U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

WISTER RESERVOIR

LEFLORE COUNTY

OKLAHOMA

EPA REGION VI

WORKING PAPER No. 595

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

☆G.P.O. 699-440

REPORT
ON
WISTER RESERVOIR
LEFLORE COUNTY
OKLAHOMA
EPA REGION VI
WORKING PAPER No. 595

WITH THE COOPERATION OF THE

OKLAHOMA DEPARTMENT OF POLLUTION CONTROL

AND THE

OKLAHOMA NATIONAL GUARD

MARCH, 1977

REPORT ON WISTER RESERVOIR

LEFLORE COUNTY, 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. 595

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 Protection 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.

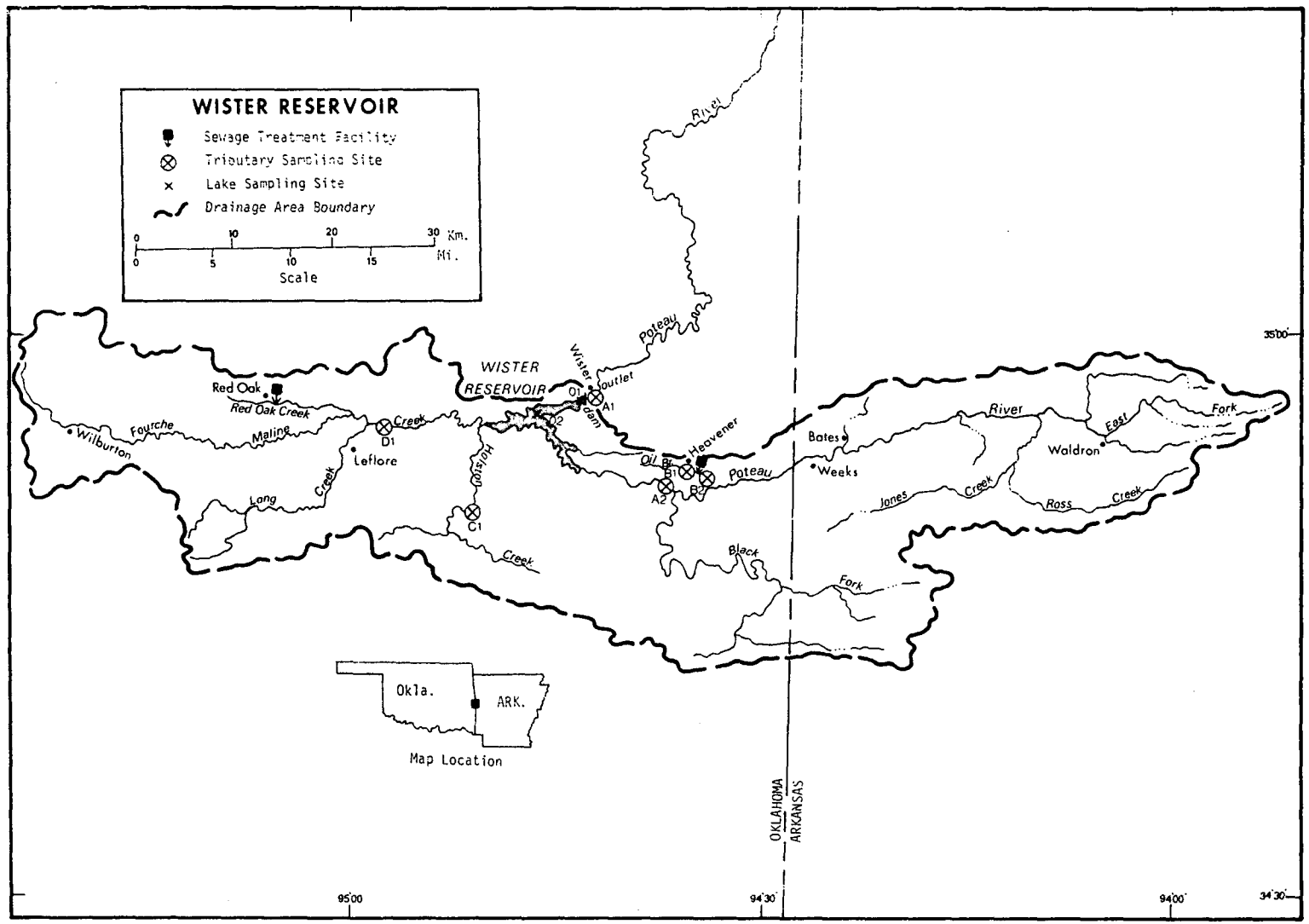
Major General John Coffey, Jr., the Adjutant General of Oklahoma, and Project Officers Colonel Curtis W. Milligan and Major James C. Haney, Jr., who directed the volunteer efforts of the Oklahoma National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

