Volume II

APPENDIXES

to

DRAFT ENVIRONMENTAL STATEMENT

SALEM UTILITY DISTRICT NO. 2

Kenosha County, Wisconsin

June 30, 1979

Environmental Protection Agency
Region V
Chicago, Illinois

Prepared by:

WAPORA, Inc.
6900 Wisconsin Avenue
Chevy Chase, MD 20015

Approved:

John L. Menke, Director
Washington Regional Office

Gerald O. Peters, Jr.
Project Advisor

Eric M. Hediger
Project Manager

APPENDIXES

APPENDIX A

SEWAGE AND SOIL PROBLEMS

APPENDIX A-1

Chris Lazzare
Tim Lazzare
Georgian Townsend

Camp Lake Oaks
Lake Front Property Owners
c/o
Post Office Box 131
Camp Lake, Wisconsin 53109

Susan Paulsen
Mary Weisman
Mildred Anderson
Ralph Arthur Jr.
Rita M. Arthur

To whom it may concern:

On the morning of July 29, Mrs. June Greb and I, James Ruck, were raking weeds, which grow in the lake, break off, drift into shore and accumulate on the shore lines of our lots. (As we must do every morning.) This morning, however, we noticed large deposits of what appeared to be human waste materials diluted by the lake waters. With futher investigation we found simular deposits along the north-east shore line of Camp Lake joining lots 91-100 of Camp Lake Oaks Subdivison.

Being extremely concerned about our findings we collected several samples for analysis, and notified the area health officals. On the evening of July 29, Mr. Hartnell and Mr. Kanta from Salem Township inspected the shore line deposits and our sample specimens and confirmed our assumption.

At Camp Lake the normal prevaling winds range from the south-east to the south-west. Under these wind conditions NO such deposits have ever been noticed. But the days preceding July 29, the winds were from the north to north-west, indicating that the human waste materials input into the lake MUST originate somewhere in the small Northern third extension of Camp Lake.

Sincerely,

Mrs. June Greb
James Ruck

Concerned property owners
at Camp Lake

Mathias Bruer
Frank Benes
Mrs. Craig Ries
Mrs. A. Wetheim
Mrs. M. Mullner
Mrs. W. R. Ernest
Raymond C. Benes
Margaret C. Benes
L. Breuer
L. Donahue
Walter J. Osowiec
Roy Behnke
Sam English
Sandi Vorpahl
Nick Crifase
Charlene Crifase

Town of Salem

KENOSHA COUNTY
ROUTE 3, BOX 270B -:- SALEM, WIS. 53168
TELEPHONE (414) 843-2313

December 1, 1975

Jensen & Johnson, Inc.
Civil & Sanitary Engineers
Elkhorn, Wisconsin 53121

Attention : Donald Zenz

Dear Sir:

Enclosed herewith are copies of the sewerage problems in our Township that have been reported to Mr. William Kavanagh, Kenosha County Zoning Administrator, as per our conversation.

Respectfully yours,

Allen J. Kanta (jh)

Allen J. Kanta, Adm.
Salem Township

AJK:jh
Enc.

June 13, 1975

SEWERAGE PROBLEMS TO BE VIEWED BY MR. KAVANAGH, COUNTY ZONING ADM.

Parcel No.

- spur of Center Lake

2670F1	John Buxton Rt 1 Box 756 Trevor, Wis. 53179	SW ¼ Section 15

Submitted By:

Sam Rizzo, Deputy Health Officer
Salem Township

SR:jh

MAURICE LAKE, Chairman
RICHARD F. HARTNELL, Supervisor
HOWARD K. GEHRKE, Supervisor

ESTELLE BLOSS, Clerk
DOLORES E. TERRY, Treasurer

Salem Township

KENOSHA COUNTY
ROUTE 3, BOX 270B -:- SALEM, WIS. 53168
TELEPHONE (414) 843-2313

August 17, 1974

SEWERAGE PROBLEMS VIEWED BY
MR. KAVANAGH COUNTY ZONING ADM.

PARCEL NUMBER	OWNER	LOCATION
2687-F	John A. Stephen & Wf.	Lot 12 Blk. 2 1st Addition to Center Lake Manor
5941-F-1-D	Edward B. Schoudel & Wf. Rt. 3 Box 795 Antioch, Illinois 60002	(Pictures taken by Mr. Kavanagh) South Shore Rock Lake
5941-F 1	James Bickley & Wf. P. O. Box 84 Trevor, Wisconsin	South Shore Rock Lake (Pictures taken by Mr. Kavanagh)
5941-F-1-A	Clendon Eckert Rt. 3 Box 471 Antioch, Illinois 60002	(Pictures taken by Mr. Kavanagh) South Shore Rock Lake

MAURICE LAKE, Chairman
RICHARD F. HARTNELL, Supervisor
HOWARD K GEHRKE, Supervisor

ESTELLE BLOSS, Clerk
DOLORES E. TERRY, Treasur A-1

Salem Township

KENOSHA COUNTY
ROUTE 3, BOX 270B -:- SALEM, WIS. 53168
TELEPHONE (414) 843-2313

August 13, 1974

SEWERAGE PROBLEMS VIEWED BY
MR. KAVANAGH COUNTY ZONING ADM.

PARCEL NUMBER	OWNER	LOCATION
2765-F-6 2765-F-7	Assemblies of God, Inc. The Teen Challenge	South Side Silver Lake
7511-F.	Alfred Hanson	Lot 12 Blk. 10 Camp Lake Gardens
6693-F	Richard O. Wright	Oakwood Knolls
2903-F	Federal National Mortgage 342 N. Water St. Milwaukee, Wisc.	Lot 4 Blk. 4 Center Lake Manor 1st Addition
2904-F	Federal National Mortgage 342 N. Water Street, Milwaukee, Wisc.	Lot 5 Blk. 4 Center Lake Manor 1st Addition
3711-F	Tito J. Petritis Camp Lake, Wisconsin	Northeast Shore Camp Lake

Co. Hwy F (S…)

RICHARD F. HARTNELL, Supervisor
HOWARD K. GEHRKE, Supervisor

DOLORES E. TERRY, Treas

Salem Township

KENOSHA COUNTY
ROUTE 3, BOX 270 B -:- SALEM, WIS. 53168
TELEPHONE (414) 843-2313

September 16, 1974

SEWERAGE PROBLEMS TO BE VIEWED BY
MR. KAVANAGH, COUNTY ZONING ADM.

PARCEL NO.	OWNER	LOCATION
6157F	Elburn C. & Marily L. Buck Rt 4 Box 392 Antioch, Illinois 60002	Lot 36 Block 9 Cepek's Cross Lake Sub.
6159F	Roy A. Anderson Rt 4 Box 387 Antioch, Illinois 60002	Lot 2 Block 10 Cepek's Cross Lake Sub.
6386F	Harold Walsh Rt 4 Box 364 Antioch, Illinois 60002	Lot 19 Block 15 Cepek's Cross Lake Sub.
6424F	Lloyd Stuart Rt 4 Antioch, Illinois 60002	Lot 17 Block 16 Cepek's Cross Lake Sub

Submitted By:

Allen J. Kanta Richard F. Ha

Allen J. Kanta, Bldg. Insp.
Richard F. Hartnell, Health Of
Salem Township

AJK:jh

· · · · · HARTNELL, Supervisor
HOWARD K GEHRKE, Supervisor

DOLORES E. TERRY, Tre

Salem Township

KENOSHA COUNTY
ROUTE 3, BOX 270B -:- SALEM, WIS. 53168
TELEPHONE (414) 843-2313

August 19, 1974

SEWERAGE PROBLEMS VIEWED BY
MR. KAVANAGH, COUNTY ZONING ADM.

PARCEL NO.	OWNER	LOCATION
2938F	Emerson A.Davis 2615 N. Seminary Ave. Chicago, Illinois 60614	Lot 20 Center Lake Manor

SEWERAGE PROBLEMS TO BE VIEWED BY
MR. KAVANAGH, COUNTY ZONING ADM.

PARCEL NO.	OWNER	LOCATION
3490F	Philip Koob 1620 Columbia Ave. Chicago, Illinois 60626	Lot 142 Sunset Oaks Manor
7575F	Arthur Wesinger & Wf. Rt 1 Trevor, Wisconsin 53179	Lot 12 Block 13 Camp Lake Gardens
7577F	Lynette J. Klein Rt 1 Trevor, Wisconsin 53179	Lot 14 Block 13 Camp Lake Gardens
7495F	Curtis Barthel II Rt 1 Box 49A Trevor, Wisconsin 53179	Lot 14 Block 9 Camp Lake Gardens

Submitted by:

Allen J Kanta - Richard Hartnell

Allen J. Kanta, Bldg, Insp.
Richard F. Hartnell, Health Officer
Salem Township

AJK:jh

January 10, 1975

SEWERAGE PROBLEMS TO BE VIEWED BY
MR. KAVANAGH, COUNTY ZONING ADM.

PARCEL NO.	OWNER	LOCATION
6739F	Fred Taylor Rt. 4 Antioch, Ill. 60002	Lot 1 Block 2 Lake Shangri-la Woodlands
7607F	Robert W. Strum 326 Lyndon Wilmette, Ill. 60091	Lot 23 Block 14 Camp Lake Gardens

Respectfully yours,

Allen J. Kanta, Bldg. Insp.
Richard Hartnell, Health Officer

AJK:jh

MAURICE LAKE, Chairman
RICHARD F. HARTNELL, Supervisor
HOWARD K. GEHRKE, Supervisor

DOLORES E. TERRY, Treasurer

A-

Salem Township

KENOSHA COUNTY
ROUTE 3, BOX 270B -:- SALEM, WIS. 53168
TELEPHONE (414) 843-2313

March 10, 1975

SEWERAGE PROBLEMS TO BE VIEWED BY
MR. KAVANAGH, COUNTY ZONING ADM.

PARCEL NO.	OWNER	LOCATION
3562F	Edward Mulick Rt 1 Box 181B1 Trevor, Wis. 53179	Lot 214 Sunset Oaks Manc
3705F	Bobby D. Leech Box 234 Camp Lake, Wis. 53109	Hillside Tavern Hwy. A.H. (Camp Lake Rd.

Submitted By:

Allen J. Kanta — Richard Har

Allen J. Kanta, Bldg. Insp.
Richard Hartnell, Health Officer
Salem Township

AJK:jh

MAURICE LAKE, Chairman
RICHARD F. HARTNELL, Supervisor
HOWARD K. GEHRKE, Supervisor

ESTELLE BLOSS, Clerk
DOLORES E. TERRY, Treasurer

Salem Township

KENOSHA COUNTY
ROUTE 3, BOX 270B -:- SALEM, WIS. 53168
TELEPHONE (414) 843-2313

August 13, 1974

William Kavanagh
County Zoning Administrator
County Court House,
Kenosha, Wisconsin 53140

Dear Bill:

Enclosed is a list of sewerage violations located in the Town of Salem that you have viewed.

We feel that as they are in the Floodland and Shoreland areas these are under your jurisdiction and should be handled by you.

Prompt action will be appreciated.

Sincerely,

Richard F. Hartnell
Health Officer

SOIL FACTORS THAT AFFECT ON-SITE WASTEWATER DISPOSAL

Evaluation of soil for on-site wastewater disposal requires an understanding of the various components of wastewater and their interaction with soil. Wastewater treatment involves: removing suspended solids; reducing bacteria and viruses to an acceptable level; reducing or removing undesirable chemicals; and disposal of the treated water. For soils to be able to treat wastewater properly they must have certain characteristics. How well a septic system works depends largely on the rate at which effluent moves into and through the soil, that is, on soil permeability. But several other soil characteristics may also affect performance. Groundwater level, depth of the soil, underlying material, slope and proximity to streams or lakes are among the other characteristics that need to be considered when determining the location and size of an on-site wastewater disposal system.

Soil permeability - Soil permeability is that quality of the soil that enables water and air to move through it. It is influenced by the amount of gravel, sand, silt and clay in the soil, the kind of clay, and other factors. Water moves faster through sandy and gravelly soils than through clayey soils.

Some clays expand very little when wet; other kinds are very plastic and expand so much when wet that the pores of the soil swell shut. This slows water movement and reduces the capacity of the soil to absorb septic tank effluent.

Groundwater level - In some soils the groundwater level is but a few feet, perhaps only one foot, below the surface the year around. In other soils the groundwater level is high only in winter and early in spring. In still others the water level is high during periods of prolonged rainfall. A sewage absorption field will not function properly under any of these conditions.

If the groundwater level rises to the subsurface tile or pipe, the saturated soil cannot absorb effluent. The effluent remains near the surface or rises to the surface, and the absorption field becomes a foul-smelling, unhealthful bog.

Depth to rock, sand or gravel - At least 4 feet of soil material between the bottom of the trenches or seepage bed and any rock formations is necessary for absorption, filtration, and purification of septic tank effluent. In areas where the water supply comes from wells and the underlying rock is limestone, more than 4 feet of soil may be needed to prevent unfiltered effluent from seeping through the cracks and crevices that are common in limestone.

Different kinds of soil - In some places the soil changes within a distance of a few feet. The presence of different kinds of soil in an absorption field is not significant if the different soils have about the same absorption capacity, but it may be significant if the soils differ greatly. Where this is so, serial distribution of effluent is recommended so that each kind of soil can absorb and filter effluent according to its capability.

Slope - Slopes of less than 15% do not usually create serious problems in either construction or maintenance of an absorption field provided the soils are otherwise satisfactory.

On sloping soils the trenches must be dug on the contour so that the effluent flows slowly through the tile or pipe and disperses properly over the absorption field. Serial distribution is advised for a trench system on sloping ground.

On steeper slopes, trench absorption fields are more difficult to lay out and construct, and seepage beds are not practical. Furthermore, controlling the downhill flow of the effluent may be a serious problem. Improperly filtered effluent may reach the surface at the base of the slope, and wet, contaminated seepage spots may result.

If there is a layer of dense clay, rock or other impervious material near the surface of a steep slope and especially if the soil above the clay or rock is sandy, the effluent will flow above the impervious layer to the surface and run unfiltered down the slope.

Proximity to streams or other water bodies - Local regulations generally do not allow absorption fields within at least 50 feet of a stream, open ditch, lake, or other watercourse into which unfiltered effluent could escape.

The floodplain of a stream should not be used for an absorption field. Occasional flooding will impair the efficiency of the absorption field; frequent flooding will destroy its effectiveness.

Soil maps show the location of streams, open ditches, lakes and ponds, and of alluvial soils that are subject to flooding. Soil surveys usually give the probability of flooding for alluvial soils.

Soil conditions required for proper on-site wastewater disposal are summarized in the Appendix A-3.

Source: Bender, William H. 1971. Soils and Septic Tanks. Agriculture Information Bulletin 349, SCS, USDA.

APPENDIX B

ATMOSPHERE

CLIMATOLOGICAL DATA

Table 1

AVERAGE TEMPERATURES AT TWO LOCATIONS NEAR THE STUDY AREA (°F)

Station	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Kenosha, Kenosha County, WI*	1975	26.2	25.4	30.6	40.6	56.7	64.8	66.9	71.5	59.5	54.7	44.1	29.3	47.5
	1976	18.7	31.8	39.0	46.9	51.5	65.6	71.2	69.1	61.8	47.4	31.2	17.6	46.0
Milwaukee Air-port, WI**	record mean	20.9	23.3	32.6	44.3	54.3	64.6	70.8	69.7	62.6	51.5	37.6	26.0	46.5

*Drainage: Lake Michigan
Latitude: 42°33'
Longitude: 87°48'
Elevation: 600 ft.
Yrs. of record: 33 temp.

**Drainage: Lake Michigan
Latitude: 42°57'
Longitude: 87°54'
Elevation: 672 ft.
Yrs. of record: 39 record mean

SOURCES:
1) National Oceanic and Atmospheric Administration. 1975 and 1976. Climatological data, Wisconsin. Annual summaries. Asheville, NC.
2) National Oceanic and Atmospheric Administration. 1976. Local climatological data: Annual summary with comparative data, Milwaukee, Wisconsin. Asheville, NC.

Table 2

TEMPERATURE EXTREMES AND FREEZE DATA AT KENOSHA STATION, KENOSHA COUNTY, WISCONSIN*

Year	Highest (Date)	Lowest (Date)	Last Spring Minimum of 32°F or Below		First Fall Minimum of 32°F or Below	
			Date	Temp.	Date	Temp.
1975	94 (5/19)	-12 (12/18)	4/21	30	11/13	30
1976	97 (7/14)	-12 (12/31)	5/7	32	10/18	31

*Drainage: Lake Michigan
Latitude: 42°33'
Longitude: 87°48'
Elevation: 600 ft.
Yrs. of record: 33 temp.

SOURCE: National Oceanic and Atmospheric Administration. 1975 and 1976. Climatological data, Wisconsin. Annual summaries. Asheville, NC.

Table 3

TOTAL PRECIPITATION IN INCHES AT TWO LOCATIONS NEAR THE STUDY AREA

Station	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Kenosha, Kenosha County, WI*	1975	1.34	1.21	1.39	3.45	1.53	4.32	1.87	4.24	.79	.99	2.94	1.00	25.07
	1976	.63	1.32	5.48	4.30	2.84	1.81	2.58	1.59	1.24	2.78	.62	.43	25.62
Milwaukee Airport, WI**	record mean	1.83	1.58	2.49	2.80	3.19	3.51	2.89	2.79	3.12	2.28	1.98	1.75	30.21

*Drainage: Lake Michigan
Latitude: 42°33'
Longitude: 87°48'
Elevation: 600 ft.
Yrs. of record: 33 precip.

**Drainage: Lake Michigan
Latitude: 42°57'
Longitude: 87°54'
Elevation: 672 ft.
Yrs. of record: 39 record mean

SOURCES:

1) National Oceanic and Atmospheric Administration. 1975 and 1976. Climatological data, Wisconsin. Annual summaries. Asheville, NC.

2) National Oceanic and Atmospheric Administration. 1976. Local climatological data: Annual summary with comparative data, Milwaukee, Wisconsin. Asheville, NC.

Table 4

TOTAL EVAPORATION AND WIND MOVEMENT AT ARLINGTON UNIV. FARM EXPERIMENTAL STATION, COLUMBIA COUNTY, WISCONSIN†

	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann.
	1975													
Evap.*		-	-	-	-	7.81B	6.40B	8.08B	6.19	3.95	4.49	-	-	-
Wind**		-	-	-	-	2817	2319	1951	2080	2279	3027	3054	-	-
Max.***		-	-	-	-	80.5	85.0	89.2	85.7	72.1	65.1	-	-	-
Min.***		-	-	-	-	56.3	61.0	65.3	64.1	50.8	45.0	-	-	-
	1976													
Evap.*		-	-	-	-	6.28	9.88	10.24B	7.98B	5.65	-	-	-	-
Wind**		-	-	-	3721	3371	3029	2564	2172	2295	2278	3300	-	-
Max.***		-	-	-	-	73.7	85.5	89.4	85.6	74.7	56.7	-	-	-
Min.***		-	-	-	-	47.6	59.3	63.3	60.1	51.2	40.0	-	-	-

†Drainage: Rock
Latitude: 43°18'
Longitude: 89°21'
Elevation: 1080 ft.
Yrs. of record: 11 evap.

*Evaporation is measured in the standard Weather Service-type pan of 4 feet in diameter.

**Wind is the total wind movement in miles over the evaporation plan, as determined by a continuous anemometer recorder located 6 to 8 inches above the pan.

***Maximum and minimum values are monthly averages of daily extremes of temperature of water in the pan, as recorded during the 24 hours ending at the time of observation.

SOURCE: National Oceanic and Atmospheric Administration. 1975 and 1966. Climatological data, Wisconsin. Annual summaries. Asheville, NC.

APPENDIX B-2

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)
ADOPTED APRIL 30, 1971, REVISED SEPTEMBER 14, 1973
40 CFR 50.4 TO 50.11

Pollutant	Time of Average	Primary Standard**	Secondary Standard**	Method of Determination
Particulate matter	Annual (geometric mean)	75 μg	60 μg	High volume sampler
	24 hrs.	260 μg*	150 μg*	
Sulfur oxides (SO_x) (measured as SO_2)	Annual (arithmetic mean)	80 μg (0.03 ppm)		Pararosanaline
	24 hrs.	365 μg (0.14 ppm)*		
	3 hrs.	-----------------	1300 μg (0.5 ppm)*	Flame photometric
Carbon monoxide CO	8 hrs.	10 mg (9 ppm)*	Same as primary	Non-dispersive Infrared#
	1 hr.	40 mg (35 ppm)*	Same as primary	
Hydrocarbons (HC) (nonmethane measured as CH_4)	3 hrs. (6 to 9 a.m.)	160 μg (0.24 ppm)*	Same as primary	Flame ionization detector
Nitrogen dioxide NO_2	Annual (arithmetic mean)	100 μg (0.05 ppm)	Same as primary	Christie
Photochemical oxidants (O_x) (measured as O_3)	1 hr.	160 μg (0.08 ppm)*	Same as primary	Photomultiplier tube (reaction with ethylene)##

* Concentration not to be exceeded more than once per year
** Concentration in weight per cubic meter (corrected to 25°C and 760 mm of Hg)
\# Gas chromatographic
\## Neutral potassium iodide, colorimetric, coulometric

Source: Wisconsin Department of Natural Resources

Table 2

SUSPENDED PARTICULATE DATA ($\mu g/m^3$)
LAKE GENEVA, WALWORTH COUNTY, WISCONSIN
(SOUTHEASTERN WISCONSIN AIR QUALITY CONTROL REGION)

Year	Sampling Interval (Months)	Months Included	Number of Samples	Maximum 24-Hr.	Minimum 24-Hr.	Geometric Mean	Standard Deviation
1975	3	1-3	15	80.90	12.40	33.65	1.72
	3	4-6	9	102.00	31.90	53.66	1.53
	3	7-9	15	78.30	9.40	41.91	1.81
	3	10-12	15	118.00	18.00	42.26	1.58
	12**	1-12	54	118.00	9.40	42.29	1.66
1976	3	1-3	16	101	13	37.0	1.7
	3	4-6	11	150*	28	63.6*	1.7
	3	7-9	14	96	30	53.6	1.4
	3	10-12	14	78	28	45.5	1.4
	12	1-12	55	150*	13	47.8	1.6
1977	3	1-3	15	196*	22	53.2	2.0
	3	4-6	16	153*	37	72.5*	1.6
	6	1-6	31	196*	22	62.4*	1.8

*Exceeded secondary standard

**Samples not seasonally distributed, alternate calculation used

SOURCE: Wisconsin Department of Natural Resources.

APPENDIX C

WATER QUALITY AND ON-SITE SYSTEMS

APPENDIX C-1

Surface Water Use Standards, as Adopted in 1973.

Water Quality Parameters	Recreational Use and Fish and Aquatic Life
Temperature (°F)	--[1]
Total Dissolved Solids (mg/l)	--
Dissolved Oxygen (mg/l)	5.0 min.
pH (units)	6.0 - 9.0
Fecal Coliforms (MFFCC/100 ml)	200 and 400

[1] There shall be no temperature changes that may adversely affect aquatic life. Natural, daily and seasonal temperature fluctuations shall be maintained. The maximum temperature rise at the edge of the mixing zone above the existing natural temperature shall not exceed 5°F for streams and 3°F for lakes. The temperature shall not exceed 89°F for warm water fish. There shall be no significant artificial increases in temperature where natural trout reproduction is to be protected.

[2] Shall not exceed a monthly geometric mean of 200 per 100 ml based on not less than five samples per month nor a monthly geometric mean of 400 per 100 ml in more than 10 percent of all samples during any month.

Source: SEWRPC, February, 1974.

WATER QUALITY MANAGEMENT
FEDERAL, STATE AND LOCAL RESPONSIBILITIES

The Clean Water Act

Water quality is the responsibility of the United States Environmental Protection Agency (EPA) in coordination with the appropriate State agency, in this case the Wisconsin Department of Natural Resources (DNR). However, the Clean Water Act instructed all Federal agencies to safeguard water quality standards in carrying out their respective missions. As the lead agency, EPA coordinates the national effort, sets standards, and reviews the work of other agencies, some of which are assigned responsibilities in line with their traditional missions. For example, the Army Corps of Engineers retains jurisdiction over dredging permits in commercially navigable waters and their adjacent wetlands and in coastal waters but now must also consider water quality. The Coast Guard keeps jurisdiction over oil spill cleanup. Certain other agencies are drawn into the water pollution control effort: for example, Federal cost-sharing is authorized in agricultural projects designed to improve water quality by controlling farm runoff. In some cases, e.g., the Soil Conservation Service (SCS), these added responsibilities may dovetail with programs to reduce soil erosion, or to construct headwaters impoundments for flood control.

In delineating the responsibilities of the various levels of government for water quality, Congress recognized the rights of the States with regard to their waters. It authorized funding for development of State plans for control of pollution and State water quality standards, plus research. If a State meets certain criteria, it is certified by EPA as the entity responsible for administration of the activity in question. The EPA may deny certification, and in all cases it retains power of enforcement of established standards, State or Federal. The State of Wisconsin has been granted certification by EPA.

Among the goals and deadlines set in the Clean Water Act are these:

> "it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985...
>
> "an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water [is to] be achieved by July 1, 1983".

The legislation requires that publicly owned treatment works discharging effluent to surface waters must at least provide secondary treatment, i.e., biological oxidation of organic wastes. Municipalities must provide the "best available technology" by 1983 and localities must address both the control of all major sources of stream pollution (including combined sewer overflows and agricultural, street and other surface runoff) and the cost effectiveness of various control measures. The use of unconventional technologies must also be considered.

The key provisions on water quality planning stipulate that to receive aid a State must provide a continuing planning process. Part of Section 208 requires the States to inventory all the sources of pollution of surface and ground waters, both point* and non-point*, and to establish priorities for the correction of substantial water quality problems within a given area. The 208 plans are intended to provide an areawide and, taken together, a statewide framework for the more local decisions on treatment facilities.

Section 201 of the Act (under which Salem Utility District No. 2 applied for funds) authorizes EPA to make grants to localities toward the improvement or construction of facilities for treatment of existing water quality problems. EPA may determine whether an Environmental Impact Statement is required on a proposed project (see Section I.B), and even where the State has been certified and assumes responsibility for water quality, EPA retains authority to approve or reject applications for construction funds for treatment facilities.

Local political jurisdictions, traditionally responsible for meeting the wastewater treatment needs of the community, now have the benefit of Federal and State assistance in meeting water quality standards and goals.

<u>Federal Agency Responsibilities for Study Area Waters</u>

- <u>EPA</u>
  - Administers the Clean Water Act
  - Sets Federal water quality standards

- <u>EPA Region V</u>
  - Administers the grant program described above for the Great Lakes Region.
  - Provides partial funding for preparation of the Salem Utility District No. 2 Facility Plan. Region V's general and specific responsibilities in this program are discussed in Section I.B.

- <u>US Army Corps of Engineers</u>
  - Grants or denies permits required for dredging, filling, or construction activities in navigable waters of the US, including the Fox River in the Study Area (by phone, Mr. Gordon Garcia, Corps of Engineers, Chicago, 27 June 1979), their 100-year floodplains and adjacent wetlands.
  - The Corps is studying flooding problems on the Fox River in Wisconsin and Illinois and connecting lakes under three resolutions of the House Public Works Committee passed 6 July 1949, 7 June 1961, and 11 April 1974; and will be reviewing and updating the "Comprehensive Plan for the Fox River Watershed" prepared by SEWRPC (see below) (by phone, Ms. Linda Blake, Corps of Engineers, Chicago, 27 June 1979). Recreational use of these waters will be studied insofar as it is related to flooding.

- US Department of Agriculture

  - Under the Rural Clean Water Program will provide cost sharing for soil conservation practices designed to improve water quality. (This program will probably be assigned to SCS; it has not yet been funded.)

- Soil Conservation Service (SCS)

  - Agency's mission is to control wind and water erosion, to sustain the soil resource base and to reduce deposition of soil and related pollutants into the water system.

  - Conducts soil surveys. Works with farmers and other land users on erosion and sedimentation problems. Drew up guidelines for inventorying prime or unique agricultural lands. Gathers information at the county level as part of program of study and research to determine new methods of eliminating pollution from agricultural sources.

  - In the Study Area has: inventoried land resources; inventoried prime agricultural land; and completed and published a soil survey (by telephone, Mr. Jim Lesley, Assistant State Conservationist, SCS, 25 June 1979).

- Fish and Wildlife Service

  - Provides technical assistance in development of 208 plans.

- US Geological Survey

  - Monitors surface water flows at the outlet of Silver Lake.

  - Has been maintaining streamflow records at the Wilmot Dam since 1939.

  - Has studied and reported on the geologic and hydrologic resources of Kenosha County.

State Responsibilities in the Study Area

- Pertinent Wisconsin Laws

  - Shoreland and Floodplain Zoning Act. See Appendix F for description of Wisconsin Shoreland Management Program.

  - Wisconsin Wetlands Act. Provides legal tools for control of development on wetlands.

State Agencies

- Department of Natural Resources (DNR)

  - Responsible for all water management functions in Wisconsin. Sets water quality standards for surface waters under Wisconsin Statutes Chapter 144. Classifies stream segments according to water quality. Has authority to issue permits to discharge pollutants into surface waters under the National Pollutant Discharge Elimination System (NPDES). Under NPDES, specifies effluent limitations (waste treatment standards) and monitoring requirements for every municipal and industrial wastewater discharge. Disposal of treated wastewater to the land is also regulated under NPDES. DNR has published guidelines for land disposal systems (1976), specifying actual minimum requirements for sizing, testing, and monitoring in accordance with Wisconsin Natural Resources Code 214. Requires information on depth to groundwater and soil conditions.

  - The Department considers interconnection of sewered areas to a central treatment plant preferable to a proliferation of smaller plants, and as a matter of policy, encourages only those sewage treatment plants it considers absolutely necessary (by telephone: Mark Stokstad, Wisconsin DNR, 7 November 1977; Herb Sims, Conservation Technician, SCS, Kenosha County, 26 June 1979).

  - DNR conducts water quality planning for the Fox River watershed in conjunction with the Southeastern Wisconsin Regional Planning Commission. DNR has designated the Study Area segment of the Fox River as "Effluent Limited," that is, the water quality meets, and will continue to meet, applicable water quality standards provided there is compliance with effluent limits for discharge to that river.

  - In 1972, DNR published a report entitled "The Fox (Illinois) River—An Implementation Schedule for Meeting Water Quality Objectives and Waste Treatment Requirements." This report, containing a plan and a timetable for implementing waste treatment and disposal requirements in the Fox River Basin was revised by the SEWRPC.

- Wisconsin Department of Health and Social Services, Plumbing Division

  - Enforces the Uniform State Plumbing Code, which regulates sizing, location, and other aspects of septic tanks, but which contains no provisions regarding maintenance.

Two other State programs that bear on water quality are: the Inland Lakes Program, organized to study and correct water quality problems other than sewer- or septic-related problems (by telephone, Mr. Oliver Williams, DNR, 26 June 1979); and the "Wisconsin Fund." The latter will, each year, assist five watershed areas in the State to survey and deal with non-point sources (by telephone, Mr. Arthur Kurtz, DNR, 25 June 1979).

Regional and Local Responsibilities

- **Southeastern Wisconsin Regional Planning Commission (SEWRPC)**

  - An advisory body composed of representatives of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties. SEWRPC's mission is the preparation of long-range comprehensive plans for the physical development of the seven-county region. Participation in the Commission by local units of government is voluntary.

  - SEWRPC is the designated 208 planning agency, and a modification of its "Regional Sanitary Sewerage System Plan" (1974) for 7 counties within the Fox River watershed, together with supplemental information supplied by DNR, constitutes the 208 Plan for the Southeastern Wisconsin Region.

  - SEWRPC has also prepared and adopted a "Comprehensive Plan for the Fox River Watershed" that has been adopted by Kenosha County and the Soil and Water Conservation District as well.

- **Kenosha County**

  - Administers a permit system for individual septic tanks under the State Uniform Plumbing Code. Administers the Kenosha County Shoreland Zoning Ordinance (No. 64).

- **Township of Salem**

  - Administers the Township of Salem Zoning Ordinance.

- **Salem Utility District No. 2**

  - Would own and operate municipal wastewater treatment plants.

APPENDIX C-2

WATER QUALITY STUDIES: SALEM UTILITY DISTRICT NO. 2

Voltz Lake, Cross Lake, Benet/Shangrila Lake, Camp Lake, Center Lake, Silver Lake, Rock Lake, Peat Lake, Fox Chain O'Lakes area (Lake County Illinois)

Surface Water Body	Source	Survey Dates	Parameters, Specific Conductance
Voltz Lake, Camp Lake, Center Lake, Silver Lake, Cross Lake.	Wisconsin DNR. Lake Use Reports. 1968-1970	4-15-60; 4-1-66; 4-20-66; 4-26-66; 8-24-66	pH; Alkalinity, calcium, magnesium, Sodium, potasium, total iron PO_4(T); PO_4(D); Cl; SO_4
Voltz Lake, Camp Lake, Center Lake, Cross Lake, Rock Lake, Rock Lake, Benet/Shangrila Lake, Silver Lake.	Wisconsin DNR. 1977, 1978. Water Analysis Delafield, WI.	1/13/78; 7/19/77; 1/19/78; 7/13/77; 7/21/77; 7/12/77; 1/16/78	nutients, turbidity, alxalinity, pH, DO, iron, manganese, special conditions, temperature, calcium, magnesium, PO_4(T) PO_4(D)
Peat Lake	Wisconsin Scientific Areas Preservation Council. Peak Lake Report. Spring 1972.	Spring 1972	Alkalinity
Fox River	Wisconsin Conservation Department. Surface Water Resources of Kenosha County. 1961.	1961	pH, Methyl-Orange, alkalinity, specific conductance.
Fox River	U.S. Department of the Interior Geological Survey. Water Resources of Racine and Kenosha Counties, Southeastern Wisconsin. 1970	April 1961-December 1964.	bicarbonate, chlorides, mitrates, DO, hardness, total solids, dissolved solids, pH

con't

Surface Water Body	Source	Survey Dates	Parameters, Specific Conductance
Fox River & Tributaries of Fox Chain O'Lakes.	State of Illinois Department of Registration and Education. Fox Chain of Lakes Investigation and Water Quality Management Plan. 1977.	Weekly samples from December 4, 1974 to November 26, 1975.	temperature, DO, turbidity, pH, alkalinity, hardness, nutrients, iron, dissolved solids total dissolved solids, algal growth potential.
Fox River & Tributaries of Fox Chain O'Lakes.	Northeastern Illinois Planning Commission. Areawide Water Quality Management Pal. Part II, Chapter 19.	April 1976 through April 1977	pH, alkalinity, turbidity, total suspended solids, total solids, nolatile suspended solids, temperature,DO, BOD_5, BOD_{20}, COD, total organic carbon, nutrients, hardness, chlorophyll, flow.
Fox-Chain O'Lakes	National Eutrophication	5/9/73;8/7/73; 10/16/73	temperature, DO, conductivity, pH, total alkalinity, nutrients, chlorophyll, secchi disc.

