U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

KANOPOLIS RESERVOIR

ELLSWORTH COUNTY

KANSAS

EPA REGION VII

WORKING PAPER No. 516

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

☆G.P.O. 699-440

REPORT

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WITH THE COOPERATION OF THE

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

AND THE

KANSAS NATIONAL GUARD

MAY, 1977

CONTENTS

	Page
Foreword	ii
List of Kansas Study Reservoirs	iv
Lake and Drainage Area Map	v,vi
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	4
III. Lake Water Quality Summary	5
IV. Nutrient Loadings	10
V. Literature Reviewed	15
VI. Appendices	16

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 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.

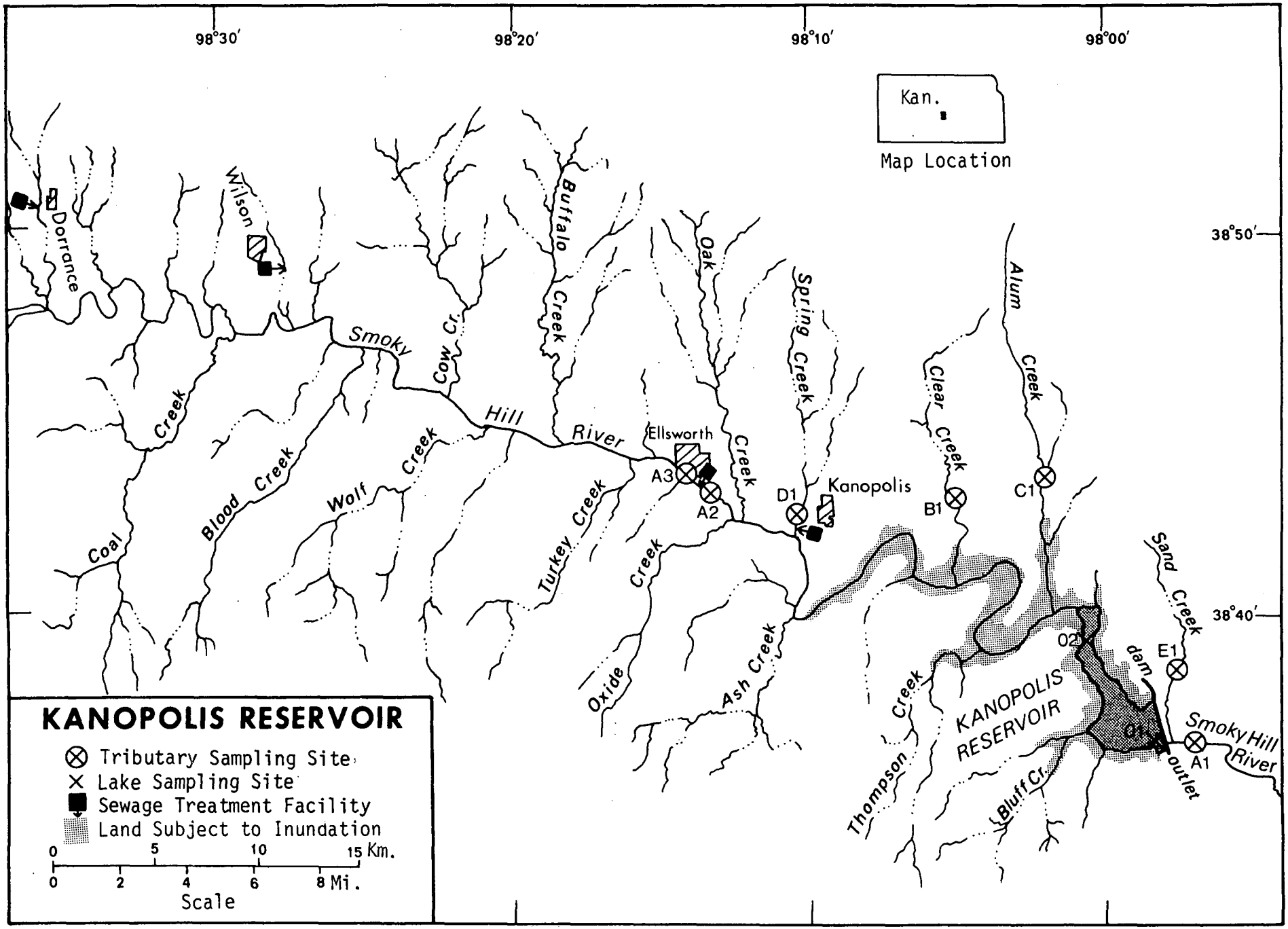
Major General Edward R. Fry, the Adjutant General of Kansas, and Project Officer Colonel Albin L. Lundquist, who directed the volunteer efforts of the Kansas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

