U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

AMISTAD RESERVOIR

VAL VERDE COUNTY

TEXAS

EPA REGION VI

WORKING PAPER No. 631

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

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REPORT
ON
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VAL VERDE COUNTY
TEXAS
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WITH THE COOPERATION OF THE
WATER QUALITY BOARD
AND THE
TEXAS NATIONAL GUARD

FEBRUARY, 1977

CONTENTS

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) expresses sincere appreciation to the Texas Water Quality Board for professional involvement, to the Texas National Guard for conducting the tributary sampling phase of the Survey, and to those Texas wastewater treatment plant operators who voluntarily provided effluent samples.

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations Division 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 Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

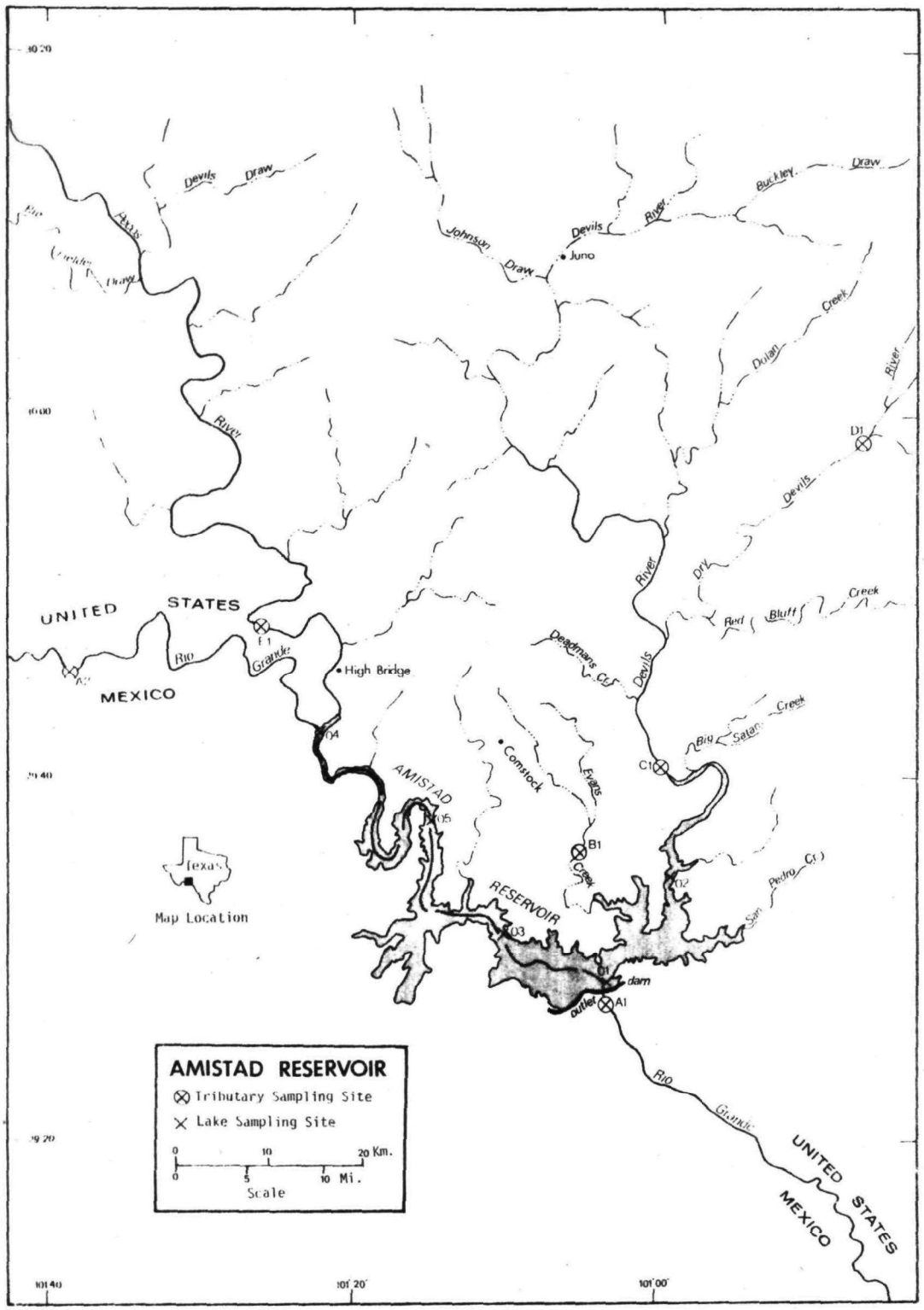
NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Texas

NAME	COUNTY
Amistad	Val Verde
Bastrop	Bastrop
Belton	Bell, Coryell
Braunig	Bexar
Brownwood	Brown
Buchanan	Burnet, Llano
Caddo	Harrison, Marion, TX; Caddo Parish, LA
Calaveras	Bexar
Canyon	Comal
Colorado City	Mitchell
Corpus Christi	Jim Wells, Live Oak, San Patricio
Diversion	Archer, Baylor
Eagle Mountain	Tarrant, Wise
Fort Phantom Hill	Jones
Houston	Harris
Kemp	Baylor
Lake O'The Pines	Camp, Marion, Morris, Upshur
Lavon	Collin
Lewisville (Garza-Little Elm)	Denton
Livingston	Polk, San Jacinto, Trinity, Walker

Lyndon B. Johnson	Burnet, Llano
Medina	Bandera, Medina
Meredith	Hutchinson, Moore, Potter
O. C. Fisher (San Angelo)	Tom Green
Palestine	Anderson, Cherokee, Henderson, Smith
Possum Kingdom	Palo Pinto, Stephens, Young
Sam Rayburn	Angelina, Jasper Nacogdoches, Sabine, San Augustine
Somerville	Burleson, Lee, Washington
E. V. Spence	Coke
Stamford	Haskell
Stillhouse Hollow	Bell
Tawakoni	Hunt, Rains, Van Zandt
Texoma	Cooke, Grayson TX; Bryan, Johnston, Love, Marshall, OK
Travis	Burnet, Travis
Trinidad	Henderson
Twin Buttes	Tom Green
White River	Crosby
Whitney	Bosque, Hill
Wright Patman (Texarkana)	Bowie, Cass


Devils Draw
Johnson Draw
Juno
Devils River
Buckley Draw
Dolan Creek
Pecos River
Rio Grande
UNITED STATES
MEXICO
High Bridge
Deadmans Cr
Dry Devils River
Red Bluff Creek
Big Satan Creek
Comstock
Evans Creek
AMISTAD RESERVOIR
San Pedro Cr
dam
outlet
A1
B1
C1
D1
E1
F1
Texas
Map Location
AMISTAD RESERVOIR
Tributary Sampling Site
Lake Sampling Site
0 10 20 Km.
0 5 10 Mi.
Scale
101°40
101°20
101°00

AMISTAD RESERVOIR

STORET NO. 4801

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Amistad Reservoir is mesotrophic; i.e., moderately supplied with nutrients. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the reservoir. In this regard, the Texas Water Quality Board has indicated that there is no known impairment of the designated beneficial uses of Amistad Reservoir.

