

**U.S. ENVIRONMENTAL PROTECTION AGENCY  
NATIONAL EUTROPHICATION SURVEY  
WORKING PAPER SERIES**



REPORT  
ON  
CEDAR BLUFF RESERVOIR  
TREGO COUNTY  
KANSAS  
EPA REGION VII  
WORKING PAPER No. 511

**CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON  
and  
ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA**

REPORT  
ON  
CEDAR BLUFF RESERVOIR  
TREGO COUNTY  
KANSAS  
EPA REGION VII  
WORKING PAPER No. 511

WITH THE COOPERATION OF THE  
KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT  
AND THE  
KANSAS NATIONAL GUARD  
MAY, 1977

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## F O R E W O R D

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 non-point 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 EPA and to augment plans implementation by the states.

#### ACKNOWLEDGMENT

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

The staff of the Kansas Division of Environmental Health provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Edward R. Fry, the Adjutant General of Kansas, and Project Officer Colonel Albin L. Lundquist, who directed the volunteer efforts of the Kansas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

## NATIONAL EUTROPHICATION SURVEY

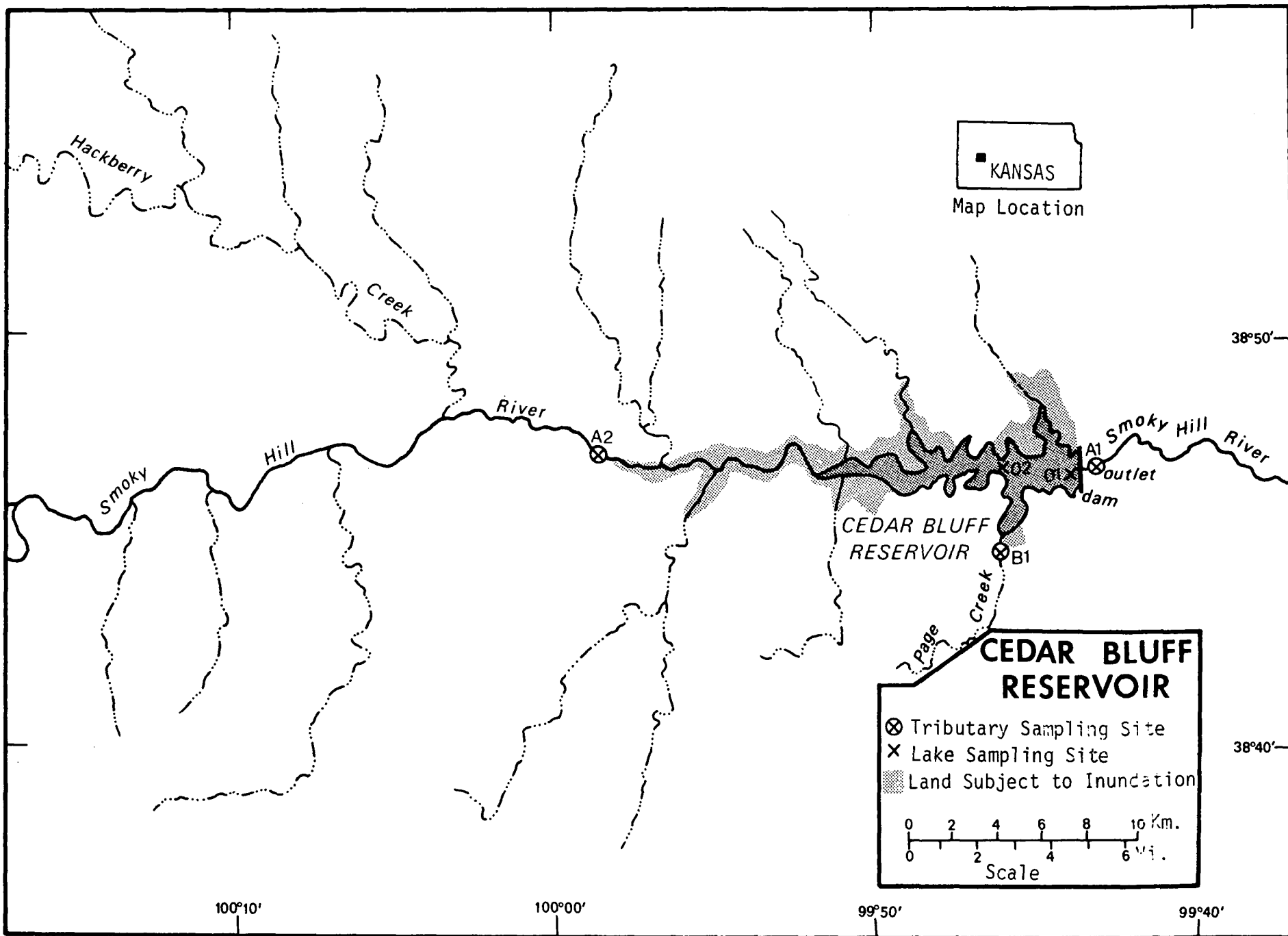
## STUDY RESERVOIRS

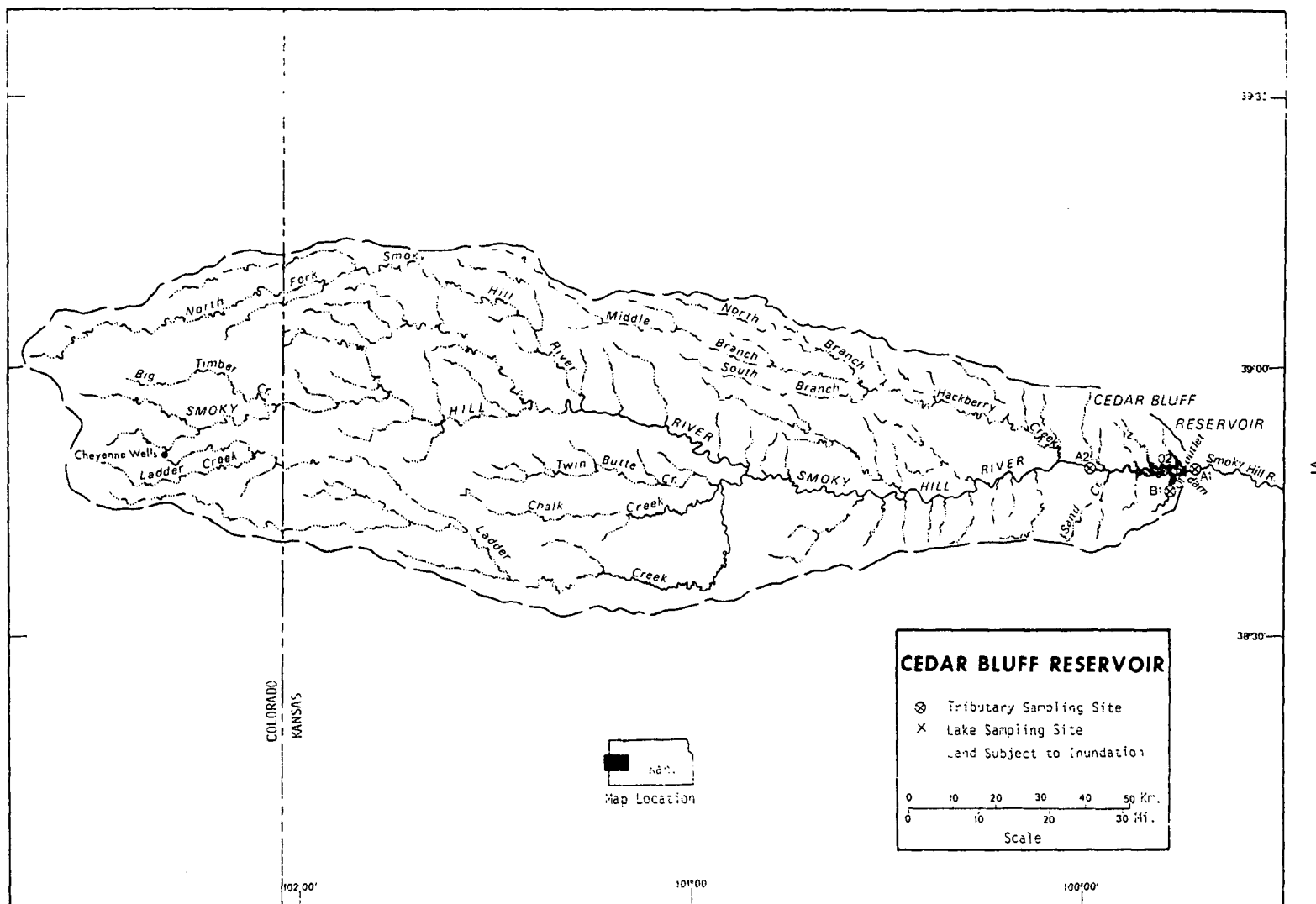
STATE OF KANSASNAME

Cedar Bluff  
Council Grove  
Elk City  
Fall River  
John Redmond  
Kanopolis  
Marion  
Melvern  
Milford  
Norton  
Perry  
Pomona  
Toronto  
Tuttle Creek  
Wilson

