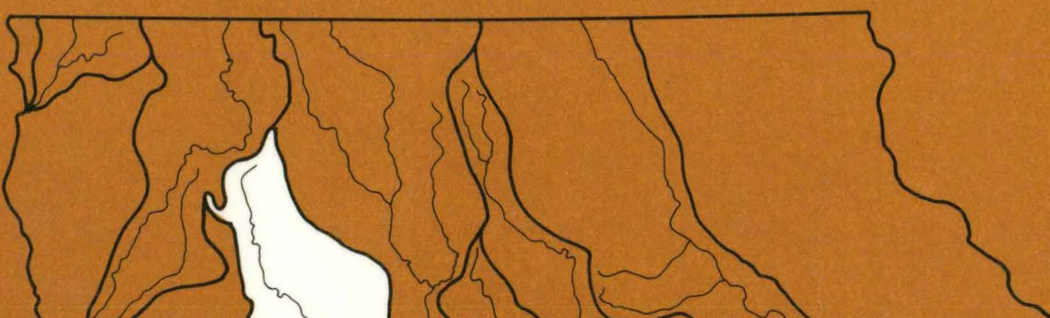
iowa department
of
environmental quality
Water Quality Management Division

RACCOON RIVER BASIN



WASTE LOAD ALLOCATION STUDY

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

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December 12, 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 "Raccoon 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

RACCOON RIVER BASIN

WASTE LOAD ALLOCATION STUDY

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SYNOPSIS

The study area includes the entire Raccoon River Basin (3,629 square miles) and that portion of the Des Moines River Basin from Saylorville Dam to the flood pool of Red Rock Reservoir (576 square miles). The Raccoon River Basin includes 81 percent of the incorporated communities but only 21 percent of the total population in the study area due to the large impact of the Des Moines metropolitan area.

Topography is slightly rolling, and natural surface drainage is generally poor. Stream flows per square mile for the North Raccoon River are generally lower than the average for the state of Iowa, while flows for the remainder of the study area are generally higher than the state average.

Most of the streams in the study area have a Class B (warm water fisheries) water quality classification. There is a lack of comprehensive water quality data on existing conditions, but the limited data available show violation of stream quality standards in the North Raccoon River. High stream flows during sampling periods have masked possible pollution of other streams in the study area.

Of the 81 incorporated communities in the study area, 48 have wastewater treatment facilities. In addition, there are 26 industrial and 38 semipublic wastewater dischargers. Under the National Pollutant Discharge Elimination System (NPDES), 22 dischargers will be required to adopt a controlled discharge mode of operation.

A computer model based on the modified Streeter-Phelps equation was utilized to determine allowable waste load allocations for the remaining dischargers. Input data to the model included physical and chemical characteristics of the stream such as velocity, deoxygenation rate constants, channel mean depth, channel slope, and flow and characteristics of discharges and groundwater. The model was used to approximate the impact of discharges on stream quality for specified winter and summer low flow conditions.

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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 study area.
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 study area is comprised of the Raccoon River Basin and that portion of the Des Moines River Basin from Saylorville Dam to the flood pool of the Red Rock Reservoir. For the purposes of this report, the Raccoon and Des Moines River Basins will be considered as separate entities, because the analyses of each were performed using slightly different computer methodology. The major river tributary to the Des Moines River is the Raccoon River. The three major river tributaries to the Raccoon River are the North, South, and Middle Raccoon Rivers. Within the study area, Beaver Creek is the only major tributary to the Des Moines River other than the Raccoon River. Brushy Creek, tributary to the South Raccoon River; Willow Creek, tributary to the Middle Raccoon River; and Big Cedar Creek, tributary to the North Raccoon River; are major Raccoon tributaries. The study area encompasses portions of the following counties and is represented as a percent of the total county in the following tabulation.

County	Percent in Raccoon Basin	Percent in Des Moines Basin	County	Percent In Raccoon Basin	Percent in Des Moines Basin
Aududon	5	0	Madison	1	0
Boone	2	31	Palo Alto	1	0
Buena Vista	67	0	Pocahontas	32	0
Calhoun	99	0	Polk	14	33
Carroll	80	0	Sac	49	0
Clay	1	0	Story	0	1
Dallas	78	19	Warren	0	1
Greene	91	9	Webster	25	1
Guthrie	75	0			

The Raccoon River Basin is the main physical entity in the study area. Study area orientation is basically northwest to southeast with the three branches of the Raccoon River oriented in more of an east-west direction. The width to length ratio is significantly larger than that of most other Iowa drainage basins. The study area encompasses approximately 4,205 square miles (2.692 million acres) of which 3,629 square miles (2.323 million acres) comprises the Raccoon River Basin. Approximate stream lengths and drainage areas of the Des Moines and Raccoon Rivers and their major tributaries are tabulated below.

Stream	Stream Length (Miles)	Drainage Area (1,000 acres)	(square miles)
Des Moines River	36	130	204
Beaver Creek	73	238	372
Raccoon River	30	120	188
North Raccoon River	165	1,253	1,956
Big Cedar Creek	50	219	342
South Raccoon River	64	251	392
Brushy Creek	50	91	142
Middle Raccoon River	80	317	495
Willow Creek	25	73	114
Total		2,692	4,205

Average annual precipitation within the study area is approximately 30.6 inches; of this total, 21.24 inches fall during the April through September growing season.

Political Subdivisions

Within the study area are 81 incorporated communities with a total population of 332,118 according to the "1970 Census of Population." As is shown by the following tabulation, the Raccoon River Basin includes 66 of the 81 communities (or 81 percent), but only 21 percent of the total population is in the Raccoon drainage basin due to the large impact of the City of Des Moines.

Range of Population	Number of Communities (and Percent of Total Population) Des Moines River Basin	Raccoon River Basin	Total
< 1,000	5 (1)	48 (6)	53 (7)
1,000 to 5,000	5 (3)	15 (8)	20 (11)
5,000 to 10,000	2 (5)	3 (7)	5 (12)
10,000 to 100,000	2 (9)	- -	2 (9)
> 100,000	1 (61)	0 -	1 (61)
Total	15 (79)	66 (21)	81 (100)

Table 1 presents a summary of the existing and projected 1990 populations for each county and incorporated city within the basin. Population projections 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 major portion of the basin uplands is slightly rolling to level. Numerous depressions, formerly sloughs or ponds prior to artificial draining, occur on these areas. Rising 20 to 30 feet above depressions, low, rounded, elongated ridges separate the broad flat areas. Isolated knobs protrude from the landscape. Slopes from bottom lands to uplands are steep only when adjacent to the large streams. At the southern edge of the basin, upland areas are undulating to strongly rolling plains and ridges. The numerous river valleys in the area are generally shallow with narrow bottoms.

The general incline of the basin is to the south and east. The ridge which is the western boundary of the basin is part of the divide separating drainage to the Missouri River on the west side and drainage to the Mississippi River on the east side.

TABLE 1

EXISTING AND PROJECTED POPULATIONS
FOR WASTE LOAD ALLOCATIONS

	1970	1990
ADAIR COUNTY	9,487	9,581
Stuart *	1,354	1,367
BOONE COUNTY	26,470	29,867
Beaver	113	119
Berkley	56	59
Ogden	1,661	1,755
BUENA VISTA COUNTY	20,693	24,423
Albert City	683	723
Lakeside	353	373
Marathon	447	473
Newell	877	928
Rembrandt	250	264
Storm Lake	8,591	11,620
Truesdale	132	140
CALHOUN COUNTY	14,292	15,060
Farnhamville	393	414
Jolley	112	118
Knierim	131	138
Lake City	1,910	2,013
Lohrville	553	583
Manson	1,993	2,100
Pomeroy	765	806
Rinard	88	93
Rockwell City	2,396	2,525
Somers	197	208
Yetter	47	50
CARROLL COUNTY	22,912	27,109
Arcadia	414	451
Breda	518	564
Carroll	8,716	11,643
Coon Rapids	1,381	1,505
Dedham	325	354
Glidden	964	1,050
Halbur	235	256
Lanesboro	203	221
Lidderdale	173	188
Ralston	129	141
Willey	72	78
DALLAS COUNTY	26,085	35,383
Adel	2,419	3,318
Bouton	160	219
Dallas Center	1,128	1,547
Dawson	232	318
De Soto	369	506
Granger	661	907
Linden	278	381
Minburn	378	519
Perry	6,906	9,074
Redfield	921	1,263
Van Meter	464	636
Waukee	1,577	2,163
Woodward	1,010	1,385

	1970	1990
GREENE COUNTY	12,716	13,101
Churdan	598	598
Dana	118	118
Grand Junction	967	967
Jefferson	4,735	5,926
Paton	329	329
Rippey	308	308
Scranton	751	751
GUTHRIE COUNTY	12,243	12,919
Bagley	365	385
Bayard	628	663
Guthrie Center	1,834	1,935
Jamaica	271	286
Menlo	391	413
Panora	982	1,036
Yale	301	318
MADISON COUNTY	11,558	12,919
Earlham	974	1,045
POCAHONTAS COUNTY	12,793	13,500
Fonda	980	1,034
Laurens	1,792	1,891
Varina	140	148
POLK COUNTY	286,130	384,859
Altoona	2,883	8,163
Ankeny	9,151	30,077
Clive	3,005	7,066
Des Moines	201,414	211,168
Grimes	902	1,182
Urbandale	14,434	48,569
West Des Moines	16,441	28,137
Windsor Heights	6,303	9,060
SAC COUNTY	15,573	16,802
Auburn	329	347
Lake View	1,249	1,316
Lytton	378	398
Nemaha	117	123
Sac City	3,268	3,445
STORY COUNTY	62,783	106,547
Slater	1,094	1,589
WEBSTER COUNTY	48,391	60,024
Callender	421	489
Gowrie	1,225	1,423
Harcourt	305	354

* 1970 population includes population for both Adair and Guthrie Counties.

Natural surface drainage in the basin is generally poor. Immature dendrite drainage patterns in most of the basin do not effectively remove surface water from upland areas. Surface ditches and drain tile are used to facilitate drainage. As much as one half of the area has been artificially drained.

At the southern edge of the basin, soils have formed from loess deposits. More active soil erosion in this area has created a well defined dendrite drainage pattern. Intermittent drainageways extend to most parts of the uplands providing adequate drainage. Bottom lands throughout the basin have poor natural drainage and are subject to flooding.

Upland soils in most of the study area have formed primarily from glacial till. Clarion soils occur on the higher portions of the upland. The substratum is moderately permeable, with small sand and gravel pockets being common. Webster soils, occurring on the nearly level, low-lying uplands below the Clarion soils, have poor natural drainage. The substratum is moderately permeable. Depressional areas in the flat uplands contain organic (muck) material and are poorly drained. At the southern edge of the basin, upland soils are formed from loess deposited over glacial till. The loess thickness ranges from 3 to 5 feet on strongly sloping areas to 10 feet or more on nearly level areas. These soils are well drained, and have moderate permeability.

Terrace soils, such as O'Neill, occupy a relatively small portion of the basin area, occurring primarily along major streams. These consist of outwash sands and gravel, and generally are well drained.

Bottom land soils, such as Wabash, occupy stream valley floors. Formed from alluvial material, their natural drainage is poor, and permeability is slow.

A surficial aquifer overlying the bedrock aquifer is formed by glacial drift and alluvium. 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.

Soil conditions on the uplands are variable. Potential pollution problems exist for unsealed sewage lagoons because some soils have moderate permeability and contain pockets of sand and/or gravel. On flat and depressional areas moderately slow permeability and a seasonal high water table present problems for the installation of both sewage lagoons and septic tank filter fields.

Alluvial aquifers in river bottoms, expecially those along major river valleys and on some terraces, produce large quantities of water. Des Moines uses water from the Raccoon River Basin alluvium. These aquifers are recharged by precipitation. Water quality is variable even in local areas but generally fair to good.

Potential contamination of groundwater in alluvial aquifers is great. The outwash material of terraces is highly permeable. Contaminated surface water 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 have severe limitations for wastewater disposal because of high permeability on terraces, and because bottom lands have slow permeability and a high water table and are subject to flooding. Therefore, all sites where wastewater disposal is proposed should be evaluated on an individual basis.

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.

Not all gages in a river basin are of the same period of record; therefore, published values of 7-day, 1-in-10 year low flows at different gages cannot be expected to correlate exactly because of the statistical nature of these values. For example, the sum of the low flows at gages 5-4840 on the South Raccoon River (16.2 mgd) and 5-4825 on the North Raccoon River (7.8 mgd) exceeds the flow listed for gage 5-4845 at the confluence of the North and South Raccoon Rivers (20 mgd).

The low flow in the North Raccoon River, particularly above the gaging station near Sac City, is significantly less than the state average when results are reduced to the common basis of discharge per square mile. The flows per square mile in the Middle Raccoon River and South Raccoon River are considerably higher than the state average. The following tabulation gives a comparison of the flows at the gaging stations in the Raccoon River Basin to the average of 84 continuous-record stations within the state of Iowa. The table refers to daily average discharges recorded at each gaging station regardless of chronological sequence.

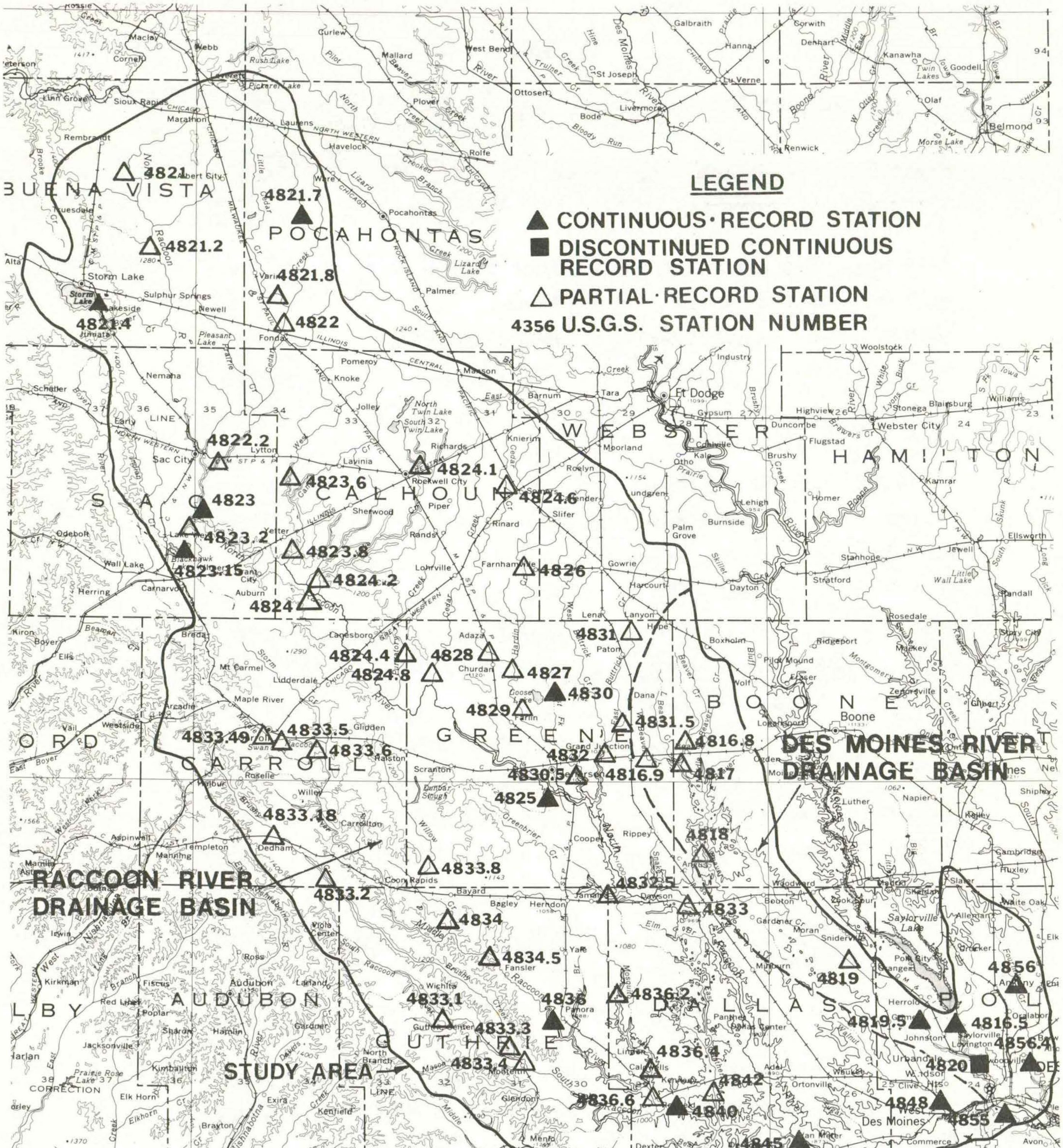
As with the daily flow data presented, the average 7-day, 1-in-10 year low flow for the North Raccoon River is considerably lower than that for the entire state, while the low flows for the Middle and South Raccoon Rivers are greater than the state average. The 7-day, 1-in-10 year low flows for the North Raccoon River at gage 5-4825 and for the South Raccoon River at gage 5-4840 (downstream of the mouth of the Middle Raccoon River) are 0.0075 cfs/sq mi and 0.0254 cfs/sq mi, respectively. The state of Iowa averages 0.020 cfs/sq mi.

	Flow, in cfs/sq mi, equaled or exceeded for Percentage of Time Indicated in Column Headings[1]				
	50	90	95	98	99
State of Iowa Average	0.150	0.033	0.024	0.018	0.015
North Raccoon River near Sac City (5-4823)	0.087	0.017	0.010	0.004	0.002
North Raccoon River near Jefferson (5-4825)	0.130	0.020	0.014	0.009	0.007
Middle Raccoon River at Panora (5-4836)	0.180	0.061	0.050	0.043	0.039
South Raccoon River at Redfield (5-4840)	0.172	0.053	0.040	0.032	0.028
Raccoon River at Van Meter (5-4845)	0.142	0.027	0.018	0.012	0.009
Des Moines River below Raccoon River at Des Moines (5-4855)	0.177	0.027	0.016	0.012	0.010

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

The Des Moines Water Works withdraws both groundwater and surface water from the Raccoon River Basin by means of infiltration galleries and river water intakes located 2.7 miles upstream of the mouth of the Raccoon River. The net amount of surface water withdrawn was assumed to be minimal, based on the understanding that water from the Water Works impoundment, Dale Moffitt Reservoir, would be released into the Raccoon River upstream of the Water Works intakes under extreme (7-day, 1-in-10 year) low flow conditions. The withdrawal of groundwater is believed to be quite high in this area, and no groundwater contributions to this portion of the Raccoon River were assumed.

Specific USGS gaging station locations are identified for both partial-record and continuous-record stations on Figure 1. Table 2 identifies the station number, tributary drainage areas, and the 7-day, 1-in-10 year low flow (where available) for each station.



U.S.G.S. GAGING STATIONS

TABLE 2

RACCOON RIVER BASIN
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)
4816	Big Creek	Rock City	91.4	<0.1	<0.065
4816.8[2]	Beaver Creek	Beaver	38.5	---	---
4816.9[2]	W. Beaver Creek	Grand Junction	12.8	---	---
4817	Beaver Creek	Near Beaver	84.5	---	---
4818	Beaver Creek	Near Berkley	175	---	---
4819	Beaver Creek	Granger	314	---	---
4820	Des Moines River	Des Moines	6,245	0.47	0.304
4821	N. Raccoon River	Near Rembrandt	77.4	---	---
4821.2	N. Raccoon River	Near Truesdale	164	---	---
4821.7	Big Creek	Near Varina	80.0	0	0
4821.8	L. Cedar Creek	Near Fonda	83.5	<0.1	<0.065
4822	Big Creek	Fonda	196	<0.1	<0.065
4822.2	Big Cedar Creek	Sac City	342	---	---
4823	N. Raccoon River	Near Sac City	713	---	---
4823.2	Indian Creek	Near Lake View	90.2	---	---
4823.6	Lamp Creek	Near Lytton	62.0	<0.1	<0.065
4823.8	Lamp Creek	Near Lake City	147	---	---
4824	N. Raccoon River	Near Lake City	1,003	---	---
4824.1	Lake Creek	Near Rockwell City	71.5	---	---
4824.2	Lake Creek	Near Lake City	128	---	---
4824.4	Purgatory Creek	Near Lanesboro	65.0	---	---
4824.6	E. Cedar Creek	Near Somers	62.4	---	---
4824.8	Cedar Creek	Near Churdan	151	---	---
4825	N.Raccoon River	Near Jefferson	1,619	12	7.8
4826[2]	Hardin Creek	Farnhamville	43.7	---	---
4827	Hardin Creek	Near Churdan	74.0	---	---
4828[2]	Happy Run	Churdan	7.58	---	---
4829[2]	Hardin Creek	Near Farlin	101	---	---
4830	E.F. Hardin Creek	Near Churdan	24.0	0	0

TABLE 2 (Cont.)

RACCOON RIVER BASIN

USGS GAGING STATION INFORMATION

Station No.	Stream[1]	Location	Drainage Area (sq mi)	7-Day, 1-in-10 Year Low Flow (cfs)	(mgd)
4830.5	Hardin Creek	Near Jefferson	161.0	<0.1	<0.065
4831	W.Butterick Creek	Farnhamville	80.1	---	---
4831.5	E.Butterick Creek	Near Grand Junction	79.6	<0.1	<0.065
4832	Butterick Creek	Near Grand Junction	202	<0.1	<0.065
4832.5	Green Brier Creek	Near Jamaica	65.8	<0.1	<0.065
4833	N.Raccoon River	Near Perry	2,169	16.0	10
4833.1	S.Raccoon River	Near Guthrie Center	77.2	---	---
4833.18[2]	Brushy Fork Creek	Near Templton	45.0	---	---
4833.3	Brushy Fork Creek	Near Guthrie Center	142	---	---
4833.4	S.Raccoon River	Near Monteith	267	---	---
4833.49	M.Racoon River	Carroll	6.58	---	---
4833.5	M.Raccoon River	Near Carroll	74.3	---	---
4833.6	M.Racoon River	Near Glidden	138	---	---
4833.8	Willow Creek	Scranton	51.8	<0.1	<0.065
4834	Willow Creek	Near Bayard	112	---	---
4834.5	M.Raccoon River	Near Bayard	375	---	---
4836	M.Raccoon River	Panora	440	---	---
4836.2	Mosquito Creek	Near Linden	67.4	---	---
4836.4	Mosquito Creek	Near Redfield	110.0	---	---
4836.6	M.Raccoon River	Redfield	609	---	---
4840	S.Raccoon River	Redfield	988	25	16
4842	Panther Creek	Near Adel	56	---	---
4845	Raccoon River	Van Meter	3,441	31	20
4847	Walnut Creek	Des Moines	64	---	---
4855	Raccoon River	Des Moines	4,872	82	53
4856	Fourmile Creek	Near Ankeny	59.3	0	0

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

2 Water Resource Data for Iowa, USGS, 1972

As indicated in Table 2, sufficient data were not available for identification of low flow at each gaging station. In order to conduct the waste load allocation analysis, 7-day, 1-in-10 year flow was determined for specific gaging stations. These values were obtained utilizing the same procedure performed by the USGS, but in some instances, based upon less than 10 years of recorded data. For these reasons, verification of these values is required as additional flow information becomes available.

Low flows in the study area portion of the Des Moines River will be influenced by Saylorville Dam flow regulation in the near future. Data from the Corps of Engineers indicated that the minimum discharge will be 200 cfs. This value has been used as the 7-day, 1-in-10 year low flow at Saylorville Dam.

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 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.

<u>Stream Hydrodynamics</u> - The term hydrodynamics refers to the characteristics of motion associated with a body of water. As is discussed in PART V - WASTE LOAD ALLOCATION METHODOLOGY, two separate means of estimating reaeration coefficients were utilized for this study area. The flow-reaeration relationship obtained by Dougal was utilized for the Raccoon River Basin while the method of Tsivoglou was used for the Des Moines River and its tributaries other than the Raccoon River. Each of these methods requires estimation of different hydrodynamic characteristics. Use of the Dougal reaeration coefficient requires only stream velocity so that time of travel may be estimated. The Tsivoglou method requires both stream velocity and slope.

Use of the Dougal method requires that stream velocity and distance be input so that the time of travel may be computed. Determination of distance is accomplished by use of USGS topographic maps. Determination of stream velocity at the 7-day, 1-in-10 year low stream flows is approximated at each USGS gaging station. Velocities at points between the gaging stations are obtained by interpolation of the values at the gaging stations.

The Tsivoglou method is based upon a relationship involving stream velocity and slope which allows definition of reaeration rate constants within particular reaches of a stream 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 the time of travel for each reach.

The effect of Saylorville Reservoir on the water surface slope at low flows is not known. Approximation of the water surface slope at 7-day, 1-in-10 year low flow is made by assuming the slope of the water surface to be 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 Des Moines River range from approximately 0.4 ft/mi to approximately 3.3 ft/mi. Water slope for the reach upstream of the low head dam in Des Moines has been estimated as 0.10 ft/mi.

Determination of time of travel is only dependent upon distance traveled and stream velocity. Distance is measured by use of 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 the stream and value of the Manning coefficient ("n"). Values of both the width and "n" are dependent upon the stream flow, and 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 do not usually include measurements at the 7-day, 1-in-10 low flows. Available data must be extrapolated to obtain an approximate value for these characteristics under low flow conditions.

Since there are relatively 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 necessarily 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.

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 is aided by knowledge of the existing water quality resulting from the interaction of man with nature within the study area.

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 South Raccoon River, Middle Raccoon River, North Raccoon River, and the Des Moines River has been identified based upon analyses of available data obtained from various sources. The data indicate some areas with 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 study area.

