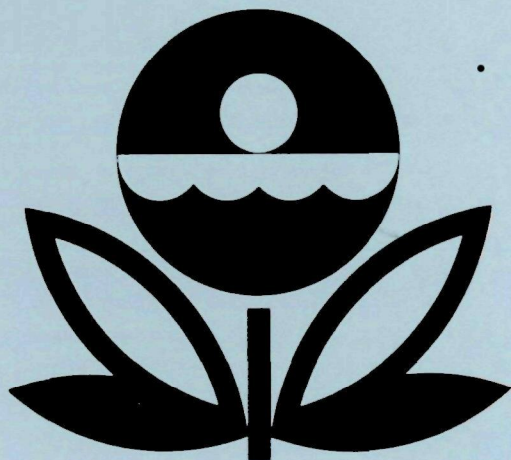


**U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY
WORKING PAPER SERIES**



REPORT
ON
TONGUE RIVER RESERVOIR
BIG HORN COUNTY
MONTANA
EPA REGION VIII
WORKING PAPER No. 803

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

REPORT
ON
TONGUE RIVER RESERVOIR
BIG HORN COUNTY
MONTANA
EPA REGION VIII
WORKING PAPER No. 803

WITH THE COOPERATION OF THE
MONTANA DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES
AND THE
MONTANA 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 fresh water 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.

ACKNOWLEDGEMENT

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

The staff of the Water Quality Bureau 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.

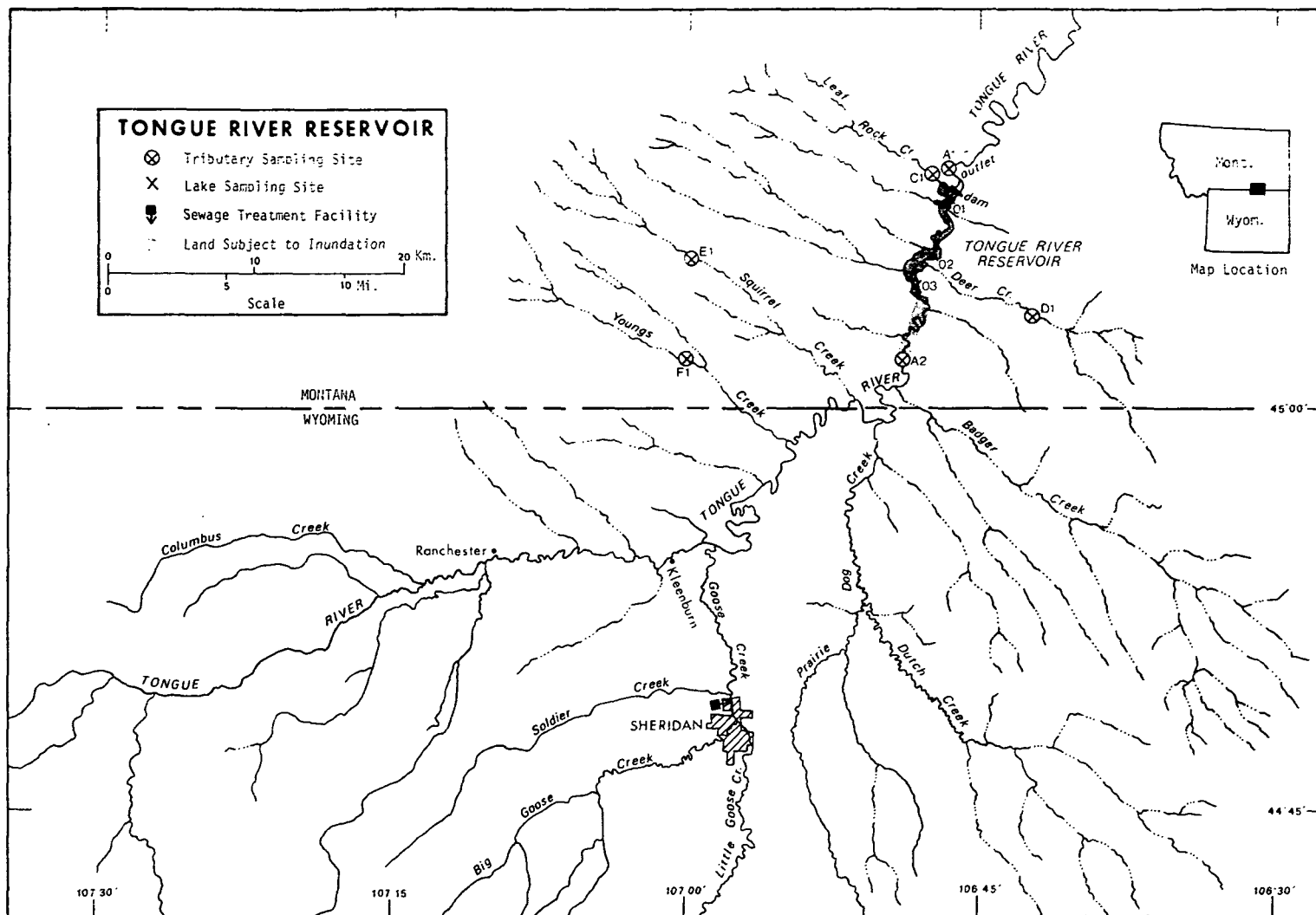
Major General John J. Womack, the Adjutant General of Montana, and Project Officer Major William Yeager, who directed the volunteer efforts of the Montana National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF MONTANA