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, Pawnee
Oologah Lake	Nowata, Rogers
Tenkiller Ferry Reservoir	Cherokee, Sequoyah
Lake Thunderbird	Cleveland
Wister Reservoir	LeFlore


WISTER RESERVOIR
Sewage Treatment Facility
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0 10 20 30 Km.
0 5 10 15 Mi.
Scale
WISTER RESERVOIR
Red Oak
Red Oak Creek
Fourche Maline Creek
Wilburton
Leflore
Lang Creek
Holson Creek
Wister Outlet
Dam
Poteau River
Heavener
Oil Creek
Bates
Weeks
Waldron
East Fork
Jones Creek
Ross Creek
Black Fork
O1
A1
D1
C1
A2
B1
B2
Okla.
ARK.
Map Location
OKLAHOMA
ARKANSAS
95°00
94°30
94°00
35°00
34°30

REPORT ON WISTER RESERVOIR, OKLAHOMA

STORET NO. 4015

I. CONCLUSIONS

A. Trophic Condition:*

Survey data indicate that Wister Reservoir is eutrophic, i.e., nutrient rich and 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.

Nutrient levels in Wister Reservoir were quite high: of the 16 Oklahoma lakes (including Lake Texoma) sampled in 1974, only 4 had higher median total phosphorus levels, 7 had higher median inorganic nitrogen values, and 6 had higher median orthophosphorus levels than this reservoir. Potential for primary productivity, as measured by algal assay control yield, was high in spring and moderate during fall sampling. Chlorophyll a values ranged from 2.7 µg/l to 8.4 µg/l, with a mean of 4.8 µg/l.

Survey limnologists did not observe macrophytes or surface algal concentrations during their sampling visits. However, it was noted that the lake at times was very turbid, and the low Secchi disc transparencies (range of 0.3 to 0.9 meters) suggest

*See Appendix E.

that primary productivity in Wister Reservoir may have been light-limited, even though no clear-cut direct relationship was noted between light penetration and chlorophyll a levels.

B. Rate-Limiting Nutrient:

The algal assay results indicate that the primary limiting nutrient in Wister Reservoir was phosphorus at the times of sampling. The lake data indicate phosphorus limitation in June and October, respectively, and primary limitation by nitrogen in March and August.

C. Nutrient Controllability:

1. Point sources -

During the 1974 sampling year, point sources were estimated to have contributed 6.1% of the total phosphorus load to Wister Reservoir. The town of Heavener contributed 4.9% and Red Oak contributed 1.2%.

Loading calculations based upon available nutrient concentrations yield a net export of both phosphorus and nitrogen from the reservoir, indicating that sampling was not adequate to depict actual loading and/or export rates from Wister Reservoir. This export might be attributable to an underestimation of nutrient loading from the known point sources and septic tanks, or to sampling error. It is known that a waterfowl refuge exists on Wister Reservoir; additional study to determine the nutrient impact of this refuge on the reservoir is needed.

The total annual phosphorus loading to Wister Reservoir is 2.89 g $P/m^2/yr$, twice that proposed by Vollenweider (1975) as "eutrophic" for a lake with such volume and hydraulic retention time. However, Vollenweider's model may not be applicable to lakes with short retention times (16 days for Wister Reservoir) or in which epilimnetic light penetration is severely reduced by the presence of suspended sediments in the surface waters. In any case, it does not appear likely that point source phosphorus control would result in any appreciable improvement in the trophic condition of the lake.

2. Nonpoint sources -

Nonpoint sources, including precipitation, were calculated to have contributed 93.9% of the total phosphorus load to Wister Reservoir. The Poteau River contributed 45.2%, Fourche Maline Creek contributed 40.6%, and ungaged tributaries were estimated to contribute 5.0%.

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 means 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: 16.19 km^2.
2. Mean depth: 2.3 meters.
3. Maximum depth: 13.4 meters.
4. Volume: 37.237 x 10^6 m^3.
5. Mean hydraulic retention time: 16 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 Poteau River	1,320.9	14.91
B-1 Oil Branch	4.5	0.04
C-1 Holston Creek	149.7	1.52
D-1 Fourche Maline Creek	686.3	7.36
Minor tributaries and immediate drainage -	393.0	4.35
Totals	2,554.4	28.18
2. Outlet - A-1 Poteau River	2,570.7	27.35

C. Precipitation:

1. Year of sampling: 122.4 cm.
2. Mean annual: 115.4 cm.

III. LAKE WATER QUALITY SUMMARY

Wister 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 two 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 12.2 meters at Station 01 and 10.7 meters at Station 02. 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.

