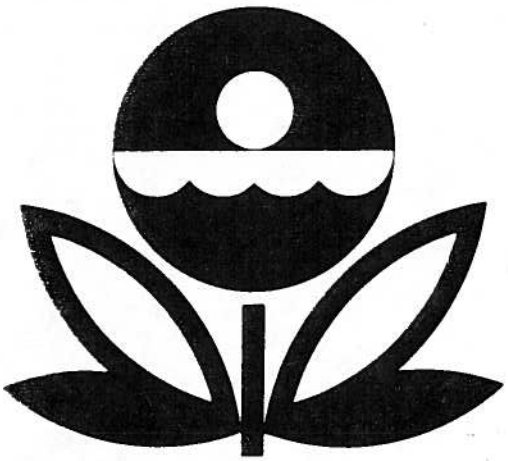
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



REPORT

ON

TENKILLER FERRY RESERVOIR

CHEROKEE AND SEQUOYAH COUNTIES

OKLAHOMA

EPA REGION VI

WORKING PAPER No. 593

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

☆G.P.O. 699-440

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WITH THE COOPERATION OF THE

OKLAHOMA DEPARTMENT OF POLLUTION CONTROL

AND THE

OKLAHOMA NATIONAL GUARD

MARCH, 1977

REPORT ON TENKILLER FERRY RESERVOIR

CHEROKEE AND SEQUOYAH COUNTIES, OKLAHOMA

EPA REGION VI

by

National Eutrophication Survey

Water and Land Monitoring Branch
Monitoring Applications Laboratory
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Eutrophication Survey Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 593

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

MARCH 1977

CONTENTS

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protectic Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Oklahoma Department of Pollution Control for professional involvement, to the Oklahoma National Guard for conducting the tributary sampling phase of the Survey, and to those Oklahoma wastewater treatment plant operators who provided effluent samples and flow data.

Dr. Denver Talley, Director, Oklahoma Department of Pollution Control; the staff of the Oklahoma Water Resources Board; and the staff of the Oklahoma State Department of Health reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

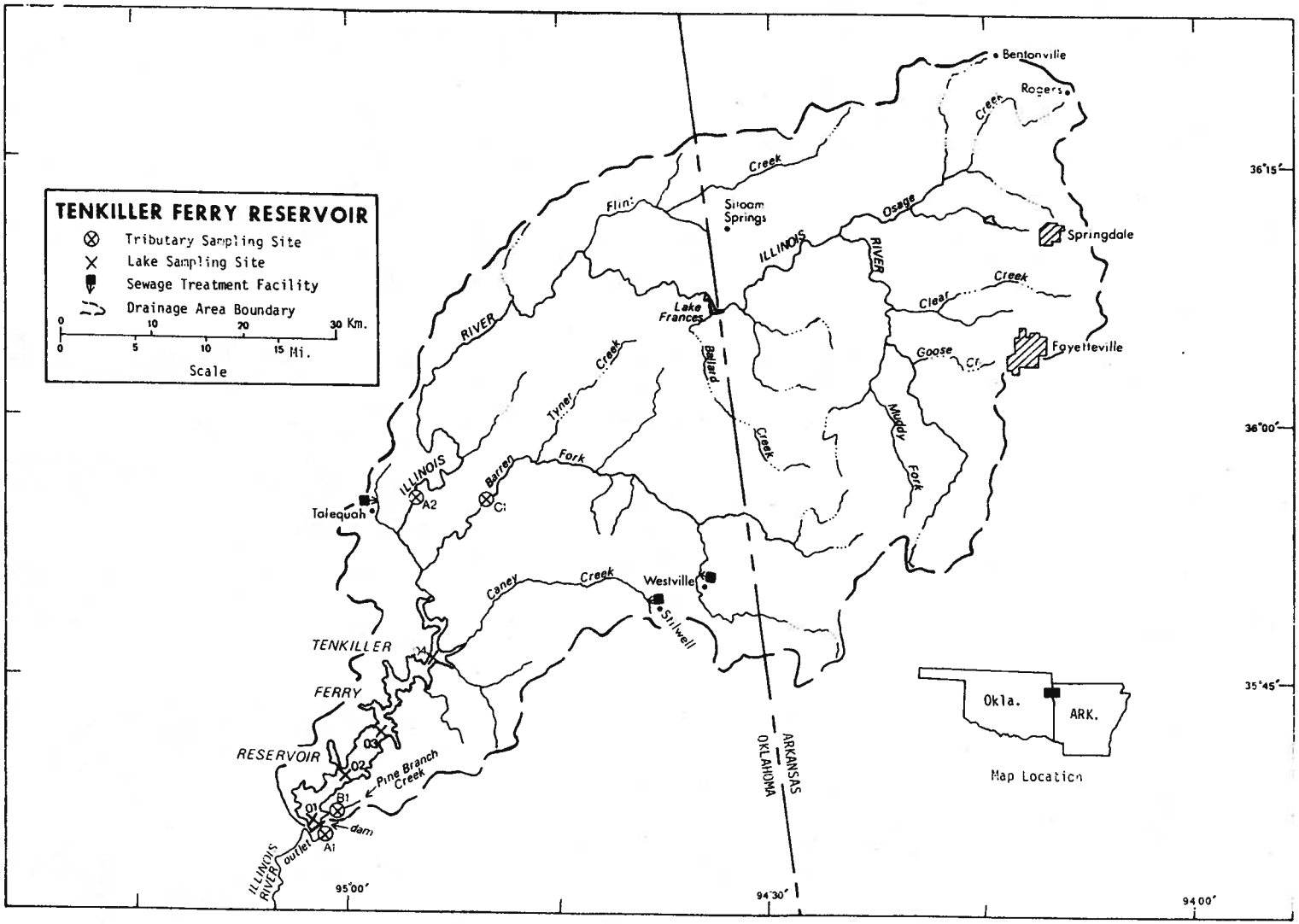
Major General John Coffey, Jr., the Adjutant General of Oklahoma, and Project Officers Colonel Curtis W. Milligan and Major James O. Haney, Jr., who directed the volunteer efforts of the Oklahoma National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF OKLAHOMA