<u>LAKE NAME</u>	<u>COUNTY</u>
Canyon Ferry	Broadwater, Lewis and Clark
Clark Canyon	Beaverhead
Flathead	Flathead, Lake
Georgetown	Deer Lodge, Granite
Hebgen	Gallatin
Koocanusa	Lincoln, MT; British Columbia, Can.
Mary Ronan	Lake
McDonald	Flathead
Nelson	Phillips
Seeley	Missoula
Swan	Lake
Tally	Flathead
Tiber	Liberty, Toole
Tongue River	Big Horn
Whitefish	Flathead
Yellowtail	Carbon, Bighorn, MT; Bighorn, WY



TONGUE RIVER RESERVOIR

STORET NO. 3014

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Tongue River Reservoir is eutrophic. It ranked fourteenth in overall trophic quality when the 15 Montana lakes and reservoirs sampled in 1975 were compared using a combination of six water-quality parameters*. All of the other water bodies had less median total phosphorus, eight had less median dissolved orthophosphorus, five had less and three had the same median inorganic nitrogen, and all of the others had less mean chlorophyll a and greater mean Secchi disc transparency. Marked depletion of dissolved oxygen with depth occurred at station 1 in May.

B. Rate-Limiting Nutrient:

Due to significant changes in nutrient levels during shipment of the samples from the field to the laboratory, the algal assay results are not considered representative of conditions in the reservoir at the times the samples were taken.

The reservoir data indicate nitrogen limitation at all sampling stations and times, with the exception of station 1 in October.

C. Nutrient Controllability:

1. Point sources--The wastewater treatment plant at Sheridan,

* See Appendix A.

Wyoming accounted for the entire point source load, contributing 11.1% of the total phosphorus input to Tongue River Reservoir during the sampling year.

The present phosphorus loading of $9.44 \text{ g/m}^2/\text{year}$ is nine times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 11), and point-source phosphorus control alone probably would not result in any significant improvement in the existing trophic condition of the reservoir.

2. Non-point sources--Non-point sources accounted for 88.9% of the total phosphorus load during the sampling year. The Tongue River contributed 75.4%, and ungaged minor tributaries and immediate drainage contributed an estimated 13.3%.

In a previous report, it is noted that agriculture is the major water use in the drainage basin (Polzin, 1974). Water is diverted for the irrigation of about 260 km^2 above the reservoir (Anonymous, 1974). It appears that improvement in the trophic quality of this water body could only result from control of nutrients in agricultural runoff as well as in point-source discharges within the drainage. Further study is needed to determine the controllability of non-point nutrients and to also determine the impact of mining operations in the area which could further degrade the quality of this water body.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS[†]A. Morphometry^{††}:

1. Surface area: 14.15 kilometers².
2. Mean depth: 6.1 meters.
3. Maximum depth: 27.7 meters.
4. Volume: 86.315×10^6 m³.
5. Mean hydraulic retention time: 78 days (based on outflow).