PHOSPHORUS INPUTS[a] FOR CAMP/CENTER LAKE AND SILVER LAKE

Phosphorus Source		Percent of total Phosphorus source in Camp Lake and Center Lake (combined)		Percent of total Phosphorus source in Silver Lake	
Manured land	Non-point source runoff	48	62	59	76
Rural runoff		14		17	
Septic tanks		26		14	
Precipitation and groundwater		11		10[b]	
TOTAL		100		100	

[a]based on 1966 data

[b]includes only precipitation

Source: SEWRPC, 1969

APPENDIX C-4

Selected water quality data*
Camp Lake

	3/19/60	4/20/66 (1 ft.)	6 ft.	8/24/66 5 ft.	7/8/75 0 ft.	10 ft.	18 ft.	10/22/75 0 ft.	18 ft.	2/17/76 0 ft.	10 ft.	18 ft.	4/6/76 0 ft.	18 ft.	7/19/77 0 ft.	12 ft.	18 ft.	1/13/78 0 ft.	9 ft.	18 ft.
Total phosphorus**		0.078	0.091	0.016	<.01	<.01	.06	.02	.03	.04	.05	.07	.05	.06	.03	.04	.07	.07	.04	.06
Soluble phosphorus***		0.042	0.016	0.016	<.005	<.005	.017	<.006	<.006	.014	.018	.044	.014	.021	.012	.015	.027	.020	<.004	.033
Ammonia nitrogen					<.03	<.03	.19	.10	.11	.27	.38	.48	.15	.13	.13	.20	.55	.08	<.03	<.03
Organic nitrogen					.72	.72	.95	.99	1.46	.81	1.01	1.16	.88	.86	1.18	1.31	1.47	1.08	1.02	.98
Nitrite nitrogen					.002	.002	.012	.005	.005	.009	.004	.005	.022	.022	.003	.004	.005	.009	.004	.002
Nitrate nitrogen					.14	.09	.14	.61	.21	.11	.12	.10	.75	.76	.25	.25	.15	.15	.18	.38
Total nitrogen					0.82	0.75	1.30	1.70	1.78	1.21	1.51	1.75	1.80	1.77				1.32	1.20	1.38
Turbidity (JTU)					4.0	4.7	20.0	3.1	3.3	1.0	1.6	1.3	5.1	5.6	4.5	5.1	7.0	1.5	1.[illegible]	1.6
Alkalinity (as $CaCO_3$)		188.0	189.0		130.0	129.0	150.0	140.0	140.0	138.0	193.0	206.0	160.0	166.0	130.0	131.0	148.0	178.0	170.0	182.0
pH	7.2	8.2	8.1	8.1	8.9	8.7	7.9	8.8	8.6	7.9	7.9	7.8	8.1	8.2	9.2	9.1	8.0	8.3	8.[illegible]	8.0
Dissolved oxygen					8.3	7.4	2.2	8.7	8.1	7.0	4.8	2.2	12.0	11.3	5.7	5.1	6.6			
Iron		0.05	0.07	0.14	<1.00	<1.00	<1.00	.10	.10	.12	.12	.17	.17	.33	.06	.18	.18	<.06	<.06	<.06
Manganese					<.20	<.20	.43	<.03	<.03	<.03	.04	<.03	.14	.16	<.03	<.03	.10	.03	.03	.07
Spec. cond. (µmhos/cm)	638.0	395.0	411.0	466.0	359.0	347.0	398.0	388.0	385.0	356.0	468.0	515.0	420.0	444.0	396.	399.	438.	475	400	474
Temperature (°F)					80.5	77.5	64.5			36.5			52.7		79.9	78.8	66.2			
Calcium		40.0	44.2	18.6	8.0	16.0	23.0	25.0	25.0	25.0	33.0	39.0	48.0	47.0	20.0	22.0	23.0	38.0	37.0	38.0
Magnesium		31.1	33.0	28.9	32.0	10.0	16.0	39.0	39.0	25.0	36.0	40.0	28.0	29.0	38.0	38.0	38.0	36.0	39.0	36.0

*Data expressed in milligrams per liter except as noted.
**Total phosphorus expressed as mg/l P.
***Soluble phosphorus expressed as mg/l PO_4-P.

†N:P ratio = Total N: Total P.

APPENDIX C-4

Selected water quality data,* Center Lake

	3/19/60	4/20/66		8/24/66		6/20/67	7/19/77			1/19/78		
	NDS	7 ft.	outlet	10 ft.	19 ft.	NDS	0 ft.	22 ft.	27 ft.			
Total phosphorus (P)		0.035	0.156	0.048	0.016	.061	0.02	0.06	0.15	.03	<.01	<.01
Soluble phosphorus (PO_4-P)		0.019	0.022	0.016	0.016					.010	.010	.016
Ammonia nitrogen						0.53	0.05	1.30	3.47	.45	.44	.74
Organic nitrogen							0.99	1.22	1.67	1.19	1.02	.95
Nitrite nitrogen							0.003	0.003	0.007	.016	.014	.069
Nitrate nitrogen						0.12	0.12	0.12	0.05	.13	.15	1.31
Total nitrogen							1.16	2.61	5.19	1.78	1.63	3.08
Total coliform (MFCC/100 ml.)						1400**						
Turbidity (JTU)							4.1	5.9	8.9	3.2	1.4	1.8
Alkalinity as $CaCO_3$		222	224	167	180		166	202	242	202	200	216
pH	7.3	8.7	8.5	8.3	8.2		8.4	7.6	7.3	8.2	8.1	7.9
Dissolved oxygen							5.5		0.1			
Iron (T)		0.06	0.14	0.05	0.11		0.15	0.06	0.06	<.06	.07	<.06
Manganese							0.03	0.10	.31	<.03	.04	.09
Spec. cond. (μmhos/cm)	708	467	468	522	538		470	522	568	542	480	541
Calcium		50.0	50.4	22.9	22.8		37.0	46.0	52.0	49	47	62
Magnesium		36.4	37.0	31.5	31.1		43.0	39.0	38.0	44	42	45
Temperature (°F)							80.6	59.0	49.1			

**6/13/67

*Data expressed in milligrams per liter except as noted.

NDS: No depth stated

Sources: 1) Wisconsin Department of Natural Resources. 1969b. Center Lake, Kenosha County. An inventory with planning recommendations. Lake Use Report No. FX-35, Madison WI.
2) Wisconsin Department of Natural Resources. 1977, 1978, Water Analysis, Delafield WI.

APPENDIX C-4

Selected water quality data,* Cross Lake

	4/20/66	8.23.66		6/23/67	7/13/77		
	3 ft.	10 ft.	25 ft.	NDS	0 ft.	18 ft.	33 ft.
Total phosphorus	0.039	0.016	0.019	0.16	0.01	0.03	0.16
Soluble phosphorus	0.009	0.006	0.016	0.33			
Ammonia nitrogen					<.04	<.04	.87
Organic nitrogen					1.68	1.99	2.35
Nitrite nitrogen					.003	.005	.008
Nitrate nitrogen					.03	.03	.04
Total nitrogen					1.70	1.99	3.27
Turbidity					2.4	2.0	2.2
Alkalinity as $CaCO_3$	160.0	126.0	134.0		136.0	142.0	171.0
pH	8.1	9.7	8.4		8.3	8.1	7.4
Dissolved oxygen					6.5	<2.0	0.1
Iron (T)	0.04	0.02	0.05		.18	.15	.18
Manganese					<.03	<.03	.44
Spec. cond. (mhos/cm)	367.0	402.0	417.0		380.0	400.0	470.0
Temperature (°F)					78.8	66.2	55.4
Calcium					29.0	32.0	45.0
Magnesium					36.0	35.0	37.0

*Data expressed in milligrams per liter except as noted.

NDS: No depth stated.

Sources:
1) Wisconsin Department of Natural Resources. 1969c. Cross Lake, Kenosha County. An inventory with planning recommendations. Lake Use Report No. FX-45. Madison WI.
2) Wisconsin Department of Natural Resources. 1977. Water analyses, Delafield WI.

APPENDIX C-4

Selected water quality data, *Rock Lake

	3/19/60	8/30/72			7/21/77			7/13/77
	NDS	10 ft.	24 ft.	32 ft.	0 ft.	12 ft.	32 ft.	19 ft.
Total phosphorus					.02	.02	.27	.03
Soluble phosphorus					.009	.008	.225	.025
Ammonia nitrogen					<.04	<.04	1.62	.21
Organic Nitrogen					.83	.75	.95	2.60
Nitrite Nitrogen					<.002	<.002	<.002	.004
Nitrate Nitrogen					.04	.02	.03	.05
Total Nitrogen					.90	.73	2.60	2.87
Turbidity (JTU)					1.6	1.4	1.8	3.4
Alkalinity as $CaCO_3$					144.0	140.0	180.0	158.0
pH	7.4				8.6	8.4	7.5	7.8
Dissolved oxygen		11.2	0.8	0	6.4	6.9	.1	.8
Iron					.15	.15	.18	.18
Manganese					<.03	<.03	.40	<.03
Spec. cond. (mhos/cm)	490				398.0			
Temperature (°F)					80.6	77.0	50.0	61.7
Calcium					26.0	26.0	38.0	31.0
Magnesium					29.0	33.0	28.0	30.0

*Data expressed in milligrams per liter except as noted.

NDS: No depth stated.

Source: Wisconsin Department of Natural Resources, 1977. Water analyses, Delafield WI. Water Quality Division, Southeast District, Milwaukee WI.

APPENDIX C-4

Selected water quality data, Benet/Shangrila Lake

	3/19/60	7/12/77			7/13/77	1/16/78		
		0 ft.	6 ft.	24 ft.	10 ft.	0 ft.	12 ft.	0 ft.
Total phosphorus		.13	.12	.32	.19	.08	.06	.08
Soluble phosphorus		.081	.068	.257	.082	.032	.018	.021
Ammonia nitrogen		.27	.40	2.16	.63	1.19	1.27	1.49
Organic nitrogen		1.84	1.50	1.26	3.06	1.20	1.09	1.14
Nitrite nitrogen		.010	.006	.011	.011	.011	.009	.010
Total nitrogen		2.19	1.96	3.51	3.78	2.83	2.97	3.11
Turbidity (Jtu)		13.0	8.0	15.0	14.0	1.3	1.4	4.5
Alkalinity as $CaCO_3$		174	176	218	163	200	200	200
pH	7.3	7.8	7.8	7.6	7.5	8.0	7.9	7.9
Dissolved oxygen		6.3	4.6	0	.1			
Iron		.57	.29	1.71	.57	.06	.06	.06
Manganese		.05	.04	1.91	<.03	.03	.14	.20
Special conditions (mhos/cm)	476.	429.	439.	455.	429.	491	459	459
Temperature (°F)		79.7	78.8	57.2	77			
Calcium		34.	34.	36.	34.	45	46	45
Magnesium		31.	32.	32.	32.	28	27	28

Note: Data expressed in milligrams per liter except as noted.

Source: Wisconsin Department of Natural Resources, 1977, 1978. **Water analyses, Delafield WI.** Water Quality Division, Southeast District, Milwaukee WI.

APPENDIX C-4f

Selected water quality data, Silver Lake

	4/15/60	4/1/66	8/23/66		6/23/67	7/19/77		
	Composite	7 ft.	15 ft.	30 ft.	Composite	0 ft.	30 ft.	42 ft.
Total phosphorus	0.071	0.061	0.045	0.061		<.01	.06	.07
Soluble phosphorus	0.006	0.013	0.009	0.009		.016	.016	.030
Ammonia nitrogen					0.36	<.04	.16	.88
Organic nitrogen						.87	1.45	1.66
Nitrite nitrogen						<.002	.005	.007
Total nitrogen						.97	1.73	2.63
Turbidity (Jtu)						4.5	7.0	6.8
Alkalinity as $CaCO_3$	168.0	163.0	157.0	159.0		140.0	162.0	186.0
pH	8.0	--	8.4	8.2		8.5	7.7	7.5
Dissolved oxygen						6.0	--	.1
Iron						.15	.18	.18
Manganese						<.03	.04	.40
Special conditions (mhos/cm)	485	489	476	486		486	530	564
Temperature (°F)						80.6	60.8	57.2
Calcium	25.0	34.1	20.4	21.5		30.0	39.0	40.0
Magnesium	34.0	32.9	30.8	29.9		38.0	39.0	40.0

Note: Data expressed in milligrams per liter except as noted.

Source: Wisconsin Department of Natural Resources, 1977. Water analyses, Delafield WI. Water Quality Division, Southeast District, Milwaukee WI.

APPENDIX C-4g

Selected water quality data, Voltz Lake

	3/19/60	4/26/66	8/23/66		6/21/67	7/13/77		
	Composite	3 ft.	8 ft.	16 ft.	NDS*	0 ft.	7 ft.	17 ft
Total phosphorus		0.234	0.189	0.221	0.195	.09	.13	.37
Soluble phosphorus		0.022	0.169	0.172	0.169	.064	.068	.270
Ammonia nitrogen						.43	.15	.56
Organic nitrogen						2.55	2.56	1.89
Nitrite nitrogen						.005	.021	.046
Total nitrogen						3.03	2.80	2.56
Turbidity (Jtu)						5.0	5.5	3.8
Alkalinity as $CaCO_3$		142.0	168.0	169.0		166.0	158.0	151.0
pH	7.2	8.8	8.1	7.6		7.7	7.6	7.5
Dissolved oxygen						8.6	2.2	2.2
Iron		0.08	0.08	0.012		<.06	.35	<.06
Manganese						.03	<.03	.63
Special conditions (mhos/cm)	492.0	332.0	382.0	378.0		391.0	393.0	376.0
Temperature (°F)						84.2	75.2	60.8
Calcium		30.9	22.8	21.0		35.0	34.0	30.0
Magnesium		25.7	24.5	24.5		34.0	31.0	30.0
PO_4(T)		0.72	0.58	0.68	0.60	0.276	0.398	1.134
PO_4(D)		0.07	0.52	0.53	0.52			

*Data expressed in milligrams per liter except as noted.

NDS: No depth stated.

Source: Wisconsin Department of Natural Resources, 1977. Water Analyses, Delafield WI, Water Quality Division, Southeast District, Milwaukee WI.

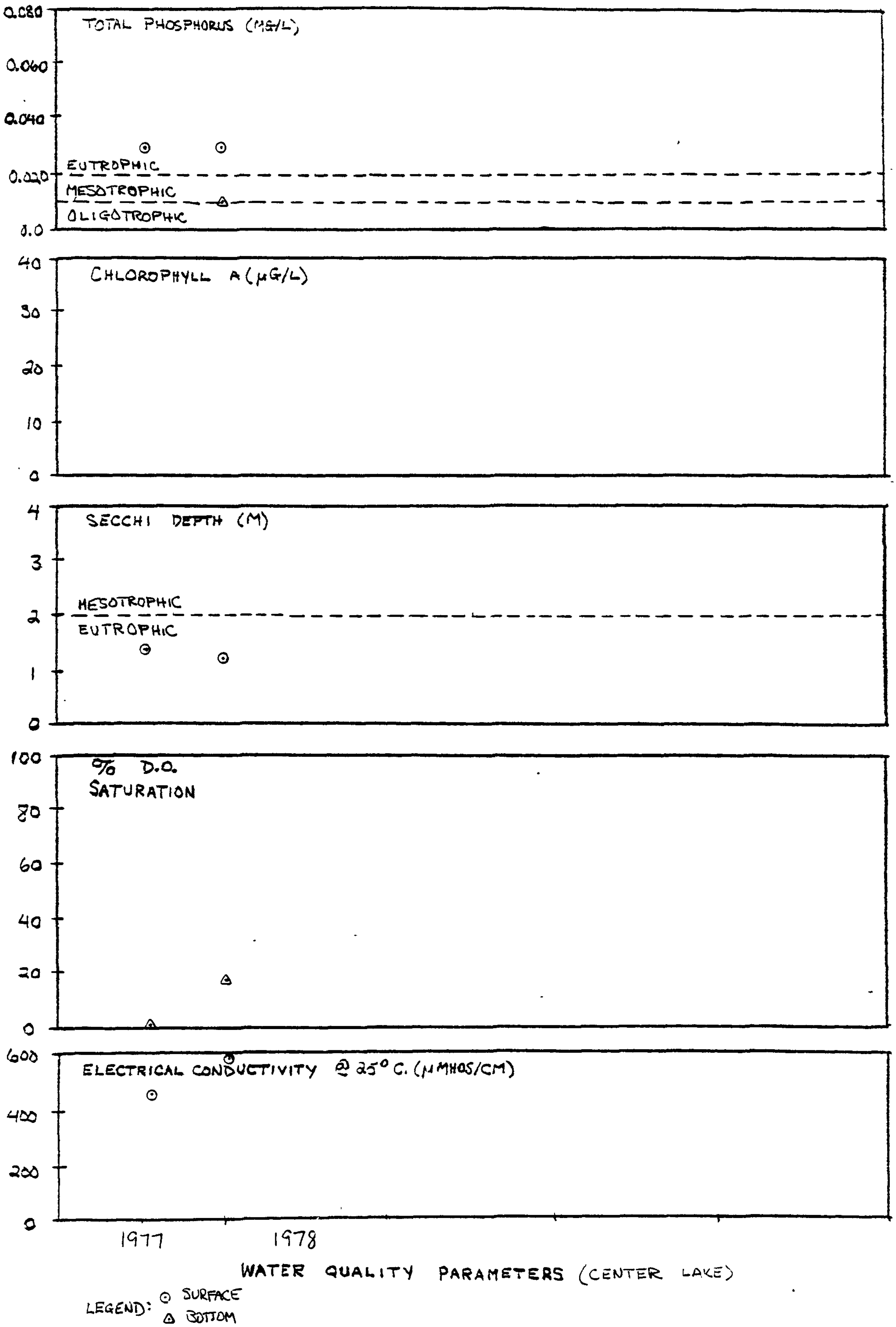

TOTAL PHOSPHORUS (MG/L)
0.080
0.060
0.040
0.020
0.0
EUTROPHIC
MESOTROPHIC
OLIGOTROPHIC
CHLOROPHYLL A (μG/L)
40
30
20
10
0
SECCHI DEPTH (M)
4
3
2
1
0
MESOTROPHIC
EUTROPHIC
% D.O. SATURATION
100
80
60
40
20
0
ELECTRICAL CONDUCTIVITY @ 25° C. (μMHOS/CM)
600
400
200
0
1977
1978
WATER QUALITY PARAMETERS (CENTER LAKE)
LEGEND: ⊙ SURFACE
△ BOTTOM

FIGURE 1

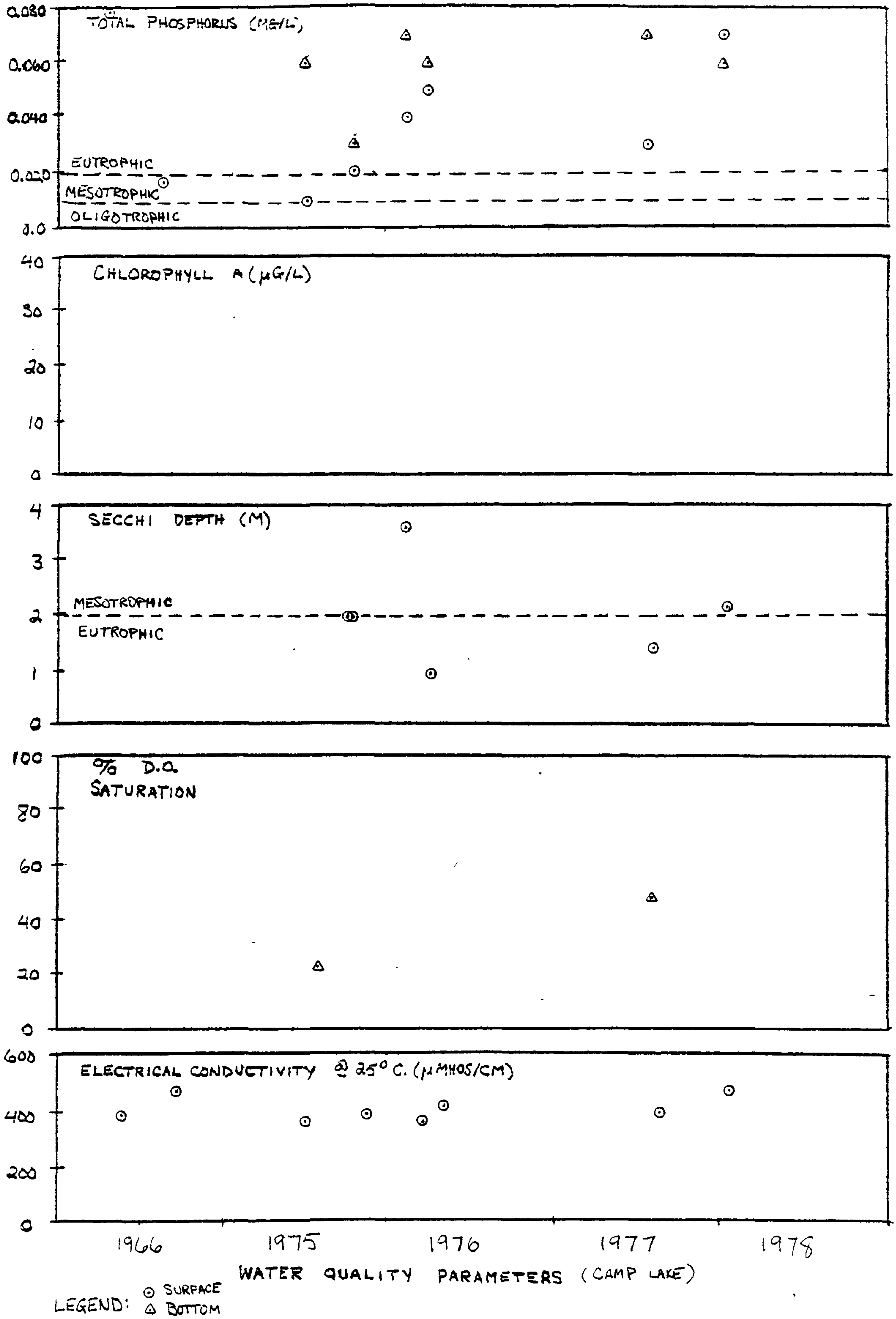

TOTAL PHOSPHORUS (MG/L)
0.080
0.060
0.040
0.020
0.0
EUTROPHIC
MESOTROPHIC
OLIGOTROPHIC
CHLOROPHYLL A (µG/L)
40
30
20
10
0
SECCHI DEPTH (M)
4
3
2
1
0
MESOTROPHIC
EUTROPHIC
% D.O. SATURATION
100
80
60
40
20
0
ELECTRICAL CONDUCTIVITY @ 25° C. (µMHOS/CM)
600
400
200
0
1966
1975
1976
1977
1978
WATER QUALITY PARAMETERS (CAMP LAKE)
LEGEND: ⊙ SURFACE
△ BOTTOM

FIGURE 2

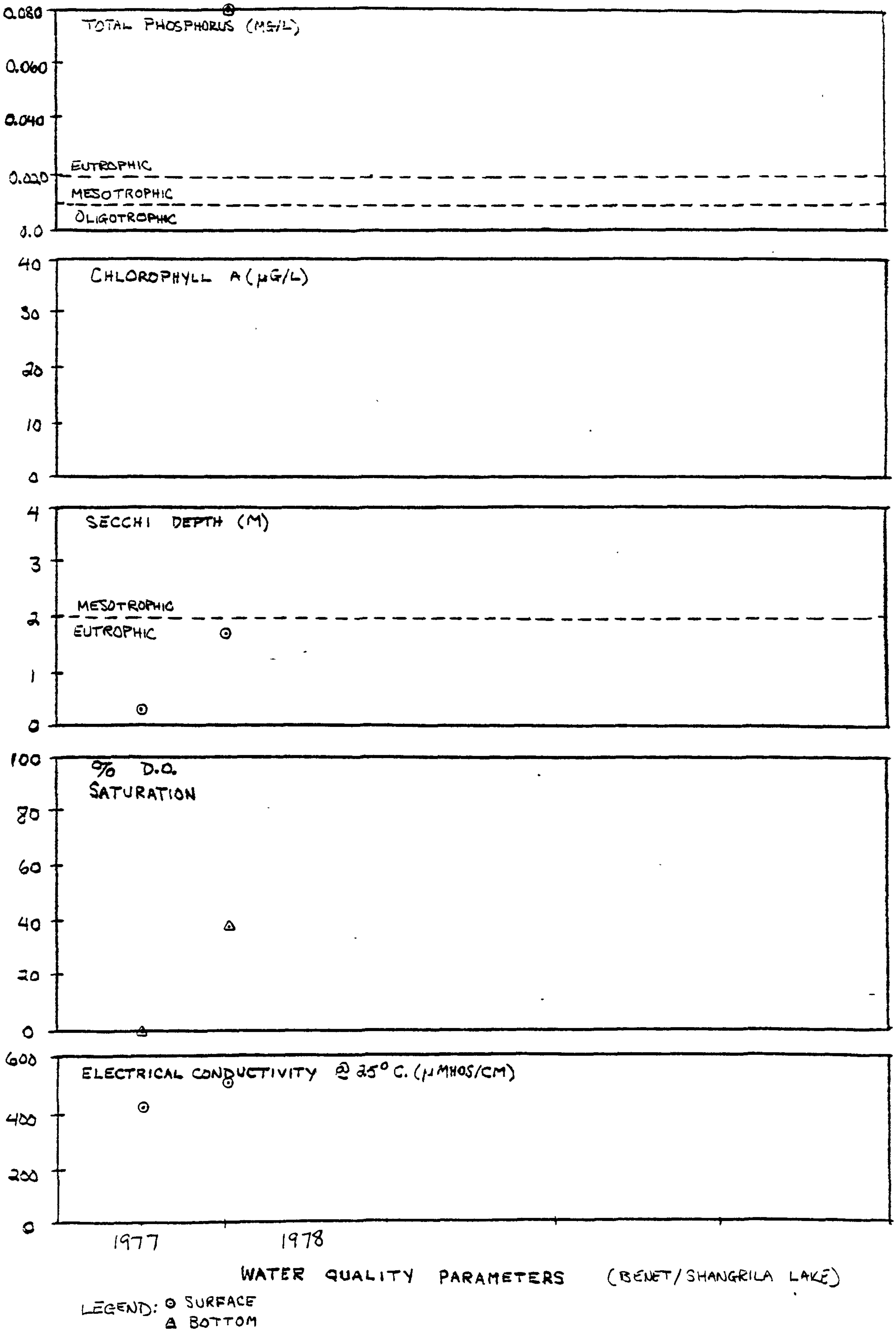

TOTAL PHOSPHORUS (MG/L)
0.080
0.060
0.040
0.020
0.0
EUTROPHIC
MESOTROPHIC
OLIGOTROPHIC
CHLOROPHYLL A (μG/L)
40
30
20
10
0
SECCHI DEPTH (M)
4
3
2
1
0
MESOTROPHIC
EUTROPHIC
% D.O. SATURATION
100
80
60
40
20
0
ELECTRICAL CONDUCTIVITY @ 25° C. (μMHOS/CM)
600
400
200
0
1977
1978
WATER QUALITY PARAMETERS (BENET/SHANGRILA LAKE)
LEGEND: ⊙ SURFACE
△ BOTTOM

FIGURE 3

SEASONAL AND LONG-TERM CHANGES IN LAKE WATER QUALITY

Seasonal changes of temperature and density in lakes are best described using as an example a lake in the temperate zone which freezes over in winter. When ice coats the surface of a lake, cold water at 0°C lies in contact with ice above warmer and denser water between 0° and 4°C.

With the coming of spring, ice melts and the waters are mixed by wind. Shortly, the lake is in full circulation, and temperatures are approximately uniform throughout (close to 4°C). With further heating from the sun and mixing by the wind, the typical pattern of summer stratification develops. That is, three characteristic layers are present: (1) a surface layer of warm water in which temperature is more or less uniform throughout; (2) an intermediate layer in which temperature declines rapidly with depth; and (3) a bottom layer of cold water throughout which temperature is again more or less uniform. These three layers are termed epilimnion, metalimnion (or thermocline), and hypolimnion, respectively. The thermocline usually serves as a barrier that eliminates or reduces mixing between the surface water and the bottom water.

In late summer and early fall, as the lake cools in sympathy with its surroundings, convection currents of cold water formed at night sink to find their appropriate temperature level, mixing with warmer water on their way down. With further cooling, and turbulence created by wind, the thermocline moves deeper and deeper. The temperature of the epilimnion gradually approaches that of the hypolimnion. Finally, the density gradient associated with the thermocline becomes so weak that it ceases to be an effective barrier to downward-moving currents. The lake then becomes uniform in temperature indicating it is again well mixed. With still further cooling, ice forms at the surface to complete the annual cycle.

The physical phenomenon described above has significant bearing on biological and chemical activities in lakes on a seasonal basis. In general, growth of algae, which are plants, in the epilimnion produces dissolved oxygen and takes up nutrients such as nitrogen and phosphorus during the summer months. Algal growth in the hypolimnion is limited mainly because sunlight is insufficient. As dead algae settle gradually from the epilimnion into the hypolimnion, decomposition of dead algae depletes a significant amount of dissolved oxygen in the bottom water. At the same time, stratification limits oxygen supply from the surface water to the bottom water. As a result, the hypolimnion shows a lower level of dissolved oxygen while accumulating a large amount of nutrients by the end of summer. Then comes the fall overturn to provide a new supply of dissolved oxygen and to redistribute the nutrients via complete mixing.

Over each annual cycle, sedimentation builds up progressively at the bottom of the lake. As a result, this slow process of deposition of sediments reduces lake depth. Because major nutrients enter the lake along with the sediments, nutrient concentrations in the lake increase over a long period of time. This aging process is a natural phenomenon and is measured in hundreds or thousands of years, depending on specific lake and watershed characteristics.

Human activities, however, have accelerated this schedule considerably. By populating the shoreline, disturbing soils in the watershed, and altering hydrologic flow patterns, man has increased the rate of nutrient and sediment loading to lakes. As a result, many of our lakes are now characterized by a state of eutrophication that would not have occurred under natural conditions for many generations. This cultural eutrophication can in some instances be beneficial, for example by increasing both the rate of growth of individual fish and overall fishery production. In most cases, however, the effects of this accelerated process are detrimental to the desired uses of the lake.

The eutrophication process of lakes is classified according to a relative scale based on parameters such as productivity, nutrient levels, dissolved oxygen, and turbidity in the lake water. Lakes with low nutrient inputs and low productivity are termed oligotrophic. Dissolved oxygen levels in the hypolimmion of these lakes remain relatively high throughout the year. Lakes with greater productivity are termed mesotrophic and generally have larger nutrient inputs than oligotrophic lakes. Lakes with very high productivity are termed eutrophic and usually have high nutrient inputs. Aquatic plants and algae grow excessively in the latter lakes, and algal blooms are common. Dissolved oxygen may be depleted in the hypolimnion of eutrophic lakes during the summer months.

NON-POINT SOURCE MODEL AND LAKE EUTROPHICATION MODELS

I. Non-Point Source Model: Omernik's Model

Because so little data was available on non-point source runoff in the Study Area, which is largely rural, empirical models or statistical methods have been used to derive nutrient loadings from non-point sources. A review of the literature led to the selection of the model proposed by Omernik (1977). Omernik's regression model provides a quick method of determining nitrogen and phosphorus concentrations and loading based on use of the land. The relationship between land use and nutrient load was developed from data collected during the National Eutrophication Survey on a set of 928 non-point source watersheds.

Omernik's data indicated that the extent of agricultural and residential/urban land vs. forested land was the most significant parameter affecting the influx of nutrient from non-point sources. In the US, little or no correlation was found between nutrient levels and the percentage of land in wetlands, or range or cleared unproductive land. This is probably due to the masking effects of agricultural and forested land.

Use of a model which relates urban/residential and agricultural land use to nutrient levels seems appropriate where agricultural and/or forest make up the main land-use types.

The regression models for the eastern region of the US are as follows:

$$\text{Log } P = 1.8364 + 0.00971A + \sigma_P \text{ Log } 1.85 \qquad (1)$$

$$\text{Log } N = 0.08557 + 0.00716A - 0.00227B + \sigma_N \text{ Lot } 1.51 \qquad (2)$$

where:

P = Total phosphorus concentration - mg/l as P

N = Total nitrogen concentration - mg/l as N

A = Percent of watershed with agricultural plus urban land use

B = Percent of watershed with forest land use

σ_P = Total phosphorus residuals expressed in standard deviation units from the log mean residuals of Equation (1). Determined from Omernik (1977), Figure 25.

σ_N = Total nitrogen residuals expressed in standard deviation units from the log mean residuals of Equation (2). Determined from Omernik (1977), Figure 27.

1.85 = f, multiplicative standard error for Equation 1.

1.51 = f, multiplicative standard error for Equation (2).

The 67% confidence interval around the estimated phosphorus or nitrogen consideration can be calculated as shown below:

$$\text{Log } P_L = \text{Log } P \pm \text{Log } 1.85 \qquad (3)$$

$$\text{Log } N_L = \text{Log } N \pm \text{Log } 1.51 \qquad (4)$$

where:

P_L = Upper and lower values of the 67% phosphorus confidence limit - mg/l as P

The 67% confidence limit around the estimated phosphorus or nitrogen concentrations indicates that the model should be used for purposes of gross estimations only. The model does not account for any macro-watershed* features peculiar to the Study Area.

II. Lake Eutrophication Models

Introduction

Two basic approaches to the analysis of lake eutrophication have evolved:

1) A complex lake/reservoir model which simulates the interactions occurring within ecological systems; and

2) the more simplistic nutrient loading model which relates the loading or concentration of phosphorus in a body of water to its physical properties.