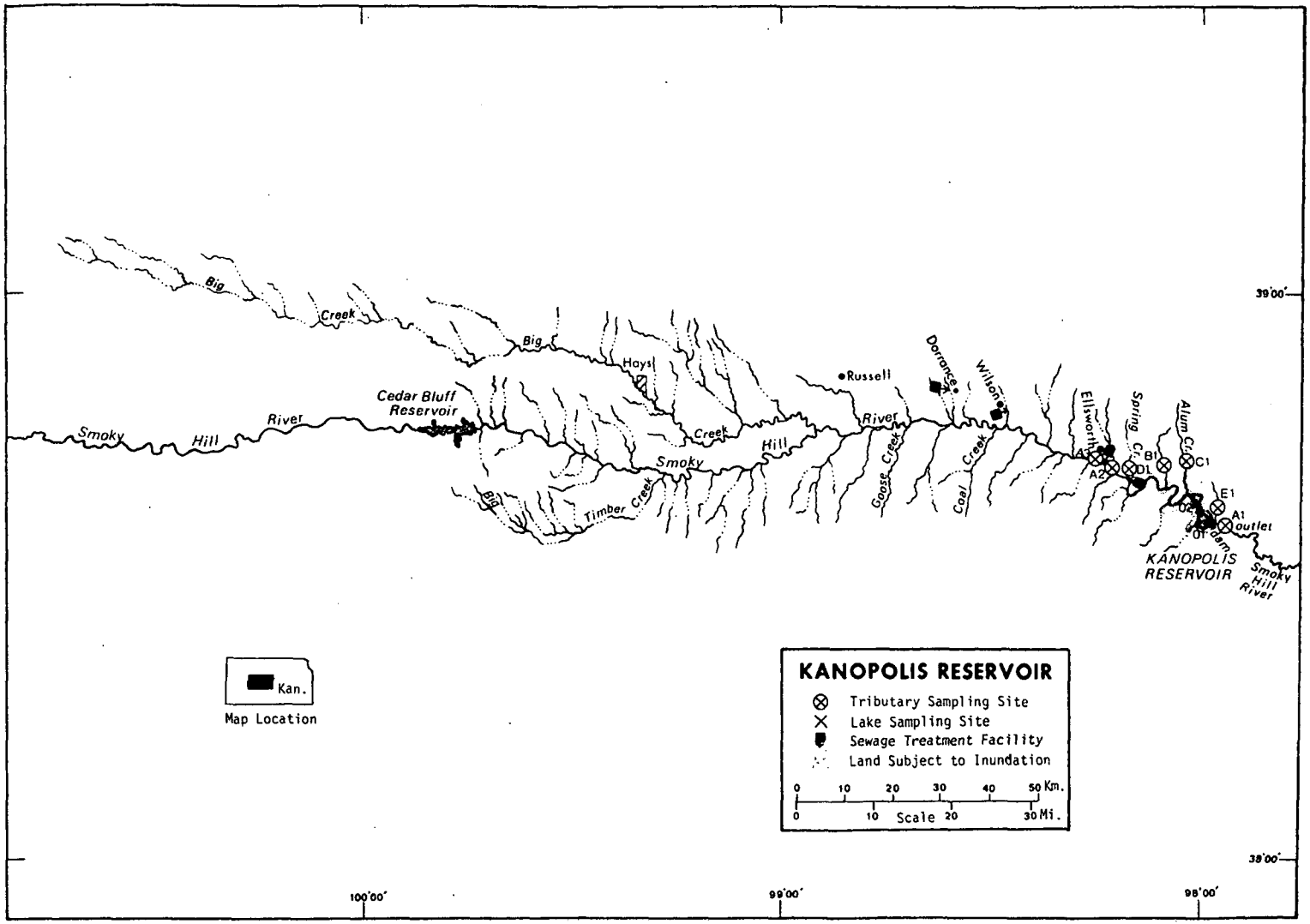
NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

STATE OF KANSAS

NAME	COUNTY
Cedar Bluff	Trego
Council Grove	Morris
Elk City	Montgomery
Fall River	Greenwood
John Redmond	Coffey, Lyon
Kanopolis	Ellsworth
Marion	Marion
Melvern	Osage
Milford	Clay, Geary
Norton	Norton
Perry	Jefferson
Pomona	Osage
Toronto	Greenwood, Woodson
Tuttle Creek	Marshall, Pottawatomie, Riley
Wilson	Russell


98°30'
98°20'
98°10'
98°00'
38°50'
38°40'
Kan.
Map Location
Dorrance
Wilson
Smoky Hill River
Cow Cr.
Buffalo Creek
Oak Creek
Spring Creek
Alum Creek
Clear Creek
Coal Creek
Blood Creek
Wolf Creek
Turkey Creek
Oxide Creek
Ash Creek
Thompson Creek
Bluff Cr.
Sand Creek
Ellsworth
Kanopolis
A3
A2
D1
B1
C1
E1
A1
O1
O2
dam
outlet
KANOPOLIS RESERVOIR
KANOPOLIS RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Land Subject to Inundation
0 5 10 15 Km.
0 2 4 6 8 Mi.
Scale


Big Creek
Big Creek
Hays
Russell
Dorrance
Wilson
Ellsworth
Spring Cr.
Alum Cr.
Cedar Bluff Reservoir
Smoky Hill River
Smoky Hill River
Big Timber Creek
Goose Creek
Coal Creek
A1
A2
B1
C1
D1
E1
outlet
dam
KANOPOLIS RESERVOIR
Smoky Hill River
39°00'
38°00'
100°00'
99°00'
98°00'
Kan.
Map Location
KANOPOLIS RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Land Subject to Inundation
0 10 20 30 40 50 Km.
0 10 Scale 20 30 Mi.