LAKE NAME	COUNTY
Altus Reservoir	Greer, Kiowa
Arbuckle Lake	Murray
Lake Elsworth	Caddo, Comanche
Lake Eufaula	Haskell, McIntosh, Okmulgee, Pittsburg
Fort Cobb Reservoir	Caddo
Fort Supply Reservoir	Woodward
Foss Dam Reservoir	Custer
Lake Frances	Adair
Grand Lake O' The Cherokees	Mayes, Delaware, Craig, Ottowa
Lake Hefner	Oklahoma
Keystone Reservoir	Tulsa, Creek, Osage, Pa
Oologah Lake	Nowata, Rogers
Tenkiller Ferry Reservoir	Cherokee, Sequoyah
Lake Thunderbird	Cleveland
Wister Reservoir	LeFlore


TENKILLER FERRY RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Drainage Area Boundary
0 10 20 30 Km.
0 5 10 15 Mi.
Scale
Bentonville
Rogers
Siloam Springs
Springdale
Fayetteville
Lake Frances
Talequah
Westville
Stilwell
TENKILLER FERRY RESERVOIR
Flint Creek
Osage Creek
Illinois River
Clear Creek
Goose Cr.
Ballard Creek
Muddy Fork
Tyner Creek
Barren Fork
Caney Creek
Pine Branch Creek
dam
outlet
A1
A2
B1
C1
O1
O2
O3
Okla.
ARK.
Map Location
ARKANSAS
OKLAHOMA
36°15'
36°00'
35°45'
95°00'
94°30'
94°00'

REPORT ON TENKILLER FERRY RESERVOIR, OKLAHOMA

STORET NO. 4013

I. CONCLUSIONS

A. Trophic Condition:*

Based upon Survey data, Tenkiller Ferry Reservoir is considered eutrophic, i.e., nutrient rich and highly productive. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by its actual or potential impact upon designated beneficial water uses of each lake.

Chlorophyll a values in the lake ranged from 0.1 µg/l to 24.6 µg/l with a mean of 6.6 µg/l. Potential for primary productivity as measured by algal assay control yield was high. Of the 16 Oklahoma lakes sampled in 1974 (including Lake Texoma), 10 had greater median total phosphorus, 4 had greater median inorganic nitrogen, and 7 had greater median orthophosphorus levels than Tenkiller Ferry Reservoir.

Survey limnologists did not report any problem conditions during their visits to the lake.

*See Appendix E.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Tenkiller Ferry Reservoir was limited by available phosphorus at the time the autumn assay sample was collected. The lake data suggest primary limitation by phosphorus at all other sampling times as well.

C. Nutrient Controllability:

1. Point sources -

Point sources were estimated to contribute 15.5% of the total phosphorus load during the sampling year. The towns of Tahlequah and Stilwell contributed 8.0% and 6.5%, respectively. Westville was estimated to contribute 1.0%.

The calculated annual phosphorus loading of 2.13 g P/m^2/yr is approximately twice that proposed by Vollenweider (1975) as "eutrophic" for a lake with such volume and retention time. Although elimination of all point source phosphorus loads would not reduce this annual loading to Vollenweider's "eutrophic" level (0.92 g P/m^2/yr), it would reduce the potential for the occurrence of nuisance conditions.

2. Nonpoint sources -

It is calculated that nonpoint sources contributed 84.5% of the total phosphorus input to Tenkiller Ferry Reservoir during the sampling year. Gaged tributaries contributed 71.1% of the total, and ungaged drainage areas were estimated to have contributed 12.6%.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake surface area and mean depth were provided by the Oklahoma Department of Pollution Control; maximum depth was provided by the Oklahoma Water Resources Board. Tributary flow data were provided by the Oklahoma District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by mean flow of the outlet. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 51.19 km^2.
2. Mean depth: 15.5 meters.
3. Maximum depth: 46.3 meters.
4. Volume: 793.445 x 10^6 m^3.
5. Mean hydraulic retention time: 240 days.

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area(km^2)	Mean Flow (m^3/sec)
A-2 Illinois River	2,483.8	23.68
C-1 Barron Fork	795.1	8.45
Minor tributaries and immediate drainage -	839.8	9.04
Totals	4,118.7	41.17
2. Outlet - A-1 Illinois River	4,169.9	38.32

C. Precipitation:

1. Year of sampling: 137.3 cm.
2. Mean annual: 113.1 cm.

III. LAKE WATER QUALITY SUMMARY

Tenkiller Ferry Reservoir was sampled four times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from four stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 44.5 meters at Station 01, 36.9 meters at Station 02, 26.2 meters at Station 03, and 15.2 meters at Station 04. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

STORET CODE 4013

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	N*	(4/ 3/74) S*** = 4 RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	N*	(6/14/74) S*** = 4 RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	N*	(8/30/74) S*** = 4 RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	8	11.2- 15.3	12.3	0.0- 1.5	8	24.3- 25.8	25.6	0.0- 1.5	4	27.0- 27.4	27.1	0.0- 0.0
MAX DEPTH**	4	8.0- 13.6	9.5	11.6- 42.7	4	13.5- 20.4	17.4	15.2- 44.5	4	18.2- 26.3	21.1	8.5- 38.1
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	4	9.0- 10.4	10.1	1.5- 1.5	4	8.0- 10.8	9.7	1.5- 1.5	4	5.2- 7.0	6.5	0.0- 0.0
MAX DEPTH**	4	8.6- 9.0	8.9	11.6- 42.7	4	0.6- 5.2	2.9	15.2- 44.5	4	0.0- 3.2	0.4	8.5- 38.1
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	8	118.- 154.	129.	0.0- 1.5	8	168.- 179.	173.	0.0- 1.5	4	142.- 183.	156.	0.0- 0.0
MAX DEPTH**	4	104.- 150.	124.	11.6- 42.7	4	119.- 148.	140.	15.2- 44.5	4	125.- 201.	162.	8.5- 38.1
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	8	7.6- 7.8	7.8	0.0- 1.5	8	8.4- 9.0	8.9	0.0- 1.5	4	7.8- 8.3	8.2	0.0- 0.0
MAX DEPTH**	4	7.1- 7.5	7.2	11.6- 42.7	4	7.2- 7.4	7.3	15.2- 44.5	4	7.3- 7.6	7.4	8.5- 38.1
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	8	53.- 77.	74.	0.0- 1.5	7	72.- 86.	78.	0.0- 1.5	4	75.- 82.	76.	0.0- 0.0
MAX DEPTH**	4	65.- 83.	73.	11.6- 42.7	4	40.- 90.	68.	15.2- 44.5	4	78.- 92.	88.	8.5- 38.1
TOTAL P (MG/L)												
0.-1.5 M DEPTH	8	0.039-0.051	0.044	0.0- 1.5	8	0.020-0.040	0.028	0.0- 1.5	4	0.030-0.067	0.036	0.0- 0.0
MAX DEPTH**	4	0.055-0.199	0.070	11.6- 42.7	4	0.049-0.232	0.162	15.2- 44.5	4	0.130-0.347	0.163	8.5- 38.1
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	8	0.034-0.048	0.038	0.0- 1.5	7	0.004-0.017	0.011	0.0- 1.5	4	0.008-0.029	0.017	0.0- 0.0
MAX DEPTH**	4	0.036-0.050	0.041	11.6- 42.7	4	0.016-0.085	0.056	15.2- 44.5	4	0.026-0.054	0.032	8.5- 38.1
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	8	0.800-0.920	0.815	0.0- 1.5	7	0.420-0.570	0.500	0.0- 1.5	4	0.040-0.210	0.085	0.0- 0.0
MAX DEPTH**	4	0.840-1.080	0.895	11.6- 42.7	4	0.550-0.880	0.865	15.2- 44.5	4	0.040-0.180	0.055	8.5- 38.1
AMMONIA (MG/L)												
0.-1.5 M DEPTH	8	0.020-0.040	0.030	0.0- 1.5	7	0.030-0.070	0.040	0.0- 1.5	4	0.050-0.190	0.060	0.0- 0.0
MAX DEPTH**	4	0.040-0.070	0.060	11.6- 42.7	4	0.040-0.130	0.080	15.2- 44.5	4	0.300-1.260	0.740	8.5- 38.1
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	8	0.200-0.600	0.300	0.0- 1.5	8	0.300-0.600	0.400	0.0- 1.5	4	0.400-1.200	0.700	0.0- 0.0
MAX DEPTH**	4	0.200-0.500	0.300	11.6- 42.7	4	0.300-0.500	0.450	15.2- 44.5	4	0.600-1.400	0.900	8.5- 38.1
SECCHI DISC (METERS)												
	4	0.8- 1.2	1.0		4	0.7- 3.4	2.5		4	0.7- 2.4	2.1	