From a scientific standpoint, the better approach is the complex model; with adequate data such models can be used to accurately represent complex interactions of aquatic organisms and water quality constituents. Practically speaking, however, the ability to represent these complex interactions is limited because some interactions have not been identified and some that are known cannot be readily measured. EPAECO is an example of a complex reservoir model currently in use. A detailed description of this model has been given by Water Resources Engineers (1975).

In contrast to the complex reservoir models, the empirical nutrient budget models for phosphorus can be simply derived and can be used with a minimum of field measurement. Nutrient budget models, first derived by Vollenweider (1968) and later expanded upon by him (1975), by Dillon (1975a and 1975b) and by Larsen - Mercier (1975 and 1976), are based upon the total phosphorus mass balance. There has been a proliferation of simplistic models in eutrophication literature in recent years (Bachmann and Jones, 1974; Reckhow, 1978). The Dillon model has been demonstrated to work reasonably well for a broad range of lakes with easily obtainable data. The validity of the model has been demonstrated by comparing results with data from the National Eutrophication Survey (1975). The models developed by Dillon and by Larsen and Mercier fit the data developed by the NES for 23 lakes located in the northeastern and northcentral United States (Gakstatter et al 1975) and for 66 bodies of water in the southeastern US (Gakstatter and Allum 1975). The Dillon model (1975b) has been selected for estimation of eutrophication potential for Crystal Lake and Betsie Lake in this study.

Historical Development

Vollenweider (1968) made one of the earliest efforts to relate external nutrient loads to eutrophication. He plotted annual total phosphorus loadings ($g/m^2/yr$) against lake mean depth and empirically determined the transition between oligotrophic, mesotrophic and eutrophic loadings. Vollenweider later modified his simple loading mean depth relationship to include the mean residence time of the water so that unusually high or low flushing rates could be taken into account.

Dillon (1975) further modified the model to relate mean depth to a factor that incorporates the effect of hydraulic retention time on nutrient retention.

The resulting equation, used to develop the model for trophic status, relates hydraulic flushing time, the phosphorus loading, the phosphorus retention ratio, the mean depth and the phosphorus concentration of the water body as follows:

$$L \frac{(1-R)}{\rho} = zP$$

where: L = phosphorus loading ($gm/m^2/yr.$)
R = fraction of phosphorus retained
ρ = hydraulic flushing rate (per yr.)
z = mean depth (m)
P = phosphorus concentration (mg/l)

The graphical solution, shown in Figure -a, is presented as a log-log plot of $L \frac{(1-R)}{P}$ versus z.

The Larsen-Mercier relationship incorporates the same variables as the Dillon relationship.

In relating phosphorus loadings to the lake trophic condition, Vollenweider (1968), Dillon and Rigler (1975) and Larsen and Mercier (1975, 1976) examined many lakes in the United States, Canada and Europe. They established tolerance limits of 20/ug/l phosphorus above which a lake is considered eutrophic and 10 mg/l phosphorus above which a lake is considered mesotrophic.

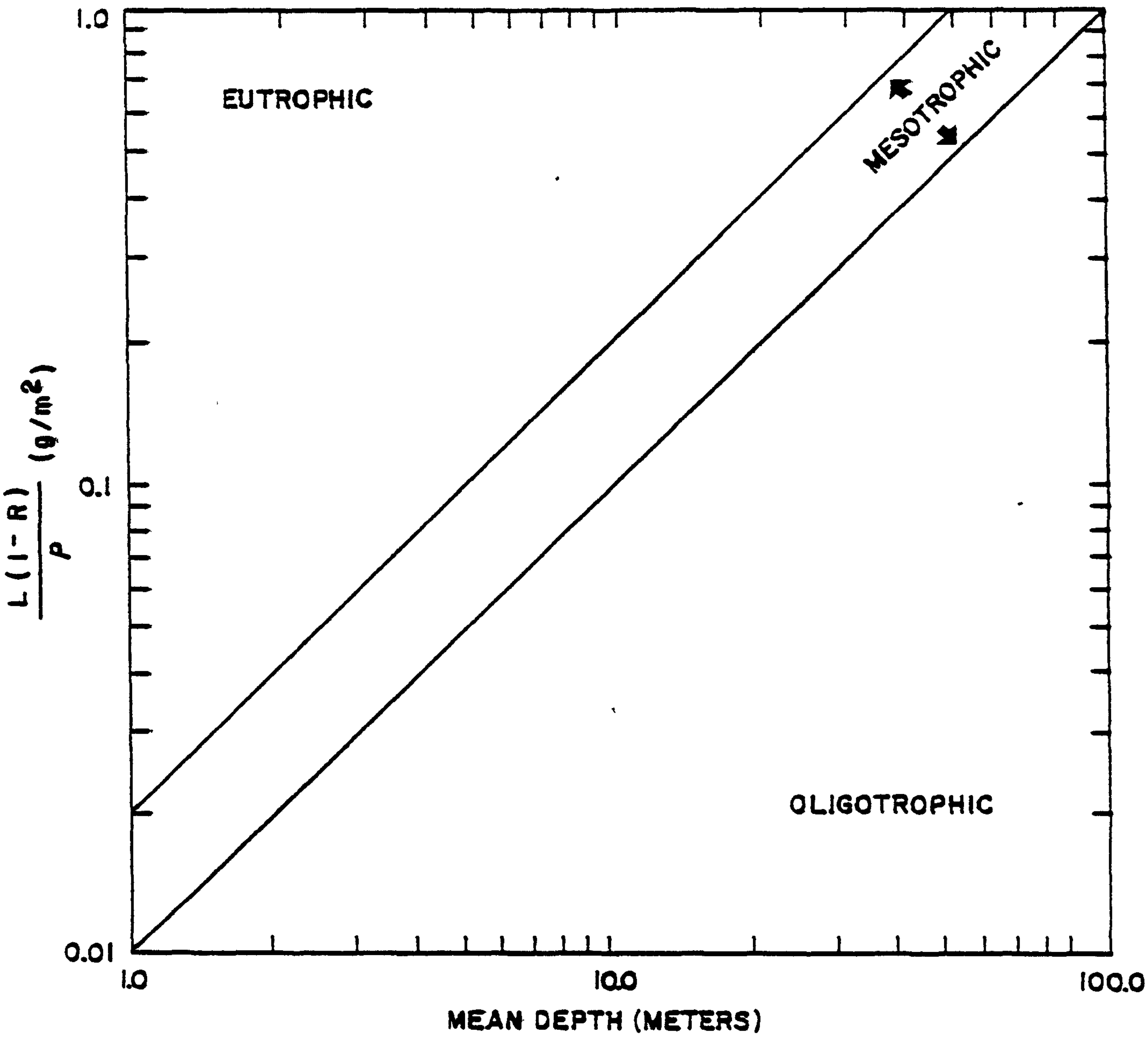
Assumptions and Limitations

The Vollenweider-Dillon model assumes a steady state, completely mixed system, implying that the rate of supply of phosphorus and the flushing rate are constant with respect to time. These assumptions are not totally true for all lakes. Some lakes are stratified in the summer so that the water column is not mixed during that time. Complete steady state conditions are rarely realized in lakes. Nutrient inputs are likely to be quite different during periods when stream flow is minimal or when non-point source runoff is minimal. In addition, incomplete mixing of the water may result in localized eutrophication problems in the vicinity of a discharge.

Another problem in the Vollenweider-Dillon model is the inherent uncertainty when extrapolating a knowledge of present retention coefficients to the study of future loading effects. That is to say, due to chemical and biological interactions, the retention coefficient may itself be dependent on the nutrient loading.

The Vollenweider/Dillon model or simplified plots of loading rate versus lake geometry and flushing rates can be very useful in describing the general trends of eutrophication in lakes during the preliminary

FIGURE



L= AREAL PHOSPHORUS INPUT (g/m²/yr)
R= PHOSPHORUS RETENTION COEFFICIENT (DIMENSIONLESS)
P= HYDRAULIC FLUSHING RATE (yr^{-1})

planning process. However, if a significant expenditure of monies for nutrient control is at stake, a detailed analysis to calculate the expected phytoplankton biomass must be performed to provide a firmer basis for decision making.

APPENDIX
C-7

INVESTIGATION OF SEPTIC RUNOFF AND LEACHATE DISCHARGES INTO THE SALEM LAKES, WISCONSIN

February, 1979

Prepared for

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Prepared by

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April, 1979

TABLE OF CONTENTS

INTRODUCTION

In porous soils, groundwater inflows frequently convey wastewaters from nearshore septic units through bottom sediments and into lake waters, causing attached algae growth and algal blooms. The lake shoreline is a particularly sensitive area since: 1) the groundwater depth is shallow, encouraging soil water saturation and anearobic conditions: 2) septic units and leaching fields are frequently located close to the water's edge, allowing only a short distance for bacterial degradation and soil adsorption of potential contaminants: and 3) the recreational attractiveness of the lakeshore often induces temporary overcrowding of homes leading to hydraulically overloaded septic units. Rather than a passive release from lakeshore bottoms, groundwater plumes from nearby on-site treatment units actively emerge along shorelines, raising sediment nutrient levels and creating local elevated concentrations of nutrients (Kerfoot and Brainard, 1978). The contribution of nutrients from subsurface discharges of shoreline septic units has been estimated at 30 to 60 percent of the total nutrient load in certain New Hampshire lakes (LRPC, 1977).

Wastewater effluent contains a mixture of near UV fluorescent organics derived from whiteners, surfactants and natural degradation products which are persistent under the combined conditions of low oxygen and limited microbial activity.

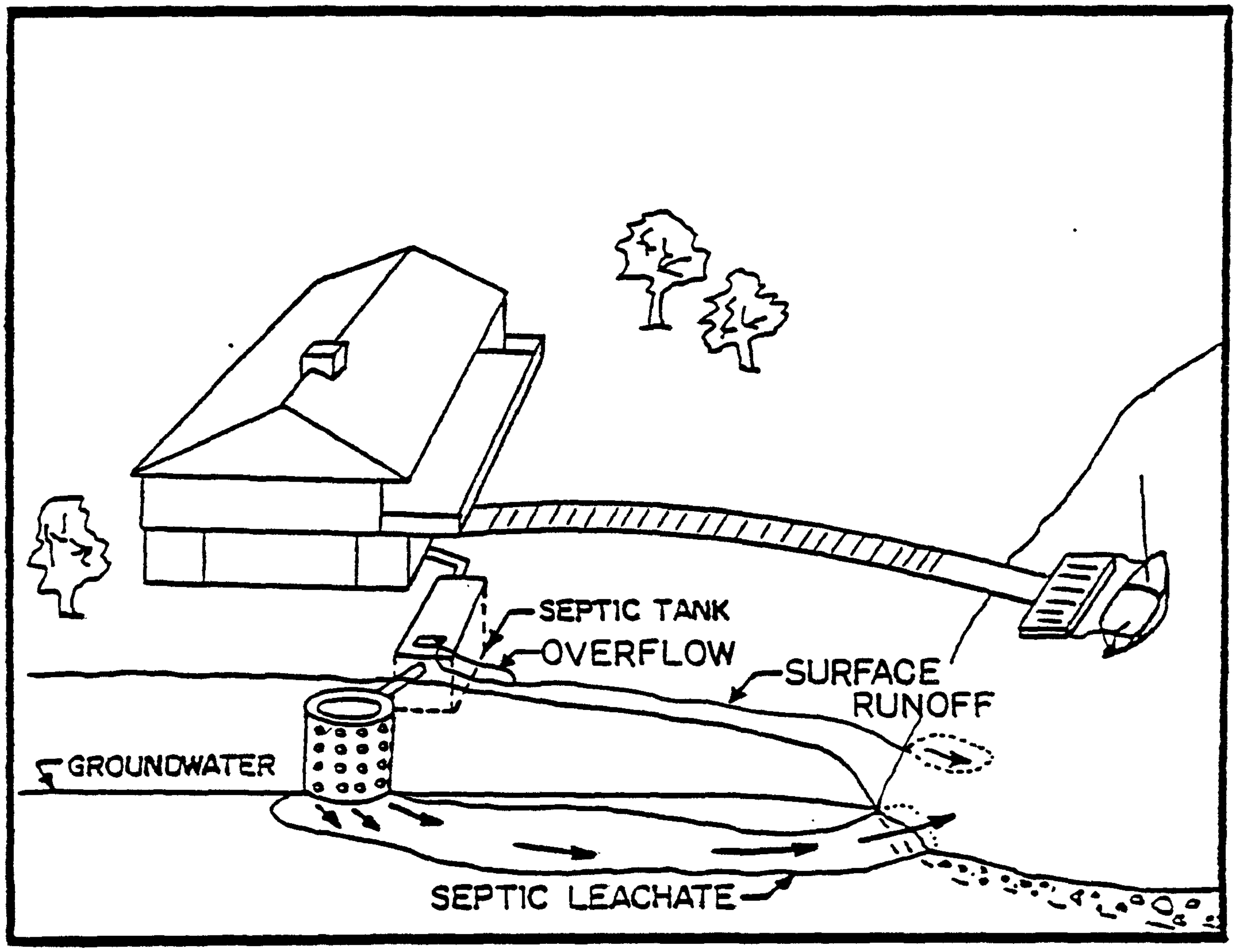


Figure 1. Excessive loading of septic systems causes the development of plumes of poorly-treated effluent which may 1) enter nearby waterways through surface runoff or which may 2) move laterally with groundwater flow and discharge near the shoreline of nearby lakes.

Figure 2 shows two samples of sand-filtered effluent from the Otis Air Force Base sewage treatment plant. One was analyzed immediately and the other after having sat in a darkened bottle for six months at 20°C. Note that little change in fluorescence was apparent, although during the aging process some narrowing of the fluorescent region did occur. The aged effluent percolating through sandy loam soil under anaerobic conditions reaches a stable ratio between the organic content and chlorides which are highly mobile anions. The stable ratio (cojoint signal) between fluorescence and conductivity allows ready detection of leachate plumes by their conservative tracers as an early warning of potential nutrient breakthrough or public health problems.

Surveys for shoreline wastewater discharges were conducted with a modified septic leachate detector. The septic leachate detector (ENDECO Type 2100 "Septic Snooper") consists of the subsurface probe, the water intake system, the analyzer control unit, and the graphic recorder (Figure 3). Initially the unit is calibrated against stepwise increases of wastewater effluent, of the type to be detected, added to the background lake water. The probe of the unit is then placed in the lake water along the shoreline. Groundwater seeping through the shoreline bottom is drawn into the subsurface intake of the probe and travels upwards to the analyzer unit. As it passes through the analyzer, separate conductivity and specific fluorescence signals are generated and sent to a signal processor which registers the separate signals

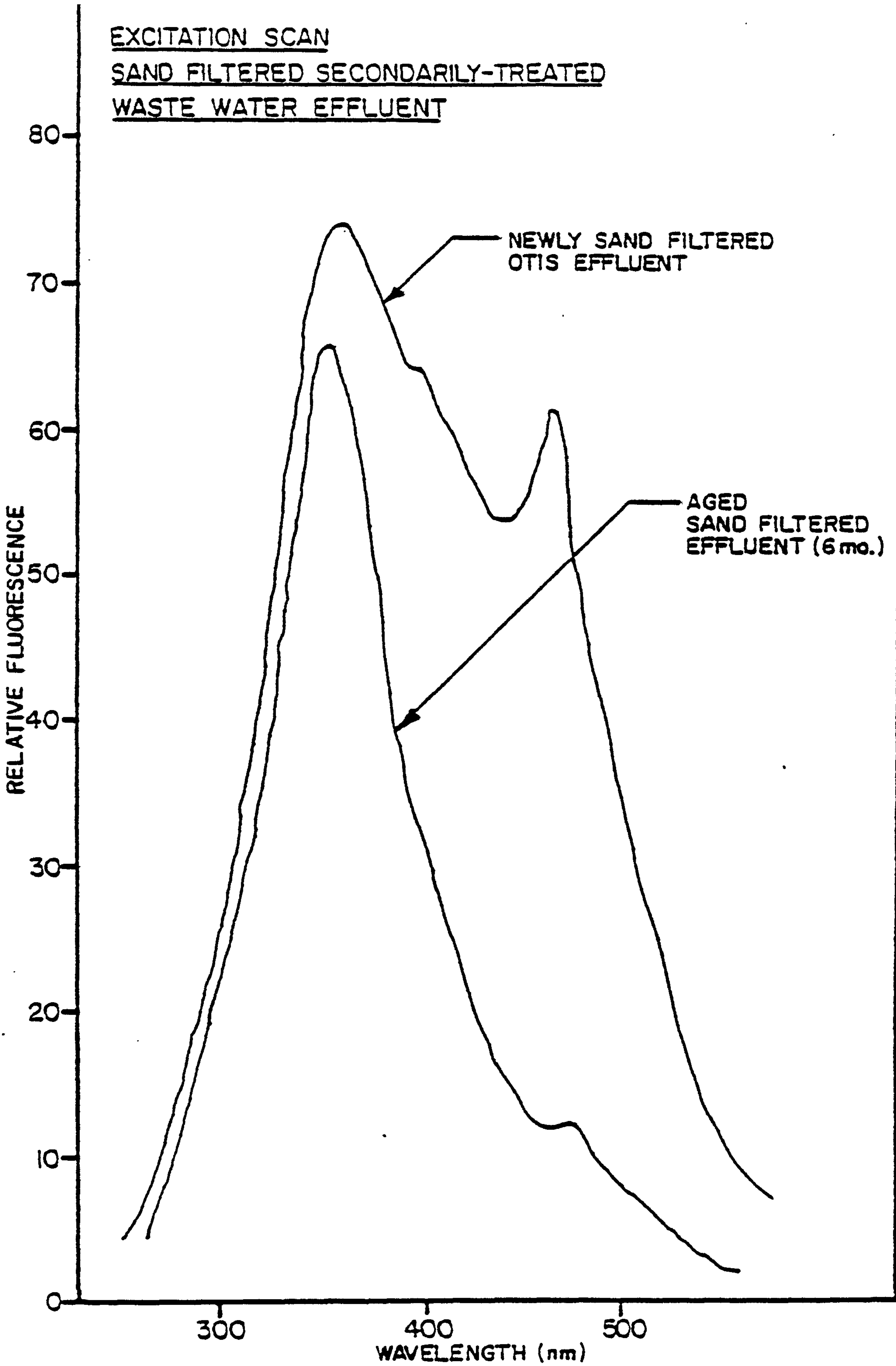
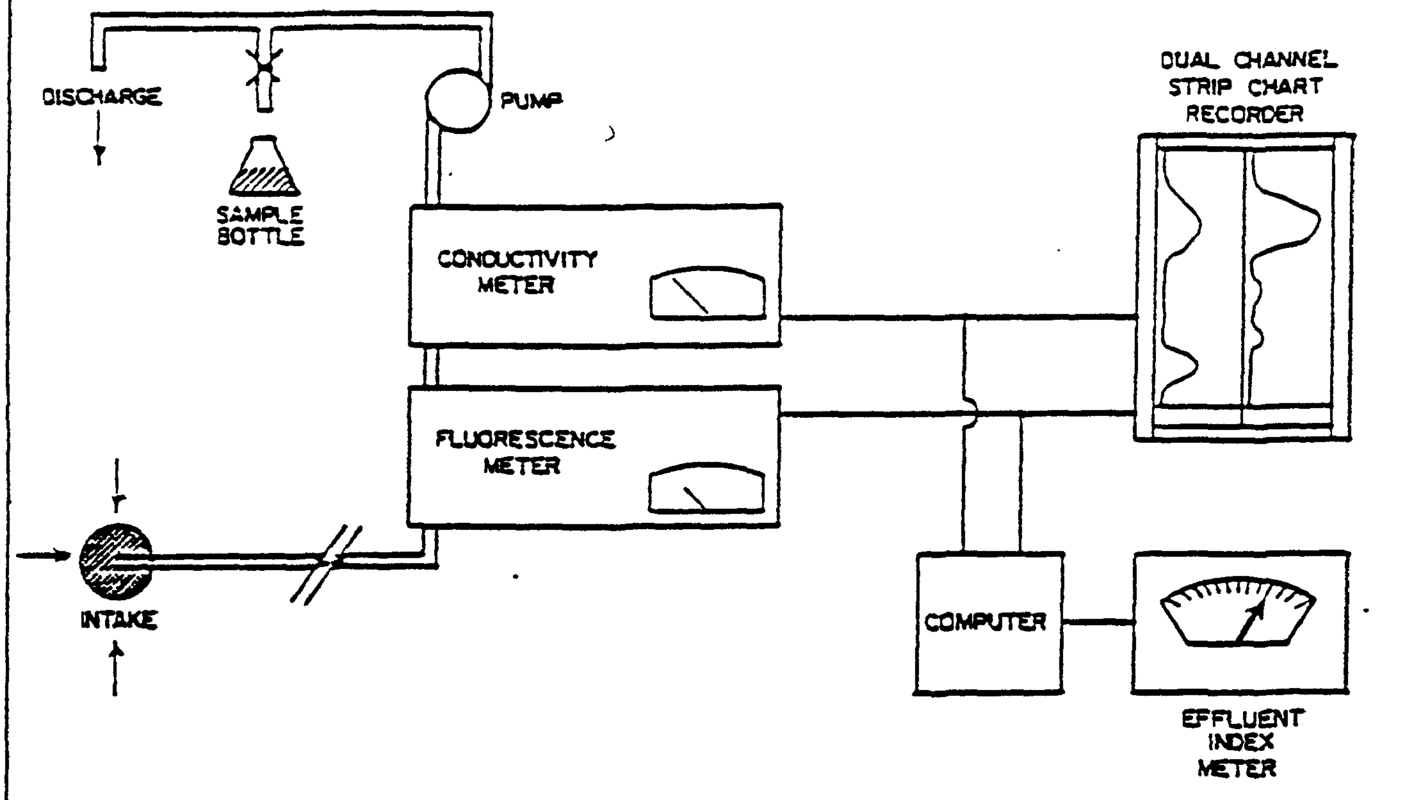


FIGURE 2. Sand-filtered Effluent Produces a Stable Fluorescent Signature, Here Shown Before and After Aging



ENDECO® SEPTIC LEACHATE DETECTOR (SEPTIC SNOOPER™) SYSTEM DIAGRAM

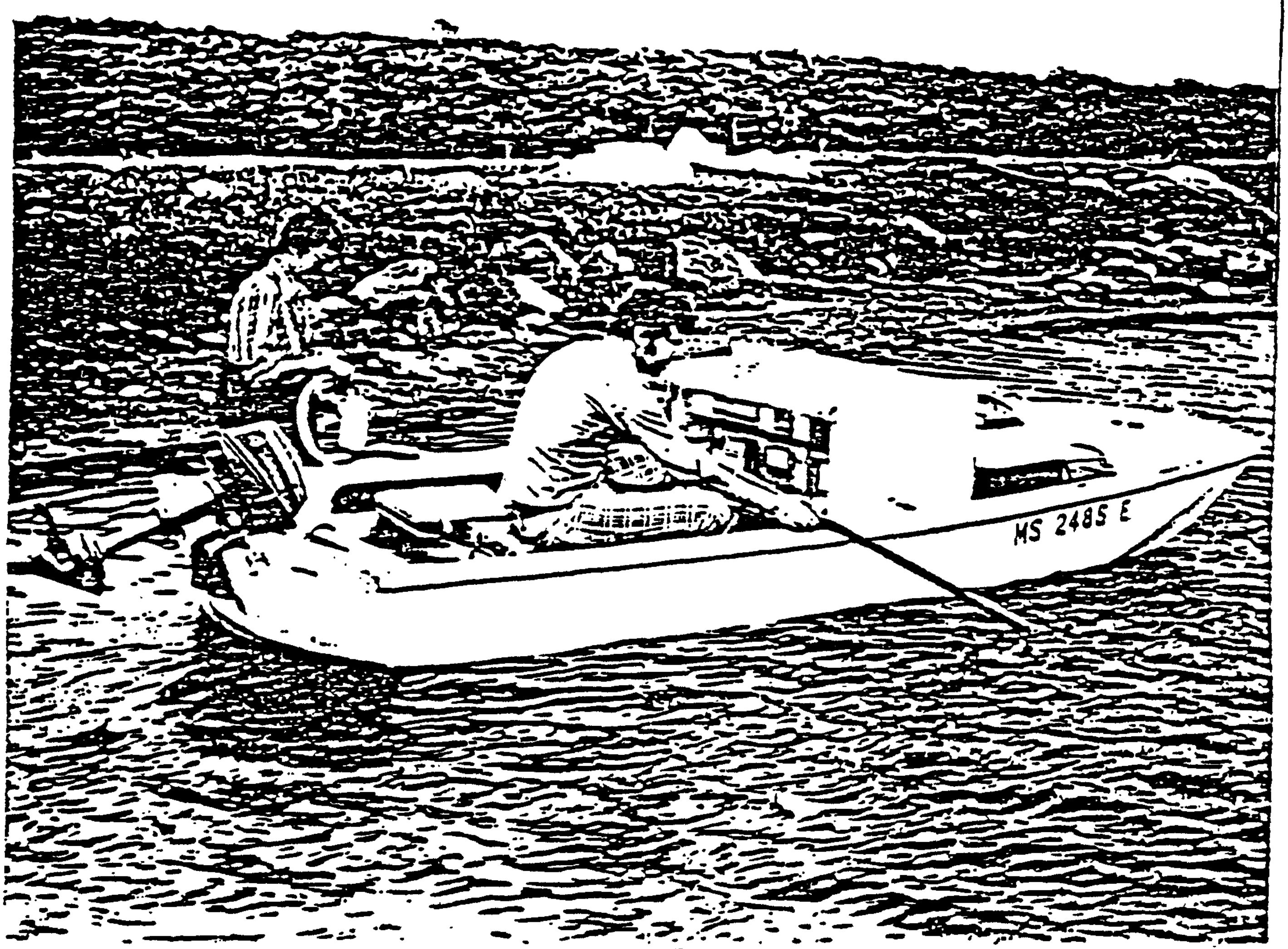


FIGURE 3. The Type 2100 "SEPTIC SNOOPER™" Consists of Combined Fluorometer/ Conductivity Units Whose Signal is Adjusted to Fingerprint Effluent. The Unit is Mounted in a Boat and Piloted Along the Shoreline.

on a strip chart recorder as theboat moves forward. The analyzed water is continuously discharged from the unit back into the receiving water. A portable unit obtained from ENDECO was used during the field studies, but was modified to operate under the conductance conditions encountered in the field.

Plume Types

The capillary-like structure of sandy porous soils and horizontal groundwater movement induces a fairly narrow plume from malfunctioning septic units. The point of discharge along the shoreline is often through a small area of lake bottom, commonly forming an oval-shaped area several meters wide when the septic unit is close to the shoreline. In denser subdivisions containing several overloaded units the discharges may overlap, forming a broader increase.

Groundwater Plumes.

Three different types of groundwater-related wastewater plumes are commonly encountered during a septic leachate survey: 1) erupting plumes, 2) passive plumes, and 3) stream source plumes. As thesoil becomes saturated with dissolved solids and organics during the aging process of a leaching on-lot septic system, a breakthrough of organics occurs first, followed by inorganic penetration (principally chlorides, sodium, and other salts). The active emerging of the combined organic and inorganic residues into the shoreline lake water describes an erupting plume. In seasonal dwellings where wastewater loads vary in time, a plume may be apparent during late summer when shoreline cottages sustain heavy use, but retreat during winter during low flow conditions. Residual organics from the wastewater often still remain attached to soil particles in the vicinity of the previous erupting plume, slowly releasing into the shoreline waters. This dormant plume indicates a previous breakthrough, but sufficient treatment of the plume exists under current conditions so that no inorganic discharge is apparent. Stream source plumes refer to either groundwater leachings or nearstream septic leaching fields which enter into streams which then empty into the lake.

Runoff Plumes.

Traditional failures of septic systemsoccur in tight soil conditions when the rate of inflow into the unit is greater than the soil percolation can accomodate. Often leakage occurs around the septic tank or leaching unit covers, creating standing pools of poorly-treated effluent. If sufficient drainage is present, the effluent may flow laterally across the surface into nearby waterways. In addition, rainfall or snow melt may also create an excess of surface water which can wash the standing effluent into water courses. In either case, the poorly-treated effluent frequently contains elevated fecal coliform bacteria, indicative of the presence of pathogenic bacteria and, if sufficiently high, must be considered a threat to public health.

2.0 METHODOLOGY - SAMPLING AND ANALYSIS

Water sampling for nutrient concentrations along the shoreline is coordinated with the septic leachate testing to identify the sources of effluent. The shoreline of the Salem Unitility District No. 2 in Kenosha County, Wisconsin consists predominantly of silty clay soils andsubsoils which have low percolation rates. The survey was conducted under winter conditions using special procedures for ice-covered shorelines. Field work proceded throughout the month of February and into early March. With daytime temperatures ranging from o^{o} to 35^{o}F, the 3-foot thick ice was frequently covered with snow or slush layers.

Silver Lake and Camp Lake were the first to be probed, during the coldest period of outdoor weather. Zero to 25^{o}F temperature made impractical the exposed use of the detector instrument out on the ice to process real time liquid samples. As a workable approach, a snowmobile was used for transportation; a gasoline-powered ice auger, with three-foot long, five-inch diameter drill was used to bore through the ice; and bright orange marker flags marked hole locations. One person was then able to travel rapidly over the ice and snow cover, drill ten holes at a time on approximate 100-foot intervals, record the locations against a shoreline map, and insert a marker flag in each hole. Upon returning to each hole, he would lower a small, 12-volt battery-operated centrifugal pump with five feet of hose and flush out a fresh water sample specimen from beneath the ice. Holes were offset from shore from 10 to 200 feet, depending upon bottom depth contours, so as to allow for 3 to 10 inches of clear water beneath the bottom of the ice.

Lake water samples were retained in 250 ml clean plastic sample bottles marked to correspond with hole numbers and kept at near-freezing temperature prior to injection into the leachate detector instrument. As each set of 10 samples was returned to the equipment van for processing, the operator would present fresh bottles to the snowmobile crewman along with instructions for retrieving groundwater samples based upon results of samples just analyzed.

The equipment van sheltered the leachate detector from wind and severe cold. Ambient inside temperature was held at about 35°F. A 40 ml sample was introduced to the instrument detection chamber by disposable syringe. Conductance and fluorescence levels were recorded, the device having been periodically calibrated against background water from a center-of-lake sample and a 10% solution of local Salem Lake treatment plant effluent.

Groundwater samples were drawn from the sandy or mucky bottom sediments of those holes displaying a high relative fluorescence signal. A 7-foot long well-point of stainless steel tubing was driven into the lake bottom substrate to a depth of 18 inches. Interstitial water samples were extracted by hand vacuum pump into a collection flask. These samples were likewise preserved in 250 ml plastic bottles and frozen for later laboratory analysis. In most cases, great difficulty was encountered in extracting free water from the mucky soil bottom sediments.

Of the lake water samples only specific background samples, center samples, or likely effluent plume samples were retained and frozen for subsequent nutrient analysis.

While this somewhat involved sample procedure was successful in allowing a rate of one mile per day, later warmer temperatures allowed operation of a mobile detector system on the ice surface. In this mode, the snowmobile was eliminated. The team moved smoothly on foot, one individual drilling holes, monitoring ice depth and free water clearance with a depth probe. The instrument operator followed towing a large lightweight polyethylene sled, a portable fish by "Snoboat" Co., laden with instrument, battery, pumps, bottles, and groundwater extraction equipment. This technique facilitated pumping a continuous flow of lake water through the leachate detector at each hole, yielding more reliable data over a larger sample volume. Retained samples were easily taken from the hose discharge, as required. The groundwater sample could also be rapidly retrieved on the spot. All data and observations were carefully recorded in a bound laboratory book. With both team members on the ice, any uncertainty as to position and hole numbering was eliminated. Relative effluent plume potential could be assessed at each hole without delay.

Bacterial samples were drawn from every observable surface inflow or outflow, as well as selected high level plume locations under the ice. Such samples were collected in sterilized 250 ml plastic containers and transported to the Kenosha County Public Health Office for analysis within 6 hours of sampling. Analyses were performed for fecal coliform by the membrane filter method.

Water samples taken in the vicinity of the peak of plumes were analyzed by EPA Standard Methods for the following chemical constituents:

Conductivity (cond.)
Ammonia-nitrogen (NH_4-N)
Nitrate-nitrogen (NO_3-N)
Total phosphorus (TP)
Orthophosphate phosphorus (PO_4-P)

A total of 400 small volume (50 ml) water samples were obtained at locations of sample holes and 120 samples at selected plumes and background stations for analysis. The samples were placed in polyethylene containers, chilled, and frozen for transport and storage. Conductivity was determined by a Beckman (Model RC-19) conductivity bridge, ammonium-nitrogen by phenolate method, nitrate-nitrogen by the brucine sulfate procedure, and orthophosphate-phosphorus and total phosphorus by the single reagent procedures following standard methods (EPA, 1975).

3.0 PLUME LOCATIONS

The Salem Lakes study area included the southern shore of Silver Lake, Camp Lake, Center Lake, Shangrila/Benet Lake, and Voltz Lake. The lakes in the Salem district are of glacial origin; Center and Voltz Lakes are kettle lakes formed by depressions left from melting ice blocks. Silver Lake is bordered on the south by a sandy moraine forming a ridge between it and Center Lake. Poorly drained lowlands surrounding Center Lake and Camp Lake and oriented in a northeast to southwest axis may have originated as a glacial trough.

Both Center Lake and Camp Lake have been extensively channelized. The canals have nearly doubled the length of Camp Lake's original mucky and marsh-edged shoreline. Development has occurred only along certain of the channels, since marsh areas and poor soils have limited building capacity. The southern canals are principally for natural resource management.

A total of 56 plumes were observed along the shorelines surveyed (Figures 4-8). Of these, only two were found to be of groundwater origin; the others represent overland runoff or bog drainage inflows. Solid circles indicate locations of probable groundwater leachate sources, with plumes emerging from porous bottom sediments into the lake. Solid squares represent locations of suspected surface discharges resulting from overflowing septic systems as sources. A line is drawn from each symbol to the location of the ice hole sampled where the plume was encountered. Spectral analysis separated the discharges from bogs (32) from wastewater inflows (23+). Substantial shoreline regions in Camp Lake and Shangrila/Benet lakes were found to contain effluent concentrations, often accompanied by elevated fecal bacterial contents.

