H. B. ROBINSON
STEAM ELECTRIC PLANT

316 DEMONSTRATION

CP&L
Carolina Power & Light Company

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1.0 Introduction

Volume II of the H. B. Robinson Steam Electric Plant 316 demonstration contains the results of extensive environmental studies as well as plant operating data which support Carolina Power and Light Company's contention stated in Volume I that "a balanced, indigenous population of shellfish, fish, and wildlife" is present in the Robinson Impoundment.

The studies were based on the enclosed study program agreed upon by the Environmental Protection Agency. Additions were made to the program as needs for additional information were identified and substitutions were made when necessary to insure a sound study program.

Additional raw data which were summarized in this volume are presented in Volume III.

H. B. Robinson Steam Electric Plant

316 Demonstration Study Program

(as submitted December 13, 1974)

PLANT OPERATING DATA

The following plant operating data are planned for inclusion in the Robinson Impoundment and Black Creek 316 study program:

1. Cooling water discharge for each unit and total for all units.

2. Time vs. delta temperature profile for condenser cooling water (at load factors of 1.0 and 0.8) from natural ambient through the cooling system to the point of discharge into the receiving water body and return to ambient.

3. Daily time vs. delta temperature profile at point of discharge under normal seasonal loads and maximum load conditions.

4. Schematic or construction drawings adequate to characterize intake configuration from point of intake to and including the screens.

5. Illustration and description of screening devices including operation cleaning, nekton return and debris disposal.

6. Profile (to scale) of intake velocity from point of intake from source of water to intake screens.

7. Schematic drawing and narrative describing configuration and velocity of discharge.

8. Description of condenser and intake cleaning methods to include types, quantities, effluent concentrations and application of biocides.

ENVIRONMENTAL DATA

The following environmental data are planned for inclusion in the Robinson Impoundment and Black Creek 316 study program:

1. Narrative description and scale drawings showing physical configuration of cooling water source.

2. The surface area, volume, mean depth, retention time and stratification of Robinson Impoundment.

3. Appropriate pool elevations.

4. Stream hydrology characters.

5. Scale drawings and tabulations at 2°C intervals of the thermal plume in three dimensions under full load conditions for summer and winter conditions. Robinson Impoundment does not exhibit fall or spring turnover.

6. Meteorological data used as input to thermal modeling and solar radiation effects on Robinson Impoundment.

BIOLOGICAL DATA

A map of the Robinson Impoundment showing sampling transects and points is presented in Figure 1. Transects are identified as A, B, C, CA, D, E, F, G, H, I, J, and K. Along transects A, B, C, CA, D, and E, three sampling stations, 1, 2, and 3, are identified, with sampling stations 1 and 3 located approximately one-quarter of the way across the impoundment from their respective shores, and sampling station 2 located at the transect middle. (Transect E-3 is located at the mouth of the discharge.)

PHYSICAL AND CHEMICAL ANALYSIS OF ROBINSON IMPOUNDMENT

Water temperature and dissolved oxygen concentrations are recorded monthly at three-foot intervals at each station identified in Table 1 with a portable dissolved oxygen and temperature field unit. Winkler titration (Standard Methods for the Examination of Water and Wastewater, 13th ed., 1971, APHA) may be utilized as a backup to the field unit. Temperatures are recorded in °C (XX.X) and converted to °F (XX.). Temperature data are also plotted to provide temperature isotherms on the surface and at various depths. Dissolved oxygen is recorded in ppm (XX.X) and correlated with sampled water temperatures to calculate percent saturation of oxygen.

Additionally, temperature will be taken monthly in the area of discharge (Figure 2). Transect lines will be run from the mouth of the discharge outward at angles of approximately 20, 40, 60, and 80 percent of the angle formed by the shoreline. Temperatures (°F) will be recorded on the surface at various points along these transects (dependent upon the location of the 1°, 2°, and 3° isotherms).

pH is sampled monthly at each station identified for water chemistry sampling using a field pH unit. Measurement is recorded to XX.X pH units.

Secchi disk depth is sampled monthly at water chemistry sampling stations by lowering a standard shallow water Secchi disk (20 cm.) over the side of the boat and noting the depth at which it disappears and the depth at which it reappears. The average of these two observations is recorded as the Secchi disk depth (in feet, X.X).

Water chemistry samples are collected monthly in the indicated area with a water sampler and transferred to labeled plastic bottles which are chilled and stored in a dark area prior to their return to the CP&L laboratory for analysis. Analytical methods of chemical parameters performed by the CP&L laboratory as of November 1, 1974, are indicated.

Parameter	Method of Analysis	Preservation Technique	Routine Laboratory Reporting Limit	Significance In Reporting Data
Alkalinity, (as $CaCO_3$) Total	ASTM Standards, pt. 23, 1972, D1067 Method A (Electrometric Titration) - Standard Methods for the Examination of of Water and Wastewater 13th Ed., 1971, APHA, Art 102 (Potentiometric Method for low alkalinity)	Analysis as soon as possible	0.5 mg/liter	X.mg/liter
Aluminum (Al) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3 - HCl)	Freezing or acidification to 0.15% HNO_3	0.1 mg/liter	.Xmg/liter
Aluminum, (Al) Dissolved	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 103B (Eriochrome Cyanine R Method)	Filtration followed by acidification to 0.15% HNO_3	0.01 mg/liter	.XXmg/liter
Ammonia, (as N)	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA. Art 132-132C (Distillation followed by phenate method or ammonia select-ion electrode)	Freezing or add'n of $HgCl_2$ and storage at 4°C	0.02 mg/liter	.XXmg/liter
Calcium, (Ca) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3 - HCl)	Freezing or acidification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter
Chemical Oxygen Demand, (COD)	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 220	Freezing or acidification with H_2SO_4	0.1 mg/liter	X.mg/liter
Chloride, (Cl^-)	ASTM Standards, pt. 23, 1972, D512, Reference Method A (Mercuric Nitrate Titration)	Freezing	0.25 mg/liter	.XXmg/liter
Chromium, (Cr^{+6}) Hexavalent	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 117A (s- diphenylcarbazide method)	Freezing	0.005 mg/liter or 5.0 µg/liter	.XXXmg/liter X.X µg/liter

Parameter	Method of Analysis	Preservation Technique	Routine Laboratory Reporting Limit	Significance In Reporting Data
Copper, (Cu) Total	Method for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 83-85 (Atomic absorption methods - direct or chelation - extraction)	Freezing or acdification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter
Copper, (Cu) Dissolved	Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 83-85 (Filtration through 0.45 micron filter followed by atomic absorption methods - direct or chelation-extraction)	Filtration followed by acidification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter
Hardness, (as $CaCO_3$)	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA 122B (EDTA Titrimetric Method)	Freezing	2.0 mg/liter	X.mg/liter
Iron, (Fe) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3 - HCl)	Freezing or acidifi-	0.05 mg/liter	.XXmg/liter
Lead, (Pb) Total	Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 105-106 (Atomic absorption methods - direct or chelation - extraction)	Freezing or acidification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter

Parameter	Method of Analysis	Preservation Technique	Routine Laboratory Reporting Limit	Significance In Reporting Data
Orthophosphate, (as P) Total	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 223 (Ascorbic Acid Method)	Freezing	0.01 mg/liter	.XXmg/liter
Phosphate, (as P) Total	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 223 (Persulfate Digestion followed by Ascorbic Acid Method)	Freezing	0.01 mg/liter	.XXmg/liter
Silica, (as SiO_2) Dissolved	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 151B-151C (Heteropoly Blue Method)	Freezing after collection in a plastic container	0.1 mg/liter	.Xmg/liter
Sodium, (Na) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3 - HCl)	Freezing or acidification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter
Solids, Total Dissolved (Filterable)	Methods for Chemical Analysis of Water and Wastes, 1971, EPA, pp. 275-277 (Glass Fiber Filtration Method, 180°C) - Data reported below 10 mg/liter for all solids is not really significant, but indicates order of magnitude	Freezing or analysis as soon as possible	1.0 mg/liter	X.mg/liter
Solids, Total Suspended (Non-filterable)	Methods for Chemical Analysis of Water and Wastes, 1971, EPA, pp. 278-279 (Glass Fiber Filtration Method, 103-105°C)	Freezing or analysis as soon as possible	1.0 mg/liter	X.mg/liter

Parameter	Method of Analysis	Preservation Technique	Routine Laboratory Reporting Limit	Significance In Reporting Data
Magnesium, (Mg) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3 - HCl)	Freezing or acidification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter
Manganese, (Mn) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3 - HCl)	Freezing or acidification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter
Mercury, (Hg) Total	Methods for Chemical Analysis of Water and Waste, 1971, EPA, pp. 121-130 (Cold-vapor technique)	Freezing or acidification to 0.15% HNO_3	0.001 mg/liter or 1.0 μg/liter	.XXXmg/liter X.Xμg/liter
Nickel, (Ni) Total	Method for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 115-116 (Atomic absorption methods - direct or chelation - extraction)	Freezing or acidification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter
Nickel (Ni) Dissolved	Method for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 115-116 (Filtration through 0.45 micron filter followed by atomic absorption methods - direct or chelation - extraction)	Filtration followed by acidification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter
Nitrate (as N)	Methods for Chemical Analysis of Water and Wastes 1971, EPA, pp. 170-174 (Brucine-Sulfate Method)	Freezing or add'n of $HgCl_2$ and storage at 4°C	0.05 mg/l	.XX mg/l
Nitrogen, (N) Organic	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA Art 135, 132C - Digestion and distillation followed by phenate method or ammonia select-ion electrode (Ammonia Nitrogen *plus* Organic Nitrogen = Total or Kjeldahl Nitrogen)	Freezing or add'n of $HgCl_2$ and storage at 4°C	0.02 mg/liter	.XXmg/liter

Parameter	Method of Analysis	Preservation Technique	Routine Laboratory Reporting Limit	Significance In Reporting Data
Solids, Total Volatile	Methods for Chemical Analysis of Water and Wastes, 1971, EPA, pp. 282-283 (Gravimetric Method, 550°C)	Freezing or analysis as soon as possible	1.0 mg/liter	X.mg/liter
Solids, Total	Methods for Chemical Analysis of Water and Wastes, 1971, EPA, pp. 280-281 (Gravimetric Method, 103-105°C)	Freezing or analysis as soon as possible	1.0 mg/liter	X.mg/liter
Sulfate	ASTM Standards, pt. 23, 1972, D516, Reference Method A (Turbidimetric Method)	Freezing, Filtration prior to analysis	1.0 mg/liter	.Xmg/liter
Turbidity	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 163A (nethelometric method)	Freezing	0 FTU	X.X FTU
Zinc, (Zn) Dissolved	Atomic Absorption Spectrophotometer (filtration through 0.45 micron filter)	Filtration followed by acidification to 0.15% HNO_3	0.05 mg/liter	.XXmg/liter
Zinc, (Zn) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3 - HCl)	Freezing or acidifi-	0.05 mg/liter	.XXmg/liter

PLANKTON POPULATION MONITORING AT ROBINSON IMPOUNDMENT

Plankton samples will be taken in accordance with the schedule presented in Table 1. Pigment concentration, primary productivity, and standing crop will be determined from which species diversity and spatial and temporal abundance can be calculated.

Pigments - Samples for pigment analysis are taken monthly at each of the plankton stations with a water sampler. The water sampler is large enough to allow for subsamples to be taken for pigment analysis, primary productivity, and standing crop whenever scheduling requires that more than one analysis be performed. Samples are taken at various depths, depending upon Secchi depth, as follows:

________________ surface
________________ 1/2 Secchi depth
________________ Secchi depth/or bottom
________________ 2x Secchi depth/or bottom
________________ 4x Secchi depth/or bottom

Samples are transferred from the sampler to labeled plastic bottles, preserved with magnesium carbonate, chilled, and stored in a dark area before being returned to the laboratory for immediate filtration and extraction. Analysis includes spectrophotometric and/or fluorametric determinations from acetone extracts of millipore filter concentrates as described in Strickland and Parsons (1968) and Golterman (1969). Significance in reporting data is X.X μgm/liter.

Primary productivity - In situ primary productivity is determined once quarterly by use of the C^{14} fixation method at each of the plankton sampling stations. Water samples are taken with the Wildco Beta bottle water sampler from depths as described previously. From each depth, initial, zero time control and light bottle samples are taken. The initial samples are stored on ice in the dark for alkalinity determinations; the zero time control samples are innoculated with C^{14}, immediately fixed with Lugol's iodine and stored in the dark; and the light bottles are innoculated with C^{14}, incubated in situ for three hours and fixed at the end of the innoculation time with Lugol's iodine.

Counting of C^{14} samples is by liquid scintillation. Laboratory analysis procedures and calculations follow established methods based on the original work of Nielsen (1952) and revised as described in Vollenweider, ed. (1969). Use of a zero time control was suggested by Dr. John E. Hobbie of North Carolina State University based on the work of Morris, Yentsch and Yentsch (1971).

Standing crop - Once quarterly, whole water samples are collected from the depths described previously at each of the plankton sampling stations. Concentrated net samples are also collected using a #20 mesh Wisconsin type plankton net. All samples are fixed in the field with Lugol's iodine, stored in a dark, cool area, and returned to the laboratory for phytoplankton and zooplankton identification, enumeration, and biomass estimates; Identification and enumeration methods include use of a 1 ml. Sedgwick-Rafter cell using a variable number of cells (at 100x) and a variable number of random fields (at 100x and 200x) and/or Utermohl sedimentation with an inverted microscope using a variable number of chambers (at 100x) and a variable number of random fields (at 100x, 200x, and if necessary, 400x and 1000x). All organisms are identified to the lowest taxon practicable using standard taxonomic references.

Biomass estimates are made using a Whipple grid micrometer to determine average volume per cell. Calibration is performed with a stage micrometer at 100x, 200x, 400x, and 1000x. Biomass is reported in XX μgm/liter.

Analysis of standing crop is performed for both number and biomass. These data can then be incorporated into a PL-1 computer program which can be used to calculate the Shannon-Werner index of general species diversity for both number and biomass (Copeland and Birkhead, 1972).

MACROBENTHIC MONITORING AT ROBINSON IMPOUNDMENT AND BLACK CREEK

Benthos samples will be taken in accordance with the schedule presented in Table 1. Samples will be analyzed for identification of organisms from which species diversity and spatial and temporal abundance can be analyzed.

Samples are collected monthly from two stations (deep and shallow) on each of nine permanent transects (Table 1) using a petite ponar grab and/or artificial substrate samplers. Three replicate samples are collected from each station. Samples are washed through a U. S. Standard No. 30 sieve and preserved in formalin.

Samples are sorted in the laboratory and preserved in 70% alcohol. Biological stains, rose bengal and phyloxine B, are frequently used as aids to sorting. All organisms are identified to the lowest taxon practicable using binocular and compound microscopes and standard taxonomic references.

After 24 hours of storage in fresh water, representative organisms from all samples are weighed to the nearest 0.001 gm.

Data are reported monthly in tabular form, expressing number of organisms/unit area and fresh weight biomass (gm/unit area) for each station.

FISHERIES MONITORING AT H. B. ROBINSON IMPOUNDMENT AND BLACK CREEK

Purpose: Collection and analysis of representative samples of the fish population of the Impoundment pursuant to the requirement for a 316(a) Demonstration.

Objectives:

1. Determine species composition relative abundance, and standing crop of fishes in various areas of the Impoundment.

2. Determine f. I habits, age, growth rate, maturity, and fecundity of repres .tive species in the Impoundment.

3. Determine the extint of reproductive activity in the immediate area of discharge and evaluate potential damage to the fishery by entrainment of ichthyoplankton.

Sample Period:

1. Annually - cove sample with rotenone

2. Quarterly - gill nets, wire traps, and seine

3. At minimum bi-weekly* during the spawning season - entrainment and spawning activity.

Sample Design:

1. Stations 1 and 3 on transects A, C, E, and G, (Figure 1) will be sampled with 100-foot experimental gill nets (equal panels of 1/2, 1, 1 1/2, 2-inch bar mesh) and wire traps (1-inch poultry netting) for approximately 48 hours. One stream station above and two stream stations below the Impoundment (H, J, and K) will be sampled with 50-foot experimental gill nets (1/2, 1, 1 1/2, and 2-inch bar mesh) and wire traps. Nets and traps will be checked at least every 24 hours and catches will be reported as number and/or weight per unit time. Shoreline stations on these transects will be sampled with a small mesh bag seine over a constant area and catches reported as number or weight per haul. All fish collected are identified, counted, weighed, and measured. Live fish in good condition are tagged and released when possible. A reference collection will be made and maintained, and representative samples of largemouth bass, bluegill, and white catfish will be retained for age-growth, stomach, and gonad analysis.

*Bi-weekly is used to indicate monitoring which occurs once each two weeks.

2. Selected coves of the impoundment (upper, mid, and lower area) and three stream stations (H, J, and K) will be blocked off with small mesh nets and rotenone applied by accepted methods. All fish recovered will be identified, counted, weighed, and measured. These data will be used in estimating the standing crop of fishes in the Impoundment and Black Creek. Largemouth bass, bluegill, and white catfish collected will be used in age-growth, stomach, and gonad analysis.

3. Largemouth bass, bluegill, and white catfish will be examined for food habits, age, growth rate, maturity, and fecundity. Stomach contents will be removed, sorted, identified, and quantified volumetrically. Scales (pectoral spines from white catfish) are read in the laboratory to determine annual growth increments. Age-growth relationships will be computed if sufficient numbers of fish are obtained. Gonad maturity will be determined by gross inspection to determine spawning periods and fecundity will be estimated using gravimetric subsampling techniques.

4. The immediate discharge area will be examined during the spawning seasons to evaluate spawning and nursery areas. Plankton sampling techniques will be employed to determine the relative abundance of fish eggs and larvae. Visual observations will be combined with seining and other techniques such as larval fish nets and electrofishing at night in near shore areas to determine the presence or absence of spawning adults and young-of-the-year. Entrainment of ichthyoplankton in the plant cooling water system will be monitored bi-weekly* during the major spawning period by sampling the intake area with accepted ichthyoplankton sampling techniques. Samples will be collected more frequently if numbers collected indicate potential damage to the fishery. Estimates will be made of the total number of fish eggs and larvae entrained.

*Bi-weekly is used to indicate monitoring which occurs once each two weeks.

TERRESTRIAL MONITORING OF ROBINSON IMPOUNDMENT AND BLACK CREEK

Purpose: Implement a sampling program pursuant to the requirements for a 316(a) Demonstration.

Objectives: 1. Identify those vertebrate species (except fish) living adjacent to, on, or in the Robinson Impoundment and Black Creek which are dependent upon the aquatic ecosystem for some portion of their life cycle.

2. Determine the nature and extent of dependence upon the aquatic ecosystem by those organisms from above.

3. Provide a scale map showing major beds of vascular plants and maintain herbarium specimens of all species collected.

4. Determine the possible effects of thermal discharge on those species dependent on the Impoundment ecosystem.

Sample Period: Quarterly.

Sample Design - Avifauna

1. Establish two 10-mile survey routes, one each on the east and the west shores of the Impoundment. Locate observation points at 1-mile intervals along each survey route. (11 points per route)

2. Spend five minutes at each point listening and observing. Record sitings by species and number.

3. Travel by boat at approximately 12 mph between points. Observations between stops will also be recorded.

4. Four surveys will be conducted during each quarterly sample. One morning and one evening survey will be conducted along each route.

5. Morning surveys begin at official sunrise, and evening surveys end at official sunset.

6. Stations H and K on Black Creek below the Impoundment will be sampled once daily during each sample period.

Sample Design - Mammals

1. Set live traps at selected points along the shoreline for a minimum of three nights during each sample period.

2. Observe nocturnal activity using boats and spotlights.

3. Observe shoreline areas for tracks and other signs.

4. Observations will also be made in conjunction with other aspects of the sample program.

Sample Design - Herptiles

1. Observe and identify reptile and amphibian species during all phases of the study.

2. Special emphasis will be placed on attempting to determine the extent of amphibian reproductive activity during spring and summer near the discharge site. This will involve cooperation with the aquatic sampling program.

Sample Design - Vegetation

1. Map major areas of aquatic vascular vegetation in the Impoundment and Black Creek (at stations H, J, and K).

2. Compile and maintain a species list and herbarium specimens for all plants collected.

TABLE 1

FIELD SAMPLING SCHEDULE AND SAMPLING LOCATIONS

	A			B & CA			C			D			E			F	G	H	I	J	K
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3						
Abiotic																					
Water Temperature (Monthly)																					
Surface	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Every 3 feet bottom	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dissolved Oxygen (Monthly)																					
Surface	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Every 3 feet to bottom	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Water Chemistry (Monthly)[a]																					
Surface	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	X	X	X	X
Bottom	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-	-
Biotic																					
Plankton																					
Pigment (Monthly)	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-	-
Primary Productivity (Quarterly)	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-	-
Standing Crop (Quarterly)	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-	-
Benthos (Monthly)		b		-	-	-		b			b			b		b	b	b	-	b	b
Fishery (Quarterly)		c		-	-	-		c		-	-	-		c		-	c	c	-	c	c

[a]A complete list of water chemistry parameters is provided in Table 2.

[b]Along designated transect at deep and shallow stations.

[c]Along designated transect.

TABLE 2

CHEMICAL PARAMETERS TO BE MONITORED

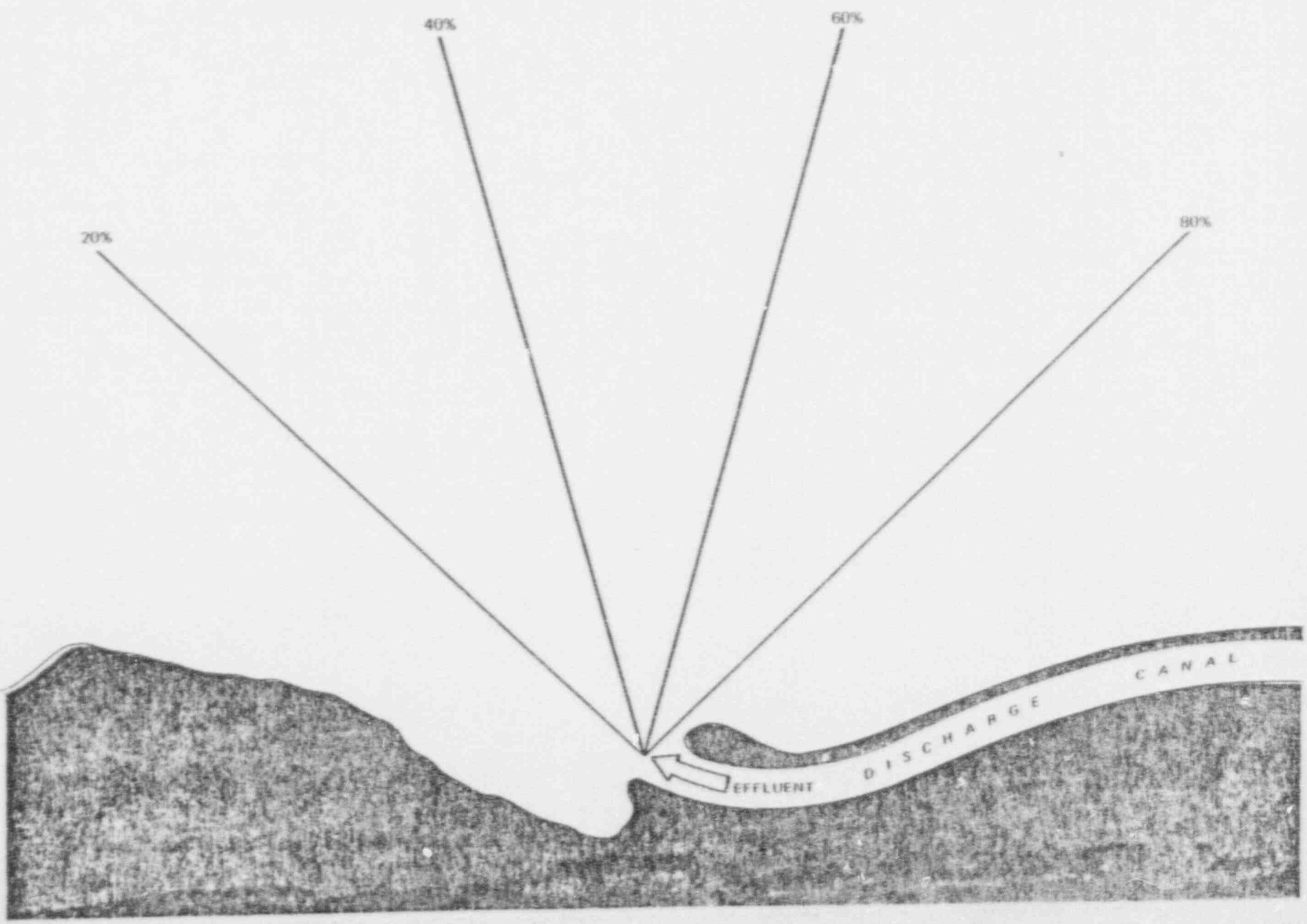
Total solids	Sulphate	Total zinc †
Total volatile solids	Total alkalinity ($CaCO_3$)	Dissolved zinc* †
Total suspended solids	Hardness	Total sodium †
Total dissolved solids	Dissolved silica	Total aluminum
Ammonia (As N)	Chloride (Cl^-)	Dissolved aluminum †
COD	Total chromium (hexavelent)	Total mercury
Kjeldahl nitrogen	Total copper †	Total calcium†
Nitrate (As N)	Dissolved copper* †	Total magnesium †
Ortho-phosphate (As P)	Total iron	Total manganese†
Total phosphate (As P)	Total lead †	Total nickel †
	pH (field analysis)	Dissolved nickel* †
		Turbidity

*Dissolved copper, zinc, aluminum, and nickel will be measured only when the total levels of these metals exceed a level of 0.05 ppm.

†Parameters to be analyzed twice yearly.

Figure 1
ROBINSON IMPOUNDMENT AND BLACK CREEK SAMPLING TRANSECTS AND SAMPLING POINTS

FIGURE 2. H. B. ROBINSON EFFLUENT SAMPLING TRANSECTS



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2.0 Plant Operating Data

2.1 Circulating Water System

The circulating water system for the H. B. Robinson plant provides for the condensation of steam from the main turbines of both units. Circulating water is withdrawn from the impoundment near the dam, passed through the main condensers for both units, and returned via the discharge canal to the impoundment approximately 6.7 km (4.2 miles) north of the plant (Figure 2.1.1).

Table 2.1.1 lists the circulating water system flow rates, temperature rise across the condenser, and the average heat rejected for both units.

The intake structures for both units are located on the west bank of the impoundment near the dam. Unit 1 has two pumps, Unit 2 has three pumps, each with a separate intake bay. The entire structure is 13.2 meters (43.4 feet) wide, 19.7 meters (64.5 feet) long, and 13.9 meters (45.5 feet) high. Water is withdrawn from the impoundment between 5.5 meters (18 feet) and 11.0 meters (36 feet). Plan views and vertical sections for Units 1 and 2 are shown in Figures 2.1.2 through 2.1.5.

Flow velocity magnitudes were measured across selected cross sections of the H. B. Robinson Units 1 and 2 intake structures and the common discharge canal. These measurements were used with other data sources, specifically, design flow rates, geometrical configurations, and observation, to construct expected flow velocity profiles within the intake structures from point of entry to the face of the traveling screens and within the canal from the origin to the weir. The measurements are generally expected to be accurate to within 10%.

A detailed presentation of the flow measurements and analysis is included as Exhibit 1.0 (VOL. III). Figures 2.1.11 and 2.1.12 show side views of the Unit 1 intake bays with assumed streamlines and measured velocity magnitudes included. The velocities given are simple averages of five measurements taken laterally at the elevations shown. Similar results for the three

bays of the Unit 2 intake structure are presented in Figures 2.1.13, 2.1.14, and 2.1.15. In Tables 1.1 through 1.6 of the exhibit, all the individual intake velocity measurements are given.

Within the Unit 1 intake structure, the flows were generally below .46 m/sec (1.5 ft/sec). The profile is somewhat skewed away from the bottom because of the 4.72 m (15.5-foot) vertical section of the bay floor. There appeared to be local high-velocity spots near the edges of the horizontal support columns and there was a recirculation region near the water surface.

Within the Unit 2 bays, the vertical profiles were fairly flat and velocities generally ranged from .31 m/sec to .92 m/sec (1.0 to 3.0 ft/sec) except in the recirculation region near the surface where flows were generally less than .31 m/sec (1 ft/sec). The design flow per bay of 6.1 x 10^5 1/min (160,700 gpm), or 102 m^3/sec (358 ft^3/sec), would imply an average velocity of .5 m/sec (1.65 fps) at the smallest physical cross-sectional area within the bay. The measured velocities compare reasonably with this result. Again, high velocities near the horizontal support columns were apparent, especially at a depth of 3.89 m (12.75 ft) in Bay A where the only flows above .92 m/sec (3 ft/sec) were recorded. This high velocity channel appeared to be a localized phenomenon since velocities measured 1.22 m (4.0 ft) above and below this depth were below .61 m/sec (2 ft/sec) (Figure 2.1.12).

Screening devices for both units are redundant traveling water screens with .95 cm (3/8-inch) mesh (Figure 2.1.6). The screens travel vertically at two speeds, 3 meters (10.0 feet) per minute, and .76 meters (2.5 feet) per minute. All material washed from the screens during the daily cleaning is flushed via the storm drains into Black Creek below the impoundment.

Each generating unit has its own separate condenser. Unit 1 has a two pass condenser with two water boxes. The Unit 2 condenser is a once-through type with four water boxes. To cont ' fouling in the condenser tubes, a 15% sodium hypochlorite solution is fed to the condenser boxes for one-half hour once each day. Maximum daily effluent concentration from the condenser is .5 mg/1 free available chlorine not to exceed a

monthly average of .2 mg/1. Once each month approximately 45 kilograms (100 lbs.) of ferrous sulfate is added to the condenser to help protect the tubes.

The condensers are periodically cleaned by passing scrapper plugs through the tubes. Unit 1 is cleaned by this method two to three times per year; Unit 2 is normally cleaned during the annual outage. Debris from these operations is washed back to the impoundment via the discharge canal.

After passing through the condensers, the circulating water from both units is routed into a common discharge canal by a sealwell structure. The discharge canal runs along the west shore of the impoundment and terminates with a weir located 6.8 km (4.2 miles) north of the plant. Diagrams of the discharge canal and the weir are shown in Figures 2.1.7 and 2.1.8.

Flow measurements were made at 20% and 80% depths at various positions across the discharge canal at a point approximately .97 km (0.6 miles) from the canal origin. The results of these measurements are shown in Figure 2.1.16. This is expected to be typical of the flow pattern all along the canal since the basic cross section is unchanged. It is seen that the flow over most of the canal varies between .45 m/sec and .76 m/sec (1.5 and 2.5 ft/sec). This range of velocities is generally consistent with discharge canal design flows at the weir.

Flows over the weir were measured at half-depth .61 m (2 feet) and found to be nearly constant laterally at around 2.01 m/sec (6.6 ft/sec). Figure 2.1.17 gives the five measured velocities and the measurement positions.

Table 2.1.2 provides the average monthly circulating water system parameters from April, 1975 through May, 1976. Comparing Table 2.1.2 with Table 2.1.1 indicates that the plant load is rarely equal to the design generating capacity on a monthly average, and that the rise across the condensers seldom approaches the rise with a load factor of 1.0. The average delta temperature profiles for the plant circulating water system at load factors 1.0 and 0.8 are shown in Figure 2.1.9. The daily delta temperature profile for the circulating water system is shown in Figure 2.1.10.

Table 2.1.1 Circulating water system, Robinson Plant (Load factor = 1.0)

Average CWS Flow, Unit 1	5.52 m^3/sec	(87,500 gpm)
Average CWS Flow, Unit 2	30.42 m^3/sec	(482,100 gpm)
Average Service Water Flow, Unit 2	1.51 m^3/sec	(24,000 gpm)
Average Plant Discharge	37.45 m^3/sec	(593,600 gpm)
Average Condenser Rise - Across Unit 1	13.33°C	(24°F)
Average Condenser Rise - Unit 2	11.11°C	(20°F)
Average Condenser Rise - Both Units	11.28°C	(20.3°F)
Average Heat Rejected - Unit 1	3.08 x 10^8W	(1.05 x 10^9 BTU/hr)
Average Heat Rejected - Unit 2	1.46 x 10^9W	(5.00 x 10^9 BTU/hr)
Average Heat Rejected - Both Units	1.77 x 10^9W	(6.05 x 10^9 BTU/hr)

Table 2.1.2 H. B. Robinson Steam Electric Plant average monthly circulating water system parameters April 1975 - May 1976.

Month	Robinson** Impoundment Discharge	Average Hourly Gross Plant Generation	CWS Flow	Average*** Intake Temperature	Average Discharge Temperature	Average Plant Rise
	m^3/Sec.	(MWe)	m^3/Sec	°C	°C	°C
Apr. '75	9.3	364.8	26.7	19.9	24.8	4.9
May '75	7.6	234.3	24.0	23.0	27.3	3.4
June '75	5.2	687.7	34.5	28.6	37.4	8.8
July '75	12.7	776.4	36.6	29.0	38.9	9.9
Aug. '75	6.2	812.2	37.4	31.2	41.4	10.2
Sept. '75	8.1	762.1	36.7	29.0	38.2	9.2
Oct. '75	6.3	735.4	35.5	25.4	34.5	9.1
Nov. '75	6.7	129.6	20.7	18.8	21.6	2.8
Dec. '75	7.4	461.6	31.0	12.6	18.0	5.4
Jan. '76	8.8	669.3	29.2	11.4	21.9	10.5
Feb. '76	8.1	750.5	32.5	15.4	25.7	10.3
Mar. '76	7.4	728.2	33.5	19.6	29.1	9.5
Apr. '76	5.0	685.1	31.9	22.3	31.8	9.5
May '76*	5.8	618.6	32.0	25.2	35.3	10.1

*Preliminary
**Apr-Sept 1975 USGS water resources data; Oct 75-Apr 76 USGS provisional record
***Measured at condensers

Figure 2.1.1 Robinson Impoundment

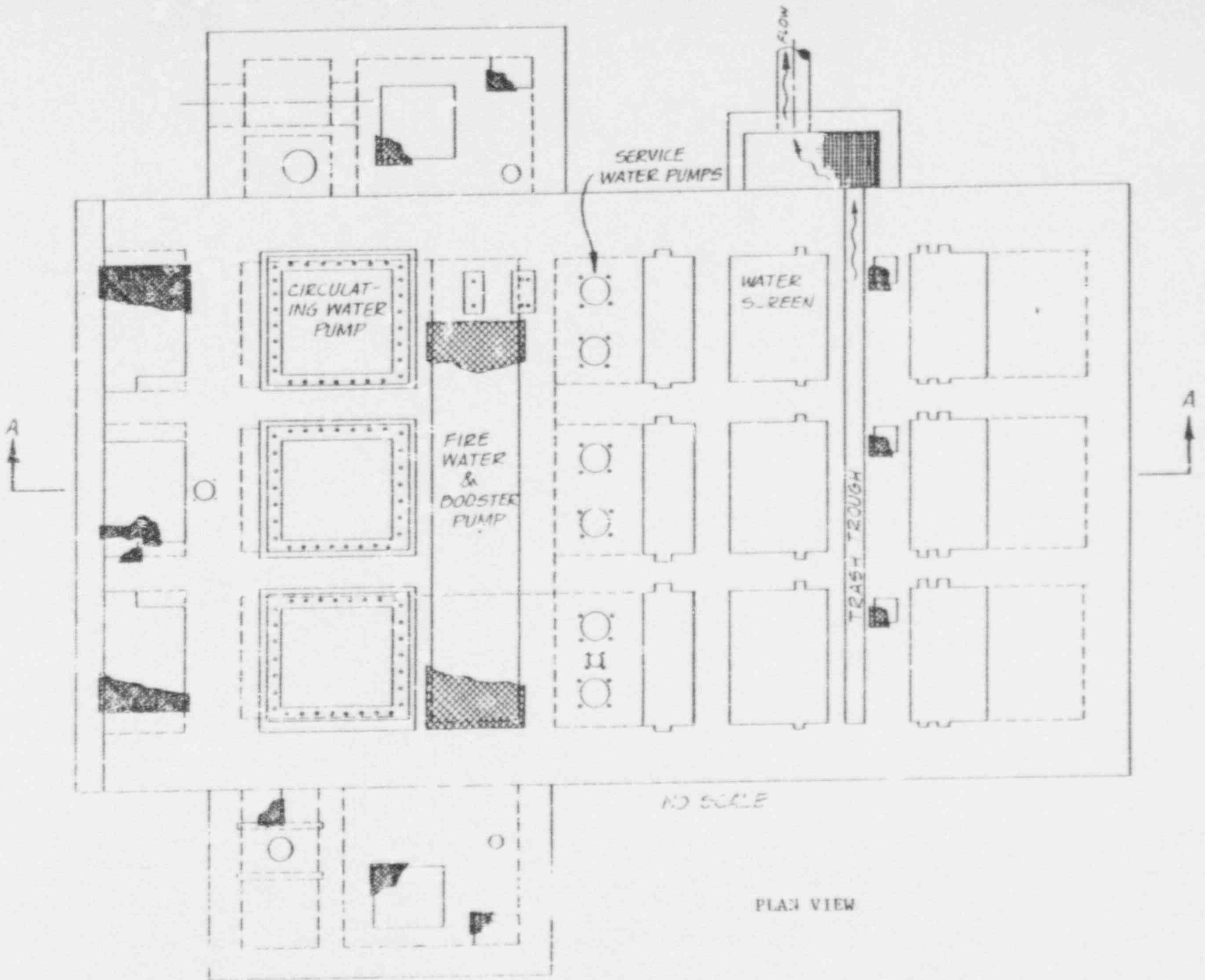

Figure 2.1.2 Intake structure, Unit 2, plan view

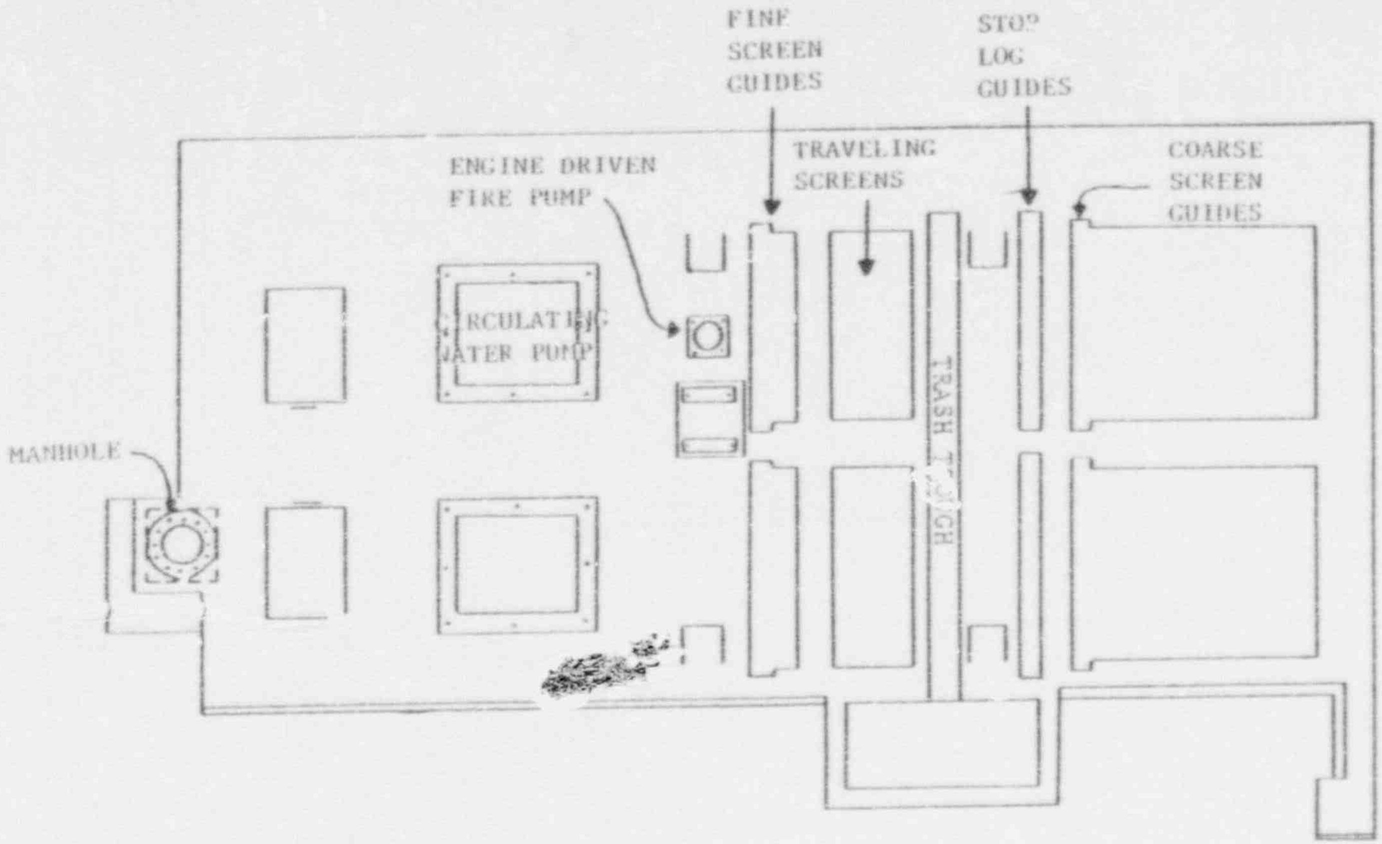

Figure 2.1.3 Intake structure, Unit 1, plan view

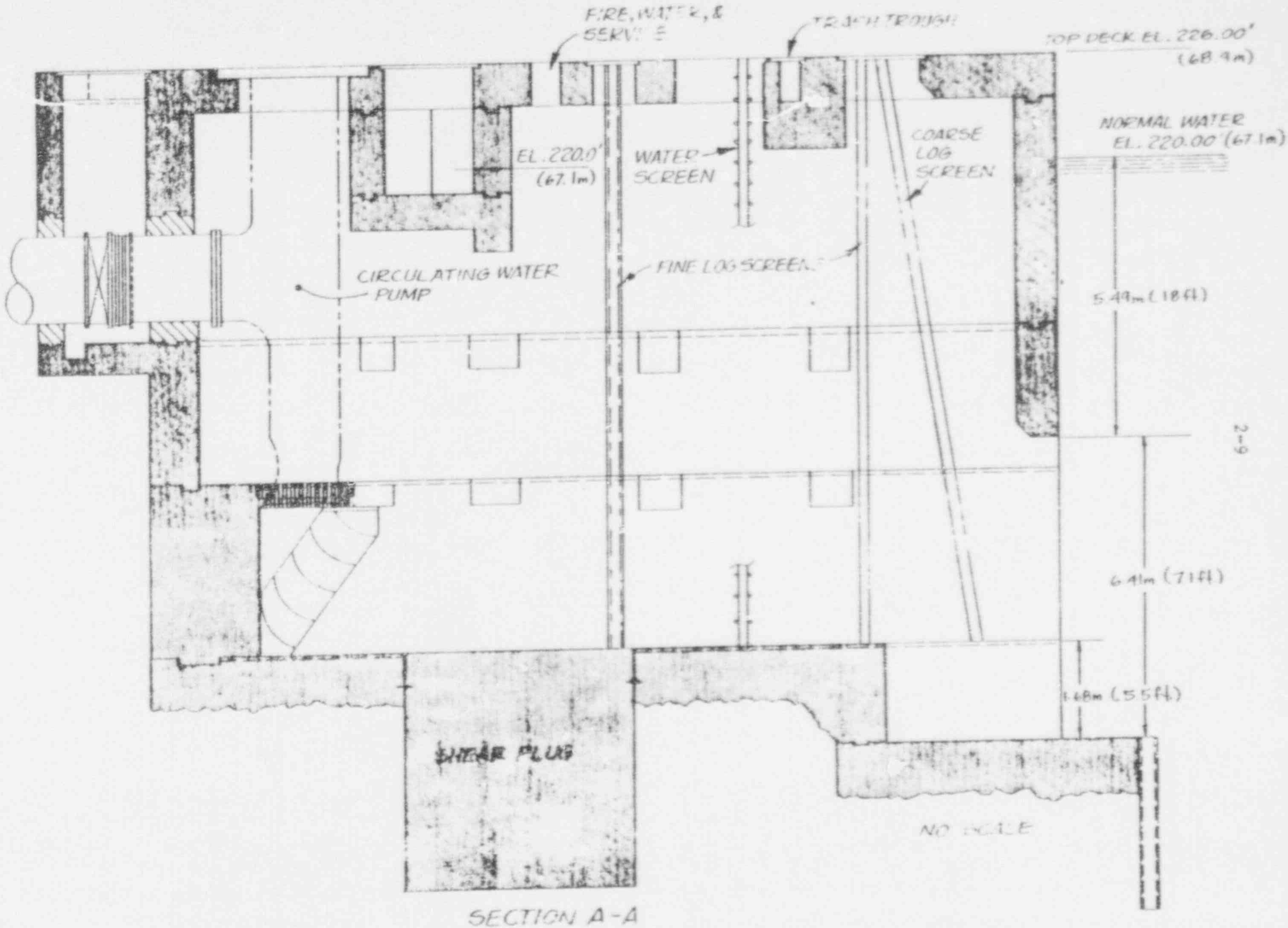

Figure 2.1.4 Intake structure, Unit 2, vertical section

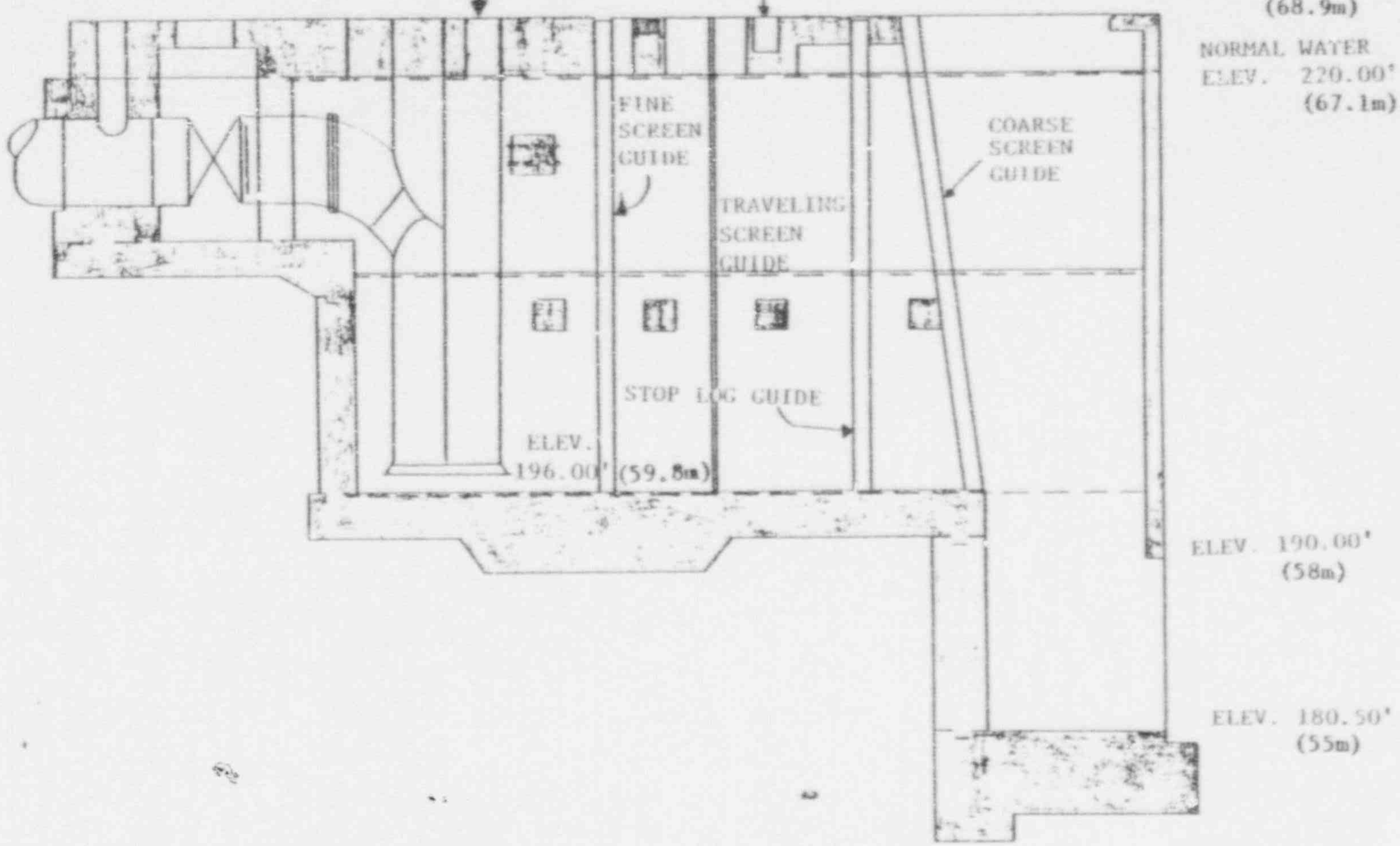

Figure 2.1.5 Intake structure, Unit 1, vertical section

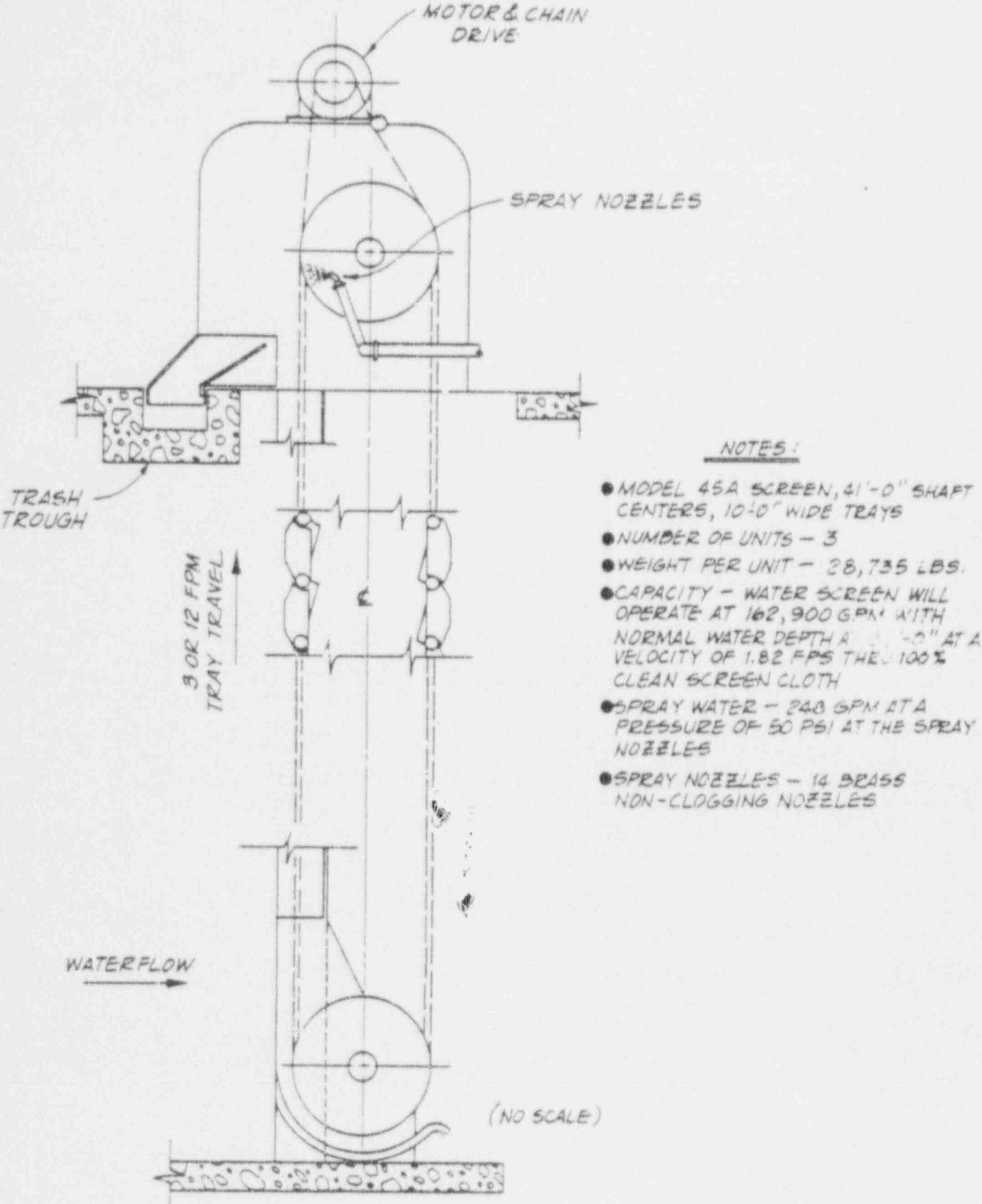

Figure 2.1.6 Intake screens, Unit 2

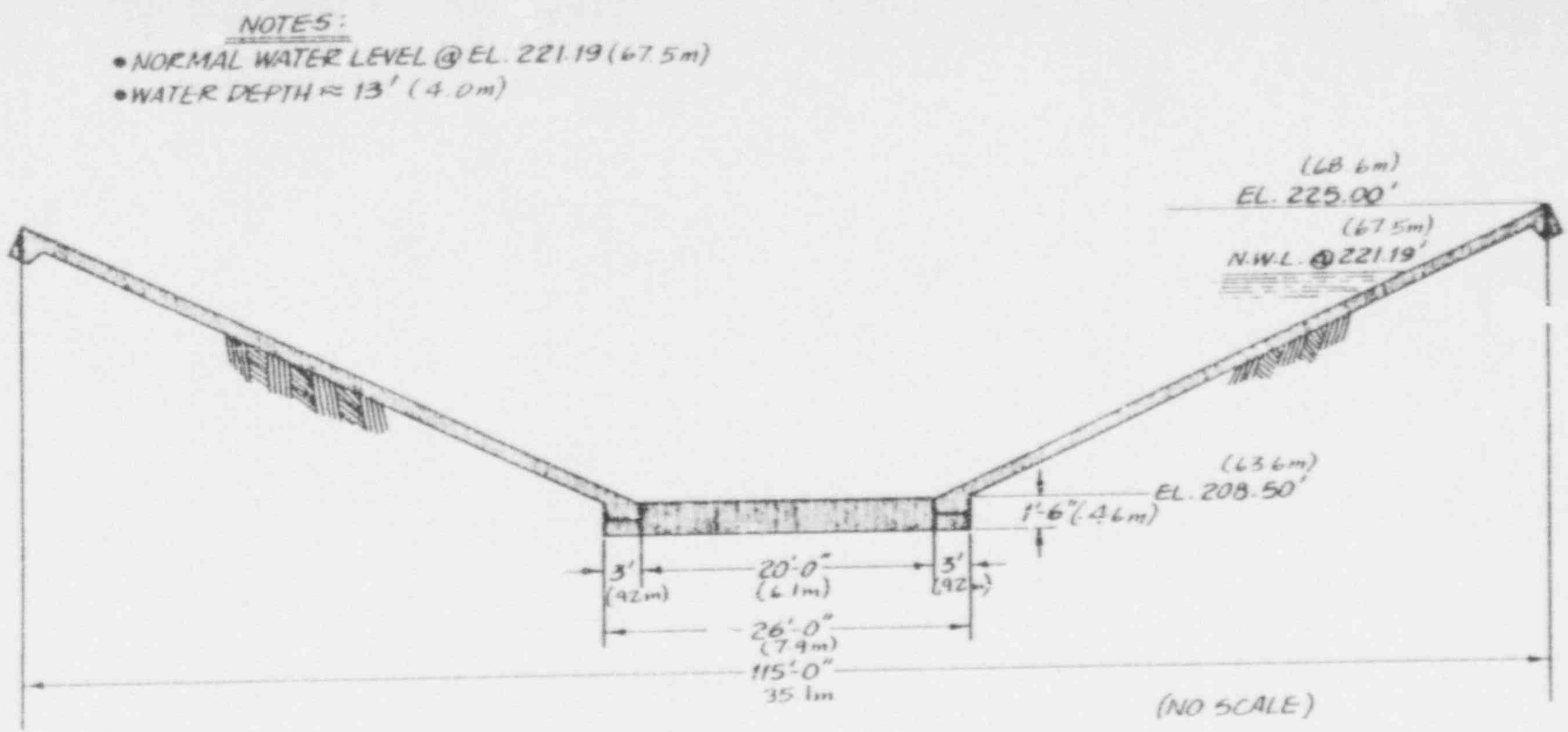

Figure 2.1.7 Discharge canal, cross section

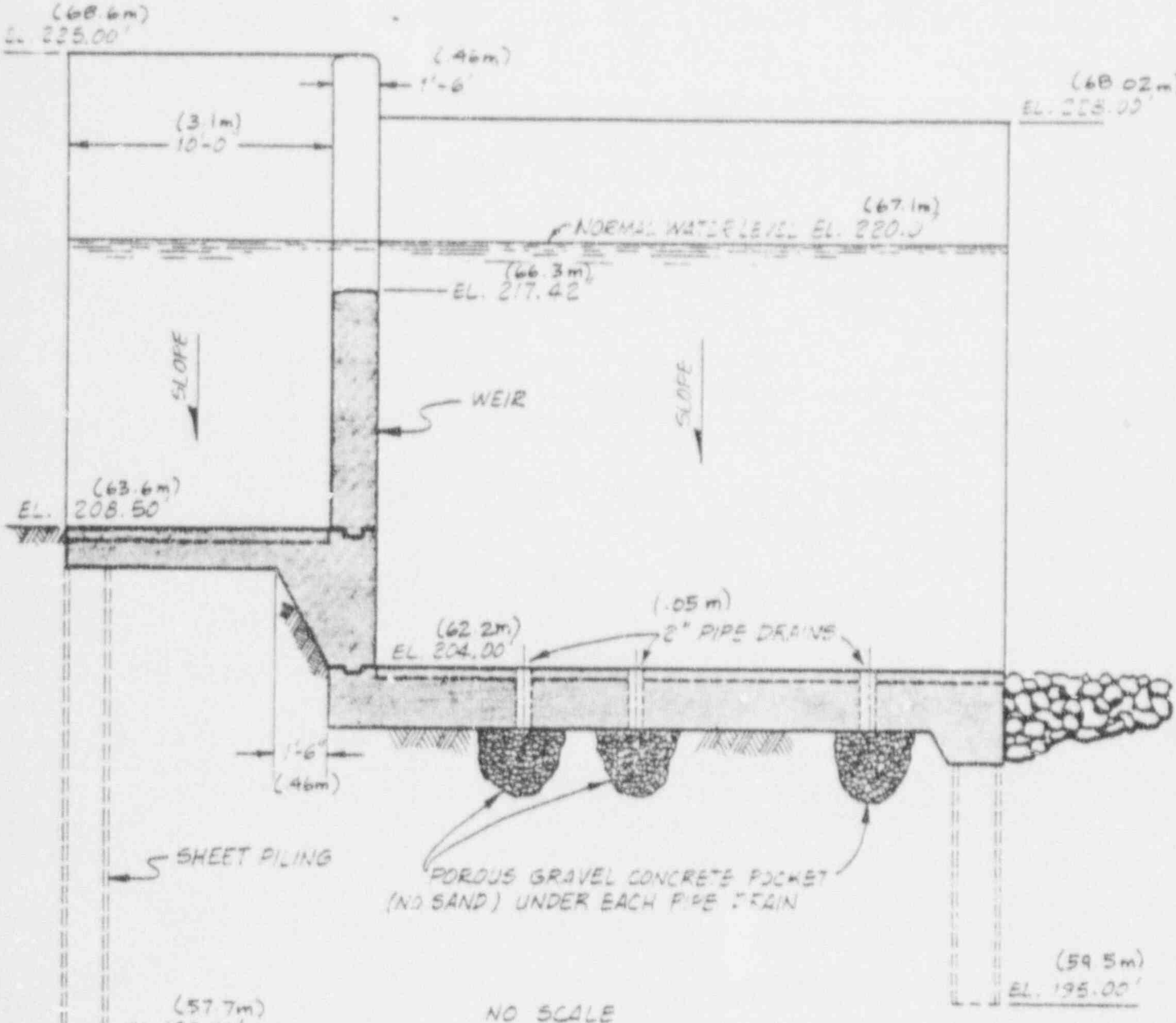

Figure 2.1.8 Discharge canal intersection with impoundment

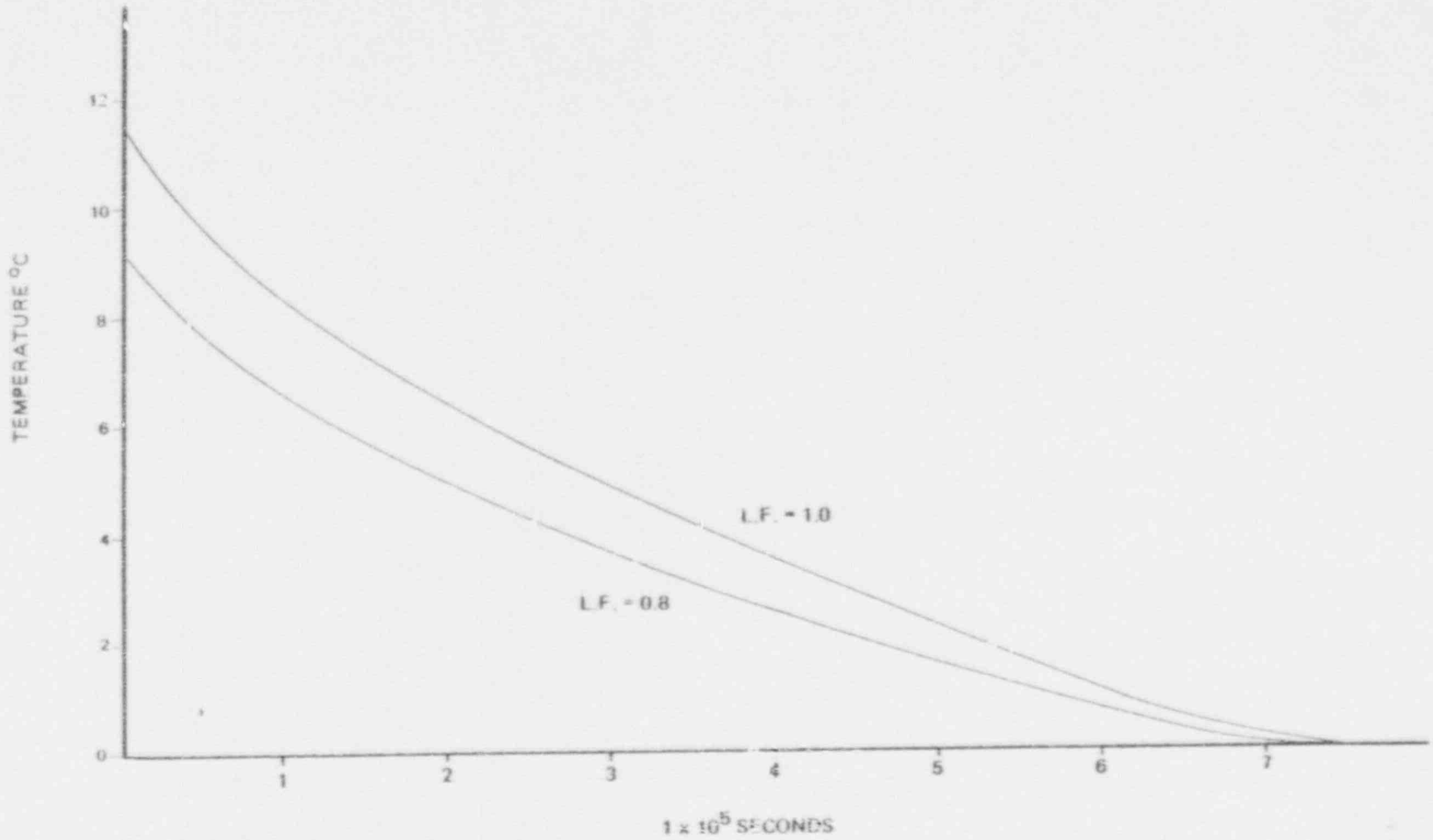

Figure 2.1.9 Circulating Water System, Time vs. Temperature Profile

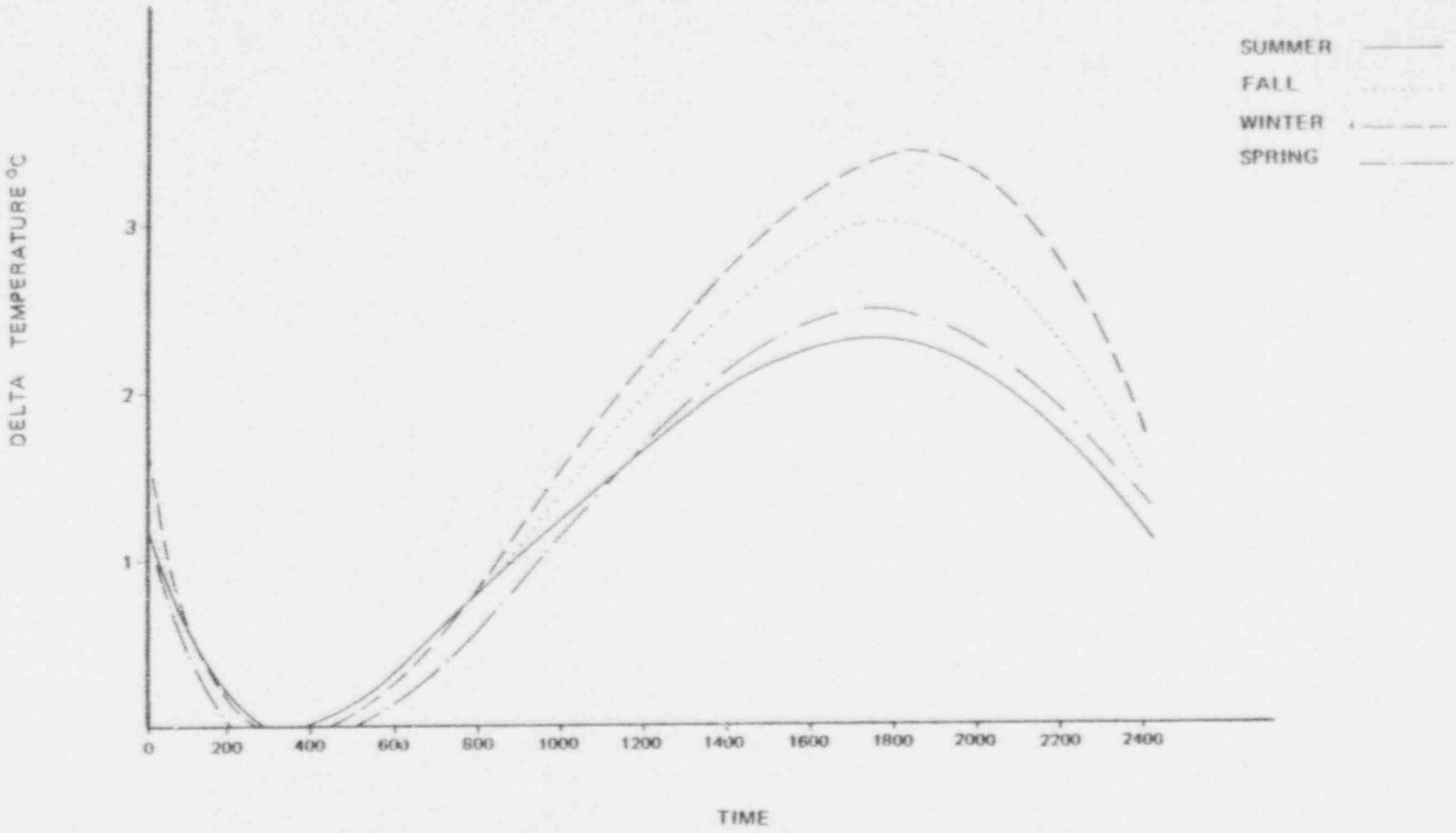

Figure 2.1.10 H. B. Robinson Steam Electric Plant
Typical Daily Variation in the
Temperature of Plant Discharge

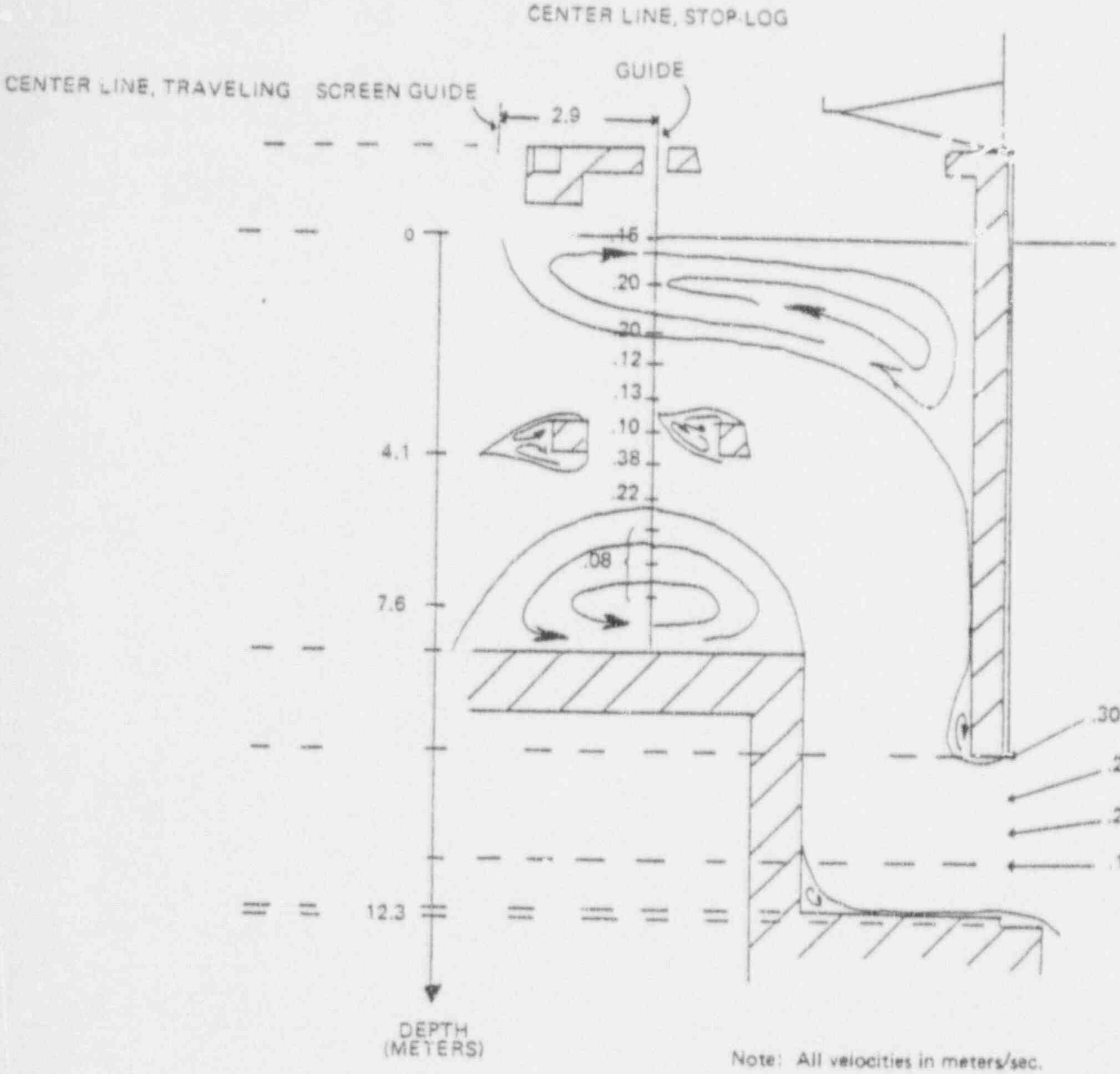

Figure 2.1.11. Flow pattern within Bay A, Unit 1 intake structure

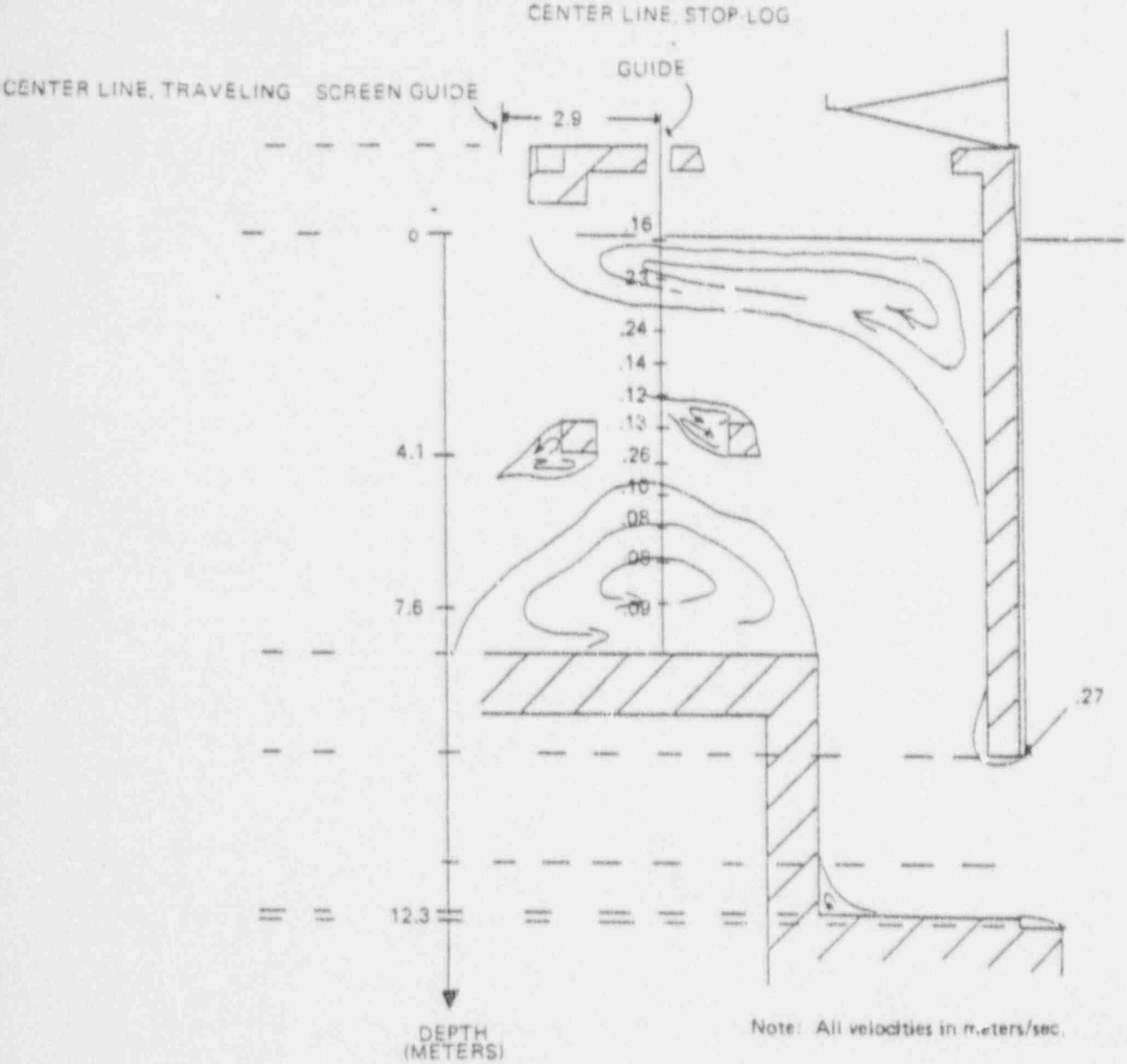

Figure 2.1.12 Flow pattern within Bay B, Unit 1 intake structure

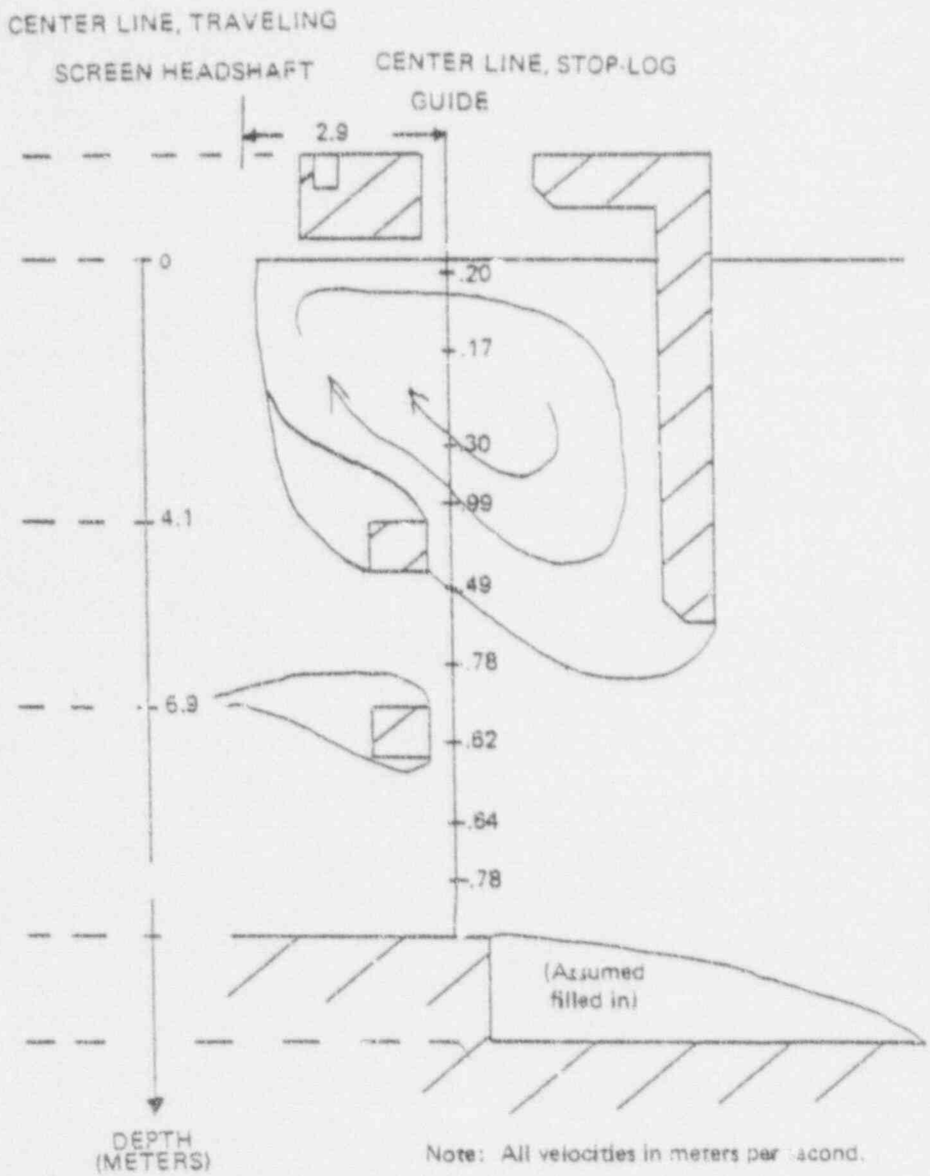

Figure 2.1.13 Flow pattern within Bay A, Unit 2 intake structure

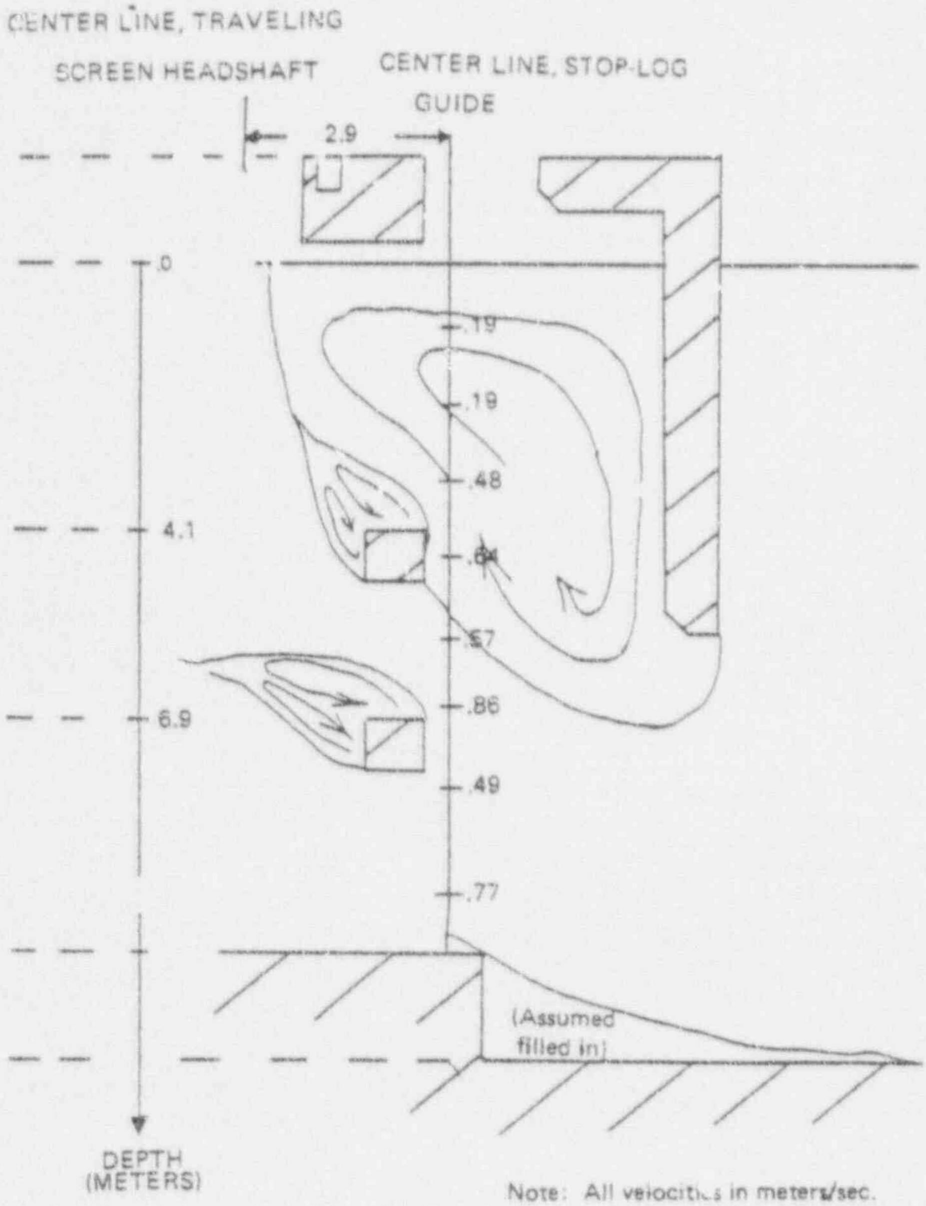

Figure 2.1.14 Flow pattern within Bay B, Unit 2 intake structure

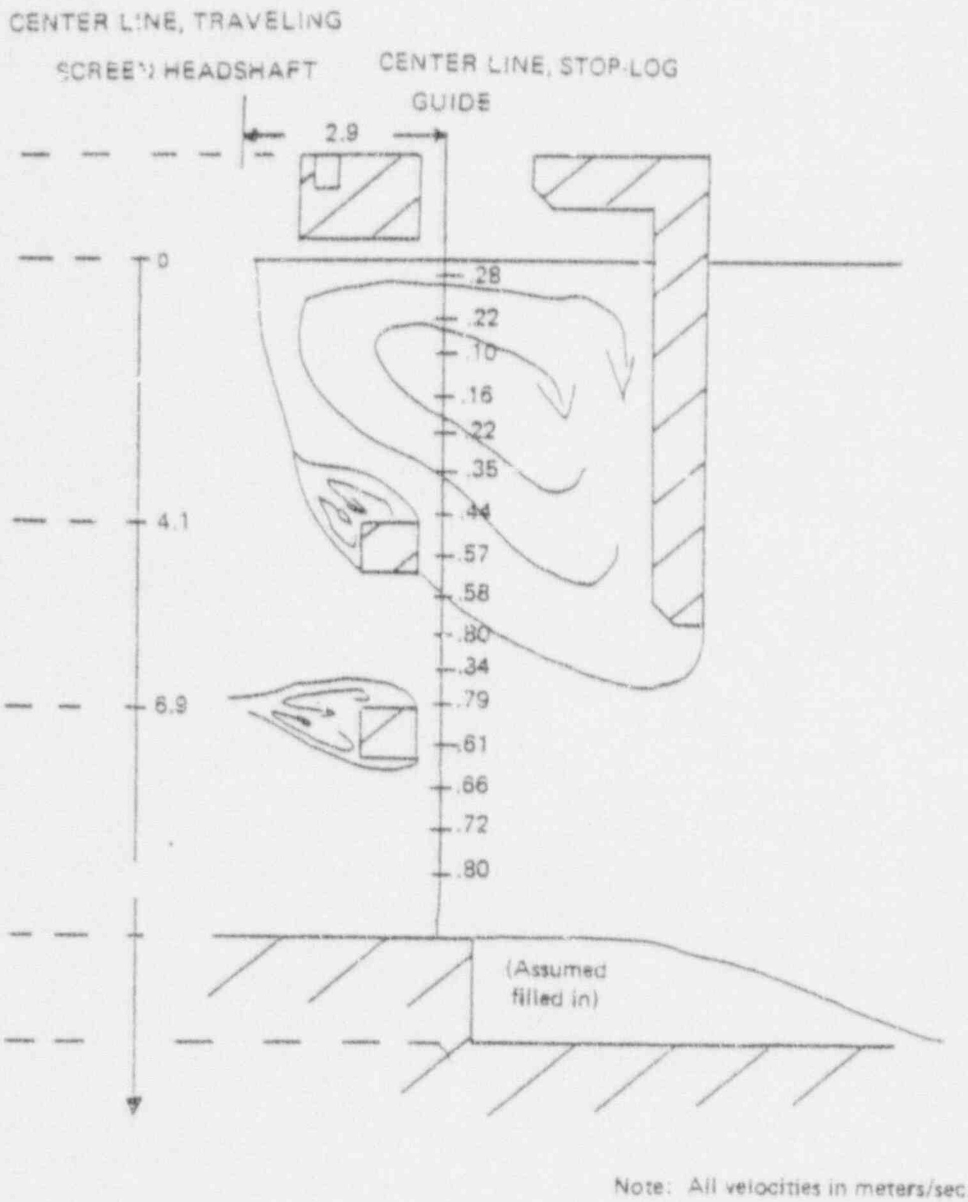

Figure 2.1.15 Flow pattern within Bay C, Unit 2 intake structure

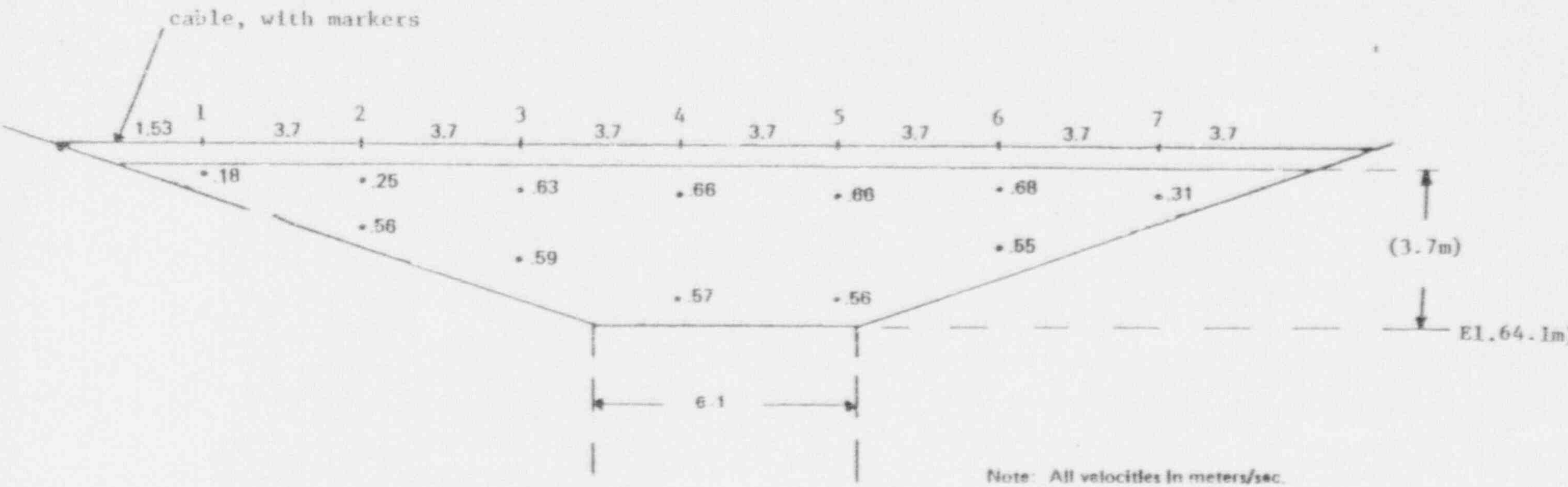

Figure 2.1.16 Approximate discharge canal cross section at test site (looking upstream)

Note: All velocities in met. per second.

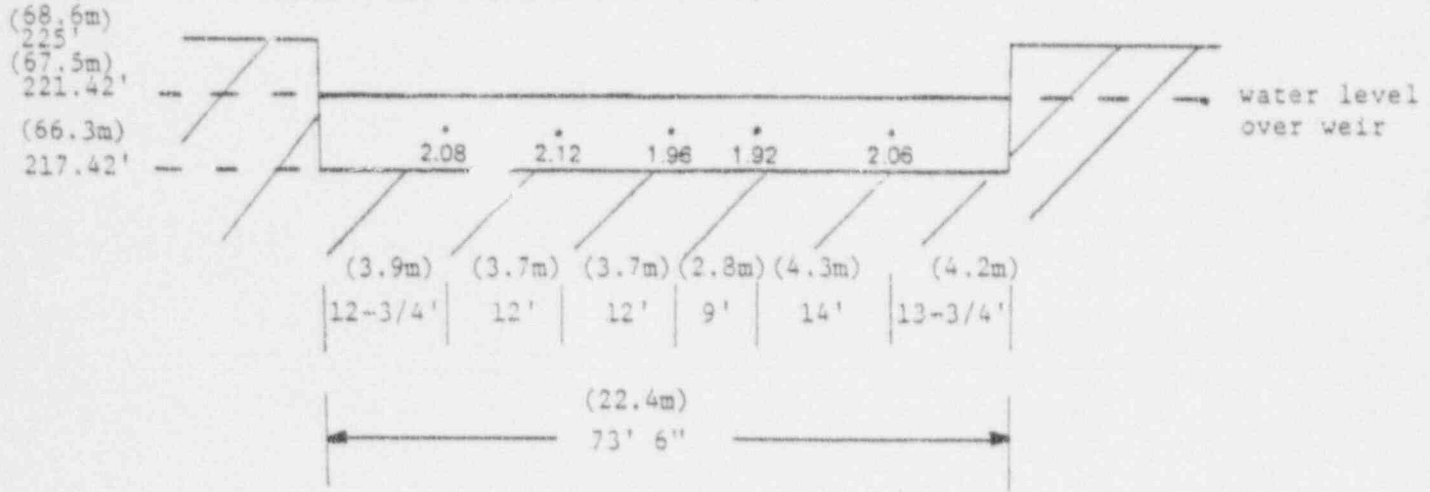

Figure2.1.17 View of weir (looking upstream)

3.0 Environmental Data

3.1 Introduction

Physical and chemical characteristics determine both the habitat and type of biological community which can exist in a defined ecosystem. Environmental data relative to these physical and chemical characteristics have been defined as hydrology and morphology; temperature; and water chemistry.

Hydrological and engineering data have been compiled to describe the hydrology and morphology of the Robinson Impoundment and Black Creek. Both pre-operational (baseline) and operational data have been used.

Temperature studies include the results of intensive sampling of water temperatures throughout the impoundment and Black Creek during 1973, 1974, 1975, and 1976. In addition, one year of pre-operational data for Black Creek above and below the impoundment (1959 and 1960) and data for impoundment water temperatures during the summer and winter of 1963 (prior to the operation of Unit 2) are available. Thermal models have also been developed which describe predicted summer maximum, winter maximum, and equilibrium temperatures in the impoundment. These data have been used to document thermal conditions, to identify cooling patterns, and to determine the effects of warmed discharge waters on natural thermal conditions.

Water chemistry studies include data from 1973, 1974, 1975, and 1976. Results of water chemistry analyses have been evaluated to determine the water quality of the Robinson Impoundment and Black Creek and to determine the effects of plant operation on various chemical variables. Since pre-operational water chemistry data are essentially nonexistent, the quality of water entering the impoundment from Black Creek has been considered an ongoing baseline.

3.2 Hydrology and Morphology

3.2.1 Methods

U. S. Geological Survey data for the State of South Carolina and engineering plans and documents were utilized to describe and deduce pertinent physical parameters of the Robinson Impoundment and Black Creek.

3.2.2 Results and Discussion

The circulating water system for the H. B. Robinson Steam Electric Plant includes Robinson Impoundment (Figure 3.2.1), a cooling impoundment created in 1959 by the damming of Black Creek. The pertinent physical parameters of the impoundment and Black Creek are shown in Table 3.2.1; Figure 3.2.2 contains the area capacity curves for the impoundment.

At the normal water elevation of 67 m (220 ft) msl, Robinson Impoundment has a surface area of 911 ha (2,250 acres), a volume of 5.06×10^7 m^3 (41,000 acre-ft) and an average depth of 5.5 m (18 ft). Theoretical average retention time within the impoundment is 86 days while circulation of impoundment water occurs approximately every 16 days.

The major inflow of water into the Robinson Impoundment is from Black Creek, an intrastate stream which rises in the fall zone near Pageland, South Carolina, and flows through Chesterfield, Darlington, and Florence counties to its confluence with the Pee Dee River east of Darlington, South Carolina (Figure 3.2.3). The creek flows through the Carolina Sandhills, and its drainage area is generally secondary pine growth with some open agricultural land. The soils of this region are generally of low fertility, and acidic, with a pH value around 5.0. Additional inflow into the impoundment is provided by various small creeks, streams, and flowing groundwater wells near the shore of the impoundment.

The drainage area at the Robinson dam is approximately 448 km^2 (173 mi^2). Discharge to Black Creek occurs either over the dam or from low level release valves. Average discharge to Black Creek (1960 - 1974) was 6.8 m^3/s (240 CFS).

3.3 Thermal

3.3.1 Methods

An intensive thermal monitoring program of the Robinson Impoundment and Black Creek was initiated in April, 1973, in conjunction with initial environmental studies. Five transects (A, B, C, D, and E) were established (Figure 3.3.1). Across each transect three sampling stations (1, 2, and 3) were utilized. In addition, two stations, consisting of a single point at F and G, were sampled.

In August, 1973, two temperature sampling stations on Black Creek were added: one below the impoundment (H) and one above the impoundment (I). An additional impoundment transect (CA) and an additional creek station (K) were added in August, 1974.

In April, 1975, a grid covering an area of approximately 74 ha (184 acres) and identifying 33 sampling points was established in the area of discharge (Figure 3.3.2). Beginning in August, 1975, at the recommendation of the U. S. Environmental Protection Agency, Region IV, the number of sampling points was reduced by one-half; three sampling stations were added in the area where Big Beaverdam Creek enters the impoundment (UBBC, MBBC, and LBBC); and an additional transect, DA, was added.

Water temperatures were sampled between April, 1973, and March, 1976, at least once monthly. Between the period May, 1975, and November, 1975, with the exception of June, 1975, when equipment failure prevented completion of sampling, water temperatures were sampled twice monthly. At each sampling station, water temperatures were recorded on the surface and at 3-foot intervals. Equipment used for sampling included: Yellow Spring Instrument (YSI)

54 Oxygen and Temperature Meter, International Biophysics Corporation (IBC) Temperature and Dissolved Oxygen Monitoring Unit, and Hydrolab TDO-2.

On June 12, 1975, continuous strip chart temperature recorders were placed at the Spillway, at the West Tower (south of C-3), at Station F, in the discharge canal immediately south of the discharge canal weir, and on Black Creek at Station K (Figure 3.3.1). All temperatures were recorded continuously at a depth of approximately 3 feet. Hourly readings were noted throughout each day, from which daily averages were calculated and daily maximum and minimum values determined. The continuous recording units used for this study were Atkins Technical, Inc. Model #22348-09.

Temperature data measured in the field specifically for environmental studies was supplemented by three additional studies: (1) during the years 1959, 1960, 1972, 1973, and 1974 on Black Creek above the impoundment (Station I) and below the impoundment (Station H), water temperatures were sampled approximately once per week, thus providing baseline data comparable to operational data; (2) sampling of impoundment stations along Transects A, B, C (approximately), and D was made in 1963; and (3) temperature prediction models were developed (USNRC, 1975; Edinger and Geyer, 1965; Edinger, et al., 1974; Graves and Geyer, 1973).

3.3.2 Results and Discussion

Intensive sampling temperature data for 1973, 1974, 1975, and 1976 are presented as CP&L Exhibit 2.1. Continuous recorder data indicating daily averages, maxima and minima temperatures are indicated in CP&L Exhibit 2.2. Black Creek water temperature data for 1959, 1960, 1972, 1973, and 1974 are included in CP&L Exhibit 2.3.

Circulating Patterns

Data indicated that during all periods of the year discharge waters were well mixed as they flowed into the impoundment. Warmed waters then dispersed, forming a surface layer over cooler bottom waters which entered the

discharge area from the upper impoundment and Black Creek drainage area. Normal circulation patterns were southward to the dam and the plant. Warmed surface waters occasionally moved northward above the SR 346 bridge, but such movement was limited by the SR 346 road bed and the relatively small span of the bridge [<61 m(200 ft)]. Indication of heated surface waters moving as far northward as Station G was not observed.

Thermal Stratification

Seasonal variation of surface and vertical temperature patterns in the impoundment was noted. During early fall, winter, and late spring waters were well mixed at Station G and at stations south of Transect DA; generally uniform temperatures were recorded for each water column, especially at the deeper southernmost transects (A and B) during winter periods (Figures 3.3.3-3.3.5). In spring and fall, overturn occurred (Figures 3.3.6-3.3.8). Between these periods a temperature gradient generally was maintained with variation of surface and bottom temperatures ranging between 4°C-6°C (7°F-11°F); and during summer temporary stratification was noted (Figures 3.3.9-3.3.11).

Throughout the entire year artificial stratification occurred in the area of discharge as warmed discharge waters layered over cooler bottom waters. An artificial thermocline was generally present in the discharge area where depths were 2.7 m (9 ft) or greater. In this area, during summer months when discharge temperatures were at maximum, variation between surface and bottom temperatures was generally 6°C-7°C (11°F-13°F).

Temperature Stability

A summary indicating temperature stability and general thermal trends between hours, within 24-hour periods, and between days is presented in Table 3.3.1. Temperature fluctuation was not great in the lower impoundment, while temperatures in the discharge canal varied directly with the intensity of fluctuation of Unit 2 operation. Areas immediately north of the SR 346 bridge were intermittently affected by plant discharges and are described as being in

a fringe area of the extention of the thermal effluent. Temperature fluctuation in this area occasionly exceeded 7°C (13°F) during a 24-hour period.

Maximum and Minimum Thermal Conditions

Maximum thermal conditions were observed during July and August, 1975, when discharge temperatures generally remained above 40°C (104°F), temperatures in the upper impoundment were above 23°C (73°F), and temperatures in the lower impoundment remained above 26°C (79°F). Modeling indicated that the summer of 1975 had higher-than-average impoundment temperatures, based on analysis of the meteorological conditions which affect impoundment water temperatures. The result was that during late August, 1975, the plant produced the highest recorded discharge temperatures since operation of Unit 2 commenced.

Under normal operating conditions annual minimum thermal conditions occurred during January and February. In 1976 discharge temperatures fell below 25°C (77°F), water temperatures in the upper impoundment fell to 5°C (41°F), and minimum temperatures in the lower impoundment were 11°C (52°F).

Ambient Thermal Conditions

Data collected in 1963, during a period when only Unit 1 was in operation and warmed discharge waters were returned to the impoundment 1.2 mi (1.9 km) north of the plant, indicate that temperatures within the impoundment ranged between 26.6°C and 30°C (80°F- 86°F) during summer (Figures 3.3.12-3.3.14). During winter periods temperatures dropped to 5.6°C (42°F) in the lower impoundment.

Data collected on Black Creek above the impoundment (Station I) and below the impoundment (Station H), prior to the commercial operation of the H. B. Robinson Plant and during the period when the initial filling of the impoundment occurred, indicate naturally occurring temperatures and the warming effects of solar radiation on impoundment waters. From May to November, 1959, the natural increase in temperature across the impoundment due to solar radiation averaged 4.1°C (7.4°F), and between December, 1959, and April, 1960, natural rise averaged 1.4°C (2.6°F). Comparing these figures with data

collected during periods when Robinson Units 1 and 2 were commercially operated (1972, 1973, and 1974) indicates that between May and December the average increase in temperature in Black Creek below the dam which can be attributed to plant operation was 1.8°C (3.2°F). For the period December to April the rise attributed to plant operation was 3.2°C (5.7°F) (Table 3.3.2).

Temperature Prediction Models

Models used to determine impoundment equilibrium temperatures without the influence of plant operation indicated that naturally occurring surface temperatures within the impoundment under normal meteorological conditions would be approximately 29.4°C (85°F). Under extreme meteorological conditions temperatures would approach 32°C (90°F). During winter periods under normal meteorological conditions, temperatures would fall below 10°C (50°F), while under extreme meteorological conditions temperatures would be slightly above 10°C (50°F) (USNRC, 1975).

The predicted, typical summer and winter surface isotherms for the impoundment are presented in Figure 3.3.15. Predicted maximum summer conditions indicated a discharge temperature of approximately 44.5°C (112.1°F) under adverse meteorological conditions and 100% plant load for at least five consecutive days (Figure 3.3.16). Predicted maximum winter conditions indicated a discharge temperature of approximately 28°C (82°F). Meteorological data used for modeling are included in Table 3.3.3.

3.4 Water Chemistry

3.4.1 Methods

Water chemistry samples were collected monthly between April, 1973, and February, 1976, from the surface and bottom at three stations within the impoundment: A-2, E-3, and G, and from Black Creek above the impoundment (I, surface) and below the impoundment (H, surface). In September, 1974, two additional Black Creek chemistry sampling stations were added: one below the impoundment (K, surface) and one above the impoundment (J, surface). Sampling at Station J was discontinued in November, 1974 (Figure 3.3.1).

Samples were collected with a beta bottle sampler and transferred to labeled plastic containers, which were chilled and stored in the dark prior to analyses. All chemical analyses followed standard procedures accepted by the U. S. Environmental Protection Agency. Analytical methods used by the CP&L Analytical Laboratory as of January 1, 1976, are presented in CP&L Exhibit 2.4.

3.4.2 Results and Discussion

Results of all 1973, 1974, 1975 and 1976 water chemistry analyses for Robinson Impoundment and Black Creek are presented in CP&L Exhibit 2.4.

Water Quality

Selected Robinson Impoundment water chemistry data compared with data from other coastal rivers and lakes, are presented in Table 3.4.1. The acidic nature of the waters of Robinson Impoundment was well within the range found for other coastal rivers and drainages of this general area. Ammonia was approximately the same, whereas NO_3-Nitrogen and Kjeldahl-Nitrogen were considerably less than that found in the Cape Fear River, but comparable to the selected acid water bodies. Iron and sodium were also comparable to the range of values found in other waters of this area.

Effects of Plant Operation

Although extensive pre-1973 data is lacking, the contemporary quality of the inflowing stream, Black Creek, provides the essential information as to the nature and magnitude of materials in suspension and solution entering Robinson Impoundment. This permits assessment of changes that occur on passage through the impoundment. The following analyses and comparisons are based on the concept that the contemporary quality of Black Creek, as determined at Station I, is a baseline for assessment of change due to the operation of Robinson Impoundment as a cooling impoundment.

The water quality data collected in Robinson Impoundment for the three years 1973, 1974, and 1975 have been organized in tables which indicate

mean values and describe similar locations: Table 3.4.2 described the water quality of the inflowing water of Black Creek (Stations I and J) and the quality of the water of Black Creek after discharge from Robinson Impoundment (Stations H and K). In Table 3.4.3 the same parameters are used to describe the quality for three impoundment stations (G, E, and A), in downstream sequence. This tabulation includes values for surface as well as bottom samples. The organization of data in this manner permits ready comparison of key locations and separates stations of flowing water from those of standing water.

Within certain clusters of parameters, such as solids, clearly defined trends of increasing quantity from 1973 to 1975 were evident. In other instances, such as for NH_3-N, the trend was a consistent decrease over the three-year period. In still other examples consistent changes in quantity of a specific constituent occurred between the samples taken from the inflowing water and the impoundment stations. Additionally, on other cases the changes were not in any particular direction in a consistent fashion nor do they appear to change to any significant degree.

To define these changes in a more rigorous fashion the statistical t-test for significance of difference of the annual mean values were carried our on year-to-year comparisons as well as station-to-station comparisons (Tables 3.4.4 and 3.4.5). The annual mean values at three stations: I, inflowing water; A, impoundment and cooling water intake location; and H, downstream of Robinson Impoundment, were used to compare the changes between 1973/1974, 1974/1975, and 1973/1975. These yearly comparisons were tested for those parameters which appeared to be making shifts of sufficient magnitude, either increasing or decreasing, to be statistically significant. The t-test for significant difference of mean values was calculated only for the mean values of surface samples. Those t values with their probability of being at a significant difference at both 95% and 99% level of probability are identified, as well as the direction of change.

The use of Station I as a station for baseline data places in perspective changes that were occurring in the impoundment as well as downstream that might have resulted from interactions within the impoundment.

All values for the t-test of the various parameters compared are shown, but only those with a significant difference are of interest and concern. It is clear that the solids content of the water, particularly total, volatile, and dissolved, increased in a consistent manner over the three-year period. The magnitude of the change increased to the point where the number of significant differences was considerably greater in the 1974-1975 comparison than that of 1973-1974. The 1974-1975 comparison showed that the difference of the mean values for total, volatile and dissolved solids were significantly different in the surface samples both at Station I, inflowing water, as well as Station H, outflowing water, whereas only the volatile solids were at a significant difference at Station A. The comparison between the values for 1973 and 1975 showed that over the two-year period total, volatile and dissolved solids all changed significantly at all three stations and suspended solids only at Station H, This direction of change in solids content was characteristic of all stations and would appear to be a change characteristic of the entire drainage rather than any effect limited to Robinson Impoundment.

Changes in quantity of COD that were at significant levels in the 1973-1974 comparison were found only at Station I and H and not at A. These changes, which were increases in COD, did not persist in the comparison of 1974-1975. NO_3-N had a significant increase in the comparison of 1973 and 1974 data at all three stations, a condition which was no longer evident in the 1974-1975 comparison. However, the difference was of sufficient magnitude to be statistically significant when 1973 values were compared to 1975 at Station A and H. Although NO_3-N was not significantly different in the 1974-1975 comparison, the decrease in NH_3-N normally associated with increases in NO_3-N was at a significantly different level, decreasing at both Stations I and A in the 1974-1975 comparison.

Total phosphate-P and total dissolved phosphate-P had significant increases at Station A between 1974-1975 which were not apparent at Stations I and H. The comparison of 1973 to 1975 found only dissolved phosphate-P significantly different, increasing at Stations I and H but not at A.

Dissolved silica and chloride, two conservative constituents, were tested for significance of difference of the annual mean values to establish

the magnitude of the t-test at their minimum levels of difference. None of their differences were at significant levels.

Alkalinity showed a significant decrease in the 1973-1974 comparisons at Stations I, H, and A. In the two-year comparison, 1973-1975, all three stations had significant differences, decreasing in quantity. Sulfate increased significantly in only one instance: at Station I in the comparison of 1974-1975.

Of the metals tested for significant difference in these year-to-year comparisons, lead had a consistent pattern of decreasing quantity. These differences were at significant levels at all stations. This implies that the inflowing water of Black Creek had a decreasing quantity each year, and this in turn was reflected in the waters of the impoundment and downstream with little or no change during impoundment retention. Aluminum levels significantly decreased at Station A in the comparison of 1973-1974 quantities but at no other station or in any of the other year-to-year comparisons.

In Table 3.4.5 significance of difference of annual mean values of water quality parameters with each year, using Station I as a baseline station, are compared. The data in Table 3.4.5 are grouped under nonconservative substances: those nitrogen and phosphorus components which are biologically intereactive; a second group of conservative substances: silica, chloride, and sulfate which are nominally nonbiologically intereactive (although silica might be significantly changed by a diatom bloom); and a third group of metals. The metals selected appeared from cursory examination of the data to either be of significant quantity or have indicated moderate to large levels of change. In each instance the t-test for significance of difference was carried out for all of the parameters.

From this analysis it is evident that none of the nonconservative or conservative constituents tested had changes at any statistically significant level whether they were within the impoundment or in downstream location of the impoundment as compared to the baseline Station I. However, of the five

metals so tested, several trends are apparent in the data. The quantity of copper at the impoundment Stations E and A and downstream at H, went from nonsignificant differences in 1973 to a significant difference in 1974 (Station A compared to I) and to very significant differences when Station I was compared to E, A, and H in 1975. It is noteworthy that the copper content at Station G did not show a significant difference in 1975. This station is upstream of the recirculating discharge point in Robinson Impoundment.

The difference, at a significant level, of the quantity of iron between Stations I and H in 1973 was no longer discernible in 1974 and just below the 95% level of probability in 1975. Zinc was at no time in either of the three years significantly different in any of the comparisons between I and the other four stations. Aluminum, in contrast, started the series of years with a significant difference between Station I and Stations G, E, and H, all increasing in downstream direction. This difference disappeared in the 1974 comparison with Station I and appeared once more only in a comparison of Station I and H in 1975 where the difference, an increase at Station H, was just significant at the 95% level.

<u>Robinson Impoundment Water Quality Levels and National Water Quality Criteria</u>

In the ultimate assessment of the Robinson Impoundment or any other body of water used for industrial purposes, changes within the impoundment due to industrial operation are required to meet water quality criteria which do not affect the indigenous biota. Contemporary water quality criteria might still be considered in a state of flux and discussion as new information and data are assembled to define, describe, and assess impact of change on the indigenous biota within the characteristics of local waters. For those water quality constituents determined in Robinson Impoundment, CP&L Exhibit 2.4 includes a description of recommended 1983 water quality goals for the various water quality constituents in question. Specific applicability of these criteria to the highly colored acidic waters characteristic of the coastal drainages of this area may not be valid due to the chelating nature of the humic acids in colored waters. However, this comparison will at least establish some perspective as to the meaning of concentrations found, the changes detected and their significance with reference to impact on indigenous aquatic life.

For all of the water quality constituents indicated in the 1983 water quality goals, the waters of Robinson Impoundment would appear to meet all recommended water quality goals as defined at this time with one exception. (The impact of temperature is not considered due to the pending decision by EPA on the 316 Demonstration exemption request.) The quantities of copper may be at the moment in excess of water quality goals not only within the impoundment but in the inflowing stream. The effects of these higher concentrations of copper on the biota are unknown at the present time.

3.5 Dissolved Oxygen

3.5.1 Methods

Monthly dissolved oxygen (DO) sampling was initiated in April, 1973, at Station 2 of each of 5 transects, A, B, C, D, and E, and at Stations F and G (Figure 3.3.1). Water samples were taken from surface, mid, and bottom depths and analyzed in the field using the Winkler titration method.

Beginning in July, 1973, and continuing until March, 1976, portable dissolved oxgen meters were used to sample DO on the surface and at 3-foot invervals at each sampling station established for water temperature sampling (Figure 3.3.1 and Figure 3.3.2). Exceptions to this schedule occurred when equipment malfunction prevented sampling. Equipment used for sampling included: Yellow Spring Instrument (YSI) 54 Oxygen and Temperature Meter, International Biophysics Corporation (IBC) Temperature and Dissolved Oxygen Monitoring Unit, and Hydrolab (TDO-2).

3.5.2 Results and Discussion

The 1975 Robinson Impoundment dissolved oxygen concentrations from representative impoundment stations are presented as Table 3.5.1; and 1973, 1974, 1975, and 1976 DO profiles are included in CP&L Exhibit 2.5.

Dissolved oxygen concentrations followed seasonal patterns with generally uniform DO concentrations from surface to bottom between mid-fall and mid-spring. Dissolved oxygen concentrations below 4 mg/l at or near the bottom of the deeper impoundment stations occurred during late spring, summer, and early fall, with temporary dissolved oxygen stratification occurring in summer at deeper stations.

3.6 Summary and Conclusions

Hydrology and Morphology

The Robinson Impoundment is a man-made impoundment of a flowing body of water which is designed specifically for the retention, withdrawal, and recirculation of water for cooling of the H. B. Robinson Plant. Circulation of water in the impoundment is similar to other man-made industrial reservoirs and impoundments (Wunderlich, 1971).

Thermal

Seasonal variation of thermal patterns occurs in Robinson Impoundment. In the lower impoundment, stratification occurs during the warmer, summer months although its intensity is most likely limited and influenced by the flows associated with the plant circulating water system. During all seasons of the year, heated discharge waters form a layer over considerably cooler bottom waters in the mid-impoundment area.

Maximum thermal conditions occur during July and August while minimum thermal condition occur during January and February (with normal plant operation). Annual variation in discharge temperatures is in excess of 15°C (27°F). In the event of an outage of Unit 2 during winter periods seasonal variation of discharge temperatures could be in excess of 27°C (47°F).

Natural temperatures within the impoundment have been recorded as high as 30°C (86°F) (Figures 3.3.12-3.3.14). Models indicate that equalibrium temperatures, under average meteorological conditions, would be approximately 29.4°C (85°F), due solely to the effects of solar radiation; under extreme meteorological conditions, temperatures would approach 32°C (90°F). Modeled temperatures as

well as observed temperatures during summer indicate that surface temperatures at the dam are warmed by about 2°C (3°F-4°F).

Water Chemistry

The acid pH of the water of Robinson Impoundment as well as the inflowing waters of Black Creek is characteristic of the drainages of the coastal areas of this region. The considerable quantities of humic materials produce both the color as well as the acidic nature of these waters. Historically such waters have always been recognized as being of low biological activity.

The variations in quantity of chemical constituents in Robinson Impoundment, both of conservative and nonconservative nature, over the three years of observation were statistically significant in only a few isolated instances. It would appear there was no overall pattern of c[illegible] from the quality of the waters of Black Creek flowing into Robinson Impoundment, changes in the quality on passage through the impoundment and changes downstream of the impoundment that could be attributed to the operation of the impoundment as a source of cooling water for the H. B. Robinson Steam Electric Plant. The exception to the pattern of differences which were nearly all at non-significant levels is an increase in quantity of copper at the stations affected by plant discharge. Other quantity variations appeared to be associated with some overall environmental factor since these changes were found up- as well as downstream of Robinson Impoundment.

All water quality consitituents of Robinson Impoundment, with one exception, appear to meet recommended federal water quality goals. Data, as analyzed, indicate that copper, both in the inflowing stream as well as within the impoundment, is approaching levels that could exceed federal water quality criteria. Concentrations of copper sulfate ($CuSO_4 \cdot 5H_2O$) that have been reported as being algastatic are .024-.075 mg/l (as copper .008-.026 mg/l) (Fitzgerald, 1971). This is with the concentration range found in 1975 in Robinson Impoundment. However, if this reflects primarily an accumulation from natural sources

in the drainage area, the existing algal population is one that has the capability of growth and survival under these circumstances.

The question as to whether the magnitude of increase in temperature over ambient levels, as recorded in Robinson Impoundment at the cooling water discharge stations, significantly affects chemical reactions has been extensively reviewed (Lee and Veith, 1971). Such temperature variations might affect both equilibria conditions, rates of equilibria for acid-base reactions, precipitations, gas transfer, oxidation-reduction, sorption and biochemical reactions. It has been concluded that the thermal effects that might be found in the cooling water discharge from a stream electric generating plant have only minimal effects on such chemical quailibria reaction rates and little or no effect on chemical parameters of water quality. It has also been noted that whereas temperature might increase growth rates of algae, it is the nutrient flux rather than temperature which establishes the total biomass that might be found during the maximum growth period.

Dissolved Oxygen

In deeper areas during warmer periods, temporary oxygen depletion occurs in most man-made impoundments which do not receive thermal discharge. Throughout other parts of the year, generally uniform DO concentrations are noted within each water column due to the natural tendency of an impoundment to mix during these periods (Frey, 1963). Robinson Impoundment DO concentrations generally follow these patterns. Dissolved oxygen stratification is temporarily established during summer, but its intensity is most likely limited and influenced by the flows associated with the plant circulating water system. Isolated instances of oxygen depletion at deeper stations is most likely associated with the decomposition of bottom sediments.

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Table 3.2.1 Physical parameters of Robinson Impoundment and Black Creek

Normal Water Level (NWL)	Elevation 67 m	(220 ft)
Capacity at NWL	5.06×10^7 m^3	(41,000 acre-ft)
Area at NWL	911 ha	(2,250 acres)
Average Depth at NWL	5.5 m	(18 ft)
Maximum Depth at NWL	12 m	(40 ft)
Maximum Length at NWL	12 km	(7.5 mi)
Width at Plant at NWL	1,210 m	(4,000 ft)
Design Low Water Level	Elevation 64 m	(210 ft)
High Water Level	Elevation 67.5 m	(221.67 ft)
Design Flood Flow	1,133 m^3/s	(40,000 ft^3/s)
Crest of Dam	Elevation 70 m	(230 ft)
Maximum Height of Dam	21 m	(70 ft)
Low Level Release Intake	Elevation 54 m	(178 ft)
and	Elevation 56.5 m	(185.5 ft)
Retention Time of Impoundment:		
For Average Creek Flow	85 Days	
For Average Circulating Water Flow	15.6 Days	
Average Discharge to Black Creek (1960-1974)	6.8 m^3/s	(240 ft^3/s)
Maximum Recorded Discharge to Black Creek	56.9 m^3/s	(2,010 ft^3/s)
Minimum Recorded Discharge to Black Creek	1.4 m^3/s	(51 ft^3/s)
Drainage Area at Dam	448 km^2	(173 mi^2)

Table 3.3.1 H. B. Robinson continuous recorders: normal fluctuation patterns with maximum/minimum recorded daily average temperatures °C (°F)

Station	Normal Fluctuation between Instantaneous Hourly Readings	Normal Fluctuation within 24-Hour Periods	Normal Fluctuation of Average Temperatures between 24-Hour Periods	Maximum Temperature	Minimum Temperature
Spillway	$\leq\pm1$°C(1.8°F)	$\leq\pm2$°C(3.6°F)	$\leq\pm2$°C(3.6°F)	33°C(91°F)	7°C(45°F)
West Tower	$\leq\pm1$°C(1.8°F)	$\leq\pm3$°C(5.4°F)	$\leq\pm2$°C(3.6°F)	36°C(97°F)	7°C(45°F)
Discharge	$\leq\pm1$°C(1.8°F)[1]	$\leq\pm2.5$°C(4.5°F)	$\leq\pm2$°C(3.6°F)[1]	44°C(111°F)	10°C(50°F)[2]
Station F	$\leq\pm2$°C(3.6°F)[3]	$\leq\pm4$°C(7.2°F)[4]	$\leq\pm2$°C(3.6°F)	37°C(99°F)	3°C(38°F)
Station K	$\leq\pm1$°C(1.8°F)	$\leq\pm1.5$°C(2.7°F)	$\leq\pm1$°C(1.8°F)	33°C(91°F)	7°C(45°F)

[1] $\leq\pm1$°C(1.8°F) fluctuation occurred except during periods when power output of Unit 2 fluctuated. Temperatures at the end of the discharge canal were directly proportional to the power output of Unit 2, as evidenced by data collected on December 12, 1975, as Unit 2 returned to power after refueling. Also noted was the fact that approximately 3 hours were required for water to travel from the plant to the end of the discharge canal.

[2] Unit 2 off line.

[3] Occasionally, variations of ±3°C(5.4°F) to 4°C(7.2°F) were noted. Whenever increases or decreases in temperature occurred, immediate change generally had occurred.

[4] Occasionally exceeding 7°C(12.6°F).

Table 3.3.2 Effects of solar radiation vs. plant operation on temperatures in Black Creek

<u>Baseline Periods</u>

May - November, 1959

SC 23 average water temperature	23.4°C	(74.1°F)
US 1 average water temperature	19.3°C	(66.7°F)
average Δt =	4.1°C	(7.4°F)

December, 1959 - April, 1960

SC 23 average water temperature	10.4°C	(50.8°F)
US 1 average water temperature	9.0°C	(48.2°F)
average Δt =	1.4°C	(2.6°F)

Δt's prior to operation of either Units 1 or 2 is attributed to the effects of solar radiation.

<u>Operational Periods</u>

May - November, 1972, 1973, and 1974

SC 23 average water temperature	25.4	(77.8°F)
US 1 average water temperature	19.6	(67.2°F)
average ΔT =	5.9C*	(10.6°F)

December - April, 1972, 1973, and 1974

SC 23 average water temperature	15.7°C	(60.3°F)
US 1 average	11.1°C	(52.0°F)
average ΔT =	4.6°C	(8.3°F)

ΔT for 1972, 1973, and 1974 is attributed to the effects of plant operation and solar radiation.

<u>Operational Periods Compared with Baseline Periods</u>

May to November

average ΔT 1972, 1973, and 1974 (plant operation and solar radiation)	5.9°C*	(10.6°F)
average Δt 1959 (solar radiation)	4.1°C	(7.4°F)
effect of plant operation	1.8°C	(3.2°F)

December to April

average ΔT 1972, 1973, and 1974 (plant operation and solar radiation	4.6°C	(8.3°F)
average Δt 1959 and 1960 (solar radiation)	1.4°C	(2.6°F)
effect of plant operation	3.2°C	(5.7°T)

* Actual values were recorded in Fahrenheit. In converting values to centigrade, accuracy to the tenths decimal place was lost. Computation of average ΔT's °C was derived by conversion from °F to °C.

Table 3.3.3 Meteorological data for thermal modeling

Month	Average Dry Bulb Temperature °C	°F	Average Wet Bulb Temperature °C	°F	Wind Speed km/hr	mi/hr	Percent Sunshine	Solar Radiation W/m^2	$BTU/Day/ft^2$	Brunt's Coefficient
January	8.3	46.9	5.3	41.6	11.3	7.0	59	156	1190	0.71
February	9.1	48.4	5.8	42.5	12.4	7.7	60	202	1540	0.71
March	12.4	54.4	8.6	47.5	13.5	8.4	65	290	2210	0.72
April	17.6	63.6	13.0	55.4	13.8	8.6	68	340	2590	0.72
May	22.3	72.2	17.3	63.2	11.3	7.0	67	381	2905	0.73
June	26.5	79.7	21.3	70.3	10.9	6.8	64	387	2950	0.74
July	27.6	81.6	22.6	72.6	10.8	6.7	64	387	2950	0.74
August	26.9	80.5	22.4	72.4	9.8	6.1	67	363	2765	0.73
September	24.1	75.3	19.9	67.8	10.1	6.3	64	313	2385	0.73
October	18.2	64.7	14.3	57.8	9.8	6.1	68	247	1880	0.72
November	12.1	53.7	8.9	48.0	10.5	6.5	64	193	1470	0.72
December	8.0	46.4	5.2	41.4	10.6	6.6	63	152	1155	0.71

Table 3.4.1 Water quality of Robinson Impoundment and comparison with coastal plain waters

	Robinson Impoundment Data Average 1973-1975					N.E. Cape Fear, N.C.[1]	Satilla R. Ga.[2]		Creeping Swamp, N.C.[3]	Par Pond S.C.[4,5]
	STA. I	STA. G	STA. E	STA. A	STA. H	1970	1969	1970	1974-1975	1973
pH	5.1	5.2	5.3	5.4	5.3	5.9	4.8	5.4	5.5-6.4	7.7
M.O. Alk. mg/l	-	-	-	-	-	-	-	-	-	-
Alk. ($CaCO_3$) mg/l	1.9	1.3	1.8	1.3	1.7	8.0	-	-	-	15
NH_3-N mg/l	0.4	0.3	0.6	0.3	0.6	.25	-	-	.10	-
NO_3-N mg/l	.20	.21	.23	.22	.22	1.2	-	-	.04	.035
Kjel-N mg/l	.28	.34	.39	.32	.36	2.0	-	-	.48	-
Total Phosphate-P mg/l	.09	.07	.08	.05	.06	.?2	-	-	.04	.008
Dissolved Oxygen mg/l	-	-	-	-	-	-	-	-	-	7.1
Secchi Depth (meters)	1	1	1	1	1	-	-	-	-	2.5
C.O.D. mg/l	22	25	26	28	24	-	-	-	-	-
Total Solids mg/l	141	131	141	135	142	-	-	-	-	-
* Total Dis. Solids mg/l	99	97	101	103	100	-	-	-	-	-
** Total Susp. Solids mg/l	26	23	23	20	26	-	-	-	-	-
Sulfate mg/l	2.64	2.61	3.39	3.05	3.63	-	.8	1.1	-	-
Chloride mg/l	2.86	2.68	2.45	2.77	2.82	-	5.8	5.4	-	-
Fe ug/l	639	714	842	830	868	-	750	1250	1700	-
Al ug/l	303	287	325	237	332	-	100	420	700	-
Cr^{+6} ug/l	13.0	12.2	12.6	12.6	12.6	-	-	-	-	-
Cu ug/l	27.7	32.8	57.5	47.9	42.4	-	-	-	-	-
Na ug/l	1925	1867	2034	1940	2125	-	4760	2800	4200	-
Zn ug/l	60	39	54	128	47	-	-	-	-	-

[1] Keup et al., 1970

[2] Beck, 1972

[3] Kuenzler, 1976

[4] Tilly, 197[illegible]a

[5] Tilly, 197[illegible]b

NOTE: For the purpose of statistical evaluation all data reported as "less than" the reporting limit was assigned a finite number equal to the mid-point between zero and the reporting limit. It is therefore possible for mean values to fall below the detection limit and/or contain significant figures which are not indicated in the original analysis results.

(*) Total filterable residue and (**) total nonfilterable residue (4/73 - 7/73: 0.75 - 1.25 µ filter; 8/73 - 12/75: 1.20 µ filter).

Table 3.4.1 (continued)

	Alligator Lake, N.C.[6]	Catfish Lake, N.C.[7]	Jones Pond N.C.[8]		Singletary Lake N.C.[8]		Salters Lake, N.C.[8]	Lake Waccamaw N.C.[9]			Great Lake N.C.[7]	
	1965	1965	1974	1975	1974	1975	1974	1957	1958	1959	1960	1965
pH	4.6	4.7	4.4	3.3	4.4	3.4	4.5	6.6	6.8	6.8	4.6	4.6
M.O. Alk. mg/l	–	–	–	–	–	–	–	15.0	24.3	20.0	–	–
Alk. ($CaCO_3$) mg/l	–	–	–	–	–	–	0.1	2.5	5.0	10.0	30.5	16.3
NH_3-N mg/l	–	–	.03	.07	.04	.04	.03	–	–	–	1.1	–
NO_3-N mg/l	–	–	–	–	–	–	–	–	–	–	.39	–
Kjel-N mg/l	–	–	.29	.48	.25	.31	.32	–	–	–	–	–
Total Phosphate-P mg/l	–	–	<.005	.007	<.005	.006	<.005	–	–	–	3.9	–
Dissolved Oxygen mg/l	7.9	6.1	8.0	8.1	9.2	8.9	9.0	8.1	7.9	8.5	6.9	6.1
Secchi Depth (meters)	–	–	1	.6	1	.6	.7	–	1.3	1.2	–	–
C.O.D. mg/l	–	–	–	–	–	–	–	–	–	–	–	–
Total Solids mg/l	–	–	–	–	–	–	–	–	–	–	–	–
* Total Dis. Solids mg/l	–		–	–	–	–	–	–	–	–	–	–
** Total Susp. Solids mg/l	–	–	–	–	–	–	–	–	–	–	–	–
Sulfate mg/l	–	–	–	–	–	–	–	–	–	–	–	–
Chloride mg/l	–	–	–	–	–	–	–	–	–	–	–	–
Fe ug/l	–	–	345	–	165	–	320	–	–	–	–	–
Al ug/l	–	–	–	–	–	–	–	–	–	–	–	–
Cr^{+6} ug/l	–	–	–	–	–	–	–	–	–	–	–	–
Cu ug/l	–	–	–	–	–	–	–	–	–	–	–	–
Na ug/l	–	–	–	–	–	–	–	–	–	–	–	–
Zn ug/l	–	–	–	–	–	–	–	–	–	–	–	–
											–	–

[6]Crowell, 1965

[7]Bayless, 1965

[8]Weiss and Kuenzler, 1976

[9]Davis, 1965

NOTE: For the purpose of statistical evaluation all data reported as "less than" the reporting limit was assigned a finite number equal to the mid-point between zero and the reporting limit. It is therefore possible for mean values to fall below the detection limit and/or contain significant figures which are not indicated in the original analysis results.

(*) Total filterable residue and (**) total nonfilterable residue (4/73 - 7/73: 0.75 - 1.25 μ filter; 8/73 - 12/75: 1.20 μ filter).

Table 3.4.2. Black Creek annual mean value water quality parameters

Inflow (Stations I, J) and Discharge (Stations H, K), Surface Samples
1973, 1974, 1975
All Values mg/l
T = Total, D = Dissolved

Station	I			J	H			K	
Year	73	74	75	74	73	74	75	74	75
(N)	(9)	(11)	(12)	(3)	(9)	(11)	(12)	(4)	(12)
T-Solids	85	118	203	115	92	120	201	112	222
T-Volatile Solids	52	55	121	72	60	68	125	74	132
**T-Suspended Solids	10	28	35	[illegible]	10	28	35	21	33
*T-Dissolved Solids	60	80	145	54	61	84	145	58	158
COD	14	31	20	8	16	33	20	19	21
T-N_2	.378	.209	.282	.140	.793	.205	.185	.162	.335
NO_3^-	.117	.296	.190	1.19	.066	.316	.253	.555	.260
NH_3	.095	.037	.014	.036	.133	.038	.018	.030	.069
T-Phosphate-P	.184	.063	.041	.020	.169	.018	.028	.067	.029
TD-Phosphate-P	.011	.013	.021	.010	.007	.010	.020	.010	.022
T-Ortho Phosphate-P	.087	.009	.019	.010	.102	.009	.008	.014	.007
TD-Ortho Phosphate-P	.005	.006	.005	.005	.005	.005	.006	.010	.005
D-Si	4.14	3.82	3.52	4.06	3.48	3.65	3.49	2.91	3.34
Cl^-	3.14	3.19	2.43	3.73	2.98	2.85	2.70	3.57	2.5[illegible]
SO_4	2.48	3.66	1.83	3.00	4.00	4.26	2.77	3.75	3.2[illegible]
T-Alk	4.30	.700	1.42	1.33	4.22	.90	.69	1.37	.8[illegible]
T-Ca	.857	.738	1.27	.997	1.11	.914	1.51	1.72	1.38
T-Na	2.02	1.88	1.901	2.19	2.12	2.02	2.15	2.61	[illegible].59
T-[illegible]	.4[illegible]	.456	.487	.443	.481	.468	.513	.547	.513

NOTE: For the purpose of statistical evaluation all data reported as "less than" the reporting limit was assigned a finite number equal to the mid-point between zero and the reporting limit. It is therefore possible for mean values to fall below the detection limit and/or contain significant figures which are not indicated in the original analysis results.

(*) Total filterable residue and (**) total nonfilterable residue (4/73 - 7/73: 0.75 - 1.25 μ filter; 8/73 - 12/75: 1.20 μ filter).

Table 3.4.2 (continued)

Inflow (Stations I, J) and Discharge (Stations H, K), Surface Samples
1973, 1974, 1975
All Values mg/l Except pH and Turbidity (NTU)
T = Total, D = Dissolved

Station	I			J	H			K	
Year	73	74	75	74	73	74	75	74	75
(N)	(9)	(11)	(12)	(3)	(9)	(11)	(12)	(4)	(12)
Hex-Cr	.019	.007	.014	.01[illegible]	.017	.007	.014	.008	.014
T-Cu	.036	.025	.C25	.023	.041	.040	.045	.044	.048
D-Cu	.021	.025	.025	-	.021	.025	.025	-	.034
T-Fe	.547	.668	.669	.907	.882	.774	.936	1.04	.920
T-Mn	.022	.025	.025	.025	.022	.025	.025	.025	.025
T-Pb	.043	.032	.025	.025	.045	.032	.025	.025	.025
T-Zn	.065	.053	.065	.037	.043	.038	.067	.042	.054
D-Zn	.025	.025	.025	-	.025	.025	.025	-	.029
T-Al	.237	.392	.267	.115	.345	.313	.339	.206	.294
D-Al	.042	.012	.075	-	.025	.007	.072	-	.[illegible]32
T-Hg	.0005	.0005	.0006	.0005	.0605	.0005	.0005	.0005	[illegible]06
T-Ni	-	.031	.025	.033	-	.031	.025	.031	.025
D-Ni	.033	.030	.025	-	.033	.030	.025	-	.025
Hardness	-	9.3	4.24	3.2	-	8.4	4.8	15.9	4.86
pH	5.3	5.0	5.0	5.5	5.8	5.3	5.2	4.9	5.2
Turbidity	-	1.6	3.3	-	-	3.1	3.9	2.8	3.6

NOTE: For the purpose of statistical evaluation all data reported as "less than" the reporting limit was assigned a finite number equal to the mid-point between zero and the reporting limit. It is therefore possible for mean values to fall below the detection limit and/or contain significant figures which are not indicated in the original analysis results.

Table 3.4.3 Robinson Impoundment annual mean values water quality parameters

1973, 1974, 1975
All Values mg/l
T = Total, D = Dissolved

Station	G			E			A		
Year	73	74	75	73	74	75	73	74	75
(N)	(9)	(11)	(12)	(9)	(11)	(12)	(9)	(11)	(12)
Surface/Bottom	S/B	S/B	S/B	S/B	S/B	S/B	S/B	S/B	S/B
T-Solids	71/93	125/155	183/197	78/75	126/134	200/195	69/77	132/125	188/200
T-Volatile Solids	55/59	65/91	155/122	57/58	74/61	134/122	51/50	67/61	131/142
** T-Suspended Solids	6.3/22	28/52	31/32	9/8	26/31	31/32	7/10	22/27	27/34
* T-Dissolved Solids	51/56	84/96	143/131	51/50	90/89	148/156	56/53	97/97	144/157
COD	19/23	33/36	23/21	22/20	31/40	24/24	20/20	26/26	35/25
T-N_2	.511/.333	.249/.700	.292/.275	.420/.329	.520/.237	.272/.223	.455/.437	.267/.293	.278/.292
NO_3-N	.068/.053	.353/.310	.189/.189	.079/.084	.331/.310	.265/.238	.089/.075	.332/.265	.228/.249
NH_3-N	.034/.041	.034/.230	.014/.012	.055/.055	.125/.080	.015/.012	.045/.047	.047/.053	.011/.030
T-Phosphate-P	.183/.174	.019/.071	.039/.026	.221/.237	.015/.065	.028/.028	.138/.129	.014/.012	.029/.029
TD-Phosphate-P	.005/.006	.011/.011	.022/.017	.008/.009	.01/.009	.017/.019	.025/.008	.010/.009	.022/.018
T-Ortho Phosphate	.095/.069	.009/.015	.014/.007	.180/.083	.007/.009	.007/.007	.084/.081	.007/.007	.009/.008
TD-Ortho Phosphate	.005/.005	.005/.005	.007/.006	.005/.006	.005/.006	.005/.006	.004/.006	.007/.006	.007/.007
D-Si	3.60/3.33	3.23/3.33	3.22/3.45	2.62/2.84	3.38/3.36	3.29/3.40	2.47/2.62	3.77/3.45	3.25/3.50
Cl^-	3.23/2.43	2.51/2.86	2.52/2.02	3.03/3.10	2.89/3.07	2.23/2.14	2.77/2.70	3.02/2.95	2.56/2.24
SO_4	3.20/2.98	2.94/2.81	1.85/1.68	4.00/2.85	3.58/3.19	2.75/2.37	3.42/3.42	3.01/3.51	2.81/2.27
T-Alk	2.35/3.31	.900/.700	.783/.592	4.13/5.07	1.25/1.20	.683/1.08	2.37/4.26	1.10/1.05	.750/.692
T-Ca	.836/.863	.697/.687	1.21/1.62	1.08/1.04	1.07/.967	1.78/1.35	1.09/1.04	.988/.963	1.34/1.25
T-Na	1.95/1.98	1.82/1.91	1.85/1.67	2.03/2.19	2.102/1.97	1.98/1.92	2.056/2.197	1.926/2.216	1.87/1.84
T-Mg	.414/.423	.383/.423	.450/.438	.457/.591	.472/.442	.483/.486	.451/.513	.454/.474	.482/.482

NOTE: For the purpose of statistical evaluation all data reported as "less than" the reporting limit was assigned a finite number equal to the mid-point between zero and the reporting limit. It is therefore possible for mean values to fall below the detection limit and/or contain significant figures which are not indicated in the original analysis results.