WISTER RESERVOIR
STORET CODE 4015

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(3/28/74) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(6/ 7/74) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(8/26/74) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	4	13.7- 14.5	14.1	0.0- 1.5	4	22.8- 24.2	23.7	0.0- 1.5	4	27.2- 28.2	27.5	0.0- 1.5
MAX DEPTH**	2	9.6- 11.1	10.3	8.5- 9.1	2	21.3- 23.6	22.4	10.7- 12.2	2	22.9- 23.2	23.0	8.2- 9.1
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	2	9.2- 9.4	9.3	1.5- 1.5	2	5.8- 6.8	6.3	1.5- 1.5	4	2.8- 5.2	4.7	0.0- 1.5
MAX DEPTH**	2	8.0- 8.2	8.1	8.5- 9.1	2	5.6- 6.2	5.9	10.7- 12.2	2	0.0- 0.2	0.1	8.2- 9.1
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	4	41.- 46.	44.	0.0- 1.5	4	53.- 63.	59.	0.0- 1.5	4	69.- 75.	71.	0.0- 1.5
MAX DEPTH**	2	39.- 43.	41.	8.5- 9.1	2	43.- 62.	53.	10.7- 12.2	2	136.- 138.	137.	8.2- 9.1
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	4	7.8- 8.1	7.8	0.0- 1.5	4	5.8- 6.8	6.7	0.0- 1.5	4	6.3- 6.5	6.4	0.0- 1.5
MAX DEPTH**	2	7.4- 7.9	7.6	8.5- 9.1	1	6.7- 6.7	6.7	12.2- 12.2	2	6.5- 6.5	6.5	8.2- 9.1
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	4	10.- 10.	10.	0.0- 1.5	4	17.- 20.	19.	0.0- 1.5	4	28.- 32.	31.	0.0- 1.5
MAX DEPTH**	2	10.- 10.	10.	8.5- 9.1	2	11.- 21.	16.	10.7- 12.2	2	38.- 47.	43.	8.2- 9.1
TOTAL P (MG/L)												
0.-1.5 M DEPTH	4	0.059-0.067	0.063	0.0- 1.5	4	0.075-0.099	0.088	0.0- 1.5	4	0.116-0.127	0.119	0.0- 1.5
MAX DEPTH**	2	0.066-0.070	0.068	8.5- 9.1	2	0.107-0.214	0.160	10.7- 12.2	2	0.179-0.183	0.181	8.2- 9.1
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	4	0.016-0.026	0.022	0.0- 1.5	4	0.010-0.017	0.012	0.0- 1.5	4	0.072-0.099	0.077	0.0- 1.5
MAX DEPTH**	2	0.018-0.021	0.019	8.5- 9.1	2	0.011-0.013	0.012	10.7- 12.2	2	0.021-0.047	0.034	8.2- 9.1
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	4	0.070-0.120	0.095	0.0- 1.5	4	0.130-0.160	0.145	0.0- 1.5	4	0.020-0.020	0.020	0.0- 1.5
MAX DEPTH**	2	0.120-0.140	0.130	8.5- 9.1	2	0.150-0.190	0.170	10.7- 12.2	2	0.030-0.030	0.030	8.2- 9.1
AMMONIA (MG/L)												
0.-1.5 M DEPTH	4	0.060-0.070	0.060	0.0- 1.5	4	0.130-0.170	0.150	0.0- 1.5	4	0.060-0.110	0.090	0.0- 1.5
MAX DEPTH**	2	0.100-0.120	0.110	8.5- 9.1	2	0.170-0.180	0.175	10.7- 12.2	2	1.000-1.290	1.145	8.2- 9.1
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	4	0.400-0.600	0.500	0.0- 1.5	4	0.500-0.700	0.650	0.0- 1.5	4	0.400-0.600	0.500	0.0- 1.5
MAX DEPTH**	2	0.400-0.400	0.400	8.5- 9.1	2	0.600-0.800	0.700	10.7- 12.2	2	1.500-1.700	1.600	8.2- 9.1
SECCHI DISC (METERS)												
	2	0.4- 0.5	0.4		2	0.5- 0.5	0.5		2	0.9- 0.9	0.9	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

WISTER RESERVOIR
STORET CODE 4015

PHYSICAL AND CHEMICAL CHARACTERISTICS

(10/21/74)