COUNTY

Trego  
Morris  
Montgomery  
Greenwood  
Coffey, Lyon  
Ellsworth  
Marion  
Osage  
Clay, Geary  
Norton  
Jefferson  
Osage  
Greenwood, Woodson  
Marshall, Pottawatomie, Riley  
Russell







## CEDAR BLUFF RESERVOIR

STORET NO. 2001

### I. CONCLUSIONS

#### A. Trophic Condition:

Survey data indicate Cedar Bluff Reservoir is mesotrophic. It ranked first in overall trophic quality when the 15 Kansas reservoirs sampled in 1974 were compared using a combination of six parameters\*. None of the other reservoirs had less median total phosphorus, one had less and one had the same median dissolved orthophosphorus, none had less median inorganic nitrogen, one had less mean chlorophyll a, and none had greater mean Secchi disc transparency. Some depression of dissolved oxygen (to 50% of saturation) occurred at sampling station 2 in June.

Survey limnologists did not observe algal concentrations or aquatic macrophytes and commented on the pleasing appearance of the reservoir in June.

#### B. Rate-Limiting Nutrient:

The algal assay results indicate Cedar Bluff Reservoir was phosphorus limited at the time the sample was taken (04/15/74).

The reservoir data indicate phosphorus limitation in April but nitrogen limitation in October.

#### C. Nutrient Controllability:

1. Point sources--No known municipal or industrial wastewater

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\* See Appendix A.

treatment plants impacted Cedar Bluff Reservoir during the sampling year. Septic tanks serving shoreline dwellings and recreational areas contributed an estimated 0.1% of the total phosphorus load, but a shoreline survey would have to be done to determine the actual significance of those sources.

The apparent phosphorus loading of  $0.17 \text{ g/m}^2/\text{yr}$  is a little more than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as an oligotrophic loading (i.e., a mesotrophic loading; see page 13). However, the level of the reservoir averaged about 4 meters below the conservation pool level during water year 1975 (10/01/74-09/30/75), and the area of the reservoir at that level is not known (Kring, 1977). Obviously, the area was less than the 26.84 square kilometers indicated on page 4; and, therefore, the actual areal phosphorus loading during the sampling year (10/74-09/75) was somewhat greater than  $0.17 \text{ gm/m}^2$  but probably was still in the mesotrophic range (i.e., with the phosphorus loading measured during the sampling year, 4,435 kg, the area at minus 4 meters would have to be 41% less than that at the conservation pool level to result in an areal loading just equal to Vollenweider's eutrophic level of  $0.28 \text{ g/m}^2/\text{yr}$ ).

If the loading is not increased significantly, the existing quality of the reservoir should persist.

2. Non-point sources--Non-point source phosphorus inputs amounted to 99.9% of the total phosphorus load to Cedar Bluff Reservoir during the sampling year. The Smokey Hill River contributed 64.3% of the total, and ungaged tributaries contributed an estimated 24.7%.

The non-point phosphorus export rate of the Smokey Hill River was  $0.2 \text{ kg/km}^2/\text{yr}$ . This rate is very low compared to the rates of Kansas tributaries sampled elsewhere.

## II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS<sup>†</sup>

### A. Morphometry<sup>††</sup>:

1. Surface area: 26.84 kilometers<sup>2</sup>.
2. Mean depth: 8.5 meters.
3. Maximum depth: 20.0 meters.
4. Volume:  $228.272 \times 10^6$  m<sup>3</sup>.
5. Mean hydraulic retention time: 4.3 years (based on outflow).

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

#### 1. Tributaries -

<u>Name</u>	<u>Drainage area (km<sup>2</sup>)*</u>	<u>Mean flow (m<sup>3</sup>/sec)*</u>
Smoky Hill River	13,519.8	2.100
Minor tributaries & immediate drainage -	<u>775.1</u>	<u>0.600</u>
Totals	14,294.9	2.700

#### 2. Outlet -

Smoky Hill River	14,322.7**	1.700
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### C. Precipitation\*\*\*:

1. Year of sampling: 36.3 centimeters.
2. Mean annual: 59.7 centimeters.

† Table of metric conversions--Appendix B.

†† At conservation pool level; Kring, 1977.

\* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".

\*\* Includes area of reservoir.

\*\*\* See Working Paper No. 175.

### III. WATER QUALITY SUMMARY

Cedar Bluff Reservoir was sampled three 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 a number of depths at two stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 9.1 meters at station 1 and 10.7 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table (the June nutrient samples were not properly preserved and were not analyzed).