Amistad ranked fifth in overall trophic quality when the 39 Texas reservoirs sampled in 1974 were compared using a combination of six parameters*. Two of the water bodies had less median total phosphorus, 11 had less and six had the same median dissolved orthophosphorus, 36 had less median inorganic nitrogen, none of the other reservoirs had less mean chlorophyll a, and none had greater mean Secchi disc transparency.

Survey limnologists did not observe any nuisance conditions during their sampling visits. However, marked depression of hypolimnetic dissolved oxygen occurred at stations 1, 2, and 3 in August and October.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Amistad Reservoir was phosphorus limited at the times the samples were collected (03/05-06/74 and 10/29-30/74). The reservoir data indicate phosphorus limitation at all sampling stations and times.

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* See Appendix A.

C. Nutrient Controllability:

1. Point sources--No known point sources impacted Amistad Reservoir during the sampling year.

The present phosphorus loading of 0.98 g/m^2/year is over two times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 13). If Vollenweider's eutrophic loading level is applicable to Texas reservoirs, increasingly undesirable responses to enrichment are likely to occur.

2. Non-point sources--The phosphorus contributions of non-point sources accounted for all of the load during the sampling year. The Rio Grande River contributed 92.3%, Devils River contributed 1.8%, and the Pecos River contributed 1.1%. The ungaged minor tributaries and immediate drainage contributed an estimated 3.0%.

The nutrient export rates of all of the gaged tributaries were quite low (page 12), and it is likely that any significant reduction in non-point phosphorus contributions would be difficult to accomplish.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 262.48 kilometers^2.
2. Mean depth: 16.5 meters.
3. Maximum depth: >61.0 meters.
4. Volume: 4,330.920 x 10^6 m^3.
5. Mean hydraulic retention time: 3.8 years (based on outflow).

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

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Rio Grande River	209,271.9	38.820
Evans Creek	114.5	0.019
Devil's River	10,259.0	10.900
Pecos River	91,116.1	7.410
Minor tributaries & immediate drainage -	7,804.9	1.357
Totals	318,566.4	58.506

2. Outlet -

Rio Grande River	318,828.9**	36.180**

C. Precipitation***:

1. Year of sampling: 44.7 centimeters.
2. Mean annual: 42.9 centimeters.

† Table of metric conversions--Appendix B.
†† Ito, 1976.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of reservoir; lesser outflow due to discharge of springs below the dam and evaporation (Ligner, 1976).
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Amistad Reservoir was sampled four times in 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 five stations on the reservoir in May, August, and October, and four stations in March (see map, page vi). 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 March and October visits, two 18.9-liter depth-integrated samples were 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 61.0 meters at station 1, 39.3 meters at station 2, 53.6 meters at station 3, 23.2 meters at station 4, and 42.7 meters at station 5.

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

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR AMISTAD LAKE
STORET CODE 4801

PARAMETER	1ST SAMPLING (3/ 5/74) 4 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (5/14/74) 5 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (8/ 6/74) 5 SITES RANGE	MEAN	MEDIAN
TEMP (C)	12.1 - 16.7	13.5	13.1	13.7 - 25.4	21.6	23.5	14.4 - 27.7	22.9	26.4
DISS OXY (MG/L)	7.4 - 10.6	9.0	9.1	0.4 - 8.4	6.1	6.8	0.1 - 8.6	4.7	6.4
CNDCTVY (MCROMO)	610. - 1875.	752.	675.	742. - 965.	861.	865.	778. - 1231.	945.	961.
PH (STAND UNITS)	7.9 - 8.4	8.2	8.3	7.4 - 8.4	8.0	8.1	7.6 - 8.6	8.1	8.2
TOT ALK (MG/L)	137. - 178.	147.	144.	108. - 146.	131.	131.	****** -**********		
TOT P (MG/L)	0.006 - 0.013	0.008	0.007	0.007 - 0.045	0.013	0.010	****** -**********		
ORTHO P (MG/L)	0.005 - 0.010	0.008	0.008	0.002 - 0.007	0.004	0.003	****** -**********		
NO2+NO3 (MG/L)	0.210 - 0.680	0.358	0.285	0.210 - 0.670	0.360	0.350	****** -**********		
AMMONIA (MG/L)	0.020 - 0.060	0.033	0.030	0.040 - 0.360	0.079	0.050	****** -**********		
KJEL N (MG/L)	0.200 - 0.400	0.275	0.300	0.200 - 0.900	0.348	0.300	****** -**********		
INORG N (MG/L)	0.240 - 0.700	0.392	0.335	0.250 - 0.810	0.439	0.430	****** -**********		
TOTAL N (MG/L)	0.430 - 0.880	0.633	0.585	0.440 - 1.340	0.708	0.590	****** -**********		
CHLRPYL A (UG/L)	0.2 - 1.5	0.5	0.2	1.2 - 2.7	1.8	1.7	2.7 - 4.3	3.1	2.8
SECCHI (METERS)	3.6 - 5.8	4.5	4.4	2.1 - 4.0	3.3	3.4	2.3 - 5.5	3.7	3.2

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR AMISTAD LAKE
STORET CODE 4801

4TH SAMPLING (10/29/74)

PARAMETER	5 SITES RANGE	MEAN	MEDIAN
TEMP (C)	16.4 - 21.5	20.4	21.0
DISS OXY (MG/L)	0.2 - 7.8	5.4	6.3
CNDCTVY (MCROMO)	446. - 1745.	812.	710.
PH (STAND UNITS)	7.4 - 8.1	7.7	7.8
TOT ALK (MG/L)	109. - 158.	131.	127.
TOT P (MG/L)	0.013 - 0.037	0.021	0.021
ORTHO P (MG/L)	0.011 - 0.022	0.016	0.015
NO2+NO3 (MG/L)	0.140 - 1.680	0.683	0.590
AMMONIA (MG/L)	0.020 - 0.070	0.027	0.020
KJEL N (MG/L)	0.200 - 0.500	0.274	0.300
INORG N (MG/L)	0.190 - 1.720	0.710	0.615
TOTAL N (MG/L)	0.340 - 2.080	0.957	0.885
CHLRPYL A (UG/L)	1.1 - 3.7	2.4	2.0
SECCHI (METERS)	0.9 - 2.7	1.8	1.9