KANOPOLIS RESERVOIR

STORET NO. 2006

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Kanopolis Reservoir is potentially eutrophic. However, the reservoir becomes quite turbid during periods of runoff, and primary productivity is intermittently light-limited (Kring, 1977).

This water body ranked tenth in overall trophic quality when the 15 Kansas reservoirs sampled in 1974 were compared using a combination of six parameters*. Eight of the reservoirs had less median total phosphorus, five had less and one had the same median dissolved orthophosphorus, eight had less median inorganic nitrogen, eleven had less mean chlorophyll a, and ten had greater mean Secchi disc transparency.

B. Rate-Limiting Nutrient:

The algal assay results indicate Kanopolis Reservoir was phosphorus limited at the times the samples were taken (04/12/74 and 10/01/74).

The reservoir data indicate phosphorus limitation at all sampling times. However, as noted above primary productivity is light-limited rather than nutrient-limited at times.

* See Appendix A.

C. Nutrient Controllability:

1. Point sources--The total phosphorus inputs of point sources amounted to 5.2% of the total load to Kanopolis Reservoir during the sampling year. The City of Ellsworth contributed 2.7% of the total load; Wilson, 1.2%; Kanopolis, 0.9%; Dorance, 0.4%; and septic tanks serving shoreline dwellings and a recreational area added less than 0.1% of the total.

The present phosphorus loading of 6.65 $g/m^2/yr$ is over nine times that proposed by Vollenweider (Vollenweider and Dillon, 1974), as a eutrophic loading (see page 14). Even complete removal of phosphorus at the point sources would still leave a loading about nine times the eutrophic level, and it does not seem likely that point-source phosphorus control would result in any significant improvement in the trophic condition of the reservoir.

2. Non-point sources--Non-point sources added 94.8% of the total phosphorus load to Kanopolis Reservoir during the sampling year. The Smoky Hill River contributed 91.3% of the total; Clear Creek, 0.4%; Sand Creek, less than 0.1%; and ungaged tributaries, an estimated 2.8%.

The phosphorus export rate of the Smoky Hill River was 4 $kg/km^2/yr$ (see page 13). This rate is considerably higher than the 0.2 kg/km^2 rate of this river at the inlet of Cedar Bluff Reservoir* about 155 kilometers upstream.

* Working Paper No. 511.

It is not known whether the higher export rate of the Smoky Hill River at Kanopolis Reservoir is due to underestimation of the phosphorus load from the known point sources or is due to other point sources in the drainage.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 14.37 kilometers^2.
2. Mean depth: 4.5 meters.
3. Maximum depth: 17.4 meters.
4. Volume: 64.665 x 10^6 m^3.
5. Fourteen-year median hydraulic retention time: 120 days.

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

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Smoky Hill River (A-2)	19,632.2	8.160
Clear Creek	44.5	0.075
Sand Creek	21.8	0.037
Minor tributaries & immediate drainage -	636.7	1.350
Totals	20,335.2	9.622

2. Outlet -

Smoky Hill River	20,349.6**	9.660

C. Precipitation***:

1. Year of sampling: 59.1 centimeters.
2. Mean annual: 66.4 centimeters.

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† Table of metric conversions--Appendix B.
†† 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

Kanopolis 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 two or more depths at two stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, 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 4.6 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR KANOPOLIS RESERVOIR
STORET CODE 2006