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

1. Tributaries -

<u>Name</u>	<u>Drainage area (km²)*</u>	<u>Mean flow (m³/sec)*</u>
Tongue River	3,825.4	14.15
Leaf Rock Creek	59.6	-
Minor tributaries & immediate drainage -	<u>685.2</u>	<u>-</u>
Totals	4,570.2	14.15

2. Outlet -

Tongue River	4,584.3**	12.83
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C. Precipitation^{***}:

1. Year of sampling: 50.7 centimeters.
2. Mean annual: 40.3 centimeters.

† Table of metric conversions--Appendix B.

†† Horpestad, 1975.

* 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

Tongue River Reservoir was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one or more depths at three 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 May and October 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 16.2 meters at station 1, 9.1 meters at station 2, and 5.8 meters at station 3.

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 TONGUE RIVER RESERVOIR
STORET CODE 3014

1ST SAMPLING (5/23/75)

2ND SAMPLING (8/29/75)

3RD SAMPLING (10/15/75)

3 SITES

3 SITES

3 SITES

PARAMETER	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	6.3 - 12.6	10.4	11.3	19.6 - 23.7	21.4	21.2	8.9 - 11.4	10.8	10.9
DISS OXY (MG/L)	1.4 - 10.4	8.3	9.0	4.2 - 14.8	9.5	10.0	8.0 - 11.4	9.3	9.0
CNDCTVY (MCROMO)	280. - 556.	457.	475.	484. - 700.	544.	507.	611. - 654.	619.	615.
PH (STAND UNITS)	8.0 - 8.7	8.5	8.6	8.4 - 9.8	8.9	8.9	8.4 - 8.5	8.4	8.4
TOT ALK (MG/L)	134. - 244.	180.	182.	159. - 296.	188.	167.	292. - 332.	309.	309.
TOT P (MG/L)	0.039 - 0.141	0.065	0.053	0.022 - 0.148	0.072	0.051	0.030 - 0.112	0.051	0.046
ORTHO P (MG/L)	0.008 - 0.037	0.017	0.015	0.003 - 0.010	0.006	0.006	0.003 - 0.019	0.006	0.004
NO2+NO3 (MG/L)	0.020 - 0.170	0.066	0.045	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020
AMMONIA (MG/L)	0.020 - 0.420	0.075	0.045	0.020 - 0.030	0.021	0.020	0.020 - 0.050	0.031	0.030
KJEL N (MG/L)	0.500 - 1.400	0.703	0.650	0.400 - 1.200	0.686	0.600	0.400 - 0.600	0.525	0.500
INORG N (MG/L)	0.050 - 0.460	0.141	0.090	0.040 - 0.050	0.041	0.040	0.040 - 0.070	0.051	0.050
TOTAL N (MG/L)	0.570 - 1.440	0.774	0.710	0.420 - 1.220	0.706	0.620	0.420 - 0.620	0.545	0.520
CHLRPYL A (UG/L)	7.3 - 11.2	8.6	7.3	16.9 - 38.8	25.4	20.5	4.9 - 24.5	16.6	20.5
SECCHI (METERS)	0.8 - 1.1	1.0	1.1	0.2 - 0.6	0.4	0.5	0.2 - 0.9	0.6	0.6

B. Biological Characteristics:

1. Phytoplankton -

<u>Sampling Date</u>	<u>Dominant Genera</u>	<u>Algal Units per ml</u>
05/23/75	1. <u>Chroomonas sp.</u>	2,447
	2. <u>Euglena sp.</u>	1,106
	3. <u>Cryptomonas sp.</u>	804
	4. <u>Stephanodiscus sp.</u>	737
	5. <u>Asterionella sp.</u>	168
	Other genera	<u>269</u>
	Total	5,531
08/29/75	1. <u>Euglena sp.</u>	946
	2. <u>Glenodinium sp.</u>	908
	3. <u>Chroomonas sp.</u>	870
	4. <u>Stipitococcus sp.</u>	416
	5. <u>Asterionella sp.</u>	378
	Other genera	<u>794</u>
	Total	4,312
10/15/75	1. <u>Stephanodiscus sp.</u>	670
	2. <u>Cryptomonas sp.</u>	591
	3. <u>Fragilaria sp.</u>	552
	4. <u>Chroomonas sp.</u>	197
	5. <u>Navicula sp.</u>	118
	Other genera	<u>354</u>
	Total	2,482