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR CEDAR BLUFF RESERVOIR  
STORET CODE 2001

PARAMETER	1ST SAMPLING ( 4/15/74)				2ND SAMPLING ( 6/26/74)				3RD SAMPLING (10/ 1/74)			
	2 SITES				2 SITES				2 SITES			
	RANGE	MEAN	MEDIAN		RANGE	MEAN	MEDIAN		RANGE	MEAN	MEDIAN	
TEMP (C)	9.0 - 9.2	9.1	9.2		21.1 - 23.4	22.4	22.4		15.9 - 16.9	16.6	16.6	
DISS OXY (MG/L)	10.0 - 10.2	10.1	10.0		4.2 - 7.8	7.0	7.6		8.0 - 8.6	8.4	8.4	
CNDCTVY (MCROMO)	530. - 701.	635.	655.		976. - 1029.	1006.	1005.		960. - 968.	965.	965.	
PH (STAND UNITS)	8.2 - 8.2	8.2	8.2		8.1 - 8.5	8.4	8.4		7.8 - 7.9	7.8	7.8	
TOT ALK (MG/L)	116. - 134.	125.	124.		***** -*****				118. - 121.	119.	119.	
TOT P (MG/L)	0.017 - 0.024	0.019	0.018		***** -*****				0.012 - 0.023	0.015	0.014	
ORTHO P (MG/L)	0.003 - 0.011	0.005	0.004		***** -*****				0.002 - 0.011	0.005	0.003	
NO2+NO3 (MG/L)	0.020 - 0.060	0.035	0.030		***** -*****				0.020 - 0.020	0.020	0.020	0
AMMONIA (MG/L)	0.030 - 0.070	0.036	0.030		***** -*****				0.020 - 0.040	0.025	0.020	
KJEL N (MG/L)	0.500 - 1.000	0.662	0.700		***** -*****				0.400 - 0.600	0.512	0.500	
INORG N (MG/L)	0.050 - 0.130	0.071	0.060		***** -*****				0.040 - 0.060	0.045	0.040	
TOTAL N (MG/L)	0.520 - 1.060	0.697	0.730		***** -*****				0.420 - 0.620	0.532	0.520	
CHLRPYL A (UG/L)	3.6 - 12.4	8.0	8.0		0.6 - 1.5	1.0	1.0		2.9 - 4.3	3.6	3.6	
SECCHI (METERS)	0.7 - 0.7	0.7	0.7		2.3 - 3.6	2.9	2.9		1.5 - 1.7	1.6	1.6	

## B. Biological Characteristics:

## 1. Phytoplankton -

<u>Sampling Date</u>	<u>Dominant Genera</u>	<u>Algal Units per ml</u>
04/15/74	1. <u>Synedra sp.</u>	312
	2. <u>Cyclotella sp.</u>	69
	3. <u>Cryptomonas sp.</u>	35
	4. <u>Oocystis sp.</u>	35
	5. <u>Scenedesmus sp.</u>	35
	Total	486
06/26/74	1. <u>Chroomonas sp.</u>	437
	2. <u>Cryptomonas sp.</u>	38
	3. <u>Carteria sp.</u>	19
	4. <u>Dinobryon sp.</u>	19
	5. <u>Stephanodiscus sp.</u>	19
	Total	532
10/01/74	1. <u>Chroomonas sp.</u>	1,041
	2. <u>Dactylococcopsis sp.</u>	337
	3. <u>Cryptomonas sp.</u>	123
	4. <u>Oocystis sp.</u>	123
	5. <u>Scenedesmus sp.</u>	123
	Other genera	366
	Total	2,113

2. Chlorophyll a -

<u>Sampling Date</u>	<u>Station Number</u>	<u>Chlorophyll a (µg/l)</u>
04/15/74	1	12.4
	2	3.6
06/26/74	1	1.5
	2	0.6
10/01/74	1	4.3
	2	2.9

## C. Limiting Nutrient Study:

## 1. Autoclaved, filtered, and nutrient spiked -

<u>Spike (mg/l)</u>	<u>Ortho P Conc. (mg/l)</u>	<u>Inorganic N Conc. (mg/l)</u>	<u>Maximum yield (mg/l-dry wt.)</u>
Control	0.005	0.057	0.1
0.050 P	0.055	0.057	1.0
0.050 P + 1.0 N	0.055	1.057	11.5
1.0 N	0.005	1.057	0.1

## 2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Cedar Bluff Reservoir was low at the time the sample was taken (04/15/74). The significant increase in yield with the addition of phosphorus alone and the lack of significant increase when only nitrogen was added indicate that the reservoir was phosphorus limited at that time.



The reservoir data indicate phosphorus limitation in April but nitrogen limitation in October. The mean inorganic nitrogen to orthophosphorus ratios were 14 to 1 in April and 9 to 1 in October.