(*) Total filterable residue and (**) total nonfilterable residue (4/73 - 7/73: 0.75 - 1.25 μ filter; 8/73 - 12/75: 1.20 μ filter).

Table 3.4.3 (continued)

1973, 1974, 1975
All Values mg/l Except pH and Turbidity (NTU)
T = Total, D = Dissolved

Station	C			E			A		
Year	73	74	75	73	74	75	73	74	75
(N)	(9)	(11)	(12)	(9)	(11)	(12)	(9)	(11)	(12)
Surface/Bottom	S/B	S/B	S/B	S/B	S/B	S/B	S/B	S/B	S/B
Hex-Cr	.016/.017	.007/.007	.014/.014	.017/.017	.007/.007	.014/.014	.017/.017	.007/.007	.014/.014
T-Cu	.039/.045	.029/.029	.932/.028	.056/.057	.053/.039	.062/.059	.053/.075	.042/.051	.049/.049
D-Cu	.021/.021	.025/.025	.025/.025	.021/.021	.025/.025	.028/.043	.021/.021	.025/.025	.028/.025
T-Fe	.775/.653	.587/.968	.780/.669	.934/1.02	.727/.918	.869/.842	.867/1.21	.852/.910	.784/1.04
T-Mn	.022/.022	.025/.025	.025/.025	.022/.022	.025/.025	.025/.025	.022/.022	.025/ 925	.025/.025
T-Pb	.044/.045	.032/.032	.025/.025	.045/.045	.032/.032	.025/.025	.045/.045	.032/.032	.925/.025
T-Zn	.038/.031	.034/.072	.047/.042	.046/.064	.057/.054	.057/.057	.168/.056	.132/.045	.062/.042
D-Zn	.025/.025	.025/.025	.025/.025	.025/.025	.025/.025	.C25/,025	.925/.025	.025? 025	.025/.025
T-Al	.312/.343	.336/.794	.230/.297	.337/.433	.404/.391	.251/.254	.276/.527	.203/.375	.236/.359
D-Al	.045/.042	.008/.012	.097/.070	.025/.025	.005/.005	.084/.082	.025/.025	.055/.005	.078/.085
T-Hg	.0005/.0005	.0005/.0005	.0006/.0006	.0005/.0005	.0005/.0005	.0005/.0005	.0005/.0005	.0005/.0005	.0005/.0007
T-Ni	- / -	.037/.031	.025/.025	- / -	.031/.031	.025/.025	- / -	.050/.031	.025/.025
D-Ni	.033/.033	.030/.030	.025/.025	.033/.037	.03/.030	.025/.025	.033/.033	.030/.030	.025/.025
Hardness	- / -	6.7/7.0	3.7/3.6	- / -	6/5/6.4	4.18/4.16	- / -	6.9/7.5	4.9/4.4
pH	5.4/5.3	5.1/5.1	5.3/5.2	6.0/5.7	5.0/5.0	5.3/5.3	5.9/5.8	4.9/5.0	5.5/5.3
Turbidity	- / -	1.3/2.6	3.6/3.4	- / -	3.5/3.0	3.7/3.5	- / -	3.0/3.0	2.8/4.9

NOTE: For the purpose of statistical evaluation all data reported as "less than" the reporting limit was assigned a finite number equal to the mid-point between zero and the reporting limit. It is therefore possible for mean values to fall below the detection limit and/or contain significant figures which are not indicated in the original analysis results.

Table 3.4.4 Comparison of the annual means of selected water quality parameters at stations I, A, and H.

t - Test for Significance of Difference of Mean Values of Surface Samples
Significant at 95% Probability $t>2.1$*
Significant at 99% Probability $t>2.9$**
Direction of Change; (+) increase, (-) decrease

Years Compared	1973/1974			1974/1975			1973/1975		
Station	I	A	H	I	A	H	I	A	H
Parameter									
Total - Solids	1.5	2.7*(+)	1.1	2.9**(+)	1.8	2.8*(+)	4.2**(+)	4.1**(+)	3.4**(+)
Total - Volatile Solids	0.3	0.9	0.4	3.2**(+)	2.9*(+)	2.8*(+)	3.4**(+)	3.9**(+)	2.7**(+)
**Total - Suspended Solids	1.4	1.2	1.5	0.4	0.3	0.4	1.9	1.7	2.1*(+)
* Total - Dissolved Solids	1.1	2.2*(+)	1.0	2.4*(+)	1.7	2.2*(+)	3.4**(+)	3.4**(+)	2.7*(+)
COD	2.1*(+)	1.0	2.2*(+)	1.3	0.9	1.8	1.2	1.6	0.9
Total-N_2	2.0	1.7	1.5	0.9	0.2	0.4	0.9	1.5	1.6
NO_3-N	2.6*(+)	3.2**(+)	5.3**(+)	1.7	1.3	0.9	1.2	4.0**(+)	3.3**(+)
NH_3-N	1.0	0.1	1.1	3.5**(-)	2.7*(-)	2.3	1.3	2.1	1.4
Total Phosphate-P	1.0	1.4	1.4	0.5	3.7**(+)	2.0	1.2	1.2	1.3
Total Dissolved Phosphate-P	0.8	1.6	1.8	1.8	3.2**(+)	0.2	3.0**(+)	0.3	4.3**(+)
Dissolved Silica	0.3	1.5	0.2	0.3	0.6	0.2	0.6	1.1	0.01
Chloride	0.2	0.5	0.2	1.4	0.8	0.2	1.7	0.5	0.5
Total Alkalinity	3.1**(-)	2.0	3.0**(-)	1.1	1.4	1.0	2.2*(-)	2.6*(-)	3.3**(-)
Sulfate	0.9	0.4	0.2	2.2*(+)	0.4	2.2	0.6	0.6	1.2
Total Lead	2.1*(-)	2.6*(-)	2.6*(-)	2.4*(-)	2.4*(-)	2.4*(-)	4.3**(-)	4.8**(-)	4.9**(-)
Total Aluminum	1.1	3.2**(-)	0.3	0.9	1.1	0.2	0.8	1.7	0.2

NOTE: (*) Total filterable residue and (**) total nonfilterable residue (4/73 - 7/73: 0.75 - 1.25 μ filter; 8/73 - 12/75: 1.20 μ filter).

Table 3.4.5 Comparisons of the annual means of selected surface water quality parameters: Stations G, E, A, and H compared to Station I

t - Test for Significance of Difference Between
Annual Mean Values of Surface Samples
Significant at 95% Probability t>2.1*
Significant at 99% Probability t>2.9**

	1973				1974				1975			
Stations Compared	I/G	I/E	I/A	I/H	I/G	I/E	I/A	I/H	I/G	I/E	I/A	I/H
Non-Conservative Substances												
Total Nitrogen	0.9	0.4	0.6	1.0	0.7	1.1	1.0	0.1	0.1	0.1	0.05	1.3
NO_3-Nitrogen	1.0	0.8	0.6	1.0	0.7	0.4	0.4	0.3	0.02	1.3	0.8	1.0
NH_3-Nitrogen	1.0	0.6	0.8	0.4	0.4	1.3	0.7	0.2	0.01	0.2	0.2	0.3
Total Phosphate-P	0.00	0.2	0.3	0.1	0.9	1.0	1.0	1.0	0.1	0.9	0.9	1.0
Total Dissolved Phosphate-P	1.7	1.0	1.4	1.4	0.3	1.4	1.6	1.4	0.02	1.1	0.2	0.2
Conservative Substances												
Dissolved Silica	0.5	1.6	1.7	0.6	0.7	0.5	0.03	0.2	0.3	0.3	0.3	0.01
Chloride	0.2	0.1	0.7	0.2	1.1	0.4	0.3	0.4	0.6	1.1	0.5	0.2
Sulfate	0.5	1.2	0.04	1.1	0.8	0.1	0.8	0.6	0.04	1.7	1.8	1.7
Metals												
Total Copper	0.3	1.9	1.4	0.5	0.5	1.9	2.2*	0.6	1.5	6.3**	3.1**	3.4**
Total Iron	1.1	2.2	1.9	2.2*	0.6	0.5	0.9	0.8	0.8	1.4	0.9	2.0
Total Zinc	1.9	1.4	1.0	1.5	1.0	0.2	0.9	0.8	1.0	0.5	0.2	0.1
Total Lead	0.2	0.3	0.3	0.3	0.1	0.00	0.1	0.1	0.90	0.00	0.00	0.00
Total Aluminum	2.2*	3.1**	1.5	3.2**	0.3	0.05	1.4	0.9	1.06	0.45	0.9	2.1*

Table 3.5.1 1975 H. B. Robinson dissolved oxygen concentrations (mg/l) and percent saturation from representative impoundment stations*

	A-2		B-2		C-2		D-2		E-2		F		G	
	D.O.	% Sat.	D.O.	% Sat	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
January 16, 1975														
Surface	10.2	98	9.8	94	9.9	97	7.5	100	8.9	100	10.7	107	13.2	107
Middle	10.0	97	9.7	96	9.7	95	9.7	101	9.0	100	12.8	112	12.8	103
Bottom	10.2	98	9.8	97	9.7	96	10.0	103	9.4	102	13.3	112	12.6	102
February 5, 1975														
Surface	8.9	86	8.8	83	8.7	85	8.8	86	8.1	79	9.6	83'	11.1	88
Middle	8.7	84	8.7	83	8.8	85	8.6	84	8.4	87	10.8	87	11.0	87
Bottom	8.7	84	8.8	85	8.8	85	8.6	84	8.7	87	10.6	86	14.0	112
March 5, 1975														
Surface	8.5	83	8.5	84	8.8	90	7.6	82	7.4	83	6.9	68	10.4	95
Middle	8.3	80	8.5	80	8.7	86	7.9	82	7.4	83	9.2	77	10.4	90
Bottom	8.0	76	8.4	81	8.5	83	8.5	84	8.0	87	9.0	75	10.2	88
May 12, 1975														
Surface	8.6	101	8.2	98	8.6	103	8.4	101	8.0	98	8.4	100	8.8	105
Middle	8.2	93	8.2	94	7.8	88	8.5	102	8.1	96	8.5	103	7.2	87
Bottom	5.2	58	5.4	60	4.8	53	8.3	97	7.9	93	7.0	75	7.0	73
June 10, 1975														
Surface	7.8	98	8.1	102	8.1	102	7.7	104	7.5	108	7.8	110	8.0	95
Middle	7.3	91	8.1	102	8.2	104	7.4	94	7.5	109	8.1	105	7.9	93
Bottom	7.9	100	2.3	28	6.8	84	5.5	69	7.3	100	6.8	84	7.5	88
July 1, 1975														
Surface	7.7	102	7.7	103	7.7	102	7.3	103	7.6	116	7.9	112	7.8	98
Middle	7.5	100	7.3	98	7.4	98	5.0	66	7.9	114	8.0	112	7.8	98
Bottom	0.7	8	1.9	24	5.8	76	3.0	39	3.9	50	6.0	76	6.1	72
August 5, 1975														
Surface	6.7	89	7.2	96	7.2	98	6.5	91	5.5	80	6.3	87	6.1	78
Middle	1.8	22	3.4	45	5.7	75	6.1	86	5.3	78	6.4	85	5.3	65
Bottom	0.0	0	0.0	0	0.4	4	5.7	80	4.0	52	4.6	57	5.0	61

Table 3.5.1 (continued)

	A-2		B-2		C-2		D-2		E-2		F		G	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
September 9, 1975														
Surface	7.3	98	7.5	100	7.0	94	6.4	91	5.8	88	7.3	103	7.7	102
Middle	2.9	37	5.5	72	6.1	80	5.1	67	6.1	89	7.3	101	5.0	63
Bottom	0.2	2	0.1	2	4.8	63	2.1	27	5.8	83	4.9	59	4.7	55
October 13, 1975														
Surface	7.5	94	7.4	93	7.3	93	7.1	93	6.3	85	7.0	91	5.3	61
Middle	4.6	54	5.2	62	5.1	60	5.7	69	6.2	85	7.3	87	4.9	53
Bottom	0.9	9	0.8	8	1.5	16	4.1	48	6.4	85	5.7	63	5.0	54
November 12, 1975														
Surface	8.4	94	8.4	94	8.6	97	8.1	92	8.1	92	8.0	89	6.4	68
Middle	8.1	91	8.4	94	8.5	96	8.0	91	7.8	90	7.9	85	6.4	68
Bottom	1.7	18	3.4	37	3.4	37	3.0	91	6.3	68	5.8	62	6.5	68
December 9, 1975														
Surface	8.2	75	9.5	87	8.7	80	9.2	85	9.1	87	9.5	82	10.8	99
Middle	8.0	73	9.4	87	8.6	78	9.2	85	9.0	85	9.4	82	10.8	99
Bottom	9.5	87	9.1	83	8.6	78	9.0	83	8.8	80	9.2	79	10.7	98

*NOTE: Average depths for each station are as follows:

A-2: 11.0m (36 ft.)
B-2: 10.1m (33 ft.)
C-2: 8.3m (27 ft.)
D-2: 3.7m (12 ft.)
E-2: 1.8m (6 ft.)
F : 2.7m (9 ft.)
G : 2.7m (9 ft.)

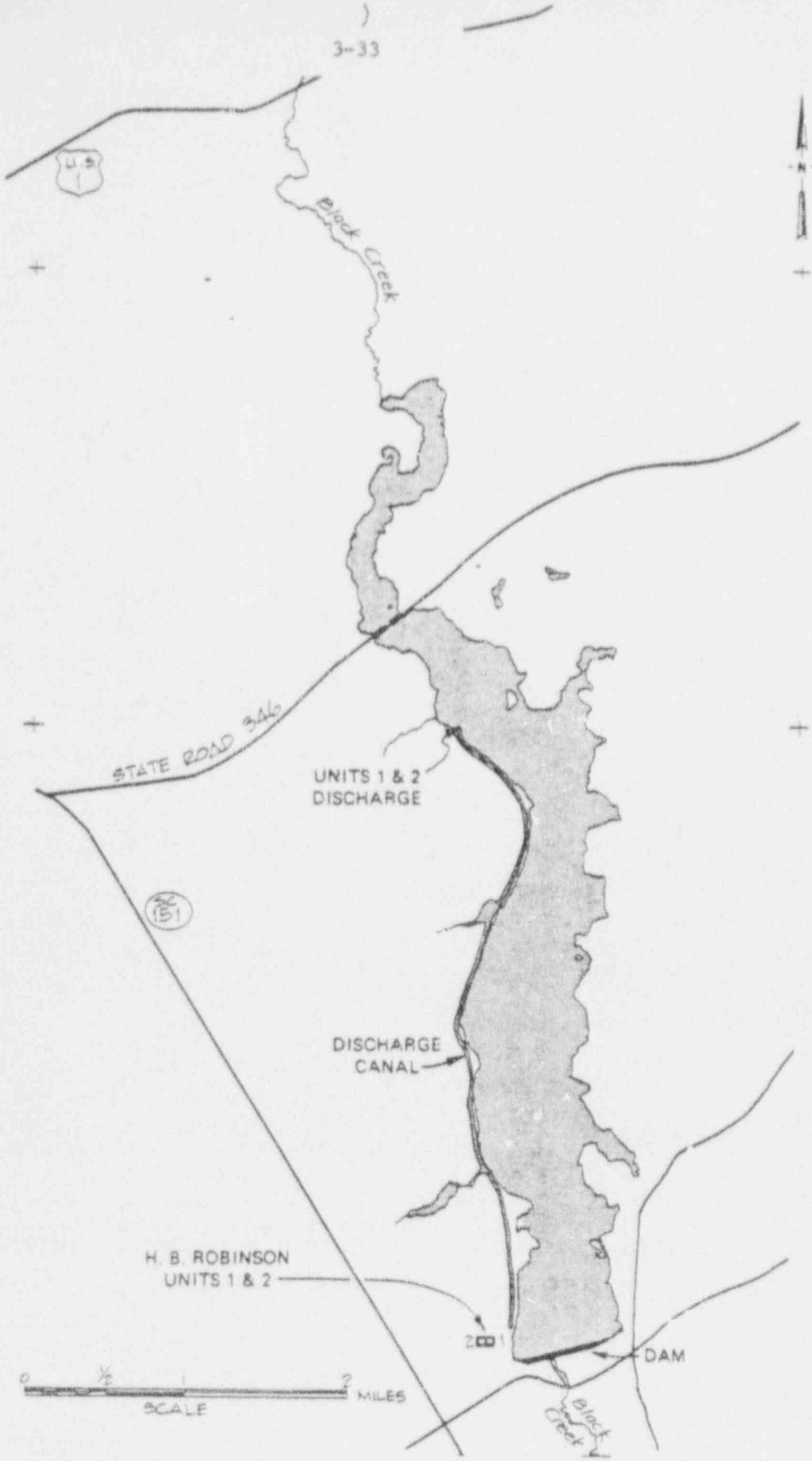


Figure 3.2.1 Robinson Impoundment and Black Creek

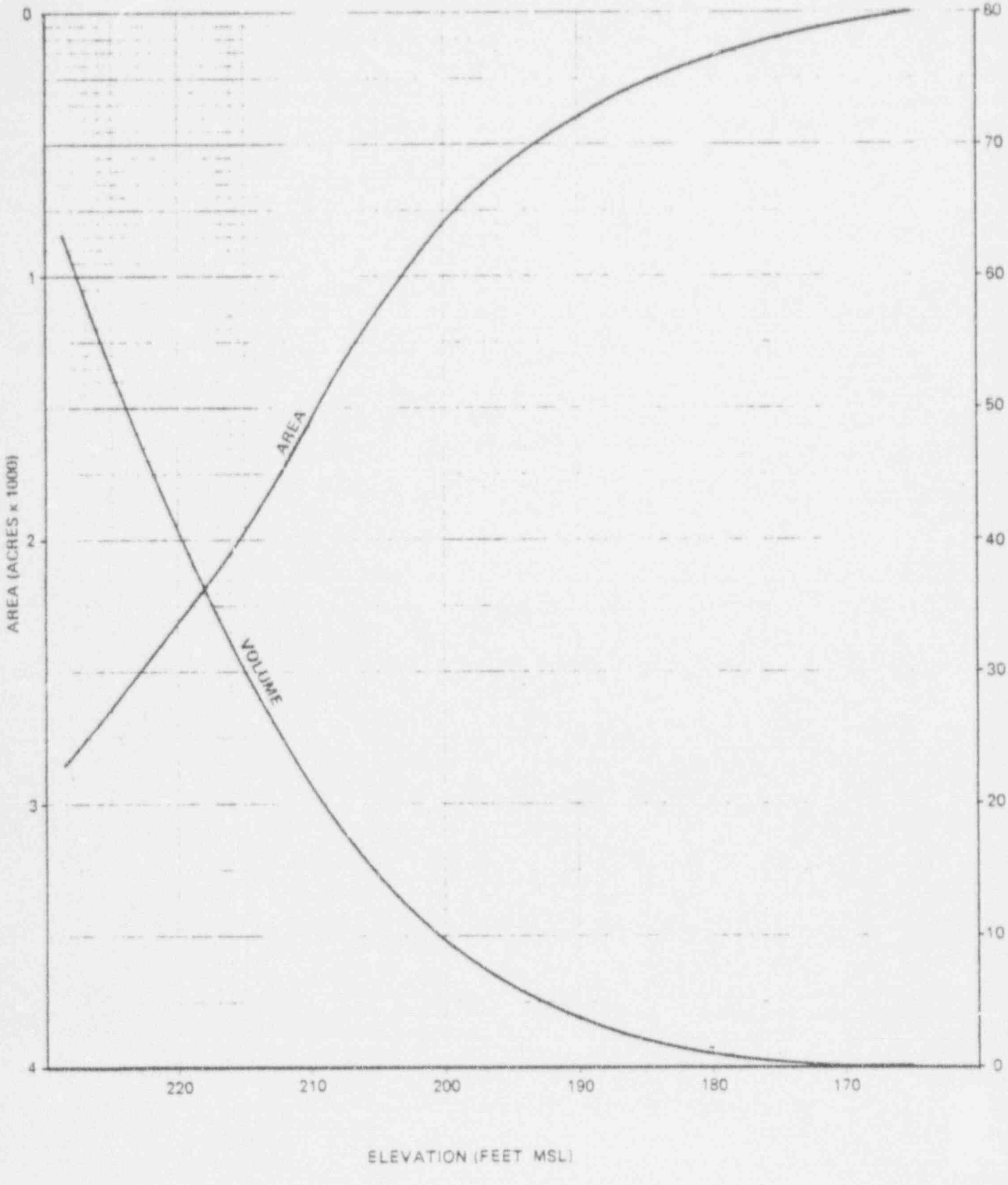


Figure 3.2.2 Area capacity curves for Robinson Impoundment

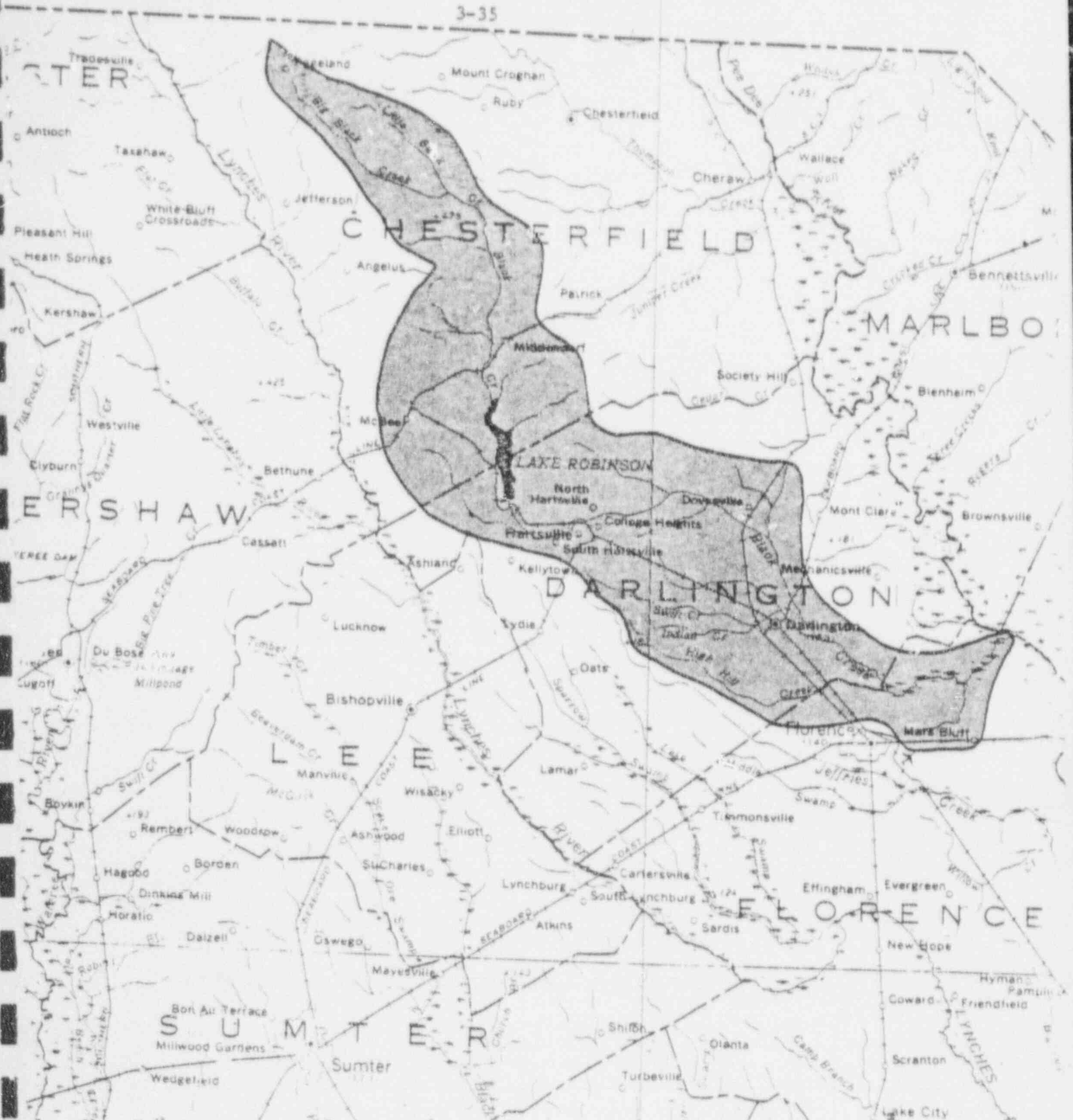


Figure 3.2.3 Black Creek drainage area

Figure 3.3.1 Robinson Impoundment and Black Creek water temperature sampling stations

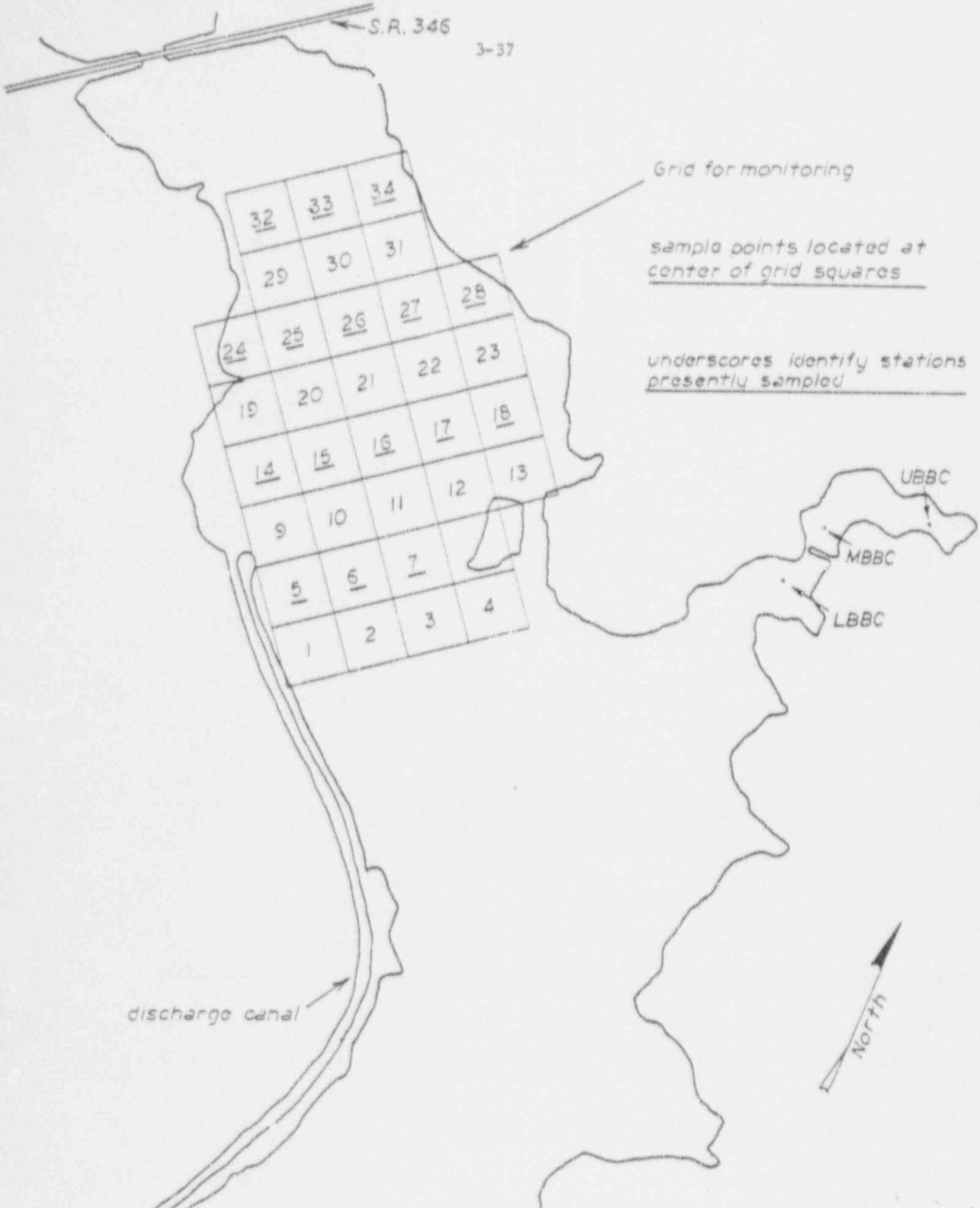


Figure 3.3.2 Robinson Impoundment water temperature sampling grid

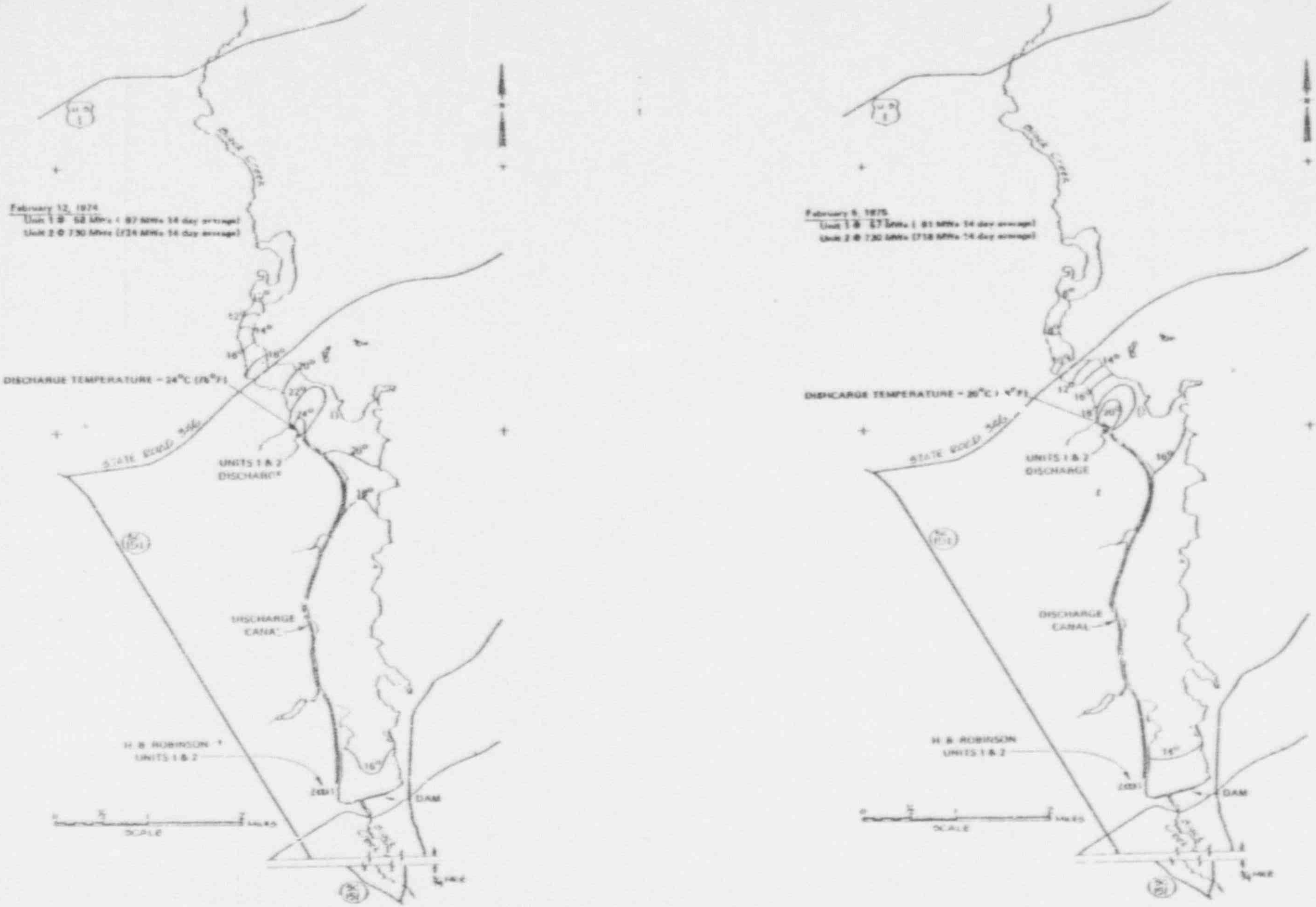


Figure 3.3.3 Robinson Impoundment 2°C surface isotherms, winter conditions: February 12, 1974 and February 5, 1975

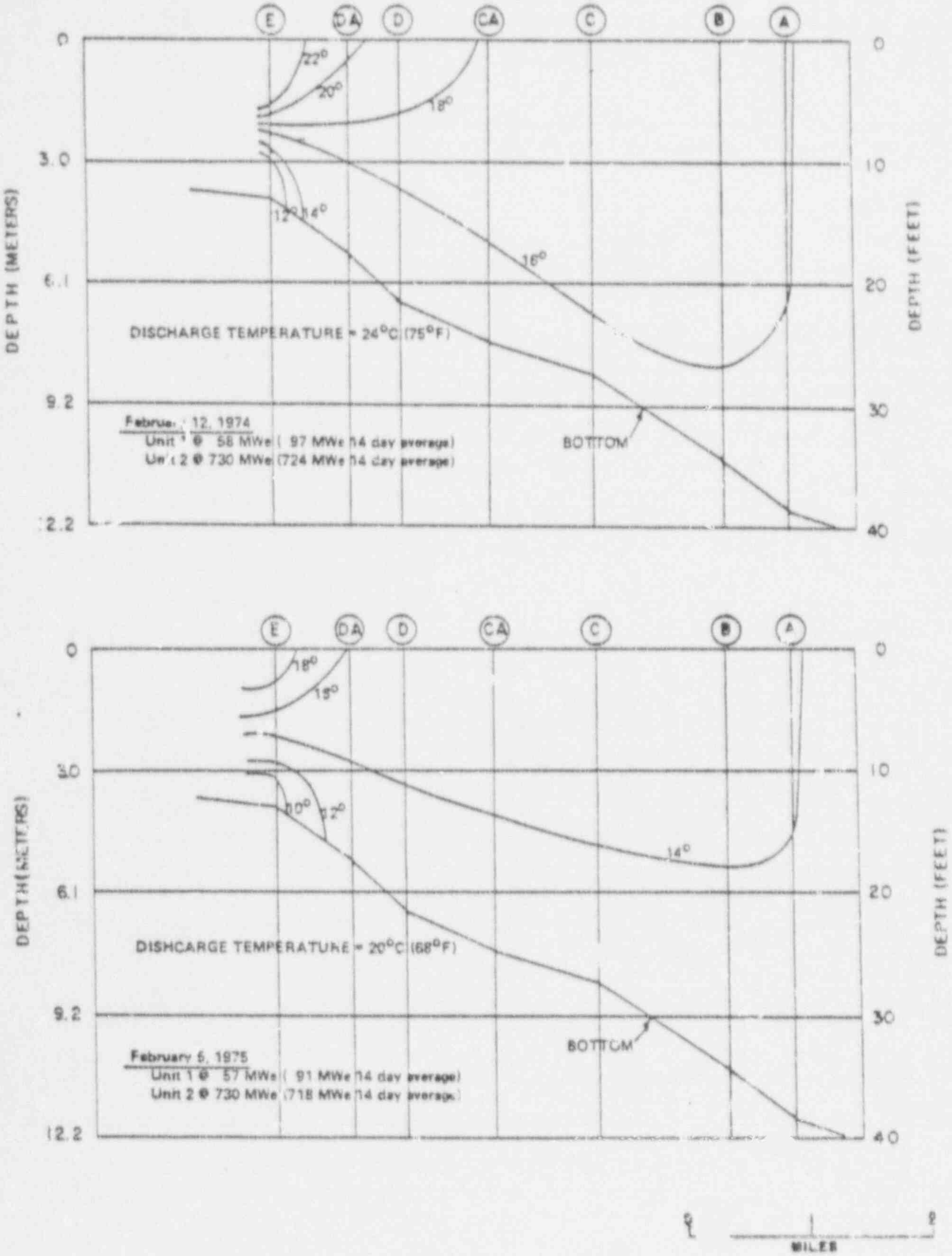


Figure 3.3.4 Robinson Impoundment 2°C vertical isotherms (north to south), winter conditions: February 12, 1974 and February 5, 1975 (indicating deepest station at each transect)

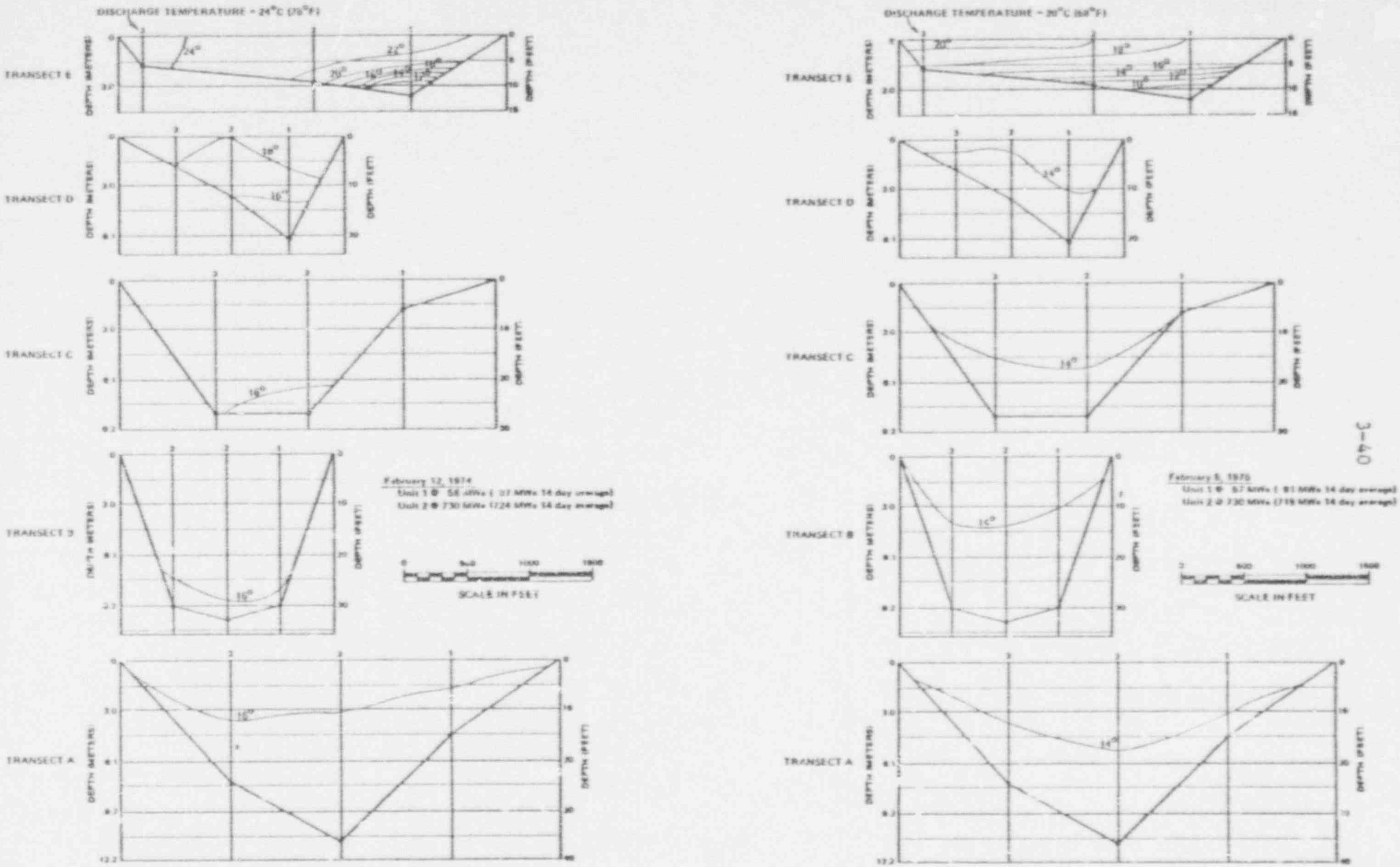


Figure 3.3.5 Robinson I. oundment 2°C vertical isothe:ms (east to west), winter conditions: February 12, 1974 and February 5, 1975

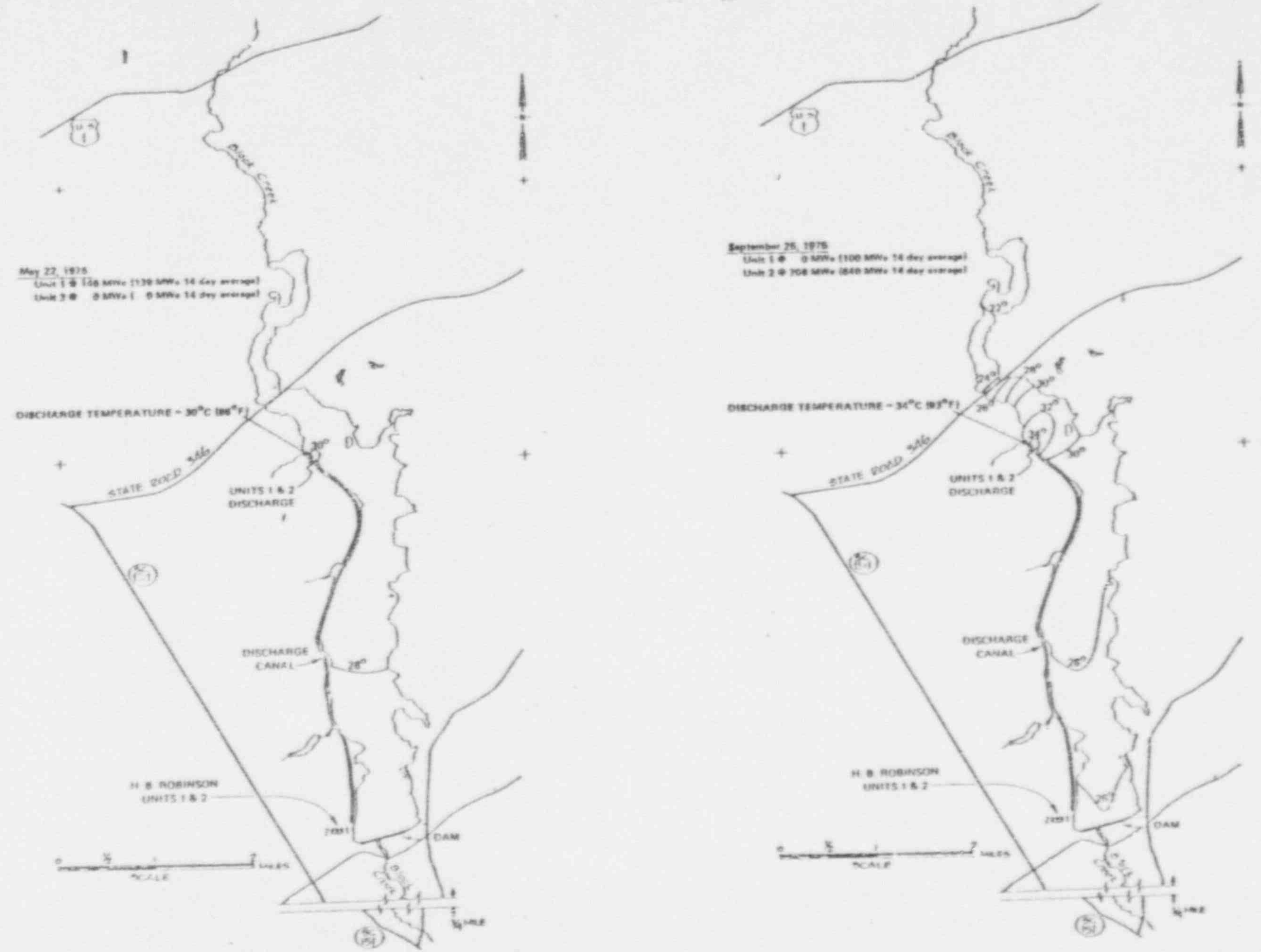


Figure 3.3.6 Robinson Impoundment 2°C surface isotherms, spring and fall mixing conditions: May 22, 1975 and September 25, 1975

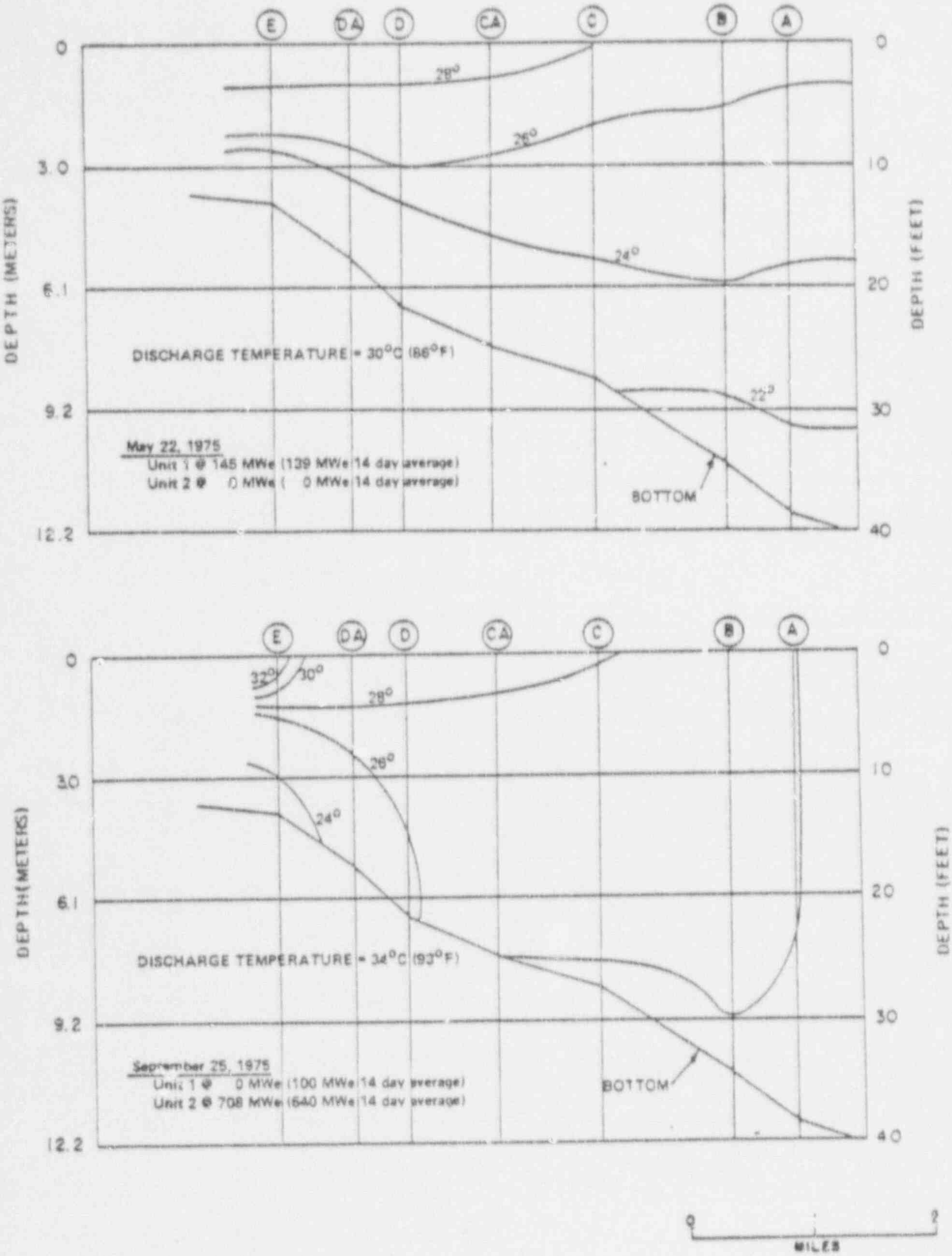


Figure 3.3.7 Robinson Impoundment 2°C vertical isotherms (north to south), spring and fall mixing conditions: May 22, 1975 and September 25, 1975 (indicating deepest station at each transect)

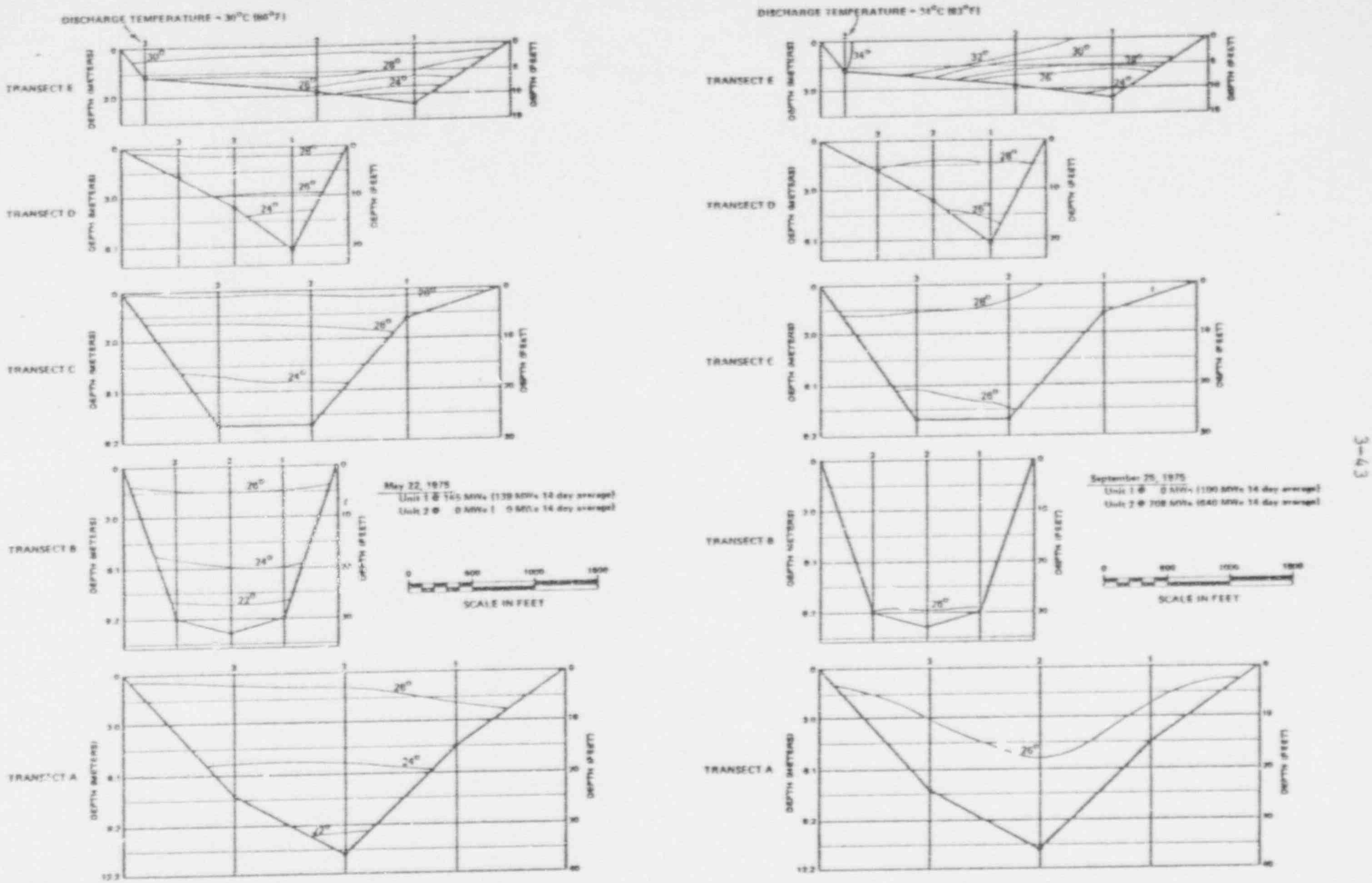


Figure 3.3.8 Robinson Impoundment 2°C vertical isotherms (east to west), spring and fall mixing conditions: May 22, 1975 and September 25, 1975

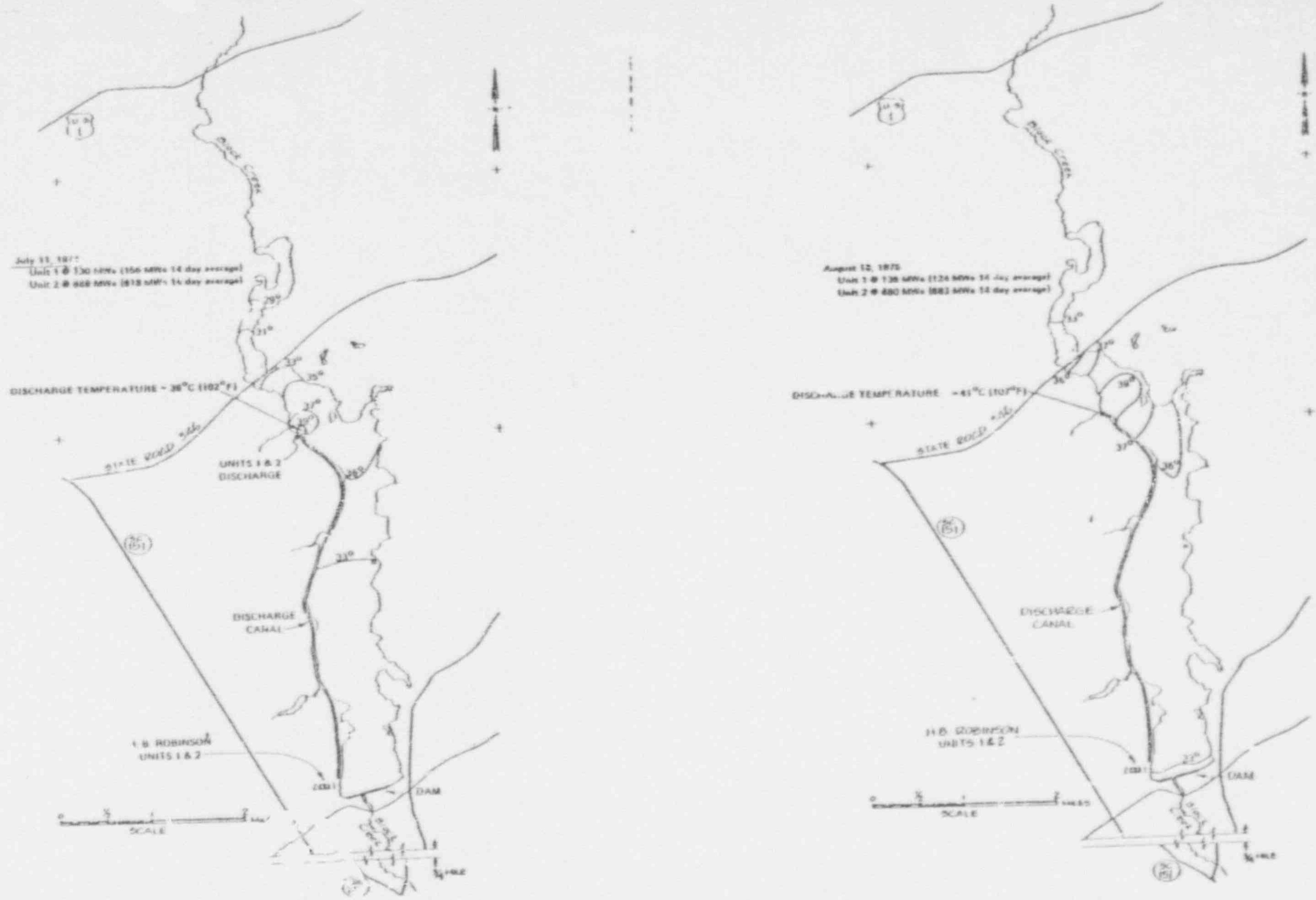
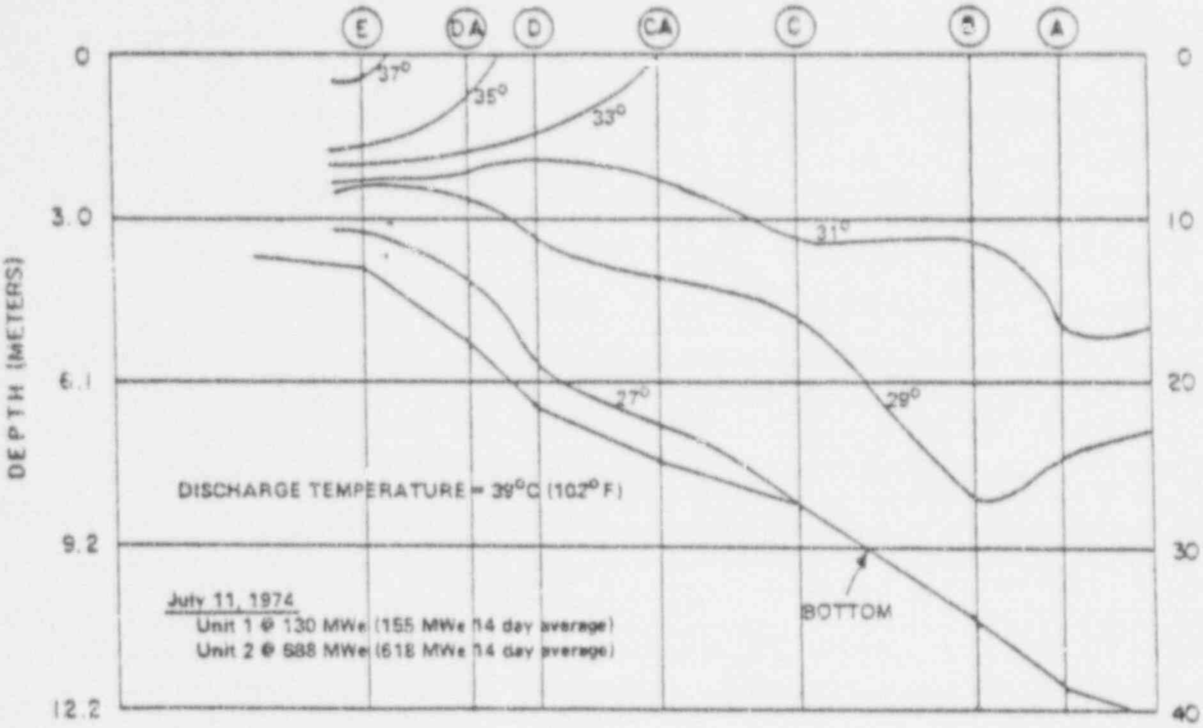


Figure 3.3.9 Robinson Impoundment 2°C surface isotherms, summer conditions:
July 17, 1974 and August 18, 1975



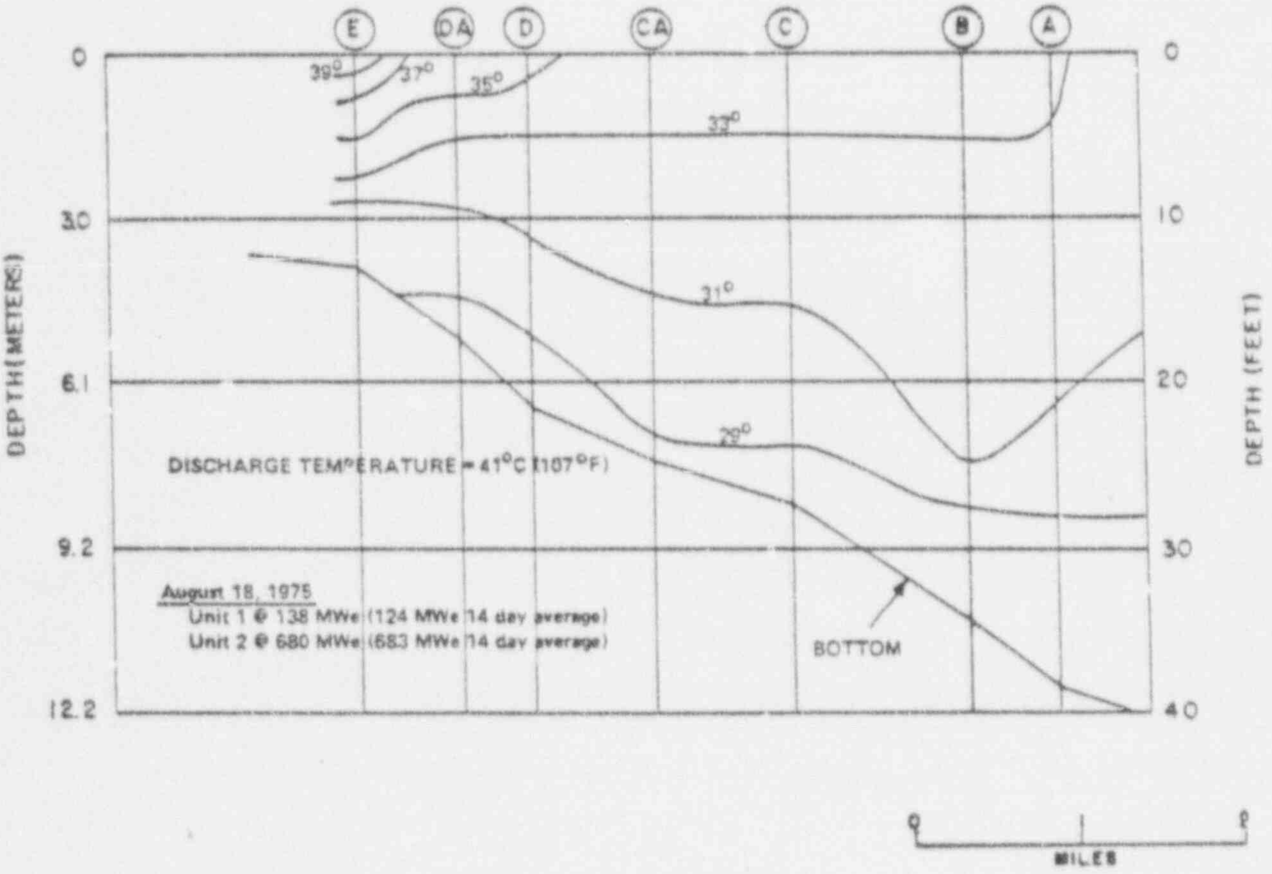


Figure 3.3.10 Robinson Impoundment 2°C vertical isotherms (north to south), summer conditions: July 11, 1974 and August 18, 1975 (indicating deepest station at each transect)

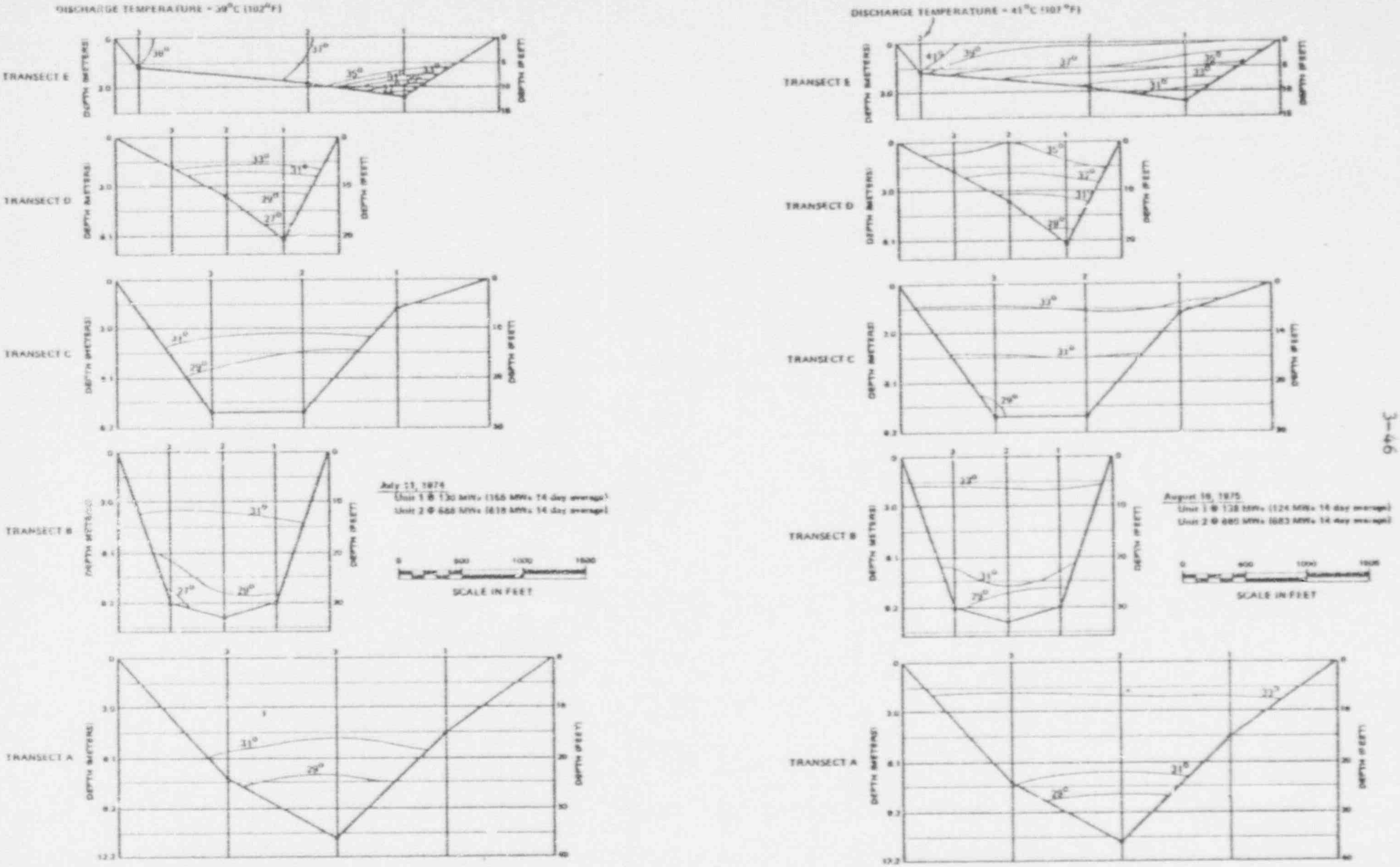


Figure 3.3.11 Robinson Impoundment 2°C vertical isotherms (east to west), summer conditions: July 11, 1974 and August 18, 1975

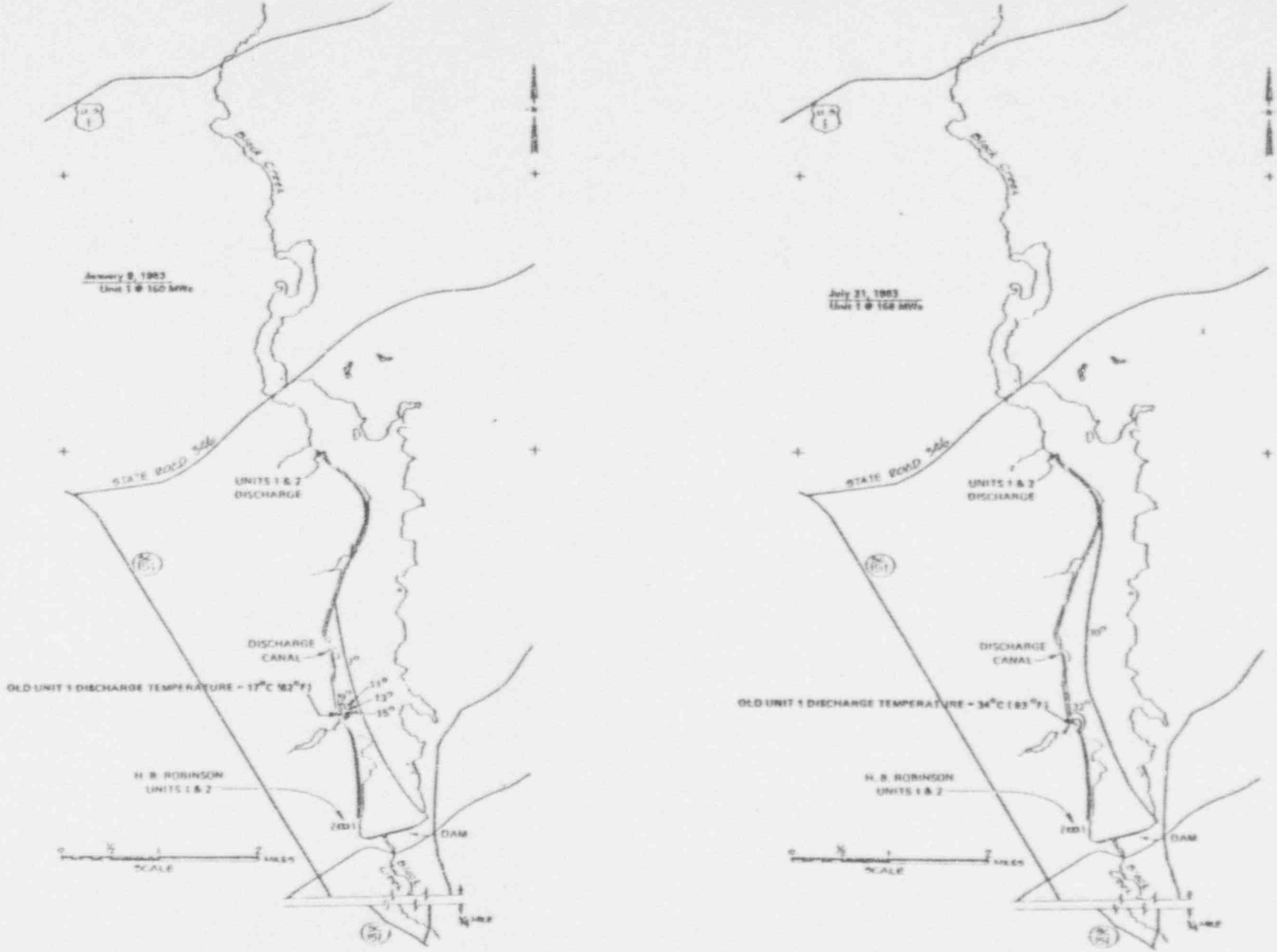


Figure 3.3.12 Robinson Impoundment 2°C surface isotherms, winter and summer conditions without the influence of Unit 2: January 9, 1963 and July 31, 1963

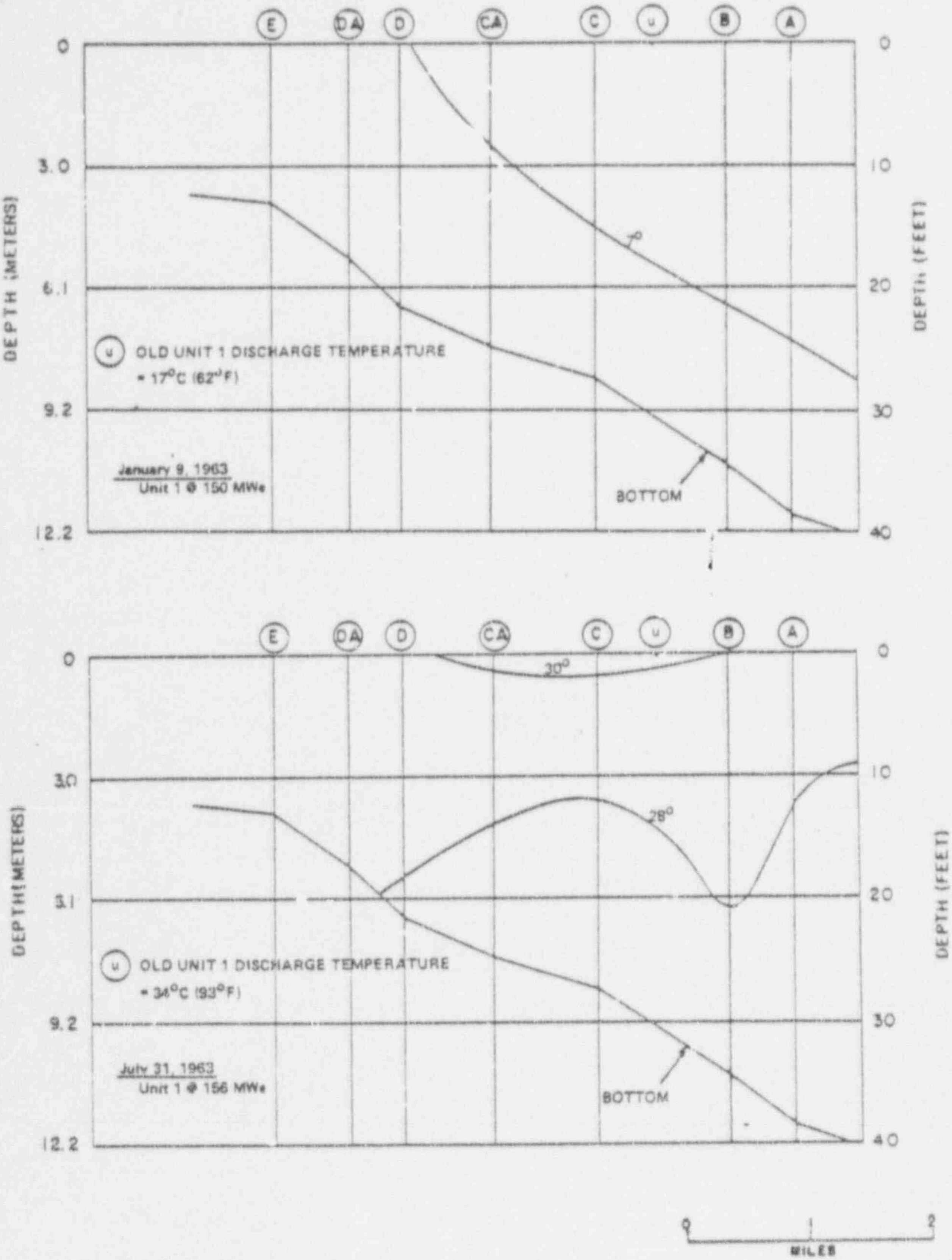


Figure 3.3.13 Robinson Impoundment 2°C vertical isotherms (north to south), winter and summer conditions without the influence of Unit 2: January 9, 1963 and July 31, 1963 (indicating deepest station from each transect; old discharge point indicated; no data available north of Transect D)

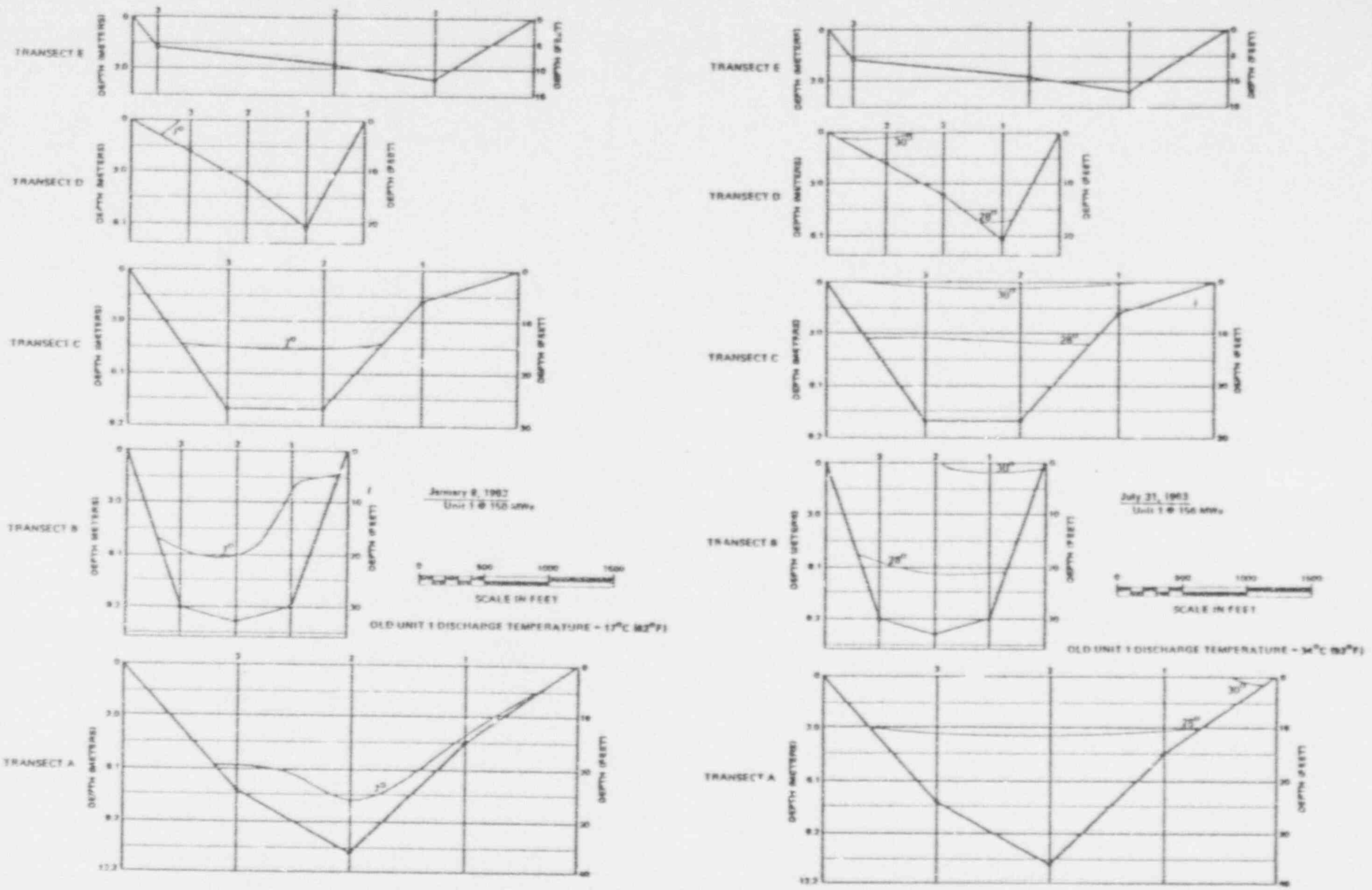


Figure 3.3.14 Robinson impoundment 2°C vertical isotherms (east to west), winter and summer conditions without the influence of Unit 2: January 9, 1963 and July 31, 1963 (no temperature data recorded at Transect E; Unit 1 discharge located between transects B and C)

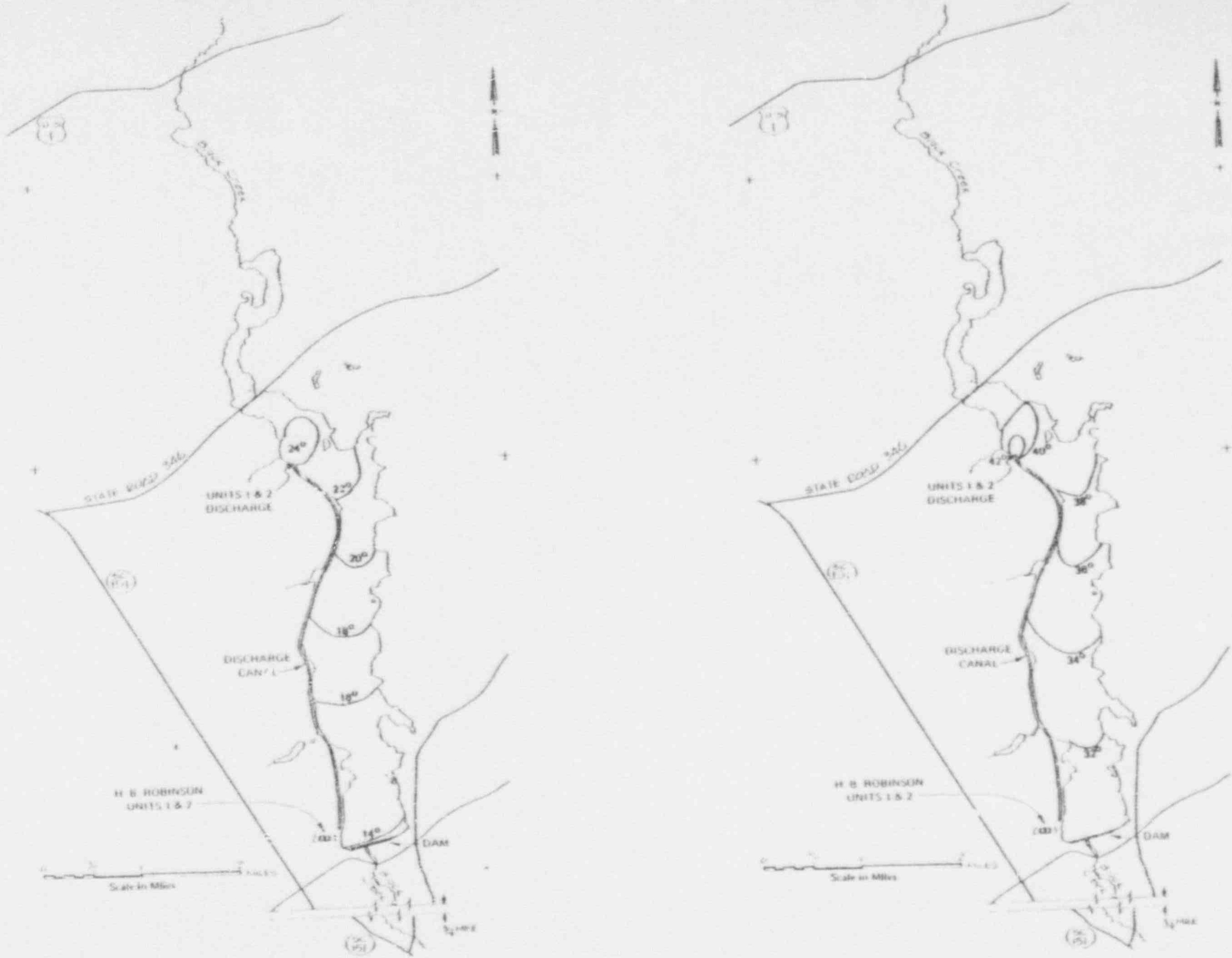


Figure 3.3.15 Robinson Impoundment predicted 2°C surface isotherms: typical winter and summer conditions

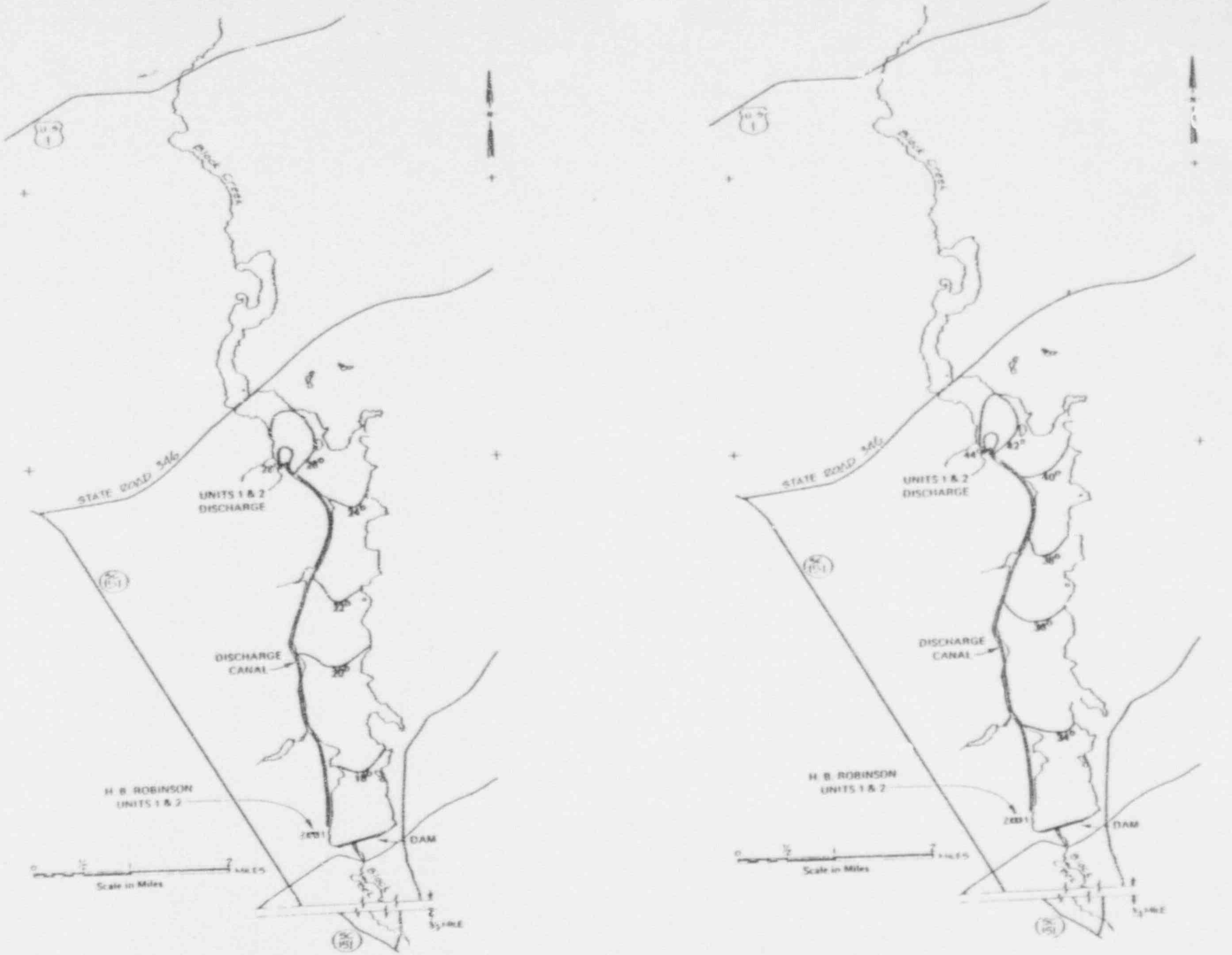


Figure 3.3.16 Robinson Impoundment predicted 2°C surface isotherms: predicted winter and summer maxima

4.0 Fisheries

4.1 Introduction

Preliminary studies of fish populations in Robinson Impoundment were begun in 1972 and 1973 and served to identify the methodology necessary to conduct a comprehensive study of the fishery and to begin compilation of a species list. During 1974 the studies were redesigned to meet the Nuclear Regulatory Commission regulations requiring fish population data and in view of the Company's decision to proceed with a 316 demonstration for the Environmental Protection Agency. Studies were further revised (added) during 1975 to strengthen weaknesses in the programs as they were identified.

The physical and chemical characteristics of Robinson Impoundment have been described in detail in Section 3 of this report. Other factors affecting fish populations such as vegetation and substrate are also described (Sections 6, 7) and should be kept in mind when examining the various characteristics of the fish population.

4.2 Fish Distributions in Robinson Impoundment

4.2.1 Introduction

Distribution of fishes is governed by environmental requirements that may vary with species or size. Certain species or sizes of fish exhibit preferences for particular water depths, temperatures, substrates, or cover types as well as being limited to certain ranges of these and other environmental parameters.

The objectives of the fish distribution study included determining the species present in the impoundment, examining variations in numbers and species among locations, and evaluating the numbers and species of fish present in the vicinity of the discharge with respect to other areas of the impoundment.

4.2.2 Methods and Materials

Gill netting, wire trapping, seining, and electrofishing were used to collect fishes from the various areas of the impoundment. The efficiency of these gear types varies with species and size of fish; therefore, results will be evaluated separately. In the quarterly sampling programs, quarters were defined as winter, January through March; spring, April through June; summer, July through September; and fall, October through December. An attempt was made to collect samples near the middle of the quarter.

Standard 30.5 m (100 ft) experimental gill nets, 2.4 m (8 ft) deep, (equal panels of 25 mm, 51 mm, 76 mm, and 102 mm (1 in, 2 in, 3 in, and 4 in) stretch mesh) were set at stations 1 and 3 of transects A, C, E, and G (Figure 4.2.1) for two consecutive days each quarter from summer 1974 through fall 1975. Nets were set off-bottom perpendicular to the shoreline at depths varying from 2 m (6.5 ft) to approximately 12.2 m (40 ft). The nets were checked and catch examined after approximately 24 and 48 hours.

Single funnel poultry wire traps approximately 1.2 m (4 ft) in length and .6 m (2 ft) in diameter were also set at stations 1 and 3 of transects A, C, E, and G for two consecutive days each quarter from spring 1974 through fall 1975. Traps were usually set in water 1 meter deep and were checked after approximately 24 and 48 hours.

Seining was conducted quarterly with a 15.2 m (50 ft) bag seine (6 mm (1/4 in) mesh) from summer 1974 through fall 1975. One seine haul was made at stations 1 and 3 of transects A, C, E, and G. Each haul consisted of extending the seine along the shoreline and sweeping an arc of 180° and radius the length of the seine (when possible). Water depth or bottom conditions at times prevented the full extension of the seine.

Electrofishing was conducted for 0.5 hour at stations 1 and 3 of transects A, E, and G monthly from April, 1975 through March, 1976. A Smith-Root type VI control unit and 3500 watt generator were used operating at 600 volts (AC). Current was generally within the range of 1-3 amps. Fishes

that were incapacitated were collected with a dip net and were held in a tub of water until the end of the collection period. The dark color of the water and low conductivity created some difficulty in collecting electrofishing samples. These conditions were generally uniform throughout the impoundment so comparison of data among stations can be made. Extreme caution should be used, however, in comparing these data with electrofishing samples collected in other bodies of water and different environmental conditions.

Numbers, lengths, and weights were recorded for all fish collected. Sex and maturity were recorded when possible. Scales, stomachs, and gonads were removed from largemouth bass, bluegill, warmouth, and chain pickerel when needed for age-growth, food habit, and fecundity studies. Larger fish which were not sacrificed and were in good physical condition were tagged with Floy anchor tags and released.

Catch rates have been adjusted to numbers and weights per 24-hour set for gill nets and wire traps, to number per haul for seine catches, and to number per hour for electrofishing to facilitate direct comparisons.

4.2.3 Results and Discussion

Species Composition

Thirty-one species of fish were collected from Robinson Impoundment during 1974 and 1975 (Table 4.2.1). Thirteen of these were centrarchids, indicating the importance of sunfish in the impoundment. The most common species collected were bluegill and warmouth, although species abundance varied with area. Three species, flier, white crappie, and black crappie were collected only from the H. B. Robinson Plant intake screens during studies of fish impingement (Section 4.9) or during creel surveys (two black crappie). Several additional species were collected from Black Creek and probably occur in the impoundment.

All of these are typical of the piedmont-coastal plain region and many are generally associated with "black water" systems. Table 4.2.2 compares the fish species collected from Robinson Impoundment and Black Creek with other

similar bodies of water in North and South Carolina. All of these, with the exception of Par Pond are characterized by darkly stained water. Par Pond, located in southeastern South Carolina, receives heated effluent from a nuclear reactor. The table illustrates that the fish species typically found in this area are well represented in Robinson Impoundment and that the species composition of Robinson Impoundment is not unlike that of other similar bodies of water in the area. (See Table 3.4.1)

Gill Netting

Gill net catches in Robinson Impoundment were generally small and varied both in number and species. Mean total catch per day (Table 4.2.3) was compared between stations on each transect as a possible basis for combination, using a paired Student's t-Test (Snedecor and Cochran, 1967). Significant differences (P = .05) were found between stations so overall variance in total catch (number per set) was evaluated using a 2-way Analysis of Variance and F Test, with sampling station and sampling date the classes of interest. Differences between sampling dates were not significant (P = .05), while differences between stations were highly significant (P = .01) (Table 4.2.4). Mean total catches by sampling station were then subjected to Duncan's five percent level New Multiple Range Test (Steele and Torrie, 1960). Three groupings of means were apparent (Table 4.2.5) indicating values which were not significantly different from each other. Catches at station G-3 were significantly higher than at the other sampling stations. The catch at the other upper impoundment sampling station (G-1) was next in numerical rank; however, no significant difference was indicated between the catches at stations G-1, E-3, E-1, A-1, and C-1. The catches at stations A-3 and C-3 were significantly lower than catches at G-1 but were not significantly different from catches at E-3, E-1, A-1, or C-1. These station differences indicate there is no difference in catch rate in the lower and middle reaches of the impoundment (including the discharge area), but these rates are lower than catches in the upper impoundment (G). In addition, catches from the discharge area and the east side of lower and mid-impoundment transects were not different from catches from the east side of the upper impoundment.

An alternative analysis was suggested by Dr. Charles H. Proctor of the North Carolina State University, Department of Statistics as being more appropriate. This analysis is presented in Exhibit 3. Discussion and conclusions were essentially the same following either procedure.

In examining species composition of catches at particular stations by season, no differences are readily apparent. There are, however, notable differences between stations. Gill nets at transects A and C generally caught a higher proportion of bluegills and chain pickerel than were taken on transects E and G. Suckers and golden shiners were generally collected in greater proportions from transects G and E than from transects C and A. Although warmouth and yellow bullheads were collected from most sampling stations, warmouth were taken in greater proportions from transects E, C, and A than from transect G, while yellow bullheads were taken in greater proportions from transects G and E than from transects A and C.

Wire Trapping

Wire trapping in Robinson Impoundment was generally inefficient with only centrarchids, primarily bluegill and warmouth, collected. Although the data were not subjected to statistical testing, mean catches by station appear to be grouped (Table 4.2.6). Largest catches were made at Station A-1 (average 3.2 fish per set), and were several times greater than catches at any other location. Mean total catches from Stations C-3, E-1, and G-1 ranged from 0.6 to 0.8 fish per set. A third grouping of Stations A-3, C-1, and E-3 (0.2 - 0.3 fish per set) was discernible. No fish were collected with wire traps at Station G-3.

In evaluating catches by year and season, more fish were taken in wire traps during 1974 than during 1975, and more fish were taken in the spring and summer than in the fall and winter. This seasonal variation is expected as lower fall and winter temperatures generally correspond to reduced activity of fishes and a decrease in trapping efficiency.

Seining

Much larger catches were made by seining in Robinson Impoundment during the spring and summer than in the fall and winter. During the cooler water periods, fish generally move from the shoreline areas to deeper water and are less susceptible to capture by seining.

Considering mean catches across all sampling periods, largest catches were taken at stations G-1, C-1, and A-1 (Table 4.2.7), ranging from 14.2 to 29.5. The low catches at stations A-3 and C-3 (1.1 and 1.2) are probably due primarily to the bottom type and topography. Both of these stations are located on washed sand shorelines which drop off rapidly preventing full extension of the seine and efficient sample collection. Collections at G were often hampered by bottom obstructions; the much larger mean catch at station G-1 due primarily to one haul which took 99 bluegills.

Bluegill was the most numerous species collected by seining at all stations and was the only species taken at station E-1. Chain pickerel and largemouth bass were also collected at most stations. The diversity of fishes collected by seining was higher at transect G than at other sampling locations. Seine catches at G included golden shiners, spotted suckers, creek chubsuckers, pirate perch, lined topminnow, black-banded sunfish, bluespotted sunfish, and dollar sunfish which were not taken at other sampling locations. Mosquitofish and redbreast sunfish were collected in the lower impoundment, but were not taken in the transect G seine hauls.

Much of the observed difference can be attributed to habitat and cover type. Low catches and diversity on transect E are probably due to the combination of high summer temperatures, cover type (algal mat over soft mud substrate), and inefficiency in seining due to roots protruding from the bottom. The smaller fishes which are susceptible to seining often are associated with aquatic vegetation, and seining at transect G included vegetated areas more frequently than seining at the other locations (Section 7).

Electrofishing

Although there was some difficulty collecting electrofishing samples from Robinson Impoundment due to the low conductivity and visibility, electrofishing was the most efficient sampling method employed. A variety of fishes was collected from each sampling location (Table 4.2.8) during most of the year and the number of species collected generally increased from the lower impoundment to the upper impoundment. This trend is best illustrated in the plot of the Shannon-Weaver diversity index (Weber, 1973) (Figure 4.2.2). The indices calculated for Stations A-1 and A-3 were generally lower than for other stations except during April, May, June, and July when the catch of bluegill declined which raised the proportion of other species in the catch, thus raising the indices. Indices calculated from catches at Stations E-1 and E-3 were generally higher than Transect A but exhibited a decline through the early summer reaching a minimum in July (August data not available), then increasing to levels comparable to early spring. Transect G indices were high and relatively stable with the exception of Station G-1 during May when no fish were collected.

Electrofishing catches were also examined by performing analysis of variance on the log transformation of bluegill, largemouth bass, warmouth, chain pickerel, and total catches per hour with sampling month and sampling location the variables of interest. Highly significant differences were evident in all of the groups considered with respect to sampling location while largemouth bass and total catch exhibited highly significant (P=.01) differences and bluegill and warmouth exhibited significant (P=.05) differences among sampling months (Table 4.2.9).

When significant differences were indicated, variation was examined further using Duncan's 5 percent level New Multiple Range Test (log transformation of catch per hour).

In this analysis, ranked means which are not significantly different from each other are grouped; any two means not included in a single group are significantly different from each other. Groups exhibiting significant differences in catches by sampling month are presented in Table 4.2.10. Differences

in sampling location for the various groups examined are presented in Table 4.2.11. Total catches at Transect A were significantly larger than from any other location. No significant differences were found between catches from E-1, E-3, G-1, and G-3. The large catches from Transect A were due primarily to the large number of bluegills collected during most sampling periods. The Duncan's test of bluegill electroshocker catches also supports this with Stations A-1 and A-3 exhibiting significantly larger catches than other sampling locations. No significant difference was evident between catches from Stations E-1, G-1, and G-3 or between catches from E-1 and E-3 but catches from G-1 and G-3 were significantly smaller than the E-3 catches. The concentration of bluegills on Transect A probably results from their utilization of the rock rip-rap along the dam for cover. Electroshocker catches of largemouth bass were significantly larger at Stations E-3, E-1, and A-1 than at Stations G-3, A-3, and G-1 with the station nearest the discharge (E-3) exhibiting the largest mean catch. Station A-1 largemouth bass catches, however, were not significantly larger than G-3 catches. Warmouth electrofishing catches from Stations A-1, G-3, and A-3 were not significantly different and were larger than catches at the other stations. Warmouth catches at stations E-1, G-1, A-3, and G-3 were not significantly different. Station E-3 catches were significantly lower than catches at the other stations. Electroshocker catches of chain pickerel were not significantly different between sampling stations. The pattern of larger bluegill and warmouth catches from the lower impoundment is probably a reflection of habitat preference, with these species occupying the rock rip-rap areas.

An alternative analysis was suggested by Dr. Charles H. Proctor of the North Carolina State University Department of Statistics as being more appropriate. This analysis is presented in Exhibit 3. Discussion and conclusions were essentially the same following either procedure.

These fish distribution data suggest that most species are distributed primarily as a function of habitat type. The area around Transect G contains many stumps, logs, and rooted aquatic vegetation. These sources of fish cover were much less abundant in the vicinity of Transect E and still less abundant at Transect A. Distributions may change seasonally as a result of environmental variable avoidance such as summer discharge temperatures (Shannon-Weaver index) but when yearly mean values were considered, the distributions appear to be based primarily on habitat. A depression in the fish population was not evident in the discharge area when mean values were considered.

4.3 Standing Crop Estimates

4.3.1 Introduction

Fish populations are generally assessed in terms of standing crop or weight of fish per unit area. The examination of standing crop incorporates the various factors affecting a fish population and allows for comparison among areas and bodies of water.

Standing crop estimations of fishes are commonly made by introducing a toxicant in an area of known size and examining fish that are killed. This method contains the inherent variability of changing physical and environmental conditions and of varying efficiency of sampling. Cove samples (the poisoning of coves isolated with block nets) have, however, been found to provide an estimate of fish biomass which is often better than other assessment methods, although relative abundance may be misrepresented (Barry, 1967; Hayne et al., 1967; and Sandow, 1970).

4.3.2.1 Methods and Materials

Three coves representing the upper, mid, and lower reaches of the impoundment were selected for rotenone sampling at Robinson Impoundment during 1974 and 1975 (Figure 4.2.1). The coves were blocked off using 1/4-inch (delta) mesh block nets. The surface area and volume of the coves were calculated and Noxfish (5% emulsifible rotenone) applied at a concentration of 2.0 parts per million. Potassium permanganate was applied outside of the block nets to neutralize rotenone diffusing out of the coves. Fish were collected inside the block net as they appeared after rotenone application and on the following day Fish were separated by species; length and weight were recorded. When numbers warranted, fish were assigned to length groups and group weights were recorded (1974 - inch groups, 1975 - centimeter groups). Scales and gonads

were removed from fresh warmouth, bluegill, chain pickerel, and largemouth bass which were collected. Fishes which could not be positively identified in the field were preserved in 10% formalin and returned to the laboratory for further examination.

4.3.3 Results and Discussion

Standing crop estimates ranged from 29.3 kg/ha in the upper impoundment cove during 1975 to a high of 139.8 kg/ha in the lower impoundment cove during 1975 (Table 4.3.1). The greatest numbers of fishes in both 1974 and 1975 were found at the mid-impoundment transect; however, diversity was lower than at the other sampling locations. During both years, diversity was highest in the upper impoundment cove although no species were conspicuous by their presence or absence at any particular sampling location.

In the lower impoundment cove, chain pickerel, spotted suckers, bluespotted sunfish, and bluegills were the major species collected during both years. The weight of redbreast sunfish collected decreased from 1974 to 1975 while the weight of warmouth and largemouth bass increased considerably. Swamp darters were second in numerical abundance in the lower impoundment cove during 1975.

The mid-impoundment cove was numerically dominated by bluegills during 1974 and 1975. The mean length of these fish was 33 mm and 71 mm during 1974 and 1975, respectively. Due to the length classes used, the 1974 lengths probably underrepresented the true mean.[1] Generally, however, most bluegill were in the 2-3 inch size range. This small size indicates the abundance of young bluegills in the area. Other young centrarchids were also present in substantial numbers as evidenced by the numbers and average sizes of bluespotted sunfish of 26 and 50 mm and largemouth bass of 129 and 94 mm. The major fish species collected from the mid-impoundment cove in terms of biomass were redfin and chain pickerel, bluegill, warmouth, and largemouth bass. The swampfish collected from the mid-impoundment cove should be noted since this little known species was not collected from any other locations during our sampling program.

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[1] Data records used in calculating mean lengths were midpoints of length classes in cases where length classes were utilized in reporting lengths.

The upper impoundment cove contained the greatest diversity of fishes although the standing crop was the lowest of the three coves sampled each year. Centrarchids, particularly bluespotted sunfish, warmouth, bluegill, and dollar sunfish were the major species collected comprising 85% and 76% of the total during 1974 and 1975. Numbers generally decreased from 1974 to 1975 (particularly bluegill) although the number of pickerel, pirate perch, and black banded sunfish increased. During both years of sampling, chain pickerel were major contributors to the total biomass. During 1974 spotted suckers and during 1975 largemouth bass weights also were important.

During sampling in 1974, biologists present felt that several factors contributed to underestimation of the fish populations in the mid-impoundment and lower impoundment coves. During the sample period, a wind blowing across the impoundment increased suspended material in the water and decreased visibility, causing a reduction in efficiency of collection. This wind also washed many small dead fish into the vegetation along the edges where recovery was impaired. In the lower impoundment cove, some difficulty was encountered in adequately fixing the block net from bottom to surface. This may have allowed the escape of some fishes and contributed to an underestimate of the population.

The mean of the six rotenone samples collected from Robinson Impoundment during 1974 and 1975 were calculated and compared to other similar lakes in the southeast (Table 4.3.2). Singletary, Alligator, Great, and Catfish Lakes are characterized by low pH and black water. Lake Waccamaw has darkly stained water; however, pH is more nearly neutral and Par Pond, located on the Savannah River Reservation (ERDA), receives heated effluent.

Major species were considered individually in Table 4.3.2 with other fishes combined and reported as "all others." When comparing Robinson Impoundment to the other lakes included, the standing crop estimate was somewhat less than Par Pond but greater than the others. Species composition and general abundance of fishes was similar in the lakes examined with bluegill, warmouth, chain pickerel, and largemouth bass frequently occurring as dominant species.

The standing crop data collected from Robinson Impoundment illustrated several points.

1. The standing crop of fishes is similar to other coastal plain lakes in the Southeast.

2. Relative abundance of fish species as estimated with rotenone is similar in Robinson Impoundment and other lakes in the Southeast which have similar environmental characteristics.

3. Fishes are utilizing upper, mid, and lower reaches of Robinson Impoundment, although abundance and diversity varies among areas.

4. Although surface temperatures in some areas of Robinson Impoundment approach thermal maxima for many of the species collected, fish are present in good numbers, possibly indicating the utilization of temperature stratified or refuge areas. There are many springs, seeps, and small creeks in the area which are sources of relatively cool water. This cool water forms a layer close to the bottom which varies in size with volume of source water, turbulence, and bottom topography. Many of these areas are too small to be illustrated from temperature/D.O. profile sampling, but are readily apparent when wading in the area. In addition, much of the impoundment has some temperature variation from top to bottom (temperature - profiles, Section 3) providing large volumes of water with temperatures less than those apparent on the surface.

5. No paucity of game or sport fish expected in a southeastern lake or reservoir with similar environmental characteristics was indicated by the rotenone samples collected from any area of Robinson Impoundment.

4.4 Food Habits

4.4.1 Introduction

Fish food habits can provide valuable information on the patterns of energy flow within a community and indicate relationships potentially subject to adverse environmental impact. These data can be useful in the interpretation

of fish growth rates, distributions, and reproductive efforts. The objectives of the study program were: (1) to procure information on the types and relative abundances of food items; (2) to qualitatively identify the major pathways and sources of energy available for fish production; and (3) to qualitatively assess the feeding conditions of the populations in question by comparison of seasonal diets with the availability of resource items in the environment.

4.4.2 Methods and Materials

Species of important sport fishes selected for stomach analysis at Robinson Impoundment included the bluegill, largemouth bass, warmouth, and chain pickerel.[1] A preliminary study of the bluegill was conducted from April to December of 1974 from specimens collected from the intake screens of the H. B. Robinson Steam Electric Plant. In January of 1975 a more intensive sampling program was initiated to provide information on the food habits of fishes from the upper, discharge and lower portions of the impoundment. Fishes were collected monthly in the littoral areas of transects A, E, and G by use of a Smith-Root Type VI boat mounted electrofisher and assorted other sampling methods. Electrofishing in the vicinity of each transect from January to December accounted for 82% of the yearly sample. The remaining 18% of the samples were obtained from seine, rotenone, gill net, and impingement samples. Fishes were injected in the field with 40% formaldehyde solution and preserved in 10% formalin for future analysis.

Laboratory analysis involved the measurement of total length (TL) to the nearest millimeter and excision of the stomach from the pyloric sphincter to the esophagus. Stomachs were emptied of contents and stored in individual vials of 70% ethyl alcohol with Rose Bengal biological stain. Contents were later identified to the lowest taxonomic level practical by use of Pennak (1953), Brooks and Kelton (1967), Parrish (1968), Johannsen (1969), and Deevey and Deevey (1971). Only stomachs with identifiable food organisms were utilized in this study. Food organisms were enumerated by taxa and if more than one item was present in a stomach, the percentage of these items was determined by centrifugation in a Wintrobe tube, water displacement, or visual inspection. The percent frequency of occurrence, mean number of organisms per stomach with food, and either the percent average volume or the percent total volume of food items were

[1] White catfish were also included at the initiation of the study but numbers collected were insufficient for analysis.

calculated for all fish on a quarterly basis. The percent average volume is influenced by the frequency of occurrence of a kind of food but not by the size of either the stomach nor its fullness. This gives the stomach contents of small fish the same importance as those of a large fish and is applicable in describing volumetrically the food of bluegill. The percent total volume emphasizes the importance of large items and is applicable to the diets of large predaceous fish (i.e., warmouth, largemouth bass, chain pickerel). Bluegills from the lower impoundment and discharge area were divided into two groups (< 100 mm and ≥ 100 mm TL) (< 3.9 in and ≥ 3.9 in) in order to demonstrate any size differences in food selectivity. This was not possible in the upper impoundment due to small sample sizes.

4.4.3 Results and Discussion

Bluegill-Limnetic Zone of Lower Impoundment

Food analysis of bluegills from the intake screens of the H. B. Robinson Steam Electric Plant during 1974 is based on the examination of 168 stomachs (Table 4.4.1). These data (Figures 4.4.1 and 4.4.2) illustrate a dominance of zooplankton in the diet and suggest a seasonal progression in numerical abundance and relative importance of zooplankton as food items. The dominant food item in the diet of small bluegill during the summer was Cyclops while Eubosmina was dominant during the fall. A comparison of food habits data with zooplankton dominance suggests that bluegills grazed upon the dominant forms available. Eubosmina was the winter and fall dominant while Cyclops was dominant during the spring and summer. During the summer Chaoborus constituted a large portion of the total volume and occurred at greater frequencies in stomachs of large bluegill than in small bluegill. During the spring Chaoborus was the dominant resource for both size groups of bluegill (Figures 4.4.1 and 4.4.2). No data were available on the numerical abundances and seasonal distributions of the pelagic instars of Chaoborus.

Bluegills for stomach analysis largely consisted of fish impinged from dusk to dawn of the following day. In stomachs containing Chaoborus, 70% contained zooplankton (i.e., Cyclops, Eubosmina, and Diaphanosoma), 21% contained only Chaoborus, and only seven percent contained Chaoborus and benthic organisms. All

instars of Chaoborus are known to feed on cladocerans and copepods in the epilimnion at night (Juday, 1921; McLaren, 1963). Two main periods of feeding have been described for bluegills. The major period occurs in the late afternoon and the other a few hours after dusk (Keast and Welsh, 1965). This would correspond to the time when Chaoborus has vertically migrated into the water column to prey upon zooplankton. Chaoborus generally escapes fish predation during the day by retreating to the hypolimnion (Juday, 1921, Stahl, 1966; Pope et al. 1973).

Benthic macroinvertebrates, represented by a total of 16 genera (Table 4.4.2), contributed little to the total volume of food of limnetic bluegills. The dominant benthic organisms consumed were dipteran larvae (11 genera) and trichopterans (3 genera). The larvae of Procladius were present at frequencies higher than 10% in both size groups of fish throughout the year. This chironomid represented between 2.7% and 5.3% of the total stomach volume of large bluegill and between 2.2% and 7.2% of small bluegill. Trichopterans (i.e., Oecetis and Polycentropus) were important benthic resources during the spring (Figures 4.4.1 and 4.4.2).

The primary sources of food for the bluegill in the area of the plant intake structures were Chaoborus, Eubosmina, Cyclops, and Oecetis. These data depict the food of limnetic bluegill during their feeding period in the evening and stress the role of zooplankton in the diet. It has been reported that all sizes of bluegill participate in diel littoral-limnetic migrations but that as fish length increases a reduction in the frequency of migration occurs. Bauman and Kitchell (1974) suggested that it is energetically advantageous for larger fish not to migrate but to remain in the littoral zone. Since the littoral zone habitat available for bluegill grazing was limited in this area of the impoundment due to impoundment topography and bluegill densities were high, the advantages of littoral feeding may be lost due to high competitive interactions for a limited food supply. The best feeding strategy under these conditions would be for increased planktivory. This is what has been observed at Robinson Impoundment for both size classes of bluegills.

Bluegill-Littoral Zone of Lower Impoundment

Data for bluegills in the lower impoundment during 1975 are based on the examination of 302 stomachs (Table 4.4.1) and indicate a major dependence

upon planktonic cladocerans and copepods during the winter, spring, and fall. Larger bluegills did not consume as large a portion of zooplankton as did smaller fish. This is typical of bluegill feeding behavior (Carlander, 1972). In small bluegills, Eubosmina accounted for 99.4% of the volume and occurred in 100% of the samples during the winter quarter (Figure 4.4.3). The dominant taxa of zooplankton throughout the year were Eubosmina, Diaphanosoma, and Cyclops. The dominant organism in the winter was Eubosmina, with Diaphanosoma dominant during the spring and summer, and Cyclops present in highest densities during the fall of 1975 (Figures 4.4.3 and 4.4.4). An examination of stomach content data with respect to zooplankton seasonal abundances indicates similar patterns of dominance (Table 5.3.4). Since bluegills are reported to be keenly responsive to search and capture time during grazing (Werner and Hall, 1974), it is energetically favorable for these fish to consume the dominant species available in the absence of any size selective feeding behavior (Canfer and Blades, 1975).

In the lower impoundment benthic organisms, represented by 29 taxa (Table 4.4.2), were important components of the diets of both size groups of bluegill. These organisms volumetrically represented 30.8% and 46.8% of the diets of small and large bluegills during 1975. An increased utilization of benthic organisms with increasing fish length is a common feeding behavior of bluegills (Carlander, 1972). Literature references to the food habits of the bluegill from a wide variety of habitats indicate that zooplankton and aquatic insects are the dominant food items (Calhoun, 1966; Carlander, 1972). Young bluegill feed on small crustacea and aquatic insects while the adults prefer the larger aquatic insects, small crayfish and fish (Carlander, 1972). In general, an inverse relationship exists between body size and the percentage of zooplankton in the diet (Turner, 1955). Bluegills generally remain within the same trophic level throughout life but shift from plankton grazing to benthos feeding as size increases (Gerking, 1962).

The most commonly consumed benthic organisms were larval chironomids. Small bluegills utilized 17 genera of chironomids while 14 genera were present in the diet of large bluegill. Chironomids were most abundant during the spring but were noticeably reduced during the winter. Procladius was present in the

food of both size groups of bluegills throughout the year. Larger bluegills also consumed Polypedilum throughout 1975 in addition to Procladius. Procladius is generally found in the sub-littoral and profundal areas of Robinson Impoundment while Polypedilum is typically found in the littoral zone. Another littoral zone chironomid, Ablabesmyia, was an important food resource for both size groups (Figures 4.4.3 and 4.4.4). Chironomid and culicid pupae were important food items of large bluegills at most times of the year. Utilization of pupae was highest during the spring, occurring in 59.2% of the stomachs and representing 19.5% of the volume (Figure 4.4.4). Oecetis, usually a littoral tricnopteran on sandy, or clay substrates, was a subdominant food item of small bluegills during the fall and occurred in 15.2% of the stomachs (Figure 4.4.3). During the summer large bluegills utilized Chaoborus and terrestrial Myrinicinae as food resources. These collectively averaged 86.5% of the total volume (Figures 4.4.3 and 4.4.4). The major sources of food for bluegills in the lower impoundment were Eubosmina, Diaphanosoma, Cyclops, Chaoborus, Polypedilum, Ablabesmyia, Oecetis, and dipteran pupae (Figures 4.4.3 and 4.4.4). Analysis of the data with respect to zooplankton (Section 5.0) and benthic data (Section 6.0) suggests that the dominant items in the diet were also dominant in the impoundment. These data indicate an overall major reliance on zooplankton as the major food resource in the lower impoundment. As indicated previously, dependence upon zooplankton was probably a function of habitat.

Bluegill-Discharge Area

In the discharge area zooplankton was an important component of the diet of both size groups of bluegills during the winter, spring, and summer as determined from analysis of 208 stomachs (Table 4.4.1). Eubosmina was the dominant food for all bluegills during the winter and summer (Figures 4.4.5 and 4.4.6) while Cyclops was dominant during the spring (Figure 4.4.5). A comparison of zooplankton species composition in the discharge area (Table 5.3.4) with food habits data indicates selection for nondominant species. During the summer the dominant taxa in the plankton were Cyclops and Diaphanosoma (Table 5.3.4). Examination of fish food habits indicate a high utilization of Eubosmina ranging from 27 to 35% of the volume (Figures 4.4.5 and 4.4.6). Zooplankton were almost eliminated in the area of the discharge during mid-summer (e.g., August) (Table 5.3.4). Fish utilized nondominant zooplankton species occurring occasionally

at relatively low densities.

Benthic organisms averaged 58.9% and 57.5% of the yearly food volume of small and large bluegills, respectively. This utilization is higher in comparison with utilization in the lower impoundment. The lower impoundment is deeper with limited littoral areas while the discharge area has large littoral areas available for bluegill grazing. In contrast with the lower impoundment, Procladius was not utilized to any great extent in the discharge area. This area is shallow and not a preferred habitat for Procladius. Procladius (aberrant), which were most abundant in the littoral areas of Station E-1 (Table 6.3.3), were not utilized by bluegills as a food resource. The important chironomid in the diet was Polypedilum which was present throughout the year. It was the dominant food item of large bluegill during the spring quarter in terms of both volume and frequency of occurrence (Figures 4.4.6). Benthic data indicate that the numbers of Polypedilum were reduced in the area of the discharge (Figure 6.3.2). Ablabesmyia was an important food of small bluegills during the summer in the discharge area occurring in 29% of the stomachs and representing 12% of the total volume (Figure 4.4.5). This chironomid was present in the littoral areas of the discharge area and was not affected by the thermal effluent (Section 6). Chaoborus larvae were utilized throughout the year by large bluegills and during the spring, summer, and fall by small bluegills. This organism was the dominant food of small bluegills during the fall and one of the dominant resources of the larger bluegills during both summer and fall (Figures 4.4.5 and 4.4.6). As indicated in the benthos data, Chaoborus densities were reduced in the discharge area during the summer (Figure 6.3.4). As suggested in Section 6, this reduction in numbers of Chaoborus resulted from elevated water temperatures and current velocities associated with plant operations. Oecetis occurred in 36.7% of the large bluegills and 50% of the small bluegills during the fall of 1975. This organism was collected in relatively high numbers at Transect E throughout 1975 (Figure 6.3.8). The food preferences of bluegills indicate utilization of several items affected by the thermal effluent of Robinson Steam Electric Plant. Diversity ($\bar{d}$) estimates of benthic organisms were extremely low in the discharge area during the summer (Table 6.3.7). Diversity was low at Station E-1 from August to October of 1975 and a zero diversity was calculated for the benthic community during September and October. Diversity was also low at Station E-3

from July to October of 1975 (Table 6.3.7). According to Headrich (1975), changes in community stability due to environmental changes are reflected by changes in diversity.

The primary sources of food for bluegills in the discharge area were Eubosmina, Chaoborus, Cyclops, Diaphanosoma, Ablabesmyia, Polypedilum, Oecetis, Oligochaetes, and chironomid pupae and emergents. As indicated by the abundance, species composition, and diversity of the benthos, the quality of feeding conditions in the discharge area during the summer was the poorest encountered in the impoundment. During the summer, benthic organisms totaled 51% and 67% volumetrically of the food of small and large bluegill yet species diversity and relative abundances of benthos in the habitat were low. This lack of stability of dominant food items in the discharge area suggests that a food stress exists on those bluegills inhabiting this area. It has been suggested that bluegills are overcrowded in Robinson Impoundment. Overcrowding is common in bluegill populations and is one of the persistent problems of fisheries management. It is not unusual for overcrowded populations to occur in marginal habitats. In terms of available food supply, the discharge area must be considered a marginal habitat during the summer months and that bluegills inhabiting this area were food stressed.

Bluegill-Littoral Zone Upper Impoundment

The food habits of bluegills in the upper impoundment during 1975 as based on the analysis of 114 fish (Table 4.4.1) were essentially different from those of the lower and middle regions. This was indicated by a greater dominance diversity of food items (Figure 4.4.7), a greater number of different taxa (Table 4.4.2), and the presence of 19 taxa of benthos not present in the diet of fish in the lower impoundment and discharge area. In the upper impoundment rooted aquatic macrophytes were more abundant than in other areas of the impoundment (Figures 7.2.1, 7.2.2, 7.2.3, 7.2.4) and provided suitable habitat for many macroinvertebrates. Of noticeable importance in the diet of bluegills in the upper impoundment was a high percentage of large-bodied benthic organisms (Figure 4.4.7). In the lower impoundment Oecetis and Oxyethira were the only trichopterans utilized by bluegills while in the upper impoundment at least six different taxa were present in the diet (i.e., Agrypnia, Leptocella, Oecetis,

Oxyethira, Pharyganea, and Pycnopsyche). During the winter Pycnopsyche was one of the major components of the diet (Figure 4.4.7). The major macroinvertebrate utilized by bluegills throughout the year was Hexagenia (Figure 4.4.7). These mayfly nymphs represented more than 20% of the volume during the winter, spring, and fall. These organisms are noticeably absent in the lower and discharge areas of the impoundment (Section 6). In the upper impoundment four dipteran larvae (i.e., Ablabesmyia, Dicrotendipes, Polypedilum, and Pseudochironomus) were present in the diet throughout the year. This is in contrast with other areas of the impoundment where Polypedilum and/or Procladius were present.

Zooplankton were not a dominant food resource for bluegill in the upper impoundment except during the fall. Eubosmina was utilized to a great extent during the fall quarter. It occurred in 73.3% of the stomachs and totaled 70.4% of the volume (Figure 4.4.7). These organisms were extremely abundant in the upper impoundment at this time (Table 5.3.4). In the lower and mid portions of the impoundment when zooplankton were utilized to this extent, the number of other taxa in the diet was generally reduced indicating primarily planktivorous feeding behavior. This pattern was not observable in the upper impoundment. This indicates greater stability in the diet. The food habits described for the bluegill in the upper impoundment are typical of those found in the literature (Carlander, 1972).

Largemouth Bass

Food habits of 24 fingerling bass (32-94 mm TL) during the spring and summer at Robinson Impoundment indicate the importance of cladocerans and large-bodied invertebrates in the diet (Table 4.4.3). Kramer and Smith (1960) reported that bass 40-100 mmTL fed on cladocerans, chironomid larvae, and ephemeropteran nymphs. This feeding pattern has also been well documented in other studies (Carlander, 1972). At Lake George, Minnesota, fish first appeared in the diet when bass attained a total length of 20 mm but occurred in no more than 50% of the stomachs (Kramer and Smith, 1960). Murphy (1949) found that bass greater than 71 mmTL fed almost exclusively on fish while Turner and Kraatz (1920) stated that insects and fish were the principle foods of bass > 50 mmTL. At Robinson Impoundment fish occurred in 54.6% of the stomachs during the spring and 31.3% in the summer. Murphy (1949) concluded that high production of

young bass can be attained only if an ample supply of forage fish is available when the fingerlings reach 63-75 mm total length. Appelgate and Mullan (1967) attributed high bass production to the consumption of midge larvae and cladocerans. The dominant forage fish for fingerling bass was larval and post-larval centrarchids which were most abundant in the upper impoundment (Table 4.7.2) and should have provided an ample food supply for the early stages of bass growth.

The major food items of adult largemouth bass ($\geq$ 100 mmTL) at Robinson Impoundment were fishes, crayfish, and odonate nymphs (Figure 4.4.8). This was determined from the analysis of 51 stomachs (Table 4.4.1). Crayfish and odonate nymphs are usually associated with rooted aquatic vegetation. There are no estimates available from Robinson Impoundment on the distributions or abundances of crayfish and odonates. Fishes represented by *Lepomis*, *Etheostoma*, *Notropis*, and *Micropterus* were the dominant food items volumetrically during the winter (90.8%), spring (43.3%), summer (83.1%), and fall (26.2%) of 1975 (Figure 4.4.8). During the fall, crayfish (*Procambarus*) contributed 20.1% to the total volume and occurred in 35.7% of the stomachs. The food habits of largemouth bass at Robinson Impoundment were typical of literature descriptions of the diet in other lakes. The principle foods of largemouth bass in other studies were small centrarchids, centrarchids and crayfish, perch, crayfish and fish, gizzard shad and crayfish, gizzard shad and crappies, gizzard shad and yellow bass, and fish in general (Goodson, 1965; Carlander, 1972). Odonates and mayfly numphs were the major groups of insects consumed by large bass in Ontario (Carlander, 1972).

At Robinson Impoundment the major sources of food for fingerling bass were hemipterans, chironomid pupae, *Chaoborus*, *Palaemonetes*, *Lepomis*, and *Etheostoma*. Adult bass foraged to a great extent on fishes, particularly *Etheostoma*, *Lepomis*, *Micropterus*, and *Notropis*. The dominant forage fish throughout the year for all sizes of largemouth bass was *Lepomis*. Small centrarchids, particularly bluegill, were abundant during most times of the year at Robinson Impoundment and provided ample forage for largemouth bass.

Warmouth

Food habits of warmouth from Robinson Impoundment as determined from the analysis of 65 stomachs (Table 4.4.1), illustrated little seasonal variation in food preference. The major food items were trichopterans, ephemeropterans, odonates, crayfish, and fish (Figure 4.4.9). Warmouth are generally found in areas of dense aquatic vegetation and soft bottoms (Larimore, 1957). Crayfish are also inhabitants of this littoral zone habitat and juveniles typically move about on the bottom during the daylight in search of food. These crayfish are susceptible to fish predation and were utilized as a food resource throughout the year. Crayfish were the dominant food items during the spring, summer, and fall. Since crayfish are detrital feeders, the primary sources of energy for warmouth growth was derived from a detrital based food chain. Fish accounted for 21.5% of the volume in the spring and 20.0% in the fall. Lepomis spp. were the dominant forage fish consumed during 1975. Small bodied aquatic invertebrates and zooplankton were consumed throughout the year to some extent but contributed very little to the overall diet.

Small warmouth generally consume crustaceans and small invertebrates while larger fish prey heavily upon crayfish and fish (Forbes, 1903; Lewis and English, 1949; Larimore, 1957; German et al., 1973). Larimore (1957) states based on his studies and a review of the literature that, "it seems very unlikely that there is any strong diet or highly restrictive food preferences for this species." As indicated by the data from Robinson Impoundment, warmouth principally consume crayfish and fish. This is typical of what has been reported in the literature.

Chain Pickerel

Chain pickerel at Robinson Impoundment are largely piscivorous in feeding behavior. Fish were the dominant items by volume during the winter (73.5%), spring (99.8%), summer (93.1%) and fall (95.8%) of 1975 (Figure 4.4.10).

This was determined by the analysis of 67 pickerel stomachs (Table 4.4.1). Forage species included Etheostoma, Lepomis, Erimyzon, Notemigonus, and Fundulus. Foote and Blake (1945) found that fish represented over 90% of the volume and occurred in 62% of the stomachs of pickerel from Babcock Pond. Raney (1942) found that fishes totaled 47% of the volume and that species were not consumed in relation to their abundance in the pond. In stomachs examined from Robinson Impoundment 82% had only one food item. This characteristic of the feeding behavior of pickerel has been reported by Raney (1942). In general, large pickerel feed mostly on fish, frogs, crayfish, or almost anything of proper size (Calander, 1969). Food was not a limiting factor for chain pickerel in Robinson Impoundment.

4.4.4 Summary and Conclusions

Planktivorous feeding was a dominant strategy of bluegills in the lower and discharge areas of the impoundment. This is not an energetically favorable feeding strategy of littoral bluegills especially for larger fish (Bauman and Kitchell, 1974). Since the efficiency of protein utilization decreases as fish become larger it is advantageous for larger bluegill to feed on large-bodied benthic invertebrates in order to maximize the net amount of energy available for growth (Gerking, 1962). This feeding strategy was characteristic of bluegills in the upper impoundment. In this area of the impoundment food habits of bluegill were typical of those described in the literature and there was no evidence of food stress from either low productivity or heat load. In the lower impoundment, which has limited littoral areas available for bluegill grazing, the advantages of littoral feeding were probably lost due to competitive interactions. In this area the most energetically efficient feeding strategy was planktivory. In the discharge area the quality of feeding conditions during the summer was the poorest in the impoundment. Several dominant benthic food items were detrimentally effected by plant effluents. During the summer benthos abundances and species diversity were very low in the discharge area creating an unstable food supply. This lack of stability of dominant food items in the discharge area during the summer of 1975 indicated a food stress on the bluegill population. This stress occurred on overcrowed bluegills in a marginal habitat with limited and unstable food resources.

Food habits of largemouth bass, warmouth, and chain pickerel were similar to literature descriptions and a comparison of food selectivity with availability in the habitat suggest that food was not a limiting factor for growth and reproduction. It should be pointed out, however, that these studies were only descriptive and that no measurements were made of any consumption rates or growth efficiencies. The dominant forage fish for largemouth bass and warmouth was Lepomis spp. These centrarchids were abundant during most times of the year in the impoundment and should have provided ample forage. Chain pickerel were found to be largely piscivorous. Important forage species included Etheostoma, Lepomis, Erimyzon, Notemigonus, and Fundulus. These species are widely distributed and common in Robinson Impoundment and should have provided an ample food supply for chain pickerel. The primary source of energy for the warmouth in the impoundment was detrital based. This was indicated by the high rate of consumption of detrital feeding crayfish. No estimates were available on the distributions and abundances of crayfish in the impoundment, therefore, no conclusions can be reached on the stability of a diet based on this dominant food resource.

4.5 Age and Growth Studies of Robinson Impoundment Fishes

4.5.1 Introduction

Growth rate, population structure, and condition of fishes provide an indication of the status or "health" of the population present. Growth rate also is indicative of production and is an important factor in determining the size of fishes available to fishermen.

Growth rate of fishes is usually related to food supply which in a reservoir ecosystem is generally based primarily on plankton production. When environmental factors such as low pH or dark color reduce the fixation of energy at the lowest trophic level, secondary production is reduced, thus fish growth is usually slowed. We have examined the growth rate of bluegill, warmouth, largemouth bass, and chain pickerel[1] from Robinson Impoundment and compared these data to the growth rate information available from similar bodies of water in the area.

[1] White catfish were originally selected for study but numbers collected were too small for analysis.

4.5.2 Methods and Materials

Age and growth of fishes are normally determined by comparison of length-frequency distributions, recovery of marked fish of know age or by interpretation of annual layers laid down in scales or other hard parts. At the Robinson Impoundment, scale anaysis was chosen as the primary method for determining age and growth rates.

Scales were removed from bluegill, warmouth, largemouth bass, and chain pickerel collected from Robinson Impoundment during 1975. Scales were removed from centrarchids posterior to the tip of the pectoral fin and from chain pickerel between the lateral line and the origin of the dorsal fin (Lagler, 1956).

Impressions of larger scales were made in warmed plastic with a hydraulic press and examined with an Eberbach scale projector. Smaller scales which would not make clear impressions were examined under a binocular microscope. For each scale examined, the total scale radius (focus to anterior scale margin) and length to each annulus (focus to anterior annulus margin) were recorded. All scales were examined by three individuals independently and were discarded if at least two of the three readings were not in agreement.

Back-calculated lengths were determined from the regression of scale radius on total length. Because of the clumping of data and relatively low numbers of smaller fish, the regression was forced through the origin. This line showed a much closer relationship to the empirical data than did the regression with an intercept. Thus, the equation,

$$\ell n = \frac{Sn}{S} \ell$$

where ℓn is the calculated length at annulus n, ℓ is the total length of the fish at capture, Sn is the scale radius at annulus n, and s is the total scale radius, was used for all back calculations.

For comparative purposes when numbers warrented, monthly length frequency histograms were computed for bluegill, warmouth, largemouth bass,

and chain pickerel collected with plexiglass larval traps and electrofishing. Variations in individual growth rate and general slow growth precluded discerning year classes in older fishes. However, the examination of recruitment into the collectable population and month-to-month changes in the histograms illustrate growth in young of the year and second year fish. These histograms are not intended to show absolute frequencies, but are for comparison of changes over time corresponding to growth.

4.5.3 Results and Discussion

Bluegill

Back calculated length of bluegills from the three areas of Robinson Impoundment (Table 4.5.1) generally appear similar, although small differences may exist. Growth was slow in all areas and fish collected from the upper impoundment exhibited slightly slower growth during the first year. Larger incremental growth during the second year increased the mean estimated size of upper impoundment second year bluegills above that from the other impoundment areas. Bluegill growth in the discharge area was not consistently lower or higher than growth in the other areas.

An examination of the length frequency of bluegills collected from Robinson Impoundment does not provide a clear growth progression through the year, particularly in fish over 125 mm total length. It is, however, indicative of growth of young of the year and yearling fish if trends in selected months are considered (Figure 4.5.1). The length frequency histogram of bluegills collected in June illustrates young fish as they are recruited into the catchable population and another large peak of 80 - 90 mm represents fish in their second year. These groups progress in size through the summer and fall to November and December when peaks are evident from 50 - 80 mm and 100 - 130 mm. These peaks are generally discernible throughout the winter and are thought to represent young of the year and yearling fish. If this is the case, the bluegill growth rate is faster than is indicated by the back calculation estimates, reaching approximately 65 mm their first year and 115 mm their second year.

A comparison of bluegill growth rates in Robinson Impoundment and data collected from similar bodies of water is made in Table 4.5.2. Although there is a shortage of data from comparable areas, bluegill growth in Robinson Impoundment appears similar to other blackwater lakes.

The length-weight relationship of bluegills (Log_{10} weight = a + b Log_{10} Length, a = intercept b = slope) was computed for the three areas by season to compare relative condition (Table 4.5.3). Regression line slopes were lowest for fish collected above the discharge area except during the spring. Regression lines for fish from the discharge area and from the lower impoundment were generally similar except during the fall when the slope at the discharge was much larger, indicating a greater weight increase per unit length increase.

Warmouth

Back calculated lengths of warmouth from Robinson Impoundment indicated very slow growth, particularly during the first two years (Table 4.5.4). Within the impoundment there were small differences in growth rates among areas with the most rapid growth occurring at the discharge area and slowest growth occurring in the lower impoundment. Examination of lengths of fish collected generally support this average growth rate but they also indicate recruitment of small fish during an extended period of time. The recruitment of small fish over a relatively long period and their presence near the end of the growing season would contribute to smaller mean growth and an underestimate of growth rate. Growth rate estimates of warmouth in Lake Robinson are within the range of values reported from several North Carolina blackwater lakes (Table 4.5.5).

Total length/weight equations for warmouth were calculated by area and season (Table 4.5.6). An examination of regression slopes do not indicate any consistent differences among areas or seasons.

Largemouth Bass

Calculated growth rates of largemouth bass in Robinson Impoundment should be considered as possibly underestimating true rates since some of the scales examined were suspected of bearing false annuli which could not be separated from true annuli. False annuli interpreted as true year marks would result in greatly reduced calculated growth. As with other species, only fish for which at least two of three independent observers agreed on the annulus location were included.

Back calculated lengths of largemouth bass collected from Robinson Impoundment during 1975 and 1976 are presented in Table 4.5.7. Growth was similar in the discharge area and the lower impoundment, but was considerably greater in the impoundment above the discharge area. Growth in all areas was slow relative to other similar lakes (Table 4.5.8).

Observed lengths through the year suggests some spawning over an extended time period which could contribute to smaller mean lengths and an underestimate of growth rate. Observed lengths also suggest a growth rate somewhat greater than that estimated from scale examinations and back calculation.

Total length/weight regression analysis indicated somewhat poorer condition (weight for a given length) in the impoundment below the discharge than in the other areas (Table 4.5.9). Slopes for regression lines were greatest for fish from the upper impoundment during all seasons with the discharge area intermediate between the upper impoundment and lower impoundment.

Chain Pickerel

Small numbers of chain pickerel were collected from Robinson Impoundment and the correlation of total length and scale radius was

somewhat variable, c conclusions must be limited. Back calculated lengths (Table 4.5.10) indicate similar growth rates between the discharge area and the area below the discharge. Growth of fish collected above the discharge appeared somewhat slower. Examination of lengths of chain pickerel collected from Robinson Impoundment generally support the growth rate estimated from scale examination and back calculation but, as with warmouth, recruitment of small fish over an extended period of time is indicated. The presence of small fish over an extended period could contribute to reduced mean sizes and underestimates of growth rate.

The back calculated lengths of Robinson Impoundment chain pickerel are less than back calculated lengths of chain pickerel from Salters Lake, Jones Lake, and Lake Waccamaw (Table 4.5.11). Only three, three and seven chain pickerel were aged from Salters Lake, Jones Lake, and Lake Waccamaw, respectively. This, in conjunction with the variability observed in the Robinson Impoundment chain pickerel, could account for the difference.

The number of chain pickerel collected from Robinson Impoundment was insufficient to examine a total length/weight analysis comparing areas.

4.6 Fecundity

4.6.1 Methods and Materials

Fecundity in this study is defined as the number of ripening eggs in the female prior to the spawning season. Bluegill, largemouth bass, and warmouth were collected at Robinson Impoundment for fecundity estimates using a variety of sampling methods (i.e., gill nets, electrofishing, wire baskets, impingement, rotenone, and creel surveys). Ovaries were removed in the field and preserved in modified Gilson's Fluid to prevent hardening of the tissues and to aid in separation of the eggs from ovarian connective tissues (Ricker, 1968). Paired lengths and weights were recorded in the field.

Laboratory analysis involved the separation of ova from the surrounding tissue, subsampling by wet weight, and subsequent enumeration of each

subsample. In most cases eggs were easily separated from the ovarian tissues upon agitation in Gilson's Fluid. Eggs were dried to a constant consistency and wet weights determined to the nearest hundredth of a gram on a Mettler P 2210 N balance. The entire gonad and each subsample was weighed in this manner. Three subsamples were placed in gridded plastic petri plates and all eggs in that plate counted under a dissecting microscope at 15X. No attempt was made to distinguish relative differences in egg numbers between the paired ovaries.