The predominance of runoff plumes corresponds to the observed soil conditions. Silty clay loams of glacial origin dominate the soils in the Salem Utility District, forming impermeable bottom sediments which severely limit groundwater flow into the lakes. The portable well-point sampler required vacuums in excess of 20 in. Hg to withdraw bottom interstitial samples, indicating tight soil conditions at almost all transect shoreline locations. Approximately 65% of the soils in the Salem District No.2 have severe limitation for onsite (land) disposal systems due to shallow depth over groundwater, poor internal drainage of subsoils or both. Morley silt loams, with a slow permeability of 0.2 inches per hour and moderately high shrink-swell potentials, dominate the southeastern portion of the study area that includes Shangrila/Benet Lake and Voltz Lake (WAPORA, 1979). The land to the east of Center and Camp Lake is Aztalan loam, characterized by slow internal drainage and a high seasonal water table of one to three feet (Link and Demo, 1970).

Key to Symbols Used on Sampling Location Maps

• ice hole location

S4 bacterial sample location

o dormant groundwater plume

● erupting groundwater plume

□ organic surface water plume without dissolved solids load

■ organic surface water plume with dissolved solids load

C-

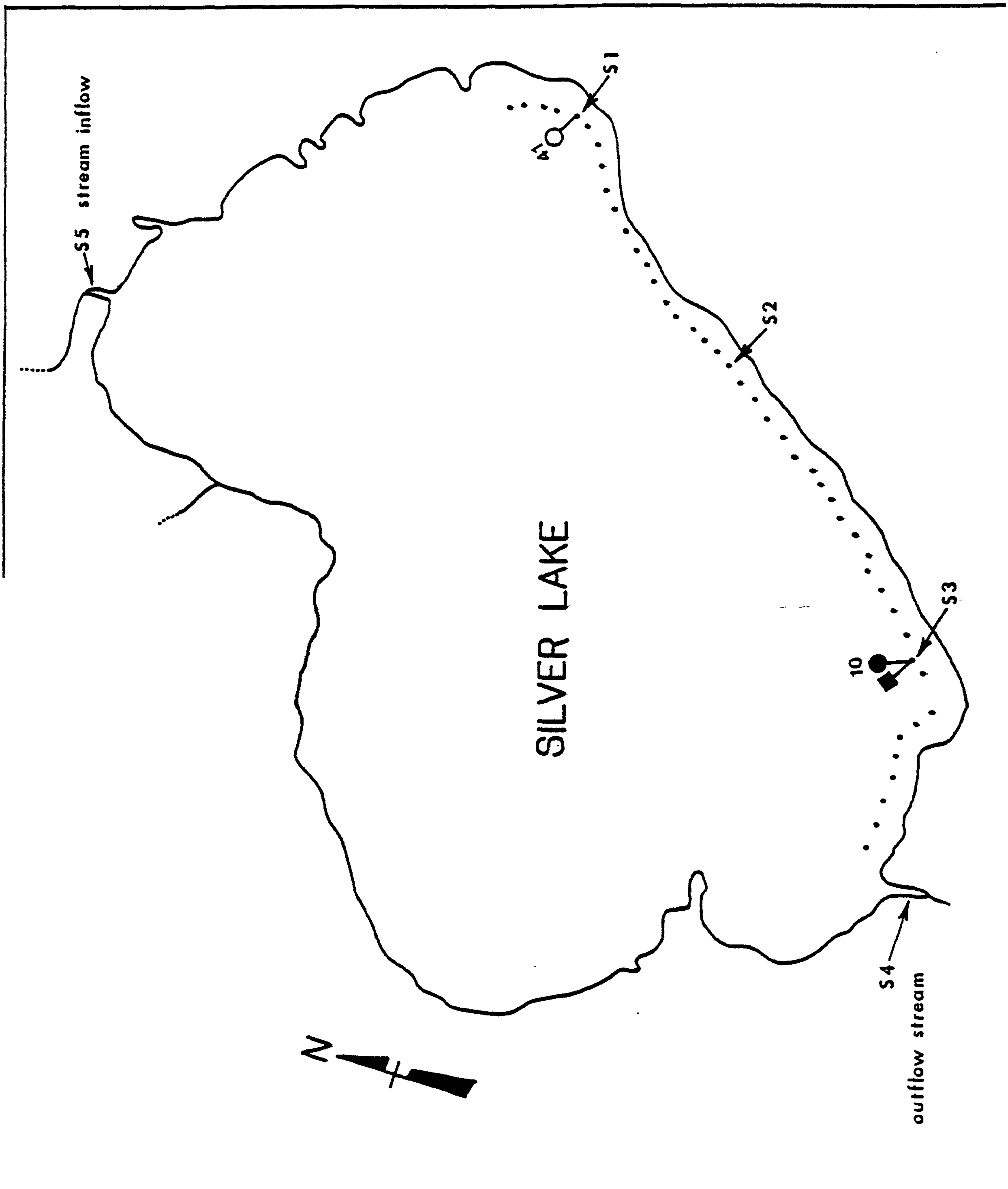


Figure 4. Sampling locations, plumes, and bacterial sample locations on Silver Lake.

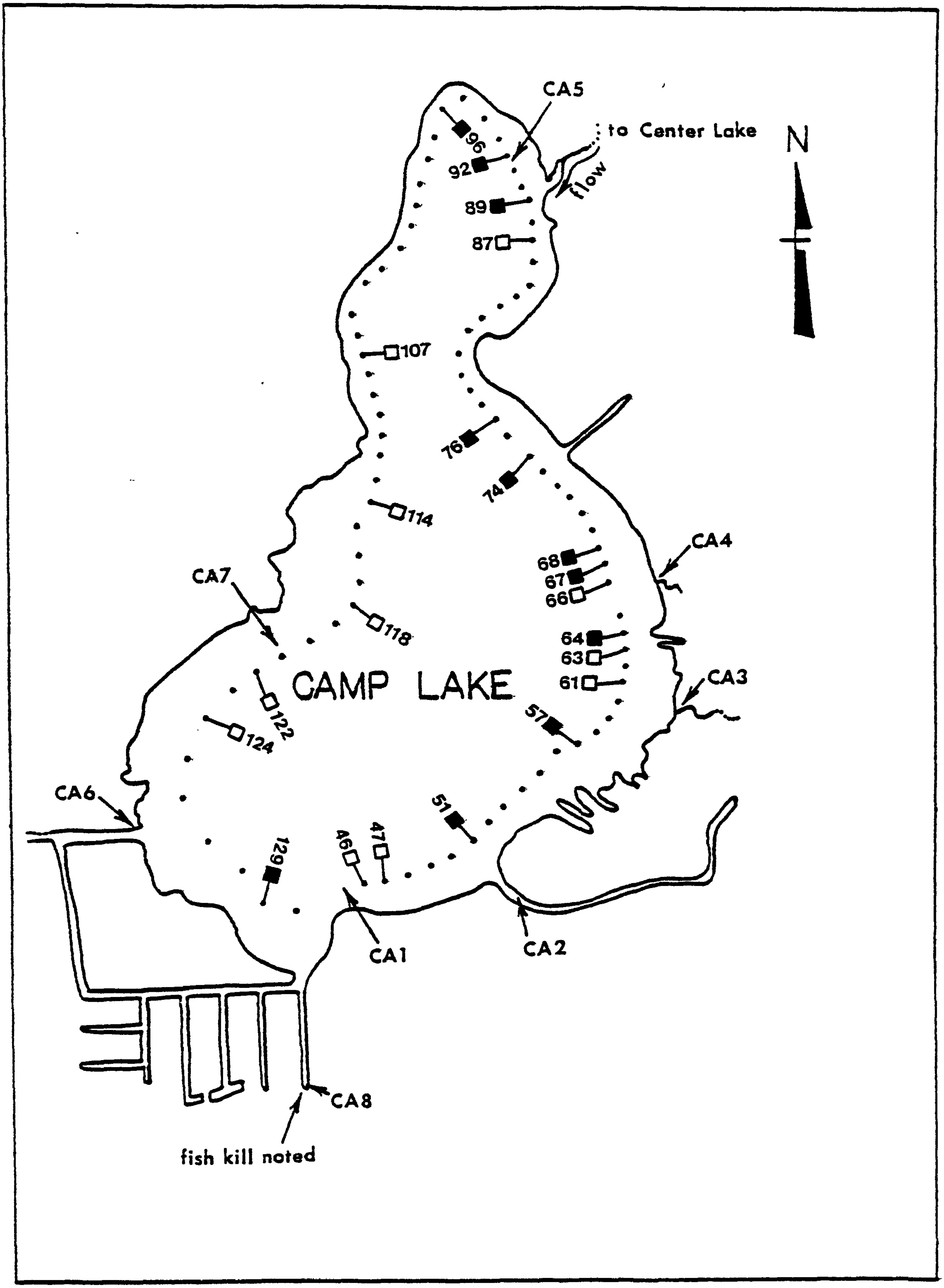


Figure 5. Sampling locations, plumes, and bacterial sample locations on Camp Lake.

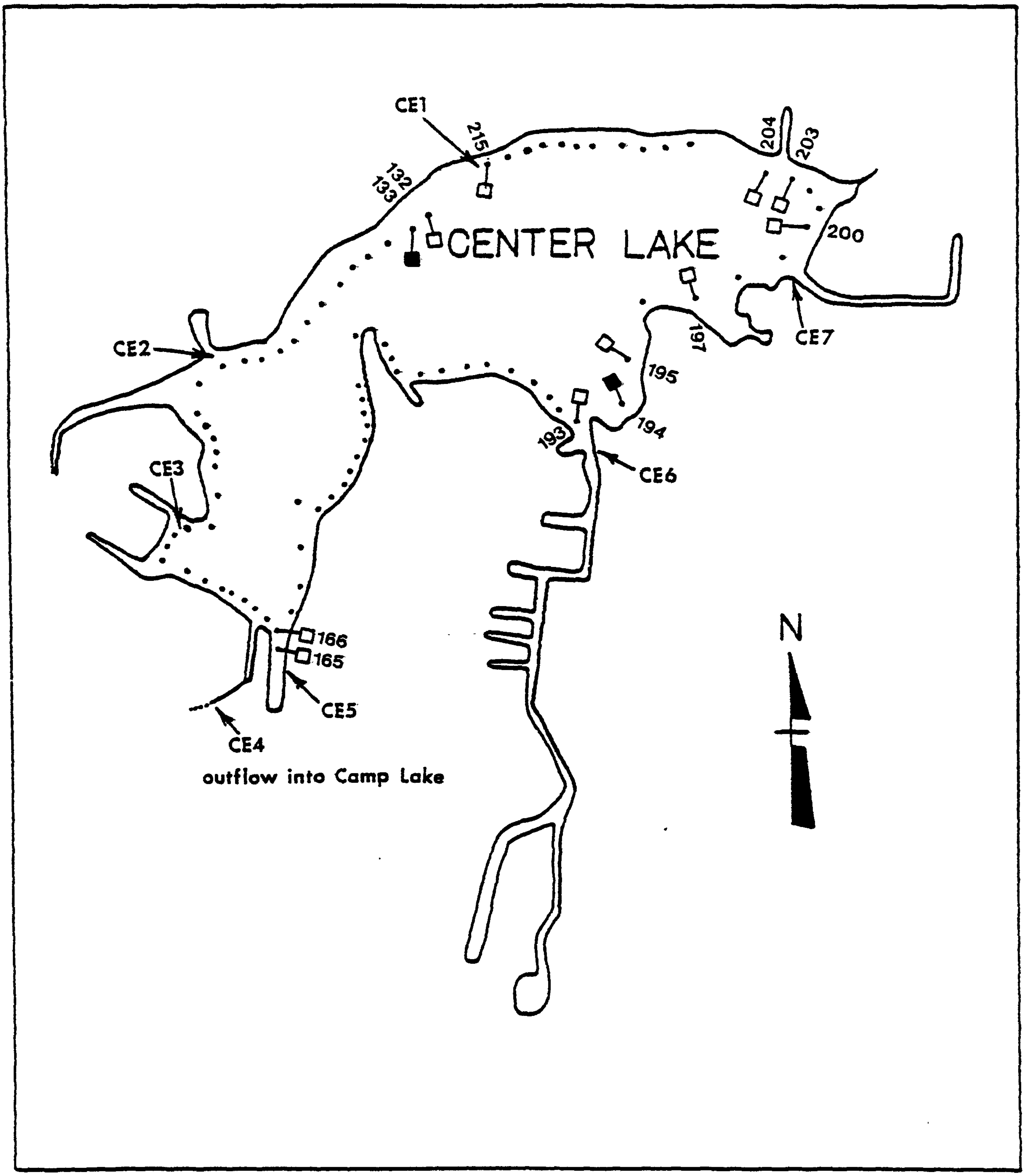


Figure 6. Sampling locations, plumes, and bacterial sample locations on Center Lake.

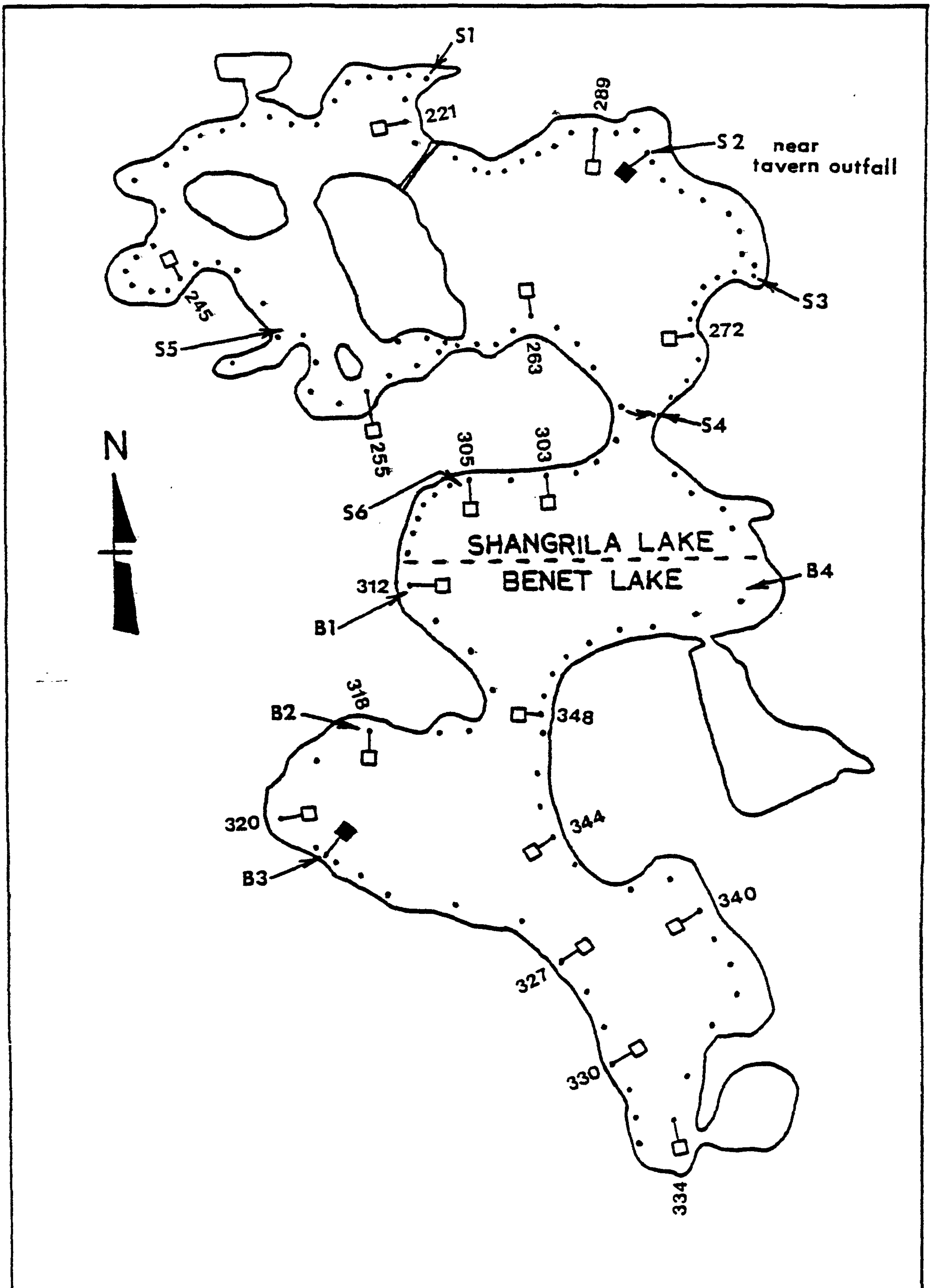


Figure 7. Sampling locations, plumes, and bacterial sample locations on Shangrila/Benet Lake.

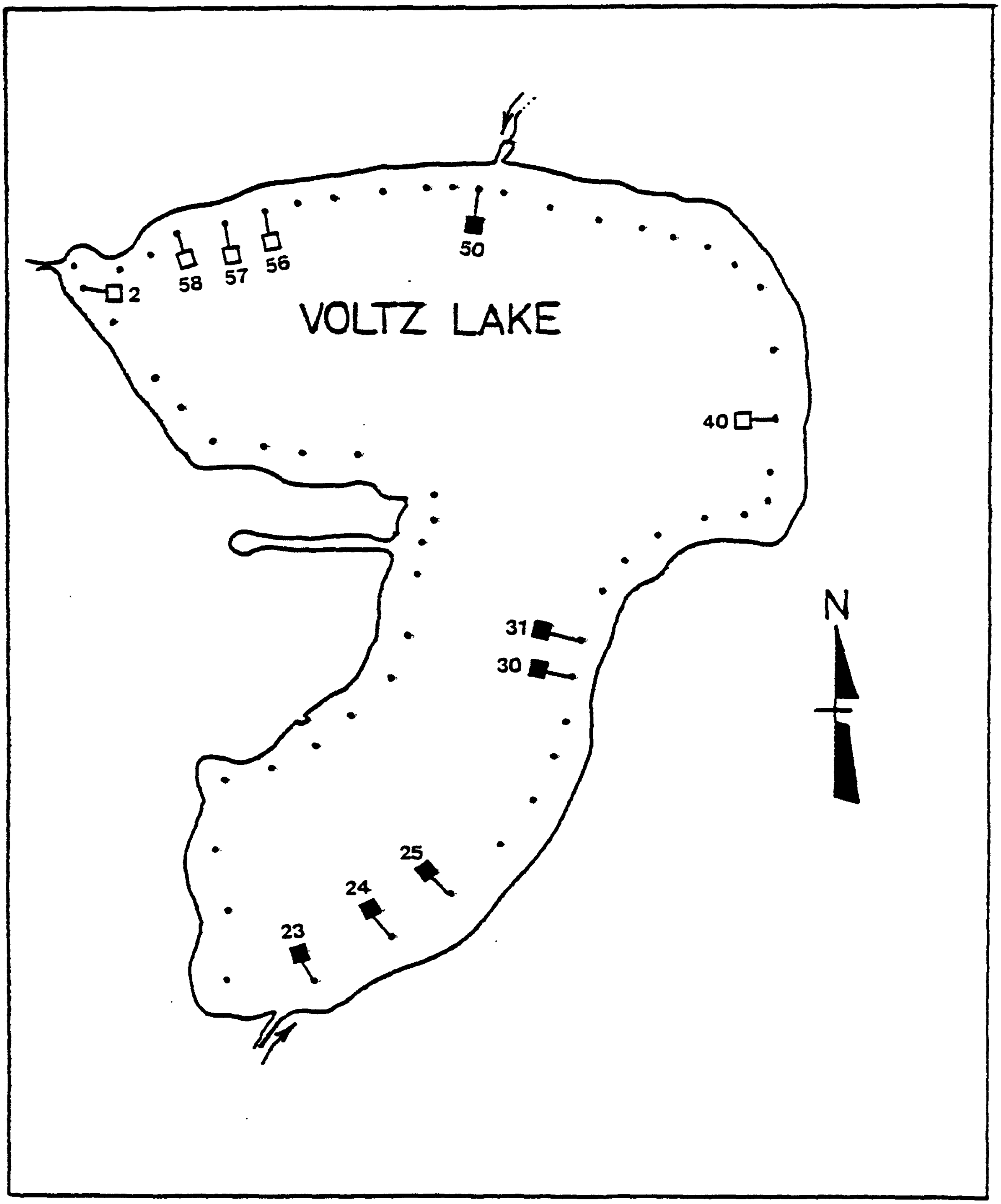


Figure 8. Sampling locations, plumes, and bacterial sample locations on Voltz Lake.

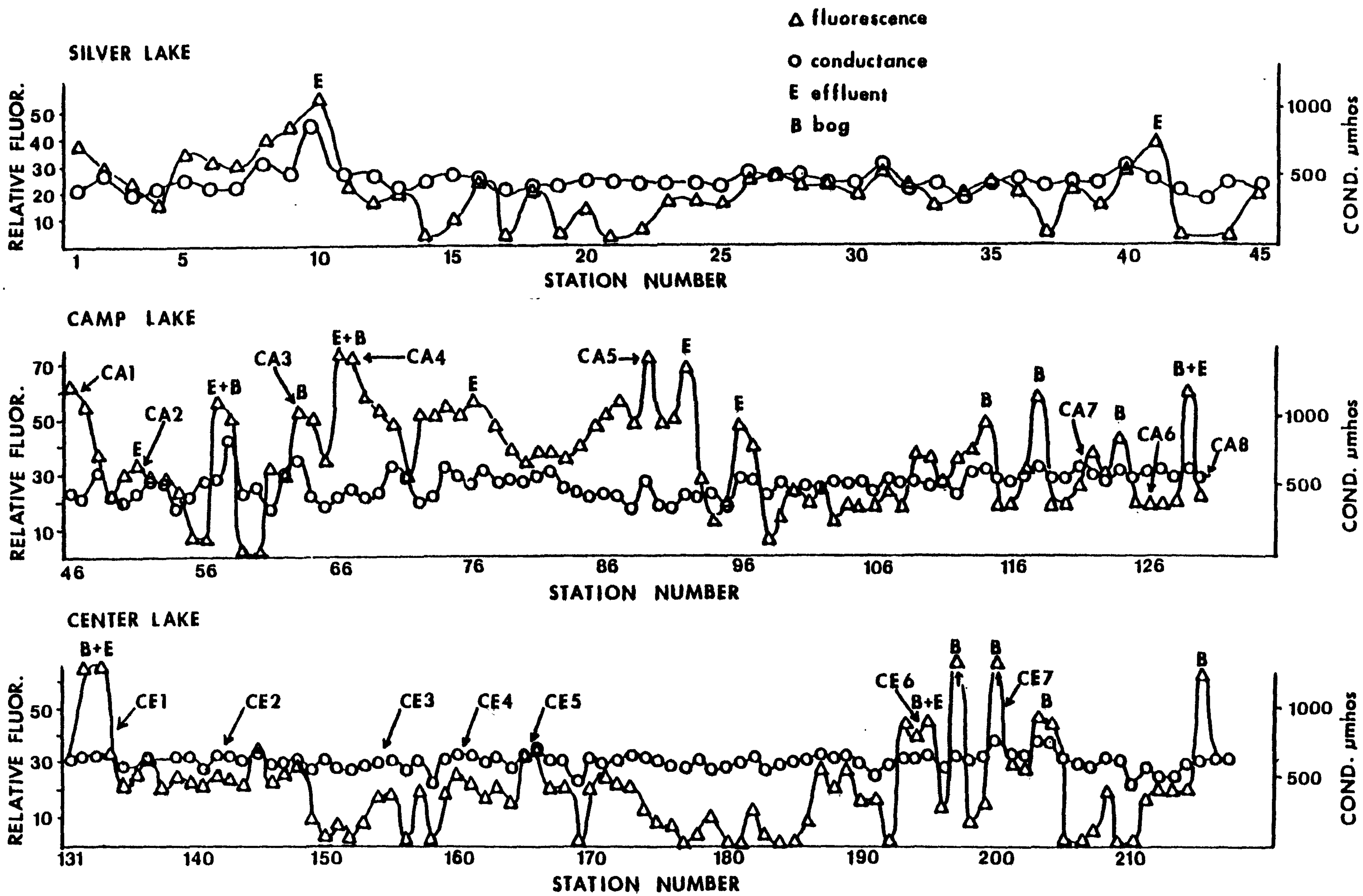


Figure 9. Profiles of fluorescence ... water samples taken from ...

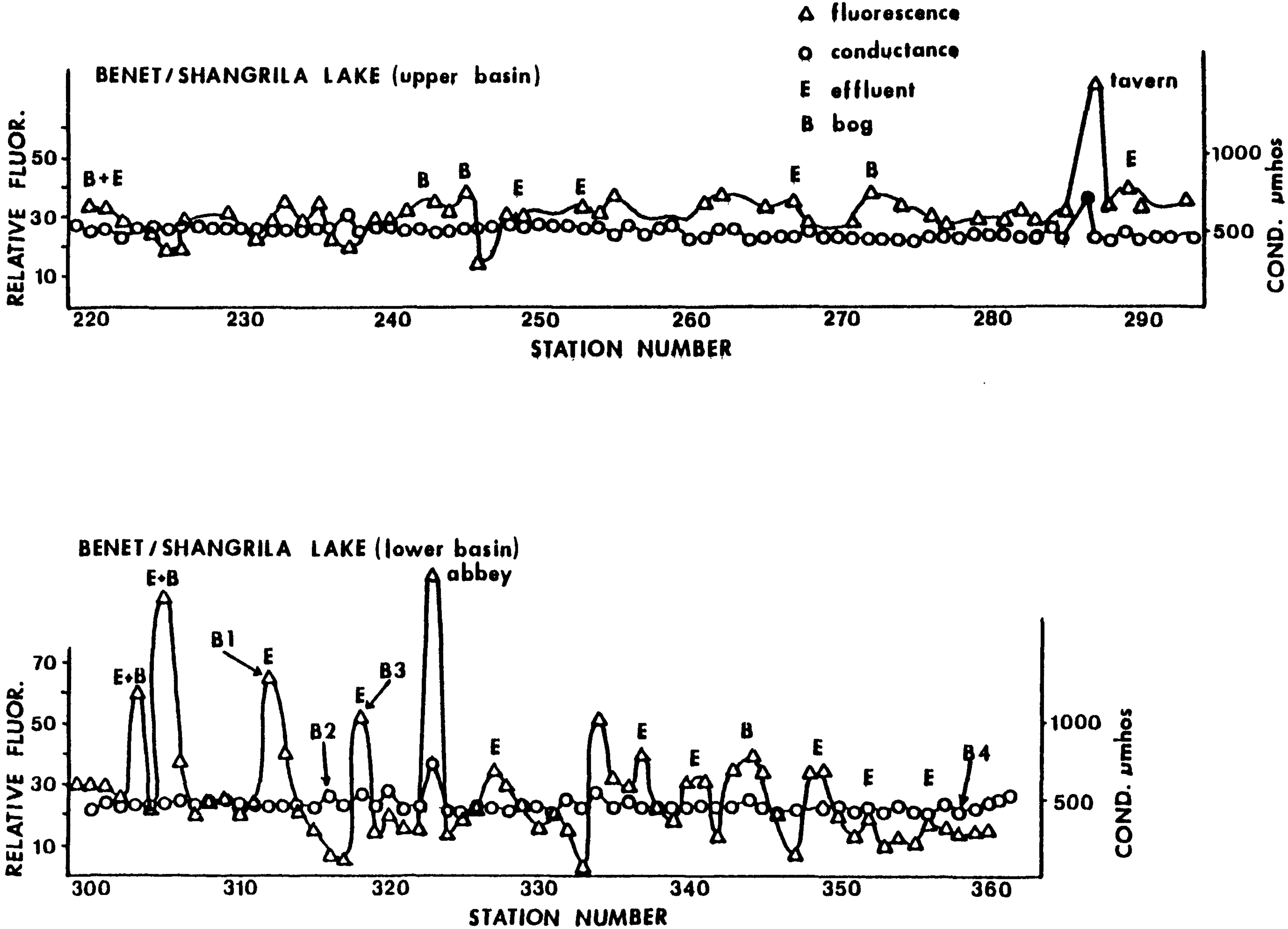


Figure 9. (continued)

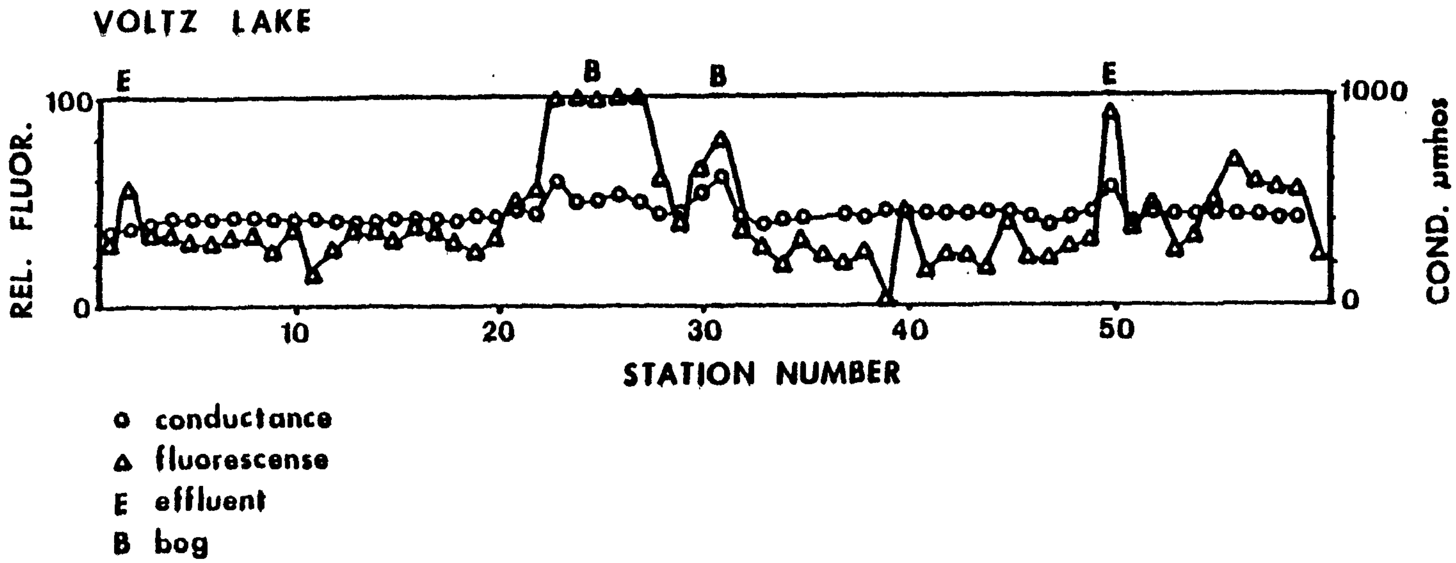


Figure 9. (continued)

4.0 NUTRIENT ANALYSES

Completed analyses of the chemical content of 81 samples taken along the Salem Lakes shorelines are presented in Table 1. The sample letters refer to the locations given in Figure 4. The symbol "S" refers to surface water sample and the symbol "G" to groundwater sample. Practically all groundwater samples represent high vacuum withdrawals from tight mucky bottom sediments and not free flowing intruding waters.

The conductivity of the water samples as conductance (μmhos/cm) is given in the second column. The nutrient analyses for orthophosphorus (PO_4-P), total phosphorus (TP), ammonium-nitrogen (NH_4-N), and nitrate-nitrogen (NO_3-N) are presented in the next four columns in parts-per-million (ppm - mg/l).

Table 1. Analysis of surface water (S) and groundwater (G) samples taken in the vicinity of wastewater plumes observed on the shorelines of Silver Lake, Camp Lake, Center Lake, Shangrila/Benet Lake, and Voltz Lake.