#### IV. NUTRIENT LOADINGS (See Appendix E for data)

For the determination of nutrient loadings, the Kansas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the months of May, June, and July when two samples were collected. Sampling was begun in October, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Kansas District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Page Creek at station B-1 and the mean annual ZZ flow.

No known wastewater treatment plants impacted Cedar Bluffs Reservoir during the sampling year.

##### A. Waste Sources:

1. Known municipal - None
2. Known industrial - None

## B. Annual Total Phosphorus Loading - Average Year:

## 1. Inputs -

<u>Source</u>	<u>kg P/ yr</u>	<u>% of total</u>
a. Tributaries (non-point load) -		
Smoky Hill River	2,850	64.3
b. Minor tributaries & immediate drainage (non-point load) -	1,095	24.7
c. Known municipal STP's - None	-	-
d. Septic tanks* -	5	0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	<u>485</u>	<u>10.9</u>
Total	4,435	100.0

## 2. Outputs -

Reservoir outlet - Smoky Hill River 2,090

## 3. Net annual P accumulation - 2,345 kg.

\* Estimate based on 6 shoreline dwellings and 2 campgrounds; see Working Paper No. 175.

\*\* See Working Paper No. 175.

## C. Annual Total Nitrogen Loading - Average Year:

## 1. Inputs -

<u>Source</u>	<u>kg N/ yr</u>	<u>% of total</u>
a. Tributaries (non-point load) -		
Smoky Hill River	92,515	58.7
b. Minor tributaries & immediate drainage (non-point load) -	35,025	22.2
c. Known municipal STP's - None	-	-
d. Septic tanks* -	205	0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	<u>30,000</u>	<u>19.0</u>
Total	157,745	100.0

## 2. Outputs -

Reservoir outlet - Smoky Hill River 73,875

## 3. Net annual N accumulation - 83,870 kg.

## D. Non-point Nutrient Export by Subdrainage Area:

<u>Tributary</u>	<u>kg P/km<sup>2</sup>/yr</u>	<u>kg N/km<sup>2</sup>/yr</u>
Smoky Hill River	0.2	6.8

## E. Mean Nutrient Concentrations in Ungaged Stream:

<u>Tributary</u>	<u>Mean Total P Conc. (mg/l)</u>	<u>Mean Total N Conc. (mg/l)</u>
Page Creek	0.058	1.851

\* Estimate based on 6 shoreline dwellings and 2 campgrounds; see Working Paper No. 175.

\*\* See Working Paper No. 175.

## F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" 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 "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	<u>Total Phosphorus</u>		<u>Total Nitrogen</u>	
	<u>Total</u>	<u>Accumulated</u>	<u>Total</u>	<u>Accumulated</u>
grams/m <sup>2</sup> /yr	0.17	0.08	5.9	3.1

Vollenweider phosphorus loadings  
(g/m<sup>2</sup>/yr) based on mean depth and mean  
hydraulic retention time of Cedar Bluff Reservoir:

"Dangerous" (eutrophic loading)	0.28
"Permissible" (oligotrophic loading)	0.14

## V. LITERATURE REVIEWED

Kring, R. Lynn, 1977. Personal communication (reservoir morphometry).  
KS Dept. of Health & Environment, Topeka.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of  
the phosphorus loading concept to eutrophication research.  
Natl. Res. Council of Canada Publ. No. 13690, Canada Centre  
for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

## 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
2001	CEDAR BLUFF RESERVOIR	0.017	0.055	431.667	4.217	10.800	0.004
2002	COUNCIL GROVE	0.069	0.830	485.889	9.789	10.400	0.028
2003	ELK CITY	0.030	0.590	490.400	3.212	14.000	0.003
2004	FALL RIVER RESERVOIR	0.053	0.470	488.667	7.683	9.200	0.016
2005	JOHN REDMOND RESERVOIR	0.118	1.250	492.667	9.467	8.200	0.066
2006	KANOPOLIS RESERVOIR	0.056	0.640	487.000	16.033	10.200	0.011
2007	MARION RESERVOIR	0.052	0.430	483.667	12.400	9.000	0.010
2008	MELVERN RESERVOIR	0.034	0.265	459.111	30.400	14.400	0.007
2009	MILFORD RESERVOIR	0.079	0.710	466.333	18.883	12.800	0.036
2010	NORTON RESERVOIR	0.122	0.110	476.750	21.360	8.000	0.036
2011	PERRY RESERVOIR	0.055	0.970	478.571	5.614	13.400	0.017
2012	POMONA RESERVOIR	0.040	1.240	481.333	8.312	13.000	0.021
2013	TORONTO RESERVOIR	0.067	0.425	488.500	6.583	13.000	0.011
2014	TUTTLE CREEK RESERVOIR	0.162	0.970	470.667	11.278	13.600	0.067
2015	WILSON RESERVOIR	0.023	0.265	445.222	8.867	13.400	0.004



LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	2001	CEDAR BLUFF RESERVOIR	539
2	2015	WILSON RESERVOIR	439
3	2007	MARION RESERVOIR	357
4	2003	ELK CITY	350
5	2004	FALL RIVER RESERVOIR	328
6	2008	MELVERN RESERVOIR	326
7	2013	TORONTO RESERVOIR	303
8	2010	NORTON RESERVOIR	292
9	2011	PERRY RESERVOIR	279
10	2006	KANOPOLIS RESERVOIR	271
11	2012	POMONA RESERVOIR	267
12	2002	COUNCIL GROVE	230
13	2009	MILFORD RESERVOIR	214
14	2005	JOHN REDMOND RESERVOIR	164
15	2014	TUTTLE CREEK RESERVOIR	139

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	INDEX NO
2001	CEDAR BLUFF RESERVOIR	100 ( 14)	100 ( 14)	100 ( 14)	93 ( 13)	57 ( 8)	89 ( 12)	539
2002	COUNCIL GROVE	29 ( 4)	29 ( 4)	36 ( 5)	43 ( 6)	64 ( 9)	29 ( 4)	230
2003	ELK CITY	86 ( 12)	50 ( 7)	7 ( 1)	100 ( 14)	7 ( 1)	100 ( 14)	350
2004	FALL RIVER RESERVOIR	57 ( 8)	57 ( 8)	14 ( 2)	71 ( 10)	79 ( 11)	50 ( 7)	328
2005	JOHN REDMOND RESERVOIR	14 ( 2)	0 ( 0)	0 ( 0)	50 ( 7)	93 ( 13)	7 ( 1)	164
2006	KANOPOLIS RESERVOIR	43 ( 6)	43 ( 6)	29 ( 4)	21 ( 3)	71 ( 10)	64 ( 9)	271
2007	MARION RESERVOIR	64 ( 9)	64 ( 9)	43 ( 6)	29 ( 4)	86 ( 12)	71 ( 10)	357
2008	MELVERN RESERVOIR	79 ( 11)	82 ( 11)	86 ( 12)	0 ( 0)	0 ( 0)	79 ( 11)	326
2009	MILFORD RESERVOIR	21 ( 3)	36 ( 5)	79 ( 11)	14 ( 2)	50 ( 7)	14 ( 2)	214
2010	NORTON RESERVOIR	7 ( 1)	93 ( 13)	64 ( 9)	7 ( 1)	100 ( 14)	21 ( 3)	292
2011	PERRY RESERVOIR	50 ( 7)	18 ( 2)	57 ( 8)	86 ( 12)	25 ( 3)	43 ( 6)	279
2012	POMONA RESERVOIR	71 ( 10)	7 ( 1)	50 ( 7)	64 ( 9)	39 ( 5)	36 ( 5)	267
2013	TORONTO RESERVOIR	36 ( 5)	71 ( 10)	21 ( 3)	79 ( 11)	39 ( 5)	57 ( 8)	303
2014	TUTTLE CREEK RESERVOIR	0 ( 0)	18 ( 2)	71 ( 10)	36 ( 5)	14 ( 2)	0 ( 0)	139
2015	WILSON RESERVOIR	93 ( 13)	82 ( 11)	93 ( 13)	57 ( 8)	25 ( 3)	89 ( 12)	439

## APPENDIX B

### CONVERSION FACTORS

## CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x  $8.107 \times 10^{-4}$  = 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 C

### TRIBUTARY FLOW DATA

LAKE CODE 2001 CEDAR BLUFF

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 14322.7

TRIBUTARY	SUR-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS)												
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2001A1	14322.7	0.16	0.27	0.40	1.10	1.47	2.83	5.66	4.81	2.18	0.91	0.34	0.15	1.70
2001A2	13519.8	0.27	0.48	1.10	0.71	3.40	9.63	4.53	2.27	1.30	0.88	0.31	0.25	2.10
2001ZZ	802.9	0.16	0.26	0.48	0.54	1.08	1.42	1.13	0.68	0.54	0.45	0.21	0.16	0.60