2. Chlorophyll a -

<u>Sampling Date</u>	<u>Station Number</u>	<u>Chlorophyll a (µg/l)</u>
05/23/75	1	7.3
	2	11.2
	3	7.3
08/29/75	1	16.9
	2	20.5
	3	38.8
10/15/75	1	20.5
	2	24.5
	3	4.9

C. Limiting Nutrient Study:

The algal assay results are not considered indicative of conditions in the reservoir at the time the samples were collected (05/23/75 and 10/15/75) due to significant changes in nutrient levels during shipment of the samples from the field to the laboratory.

The reservoir data indicate nitrogen limitation at all stations and sampling times, with the exception of station 1 in October; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 10/1 or less. However, the mean N/P ratio in October at station 1 was 15/1, and phosphorus limitation would be expected.

IV. NUTRIENT LOADINGS (See Appendix E for data)

For the determination of nutrient loadings, the Montana National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v). 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 Montana District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. 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 nutrient loads at station A-2, in $\text{kg/km}^2/\text{year}$, and multiplying by the ZZ area in km^2 .

The operator of the Sheridan wastewater treatment plant provided monthly effluent samples and corresponding flow data.

* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal* -

<u>Name</u>	<u>Pop. Served</u>	<u>Treatment</u>	<u>Mean Flow (m³/d)</u>	<u>Receiving Water</u>
Sheridan, WY	10,000	tr. filter	7,129.2	Goose Creek

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) -		
Tongue River	100,690	75.4
b. Minor tributaries & immediate drainage (non-point load) -	17,815	13.3
c. Known municipal STP's -		
Sheridan	14,775	11.1
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation** -	<u>250</u>	<u>0.2</u>
Total	133,530	100.0

2. Outputs -

Reservoir outlet - Tongue River 16,490

3. Net annual P accumulation - 117,040 kg.

* Treatment plant questionnaire.

** 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) -		
Tongue River	504,485	76.4
b. Minor tributaries & immediate drainage (non-point load) -	90,445	13.7
c. Known municipal STP's -		
Sheridan	50,200	7.6
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	<u>15,275</u>	<u>2.3</u>
Total	660,405	100.0

2. Outputs -

Reservoir outlet - Tongue River 618,385

3. Net annual N accumulation - 42,020 kg.

D. Non-point Nutrient Export by Subdrainage Area:

<u>Tributary</u>	<u>kg P/km²/yr</u>	<u>kg N/km²/yr</u>
Tongue River	26	132

* See Working Paper No. 175.

E. Mean Nutrient Concentrations in Ungaged Streams:

<u>Tributary</u>	<u>Mean Total P Conc. (mg/l)</u>	<u>Mean Total N Conc. (mg/l)</u>
Deer Creek	0.063	1.399
Squirrel Creek	0.127	1.719
Youngs Creek	0.099	1.430

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 ² /yr	9.44	8.27	46.7	3.0

Vollenweider phosphorus loadings
(g/m²/yr) based on mean depth and mean
hydraulic retention time of Tongue River Reservoir:

"Dangerous" (eutrophic loading)	1.04
"Permissible" (oligotrophic loading)	0.52

V. LITERATURE REVIEWED

Anonymous, 1974. Water resources data for Montana. Part 1: Surface water records. U.S. Geol. Surv., Helena.

Horpestad, Abe, 1975. Personal communication (morphometric data). MT Dept. of Health & Env. Sciences, Helena.

Polzin, Paul E., 1974. Water use and coal development in eastern Montana: Water availability, water demands, and economic impacts. Proj. C-5258 MONT, MT U. Joint Water Resources Res. Ctr., Bozeman.