	1ST SAMPLING (4/12/74) 2 SITES			2ND SAMPLING (6/27/74) 2 SITES			3RD SAMPLING (10/ 1/74) 2 SITES		
PARAMETER	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	10.4 - 12.2	11.4	11.0	22.2 - 23.6	22.8	22.6	15.1 - 15.7	15.5	15.6
DISS OXY (MG/L)	9.8 - 10.0	9.9	10.0	4.8 - 7.2	5.9	5.8	8.0 - 9.4	8.3	8.0
CNDCTVY (MCROMO)	1203. - 1304.	1251.	1219.	948. - 1106.	994.	951.	1065. - 1118.	1082.	1067.
PH (STAND UNITS)	8.2 - 8.2	8.2	8.2	8.0 - 8.4	8.2	8.0	7.7 - 7.8	7.8	7.8
TOT ALK (MG/L)	181. - 185.	183.	183.	132. - 141.	136.	136.	138. - 151.	148.	150.
TOT P (MG/L)	0.039 - 0.118	0.062	0.056	0.037 - 0.157	0.081	0.060	0.027 - 0.075	0.040	0.035
ORTHO P (MG/L)	0.006 - 0.012	0.008	0.007	0.009 - 0.026	0.016	0.016	0.002 - 0.013	0.009	0.011
NO2+NO3 (MG/L)	0.470 - 0.680	0.616	0.620	0.300 - 0.630	0.516	0.600	0.270 - 0.330	0.308	0.325
AMMONIA (MG/L)	0.040 - 0.090	0.066	0.060	0.060 - 0.090	0.070	0.070	0.020 - 0.090	0.062	0.070
KJEL N (MG/L)	0.600 - 0.900	0.743	0.700	0.600 - 1.000	0.737	0.700	0.500 - 0.900	0.600	0.550
INORG N (MG/L)	0.510 - 0.770	0.681	0.680	0.370 - 0.700	0.586	0.665	0.310 - 0.420	0.370	0.370
TOTAL N (MG/L)	1.070 - 1.580	1.359	1.370	1.000 - 1.430	1.254	1.255	0.830 - 1.170	0.908	0.850
CHLRPYL A (UG/L)	14.8 - 23.4	19.1	19.1	1.1 - 10.6	5.8	5.8	10.2 - 36.1	23.1	23.1
SECCHI (METERS)	0.3 - 0.4	0.3	0.3	0.3 - 0.3	0.3	0.3	0.3 - 0.5	0.4	0.4

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/12/74	1. *Dactylococcopsis sp.*	2,563
	2. Centric diatoms	1,955
	3. *Skeletonema sp.*	1,260
	4. *Chroomonas sp.*	738
	5. Chrysophytan cells	652
	Other genera	1,606
	Total	8,774
06/27/74	1. *Chlamydomonas sp.*	3,393
	2. *Chroomonas sp.*	664
	3. Zoospores	553
	4. *Cyclotella sp.*	332
	5. *Euglena sp.*	258
	Other genera	1,401
	Total	6,601
10/01/74	1. Flagellates	1,410
	2. *Stephanodiscus sp.*	1,234
	3. *Chroomonas sp.*	529
	4. *Cryptomonas sp.*	485
	5. *Skeletonema sp.*	264
	Other genera	440
	Total	4,362

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
04/12/74	1	14.8
	2	23.4
06/27/74	1	1.1
	2	10.6
10/01/74	1	10.2
	2	36.1

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. April sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	<0.005	0.598	0.1
0.050 P	<0.055	0.598	14.2
0.050 P + 1.0 N	<0.055	1.598	14.4
1.0 N	<0.005	1.598	0.1

b. October sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.020	0.362	0.8
0.050 P	0.070	0.362	6.5
0.050 P + 1.0 N	0.070	1.362	7.6
1.0 N	0.020	1.362	0.7

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential primary productivity of Kanopolis Reservoir was low in April and moderate in October. There was a significant growth response in both assays when phosphorus was added but no such response to the addition of only nitrogen. These results indicate phosphorus limitation.

The reservoir data support the assay findings. The mean inorganic nitrogen to orthophosphorus ratios were 85 to 1 in April, 37 to 1 in June, and 41 to 1 in October; and phosphorus limitation would be expected. However, the reservoir is intermittently light-limited rather than nutrient-limited (Kring, 1977).

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 June and July when two samples were collected at most of the sites. 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 lake.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Sand Creek at station E-1 and the mean annual ZZ flow.

The operator of the Ellsworth wastewater treatment plant provided monthly effluent samples and corresponding flow data. The operator of the Wilson wastewater treatment plant provided effluent samples but could not provide flow data. Therefore, the nutrient loads for Wilson were estimated at 1.134 P and 3.401 N/capita/year.

The towns of Kanopolis and Dorance did not participate, and nutrient loads from these sources also were estimated at 1.134 P and 3.401 N kg/capita/year.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Ellsworth*	2,486	act. sludge	860.2†	Smoky Hill R.
Wilson*	974	tr. filter	368.7†	Dry Creek to Smoky Hill R.
Kanopolis**	720	stab. pond	272.5†	Spring Creek
Dorrance**	310	stab. pond	117.3†	Trib of Smoky Hill R.

2. Known industrial - None

* Treatment plant questionnaires.
** Anonymous, 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 (non-point load) -		
Smokey Hill River	87,305	91.3
Clear Creek	385	0.4
Sand Creek	75	<0.1
b. Minor tributaries & immediate drainage (non-point load) -	2,725	2.8
c. Known municipal STP's -		
Ellsworth	2,595	2.7
Wilson	1,105	1.2
Kanopolis	815	0.9
Dorrance	350	0.4
d. Septic tanks* -	15	<0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	250	0.3
Total	95,620	100.0

2. Outputs -

Reservoir outlet - Smoky Hill River 21,020

3. Net annual P accumulation - 74,600 kg.

* Estimate based on 40 shoreline dwellings and one campground; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Smoky Hill River	559,815	87.6
Clear Creek	4,035	0.7
Sand Creek	1,175	0.2
b. Minor tributaries & immediate drainage (non-point load) -	42,955	6.7
c. Known municipal STP's -		
Ellsworth	8,385	1.3
Wilson	3,315	0.5
Kanopolis	2,450	0.4
Dorrance	1,055	0.2
d. Septic tanks* -	495	<0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	15,515	2.4
Total	639,195	100.0

2. Outputs -

Reservoir outlet - Smoky Hill River 496,560

3. Net annual N accumulation - 142,635 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Smoky Hill River (at A-2)	4	29
Clear Creek	9	91
Sand Creek	3	54

* Estimate based on 40 shoreline dwellings and one campground; see Working Paper No. 175.
** See Working Paper No. 175.