Sample Number		Cond.	Concentration (ppm - mg/l) PO_4-P	TP	NH_4-N	NO_3-N	ΔC	Ratio ΔTP	ΔTN	% Effl.	% of Expected Loading %P	%N	
Silver Lake (bkgd.		350	.005	.064	.350)								
4	S	442	.001	.022	.144	.315							
4	G	480	.006	3.100	.658	.073							
8	S	405	.002	.267	.196	.122							
9	G	572	.007	2.480	.892	.022							
10	S	562	.001	.109	.396	.031	222	.090	-	3%	64%		E
10	G	718	.006	5.890	.984	.022	[118	.00	.3	ns	30%]		
14	S	442	.001	.025	.146	.197							
14	G	543	.016	6.588	.581	.098							
19	S	382	.001	.025	.560	.011							
20	S	593	.002	.019	.654	.036							
21	S	355	.003	.019	.360	.045							
26	S	450	.002	.016	.090	.386							
28	S	475	.0003	.012	.076	.375							
29	S	494	.001	.012	.148	.357							
29	G	560	.011	6.975	.732	.013							
31	S	482	.002	.012	.174	.123							
31	G	530	.011	2.015	.561	.004							
41	S	322	.002	.009	.195	.069				.3%	ns	ns	E
45	G	535	.009	1.085	1.767	.004							
Gross house - well water			.006										

[ ] denotes calculation of % breakthrough for groundwater inflow of phosphorus (%P) and nitrogen (%.
ns = not significant for computation
E = effluent present in water sample as determined by fluorescent scanning
B = bog residue as determined by fluorescent scanning

Table 1. (continued)

Sample Number		Cond.	Concentration (ppm - mg/l) PO_4-P	TP	NH_4-N	NO_3-N	ΔC	Ratio ΔTP	ΔTN	% Effl.	% of Expected Loading %P	%N	
Camp Lake (bkgd,		350		.019		.320)							
46	S	575	.001	.093	.371	.059	225	.07	.11				B
46	G	530	.017	1.860	1.323	.008							
56	S	470	.027	.062	.682	.027	120	.04	.39				B
57	S	645	.025	.102	.767	.006	295	.08	.45	2%	89%	98%	E+B
59	S	560	.006	.087	.297	1.133	210	.07	1.11				B
63	S	445	.002	.059	1.033	.027	95	.04	.74				B
66	G	623	.004	1.240	1.074	.041							
71	S	385	.001	.012	.244	.118	ns						
71	G	640	.008	.276	5.222	.006							
76	S	580	.043	.112	.624	.028	230	.09	.33	4.7%	41%	31%	E
85	S	525	.006	.031	.465	.129	175	.01	.27				
89	S	535	.010	.028	.456	.210	185	.01	.35				
89	G	570	.011	.698	1.439	.032							
92	S	362	.002	.028	.708	.169	ns						
92	G	583	.002	1.783	1.204	.165							
94	S	464	.018	.130	.826	.188	114	.11	.69		16%	21%	
94	G	430	.019	.806	.451	.035							
98	S	480	.006	.037	.747	.153	130	.02	.58		3%	9%	
112	S	440	.010	.049	.110		90	.03					
114	S	615	.005	.040	.099		265	.02					
118	S	620	.004	.030	.120		270	.01					
120	S	530	.004	.160	.530		180	.14					
129	S	600	.011	.125	.092		250	.10		.8%	100%		E+]
East side canal	S	478	.007	.030	.417	.064	128	.01	.16	6.7%	3%	10%	E

Table 1. (continued)

Sample Number		Cond.	Concentration (ppm - mg/l) PO_4-P	TP	NH_4-N	NO_3-N	ΔC	Ratio ΔTP	ΔTN	% Effl.	% of Expected Loading %P	%N
Center Lake												
(bkgd.		560		.041								
131	S	610	.006	.049	.075							
132	S	640	.005	.490	.081							
133	G		.009	.110	.450							
134	G		.011	.120	.450							
145	S	660	.017	.041	.100							
145	G		.019	.052	.440							
149	S	560	.008	.041	.490							
150	S	595	.003	.040	.130							
169	S	490	.022	.068	.078							
169	G		.007	.041	.600							
187	S	615	.014	.060	.081							
187	G		.028	.071	.190							
193	S	640	.010	.049	.100		80	.01	ns			B+
193	G		.052	.105	.800							
197	S	650	.030	.060	.160		90	.02				B
197	G		.120	.380	.290							
200	S	640	.012	.160	.095		80	.12				B
200	G		.044	.082	.120							
213	S	595	.062	.041	.035							
215	S	625	.008	.100	.069		65	.06				B
216	S	625	.007	.071	.078							

Table 1. (continued)

Sample Number		Cond.	Concentration (ppm - mg/l) PO_4-P	TP	NH_4-N	NO_3-N	ΔC	Ratio ΔTP	ΔTN	% Effl.	% of Expected Loading %P	%N	
Shangrila/Benet Lake													
(bkgd.		350		.033	.53)								
221	S	450	.020	.048	.416	.237	100	.02	.12	3.1%	34%	17%	B+E
241	S	450	.024	.046	.981	.136	100	.03	.59		5%	21%	
253	S	390	.011	.033	.316	.223	ns						
253	G	590	.004	.122	1.869	.011							
268	S	400	.015	.031	.431	.232	ns						
274	G	550	.005	.029	8.008	.029							
276	S	584	.011	.031	.762	.232	234	.01	.46				B
282	S	420	.011	.031	.428	.221	ns						
286	G	1113	.003	.047	7.518	.014							
298	S	370	.005	.028	.710	.161	ns						
299	S	420	.011	.030	.818	.216	ns						
303	G	469	.027	.171	.020	2.268							
305	S	458	.011	.033	.398	.606	108	.01	.47	2.5%	8%	81%	B+E
305	G	580	.017	.037	7.406	.524							
316	G	385	.005	.034	3.059	1.76							
318	G	610	.024	.107	5.173	.736							
321	S	533	.009	.034	3.584	.134	183	.02	3.19	2.0%	22%	100%	E
323	G	410	-	.050	.034	1.492							
344	S	392	.019	.084	.619	.181	ns						
350	G	433	.005	.034	3.059	.101							
352	S	410	.007	.025	.729	.672	ns						
353	S	394	.013	.040	.868	.239	ns						
354	S	390	.009	.051	.615	.063	ns						
356	S	270	.003	.004	.680	1.673	ns						
356	G	560	.007	.038	4.620	.024							
357	S	420	.019	.055	.375	.658	70	.03	.50	ns			E
359	S	390	.010	.026	.442	.246	ns						
360	S	400	.008	.032	.833	.126	ns						
361	S	425	.015	.033	.323	.289	75	.01	.08	ns			E
Abbey	S	988	3.700	4.400	1.100		638	4.4	>.60	90%	99%	>3%	E
Tavern	S												

Table 1. (continued)

Sample Number	Cond.	Concentration (ppm - mg/l) PO_4-P	TP	NH_4-N	NO_3-N	C	Ratio TP	TN	% Effl.	% of Expected Loading %P	%N	
Voltz Lake (bkgd. S	425	.014	.045	.025)								
11	410	.029	.045	.025								
23	600	.020	.094	.039		175	.05					B
33	600	.028	.071	.025		175	.03		3.3%	20%		E
34	465	.010	.082	.120		40			ns			E
Salem Eff.	1130	4.232	4.821	2.398	2.526							
Silver Lake T.P. Eff.	1172	3.643	4.495	21.000	20.020							
Local Effluent						780	4.6	23				
Background (groundwater)	530		.017	.451	.035							
Dock wellwater			.010	.006	.360							

5.0 NUTRIENT RELATIONSHIPS

Two types of wastewater discharges were observed along the shoreline of the Salem Lakes: groundwater seepage and surface runoff. The two sources are treated differently in evaluating their loading contributions.

5.1 Groundwater Plumes

By the use of a few calculations, the characteristics of the wastewater plumes can be described. Firstly, a general groundwater background concentration for conductance and nutrients is determined. The concentration of nutrients found in the plume is then compared to the background and to wastewater effluent from the lake region to determine the percent breakthrough of phosphorus and nitrogen to the lake water. Because the well-point sampler does not always intercept the center of the plume, the nutrient content of the plume is always partially diluted by surrounding ambient background groundwater or seeping lake-water concentrations. To correct for the uncertainty of location of withdrawal of the groundwater plume sample, the nutrient concentrations above background values found with the groundwater plume are corrected to the assumed undiluted concentration anticipated in local standard sand-filtered effluent (assuming 100% of conductance should pass through) and then divided by the net nutrient content of raw effluent over municipal water. Computational formulae can be expressed:

for the difference between background (C_o) and observed (C_i) values:

$C_i - C_o = \Delta C_i$ conductance

$TP_i - TP_o = \Delta TP_i$ total phosphorus

$TN_i - TN_o = \Delta TN_i$ total nitrogen (here, sum of NO_3-N and NH_4-N)

for attenuation during soil passage:

$$100 \times \left(\frac{\Delta C_{ef}}{\Delta C_i}\right) \frac{\Delta TP}{TP_{ef}} = \%\ \text{breakthrough of phosphorus}$$

$$100 \times \left(\frac{\Delta C_{ef}}{\Delta C_i}\right) \frac{\Delta TN}{TN_{ef}} = \%\ \text{breakthrough of nitrogen}$$

where: C_o = conductance of background groundwater (μmhos/cm

C_i = conductance of observed plume groundwater (μmhos/cm)

ΔC_{ef} = conductance of sand-filtered effluent minus the background conductance of municipal source water (μmhos/cm)

TP_o = total phosphorus in background groundwater (ppm-mg/l)

TP_i = total phosphorus of observed plume groundwater (ppm-mg/l)

TP_{ef} = total phosphorus concentration of standard effluent

TN_o = total nitrogen content of background groundwater, here calculated as NO_3-N + NH_4-N

TN_i = total nitrogen content of observed plume groundwater, here calculated as NO_3-N + NH_4-N (ppm - mg/l)

TN_{ef} = total nitrogen content of standard effluent

5.2 Surface Runoff Plumes

A number of locations were found where surface runoff under the snow entered the shoreline lake waters. The inflow was treated similarly to stream inflow carrying wastewater loads. Each inflow rivulet carries a certain dissolved solids load possessing its own peculiar nutrient concentration of phosphorus (TP) and nitrogen (TN). The percent effluent was characterized in the surface water, based on a comparison with a Salem effluent standard. The fraction of phosphorus (TP) and nitrogen (TN) expected in a diluted sample of effluent with lake water was then compared to the background-corrected solids load and observed nutrient concentrations. The fraction of phosphorus and nitrogen accounted for by the observed dilution wastewater load is given as percent nutrient residual. If the amount of effluent-related nutrients is only a small percentage of the observed loading, other sources must be contributing, presumably due to road runoff, agricultural runoff, or other non-point sources.

The computational formulae can be expressed:

F_E = fluorescent units observed in water sample

F_B = fluorescent units corresponding to background lake surface water

F_S = fluorescent units corresponding to 100% standard effluent from nearby treatment plant

$\Delta F = \frac{F_E - F_B}{F_S}$ = fraction of effluent observed in shoreline water

$100 \times \Delta F = \% E_o$ = percentage of effluent observed in shoreline water for fraction of nutrients accounted for by effluent fraction:

$$100 \times \frac{\left(\frac{\Delta C_{ef}}{\Delta C_i}\right) \Delta TP}{\Delta F \cdot TP_{ef}}$$ = observed phosphorus as % of expected effluent fraction in shoreline water

$$100 \times \frac{\left(\frac{\Delta C_{ef}}{\Delta C_i}\right) \Delta TN}{\Delta F \cdot TP_{ef}}$$ = observed nitrogen as % of expected effluent fraction in shoreline water

5.3 Assumed Wastewater Characteristics

Local samples of effluent were obtained at the Salem sewage treatment plant and Silver Lake treatment plant near the study area. Whereas the conductance and phosphorus contents were comparable, the nitrogen content of the effluent samples varied greatly. A conductance : total phosphorus : total nitrogen ratio of 1130:4.6:23 was obtained. Subtracting the background lake water concentration of 350 μmhos/cm gives a $\Delta C:\Delta TP:\Delta TN$ ratio of 780:4.6:23 representing the change in concentration to source water by household use in the Salem Lakes study region.

6.0 COLIFORM LEVELS IN SURFACE WATERS

A series of water samples were analyzed at each lake for fecal coliform content to confirm the presence of surface runoff from malfunctioning systems. Previous field survey of the study region during December, 1977 documented malfunctioning on-site wastewater treatment systems (WAPORA, 1978). Water quality sampling from Center Lake has previously indicated a fairly high pollution hazard index based upon chemical concentrations of sodium, potassium, chloride, and sulfate, indicating effluent contributions (WDNR, 1969). Both Camp and Center Lakes were found to have bacterial levels in excess of that allowed by current Wisconsin water quality standards for recreation/fish and aquatic life. Wisconsin water quality standards specify that fecal coliform numbers not exceed a geometric mean of 200 organisms per 100 ml of water based upon five samples per month or 400 organisms per 100 ml of water in more than 10% of all samples during any month for recreational use and aquatic life.

While no detectable fecal coliform indicators were observed in samples from Silver Lake, the other water bodies of Camp Lake, Shangrila/Benet and Center Lakes exhibited fecal contamination. No bacterial sampling was performed on Voltz Lake since the survey was conducted during the weekend when samples could not be analyzed. The principal sources of bacterial contamination appeared to be outflow from canal regions, streams, outfall pipes, and snowmelt rivulets which drained into the lake under the ice. On Shangrila/Benet, two sampled outfall pipe locations showed considerable fecal bacteria content. The outflows originated from a tavern on the north side of Shangrila Lake and from the abbey on Benet Lake

Table 2. Bacterial Content of Shoreline Samples.

Water Body	Station	Coliform Content (#/100 ml) Fecal Coliform
Silver Lake	SI-1	<1
	SI-2	<1
	SI-3	<3
	SI-4	-
	SI-5	<1
Camp Lake	CA-1	1
	CA-2	360 (canal)
	CA-3	9
	CA-4	520 (stream)
	CA-5	<1
	CA-6	17
	CA-7	3
	CA-8	22
Center Lake	CE-1	<1
	CE-2	<1
	CE-3	<1
	CE-4	4
	CE-5	<1
	CE-6	12
	CE-7	<1
Shangrila/Benet	S-1	1
	S-2	110 (tavern)
	S-3	2
	S-4	3
	B-1	<1
	B-2	<2
	B-3	540 (abbey)
	B-4	<10

7.0 CONCLUSIONS

Deteriorating water quality due to sewage loading has previously been documented for Silver Lake (WDNR, 1968), Camp Lake (WDNR, 1969), Center Lake (WDNR, 1969), and Voltz Lake (WDNR, 1970). Analysis of selected ions (sodium, potassium, chloride, and sulfate) indicating pollution for domestic wastes have shown a fairly high hazard index for Center, Camp, and Voltz Lakes. Numerous incidents of malfunctioning septic units have been documented along the lake shorelines of Center and Camp Lakes (Terry, 1978; WAPORA, 1978). Fecal bacterial contamination has been found in samples from Silver Lake, Camp, Center, and Voltz Lakes (WAPORA, 1978).

The septic leachate survey confirmed the previously documente impacts of domestic wastewater on the lakes. Even though the survey was conducted during winter, sources of high fecal contamination could be located discharging into the lakes through canal drainage, surface runoff from snow melt, wetlands drainage, or outfall piping. Tight soils throughout the study region virtually eliminated groundwater inflows, except perhaps in Silver Lake. Analysis of the characteristics of the discharges revealed the following conclusions:

1. A substantial public health threat exists from the volume of septic discharges entering Camp and Center Lakes. Inflows containing waters as high as 6.7% effluent were observed with fecal coliform contents as high as 520 counts/100 ml.

2. A substantial portion (1/3) of the shoreline of Camp Lake was found to contain identifiable traces of effluent. The nutrient loadings from the runoff from the malfunctioning systems are sufficient to encourage development of emergent vegetation and to stimulate marshland development along shorelines.

3. The frequent coincidence of bog and effluent discharges, often with elevated nutrients, indicated that wastewater discharges were likely stimulating wetlands development along numerous areas of the shoreline of Camp, Center, Shangrilla, and Benet Lakes.

4. Wastewater discharges are infrequent along the southern shoreline of Silver Lake. The most noticeable discharge occurs in a shallow valley region which drains a series of dense residential structures. The intrusion probably occurs as groundwater inflow during dry periods and is combined with runoff during wet periods.

5. Outfall flows were observed at two locations along the shoreline of Shangrila/Benet Lakes. In both cases, even though some treatment of the wastewater apparently was occurring, fecal bacterial contamination was present and phosphorus concentrations equivalent to wastewater effluent or laundry wastes were observed.

STORET DATE 77/11/30

303001 2020AA303001
42 30 42.3 088 10 45.5 1
FOX (ILLINOIS) RIVER AT WILMOT
55059 WISCONSIN
UPPER MISSISSIPPI RIVER 071691
FOX (ILLINOIS)
21WIS 04001004
0006 CLASS 00

/TYPA/AMBNT/STREAM

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	188	12.3564	91.6424	9.57300	30.0000	.000000	61/04/20	76/12/28
00040	WIND	DIRECT	AZIMUTH	2	32.0000	18.0000	4.24264	35.0000	29.0000	75/01/02	75/04/30
00060	STREAM	FLOW	CFS	137	512.993	343878	586.411	3920.00	67.0000	61/04/20	73/08/29
00076	TURB	TRBIDMTR	HACH FTU	15	11.2533	89.1098	9.43980	35.0000	1.50000	75/01/29	76/12/28
00080	COLOR	PT-CO	UNITS	188	33.2021	210.474	14.5077	100.000	5.00000	61/04/20	76/12/28
00300	DO		MG/L	184	10.9793	8.67012	2.94451	21.5000	2.10000	61/04/20	76/12/28
00310	BOD	5 DAY	MG/L	181	5.04359	7.83969	2.79994	13.0000	.500000	61/04/20	76/12/28
00312	BOD	6 DAY	MG/L	5	6.96000	27.1630	5.21182	14.0000	2.40000	75/03/31	76/08/30
00400	PH		SU	183	8.20046	.161401	.401748	9.00000	7.00000	61/04/20	76/12/28
00402	INVALID	PAR	NUMBER	2	8.05000	.005142	.071709	8.10000	8.00000	75/01/02	75/04/30
00403	LAB	PH	SU	24	8.11666	.084101	.290002	8.60000	7.60000	75/01/29	76/12/28
00410	T ALK	CACO3	MG/L	188	246.101	1521.67	39.0086	373.000	134.000	61/04/20	76/12/28
00500	RESIDUE	TOTAL	MG/L	188	467.537	3190.33	56.4830	750.000	276.000	61/04/20	76/12/28
00530	RESIDUE	TOT NFLT	MG/L	188	40.3138	1065.90	32.6481	242.000	.000000	61/04/20	76/12/28
00535	RESIDUE	VOL NFLT	MG/L	186	13.2957	93.1608	9.65198	60.0000	.000000	61/04/20	76/12/28
00605	ORG N	N	MG/L	62	1.30612	.296995	.544972	2.86000	.130000	61/04/20	76/09/29
00610	NH3-N	TOTAL	MG/L	62	.233387	.053527	.231360	1.07000	.040000	61/04/20	76/09/29
00618	NO3-N	DISS	MG/L	58	1.04482	.661799	.813510	3.12000	.040000	61/04/20	75/12/29
00629	TOT ORG	KJELDL N	MG/L	1	1.30000			1.30000	1.30000	73/10/01	73/10/01
00631	NO2&NO3	N-DISS	MG/L	9	1.37333	.866852	.931049	3.00000	.420000	74/09/30	76/09/29
00665	PHOS-TOT		MG/L P	63	.409044	.049434	.222337	1.30000	.110000	61/04/20	76/09/29
00671	PHOS-DIS	ORTHO	MG/L P	8	.185500	.112000	.334665	1.00000	.005000	75/01/02	76/09/29
00900	TOT HARD	CACO3	MG/L	188	328.638	1989.73	44.6064	430.000	190.000	61/04/20	76/12/28
00940	CHLORIDE	CL	MG/L	188	30.3324	321.859	17.9404	140.000	3.00000	61/04/20	76/12/28
31613	FEC COLI	M-FCAGAR	/100ML	32	92.5000	33296.8	182.474	1000.00	10.0000	73/12/26	76/12/28
31616	FEC COLI	MFM-FCBR	/100ML	97	744.330	1297741	1139.18	4600.00	5.00000	65/07/23	73/11/28
31679	FECSTREP	MF M-ENT	/100ML	6	28.3333	576.667	24.0139	70.0000	10.0000	76/05/26	76/12/28

SEPTIC SYSTEM ANALYSIS - SALEM UTILITY DISTRICT NO. 2, WISCONSIN

An analysis was done in the Salem Utility District No. 2, Wisconsin Study Area to identify and locate individual home sewage disposal systems exhibiting signs of failure utilizing aerial imagery flown on May 5, 1978. The two types of film used in the aerial survey included normal color (Ektachrome 2448) and color infrared (Ektachrome 2443), flow at a scale of 1:10,000.

Failure of septic tank systems can usually be attributed to one or more of the following cases: 1) the soil used in the absorption field has too slow a percolation rate to allow for adequate assimilation, filtration, and biodegradation of sewage effluent flowing into it, 2) the septic system is installed too close to an underlying impervious layer, 3) the soil used in the adsorption field has too high a percolation rate for effective attentuation of sewage effluent prior to its reaching underlying groundwater, 4) mechanical malfunctions, or breakage, in the septic tank, distribution box, and/or drainage lines have occurred, 5) caustic, toxic, or otherwise harmful substances which could kill bacteria in the septic tank and/or absorption field, and cause subsequent clogging, have been flushed into the system, and 6) all or part of the system has been improperly installed. Other potential causes for on-lot disposal system malfunctions which are noticeable on the surface can be detected on aerial imagery. Those failures which are related to sewage backing up into the home, or too rapid transport through the soil into the groundwater cannot be detected via remote sensing. In instances where the latter is occurring, the use of a soil lysimeter or similar apparatus may be necessary to determine the existence of a problem.

Based upon work undertaken to date, it has been determined that the primary surface manifestations associated with failing septic tanks and/or absorption fields are: 1) conspicuously lush vegetation, 2) dead vegetation (specifically grass), 3) standing wastewater or seepage, and 4) dark soil where excess organic matter has accumulated. All of the above are a result of the upward movement of partially treated or untreated wastewater to the soil surface, and usually appear either directly above or adjacent to one or more components of the septic system (i.e., septic tank, distribution box, and/or absorption field). More often than not, two or more of these manifestations will occur simultaneously at any given homesite. In some cases, depending upon the soil's makeup of the particular area, the outline of the drainage line(s) of a properly functioning septic system can be distinguished on aerial photography. This peculiarity points up the need for tailoring "photo interpretation keys" to specific geographical areas.

Using the above signatures as photo interpretation keys, 125 homesites in the Study Area were chosen for ground inspection. Of these 42 were determined to have failing septic tanks or absorption fields at the time of the inspection, and 57 were judged to be marginally failing systems (see large-scale map). The marginally failing systems were those that exhibited signs of having failed in the past, or having the potential for malfunctioning during periods of excessive use or moderate to heavy rainfall.

The overestimation of suspect sites is attributed primarily to the similarity in signatures of failing septic systems and unrelated ground phenomena. This problem was especially apparent when analyzing the homesites immediately adjacent to water in the Study Area. Most of these homes are situated on sandy soil which exhibited a wide range of signatures (e.g. varying soil colors and tones, and "patchy" vegetative cover), thus making it difficult to discriminate between natural phenomena and septic tank system failures. Many "suspect" sites were identified around the lake in the photo analysis, but not many surface-related failures in this area were found in the subsequent ground inspection.

The high percentage of tree cover, particularly near the water, also presented problems during the photo analysis. It is possible that some failures may have been missed because they were obscured by foliage and/or shadows cast by trees and/or large shrubs.

Thus, based upon the photo analysis and the subsequent ground inspection, it was concluded that most, if not all, of the septic systems in the study area exhibiting surface failures were identified and located. Because of the difficulty experienced in detecting failures in sandy soils and under vegetation canopies, it is possible that some malfunctioning systems may not have been detected. As mentioned above, however, this assumption was not supported by findings of the ground inspection.

Source: Commonwealth of Pennsylvania, Department of Environmental Resources, Technical Manual for Sewage Enforcement Officers, May 1975.

RULES FOR REGULATING SEPTIC TANK SYSTEMS (EXCERPTS)

The Wisconsin Department of Health and Social Services has established rules for regulating septic tank systems in the Plumbing Code, Wisconsin Administrative Code, Chapters H61 and H62 (1976). The following clauses of Section H62.20 are of relevance:

- Soil maps. When a parcel of land consists entirely of soils having very severe of severe limitations for on-site liquid waste disposal as determined by use of a detailed soil map and interpretive data, that map and interpretive data may be used as a basis for denial for an on-site waste disposal system. Nevertheless, in all cases the property owner shall be permitted to present evidence consisting of soil percolation test data, bore hole data and topographic survey data to support the contention that a suitable site for an on-site liquid waste disposal system does exist.

- Septic tank location. No tank shall be located within 5 feet of any building or its appendage, 2 feet of any lot line, 10 feet of any cistern, 25 feet of any well, reservoir, below ground swimming pool or the high water mark of any lake, stream, pond or flowage. Note: Septic tanks should be located to provide accessibility for pumping and service vehicles.

- Soil absorption site. Location. The surface grade of all soil absorption disposal systems shall be located at a point lower than the surface grade of any nearby water well or reservoir on the same or adjoining property, except that when this is not possible, the site shall be so located that surface water drainage from the site is not directly toward a well or reservoir and will bypass the well or reservoir site by several feet. The soil absorption system shall be located not less than 5 feet from any lot line; 10 feet from a water service, or an uninhabited slab constructed building; 15 feet from an aboveground swimming pool; 25 feet from any occupied or habitable building or dwelling, building with below grade foundation, public water main, below grade swimming pool or cistern; 50 feet from any water well or reservoir and 50 feet from the high water mark of any lake, stream or other watercourse. Effluent disposal systems in compacted areas such as parking lots and driveways are prohibited. Surface waters shall be diverted away from the soil absorption site.

- Percolation rate—trench or bed. A subsurface soil absorption system of the trench or bed type shall not be installed where the percolation rate for any one of the 3 tests is slower than 60 minutes for water to fall one inch. The slowest percolation rate shall be used to determine the absorption area.

- Percolation rate--seepage pit. For a seepage pit, percolation tests shall be made in each stratum penetrated below the inlet pipe. Soil strate in which the percolation rates are slower than 30 minutes per inch shall not be included in computing the absorption area. The slowest percolation rate shall be used to determine the absorption area.

- Floodplain. A soil absorption system shall not be installed in a floodway. Soil absorption systems in areas considered floodplains excluding the floodway shall not be installed unless written approval is received from the department. The department shall receive written approval is received from the department. The department shall receive written local government approval for construction in and filling of the floodplain area prior to reviewing plans.

- Slope. The soil absorption system shall be constructed on that portion of the lot which does not exceed the slope here specified for the class. In addition, the soil absorption system shall be located at least 20 feet from the crown of any slope that is greater than the specified slope in its class.

Class of Slope	Minutes Required for Water to Fall One Inch	Slope
1	Under 3	20%
2	3 to 45	15%
3	45 to 60	10%

- Groundwater, bedrock or slowly permeable soils. Soil having a percolation rate of 60 minutes per inch or faster shall exist for at least 3 feet below the proposed bottom of the soil absorption system. There shall be at least 5 feet of soil over bedrock and above the high groundwater level.

APPENDIX D

BIOTA

DOMINANT SPECIES OF AQUATIC VEGETATION IN

SALEM UTILITY DISTRICT NO. 2

Lake	Scientific Name	Common Name	Growth Character	Extent in Basin
CAMP LAKE	*Ruppia maritima*	Widgeon grass	Submerged	Abundant to 13
	Nuphar advena	Yellow pond lily	Floating	Abundant scatte
	Myriophyllum sp.	Water milfold	Submerged	Common scattere
	Typha angustifolia	Narrow-leaf cattail	Emergent	Abundant, shore
	Potamogeton amplifolius	Large-leaf pondweed	Submerged-floating	Scattered patch
	P. crispus	Curly-leaf pondweed	Submerged	Common near sho
	Elodea sp.	Waterweed	Submerged	Common near sho
CENTER LAKE	*Chara* sp.	Chara	Submerged mats	Entire basin to 5 ft.
	Najas marina	Spiny Naiad	Submerged mats	Entire basin to 5 ft.
	Typha	Common Cattail	Emergent	Western shoreli
	Nymphaea	White water lily	Floating	Patches along shoreline
	Nuphar	Yellow water lily	Floating	Patches along shoreline
CROSS LAKE	*Ceratophyllum* sp.	Coontail	Submergent	Abundant in deeper water
	Chara sp.	Chara	Submergent	Abundant in shallow water
	Myriophyllum sp.	Water Milfoil	Submergent	Abundant in deeper water
	Nuphar sp.	Yellow water Lily	Floating	Abundant in SW corner

(cont'd.)

Lake	Scientific Name	Common Name	Growth Character	Extent in Basin
CROSS LAKE (Cont'd)	Nymphaea sp.	White water lily	Floating	Abundant SW corne
	Potamogeton illinoensis	Illinois pondweed	Sub-floating	Abundant entire basin
	P. pectinatus	Sago pondweed	Submergent	Abundant entire basin
	P. sp.	Broadleaf pondweed	Sub-floating	Abundant entire basin
	Scirpus validus	Bulrush	Emergent	Scattered entire shoreline
	Typha sp.	Cattail sp.	Emergent	SW corner-small stand
SILVER LAKE	Chara sp.	Muskgrass	Dense mats - submerged	Abundant 5-9 ft.
	P. pectinatus	Sago pond-weed	Submerged - silamentous	Abundant 8-12 ft
	Nitella sp.	Nitella	Submerged mats	Dense 12-15 ft.
	Vallisneria sp.	Eel grass	Submerged	Scattered 0-5 ft
	Najas marina	Spiny Naiad	Submerged mats	Common 9-15 ft.
	P. crispus	Curly-leaf pondweed	Submerged	Scattered, shall
VOLTZ LAKE	Potamogeton crispus	Curly-leaf pondweed	Submergent	Abundant in shal
	Elodea sp.	Elodea	Submergent	Dense in mats
	Ceratophyllum sp.	Coontail	Submergent	Dense mats
	Nymphaea sp.	White water lily	Floating	Abundant in shallows
	Typha latifolia	Common cattail	Emergent	Common along wet shores

(cont'd.)

Lake	Scientific Name	Common Name	Growth Character	Extent in Basin
BENET LAKE/LAKE SHANGRILA[1]	Ceratophyllum sp.	Coontail	Submergent	Unknown
	Typha	Common cattail	Emergent	Unknown
	Potamogeton pectinatus	Sago pond-weed	Submergent	Unknown
	P. crispus	Curly-leaf pondweed	Submergent	Unknown
	Myriophyllum Heterophyllum	Water milfoil	Submergent	Unknown
	Chara	Muskgrass	Submergent	Unknown
	Nuphar advena	Yellow pond lily	Floating	Unknown
	Limnea minor	Duck weed	Floating	Unknown
	Nymphaea tuverosa	White water lily	Floating	Unknown
PEAT LAKE	Nuphar	Yellow water lily	Floating	Unknown
	Nymphaea sp.	White water lily	Floating	Unknown
	Utricularia vulgaris	Common bladder-wort	Floating	Unknown
	Myriophyllum sp.	Water milfoil	Submergent	Unknown
	Potamogeton pectinatus	Pondweed	Submergent	Unknown
	P. illinoense	Illinois pond-weed	Sub-floating	Unknown
	Pontederia cordata	Pickeralweed	Emergent	Unknown
	Scirpus validus	Bulrush	Emergent	Abundant entir shoreline
ROCK[2] LAKE	Nymphaea sp.	White water lily	Floating	Unknown
	Myriophyllum sp	Water milfoil	Submergent	Unknown

(cont'd.)

Lake	Scientific Name	Common Name	Growth Character	Extent in Basin
ROCK LAKE (Cont'd)	*Elodea* sp.	Elodea	Submergent	Unknown
	Ceratophyllum sp.	Coontail	Submergent	Unknown
	Spirogyra	Algae	Submergent	Unknown
	Potamogeton crispus	Curly-leaf pondweed	Submergent	Unknown

SOURCE: WISCONSIN DEPARTMENT OF NATURAL RESOURCES (DNR), 1967.

1. Source: By telephone, Jeff Bode, Wisconsin DNR, September 11, 1978.

2. Source: Ron Piening, Wisconsin DNR, July 1977.

GAME, FOOD, AND ROUGH FISHES OF THE LAKES OF SALEM UTILITY DISTRICT NO. 2

GAME FISHES	ROCK	CROSS	CAMP	CENTER	BENET-SHANGRILA	VOLTZ	SILVER	PEAT
Rainbow Trout *(Salmo gairdneri)*	X[1]							
Brown Trout *(Salmo trutta)*	X[1]							
Rock Bass *(Ambloplites rupestris)*							X	
White Bass *(Morone chrysops)*			X	X	X		X	
Largemouth Bass *(Micropterus salmoides)*	X	X[3]	X	X	X	X	X	
Smallmouth Bass *(Micropterus dolomieui)*							X	
Warmouth *(Lepomis gulosus)*		X	X	X	X		X	
Channel Catfish *(Ictalurus punctatus)*			X		X	X	X	
Black Bullhead *(Ictalurus melas)*	X		X	X			X	
Brown Bullhead *(Ictalurus nebulosus)*			X	X		X	X	
Yellow Bullhead *(Ictalurus natalis)*		X	X	X		X		
Grass Pickerel *(Esox americanus vermiculatus)*	X	X	X	X	X		X	
Northern Pike *(Esox lucius)*		X[3]	X	X	X[2,3]	X	X[2]	

GAME FISHES (Cont'd.)	ROCK	CROSS	CAMP	CENTER	BENET-SHANGRILA	VOLTZ	SILVER	PEAT
Yellow Perch *(Perca flavescens)*	X		X	X	X	X	X	
Walleye *(Stizostedion vitreum)*			X[2]	X			X[2]	
Bluegill *(Lepomis macrochirus)*	X	X	X	X[1]	X	X	X	
Pumpkinseed *(Lepomis gibbosus)*	X	X	X	X	X	X	X	
Green Sunfish *(Lepomis cyanellus)*				X	X		X	
Black Crappie *(Pomoxis nigromaculatus)*	X		X	X	X[3]	X	X	
White Crappie *(Pomoxis annularis)*	X			X				
FOOD FISHES (MINNOWS)								
Golden Shiner *(Notemigonus crysoleucas)*			X	X			X	
Emerald Shiner *(Notropis atherinoides)*		X		X				
Blackchinned Shiner *(Notropis heterodon)*			X				X	
Common Shiner *(Notropis cornutus)*			X					
Blacknose Shiner *(Notropis heterolepis)*	X	X	X				X	
Pugnose Shiner *(Notropis anogenus)*							X[E]	

FOOD FISHES (MINNOWS) (Cont'd.)	ROCK	CROSS	CAMP	CENTER	BENET-SHANGRILA	VOLTZ	SILVER	PEAT
Mimic Shiner *(Notropis volucellus)*							X	
Mud Minnow *(Umbra limi)*							X	
Bluntnose Minnow *(Pimephales notatus)*	X			X	X		X	
Pugnose Minnow *(Notropis emiliae)*			X[W]					
Fathead Minnow *(Pimephales promelas)*					X			
Johnny Darter *(Etheostoma nigrum)*			X				X	
Fantail Darter *(Etheostoma flabellare)*							X	
Logperch *(Percina caprodes)*							X	
Banded Killifish *(Fundulus diaphanus)*			X				X	
Lake Chubsucker *(Erimyzon sucetta)*	X[W]		X[W]	X[W]		X[W]	X[W]	
Brook Silversides *(Labidesthes sicculus)*			X	X	X		X	
ROUGH FISHES								
Carp *(Cyprinus carpio)*	X	X	X	X		X	X	X
Long-nosed Gar *(Lepisosteus osseus)*			X	X	X		X	

ROUGH FISHES (Cont'd.)	ROCK	CROSS	CAMP	CENTER	BENET-SHANGRILA	VOLTZ	SILVER	PEAT
Bowfin *(Amia calva)*	X		X	X			X	
White Sucker *(Catostomus commersoni)*	X		X	X				

X - Present

W - "Watch status"

E - Endangered status

1 - Stocked annually

2 - Stocked occasionaly by DNR (in the past)

3 - Stocked privately by permit (in the past)

NOTE: All blank spaces indicate N/A (not applicable).

SOURCE: By letter, ron Piening, Wisconsin DNR, February 10, 1978.
By telephone, Mr. Tills, Wisconsin DNR, June 21, 1978.

1. According to the 1978 Wisconsin Fishing Regulations, a gamefish is defined as any fish that is not categorized as a rough fish (by telephone, Don Tills, Wisconsin DNR, June 21, 1978).

2. Those species not prized for game purposes or for eating (gars, suckers, etc.). Many are more tolerant of changing environmental conditions than game species.