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 CHLOROP	15- MIN DO	MEDIAN DISS ORTHO P
3001	CANYON FERRY RESERVOIR	0.047	0.170	442.800	5.816	14.400	0.029
3002	CLARK CANYON RESERVOIR	0.049	0.160	398.750	2.375	12.000	0.027
3003	FLATHEAD LAKE	0.008	0.050	267.833	1.273	9.000	0.004
3004	GEORGETOWN RESERVOIR	0.022	0.040	367.333	6.983	10.200	0.011
3005	HEBGEN RESERVOIR	0.022	0.040	367.700	4.083	13.800	0.020
3006	KOOCANUSA RESERVOIR	0.045	0.100	337.643	2.669	10.400	0.044
3007	MARY RONAN LAKE	0.020	0.040	371.091	4.673	14.200	0.006
3008	MC DONALD LAKE	0.006	0.180	190.667	0.467	6.400	0.002
3009	NELSON RESERVOIR	0.029	0.075	456.750	7.233	11.400	0.007
3010	SEELEY LAKE	0.015	0.040	362.857	2.171	13.200	0.010
3011	SWAN LAKE	0.010	0.050	282.750	3.289	9.600	0.004
3012	TALLY LAKE	0.011	0.050	339.167	2.083	9.200	0.004
3013	TIBER RESERVOIR	0.018	0.180	448.555	2.806	9.600	0.004
3014	TONGUE RIVER RESERVOIR	0.051	0.050	474.111	16.878	13.600	0.008
3016	WHITEFISH LAKE (LOWER)	0.008	0.040	290.000	1.400	7.000	0.003

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
3001	CANYON FERRY RESERVOIR	14 (2)	14 (2)	21 (3)	21 (3)	0 (0)	7 (1)	77
3002	CLARK CANYON RESERVOIR	7 (1)	21 (3)	29 (4)	64 (9)	36 (5)	14 (2)	171
3003	FLATHEAD LAKE	89 (12)	61 (8)	93 (13)	93 (13)	86 (12)	75 (9)	497
3004	GEORGETOWN RESERVOIR	39 (5)	79 (10)	50 (7)	14 (2)	57 (8)	29 (4)	268
3005	HEBGEN RESERVOIR	39 (5)	79 (10)	43 (6)	36 (5)	14 (2)	21 (3)	232
3006	KOOCANUSA RESERVOIR	21 (3)	29 (4)	71 (10)	57 (8)	50 (7)	0 (0)	228
3007	MARY RONAN LAKE	50 (7)	96 (13)	36 (5)	29 (4)	7 (1)	57 (8)	275
3008	MC DONALD LAKE	100 (14)	4 (0)	100 (14)	100 (14)	100 (14)	100 (14)	504
3009	NELSON RESERVOIR	29 (4)	36 (5)	7 (1)	7 (1)	43 (6)	50 (7)	172
3010	SEELEY LAKE	64 (9)	96 (13)	57 (8)	71 (10)	29 (4)	36 (5)	353
3011	SWAN LAKE	79 (11)	46 (6)	86 (12)	43 (6)	68 (9)	75 (9)	397
3012	TALLY LAKE	71 (10)	61 (8)	64 (9)	79 (11)	79 (11)	75 (9)	429
3013	TIBER RESERVOIR	57 (8)	4 (0)	14 (2)	50 (7)	68 (9)	75 (9)	268
3014	TONGUE RIVER RESERVOIR	0 (0)	46 (6)	0 (0)	0 (0)	21 (3)	43 (6)	110
3016	WHITEFISH LAKE (LOWER)	89 (12)	79 (10)	79 (11)	86 (12)	93 (13)	93 (13)	519

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3016	WHITEFISH LAKE (LOWER)	519
2	3008	MC DONALD LAKE	504
3	3003	FLATHEAD LAKE	497
4	3012	TALLY LAKE	429
5	3011	SWAN LAKE	397
6	3010	SEELEY LAKE	353
7	3007	MARY RONAN LAKE	275
8	3013	TIBER RESERVOIR	268
9	3004	GEORGETOWN RESERVOIR	268
10	3005	HEBGEN RESERVOIR	232
11	3006	KOOCANUSA RESERVOIR	228
12	3009	NELSON RESERVOIR	172
13	3002	CLARK CANYON RESERVOIR	171
14	3014	TONGUE RIVER RESERVOIR	110
15	3001	CANYON FERRY RESERVOIR	77

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 MONTANA

08/05/76

LAKE CODE 3014 TONGUE RIVER RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 4584.3