Analysis of the data included a plot of fecundity and total length for each species, transformation of the data using logarithmic functions, and calculation of a best fit regression line. A linear regression equation was fitted to the data using the Statistical Analysis System developed by North Carolina State University.

4.6.2 Results and Discussion

Bluegill

Fecundity estimates for the bluegill were based on 46 mature ovaries collected from June to September of 1975. Ovaries obtained from fish 75 to 261 mm total length were subjected to analysis. The smallest mature individual encountered during the study program was a 71 mm female at station A-3. The smallest mature individuals reported by Carlander (1972) were 76-90 mm total length. Fecundity estimates for bluegills in the impoundment ranged from 571 to 27,027 mature eggs per female. The mean minimum and maximum sizes of mature eggs counted ranged from 0.50 mm $\pm$ 0.11 to 0.79 mm $\pm$ 0.11 and were smaller than the mean egg diameter of 1.09 $\pm$ 0.05 reported by Carlander (1972) for mature eggs.

The regression equation and coefficient of determination (r^2) of fecundity on total length for the bluegill at Robinson Impoundment were:

$$\log_{10} F = -2.337 + 2.839 \log_{10} TL\ (mm) \qquad r^2 = 0.59$$

where: F = fecundity

TL (mm) = total length in millimeters

A plot of fecundity and total length in Figure 4.2.1 contains the resulting regression line. Fecundity estimates for bluegills of different size as determined from the above regression are slightly below average when compared to the literature (Carlander, 1972). The causative environmental and/or biological determinants for these findings were not apparent from the data.

Warmouth

Fecundity estimates for the warmouth at Robinson Impoundment were based on 29 samples collected from April to September of 1975. Ovaries for laboratory analysis were obtained from fish ranging from 95 to 212 mm total length. In the Suwannee River and Okefenoke Swamp in southern Georgia, Germann (1974) illustrated a bimodal distribution of egg sizes in warmouth ovaries. Mature ova diameter in their study averaged 0.97 mm for warmouth over 200 mm TL and 0.85 mm for smaller mature fish. In Illinois, Larimore (1957) found seven size classes of ova ranging from 0.15 to 1.10 mm. At Robinson Impoundment warmouth also exhibited a size series of ova. The average percent of egg sizes in the ovaries of Robinson Impoundment warmouth are listed below. In this study all eggs with diameter >0.5 mm were considered mature.

Size Range	% Total Eggs
0.01-0.34	4.67
0.35-0.49	11.55
0.50-0.64	22.48
0.65-0.79	22.39
0.80-0.94	27.77
0.95-1.09	9.67
1.10 and over	1.46

Fecundity estimates ranged from 798 to 34,257 eggs per mature female. Larimore (1957) found the total number of eggs to range from 4,500 to 63,200 for warmouth in Illinois. Germann (1974) found the number of mature eggs to range from 8,721 to 20,064 in fish from 150 to 239 mm total length. A plot of fecundity on total length for Robinson Impoundment warmouth appears in Figure 4.2.2 along with the appropriate best fit regression

line. The regression equation generated after logarithmic transformation of the data is:

$$\log_{10}F = -4.678 + 3.839\ TL\ (mm)\quad r^2 = 0.67$$

where: F and TL (mm) are as listed above for the bluegill.

Largemouth Bass

Fecundity estimates of the largemouth bass at Robinson Impoundment were based on the analysis of 16 ovaries collected from February to April of 1975 and between March and April of 1976. Ovaries were obtained from bass ranging in size from 215 to 490 mm total length representing a fecundity range of 5,281 to 57,140 mature eggs per female. No correlations were evident between fecundity and either total length or weight. Data variability and a small sample size precluded any reliable statistical analyses. Mature ova diameter ranged from 0.8 mm ± 0.12 to 1.6 mm ± 0.20 at Robinson Impoundment. Kelley (1962) considered largemouth bass eggs with diameters over 0.75 mm to be mature. Carlander (1972) reported mature egg diameters of 1.4-1.8 mm and 1.74 ± 0.06 from other localities. In general, the range of fecundities and mature egg diameters for largemouth bass at Robinson Impoundment are within the established ranges summarized by Carlander (1972).

4.7 Fish Reproduction in Robinson Impoundment

4.7.1 Introduction

Successful reproduction is the first step in the maintenance of any population of organisms. Without reproduction or when reproduction is insufficient to maintain the population at the carrying capacity, mortality rates rather than life requirements such as suitable habitat and adequate food begin to govern population size. Section 4.6 has addressed the potential for reproduction (fecundity). This section of the study addresses the observed seasonal and spatial distribution of fish during their early life stages in Robinson Impoundment.

4.7.2 Methods and Materials

Larval and juvenile fishes in Robinson Impoundment were sampled primarily with the use of plexiglass fish traps similar to those described by

Ricker (1968). Traps were set on each side of the impoundment at Transects A, E, and G for two nights each week from March 1975 through February 1976. Samples were collected after approximately 24 and 48 hours, preserved, and returned to the laboratory for identification and measurement.

Ichthyoplankton samples were also collected by towing a 30 cm, 570μ mesh net in upper, mid, and lower impoundment areas monthly during day and night for five-minute periods from April through October and during December and February. Only surface tows in open water areas were made due to the numerous obstructions on the bottom and along the shorelines.

The identification of larval fish was reported at the lowest taxonomic level of positive identification. The presence of similar species and genera of fishes (during the larval stages), or the presence of species with incompletely described larvae which could result in confusion or misidentification often resulted in reporting data at the family level.

4.7.3 Results and Discussion

Plexiglass larval fish traps were effective in capturing fish up to approximately 75 mm total length so lengths of individuals were considered in evaluating catch rates. Most spawning activity apparently occurred from mid-April through mid-October although larval fish were collected during all months (Table 4.7.1).

Catches from December through mid-April were dominated by percids (thought to be primarily swamp darters with some sawcheek darters). From an examination of percid lengths, reproduction appears to occur throughout the year and at all stations. Percid numbers appeared to be depressed at Transect E during July and August but more percids were taken at Transect E during January, February, and March than at Transects A or G. This pattern also is generally evident with other species.

Centrarchid spawning occurred primarily from May through September with several pulses evident. The majority of these were probably bluegill and warmouth although during the larval stages centrarchids could not be identified to the species level. The centrarchid species catch rates reported

refer to early juveniles. Catastomids were found primarily at Transect G during early June indicating May spawning while Esox were found in low numbers but widely distributed from November through February.

Surface ichthyoplankton tows collected primarily percids (Table 4.7.2). Greatest numbers were taken during May and June although some percids were taken from the discharge area and upper impoundment during February and from the lower and upper impoundment areas during September. Centrarchids were collected from all areas during June and from the upper impoundment during May. Spotted suckers were collected from the upper impoundment during May.

The greater relative abundance of percids in the surface tow samples is probably due to centrarchid preference for the littoral zone during most of their larval and early juvenile stages. The presence of the non-percid species in the tow samples generally corresponds to their presence in the larval trap samples (seasonally).

The species distribution indicated by the sampling of larval and early juvenile fishes generally correspond to the pattern seen in the adult fish sampling. Greatest diversity was found at Transect G while the number of taxa was reduced at Transect A and Station E-3. The data also indicate that reproduction may be somewhat restricted in the vicinity of the discharge during the summer but additional spawning occurs in this region during the spring and fall.

4.8 Ichthyoplankton Entrainment

4.8.1 Introduction

The removal or processing of large volumes of water can affect fish reproduction in the body of source water by destroying large numbers of fish eggs or larvae. Entrainment becomes critical when a large percentage of a population of eggs or larvae occur in water subject to passage through an intake during the period of susceptibility. This situation most often occurs when species which spawn in concentrations do so in the vicinity of an intake structure or in a river upstream from an intake structure. Of the fish species inhabiting Robinson Impoundment, none is known to prefer the pelagic

habitat such as surrounds the intake structure for spawning. Some fish larvae produced on the bottom or in the shallows may move to open water areas and become subjected to entrainment. This portion of the study was designed to examine numbers of fish eggs or larvae entrained by the H. B. Robinson Steam Electric Plant.

4.8.2 Methods and Materials

Duplicate samples were collected weekly during the day and at night from March, 1975 through February, 1976 with a 30 cm, 570μ plankton net. For each sample the net was suspended in the center of the southern intake bay (Figures 2.2 and 2.3) below the skimmer wall for 0.3 hour. A General Oceanic model 2030 flowmeter was fixed in the mouth of the net to measure the volume strained. At the end of the collection period, all organisms in the net were washed into the collection cup, transferred to a sample container, and preserved in buffered formalin for transport to the laboratory. In the laboratory ichthyoplankton were removed from the sample, identified, measured, and catalogued for future reference.

4.8.3 Results and Discussion

No fish eggs were collected in entrainment samples during the period of the study; however, larval fish were taken during all months sampled except January. All of these were percids except a very small number of catastomids collected during May and some centrarchids collected during June, July, and October (Table 4.8.1). Collection rates were variable between day and night on the same day and between sampling weeks indicating variability in entrainment rates. No diel patterns were evident.

The percentage of percids collected in entrainment sampling was higher than percid relative abundance in the larval fish traps and surface ichthyoplankton tows (Section 4.7) although these gear types collected percids (primarily swamp darters and probably some sawcheek darters) during most months for all areas of the impoundment. This is a function both of gear selectivity and, we suspect, behavior. During the sampling program we noticed that larval traps which either slid into deeper water or were tampered with and set in deeper water collected a larger percentage of darters. During the summer of 1975, we also attempted trawling in the

deeper reaches of the impoundment. The one tow completed in water approximately 10.5 m (35 feet) deep contained 41 swamp darters, 2 bluegills, and 1 warmouth. These observations indicate a greater abundance of darters in the deeper water areas than has been indicated in the fish sampling program, which relied heavily on sampling the littoral zone. The affinity of most centrarchid larval forms for littoral areas has been documented to some extent in the literature. The abundance of percids in the ichthyoplankton tows and the number entrained suggests that percid larval forms move from the deeper water areas up into the water column. The number of percids entrained apparently does not effect the population drastically since after four years of plant operation darters are widely distributed and very abundant.

4.9 Fish Impingement at H. B. Robinson Steam Electric Plant

4.9.1 Introduction

Industries which require large volumes of water usually must screen their intake areas to prevent the introduction of debris into the water systems. These screens also prevent the passage of larger aquatic organisms which are drawn toward the intake with the water. Organisms trapped in this manner are impinged on the screens at a rate proportional to their abundance in the vicinity of the intake and to the velocity of the intake water. Fish impinged on the intake screens of H. B. Robinson Steam Electric Plant were examined from December, 1973 to December, 1975 to evaluate the number and size of fishes impinged.

4.9.2 Methods and Materials

Monthly impingement sampling (48 hours) was conducted from December, 1973 through July, 1975 when the sampling frequency was increased to weekly (24 hours) at the request of the NRC. Sampling consisted of an initial screen washing followed by washings at intervals of approximately 12 hours. Fishes washed from the intake screens were collected, identified, weighed, and measured. Lengths were generally recorded in 25 mm groups with the exception of the smallest group which included fish 0-50 mm in length. Other groupings, occasionally used during the study are noted where appropriate.

4.9.3 Results and Discussions

The numbers and weights of fishes impinged on the H. B. Robinson Unit 1 intake screens were low throughout 1974 and 1975 (Table 4.9.1) with daily averages of 37.1 fish weighing 418 grams and 32.5 fish weighing 394 grams in the two years respectively. Bluegills were the most abundant fish collected both numerically and gravimetrically making up 91% and 89% of the fish collected in 1974 and 1975 and comprising 62% and 66% of the biomass. Greatest numbers were collected in November of 1974 and June of 1975.

Impingement at the H. B. Robinson Unit 2 intake was higher than at the Unit 1 intake but numbers and weights were not excessive when the size of the lake and the measured standing crops are considered. Mean numbers and weights of fish per day were 866.3 fish weighing 5807 g during 1974 and 291.4 fish weighing 4775 g during 1975 (Table 4.9.2). Of these, bluegills made up 89% (74% of the biomass) and 95% (57% of the biomass) of the catch during 1974 and 1975. Chain pickerel were also important in terms of biomass comprising 14% and 28% in the two years although numbers were small.

Maximum impingement on Unit 2 occurred during late summer of both years (Figure 4.9.1) with the lower rates occuring during the winter months. Biomass impinged follows the same general pattern (Figure 4.9.2); however, increased differences between the two during the late winter and spring months result from the impingement of larger individuals.

Figures 4.9.1 and 4.9.2 also illustrate variations in impingement rates which occurred when fewer than the three Unit 2 intake pumps were operating. Samples collected when 1 or 2 pumps were operating indicate reduced impingement rates, but there is insufficient operating time with 1 or 2 pumps to determine the relationship between impingement rate and number of pumps.

The length frequency of bluegills impinged at the Robinson Plant (Figure 4.9.3) was examined in evaluating the size of fishes impinged. The majority of bluegills collected were fish less than 115 mm in length with larger percentages of smaller fish collected during certain periods. As expected, larger fishes comprised a larger percentage of the catch during winter and early spring months although impingement rates were generally lower.

Several points can be summarized from the above results and discussion:

1. Impingement rates at the H. B. Robinson SEP Unit 1 intake structure averaged 37.1 fish per day weighing 418 grams and 32.5 fish per day weighing 394 grams in 1974 and 1975 respectively.
2. Impingement rates at the H. B. Robinson SEP Unit 2 intake structure were larger than from Unit 1 but were relatively low averaging 866.3 fish per day weighing 5807 grams and 291.4 per day weighing 4775 grams during 1974 and 1975 respectively.
3. Bluegills were the largest component of the catches.
4. Most bluegills impinged were less than 115 mm in length.

4.10 Creel Survey

4.10.1 Introduction

Creel surveys are used extensively in conjunction with other fisheries sampling to provide data on distribution and relative abundance. For areas having restricted access and/or permit requirements, a complete creel census can often be obtained. However, for reservoirs with uncontrolled access, and where available personnel preclude a complete census, a sampling method must be devised to give an unbiased estimate of the angler use (Carlander, 1956). At Robinson Impoundment, a stratified random design was used where weekdays and weekend days were separated into strata.

4.10.2 Methods

A survey design similar to that of Hansen (1971) was used to determine angler usage. During the survey one weekday and one weekend day were surveyed each week on half-day basis. The morning survey was conducted from sunrise until 1:00 p.m. and the evening survey from 1:00 p.m. until dark. At least twice during each survey a total count was made of all anglers and other recreational users on the lake. Survey dates and morning or evening periods were all chosen using a table of random numbers, except that no weekday was sampled again in any month until all other weekdays had been sampled.

Between each count, as many anglers as possible were interviewed. Information recorded included transect and station, date, survey period (weekday a.m. or p.m.), interview and starting time, method (boat or shore), and gear (cane pole, bait casting, artificial casting, or trolling). Each fish caught was identified to species and length and weight recorded. Each party interviewed was given a duplicate postpaid card and asked to note the finishing time and additional fish caught and put the card in one of the creel survey return boxes located at each landing or in the mail.

Estimates of total angling pressure and yield were calculated by the following formulae (Moore et al. 1973):

$$E = \sum_{i=1}^{n} \frac{N_i T}{T_i} (X)$$

where

E = estimated pressure (angler hours) in period

N = mean number of anglers observed during randomized counts on survey dates in period

T = length of fishing day (considred as constant 13 hours)

t = mean number of fishing trip

x = number of days in period

n = number of surveys in period

and

$$Y = Ec$$

where

Y = estimated total catch

E = pressure (hours)

c = catch per hour

Catch per hour was computed by summing total hours for completed trips with hours fished at interview time for incomplete (no survey card returned) trips and dividing this into total catch sums computed in a like manner. Length of fishing trip was determined from completed trip data

with two exceptions. If no completed trip data were available, then length of time fished at interview time of incomplete trips was used. If completed trip data showed average trip lengths less than time fished at interview for incomplete trips, an average of completed and incomplete trips was used.

For comparisons the impoundment has been separated into three sections, the upper impoundment above SR 346 (Transects F and G), the discharge area (Transect E), and the lower impoundment (Transects A, B, C, and D). Months were combined into the following seasons: Spring (March, April, May); summer (June, July, August); fall (September, October, November); and winter (December, January, February).

4.10.3 Results and Discussion

Because the entire years' survey was not completed until June 10, 1976, complete analysis of the data will be delayed until sufficient time has elapsed to allow for return of all creel cards. The results reported below, however, include all data now available and should change very little.

During the survey year, an estimated 10967 anglers (Table 4.10.1) fished 26993 hours and caught 7952 fish for a success rate of 0.29 fish per angler hour. A completed trip card return of 34% was obtained.

Pressure and catch rates were highly variable, although trends can be seen. Angling pressure was greater in the upper impoundment where 54% of the anglers were counted. This was followed by the lower impoundment with

24% of the anglers and the discharge area with 22%. Catch per angler hour rates of 0.33 for the upper impoundment, 0.26 for the discharge, and 0.22 for the lower impoundment showed similar success rates for the discharge and lower impoundment areas.

The angler preference for the upper impoundment appears related to the easier access to this area for shore fishermen. A boat landing is adjacent to SR 346 and parking for shore anglers is available on both sides of the bridge. The greater use of the lower impoundment for swimming and boating, because of the developed recreational areas, probably also effects the anglers preference for the upper impoundment (Figures 7.2.1a - 7.2.3a).

Seasonally, pressure is greatest in spring when 35% of anglers were observed, followed by winter (26%), summer (21%), and fall (18%). Seasonal catch per angler hour rates varied from 0.37 in summer to 0.21 in winter with intermediate values of 0.33 and 0.26 for spring and fall.

Comparison of the actual (not expanded) angler catch by species shows centrarchids accounting for 90% of the total catch, while pickerel comprise 8%. The remaining 2% includes bowfin, suckers, and bullheads. Of the Centrarchidae, 36% are largemouth bass, 49% are bluegill, and 13% are warmouth, with the remainder including redbreast sunfish (2%), pumpkinseed (<1%), black crappie (<1%), and dollar sunfish (<1%).

Comparison of the predominant species by location shows the following:

Location	Bass	Bluegill	Warmouth	Pickerel
Discharge	50%	34%	8%	5%
Upper Impoundment	26%	48%	12%	8%
Lower Impoundment	46%	33%	8%	10%

Seasonal comparisons show the greatest total catch by number occurred in summer (37%), followed by spring (31%), fall (18%) and winter (14%). These rates reflect the same ranking as the seasonal catch per hour rates noted above.

4.11 Miscellaneous Observations and Activities

Hybrid Sunfish

A small number of specimens considered to be hybrid sunfish were collected from Robinson Impoundment. Their occurrence seems to be more frequent in the lower reaches of the impoundment than in other areas. Most of these fish exhibit bright coloration and are thought to be warmouth-bluegill crosses. This phenomenon is not uncommon when populations of warmouth and bluegill utilize the same spawning areas (Carlander, 1972).

Stocking Activities

Many residents of the area around Robinson Impoundment have requested stockings of largemouth bass. In an attempt to gain insight into the effectiveness of stocking, approximately 1000 largemouth bass fingerlings were marked and released at each of 2 locations in the impoundment during May 1975. Ongoing sampling programs, which sampled the release areas, were expected to collect fingerlings which survived and provide some information as to the number of stocked fish in the area relative to the number of native fish.

Of approximately 110 largemouth bass collected during subsequent months which were within the size range of stocked fish (with estimated growth), only 1 marked bass was collected. The low number of bass marked and the low number of bass considered preclude any conclusions. However, the low percentage of marked bass recaptured does not indicate a reliance on introduced fish.

Fisheries Management

The fish distribution and abundance data suggest that common management practices may be beneficial to fish populations in Robinson Impoundment. The lack of cover and scarcity of benthic fish food organisms in many areas of the lower impoundment appear to be limiting abundance. These factors may be modified through the placement of artificial substrate and cover much as has been employed in several other southeastern lakes. Other management possibilities such as the utilization of artificial spawning substrates by largemouth bass and the setting of catch length limits for certain species should be investigated.

Reported Changes in Crappie Populations

Several people have expressed their opinion that crappie populations in Robinson Impoundment have declined drastically due to the operations of HBRSEP (ASLB Hearing, 1975). The sampling programs conducted during 1974, 1975, and 1976 indicate that crappie were present only in very low numbers. No data exist indicating appreciably greater numbers in the past.

Assuming that population fluctuations have occurred and have been detected by fishermen, there is no indication of the relationship between population fluctuation and plant operation. Many factors can and do cause fluctuations in fish population, and the cyclic nature of crappie abundance is well documented in the literature (Goodson, Jr., 1966; Swingle and Swingle, 1967). The observations may have been entirely due to a natural cycle or to a combination of a phase of the cycle and favorable or unfavorable conditions (food supply, pesticide run off, competition of other species).

Fish Tagging

Fish collected from Robinson Impoundment, which were alive and appeared to be in good condition and were not required for food habit or fecundity studies, were tagged with numbered Floy Anchor tags. Each tag was also imprinted with "Reward" and a Raleigh, N. C., post office box number. Three hundred ninety fish were tagged during 1974, 1975, and 1976 and 25 were recaptured (or returned by anglers). The number of recaptures to date (Table 4.11.1) has been insufficient to provide indications of movement between the various areas of the impoundment although some individuals have moved considerable distances and one warmouth moved out of the lake into the creek below the dam.

4.12 Discussion of Thermal Effects

Temperature is one of the most important environmental parameters affecting fish populations. Reproduction, growth, and behavior are all affected by temperatures directly, and in some cases indirectly such as in maturation of gonads and initiation of spawning behaviour with spring temperature increases. Fish generally exhibit temperature preference and avoidance within their tolerance limits. In addition, thermal tolerance

limits are a function of acclimation temperature and time of exposure. Laboratory experiments serve to indicate these temperatures under controlled conditions but field observations often deviate from laboratory based expectations or predictions. In evaluating a field situation, the laboratory determinations should serve as general guidelines while field observations provide the basis for evaluation.

The fish population of Robinson Impoundment has been shown to be similar to other comparable bodies of water with respect to species composition and standing crop. This indicated that the expected fish species are living in the impoundment and no abnormal species composition exists. In order for the standing crop and species composition of fishes in Robinson Impoundment to be similar to other similar bodies of water, the system must provide adequate energy (food) to support the population, and successful reproduction of fishes must be adequate to balance mortality. In the period since 1971 when H. B. Robinson Unit 2 introduced significant thermal effluent, if energy production or fish reproduction had been affected beyond the natural limitations, standing crop estimates and composition would appear dissimilar between Robinson Impoundment and other lakes considered.

At the species level, observations have been recorded indicating little average (or overall) effect of the H. B. Robinson discharge on the fish population although seasonal, localized adjustments were evident. Examination of the fish distribution data (Section 4.2) for the discharge area indicates a general decrease of species, number, and weig during the warmer months; however, even during periods of maximum thermal effluent, a variety of fish have been documented utilizing the area. Thermal variation in these areas exists both in the forms of stratification and cool water, spring or creek input.

An examination of available thermal information on bluegill, warmouth, largemouth bass, and chain pickerel provided information both in agreement and in conflict with our observations. A wide variety of thermal tolerance limits have been published (Kramer and Smith, 1960; Strawn, 1961; Kelly, 1968; NTAC, 1968, USEPA, 1976; Holland et al., 1973) which apply to various conditions and life stages. Many of these have been derived from laboratory studies which may

or may not apply to field situations (Stauffer, 1975). Within this literature there are conflicting observations. There are also published reports of field observations of fishes living in excess of many of the published tolerance limits (Clugston, 1973; Siler and Clugston, 1975). In Robinson Impoundment, we have observed fish exceeding many of their published limits. We attribute this to a combination of natural acclimation and the presence of lower temperature water which can be utilized for resting or refuge. There are numerous springs, seeps, and streams in the impoundment providing cool water to Robinson Impoundment. The volumes of water involved are generally small but a layer of cool water forms over the bottom which is readily apparent when wading. Most of these areas are too small to be illustrated with the resolution available in the temperature profiles. The effect of the high temperature must be considered seasonal (distribution data) and appeared to be of minor importance at the species level (composition and population structure data).

4.13 Fish Population in Black Creek

4.13.1 Introduction

Studies of fish populations in Black Creek were begun in 1974 in conjunction with sampling in Robinson Impoundment. Soon after sampling was initiated, the program was redesigned in view of regulatory agency guidelines and the contention that operation of the H. B. Robinson Steam Electric Plant had destroyed the fish populations present. Studies were further revised (added) in 1975 to strengthen the study program.

The physical and chemical characteristics of Black Creek have been described in detail in Section 3 of this report. Other factors effecting fish populations, such as vegetation and substrate, are also described (Sections 6 and 7) and must be kept in mind when examining the various characteristics of the fish population.

4.13.2 Fish Distributions and Standing Crop in Black Creek

4.13.3 Introduction

Distribution of fishes is governed by enviromental requirements that may vary with species or size. Certain species or sizes of fish exhibit preferences for particular water depths, temperatures, substrates, and/or cover types as well as being limited to certain ranges of environmental parameters.

The objectives of examining the distributions of fishes in Black Creek include determining the species present, examining variations in numbers and species between locations, and obtaining an estimate of fish standing crop.

4.13.4 Methods and Materials

Gill netting, wire trapping, seining, electrofishing, and rotenone were used to collect fishes from various areas of the creek. The efficiency of these collection types varies with species and size of fish; therefore, results will be evaluated separately. In the quarterly sampling programs, quarters were defined as winter - January through March, spring - April through June, summer - July through September, and fall - October through December. An attempt was made to collect samples near the middle of the quarter.

Standard 15.3 m (50 ft) experimental gill nets, 1.2 m (4 ft) deep, (equal panels of 25 mm, 51 mm, 76 mm, and 102 mm (1 in, 2 in, 3 in, and 4 in) stretch mesh) were set at Transects J, H, and K (Figure 4.13.1) for two consecutive days each quarter from summer 1974 through fall 1975. Nets were set off-bottom at a 45° angle to the stream. Depth varied from 1 m (3.3 ft) to approximately 3 m (10 ft). The nets were checked and catch examined after approximately 24 and 48 hours. Leaves and debris in the stream often caught in the nets and decreased their catching efficiency. High stream velocities may also have affected catch rates.

Single funnel poultry wire traps approximately 1.2 m (4 ft) in length and .6 m (2 ft) in diameter were also set at Transects J, H, and K for two consecutive days each quarter from spring 1974 through fall 1975. Traps were usually set in water 1 meter deep and were checked after approximately 24 and 48 hours.

Electrofishing was conducted for 0.5 hour at Transects J, H, K, and L monthly from April, 1975, through March, 1976. A Smith-Root type VI control unit and 3500 watt generator were used operating at 600 volts (AC). Current was generally within the range of 1-3 amps. Fishes that were incapacitated were collected with a dip net and were held in a tub of water until the end of the collection period. The dark color of the water, high velocity, fluctuation of water levels, and low conductivity created some difficulty in collecting electrofishing samples.

Generally, there was more difficulty collecting samples from Stations H and L than from Station J and more difficulty in collecting samples from Station K than from any of the other stations. These limitations should be kept in mind when comparing electrofishing samples.

Rotenone samples were collected during August of 1974 and 1975 from stations J, H, and K. An area of stream was blocked off at each station using 1/4-inch delta mesh block nets. The surface area and volume was calculated and Noxfish (5% emulsifiable rotenone) applied to a rate of 2.0 parts per million. Potassium permanganate was applied outside of the downstream block net to neutralize rotenone passing through the sample area. Fish were collected inside the block net as they appeared after rotenone application. After all apparent activity ceased, the downstream block net was pursed to retain any trapped fish and retrieved.

Numbers, lengths, and weights were recorded from all fish collected. Sex and maturity were recorded when possible. Larger fish which appeared to be in good physical condition were tagged with Floy Anchor tags and released.

Gill net and wire trap catch rates have been adjusted to numbers and weights per 24-hour set, electrofishing to number per hour, and rotenone samples to number and weighting per hectare to facilitate direct comparisons.

4.13.5 Results and Discussion

Species Composition

Thirty species of fish were collected from Black Creek during 1974 and 1975 (Table 4.13.1). In addition, one shiner was not identified to the specific level and may represent another species and several hybrid sunfish were collected. All of these fishes are typical of the piedmont-coastal plain region and many are generally associated with blackwater streams.

Fish Distribution and Standing Crops

Gill netting was ineffective in sampling Black Creek. The combination of debris catching in the net and the high stream velocities apparently allowed the fish to avoid the net. Only 3 fish were taken in gill nets during the study; a golden shiner at Station J during November, 1974, a creek chubsucker at Station H during May, 1975, and another creek chubsucker at Station H during August, 1975.

Wire trapping was also ineffective in sampling Black Creek. More fish were collected with wire traps than with gill nets but numbers were too low to provide any distribution information. One American eel and one chubsucker were collected at Station J during May, 1975; and 12 bluegills and a warmouth during June, 1974, 1 warmouth during June, 1975, and 2 bluegills during August, 1975 at Station H; and 2 creek chubsuckers and one warmouth during November, 1974, and 1 warmouth during August, 1975, at Station K.

Electrofishing efficiency in Black Creek varied with water level and stream morphology in the sample area. The low conductivity of the water restricted the electrical field so that fish in deep or fast flowing water could usually avoid the field or escape. Station H contained more area conducive to electrofishing than the other areas and was followed by Station J. Station K was the least conducive to electrofishing.

The greatest variety of fishes were collected by electrofishing at Station J (Table 4.13.2) reflecting both collection efficiency and the habitat present. Station J contains many shallow areas away from the main stream channel with abundant aquatic vegetation which provide cover and feeding areas. Chain pickerel and creek chubsuckers were the most abundant fishes collected at Station J and were taken during all sampling months. Dusky shiners, blue-spotted sunfish, warmouth, and largemouth bass were also abundant and frequently collected.

Electrofishing catches at Station K were generally low, due primarily to collecting difficulty. Chain pickerel were the most consistently collected species but American eel, redfin pickerel, and bluegill were also abundant. Station L electrofishing catches frequently collected chain pickerel, creek chubsuckers, American eels, bluegills, and largemouth bass. Mats of cypress roots along the stream channel at Station L and swamp runs off the main channel yielded the most fish. Such areas provide cover and feeding areas for fishes as well as restricting movement thus increasing electrofishing efficiency.

Catches in the four stream stations sampled reflect habitat and gear efficiency as well as species composition and abundance. Catches were generally similar at all stations and were typical of fishes expected in most blackwater streams.

Rotenone samples collected from Black Creek during 1974 and 1975 probably produced underestimates of standing crop. The water depth and rapid velocity prevented maintaining block nets in position. Lead lines were pulled off the bottom, nets were ripped, and float lines were pulled below the water surface during 1974. Samples collected during 1975 were somewhat better but holes still opened in the downstream net. The water depth and velocity also created difficulty in mixing and distributing rotenone within the sample area and some eddy areas or bank undercuts may not have received a lethal application.

The greatest variety and standing crop fishes in both 1974 and 1975 were collected at Station J (Table 4.13.3). The absence of pickerel in the 1974 sample is probably due to the problems associated with the block net since

several large pickerel were observed in the sample area but were not recovered. Large portions of the biomass in 1974 consisted of lake chubsuckers, spotted suckers, redbreast sunfish, and warmouth while in 1975 redfin pickerel, chain pickerel, spotted suckers, and redbreast sunfish were the major components of the biomass. The larger number of small fishes (juveniles) in the 1974 sample probably resulted from using a smaller mesh block net (1/8 in). One-fourth inch mesh was used during 1975 in an attempt to maintain the net in better position.

Rotenone samples collected from Station H were smaller and diversity was lower than at Station J. During both years most of the catch consisted of bluegill. Warmouth and yellow bullheads were also abundant during both years, while pirate perch, not collected during 1974, were second in numerical abundance during 1975. Little cover or feeding area was available in the section of stream sampled at Station H and is probably the prime reason for relatively small collections.

A greater variety of species was collected with rotenone at Station K than at Station H. Maintaining a block net in the stream at Station K was extremely difficult and probably contributed to the small catches. High stream velocities and obstruction (roots and undercuts) probably prevented some areas from receiving a lethal dose of rotenone. During both years bluegill and chain pickerel were the largest component of the biomass.

4.14 Summary and Conclusions

Fisheries studies at Robinson Impoundment were initiated in 1972 and 1973. The preliminary work began the compilation of a species list and evaluation of sampling gear suitability. Studies were refined and intensified in 1974 and again in 1975.

Thirty-one (31) species have been collected from Robinson Impoundment. Thirteen (13) of these were centrarchids, indicating the importance of that group. The species list is similar to other lakes in the region with similar environmental characteristics (low pH, dark color).

Total gill net catches were evaluated using analysis of variance with respect to sampling month and location. Significant differences were further evaluated using Duncan's New Multiple Range Test. No differences were evident in lower and mid-impoundment catches, but catches in these areas were significantly (P=.05) lower than catches in the upper impoundment. Also, catches from the discharge area and the east side of the lower impoundment were not significantly different from the east side of the upper impoundment. More bluegills and chain pickerel were collected with gill nets on Transects A and C, while more suckers and golden shiners were taken on Transects G and E.

Only centrarchids (primarily bluegill and warmouth) were collected with wire traps. Catches at Station A-1 were the largest, indicating the centrarchid abundance in that region. Seine catches were affected by bottom topography and fish habitat with largest catches at G-1, C-1, and A-1.

Electrofishing catches generally increased in diversity (Shannon-Weaver index) from the lower impoundment to the upper impoundment. Analysis of variance of total, bluegill, warmouth, largemouth bass, and chain pickerel catches with respect to sampling month and location indicated location differences for all groups and monthly differences in total, bluegill, largemouth bass and warmouth catches. Duncan's multiple range test of catches by location indicated Transect A total and bluegill catches larger than other areas. No difference was apparent in total catch among Stations E-1, E-3, G-1, and G-3. Largemouth bass catches at Stations E-3, E-1, and A-1 were not significantly different (P=.05) and were larger than catches at G-3, A-3, and G-1 which also were not significantly different. Warmouth catches at A-1, G-3, and A-3 were larger than at the other stations.

Standing crop estimates (cove rotenone samples) ranged from 29.3 kg/ha in the upper impoundment during 1975 to a high of 139.8 kg/ha in the lower impoundment during 1975. During both 1974 and 1975, greatest numbers of fishes were collected from the mid-impoundment, but diversity was greatest in the upper impoundment. No species were conspicuous by their presence or absence. Relative abundance of fishes in the rotenone samples was similar to

other lakes in the region with similar environmental characteristics. Some surface temperatures in Robinson Impoundment approached thermal maxima for many of the species collected, but standing crop data indicated fish were present in good numbers, possibly indicating utilization of temperature stratified or refuge areas.

Food habits analysis for the bluegill have indicated that planktivory is an important feeding strategy of bluegills in the lower impoundment and that this feeding strategy probably reflects optimal feeding conditions under the habitat conditions present (i.e., limited littoral habitat). In the upper impoundment, the diet of bluegills was more diverse, had a greater evenness in distribution of major food items, and included a greater proportion of large-bodied benthic invertebrates. This feeding behavior is typical to those described in the literature and no stresses were apparent from either low productivity or heat load. In the discharge area, the feeding conditions during the summer of 1975 were the poorest encountered in the impoundment. Benthic food items were demonstrated to be reduced in abundance in this area and the community unstable. This lack of stability in the food supply was reflected in the food habits and indicated food stress during the summer months in the discharge area. Food habits of largemouth bass, warmouth, and chain pickerel were similar to literature descriptions and a comparison of food selectivity with availability in the habitat suggest that food was not a limiting factor for growth and reproduction.

Bluegill, warmouth, largemouth bass, and chain pickerel growth rates were estimated from scale examination. Growth estimates were generally similar from all areas of the impoundment, although small differences may exist. There is some indication that growth was underestimated, but the rates were similar to the low growth rates observed in other blackwater lakes in the region.

Length-weight relationships were calculated for bluegill, warmouth, largemouth bass, and chain pickerel for upper, mid, and lower areas of the impoundment by season. Some variations did exist, but definite trends were not evident. Poor condition in the vicinity of the discharge was not evident from the analysis.

Fecundity estimates of largemouth bass and warmouth, which are indicators of potential reproductive effort, were similar to those reported in the literature. The potential reproductive effort of bluegills (fecundity) was lower than values reported in the literature. Mean mature egg diameters were also considerably lower than reported. The causative environmental and/or biological determinants for these findings were not apparent from the data.

Most spawning activity as evidenced by the presence of fish during their early life stages occurred from mid-April through mid-October, although some larval fish were collected during all months. Most larval fish collected from December through mid-April were percids which apparently spawn during all months of the year in Robinson Impoundment, and were the most abundant larval fish in the open water areas. Most centrarchid spawning occurred from May through September, while most catastomid reproduction occurred during May. Numbers of larval fish in the discharge area were depressed during the summer months but were larger during spring and fall.

Some larval fish were entrained through the H. B. Robinson Steam Electric Plant during all months except January. The majority of these were percids which, apparently, occupy the pelagic areas of the impoundment more frequently than the other species present. The effect of darter entrainment seems to be negligible, since darters are one of the most abundant and widely distributed species in the impoundment.

Fish impingement on the H. B. Robinson Unit 1 intake screens has been negligible, averaging less than 0.5 kilogram of fish per day during 1974 and 1975. Impingement rates were higher on the Unit 2 intake screens, averaging 5.8 kilograms per day in 1974 and 4.8 kilograms per day in 1975. Most of these fish were bluegills less than 115 mm in length, and their impingement was not considered to be significant when the size of the lake and the measured standing crops were considered.

Fish populations in Black Creek appeared typical of blackwater streams, although many sampling problems were encountered.

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Table 4.2.1 Common and scientific names of fishes collected from H. B. Robinson Impoundment during 1974 and 1975

Bowfin	*Amia calva*
Eastern mudminnow	*Umbra pygmaea*
Redfin pickerel	*Esox americanus*
Chain pickerel	*Esox niger*
Golden shiner	*Notemigonus chrysoleucas*
Dusky shiner	*Notropis cummingsae*
Creek chubsucker	*Erimyzon oblongus*
Lake chubsucker	*Erimyzon sucetta*
Spotted sucker	*Minytrema melanops*
White catfish	*Ictalurus catus*
Yellow bullhead	*Ictalurus natalis*
Flat bullhead	*Ictalurus platycephalus*
Swampfish	*Chologaster cornuta*
Pirate perch	*Aphredoderus savanus*
Lined topminnow	*Fundulus lineolatus*
Mosquitofish	*Gambusia affinis*
Mud sunfish	*Acantharchus pomotis*
Flier	*Centrarchus macropterus*
Banded Pigmy sunfish	*Elassoma zonatum*
Blackbanded sunfish	*Ennaecanthus chaetodon*
Bluespotted sunfish	*Enneacanthus gloriosus*
Redbreast sunfish	*Lepomis auritus*
Pumpkinseed	*Lepomis gibbosus*
Warmouth	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
Dollar sunfish	*Lepomis marginatus*
Largemouth bass	*Micropterus salmoides*
White [illegible]pie	*Pomoxis annularis*
Bla[illegible]e	*Pomoxis nigromaculatus*
Su[illegible]id	*Lepomis sp.*
Sw[illegible]r	*Etheostoma fusiforme*
Sawch[illegible] darter	*Etheostoma serriferum*

Table 4.2.2 Fish species composition of H. B. Robinson Impoundment and other similar bodies of water in North and South Carolina

Common Name	Robinson Impoundment 2250 a Present Study	Singletary Lake 572 a (Louder, 1961)	Lake Waccamaw 8938 a (Louder, 1961)	Par Pond 3000 a (Clugston, 1973)	Alligator Lake 5600 a (Crowell, 1966)	Great Lake 2992 a (Bayless, 1966)	Catfish Lake 921 a (Bayless, 1966)
Longnose gar			x		x	x	
Bowfin	x		x		x		
American eel	x*		x	x	x		
Blueback herring				x			
Gizzard shad			x	x			
Eastern mudminnow	x	x					
Redfin pickerel	x	x	x	x			
Chain pickerel	x	x	x	x			
Carp			x				
Golden shiner	x		x	x	x	x	x
Ironcolor shiner		x	x				
Dusky shiner	x						
Coastal shiner			x	x			
Creek chubsucker	x	x	x				
Lake chubsucker	x	x	x	x			
Spotted sucker	x			x			
White catfish	x		x		x		
Yellow bullhead	x	x	x	x	x	x	x
Brown bullhead				x	x		
Flat bullhead	x		x	x			
Channel catfish				x			
Tadpole madtom	x*	x	x		x		
Margined madtom	x*						
Swampfish	x						
Pirate perch	x	x	x	x			
Lined topminnow	x						
Waccamaw killifish			x				
Mosquitofish	x	x	x	x		x	
Brook silverside				x			
Waccamaw silverside			x				
White perch			x				
Mud sunfish	x		x				
Flier	x	x	x		x		
Banded pigmy sunfish	x		x	x			
Blackbanded sunfish	x						
Bluespotted sunfish	x		x				x
Banded sunfish			x			x	
Redbreast sunfish	x		x	x			
Pumpkinseed	x		x				
Warmouth	x	x	x	x		x	x
Bluegill	x	x	x	x	x		
Dollar sunfish	x			x			
Redear sunfish				x			
Spotted sunfish			x	x			
White crappie	x				x		
Black crappie	x				x		
Largemouth bass	x	x	x	x			
Swamp darter	x	x	x	x			
Tessellated darter	x*						
Waccamaw darter			x				
Sawcheek darter	x						
Yellow perch		x	x	x	x	x	x
Piedmont darter	x*						
*Black Creek only							
Total Collected	36	16	35	26	13	7	5

Table 4.2.3 Total catch (all species) per day of fishes with standard experimental gill nets in H. B. Robinson Impoundment during quarterly sampling from Summer 1974 - Fall 1975

	Day	A-1	A-3	C-1	C-3	E-1	E-3	G-1	G-3
	29	4.09	0.00	1.03	6.08	5.04	8.96	1.03	6.32
August 1974	30	2.59	0.00	0.00	0.00	4.90	11.14	2.07	5.06
	13	5.94	0.00	0.00	1.20	1.18	0.00	10.69	22.24
November 1974	14	4.29	0.00	2.74	0.89	0.95	2.86	19.00	13.51
	4	0.00	2.36	0.00	2.32	3.67	2.49	3.91	9.33
February 1975	5	1.06	0.00	1.01	1.00	1.03	5.04	1.03	7.06
	21	2.17	0.00	6.46	0.00	3.13	2.09	5.08	12.10
May 1975	22	0.00	3.14	13.09	0.00	7.38	1.92	4.38	5.45
	18	9.18	0.00	3.85	8.09	4.73	2.39	1.01	6.86
August 1975	19	1.01	0.00	1.10	3.19	6.70	0.00	3.62	1.06
	12	2.65	0.00	0.00	0.00	0.00	4.09	21.18	29.65
November 1975	13	0.77	0.77	0.00	1.61	1.68	0.00	4.49	20.54

Table 4.2.4 Analysis of variance of gill net catches at H. B. Robinson Impoundment Summer 1974 through Fall 1975

Source	DF	Mean Square	F
Sampling date	11	17.9719	.8328
Sampling station	7	143.7222**	6.6595
Residual	76	21.5815	

**Highly Significant (P = .01)

Table 4.2.5 Duncan's new multiple range test (P=.05) for differences in gill net catch per day between sampling stations at H. B. Robinson Impoundment Summer 1974 through Fall 1975

Sampling Station	Mean Number [illegible] Set
G3	1[illegible]
G1	6[illegible]
E3	3.[illegible]1
E1	3.36652
A1	2.81150
C1	2.43885
C3	2.03005
A3	0.54031

Table 4.2.6 Catch of fishes per 24-hour set with poultry wire traps at H. B. Robinson Impoundment Spring 1974 through Fall 1975 (Blank values indicate no catch)

		SAMPLING PERIOD														
		Spring '74		Summer '74		Fall '74		Winter '75		Spring '75		Summer '75		Fall '75		
Sampling Station	Species	6/25	6/26	8/29	8/30	11/13	11/14	2/4	2/5	5/21	5/22	8/19	8/20	11/12	11/13	Mean
A-1	Bluegill	8.2	5.9	12.2	12.4		3.4				[illegible]		[illegible]			3.1
																.1
A-3	Bluegill			1.0			1.7									.3
C-1	Redbreast		1.6							[illegible]						.1
	Warmouth															.1
C-3	Bluegill	4.1		1.0							2.6					.4
	Warmouth															.2
E-1	Bluegill	1.9			1.0	1.2	1.0	1.3		2.2						.6
	Warmouth		1.6													.1
E-3	Bluegill		1.5			1.2										.2
G-1	Bluegill				3.1							2.4	3.1			.6
	Warmouth	1.0			1.0											.1
	Dollar sunfish	1.0														.1
G-3	None Collected															

.e 4.2.7 Numbers of fishes collected by seining at H. B. Robinson Impoundment from Summer
74 through Fall 1975

ampling Station	Species	Summer 8/74	Fall 11/74	Winter 2/75	Spring 6/75	Summer 8/75	Fall 11/75	Mean number/haul
-1	Mosquitofish		1					.2
	Chain Pickerel	1		1				.3
	Redbreast Sunfish					1		.2
	Bluegill	14				65	1	[illegible]
	Largemouth bass					1		
	TOTAL	15	1	1	0	67	1	[illegible]
-3	Mosquitofish		1					.2
	Chain Pickerel						1	.2
	Bluegill	1	1			2		.7
	TOTAL	1	2	0	0	2	1	1.1
-1	Mosquitofish		1		7			1.3
	Chain Pickerel					2		.3
	Warmouth	1						.2
	Bluegill	21	14		43	35	1	19.0
	Largemouth bass	1	1		1	2		.8
	TOTAL	23	16	0	51	39	1	21.6
-3	Bluegill	5			1			1.0
	Largemouth bass				1			.2
	TOTAL	5	0	0	2	0	0	1.2
-1	Bluegill	5	5	5			1	2.7
	TOTAL	5	5	5	0	0	1	2.7
-3	Bluegill	8	2	2				2.0
	Largemouth bass	2	1		2			.8
	TOTAL	10	3	2	2	0	0	2.8
-1	Chain Pickerel	1	3		2		1	1.2
	Golden Shiner	1		2				.5
	Creek Chubsucker			1				.2
	Pirate Perch						1	.2
	Blackbanded Sunfish	1	3	1	2		3	1.7
	Bluespotted Sunfish	1			3		7	1.8
	Warmouth				1			.2
	Bluegill	99	1		13	9		20.3
	Dollar Sunfish	5			3	2		1.7
	Largemouth Bass	5			4	1		1.7
	TOTAL	113	7	4	28	12	12	29.5
-3	Chain Pickerel	2	4	2	2	1	1	2.0
	Spotted Sucker	1						.2
	Lined Topminnow	1					1	.3
	Blackbanded Sunfish					1	4	.8
	Bluespotted Sunfish				2			.3
	Warmouth		1		2			.5
	Bluegill	4	2		24	16		7.7
	Dollar Sunfish	1			7	5		2.2
	Largemouth Bass	1			9	6		2.7
	TOTAL	10	7	2	46	29	6	16.7
OTAL ALL STATIONS		182	41	14	129	149	22	

Table 4.2.8 Number of fish per hour of electrofishing in H. B. Robinson Impoundment

	1976			1975								
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.*	Sep.	Oct.	Nov.	Dec.
Station A-1												
Chain Pickerel	2				2							
Golden Shiner		2										
Spotted Sucker					8	4				10	4	
Pirate Perch											2	
Bluespotted Sunfish				4	2							
Redbreast Sunfish	2											
Warmouth	6	28	18	92	2	4			22	14	12	14
Bluegill	316	440	308	116	2	12	44		152	152	172	400
Largemouth Bass	4	12	6				2		2	10	4	30
Sunfish Hybrid							2		2			
Swamp Darter						2						
Sawcheek Darter			2									
Station A-3												
Chain Pickerel			2			2						2
Golden Shiner	4		2				2					
Spotted Sucker				4								2
Yellow Bullhead												2
Pirate Perch												2
Bluespotted Sunfish				4								
Redbreast Sunfish		2							2			
Pumpkinseed										2		
Warmouth	6	8	12		4	6	12		14	2	27	6
Bluegill	230	166	162	10	16	46	224		142	120	172	150
Dollar Sunfish											3	
Largemouth Bass		2							10	10		4
Sunfish Hybrid				2						4		
Swamp Darter				2		2						

*Data not available due to sampling complications.

Table 4.2.8 (continued)

	1976							75				
	Jan.	Feb.	Mar.	Apr.	May	Jun.		Aug.*	Sep.	Oct.	Nov.	Dec.
Station E-1												
Bowfin		2	2									
Redfin Pickerel					2						2	
Chain Pickerel	2	14	2	2	2	2			2	2	2	4
Golden Shiner	6											
Creek Chubsucker					8							
Spotted Sucker	2								10		4	8
Pirate Perch											2	
Blackbanded Sunfish										2		2
Bluespotted Sunfish						2						
Warmouth	4	8	2	22	2	2	2		8		2	
Bluegill	2	4	28	10	4	30	38		38	32	18	
Dollar Sunfish							2					
Largemouth Bass	2	16	4	2			8		14	16	6	12
Station E-3												
Bowfin		2										
Redfin Pickerel					8	2				4	2	
Chain Pickerel		2		8							4	2
Creek Chubsucker											2	
Lake Chubsucker											2	
Spotted Sucker		2	4	2							2	6
Pirate Perch		4	2			2						
Bluespotted Sunfish			2							4		
Warmouth		2	12			2					2	
Bluegill	8	40	104	18	4	32	32		40	34	16	
Largemouth Bass	12	16	16	2			6		20	14	12	2
Centrarchid Hybrid			2									
Sawcheek Darter		2										
Tessellated Darter		2										

*Data not available due to sampling complications.

Table 4.2.8 (continued)

	1976			1975								
	Jan.	Feb.	Mar.	Apr.	May[1]	Jun.	Jul.	Aug.*	Sep.	Oct.	Nov.	Dec.
Station G-1												
Bowfin		4									4	
Redfin Pickerel									2			
Chain Pickerel	8	2		6		12	4		6	16	8	8
Dusky Shiner		4										
Golden Shiner	24		2						6			22
Creek Chubsucker	2	16	14	4		2	2			10	8	8
Lake Chubsucker		48		4			2		2	6	16	6
Spotted Sucker	44	26	16				6		6	4	12	4
Lined Topminnow												2
Pirate Perch												2
Blackbanded Sunfish	2	12				2	4		2			
Bluespotted Sunfish		36	2	12						6	4	8
Redbreast Sunfish									2			
Warmouth	2	6	8	30					4	8	2	6
Bluegill	2	6	4	4		20	2		8	56	10	2
Dollar Sunfish		4	2			4				10	2	
Largemouth Bass		2				2			2	2	2	4
Swamp Dater				2								
Station G-3												
Bowfin			2									
Redfin Pickerel							2					
Chain Pickerel	4	10	4	6	1	12	4		24	14	12	6
Golden Shiner	10	16		2		6			8	58		8
Creek Chubsucker	2	2	6	12			4		4	2	2	
Lake Chubsucker	2	8		2		4	6		8	2	6	
Spotted Sucker	14	4				2	4			4	8	10
Lined Topminnow		4	6	6								
Mosquitoefish				2								
Yellow Bullhead						2						
Pirate Perch		6				2			2		2	2
Blackbanded Sunfish	6			2			4			18		2
Bluespotted Sunfish	12	18	8	6			6		6		2	2
Redbreast Sunfish									2			
Warmouth	2	8	16	20	2	14	2		4	38	8	2
Bluegill	2	2	2	14	1	30	26		18		4	2
Dollar Sunfish		2		28		6			6	22		
Largemouth Bass					2	6	2			2	4	4
Swamp Darter		2										4

*Data not available due to sampling complications.

[1]No catch

Table 4.2.9 Analysis of variance in electroshocker (log) catch per hour from Robinson Impoundment during 1975 and 1976 with respect to sampling month and sampling location

Analysis	Variable	Mean Square	Degree of Freedom
Total	Sampling Month	2.9671**	10
	Sampling Location	3.8556**	5
	Residual	.4897	50
Bluegill	Sampling Month	3.1389*	10
	Sampling Location	18.3336**	5
	Residual	1.2192	50
Largemouth Bass	Sampling Month	2.6391**	10
	Sampling Location	3.4006**	5
	Residual	.6214	50
Warmouth	Sampling Month	1.8859*	10
	Sampling Location	5.0152**	5
	Residual	.8043	50
Chain Pickerel	Sampling Month	.4923	10
	Sampling Location	6.0183**	5
	Residual	.5519	50

*Significant P = .95
**Highly significant P = .99

Table 4.2.10 Duncan's new multiple range test (P = .05) for differences in electrofishing catches between sampling months at H. B. Robinson Impoundment, April 1975 through March 1976.[1] Values represent log transformation of mean catch per hour

Total Catch	Mean	Month
	4.8336	February 1976
	4.6732	March 1976
	4.5534	December 1975
	4.4752	January 1976
	4.3474	October 1975
	4.2876	September 1975
	4.1622	November 1975
	4.0500	April 1975
	4.0198	July 1975
	3.7762	June 1975
	2.2222	May 1975
Bluegill	3.7520	September 1975
	3.5927	March 1976
	3.4869	October 1975
	3.4629	July 1975
	3.3486	November 1975
	3.3040	June 1975
	3.2624	February 1976
	2.8033	April 1975
	2.7824	January 1976
	2.2014	December 1975
	1.3073	May 1975
Largemouth Bass	2.0891	October 1975
	1.9876	December 1975
	1.7381	February 1976
	1.7246	September 1975
	1.4714	November 1975
	1.0648	March 1976
	1.0567	July 1975
	0.8788	January 1976
	0.5074	June 1975
	0.3662	April 1975
	0.1831	May 1975
Warmouth	2.3672	March 1976
	2.3578	April 1975
	2.1673	February 1976
	1.8984	November 1975
	1.8766	September 1975
	1.6112	October 1975
	1.4101	June 1975
	1.2831	January 1976
	1.2831	December 1975
	0.8176	May 1975
	0.7937	July 1975

[1]Except for August when data were not collected due to sampling difficulties

Table 4.2.11 Duncan's new multiple range test (P = .05) for differences in electrofishing catches between sampling locations at H. B. Robinson Impoundment, April 1975 through March 1976[1]. Values represent log transformation of mean catch per hour

Total Catch	Mean	Sampling Location
	4.9820	A-1
	4.7333	A-3
	4.0455	G-3
	3.7653	G-1
	3.6306	E-3
	3.6073	E-1
Bluegill	4.6384	A-1
	4.5528	A-3
	2.9285	E-3
	2.4804	E-1
	1.8312	G-1
	1.7345	G-3
Largemouth Bass	1.8811	E-3
	1.7172	E-1
	1.4326	A-1
	0.7692	G-3
	0.6822	A-3
	0.6457	G-1
Warmouth	2.4195	A-1
	2.0589	G-3
	1.9921	A-3
	1.4115	G-1
	1.3302	E-1
	.5328	E-3
Chain Pickerel	2.0789	G-3
	1.4902	G-1
	1.0916	E-1
	0.5458	E-3
	0.2996	A-3
	0.1998	A-1

[1]Except for August when data were not collected due to sampling difficulties.

Table 4.3.1 Numbers and weights of fishes per hectare collected from three coves of Robinson Impoundment during August 1974 and August 1975

Species	Lower Impoundment[1]				Mid Impoundment[1]				Upper Impoundment[1]			
	Number		Weight (g)		Number		Weight (g)		Number		Weight (g)	
	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
Eastern Mudminnow		12		25					15	5	22	22
Redfin Pickerel	25	49	544	314	20	49	1090	2486	7	37	487	79
Chain Pickerel	59	175	11574	43504	86	35	7791	4519	77	133	3632	5819
Golden Shiner	69		311		57	79	170	240	388	74	642	376
Dusky Shiner						10		10				
Unidentified Shiner	7		7									
Creek Chubsucker	25		86		20	44	64	35	371	59	642	398
Lake Chubsucker										5		138
Spotted Sucker	138	126	19108	33618					40		2918	
White Catfish	7		17									
Yellow Bullhead		37		57	99	89	2051	924	47	81	356	235
Swampfish						44		27				
Pirate Perch	25	62	180	264	17	72	89	257	40	833	69	729
Lined Topminnow	25		42						109	106	32	146
Mosquitoefish	586	25	225	25					47	96	15	69
Mudsunfish						17		924	15	22	457	86
Banded Pigmy Sunfish		12		2						5		5
Blackbanded Sunfish	173	37	180	49	30	274	124	319	465	546	573	526
Bluespotted Sunfish	2298	1144	1688	1584	640	435	271	1092	2231	4806	2301	3067
Redbreast Sunfish	423	25	6140	855		10		27				
Warmouth	1438	213	1964	29798	860	613	17875	37621	1510	870	15921	9617
Bluegill	3022	8656	6089	17675	31508	12046	54834	85336	4322	220	11671	3400
Dollar Sunfish					32		57		2192	988	2308	2431
Largemouth Bass	25	62	259	11320	252	195	8656	2849	77	22	388	2053
Unidentified Sunfish										49		22
Swamp Darter	25	1483	25	657	12	339	12	161	109	69	47	32
Sawcheek Darter		151		84		17		10		22		7
Total	8369	12269	48241	139831	[illegible]5677	14364	93189	136836	12058	9051	42481	29259

		Lower Impoundment	Mid Impoundment	Upper Impoundment
Surface Water Temperature at Time of Sample	1974	32.0	35.0	31.0
	1975	32.5	38.0	30.5
Area Sampled ha.	1974	.116	.245	.129
	1975	.080	.113	.218

[1] See Figure 4.2.1 for specific sample location.

Table 4.3.2 Comparison of numbers and weights of fishes (per hectare) collected with rotenone from several North and South Carolina lakes. When fishes were grouped by family in the literature, they are included in the category all others

Common Name	Robinson Impoundment 911 hectare (2250a) Present Study[1]		Singletary Lake[2] 231 hectare (572a) (Adopted from Louder 1961)		Lake Waccamaw[3] 3617 hectare (8938a) (Adopted from Louder 1961 and Davis 1966)		Par Pond[4] 1214 hectare (3000a) (Adopted from Clugston, 1973)		Alligator Lake[5] 2266 hectare (5600a) (Adopted from Crowell, 1966)		Great Lake ;'11 hectare (2992a) Bayless 1968	Catfish Lake 372 hectare (921a) Bayless 1968	
	Number	Weight(g)	Number	Weight(g)	Number	Weight(g)	Number	Weight(g)	Number	Weight(g)		Number	Weight(g)
Redfin Pickerel	30	833			15	173	Not Available	Trace			Note: 1 yellow perch was collected in 18 acre ft. of water during 1960 and 1965.		
Chain Pickerel	94	12805			22	4561		13809					
Golden Shiner	131	257			222	647		4080	15	262		96	673
Creek Chubsucker	86	205											
Lake Chubsucker	2	22	17	934	2	410		45103					
Spotted Sucker	52	9274						1350					
White Catfish	2	2			7	25			2	262		7	349
Yellow Bullhead	59	603	25	410	2	Trace		350	110	5978			
Tadpole Madtom			27	37					109	262			
Pirate Perch	175	264			30	74							
Mosquitofish	126	57			32	12							
Banded Pigmy Sunfish	2	2											
Bluespotted Sunfish	1925	1683	148	484								5	75
Redbreast Sunfish	77	1171			2	49		200				8	224
Warmouth	917	18799	57	1346	123	3067		15750					
Bluegill	9963	29835			70	3664		25400	3	262			
Dollar Sunfish	536	801						2550					
Largemouth Bass	106	4255			30	3427		16950					
Swamp Darter	339	138	22	Trace									
Yellow Perch			361	2992	74	3421		3850	2	149		215	747
All Others	376	623	52	111	521	17401		12120	44	3736			
Total	14978	81629	709	6314	3100	34931		141300	285	10911		241	1868

[1] Mean of 6 samples collected during 1974 and 1975.

[2] Mean of 6 samples collected during 1957, 1958, and 1959.

[3] Mean of 9 samples, 6 collected during 1957, 1958, 1959, and 3 collected during 1965.

[4] Mean of 2 samples, 1969, 1972.

[5] Mean of 3 samples.

Table 4.4.1 List of sampling statistics for selected indicator species utilized in fish food habits analysis at Robinson Impoundment

Species	Location	Statistic	Winter	Spring	Summer	Fall	Year
Bluegill	Intake	sample size	No Data	15	19	38	1974
		mean TLmm	No Data	92	98	86	
		range TLmm	No Data	81-100	77-100	54-100	
Bluegill	Intake	sample size	No Data	21	37	38	1974
		mean TLmm	No Data	134	124	125	
		range TLmm	No Data	101-190	101-147	101-190	
Bluegill	Lower Impoundment	sample size	46	71	28	33	1975
		mean TLmm	75	78	87	84	
		range T'mm	49-99	47-99	42-99	59-98	
Bluegill	Lower Impoundment	sample size	21	27	36	40	1975
		mean TLmm	131	133	119	137	
		range TLmm	101-187	103-203	100-179	100-216	
Bluegill	Discharge	sample size	31	21	48	6	1975
		mean TLmm	62	82	80	79	
		range TLmm	41-99	51-92	57-99	70-90	
Bluegill	Discharge	sample size	32	18	22	30	1975
		mean TLmm	147	145	110	128	
		range TLmm	101-206	105-208	100-130	104-210	
Bluegill	Upper Impoundment	sample size	17	38	14	45	1975
		mean TLmm	156	108	120	112	
		range TLmm	106-236	48-219	71-218	55-253	
Largemouth Bass	Entire Lake	sample size	9	16	12	14	1975
		mean TLmm	247	260	156	162	
		range TLmm	145-490	165-427	103-220	100-204	
Warmouth	Entire Lake	sample size	6	20	29	10	1975
		mean TLmm	180	153	145	147	
		range TLmm	156-207	56-190	45-401	106-180	
Chain pickerel	Entire Lake	sample size	6	22	19	14	1975
		mean TLmm	270	204	148	192	
		range TLmm	133-320	71-455	66-436	108-362	

[illegible] from various areas of Robinson Im[illegible]undment. Seasonal occurrence in the food is ind[illegible]ated for each taxon (1= winter, 2=spring, 3=summer, 4=fall)

Intake Area

Cladocera
- *Diaphanosoma* (2,3)
- *Eubosmina* (2,3,4)

Copepoda
- *Cyclops* (2,3,4)

Diptera
- *Ablabesmyia* (2)
- *Bezzia* (2,4)
- *Chaoborus* (2,3,4)
- *Chironomus* (2,3,4)
- *Cryptochironomus* (3,4)
- *Harnischia* (2,3)
- *Microtendipes* (3)
- *[P]entaneura* (3,4)
- *Procladius* (2,3,4)
- *Pseudochironomus* (2)
- *Psectrocladius* (2)

Trichoptera
- *Oecetis* (2,3)
- *Oxyethira* (2)
- *Polycentropus* (2,3,4)

Hymenoptera
- Formicidae (3)

Coleoptera
- Elmidae (2,3)

Hirudinea (2)

Nematoda (4)

Osteichthyes
- *Lepomis* (2,3)

No. Taxa = 22

Lower Impoundment

Cladocera
- *Acroperus* (1,4)
- *Diaphanosoma* (1,2,3,4)
- *Eubosmina* (1,2,3,4)
- *Eurycercus* (3,4)
- *Polyphemus* (1)

Copepoda
- *Cyclops* (1,2,3,4)
- *Diaptomus* (1,2,3)

Diptera
- *Ablabesmyia* (2,3,4)
- *Bezzia* (1,2,3,4)
- *Chaoborus* (2,3,4)
- *Chironomus* (1,2,3,4)
- *Corynoneura* (2)
- *Cricotopus* (2)
- *Cryptochironomus* (4)
- *Dicrotendipes* (2,3,4)
- *Nanocladius* (2,4)
- Orthocladinae (2,3)
- *Orthocladius* (2,3)
- *Polypedilum* (1,2,3,4)
- *Procladius* (1,2,3,4)
- *Psectrocladius* (1,2,3,4)
- *Pseudochironomus* (1)
- *Stenochironomus* (1)
- *Tanytarsus* (2,3)
- *Thienemanniella* (2)
- emergents (2,3,4)
- pupae (2,3,4)

Trichoptera
- *Oecetis* (1,2,3,4)
- *Oxyethira* (3)

Odonata
- *Didymops* (2)
- *Dorocordulia* (2)

Hemiptera
- Formicidae (3)
- Myrinicinae (3,4)
- Pseudomyrinicinae (3)

Discharge Area

Cladocera
- *Diaphanosana* (2,3,4)
- *Eubosmina* (1,2,3,4)
- *Eurycercus* (4)

Copepoda
- *Cyclops* (1,2,3,4)
- *Diaptomus* (1)

Ostracoda
- Cypridae (3)

Diptera
- *Ablabesmyia* (1,2,3,4)
- *Bezzia* (1,2,3)
- *Chaoborus* (1,2,3,4)
- *Chironomus* (3,4)
- *Cryptochironomus* (1,4)
- *Dicrotendipes* (1,2,3)
- *Harnischia* (3)
- *Nanocladius* (3,4)
- *Orthocladius* (3)
- *Paralauterborniella* (1)
- *Polypedilum* (1,2,3,4)
- *Procladius* (3,4)
- *Psectrocladius* (1,2,3)
- *Thiemanniella* (2)
- emergents (2,3,4)
- pupae (1,2,3,4)

Ephemeroptera
- *Ephemerella* (1)

Trichoptera
- *Oecetis* (2,3,4)

Odonata
- Coenagrimidae (3)
- *Didymops* (2)
- *Enallagma* (2)
- Libellulidae (3)
- *Neurocordulia* (1)
- *Tetrogoneuria* (1)

Hemiptera
- Corixidae (4)

Upper Impoundment

Cladocera
- *Acroperus* (1,2)
- *Daphnia* (1)
- *Diaphanosoma* (2,3,4)
- *Eubosmina* (2,3,4)
- *Eurycercus* (4)

Copepoda
- *Cyclops* (1,2,3,4)

Diptera
- *Ablabesmyia* (1,2,3,4)
- *Bezzia* (1,2,3)
- *Chaoborus* (2)
- *Chironomus* (1,2)
- *Conchaplopia* (3)
- *Cricotopus* (2)
- *Crypotchironomus* (1,2,3,4)
- *Microtendipes* (1)
- *Nanocladius* (1,3,4)
- Orthocladinae (1,4)
- *Orthocladius* (2,4)
- *Parachironomus* (4)
- *Paralauterborniella* (3)
- *Pentaneura* (1)
- *Polypedilum* (1,2,3,4)
- *Procladius* (1,2)
- *Psectrocladius* (1,2,4)
- *Pseudochironomus* (1,2,3,4)
- *Rheotanytarsus* (3)
- *Stenochironomus* (2)
- *Thienemanniella* (1)
- *Tribelos* (4)
- pupae (2,3,4)
- unidentified (3,4)

Trichoptera
- *Agrypnia* (1,4)
- *Leptocella* (4)
- *Oecetis* (3,4)
- *Oxyethira* (1,2,3)
- *Pharyganea* (4)
- *Pycnopsyche* (1)

Table 4.4.2 (continued)

Lepidoptera
Nymphula (4)
Coleoptera
Berosus (1)
Hydrophilidae (2)
Hydroporus (2)
Hydracarina
Hydrachna (2,3,4)
Amphipoda
Gammarus (3)
Aranea (4)
Nematoda (4)
Oligochaeta (4)
egg cases (3)
Osteichthyes
Etheostoma (2)
eggs (2)

No. Taxa = 47

Hymenoptera
Formicidae (2)
Myrinicinae (3,4)
Coleoptera
Berosus (1)
Hydrophilidae (2)
Lepidoptera
Nymphula (1,2)
Hydracarina
Hydrachna (3)
Amphipoda
Gammarus (1)
Aranea (2,4)
Nematoda (2)
Oligocheata (2,3,4)

No. Taxa = 40

Ephemeroptera
Hexagenia 1,2,3,4
Stenonoma 1,3
Odonata
Didymops (4)
Enallagma (2,3,4)
Lestes (1)
Libelielidae (3)
Hemiptera
Corixidae (3)
Palmacorixa (2)
Sigara (2)
Hymenoptera
Formicidae (2)
Myrinicinae (3,4)
Pseudomyrinicinae (3)
Lepidoptera
Nymphula (1,3,4)
Hydracarina
Hydrachna (1,3,4)
Decapoda
Procambarus (2)
Aranea (4)
Oligochaeta (1,2,3,4)
Nematoda (1)
Ostrichthyes
Enneacanthus (3)
Etheostoma (3)
Lepomis (2,3)
Notropis (2)
eggs (2)
larvae (2)

No. Taxa = 61

Table 4.4.3 Summary of the food habits of young-of-the-year largemouth bass (< 94 mmTL) from Robinson Impoundment from April to September of 1975

	Spring			Summer		
	No. Per Stomach	% Freq.	% Vol.	No. Per Stomach	% Freq.	% Vol.
Cladocera						
<u>Acroperus</u>	1.5	18.2	7.2			
<u>Diaphanosana</u>	0.3	36.4	0.3	10.8	7.7	4.5
<u>Eubosmina</u>				0.1	7.7	0.0
Copepoda						
<u>Cyclops</u>	0.1	9.1	0.1	7.4	7.7	2.1
<u>Diaptomus</u>				0.5	7.7	0.2
Diptera						
chironomid pupae	0.3	18.2	9.9	1.8	7.7	6.8
ceratopogonid pupae	0.1	9.1	0.9			
culicid puape	0.1	9.1	0.3			
<u>Chaoborus</u>				5.4	30.8	17.1
Ephemeroptera						
unidentified				2.0	7.7	7.3
Odanata						
<u>Enallagma</u>				0.3	7.7	6.7
Hemiptera						
Myrinicinae				0.8	7.7	6.7
<u>Palmacorixa</u>	0.6	36.4	27.7			
Amphipoda						
<u>Hyallela azteca</u>	0.1	9.1	0.2			
<u>Gammarus</u>				0.2	7.7	3.8
Decapoda						
<u>Palaemonetes</u>				0.1	7.7	7.7
Oligochaete						
unidentified				0.1	7.7	0.0
Osteichthyes						
<u>Lepomis</u>	1.6	54.6	53.4	0.2	15.4	12.3
<u>Cyprinidae</u>				0.1	7.7	3.1
<u>Gambusia</u>				0.2	7.7	7.1
<u>Etheostoma</u>				0.2	15.4	14.6
Sample Size		11			13	
Range (TLmm)		48-92			32-94	
Mean (TLmm)		61			74	

Table 4.5.1 Back calculated length (mm) of bluegill collected from Robinson Impoundment during 1975 and 1976

DISCHARGE AREA

Age Group	Sample Size	Calculated Total Length at Age (mm) 1	2	3	4	5	6
1	47	65	-	-	-	-	-
2	9	51	95	-	-	-	-
3	6	50	89	120	-	-	-
4	16	34	74	109	137	-	-
5	10	33	65	101	132	158	-
6	5	29	67	92	122	143	170
Weighted Mean	-	52	77	106	133	153	170
No. of Fish	-	93	46	37	31	15	5
Mean Increment		52	25	29	27	20	17

LAKE ABOVE DISCHARGE AREA

Age Group	Sample Size	1	2	3	4	5	6
1	14	62	-	-	-	-	-
2	6	63	126	-	-	-	-
3	7	45	84	133	-	-	-
4	5	28	75	113	146	-	-
5	5	30	60	93	137	158	-
6	3	27	63	90	120	147	174
Weighted Mean	-	48	85	112	137	154	174
No. of Fish	-	40	26	20	13	8	3
Mean Increment		48	37	27	25	17	20

LAKE BELOW DISCHARGE AREA

Age Group	Sample Size	1	2	3	4	5	6
1	69	66	-	-	-	-	-
2	19	53	94	-	-	-	-
3	10	43	79	115	-	-	-
4	31	35	68	106	130	-	-
5	11	30	63	99	1[illegible]4	161	-
6	3	27	50	84	117	156	180
Weighted Mean	-	52	75	105	130	160	180
No. of Fish	-	143	74	55	45	14	3
Mean Increment		52	23	30	25	30	20

Table 4.5.2 Comparison of back calculated lengths of bluegill from Robinson Impoundment and from other similar lakes

Location	Calculated Total Length at Age (mm) 1	2	3	4	5	6
Present Study[1]	51 n=276	77 n=147	106 n=112	132 n=89	156 n=37	174 n=11
Lake Robinson 1968 (Phillips 1969)	50 n=33	104 n=23	124 n=4	- -	- -	- -
Kitty Hawk Fresh Pond (Dickson, 1961)	56 n=8	81 n=8	112 n=8	135 n=1	198 n=1	- -
Lake Waccamaw (Davis, 1966)	36 n=8	81 -	127 -	152 -	178 -	188 -
Lake Waccamaw (Louder, 1961)	43 n=14	94 -	134 -	165 -	- -	- -

[1]Weighted mean values from all areas

Table 4.5.3 Total length/weight relationship for bluegills from three areas of Robinson Impoundment collected by electrofishing during 1975 and 1976

Season[1]	Location	Number	Intercept	Slope	Correlation Coefficient
Winter	Lake above discharge	8	- 4.603	2.955	.970
	Discharge area	27	- 5.077	3.136	.973
	Lake below discharge	851	- 5.380	3.287	.963
Spring	Lake above discharge	13	- 6.270	3.705	.914
	Discharge area	74	- 4.922	3.059	.962
	Lake below discharge	251	- 5.179	3.190	.964
Summer	Lake above discharge	42	- 4.836	2.980	.926
	Discharge area	67	- 5.420	3.301	.937
	Lake below discharge	179	- 5.732	3.441	.951
Fall	Lake above discharge	48	- 4.537	2.864	.963
	Discharge area	87	- 6.451	3.808	.950
	Lake below discharge	377	- 4.981	3.086	.923

[1]Winter = December, January, February
Spring = March, April, May
Summer = June, July, August
Fall = September, October November

Table 4.5.4 Back calculated lengths (mm) of warmouth collected from Robinson Impoundment during 1975 and 1976

Age Group	Sample Size	DISCHARGE AREA - Calculated Total Length at Age					
		1	2	3	4	5	6
1	6	43	-	-	-	-	-
2	3	31	59	-	-	-	-
3	3	42	91	139	-	-	-
Weighted Mean	-	40	75	139	-	-	-
No. of Fish	-	12	6	3	-	-	-
Mean Increment	-	40	35	64	-	-	-
		LAKE ABOVE DISCHARGE AREA -					
		1	2	3	4	5	6
1	3	53	-	-	-	-	-
2	4	41	82	-	-	-	-
3	11	42	78	120	-	-	-
4	5	45	79	119	155	-	-
5	5	38	68	100	137	159	-
Weighted Mean	-	43	71	115	146	159	-
No. of Fish	-	28	25	21	10	5	-
Mean Increment	-	43	28	44	31	13	
		LAKE BELOW DISCHARGE AREA -					
		1	2	3	4	5	6
1	-	-	-	-	-	-	-
2	5	32	70	-	-	-	-
3	4	45	90	135	-	-	-
4	12	37	76	123	164	-	-
5	11	27	59	95	134	162	-
6	4	25	44	75	107	152	187
Weighted Mean	-	33	68	108	143	159	187
No. of Fish	-	36	36	31	27	15	4
Mean Increment	-	33	35	40	35	16	28

Table 4.5.5 Comparison of back calculated lengths of warmouth from Robinson Impoundment and from other similar areas

Location	Calculated Total Length at Age (mm)						
	1	2	3	4	5	6	7
Present Study[1]	38	70	112	143	159	187	-
	n=76	n=67	n=55	n=37	n=20	n=4	-
Lake Robinson 1968	43	89	132	165	-	-	-
(Phillips, 1969)	n=25	n=10	n=6	n=1	-	-	-
Lake Waccamaw	41	86	116	135	-	-	-
(Louder, 1961)	n=2	-	-	-	-	-	-
Salters Lake	33	69	107	157	193	234	251
(Louder, 1961)	n=10	-	-	-	-	-	-
Jones Lake	36	86	122	180	205	-	-
(Louder, 1961)	n=8	-	-	-	-	-	-
Singletary Lake	43	66	122	183	213	231	-
(Louder, 1961)	n=6	-	-	-	-	-	-
Black Lake	25	48	99	150	-	-	-
(Louder, 1961)	n=1	-	-	-	-	-	-

[1]Weighted mean values from all areas.

Table 4.5.6 Length/weight relationship for warmouth from three areas of Robinson Impoundment collected by electrofishing during 1975 and 1976

Season[1]	Location	Number	Intercept	Slope	Correlation Coefficient
Winter	Lake above discharge	15	- 5.398	3.315	.991
	Discharge area	11	- 3.651	2.559	.947
	Lake below discharge	47	- 5.300	3.286	.980
Spring	Lake above discharge	40	- 4.677	3.003	.997
	Discharge area	31	- 5.774	3.484	.984
	Lake below discharge	64	- 5.591	3.419	.990
Summer	Lake above discharge	9	- 4.315	2.859	.926
	Discharge area	3	- 5.636	3.435	.999
	Lake below discharge	14	- 3.669	2.565	.836
Fall	Lake above discharge	33	- 5.387	3.299	.843
	Discharge area	6	- 5.035	3.181	.999
	Lake below discharge	41	- 4.675	3.079	.954

[1] Winter = December, January, February
Spring = March, April, May
Summer = June, July, August
Fall = September, October, November

Table 4.5.7 Back calculated lengths (mm) of largemouth bass collected from Robinson Impoundment during 1975 and 1976

		DISCHARGE AREA - Calculated Total Length at Age				
Age Group	Sample Size	1	2	3	4	5
1	3	105	-	-	-	-
2	-	-	-	-	-	-
3	5	44	83	[illegible]	-	-
4	5	43	93	137	178	-
5	5	33	105	147	209	251
Weighted Mean	-	51	94	138	194	251
No. of Fish	-	18	15	15	10	5
Mean Increment		51	43	44	56	57

		IMPOUNDMENT ABOVE DISCHARGE AREA				
		1	2	3	4	5
1	3	87	-	-	-	-
2	-	-	-	-	-	-
3	3	81	141	217	-	-
4	5	97	189	237	310	-
Weighted Mean	-	90	171	230	310	-
No. of Fish	-	11	8	8	3	-
Mean Increment		90	81	59	80	

		IMPOUNDMENT BELOW DISCHARGE AREA				
		1	2	3	4	5
Combined	-	52	99	161	221	257
No. of Fish	-	5	4	4	4	2
Mean Increment		52	47	62	60	36

Table 4.5.8 Comparison of back calculated lengths of largemouth bass from Robinson Impoundment and other similar areas

Location	Calculated Total Length at Age (mm) 1	2	3	4	5	6	7	8
Present Study[1]	64 n=34	118 n=27	168 n=27	220 n=17	252 n=7	-	-	-
Lake Robinson 1968 (Phillips, 1969)	99 n=40	210 n=29	322 n=9	343 -	- -	- -	- -	- -
Singletary Lake (Louder, 1961)	53 n=2	124 -	228 -	343 -	383 -	445 -	464 -	480 -
Lake Waccamaw (Louder, 1961)	116 n=17	231 -	318 -	385 -	- -	- -	- -	- -
Lake Waccamaw (Davis, 1966)	112 n-13	226 -	235 -	381 -	437 -	483 -	- -	- -

[1]Weighted mean values from all areas

Table 4.5.9 Length/weight relationship for largemouth bass from three areas of Robinson Impoundment collected by electrofishing during 1975 and 1976

Season[1]	Location	Number	Intercept	Slope	Correlation Coefficient
Winter	Lake above discharge	5	- 6.153	3.559	.997
	Discharge area	30	- 5.102	3.087	.978
	Lake below discharge	26	- 3.073	2.252	.841
Spring	Lake above discharge*	-	-	-	-
	Discharge area	12	- 5.615	3.295	.987
	Lake below discharge	3	- 5.108	3.115	.999
Summer	Lake above discharge	6	- 4.935	3.013	.997
	Discharge area	7	- 5.292	3.166	.993
	Lake below discharge	4	- 4.851	3.011	.999
Fall	Lake above discharge	20	- 5.234	3.148	.994
	Discharge area	42	- 4.887	2.994	.961
	Lake below discharge	18	- 3.827	2.572	.926

*Insufficient data to perform analysis.

[1] Winter = December, January, February
Spring = March, April, May
Summer = June, July, August
Fall = September, October, November

Table 4.5.10 Back calculated lengths (mm) of chain pickerel collected from Robinson Impoundment during 1975 and 1976

Age Group	Sample Size	DISCHARGE AREA Calculated Total Length at Age 1	2	3	4
1	-	-	-	-	-
2	5	130	224	-	-
3	5	136	248	315	-
Weighted Mean	-	133	236	315	-
No. of Fish	-	10	10	5	-
Mean Increment	-	133	103	79	

		LAKE ABOVE DISCHARGE AREA 1	2	3	4
1	9	119	-	-	-
2	17	127	219	-	-
3	6	113	189	232	-
4	4	159	229	284	334
Weighted Mean	-	126	214	253	334
No. of Fish	-	36	27	10	4
Mean Increment		126	88	39	81

		LAKE BELOW DISCHARGE 1	2	3	4
1	-	-	-	-	-
2	5	120	223	-	-
3	8	120	218	312	-
Weighted Mean	-	120	220	312	-
No. of Fish	-	13	13	8	-
Mean Increment		120	100	92	

Table 4.5.11 Comparison of back calculated lengths of chain pickerel from Robinson Impoundment and other similar areas

Location	1	2	3	4	5
Present Study[1]	126 n=59	219 n=50	287 n=23	334 n=4	- -
Salters Lake (Louder, 1961)	170 n=3	330 -	447 -	518 -	- -
Jones Lake (Louder, 1961)	132 n=3	279 -	358 -	493 -	- -
Lake Waccamaw (Louder, 1961)	132 n=7	284 -	368 -	- -	- -

[1] Weighted mean values from all areas

Table 4. .1 Fishes collected in plexiglass larval fish traps March 1975 through February 1976 from H. B. Robinson Impoundment

Table 4.7.2 Numbers (per 100 m^3) of fishes collected in ichthyoplankton surface tows in various areas of Robinson Impoundment May 1975 through February 1976

Sampling Month	Period	SAMPLING AREA					
		Lower Impoundment		Discharge Area		Upper Impoundment	
February	D		0		0		0
	N		0	Percidae	5.25	Percidae	3.34
May	D	Percidae	10.24	Percidae	3.[illegible]		0
	N	Percidae	30.63	Percidae	14.27	_Minytrema melanops_	20.16
						Centrarchidae	10.08
June	D	Percidae	1.80		0	_Etheostoma_ sp.	1.58
		Unidentified	3.60			Percidae	3.16
	N	Centrarchidae	10.80	Percidae	26.84		
				Centrarchidae	3.83	Centrarchidae	118.11
July	D		0		0		0
	N		0		0		0
August	D		0		0		0
	N		0		0		0
September	D	Percidae	3.02		*	Percidae	9.41
	N		*		*		*
October	D		0		0		0
	N		0		0		0
December	D		0		0		0
	N		0		0		0

*No data available.

ole 4.8.1 Ichthyoplankton entrainment at Robi. .n Steam Electric Plant, March 1975 through Febi .ry 1976

Month	Week	Period	Taxon	Number per 100 M^3	Month	Week	Period	Taxon	Number per 100 M^3
January	1	D			February	1	D	Percidae	.87
		N					N		
	2	D				2	D	Percidae	5.61
		N					N	Percidae	49.37
	3	D		*		3	D	Percidae	3.97
		N		*			N	Percidae	.99
	4	D				4	D	Percidae	24.02
		N					N		
March	1	D	Percidae	1.14	April	1	D	Percidae	1.13
		N					N		
	2	D		*		2	D	Percidae	1.17
		N		*			N		
	3	D				3	D		*
		N	Percidae	1.48			N		*
	4	D		*		4	D	Percidae	7.71
		N		*			N	Percidae	24.59
May	1	D	Percidae	6.91	June	1	D		
		N					N		
	2	D	Percidae	.75		2	D	Percidae	1.18
			Catostomidae	.75			N	Percidae	1.03
		N	Percidae	18.77		3	D	Unidentified	4.42
	3	D	Percidae	10.03			N		
		N		*		4	D	Percidae	3.78
	4	D						Centrarchidae	2.52
		N					N	Percidae	5.63
July	1	D	Percidae	.82	August	1	D		
		N					N		
	2	D				2	D		
		N					N		
	3	D				3	D	Percidae	9.32
		N	Centrarchidae	.85			N		
	4	D	Lepomis	2.56		4	D		
		N					N		
	5	D							
		N							

Table 4.8.1 (continued)

Month	Week	Period	Taxon	Number per 100 M^3
September	1	D		
		N		
	2	D	+	
		N	+	
	3	D		
		N		
	4	D		
		N		
December	2	D		
		N	Percidae	.96
	3	D		
		N	Percidae	1.84
	4	D		
		N		
	5	D	Percidae	.73
		N		

Month	Week	Period	Taxon	Number per 100 M^3
October	1	D	Percidae	2.12
			Lepomis	1.06
			Unidentified	1.06
		N	Percidae	14.61
	2	D	Percidae	29.43
			Unidentified	2.35
		N	Percidae	7.09
	3	D		
		N	Percidae	5.80
			Unidentified	1.16
	4	D		
		N	Percidae	5.87
	5	D		
		N	Percidae	8.08

*Sample not collected quantitatively.

NOTE: Plant off line November 1 - December 10, 1975

†No larvae were collected in the ichthyoplankton net; however, 2-minute zooplankton sampling (300μ 30 cm net) continued 14.00 per $100m^3$ in the day samples and 2700 per $100m^3$ in the night samples

Table 4.9.1 Fishes impinged on H. B. Robinson Steam Electric Plant Unit 1 intake screens (number and weight per 24 hours), December 1973 - December 1975

		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.	
		no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day
1973	Chain Pickerel																
	Warmouth																
	Bluegill																
	Darter (primarily swamp)																
	Other[1]																
	Total[2]																
	Time Sampled																
1974	Chain Pickerel							.5	63							1.0	510
	Warmouth							3.5	444					3.5	3		
	Bluegill	.5	1	6.5	165			32.5	827	1.0	15	2.0	39	6.0	23	25.0	516
	Darter (primarily swamp)							.5	1								
	Other[1]	.5	48	.5	10			3.0	129								
	Total[2]	1.0	49	5.0	175	*	*	40.1	1462	1.0	15	2.0	39	9.5	26	26.0	1026
	Time Sampled	48 hrs.		48 hrs.				48 hrs.		48 hrs.		36 hrs.		48 hrs.		48 hrs.	
1975	Chain Pickerel											1.0	631	.6	161		
	Warmouth			1.0	2	.5	2	1.0	3	1.5	3	1.6	3	1.0	7	.7	101
	Bluegill			3.5	21	35.8	236	5.0	36	10.5	92	116.9	983	56.5	529	38.3	396
	Darter (primarily swamp)			2.5	3	7.1	5	3.6	2			.5	1	1.0	1	1.0	1
	Other[1]			.5	6	3.9	38	1.0	9	1.0	24			.6	15	4.0	10
	Total[2]	*	*	7.5	30	47.4	281	10.0	50	13.0	119	120.0	1618	59.5	712	44.0	508
	Time Sampled			48 hrs.		49.6 hrs.		24 hrs.		48 hrs.		46 hrs.		120.7 hrs.		97 hrs.	

*Data not available

[2]Totals were calculated independently thus rounding descrepancies may have occurred

[1]Includes white catfish, yellow bullhead, pirate perch, bluespotted sunfish, and bowfin

Table 4.9.1 (continued)

Year		Sept. no/day	Sept. wt/day	Oct. no/day	Oct. wt/day	Nov. no/day	Nov. wt/day	Dec. no/day	Dec. wt/day	Mean no/day	Mean wt/day	Percent Number	Percent Weight
1973	Chain Pickerel							.5	*				
	Warmouth							.5	65				
	Bluegill							.5	4				
	Darter (primarily swamp)							.5	1				
	Other[1]												
	Total[2]							2.0	70				
	Time Sampled							48 hrs.					
1974	Chain Pickerel									.1	52	<1%	12%
	Warmouth	12.7	22	1.0	2	4.0	262			2.2	67	6%	16%
	Bluegill	29.3	91	51.5	388	211.3	690	8.4	75	33.8	257	91%	62%
	Darter (primarily swamp)	2.6	1					.6	1	.3	1	1%	<1%
	Other[1]	1.3	17			1.3	258			.6	42	2%	10%
	Total[2]	45.3	131	52.5	390	216.7	1210	9.1	76	37.1	418		
	Time Sampled	36 hrs.		48 hrs.		36 hrs.		37 hrs.					
1975	Chain Pickerel	.3	104			.2	86			.2	89	<1%	23%
	Warmouth									.7	11	2%	3%
	Bluegill	19.0	113	15.2	110	15.0	310	1.5	31	28.8	260	89%	66%
	Darter (primarily swamp)	1.3	1	.6	1	.5	1	1.0	1	1.7	2	5%	1%
	Other[1]	.5	2	1.0	253					1.1	32	3%	8%
	Total[2]	21.0	221	16.8	364	15.7	397	2.5	32	32.5	394		
	Time Sampled	94.8 hrs.		120.2 hrs.		96.1 hrs.		95.2 hrs.					

Table 4.9.2 Fishes impinged on the H. B. Robinson Steam Electric Plant Unit 2 intake screens (Number & weight per 24 hrs.) December 1973 - December 1975

Year		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.	
		no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day	no/day	wt/day
1973	Chain Pickerel																
	White Catfish																
	Warmouth																
	Bluegill																
	Other[1]																
	Total[2]																
	Time Sampled																
1974	Chain Pickerel	1.0	235			.7	208	3.5	1111					2.0	1200	4.0	2050
	White Catfish	39.5	1436	2.5	50	.7	51	1.5	210					2.0	100	2.0	136
	Warmouth	.5	22	.5	41	.7	53	9.5	1636					2.5	220	5.3	337
	Bluegill	125.5	3991	40.5	1672	39.1	1201	96.7	2596			86.0	1444	240.5	3847	3382.6	10358
	Other[1]	4.5	169	5.0	408	3.4	43	8.5	95			2.0	2	.5	189	1.3	3
	Total[2]	171.0	5852	48.5	2171	44.6	1557	119.7	5648	*1	*1	88.0	1446	247.5	5555	3395.3	12882
	Time Sampled[3]	48 hrs.		48 hrs.		35 hrs.		47.9 hrs.				12 hrs.[3]		48 hrs.		36 hrs.[3]	
1975	Chain Pickerel[1]	1.0	444	1.0	954							6.3	2734	11.7	5347	5.7	2741
	White Catfish	.5	7	10.0	365	6.8	328	4.0	700			5.7	177	1.0	21	5.9	42
	Warmouth			1.0	57	1.0	259	1.0	308			4.7	538	4.4	331	6.7	775
	Bluegill[1]	119.5	1076	100.5	1037	245.9	2166	136.0	1608			235.3	2494	414.9	2968	855.6	7037
	Other[1]	4.0	67	6.5	566	6.8	5.3	4.0	83			.5	8	2.4	34	5.4	370
	Total[2]	125.0	1593	119.0	2976	260.5	3265	145.0	2699	*2	*2	252.5	5953	434.5	8701	879.3	10465
	Time Sampled[3]	48 hrs.		48 hrs.		49.2 hrs.		26 hrs.				46 hrs.		119.1 hrs.		97.2 hrs.	

*1 Plant offline May 6-30, 1974

*2 Plant offline May 2-27, 1975

*3 Plant offline November 1-30, 1975

[1] Includes golden shiner, creek chubsucker, lake chubsucker, spotted sucker, bluespotted sunfish, redbreast sunfish, pirate perch, flier, largemouth bass, dollar sunfish, swamp darter, eastern mudminnow, flat bullhead, black crappie, white crappie

[2] Totals were calculated independently thus rounding discrepancies may have occurred

[3] Additional sampling was conducted with fewer than 3 pumps operating, see Figure 4.9.1

Table 4.9.2 (continued)

Year		Sept. no/day	Sept. wt/day	Oct. no/day	Oct. wt/day	Nov. no/day	Nov. wt/day	Dec. no/day	Dec. wt/day	Mean no/day	Mean wt/day	Percent Number	Percent Weight
1973	Chain Pickerel							7.0	2416				
	Warmouth							1.0	26				
	Bluegill							1.5	152				
	Darter (primarily swamp)							242.5	5364				
	Other[1]							4.0	164				
	Total[2]							256.0	8122				
	Time Sampled												
1974	Chain Pickerel	3.1	1159			2.7	1893	2.8	1274	1.8	830	<1%	14%
	Warmouth	3.0	10	.5	5	22.0	979	1.7	102	6.9	280	1%	5%
	Bluegill	7.0	399	1.0	97	4.0	120	1.1	140	2.9	279	<1%	5%
	Darter (primarily swamp)	3586.5	11471	1093.0	6190	496.7	2765	176.6	1549	851.2	4280	98%	74%
	Other[1]	2.5	17	1.0	19	3.3	235	6.1	342	3.5	138	<1%	2%
	Total[2]	3602.0	13055	1095.5	6310	528.7	5993	188.1	3407	866.3	5807		
	Time Sampled	48 hrs.		48 hrs.		36 hrs.		43.5 hrs.					
1975	Chain Pickerel	1.4	494	2.0	966			.5	312	3.0	1349	1%	28%
	Warmouth	4.4	43	1.4	77					4.0	176	1%	4%
	Bluegill	1.7	132							2.0	240	1%	5%
	Darter (primarily swamp)	487.2	4907	128.8	1867			58.5	1858	278.2	2702	95%	57%
	Other[1]	2.0	72	4.6	582			5.5	788	4.2	308	1%	6%
	Total[2]	496.7	5648	136.8	3493	*3	*3	64.5	2957	291.4	4775		
	Time Sampled	70.3 hrs.		120.2 hrs.				48 hrs.					

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Table 4.10.1 Estimated total angler use and catch rate for H. B. Robinson Impoundment, June 1975 - June 1976

			WEEKDAY						WEEKEND						
Season	Location		Anglers	Average Trip Length	Estimated Total Anglers	Total Hours Fished	Catch/ Hour[1]	Estimated Total Catch	Anglers	Average Trip Length	Estimated Total Anglers	Total Hours Fished	Catch/ Hour	Estimated Total Catch	Seasonal Total
Spring	Upper Lake	AM	11	3.01	151	455	.47	214	34	2.70	327	883	.15	132	2365
		PM	63	3.21	1275	4096	.21	860	54	2.29	613	1404	.84	1179	
	Discharge	AM	9	3.00	195	585	0	0	8	4.00	52	208	.04	8	780
		PM	20	2.66	489	1301	.51	664	13	2.21	153	338	.32	108	
	Lower Lake	AM	4	2.98#	87	252	0#	0	7	2.00	91	182	0	0	279
		PM	10	2.23*	291	649	.41	266	8	1.50	139	209	.06	13	
														All Locations	3424
Summer	Upper Lake	AM	18	3.03*	386	1170	.30*	351	7	2.22	82	182	.29	53	1606
		PM	10	2.36	275	649	.83	539	44	2.83	404	1143	.58	663	
	Discharge	AM	2	1.43*	45	64	.06#	4	3Δ	3.20	61	195	.63	123	183
		PM	13Δ	5.00	169	845	.03*	25	5	4.13	31	128	.24	31	
	Lower Lake	AM	3	2.89	67	194	.69	134	8	0.33*	630	208	0#	0	156
		PM	9	1.72	113	194	.06	12	10	2.61*	100	261	.04*	10	
														All Locations	1945
Fall	Upper Lake	AM	16	3.68	283	1041	.40	416	26	6.10	165	677	.27	149	889
		PM	10	3.24*	201	651	.24	156	47	3.56	343	1221	.13	159	
	Discharge	AM	3	2.25	87	196	.65	127	8	1.74	120	209	.27	56	288
		PM	1	1.58#	41	65	.21#	14	12	2.50	125	313	.29	91	
	Lower Lake	AM	5	3.00	108	324	0	0	6	3.29#	47	155	.17#	26	232
		PM	4	1.70	153	260	0	0	18	1.82#	257	468	.44#	206	
														All Locations	1400
Winter	Upper Lake	AM	3	0.48#	406	195	0#	0	25	2.19	297	650	.08	52	506
		PM	17	2.00	553	1106	.29	321	32	4.71	177	834	.16	133	
	Discharge	AM	2	3.80	34	129	.24	31	13	3.74	90	337	.23	78	332
		PM	10	1.41	461	650	.20	130	21	2.50	218	545	.17	93	
	Lower Lake	AM	3	2.10	93	195	.48	94	3	2.12*	98	208	.16	33	325
		PM	9	1.83	320	586	.27	160	7	2.90*	63	183	.21	38	
														All Locations	1163
														GRAND TOTAL	7952

*Average of completed and partial trip data.

#Partial trip data only.

[1]Catch/hour data are means of completed and partial trips.

ΔTotal anglers interviewed during period (no anglers observed during instantaneous counts).

Table 4.11.1 Fishes tagged and recaptured in H. B. Robinson Impoundment during 1974, 1975, and 1976

	Tag Number	Tagged				Recapture				Comment
		Date	Location	Length	Weight	Date	Location	Length	Weight	
Warmouth	80	6/25/74	G-1	184	120	8/28/74	G-1	190	145	
	400	6/25/74	A-1	145	45	4/2/75	A-1	160	89	
	667	2/10/76	A-1	163	86	2/15/76	H	164	88	
	839	2/13/75	A-1	185	140	5/29/75	Canal N. of A-1			Angler Return
	870	2/6/75	E-1	178	115	4/5/75				Angler Return
	873	2/13/75	A-3	180		4/2/75	A-3	182	146	
	874	2/13/75	A-3	170	110	2/10/76	A-3	180	124	
	874	2/10/76	A-3	180	124	3/24/76	A-3	182	124	
	914	4/30/75	E-1	163	85	5/9/75				Angler Return
	996	2/13/75	A-1	170	120	7/5/75	A-1			Angler Return
Largemouth Bass	661	2/10/76	A-1	241	158	2/13/76	N. of B-1			Angler Return
	697	9/26/75	A-1	240	146	10/14/75	S. of C-1			Angler Return
	713	10/16/75	F-3	337	565	11/18/75	F-3			Angler Return
	796	2/11/76	E-1	200	95	2/25/76				Angler Return
	798	2/11/76	E-1	224	122	2/25/76				Angler Return
Chain Pickerel	644	1/12/76	E-1	446	439	2/29/76				Angler Return
	649	1/13/76	G-3	460	820	2/29/76	N. of [illegible]-3			Angler Return
	787	2/11/76	E-1	390	290	2/29/76	E-1 cove			Angler Return
	984	2/20/75	E	264	100	4/2/75	E-3	280	120	
Bowfin	955	5/13/75	J	612	2550	6/11/75	J	627	2724	
	986	2/20/75	E	604	2040	6/18/75	E-3			Angler Return
Yellow Bullhead	87	6/26/74	G-3	292	330	11/2/74	N. of G-3			Angler Return
	861	2/5/75	A-3	283	355	4/9/75	F-1			Angler Return
Flat Bullhead	119	2/13/74	G-3	334	638	11/15/74	G-3			Angler Return
Redbreast	641	1/12/76	A-1	213	182	2/10/76	A-3	212	180	

Table 4.13.1 Common and scientific names of fishes collected from Black Creek during 1974 and 1975

Common	Scientific
Bowfin	*Amia calva*
American eel	*Anguilla rostrata*
Redfin pickerel	*Esox americanus*
Chain pickerel	*Esox niger*
Golden shiner	*Notemigonus chrysoleucas*
Dusky shiner	*Notropis cummingsae*
Unidentified shiner	*Notropis* sp.
Creek chubsucker	*Erimyzon oblongus*
Lake chubsucker	*Erimyzon sucetta*
Spotted sucker	*Minytrema melanops*
White catfish	*Ictalurus catus*
Yellow bullhead	*Ictalurus natalis*
Tadpole madtom	*Noturus gyrinus*
Margined madtom	*Noturus insignis*
Pirate perch	*Aphredoderus sayanus*
Lined topminnow	*Fundulus lineolatus*
Mosquitoefish	*Gambusia affinis*
Mud sunfish	*Acantharchus pomotis*
Banded pigmy sunfish	*Elassoma zonatum*
Black banded sunfish	*Enneacanthus chaetodon*
Bluespotted sunfish	*Enneacanthus gloriosus*
Redbreast sunfish	*Lepomis auritus*
Pumpkinseed	*Lepomis gibbosus*
Warmouth	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
Dollar sunfish	*Lepomis marginatus*
Largemouth bass	*Micropterus salmoides*
Sunfish hybrid	*Lepomis* sp.
Swamp darter	*Etheostoma fusiforme*
Tessellated darter	*Etheostoma olmstedi*
Sawcheek darter	*Etheostoma serriferum*
Piedmont darter	*Percina crassa*

Table 4.13.2 Number of fish per hour of electrofishing in Black Creek during 1975 and 1976

	1976			1975								
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Station J												
Bowfin					2	4	2	2				
Redfin pickerel		2	2			2		2				
Chain p'ckerel	18	12	2	8	20	30	20	8	22	20	22	14
Golden shiner	4		2				2		4			4
Dusky shiner	2		20		42	30	8	6	22	40	138	8
Creek chubsucker	8	26	46	4	20	10	8	2	30	26	8	8
Lake chubsucker			4	4	2				2			
Spotted sucker	2	4	8	6	2	8	6		6	2		2
Yellow bullhead		4	4	4		6					2	
Tadpole madtom		2		2					8			
Margined madtom				2	4							4
Pirate perch					6	4	4		8	6		
Lined topminnow	2				6					2		
Mud sunfish	2			2		8			6			
Banded pigmy sunfish					2				2		2	
Black banded sunfish	4		4		2	2			6	4	6	4
Bluespotted sunfish	6	6	12	2	6	8		2	10	8	4	4
Redbreast sunfish		2	4			10	2					
Pumpkinseed										8	4	
Warmouth		4	4	2	2	16	8	8	6	14	10	6
Bluegill				2		2	2		4	6	6	
Bollar sunfish			4		6		2		4			
Largemouth bass		2	4	2	2	4	2		4	2	2	4
Swamp darter					2				2			
Tessellated darter					2				2			2
Sawcheek darter											2	

Table 4.13 (continued)

	1976			1975								
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Station B												
American eel	4	2	4	6	10	10	4	6	8	10	4	
Redfin pickerel		2					2		2	4	2	4
Chain pickerel	6	6		2		4		2	4	2		2
Golden shiner				10		14		2		2		2
Creek chubsucker	6	4	4	26	4	2	2	2	2	2		10
Lake chubsucker				2			4				2	
Spotted sucker						2	4				2	
Yellow bullhead	4			2								
Pirate perch	4	2			2							
Banded pigmy sunfish		2										
Black banded sunfish		2									2	
Bluespotted sunfish					4		4					
Redbreast sunfish					2	2			4			
Warmouth	4	6		2	6	6	4	2	2	8	4	2
Bluegill	18	26	32	24	50	126	92	70	92	22	12	42
Dollar sunfish						2						2
Largemouth bass				12	6	8	3	14	12	2	6	
Sunfish hybrid		2									2	
Swamp darter										2		

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Station K												
American eel			2			6	10	3		8		4
Redfin pickerel						24	12	3		2		2
Chain pickerel	2		4	2	4	14	4	3	6	6	2	2
Golden shiner		2										
Creek chubsucker				2	2		2					
Spotted sucker			2	6								
Yellow bullhead								3				
Pirate perch						2						
Banded pigmy sunfish		2										
Black banded sunfish									2	2		
Bluespotted sunfish	2											
Redbreast sunfish						2						
Warmouth									2			2
Bluegill				2		2	2	17	6	10		

Table 4.13.2 (continued)

	1976			1975								
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Station L												
Bowfin											2	
American eel		4		10	16	12	10	4	8	6	2	10
Redfin pickerel	2						6					8
Chain pickerel	8	6	4	4	4	22	12	12	12	2	20	12
Golden shiner		2										
Dusky shiner					2	8	4					
Creek chubsucker		2	2	8	22	6	2	10	12	2	4	4
Lake chubsucker									2			
Spotted sucker	2									2		
Yellow bullhead						2						
Pirate perch			2						2	2		
Lined topminnow	2											
Black banded sunfish	4											2
Bluespotted sunfish	4										2	2
Redbreast sunfish							2					2
Warmouth	4		8			6		2				2
Bluegill		2	2		6	4	2	2	6		2	2
Largemouth bass				2		2	2		2	6		
Swamp darter			2									

Table 4.13.3 Numbers and weights (per hectare) of fish collected from Black Creek during August 1974, and August 1975

Species	Station	1974 No./Hectare	1974 Kg./Hectare	1975 No./Hectare	1975 Kg./Hectare
Redfin pickerel	J			119.43	4.3792
Chain pickerel				457.82	34.2172
Golden shiner				59.72	0.6768
Dusky shiner		2257.3	1.[illegible]407	3244.56	2.0701
Creek chubsucker		250.8	0.5016	199.05	0.4777
Lake chubsucker		35.8	12.8986	19.91	0.8559
Spotted sucker		35.8	5.2311	19.91	18.9697
White catfish		107.5	0.0717		
Yellow bullhead		537.4	0.2508	159.24	0.3981
Tadpole madtom		859.9	0.8957	696.68	0.5175
Margined madtom		3081.3	0.8957	218.96	0.3981
Pirate perch		788.2	1.4690	418.01	0.9156
Lined topminnow		71.7	0.0358	99.53	0.3185
Mosquitofish				19.91	0.0199
Mud sunfish				139.34	1.9905
Banded pygmy sunfish		107.5	0.0717	39.81	0.0199
Blackbanded sunfish		322.5	1.1824	776.31	3.3640
Bluespotted sunfish		179.1	0.6449	199.05	0.6370
Redbreast sunfish		394.1	2.6514	199.05	9.2360
Warmouth		215.0	5.0520	119.43	0.5573
Bluegill		35.8	1.4690	119.43	2.1896
Dollar sunfish		35.8	0.2866		
Largemouth bass		71.7	0.3225	99.53	0.9754
Swamp darter		537.4	0.2508	218.96	0.1791
Tessalated darter		286.6	0.4658	59.72	0.0995
Sawcheek darter		71.7	0.1433	79.62	0.0398
Piedmont darter		250.8	0.2866		
Total		10533.9	36.6177	7782.96	83.5026
Redfin pickerel	H			17.91	0.0537
Chain pickerel				17.91	3.4934
Yellow bullhead		35.83	0.2687	53.74	3.8875
Pirate perch				89.57	0.5016
Lined topminnow		17.91	0.0358		
Mud sunfish				17.91	1.0391
Blackbanded sunfish				17.91	0.0179
Warmouth		35.83	4.8728	53.74	8.4737
Bluegill		4030.82	22.7338	1791.47	27.3917
Largemouth bass		17.91	0.0358	35.83	1.4511
Total		4138.31	27.9470	2096.03	46.3096

Table 4.13.3 (continued)

Species	Station	1974 No./Hectare	1974 Kg./Hectare	1975 No./Hectare	1975 Kg./Hectare
American eel	K	35.83	3.6188		
Redfin pickerel		17.91	0.0717	95.97	0.6526
Chain pickerel		35.83	10.1039	76.78	7.7737
Yellow bullhead		35.83	0.0896	57.58	0.0768
Pirate perch		17.91	0.0358	38.39	0.1727
Lined topminnow	K	143.32	0.0717		
Mosquitofish	(cont'd)	17.91	0.0179		
Mud sunfish				19.19	1.2092
Blackbanded sunfish		35.83	0.0175	115.17	0.3071
Bluespotted sunfish		35.83	0.1433	38.39	0.1152
Redbreast sunfish				19.10	0.0192
Warmouth				76.78	1.6699
Bluegill		3117.17	11.5013	652.61	3.4934
Dollar sunfish		35.83	0.0537	19.19	0.4223
Largemouth bass		17.91	4.2637		
Swamp darter		53.74	0.0537	19.19	0.0384
Tessalated darter		35.83	0.1075	19.19	0.0384
Sawcheek darter				19.19	0.0192
Total		3636.69	30.2401	1266.83	16.0081

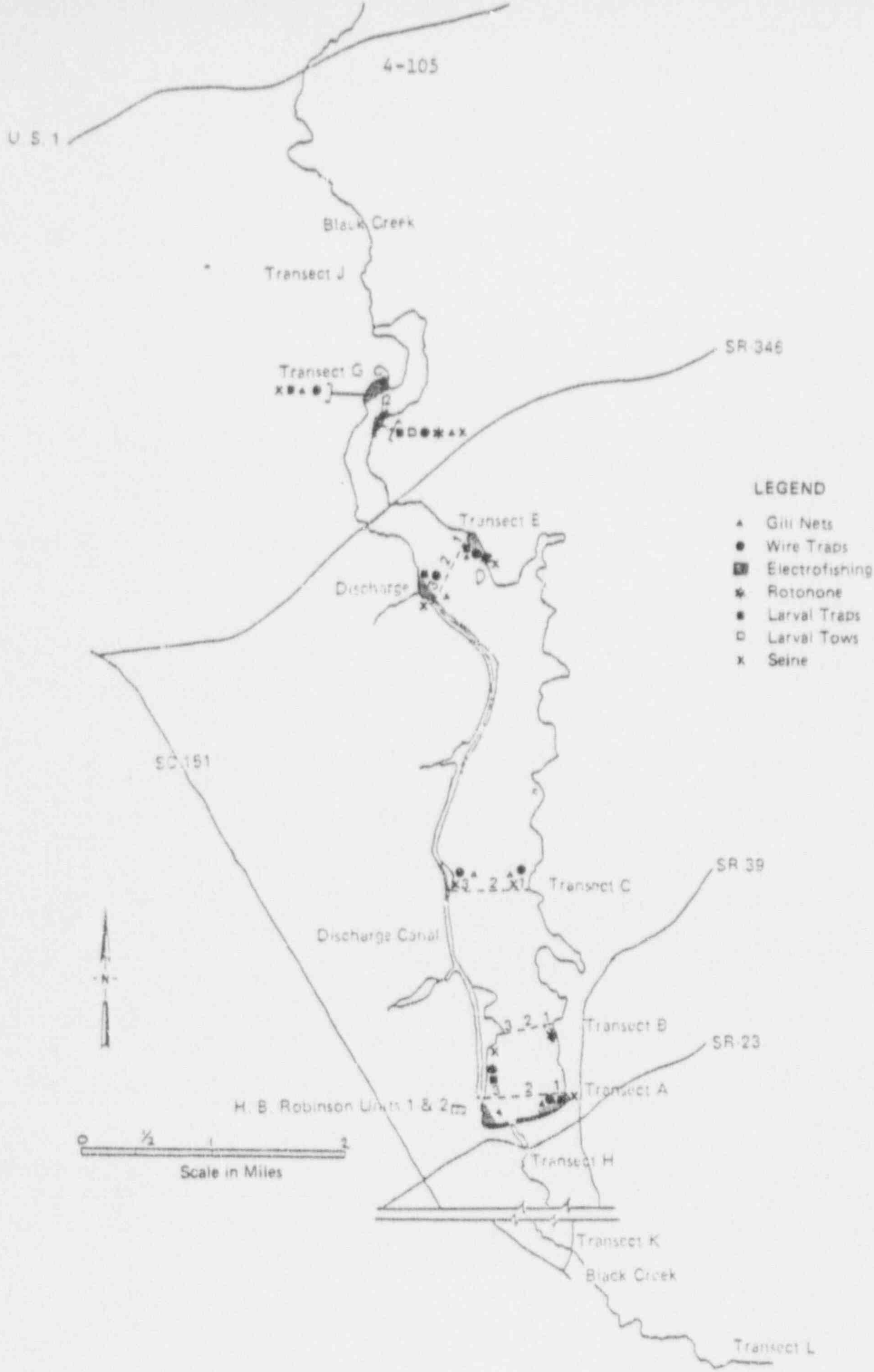


Figure 4.2.1 Ficheries sampling stations, Robinson Impoundment

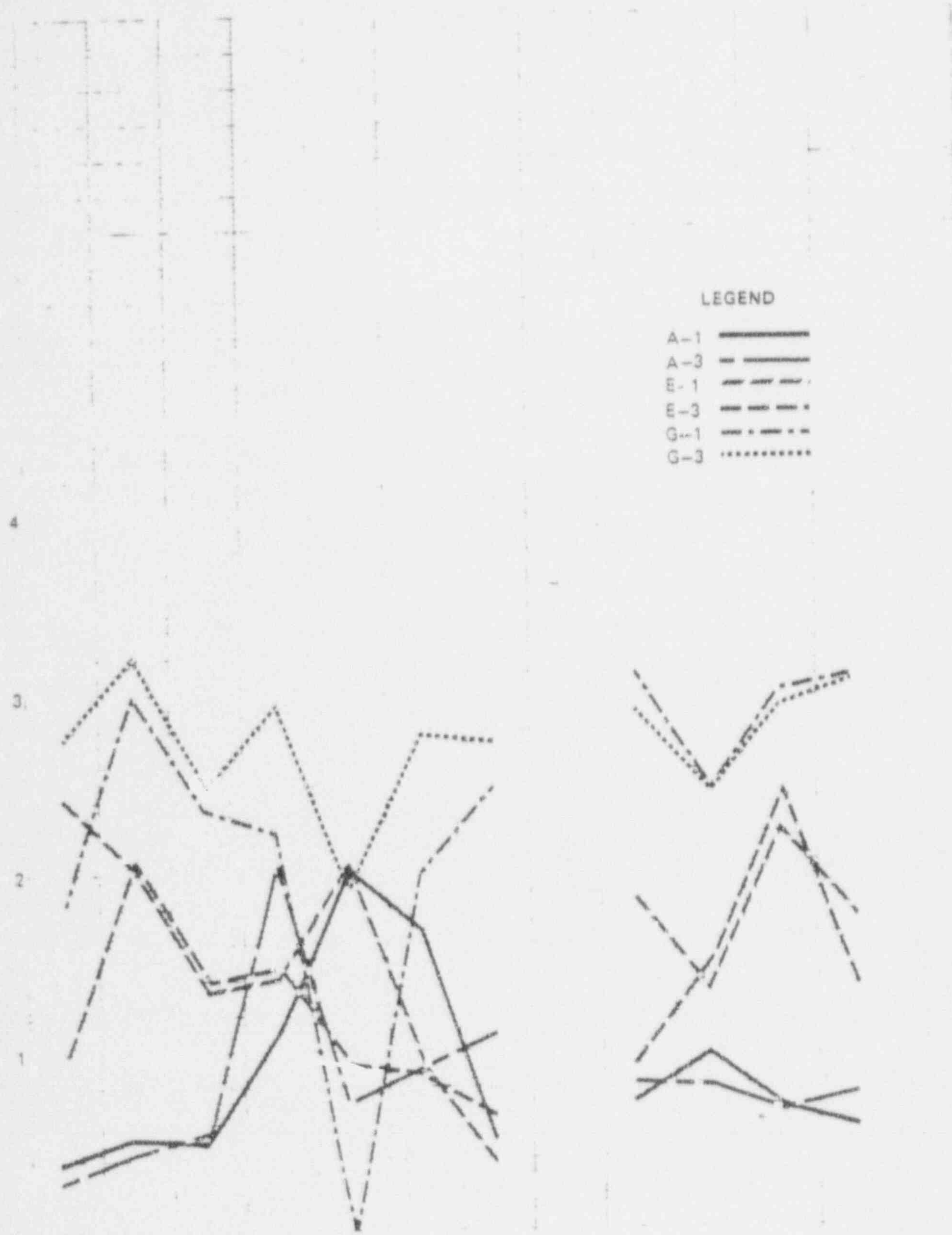


Figure 4.2.2 Shannon-Weaver diversity index of fishes collected from Robinson Impoundment during 1975 and 1976

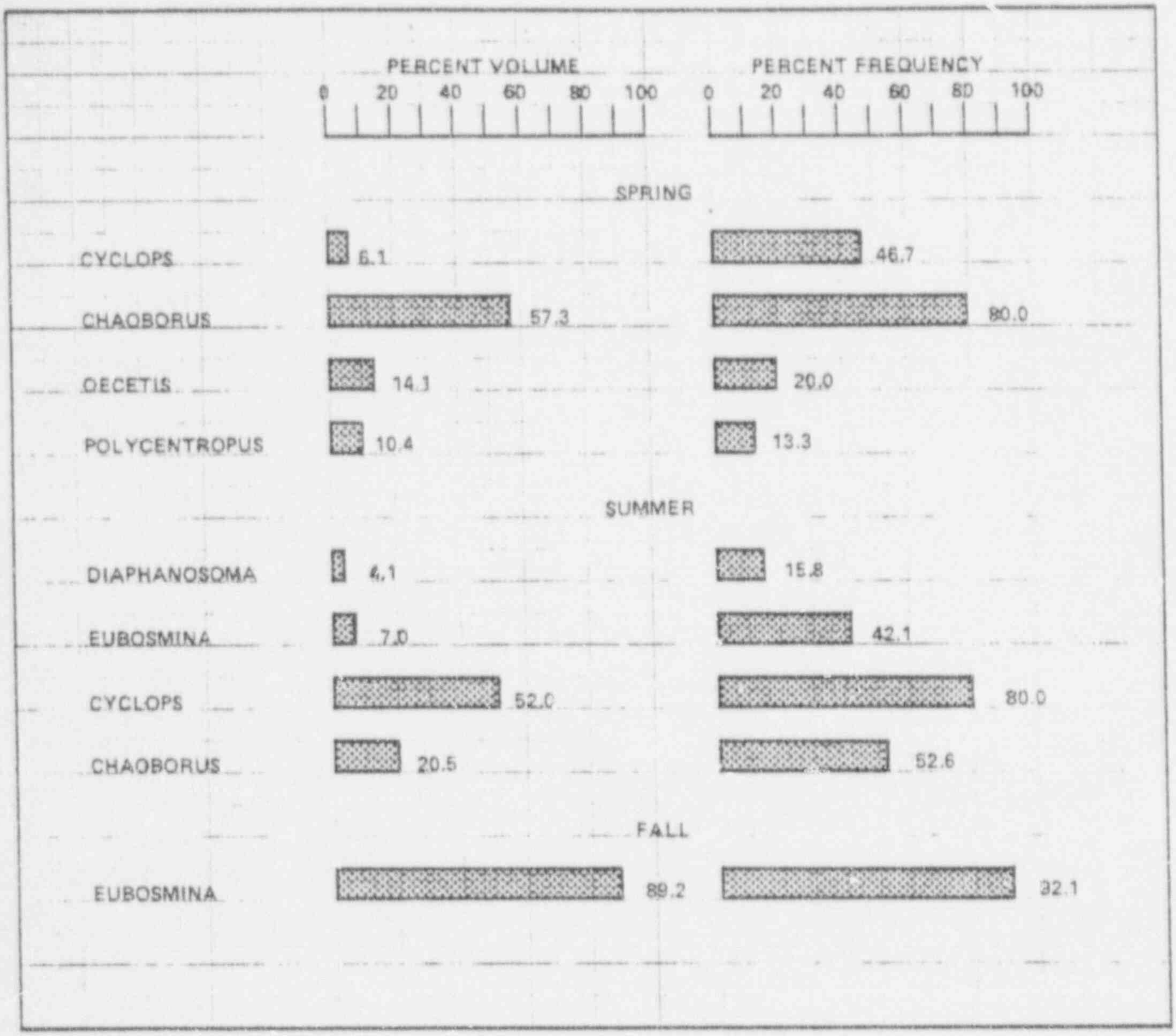


Figure 4.4.1 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the bluegill (<100 mm TL) at Robinson Impoundment in the immediate vicinity of the intake structures during 1974

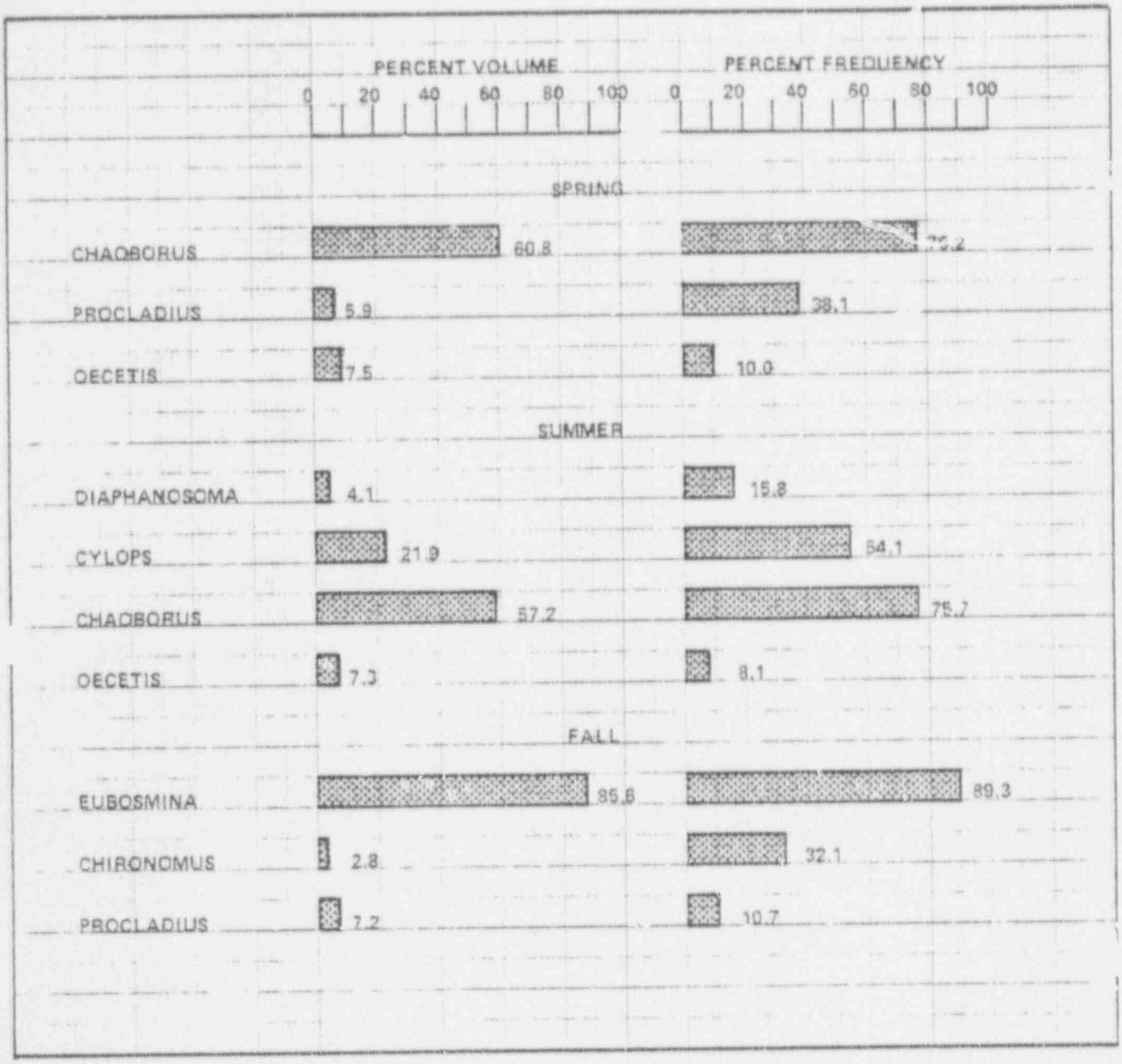


Figure 4.4.2 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the bluegill (> 100 mm TL) at Robinson Impoundment in the immediate vicinity of the intake structure during 1974

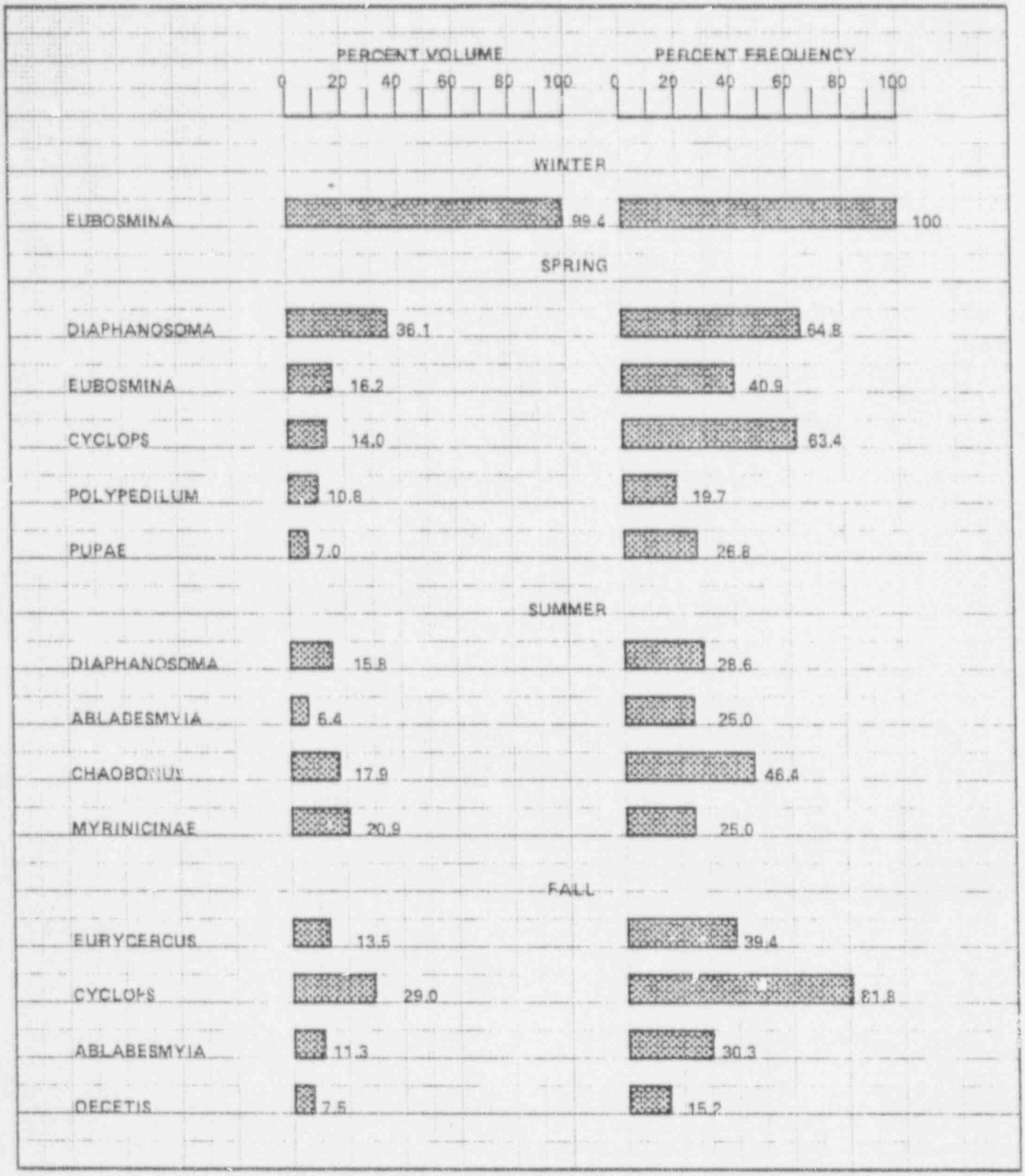


Figure 4.4.3 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the bluegill (< 100 mm TL) at Robinson Impoundment along Transect A during 1975

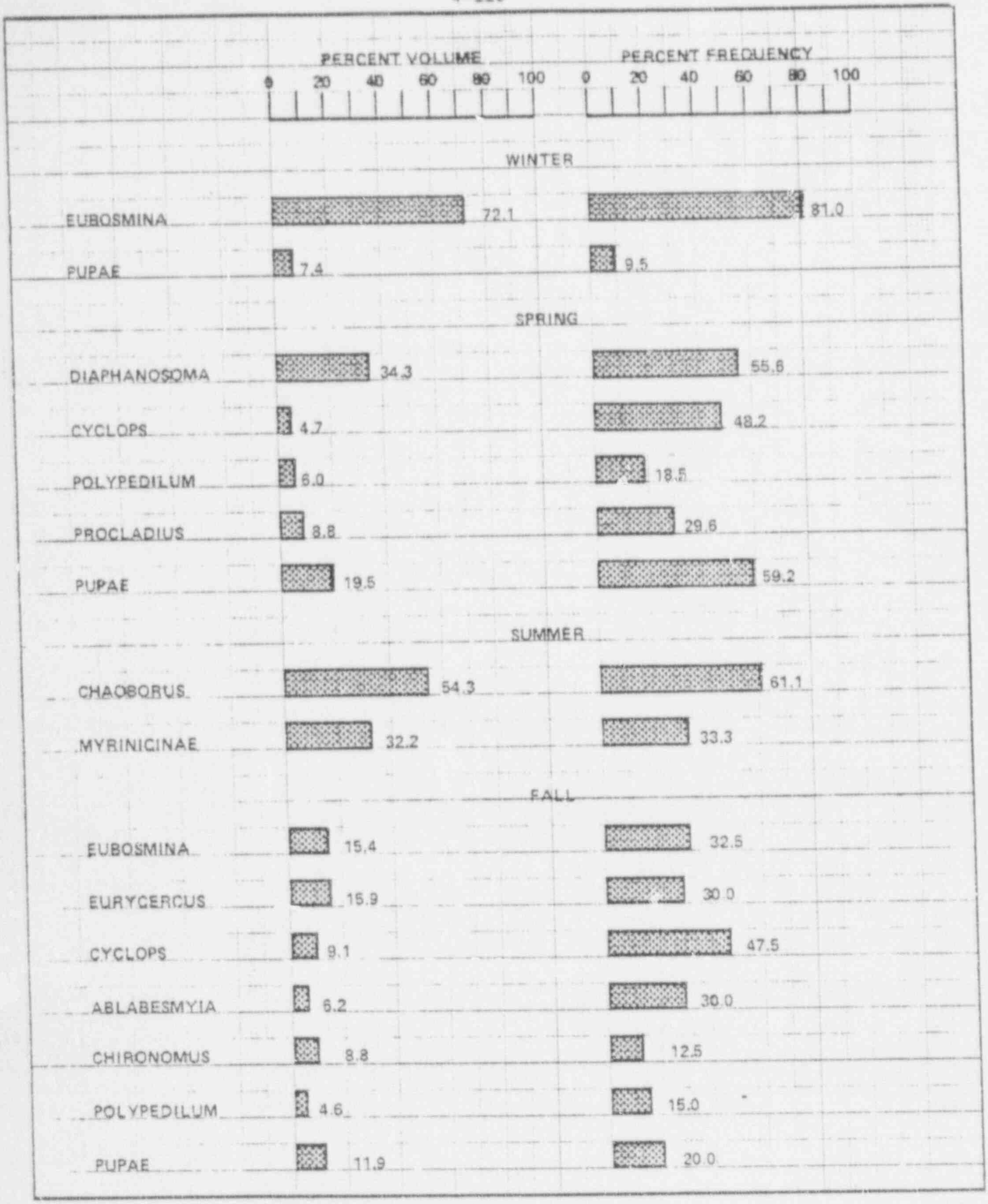


Figure 4.4.4 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the bluegill (> 100 mm TL) at Robinson Impoundment along Transect A during 1975

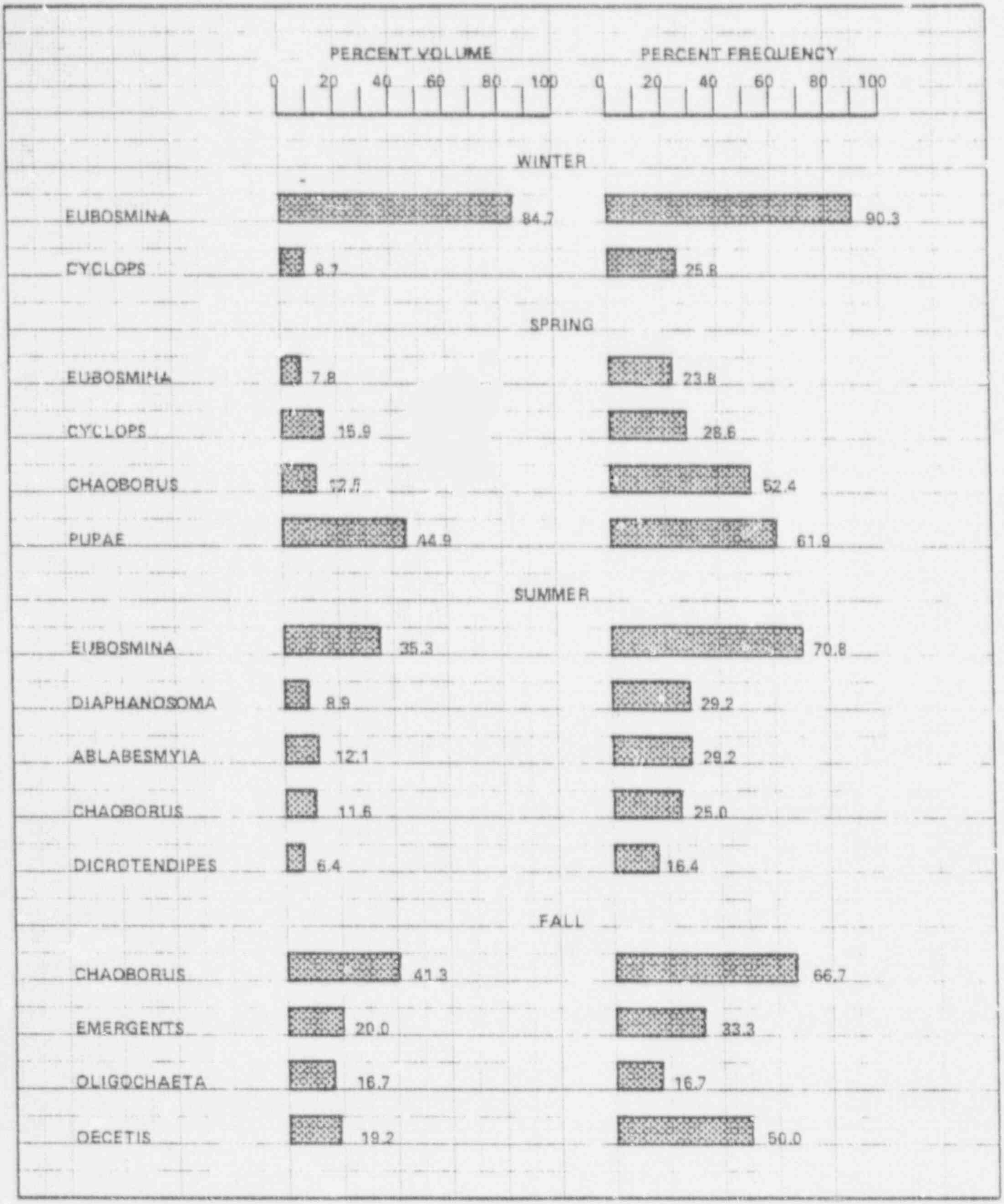


Figure 4.4.5 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the bluegill (< 100 mm TL) at Robinson Impoundment along Transect E during 1975