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/05/74	1. Cysts	262
	2. Chroomonas sp.	174
	3. Coelastrum sp.	87
	4. Cryptomonas sp.	87
	5. Cyclotella sp.	87
	Other genera	44
	Total	741
05/15/74	1. Coelastrum sp.	161
	2. Cryptomonas sp.	107
	3. Chroomonas sp.	40
	4. Dinobryon sp.	40
	5. Fragilaria sp.	40
	Other genera	68
	Total	456
08/07/74	1. Navicula sp.	739
	2. Chroomonas sp.	370
	3. Oscillatoria sp.	269
	4. Peridinium sp.	168
	5. Centric diatoms	101
	Other genera	268
	Total	1,915
10/29/74	1. Coelastrum sp.	30
	2. Chroomonas sp.	20
	3. Cryptomonas sp.	20
	4. Melosira sp.	20
	5. Scenedesmus sp.	10
	Other genera	21
	Total	121

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
03/05-06/74	1	0.2
	2	0.2
	3	0.3
	4	1.5
	5	-
05/14-15/74	1	1.2
	2	2.2
	3	1.4
	4	2.7
	5	1.7
08/06-07/74	1	2.7
	2	2.8
	3	2.8
	4	4.3
	5	2.9
10/29-30/74	1	1.1
	2	2.0
	3	3.3
	4	1.8
	5	3.7

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. March sample -

(1). Stations 1 and 2 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	<0.005	0.299	0.1
0.050 P	<0.055	0.299	5.7
0.050 P + 1.0 N	<0.055	1.299	11.3
1.0 N	<0.055	1.299	0.1

(2). Stations 3 and 4 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	<0.005	0.525	0.1
0.050 P	<0.055	0.525	10.8
0.050 P + 1.0 N	<0.055	1.525	11.4
1.0 N	<0.005	1.525	0.1

b. October sample -

(1). Stations 1, 2, and 3 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.009	0.424	0.3
0.050 P	0.059	0.424	12.5
0.050 P + 1.0 N	0.059	1.424	20.0
1.0 N	0.009	1.424	0.2

(2). Stations 4 and 5 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.005	(1.058)*	0.2
0.050 P	0.055	(1.058)	13.0
0.050 P + 1.0 N	0.055	(2.058)	15.6
1.0 N	0.005	(2.058)	0.2

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential primary productivity of Amistad Reservoir was low in March and moderate in October. The significant increases in yields with the addition of orthophosphorus and the lack of changes in yields when only nitrogen was added indicate phosphorus limitation.

* Sample for nitrogen analysis was inadvertently discarded. The reservoir data indicate a mean inorganic nitrogen concentration of 1.058 mg/l.

The reservoir data also indicate phosphorus limitation; i.e., the mean inorganic nitrogen to orthophosphorus ratios were 44 to 1 or greater in March, May, and October.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Texas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff month of April when two samples were collected. Sampling was begun in September, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Texas 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*.

Because of lack of flow, Evans Creek was not sampled, and the nutrient loads for this stream and the unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads at stations C-1 and E-1, in $kg/km^2/year$, and multiplying the means by the Evans Creek and ZZ areas in km^2.

No known point sources impacted Amistad Reservoir during the sampling year.

* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Rio Grande River	237,445	92.3
Evans Creek	115	<0.1
Devil's River	4,585	1.8
Pecos River	2,750	1.1
b. Minor tributaries & immediate drainage (non-point load) -	7,805	3.0
c. Known municipal STP's - None	-	-
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	4,595	1.8
Total	257,295	100.0

2. Outputs -

Lake outlet - Rio Grande River 14,320

3. Net annual P accumulation - 242,975 kg.

* 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) -		
Rio Grande River	2,106,250	49.6
Evans Creek	5,555	0.1
Devil's River	938,080	22.1
Pecos River	533,080	12.6
b. Minor tributaries & immediate drainage (non-point load) -	378,540	8.9
c. Known municipal STP's - None	-	-
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	283,375	6.7
Total	4,244,880	100.0

2. Outputs -

Lake outlet - Rio Grande River 1,193,690

3. Net annual N accumulation - 3,051,190 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Rio Grande River	1	10
Devil's River	<1	91
Pecos River	<1	6

* See Working Paper No. 175.

E. 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	0.98	0.93	16.2	11.6

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Amistad Reservoir:

"Dangerous" (eutrophic loading)	0.40
"Permissible" (oligotrophic loading)	0.20

V. LITERATURE REVIEWED

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Ligner, James J., 1976. Personal communication (tributary flows). Intn. Boundary & Water Comm., El Paso.

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

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
4801	AMISTAD LAKE	95 (36)	5 (2)	100 (38)	100 (38)	39 (14)	63 (21)	402
4802	BASTROP LAKE	79 (30)	76 (28)	82 (31)	47 (18)	17 (0)	92 (34)	393
4803	BELTON RESERVOIR	92 (35)	26 (10)	97 (37)	68 (26)	17 (0)	84 (31)	384
4804	BRAUNIG LAKE	5 (2)	42 (16)	50 (19)	8 (3)	49 (17)	5 (2)	159
4805	BROWNWOOD LAKE	66 (25)	70 (26)	29 (11)	87 (33)	58 (22)	84 (31)	394
4806	LAKE BUCHANAN	47 (18)	21 (7)	74 (28)	63 (24)	17 (0)	39 (14)	261
4807	CADDO LAKE	26 (10)	91 (33)	42 (16)	32 (12)	76 (29)	30 (10)	297
4808	CALAVERAS LAKE	45 (17)	100 (38)	47 (18)	11 (4)	67 (25)	92 (34)	362
4809	CANYON RESERVOIR	99 (37)	8 (3)	95 (36)	97 (37)	49 (17)	97 (37)	445
4810	LAKE COLORADO CITY	39 (14)	76 (28)	26 (10)	42 (16)	88 (33)	39 (14)	310
4811	CORPUS CRISTI LAKE	8 (3)	47 (18)	18 (7)	13 (5)	61 (23)	8 (3)	155
4812	DIVERSION LAKE	68 (26)	83 (31)	32 (12)	29 (11)	97 (37)	63 (21)	372
4813	EAGLE MOUNTAIN LAKE	71 (27)	91 (33)	34 (13)	79 (30)	79 (30)	76 (28)	430
4814	FT PHANTOM HILL LAKE	24 (9)	66 (25)	21 (8)	74 (28)	95 (36)	16 (6)	296
4815	GARZA LITTLE ELM RESERVO	34 (13)	13 (5)	16 (6)	34 (13)	55 (21)	21 (7)	173
4816	KEMP LAKE	76 (29)	61 (22)	55 (21)	55 (21)	84 (32)	92 (34)	423
4817	HOUSTON LAKE	16 (6)	16 (6)	0 (0)	24 (9)	72 (27)	11 (4)	139
4818	LAKE OF THE PINES	54 (20)	76 (28)	66 (25)	39 (15)	17 (0)	46 (17)	298
4819	LAVON RESERVOIR	21 (8)	29 (11)	3 (1)	84 (32)	100 (38)	21 (7)	258
4820	LIVINGSTON LAKE	3 (1)	3 (1)	39 (15)	26 (10)	17 (0)	3 (1)	91
4821	LYNDON B JOHNSON LAKE	39 (14)	11 (4)	53 (20)	66 (25)	39 (14)	30 (10)	238
4822	MEDINA LAKE	99 (37)	0 (0)	89 (34)	37 (14)	17 (0)	100 (38)	342
4823	LAKE MEREDITH	82 (31)	91 (33)	71 (27)	95 (36)	39 (14)	63 (21)	441
4824	PALESTINE LAKE	54 (20)	32 (12)	63 (24)	53 (20)	49 (17)	51 (19)	302
4825	POSSUM KINGDOM RESERVOIR	74 (28)	91 (33)	84 (32)	58 (22)	17 (0)	63 (21)	387
4826	SAN ANGELO RESERVOIR	13 (5)	45 (17)	8 (3)	0 (0)	88 (33)	46 (17)	200
4827	SAM RAYBURN RESERVOIR	59 (22)	39 (15)	68 (26)	76 (29)	17 (0)	63 (21)	322
4828	E V SPENCE RESERVOIR	50 (19)	83 (31)	45 (17)	50 (19)	17 (0)	76 (28)	321