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Alum Creek	0.189	1.615
Spring Creek	0.165	3.528

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.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	6.65	5.19	44.5	9.9

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and 14-year median hydraulic retention time of Kanopolis Reservoir:

"Dangerous" (eutrophic loading)	0.72
"Permissible" (oligotrophic loading)	0.36

V. LITERATURE REVIEWED

Kring, R. Lynn, 1977. Personal communication (reservoir morphometry and hydraulic retention time). 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 8.107×10^{-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

TRIBUTARY FLOW INFORMATION FOR KANSAS 05/03/76

LAKE CODE 2006 KANOPOLIS

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 20349.6

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2006A1	20349.6	2.44	4.53	5.66	10.19	10.76	16.99	16.14	12.74	12.18	13.31	6.23	4.53	9.66
2006A2	19632.2	2.55	2.66	8.21	7.36	10.76	16.14	17.56	8.21	11.33	7.08	3.40	2.35	8.16
2006A3	19632.2	2.55	2.66	8.21	7.36	10.76	16.14	17.56	8.21	11.33	7.08	3.40	2.35	8.16
2006B1	44.5	0.027	0.040	0.102	0.071	0.136	0.139	0.170	0.048	0.045	0.059	0.023	0.031	0.075
2006E1	21.8	0.014	0.019	0.054	0.034	0.068	0.065	0.085	0.023	0.021	0.031	0.011	0.016	0.037
2006ZZ	672.9	0.45	0.71	1.30	1.39	2.41	2.83	2.55	1.27	1.22	1.05	0.54	0.48	1.35

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 20349.6
SUM OF SUB-DRAINAGE AREAS = 40003.6
TOTAL FLOW IN = 212.74
TOTAL FLOW OUT = 115.70

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2006A1	10	74	3.256	13	1.529				
	11	74	3.766	10	3.341				
	12	74	2.308	3	1.331				
	1	75	1.441	12	1.416				
	2	75	1.518	8	1.501				
	3	75	1.614	29	1.416				
	4	75	1.560	12	1.444				
	5	75	1.506	3	1.416				
	6	75	19.255	7	3.625	21	21.323		
	7	75	18.689	10	41.909	30	0.934		
	8	75	9.514	16	8.835				
	9	75	9.939	20	13.592				
2006A2	10	74	1.917	13	3.228				
	11	74	2.328	10	2.492				
	12	74	2.138	15	2.280				
	1	75	3.030	12	1.416				
	2	75	2.435	8	1.982				
	3	75	2.506	29	2.633				
	4	75	3.993	12	2.067				
	5	75	4.701	3	8.212				
	6	75	24.381	7	7.362	21	4.729		
	7	75	3.823	10	3.936	30	1.671		
	8	75	15.857	16	6.513				
	9	75	5.493	20	2.690				

TRIBUTARY FLOW INFORMATION FOR KANSAS 05/03/76

LAKE CODE 2006 KANOPOLIS

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2006A3	10	74	1.917	13	3.228				
	11	74	2.328	10	2.492				
	12	74	2.138	15	2.280				
	1	75	3.030	12	1.416				
	2	75	2.435	8	1.982				
	3	75	2.506	29	2.633				
	4	75	3.993	12	2.067				
	5	75	4.701	3	8.212				
	6	75	24.381	7	7.362	21	4.729		
	7	75	3.823	10	3.936	30	1.671		
	8	75	15.857	16	6.513				
	9	75	5.493	20	2.690				
2006B1	10	74	0.164	13	0.008				
	11	74	0.048	10	0.028				
	12	74	0.020	15	0.028				
	1	75	0.051	12	0.0				
	2	75	0.042	8	0.034				
	3	75	0.074	29	0.042				
	4	75	0.076	12	0.031				
	5	75	0.190	3	0.042				
	6	75	0.258	7	0.042	21	0.079		
	7	75	0.012	10	0.031	30	0.003		
	8	75	0.736	16	0.023				
	9	75	0.037	20	0.051				
2006E1	10	74	0.085	12	0.020				
	11	74	0.022	10	0.045				
	12	74	0.010	15	0.037				
	1	75	0.025	12	0.0				
	2	75	0.020	8	0.006				
	3	75	0.040	29	0.028				
	4	75	0.037	12	0.028				
	5	75	0.093	3	0.091				
	6	75	0.122	7	0.023	21	0.042		
	7	75	0.014	10	0.020	30	0.008		
	8	75	0.340	16	0.008				
	9	75	0.017	20	0.006				
2006ZZ	10	74	2.577						
	11	74	1.671						
	12	74	0.311						
	1	75	0.255						
	2	75	1.331						
	3	75	1.727						
	4	75	1.303						
	5	75	2.464						
	6	75	7.929						
	7	75	0.934						
	8	75	1.529						
	9	75	0.028						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/05/03