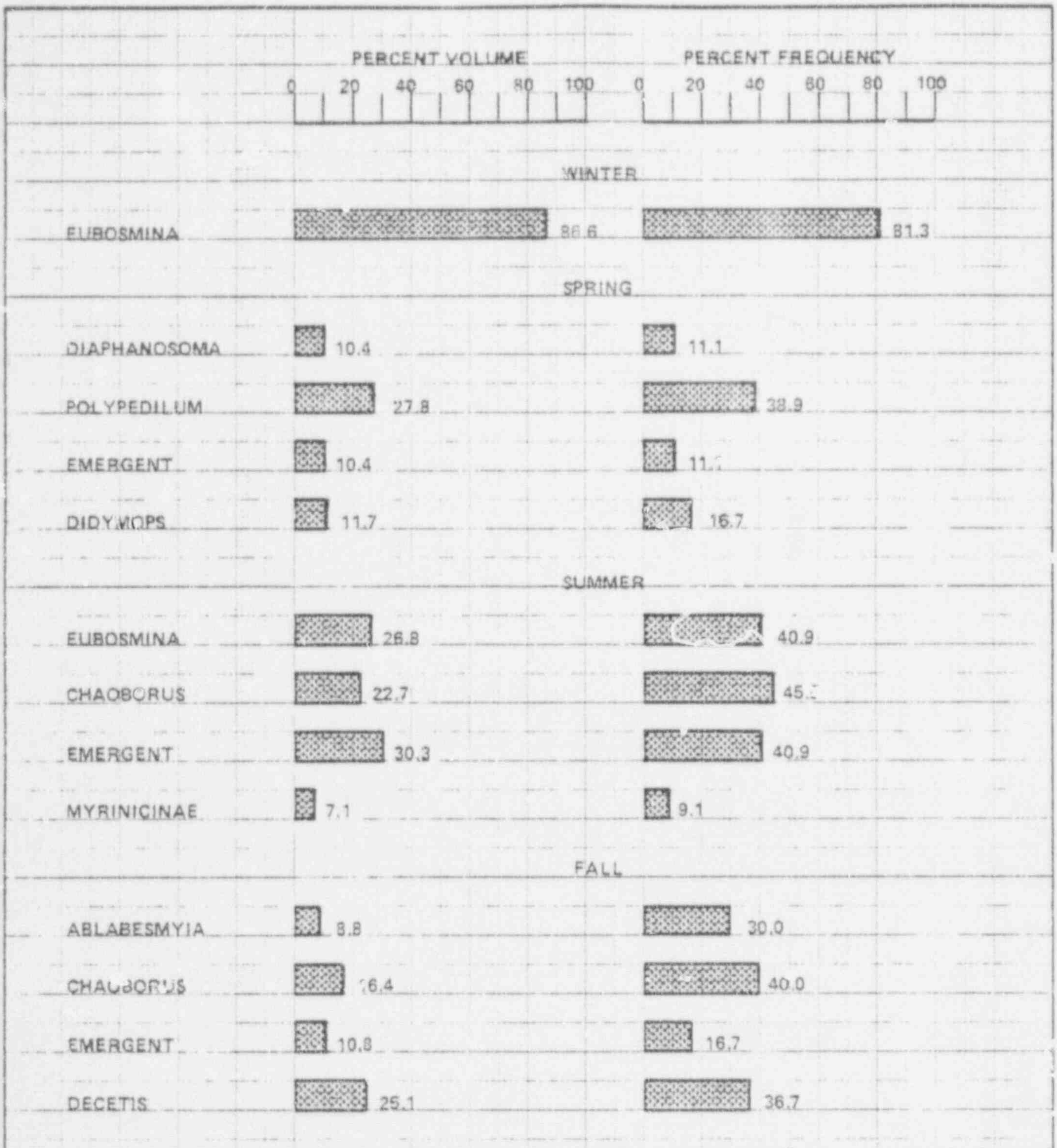


Figure 4.4.6 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the bluegill (≥ 100 mm TL) at Robinson Impoundment along Transect E during 1975

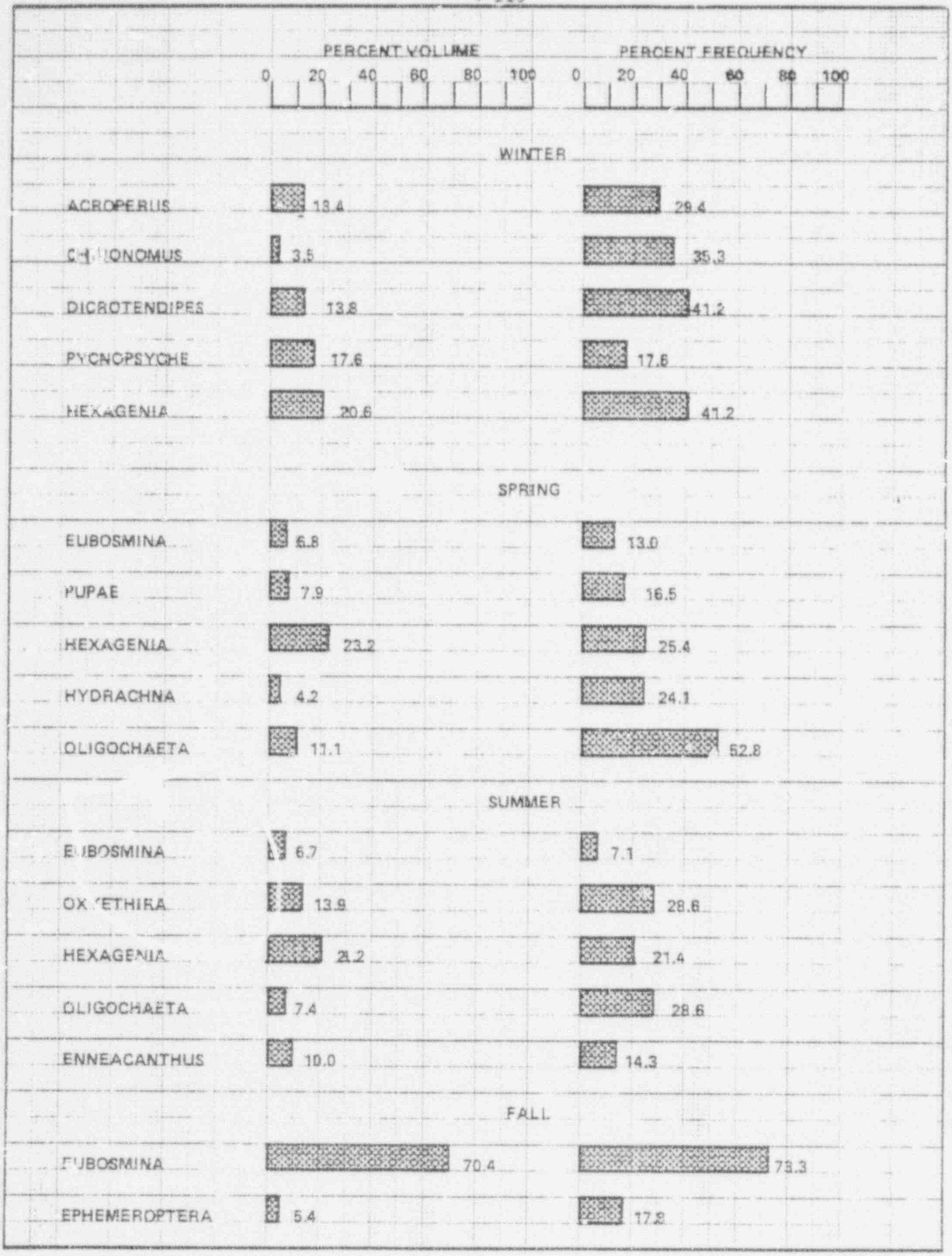


Figure 4.4.7 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the bluegill at Robinson Impoundment along Transect G during 1975

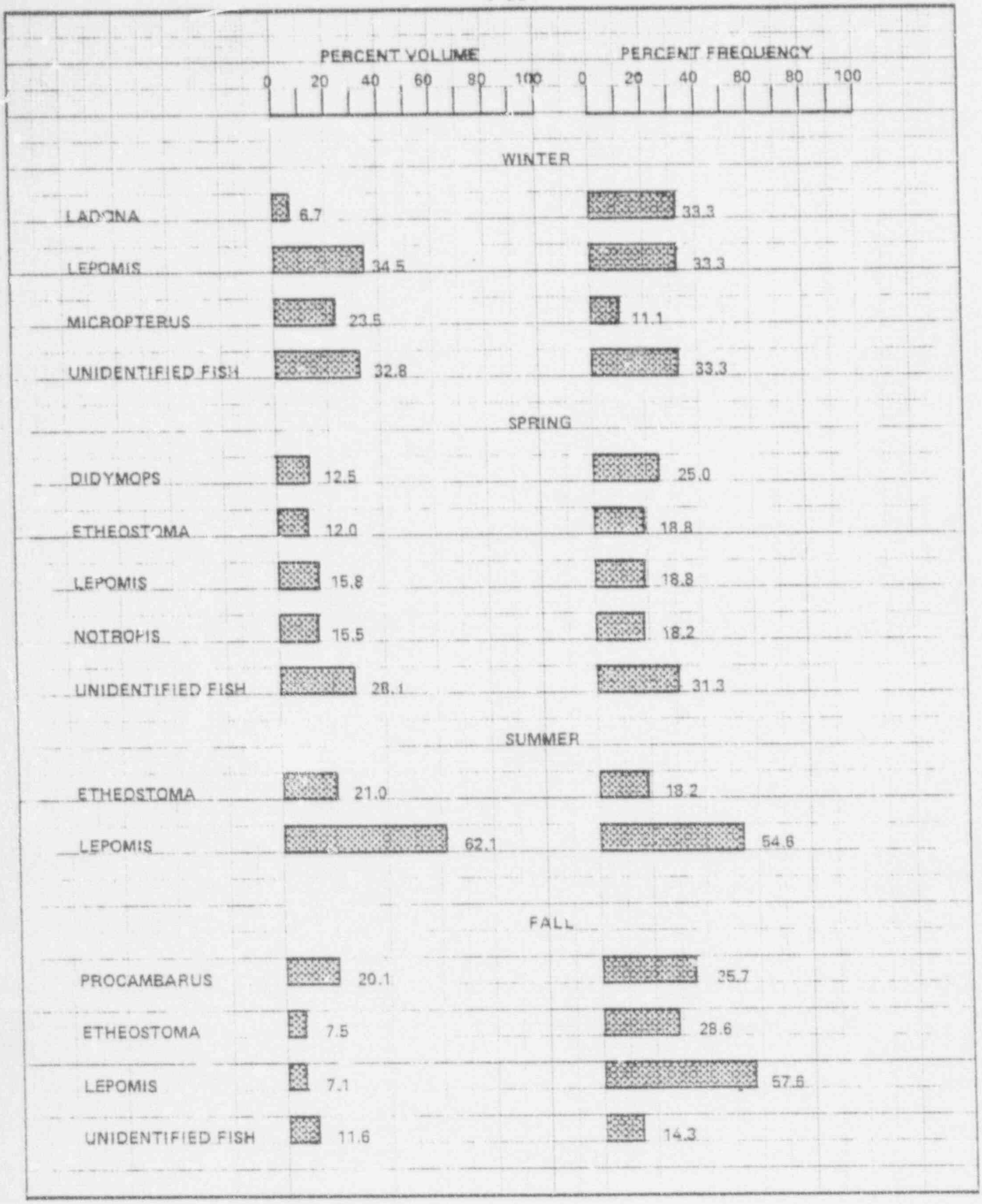


Figure 4.4.8 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the largemouth bass at Robinson Impoundment from all transects during 1975

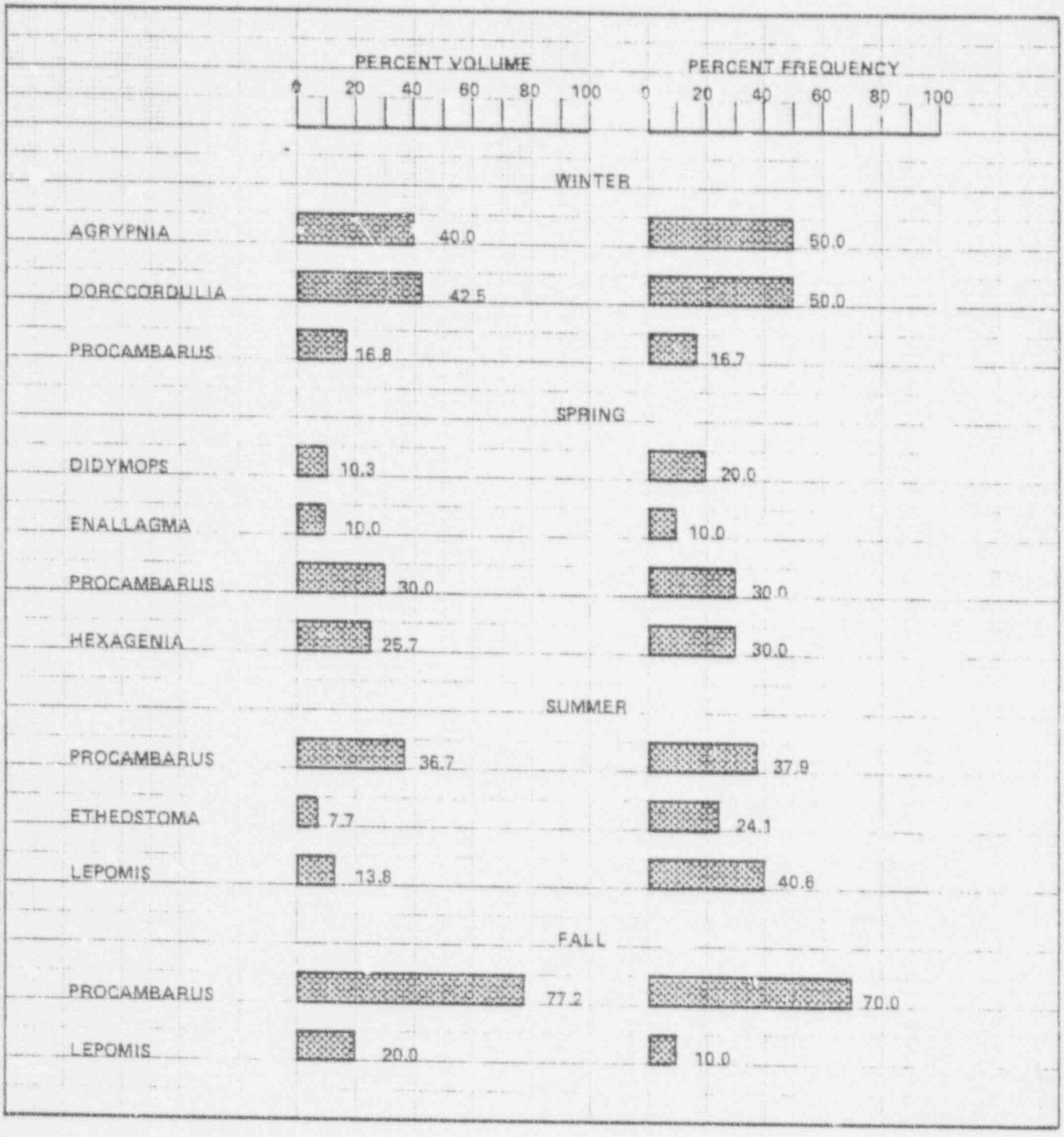


Figure 4.4.9 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the warmouth at Robinson Impoundment from all transects during 1975

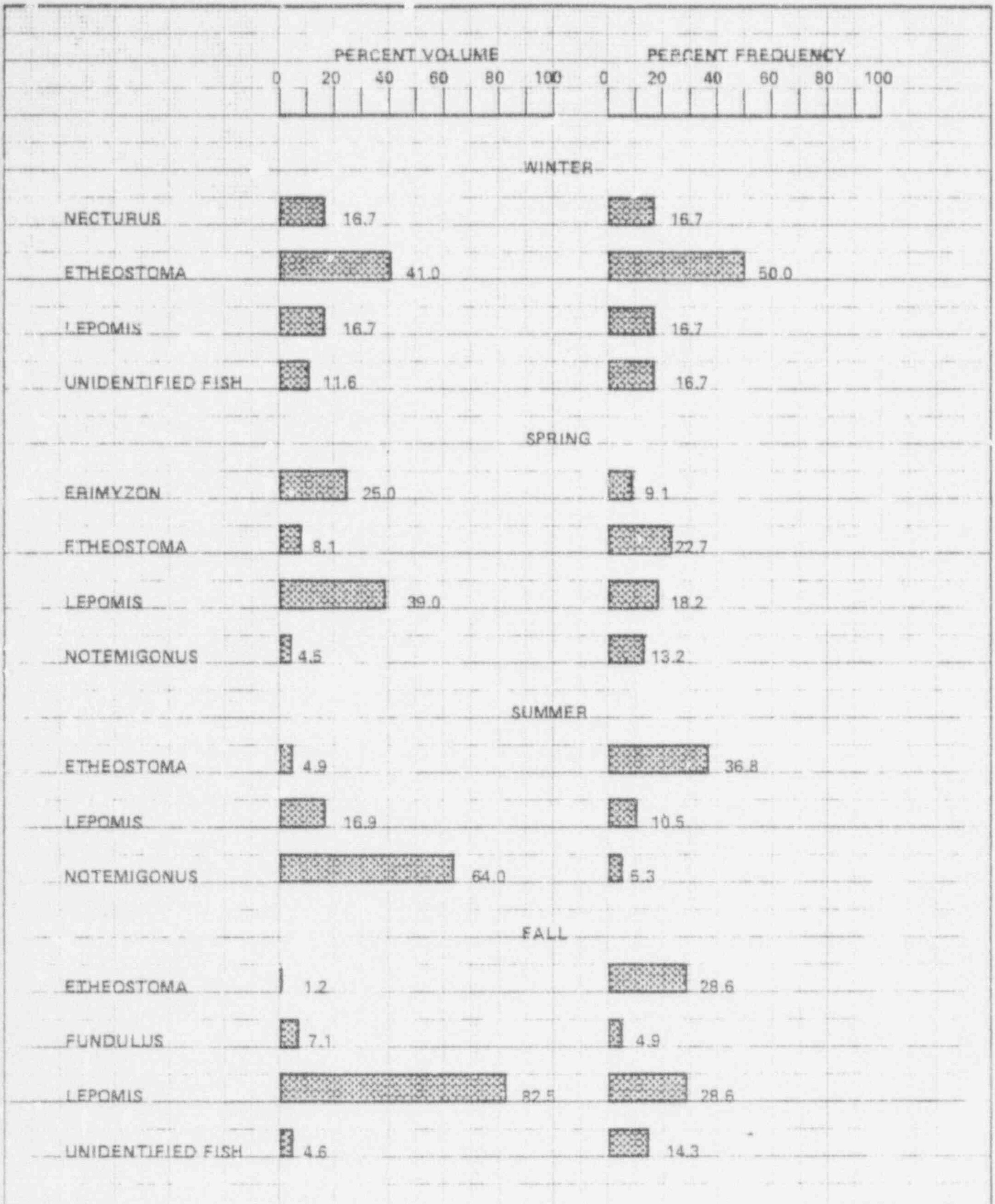
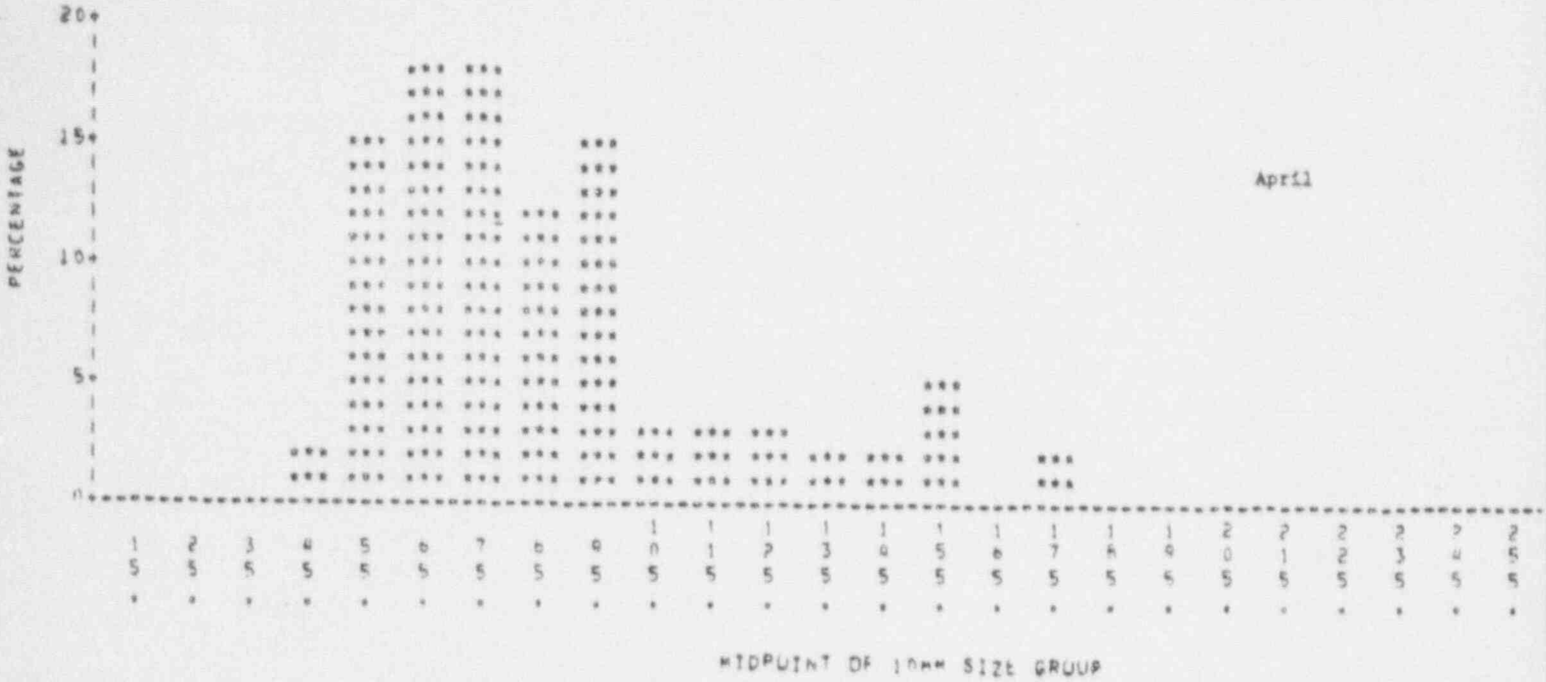


Figure 4.4.10 Percent of total volume and percent frequency of occurrence of the major components in the seasonal food habits of the chain pickerel at Robinson Impoundment from all transects during 1975

Figure 4.5.1 Length frequency histograms of bluegill collected from Robinson Impoundment from April, 1975 through March, 1976 with larval fish traps and electrofishing



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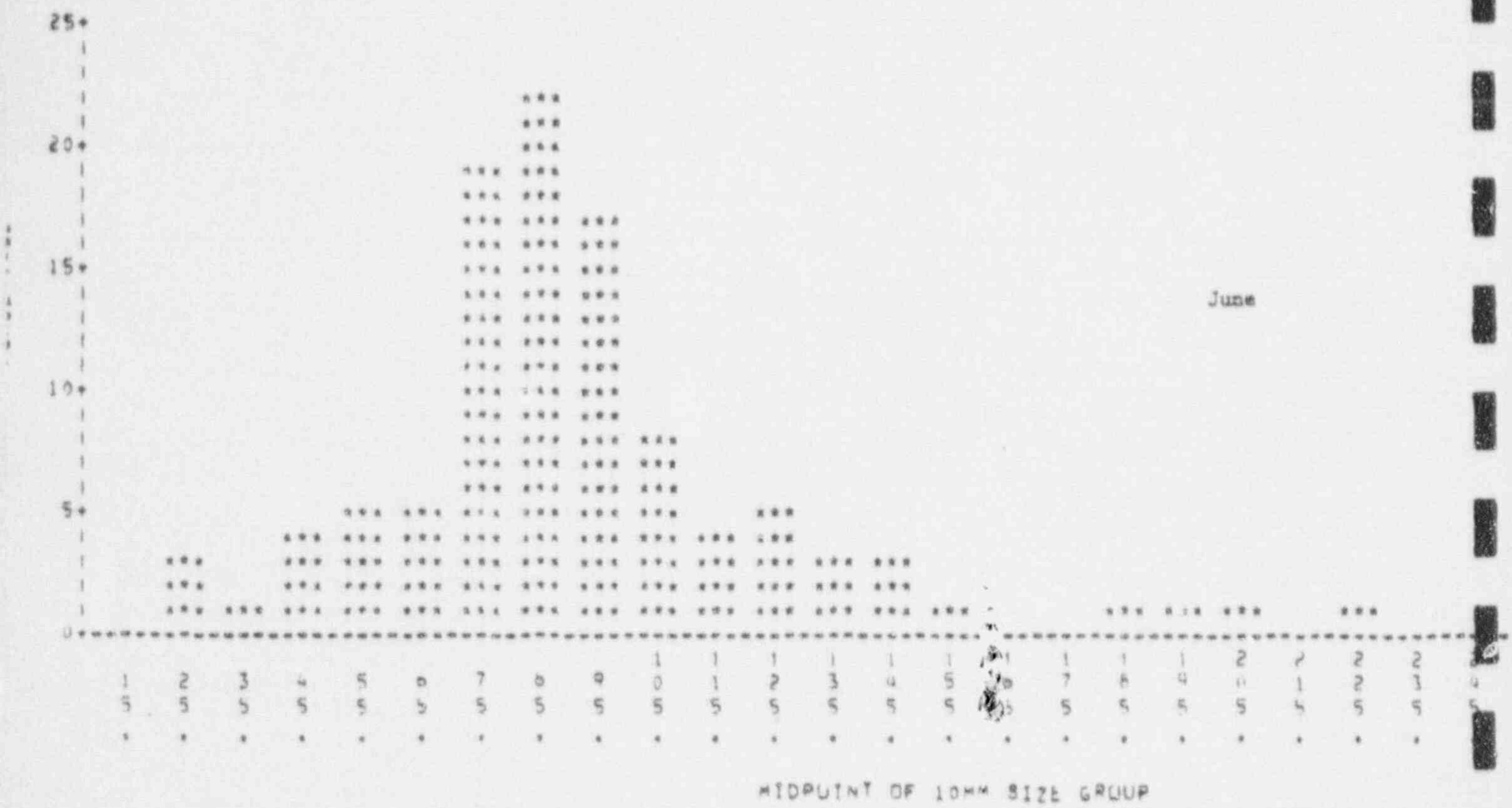

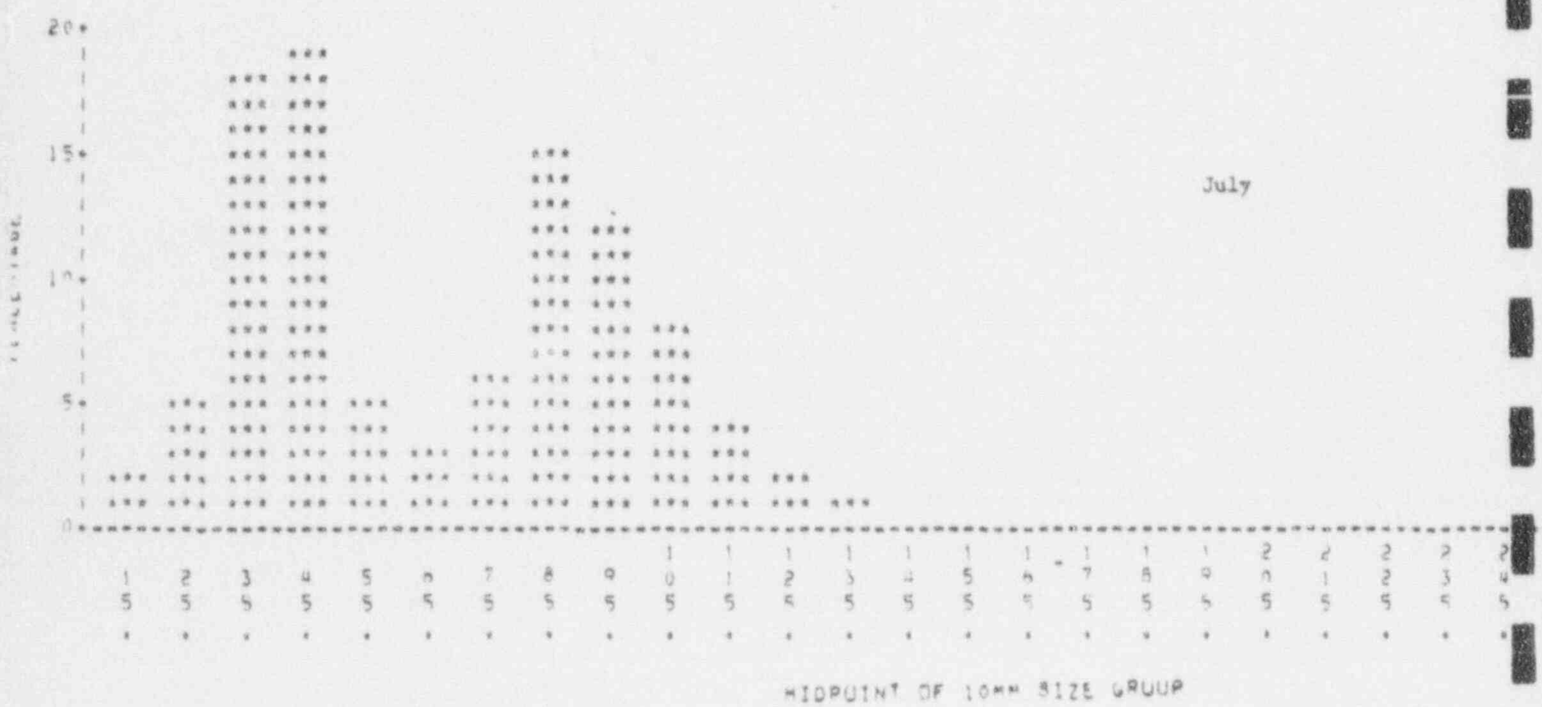

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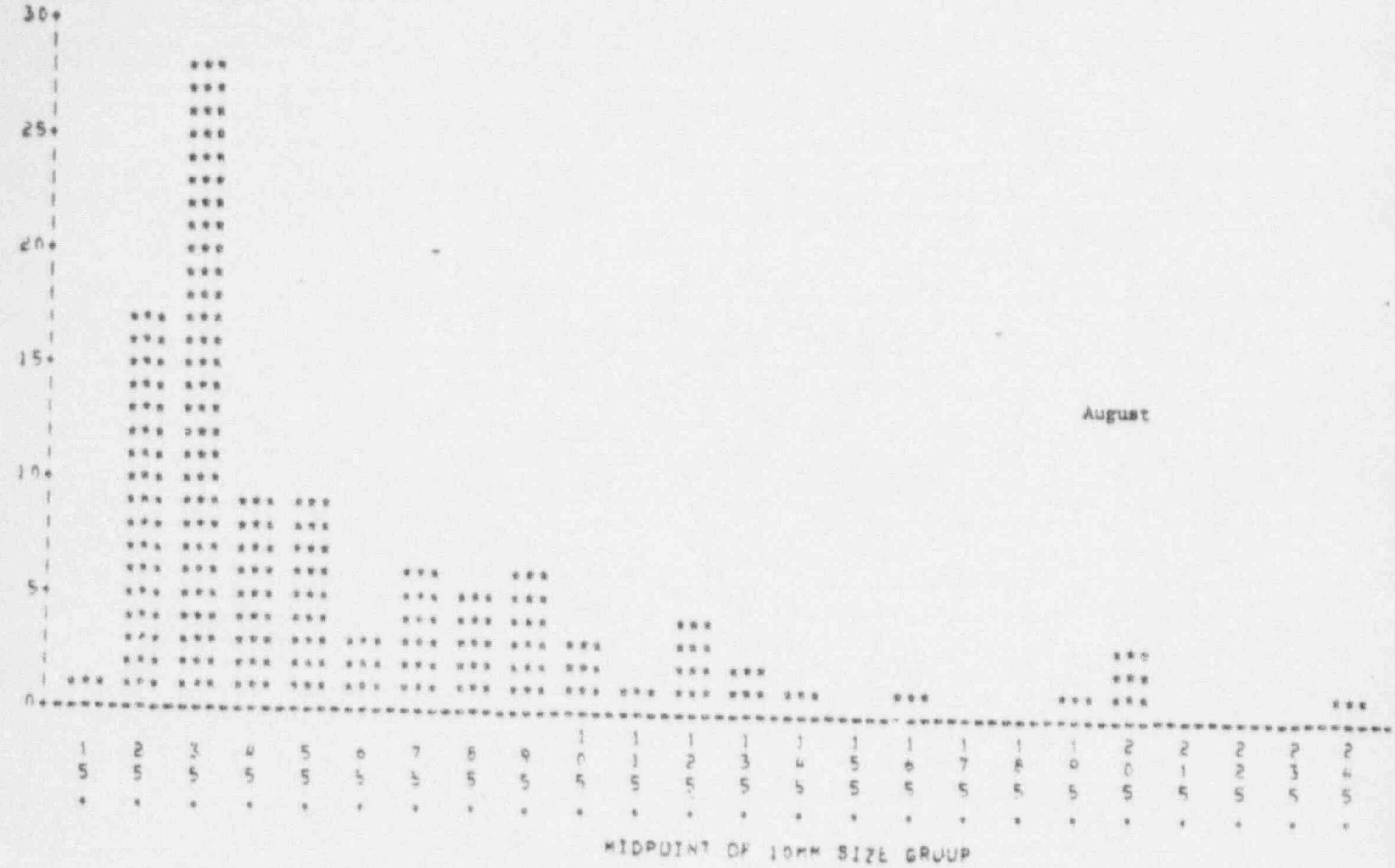

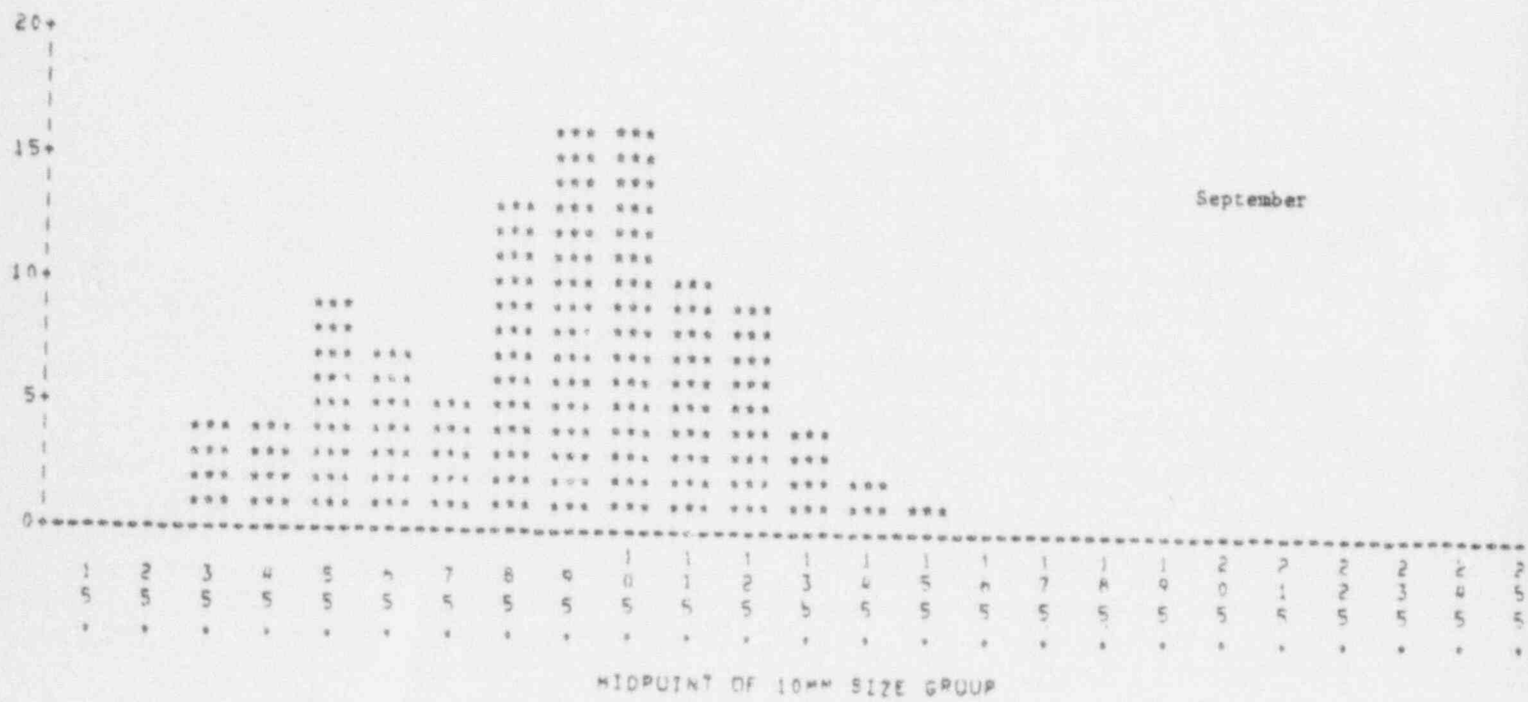

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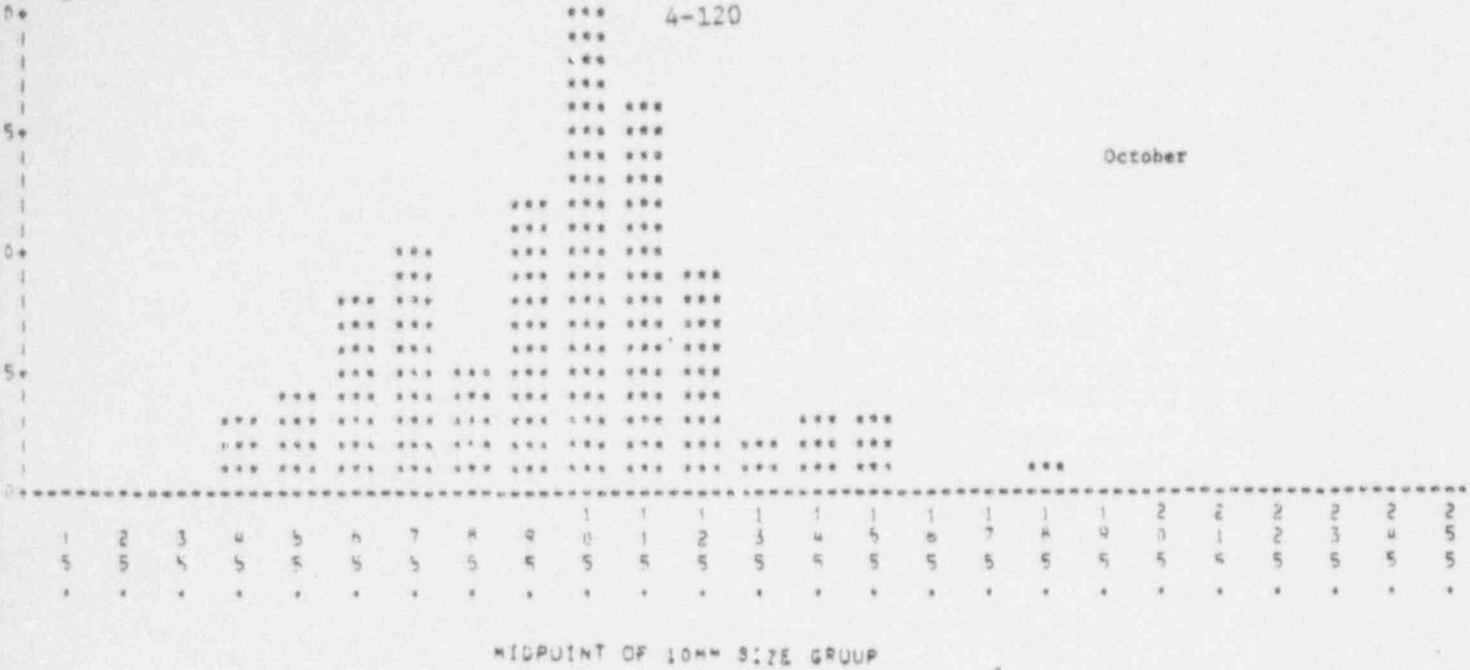

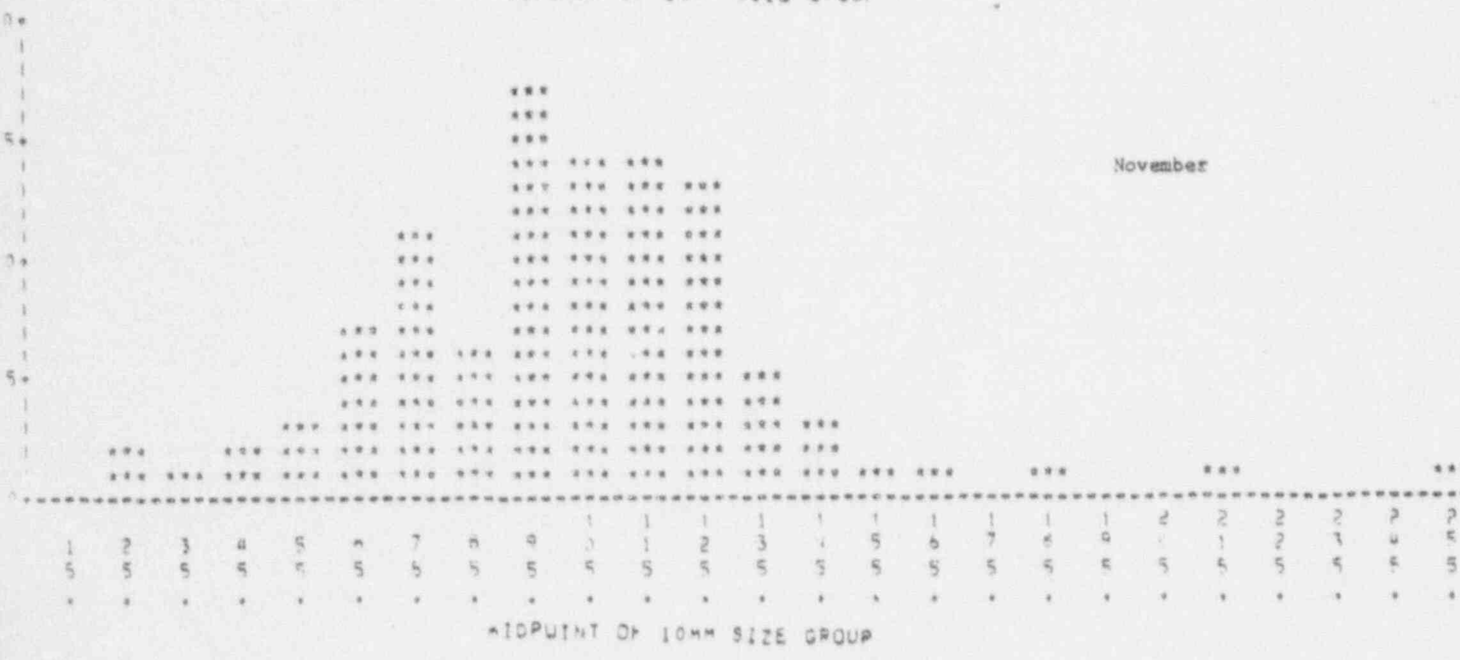

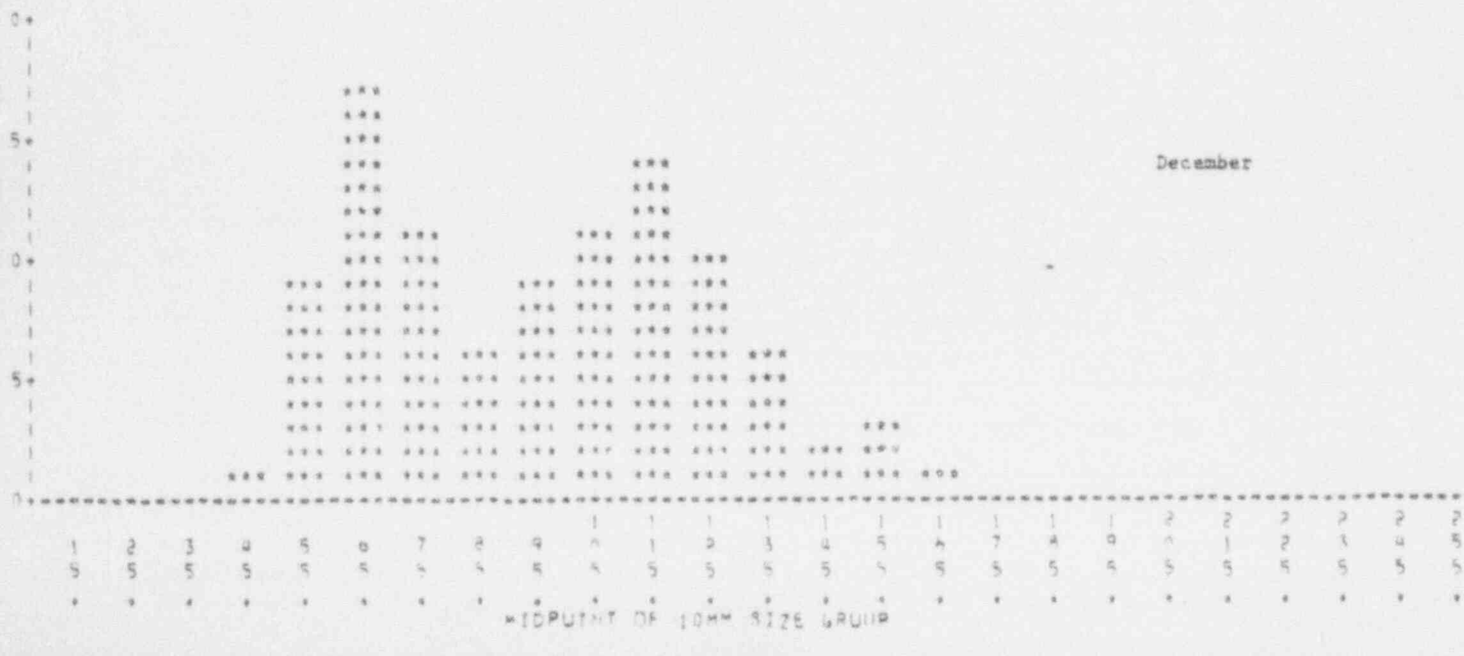

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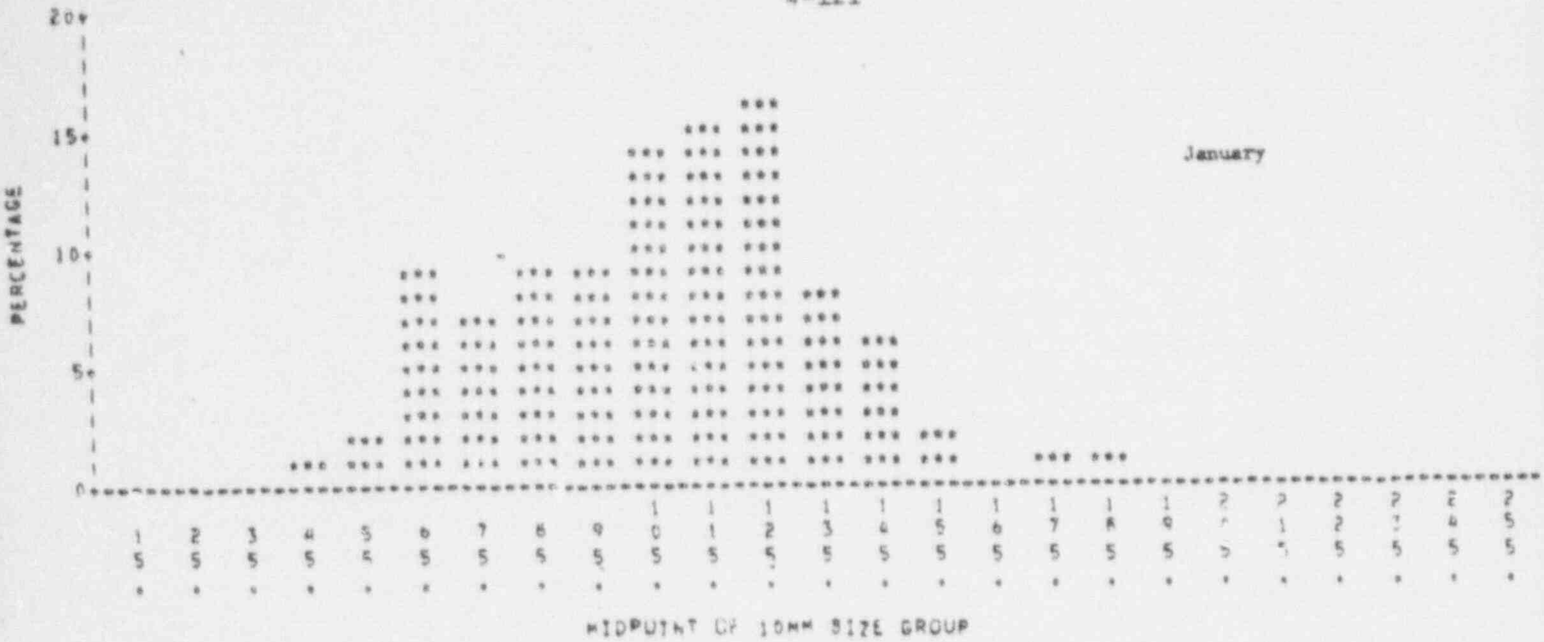

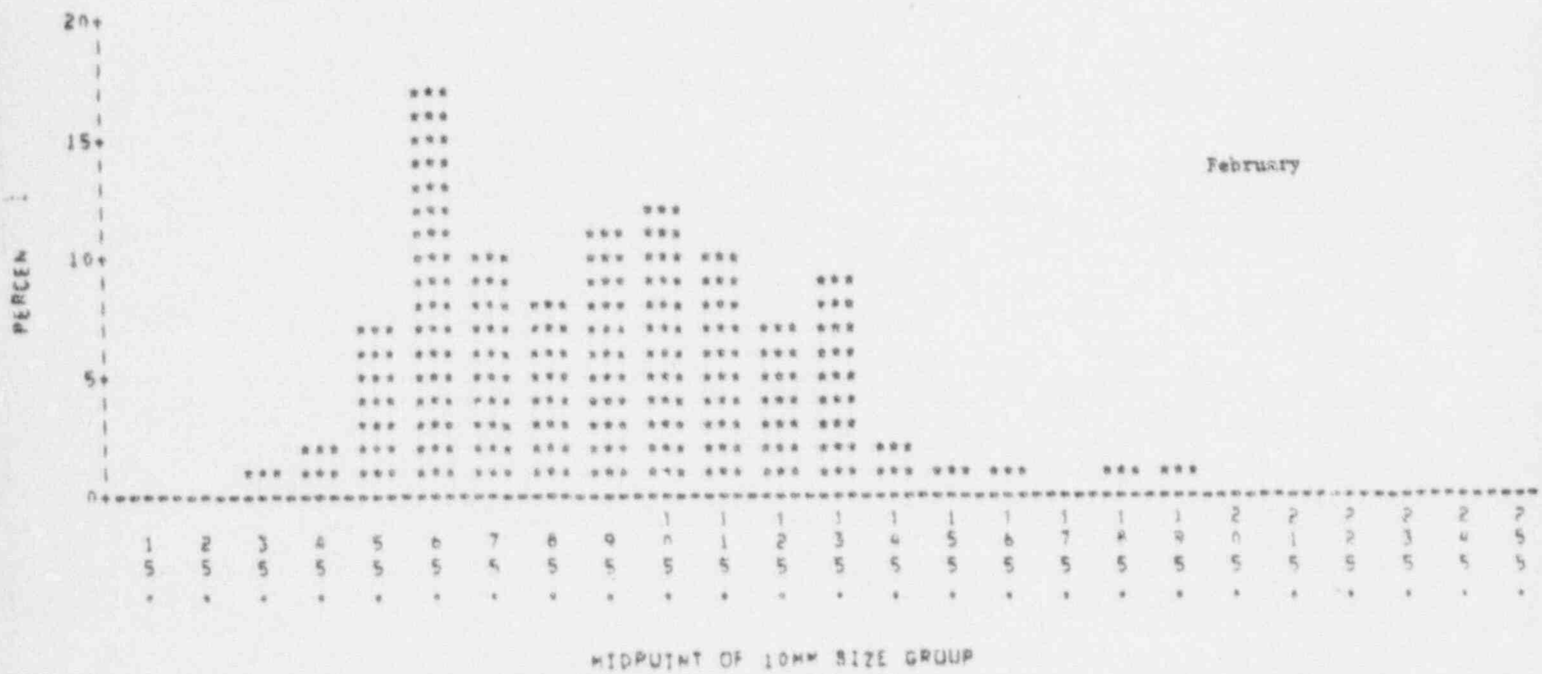

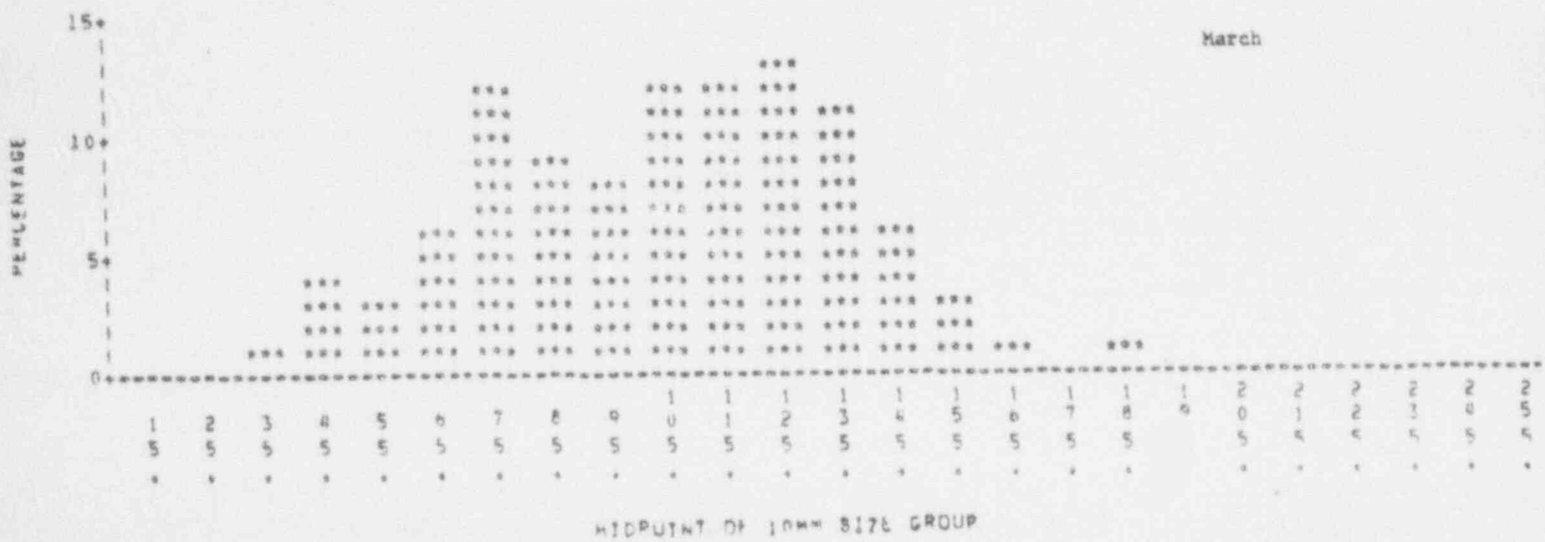

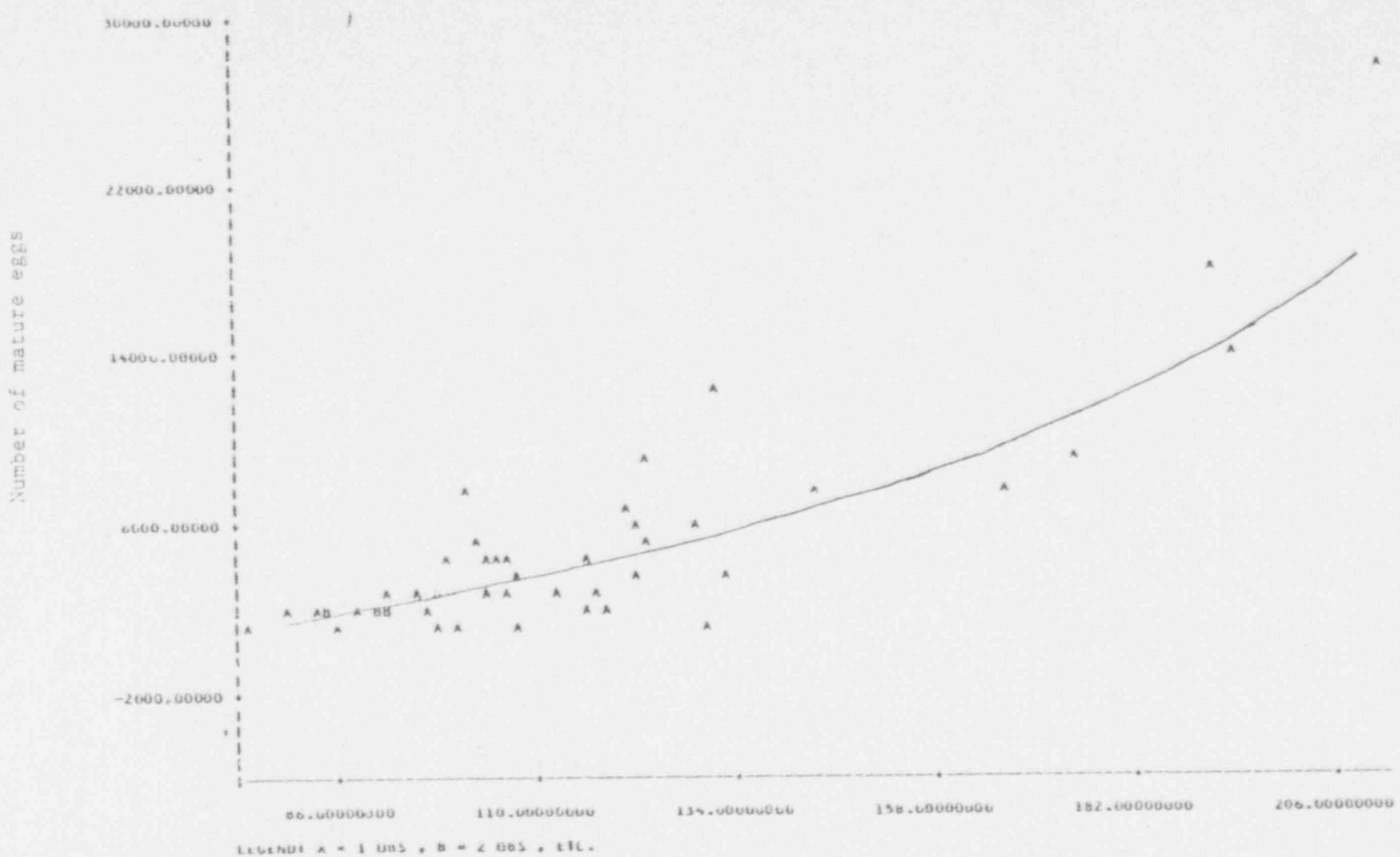

Figure 4.6.1 Relationship of the number of mature eggs and total length of *Lepomis macrochirus* in Robinson Impoundment

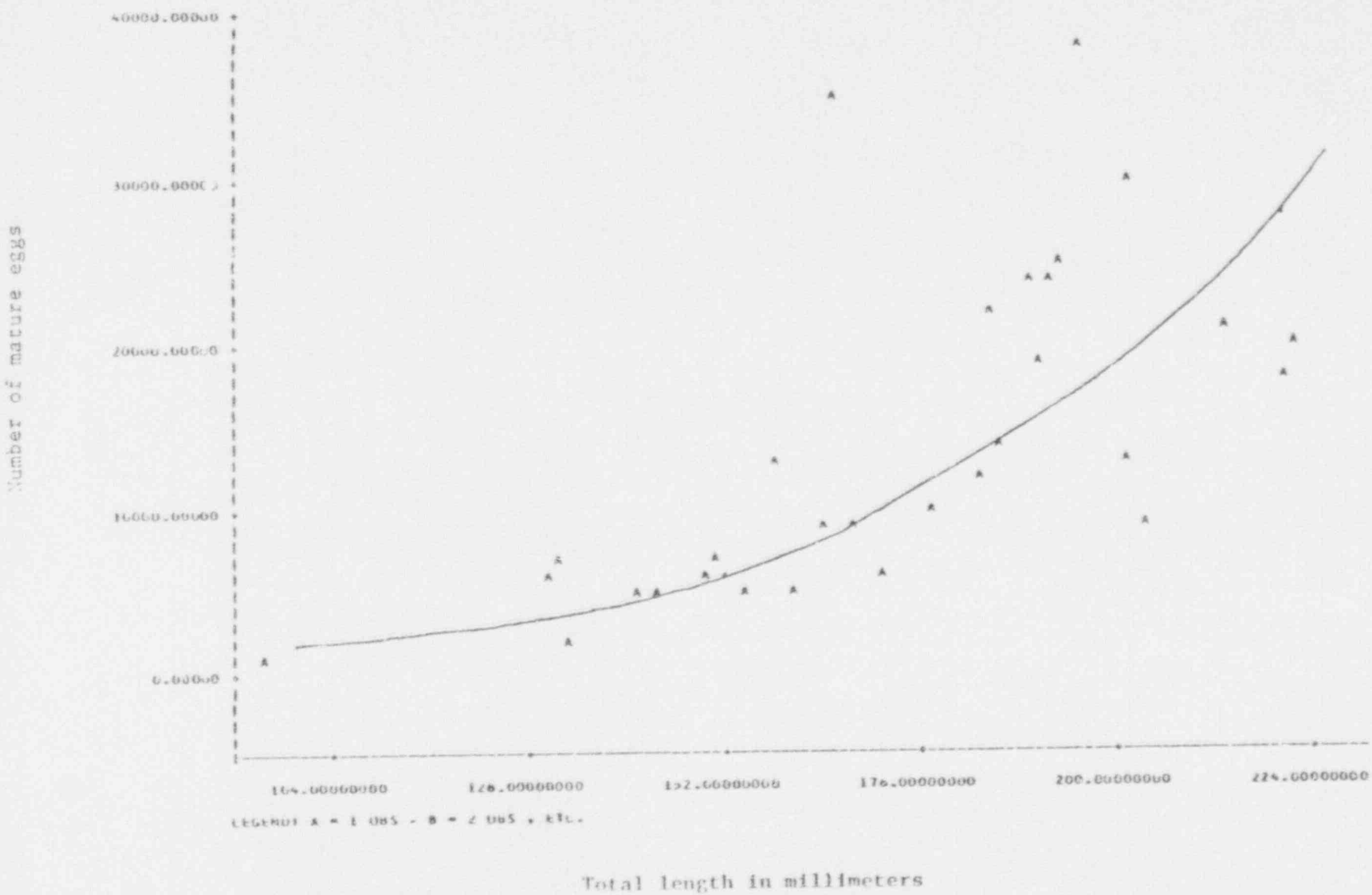

Figure 4.6.2 Relationship of the number of mature eggs and total length of <u>Lepomis gulosus</u> in Robinson Impoundment

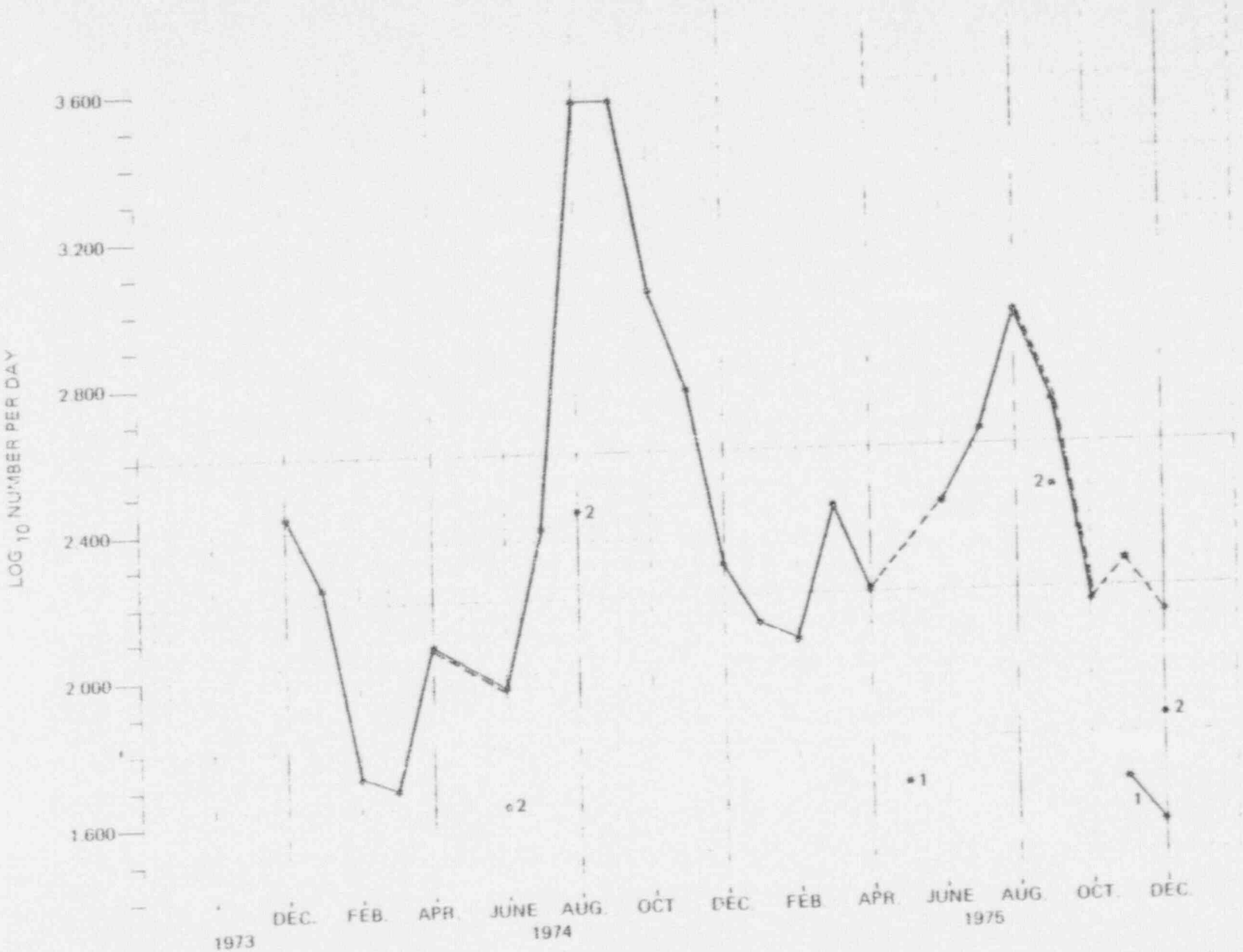

Figure 4.9.1 Fish impingement on Unit 2 intake screens (Log_{10} number per day), December 1973-December 1975. Samples collected with less than three pumps operating are indicated

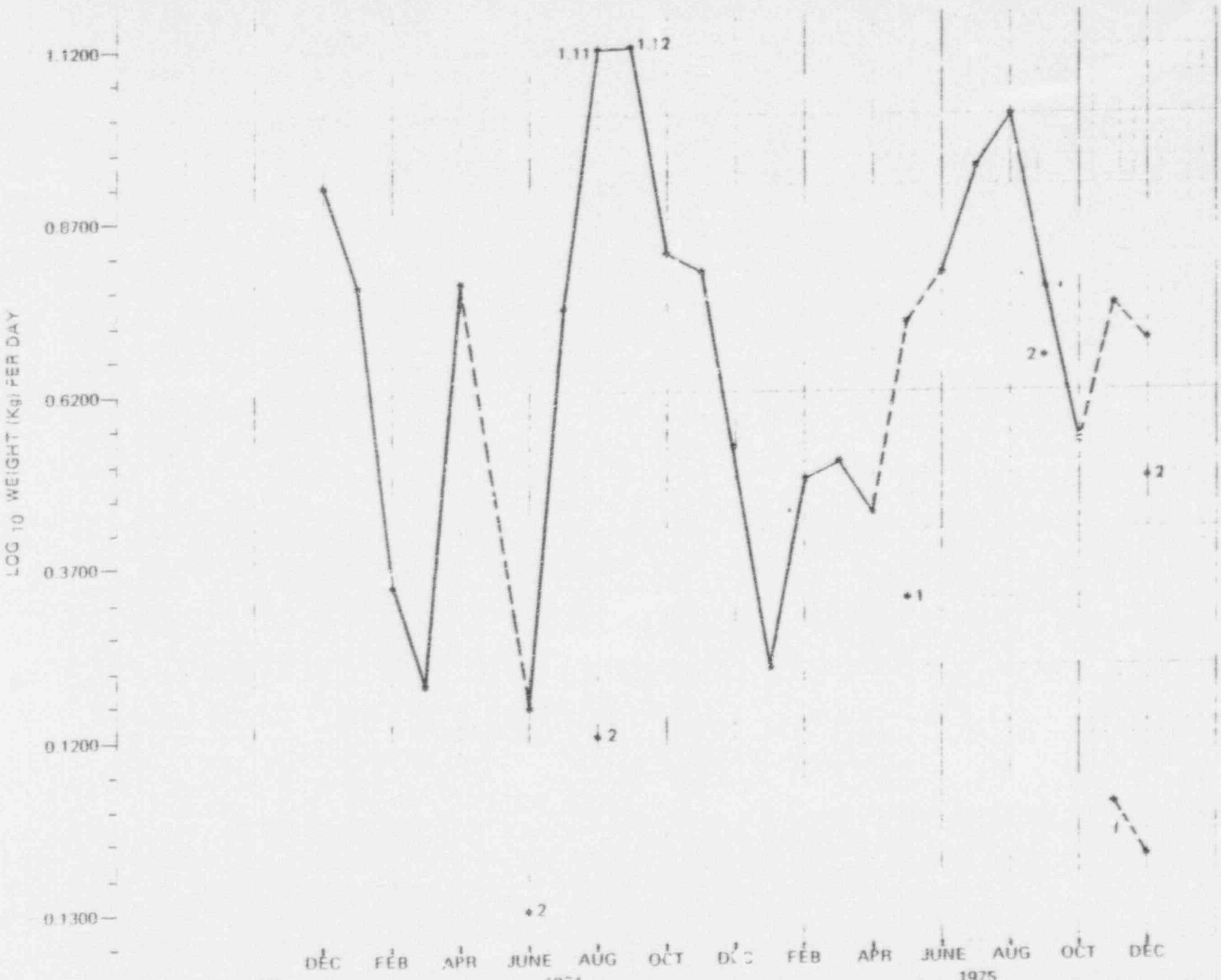

Figure 4.9.2 Fish biomass impinged on Unit 2 intake screens (Log_{10} Kg per day), December 1973-December 1975. Samples collected with less than three pumps operating are indicated

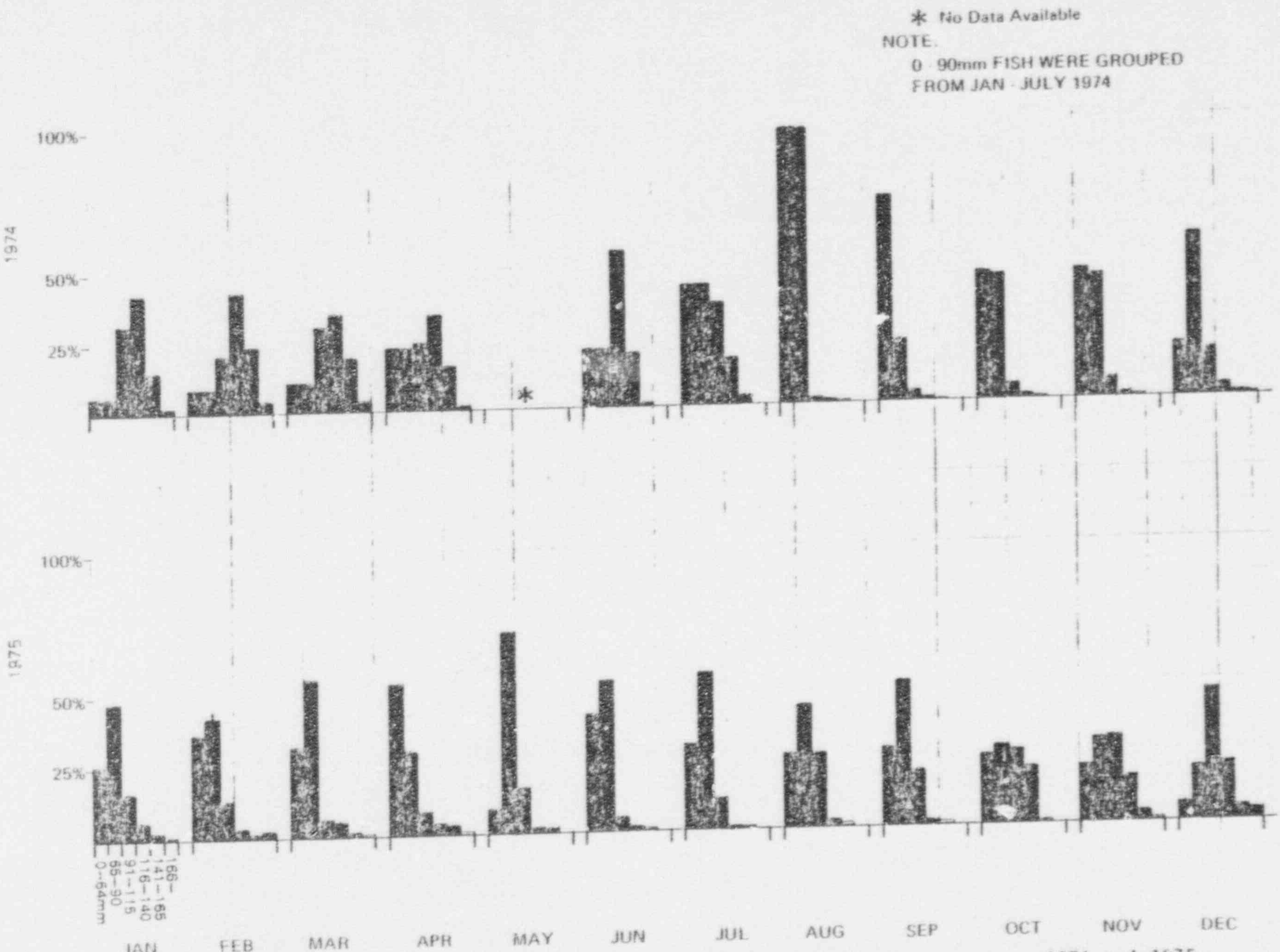

Figure 4.9.3 Size distribution of bluegills impinged on H. B. Robinson intake screens, 1974 and 1975

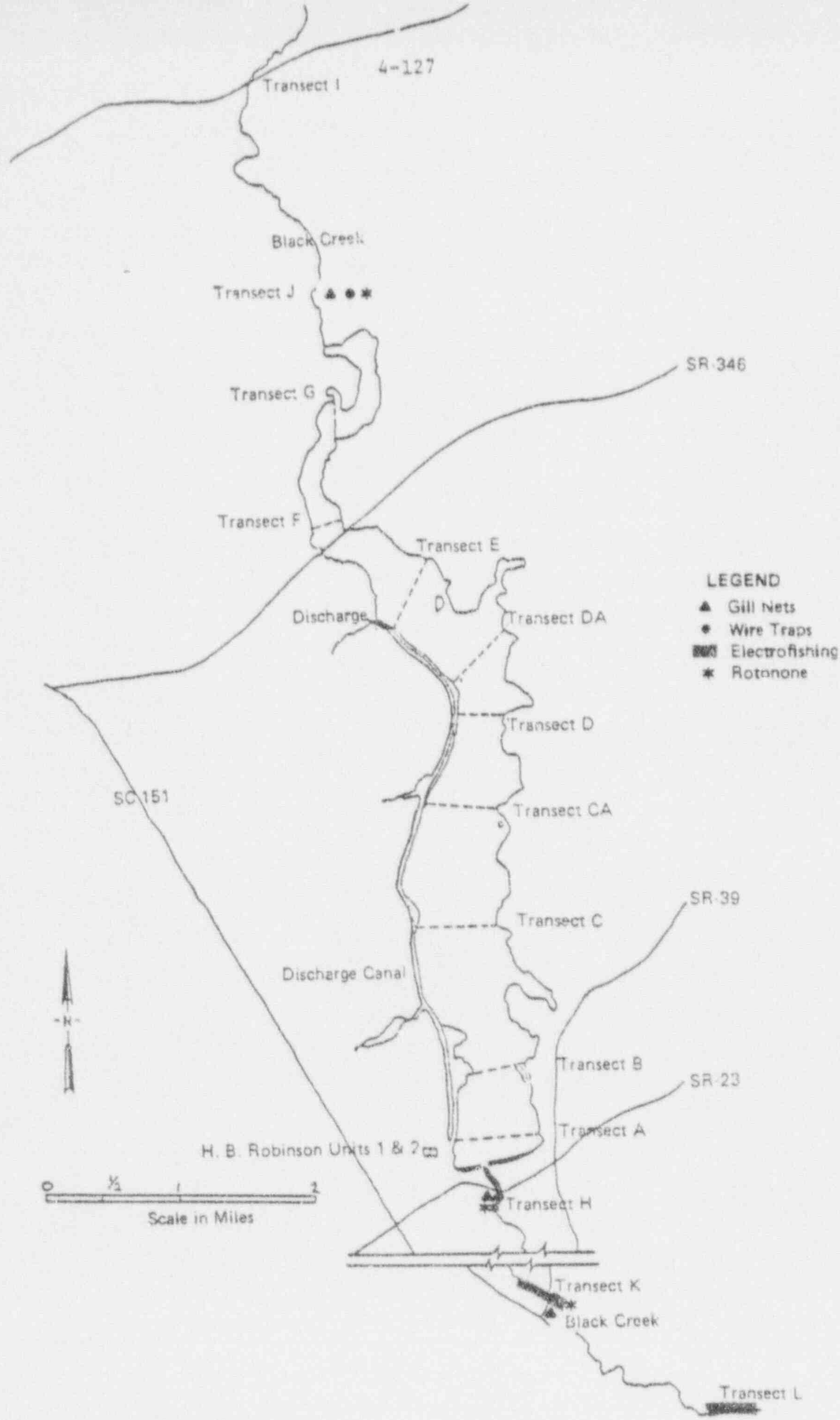

Figure 4.13.1 Map of H. B. Robinson Impoundment and Black Creek illustrating fisheries sampling stations in Black Creek during 1974-1976

5.0 Plankton

5.1 Introduction

The Robinson Impoundment ecosystem is unique in two respects. First, it is an impoundment, with "black-water" (swamp-like) characteristics, as opposed to a natural lacustrine (lake) system. Secondly, it receives physical influences from the operation of a power plant. In attempting to assess the thermal effects on the biota of the Robinson Impoundment, the effects of "black-water" chemical parameters cannot be eliminated. It becomes the task of this work to monitor selected indicator components of the biotic community and to assess the overall "health" of this ecosystem.

The phytoplankton community is the principal primary producer in lacustrine (lake) environments. This community responds rapidly to changes in the environment and can serve as a "pulse" to the ecosystem. Stress, ecosystem stability, and initial energy availability are indicated by structural and functional dynamics of the phytoplankton community. Structure of the phytoplankton community can best be estimated by standing crop data. Standing crop describes species composition, abundance, and biomass at the time of sampling. Function is expressed by primary production rates as carbon fixation for a short period of time under the conditions present at that time. Chlorophyll can offer rough estimates of the phytoplankton community in the absence of standing crop and primary productivity measurements. Chlorophyll, or pigment analysis, estimates the size of the algal community. Moreover, under specific light conditions the chlorophyll within the euphotic zone adapts to nutrients and other limiting factors so that total photosynthesis can also be derived from chlorophyll estimates (Odum, 1963).

An adequate sampling design must include structural and functional determinations which can be separated for initial analysis and later recombined with appropriate data to evaluate the holocoenotic[1] relationships

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[1] holocoenotic principal - an environment (or ecosystem) acts as a whole unit because of lack of barriers to the interaction of its component factors (Billings, 1965).

between environmental factors and organisms. The environmental factors of Robinson Impoundment which are more important to the phytoplankton include the "black-water" chemical factors: low pH, alkalinity, available nutrients, and particulates and water color as they limit light penetration. Also important are the physical factors which result from plant operations such as temperature and current patterns. Plankton studies of the environmental monitoring program concentrated on these environmental factors, as well as the structure and function of the phytoplankton community. The basic sampling design consisted of monthly chlorophyll profiles in addition to quarterly standing crop and primary productivity studies. The design monitored plankton dynamics in three dimensions: by depth, by location (the upper, discharge, and lower areas of the impoundment), and by season.

5.2 Methods

Plankton monitoring began in May, 1973. The initial program was intensified in 1975 by increasing the frequency of productivity measurements for the spring through fall months. Zooplankton horizontal and vertical tows were added to the monthly program in May, 1975.

The sampling program extracted whole water samples from Station A-2 (the lower impoundment), Station E-3 (the discharge), and Point Station G (Figure 3.3.1).

The "Van Dorn" type beta bottle water sampler was large enough to allow for subsamples to be taken for pigment analyses, primary productivity, and standing crop whenever scheduling required that more than one analysis be performed. Samples were taken at various depths, dependent upon the Secchi depth; surface, 1/2 Secchi depth, Secchi depth, 2 x Secchi depth (or bottom), and 4 x Secchi depth if depth permitted. There is high correlation between the Secchi disk transparency and transmission of light in a water column (Poole and Atkins, 1929). It has been generally accepted that the Secchi disk disappears at about the level of penetration of five percent of solar radiation, but varies with different environments. Transparency is inversely correlated with both water color and seston (floating matter) content (Vollenweider, 1969). Since the mean Secchi depth for the impoundment was found to be 1 meter (see

Section 5.3, Environmental Factors) in May 1975, the sample depths were changed to surface, 1/2 m, 1 m, 2 m, and 4 m to accommodate primary productivity calculations. Secchi depth, water temperature, and water chemistry samples were taken in conjunction with plankton sampling.

Chlorophyll Analyses

Monthly pigment samples were transferred from the beta bottle to labeled plastic bottles and preserved with magnesium carbonate to prevent further conversion of chlorophyll to phaeopigments. Samples were chilled and stored in the dark prior to filtration. Filtration within twenty-four hours did not appreciably influence chlorophyll results.

Pigment analyses generally followed Strickland and Parsons (1968) and Golterman (1969). Samples were filtered, extracted with acetone, sonified, centrifuged, and extractions were read spectrophotometrically. Acid was added to obtain phaeopigment corrections. Chlorophyll a and phaeopigment calculations followed IBP (International Biological Programme) recommended equations (Golterman, 1969). Chlorophyll a concentrations were plotted with depth and an average concentration for the water column was calculated. Procedural experiments indicated that variability within samples (as replicates) was as great as variability between depth samples. Therefore, it was determined that an average of the depth samples was the best estimate of chlorophyll concentrations for the water column.

Primary Productivity

"In situ" primary productivity was determined by use of the ^{14}C techr .e. Three subsamples, an initial bottle, a zero time control bottle, and a light bottle were taken from the water sampler. The initial bottle was stored on ice in the dark for alkalinity determinations. The zero time control sample was innoculated with 1 μCi (microcurie) ^{14}C - labeled bicarbonate solution and immediately fixed with Lugol's iodine and stored in the dark. The light bottle was innoculated with 1 μCi of ^{14}C, suspended at the depth the sample was taken, and incubated for three hours in the middle of the day.

Time was recorded to the nearest 15-minute interval. Replicate light bottles were hung at the Secchi depth (1 meter). Light bottles were recovered at the end of incubation time, fixed with Lugol's iodine, and stored in the dark to be returned with the zero time bottles to the laboratory for analyses.

The procedures for Carbon-14 assimilation estimates followed Vollenweider (1969) and Taylor (1971). A zero time control was used instead of a dark bottle control (Morris, Yentsch, and Yentsch, 1971). Solar radiation data were obtained from a portable pyrheliograph (Belfort Industries) during the day (24 hours) of sampling. Alkalinity was measured potentiometrically (recommended for low pH, humic waters in Standard Methods, 13th Ed., APHA). Total carbon was estimated from pH-alkalinity relationships with Bachman's tables (Saunders et al. 1962). Oxygen and temperature were measured with equipment previously described (Section 3.2).

In the laboratory samples were vigorously shaken and a 10 ml aliquot filtered on a Whatman 25 mm type HA (0.45 μ pore) millipore filter. The filters were immediately placed in a scintillation vial containing scintillization grade dioxane mixed with Omnifluor (New England Nuclear). These were counted by liquid scintillization by Dr. Don Stanley at North Carolina State University.

Calculations followed those described by Taylor (1971), estimating an integrated mg of carbon fixed/m^2/day for the water column. MgC/m^3/3 hrs was also plotted with depth to estimate a production profile and obtain the depth of maximum productivity (P_{max}).

Standing Crop

Standing crop samples for nannoplankton were also extracted from the beta bottle water sampler, fixed with Lugol's iodine, stored in the dark and returned to the laboratory for analysis. In addition to whole water samples, one hundred liters of surface water were dipped with a ten liter bucket and poured through a standard #20 mesh Wisconsin type plankton net, fixed with Lugol's iodine, and returned for net plankton determinations. A supplemental vertical tow was taken for zooplankton and to check on vertical distribution

of the larger phytoplankton. Both phytoplankton and zooplankton were enumerated from these net samples. Further, in May 1975 a more intensive zooplankton program was initiated to better assess zooplankton composition for comparison with fish stomach contents. Vertical and horizontal tows were taken (30 cm diameter truncated zooplankton net #10 mesh) in the daytime and at night at the three plankton stations. Samples were fixed with buffered formalin and returned for enumeration.

The Sedgwick-Rafter enumeration procedure was used for 1973 and 1974 samples. Utermohl sedimentation was used to process the 1975 samples. Wild M20 and M40 (inverted) phase contrast microscopes were used for identification and enumeration. A Whipple eyepiece micrometer calibrated by stage micrometer was used to estimate cell dimensions incorporated into biomass estimates. Net sample concentrate volumes were adjusted to 50 ml or 100 ml depending upon visible density of the contents. A 10 ml subsample was extracted and settled in a Utermohl sedimentation chamber for at least 24 hours in the dark. Fifty ml subsamples of the 500 ml whole water samples were settled in the same manner. A nested or stratified sampling design was used for phytoplankton enumeration. Nested counts were made as follows:

All organisms were identified and enumerated in three or five (if variability of three field counts were too high) random microscope fields. Means and standard deviations were calculated. Larger organisms and those whose distributions were too variable in the random field counts were enumerated in strip counts. Three random strips were enumerated and the means and standard deviations of counts calculated. The entire Sedgwick-Rafter cell or a 1 cm × 1 cm square of the Utermohl chamber whole cell count was made. The whole cell count was for colonial or filamentous forms, those larger more rare forms, and zooplankton (especially protozoans and rotifers). A pilot sampling study indicated that different depth whole water samples were good replicates for estimating the water column population. Therefore, replicate sampling at each depth was superceded by depth replicates for the water column to obtain a water column population estimate. This greatly increased efficiency of sample enumeration. The whole water depth samples offered reliable estimates of the nannoplankton within the water column.

The net samples were enumerated in the same manner; however, strip counts and whole cell counts were emphasized. Since the Utermohl chamber sample represented 10 to 20 percent of the original sample volume (100 liters), only one chamber was enumerated for each sample. The number of Sedgwick-Rafter cells enumerated for net samples depended upon the enumeration time. Vertical tow samples were qualitative.

The water column phytoplankton population was indicated by a combination of both of these population estimates. Those organisms whose abundance was best estimated by whole water samples were excluded from estimates based on net sample counts and vice versa. As an example, if an organism was enumerated in one whole water sample, the estimate of number per liter may be exaggerated compared to the estimate of number per liter for that organism from the 100 liter net sample. In this case, the net sample estimate would be used as the best population estimate for that organism. A value judgment based on knowledge of the different organisms was required when numerical data did not indicate an obvious choice.

Utermohl sample random fields and .1 cm strips were enumerated at 200X magnification. Identifications were made at 400X or 1000X oil when necessary. The 1 cm x 1 cm (whole cell) count was made at 100X. Conversion factors based on area/volume were applied to each stratified level average count to elicit the estimated number of organisms per liter for each species. Sedgwick-Rafter counts subsampled 1 ml and the same magnifications were used for the counts.

Biomass estimates were calculated from average dimensions of three to ten individuals of each species if at least three were present. Species volumes were multiplied by the number per liter to obtain biomass as ugm/liter (mg/m^3), and from these data a total biomass estimate for the water column was derived.

Organisms were identified to the lowest taxa practical using standard taxonomic keys (see Literature Cited, 5.6). On several occasions live samples were examined to aid identifications. Organisms were illustrated and photomicrographs taken as time allowed.

A combined species list was assembled for the three stations for each quarterly sampling date. These data were analyzed using a PL-1 computer program developed by Copeland and Birkhead (1972), to obtain a Shannon-Weaver index of species diversity by number and by biomass. In addition to the diversity index, a measure of evenness (E), a dimensionless measure indicating the relative numbers of individuals in each species, was applied to these data (Knight, 1973).

5.3 Results and Discussion

Environmental Factors

Recounting several "black-water" characteristics pointed out in Section 3.4, Robinson Impoundment waters are acidic (pH 5.3), display very low alkalinity (<2 as mg/l $CaCO_3$), and are nitrogen and phosphorus poor, but not deplete. In addition, Secchi depth averaged 1 m throughout this study indicating limited light penetration due in part to the highly colored water (Secchi depth at A-2, 1.19 ± 0.28; E-3, 1.07 ± 0.24; G, 1.09 ± 0.31 meters). These environmental factors and their many faceted interactions ultimately affect the biota and could limit primary productivity. Identifying a cause-effect relationship of one environmental factor to one biotic component is unlikely.

The interacting effects of temperature influences on chemical, physical, and biological processes make it especially difficult to determine cause-effect relationships of temperature alone. A change in water temperature will affect an ecosystem at all levels directly and indirectly. It is the overall magnitude of the effects that must be observed. Realizing complexities of these interactions in the dynamic system, factors must be evaluated individually. Table 3.4.1 compares key water chemical parameters for Robinson Impoundment with other area water bodies.

Chlorophyll

Chlorophyll concentrations when plotted with depth revealed no consistent trends. The results of chlorophyll procedural experiments indicated that the best estimate of chlorophyll concentrations for the water column was

an average of the depth sample measurements. Coefficients of variation were calculated for each water column by sampling date and revealed high variability among the depth samples at each station. The highest variabilities were noted at the times of lowest chlorophyll concentration. This would be expected since these were approaching the detection limits for chlorophyll. Average water column concentrations as micrograms of chlorophyll a per liter were calculated for comparison among stations and to observe seasonal trends (Table 5.3.1).

The water column mean chlorophyll a coefficient of variation data revealed that the same degree of variability was displayed among location means throughout the study. This indicated that variation between depth sample measurements may be due to the problems associated with the chlorophyll procedure (i.e., high particulate load prohibited filtration of larger volumes of water, an interference of phaeopigment determinations was occasionally encountered, masking the chlorophyll concentrations, etc). If variation about the means were consistent between locations at one time, this would indicate that elements (whether procedural, environmental, or chemical) producing this variation were constant. Homogeneity of the variances were checked to test whether the water column means could be compared statistically (Sokal and Rohlf, 1969). This revealed that the variances were homogeneous ($\alpha < .05$ comparing A-2 to E-3, $\alpha < .01$ comparing A-2 to G and E-3 to G). Frequency distribution of the monthly means indicated that these were normally distributed. The assumptions for a -test being met, the monthly chlorophyll means were tested to see if these measurements were sample means from the same population.

In comparing locations (Figures 5.3.1 and 5.3.2) it was found that chlorophyll followed the same seasonal patterns at A-2 and E-3, but both were different from G. Concentrations were generally higher in the lower impoundment than in the upper impoundment. A t-test for comparison of sample means over the 31 sample dates indicated no significant difference between chlorophyll concentrations at A-2 and E-3 ($\alpha = .05$) (Dixon and Massey, 1957; Sokal and Rohlf, 1969).

	A-2	E-3	G
Average (31 monthly means)	11.81	12.32	5.87
S.D.	8.34	8.90	5.71
t_s	-0.232		
			3.26
			3.40

Levels of significance for 31 degrees of freedom (df = 31).

$(\alpha = .05)\ -1.697 < t_s > 1.697$

$(\alpha = .01)\ -2.46 < t_s > 2.46$

There were significant differences, however, between A-2 and G and between E-3 and G. Mean chlorophyll concentrations were 49% higher in the lower impoundment and discharge area than in the upper impoundment. There were no significant differences between the annual mean chlorophyll concentrations in the heated discharge area (E-3) and the lower impoundment (A-2). A correlation coefficient of r = .957 was obtained for 1975 data between A-2 and E-3 indicating that seasonal distribution of chlorophyll was highly correlated between these two stations. These data indicate that chlorophyll concentrations were not affected by the elevations of temperatures observed between these two stations. Increased temperatures, dependent upon the ΔT and the time of exposure, may have an initial inhibitory effect on production followed by an accelerated stimulation so that net results may be negligible (Jensen, 1974). Seasonal fluctuations of chlorophyll as demonstrated in Figures 5.3.1 and 5.3.2 indicated that chlorophyll concentrations were highest in September-November and lowest in March-June in the discharge and lower impoundment. Chlorophyll fluctuations at G in the upper impoundment were more erratic, and seasonal trends were not apparent. The observed fluctuations and the absence of a seasonal pattern indicate that this area may support a more fluviatile (of stream origin) population.

Robinson Impoundment chlorophyll concentrations were compared with available literature values (Table 5.3.2). Robinson summer chlorophyll concentrations were higher than those reported by Tilly (1973a), for the four other

South Carolina water bodies. Par Pond is a cooling reservoir in the coastal plain, Clark Hill is a reservoir in the piedmont, Clear Pond is a "black-water" Carolina Bay Lake, and Big Snooks is an oxbow lake all in the Savannah River drainage basin. Robinson Impoundment chlorophyll concentrations fall within the ranges reported for "black-water" acidic waters in North Carolina by Weiss and Kuenzler (1976).

It can be concluded that the same "population" existed in the lower impoundment and at the discharge by (1) comparison of monthly mean chlorophyll concentrations for the respective water columns, and (2) by seasonal patterns. The impoundment concentrations were 49% higher than the upper impoundment (headwaters) concentrations. The net affects of the increase in temperature between A-2 and E-3 were negligible as demonstrated by the chlorophyll concentrations.

Standing Crop

The species lists by sample date were summarized into one list of important species (Table 5.3.3). An important species was defined as any taxa which comprised at least 10% of any water column population on any sampling date by number or biomass. Seasonal distribution and abundance were indicated by importance number. This was calculated as an average of the percent by number and the percent by biomass of the total population represented by each taxa. As an example, if the small coccoid green alga, Nannochloris sp., represented 60% of the total population by number, the contribution to the importance number would be 30. If this species represented less than 10% of the total population biomass, the contribution to the importance number would be considered zero, so that the importance number for this organism on this sampling date would be 30.

Population composition data are summarized in Figures 5.3.3 and 5.3.4. The total population number or biomass comparing A-2, E-3, and G are apportioned into the major groups; Cyanophyta, Chlorophyta, Chrysophyta, and other by percent composition.

Analyses of standing crop data indicated that similar populations of organisms by composition and abundance were observed at A-2 and E-3 on each sampling date. The population at G was generally much smaller by number and biomass and contained a different population by composition. However, the same taxa and major groups were primarily important at all three stations. Chlorophyta (green algae) were the dominant group all year (> 90% at A-2 and E-3, 87% at G by number, > 75% at A-2 and E-3, > 50% at G by biomass). The small coccoid green algae and the desmids were the most abundant organisms throughout the year. Whitford (1958) found in analyzing net plankton samples from several "brown-water" lakes and ponds, that Chrysophyceae were common but never really abundant; the Chlorophyceae were the most abundant and were comprised almost entirely of desmids; that Bacillariophyceae (diatoms) were almost never abundant, and Cyanophyceae were never dominant. Observations of nannoplankton revealed that the coastal plain waters were dominated by small celled species of Chlorococcales and desmids. The Robinson Impoundment phytoplankton would seem to be typical for black-water type areas in the coastal plain.

Diatoms have an upper thermal tolerance of about 30°C (Patrick, 1974) and would be excluded from the community at greater temperatures. The only diatom which contributed significantly to the lower impoundment population was Asterionella which was abundant in May in 1973 and 1975. There are only a few acidophilic (thriving in lower pH waters) diatoms, e.g. Tabellaria, Eunotia, Navicula, Frustulia, and Pinnularia (Patrick, 1974). All of these were observed in low numbers at one time or another in the samples primarily in the upper impoundment. Blue-green algae (Cyanophyta), which are usually selected for by temperatures exceeding 37°C (Patrick, 1974), would never be expected to bloom in low pH water (pH 5-6) where they are uncommon (Brock, 1973).

The associations, seasonal distributions, and abundance of organisms found in Robinson Impoundment agree with those expected in black-water, low pH, low alkalinity waters (Whitford, 1958; Whitford and Schumacher, 1963; Hutchinson, 1967).

Seasonal patterns indicated the greatest number of organisms were present in February and August with the greatest biomass observed in August, November, and February. Lowest numbers and biomass were observed in May and

June. Station G populations were always much less than the impoundment except in May and June, when they were the same. Whitford (1958) indicated that a spring peak was absent from the seasonal totals of his "brown-water" pond observations, but that a small rise in March and April was due to spring desmids. He noticed a distinct drop in June, with a rise to an annual peak in August. This agrees with observations at Robinson Impoundment.

Species diversity data indicated that diversity was low for all three stations. The evenness index which compares the diversity index obtained from enumeration data to the maximum diversity possible for the number of species present is a better comparative index than the actual diversity index. Averaging this measure for all sample dates to compare locations, the following was obtained:

Robinson Impoundment
Average (9 observations)

	Evenness index
A-2	.50 ± .08
E-3	.52 ± .08
G	.42 ± .18

Campbell and Weiss (in preparation), in a survey of North Carolina lakes and impoundments, reported an evenness index (30 observations) of .55 ± .18 for nine lakes which were acidic in quality. A t-test comparing the evenness indices of A-2, E-3, and G revealed no significant differences (α = .05) among the three stations. Species diversity was low, but not different from other water bodies of similar water quality.

Zooplankton standing crop data are summarized in Table 5.3.4. These data indicated that a very few taxa were present throughout the sampling period and were dominated by the small crustaceans, Cladocerans: Eubosmina sp., Diaphanosoma sp., and Copepods: Cyclops spp. (several species), Diaptomus sp., and Nauplii larvae of copepods (unidentified).

Several of the Cyclops were present throughout the year and were usually associated with Eubosmina sp. A Eubosmina sp. maximum was observed in the fall with a spring maximum of Diaphanosoma sp. and Diaptomus sp. observed. Occasionally rotifers were present in low numbers, but these did not contribute greatly to zooplankton standing crop.

The zooplankton population was greatly reduced in August, 1975, at A-2 and E-3. This could have been a result of temperatures exceeding thermal tolerance limits, although no literature on the subject was available. During the July thermal plume monitoring, dead Chaoborus larvae were noted floating in the shallow area north of the discharge. Many dead Chaoborus were also present in the August samples. These were most likely temperature effects.

Primary Productivity

The relationship of primary productivity with depth indicated a decrease in production with depth as would be expected due to the decrease in light penetration. Maximum production (P_{max}) was observed most consistently at the surface, but ranged from surface to 1 meter. Tilly (1973b) found that P_{max} m^{-3} was correlated with temperature at the depth of P_{max} through the year, and that there was a tendency for the warm station to be more productive than the cooler station in surface waters. These same trends were observed at Robinson Impoundment for most measurements. Primary production appears limited to the top 1 meter at Point Station G. The euphotic zone ranged from 2 meters to 4 meters at A-2 and included the entire water column at E-3 (2 meters), for most of the year.

Limiting Factors to Primary Production

The rate of primary production is dependent upon several important factors including the population of organisms present and their physiological "health," available solar energy, available carbon and nutrients, and temperature. The same population of organisms were present at A-2 (the upper impoundment) and E-3 (the discharge) as indicated by chlorophyll and standing crop data. These same data indicated that a smaller population of different composition existed at G in the upper impoundment. Available solar radiation (24 hours)

was constant at all stations for a sampling date. The actual Langley per hour of incubation was slightly different due to the different times of incubation (Table 5.3.5). Available carbon may or may not be constant and will vary for each sampling date at each station, and available nutrients must be analyzed on a case by case basis. Temperature is the principal variable which is always different among the three stations (Figure 5.3.5). The relationship of available carbon, available nutrients, and temperature to primary production will each be discussed.

Available Carbon

Available carbon is dependent upon pH. Alkalinity, pH, and temperature can be used to estimate carbon availability as stable inorganic carbon from relationships summarized by Saunders et al. (1962). The total available carbon is the sum of the carbon as dissolved carbon dioxide, carbonic acid, bicarbonate ions, and carbonate ions. The dissociation of carbon in water as pH increases from 1 to 12 progresses from dissolved CO_2 and carbonic acid (H_2CO_3) where CO_2 can be liberated to the atmosphere (depending upon the temperature-partial pressure relationship), to bicarbonate (HCO_3^-) to carbonate ($CO_3^=$). At pH levels below 6, carbon is in the form of carbonic acid or free CO_2, so that alkalinity as mg$CaCO_3$ would be low. The question of carbon as a limiting factor in low alkalinity situations has not yet been resolved. Tilly (1973a) questioned whether carbon could be limiting in alkalinity concentrations (0.9 as mg/ℓ $CaCO_3$) observed at Clear Pond a Carolina Bay Lake in South Carolina. However, Schindler et al. (1972) found that atmospheric carbon dioxide may invade waters of low alkalinity in sufficient supply to permit eutrophication if enough phosphorus and nitrogen were available. In Robinson Impoundment this question remains unanswered. Carbon availability was considered as a possible limiting factor to primary productivity. Alkalinity measurements were averaged for the water column. Measurements of alkalinity at very low levels produce variations which are more pronounced. A study of alkalinity measurements within samples and among the depth samples for each location revealed high variability at both levels. It was determined that the best estimate of carbon availability for the water column would be an average of the depth samples. These values are presented in Table 5.3.6.

To test whether the alkalinity measurements observed at the three stations over the sampling period were homogeneous, a t-test comparing overall means was applied to these data. There were no significant (α = .05) differences in mean alkalinities among the three stations for the sampling period. This indicated that the low alkali ities observed were homogeneous within the impoundment. However, if on one sam..ing date alkalinity was significantly reduced in the water column of one station compared to another station, the primary productivity could b appreciably reduced as a result. Examination of Table 5.3.6 indicated that alkalinity measurements on several sample dates warrant comparison by location (i.e., March 6, 1975 and September 25, 1975).

A t-test comparison of means of individuals depth measurements indicated that alkalinities at A-2 and E-3 were significantly different (α = .05) for both of these months. Alkalinity was 39.6% lower at E-3 than at A-2 on March 6, 1975 and 57.7% lower at E-3 than A-2 on September 25, 1975. These differences could produce proportional reductions in primary productivity independent of any other variables. Primary productivity at E-3 was 55% less than A-2 on March 6, 1975 and 77% less on September 25, 1975.

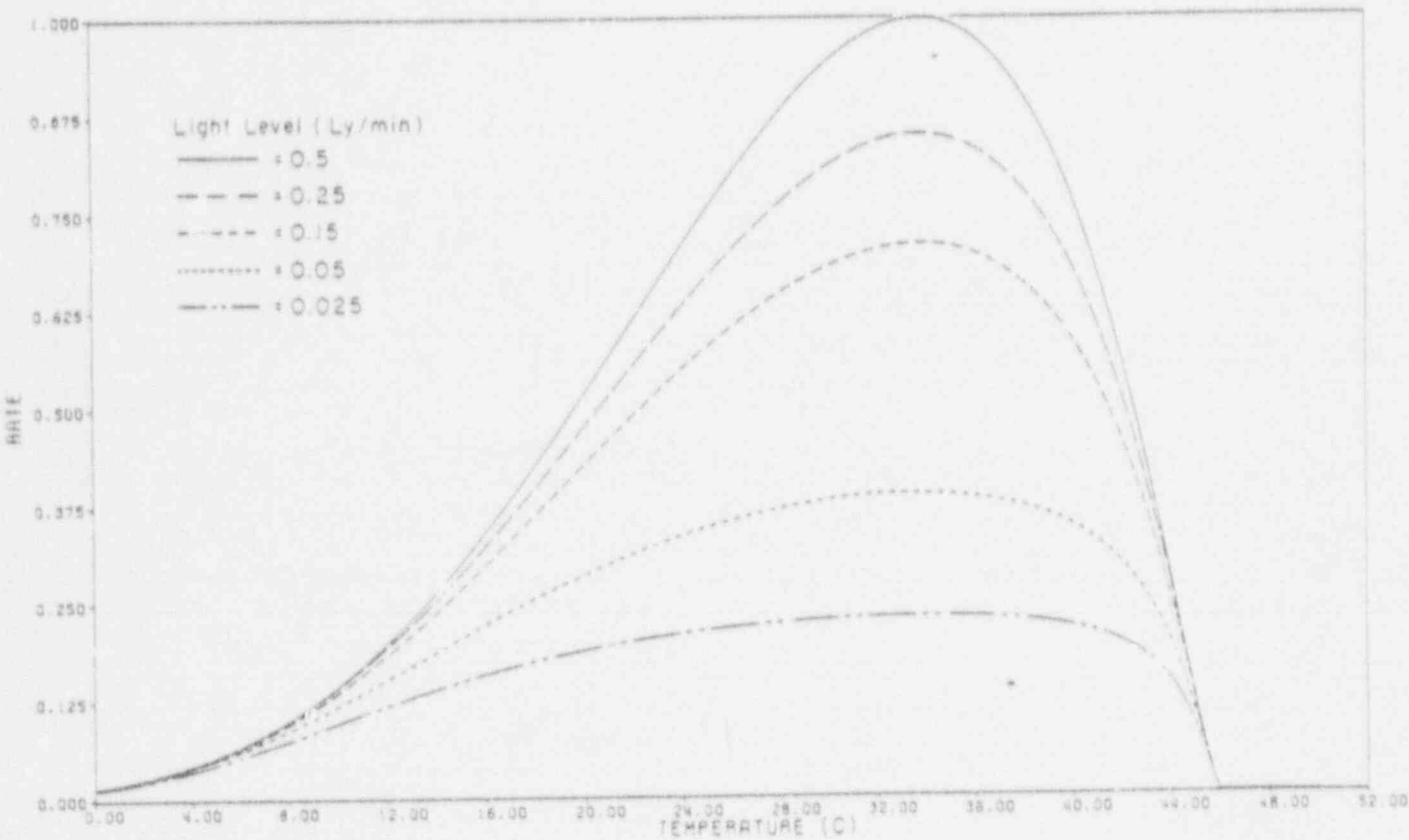
Available Nutrients

Total nitrate (N) was plotted with total phosphate (P) in Figures 5.3.6 and 5.3.7 to indicate seasonal availability of relative concentrations of these nutrients. The nitrate to phosphate ratio indicates which of these nutrients is most likely limiting to production. This ratio is high (> 30) for .binson Impoundment and is extremely variable from month to month. In most instances the phosphate levels would limit production if other limiting factors were not influencing production rates. Overall, nutrient levels do not appear deficient. The highest concentrations of nitrates were observed in July and August with a secondary peak in the winter. Lowest concentrations were observed in April and May. Phosphates were low and less variable than nitrates. When nitrates were observed in higher concentrations and the phytoplankton data indicated an increase in abundance, the phosphates were depleted. In these instances phosphates would limit further phytoplankton population increases. Data also indicated that nitrates decreased drastically following a phytoplankton pulse which would be expected. The availability of these nutrients definitely

influence the potential productivity of the Robinson Impoundment. Polisini et al. (1970) found, in studying a pond with low pH and total alkalinity on the Savannah River Plant site, that a nutrient combination limited productivity in this pond and that the community was adapted to low concentrations of nutrients. The nutrients which were found to influence primary production rates were nitrate, phosphate, sulfate, calcium, and potassium. These nutrients would also be expected to influence productivity in Robinson Impoundment.

Temperature

Rate of primary production has been shown to vary according to temperature and light intensity by a predictable relationship. The exact response of the endemic community present at any time would vary and should be determined by incubation experiments for each case. Jensen (1974), working on Lake Norman, North Carolina, found the relationship graphed below, to hold for incubation experiments.



Relative rate of primary production vs. temperature at different light intensities.

(from Jensen, 1974)

His equation from which this model was derived for the change in production rate resulting from a temperature elevation from T_1 to T_2 was tested with four months data for primary production at the Robinson Impoundment. His regression analysis results for constants and temperature bounds were borrowed in the absence of such data for Robinson. Temperatures and production rates measured at A-2 were used to predict production rates at E-3 (the discharge area) for the measured increases in temperature. Production rates actually measured at E-3 were compared to those predicted:

Temperatures (°C)			Production Rates ($mgC/m^2/day$)			Solar Radiation Langleys/Min.	
Date	T_1 (A-2)	T_2 (E-3)	P_{T_1} (A-2)	Predicted (P_{T_2})	E-3 (Actually Measured)	L_1 (A-2)	L_2 (E-3)
11-11-75	22	24	449.68	384.19	262.49	.6278	.7667
12-12-74	13	22	320.00	776.02	444.00	.2151	.2212
8-6-75	29.2	39.6	501.46	332.61	212.35	.7864	.9400
8-7-74	29.5	38.5	3110.63	2875.40	2956.26	1.0075	.9399

T_1 = temperature measured at A-2
T_2 = temperature measured at E-3
P_{T_1} = production rate actually measured at A-2
P_{T_2} = predicted production rate at temperature (T_2)
L_1 = solar radiation for incubation period at A-2
L_2 = solar radiation for incubation period at E-3

A correlation coefficient of .907 was obtained by comparing predicted versus actual measurements. Although sample sizes were small, our data appear to fit Jensen's model. This equation could be used as a predictive tool or as a check on temperature effects alone upon primary production. Differences between actual predicted versus measured rates could be due to slight differences in water quality, light, the numbers of kinds or organisms present, and "health" effects of condenser passage upon the phytoplankton organisms, or sample variance. Jensen (1974) indicates "a temperature optimum of about 32°C (90°F)," and that these curves resemble plots of algal photosynthesis reported in the

literature. From the foregoing discussion, it can be deduced that increases in temperature (with light constant) will produce an increase in production rate until temperatures approach approximately 32°C (this temperature may be higher in a lower latitude lake than Lake Norman, N. C.) where further temperature increases result in reduction of primary productivity.

Primary Productivity Comparisons by Location

Integrated primary production rates for the water column at each location as milligrams of carbon fixed per square meter per day ($mgC/m^2/day$) can be found in Table 5.3.7.

Productivity data for 1973-1974 were compared by location. These data were then compared with 1975 data. Results indicated that there was no significant difference between the mean of six measurements for the 1973-1974 data at A-2 and E-3 using a t-test (α = .05). Productivity was 97% lower at C than the rest of the impoundment. In 1975 there was a significant difference between A-2 and E-3, E-3 productivity was reduced by 56%. A and G values were significantly different but E and G were not in 1975. Comparing productivity means for A-2 (1973-74) to A-2 (1975), there was no significant difference (α = .05) with the t-test. There was, however, a significant difference between E-3 (1973-74) and E-3 (1975) production rates (α = .01). No significant difference was indicated comparing G (1973-74) to G (1975) productivity data (Dixon and Massey, 1975; Sokal and Rohlf, 1969). These changes, a 56% reduction comparing A-2 to E-3 in 1975, and a 1973-74 to 1975 reduction of 77% in the primary production rate at E-3 could result from differences in the algal population, differences in carbon availability, differences in nutrients, temperature effects, or some other stress producing agent.

Seasonal Patterns

Seasonal patterns at A-2 and E-3 in 1973-74 were the same. The normal seasonal pattern seemed to indicate a January to February peak, with a secondary peak in late summer; the low occurs in June. In 1974 there was a significant peak in August. This appeared to be due to an increase in alkalinity in the presence of available nutrients. Monthly productivity studies were conducted from spring to fall in 1975 to monitor productivity

more closely; however, the 1974 peak was not repeated. The 1974 August peak appears to be an occasional phenomenon and these data were excluded from the estimation of an annual average for comparison with literature values.

Annual Average Estimated Primary Production for Robinson Impoundment

The annual average was computed by using (1) the two 1973 estimates as a six-month average projected to a yearly average, (2) the 1974 data excluding August, and (3) the quarterly averages of the 1975 data. These estimates were incorporated into a yearly average for the impoundment:

	A-2	E-3	G
1. 1973	371	342	31
2.a. 1974	1156	1115	27
2.b. 1974 (excluding August)	397	473	27
3. 1975	494	230	139
4. Averaging 1, 2b, and 3	421	348	66
	± 64.8	121.6	63.5

5. Averaging A & E from line 4 as the best estimate for the impoundment: 385 $mgC/m^2/day$
6. An impoundment estimate including G data would be 278 $mgC/m^2/day$.
7. An impoundment estimate including all data (1., 2.a., and 3.) would be 434 $mgC/m^2/day$.

Estimate 5. was compared with reported literature values in Table 5.3.8. Robinson primary productivity compares most closely with Par Pond, Aiken, South Carolina (Tilly, 1973a). Wetzel (1969) termed his rates "moderately low" which are similar to the rates observed at Robinson.

It can be concluded that in spite of reductions in productivity at E-3 observed in 1975, the yearly estimated average production rate is comparable with available literature. If increased temperature has a definitive overall effect, it would seem to be increasing phytoplankton primary production in the lower impoundment compared with the upper impoundment.

Population Dynamics

Robinson Impoundment phytoplankton population dynamics information are summarized in Table 5.3.9 and illustrated in Figures 5.3.1 and 5.3.2. The interrelationships among the three indicator parameters of structure and function, 1) phytoplankton standing crop (numbers, biomass, and species diversity), 2) chlorophyll, and 3) primary productivity, indicate community stability.

Assessment of these data offer an overview of phytoplankton population dynamics. Quarterly estimates of primary productivity and standing crop were comparable with chlorophyll values. Chlorophyll then offers a good estimate of phytoplankton standing crop and potential productivity. The assimilation ratio (Odum, 1963) which is production per unit chlorophyll, and production per unit biomass correspond to changes in primary productivity. When environmental parameters effect primary productivity the community efficiency and the energy flow for that time and place are affected. If community composition and total abundance are not changed by these effects the community would be considered stable.

The phytoplankton community in the Robinson Impoundment appears to be adapted to the regime of low alkalinity, fluctuations of available nutrients, and the range of temperatures observed over the sampling period. At temperatures exceeding 32°C for long periods of time a stress upon the population was indicated. Since the population composition and total abundance were not altered as a result of this stress, it can be concluded that the population is stable and can recover from periodic stresses rapidly when conditions return to normal.

Seasonal distributions indicated the population fluctuations correspond to seasonal patterns observed in other coastal plain black-water areas. Population composition of the phytoplankton was similar to those reported in available literature for low pH, low alkalinity waters. However, the diatom and perhaps other Chrysophycean components of the population expected to be present in low numbers may be excluded from the impoundment populations at temperatures above 30°C. These organisms were present but not abundant at Station G in the upper impoundment. Overall, the phytoplankton population

standing crop and primary productivity appears enhanced in the lower impoundment compared with the upper impoundment. The production of the Robinson Impoundment was moderately low. Primary production of the phytoplankton was compared with available literature. These rates were comparable with reported production rates for other water bodies in the area.

5.4 Problem Areas

Carbon may be a limiting factor to primary production in low alkalinity - low pH situations. The variability of alkalinity measurements at such low levels will effect determinations of carbon availability, and ^{14}C primary production measurements. Since these problems were consistent at all three sampling stations, data are comparable. Our data compare well with reported values for water bodies in the same area, so that these estimates would seem reliable. Research into this problem area is beyond the scope of this report.

Copper was reported in algastatic concentrations in the Robinson Impoundment. The toxicity of copper is dependent on several factors (Hutchinson, 1967). Humic substances serve as chelating agents (Patrick and Reimer, 1966). Chelation is a complex formation with metal ions that keeps the element in solution and nontoxic, as compared with the inorganic salts of the metal (Odum, 1971). The dark color associated with "black-waters" comes from the presence of humic substances. Most of the research which determines the toxicity of metals is done with the more toxic inorganic salts of the metal. Toxicity of a metal for a particular alga varies according to the abundance of the alga, temperature, alkalinity, the amount of organic material in the water, and other factors (Palmer, 1962). The safe level of copper for a particular water body must be determined from a 96-hour LC 50 using receiving water and the most sensitive important species in the locality as the test organism as recommended in Water Quality Criteria 1972, Committee on Water Quality Criteria. An algal assay should be conducted to determine levels of copper which would adversely affect the indigenous algal population. This is beyond the scope of this report.

5.5 Summary and Conclusions

Robinson Impoundment phytoplankton population dynamics are indicated by the interrelationships among the three indicator parameters of structure

and function; phytoplankton standing crop (numbers, biomass, and species diversity), chlorophyll, and primary productivity. Stress, ecosystem stability, and initial energy availability can be determined from structural and functional dynamics of the phytoplankton community. Assessment of community structure determines whether the populations are "indigenous" and community stability indicates a "balanced" population.

Analysis of standing crop data indicated that similar populations of organisms by abundance and population composition were observed at A-2 in the lower impoundment and E-3 at the discharge. The population at G in the upper impoundment was generally much smaller by number and biomass and contained a different population by composition. The same taxa and major groups were primarily important at all three stations. The Chlorophyta (green algae) was the dominant group all year and within this group the small coccoid green algae and the desmids were the most abundant. Species diversity was low at all three stations but not different from other water bodies of similar water quality. The associations of organisms, seasonal distributions and abundance of organisms found in Robinson Impoundment agree with those expected in black-water, low ph, low alkalinity waters.

The zooplankton population was dominated by a very few taxa of the Cladocera and Copepoda (small crustaceans). Eubosmina sp. and Cyclops spp. dominate in the fall while Diaphanosoma sp. and Diaptomus sp. were dominant in the spring. The zooplankton population was greatly reduced in August 1975 at the discharge and at A-2 but recovered rapidly in succeeding months. Data were not extensive enough to make a judgment as to whether this population is "balanced and indigenous."

Chlorophyll data were comparable with quarterly estimates of primary productivity and standing crop. Chlorophyll then offers a good estimate of phytoplankton standing crop and potential productivity. The same "population" existed in the lower impoundment and at the discharge by comparison of monthly mean chlorophyll concentrations for the respective water columns and by seasonal patterns. The observed erratic fluctuations in chloroplyll concentrations and other parameters at Point Station G in the upper impoundment, and the absence of a seasonal pattern indicate that this area may support a more fluviatile (of stream origin) population.

The phytoplankton community in the Robinson Impoundment appears to be adapted to the regime of low alkalinity, fluctuations of available nutrients, and the range of temperatures observed over the sampling period. At temperatures exceeding 32°C for long periods of time a stress upon the population was indicated by the redUction of primary productivity at E-3 (the discharge). These effects were reflected in community production efficiency and the energy flow for the summer at the discharge area. However, since the population composition and total abundance were not altered as a result of this stress, it can be concluded that the population is stable and can recover from periodic stresses when conditions are more favorable.

Overall, the phytoplankton population standing crops and primary productivity appears enhanced in the lower impoundment compared with the upper impoundment. Phytoplankton primary productivity of the Robinson Impoundment was moderately low, and measurements were comparable with reported production rates for other water bodies in the area.

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Table 5.3.1 Chlorophyll a estimates (micrograms/liter) as a water column average and the coefficient of variation for this average at Robinson Impoundment from June 1973 to December 1975

Mean water column chlorophyll a concentrations

Date	A-2	C-2	E-3	G
June 7, 1973	5		9	6
July 26, 1973	4		5	5
August 22, 1973	8		12	4
September 25, 1973	13		12	3
October 24, 1973	36		34	5
November 27, 1973	19		19	1
December 19, 1973	8		5	< 1
January 22, 1974	14		25	10
February 13, 1974	19		18	3
March 18, 1974	6	3	3	< 1
April 24, 1974	9	11	11	16
May 21, 1974	12	14	11	21
June 28, 1974	3		3	3
July 11, 1974	8		4	3
August 7, 1974	16		14	3
September 5, 1974	6		17	10
October 16, 1974	15		5	7
November 13, 1974	13		20	3
December 12, 1974	18		16	14
January 8, 1975	5		6	3
February 5, 1975	4		3	1
March 6, 1975	2		3	2
April 2, 1975	6		6	4
May 14, 1975	10		7	4
June 11, 1975	18		7	4
July 2, 1975	8		7	9
August 6, 1975	6		15	21
September 25, 1975	32		34	1
October 14, 1975	26		28	12
November 11, 1975	14		18	< 1
December 9, 1975	3		7	2

Table 5.3.1 (continued)

Chlorophyll concentration coefficients of variation with depth by sample date

Date	A-2	C-2	E-3	G
August 22, 1973	27.42		8.79	42.41
September 26, 1973				
October 24, 1973	7.57		6.97	5.11
November 27, 1973	11.69		12.09	224.11
December 19, 1973	84.12		57.71	0
January 22, 1974	64.12		3.13	41.57
February 13, 1974	23.74		20.66	18.21
March 18, 1974	108.65		99.26	77.57
April 24, 1974	94.77	35.32	70.64	64.38
May 21, 1974	20.31	22.77	0	45.52
June 28, 1974	91.39		200.00	115.30
July 11, 1974	79.33		126.40	115.66
August 7, 1974	9.22		41.17	115.66
September 5, 1974	146.10		141.42	70.82
October 16, 1974	60.08		200.00	173.15
November 13, 1974	48.61		21.77	94.33
December 12, 1974	27.75		58.93	82.43
January 8, 1975	74.26		100.00	108.02
February 5, 1975	69.21		95.25	121.04
March 6, 1975	146.78		30.24	109.43
April 2, 1975	55.41		62.44	19.73
May 14, 1975				
Normal	21.69		40.89	67.61
Sonified	66.66		78.78	34.43
June 11, 1975	26.62		49.64	70.64
July 2, 1975	30.46		38.16	42.47
August 6, 1975	89.64		20.81	6.19
September 25, 1975	20.61		56.22	85.86
October 14, 1975	12.34		15.96	68.42
November 11, 1975	40.87		37.89	200.00
December 9, 1975	149.09		93.32	118.83

Table 5.3.2 Comparison of Robinson Impoundment average summer chlorophyll concentrations with available literature values

Lake Name	Chlorophyll a µg/1 (A-2&E-3)	(G)	ear
Robinson Impoundment, S.C.[1]	7.6	6.2	1973
Robinson Impoundment, S.C.[1]	9.1	2.8	1974
Robinson Impoundment, S.C.[1]	12.8	6.0	1975
Clark Hill, S.C.[2]	6.3		1967
Par Pond, S.C.[2]	2.1		1967
Clear Pond, S.C.[2]	5.3		1967
Big Snooks, S.C.[2]	1.2		1967
"Black-water" acidic water bodies in North Carolina			
Hodgins, Hoke County[3]	7.0		1974
Singleta.y, Bladen County[3]	16.1		1975
Jones , Bladen County[3]	6.1		1975
Jones Lake, Scotland County[3]	20.1		1974
Johns, Scotland County[3]	33.4		1974
Lytches, Scotland County[3]	3.7		1974

[1]Present study

[2]Tilly, 1973

[3]Weiss and Kuenzler, 1976

Table 5.3.3 Seasonal abundance of important phytoplankton species in Robinson Impoundment

	*August 22, 1973			Nov. 27, 1973			Feb. 13, 1974			June 28, 1974			August 7, 1974			December 12, 1974			March 6, 1975			May 12, 1975			August 6, 1975			November 11, 12, '75		
	A	E	C	A	E	C	A	E	C	A	E	C	A	E	C	A	E	C	A	E	C	A	E	C	A	E	C	A	E	C
CYANOPHYTA																														
Chroococcus sp.		6																												
Aphanocapsa delicatissima															25															
Polycystis sp.															23			6												
CHLOROPHYTA																														
Dicellula sp.	12	11																	5	14		14	7							
Chlamydomonas sp.										6												5	8	5			6			
Chalmydomonas patellaria																			23	18										
Chalmydomonas pertyi																					10									
Lobomonas sp.																				5	8									
Loccocomas orbicularis										23	20	5									6									
Gloeocystis gigas																				5										
Nannochloris sp.							9	14	29	34	2-	33	19	13	26	11	11	21	28	15	20	14	17		10	12	12	13	13	43
Dispora crucigenioides									10						5			9	5											
Chlorococcum humicola										6	6	5																		
Chlorella ellipsoida						7																								
Chlorella vulgaris						9	7	10	6												5	12		5						
Ankistrodesmus convolutus																							6							
Ankistrodesmus falcatum				10	9		60	56											6	15										
Tetrastrum heteracanthum														23																
Mougeotia sp.																		6												
Cosmarium sp.				14	9	17																								
Cosmarium biconeatum																									27	19	14	16	16	
Cosmarium contractum var. incrassatum																							9							
Staurastrum spp.	59	60		43	41	31															17									
Staurastrum capitolum									47																					
Staurastrum dejectum														6		19	12													
Strastrum paradoxum var. parvulum																7	9													
Sphaerozosma granulatum																									17	16	5	14	16	
Spondylosium pygmaeum					19	23										14	14													
Bambusina brebissonii																														36
CHRYSOPHYTA																														
Chrysophyceae																														
Dinobryon sp.										10	20																			
Chrysocapsa paludosa													34	24		10	15													
Phaeaster aphanaster							5	6																						
Bacillariophyceae																														
Tabellaria flocculosa			6																											
Asterionella formosa																						8	14							
Eunotia sp.												10						16												
Frustulia sp.			6																											
Frustulia rhomboides			7									19																		
Navicula sp.			9																											
Pinnularia sp.																					11									
OTHER																														
Phacus sp.	8		11			7																								
Peridinium sp.			6																					15						
Peridinium westii			5																											
Cryptomonad (unidentified)													8	7																
Gonyostomum sp.																								9		6				

*Net plankton only

importance number = $\frac{\%\text{ number} + \%\text{ biomass}}{2}$; percent composition of the total number of organisms, or total biomass

important species = any species which comprised $\geq$ 10% of any sample date population by number or biomass

Table 5.3.4 Zooplankton intensive data summary indicating total population numbers as $\#/m^3$ and percent composition by dominant organisms.

	5-12-75			6-10-75			7-1-75			8-5-75		
	A-2	E-3	G	A-2	E-3	G	A-2	E-3	G	A-2†	E-3	G
Total $\#/m^3$	5000	6000	10000	16000	38000	11000	60000	35000	26000	1000	900	12000
Eubosmina sp.	12	36	21	33	27	66	< 1	2	3	16	18	10
Diaphanosoma sp.	19	18	18	46	45	4	97	82	12	3	3	3
Cyclops spp.	27	13	45	7	14	24	1	8	82	76	66	84
Diaptomus sp.	29	20	12	10	11	2	2	7	1	4	10	< 1
Nauplii larvae	5	4	4	6	4	4	1	2	3	1	3	1
Chaoborus	2	–	–	–	–	–	< 1	*	< 1	< 1	**1	2

	9-9-75			10-13-75			11-11-75			12-9-75		
	A-2	E-3	G	A-2	E-3	G	A-2	E-3	G	A-2	E-3	G
Average total $\#/m^3$	13000	15000	41000	10000	43000	53000	13000	19000	30000	7000	19000	3000
Eubosmina sp.	2	8	26	56	53	48	67	75	78	81	65	89
Diaphanosoma sp.	92	84	61	8	8	17	1	1	1	< 1	< 1	0
Cyclops spp.	5	6	12	33	34	34	29	21	21	18	12	5
Diaptomus sp.	< 1	–	< 1	1	1	1	1	1	< 1	< 1	23	0
Nauplii larvae	1	< 1	1	33	3	< 1	3	3	< 1	–	0	2
Chaoborus	< 1	3	< 1	1	2	1	1	< 1	< 1	–	0	–

< 1 observed in sample but comprising less than 1% of the total
– not observed in samples
* Dense floating aggregation of dead Chaoborus noted above E during thermal plume mapping 7-2-75
** Chaoborus in the water column in daytime samples at E, many dead ones present in the sample but not counted
† A-2, 8-5-75, night horizontal and vertical samples combined

NOTE: 1) Estimated total $\#/m^3$ is the average of 4 samples, day and night vertical and horizontal tows rounded off to the nearest 10^3.

2) Importance No. = average of 4 samples: % composition of organisms

Table 5.3.5 Solar radiation (Langleys) for the 24-hour and 3-hour incubation periods for primary production sampling dates for the Robinson Impoundment

Date	24 Hrs.	Transect A Station 2	Transect E Station 3	Point Station G
8-22-73	323	111	146	198
11-27-73	171	75	83	85
2-13-74	575	188	232	227
6-28-74	499	131	111	101
8-7-74	368	181	169	126
12-12-74	93	40	39	39
3-6-75	529	221	226	215
5-14-75	639	236	238	226
6-11-75	396	111	126	129
7-2-75	566	228	[illegible]	206
8-6-75	376	142	169	157
8-19-75	500	208	216	197
9-25-75	178	58	52	44
10-14-75	398	165	188	198
11-11-75	273	113	138	154

Table 5.3.6 Alkalinity and pH from productivity samples as euphotic zone water column averages

	Alkalinity (as mg/l $CaCO_3$)			pH (units)		
Date	A	E	G	A	E	G
8-22-73	4.1	2.6	1.6	5.5	5.7	5.4
11-27-73	3.1	3.3	3.2	6.0	5.9	5.7
Yearly Mean	3.6	3.0	2.4	5.8	5.8	5.6
S.D.	± .7	± .5	± 1.1	± .3	± .1	± .2
C.V.	19.6	16.5	47.1	5.2	2.2	3.2
2-13-74	1.0	0.9	0.3	5.8	5.8	5.1
6-28-74	0.9	1.2	0.8	5.9	5.8	5.7
8-7-74	3.9	4.7	2.1	5.8	5.9	4.9
12-12-74	1.0	1.0	1.0	5.5	5.5	4.7
Yearly Mean	1.7	2.0	1.1	5.8	5.8	5.1
S.D.	± 1.5	± 1.8	± .8	± .2	± .2	± .4
C.V.	86.3	91.9	69.0	3.0	3.0	8.5
3-6-75	1.0	0.4	0.9	5.1	5.0	4.9
5-14-75	0.5	0.4	0.3	5.2	5.1	5.1
6-11-75	0.8	0.9	0.8	6.1	6.0	5.8
7-2-75	0.8	0.9	0.8	6.1	6.0	5.8
8-6-75	1.5	1.2	0.9	5.6	5.4	5.4
8-19-75	0.4	0.5	0.5	5.7	5.2	4.9
9-25-75	0.5	0.3	0.7	5.1	5.1	4.8
10-14-75	0.3	0.4	0.9	5.7	5.4	5.6
11-11-75	0.9	1.1	0.5	5.3	5.4	5.2
Yearly Mean	0.7	0.7	0.7	5.5	5.4	5.3
S.D.	± .4	± .4	± .2	± .4	± .4	± .4
C.V.	53.0	49.4	31.1	7.2	6.9	7.4
Overall mean & standard deviation	1.38	1.32	.96	5.6	5.6	5.3
	± 1.25	± 1.25	± .80	± .34	± .35	± .385
C.V.	90.58	94.70	83.33	6.07	6.25	7.26

Table 5.3.7 Primary productivity data summary indicating integral production for the water column ($mgC/m^2/day$) and P_{max} ($mgC/m^3/hr$) and the depth of maximum production by sample date for the Robinson Impoundment

Date	A-2 P ($mgC/m^2/day$)	P_{max}	depth (meters) of P_{max}	E-3 P ($mgC/m^2/day$)	P_{max}	depth (meters) of P_{max}	G P ($mgC/m^2/day$)	P_{max}	depth (meters) of P_{max}
8-22-73	100	22	1.0	77	24	1.5	7	4	1.0
11-27-73	642	395	sfc	529	306	sfc	54	38	0.5
2-13-74	776	139	1.0	865	316	sfc	1	(.3)	0.5
6-28-74	96	16	sfc	110	27	sfc	78	28	sfc
8-7-74	3111	1036	sfc	2956	1390	sfc	29	9	sfc
12-12-74	320	133	sfc	444	290	sfc	1	(.01)	sfc
3-6-75	838	188	sfc	238	125	sfc	6	3	sfc
5-14-75	325	70	sfc	121	27	sfc	59	26	sfc
6-11-75	89	23	sfc	59	18	sfc	46	21	sfc
7-2-75	577	123	0.5	242	60	1.0	284	127	sfc
8-6-75	502	144	sfc	212	99	sfc	116	74	sfc
8-19-75	205	63	sfc	197	62	0.5	224	145	sfc
9-25-75	272	122	sfc	100	37	sfc	8	2	sfc
10-14-75	609	159	1.0	276	125	sfc	309	602	sfc
11-11-75	450	222	sfc	263	130	sfc	7	36	0.5

Table 5.3.8 Comparison of Robinson Impoundment annual average primary productivity with reported literature values

Water body (type)	Productivity $mgC/m^2/day$	Rank	Author(s)
*Sylvan, Ind.	1564	1	Wetzel, 1966
*Fredriksburg, Denmark	1030	2	Nygaard, 1955
*Fureso, Denmark	750	3	Jonassen & Mathiesen, 1959
Little Crooked Lake, Ind.	608	4	Wetzel, 1969
*Clear Lake, Calif.	438	5	Goldman & Wetzel (1963)
*Walters, Ind.	437	6	Wetzel, 1966
Crooked Lake, Ind.	414	7	Wetzel, 1969
*Par Pond, S. C. (reactor-cooling reservoir)	396	8	Tilly, 1973
Robinson Impoundment (reactor-cooling impoundme[illegible]	385	9	Miller
*Clear [illegible]ond, S. C. (Carolina bay)	285	10	Tilly, 1973
*Clark Hill, S. C. (reservoir)	240	11	Tilly, 1973
*Naknek, Alaska	173	12	Goldman, 1960
*Brooks, Alaska	158	13	Goldman, 1960
*Big Snooks, S. C.	102	14	Tilly, 1973

*from Tilly (1973a)

Table 5.3.9 Phytoplankton population dynamics information

Date		P mgC/m² /day	C chlor a mg/m³	B biomass mg/m³	P/C	P/B	Species diversity bits/cells H̄ by no.	E evenness H̄/H̄ max	S # species	No. #/ml	No. /B
1-22-73	A	99.9	8.3	4	12.1		1.656	.51	26	*.7	
	E	76.5	17.6	95	6.2		1.766	.49	36	*9.8	
	C	12.4	4.2	94	1.7		2.996	.77	50	*4.7	
11-27-73	A	641.8	17.6	8500	36.9	.076				7,750	.91
	E	528.5	21.2	7300	24.9	.072				7,650	1.05
	C	53.7	1.6	1200	33.6	.045				874	.73
!-13-74	A	776.4	19.3	5841	40.2	.133	1.630	.46	35	31,759	5.44
	E	864.6	18.2	7152	47.5	.121	1.508	.40	43	37,076	5.18
	C	.2	2.9	4800	.1	.001	1.333	.32	67	6,194	1.29
i-28-74	A	95.5	3.4	934	28.1	.102	1.236	.34	36	8,862	9.50
	E	109.5	2.8	1932	39.1	.057	1.466	.39	45	9,210	4.77
	C	77.5	2.8	1375	27.7	.056	1.307	.30	74	8,508	6.19
								.55			
1-7-74	A	3110.6	16.0	9310	194.0	.334	2.175	.55	54	24,700	2.65
	E	2956.2	14.3	7770	206.7	.381	2.286	.59	47	27,200	3.50
	C	29.2	2.8	710	10.4	.041	1.452	.46	42	4,050	7.11
12-12-74	A	320.0	18.2	7407	17.6	.043	2.203	.57	47	37,154	5.02
	E	444.0	16.3	7939	27.2	.056	2.136	.57	42	40,540	5.11
	C	.1	13.5	61	< .1	.002	1.884	.48	53	81	1.33
1-6-75	A	837.8	1.7	535	492.8	1.566	1.572	.42	42	16,100	30.09
	E	237.9	3.3	439	72.1	.542	2.118	.56	45	6,450	14.69
	C	5.6	1.6	214	3.5	.026	1.844	.47	50	927	4.33
i-14-75	A	324.7	4.3	1506	75.5	.216	2.065	.56	41	6,710	4.46
	E	121.2	7.0	1407	17.3	.086	2.127	.54	51	7,610	5.41
	C	59.3	10.1	1064	5.9	.056	1.033	.27	47	6,730	6.33
i-11-75	A	89.0	3.8		23.4						
	E	59.2	6.9		8.6						
	C	45.5	18.3		2.5						
7-2-75	A	576.8	8.8		65.6						
	E	242.3	7.3		33.2						
	C	283.6	8.0		35.5						
1-6-75	A	501.5	20.7	6995	24.2	.072	1.930	.50	49	14,300	2.04
	E	212.4	14.6	7139	14.6	.030	2.074	.55	39	9,210	1.29
	C	115.8	6.2	3539	18.7	.033	2.342	.60	51	5,250	1.48
1-25-75	A	272.1	32.4		8.4						
	E	100.2	33.9		3.0						
	C	7.7	1.0		7.7						
10-14-75	A	609.0	25.7		23.7						
	E	275.8	28.4		9.7						
	C	309.2	12.0		25.8						
13-11-75	A	449.7	13.9	7078	32.4	.064	2.061	.56	39	10,400	1.47
	E	262.5	17.8	7909	34.8	.033	2.023	.58	33	11,200	1.42
	C	7.0	.3	2873	23.3	.002	0.769	.39	55	1,010	.35

*Net samples only

P (mg C/m²/day) is integral primary production for the water column as milligrams of carbon assimilated per square meter per day.

C is chlorophyll a averaged for the water column as milligrams per cubic meter (ugm/l).