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
4829	SOMERVILLE LAKE	29 (11)	55 (21)	24 (9)	3 (1)	67 (25)	30 (10)	208
4830	STAMFORD LAKE	18 (7)	97 (37)	5 (2)	18 (7)	82 (31)	39 (14)	259
4831	STILLHOUSE HOLLOW RESERV	88 (33)	37 (14)	87 (33)	92 (35)	17 (0)	51 (19)	372
4832	TAWAKONI LAKE	32 (12)	70 (26)	37 (14)	21 (8)	63 (24)	30 (10)	253
4833	TEXARKANA LAKE	11 (4)	51 (19)	13 (5)	16 (6)	72 (27)	13 (5)	176
4834	TEXOMA LAKE	39 (14)	34 (13)	61 (23)	45 (17)	17 (0)	21 (7)	217
4835	TRAVIS LAKE	88 (33)	21 (7)	92 (35)	82 (31)	17 (0)	84 (31)	384
4836	TRINIDAD	0 (0)	61 (22)	11 (4)	5 (2)	92 (35)	0 (0)	169
4837	TWIN BUTTES RESERVOIR	59 (22)	21 (7)	58 (22)	61 (23)	49 (17)	63 (21)	311
4838	WHITE RIVER RESERVOIR	84 (32)	61 (22)	76 (29)	89 (34)	17 (0)	63 (21)	390
4839	WHITNEY LAKE	63 (24)	51 (19)	79 (30)	71 (27)	17 (0)	76 (28)	357

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4809	CANYON RESERVOIR	445
2	4823	LAKE MEREDITH	441
3	4813	EAGLE MOUNTAIN LAKE	430
4	4816	KEMP LAKE	423
5	4801	AMISTAD LAKE	402
6	4805	BROWNWOOD LAKE	394
7	4802	BASTROP LAKE	393
8	4838	WHITE RIVER RESERVOIR	390
9	4825	POSSUM KINGDOM RESERVOIR	387
10	4835	TRAVIS LAKE	384
11	4803	BELTON RESERVOIR	384
12	4831	STILLHOUSE HOLLOW RESERV	372
13	4812	DIVERSION LAKE	372
14	4808	CALAVERAS LAKE	362
15	4839	WHITNEY LAKE	357
16	4822	MEDINA LAKE	342
17	4827	SAM RAYBURN RESERVOIR	322
18	4828	E V SPENCE RESERVOIR	321
19	4837	TWIN BUTTES RESERVOIR	311
20	4810	LAKE COLORADO CITY	310
21	4824	PALESTINE LAKE	302
22	4818	LAKE OF THE PINES	298
23	4807	CADDO LAKE	297
24	4814	FT PHANTOM HILL LAKE	296
25	4806	LAKE BUCHANAN	261
26	4830	STAMFORD LAKE	259
27	4819	LAVON RESERVOIR	258
28	4832	TAWAKONI LAKE	253

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
29	4821	LYNDON B JOHNSON LAKE	238
30	4834	TEXOMA LAKE	217
31	4829	SOMERVILLE LAKE	208
32	4826	SAN ANGELO RESERVOIR	200
33	4833	TEXARKANA LAKE	176
34	4815	GARZA LITTLE ELM RESERVO	173
35	4836	TRINIDAD	169
36	4804	BRAUNIG LAKE	159
37	4811	CORPUS CRISTI LAKE	155
38	4817	HOUSTON LAKE	139
39	4820	LIVINGSTON LAKE	91

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4809	CANYON RESERVOIR	445
2	4823	LAKE MEREDITH	441
3	4813	EAGLE MOUNTAIN LAKE	430
4	4816	KEMP LAKE	423
5	4801	AMISTAD LAKE	402
6	4805	BROWNWOOD LAKE	394
7	4802	BASTROP LAKE	393
8	4838	WHITE RIVER RESERVOIR	390
9	4825	POSSUM KINGDOM RESERVOIR	387
10	4835	TRAVIS LAKE	384
11	4803	BELTON RESERVOIR	384
12	4831	STILLHOUSE HOLLOW RESERV	372
13	4812	DIVERSION LAKE	372
14	4808	CALAVERAS LAKE	362
15	4839	WHITNEY LAKE	357
16	4822	MEDINA LAKE	342
17	4827	SAM RAYBURN RESERVOIR	322
18	4828	E V SPENCE RESERVOIR	321
19	4837	TWIN BUTTES RESERVOIR	311
20	4810	LAKE COLORADO CITY	310
21	4824	PALESTINE LAKE	302
22	4818	LAKE OF THE PINES	298
23	4807	CADDO LAKE	297
24	4814	FT PHANTOM HILL LAKE	296
25	4806	LAKE BUCHANAN	261
26	4830	STAMFORD LAKE	259
27	4819	LAVON RESERVOIR	258
28	4832	TAWAKONI LAKE	253

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
29	4821	LYNDON B JOHNSON LAKE	238
30	4834	TEXOMA LAKE	217
31	4829	SOMERVILLE LAKE	208
32	4826	SAN ANGELO RESERVOIR	200
33	4833	TEXARKANA LAKE	176
34	4815	GARZA LITTLE ELM RESERVO	173
35	4836	TRINIDAD	169
36	4804	BRAUNIG LAKE	159
37	4811	CORPUS CRISTI LAKE	155
38	4817	HOUSTON LAKE	139
39	4820	LIVINGSTON LAKE	91