** N = NO. OF SAMPLES

TENKILLER FERRY RESERVOI
STORET CODE 4013

PHYSICAL AND CHEMICAL CHARACTERISTICS

(10/21/74)

5*** = 4

PARAMETER	N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)				
0.-1.5 M DEPTH	8	18.5- 19.6	19.5	0.0- 1.5
MAX DEPTH**	4	17.2- 19.2	18.7	10.4- 41.5
DISSOLVED OXYGEN (MG/L)				
0.-1.5 M DEPTH	8	5.8- 10.0	7.6	0.0- 1.5
MAX DEPTH**	4	0.4- 7.4	4.1	10.4- 41.5
CONDUCTIVITY (UMHOS)				
0.-1.5 M DEPTH	8	145.- 147.	145.	0.0- 1.5
MAX DEPTH**	4	155.- 189.	161.	10.4- 41.5
PH (STANDARD UNITS)				
0.-1.5 M DEPTH	8	7.2- 8.5	7.7	0.0- 1.5
MAX DEPTH**	4	6.9- 7.4	7.1	10.4- 41.5
TOTAL ALKALINITY (MG/L)				
0.-1.5 M DEPTH	8	71.- 80.	74.	0.0- 1.5
MAX DEPTH**	4	80.- 91.	86.	10.4- 41.5
TOTAL P (MG/L)				
0.-1.5 M DEPTH	8	0.020-0.052	0.025	0.0- 1.5
MAX DEPTH**	4	0.085-0.154	0.113	10.4- 41.5
DISSOLVED ORTHO P (MG/L)				
0.-1.5 M DEPTH	8	0.003-0.007	0.004	0.0- 1.5
MAX DEPTH**	4	0.005-0.019	0.018	10.4- 41.5
NO2+NO3 (MG/L)				
0.-1.5 M DEPTH	8	0.200-0.350	0.240	0.0- 1.5
MAX DEPTH**	4	0.220-0.550	0.360	10.4- 41.5
AMMONIA (MG/L)				
0.-1.5 M DEPTH	8	0.020-0.040	0.025	0.0- 1.5
MAX DEPTH**	4	0.020-0.920	0.175	10.4- 41.5
KJELDAHL N (MG/L)				
0.-1.5 M DEPTH	8	0.200-0.600	0.350	0.0- 1.5
MAX DEPTH**	4	0.200-1.200	0.400	10.4- 41.5
SECCHI DISC (METERS)				
	4	1.2- 1.6	1.5	

B. Biological Characteristics:

1. Phytoplankton -

	Dominant Genera		Algal Units per ml
04/03/74	1.	Stephanodiscus	1,685
	2.	Melosira	481
	3.	Chroomonas	289
	4.	Cyclotella	96
	5.	Cryptomonas	48
		Other genera	145
		Total	2,744
06/14/74	1.	Cyclotella	369
	2.	Melosira	276
	3.	Cryptomonas	184
	4.	Chlamydomonas	46
		Other genera	---
		Total	875
08/30/74	1.	Achnanthes	873
	2.	Raphidiopsis	457
	3.	Synedra	416
	4.	Stephanodiscus	374
	5.	Nitzschia	333
		Other genera	666
		Total	3,119
10/21/74	1.	Melosira	1,707
	2.	Cyclotella	443
	3.	Chroomonas	316
	4.	Ankistrodesmus	253
	5.	Tetraedron	190
		Other genera	695
		Total	3,604

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
04/03/74	01	2.9
	02	4.9
	03	7.1
	04	7.0
06/14/74	01	0.1
	02	0.2
	03	0.3
	04	0.7
08/30/74	01	6.6
	02	5.7
	03	6.6
	04	12.0
10/21/74	01	6.1
	02	7.1
	03	14.4
	04	24.6

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked - 10/21/74

Spike(mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.020	0.320	5.2
0.05 P	0.070	0.320	10.0
0.05 P + 1.0 N	0.070	1.320	19.6
1.00 N	0.020	1.320	5.5

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity in Tenkiller Ferry Reservoir was high at the time of autumn sampling. There was a significant increase in yield over that of the control when orthophosphorus was added, indicating phosphorus limitation at that time. The addition of nitrogen alone did not result in an increase in yield over that of the control, and the simultaneous addition of the two nutrients produced the maximum increase in yield.

There is no spring assay available for Tenkiller Ferry Reservoir. However, mean inorganic nitrogen to orthophosphorus (N/P) ratios in the lake were 17/1 or greater on all sampling occasions, further suggesting primary limitation by phosphorus.

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Oklahoma National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May when two samples were generally collected. Sampling was begun in November 1974, and was completed in October 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Oklahoma District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual concentrations in Pine Branch Creek at Station B-1 and mean annual ZZ flow.

The operators of the Stilwell and Tahlequah wastewater treatment plants provided monthly effluent samples and corresponding flow data. Nutrient loads for the city of Westville wastewater treatment plant were estimated at 1.134 kg P and 3.401 kg N/capita yr.

A. Waste Sources:

1. Known municipal -

Name	Pop.* Served	Treatment*	Mean Flow ($m^3/d \times 10^3$)	Receiving Water
Stilwell	3,000	Trickling filter	2.231	Caney Creek/ Illinois Riv
Tahlequah	10,500	Activated sludge	3.679	Ross Branch/ Illinois Riv
Westville	1,000	Trickling filter	0.378**	Shell Branch/ Barren Fork

2. Known industrial -

Name	Product	Treatment	Mean Flow ($m^3/d \times 10^3$)	Receiving Water
Allen Canning Company	Canned vegetables	?	?	Tar Creek
Stilwell Cannery	Canned vegetables	Landfill disposal	?	Caney Creek/ Illinois Riv

*Treatment plant questionnaires; U.S.EPA, 1971.
**Estimated at 0.3785 m^3/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Illinois River	68,875	63.2
C-1 Barron Fork	8,605	7.9
b. Minor tributaries and immediate drainage (nonpoint load) -	13,685	12.6
c. Known municipal STP's -		
Stilwell	7,110	6.5
Tahlequah	8,725	8.0
Westville	1,135	1.0
d. Septic tanks* -	20	<0.1
e. Known industrial -		
Allen Canning Company	Unknown	---
Stilwell Cannery	Unknown	---
f. Direct precipitation** -	895	0.8
Totals	109,050	100.0

2. Output - A-1 Illinois River 59,305

3. Net annual P accumulation - 49,745

*Estimate based on 40 lakeside residences and 8 parks.
**Estimated (see NES Working Paper No. 175).

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Illinois River	1,750,390	67.4
C-1 Barron Fork	434,890	16.8
b. Minor tributaries and immediate drainage (nonpoint load) -	321,290	12.4
c. Known municipal STP's -		
Stilwell	12,995	0.5
Tahlequah	18,015	0.7
Westville	3,400	0.1
d. Septic tanks* -	705	<0.1
e. Known industrial -		
Allen Canning Company	Unknown	---
Stilwell Cannery	Unknown	---
f. Direct precipitation** -	55,265	2.1
Totals	2,596,950	100.0

2. Output - A-1 Illinois River 2,070,280

3. Net annual N accumulation - 526,670

*Estimate based on 40 lakeside residences and 8 parks.
**Estimated (see NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Illinois River	28	705
Barron Fork	11	547

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P (mg/l)	Mean Total N (mg/l)
B-1 Pine Branch Creek	0.048	1.127

F. Yearly Loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his "eutrophic" loading is that at which the receiving waters would become eutrophic or remain eutrophic; his "oligotrophic loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A "mesotrophic" loading would be considered one between "eutrophic" and "oligotrophic".

Note that Vollenweider's model may not be applicable to water bodies with very short retention times or in which light penetration is severely restricted by high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading ($g/m^2/yr$)
Estimated loading for Tenkiller Ferry Reservoir	2.13
Vollenweider's "eutrophic" loading	0.92
Vollenweider's "oligotrophic" loading	0.46

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR OKLAHOMA 03/25/77

LAKE CODE 4013 TENKILLER FERRY RES.

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 4169.9

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4013A1	4169.9	35.40	45.31	41.06	61.73	61.73	41.06	47.57	29.45	20.67	18.41	28.60	29.45	38.32
4013A2	2483.8	18.69	30.58	34.55	43.04	54.65	23.59	15.43	11.69	7.50	11.52	17.70	15.74	23.68
4013C1	795.1	6.46	11.69	11.81	14.53	27.33	10.59	7.02	2.52	1.47	2.04	3.54	2.83	8.45
4013ZZ	891.0	6.80	11.61	15.86	15.57	22.37	9.34	6.23	3.96	2.44	3.68	5.66	5.10	9.04

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 4169.9
SUM OF SUB-DRAINAGE AREAS = 4169.9
TOTAL FLOW IN = 494.95
TOTAL FLOW OUT = 460.43

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4013A1	11	74	120.885	3	32.848				
	12	74	133.372	12	95.994				
	1	75	91.463	13	103.640				
	2	75	124.028	11	105.339				
	3	75	144.699	6	0.510				
	4	75	95.711	8	99.392	28	60.032		
	5	75	60.881	8	101.941	29	48.988		
	6	75	68.527						
	7	75	24.919	19	25.485				
	8	75	20.954						
	9	75	36.529						
	10	75	31.149	14	0.0				
4013A2	11	74	124.877	2	159.424				
	12	74	24.352	12	31.432				
	1	75	36.246	19	22.993				
	2	75	69.376	16	29.166				
	3	75	99.169	8	49.271				
	4	75	35.113	13	28.600	30	48.422		
	5	75	37.378	4	64.846	29	95.145		
	6	75	37.378	22	36.246				
	7	75	16.424	19	12.459				
	8	75	12.743	17	26.051				
	9	75	42.758	6	9.345				
	10	75	45.307	14	10.449				

TRIBUTARY FLOW INFORMATION FOR OKLAHOMA 03/25/77

LAKE CODE 4013 TENKILLER FERRY RES.

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4013C1	11	74	42.475	3	231.349				
	12	74	10.194	10	14.442				
	1	75	11.327	19	7.929				
	2	75	26.618	16	9.061				
	3	75	30.016	13	37.661				
	4	75	13.592	13	10.222	30	16.820		
	5	75	10.760	5	19.539	23	8.495	30	7.079
	6	75	7.079	22	8.778				
	7	75	3.115	19	2.265				
	8	75	2.095	29	1.841				
	9	75	4.531	7	1.416				
	10	75	4.814	14	1.784				
4013ZZ	11	74	37.945						
	12	74	9.061						
	1	75	10.194						
	2	75	23.503						
	3	75	26.618						
	4	75	12.176						
	5	75	9.628						
	6	75	6.230						
	7	75	2.832						
	8	75	1.982						
	9	75	1.416						
	10	75	4.248						

APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 77/03/28

401301
35 35 50.0 095 02 20.0 4
TENKILLER FERRY RESERVOIR
40135 OKLAHOMA
100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0145 FEET DEPTH .CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/03	10	0000	11.4		36	118	7.60	60	0.040	0.300	0.800	0.046
	10	0005	11.2	10.4		119	7.60	53	0.030	0.200K	0.810	0.048
	10	0015	11.0	9.6		116	7.60	54	0.030	0.200K	0.820	0.044
	10	0050	10.3	9.8		115	7.50	54	0.030	0.200K	0.820	0.042
	10	0100	8.8	9.4		110	7.30	64	0.050	0.200	0.840	0.051
	10	0140	8.0	9.0		104	7.10	65	0.070	0.500	0.840	0.050
74/06/14	12	0000	25.3		132	175	8.90	86	0.050	0.600	0.510	0.011
	12	0005	24.3	8.0		168	8.40			0.300		
	12	0020	23.4	6.8		167	7.90	98	0.050	0.300	0.540	0.011
	12	0040	22.1	4.8		158	7.90	74	0.050	0.200	0.650	0.014
	12	0070	20.1	4.4		123	7.40	58	0.050	0.300	0.650	0.043
	12	0090	18.2	4.0		148	7.40	74	0.030	0.200	0.780	0.012
	12	0115	15.2	3.6		140	7.50	74	0.030	0.200	0.860	0.014
	12	0146	13.5	1.0		137	7.40	80	0.060	0.500	0.880	0.016
74/08/30	09	0000	27.0	7.0	96	142	8.30	75	0.050	1.200	0.100	0.023
	09	0015	27.0	6.8		152	8.30	74	0.040	0.400	0.100	0.015
	09	0030	27.0	4.6		153	8.00	75	0.050	0.200	0.170	0.010
	09	0035	26.6	3.2		152	7.90	74	0.040	0.200K	0.180	0.010
	09	0045	26.1	1.2		153	7.45	77	0.050	0.200	0.180	0.016
	09	0055	25.3	0.1		160	7.70	83	0.050	0.200	0.140	0.014
	09	0080	21.1	0.2		110	7.60	65	0.090	0.200	0.450	0.025
	09	0100	19.9	0.2		105	7.50	66	0.380	0.600	0.200	0.038
	09	0125	18.2	0.0		125	7.30	78	1.260	1.400	0.060	0.054
74/10/21	11	0000	19.6	6.2	62	145	7.22	74	0.020	0.600	0.350	0.005
	11	0005	19.6	5.8		145	7.21	74	0.020	0.200K	0.350	0.006
	11	0015	19.6	6.0		145	7.21	75	0.020K	0.200K	0.340	0.006
	11	0035	19.6	6.0		145	7.23	74	0.020K	0.200K	0.340	0.005
	11	0055	19.6	6.8		145	7.23	74	0.020K	0.200	0.340	0.006
	11	0075	19.6	5.8		144	7.23	74	0.020K	0.200	0.330	0.006
	11	0095	19.6	7.4		143	7.17	75	0.020K	0.300	0.350	0.007
	11	0115	19.3	7.4		153	6.93	79	0.040	0.500	0.490	0.012
	11	0136	18.4	0.4		189	6.87	91	0.920	1.200	0.220	0.019

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/07/28

401301
35 35 50.0 095 02 20.0 4
TENKILLER FERRY RESERVOIR
40135 OKLAHOMA

100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0145 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/03	10 10	0000	0.048	2.9	
	10 10	0005	0.047		
	10 10	0015	0.045		
	10 10	0050	0.045		
	10 10	0100	0.076		
	10 10	0140	0.199		
74/06/14	12 25	0000	0.023	0.1	
	12 25	0005	0.020		
	12 25	0020	0.022		
	12 25	0040	0.023		
	12 25	0070	0.080		
	12 25	0090	0.022		
	12 25	0115	0.021		
	12 25	0146	0.232		
74/08/30	09 45	0000	0.035	6.6	
	09 45	0015	0.030		
	09 45	0030	0.025		
	09 45	0035	0.023		
	09 45	0045	0.031		
	09 45	0055	0.027		
	09 45	0080	0.063		
	09 45	0100	0.154		
	09 45	0125	0.347		
74/10/21	11 35	0000	0.052	6.1	
	11 35	0001			50.0
	11 35	0005	0.031		
	11 35	0011			1.0
	11 35	0015	0.031		
	11 35	0035	0.030		
	11 35	0055	0.032		
	11 35	0075	0.030		
	11 35	0095	0.034		
	11 35	0115	0.096		
	11 35	0136	0.113		

STORET RETRIEVAL DATE 77/03/28

401302
35 38 45.0 095 00 10.0 4
TENKILLER FERRY RESERVOIR
40021 OKLAHOMA
100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0115 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/03	10	45 0000	12.0		42	125	7.80	74	0.030	0.300	0.810	0.036
	10	45 0005	12.0	10.2		125	7.80	77	0.020	0.200K	0.820	0.039
	10	45 0015	11.9	10.0		126	7.70	79	0.020	0.200K	0.820	0.038
	10	45 0040	11.5	10.0		127	7.60	80	0.020	0.200K	0.840	0.039
	10	45 0080	9.8	9.0		123	7.40	81	0.030	0.200K	0.880	0.043
	10	45 0110	9.0	8.6		115	7.20	75	0.040	0.200	0.900	0.047
74/06/12	13	00 0000	25.6		115	175	8.90	83	0.030	0.400	0.520	0.004
	13	00 0005	25.5	9.4		171	9.00	80	0.040	0.400	0.420	0.010
	13	00 0010	24.4	9.2		169	8.80	78	0.040	0.400	0.470	0.006
	13	00 0020	23.7	7.6		168	8.50	82	0.060	0.400	0.500	0.008
	13	00 0035	22.5	4.8		151	7.80	73	0.040	0.300	0.650	0.016
	13	00 0045	21.1	5.2		121	7.50	57	0.080	0.400	0.660	0.056
	13	00 0070	20.2	5.0		81	7.40	41	0.150	0.600	0.580	0.077
	13	00 0090	18.3	2.0		152	7.50	79	0.100	0.300	0.860	0.022
	13	00 0100	16.1	2.2		147	7.50	87	0.090	0.300	0.890	0.021
	13	00 0121	14.8	0.8		148	7.20	90	0.040	0.300	0.880	0.028
74/08/30	10	40 0000	27.1	6.6	96	155	8.20	76	0.060	0.500	0.070	0.008
	10	40 0015	27.1	6.4		155	8.20	75	0.040	0.200	0.050	0.012
	10	40 0030	26.9	4.2		156	7.90	78	0.060	0.200	0.080	0.011
	10	40 0035	26.6	2.4		156	7.80	77	0.080	0.200K	0.120	0.014
	10	40 0045	26.3	1.6		150	7.70	78	0.150	0.200K	0.130	0.011
	10	40 0060	23.3	0.2		156	7.60	84	0.120	0.200K	0.160	0.014
	10	40 0085	20.5	0.4		119	7.50	71	0.320	0.500	0.230	0.025
	10	40 0100	19.8	0.8		144	7.40	85	0.750	0.900	0.050	0.032
74/10/21	10	50 0000	19.5	7.2	62	145	7.55	71	0.040	0.400	0.250	0.005
	10	50 0005	19.5	7.4		145	7.55	71	0.020	0.200	0.240	0.004
	10	50 0015	19.5	7.6		145	7.55	70	0.020K	0.200K	0.250	0.003
	10	50 0035	19.5	5.8		143	7.53	74	0.020	0.200	0.240	0.003
	10	50 0055	19.5	7.4		145	7.49	77	0.020K	0.200	0.240	0.003
	10	50 0075	19.5	7.2		143	7.47	77	0.020	0.200	0.250	0.003
	10	50 0096	19.2	4.0		155	6.99	80	0.020K	0.200	0.480	0.005

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/25

401302
35 38 45.0 095 00 10.0 4
TENKILLER FERRY RESERVOIR
40021 OKLAHOMA

100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0115 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/03	10 45	0000	0.039	4.9	
	10 45	0005	0.042		
	10 45	0015	0.040		
	10 45	0040	0.039		
	10 45	0080	0.041		
	10 45	0110	0.080		
74/06/12	13 00	0000	0.029	0.2	
	13 00	0005	0.025		
	13 00	0010	0.025		
	13 00	0020	0.025		
	13 00	0035	0.038		
	13 00	0045	0.118		
	13 00	0070	0.162		
	13 00	0090	0.058		
	13 00	0100	0.043		
	13 00	0121	0.049		
74/08/30	10 40	0000	0.030	5.7	
	10 40	0015	0.030		
	10 40	0016			5.0
	10 40	0021			1.0
	10 40	0030	0.026		
	10 40	0035	0.030		
	10 40	0045	0.026		
	10 40	0060	0.032		
	10 40	0085	0.107		
	10 40	0100	0.186		
74/10/21	10 50	0000	0.023	7.1	
	10 50	0001			50.0
	10 50	0005	0.020		
	10 50	0013			1.0
	10 50	0015	0.019		
	10 50	0035	0.021		
	10 50	0055	0.038		
	10 50	0075	0.030		
	10 50	0096	0.154		

STORET RETRIEVAL DATE 77/03/28

401303
35 41 25.0 094 57 40.0 4
TENKILLER FERRY RESERVOIR
40021 OKLAHOMA

100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0090 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/03	11	30 0000	12.7		48	132	7.80	75	0.030	0.400	0.820	0.034
	11	30 0005	12.7	10.0		132	7.80	73	0.030	0.200	0.810	0.034
	11	30 0015	12.6	10.2		133	7.80	72	0.030	0.200	0.840	0.026
	11	30 0040	12.1	9.8		131	7.70	72	0.040	0.200	0.870	0.028
	11	30 0080	10.1	9.0		132	7.30	70	0.050	0.300	1.080	0.036
74/06/14	10	55 0000	25.8		80	179	8.90	78	0.070	0.400	0.570	0.012
	10	55 0005	25.7	10.0		177	8.90	76	0.040	0.300	0.500	0.009
	10	55 0015	25.1	9.2		175	8.80	78	0.060	0.300	0.500	0.009
	10	55 0030	23.1	5.4		164	7.90	77	0.070	0.300	0.620	0.014
	10	55 0045	20.6	5.4		166	7.30	44	0.090	0.500	0.580	0.089
	10	55 0086	20.1	4.8		143	7.30	40	0.130	0.500	0.550	0.084
74/08/30	11	15 0000	27.4	6.4	72	157	8.20	76	0.060	0.400	0.040	0.011
	11	15 0025	27.3	5.0		159	7.90	76	0.060	0.200	0.040	0.012
	11	15 0035	26.6	0.5		166	7.60	79	0.120	0.300	0.070	0.016
	11	15 0050	25.5	0.0		177	7.50	90	0.410	0.500	0.020	0.026
	11	15 0065	22.5	0.0		179	7.40	91	0.730	0.900	0.040	0.032
74/10/21	10	15 0000	19.5	8.0	58	145	7.76	75	0.040	0.600	0.240	0.004
	10	15 0005	19.5	7.8		145	7.76	74	0.030	0.200	0.220	0.003
	10	15 0015	19.5	7.8		145	7.75	74	0.030	0.200	0.220	0.003
	10	15 0025	19.5	7.6		143	7.73	74	0.030	0.200K	0.220	0.004
	10	15 0045	19.5	7.6		145	7.71	73	0.050	0.200	0.220	0.004
	10	15 0065	19.2	6.2		151	7.37	77	0.130	0.300	0.220	0.007
	10	15 0083	19.1	4.2		155	7.19	81	0.250	0.600	0.240	0.018

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/28

401303
35 41 25.0 094 57 40.0 4
TENKILLER FERRY RESERVOIR
40021 OKLAHOMA

100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0090 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/03	11 30	0000	0.041	7.1	
	11 30	0005	0.039		
	11 30	0015	0.038		
	11 30	0040	0.042		
	11 30	0080	0.055		
74/06/14	10 55	0000	0.031	0.3	
	10 55	0005	0.028		
	10 55	0015	0.025		
	10 55	0019			1.0
	10 55	0030	0.033		
	10 55	0045	0.172		
	10 55	0086	0.181		
74/08/30	11 15	0000	0.038	6.6	
	11 15	0025	0.034		
	11 15	0035	0.039		
	11 15	0050	0.084		
	11 15	0065	0.130		
74/10/21	10 15	0000	0.024	14.4	
	10 15	0005	0.021		
	10 15	0012			1.0
	10 15	0015	0.020		
	10 15	0025	0.021		
	10 15	0045	0.021		
	10 15	0065	0.043		
	10 15	0083	0.085		

STORET RETRIEVAL DATE 77/03/28

401304
35 45 45.0 094 53 50.0 4
TENKILLER FERRY RESERVOIR
40021 OKLAHOMA

100992

/TYPA/AMBNT/LAKE

11EPALES 04001002
0043 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/03	12 00	0000	15.3		30	154	7.75	73	0.040	0.600	0.920	0.038
	12 00	0005	15.3	9.0		153	7.75	75	0.040	0.300	0.920	0.034
	12 00	0015	15.3	9.4		154	7.65	77	0.040	0.300	0.920	0.033
	12 00	0038	13.6	8.8		150	7.50	83	0.070	0.300	0.890	0.036
74/06/14	10 30	0000	25.6		29	169	8.90	72	0.050	0.500	0.480	0.014
	10 30	0005	25.6	10.8		168	9.00	75	0.040	0.500	0.430	0.017
	10 30	0010	23.3	7.6		139	9.10			0.400		
	10 30	0015	22.1	6.2		116	7.80			0.400		
	10 30	0025	20.5	5.6		120	7.50	55	0.080	0.300	0.840	0.084
	10 30	0050	20.4	5.2		119	7.40	56	0.100	0.400	0.850	0.085
74/08/30	11 45	0000	27.1	5.2	26	183	7.80	82	0.190	0.900	0.210	0.029
	11 45	0015	27.0	5.0		184	7.75	82	0.190	0.600	0.170	0.027
	11 45	0025	26.7	3.4		196	7.70	86	0.270	0.700	0.290	0.031
	11 45	0028	26.3	3.2		201	7.60	92	0.300	0.600	0.180	0.026
74/10/21	09 45	0000	18.6	10.0	48	147	8.51	79	0.030	0.600	0.220	0.007
	09 45	0005	18.5	10.0		147	8.51	80	0.020K	0.300	0.200	0.003
	09 45	0020	18.2	9.4		150	8.43	81	0.040	0.400	0.280	0.008
	09 45	0034	17.2	7.4		167	7.39	91	0.100	0.200	0.550	0.019

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/28

401304
35 45 45.0 094 53 50.0 4
TENKILLER FERRY RESERVOIR
40021 OKLAHOMA

100992

/TYPA/AMBNT/LAKE

11EPALES 04001002
0043 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/03	12 00	0000	0.051	7.0	
	12 00	0005	0.047		
	12 00	0015	0.049		
	12 00	0038	0.061		
74/06/14	10 30	0000	0.035	0.7	
	10 30	0001			50.0
	10 30	0005	0.040		
	10 30	0010	0.035		
	10 30	0015	0.118		
	10 30	0025	0.118		
	10 30	0050	0.143		
74/08/30	11 45	0000	0.067	12.0	
	11 45	0015	0.093		
	11 45	0025	0.141		
	11 45	0028	0.141		
74/10/21	09 45	0000	0.044	24.6	
	09 45	0005	0.026		
	09 45	0009			1.0
	09 45	0020	0.046		
	09 45	0034	0.114		

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 77/03/24

4013A1
35 35 50.0 095 02 15.0 4
ILLINOIS RIVER
40 15 WEBBERS FALLS
O/TENKILLER FERRY RES 100991
OUTLET OF TENKILLER RES DAM ON HWY 100
11EPALES 04001004
0000 FEET DEPTH CLASS 00

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/03	10 00		0.368	0.300	0.030	0.030	0.070
74/12/12	18 30		0.480	1.100	0.020	0.030	0.050
75/01/13	18 15		0.520	1.200	0.016	0.025	0.070
75/02/11			0.520	0.900	0.016	0.016	0.020
75/03/06	06 15		0.550	1.400	0.048	0.016	0.040
75/04/08	13 50		0.850	2.000	0.015	0.040	0.055
75/04/28	19 00		0.030	1.100	0.030	0.005K	0.020
75/05/08	11 00		0.960	1.800	0.025	0.045	0.050
75/05/29	10 40		0.960	0.350	0.010	0.055	0.060
75/10/14	14 10		0.430	2.000	0.145	0.030	0.090

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

4013A2
35 55 25.0 094 56 00.0 4
ILLINOIS RIVER
40 7.5 WELLING NW
T/TENKILLER FERRY RES 100992
HWY 62 BRDG 2.2 MI NE OF TAHLEQUAH
11EPALES 04001004
0000 FEET DEPTH CLASS 00

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/02	12 30		0.720	1.300	0.035	0.070	0.135
74/12/12	14 30		1.280	1.300	0.025	0.040	0.070
75/01/19	13 45		1.340	2.500	0.032	0.045	0.050
75/02/16	14 00		1.300	1.400	0.024	0.040	0.040
75/03/08	14 30		1.585	1.900	0.072	0.048	0.070
75/04/13	17 00		1.400	1.800	0.035	0.035	0.040
75/04/30	16 30		1.100	0.675	0.025	0.040	0.090
75/05/04	16 00		1.100	0.250	0.007	0.060	0.080
75/05/29	16 30		0.575	1.700	0.030	0.075	0.220
75/06/22	10 00		0.870	1.050	0.025	0.065	0.085
75/07/19	09 35		0.260	0.250	0.010	0.035	0.090
75/08/17	08 30		0.640	0.600	0.020	0.075	0.125
75/09/06	09 00		0.380	1.200	0.020	0.055	0.110
75/10/14	09 30		1.150	1.600	0.035	0.045	0.080

STORET RETRIEVAL DATE 77/03/24

401381
35 36 35.0 095 01 00.0 4
PINE BRANCH CREEK
40 15 WEBBERS FALLS
T/TENKILLER FERRY RES 100991
BRDG ON DIRT RD 1 MI NE OF RES
11EPALES 04001004
0000 FEET DEPTH CLASS 00

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/03	10	30	0.056	0.200	0.020	0.010	0.020
74/12/10	18	30	0.504	1.000	0.030	0.030	0.050
75/01/13	06	30	0.016	2.000	0.032	0.010	0.010
75/02/11			0.015	0.700	0.016	0.008K	0.010K
75/03/06	18	30	0.012	1.150	0.024	0.008K	0.010K
75/04/08	14	10	0.015	1.400	0.025	0.010	0.030
75/04/28	18	45	0.890	1.650	0.025	0.070	0.130
75/05/16	11	15	0.060	0.310	0.075	0.005	0.010K
75/05/29	11	10	0.015	0.150	0.005	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

4013C1
35 55 25.0 094 50 15.0 4
BARRON FORK
40 7.5 WELLING NE
T/TENKILLER FERRY RES 100992
HWY 51 BRDG 0.4 MI SE ELDON JCT W HWY 62
11EPALES 04001004
0000 FEET DEPTH CLASS 00

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/03	12 55		0.576	1.400	0.020	0.060	
74/12/10	14 30		0.740	0.700	0.015	0.015	0.030
75/02/16	14 50		0.687	1.200	0.016	0.015	0.015
75/03/13	11 20		0.690	1.900	0.072	0.032	0.080
75/04/13	16 50		0.590	2.200	0.030	0.015	0.015
75/04/30	17 35		0.590	2.000	0.025	0.025	0.050
75/05/05	15 30		0.510	0.150	0.005K	0.030	0.030
75/05/23	22 00		0.500	0.100	0.010	0.020	0.030
75/05/30	10 00		0.490	0.100	0.005	0.015	0.020
75/06/22	09 40		0.480	1.950	0.090	0.015	
75/07/19	09 50		0.315	1.700	0.035	0.015	0.040
75/08/29	07 50		0.280	0.450	0.025	0.015	0.060
75/09/07	10 15		0.280	0.500	0.020	0.040	0.040
75/10/04	13 35		0.400	1.300	0.030	0.015	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

4013XA AS4013XA P010500
35 54 00.0 094 58 30.0 4
TAHLEQUAH
40 CHEROKEE CO MAP
T/TENKILLER FERRY RESER. 100992
BRANCH CREEK
11EPALES 00001004
0000 FEET DEPTH CLASS 00

/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/06/13	00 00								
CP(T)-			7.700	3.800	0.150	4.400	4.500	1.440	1.600
75/06/13	24 00								
75/07/08	00 00								
CP(T)-			10.500	1.900	0.180	6.400	6.450	0.901	0.958
75/07/08	24 00								
75/07/31			15.000	2.100	0.050	10.000	10.000	0.840	0.861
75/08/21	21 00								
CP(T)-			15.400	2.200	0.110		4.900	0.900	0.820
75/08/21	24 00								
75/09/24			4.700	5.100	0.125	6.300	6.700	0.925	1.030
75/10/15	00 00		15.400	3.300	0.325	9.700	10.000	0.814	0.844
75/11/10	00 00								
CP(T)-			13.800	2.700	0.042	7.700	8.100	0.849	0.796
75/11/10	24 00								
75/12/02	12 00								
CP(T)-			2.880	11.000	1.650	4.500	7.100	1.170	0.970
75/12/03	12 00								
76/01/05	12 00								
CP(T)-			4.100	3.700	0.110	4.700	5.100	0.898	1.100
76/01/06	12 00								
76/02/19	00 00								
CP(T)-			3.525	9.400	1.200	2.750	3.200	0.749	0.739
76/02/20	00 00								

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1974

STATE OF OKLAHOMA

LAKE DATA TO BE USED IN REGRESSION

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
4001	ALTUS RESERVOIR	0.041	0.060	468.625	14.750	8.400	0.010
4002	ARBUCKLE LAKE	0.020	0.070	443.600	7.027	14.600	0.008
4003	LAKE ELLSWORTH	0.037	0.070	459.400	8.430	9.400	0.009
4004	LAKE EUFAULA	0.041	0.405	482.513	4.383	14.200	0.029
4005	FORT COBB RESERVOIR	0.035	0.110	454.667	14.967	8.400	0.012
4006	FORT SUPPLY RESERVOIR	0.070	0.135	485.167	9.733	7.800	0.014
4007	FOSS DAM RESERVOIR	0.027	0.090	463.857	4.862	8.400	0.006
4008	LAKE FRANCES	0.142	1.780	484.333	7.973	8.200	0.093
4009	GRAND LAKE O' THE CHEROK	0.067	0.740	468.857	6.768	14.800	0.038
4010	LAKE HEFNER	0.057	0.250	461.000	5.667	9.000	0.036
4011	KEYSTONE RESERVOIR	0.136	0.690	484.303	21.427	14.900	0.096
4012	OOLOGAH LAKE	0.059	0.580	483.000	5.137	14.600	0.031
4013	TENKILLER FERRY RESERVOI	0.039	0.550	435.500	6.646	15.000	0.016
4014	LAKE THUNDERBIRD	0.027	0.150	465.000	8.422	12.000	0.009
4015	WISTER RESERVOIR	0.080	0.230	478.500	4.812	15.000	0.016
4834	TEXOMA LAKE	0.045	0.160	460.875	12.325	14.600	0.016

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P
4001	ALTUS RESERVOIR	60 (9)	100 (15)	47 (7)	13 (2)	80 (11)	73 (11)
4002	ARBUCKLE LAKE	100 (15)	90 (13)	93 (14)	53 (8)	33 (4)	93 (14)
4003	LAKE ELLSWORTH	80 (12)	90 (13)	80 (12)	33 (5)	60 (9)	87 (13)
4004	LAKE EUFAULA	20 (3)	33 (5)	27 (4)	100 (15)	47 (7)	33 (5)
4005	FORT COBB RESERVOIR	73 (11)	73 (11)	87 (13)	7 (1)	80 (11)	67 (10)
4006	FORT SUPPLY RESERVOIR	33 (5)	67 (10)	0 (0)	27 (4)	100 (15)	60 (9)
4007	FOSS DAM RESERVOIR	93 (14)	80 (12)	60 (9)	87 (13)	80 (11)	100 (15)
4008	LAKE FRANCES	0 (0)	0 (0)	7 (1)	47 (7)	93 (14)	7 (1)
4009	GRAND LAKE O' THE CHEROK	13 (2)	7 (1)	40 (6)	60 (9)	20 (3)	13 (2)
4010	LAKE HEFNER	47 (7)	40 (6)	67 (10)	73 (11)	67 (10)	20 (3)
4011	KEYSTONE RESERVOIR	7 (1)	13 (2)	13 (2)	0 (0)	13 (2)	0 (0)
4012	OOLOGAH LAKE	40 (6)	20 (3)	20 (3)	80 (12)	33 (4)	27 (4)
4013	TENKILLER FERRY RESERVOI	67 (10)	27 (4)	100 (15)	67 (10)	3 (0)	50 (7)
4014	LAKE THUNDERBIRD	87 (13)	60 (9)	53 (8)	40 (6)	53 (8)	80 (12)
4015	WISTER RESERVOIR	27 (4)	47 (7)	33 (5)	93 (14)	3 (0)	40 (6)
4834	TEXOMA LAKE	53 (8)	53 (8)	73 (11)	20 (3)	33 (4)	50 (7)