Scientific Area No. 106

APPENDIX D-3
Wisconsin Scientific Areas Preservation Council
Scientific or Natural Area Report

Name of Area Peat Lake Inspection Date Spring, 1974

County Kenosha Twsp. 1N Range 20E Sections 32

Boundaries and acreage of proposed or established area and buffer: S 1/2 E 1/2 E 1/2 SW 1/4, (20 acres); W 1/2 SE 1/4 SW 1/4, (20 acres); NE 1/4 SW 1/4, (39 acres); W 1/2 SE 1/4 and part of NE 1/4 SE 1/4, (92 acres). Total acreage: 171 acres, including buffer. See map on reverse for area of buffer zone, labelled "Zone B."

Access to area: Access across private land from C.T.H. "B" through Gauger farm on west side of area - permission required. A legal easement also makes access possible through Illinois. Primitive boardwalk to the lake edge is located on the west side.

Description of area: Outstanding features, primary and secondary biotic communities, dominants, understory and rare species, topography, soils, geology and archeology.

Peat Lake is a shallow, somewhat alkaline lake with about 12 acres of open water and has no development. The lake is situated in the ground moraine and contains a wide belt of sedge meadow and cattail marsh. Among the few undeveloped lakes in Kenosha County isolated from roads and houses, this area is a nesting and feeding refuge for rails, redwings, wrens, teal, great blue herons and various ducks. Bullfrogs are known to inhabit the lake. Carp exist in the lake and may be a factor in the paucity of submerged aquatic plants found. Still, the lake contains yellow and white water lilies, common bladderwort (Utricularia vulgaris), water milfoil (Myriophyllum), pondweeds (Potamogeton pectinatus, P. illinoense, etc.) and pickerel weed (Pontederia cordata). Cattail and soft-stem bulrush (Scirpus validus) predominate the shoreline. The lake bottom is deep muck with occasional marl mounds; reported greatest depth is 5 feet.

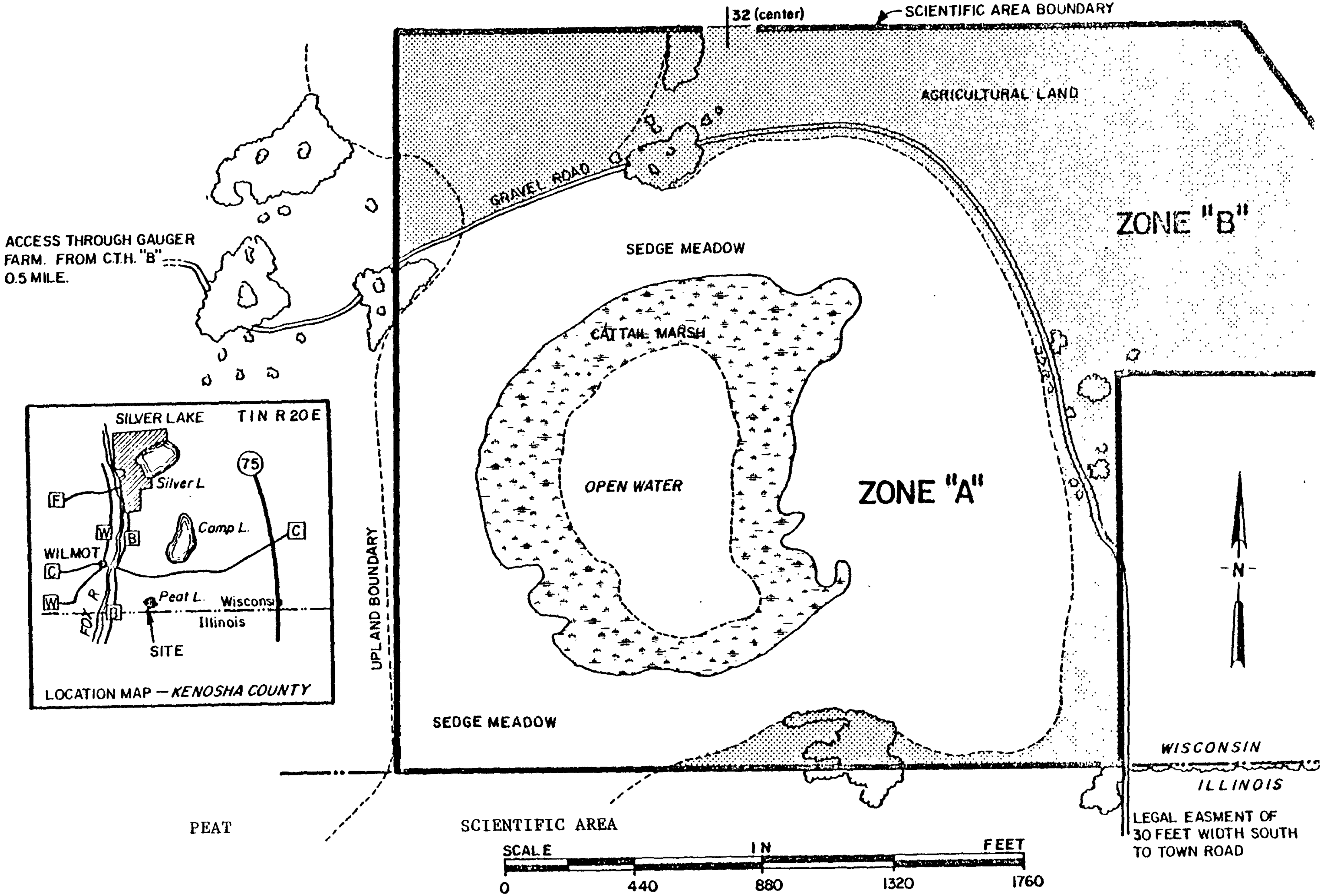
History of land use and limiting factors: Lands around the lake including the sedge meadow margins have been grazed through 1972. One duck blind is located on the lake. A gravel road runs across the north side of the lake into the sedge meadow.

Administrative information: Landowner and administrator, existing and proposed management, degree of scientific, educational and recreational use of area, adjacent lands and compatibility. Managed by the Bureau of Game Management as a wildlife area deeded to the DNR for scientific, educational and aesthetic use; closed to hunting by administrative order. Originally a gift by the James R. Anderson family to the Nature Conservancy, subsequently deeded to the DNR with reverter provisions. Management of "Zone A" (see map: primary scientific area) is to be minimum management area to allow natural processes. "Zone B" management may utilize standard wildlife management techniques to enhance habitat.

Reference information: person recommending area, references, quadrangle and other publications and date of action taken toward designation of area. Recommended by Al Krampert, The Nature Conservancy project leader for this area. See "Surface Water Resources of Kenosha County" DNR, 1961. Quadrangle: Silver Lake 7.5' (1971 photorevised). Gift from Anderson family to The Nature Conservancy, December, 1972; The Nature Conservancy transfer to DNR, March, 1973; designated state scientific area #106, May 11, 1973.

Report by: Robert H. Read Date: December 2, 1974

7/74



PEAT SCIENTIFIC AREA

APPENDIX D-4

Birds Found in Kenosha County and the Salem Area, Wisconsin

Common loon
Pied-billed grebe*
Canada goose
Mallard*
Pintail
Gadwall
American wigeon
Northern shoveller
Blue-winged teal*
Wood duck*
Canvasback
Ring-necked duck
Greater scaup
Ruddy duck
Common merganser
Marsh hawk*
Red-tailed hawk*
Broad-winged hawk*
American kestrel*
Ferruginous
Hungarian partridge*
Ring-necked pheasant*
Great blue heron*
Green heron*
Least bittern*
Virginia rail
Sora
Common gallinule
American coot*

Black-bellied plover
Piping plover
Killdeer
Upland sandpiper*
Lesser yellowlegs
Solitary sandpiper
Spotted sandpiper
Ruddy turnstone
Dunlin
Sanderling
Least sandpiper
American woodcock*
Common snipe*
Herring gull
Ring-billed gull
Bonaparte's gull
Common tern
Forster's tern
Caspian tern
Black tern
Rock dove
Mourning dove
Black-billed cuckoo
Screech owl*
Great horned owl*
Common nighthawk
Chimney swift
Ruby-throated hummingbird

Monk parakeet
Belted kingfisher*
Common flicker*
Red-bellied woodpecker
Red-headed woodpecker
Hairy woodpecker
Downy woodpecker
Eastern kingbird
Great-crested flycatcher
Eastern phoebe
Yellow-bellied flycatcher
Willow flycatcher
Least flycatcher
Eastern pewee
Horned lark*
Barn swallow*
Cliff swallow
Tree swallow
Bank swallow
Rough-winged swallow
Purple martin
Blue jay*
Common crow*
Black-capped chickadee
White-breasted nuthatch
Red-breasted nuthatch
House wren
Bewick's wren
Long-billed marsh wren*
Gray catbird*
Brown thrasher*
American robin*
Wood thrush
Hermit thrush
Swainson's thrush
Gray-cheecked thrush
Veery
Eastern bluebird*
Blue-gray gnatcatcher
Golden-crowned kinglet
Ruby-crowned kinglet
Cedar waxwing*
Loggerhead shrike
Starling*
Yellow-throated vireo
Red-eyed vireo
Philadelphia vireo
Solitary vireo
Warbling vireo
Black-and-white warbler
Golden-winged warbler
Blue-winged warbler
Tennessee warbler
Orange-crowned warbler
Nashville warbler
Northern parula
Yellow warbler
Magnolia warbler
Cape May warbler
Yellow-rumped warbler
Black-throated green warbler
Cerulean warbler

Blackburnian warbler
Chestnut-sided warbler
Bay-breasted warbler
Blackpoll warbler
Pine warbler
Palm warbler
Ovenbird
Northern waterthrush
Yellowthroat*
Connecticut warbler
Wilson's warbler
Canada warbler
American redstart
House sparrow
Bobolink*
Eastern meadowlark*
Yellow-headed blackbird
Red-winged blackbird
Rusty blackbird
Common grackle*
Brown-headed cowbird*
Orchard oriole
Northern oriole
Brewer's oriole
Scarlet tanager
Cardinal*
Rose-breasted grosbeak*
Indigo bunting
Purple finch
American goldfinch*
Rufous-sided towhee
Savannah sparrow*
Grasshopper sparrow
Vesper sparrow
Lark sparrow
Tree sparrow
Chipping sparrow*
Field sparrow
White-crowned sparrow
White-throated sparrow
Fox sparrow*
Lincoln's sparrow
Swamp sparrow
Song sparrow

* Birds found in the area of Salem Utility District No. 2. (Source: By telephone, Don Reed, SEWRPC, May 1, 1978).

SOURCE: Hoy Nature Club, Inc. May Bird Counts in Kenosha County. May 14, 1977.

APPENDIX D-4

LIST OF MAMMALS IN THE SALEM AREA

COMMON NAME	SCIENTIFIC NAME
Virginia opossum	Didelphis virginiana
Short-tailed shrew	Blarina brevicauda
Eastern mole	Scalopus aquaticus
Eastern cottontail	Sylvilagus floridanus
Eastern chipmunk	Tamuas striatus
Woodchuck	Marmota monax
Thirteen-lined ground squirrel	Spermophilus tridecemlineatus
Franklin's ground squirrel	Spermophilus franklinii
Gray squirrel	Sciurus carolinensis
Fox squirrel	Sciurus niger
White-footed mouse	Peromyscus levcopus
Meadow vole	Microtus pennsylvanicus
Muskrat	Ondatra zibethicus
Norway rat	Rattus norvegicus
House mouse	Mus musculus
Coyote	Canis latrans
Red fox	Vulpes vulpes
Gray fox	Vrocyon cinereoargenteus
Raccoon	Rocyon lotor
Long-tailed weasel	Mustela frenata
Mink	Mustila vison
Badger	Taxidea taxus
Striped skunk	Mephitis mephitis
White-tailed deer	Odocoileus virginianus

Source: Burt and Grossenheider, 1964.

APPENDIX E

POPULATION PROJECTION METHODOLOGY

APPENDIX E

METHODOLOGY FOR PROJECTING PROPOSED EIS SERVICE AREA
PERMANENT AND SEASONAL POPULATIONS, 1975 and 2000

1975 Population Estimate

The 1975 population estimate for the Salem EIS Service Area was based on an analysis of aerial photography, an examination of property tax rolls for the District, and an extensive telephone survey of local post offices and other locally knowledgeable information sources (SEWRPC, Jensen and Johnson, Inc., local utilities, realtors, business establishments). The following information was obtained from these analyses and surveys:

- Dwelling unit count by subarea and by segments (see Figure E-1 and Table E-1)
- Permanent and seasonal resident percentage breakdowns (see Table E-2)
- Permanent and seasonal dwelling unit occupancy rates (persons per household) (see Table E-2).

Table E-1 presents the results of the dwelling unit count with the permanent and seasonal resident percentage breakdowns applied to them. Table E-2 indicates the permanent/seasonal percentage breakdowns as well as the occupancy rates. Based on these figures, a seasonal and permanent population total for 1975 was derived by multiplying the seasonal and permanent dwelling units for each segment by their respective occupancy rates. The totals, by segment, were then summed for each subarea. Table E-3 indicates the 1975 permanent and seasonal populations by subarea.

An additional population consideration for the Proposed Service Area was Camp Wonderland and Silver Lake Park. These two areas were singled out because of their size and their small permanent and large seasonal populations. These factors prevented their being analyzed by the method used for the other segments. As a result, discussions with the representatives of the Camp and the Park were held to determine existing and future levels of permanent and seasonal populations. Table E-3 summarizes the 1975 population levels for these two areas. These estimates were added to Camp Lake and Center Lake subarea to develop the total in-summer population for the proposed Service Area as indicated in Table E-3.

2000 Population Projections

The year 2000 permanent and seasonal baseline population projections considered the three growth factors influencing future population levels in the Salem Proposed Service Area: (1) the rate of growth or decline of the permanent population; (2) the rate of growth or decline of the seasonal population; and (3) the potential conversion of seasonal to permanent dwelling units. The best available information regarding each of these factors was utilized and resulted in the following assumptions:

- The rate of permanent population growth in each of the Salem EIS Service Area subareas will be equivalent to the rate of growth indicated by the SEWRPC population projections. These rates are 28.6% for Camp Lake/Center Lake, 50.0% for Cross Lake, 116.7% for Rock Lake, and 60.0% for Wilmot.

- Existing seasonal dwelling units will convert to permanent dwelling units at a rate of approximately 1.0% per year or 20.0% during the planning period.

- The total seasonal population will remain relatively stable in size, with new seasonal units largely replacing those lost to conversion. The percentage of total population represented by seasonal population will decline by approximately 25% during the planning period in keeping with the general trend toward a decreasing seasonal population.

Based on these assumptions, the population projections and dwelling unit equivalents for the year 2000 were developed for each subarea as indicated in Table E-4. As in the 1975 population estimates, the population figures for Camp Wonderland and Silver Lake Park were added to the Camp Lake/Center Lake subarea. As indicated in Table E-4, Camp Wonderland remained stable while Silver Lake Park representatives projected an average visitor rate of 800 people per day and no permanent staff at the Park. The resultant total in-summer population for the Proposed Service Area is projected to be 10,925 people consisting of 7,913 (72.4%) permanent residents and 3,012 (27.6%) seasonal residents.

Comparison of EIS Populations with Previously Prepared Projections

The Facility Plan population total of 8,354 people is 11.6% higher than the WAPORA, Inc. estimate of 7,488 people. The Facility Plan estimate includes a 1975 Silver Lake Park population (whereas the Park was not in operation in 1975) and an overestimation of the population at Camp Wonderland (based on a comparison with the Camp Commandant's figures) which resulted in a highly inflated seasonal population total.

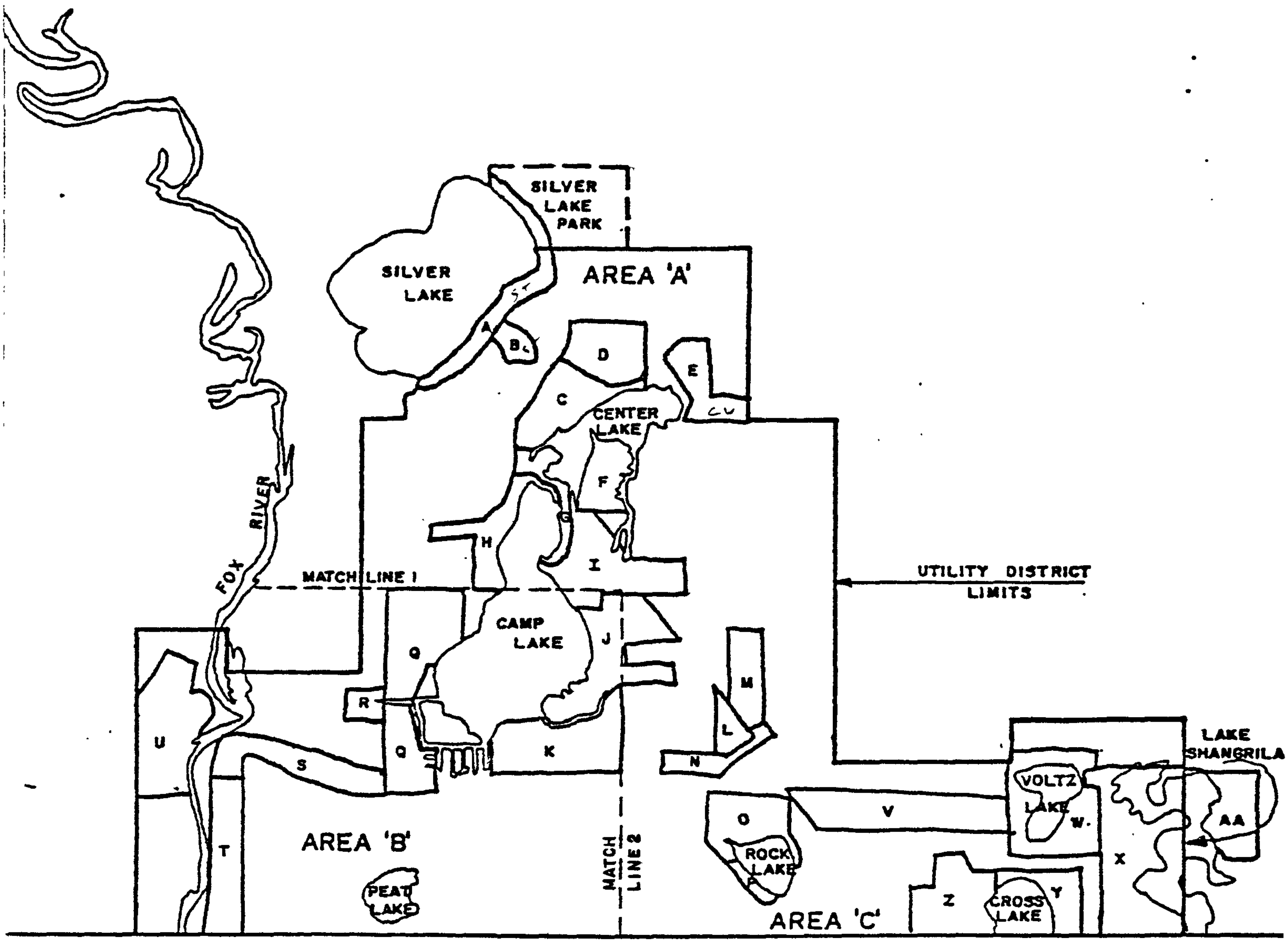
The SEWRPC permanent population estimate of 4,600 people differs by nearly 13% from the WAPORA, Inc. estimate of 5,276 people. The major reason for this difference is that the WAPORA estimate of the percentage of total population accounted for by seasonal residents in each of the four subareas yielded a much lower figure (30%) than that implied by the Facility Plan and SEWRPC numbers (45% to 50%). The WAPORA estimate of seasonal population is based on an extensive examination of the tax rolls and a survey of post offices, public utilities, local newspapers and resorts (see Table E-5) which allowed the use of subarea specific seasonal percentages and of seasonal permanent and seasonal occupancy rates common to all four subareas. Consequently, the WAPORA estimate of total seasonal population is based on locally documented information which does not support a 50% seasonal population figure.

Comparison of 2000 Population Projections

The SEWRPC rate of growth for permanent population in the four subareas was found to be indicative of future conditions and applied to the WAPORA 1975 population estimates. For the reasons noted above, the WAPORA estimate for 1975 was higher than the SEWRPC estimate of permanent population. When the same growth rates were applied to each estimate, the WAPORA, Inc. projection of permanent population in the year 2000 was nearly 15% higher than the SEWRPC projections.

The 27% difference between the Facility Plan and WAPORA, Inc. total population proejctions for 2000 results largely from the difference in seasonal population totals. Whereas the Facility Plan projects that 50% of the total population will be seasonal, WAPORA projects that only 27.6% of the total population will be seasonal residents. Table E-6 indicates the 1975 estimates and 2000 projections from each source.

FIGURE E-1



SALEM UTILITY DISTRICT
NUMBER 2
SEGMENT LOCATION MAP

SCALE : 1 = 62,500

Table E-1

EXISTING HOUSING ANALYSIS FOR SALEM UTILITY DISTRICT NO. 2
PROPOSED SEWER SERVICE AREA (1975)

Study Area Segment*	Segment Size (acres)	Total Number of Residences	Permanent Units	Seasonal Units	Gross Density of Segment (dwelling unit/acre)
A	127.7	34	27	7	.27
B	28.6	18	14	4	.63
C	141.1	94	71	23	.67
D	122.6	51	40	11	.42
E	105	56	43	13	.53
F	99.1	140	107	33	1.41
G	50	67	53	14	1.34
H	102.5	46	37	9	.45
I	155	118	89	29	.76
J	225.1	190	144	46	.84
K	202.9	199	151	48	.98
L	36.1	25	22	4	.69
M	90.7	9	8	1	.10
N	63.4	12	11	1	.19
O	100.4	127	107	20	1.26
P	25.6	19	16	3	.74
Q	273.4	103	78	25	.38
R	45.8	13	11	2	.28
S	121	15	12	3	.12
T	204.1	14	13	1	.07
U	167.15	129	125	4	.77
V	243.2	12	11	1	.05
W	263.3	46	40	6	.17
X	102.1	178	161	17	1.74
Y	90.3	48	43	5	.53
Z	168	149	132	17	.89
AA	105	81	70	11	.77
	Σ = 3459	Σ = 1993	Σ = 1635	Σ = 358	.58

*See Figure E-1 for delineation of Study Area segments.

Table E-2

OCCUPANCY RATES AND PERCENTAGE OF SEASONAL POPULATION
FOR THE PROPOSED SERVICE AREA (1975 and 2000)

	1975			2000		
	Population (% Seasonal)	Occupancy Rates		Population (% Seasonal)	Occupancy Rates	
		Permanent	Seasonal		Permanent	Seasonal
Camp/Center	30.0	3.2	4.5	15.0	3.0	4.0
Cross	15.0	3.2	4.5	7.5	3.0	4.0
Rock	20.0	3.2	4.5	10.0	3.0	4.0
Wilmot	5.0	3.2	4.5	5.0	3.0	4.0

SOURCE: From an examination of the Salem Township property tax rolls and discussion with knowledgeable local individuals.

Table E-3

POPULATION AND DWELLING UNIT EQUIVALENTS FOR THE TOTAL,
PERMANENT, AND SEASONAL POPULATION OF THE PROPOSED SALEM SERVICE AREA (1975)

	Population			Dwelling Unit Equivalents		
	Total	Permanent	Seasonal	Total	Permanent	Seasonal
Camp/Center Lakes	4,651	2,850	1,801	1,291	891	400
Camp Wonderland[1]	644	44	600	147	14	133
Silver Lake Park[1]	0	0	0	0	0	0
Cross Lake	1,719	1,462	257	514	457	57
Rock Lake	653	522	131	192	163	29
Wilmot	465	442	23	143	138	5
Salem Utility District No. 2	7,488	5,276	2,212	2,140	1,649	491

[1]Included in Camp/Center Lakes subarea total

NOTE: Camp/Center Lakes subarea includes segments A through K and Q through S.
Cross Lake subarea includes segments V through AA (1990, not 1975).
Rock Lake subarea includes segments L through P.
Wilmot subarea includes segments T and U.

Table E-4

POPULATION AND DWELLING UNIT EQUIVALENTS FOR THE TOTAL,
PERMANENT, AND SEASONAL POPULATION OF THE PROPOSED SALEM SERVICE AREA (2000)

	Population			Dwelling Unit Equivalents		
	Total	Permanent	Seasonal	Total	Permanent	Seasonal
Camp Lake/Center Lake	6,317	3,821	2,496	1,897	1,273	624
Camp Wonderland[1]	644	44	600	164	14	150
Silver Lake Park[1]	800	0	800	200	0	200
Cross Lake	2,516	2,232	284	815	744	71
Rock Lake	1,353	1,149	204	434	383	51
Wilmot	739	711	28	244	237	7
Salem Utility District No. 2	10,925	7,913	3,012	3,390	2,637	753

[1]Included in Camp Lake/Center Lake subarea total.

Table E-5

TELEPHONE CONTACTS CONCERNING THE RATIO OF SUMMER TO WINTER POPULATION IN SALEM UTILITY DISTRICT NO. 2

Agency Contacted	Date	Summary of Comments
Camp Lake Post Office	4/26/78	Located in the Camp Lake Cash & Carry Grocery; no deliveries, but boxes are rented; 7 or 8 more boxes rented in summer than in winter.
Antioch Post Office	4/27/78	Deliveries to S. shore, Rock Lake (about 20 houses) estimated 90% or higher are permanent residences. Deliveries to S. part of Shangrila, including the peninsula; Cross Lake, except the abbey; all of Voltz; and Rte. 83 up to Rte. JF. Estimated 90-95% or higher are permanent residences.
Trevor Post Office	4/27/78	774 mail deliveries in July; 650 in December (20% increase in summer population). These additional families stay from April to Nov. This route includes the S, E, & NE portions of Camp, all of Center, and N. shore of Rock Lake. Seasonal population (boarded-up homes) concentrated from Center Lake Woods & Camp Lake Gardens.
Bristol Post Office	4/27/78	Route includes Lake Shangrila Island, the NE shore of 120th St., and the NW shore to 224 Av. 95% are year-round, permanent residences; this is increasing.
Salem Post Office	4/24/78	The #3 route includes Timberlane subdivision, S. shore of Silver Lake, Hi Woods, Hooker Lake, Paddock Lake south of Rte. 50, Montgomery Lake, and the open areas between. Seasonal population range 15-25%
Wilmot Post Office	4/24/78	No rural delivery; boxes. Jurisdictional area extends from the landing strip to the Fox, but since Trevor's rural delivery only extends to Rte. B intersection with C, rest of residents cross the Fox to pick up their mail. The estimated 250 dwelling units are permanent, year-round dwellings.
Kenosha News	4/25/78	Rough estimate of the difference between permanent and seasonal is 20%.
Wilmot Stage Stop	4/25/78	Business almost constant all year; slight increase in summer.

APPENDIX F

LAKESHORE REGULATORY MEASURES

APPENDIX F

LAKESHORE REGULATORY MEASURES

The Wisconsin Shoreland Management Program requires counties to adopt shoreland management ordinances to control development along the shores of their streams and lakes. In addition, the ordinance requires a minimum building setback of 75 feet from the shores of all public lakes in the state. This applies to all lakes in the Study Area.

Kenosha County has adopted a Shoreland Zoning Ordinance, but has not yet adopted an official map. Until such time as a map is adopted, development around the lakes in Salem Utility District No. 2 will comply with the requirements of the State ordinance and with Salem Township's land division and zoning ordinances.

The Township of Salem Zoning Ordinance provides for the division of land uses into six districts. The shoreland along the eight lakes and the Fox River has been classified into three of these districts: Residential "B", Commercial, and Recreational (see Table 1). All eight lakes and the Fox River have shoreland classified as Residential "B". The Fox River and Center Lake also have some limited shoreland zoned for commercial use. In addition, the Fox River, Camp Lake, and Rock Lake have several major areas designated as Recreational Districts.

Table 1

ZONING DESIGNATIONS

Resource	District Designations
Fox River*	Residential "B", Commercial, Recreational
Silver Lake*	Residential "B"
Camp Lake	Residential "B", Recreational
Center Lake	Residential "B", Commerical
Rock Lake	Residential "B", Recreational
Cross Lake*	Residential "B"
Voltz Lake	Residential "B"
Benet/Shangrila Lake*	Residential "B"

*Only a portion of the resource is included in Salem Utility District No. 2.

SOURCE: Town of Salem Zoning Ordinance.

A Residential "B" District is defined as that area which is suitable for single and multiple dwelling residential purposes, but not serviced by public sewer. Over 75 percent of the shoreland along the lakes and river is classified for such use. Minimum lot sizes and corresponding maximum development densities established under provisions for this district are outlined in Table 2.

Table 2

RESIDENTIAL DEVELOPMENT RESTRICTIONS

	Minimum Lot Size	Maximum Development Density	Minimum Setback From Lakeshore
Single Family Housing	14,000 sq. ft.	3 dwellings	100 ft.
Multiple Family Housing	7,000 sq. ft. per unit	6 units	100 ft.

SOURCE: Town of Salem Zoning Ordinance.

A Commercial District is defined as that area allowing any use in which either services or merchandise are sold or offered for sale, except those uses apt to become public nuisances. No restrictions are placed on height, area, rear yard or side yard; but setbacks are restricted according to code.

A Recreational District is defined as that territory in or on which only the following uses are permitted: fishing, boating, water sports, hunting, and general recreation. No house, building or structure may be erected on this land, and any commercial enterprise such as buoy rental, house boats, camping, camps, gasoline pumps, or food sale, is prohibited.

APPENDIX G

SITES OF HISTORIC OR ARCHITECTURAL SIGNIFICANCE

APPENDIX G

Sites of Historic or Architectural Significance Within the Study Area Listed With the Wisconsin Inventory of Historic Places

Town 1 North, Range 20 East

Section 10, SW 1/4 of the SE 1/4--Frame Italianate house at the Northeast corner of 252nd Avenue and 83rd Place.

Section 10, SE 1/4--Frame house with carved ornament located at the Northwest corner of 251st Avenue and 83rd Place.

Section 16, NW 1/4--Late Picturesque house on Highway F.

Section 35, NE 1/4 of the NW 1/4--Frame Italianate house on County Trunk Highway "JF."

Section 36, SE 1/4 of the SW 1/4--Stone house (circa 1920) located in Cross Lake.

In the Village of Wilmot:

The Carey House (1898) on Fox River Road
The Wright House on Fox River Road
The Old Drug Store on Fox River Road
A house surrounding a log cabin on Fox River Road
A Victorian House at the Northeast corner of Fox River Road and 111th Street.
Salem Lodge I.O.O.F. (1878) located at the Northwest corner of Fox River Road and 114th Street.
The Wilmot Stage Stop (1848) located on Fox River Road and 113th Street.
The Sorenson Brothers Tailor Shop, also at Fox River Road and 113th Street.

SOURCE: State Historical Society of Wisconsin, 1977, Letter to WAPORA, Inc.

APPENDIX H

FLOW REDUCTION DEVICES AND FINANCING

RESIDENTIAL FLOW REDUCTION DEVICES

A variety of devices are available to control the consumption of water in residences. Some of these, especially some alternative toilets, also reduce the quantities of impurities discharged to wastewater facilities. These devices differ in cost and in effectiveness for reducing flows. Table 1 lists a number of these devices and, where sufficient data are available, their costs and water savings are listed. Water savings are expressed as daily conservation in gallons for a "standard household" of four persons using a total of 255 gallons per day without water conservation devices (Bailey et al. 1969). Nationwide, and especially in rural areas, per capita residential water use is lower than the 64 gallons per capita per day (gpcd) for the "standard household" so that daily household conservation estimates in Table 1 may be somewhat high.

Justification for use of flow reduction devices depends in part on the type of sewer service available. In areas provided or expected to be provided with centralized collection and treatment, the justification is primarily economic except where water supplies are limited. Two types of devices which yield the greatest reduction in sewage flow for their cost are:

- Dual-flush toilets in all new residences and in existing residences when replacement is required because existing toilets have worn out or plumbing systems require rehabilitation;

- Dual-flush toilets were developed in Britian where their use is mandatory in some areas. The capability of selecting different flush volumes depending on the type of waste plus a shallow trap seal result in considerable volume reduction. Compared to standard U.S. toilet flush volumes of 5 to 6 gallons and shallow-tray toilet flush volume of 3.5 gallons, the dual cycle toilet uses 2.5 gallons (U.S.) for the solid wastes cycle or 1.25 gallons for the urine cycle. Bailey et al. (1969) provide a more detailed discussion of this device and note "that this design may not meet the requirements of the plumbing codes in some U.S. localities." However, Bailey et al. also cite a source which states that "There would be no difficulty in designing a syphon closet, suitable for the American bottom outlet requirements, which will also work efficiently with a 2 gallon (Imperial; 2.5 gallons U.S.) flush."

- Flow restriction devices for shower heads and for kitchen and bathroom faucets. These flow restriction devices include both in-line valves which can be added to existing plumbing and replacement shower and faucet fixtures. Either allows a maximum flow rate that is considerably less than that allowed by standard shower heads and faucets.

The flow reduction estimated for use of these devices is 16 gpcd. Design flows in primarily residential sections of the Study Area can be reduced from 60 gpcd to 44 gpcd when these devices are used.

Table 1

FLOW REDUCTION AND COST DATA FOR RESIDENTIAL WATER-SAVING DEVICES

Device	Daily Conservation (gpd)	Daily Conservation (Hot Water) (gpd)	Capital Cost	Installation Cost	Useful Life (yrs.)	Average Annual O&M
Toilet modifications						
Water displacement device--plastic bottles, bricks, etc.	10	0	0	H-O[a]	15	0
Water damming device	30	0	3.25	H-O	20	0
Dual flush adaptor	25	0	4.00	H-O	10	0
Improved ballcock assembly	20	0	3.00	H-O	10	0
Alternative toilets						
Shallow trap toilet	30	0	80.00	55.20	20	0
Dual cycle toilet	60	0	95.00	55.20		0
Vacuum toilet	90	0				
Incinerator toilet	100	0				
Organic waste treatment system	100	0				
Recycle toilet	100	0				
Faucet modifications						
Aerator	2	1	1.50	H-O	15	0
Flow control device	4.8	2.4	3.00	H-O	15	0

Table 1
(Continued)

Device	Daily Conservation (gpd)	Daily Conservation (Hot Water) (gpd)	Capital Cost	Installation Cost	Useful Life (yrs.)	Average Annual O&M
Alternative faucets						
Flow control faucet	4.8	2.4	40.00	20.70		0
Spray tap faucet	7	3.5	56.50	20.70		0
Shower modifications						
Shower flow control insert device	19	14	2.00	H-O	15	0
Alternative shower equipment						
Flow control shower head	19	14	15.00	H-O or 13.80	15	0
Shower cutoff valve			2.00	H-O		0
Thermostatic mixing valve			62.00	13.80		0

[a] H-O = Homeowner-installed; cost assumed to be zero.