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 TEXAS 05/03/76

LAKE CODE 4801 AMISTAD

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 318828.9

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4801A1	318828.9	25.91	69.94	23.19	28.60	55.50	52.95	33.98	32.28	44.17	35.68	18.21	16.93	36.18
4801A2	209271.9	24.35	24.41	21.04	19.20	24.61	39.36	47.29	54.65	87.50	70.51	28.88	23.33	38.82
4801B1	114.5	0.001	0.004	0.001	0.004	0.036	0.040	0.011	0.005	0.083	0.044	0.002	0.000	0.019
4801C1	10259.0	7.08	6.88	6.06	6.85	15.69	12.88	7.33	22.12	17.13	12.63	8.24	7.56	10.90
4801E1	91116.1	5.10	5.10	4.59	6.74	10.28	7.45	6.71	8.83	13.22	9.94	5.75	5.13	7.41
4801ZZ	8067.8	0.059	0.261	0.059	0.311	2.549	2.832	0.765	0.368	5.833	3.087	0.159	0.020	1.357

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 318828.9
SUM OF SUB-DRAINAGE AREAS = 318829.2
TOTAL FLOW IN = 700.95
TOTAL FLOW OUT = 437.35

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4801A1	9	74	605.980	7	148.947				
	10	74	373.782	8	433.248				
	11	74	237.862	7	278.921				
	12	74	99.675	6	210.111				
	1	75	51.820	7	37.661				
	2	75	84.384	6	71.642				
	3	75	109.869	1	82.968				
	4	75	163.105	11	114.117	23	210.961		
	5	75	75.323	17	37.378				
	6	75	30.865	5	28.600				
	7	75	66.261	16	53.236				
	8	75	90.897	7	114.117				
4801A2	9	74	280.903	7	24.777				
	10	74	182.644	8	231.632				
	11	74	58.050	7	56.067				
	12	74	31.149	6	32.848				
	1	75	26.533	7	28.062				
	2	75	43.325	6	26.448				
	3	75	103.640	1	89.481				
	4	75	61.731	11	96.844	23	29.733		
	5	75	27.354	17	25.598				
	6	75	24.381	5	23.673				
	7	75	40.210	16	30.582				
	8	75	51.820	7	27.977				

LAKE CODE 4801 AMISTAD

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4801B1	9	74	3.143	7	0.0				
	10	74	0.255	8	0.0				
	11	74	0.0	7	0.0				
	12	74	0.0	6	0.0				
	1	75	0.0	7	0.0				
	2	75	0.0	6	0.0				
	3	75	0.0	1	0.0				
	4	75	0.0	11	0.0	23	0.0		
	5	75	0.0	17	0.0				
	6	75	0.0	3	0.0				
	7	75	0.212	16	0.0				
	8	75	0.0	7	0.0				
4801C1	9	74	239.561	7	6.966				
	10	74	18.831	8	15.036				
	11	74	14.130	7	15.319				
	12	74	12.120	6	12.374				
	1	75	11.100	7	11.553				
	2	75	12.006	6	12.799				
	3	75	10.392	1	10.704				
	4	75	9.968	11	10.222	23	9.769		
	5	75	10.336	17	9.628				
	6	75	9.826	5	9.968				
	7	75	13.281	16	9.543				
	8	75	11.525	7	12.091				
4801E1	9	74	382.277	7	4.106				
	10	74	52.386	8	72.491				
	11	74	28.317	7	33.980				
	12	74	17.443	6	18.916				
	1	75	13.479	7	14.555				
	2	75	12.969	6	14.470				
	3	75	10.194	1	10.930				
	4	75	9.288	11	9.543	23	8.863		
	5	75	8.382	17	7.617				
	6	75	6.994	5	7.306				
	7	75	11.610	16	6.711				
	8	75	8.325	7	7.674				
4801ZZ	9	74	188.307						
	10	74	14.725						
	11	74	11.044						
	12	74	9.628						
	1	75	8.778						
	2	75	9.345						
	3	75	8.212						
	4	75	7.929						
	5	75	7.929						
	6	75	7.646						
	7	75	10.477						
	8	75	9.061						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/02/11

480101
29 27 35.0 101 03 20.0
AMISTAD LAKE
48465 TEXAS

11EPALES
4

2111202
0205 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/05	15 00	0000	13.2		164	645	8.40	144	0.030	0.300	0.250	0.008
	15 00	0010	13.0	9.2		642	8.30	145	0.030	0.300	0.270	0.009
	15 00	0030	12.8	9.2		655	8.30	144	0.030	0.300	0.260	0.008
	15 00	0060	12.5	9.2		667	8.30	143	0.040	0.200	0.260	0.008
	15 00	0100	12.3	9.0		670	8.30	144	0.030	0.300	0.240	0.005
	15 00	0150	12.2	10.6		672	8.30	144	0.030	0.300	0.240	0.006
	15 00	0200	12.2	9.0		677	8.30	144	0.030	0.200	0.230	0.006
74/05/14	15 00	0000	24.0		156	865	8.30	129	0.090	0.600	0.250	0.006
	15 00	0005	23.7	7.6		865	8.40	129	0.050	0.200	0.240	0.002
	15 00	0020	23.5	8.0		862	8.40	127	0.060	0.200	0.250	0.003
	15 00	0045	21.0	7.4		856	8.20	131	0.060	0.200K	0.280	0.003
	15 00	0090	15.1	6.0		760	8.00	136	0.050	0.200K	0.380	0.002
	15 00	0170	13.7	6.4		742	7.90	137	0.050	0.200K	0.390	0.002
74/08/06	15 45	0000	26.5	7.6	216	998	8.40					
	15 45	0005	26.5	7.6		997	8.40					
	15 45	0015	26.4	7.6		998	8.40					
	15 45	0047	26.3	7.2		997	8.40					
	15 45	0065	23.6	4.0		967	7.70					
	15 45	0085	16.6	0.6		814	7.70					
	15 45	0125	14.8	2.4		787	7.60					
	15 45	0170	14.4	2.8		782	7.90					
74/10/29	14 15	0000	21.0	7.2	107	708	7.96	123	0.030	0.300	0.460	0.013
	14 15	0005	21.0	7.2		708	7.95	124	0.030	0.300	0.470	0.014
	14 15	0020	21.0	7.2		710	7.94	114	0.020	0.200	0.470	0.013
	14 15	0040	21.0	7.4		714	7.92	117	0.020	0.200	0.480	0.012
	14 15	0060	20.9	7.4		719	7.87	118	0.020	0.200	0.510	0.014
	14 15	0085	20.9	6.0		733	7.80	122	0.020K	0.300	0.620	0.015
	14 15	0090	20.1	2.2		833	7.47	123	0.030	0.200	0.810	0.017
	14 15	0120	18.3	1.4		831	7.39	134	0.020K	0.200K	0.680	0.019
	14 15	0145	16.4	0.2		747	7.42	150	0.040	0.200K	0.170	0.018
	14 15	0176	16.4	0.2		746	7.42	152	0.050	0.200K	0.140	0.018