## SUMMARY

 TOTAL DRAINAGE AREA OF LAKE = 14322.7  
 SUM OF SUB-DRAINAGE AREAS = 14322.7

 TOTAL FLOW IN = 32.25  
 TOTAL FLOW OUT = 20.29

## MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2001A1	10	74	0.040	13	0.020				
	11	74	0.045	9	0.011				
	12	74	0.059	14	0.025				
	1	75	0.074	12	0.028				
	2	75	0.068	8	0.028				
	3	75	0.079	9	0.017				
	4	75	0.068	13	0.011				
	5	75	0.510	10	0.007	25	0.006		
	6	75	0.368	15	0.017	29	0.020		
2001A2	7	75	3.398	13	0.013	27	0.010		
	8	75	2.379	14	0.008				
	9	75	0.850	14	0.017				
	10	74	0.040	13	0.065				
	11	74	0.079	9	0.051				
	12	74	0.011	14	0.016				
	1	75	0.017	12	0.011				
	2	75	0.031	8	0.011				
	3	75	0.051	9	0.022				
2001ZZ	4	75	0.037	13	0.130				
	5	75	1.430	10	0.027	25	0.059		
	6	75	5.862	15	1.331	29	1.303		
	7	75	0.997	13	0.340	27	0.159		
	8	75	1.396	24	0.142				
	9	75	0.025	13	0.022				
	10	74	0.006						
	11	74	0.014						
	12	74	0.003						
	1	75	0.014						
	2	75	0.025						
	3	75	0.008						
	4	75	0.566						
	5	75	0.108						
	6	75	4.531						
	7	75	0.031						
	8	75	0.003						
	9	75	0.0						

## APPENDIX D

### PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/05/03

200101  
38 47 00.0 099 43 30.0 4  
CEDAR BLUFF RESERVOIR  
20195 KANSAS

11EPALES 2111202  
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 CONDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CAC03 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
74/04/15	12 10	1000	9.2		26	660	8.20	117	0.070	1.000	0.060	0.011
	12 10	1005	9.2	10.0		588	8.20	116	0.030	0.500	0.020	0.003
	12 10	1015	9.1	10.0		655	8.20	119	0.030	0.500	0.040	0.004
	12 10	1030	9.0	10.2		701	8.20	121	0.030	0.500	0.030	0.003
74/06/26	13 50	1000	22.4	7.8	140	1009	8.50					
	13 50	1005	22.4	7.8		1005	8.50					
	13 50	1020	21.8	7.6		994	8.40					
	13 50	1030	21.6	6.8		991	8.40					
74/10/01	14 55	1000	16.9	8.6	66	968	7.90	121	0.040	0.600	0.020	0.007
	14 55	1005	16.8	8.4		968	7.90	119	0.020K	0.500	0.020	0.003
	14 55	1015	16.6	8.4		965	7.80	120	0.020	0.500	0.020K	0.003
	14 55	1025	16.5	8.2		967	7.80	119	0.020	0.500	0.020K	0.004

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/15	12 10	0000	0.024	12.4	
	12 10	0005	0.020		
	12 10	0015	0.018		
	12 10	0030	0.020		
74/06/26	13 50	0000		1.5	
74/10/01	14 55	0000	0.016	4.3	
	14 55	0005	0.013		
	14 55	0014			1.0
	14 55	0015	0.014		
	14 55	0025	0.016		

K VALUE KNOWN TO BE  
LESS THAN INDICATED



STORET RETRIEVAL DATE 76/05/03 \*

200102  
38 47 15.0 099 46 00.0 4  
CEDAR BLUFF RESERVOIR  
20195 KANSAS

11EPALES 2111202  
0041 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 CONDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CAC03 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-UIS ORTHO MG/L P
74/04/15	12 35	0000	9.2		28	530	8.20	126	0.040	0.700	0.040	0.006
	12 35	0005	9.2	10.0		590	8.20	134	0.030	0.700	0.030	0.007
	12 35	0015	9.1	10.0		655	8.20	134	0.030	0.700	0.030	0.004
	12 35	0035	9.1	10.2		699	8.20	133	0.030	0.700	0.030	0.005
74/06/26	14 20	0000	23.4	7.8	90	1029	8.50					
	14 20	0005	23.4	7.6		1029	8.10					
	14 20	0020	23.1	7.4		1020	8.50					
	14 20	0030	22.0	6.4		1001	8.20					
	14 20	0035	21.1	4.2		976	8.10					
74/10/01	14 30	0000	16.8	8.4	60	964	7.90	119	0.030	0.600	0.020K	0.002
	14 30	0005	16.7	8.6		964	7.80	119	0.020K	0.400	0.020K	0.003
	14 30	0015	16.4	8.6		960	7.80	118	0.020K	0.500	0.020K	0.011
	14 30	0033	15.9	8.0		964	7.80	118	0.030	0.500	0.020K	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/15	12 35	0000	0.018	3.6	
	12 35	0005	0.019		
	12 35	0015	0.017		
	12 35	0035	0.017		
74/06/26	14 20	0000		0.6	
74/10/01	14 30	0000	0.012	2.9	
	14 30	0005	0.013		
	14 30	0015	0.015		
	14 30	0016			1.0
	14 30	0033	0.023		