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS)												MEAN
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
3014A1	4584.3	4.76	5.18	6.82	11.55	27.33	44.17	14.95	8.24	8.44	8.69	8.35	5.44	12.83
3014A2	3825.4	5.32	7.79	10.17	11.36	33.92	56.63	13.79	4.64	6.99	7.25	6.65	5.41	14.15
3014C1	59.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3014Z2	694.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 4584.3
SUM OF SUB-DRAINAGE AREAS = 4584.3

TOTAL FLOW IN = 169.99
TOTAL FLOW OUT = 153.93

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3014A1	10	74	7.589	5	6.711				
	11	74	8.495	12	7.815				
	12	74	6.371	4	8.863				
	1	75	4.186	2	4.191	4	4.191		
	2	75	4.186	22	4.191				
	3	75	7.929	22	10.194				
	4	75	12.743	13	11.950				
	5	75	37.095	27	47.855				
	6	75	85.800	7	53.519	18	99.392		
	7	75	57.965						
	8	75	22.399						
	9	75	6.909	28	5.720				
3014A2	10	74	7.815	5	10.307				
	11	74	8.523	12	7.646				
	12	74	6.626	4	8.155				
	1	75	5.097	2	12.459				
	2	75	5.012	22	19.199				
	3	75	17.585	22	10.732				
	4	75	11.440	13	10.449				
	5	75	37.067	27	37.378				
	6	75	97.325	18	97.127				
	7	75	47.402						
	8	75	9.288						
	9	75	5.352	28	5.550				

TRIBUTARY FLOW INFORMATION FOR MONTANA

08/05/76

LAKE CODE 3014 TONGUE RIVER RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW
3014C1	10	74	0.0	5	0.0		
	11	74	0.0	12	0.0		
	12	74	0.0	4	0.0		
	1	75	0.0	2	0.0		
	2	75	0.0	22	0.0		
	3	75	0.0	22	0.0		
	4	75	0.0	13	0.0		
	5	75	0.0	27	0.0		
	6	75	0.0				
	7	75	0.0				
	8	75	0.0				
	9	75	0.0	28	0.0		

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/08/05

301401
45 07 40.0 106 46 14.0 3
TONGUE RIVER RESERVOIR
30003 MONTANA

090291

11EPALES 2111202
0057 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 URTHO MG/L P
75/05/23	09 30	0000	12.5	10.4	42	541	8.55	199	0.050	0.800	0.040	0.008
	09 30	0005	12.5	8.8		552	8.55	199	0.050	0.600	0.030	0.017
	09 30	0015	12.6	8.2		556	8.30	199	0.050	0.600	0.030	0.008
	09 30	0030	9.0	5.6		400	8.05	153	0.100	0.500	0.120	0.027
	09 30	0053	7.1	1.4		516	8.00	244	0.420	1.400	0.040	0.037
75/08/29	15 00	0000	23.7	13.2	24	507	9.80	165	0.020	1.200	0.020K	0.009
	15 00	0005	21.2	9.8		484	8.90	167	0.020K	0.700	0.020K	0.006
	15 00	0022	19.6	4.2		567	8.45	185	0.020K	0.500	0.020K	0.003
75/10/15	12 45	0000	11.4	8.8	36	620	8.45	296	0.030	0.500	0.020K	0.005
	12 45	0005	11.2	9.0		615	8.40	314	0.040	0.500	0.020K	0.004
	12 45	0015	11.0	8.0		611	8.40	320	0.050	0.500	0.020K	0.003
	12 45	0025	10.8	8.8		615	8.45	312	0.040	0.400	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
75/05/23	09 30	0000	0.039	7.3	
	09 30	0005	0.046		
	09 30	0015	0.051		
	09 30	0030	0.083		
	09 30	0053	0.141		
75/08/29	15 00	0000	0.141	16.9	
	15 00	0005	0.054		
	15 00	0022	0.022		
75/10/15	12 45	0000	0.050	20.5	
	12 45	0005	0.041		
	12 45	0015	0.031		
	12 45	0025	0.030		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