200601
38 36 38.0 097 58 02.0 3
KANOPOLIS RESERVOIR
20053 KANSAS

091191

11EPALES 2111202
0037 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
74/04/12	13 40	0000	11.0		14	1219	8.20	183	0.090	0.900	0.680	0.007
	13 40	0005	11.0	9.8		1217	8.20	184	0.090	0.700	0.670	0.006
	13 40	0015	10.8	10.0		1212	8.20	184	0.090	0.700	0.660	0.007
	13 40	0030	10.4	9.8		1203	8.20	181	0.040	0.600	0.470	0.012
74/06/27	12 30	0000	22.5	6.4		951	8.10	134	0.070	0.800	0.600	0.016
	12 30	0005	22.5	5.2		951	8.00	132	0.060	0.600	0.600	0.016
	12 30	0015	22.7	4.8		951	8.00	133	0.070	0.600	0.610	0.016
	12 30	0025	22.3	4.8		948	8.00	136	0.070	0.700	0.630	0.026
	12 30	0030	22.2	4.8		948	8.00	135	0.070	0.700	0.600	0.020
74/10/01	12 10	0000	15.6	8.0	18	1066	7.80	148	0.070	0.600	0.320	0.011
	12 10	0005	15.6	8.0		1065	7.80	150	0.070	0.500	0.330	0.012
	12 10	0015	15.6	8.0		1066	7.80	149	0.020	0.500	0.330	0.013
	12 10	0020	15.6	8.0		1068	7.70	151	0.090	0.500	0.330	0.012

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/12	13 40	0000	0.056	14.8	
	13 40	0005	0.055		
	13 40	0015	0.049		
	13 40	0030	0.039		
74/06/27	12 30	0000	0.062	1.1	
	12 30	0001			50.0
	12 30	0005	0.058		1.0
	12 30	0015	0.059		
	12 30	0025	0.049		
	12 30	0030	0.037		
74/10/01	12 10	0000	0.038	10.2	
	12 10	0003			1.0
	12 10	0005	0.030		
	12 10	0015	0.027		
	12 10	0020	0.033		

STORET RETRIEVAL DATE 76/05/03

200602
38 39 07.0 098 00 34.0 3
KANOPOLIS RESERVOIR
20053 KANSAS

091191

11EPALES 2111202
0020 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
74/04/12	14 05	0000	12.2		10	1304	8.20	183	0.050	0.800	0.610	0.006
	14 05	0005	12.2	10.0		1304	8.20	182	0.040	0.700	0.600	0.007
	14 05	0015	12.1	10.0		1300	8.20	185	0.060	0.800	0.620	0.010
74/06/27	12 05	0000	23.6	7.0	11	1047	8.40	140	0.090	1.000	0.430	0.009
	12 05	0005	23.6	7.0		1052	8.40	141	0.060	0.800	0.360	0.011
	12 05	0015	23.4	7.2		1106	8.40	140	0.070	0.700	0.300	0.011
74/10/01	12 00	0000	15.7	9.4	12	1118	7.80	138	0.040	0.600	0.270	0.002
	12 00	0005	15.1	8.2		1110	7.70	151	0.080	0.900	0.270	0.005

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/12	14 05	0000	0.059	23.4	
	14 05	0005	0.059		
	14 05	0015	0.118		
74/06/27	12 05	0000	0.120	10.6	
	12 05	0001			50.0
	12 05	0003			1.0
	12 05	0005	0.110		
	12 05	0015	0.157		
74/10/01	12 00	0000	0.038	36.1	
	12 00	0002			1.0
	12 00	0005	0.075		

APPENDIX E

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/05/04

20006A1
38 36 38.0 097 57 04.0 4
SMOKY HILL RIVER
20 7.5 LANGLEY
O/KANOPOLIS RESERVOIR 091191
BRDG .8 MI DWNSTRM FROM KANOPOLIS 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	16	45	0.320	1.200	0.120	0.025	0.065
74/11/10	15	40	0.336	3.200	0.160	0.025	0.080
74/12/03	13	00	1.520	0.800	0.090	0.015	0.020
75/02/08	16	10	0.352	1.200	0.056	0.008K	0.030
75/03/29	09	40	0.317	1.300	0.031	0.009	0.040
75/04/12	14	45	0.100	1.100	0.040	0.045	0.045
75/05/03	15	05	0.045	0.650	0.085	0.010	0.020
75/06/07	17	40	0.185	1.300	0.200	0.010	0.050
75/06/21	11	30	0.260	1.250	0.240	0.020	0.090
75/07/10	20	30	0.330	1.100	0.045	0.040	0.080
75/07/30	15	30	0.185	0.750	0.070	0.010	0.060
75/08/16	14	15	0.185	0.850	0.075	0.020	0.100
75/09/20	11	35	0.650	1.700	0.025	0.045	0.220