K VALUE KNOWN TO BE  
LESS THAN INDICATED

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/05/04

2001A1  
 38 47 30.0 099 43 20.0 4  
 SMOKY HILL RIVER  
 20 TREGO CO HWY MAP  
 O/CEDAR BLUFF RESERVOIR  
 BANK SAMPLE NEAR BASE OF DAM  
 11EPALES 2111204  
 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
74/10/13	11 20		0.016	2.000	0.075	0.005K	0.015
74/11/09	13 45		0.012	0.900	0.040	0.012	0.012
75/01/12	11 05		0.008	2.800	0.040	0.008K	0.050
75/02/08	12 10		0.480	0.800	0.024	0.008K	0.015
75/03/09	11 35		0.008	1.200	0.028	0.008K	0.010K
75/04/13	12 23		0.005	0.450	0.025	0.005K	0.020
75/05/10	12 00		0.005	1.300	0.025	0.010	0.050
75/05/25	11 30		0.005	1.700	0.040	0.010	0.100
75/06/15	11 15		0.015	0.750	0.030	0.005	0.050
75/06/29	16 30		0.005	0.600	0.025	0.010	0.060
75/07/13	14 45		0.005	0.500	0.020	0.005	0.030
75/07/27	14 55		0.015	4.400	0.090	0.010	0.060
75/08/14	10 10		0.005	0.600	0.040	0.005K	0.040
75/09/14	12 00		0.015	0.700	0.022	0.005K	0.040

K VALUE KNOWN TO BE  
 LESS THAN INDICATED

STORET RETRIEVAL DATE 76/05/04

2001A2  
38 47 30.0 099 38 15.0 4  
SMOKY HILL RIVER  
20 TREGO CO HWY MAP  
T/CEDAR BLUFF RESERVOIR  
SEC RD 370 BRDG 8 MI SE OF TREGO CENTER  
11EPALES 2111204  
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
74/10/13	10 30		0.200	1.000	0.050	0.005K	0.020
74/11/09	14 30		0.272	2.100	0.080	0.012	0.012
75/01/12	11 45		0.128	1.500	0.256	0.032	0.080
75/03/09	12 30		0.072	0.700	0.044	0.008K	0.030
75/04/13	13 15		0.095	1.700	0.090	0.005K	0.010
75/05/10	12 45		0.160	1.650	0.100	0.008	0.030
75/05/25	12 15		0.210	0.650	0.105	0.010	0.030
75/06/15	12 10		0.075	0.850	0.020	0.015	0.130
75/06/29	17 25		0.070	0.750	0.035	0.005	0.080
75/07/13	15 40		0.055	0.450	0.025	0.020	0.020
75/07/27	15 45		0.140	3.400	0.070	0.005K	0.050
75/08/24	11 05		0.045	0.750	0.015	0.010	0.030
75/09/13	13 00		0.045	1.100	0.045	0.025	0.040

K VALUE KNOWN TO BE  
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/05/04

200181  
38 44 15.0 099 46 10.0 4  
PAGE CREEK  
20 TREGO CO HWY MAP  
T/CEDAR BLUFF RESERVOIR 091192  
SEC RD BRDG 2.4 MI W OF ST RT 147 JCT  
11EPALES 2111204  
0000 FEET DEPTH CLASS 00

DATE	TIME	DEPTH	00630	00625	00610	00671	00665
FROM	OF		NO2&NO3	TOT KJEL	NH3-N	PHOS-DIS	PHOS-TOT
TO	DAY	FEET	N-TOTAL	N	TOTAL	ORTHO	
			MG/L	MG/L	MG/L	MG/L P	MG/L P
74/10/13	09 55		0.184	2.200	0.042	0.007	0.050
74/11/09	14 00		0.552	1.300	0.075	0.010	0.010
75/01/12	11 20		1.010	1.600	0.144	0.008K	0.030
75/03/09	12 00		0.475	0.800	0.059	0.007	0.020
75/04/13	12 45		0.075	2.600	0.050	0.005K	0.020
75/05/10	12 18		0.005	1.350	0.040	0.010	0.120
75/05/25	11 52		0.010	1.750	0.035	0.005	0.110
75/06/15	11 35		0.440	1.250	0.065	0.015	0.100
75/06/29	16 45		0.310	0.775	0.035	0.015	0.080
75/07/13	15 10		0.005	0.550	0.020	0.005	0.040
75/07/27	15 15		0.015	3.100	0.330	0.005	0.060

K VALUE KNOWN TO BE  
LESS THAN INDICATED