S*** = 2

PARAMETER	N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)				
0.-1.5 M DEPTH	4	17.7- 17.9	17.8	0.0- 1.5
MAX DEPTH**	2	17.5- 17.7	17.6	7.9- 10.1
DISSOLVED OXYGEN (MG/L)				
0.-1.5 M DEPTH	4	6.0- 8.0	6.8	0.0- 1.5
MAX DEPTH**	2	6.4- 6.4	6.4	7.9- 10.1
CONDUCTIVITY (UMHOS)				
0.-1.5 M DEPTH	4	41.- 43.	42.	0.0- 1.5
MAX DEPTH**	2	41.- 45.	43.	7.9- 10.1
PH (STANDARD UNITS)				
0.-1.5 M DEPTH	4	6.2- 6.2	6.2	0.0- 1.5
MAX DEPTH**	2	6.1- 6.2	6.1	7.9- 10.1
TOTAL ALKALINITY (MG/L)				
0.-1.5 M DEPTH	4	10.- 18.	14.	0.0- 1.5
MAX DEPTH**	2	13.- 16.	15.	7.9- 10.1
TOTAL P (MG/L)				
0.-1.5 M DEPTH	4	0.063-0.077	0.069	0.0- 1.5
MAX DEPTH**	2	0.079-0.104	0.091	7.9- 10.1
DISSOLVED ORTHO P (MG/L)				
0.-1.5 M DEPTH	4	0.007-0.015	0.008	0.0- 1.5
MAX DEPTH**	2	0.007-0.015	0.011	7.9- 10.1
NO2+NO3 (MG/L)				
0.-1.5 M DEPTH	4	0.070-0.150	0.120	0.0- 1.5
MAX DEPTH**	2	0.060-0.130	0.095	7.9- 10.1
AMMONIA (MG/L)				
0.-1.5 M DEPTH	4	0.060-0.140	0.085	0.0- 1.5
MAX DEPTH**	2	0.080-0.110	0.095	7.9- 10.1
KJELDAHL N (MG/L)				
0.-1.5 M DEPTH	4	0.400-0.700	0.550	0.0- 1.5
MAX DEPTH**	2	0.500-0.600	0.550	7.9- 10.1
SECCHI DISC (METERS)				
	2	0.3- 0.5	0.4	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/28/74	1. Melosira	488
	2. Ankistrodesmus	325
	3. Chroomonas	293
	4. Cryptomonas	163
	5. Flagellates	65
	Other genera	358
	Total	1,692
06/07/74	1. Melosira	3,422
	2. Flagellates	254
	3. Nitzschia	95
	4. Coelastrum	32
	Other genera	----
	Total	3,803
08/26/74	1. Melosira	344
	2. Anabaena	31
	3. Ankistrodesmus	31
	4. Closterium	31
	5. Cryptomonas	31
	Other genera	187
	Total	655
10/21/74	1. Melosira	2,479
	2. Dactylococcopsis	303
	3. Nitzschia	220
	4. Kirchneriella	138
	5. Cryptomonas	83
	Other genera	494
	Total	3,717

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
03/28/74	01	5.3
	02	2.6
06/07/74	01	6.5
	02	2.7
08/26/74	01	4.3
	02	3.9
10/21/74	01	4.8
	02	8.4

C. Limiting Nutrient Study -

1. Autoclaved, filtered, and nutrient spiked -

Spike(mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum Yield (mg/l-dry wt.)
a. 03/28/74			
Control	0.020	0.119	2.5
0.05 P	0.070	0.119	4.6
0.05 P + 1.0 N	0.070	1.119	23.0
1.00 N	0.020	1.119	2.3
b. 10/21/74			
Control	0.010	0.158	0.9
0.05 P	0.060	0.158	5.6
0.05 P + 1.0 N	0.060	1.158	17.3
1.00 N	0.010	1.158	0.6

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity in Wister Reservoir was high at the time of spring sampling (03/28/74) and moderate during fall (10/21/74). The control yields would likely have been higher still had there been no substantial nutrient loss between sampling and assay. In both assays, there was a significant increase in yield over that of the control when orthophosphorus was added, indicating phosphorus limitaton. The addition of nitrogen alone did not result in an increase in yield over that of the control.

Mean inorganic nitrogen to orthophosphorus (N/P) ratios in the lake data were 24/1 and 20/1 in June and October, respectively, supporting primary limitation by phosphorus in

Wister Reservoir. Mean N/P ratios were 8/1 and 7/1, respectively, in March and August, however, suggesting nitrogen was the primary limiting nutrient upon those sampling occasions.

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 month of May when two samples were collected. Sampling was begun in November 1974, and was completed 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 nutrient loads, in $kg/km^2/yr$, in Oil Branch and Holston Creek at Stations B-1 and C-1, and multiplying the means by the ZZ area in km^2.