B total biomass estimate for the water column as milligrams per cubic meter

P/C production per unit chlorophyll is also call.. the assimilation ratio and is an indication of production efficiency for that day under the co..ditions present on that day at each location

P/B production per unit biomass. Margalef (1964) found that P/B was negatively correlated with species diversity and P/B has been used to indicate energy flow or the amount of energy being stored by the cells present for the day measurements took place.

H̄ is a species diversity index computed from standing crop estimates

E or an evenness index compares the computed species diversity index with the maximum diversity possible for the number of species encountered.

S number of species encountered in counts of standing crop samples

No. is the total number of organisms per milliliter estimated for .he water column from standing crop samples

No./B is the number of organisms per unit biomass as a comparative index. This ..mber should actually be multiplied by 10^6 to obtain the tru. #/unit biomass. This indicates the relative sizes of the organisms present for that sample date, the higher the number the smaller the majority of organisms present.

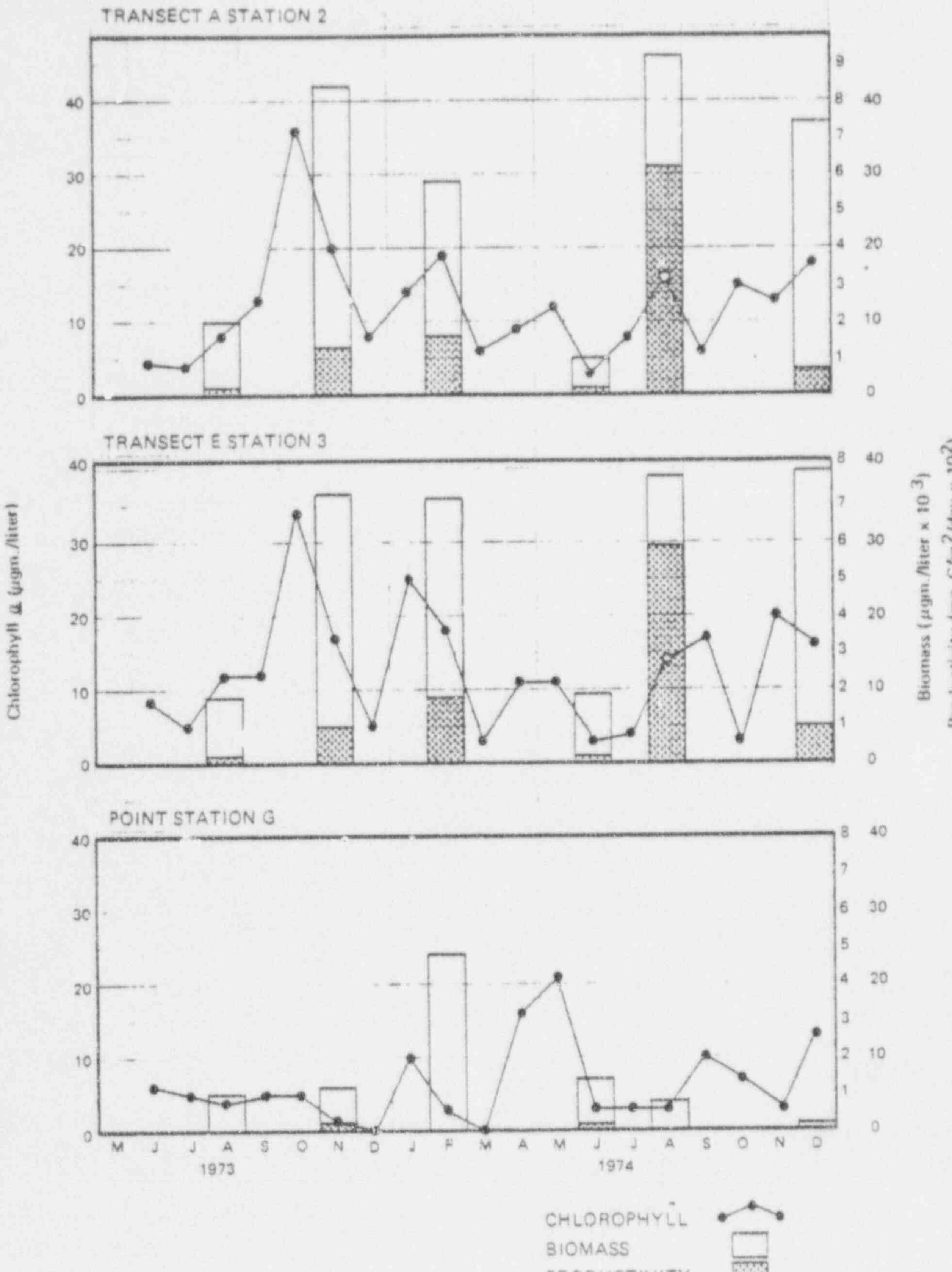

Figure 5.3.1 Chlorophyll, biomass, and primary productivity by month and quarter: Robinson Impoundment, May 1973 - December 1974

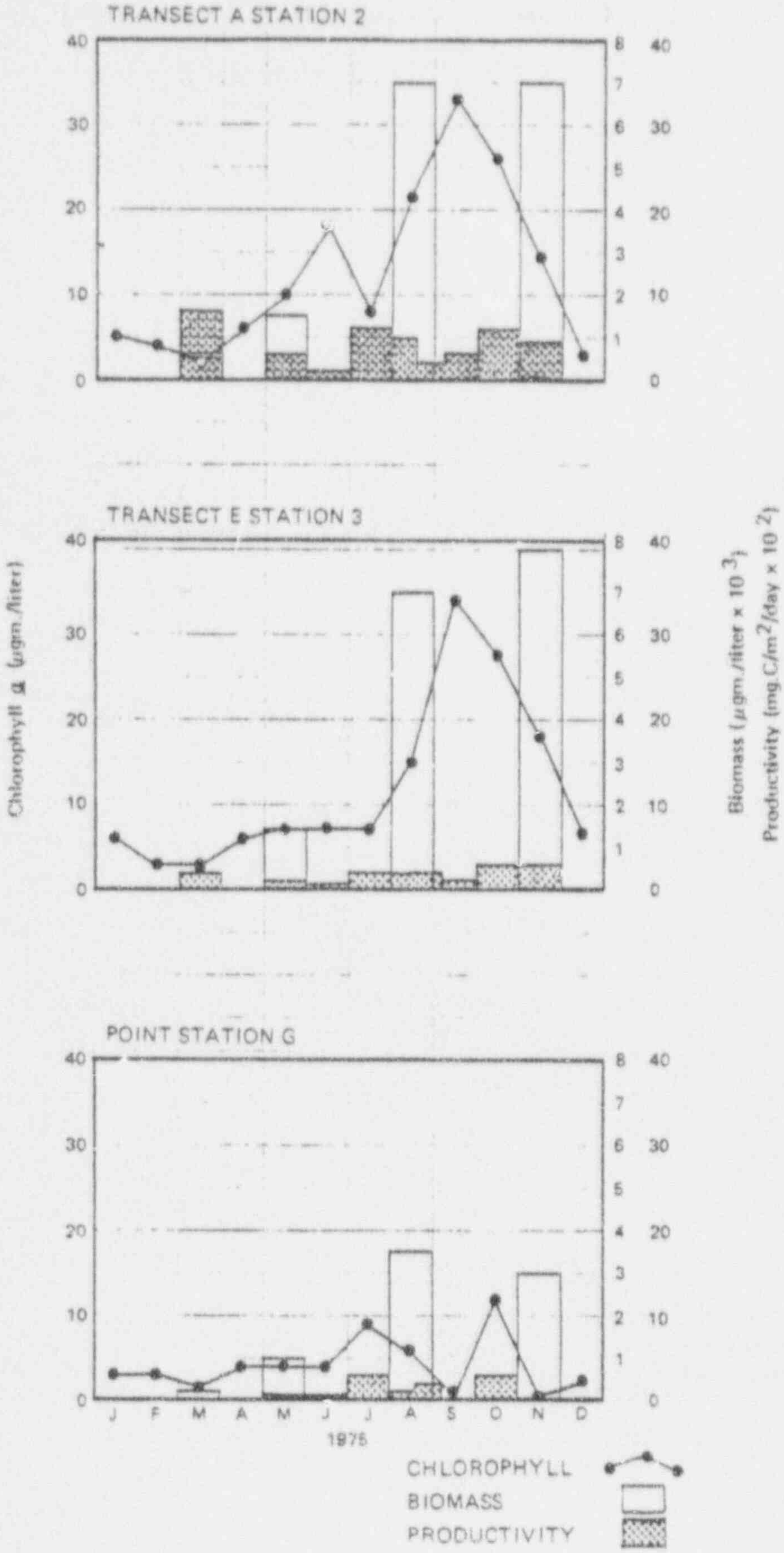

Figure 5.3.2 Chlorophyll, biomass, and primary productivity by month and quarter: Robinson Impoundment, January to December 1975

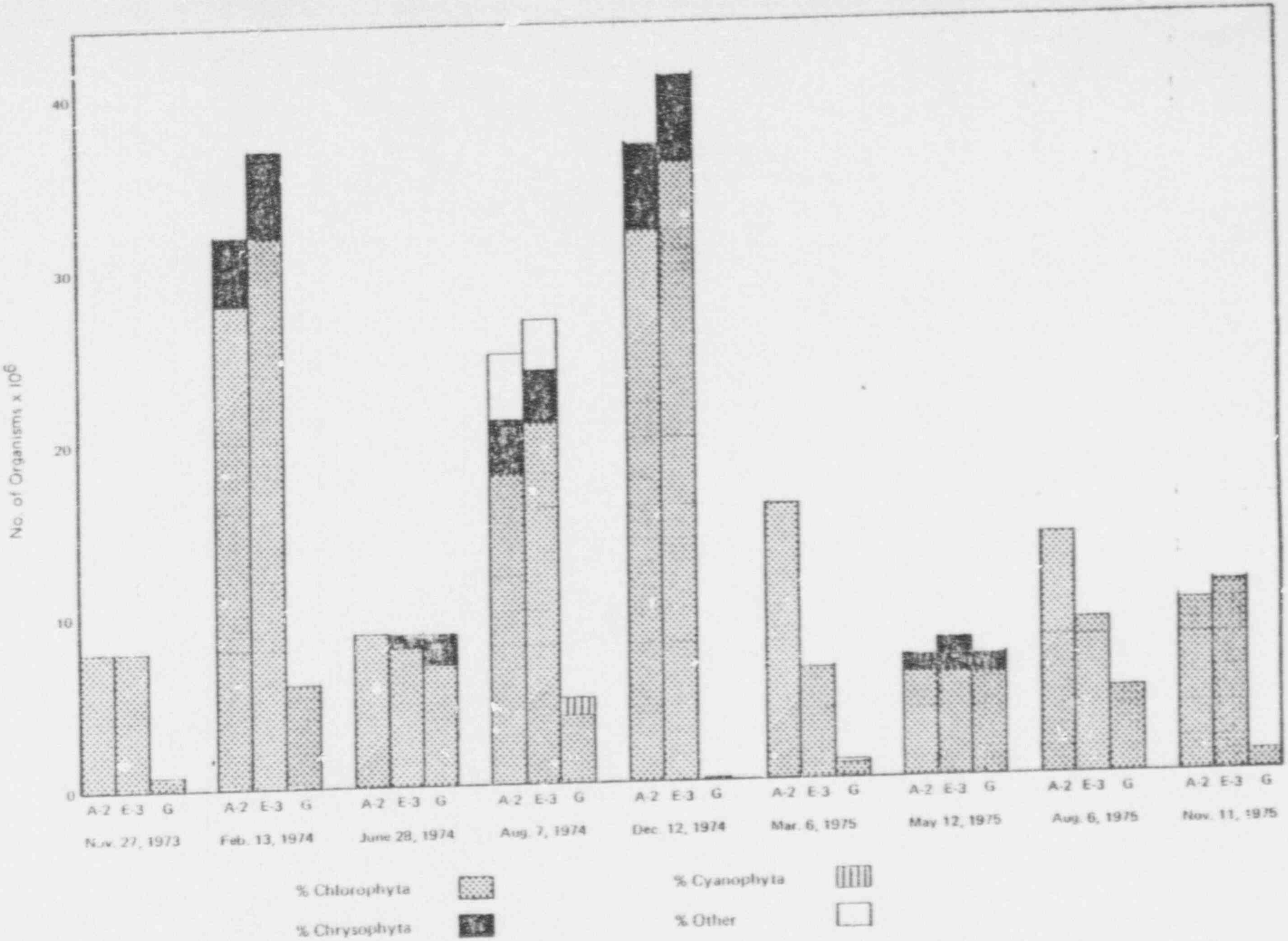

Figure 5.3.3 Phytoplankton population percent composition by number by sample date

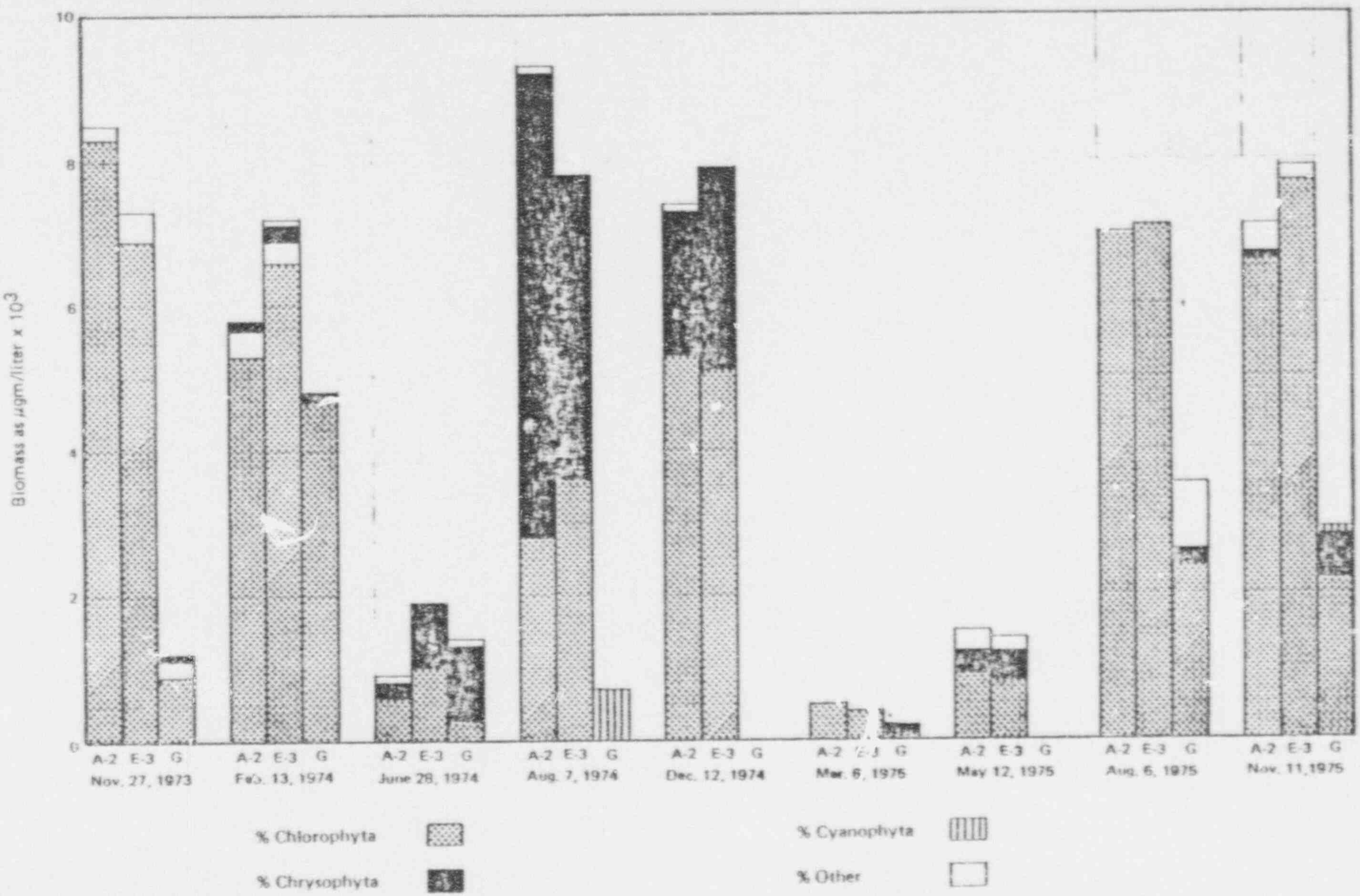

Figure 5.3.4 Phytoplankton population percent composition by biomass by sample date

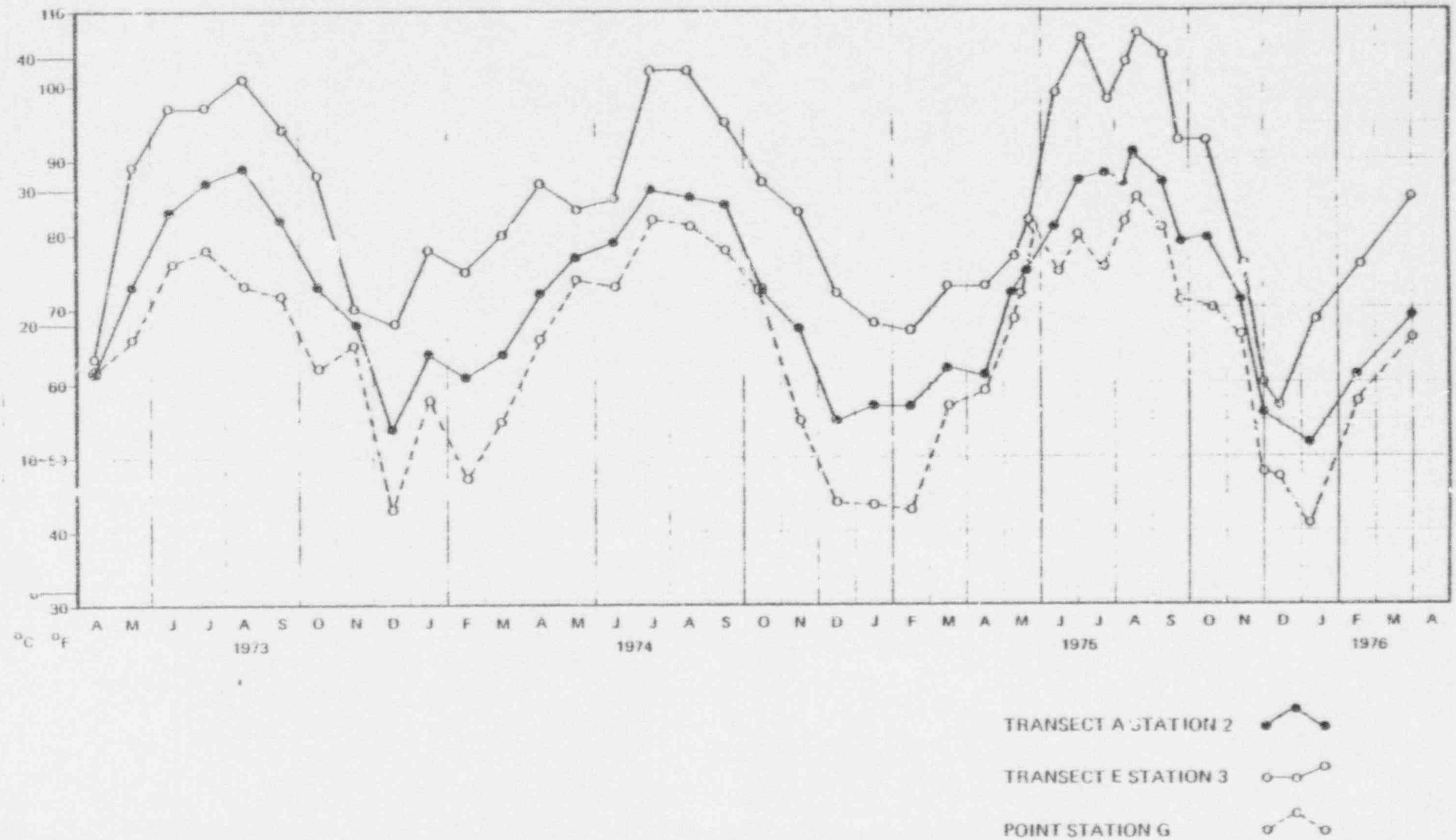

Figure 5.3.5 Average water column (euphotic zone) temperatures for A-2, E-3, and G, Robinson impoundment, April 1973-April 1976

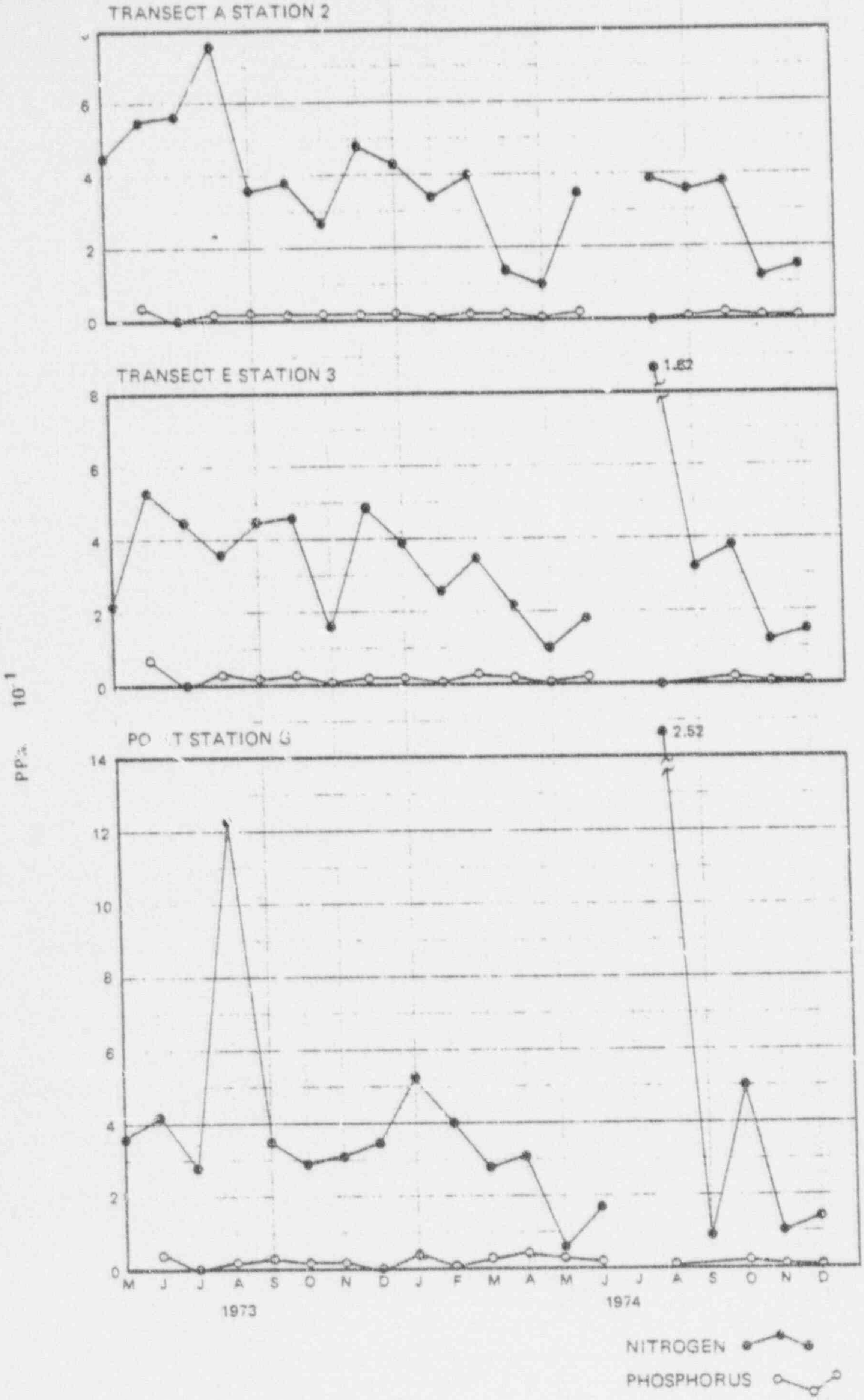

Figure 5.3.6 Total nitrate as N ersus total phosphate as P: Robinson Impoundment, May 1973 to December 1974

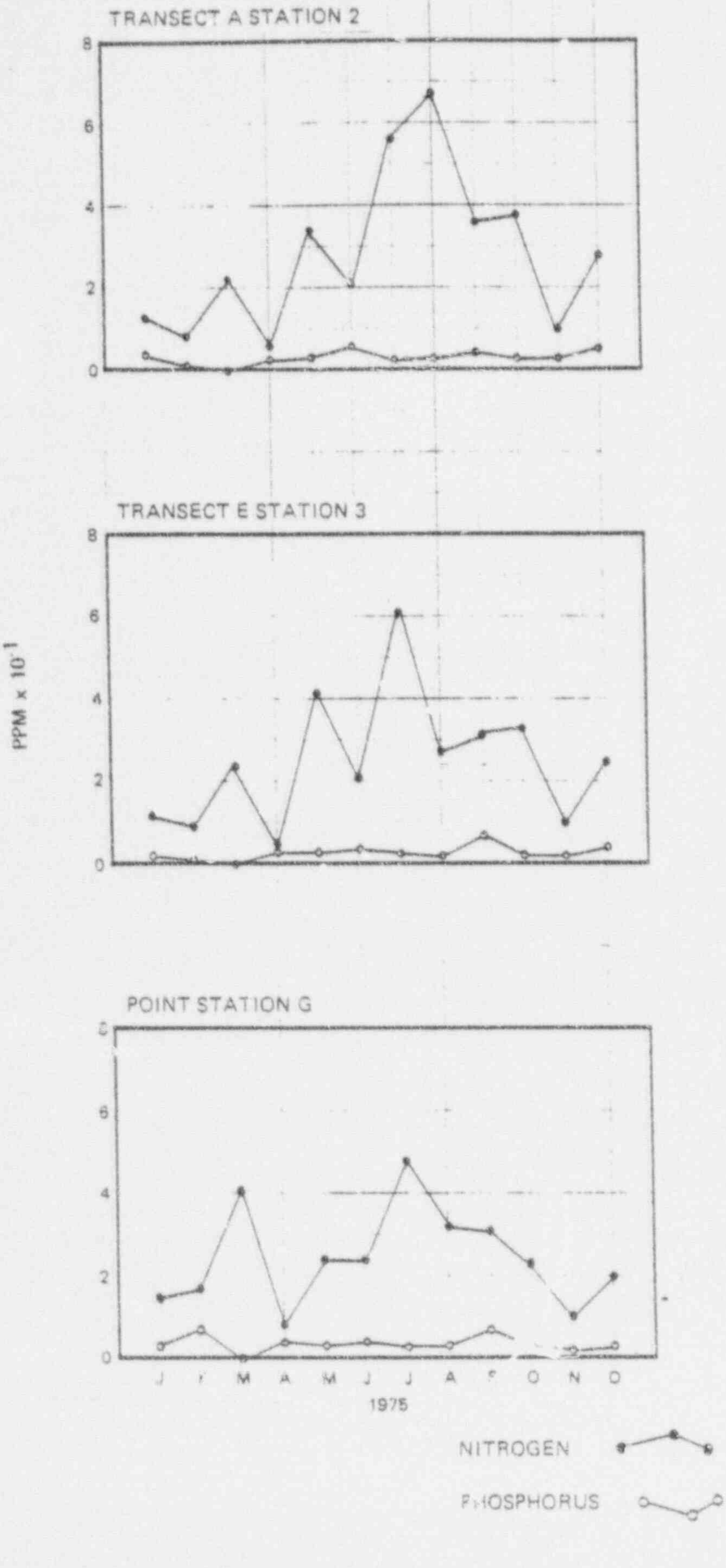

Figure 5.3.7 Total nitrate as N versus total phosphate as P;

6.0 Benthos

6.1 Introduction

Benthic macroinvertebrates are animals living at least part of their life cycle upon or within the available substrate (e.g., bottom sediments, debris, vascular plants, filamentous algae, etc.) in an aquatic environment. Benthic organisms are less mobile than fish and require relatively longer periods to complete the aquatic portion of their life cycle than plankton. Since benthic organisms exhibit limited mobility and relatively long life cycles, they are often slow to recolonize areas subjected to severe environmental perturbations. The specific types and number of benthic organisms present at a site tend to reflect extreme rather than average environmental conditions which have occurred in the recent past. This reflection of extremes enables the benthos to act as detectors of even occasional severe environmental changes. (Garton and Harkins, 1970; Weber, 1973)

The major taxonomic groups comprising a freshwater benthic community may include flatworms, roundworms, annelids, molluscs, crustaceans, and insects. Such a taxonomically diverse benthic community would contain organisms participating in the aquatic food web at several trophic levels (i.e., some groups of benthic organisms are considered herbivores, other omnivores, while still others are carnivores) (Weber, 1973). Assuming organisms in one trophic level may be more sensitive to a particular adverse environmental condition than organisms in some other trophic level, an analysis of the physical "well-being" of the benthic community may yield valuable information concerning the suitability of an area for organisms occupying various levels of the trophic structure.

The purpose of this investigation was (1) to establish spatial and temporal distribution of selected groups of organisms, and (2) to evaluate the effects of the H. B. Robinson Steam Electric Plant effluent on selected portions of the benthic community.

The effects of thermal effluent on benthic communities have not been studied extensively at this time. Many of the studies conducted to date have dealt with rivers rather than lakes, or with lakes receiving organic enrichment, or heavy siltation, etc. in addition to thermal effluent (Weiss et al., 1974).

Since the effects of thermal effluents on systems not complicated by other factors appear to be largely unknown, a comparison of Robinson Impoundment with similar black-water reservoirs is difficult.

Studies on the effects of thermal effluents include a study by Lenat and Weiss (1973) on Lake Wylie located in portions of North and South Carolina. They reported that in the area of thermal discharge the number of littoral organism groups (i.e., taxa) exhibiting population density increases was approximately equal to the number of groups exhibiting population decreases. Thermal effluents also influenced the standing crop of several groups of organisms living in the sublittoral portions of the lake.

From a study conducted on Lake Hyco, North Carolina, Weiss et al. (1974) reported that thermal effects on the littoral benthic community included depression of organism standing crop and diversity in the discharge pool and at a nearby lake station receiving the warm water plume.

As temperature rises above 4°C, water decreases in density. This decrease enables heated effluents to "float" over the colder water usually associated with increased depth. The greatest increases over ambient temperatures, therefore, may occur in the shallower portions of a lake. Benthic organisms inhabiting these shallow areas are often subjected to naturally occurring severe daily and seasonal temperature fluctuations. If benthic organisms in shallow areas can survive these natural fluctuations, the effect of thermal discharge may not be as great as might be expected (Lenat and Weiss, 1973).

Without the benefit of pre-operational benthic data, it was not possible to determine if the observations made during this study adequately reflect the relative numerical abundance, spatial distribution, or species composition of organisms present prior to plant operations. This study may indicate the possible effects of plant effluent on the spatial and temporal distributions of selected benthic macroinvertebrate groups during the recent past.

6.2 Methods

Selected portions of Robinson Impoundment benthic community were sampled monthly from January 1975 through December 1975. This sampling program included collection of three replicate samples at each of two station located on each transect. Six transects were established at intervals along the length of the lake using preimpoundment topographic maps (Figure 3.1.1).

Station locations illustrated in Figure 3.1.1 correspond to benthic sampling stations with the following exceptions: (1) benthic sampling station A-3 was located approximately 50 to 75 meters west of temperature sampling Station A-2, (2) benthic sampling Stations E-1, F-S, and G-S were located in littoral areas east of thermal sampling Stations E-1, F, and G respectively.

Benthic samples were collected with a Petite Ponar Grab which samples an area 15.2 cm x 15.2 cm (6 in x 6 in) and a volume, under optimal conditions, of 2.46 l (150 in^3). Samples were washed on station using a U. S. Standard No. 30 mesh sieve. The sample residue was immediately placed in a plastic container and preserved with 10% formalin solution containing biological stain. In the laboratory each sample was hand sorted; benthic organisms were removed, preserved in 70% ethyl alcohol, and stored to await enumeration and identification. Numbers of organisms were recorded to the lowest practical taxon with the aid of suitable taxonomic references (Ross, 1944; Edmondson, 1944; Parrish, 1968; Klemm, 1972; Brown, 1972; Mason, 1973). The identification of larval Chironomidae required the use of a compound scope and the mounting of organisms using CMC-9 (Master's Chemical Company, 2504 South Harvey Ave., Berwyn, Illinois 60402).

The substrate contained in each benthic grab was subjectively characterized according to content as either silt-detritus or sand-detritus. This subjective description of substrate type as well as the depth of water overlying the substrate were recorded for each benthic grab.

Additional monthly macroinvertebrate collections were made in portions of Black Creek above and below Robinson Impoundment (Stations H, K, and I) and in shallow areas of the impoundment adjacent to Transects E, F, and G using slightly modified multiplate samplers similar to the sampler described by Fullner (1971). Three samplers were placed at each station with the first

sampler suspended at a depth of 0.3 m (0.98 ft) below the surface of the water, the second at the 0.6 m (1.97 ft depth and the third at 0.9 m (2.95 ft). Samplers were set out at each station for approximately one month to allow sufficient time for colonization. Afterwards, the samplers were removed individually with special care being taken to collect all organisms. Benthic macroinvertebrates were removed, preserved, and returned to the laboratory for analysis. Samplers were returned to the water.

Analysis of benthic organisms following identification included computation of mean diversity ($\bar{d}$) using the machine formula presented by Lloyd, Zar, and Karr (1968).

Although the initial study design for this 316 demonstration included determination of benthic biomass estimates of selected taxa collected in the Robinson Impoundment, these estimates could not be made for the following reasons:

1. Dominant taxa were not collected in sufficient numbers from each station to allow the determination of monthly biomass estimates.

2. Organisms representing many of the dominant taxa were mounted prior to identification, thus they were unavailable for biomass estimates.

6.3 Results and Discussion

Although many factors may cause the horizontal variation in the occurrence of benthic macroinvertebrates in Robinson Impoundment, some of the more obvious include substrate, depth, and temperature. In an attempt to reduce the inter-station variation in organism abundance due to differences in either substrate or depth, stations were grouped according to depth and substrate similarities. The following four groups of stations were established and designated as groups I, II, III, and IV.

Group	Station	Depth At Station	Substrate
I	A-1	3 m	sand-detritus
	C-1	3 m	sand-detritus
	E-3	2 m	sand-detritus
II	A-3	10 m	sand-detritus
	C-3	9 m	silt-detritus
	D-1	6 m	silt-detritus
III	D-3	2 m	silt-detritus
	F	3 m	silt-detritus
	G	2.5 m	silt-detritus
IV	E-1	1 m	sand-detritus
	F-S	1 m	sand-detritus
	G-S	1 m	sand-detritus

Since substrates sampled at Station A-3 appeared to contain more sand than substrates collected at Stations C-3 and D-1, the three stations are considered loosely grouped according to depth.

Species Composition

During the one-year study presented in this report, 135 taxa of benthic macroinvertebrates were collected in Robinson Impoundment and portions of Black Creek. The major taxonomic groups, presented in order of decreasing numbers of taxa, include Diptera (60 taxa), Trichoptera (15 taxa), Odonata (12 taxa), Ephemeroptera (10 taxa), Plecoptera (10 taxa), Coleoptera (9 taxa), Annelida (9 taxa), Amphipoda (3 taxa), Lepidoptera (2 taxa), Turbellaria (1 taxon), Nematoda (1 taxon), Hydracarina (1 taxon), Collembola (1 taxon), and Megaloptera (1 taxon). A complete list of taxa is presented in Table 6.3.5. This table also indicates taxa collected at Black Creek Stations H, K, and I.

Groups of organisms represented in this list were collected using one or both sampling methods described above. The two types of samplers

collect qualitatively and quantitatively different faunal samples (Weber, 1973). The observed qualitative differences in faunal samples can be summarized as follows: (1) Petite Ponar samples contained organisms representing 26 taxa which were not collected by substrate samples, (2) substrate samples contained 44 taxa which were not present in ponar samples, and (3) the total number of taxa (91) collected from ponar grabs was less than the total number (109) collected from multiple plate samplers. These differences indicate each of the two samplers collected organisms from slightly different portions of the benthic community present in the study area. The data obtained using ponar grabs, therefore, cannot be easily compared with data obtained from substrate samplers. Since a comparsion will not be attempted, data obtained from grab samplers will be presented in the impoundment portion of this report while data collected from multiplate samplers located at Stations H, I, and K will be presented in the Black Creek section.

The number of taxa collected in a lake study is influenced by the number and type of microhabitats sampled, by the frequency and intensity of sample collection, and by the type of sampler used. It is difficult, therefore, to accurately compare the qualitative and quantitative aspects of total numbers of taxa collected from the Robinson Impoundment with numbers presented in other studies.

6.3.3 Numerically Dominant Organisms

Although a relatively large number of taxa were collected throughout the study period, only a few groups of organisms could be considered numerically important. Arbitrarily defining a numerically important group as one containing >5% of the total organisms, the important taxa include Chironomidae (41% of the total), Oligochaeta (33%), and Culicidae (12%). Combined, these three taxa made up 86% of the total number of organisms collected. Organisms representing taxa not mentioned above were collected in relatively low numbers and were considered uncommon. With the exception of a few genera of Trichoptera and Ephemeroptera, considered important fish food organisms, the spatial and temporal distributions of uncommon taxa were not determined from this study.

Chironomidae

Organisms representing 36 genera of Chironomidae (midges) were taken from ponar samples. The numbers of genera collected in each subfamily include 18 genera of Chironominae, nine Orthocladiinae, and eight Tanypodinae. Chironomus (Chironominae) was the dominant midge representing 7.6 percent of the total number of Chironomidae collected.

The numerical dominance of Chironomus has been reported from other studies. For example, Weiss et al. (1974) reports Chironomus is a common dominant in shallow or eutrophic lakes, especially those with thermocline formation. According to Hilsenhoff and Narf (1968), Chironomus is the most common benthic organism in 14 Wisconsin lakes which have maximum depths of 20-32 feet, relatively large profundal zones, and soft sediments. Although the total number of organisms representing Chironomus indicate it was the numerically dominant midge collected in Robinson Impoundment, this dominance was effectively restricted to the three relatively deep Stations A-3, C-3, and D-1. Figure 6.3.1 illustrates the observed spatial distribution of Chironomus expressed as monthly mean number of organisms per meter^2 collected at each station. Numbers of organisms ranged from a high of 579/m^2 at Station C-3 to a low of 82/m^2 at Station D-1, while at Station A-3 an intermediate value of 222/m^2 was observed. Numbers of organisms collected at the remaining nine stations were comparatively low, ranging from 61/m^2 at Station A-1 to 2/m^2 at Station G.

The abundance presented above clearly indicate that Chironomus preferred the deeper stations. Depth preferences have been reported in published studies including one conducted on Lake Washington by Thut (1969). He reported that numbers of fourth instar Chironomus sp. (nr. ferrugenoerittatus) gradually increased in abundance with increasing depth, finally reaching an abundance peak at 50 meters (16.5 ft). He also observed a peak in the numerical abundance of Chironomus plumosus at 10 meters (33 ft), while at greater depths abundance steadily decreased. A depth preference may explain the relatively higher numbers of organisms collected at Robinson Impoundment Stations A-3, C-3, and D-1 and

the lower numbers collected at the remaining nine benthic stations.

Other environmental factors appear to influence the depth distribution of Chironomus. The influence of these factors was apparent from a comparison of the relative numerical abundance of Chironomus at stations of similar depth. For example, the depth at Station A-1 was comparable to depth at Station C-1, yet monthly mean numbers collected were not similar at these two stations (Figure 6.3.1). This station to station variability may be related to a depth preference coupled with various inter-station changes in environmental factors (e.g. availability of suitable food, microhabitat, temperature or dissolved oxygen concentrations). It is unclear from this study which factor or combination of factors influenced inter-station change in the numerical abundance of Chironomus.

The number of generations per year of Chironomus was not clearly evident from the data collected. A reasonable estimate, however, is one generation per year with an abundance peak in the fall and winter, and decreasing numbers in the spring and summer.

Since relatively large numbers of Chironomus preferred the deeper cooler stations and reached their peak abundance during the colder seasons, it appears that thermal effluents from the H. B. Robinson Plant did not adversely effect the numerical abundance of Chironomus.

In the subfamily Chironominae, other organisms considered common or frequently collected represented the genera Polypedilum (2.4% of the total number of larval chironomids), Cladotanytarsus (2.2%), Cryptochironomus (0.8%), and Harnischia (0.8%). These midges will be discussed in order of numerical abundance.

The results of two studies, one conducted on Lake Wylie by Lenat and Weiss (1973), the other on Belews Lake by Weiss et al. (1974), indicate Polypedilum is a common littoral organism which may favor areas containing organic enrichment According to Lenat and Weiss, this preference for enriched areas, rather than temperatures, may control the occurrence of Polypedilum.

The spatial distribution of Polypedilum in Robinson Impoundment is demonstrated in Figure 6.3.2, which presents the monthly mean number of Polypedilum/m^2 collected at each of the 12 stations. These data indicate higher numbers of organisms were collected at Stations F-S, G-S, C-1, and A-1 (corresponding no/m^2 were 72, 65, 53, and 44, respectively), lower numbers at Stations A-3 (1/m^2), C-3 (none observed), and D-1 (1/m^2) and intermediate values at Stations D-3 (16/m^2), E-1 (23/m^2), E-3 (16/m^2), F (11/m^2), and G (18/m^2). These data indicate that Polypedilum were relatively common at all stations where depth was less than 5 meters (16.5 ft.) and uncommon at the deeper stations. This depth distribution agrees, in part, with the above mentioned published literature.

The spatial distribution of Polypeidlum presented in Figure 6.3.2 clearly indicates that comparable numbers of organisms were collected at several stations previously grouped as having similar substrate and depth. The monthly mean number collected at Station D-1 was comparable, for example, to the numbers collected at Station F and G (Group III). A second group of stations having similar depth and substrate include A-1, C-1, and E-3 (Group I). The monthly mean number of Polypedilum collected at Station A-1 was similar to the number collected at Station C-1; however, abundance was reduced by one-half at Station E-3. Stations E-1, F-S, and G-S (Group IV) were also grouped according to depth and substrate similarities. A comparison of the mean numbers of Polypedilum collected at these three stations indicated abundance was similar at Stations F-S and G-S while the number of organisms collected at Station E-1 were decreased threefold. With the exception of the relatively low numbers of organisms collected at Stations E-1 and E-3, comparable numbers of organisms were collected at all stations grouped as offering similar depths and substrates. Although naturally occurring environmental factors may be responsible for the depressed organism abundance observed at Station E-1 and E-3, this study did not eliminate the possibility that depressed organism abundance was due to a low tolerance to the effects of heated effluents.

Other members of the subfamily Chirononimae include Cladotanytarsus, Harnischia, and Cryptochironomus. The spatial distribution of organisms repre-

senting each taxon is presented in Table 6.3.2 as the monthly mean number of organisms/m^2 collected at each of the twelve benthic sampling stations.

The observed spatial distribution of Cladotanytarsus indicated organisms were either collected in relatively low numbers or were not encountered at the three relatively deep stations (i.e., A-3, C-3, and D-1). These data appear to indicate that Cladotanytarsus preferred the shallower areas of the impoundment. The spatial distribution of Cladotanytarsus also indicated organisms were encountered at all benthic sampling stations with the exception of the deeper stations mentioned above and Station E-1 and E-3 which are located in the discharge area. The absence of Cladotanytarsus in the discharge area may be related to elevated water temperatures (Section 3.3.2) or other environmental factors not apparent from this study.

The data presented in Table 6.3.2 indicate organisms representing Harnischia were collected in relatively higher numbers at Stations D-1, F, F-S, G, and G-S and in lower numbers at the remaining benthic sampling stations. It was not clear from this study what environmental factors influenced the observed station to station variation in organism abundance.

Cryptochironomus was collected in relatively low number (1 organism/m^2) at Stations A-3, C-3, D-1, and D-3 while at the remaining stations numbers of organisms ranged from 5 organisms/m^2 at Station F-S to 26 organisms/m^2 at Station A-1. These data (Table 6.3.2) do not clearly indicate if organism abundance is depressed at the mid-impoundment stations.

Tanypodinae

The Tanypodinae collected in Robinson Impoundment included Procladius, Ablabesmyia, and Clinotanypus.

Groups of organisms representing Procladius (3.5% of total number of midges collected) and Ablabesmyia (3.0% of midges collected) were considered common in benthic sampling while Clinotanypus (<1% of the midges collected) was frequently encountered.

Two morphologically different forms of Procladius were collected in Robinson Impoundment. These forms will be represented as Procladius (aberrant) and Procladius. The spatial distribution of organisms representing each form was determined to illustrate changes in abundance throughout the impoundment (Table 6.3.3).

The group of organisms representing Procladius (aberrant) included 22% of all Procladius collected. Procladius (aberrant) was encountered in collections from all twelve benthic stations except Station D-3. Numbers ranged from a high of 138/m^2 at Station E-1 to 1/m^2 at Station A-3. Highest numbers were collected at the shallower stations (depth less than 1 meter), lower numbers at the deeper stations (depth greater than 5 meters), and intermediate numbers at the remaining stations (Table 6.3.3).

The spatial distribution observed for Procladius (aberrant) indicates an apparent preference for littoral areas. This preference is illustrated by a peak in the numerical abundance at Stations E-1 and F-S. The relatively lower numbers of organisms collected at the third littoral station (G-S) cannot be adequately explained from the data collected. The study appears to indicate, however, that heated effluent did not adversely influence organism abundance at any of the littoral stations.

The spatial distribution of organisms representing the second morphological form of Procladius is illustrated in Table 6.3.3. These data indicate Procladius were present in collections from all benthic sampling stations. The monthly mean number of Procladius ranged from a high of 265/m^2 at Station G to a low of 34/m^2 at Station E-1. The data also indicate relatively higher numbers of Procladius were collected at stations located in the lower and upper impoundment stations. In an attempt to limit the number of environmental factors other than temperature which might influence the observed inter-station variation in organism abundance, only stations with similar depths and substrates were compared for variations in numerical abundance. As mentioned above substrate and depth were similar at Stations A-1, C-1, and E-3. The monthly mean number of organisms collected at each of the two lower impoundment stations was greater than the mean number of

organisms collected at Station E-3. Substrates and depth also appeared comparable at Stations G-S, F-S, E-1. The monthly mean number of Procladius collected at Stations G-S and F-S ($114/m^2$ and $75/m^2$, respectively) was two-fold higher than the number collected at Station E-1 ($34/m^2$). The numerical abundance of Procladius collected at Stations D-3, F, and G ranged from a low of $89/m^2$ at Station D-3 to a high of $265/m^2$ at Station G. Numerical abundance at the remaining group of stations (Group II) ranged from $230/m^2$ at Station C-3 to $134/m^2$ at Station A-3. It is apparent from the above comparisons that the numerical abundance of Procladius was reduced at Stations E-1 and E-3 when compared to the abundance at other benthic sampling stations.

A similar reduction in abundance has been observed at Lake Hyco, North Carolina (Weiss et al., 1974). Weiss reported all dominant Chironomidae were depressed by therma[illegible] [illegible]ts with Procladius adumbratus depressed mainly in the discharge [illegible] [illegible]though it appears likely that the depressed abundance of Procladius at the discharge stations of Robinson Impoundment reflects adverse effects of thermal effluents, it is possible that other factors not apparent from this study influenced the abundance of Procladius at Stations E-1 and E-3.

Organisms representing Ablabesmyia were collected from all twelve benthic sampling stations. Greater numbers of organisms were collected from the relatively shallow stations (depth less than 5 meters) and fewer organisms at the deeper Stations A-3, C-3, and D-1 (Figure 6.3.3). Abundance ranged from a high of $114/m^2$ at Station G-1 to a low of $2/m^2$ at Stations C-3 and D-1. It was not apparent from this study what environmental factor or combination of factors influenced the observed spatial distribution. It was also unclear what effect plant effluent had on the abundance of organisms collected throughout the impoundment.

The spatial distribution of organisms representing Clinotanypus is illustrated in Table 6.3.4. It is apparent from these data that Clinotanypus was collected in greater numbers at the relatively shallow Stations F-S and G-S, with 39 and 26 organisms/m^2, respectively, thus indicating a possible

preference for littoral areas. Organism abundance decreased at Stations A-1, C-1, D-1, E-3, E-1, F, and G, and ranged from a high of 6 organisms/m^2 to a low of 1/m^2, while Clinotanypus was not encountered in collections from Stations A-3, C-3, and D-3. Since Clinotanypus appears to be a littoral organism, a comparison of sublittoral inter-station variation in organism abundance will not be included. A comparison of inter-station variation, therefore, will be restricted to Stations G-S, F-S, and E-1 which were located in littoral areas. The decreased abundance of Clinotanypus at Station E-1 (5 organisms/m^2) possibly indicates this group of organisms was adversely effected by thermal effluents, however, other environmental factors not apparent from this study may have influenced the numerical abundance of Clinotanypus.

Oligochaetes

Oligochaetes (worms) were collected at all twelve benthic sampling stations throughout the year (Table 6.3.5). The monthly mean number of worms collected ranged from a high of 818/m^2 at Station A-3 to a low of 133/m^2 at Station E-1. For the efficient utilization of time and energy, worms were identified to class. Since the spatial and temporal distributions of organisms identified to class frequently yields little information, further discussion of Oligochaetes will not be presented.

Culicidae

Chaoborus (phantom midge) is considered an important food source for fish in the Robinson Impoundment. Chaoborus larvae are, according to Larow and Marzolf (1970), unique in the Class Insecta in that they exhibit a regular diel vertical migration. The first two instars (immature larvae) are planktonic, thus unavailable for collection by the benthic samplers used in the Robinson Impoundment study. The third and fourth instars (mature larvae) are planktonic at night but burrow in the bottom sediments during the day when they may be collected as "benthic" organisms. This difference between immature and mature larvae during diel vertical migration has been widely reported (Juday, 1921; Wood, 1956; Woodmansee and Grantham, 1961) in the published literature. All

four instars migrate to the surface water after sunset and return to the deeper portions of the lake (immature larvae) or to the sediments (mature larvae) shortly before sunrise. The daily vertical migration of larval *Chaoborus* may expose both immature and mature organisms to the effects of thermal effluents which "float" over ambient water and to loss due to plant entrainment (Weiss et al., 1974).

Organisms representing larval *Chaoborus* comprised 12.7% of the total number of organisms collected. Figure 6.3.4 illustrates the monthly mean number of larval *Chaoborus*/meter^2 collected at each benthic sampling station. These data indicated that phantom midges either were not observed or were not collected in relatively low numbers at the shallow Stations E-1 (*Chaoborus* not observed), F-S (2/m^2), and G-S (8/m^2). At stations of intermediate depth, numbers of organisms collected ranged from 29/m^2 at Station C-1 to 128/m^2 at Station F. Relatively higher numbers of *Chaoborus* were collected at the deeper Stations A-3, C-3, and D-1 with 224, 554, and 435/m^2, respectively.

Throughout the year *Chaoborus* exhibited two abundance peaks: one in July 1975, and the other in November 1975 (Figure 6.3.8). Seasonally, numbers of *Chaoborus* decreased from January through May, increased in June, peaked in July, then decreased again in August. Numbers of organisms began increasing in September, reached a second abundance peak in November, then decreased in December. This seasonal pattern indicates two generations per year, a relatively long winter generation occurring from September through May and a second short summer generation from June through August or September (Figure 6.3.8). The number of generations per year reported in the published literature apparently varies between lakes. Usually one generation per year is reported (Sublette, 1957; Hilsenhoff and Narf, 1968); however, Weiss et al., (1974) reported two generations per year for *Chaoborus* in Lake Hyco. He also reported that in both one and two generation patterns larval *Chaoborus* are never entirely absent at any time.

Information from the published literature indicates that the greater numbers of organisms collected from the relatively deep stations in Robinson Impoundment is to be expected. The two generation pattern per year has been reported in the literature and is not unique to the Robinson Impoundment.

A comparison of numbers of organisms collected at Station A-3 with numbers collected at Stations C-3 and D-1 indicates relatively large inter-station variation in organism abundance. The mean numbers of Chaoborus collected at Station A-3 was approximately one-half the number collected at Stations C-3 and D-1 (Figure 6.3.4). A limited entrainment study indicated 5.2×10^8 and 5.5×10^8 larval Chaoborus were lost to the plant per day during July and September, respectively. The larval Chaoborus lost during these two periods appear to be early instars of the above mentioned summer and winter generations. Although it appears likely that the numbers of organisms lost to the plant through entrainment account for the decreased abundance of larval Chaoborus at Station A-3, it is possible that other environmental factors including substrate and food availability may account for the depressed abundance observed during this study.

The depressed abundance of Chaoborus due to apparent loss by entrainment has been reported by Weiss et al. (1974) during his study of Lake Hyco. He observed a 52% reduction in the standing crop of larval Chaoborus in the vicinity of plant intake structures. This reduced abundance at Lake Hyco is similar to the depressed numbers of organisms observed at Robinson Impoundment Station A-3.

Although relatively low numbers of Chaoborus were collected at stations (Groups I, III, and IV) where depth was less than 5 meters (16.5 ft), it should be noted that Chaoborus were present in samples nine of twelve months at most stations with the exception of Station E-3 and littoral Stations E-1, F-S, G-S. Since Chaoborus are not littoral organisms, the low numbers or absence of Chaoborus at Stations E-1, F-S, and G-S is to be expected. The absence of Chaoborus at Station E-3 during portions of the year, however, appears to indicate the discharge area may not offer suitable habitat. Although many environmental factors may reduce the suitability of a habitat, it appears likely that physical scouring and/or increased water temperatures may explain the periodic absence of Chaoborus at Station E-3 during this study.

Ephemeroptera (Mayflies)

Hexagenia was considered a common mayfly in benthic samples collected

in the upper portion of Robinson Impoundment. This mayfly belongs to a family (Ephemeridae) of burrowing organisms. Hexagenia is a common inhabitant of the sublittoral and profundal zones of lakes and it is reported (Eriksen, 1968) to occur in undisturbed sediments where the dissolved oxygen concentration of the water is greater than 0.8 mg/l. According to Gaufin (1973), the lethal temperature, at which 50% of his test specimens of Hexagenia lumbrata died after 96 hours exposure (TLm^{96}), was 26.6°C.

In Robinson Impoundment, Hexagenia were present in samples collected at four stations (i.e., Stations F, F-S, G, and G-S) and were not observed in samples collected at the remaining eight stations (Figure 6.3.6). The absence of Hexagenia from discharge and lower impoundment stations can not be explained from this study.

Trichoptera (caddisflies)

Two genera of caddisflies (Polycentropus and Oecetis), considered common fish food organisms, were collected in Robinson Impoundment. Organisms representing each genera were relatively more abundant in samples collected at comparatively shallow stations and less numerous or absent from samples collected at the deeper Stations A-3, C-3, and D-1. The mean monthly number of Polycentropus per meter^2 collected at each of the twelve benthic stations is illustrated in Figure 6.3.6. Data presented in this figure indicate that the number of organisms collected at most upper and lower impoundment stations, except deep Stations A-3, C-3, and D-1, was greater than numbers of organisms collected at either Station E-3 or E-1. An adequate explanation for the decreased abundance of Polycentropus at Stations E-1 and E-3 was not apparent from this study. Temporal distributions indicate, however, that immature Polycentropus were present during the summer at most stations with the exception of Stations E-1 and E-3. Adverse environmental factors including temperature may be reflected in the absence of Polycentropus from discharge stations during the warmer seasons. This absence may account for the observed decreased abundance reflected in monthly mean numbers.

The second group of caddisflies collected in the Robinson Impoundment represented Oecetis. According to Sublette (1957), Oecetis is considered

unusual in that it occurs most commonly on sandy substrates. In Robinson Impoundment, Oecetis was collected in relatively high numbers at Stations D-3, E-1, E-3, F-S, and G-S where the substrate contained a comparatively high percentage of sand, while lower numbers of organisms were collected at Stations G and F where the substrate contained a relatively larger amount of silt (Figure 6.3.7). These data seem to indicate that the spatial distribution of Oecetis may be influenced, in part, by substrate differences and that plant effluents may not adversely effect organism abundance.

Species Diversity

A diversity index ($\bar{d}$) derived from information theory, is a commonly used technique for the evaluation of benthic community structure. The greater the number of species present and the more equal their abundance, the greater the uncertainty and hence the greater the diversity. Conversely, if large numbers of individuals and small numbers of taxa typify the community, then a high probability exists that an individual species observed during sampling belongs to a taxa previously observed; thus considerable replication of information would exist and diversity would be low. (Cairns and Dickson, 1971).

Environmental change which infringes upon the lethal limits for any species in a community will result in the reallocation of resources and the alternation of patterns of community stability. According to Headrich (1975) such alterations and reallocations will be reflected by changes in diversity. Environmental stress, for example, will narrow the lethal limits of the less tolerant species in a system. Organisms representing these species will be eventually reduced in abundance or eliminated from the community. This reduction or elimination will decrease local community diversity. Numerous published field studies have shown that community diversity decreases in the face of severe environmental stress (e.g., King and Ball, 1964; Wilhm and Doris, 1966; and Wilhm, 1967).

The diversity of aquatic insect populations in thermal, post-thermal and natural streams were compared by Howell and Gentry (1974). They observed that for insect communities the highest diversity indices corresponded with natural streams, intermediate diversity estimates with post-thermal streams and lowest diversity estimates with thermal streams.

Monthly diversity estimates ($\bar{d}$) for each benthic station are presented in Table 6.3.6. These data indicate that values for $\bar{d}$ varied from a high of 4.21 at Station G-S to a low of 0.00 at Station E-1 and that diversity estimates for stations located in the upper impoundment were somewhat higher than the diversity estimates for stations located either in the lower or the mid-impoundment. With some exceptions, diversity estimates for relatively shallow stations were generally higher than estimates for the deep stations. For example, values of $\bar{d}$ ranged from a low of 0.74 to a high of 2.27 for Station D-1 (a deep station), while for Station D-3 (a shallow station) the range was 1.55 to 2.99. Diversity estimates also varied seasonally with $\bar{d}$ values generally increasing in the winter and decreasing in the late spring, summer, and early fall. Seasonal variation in diversity estimates were observed for all benthic sampling stations; however, for most shallow stations values for were greater than one throughout the study. Values for $\bar{d}$ <1 may indicate insufficient sample size or adverse environmental conditions which might include inadequate dissolved oxygen concentrations or unsuitable water temperatures. It was unclear from this study if the calculated values of $\bar{d}$ <1 reflected inadequate sample size or environmental stress. If the observed low values of $\bar{d}$ indicate environmental stress, the benthic community at Stations C-3, E-1, and E-3 may not be balanced or stable during the summer.

Black Creek

A general summary of number of taxa, number of organisms and major components of the fauna at Stations H, K, and I is given in Table 6.3.7. Station H, just below the outfall, had the fewest number of taxa and relatively highest number of organisms. The web spinning hydropsychids dominated the fauna comprising 67% of the organisms collected. The chironomids were considered common at Station H, comprising 27% of the total number of organisms collected.

One possible explanation for the high number of hydropsychids collected just below the impoundment was proposed by Spence and Hynes (1971). They stated that high numbers of web spinning trichopterans were found below an impoundment's outfall and that the high organic and detrital matter coming out of the lake supported high numbers of Hydropschidae.

At Station K, located downstream of Station H, the fewest numbers of organisms were collected. Of the total number of organisms collected, 55% were chironomids and 37% were trichopterans.

The number of taxa collected at Station I was two-fold higher than the number collected at Station H and 1.5 times higher than the number collected at Station K. Midges were the numerically dominant groups of organisms collected at Station I where they accounted for 69% of the total number of organisms collected.

These data indicate that the benthic community is similar at Stations I and K, while at Station H the benthos is dominated by Hydropsychids.

Summary and Conclusions

The numerically important benthic taxa collected during the study were chironomids (41% of the total), Oligochaeta (33%) and Culicidae (12%). Combined these three taxa totaled 86% of the organisms collected. Within the remaining 14% two additional taxa, Trichoptera and Ephemeroptera were examined because of their importance as fish food items. The remaining taxa were not collected in sufficient numbers to merit further consideration.

Within the numerically important taxa, spatial and temporal distributions were determined for the most frequently collected genera (Tables 6.3.2 - 6.3.6 and Figures 6.3.1 - 6.3.8).

Diversity indices were calculated to obtain information on benthic community structure and stability (Table 6.3.6).

Organism abundance and diversity appeared to be relatively consistent throughout the year at all parts of the impoundment except the discharge area. The abundance and diversity at the discharge were similar to the other sampling areas of the impoundment from November through May, but were depressed during summer months. Data suggest that this depression of diversity and abundance at the discharge is the result of the thermal effluent during the summer months.

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Table 6.3.1 Robinson Impoundment and Black Creek benthic taxa list
January - December 1975

Taxa	Organisms Collected from Black Creek	Collection Method[1]
Platyhelminthes		
Turbellaria		
Planariidae		
Dugesia	+	P.S.
Nematoda	+	P.S.
Annelida		
Oligochaeta	+	P.S.
Lumbriculidae		P
Naididae		P.S.
Tubificidae		P.S.
Peloscolex variegatus		P
Peloscolex sp.	+	P.S.
Polychaeta		
Serpulidae		
Manayunkia speciosa		P
Hirundinea		
Erpobdellidae		
Erpobdella		P.S.
Glossiphonidae		
Placobdella		P.S.
Arthropoda		
Crustacea		
Amphipoda		
Talitridae		
Hyallela azteca		P.S.
Gammaridae		
Gammarus		P
Crangonyx		S
(Arachnoidea-Hydracarina)	+	P.S.
Insecta		
Collembola	+	P.S.
Ephemeroptera		
Ephemeridae		
Hexagenia		P.S.
Caenidae		
Caenis		P.S.
Ephemerellidae		
Ephemerella	+	P.S.
Leptophlebiidae		
Leptophlebia		P.S.
Paraleptophlebia	+	P.S.
Heptageniidae		
Stenonema	+	S

P = found in Ponar sample
S = found on artificial substrate
P.S. = Collected by both types of samplers

Table 6.3.1 (continued)

Taxa	Organisms Collected from Black Creek	Collection Method[1]
Siphlonuridae		
Ameletus		P.S.
Baetidae		
Callibaetis		P
Baetis	+	P.S.
Centroptilum	+	S
Odonata		
Zygoptera		
Agrionidae		
Argia	+	S
Enallagma		P.S.
Anisoptera		
Gomphidae		
Dromogomphus		P
Gomphus		P
Aeshnidae		
Coryphaeschna		S
Macromiidae		
Macromia		P
Didymops		P
Libellulidae		
Tetragoneuria		P.S.
Celithemis		P.S.
Sympetrum		P
Libellula		P
Orthemis		P
Plecoptera		
Pteronarcidae		
Pteronarcys dorsata		S
Nemouridae		
Nemoura	+	S
UID Nemouridae	+	
Perlidae		
Perlesta	+	S
Acroneuria	+	S
Phasganophora capitata	+	S
Paragnetina		S
UID Perlidae	+	S
Perlodidae		
Isoperla/Diploperla	+	S
Taeniopterygidae		
Taeniopteryx	+	S
Coleoptera		
Amphizoidae	+	P.S.
Dytiscidae		
Oreodytes/Deronectes		P
Hydrophilidae		
Berosus	+	P.S.
Gyrinidae		
Dineutus		P

Table 6.3.1 (continued)

Taxa	Organisms Collected from Black Creek	Collection Method[1]
Elmidae		
Ancyronyx variegatus	+	S
Stenelmis	+	P.S.
UID Elmidae	+	S
Chrysornleidae		
Donacia	+	P.S.
Helodidae		P
Megaloptera		
Sialidae		
Sialis		S
Trichoptera		
Hydropsychidae		
Hydropsyche	+	S
Hydropsyche sp A	+	S
Cheumatopsyche	+	S
Macronemum	+	S
Philopotamidae		
Chimarra	+	S
Psychomyiidae		
Phylocentropus		P
Cyrnellus	+	S
Polycentropus	+	P.S.
Nyctiophylax	+	S
Neureclipsis	+	P.S.
Hydroptilidae		
Ochrotrichia	+	S
Oxyethira	+	S
Brachycentridae		
Brachycentrus numerosus	+	S
Leptoceridae		
Oecetis	+	P.S.
Leptocerid pupae		P.S.
Lepidoptera		
Pyralidae		
Nymphula		P
Cataclysta		P
Diptera		
Culicidae		
Chaoborus	+	P.S.
Tipulidae		
Tipula		P
Simuliidae-larvae pupae	+	S
Ceratopogonidae		
Bezzia/Probezzia	+	P.S.
Tabanidae		
Chrysops	+	P.S.
Empididae	+	S

Table 6.3.1 (continued)

Taxa	Organisms Collected from Black Creek	Collection Method[1]
Rhagionidae		
Atherix variegatus	+	S
Chironomidae		
Tanypoidinae		
Pentaneurini		
Ablabesmyia	+	P.S.
Conchapelopia	+	P.S.
Pentaneura	+	P.S.
Labrundinia		P.S.
Zavrelimyia		P
Larsia		P
Coelotanypodinae		
Tanypus		P
Anatopynia		P
Psectrotanypus		P.S.
Procladius	+	P.S.
Clinotanypus	+	P.S.
Coelotanypus		P
Orthocladiinae		
Corynoneura	+	S
Thienemaniella	+	S
Cricotopus	+	P.S.
Cardiocladius	+	P.S.
Nanocladius	+	P.S.
Eukiefferiella	+	P.S.
Brillia par	+	P.S.
Stenochironomus		S
Psectrocladius	+	P.S.
Orthocladius	+	S
Zalutschia		P.S.
Trichocladius	+	P.S.
Microcricotopus	+	S
UID Orthoclad V	+	S
UID Orthoclad W	+	S
UID Orthoclad X	+	S
UID Orthoclad Y	+	S
Diamesinae		
Potthastia longimanus	+	S
Chironominae		
Chironomini		
Paralauterborniella		P.S.
Paratendipes		P.S.
Microtendipes	+	P.S.
Chironomus	+	P.S.
Cryptochironomus	+	P.S.

Table 6.3.1 (continued)

Taxa	Organisms Collected Black Creek	Collection Method[1]
Harnischia	+	P.S.
Polypedilum	+	P.S.
Polypedilum fallax	+	P.S.
Pseudochironomus		P.S.
Phaenopsectra	+	P.S.
Tribelos	+	P.S.
Parachironomus		P.S.
Cryptocendipes		P
Xenochironomus		P
Dicrotendipes	+	P.S.
Paracladopelma		P.S.
Chironomini sp A (Roback)	+	S
Chironomini sp C (Roback)		S
UID Chironomini A	+	P.S.
Tanytarsini		
Micropsectra		S
Cladotanytarsus	+	P.S.
Rheotanytarsus	+	P.S.
Tanytarsus	+	P.S.

Table 6.3.2 Mean number of Cladotanytarsus, Harnischia, and Cryptochironomus/m^2 collected at Robinson Impoundment, January - December, 1975

Group	Station	Cladotanytarsus	Harnischia	Cryptochironomus
I	A-1	8	5	26
	C-1	8	1	5
	E-3	-	1	14
II	A-3	-	2	1
	C-3	-	7	1
	D-1	1	13	1
III	D-3	2	6	1
	F	56	15	6
	G	125	14	19
IV	E-1	-	2	5
	F-S	2	11	5
	G-S	98	33	23

Table 6.3.3 Mean number of *Procladius*/m^2 collected at Robinson Impoundment, January - December, 1975

Group	Station	Procladius	Procladius (aberrant)
I	A-1	156	25
	C-1	92	27
	E-3	51	5
II	A-3	134	1
	C-3	230	2
	D-1	175	2
III	D-3	89	-
	F	153	13
	G	265	15
IV	E-1	34	138
	F-S	75	95
	G-S	114	22

Table 6.3.4 Mean number of *Clinotanypus*/m^2 collected at Robinson Impoundment, January - December, 1975

Group	Station	Mean Number/$meter^2$
I	A-1	2
	C-1	1
	E-3	1
II	A-3	-
	C-3	-
	D-1	1
III	D-3	-
	F	6
	G	1
IV	E-1	5
	F-S	39
	G-S	26

Table 6.3.5 Mean number of Oligochaeta/m^2 collected at Robinson Impoundment

Station	Mean Number/meter^2
A-1	225
C-1	184
E-3	377
A-3	818
C-3	279
D-1	740
D-3	251
F	417
G	273
E-1	133
F-S	336
G-S	453

Table 6.3.6 Diversity estimates (d) of benthos collected in Robinso impoundment, January - December, 1975

	STATIONS											
	A-1	A-3	C-1	C-3	D-1	D-3	E-1	E 3	F	F-S	G	G-S
Jan.	1.99	0.73	1.49	1.98	1.98	2.06	2.33	1.58	2.54	2.19	3.16	2.71
Feb.	2.22	0.72	2.13	2.23	1.72	2.13	1.22	1.79	3.07	2.72	2.88	3.78
Mar.	2.19	1.87	2.86	2.01	1.73	1.97	1.78	2.22	2.01	3.22	2.56	3.92
Apr.	2.82	2.10	3.11	2.61	1.73	2.18	1.20	2.19	2.30	2.88	3.10	3.91
May	2.98	1.49	2.56	1.61	2.27	2.95	2.35	2.62	2.99	3.03	2.62	3.62
Jun.	0.83	2.10	3.18	1.51	0.73	2.89	2.69	2.47	2.34	3.10	2.15	2.79
Jul.	3.04	1.06	2.10	0.64	1.45	2.40	2.77	1.00	2.91	3.19	3.15	3.56
Aug.	2.17	1.53	2.52	0.87	1.18	2.99	0.35	1.39	2.32	3.30	2.52	2.98
Sep.	2.01	1.49	1.73	0.44	1.78	2.23	0.0	0.47	2.25	1.90	1.45	2.71
Oct.	2.89	1.48	1.41	1.30	0.74	1.55	0.0	0.82	2.56	1.55	2.70	2.73
Nov.	1.70	1.20	1.84	1.74	1.09	1.88	1.70	2.70	2.70	1.91	2.45	3.90
Dec.	1.72	1.44	2.81	2.02	2.21	2.62	2.05	2.28	2.91	2.32	1.99	4.21

Table 6.3.7 Dominant benthic taxa collected on artificial substrates in Black Creek, January - December, 1975

	Station H			Station K			Station I		
1975	Organisms	No. Collected	% of Total	Organisms	No. Collected	% of Total	Organisms	No. Collected	Total
Jan.	Hydracarinid	1	100	Hydropsyche	10	67	Simuliidae larvae	6	38
				Neureclipsis	3	20	Taeniopteryx	3	18
Feb.	Polypedilum	7	54	Trichocladius	9	56	Stenonema	4	25
	Eukiefferiella	3	23	Eukiefferiella	3	19	Oligochaetes	3	19
							Brachycentrus	3	19
Mar.	Polypedilum	38	64	Eukiefferiella	92	-	Stenonema	12	23
	Cricotopus	11	19	Trichocladius	33	-	Simuliidae pupae	10	19
	Psectrocladius	4	7	Hydropsyche	28	-	Rheotonytarsus	8	15
Apr.	Cricotopus	26	58	Hydropsyche	47	47	Simuliidae larvae	54	35
	Polypedilum	8	18	Eukiefferiella	29	29	Polypedilum	47	30
	Oligochaetes	5	11	UID Orthoclad X	20	20	Perlesta	16	10
							Macronemum	7	5
May	Polypedilum	240	12	Eukiefferiella	35	29	Polypedilum	11	16
	Polycentropus	98	25	Polypedilum	26	22	Microtendipes	8	11
	Planariidae	18	4	Hydropsyche	24	20	Stenonema	7	10
				Perlesta	11	9			
Jun.	Hydropsyche	149	46	Polycentropus	5	22	Missing		
	Polypedilum	86	26	Polypedilum	5	22			
	Macronemum	34	10	Trichocladius	3	13			
Jul.	Hydropsyche	410	49	Macronemum	41	41	Missing		
	Polycentropus	227	27	Polypedilum	12	12			
	Planariidae	79	10	Cryptochironomus	9	9			
	Polypedilum	24	5						

Table 6.3.7 (continued)

1975	Station H Organisms	Station H No. Collected	Station H % of Total	Station K Organisms	Station K No. Collected	Station K % of Total	Station I Organisms	Station I No. Collected	Station I Total
Aug.	Hydropsyche	23	88	UID Orthoclads	10	24	Missing		
				Polypedilum	8	19			
				Ablabesmyia	8	19			
				Oligochaetes	5	12			
Sep.	Hydropsyche spp	102	55	Polypedilum	20	29	Tanytarsus	110	28
	Hydropsyche sp	32	17	Ablabesmyia	9	13	Microtendipes	66	17
	Polypedilum	20	11	Hydropsyche	9	13	Polypedilum fallax	42	11
							Polypedilum	30	8
Oct.	Polypedilum	47	34	Oligochaetes	6	19	UID Orthoclad W	56	24
	Hydropsyche	46	33	Polypedilum	6	19	Oligochaetes	25	11
	Oligochaetes	20	14	Cryptochironomus	3	9	UID Orthoclad X	25	11
	Polycentropus	19	13				Pentaneurini	18	8
Nov.	Neureclopis	116	42	Oligochaetes	6	15	UID Orthoclad X	37	19
	Hydropsyche spp	127	45	Cryptochironomus	5	13	UID Orthoclad S	16	8
	Polypedilum	24	9				Tanytarsus	14	7
							Cricotopus	13	7
Dec.	Neureclipsis	36	57	Hydropsyche spp	31	35	UID Orthoclad X	101	59
	Polypedilum	13	20	UID Orthoclad Y	9	13	UID Orthoclad S	11	6
	Hydropsyche sp	9	14	Neureclipsis	7	10	Stenonema	10	6

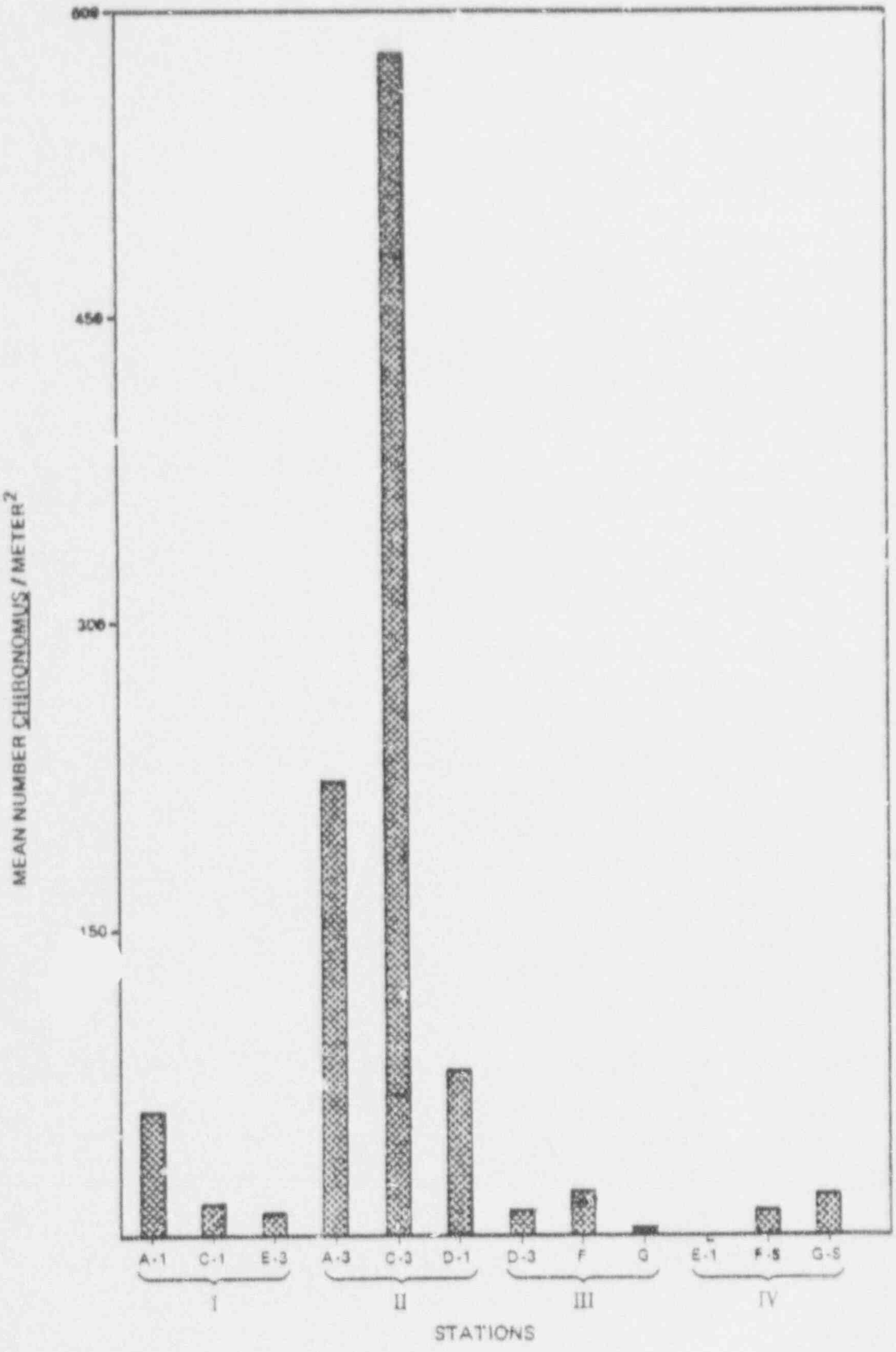

Figure 6.3.1 Monthly mean number of Chironomus/meter^2 collected at each of the twelve benthic sampling stations in the Robinson Impoundment, January through December 1975

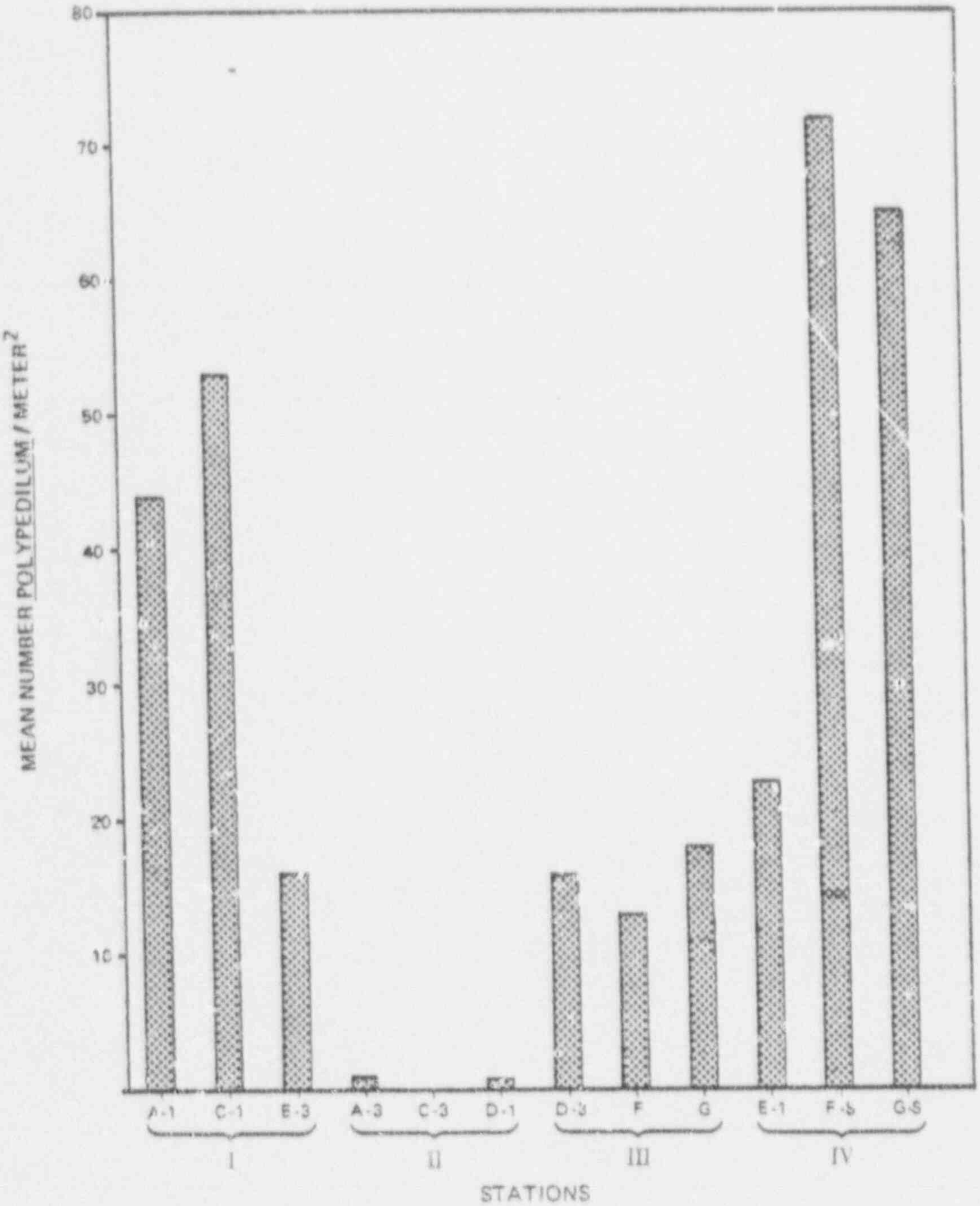

Figure 6.3.2 Monthly mean number of Polypedilum/meter^2 collected at each of the twelve benthic sampling stations in the Robinson Impoundment, January through December 1975

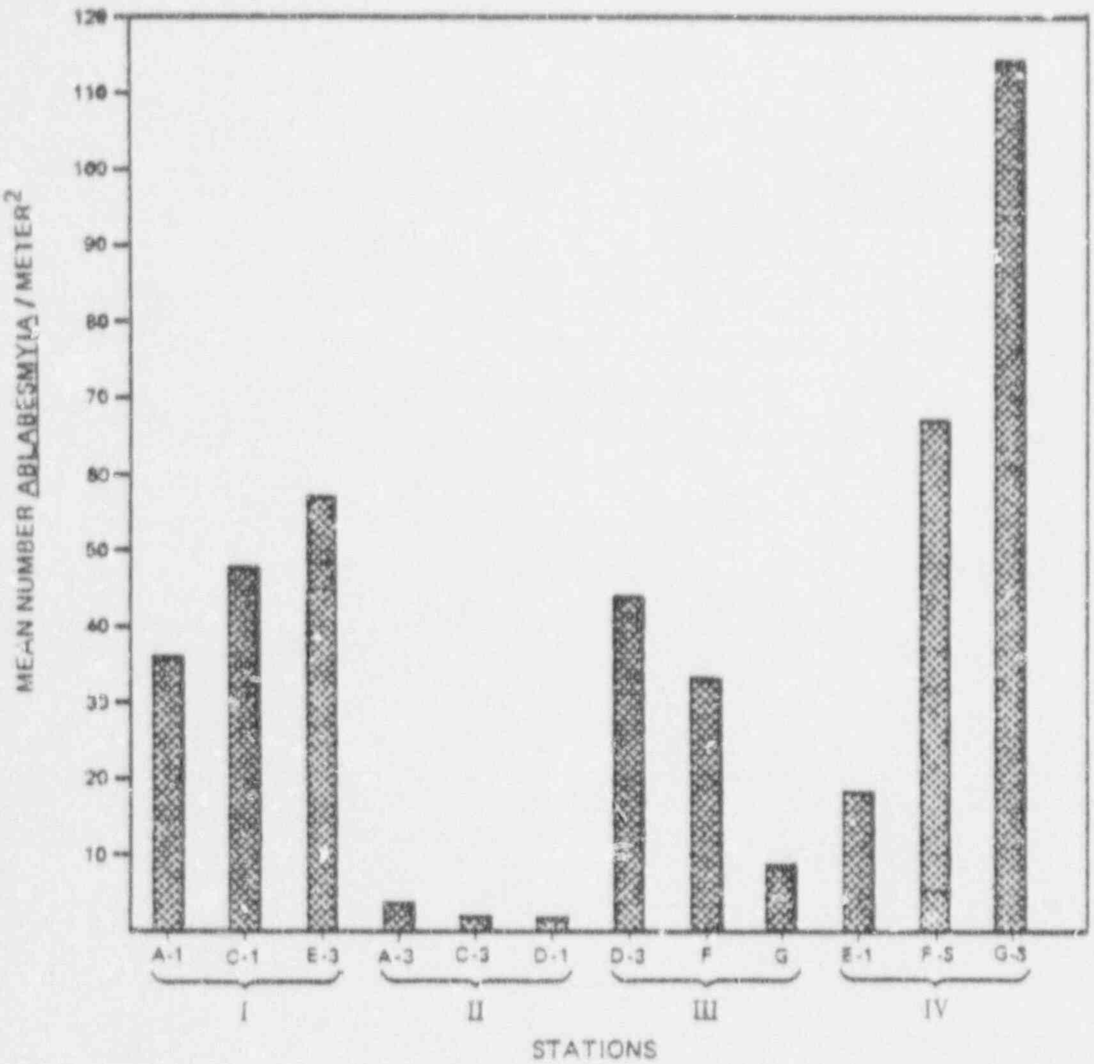

Figure 6.3.3 Monthly mean number of Ablabesmyia/meter^2 collected at each of the twelve benthic sampling stations in the Robinson Impoundment, January through December 1975

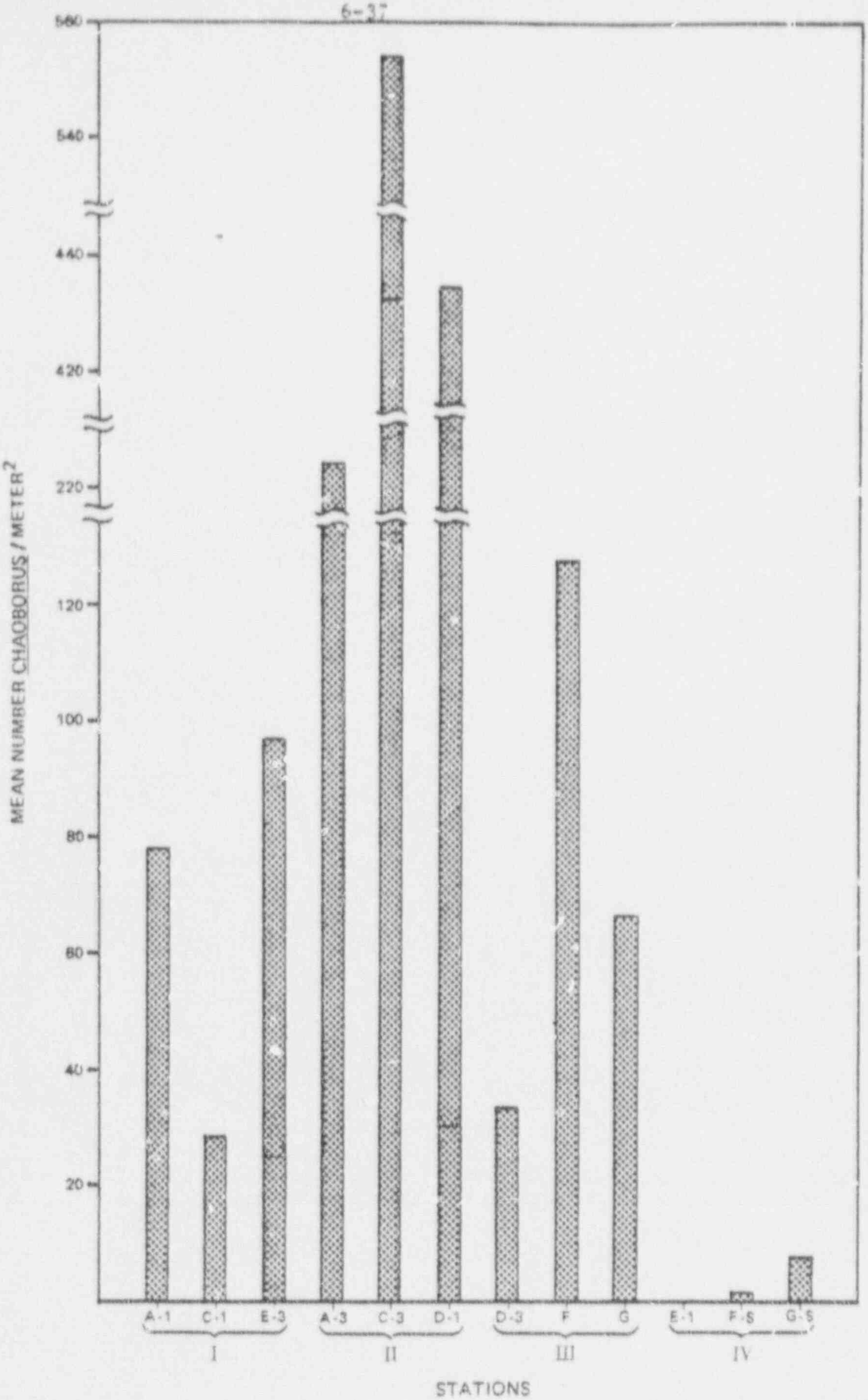

Figure 6.3.4 Monthly mean number of Chaoborus/meter^2 collected at each of the twelve benthic sampling stations in the Robinson Impoundment, January through December 1975

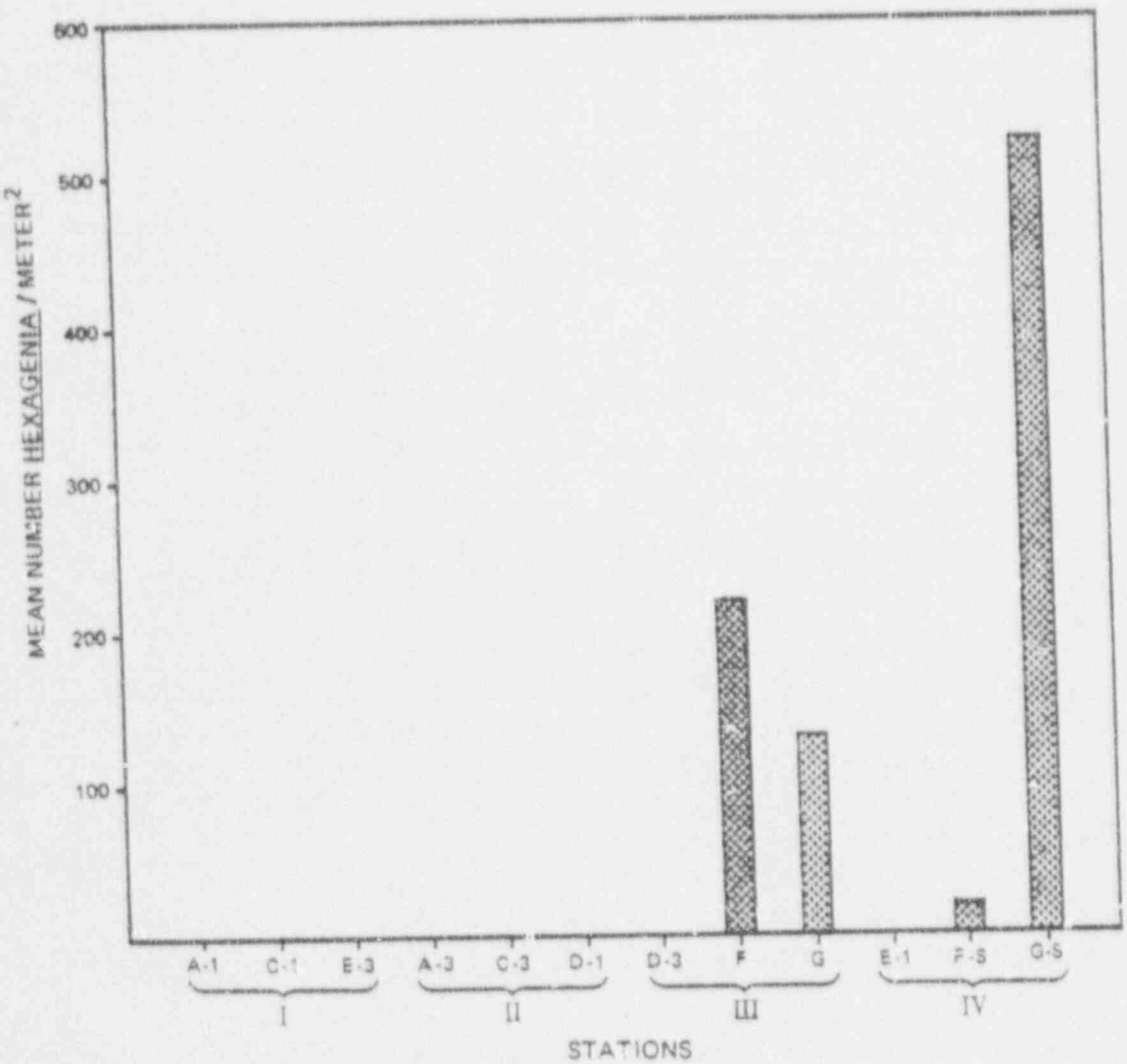

Figure 6.3.5 Monthly mean number of *Hexagenia*/meter^2 collected at each of the twelve benthic sampling stations in the Robinson Impoundment, January through December 1975

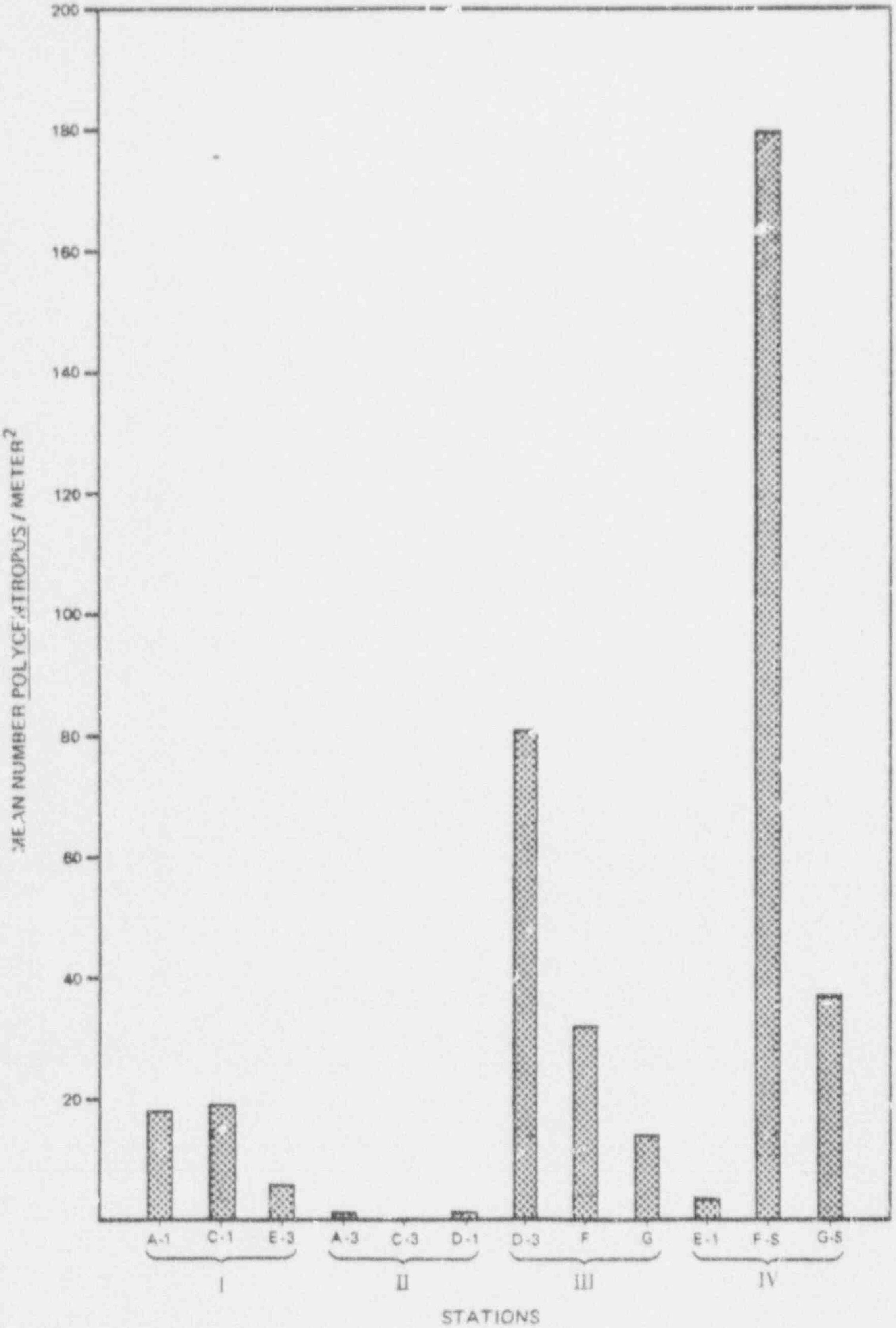

Figure 6.3.6 Monthly mean number of Polycentropus/meter^2 collected at each of the twelve benthic sampling stations in the Robinson Impoundment, January through December 1975

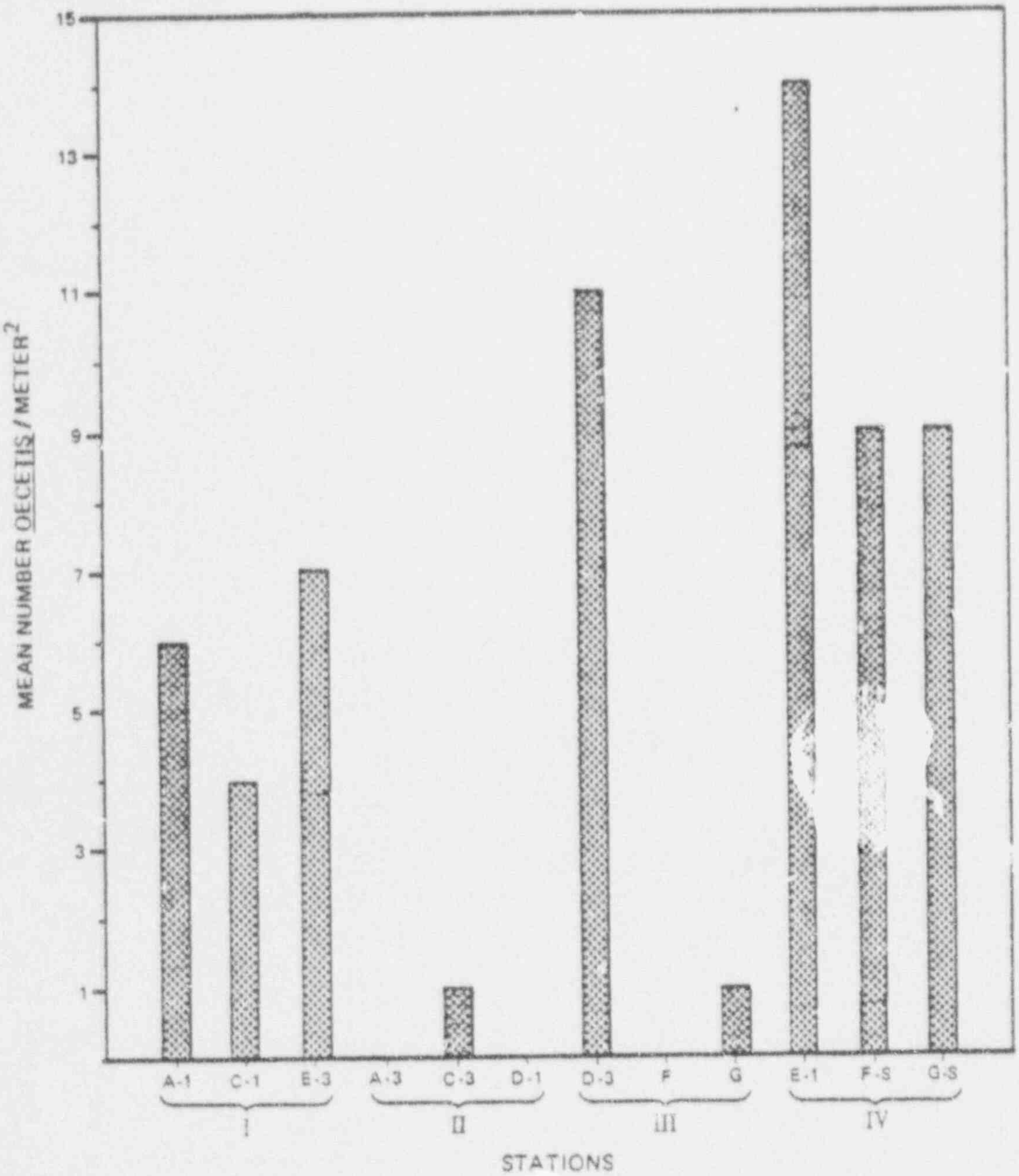

Figure 6.3.7 Monthly mean number of Oecetis/meter^2 collected at each of the twelve benthic sampling stations in the Robinson Impoundment, January through December 1975

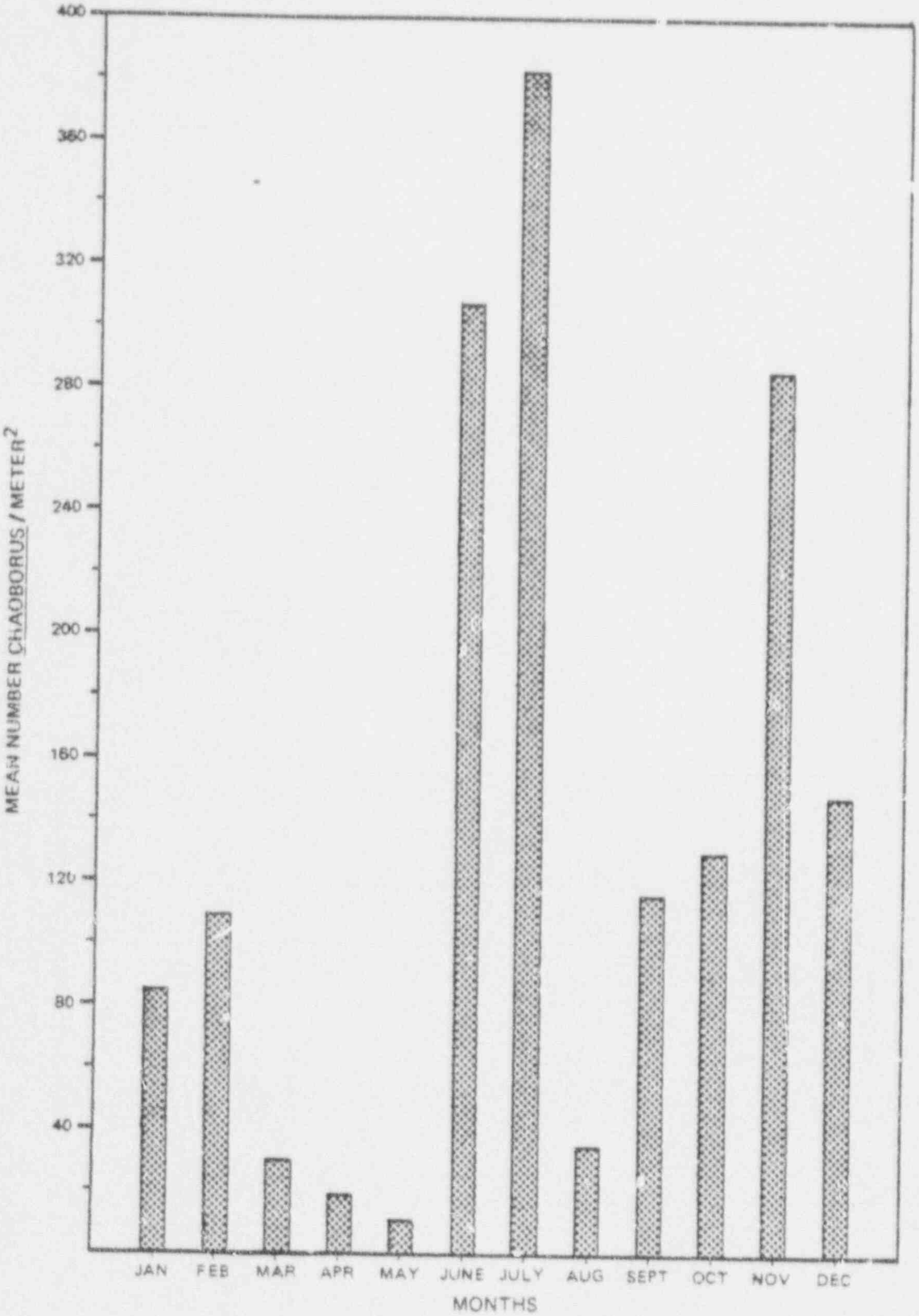

Figure 6.3.8 Monthly mean number of Chaoborus/meter^2 collected in the Robinson Impoundment, January through December 1975.

7.0 Aquatic Vegetation

7.1 Introduction

A study of the aquatic macrophytes found in the Robinson Impoundment and Black Creek was initiated in the fall of 1974 to assess their importance in the aquatic ecosystem and to identify any influence of the heated effluent from the H. B. Robinson Steam Electric Plant on the number of species present, their abundance and distribution.

Field work proceeded on a quarterly basis until the summer of 1975 when a more intensive effort was begun. During this period the entire impoundment was investigated and the aquatic vegetation was plotted on a scale map as prescribed in the EPA Region IV Basic Guide to the Design of 316 Demonstrations. Black Creek above and below the impoundment at Stations H, J, and K (Figure 7.1.1) was also studied in order to describe the aquatic vascular vegetation occurring there.

For the purposes of this report, the definition of "aquatic vascular vegetation" or "aquatic macrophytes" was taken from Muenscher (1944). "Aquatic plants . . . are those species which normally start in water and must grow for at least part of their life cycle, either completely submersed or emersed." It is difficult, however, to adhere strictly to a single definition because many species, although not true "aquatics," must be included in this report for they receive direct influences from the Robinson Impoundment and Black Creek. Red maple (*Acer rubrum*), black willow (*Salix nigra*), tag alder (*Alnus serrulata*), Atlantic white cedar (*Chamaecyparis thyoides*), and *Viburnum nudum* , for example, are often found in low marshy areas along the shores of the impoundment and the seasonally innundated flood-plain along Black Creek. Sculthorpe (1967) states that it may be unwise to stick entirely to a single definition in the following:

> "It is difficult to suggest a definition of vascular hydrophytes that is universally acceptable yet not utterly artificial. The difficulty arises mainly because aquatic habitats cannot be sharply distinguished from terrestrial ones. In most climates there is a seasonal fluctuation of the water table. Habitats with standing

water for most of the year may dry out completely in the summer whilst normally terrestrial soils may be flooded during a rainy season. At no time is there an abrupt transition from dry through waterlogged to submerged soils. The reversion of vascular plants to aquatic life has involved colonization of all these transitional habitats as well as the water itself, and some of the marginal sites that are periodically flooded have come to possess their own distinctive plant associations."

The role of aquatic vascular plants in the aquatic ecosystem is complex and varied. As primary producers they add to the supply of food and oxygen for other organisms throughout a range of trophic levels. Upon their death and decomposition they add carbon dioxide and nutrients to the water for use in photosynthesis by lower plants. The aquatic macrophytes provide shelter for fish, reptiles and amphibians and serve as breeding areas for certain species (Hotchkiss, 1941; and Odum, 1956). Some species of invertebrate organisms attach to the macrophytes for shelter, access to food and/or for breeding. A variety of plant parts such as leaves, fruits, roots, and rhizomes provide a good food source for invertebrates, fish, birds, and mammals. Submerged aquatic plants with finely dissected leaves, such as Myriophyllum pinnatum, which is widely distributed in the Robinson Impoundment, generally support significant numbers of invertebrates (Hotchkiss, 1941) which are often eaten by fish. Table 7.1.1 taken from Sculthorpe (1967) and Table 7.1.2 assimilitated from Martin, et al. (1951) illustrate some genera of aquatic plants used for food and shelter by fish, birds, and mammals. Emergent species also reduce erosion and add stability to the shoreline.

However, there are some negative aspects to vast areas of aquatic vegetation (Hotchkiss, 1941). While it is true that higher plants furnish food and make lakes more "habitable" they "destroy the habitat for both themselves and their animal associates. They add oxygen . . . but cut down on the ability of the water to absorb it . . . . They furnish ducks with essential food, but their contribution of decomposing material may periodically help to reduce oxygen to the point where botulism can take its toll. They support an abundance of fish food, but their dense growths may favor an increase of snails and other intermediate hosts of fish parasites."

While furnishing habitat for other members of the ecosystem, plants may also contribute to its destruction and create additional problems for man (Blackburn et al., 1968; and Holm et al., 1969). Dense weed growth can hinder navigation, destroy recreational areas, present health hazards, and generally reduce the suitability of the waterways for the purposes for which they were constructed. Aquatic macrophytes provide a necessary link in the ecosystem but their overabundance can be detrimental.

7.2 Vegetational Distributions

7.2.1 Methods

During the field sampling, the entire impoundment was investigated by boat and by wading along the shore.

When possible, plants were identified and labeled in the field. Specimens which could not be readily identified were numbered and plotted on the map by number. Upon returning to the laboratory such specimens were identified. Plants were pressed, dried, and mounted using standard herbarium procedures, and stored in the CP&L herbarium collection.

Taxonomic keys used in the identification of the plants encountered include Radford et al. (1968); Fassett (1957); Eyles and Robertson (1944); Musenscher (1944); and Justice and Bell (1968). Some plants were taken to the North Carolina State University herbarium for comparison with specimens maintained there. Several were also sent to Dr. E. O. Beal, Western Kentucky University for annotation. Nomenclature follows that of Radford et al. (1968). The information depicted on the map (Figure 7.2.1 - Figure 7.2.4) was assimilated during the growing season of 1975. Seasonal (winter dieback) and successional changes in species composition, distribution, and biomass are therefore not reflected in the map. Included with the map, which depicts the entire Robinson Impoundment and areas of significant beds of aquatic plants, are facing page maps (Figures 7.2.1a, 7.2.2a, and 7.2.3a) which indicate physiographic and man-made features influencing the distribution of aquatic vegetation along the shoreline of the impoundment. As the map is intended to show "major beds of aquatic vascular vegetation," a minimum size for an area to be illustrated was necessary. Areas appearing on the map are

approximately 18.6 m^2 (200 ft^2) as a practical lower limit. Plant species which occur as individuals or in groups smaller than the lower size limit do, however, appear in the species list (Table 7.2.1) for the impoundment and Black Creek and are included in discussions and descriptions of the aquatic communities. Vegetative communities along Black Creek above and below the impoundment are described in the text but do not appear on the map.

7.2.2 Results and Discussion

Much of the area surrounding the Robinson Impoundment supports vegetation which typifies the Sandhill community. The long leaf pine-turkey oak-wire grass association is predominant on the dry, sandy, upland areas. The species of primary importance include long leaf pine (Pinus palustris), loblolly pine (P. taeda), turkey oak (Quercus laevis), blackjack oak (Q. marilandica), and post oak (Q. stellata). The ground cover is composed mainly of wire grass (Aristida stricta). Other herbaceous species identified include dayflower (Commelina erecta), pine-barren gentian (Gentiana atumnalis), and rose pink (Sabatia angularis). A species list which includes all plants identified and/or collected in the area is included as Table 7.2.1. This table consists of species common to Sandhill communities and lowland areas, although fieldwork has been directed primarily to aquatic species in the Robinson Impoundment and along Black Creek.

One hundred and thirty eight species have been identified in and around the Impoundment. Of this number, seventy eight are aquatic plants or have been found in lower or periodically flooded areas. Many of the same aquatic species identified in the Robinson Impoundment were found to inhabit Prestwood Lake by Coker (1911). He lists the "aquatic plants" occurring in the lake as Brasenia schreberi, Nymphoides aquaticum, Potamogeton diversifolius, Potamogeton heterophyllus, Nymphaea advena (Nuphar luteum spp. macrophyllum), Utricularia fibrosa, Utricularia biflora, and Mayaca fluviataiis. Other aquatic species were distributed around the borders of the impoundment.

Aquatic species appearing on the map (Figure 7.2.1 - Figure 7.2.4) of major beds of vascular vegetation include:

Myriophyllum	*Myriophyllum pinnatum*
Water lily	*Nymphaea odcrata*
Water shield	*Brasenia schreberi*
Spatter dock	*Nuphar luteum*
Bur-reed *	*Sparganium americanum*
Golden club	*Orontium aquaticum*
Pipewort	*Eriocaulon compressum*
Pondweed	*Potamogeton diversifolius*
Bulrush	*Scirpus etuberculatus*
Dulichium	*Dulichium arundinaceum*
Spike rush	*Eleocharis baldwinii*
Juncus	*Juncus repens*

These species occur in large enough areas to be plotted conveniently on the map. Other plants important in the ecosystem are enumerated and discussed in the text.

Figure 7.2.1 covers approximately the lower quarter of the impoundment. Aquatic vegetation is quite sparse except in the cove in the northeastern portion which is more protected from wave action. The dam and the southwest corner are covered with rip-rap (large rocks) which do not provide a suitable substrate for vegetation (see Figure 7.2.1a). Scattered red maple (*Acer rubrum*), broom sedge (*Andropogon virginicus*), and *Juncus effusus* occur to a limited extent here. The middle portion of the western shore has a predominantly sandy substrate and supports small populations of *Juncus effusus*, *Myriophyllum pinnatum* and the submerged, mat-forming spike-rush (*Eleocharis baldwinii*). The northwestern portion is largely devoid of vegetation except for scattered areas of *Juncus repens* and *Eleocharis baldwinii*, as rip-rap has also been placed in this section during construction of the discharge canal. The eastern shore supports a larger amount of vegetation especially in the more protected areas. In addition to species appearing on the map, populations of alder (*Alnus serrulata*), black willow (*Salix nigra*), red maple, *Peltandra virginica*, and *Panicum hemitomon* are well represented along the shore in this section. Figures 7.2.5 and 7.2.6 are photographs illustrating the rip-rap and sandy areas found in this portion of the impoundment.

Figure 7.2.2 represents the next portion of the impoundment northward. The entire western side of the impoundment along the discharge canal supports

no beds of aquatic vascular plants large enough to be illustrated on the map. This is due to the sandy substrate and rip-rap placed along the shoreline. Occurring along the shoreline are red maple, broom sedge, and Juncus canadensis. The eastern shore supports limited areas of aquatic vascular macrophytes. Boat docks, swimming areas, and other activities of man have removed a portion of this area for colonization by aquatic vegetation (see Figure 7.2.2a). Alder, red maple, Panicum hemitomon, Peltandra virginica, cat-tail (Typha latifolia), and Juncus spp. also are found along this shoreline in areas which have not been disturbed for residential purposes.

Figure 7.2.3 depicts the major beds of aquatic vascular vegetation found in the area where the heated effluent empties into the impoundment.. The western shore which borders the discharge canal is lined with rip-rap to a great extent. Major species found here in addition to those on the map include thoroughwort (Eupatorium sp.), red maple, cat-tail, and Panicum hemitomon . The area to the north of the mouth of the canal is generally low and marshy along the shoreline and except for the cove area directly north of the discharge has considerable vegetation including red maple, alder, Panicum hemitomon and cat-tail as species which do not appear on the map. The cove north of the discharge is shown in Figure 7.2.7. Spike-rush (Eleocharis baldwinii) was first noted near the mouth of the discharge canal in February, 1976. This species was not found in this area during the sampling which took place in the summer of 1975. The reduction of this species during the summer months is apparently due to elevated water temperatures in this area.

The southeastern portion of the impoundment in this section is dotted with houses and boating facilities, yet does support some aquatic vegetation. The cove which is formed in the old Big Beaverdam Creek bed and surrounding edges is covered with extensive beds of plants. Peltandra virginica, Panicum hemitomon, cat-tails, bladderworts (Utricularia spp.), and several species of Sagittaria are found here, along with an abundance of Sparganium americanum. The northeastern areas are predominantly shallow and marshy. The plants mentioned above in addition to floating heart (Nymphoides aquaticum) and Eleocharis baldwinii are prevalent. On slightly higher ground alder, willow, and red maple make up the dominant woody vegetation.

Figure 7.2.4 illustrates the upper portion of the impoundment above the S. R. 346 bridge. It is in this section that aquatic vascular vegetation attains its greatest development. Myriophyllum and more of the broader leaved floating species such as the water lilies (Nymphaea odorata and Nuphar luteum), along with emergent varieties like golden club (Orontium aquaticum), Peltandra virginica, pipewort (Eriocaulon compressum), and several species of Sagittaria also occur more frequently in this area. A significant factor in the increased development of the emergent and floating species in this portion of the impoundment is protection from wave action. The protected, shallow coves and marshy sections in this area of the impoundment contain silt and organic material which is suitable for the colonization of aquatic macrophytes. Although aquatic plants vary considerably in resistance to wave action, it is the submerged forms with strong rhizomes or those occurring in rosettes (Sculthorpe, 1967), such as Eleocharis baldwinii, Juncus repens, and Sagittaria graminea, which best survive wind and waves. In more exposed areas of the lower impoundment turbulence has removed finer silt and organic matter which provide the necessary substrate for many species. Figure 7.2.8 pictorally depicts shoreline vegetation which is typical of this section of the impoundment.

Predominant emergent species occurring along the shoreline include cat-tails, Panicum hemitomon, bulrush (Scirpus cyperinus), sedge (Carex lurida), red maple, black willow, Juncus canadensis, and J. effusus. On the cove on the western shore bur-reed (Sparganium americanum) and golden club (Orontium aquaticum) are common in the marsh where a small creek enters the area. Vast beds composed primarily of Myriophyllum and Nymphaea are found in the shallow northeastern section. Bog moss (Mayaca fluviatalis) and Proserpinaca pectinata are scattered in marshy areas in this section of the impoundment. Scirpus etuberculatus, which is found in the upper portion of the impoundment is pictured in Figure 7.2.9.

Station J (Figure 7.1.1) is located in a transitional area between the upper impoundment and Black Creek itself. The stream channel and adjacent flooded areas support growths of Scirpus etuberculatus, bur-reed (Sparganium americanum), Myriophyllum, and pondweed (Potamogeton diversifolius) as major species. Along the channel are tussocks of sedges, rushes, and grasses such as Carex lurida, Scirpus cyperinus, several species of Juncus and Panicum hemitomon. Also present are cat-tails, and small lowland tree species such as red maple,

no beds of aquatic vascular plants large enough to be illustrated on the map. This is due to the sandy substrate and rip-rap placed along the shoreline. Occurring along the shoreline are red maple, broom sedge, and Juncus canadensis. The eastern shore supports limited areas of aquatic vascular macrophytes. Boat docks, swimming areas, and other activities of man have removed a portion of this area for colonization by aquatic vegetation (see Figure 7.2.2a). Alder, red maple, Panicum hemitomon, Peltandra virginica, cat-tail (Typha latifolia), and Juncus spp. also are found along this shoreline in areas which have not been disturbed for residential purposes.

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Moyle (1945) in discussing water chemistry states that, "Although water chemistry appears to be the most important single factor influencing the general distribution of aquatic plants in Minnesota, field observations show that the type of bottom soil and the physical nature of the body of water greatly influence the local distribution of a species within its range of chemical tolerances." Sculthorpe (1967) notes that hardness or alkalinity expressed as ppm $CaCO_3$ is often used as a measure of nutrient status of water. He considers levels below 15 ppm to be an indication of a nutrient poor status. The Robinson Impoundment generally possesses levels of hardness (as $CaCO_3$) of less than 2 ppm (Table 3.4.1). Moore (1950) states that a "high carbonate" lake usually supports abundant aquatic vegetation. (See Water Chemistry, Section 3.4.) Nitrogen, phosphate, iron, sulfate are other important nutrients (Sculthorpe, 1967) which are not in abundance in the Robinson Impoundment (Exhibit 2.4).

The influence of substrate on the distribution is primarily through the texture and particle size rather than through the nutrients contained in it (Sculthorpe, 1967). The loose sands of the Sandhill community now form much of the substrate along the shores of the Robinson Impoundment. Coarse sand and gravel sometimes shifting with wave action provide a poor substrate for rooted aquatic plants (Hotchkiss, 1941). Bare rocks, such as the rip-rap found on portions of the shore in the impoundment also do not facilitate colonization. Figures 7.2.1a, 7.2.2a, and 7.2.3a illustrate some areas which have unsuitable substrates for vegetative growth.

Turbulence is another key factor in determining the distribution of aquatic vegetation in the Robinson Impoundment. Sculthorpe (1967) states that, "On large lakes, reed-swamp" (emergent hydrophytes) "may be completely lacking or limited to shallow bays . . . . The smaller and less exposed the lake, the greater is the extent of reed-swamp, and the more likely that floating-leaved vegetation which is generally still less tolerant of wind and waves, will also be present." The shallow areas in the upper part of the impoundment and the cover occurring further down are more protected from wind and waves and as a rule, support larger areas of aquatic plants than the more exposed, open water shoreline. During windy periods, up-rooted vegetation, especially <u>Myriophyllum</u>, has been noted piled up along the shore.

black willow, tag alder, sweet bay (Magnolia virginiana), Viburnum nudum, leatherwood (Cyrilla racemiflora), Atlantic white cedar (Chamaecyparis thyoides), and bald cypress (Taxodium distichum). Among the tussocks are shallow rivulets or sloughs which may dry up during low flow periods. Along with the species mentioned earlier for the stream channel, spike rush (Eleocharis quadrangulata and E. equisitoides) and pipeworts are found here. As the distance from the main channel increases and elevation of the terrain rises, more large trees are encountered, including Atlantic white cedar, red maple, and bald cypress.

The bottomland along Black Creek at Stations H and K (Figure 7.1.1) is a seasonally flooded diverse community composed primarily of lowland hardwoods, bald cypress and a few pines. Figure 7.2.10 is a picture of the community typical of Black Creek below the dam. The predominant tree species are gum (Nyssa spp.), bald cypress, Atlantic white cedar, water oak (Quercus nigra), and loblolly pine (Pinus taeda). Other trees along the Black Creek flood plain and adjacent areas include sweet bay, red maple, red bay (Persea borbonia) and black willow. Included in the understory are tag alder, sweet pepperbush (Clethra alnifolia), leatherwood (Cyrilla racemiflora), sparkleberry (Vaccinium arboreum), and Myrica spp. Herbaceous species include giant cane (Arundinaria gigantea), netted chain-fern (Woodwardia areolata), knotweed (Polygonum hydropiperoides), and Iris spp.

Aquatic macrophytes identified in the creek at Station H include Eleocharis baldwinii, Sagittaria engelmanniana, Juncus effusus, and Scirpus sp. Station K is quite similar to H except that it is more undisturbed and supports a few additional species of aquatic plants. Eleocharis baldwinii, Juncus repens, Nuphar luteum, Scirpus etuberculatus, and Eriocaulon compressum are present here.

7.2.3 Factors Influencing Distribution

A complex set of interacting factors act separately and together to determine the distribution of aquatic vegetation. Among these parameters are water chemistry (including dissolved nutrients), substrate, turbulence, light and temperature.

Pond C of the Par Pond system at the Savannah River Plant, noted in a study by Parker et al. (1973), reaches a maximum temperature of 50°C (122°F) and remains above 45°C (113°F) for much of the year. Vegetation does exist in Pond C but is significantly less than that of adjacent areas in which ambient temperatures range from 10°C (50°F) to 30°C (86°F). These authors consider temperature to be the primary criterion in evaluating the distribution of vegetation in the Par Pond system. Grace and Tilly (1975) have studied temperature related competition. Najas guadalupensis overtakes Myriophyllum spicatum at the "hot" station. Their "hot" station has an average maximum temperature of 33.4°C (93.9°F). Stanley (1970), also studying Myriophyllum spicatum, reveals that photosynthesis increases with temperature up to 35°C (95°F). At that point the depth to which colonies will become established is restricted. Stanley also found the optimum pH for growth of M. spicatum to be 8.5 - 9.0. The average pH value for the Robinson Impoundment is near 5.1.

In studies of other aquatic species Wilkinson (1963) indicates that the optimal temperature range for growth of waterstargrass (Heteranthara dubia) and coontail (Ceratophyllum demersum) to be 25°C (77°F) and 30°C (86°F), respectively, and that Vallisneria spiralis grows best at 33°C (91°F) to 36°C (97°F). Anderson (1969) reports a high temperature tolerance for coontail of 50°C (122°F). Anderson's study, which dealt primarily with the respiration rates of pondweed (Potamogeton perfoliatus), revealed that the plants are capable of some physiological adjustment to elevated temperatures up to 45°C (113°F). The respiration rate of Potamogeton perfoliatus was found to increase in the ranges studies 25°C (77°F) to 45°C (113°F). Yarwood (1961) has also investigated acquired heat tolerance in plant leaves. He has demonstrated adaptations to temperatures as high as 55°C (131°F).

7.3 Summary and Conclusions

It can be generalized from the literature reviewed that detrimental temperature effects may become apparent near 35°C (95°F). However, damaging temperatures and their effects vary among species. Monthly thermal sampling at the Robinson Impoundment has shown that surface temperatures have not exceeded 35°C (95°F) below Transect CA or above Station F during 1975 and below Transect D or above

Light penetration affects the depth to which photosynthesis can occur. Aquatic macrophytes may colonize depths having light intensities 1% to 2% of the intensity of the surface (Sculthorpe, 1967). The mean secchi depth, which can be related to light transmission, has been found to be 1 meter (3.3 feet) for the Robinson Impoundment (see Section 5.3.1 for further discussion). In the Robinson Impoundment rooted aquatics have been found in areas having a suitable substrate at depths of approximately 2 meters (6.6 feet). The "dark colored" nature of the water reduces light penetration in the impoundment so that only the shallower areas are available to rooted plants. Shading provided by the floating leaved species, such as Nymphaea odorata, Nuphar luteum and Brasenia schreberi, also reduces light so that submerged forms are restricted.

For the assessment of the impact of the effluent from the Robinson Plant on the aquatic macrophytes in the impoundment, temperature must be a primary consideration in evaluating the distribution of aquatic vegetation. Sculthorpe (1967) suggests that natural solar heating of a body of water may be greatest in slow moving swamps and ponds. The surface temperatures will generally be close to the air temperature if wind caused turbulence is not great. Heating of this type is thus more of a factor in the isolated coves and shallow, marshy areas of the Robinson Impoundment. However, Sculthorpe further states that in natural situations, temperature at a given site does not appreciably affect the distribution of a species within that site. Owing to the fact that increased temperatures from the plant discharge are not a natural phenomenon, temperature must be considered.

Temperature effects on vascular vegetation have received increased attention in recent years (Grace and Tilly, 1975; Sharitz et al., 1974a; Sharitz et al., 1974b, Parker et al., 1973; and Anderson, 1969). The effects have been varied. Increased growth has been noted with elevated temperature. Changes in species composition and the elimination of some species in heated areas have been observed. Seasonal biomass peaks have occurred earlier in the growing season and flowering of some species has been enhanced or eliminated. At temperatures above 45°C (113°F), death of vegetation has been reported.

the impoundment is an important limiting factor. As previously mentioned, turbulence, substrate, and the physiographic and man-made features (illustrated on Figures 7.2.1a - 7.2.3a) are primary reasons for the reduction of the amount of aquatic vascular vegetation in unprotected areas of the impoundment.

Above the SR 346 bridge (Figure 7.2.4), an abrupt change in vegetation is apparent. Substrate and reduced wave action increase the suitability of this area for colonization by macrophytes. Except when strong southerly winds force heated water under the bridge, very little, if any, thermal addition is made to this area by the plant discharge. There are no identifiable effects of the thermal effluent from the Robinson Plant in this area.

On Black Creek below the impoundment, shading of the channel by the tree canopy, steepness of the banks, and low nutrient content are important factors governing submerged, floating, and emergent aquatic macrophytes. Maximum temperatures at Stations H and K along Black Creek, 32.9°C (90°F) and 31.8°C (88°F) are not adverse to the vegetative communities found here.

In considering the entire impoundment, the limited areas which are thermally influenced from the standpoint of aquatic macrophytes do not pose a threat to the protection of a balanced and indigenous community of shellfish, fish, and wildlife in and around the impoundment.

the bridge during 1974. At the 3' depth, 35°C (95°F) has been exceeded at Transect D in 1975 but not in 1974, similarly for the 6' depth. Table 7.3.1 presents maximum temperatures found at the various transects (Figure 7.1.1) at the Robinson Impoundment during 1974 and 1975. Other pertinent temperature data is available from Section 3.3 and Exhibit 2.1.

Referring to the map (Figure 7.2.1 through Figure 7.2.4), no significant difference in the overall species distribution could be discerned from the dam to the SR 346 bridge, except those caused by substrate and turbulence. Nevertheless, the area near the immediate discharge would be expected to support somewhat more extensive populations of aquatic macrophytes without the thermal effluent from the Robinson Plant. Small mats of Eleocharis baldwinii have been found in this area during the winter months, but apparently its vegetative shoots die back due to elevated temperatures during the summer. However, the rootstock remains alive and reestablishes active growth during cooler periods.

Areas in which the thermal effluent restricts the growth of aquatic plants occur in the protected coves on the eastern shore opposite the discharge canal and in the coves directly north of the canal. These areas provide necessary habitat for colonization of aquatic plants. Wind caused turbulence is moderate; the substrate contains some silt and organic material, and the bottom slopes gradually away from the shores, providing an expanse of shallow water. Figures 7.3.1 and 7.3.2 illustrate areas of possible reduced aquatic macrophyte growth due to the thermal effluent from the Robinson Plant. Surface temperatures in this region reached 40.4°C (105°F) in July of 1975 and 37.8°C (100°F) in July of 1974 on the discharge side of the impoundment and 38.9°C (102°F) in July of 1975 and 36.5°C (98°F) in July of 1974 on the side opposite to the discharge canal. From a fisheries standpoint, areas of aquatic macrophytes are important in providing a spawning medium, shelter, and food sources, and any additional areas of macrophytic growth would be of value.

It is felt that the vegetation in the lower part of the impoundment represented in Figures 7.2.1 and 7.2.2 is not limited by the thermal effluent from the Robinson Plant. Increased growth due to elevated temperatures up to 35°C (95°F) would probably not be apparent because the low nutrient content of

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Table 7.1.2 Robinson Impoundment aquatic vegetation important* as a wildlife food sources**

Fauna	*Typha*	*Sparganium*	*Potamogeton*	*Sagitteria*	*Cyperus*	*Scirpus*	*Eleocharis*	*Peltandra*	*Brasenia*	*Nymphaea*
Muskrat	X	X								
Wood Duck								X		X
Mallard		X	X	X	X	X	X			
Black Duck		X				X	X			
Redhead		X								X
Ruddy Duck		X				X				
Whistling Swan		X	X				X			
Gadwall		X	X			X				
Canada goose							X			
Ring-necked Duck		X	X			X	X		X	X
American Coot		X					X			
Lesser Scaup		X								X
Blue-winged Teal					X		X			X
Green-winged Teal					X	X				
King Rail							X			

*Comprises greater than 2% of food in the Southeast.
**Source: Martin et al., 1951.

Table 7.1.1 Importance of some genera of aquatic plants in the Robinson Impoundment for fish, birds, and mammals.*

Genera	Plant part	Important to Fish as: ** Food Producer	Important to Fish as: Shade & Shelter	As Food for Birds: Ducks	As Food for Birds: Coots & Geese, etc.	As Food for Birds: Grebes & Swans, etc.	As Food for Birds: Marsh birds (waders)	As Food for Birds: Game Birds	As Food for Mammals: Beaver	As Food for Mammals: Muskrat
Brasenia, Carex, Nuphar, Nymphaea, Nymphoides Sparganium	Fruits & Seeds			0	0	0	0	0		0
	Foliage	0	0							
	Rhizomes & Tubers								0	0
Saggittaria, Scirpus, Cyperus	Fruits & Seeds			X	X	X		0		
	Foliage	0	0		0	0				
	Rhizomes & Tubers								X	X
Typha	Fruits & Seeds			0						
	Vegetative Parts	0	0							X
Utricularia	Whole Plants	0	0							
Myriophyllum, Proserpinaca, Potamogeton	Foliage	X	X							
	Fruits & Seeds			X	X	X	X	X		

0 - Denotes moderate importance
X - Denotes primary importance

*Adapted from Sculthorpe (1967)
**Attached macroinvertebrates

Family	Species	Common Name
Eriocaulaceae	Eriocaulon compressum*	Pipewort
Commelinaceae	Commelina erecta	Dayflower
Juncaceae	Juncus canadensis*	Juncus
	J. effusus*	Juncus
	J. polycephalus*	Juncus
	J. repens*	Juncus
Liliaceae	Allium sp.	Wild Onion
	Hemerocallis fulva	Day Lily
	Smilax bona-nox*	Greenbrier
	Yucca filamentosa	Bear-grass
Haemodoraceae	Lachnanthes caroliniana*	Redroot
Iridaceae	Iris virginica*	Blue Flag Iris
	I. tridentata*	Iris
Orchidaceae	Po[illegible] ophioglossoides*	Rose Pogonia
Salicaceae	Salix nigra*	Black Willow
	Populus heterophylla*	Swamp Cottonwood
Myricaceae	Myrica cerifera*	Wax Myrtle
	M. heterophylla*	Bayberry
Juglandaceae	Carya tomentosa	Mockernut Hickory
Betulaceae	Alnus serrulata*	Tag Alder
Fagaceae	Quercus incana	Upland Willow Oak
	Q. coccinea	Scarlet Oak
	Q. falcata	Southern Red Oak
	Q. laurifolia*	Laurel Oak
	Q. phellos*	Willow Oak
	Q. nigra*	Water Oak
	Q. marilandica	Blackjack Oak
	Q. margaretta	Scrubby Post Oak
	Q. laevis	Turkey Oak
	Q. stellata	Post Oak
Moraceae	Morus rubra	Red Mulberry
Loranthaceae	Phoradendron serotinum	Mistletoe
Polygonaceae	Rumex acetosella	Sheep-sorrel
	Polygonum hydropiperoides	Polygonum
Phytolacaceae	Phytoloacca americana	Poke Weed
Nymphaeaceae	Nuphar luteum*	Spatter-dock
	Nymphaea odorata*	Water-lily
Cabombaceae	Brasenia schreberi*	Water Shield
	Cabomba caroliniana*	Fanwort

Table 7.2.1 Plant species collected and/or observed in and near the Robinson Impoundment during 1974 and 1975.