301402
45 06 17.0 106 46 42.0 3
TONGUE RIVER RESERVOIR
30003 MONTANA

090291

11EPALES 2111202
0034 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 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
75/05/23	09 55	0000	12.1	10.0	44	536	8.70	199	0.030	0.800	0.020K	0.013
	09 55	0005	12.0	8.8		506	8.60	191	0.030	0.600	0.020	0.008
	09 55	0015	11.4	8.8		444	8.35	172	0.030	0.800	0.060	0.017
	09 55	0030	6.8	9.2		280	8.60	135	0.050	0.700	0.140	0.027
75/08/29	15 20	0000	22.9	14.8	18	505	9.10	159	0.020	1.000	0.020K	0.007
	15 20	0005	21.2	10.0		496	8.90	163	0.020K	0.600	0.020K	0.006
	15 20	0014	20.4	4.2		546	8.50	178	0.020K	0.400	0.020K	0.004
75/10/15	13 05	0000	11.3	10.0	24	612	8.45	306	0.020	0.500	0.020K	0.005
	13 05	0005	10.9	9.0		614	8.50	292	0.020K	0.600	0.020K	0.005
	13 05	0013	10.8	9.4		614	8.50	300	0.020K	0.600	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
75/05/23	09 55	0000	0.053	11.2	
	09 55	0005	0.053		
	09 55	0015	0.051		
	09 55	0030	0.077		
75/08/29	15 20	0000	0.148	20.5	
	15 20	0005	0.047		
	15 20	0014	0.044		
75/10/15	13 05	0000	0.056	24.5	
	13 05	0005	0.049		
	13 05	0013	0.043		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

301403
45 04 03.0 106 48 06.0 3
TONGUE RIVER RESERVOIR
30003 MONTANA

090291

11EPALES 2111202
0023 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
75/05/23	10 20	0000	11.2	9.8	30	434	8.65	169	0.030	0.700	0.050	0.010
	10 20	0005	11.2	9.6		421	8.60	167	0.020	0.500	0.070	0.008
	10 20	0019	6.3	9.6		302	8.65	134	0.040	0.500	0.170	0.021
75/08/29	15 30	0000	20.9	10.0	9	700	8.65	296	0.030	0.400	0.020	0.010
75/10/15	13 30	0000	8.9	11.4	6	654	8.45	332	0.030	0.600	0.020K	0.019

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/05/23	10 20	0000	0.060	7.3	
	10 20	0005	0.045		
	10 20	0019	0.086		
75/08/29	15 30	0000	0.051	38.8	
75/10/15	13 30	0000	0.112	4.9	

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E
TRIBUTARY AND WASTEWATER
TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/08/05

3014A1
 45 08 29.0 106 46 15.0 4
 TONGUE RIVER
 30 7.5 TONGUE RV DM
 O/TONGUE RIVER RESERVOIR 090291
 BNK OFF SEC RD .5 M DWNSTRM TONGUE RV DM
 11EPALES 2111204
 0000 FEET DEPTH CLASS 00

DATE	TIME	DEPTH	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
FROM	OF						
TO	DAY	FEET					
74/10/05	12	00	0.040	1.400	0.025	0.010	0.035
74/11/12	17	00	0.020	1.000	0.128	0.005	0.020
74/12/04	12	30	0.008	0.700	0.025	0.005K	0.020
75/01/02	12	00	0.032	0.900	0.064	0.005K	0.015
75/01/04	10	39	0.384	0.900	0.010	0.015	0.020
75/02/22	15	30	0.096	0.837	0.080	0.008	0.020
75/03/22	16	30	0.210	1.300	0.220	0.055	0.060
75/04/13	13	00	0.240	1.930	0.810	0.055	0.090
75/05/27	10	30	0.125	2.200	0.070	0.020	0.120
75/06/07	11	15	0.420	0.550	0.045	0.005	0.010K
75/06/18	11	00	0.055	2.900	0.080	0.010	0.080
75/09/07	18	00	0.340	0.700	0.015	0.015	0.030
75/09/28	13	00	0.010	0.400	0.005	0.005K	0.030