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:

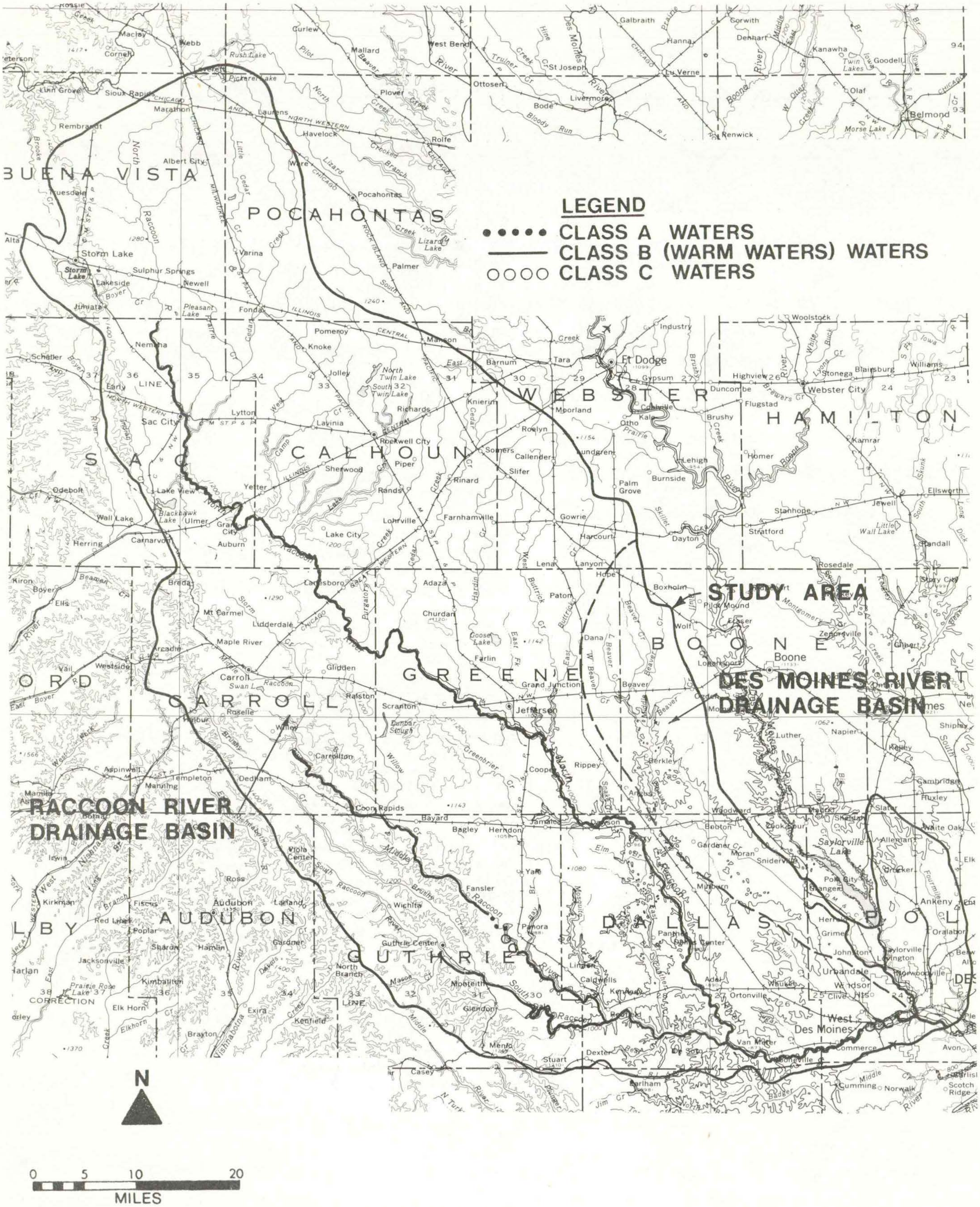
Class A - Body Contact Recreation

Class B - Wildlife, Nonbody 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), Class C, and certain designated areas must satisfy the Class A requirements. Figure 2 indicates which streams within the study area must satisfy Class A, Class B, and Class C requirements. Other streams have not been classified and must satisfy General Water Quality Criteria. Tables 3, 4, 5, and 6 summarize the applicable standards for the classifications.

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 3 contains stream standards applicable for warm water fisheries.



SURFACE WATER CLASSIFICATION

FIG. 2

TABLE 3

WATER QUALITY STANDARDS

Water Quality Parameter	Class A	Class B	Class C
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.	
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.	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.	Not less than 6.5, nor greater than 9.0.
Turbidity	Shall not be increased by more than 25 Jackson turbidity units by any point source discharge.	Shall not be increased by more than 25 Jackson turbidity units by any point source discharge.	
Fecal Coliforms	Maximum allowable count of 200 per 100 ml when the count is attributable to waste discharges which may contain human pathogens or parasites.	Shall not exceed 2,000 per 100 ml, except when waters are materially affected by surface runoff.	
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. 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 6 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 nonpoint sources. All substances toxic or detrimental to aquatic life shall be limited to non-toxic or non-detrimental concentrations in the surface water.	The concentrations given in Table 6 shall not be exceeded at the point of withdrawal. Allowable levels of radioactive substances are given in Table 5. All substances toxic or detrimental to humans or detrimental to treatment processes shall be limited to non-toxic or non-detrimental concentrations in the surface water.

TABLE 4

WATER QUALITY STANDARDS
GENERAL WATER QUALITY CRITERIA

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.

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.

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.

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.

The turbidity of the receiving water shall not be increased by more than 25 Jackson turbidity units by any point source discharge.

TABLE 5

WATER QUALITY STANDARDS
RADIOACTIVE SUBSTANCES - CLASS C

Gross beta activity: Shall not exceed 1,000 picocuries per liter.
Radium 226: Concentrations shall not exceed 3 picocuries per liter.
Strontium 90: Concentration shall not exceed 10 picocuries per liter.
Other radionuclides: Annual average concentration for the 168-hour week as set forth by the International Commission of Radiological Protection and the National Committee on Radiation Protection - Handbook 69.

TABLE 6

WATER QUALITY STANDARDS
CHEMICAL CONSTITUENTS

Chemical Constituent	Allowable Concentration[1] Class B (mg/l)	Class C2 (mg/l)
Ammonia Nitrogen-N	2.0	---
Nitrate	---	45.0
Phenols (other than natural sources)	0.001	0.001
Total Dissolved Solids	750.	750.
Chlorides	250.	250.
Arsenic	1.00*	0.05
Barium	1.00*	1.00
Cadmium	0.05*	0.01**
Chromium (hexavalent)	0.05*	0.05**
Chromium (trivalent)	1.00*	---
Copper	0.02*	1.00
Cyanide	0.025	0.025
Fluoride	---	1.5
Lead	0.10*	0.05**
Mercury	0.005*	0.005**
Selenium	1.00*	0.01**
Zinc	1.00*	0.00

[1] 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.

[2] Shall not be exceeded at point of withdrawal.

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

**Sum of these constituents shall not exceed 1.5 mg/l.

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

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 on 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 7 for reference.

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

TABLE 7

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.

Water Quality Criteria Summary - Examination of Table 7 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 bioassay determinations of toxic concentrations, a direct comparison is not possible.

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 - Because of the short length of the Des Moines River within the study area, only the water quality within the Raccoon River Basin will be investigated. The evaluation of water quality data herein is based upon data collected by the State Hygenic Laboratory. Some data are available from other Federal, State, and local agencies; but these data are scattered, both in time and over the basin, and 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.

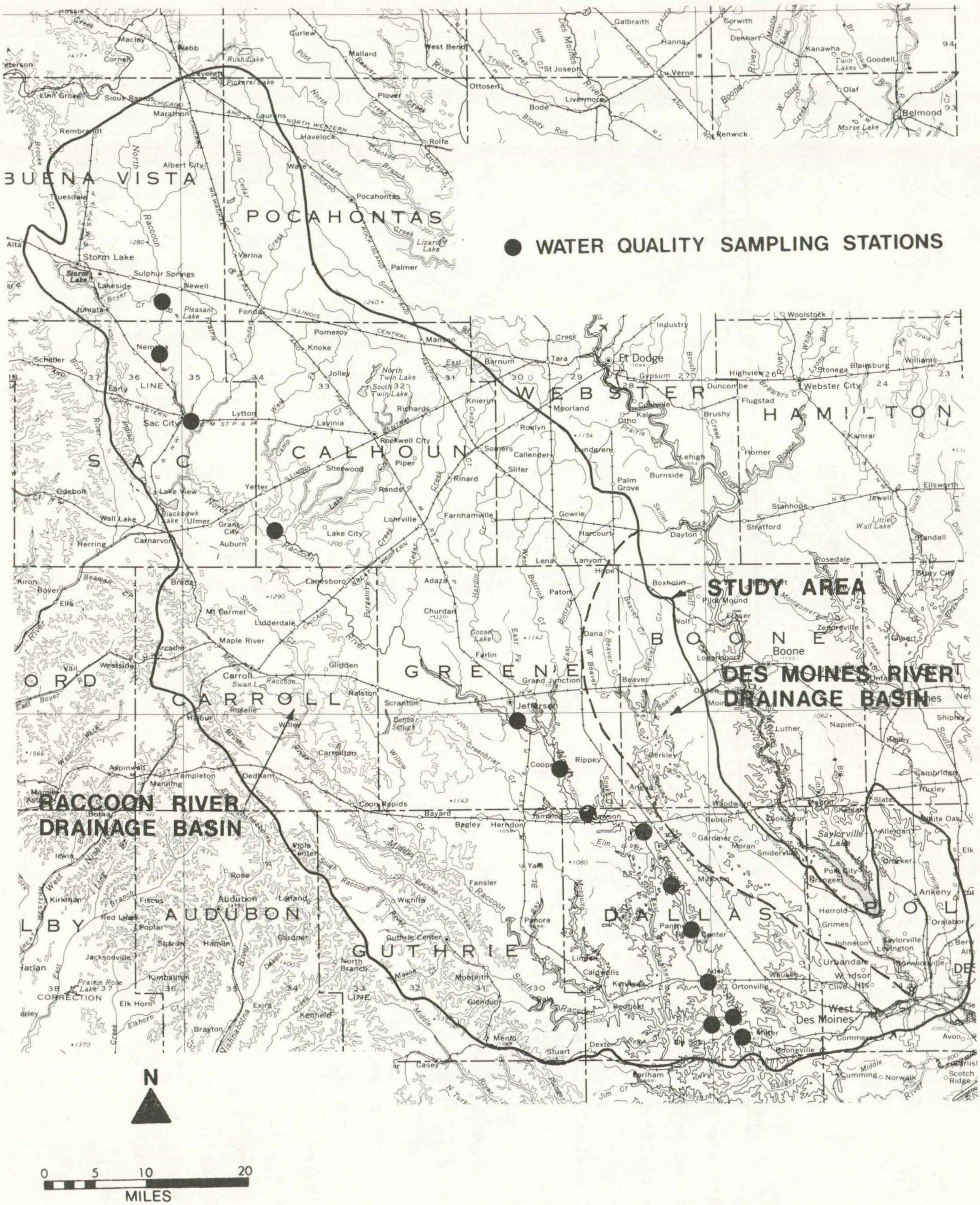
South Raccoon River - This stream rises in Audubon County and ends at the confluence with the North Raccoon. The Middle Raccoon River is tributary to this stream in the lower reaches. Report No. 74-21, "Iowa Internal Stream Quality Study," contains the only available data for the South Raccoon. These data were taken from August Through December, 1973.

The only sampling station is near Van Meter only a few miles upstream from the confluence with the North Raccoon River. This station is also downstream of the confluence of the Middle Raccoon with the South Raccoon. The sampling station is distant from any upstream wastewater dischargers, and there are no violations of stream quality criteria. Data from this sampling station are summarized in Table 8. Fecal coliform counts are higher than would be expected, but no other parameters indicate pollution of the stream. Stream flows during the August through December sampling period were much higher than those normally encountered.

Data, for the period sampled at this station, show very good to excellent stream water quality. However, nothing is known of stream water quality during periods of low flow.

Middle Raccoon River - There is no definitive data on existing water quality of the Middle Raccoon River.

North Raccoon River - This stream rises in Buena Vista County and ends at the confluence with the South Raccoon. Following are reports which give comprehensive water quality data on this stream: Report No. 72-49, "Winter Water Quality of the North Raccoon River," containing data taken in February, 1972; Report No. 71-41, "Winter Water Quality of the North Raccoon River," with data taken in February, 1971; Report No. 72-53,



WATER QUALITY SAMPLING STATIONS

FIG. 3

TABLE 8

WATER QUALITY DATA
SOUTH RACCOON RIVER - NEAR VAN METER

Parameter	Date of Sampling			
	Aug. 20, 1973	Sept. 17, 1973	Oct. 15, 1973	Nov. 13, 1973
Temperature (° C)	25	13.5	15.5	8.5
Dissolved oxygen (mg/l)	8.4	9.5	9.6	11.7
Fecal coliform (MPN/100 ml)	200	12,000	3,500	700
pH	8.15	7.8	7.95	7.9
Total Kjeldahl nitrogen (mg/l)	0.76	0.64	0.88	0.66
Ammonia nitrogen (mg/l)	0.10	0.38	0.36	0.08
Nitrate nitrogen (mg/l)	5.0	3.6	5.8	6.0
Total suspended solids (mg/l)	--	334	--	60
Phosphate (filtrable) (mg/l)	--	0.04	--	0.13
BOD_5 (mg/l)	2	2	1	1
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	--	0.2
Cadmium (mg/l)	--	0.01	--	0.01
Copper (mg/l)	--	0.01	--	0.01
Lead (mg/l)	--	0.01	--	0.01
Mercury (mg/l)	--	1	--	1
Zinc (mg/l)	--	0.02	--	0.02

"Investigations of the North Raccoon River Fish Kill," containing data taken in April, 1972; Report No. 74-21, "Iowa Internal Stream Quality Study," with data taken from August through December, 1973; and unpublished data taken during 1971 and 1974.

Based on the above data, dissolved oxygen and ammonia nitrogen profiles were obtained for dates in the month of February for the years 1971, 1972, and 1974. Figure 4 gives the dissolved oxygen profiles for these dates and Figure 5 the ammonia nitrogen profiles. Under summer conditions (no ice cover and temperatures high enough for nitrification), the data give dissolved oxygen and ammonia nitrogen profiles (Figures 6 and 7) for April of 1972, August of 1971, and June of 1974. All of the surveys under winter conditions show violation of either the ammonia nitrogen or dissolved oxygen standards, or both. Under summer conditions there were no violations of either of the stream standards except for ammonia nitrogen in April, 1972. All stream quality criteria violations have been directly attributed to wastewater discharges according to the State Hygenic Laboratory. Winter and summer water quality data gathered in the stream surveys conducted in 1971 through 1974 are summarized in Tables 9 through 14. Samples with low dissolved oxygen and high ammonia concentrations generally had higher BOD_5 and phosphate concentrations and fecal coliform counts. Some high fecal coliform counts may be due to surface runoff. Summer BOD_5 concentrations were sometimes 2 to 3 times greater than winter values with little effect upon dissolved oxygen concentrations. High stream flows during most of the surveys contributed to generally good water quality. Stream flows during each survey are compared to the 7-day, 1-in-10 year low stream flow in Table 15.

The dissolved oxygen and ammonia nitrogen profiles indicate that during winter conditions wastewater discharges will have an adverse impact upon stream quality, but do not necessarily indicate what stream quality conditions may be under low stream flows.

FIGURE 4
NORTH RACCOON RIVER
DISSOLVED OXYGEN CONCENTRATIONS

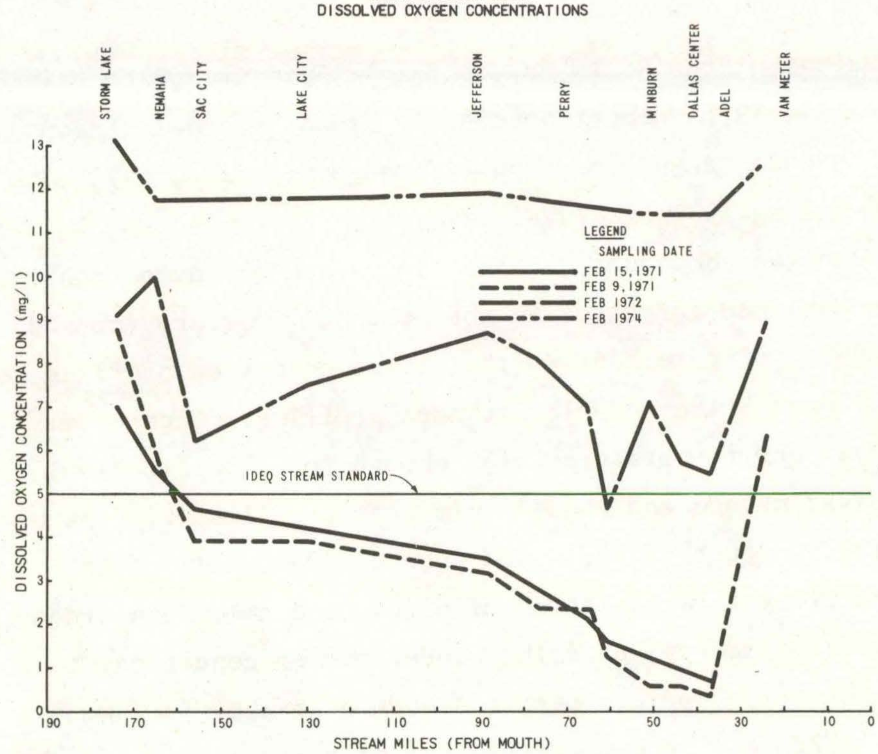


FIGURE 5
NORTH RACCOON RIVER
AMMONIA NITROGEN CONCENTRATIONS

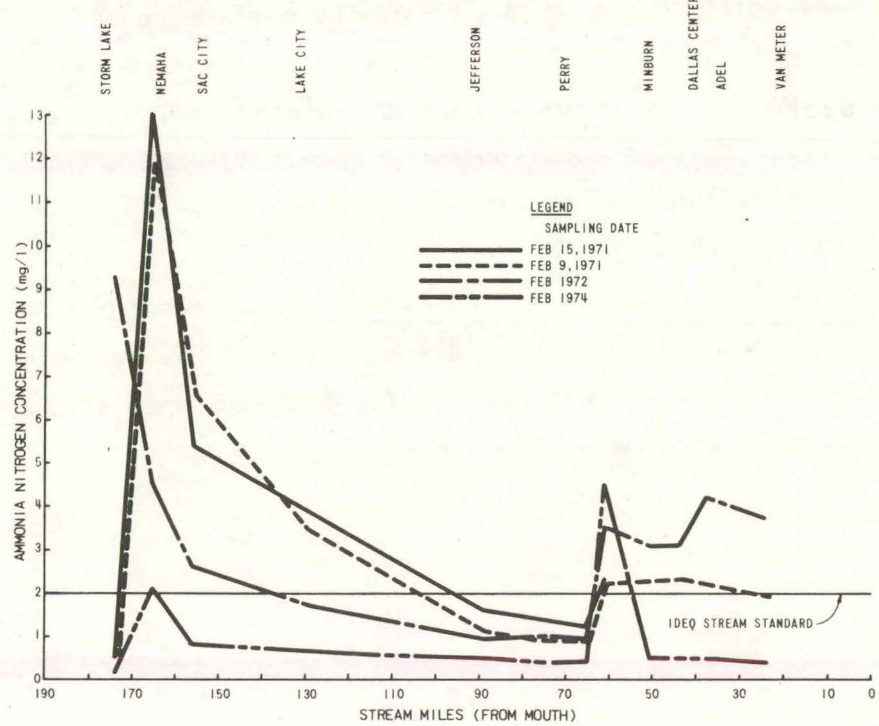


FIGURE 6
NORTH RACCOON RIVER
DISSOLVED OXYGEN CONCENTRATIONS

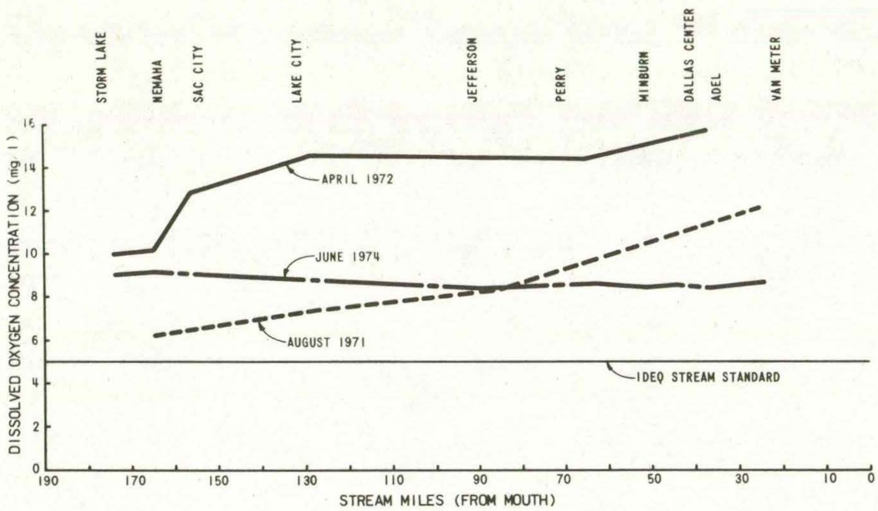


FIGURE 7
NORTH RACCOON RIVER
AMMONIA NITRIGEN CONCENTRATIONS

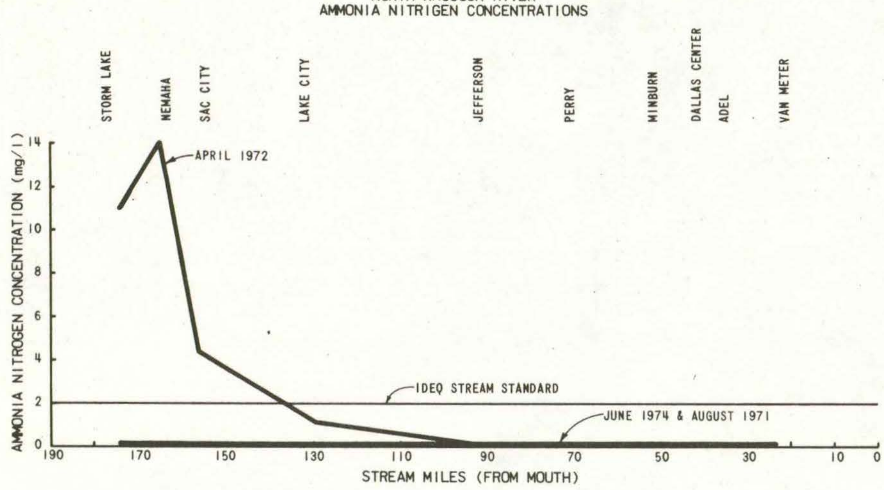


TABLE 9

WATER QUALITY DATA 1971

NORTH RACCOON RIVER

Parameter	Storm Lake - Co. Rd. C-49 N of Storm Lake		Nemaha - Co. Rd. D-15		Sac City - Co. Rd. D-42 Below Sac City		Lake City - Hwy. 175 W of Lake City		Jefferson - Co. Rd. E-53 Above Jefferson		Cooper - Co. Rd. E-57 E of Cooper	
	Feb. 9	Feb. 16	Feb. 9	Feb. 15	Feb. 9	Feb. 15	Feb. 9	Feb. 15	Feb. 9	Feb. 15	Feb. 9	Feb. 15
Temperature (° C)	0	0	0	0	0	0	0		0	0	0	
Dissolved Oxygen (mg/l)	8.8	7.0	5.9	5.5	3.9	4.6	4.9		3.2	3.5	2.4	
Fecal Coliforms (MPN/100 ml)	510	730	5,000	3,000	2,900	3,200	350		120	570	4,800	
Conductance (Micromhos)		94		110		110				84		
pH (SU)	7.3	7.6	7.4	7.9	7.35	7.45	7.45		7.2	7.7	7.3	
Organic Nitrogen (mg/l)	0.51	0.80	0.89	1.1	0.72	0.80	0.75		0.48	0.31	0.49	
Ammonia Nitrogen (mg/l)	0.46	0.69	12	13	6.6	5.4	3.5		1.1	1.6	0.93	
Nitrate Nitrogen (mg/l)	3.6	3.6	2.4	2.4	2.4	2.3	3.6		4.0	3.6	4.0	
Total Solids (mg/l)	730	673										
Total Volatile Solids (mg/l)	224	201										
Total Suspended Solids (mg/l)	50	12										
Volatile Suspended Solids (mg/l)	14	2										
Phosphate (Filtrable) (mg/l)	0.7	0.9	6.6	6.8	3.6	3.1	2.2		1.1	1.4	1.1	
Total Phosphate (mg/l)	0.7	1.0	6.8	7.2	3.8	3.5	2.3		1.1	1.4	1.1	
BOD_5 (mg/l)	2	4	4	5	2	4	1		<1	2	<1	
COD (mg/l)	12.1	24.8	30.3	41.3	24.2	31.0	20.2		14.1	24.8	12.1	

TABLE 9 (Cont.)