Family	Species	Common Name
Lycopodiaceae	Lycopodium appressum*	Southern Bog Clubmoss
Osmundaceae	Osmunda regalis var. spectabilis*	Royal Fern
Blechnaceae	Woodwardia virginica*	Virginia Chain-Fern
	W. areolata*	Netted Chain-Fern
Pinaceae	Pinus elliottii	Slash Pine
	P. palustris	Longleaf Pine
	P. taeda	Loblolly Pine
Taxodiaceae	Taxodium distichum*	Bald Cypress
Cupressaceae	Chamaecyparis thyoides*	Atlantic White Cedar
	Juniperus virginiana	Eastern Red Cedar
Typhaceae	Typha latifolia*	Cat-tail
Sparganiaceae	Sparganium americanum*	Bur-reed
Potamogetonaceae	Potamogeton diversifolius*	Pondweed
Alismataceae	Sagittaria engelmanniana*	Arrowhead
	S. graminea*	Arrowhead
	S. latifolia*	Wapato
Poaceae	Arundinaria gigantea*	Cane
	Arundo donax*	Giant Reed
	Aristida stricta	Wire Grass
	Andropogon virginicus	Broomsedge
	Panicum hemitomon	Panicum
Cyperaceae	Carex lurida*	Sedge
	Cyperus sp.*	Sedge
	Scirpus cyperinus*	Bulrush
	S. etuberculatus*	Bulrush
	Dulichium arundinaceum*	Dulichium
	Eleocharis equisitodes*	Spike-rush
	E. baldwinii*	Spike-rush
	E. quadrangulata*	Spike-rush
	E. obtusa*	Spike-rush
Araceae	Orontium aquaticum*	Golden Club
	Peltandra virginica*	Peltandra
Mayacaceae	Mayaca fluviatalis*	Bog Moss
Xyridaceae	Xyris sp.*	Yellow-eyed Grass

Table 7.2.1 continued

Family	Species	Common Name
Onagraceae	Oenothera sp.	Evening Primrose
Haloragaceae	Myriophyllum pinnatum*	Myriophyllum
	Proserpinaca pectinata*	Proserpinaca
Apiaceae	Hydrocotyle umbellata*	Marsh Pennywort
Nyssaceae	Nyssa sylvatica*	Black Gum
	N. sylvatica var. biflora*	Black Gum
Cornaceae	Cornus florida	Dogwood
Clethraceae	Clethra alnifolia*	Sweet Pepperbush
Ericaceae	Vaccinium arboreum*	Sparkleberry
	V. corymbosum	Highbush Blueberry
	V. atrococcum	Black Highbush Blueberry
	Leucothoe racemosa*	Fetter-bush
	Gaylussacia sp.	Huckleberry
	Lyonia lucida*	Fetter-bush
	Diospyros virginiana	Persimmon
Styracaceae	Styrax americana*	Storax
Gentianaceae	Gentiana atumnalis	Pine-Barren Gentian
	Nymphoides cordata*	Floating Heart
	Sabatia angularis	Rose Pink
Solanaceae	Solanum sp.	Horse Nettle
Bignoniaceae	Anisostichus carpreolata*	Cross Vine
Lentibulariaceae	Utricularia biflora*	Bladderwort
	U. inflata*	Bladderwort
Rubiaceae	Cephalanthus occidentalis*	Button Bush
Caprifoliaceae	Viburnum nudum*	Viburnum
	Lonicera sempervirens	Coral Honeysuckle
	L. japonica*	Japanese Honeysuckle
	Sambucus canadensis	Elderberry
Campanulaceae	Lobelia glandulosa	Lobelia
Asteraceae	Aster	Aster
	Chrysanthemum sp.	Chrysanthemum
	Helenium sp.	Sneeze-weed
	Eupatorium aromaticum	Thoroughwort
	Liatris earlei	Blazing Star

*Denotes true aquatic species and species found to occur in intermittently or seasonally flooded areas

Family	Species	Common Name
Magnoliaceae	Magnolia grandiflora	Southern Magnolia
	M. virginiana*	Sweet Bay
	Liriodendron tulipifera	Tulip Tree
Lauraceae	Persia borbonia	Red Bay
	Sassafras albidum	Sassafras
	Lindera benzoin*	Spice Bush
Sarraceniaceae	Sarracenia flava*	Yellow Pitcher-plant
	S. rubra*	Sweet Pitcher-plant
Droseraceae	Drosera intermedia*	Sundew
Saxifragaceae	Itea virginica*	Virginia Willow
Hamamelidaceae	Liquidambar styraciflua*	Sweet Gum
Rosaceae	Rubus sp.*	Blackberry
	Crataegus sp.	Hawthorn
	Prunus serotina	Black Cherry
	Sorbus arbutifolia*	Red Chokeberry
Fabaceae	Baptisia cinerea	Baptisia
	Albizia julibrissin	Mimosa
	Desmodium sp.	Beggar Lice
Geraniaceae	Geranium sp.	Cranesbill
Meliaceae	Melia azedarach	China-berry
Polygalaceae	Polygala lutea	Polygala
Anacardiaceae	Rhus copallina	Winged Sumac
	R. glabra	Common Sumac
	R. radicans	Poison Ivy
Cyrillaceae	Cyrilla racemiflora*	Leatherwood
Aquifoliaceae	Ilex opaca	Holly
Aceraceae	Acer rubrum*	Red Maple
Vitaceae	Vitis sp.*	Grape
Theaceae	Gordonia lasianthus*	Loblolly Bay
Hypericaceae	Hypericum reductum	St. John's-wort
	H. stans	St. Peter's-wort
Melastomataceae	Rhexia virginica	Meadow Beauty

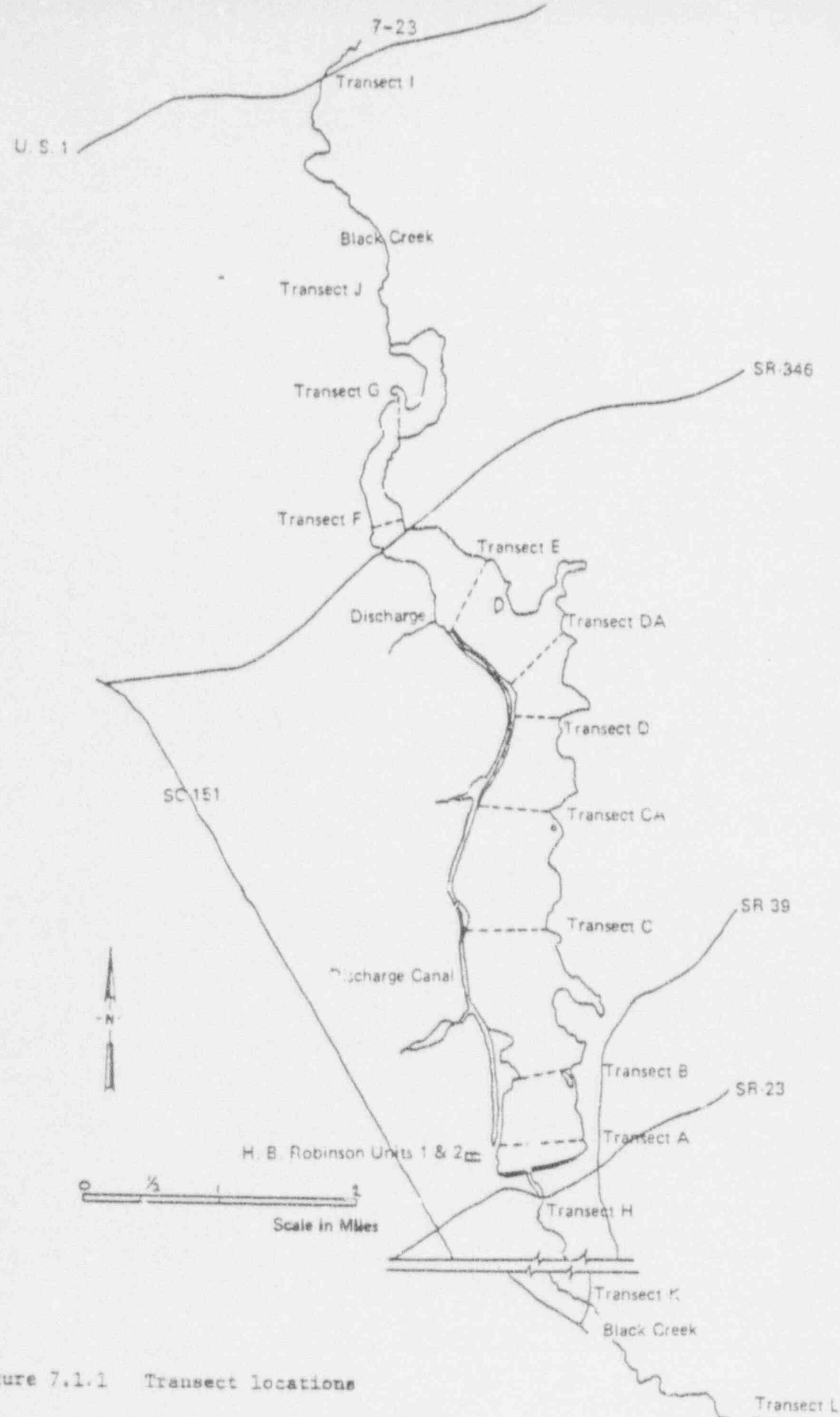

Figure 7.1.1 Transect locations

Table 7.3.1. Maximum average[1] temperatures recorded[2] in 1974 and 1975.

		1974		1975	
		°C	°F	°C	°F
Transect A	Surface	31.1	88	33.4	92
	3'	31.1	88	33.4	92
	6'	31.1	88	33.4	92
Transect B	Surface	31.1	88	33.4	92
	3'	31.1	88	33.4	92
	6'	31.1	88	32.8	91
Transect C	Surface	32.2	90	34.5	94
	3'	32.2	90	33.9	93
	6'	32.2	90	32.8	91
Transect CA[3]	Surface	--	--	35.0	95
	3'	--	--	33.9	93
	6'	--	--	32.8	91
Transect D	Surface	33.9	93	35.6	96
	3'	34.5	94	35.6	96
	6'	33.9	93	35.0	95
Transect E[4]	Surface	37.8	100	40.4	105
	3'	37.8	100	39.5	103
	6'	37.8	100	36.1	97
Station F[5]	Surface	32.8	91	34.5	94
	3'	32.2	90	33.4	92
	6'	31.1	88	30.0	86
Station G	Surface	31.7	89	31.7	89
	3'	28.9	84	28.9	84
	6'	25.0	77	27.2	81

Notes

1. Transect values are the average of three stations at each Transect.

2. Maximum for the year, taken at monthly sampling intervals.

3. Not recorded in 1974.

4. Temperatures at Station 3 of Transect E which is 200' from the point of discharge reached 39.0°C (102°F) in 1974 and 41.5°C (107°F) in 1975.

5. One reading taken for each depth at Stations.

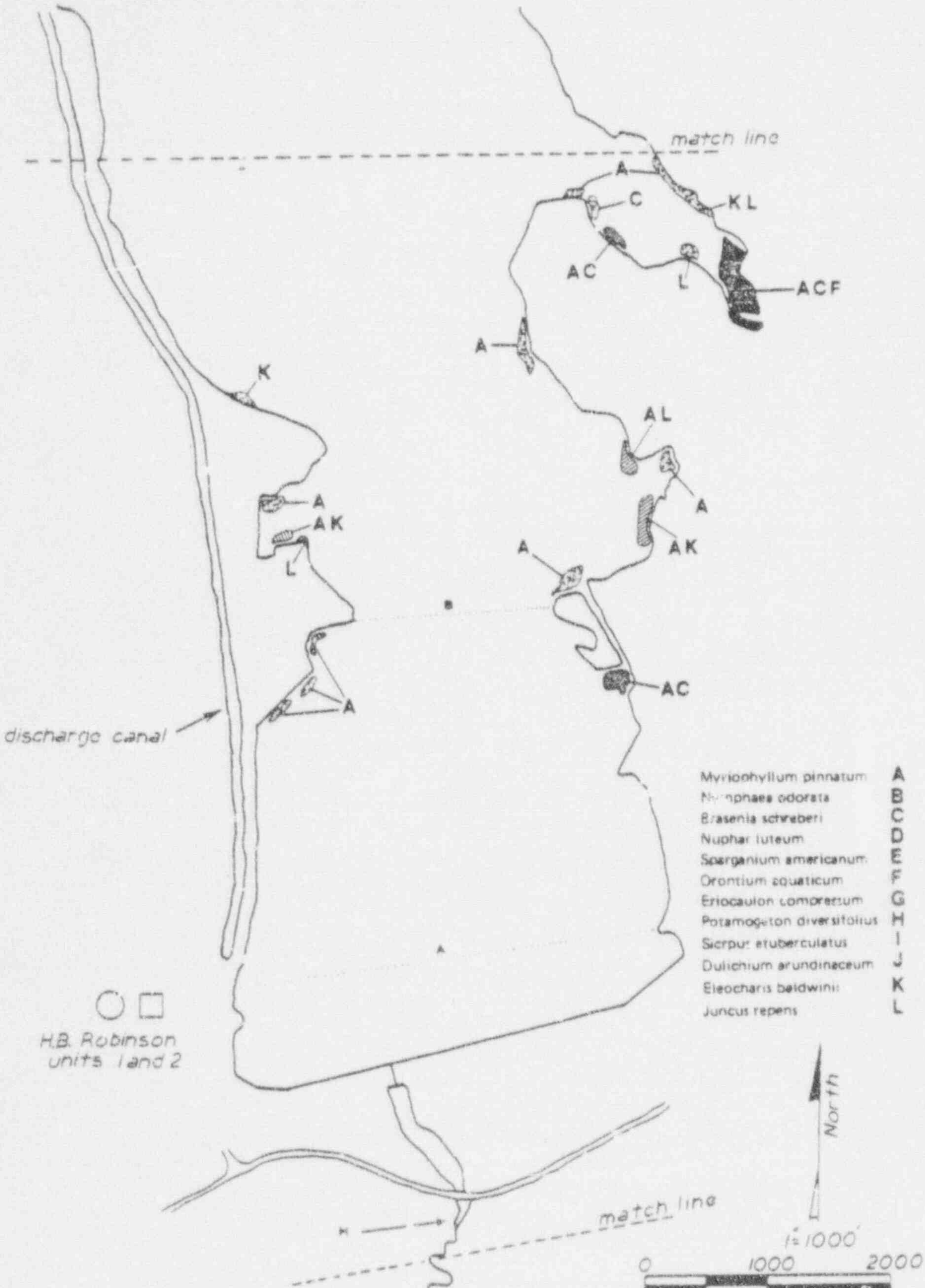

Figure 7.2.1 Vegetational distributions

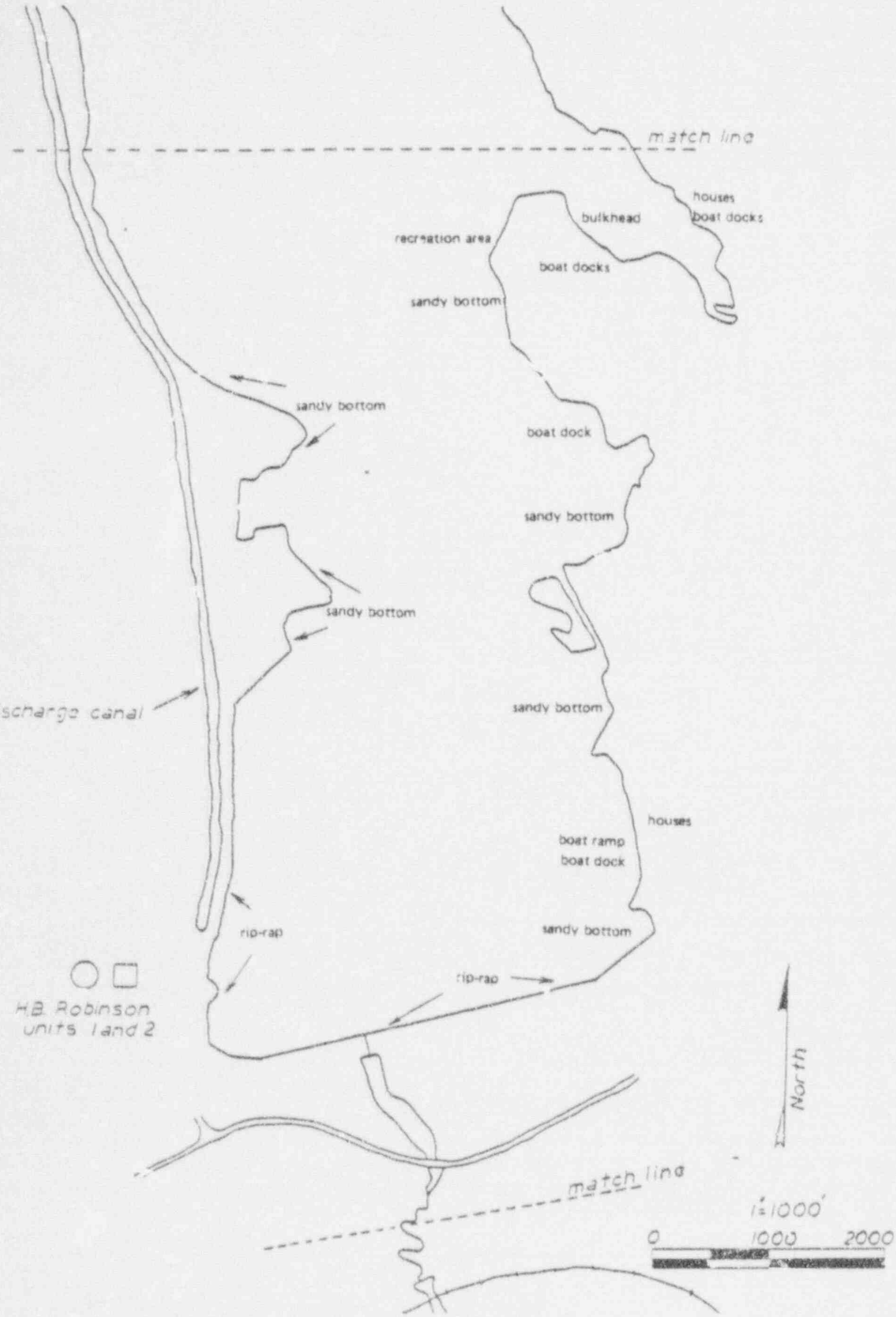

Figure 7.2.1a Physiographic and man-made features which influence the distribution of aquatic vegetation

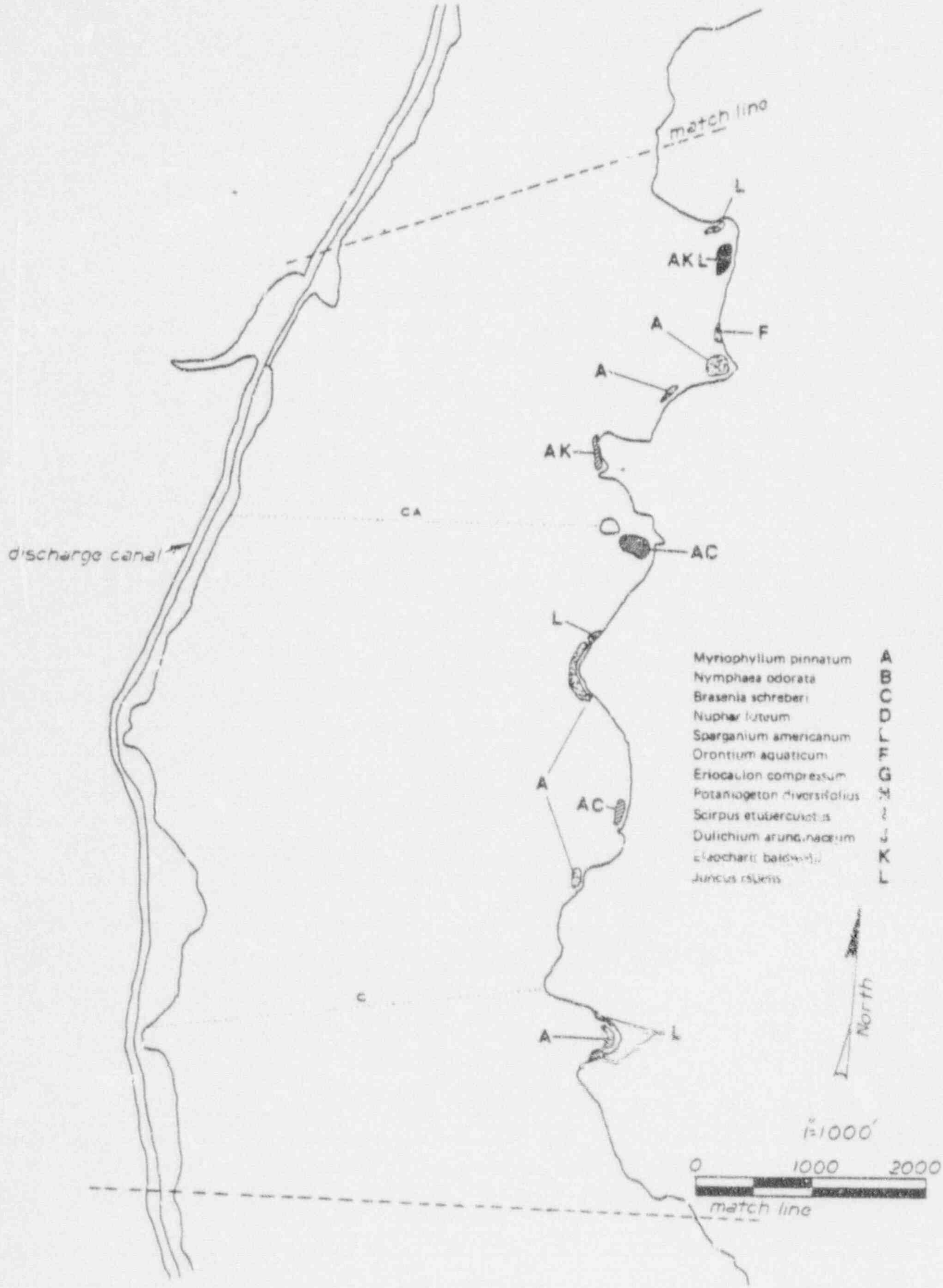

Figure 7.2.2 Vegetational distributions

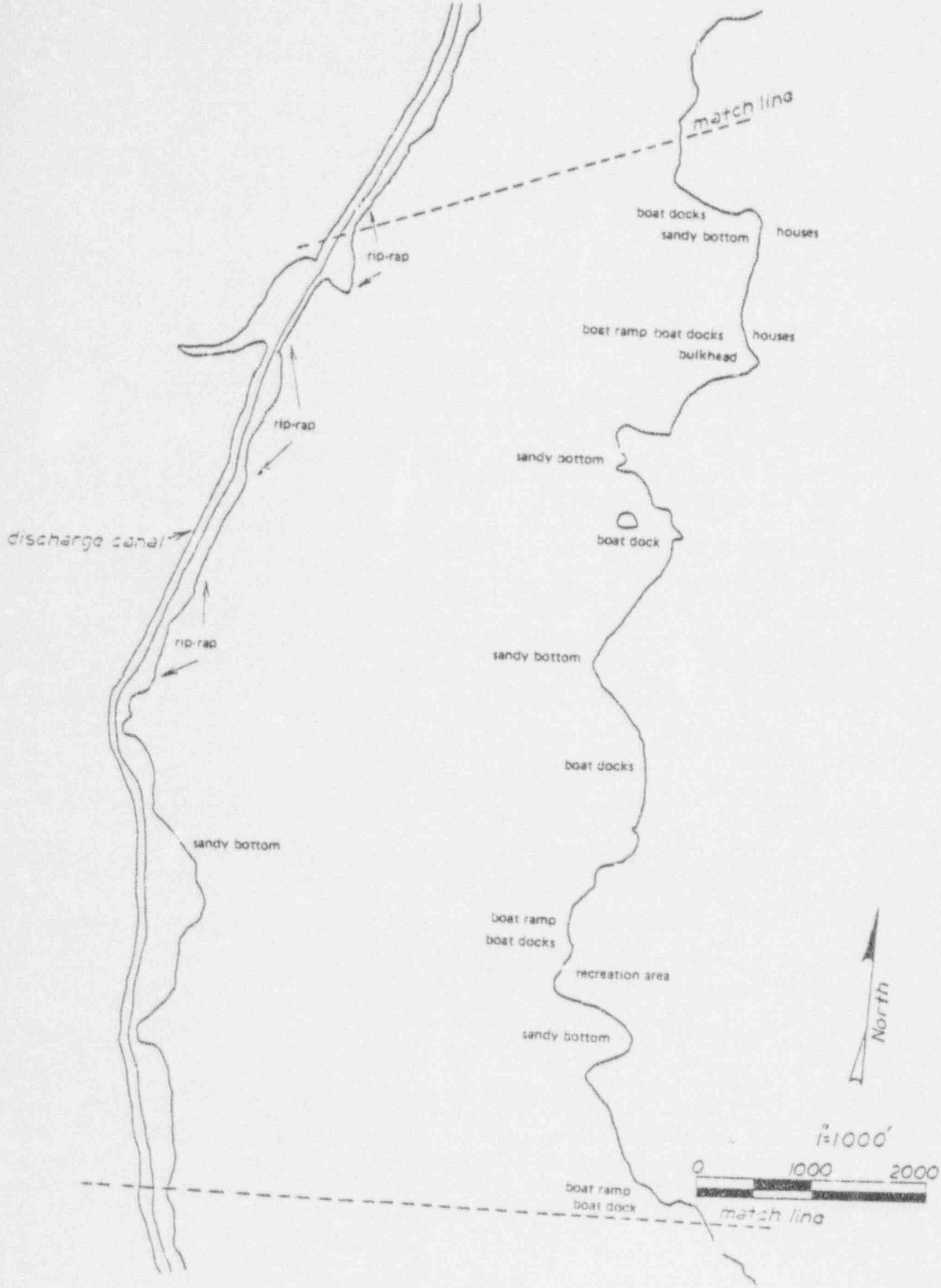

Figure 7.1.2a Physiographic and man-made features which influence the distribution of aquatic vegetation

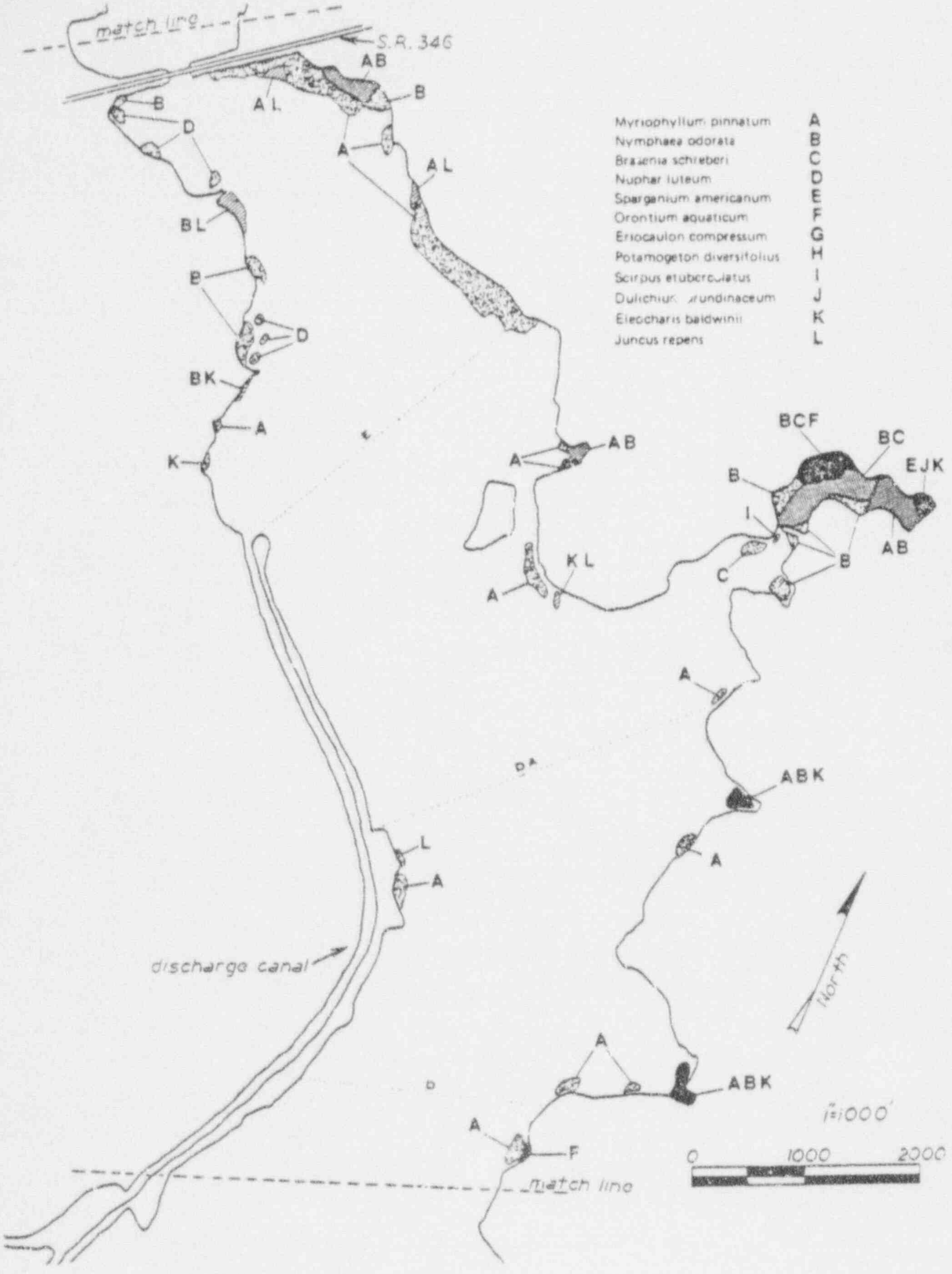

Figure 7.2.3 Vegetational distributions

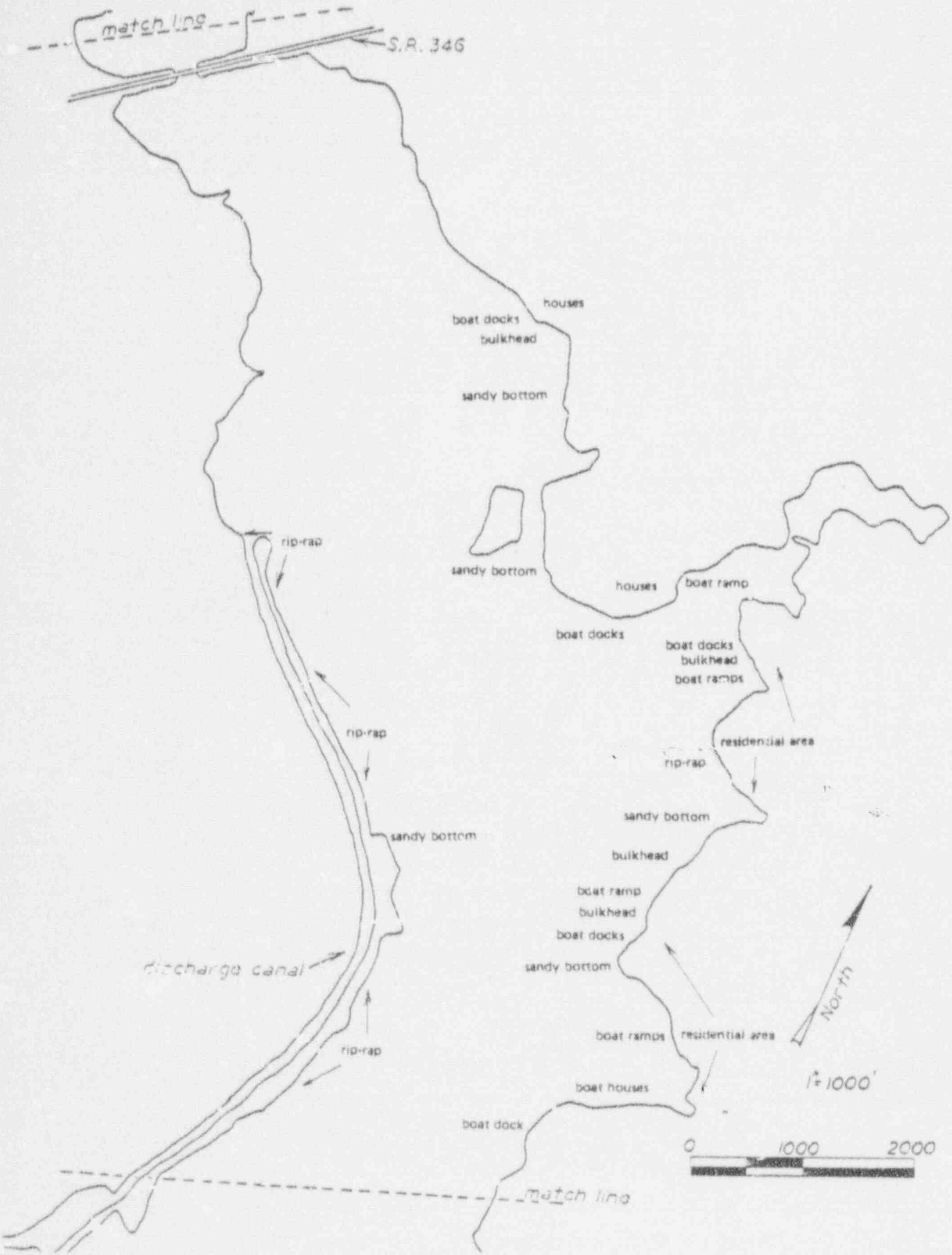

Figure 7.2.3a Physiographic and man-made features which influence the distribution of aquatic vegetation

Figure 7.2.5 Rip-rap along discharge canal above Transect A showing scattered red maple along shore

Figure 7.2.6 Sandy area near Transect A and rip-rap on dam in background

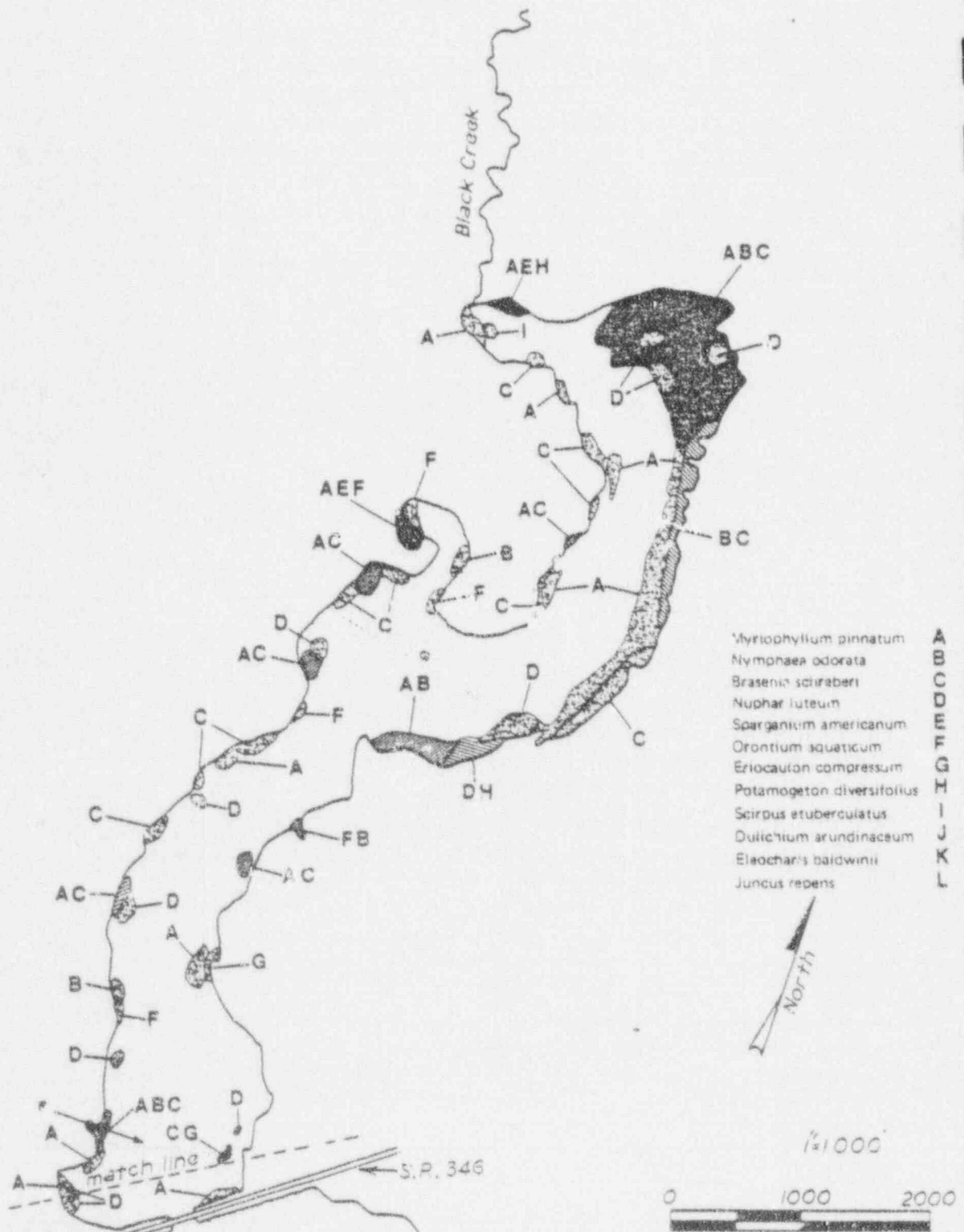

Figure 7.2.4 Vegetational distributions

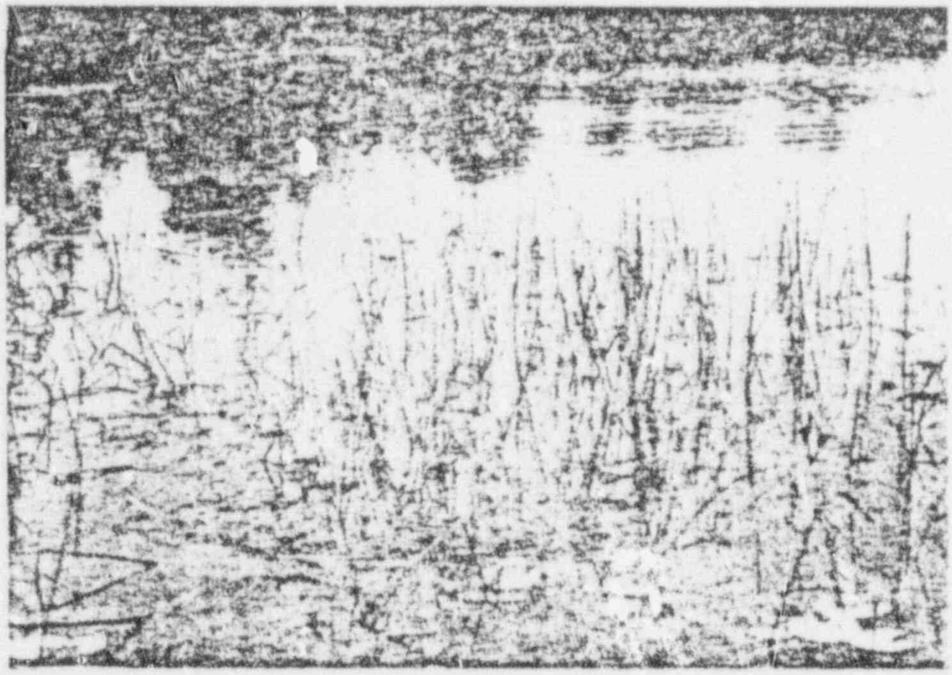

Figure 7.2.9 Upper impoundment below Station J showing Scirpus, Nuphar, and Brasenia with other marsh vegetation in background

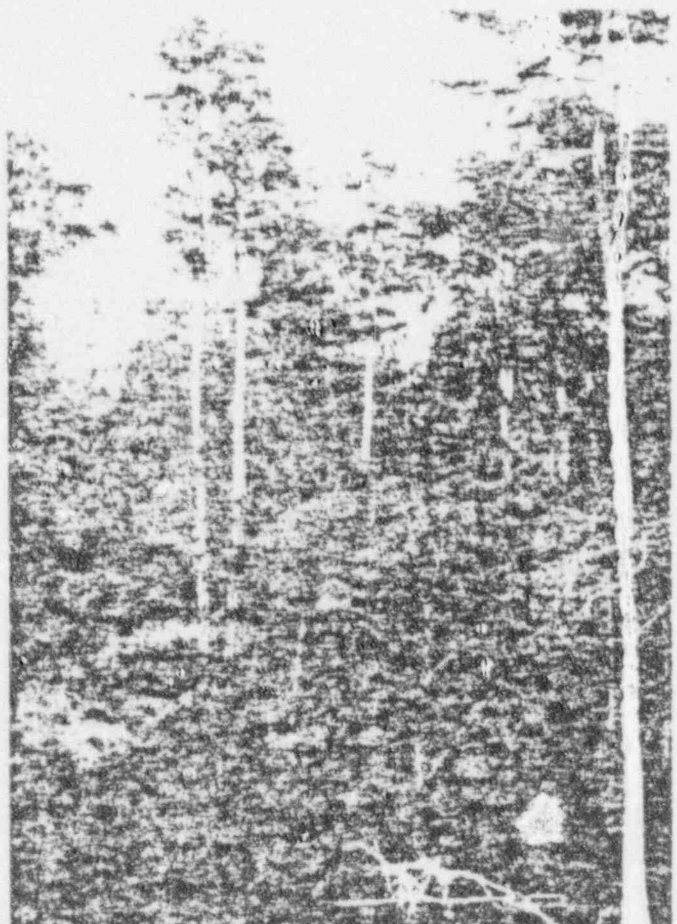

Figure 7.2.10 Gum, cypress, and associated swamp hardwoods at Black Creek Station K

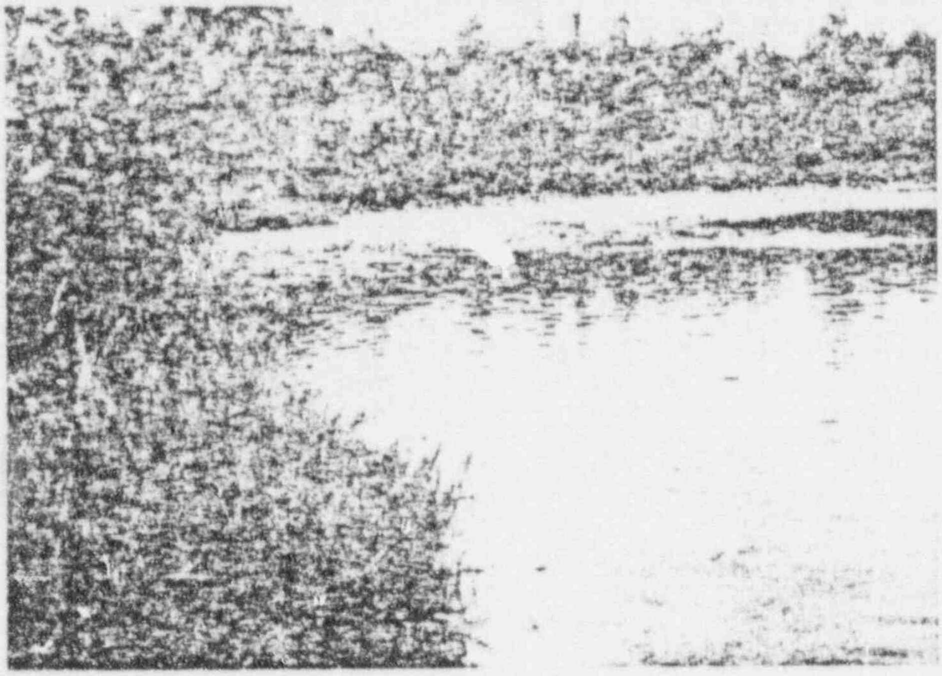

Figure 7.2.7 Cove approximately 2000' north of mouth of discharge canal showing flowering Nymphaea and Nuphar

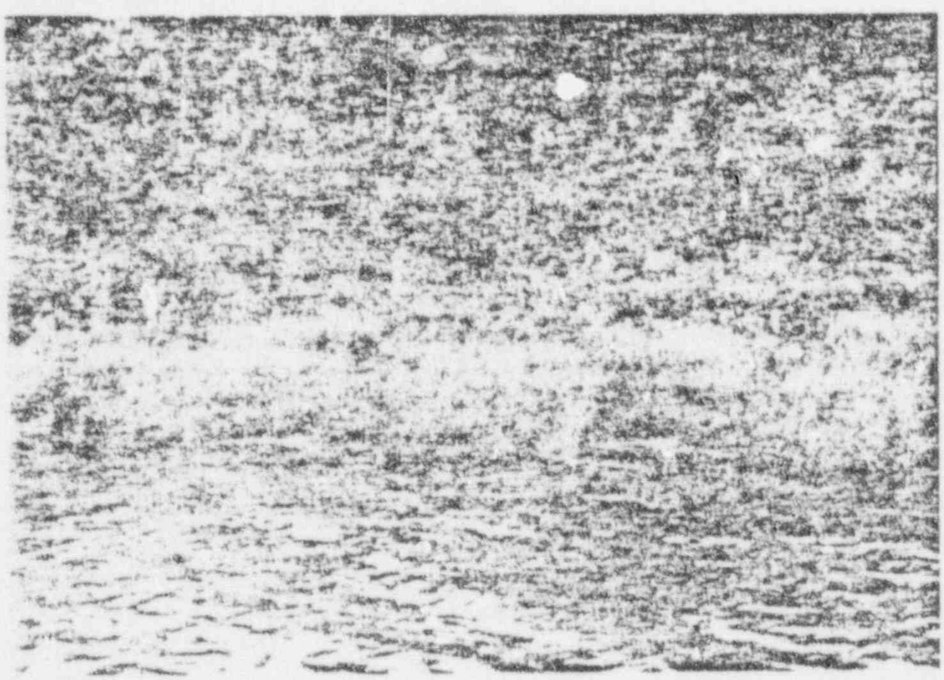

Figure 7.2.8 Shoreline vegetation illustrating Panicum hemitomon and lowland species with Sandhills vegetation rising in the background

Figure 7.3.2 Areas of reduced aquatic macrophyte growth due to the thermal effluent from the Robinson Plant

Figure 7.3.1 Areas of reduced aquatic macrophyte growth due to the thermal effluent from the Robinson Pla: :

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION
TEST TARGET (MT-3)

150mm

6"

8.0 Terrestrial Vertebrate Zoology

8.1 Introduction

When considering the effects of heat on the capacity of Robinson Impoundment to support a balanced indigenous community of fish, shellfish, and wildlife, account must be taken of the interactions which exist between the terrestrial and amphibious fauna and the aquatic ecosystem. These interactions have been evaluated by means of a terrestrial vertebrate sampling program at Robinson Impoundment. The objectives of the program were to identify the species which are dependent on the aquatic ecosystem, define the nature and extent of dependence, and determine the effects, if any, of thermally induced changes in the aquatic system on the identified species. Sampling, to achieve those objectives, was initiated in August, 1974, and continued on a quarterly schedule through February, 1976. Beginning July, 1975, through May, 1976, a special monthly study was conducted to determine what effects, if any, the heated effluent had on amphibian reproduction.

8.2 Amphibians

8.2.1 Methods

Because amphibians exhibit a high degree of dependence on an aquatic ecosystem, special emphasis was placed on identifying the amphibian species, distributions, and reproductive activities at Robinson Impoundment and Black Creek. Data on amphibians were obtained using three methods.

First, a monthly systematic effort was directed at the collection and identification of larval amphibians from selected locations within the study area. Thirteen stations (Figure 8.2.1) were located in suitable habitat in both the heated (MHS-5 to 9) and unheated (MHS-10 to 13) portions of the impoundment, in an outpocket of the discharge canal (MHS-4), and in Black Creek below the impoundment (MHS-1 to 3). The stations in the heated portion of the impoundment were restricted to the area between Transects DA and F where the greatest thermal stress was expected and where appropriate habitat

Observed Distribution

The observed distribution of each species was summarized geographically and thermally. Table 8.2.2 shows the distribution of observations and collections of each species from four regions of the study area. Those regions were Black Creek south of the impoundment, the impoundment north of Transect F, the impoundment south of Transect F, and the discharge canal (Figure 8.2.1). Since sampling effort was not equal among the four regions, no conclusions were possible concerning the relative abundance of the species in those regions. Table 8.2.3 reports water temperature means and ranges associated with both larval and adult specimens of the species collected or observed. Comparisons between the observed temperature data and the thermal tolerances reported in the literature are discussed in the sections entitled: Thermal Effects on Distribution and Thermal Effects on Reproduction, Development, and Growth.

Of the twenty-two identified amphibian species, only the southern two-lined salamander (Eurycea bislineata), the southern toad (Bufo terrestris), the southern cricket frog (Acris g. gryllus), the bullfrog (Rana catesbeiana), and the southern leopard frog (Rana utricularia) were found in all four regions of the study area. However, seven other species, including the lesser siren (Siren i. intermedia), the dwarf waterdog (Necturus punctatus), the mud salamander (Pseudotriton montanus), the spring peeper (Hyla crucifer), the green treefrog (Hyla cinerea), the carpenter frog (Rana virgatipes), and the bronze frog (Rana clamitans), occurred in all regions except the discharge canal. The little grass frog (Limnaoedus ocularis) was observed at the impoundment both north and south of Transect F. Of particular significance was the fact that five species; the dusky salamander (Desmognathus fuscus), the red salamander (Pseudotriton ruber), the American toad (Bufo americanus), the Fowler's toad (Bufo woodhousei fowleri), and the squirrel treefrog (Hyla squirrella); were observed at the thermally affected portion of the impoundment south of Transect F but not at the thermally unaffected portion of the impoundment north of Transect F. Only one species was found in the cooler upper impoundment that did not occur in at least one of the other regions of the study area. That species was the northern cricket frog (Acris c. crepitans) which at Robinson Impoundment is near the periphery of its reported range (Conant, 1975). Three additional species; the two-toed amphiuma

was available. Very little shoreline habitat suitable for amphibian reproduction existed south of Transect DA (Figures 7.2.1 to 7.2.4 and 7.2.1a to 7.2.3a). Hand held dip nets were used to collect specimens. One man-hour of effort was expended monthly at each station. Water temperatures were measured and recorded at the stations during each sampling period.

Second, an evening frog and toad call survey was conducted in conjunction with the monthly larval amphibian sampling. A minimum of five minutes was spent at each of eight stations (Figure 8.2.1) during which time any calling frogs and toads were identified. Four stations were located in heated areas of the impoundment between Transects DA and F (MHC-4 to 7), one in an unheated area north of Transect F (MHC-8), and three in Black Creek south of the impoundment (MHC-1 to 3). As with the larval sampling stations, no call survey stations were located south of Transect DA due to the limited amount of appropriate habitat available there.

Third, general observations and collections of specimens were made during all phases of terrestrial, aquatic, and fishery sampling throughout the impoundment area and at Black Creek. Collected specimens were preserved in 10% formalin, returned to the laboratory for positive indentification, cataloged, and retained in a reference collection. Essential details of all observations and collections were coded on computer data cards to facilitate data sorting and analysis.

8.2.2 Results and Discussion

Species Observed

Twenty-two amphibian species representing twelve genera were identified within the study area. Seven of those species were found only at Robinson Impoundment while three others were observed only at Black Creek. A total of nineteen and fifteen species were reported from the impoundment and Black Creek, respectively. A species list is presented in Table 8.2.1.

Anuran food habits range from entirely herbivorous tadpoles to strictly carnivorous adults. Both adult and larval salamanders are completely carnivorous (Goin and Goin, 1962). Thus, aquatic vegetation provides a direct source of food for the herbivorous tadpoles and an indirect source for the carnivorous larvae and adults which prey upon invertebrate and small vertebrate species associated with the vegetation.

Thermal Effects on Distribution

Thermal requirements and tolerances differ among the amphibian species as well as between the larval and adult stages of each species. Experimentally determined values for adult and larval critical thermal maxima (CTM), adult maximum voluntary temperatures (MVT), maximum temperatures for larval development, and maximum embryonic temperature tolerances have been reported in the literature. Values available for the species found within the study area are presented in Table 8.2.4.

Comparison of observed water temperature data included in CP&L Exhibit 2.1 with available adult CTM and MVT values in Table 8.2.4 indicated that thermal exclusion areas existed within the impoundment during the summer months. However, those thermal exclusion areas were believed to have had little direct effect on the actual distribution of most of the amphibian species. The expected (Bishop, 1943; Wright and Wright, 1949; Conant, 1975) and observed habitat preferences and requirements were responsible for the restriction of most of the amphibian species to the shallow, more heavily vegetated margins of the impoundment. Only specimens of lesser siren and dwarf waterdog were collected or observed away from the shallow waters (>0.5 m) along the immediate shoreline of the impoundment. Observed water temperature means and ranges for collected or observed amphibians (Table 8.2.3) and water temperatures recorded during the larval amphibian study (Table 8.2.5) indicated that, in addition to providing appropriate shoreline habitat, the many tributary springs, seeps, and streams created cool water plumes, marshy areas, and swamps which acted as thermal buffer zones. Those buffer zones protected amphibians occurring there from the encroachment of hotter water during the critical summer months.

(*Amphiuma means*), the many-lined salamander (*Stereochilus marginatus*), and the dwarf salamander (*Eurycea quadridigitata*); were collected only along Black Creek south of the impoundment.

Dependence on the Aquatic Ecosystem

The specific nature and extent of dependence on the aquatic ecosystem are quite different for each of the identified species. Some remain in or closely associated with water throughout their life cycles. Others return to water only during their respective breeding seasons. Nevertheless, appropriate and adequate breeding sites, cover, food, and water temperatures within tolerable ranges are needs common to all species encountered at the impoundment or Black Creek. Each of those needs was considered subject to possible thermal influence.

Amphibians are largely dependent on the heat in the environment to maintain body temperatures at levels which enable the continuance of normal metabolic functions and behavioral activities. Since amphibians have little or no physiological and only limited behavioral means of thermoregulation, environmental temperatures above or below the tolerable range of each species threaten the survival of individuals, and thus the continued existence of the species at the study area.

The reproductive phase of the life cycles of all amphibians found in the study area occurs in or near water, and aquatic plants provide the necessary breeding sites for many of those species (Bishop, 1943; Wright and Wright, 1949). Eggs are often laid attached to or among aquatic vegetation such as found in the shallow areas of the impoundment and Black Creek (Figures 7.2.1 to 7.2.4). Larval stages depend on the vegetation for protective cover during the subsequent period of growth and development. Following metamorphosis, the adults of those species which remain at the impoundment or Black Creek continue to utilize the vegetation for cover. Adults of the more terrestrial species of salamanders, frogs, and toads may no longer depend on the aquatic ecosystems of the study area until the following breeding season.

more likely subjected to the effects of increased heat than the other species, but the low number of observations and the lack of life history information made conclusions regarding those species impossible. Few observations of adults and no observations of larvae (Table 8.2.2) made conclusions concerning the American toad, Fowler's toad, northern cricket frog, squirrel treefrog, and little grass frog difficult. However, the location of the study area at or near the periphery of the reported geographical ranges of those five anuran species (Conant, 1975) was more likely responsible for the low number of observations than the effects of heat. The remainder of this discussion centers on the other anuran species (southern toad, southern cricket frog, spring peeper, green treefrog, bullfrog, carpenter frog, bronze frog, and southern leopard frog) listed in Table 8.2.1. The observed distribution of the larvae and breeding calls of those eight anuran species was included in Table 8.2.2.

As was previously discussed for the distribution of the adults of the eight species, the observed distribution of both larvae and calls seemed to be more dependent upon the availability of suitable habitat than on the direct effect of heat. Wright and Wright (1949) indicated that these species lay eggs attached to or among aquatic vegetation found in shallow water areas. Therefore, the thermal limitation of aquatic vegetation near the point of discharge, reported in Section 7.0, probably had some small indirect affect on reproduction, by reducing available breeding sites, and on larval development and growth, by reducing cover and food supply.

Because the larvae of the anuran species found at the impoundment are primarily herbivorous, any effects of heat on the distribution or productivity of benthic invertebrates did not likely produce any measurable effect on the larval development or growth. As previously stated, the carnivorous larvae of the salamander species were restricted by habitat requirements from areas where the benthic productivity was found to be low.

The breeding seasons of frogs and toads are dependent on two thermally influenced factors (Goin and Goin, 1962). First, the animals must be physiologically ready with supplies of ripe ova or sperm. That reproductive

The thermal limitation of the distribution and productivity of aquatic plants and associated benthic fauna discussed in Sections 6.0 and 7.0 probably had some indirect influence on the distribution of some of the amphibian species near the point of discharge by reducing the available cover and food supply. The distribution of the two species which inhabited the impoundment waters away from the immediate shoreline (lesser siren and dwarf waterdog) were more likely affected in this way. Because most of the amphibian species occurred exclusively along the shoreline where thermal impact on vegetation and benthos was minimized by the influx of cooler water from tributaries, little impact on the distribution of those species was believed to have resulted.

Thermal Effects on Reproduction, Development and Growth

Thermal impact on amphibian reproduction, development, and growth may occur in a number of ways. The availability of aquatic vegetation which provides breeding sites and food to some species may be limited. The occurrence of suitable prey species required by carnivorous larvae may be reduced. Reproductive behavior may be stimulated outside the normal breeding seasons. The viability of eggs and the survival of larvae may be threatened by temperatures approaching or reaching respective critical thermal tolerances. The rates of embryonic and larval development may be altered.

Breeding habits and requirements of some of the amphibian species found at the study area excluded them from the possible effects of increased heat. The six identified salamander species (Table 8.2.1) required cool water streams, springs, or swamps for egg laying sites and larval nursery areas (Bishop, 1943). Because all collections and observations of both adults and larvae of those six species were made at the mouths of tributaries or in associated marshes and swamps, any expectation of thermal impact on their reproduction, development, or growth was considered unrealistic.

The actual nature and extent of thermal impact on the reproduction, development, or growth of the remaining species was not determined, but some species were more exposed to the elevated water temperatures of the impoundment than others. The entirely aquatic lesser siren and dwarf waterdog were

Goin and Goin (1962) reported that higher temperatures accelerate both the embryonic and larval development of amphibians. For the leopard frog (Rana pipiens), hatching occurs in 6 days and metamorphosis in 3 months at 18°C (64°F). At 25°C (77°F) the rate of development is increased such that hatching takes place in 5 days followed by metamorphosis in 2 1/2 months. Larval development of the leopard frog was found to be accelerated by an increase in temperature up to the CTM by Atlas (1935). Volpe (1953) found that the rate of the embryonic development of toads (Bufo sp.) was increased up to a limiting temperature of 35°C (95°F).

No specific study was conducted to determine if the development of anuran eggs and larvae was more rapid south of Transect F than north of Transect F, but some evidence of this was indicated for at least one species. With approximately equal sampling effort, the ratio of adult to larval southern cricket frogs collected or observed through the 1975 breeding season was much higher south of Transect F (86/11) than north of Transect F (25/88). Assuming breeding took place at the same time, which may not be true since calls continued a month later at the upper impoundment, those ratios indicated accelerated development with metamorphosis occurring earlier at the lower impoundment.

The combined thermal impact on the reproduction, development, and growth of the amphibian species exposed to the increased heat was not considered a significant threat to the continued existence of those species or population balances within the study area. Given that Unit 2 had been in operation for approximately four years prior to the current study, the presence of the amphibian species was considered evidence of successful reproduction, development, and growth throughout the study area during that period of time.

8.3 Reptiles

8.3.1 Methods

Data pertaining to the reptiles of Robinson Impoundment and Black Creek were gathered by observation and collection of specimens throughout all phases of the biological sampling programs conducted within the study area.

readiness is probably controlled by seasonal changes in the activity of the anterior pituitary gland which is known to be influenced by changes in environmental temperature. Second, after breeding condition has been achieved, breeding activity must be induced by appropriate climatic factors which, depending on species, may or may not include a rise in temperature.

A comparison of observed breeding seasons in three regions of the study area for the eight anuran species most likely exposed to the effects of increased heat was made in Table 8.2.6. Breeding calls were considered evidence of breeding season. Data included in the table for the observed breeding months was collected beginning in June, 1975 through May, 1976. During that period some differences were noted between the observed breeding months at the three designated regions. To what degree any of the observed differences were caused by increased water temperatures resulting from the heated discharge was not possible to determine. However, the thermal disch...e wa... ected to be a factor only where differences were observed betwe... the essentially unheated portion of the impoundment north of Transect F and the heated portion of the impoundment south of Transect F. Such differences occurred for four of the eight species (southern cricket frog, bullfrog, bronze frog, and southern leopard frog). The differences in the observed breeding seasons north and south of Transect F wer... not considered great enough to have had a negative impact on the populations of the respective species.

Available literature values for the thermal tolerances of the eggs and larvae of the amphibians found at the study area are presented in Table 8.2.4. Although water temperatures throughout much of the study area (CP&L Exhibit 2.1) exceeded the reported embryonic and larval toleran... values, the water temperatures recorded during the larval amphibian sampling program (Table 8.2.5) in appropriate breeding habitat indicated availability of water cool enough for successful reproduction throughout the study area. The larvae of only one anuran species, the green treefrog, was found north of Transect F but not south of Transect F. Since only two specimens were collected, that difference was more likely a result of sampling error than a function of thermal stress.

only single specimens of river cooter (Chrysemys c. concinna) and red-bellied turtle (Chrysemys rubriventris) were observed. Both of these observations occurred in the impoundment south of Transect F. Four observations of snapping turtles (Chelydra serpentina) were recorded at the same location on Black Creek several hundred meters below the impoundment. Because snapping turtles rarely bask (Conant, 1975), other specimens may have gone undetected during the study.

A greater number of observations made possible a better understanding of the distributions of spotted turtles (Clemmys guttata) and chicken turtles (Deirochelys r. reticularia). Spotted turtles were found to occur along the shoreline of the impoundment north of Transect F, as well as in the swamps adjacent to Black Creek south of the impoundment. Chicken turtles were sighted on several occasions at the impoundment north of Transect F but only once at the impoundment south of Transect F.

A relatively large number of observations of stinkpots (Sternotherus odoratus) and yellow-bellied turtles (Chrysemys s. scripta) enabled a better determination of their respective distributions. Stinkpots were seen throughout the impoundment and in Black Creek north of the impoundment with most of the observations reported from the impoundment south of Transect F. Yellow-bellied turtles were found in both regions of the impoundment as well as at Black Creek south of the impoundment. The majority of those observations were made in the impoundment north of Transect F. Many of the unidentified turtles observed and reported in Table 8.3.2 were believed to have been yellow-bellied turtles. Special note should be made of the fact that during the course of the study twelve yellow-bellied turtles and one stinkpot were observed in a shallow outpocket of the discharge canal.

Specimens of all three species of aquatic snakes known to occur in the study area were observed throughout the impoundment and at Black Creek north and south of the impoundment. Both the banded water snake (Natrix f. fasiata) and the brown water snake (Natrix taxispilota) were encountered most frequently along the shoreline of the impoundment south of Transect F. The majority of eastern cottonmouth (Agkistrodon p. piscivorus) observations were made in the swampy areas adjacent to Black Creek north and south of the impoundment and in the marshy areas along the shores of the impoundment north of Transect F.

Most of the observations and collections were made in conjunction with the other terrestrial zoology studies, with supplemental information provided by observations and collections made during aquatic and fishery sampling.

In most instances, captured specimens were identified in the field and released unharmed. Collected specimens were preserved in 10% formalin, returned to the laboratory for positive identification, cataloged, and retained in a reference collection. Essential details of all observations and collections were coded on computer data cards to facilitate interpretation and analysis.

8.3.2 Results and Discussion

Species Observed

Twenty reptilian species were identified during the field studies conducted at Robinson Impoundment and Black Creek (Table 8.3.1). Of those, seven species of turtles and three species of snakes were considered to be dependent upon the aquatic ecosystems of the impoundment or Black Creek for some portion of their life cycle. The remaining ten species were considered to be terrestrial and not likely to be exposed to any effects of the thermal discharge. The following results and discussion centers on the ten aquatic or semi-aquatic species found to be present within the study area.

Observed Distributions

The observed distribution of each species is summarized in Table 8.3.2 by the number of observations or collections of each species from five generalized regions of the study area. Those regions were Black Creek north of the impoundment, Black Creek south of the impoundment, the impoundment north of Transect F, the impoundment south of Transect F, and the discharge canal (Figure 8.2.1).

Little can be said concerning the actual distribution of several of the observed species within the study area. During the course of the study,

must be able to behaviorally or physiologically thermoregulate in order to survive (Brattstrom, 1965).

Thermal Effects on Distribution

Experiments which established values for critical thermal maximum (CTM) and maximum voluntary temperatures (MVT) for many reptilian species have been reported in the literature. The values available for species found within the study area are presented in Table 8.3.3. Caution must be exercised in interpreting and drawing conclusions from the information in Table 8.3.3 because the values for the CTM and MVT were experimentally determined for specimens which, in many cases, were collected from regions with colder climates than the Robinson study area. Those specimens very likely exhibited considerably lower CTM and MVT values than expected for specimens acclimated to a more southern locality.

Based on the CTM and MVT values in Table 8.3.3, the water temperature data presented in CP&L Exhibit 2.1, and the conclusions expressed in Se :ions 6.0 and 7.0, the distributions of some of the aquatic and semi-aquatic reptilian species within the study area were limited both directly and indirectly by the thermal discharge. The direct effect of the increased heat on the distribution of reptiles resulted from the existence of exclusion areas centered at the mouth of the discharge canal during the summer months. The actual size and duration of the exclusion areas varied for each species based on specific thermal tolerances. The reptilian collections and observations reported in Table 8.3.2 generally supported the occurrence of the exclusion areas.

Regardless of the size and duration of the exclusion areas, the actual impact was probably reduced by several considerations. Due to habitat preference, not all of the reptilian species identified at Robinson Impoundment were likely to occur in the thermally affected areas. Species including the spotted turtle, river cooter, and eastern cottonmouth were among that group. The red-bellied turtle which was observed a single time at Robinson Impoundment was considerably removed from the reported range of that species, and may have been artificially introduced by escape or release from captivity. Although the CTM of several of the remaining six species was exceeded near the point of thermal discharge, no

Dependence on the Aquatic Ecosystem

The life histories of each of the ten aquatic or semi-aquatic reptilian species identified within the study area are closely associated with the waters of Robinson Impoundment and Black Creek. For those species to be present and continue to exist in the study area, the impoundment and Black Creek must meet the specific habitat and physiological requirements of each. Although the nature and extent of dependence on the aquatic ecosystem varies for each species, the impoundment and Black Creek must provide such thermally dependent conditions as appropriate escape cover, adequate food supply, and a suitable medium in which thermoregulation can be achieved.

Escape cover for any species must provide an appropriate refuge or escape route for disturbed or threatened individuals. Although the open water of the impoundment and Black Creek performed this function to some degree, the aquatic vegetation was of more importance. Essentially all observations of the chelonian and serpentine species found within the study area were made in or near significant beds of vegetation (Figures 7.2.1 to 7.2.4).

Beds of vegetation not only provide escape cover, but also, serve as a source of food for the aquatic and semi-aquatic reptiles. Some species feed directly on the vegetation while other species feed on the fauna associated with the vegetation. Carr (1952) reported the food habits of snapping turtles, yellow-bellied turtles, red-bellied turtles, and chicken turtles to be essentially omnivorous. A study of yellow-bellied turtles of South Carolina by Clark and Gibbons (1969) found evidence which showed that juveniles tended to be primarily carnivorous with adults becoming generally herbivorous. Carnivorous food habits were reported for the spotted turtle and stinkpot (Carr, 1952), as well as, for the eastern cottonmouth and the banded and brown water snakes (Wright and Wright, 1957). No food habit studies were performed on the reptiles collected from Robinson Impoundment and Black Creek.

The existence and survival of the reptiles directly depends on the ability to successfully thermoregulate within the surrounding environment. If temperatures of the environment rise above or fall below the range where normal activities and functions can be performed, each animal

Gibbons' studies indicated that specimens from an experimental population at Par Pond exhibited exceptionally large individual body sizes and extraordinary juvenile growth rates when compared to specimens from a control population. Increased water temperature was ruled out as being a direct cause of those observations, but was offered as a possible indirect cause by increasing the productivity at lower trophic levels. As a result of the increased productivity, a diet of higher protein content was made available to and utilized by the turtles. Further observations by Gibbons indicated an increased reproductive potential for the Par Pond population. That conclusion was based on findings that the females of the experimental population tended to lay more eggs per clutch and possibly more clutches per year than the control populations.

8.4 Avifauna

8.4.1 Methods

Quarterly quantitative sampling began in August, 1974 and ended in February, 1976. Quantitative observations were recorded at the stations shown in Figure 8.4.1. During each quarter, one morning and one evening survey were conducted along the east and west shorelines. Qualitative observations were recorded during monthly visits to the impoundment.

8.4.2 Results and Discussion

To facilitate data analyses and discussion, the aquatic avifauna (44 species) were grouped into categories based upon taxonomic and ecological similarities. Each category will be discussed individually. Similarly, the impoundment was divided into three sections (Figure 8.4.1) based on relative heat load. Sections I and II received heat from the discharge, Section III did not. Black Creek observations are discussed separately.

During the sampling, a large number of nonaquatic avifauna (91 species) were identified around the impoundment and along Black Creek. These observations

deaths were likely to have resulted since the individuals of those species were expected to have moved away from the exclusion areas as the water temperature reached and exceeded the respective MVT requirements.

Another consideration was that cooler refuge areas existed within or adjacent to the reported exclusion areas. Those refuge areas included springs and streams and the associated swamps or marshy areas at the edge of the impoundment and along Black Creek. Each of these refuge areas provided a suitable habitat where the displaced reptiles were able to survive during the periods when the exclusion areas existed. A negative impact of movements into the refuge areas may have resulted due to increased competition for available food supplies.

Because the aquatic vegetation of the impoundment provided both cover and food, any thermal effects on the distribution and productivity of that vegetation and the associated fauna were assumed to cause corresponding indirect effects on the distributions of the aquatic and semi-aquatic reptiles. Because the distribution and productivity of aquatic vegetation and benthos were reduced near the point of thermal discharge by the increased temperatures during the summer months (Section 6.0 and 7.0), the dependent reptilian species were probably forced to move to adequate food and cover if not previously forced to move due to direct effects of the increased temperatures. It was not possible to separate the impact of direct and indirect thermal effects on the observed distributions of reptiles.

Thermal Effects on Growth and Reproduction

Other effects that may result from the increased heat load on Robinson Impoundment relate to the growth and reproduction of the reptilian species. Although no special studies were conducted at the study area to determine the nature or extent of this possible impact, some previous work was reported by Gibbons (1970) on the yellow-bellied turtles (*Chrysemys scripta*) of Par Pond, a thermally influenced reservoir at the ERDA Savannah River Plant, Aiken, South Carolina.

All seven species were highly prized and actively sought during the South Carolina waterfowl hunting season. In addition, the wood duck (Aix sponsa), which is the only species known to nest in the Robinson Impoundment area, was included in this group. As a group, surface-feeding ducks utilized the aquatic ecosystem in two ways--as a resting site, and as a feeding area.

Surface-feeding ducks are almost entirely vegetarian with the bulk of their diet composed of aquatic species such as wild millet (Echinochloa spp.), smartweed (Polygonum sp.), bulrush (Scirpus spp.), pondweed (Potamogeton spp.), wigeongrass (Ruppia maritima), and a variety of other species (Martin et al. 1951). An exception to this is the wood duck whose primary foods are acorns, hickory nuts, and the aquatic vegetation associated with the wooded swamps where it spends much of its time (Martin et al. 1951). Smart weed, bulrush, and pondweed were observed at the impoundment (Section 7.0). The small amount of animal matter consumed by this group consists primarily of the immature aquatic insects.

At Robinson Impoundment, members of this group were observed during all seasons of the year. Their numbers peaked during fall migrations and during the return flight in the spring.

The 516 observations recorded for this group during the study comprised 14% of the total (Table 8.4.2). Wood ducks were the most commonly observed species.

Brisbin (1973) identified this group as the most thermally intolerant of those he studied. He further stated that no individuals from this group were ever observed in the heated portion of his study area, and a superficial examination of the distribution data recorded for this group at the impoundment supports his conclusions. There are, however, three factors other than heat present at Robinson Impoundment which could have had a significant impact on the distribution of this group in the impoundment.

will not be discussed, but are included in Table 8.4.4 to provide additional information on the species diversity and seasonal changes of the bird populations in the Robinson Impoundment area.

A species list of the avifauna (135 species) observed at Robinson Impoundment and Black Creek during the study is presented in Table 8.4.3.

Grebes, Three Species (Table 8.4.1)

Grebes are small, recreationally unimportant waterbirds found throughout the United States on inland lakes and along coasts. Grebes are weak flyers but strong swimmers, and are entirely dependent on the aquatic ecosystem for food. Martin et al. (1951) states that grebes are entirely carnivorus feeding primarily on fish, crustaceans, aquatic insects, and mollusks.

At the Robinson Impoundment, grebes were present primarily during fall and winter. Of the total number of waterfowl observations made (3,704), grebes accounted for only 2% (92) of the total (Table 8.4.2). Grebes were not restricted to any specific area of the impoundment and were noted in approximately equal numbers in heated and unheated portions of the impoundment (Table 8.4.2). Brisbin (1973) also reported no significant differences in distribution of grebes between heated and unheated portions of his study area on the ERDA Savannah River Plant.

Grebes are entirely dependent upon the aquatic ecosystem for food and apparently show no aversion to heated water. The availability of suitable habitat for their major food species was the overriding factor which determined their distribution in Robinson Impoundment. During the months when grebes were most common on the impoundment, the water temperatures were well within the tolerances limits for their major food items and did not restrict their distribution. During the study no adverse effects upon the grebes from the heated effluent were noted.

Surface-Feeding Ducks, Seven Species (Table 8.4.1)

The surface-feeding or dabbling ducks were the most important group of water birds (from a recreational standpoint) at Robinson Impoundment.

Diving Ducks, Nine Specie (Table 8.4.1)

In terms of recreational importance, the diving ducks rank second behind the surface-feeding ducks. Most hunters consider them to be inferior in quality as table fare, and while they may be taken occasionally, are usually not actively hunted as a group. Diving ducks are generally thought to be primarily animal feeders giving rise to the commonly used term "fish duck." Martin et al. (1951), however, cites numerous studies which show that, except for the mergansers and the bufflehead, plant matter constitutes the major portion of their diet. Plant species known to comprise a significant food source for this group include pondweed (Potamogeton sp.), muskgrass (Chara sp.), coontail (Ceratophyllum demersum), watershield (Brasenia schreberi), and wigeongrass (Ruppia maritima). Most of the animal food consists of immature aquatic forms of insects, crustaceans, fish, and mollusks. Mergansers and buffleheads are primarily fish eaters, with the remainder of the diet consisting of crayfish, shrimp, frogs, and insects (Martin et al. 1951).

Diving ducks usually frequent the open water areas of lakes where they may flock together in large "rafts" to rest and feed. As a group, diving ducks tend to migrate later than other waterfowl, usually moving south just ahead of temperatures which freeze their resting and feeding grounds. At Robinson Impoundment, observations of this group confirmed these behavioral characteristics.

The greatest concentrations for this group were noted in November and February quarterly samples, when rafts of up to 150 birds of a given species were often recorded. Of the 544 observations recorded for this group, 71% were from the lower third of the impoundment, and 21% from the middle third near the heated discharge. In summary, 92% of the observations for this group came from the areas of the impoundment subject to thermal influence. Brisbin (1973) reported similar results regarding seasonal abundance and species observed, from this group, and stated that while there was a significant difference in abundance between heated and unheated portions of his study area, the diving ducks appeared less thermally sensitive than the surface-feeding ducks.

First, preferred habitat for surface-feeding ducks was not equally distributed between the heated and unheated portions of the impoundment. Eighty-eight percent of the observations for this group were recorded from the upper impoundment which is not subjected to thermal stress, but which does contain the major areas of preferred habitat for this group. Several small areas of shallow marsh do exist in the heated portion of the impoundment and on several occasions surface-feeding ducks were observed in these areas. Of the twelve percent of the observations for this group recorded below the bridge, eleven percent were in the area subjected to the greatest thermal stress.

Second, the shallow marsh areas below the bridge which form the preferred habitat for surface-feeders are either situated near residential areas along the impoundment or are visited frequently by boaters and fishermen. Utilization of these areas by surface-feeding ducks was reduced as a result of frequent disturbance.

The third factor contributing to the distribution of this group in Robinson Impoundment is the temperature difference between the heated and unheated areas of the impoundment. Brisbin (1973) reports temperatures of 30-35°C in his heated study area at the Savannah River plant during the winter months when this group is most abundant. Robinson Impoundment temperatures in the heated area averaged approximately 10-15° cooler during the winter months. It appears likely that the surface-feeding ducks may be adversely affected by temperatures above the 30°C mark, but when cooler temperatures prevail, the presence and suitability of preferred habitat has the strongest influence on distribution.

In general, the seasonal abundance of this group at Robinson Impoundment and the preference for habitat areas away from the heated effluent make it unlikely that there is a significant impact attributable solely to heat.

Rails, Two Species (Table 8.4.1)

Of the two species of this group at Robinson Impoundment, the coot was the most noteworthy. Coot are one of the most abundant waterbirds in the U. S. and may be exceeded in numbers only by the mallard and pintail (Martin et al. 1951). Coot are often erroneously referred to as "ducks," but are in fact more closely related to rails or "marsh hens." They are not recreationally important and are often considered a nuisance in areas where they congregate.

Coot feed almost entirely on aquatic vegetation with duckweed (*Lemna sp.*), wigeongrass (*Ruppia maritima*), various algae and muskgrass (*Chara sp.*) being of primary importance (Martin et al. 1951). The small amount of animal food consists mainly of aquatic insects.

At Robinson Impoundment, coot were the most frequently observed species, comprising 60% of the aquatic birds observed. Such high numbers of coot are not uncommon based on evidence from other southeastern study areas. Coot accounted for 66% of the total number of waterfowl observed by Brisbin (1973), and he cites other studies (Pratt, 1969; Dopson, 1964) where similar results were obtained.

Highest numbers were observed during November and February quarterly samples, again similar to results observed elsewhere in South Carolina. Within the reservoir, 94% of the coot observations were recorded from the heated portions of the reservoir (Table 8.4.2). Large flocks of coot were observed in coves and in the open water from the discharge point to the dam. Based on these observations, the heated effluent obviously had no adverse effect upon coot.

The other member of this family, the king rail, inhabits the tall marsh grasses where it feeds primarily on insects. At the impoundment, king rails were most common in late summer and autumn in the marshy areas above the SR 346 bridge.

Robinson Impoundment provides suitable habitat for several species of diving ducks, and during the time when they are present they do not seem to be adversely affected by the heated effluent.

<u>Herons, Egrets, Bitterns, Eight Species</u> (Table 8.4.1)

Members of this group of waterbirds are restricted to the water margin habitat along lakes and rivers. They are commonly observed in marshy or swampy areas wading slowly in the shallows in search of food. Birds of this family have little economic or recreational importance. They are, however, directly dependent on the aquatic ecosystem as a food source. These birds are primarily carnivorus, with fish, crustaceans, amphibians, mollusks, and insects forming the major portion of their diet (Martin et al. 1951).

Members of this group were observed year-round at the impoundment with slightly greater numbers and diversity during spring and summer months. Thirty observations of this group accounted for one percent of the total. Distribution in the impoundment area was as expected considering the habitat requirements for this group. Half (50%) were noted in the marshy areas above the bridge with the remainder observed in the scattered suitable areas in the heated portion of the reservoir.

Since these birds are not truly aquatic, the heated water does not affect them directly. They do, however, rely on the marshy areas around the impoundment for food, and changes in the distribution of these areas or their suitablility as habitat for the aquatic species which form the prey for this group would adversely affect these birds. Data presented in Section 7.0 (Aquatic Vegetation) indicate that heat has reduced the potential for growth of aquatic plants in some areas of the impoundment. However, the small number of birds of this group observed and the limited areas of vegetation affected by the heat do not constitute a significant impact on the population present.

this family accounted for five percent of the total. Ninety-four percent (94%) of the observations for this group came from the heated portion of the impoundment, indicating possible attraction to, or at least no adverse affects from, the heated effluent.

Miscellaneous, Five Species (Table 8.4.1)

The five species discussed here do not conveniently fit into the larger groups discussed previously and, except for the kingfisher, were recorded infrequently or in such small numbers that separate discussion is unnecessary. They do depend upon the aquatic ecosystem when present, however, and thus merit at least brief mention.

Kingfishers which feed primarily on fish (Martin et al. 1951) were year-round residents of Robinson Impoundment. Since they were restricted to specific habitats around the lake and were not present in large numbers, impact from thermal effluent was considered minimal.

The Canada goose and whistling swan occasionally rested on the impoundment for short periods during migrations. Their habitat preferences and food requirements were similar to the surface-feeding ducks and if present in larger numbers would be subjected to the same type of thermal impact.

The common loon and the double-crested cormorant were also infrequent visitors to Robinson Impoundment. Feeding primarily upon fish, both species closely resemble the diving ducks in their relationship with the aquatic ecosystem and the potential for impact from the heated effluent.

Black Creek Below the Impoundment

Below Robinson Impoundment, Black Creek flows through a cutover gum-cypress swamp until it reaches Prestwood Lake in the city of Hartsville. Swamps of this type are poor habitat for the majority of waterfowl observed in the Robinson area, but are occasionally used by surface-feeding ducks as resting and feeding areas. Three locations (Transects H, K, L) (Figure 8.4.1)

Shorebirds, Five Species (Table 8.4.1)

Like the herons, members of this group are lake margin inhabitants often seen near the water's edge along sandy shoreline areas. Shorebirds feed almost exclusively on animal matter, with insects, especially immature aquatic forms, small crustaceans, mollusks, and worms the most important groups (Martin et al. 1951).

At Robinson Impoundment, members of this group were observed year-round but were most abundant during spring and summer. Two percent of the total observations recorded were of this group (Table 8.4.2). Their preference for relatively barren beach areas was reflected by their distribution at the impoundment. Observations for this group were recorded from the lower sections of the impoundment where such habitat exists.

If the thermal effluent restricts the distribution of food items for this group within the impoundment, corresponding shifts in the distribution of shorebirds would occur. Benthic data (Section 6.0) indicate that the heated discharge has little or no impact upon aquatic invertebrates in the lower sections of the impoundment where shorebirds were most common. Therefore, there was probably no adverse impact upon this group attributable either directly or indirectly to heat.

Gulls and Terns, Five Species (Table 8.4.1)

The gulls and terns observed at the impoundment are common visitors to inland waters. This group spends much of its time on land, but feeds almost exclusively on the water. Terns feed primarily upon fish but also take insects and other aquatic fauna. Gulls are scavengers, subsisting to a large degree on fish, crustacea, insects, and aquatic garbage.

This group has been observed during all seasons at-Robinson Impoundment, but are most common during winter and spring. Observations of

muskrat, raccoon, mink, and otter) were determined to depend on or interact with the aquatic ecosystem to the extent that changes in the aquatic ecosystem could affect their habits.

The remaining species may interact with the aquatic ecosystem on an occasional basis but were probably not influenced to any great degree by changes within the impoundment.

Since each species interfaced with the aquatic ecosystem in a manner different in both type and degree from the others, a separate discussion of each is presented.

Beaver (*Castor canadensis*)

Beaver were once extinct in South Carolina but restocking efforts on the Sandhills National Wildlife Refuge reintroduced this species to the Robinson area. During the study, observations indicated that beaver were the most numerous aquatic mammal in Robinson Impoundment. Figure 8.5.3 shows the location of actual sightings and indications (scats, girdled trees, scent mounds) of beaver activity along the shoreline. Thirteen lodges (Figure 8.5.2) in various states of repair were located along the impoundment shore and in Black Creek.

Beavers interact with the aquatic ecosystem in a number of ways. The lodges and felled trees along the shoreline provide shelter for fish and sunning areas for turtles and snakes. In some areas beavers impound tributary streams creating additional habitat for all aquatic species. A large part of the diet of beavers is aquatic in origin. Jackson (1961) states that in summer beavers feed primarily on sedges, rushes, water grasses, lily pads, roots and tubers of water plants, and twigs of shoreline woody vegetation. Such vegetation is present in several areas along the impoundment shoreline.

Beavers, as is the case with all mammals, thermoregulate to avoid the effects of extreme heat or cold, thus the direct effect of the heated effluent on beavers was minimal. However, since beaver depend primarily on aquatic plants for food, especially during the summer months, any changes in

were used as sampling stations. Observations were recorded for two ten-minute periods during each quarterly sample. Table 8.4.5 summarizes the Black Creek observations. Wood ducks were the most commonly observed waterbird along Black Creek, and were observed nesting in suitable locations along the stream.

The only other aquatically dependent birds observed along Black Creek were the spotted sandpiper, American bittern, and belted kingfisher. Both the sandpiper and the bittern were observed on only one occasion at transect H just below the impoundment outfall. Kingfishers were observed at all locations along the creek.

The wood duck was the only waterfowl species which frequented the swamp along the creek on a regular basis. Even though wood ducks nest in the Black Creek swamp, it is unlikely that the temperatures recorded in the creek affected breeding success or brook survival. Based on our observations, the heated effluent has no effect on aquatic avifauna in the Black Creek swamp.

8.5 Mammals

8.5.1 Methods

Three methods were used to gather information on mammal populations and distributions at Robinson Impoundment and along Black Creek. First, live trapping was conducted during quarterly samples at ten stations around the impoundment and at two stations along Black Creek (Figure 8.5.1). Traps were set along the impoundment shore using fish as bait. Second, suitable shoreline areas around the impoundment were examined for tracks, scats, and other signs of mammal activity. Third, observations were recorded during all phases of biological sampling and during early evening trips along shoreline areas.

8.5.2 Results and Discussion

Fifteen species of mammals were identified as resident in Robinson Impoundment area (Table 8.5.1). Of these species, five (beaver,

Mink (Mustela vison)

The mink, while not truly aquatic, is seldom encountered far from water. This active carnivore inhabits pond, lake, and stream edges particularly in brushy or forested areas. Although mink spend little time actually in the water, aquatic or amphibious vertebrates and invertebrates form a major portion of their diet. Jackson (1961) reports that crayfish formed a significant percentage (68%) of the summer diet of mink, with frogs and fish also prevalent. Golley (1966) reports that mink in South Carolina are known to feed on fish, frogs, snakes, birds, aquatic insects, and muskrats.

One specimen was captured in a live trap set along the shoreline of the impoundment approximately 3/4 mile north of the plant. Other sign of mink activity in the study area is indicated in Figure 8.5.4.

Mink were probably at or near the top of the food web at Robinson Impoundment and as such were not subject to direct effects of thermal load in the impoundment. Since mink are not dependent upon any single group of aquatic aniamls, but feed upon a variety of aquatic and terrestrial organisms no impact from the heated effluent was identified.

Raccoon (Procyon lotor)

Like the mink, the raccoon is a terrestrial mammal which spends much of its time and obtains much of its food from aquatic habitats. Raccoons are usually classed as omnivores with the ratio of plant to animal matter in their diet subject to considerable variation. Jackson (1961) reports that as much as 70% of a raccoons diet may consist of animal matter with the chief foods being crayfish, snails, clams, insects, frogs and tadpoles, shallow water fish, immature turtles, and other animal matter. The remainder of their diet consists primarily of nuts, seeds, and fruit of a variety of plants (Golley, 1966; Jackson, 1961; Burt and Grossenheider, 1964).

Raccoon signs were observed along most of the suitable shoreline areas around the impoundment and in the swamps along Black Creek. (Figure 8.5.5). Several road kills were noted on roads near the impoundment.

the extent of present beds of vascular vegetation could result in a concomitant shift in numbers and/or distribution of the beavers in the impoundment. Data reported in Section 7.0 (Aquatic Vegetation) indi ted that no significant changes in the distribution of aquatic vegetation are apparent. It is, therefore, probable that beavers are unaffected by the thermal discharge.

Muskrat (Ondatra zibethica)

Like the beaver, the muskrat spends much of its life and derives much of its food from the aquatic ecosystem. Muskrats are usually found in swampy or weedy portions of lakes and streams where they feed chiefly on aquatic plants, the most important of which are cattails (Typha sp.), arrowhead (Sagittaria sp.), spike rush (Eleocharis sp.), bullrushes (Scirpus sp.), pickerel weed (Pontederia sp.), and pond weed (Potamogeton sp.) (Jackson, 1961). Although primarily herbivorus, muskrats have been reported to feed upon clams, fish, snails, and crayfish (Golley, 1966, Jackson, 1961). Muskrats are known to fall prey to a number of species including mink, fox, large turtles, aquatic snakes, and larger predatory fish.

Robinson Impoundment and Black Creek support a small population of muskrats. Signs were observed in several localities in the study area (Figure 8.5.4) and were usually found in areas where aquatic vascular vegetation is present. It is possible, however, that competition with beavers for available food may be a factor limiting potential expansion of the muskrat population. In addition, Blair, et al. (1968) and Hall and Kelson (1959) list the South Carolina coastal plain as the southeastern edge of the muskrat's range in North America.

Since thermal load in the impoundment has essentially the same effect on muskrats as on beavers, and because of the smaller number of animals involved, the potential for damage to the muskrat population is proportionally greater. Since the major beds of vascular vegetation are unaffected by heat, interspecific competition with beavers and the fact that the impoundment is on the edge of the muskrat's range are two factors limiting the muskrat population in the impoundment.

effluent. This combined with the variety of fish available as prey and the large home range of otters eliminates the possibility of impact upon otters by the heated effluent.

8.6 Summary and Conclusions

Amphibians

Twenty-two species of amphibians were identified within the study area. Needs common to all individuals of those species at Robinson Impoundment or Black Creek included water temperatures within tolerable ranges, cover, food, and breeding sites. Each of those needs was considered subject to possible thermal influence.

Comparison of observed water temperature data with available temperature tolerance values indicated that thermal exclusion areas existed within the impoundment during the summer months. However, the expected and observed habitat preferences and requirements were considered primarily responsible for the restriction of most of the amphibian species to shallow, more heavily vegetated margins of the impoundment. As a result, the exclusion areas were believed to have had little effect on the overall distribution of the amphibians within the study area.

The thermal limitation of the distribution and productivity of aquatic plants and benthic fauna probably indirectly influenced the distributions of at least two of the amphibian species by reducing the available cover and food supply. But again, habitat preferences and requirements were believed to exclude most species from any serious distributional impact resulting in that way.

Thermal limitation of the distribution of aquatic vegetation probably had some indirect effect on reproduction and larval development of some anuran species in the area of the impoundment adjacent to the point of thermal discharge by limiting the availability of suitable habitat. Breeding seasons of four anuran species were found to differ slightly between heated and unheated

The variety of habitats utilized by raccoons and the varied diet which does not depend on one specific group of organisms preclude significant impact from the heated effluent.

Otter (Lutra canadensis)

Of all the mammals observed in Robinson Impoundment area, the river otter was the most dependent upon the aquatic ecosystem.

Otters spend most of their time in the water, feed almost entirely upon aquatic prey, and may travel up to 15 miles along a stream or lake in search of food (Burt and Grossenheider, 1964). Exclusively carnivorous the otter is at or near the top of the aquatic food web. Numerous studies indicate a preference for crayfish during summer months when they are easily caught, but fish probably constitute the major portion of the otter's diet. Jackson (1961) sites a study in which forage fish comprised 40% of the diet of otters followed by amphibians (25%), game and pan fishes (23%), crayfish 7%), and miscellaneous vertebrates (5%). Golley (1966) states that otters in South Carolina eat fish, crustacea, insects, birds, muskrats, and clams, with the major fish consumed being carp, suckers, and sunfish.

Otters were observed on several occasions feeding in the upper end of the impoundment and signs were noted both in the heated portion of the impoundment and in Black Creek below the dam. (Figure 8.5.5). Examination of otter feces in the impoundment revealed the presence of fish scales identified as belonging to suckers of the genera Erimyzon and Minytrema.

In view of the close relationship to the aquatic ecosystem displayed by the otter, heated effluent in the impoundment could have an effect on the otter population by limiting the fishery resources available to it for prey. However, data presented in Section 4.0 (Fisheries) indicate that no reduction in fish populations of a magnitude great enough to affect the otter population in the impoundment has occurred. The otter observations at the impoundment were for the most part confined to the upper impoundment away from the heated

of thermal discharge. It was not possible to separate the impact of that indirect effect from the direct effect of heat on the observed distributions of reptiles.

Increased body size and juvenile growth rate were reported in the literature as a possible indirect effect of increased water temperatures on one species of turtle. Whether that was true at Robinson Impoundment for that species or any other species was not determined.

Avifauna

Robinson Impoundment provides an attractive habitat for a wide variety of aquatic avifauna. Three thousand seven hundred four observations from seven groups of aquatic birds (44 species) were recorded (Table 8.4.2). Coot accounted for 60% of the total observations, and the recreationally important surface-feeding and diving ducks totaled 14% and 15%, respectively. Comparisons of the species composition and relative abundance of avifauna present at Robinson Impoundment with those recorded at the Sandhills National Wildlife Refuge, the ERDA Savannah River Plant, and other study areas in the Southeast, indicate little or no difference. It is apparent that Robinson Impoundment does not differ from other such bodies of water in the numbers and types of aquatic avifauna which are attracted to it, and that a balanced indigineous population of avifauna is being maintained.

Within the impoundment, the availability of suitable habitat determined the distribution of the species. Habitat for a given group did not differ in its attractiveness between heated and unheated portions of the impoundment in any way that could be attributed to heat load.

Within habitat types, the effects of the thermal effluent on aquatic avifauna are indirect. Each group of waterbirds utilizes one or more components of the aquatic ecosystem as a food source. Impact upon these components by the heated effluent would result in changes in numbers and distribution in the higher trophic levels occupied by aquatic birds. Data presented in Sections 4.0, 6.0, and 7.0 indicate that these lower trophic levels were not impacted to the extent that the avifauna utilizing them as a food source were affected.

portions of the impoundment. At least for one species, there was evidence which indicated the possibility of accelerated development as a result of increased heat. Although water temperatures throughout much of the study area exceeded the reported literature values for embryonic and larval tolerances, the water temperatures recorded in appropriate breeding habitat indicated the availability of cool enough water for successful reproduction and larval development throughout the impoundment and Black Creek. The combined thermal impact on the reproduction, development, and growth of the amphibian species exposed to the increased heat was not considered a significant threat to the continued existence of those species or population balances within the study area.

Reptiles

Ten species of aquatically dependent reptiles were found to occur within the study area. Another ten species were identified but were considered terrestrial and not subject to any thermal stress resulting from the operation of Unit 2. The aquatic and semi-aquatic species depended on the ecosystems of Robinson Impoundment and Black Creek for such thermally influenced factors as water temperature within the tolerable ranges, appropriate cover, and adequate food supply.

A direct effect of increased heat on the distribution of reptiles resulted from the existence of seasonal thermal exclusion areas. The size and duration of those exclusion areas varied by species based on respective thermal tolerances. Regardless of the size and duration, the actual impact of each exclusion area was believed to be minimized by several considerations. Specific habitat preferences or requirements other than temperature tolerances restricted some of the species from inhabiting the thermally affected areas of the impoundment. For those species which did occur in the thermally affected area, cooler refuge areas existed within or adjacent to the exclusion areas and provided a suitable habitat where displaced reptiles could survive critical periods.

The thermal effects on the distribution and productivity of the aquatic vegetation and benthos during the summer months probably caused some corresponding indirect effects on the reptilian distributions near the point

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Mammals

Fifteen species of mammals were observed at Robinson Impoundment and Black Creek during the study period. Five species were determined to interact with the aquatic ecosystem to a significant extent.

The presence of the impoundment created a series of habitats which encouraged establishment of populations of such species as beaver and muskrat which would not be present in such numbers in a nonimpoundment situation. The mammalian populations we have examined appear to be in a favorable balance on both an intra- and interspecific level.

The ability of mammals to thermoregulate precludes any direct effect of the heated effluent upon species residing in the water. Availability of suitable habitat was the factor determined to have exercised the greatest influence on mammal distributions at Robinson Impoundment and along Black Creek. Where suitable habitat was available for a given species in both heated and unheated sections of the impoundment, no difference in the distribution of mammals associated with the habitats could be discerned.

Conclusion

Given that the combined thermal effluent from Units 1 and 2 operation has been discharged into Robinson Impoundment since September, 1970, the terrestrial vertebrate species and populations observed during the current study were considered to have adapted to any thermal stress imposed during that period. After five years, those species and populations have approached an equilibrium with the existing conditions at the impoundment including any changes which resulted from the increased heat load. The thermal impact on the terrestrial vertebrates was not considered great enough to threaten the existence or maintenance of the balanced indigineous populations found to occur at the impoundment and Black Creek during the study.

Table 8 .1 Amphibian species collected and/or observed at Robinson Impoundment and Black Creek, August 1974 through May 1976. (Nomenclature follows Conant, 1975)

Scientific Name	Common Name	Impoundment	Black Creek
Siren intermedia intermedia	Eastern lesser siren	X	X
Necturus punctatus	Dwarf waterdog	X	X
Amphiuma means	Two-toed amphiuma		X
Desmognathus fuscus	Dusky salamander	X	
Stereochilus marginatus	Many-lined salamander		X
Pseudotriton montanus	Mud salamander	X	X
Pseudotriton ruber	Red salamander	X	
Eurycea bislineata	Southern two-lined salamander	X	X
Eurycea quadridigitata	Dwarf salamander		X
Bufo americanus	American toad	X	
Bufo terrestris	Southern toad	X	X
Bufo woodhousei fowleri	Fowler's toad	X	
Acris gryllus gryllus	Southern cricket frog	X	X
Acris crepitans crepitans	Northern cricket frog	X	
Hyla crucifer	Spring peeper	X	X
Hyla cinerea	Green treefrog	X	X
Hyla squirrella	Squirrel treefrog	X	
Limnaoedus ocularis	Little grass frog	X	
Rana catesbeiana	Bullfrog	X	X
Rana virgatipes	Carpenter frog	X	X
Rana clamitans	Bronze frog	X	X
Rana utricularia	Southern leopard frog	X	X

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Table 8.2.3 Observed water temperature means and ranges for larval and adult amphibians collected or observed at Robinson Impoundment and Black Creek, August 1974 through May 1976

	Larvae					Adults				
		Mean		Range			Mean		Range	
Species	n	°C	°F	°C	°F	n	°C	°F	°C	°F
Siren intermedia	7	22.4	72	14.0-28.5	57-83	15	28.0	82	15.0-35.0	59-95
Necturus punctatus	9	18.1	64	12.5-28.0	54-82	10	24.3	76	18.2-32.0	65-90
Amphiuma means	0	-	-	-	-	3	20.7	69	20.5-21.0	69-70
Desmognathus fuscus	0	-	-	-	-	1	17.0	63	17.0	63
Stereochilus marginatus	2	6.0	43	6.0	43	0	-	-	-	-
Pseudotriton montanus	7	18.4	65	10.0-25.5	50-78	1	20.0	68	20.0	68
Pseudotriton ruber	10	18.0	64	17.0-22.0	63-72	0	-	-	-	-
Eurycea bislineata	258	18.4	65	5.5-29.0	42-84	4	19.8	68	17.0-25.5	63-78
Eurycea quadridigitata	3	12.0	54	12.0	54	0	-	-	-	-
Bufo americanus	0	-	-	-	-	0	-	-	-	-
Bufo terrestris	3	28.0	82	28.0	82	7	26.5	80	20.5-31.0	69-88
Bufo woodhousei fowleri	0	-	-	-	-	0	-	-	-	-
Acris gryllus gryllus	117	29.5	85	25.0-35.0	77-95	693	29.4	85	10.0-33.0	50-91
Acris crepitans crepitans	0	-	-	-	-	1	31.0	88	31.0	88
Hyla crucifer	0	-	-	-	-	4	8.0	46	8.0	46
Hyla cinerea	2	32.0	90	31.0-33.0	88-91	1	31.0	88	31.0	88
Hyla squirrella	0	-	-	-	-	0	-	-	-	-
Limnaoedus ocularis	0	-	-	-	-	0	-	-	-	-
Rana catesbeiana	2	16.5	62	6.0-27.0	43-81	2	22.0	72	20.5-23.5	69-74
Rana virgatipes	177	23.2	74	5.5-32.5	42-90	8	23.7	75	19.0-31.0	66-88
Rana clamitans	105	17.1	63	8.5-31.0	47-88	4	23.9	75	18.5-31.0	65-88
Rana utricularia	37	19.4	67	9.5-31.0	49-88	14	25.7	78	20.0-34.5	68-94
Unidentified Rana sp.	12	17.7	64	12.0-26.0	54-79	0	-	-	-	-

Table 8.2.2 Amphibians collected, observed, or heard calling at Robinson Impoundment and Black Creek
August 1974 through May 1976

Species	Black Creek South of Impoundment Larvae	Adults	Calls	Impoundment[1] North of Transect F Larvae	Adults	Calls	Impoundment[1] South of Transect F Larvae	Adults	Calls	Discharge Canal Larvae	Adults	Calls
Siren intermedia intermedia	0	1	–	7	4	–	0	9	–	0	0	–
Necturus punctatus	0	1	–	9	7	–	0	1	–	0	0	–
Amphiuma means	0	2	–	0	0	–	0	0	–	0	0	–
Desmognathus fuscus	0	0	–	0	0	–	0	1	–	0	0	–
Stereochilus marginatus	2	0	–	0	0	–	0	0	–	0	0	–
Pseudotriton montanus	0	1	–	2	0	–	5	0	–	0	0	–
Pseudotriton ruber	0	0	–	0	6	–	10	0	–	0	0	–
Eurycea bislineata	21	0	–	28	1	–	252	3	–	1	0	–
Eurycea quadridigitata	3	0	–	0	0	–	0	0	–	0	0	–
Bufo americanus	0	0	–	0	0	–	0	0	X	0	0	–
Bufo terrestris	0	6	X	0	0	X	3	8	X	0	1	–
Bufo woodhousei fowleri	0	0	–	0	0	–	0	0	X	0	0	–
Acris gryllus gryllus	1	2	X	88	557	X	11	122	X	7	14	X
Acris crepitans crepitans	0	0	–	0	1	–	0	0	–	0	0	–
Hyla crucifer	0	0	X	0	0	X	0	4	X	0	0	–
Hyla cinerea	0	0	X	2	1	X	0	0	X	0	0	–
Hyla squirrella	0	0	–	0	0	–	0	0	X	0	0	–
Limnaoedus ocularis	0	0	–	0	0	X	0	0	X	0	0	–
Rana catesbeiana	1	3	X	0	1	X	1	0	X	1	0	–
Rana virgatipes	23	1	X	148	6	X	2	1	X	0	0	–
Rana clamitans	61	1	X	16	2	X	28	2	X	0	0	–
Rana utricularia	10	28	X	5	2	X	12	4	X	10	3	–
Unidentified *Hyla* sp.	0	0	–	0	0	–	0	2	–	0	0	–
Unidentified *Rana* sp.	4	0	–	2	0	–	6	0	–	0	0	–
Unidentified Anuran sp.	0	4	–	0	2	–	0	2	–	0	0	–

[1] [illegible]gure [illegible]2.1 [illegible] X i[illegible]ate[illegible]ll[illegible]

Table 8.2.5 Water temperatures recorded at larval amphibian sampling stations at Robinson Impoundment and Black Creek, July 1975 through May 1976

Station (Figure 8.2.1)	1975												1976									
	July		Aug.		Sept.		Oct.		Nov.		Dec.		Jan.		Feb.		March		April		May	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
MHS-1 Creek	28	82	28	82	26.5	79	22.5	72	20	68	11.5	52	9	48	10	50	15.5	60	19.5	67	19	66
Swamp	22	72	26	79	23	73	19	66	20	68	9.5	49	5.5	42	6	43	11	52	15	59	17	63
MHS-2 Creek	28	82	29	84	29.5	85	23.5	74	21	70	12	54	10.5	51	12.5	54	16.5	64	20	68	23	73
Swamp	22	72	–	–	24	75	–	–	–	–	–	–	–	–	–	–	–	–	17	63	–	–
Stream	–	–	–	–	–	–	–	–	20.5	69	11.5	52	–	–	–	–	–	–	–	–	–	–
MHS-3 Creek	31	88	31	88	30.5	87	24.5	76	21	70	12.5	54	11	52	13	55	17.5		21	70	23.5	74
Stream	–	–	–	–	–	–	17	63	21	70	11	52	–	–	–	–	–	–	17	63	–	–
Puddle	–	–	–	–	–	–	–	–	–	–	–	–	9.5	49	13	55	12	54	17	63	19	66
MHS-4 Discharge Canal	39	102	41	106	39	102	34	93	21	70	13	55	24	75	25	77	28	82	30.5	87	34	93
Cove Surface	27	81	33	91	30	86	29	84	20	68	14	57	20	68	21.5	70	22	72	23	73	27	81
Cove Bottom	24	75	23	73	25	77	21.5	70	–	–	–	–	18	64	20.5	69	19	66	19	66	26	79
MHS-5 Cove	37	99	38	100	37	99	34	93	21	70	13	55	21	70	23	73	26	79	31	88	32	90
Stream Mouth	19	66	19	66	19	66	19	66	17	63	14	57	11	52	15	59	14.5	58	18.5	65	17	63
MHS-6 Lower Lagoon	29	84	33	91	34.5	94	26	79	18.5	65	11.5	52	10	50	10	50	14	57	26	79	22	72
Upper Lagoon	–	–	23.5	74	24	75	19	66	18	64	11	52	10	50	10	50	13	55	20	68	22	72
Stream Mouth	–	–	–	–	22	72	18	64	18	64	11	57	10	50	8	46	13	55	19.5	67	18	64
MHS-7 Cove	36	97	36.5	98	39	102	33	91	21.5	70	12.5	54	20	68	20.5	69	24.5	76	30	86	30	86
Stream Mouth	–	–	–	–	–	–	–	–	17	63	–	–	–	–	8.5	47	17	63	17	63	18	64
MHS-8 Cove	34	93	37	99	35	95	31	88	19.5	67	10	50	16	61	19.5	67	22	72	29	84	30	86
Beaver Pool	16.5	61	17	63	17.5	64	17	63	17.5	64	17	63	17.5	64	17	63	17	63	17	63	17	63
MHS-9 Cove	33.5	92	38	100	36	97	29.5	67	21.5	70	11	52	18	64	18	64	23.5	74	30	86	31	88
Stream	25	77	27	81	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–
Marsh	–	–	–	–	30.5	87	25	77	21.5	70	9	48	5	41	16	61	12.5	54	29	84	30	86
MHS-10 Impoundment	30.5	87	30	86	32	90	28	82	19	66	9	48	8	46	8	46	10	50	26.5	79	22	72
Lagoon	28	82	26	79	29	84	27	81	21	70	11	52	10.5	51	6	43	10	50	31	88	22	72
MHS-11 Lagoon	26	79	28	82	27	81	23.5	74	20	68	10	50	13	55	15.5	60	12.5	54	23	73	26	79
Stream Mouth	19.5	67	20.5	69	22	72	19.5	67	20	68	11	52	11.5	52	14	57	12.5	54	20	68	19	66
MHS-12 Shoreline	32.5	90	33	91	31	88	24	75	19	66	8.5	47	8.5	47	10.5	51	12.5	54	23.5	74	21	70
MHS-13 Cove	33	91	30.5	87	31	88	25	77	18	64	8	46	12.5	54	14	57	12	54	23	73	22	72

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Table 8.2.4 Maximum thermal tolerance values for amphibian species collected or observed at Robinson Impoundment and Black Creek

Species	Adult Critical Thermal Maximum °C	°F	Adult Maximum Voluntary Temperature °C	°F	Larval Critical Thermal Maximum °C	°F	Maximum Temperature for Larval Development °C	°F	Maximum Embryonic Temperature Tolerance °C	°F
Siren intermedia										
Necturus punctatus										
Amphiuma means[1]	37.1[a]	99								
Desmognathus fuscus[2]	33.5[b]-36.2[a]	92-97								
Stereochilus marginatus										
Pseudotriton montanus										
Pseudotriton ruber	35.0[b]	95								
Eurycea bislineata	34.5[b]-34.6[a]	94	16.0[f]	61	34.5[c]	94				
Eurycea quadridigitata										
Bufo americanus	40.2[d]	104	32.3[f]	90	35.0[g]	95	31.0[i]	88		
Bufo terrestris			24.2[f]	76			35.0[i]	95		
Bufo woodhousei fowleri										
Acris gryllus										
Acris crepitans			34.8[f]	95						
Hyla crucifer			26.5[f]	80						
Hyla cinerea			33.4[f]	92			39.0[i]	102		
Hyla squirrella			25.0[f]	77						
Limnaoedus ocularis										
Rana catesbeiana	38.2[e]	101	30.0[f]-34.7[e]	86-95			35.0[j]	95	32.0[m]	90
Rana virgatipes										
Rana clamitans			29.0[f]	84					32.0[m]-35.0[n]	90-95
Rana utricularia[3]			34.7[f]	95	31.0-33.0[h]	88-91	33.0[j]-33.8[k]	91-93	28.0[m]	82

[1] Value reported for *Amphiuma means tridactylum*
[2] Values reported for *Desmognathus f. fuscus*
[3] Values reported for *Rana pipiens*
[a] Hutchinson (1961)
[b] Zweifel (1957)
[c] Brooks and Sassman (1965)
[d] Frost and Martin (1971)
[e] Lillywhite (1976)
[f] Brattstrom (1963)
[g] Volpe (1953)
[h] Atlas (1935)
[i] Ballinger & McKinney (1966)
[j] Lucas and Reynolds (1967)
[k] Zweifel (1968)
[m] Moore (1942)
[n] Moore (1939)

Table 8.3.1 Reptiles collected and/or observed at Robinson Impoundment and Black Creek, August 1974 through May 1976 (Nomenclature follows Conant, 1975)

Scientific Name	Common Name
	Aquatic and Semi-aquatic Species
Chelydra serpentina	Snapping turtle
Sternotherus odoratus	Stinkpot
Clemmys guttata	Spotted turtle
Chrysemys scripta scripta	Yellow-bellied turtle
Chrysemys concinna concinna	River cooter
Chrysemys rubriventris	Red-bellied turtle
Deirochelys reticularia reticularia	Eastern chicken turtle
Natrix fasciata fasciata	Banded water snake
Natrix taxispilota	Brown water snake
Agkistrodon piscivorus piscivorus	Eastern cottonmouth
	Terrestrial Species
Terrapene carolina carolina	Eastern box turtle
Anolis carolinensis carolinensis	Green anole
Cnemidophorus sexlineatus sexlineatus	Six-lined racerunner
Eumeces fasciatus	Five-lined skink
Heterodon platyrhinos	Eastern hognose snake
Coluber constrictor	Black racer
Opheodrys aestivus	Rough green snake
Elaphe obsoleta obsoleta	Black rat snake
Lampropeltis getulus getulus	Eastern kingsnake
Leiolopisma laterale	Ground skink

Table 8.2.6 Observed breeding seasons for eight anuran species found at Robinson Impoundment and Black Creek, June 1975 through May 1976 (Breeding calls were considered evidence of breeding season)

Species	Location (Figure 8.2.1)	1975 June	July	Aug	Sept	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May
Bufo terrestris	NF[1]	X[4]	X	X	X	X	X					X	X
	SF[2]	X	X	X	X	X	X					X	X
	BC[3]	X	X	X	X	X	X					X	X
Acris gryllus gryllus	NF	X	X	X	X							X	X
	SF	X	X	X								X	X
	BC		X										
Hyla crucifer	NF									X	X		
	SF									X	X		
	BC									X	X		
Hyla cinerea	NF	X	X	X									X
	SF	X	X	X									X
	BC	X	X	X									
Rana catesbeiana	NF	X											X
	SF	X	X		X							X	
	BC	X	X										
Rana virgatipes	NF		X	X								X	X
	SF		X	X								X	X
	BC											X	X
Rana clamitans	NF	X		X									X
	SF	X	X	X									X
	BC		X	X									
Rana utricularia	NF									X		X	X
	SF						X			X		X	X
	BC											X	X

[1]North of Transect F

[2]South of Transect F

[3]Black Creek South of Robinson Impoundment

[4]Indicates Months That Breeding Calls Were Heard

Table 8.3.3 Critical thermal maxima (CTM) and maximum voluntary temperature (MVT) for aquatic reptilian species found at Robinson Impoundment and Black Creek

Species	Adult Critical Thermal Maximum (°C)				Adult Maximum Voluntary Temperature (°C)	
	Mean		Range			
	°C[1]	°F	°C[1]	°F	°C[2]	°F
Chelydra serpentina	39.46	103	37.4-40.6	99-105	24.5	76
Sternotherus odoratus	41.03	106	40.3-41.7	105-107	28.8	84
Clemmys guttata	41.98	107	41.2-42.5	106-109	-	-
Clemmys sp.[3]	-	-	-	-	27.0	81
Chrysemys scripta	41.00	106	40.2-42.0	104-108	-	-
Chrysemys concinna	41.80	107	40.4-42.8	105-109	-	-
Chrysemys rubriventria	39.36	103	38.4-39.9	101-104	-	-
Chrysemys sp.[4]	-	-	-	-	32.0	90
Deirochelys reticularia	41.30	106	40.8-42.2	105-108	25.6	78
Natrix f. fasciata	-	-	-	-	-	-
Natrix taxispilota	-	-	-	-	-	-
Natrix sp.[5]	-	-	-	-	29.5	85
Agkistrodon piscivorus	-	-	-	-	27.7	82

[1]Data from Hutchinson, et al. (1966)

[2]Data from Brattstrom (1965)

[3]Value reported for *Clemmys marmorata*

[4]Value reported for *Chrysemys picta*

[5]Value reported for *Natrix sipedon*

Table 8.3.2 Number of aquatic reptiles collected and/or observed at Robinson Impoundment and Black Creek, August 1974 through May 1976

Species	Black Creek		Impoundment[1]		
	Above Impoundment	Below Impoundment	North of Transect F	South of Transect F	Discharge Canal
Chelydra serpentina	0	4	0	0	0
Sternotherus odoratus	2	0	7	19	1
Cl s guttata	0	2	5	0	0
Chr,.emys s. scripta	0	6	48	22	12
Chrysemys c. concinna	0	0	0	1	0
Chrysemys rubriventris	0	0	0	1	0
Deirochelys r. reticularia	0	0	4	1	0
Unidentified turtles	0	1	40	13	0
Natrix f. fasciata	1	2	1	4	0
Natrix taxispilota	2	5	1	10	0
Unidentified Natrix sp.	2	4	3	3	0
Agkistrodon p. piscivorus	3	9	4	2	0

[1] Figure 8.2.1

Table 8.4.1 (continued) Page 2

Category	Species
Gulls and Terns	Herring gull
	Ring-billed gull
	Bonaparte's gull
	Common tern
	Black tern
Miscellaneous	Common loon
	Canada goose
	Whistling swan
	Double crested cormorant
	Belted kingfisher

Table 8.4.1 Aquatic avifauna species by category observed at Robinson Impoundment, August 1974 through February 1976

Species	Species
Grebes	Red-necked grebe
	Horned grebe
	Pied-billed grebe
Surface-Feeding Ducks	Mallard
	Black duck
	Gadwall
	American wigeon
	Blue-winged teal
	Green-winged teal
	Wood duck
Diving Ducks	Redhead
	Ring-necked duck
	Lesser scaup
	Old squaw
	Bufflehead
	Ruddy duck
	Hooded merganser
	Red breasted merganser
	Common merganser
Herons and Bitterns	Great blue heron
	Green heron
	Little blue hero[illegible]
	Great egret
	Snowy egret
	Yellow-crowned [illegible]ght heron
	Am[illegible]ican bitte[illegible]n
	Least bittern
Rails	King rail
	American coot
Shorebirds	Spotted sandpiper
	Killdeer
	Silitary sandpiper
	Northern phalarope
	Common snip

Table 8.4.3 Bird species observed at the Robinson Impoundment and Black Creek August 1974 through February 1976

Common Name	Scientific Name
Common loon	*Gavia immer*
Red-necked grebe	*Podiceps grisegena*
Horned grebe	*Podiceps auritus*
Pied-billed grebe	*Podilymbus podiceps*
Double-crested cormorant	*Phalacrocorax auritus*
Great blue heron	*Ardea herodias*
Green heron	*Butorides virescens*
Little blue heron	*Florida caerula*
Great egret	*Casmerodius albus*
Snowy egret	*Leucophoyx thula*
Black-crowned night heron	*Nycticorax nycticorax*
Yellow-crowned night heron	*Nyctanassa violacea*
Least bittern	*Botarus lentiginosus*
Whistling swan	*Olor columbianus*
Canada goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Black duck	*Anas rubripes*
Gadwall	*Anas strepera*
Green-winged teal	*Anas carolinensis*
Blue-winged teal	*Anas discors*
American wigeon	*Mareca americana*
Wood duck	*Aix sponsa*
Redhead	*Aythya americana*
Lesser scaup	*Aythya affinis*
Ring-necked duck	*Aythya collaris*
Bufflehead	*Bucephala albeola*
Oldsquaw	*Clangula hyemalis*
Ruddy duck	*Oxyura jamaicensis*
Hooded merganser	*Lophodytes cucullatus*
Red-breasted merganser	*Mergus serrator*
Common merganser	*Mergus merganser*
Turkey vulture	*Cathartes aura*

Table 6.4.2 Summary of aquatic avifauna quantitative observations in Robinson Impoundment, August 1974 through February 1976

Group	Number Observed	% of Total	% Observed Area I	% Observed Area II	% Observed Area III
Grebes	92	2	35	25	40
Surface-Feeding Ducks	516	14	1	11	88
Diving Ducks	544	15	71	21	8
Herons	30	1	17	33	50
Rails	2214	60	71	23	6
Shorebirds	59	2	49	42	9
Gulls	178	[illegible]	68	26	6
Miscellaneous*	71	2	34	23	43
TOTAL	3704	100	59	22	19

*Combined figures for Common loon
Canada goose
Whistling swan
Double-crested cormorant
Belted kingfisher

Table 8.4.3 (continued)

Common Name	Scientific Name
Pileated woodpecker	*Dryocopus pileatus*
Red-bellied woodpecker	*Centurus carolinus*
Red-headed woodpecker	*Melanerpes erythrocephalus*
Hairy woodpecker*	*Dendrocopos villosus*
Downy woodpecker	*Dendrocopos pubescens*
Eastern kingbird	*Tyrannus tyrannus*
Least flycatcher	*Empidonax minimus*
Eastern wood pewee	*Contopus virens*
Tree swallow	*Iridoprocne bicolor*
Rough-winged swallow	*Stelgidopteryx ruficollis*
Barn swallow	*Hirundo rustica*
Cliff swallow	*Petrochelidon pyrrhonota*
Purple martin	*Progne subis*
Bank swallow	*Riparia riparia*
Blue jay	*Cyanocitta cristata*
Common crow	*Corvus brachyrhynchos*
Fish crow	*Corvus ossifragus*
Carolina chickadee	*Parus carolinensis*
Tufted titmouse	*Parus bicolor*
White-breasted nuthatch*	*Sitta carolinensis*
Brown-headed nuthatch	*Sitta pusilla*
Brown creeper*	*Certhia familiaris*
Winter wren	*Troglodytes troglodytes*
Carolina wren	*Thryothorus ludovicianus*
Mockingbird	*Mimus polyglottos*
Grey catbird	*Dumetella carolinensis*
Brown thrasher	*Toxostoma rufum*
Robin	*Turdus migratorius*
Hermit thrush	*Hylocichla guttata*
Veery	*Hylocichla fuscescens*
Eastern bluebird	*Sialia sialis*
Blue-gray gnatcatcher	*Polioptila caerulea*
Golden-crowned kinglet*	*Regulus satrapa*

Table 8.4.3 (continued)

Common Name	Scientific Name
Black vulture	Coragyps atratus
Sharp-shinned hawk	Accipiter striatus
Cooper's hawk	Accipiter cooperii
Red-tailed hawk	Buteo jamaicensis
Red-shouldered hawk	Buteo lineatus
Broad-winged hawk	Buteo platypterus
Marsh hawk	Circus cyaneus
Osprey	Pandion haliaetus
Pigeon hawk	Falco columbarius
Kestrel	Falco sparverius
Bobwhite	Colinus virginianus
King rail	Rallus elegans
American coot	Fulica americana
Killdeer	Charadrius vociferus
American woodcock	Philohela minor
Common snipe	Capella gallinago
Spotted sandpiper	Actitis macularia
Northern phalarope	Lobipes lobatus
Solitary sandpiper	Tringa solitaria
Herring gull	Larus argentatus
Ring-billed gull	Larus delawarensis
Bonaparte's gull	Larus philadelphia
Common tern	Sterna hirundo
Black tern	Childonias niger
Rock dove	Columba livia
Mourning dove	Zenaidura macroura
Yellow-billed cuckoo	Coccyzus americanus
Great horned owl	Bubo virginianus
Whip-poor-will	Caprimulgus vociferus
Chuck-will's-widow	Caprimulgus carolinensis
Common nighthawk	Chordeiles minor
Chimney swift	Chaetura pelagica
Ruby-throated hummingbird	Archilochus colubris
Belted kingfisher	Megaceryle alcyon
Yellow-shafted flicker	Colaptes auratus

Table 8.4.3 (continued) Page 5

Common Name	Scientific Name
Fox sparrow	_Passerella iliaca_
Swamp sparrow	_Melospiza georgiana_
Song sparrow	_Melospiza melodia_
Sharp-tailed sparrow	_Ammospiza caudacuta_

*Observed along Black Creek only.

Table 8.4.3 (continued)

Common Name	Scientific Name
Ruby-crowned kinglet	Regulus calendula
Cedar waxwing	Bombycilla cedrorum
Loggerhead shrike	Lanius ludovicianus
Starling	Sturnus vulgaris
White-eyed vireo	Vireo griseus
Solitary vireo	Vireo solitarius
Black and white warbler*	Mniotilta varia
Prothonatary warbler	Protonotaria citrea
Nashville warbler	Vermivora ruficapilla
Parula warbler	Parula americana
Myrtle warbler	Dendroica coronata
Pine warbler	Dendroica pinus
Yellowthroat	Geothlypis trichas
American redstart	Setophaga ruticilla
House sparrow	Passer domesticus
Eastern meadowlark	Sturnella magna
Red-winged blackbird	Agelaius phoeniceus
Orchard oriole	Icterus spurius
Rusty blackbird	Euphagus carolinus
Common grackle	Quiscalus quiscula
Brown-headed cowbird	Molothrus ater
Summer tanager	Piranga rubra
Cardinal	Richmondena cardinalis
Indigo bunting	Passer cyanea
American goldfinch	Spinus tristis
Rufous-sided towhee	Pipilo erythrophthalmus
Savannah sparrow	Passerculus sandwichensis
Vesper sparrow	Pooecetes gramineus
Slate-colored junco	Junco hyemalis
Field sparrow	Spizella pusilla
White-throated sparrow	Zonotrichia albicollis

Table 8.4.4 (continued)

Least flycatcher	-	-	-	-	-	1 (1)	-	-	-	-	-	-	-	-	-	1	1
Eastern wood pewee	-	-	-	-	-	1 (1)	-	-	-	-	-	-	-	-	-	1	1
Tree swallow	-	-	-	-	-	31 (6)	-	-	-	x	-	-	-	-	-	2	31
Rough-winged swallow	x	16 (10)	-	-	x	7 (4)	x	x	47 (46)	x	-	-	-	-	-	8	70
Barn swallow	-	-	-	-	-	22 (11)	x	x	8 (4)	-	-	-	-	-	-	4	30
Cliff swallow	-	26 (21)	-	-	-	-	-	-	-	-	-	-	-	-	-	2	26
Purple martin	-	-	-	-	-	35 (15)	x	x	389 (156)	-	-	-	-	-	-	4	424
Bank swallow	-	13 (11)	-	-	-	-	x	-	-	-	-	-	-	-	-	2	13
Blue jay	x	103 (47)	35 (6)	83 (56)	x	22 (7)	x	x	26 (8)	-	x	4 (3)	-	x	8 (4)	14	760
Common crow	x	9 (5)	-	2 (1)	x	27 (17)	x	x	15 (11)	x	x	10 (10)	-	x	-	12	63
Fish crow	x	3 (7)	-	x	x	8 (6)	x	x	3 (3)	-	x	-	-	-	-	9	33
Carolina chickadee	-	2 (4)	7 (7)	7 (7)	x	-	-	-	2 (2)	-	-	3 (2)	x	x	7 (3)	9	25
Brown-headed nuthatch	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	1	1
Carolina wren	-	1 (1)	1 (1)	2 (1)	-	3 (3)	x	-	4 (1)	-	-	2 (1)	x	x	x 7 (7)	11	15
Mockingbird	-	7 (5)	-	6 (5)	x	7 (4)	-	x	12 (6)	x	x	1 (1)	x	x	3 (3)	12	37
Catbird	-	7 (5)	-	3 (2)	-	8 (6)	-	x	8 (4)	-	x	1 (1)	-	x	2 (2)	10	28
Bluebird	-	-	-	-	-	-	-	-	-	-	-	6 (6)	-	-	x	2	6
Brown thrasher	-	-	-	-	-	3 (2)	-	x	-	x	-	-	x	-	-	4	3
Robin	-	-	2 (2)	44 (28)	-	14 (7)	x	-	11 (7)	-	-	16 (12)	x	-	3 (2)	8	87
Hermit thrush	-	-	-	1 (4)	-	-	-	-	-	-	-	-	-	-	-	1	1
Veery	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	1	-
Blue-gray gnatcatcher	-	-	-	-	x	5 (4)	x	-	3 (3)	-	-	-	-	-	-	4	8
Ruby-crowned kinglet	-	-	-	8 (5)	x	-	-	-	-	-	-	3 (2)	x	x	25 (15)	6	2-
Cedar waxwing	-	-	-	56 (30)	-	-	-	-	-	-	-	-	-	x	-	2	56
Loggerhead shrike	-	-	1 (1)	x	x	x	x	x	-	-	x	1 (1)	-	x	-	8	2
Starling	-	78 (62)	23 (16)	58 (58)	x	36 (38)	x	-	37 (32)	-	-	6 (5)	x	-	4 (5)	10	239
White-eyed vireo	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	2	-
Solitary vireo	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	1	-
Prothonotary warbler	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	1	-
Nashville warbler	-	-	-	-	-	1 (1)	-	-	1 (1)	x	x	-	-	-	-	4	2
Parula warbler	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrtle warbler	-	-	-	2 (1)	x	-	-	-	-	-	-	-	x	x	5 (4)	3	7
Pine warbler	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	1	-
Yellow throat	-	-	-	-	-	8 (4)	x	x	1 (7)	x	-	-	-	x	-	6	71
American redstart	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	1	-
House sparrow	-	-	-	1 (1)	-	-	-	-	-	-	-	-	-	-	-	1	1
Eastern meadowlark	-	3 (3)	35+ (35+)	7 (3)	x	2 (1)	x	-	-	-	-	1 (1)	x	x	19 (13)	10	62
Red-winged blackbird	-	137 (96)	339+ (266+)	662+ (195+)	x	283+ (115+)	x	x	78 (40)	-	x	2069 (1068)	x	-	87 (75)	14	3,753
Orchard oriole	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	1	-
Rusty blackbird	-	-	36 (25)	-	-	-	-	-	-	-	-	-	-	-	-	1	36
Common grackle	-	82 (74)	4 (3)	65 (23)	x	167 (98)	x	x	74 (53)	-	-	14 (40)	-	-	25 (19)	10	443
Brown-headed cowbird	-	3 (3)	-	-	-	3 (3)	-	-	-	-	-	-	-	-	-	2	6
Summer tanager	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	1	-
Cardinal	-	1 (1)	-	7 (4)	x	7 (3)	x	-	2 (2)	-	x	1 (1)	x	x	2 (1)	11	25
Indigo bunting	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	1	-
American goldfinch	-	-	-	-	-	-	-	-	-	-	-	-	x	x	-	2	-
Rufous-sided towhee	-	4 (3)	4 (2)	17 (5)	x	8 (5)	x	x	16 (5)	x	-	4 (2)	x	x	10 (4)	13	58
Savannah sparrow	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	1	-
Vesper sparrow	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	1	-
Slate-colored junco	-	-	-	3 (3)	-	-	-	-	-	-	-	2 (2)	-	x	-	3	5
Field sparrow	-	-	2 (1)	3 (1)	x	-	x	-	-	-	-	-	x	x	3 (4)	2	6
Fox sparrow	-	-	1 (1)	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Swamp sparrow	-	-	6 (3)	25 (7)	-	-	-	-	-	-	-	x	-	-	-	5	27
Song sparrow	-	-	7 (2)	-	-	-	-	-	-	-	-	12 (17)	x	-	5 (3)	4	58
Sharp-tailed sparrow	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	1	-
Tufted titmouse	-	-	-	-	-	-	-	-	1 (1)	-	-	-	-	x	-	2	2
Ruby-throated hummingbird	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	1	-
Downy woodpecker	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	1	-
White-throated sparrow	-	-	-	-	-	-	-	-	-	-	-	5 (5)	-	x	3 (3)	4	8
Common merganser	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 (2)	2	2
Oldsquaw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8 (4)	1	8
Common snipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 (1)	1	2
TOTAL SPECIES OBSERVED	19	38	43	50	43	67	47	27	45	25	25	44	28	37	51		
TOTAL NUMBERS OBSERVED	-	769	1326+	1217+	-	853	-	-	1318	-	-	3016	-	-	457		19,230

*First figure indicates total number observed for all four surveys. Number in parenthesis is the maximum number observed during any one survey.