K VALUE KNOWN TO BE
 LESS THAN INDICATED

STJRET RETRIEVAL DATE 76/08/05

3014A2
 45 01 50.0 106 48 45.0 4
 TONGUE RIVER
 30 7.5 DECKER
 T/TONGUE RIVER RESERVOIR 090291
 SEC RD BRDG AT S END OF LAKE
 11EPALES 2111204
 0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 N02&N03 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
74/10/05	11 15		0.048	1.300	0.030	0.025	0.115
74/11/12	15 56		0.024	0.400	0.032	0.025	0.040
74/12/04	11 30		0.032	1.100	0.020	0.015	0.120
75/01/02	11 30		0.272	0.600	0.048	0.025	0.320
75/02/22	17 20		0.336	0.635		0.097	0.138
75/03/22	15 45		0.200	1.800	0.270	0.300	0.380
75/04/13	12 00		0.085	1.900	0.040	0.045	0.090
75/05/27	12 00		0.070	1.000	0.030	0.040	0.290
75/06/18	12 20		0.180	1.650	0.175	0.030	0.390
75/09/28	12 45		0.005	0.200	0.005K	0.015	0.040

K VALUE KNOWN TO BE
 LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

3014D1
45 03 20.0 106 42 10.0 4
DEER CREEK
30 7.5 HOLMES RANCH
T/TONGUE RIVER RESERVOIR 090291
SEC RD XING 9 MI ENE OF DECKER
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
74/10/05	10 55		0.042	1.800	0.440	0.025	0.090
74/11/12	15 40		0.008	1.100	0.100	0.005	0.050
75/03/22	05 30		0.045	1.300	0.210	0.010	0.090
75/04/13	12 30		0.015	2.100	0.050	0.007	
75/05/27	11 30		0.030	1.100	0.030	0.005	0.030
75/09/07	14 00		0.240	0.400	0.025	0.005K	0.010
75/09/28	12 00		0.005	1.600	0.090	0.015	0.110

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

3014E1
45 05 20.0 106 59 20.0 4
SQUIRREL CREEK
30 7.5 PEARL SCHOOL
T/TONGUE RIVER RESERVOIR 090291
UNMPRVD RD XING 9.5 MI NW OF DECKER
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
74/11/12	14 10		0.024	1.100	0.330	0.005K	0.020
74/12/04	10 30		0.072	0.300	0.030	0.005K	0.010K
75/01/02	10 25		0.184	2.200	0.040	0.005K	0.040
75/03/22	14 50		0.550	3.150	0.640		0.460
75/04/13	10 10		0.260	2.700	0.050	0.020	0.060
75/05/27	13 30		0.290	0.900	0.010	0.040	0.260
75/09/28	11 00		0.005	0.300	0.005K	0.010	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

3014F1
45 01 40.0 106 59 55.0 4
YOUNGS CREEK
30 7.5 PEARL SCHOOL
T/TONGUE RIVER RESERVOIR 090291
SEC RD XING 1.5 MI NW OF PEARL SCHOOL
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&N03 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
74/10/05	09 35		0.016	1.300	0.165	0.035	0.075
74/11/12	14 00		0.064	0.800	0.145	0.010	0.030
74/12/04	10 00		0.064	0.800	0.015	0.010	0.040
75/01/02	09 30		0.208	3.200	0.152	0.015	0.030
75/03/22	14 45		0.175	0.850	0.045	0.035	0.120
75/04/13	08 30		0.155	1.850	0.030	0.025	0.110
75/05/27	14 30		0.250	0.950	0.020	0.035	0.280
75/06/18	08 25		0.230	1.550	0.055	0.030	0.150
75/09/28	10 30		0.005	0.400	0.010	0.015	0.060

STORET RETRIEVAL DATE 76/08/05

3014XA TF3014XA P010000
 44 49 15.0 106 57 00.0 4
 SHERIDAN
 56 7.5 SHERIDAN
 T/TONGUE RIVER RES. 090291
 GOOSE 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
75/03/13	00 00								
CP(T)-			0.600	25.000	9.130	4.370	7.800	1.600	1.800
75/03/13	12 00								
75/05/06	00 00		1.350	19.500	2.300	2.700	4.600	3.000	2.000
75/07/16	00 00								
CP(T)-			0.400	15.000	1.600	2.630	4.100	2.500	2.500
75/07/16	12 00								
75/08/25	08 00								
CP(T)-			0.100	18.000	5.100	5.600	7.300	2.500	2.000
75/08/25	20 00								
75/12/15	00 00								
CP(T)-			0.250	18.000	2.900	2.900	5.500	2.000	1.500
75/12/15	08 00								
76/01/29	12 00		0.250	19.000	4.800	3.800	5.700	2.000	1.500