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/11

480101
29 27 35.0 101 03 20.0
AMISTAD LAKE
48465 TEXAS

11EPALES 2111202
4 0205 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/05	15	00 0000	0.006	0.2	
	15	00 0010	0.007		
	15	00 0030	0.006		
	15	00 0060	0.006		
	15	00 0100	0.006		
	15	00 0150	0.006		
	15	00 0200	0.006		
74/05/14	15	00 0000	0.011	1.2	
	15	00 0005	0.008		
	15	00 0020	0.008		
	15	00 0045	0.007		1.0
	15	00 0090	0.007		
	15	00 0170	0.008		
74/08/06	15	45 0000		2.7	
	15	45 0047			1.0
74/10/29	14	15 0000	0.013	1.1	
	14	15 0001			50.0
	14	15 0005	0.030		
	14	15 0010			1.0
	14	15 0020	0.028		
	14	15 0040	0.027		
	14	15 0060	0.028		
	14	15 0085	0.029		
	14	15 0090	0.018		
	14	15 0120	0.033		
	14	15 0145	0.029		
	14	15 0176	0.029		

STORET RETRIEVAL DATE 76/02/11

480102
29 33 30.0 100 58 30.0
AMISTAD LAKE
48465 TEXAS

11EPALES
4

2111202
0130 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/05	14	35 0000	16.7		140	664	8.30	147	0.020	0.400	0.470	0.007
	14	35 0010	15.0	9.4		654	8.30	144	0.020	0.300	0.330	0.007
	14	35 0030	12.8	9.0		610	8.30	148	0.020	0.300	0.420	0.007
	14	35 0060	12.1	8.8		625	8.30	144	0.050	0.300	0.300	0.009
	14	35 0090	12.1	8.8		632	8.30	144	0.040	0.400	0.260	0.009
	14	35 0124	12.1	8.8		644	8.30	143	0.060	0.300	0.270	0.010
74/05/14	15	45 0000	24.8		156	836	8.20	131	0.070	0.500	0.360	0.003
	15	45 0005	24.3	8.4		830	8.30	131	0.050	0.200	0.340	0.002K
	15	45 0020	24.2	8.0		830	8.30	130	0.050	0.300	0.320	0.002K
	15	45 0035	23.5	8.0		813	8.30	131	0.050	0.200	0.350	0.002K
	15	45 0060	16.9	5.0		753	7.90	139	0.050	0.200K	0.390	0.002K
	15	45 0115	14.0	5.0		760	7.80	139	0.050	0.200K	0.400	0.002
74/08/07	17	45 0000	27.7	6.1	120	829	8.30					
	17	45 0005	27.3	8.6		824	8.50					
	17	45 0015	27.0	7.6		858	8.40					
	17	45 0029	26.5	7.0		946	8.40					
	17	45 0040	25.1	4.4		955	7.90					
	17	45 0055	24.4	3.6		947	7.90					
	17	45 0070	21.3	0.4		874	7.60					
	17	45 0085	17.0	0.1		804	7.60					
	17	45 0100	16.1	0.1		792	7.60					
	17	45 0115	15.0	0.4		778	7.60					
74/10/29	13	30 0000	21.2	6.0	73	446	7.75	130	0.030	0.400	0.590	0.014
	13	30 0005	21.2	6.2		446	7.75	127	0.020	0.300	0.590	0.012
	13	30 0020	20.9	5.8		451	7.65	127	0.020K	0.300	0.580	0.013
	13	30 0040	20.9	5.8		469	7.67	126	0.030	0.200	0.530	0.014
	13	30 0060	20.7	5.8		544	7.72	125	0.020	0.200	0.440	0.014
	13	30 0080	20.3	2.8		544	7.47	132	0.030	0.200	0.600	0.020
	13	30 0090	19.6	1.2		631	7.43	135	0.020K	0.200K	0.520	0.018
	13	30 0129	17.1	0.4		718	7.49	154	0.070	0.200K	0.220	0.022

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/11

420102
29 33 30.0 100 58 30.0
AMISTAD LAKE
48465 TEXAS

11EPALES 2111202
4 0130 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/05	14	35 0000	0.007	0.2	
	14	35 0010	0.009		
	14	35 0030	0.007		
	14	35 0060	0.008		
	14	35 0090	0.011		
	14	35 0124	0.012		
74/05/14	15	45 0000	0.010	2.2	
	15	45 0005	0.008		
	15	45 0020	0.008		
	15	45 0035	0.008		1.0
	15	45 0060	0.010		
	15	45 0115	0.015		
74/08/07	17	45 0000		2.8	
	17	45 0003			50.0
	17	45 0029			1.0
74/10/29	13	30 0000	0.014	2.0	
	13	30 0001			50.0
	13	30 0005	0.020		
	13	30 0009			1.0
	13	30 0020	0.013		
	13	30 0040	0.014		
	13	30 0060	0.013		
	13	30 0080	0.018		
	13	30 0090	0.020		
	13	30 0129	0.025		