Nutrient loads for the Heavener and Red Oak wastewater treatment plants 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
Heavener	2,000	Trickling filter	0.757**	Oil Branch/ Poteau River
Red Oak	500	Stabilization pond	0.189**	Red Oak Creek/ Fourche Maline Creek

2. Known industrial - None

*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 Poteau River	21,140	45.2
B-1 Oil Branch	25	0.1
C-1 Holston Creek	1,110	2.4
D-1 Fourche Maline Creek	18,965	40.6
b. Minor tributaries and immediate drainage (nonpoint load) -	2,360	5.0
c. Known municipal STP's -		
Heavener	2,270	4.9
Red Oak	565	1.2
d. Septic tanks* -	5	<0.1
e. Known industrial - None		
f. Direct precipitation** -	285	0.6
Totals	46,725	100.0

2. Output - A-1 Poteau River 58,145

3. Net annual P export*** - 11,420

*Estimate based on 10 lakeshore residences and 1 park.
**Estimated (see NES Working Paper No. 175).
***Export probably due to unknown sources and/or sampling error.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source		kg N/yr	% of total
a.	Tributaries (nonpoint load) -		
	A-2 Poteau River	360,475	54.3
	B-1 Oil Branch	815	0.1
	C-1 Holston Creek	21,695	3.3
	D-1 Fourche Maline Creek	191,125	28.8
b.	Minor tributaries and immediate drainage (nonpoint load) -	64,060	9.6
c.	Known municipal STP's -		
	Heavener	6,800	1.0
	Red Oak	1,700	0.3
d.	Septic tanks* -	140	<0.1
e.	Known industrial - None		
f.	Direct precipitation** -	17,480	2.6
	Totals	664,290	100.0

2. Output - A-1 Poteau River 791,155

3. Net annual N export*** - 126,865

*Estimate based on 10 lakeshore residences and 1 park.
**Estimated (see NES Working Paper No. 175).
***Export probably due to unknown sources and/or sampling error.

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Poteau River	16	273
Oil Branch	5	181
Holston Creek	7	145
Fourche Maline Creek	28	278

E. 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 from high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading ($g/m^2/yr$)
Estimated loading for Wister Reservoir	2.89
Vollenweider's "eutrophic" loading	1.46
Vollenweider's "oligotrophic" loading	0.73

IV. 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 4015 OWISTER RES.

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 2570.7

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4015A1	2570.7	35.40	37.94	51.54	52.67	62.86	19.26	9.06	8.21	5.66	7.36	16.42	22.37	27.35
4015A2	1320.9	20.39	26.19	27.18	26.53	30.87	7.90	4.53	2.27	3.06	4.11	8.98	17.56	14.91
401581	4.5	0.023	0.031	0.045	0.045	0.125	0.031	0.028	0.011	0.034	0.028	0.020	0.020	0.037
4015C1	149.7	1.13	1.70	2.46	2.41	3.85	1.22	1.13	0.40	1.02	1.08	0.85	0.99	1.52
4015D1	686.3	5.10	11.61	12.18	17.27	16.99	5.38	5.10	1.39	2.27	2.41	3.68	5.38	7.36
4015ZZ	409.2	3.11	6.51	7.08	9.63	10.19	3.11	3.11	0.85	1.70	1.70	2.27	3.11	4.35

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 2570.7
SUM OF SUB-DRAINAGE AREAS = 2570.7
TOTAL FLOW IN = 339.37
TOTAL FLOW OUT = 328.76

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4015A1	11	74	91.180	2	1.699				
	12	74	92.313	17	88.915				
	1	75	22.653	15	34.263				
	2	75	84.384	13	109.586				
	3	75	82.402	28	0.425				
	4	75	73.624	22	3.058				
	5	75	61.164	12	112.984	22	30.299		
	6	75	63.996	12	88.349				
	7	75	31.998	8	30.016				
	8	75	0.566	15	0.566				
	9	75	0.453						
	10	75	0.368	7	0.396				
4015A2	11	74	60.315	2	22.625				
	12	74	15.291	17	11.298				
	1	75	15.999	15	11.298				
	2	75	45.873	13	13.592				
	3	75	60.315	28	484.218				
	4	75	42.475	22	0.0				
	5	75	33.131	12	17.698	22	8.382		
	6	75	34.547	12	21.691				
	7	75	1.557	8	1.926				
	8	75	0.368	15	0.113				
	9	75	0.510						
	10	75	0.368	7	0.122				

TRIBUTARY FLOW INFORMATION FOR OKLAHOMA 03/25/77

LAKE CODE 4015 OOLOGAH RES.