H

Some situations may require greater reductions in sewage generation. An example would be existing residences for which holding tanks are required because on-site soils are not suitable for subsurface wastewater disposal and centralized or other alternative disposal methods are not available. Also, where rehabilitation of existing on-lot systems may by itself be less than totally effective in remedying failures, heroic measures to reduce wastewater volume may be justified to improve the systems' effectiveness. In such instances, the per capita rate could be reduced to a range of 15 to 30 gpcd by combination of the following methods:

- Elimination of water-carried toilet wastes by use of in-house composting toilets.

- Recycling of bath and laundry wastewaters for toilet flushing. Filtering and disinfection of bath and laundry wastes for this purpose has been shown to be feasible and aesthetically acceptable in pilot studies (Cohen and Wallman 1974; McLaughlin 1968). This is an alternative to in-house composting toilets that could achieve the same level of wastewater flow reduction.

- Replacement of standard toilets with dual cycle or other low volume toilets to help assure that bath and laundry wastewater will meet toilet flushing demand.

- Application of surplus recycled bath and laundry wastewaters for lawn sprinkling in summer. The feasibility of this method would have to be evaluated on a trial basis in a Study Area, since its general applicability has not been demonstrated.

- Reduction of lavatory water usage by installation of spray tap faucets.

- Reduction of shower water usage by installation of thermostatic mixing valves along with flow controlling shower heads. Personal bathing habits should include maximum use of showers instead of baths because of a large difference in water consumption.

- Replacement of standard clothes washing machines with machines equipped for water level control or with front-loading machines.

The benefits of the flow and waste reduction devices listed in Table 1, when used with small scale technologies, are strongly dependent on local conditions of soil suitability for effluent disposal, housing density, groundwater conditions and family water consumption patterns. The reader should be aware that such devices are available and that they have the potential for improving the reliability and, perhaps, the economics of small waste flow technologies that are dependent on soil disposal.

The economic benefits of all residential flow reduction devices can also be examined from a broader perspective than just wastewater treatment economics. Actual acceptance and use of any of these devices will depend on the homeowner's motivations. His economic motivation for using flow reduction devices includes reductions in water supply and water heating costs in addition to wastewater treatment costs. Examined from the homeowner's economic perspective, many flow reduction devices, especially those that conserve heated water, are very attractive. To quantify possible annual homeowner savings for various devices, local costs for water supply and water heating plus expected wastewater treatment costs for the least expensive, centralized regional alternative evaluated in this EIS (see Section IV.D.) have been estimated. These costs are:

- Water Supply at $0.02 per 1,000 gallons for private, on-lot wells. Only the cost of electricity for pump operation is incorporated.
- Water Heating at $7.50 per 1,000 gallons heated.
- Electric water heater, temperature rise of 100°F and $0.03/kilowatt-hour are assumed.
- Wastewater Treatment at $2.23 per 1,000 gallons including payback of capital costs and operational costs of the least expensive centralized alternative.

Using these costs, data presented in Table 1, and assumptions about the "standard household" (Bailey 1969), the annual homeowner savings of several devices are calculated to be:

	First Year Savings (or Cost)	Annual Savings After First Year
Shower flow control insert device	$46.46	$48.46
Dual cycle toilet[a]	24.28	44.28
Toilet damming device	18.89	22.14
Shallow trap toilet[a]	17.14	22.14
Dual flush adapter for toilets	14.45	18.45
Improved ballcock assembly for toilets	11.76	14.76
Spray tap faucet	(63.43)	13.77
Faucet flow control device	6.45	9.45
Faucet aerator	1.44	3.94

[a] First year expenditure assumed to be difference in capital cost between flow-saving toilet and a standard toilet costing $75.

Agency Contacted	Date	Summary of Comments
WI So. Gas Co.	4/25/78	Gas service in this area. 1% seasonality, with many so-called "permanent" residents living in District only on weekends.
WI Elec. Power Co.	4/25/78	"Minimum billing policy"--a flat monthly rate, Town of Salem electricity sewage rates: June-July 1977: 1.7-2.5 million kilowatt hrs/mo; Jan-Feb 1978: 1.9-2.3 million kilowatt hrs/mo.
Camp Lake Cash & Carry Grocery	4/26/78	Grocery business can be as much as 50% better in the summer.
Vito's Lake Side Resort	5/1/78	Restaurant and tavern business last year; May, June, July, Aug. 25% higher than Nov., Dec., Jan., and Feb.
Salem Utility District Number #11	4/25/78	Marvin Schwenn, operator: "Estimated seasonal population is 30%.

Table E-6

COMPARISON OF POPULATION AND DWELLING UNIT ESTIMATES
1975 AND 2000

1975	Total	Permanent	Seasonal	Total	Permanent	Seasonal
Salem Utility District #2						
Facility Plan	8,354	4,200	4,154	2,387		
WAPORA, Inc.	7,488	5,276	2,212	2,195	1,649	546
SEWRPC		4,600				
Camp Lake/Center Lake						
WAPORA, Inc.		2,850				
SEWRPC		2,100				
Cross Lake						
WAPORA, Inc.		1,452				
SEWRPC		1,400				
Rock Lake						
WAPORA, Inc.		522				
SEWRPC		600				
Wilmot						
WAPORA, Inc.		442				
SEWRPC		500				
Salem Utility District #2						
Facility Plan	15,000	7,500	7,500			
WAPORA, Inc.	10,925	7,913	3,012	3,390	2,637	753
SEWRPC		6,900				
Camp/Center Lakes						
WAPORA, Inc.		3,821				
SEWRPC		2,700				
Cross Lake						
WAPORA, Inc.		2,232				
SEWRPC		2,100				
Rock Lake						
WAPORA, Inc.		1,149				
SEWRPC		1,300				
Wilmot						
WAPORA, Inc.		711				
SEWRPC		300				

APPENDIX I

COSTS

DESIGN AND COSTING ASSUMPTIONS

TREATMENT

Activated Sludge:

- The Conventional Activated Sludge treatment system for the Salem area alternatives is of the same design as that presented in the Facility Plan.
- Polymer was assumed to be added along with alum to aid in settling.
- The operation and maintenance cost for contract sludge handling was determined by assuming 2,700 gallons of sludge would be produced per million gallon of sewerage per day (Wastewater Engineering, Metcalf and Eddy).
- Mixed media filtration was added in Alternatives 2 and 5. The effluent generated from these alternatives would be of a higher quality than the requirements of BOD 30 mg/l, Suspended Solids 30 mg/l, and Phosphorus 1.0 mg/l.

Land Application - Spray Irrigation:

- The application technique for crop production is spray irrigation. This is an advantageous method of applying effluent because the areas are predominantly flat and are prime agricultural lands. With this type of application there is also the added benefit of income from crop revenues which defrays part of the yearly operation and maintenance expense.
- An application rate of 1.6 in./wk was determined after comparing the hydraulic and nitrogen loading rate for corn and alfalfa.
- Alfalfa was the chosen crop since alfalfa allows a higher application rate and because it is a perenial crop with its growing season limited solely by climatic factors. Higher loading rates may produce poor crop growth and could easily result in contamination of the groundwater since the underlying soil of the area is classified in the very rapid permeability range and the depth to groundwater at times during the year may be as high as 5 feet.
- An application rate of 6 in./year was used for application by "agronomic rate". According to the University of Wisconsin Agricultural Extension Office, this rate was considered conservative over a 20-year design period.
- The storage period is based primarily on climatic factors. The EPA manual "Land Treatment of Municipal Wastewater", October 1977 recommends a 120-day storage period or approximately 17 weeks. EPA assumed a 20-week storage period allowing for periodic harvesting of the alfalfa.

- A 200-foot buffer zone was included around application areas.

- Crop revenue was estimated for alfalfa according to the following:

  - 2.5 tons/acre
  - $66/ton.

Land Application - Overland Flow:

- An application rate of 4 in./wk was assumed. Biological activity, rather than soil permeability determines the application rate in an overland flow treatment scheme. 4 in./wk will easily match the biological activity according to "Land Treatment of Municipal Wastewater".

- The storage period is the same as for spray irrigation.

- Renovated water that was collected and discharged to the wetlands area was chlorinated (prior to discharge).

- Wisconsin DNR effluent limitations for wetlands discharge include:

  - BOD_5 = 20 mg/1
  - Suspended Solids = 20 mg/1.

- A 200-foot buffer zone was included around application areas.

Land Application - Rapid Infiltration:

- An application rate of 12 in./wk was used according to "Land Treatment of Municipal Wastewater".

- Since rapid infiltration can be used year-round, no storage facility was considered.

- Renovated water that was collected and discharged to the Fox River was chlorinated prior to discharge.

- A 200-foot buffer zone was included around application areas.

Collection:

- All sewer lines are to be placed at or below 6 feet of depth, due to frost penetration in the Salem area. Gravity lines are assumed to be placed at an average depth of 12 feet.

- The determination of the percent shoring of gravity collection lines was performed on a segment basis. Ten percent less shoring is required for force mains and low pressure sewers due to their shallower average depth.

- All pressure sewer lines and force mains 8 inches in diameter or less will be PVC SDR26, with a pressure rating of 160 psi. Those force mains larger than 8 inches in diameter will be constructed of ductile iron with mechanical joints.

- A minimum velocity of 2 fps will be maintained in all pressure sewer lines and force mains to provide for scouring.

- Cleanouts in the pressure sewer system will be placed at the beginning of each line, and one every 500 feet of pipe in line. Cleanout valve boxes will contain shut-off valves to provide for isolation of various sections of line for maintenance and/or repairs.

- The pumping units investigated for the pressure sewer system utilized effluent and grinder pumps. Both units include a 2- by 8-foot basin with discharge at 6 feet, control panel, visual alarm, mercury float level controls, valves, rail system for removal of pump, antifloatation device, and the pump itself. The grinder pump is a 2 hp pump with a total dynamic head of 90 feet. The effluent pump is manufactured in a 1, 1½ or 2 hp pump. For the Salem area, the 1 hp pump proved to be impractical as its total dynamic head is only 60 feet, and insufficient for long runs of pressure lines. The 1½ and 2 hp pumps reach a total dynamic head of 80 and 120 feet respectively.

- On-site and effluent pumping units (STEP) require the use of septic tanks. Due to undersize and faulty units, a 50 percent replacement of all septic tanks was assumed. All units are to be 1,000 gallon concrete septic tanks.

- An even distribution of population was primarily assumed along collection lines for all alternatives indicated.

- A peaking factor for design flows of the various systems investigated was based on the Ten State Standards in concurrence with the Salem Facility Plan.

Cost-Effectiveness Analysis:

- Quoted costs are in 1978 dollars.

- EPA Sewage Treatment Plant (STP) Index of 135 (4th Quarter 1977), and Engineering News Record Index of 2693 (1 March 1978) were used for updating costs.

- i, interest rate - 6 5/8%
  Planning period - 20 years
  Life of facilities, structures - 50 years
  Mechanical components - 20 years.

- Straight line depreciation assumed.

- Land for land application sites valued at $1900/acre (except in EIS Alternative 6, where land would be secured at no cost, under cooperative agreement.

ITEMIZED AND TOTAL COSTS FOR EACH ALTERNATIVE

FACILITY PLAN PROPOSED ACTION

EIS ALTERNATIVES 1-8

Note: Costs are shown to nearest $100. This should not be interpreted as meaning that estimates are accurate to that level. Most cost estimates are accurate within ± 10%.

FACILITY PLAN
PROPOSED ACTION

SALEM TREATMENT
COST ESTIMATE
CONVENTIONAL ACTIVATED SLUDGE

Q = 0.73 MGD Costs in 1978 Dollars

PROCESS	CAPITAL $ COST	O & M $ COSTS	SALVAGE
Preliminary Treatment	45,650	4,500	20,550
Influent Pumping	115,500	2,250	34,650
Primary Sedimentation	53,900	5,100	32,350
Activated Sludge	192,500	5,650	0
Final Clarification	88,000	5,100	52,800
Chemical Addition (Alum & Polymer)	31,900	5,400	0
Chlorination	41,250	2,700	16,100
Lab/Maint. Bldg.	137,500	6,700	61,900
Anaerobic Digestion	88,000	11,800	39,600
Effluent Pumping	24,200	1,700	0
Effluent Outfall	57,200	100	34,300
Yard Piping	80,300		48,200
Mobilization	34,650		0
Sitework	91,300		54,800
Excavation	115,500		0
Electrical	110,000		0
HVAC	23,650		0
Controls & Instrument.	39,600	Sludge Hauling 21,550	0
Sub-Total	$1,370,600	Yardwk. 1,700	$395,250
Non-Construction Cost (.2264)	310,300	Admin. 4,900	79,050
TOTAL	$1,680,900	$79,150	$474,300

FACILITY PLAN
PROPOSED ACTION

SALEM - COLLECTION

COST ESTIMATE

Cost in 1978 Dollars
x $1,000

SERVICE AREA	CAPITAL COST	O&M COSTS	SALVAGE VALUE
1980			
Service Area	9,088.55	40.25	4,186.53
On-Site:			
Silver Lake Park	229.64	.08	28.24
	9,318.19*	40.33	4,214.77
25% Engineering Contingencies	2,329.55		842.95
Total	11,647.74	40.33	5,057.72
1990			
Segment AA	275.83	1.57	151.04
1980-2000			
Future Hook-Ups	60.50/yr		

*Includes costs for private sewer service line connections

ALTERNATIVE #1

SALEM TREATMENT
COST ESTIMATE
CONVENTIONAL ACTIVATED SLUDGE

Q = 0.73 MGD

Costs in 1978 Dollars

PROCESS	CAPITAL $ COST		O & M $ COST	SALVAGE
Preliminary Treatment	45,650		4,500	20,550
Influent Pumping	115,500		2,250	34,650
Primary Sedimentation	53,900		5,100	32,350
Activated Sludge	192,500		5,650	0
Final Clarification	88,000		5,100	52,800
Chemical Addition (Alum & Polymer)	31,900		5,400	0
Chlorination	41,250		2,700	16,100
Lab/Maint. Bldg.	137,500		6,700	61,900
Anaerobic Digestion	88,000		11,800	39,600
Effluent Pumping	24,200		1,700	0
Effluent Outfall	57,200		100	34,300
Yard Piping	80,300			48,200
Mobilization	34,650			0
Sitework	91,300			54,800
Excavation	115,500			0
Electrical	110,000			0
HVAC	23,650			0
Controls & Instrument.	39,600	Sludge Hauling	21,550	0
Sub-Total	$1,370,600	Yardwk.	1,700	$395,250
Non-Construction Cost (.2264)	310,300	Admin.	4,900	79,050
TOTAL	$1,680,900		$79,150	$474,300

ALTERNATIVE #1

SALEM - COLLECTION

COST ESTIMATE

Costs in 1978 Dollars
x $1,000

SERVICE AREA	CAPITAL COST	O&M COSTS	SALVAGE VALUE
1980			
Service Area	8,927.88	43.45	4,041.11
On-Site:			
Silver Lake Park	229.64	.08	28.24
	9,157.52*	43.53	4,069.35
25% Engineering Contingencies	2,289.38		813.87
Total	11,446.90	43.53	4,883.22
1990			
Segment AA	275.83	1.57	151.04
1980-2000			
Future Hook-Ups	75.70	.49**	183.41

*Includes costs for private sewer service line connections.
**Gradient per year over 20 years.

ALTERNATIVE #2

SALEM TREATMENT
COST ESTIMATE
CONVENTIONAL ACTIVATED SLUDGE

Q = .073 MGD

Costs in 1978 Dollars

PROCESS	CAPITAL $ COSTS	O & M $ COSTS	SALVAGE
Preliminary Treatment	45,650	4,500	20,550
Influent Pumping	115,500	2,250	34,650
Primary Sedimentation	53,900	5,100	32,350
Activated Sludge	192,500	5,650	0
Final Clarification	88,000	5,100	52,800
Mixed Media Filtration	148,500	4,100	44,550
Chemical Addition (Alum & Polymer)	31,900	5,400	0
Chlorination	41,250	2,700	16,100
Lab/Maint. Bldg.	137,500	6,700	61,900
Anaerobic Digestion	88,000	11,800	39,600
Effluent Pumping	24,200	1,700	0
Effluent Outfall	57,200	100	34,300
Yard Piping	80,300		48,200
Mobilization	34,650		0
Sitework	91,300		54,800
Excavation	115,500		0
Electrical	110,000		0
HVAC	23,650		0
Controls & Instrument	39,600	Sludge Hauling 21,550	0
Sub-Total	$1,519,100	Yardwk. 1,700	395,250
Non-Construction Cost (.2264)	343,900	Admin. 4,900	79,050
TOTAL	$1,863,000	$83,250	$518,850

ALTERNATIVE #2

SALEM - COLLECTION

COST ESTIMATE

Costs in 1978 Dollars
x $1,000

SERVICE AREA	CAPITAL COST	O&M COSTS	SALVAGE VALUE
1980			
Service Area	8,927.88	43.45	4,041.11
On-Site:			
Silver Lake Park	229.64	.08	28.24
	9,157.52*	43.53	4.069.35
25% Engineering Contingencies	2,289.38		813.87
Total	11,446.90	43.53	4.883.22
1990			
Segment AA	275.83	1.57	151.04
1980-2000			
Future Hook-Ups	75.70	.49**	183.41

*Includes costs for private sewer service line connections.
**Gradient per year over 20 years.

ALTERNATIVE #3

SALEM TREATMENT

COST ESTIMATE

LAND TREATMENT - CENTRAL

Q = 0.73 MGD

Costs in 1978 Dollars

PROCESS	CAPITAL $ COSTS	O & M $ COSTS	SALVAGE VALUE
Preliminary Treatment	57,750	4,500	26,000
Storage Lagoon (91 MG) Fully Lined	534,600	2,500	320,750
Transmission-Pipe Force Mains	50,800	100	30,480
Land 294 Acres $1900/Acre	558,600		1,008,832
Application-Spray Irrigation Q Effective = 1.18 MGD	756,000	42,600	113,400
Crop Revenues		-29,040	
TOTALS	$1,957,750	$20,660	$1,499,462

ALTERNATIVE #3

SALEM - COLLECTION

COST ESTIMATE

Costs in 1978 Dollars
x $1,000

SERVICE AREA	CAPITAL COST	O&M COSTS	SALVAGE VALUE
1980			
Service Area	8,927.88	43.45	4,041.11
On-Site:			
Silver Lake Park	229.64	.08	28.24
Conveyance to Land Application	685.88	1.34	386.09
Total	9,843.40*	44.87	4,455.44
25% Engineering Contingencies	2,460.85		891.09
	12,304.25	44.87	5346.53
1990			
Segment AA	239.83	44.00	127.07
1980-2000			
Future Hook-Ups	75.70/yr.	.49**	183.41

*Includes costs for private sewer service line connections.
**Gradient per year over 20 years.

ALTERNATIVE #4

SALEM TREATMENT

COST ESTIMATE

LAND TREATMENT - CENTRAL

Q = 0.70 MGD

Costs in 1978 Dollars

PROCESS	CAPITAL $ COSTS	O & M $ COSTS	SALVAGE VALUE
Preliminary Treatment	53,600	4,250	24,100
Storage Lagoon (87 MG) Fully Lines	519,750	2,500	311,850
Transmission-Pipe Force Mains	50,100	70	30,060
Land 286 Acres $1900/Acre	543,400		981,380
Application-Spray Irrigation Q Effective = 1.13 MGD	745,000	42,000	111,750
Crop Revenues		-27,720	
TOTALS	$1,911,850	$21,100	$1,459,140

ALTERNATIVE #4

SALEM - COLLECTION

COST ESTIMATE

Costs in 1978 Dollars
x $1,000

SERVICE AREA	CAPITAL COST	O&M COSTS	SALVAGE VALUE
1980			
Service Area	8,307.21	38.03	3,796.96
On-Site:			
Silver Lake Park	229.64	.08	28.24
Segment A and B	7.38	.08	.80
Cluster:			
Segment E	253.61	1.78	98.67
Conveyance to Land Application	685.88	1.34	386.09
Total	9,483.72*	41.31	4,310.76
25% Engineering Contingencies	2,370.93		862.15
	11,854.65	41.00	5,172.91
1990			
Segment AA	275.83	42.50	151.04
1980-2000			
Future Hook-Ups	70.93	.41**	154.83
On-Site	3.32	.03**	9.54
	74.25/yr.	.44**	164.37

*Includes costs for private sewer service line connections.
**Gradient per year over 20 years.

ALTERNATIVE #5

SALEM TREATMENT

COST ESTIMATE

CONVENTIONAL ACTIVATED SLUDGE

Q = 0.70 MGD

Costs in 1978 Dollars

PROCESS	CAPITAL $ COST		O & M $ COST	SALVAGE
Preliminary Treatment	42,900		4,250	19,300
Influent Pumping	110,000		2,250	33,000
Primary Sedimentation	51,700		5,000	31,000
Activated Sludge	181,500		5,300	0
Final Clarification	84,700		5,000	50,800
Mixed Media Filtration	143,000		3,900	42,900
Chemical Addition (Alum & Polymer)	29,700		5,200	0
Chlorination	40,700		2,600	15,850
Lab/Maint. Bldg.	132,000		6,650	59,400
Anaerobic Digestion	85,250		11,450	38,350
Effluent Pumping	23,650		1,700	0
Effluent Outfall	52,800		100	31,700
Yard Piping	77,000			46,200
Mobilization	33,000			0
Sitework	88,000			52,800
Excavation	110,000			0
Electrical	106,700			0
HVAC	23,100			0
Controls & Instrument.	37,400	Sludge Hauling	20,550	0
Sub-Total	$1,453,100	Yardwk.	1,650	$378,400
Non-Construction Cost (.2264)	329,000	Admin.	4,750	75,700
TOTAL	$1,782,100		$80,350	$497,000

ALTERNATIVE #5

SALEM - COLLECTION

COST ESTIMATE

Costs in 1978 Dollars
x $1,000

SERVICE AREA	CAPITAL COST	O&M COSTS	SALVAGE VALUE
1980			
Service Area	8,307.21	38.03	3,796.96
On-Site:			
Silver Lake Park	229.64	.08	28.24
Segment A and B	7.38	.08	.80
Cluster:			
Segment E	253.61	1.78	98.67
	8,797.84*	39.97	3,924.75
25% Engineering Contingencies	2,199.46		784.95
Total	10,997.30	39.97	4,709.70
1990			
Segment AA	275.83	1.57	151.04
1980-2000			
Future Hook-Ups	70.93	.41**	154.83
On-Site	3.32	.03**	9.54
	74.25/yr.	.44**	164.37

*Includes costs for private sewer service line connections.
**Gradient per year over 20 years.

ALTERNATIVE #6

SALEM TREATMENT

LAND TREATMENT - CENTRAL

AGRONOMIC APPLICATION RATES

NO LAND PURCHASE COST

Q = 0.70 MGD

Costs in 1978 Dollars

PROCESS	CAPITAL $ COST	O & M $ COST	SALVAGE
Preliminary Treatment	53,600	4,250	24,100
Storage Lagoon (87 MG) Fully Lined	519,750	2,500	311,850
On-Site Pipe	105,000	150	63,000
Land 1,547 Acres	-0-		-0-
Application-Spray Irrigation Q Effective = 1.13 MGD Center Pivot	2,175,000	102,273	326,250
Crop Revenues		-221,595	
TOTALS	$2,853,350	$-112,422	$725,200

ALTERNATIVE #6

COST ESTIMATE

SALEM - COLLECTION

Costs in 1978 Dollars
x $1,000

SERVICE AREA	CAPITAL COST	O&M COSTS	SALVAGE VALUE
1980			
Service Area	8,307.21	38.03	3,796.96
On-Site:			
Silver Lake Park	229.64	.08	28.24
Segment A and B	7.38	.08	.80
Cluster:			
Segment E	253.61	1.78	98.67
Conveyance to Land Application	685.90	1.00	386.10
TOTAL	9,483.74	40.97	4,310.77
25% Engineering and Contingencies	2,370.93	-	862.15
	11,854.67	40.97	5,172.92
1990			
Segment AA	275,83	1.57	151.04
1980-2000			
Future Hook-Ups	70.93	.41*	154.83
On-Site	3.32	.03*	9.54
	74.25/Yr.	0.44*	164.37

*Gradient per year over 20 years.

ALTERNATIVE 7

SALEM

COST ESTIMATE

RAPID INFILTRATION - CENTRAL

Q = 0.70 MGD

Cost in 1978 Dollars

PROCESS	CAPITAL COST($)	O&M COSTS($)	SALVAGE VALUE($)
Preliminary Treatment	53,600	4,250	24,100
Stabilization Pond	616,000	15,330	369,600
Chlorination	48,950	3,500	19,100
Rapid Infiltration Basin (Including Laboratory)	253,100	15,330	151,900
Mobilization	33,000	0	0
Sitework (Incl. Excv.)	121,000	0	72,600
Electrical	107,800	0	0
Yard Piping	77,000	0	46,200
HVAC	22,000	0	0
Controls and Instrumentation	35,200	0	0
Land (94 Ac.)	178,600	0	322,600
Administration	0	4,400	0
Laboratory	0	4,000	0
TOTAL	1,546,250	46,810	1,006,100
Engineering & Contingency (25%)	386,563	--	@ 20% 201,220
	1,932,813	46,810	1,207,320

ALTERNATIVE #7

COST ESTIMATE

SALEM - COLLECTION

Costs in 1978 Dollars
x $1,000

SERVICE AREA	CAPITAL COST ($)	O&M COSTS ($)	SALVAGE VALUE ($)
1980			
Service Area	8,307.21	38.03	3,796.96
On-Site:			
Silver Lake Park	229.64	.08	28.24
Segment A and B	7.38	.08	.80
Cluster:			
Segment E	253.61	1.78	98.67
Conveyance to Rapid Infilt.	1,025.10	1.91	564.18
Effluent to Point of Disc.	428.05	2.21	226.59
TOTAL	10,250.99	44.09	4,715.44
25% Engineering and Contingencies	2,562.75	--	@ 20% 943.09
	12,813.74		5,658.53
1990			
Segment AA	275.83	1.57	151.04
1980-2000			
Future Hook-Ups	70.93	.41*	154.83
On-Site	3.32	.03*	9.54
	74.25/Yr.	0.44*	164.37

*Gradient per year over 20 years.

ALTERNATIVE #8

SALEM TREATMENT

COST ESTIMATE

CONVENTIONAL ACTIVATED SLUDGE

Q = 0.45 MGD

Costs in 1978 Dollars

PROCESS	CAPITAL $ COST	O & M $ COST		SALVAGE
Preliminary Treatment	25,850		3,450	11,650
Influent Pumping	71,500		1,900	21,450
Primary Sedimentation	32,450		4,200	19,450
Activated Sludge	126,500		4,200	0
Final Clarification	55,000		4,200	33,000
Mixed Media Filtration	55,000		2,500	16,500
Chemical Addition (Alum & Polymer)	13,600		4,700	0
Chlorination	26,400		2,350	10,300
Lab/Maint. Bldg.	88,000		5,700	39,600
Anaerobic Digestion	52,800		9,600	23,750
Effluent Pumping	13,750		1,450	0
Effluent Outfall	29,150		100	17,500
Yard Piping	49,500			29,700
Mobilization	19,800			0
Sitework	59,400			35,650
Excavation	72,600			0
Electrical	70,400			0
HVAC	13,200			0
Controls & Instrument.	23,100	Sludge Hauling	13,250	0
Sub-Total	$ 898,000	Yardwk.	1,250	242,050
Non-Construction Cost (.2264)	203,300	Admin.	3,700	48,400
TOTAL	$1,101,300		$62,550	$306,950

ALTERNATIVE #8

SALEM TREATMENT

COST ESTIMATE

LAND TREATMENT - CENTRAL

WILMOT

Q = .05 MGD

Costs in 1978 Dollars

PROCESS	CAPITAL $ COSTS	O & M $ COSTS	SALVAGE VALUE
Preliminary Treatment	22,500	1,200	10,100
Storage Lagoon 20 weeks storage Fully Lined	148,500	500	89,100
Transmission-Pipe Force Mains	12,000	15	7,200
Land 40 Acres $1900/Acre	76,000		137,250
Application-Spray Irrigation Q Effective = .084 MGD	217,500	5,500	32,630
Crop Revenues		-2,180	
TOTALS	476,500	5,035	276,280

ALTERNATIVE #8

SALEM - COLLECTION

COST ESTIMATE

Costs in 1978 Dollars
x $1,000

SERVICE AREA	CAPITAL COST	O&M COSTS	SALVAGE VALUE
1980			
Service Area	5,366.45	21.07	2,376.86
On-Site:			
Silver Lake Park	229.64	.08	28.24
Segments A, B, T and S	11.81	.13	1.28
Land Application:			
Segment U	614.23	5.64	275.54
Overland Flow with Wetlands Discharge:			
Segments V, W, X, Y and Z	2,083.91	13.84	988.15
Cluster:			
Segment E	253.61	1.78	98.67
	8,559.65*	42.54	3,768.74
25% Engineering Contingencies	2,139.91	——	753.75
Total	10,699.56	42.54	4,522.49
1990			
Segment AA	275.83	1.57	151.04
1980-2000			
Future Hook-Ups	70.13		
On-Site	5.32	.41**	154.83
	75.45	.41**	154.83

*Includes costs for private sewer service line connections.
**Gradient per year for 20 years.

ALTERNATIVE #8

SALEM TREATMENT

COST ESTIMATE

LAND TREATMENT - CENTRAL OVERLAND FLOW AND WETLANDS DISCHARGE

Q = .18 MGD

Costs in 1978 Dollars

PROCESS	CAPITAL $ COSTS	O & M COSTS	SALVAGE VALUE
Preliminary Treatment	54,000	2,150	24,300
Storage Lagoon Fully Lined	200,500	1,250	120,300
Oxidation Ponds	222,750	1,250	133,650
Chlorination - included in overland flow			
Overland Flow	371,250	13,300	167,050
Transmission Gravity 1 mi.	118,800	400	71,300
Land 85 Acres @ $1900/Ac.	161,500		291,700
TOTALS	$1,128,800	$18,350	$808,300

APPENDIX J

PRELIMINARY SITE EVALUATION: PAASCH LAKE WETLAND, KENOSHA COUNTY, WISCONSIN

PRELIMINARY
SITE EVALUATION

Paasch Lake Wetland
Kenosha County, Wisconsin

May 1978

Robert H. Kadlec

Donald L. Tilton

Wetland Ecosystem Research Group
University of Michigan
Ann Arbor, Michigan

SUMMARY

The purpose of this report is to present an initial evaluation of the Paasch Lake wetland in Kenosha County, Wisconsin with respect to its tertiary wastewater treatment potential. The upper half of the wetland currently is acting as a nutrient and sediment trap for runoff waters. It discharges at the midpoint to Paasch Lake, a small, multifunctional recreational lake. The discharge from Paasch Lake moves through a channel in the lower half of the wetland out across Co. Rd. JS. The upper half of the wetland is marginally sized for the anticipated discharge. No deleterious effects on flora and fauna would be likely, but the quality and use patterns of Paasch Lake would likely be altered by the discharge. The fence row channels in the wetland are presently carrying the moving surface waters, thus any design would require effective surface distribution of the added treated wastewater.

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1. Water Budget and Water Flows

The estimated annual water budget for the wetland is given in Table I. Precipitation values are averages for Milwaukee, as reported by NOAA (U.S. Weather Bureau). Evapotranspiration is calculated from solar radiation and average temperature, according to the Thornthwaite method, which has proven accurate in other wetland situations. Total annual precipitation (731 mm) exceeds total annual evapotranspiration (607 mm), the balance occurring as net runoff (124 mm). Actual runoff occurs in a peak during springtime; the pattern used here is: March 20%, April 50%, May 20%, June 10%. This corresponds to both Thornthwaite's recommendation and our field experience at a similar site at Houghton Lake, Michigan. Runoff during late summer and winter is probably not appreciable. Run-in presumably follows the same pattern, but must be less by the difference between precipitation and evapotranspiration.

Actual runoff was measured, in mid-May 1978, to be 240 mm/mo (2450 m^3/d on 75 acres above Paasch Lake). Storage was measured at the same time (13 data points on depths) and found to be 138 mm (5.4 inches). Thus, using estimated precipitation, evapotranspiration, run-in and run-off; coupled with this inventory number in mid-May, the entire storage-time pattern can be estimated. The results are given in Table I.

The drainage mechanism for the wetland appears to be primarily channel flow along fence-row channels. These collect water and deliver it to Paasch Lake after a residence time of about 17 days for the mid-May condition. Flow in the axial fence row channel was measured at 1.0 ± 0.2 cfs; and the outlfow to Paasch Lake was also 1.0 ± 0.2 cfs. Drainage out of the remainder of the lake-wetland system at Co. Rd. JS was measured as 0.9 ± 0.2 cfs.

If the wetland were not channelled by the fence row, we would expect a drainage rate of about 600 m^3/d. This is based on a surface hydraulic conductivity of 50 cm/sec (from out Houghton Lake results for the 5.4 inch water depth), a gradient of 1.36 ft/mile (from our May 1978 survey) and an approximate width of 400 meters. The observed outflow (2450 m^3/d) is considerably higher than the expected 600 m^3/d; which lends support to the concept of channel flow along fence rows.

No data are available on possible subsurface flows. However, soil probing indicates clay and/or marl underlays the wetland. This indicates a minimal communication and flow between the surface waters and shallow subsurface aquifers.

2. Water Quality

Water samples were taken at selected wetland stations, and analyzed for conductivity, pH, NH_4^+, NO_3^-, $PO_4^{\equiv}$ (TDP), Cl^- and suspended solids. Stations JS, 0, 1, 5 and 9 in Figure 2 were sampled; the results are given in Table III. Interior wetland points show relatively high nitrogen, phosphorus, chloride and conductivity; surface discharge points into Paasch Lake and across Co. Rd. JS show lower values. This indicates that the wetland is currently receiving a nutrient load from some external source, probably agricultural runoff, and is doing an effective job of nutrient removal.