STORET RETRIEVAL DATE 76/02/11

480103
29 30 50.0 101 10 15.0
AMISTAD LAKE
48465 TEXAS

11EPALES
4

2111202
0140 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/06	14 50	0000	16.0		180	709	8.20	141	0.040	0.300	0.210	0.009
	14 50	0010	15.0	9.2		685	8.20	137	0.020	0.300	0.220	0.009
	14 50	0035	13.3	9.4		694	8.20	140	0.020	0.300	0.240	0.006
	14 50	0070	12.5	9.2		701	8.15	140	0.040	0.200	0.300	0.010
	14 50	0130	12.4	8.8		717	8.10	141	0.050	0.300	0.330	0.010
74/05/15	10 55	0000	25.2		120	918	8.25	127	0.040	0.300	0.210	0.002K
	10 55	0005	25.1	7.8		918	8.20	127	0.040	0.300	0.220	0.003
	10 55	0040	23.4	7.4		903	8.10	126	0.040	0.300	0.220	0.004
	10 55	0065	19.7	5.6		884	7.80	135	0.060	0.300	0.370	0.003
	10 55	0130	14.2	5.6		770	7.70	137	0.050	0.200	0.390	0.003
74/08/06	14 50	0000	27.5	7.4	180	1028	8.50					
	14 50	0005	27.2	7.6		1018	8.50					
	14 50	0015	26.9	7.0		1017	8.40					
	14 50	0042	26.8	7.0		1014	8.40					
	14 50	0055	26.7	7.0		1014	8.30					
	14 50	0070	22.2	1.6		936	7.90					
	14 50	0085	16.7	1.0		825	7.80					
	14 50	0110	15.1	1.4		804	7.75					
	14 50	0140	14.6	1.6		797	7.70					
	14 50	0170	14.5	1.8		799	7.70					
74/10/29	15 15	0000	21.3	7.8	100	710	8.07	113	0.040	0.500	0.490	0.013
	15 15	0005	21.3	7.8		710	8.07	111	0.020K	0.200	0.490	0.012
	15 15	0020	21.2	7.8		709	8.04	112	0.020K	0.200	0.500	0.012
	15 15	0040	21.0	7.2		702	7.95	111	0.020	0.200	0.530	0.011
	15 15	0060	21.0	7.8		702	7.92	109	0.020	0.200	0.530	0.012
	15 15	0080	21.0	6.4		699	7.88	111	0.020	0.200K	0.560	0.013
	15 15	0105	21.5	2.8		1745	7.42	145	0.020K	0.300	0.730	0.016
	15 15	0120	19.7	2.8		1439	7.41	146	0.020K	0.300	0.690	0.017
	15 15	0135	17.2	0.8		860	7.44	143	0.030	0.300	0.540	0.017
	15 15	0176	16.7	0.4		779	7.46	145	0.040	0.200	0.290	0.016

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/11

480103
29 30 50.0 101 10 15.0
AMISTAD LAKE
48465 TEXAS

11EPALES 2111202
4 0140 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/06	14	50 0000	0.006	0.3	
	14	50 0010	0.006		
	14	50 0035	0.006		
	14	50 0070	0.006		
	14	50 0130	0.008		
74/05/15	10	55 0000	0.008	1.4	
	10	55 0005	0.013		
	10	55 0040	0.008		
	10	55 0065	0.008		
	10	55 0130	0.007		
74/08/06	14	50 0000		2.8	
	14	50 0003			50.0
	14	50 0042			1.0
74/10/29	15	15 0000	0.014	3.3	
	15	15 0001			50.0
	15	15 0005	0.014		
	15	15 0020	0.014		
	15	15 0021			1.0
	15	15 0040	0.013		
	15	15 0060	0.023		
	15	15 0080	0.013		
	15	15 0105	0.018		
	15	15 0120	0.020		
	15	15 0135	0.018		
	15	15 0176	0.016		

STORET RETRIEVAL DATE 75/02/11

480104
29 41 50.0 101 22 20.0
AMISTAD LAKE
48465 TEXAS

11EPALES
4

2111202
0080 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/06	15 45	0000	16.3		228	850	8.20	149	0.040	0.300	0.510	0.010
	15 45	0010	14.8	9.4		831	8.20	151	0.020	0.200	0.510	0.008
	15 45	0020	14.5	9.6		836	8.20	155	0.040	0.200	0.560	0.009
	15 45	0040	14.2	9.0		868	8.10	161	0.040	0.200	0.610	0.009
	15 45	0060	13.4	7.4		815	7.95	178	0.020	0.200K	0.680	0.006
	15 45	0075	13.6	7.8		1875	8.00	159	0.040	0.200	0.630	0.006
74/05/15	09 40	0000	25.4		84	960	8.05	146	0.100	0.700	0.640	0.003
	09 40	0005	25.2	7.2		965	8.00	141	0.110	0.400	0.610	0.007
	09 40	0020	24.7	6.4		949	8.00	142	0.100	0.500	0.620	0.005
	09 40	0060	22.7	2.8		905	7.60	136	0.140	0.500	0.670	0.004
	09 40	0073	20.6	0.4		927	7.45	108	0.360	0.900	0.350	0.007
74/08/07	13 10	0000	27.3	6.8	90	1126	8.40					
	13 10	0005	27.2	6.8		1126	8.40					
	13 10	0027	27.2	7.0		1126	8.20					
	13 10	0050	27.2	7.0		1126	8.40					
	13 10	0072	27.2	5.2		1231	8.10					
74/10/30	09 05	0000		7.2	36			145	0.040	0.400	1.680	0.018
	09 05	0005	21.4	7.0		975	7.94	157	0.020	0.300	0.980	0.019
	09 05	0020	21.4	7.0		973	7.92	156	0.020	0.300	0.980	0.019
	09 05	0035	21.3	7.0		963	7.90	157	0.020	0.300	0.960	0.019
	09 05	0050	20.6	5.6		901	7.83	144	0.030	0.300	0.860	0.020
	09 05	0076	20.1	5.4		1415	7.71	158	0.020	0.400	0.990	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/11 .

480104
29 41 50.0 101 22 20.0
AMISTAD LAKE
48465 TEXAS

11EPALES 2111202
4 0080 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/06	15 45	0000	0.008	1.5	
	15 45	0010	0.012		
	15 45	0020	0.013		
	15 45	0040	0.010		
	15 45	0060	0.006		
	15 45	0075	0.013		
74/05/15	09 40	0000	0.018	2.7	
	09 40	0005	0.023		
	09 40	0020	0.020		
	09 40	0060	0.022		
	09 40	0073	0.045		
74/08/07	13 10	0000		4.3	
	13 10	0002			50.0
	13 10	0027			1.0
74/10/30	09 05	0000	0.037	1.8	
	09 05	0001			50.0
	09 05	0005	0.021		
	09 05	0008			1.0
	09 05	0020	0.024		
	09 05	0035	0.022		
	09 05	0050	0.028		
	09 05	0076	0.023		