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4015B1	11	74	0.238	2	0.142				
	12	74	0.062	17	0.051				
	1	75	0.068	15	0.028				
	2	75	0.212	13	0.062				
	3	75	0.147	28	1.189				
	4	75	0.105	22	0.020				
	5	75	0.105	12	0.040	22	0.017		
	6	75	0.139	12	0.031				
	7	75	0.008	8	0.008				
	8	75	0.002	15	0.0				
	9	75	0.006						
	10	75	0.001	7	0.0				
4015C1	11	74	7.900	2	15.008				
	12	74	2.095	17	1.274				
	1	75	2.265	15	1.133				
	2	75	7.079	13	1.699				
	3	75	4.814	28	15.008				
	4	75	3.398	22	0.736				
	5	75	3.398	12	1.699	22	0.538		
	6	75	4.531	12	1.416				
	7	75	0.283	8	0.368				
	8	75	0.057	15	0.252				
	9	75	0.193						
	10	75	0.025	7	0.028				
4015D1	11	74	36.246	2	68.244				
	12	74	9.628	17	5.947				
	1	75	10.477	15	7.362				
	2	75	32.281	13	7.646				
	3	75	22.370	28	66.261				
	4	75	15.857	22	2.039				
	5	75	16.141	12	8.212	22	1.727		
	6	75	20.954	12	6.796				
	7	75	1.359	8	1.671				
	8	75	0.258	15	1.161				
	9	75	0.878						
	10	75	0.122	7	0.136				
4015ZZ	11	74	21.521						
	12	74	5.663						
	1	75	6.230						
	2	75	19.255						
	4	75	9.345						
	5	75	9.628						
	6	75	12.459						
	7	75	0.850						
	8	75	0.153						
	9	75	0.566						
	10	75	0.074						

APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 77/03/28

401501
34 56 15.0 094 43 10.0 3
WISTER RESERVOIR
40079 OKLAHOMA

100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0035 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
74/03/28	16 15	0000	14.5		15	41	7.80	10K	0.060	0.500	0.120	0.026
	16 15	0005	14.5	9.4		42	8.10	10K	0.060	0.500	0.120	0.025
	16 15	0015	12.0	8.4		40	8.10	10K	0.100	0.400	0.130	0.030
	16 15	0030	11.1	8.2		39	7.90	10K	0.120	0.400	0.140	0.021
74/06/07	14 30	0000	24.2		18	62	6.80	20	0.170	0.700	0.150	0.012
	14 30	0005	24.1	6.8		63	6.70	20	0.160	0.500	0.160	0.012
	14 30	0025	23.7	6.6		62	6.90	19	0.160	0.500	0.160	0.010
	14 30	0040	23.6	6.2		62	6.70	21	0.180	0.600	0.150	0.011
74/08/26	13 30	0000	27.2	4.4	36	69	6.44	30	0.090	0.600	0.020	0.078
	13 30	0005	27.2	5.0		69	6.50	31	0.090	0.400	0.020	0.077
	13 30	0015	25.0	0.2		98	6.47	41	0.520	0.900	0.030	0.070
	13 30	0030	22.9	0.2		136	6.53	47	1.000	1.500	0.030	0.021
74/10/21	14 25	0000	17.7	6.0	12	41	6.18	18	0.140	0.700	0.150	0.010
	14 25	0005	17.7	6.8		41	6.17	14	0.090	0.400	0.140	0.007
	14 25	0020	17.6	6.0		43	6.15	13	0.100	0.400	0.130	0.007
	14 25	0033	17.5	6.4		41	6.17	13	0.110	0.500	0.130	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/28

401501
34 56 15.0 094 43 10.0 3
WISTER RESERVOIR
40079 OKLAHOMA
100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0035 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
74/03/28	16	15 0000	0.061	5.3	
	16	15 0005	0.059		
	16	15 0015	0.064		
	16	15 0030	0.066		
74/06/07	14	30 0000	0.087	6.5	
	14	30 0005	0.075		
	14	30 0025	0.082		
	14	30 0040	0.107		
74/08/26	13	30 0000	0.118	4.3	
	13	30 0005	0.116		
	13	30 0015	0.136		
	13	30 0030	0.183		
74/10/21	14	25 0000	0.075	4.8	
	14	25 0002			1.0
	14	25 0005	0.063		
	14	25 0020	0.078		
	14	25 0033	0.079		