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/05/04

2006A2
38 45 10.0 098 13 30.0 4
SMOKY HILL RIVER
20 7.5 ELLSWORTH
T/KANOPOLIS RESERVOIR 091191
BANK SAMPLE .4 MI BELOW STP
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	15 10		0.088	1.700	0.450	0.105	0.155
74/11/10	14 00		0.704	1.350	0.140	0.140	0.160
74/12/15	11 40		1.060	1.900	0.175	0.140	0.480
75/02/08	14 55		2.000	1.800	0.304	0.184	0.310
75/03/29	08 45		0.245	1.350	0.095	0.086	0.140
75/04/12	13 45		0.700	0.550	0.035		0.130
75/06/07	15 45		0.710	3.800	0.075	0.185	0.880
75/06/21	15 20		0.015	1.500	0.015	0.145	0.470
75/07/10	19 28		0.015	1.100	0.025	0.090	0.280
75/07/30	14 15		0.345	2.150	0.125	0.150	0.510
75/08/16	12 55		0.450	2.000	0.160	0.183	0.660
75/09/20	11 00		0.165	1.000	0.155	0.080	0.090

STORET RETRIEVAL DATE 76/05/04

2006A3
38 43 36.0 098 14 00.0 4
SMOKY HILL RIVER
20 7.5 ELLSWORTH
T/KANOPOLIS RESERVOIR 091191
BRDG ON DOUGLAS AVE ABOVE STP
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	14 50		0.056	1.600	0.060	0.010	0.040
74/11/10	13 45		0.672	1.100	0.050	0.110	0.130
74/12/15	11 35		1.080	0.600	0.055	0.085	0.110
75/02/08	14 45		1.800	1.000	0.104	0.120	0.130
75/03/29	08 30		0.236	1.000	0.025	0.058	0.110
75/04/12	13 30		0.065	1.100	0.110	0.035	0.080
75/06/07	15 40		0.735	3.750	0.070	0.185	0.920
75/06/21	15 15		0.010	1.600	0.075	0.145	0.460
75/07/10	19 15		0.010	1.100	0.055	0.075	0.250
75/07/30	14 09		0.300	1.900	0.050	0.095	0.400
75/08/16	12 40		0.450	1.950	0.030	0.140	0.600
75/09/20	10 50		0.115	1.400	0.035	0.065	0.190

STORET RETRIEVAL DATE 76/05/04

200681
38 44 50.0 098 05 00.0 4
CLEAR CREEK
20 7.5 CARNEIRO
T/KANOPOLIS RESERVOIR 091191
BRDG 4.5 MI SW OF CARNEIRO
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	15 55		0.008	0.750	0.080	0.035	0.090
74/11/10	14 30		0.810	1.700	0.200	0.055	0.100
74/12/15	12 10		1.480	0.500	0.030	0.015	0.040
75/03/29	09 05		0.655	1.700	0.062	0.035	0.240
75/04/12	14 30		0.050	0.700	0.025	0.043	0.060
75/05/03	14 15		0.500	1.200	0.440	0.055	0.160
75/06/07	16 10		0.510	2.800	0.160	0.130	0.580
75/06/21	15 40		0.960	1.050	0.025	0.060	0.140
75/07/10	19 50		0.640	0.650	0.015	0.035	0.060
75/07/30	14 50		0.230	0.800	0.065	0.045	0.100
75/08/16	13 35		0.470	1.300	0.185	0.110	0.290
75/09/20	13 00		0.410	0.600	0.065	0.045	0.100

STORET RETRIEVAL DATE 76/05/04

2006C1
38 43 35.0 098 01 55.0 4
ALUM CREEK
20 7.5 CARNEIRO
T/KANOPOLIS RESERVOIR 091191
SEC RD BRDG 1 MI S OF ST RT 40
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
74/11/10	15 00		0.072	1.600	0.045	0.035	0.070
75/02/08	15 40		0.290	0.800	0.024	0.016	0.060
75/03/29	09 20		0.117	1.450	0.018	0.033	0.130
75/04/12	14 23		0.005	1.200	0.035	0.035	0.050
75/05/03	14 30		0.330	0.700	0.041	0.075	0.160
75/06/07	16 38		0.300	2.400	0.140	0.090	0.330
75/06/21	16 00		0.290	2.500	0.080	0.090	0.630
75/07/10	20 00		0.015	0.850	0.029	0.022	0.080

STORET RETRIEVAL DATE 76/05/04

20060101
38 42 40.0 098 10 15.0 4
SPRING CREEK
20 7.5 ELLSWORTH
T/KANOPOLIS RESERVOIR 091191
BRDG ON FAS HWY 228 .3 MI FROM KANOPOLIS
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
74/11/10	14	10	3.300	1.300	0.080	0.040	0.070
74/12/15	11	55	4.200	1.100	0.030	0.010	0.020
75/02/08	15	05	0.700	1.100	0.040	0.016	0.050
75/03/29	08	50	1.860	1.800	0.050	0.049	0.220
75/04/12	13	55	2.100	1.400	0.075	0.010	0.035
75/05/03	14	50	1.950	1.100	0.170	0.090	0.170
75/06/07	15	53	0.330	2.100	0.070	0.165	0.600
75/06/21	15	36	1.900	3.150	0.035	0.060	0.130
75/07/10	19	35	1.700	1.550	0.025	0.070	0.080
75/07/30	14	45	1.650	1.250	0.082	0.065	0.110
75/08/16	13	15	1.800	1.400	0.115	0.170	0.380
75/09/20	11	10	2.600	1.000	0.090	0.035	0.110

STORET RETRIEVAL DATE 76/05/04

2006E1
38 37 55.0 097 57 50.0 4
SAND CREEK
20 7.5 VENANGO
T/KANOPOLIS RESERVOIR 091191
BRDG 1.6 MI SE OF VENANGO
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
74/10/12	16	35	0.064	1.000	0.320	0.020	0.075
74/11/10	15	30	0.070	1.100	0.040	0.010	0.020
74/12/15	12	45	0.090	0.700	0.015	0.005	0.010
75/02/08	16	00	0.660	1.200	0.024	0.008	0.040
75/03/29	10	40	0.025	0.950	0.018	0.009	0.060
75/04/12	14	40	0.005	1.450	0.020	0.110	0.120
75/05/03	15	00	0.010	0.400	0.080	0.025	0.040
75/06/07	17	30	0.065	1.500	0.025	0.030	0.170
75/06/21	16	10	0.020	1.850	0.030	0.015	0.050
75/07/10	20	25	0.015	0.350	0.005	0.025	0.030
75/07/30	15	15	0.010	0.600	0.025	0.030	0.130
75/08/16	14	05	0.020	0.450	0.015	0.025	0.060
75/09/20	11	30	0.017	0.500	0.025	0.020	0.030

STORET RETRIEVAL DATE 76/05/04

2006AA AS2006AA P002486
38 43 30.0 098 13 40.0 4
ELLSWORTH
20 7.5 WESTFALL SW
T/KANOPOLIS RES 091191
SMOKY HILL RIVER
11EPALES 2141204
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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/01/14	08	00							
CP(T)-			0.160	36.000	8.800	8.750	11.500	0.240	0.270
75/01/14	16	00							
75/02/13	14	15	0.096	26.000	14.000	6.250	6.950	0.163	0.163
75/03/17	08	35	0.080	11.000	9.500	9.900	9.900	0.243	0.243
75/04/17	09	00	0.050	27.000	13.000	6.100	7.300	0.264	0.220
75/05/15	08	45	0.050	29.000	9.100	8.100	9.500	0.227	0.230
75/06/23	09	00	0.100	24.000	6.400	5.450	6.600	0.267	0.244
75/07/17	08	35	0.050	18.000	5.900	2.800	3.500	0.258	0.240
75/08/18	20	30	0.075	28.000	15.500	2.800	3.600	0.260	0.260
75/09/15	09	15	0.150	24.000	10.000	1.650	2.500	0.221	0.240
75/10/16	09	30	0.100	25.000	8.700	3.600	4.600	0.211	0.207
75/11/18	09	20	0.050	28.000	8.800	12.600	16.500	0.211	0.201
75/12/19	13	20	0.025	47.000	15.500	10.500	19.000	0.204	0.209

STORET RETRIEVAL DATE 76/05/04

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WILSON
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DRY CREEK
11EPALES 2141204
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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/02/10	16	30	17.100	9.300	0.008	1.180	6.900		
75/03/05	09	00	16.800	8.000	0.080K	5.250	6.300		
75/04/08	09	45	1.520	4.700	0.270		6.200		
75/04/30	09	00	16.000	5.700	0.050	2.600	6.200		
75/05/27	09	00	4.900	17.500	8.250	3.900	6.700		
75/06/10	14	30	15.000	4.700	0.050K	5.730	6.300		
75/07/01	09	00	9.900	1.700	0.025K	1.500	6.000		
75/07/22	09	00	10.000	5.300	0.110	1.750	6.100		
75/08/12	09	00	11.500	3.700	0.025K	3.100	3.975		
75/09/02	08	30	12.000	2.400	0.036	1.870	4.200		
75/09/25	08	30	12.000	2.900	0.025K	4.300	4.300		
75/10/14	08	30	8.400	9.600		5.200	5.200		
75/11/05	08	30	5.400	14.500	0.340	2.200	8.100		

K VALUE KNOWN TO BE
LESS THAN INDICATED