WATER QUALITY DATA 1971

NORTH RACCOON RIVER

Parameter	Dawson - Co. Rd. P-46 N of Dawson		Perry - Co. Rd. P-58 S of Perry		Minburn - Co. Rd. F-31 W of Minburn		Dallas Center - Hwy. 44 W of Dallas Center		Adel - Below Hwy. 69 Bridge (Above Dam)		Van Meter - Co. Rd. R-16 Above I-80	
	Feb. 9	Feb. 15	Feb. 9	Feb. 15	Feb. 9	Feb. 15	Feb. 9	Feb. 15	Feb. 9	Feb. 15	Feb. 9	Feb. 15
Temperature (° C)	0	0	0	0	0		0		0	0	0	
Dissolved Oxygen (mg/l)	2.4	2.1	1.3	1.6	0.6		0.6		0.35	0.7	6.4	
Fecal Coliforms (MPN/100 ml)	2,700	3,000	8,000	4,000			1,200				2,200	
Conductance (Micromhos)		95		99								
pH (SU)	7.4	7.4	7.3	7.45			7.3				7.3	
Organic Nitrogen (mg/l)	0.67	0.55	0.89	0.57			0.51				0.48	
Ammonia Nitrogen (mg/l)	0.88	1.2	2.2	2.3			2.3				1.9	
Nitrate Nitrogen (mg/l)	4.0	3.2	4.0	3.6			4.0				4.0	
Total Solids (mg/l)											622	
Total Volatile Solids (mg/l)											220	
Total Suspended Solids (mg/l)											3	
Volatile Suspended Solids (mg/l)											0	
Phosphate (Filtrable) (mg/l)	1.1	1.3	1.5	1.6			1.4				1.4	
Total Phosphate (mg/l)	1.1	1.5	1.7	1.6			1.5				1.5	
BOD_5 (mg/l)	3	2	2	2			1				1	
COD (mg/l)	18.2	18.6	20.2	24.8			14.1				14.1	

TABLE 10

WATER QUALITY DATA 1972
NORTH RACCOON RIVER

Parameter	Storm Lake E of Hwy. 71 Feb. 22	Nemaha Co. Rd. D-15 Feb. 22	Sac City Co. Rd. D-42 Feb. 22	Lake City Hwy. 175 Feb. 22	Jefferson Co. Rd. E-53 Feb. 22	Jefferson Co. Rd. E-57 Feb. 22
Dissolved Oxygen (mg/l)	9.1	10.0	6.2	7.5	8.7	8.1
Fecal Coliforms (MPN/100 ml)	300	70	4,500	140	20	410
Conductance (Micromhos)	1,100	980	970	930	900	860
pH (SU)	7.2	7.25			7.35	7.35
Organic Nitrogen (mg/l)	1.3	0.81	0.72	0.52	0.41	0.48
Ammonia Nitrogen (mg/l)	9.3	4.5	2.6	1.7	0.87	0.96
Nitrate Nitrogen (mg/l)	1.6	1.6	1.6	1.5	1.4	1.3
Total Solids (mg/l)	667	640			570	557
Total Volatile Solids (mg/l)	139	135			105	99
Total Suspended Solids (mg/l)	11	7			4	13
Volatile Suspended Solids (mg/l)	6	4			0	0
Phosphate (Filtrable)(mg/l)	3.4	1.4	0.90	0.55	0.29	0.33
Total Phosphate (mg/l)	3.5	1.4	0.97	0.59	0.31	0.37
BOD_5 (mg/l)	9	4	4	3	4	5
COD (mg/l)	36.7	20.4	16.3	12.2	12.2	12.2

Parameter	Co. Rd. P-46 Feb. 23	Perry Hwy. 141 Feb. 23	Co. Rd. P-58 Feb. 23	Minburn Co. Rd. F-31 Feb. 23	Dallas Center Hwy. 44 Feb. 23	Adel Hwy. 169 Feb. 23	Van Meter Co. Rd. R-16 Feb. 23
Dissolved Oxygen (mg/l)	6.9	5.6	4.6	7.1	5.7	5.4	9.0
Fecal Coliforms (MPN/100 ml)	240	500	8,600	4,500	2,400	1,900	2,600
Conductance (Micromphos)	860	970	910	910	900	910	890
pH (SU)	7.3		7.3				7.35
Organic Nitrogen (mg/l)	0.43	0.71	0.61	0.57	0.67	1.1	0.87
Ammonia Nitrogen (mg/l)	0.88	7.7	3.5	3.1	3.1	4.2	3.7
Nitrate Nitrogen (mg/l)	1.4	0.5	0.3	1.4	1.4	0.9	1.0
Total Solids (mg/l)	556		572				546
Total Volatile Solids (mg/l)	120		122				112
Total Suspended Solids (mg/l)	6		20				7
Volatile Suspended Solids (mg/l)	1		10				0
Phosphate (Filtrable)(mg/l)	0.32	0.79	0.64	0.65	0.60	0.59	0.61
Total Phosphate (mg/l)	0.35	0.82	0.68	0.74	0.66	0.65	0.67
BOD_5 (mg/l)	3	6	4	4	4	4	5
COD (mg/l)	14.3	12.3	8.2	10.2	10.2	12.3	16.4

TABLE 11

WATER QUALITY DATA

NORTH RACCOON RIVER

FEBRUARY 5, 1974

Parameter	Storm Lake - Co. Rd. NE of Storm Lake	Storm Lake - Co. Rd.	Nemaha - Co. Rd. D-15	Sac City - Co. Rd. D-42	Lake City - Hwy. 175	Jefferson - Co. Rd. E-53	Jefferson - Co. Rd.	Perry - Co. Rd. P-46	Perry - Co. Rd. P-58	Minburn - Co. Rd. F-31	Dallas Center - Hwy. 44	Adel - Below Hwy. 169 Above Dam	Van Meter - I-80
Temperature (° C)	0	0	0	0	0	0	0	0	0	0	0	0	0
Dissolved Oxygen (mg/l)	13.1	12.3	11.8	11.8	11.8	11.9	11.7	11.6	11.5	11.4	11.4	11.4	12.7
Fecal Coliforms (MPN/100 ml)	50	1,400	1,200	450	180	50	140	330	290	240	300	160	90
Conductance (Micromhos)	920	990	980	960	910	860	860	840	820	820	770	800	790
pH (SU)	7.8	7.8	7.8	7.8	7.8	7.8	7.6	7.7	7.7	7.7	7.75	7.7	7.8
Organic Nitrogen (mg/l)	0.08	0.28	0.28	0.41	0.47	0.57	0.51	0.51	0.49	0.57	0.67	0.63	0.73
Ammonia Nitrogen (mg/l)	0.09	3.4	2.1	0.81	0.65	0.51	0.43	0.40	0.45	0.51	0.52	0.48	0.43
Nitrate Nitrogen (mg/l)	9.5	8.0	8.5	8.0	8.5	7.0	8.5	8.0	7.5	8.0	8.0	7.5	7.0
Total Solids (mg/l)	594	639	622	623	602	558	568	565	556	549	551	546	541
Total Volatile Solids (mg/l)	229	234	237	241	187	223	223	165	209	211	180	123	201
Total Suspended Solids (mg/l)	0	0	0	0	0	0	0	0	0	0	24	0	0
Volatile Suspended Solids (mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphate (Filtrable) (mg/l)	0.08	0.52	0.39	0.24	0.22	0.23	0.23	0.25	0.23	0.26	0.29	0.26	0.28
Total Phosphate (mg/l)	0.10	0.52	0.39	0.24	0.22	0.23	0.25	0.27	0.26	0.27	0.29	0.27	0.28
BOD_5 (mg/l)	3	2	3	3	3	2	2	3	3	3	3	3	4
COD (mg/l)	8	10	6	8	4	8	8	4	6	6	8	10	12

TABLE 12

WATER QUALITY DATA

NORTH RACCOON RIVER

AUGUST 25, 1971

Parameter	Nemaha Co. Rd. D-15	Lake City Hwy. 175	Jefferson Co. Rd. E-53	Dawson Co. Rd. P-46	Dallas Center Hwy. 44	Van Meter 1/2 mi N of I-80 Co. Rd. R-16
Temperature (° C)	18.3	19.4	21.1	22.8	24.4	25.5
Dissolved Oxygen (mg/l)	6.2	7.3	8.2	9.5	10.9	12.3
Fecal Coliforms (MPN/100 ml)	1,900	310	300	500	500	350
Conductance (Micromhos)						
pH (SU)	8.2	8.1	7.9	8.1	8.3	8.2
Organic Nitrogen (mg/l)	1.9	1.1	1.2	1.3	1.7	1.4
Ammonia Nitrogen (mg/l)	0.01	$<$0.01	$<$0.01	$<$0.01	$<$0.01	$<$0.01
Nitrate Nitrogen (mg/l)	$<$0.1	$<$0.1	$<$0.1	$<$0.1	$<$0.1	$<$0.1
Total Solids (mg/l)	782	527	496	462	432	469
Total Volatile Solids (mg/l)	180	153	146	138	150	157
Total Suspended Solids (mg/l)	82	23	44	82	23	53
Volatile Suspended Solids (mg/l)	4	19	13	26	21	14
Phosphate (Filtrable) (mg/l)	2.4	0.4	0.1	0.2	0.3	0.2
Total Phosphate (mg/l)	2.6	0.5	0.3	0.5	0.8	0.6
BOD_5 (mg/l)	7	6	7	9	11	9
COD (mg/l)	60.7	48.6	48.6	52.6	48.6	48.6

TABLE 13

WATER QUALITY DATA

NORTH RACCOON RIVER

APRIL 10 & 11, 1972

Parameter	Storm Lake Below Boyer Cr.	Nemaha Co. Rd. D-15	Sac City Hwy. 196	Lake City Hwy. 175	Jefferson Co. Rd. E-53	Dawson Hwy. 335	Minburn Co. Rd. F-31	Adel Hwy. 169
Temperature (° C)	8	10	14	14	15	15	14	11.1
Dissolved Oxygen (mg/l)	9.9	10.1	12.8	14.5	14.4	14.3	15.0	15.7
Fecal Coliforms (MPN/100 ml)	700	120	10	10	10	10	10	10
Conductance (Micromphos)	1,100	1,300	970	840	720	690	720	680
pH (SU)	8.0	7.9	8.2	8.45	8.3	8.3	8.2	8.05
Organic Nitrogen (mg/l)	1.7	2.2	0.89	1.3	1.2	1.1	1.3	1.2
Ammonia Nitrogen (m g/l)	11	14	4.4	1.1	0.01	0.01	0.05	0.01
Nitrate Nitrogen (mg/l)	2.3	2.3	2.9	2.5	1.7	1.9	2.0	2.1
Total Solids (mg/l)	699	743	600			448	476	
Total Volatile Solids (mg/l)	166	167	127			104	120	
Total Suspended Solids (mg/l)	69	30	26			32	34	
Volatile Suspended Solids (mg/l)	17	7	13			2	0	
Phosphate (Filtrable) (mg/l)	1.0	2.0	0.68	0.33	0.03	0.03	0.07	0.07
Total Phosphate (mg/l)	1.2	4.0	0.75	0.42	0.12	0.12	0.16	0.17
BOD_5 (mg/l)	9	10	5	5	5	4	6	5
COD (mg/l)	47	60	39	39	19	23	23	19

TABLE 14

WATER QUALITY DATA

NORTH RACCOON RIVER

JUNE 4, 1974

Parameter	Storm Lake Co. Rd. NE of Storm Lake	Nemaha Co. Rd. D-15	Sac City Co. Rd. D-42	Lake City Hwy. 175	Jefferson Co. Rd. E-53	Jefferson Co. Rd.	Dawson Co. Rd. N of Dawson	Perry Co. Rd. P-58	Minburn Co. Rd. F-31	Dallas Center Hwy. 44	Adel Below Hwy. 169	Van Meter I-80
Temperature (° C)	22.5	22.5	22	22	22	21	21.5	21	21.5	21	21	21
Dissolved Oxygen (mg/l)	9.0	9.1	9.0	8.8	8.4	8.6	8.6	8.6	8.4	8.5	8.4	8.7
Fecal Coliforms (MPN/100 ml)	660	590	2,300	2.200	810	480	1,100	1,100	360	650	680	440
Conductance (Micromhos)	850	740	820	760	760	740	770	740	750	730	730	810
pH (SU)	8.3	8.3	7.8	8.2	8.3	8.3	8.3	7.9	8.2	8.3	8.3	8.3
Organic Nitrogen (mg/l)	0.76	1.2	0.87	1.0	1.2	0.99	1.0	1.4	1.2	0.93	1.0	0.71
Ammonia Nitrogen (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate Nitrogen (mg/l)	11	9.2	10	10	9.2	8.5	9.2	9.2	9.2	9.0	9.0	10.0
Total Solids (mg/l)	699	696									690	692
Total Volatile Solids (mg/l)	253	245									226	258
Total Suspended Solids (mg/l)	129	201									190	132
Volatile Suspended Solids (mg/l)	4	31									13	20
Phosphate (Filtrable)(mg/l)	0.08	0.11	0.14	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.12	0.15
Total Phosphate (mg/l)	0.20	0.22	0.20	0.22	0.21	0.22	0.20	0.22	0.18	0.21	0.23	0.22
BOD_5 (mg/l)	2	1	2	3	2	2	2	2	2	2	2	1
COD (mg/l)	23	29	16	20	10	27	23	23	20	25	37	20

TABLE 15

WATER QUALITY DATA - STREAM FLOWS
NORTH RACCOON RIVER

Gaging Station	Flow (cfs) on Date of Sampling							7-day, 1-in-10 Year Low Flow (cfs)
	Feb. 9, 1971	Feb. 16, 1971	Feb. 22, 1972	Feb. 5, 1974	Aug. 25, 1971	Apr. 11, 1972	June 4, 1974	
Near Sac City (5-4823)	16	23	20	160	18	80	367	1.2*
Near Jefferson (5-4825)	37	51	56	560	49	188	1380	12
Raccoon River near Van Meter (5-4845)	100	130	760	1250	120	370	4270	31

*Estimated

Monthly data taken during the "Iowa Internal Stream Quality Study" do not show any violation of stream quality standards. The sampling point for this survey is just above the confluence of the North Raccoon with the South Raccoon. The relatively high stream flows occurring during this sampling have masked any possible impact of wastewater discharges upon stream quality. Water quality data from this survey are summarized in Table 16.

Raccoon River - This stretch of stream begins at the confluence of the North and South Raccoon Rivers and extends to the confluence with the Des Moines River. There are no comprehensive water quality data available for this stretch of stream. Stream water quality is determined at the point of water withdrawal by the Des Moines Water Works, but dissolved oxygen and ammonia nitrogen concentrations are not part of their regular sampling program. Thus, no presentation of these data are made in this report.

Summary

Available water quality data indicate violation of stream quality standards in the North Raccoon River at some of the times when water

TABLE 16

WATER QUALITY DATA
NORTH RACCOON RIVER - NEAR I-80

Parameter	Date of Sampling Aug. 20, 1973	Sept. 17, 1973	Oct. 15, 1973	Nov. 13, 1973
Temperature (° C)	25	13.5	14.5	8
Dissolved oxygen (mg/l)	8.0	9.7	9.3	12.4
Fecal coliform (MPN/100 ml)	3,500	1,800	1,200	270
pH	7.9	7.75	7.85	7.95
Total Kjeldahl nitrogen (mg/l)	0.94	0.72	1.0	0.62
Ammonia nitrogen (mg/l)	0.18	0.36	0.46	0.26
Nitrate nitrogen (mg/l)	4.1	4.5	6.2	8.4
Total suspended solids (mg/l)	--	61	--	25
Phosphate (filtrable) (mg/l)	--	0.04	--	13
BOD_5 (mg/l)	4	5	<1	1
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)	--	0.1	--	0.2
Cadmium (mg/l)	--	<0.01	--	<0.01
Copper (mg/l)	--	<0.01	--	<0.01
Lead (mg/l)	--	<0.01	--	<0.01
Mercury (mg/l)	--	<1	--	<1
Zinc (mg/l)	--	<0.01	--	0.02

quality surveys have been conducted. No water quality data are available for the Middle Raccoon River. Available data for the South Raccoon River, Raccoon River, and the Des Moines River are insufficient to obtain an idea of stream water quality under low flow conditions. High stream flows during the past two years have even masked normal seasonal water quality variations. Much additional water quality data during low flow periods are required for both the Raccoon River Basin and the portion of the Des Moines River within the study area. Monitoring of stream water quality will be necessary to check the effectiveness of the NPDES program.

PART IV

POINT SOURCE WASTEWATER DISCHARGES

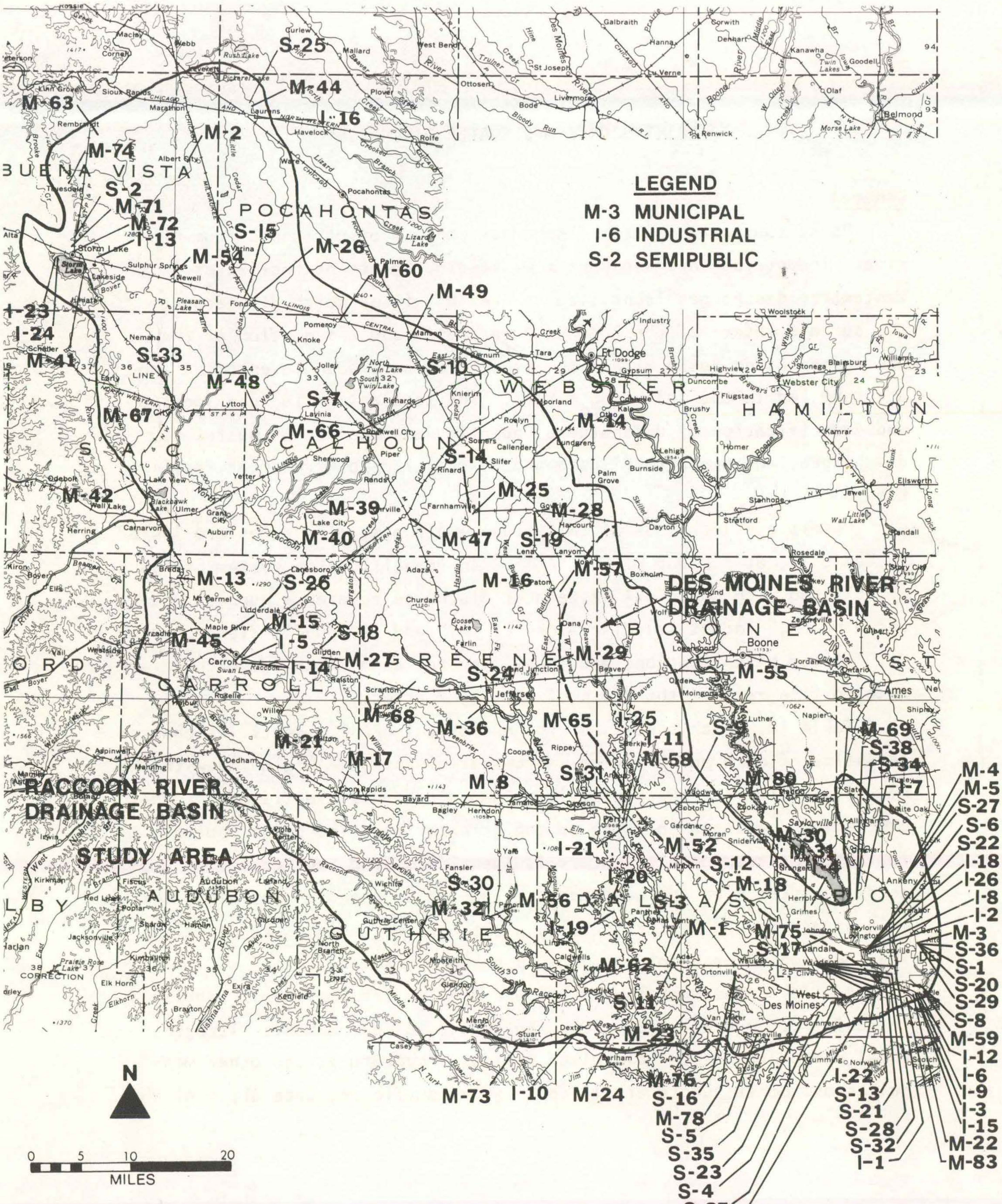
General

Point source wastewater discharges consist of effluents from municipal, industrial, and semipublic wastewater treatment facilities. Wastewater discharges identified in the IDEQ files which discharge to the surface waters of the Raccoon River Basin and the portion of the Des Moines River Basin within the study area have been inventoried and 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.

Owners and locations of individual wastewater discharges are listed in Table 17, at the end of this PART. An identification system has been established with municipal wastewater discharge reference numbers preceded by "M," industrial discharges by "I," and semipublic discharges by "S." River mile locations are identified for each discharge with reference to mile zero at the mouth of the major stream.

Table 18, which appears at the end of this PART, identifies characteristics of each point source wastewater discharge. Beginning with the Des Moines River at the Saylorville Dam, discharges are listed in order proceeding downstream picking up the tributaries. The point source farthest upstream on a tributary is identified, and the tabulation proceeds downstream to the confluence. Tabulation then resumes along the main stream to the next tributary, where the procedure is repeated. The location of each point source is shown on Figure 8.

Available wastewater quantity and quality information is tabulated in Table 18. Average flow, BOD_5, suspended solids, ammonia nitrogen, total phosphorus, total dissolved solids, temperature, and other miscellaneous constituents are listed. Where sufficient data are available,



POINT SOURCE WASTEWATER DISCHARGES

FIG. 8

STANLEY CONSULTANTS

BOD_5, ammonia nitrogen, and temperature values have been reported 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.

Municipal

Sewage flow and quality data for 48 municipalities were extracted from IDEQ records and files. Of these dischargers, 39 were within the Raccoon River Basin and 9 within the Des Moines Basin. 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." Flow values shown in Table 18 are the averages obtained for the last full year of record; in most instances 1972.

Most quality data were collected from "Effluent Quality Analysis Program" (EQAP) by IDEQ. These data were supplemented by review of treatment facility reports supply by the operators. Data reported through EQAP are results of tests conducted by the Iowa State Hygenic Laboratory on wastewater samples supplied by 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 probably 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 averages of the available data.

Industrial

Information for 26 industries discharging wastewater to streams within the study area was obtained. There are 15 industrial dischargers in the Raccoon River Basin and 11 in the Des Moines River Basin. U. S. Army Corps of Engineers discharge permit applications (Discharge Permit Program, River and Harbors Act of 1899), IDEQ industrial files, and the National Pollutant Discharge Elimination System (NPDES) applications, were the three sources of information utilized.

Although these sources provide the best available discharge information, caution must be exercised in data interpretation. Information tabulated in Table 18 has been submitted by the individual industries with very little verification.

Semipublic

Information identifying semipublic treatment facilities was obtained from IDEQ files. A total of 38 semipublic facilities could be identified in the study area, 31 in the Raccoon River Basin and 7 in the Des Moines River Basin. Description of semipublic facility discharges is difficult due to the minimal surveillance provided. Quantity and quality relationships are practically nonexistent and in most cases, design information is all that is available. Therefore, values in Table 18 are based upon design characteristics and do not necessarily reflect actual operating conditions.

Existing Wastewater Treatment Facilities

Inventory information for existing wastewater treatment facilities from IDEQ files and records has been compiled in Table 19 at the end of this PART. The order of presentation in Table 19 is the same as that utilized in Table 18, beginning with the facilities on upstream reaches and continuing downstream.

Table 19 contains existing design average day capacity, present average day flow, both influent and effluent concentrations of BOD_5 and suspended solids, type of treatment process, and comments about the facility. Influent values are only available for the larger treatment facilities. Specific processes identify primary treatment, secondary 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 operation, age of existing facilities, specific IDEQ permit requirements, IDEQ orders for additional treatment, and delineation of proposed facilities.

An additional 33 incorporated communities presently without municipal collection or treatment systems are included in Table 19.

Summary

Distribution of hydraulic and organic loads upon the streams in the study area from the three point source wastewater discharge classifications is summarized in Table 20.

TABLE 20

REPORTED POINT SOURCE
WASTEWATER DISCHARGE SUMMARY

		Municipal		Industrial		Semipublic	
	Total	Raccoon Basin	Des Moines Basin	Raccoon Basin	Des Moines Basin	Raccoon Basin	Des Moines Basin
Flow, mgd	259.986	7.750	41.366	3.737	205.972	1,116	0.045
Percent	100	3.0	15.9	1.4	79.2	0.4	0.1
BOD_5, lb/day	12.879	1,468	4,436	1,011	460	1	3
Percent	100	15.3	73.3	7.8	3.6	0.1	0.1
Ammonia-N, lb/day	2,645	42.4	1,816	235	100	0.0	0.0
Percent	100	18.7	68.6	8.9	3.8	0.0	0.0
Phosphorus-P, lb/day	10,431	945	9,248	0.0	238	0.0	0.0
Percent	100	9.0	88.7	0.0	2.3	0.0	0.0

The relatively low percentage of BOD_5 discharged by industries compared to flow is due to the following:

1. Iowa Power and Light Co. at Pleasant Hill discharges a large quantity (208 mgd) of cooling water which has a low BOD_5.
2. Several industrial discharges consist only of cooling water; therefore, negligible amounts of BOD_5 are discharged.

Table 21 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 a population of greater than 1,000 maintain a waste stabilization pond, while four communities having populations less than 1,000 are served by trickling filters.

TABLE 21

WASTEWATER TREATMENT FACILITIES
PROCESS SUMMARY

	Communities Served		Population Served	
Type of Plant	Raccoon Basin	Des Moines Basin	Raccoon Basin	Des Moines Basin
Trickling Filter	22	7	54,679	229,019
Waste Stabilization Pond	18	3	11,749	2,765

None of the communities in the study area presently operates advanced waste treatment facilities. However, IDEQ is currently reviewing plans for one new high-level treatment facility. The city of Des Moines has submitted plans for aeration basins following an existing secondary trickling filter treatment facility.

TABLE 17
POINT SOURCE WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal						
Adel	M-1	Dallas	37.4	North Raccoon River	56	63
Albert City	M-2	Buena Vista		Lateral 2	55	60
Altoona	M-3	Polk		Four Mile Creek	58	66
Ankeny E	M-4	Polk		Four Mile Creek	58	66
Ankeny W	M-5	Polk		Four Mile Creek	55	59
Arcadia	M-6	Carroll			NEMTF	
Auburn	M-7	Sac			NEMTF	
Bagley	M-8	Guthrie		Mosquito Creek	57	64
Bayard	M-9	Guthrie			NEMTF	
Beaver	M-10	Boone			NEMTF	
Berkley	M-11	Boone			NEMTF	
Bouton	M-12	Dallas			NEMTF	
Breda	M-13	Carroll	75.5	Middle Raccoon River	57	63
Callender	M-14	Webster		West Butterick Creek	56	62
Carroll	M-15	Carroll	66.2	Middle Raccoon River	57	63
Churdan	M-16	Greene		Hardin Creek	56	62
Coon Rapids	M-17	Carroll	47.4	Middle Raccoon River	57	64
Dallas Center	M-18	Dallas		Walnut Creek	58	65
Dana	M-19	Greene			NEMTF	
Dawson	M-20	Dallas			NEMTF	
Dedham	M-21	Carroll		Brushy Creek	57	63
Des Moines	M-22	Polk	196.5	Des Moines River	58	66
Des Moines Area C	M-83	Polk		Yeader Creek	58	66
De Soto	M-23	Dallas		Bulger	57	64
Earlham	M-24	Madison		Bear Creek	57	64
Farnhamville	M-25	Calhoun		Hardin Creek	56	60
Fonda	M-26	Pocahontas		Cedar Creek	55	60
Glidden	M-27	Carroll		Willow Creek	57	64
Gowrie	M-28	Webster		West Butterick Creek	56	62

TABLE 17 (Cont.)

POINT SOURCE WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal (Cont.)						
Grand Junction	M-29	Greene		East Butterick Creek	56	62
Granger	M-30	Dallas		Beaver Creek	55	59
Grimes	M-31	Polk		Beaver Creek	55	59
Guthrie Center	M-32	Guthrie	43.4	South Raccoon River	57	63
Halbur	M-33	Carroll			NEMTF	
Harcourt	M-34	Webster		East Butterick Creek	NEMTF	
Jamaica	M-35	Guthrie			NEMTF	
Jefferson	M-36	Greene		Drainage Ditch 132	56	62
Jolley	M-37	Calhoun			NEMTF	
Knierim	M-38	Calhoun			NEMTF	
Lake City - North	M-39	Calhoun		Lake Creek	56	61
Lake City - Southwest	M-40	Calhoun		Lake Creek	56	61
Lakeside	M-41	Buena Vista		Boyer Creek	NEMTF	
Lakeview	M-42	Sac		Indian Creek	55	61
Lanesboro	M-43	Carroll		Cedar Creek	NEMTF	
Laurens	M-44	Pocahontas		North Raccoon River	55	60
Lidderdale	M-45	Carroll		Storm Creek	57	63
Linden	M-46	Dallas			NEMTF	
Lohrville	M-47	Calhoun		Cedar Creek	56	61
Lytton	M-48	Sac		Camp Creek	56	61
Manson	M-49	Calhoun		Cedar Creek	56	61
Marathon	M-50	Buena Vista			NEMTF	
Menlo	M-51	Guthrie			NEMTF	
Minburn	M-52	Dallas	52.0	North Raccoon River	56	63
Nemaha	M-53	Sac			NEMTF	
Newell	M-54	Buena Vista	154.0	North Raccoon River	55	61
Ogden	M-55	Boone		Beaver Creek	55	59

TABLE 17 (Cont.)

POINT SOURCE WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal (Cont.)						
Panora	M-56	Guthrie	16.3	Middle Raccoon River	57	64
Paton	M-57	Greene			NEMTF	
Perry	M-58	Dallas	60.6	North Raccoon River	56	62
Pleasant Hill (U)	M-59	Polk		Des Moines River	58	66
Pomeroy	M-60	Calhoun		Lake Creek	56	61
Ralston	M-61	Carroll			NEMTF	
Redfield	M-62	Dallas	16.4	Middle Raccoon River	57	64
Rembrandt	M-63	Buena Vista	196.0	North Raccoon River	55	60
Rinard	M-64	Calhoun		Cedar Creek	56	61
Rippey	M-65	Greene		Snake Creek	56	62
Rockwell City	M-66	Calhoun		Lake Creek	56	61
Sac City	M-67	Sac	156.3	North Raccoon River	55	60
Scranton	M-68	Greene		Drainage Ditch 171	56	62
Slater	M-69	Story		Four Mile Creek	58	66
Somers	M-70	Calhoun			NEMTF	
Storm Lake	M-71	Buena Vista		Boyer Creek	55	60
Storm Lake (Hy-Grade)	M-72	Buena Vista		Boyer Creek	55	60
Stuart	M-73	Adair		South Raccoon River	57	63
Truesdale	M-74	Buena Vista		Poor Farm Creek	NEMTF	
Urbandale Sanitary Sewer District	M-75	Polk		Beaver Creek	55	59
Van Meter	M-76	Dallas	29.2	South Raccoon River	57	65
Varina	M-77	Pocahontas			NEMTF	
Waukee	M-78	Dallas		Sugar Creek	57	65
Willey	M-79	Carroll			NEMTF	
Woodward	M-80	Dallas		Beaver Creek	55	59
Yale	M-81	Guthrie			NEMTF	
Yetter	M-82	Calhoun			NEMTF	

TABLE 17 (Cont.)

POINT SOURCE WASTEWATER DISCHARGE POINTS

Discharge	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Industrial						
American Oil Co.	I-1	Polk		Walnut Creek	58	65
American Can Co.	I-2	Polk		Des Moines River	55	60
Amundson Mfg.	I-25			North Raccoon River	56	62
Armstrong Rubber Co.	I-3	Polk		Dean Lake	58	66
Beaver Valley Canning Co.	I-4	Polk		Little Beaver Creek	55	59
Carroll Rendering Co.	I-5	Carroll		Middle Raccoon River	57	63
Chicago, Rock Island, and Pacific R.R.	I-6	Polk		Dean Lake	58	51
Deere & Co.	I-7	Polk		Rock Creek	55	59
Firestone Tire & Rubber Co.	I-8	Polk		Walfley Creek	55	59
Ford Motor Co.	I-26	Polk		Walfley Creek	55	59
Frye Copy Systems	I-9	Polk		Des Moines River	58	66
Gendler Stone Products Co.	I-10	Dallas		Bear Creek	57	64
Iowa Electric Light & Power Co. Perry Iowa	I-11	Dallas		North Raccoon River	56	63
Iowa Power & Light Co.	I-12	Polk		Des Moines River	58	66
Iowa Public Service Co.	I-13	Buena Vista		Boyer Creek	55	60
Iowa Public Service Co. Carroll Station	I-14	Carroll		Middle Raccoon River	57	63
Lennox Industries	I-15	Polk		Dean Lake	58	66
Mefferd Industries	I-16	Pocahontas		Cedar Creek	55	60

TABLE 17 (Cont.)

POINT SOURCE WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference	
					Quantity	Treatment
Industrial (Cont.)						
Meredith Corporation (Printing Division)	I-17	Polk		Raccoon River	58	65
Mid Contintent Bottling Co.	I-18	Polk		Walfley Creek	55	59
Northern Iowa Natural Gas Co. (Redfield Compressor Station)	I-19	Dallas		South Raccoon River (Panther Creek)	57	64
Northern Iowa Natural Gas Co. (Redfield Storage Field)	I-20	Dallas		South Raccoon River (Pitzenbarger Creek)	57	64
Oscar Mayer & Co.	I-21	Dallas		North Raccoon River	56	62
Skelly Oil Company	I-22	Polk		Unnamed Tributary	58	65
Vilas & Company	I-23	Buena Vista		Storm Lake	55	60
Vista Products Co.	I-24	Buena Vista		Storm Lake	55	60
Semipublic						
Adel WTP	S-11	Dallas		North Raccoon River	--	63
Country Living Mobile Home Park	S-1	Polk		Four Mile Creek	--	66
Country Village Mobile Home Park	S-2	Buena Vista		Storm Lake	--	60
Dallas County Home	S-3	Dallas		Raccoon River	--	63
Dallas Center WTP	S-12	Dallas		North Raccoon River	--	65

TABLE 17 (Cont.)

POINT SOURCE WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Semipublic (cont.)						
Des Moines Golf and Country Club	S-13	Polk		Walnut Creek	58	65
Farnhamville WTP	S-14	Calhoun		Hardin Creek	56	62
Fonda WTP	S-15	Pocahontas		Cedar Creek	--	60
Fox Creek Water Co.	S-16	Dallas		Sugar Creek	--	65
Frist Continental Co. Motel	S-17	Polk		Beaver Creek	--	59
Glidden WTP	S-18	Carroll		Storm Creek	57	63
Gowrie WTP	S-19	Webster		Butterick Creek	--	62
Greenwood WTP	S-20	Polk		Four Milk Creek	--	66
Hinkson MHP	S-21	Polk		Walnut Creek	58	65
Iowa Fund	S-22	Polk		Walfley Creek	--	59
Iowa Highway Commission Rest Area	S-23	Polk		Des Moines River	57	65
Jefferson WTP	S-24	Greene		Drainage Ditch #132	56	62
KOA Campground	S-4	Polk		Raccoon River	--	65
Laurens WTP	S-25	Pocahontas		Cedar Creek	--	60
Lidderdale WTP	S-26	Carroll		Storm Creek	--	63
MelRay Mobile Home Park	S-27	Polk		Saylor Creek	--	59
National Crossroads Campground	S-28	Polk		Walnut Creek	--	65
Oakwood Heights	S-24	Polk		Four Mile Creek	--	66
Panora WTP	S-30	Guthrie		Middle Raccoon River	57	64
Perry WTP	S-31	Dallas		North Raccoon River	--	62
Prairie Village Mobile Home Park	S-5	Dallas		Raccoon River	--	65

TABLE 17 (Cont.)

POINT SOURCE WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Semipublic (Cont.)						
Regency Manor Mobile Home Park	S-6	Polk		Des Moines River	--	60
Roadrunner Campground and Mobile Home Park	S-32	Polk		Walnut Creek	--	65
Rockwell City Womens Reformatory	S-7	Calhoun		Lake Creek	56	61
Sac City WTP	S-33	Sac		North Raccoon River	55	60
Sayorville Lake and Recreation Center	S-34	Polk		Des Moines River	--	59
Southeast Polk Community School	S-8	Polk		Four Mile Creek	58	66
Southeast Polk Water Co.	S-35	Polk		Des Moines River	57	65
Sunnybrook Mobile Home Park	S-36	Polk		Four Mile Creek	58	66
Town & Country	S-9	Dallas		Beaver Creek	--	59
Twin Lakes Travel Park	S-10	Calhoun		Lake Creek	--	61
Walter T. Giles High Rise Motel	S-37	Polk		Jordan Branch	--	65
YMCA Home	S-38	Polk		Des Moines River	--	59

TABLE 18

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)
Des Moines River																		
Rock Creek																		
I-7	0.130																	
Beaver Creek																		
M-55	0.342	25	71					7	20	20	57	30	86					
M-80	0.084	25	18	45	32			20	14	30	21	21	8					T Coli = 30×10^3/100 ml pH = 8.8 COD = 40 Grease = 9.8
M-30	0.057	25	12					1	1			30	14					
M-31	0.100	30	25	35	29			5	4	8	7	10	8					
I-4	0.063	75	39	159	79			4	2	8	4							Org-N = 9
M-75	0.259	25	54	30	65			6	13	10	22	17	37					
Saylor Creek																		
M-5	0.517	25	108	30	129			10	43	30	129							
Walfley Creek																		
I-8	1.270	5	53			20	212	0.30	3			1	11					TDS = 500
I-18	0.500	25	104	65	271	30	125	4	17	1	4							
I-26	0.194																	
I-2																		
North Raccoon River																		
M-63	0.075	25	16					16	10									
Lateral 2																		
M-2	0.080	25	17	25	17			6	4	9	6	15	10					
North Raccoon River																		
Boyer Creek																		
I-13	0.016	3	<1			4	<1	0	0			6.6	0.8					TDS = 1,355
M-71	1.516	30	379	35	443			5	63	25	316							
M-72	1.045	30	261	30	261	60	523	17	148	90	784							
I-23	0.0986							3	2							48	43	
I-24	0.180	28	42					3	5							115		
North Raccoon River																		
S-33	0.006																	
M-67	0.270	25	56	50	113			8	18	17	38	38	86					
Big Cedar Creek																		
M-44	0.198	30	50	95	157			2	3	24	40	13	21					
I-16	0.0082																	
M-26	0.088	40	29	100	74			5	4	10	7	30	22					
Prairie Creek																		
M-54	0.087	25	18	100	73			4	3	30	22	21	15					
Indian Creek																		
M-42	0.218	25	45	30	55													

TABLE 18 (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)
North Raccoon River																		
Camp Creek																		
M-48	0.157	30	39	50	65			1	1	12	16	5	7					
Lake Creek																		
M-60	0.073	50	30	25	15			1	1	18	11	7	4					
M-66	0.264	25	55	35	77			6	13	26	57	17	37					
S-7						25												
M-39	0.090	25	19	25	19					35	26							
M-40	0.080	25	17	45	30			2	1	18	12	17	11					
Cedar Creek																		
M-49	0.110	25	23	60	55			10	9	17	16	35	32					
M-64		25		25														
M-47	0.053	25	11	40	18			4	2	13	6	16	7					
Drainage Ditch 171																		
M-68	0.065	30	16	60	33			7	4	28	15	20	11					
Drainage Ditch 132																		
S-24	0.001																	
M-36	0.485	30	121	50	202			5	20	18	73	16	65					
Hardin Creek																		
S-14	0.002																	
M-25	0.110	25	23	25	23			4	4	1	1	25	23					
M-16	0.028	30	7	25	6			1	0			8	2					
Buttrick Creek																		
M-14	0.020																	
M-28	0.070	25	15	50	29			12	7	2	1	15	9					
M-29	0.040	25	8	35	11			1	0	1	0	10	3					
Snake Creek																		
M-65	0.012	25	3					6	1			2	0					Org-N = 5 lb/day
North Raccoon River																		
I-25																		
M-58	1.052	25	219	30	263			3	26	10	88	16	140					
I-21		25		110				34		127								
I-11	0.002																	
M-52		25		25						4		6						
M-1	0.069	25	14	35	20			1	1	13	7	21	12					No_3-N = 16 lb/day

TABLE 18 (Cont.)

POINT SOURCE
WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD5 Summer (mg/l)	BOD5 Summer (lb/day)	BOD5 Winter (mg/l)	BOD5 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)
South Raccoon River																		
M-32	0.186	25	39	40	62			1	2	16	25	35	54					
Brushy Creek																		
M-21	0.009	25	2	40	3													
Long Branch																		
M-73	0.201	25	42	35	59			2	3	40	67	23	39					
Middle Raccoon River																		
M-13	0.063	25	13	85	45					6	3	27	14					
M-15	0.805	25	168	25	168			1	7	14	94	30	201					Org-N = 14
I-5																		
I-14		0	0			0.3		0.6				2						TDS = 157 NO_3-N = 2
Storm Creek																		
M-45																		
S-18	0.003																	
Middle Raccoon River																		
M-17	0.081	25	17	35	24			4	3	19	13							
Willow Creek																		
M-27	0.062	60	13	130	67			10	5	130	67	37	19					
Middle Raccoon River																		
S-30	0.010																	
M-56	0.150	25	31	40	50													
Mosquito Creek																		
M-8																		
South Raccoon River																		
M-62	0.062	25	13	50	26			1	1	12	6	8	4					
Panther Creek																		
I-19	0.0015																	
I-20	0.34 (based on 28 day/yr)	20	58															
Bear Creek																		
M-24	0.236	25	49	35	69			1	2	11	22	10	20					
I-10																		
Bulger Creek																		
M-23	0.047	25	10	40	16													
Raccoon River																		
M-76	0.033	25	7	95	26			1	0	56	15							
S-23	0.078																	
S-35	0.006																	
Sugar Creek																		
M-78		30		100														

TABLE 18 (Cont.)
POINT SOURCE
WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD5 Summer (mg/l)	BOD5 Summer (lb/day)	BOD5 Winter (mg/l)	BOD5 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)
Raccoon River																		
Walnut Creek																		
M-18	0.188	25	39	25	39			1	2	4	6	14	22					
S-21	0.005																	
S-13	0.050	25	10															
I-22	0.008																	
I-1	0.0016															68	60	
Raccoon River																		
I-17	0.85																	
Des Moines River																		
I-3	2.848	1	24	8	190	10	238	1	24	1	24	10	238					NO_2-N = 1 TDS = 715
I-6	0.005																	
I-9	0.72							0.2	1			0.5	3			68	64	Org-N = 0.15 NO_3-N = 0.16
I-15	0.038															75	45	
M-22	38.984	25	8,109	35	11,353			1	324	20	6,488	35	11,353					
Yeader Creek																		
M-83																		
Des Moines River																		
I-12	208.0																	
Four Mile Creek																		
M-69	0.095	35	277	80	634			2	16	21	166	20	158					
M-4	0.910	25	190	55	417					8	61	30	228					
S-36	0.025																	
M-3	0.534	30	134	40	178			4	18	12	53	37	165					
S-8	0.013 (per 10 hr/day)																	TDS = 2,122 Org-N = 1.7 NO_2-N = 1.8 NO_3-N = 8.6
Des Moines River																		
M-59	0.11	25	23	45	41			12	11	27	25	31	28					

TABLE 19

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
Des Moines River										
Rock Creek										
Deere & Co. (I-7)		0.130								Deere & Co. plans to send all cooling and process wastes to city industrial sewer by end of 1974.
Des Moines River										
Saylorville Lake Recreation Area (S-34)							Lo			
YMCA Home (S-38)							Lo			
Des Moines River										
Beaver Creek										
Beaver (M-10)										No existing municipal treatment facility.
Ogden (M-55)	0.246	0.342		35			Sch Gm Cm	Ftr Cp	Dfp Bo	Plant placed in operation in 1958. Existing sewers have a large quantity of infiltration during periods of wet weather.
Berkley (M-11)										No existing municipal treatment facility.
Woodward (M-80)	0.0965	0.084		30		45	Lo	Lo		Total surface area equals 8.52 acres.
Bouton (M-12)										No existing municipal treatment facility.
Town & Country, Inc. (S-9)	0.0065						Lo	Lo		Total surface area equals 0.58 acres.
Granger (M-30)	0.057	0.057		37			Lo	Lo		
Grimes (M-31)	0.080	0.100		30			Sh (Cp Do)	Ftr Cp	Bo	The city of Grimes is in the process of building a new treatment facility.
Beaver Valley Canning Co. (I-4)		0.063		850			La	Lo Lo I (Aug-Sept)		Plans are being made to connect into the city's new treatment facility when completed.
Urbandale Sanitary Sewer District (M-75)	0.428	0.259		26			G Sn	C FtC E	DB	
First Continental County Motel (S-17)	0.025							Ae Lp		To city in future.
Saylor Creek										
Ankeny W (M-5)	0.404	0.517		35			Gh Sh Cm	Ftr Cm	Dfh Bo	
Mel Ray Mobile Home Park (S-27)							Lo			
Des Moines River										
Walfley Creek										
Iowa Fund (S-22)							Lo			
Mid Continent Bottling Co. (I-18)	0.050			31			La	La		They have NPDES Permit (11-73 to 11-78) which limits BOD_5 to 25 mg/l.
Firestone Tire & Rubber Co. (I-8)		1.270		5						Discharges are cooling water, curing water, and blowdown. All other wastes are handled by the city of Des Moines STP.
Ford Motor Co. (I-26)		0.194								Cooling water - no treatment.

TABLE 19 (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Day Average Flow (mgd)	Influent Conc. (mg/l)	Effluent Conc. (mg/l)	Influent Conc. (mg/l)	Effluent Conc. (mg/l)	Type of Treatment: Primary	Type of Treatment: Secondary	Type of Treatment: Solids Treatment	Comments
Des Moines River (Cont.)										
American Can Co. (I-2)	0.202									Discharge is water for cooling, air conditioning, etc.
Regency Manor Mobile Home Park (S-6)								Ae Lp		
North Raccoon River										
Marathon (M-50)										No existing municipal treatment facility.
Rembrandt (M 63)		0.075		30			Lo	Lo		
Lateral 2										
Albert City (M-2)	0.048	0.080		25			Sh Ci	Ftrc Cp	Bo Xl	Plant put into operation during October, 1951. It is in good condition considering its age but is about due to be replaced.
Poor Farm Creek										
Truesdale (M-74)										No existing municipal treatment facility.
Boyer Creek										
Iowa Public Service (I-13)		0.016		3	2	4	None			Discharge is cooling water.
Storm Lake (M-71)	2.40	1.516		40			Sh Gm Cm	Fo Cm Ftr Cm	Dfh Bo	IDEQ requires final plans for new STP by 1-1-75.
Storm Lake, Hy-Grade (M-72)	2.653	1.045		25			Ln La La	Lo Lo Lp		(Constructed in 1966).
Country Village Mobile Home Park (S-2)							Lo			Permit issued March, 1972.
Vilas and Co., Inc. (I-23)		0.0986		0						Sanitary wastes are sent to Storm Lake's STP. Discharge is defreeze water. Process wastes sent to Hy-Grade's lagoon.
Vista Products Co. (I-24)		0.180		28						Discharge is cooling water. Process wastes sent to Hy-Grade's lagoon.
Lakeside (M-41)										Lakeside discharges to Hy-Grade's industrial lagoon.
North Raccoon River										
Nemaha (M 53)										City and school is served by industrial septic tanks.
Sac City WTP (S-33)		0.006								Filter backwash water - no treatment.
Sac City (M-67)	0.220	0.270		40			Sch Cm	Ftr Cm	Dcmh	Preliminary plans were made for a new STP in 1973.
Big Cedar River										
Laurens WTP (S-25)										Filter backwash water - no treatment.
Laurens (M-44)	0.198	0.150		40			Sh Cm	Ftr Cm	Dfh Bo	Plant constructed in 1953.
Mefferd Industries (I-16)		0.0082								Discharge is from the chrome plating rinse tank.
Varina (M-77)										
Fonda WTP (S-15)										Filter backwash water - no treatment.
Fonda (M-26)	0.111	0.088		54			Sh Ci	Ftr Cp	Dfp Bo	Plant originally built in 1919 with major modification in 1957. Needs updating. Large quantity of infiltration during wet weather.

TABLE 19 (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
Big Cedar Creek (cont.)										
Prairie Creek										
Newell (M-54)	0.110	0.087		35			Sh Ci	Ftr Cm	Bo	Plant constructed in 1964.
Indian Creek										
Lakeview (M-42)	0.280	0.218		27			Gh Sch Cm	Fctr Ftr Cm	Dfh Bo Ls	Plant constructed in 1970.
North Raccoon River										
Auburn (M-7)										No existing municipal treatment facility. A waste stabilization pond is being considered.
Camp Creek										
Jolley (M-37)										No existing municipal treatment facility.
Lytton (M-48)	0.167	0.157		40			La	Lo Lo		
Yetter (M-82)										No existing municipal treatment facility.
Lake Creek										
Pomeroy (M-60)	0.062	0.073		35			Lo	Lo		
Rockwell City (M-66)	0.288	0.264		30			Sch Gh Cm	Ftr Cm	Dfh Bo	Sewers have large quantity of infiltration during wet weather.
Rockwell City Women's Reformatory (S-7)				25			Lo	Lo		Lagoon (0.68 acres) constructed in 1961.
Lake City N (M-39)	0.150	0.090		30			Sh Gh Cm	Ftr Ci Ftn	Dop Bo	
Lake City SW (M-40)	0.20	0.080					Ci	Ftn	Bo	A new plant consisting of two mechanically equipped settling tanks, trickling filter, polishing lagoon, and digestor is proposed.
Twin Lakes Travel Park (S-10)										Permit issued November 15, 1967, for a complete retention lagoon.
North Raccoon River										
Lanesboro (M-43)										No existing municipal treatment facility.
Cedar Creek										
Manson (M-49)	0.190	0.110		35			Lo	Lo		Lagoons constructed in 1960.
Knierim (M-38)										No existing municipal treatment facility.
Somers (M-70)										No existing municipal treatment facility.
Rinard (M-64				25			Cs	Fs		
Lohrville (M-47)	0.069	0.053		30			Sh Ci	Ftrc Cm	Bo Xl	Plant constructed in 1958.

TABLE 19 (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
North Raccoon River (Cont.)										
Drainage Ditch 171										
Scranton (M-68)	0.127	0.065		35			Sh Ci	Ftr Cp	Bo	
Drainage Ditch 132										
Jefferson WTP (S-24)		0.100								Water softening backwash.
Jefferson (M-36)	0.360	0.485		40			Sm Km Cm	Ftr Cm	Dfh Bo Xl	Preliminary plans have been prepared for expansion, including nitrification.
Hardin Creek										
Farnhamville WTP (S-14)		0.002					Lo			Backwash water.
Farnhamville (M-25)	0.180	0.110		25			Lo	Lo		Total surface area equals 2.5 acres.
Churdan (M-16)	0.032	0.028		27			Lo	Lo		Lagoons built in 1962. Total surface area equals 2.9 acres.
Butterick Creek										
Callendar (M-14)	0.050	0.020					Lo	Lo		Presently constructed two waste stabilization lagoons.
Gowrie WTP (S-19)										No treatment.
Gowrie (M-28)	0.081	0.070		26			Sh Cm	Ftr Cp	Do Bo	Excessive infiltration during wet weather.
Harcourt (M-34)	0.04									Proposed two-cell lagoon with total surface area of 3.2 acres.
Paton (M-57)	0.048									Construction permit issued for a two-cell lagoon.
Dana (M-19)										No existing treatment plant facility.
Grand Junction (M-29)	0.072	0.040		35			Sch Ci	Ftr Cp	Bo	Sewers have large quantity of infiltration during wet weather.
North Raccoon River										
Jamaica (M-35)										No existing treatment plant facility.
Snake Creek										
Rippey (M-65)	0.040	0.012		25			Lo	Lo		One-cell lagoon (3.2 acres) constructed in 1969.
North Raccoon River										
Dawson (M-20)										Town with decreasing population. No treatment facility planned.
Asmundson Mfg. Co. (I-25)	0.011						Lo			
Perry WTP (S-31)							Lo	Lo		
Perry (M-58)	1.545	1.052		35			Sch Ga Cm	Fto Cm Ftr Cm	Dfh Bo Ls	
Oscar Mayer Co. (I-21)	1.00			50			Ln	Lo	Lp	They have had odor complaints. New plant is planned.

TABLE 19 (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
North Raccoon River (cont.)										
Iowa Electric Light & Power Co. (I 11)		0.002								Discharges boiler, cooling tower blowdown, and water softener wash water.
Minburn (M-52)	0.048			25			Lo	Lo		Two-cell lagoon with total surface area of 5.2 acres, built in 1967.
Dallas County Home (S-3)										In late 1972, they were about to build a lagoon sized for 110 people (one acre). No further information is available.
Adel WTP (S-11)							Lo			
Adel (M-1)	0.224	0.069		30			Gmw Sm (Cp Do)	Ftr Cp	Bc	
South Raccoon River										
Guthrie Center (M-32)	0.286	0.186		35			Sch Gawka Cm	Foc Cm Fth Cm	Dth Bo Xl	
Brushy Creek										
Arcadia (M-6)										No existing municipal treatment facility. City has applied for FHA funds for a waste stabilization lagoon.
Halbur (M-33)										No existing municipal treatment facility. A consent order issued by IDEQ required a preliminary report before 1970.
Dedham (M-21)	0.035	0.009		30			Lo	Lo		
South Raccoon River										
Menlo (M-51)										No existing municipal treatment facility.
Long Branch										
Stuart (M-73)	0.150	0.201		35			Gh Sh Cm	Ftr Cp	Dop Bo X Ll	Sewers have a large quantity of infiltration during wet weather.
Middle Raccoon River										
Breda (M-13)	0.055	0.063		40			Lo	Lo		Permit issued June 4, 1973, to build waste stabilization lagoon.
Carroll (M 15)	1.200	0.805		27			Sch Km Cm	Fth Cm Ftr Cm	Dfh Bo Xl	Presently building a new plant.
Carroll Rendering Co. (I-5)		1.0*		40*						As of September 28, 1970, Carroll Rendering Co. was in the process of building a new sewage treatment facility.
Iowa Public Service Co. Carroll Station (I-14)			0	0	1	0.3				Discharge is cooling water. Submitted application for operating permit February 27, 1974.
Storm Creek										
Lidderdale WTP (S 26)										Iron removal backwash - no treatment.
Lidderdale (M-45)							Lo	Lo		Lagoon constructed in 1973.
Glidden WTP (S-18)		0.003								

*Assumed value.

TABLE 19 (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
Middle Raccoon River										
Willey (M-79)										No existing municipal treatment facility.
Coon Rapids (M-17)	0.120	0.081		25			Sh Km Cm	Ftr Cm	Dfr Bo	Plant constructed in 1942.
Willow Creek										
Glidden (M-27)	0.088	0.062		50			Sh Ci	Ftr Cp	Bo	Plant constructed in 1951.
Ralston (M-61)										No existing municipal treatment facility.
Bayard (M-9)										No existing municipal treatment facility. A permit was issued February 1, 1973, to construct a contact stabilization plant with a polishing pond.
Middle Raccoon River										
Panora WTP (S-30)		0.010								No treatment.
Panora (M-56)	0.125	0.150		35			Lo	Lo		Total surface area equals 10 acres.
Linden (M-46)										No existing municipal treatment facility.
Mosquito Creek										
Bagley (M-8)							Cs	None	Xl	Inadequate treatment facility with no future plans. City has been decreasing in population.
Yale (M-81)										No existing municipal treatment facility.
South Raccoon River										
Redfield (M-62)	0.120	0.062		40			Lo	Lo		Lagoon constructed in 1968.
Northern Iowa Natural Gas Co., Redfield Compressor Station. (I-19)		0.0015								
Northern Iowa Natural Gas Co., Redfield Storage Area (I-20)		0.35 (28 days/year)					Lo			
Bear Creek										
Earlham (M-24)	0.093	0.236		30			Lo	Lo		Lagoons have wet weather problem, but seem to be functioning properly.
Gendler Stone Products Co., Inc. (I-10)		0.024								
Bulger Creek										
De Soto (M-23)	0.047			31			Lo	Lo		Lagoon built in 1970.

TABLE 19 (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
Raccoon River										
Van Meter (M-76)	0.045	0.033		50			Lo	Lo		Plant built in 1963 and is having seepage problems. Total surface area equals 3.8 acres. Using only one cell.
Prairie Village Mobile Home Park (S-5)							Lo			Lagoon is so oversized there is no discharge. It is, in effect, an evaporation pond.
Iowa Highway Commission Rest Area (S-23)		0.078					Lo			
Southwest Polk Water Co. (S-35)		0.006								Iron removal backwash.
Sugar Creek										
Waukee (M-78)	0.300			50			La	Lo		Seems that lagoon is too small. Aeration should help, but no results were actually given.
Fox Creek Water Co. (S-16)										Iron removal backwash.
Jordan Branch										
Walter T. Giles High Rise Motel (S-37)							Lo	La		To municipal in future.
Walnut Creek										
Dallas Center WTP (S-12)										Iron removal backwash.
Dallas Center (M-18)	0.066	0.018		25			Sh Ci	Ftr Cp	Bo	
Hinkson Mobile Home Park (S-21)		0.005					Lo			
Des Moines Golf & Country Club (S-13)		0.05		25			La			
National Crossroads Campground (S-28)							Lo			
Skelly Oil Co. (I-22)		0.008		25			La			
American Oil Co. (I-1)										Run-off to stream, possible oil product spillage.
Roadrunner Campground & Mobile Home Park (S-32)							Lo			
Raccoon River										
Meredith Corporation (I-17)		0.85								NPDES permit issued September 27, 1973, limits SS to 20 mg/l and pH to 6.5 - 9.0.
KOA Campgrounds (S-4)							Lo	Lo		Permit issued August 25, 1969, for a waste stabilization lagoon.

TABLE 19 (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
Des Moines River										
Armstrong Rubber Co. (I-3)		2.85								
Chicago, Rock Island, and Pacific Railroad (I-6)		0.005								
Frye Copy Systems (I-9)		0.72								Cooling water discharged to city storm sewer.
Lennox Industries (I-15)		0.038								Sanitary wastes discharged to city sanitary sewer. Cooling water discharged to city storm sewer.
Des Moines (M-22)	35.000	38.894		30			Smt Gamw Ov Ka Cm	Fo Cm Fth Cm Ecg	Dfh Zp Vr Xl Bo	An additional aeration basin is being considered.
Yeader Creek										
Des Moines Area C (M 83)							Lo			Under construction.
Des Moines River										
Iowa Power & Light Co. (I-12)		150-200 7.4								Four wastewater discharges: - Condenser cooling water - Ash sluicing water (following ash settling pond) - Boiler blowdown and softening demineralizing flows - Cooler tower blowdown
Four Mile Creek										
Slater (M-69)	0.158	0.095		60			(Fto) Lo	Lo		
Ankeny E (M-4)	0.285	0.910					Sm Gh Cm	Ftr Cm	Dfh Bo	New plant is being constructed to relieve hydraulic and organic loading.
Oakwood Heights (S-24)							Lo			
Greenwood WTP (S-20)										
Sunnybrook MHP (S-36)		0.025								
Altoona (M-3)	0.500	0.534		30			Sch Cm	Ftr Cm Ecg	Dfhm Xl	
Country Living Mobile Home Park (S-1)							Lo			Permit issued December, 1967, and April, 1969.
South East Polk Comm. School (S-8)	0.026	0.013/ 10 hr day		25		12	S	Ae Lo		Extended aeration was added in 1963
Des Moines River										
Pleasant Hill (M-59)	0.236	0.110		36			Sc (Km Cm)	Ftr Cm Ecg	Ha Zil Vv Xp	

ABBREVIATIONS

WASTEWATER TREATMENT FACILITIES

A ----Aeration (in tanks or basins)
Aa----Activated sludge, diffused air aeration
Ac----Contact stabilization
Ad----Aerobic digestion
Ae----Extended aeration
Af----Air flotation
Am----Activated sludge, mechanical aeration
Ao----Oxidation ditch
Ap----Aeration, plain, without sludge return

B ----Sludge beds
Bo----Open
Bc----Glass covered

C ----Settling tanks
Ci----Two-story (Imhoff)
Cm----Mechanically equipped
Cp----Plain, hopper bottom, or intermittently drained for cleaning
Cs----Septic tank
Ct----Multiple tray, mechanically equipped
CmDm--Two-story "Clarigester"
CpDo--Two-story "Spiragester"

D ----Digesters, separate sludge
Dc----With cover (fixed if not otherwise specified)
D(cg)-Gasometer in fixed cover
De----Gas used in engines (heat usually recovered)
Df----With floating cover
Dg----With gasometer cover
Dh----Gas used in heating
Dm----Mixing
Do----Open top
Dp----Unheated
Dr----Heated
Ds----Gas storage in separate holder
Dt----Stage digestion

E ----Chlorination
Ec----With contact tank
Eg----By chlorine gas
Eh----By hypochlorite

F ----Filters
Fc----Covered filter
Fo----Roughing filter
Fr----Rapid sand or other sand straining
Fs----Intermittent sand
Ft----Trickling (no further details)
Fth---High capacity
Ft2H--High capacity, two-stage
Ftn---Fixed nozzle, standard capacity
Ftr---Rotary distributor, standard capacity
Ftt---Traveling distributor, standard capacity

G ----Grit chambers
Ga----Aerated grit removal
Gh----Without continuous removal mechanism
Gm----With continuous removal mechanism
Gp----Grit pocket at screen chamber
Gw----Separate grit washing device

H ----Sludge storage tanks (not second-stage digestion units)
Ha----Aerated
Hc----Covered
Hm----With stirring or concentrating mechanism
Ho----Open

I ----Sewage application to land
If----Ridge and furrow irrigation
Is----Subsurface application
Iu----Land underdrained
Iy----Spray irrigation

ABBREVIATIONS

WASTEWATER TREATMENT FACILITIES

K ----Chemical treatment-flocculation. Chemical treatment-type units or equipment not necessarily complete or operated as chemical treatment.
Ka----Flocculation tank, air agitation
Kc----Chemicals used
Km----Flocculation tank, mechanical agitation
Kx----No chemicals used

L ----Lagoons
La----Aerated lagoon
Le----Evaporation lagoon
Ln----Anaerobic lagoon
Lo----Waste stabilization lagoon
Lp----Polishing lagoon
Ls----Sludge lagoon - not for treatment of sewage

O ----Grease removal or skimming tanks - not incidental to settling tanks
Oa----Aerated tank (diffused air)
Om----Mechanically equipped tank
Ov----Vacuum type

S ----Screens
Sc----Comminutor (screenings ground in sewage stream)
Sf----Fine screen (less than 1/8" opening)
Sg----Screenings ground in separate grinder and returned to sewage flow
Sh----Bar rack, hand cleaned 1/2" to 2" openings
Si----Intermediate screen 1/8" to 1/2" openings
Sm----Bar rack mechanically cleaned 1/2" to 2" openings
Sr----Coarse rack (openings over 2")
St----Garbage ground at plant and returned to sewage flow

T ----Sludge thickener
Tc----Covered
Tm----Stirring mechanism
Tp----Open top

V ----Mechanical sludge dewatering
Vc----Sludge centrifuge
Vp----Pressure filter
Vv----Rotary vacuum filter
Vo----Other

X ----Sludge drying or incineration
Xd----Used for fertilizer
Xf----Sludge burned for fuel
Xl----Disposal to land
Xn----Incinerated
Xp----Used for fill

Z ----Sludge conditioning
Za----Chemicals used, alum
Zc----Chemical used (unidentified)
Zi----Chemicals used, iron salts
Zl----Chemicals used, lime
Zp----Polyelectrolytes used
Zx----No chemicals used
Zy----Elutriation

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 Raccoon River and Des Moines River Basins, a computer-based mathematical model was utilized. Model input data were developed from available information. In many 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 updated and improved as more information is obtained for the Raccoon River and Des Moines River Basins 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 without detailed field investigations of the study area.

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 to fit harmonic functions to this phenomenon have had 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 biochemical oxygen demands.

The nitrogenous biochemical oxygen demand is due to the oxidation 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 species 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 or more, 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. Algal and benthal effects 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:

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

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.

The biological nitrification process is generally more sensitive to environmental conditions than the carbonaceous decomposition process. 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 during the low flow, warm weather periods of the year (August and September), especially in small streams which receive relatively large volumes of secondary wastewater effluents. 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 inhibition of the nitrifying bacteria to low temperatures. During analyses of winter low flow 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 DO concentrations. Therefore, waste load allocations identified in this manner will generally be on the conservative side; although justifiably so, considering the high probability that nitrifying organisms (both dispersed and attached) would be present.

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 constant 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 model.

Many predictive formulations have been used for stream reaeration. For the Raccoon River Basin study, reaeration rate constants were predicted by the following equation developed by Dougal for the Skunk River ("Physical and Economic Factors Associated with the Establishment of Stream Quality Standards"; Dougal, Baumann, and Timmons; Volume No. 2, March, 1970):

$$K_2 = 11.5\ Q^{-0.0185}$$

Where:

K_2 = Reaeration rate constant, per day.

Q = Stream flow, mgd.

The formulation is applicable for flows less than 65 mgd (100 cfs).

Differences in physical characteristics and low flow conditions between the Raccoon River Basin and the Skunk River Basin are assumed to be insignificant. Within the range of flow encountered in the Raccoon River Basin (0.1 to 30 mgd), reaeration rate constant values calculated by the above equation range from about 11 to 12/day. These values are relatively high but may be justified because the streams are relatively wide and shallow, in some cases approximating an in-stream trickling filter.

During winter ice conditions, the reaeration rate constant was reduced to 0.5/day to represent the much lower reaeration which would occur when the water surface is partially covered with ice.

For the Des Moines River, 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). Dougal's method was not considered applicable to the Des Moines River because of the comparatively high stream flow (200 cfs at Saylorville Dam). 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:

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

Where:

K_2 = Reaeration rate constant, per day.

h = Water surface elevation change, feet.

t = Time of flow, 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 constant 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:

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

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

$$K_{n(T)} = K_{n(20)} \times (0.058T - 0.16) \qquad T > 3^\circ C$$

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 nitrification rate constant is set equal 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.

Stream Velocity and Depth Calculations (Raccoon River Basin) - Stream velocities and depths are important in determining reaeration and the downstream dispersion of pollutants. The computer model utilized depth and velocity estimates based on extrapolating known low flow data at stream gaging stations to other points along the stream. The extrapolation is a very rough approximation, but should be reasonably close over the length of a reach. Again, field investigations to determine actual stream velocities and depths would improve the accuracy of the model.

Stream Velocity Calculations (Des Moines River) - 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 section 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 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 following 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-sectional 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 longitudinal 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 and are called groundwater contributions. It was assumed that there were no wastewater losses due to infiltration into the stream bed, or to evaporation.

Actual data input into the computer program are as follows:

1. Initial river conditions such as flow, temperature, 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 in the groundwater.
3. The number of and the following for each reach:
    a. Length.
    b. Number of sections.
    c. Water temperature.
    d. Mean river velocity (Raccoon River Basin); channel slope (Des Moines River).
    e. Mean water depth (Raccoon River Basin); river width (Des Moines River).
    f. Deoxygenation rate constants.
    g. Roughness coefficient (Des Moines River only).
4. Wastewater or tributary inflows consisting of flow 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 (Des Moines River only).
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 study area 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 allocations 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 study area, specific assumptions are required. Identification of the major items required to evaluate and determine waste load allocations are identified in the following list.

1. The major objective of the present investigation is to satisfy Iowa Water Quality Standards with future effluent discharges. Determination of allowable effluent concentrations was based upon varying the effluent quality from point source dischargers 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 model. The low flow at all continuous record gaging stations, except the one at Sac City, exceeded the total present average daily wastewater discharges from upstream point sources. The difference

between present average daily wastewater upstream discharges and the estimated 7-day, 1-in-10 year low flow at Sac City was not considered great enough to consider the stream as losing flow to groundwater. The period of record for the gage at Sac City is relatively short (15 years), and a low confidence is associated with the statistical low flow value. The difference, if any, 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 6.0 mg/l ultimate carbonaceous BOD, 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 concentration or temperatures, the following values were assumed for each class of wastewater discharger.

	Summer Condition			Winter Condition		
Discharger	Dissolved Oxygen (mg/l)	Temperature (°C)	Temperature (°F)	Dissolved Oxygen (mg/l)	Temperature (°C)	Temperature (°F)
Trickling Filter	3.0	20	68	4.0	9	48
Activated Sludge	3.0	20	68	4.0	9	48
Industrial	Each Discharge Handled Individually					

5. Two different means of assessing reaeration coefficients for winter conditions were utilized. Within the Raccoon River Basin partial ice cover conditions were assumed, and a reaeration rate constant of 0.5/day was assigned to all reaches of the stream.

For the Des Moines River, 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 summer reaeration rate 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 individuals familiar with the area. Complete ice cover was assumed to be noncoincidental with the 7-day, 1-in-10 year low flow.

6. Deoxygenation rate constants were assumed to be 0.2/day for carbonaceous demand and 0.3/day for nitrogenous demand.
7. Best practicable treatment 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. The background water quality of tributaries discharging to the streams being modeled was assumed to be saturated dissolved oxygen concentrations, an ultimate carbonaceous BOD of 6.0 mg/l, and ammonia nitrogen concentrations of 0.0 mg/l in the summer and 0.5 mg/l in the winter. The average velocity of these tributary streams was conservatively assumed to be 10 miles per day.
9. It is assumed that all of the wastewater discharged into a tributary stream actually reaches the river being modeled, and that none is lost by seepage into the dry stream bed.
10. The model has been carried through the impoundment in Des Moines. The actual water surface slope has been estimated through the impoundment reach of the Des Moines River. The dam is assumed to take up a reach of the stream equal to 0.001 miles with a change in head equal to the height of the dam. This results in a high reaeration rate constant for the stream flow over the dam.

Results - Raccoon River Basin

Considerations - The waste load allocations are based upon a computer model that utilizes the best available information for the study area. 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 the best practicable treatment (industries). Where the model indicated violation of IDEQ stream quality criteria, more stringent effluent requirements were imposed until satisfactory levels were reached. 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 during summer conditions are given in Table 22. The upper limit for wastewater discharges is secondary treatment for municipal dischargers and best practicable treatment (BPT) for industrial dischargers. IDEQ has set the allowable ammonia nitrogen level for secondary treatment at 10 mg/l in summer.

Dissolved oxygen concentration profiles for the South Raccoon River, Middle Raccoon River, North Raccoon River, and Raccoon River for 1990 discharges for both secondary treatment and the waste load allocations given in Table 22 are shown on Figures 9 and 10. The stream quality criteria of 5.0 mg/l of DO is met in all sections of the streams which are water quality classified under both secondary treatment and waste load allocation conditions. The carbonaceous BOD waste load allocation conditions are the same as secondary treatment.

Summer ammonia nitrogen concentration profiles are shown on Figures 11 and 12 for the South Raccoon River, Middle Raccoon River, North Raccoon River, and Raccoon River. The waste load allocations given in Table 22

TABLE 22

WASTE LOAD ALLOCATION

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

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Des Moines River							
Rock Creek							
Deere & Co. (I-7)		-	To Municipal Treatment Facility				
Des Moines River							
Saylorville Lake Recreation Area (S-34)		0	Controlled Discharge				
YMCA Home (S-38)		0	Controlled Discharge				
Beaver Creek							
Beaver (M-10)		-	No Existing Municipal Facility				
Ogden (M-55)	0	0.271	6	11	2	4	3.0
Berkley (M-11)		-	No Existing Municipal Facility				
Woodward (M-80)		0	Controlled Discharge				
Bouton (M-12)		-	No Existing Municipal Facility				
Town & Country (S-9)		0	Controlled Discharge				
Granger (M-30)		0	Controlled Discharge				
Grimes (M-31)	1.91	0.129	45	48	10	11	3.0
Beaver Valley Canning Co. (I-4)		-	To Municipal Treatment Facility				
Urbandale Sanitary Sewer District (M-75)	2.64	0.873	15	109	7	51	3.0
First Continental Co. Motel (S-17)		-	To Municipal Treatment Fcility				

TABLE 22 (Cont.)

WASTE LOAD ALLOCATION

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

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Des Moines River (cont.)							
Saylor Creek							
Ankeny W (M-5)	133.26	1.707	45[3]	641	10[3]	142	3.0
Mel Ray Mobile Home Park (S-27)		0	Controlled Discharge				
Walfley Creek							
Iowa Fund (S-22)		0	Controlled Discharge				
Mid-Continent Bottling Co. (I-18)	133.35	0.050	25[4]	10	-		-
Firestone Tire & Rubber Co. (I-8)	133.35	1.270	No Discharge Limitations Necessary[5]				
Ford Motor Co. (I-26)	133.35	0.194	No Discharge Limitations Necessary[5]				
American Can Co. (I-2)	133.35	0.202	No Discharge Limitations Necessary[5]				
Regency Manor Mobile Home Park (S-6)	133.35		No Discharge Data Available				
North Raccoon River							
Marathon (M-50)		-	No Existing Municipal Facility				
Rembrandt (M-63)		0	Controlled Discharge				
Lateral 2							
Albert City (M-2)	0.01	0.085	45[3]	32	10[3]	7	3.0
Poor Farm Creek							
Truesdale (M-74)		-	No Existing Municipal Facility				

TABLE 22 (Cont.)

WASTE LOAD ALLOCATION

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

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
North Raccoon River (cont.)							
Boyer Creek							
Iowa Public Service (I-13)	0.10	0.016	No Discharge Limitations Necessary[5]				
Storm Lake (M-71)	0.10	3.090	45[3]	1,160	3	77	3.0
Storm Lake, Hy-Grade (M-72)		-	To Municipal Treatment Facility (M-71)				
Country Village Mobile Home Park (S-2)		0	Controlled Discharge				
Vilas and Co., Inc. (I-23)	0.10	0.099	No Discharge Limitations Necessary[5]				
Vista Products Co. (I-24)	0.10	0.180	45[3]	68	2	3	3.0
Lakeside (M-41)		-	To Municipal Treatment Facility (M-71)				
North Raccoon River							
Sac City WTP (S-33)		-	No Discharge				
Sac City (M-67)	3.49	0.280	45[3]	105	10	23	3.0
Nemaha (M-53)			No Discharge Data Available				
Cedar Creek							
Laurens WTP (S-25)		-	No Discharge				
Laurens (M-44)	3.77	0.160	45[3]	60	10	13	3.0
Mefferd Industries (I-16)	3.77	0.008	No Discharge Data Available				
Varina (M-77)		-	No Existing Municipal Facility				
Fonda WTP (S-15)		-	No Discharge				
Fonda (M-26)	3.77	0.093	45[3]	35	10	8	3.0

TABLE 22 (Cont.)

WASTE LOAD ALLOCATION

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

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Middle Raccoon River							
Panora WTP (S-30)		-	No Discharge				
Panora (M-56)		0	Controlled Discharge				
Linden (M-46)		-	No Existing Municipal Facility				
Mosquito Creek							
Bagley (M-8)			No Discharge Data Available				
Yale (M-81)			No Existing Municipal Facility				
South Raccoon River							
Redfield (M-62)		0	Controlled Discharge				
Northern Iowa Natural Gas Go., Redfield Compressor Station (I-19)	17.45	0.0015	No Discharge Data Available				
Northern Iowa Natural Gas Co., Redfield Storage Area (I-20)	17.45	0.35	No Discharge Data Available				
Bear Creek							
Earlham (M-24)		0	Controlled Discharge				
Gendler Stone Products Co., Inc. (I-10)	18.10	0.024	No Discharge Limitations Necessary[5]				
Bugler Creek							
DeSoto (M-23)		0	Controlled Discharge				
Raccoon River							
Van Meter (M-76)		0	Controlled Discharge				

TABLE 22 (Cont.)
WASTE LOAD ALLOCATION

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

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	(lb/day)	Ammonia Nitrogen (N) (mg/l)	(lb/day)	Effluent Dissolved Oxygen (mg/l)
Raccoon River (cont.)							
Prairie Village Mobile Home Park (S-5)		0	Controlled Discharge				
Iowa Highway Commission Rest Area (S-23)		0	Controlled Discharge				
Southwest Polk Water Co. (S-35)		-	No Discharge				
Sugar Creek							
Waukee (M-78)		0	Controlled Discharge				
Fox Creek Water Co. (S-16)		-	No Discharge				
Jordan Branch							
Walter T. Giles High Rise Motel (S-37)		-	To Municipal Treatment Facility				
Walnut Creek							
Dallas Center WTP (S-12)		-	No Discharge				
Dallas Center (M-18)	35.45	0.258	45[3]	97	10[3]	22	3.0
Hinkson Mobile Home Park (S-21)		0	Controlled Discharge				
Des Moines Golf & County Club (S-13)	35.45	0.050	45[3]	19	10[3]	4	3.0
National Crossroads Campground (S-28)		0	Controlled Discharge				
Skelly Oil Co, (I-22)	35.45	0.008	No Discharge Data Available				

TABLE 22 (Cont.)

WASTE LOAD ALLOCATION

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

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	(lb/day)	Ammonia Nitrogen (N) (mg/l)	(lb/day)	Effluent Dissolved Oxygen (mg/l)
Raccoon River (cont.)							
American Oil Co. (I-1)			No Discharge Data Available				
Roadrunner Campground & Mobile Home Park (S-32)		0	Controlled Discharge				
Meredith Corporation (I-17)	35.70	0.850	No Discharge Data Available				
KOA Campgrounds (S-4)		0	Controlled Discharge				
Des Moines River							
Armstrong Rubber Co. (I-3)	172.40	2.850	No Discharge Data Available				
Chicago, Rock Island, and Pacific Railroad (I-6)	172.40	0.005	No Discharge Data Available				
Frye Copy Systems (I-9)	172.40	0.72	No Discharge Limitations Necessary[5]				
Lennox Industries (I-15)	172.40	0.038	No Discharge Limitations Necessary[5]				
Des Moines (M-22)	175.29	40.776	15	5,101	2	680	3.0
Yeader Creek							
Des Moines Area C (M-83)		0	Controlled Discharge				
Four Mile Creek							
Slater (M-69)		0	Controlled Discharge				
Ankeny E (M-4)	216.72	2.992	45[3]	1,123	10[3]	250	3.0
Oakwood Heights (S-29)		0	Controlled Discharge				
Greenwood WTP (S-20)		-	No Discharge				

TABLE 22 (Cont.)

WASTE LOAD ALLOCATION

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

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Des Moines River (cont.)							
Sunnybrook Mobile Home Park (S-36)	216.72	0.025	45[3]	9	10[3]	2	3.0
Altoona (M-3)	216.72	1.513	45[3]	568	10[3]	126	3.0
Country Living Mobile Home Park (S-1)		0	Controlled Discharge				
Southeast Polk Comm. School (S-8)	216.72	0.013	45[3]	5	10[3]	1	3.0
Des Moines River							
Pleasant Hill (M-59)	223.85	0.220	45[3]	83	10[3]	18	3.0

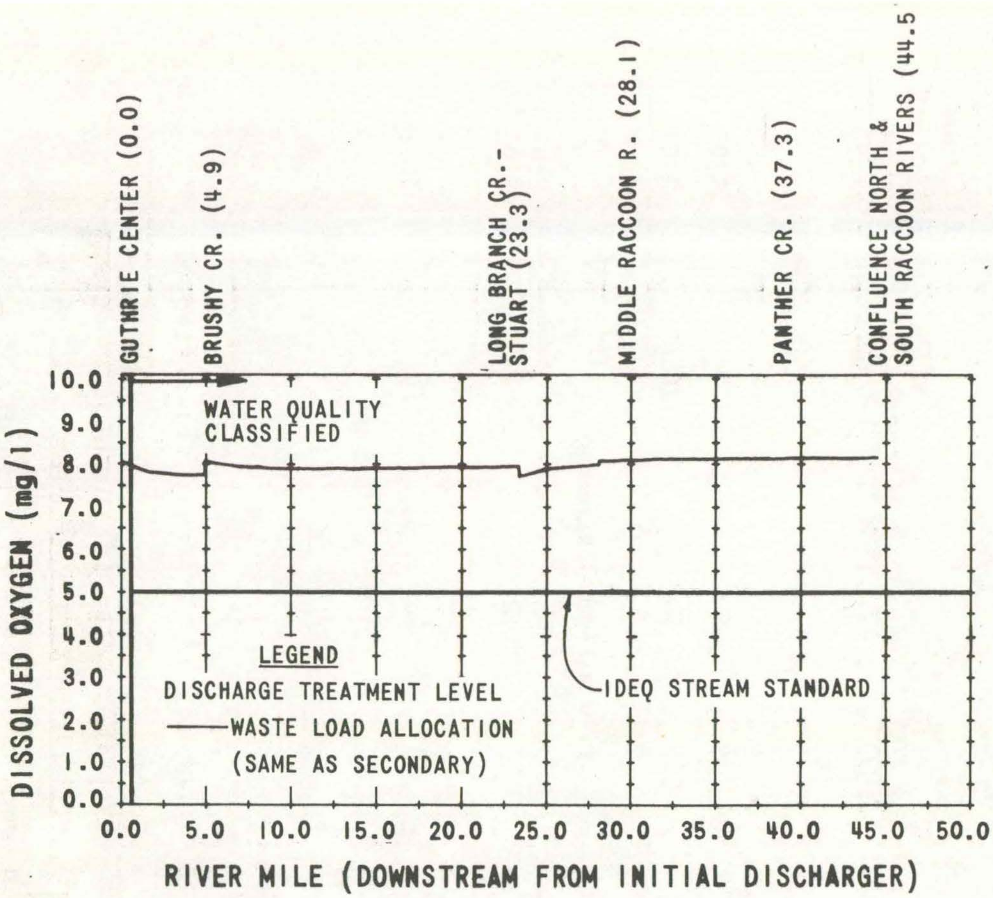
1 UBOD = 1.5 (BOD_5).

2 Seven-day, 1-in-10 year low flow in stream just above point of discharge, if stream is classified, or flow of classified stream at confluence with tributary.

3 Meets BPWTT guidelines. Higher discharge quantities could satisfy stream criteria.

4 As given on NPDES permit.

5 No waste load allocation necessary. Low quantities of BOD and ammonia nitrogen in effluent.



SOUTH RACCOON RIVER

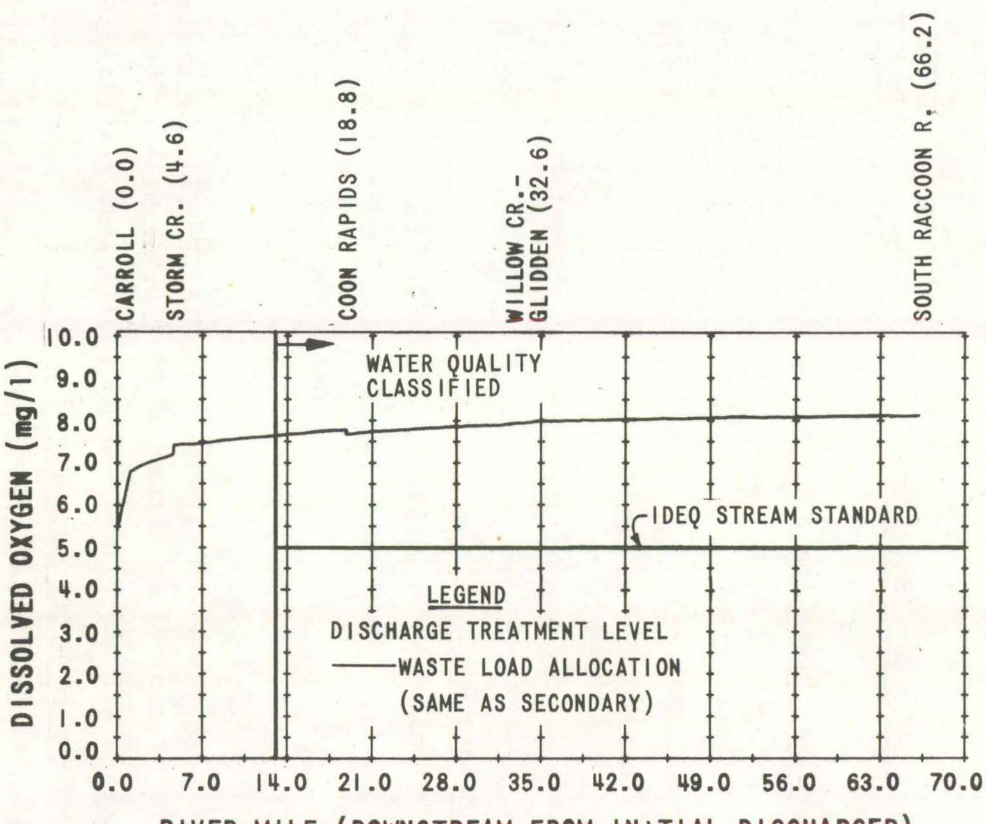
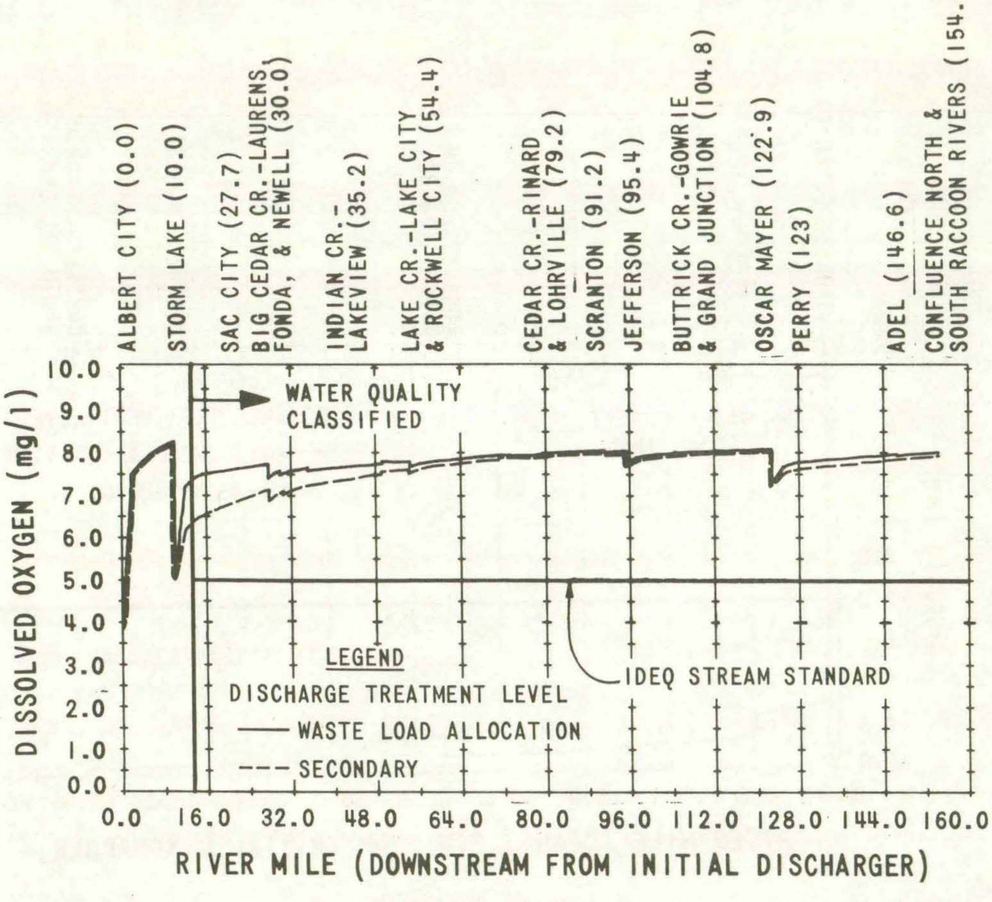
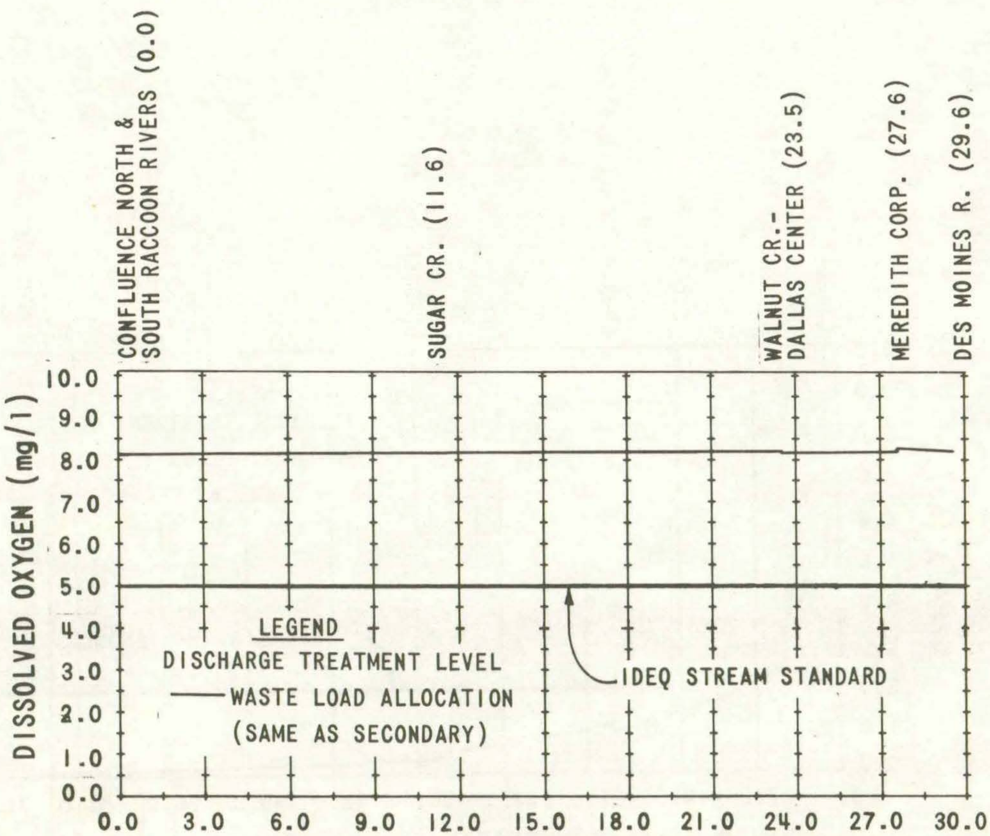


FIGURE 9
DISSOLVED OXYGEN
CONCENTRATIONS
SUMMER CONDITIONS

MIDDLE RACCOON RIVER

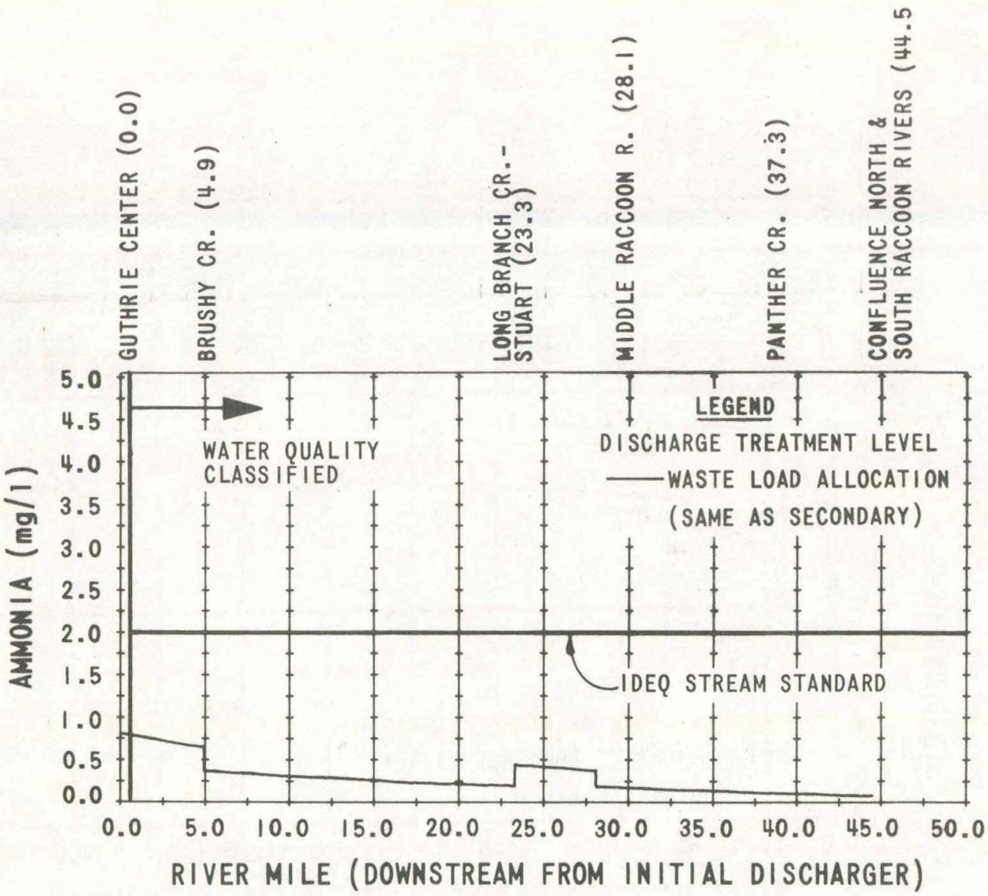


NORTH RACCOON RIVER

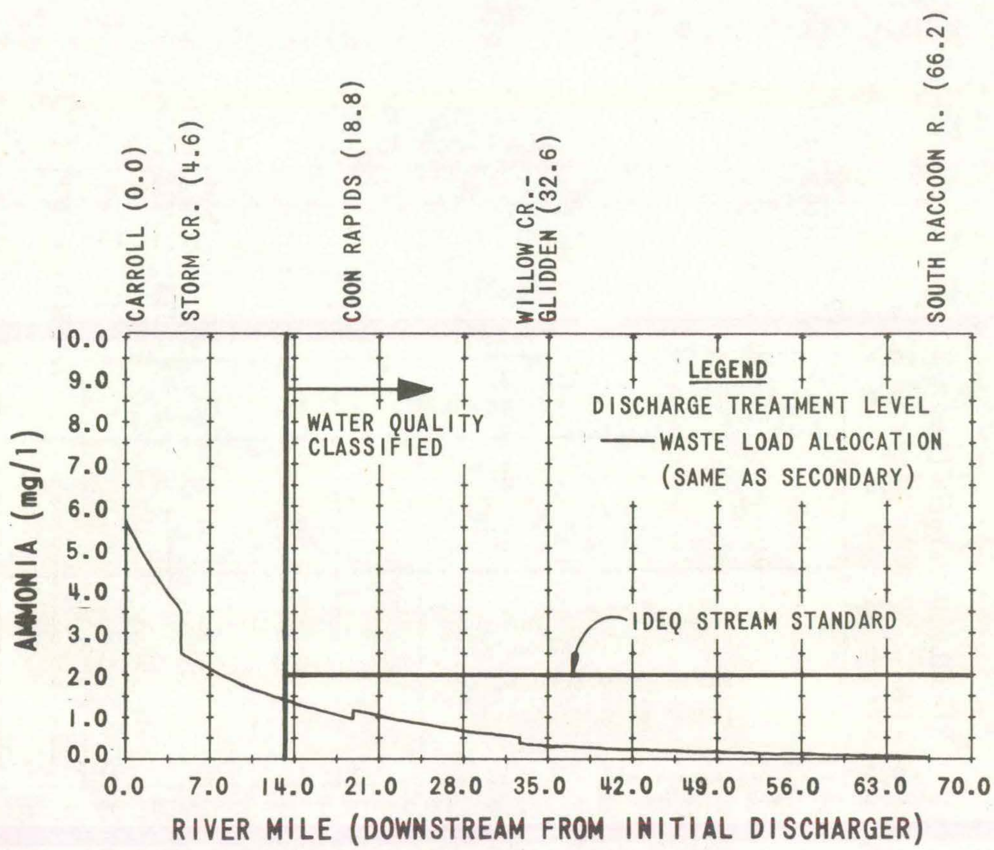


RACCOON RIVER

FIGURE 10
DISSOLVED OXYGEN
CONCENTRATIONS
SUMMER CONDITION

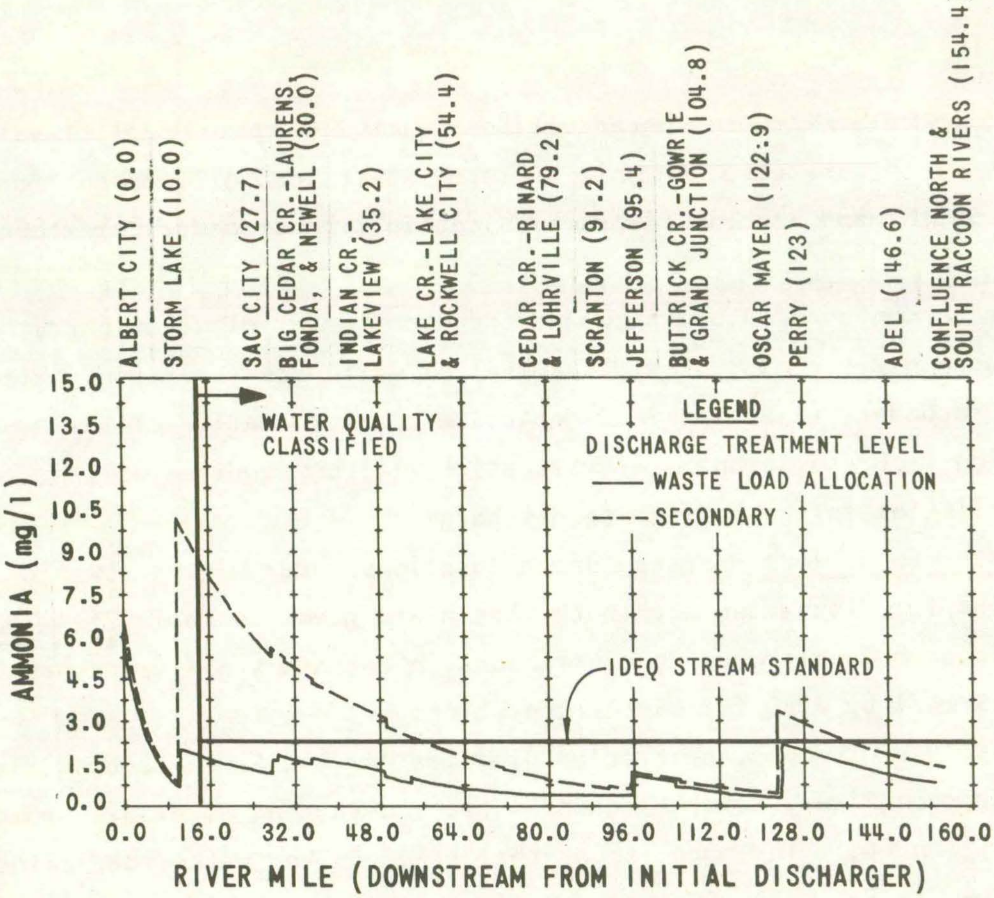


SOUTH RACCOON RIVER

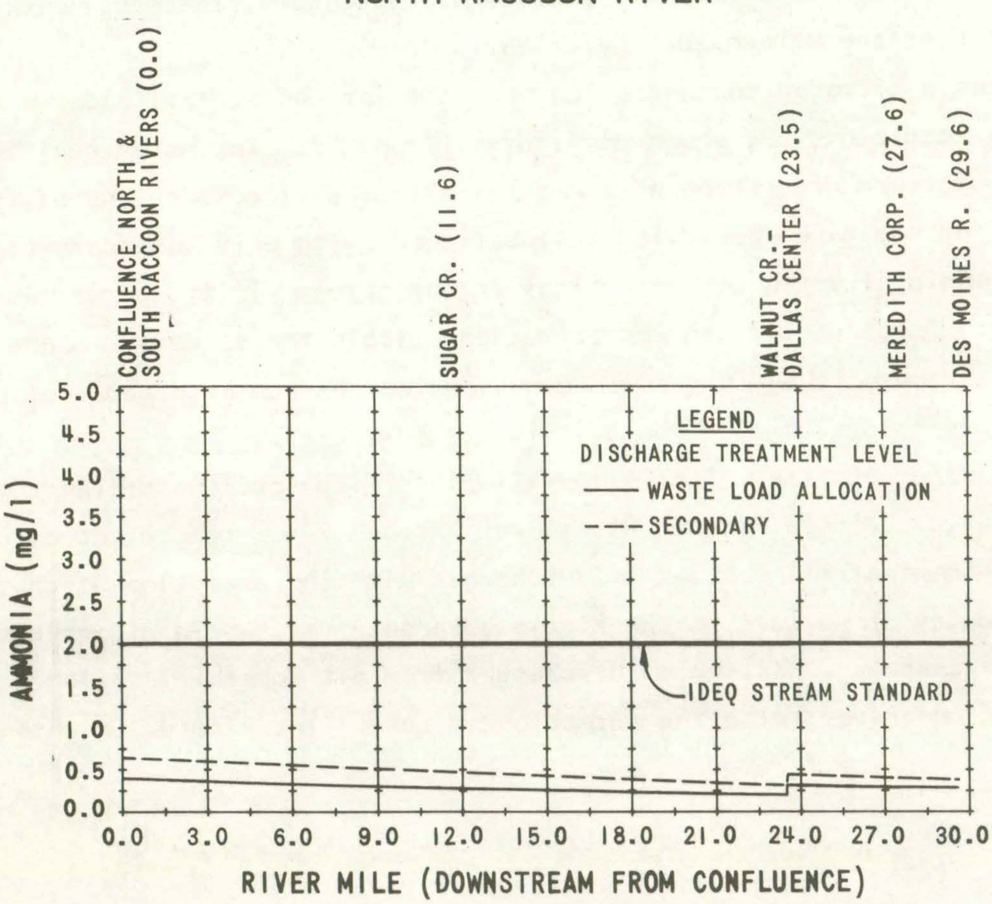


MIDDLE RACCOON RIVER

FIGURE 11
AMMONIA NITROGEN
CONCENTRATIONS
SUMMER CONDITIONS



NORTH RACCOON RIVER



RACCOON RIVER

FIGURE 12
AMMONIA NITROGEN
CONCENTRATIONS
SUMMER CONDITIONS

maintain ammonia nitrogen concentrations below 2.0 mg/l in all classified sections of the streams. Ammonia nitrogen waste load allocations for the Middle, South, and Raccoon Rivers are identical to secondary treatment levels.

The community of Storm Lake and the Oscar Mayer plant at Perry on the North Raccoon River must provide a level of wastewater treatment exceeding that of secondary treatment in order to meet water quality criteria under summer low flow conditions. Nitrification will be required at the treatment facilities for both of these dischargers.

Winter Conditions - Waste load allocations under winter low flow conditions for discharges within the basin are given in Table 23. The allowable ammonia nitrogen concentrations in secondary effluents has been set as 15 mg/l by IDEQ for winter conditions.

Dissolved oxygen concentration profiles for the South Raccoon River, Middle Raccoon River, North Raccoon River, and Raccoon River are shown on Figures 13 and 14. The model shows that based on the waste load allocations given in Table 23, DO concentrations meet the water quality criteria in all classified portions of the streams. Secondary treatment levels for BOD also meet the stream quality criteria for DO.

Ammonia nitrogen concentration profiles for the streams under winter low flow conditions are shown on Figures 15 and 16. The water quality criteria for ammonia nitrogen is met for all classified sections of the streams for the given waste load allocations. With only secondary treatment, ammonia nitrogen concentrations in the stream violate stream quality criteria. Ammonia nitrogen concentrations within the streams are not reduced as appreciably in the winter as during the summer because of the lack of bio-oxidation of ammonia at low temperatures.

The water quality criteria for all classified sections of the South Raccoon River, Middle Raccoon River, and Raccoon River can be met by secondary treatment of all wastewater discharges with the exception of that from the community of Carroll on the Middle Raccoon River, where nitrification will be necessary. Wastewater discharges from all communities along the North Raccoon River; with the exception of Lohrville, Rinard, Scranton,

TABLE 23

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Des Moines River							
Rock Creek							
Deere & Co. (I-7)		-	To Municipal Treatment Facility				
Des Moines River							
Saylorville Lake Recreation Area (S-34)		0	Controlled Discharge				
YMCA Home (S-38)		0	Controlled Discharge				
Beaver Creek							
Beaver (M-10)		-	No Existing Municipal Facility				
Ogden (M-55)	0	0.271	21		2	4	4.0
Berkley (M-11)		-	No Existing Municipal Facility				
Woodward (M-80)		0	Controlled Discharge				
Bouton (M-12)		-	No Existing Municipal Facility				
Town & Country (S-9)		0	Controlled Discharge				
Granger (M-30)		0	Controlled Discharge				
Grimes (M-31)	1.91	0.129	45	48	15	16	4.0
Beaver Valley Canning Co. (I-4)		-	To Municipal Treatment Facility				
Urbandale Sanitary Sewer District (M-75)	2.64	0.873	15	109	5	36	4.0
First Continental Co. Motel (S-17)		-	To Municipal Treatment Fcility				

TABLE 23 (Cont.)

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Des Moines River (cont.)							
Saylor Creek							
Ankeny W (M-5)	133.26	1.707	45[3]	641	15[3]	213	4.0
Mel Ray Mobile Home Park (S-27)		0	Controlled Discharge				
Walfley Creek							
Iowa Fund (S-22)		0	Controlled Discharge				
Mid-Continent Bottling Co. (I-18)	133.35	0.050	25[4]	10	-		-
Firestone Tire & Rubber Co. (I-8)	133.35	1.270	No Discharge Limitations Necessary[5]				
Ford Motor Co. (I-26)	133.35	0.194	No Discharge Limitations Necessary[5]				
American Can Co. (I-2)	133.35	0.202	No Discharge Limitations Necessary[5]				
Regency Manor Mobile Home Park (S-6)	133.35		No Discharge Data Available				
North Raccoon River							
Marathon (M-50)		-	No Existing Municipal Facility				
Rembrandt (M-63)		0	Controlled Discharge				
Lateral 2							
Albert City (M-2)	0.01	0.085	45[3]	32	8	6	4.0
Poor Farm Creek							
Truesdale (M-74)		-	No Existing Municipal Facility				

TABLE 23 (Cont.)

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
North Raccoon River (cont.)							
Boyer Creek							
Iowa Public Service (I-13)	0.10	0.016	No Discharge Limitations Necessary[5]				
Storm Lake (M-71)	0.10	3.090	45[3]	1,160	2.1	54	4.0
Storm Lake, Hy-Grade (M-72)		-	To Municipal Treatment Facility (M-71)				
Country Village Mobile Home Park (S-2)		0	Controlled Discharge				
Vilas and Co., Inc. (I-23)	0.10	0.099	No Discharge Limitations Necessary[5]				
Vista Products Co. (I-24)		-	No Winter Discharge				
Lakeside (M-41)		-	To Municipal Treatment Facility (M-71)				
North Raccoon River							
Sac City WTP (S-33)		-	No Discharge				
Sac City (M-67)	3.49	0.280	45[3]	105	2	5	4.0
Nemaha (M-53)			No Discharge Data Available				
Cedar Creek							
Laurens WTP (S-25)		-	No Discharge				
Laurens (M-44)	3.77	0.160	45[3]	60	2	3	4.0
Mefferd Industries (I-16)	3.77	0.008	No Discharge Data Available				
Varina (M-77)		-	No Existing Municipal Facility				
Fonda WTP (S-15)		-	No Discharge				
Fonda (M-26)	3.77	0.093	45[3]	35	2	2	4.0

TABLE 23 (Cont.)

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	(lb/day)	Ammonia Nitrogen (N) (mg/l)	(lb/day)	Effluent Dissolved Oxygen (mg/l)
North Raccoon River (cont.)							
Prairie Creek							
Newell (M-54)	3.77	0.092	45[3]	35	2	2	4.0
Indian Creek							
Lakeview (M-42)	4.43	0.229	45[3]	86	4	8	4.0
North Raccoon River							
Auburn (M-7)		-	No Existing Municipal Facility				
Camp Creek							
Jolley (M-37)		-	No Existing Municipal Facility				
Lytton (M-48)		0	Controlled Discharge				
Yetter (M-82)		-	No Existing Municipal Facility				
Lake Creek							
Pomeroy (M-60)		0	Controlled Discharge				
Rockwell City (M-66)	6.06	0.227	45[3]	104	7	16	4.0
Rockwell City Women's Reformatory (S-7)		0	Controlled Discharge				
Lake City N (M-39)	6.06	0.095	45[3]	36	6.6	5	4.0
Lake City SW (M-40)	6.06	0.084	45[3]	32	6.6	5	4.0
Twin Lakes Travel Park (S-10)		-	No Discharge				
North Raccoon River							
Lanesboro (M-43)		-	No Existing Municipal Facility				

TABLE 23 (Cont.)

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	(lb/day)	Ammonia Nitrogen (N) (mg/l)	(lb/day)	Effluent Dissolved Oxygen (mg/l)
North Raccoon River (cont.)							
Cedar Creek							
Manson (M-49)		0	Controlled Discharge				
Knierim (M-38)		-	No Existing Municipal Facility				
Somers (M-70)		-	No Existing Municipal Facility				
Rinard (M-64)			No Discharge Data Available				
Lohrville (M-47)	8.39	0.056	45[3]	21	15[3]	7	4.0
Drainage Ditch 111							
Scranton (M-68)	8.77	0.065	45[3]	24	15[3]	8	4.0
Drainage Ditch 132							
Jefferson WTP (S-17)		-	No Discharge				
Jefferson (M-36)	8.95	0.606	45[3]	227	6	30	4.0
Hardin Creek							
Farnhamville WTP (S-14)		-	No Discharge				
Farnhamville (M-25)		0	Controlled Discharge				
Churdan (M-16)		0	Controlled Discharge				
Butterick Creek							
Callender (M-14)		0	Controlled Discharge				
Gowrie WTP (S-19)		-	No Discharge				
Gowrie (M-28)	11.49	0.081	45[3]	30	15[3]	10	4.0
Harcourt (M-34)		0	Controlled Discharge				
Paton (M-57)		0	Controlled Discharge				
Dana (M-19)			No Existing Municipal Facility				
Grand Junction (M-29)	11.49	0.040	45[3]	13	15[3]	5	4.0

TABLE 23 (Cont.)

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
North Raccoon River							
Jamaica (M-35)		-	No Existing Municipal Facility				
Snake Creek							
Rippey (M-65)		0	Controlled Discharge				
North Raccoon River							
Dawson (M-20)		-	No Existing Municipal Facility				
Admundson Manufacturing Co. (I-25)		0	Controlled Discharge				
Perry WTP (S-31)		-	No Discharge				
Oscar Mayer Co. (I-21)	12.18	1.233	50[3]	514	4	41	4.0
Perry (M-58)	13.42	1.378	45[3]	517	2	23	4.0
Iowa Electric Light & Power Co. (I-11)	13.42	0.002	No Discharge Data Available				
Minburn (M-52)		0	Controlled Discharge				
Dallas County Home (S-3)		0	Controlled Discharge				
Adel WTP (S-11)		-	No Discharge				
Adel (M-1)	15.17	0.095	45[3]	36	15	12	4.0
South Raccoon River							
Guthrie Center (M-32)	2.22	0.196	45[3]	74	15[3]	25	4.0
Brushy Creek							
Arcadia (M-6)		-	No Existing Municipal Facility				
Halbur (M-33)		-	No Existing Municipal Facility				
Dedham (M-21)		0	Controlled Discharge				

TABLE 23 (Cont.)

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
South Raccoon River							
Menlo (M-51)		-	No Existing Municipal Facility				
Long Branch							
Stuart (M-73)	6.38	0.203	45[3]	76	15[3]	25	4.0
Middle Raccoon River							
Breda (M-13)		0	Controlled Discharge				
Carroll (M-15)	0.84	1.075	45[3]	403	5	45	4.0
Carroll Rendering Co. (I-5)	0.84	0.080	50	33	10	7	4.0
Iowa Public Service Co., Carroll Station (I-14)	0.84	0.025	No Discharge Limitations Necessary[5]				
Storm Creek							
Lidderdale WTP (S-26)		-	No Discharge				
Lidderdale (M-45)		0	Controlled Discharge				
Middle Raccoon River							
Willey (M-79)		-	No Existing Municipal Facility				
Storm Creek							
Coon Rapids (M-17)	3.95	0.088	45[3]	33	15[3]	11	4.0
Willow Creek							
Glidden WTP (S-18)		-	No Discharge				
Glidden (M-27)	6.58	0.068	45[3]	26	15[3]	8	4.0
Ralston (M-61)		-	No Existing Municipal Facility				
Bayard (M-9)		0	Controlled Discharge				

TABLE 23 (Cont.)

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Middle Raccoon River							
Panora WTP (S-30)		-	No Discharge				
Panora (M-56)		0	Controlled Discharge				
Linden (M-46)		-	No Existing Municipal Facility				
Mosquito Creek							
Bagley (M-8)			No Discharge Data Available				
Yale (M-81)			No Existing Municipal Facility				
South Raccoon River							
Redfield (M-62)		0	Controlled Discharge				
Northern Iowa Natural Gas Go., Redfield Compressor Station (I-19)	17.45	0.0015	No Discharge Data Available				
Northern Iowa Natural Gas Co., Redfield Storage Area (I-20)	17.45	0.35	No Discharge Data Available				
Bear Creek							
Earlham (M-24)		0	Controlled Discharge				
Gendler Stone Products Co., Inc. (I-10)	18.10	0.024	No Discharge Limitations Necessary[5]				
Bugler Creek							
DeSoto (M-23)		0	Controlled Discharge				
Raccoon River							
Van Meter (M-76)		0	Controlled Discharge				

TABLE 23 (Cont.)
WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Raccoon River (cont.)							
Prairie Village Mobile Home Park (S-5)		0	Controlled Discharge				
Iowa Highway Commission Rest Area (S-23)		0	Controlled Discharge				
Southwest Polk Water Co. (S-35)		-	No Discharge				
Sugar Creek							
Waukee (M-78)		0	Controlled Discharge				
Fox Creek Water Co. (S-16)		-	No Discharge				
Jordan Branch							
Walter T. Giles High Rise Motel (S-37)		-	To Municipal Treatment Facility				
Walnut Creek							
Dallas Center WTP (S-12)		-	No Discharge				
Dallas Center (M-18)	35.45	0.258	45[3]	97	15	32	4.0
Hinkson Mobile Home Park (S-21)		0	Controlled Discharge				
Des Moines Golf & County Club (S-13)	35.45	0.050	45[3]	19	15[3]	6	4.0
National Crossroads Campground (S-28)		0	Controlled Discharge				
Skelly Oil Co, (I-22)	35.45	0.008	No Discharge Data Available				

TABLE 23 (Cont.)

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Raccoon River (cont.)							
American Oil Co. (I-1)			No Discharge Data Available				
Roadrunner Campground & Mobile Home Park (S-32)		0	Controlled Discharge				
Meredith Corporation (I-17)	35.70	0.850	No Discharge Data Available				
KOA Campgrounds (S-4)		0	Controlled Discharge				
Des Moines River							
Armstrong Rubber Co. (I-3)	172.40	2.850	No Discharge Data Available				
Chicago, Rock Island, and Pacific Railroad (I-6)	172.40	0.005	No Discharge Data Available				
Frye Copy Systems (I-9)	172.40	0.72	No Discharge Limitations Necessary[5]				
Lennox Industries (I-15)	172.40	0.038	No Discharge Limitations Necessary[5]				
Des Moines (M-22)	175.29	40.776	45[3]	15,303	4	1,360	4.0
Yeader Creek							
Des Moines Area C (M-83)		0	Controlled Discharge				
Four Mile Creek							
Slater (M-69)		0	Controlled Discharge				
Ankeny E (M-4)	216.72	2.992	45[3]	1,123	15[3]	375	4.0
Oakwood Heights (S-29)		0	Controlled Discharge				
Greenwood WTP (S-20)		-	No Discharge				

TABLE 23 (Cont.)

WASTE LOAD ALLOCATION

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

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[2] (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)
Des Moines River (cont.)							
Sunnybrook Mobile Home Park (S-36)	216.72	0.025	45[3]	9	15[3]	3	4.0
Altoona (M-3)	216.72	1.513	45[3]	568	15[3]	189	4.0
Country Living Mobile Home Park (S-1)		0	Controlled Discharge				
Southeast Polk Comm. School (S-8)	216.72	0.013	45[3]	5	15[3]	2	4.0
Des Moines River							
Pleasant Hill (M-59)	223.85	0.220	45[3]	83	15[3]	27	4.0

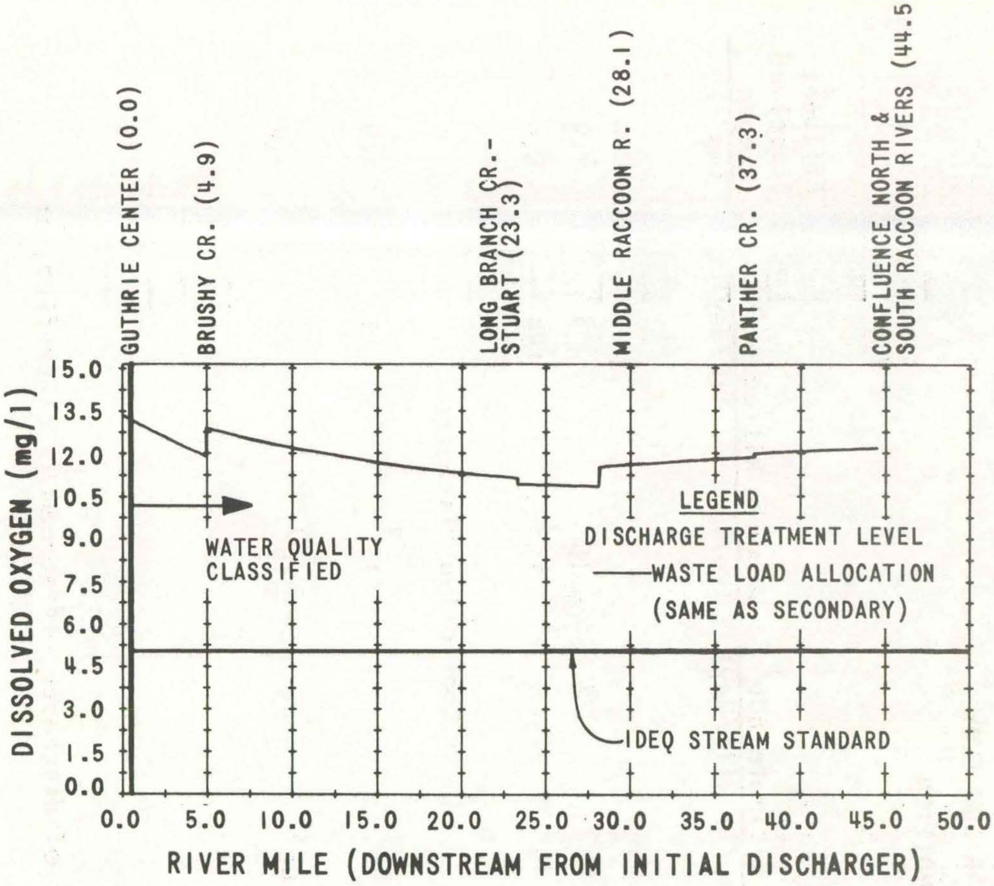
[1] UBOD = 1.5 (BOD_5).

[2] Seven-day, 1-in-10 year low flow in stream just above point of discharge, if stream is classified, or flow of classified stream at confluence with tributary.

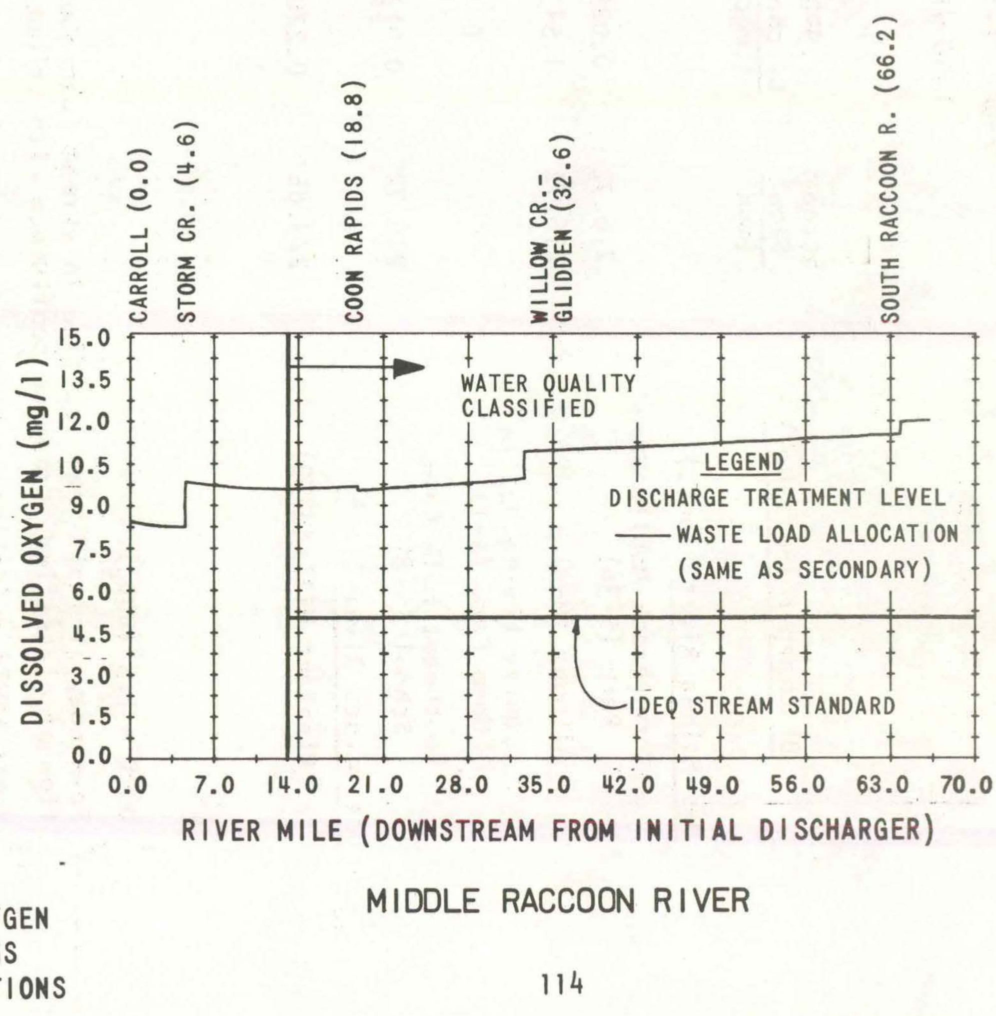
[3] Meets BPWTT guidelines. Higher discharge quantities could satisfy stream criteria.

[4] As given on NPDES permit.

[5] No waste load allocation necessary. Low quantities of BOD and ammonia nitrogen in effluent.

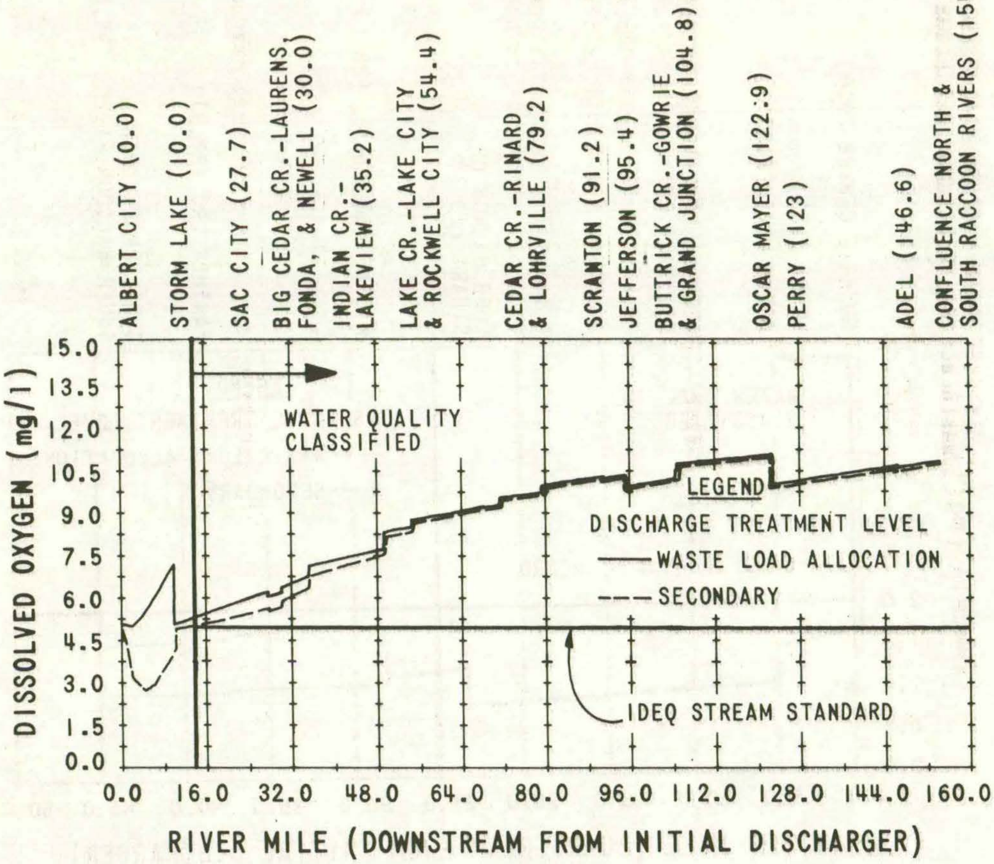


SOUTH RACCOON RIVER

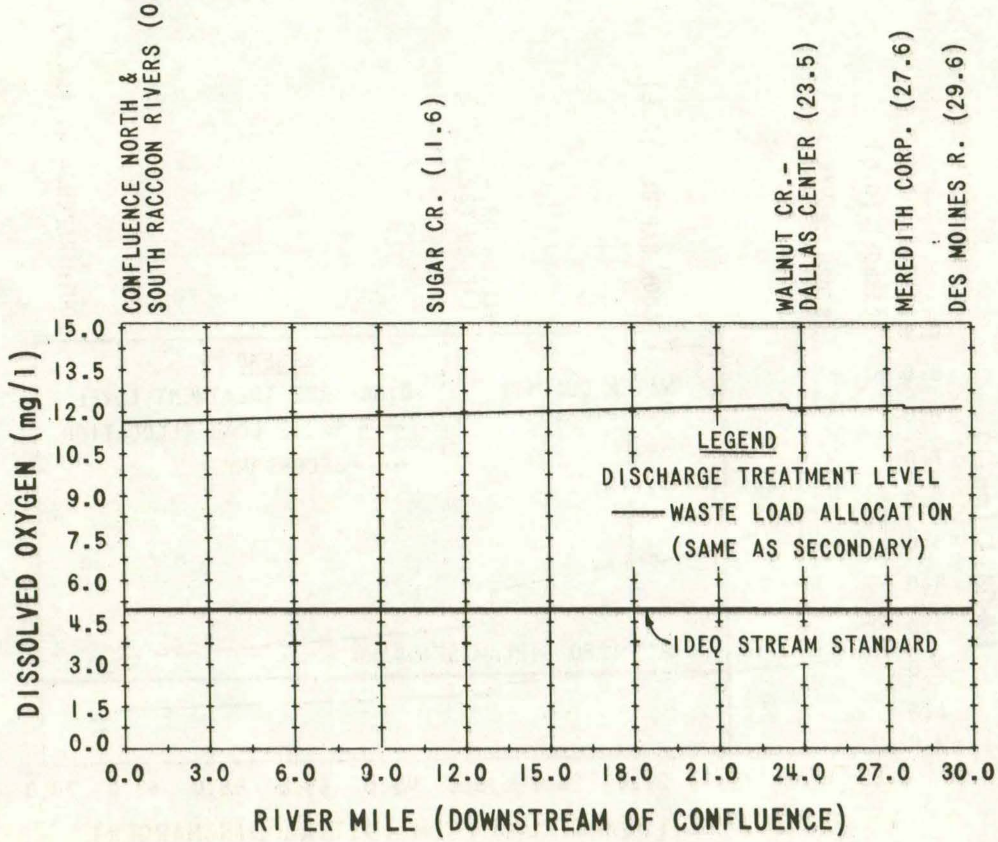


MIDDLE RACCOON RIVER

FIGURE 13
DISSOLVED OXYGEN
CONCENTRATIONS
WINTER CONDITIONS

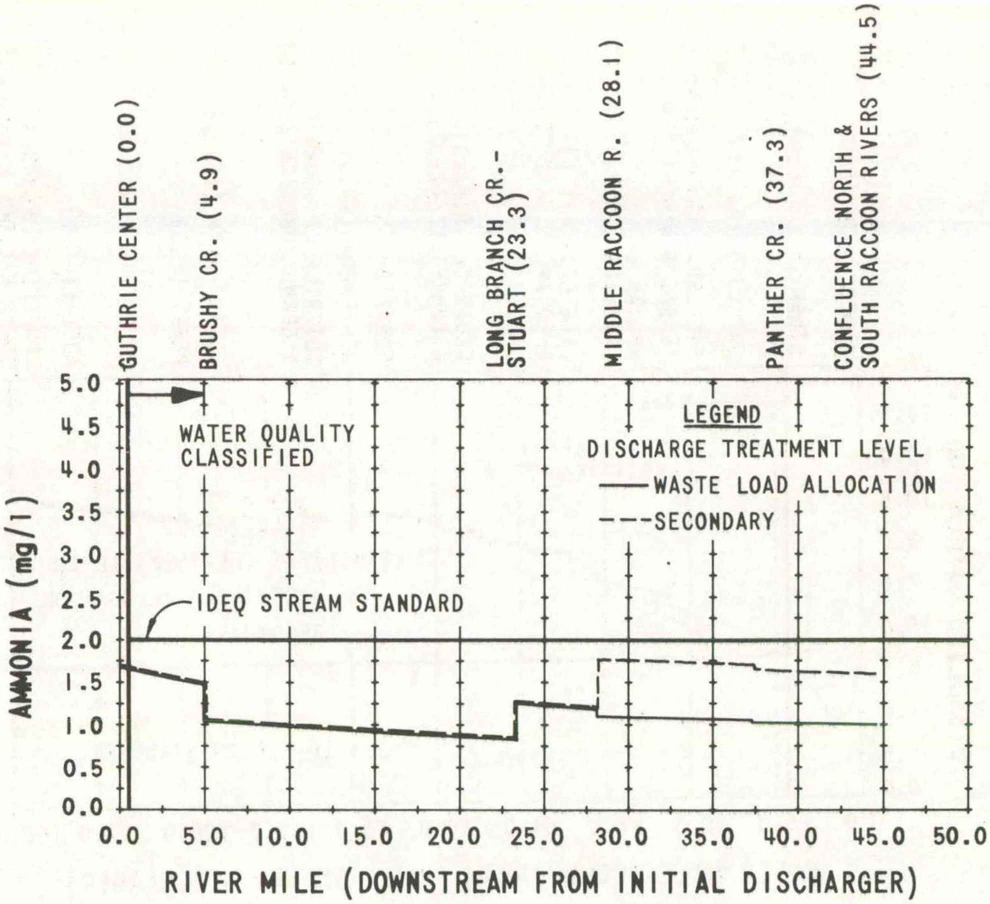


NORTH RACCOON RIVER

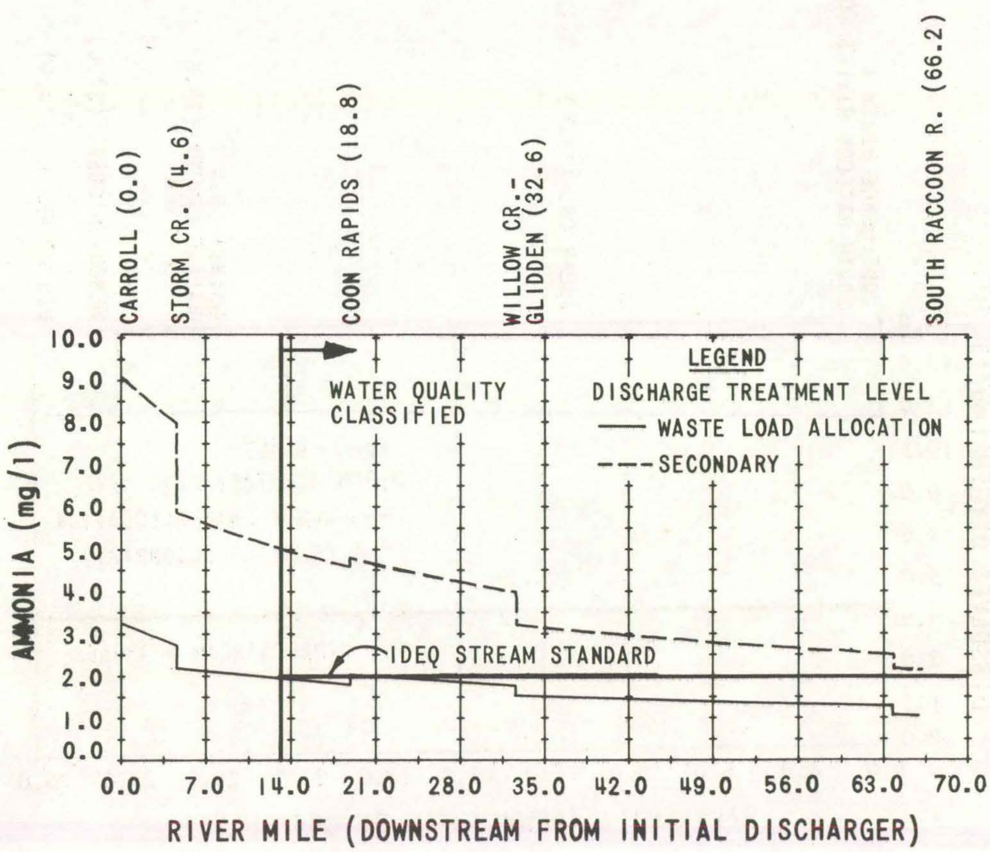


RACCOON RIVER

FIGURE 14
DISSOLVED OXYGEN CONCENTRATIONS

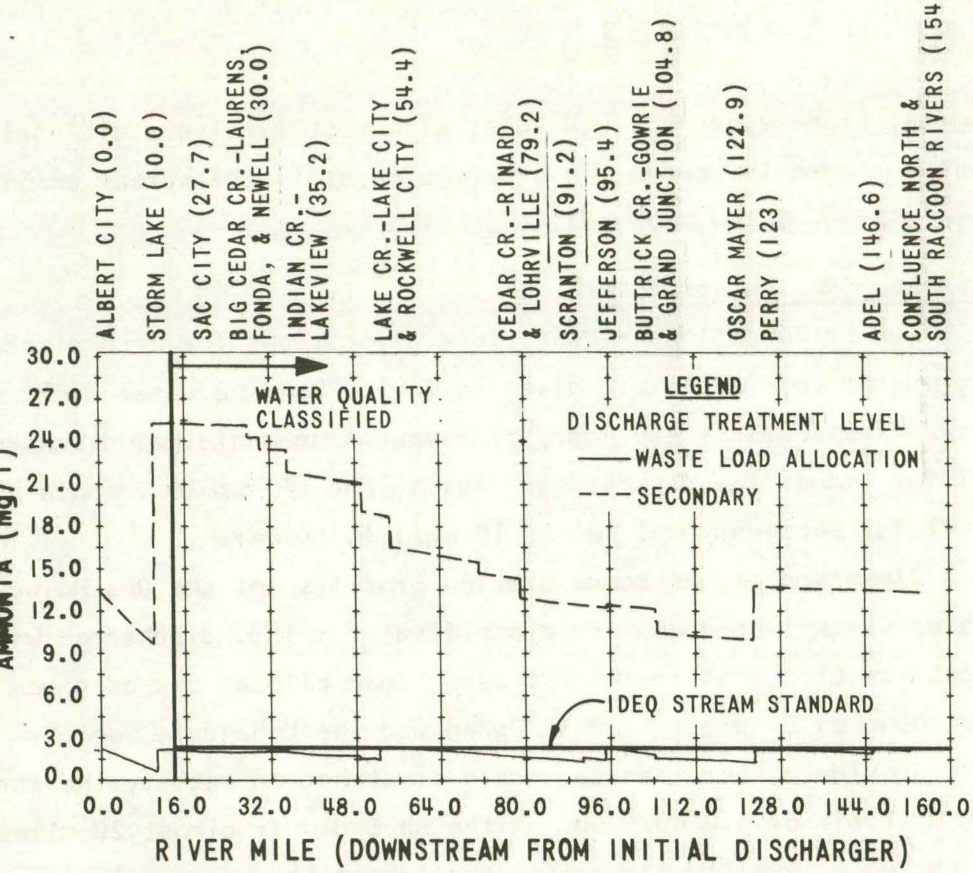


SOUTH RACCOON RIVER

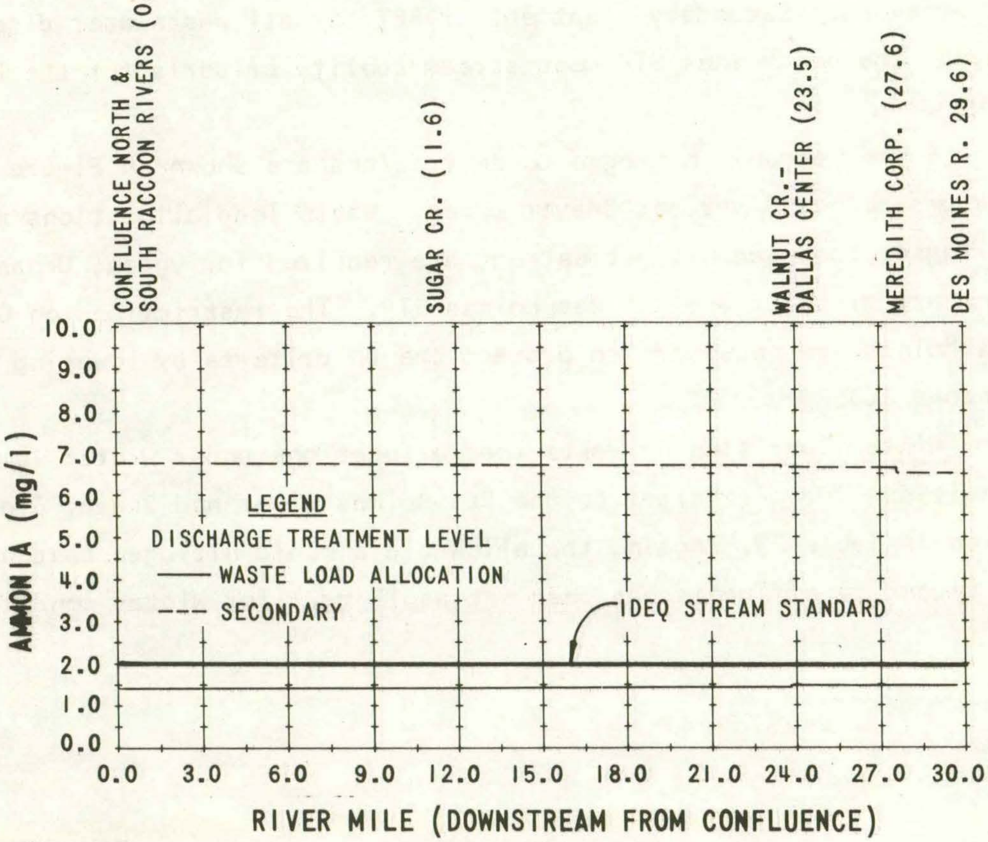


MIDDLE RACCOON RIVER

FIGURE 15
AMMONIA NITROGEN
CONCENTRATIONS
WINTER CONDITIONS



NORTH RACCOON RIVER



RACCOON RIVER

FIGURE 16
AMMONIA NITROGEN
CONCENTRATIONS
WINTER CONDITIONS

Gowrie, Grand Junction, and Adel; also must receive additional treatment for ammonia removal in order to maintain the stream ammonia nitrogen levels at or below 2.0 mg/l.

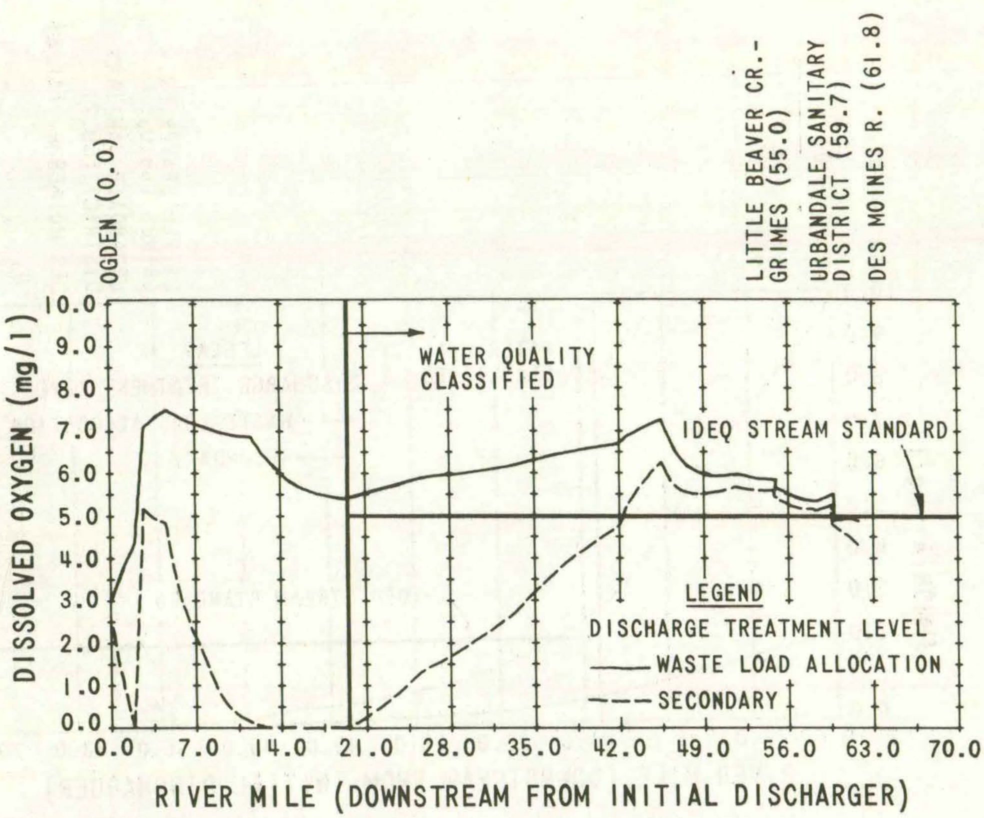
Results - Des Moines River

Summer Conditions - Waste load allocations for each discharger during summer conditions are given in Table 22. The upper limit for wastewater discharges is secondary treatment from municipal discharges and BPT for industrial discharges. Again, the allowable ammonia nitrogen level for secondary was set as 10 mg/l in summer.

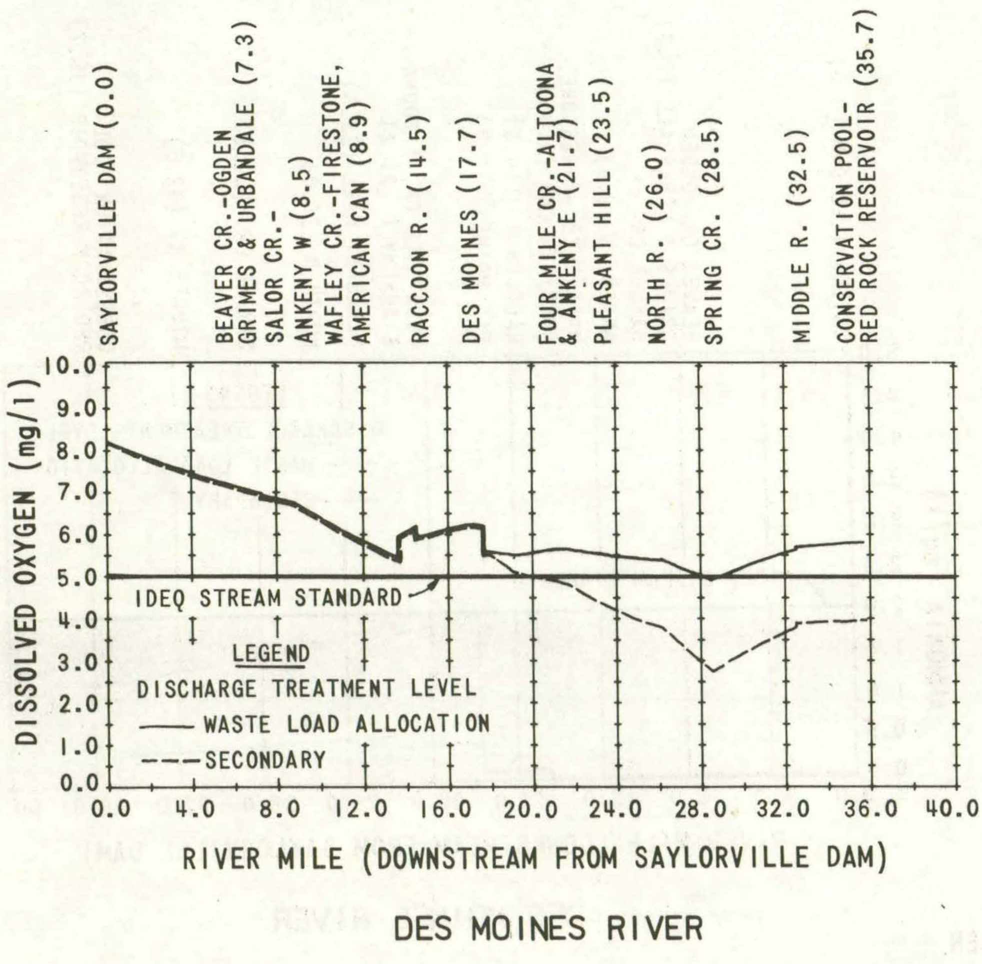
Dissolved oxygen concentration profiles for the Des Moines River and Beaver Creek (water quality classified) for 1990 discharges with both secondary treatment levels and waste load allocations as given in Table 22 are shown on Figure 17. Both Ogden and the Urbandale Sanitary District must provide better than secondary treatment to satisfy the stream quality criteria of 5.0 mg/l DO. Although Ogden is almost 20 miles upstream of the water quality classified section of the stream, low stream flows require extremely stringent waste load allocations for Ogden. Further study of water quality under low flow conditions in Beaver Creek is recommended. Secondary treatment or BPT for all wastewater dischargers except the Des Moines STP meet stream quality criteria for the Des Moines River.

Summer ammonia nitrogen concentrations are shown on Figure 18 for the Des Moines River and Beaver Creek. Waste load allocations more stringent than secondary treatment are required for Ogden, Urbandale Sanitary District and the Des Moines STP. The restrictions on Ogden and Des Moines are necessary to protect the DO criteria by lowering the nitrogeneous BOD.

Winter Conditions - Waste load allocations under winter low flow conditions for discharges to the Des Moines River and Beaver Creek are given in Table 23. Again, the allowable ammonia nitrogen concentration in secondary effluents has been set as 15 mg/l for winter conditions.

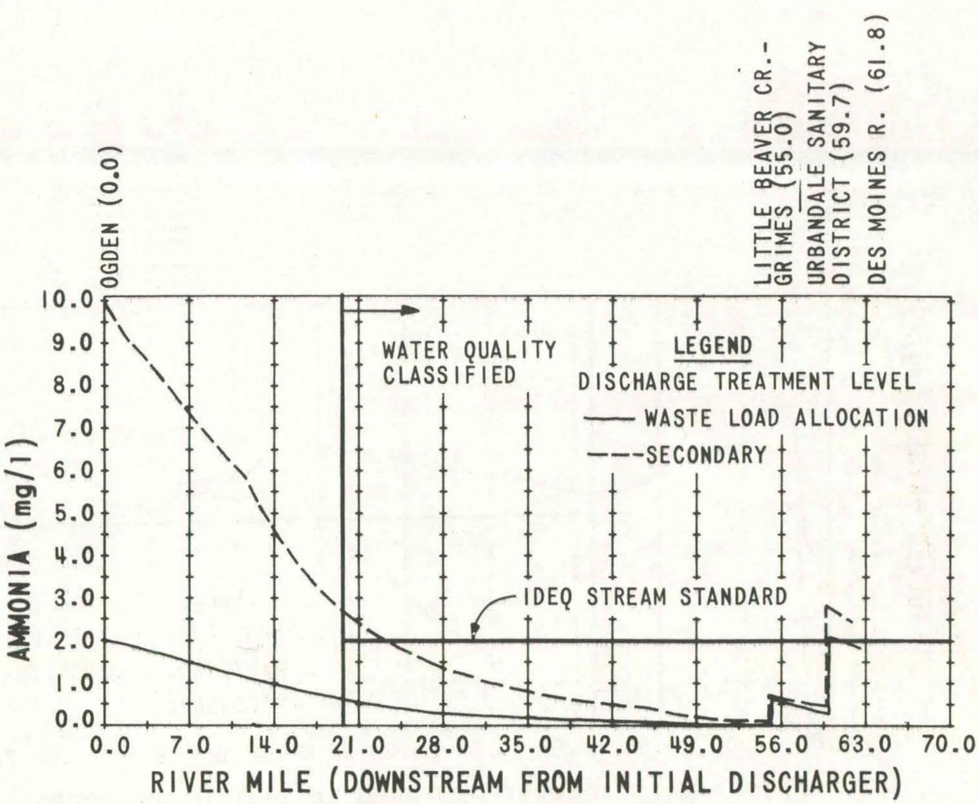


BEAVER CREEK

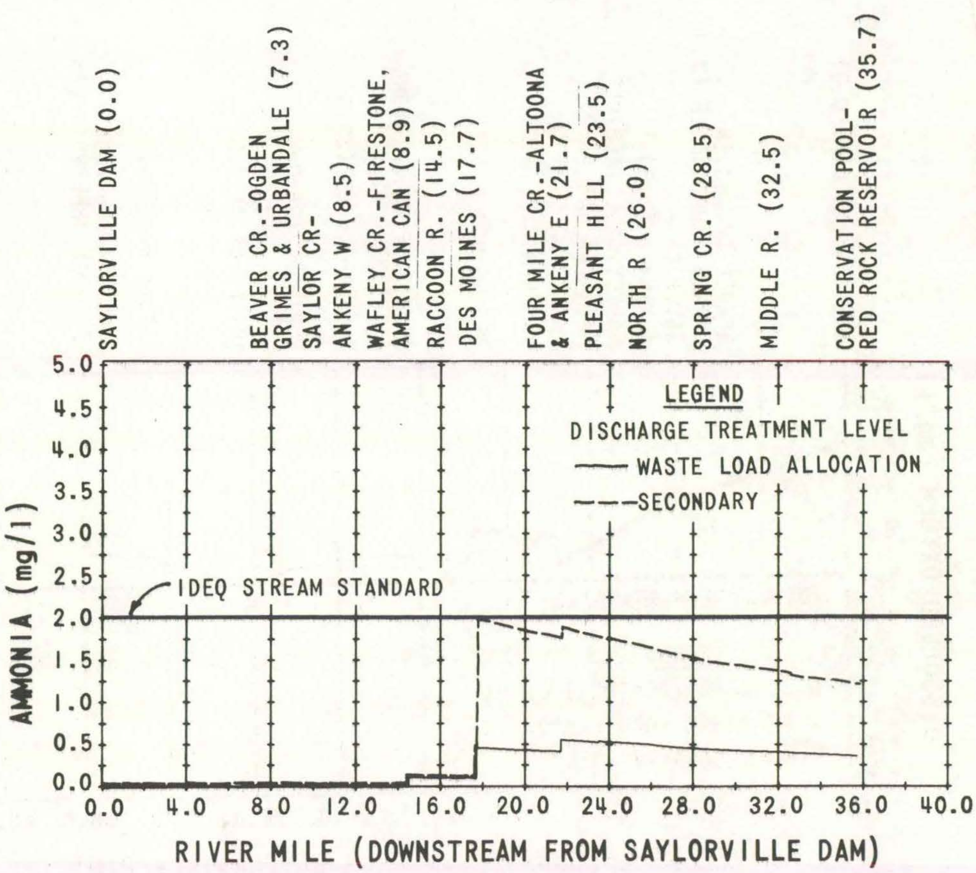


DES MOINES RIVER

FIGURE 17
DISSOLVED OXYGEN CONCENTRATIONS
SUMMER CONDITIONS



BEAVER CREEK



DES MOINES RIVER

FIGURE 18
AMMONIA NITROGEN
CONCENTRATIONS
SUMMER CONDITIONS

Dissolved oxygen concentrations for the Des Moines River and Beaver Creek are shown on Figure 19. Both Ogden and Urbandale Sanitary District must provide better than secondary treatment level removals of BOD to meet the 5.0 mg/l DO criteria. Although Ogden is almost 20 miles upstream of the water quality classified segment of Beaver Creek, unless better than secondary treatment level removals of both BOD and ammonia nitrogen are accomplished Urbandale Sanitary District cannot meet either the DO or ammonia nitrogen criteria without extremely stringent waste load allocations under winter condtions. As before, further study of Beaver Creek is recommended.

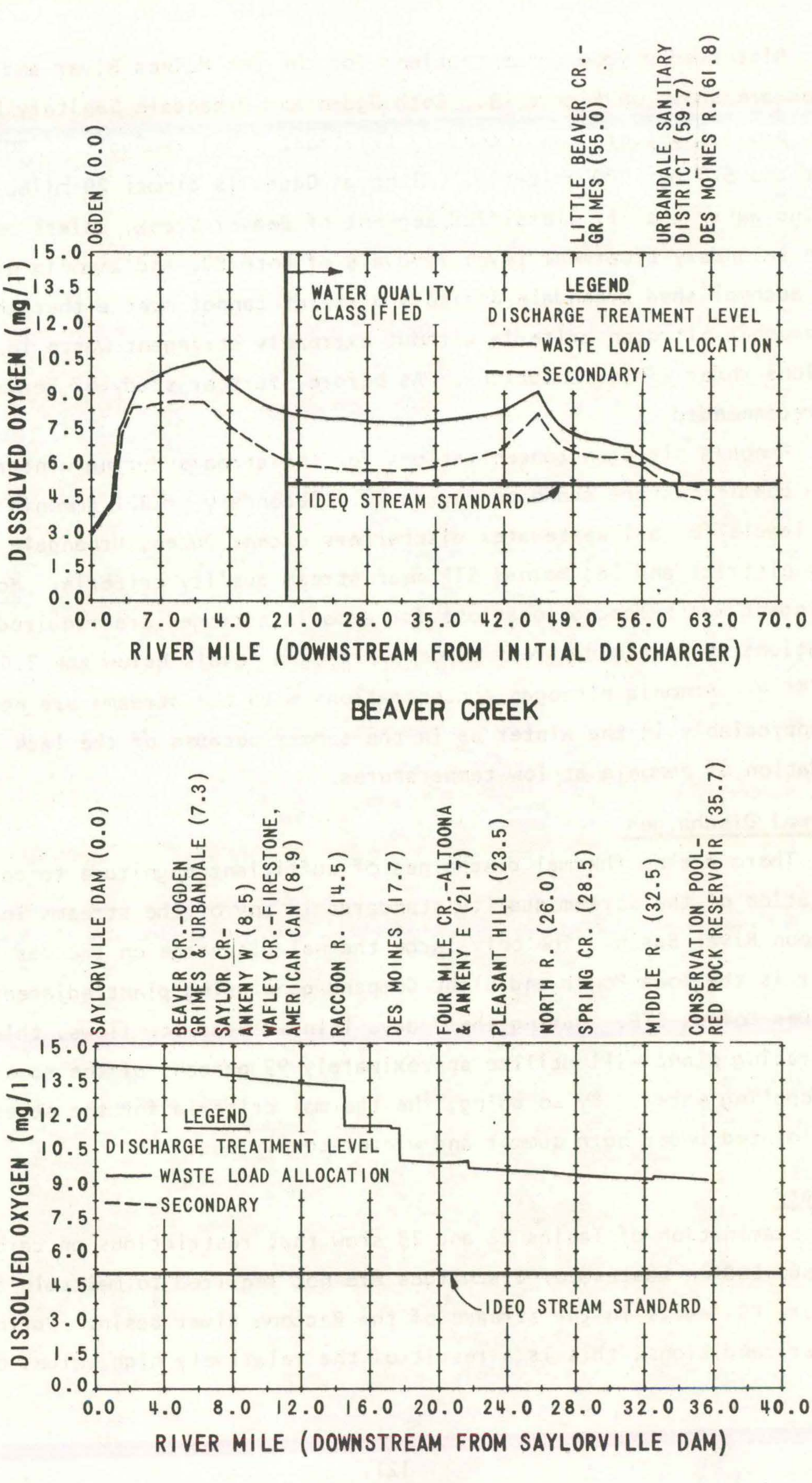
Ammonia nitrogen concentrations for the streams during winter low flow conditions are shown on Figure 20. Secondary or BPT ammonia nitrogen levels for all wastewater dischargers except Ogden, Urbandale Sanitary District and Des Moines STP meet stream quality criteria. More stringent waste load allocations for ammonia nitrogen are required at these locations to maintain stream ammonia nitrogen levels below the 2.0 mg/l criteria. Ammonia nitrogen concentrations with the streams are not reduced as appreciably in the winter as in the summer because of the lack of biooxidation of ammonia at low temperatures.

Thermal Discharges

There are no thermal discharges of sufficient magnitude to cause violation of the stream quality standards in any of the streams in the Raccoon River Basin. The only large thermal discharge on the Des Moines River is the Iowa Power and Light Company generating plant adjacent to the Des Moines STP. During the 7-day, 1-in-10 year low flows, this power generating plant will utilize approximately 97 percent of the stream flow for cooling water. By so doing, the thermal criteria for the stream will be violated under both summer and winter conditions.

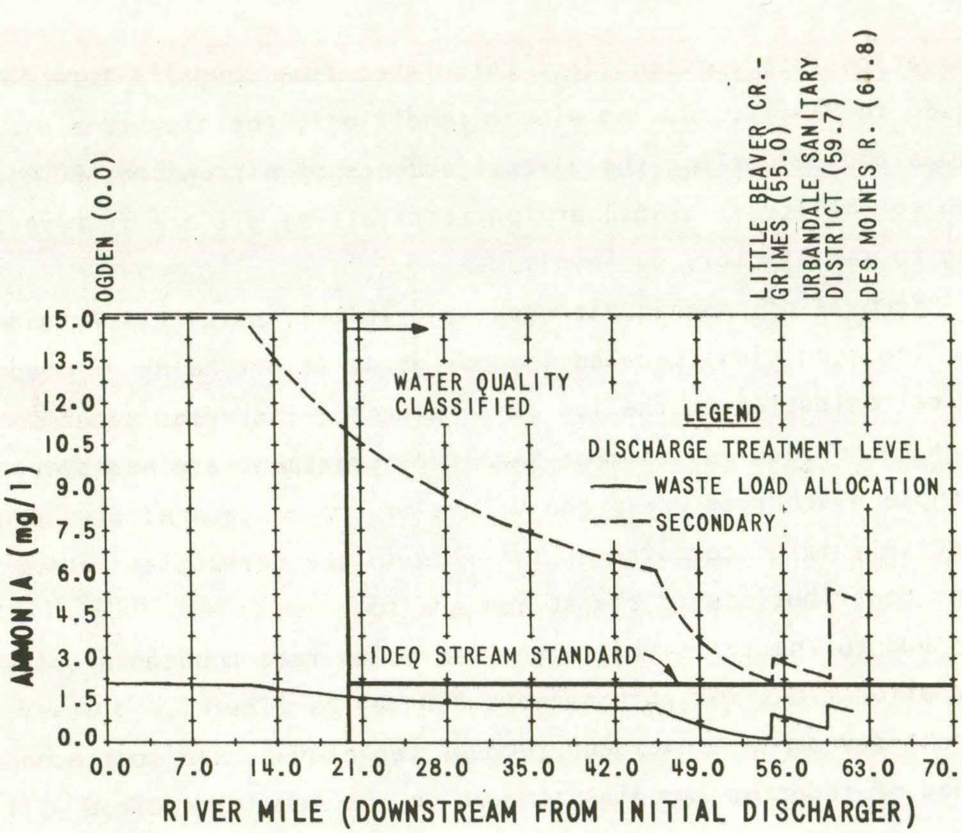
Summary

Examination of Tables 22 and 23 show that restrictions on carbonaceous BOD in wastewater discharges are not required to maintain satisfactory DO levels in the streams of the Raccoon River Basin. During summer conditions, this is a result of the relatively high values of the

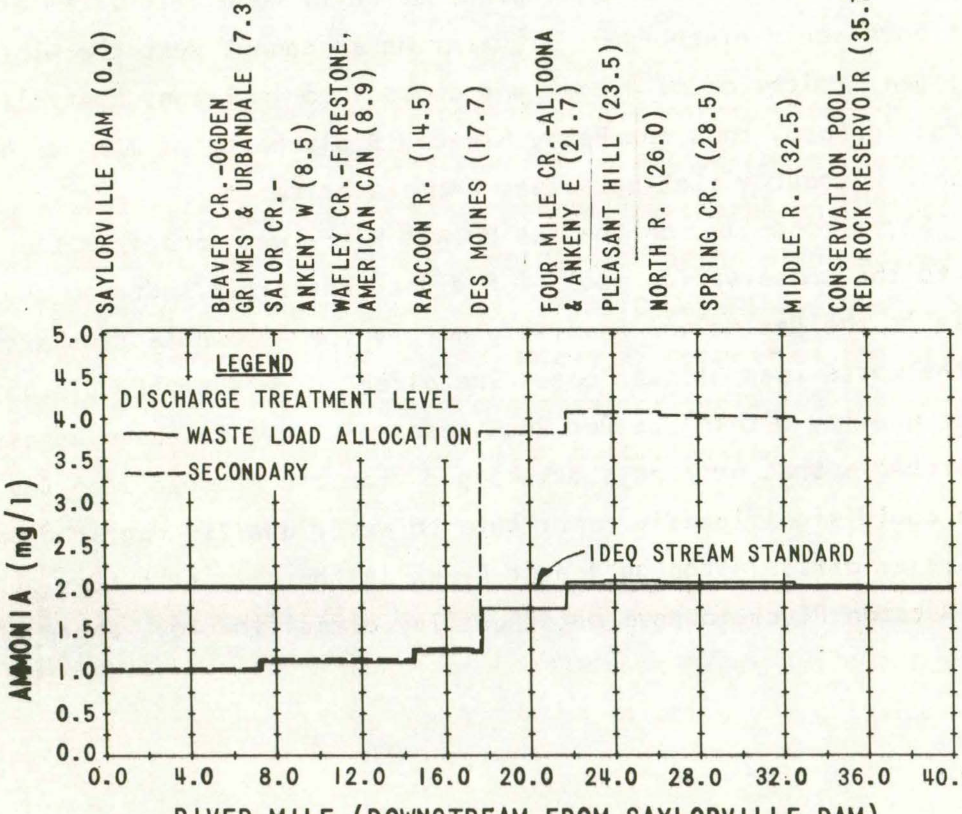


DES MOINES RIVER

FIGURE 19
DISSOLVED OXYGEN
CONCENTRATIONS
WINTER CONDITIONS



BEAVER CREEK



DES MOINES RIVER

FIGURE 20
AMMONIA NITROGEN
CONCENTRATIONS
WINTER CONDITIONS

reaeration rate constant (K_2) calculated from Dougal's formula as discussed in PART V. During winter conditions, the slow rate of carbonaceous BOD oxidation, the virtual absence of nitrogenous BOD, and the high solubility of oxygen at low temperatures all are factors contributing to satisfactory DO levels.

Removal of ammonia nitrogen is critical, particularly 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, and where groundwater contributions to the stream are low.

Due to the relatively high reaeration rate constants used, the waste load allocations for carbonaceous BOD may be liberal. However, using present-day ammonia nitrogen removal techniques, the most economical method of reducing ammonia nitrogen to the levels required will either require, or result in, additional carbonaceous BOD reduction.

The waste load allocations presented in Tables 22 and 23 for the Perry STP and the Oscar Mayer plant at Perry were calculated assuming that both would discharge. If Oscar Mayer cannot meet the winter ammonia nitrogen limitation of 4 mg/l and chooses to implement controlled discharge instead, then the Perry STP could discharge as much as 4 mg/l of ammonia without violating stream ammonia criteria.

Stream modeling on the Des Moines River was done from the Saylorville Dam to the conservation pool of Red Rock Reservoir. Stream quality criteria in the Des Moines River are met by the allowable discharges given in the waste load allocations. The effect of wastewater discharges upon water quality within the Red Rock Reservoir have not been assessed. It is probable that nutrients discharged from the metropolitan Des Moines area could significantly contribute to water quality degradation within the reservoir. Although Beaver Creek is the only tributary other than the Raccoon River to have water quality classification, there are a number of small streams in the metropolitan Des Moines area which are of aesthetic value to the community. Computations done in the process of determining waste load allocations for the Des Moines River show that under 1990 flow conditions, Four Mile Creek will suffer a complete loss of dissolved oxygen during 7-day, 1-in-10 year low flows, allowing anaerobic conditions to prevail within the stream. The resultant anaerobic conditions and poor aesthetic qualities would violate the general water quality criteria and should be avoided by assigning waste load allocations more stringent than secondary treatment to dischargers to Four Mile Creek.

Respectfully submitted,

STANLEY CONSULTANTS, INC.

By ____________________
Roger J. Weber

By ____________________
Eric G. Hanson

Approved by ____________________
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.

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Robert L. Thoem

December 12, 1974 Reg. No. 5802

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