STORET RETRIEVAL DATE 77/03/28

401502
34 55 52.0 094 46 32.0 3
WISTER RESERVOIR
40079 OKLAHOMA
100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0033 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
74/03/28	16 35	0000	13.8		19	46	7.80	10K	0.060	0.400	0.070	0.019
	16 35	0005	13.7	9.2		46	7.80	10K	0.070	0.600	0.070	0.016
	16 35	0015	10.9	8.2		47	7.60	10K	0.090	0.400	0.110	0.024
	16 35	0028	9.6	8.0		43	7.40	10K	0.100	0.400	0.120	0.018
74/06/07	15 00	0000	23.3		18	56	6.80	17	0.140	0.700	0.130	0.010
	15 00	0005	22.8	5.8		53	5.80	17	0.130	0.600	0.140	0.017
	15 00	0015	21.9	5.8		48		13	0.110	0.600	0.160	0.015
	15 00	0035	21.3	5.6		43		11	0.170	0.800	0.190	0.013
74/08/26	13 00	0000	28.2	5.2	36	73	6.44	28	0.060	0.600	0.020K	0.099
	13 00	0005	27.8	2.8		75	6.28	32	0.110	0.400	0.020K	0.072
	13 00	0015	25.9	0.0		95	6.33	38	0.400	0.900	0.030	0.039
	13 00	0027	23.2	0.0		138	6.53	38	1.290	1.700	0.030	0.047
74/10/21	14 50	0000	17.9	8.0	18	43	6.17	10	0.060	0.700	0.100	0.015
	14 50	0005	17.8	6.8		43	6.17	13	0.080	0.400	0.070	0.007
	14 50	0015	17.8	6.2		43	6.15	15	0.080	0.400	0.060	0.008
	14 50	0026	17.7	6.4		45	6.11	16	0.080	0.600	0.060	0.007

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/28

401502
34 55 52.0 094 46 32.0 3
WISTER RESERVOIR
40079 OKLAHOMA
100991

/TYPA/AMBNT/LAKE

11EPALES 04001002
0033 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
74/03/28	16	35 0000	0.066	2.6	
	16	35 0005	0.067		
	16	35 0015	0.067		
	16	35 0028	0.070		
74/06/07	15	00 0000	0.090	2.7	
	15	00 0005	0.099		
	15	00 0015	0.119		
	15	00 0035	0.214		
74/08/26	13	00 0000	0.121	3.9	
	13	00 0005	0.127		
	13	00 0015	0.156		
	13	00 0027	0.179		
74/10/21	14	50 0000	0.077	8.4	
	14	50 0003			1.0
	14	50 0005	0.063		
	14	50 0015	0.073		
	14	50 0026	0.104		

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 77/03/24

4315A1
34 56 05.0 094 37 40.0 4
POTEAU RIVER
40 15 HEAVENER
O/LAKE WISTER RESERVOIR 100991
OUTLET OF WISTER DAM 2.5 MI SE OF WISTER
/TYPA/AMBNT/STREAM
11EPALES 04001004
0000 FEET DEPTH CLASS 00

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	11	20	0.116	0.500	0.072	0.012	0.050
74/12/17	14	08	0.104	0.600	0.270	0.060	0.070
75/01/15	11	10	0.080	2.500	0.064	0.015	0.080
75/02/13	10	45	0.080	0.600	0.064	0.016	0.060
75/03/28	10	25	0.060	0.650	0.060	0.010	0.090
75/04/22	10	28	0.015	0.950	0.025	0.010	0.100
75/05/12	11	01	0.040	0.900	0.080	0.010	0.060
75/05/22	13	19	0.020	0.650	0.085	0.010	0.050
75/06/12	12	53	0.010	0.650	0.050	0.010	0.060
75/07/08	13	02	0.015	1.200	0.230	0.100	0.200
75/08/15	10	45	0.025	1.200	0.540	0.055	0.110
75/10/07	13	40	0.290	0.700	0.035	0.005	0.080

STORET RETRIEVAL DATE 77/03/24

401542
34 51 30.0 094 47 00.0 4
POTEAU RIVER
40 15 HEAVENER
T/LAKE WISTER RESERVOIR 100992
HWY 290/59 BRDG 2.7 MI SW OF HEAVENER
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 00		0.080	0.600	0.055	0.020	0.080
74/12/17	14 35		0.072	0.500	0.030	0.010	0.040
75/01/15	13 36		0.048	0.600	0.032	0.010	0.050
75/02/13	13 15		0.088	0.500	0.056	0.016	0.030
75/03/28	12 15		0.100	1.150	0.080	0.025	
75/04/22	12 15		0.005	0.500	0.010	0.005	0.040
75/05/12	11 45		0.050	0.400	0.022	0.010	0.040
75/05/22	14 05		0.005	0.300	0.020	0.010	0.050
75/06/12	13 35		0.065	2.200	0.130	0.010	0.070
75/07/08	13 40		0.005	0.450	0.025	0.005	0.040
75/08/15	12 00		0.015	0.700	0.025	0.005	0.040
75/10/07	14 45		0.005	0.300	0.020	0.005K	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

401581
34 52 20.0 094 36 20.0 4
OIL BRANCH
40 15 HEAVENER
T/LAKE WISTER RESERVOIR 100991
HWY 270 BRDG 1.0 MI S HEAVENER ABOV STP
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	11	45	0.224	0.100	0.030	0.010	0.020
74/12/17	14	25	0.212	0.600	0.040	0.010	0.010
75/01/15	13	58	0.168	2.300	0.072	0.005	0.020
75/02/13	13	30	0.208	0.200	0.016	0.008K	0.010K
75/03/28	12	20	0.095	0.850	0.052	0.022	0.125
75/04/22	12	21	0.035	0.300	0.020	0.005K	0.020
75/05/12	11	33	0.160	0.250	0.035	0.010	0.020
75/05/22	13	56	0.115	0.525	0.055	0.005	0.010
75/06/12	13	25	0.110	0.300	0.030	0.005	0.020
75/07/08	13	30	0.065	0.550	0.120	0.005	0.020
75/08/15	11	40	0.040	1.600	0.115	0.020	
75/10/07	14	30	0.005	0.500	0.045	0.005	0.030

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

401582
34 51 45.0 094 34 30.0 4
OIL BRANCH
40 15 HEAVENER
T/LAKE WISTER RESERVOIR 100991
2NDRY RD BRDG 2.6 MI SE HEAVENER BLO STP
/TYPA/AMBNT/STREAM
11EPALES 04001004
0000 FEET DEPTH CLASS 00

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	20	0.256	0.700	0.100	0.120	0.200
74/12/17	14	57	0.640	1.300	0.260	0.375	0.690
75/01/15	14	16	0.830	4.800	0.940	1.400	1.500
75/02/13	13	50	0.510	1.900	0.448	0.390	0.720
75/03/28	12	30	0.095	1.150	0.065		0.210
75/04/22	12	33	1.650	1.350	0.200	1.570	1.700
75/05/12	11	22	1.050	0.800	0.080	0.360	0.500
75/05/22	13	39	1.050	2.000	0.770	1.150	0.130
75/06/12	13	14	0.450	0.800	0.095	0.210	0.340
75/07/08	13	21	1.150	2.300	1.250	1.950	2.000
75/08/15	11	20	0.250	8.750	6.550	10.800	12.000
75/10/07	14	10	0.630	6.500	3.900	7.500	8.200

STORET RETRIEVAL DATE 77/03/24

4015C1
34 50 40.0 094 51 00.0 4
HOLSON CREEK
40 LEFLORE CO MAP
T/LAKE WISTER RESERVOIR 100992
2NDRY RD XING 4 MI S OF SUMMERFIELD
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	10	20	0.048	0.200	0.025	0.010	0.020
74/12/17	13	28	0.032	0.400	0.135	0.010	0.010
75/01/15	12	47	0.016	0.500	0.074	0.015	0.020
75/02/13	12	25	0.020	0.100	0.010	0.005	0.010
75/03/28	11	25	0.025	0.750	0.120	0.010	0.090
75/04/22	11	35	0.005	0.350	0.035	0.005	0.025
75/05/12	12	48	0.015	1.400	0.030	0.005	0.020
75/05/22	14	32	0.015	0.300	0.020	0.010	0.020
75/06/12	14	21	0.020	0.350	0.025	0.010	0.040
75/07/08	14	14	0.030	0.275	0.230	0.010	0.010
75/08/15	12	50	0.025	0.250	0.020	0.005K	0.010
75/10/07	15	35	0.010	0.300	0.015	0.010	0.025

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 77/03/24

401501
34 55 10.0 095 54 20.0 4
FOURCHE MOLINE
40 7.5 LEFLORE
T/LAKE WISTER RESERVOIR 101392
2NDRY RD BRDG 3.6 MI NE OF LEFLORE
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	09 30		0.024	0.700	0.040	0.050	0.130
74/12/17	13 00		0.064	0.700	0.040	0.020	0.050
75/01/15	12 21		0.064	1.000	0.040	0.035	0.100
75/02/13	11 55		0.056	0.300	0.032	0.024	0.050
75/03/28	11 03		0.050	1.300	0.085	0.025	
75/04/22	11 04		0.010	1.250	0.020	0.010	0.050
75/05/12	12 55		0.105	0.600	0.060	0.020	0.100
75/05/22	14 53		0.107	0.600	0.025	0.022	0.090
75/06/12	14 42		0.070	0.650	0.035	0.025	0.120
75/07/08	14 36		0.100	0.400	0.040	0.015	0.060
75/08/15	13 25		0.010	0.850	0.040	0.015	0.100
75/10/07	16 00		0.010	0.500	0.010	0.012	0.110

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1974

STATE OF OKLAHOMA

LAKE DATA TO BE USED IN RANKINGS

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	0.061	0.405	482.513	4.383	14.200	0.029
4005	FORT COBB RESERVOIR	0.036	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	0.087	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)