Table 8.4.4 Bird species by month of observation and summary of quarterly surveys at Robinson Impoundment, August 1974 through February 1976

Species	August '74	September	November	February '75	April	May	June	July	August	September	October	November	December	January '76	February	Months Observed	Total Number Observed
Common loon	-	-	2 (1.)	-	-	4 (2.)	-	-	-	-	-	15 (14.)	-	-	-	2	23
Red-necked grebe	*	-	4 (3.)	5 (4.)	*	-	-	-	-	-	-	-	-	-	-	3	6
Horned grebe	-	-	-	-	-	3 (2.)	-	-	-	-	-	3 (2.)	*	-	2 (1.)	6	7
Pied-billed grebe	-	3 (2.)	26 (8.)	16 (5.)	*	-	-	-	-	-	*	14 (5.)	-	*	16 (8.)	8	75
Double-crested cormorant	-	-	-	-	-	3 (1.)	-	-	-	-	-	-	-	-	-	1	1
Great blue heron	-	2 (3.)	3 (2.)	6 (3.)	*	2 (1.)	*	-	1 (1.)	*	*	5 (1.)	*	*	4 (4.)	13	19
Green heron	-	-	-	-	-	7 (3.)	*	*	2 (2.)	*	-	-	-	-	-	5	6
Little blue heron	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	1	-
Great egret	*	-	-	1 (3.)	*	-	-	-	2 (1.)	-	-	-	-	-	-	6	3
Snowy egret	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Yellow-crowned night heron	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	2	-
Least bittern	-	-	-	-	-	*	*	-	*	-	-	-	-	-	-	3	-
American bittern	-	3 (3.)	-	-	*	-	-	-	1 (1.)	-	-	-	-	-	-	7	2
Whistling swan	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	1	-
Canada goose	-	-	-	12 (2.)	*	-	-	-	-	-	-	-	-	*	-	6	12
Mallard	*	3 (2.)	9 (5.)	16 (5.)	*	13 (7.)	*	-	1 (1.)	-	-	25 (25.)	*	*	2 (2.)	13	63
Black duck	-	-	2 (1.)	-	-	-	-	-	-	-	-	*	-	-	2 (2.)	3	6
Gadwall	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	1	-
Green-winged teal	-	-	2 (1.)	-	*	-	-	-	-	-	-	-	-	-	-	2	2
Blue-winged teal	-	3 (3.)	2 (1.)	1 (2.)	*	-	-	-	-	-	*	-	-	-	2 (2.)	7	43
American wigeon	-	-	2 (2.)	12 (6.)	*	-	-	-	-	-	-	7 (5.)	-	-	*	3	18
Wood duck	*	167 (62.)	6 (4.)	6 (3.)	*	17 (14.)	*	-	86 (48.)	-	-	27 (19.)	*	-	7 (6.)	13	396
Redhead	-	-	-	-	-	-	-	-	-	-	-	3 (2.)	-	-	2 (2.)	2	5
Ring-necked duck	-	-	35 (22.)	-	-	-	-	-	-	-	-	122 (100.)	*	-	33 (18.)	6	270
Lesser scaup	-	-	*	-	*	-	-	-	-	-	-	-	-	-	4 (2.)	3	4
Bufflehead	-	-	21 (7.)	3 (2.)	-	-	-	-	-	-	-	*	-	*	15 (14.)	5	47
Ruddy duck	-	-	134 (114.)	*	-	-	-	-	-	-	-	2 (1.)	-	*	129 (72.)	5	196
Hooded merganser	-	-	*	-	*	-	-	-	-	-	-	-	-	-	6 (5.)	3	6
Red-breasted merganser	-	-	2 (1.)	-	-	3 (2.)	-	-	-	-	-	-	-	-	5 (5.)	3	5
Turkey vulture	*	2 (3.)	4 (4.)	*	*	3 (1.)	*	*	3 (3.)	*	*	*	-	*	5 (3.)	14	36
Black vulture	-	-	-	*	-	-	-	-	-	-	-	-	-	-	3 (3.)	2	5
Sharp-shinned hawk	-	4 (1.)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Cooper's hawk	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Red-tailed hawk	-	5 (1.)	-	2 (1.)	*	-	*	*	-	-	-	2 (1.)	*	-	-	8	5
Red-shouldered hawk	*	1 (1.)	-	-	-	-	-	-	-	-	*	-	-	-	-	3	1
Broad-winged hawk	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	2	-
Marsh hawk	-	*	-	-	-	1 (1.)	-	-	*	-	-	2 (1.)	*	*	1 (1.)	7	6
Osprey	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	2	-
Kestrel	-	-	2 (2.)	*	-	-	-	-	-	-	-	3 (1.)	*	-	1 (1.)	8	6
Bobwhite	*	1 (1.)	1 (1.)	2 (2.)	-	2 (2.)	*	*	1 (1.)	-	-	-	-	-	-	10	7
King rail	*	2 (2.)	5 (3.)	*	*	-	*	-	3 (1.)	-	-	-	-	-	-	8	10
American coot	-	-	339+ (116.)	172 (85.)	*	3 (3.)	-	-	3 (1.)	-	-	1394 (587.)	*	*	174 (58.)	10	2,183
Killdeer	-	-	-	2 (2.)	-	-	-	-	-	-	-	2 (2.)	-	-	1 (1.)	3	3
American woodcock	-	-	-	-	-	*	-	-	-	-	-	-	*	-	-	2	-
Spotted sandpiper	-	2 (3.)	-	-	-	30 (13.)	*	-	19 (8.)	-	-	-	-	-	-	4	56
Northern phalarope	-	-	-	-	-	3 (3.)	-	-	-	-	-	-	-	-	-	3	3
Solitary sandpiper	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	1	-
Herring gull	-	-	4 (3.)	-	-	*	-	-	-	-	-	1 (1.)	-	-	2 (2.)	4	7
Ring-billed gull	-	-	117 (38.)	2 (6.)	*	7 (6.)	-	-	-	-	-	5 (4.)	*	*	6 (2.)	10	162
Bonaparte's gull	*	-	24 (17.)	-	-	*	-	-	*	-	-	-	-	-	-	3	26
Common tern	*	1 (3.)	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1
Black tern	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Rock dove	*	-	-	6 (6.)	-	4 (1.)	*	-	-	-	-	-	-	-	7 ( )	3	43
Mourning dove	*	17 (16.)	5 (3.)	30 (9.)	*	15 (15.)	*	*	196 (110.)	-	*	23 (22.)	*	*	28 (7.)	14	139
Yellow-billed cuckoo	-	-	-	-	-	*	-	-	1 (1.)	-	*	*	-	-	-	4	2
Great horned owl	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	3	-
Whip-poor-will	-	-	-	-	-	2 (2.)	*	*	-	-	-	-	-	-	-	3	2
Chuck-will's-widow	-	-	-	-	-	*	*	-	-	-	-	-	-	-	-	2	-
Common nighthawk	-	-	-	-	-	3 (3.)	-	-	2 (2.)	*	-	-	-	-	-	3	3
Chimney swift	-	16 (15.)	-	-	*	2 (2.)	*	-	7 (6.)	*	-	-	-	-	-	6	37
Belted kingfisher	*	21 (8.)	6 (3.)	7 (2.)	-	1 (2.)	-	-	6 (5.)	*	-	7 (4.)	*	*	2 (2.)	12	37
Yellow-shafted flicker	-	35 (11.)	5 (3.)	19 (2.)	-	4 (2.)	*	*	1 (1.)	*	*	15 (8.)	*	*	6 (2.)	12	85
Pileated woodpecker	-	4 (2.)	3 (3.)	2 (1.)	-	7 (3.)	-	-	3 (1.)	*	-	-	-	*	1 (2.)	8	37
Red-bellied woodpecker	-	-	-	-	-	-	-	-	-	-	-	1 (1.)	-	*	2 (3.)	6	3
Red-headed woodpecker	-	*	-	*	*	-	-	-	-	-	-	-	-	-	-	3	-
Eastern kingbird	*	-	-	-	-	28 (13.)	*	*	55 (27.)	*	-	-	-	-	-	6	80

Table 8.5.1 Mammal species observed at Robinson Impoundment and Black Creek, August 1974 through February 1976

Opossum (Didelphis marsupialis)

Starnose mole (Condylura cristata)

Eastern cottontail (Sylvilagus floridanus)

Gray squirrel (Sciurus carolinensis)

Beaver (Castor canadensis)

Cotton rat (Sigmodon hispidus)

Muskrat (Ondatra zibethica)

Norway rat (Rattus norvegicus)

Red fox (Vulpes fulva)

Grey fox (Urocyon cinereoargentus)

Raccoon (Procyon lotor)

Mink (Mustela vison)

Striped Skunk (Mephitis mephitis)

Otter (Lutra canadensis)

Whitetail deer (Odocoileus virginianus)

Table 8.4.5 Bird species by month of observation and summary of quarterly survey at Black Creek September 1974 through February 1976

Species	September '74 N	September '74 E	November N	November E	February '75 N	February '75 E	May N	May E	May L	June N	June E	June L	July N	July E	July L
Black vulture	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Bobwhite (call)	-	-	-	-	-	-	-	1	1	-	-	-	-	-	*
Mourning dove	3	-	2	-	-	-	-	1	*	-	-	-	*	*	*
Chimney swift	-	-	-	-	-	-	-	-	4	-	-	-	-	-	*
Belted kingfisher	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow-shafted flicker	-	-	4	-	1	-	-	*	2	-	-	-	-	-	*
Pileated woodpecker	-	-	-	-	-	-	-	4	1	-	*	-	-	-	-
Red headed woodpecker	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Downy woodpecker	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Bluejay	1	1	2	-	2	2	-	1	1	-	-	-	-	-	*
Common crow	-	1	-	-	-	-	-	5	*	-	-	-	-	-	-
Fish crow	-	-	-	-	-	-	1	-	2	-	-	-	-	-	-
Carolina chickadee	-	6	-	-	-	2	3	-	-	-	-	-	-	-	-
Tufted titmouse	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
White breasted nuthatch	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Winter wren	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-
Carolina wren	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Gray catbird	-	1	-	1	-	*	-	-	-	-	-	-	-	-	-
Veery	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Blue gray gnatcatcher	-	-	-	-	-	-	1	5	8	*	*	*	-	*	-
Golden crowned kinglet	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Ruby crowned kinglet	-	-	-	3	-	1	-	-	-	-	-	-	-	-	-
Loggerhead shrike	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Starling	1	-	16	2	5	-	3	-	-	-	-	-	*	-	-
Prothonotary warbler	-	-	-	-	-	-	1	1	2	-	*	-	-	-	-
Parula warbler	-	-	-	-	-	-	-	2	5	-	*	*	-	-	*
Yellowthroat	-	-	-	-	-	-	-	-	1	-	-	*	-	-	-
Red-winged blackbird	17	-	3	-	-	-	-	-	-	-	-	-	*	-	-
Common grackle	2	-	-	-	-	2	1	2	10	-	-	-	-	-	*
Cardinal	1	-	-	2	-	-	4	1	2	*	-	*	-	-	*
Rufous-sided towhee	-	-	-	3	1	1	-	-	-	-	-	-	-	-	-
Savannah sparrow	-	-	-	7	*	*	-	-	-	-	-	-	-	-	-
White throated sparrow	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-
Song sparrow	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Wood duck	-	-	-	-	-	-	-	*	*	-	-	-	*	*	-
Spotted sandpiper	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-
Hairy woodpecker	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-
Eastern kingbird	-	-	-	-	-	-	-	*	-	-	-	-	*	-	-
Purple martin	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-
Indigo bunting	-	-	-	-	-	-	-	*	*	-	-	-	-	-	-
Mockingbird	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-
Black and white warbler	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-
Whip-poor-will	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Eastern bluebird	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Barn swallow	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-
American bittern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow billed cuckoo	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-
Red-tailed hawk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Robin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eastern meadowlark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red bellied woodpecker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cedar waxwing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrtle warbler	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slate colored junco	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
American goldfinch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown creeper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown thrasher	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hermit thrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rusty blackbird	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broad-winged hawk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pigeon hawk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown headed nuthatch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N	E	N	E	N	E	N	E	L	N	E	L	N	E	L
Total Number of Species Observed	[illegible]	5	7	6	6	8	16	15	18	2	4	4	6	3	10
Total Number Seen (Quarterly only)	28	10	31	15	13	10	17	26	43	-	-	-	-	-	-

Species	August N	August E	August L	September N	September E	September L	October N	October E	October L	November N	November E	November L	December N	December E	December L	January '76 N	January '76 E	January '76 L	February N	February E	February L	Total Number Observed N	Total Number Observed E	Total Number Observed L
Black vulture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Bobwhite (call)	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	*	1
Mourning dove	2	-	1	-	-	*	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	8	2	1
Chimney swift	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
Belted kingfisher	1	-	-	-	-	-	-	-	*	-	1	1	-	-	-	-	-	-	1	-	-	3	1	1
Yellow-shafted flicker	-	-	1	-	-	*	*	-	*	2	1	2	*	-	*	-	-	-	-	-	-	7	1	5
Pileated woodpecker	1	1	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	*	-	-	-	1	5	1
Red headed woodpecker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Downy woodpecker	-	-	-	-	-	-	-	*	-	-	-	1	-	-	-	*	-	-	-	-	-	-	-	3
Bluejay	1	-	*	*	*	*	*	*	*	1	-	1	-	-	-	-	-	-	-	-	-	5	4	2
Common crow	2	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6	-
Fish crow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2
Carolina chickadee	-	-	-	-	-	-	-	-	*	15	2	5	-	-	*	*	*	*	1	2	-	19	12	5
Tufted titmouse	-	-	-	-	-	-	*	*	-	-	1	-	-	*	*	*	-	-	5	-	-	6	1	-
White breasted nuthatch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Winter wren	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
Carolina wren	-	-	-	-	-	-	-	*	*	-	5	1	-	*	*	*	-	-	1	-	-	1	6	1
Gray catbird	1	-	1	-	-	*	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	1	2	1
Veery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Blue gray gnatcatcher	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	8
Golden crowned kinglet	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	2	-
Ruby crowned kinglet	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	3	-	-	9	4	-
Loggerhead shrike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Starling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	27	2	-
Prothonotary warbler	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
Parula warbler	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	6
Yellowthroat	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2
Red-winged blackbird	3	-	-	-	-	-	*	-	-	2	13	2	-	-	-	-	-	-	-	-	-	25	13	2
Common grackle	-	1	3	*	-	-	-	*	-	-	42	20	-	-	-	-	-	-	-	25	-	3	72	33
Cardinal	1	-	-	-	-	*	*	-	-	1	2	-	*	-	-	-	-	-	2	-	-	9	5	2
Rufous-sided towhee	2	-	*	-	-	*	*	-	*	1	-	-	-	*	-	-	-	-	-	-	-	4	4	-
Savannah sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
White throated sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	*	-	7	-
Song sparrow	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	3	-	1
Wood duck	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
Spotted sandpiper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hairy woodpecker	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	1	-	1
Eastern kingbird	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purple martin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indigo bunting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mockingbird	-	-	*	-	-	-	*	-	-	2	-	1	-	-	-	-	*	-	-	-	-	2	-	1
Black and white warbler	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Whip-poor-will	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eastern bluebird	-	-	-	-	-	-	-	-	-	-	-	3	-	-	*	-	-	-	-	-	-	-	-	3
Barn swallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
American bittern	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Yellow billed cuckoo	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Red-tailed hawk	-	-	*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	2	-	-
Robin	-	-	*	-	-	-	-	-	-	-	-	27	-	-	-	-	-	-	-	1	5	-	1	32
Eastern meadowlark	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red bellied woodpecker	-	-	-	-	-	-	-	-	-	1	1	-	-	-	*	*	-	-	1	-	-	2	1	-
Cedar waxwing	-	-	-	-	-	-	-	-	-	-	8	6	-	-	*	-	-	-	-	-	-	-	8	6
Myrtle warbler	-	-	-	-	-	-	-	-	-	-	-	25	-	-	-	-	-	-	11	-	1	11	-	28
House sparrow	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Slate colored junco	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-
American goldfinch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-
Brown creeper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-
Brown thrasher	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-
Hermit thrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	1	-	-	1	-
Rusty blackbird	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-
Broad-winged hawk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-
Pigeon hawk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Brown headed nuthatch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-
	N	E	L	N	E	L	N	E	L	N	E	L	N	E	L	N	E	L	N	E	L	N	E	L
Total Number of Species Observed	10	3	11	3	3	6	8	6	8	12	10	16	3	3	10	8	5	3	9	9	5			
Total Number Seen (Quarterly only)	15	3	12	-	-	-	-	-	-	35	76	98	-	-	-	-	-	-	26	35	9	166	173	165

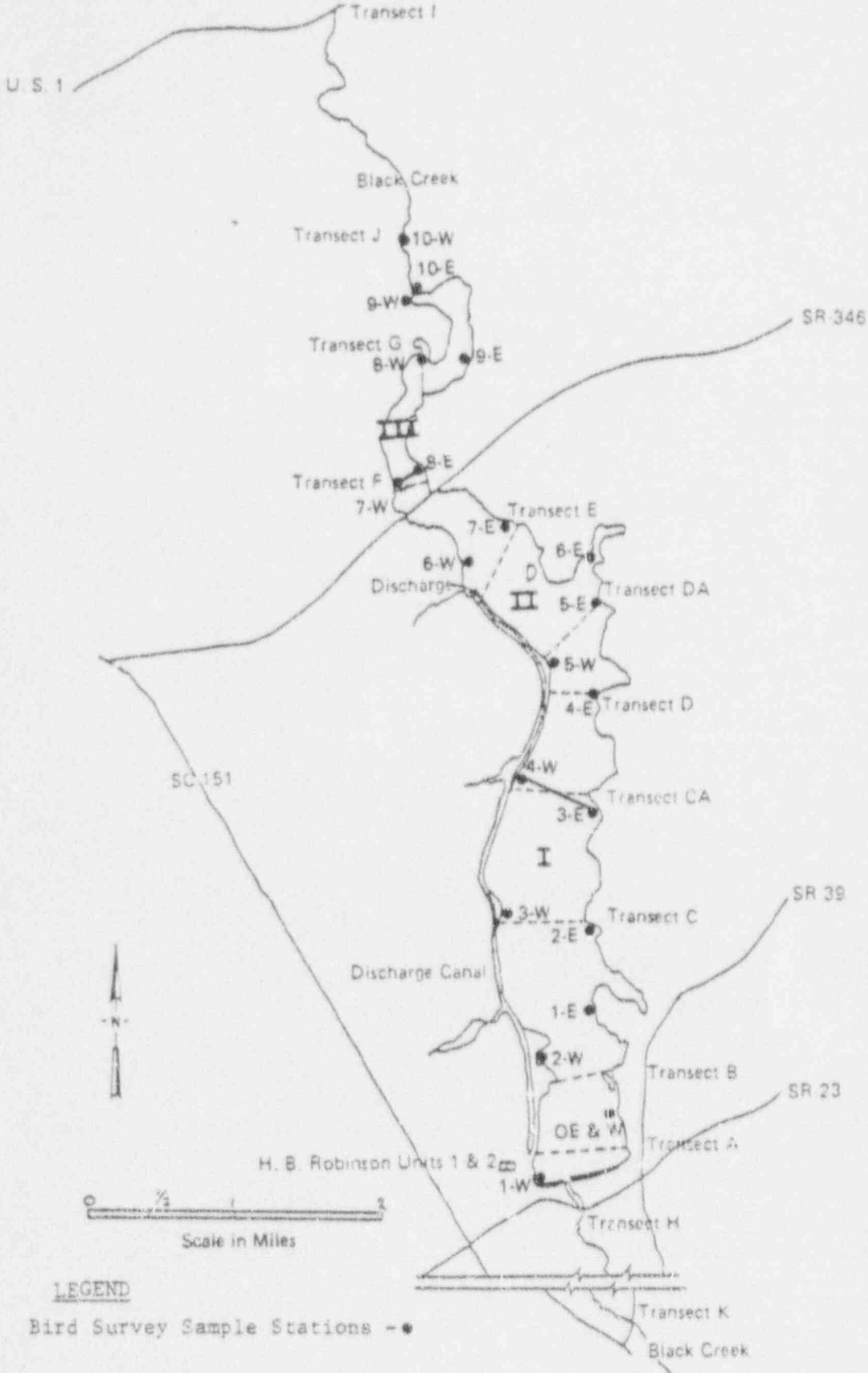


Figure 8.4.1 Bird survey sample stations and boundary of arbitrary impoundment sections

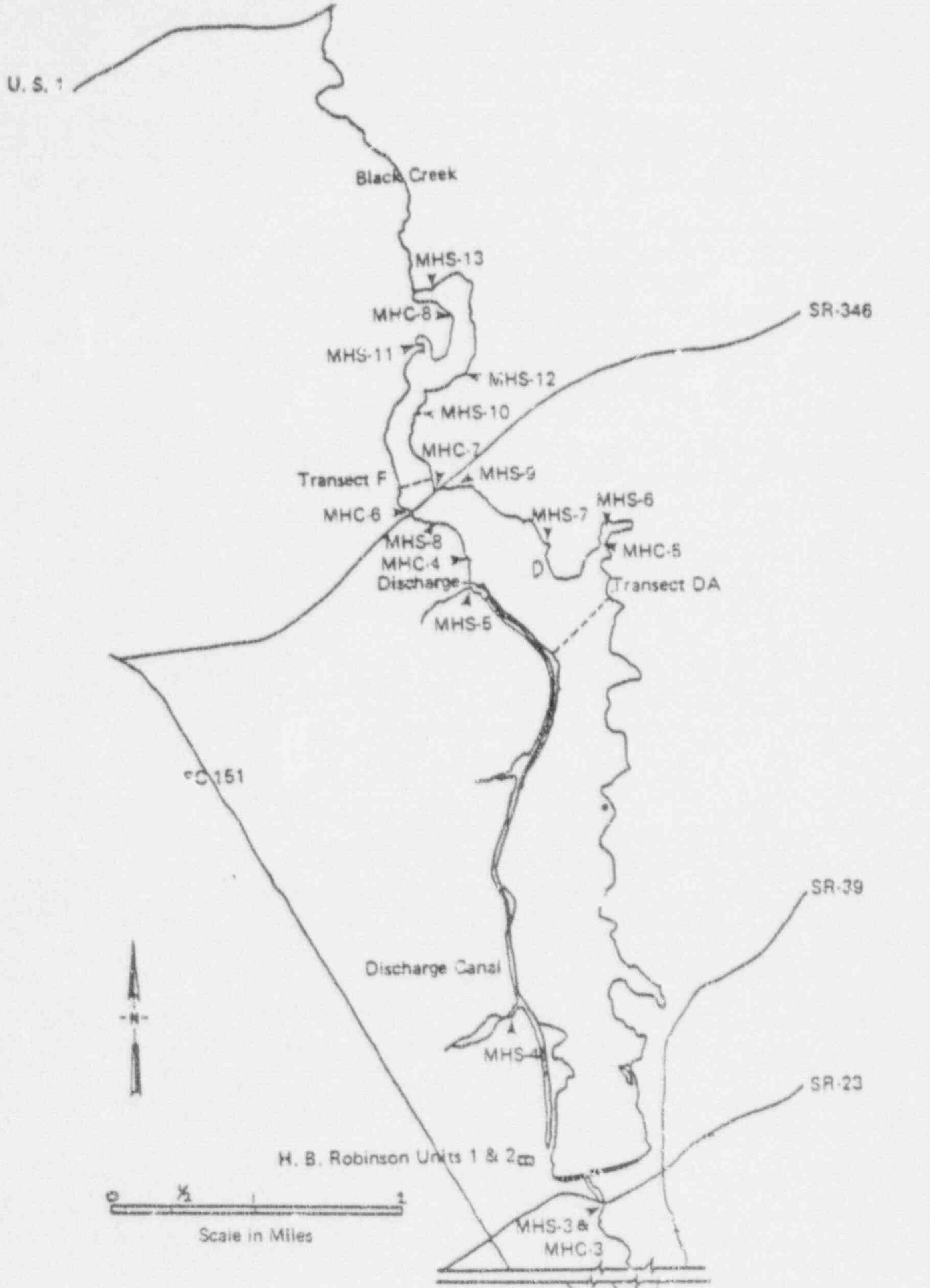


Figure 8.2.1 Locations of larval amphibian sampling stations (MHS) and evening frog and toad call survey stations (MHC)

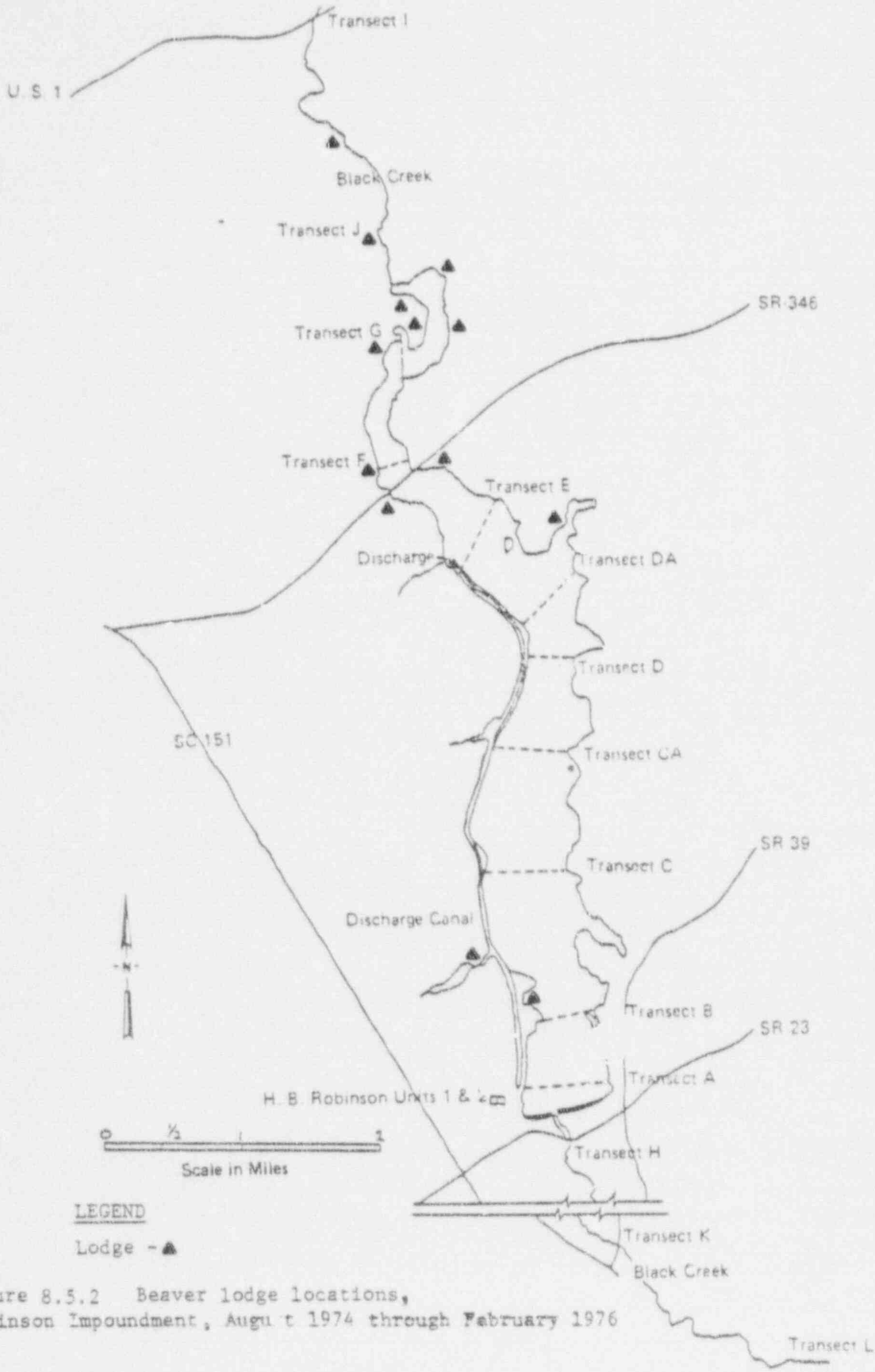
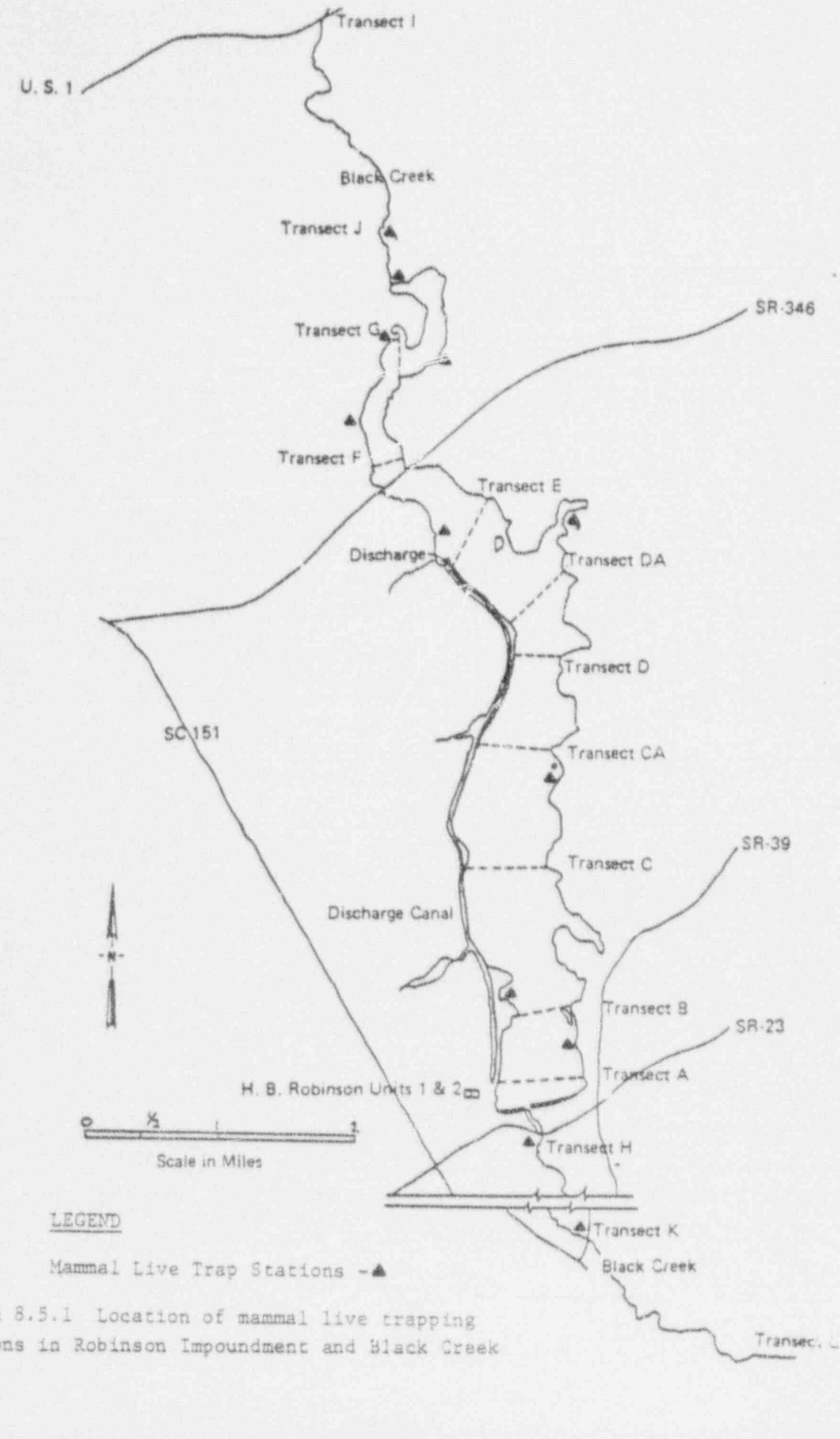


Figure 8.5.2 Beaver lodge locations, Robinson Impoundment, Augu t 1974 through February 1976



LEGEND

Mammal Live Trap Stations - ▲

Figure 8.5.1 Location of mammal live trapping stations in Robinson Impoundment and Black Creek

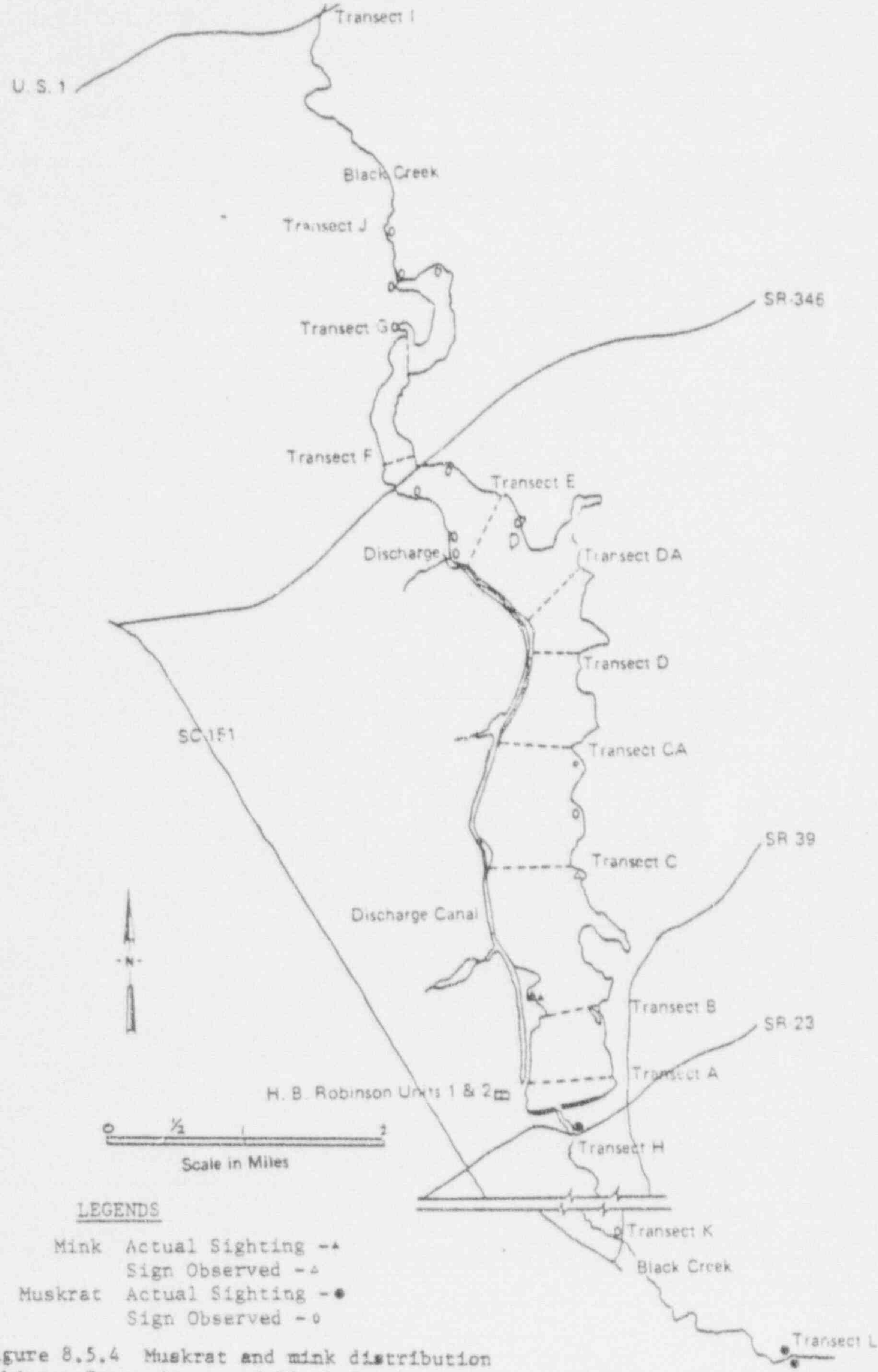


Figure 8.5.4 Muskrat and mink distribution
Robinson Impoundment and Black Creek,
August 1974 through February 1976

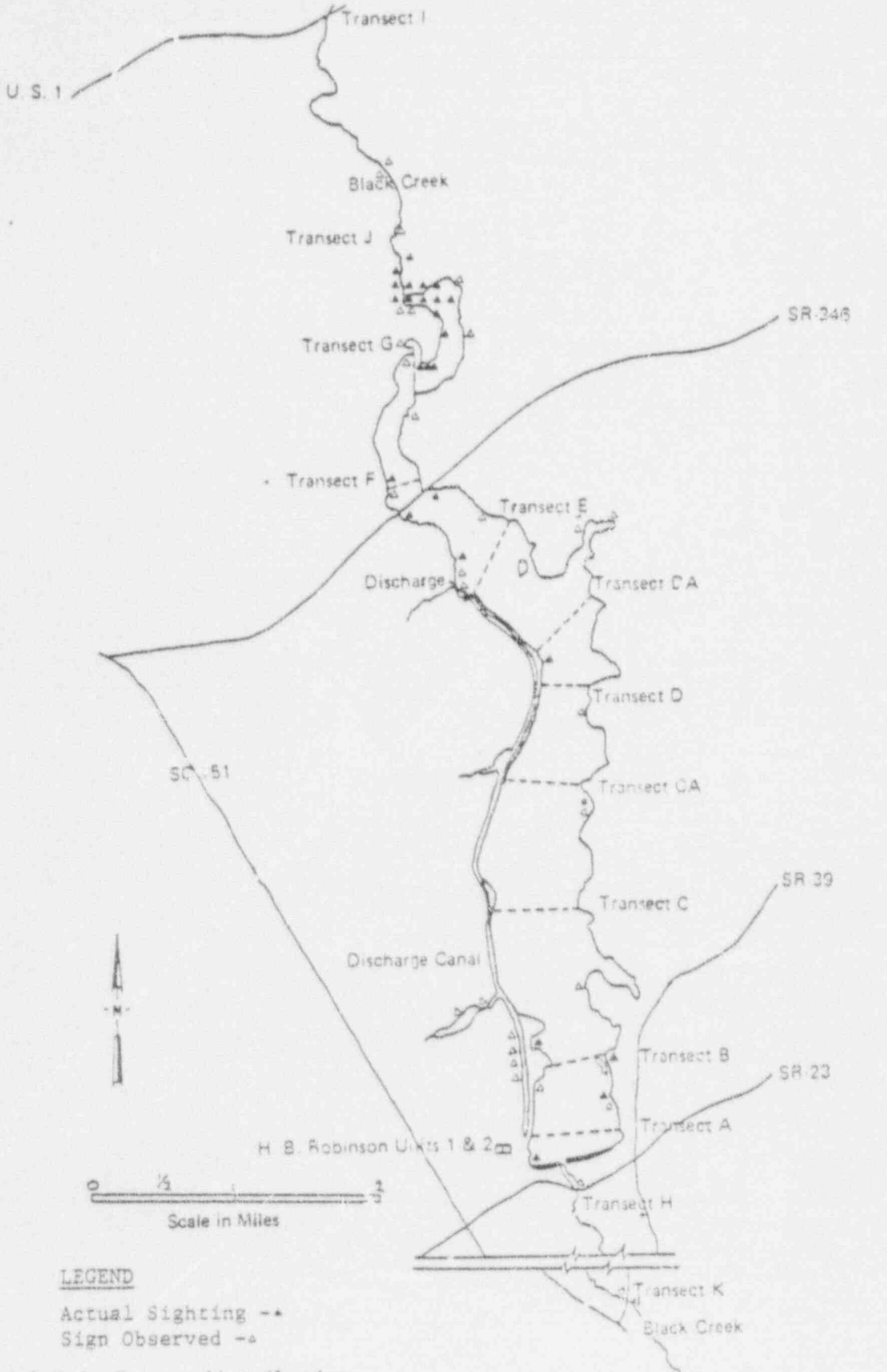
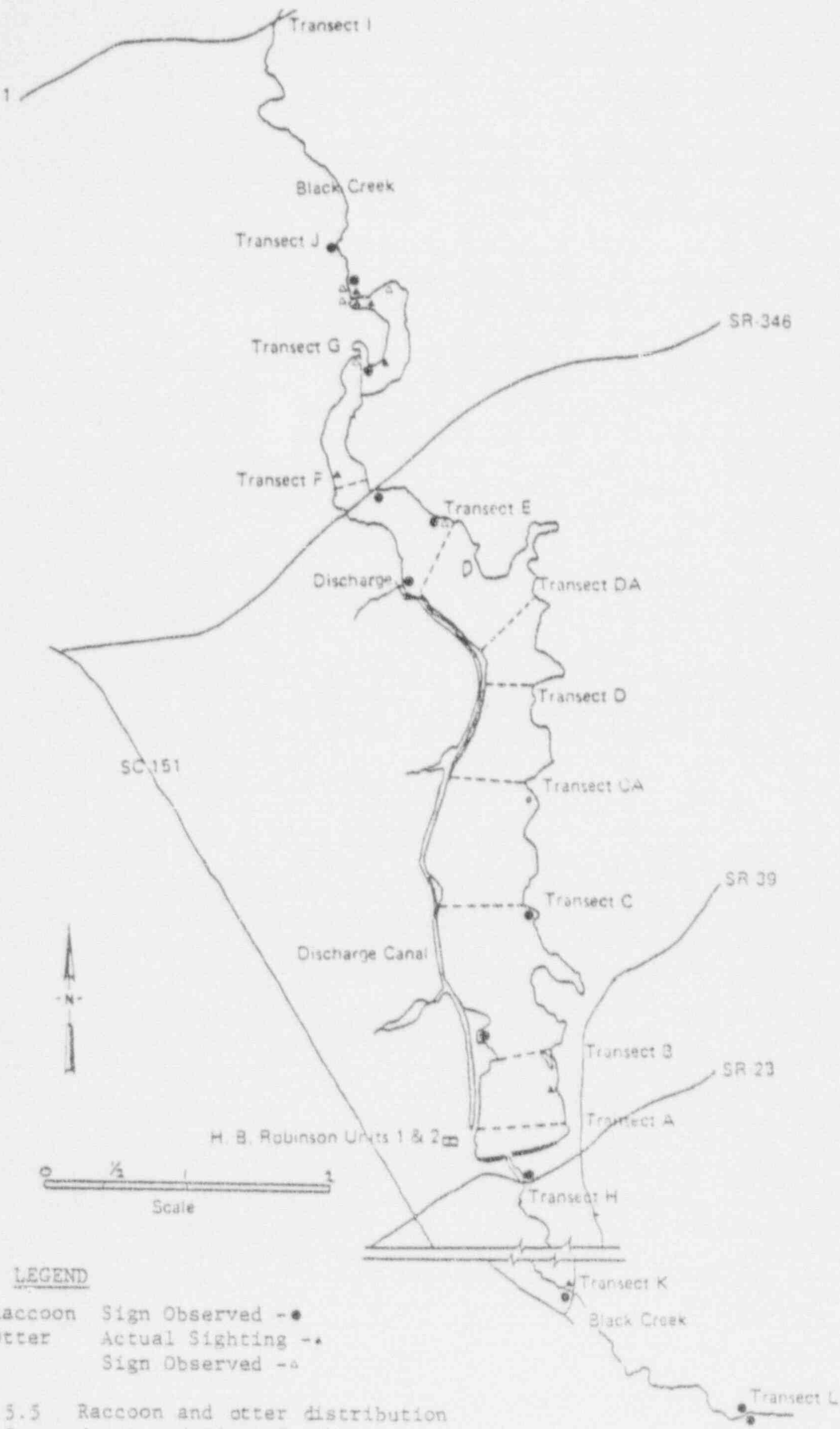


Figure 8.5.3 Beaver distribution Robinson Impoundment and Black Creek, August 1974 through February 1976



LEGEND

Raccoon Sign Observed - ●
Otter Actual Sighting - ▲
Sign Observed - △

Figure 8.5.5 Raccoon and otter distribution
Robinson Impoundment and Black Creek,
August 1974 through February 1976

Carolina Power & Light Company

H. B. Robinson Steam Electric Plant

316 Demonstration

Volume III

Exhibits

June 30, 1976

CP&L EXHIBIT 1.0

Circulating Water System Flow Studies

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Views of a typical bay of the Unit 1 intake structure are shown in Figures 2.1.3 and 2.1.4. The mouth of each bay is defined by a concrete base with a .15m (6-inch lip) (see Figure 2.1.3), a skimmer wall extending down to an elevation of 57.9m (190 feet), and vertical walls which form an opening 3.4m (11 feet 2 inches) wide and 2.9m (9 feet 6 inches high). Use of the skimmer wall results in cooler water from depths of 9.2m to 12.2m (30 to 40 feet) (typical) being drawn into the intake structure.

The frame was lowered along the outside of the skimmer wall to measure flow rates through the structure mouth. For this maneuver the hoist rig was rotated on to its side and placed against the security fence located along the edge of the structure. Measurements were taken at approximately .61m (two-foot) intervals from the lowest positions that the frame would reach in each bay.

To measure flow rates near the traveling screens of both bays, the frame was lowered into the vertical stop-log guides on the lake side of the screens. Again, measurements were made at measured intervals from the bottom position of the frame. Depth of the meters into the water was determined from markers on a rope tied to the frame. The measurement locations are noted in Figure 2.1.4.

A side view of a typical bay of the Unit 2 intake structure is shown in Figure 2.1.5, and an inside front view is given in Figure 2.1.6. The design is similar to the bay design of Unit 1, with a few significant differences. The skimmer wall does not extend down as far, resulting in a larger mouth opening; and there is no overlap of the skimmer wall with the bay floor as in Unit 1 (cf. Figure 2.1.3). This results in less directional variation in velocity and a flatter velocity profile inside the bay.

Flow rates were measured in front of the traveling screen guides by positioning the frame along the vertical stop-log guides, as was done in the Unit 1 testing. However, mouth flow rates could not be measured by this technique because objects along the outside wall interfered with the lowering of the frame. Average velocity estimates are made based on design values of volumetric flow rate and cross-sectional area.

1.0 Introduction

As part of the H. B. Robinson Steam Electric Plant 316 Demonstration Program, flow velocity profiles were measured within the plant intake structures and the discharge canal on March 24-26, 1976. The circulating water pumps for Unit 1 were running although the unit was off-line, and the Unit 2 circulating and service water pumps were running and drawing typical flow rates for normal full-load plant conditions. Rotating digital flow meters were used for all measurements because of their availability and their suitability for local velocity measurements. The flow meters indicate velocity magnitudes only; directional characteristics must be inferred from geometrical considerations and visual observation. This is considered sufficient since general directional patterns are known and magnitudes will have the major effect on entrapment and entrainment.

The intake structure tests are described separately from the discharge canal tests in Sections 2.0 and 3.0, respectively. Certain discussions and conclusions common to both sets of tests are presented in Section 4.0.

2.0 Intake Structure Testing

The intake structure of Unit 1 has two bays and is physically separate from the Unit 2 intake structure, which has three bays. Velocity measurements were made on the impoundment side of the mouth of the Unit 1 intake structure and in front of the traveling screens within the intake structures of both Units 1 and 2.

2.1 System Description

Five General Oceanics, Inc. Model 2030 digital flow meters were positioned approximately .76m (2.5 feet) apart within a frame as shown in Figure 2.1.1. The frame was raised and lowered by a hand crank mounted on a hoist rig as shown in Figure 2.1.2. Aerodynamic foils were placed around the horizontal pipe sections of the frame to reduce the drag force acting on the frame when in the water. Each meter was free to rotate in its vertical plane but was constrained in the horizontal plane. Wheels were included in the frame design to provide rolling friction instead of sliding friction.

this bay. Bay C flow velocity test results are given in Table 2.2.6. Bays A and B were tested at offset 1.2m (4-foot) intervals, as indicated in Tables 2.2.4 and 2.2.5. In some cases during Unit 2 testing, a meter indicator apparently did not properly increment to the next hundreds or thousands (or other) digit. In these cases the assumed proper meter reading has been used to calculate net counts and hence flow velocity. Flow velocities calculated using assumed meter readings are identified in the tables. Correction runs were generally carried out at every other depth; i.e., every 1.2m (4 feet) for Bay C and every 2.4m (8 feet) for Bays A and B. The results were plotted and correction values were read from the resulting graphs.

3. Discharge Canal Testing

Flow velocities were measured at various points across the discharge canal at a site approximately .9km (0.6 miles) from the seal well at the canal origin near the plant and across the weir at the end of the canal.

3.1 System Description

A velocity probe support structure (see Figure 3.1.1) was designed to attach to a boat and hold a velocity probe approximately 1.8m (6 feet) in front of the boat and at various depths. The probe holder could be rotated toward the boat deck for reading the meter, adjusting the depth, and controlling the sample time.

A cross section of the canal at the test site is shown in Figure 3.1.2. A cable was stretched across the canal and markers were placed every 3.7m (12 feet) from the right shoreline, looking upstream. The last marker (Number 1 in Figure 3.1.2) was 1.5m (5 feet) from the left shoreline. The cable was threaded through some piping on the boat deck so that the boat was held in place by the cable. Thus, the measurements were made about 2.1m (7 feet) upstream from the cable. At each marker the probe was lowered into the water for a measured time at both 20% and 80% of the local canal depth, except at the first and last markers where the measurements were made at mid-depth only.

In order to account for meter rotation during transit of the meters to and from the desired depth, correction runs were made. This consisted of lowering the frame to the desired depth and raising it immediately and recording the total counts accumulated in transit (1/10 of a meter rotation = 1 count). For Unit 2 measurements, the correction counts were determined by graphical interpolation or extrapolation of correction count data taken at various depths. This is expected to reduce the error associated with variations in lowering and raising rates.

2.2 Results

The measurement frame was lowered over the outside edge of Unit 1 intake structure, Bays A and B, until the hoist line became slack. The bottom position reached outside Bay B was 1.8m (6 feet) lower than outside Bay A and was about .15m (1/2 foot) above the concrete floor at elevation 55m (180.5 feet) (indicating slight buildup of material on the Bay B floor and some impediment 1.9m (6-1/2 feet) above the Bay A floor). From the bottom positions outside both bays, the flow was measured at .61m (2-foot) intervals to a depth well above the bottom of the skimmer wall. The flow velocity results are reported in Table 2.2.1, and profiles are plotted in Figure 2.2.1 up to the bottom of the skimmer wall.

Next, the measurement frame was lowered down the stop-log guides which are about 2.8m (9.25 feet) upstream of the centerline of the traveling screen guides. The frame stopped about .15m (1/2 foot) above the concrete floor at elevation 59.8m (196.0 feet) in Bay A and dropped all the way to the floor in Bay B. The flow velocity results of Bay A testing are given in Table 2.2.2 while Table 2.2.3 lists the Bay B results.

As previously indicated, the measurement frame could not be lowered down the outside wall of the Unit 2 intake structure because of interferences. Thus, measurements were made only along the stop-log guides, which are about 3.1m (10 feet 1.5 inches) upstream of the traveling screen headshaft, centerline to centerline. Measurements were made at .61m (2-foot) intervals in Bay C from a depth of 9.4m (30.75 feet). This depth corresponded to the frame bottom being about .38m (1.25 feet) above the concrete floor at elevation 56.7m (186.0 feet) and is the lowest point the frame could be lowered to in

than 10% whereas the velocities below .3m/sec (1.0 foot per second) may not always be within 10%. The depth measurements are expected to be accurate to within .15m (1/2 foot).

The results of Table 2.2.1 indicate that the Unit 1 mouth velocities at a depth of 9.5m (31 feet) are about 10% higher for Bay B than for Bay A. However, these measurements were made very near the bottom of the skimmer wall (see Figure 2.1.4) where the profile is changing rapidly and a slight difference in depth measurement could result in the noted difference in velocity results. Hence, it is likely that the velocities at the same depth within the two bays are about the same; i.e., less than 10% different. Only Bay B could be measured below this depth, and these results show a general decrease in velocity with increasing depth below the skimmer wall (see Figure 2.2.4). The measurements indicate the maximum velocity through the mouth is on the order of .34m/sec (1.1 feet per second). The circulating water pump design flow is 1.3m^3/sec (47.42 cfs). At the mouth this represents an average velocity of 0.92 feet per second. The measured flows would appear to have a lower average, indicating possibly that the pumps were drawing less than design flow.

The effective flow area within each bay of the Unit 1 intake structure is never smaller than at the mouth. Hence, the maximum average flow velocity should occur at the mouth. After entering the structure, the water flows generally upward between the skimmer wall and the vertical portion of the structure floor (see Figure 2.1.3) through an area only slightly larger, 10.4m^2 (111.67 feet^2), than the mouth area, 9.9m^2 (106.08 feet^2). Thus, the flow profile here is similar in magnitude to that at the mouth but directed vertically instead of horizontally.

The flows inside the Unit 1 intake structure appear nowhere to exceed .5m/sec (1.5 feet per second). It is noted that the velocities at the cross section defined by the stop-log guides are quite low, generally below .001m/sec (0.25 feet per second), within 2.2m (7.25 feet) of the bottom of the structure. This is reasonable since the water must turn the corner after its vertical ascent (see Figure 2.1.3). The flow near the water surface is generally in a reverse direction (i.e., away from the pumps) and is on the order of .15m/sec (0.5 feet per second). The maximum velocities at this cross section occur just

An upstream view of the weir is given in Figure 3.1.3. Flow velocity was measured at mid-depth (.61m) (2 feet) at each of five test sites across the weir, labeled one through five in Figure 3.1.3. These measurements were accomplished by tying the boat to the fence above the weir and lowering the probe into the water for two minutes.

3.2 Results

The flow velocity results at the discharge canal test locations are presented in Table 3.2.1. Correction counts were obtained only at test locations 3b, 4b, and 6b. The correction count for test location 5b was assumed the same as for 4b since they were at the same depth and only 3.7m (12 feet) apart. The transit time for all other test locations was considered small enough to neglect correction counts.

Table 3.2.2 lists the flow velocities obtained at the weir test sites. From visual observation, it appeared there was not appreciable linear flow rate change across the weir except within about .3m (one foot) of the weir walls. This observation is verified by the results of Table 3.2.2. The flow velocities, V, were obtained from the count rates, C, using the linear relationship

$$V\ (\text{mps}) = 0.026\ C$$

where C is in counts per second. This was obtained by linear extrapolation of the calibration curve for the meter used (#00900).

4.0 Discussion and Conclusions

In general, the flow velocity results are expected to be accurate to within 10%. This is a subjective estimate based upon the following sources of error: differences in transit time between correction runs and measurement runs (due to unintentional differences in lowering and raising rates), inaccurate sample time measurement (perhaps five seconds out of two minutes), and possible reverse rotation of the meters for a brief time during and after entry into the water. Actually, the larger velocities are probably accurate to less

velocity in each bay of .5m/sec (1.73 feet per second) results. Because the directional variation of velocity at the stop-log guide cross section is not known exactly, it is not possible to meaningfully integrate the measured velocity profile to obtain net volumetric flow (or, alternatively, average velocity) toward the pumps. However, reference to Tables 2.2.4, 2.2.5, and 2.2.6 indicates velocities generally in the range .2 to .8m/sec (0.5 to 2.9 feet per second), which appear to be reasonable for the design flow indicated above.

The discharge canal was constructed with a 6.1m (20-foot) base and sides with 1:3 slopes, as indicated in Figure 3.1.2. The measurements within the canal indicate a gradually changing flow profile with velocity generally between .3m (one foot) and just over .6m (two feet) per second. This is expected to be very characteristic of the flow pattern all along the canal since the cross section is uniform, except for minor variations resulting from local buildup and erosion, and there are no major sources or sinks between the origin and the weir. Minor streams which feed into the canal, such as from the ash pond, introduce only a fraction of the total canal flow.

At the weir the measured flow velocities indicate a very flat lateral profile around approximately 2.0 m/sec (6.65 feet per second) all the way across the weir (except very near the edges). Theoretically, a vertical profile which varies roughly as the square root of the depth, measured from the water level behind the weir, is expected for a sharp-crested weir whose nappe is exposed to the air on the underside. However, the lake level was high enough that the underside of the nappe was not open to the atmosphere and this weir is not truly sharp-crested so the exact nature of the vertical profile is not known.

below the horizontal support columns; i.e., at a depth of about 4.3m (14 feet). The profile in Bay B is more uniformly distributed between the depths of 1.7 and 4.7m (5.5 and 15.5 feet) than the profile in Bay A. The velocity profiles are not expected to change significantly between the stop-log guide and the face of the traveling screen, except that the screen should have a tendency to damp out directional variations and make the profile more uniform.

The geometry of the Unit 2 intake structure is such that the mouth itself is not the smallest cross-sectional flow area within the structure (hence the average velocity at the mouth is not the maximum). The cross section from the skimmer wall to the corner of the structure floor at elevation 56.7m (186 feet) (see Figure 2.1.5) is the smallest at $20.2m^2$ ($217.28\ feet^2$). The mouth crosssectional area is $22m^2$ ($236.5\ feet^2$). Also, there is no region of predominantly vertical flow as there was in the Unit 1 intake structure and the vertical profiles at the stop-log guides are thus much flatter.

With few exceptions, the flows at the cross section defined by the fine-screen stop-log guides within the Unit 2 bays agree fairly well at the same depths (compare Tables 2.2.4, 2.2.5, and 2.2.6). Within 1.8m (6 feet) of the concrete floor, the velocities are generally between .6 and .9m/sec (2 and 3 feet per second) .9m/sec (2.89 feet per second) is the maximum measured in all three bays. Near the water surface, the Bay C results are generally higher (around .3m/sec) (one foot per second) than the Bay A results (around .2m/sec) (0.5 feet per second) at depths areoun .9 to 2.1m (3 to 7 feet). The most complete set of results, for Bay C, show a basically flat profile from the bottom up to a depth of 5.7m (18.75 feet), a general decrease from there up to a minimum at about 1.5m (4-3/4 feet) and an increase (in the reverse direction) up to the water surface. The usually high flow rates at 3.9m (12.75 feet) deep in Bay A (above .9m/sec) (3 feet per second) are not typical of the other measurements but may indicate a region where flow is channeled by the horizontal support column.

The Unit 2 circulating water pumps are rated at 6.1×10^5 ℓ/min (160,700 gpm) each. The service water pumps are designed to supply about $30.3m^3$/min (8,000 gpm) each. Thus, total flow through each bay should be on the order of $638.6m^3$/sec (375.86 cfs). Dividing by the minimum cross-sectional area of $20.2m^2$ ($217.28\ feet^2$) (discussed previously), a maximum design average flow

Table 2.2.2 Intake flow velocity test results, Unit 1, Bay A, inside.

Depth Meters (ft)	Verticle distance from bottom, h meters (ft)	Horizontal distance from left side, d meters (ft): .305 (1)	.99 (3 1/4)	1.68 (5 1/2)	2.36 (7 3/4)	3.05 (10)
		Flow Velocities m/sec (ft/sec)				
.08 (1/4)	7.5 (24 1/2)	.15 (0.49)	.16 (0.53)	.11 (0.36)	.16 (0.54)	.14 (0.47)
.76 (2 1/2)	6.8 (22 1/4)	.23 (0.75)	.21 (0.68)	.13 (0.44)	.20 (0.65)	.25 (0.83)
1.7 (5 1/2)	5.9 (19 1/4)	.16 (0.52)	.24 (0.79)	.21 (0.69)	.21 (0.68)	.20 (0.66)
2.3 (7 1/2)	5.3 (17 1/4)	.10 (0.32)	.15 (0.50)	.11 (0.35)	.12 (0.39)	.10 (0.32)
2.9 (9 1/2)	4.7 (15 1/4)	.09 (0.30)	.13 (0.42)	.12 (0.40)	.17 (0.56)	.13 (0.44)
3.5 (11 1/2)	4.0 (13 1/4)	.09 (0.29)	.10 (0.33)	.09 (0.28)	.11 (0.36)	.11 (0.37)
4.1 (13 1/2)	3.4 (11 1/4)	.41 (1.36)	.43 (1.41)	.31 (1.02)	.38 (1.25)	.37 (1.22)
4.7 (15 1/2)	2.8 (9 1/4)	.21 (0.70)	.25 (0.81)	.16 (0.52)	.22 (0.73)	.27 (0.89)
5.3 (17 1/2)	2.2 (7 1/4)	* *	* *	* *	.09 (0.28)	* *
5.9 (19 1/2)	1.6 (5 1/4)	* *	* *	* *	* *	* *
6.6 (21 1/2)	1.0 (3 1/4)	* *	* *	* *	* *	* *

*Measured flow velocity was less than .08m/sec (0.25 ft/sec).

Table 2.2.1 Intake flow velocity test results, Unit 1, outside.

Horizontal distance from left side, d meters (ft)		.31 (1)	.99 (3 1/4)	1.7 (5 1/2)	2.36 (7 3/4)	3.05 (10)
Depth Meters (ft)	**Verticle distance from bottom, h meters (ft)**	**Flow Velocities m/sec (ft/sec)**				
Bay A						
8.8 (29)	3.4 (11 1/4)	* *	.11 (0.35)	.08 (0.27)	.13 (0.41)	* *
9.5 (31)	2.8 (9 1/4)	.25 (0.83)	.28 (0.92)	.27 (0.87)	.29 (0.95)	.26 (0.85)
Bay B						
8.9 (29)	3.4 (11 1/4)	* *	.14 (0.47)	* *	* *	.09 (0.30)
9.5 (31)	2.8 (9 1/4)	.24 (0.79)	.33 (1.09)	.28 (0.92)	.32 (1.05)	.32 (1.04)
10.1 (33)	2.2 (7 1/4)	.20 (0.65)	.32 (1.05)	.02 (0.70)	.29 (0.95)	.30 (0.98)
10.7 (35)	1.6 (5 1/4)	.16 (0.54)	.20 (0.66)	.20 (0.66)	.28 (0.92)	.23 (0.77)
11.3 (37)	.99 (3 1/4)	.12 (0.39)	.20 (0.65)	.18 (0.56)	.18 (0.60)	.15 (0.50)

*Measured flow velocity was less than .076m/sec (0.25 ft/sec).

Table 2.2.4 Intake flow velocity test results, Unit 2, Bay A, inside.

Horizontal distance from left side, d meters (ft)		.305 (1)	.99 (3 1/4)	1.68 (5 1/2)	2.36 (7 3/4)	3.05 (10)
Depth Meters (ft)	**Verticle distance from bottom, h meters (ft)**			**Flow Velocities m/sec (ft/sec)**		
.23 (3/4)	10.37 (34)	.20 (0.64)	.20 (0.67)	.26 (0.86)	.13 (0.43)[a]	.18 (0.60)
1.45 (4 3/4)	9.15 (30)	.23 (0.74)	.19 (0.39)	.11 (0.35)	.13 (0.43)	.28 (0.92)
2.67 (8 3/4)	7.93 (26)	.37 (1.21)	.31 (1.02)	.21 (0.68)	.26 (0.85)[a]	.35 (1.15)
3.89 (12 3/4)	6.71 (22)	1.07 (3.52)	1.02 (3.36)	.94 (3.07)	1.00 (3.28)	.94 (3.07)
5.11 (16 3/4)	5.49 (18)	.61 (1.99)	.50 (1.64)	.45 (1.49)	.38 (1.23)	.51 (1.67)
6.33 (20 3/4)	4.27 (14)	.79 (2.58)[a]	.84 (2.76)	.86 (2.82)	.73 (2.40)	.68 (2.23)
7.55 (24 3/4)	3.05 (10)	.66 (2.16)[a]	.68 (2.21)	.66 (2.16)	.58 (1.90)[a]	.55 (1.79)
8.77 (28 3/4)	1.83 (6)	.56 (1.85)	.64 (2.10)	.70 (2.30)	.69 (2.27)[a]	.61 (2.00)
9.76 (32)	.84 (2 3/4)	.73 (2.40)	.74 (2.43)	.78 (2.57)	.88 (2.89)[a]	.75 (2.45)

[a] Meter indicator assumed not to have incremented properly.

Table 2.2.3 Intake flow velocity test results, Unit 1, Bay B, inside.

Depth Meters (ft)	Verticle distance from bottom, h meters (ft)	Horizontal distance from left side, d meters (ft): .305 (1)	.99 (3 1/4)	1.68 (5 1/2)	2.36 (7 3/4)	3.05 (10)
		Flow Velocities m/sec (ft/sec)				
.08 (1/4)	7.47 (24 1/2)	.16 (0.51)	.18 (0.58)	.12 (0.39)	.18 (0.59)	.16 (0.53)
.76 (2 1/2)	6.79 (22 1/4)	.25 (0.82)	.26 (0.84)	.17 (0.55)	.20 (0.65)	.25 (0.82)
1.68 (5 1/2)	5.87 (19 1/4)	.20 (0.64)	.26 (0.85)	.23 (0.75)	.27 (0.88)	.27 (0.89)
2.29 (7 1	5.26 (17 1/4)	.09 (0.31)	.13 (0.44)	.12 (0.40)	.21 (0.69)	.16 (0.52)
2.90 (9 1/2)	4.65 (15 1/4)	.12 (0.39)	.14 (0.45)	.10 (0.32)	.12 (0.39)	.13 (0.43)
3.51 (11 1/2)	4.04 (13 1/4)	.12 (0.38)	.16 (0.51)	.11 (0.35)	.12 (0.39)	.13 (0.42)
4.12 (13 1/2)	3.43 (11 1/4)	.23 (0.76)	.29 (0.94)	.22 (0.72)	.29 (0.96)	.25 (0.82)
4.73 (15 1/2)	2.82 (9 1/4)	.09 (0.29)	.12 (0.39)	.07 (0.23)	.12 (0.39)	.09 (0.28)
5.34 (17 1/2)	2.21 (7 1/4)	.08 (0.25)	* *	* *	* *	* *
5.95 (19 1/2)	1.60 (5 1/4)	* *	* *	* *	* *	* *
6.71 (22)	.84 (2 3/4)	.08 (0.26)	.08 (0.26)	.10 (0.32)	.12 (0.39)	* *

*Measured flow velocity was less than .076 m/sec (0.25 ft/sec).

Table 2.2.6 Intake flow velocity test results, Unit 2, Bay C, inside.

Horizontal distance from left side, meters (ft)		.305 (1)	.99 (3 1/4)	1.68 (5 1/2)	2.36 (7 3/4)	3.05 (10)
Depth Meters (ft)	Verticle distance from bottom, h meters (ft)	Flow Velocities m/sec (ft/sec)				
.23 (3/4)	10.37 (34)	.31 (1.02)[a]	.34 (1.11)	.31 (1.00)	.25 (0.83)[a]	.19 (0.62)
.84 (2 3/4)	9.76 (32)	.20 (0.66)	.24 (0.79)	.17 (0.55)	.20 (0.66)	.31 (1.01)
1.45 (4 3/4)	9.15 (30)	.09 (0.28)	.13 (0.41)	.08 (0.27)	.11 (0.35)	.11 (0.35)
2.06 (6 3/4)	8.54 (28)	.16 (0.51)	.19 (0.62)	.17 (0.55)	.16 (0.54)	.11 (0.36)
2.67 (8 3/4)	7.93 (26)	.24 (0.78)	.26 (0.84)	.16 (0.54)	.22 (0.72)	.22 (0.71)
3.28 (10 3/4)	7.[illegible] (24)	.38 (1.24)	.35 (1.14)	.28 (0.90)	.35 (1.16)	.40 (1.32)
3.89 (12 3/4)	6.71 (22)	.45 (1.48)	.45 (1.47)	.39 (1.29)	.42 (1.40)	.46 (1.50)
4.50 (14 3/4)	6.1 (20)	.63 (2.08)	.60 (1.98)	.53 (1.74)	.54 (1.76)	.54 (1.77)
5.11 (16 3/4)	5.49 (18)	.66 (2.16)	.62 (2.02)	.54 (1.77)	.53 (1.74)[a]	.57 (1.86)
5.[illegible] (18 3/4)	4.88 (16)	.77 (2.54)	.80 (2.62)	.82 (2.70)	.81 (2.66)	.77 (2.54)
6.33 (20 3/4)	4.27 (14)	.82 (2.68)	.88 (2.87)	.88 (2.87)	.84 (2.77)[a]	.82 (2.68)
6.94 (22 3/4)	3.66 (12)	.82 (2.69)	.84 (2.77)	.83 (2.73)	.79 (2.58)	.66 (2.16)
7.55 (24 3/4)	3.05 (10)	.63 (2.08)	.67 (2.20)	.64 (2.10)	.68 (2.22)	.44 (1.45)
8.16 (26 3/4)	2.44 (8)	.64 (2.10)	.68 (2.23)	.68 (2.22)	.67 (2.21)	.63 (2.07)

Table 2.2.5 Intake flow velocity test results, Unit 2, Bay B, inside.

Depth Meters (ft)	Verticle distance from bottom, h meters (ft)	Horizontal distance from left side, d meters (ft): .305 (1)	.99 (3 1/4)	1.68 (5 1/2)	2.36 (7 3/4)	3.05 (10)
		Flow Velocities m/sec (ft/sec)				
.84 (2 3/4)	9.76 (32)	.21 (0.70)	.18 (0.59)	.18 (0.58)	.16 (0.54)[a]	.20 (0.66)
2.06 (6 3/4)	8.54 (28)	.15 (0.48)	.18 (0.58)	.16 (0.54)	.31 (1.00)[a]	.46 (1.52)
3.28 (10 3/4)	7.32 (24)	.49 (1.60)	.41 (1.34)	.38 (1.26)	.53 (1.74)	.61 (2.00)
4.50 (14 3/4)	6.1 (20)	.73 (2.39)	.61 (2.01)	.58 (1.90)	.60 (1.97)[a]	.67 (2.20)
5.72 (18 3/4)	4.88 (16)	.70 (2.30)	.59 (1.92)	.58 (1.89)	.50 (1.64)[a]	.51 (1.66)
6.94 (22 3/4)	3.66 (12)	.89 (2.92)	.90 (2.94)	.84 (2.74)	.84 (2.77)[a]	.81 (2.66)
8.16 (26 3/4)	2.44 (8)	.41 (1.34)	.50 (1.64)	.52 (1.72)	.52 (1.71)	.48 (1.57)
9.76 (32)	.84 (2 3/4)	.73 (2.40)	.80 (2.62)	.80 (2.63)	.78 (2.56)[a]	.75 (2.47)

[a]Meter indicator assumed not to have incremented properly.

Table 3.2.1 Discharge canal flow velocities.

Test Location	Lateral Distance from Left Edge Meters (Feet)	Measurement Depth cm (Inches)	Percent of Total Depth	Corrected Meter Counts in 2 Min.	Velocity m/sec (feet/sec)
1	1.53 (5)	20.32 (8)	50%	820	.18 (0.58)
2a	5.19 (17)	35.56 (14)	20%	1166	.25 (0.83)
2b		147.32 (58)	80%	2566	.56 (1.82)[a]
3a	8.85 (29)	55.88 (22)	20%	2905	.63 (2.06)
3b		213.36 (84)	80%	2732	.59 (1.94)
4a	12.51 (41)	73.66 (29)	20%	3050	.66 (2.17)
4b		292.10 (115)	80%	2359	.51 (1.68)
5a	16.17 (53)	73.66 (29)	20%	3052	.66 (2.17)
5b		292.10 (115)	80%	2[illegible]6	.56 (1.83)
6a	19.83 (65)	45.72 (18)	20%	3140	.68 (2.23)
6b		182.88 (72)	80%	2548	.55 (1.81)
7	23.49 (77)	55.88 (22)	50%	1401	.31 (1.00)

[a]Meter indicator assumed not to have incremented properly.

Table 3.2.1 Discharge canal flow velocities.

Test Location	Lateral Distance from Left Edge Meters (Feet)	Measurement Depth cm (Inches)	Percent of Total Depth	Corrected Meter Counts in 2 Min.	Velocity m/sec (feet/sec)
1	1.53 (5)	20.32 (8)	50%	820	.18 (0.58)
2a	5.19 (17)	35.56 (14)	20%	1166	.25 (0.83)
2b		147.32 (58)	80%	2566	.56 (1.82)[a]
3a	8.85 (29)	55.88 (22)	20%	2905	.63 (2.06)
3b		213.36 (84)	80%	2732	.59 (1.94)
4a	12.51 (41)	73.66 (29)	20%	3050	.66 (2.17)
4b		292.10 (115)	80%	2359	.51 (1.68)
5a	16.17 (53)	73.66 (29)	20%	3052	.66 (2.17)
5b		292.10 (115)	80%	2576	.56 (1.83)
6a	19.83 (65)	45.72 (18)	20%	3140	.68 (2.23)
6b		182.88 (72)	80%	2548	.55 (1.81)
7	23.49 (77)	55.88 (22)	50%	1401	.31 (1.00)

[a]Meter indicator assumed not to have incremented properly.

Table 2.2.6 con't

Horizontal distance from left side, d meters (ft)		.305 (1)	.99 (3 1/4)	1.68 (5 1/2)	2.36 (7 3/4)	3.05 (10)
Depth Meters (ft)	Verticle distance from bottom, h meters (ft)	Flow Velocities m/sec (ft/sec)				
8.77 (28 3/4)	1.83 (6)	.70 (2.28)	.81 (2.64)	.87 (2.85)	.68 (2.23)	.57 (1.87)
9.38 (30 3/4)	1.22 (4)	.82 (2.70)	.85 (2.79)	.83 (2.71)	.79 (2.58)	.73 (2.38)

[a]Meter indicator assumed not to have incremented properly.

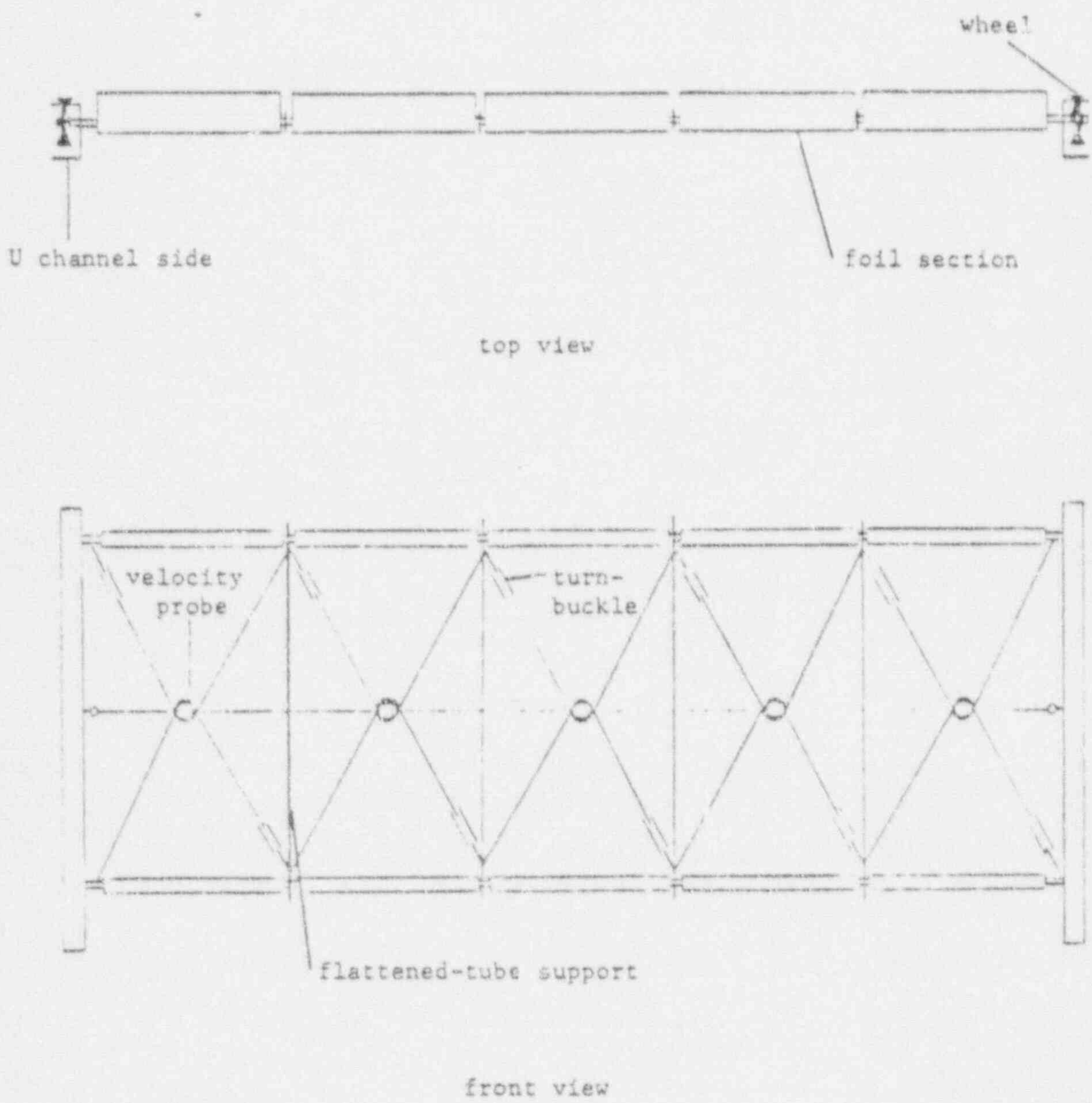

Figure 2.1.1 Flow velocity measurement frame.

Table 3.2.2 Flow velocities at the weir.[a]

Test Location	Lateral Distance from Left Edge (Approximate)	Meter Counts in 2 Minutes	Velocity m/sec (feet/sec)
1	3.89 12'9"	9602	2.09 (6.82)
2	7.55 24'9"	9761	2.12 (6.94)
3	11.21 36'9"	9040	1.96 (6.42)
4	13.95 45'9"	8881	1.92 (6.31)
5	18.22 59'9"	9505	2.06 (6.75)

[a]All measurements made at depth at .61m (2 feet).

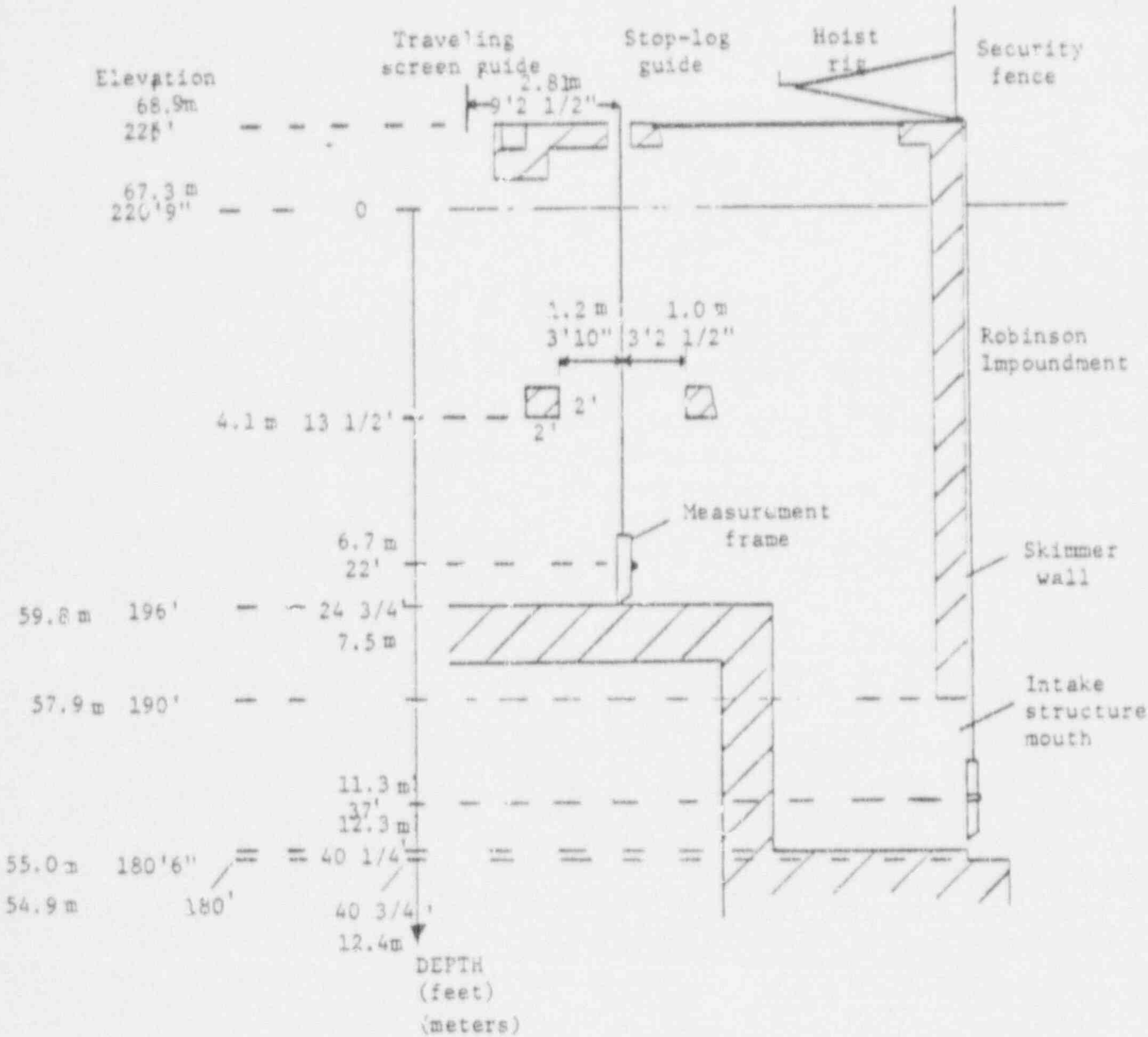

Figure 2.1.3 Side view of typical bay of Unit 1 intake structure.

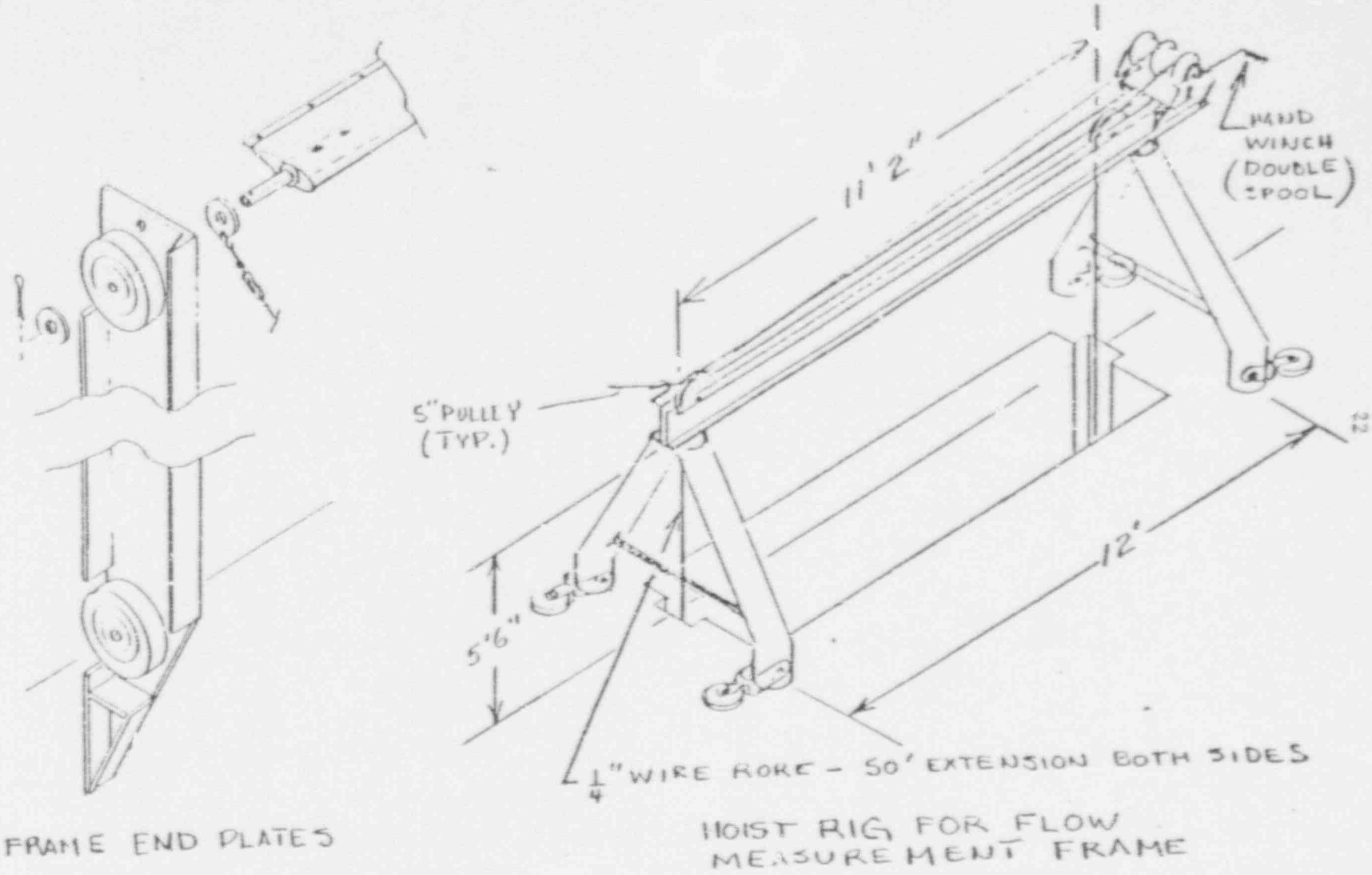

Figure2.1.2 Hoist rig for flow velocity measurement frame.

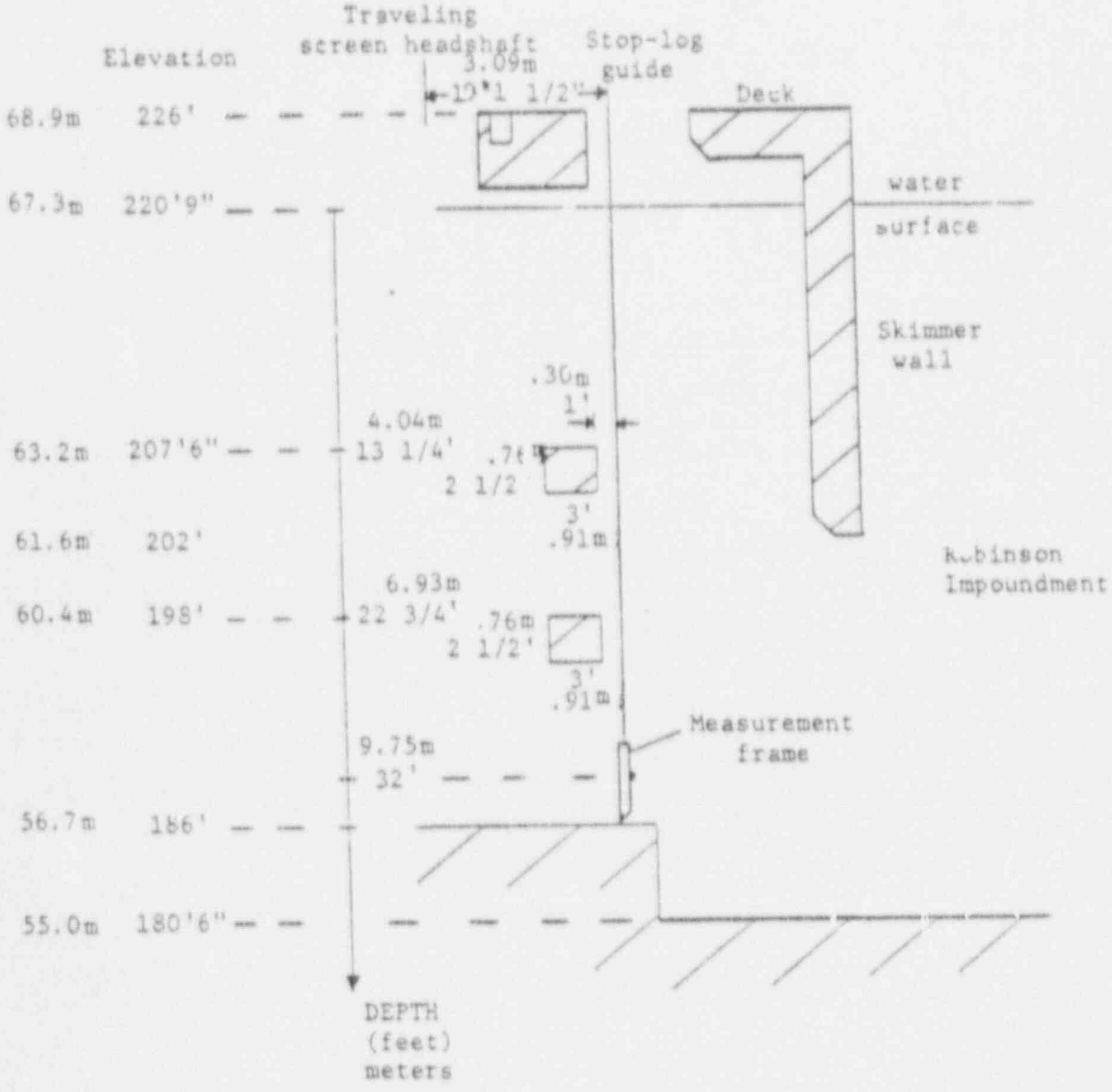

Figure 2.1.5 Side view of typical bay of Unit 2 intake structure.

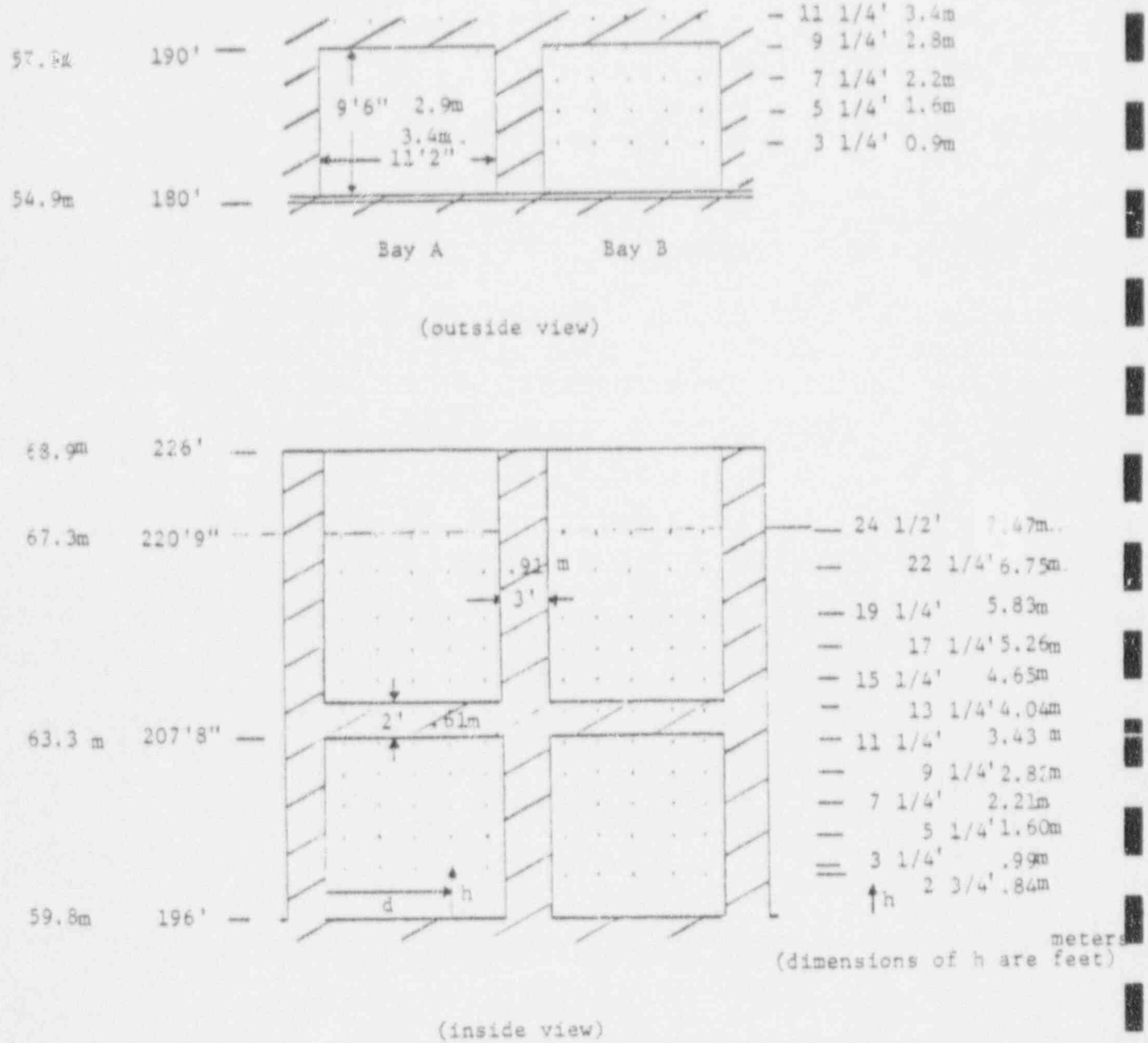

Figure 2.1.4 Front views of Unit 1 intake structure.

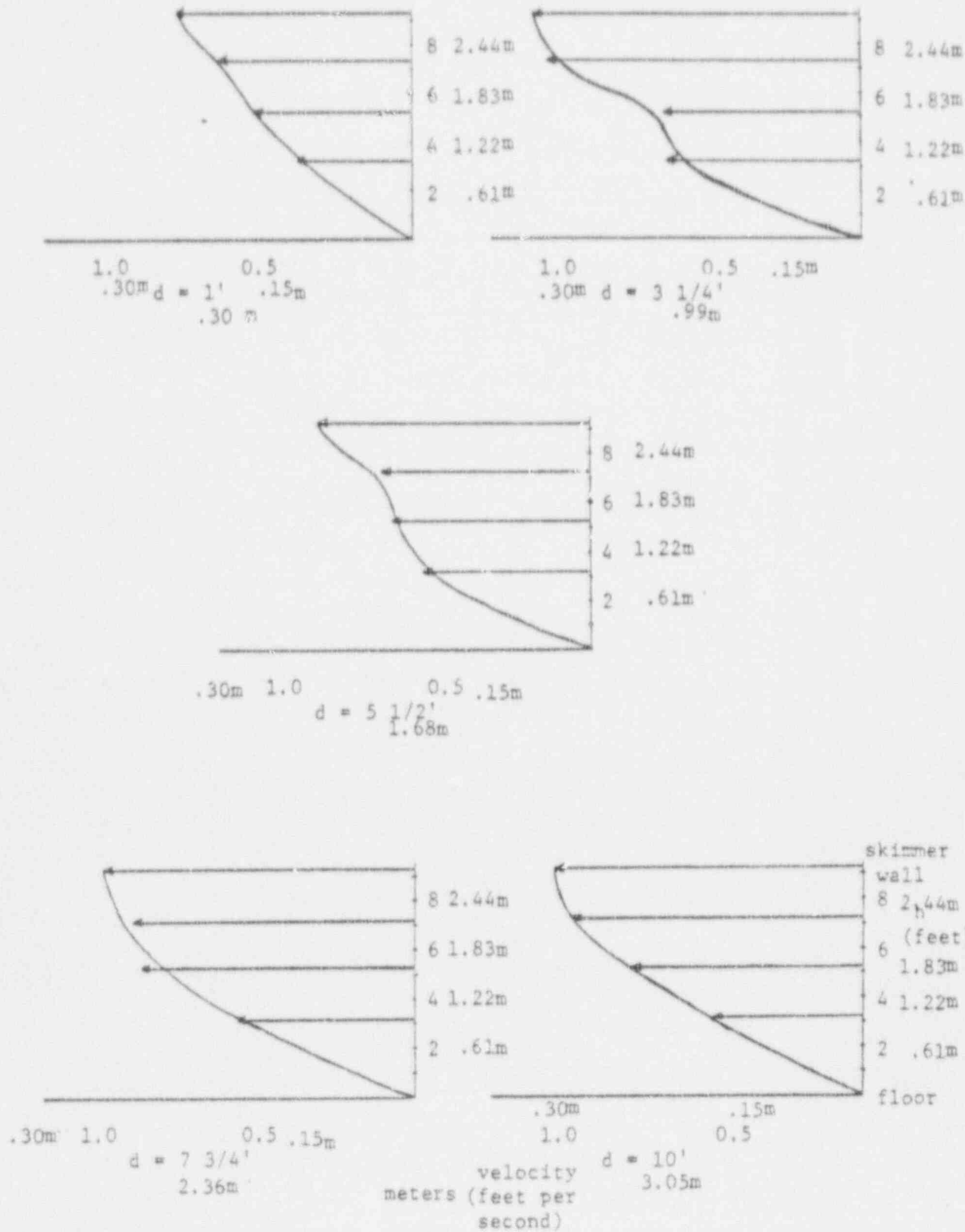

Figure 2.2.1 Measured velocities at the mouth of Bay B of the Unit 1 intake structure.

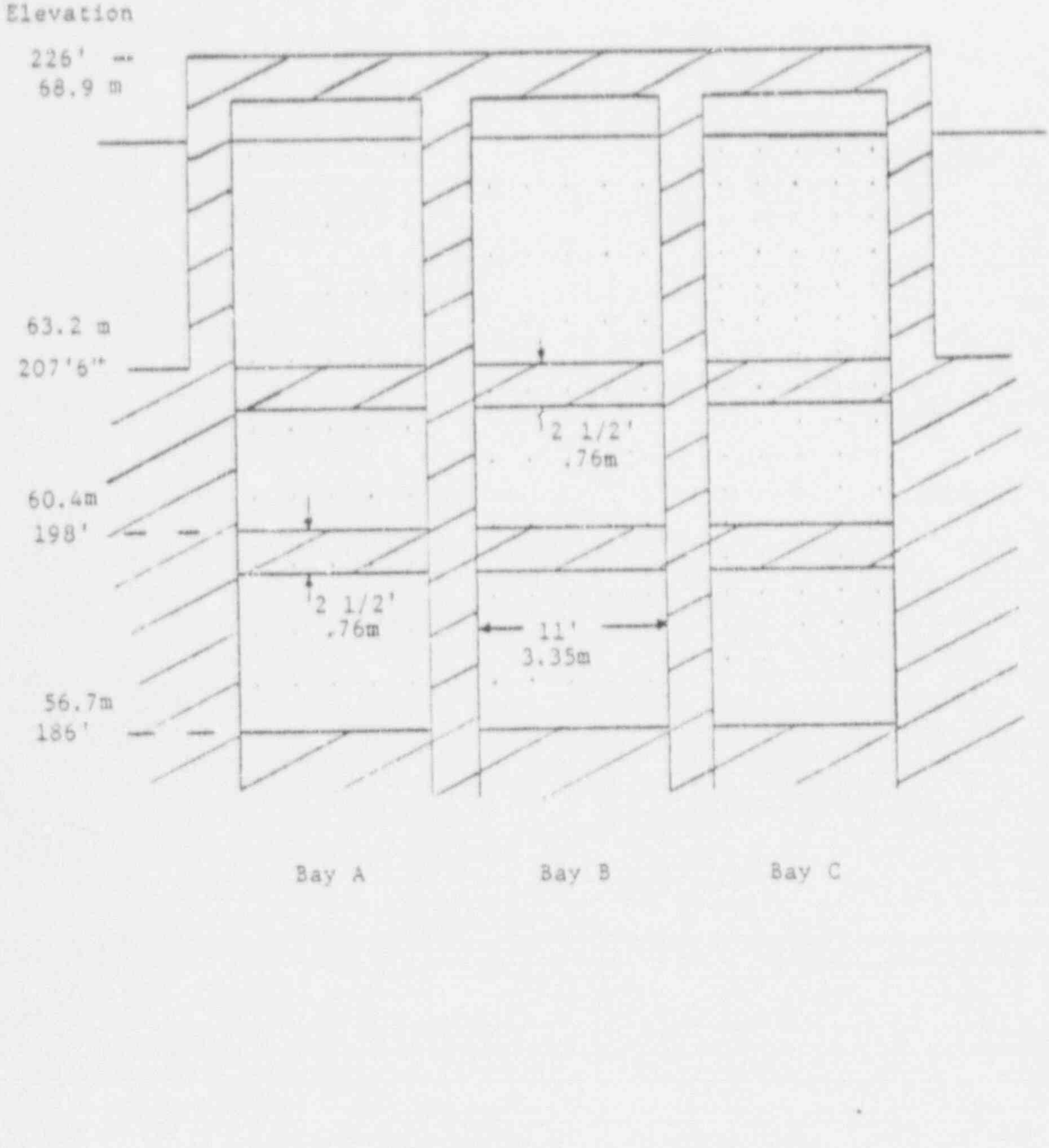

Figure 2.1.6 Front inside view of Unit 2 intake structure.

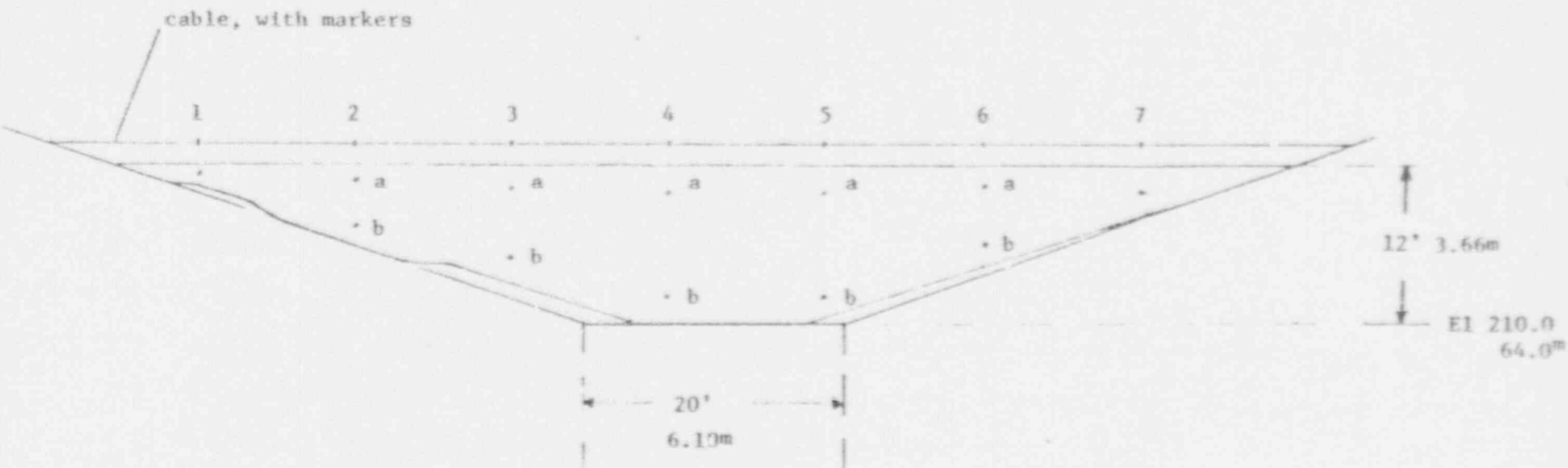

Figure ... Approximate discharge canal cross section at test site (looking upstream).

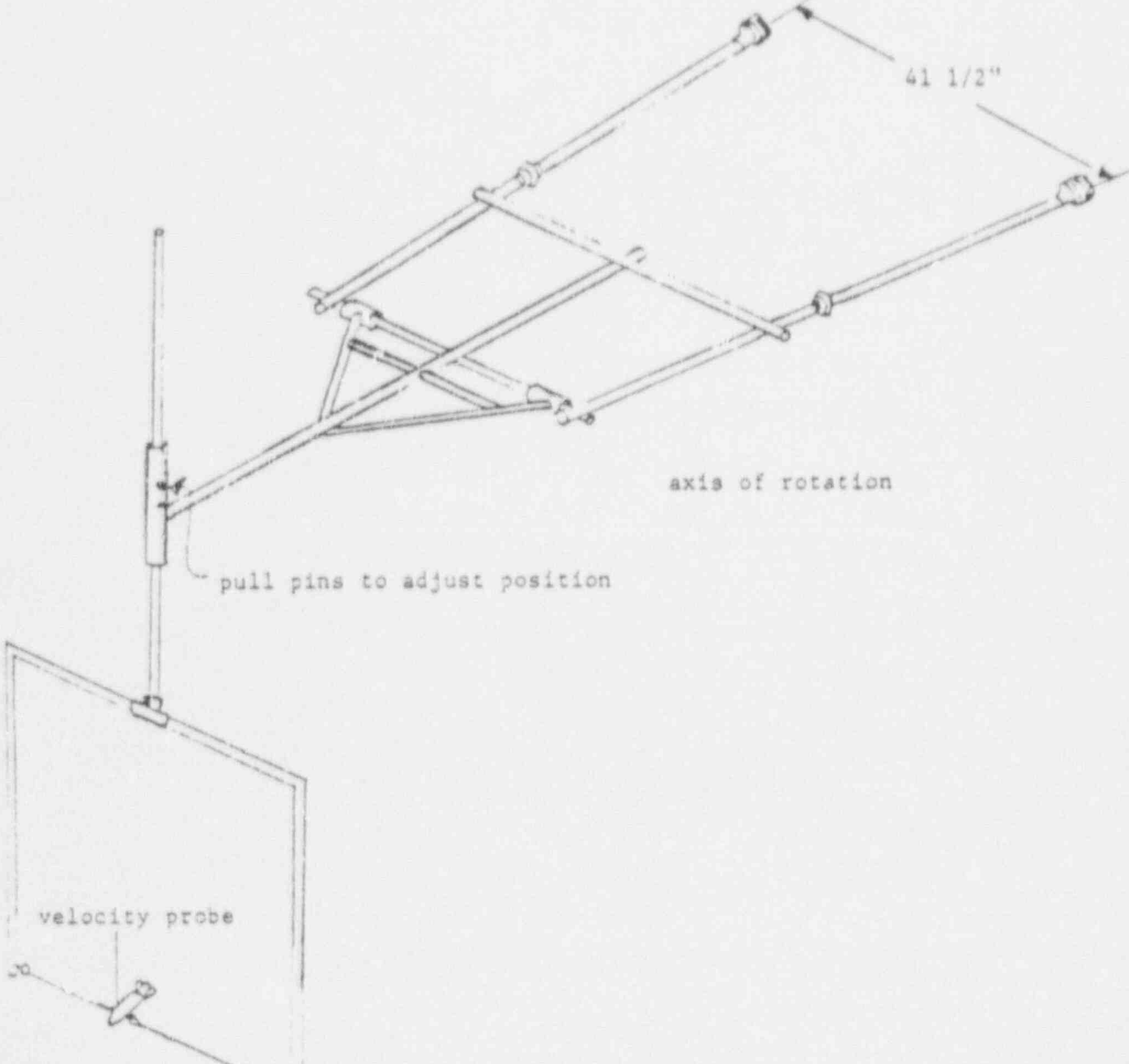

Figure 3.1.1 Velocity probe support structure.

CP&L EXHIBIT 2.1

Intensive Sampling Period Thermal

Data: Water Temperature Profiles

April 1973 to March 1976

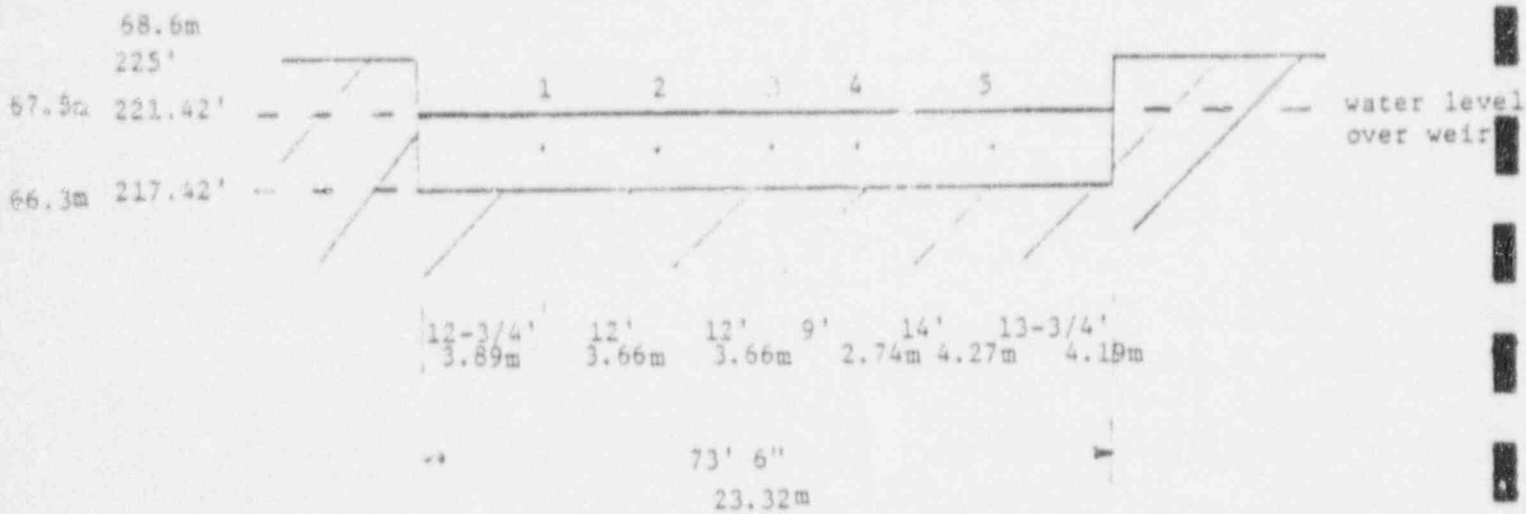

Figure 3.1.3 View of weir (looking upstream).

H. B. ROBINSON WATER TEMPERATURE PROFILE
April 18, 1973

Transect A	3	2	1
0'	64°	63°	62°
3'	63°	63°	62°
6'	63°	62°	61°
9'	62°	62°	62°
12'	63°	62°	62°
15'	63°	62°	-
18'	62°	62°	-
21'	61°	62°	-
24'	60°	-	-

Transect B	3	2	1
0'	64°	64°	64°
3'	64°	64°	63°
6'	63°	62°	63°
9'	62°	62°	62°
12'	62°	62°	62°
15'	62°	61°	61°
18'	61°	61°	61°
21'	61°	61°	60°
24'	61°	60°	60°
27'	61°	60°	60°
30'	60°	60°	60°

Transect C	3	2	1
0'	64°	64°	64°
3'	64°	64°	64°
6'	64°	64°	64°
9'	64°	64°	64°
12'	64°	62°	-
15'	61°	61	-
18'	61°	61°	-
21'	61°	60°	-
24'	60°	60°	-
27'	60°	60°	-

Transect D	3	2	1
0'	66°	66°	66°
3'	66°	66°	66°
6'	66°	66°	66°
9'	-	66°	66°
12'	-	66°	66°
15'	-	-	63°
18'	-	-	62°

Transect E	3	2	1
0'	67°	68°	66°
3'	67°	68°	66°
6'	67°	-	66°
9'	-	-	66°
12'	-	-	66°
15'	-	-	63°
18'	-	-	62°

Station F	
0'	66°
3'	65°
6'	64°
9'	62°

Station G	
0'	65°
3'	63°
6'	62°
9'	61°
12'	58°

Water Temperature Profile Data

Water temperatures were recorded in the field to the nearest 0.1°C and converted at a later date to the nearest 1°F for reporting purposes. Therefore, the 2°C surface, north to south vertical and east to west vertical 180 therms were defined by using original field data sheets rather than Fahrenheit temperatures. Conversion of Fahrenheit temperatures contained in these data back to centigrade may result in the loss of a significant centigrade degree. For example:

$$21.4°C = 70.5°F = 71°F = 21.7°C = 22°C$$

Such cases are the exception and are not considered to significantly occur within these data.

Accuracy of the instrumentation used to record these data is considered to be $\pm$ 0.5°C ($\pm$ 0.9°F).

H. B. ROBINSON WATER TEMPERATURE PROFILE
June 7, 1973

Transect A	3	2	1
0'	88°	88°	88°
3'	87°	87°	88°
6'	86°	85°	84°
9'	86°	84°	85°
12'	84°	83°	-
15'	83°	83°	-
18'	83°	82°	-
21'	-	82°	-
24'	-	80°	-
27'	-	78°	-
30'	-	77°	-

Transect B	3	2	1
0'	89°	89°	88°
3'	87°	87°	88°
6'	85°	86°	85°
9'	84°	83°	83°
12'	84°	83°	82°
15'	82°	82°	83°
18'	82°	82°	82°
21'	-	80°	81°
24'	-	79°	79°
27'	-	78°	78°
30'	-	77°	77°
33'	-	76°	76°

Transect C	3	2	1
0'	89°	88°	88°
3'	89°	87°	86°
6'	87°	84°	84°
9'	85°	84°	84°
12'	83°	83°	-
15'	82°	82°	-
18'	80°	81°	-
21'	-	80°	-
24'	-	78°	-
27'	-	77°	-

Transect D	3	2	1
0'	90°	92°	92°
3'	90°	92°	92°
6'	90°	88°	89°
9'	-	85°	85°
12'	-	84°	84°
15'	-	-	82°
18'	-	-	80°
21'	-	-	80°

Transect E	3	2	1
0'	101°	99°	97°
3'	100°	99°	97°
6'	89°	-	91°
9'	-	-	82°
12'	-	-	82°

Station F	
0'	93°
3'	86°
6'	80°
9'	79°

Station G	
0'	79°
3'	79°
6'	75°
9'	72°

H. B. ROBINSON WATER TEMPERATURE PROFILE
May 22, 1973

Transect A	3	2	1
0'	74°	74°	74°
3'	74°	74°	74°
6'	74°	74°	74°
9'	74°	74°	74°
12'	74°	74°	74°
15'	74°	74°	73°
18'	72°	72°	-
21'	71°	72°	-
24'	-	71°	-
27'	-	71°	-
30'	-	71°	-
33'	-	71°	-

Transect B	3	2	1
0'	74°	74°	74°
3'	75°	74°	74°
6'	74°	74°	74°
9'	73°	74°	73°
12'	73°	73°	73°
15'	72°	72°	72°
18'	71°	71°	71°
21'	71°	71°	71°
24'	71°	71°	71°
27'	70°	71°	70°
30'	70°	70°	70°

Transect C	3	2	1
0'	77°	75°	75°
3'	75°	75°	74°
6'	75°	75°	74°
9'	73°	73°	-
12'	71°	72°	-
15'	71°	71°	-
18'	71°	71°	-
21'	71°	71°	-
24'	71°	71°	-
27'	-	71°	-

Transect D	3	2	1
0'	79°	80°	80°
3'	75°	76°	77°
6'	73°	72°	71°
9'	-	71°	71°
12'	-	-	71°
15'	-	-	71°
18'	-	-	70°

Transect E	3	2	1
0'	89°	87°	87°
3'	89°	84°	81°
6'	89°	78°	75°
9'	89°	-	69°
12'	89°	-	69°
15'	-	-	69°
18'	-	-	68°

Station F	
0'	78°
3'	71°
6'	67°
9'	67°

Station G	
0'	70°
3'	65°
6'	62°

H. B. ROBINSON WATER TEMPERATURE PROFILE
August 22, 1973

Transect A	3.	2	1
0'	88°	88°	90°
3'	89°	88°	90°
6'	90°	88°	89°
9'	89°	89°	89°
12'	90°	89°	89°
15'	-	89°	-
18'	-	89°	-
21'	-	89°	-

Transect B	3	2	1
0'	90°	89°	89°
3'	90°	90°	89°
6'	90°	90°	89°
9'	89°	90°	89°
12'	89°	90°	89°
15'	-	89°	88°
18'	-	89°	89°
21'	-	89°	88°
24'	-	89°	-
27'	-	89°	-
30'	-	89°	-

Transect C	3	2	1
0'	91°	90°	90°
3'	91°	90°	90°
6'	92°	90°	-
9'	91°	90°	-
12'	91°	90°	-
15'	90°	90°	-
18'	-	90°	-
21'	-	89°	-
24'	-	89°	-

Transect D	3	2	1
0'	97°	93°	95°
3'	97°	95°	95°
6'	-	95°	94°
9'	-	91°	92°
12'	-	-	92°
15'	-	-	92°
18'	-	-	92°

Transect E	3	2	1
0'	100°	97°	92°
3'	100°	99°	92°
6'	100°	99°	90°
9'	101°	-	84°
12'	102°	-	84°

Station F	
0'	84°
3'	84°
6'	82°

Station G	
0'	73°
3'	73°
6'	73°

Station H	
0'	89°
3'	89°

Station I	
0'	77°
3'	76°
6'	76°
9'	76°

H. B. ROBINSON WATER TEMPERATURE PROFILE
July 31, 1973

Transect A	3	2	1
0'	89°	89°	88°
3'	88°	88°	88°
6'	88°	88°	88°
9'	88°	88°	88°
12'	87°	87°	87°
15'	86°	87°	86°
18'	86°	87°	-
21'	86°	86°	-
24'	85°	86°	-
27'	-	85°	-

Transect B	3	2	1
0'	90°	90°	89°
3'	88°	89°	88°
6'	88°	88°	88°
9'	88°	88°	88°
12'	88°	87°	87°
15'	86°	87°	86°
18'	86°	86°	86°
21'	86°	86°	86°
24'	86°	85°	85°
27'	-	84°	84°
30'	-	84°	84°
33'	-	84°	-

Transect C	3	2	1
0'	90°	90°	90°
3'	90°	90°	89°
6'	89°	89°	89°
9'	89°	89°	-
12'	88°	89°	-
15'	88°	88°	-
18'	86°	86°	-
21'	84°	86°	-
24'	84°	84°	-
27'	-	84°	-

Transect D	3	2	1
0'	93°	95°	95°
3'	93°	93°	93°
6'	-	91°	91°
9'	-	90°	91°
12'	-	89°	91°
15'	-	-	86°
18'	-	-	84°

Transect E	3	2	1
0'	99°	99°	99°
3'	97°	99°	98°
6'	96°	97°	97°
9'	94°	88°	86°
12'	-	85°	85°

Station F	
0'	91°
3'	90°
6'	83°
9'	81°

Station G	
0'	81°
3'	80°
6'	73°

H. B. ROBINSON WATER TEMPERATURE PROFILE
October 24, 1973

Transect A	3	2	1
0'	73°	73°	72°
3'	74°	73°	73°
6'	74°	73°	73°
9'	74°	73°	73°
12'	74°	73°	-
15'	74°	73°	-
18'	74°	73°	-
21'	74°	73°	-
24'	74°	73°	-
27'	-	73°	-
30'	-	73°	-

Transect B	3	2	1
0'	73°	72°	72°
3'	73°	73°	73°
6'	73°	73°	73°
9	73°	73°	73°
12'	73°	73°	73°
15'	-	73°	73°
18'	-	73°	73°
21'	-	73°	73°
24'	-	73°	73°
27'	-	73°	73°

Transect C	3	2	1
0'	72°	73°	73°
3'	73°	73°	74°
6'	73°	73°	75°
9'	73°	73°	-
12'	73°	73°	-
15'	73°	73°	-
18'	73°	73°	-
21'	73°	73°	-

Transect D	3	2	1
0'	77°	77°	77°
3'	79°	79°	77°
6'	-	78°	77°
9'	-	76°	77°
12'	-	-	75°
15'	-	-	73°
18'	-	-	72°
21'	-	-	72°

Transect E	3	2	1
0'	88°	84°	79°
3'	88°	83°	80°
6'	-	80°	73°
9	-	-	70°

Station F	
0'	72°
3'	73°
6'	73°

Station G	
0'	63°
3'	62°
6'	62°

Station H	
0'	75°

Station I	
0'	64°
3'	63°
6'	63°

H. B. ROBINSON WATER TEMPERATURE PROFILE
September 26, 1973

Transect A	3	2	1
0'	82°	82°	82°
3'	83°	82°	82°
6'	83°	82°	82°
9'	83°	82°	82°
12'	83°	82°	82°
15'	83°	82°	-
18'	83°	82°	-
21'	-	82°	-
24'	-	82°	-
27'	-	82°	-
30'	-	82°	-
33'	-	82°	-

Transect B	3	2	1
0'	82°	81°	82°
3'	83°	82°	82°
6'	84°	82°	82°
9'	84°	84°	82°
12'	83°	84°	82°
15'	-	83°	82°
18'	-	83°	82°
21'	-	82°	82°
24'	-	83°	82°
27'	-	82°	82°
30'	-	82°	82°

Transect C	3	2	1
0'	82°	82°	82°
3'	[illegible]	82°	82°
6'	84°	82°	-
9'	84°	82°	-
12'	84°	82°	-
15'	84°	-	-
18'	84°	-	-

Transect D	3	2	1
0'	88°	86°	81°
3'	88°	86°	82°
6'	-	86°	82°
9'	-	-	82°
12'	-	-	82°
15'	-	-	81°

Transect E	3	2	1
0'	95°	93°	86°
3'	93°	95°	86°
6'	93°	90°	84°
9'	-	-	82°

Station F	
0'	82°
3'	82°
6'	79°
9'	79°

Station G	
0'	72°
3'	72°
6'	72°

Station H	
0'	82°
3'	82°

Station I	
0'	75°
3'	73°
6'	73°

H. B. ROBINSON WATER TEMPERATURE PROFILE
December 19, 1973

Transect A	3	2	1
0'	54°	52°	52°
3'	54°	54°	54°
6'	54°	54°	54°
9'	54°	54°	54°
12'	54°	54°	-
15'	54°	54°	-
18'	54°	54°	-
21'	54°	54°	-
24'	[illegible]	54°	-
27'	54	54°	-
30'	54°	54°	-
33'	54°	54°	-
36'	54°	54°	-
39'	54°	-	-

Transect B	3	2	1
0'	55°	54°	53°
3'	56°	56°	54°
6'	56°	56°	54°
9'	56°	56°	54°
12'	56°	56°	54°
15'	56°	56°	54°
18'	-	56°	54°
21'	-	55°	54°
24'	-	55°	54°
27'	-	55°	54°
30'	-	55°	54°
33'	-	55°	54°

Transect C	3	2	1
0'	56°	54°	52°
3'	56°	55°	52°
6'	57°	55°	52°
9'	57°	55°	52°
12'	56°	55°	-
15'	56°	-	-

Transect D	3	2	1
0'	61°	60°	56°
3'	61°	61°	57°
6'	61°	59°	57°
9'	-	59°	55°
12'	-	-	54°
15'	-	-	54°
18'	-	-	51°
21'	-	-	51°
24'	-	-	50°

Transect E	3	2	1
0'	68°	66°	63°
3'	68°	66°	64°
6'	65°	64°	59°
9'	-	-	48°
12'	-	-	47°

Station F	
0'	48°
3'	47°
6'	41°
9'	41°

Station G	
0'	41°
3'	43°
6'	43°

Station H	
0'	52°
3'	53°
6'	53°

Station I	
0'	38°
3'	38°
6'	38°

H. B. ROBINSON WATER TEMPERATURE PROFILE
November 27, 1973

Transect A	3	2	1
0'	68°	68°	68°
3'	68°	68°	67°
6'	68°	68°	67°
9'	67°	68°	-
12'	67°	67°	-
15'	67°	67°	-
18'	-	67°	-
21'	-	67°	-

Transect B	3	2	1
0'	68°	68°	68°
3'	67°	68°	68°
6'	67°	68°	68°
9'	67°	67°	68°
12'	67°	67°	68°
15'	67°	67°	68°
18'	67°	67°	67°
21'	66°	67°	-
24'	-	67°	-
27'	-	66°	-
30'	-	66°	-
33'	-	66°	-

Transect C	3	2	1
0'	68°	68°	68°
3'	68°	68°	68°
6'	68°	68°	68°
9'	68°	68°	-
12'	68°	68°	-
15'	-	68°	-
18'	-	68°	-
21'	-	68°	-
24'	-	68°	-

Transect D	3	2	1
0'	68°	68°	68°
3'	68°	68°	68°
6'	-	68°	68°
9'	-	68°	68°
12'	-	-	68°
15'	-	-	67°

Transect E	3	2	1
0'	70°	69°	70°
3'	70°	70°	72°
6'	70°	70°	72°
9'	70°	68°	68°
12'	70°	-	65°

Station F	
0'	69°
3'	69°
6'	64°

Station G	
0'	66°
3'	66°
6'	64°

Station H	
0'	68°
3'	68°

Station I	
0'	64°
3'	64°
6'	64°

H. B. ROBINSON WATER TEMPERATURE PROFILE

February 12, 1974

Transect A	3	2	1
0'	59°	61°	60°
3'	60°	61°	61°
6'	61°	61°	61°
9'	61°	61°	61°
12'	61°	61°	61°
15'	61°	61°	60°
18'	61°	61°	60°
21'	61°	61°	60°
24'	61°	60°	--
27'	61°	60°	--
30'	61°	60°	--
33'	61°	60°	--
36'	60°	60°	--

Transect B	3	2	1
0'	61°	61°	61°
3'	62°	62°	62°
6'	62°	62°	62°
9'	62°	62°	62°
12'	62°	62°	62°
15'	62°	62°	62°
18'	62°	62°	61°
21'	60°	62°	61°
24'	60°	60°	61°
27'	60°	60°	61°
30'	60°	60°	61°
33'	60°	60°	61°
36	60°	60°	--

Transect C	3	2	1
0'	64°	63°	63°
3'	64°	63°	63°
6'	63°	63°	63°
9'	63°	63°	63°
12'	63°	63°	--
15'	63°	62°	--
18'	63°	62°	--
21'	63°	61°	--
24'	63°	62°	--
27'	--	61°	--

Transect D	3	2	1
0'	65°	64°	66°
3'	66°	65°	67°
6'	64°	65°	65°
9'	--	64°	64°
12'	--	61°	62°
15'	--	--	59°
18'	--	--	59°

Transect E	3	2	1
0'	74°	72°	72°
3'	74°	73°	72°
6'	74°	72°	72°
9'	75°	--	54°
12'	75°	--	53°
15'	75°	--	--

Point [illegible]	
0'	64°
3'	50°
6'	49°
9'	49°

Point G	
0'	48°
3'	47°
6'	47°
9'	--

Point H	
0'	61°
3'	61°

Point I	
0'	45°
3'	44°
6'	44°
9'	44°
12'	44°

LAKE ROBINSON WATER TEMPERATURES

January 22, 1974

Transect A	3	2	1
0'	69°	65°	67°
3'	69°	65°	67°
6'	67°	64°	64°
9'	67°	64°	64°
12'	66°	64°	64°
15'	66°	64°	64°
18'	66°	64°	64°
21'	66°	64°	64°
24'	65°	63°	63°
27'	65°	62°	62°
30'	65°	62°	62°
33'	64°	62°	62°
36'	64°	62°	62°

Transect B	3	2	1
0'	66°	66°	68°
3'	66°	66°	67°
6'	65°	66°	65°
9'	65°	64°	65°
12'	65°	64°	64°
15'	65°	64°	64°
18'	65°	64°	64°
21'	64°	64°	64°
24'	63°	64°	64°
27'	63°	63°	63°
30'	62°	63°	63°
33'	-	-	62°

Transect C	3	2	1
0'	68°	69°	68°
3'	67°	68°	67°
6'	67°	67°	66°
9'	66°	66°	-
12'	65°	65°	-
15'	64°	64°	-
18'	64°	63°	-
21'	63°	62°	-
24'	62°	61°	-
27'	61°	61°	-

Transect D	3	2	1
0'	71°	72°	73°
3'	70°	71°	72°
6'	69°	70°	68°
9'	-	66°	66°
12'	-	64°	65°
15'	-	64°	64°
18'	-	61°	62°

Transect E	3	2	1
0'	77°	77°	75°
3'	79°	77°	76°
6'	78°	74°	72°
9'	-	-	64°

Point F	
0'	66°
3'	64°
6'	63°
9'	61°

Point G	
0'	59°
3'	58°
6'	57°

Point H	
0'	63°
3'	65°
6'	[illegible]

Point I	
0'	61°
3'	59°
6'	58°
9'	58°

H. B. ROBINSON WATER TEMPERATURE PROFILE

April 24, 1974

Transect A	3	2	1
0'	72°	71°	72°
3'	72°	71°	7[illegible]°
6'	72°	71°	72°
9'	72°	72°	72°
12'	72°	72°	72°
15'	---	72°	72°
18'	---	72°	72°
21'	---	72°	72°
24'	---	72°	72°
27'	---	72°	---
30'	---	72°	---
33'	---	72°	---
36'	---	72°	---

Transect B	3	2	1
0'	73°	73°	72°
3'	73°	73°	73°
6'	73°	73°	73°
9'	73°	73°	73°
12'	73°	73°	73°
15'	73°	73°	73°
18'	72°	73°	73°
21'	72°	72°	73°
24'	72°	72°	72°
27'	72°	72°	72°
30'	72°	72°	72°
33'	72°	---	72°

Transect C	3	2	1
0'	73°	73°	73°
3'	74°	73°	73°
6'	74°	73°	73°
9'	74°	74°	---
12'	74°	74°	---
15'	74°	74°	---
18'	74°	74°	---
21'	73°	74°	---
24'	73°	73°	---
27'	73°	73°	---

Transect D	3	2	1
0'	77°	77°	77°
3'	78°	78°	77°
6'	77°	77°	77°
9'	74°	74°	76°
12'	---	---	74°
15'	---	---	74°
18'	---	---	73°

Transect E	3	2	1
0'	87°	82°	80°
3'	87°	82°	81°
6'	87°	82°	80°
9'	---	---	74°
12'	---	---	75°

Station F	
0'	70°
3'	69°
6'	70°
9'	69°

Station G		Station H		Station I	
0'	66°	0'	70°	0'	67°
3'	66°	3'	70°	3'	66°
6'	66°	6'	71°	6'	66°

H. B. ROBINSON WATER TEMPERATURE PROFILES

March 18, 1974

Transect A	3	2	1
0'	65°	65°	65°
3'	65°	65°	65°
6'	64°	64°	64°
9'	64°	64°	64°
12'	64°	64°	64°
15'	64°	64°	64°
18'	64°	64°	---
21'	63°	63°	---
24'	63°	63°	---
27'	NA	NA	---
30'	↓	NA	---
33'		NA	---
36'		NA	---

Transect B	3	2	1
0'	68°	68°	68°
3'	66°	65°	66°
6'	66°	64°	65°
9'	64°	64°	64°
12'	64°	64°	64°
15'	64°	64°	64°
18'	64°	64°	64°
21'	64°	64°	64°
24'	64°	64°	64°
27'	NA	NA	NA
30'	↓	NA	↓
33'		NA	

Transect C	3	2	1
0'	68°	68°	68°
3'	66°	66°	66°
6'	65°	65°	64°
9'	64°	65°	---
12'	64°	65°	---
15'	64°	64°	---
18'	64°	64°	---
21'	64°	64°	---
24'	64°	64°	---
27'	NA	NA	---
	↓		

Transect D	3	2	1
0'	72°	71°	72°
3'	70°	70°	72°
6'	68°	68°	68°
9'	---	67°	66°
12'	---	66°	66°
15'	---	---	[illegible]
18'	---	---	[illegible]
21'	---	---	66°
24'	---	---	NA
			↓

Transect E	3	2	1
0'	79°	77°	75°
3'	79°	75°	75°
6'	79°	71°	71°
9'	80°	---	61°
12'	81°	---	60°
15'	81°	---	---

Station F	
0'	67°
3'	63°
6	57°
9'	56°

Station G	
0'	56°
3'	54°
6'	54°

Station H	
0'	66°
3'	65°

Station I	
0'	58°
3'	57°
6'	56°
9'	55°

NA - Not available: portable thermister - DO probe cord length = 24'. Temperatures - DO's below this depth were not sampled and water depth not recorded except at transect A - station 2 and transect B - station 2 where Winkler DO's sampled.

H. B. ROBINSON WATER TEMPERATURE PROFILE

May 23, 1974

Transect A	3	2	1
0'	77°	77°	76°
3'	77°	77°	76°
6'	77°	77°	76°
9'	77°	77°	77°
12'	77°	77°	77°
15'	77°	77°	77°
18'	77°	77°	77°
21'	77°	77°	-
24'	-	77°	-
27'	-	76°	-
30'	-	75°	-
33'	-	75°	-

Transect B	3	2	1
0'	78°	78°	78°
3'	78°	78°	78°
6'	78°	78°	78°
9'	77°	78°	78°
12'	77°	78°	78°
15'	77°	77°	77°
18'	77°	77°	77°
21'	77°	77°	77°
24'	75°	77°	76°
27'	76°	76°	76°
30'	75°	75°	75°
33'	-	75°	75°

Transect C	3	2	1
0'	79°	78°	77°
3'	79°	78°	77°
6'	79°	78°	77°
9'	78°	78°	-
12'	78°	78°	-
15'	78°	78°	-
18'	78°	78°	-
21'	78°	78°	-
24'	77°	77°	-
27'	-	77°	-

Transect D	3	2	1
0'	78°	78°	79°
3'	78°	78°	78°
6'	77°	78°	78°
9'	-	78°	78°
12'	-	78°	78°
15'	-	78°	78°
18'	-	77°	78°

Transect E	3	2	1
0'	84°	82°	82°
3'	84°	82°	81°
6'	84°	82°	81°
9'	-	-	77°
12'	-	-	76°

Station F	
0'	79°
3'	77°
6'	76°
9'	75°

Station G	
0'	76°
3'	73°
6'	73°

Station H	
0'	76°
3'	76°

Station I	
0'	72°
3'	72°
6'	72°
9'	72°

H. B. ROBINSON WATER TEMPERATURE PROFILE

May 21, 1974

Transect A	3	2	1
0'	80°	76°	79°
3'	76°	76°	78°
6'	75°	75°	78°
9'	75°	75°	78°
12'	74°	75°	75°
15'	74°	75°	75°
18'	74°	75°	74°
21'	73°	74°	74°
24'	73°	73°	73°
27'	-	73°	-
30'	-	72°	-
33'	-	72°	-
36'	-	71°	-
39'	-	71°	-

Transect B	3	2	1
0'	75°	77°	75°
3'	75°	77°	75°
6'	75°	77°	75°
9'	75°	76°	75°
12'	75°	76°	75°
15'	75°	76°	75°
18'	75°	76°	75°
21'	73°	75°	75°
24'	73°	74°	74°
27'	73°	73°	73°
30'	73°	73°	73°

Transect C	3	2	1
0'	75°	78°	77°
3'	76°	76°	77°
6'	76°	76°	77°
9'	76°	75°	-
12'	75°	75°	-
15'	75°	75°	-
18'	75°	75°	-
21'	75°	75°	-
24'	73°	73°	-
27'	-	73°	-

Transect D	3	2	1
0'	76°	76°	77°
3'	76°	76°	77°
6'	76°	76°	76°
9'	76°	76°	76°
12'	-	74°	75°
15'	-	73°	75°
18'	-	-	74°

Transect E	3	2	1
0'	79°	79°	79°
3'	79°	77°	77°
6'	79°	-	77°
9'	79°	-	75°
12'	79°	-	
15'	79°	-	-

Station F	
0'	77°
3'	77°
6'	75°
9'	75°

Station G	
0'	73°
3'	73°
6'	70°

Station H	
0'	77°
3'	77°
6'	77°

Station I	
0'	70°
3'	70°
6'	70°

H. B. ROBINSON WATER TEMPERATURE PROFILE

July 11, 1974

Transect A	3	2	1
0'	89°	88°	88°
3'	89°	88°	88°
6'	89°	88°	88°
9'	88°	88°	88°
12'	88°	88°	88°
15'	88°	88°	-
18'	88°	88°	-
21'	88°	86°	-
24'	-	84°	-
27'	-	83°	-
30'	-	82°	-
33'	-	82°	-

Transect B	3	2	1
0'	88°	88°	88°
3'	88°	88°	88°
6'	88°	88°	88°
9'	88°	88°	88°
12'	88°	88°	88°
15'	86°	86°	86°
18'	85°	85°	86°
21'	84°	85°	84°
24'	83°	84°	83°
27'	82°	81°	82°
30'	81°	80°	81°
33'	-	80°	79°

Transect C	3	2	1
0'	90°	90°	90°
3'	90°	90°	90°
6'	90°	90°	90°
9'	90°	88°	-
12'	89°	88°	-
15'	85°	84°	-
18'	84°	85°	-
21'	84°	85°	-
24'	83°	-	-
27'	82°	-	-

Transect D	3	2	1
0'	93°	94°	93°
3'	94°	94°	93°
6'	93°	94°	93°
9'	-	86°	87°
12'	-	85°	85°
15'	-	80°	82°
18'	-	80°	81°

Transect E	3	2	1
0'	102°	99°	98°
3'	102°	100°	98°
6'	102°	99°	98°
9'	-	-	82°
12'	-	-	79°

Station F	
0'	90°
3'	90°
6'	88°
9'	80°

Station G	
0'	84°
3'	84°
6'	77°

Station H	
0'	85°
3'	86°
6'	86°

Station I	
0'	75°
3'	-*
6'	-*

*Not Available

H. B. ROBINSON WATER TEMPERATURE PROFILE

June 27, 1974

Transect A	3	2	1
0'	79°	79°	79°
3'	79°	79°	79°
6'	79°	79°	79°
9'	79°	79°	79°
12'	79°	79°	79°
15'	79°	79°	-
18'	79°	79°	-
21'	79°	79°	-
24'	79°	79°	-
27'	-	79°	-
30'	-	79°	-
33'	-	79°	-

Transect B	3	2	1
0'	78°	78°	79°
3'	79°	78°	79°
6'	79°	73°	79°
9'	79°	78°	79°
12'	79°	78°	79°
15'	79°	78°	79°
18'	79°	78°	79°
21'	79°	78°	79°
24'	79°	78°	9°
27'	-	7[illegible]	79°
30'	-	79°	79°
33'	-	79°	-

Transect C	3	2	1
0'	78°	79°	79°
3'	78°	79°	79°
6'	78°	79°	-
9'	78°	79°	-
12'	78°	79°	-
15'	78°	79°	-
18'	79°	79°	-
21'	79°	79°	-
24'	79°	79°	-

Transect D	3	2	1
0'	79°	80°	77°
3'	81°	80°	80°
6'	81°	80°	80°
9'	-	79°	79°
12'	-	80°	79°
15'	-	78°	79°
18'	-	78°	79°

Transect E	3	2	1
0'	85°	84°	82°
3'	86°	84°	82°
6'	85°	-	82°
9'	-	-	80°
12'	-	-	80°

Station F	
0'	76°
3'	76°
6'	76°

Station G	
0'	72°
3'	73°
6'	73°

Station H	
0'	78°
3'	-
6'	-

Station I	
0'	68°
3'	-
6'	-

H. B. ROBINSON WATER TEMPERATURE PROFILES
September 4, 1974

Transect A	3	2	1
0'	85°	84°	83°
3'	84°	84°	83°
6'	84°	84°	83°
9'	84°	84°	83°
12'	84°	84°	--
15'	84°	84°	--
18'	84°	84°	--
21'	84°	84°	--
24'	--	84°	--
27'	--	84°	--
30'	--	84°	--
33'	--	84°	--

Transect B	3	2	1
0'	84°	84°	84°
3'	85°	84°	84°
6'	85°	84°	84°
9'	85°	84°	84°
12'	85°	84°	84°
15'	85°	84°	84°
18'	85°	84°	84°
21'	85°	84°	84°
24'	85°	84°	84°
27'	85°	84°	84°
30'	--	84°	84°
33'	--	84°	84°

Transect C	3	2	1
0'	[illegible]	85°	83°
3'	86°	85°	84°
6'	86°	85°	84°
9'	86°	85°	83°
12'	86°	85°	--
18'	86°	85°	--
21'	85°	--	--
24'	85°	--	--

Transect CA	3	2	1
0'	89°	88°	86°
3'	89°	88°	86°
6'	89°	88°	86°
9'	88°	87°	86°
12'	--	87°	86°
15'	--	86°	85°
18'	--	86°	85°
21'	--	86°	--
24'	--	86°	--

Transect D	3	2	1
0'	91°	90°	90°
3'	91°	91°	90°
6'	91°	91°	90°
9'	--	[illegible]	88°
12'	--	[illegible]	86°
15'	--	86°	86°
18'	--	--	86°

Transect E	3	2	1
0'	97°	97°	96°
3'	96°	97°	96°
6'	91°	92°	93°
9'	--	88°	86°
12'	--	--	85°

Station F	
0'	88°
3'	86°
6'	85°
9'	82°

Station G	
0'	78°
3'	78°
6'	78°

Station H	
0'	82°
3'	82°
6'	82°

Station I	
0'	73°
3'	73°
6'	73°
9'	73°

Station J	
0'	73°
3'	73°
6'	73°

Station K	
0'	81°
3'	81°
6'	81°

H. B. ROBINSON WATER TEMPERATURE PROFILE
August 29, 1974

Transect A	3	2	1
0'	87°	86°	86°
3'	87°	86°	86°
6'	87°	86°	86°
9'	87°	86°	86°
12'	87°	86°	--
15'	86°	86°	--
18'	86°	86°	--
21'	86°	85°	--
24'	86°	84°	--
27'	--	84°	--
30'	--	83°	--
33'	--	82°	--
36'	--	82°	--

Transect B	3	2	1
0'	88°	88°	88°
3'	88°	88°	88°
6'	88°	88°	88°
9'	87°	87°	88°
12'	87°	87°	88°
15'	86°	86°	87°
18'	86°	86°	86°
21'	86°	86°	86°
24'	85°	85°	86°
27'	84°	85°	84°
30'	84°	77°	84°

Transect C	3	2	1
0'	88°	88°	88°
3'	88°	88°	88°
6'	88°	88°	88°
9'	88°	88°	--
12'	88°	88°	--
15'	86°	88°	--
18'	86°	87°	--
21'	85°	84°	--
24'	84°	84°	--

Transect CA	3	2	1
0'	88°	88°	88°
3'	88°	89°	88°
6'	88°	90°	88°
9'	--	89°	88°
12'	--	88°	--
15'	--	88°	--
18'	--	87°	--
21'	--	86°	--

Transect D	3	2	1
0'	91°	91°	93°
3'	91°	91°	93°
6'	91°	91°	93°
9'	--	91°	91°
12'	--	91°	90°
15'	--	--	88°
18'	--	--	86°

Transect E	3	2	1
0'	100°	100°	97°
3'	101°	97°	97°
6'	102°	96°	97°
9'	102°	88°	91°
12'	103°	87°	--

Station F	
0'	91°
3'	91°

Station G	
0'	84°
3'	82°
6'	81°
9'	80°
12'	80°

Station H	
0'	86°
3'	86°

Station I	
0'	79°
3'	78°
6'	78°

Station J	
0'	78°
3'	77°
6'	77°

Station K	
0'	85°
3'	86°
6'	85°

H. B. ROBINSON WATER TEMPERATURE PROFILE
November 13, 1974

Transect A	3	2	1
0'	65°	67°	66°
3'	65°	67°	66°
6'	66°	67°	66°
9'	66°	67°	66°
12'	66°	67°	66°
15'	66°	68°	--
18'	66°	68°	--
21'	66°	68°	--
24'	--	68°	--
27'	--	67°	--
30'	--	67°	--
33'	--	67°	--

Transect B	3	2	1
0'	67°	67°	67°
3'	67°	68°	67°
6'	67°	68°	68°
9'	67°	67°	68°
12'	67°	67°	68°
15'	67°	67°	67°
18'	67°	67°	67°
21'	67°	67°	67°
24'	67°	67°	67°
27'	--	67°	67°
30'	--	67°	67°
33'	--	--	67°

Transect C	3	2	1
0'	67°	68°	68°
3'	68°	68°	68°
6'	68°	68°	68°
9'	68°	68°	--
12'	68°	68°	--
18'	68°	68°	--
21'	67°	68°	--
24'	67°	68°	--

Transect CA	3	2	1
0'	70°	70°	70°
3'	70°	71°	71°
6'	70°	71°	70°
9'	69°	70°	71°
12'	69°	69°	70°
15'	--	68°	70°
18'	--	68°	--
21'	--	68°	--

Transect D	3	2	1
0'	72°	73°	73°
3'	71°	73°	73°
6'	70°	72°	73°
9'	--	72°	70°
12'	--	70°	70°
15'	--	--	68°
18'	--	--	67°

Transect E	3	2	1
0'	82°	81°	78°
3'	83°	78°	77°
6'	83°	74°	75°
9'	--	--	63°

Station F		Station G		Station H*	
0'	65°	0'	56°	0'	64°
3'	63°	3'	55°	3'	64°
6'	59°	6'	54°		

Station I*		Station J		Station K	
0'	52°	0'	50°	0'	64°
3'	52°	3'	50°	3'	64°
6'	52°	6'	50°	6'	64°

* On November 14, 1974

H. B. ROBINSON WATER TEMPERTURE PROFILE
October 16, 1974

Transect A	3	2	1
0'	71°	72°	72°
3'	72°	72°	72°
6'	72°	72°	72°
9'	72°	72°	72°
12'	72°	72°	--
15'	72°	72°	--
18'	72°	72°	--
21'	72°	72°	--
24'	--	71°	--
27'	--	71°	--
30'	--	70°	--

Transect B	3	2	1
0'	73°	72°	72°
3'	73°	73°	73°
6'	73°	73°	73°
9'	73°	73°	73°
12'	73°	73°	73°
15'	73°	73°	73°
18'	73°	73°	73°
21'	73°	72°	72°
24'	72°	72°	72°
27'	71°	70°	71°
30'	71°	70°	70°
33'	--	--	70°

Transect C	3	2	1
0'	73°	73°	73°
3'	73°	73°	73°
6'	73°	73°	73°
9'	73°	73°	--
12'	73°	73°	--
15'	73°	73°	--
18'	73°	73°	--
21'	72°	73°	--
24'	72°	71°	--

Transect CA	3	2	1
0'	75°	76°	74°
3'	75°	76°	75°
6'	75°	76°	75°
9'	74°	76°	75°
12'	--	76°	75°
15'	--	73°	73°
18'	--	72°	73°
21'	--	72°	71°

Transect D	3	2	1
0'	77°	79°	80°
3'	77°	79°	80°
6'	77°	79°	80°
9'	--	79°	79°
12'	--	--	77°
15'	--	--	73°
18'	--	--	72°

Transect E	3	2	1
0'	86°	85°	85°
3'	87°	86°	86°
6'	87°	85°	85°
9'	87°	--	82°
12'	87°	--	--

Station F		Station G		Station H	
0'	81°	0'	73°	0'	72°
3'	81°	3'	73°	3'	72°
6'	76°	6'	69°		

Station I*		Station J		Station K*	
0'	63°	0'	64°	0'	68°
3'	63°	3'	64°	3'	68°
6'	63°			6'	68°

*October 17, 1974

H. B. ROBINSON WATER TEMPERATURE PROFILE
January 16, 1975

Transect A	3	2	1
0'	57°	57°	55°
3'	57°	57°	55°
6'	57°	57°	57°
9'	58°	57°	55°
12'	58°	57°	-
15'	58°	57°	-
18'	58°	57°	-
21'	57°	57°	-
24'	58°	57°	-
27'	-	57°	-
30'	-	57°	-
33'	-	57°	-

Transect B	3	2	1
0'	59°	57°	57°
3'	59°	59°	58°
6'	59°	59°	58°
9'	59°	59°	58°
12'	59°	59°	58°
15'	59°	59°	58°
18'	59°	59°	58°
21'	59°	59°	58°
24'	58°	59°	58°
27'	58°	59	58°
30'	58°	59°	58°
33'	58°	59°	58°

Transect C	3	2	1
0'	59°	59°	59°
3'	60°	59°	59°
6'	60°	59°	59°
9'	60°	59°	59°
12'	59°	59°	-
15'	59°	-	-
18'	59°	-	-
21'	59°	-	-
24'	59°	-	-
27'	59°	-	-

Transect CA	3	2	1
0'	61°	61°	61°
3'	61°	61°	61°
6'	61°	61°	61°
9'	61°	61°	61°
12'	61°	61°	61°
15'	60°	60°	60°
18'	60°	60°	60°
21'	-	59°	59°
24'	-	59°	50°

Transect D	3	2	1
0'	64°	65°	64°
3'	64°	65°	65°
6'	64°	64°	64°
9'	64°	64°	63°
12'	-	63°	62°
15'	-	-	56°
18'	-	-	56°
21'	-	-	56°

Transect E	3	2	1
0'	68°	70°	72°
3'	68°	70°	73°
6'	68°	68°	71°
9'	55°	-	59°
12'	-	-	54°
15'	-	-	52°

Point F	
0'	60°
3'	50°
6'	48°
9'	46°

Point G	
0'	45°
3'	45°
6'	44°
9'	44°
12'	44°

Point H	
0'	58°
3'	58°
6'	59°
9	59°

Point I	
0'	48°
3'	47°
6'	47°
9'	47°

Point K	
0'	57°
3'	57°
6'	57°

H. B. ROBINSON WATER TEMPERATURE PROFILE
December 11, 1974

Transect A	3	2	1
0'	55°	54°	55°
3'	55°	55°	55°
6'	56°	55°	55°
9'	56°	55°	55°
12'	56°	55°	55°
15'	56°	55°	55°
18'	56°	55°	--
21'	56°	55°	--
24'	56°	55°	--
27'	--	55°	--
30'	--	55°	--

Transect B	3	2	1
0'	57°	56°	56°
3'	57°	57°	56°
6'	57°	57°	56°
9'	57°	57°	56°
12'	57°	57°	56°
15'	57°	57°	56°
18'	57°	56°	56°
21'	56°	56°	56°
24'	56°	56°	56°
27'	56°	56°	56°
30'	56°	56°	56°
33'	--	--	56°

Transect C	3	2	1
0'	57°	56°	56°
3'	57°	57°	55°
6'	57°	57°	55°
9'	57°	57°	--
12'	57°	57°	--
15'	57°	57°	--
18'	56°	57°	--
21'	56°	57°	--
24'	56°	56°	--
27'	--	56°	--

Transect CA	3	2	1
0'	62°	61°	61°
3'	61°	61°	59°
6'	59°	59°	58°
9'	58°	58°	57°
12'	57°	57°	57°
15'	56°	57°	57°
18'	--	56°	--
21'	--	55°	--

Transect D	3	2	1
0'	65°	64°	65°
3'	64°	64°	65°
6'	64°	60°	60°
9'	--	58°	59°
12'	--	57°	58°
15'	--	--	55°
18'	--	--	54°

Transect E	3	2	1
0'	71°	70°	69°
3'	72°	68°	70°
6'	73°	64°	67°
9'	--	--	53°
12'	--	--	52°

Station F	
0'	59°
3'	48°
6'	47°

Station G	
0'	44°
3'	44°
6'	44°

Station H	
0'	57°
3'	57°
6'	57°

Station I	
0'	55°
3'	55°
6'	55°
9'	46°

Station K	
0'	57°
3'	57°
6'	57°

H. B. ROBINSON WATER TEMPERATURE PROFILE
March 5, 1975

Transect A	3	2	1
0'	61°	59°	58°
3'	60°	58°	58°
6'	59°	58°	57°
9'	58°	57°	57°
12'	58°	57°	57°
15'	57°	57°	57°
18'	57°	57°	57°
21'	57°	57°	57°
24'	--	57°	--
27'	--	56°	--
30'	--	56°	--
33'	--	56°	--

Transect B	3	2	1
0'	61°	60°	58°
3'	60°	59°	59°
6'	59°	58°	57°
9'	58°	58°	57°
12'	57°	57°	57°
15'	57°	57°	57°
18'	57°	57°	56°
21'	57°	57°	56°
24'	57°	57°	56°
27'	57°	57°	56°
30'	57°	57°	56°
33'	57°	57°	56°
36'	--	--	56°

Transect C	3	2	1
0'	64°	62°	62°
3'	63°	60°	61°
6'	61°	59°	59°
9'	59°	59°	--
12'	59°	58°	--
15'	59°	58°	--
18'	58°	--	--
21'	57°	--	--
24'	57°	--	--

Transect CA	3	2	1
0'	66°	65°	63°
3'	64°	64°	63°
6'	61°	61°	61°
9'	59°	60°	60°
12'	--	59°	59°
15'	--	59°	--
18'	--	58°	--
21'	--	57°	--
24'	--	57°	--

Transect D	3	2	1
0'	67°	67°	68°
3'	64°	64°	65°
6'	61°	63°	62°
9'	--	60°	61°
12'	--	--	60°
15'	--	--	58°
18'	--	--	55°

Transect E	3	2	1
0'	73°	71°	70°
3'	73°	71°	70°
6'	73°	67°	66°
9'	--	--	53°
12'	--	--	52°

Station F	
0'	59°
3'	55°
6'	47°
9'	46°
12'	46°

Station G	
0'	54°
3'	48°
6'	47°

Station H*	
0'	55°
3'	56°
6'	57°

Station I*	
0'	53°
3'	51°
6'	50°
9'	50°

Station K*	
0'	60°
3'	59°
6'	59°
9'	59°

*March 6, 1975

H. B. ROBINSON WATER TEMPERATURE PROFILE
February 5, 1975

Transect A	3	2	1
0'	57°	57°	57°
3'	57°	57°	57°
6'	57°	57°	57°
9'	57°	57°	57°
12'	57°	57°	57°
15'	57°	57°	57°
18'	57°	57°	--
21'	57°	57°	--
24'	--	57°	--
27'	--	57°	--
30'	--	57°	--

Transect B	3	2	1
0'	57°	56°	56°
3'	57°	57°	56°
6'	57°	57°	56°
9'	57°	57°	56°
12'	57°	57°	56°
15'	57°	57°	56°
18'	57°	57°	56°
21'	57°	57°	56°
24'	57°	57°	56°
27	57°	57°	56°
30'	57°	57°	56°

Transect C	3	2	1
0'	58°	58°	58°
3'	58°	58°	58°
6'	58°	58°	57°
9'	58°	58°	--
12'	58°	57°	--
15'	58°	57°	--
18'	58°	57°	--
21'	57°	57°	--
24'	57°	57°	--

Transect CA	3	2	1
0'	59°	59°	57°
3'	59°	59°	57°
6'	59°	58°	57°
9'	59°	57°	56°
12'	58°	57°	55°
15'	--	57°	55°
18'	--	57°	55°
21'	--	57°	55°
24'	--	57°	55°

Transect D	3	2	1
0'	57°	58°	59°
3'	60°	59°	59°
6'	60°	59°	59°
9'	58°	59°	58°
12'	--	59°	57°
15'	--	--	57°
18'	--	--	55°

Transect E	3	2	1
0'	68°	59°	64°
3'	68°	64°	65°
6'	64°	61°	65°
9'	--	--	50°
12'	--	--	50°

Station F	
0'	49°
3'	45°
6'	45°

Station G	
0'	43°
3'	43°
6'	43°
9'	43°

Station H	
0'	55°
3'	56°

Station I*	
0'	46°
3'	46°
6'	46°

Station K	
0'	55°
3'	55°
6'	55°
9'	56°

* Sampled February 6, 1975

H. B. ROBINSON WATER TEMPERATURE PROFILE
April 10, 1975

Transect A	3	2	1
0'	61°	62°	62°
3'	61°	62°	62°
6'	61°	62°	62°
9'	61°	61°	62°
12'	61°	61°	62°
15'	61°	61°	61°
18'	61°	61°	-
21'	61°	61°	-
24'	61°	61°	-
27'	-	61°	-
30'	-	61°	-
33'	-	60°	-

Transect B	3	2	1
0'	61°	62°	62°
3'	62°	62°	62°
6'	62°	62°	62°
9'	62°	62°	62°
12'	62°	62°	62°
15'	61°	62°	62°
18'	61°	61°	61°
21'	61°	61°	61°
24'	61°	61°	61°
27'	61°	61°	61°
30'	61°	61°	61°
33'	61°	60°	60°

Transect C	3	2	1
0'	63°	63°	63°
3'	63°	63°	63°
6'	63°	63°	63°
9'	63°	63°	63°
12'	63°	63°	-
15'	63°	62°	-
18'	62°	61°	-
21'	61°	61°	-
24'	61°	60°	-

Transect CA	3	2	1
0'	64°	64°	64°
3'	64°	64°	64°
6'	64°	64°	64°
9'	64°	64°	64°
12'	-	64°	64°
15'	-	64°	64°
18'	-	60°	-
21'	-	59°	-
24'	-	59°	-

Transect D	3	2	1
0'	68°	69°	69°
3'	68°	69°	69°
6'	68°	67°	69°
9'	-	66°	66°
12'	-	-	64°
15'	-	-	59°
18'	-	-	59°

Transect E	3	2	1
0'	74°	73°	73°
3'	74°	74°	73°
6'	72°	74°	73°
9'	-	-	61°
12'	-	-	61°

Station F	
0'	68°
3'	68°
6'	60°
9'	58°

Station G	
0'	62°
3'	59°
6'	57°

Station H	
0'	62°
3'	62°
6'	62°

Station I	
0'	61°
3'	60°
6'	60°
9'	60°

Station K	
0'	63°
3'	63°
6'	63°
9'	63°

H. B. ROBINSON WATER TEMPERATURE PROFILE
March 20, 1975

Transect A	3	2	1
0'	63°	63°	63°
3'	63°	63°	63°
6'	63°	63°	63°
9'	62°	62°	--
12'	62°	62°	--
15'	62°	62°	--
18'	62°	62°	--
21'	--	62°	--
24'	--	62°	--
27'	--	62°	--
30'	--	61°	--
33'	--	61°	--
36'	--	61°	--

Transect B	3	2	1
0'	63°	64°	62°
3'	63°	62°	62°
6'	63°	62°	62°
9'	62°	62°	62°
12'	62°	62°	62°
15'	62°	62°	62°
18'	62°	62°	62°
21'	62°	62°	61°
24'	62°	62°	61°
27'	62°	62°	61°
30'	62°	61°	61°
33'	62°	61°	61°

Transect C	3	2	1
0'	64°	64°	64°
3'	64°	64°	64°
6'	64°	64°	63°
9'	63°	64°	--
12'	63°	64°	--
15'	62°	62°	--
18'	61°	62°	--
21'	61°	61°	--
24'	61°	--	--
27'	61°	--	--

Transect CA	3	2	1
0'	66°	66°	66°
3'	65°	66°	66°
6'	64°	66°	66°
9'	63°	63°	63°
12'	--	63°	62°
15'	--	62°	62°
18'	--	62°	--
21'	--	62°	--
24'	--	62°	--

Transect D	3	2	1
0'	68°	68°	68°
3'	68°	68°	68°
6'	68°	68°	68°
9'	--	67°	67°
35 12'	--	65°	63°
15'	--	64°	64°
18'	--	63°	63°

Transect E	3	2	1
0'	73°	73°	73°
3'	73°	72°	73°
6'	74°	73°	68°
9'	--	60°	58°
12'	--	--	57°

Station F	
0'	58°
3'	57°
6'	57°
9'	57°

Station G	
0'	57°
3'	58°
6'	57°

Station H	
0'	64°
3'	64°
6'	64°

Station I	
0'	60°
3'	60°
6'	60°
9'	60°

H. B. ROBINSON WATER TEMPERATURE PROFILE
May 12, 1975

Transect A	3	2	1
0'	75°	75°	77°
3'	73°	73°	75°
7'	73°	73°	73°
10'	73°	72°	73°
13'	72°	72°	72°
16'	72°	72°	72°
20'	72°	72°	72°
23'	72°	72°	-
26'	71°	71°	-
30'	-	71°	-
33'	-	71°	-
36'	-	71°	-
39'			

Transect B	3	2	1
0'	76°	77°	77°
3'	76°	76°	77°
7'	73°	74°	73°
10'	73°	73°	73°
13'	73°	73°	73°
16'	72°	72°	72°
20'	72°	72°	72°
23'	72°	72°	72°
26'	72°	72°	72°
30'	71°	71°	71°
33'	71°	71°	71°
36'	-	71°	70°
39'	-	-	70°

Transect C	3	2	1
0'	78°	77°	77°
3'	77°	77°	76°
7'	74°	75°	76°
10'	74°	73°	-
13'	73°	72°	-
16'	72°	72°	-
20'	70°	71°	-
23'	70°	70°	-
26'	70°	70°	-

Transect CA	3	2	1
0'	77°	77°	77°
3'	77°	77°	77°
7'	77°	77°	76°
10'	75°	73°	73°
13'	-	-	73°
16'	-	-	72°
20'	-	-	70°
23'	-	-	70°

Transect D	3	2	1
0'	78°	77°	77°
3'	78°	77°	77°
7'	77°	77°	77°
10'	-	75°	73°
13'	-	-	72°
16'	-	-	69°
20'	-	-	69°

Transect E	3	2	1
0'	77°	79°	77°
3'	77°	77°	77°
7'	77°	78°	77°
10'	77°	-	68°
13'	77°	-	67°
16'	77°	-	-

Station F	
0'	77°
3'	77°
7'	67°
10'	67°

Station G	
0'	77°
3'	66°
7'	64°

Station H	
0'	72°
3'	72°
7'	72°

Station I	
0'	68°

Station K	
0'	73°
3'	73°
7'	73°
9'	73°

*Temperatures were recorded at meter intervals.