Suspended solids were present in trace amounts at all locations; however our sample size was too small to determine accurate numbers. All were in the range 20-50 mg/ℓ, as would be expected based on other comparable wetland situations.

High readings on chloride and conductivity at interior wetland points could be due to groundwater sources, or to runoff from surrounding fields. The later appears more likely. Nitrogen and phosphorus discharges from the wetland are low, as would be expected for this type of wetland. Values of pH are high for this type of wetland, indicating the influence of runoff waters which have not yet equilibrated to the usual slightly acid condition. No nitrate was found; this is the expected springtime condition.

3. Soil Processes

A soil map is shown in Figure 3. The central area of the wetland area is Houghton muck with an organic matter accumulation of 2.5-3.0 m in the middle and 10-20 cm at the edges. Marl underlies the peat in the central region while clay underlies the peat at the edges. Cation exchange capacity of this peat is known to be high ($\geq$ 100 meq/100 g soil). This type of soil and depth of organic matter accumulation are suitable for tertiary stage wastewater treatment. Permeability of the Houghton muck and Palms muck is estimated to be 5.0-16.0 cm/hour. The impermeable soil and underlying clay profile suggest that water movement is predominantly over the surface and into Paasch Lake.

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4. Flora

The wetland west of Pausch Lake consists of two cover types. The majority of the area is sedge (*Carex* sp.) with scattered cattail (*Typha* sp.) areas of lesser extent. Marsh marigold (*Caltha* palustris) and currant (*Ribes* sp.) are scattered about the wetland. No rare or endangered plant species were observed in the area.

The distribution of sedges was clumped with 50% of the sedge areas in open water. Filamentous algae were prevalent in these open water areas and algal populations will flourish in these channels during wastewater application.

5. Use Patterns

No sign of muskrat activity was observed although the smaller cattail areas could support a small population. Beaver were not present in the area. Waterfowl were not observed, although the area is probably a nesting site as well as a feeding area for several waterfowl. Although pike (Esox lucius) spawning was not observed, it seems likely that such activity occurs in this wetland especially since pike are caught from Paasch Lake.

Human use of the wetland seems minimal. At one time, cattle were probably grazed on the land but no recent grazing seems to have occurred. The area has been fenced along property lines, but the fences are in need of repair.

Compared to the wetland, Paasch Lake has considerably more recreational use. Local residents fish the lake (winter and summer) and some residents use the lake for swimming and recreational boating. There may be limited waterfowl hunting during the fall. The use of this area by the public, especially for swimming, detracts from its usefulness as a wastewater treatment area.

6. Treatment Potential

Applicable data on the amount and type of effluent under consideration are included in the appendix. The amount of wastewater is 95,000 gpcd, increasing to 143,000 gpcd in the year 2000. Based on a four month irrigation season, this means the 164 acre wetland/21 acre lake must be capable of treating 429,000 gpd for a summer discharge. Further, a "winter" storage pond of capacity 4.65 x 10^6 ft^3 (ca. 18 acres at 6' working depth) would be required.

A surface distribution piping system would be required - presumably a gravity-fed system of 6-8 inch gated aluminum irrigation piping. Existence of fence row ditches would require careful planning of water release to avoid excessive channeling.

Irrigation could be conducted after spring runoff has ended, until early fall when low temperatures, plant senescence and frost would limit treatment potential.

In view of the focussing of the upper drainage basin (ca. 75 acres) on Paasch Lake, before further wetland portions are encountered, only this upper area can be regarded as the "treatment" site. The balance of the acreage, as well as Paasch Lake itself, would probably provide some lesser level of treatment. The discharge would thus amount to 1.5 inches per week on 75 acres during June-September. Alternatively, the loading would be 28 people/acre. This is at the upper limit of loading based on other experiences with wetland treatment.

At the current population level (1976 data), the loading would be 0.93 inches per week, or 17 people/acre. This should provide adequate rennovation of the wastewater - if it is properly distributed. Based on other experiences, we would expect BOD_5 to be marsh background at the wetland outflow point. Entering suspended solids would be retained in major part, but a discharge of natural suspended solids would continue. Nitrogen and phosphorus should be dramatically reduced, probably by 90+ %.

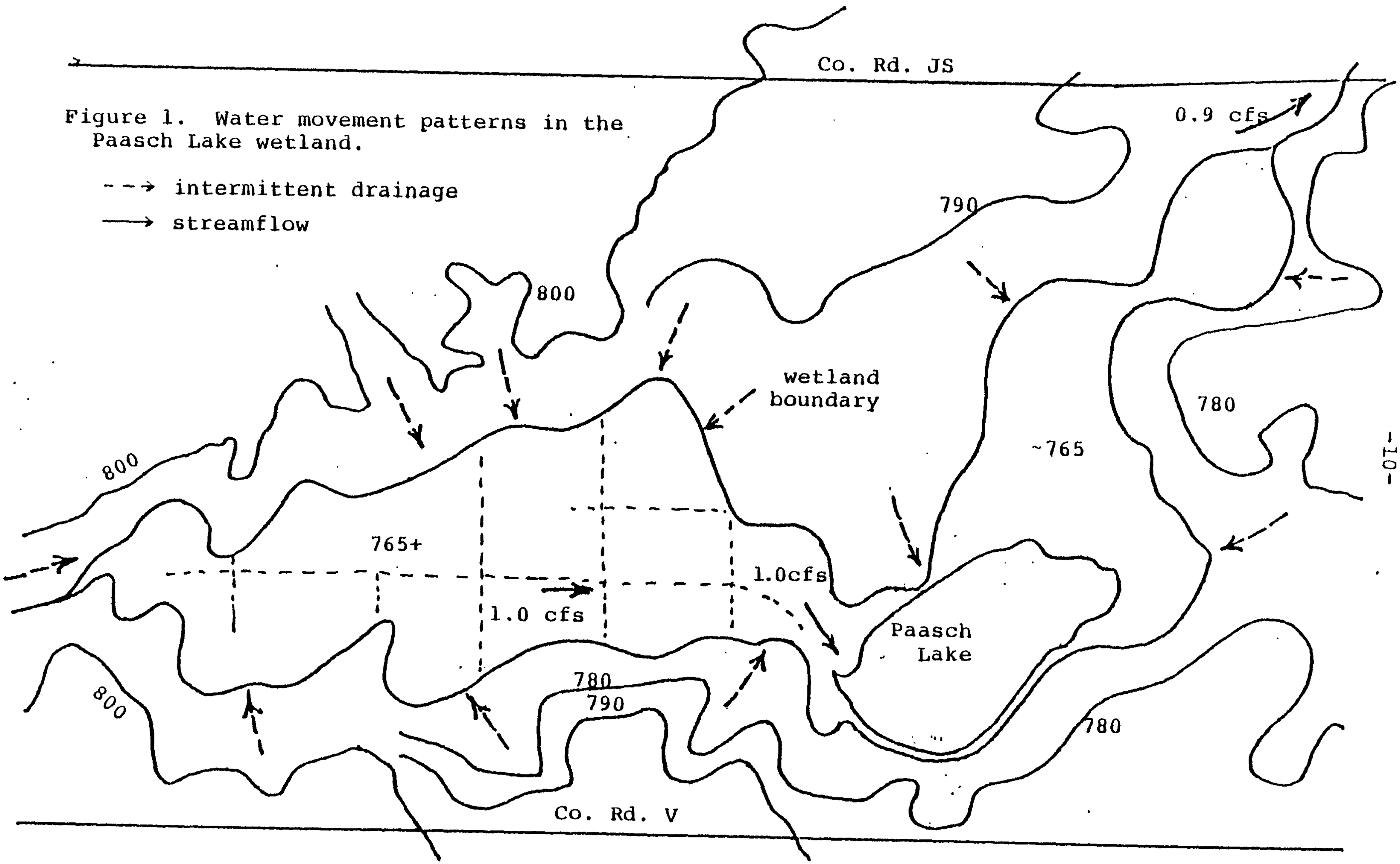
Chlorination is not recommended because of the adverse effects of residual chlorine on wetland plants and microbes. Summer dissolved oxygen should average at an acceptable level, based on Houghton Lake, Michigan data.

Effects of the added treated wastewater would be minimal as far as wetland flora and fauna are concerned. The more aquatic species, such as cattails, would encouraged, at the expense of the more terrestrial species such as currant. It is clear, however, that the use patterns of Paasch Lake would be altered. Fishing and swimming would no longer be recommended activities. Further eutrophication of the lake would occur over some time span.

Figure 1. Water movement patterns in the Paasch Lake wetland.

- - → intermittent drainage

——→ streamflow



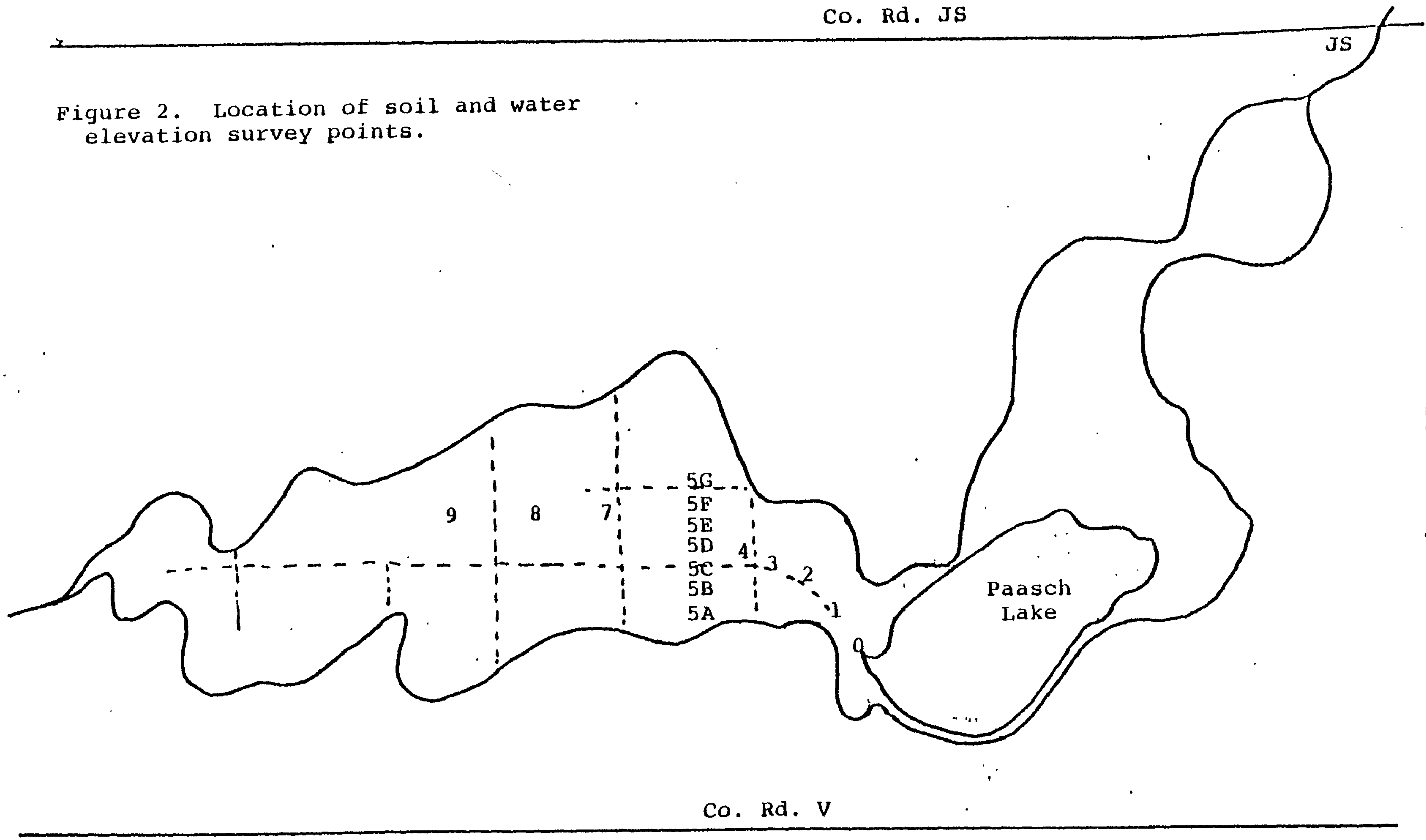


Figure 2. Location of soil and water elevation survey points.

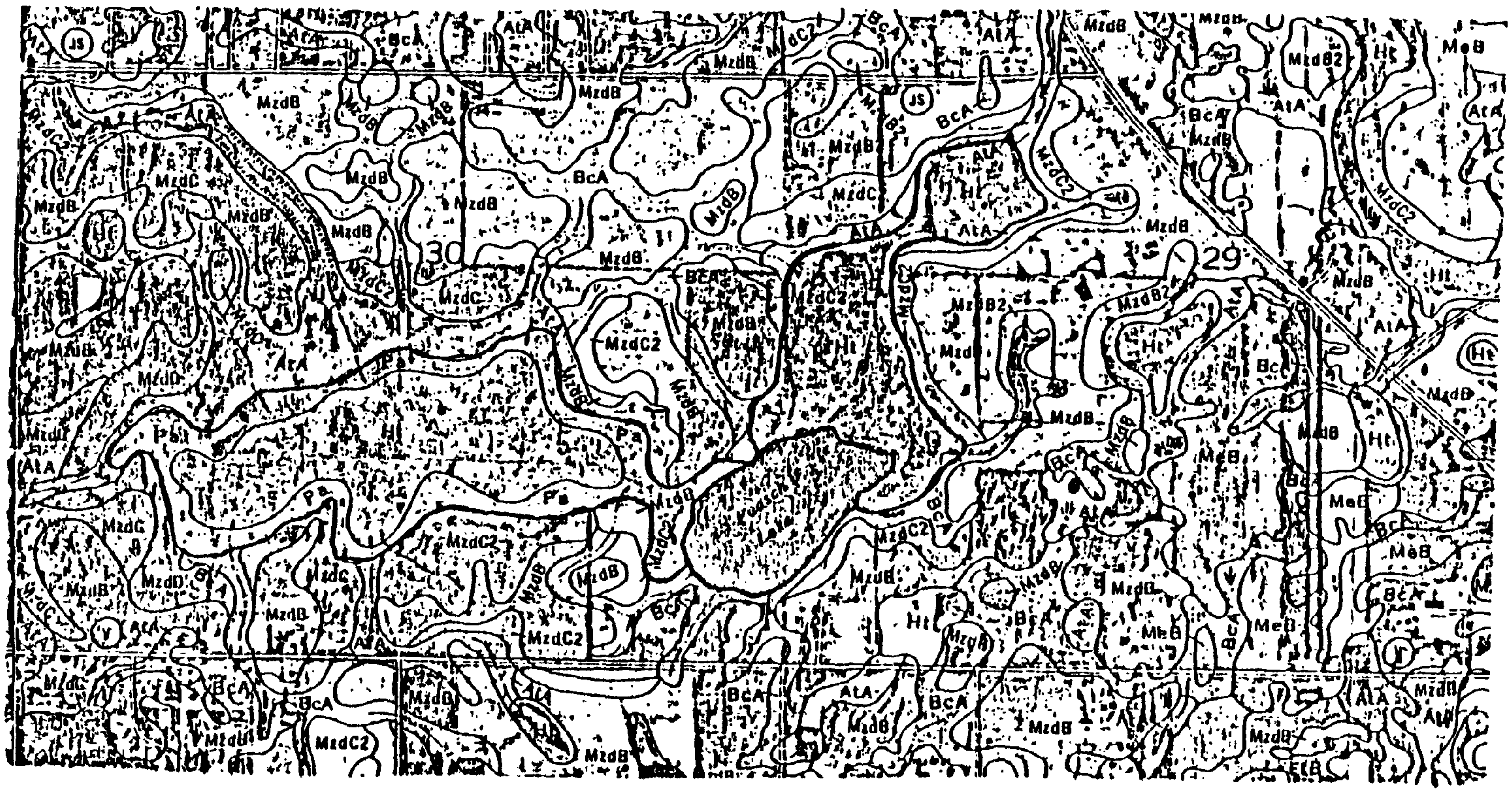


Figure 3. Soil Survey Map of Paasch Lake Wetland.

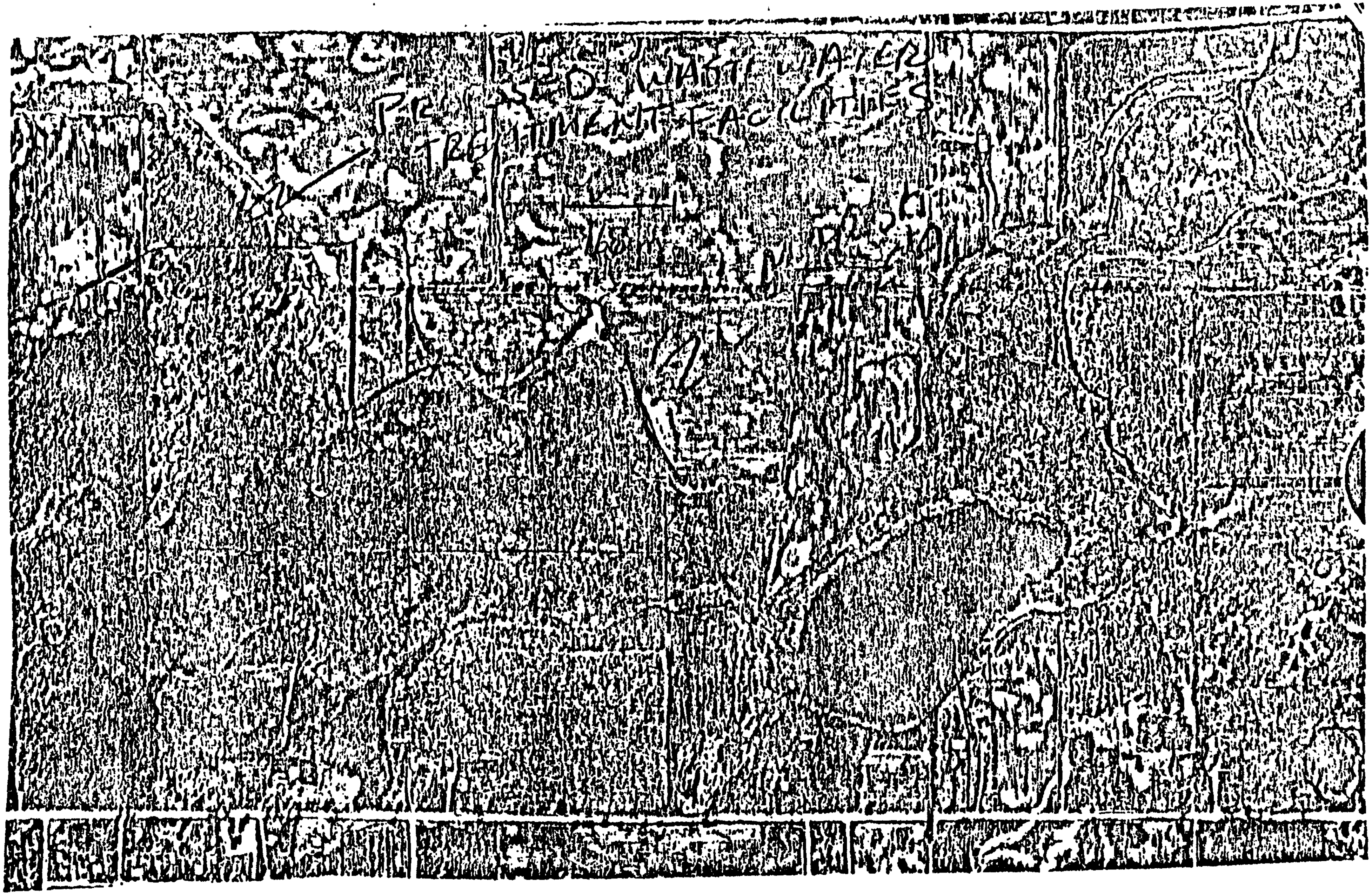


Figure 4. Aerial photo of Paasch Lake Wetland. (ca. 1" = 225 m)

Table I. Estimated Water Budget for the Paasch Lake Wetland
(Kenosha Co., Wisconsin)

Month	Precipitation mm	Evapotranspiration mm	Run In mm	Runoff mm	Storage mm
					94 s
January	33	0	0	0	
					127
February	28	0	0	0	
					155
March	57	0	216	240	
					188
April	70	34	537	600	
					161
May	73	72	216	240*	
					138*
June	91	111	107	120	
					105
July	87	134	0	0	
					58
August	68	122	0	0	
					4
September	77	81	0	0	
					0
October	51	46	0	0	
					5
November	52	7	0	0	
					50
December	44	0	0	0	
					94
Total	731	607	1076	1200	

Notes: a) Precipitation = average for Milwaukee.
b) Evapotranspiration from Thornthwaite method.
* = measured.

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Table II

Measured Soil Elevations and Water Depths,
Paasch Lake Wetland May, 1978

[Stations are keyed to Figure 2]

Station Number	Distance from Paasch Lake Spillway (m)	Relative Soil Elevation (m)	Water Depth (cm)
0	0	-	40.5
1	20	0.219	29.0
2	100	0.323	30.6
3	150	0.323	30.6
4	200	0.442	7.6
5A	260	0.433	20.4
5B	260	0.454	12.8
5C	260	0.430	10.1
5D	260	0.500	10.1
5E	260	0.509	5.2
5F	260	0.491	5.2
5G	260	0.491	2.4
6	300	0.466	7.6
7	400	0.475	7.6

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Table III

Water Chemistry at Selected Points in the Paasch Lake Wetland May 1978

Station	Conductivity µmho/cm	pH	Cl^- mg/ℓ	NH_4^+ mg/ℓ	NO_3^- mg/ℓ	TDP mg/ℓ
9	1020	7.6	120	0.22	0	0.35
5	1010	8.2	165	0.62	0	0.45
1	850	7.9	58	0.04	0	0.045
0	650	8.5	48	0.04	0	0.11
JS	820	8.7	76	0.04	0	0.09

APPENDIX

WAPORA PROJECT 662

PROPOSED WETLANDS DISCHARGE
KENOSHA COUNTY, WISCONSIN

I. GENERAL INFORMATION

A. Proposed Wetlands Discharge Site

1. Location: northeast of Lake Shangrila in sections 30 and 29 of "Paddock Lake" quadrangle (see accompanying USGS topographic maps, xeroxed copy and aerial photograph of proposed wetlands discharge site).

2. Area: total area of wetlands (colored green on xeroxed topographic map) approx. 164 acres; area of Paasch Lake approx. 21 acres.

3. Soils: see attached SCS soil map.

4. Zoning: Kenosha County Zoning Office has stated that most of section 30 is zoned Agricultural; the NW 1/4 of the northern half of section 30 (north of County Road JS) is zoned "A" Residential.

5. Current land use: (based on Southeastern Wisconsin Regional Planning Commission [SEWRPC] data)

   a. Sections 30 and 29 are largely managed as woodlands, swampland or cropland (crop and rotation pasture); low density residential development is located NW of County Road JS.

   b. There currently exists no public land on or near the proposed wetlands discharge site; no land is expected to be publicly acquired within the 20 year planning period.

   c. The Kenosha County Zoning Office identified some 26 landowners in section 30. Inquiries may be made of the Kenosha County Tax Assessor's Office (414-656-6544) for names and addresses of homeowners in this area.

6. Air Quality: The following data on prevailing direction and mean speed of wind over the proposed wetlands discharge site were obtained from the Climatic Atlas of the United States, U.S. Department of Commerce, 1977:

	Prevailing direction	Approximate mean speed (mph)
Jan.	E-SE	12
Feb.	E-SE	12
Mar.	W-SW	11
Apr.	E-SE	11
May	W-SW	11
June	N-NE	9

J

	Prevailing direction	Approximate mean speed (mph)
July	N-NE	10
Aug.	N-NE	10
Sep.	N-NE	11
Oct.	N-NE	11
Oct.	N-NE	12
Nov.	E-SE	11
Dec.	E-SE	11
Annual	E-SE	11

B. Population to be Served

1. Location: residential area surrounding Cross Lake (Wisconsin side only), Voltz Lake, Lake Shangrila, and Benet Lake.

2. Population:

   a. ∿1300 residents in 1976.
   ∿2100 residents in 2000 (design year population).

   b. estimated current seasonality approx. 5-10%.

   c.

C. Wastewater Characteristics

1. Type and pre-treatment: purely domestic wastewater to receive secondary treatment via oxidation ponds (at least two, with 6 months storage capacity).

2. Effluent quantity

   a. 1976: ∿1300 population x 60 gal/cap/day = 78,000 gal/day
   + allowance for infiltration = 16,777
   Total = 94,777 gal/day

   b. 2000, design year:
   ∿2100 population x 60 gal/cap/day = 126,000 gal/day
   + allowance for infiltration = 16,777 gal/day
   Total = 142,777 gal/day

3. Effluent quality following pre-treatment: Based on a review of the literature, the character of the effluent (prior to proposed overland flow treatment) is expected to be as follows:

Parameter	mg/l
BOD_5	30
Total suspended solids	90
Dissolved oxygen	2-4
Total Phosphorus	10
Total Nitrogen	∿12

D. <u>Wisconsin Effluent Limitations for Wetlands Discharge</u>

1. Regulations: Wisconsin NR 104.02 (3)(b)3. States that effluent discharged to wetland ("marginal surface water") shall meet the following limitations on both a weekly and monthly basis:

Parameter	Monthly Avg. (mg/l)	Weekly Avg. (mg/l)	Other (mg/l)
BOD_5	20	30	—
Total suspended solids	20	30	—
Dissolved Oxygen	—	—	4 (min.)
Total Residual Chlorine	—	—	0.50 (max.)

APPENDIX K

MANAGEMENT OF SMALL WASTEWATER SYSTEMS OR DISTRICTS

SOME MANAGEMENT AGENCIES FOR DECENTRALIZED FACILITIES

Central management entities that administer non-central systems with various degrees of authority have been established in several States. Although many of these entities are quasi-public, few of them both own and operate each component of the facility. The list of small waste flow management agencies that follows is not comprehensive. Rather, it presents a sampling of what is currently being accomplished. Many of these entities are located in California, which has been in the vanguard of the movement away from conventional centralized systems to centrally managed decentralized systems to serve rural areas (State of California, Office of Appropriate Technology, 1977).

Westboro (Wisconsin Town Sanitary District)

Sanitary District No. 1 of the Town of Westboro represents the public ownership and management of septic tanks located on private property. In 1974 the unincorporated community of Westboro was selected as a demonstration site by the Small Scale Waste Management Project (SSWMP) at the University of Wisconsin to determine whether a cost-effective alternative to central sewage for small communities could be developed utilizing on-site disposal techniques. Westboro was thought to be typical of hundreds of small rural communities in the Midwest which are in need of improved wastewater treatment and disposal facilities but are unable to afford conventional sewerage.

From background environmental data such as soils and engineering studies and groundwater sampling, it was determined that the most economical alternative would be small diameter gravity sewers that would collect effluents from individual septic tanks and transport them to a common soil absorption field. The District assumed responsibility for all operation and maintenance of the entire facility commencing at the inlet of the septic tank. Easements were obtained to allow permanent legal access to properties for purposes of installation, operation, and maintenance. Groundwater was sampled and analyzed during both the construction and operation phases. Monthly charges were collected from homeowners. The system, now in operation, will continue to be observed by the SSWMP to assess the success of its mechanical performance and management capabilities.

Washington State

Management systems have been mandated in certain situations in the State of Washington to assist in implementing the small waste flow management concept. In 1974 the State's Department of Social and Health Services established a requirement for the management of on-site systems: an approved management system would be responsible for the maintenance of sewage disposal systems when subdivisions have gross densities greater than 3.5 housing units or 12 people per acre (American Society of Agricultural Engineers 1977). It is anticipated that this concept will soon be applied to all on-site systems.

Georgetown Divide (California) Public Utility District (GDPUD)

The GDPUD employs a full-time geologist and registered sanitarian who manage all the individual wastewater sytems in the District. Although it does not own individual systems this district has nearly complete central management responsibility for centralized systems. The Board of Directors of the GDPUD passed an ordinance forming a special sewer improvement district within the District to allow the new 1800-lot Auburn Lake Trails subdivision to receive central management services from the GDPUD. The GDPUD performs feasibility studies on lots within the subdivision to evaluate the potential for the use of individual on-site systems, designs appropriate on-site systems, monitors their construction and installation, inspects and maintains them, and monitors water quality to determine their effects upon water leaving the subdivision. If a septic tank needs pumping, GDPUD issues a repair order to the homeowner. Service charges are collected annually.

Santa Cruz County (California) Septic Tank Maintenance District

This district was established in 1973 when the Board of Supervisors adopted ordinance No. 1927, "Ordinance Amending the Santa Cruz County Code, Chapter 8.03 Septic Tank System Maintenance District." Its primary function is the inspection and pumping of all septic tanks within the District. To date 104 residences in two subdivisions are in the district, which collects a one-time set-up fee plus monthly charges. Tanks are pumped every three years and inspected annually. The County Board of Supervisors is required to contract for these services. In that the District does not have the authority to own systems, does not perform soil studies on individual sites, or offer individual designs, its powers are limited.

Bolinas Community (California) Public Utility District (BCPUD)

Bolinas, California is an older community that faced an expensive public sewer proposal. Local residents organized to study the feasibility of retaining many of their on-site systems, and in 1974 the BCPUD Sewage Disposal and Drainage Ordinance was passed. The BCPUD serves 400 on-site systems and operates conventional sewerage facilities for 160 homes. The District employs a wastewater treatment plant operator who performs inspections and monitors water quality. The County health administration is authorized to design and build new septic systems.

Kern County (California) Public Works

In 1973 the Board of Supervisors of Kern County, California, passed an ordinance amending the County Code to provide special regulations for water quality control. County Service Area No. 40, including 800 developed lots of a 2,900-lot subdivision, was the first Kern County Service Area (CSA) to arrange for management of on-site disposal systems. Inspections of installations are made by the County Building Department. Ongoing CSA responsibilities are handled by the Public Works Department. System design is provided in an Operation and Maintenance Manual.

Marin County (California)

In 1971 the Marin County Board of Supervisors adopted a regulation, "Individual Sewage Disposal Systems," creating an inspection program for all new installations (Marin County Code Chapter 18.06). The Department of Environmental Health is responsible for the inspection program. The Department collects a charge from the homeowner and inspects septic tanks twice a year. The homeowner is responsible for pumping. The Department also inspects new installations and reviews engineered systems.

LEGISLATION BY STATES AUTHORIZING MANAGEMENT
OF SMALL WASTE FLOW DISTRICTS

In a recent act, the California legislature noted that then-existing California law authorized local governments to construct and maintain sanitary sewerage systems but did not authorize them to manage small waste flow systems. The new act, California Statutes Chapter 1125 of 1977, empowers certain public agencies to form on-site wastewater disposal zones to collect, treat, and dispose of wastewater without building sanitary sewers or sewage systems. Administrators of such on-site wastewater disposal zones are to be responsible for the achievement of water quality objectives set by regional water quality control boards, protection of existing and future beneficial uses, protection of public health, and abatement of nuisances.

The California act authorizes an assessment by the public agency upon real property in the zone in addition to other charges, assessments, or taxes levied on property in the zone. The Act assigns the following functions to an on-site wastewater disposal zone authority:

- To collect, treat, reclaim, or dispose of wastewater without the use of sanitary sewers or community sewage systems;

- To acquire, design, own, construct, install, operate, monitor, inspect, and maintain on-site wastewater disposal systems in a manner which will promote water quality, prevent the pollution, waste, and contamination of water, and abate nuisances;

- To conduct investigations, make analyses, and monitor conditions with regard to water quality within the zone; and

- To adopt and enforce reasonable rules and regulations necessary to implement the purposes of the zone.

To monitor compliance with Federal, State and local requirements an authorized representative of the zone must have the right of entry to any premises on which a source of water pollution, waste, or contamination including but not limited to septic tanks, is located. He may inspect the source and take samples of discharges.

The State of Illinois recently passed a similar act. Public Act 80-1371 approved in 1978 also provides for the creation of municipal on-site wastewater disposal zones. The authorities of any municipality (city, village, or incorporated town) are given the power to form on-site wastewater disposal zones to "protect the public health, to prevent and abate nuisances, and to protect existing and further beneficial water use." Bonds may be issued to finance the disposal system and be retired by taxation of property in the zone.

A representative of the zone is to be authorized to enter at all reasonable times any premise in which a source of water pollution, waste, or contamination (e.g., septic tank) is located, for the purposes of inspection, rehabilitation and maintenance, and to take samples from discharges. The municipality is to be responsible for routinely inspecting the entire system at least once every 3 years. The municipality must also remove and dispose of sludge, its designated representatives may enter private property and, if necessary, respond to emergencies that present a hazard to health.

MANAGEMENT CONCEPTS FOR SMALL WASTE FLOW DISTRICTS

Several authors have discussed management concepts applicable to decentralized technologies. Lenning and Hermason suggested that management of on-site systems should provide the necessary controls throughout the entire lifecycle of a system from site evaluations through system usage. They stressed that all segments of the cycle should be included to ensure proper system performance (American Society of Agricultural Engineers 1977).

Stewart stated that for on-site systems a three-phase regulatory program would be necessary (1976). Such a program would include: 1) a mechanism to ensure proper siting and design installation and to ensure that the location of the system is known by establishing a filing and retrieval system; 2) controls to ensure that each system will be periodically inspected and maintained; and 3) a mechanism to guarantee that failures will be detected and necessary repair actions taken.

Winneberger and Burgel suggested a total management concept, similar to a sewer utility, in which a centralized management entity is responsible for design, installation, maintenance, and operation of decentralized systems (American Society of Agricultural Engineers 1977). This responsibility includes keeping necessary records, monitoring ground and surface water supplies and maintaining the financial solvency of the entity.

Otis and Stewart (1976) have identified various powers and authorities necessary to perform the functions of a management entity:

- To acquire by purchase, gift, grant, lease, or rent both real and personal property;
- To enter into contracts, undertake debt obligations either by borrowing and/or by issuing bonds, sue and be sued. These powers enable a district to acquire the property, equipment, supplies and services necessary to construct and operate small flow systems;
- To declare and abate nuisances;
- To require correction or private systems;
- To recommend correction procedures;
- To enter onto property, correct malfunctions, and bill the owner if he fails to repair the system;
- To raise revenue by fixing and collecting user charges and levying special assessments and taxes;
- To plan and control how and when wastewater facilities will be extended to those within its jurisdiction;
- To meet the eligibility requirements for loans and grants from the State and Federal government.