STORET RETRIEVAL DATE 76/02/11

480105
29 37 30.0 101 15 00.0
AMISTAD LAKE
48465 TEXAS

11EPALES
4

21112U2
0140 FEET DEPTH

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
74/05/15	10 15	0000	25.3		132	944	8.20	124	0.060	0.500	0.230	0.004
	10 15	0005	25.3	8.0		943	8.20	125	0.050	0.300	0.210	0.007
	10 15	0035	24.3	7.4		927	8.20	124	0.060	0.300	0.230	0.006
	10 15	0075	18.7	0.6		753	7.60	121	0.190	0.500	0.360	0.003
	10 15	0130	14.8	5.0		811	7.70	139	0.050	0.200	0.430	0.004
74/08/07	14 00	0000	27.1	7.8	126	1035	8.60					
	14 00	0005	27.0	7.8		1034	8.60					
	14 00	0015	27.0	7.6		1032	8.60					
	14 00	0038	27.0	7.4		1031	8.50					
	14 00	0055	26.9	7.0		1029	8.60					
	14 00	0070	24.8	1.4		1130	7.80					
	14 00	0085	16.6	1.2		836	7.90					
	14 00	0110	15.3	0.4		820	7.90					
	14 00	0140	15.0	0.6		821	7.90					
74/10/30	08 15	0000	21.3	7.2	34	685	7.91	119	0.020	0.300	0.780	0.013
	08 15	0005	21.3	7.6		684	7.92	117	0.020K	0.300	0.790	0.012
	08 15	0015	21.3	7.2		685	7.90	117	0.020	0.300	0.800	0.015
	08 15	0030	21.3	7.2		686	7.89	117	0.020	0.300	0.800	0.015
	08 15	0050	21.3	7.2		694	7.87	117	0.020K	0.300	0.810	0.015
	08 15	0080	21.3	6.8		743	7.76	124	0.020K	0.300	0.960	0.017
	08 15	0110	20.9	6.0		1483	7.72	148	0.040	0.400	1.430	0.018
	08 15	0139	20.6	5.2		1654	7.69	147	0.050	0.400	1.630	0.018

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/11

430105
29 37 30.0 101 15 00.0
AMISTAD LAKE
48465 TEXAS

11EPALES 2111202
4 0140 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/05/15	10	15 0000	0.011	1.7	
	10	15 0005	0.012		
	10	15 0035	0.008		1.0
	10	15 0075	0.025		
	10	15 0130	0.011		
74/08/07	14	00 0000		2.9	
	14	00 0003			50.0
	14	00 0038			1.0
74/10/30	08	15 0000	0.025	3.7	
	08	15 0005	0.021		
	08	15 0015	0.019		
	08	15 0030	0.019		
	08	15 0050	0.021		
	08	15 0080	0.021		
	08	15 0110	0.022		
	08	15 0139	0.029		

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/03/10

480141
29 26 55.0 101 03 25.0 4
RIO GRANDE
48051 15 DEVILS RIVER
0/AMISTAD LAKE
TURBINE DISCH AT AMISTAD DAM POWERHOUSE
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
74/10/08	19	50	2.880	0.600	0.040	0.005	0.010K
74/11/07	14	00	0.448	1.300	0.045	0.010	0.010
74/12/06	11	45	0.552	0.500	0.024	0.010	0.022
75/01/07	15	45	0.528	0.500	0.048	0.005K	0.010K
75/02/06	10	15	0.560	0.200	0.020	0.020	0.020
75/03/01	15	00	0.625	0.300	0.025	0.005K	0.010K
75/04/11	11	30	0.630	0.750	0.045	0.005	
75/04/23	11	10	0.650	1.000	0.190	0.005K	0.010K
75/05/17	11	15	0.630	0.200	0.015	0.005	0.010K
75/06/05	13	20	0.620	1.300	0.130	0.005K	0.010K
75/07/16	10	30	0.540	0.400	0.015	0.010	0.010
75/08/07	11	45	0.450	0.525	0.010	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/10

450142
29 46 05.0 101 41 10.0 4
RIO GRANDE RIVER
48 15 LANGTRY
T/AMISTAD LAKE
0.5 MI S OF DIRT RD 11.5 MI SW LANGTRY
11EPALES 21112U4
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
74/09/07	14	20	0.720	0.400	0.080		0.020
74/10/08	12	30	2.080	1.800	0.040	0.015	1.350
74/11/07	14	30	0.890	0.700	0.020	0.015	0.210
74/12/06	12	30	0.760	0.800	0.024	0.008	0.080
75/01/07	14	30	0.720	0.800	0.040	0.005K	0.030
75/02/06	11	00	0.672	0.200	0.008	0.008K	0.020
75/03/01	16	00	0.980	0.650	0.015	0.015	0.240
75/04/11	11	55	1.000	0.850	0.030	0.010	0.010
75/04/23	11	45	0.780	0.300	0.025	0.005K	0.050
75/05/17	12	20	0.890	1.600	0.041	0.020	0.670
75/06/05	12	20	0.710	1.020	0.020	0.005	0.010K
75/07/16	11	00	1.350		0.120	0.025	0.700
75/08/07	11	00	0.950	0.450	0.005K	0.035	0.165

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/10

4801C1
29 40 35.0 101 00 10.0 4
DEVILS RIVER
48 ` 15 FEELY
T/AMISTAD LAKE
RUBBOARD XING 10.5 MI E OF COMSTOCK
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
74/09/07	11	24	1.500	0.800	0.025	0.005K	0.005K
74/10/08	13	00	2.640	0.200	0.020	0.005K	0.010K
74/11/07	15	45	2.320	0.700	0.030	0.005	0.020
74/12/06	13	40	2.400	0.200	0.008	0.010	0.010
75/01/07	15	30	2.400	0.300	0.012	0.005K	0.010K
75/02/06	11	05	3.000	0.100K	0.010	0.005	0.010K
75/03/01	15	20	2.300	0.300	0.040	0.005K	0.010K
75/04/11	13	00	2.200	1.100	0.260	0.005	0.010K
75/04/23	12	35	2.200	0.250	0.025	0.005K	0.010
75/05/17	11	35	2.100	0.300	0.035	0.005K	0.010
75/06/05	11	50	1.950	0.400	0.060	0.005K	0.010K
75/07/16			1.880	0.700	0.045	0.005K	0.010
75/08/07	12	10	2.000	0.200	0.010	0.005K	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/10

4801E1
29 48 05.0 101 26 30.0 4
PECOS RIVE
48 15 SHUMLA
T/AMISTAD LAKE
0.3 MI N OF 2NDARY RD 0.8 M E US 90 JCT
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
74/09/07	14	50	0.660	0.600	0.050	0.010	0.010
74/10/08	13	20	3.300	0.600	0.115	0.005K	0.030
74/11/07	15	15	3.000	0.700	0.030	0.010	0.020
74/12/06	13	10	3.100	0.400	0.024	0.010	0.010
75/01/07	15	00	3.120	0.300	0.024	0.005K	0.010K
75/02/06	11	15	2.300	0.100K	0.016	0.008	0.010K
75/03/01	15	00	2.400	0.150	0.030	0.005K	0.010K
75/04/11	13	20	2.100	0.550	0.290	0.005K	0.010K
75/04/23	12	15	2.000	0.450	0.148	0.005K	0.020
75/05/17	12	00	2.000	0.400	0.050	0.005	0.010K
75/06/05	12	35	2.000	1.050	0.220	0.005K	0.010K
75/07/16	11	30	1.400	0.400	0.045	0.005	0.010
75/08/07	11	20	1.570	0.350	0.015	0.005K	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED