboratory. The data indicate some areas of degraded water quality and provide limited information on overall water quality within the basin. Review of existing data shows major deficiencies in the extent of water quality monitoring in the basin.

Water Quality Criteria

Water quality criteria define the constituent levels which will protect the utility of the water resource for multiple uses. Concentrations of water quality parameters in a "pristine" state are impossible to locate or estimate because of the activities of man within the basin. Existing criteria are the standard against which water quality parameters are compared to determine the quality of a stream. Differences between existing quality and criteria establish a basis for defining waste load allocations.

Iowa Department of Environmental Quality Regulations - Regulations promulgated by the Iowa Water Quality Commission specify water quality for all surface waters within Iowa. Powers and authorities of IDEQ are defined in the Code of Iowa, 1973, Sections 455B.32(2) and 455B.35. Specific regulations are given in the "Iowa Departmental Regulations - Department of Environmental Quality" (IDR-DEQ).

The most important regulations applicable to the study area are identified in Chapter 16, Sections 1 and 2, "Water Quality Standards" of the IDR-DEQ. This document specifies the stream quality requirements for the following use classifications:

Class A - Body Contact Recreation

Class B - Wildlife, Non-body Contact Recreation and Aquatic Life

Class C - Potable Water Supply

In accordance with use classifications, certain streams within the basin must satisfy the water quality standards for Class B (warm water). Figure 2 indicates which streams within the study area must satisfy the Class B requirements. Other streams have not been classified and must satisfy General Water Quality Criteria. Tables 4 and 5 summarize the applicable water quality standards.

Class B uses apply to waters which will support both cold and warm water fisheries, and different sets of criteria are enumerated for each use. All Class B streams within the basin study area must satisfy criteria for warm water fisheries. Therefore, Table 4 contains stream standards applicable for warm water fisheries. Table 5 identifies the concentration of chemical constituents allowable in Class B streams.

Federal EPA Regulations - In conformance with 1972 Federal Water Pollution Control Act Amendments [Section 304(a)(1) and (2), Public Law 92-500], EPA has published "Proposed Criteria for Water Quality." Under existing legislation, major programs which will be affected by the criteria are:

Water Quality Standards

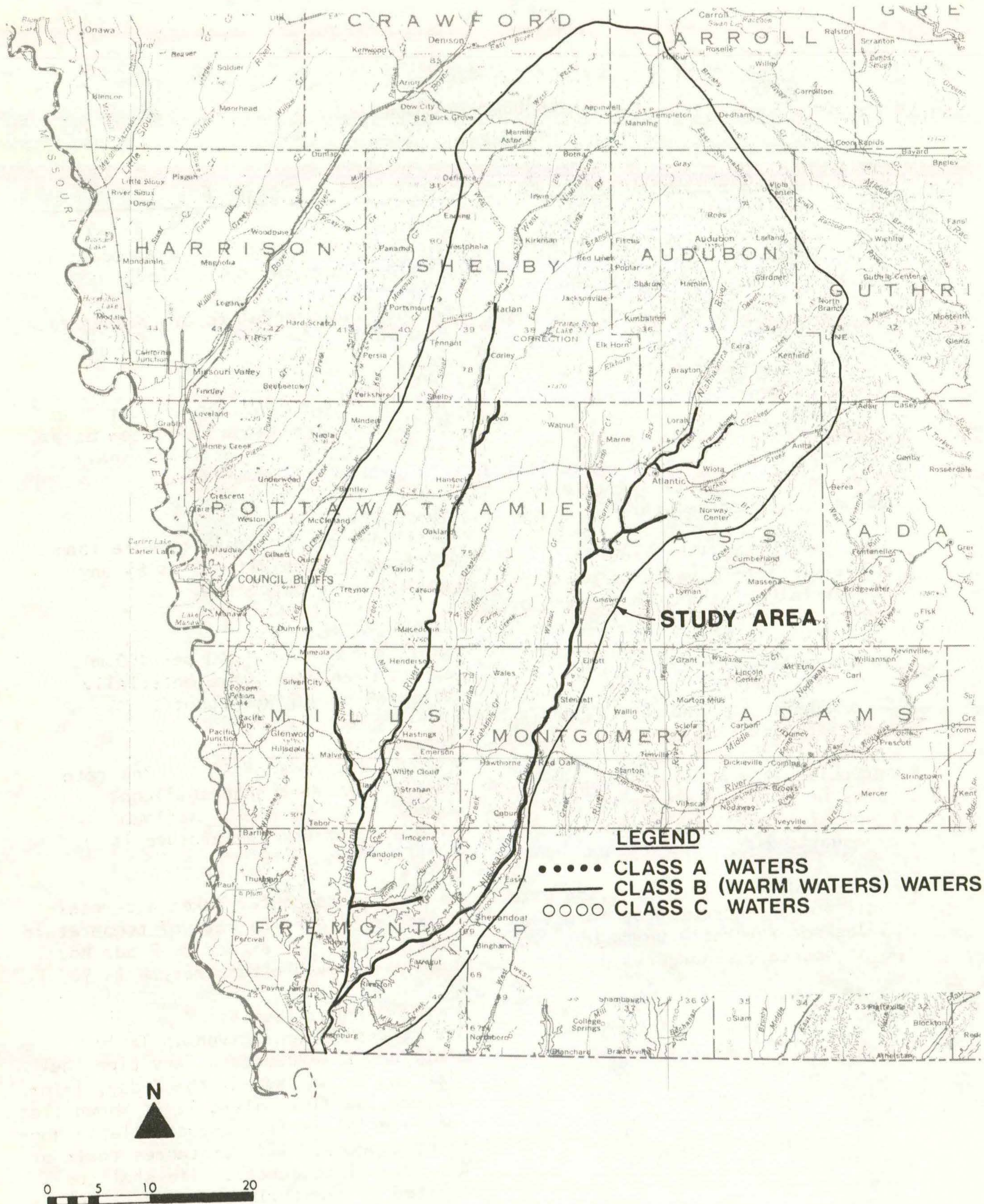
Toxic and Pretreatment Standards

Water Quality Inventory (monitoring)

Toxic and Pretreatment Effluent Standards

National Pollutant Discharge Elimination System

Ocean Discharge Criteria



SURFACE WATER CLASSIFICATION

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FIG. 2

TABLE 4

WATER QUALITY STANDARDS

NISHNABOTNA RIVER

General Criteria	Class B
Such waters shall be free from substances attributable to municipal, industrial or other discharges, or agricultural practices that will settle to form objectionable sludge deposits.	Dissolved Oxygen: At least 5.0 mg/l during at least 16 hours of any 24-hour period. At all times equal to or greater than 4.0 mg/l.
Such waters shall be free from floating debris, oil, grease, scum, and other floating materials attributable to municipal, industrial or other discharges, or agricultural practices in amounts sufficient to be unsightly or deleterious.	pH: Not less than 6.5, nor greater than 9.0. Maximum change permitted as a result of a waste discharge shall not exceed 0.5 pH units. Turbidity: Shall not be increased by more than 25 Jackson turbidity units by any point source discharge.
Such waters shall be free from materials attributable to municipal, industrial or other discharges, or agricultural practices producing color, odor, or other conditions in such degree as to create a nuisance.	Fecal Coliforms: Shall not exceed 2,000 per 100 ml, except when waters are materially affected by surface runoff.
Such waters shall be free from substances attributable to municipal, industrial or other discharges, or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.	Temperature: Maximum increase of 5° F. The rate of temperature change shall not exceed 2° F per hour. Maximum allowable stream temperature is 90° F.
The turbidity of the receiving water shall not be increased by more than 25 Jackson turbidity units by any point source discharge.	Maximum increase for lakes and reservoirs is 3° F. The rate of temperature change shall not exceed 2° F per hour. Maximum allowable temperature is 90° F. Chemical Constituents: The concentrations given in Table 5 shall not be exceeded at any time the flow equals or exceeds the 7-day, 1-in-10 year low flow unless it is known that the material is from uncontrollable non-point sources. All substances toxic or detrimental to aquatic life shall be limited to non-toxic or non-detrimental concentrations in the surface water.

TABLE 5

WATER QUALITY STANDARDS

NISHNABOTNA RIVER

CHEMICAL CONSTITUENTS - CLASS B

Chemical Constituent	Allowable Concentration** (mg/l)
Ammonia Nitrogen-N	2.0
Phenols (other than natural sources)	0.001
Total Dissolved Solids	750.
*Arsenic	1.00
*Barium	1.00
*Cadmium	0.05
*Chromium (hexavalent)	0.05
*Chromium (trivalent)	1.00
*Copper	0.02
Cyanide	0.025
*Lead	0.10
*Mercury	0.005
*Selenium	1.00
*Zinc	1.0

*The sum of the entire heavy metal group shall not exceed 1.5 mg/l.

**Not to be exceeded when flow is equal to or greater than the 7-day, 1-in-10 year low flow unless from uncontrollable non-point sources.

The major objectives of the EPA water quality criteria are to provide protection of all waters and improve natural water quality. The means by which this will be accomplished is best described by the following:

> "EPA Water Quality Criteria will be incorporated into revised State water quality standards under the direction of EPA Regions by means of policy guidelines developed by the EPA Office of Water Planning and Standards. Those guidelines have provisions for waters to be exempted from specific criteria on a case-by-case basis for specified periods when naturally occurring conditions exceed limits of the EPA criteria or other extenuating conditions prevail to warrant such exemptions."[1]

These criteria are to provide the protection necessary to sustain recreational uses in/on the water, and for the preservation and propagation of desirable aquatic biota. This level of protection ensures the suitability of all waters for other uses. Based upon the latest scientific information, these criteria define the water quality necessary to satisfy 1983 interim goals (Section 101(a)(2), Public Law 92-500).

The "Proposed Criteria for Water Quality" are not used in evaluating water quality for this study. However, a comparison between proposed EPA criteria and IDEQ water quality standards for Class B streams (warm water fisheries) is presented in Table 6 for reference.

Water Quality Criteria Summary - Examination of Table 6 indicates both differences and similarities between proposed EPA criteria and Iowa water quality standards. Many parameters not limited by Iowa criteria are to be regulated by EPA. Since proposed EPA criteria must be incorporated into Iowa criteria through resolution of differences with the state of Iowa, evaluation of existing stream quality using EPA criteria would not provide meaningful results. Thus, for purposes of this study, IDEQ standards will be utilized.

Iowa standards are either more stringent or comparable to proposed EPA criteria for all parameters except trivalent chromium, lead, mercury, and dissolved oxygen (DO). Differences may exist between the two agencies for other toxic materials; however, since EPA values are based upon bio-assay determinations of toxic concentrations, a direct comparison is not possible.

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1 "Proposed Criteria for Water Quality," Volume 1, U.S. Environmental Protection Agency, Washington, D.C., October, 1973, p. 17.

TABLE 6

COMPARISON OF WATER QUALITY CRITERIA

Water Quality Parameter	IDEQ Class B Water Quality Standards	EPA Proposed Criteria for Water Quality
pH	6.5 - 9.0	6.0 - 9.0
Alkalinity	--	30 - 130 mg/l
Acidity	--	Addition of acids unacceptable
Ammonia	2.0 mg/l-N (ammonia plus ammonium ion)	0.02 mg/l-N maximum (ammonia only) or 0.05 of the 96-hour LC_{50}[1]
Cadmium	0.05 mg/l	0.03 mg/l - hard water[2] 0.004 mg/l - soft water
Chlorine (free)	--	0.003 mg/l - chronic exposure 0.05 mg/l - 30 minute exposure
Chromium (hexavalent)	0.05 mg/l	0.03 mg/l
Chromium (trivalent)	1.0 mg/l	0.03 mg/l
Copper	0.02 mg/l	0.10 of the 96-hour LC_{50}[1]
Cyanide	0.025 mg/l	0.05 of the 96-hour LC_{50}[1]
Lead	0.10 mg/l	0.03 mg/l
Mercury	5.0 ug/l	0.2 ug/l - single occurrance 0.5 ug/l - average concentration
Nickel	--	0.02 of the 96-hour LC_{50}[1]
Phosphorus	--	25 ug/l-P - lakes and reservoirs[3] 100 ug/l-P - streams[3]
Zinc	1.0 mg/l	0.003 of the 96-hour LC_{50}[1]

Water Quality Parameter	IDEQ Class B Water Quality Standards	EPA Proposed Criteria for Water Quality
Fecal Coliforms	200 per 100 ml - Class A waters 2,000 per 100 ml - Class B waters	2,000 per 100 ml average - non-recreational waters 200 per 100 ml average - recreational waters.
Dissolved Solids	750 mg/l	Bio-assay to be used to determine limits of tolerance of aquatic ecosystem.
Temperature	4	5
Pesticides	--	0.01 of the 96-hour LC_{50}[1] for those pesticides not listed in Reference 7.
Turbidity	Less than 25 Jackson Turbidity Unit increase from any point source.	Compensation point may not be changed by more than 10 percent.
Radioactivity	--	8
Dissolved Oxygen	5.0 mg/l for at least 16 hours of any 24-hour period. Never less than 4.0 mg/l at any time.	6.8 mg/l at 1.5° C 6.8 mg/l at 7.7° C 6.5 mg/l at 16.0° C 6.2 mg/l at 21.0° C 5.8 mg/l at 27.5° C 5.8 mg/l at 36.0° C Never less than 4.0 mg/l for a 24-hour or less period when water temperatures exceed 31.0° C.
Sulfides	--	0.002 mg/l
Detergents (as LAS)	--	0.2 mg/l - maximum or 0.05 of the 96-hour LC_{50}[1]
Oils	--	No visible oil 0.05 of the 96-hour LC_{50}[1]
Phthalate Esters	--	0.3 ug/l
Polychlorinated Biphenyls	--	0.002 ug/l
Tainting Substances	--	6

1 LC_{50} identifies the concentration at which 50 percent of the test organisms die within the stated time period.
2 Hard water is defined as having a total hardness of 100 mg/l as $CaCO_3$ or more.
3 Concentrations required to prevent nuisance aquatic plant growths where phosphorus is the limiting constituent.
4 Refer to Table 4.
5 Refer to "Proposed Criteria for Water Quality," EPA, p. 144-170.
6 Refer to "Proposed Criteria for Water Quality," EPA, p. 141-143.
7 Refer to "Proposed Criteria for Water Quality," EPA, p. 125.
8 "Water Quality and Treatment," American Waterworks Association, Inc., 1971, p. 27-32.

Initial review of ammonia levels suggests EPA criteria are much more stringent than Iowa standards. However, EPA criteria refer to the concentration of un-ionized ammonia while Iowa standards specify total ammonia concentration. The differences between the Iowa 2.0 mg/l total ammonia standard and EPA criteria depend on stream pH as evidenced below:

pH	(NH_4^+) (mg/l-N)	(NH_3) (mg/l-N)	Total Ammonia (mg/l-N)
6	39.98	0.02	40.00
7	3.62	0.02	3.64
8	0.36	0.02	0.38

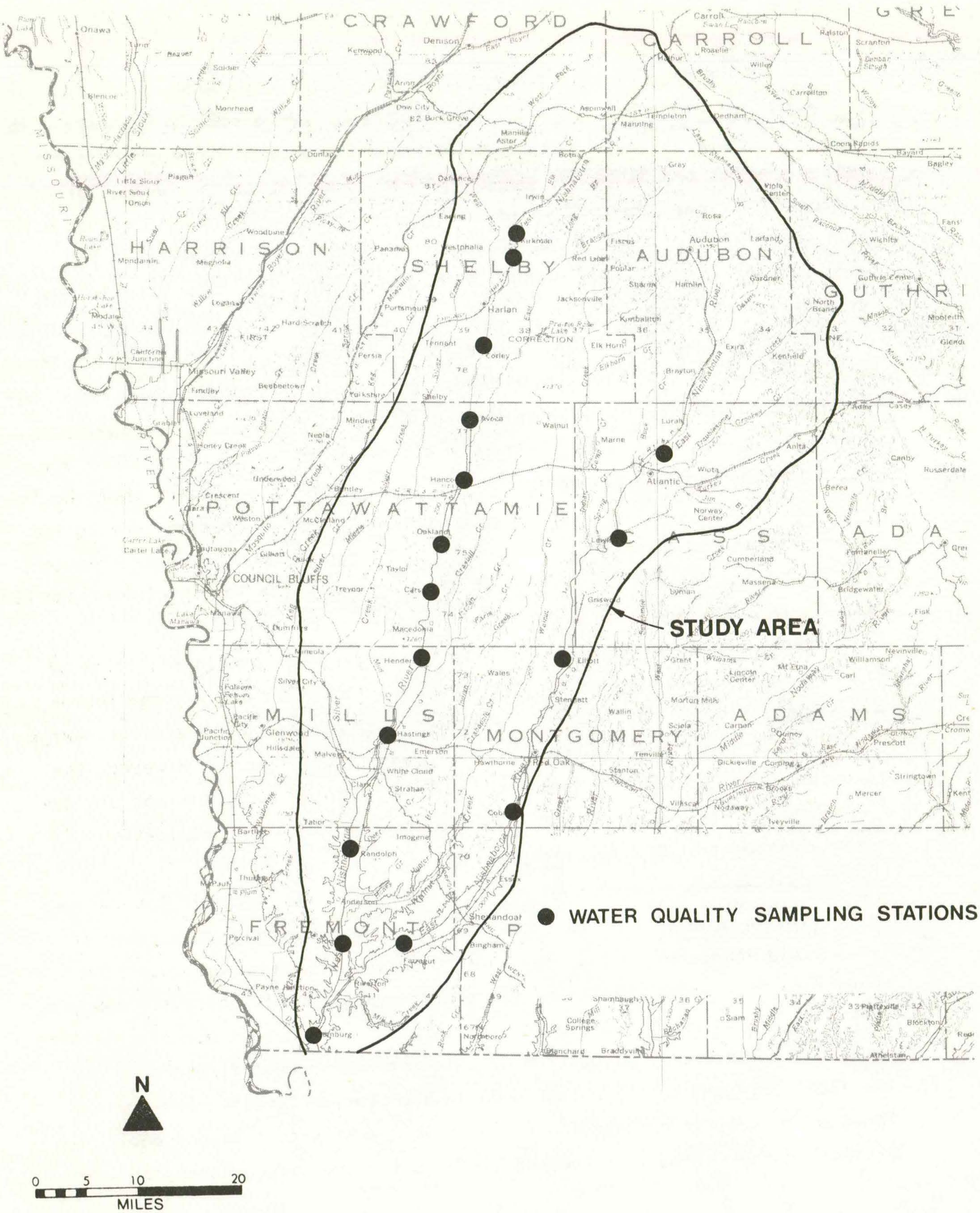
Note: Values based upon the dissociation constant at 25° C.

Existing Water Quality

Data Sources - The study area is the drainage basin of the Nishnabotna River to the Iowa-Missouri border. The evaluation of water quality data herein is based upon data collected by the State Hygienic Laboratory. Some data are available from other Federal, State, and local agencies; but these data are so scattered, both in time and over the basin, that they are not useful in evaluating water quality. No additional sampling, gaging, or quality analyses were initiated specifically for this program.

The locations of all sampling stations collecting data utilized for this report are shown on Figure 3. All of the water quality data used in this evaluation have been obtained since 1971.

West Nishnabotna River - This stream rises in southwestern Carroll County and ends at the confluence of the Nishnabotna River with the East Nishnabotna River just north of the Iowa-Missouri border. Definitive data for the West Nishnabotna comes from Report No. 72-39, "West Nishnabotna Water Quality Survey," containing data collected in January and February, 1972, and from Report No. 74-21, "Iowa Internal Stream Quality Survey." The purpose of Report No. 72-39 was to investigate the effects of packing plant discharges upon the stream, while Report No. 74-21 presents data taken at a single sampling station.



WATER QUALITY SAMPLING STATIONS

STANLEY CONSULTANTS

FIG. 3

Stream conditions were essentially the same in both January and February of 1972. The report states that the stream was ice-covered in February with some small open areas. Stream flows at the USGS gage at Randolph were 72 cfs on January 26, and 50 and 48 cfs on February 8 and 9, respectively. At the Hancock USGS gage, these flows were 14 cfs on January 26, and 15 cfs on both February 8 and 9. These flows compare with the 7-day, 1-in-10 year low flow of 4.8 cfs at Hancock and 17.0 cfs at Randolph. No flow data for the tributaries are available.

Dissolved oxygen concentrations for the February, 1972, survey are shown on Figure 4. This figure also includes data taken at Hamburg, below the confluence with the East Nishnabotna River. No dissolved oxygen concentrations were taken during the January survey. Dissolved oxygen concentrations are all below the stream standard of 5.0 mg/l. The report indicates that the low dissolved oxygen concentrations can be traced to low reaeration, due to ice cover, and the oxygen demand exerted by discharges from wastewater treatment plants and the industrial wastewater discharge from the lagoon of American Beef packers near Oakland.

Nearly all of the ammonia nitrogen concentrations are in violation of the 2.0 mg/l stream standard. This applies to both the Janaury and February surveys plotted on Figure 5. American Beef Packers wastewater discharge is the causative agent for the high ammonia nitrogen levels. However, the relatively high background levels of ammonia nitrogen above Oakland are due to wastewater treatment plant discharges and the lack of bio-oxidation of ammonia nitrogen at low temperatures.

Other pertinent water quality data from the State Hygienic Laboratory Report No. 72-39 are given in Table 7. This table contains data taken in January and February and includes that taken on tributary streams. From these data, the water quality of the tributary streams is obviously good, with high dissolved oxygen concentrations and low values of ammonia nitrogen and other pollutants. Of particular interest on the West Nishnabotna is the fecal coliform count, which is quite high for wintertime conditions. The BOD_5 concentrations are low compared to the amount of oxygen depletion present in the stream as evidenced by the dissolved oxygen concentrations.

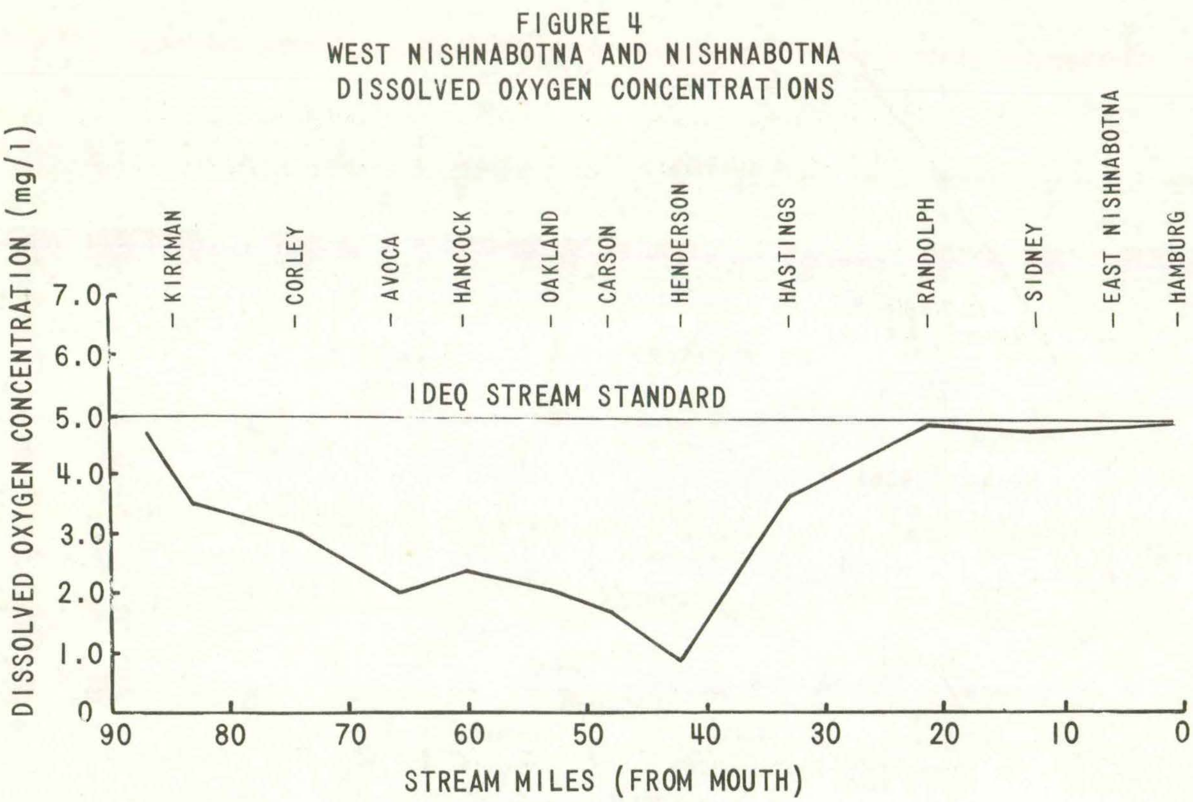


FIGURE 4
WEST NISHNABOTNA AND NISHNABOTNA
DISSOLVED OXYGEN CONCENTRATIONS
DISSOLVED OXYGEN CONCENTRATION (mg/l)
KIRKMAN
CORLEY
AVOCA
HANCOCK
OAKLAND
CARSON
HENDERSON
HASTINGS
RANDOLPH
SIDNEY
EAST NISHNABOTNA
HAMBURG
IDEQ STREAM STANDARD
STREAM MILES (FROM MOUTH)

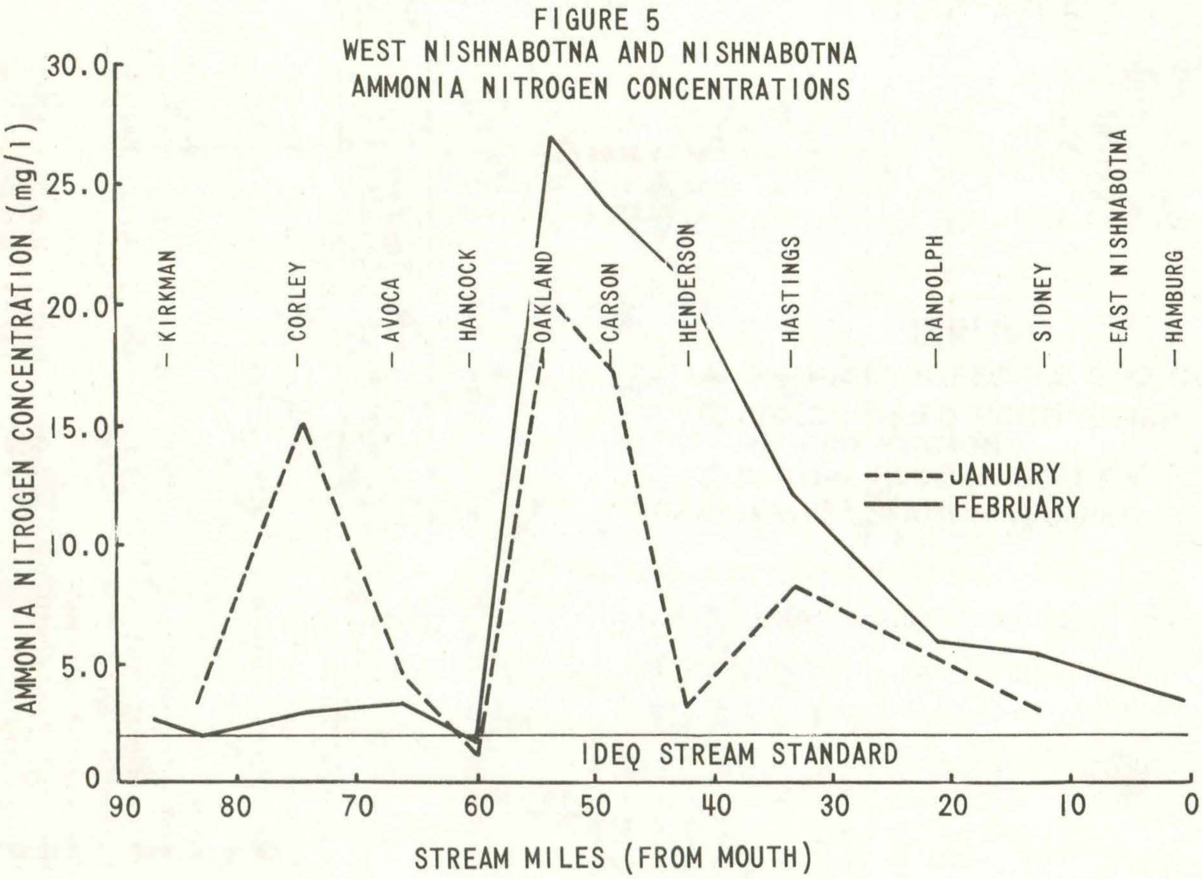


FIGURE 5
WEST NISHNABOTNA AND NISHNABOTNA
AMMONIA NITROGEN CONCENTRATIONS
AMMONIA NITROGEN CONCENTRATION (mg/l)
KIRKMAN
CORLEY
AVOCA
HANCOCK
OAKLAND
CARSON
HENDERSON
HASTINGS
RANDOLPH
SIDNEY
EAST NISHNABOTNA
HAMBURG
JANUARY
FEBRUARY
IDEQ STREAM STANDARD
STREAM MILES (FROM MOUTH)

TABLE 7
WATER QUALITY DATA
WEST NISHNABOTNA RIVER 1972

	Sampling Station													
	North of Kirkman		South of Kirkman		Near Corley		Near Avoca		Near Hancock		Near Oakland		Near Carson	
Parameter	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.
Temperature (°C)	---	0	0	0	0	0	0	---	---	0	0	0	0	0
Dissolved oxygen (mg/l)	---	4.7	---	3.5	--	3.0	--	2.0	---	2.4	---	2.1	---	1.7
Fecal coliforms (MPN/100 ml)	---	2,870	240	1,220	580	11,300	390	690	1,540	4,600	800	510	770	6,600
pH	---	7.05	7.15	---	7.2	---	--	---	7.35	---	7.4	7.6	---	---
Organic nitrogen (mg/l)	---	0.57	1.9	0.44	2.3	0.51	2.1	0.45	1.6	0.41	2.3	1.5	2.3	1.2
Ammonia nitrogen (mg/l)	---	2.3	3.5	2.0	15.0	3.1	4.6	3.3	1.3	1.7	20.0	27.0	17.0	24.0
Nitrate nitrogen (mg/l)	---	1.7	1.8	1.1	1.3	0.7	0.9	0.4	0.8	0.4	0.8	0.3	0.9	0.4
Total solids (mg/l)	---	479	534	---	777	486	---	---	---	481	848	1,027	---	---
Total suspended solids (mg/l)	---	9	77	---	8	6	---	---	---	1	8	3	---	---
Phosphate (filtrable)(mg/l)	---	0.28	0.37	0.14	0.77	0.68	0.63	0.49	0.44	0.23	1.00	1.00	0.87	0.79
Phosphate (total)(mg/l)	---	0.3	0.40	0.22	0.79	0.72	0.66	0.49	0.48	0.31	1.00	1.10	0.89	0.80
BOD_5 (mg/l)	---	3	6	2	6	5	8	3	5	2	8	5	7	3
COD (mg/l)	---	24.7	40.0	35.0	46.0	24.7	50.0	18.5	44.0	12.3	52.0	49.3	48.0	41.2

	Near Henderson		Near Hastings		Near Malvern (Silver Cr.)		Near Randolph		Near Sidney (Walnut Cr.)		Near Sidney		Near Hamburg	
Parameter	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.
Temperature (° C)	0	0	0	0	---	0	---	0	---	0	0	0	---	0
Dissolved oxygen (mg/l)	---	0.9	---	3.7	---	10.7	---	4.9	---	9.8	---	4.8	---	4.8
Fecal coliforms (MPN/100 ml)	1,460	4,000	100	1,200	---	8,100	---	2,300	---	50	30	860	---	4,000
pH	---	---	---	---	---	7.15	---	---	---	7.2	7.4	7.1	---	7.1
Organic nitrogen (mg/l)	2.0	1.0	1.5	0.61	---	0.71	---	0.68	---	0.31	0.79	0.52	---	0.53
Ammonia nitrogen (mg/l)	3.3	21.0	8.3	12.0	---	0.45	---	5.9	---	0.07	3.3	5.4	---	3.6
Nitrate nitrogen (mg/l)	1.2	0.4	1.7	1.0	---	2.4	---	1.8	---	1.5	2.3	1.7	---	1.5
Total solids (mg/l)	---	---	---	---	---	424	---	557	---	440	541	558	---	490
Total suspended solids (mg/l)	---	---	---	---	---	0	---	1	---	10	0	5	---	3
Phosphate (filtrable)(mg/l)	0.59	0.66	0.38	0.31	---	0.10	---	0.19	---	0.05	0.18	0.03	---	0.10
Phosphate (total)(mg/l)	0.59	0.67	0.38	0.40	---	0.14	---	0.25	---	0.05	0.19	0.17	---	0.19
BOD_5 (mg/l)	7	3	5	3	---	4	---	4	---	3	3	2	---	2
COD (mg/l)	44.0	32.9	28.0	24.7	---	10.3	---	16.5	---	12.3	12.0	12.3	---	12.3

Data from the sampling station near Sidney do not give much indication of the effect of wastewater discharges upon water quality within the stream. There is some indication of the variance of water quality with season of the year at that point. The 1973 data from the station near Sidney do not violate any of the stream quality criteria. Data from this sampling station are summarized in Table 8. Fecal coliform counts are high and ammonia nitrogen concentrations are slightly greater than would be expected, but otherwise there is little indication of stream pollution at this sampling station.

From available data, stream quality on the West Nishnabotna is decidedly lowered by wastewater discharges during conditions of low flow and ice cover. The extent of water quality degradation is decreased during warm weather and at higher flows.

East Nishnabotna River - This stream also rises in southwestern Carroll County and ends at the confluence with the Nishnabotna River and West Nishnabotna River. There are two sources of comprehensive water quality data for this stream. Report No. 72-39, "West Nishnabotna Water Quality Survey," also contains data on the East Nishnabotna River taken in January, 1972. In addition, a single water quality sampling station near Farragut was included in the statewide survey done during 1973 from August through December, and results of this survey are presented in Report No. 74-21, "Iowa Internal Stream Quality Survey."

Data at the sampling station near Farragut do not give much indication of the effect of wastewater discharges upon water quality within the stream. However, data at that sampling point do give an indication of the variance in water quality with season of the year. Conditions during the January, 1972, survey are the same as those identified in the discussion on the West Nishnabotna. On January 26, stream flow at the USGS gaging station near Atlantic was 15 cfs and at the gage near Red Oak, 38 cfs. This compares with the 7-day, 1-in-10 year low flows of 3.6 cfs at Atlantic and 12.0 cfs at Red Oak.

TABLE 8

1973 WATER QUALITY DATA

WEST NISHNABOTNA RIVER - NEAR SIDNEY

Parameter	Date of Sampling Aug. 20, 1973	Sept. 17, 1973	Oct. 15, 1973	Nov. 13, 1973
Temperature (° C)	28	12	14.5	10.5
Dissolved oxygen (mg/l)	8.0	9.4	9.1	11.3
Fecal coliform (MPN/100 ml)	3,600	100,000	14,000	2,400
pH	8.1	7.65	7.65	7.95
Total Kjeldahl nitrogen (mg/l)	0.98	0.90	0.46	0.38
Ammonia nitrogen (mg/l)	0.06	0.54	0.40	0.18
Nitrate nitrogen (mg/l)	4.7	3.5	3.2	5.0
Total suspended solids (mg/l)	---	494	---	230
Phosphate (filtrable)(mg/l)	---	0.11	---	0.14
BOD_5 (mg/l)	1	5	1	2
Total chromium (mg/l)	<0.01	<0.01	<0.01	<0.01
Hexavalent chromium (mg/l)	<0.01	<0.01	<0.01	<0.01
Arsenic (mg/l)	---	<0.01	---	<0.01
Barium (mg/l)	---	0.3	---	0.3
Cadmium (mg/l)	---	<0.01	---	<0.01
Copper(mg/l)	---	<0.01	---	0.02
Lead (mg/l)	---	<0.01	---	<0.01
Mercury(µg/l)	---	<1	---	<1
Zinc (mg/l)	---	0.04	---	0.02

Dissolved oxygen concentrations identified in the January, 1972, report are shown on Figure 6. Although the concentrations are well below saturation downstream of Atlantic, the stream standard of 5.0 mg/l is not violated. Downstream reaeration and dilution raise this dissolved oxygen concentration to almost the saturation level. At 7-day, 1-in-10 year low flows, the impact of wastewater treatment plant discharges at Atlantic and Red Oak may have a more significant effect on dissolved oxygen levels in the stream.

Ammonia nitrogen concentrations follow the same general pattern as the dissolved oxygen concentrations. A profile of the ammonia nitrogen concentrations is shown on Figure 7. Concentrations are high downstream of Atlantic and decrease to the confluence with the West Nishnabotna River. The IDEQ stream standard of 2.0 mg/l is not violated.

Other water quality data taken during the January, 1972, survey are presented in Table 9, while the data taken in 1973 at Farragut are shown in Table 10. Comparison of the data taken in November, 1973 to that taken near Farragut during January, 1972, shows comparable water quality in the stream. The 1973 data show expected seasonal variations with dissolved oxygen and ammonia nitrogen concentrations being lower, and fecal coliform counts being higher during warm weather. None of the applicable water quality criteria was violated during the 1973 samplings. Both surveys show high fecal coliform counts for the season of the year. The January, 1972, survey shows a significant increase in fecal coliform counts below the Atlantic and Red Oak wastewater treatment plant discharges.

The above data show the water quality of the East Nishnabotna to be lowered during times of relatively low flow and ice cover, by discharges from the wastewater treatment plants. Greater degradation of water quality with possible violations of the stream standards should be the result of 7-day, 1-in-10 year low flows.

Nishnabotna River - This reach of stream extends from the confluence of the East and West Nishnabotna Rivers to the Iowa-Missouri state line; a distance of only a few miles. The only available comprehensive data on this stream are in Report No. 72-39, "West Nishnabotna Water

FIGURE 6
EAST NISHNABOTNA
DISSOLVED OXYGEN CONCENTRATIONS

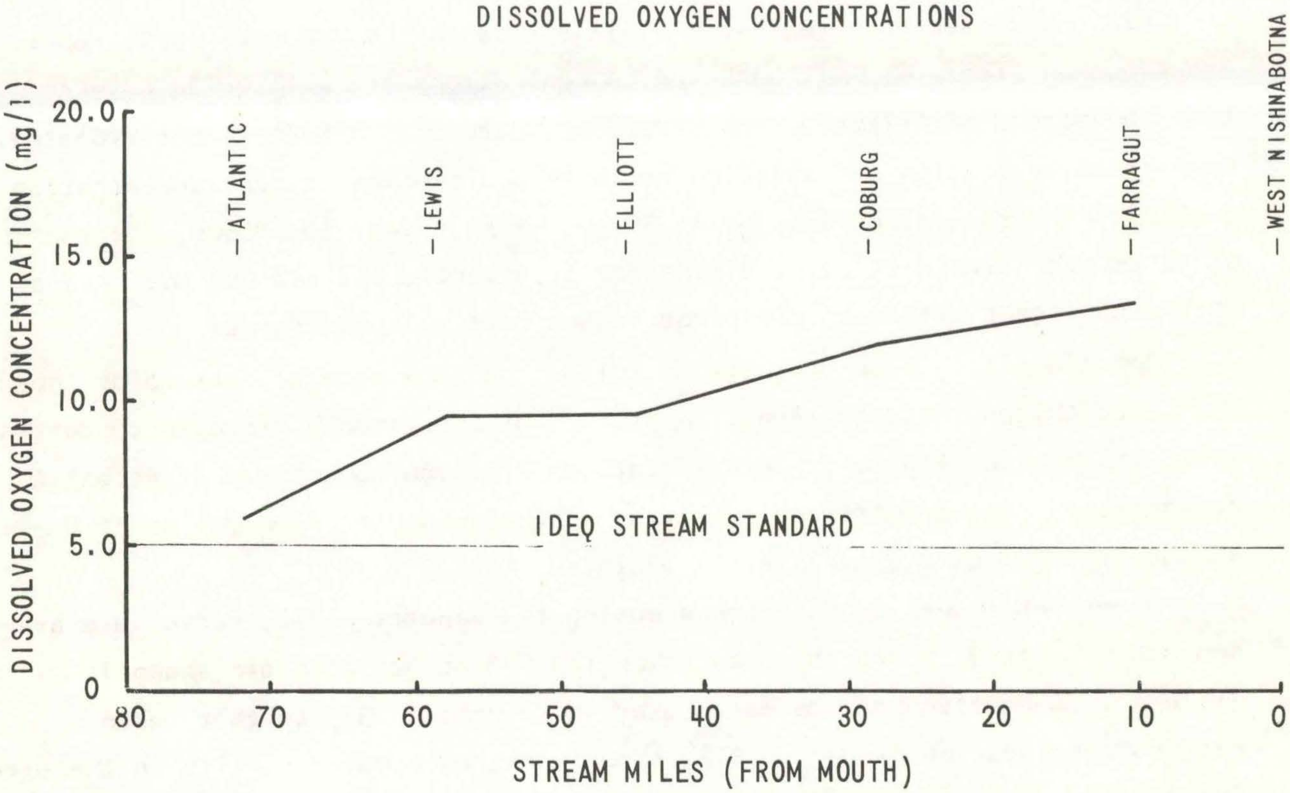


FIGURE 7
EAST NISHNABOTNA
AMMONIA NITROGEN CONCENTRATIONS

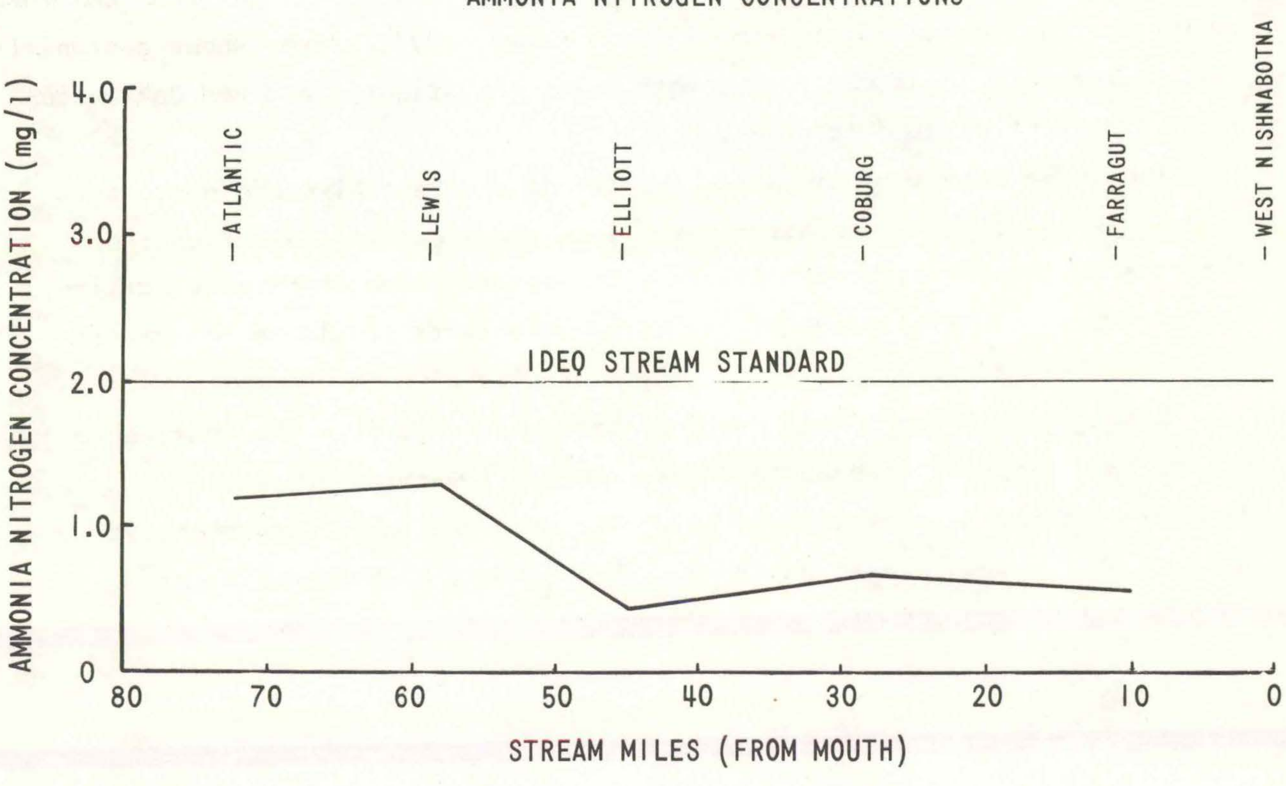


TABLE 9

WATER QUALITY DATA

EAST NISHNABOTNA RIVER 1972

Parameter	Sampling Station: Near Atlantic	Near Lewis	Near Elliot	Near Coburg	Near Farragut
Temperature (° C)	0	0	0	0	0
Dissolved oxygen (mg/l)	6	9.4	9.5	12.1	13.55
Fecal coliforms (MPN/100 ml)	70	3,600	930	920	9,400
Organic nitrogen (mg/l)	0.88	0.04	0.51	0.57	0.40
Ammonia nitrogen (mg/l)	1.2	1.3	0.45	0.69	0.60
Nitrate nitrogen (mg/l)	2.6	2.3	0.8	1.5	1.4
Total solids (mg/l)	413	---	---	---	343
Total suspended solids (mg/l)	0	---	---	---	0
Phosphate (filtrable)(mg/l)	0.23	0.55	0.24	0.26	0.27
Phosphate (total)(mg/l)	0.25	0.65	0.25	0.30	0.30
BOD_5 (mg/l)	3	3	2	3	2
COD (mg/l)	16.0	14.0	12.0	8.0	4.0

TABLE 10

1973 WATER QUALITY DATA

EAST NISHNABOTNA RIVER - NEAR FARRAGUT

Parameter	Date of Sampling			
	Aug. 20, 1973	Sept. 17, 1973	Oct. 15, 1973	Nov. 13, 1973
Temperature (° C)	29	12.5	15	11.5
Dissolved oxygen (mg/l)	7.8	9.7	9.7	11.0
Fecal coliform (MPN/100 ml)	12,000	39,000	26,000	6,800
Total Kjeldahl nitrogen (mg/l)	1.2	0.76	0.40	0.64
Ammonia nitrogen (mg/l)	0.12	0.60	0.24	0.24
Nitrate nitrogen (mg/l)	3.3	2.2	5.2	8.2
Total suspended solids (mg/l)	---	242	---	145
Phosphate (filtrable)(mg/l)	---	0.12	---	0.14
BOD_5 (mg/l)	2.0	3.0	2.0	2.0
Total chromium (mg/l)	<0.01	<0.01	<0.01	<0.01
Hexavalent chromium (mg/l)	<0.01	<0.01	<0.01	<0.01
Arsenic (mg/l)	---	<0.01	---	<0.01
Barium (mg/l)	---	0.2	---	0.1
Cadmium (mg/l)	---	<0.01	---	<0.01
Copper (mg/l)	---	<0.01	---	<0.01
Lead (mg/l)	---	<0.01	---	<0.01
Mercury (μg/l)	---	<1	---	<1
Zinc (mg/l)	---	0.02	---	0.02

Quality Survey," containing data collected in January and February, 1972, and from the ongoing quarterly stream monitoring survey.

Conditions during the 1972 survey are the same as those identified in the discussion of the West Nishnabotna. Dissolved oxygen and ammonia nitrogen concentrations near Hamburg are shown as part of the West Nishnabotna data on Figures 4 and 5. Although downstream of the confluence of the West and East Nishnabotna Rivers, this station still shows violations of the dissolved oxygen and ammonia nitrogen criteria. Other water quality data taken near Hamburg in February, 1972, are shown in Table 7. During February 8 and 9, the flow at the USGS gage near Hamburg was 105 cfs as compared with the 7-day, 1-in-10 year low flow of 19 cfs.

Even though considerable good quality water is added to the stream at the confluence of the East and West Nishnabotna, and from groundwater; there is not the increase in stream water quality that might be expected. Under warm weather conditions, it is unlikely that the stream would show poor water quality at this point due to faster rates of pollutant removal.

Data from the quarterly stream monitoring survey is summarized in Table 11. There are no violations of stream quality criteria, and none of the data indicates pollution of the stream. As indicated in Table 11, stream flows at Hamburg are very high on the dates of sampling. The high flows have caused substantial increases in the value of total suspended solids over those found at low flows. These data do not provide any indication of stream water quality during low flow, and the high flows have eliminated much of the expected seasonal variations.

Summary

Available water quality data for the Nishnabotna River Basin only allows definition of stream quality along the streams during January and February, 1972. This survey was conducted at a time of low flow and the impact of wastewater treatment plant discharges upon water quality is evident. No data are available to show water quality in the stream under more favorable conditions of reaeration and pollutant degradation. Additional water quality sampling under varying conditions will be necessary to assess the effectiveness of the waste load allocations in maintaining the stream quality standards.

TABLE 11

WATER QUALITY DATA
NISHNABOTNA RIVER - NEAR HAMBURG

Parameter	Date of Sampling					
	Aug. 29, 1972	Nov. 20, 1972	Feb. 20, 1973	Jun. 12, 1973	Aug. 20, 1973	Nov. 13, 1973
Temperature (° C)	26.5	5	1.5	24	27.5	10
Dissolved Oxygen (mg/l)	12.9	12.2	12.7	8.1	7.5	11.3
Fecal Coliforms (MPN/100 ml)	460	12,500	800	1,900	5,600	2,000
Organic Nitrogen (mg/l)	1.3	1.6	0.55	1.2	1.5	0.75
Ammonia Nitrogen (mg/l)	<0.01	0.08	0.29	0.03	<0.01	<0.01
Nitrate Nitrogen (mg/l)	4.6	6.8	2.9	6.2	4.2	4.4
Total Solids (mg/l)	443	958	499	862	874	582
Total Suspended Solids (mg/l)	83	596	171	526	486	215
Volatile Suspended Solids (mg/l)	8	28	13	24	42	16
Phosphate (Filtrable) (mg/l)	0.17	0.13	0.11	0.20	0.26	0.16
BOD_5 (mg/l)	6	4	2	1	2	2
COD (mg/l)	16	41	16	35	34	20
pH (SU)	-	-	-	8.15	8.1	8.05
Flow (cfs)	320	2,850	6,420	2,520	1,340	1,850
Flow Exceeded 20% of Time	1,300	1,300	1,300	1,300	1,300	1,300

PART IV

POINT SOURCE WASTEWATER DISCHARGES

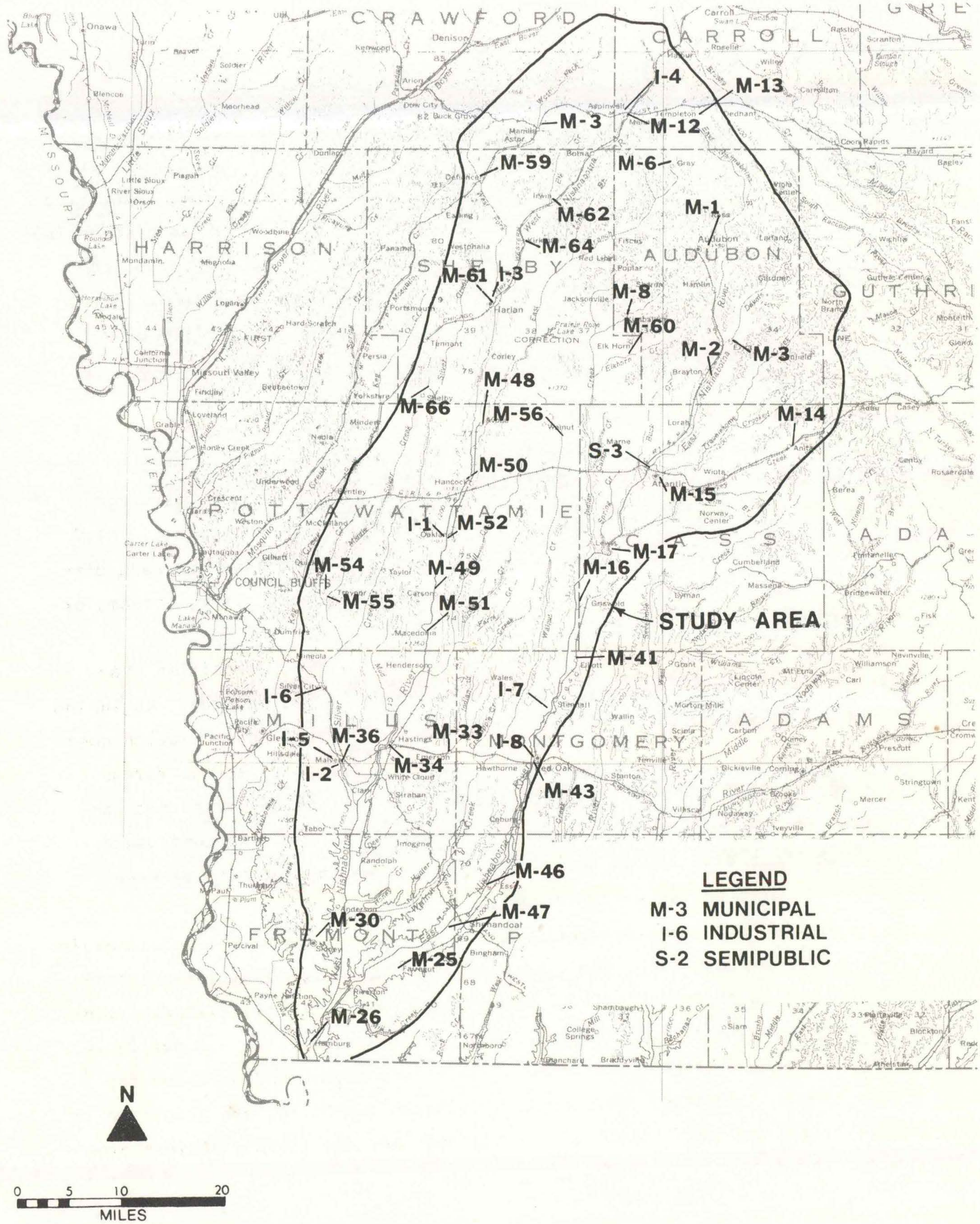
General

Effluents from municipal, industrial, and semipublic wastewater treatment facilities comprise the point source wastewater discharges identified in the Iowa Department of Environmental Quality (IDEQ) files as discharging to the surface waters of the Nishnabotna River Basin. The inventoried discharges are compiled in the following tables. The tabulations include location and identification of dischargers, quantity and quality of wastewater discharged, and operational data and descriptions of treatment facilities.

Table 12, at the end of this PART, lists individual wastewater discharges, location, and river mile. An identification system has been established whereby "M," "I," or "S" precedes the wastewater discharge number. Municipal discharges are represented by "M," industrial by "I," and semipublic by "S." River mile locations are identified for each discharge with reference to mile zero at the mouth of each river, stream, or tributary.

Table 13, which appears at this end of this PART, identifies characteristics of each point source wastewater discharge, in order, beginning with the upstream end of the West Nishnabotna River. The tabulation continues downstream picking up the tributaries. The point source farthest upstream on a tributary is identified and the tabulation proceeds downstream to the confluence. The procedure is repeated at the confluence with the East Nishnabotna River. Figure 8 shows the location of each existing point source wastewater discharge.

Available wastewater quality and quantity information is tabulated in Table 13. Average flow, BOD_5, suspended solids, ammonia nitrogen, phosphorus, total dissolved solids, temperature, and other miscellaneous constituents are reported in Table 13. Where sufficient data are available, BOD_5, ammonia nitrogen, and temperature values have been indicated for both summer and winter conditions. Discharge quantities are tabulated in both milligrams per liter (mg/l) and pounds per day (lb/day) unless otherwise stated.



POINT SOURCE WASTEWATER DISCHARGES

FIG. 8

STANLEY CONSULTANTS

Municipal

Sewage flow and quality data for 33 municipalities were extracted from IDEQ records and files. Average sewage flow values contained in reports submitted by treatment plant operators have been extracted by IDEQ and published in "Wastewater Treatment Plant Flow Data - 1970, 1971, and 1972."

Most quality data were collected from "Effluent Quality Analysis Program" (EQAP) by IDEQ. These data were supplemented by a review of treatment facility reports supplied by the operators. Data reported through EQAP are results of tests conducted by the Iowa State Hygienic Laboratory on wastewater samples supplied by the individual dischargers. In most instances, the number of BOD_5, ammonia nitrogen, and total phosphorus values reported each year was minimal. Because of large seasonal variations in BOD_5, ammonia nitrogen, and temperature, both summer and winter values have been tabulated, where available.

BOD_5 analysis results from the Iowa State Hygienic Laboratory (reported in EQAP) are reported 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 less than 25 mg/l, thus lower summer BOD_5 average values would result. The adequacy of this reporting procedure should be reviewed since some dischargers are, or soon will be, required to provide BOD_5 removals of less than 25 mg/l. In some instances, due to the scarcity of data, engineering judgment was applied to arrive at representative values rather than taking straight averages of available data.

Industrial

Information for eight industries discharging wastewater to streams within the study area was obtained. The best source of available discharge information utilized was the IDEQ industrial files containing NPDES information. Table 13 represents a tabulation of available information; however, caution must be exercised in data interpretation as information has been submitted by the individual industries with very little verification.

Semipublic

Information identifying only three semipublic facilities was obtained from IDEQ files. Two facilities discharge through septic tanks into the ground with no further treatment. The third facility has a lagoon. Due to the minimal surveillance provided, quality and quantity relationships are practically nonexistent with virtually no information available.

Existing Wastewater Treatment Facilities

Inventory information for existing wastewater treatment facilities has been compiled in Table 14 at the end of this PART. The order of presentation in Table 14 is identical to that utilized in Table 13 beginning with the facilities at the upstream reaches and continuing downstream to the Iowa-Missouri state line.

Table 14 contains existing design average day capacity, present average day flow, both influent and effluent concentrations for BOD_5 and suspended solids, type of treatment process, and comments about the facility or process. Influent values are only available for the larger treatment facilities. Specific processes identify primary treatment, secondary treatment, and solids handling operations. The treatment abbreviations are those presently used by IDEQ and are listed at the end of the table. The "Comments" column includes information obtained by IDEQ personnel on existing operations, age of existing facilities, specific IDEQ permit requirements, IDEQ orders for additional treatment, and delineation of proposed facilities.

A total of 33 municipalities, 8 industrial, and 1 semipublic treatment facilities have been identified in the study area. In addition, 34 small communities and 2 semipublic county homes presently without collection or treatment systems are also included in Table 14. Some of these are in various stages of municipal treatment facility development.

Summary

Total hydraulic and organic loads (after existing treatment), as contained in EQAP, upon the streams in the Nishnabotna River Basin from the three types of point source wastewater discharges are summarized in Table 15.

TABLE 15

REPORTED POINT SOURCE

WASTEWATER DISCHARGE SUMMARY

	Total	Municipal	Industrial	Semipublic
Flow, mgd	5.710	4.683	1.027	N.A.
Percent		82	18	
BOD_5, lb/day	1,775.4	1,301.4	474.0	N.A.
Percent		73	27	
Ammonia-N, lb/day	1,219.1	443.4	775.7	N.A.
Percent		36	64	
Phosphorus-P, lb/day	916.1	916.1	N.A.	N.A.
Percent		100		

Table 16 summarizes the classifications of municipal treatment facilities and populations served. The smaller communities are typically served by waste stabilization pond systems, while most larger cities utilize trickling filter plants. Only two communities having populations of less than 1,000 have trickling filter plants, while five communities with more than 1,000 maintain waste stabilization ponds.

TABLE 16

WASTEWATER TREATMENT FACILITIES

PROCESS SUMMARY

Type of Plant	Communities Served	Population Served
Trickling Filter	10	32,578
Waste Stabilization Pond	22	16,274

TABLE 12

POINT SOURCE
WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal						
Anita	M-14	Cass	62.9	Turkey Creek	44	48
Aspinwall	M-22	Crawford		Elk Creek	NEMTF	
Atlantic	M-15	Cass	68.7	East Nishnabotna River	44	48
Audubon	M-1	Audubon	89.1	Blue Grass Creek	44	48
Avoca	M-48	Pottawattamie	67.2	E.Branch West Nishnabotna R.	43	46
Brayton	M-2	Audubon	80.6	East Nishnabotna River	44	48
Carson	M-49	Pottawattamie	48.6	West Nishnabotna River	43	47
Coburg	M-40	Montgomery		East Nishnabotna River	NEMTF	
Defiance	M-59	Shelby	83.2	West Fork West Nishnabotna River	43	46
Elk Horn	M-60	Shelby	59.2	Elkhorn Creek	44	49
Elliott	M-41	Montgomery	48.4	East Nishnabotna River	45	49
Emerson	M-33	Mills	34.4	Indian Creek	43	47
Essex	M-46	Page	23.1	East Nishnabotna River	45	49
Exira	M-3	Audubon	84.4	East Nishnabotna River	44	48
Farragut	M-25	Fremont	6.3	Thomas Ditch	45	49
Gray	M-6	Audubon		East Branch West Nishnabotna River	44	49
Griswold	M-16	Cass	51.6	Baughmans Creek	45	49
Hamburg	M-26	Fremont	0.6	Nishnabotna River	45	50
Hancock	M-50	Pottawattamie	65.6	West Nishnabotna River	43	46
Harlan	M-61	Shelby	82.5	West Nishnabotna River	43	46
Hastings	M-34	Mills		Indian Creek	NEMTF	
Henderson	M-35	Mills		West Nishnabotna River	--	47
Imogene	M-27	Fremont		Hunters Branch	NEMTF	
Irwin	M-62	Shelby	93.7	West Nishnabotna River	43	46
Kimballtown	M-8	Audubon	59.2	Indian Creek	44	49
Kirkman	M-64	Shelby		West Nishnabotna River	NEMTF	
Lewis	M-17	Cass	61.9	East Nishnabotna River	44	49
Macedonia	M-51	Pottawattamie		West Nishnabotna River	43	47

*River mile of discharge or tributary confluence with the main stream.
NEMTF: No Existing Municipal Treatment Facility.

TABLE 12 (Cont.)

POINT SOURCE
WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal (cont.)						
Malvern	M-36	Mills	27.0	Silver Creek	44	47
Manilla	M-23	Crawford	83.2	West Fork West Nishnabotna River	43	46
Manning	M-12	Carroll	104.0	West Nishnabotna River	43	46
Marne	M-19	Cass		Camp Creek	NEMTF	
Norway Center	M-20	Cass		Jim Branch	NEMTF	
Oakland	M-52	Pottawattamie	54.6	West Nishnabotna River	43	46
Randolph	M-28	Fremont		Deer Creek	NEMTF	
Red Oak	M-43	Montgomery	36.1	East Nishnabotna River	45	49
Riverton	M-29	Fremont		East Nishnabotna River	NEMTF	
Shelby	M-66	Shelby	27.0	Little Silver Creek	43	47
Shenandoah	M-47	Page	12.5	East Nishnabotna River	45	49
Sidney	M-30	Fremont	15.0	Dry Run	44	48
Silver City	M-37	Mills		Silver Creek	NEMTF	
Templeton	M-13	Carroll	109.4	East Nishnabotna River	44	48
Treynor NW	M-54	Pottawattamie	27.0	Middle Silver Creek	43	47
Treynor SE	M-55	Pottawattamie	21.4	Middle Silver Creek	43	47
Walnut	M-56	Pottawattamie	15.4	Walnut Creek	44	47
Westphalia	M-67	Shelby		Silver Creek	NEMTF	
Wiota	M-21	Cass		Turkey Creek	NEMTF	
Industrial						
American Beef Packers (Oakland)	I-1	Pottawattamie	48.0	West Nishnabotna River	43	46
Henningson Foods, Inc. (Malvern)	I-2	Mills	21.4	Silver Creek	44	47
Kaser Construction Co. - Malvern Quarry (Malvern)	I-5	Mills	27.0	Silver Creek	44	47

*River mile of discharge or tributary confluence with the main stream.

TABLE 12 (Cont.)

POINT SOURCE
WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Industrial (cont.)						
Kaser Construction Co.-Stennett Quarry (Red Oak)	I-7	Montgomery	36.0	East Nishnabotna River	45	49
Schildberg Construction Co. - Silver City Quarry (Silver City)	I-6	Mills	27.0	Silver Creek	44	47
Soypro International (Manning)	I-4	Carroll	104.0	West Nishnabotna River	--	46
Uniroyal, Inc. (Red Oak)	I-8	Montgomery	36.1	East Nishnabotna River	45	49
Western Iowa Pork (Harlan)	I-3	Shelby	75.0	West Nishnabotna River	43	46
Semipublic						
Abild Mobile Home Park (Atlantic)	S-3	Cass	68.7	East Nishnabotna River	43	48
Fremont County Home (Sidney)	S-1	Fremont		West Nishnabotna River	--	48
Montgomery County Home (Red Oak)	S-2	Montgomery		East Nishnabotna River	--	49

*River mile of discharge or tributary confluence with the main stream.

TABLE 13

POINT SOURCE
WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD_5 Summer (mg/l)	BOD_5 Summer (lb/day)	BOD_5 Winter (mg/l)	BOD_5 Winter (lb/day)	Suspended Solids (mg/l)	Suspended Solids (lb/day)	Ammonia Nitrogen (N) Summer (mg/l)	Ammonia Nitrogen (N) Summer (lb/day)	Ammonia Nitrogen (N) Winter (mg/l)	Ammonia Nitrogen (N) Winter (lb/day)	Phosphorus (Total P) (mg/l)	Phosphorus (Total P) (lb/day)	Total Dissolved Solids (mg/l)	Total Dissolved Solids (lb/day)	Temperature Summer (F)	Temperature Winter (F)	Other (mg/l unless noted otherwise)
West Nishnabotna River																		
M-12	0.159	30	39.8	30	39.8			10	13.3	17	22.5	24	31.8					
M-62	0.030	90	22.5	140	35			28	7			57	14.3					
West Fork Nishnabotna River																		
M-23	0.055	45	20.6	105	48.2			2	0.9			5	2.3					
M-59	0.020	30	5	64	10.7					16	2.7	14	2.3					pH = 8.0 SU DO = 8.0
West Nishnabotna River																		
M-61	0.716	25	149	41	245			15	89.6	19	113	32	197					
I-3	0.300	25	62.6	50	125	44	100	16	40	20	50					78	34	pH = 8.5 SU
East Branch West Nishnabotna River																		
M-48	0.265	30	66.3	25	55.3													
West Nishnabotna River																		
M-50	0.008	55	3.7	30	2													
M-52	0.125	45	46.9	51	53.2			8	8.3	12	12.5	22	22.9					
I-1	0.718	70	419	35	210			82	491	163	976					75	18	DO = 7.2 Total coliform = 14,000 MPN/100 ml pH = 8.05 SU Alkalinity: T = 1,090 Organic Nigrogen-N = 24 NH_3-N = 85 NO_2-N = 1.4 NO_3-N = 5.5 TS = 8,424 TVS = 447 TDS = 8,258 VDS = 308 TSS = 166 VSS = 139 Ortho PO_4-P = 8.3 PO_4-P = 9.3 COD = 597 Turbidity = 140 JTU
M-49	0.119	61	60.5	77	76.4			26	25.8	32	31.8	25	24.8					
M-51	0.010	55	0.5	45	0.4			8	0.1	12	0.1	27	0.2					
Indian Creek																		
M-33	0.036	25	7.5	25	7.5			21	6.3	13	3.9	20	6					
Silver Creek																		
Little Silver Creek																		
M-66		48		44				12		4		28						
Middle Silver Creek																		
M-54	0.037	36	11.1	50	15.4			2	0.6			7	2.2					
M-55	0.011	36	3.3	33	3.0			6	0.6			17	1.6					

TABLE 13 (Cont.)

POINT SOURCE
WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD_5 Summer (mg/l)	BOD_5 Summer (lb/day)	BOD_5 Winter (mg/l)	BOD_5 Winter (lb/day)	Suspended Solids (mg/l)	Suspended Solids (lb/day)	Ammonia Nitrogen (N) Summer (mg/l)	Ammonia Nitrogen (N) Summer (lb/day)	Ammonia Nitrogen (N) Winter (mg/l)	Ammonia Nitrogen (N) Winter (lb/day)	Phosphorus (Total P) (mg/l)	Phosphorus (Total P) (lb/day)	Total Dissolved Solids (mg/l)	Total Dissolved Solids (lb/day)	Temperature Summer (F)	Temperature Winter (F)	Other (mg/l unless noted otherwise)
West Nishnabotna River (cont.)																		
Silver Creek																		
I-6	2.030													89	1507	75	36	pH = 7.3 SU SS (Influent) = 203 Alkalinity = 239 Turbidity = 47 JTU
M-36																		
I-5	9.150					0	0							635	48460			pH = 8.2 SU TS = 635 TVS = 0 Turbidity = 32 JTU Alkalinity = 178
I-2	0.009	50	3.8	50	3.8			1	0.1	1	0.1							
Walnut Creek																		
M-56	0.054	25	11.3	25	11.3			1	0.4	14	6.3	13	5.8					
Dry Run																		
M-30	0.053	25	11.1	25	11.1			4	1.8	15	6.6	48	21.2					
East Nishnabotna River																		
M-13																		
Blue Grass Creek																		
M-1	0.310	25	64.6	25	64.6					4	10.3	20	51.7					
East Nishnabotna River																		
M-3	0.053	25	11.1	25	11.1			1	0.4	15	6.6	27	11.9				55	pH = 7.5 SU DO = 1.3
M-2	0.007	30	1.8	30	1.8					8	0.5	8	0.5					
M-15	0.741	25	154	25	154			19	117	11	68	23	142					
S-3	0.001															50	32	
Turkey Creek																		
M-14	0.080	35	23.4	25	16.7					1	0.7	1	0.7					
East Nishnabotna River																		
M-17		25		25				16		6		16						
Indian Creek																		
M-8	0.019	140	22.2	90	14.3													
Elkhorn Creek																		
M-60	0.067	40	22.4	42	23.5	75	41.9	4	2.2	1	0.6	26	14.5				10	Ortho-P = 10.4 Total coliform = 24,000 MPN/100 ml COD = 168 pH = 8.8 SU NO_3-N = 0.12 TDS = 485

TABLE 13 (Cont.)

POINT SOURCE
WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD$_5$ Summer (mg/l)	BOD$_5$ Summer (lb/day)	BOD$_5$ Winter (mg/l)	BOD$_5$ Winter (lb/day)	Suspended Solids (mg/l)	Suspended Solids (lb/day)	Ammonia Nitrogen (N) Summer (mg/l)	Ammonia Nitrogen (N) Summer (lb/day)	Ammonia Nitrogen (N) Winter (mg/l)	Ammonia Nitrogen (N) Winter (lb/day)	Phosphorus (Total P) (mg/l)	Phosphorus (Total P) (lb/day)	Total Dissolved Solids (mg/l)	Total Dissolved Solids (lb/day)	Temperature Summer (F)	Temperature Winter (F)	Other (mg/l unless noted otherwise)
East Nishnabotna River (cont.)																		
Baughmans Creek																		
M-16	0.120	30	30	25	25			10	10	10	10	18	18					
East Nishnabotna River																		
M-41	0.055	50	22.9	25	11.5			1	0.5	3	1.4	4	1.8					
M-43	0.541	35	158	33	149			12	54.1	16	72.2	25	113					Cadmium = <0.01 Chromium = 0.82 Copper = 0.05 Lead = <0.01 Nickel = 0.23 Zinc = 2.6 pH = 7.0 SU Nitrate = 80
I-7	3.260															74		pH = 7.9 SU TDS = 3,468 Turbidity = 22 JTU Alkalinity = 52
I-8	0.135	24				39		1.4						219		74	52	pH = 7.8 SU COD = 46 TS = 258 TVS = 22 Kjeldahl N = 4.7 NO_3-N = 1.7 $SO_4^{=}$ = 80 Cl^- = 17 Cadmium = <0.02 Lead = <0.01 Sodium = 30 Zinc = 0.03 Oil and grease = 0.3 Surfactants = 0.14
M-46	0.091	25	1.9	25	1.9			1	0.1	8	0.6	9	0.7					
M-47	0.750	25	156	33	206	66	413	14	87.6	19	119	36	225					BOD$_5$ (influent) = 220 pH = 7.3 SU SS influent = 304
Thomas Ditch																		
M-25	0.041	25	8.6	25	8.6			2	0.7	3	1	4	1.4					
Nishnabotna River																		
M-26	0.110	13	11.9															

TABLE 14

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD$_5$ Influent Conc. (mg/l)	BOD$_5$ Effluent Conc. (mg/l)	Suspended Solids Influent Conc. (mg/l)	Suspended Solids Effluent Conc. (mg/l)	Type of Treatment: Primary	Type of Treatment: Secondary	Type of Treatment: Solids Treatment	Comments
West Nishnabotna River										
Manning (M-12)	0.198	0.159		70			Sh Gmw Cm	Ftn Cp	Dcp BoXl	
Soypro International (I-4)	0.020									Proposed facility.
Irwin (M-62)	0.045	0.030		95			Lo	Lo		Lagoon of 4.5 acre design; constructed one acre, one-cell instead of two-cell; lagoon too small--study for remedial measures.
Elk Creek										
Aspinwall (M-22)										No existing municipal treatment facility.
West Nishnabotna River										
Kirkman (M-64)										No existing municipal treatment facility.
West Fork West Nishnabotna River										
Manilla (M-23)	0.102	0.055		69			Lo	Lo		Plant completed in July, 1968, replacing earlier facility.
Defiance (M-59)	0.048	0.020		44			Lo	Lo		Two-cell lagoon, 3.97 acres total. North lagoon not in use due to leakage into receiving stream. Plans and specifications submitted for 1974 lagoon sealing project.
West Nishnabotna River										
Harlan (M-61)	0.412	0.716		25			Sc (Gaw Km) Cm	Ftr Cp	Dfh Hc Bo XL	High infiltration/inflow problems. Plans approved for new plant.
Western Iowa Pork Co. (AKA American Beef Packers) (I-3)	0.390	0.300	1,060	37	948	40	2-Lo (anaerobic)	2-Lo - Lp (aerobic)		Sited by state as requiring new facilities--under construction.
East Branch West Nishnabotna River										
Gray (M-6)										No existing municipal treatment facility.
Avoca (M-48)	0.131	0.265	30				Lo	Lo		Possible water treatment plant lime sludge discharge requiring further treatment.
West Nishnabotna River										
Hancock (M-50)	0.025	0.008		34			Lo	Lo		Seepage--exfiltration problems.
Oakland (M-52)	0.148	0.125		52			Lo	Lo		
American Beef Packers (I-1)	0.720	0.718		63			Lo	Lo		Waste treatment system consists of two anaerobic lagoons operating in parallel, two aerated lagoons, and two aerobic lagoons. Sited by state as requiring in-plant modifications and lagoon system improvements. Should be completed.

TABLE 14 (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD_5 Influent Conc. (mg/l)	BOD_5 Effluent Conc. (mg/l)	Suspended Solids Influent Conc. (mg/l)	Suspended Solids Effluent Conc. (mg/l)	Type of Treatment: Primary	Type of Treatment: Secondary	Type of Treatment: Solids Treatment	Comments
West Nishnabotna River (Cont.)										
Carson (M-49)	0.049	0.119		35			Sh Cp Do	Fth Cp	Bo	
Macedonia (M-51)	0.030	0.010		43			Lo	Lo		
Farm Creek										
Henderson (M-35)										Plans for a three-cell waste stabilization pond submitted as of November, 1973.
Indian Creek										
Emerson (M-33)	0.021	0.036		25			Ci	Ftr Cp	Bo	Requires in-plant modifications--plans submitted.
Hastings (M-34)										No existing municipal treatment facility.
Silver Creek										
Westphalia (M-67)										No existing municipal treatment facility.
Little Silver Creek										
Shelby (M-66)				90			Lo	Lo		Sited by state as requiring new facility. Grant accepted, contract awarded 4/2/73.
Middle Silver Creek										
Treynor NW (M-54)	0.040	0.037		40			Lo	Lo		Improper construction 1972 - ISDH.
Treyner SE (M-55)	0.015	0.011		40			Lo	Lo		Overloaded 1972 - ISDH. Town has engineer working on preliminary plans.
Silver Creek										
Silver City (M-37)										No existing municipal treatment facility.
Schildberg Construction Co.- Silver City Quarry (I-6)		2.03								
Malvern (M-36)	0.150						Lo	Lo		Two-cell waste stabilization pond in operation in 1973.
Kaser Construction Co.- Malvern Quarry (I-5)		9.15			635	635				
Henningson Foods, Inc. (I-2)		0.009		150						To Malvern treatment facility approx. 0.009 mgd. Approximately 0.059 mgd cooling water discharge. Began operation June 19, 1974.
Deer Creek										
Randolph (M-28)										No existing municipal treatment facility.
Walnut Creek										
Walnut (M-56)	0.104	0.054		26			Lo	Lo		

TABLE 14 (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD$_5$ Influent Conc. (mg/l)	BOD$_5$ Effluent Conc. (mg/l)	Suspended Solids Influent Conc. (mg/l)	Suspended Solids Effluent Conc. (mg/l)	Type of Treatment: Primary	Type of Treatment: Secondary	Type of Treatment: Solids Treatment	Comments
West Nishnabotna River (Cont.)										
Hunters Branch										
Imogene (M-27)										No existing municipal treatment facility; in 1970, a site was proposed. No further action.
Dry Run										
Sidney	0.100	0.053		35			Ci	Ftn Cp	BoXl	
West Nishnabotna River										
Fremont County Home (S-1)										Sewage discharged into large septic tank; effluent from tank discharges through a sewer line without further treatment. A subsurface filter system should be installed to dispose of the effluent from the septic tank. No information since March, 1949.
East Nishnabotna River										
Templeton (M-13)							Lo	Lo		Design for 3.96-acre waste stabilization pond. Sited by state as requiring a new waste treatment facility. Grant accepted, contract, and awarded 7/21/72. Flooding problems--being negotiated.
Blue Grass Creek										
Audubon (M-1)	0.250	0.310		25			Sch Cm	Ftr Cm	Dfh Bo	Need for action to correct excessive infiltration/inflow problem. Excess flows are disrupting treatment processes.
East Nishnabotna River										
Exira (M-3)	0.50	0.053		25			Lo	Lo		Total water surface area of 11.6 acres.
Brayton (M-2)	0.010	0.007		32			Lo	Lo		
Atlantic (M-15)	0.880	0.741		35			Gm Km 2 Cm	2 Ftr Cm	Dfh Bo	
Abild Mobile Home Park (S-3)							Lo			
Turkey Creek										
Anita (M-14)	0.140	0.080		28			Lo	Lo		Infiltration problems.
Wiota (M-21)										No existing municipal treatment facility.
Jim Branch										
Norway Center (M-20)										No existing municipal treatment facility.

TABLE 14 (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD$_5$ Influent Conc. (mg/l)	BOD$_5$ Effluent Conc. (mg/l)	Suspended Solids Influent Conc. (mg/l)	Suspended Solids Effluent Conc. (mg/l)	Type of Treatment: Primary	Type of Treatment: Secondary	Type of Treatment: Solids Treatment	Comments
East Nishnabotna River (Cont.)										
Lewis (M-17)	0.061			25			Lo	Lo		Two-cell waste stabilization lagoon--7.02 acres total. The east cell is not operable as it does not hold water. West cell limited to an equivalent waste loading of 600 persons.
Indian Creek										
Kimballton (M-8)	0.050	0.019		106			La	Lo Lo		
Elkhorn Creek										
Elk Horn (M-60)	0.083	0.067		38		75	Lo	Lo		Two-cell lagoon--6.09 acres total.
Camp Creek										
Marne (M-19)										No existing municipal treatment facility.
Baughmans Creek										
Griswold (M-16)	2.61	0.120		50			Sh Ci	Ftr Cp	Bo X1	Severe infiltration problems.
East Nishnabotna River										
Elliott (M-41)	0.074	0.055		30			Lo	Lo		Two-cell waste stabilization lagoon--5.72 acres total.
Red Oak (M-43)	0.796	0.541		33			Sch Gaw Cm	Fth Cm	Dfht Bo	As of August, 1971, improved operation and maintenance was needed.
Montgomery County Home (S-2)										In 1950, the septic tank was reported to have been operating satisfactorily with effluent being discharged to ground surface without further treatment.
Kaser Construction Co.-Stennett Quarry (I-7)		3.26								Seasonal discharge for a total of 80 days per year.
Uniroyal, Inc. (I-8)		0.135		24		39				Sanitary wastes are separately collected and sent to the city treatment plant. Industrial and process wastes flow from a common gravity main into a retention pond, then by open ditch to the river.
Coburg (M-40)										No existing municipal treatment facility.
Essex (M-46)	0.166	0.091		25			Lo	Lo		Two-cell waste stabilization lagoon--8.58 acres total.
Shenandoah (M-47)	1.26	0.750	220	25			Sch Gw Cm	Fth Cm	Dfh Dfp Bo X1	
Thomas Ditch										
Farragut (M-25)	0.032	0.041		25			Lo	Lo		Two-cell waste stabilization lagoon--5.23 acres total.

TABLE 14 (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD_5 Influent Conc. (mg/l)	BOD_5 Effluent Conc. (mg/l)	Suspended Solids Influent Conc. (mg/l)	Suspended Solids Effluent Conc. (mg/l)	Type of Treatment: Primary	Type of Treatment: Secondary	Type of Treatment: Solids Treatment	Comments
East Nishnabotna River (Cont.)										
Riverton (M-29)										No existing municipal treatment facility.
Nishnabotna River										
Hamburg (M-26)	0.252	0.110		13			Lo	Lo		Two-cell waste stabilization lagoon--13.6 acres total. Action needed to correct deficiencies in the plant or its operation.

PART V

WASTE LOAD ALLOCATION METHODOLOGY

The most important consideration in determining the capacity of a stream to assimilate wastewater discharges is the ability to maintain an acceptable dissolved oxygen (DO) concentration. Microbial oxidation of organics and certain inorganics present in wastewater creates an oxygen demand. Oxygen is supplied to a stream principally by reaeration from the atmosphere. If the rate of deoxygenation exceeds the rate of reoxygenation, DO concentrations may decrease below minimum allowable standards.

To assess the variations in DO and ammonia nitrogen concentrations in the Nishnabotna River Basin, a computer-based mathematical model was utilized. Model input data was developed from available information. In most cases data were lacking and more extensive data would improve the validity of the model. However, it is felt that the developed methodology is an equitable method for establishing waste load allocations.

It is recommended that the computer-based mathematical modeling techniques should be dated and improved as more information is obtained for the Nishnabotna River Basin to more accurately predict water quality.

Theory and Methodology

General - Dissolved oxygen concentrations in streams are controlled by atmospheric reaeration, biochemical oxygen demands (carbonaceous and nitrogenous), algal photosynthesis and respiration, benthal demands, temperature, and the physical characteristics of the stream. Many of these factors are difficult, if not impossible, to accurately define.

Photosynthesis can produce large quantities of oxygen during the day if algae are present in the stream. Conversely, at night algal respiration creates an oxygen demand. Research efforts have attempted to fit harmonic functions to this phenomenon, but with limited success. Therefore, allowance for diurnal fluctuations in oxygen levels is not included in the computer model.

Benthal demands result from anaerobic decomposition of settled organic material at the bottom of the stream. These reactions release carbonaceous and nitrogenous organic materials which create biochemical oxygen demands.

The inclusion of benthal demands in the model requires extensive field surveys to determine the areal extent of sludge deposits within a stream and coefficients that describe the release into the water. Since the impact is minor in most instances and no data are available describing sludge deposition areas, no benthal oxygen demands are included in the model formulation.

Model Equation - A complete mathematical model to describe DO concentrations within the stream would include all significant factors. Natural systems cannot presently be expressed mathematically with absolute certainty, but reasonably accurate predictions can be made through realistic assumptions of the reaeration phenomenon and deoxygenation caused by carbonaceous and nitrogenous biochemcial oxygen demands.

The nitrogenous biochemical oxygen demand is due to the oxygenation of ammonia to nitrates by certain species of bacteria. This oxidation process is called nitrification. Nitrification is a two-step process whereby a specific bacterial species oxidizes ammonia to nitrite and a different bacterium oxidizes the nitrite to nitrate. Approximately 4.5 mg/l of oxygen are required to oxidize 1 mg/l of ammonia (expressed as nitrogen) to nitrate, although this value may vary between 3.8 and 4.5 mg/l. Since secondary wastewater effluents quite commonly contain ammonia nitrogen levels of 10 mg/l, the equivalent nitrogenous biochemical oxygen demand (should all the ammonia be converted to nitrates) is approximately 45 mg/l. This is equivalent to the carbonaceous biochemical oxygen demand of most secondary wastewater effluents.

For the modeling program, a modified version of the Streeter-Phelps equation for DO deficit within the stream was utilized. This approach recognizes both carbonaceous and nitrogenous biochemical oxygen demands, and atmospheric reaeration. Effects of photosynthesis and benthal demands are not considered. The rate of deoxygenation is as follows:

$$\frac{dD}{dt} = K_1 L + K_n N - K_2 D$$

Integrated this equation becomes the modified Streeter-Phelps equation as follows:

$$D(t) = \frac{K_1 L_o}{K_2 - K_1} (e^{-K_1 t} - e^{-K_2 t}) + \frac{K_n N_o}{K_2 - K_n} (e^{-K_n t} - e^{-K_2 t}) + D_o e^{-K_2 t}$$

Where:

$D(t)$ = DO deficit at time t.

D_o = Initial DO deficit.

L_o = Initial ultimate carbonaceous BOD.

N_o = Initial nitrogenous BOD.

K_1 = Carbonaceous deoxygenation rate constant.

K_n = Nitrogenous deoxygenation rate constant.

K_2 = Reaeration rate constant.

In this equation, the rates of oxygen utilization due to both carbonaceous and nitrogenous biochemical oxygen demands are expressed as first order reactions.

Ultimate BOD and ammonia nitrogen concentrations are calculated as follows:

$$L(t) = L_o e^{-K_1 t}$$

$$N(t) = N_o e^{-K_n t}$$

Where:

$L(t)$ = Ultimate carbonaceous BOD at time t.

$N(t)$ = Nitrogenous BOD at time t.

and nitrogenous oxygen demand (N) equals 4.5 times the ammonia nitrogen concentration.

Since nitrification is a two-step process, many researchers have proposed that it is a second order reaction, although no practical DO prediction equation has been developed in this form. Since nitrogenous biochemical oxygen demands are too great to ignore, most developed models assume that it is a first order reaction. The present investigation has also utilized this assumption.

Nitrifying bacteria are generally present in relatively small numbers in untreated wastewaters. The growth rate at 20° C (68° F) is such that the organisms do not exert an appreciable oxygen demand until about 8 to

10 days have elapsed. This lag period may be reduced or practically eliminated in a stream receiving large amounts of secondary effluent containing seed organisms. In biological treatment systems, substantial nitrification can take place with a resultant buildup of nitrifying organisms. These nitrifying bacteria can immediately begin to oxidize the ammonia nitrogen present and exert a significant oxygen demand in a stream.

In addition to dispersed bacteria, there can be considerable nitrification by nitrifying organisms that are attached to sediments, rocks, weeds, etc., along the stream bottom. These organisms oxidize the ammonia nitrogen in the stream as it passes by them. Such attached growths can build up below treatment plant discharges where the stream is enriched with ammonia nitrogen.

It is known that the nitrification biological process is generally more sensitive to environmental conditions than carbonaceous decomposition. The optimal temperature range for growth and reproduction of nitrifying bacteria is 26° to 30° C (79° to 86° F). It is generally concluded that the nitrogenous BOD will assume greatest importance in small streams which receive relatively large volumes of secondary wastewater effluents, and during the low flow, warm weather periods of the year (August and September). These conditions were utilized for the low flow determination of allowable effluent characteristics during summer periods. During winter low flow periods (January and February), nitrification will probably have limited influence upon the oxygen demand due to the intolerance of the nitrifying bacteria to low temperatures; thus, for winter conditions, it was assumed nitrification did not occur.

To assume that nitrification, during summer conditions, proceeds immediately following a wastewater discharge, and simultaneously with carbonaceous oxidation, is to generally assume the worst possible conditions in regards to downstream dissolved oxygen concentrations. Therefore, waste load allocations identified in this manner will generally be on the conservative side.

In addition, to assume no nitrification occurs during winter flow conditions is to treat ammonia nitrogen as a conservative (nondegrading) pollutant.

In many streams during winter conditions, the water quality criteria of 2 mg/l of ammonia nitrogen becomes the determining factor in waste load allocations. During summer conditions, the critical water quality factor is generally dissolved oxygen.

Rate Constant Determination - The carbonaceous deoxygenation rate constant (K_1) for most streams will vary from 0.1 to 0.5 per day. Early work by Streeter and Phelps determined an average value for the Ohio River of 0.23/day (0.1/day, base 10). This value has been accepted and commonly used for years with reasonable results.

Deoxygenation rates higher than 0.23/day have been reported for various streams in the United States. No measurements of deoxygenation rates for the streams under investigation are available. For this study a carbonaceous deoxygenation rate of 0.2/day (base e) was used. Field measurements of typical deoxygenation rates for streams in Iowa are needed to verify this value and would greatly improve the predictability of the modeling.

Information on nitrogenous deoxygenation rates is extremely limited. Available information indicates that nitrification rates (when active nitrification does occur) are somewhat greater than carbonaceous oxidation rates. Therefore a nitrogenous deoxygenation rate (K_n) of 0.3/day (base e) was selected for the study. Again, field measurements of typical nitrogenous deoxygenation rates in Iowa streams would greatly enhance the accuracy of the modeling effort.

Many predictive formulations have been used for stream reaeration. For this study, reaeration rate constants were predicted by a method developed by Tsivoglou ("Characterization of Stream Reaeration Capacity," Tsivoglou and Wallace, EPA-R3-72-012, October, 1972). Tsivoglou's method is based on the premise that the reaeration capacity of nontidal fresh water streams is directly related to the energy expended by the flowing water, which in turn is directly related to the change in water surface elevation.

The change in water surface elevation divided by the time of flow is the average rate of energy expenditure. This relationship is expressed by:

$$K_2 = 0.048 \left(\frac{h}{t}\right) \text{ @ } 20° \text{ C}$$

Where:

K_2 = Reaeration rate constant (base e) per day.

h = Water surface elevation change in feet.

t = Time of flow in days.

Tsivoglou's method was derived from actual measurement of stream reaeration rates by a new field tracer procedure in which a radioactive form of the noble gas krypton serves as a tracer for oxygen.

The reaeration rate predictive model has been verified for streams ranging in flow from 5 to 3,000 cfs. It can also be used to quite accurately predict reaeration effects of dams and waterfalls.

In development of Tsivoglou's procedure, other reaeration rate predictive formulas were compared with results obtained from the field tracer technique, but none appeared to predict stream reaeration rates as accurately as the Tsivoglou model.

Under winter ice conditions, the reaeration rate constant is reduced in direct proportion to the percentage of ice cover up to 95 percent. For instance, if it is estimated that there is 90 percent ice cover, then the reaeration rate constant is reduced by 90 percent. With 100 percent ice cover, the reaeration rate is reduced only by 95 percent, for it is estimated that there will always be a small amount of reaeration taking place.

Temperature corrections for the carbonaceous and nitrogenous deoxygenation rate constants and also the reaeration rate constants are subroutines within the computer model. The following formulations define the specific temperature corrections utilized in the program:

$$K_{1(T)} = K_{1(20)} \times 1.047^{T-20}$$

$$K_{2(T)} = K_{2(20)} \times 1.0241^{T-20}$$

$$K_{n(T)} = K_{n(20)} \times (0.058T - 0.16) \qquad T < 3° \text{ C}$$

Where T = water temperature, ° C.

Temperature corrections for K_1 and K_2 are generally accepted formulations. Information on the effects of temperature on K_n is lacking. The formula given was derived from information on temperature effects on nitrification rates in biological treatment systems. The formula predicts nitrification rates of zero at approximately 3° C (37° F). The rate constant is set to zero at all temperatures below 3° C (37° F).

The principal factor affecting the solubility of oxygen is the water temperature. Dissolved oxygen saturation values at various temperatures are calculated as follows:

$$C_s = 24.89 - 0.426t + 0.00373t^2 - 0.0000133t^3$$

Where:

t = Water temperature, ° F.

C_s = Saturation value for oxygen at temperature, t (° F), at standard pressure.

<u>Stream Velocity Calculations</u> - Stream velocities are important in determining reaeration rates and the downstream dispersion of pollutants. The computer model utilized calculates velocity based on a variation of the Manning formula for open channel flow. The Manning formula for open channel flow is:

$$v = \frac{1.5R^{2/3}S^{1/2}}{n}$$

Where:

v = Velocity, fps.

R = Hydraulic radius, ft = wetted perimeter/cross sectional area which approximately equals the mean depth for rivers.

S = Channel slope, ft/ft.

n = Roughness coefficient.

By multiplying both sides of the equation by the cross sectional area, which is equal to the mean depth times the water surface width, and solving for the mean depth, the following relationship is obtained:

$$d = \left(\frac{Qn}{1.5WS^{1/2}}\right)^{3/5}$$

Where:

d = Mean river depth, ft.

Q = Discharge, cfs.

W = Water surface width, ft.

S = Slope, ft/ft.

n = Roughness coefficient.

Once mean depths were calculated, velocities were determined from the relationship:

$$v = Q/A = Q/W \cdot d$$

River slopes were obtained from existing profiles when available, but usually were taken from USGS topographic maps. Slopes obtained from USGS maps are rather generalized, and more accurate river profiles would greatly improve the accuracy of velocity determinations.

River widths and roughness coefficients were estimated from information obtained from field observations, and flow and cross section data at each USGS gaging station.

Computer Input and Output Data - In order to calculate water quality at various points in the river, the river length to be modeled was divided into reaches. River characteristics such as mean velocities and depths, river widths, deoxygenation and reaeration rate constants, and water temperature were considered constant for each reach. The location of the reaches was set by one or more of the following:

1. A tributary.
2. A wastewater discharge.
3. A change in river characteristics such as river width or slope.
4. A dam.

In order to calculate water quality characteristics at various points within each reach, the reaches were divided into segments called sections.

Mixing and dispersion assumptions inherent in the model are:

1. Complete and instantaneous mixing of wastewater and tributary flows with the main river flow.
2. Uniform lateral and logitudinal dispersion (plug flow) of the stream constituents as they move downstream.

Flows that could not be allocated to tributary inflows or wastewater discharges were distributed uniformly along the main river stem and are called groundwater contributions.

Actual data input into the computer program are as follows:

1. Initial river conditions such as flow and concentrations of ultimate carbonaceous BOD, ammonia nitrogen, and DO.
2. Uniform groundwater contributions for each reach and concentrations of ultimate carbonaceous BOD, ammonia nitrogen, and DO.
3. The number of reaches and the following for each reach:
   a. Length.
   b. Number of sections.
   c. Water temperature.
   d. Channel slope.
   e. River width.
   f. Deoxygenation rate constants.
   g. Roughness coefficient.
4. Wastewater or tributary inflows consisting of inflow rates, ultimate carbonaceous BOD, ammonia nitrogen, and DO concentrations.

After calculations, computer output data consists of the following for each reach:

1. Mean river velocities.
2. Mean river depths.
3. Reaeration rate constants.
4. Temperature corrected reaeration and deoxygenation rate constants.
5. Saturation DO concentrations for the given temperature.

and the following at the beginning of every section within a reach:

1. Summation of the river miles evaluated.
2. Cumulative discharge.
3. Cumulative travel time in days.
4. Ammonia nitrogen concentrations.
5. Ultimate carbonaceous BOD concentrations.
6. DO concentrations.
7. DO deficits.

PART VI

WASTE LOAD ALLOCATIONS

Utilizing the previously defined computer methodology, waste load allocations required for dischargers to meet state water quality standards within the Nishnabotna River Basin were determined. The evaluation procedure considered the situation with 1990 wastewater discharges under both summer and winter low flow conditions. The following sections describe specific results for these evaluations and a tabulation of the waste load allocation for each discharger is presented for both summer and winter conditions. Analyses were conducted for all streams with a water quality classification and a wastewater discharger.

Evaluation Assumptions

In order to define waste load allocations for dischargers within the Nishnabotna River Basin, 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 dischargers 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. For both branches of the Nishnabotna River, the low flow exceeded the total present average daily wastewater discharges from all entities within their respective basins. The difference between the 7-day, 1-in-10 year low flow and the 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 period, the 7-day, 1-in-10 year low flow in 1990 is greater by the amount of this increase. Groundwater contribution to the stream flow was distributed throughout the drainage basin 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 the water quality of the groundwater contribution.

3. Ultimate carbonaceous BOD was assumed to be 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.

Discharger	Summer Condition: Dissolved Oxygen (mg/l)	Summer Condition: Temperature (°C)	Summer Condition: Temperature (°F)	Winter Condition: Dissolved Oxygen (mg/l)	Winter Condition: Temperature (°C)	Winter Condition: Temperature (°F)
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 non-coincidental 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 (BPWTT) effluent limitations described by 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.

Discussion of Results

The waste load allocations are based upon a computer model that utilizes the best available information for the Nishnabotna River Basin. Some of the input data provided are approximations and model predictability could be considerably improved with more accurate field information. Based on the available data, the model computes stream quality for the assigned wastewater discharges. For the initial run, all discharges were assumed to meet either secondary treatment (municipalities) or best practicable treatment (industries). Where the model indicated violation of IDEQ stream quality criteria, more stringent effluent requirements were imposed until satisfactory levels were advised. Whenever more than one entity was required to meet more stringent effluent limitations in a particular stream reach to maintain quality, approximately the same requirements were established for all of the entities regardless of size or whether they were municipal or industrial dischargers. Other possible combinations of effluent limitations on BOD, ammonia nitrogen, and dissolved oxygen could result in meeting stream quality criteria.

Summer Conditions - Waste load allocations for each discharger for summer conditions are given in Table 17. The upper limit for wastewater discharges is secondary treatment for municipal discharges and best practicable treatment for industrial dischargers. IDEQ has set the allowable ammonia nitrogen level for secondary treatment as 10 mg/l in summer.

TABLE 17

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITIONS

Discharge (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
West Nishnabotna River							
Manning (M-12)	0.04	0.173	45	65	10	14	3.0
Irwin (M-62)		0			Controlled Discharge		
West Fork West Nishnabotna River							
Manilla (M-23)		0			Controlled Discharge		
Defiance (M-59)		0			Controlled Discharge		
West Nishnabotna River							
Harlan (M-61)	0.96	1.038	15	130	4	35	3.0
Western Iowa Pork Co. (AKA American Beef Packers) (I-3)		0			Controlled Discharge		
East Branch West Nishnabotna River							
Gray (M-6)		---			No Existing Municipal Facility		
Avoca (M-48)		0			Controlled Discharge		
West Nishnabotna River							
Hancock (M-50)		0			Controlled Discharge		
Oakland (M-52)		0			Controlled Discharge		
American Beef Packers (I-11)		0			Controlled Discharge		
Carson (M-49)	4.69	0.150	45[2]	56	10[2]	13	3.0
Macedonia (M-51)		0			Controlled Discharge		

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-in-10 YEAR LOW FLOW

1990 SUMMER CONDITIONS

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
West Nishnabotna River (Cont.)							
Farm Creek							
Henderson (M-35)		---	No Existing Municipal Facility				
Indian Creek							
Emerson (M-33)	0.30[3]	0.038	45[2]	14	10[2]	3	3.0
Hastings (M-34)		---	No Existing Municipal Facility				
Little Silver Creek							
Shelby (M-66)		0	Controlled Discharge				
Middle Silver Creek							
Treynor NW (M-54)		0	Controlled Discharge				
Treynor SE (M-55)		0	Controlled Discharge				
Silver Creek							
Silver City (M-37)		---	No Existing Municipal Facility				
Malvern (M-36)		0	Controlled Discharge				
Henningson Foods, Inc. (I-2)		0	Controlled Discharge				
Deer Creek							
Randolph (M-28)		---	No Existing Municipal Facility				
Walnut Creek							
Walnut (M-56)		0	Controlled Discharge				

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITIONS

Discharge (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
West Nishnabotna River (Cont.)							
Hunters Branch							
Imogene (M-27)		---	No Existing Municipal Facility				
Dry Run							
Sidney (M-30)	0.0[3]	0.060	45[2]	23	10[2]	5	3.0
West Nishnabotna River							
Fremont County Home (S-1)		---	No Discharge Data Available				
East Nishnabotna River							
Templeton (M-13)		0	Controlled Discharge				
Blue Grass Creek							
Audubon (M-1)	0.01[3]	0.380	45	139	10[2]	31	3.0
East Nishnabotna River							
Exira (M-3)		0	Controlled Discharge				
Brayton (M-2)		0	Controlled Discharge				
Atlantic (M-15)	1.58	0.945	15	118	4	32	3.0
Turkey Creek							
Anita (M-14)		0	Controlled Discharge				
Wiota (M-21)		---	No Existing Municipal Facility				
East Nishnabotna River							
Lewis (M-17)		0	Controlled Discharge				

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITIONS

Discharge (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
East Nishnabotna River (Cont.)							
Indian Creek							
Kimballton (M-8)		0			Controlled Discharge		
Elk Horn Creek							
Elk Horn (M-60)		0			Controlled Discharge		
Camp Creek							
Marne (M-19)		---			No Existing Municipal Facility		
Baughmans Creek							
Griswold (M-16)	0.49[3]	0.124	45[2]	47	10[2]	10	3.0
East Nishnabotna River							
Elliott (M-41)		0			Controlled Discharge		
Red Oak (M-43)	8.00	0.676	45[2]	254	10[2]	56	3.0
Montgomery County Home (S-2)	8.00	---			No Discharge Data Available		
Uniroyal, Inc. (I-8)	8.00	0.135	45[2]	51	10[2]	11	3.0
Essex (M-46)		0			Controlled Discharge		
Shenandoah (M-47)	11.50	0.800	45[2]	300	10[2]	67	3.0

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITIONS

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
East Nishnabotna River (Cont.)							
Thomas Ditch							
Farragut (M-25)		0			Controlled Discharge		
East Nishnabotna River							
Riverton (M-29)		---			No Existing Municipal Facility		
Nishnabotna River							
Hamburg (M-26)		0			Controlled Discharge		

[1]Ultimate BOD = 1.5 (BOD_5).

[2]Meets BPWTT gùidelines. Higher discharge quantities could satisfy stream criteria.

[3]Flow in tributary upstream of discharge.

Dissolved oxygen concentration profiles for the Nishnabotna River, East Nishnabotna River, and West Nishnabotna River for 1990 discharges with the waste load allocations given in Table 17 are shown on Figure 9. The stream quality criteria of 5.0 mg/l are met in all sections of the streams which are water quality classified. Dissolved oxygen concentrations of less than 5.0 mg/l are present in the upper reaches of both the East and West Nishnabotna Rivers between the upstream dischargers and the beginning of the water quality classified segment of the stream.

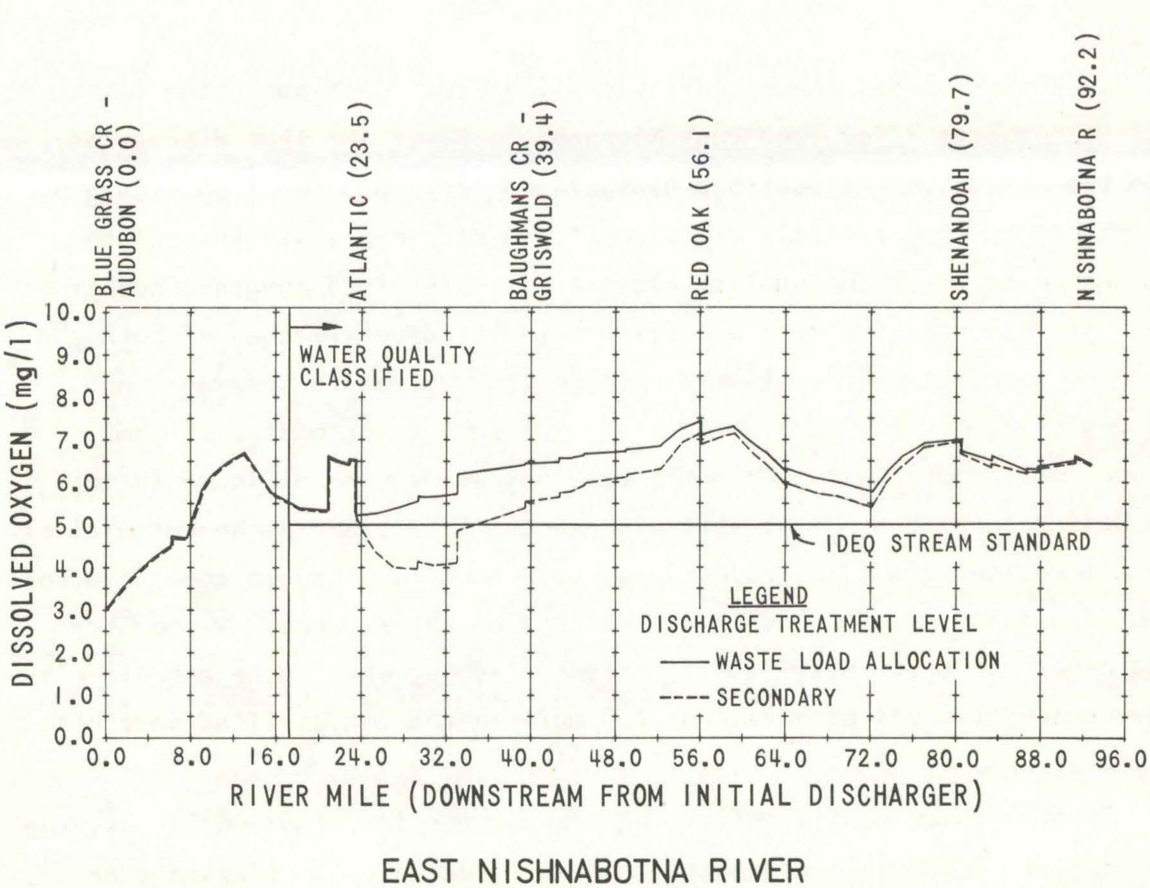
Summer ammonia nitrogen concentrations are shown on Figure 10 for the East Nishnabotna River, West Nishnabotna River, and Nishnabotna River. The allocations given in Table 17 maintain ammonia nitrogen concentrations below 2.0 mg/l for all classified sections of the streams. Wastewater discharges above the water quality classified segments cause ammonia nitrogen concentrations of more than 2.0 mg/l in the unclassified portions of the stream.

To meet water quality criteria under summer low flow conditions, the communities of Atlantic and Harlan must provide a level of wastewater treatment exceeding that of secondary treatment. Nitrification will be required at the treatment facilities for both of these communities.

<u>Winter Conditions</u> - Waste load allocations under winter low flow conditions for dischargers within the basin are given in Table 18. The allowable ammonia nitrogen concentration in secondary effluents has been set as 15 mg/l by IDEQ for winter conditions.

Dissolved oxygen concentrations for the East Nishnabotna River, West Nishnabotna River, and Nishnabotna River are shown on Figure 11. The model shows that for the waste load allocations given in Table 18, dissolved oxygen concentrations meet the water quality criteria in all classified portions of the streams. Concentrations of less than 5.0 mg/l are shown by the model upstream of the classified sections due to wastewater treatment plant effluents.

Ammonia nitrogen concentrations for the streams under winter low flow conditions are shown on Figure 12. The water quality criteria for ammonia nitrogen are met for all classified sections of the streams for the given



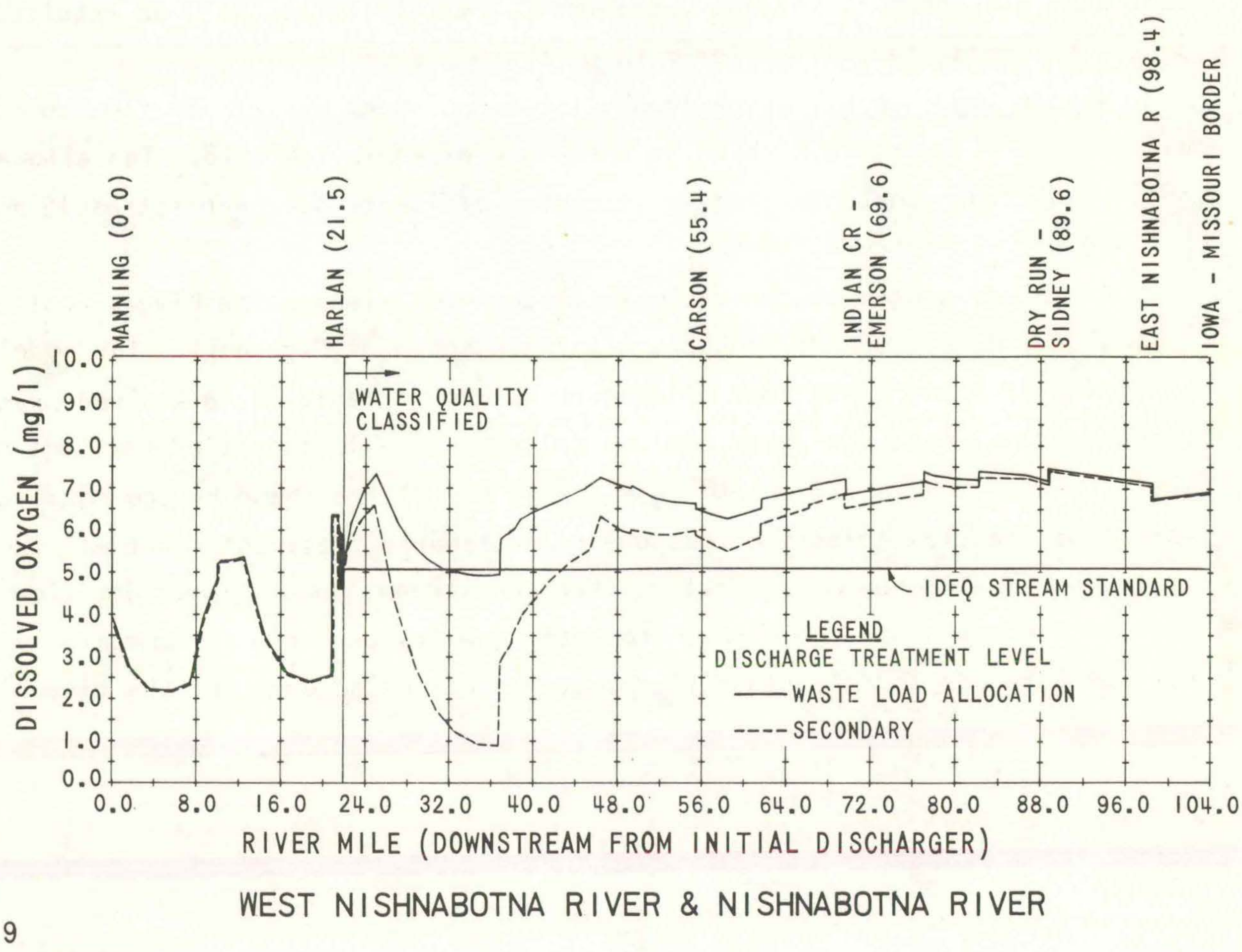


FIGURE 9
DISSOLVED OXYGEN
CONCENTRATIONS
SUMMER CONDITIONS

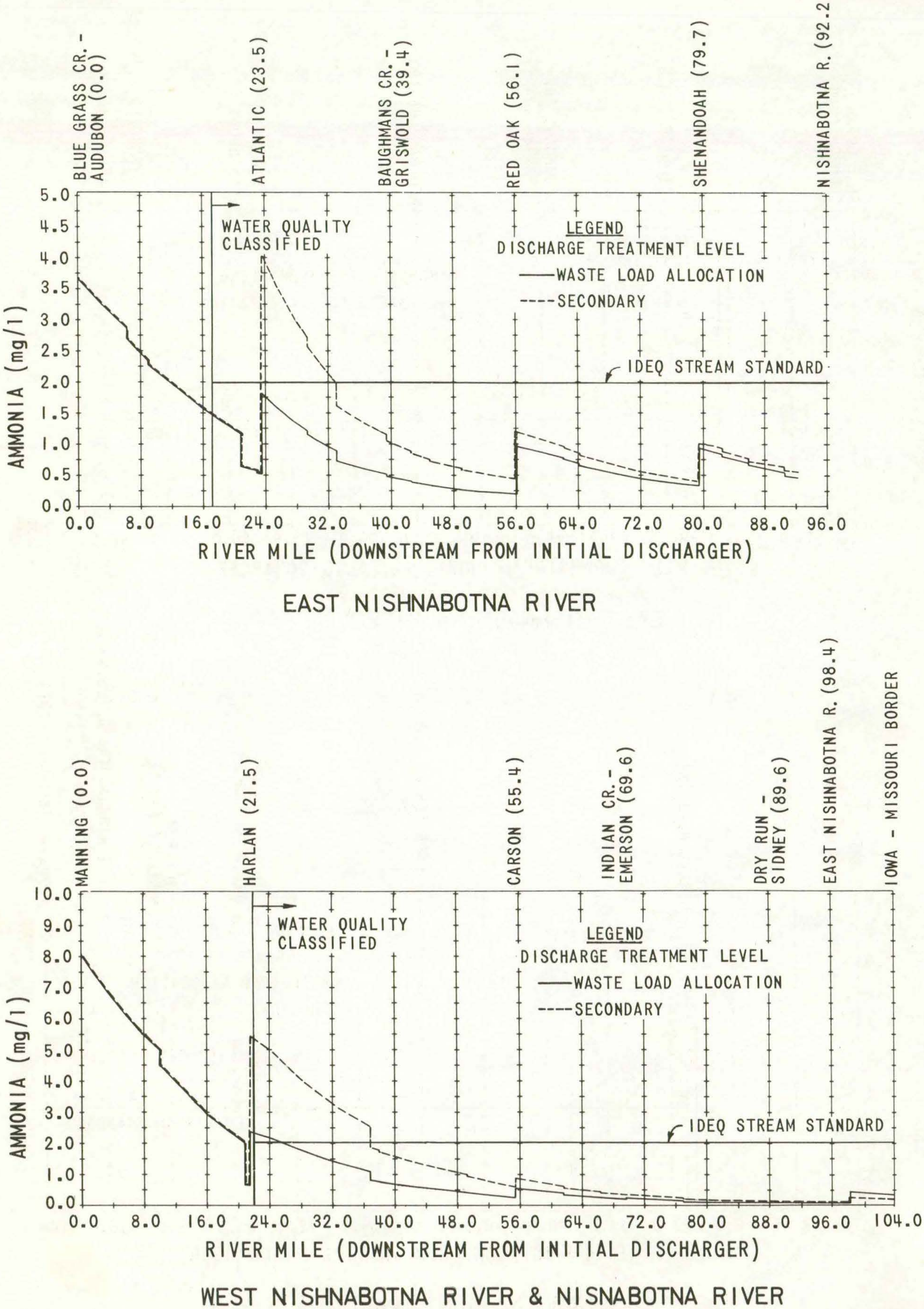
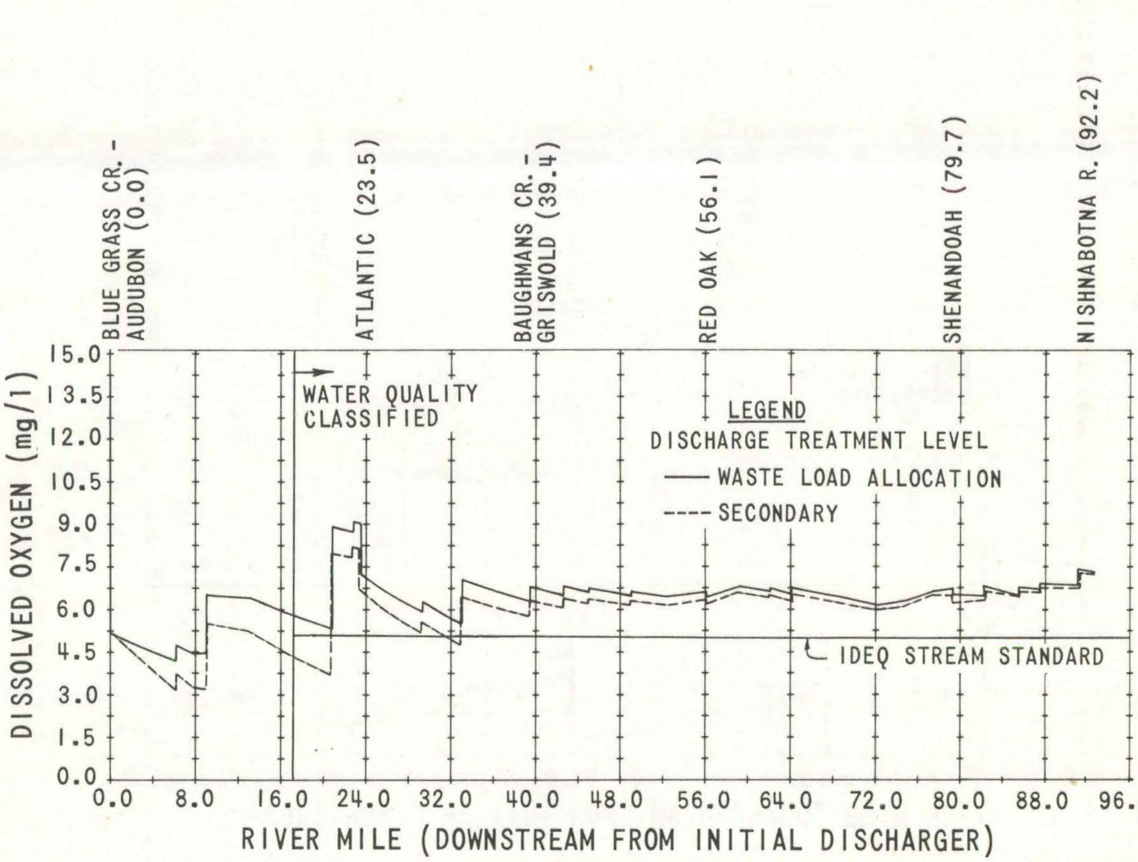
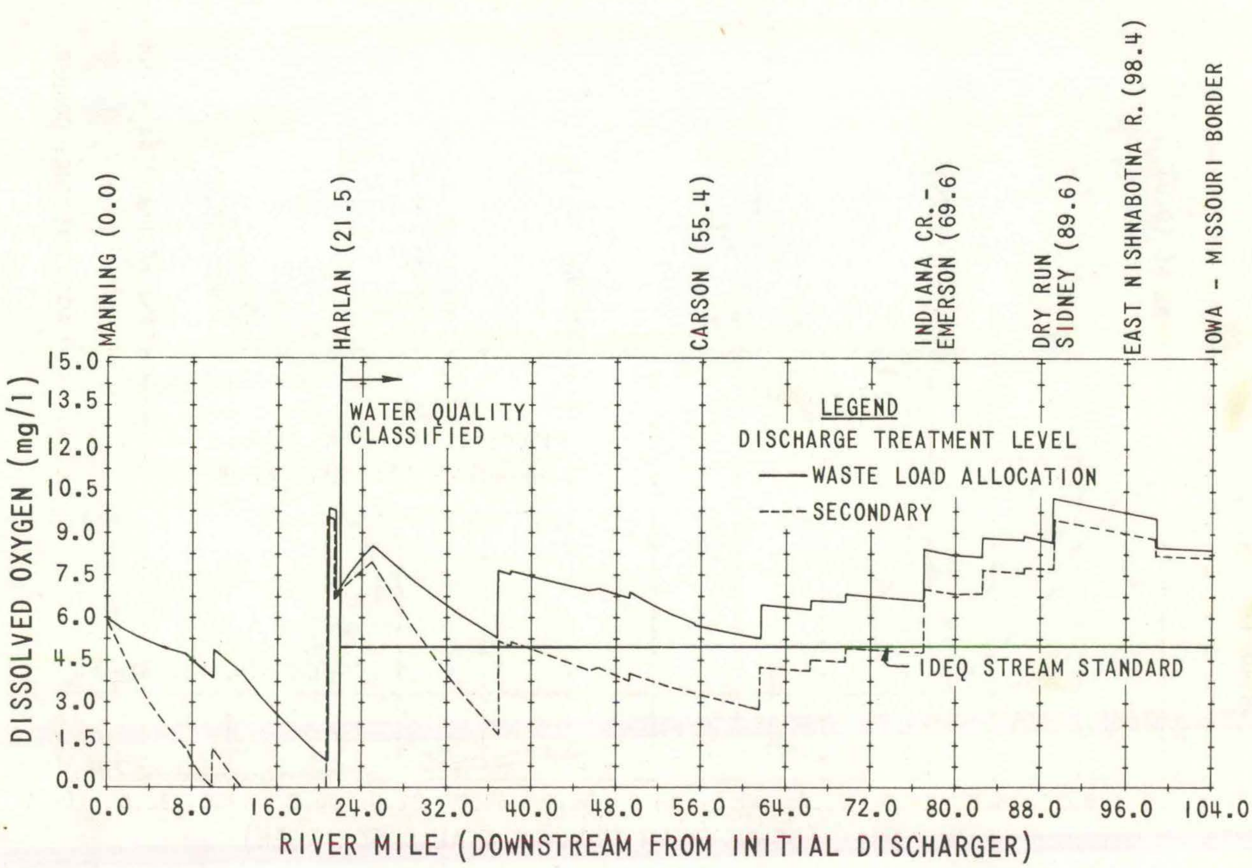


FIGURE 10
AMMONIA NITROGEN
CONCENTRATIONS
SUMMER CONDITIONS

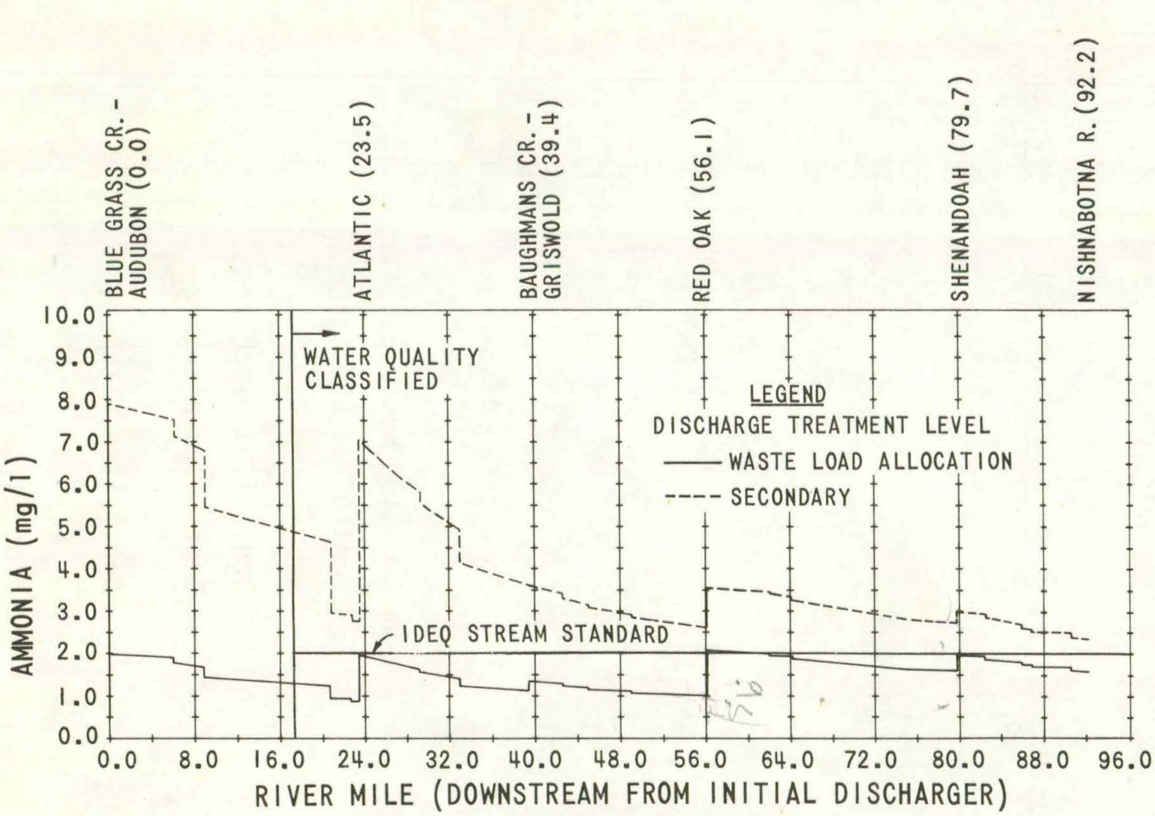


EAST NISHNABOTNA RIVER

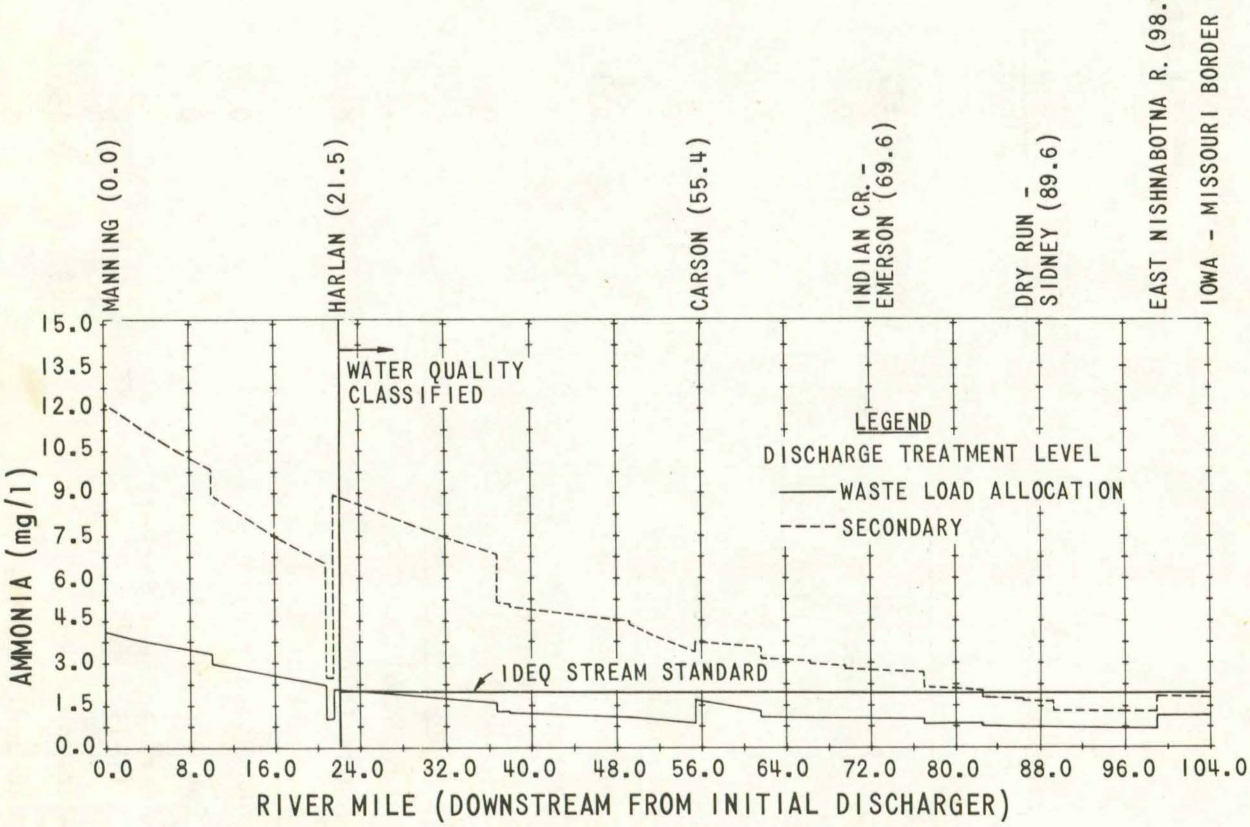


WEST NISHNABOTNA & NISHNABOTNA RIVER

FIGURE 11
DISSOLVED OXYGEN
CONCENTRATIONS
WINTER CONDITIONS



EAST NISHNABOTNA RIVER



WEST NISHNABOTNA RIVER & NISHNABOTNA RIVER

FIGURE 12
AMMONIA NITROGEN
CONCENTRATIONS
WINTER CONDITIONS

TABLE 18

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITIONS

Discharge (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1]		Ammonia Nitrogen (N)		Effluent Dissolved Oxygen (mg/l)
			(mg/l)	(lb/day)	(mg/l)	(lb/day)	
West Nishnabotna River							
Manning (M-12)	0.04	0.173	30	43	5	7	4.0
Irwin (M-62)		0			Controlled Discharge		
West Fork West Nishnabotna River							
Manilla (M-23)		0			Controlled Discharge		
Defiance (M-59)		0			Controlled Discharge		
West Nishnabotna River							
Harlan (M-61)	0.96	1.038	30	258	3	26	4.0
Western Iowa Pork Co. (AKA American Beef Packers) (I-3)		0			Controlled Discharge		
East Branch West Nishnabotna River							
Gray (M-6)		---			No Existing Municipal Facility		
Avoca (M-48)		0			Controlled Discharge		
West Nishnabotna River							
Hancock (M-50)		0			Controlled Discharge		
Oakland (M-52)		0			Controlled Discharge		
American Beef Packers (I-11)		0			Controlled Discharge		
Carson (M-49)	4.69	0.150	45	56	15[2]	19	4.0
Macedonia (M-51)		0			Controlled Discharge		

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-in-10 YEAR LOW FLOW

1990 WINTER CONDITIONS

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
West Nishnabotna River (Cont.)							
Farm Creek							
Henderson (M-35)		---	No Existing Municipal Facility				
Indian Creek							
Emerson (M-33)	0.30[3]	0.038	45[2]	15	15[2]	5	4.0
Hastings (M-34)		---	No Existing Municipal Facility				
Little Silver Creek							
Shelby (M-66)		0	Controlled Discharge				
Middle Silver Creek							
Treynor NW (M-54)		0	Controlled Discharge				
Treynor SE (M-55)		0	Controlled Discharge				
Silver Creek							
Silver City (M-37)		---	No Existing Municipal Facility				
Malvern (M-36)		0	Controlled Discharge				
Henningson Foods, Inc. (I-2)		0	Controlled Discharge				
Deer Creek							
Randolph (M-28)		---	No Existing Municipal Facility				
Walnut Creek							
Walnut (M-56)		0	Controlled Discharge				

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITIONS

Discharge (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
West Nishnabotna River (Cont.)							
Hunters Branch							
Imogene (M-27)		---	No Existing Municipal Facility				
Dry Run							
Sidney (M-30)	0.0[3]	0.060	45[2]	23	15[2]	8	4.0
West Nishnabotna River							
Fremont County Home (S-1)		---	No Discharge Data Available				
East Nishnabotna River							
Templeton (M-13)		0	Controlled Discharge				
Blue Grass Creek							
Audubon (M-1)	0.01[3]	0.380	40	123	3.5	11	4.0
East Nishnabotna River							
Exira (M-3)		0	Controlled Discharge				
Brayton (M-2)		0	Controlled Discharge				
Atlantic (M-15)	1.58	0.945	45[2]	355	4	32	4.0
Turkey Creek							
Anita (M-14)		0	Controlled Discharge				
Wiota (M-21)		---	No Existing Municipal Facility				
East Nishnabotna River							
Lewis (M-17)		0	Controlled Discharge				

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITIONS

Discharge (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
East Nishnabotna River (Cont.)							
Indian Creek							
Kimballton (M-8)		0			Controlled Discharge		
Elk Horn Creek							
Elk Horn (M-60)		0			Controlled Discharge		
Camp Creek							
Marne (M-19)		---			No Existing Municipal Facility		
Baughmans Creek							
Griswold (M-16)	0.49[3]	0.124	45[2]	47	15[2]	16	4.0
East Nishnabotna River							
Elliott (M-41)		0			Controlled Discharge		
Red Oak (M-43)	8.00	0.676	45[2]	254	15	85	4.0
Montgomery County Home (S-2)	8.00	---			No Discharge Data Available		
Uniroyal, Inc. (I-8)	8.00	0.135	45[2]	51	15	17	4.0
Essex (M-46)		0			Controlled Discharge		
Shenandoah (M-47)	11.50	0.800	45[2]	300	7	47	4.0

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITIONS

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] lb/day	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
East Nishnabotna River (Cont.)							
Thomas Ditch							
Farragut (M-25)		0			Controlled Discharge		
East Nishnabotna River							
Riverton (M-29)		---			No Existing Municipal Facility		
Nishnabotna River							
Hamburg (M-26)		0			Controlled Discharge		

[1]Ultimate BOD = 1.5 (BOD_5).

[2]Meets BPWTT guidelines. Higher discharge quantities could satisfy stream criteria.

[3]Flow in tributary upstream of discharge.

waste load allocations. Reduction of ammonia nitrogen concentrations within the streams is less evident in the winter than the summer because of the lack of bio-oxidation of ammonia at low temperatures.

The water quality criteria for all classified sections of the East Nishnabotna River, West Nishnabotna River, and Nishnabotna River can be met by secondary treatment of all wastewater discharges with the exception of those from the communities of Atlantic, Audubon, ~~Carson,~~ Harlan, Manning, and Shenandoah. Even though Manning and Audubon are upstream of the water quality classified sections of the streams, additional wastewater treatment is required so that reasonable waste load allocations can be made to the cities of Atlantic and Harlan. Nitrification will be necessary at Atlantic, Audubon, Harlan, Manning, and Shenandoah.

<u>Thermal Discharges</u> - There are no thermal discharges to any of the study area streams of sufficient magnitude to cause violation of the stream quality standards.

<u>Summary</u> - Examination of Tables 17 and 18 shows that restrictions on allowable discharges of BOD are more stringent under summer low flow conditions than winter. Factors which contribute to this condition are the lower amount of dissolved oxygen available in the stream during warm weather and the more rapid uptake of oxygen during biological oxidation. Removal of ammonia nitrogen is more critical under winter low flow conditions because the pollutant is not being removed by biological oxidation at the low temperatures. Increased treatment levels above those required to meet secondary treatment are necessary primarily at those discharges where the volume of the wastewater discharge is relatively large compared to the flow in the stream.

Respectfully submitted,

STANLEY CONSULTANTS, INC.

By Sharon L. Carter
Sharon L. Carter

By R. John Tagg
R. John Tagg

Approved by Robert L. Thoem
Robert L. Thoem

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Iowa.

Robert L. Thoem
Robert L. Thoem

November 1, 1974 Reg. No. 5802

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