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT

April 10, 1975

Sampling Station	Surface		3'		6'		9'		12'		15'	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
1	22.0	72	22.0	72	22.0	72	19.0	66				
2	22.5	72	22.0	72	21.0	70	19.5	67	16.0	61		
3	23.0	73	22.0	72	20.5	69	20.0	68	16.0	61		
4	22.5	72	21.0	70	20.0	68						
5	22.5	72	22.5	72	22.5	72	19.0	66				
6	22.5	72	22.5	73	21.5	71	18.5	65	15.5	60		
7	23.0	73	23.5	74	22.0	72	18.5	65	15.5	60		
9	22.0	72	23.0	72	20.5	69						
10	22.0	72	22.0	72	21.0	70	18.0	64	15.5	60		
11	22.0	72	22.0	72	22.0	72	17.0	63	15.5	60		
12	23.0	73	23.0	73	23.0	73	18.0	64	15.0	59		
13	22.5	72	23.0	73	23.0	73	16.0	61	15.5	60		
14	24.0	75	22.5	72	20.0	69						
15	22.5	72	22.5	73	21.5	71	20.0	68				
16	23.0	73	23.5	74	23.5	74	18.0	64	16.0	61		
17	23.0	73	23.0	73	23.0	73	17.0	63	15.5	60		
18	23.0	73	23.0	73	23.0	73	17.0	63	15.0	59		
19	23.0	73	23.5	74								
20	23.0	73	23.5	74								
21	23.0	73	23.0	73	23.0	73	16.5	62	15.5	60	15.0	59
22	23.0	73	23.0	73	23.0	73	16.0	61	16.0	61		
23	23.0	73	23.0	73	23.0	73	16.0	63	16.0	61		
24	22.5	72										
25	23.0	73	23.5	74								
26	23.0	73	23.5	74	23.0	73	16.0	61	16.0	61		
27	22.5	72	23.0	73	23.0	73	16.5	62	16.0	61		
28	23.0	73	23.0	73								
29	22.0	72	22.5	72								
30	22.0	72	22.5	72	22.5	72	16.0	61	15.5	60		
31	22.0	72	22.5	72	16.0	61	15.5	60				
32	20.5	69										
33	22.0	72	22.0	72	15.5	60	15.0	59				
34	22.0	72	22.0	72	16.0	72						

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT

May 22, 1975

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F	15' °C	15' °F
1	28.5	83	27.5	82	27.0	81	26.0	79	25.5	78		
2	29.0	84	29.0	84	27.8	82	26.5	80	24.0	75	23.0	73
3	30.5	87	30.5	87	28.0	82	27.5	82	23.0	73		
4	30.5	87	30.5	87	29.5	85	27.0	81	25.5	78		
5	28.5	83	27.8	82	26.5	80	26.0	79				
6	29.0	84	29.0	84	28.0	82	26.2	79	23.2	74		
7	30.5	87	29.5	85	27.5	82	26.2	79	23.5	74		
9	29.5	85	29.0	84	26.5	80						
10	29.5	85	28.0	82	28.0	82	25.5	78				
11	29.5	85	29.0	84	27.2	81	26.0	79	23.0	73		
12	29.8	86	29.5	85	27.8	82	26.2	79	22.5	72		
13	30.0	86	30.0	86	30.0	86	26.2	79	22.5	72		
14	28.2	83	28.0	82	27.5	82						
15	30.0	86	29.2	85	28.0	82	28.0	82				
16	29.2	85	29.2	85	28.0	82						
17	29.5	85	29.5	85	27.5	82	24.5	76	22.5	72		
18	30.0	86	30.2	86	27.5	82	25.0	77	22.5	72		
19	29.5	85	28.0	82								
20	30.5	87	28.8	84								
21	30.0	86	28.8	84	28.0	82	24.0	75	23.0	73		
22	29.8	86	30.0	86	27.8	82	23.2	74	22.8	73		
23	30.5	87	31.0	88	27.0	81	24.8	77	23.2	74		
24	31.0	88										
25	30.0	86	30.2	86								
26	30.0	86	29.8	85	27.5	82	24.0	75	22.5	72		
27	30.2	86	30.0	86	22.2	72	23.2	74	22.5	72		
28	30.8	87	30.8	87	28.5	83						
29	30.0	86	29.0	84								
30	30.0	86	30.0	86	27.8	82	22.8	73	22.5	72		
31	30.5	87	30.5	87	27.5	82	24.2	76	23.0	73		
32	30.2	86										
33	30.0	86	30.0	86	[illegible]	81	23.0	73	22.8	73		
34	31.5	89	31.5	89	27.5	82	25.0	77	24.0	75		

H. B. ROBINSON WATER TEMPERATURE PROFILE
May 22, 1975

Transect A	3	2	1
0'	80°	81°	80°
3'	78°	79°	80°
6'	77°	78°	79°
9'	77°	78°	77°
12'	76°	77°	77°
15'	76°	76°	77°
18'	75°	76°	-
21'	74°	74°	-
24'	-	74°	-
27'	-	73°	-
30'	-	73°	-
33'	-	73°	-
36'	-	71°	-
39'	-	71°	-

Transect B	3	2	1
0'	82°	81°	82°
3'	79°	80°	81°
6'	77°	77°	77°
9'	77°	77°	77°
12'	76°	77°	77°
15'	76°	76°	77°
18'	75°	75°	75°
21'	74°	75°	75°
24'	74°	73°	74°
27'	73°	73°	73°
30'	71°	71°	71°
33'	71°	71°	71°

Transect C	3	2	1
0'	82°	82°	82°
3'	82°	82°	81°
6'	79°	80°	80°
9'	78°	78°	-
12'	77°	77°	-
15'	76°	76°	-
18'	75°	75°	-
21'	74°	74°	-
24'	73°	74°	-
27'	72°	-	-

Transect CA	3	2	1
0'	83°	84°	84°
3'	82°	82°	82°
6'	81°	81°	81°
9'	79°	79°	79°
12'	77°	77°	77°
15'	76°	76°	77°
18'	74°	74°	75°
21'	73°	74°	-
24'	73°	73	-

Transect D	3	2	1
0'	85°	84°	84°
3'	82°	82°	82°
6'	81°	81°	82°
9'	81°	80°	80°
12'	-	77°	76°
15'	-	-	73°
18'	-	-	73°

Transect E	3	2	1
0'	82°	85°	86°
3'	82°	85°	86°
6'	82°	82°	81°
9'	82°	-	74°
12'	82°	-	73°

Point	Depth	Temp.
Point F	0'	85°
	3'	79°
	6'	79°
Point G	0'	85°
	3'	84°
	6'	73°
Point H	0'	79°
	3'	78°
	6'	78°
Point I	0'	78°
	3'	79°
	6'	79°
Point K	0'	73°
	3'	73°
	6'	73°
	9'	72°

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT

June 10, 1975

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F	15' °C	15' °F
1	33.8	93	33.8	93	33.5	92	28.0	82				
2	34.5	94	34.5	94	30.2	86	27.8	82	27.0	81		
3	33.2	92	33.0	91	28.8	84	28.0	82	27.0	81		
4	32.0	90	31.8	89	28.5	83	28.0	82				
5	33.2	92	33.2	92	31.0	88	28.5	83				
6	34.8	95	34.8	95	34.0	93	28.0	82	27.0	81		
7	35.0	95	34.0	93	30.0	86	28.0	82	26.8	80		
9	33.0	91	33.0	91	32.8	91						
10	34.2	94	33.0	91	31.0	88	28.0	82				
11	35.5	96	33.8	93	32.0	90	27.5	81	27.0	81		
12	34.8	95	34.5	94	32.0	90	27.0	81	26.2	79		
13	33.2	92	33.2	92	32.0	90	28.0	82	26.5	80		
14	36.5	98	36.5	98	36.8	98						
15	36.0	97	35.2	95	34.0	93	28.0	82				
16	35.5	96	35.8	96	32.8	91						
17	34.0	93	34.0	93	32.5	90	28.0	82	26.0	79		
18	34.5	94	33.5	92	32.0	90	28.0	82	26.0	79		
19	35.5	96	35.5	96								
20	36.0	97	36.2	97								
21	35.5	96	35.8	96	32.2	90	28.2	83	26.2	79		
22	34.0	93	34.0	93	32.8	91	27.5	81	26.0	79		
23	34.0	93	33.8	93	32.2	90	28.5	83				
24	31.2	88										
25	35.0	90	35.0	95								
26	35.5	96	35.2	95	32.0	90	28.0	82	27.0	81		
27	35.0	90	35.0	95	33.0	92	27.5	81	27.0	81		
28	34.5	94	34.5	94	34.2	94						
29	34.0	93	34.0	93								
30	34.2	94	34.2	94	32.5	90	27.5	81	27.2	81		
31	34.5	94	34.5	94	33.0	92	28.2	83	27.5	81		
32	32.0	90										
33	34.0	93	34.0	93	32.5	90	28.0	82	27.0	81		
34	33.5	92	33.2	92	32.8	91	27.0	81				
Discharge	37.0	99	37.0	99	37.0	99	37.0	99	37.0	99	37.0	99

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT

June 10, 1975

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F	15' °C	15' °F
1	33.8	93	33.8	93	33.5	92	28.0	82				
2	34.5	94	34.5	94	30.2	86	27.8	82	27.0	81		
3	33.2	92	33.0	91	28.8	84	28.0	82	27.0	81		
4	32.0	90	31.8	89	28.5	83	28.0	82				
5	33.2	92	33.2	92	31.0	88	28.5	83				
6	34.8	95	34.8	95	34.0	93	28.0	82	27.0	81		
7	35.0	95	34.0	93	30.0	86	28.0	82	26.8	80		
9	33.0	91	33.0	91	32.8	91						
10	34.2	94	33.0	91	31.0	88	28.0	82				
11	35.5	96	33.8	93	32.0	90	27.5	81	27.0	81		
12	34.8	95	34.5	94	32.0	90	27.0	81	26.2	79		
13	33.2	92	33.2	92	32.0	90	28.0	82	26.5	80		
14	36.5	98	36.5	98	36.8	98						
15	36.0	97	35.2	95	34.0	93	28.0	82				
16	35.5	96	35.8	96	32.8	91						
17	34.0	93	34.0	93	32.5	90	28.0	82	26.0	79		
18	34.5	94	33.5	92	32.0	90	28.0	82	26.0	79		
19	35.5	96	35.5	96								
20	36.0	97	36.2	97								
21	35.5	96	35.8	96	32.2	90	28.2	83	26.2	79		
22	34.0	93	34.0	93	32.8	91	27.5	81	26.0	79		
23	34.0	93	33.8	93	32.2	90	28.5	83				
24	31.2	88										
25	35.0	90	35.0	95								
26	35.5	96	35.2	95	32.0	90	28.0	82	27.0	81		
27	35.0	90	35.0	95	33.0	92	27.5	81	27.0	81		
28	34.5	94	34.5	94	34.2	94						
29	34.0	93	34.0	93								
30	34.2	94	34.2	94	32.5	90	27.5	81	27.2	81		
31	34.5	94	34.5	94	33.0	92	28.2	83	27.5	81		
32	32.0	90										
33	34.0	93	34.0	93	32.5	90	28.0	82	27.0	81		
34	33.5	92	33.2	92	32.8	91	27.0	81				
Discharge	37.0	99	37.0	99	37.0	99	37.0	99	37.0	99	37.0	99

H. B. ROBINSON WATER TEMPERATURE PROFILE
June 10, 1975

1975

Transect A	3	2	1
0'	81°	81°	81°
3'	82°	81°	81°
6'	82°	81°	81°
9'	82°	81°	81°
12'	82°	81°	81°
15'	82°	81°	81°
18'	82°	81°	-
21'	82°	82°	-
24'	82°	82°	-
27'	-	82°	-

Transect B	3	2	1
0'	82°	82°	81°
3'	82°	82°	82°
6'	82°	82°	82°
9'	82°	82°	82°
12'	82°	82°	82°
15'	82°	82°	82°
18'	82°	82°	82°
21'	82°	82°	82°
24'	82°	82°	81°
27'	82°	82°	81°
30'	-	80°	81°
33'	-	79°	79°

Transect C	3	2	1
0'	86°	82°	81°
3'	86°	82°	81°
6'	86°	82°	81°
9'	85°	82°	-
12'	83°	82°	-
15'	82°	82°	-
18'	80°	82°	-
21'	82°	82°	-
24'	81°	81°	-
27'	81°	81°	-

Transect CA	3	2	1
0'	83°	82°	82°
3'	83°	82°	82°
6'	83°	82°	82°
9'	83°	82°	82°
12'	-	82°	82°
15'	-	82°	80°
18'	-	82°	-
21'	-	82°	-
24'	-	82°	-
27'	-	81°	-

Transect D	3	2	1
0'	86°	85°	85°
3'	86°	85°	85°
6'	82°	82°	82°
9'	80°	82°	82°
12'	81°	82°	82°
15'	-	82°	81°
18'	-	81°	81°
21'	-	82°	81°

Transect E	3	2	1
0'	99°	96°	95°
3'	99°	96°	95°
6'	99°	91°	91°
9'	99°	-	82°
12'	99°	-	81°
15'	99°	-	-

Station F	
0'	86°
3'	85°
6'	82°
9'	80°

Station G	
0'	75°
3'	75°
6'	74°

Station H	
0'	81°
3'	81°

Station I	
0'	70°

Station K	
0'	81°
3'	81°
6'	81°

July 1, 1975

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F	15' °C	15' °F
1	36.6	98	37.0	99	31.5	89	30.2	86				
2	38.2	101	33.2	92	30.6	87	30.0	86	28.8	84		
3	38.0	100	33.4	92	30.6	87	30.0	86	28.5	84	28.0	82
4	35.8	96	32.0	90	30.5	87	30.1	86	29.5	85		
5	37.0	99	36.0	97	30.7	87	30.0	86				
6	37.2	99	35.5	96	32.0	90	29.8	86	29.0	84		
7	38.0	100	37.0	99	32.0	90	30.0	86	28.6	83		
9	38.0	100	36.6	98	30.2	86						
10	37.5	99	35.5	96	30.5	87	29.6	85				
11	38.5	101	36.5	98	31.5	89	30.0	86	28.5	83		
12	38.0	100	38.0	100	31.0	88	30.0	86	28.5	83		
13	38.5	96	38.5	101	31.6	89	29.2	84	28.5	83		
14	40.4	105	40.5	105	40.5	105						
15	40.0	104	38.5	101	31.6	89	31.0	88				
16	39.0	102	38.2	101	35.5	96	29.5	85	29.0	84		
17	39.2	103	39.0	102	34.5	94	30.0	86	28.7	84		
18	38.5	101	38.8	102	31.8	89	29.0	84	28.0	82		
19	40.0	104	40.0	104								
20	39.5	103	39.5	103								
21	39.0	102	39.5	103	34.5	94	29.5	85	28.0	82		
22	39.0	102	31.5	89	33.0	92	30.0	86	28.2	82		
23	38.5	101	38.6	101	33.2	92	29.5	85	28.0	82		
24	37.6	100										
25	39.0	102										
26	39.0	102	39.0	102	33.5	92	29.5	85				
27	38.5	101	37.0	99	33.5	92	29.5	85	28.5	83		
28	37.8	100	38.0	100	31.5	89						
29	38.0	100	37.8	100								
30	39.0	102	38.0	100	33.5	92	29.5	85	29.0	84		
31	38.5	101	37.5	99	31.8	89	29.5	85	28.6	83		
32	38.5	101										
33	39.0	102	38.8	102	34.0	93	29.5	85				
34	38.2	101	36.5	98	34.5	94	29.5	85				
Discharge	40.4	105	41.0	106	41.0	106						

H. B. ROBINSON WATER TEMPERATURE PROFILE
July 1, 1975

Transect A	3	2	1
0'	88°	88°	88°
3'	88°	88°	88°
6'	88°	88°	88°
9'	88°	88°	87°
12'	88°	88°	87°
15'	88°	88°	-
18'	88°	88°	-
21'	87°	88°	-
24'	87°	88°	-
27'	-	87°	-
30'	-	87°	-
33'	-	87°	-
36'	-	85°	-
39'	-	84°	-

Transect B	3	2	1
0'	89°	89°	88°
3'	89°	89°	89°
6'	88°	88°	88°
9'	88°	88°	88°
12'	88°	88°	88°
15'	88°	88°	88°
18'	87°	88°	88°
21'	87°	87°	88°
24'	87°	87°	87°
27'	87°	87°	87°
30'	86°	86°	86°
33'	-	85°	85°

Transect C	3	2	1
0'	89°	88°	87°
3'	89°	88°	87°
6'	89°	88°	87°
9'	88°	88°	-
12'	88°	88°	-
15'	88°	88°	-
18'	87°	87°	-
21'	87°	87°	-
24'	84°	-	-
27'	84°	-	-

Transect CA	3	2	1
0'	91°	91°	90°
3'	91°	91°	90°
6'	91°	90°	87°
9'	89°	88°	87°
12'	-	87°	87°
15'	-	86°	86°
18'	-	85°	-
21'	-	84°	-
27'	-	83°	-

Transect D	3	2	1
0'	93°	93°	92°
3'	94°	93°	92°
6'	90°	88°	89°
9'	-	86°	87°
12'	-	86°	86°
18'	-	85°	85°
21'	-	-	83°

Transect E	3	2	1
0'	105°	102°	102°
3'	106°	101°	89°
6'	106°	96°	90°
9'	-	85°	86°
12'	-	84°	83°

Station F	
0'	93°
3'	91°
6'	85°
9'	82°

Station G	
0'	82°
3'	82°
6'	75°

Station H	
0'	89°
3'	89°

Station I	
0'	74°
3'	73°
6'	73°

Station K	
0'	80°
3'	80°
6'	80°

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT

July 29, 1975

Sampling Station	Surface		3'		6'		9'		12'		15'	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
5	36.0	97	35.5	96	33.5	92	31.5	89				
6	36.0	97	35.5	96	34.5	94	31.5	89	27.0	81	27.0	81
7	36.0	97	36.0	97	34.0	93	31.5	89	27.5	82	27.0	81
14	37.5	100	36.5	98	35.5	96	35.0	95				
15	36.5	98	36.5	98	34.0	93	33.8	93				
16	37.0	99	36.5	98	36.5	98	34.5	94				
17	37.0	99	37.0	99	36.5	98	29.0	84	27.5	82	26.5	80
18	37.0	99	37.0	99	36.5	98	29.5	85	26.5	80		
24	37.5	100										
25	37.5	100	37.5	100								
26	37.5	100	36.5	98	35.5	96	29.5	85	27.5	82	27.5	82
27	37.5	100	36.5	98	36.0	97	30.5	87	27.5	82		
28	37.5	100	37.5	100	36.5	98	35.5	96				
32	37.0	99										
33	36.5	98	36.0	97	35.0	95	27.5	82	27.5	82		
34	37.0	99	36.5	98	35.5	96	29.0	84	28.0	82		

H. B. ROBINSON TEMPERATURE PROFILE
July 29, 1975

Transect A	3	2	1
0'	91°	92°	92°
3'	89°	89°	89°
6'	88°	87°	87°
9'	87°	87°	87°
12'	87°	87°	87°
15'	86°	86°	--
18'	86°	86°	--
21'	82°	83°	--
24'	82°	82°	--
27'	--	82°	--
30'	--	81°	--
33'	--	79°	--

Transect B	3	2	1
0'	92°	91°	89°
3'	89°	89°	88°
6'	87°	87°	88°
9'	87°	87°	87°
12'	87°	86°	86°
15'	86°	86°	86°
18'	86°	86°	86°
21'	83°	83°	84°
24'	82°	82°	82°
27'	81°	82°	81°
30'	80°	79°	80°
33'	79°	77°	78°

Transect C	3	2	1
0'	95°	95°	91°
3'	92°	91°	90°
6'	90°	89°	89°
9'	88°	89°	--
12'	87°	87°	--
15'	85°	87°	--
18'	82°	82°	--
21'	82°	82°	--
24'	81°	82°	--
27'	81°	81°	--

Transect CA	3	2	1
0'	95°	95°	96°
3'	93°	92°	94°
6'	89°	89°	89°
9'	89°	89°	88°
12'	87°	87°	87°
15'	--	85°	87°
18'	--	82°	--
21'	--	81°	--
24'	--	81°	--

Transect D	3	2	1
0'	95°	96°	97°
3'	94°	96°	97°
6'	93°	91°	90°
9'	--	90°	90°
12'	--	87°	89°
15'	--	83°	83°
18'	--	81°	82°
21'	--	81°	--
24'	--	81°	--

Transect E	3	2	1
0'	100°	99°	100°
3'	98°	98°	100°
6'	96°	98°	98°
9'	--	94°	96°

Station F	
0'	91°
3'	90°
6'	81°
9'	79°

Station G	
0'	81°
3'	75°
6'	73°
9'	73°

Station H	
0'	89°
3'	89°
6'	89°

Station I*	
0'	75°
3'	75°
6'	75°
9'	74°
12'	74°

Station K	
0'	86°
3'	86°
6'	86°
9'	86°

*July 30, 1975

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT

August 5, 1975

Sampling Station	Surface		3'		6'		9'		12'	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
5	36.0	97	36.0	97	34.5	94	33.5	92	-	-
6	36.5	98	36.5	98	34.5	94	34.0	93	30.0	86
7	37.0	99	37.0	99	35.0	95	33.6	93	30.0	86
14	38.8	102	38.5	101	38.5	101	-	-	-	-
15	38.0	100	37.6	100	35.5	96	34.2	94	-	-
16	37.0	99	37.0	99	37.0	99	33.5	92	30.0	86
17	37.5	100	37.5	100	37.5	100	32.5	91	29.5	85
18	37.0	99	37.0	99	37.0	99	33.0	91	30.0	86
24	38.5	101	-	-	-	-	-	-	-	-
25	39.0	102	-	-	-	-	-	-	-	
26	38.5	101	38.0	100	36.0	97	32.0	90	29.8	86
27	37.5	100	37.5	100	37.0	99	31.0	88	30.0	86
28	37.5	100	37.5	100	37.5	100	-	-	-	-
32	36.0	97	-	-	-	-	-	-	-	-
33	36.5	98	36.5	98	35.8	96	29.5	85	29.5	85
34	36.0	97	36.5	98	36.5	98	30.5	87	-	-
Discharge	39.5	103	39.6	103	39.8	104	39.6	103	39.6	103
Lower Big Beaverdam Creek	34.5	94	34.5	94	34.5	94				
Middle Big Beaverdam Creek	32.6	91	26.5	80						

H. B. ROBINSON TEMPERATURE PROFILE
August 5, 1975

Transect A	3	2	1
0'	87°	88°	89°
3'	87°	88°	89°
6'	87°	88°	89°
9'	87°	87°	89°
12'	87°	87°	89°
15'	86°	85°	--
18'	86°	84°	--
21'	84°	83°	--
24'	83°	82°	--
27'	--	82°	--
30'	--	82°	--
33'	--	80°	--

Transect B	3	2	1
0'	89°	88°	89°
3'	89°	89°	89°
6'	89°	89°	89°
9'	89°	89°	89°
12'	89°	89°	89°
15'	88°	87°	88°
18'	86°	86°	87°
21'	84°	85°	84°
24'	83°	83°	82°
27'	82°	82°	82°
30'	82°	82°	81°
33'	--	81°	81°

Transect C	3	2	1
0'	91°	90°	91°
3'	91°	91°	91°
6'	91°	91°	91°
9'	90°	90°	--
12'	89°	90°	--
15'	88°	89°	--
18'	86°	87°	--
21'	84°	85°	--
24'	83°	83°	--
27'	--	82°	--

Transect CA	3	2	1
0'	91°	91°	92°
3'	91°	91°	92°
6'	91°	91°	92°
9'	91°	92°	92°
12'	91°	91°	92°
15'	--	90°	--
18'	--	89°	--
21'	--	84°	--
24'	--	84°	--

Transect D	3	2	1
0'	94°	94°	95°
3'	94°	95°	95°
6'	94°	95°	95°
9'	--	94°	94°
12'	--	--	93°
15'	--	--	91°
18'	--	--	86°

Transect E	3	2	1
0'	103°	99°	100°
3'	103°	99°	100°
6'	104°	99°	99°
9'	103°	92°	89°
12'	103°	86°	85°

Station F	
0'	93°
3'	89°
6'	84°
9'	82°

Station G	
0'	85°
3'	81°
6'	80°

Station H	
0'	87°
3'	87°

Station I*	
0'	78°
3'	78°
6'	77°
9'	77°

Station K	
0'	86°
3'	86°
6'	86°

*August 6, 1975

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT

August 18, 1975

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F
5	37.5	99	37.5	99	33.5	92	32.0	90		
6	37.5	99	36.8	98	33.3	92	31.5	89	30.5	87
7	37.5	99	37.5	99	33.5	92	31.5	89	29.5	85
14	40.5	105	38.5	101	33.0	95				
15	40.0	104	38.5	101	33.5	92				
16	38.8	102	38.0	100	34.8	95	31.6	89	30.0	86
17	39.0	102	39.0	102	33.8	96	30.6	87	29.2	85
18	39.2	103	39.2	103	36.0	97	32.5	91	28.5	83
24	39.2	103								
25	39.8	104								
26	40.0	104	39.0	102	35.5	96	31.8	89	30.2	86
27	39.5	103	39.0	102	36.0	97	31.0	88	30.2	86
28	39.0	102	39.0	102	36.5	98				
32	38.2	101								
33	38.5	101	37.5	99	36.2	97	30.2	86		
34	38.2	101	37.0	99	36.0	97	30.8	87		
Lower Big Beaverdam Creek	34.0	93	34.5	94	32.5	91	30.2	86		
Middle Big Beaverdam Creek	33.0	91	26.0	79						

H. B. ROBINSON TEMPERATURE PROFILE
August 18, 1975

Transect A	3	2	1
0'	92°	91°	91°
3'	92°	92°	92°
6'	91°	92°	92°
9'	90°	91°	91°
12'	90°	90°	90°
15'	89°	89°	89°
18'	89°	89°	88°
21'	88°	88°	-
24'	-	87°	-
27'	-	84°	-
30'	-	83°	-
33'	-	82°	-
36'	-	82°	-

Transect B	3	2	1
0'	92°	92°	92°
3'	92°	92°	92°
6'	91°	91°	91°
9'	91°	90°	89°
12'	90°	89°	86°
15'	89°	89°	88°
18'	89°	88°	88°
21'	88°	88°	88°
24'	86°	87°	87°
27'	85°	84°	84°
30'	-	83°	83°
33'	-	82°	82°

Transect C	3	2	1
0'	94°	93°	91°
3'	95°	93°	92°
6'	92°	91°	91°
9'	89°	90°	-
12'	89°	89°	-
15'	88°	88°	-
18'	87°	87°	-
21'	85°	84°	-
24'	84°	84°	-
27'	83°	83°	-

Transect CA	3	2	1
0'	94°	93°	93°
3'	95°	94°	91°
6'	91°	91°	90°
9'	-	90°	90°
12'	-	89°	89°
15'	-	88°	-
18'	-	87°	-
21'	-	85°	-
24'	-	84°	-

Transect D	3	2	1
0'	94°	95°	96°
3'	95°	96°	96°
6'	92°	91°	96°
9'	-	88°	89°
12'	-	88°	88°
15'	-	85°	87°
18'	-	84°	84°

Transect DA	3	2	1
0'	9[illegible]°	95°	95°
3'	[illegible]8°	95°	94°
6'	[illegible]3°	92°	91°
9'	89°	89°	89°
12'	-	86°	87°
15'	-	-	83°

Transect E	3	2	1
0'	106°	102°	103°
3'	107°	100°	102°
6'	107°	95°	97°
9'	107°	89°	88°
12'	107°	86°	86°
15'	107°	-	-

Point F	
0'	[illegible]4°
3'	[illegible]0°
6'	86°
9'	84°

Point G	
0'	89°
3'	84°
6'	81°

Point H	
0'	89°
3'	90°

Point I	
0'	78°
3'	78°
6'	78°

Point K	
0'	88°
3'	88°

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT September 9, 1975

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F
5	36.0	97	35.5	96	31.5	89	29.0	84		
6	36.0	97	36.0	97	31.2	88	29.0	84	28.0	82
7	36.5	98	37.0	99	31.0	88	29.2	85	28.0	82
14	38.5	101	37.0	99	35.5	96				
15	39.2	101	37.8	100	32.0	90				
16	39.0	102	37.0	99	35.0	95				
17	37.6	100	37.5	100	32.0	90	28.5	83	28.0	82
18	38.0	100	37.2	99	30.6	87	28.2	83	28.0	82
24	37.5	100								
25	38.0	100								
26	37.5	100	37.0	99	35.0	95	28.0	82	27.2	81
27	37.5	100	37.0	99	32.0	90	27.6	82	27.2	81
28	37.7	100	36.5	98	32.0	90				
32	36.5	98								
33	36.5	98	36.2	97	35.0	95	27.5	82		
34	36.2	97	36.0	97	33.0	91	27.5	82		
Lower Big Beaverdam Creek	32.5	91	32.6	91	31.0	88	30.0	86		
Middle Big Beaverdam Creek	29.5	85	23.0	73						
Upper Big Beaverdam Creek	23.0	73								

H. B. ROBINSON TEMPERATURE PROFILE
September 9, 1975

Transect A	3	2	1
0'	88°	88°	88°
3'	88°	88°	88°
6'	88°	88°	88°
9'	88°	88°	88°
12'	89°	87°	87°
15'	87°	87°	87°
18'	87°	86°	-
21'	86°	86°	-
24'	86°	84°	-
27'	86°	86°	-
30'	85°	85°	-
33'	85°	85°	-
36'	-	84°	-
39'	-	84°	-
42'	-	84°	-

Transect B	3	2	1
0'	87°	88°	87°
3'	87°	88°	88°
6'	87°	88°	88°
9'	87°	88°	88°
12'	87°	87°	87°
15'	86°	87°	87°
18'	86°	87°	87°
21'	86°	86°	86°
24'	85°	86°	86°
27'	84°	85°	85°
30'	-	84°	84°
33'	-	84°	84°

Transect C	3	2	1
0'	89°	88°	89°
3'	89°	88°	88°
6'	88°	88°	88°
9'	88°	88°	-
12'	87°	87°	-
15'	87°	87°	-
18'	87°	-	-
21'	85°	-	-
24'	84°	-	-
27'	83°	-	-

Transect CA	3	2	1
0'	91°	90°	90°
3'	91°	90°	89°
6'	91°	89°	88°
9'	89°	88°	88°
12'	88°	87°	87°
15'	87°	87°	-
18'	86°	86°	-
21'	-	84°	-
24'	-	84°	-

Transect D	3	2	1
0'	95°	95°	94°
3'	93°	94°	94°
6'	91°	89°	90°
9'	-	88°	88°
12'	-	87°	88°
15'	-	86°	87°
18'	-	-	85°

Transect DA	3	2	1
0'	96°	95°	92°
3'	95°	94°	92°
6'	91°	91°	89°
9'	87°	87°	88°
12'	85°	85°	84°

Transect E	3	2	1
0'	104°	102°	100°
3'	104°	99°	99°
6'	104°	95°	90°
9'	-	-	82°
12'	-	-	81°

Station F	
0'	93°
3'	92°
6'	81°
9'	79°

Station G	
0'	89°
3'	81°
6'	77°
9'	76°

Station H	
0'	87°
3'	87°

Station I	
0'	76°
3'	75°
6'	75°
9'	74°

Station K	
0'	86°
3'	86°
6'	86°

THERMAL PLUME MONITORING
H. B. Robinson Steam Electric Plant   September 25, 1975

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F
5	30.5	87	30.6	87	26.5	80	25.0	77	24.5	76
6	30.5	87	27.5	82	26.5	80	24.5	76	24.5	76
7	32.0	90	30.0	86						
14	32.0	90	30.5	87	26.0	79				
15	31.0	88	31.0	88	27.5	82	25.1	77		
16	32.0	90	32.0	90	26.5	80	24.5	76		
17	32.4	90	32.5	91	25.5	78	25.0	77	24.3	76
18	32.5	91	32.5	91	25.0	77	24.5	76		
24	33.0	91								
25	32.8	91	33.0	91						
26	32.5	91	32.5	91	25.5	78	24.0	75	24.0	75
27	31.5	89	31.5	89	25.0	77	24.0	75	24.0	75
28	31.5	89	31.6	89	27.2	81	25.0	77		
32	30.0	8[illegible]								
33	30.5	87	30.5	87	24.0	75	23.5	74	23.5	74
34	31.0	88	31.5	89	25.5	78	24.0	75		
Lower Big Beaverdam Creek	27.0	81	27.0	81	26.5	80	25.5	78	25.0	77
Middle Big Beaverdam Creek	26.2	79	26.5	80						

H. B. ROBINSON WATER TEMPERATURE PROFILE
September 25, 1975

Transect A	3	2	1
0'	78°	79°	78°
3	79°	79°	79°
6	79°	79°	79°
9'	79°	79°	79°
12'	79°	79°	79°
15'	79°	79°	-
18'	79°	79°	-
21'	79°	79°	-
24'	-	79°	-
27'	-	79°	-

Transect B	3	2	1
0'	80°	80°	79°
3'	80°	80°	80°
6'	80°	80°	80°
9'	80°	80°	80°
12'	79°	79°	80°
15'	79°	79°	80°
18'	79°	79°	79°
21'	79°	79°	80°
24'	73°	79°	80°
27'	79°	79°	79°
30'	79°	79°	79°
33'	-	79°	78°

Transect C	3	2	1
0'	82°	83°	82°
3'	83°	82°	82°
6'	82°	82°	81°
9'	80°	82°	-
12'	79°	80°	-
1.	79°	80°	-
18'	79°	80°	-
21'	79°	79°	-
24'	79°	79°	-
27'	79°	79°	-

Transect CA	3	2	1
0'	84°	84°	82°
3'	84°	84°	82°
6'	81°	81°	81°
9'	80°	80°	80°
12'	80°	80°	80°
15'	-	80°	80°
18'	-	80°	-
21'	-	80°	-
24'	-	80°	-

Transect D	3	2	1
0'	85°	85°	85°
3'	84°	85°	85°
6'	82°	81°	81°
9'	-	80°	80°
12'	-	80°	80°
15'	-	80°	79°
18'	-	78°	79°
21'	-	78°	78°

Transect DA	3	2	1
0'	87°	85°	82°
3'	86°	82°	82°
6'	80°	81°	80°
9'	79°	79°	78°
12'	-	77°	77°
15'	-	77°	77°
18'	-	-	77°
21'	-	-	76°

Transect E	3	2	1
0'	92°	90°	89°
3'	93°	90°	89°
6'	93°	80°	77°
9'	93°	76°	75°
12'	93°	-	75°
15'	94°	-	-

Station F	
0'	73°
3'	73°
6'	73°
9'	72°

Station G	
0'	72°
3'	71°
6'	71°
9'	71°
12'	71°

Station H	
0'	78°
3'	79°
6'	79°

Station I	
0'	71°
3'	71°
6'	71°
9'	71°

Station K	
0'	77°
3'	77°
6'	78°
9'	78°

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT October 13, 1975

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F
5	31.2	88	30.2	86	26.0	79	25.0	77		
6	31.2	88	30.0	86	27.0	81	23.5	74	23.0	73
7	31.6	89	30.5	87	26.6	80	24.0	75	23.0	73
14	33.5	92	32.6	91	32.0	90				
15	32.5	91	32.0	90	27.5	81				
16	32.5	91	32.0	90	30.0	86				
17	32.5	91	32.5	91	27.4	81	23.0	73	23.0	73
18	32.5	91	32.5	91	28.2	83	23.5	74	23.0	73
24	33.9	93								
25	33.5	92	33.8	93						
26	33.6	93	31.2	88	27.8	82	24.0	75		
27	32.8	91	33.0	91	30.0	86	24.2	75	22.6	73
28	32.6	91	32.8	91	31.0					
32	31.5	89								
33	33.0	91	31.8	89	30.5	88	23.5	74	22.5	73
34	33.0	91	33.0	91	27.0	81	24.0	75		
Lower Big Beaverdam Creek	30.5	87	30.0	86	27.0	81	24.0	75	23.5	74
Middle Big Beaverdam Creek	28.5	83	21.0	70						
Upper Big Beaverdam Creek	22.0	72								

H. B. ROBINSON WATER TEMPERATURE PROFILE
October 13, 1975

Transect A	Intake	3	2	1
0'	80°	81°	82°	82°
3'	80°	81°	82°	81°
6'	80°	81°	80°	79°
9'	80°	79°	79°	79°
12'	79°	79°	79°	79°
15'	78°	79°	76°	-
18'	77°	77°	75°	-
21'	75°	-	75°	-
24'	75°	-	74°	-
27'	73°	-	73°	-
30'	73°	-	73°	-
33'	73°	-	73°	-
36'	73°	-	-	-

Transect B	3	2	1
0'	82°	82°	82°
3'	82°	81°	81°
6'	80°	80°	80°
9'	79°	79°	79°
12'	79°	78°	79°
15'	78°	78°	78°
18'	77°	77°	77°
21'	75°	76°	76°
24'	73°	74°	75°
27'	73°	73°	73°
30'	-	73°	73°
33'	-	73°	73°

Transect C	3	2	1
0'	83°	83°	84°
3'	83°	83°	83°
6'	82°	81°	82°
9'	80°	80°	-
12'	78°	78°	-
15'	77°	77°	-
18'	75°	76°	-
21'	75°	75°	-
24'	73°	74°	-
27'	73°	73°	-

Transect CA	3	2	1
0'	85°	86°	85°
3'	83°	83°	82°
6'	81°	81°	80°
9'	79°	79°	79°
12'	78°	78°	78°
15'	76°	77°	-
18'	-	75°	-
21'	-	73°	-

Transect D	3	2	1
0'	86°	86°	86°
3'	84°	84°	86°
6'	82°	81°	80°
9'	-	79°	79°
12'	-	77°	77°
15'	-	75°	75°

Transect DA	3	2	1
0'	90°	88°	87°
3'	83°	83°	83°
6'	82°	81°	81°
9'	81°	74°	79°
12'	78°	73°	73°
15'	75°	-	73°

Transect E	3	2	1
0'	93°	91°	91°
3'	93°	90°	91°
6'	93°	86°	86°
9'	93°	-	76°
12'	93°	-	73°
15'	93°	-	-

Station F	
0'	85°
3'	78°
6'	71°

Station G	
0'	75°
3'	68°
6'	68°

Station H	
0'	77°
3'	78°
6'	78°

Station I	
0'	65°
3'	65°
6'	65°
9'	65°

Station K	
0'	76°
3'	76°
6'	76°
9'	76°

Unit 2 outlet: 93°

Discharge canal outlet: 93°

October 28, 1975

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F	15' °C	15' °F
5	29.0	84	28.8	84	24.0	75	23.5	74				
6	29.2	85	29.0	84	25.0	77	23.5	74				
7	30.0	86	28.0	82	25.0	77	22.8	73	21.2	70		
14	33.0	91	31.8	89								
15	31.5	89	31.2	88	25.5	78						
16	31.5	89	31.0	88	26.2	79	22.0	72	21.2	70	21.0	70
17	30.8	87	30.5	87	24.8	77	21.5	71	21.0	70		
18	30.5	87	30.2	87	26.5	80	21.5	71				
24	32.5	91										
25	32.5	91										
26	32.0	90	29.2	85	26.5	80	21.5	71	21.2	70		
27	32.0	90	30.8	87	26.0	79	21.5	71	21.2	70		
28	31.5	89	31.5	89	24.2	76						
32	30.5	87										
33	31.0	88	31.0	88	28.0	82	21.5	71				
34	30.8	87	30.5	87	28.0	82	21.5	71				
Lower Big Beaverdam Creek	24.8	77	24.5	76	24.2	76	23.5	74				
Middle Big Beaverdam Creek	19.8	68	17.2	63								
Upper Big Beaverdam Creek	18.0	64										

H. B. ROBINSON WATER TEMPERATURE PROFILE
October 28, 1975

Transect A	Intake	3	2	1
0'	76°	75°	75°	75°
3'	76°	76°	76°	75°
6'	76°	76°	76°	75°
9'	76°	76°	76°	75°
12'	76°	76°	76°	75°
15'	76°	76°	76°	75°
18'	76°	76°	76°	75°
21'	76°	76°	76°	-
24'	76°	-	76°	-
27'	76°	-	76°	-
30'	76°	-	76°	-
33'	76°	-	76°	-
36'	76°	-	76°	-
39'	76°	-	-	-

Transect B	3	2	1
0'	77°	77°	76°
3'	76°	76°	76°
6'	76°	76°	76°
9'	76°	76°	75°
12'	76°	76°	75°
15'	76°	76°	75°
18'	76°	76°	75°
21'	76°	76°	75°
24'	75°	75°	75°
27'	75°	75°	75°
30'	75°	75°	75°
33'	-	-	74°
36'	-	-	74°

Transect C	3	2	1
0'	77°	76°	75°
3'	77°	77°	75°
6'	77°	77°	75°
9'	76°	76°	-
12'	76°	76°	-
15'	75°	76°	-
18'	75°	75°	-
21'	73°	72°	-
24'	72°	72°	-
27'	72°	72°	-

Transect CA	3	2	1
0'	79°	78°	77°
3'	79°	77°	76°
6'	79°	77°	75°
9'	77°	75°	75°
12'	-	75°	75°
15'	-	74°	75°
18'	-	71°	-
21'	-	70°	-

Transect D	3	2	1
0'	82°	82°	82°
3'	80°	80°	81°
6'	76°	76°	76°
9'	-	75°	75°
12'	-	74°	73°
15'	-	70°	71°
18'	-	-	70°

Transect DA	3	2	1
0'	82°	79°	78°
3'	80°	79°	78°
6'	77°	75°	75°
9'	74°	73°	74°
12'	-	71°	71°
15'	-	69°	69°

Transect E	3	2	1
0'	91°	89°	90°
3'	92°	88°	87°
6'	92°	79°	79°
9'	91°	72°	71°
12'	92°	70°	70°
15'	-	70°	-

Station F	
0'	81°
3'	77°
6'	68°
9'	68°

Satation G	
0'	68°
3'	67°
6'	66°

Station H	
0'	75°
3'	75°

Station I*	
0'	66°
3'	65°
6'	65°
9'	65°

Station K	
0'	74°
3'	74°
6'	74°

Unit 2 discharge 93.2°
End of discharge canal 90.5°
*October 27,1975

H. B. ROBINSON WATER TEMPERATURE PROFILE
November 12, 1975

Transect A	Intake	3	2	1
0'	71°	71°	71°	71°
3'	71°	71°	71°	71°
6'	71°	71°	71°	71°
9'	70°	71°	71°	71°
12'	70°	71°	71°	71°
15'	70°	70°	71°	71°
18'	70°	70°	71°	70°
21'	70°	-	70°	70°
24'	70°	-	70°	70°
27'	70°	-	70°	-
30'	69°	-	69°	-
33'	69°	-	68°	-
36'	69°	-	68°	-
39'	68°	-	-	-
42'	68°	-	-	-

Transect B	3	2	1
0'	71°	71°	71°
3'	71°	71°	71°
6'	71°	71°	71°
9'	71°	71°	71°
12'	71°	71°	71°
15'	70°	71°	71°
18'	70°	71°	71°
21'	70°	70°	71°
24'	70°	70°	71°
27'	70°	70°	70°
[illegible]	68°	69°	68°
[illegible]	68°	68°	68°

Transect C	3	2	1
0'	72°	72°	72°
3'	71°	72°	71°
6'	71°	72°	71°
9'	71°	72°	-
12'	71°	72°	-
15'	71°	71°	-
18'	70°	70°	-
21'	69°	69°	-
24'	69°	68°	-
27'	-	68°	-

Transect CA	3	2	1
0'	72°	72°	72°
3'	72°	71°	72°
6'	72°	71°	72°
9'	72°	71°	72°
12'	70°	71°	72°
15'	70°	71°	71°
18'	-	69°	70°
21'	-	69°	68°
24'	-	69°	-

Transect D	3	2	1
0'	72°	72°	72°
3'	72°	72°	72°
6'	72°	72°	72°
12'	71°	72°	72°
15'	-	-	69°
18'	-	-	68°

Transect DA	3	2	1
0'	73°	73°	72°
3'	73°	73°	72°
6'	72°	72°	72°
9'	70°	72°	72°
12'	69°	69°	72°
15'	69°	68°	67°

Transect E	3	2	1
0'	75°	74°	73°
3'	75°	73°	73°
6'	76°	72°	73°
9'	76°	69°	70°
12'	76°	-	69°
15'	76°	-	-

Station F	
0'	70°
3'	70°
6'	67°

Station G	
0'	66°
3'	66°
6'	65°

Station H	
0'	70°
3'	70°
6'	70°

Station I	
0'	66°
3'	65°
6'	65°
9'	65°

Station K	
0'	70°
3'	70°
6'	70°

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT   November 12, 1975

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F	15' °C	15' °F
5	22.8	73	22.7	73	22.5	73	21.5	71				
6	22.8	73	22.8	73	22.7	73	21.0	70	20.5	69		
7	23.0	73	23.0	73	23.0	73	21.2	70	20.5	69	20.5	69
14	24.0	75	24.0	75	23.5	74						
15	23.4	74	23.5	74	23.5	74	23.4	74				
16	23.5	74	23.0	73	22.0	72	20.5	69				
17	23.0	73	23.2	74	23.0	73	21.0	70	20.0	68		
18	23.0	73	23.0	73	23.0	73	23.0	73	20.5	69		
*25	24.0	75										
26	23.4	74	23.5	74	23.2	74	21.0	70	20.6	69		
27	23.0	73	23.0	73	23.0	73	21.0	70	20.5	69		
28	23.0	73	23.0	73	23.0	73						
32	23.0	73										
33	22.6	73	22.7	73	22.7	73	20.1	68				
34	22.6	73	22.9	73	22.9	73	20.4	69				
Lower Big Beaverdam Creek	22.5	73	22.5	73	22.2	72	22.0	72	20.5	69		
Middle Big Beaverdam Creek	19.5	67	19.5	67								
Upper Big Beaverdam Creek	19.5	67	19.4	67								

* Station 24 not taken, too shallow

H. B. ROBINSON WATER TEMPERATURE PROFILE
November 25, 1975

Transect A	Intake	3	2	1
0'	56°	56°	56°	56°
3'	56°	57°	56°	56°
6'	56°	57°	56°	56°
9'	56°	56°	56°	56°
12'	56°	56°	56°	56°
15'	56°	56°	[illegible]	-
18'	56°	56°	56°	-
21'	56°	56°	56°	-
24'	56°	56°	56°	-
27'	56°	-	56°	-
30'	56°	-	56°	-
33'	56°	-	56°	-
36'	56°	-	56°	-

Transect B	3	2	1
0'	56°	56°	55°
3'	56°	56°	56°
6'	56°	56°	56°
9'	56°	56°	56°
12'	56°	56°	56°
15'	56°	56°	56°
18'	56°	56°	56°
21'	56°	56°	56°
24'	56°	56°	56°
27'	56°	56°	56°
30'	56°	56°	56°
33'	-	56°	56°

Transect C	3	2	1
0'	55°	55°	56°
3'	56°	56°	56°
6'	56°	56°	56°
9'	56°	56°	-
12'	56°	56°	-
15'	56°	56°	-
18'	56°	56°	-
21'	56°	56°	-
24'	56°	56°	-
27'	56°	56°	-

Transect CA	3	2	1
0'	56°	56°	55°
3'	56°	56°	56°
6'	56°	56°	56°
9'	56°	56°	56°
12'	-	56°	56°
15'	-	56°	-
18'	-	56°	-

Transect D	3	2	1
0'	56°	56°	56°
3'	56°	56°	56°
6'	56°	56°	56°
9'	56°	56°	56°
12'	-	56°	56°
15'	-	56°	56°

Transect DA	3	2	1
0'	56°	55°	55°
3'	56°	56°	55°
6'	56°	56°	55°
9'	55°	56°	55°
12'	-	55°	55°
15'	-	55°	55°

Transect E	3	2	1
0'	59°	58°	57°
3'	60°	58°	57°
6'	60°	54°	57°
9'	-	-	52°
12'	-	-	52°

Station F	
0'	49°
3'	49°
6'	49°
9'	49°

Station G	
0'	48°
3'	48°
6'	48°

Station H	
0'	57°
3'	57°

Station I	
0'	48°
3'	48°
6'	48°
9'	48°

Station K	
0'	56°
3'	56°
6'	56°

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT   November 25, 1975

Sampling Station	Surface		3'		6'		9'		12'	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
5	13.4	56	13.5	56	11.6	53	11.6	53		
6	13.5	56	13.7	57	13.5	56	11.0	52		
7	13.5	56	13.8	57	13.6	57	12.8	55	11.0	52
14	14.8	59	14.8	59	14.0	57				
15	14.3	58	14.5	58	14.3	58				
16	14.5	58	14.3	58	12.3	54				
17	14.4	58	14.5	58	14.0	57	11.0	52	11.0	52
18	14.0	57	14.3	58	14.2	58	11.2	52	11.0	52
24	14.8	59								
25	14.6	58								
26	14.5	58	14.5	58	13.0	55	11.0	52		
27	14.0	57	14.0	57	14.0	57	11.0	52	11.0	52
28	13.7	57	14.0	57						
32	13.0	55								
33	13.4	56	13.6	57	12.0	54	10.3	51		
34	13.0	55	13.5	56	13.5	56	10.6	51		
Lower Big Beaverdam Creek	14.0	57	13.0	55	13.0	55	13.5	56	12.0	54
Middle Big Beaverdam Creek	11.0	52	11.0	52						
Upper Big Beaverdam Creek	12.0	54	12.0	54						

H. B. ROBINSON WATER TEMPERATURE PROFILE
December 9, 1975

Transect A	3	2	1
0'	54°	54°	53°
3'	54"	54"	54°
6'	54°	54°	54°
9'	54°	54°	54°
12'	54°	54°	53°
15'	54°	54°	-
18'	54°	54°	-
21'	54°	54°	-
24'	54°	54°	-
27'	54°	54°	-
30'	54°	54°	-
33'	54°	54°	-
36'	54°	54°	-
39'	54°	-	-

Transect B	3	2	1
0'	54°	54°	54°
3'	54°	54°	54°
6'	54°	54°	54°
9'	54°	54°	54°
12'	54°	54°	54°
15'	54°	54°	54°
18'	54°	54°	54°
21'	54°	54°	54°
24'	54°	54°	54°
27'	54°	54°	54°
30'	54°	54°	54°
33'	-	-	54°

Transect C	3	2	1
0'	54°	54°	53°
3'	54°	54°	54°
6'	54°	54°	-
9'	54°	54°	-
12'	54°	54°	-
15'	54°	54°	-
18'	54°	54°	-
21'	54°	54°	-
24'	54°	54°	-

Transect CA	3	2	1
0'	54°	54°	54°
3'	54°	54°	54°
6'	54°	54°	54°
9'	54°	54°	54°
12'	-	54°	54°
15'	-	54°	54°
18'	-	54°	54°
21'	-	54°	-
24'	-	54°	-

Transect D	3	2	1
0'	54°	54°	55°
3'	55°	55°	55°
6'	55°	55°	55°
9'	-	55°	55°
12'	-	-	55°
15'	-	-	54°
18'	-	-	54°

Transect DA	3	2	1
0'	54°	54°	54°
3'	55°	54°	54°
6'	55°	54°	54°
9'	54°	54°	54°
12'	-	54°	54°
15'	-	-	54°

Transect E	3	2	1
0'	57°	56°	54°
3'	57°	56°	54°
6'	56°	53°	52°
9'	-	-	50°
12'	-	-	50°

Station F	
0'	49°
3'	49°
6'	49°
9'	49°

Station G	
0'	48°
3'	48°
6'	48°
9'	48°

Station H	
0'	54°
3'	54°
6'	54°

Station I*	
0'	47°
3'	47°
6'	47°
9'	47°

Station K	
0'	53°
3'	53°
6'	53°

*December 10, 1975

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT   December 9, 1975

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F
5	12.4	54	12.6	55	12.5	55	12.5	55		
6	12.8	55	12.7	55	12.5	55	11.2	52		
7	13.0	55	12.7	55	12.5	55	11.0	52	11.0	52
14	13.8	57	14.0	57	12.8	55				
15	13.7	57	13.5	56	12.0	54				
16	13.6	56	13.6	56	11.5	53				
17	13.0	55	12.8	55	11.5	53	10.5	51	10.5	51
18	12.5	55	12.5	55	11.6	53	11.0	52		
24	12.0	54								
25	12.0	54								
26	12.5	55	12.5	55	11.0	52	10.1	50	10.1	50
27	12.2	54	12.2	54	11.0	52	10.1	50	10.1	50
28	12.1	54	12.2	54	11.5	53	10.4	51		
32	12.4	54								
33	12.0	54	12.0	54	10.1	50	10.1	50		
34	12.0	54	12.1	54	10.5	51	10.1	50		
Lower Big Beaverdam Creek	11.8	53	12.0	54	12.0	54	11.4	53		
Middle Big Beaverdam Creek	11.5	53	11.1	52						
Upper Big Beaverdam Creek	12.0	54	12.1	54						

H. B. ROBINSON WATER TEMPERATURE PROFILE
January 6, 1976

Transect A	Intake	3	2	1
0'	52°	52°	52°	51°
3'	52°	53°	52°	51°
6'	52°	53°	52°	51°
9'	53°	53°	52°	52°
12'	53°	53°	52°	51°
15'	53°	53°	52°	51°
18'	53°	53°	52°	-
21'	53°	-	53°	-
24'	53°	-	53°	-
27'	53°	-	53°	-
30'	53°	-	53°	-
33'	53°	-	-	-
36'	54°	-	-	-
39'	54°	-	-	-
42'	54°	-	-	-

Transect B	3	2	1
0'	53°	54°	53°
3'	54°	54°	54°
6'	54°	54°	54°
9'	54°	55°	55°
12'	54°	54°	55°
15'	54°	55°	55°
18'	54°	55°	55°
21'	54°	55°	54°
24'	54°	54°	54°
27'	54°	54°	55°
30'	54°	54°	54°
33'	-	54°	55°

Transect C	3	2	1
0'	56°	55°	54°
3'	57°	55°	55°
6'	56°	55°	55°
9'	57°	55°	-
12'	57°	55°	-
15'	57°	55°	-
18'	57°	55°	-
21'	57°	56°	-
24'	56°	56°	-
27'	-	56°	-

Transect CA	3	2	1
0'	57°	56°	55°
3'	59°	57°	56°
6'	59°	57°	56°
9'	59°	57°	56°
12'	-	56°	56°
15'	-	56°	56°
18'	-	56°	-
21'	-	56°	-

Transect D	3	2	1
0'	60°	60°	54°
3'	61°	60°	56°
6'	59°	57°	56°
9'	-	56°	56°
12'	-	56°	56°
15'	-	-	55°
18'	-	-	55°
21'	-	-	55°

Transect DA	3	2	1
0'	62°	60°	55°
3'	63°	58°	57°
6'	58°	58°	57°
9'	55°	57°	57°
12'	-	54°	53°
15'	-	54°	53°

Transect E	3	2	1
0'	68°	67°	67°
3'	70°	66°	65°
6'	69°	63°	64°
9'	-	54°	52°
12'	-	-	51°

Station F	
0'	44°
3'	45°
6'	44°
9'	44°

Station G	
0'	41°
3'	41°
6'	41°
9'	41°

Station H*	
0'	52°
3'	52°
6'	52°

Station I*	
0'	39°
3'	39
6'	38

Station K*	
0'	50°
3'	50°
6'	50°

*January 7, 1976

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT January 6, 1976

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F
5	17.0	63	17.5	63	12.5	55	11.2	52		
6	16.5	62	16.7	62	14.0	57	11.3	52	10.5	51
7	17.2	63	17.0	63	10.5	51	10.0	50	10.0	50
14	19.5	67	20.5	69	20.5	69				
15	19.5	67	19.4	67	14.5	58				
16	19.5	67	18.8	66	17.0	63	12.0	54		
17	19.8	68	20.4	69	17.5	63	11.0	52	11.0	52
18	19.0	66	18.5	65	17.0	63	11.2	52	11.0	52
24	19.5	67								
25	19.5	67	20.2	68						
26	19.0	66	20.0	68	16.0	61	10.5	51	10.5	51
27	19.5	67	18.5	65	17.5	63	11.0	52	10.5	51
28	19.5	67	19.7	67	18.4	65	11.2	52		
32	19.0	66	19.0	66	16.0	61	11.0	52		
33	18.5	65	18.5	65	16.0	61	10.0	50		
34	19.5	67								
Lower Big Beaverdam Creek	12.5	55	13.0	55	12.8	55	11.5	53	10.5	51
Middle Big Beaverdam Creek	8.0	46	8.0	46						
Upper Big Beaverdam Creek	9.0	48								

H. B. ROBINSON WATER TEMPERATURE PROFILE
February 17, 1976

Transect A	Intake	3	2	1
0'	61°	61°	62°	62°
3'	60°	60°	61°	62°
6'	60°	60°	61°	61°
9'	60°	60°	61°	61°
12'	59°	60°	60°	61°
15'	59°	60°	61°	61°
18'	59°	58°	61°	-
21'	59°	-	58°	-
24'	59°	-	58°	-
27'	58°	-	58°	-
30'	58°	-	58°	-
33'	58°	-	57°	-
36'	58°	-	-	-
39'	57°	-	-	-

Transect B	3	2	1
0'	63°	62°	63°
3'	63°	62°	62°
6'	62°	62°	62°
9'	62°	62°	62°
12'	62°	62°	62°
15'	61°	62°	62°
18'	61°	61°	62°
21'	60°	60°	60°
24'	60°	59°	60°
27'	59°	57°	58°
30'	-	57°	58°
33'	-	57°	57°

Transect C	3	2	1
0'	64°	64°	64°
3'	64°	64°	64°
6'	63°	64°	64°
9'	64°	64°	-
12'	63°	63°	-
15'	62°	63°	-
18'	61°	63°	-
21'	61°	58°	-
24'	58°	58°	-
27'	-	57°	-

Transect CA	3	2	1
0'	67°	68°	67°
3'	67°	67°	67°
6'	67°	67°	67°
9'	67°	65°	67°
12'	67°	64°	67°
15'	63°	62°	63°
18'	-	62°	-
21'	-	59°	-
24'	-	59°	-

Transect D	3	2	1
0'	69°	69°	69°
3'	69°	71°	69°
6'	69°	69°	69°
9'	68°	-	69°
12'	-	-	69°
15'	-	-	67°
18'	-	-	61°

Transect DA	3	2	1
0'	70°	70°	70°
3'	70°	71°	70°
6'	70°	71°	70°
9'	67°	70°	70°
12'	-	61°	63°
15'	-	60°	59°

Transect E	3	2	1
0'	75°	73°	73°
3'	76°	73°	74°
6'	76°	73°	74°
9'	-	66°	61°
12'	-	62°	-

Station F	
0'	66°
3'	65°
6'	59°
9'	58°

Station G	
0'	58°
3'	58°
6'	58°

Station H	
0'	62°
3'	60°
6'	60°

Station I	
0'	59°
3'	59°
6'	59°
9'	58°

Station K	
0'	63°
3'	62°
6'	62°

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT February 17, 1976

Sampling Station	Surface °C	°F	3' °C	°F	6' °C	°F	9' °C	°F	12' °C	°F
5	21.5	71	21.1	70	20.5	69	18.8	66		
6	22.0	72	21.5	71	21.5	71	16.4	62		
7	22.5	72	22.5	72	22.3	72	19.8	68	16.0	61
14	24.0	75	24.0	75	23.5	74				
15	22.5	72	22.8	73	22.8	73				
16	23.0	73	23.0	73	22.8	73	19.0	66	16.5	62
17	22.5	72	22.8	73	23.0	73	17.5	64		
18	22.4	72	22.5	72	22.5	72	22.5	72		
24	23.0	73								
25	23.5	74								
26	23.4	74	23.2.	74	21.5	71	16.5	62		
27	23.0	73	23.3	74	23.1	74	16.3	61		
28	22.5	72	23.0	73						
32	20.0	68								
33	22.0	72	22.5	72	21.0	70	16.0	61		
34	22.5	72	22.5	72	22.5	72	16.5	62		
Lower Big Beaverdam Creek	21.2	70	21.2	70	21.0	70	20.8	69		
Middle Big Beaverdam Creek	17.0	63	16.3	61						
Upper Big Beaverdam Creek	17.0	63								

H. B. ROBINSON WATER TEMPERATURE PROFILE
March 30, 1976

Transect A	Intake	3	2	1
0'	70°	70°	70°	69°
3'	70°	70°	69°	69°
6'	69°	70°	69°	69°
9'	69°	69°	69°	69°
12'	69°	69°	69°	68°
15'	69°	69°	68°	68°
18'	69°	69°	68°	-
21'	68°	68°	68°	-
24'	68°	-	67°	-
27'	68°	-	67°	-
30'	68°	-	66°	-
33'	66°	-	66°	-
36'	68°	-	-	-
40'	68°	-	-	-

Transect B	3	2	1
0'	71°	71°	70°
3'	71°	71°	70°
6'	70°	70°	70°
9'	70°	70°	70°
12'	69°	69°	69°
15'	68°	69°	68°
18'	68°	68°	68°
21'	68°	68°	68°
24'	68°	67°	67°
27'	67°	66°	67°
30'	67°	66°	67°
33'	-	66°	66°

Transect C	3	2	1
0'	72°	73°	72°
3'	73°	72°	72°
6'	72°	72°	72°
9'	71°	71°	-
12'	71°	71°	-
15'	70°	70°	-
18'	70°	70°	-
21'	70°	69°	-
24'	70°	68°	-
27'	67°	-	-

Transect CA	3	2	1
0'	75°	76°	76°
3'	73°	76°	75°
6'	73°	73°	73°
9'	72°	72°	72°
12'	72°	72°	72°
15'	71°	71°	-
18'	-	71°	-
21'	-	69°	-

Transect D	3	2	1
0'	79°	79°	79°
3'	79°	79°	79°
6'	74°	76°	75°
9'	73°	73°	74°
12'	-	73°	73°
15'	-	73°	72°
18'	-	-	69°

Transect DA	3	2	1
0'	78°	78°	78°
3'	78°	78°	78°
6'	75°	78°	78°
9'	73°	73°	73°
12'	-	73°	73°
15'	-	69°	68°
18'	-	-	66°
21'	-	-	64°

Transect E	3	2	1
0'	84°	83°	82°
3'	84°	83°	82°
6'	84°	82°	82°
9'	86°	73°	72°
12'	-	72°	71°

Station F	
0'	76°
3'	76°
6'	67°
9'	66°

Station G	
0'	69°
3'	65°
6'	65°

Station H	
0'	68°
3'	68°
6'	68°

Station I	
0'	64°
3'	64°
6'	64°
9'	64°

Station K	
0'	66°
3'	66°
6'	66°

THERMAL PLUME MONITORING
H. B. ROBINSON STEAM ELECTRIC PLANT March 30, 1976

Sampling Station	Surface °C	Surface °F	3' °C	3' °F	6' °C	6' °F	9' °C	9' °F	12' °C	12' °F	15' °C	15' °F
5	26.0	79	26.3	79	24.0	75	22.5	73				
6	27.0	81	27.0	81	25.0	77	23.0	73	21.5	71	21.0	70
7	27.5	81	27.5	81	24.8	77	23.0	73	22.0	72	20.5	69
14	29.0	84	28.0	82	25.0	77						
15	29.0	84	29.0	84	27.5	81	23.5	74				
16	28.5	83	28.5	83	28.0	82	23.0	73	22.0	72		
17	28.5	83	28.5	83	28.0	82	23.0	73	21.8	71		
18	28.8	84	28.5	83	28.0	82	22.5	73	21.5	71		
24	29.0	84										
25	29.0	84	27.5	81	26.0	79						
26	28.5	83	28.5	83	26.0	79	23.0	73	21.5	71		
28	27.5	81	28.5	83								
32	26.5	80	26.5	80								
33	26.5	80	26.5	80	26.5	80	21.0	70	21.0	70		
34	27.0	81	27.0	81	27.0	81	22.0	72				
Lower Big Beaverdam Creek	24.8	77	24.8	77	24.8	77	23.0	73				
Middle Big Beaverdam Creek	21.0	70	18.0	64								
Upper Big Beaverdam Creek	20.0	68										

CP&L EXHIBIT 2.2

Continuous Recorder Data:

Daily Average, Maxima and Minima

June 12, 1975 to May 10, 1976

Continuous Recorder Data

On June 12, 1975, the five continuous temperature monitoring units were installed as recommended and specified by the Atkins Technical, Inc. Initial retrieval of data strip charts indicated various problems associated with the electronic operation of the units. Discussions with Atkins began in an attempt to correct these problems and in an attempt to assure the accuracy of the data. It was not until mid-July that CP&L was informed that information relating to the proper positioning and installation of the submerged units had been incorrectly indicated. Work was immediately begun to have custom canister cases manufactured which would securely house and properly position each unit. On August 26, 1975, all units had been re-installed in a proper manner.

Because of various problems arising from and resulting from incorrect information supplied by the manufacturer to CP&L, a check of the calibration of the units was performed during the period September 22-26, 1975. Electronic circuiting for each unit was inspected and calibration checked against a laboratory thermometer, traceable to the National Bureau of Standards. Corrections to the calibration of each unit were made whenever necessary.

As a followup to the calibration of the units, discussions continued with Atkins and the following changes should be noted:

1. By November 14, 1975, units at the Spillway, the West Tower, the discharge, and Station K had been removed from their submerged positions, re-calibrated and re-installed on "land" with leads running to the water. Only Station F remained submerged.

2. Original specifications on the units indicated an electronic accuracy of ± 0.6°C (± 1.1°F). However, the manufacturer did not take into consideration the accuracy of the recording mechanism. Considering both the electronics and recording mechanisms, actual accuracy of each unit is ± 1.2°C (2.3°F).

Realizing the problems associated with the initial operation of the units, their inproper installation and various other misunderstandings between Atkins and CP&L, it is difficult to assign a specific degree of accuracy to the data collected prior to September 22, 1975. However, after this date, all data are accurate to ± 1.2°C (2.3°F).

Present plans call for collection of data through September, 1976, at which time a supplemental report will be available for EPA review. Since the original purpose (as indicated by EPA) for the installtion of continuous recorders "at three or four key locations" was "to allow evaluation of the thermal regime between intensive measurement periods," it is believed that data which are presently available are relative to this question , especially in the light that the "intensive measuring periods" (water temperature profile monitoring) were increased from once per month to twice monthly during the period when accuracy of the continuous monitors was questionable.

All data which were considered transcribable are presented in tabular form as daily means, maxima and minima. Generally, previous to September 5, 1975, calculations of daily means and determination of daily maxima and minima were done manually. Subsequent to September 5, 1975, a computer program was used.

LOCATION=STATION X MONTH=6 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30			

LOCATION=STATION X MONTH=7 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30			
31	31			

LOCATION=STATION X MONTH=8 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30			
31	31			

LOCATION=STATION X YEAR=75 MONTH=9

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5	32.7143	32.2	32.8
6	6	31.8500	31.0	32.8
7	7	30.6750	29.2	31.6
8	8	30.8750	29.8	32.2
9	9	31.6250	31.0	32.2
10	10	30.9750	30.4	31.0
11	11	30.5250	29.8	31.0
12	12	29.9000	29.8	30.4
13	13	28.3250	27.4	29.8
14	14	27.2250	26.2	27.4
15	15	26.8250	26.2	27.4
[illegible]	16	26.6435	26.2	27.4
17	[illegible]			
18	[illegible]			
19	[illegible]			
20	[illegible]			
[illegible]	[illegible]			
[illegible]	22			
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	26			
[illegible]	27			
[illegible]	28			
[illegible]	29			
30	30			

LOCATION=STATION X YEAR=75 MONTH=10

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22	21.7500	20.8	22.6
23	23	22.0500	21.4	23.2
24	24	23.0000	22.4	23.8
25	25	23.4000	23.2	23.8
26	26	23.6500	23.2	23.8
27	27	23.6250	23.2	23.8
28	28	23.4087	21.4	23.8
29	29	23.0750	22.6	23.8
30	30	22.6000	22.6	22.6
31	31	21.3000	20.8	22.0

LOCATION=STATION X YEAR=75 MONTH=11

OBS	DAY	MEAN	LOW	HIGH
1	1	20.4087	19.6	21.4
2	2	20.0750	19.8	20.8
3	3	20.2000	19.6	20.8
4	4	20.2500	20.2	20.8
5	5	20.4087	20.2	20.8
6	6	20.6250	20.2	21.4
7	7	20.2000	20.2	20.2
8	8	20.0750	19.6	20.2
9	9	19.6750	19.0	20.2
10	10	19.9250	19.0	20.2
11	11	19.0750	19.0	19.6
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25			
26	26			
27	27			
28	28	12.1000	11.8	12.4
29	29	11.6696	11.2	11.8
30	30	11.8750	11.2	13.0

LOCATION=STATION X YEAR=75 MONTH=12

OBS	DAY	MEAN	LOW	HIGH
1	1	11.7217	11.2	11.8
2	2	10.4250	10.6	11.2
3	3	10.9652	10.6	11.8
4	4	10.9000	10.6	11.8
5	5	10.9652	10.6	11.8
6	6	11.1000	10.6	11.8
7	7	11.2522	10.6	11.8
8	8	10.6000	10.6	10.6
9	9	10.6000	10.6	10.6
10	10	10.3391	9.4	10.6
11	11	9.5826	8.8	10.6
12	12	9.6348	8.8	10.6
13	13	9.0500	8.8	9.4
14	14			
15	15			
16	16			
17	17			
18	18			
19	19	7.1000	6.4	7.6
20	20	7.3652	6.4	8.2
21	21			
22	22			
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30			
31	31			

LOCATION=STATION X YEAR=76 MONTH=1

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5	9.4609	9.4	9.4
6	6	9.4000	9.4	9.4
7	7	9.1000	8.8	9.4
8	8	9.4000	8.8	10.0
9	9	8.5652	8.2	9.4
10	10	8.4471	7.6	8.8
11	11	8.7217	8.2	9.4
12	12	8.7750	8.2	9.4
13	13	9.0870	8.2	10.0
14	14	9.3478	8.8	9.4
15	15	8.9043	8.2	9.4
16	16	9.2435	8.8	10.0
17	17	9.2000	8.8	9.4
18	18	7.9609	7.0	8.8
19	19	7.1000	6.4	7.6
20	20	7.3043	6.4	8.2
21	21	7.0522	7.0	7.6
22	22	6.8636	6.4	7.0
23	23	7.2000	6.4	8.2
24	24	7.6545	7.0	8.2
25	25	8.0636	7.6	8.8
26	26	8.5435	8.2	9.4
27	27	9.2636	8.8	9.4
28	28	9.0609	8.2	10.0
29	29	10.0000	9.4	11.2
30	30	10.0545	9.4	10.6
31	31	10.3652	9.4	11.2

H.B. ROBINSON CONTINUOUS RECORDERS: CENTIGRADE

LOCATION=STATION K YEAR=76 MONTH=2 -

OBS	DAY	MEAN	LOW	HIGH
1	1	10.7909	10.6	11.2
2	2	9.9100	9.4	10.6
3	3	10.2182	9.4	11.8
4	4	10.4909	9.4	11.8
5	5	10.7333	10.6	11.8
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			

LOCATION=STATION K YEAR=76 MONTH=3 -

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15	16.6000	16.6	16.6
16	16	16.5143	16.0	16.6
17	17	15.8091	14.2	16.6
18	18	16.2348	15.4	16.6
19	19	16.8087	15.4	17.8
20	20	16.9250	16.0	17.8
21	21	17.0500	16.6	17.8
22	22	16.4364	15.4	16.6
23	23	17.4286	16.6	17.8
24	24	18.1000	16.6	19.0
25	25	17.5000	16.6	18.4
26	26	17.9750	16.6	19.0
27	27	17.9000	17.2	19.0
28	28	18.3217	16.6	19.6
29	29	19.6429	19.0	20.2
30	30	19.0000	17.8	19.6
31	31	19.5478	19.0	20.2

LOCATION=STATION K YEAR=76 MONTH=4 -

OBS	DAY	MEAN	LOW	HIGH
1	1	18.8091	17.8	19.6
2	2	18.7913	17.8	20.2
3	3	19.1565	17.8	20.8
4	4	19.2087	18.4	20.2
5	5	18.8435	17.8	20.2
6	6	18.8957	17.8	20.2
7	7	19.6522	17.8	20.8
8	8	19.8727	19.0	20.2
9	9	19.5478	19.0	20.8
10	10	19.0783	17.8	20.2
11	11	19.3391	18.4	20.2
12	12	18.9100	18.4	19.6
13	13	18.8957	17.8	20.2
14	14	18.7545	17.8	19.6
15	15	19.4174	19.0	20.2
16	16	19.6783	19.0	21.4
17	17	20.3091	19.0	22.0
18	18	21.5304	20.2	23.2
19	19	22.0783	21.4	22.6
20	20	21.8696	20.8	23.2
21	21	21.7273	20.8	23.2
22	22	22.0000	21.4	23.2
23	23	22.2810	21.4	23.8
24	24	22.8087	22.0	23.8
25	25	21.6182	21.4	22.0
26	26	21.4783	20.8	22.0
27	27	21.1500	20.2	22.0
28	28	21.9182	21.4	22.6
29	29	21.7913	20.8	22.6
30	30	21.4000	21.4	21.4

LOCATION=STATION K YEAR=76 MONTH=5 -

OBS	DAY	MEAN	LOW	HIGH
1	1	21.4783	20.8	22.0
2	2	21.9727	21.4	23.2
3	3	21.8957	20.8	23.2
4	4	21.2696	20.8	22.0
5	5	21.4261	20.2	22.6
6	6	21.6727	20.8	22.6
7	7	21.9727	21.4	22.6
8	8	21.3478	20.8	22.0
9	9	21.6609	20.8	22.6

H.B. ROBINSON CONTINUOUS RECORDERS: CENTIGRADE

LOCATION=SPILLWAY MONTH=6 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30			

LOCATION=SPILLWAY MONTH=7 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30			
31	31			

LOCATION=SPILLWAY MONTH=8 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30			
31	31			

- LOCATION=SPILLWAY YEAR=75 MONTH=9 -

OBS	DAY	MEAN	LOW	HIGH
1	1	30.0000	26.0	34.0
2	2	29.0000	26.0	31.0
3	3	29.0000	28.0	31.0
4	4	30.0000	28.0	33.0
5	5	33.1273	32.8	34.0
6	6	32.0000	31.6	32.2
7	7	31.6000	31.0	32.2
8	8	32.8000	31.6	34.6
9	9	32.7000	31.6	33.4
10	10	31.4500	31.0	32.2
11	11	31.3000	31.0	32.2
12	12	31.0000	31.0	31.0
13	13	30.0750	29.8	31.0
14	14	28.8750	28.6	29.8
15	15	27.7750	27.4	28.6
16	16	27.4000	27.4	27.4
17	17	27.4000	27.4	27.4
18	18	27.2750	26.6	27.4
19	19	27.1500	26.8	27.4
20	20	26.5500	26.2	27.4
21	21	26.9500	26.2	27.4
22	22	27.6800	27.4	28.6
23	23			
24	24			
25	25			
26	26	28.4500	27.4	29.8
27	27	28.0500	27.4	28.6
28	28	27.2750	26.8	27.4
29	29	26.4500	26.2	26.8
30	30	25.8250	25.0	26.2

LOCATION=SPILLWAY YEAR=75 MONTH=10

OBS	DAY	MEAN	LOW	HIGH
1	1	26.250	25.6	26.8
2	2	27.000	26.8	27.4
3	3	25.400	25.0	26.8
4	4	24.350	23.8	25.0
5	5	23.525	23.2	23.8
6	6	24.275	23.2	26.2
7	7	25.350	24.4	26.2
8	8	24.750	24.4	25.6
9	9	25.325	23.8	26.8
10	10	27.125	26.2	28.6
11	11	26.625	26.2	27.4
12	12	26.650	26.2	28.0
13	13	26.925	26.2	27.4
14	14	26.950	26.8	27.4
15	15	26.325	25.6	26.8
16	16	26.025	25.6	26.2
17	17	25.575	25.0	26.2
18	18	25.125	25.0	25.6
19	19	24.550	24.4	25.0
20	20	23.800	23.8	23.8
21	21	23.325	23.2	24.4
22	22	23.650	23.2	24.4
23	23	24.175	23.2	25.0
24	24	24.525	24.4	25.0
25	25	24.775	23.8	26.8
26	26	25.425	25.0	25.6
27	27	24.900	24.4	25.0
28	28	24.350	23.8	25.0
29	29	24.625	23.8	25.6
30	30	24.200	23.2	25.0
31	31	22.750	22.0	23.2

LOCATION=SPILLWAY YEAR=75 MONTH=11

OBS	DAY	MEAN	LOW	HIGH
1	1	22.3250	21.4	23.2
2	2	22.2750	21.4	23.8
3	3	21.7250	21.4	23.8
4	4	21.5750	20.8	22.6
5	5	22.2750	21.4	23.8
6	6	21.7000	21.4	22.6
7	7	20.9500	20.8	21.4
8	8	21.1500	20.8	22.6
9	9	21.0500	20.8	21.4
10	10	20.6750	20.2	20.8
11	11	21.1250	20.2	21.4
12	12	21.0250	20.8	21.4
13	13	20.8000	20.8	20.8
14	14	18.6182	17.8	19.0
15	15	17.5500	17.2	18.4
16	16	16.8500	16.6	17.2
17	17	17.0000	16.6	17.8
18	18	16.7500	16.0	19.0
19	19	16.0250	15.4	16.6
20	20	15.6250	15.4	16.6
21	21	15.3000	14.8	16.0
22	22	14.4500	14.2	14.8
23	23	13.3500	13.0	14.2
24	24	12.8857	12.4	13.0
25	25	12.6435	12.4	13.0
26	26	12.2750	11.8	13.0
27	27	11.8000	11.8	11.8
28	28	12.2000	11.8	13.0
29	29	11.8000	11.8	11.8
30	30	11.8000	11.8	11.8

LOCATION=SPILLWAY YEAR=75 MONTH=12

OBS	DAY	MEAN	LOW	HIGH
1	1	11.6080	11.8	11.8
2	2	11.8000	11.2	12.4
3	3	11.9565	11.2	13.0
4	4	11.6500	11.2	12.4
5	5	11.4348	11.2	11.8
6	6	11.3250	10.6	11.8
7	7	11.4609	11.2	11.8
8	8	11.4348	10.6	11.8
9	9	10.6000	10.6	10.6
10	10	10.5739	10.0	10.6
11	11	10.2000	9.4	10.6
12	12	10.0522	9.4	10.6
13	13	10.3913	9.4	11.8
14	14	11.1739	10.0	13.0
15	15	11.2500	10.6	11.8
16	16	11.2261	10.6	11.8
17	17	11.6174	11.2	12.4
18	18	12.0750	11.8	12.4
19	19	11.5652	10.6	13.0
20	20	10.6783	9.4	11.8
21	21	9.6500	9.4	10.6
22	22	9.2091	8.2	9.4
23	23	9.5304	8.2	10.0
24	24	9.5565	9.4	10.0
25	25	9.4000	9.4	9.4
26	26	9.4000	9.4	9.4
27	27	9.4000	9.4	9.4
28	28	10.0000	9.4	10.6
29	29	10.7304	10.6	11.2
30	30	10.6000	10.6	10.6
31	31	10.6783	10.6	11.2

- LOCATION=SPILLWAY YEAR=76 MONTH=1

OBS	DAY	MEAN	LOW	HIGH
1	1	10.6261	10.6	11.2
2	2	11.6435	10.6	12.4
3	3	11.4870	10.6	11.8
4	4	10.8250	10.6	11.2
5	5	11.3000	10.6	11.8
6	6	10.9652	10.6	11.8
7	7	10.3913	10.0	10.6
8	8	10.2348	10.0	10.6
9	9	9.8435	9.4	10.6
10	10	9.5412	8.8	10.6
11	11	9.5826	9.4	10.0
12	12	9.4261	9.4	10.0
13	13	9.5043	9.4	10.0
14	14	9.8174	9.4	10.6
15	15	9.9217	9.4	10.6
16	16	10.2870	10.0	10.6
17	17	9.7391	9.4	10.6
18	18	9.2435	8.8	10.0
19	19	8.1420	7.6	9.4
20	20	7.5625	7.0	8.2
21	21	7.1091	7.0	7.6
22	22	7.0261	7.0	7.6
23	23	7.7909	7.0	8.2
24	24	7.9130	7.6	8.2
25	25	8.3091	8.2	9.4
26	26	8.5304	8.2	9.4
27	27	9.5636	9.4	10.6
28	28	10.9652	10.0	11.8
29	29	11.8000	11.8	11.8
30	30	11.6957	11.2	11.8
31	31	11.5000	11.2	11.8

H.B. ROBINSON CONTINUOUS RECORDERS: CENTIGRADE

- LOCATION=SPILLWAY YEAR=76 MONTH=2 -

OBS	DAY	MEAN	LOW	HIGH
1	1	11.4087	11.2	11.8
2	2	10.7200	10.6	11.2
3	3			
4	4			
5	5	12.2286	11.8	13.0
6	6	12.1143	11.8	13.0
7	7	12.6571	11.8	13.0
8	8	12.3455	11.8	13.0
9	9	12.0286	11.8	12.4
10	10	11.9714	11.8	12.4
11	11	12.1273	11.8	12.4
12	12	13.2857	12.4	14.2
13	13	13.0571	13.0	13.6
14	14	13.9273	13.0	14.8
15	15	14.2571	14.2	14.8
16	16	14.3714	13.6	15.4
17	17	14.7455	14.2	15.4
18	18	15.3727	14.8	15.4
19	19	16.5727	15.4	17.2
20	20	17.3364	16.0	19.0
21	21	17.4455	16.6	18.4
22	22	16.1273	16.6	17.2
23	23	16.6000	16.6	16.6
24	24	16.3273	16.0	16.6
25	25	15.8909	15.4	16.6
26	26	16.2455	16.0	16.6
27	27	17.5273	16.6	19.0
28	28	18.8909	18.4	19.6
29	29	18.0182	17.8	19.0

- LOCATION=SPILLWAY YEAR=76 MONTH=3 -

OBS	DAY	MEAN	LOW	HIGH
1	1	19.5455	17.8	21.4
2	2	19.1636	18.4	20.2
3	3	20.0364	19.0	21.4
4	4	20.2818	19.0	21.4
5	5	20.0364	19.6	20.8
6	6	20.7727	20.2	21.4
7	7	21.8091	21.4	23.2
8	8	21.4000	21.4	21.4
9	9	20.9091	20.2	21.4
10	10	19.6000	19.0	20.8
11	11	19.4364	19.0	20.2
12	12	19.0000	19.0	19.0
13	13	19.0000	19.0	19.0
14	14	18.0182	17.8	19.0
15	15	17.8000	17.8	17.8
16	16	17.6636	16.6	17.8
17	17	16.8087	16.6	17.8
18	18	16.5182	16.0	16.6
19	19	16.6000	16.6	16.6
20	20	16.6000	16.6	16.6
21	21	16.6818	16.6	17.2
22	22	16.8875	16.6	17.2
23	23	17.8000	16.6	19.0
24	24	17.7217	17.2	17.8
25	25	17.6636	17.2	17.8
26	26	18.4261	17.8	21.4
27	27	17.8000	17.8	17.8
28	28	19.8087	17.8	21.4
29	29	21.2667	20.8	21.4
30	30	20.4571	20.2	20.8
31	31	20.1000	19.0	20.2

- LOCATION=SPILLWAY YEAR=76 MONTH=4 -

OBS	DAY	MEAN	LOW	HIGH
1	1	20.1739	19.0	20.8
2	2	20.2000	19.6	20.8
3	3	20.0174	19.0	20.2
4	4	20.0250	19.6	20.2
5	5	20.0435	19.0	20.2
6	6	20.0500	19.0	22.6
7	7	20.8783	20.2	22.6
8	8	21.4000	20.8	22.0
9	9	21.0750	20.2	21.4
10	10	20.1250	19.6	20.8
11	11	20.2000	20.2	20.2
12	12	20.0696	19.0	20.8
13	13	20.3636	20.2	20.8
14	14	20.2750	19.6	20.8
15	15	20.4500	20.2	21.4
16	16	20.7250	20.2	21.4
17	17	22.3250	21.4	25.0
18	18	25.5500	23.8	28.0
19	19	25.0750	23.8	26.2
20	20	24.5250	23.8	25.0
21	21	24.1750	22.6	25.0
22	22	24.5250	23.8	25.6
23	23	26.5130	25.0	28.6
24	24	26.3500	25.0	28.0
25	25	24.8696	24.4	25.0
26	26	24.6250	24.4	25.0
27	27	24.5364	23.8	25.6
28	28	24.1391	23.8	25.0
29	29	23.8000	23.8	23.8
30	30	23.5913	23.2	23.8

- LOCATION=SPILLWAY YEAR=76 MONTH=5 -

OBS	DAY	MEAN	LOW	HIGH
1	1	22.8609	22.6	23.2
2	2	23.0435	22.6	23.8
3	3	23.1739	22.6	23.2
4	4	23.2261	22.6	24.4
5	5	23.0435	22.6	23.8
6	6	22.7043	22.6	23.2
7	7	23.1739	22.6	24.4
8	8	23.4087	23.2	23.8
9	9	23.9043	22.6	25.6

H.B. ROBINSON CONTINUOUS RECORDERS: CENTIGRADE

LOCATION=WEST TOWER MONTH=6 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12	29.0000	29.0	29.0
13	13	31.0000	29.0	31.0
14	14	32.0000	31.0	34.0
15	15	31.0000	31.0	32.0
16	16	31.0000	29.0	32.0
17	17	34.0000	32.0	36.0
18	18	33.0000	32.0	35.0
19	19	33.0000	31.0	34.0
20	20	34.0000	32.0	35.0
21	21	33.0000	32.0	34.0
22	22	32.0000	32.0	33.0
23	23	33.0000	32.0	35.0
24	24	33.0000	32.0	35.0
25	25	33.0000	32.0	36.0
26	26	35.0000	32.0	35.0
27	27	33.0000	32.0	34.0
28	28	33.0000	32.0	34.0
29	29	33.0000	32.0	34.0
30	30	33.0000	32.0	34.0

LOCATION=WEST TOWER MONTH=7 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1	33.0001	32.1	34.1
2	2	34.0000	32.0	36.0
3	3	33.0000	32.0	33.0
4	4	32.0000	31.0	32.0
5	5	33.0000	31.0	35.0
6	6	33.0000	32.0	34.0
7	7	32.0000	31.0	32.0
8	8	31.0000	31.0	32.0
9	9	31.0000	31.0	32.0
10	10	32.0000	31.0	32.0
11	11	31.0000	31.0	32.0
12	12	31.0000	31.0	32.0
13	13	31.0000	30.0	31.0
14	14	30.0000	29.0	31.0
15	15	30.0000	29.0	31.0
16	16	30.0000	29.0	32.0
17	17	30.0000	29.0	31.0
18	18	31.0000	30.0	31.0
19	19	30.0000	29.0	31.0
20	20	30.0000	29.0	31.0
21	21	31.0000	30.0	32.0
22	22	32.0000	31.0	33.0
23	23	33.0000	32.0	33.0
24	24	32.0000	32.0	33.0
25	25	32.0000	31.0	32.0
26	26	33.0000	32.0	33.0
27	27	33.0000	32.0	33.0
28	28	32.0000	31.0	32.0
29	29	33.0000	31.0	35.0
30	30	33.0000	32.0	35.0
31	31	33.0000	32.0	34.0

LOCATION=WEST TOWER MONTH=8 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1	33.0000	32.0	34.0
2	2	33.0000	32.0	34.0
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12	34.0000	31.0	35.0
13	13	34.0000	33.0	35
14	14	33.0000	32.0	34.0
15	15	33.0000	32.0	34.0
16	16	32.0000	32.0	32.0
17	17	32.0000	32.0	32.0
18	18	33.0000	32.0	34.0
19	19	33.0000	32.0	34.0
20	20	33.0000	32.0	34.0
21	21	34.0000	32.0	35.0
22	22	35.0000	33.0	35.0
23	23	34.0000	34.0	35.0
24	24			
25	25			
26	26	36.0000	35.0	38.0
27	27	35.0000	34.0	37.0
28	28	33.0000	33.0	34.0
29	29	34.0000	34.0	35.0
30	30	34.0000	33.0	35.0
31	31	34.0000	33.0	37.0

LOCATION=WEST TOWER MONTH=9 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1	34.0001	33.0	35.0
2	2	34.0000	32.0	35.0
3	3	34.0000	34.0	36.0
4	4	35.0000	34.0	35.0
5	5	35.2750	34.0	36.4
6	6	32.6105	31.0	34.0
7	7	32.4000	31.0	34.0
8	8	32.7333	31.0	34.4
9	9	33.7000	32.8	34.6
10	10	32.8857	32.2	33.4
11	11	32.2750	31.6	32.8
12	12	31.5250	31.0	32.2
13	13	30.7913	30.4	31.6
14	14	29.3250	28.6	30.4
15	15	28.4000	28.0	29.2
16	16	28.4174	28.0	29.2
17	17	28.5850	28.0	28.6
18	18	27.5750	27.4	28.0
19	19	27.3000	25.8	27.4
20	20	28.1000	27.4	29.2
21	21	28.6000	28.0	29.8
22	22	29.3385	29.2	29.8
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30	27.2400	26.2	28.6

LOCATION=WEST TOWER YEAR=75 MONTH=10

OBS	DAY	MEAN	LOW	HIGH
1	1	27.850	27.4	28.6
2	2	27.925	27.4	29.2
3	3	25.875	25.0	26.8
4	4	24.975	24.4	25.6
5	5	24.225	23.8	25.0
6	6	24.825	24.4	26.2
7	7	26.625	25.0	28.0
8	8	26.375	26.2	27.4
9	9	27.775	25.6	28.6
10	10	28.075	27.4	28.6
11	11	27.900	26.8	28.6
12	12	27.875	26.8	29.2
13	13	28.625	27.4	29.8
14	14	28.150	27.4	28.6
15	15	27.850	27.4	28.6
16	16	27.650	27.4	28.6
17	17	27.375	26.8	28.0
18	18	26.600	26.2	27.4
19	19	25.800	25.0	26.2
20	20	24.950	24.4	25.0
21	21	24.700	23.8	25.0
22	22	24.375	23.8	25.0
23	23	26.175	25.6	27.4
24	24	25.425	24.4	27.4
25	25	25.725	25.0	27.4
26	26	26.683	25.6	28.0
27	27	25.925	25.6	26.2
28	28	26.375	25.6	27.4
29	29	26.550	26.2	27.4
30	30	25.050	23.8	26.8
31	31	22.900	22.6	23.8

LOCATION=WEST TOWER YEAR=75 MONTH=11

OBS	DAY	MEAN	LOW	HIGH
1	1	22.875	22.0	23.8
2	2	21.850	21.4	22.6
3	3	21.600	21.4	22.6
4	4	21.850	21.4	22.6
5	5	22.100	21.4	23.8
6	6	22.200	21.4	22.6
7	7	21.425	21.4	22.0
8	8	21.750	21.4	22.6
9	9	22.075	21.4	22.6
10	10	21.875	21.4	22.6
11	11	21.775	21.4	22.6
12	12	21.825	21.4	22.6
13	13	21.400	21.4	21.4
14	14	18.400	17.8	19.0
15	15	17.425	16.6	17.8
16	16	16.850	16.0	17.8
17	17	16.725	15.4	17.8
18	18	16.275	15.4	17.2
19	19	16.025	15.4	17.2
20	20	16.075	15.4	16.6
21	21	15.875	15.4	16.0
22	22	14.675	14.2	15.8
23	23	13.550	13.0	14.2
24	24	12.600	11.8	13.0
25	25	12.175	11.8	13.0
26	26	11.825	11.8	12.4
27	27	11.800	11.8	11.8
28	28	12.250	11.8	13.0
29	29	11.850	11.8	12.4
30	30	12.175	11.8	13.0

LOCATION=WEST TOWER YEAR=75 MONTH=12

OBS	DAY	MEAN	LOW	HIGH
1	1	11.8000	11.8	11.8
2	2	11.4500	11.2	12.4
3	3	11.4250	10.6	13.0
4	4	11.2500	10.6	13.0
5	5	11.4750	10.6	13.0
6	6	12.0000	11.2	13.0
7	7	11.8250	11.2	12.4
8	8	10.8182	10.6	11.2
9	9	10.7000	10.6	11.2
10	10	10.5750	10.0	10.6
11	11	10.2750	9.4	10.6
12	12	9.9500	9.4	10.6
13	13	10.7500	9.4	13.0
14	14	11.6000	10.6	13.0
15	15	12.1000	11.8	13.0
16	16	12.0000	11.8	13.0
17	17	13.3750	12.4	14.2
18	18	12.2400	11.8	13.0
19	19			
20	20			
21	21			
22	22	9.4000	9.4	9.4
23	23	11.1250	10.0	11.8
24	24	10.8000	10.0	11.8
25	25	10.8250	10.0	11.8
26	26	10.2750	10.0	10.6
27	27	10.3500	9.4	11.8
28	28	12.1750	11.8	12.4
29	29	11.6500	11.2	11.8
30	30	11.4500	10.6	11.8
31	31	12.1750	11.8	13.6

LOCATION=WEST TOWER YEAR=76 MONTH=1

OBS	DAY	MEAN	LOW	HIGH
1	1	12.0750	11.2	14.2
2	2	13.6750	13.0	14.2
3	3	12.5500	12.4	13.0
4	4	11.8000	11.2	12.4
5	5	11.7727	11.2	12.4
6	6	11.4750	10.6	12.4
7	7	11.4500	11.2	11.8
8	8	10.7750	10.0	11.8
9	9	10.6250	9.4	11.8
10	10	10.8000	10.0	11.8
11	11	10.1000	10.0	10.6
12	12	10.7000	9.4	13.0
13	13	11.7250	11.2	13.0
14	14	10.9250	10.6	11.2
15	15	11.4000	10.6	12.4
16	16	10.4750	10.0	10.6
17	17	9.8000	9.4	10.0
18	18	9.0500	8.8	9.4
19	19	9.2500	7.6	10.6
20	20	7.0000	7.0	7.0
21	21	7.0250	7.0	7.6
22	22	8.4250	6.4	10.0
23	23	8.6750	8.2	9.4
24	24	8.3000	8.2	8.8
25	25	9.3750	8.2	10.6
26	26	10.6500	10.0	11.8
27	27	11.9000	11.2	12.4
28	28	12.6000	11.2	13.6
29	29	12.2500	11.4	13.0
30	30	12.2000	11.6	13.0
31	31	12.9250	11.8	14.2

H.B. ROBINSON CONTINUOUS RECORDERS: CENTIGRADE

LOCATION=WEST TOWER YEAR=76 MONTH=2

OBS	DAY	MEAN	LOW	HIGH
1	1	12.200	11.8	13.0
2	2	11.450	11.2	11.8
3	3	12.075	11.2	13.0
4	4	14.175	12.4	15.4
5	5	13.525	13.0	14.2
6	6	13.875	13.0	14.2
7	7	13.325	[illegible]	13.6
8	8	13.050	13.0	13.6
9	9	12.650	11.8	14.2
10	10	13.550	13.6	14.8
11	11	12.975	12.4	13.6
12	12	14.925	13.6	15.4
13	13	14.025	13.6	14.8
14	14	15.725	14.2	17.8
15	15	15.775	15.4	16.6
16	16	15.900	15.4	16.6
17	17	16.575	15.0	17.2
18	18	17.125	16.6	17.8
19	19	17.900	17.2	19.0
20	20	19.325	17.8	21.4
21	21	18.600	17.8	20.2
22	22	18.025	17.8	18.4
23	23	17.175	16.6	17.8
24	24	17.725	17.2	17.8
25	25	17.025	16.6	17.6
26	26	17.925	17.2	19.2
27	27	19.400	17.8	20.8
28	28	19.900	19.0	20.8
29	29	19.250	19.0	20.2

LOCATION=WEST TOWER YEAR=76 MONTH=3

OBS	DAY	MEAN	LOW	HIGH
1	1	20.9050	19.0	23.2
2	2	21.2000	20.2	22.0
3	3	22.0000	21.4	23.2
4	4	22.5000	21.4	23.8
5	5	22.4500	22.0	23.2
6	6	22.6500	22.6	23.2
7	7	23.1750	22.6	24.4
8	8	22.2750	21.4	23.2
9	9	21.3000	20.2	22.0
10	10	20.3000	19.6	21.4
11	11	20.3000	19.6	22.6
12	12	19.6000	19.0	20.2
13	13	19.3000	19.0	20.2
14	14	19.0500	17.8	20.2
15	15	18.7913	18.4	19.0
16	16	18.3750	17.8	19.0
17	17	17.5250	17.2	17.8
18	18	17.7000	17.2	17.8
19	19	17.3250	16.6	17.8
20	20	17.7000	17.2	17.8
21	21	17.8000	17.8	17.8
22	22	18.6000	17.8	19.0
23	23	19.0250	18.4	20.2
24	24	18.9000	18.4	20.2
25	25	18.0250	17.8	18.4
26	26	20.0750	18.4	23.8
27	27	18.8500	18.4	19.0
28	28	20.4250	18.4	22.6
29	29	21.9600	22.8	22.6
30	30			
31	31			

LOCATION=WEST TOWER YEAR=76 MONTH=4

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12	22.1636	21.4	22.6
13	13	20.9250	20.2	22.0
14	14	20.6750	20.2	21.4
15	15	22.0250	20.8	23.8
16	16	22.7000	21.4	23.8
17	17	24.3000	22.6	26.2
18	18	26.3500	25.0	28.6
19	19	25.8500	25.0	27.4
20	20	25.6750	25.0	26.2
21	21	25.6250	25.6	26.2
22	22	25.7000	25.0	26.2
23	23	27.3500	26.2	28.6
24	24	27.2000	26.2	28.6
25	25	25.8609	25.6	26.2
26	26	25.0000	24.4	25.6
27	27	24.4500	23.8	25.6
28	28	24.1500	23.8	25.0
29	29	24.6000	23.8	26.2
30	30	23.5500	22.6	23.8

LOCATION=WEST TOWER YEAR=76 MONTH=5

OBS	DAY	MEAN	LOW	HIGH
1	1	22.925	22.6	23.2
2	2	23.300	22.6	23.8
3	3	23.125	22.6	23.2
4	4	23.125	22.0	25.6
5	5	23.775	23.2	25.8
6	6	23.250	22.6	23.8
7	7	23.475	23.2	23.4
8	8	24.400	23.8	25.0
9	9	24.450	23.8	25.6
10	10	25.725	25.0	26.0

H.B. ROBINSON CONTINUOUS RECORDERS: CENTIGRADE

LOCATION=DISCHARGE MONTH=6 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12	40.0000	40.0	40.0
13	13	39.0000	38.0	41.0
14	14	40.0000	40.0	41.0
15	15	40.0000	37.0	41.0
16	16	40.0000	40.0	41.0
17	17	41.0000	40.0	41.0
18	18	41.0000	40.0	42.0
19	19	41.0000	41.0	42.0
20	20	42.0000	41.0	43.0
21	21	42.0000	41.0	43.0
22	22	42.0000	41.0	43.0
23	23	42.0000	41.0	42.0
24	24	42.0000	41.0	43.0
25	25	42.0000	41.0	43.0
26	26	42.0000	41.0	42.0
27	27	41.0000	40.0	42.0
28	28	42.0000	40.0	43.0
29	29	42.0000	41.0	43.0
30	30	43.0000	42.0	43.0

LOCATION=DISCHARGE MONTH=7 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25	40.3500	40.0	40.6
26	26	40.3700	40.0	41.0
27	27	41.1000	38.8	41.8
28	28	40.9250	40.0	41.8
29	29	40.8250	40.0	42.4
30	30	40.8250	40.0	41.8
31	31	41.0000	40.0	42.4

LOCATION=DISCHARGE MONTH=8 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1	41.2750	40.6	41.8
2	2	41.6250	40.6	42.4
3	3	41.4500	39.4	42.4
4	4	41.5000	40.6	42.4
5	5	41.8500	41.2	42.4
6	6	41.5250	41.2	42.4
7	7	41.0250	40.0	41.8
8	8	40.6250	40.0	41.8
9	9	41.5750	41.2	42.4
10	10	41.9565	40.0	42.4
11	11			
12	12			
13	13			
14	14	41.9043	41.2	42.4
15	15	41.6000	41.2	41.8
16	16	41.6000	41.2	41.8
17	17	42.5500	40.0	41.8
18	18			
19	19			
20	20			
21	21			
22	22			
23	23			
24	24			
25	25			
26	26	44.0000	43.0	44.0
27	27	42.0000	37.0	44.0
28	28	43.0000	42.0	44.5
29	29	43.0000	43.0	44.0
30	30	43.0000	43.0	44.0
31	31	43.0000	43.0	44.5

LOCATION=DISCHARGE YEAR=75 MONTH=9

OBS	DAY	MEAN	LOW	HIGH
1	1	43.5000	42.6	44.0
2	2	43.0000	42.0	43.0
3	3	43.0000	42.0	44.0
4	4	41.0000	35.0	43.0
5	5	42.4857	42.4	43.8
6	6	41.9250	40.6	42.4
7	7	41.4000	40.6	42.4
8	8	41.9500	40.6	43.0
9	9	41.7750	41.2	42.4
10	10	41.3250	40.6	41.8
11	11	41.3750	40.6	41.8
12	12	40.0000	40.6	41.2
13	13	39.6250	39.4	40.6
14	14	36.9250	35.8	39.4
15	15	37.8750	37.0	38.2
16	16	37.8750	37.0	38.2
17	17	37.4500	37.0	38.2
18	18	36.7750	36.4	37.6
19	19	36.8750	36.4	37.6
20	20	37.3500	37.0	38.2
21	21	31.9250	29.2	37.6
22	22	32.4000	28.5	37.6
23	23			
24	24			
25	25			
26	26	38.7250	37.6	39.4
27	27	37.8750	37.0	38.8
28	28	36.9500	34.6	38.2
29	29	36.8750	36.4	37.6
30	30	36.6000	35.8	37.6

LOCATION=DISCHARGE YEAR=75 MONTH=10

OBS	DAY	MEAN	LOW	HIGH
1	1	37.2750	35.8	38.2
2	2	37.3750	37.0	38.2
3	3	35.8500	35.2	37.0
4	4	34.8500	34.6	35.2
5	5	33.7750	31.6	34.6
6	6	35.0000	34.0	36.4
7	7	35.5000	34.0	36.4
8	8	35.4000	34.6	36.4
9	9	35.7250	34.6	37.0
10	10	36.1500	35.8	37.0
11	11	35.6091	35.2	36.4
12	12	35.4571	33.4	36.4
13	13	36.0000	35.2	37.0
14	14	36.0750	35.2	37.0
15	15	36.2000	35.2	37.0
16	16	36.4000	35.8	37.0
17	17	35.7750	35.2	36.4
18	18	35.1750	33.4	35.8
19	19	25.6750	23.8	31.6
20	20	33.6750	28.6	35.2
21	21	34.1500	33.4	35.2
22	22	33.8250	33.4	34.6
23	23	34.5250	33.4	36.4
24	24	35.2250	34.6	35.8
25	25	35.4250	34.6	35.8
26	26	35.9000	35.2	36.4
27	27	35.2000	34.6	36.4
28	28	35.5000	33.4	35.8
29	29	35.3750	34.6	35.8
30	30	34.1500	33.4	34.6
31	31	32.9750	32.2	33.4

LOCATION=DISCHARGE YEAR=75 MONTH=11

OBS	DAY	MEAN	LOW	HIGH
1	1	25.4636	23.8	31.0
2	2	25.4429	23.8	27.4
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11	23.8000	23.2	25.0
12	12	23.7000	23.2	24.4
13	13	22.4000	21.4	23.2
14	14	21.3000	20.2	22.0
15	15	20.5250	19.6	21.4
16	16	19.7500	19.0	21.4
17	17	19.5000	18.4	21.4
18	18	19.3500	18.4	21.4
19	19	19.0000	17.8	20.8
20	20	18.9000	17.6	20.2
21	21	18.2000	17.0	19.0
22	22	17.3750	16.6	17.8
23	23	16.0250	15.4	16.6
24	24	15.4522	14.8	16.0
25	25	15.6500	15.4	16.6
26	26	15.3060	14.8	16.0
27	27	14.7000	14.2	15.4
28	28	13.2000	11.8	14.8
29	29	12.600	12.4	13.0
30	30	12.6750	11.8	13.6

LOCATION=DISCHARGE YEAR=75 MONTH=12

OBS	DAY	MEAN	LOW	HIGH
1	1	13.4500	12.4	14.8
2	2	14.4750	13.6	17.0
3	3	14.6500	13.6	16.0
4	4	14.8000	14.2	16.6
5	5	14.2000	13.0	15.4
6	6	13.6750	13.0	14.8
7	7	14.1750	13.0	14.8
8	8	13.6000	12.4	14.2
9	9	13.7750	12.4	14.8
10	10	13.0250	11.8	14.2
11	11	15.3500	13.0	19.0
12	12	14.1250	13.6	14.8
13	13	16.5500	14.2	17.8
14	14	17.8000	16.6	19.8
15	15	19.1300	18.4	20.2
16	16	19.2250	18.4	20.2
17	17	20.8000	15.4	22.6
18	18	16.4000	14.2	20.8
19	19	21.1714	20.2	22.0
20	20	20.9200	20.2	21.4
21	21	16.1500	12.4	20.2
22	22	19.4000	18.4	20.2
23	23	19.7750	19.6	20.2
24	24	20.8000	20.2	21.4
25	25	20.7250	20.2	21.4
26	26	20.8261	20.2	21.4
27	27	20.5000	19.6	21.4
28	28	16.3130	11.8	20.8
29	29	19.4000	11.8	24.4
30	30	22.8870	21.4	23.8
31	31	21.4250	20.8	22.0

LOCATION=DISCHARGE YEAR=76 MONTH=1

OBS	DAY	MEAN	LOW	HIGH
1	1	21.4522	20.8	22.0
2	2	22.0000	20.8	23.2
3	3	21.9478	21.4	23.2
4	4	20.6250	17.8	22.0
5	5	20.9125	20.2	21.4
6	6	22.6857	20.8	23.8
7	7	23.6500	22.6	23.8
8	8	23.4000	22.0	23.8
9	9	20.5750	11.8	24.4
10	10	23.0500	22.0	23.8
11	11	23.3500	22.6	23.8
12	12	23.5750	23.2	24.4
13	13	23.9750	23.2	24.4
14	14	12.2000	10.6	23.8
15	15	10.3750	9.4	10.6
16	16	10.2250	10.0	10.6
17	17	11.2250	10.6	11.8
18	18	12.9250	10.6	20.8
19	19	21.8400	21.4	22.0
20	20	21.4250	21.4	22.0
21	21	21.9500	21.4	22.6
22	22	21.2250	20.2	21.4
23	23	21.7000	21.4	22.6
24	24	21.8250	21.4	22.6
25	25	22.8250	19.0	23.8
26	26	22.7750	21.4	23.8
27	27	23.4750	22.6	25.0
28	28	23.8000	22.6	25.6
29	29	24.7250	23.2	25.2
30	30	24.3500	22.6	26.8
31	31	26.1000	25.6	26.9

LOCATION=DISCHARGE YEAR=76 MONTH=2

OBS	DAY	MEAN	LOW	HIGH
1	1	24.9250	23.2	25.6
2	2	24.1000	23.2	25.0
3	3			
4	4			
5	5	25.3429	23.2	26.8
6	6	22.7143	22.6	23.2
7	7	23.2000	22.6	23.8
8	8	22.8500	22.0	23.8
9	9	23.0000	22.0	23.8
10	10	23.2250	22.6	23.8
11	11	23.4000	22.6	23.8
12	12	23.6250	22.6	24.4
13	13	24.2500	23.8	25.0
14	14	24.6500	23.8	25.6
15	15	25.4750	24.4	26.2
16	16	24.7545	23.8	25.0
17	17	25.5500	25.0	26.8
18	18	25.9000	25.0	26.8
19	19	26.9750	26.2	27.4
20	20	27.8500	26.8	29.2
21	21	28.1500	26.8	28.6
22	22	26.7500	22.6	28.0
23	23	27.4750	26.8	28.0
24	24	27.4750	26.8	28.0
25	25	27.4000	26.2	28.0
26	26	27.5250	27.4	28.0
27	27	28.1750	27.4	29.8
28	28	29.2000	28.0	30.4
29	29	28.6500	26.2	29.8

LOCATION=DISCHARGE YEAR=76 MONTH=3 -

OBS	DAY	MEAN	LOW	HIGH
1	1	29.-000	28.6	31.0
2	2	29.8750	28.6	30.4
3	3	30.0500	28.6	31.6
4	4	30.4500	29.2	31.6
5	5	29.4000	29.6	30.4
6	6	30.7250	29.8	31.6
7	7	31.6500	29.2	32.8
8	8	31.9750	31.0	32.2
9	9	30.8750	30.4	32.2
10	10	30.8250	29.8	31.6
11	11	30.7250	29.8	31.6
12	12	30.6500	30.4	31.0
13	13	29.9750	29.2	31.0
14	14	28.6750	26.8	29.8
15	15	29.1000	28.0	29.8
16	16	28.1000	26.8	29.2
17	17	28.1256	27.4	28.6
18	18	27.5000	26.2	28.6
19	19	27.7250	26.2	28.6
20	20	27.5500	26.2	28.6
21	21	27.5750	25.0	28.6
22	22	27.9000	27.4	28.6
23	23	25.7000	19.0	28.6
24	24	28.6000	27.4	29.8
25	25	28.0500	27.4	28.6
26	26	29.0250	27.4	30.4
27	27	28.2750	26.6	29.2
28	28	29.7050	28.6	31.0
29	29	30.9077	29.8	31.0
30	30	30.6571	29.8	31.0
31	31	28.9000	19.6	31.0

LOCATION=DISCHARGE YEAR=76 MONTH=4

OBS	DAY	MEAN	LOW	HIGH
1	1	28.2000	22.0	3[illegible].0
2	2	30.7750 *	29.8	31.0
3	3	30.6750	29.8	31.6
4	4	24.6750	20.2	31.0
5	5	26.0250	23.8	29.8
6	6	30.6000	29.8	31.0
7	7	31.0500	30.4	32.2
8	8	30.7500	30.4	31.0
9	9	30.7250	29.8	31.6
10	10	30.6500	29.8	31.0
11	11	30.6250	29.8	31.0
12	12	30.2957	28.6	31.0
13	13	30.9000	30.4	31.6
14	14	30.4500	29.8	31.0
15	15	30.6000	30.4	31.0
16	16	30.8000	30.4	31.6
17	17	30.8250	22.6	32.2
18	18	32.5750	25.6	34.0
19	19	33.0500	32.8	33.4
20	20	32.8250	32.2	33.4
21	21	32.9750	31.6	33.4
22	22	33.5250	32.2	34.6
23	23	35.1250	34.0	35.8
24	24	34.8500	32.2	35.8
25	25	33.9250	33.4	34.6
26	26	34.0500	22.0	35.2
27	27	34.4696	33.4	35.2
28	28	34.6250	33.4	35.8
29	29	34.5000	33.4	35.2
30	30	34.1000	33.4	34.6

LOCATION=DISCHARGE YEAR=76 MONTH=5

OBS	DAY	MEAN	LOW	HIGH
1	1	24.825	22.6	33.[illegible]
2	2	24.200	23.2	29.8
3	3	32.875	31.0	34.[illegible]
4	4	33.000	[illegible]	34.0
5	5	33.100	[illegible]	34.0
6	6	33.050	32.2	33.4
7	7	33.325	[illegible]	34.0
8	8	33.425	[illegible]	34.0
9	9	34.675	33.0	35.2

H.B. ROBINSON CONTINUOUS RECORDERS: CENTIGRADE

LOCATION=STATION F MONTH=6 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12	31.0000	29.0	32.0
13	13	31.0000	30.0	34.0
14	14	32.0000	29.0	36.0
15	15	33.0000	31.0	35.0
16	16	31.0000	27.0	34.0
17	17	33.0000	31.0	35.0
18	18	33.0000	30.0	35.0
19	19	29.0000	26.0	31.0
20	20	34.0000	31.0	36.0
21	21	32.0000	29.0	34.0
22	22	3?.0000	30.0	35.0
23	23	33.0000	31.0	35.0
24	24	34.0000	32.0	35.0
25	25	34.0000	32.0	37.0
26	26	35.0000	31.0	36.0
27	27	34.0000	32.0	35.0
28	28	32.0000	31.0	33.0
29	29	32.0000	31.0	35.0
30	30	33.0000	31.0	34.0

LOCATION=STATION F MONTH=7 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5			
6	6			
7	7			
8	8			
9	9			
10	10			
11	11			
12	12			
13	13			
14	14			
15	15			
16	16			
17	17			
18	18			
19	19	22.0857	21.4	23.2
20	20	22.?400	21.4	23.8
21	21	22.8400	21.?	23.8
22	22	23.5?14	22.6	23.8
23	23	25.1714	23.8	26.8
24	24	26.2545	23.8	28.6
25	25	27.8800	25.0	32.8
26	26	25.7200	24.?	28.6
27	27	26.1100	25.?	27.4
28	28	28.2842	24.4	32.2
29	29	30.7750	25.0	32.8
30	30	31.2000	25.6	33.4
31	31	?3.9250	32.2	35.8

LOCATION=STATION F MONTH=8 YEAR=75

OBS	DAY	MEAN	LOW	HIGH
1	1	34.5667	32.2	36.4
2	2	36.1176	34.6	37.6
3	3	36.5059	35.8	37.0
4	4	36.5125	35.8	37.0
5	5	36.2000	35.8	37.?
6	6	33.0348	27.4	36.?
7	7	30.3756	28.6	32.8
8	8	28.80	27.?	30.4
9	9	26.95?	26.2	29.8
10	10	26.30?	?5.0	29.2
11	11	26.00?	?0	28.6
12	12			
13	13			
14	14			
15	15			
16	16			
17	17	33.0000	29.0	35.0
18	18	32.0030	31.0	33.0
19	19	32.000?	30.0	34.0
20	20	31.0000	29.0	32.0
21	21	30.0000	29.0	3?.0
22	22	30.0000	29.0	31.0
23	23	32.0000	31.0	34.0
24	24	32.0000	31.0	33.0
25	25	32.0000	30.0	33.0
26	26	32.0000	30.0	35.0
27	27	35.0000	33.0	36.0
28	28	32.0000	29.0	35.0
29	29	30.0000	28.0	31.0
36	30	31.000?	28.0	33.0
31	31	33.0?	31.0	3?.0

LOCATION=STATION F YEAR=75 MONTH=9

OBS	DAY	MEAN	LOW	HIGH
1	1			
2	2			
3	3			
4	4			
5	5	36.9250	36.4	37.0
6	6	36.2250	35.2	3?.0
7	7	?4.0250	32.8	35.8
8	8	?4.0500	32.2	36.4
9	9	35.6750	34.6	37.0
10	10	34.5250	33.4	35.8
11	11	34.2500	33.4	35.8
12	12	33.9750	32.8	35.2
13	13	30.2020	28.0	33.4
14	14	2?.4750	2?.6	29.2
15	15	26.4750	24.4	28.?
16	16	29.0000	28.0	29.8
17	17	28.5217	27.4	29.8
18	18	28.4250	26.8	30.4
19	19	29.3000	28.6	31.0
20	20	30.5750	28.6	32.8
21	21	31.5250	30.4	33.4
22	22	29.9125	28.6	31.0
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30	23.2609	20.8	25.6

LOCATION=STATION F YEAR=75 MONTH=10

OBS	DAY	MEAN	LOW	HIGH
1	1	27.6056	26.2	28.6
2	2	27.6750	23.8	29.8
3	3	21.2500	19.6	25.0
4	4	22.7500	20.8	26.2
5	5	23.5000	21.4	25.0
6	6	25.9750	22.6	29.8
7	7	28.4000	27.4	29.8
8	8	28.1750	26.8	29.8
9	9	28.0000	26.2	29.2
10	10	27.2000	25.6	29.2
11	11	28.8250	27.4	30.4
12	12	28.3250	26.2	31.0
13	13	28.5182	26.2	29.8
14	14	29.7000	27.4	31.0
15	15	29.6500	28.6	31.0
16	16	29.8750	28.6	31.0
17	17	28.2750	26.8	30.4
18	18	27.4250	26.2	29.2
19	19	24.9250	2? ?	26.2
20	20	21.5000	?	22.6
21	21	23.1500	1?	27.4
22	22	25.9750	23.8	27.4
23	23	25.8750	24.4	28.0
24	24	25.2000	24.4	26.2
25	25	26.6500	23.8	27.2
26	26	27.0750	26.2	28.0
27	27	25.0250	23.8	27.4
28	28	26.8500	25.6	28.6
29	29	27.3000	26.2	28.6
30	30	23.4000	19.0	27.4
31	31	20.4000	17.2	23.2

LOCATION=STATION F YEAR=75 MONTH=11

OBS	DAY	MEAN	LOW	HIGH
1	1	20.5500	19.0	22.0
2	2	19.2750	17.8	20.8
3	3	18.5250	16.6	20.2
4	4	20.6750	20.2	22.0
5	5	21.6250	20.?	23.8
6	6	20.8000	19.6	21.4
7	7	20.4000	20.2	20.8
8	8	21.0000	19.0	23.2
9	9	21.1500	19.6	22.0
?	10	21.6727	20.8	22.6
?	11	20.3750	19.6	20.8
	12	19.6750	19.0	20.2
13	13	17.6250	16.0	19.6
14	14	13.9000	11.8	16.0
15	15	11.0000	10.6	11.8
16	16	9.8750	8.8	11.8
17	17	9.9500	8.2	13.0
18	18	10.5250	8.8	13.0
19	19	12.3000	10.0	15.4
20	20	13.2000	10.6	14.2
21	21	13.4250	11.8	14.2
22	22	10.5000	9.4	11.2
23	23	8.7000	8.2	9.4
24	24	9.2091	7.6	10.6
25	25	9.7500	9.4	10.6
26	26	9.2957	8.8	9.4
27	27	10.2250	9.4	12.4
28	28	10.3250	9.4	11.8
29	29	9.825?	9.4	11.2
30	30	10.0250	9.4	11.2

LOCATION=STATION F YEAR=75 MONTH=12

OBS	DAY	MEAN	LOW	HIGH
1	1	11.0435	10.6	11.8
2	2	10.2000	9.?	11.2
3	3	10.0250	9.4	11.2
4	4	9.4750	7.6	11.2
5	5	9.6500	8.8	11.2
6	6	10.7304	9.4	12.4
7	7	11.5900	10.6	13.0
8	8	9.8250	8.2	11.2
9	9	8.1217	7.6	8.2
10	10	7.1750	7.0	7.6
11	11	6.6087	5.8	7.0
12	12	6.7500	6.4	7.6
13	13	6.4783	5.2	8.2
14	14	7.2750	5.2	13.6
15	15	11.8261	9.4	13.6
16	16	13.3750	11.8	16.0
17	17	11.0696	9.4	11.8
18	18	8.6500	7.0	11.2
19	19	6.9739	5.8	9.4
20	20	6.0250	4.6	7.4
21	21	4.6261	3.4	7.6
22	22	3.2957	2.2	5.4
23	23	4.3750	2.8	8.2
24	24	5.7478	3.4	10.0
25	25	5.8750	3.4	9.4
26	26	8.1500	5.8	10.6
27	27	5.9304	4.6	8.8
28	28	6.5750	5.2	9.4
29	29	5.8000	4.6	8.2
30	30	7.4435	4.6	13.0
31	31	7.4750	4.6	11.2

LOCATION=STATION F YEAR=76 MONTH=1

OBS	DAY	MEAN	LOW	HIGH
1	1	7.6750	7.0	8.2
2	2	8.1217	7.6	10.6
3	3	10.6250	7.0	12.4
4	4	7.1250	5.8	12.4
5	5	5.7750	5.2	6.4
6	6	4.2750	3.4	5.8
7	7	3.7750	3.4	5.8
8	8	4.4750	3.4	10.6
9	9	3.3739	2.8	3.4
10	10	3.9500	2.8	5.2
11	11	4.8500	3.4	7.0
12	12	4.5217	3.4	7.0
13	13	7.3500	3.4	13.0
14	14	7.5250	5.8	10.0
15	15	5.8000	5.2	6.4
16	16	5.4870	5.2	5.8
17	17	5.? 100	5.2	5.2
18	18	3.?20	2.8	4.0
19	19	3.6087	2.2	5.2
20	20	4.9130	4.0	11.8
21	21	4.0174	4.0	12.4
22	22	4.8455	3.4	10.6
23	23	4.4957	2.8	8.2
24	24	8.1478	4.6	11.2
25	25	10.0783	5.2	14.8
26	26	15.5826	13.0	19.0
27	27	16.?364	15.4	17.8
28	28	12.4000	10.0	16.6
29	29	9.6087	8.2	11.8
30	30	8.8174	7.0	10.6
31	31	6.9217	5.8	8.2

LOCATION=STATION F YEAR=76 MONTH=2

OBS	DAY	MEAN	LOW	HIGH
1	1	8.1700	6.4	11.2
2	2	6.4000	5.8	7.6
3	3	7.5000	6.4	11.8
4	4	8.5652	6.4	11.8
5	5	12.7500	7.6	19.6
6	6	12.6250	8.2	18.4
7	7	8.4609	8.2	10.0
8	8	8.9000	7.6	11.8
9	9	7.5217	6.4	9.4
10	10	9.3750	5.8	13.0
11	11	11.4000	9.4	13.6
12	12	11.5652	8.2	16.6
13	13	14.7250	11.8	17.8
14	14	16.3391	14.2	18.4
15	15	15.7750	14.2	19.6
16	16	18.8500	16.6	20.8
17	17	17.9250	16.6	19.0
18	18	18.1250	16.6	19.0
19	19	18.5000	16.0	22.0
20	20	18.0750	15.4	21.4
21	21	18.7000	15.4	20.2
22	22	17.7750	14.8	20.2
23	23	13.4250	13.0	14.8
24	24	15.8000	12.4	19.6
25	25	18.9250	16.0	20.8
26	26	20.0500	17.8	22.6
27	27	19.8500	17.2	22.0
28	28	19.9000	17.8	22.0
29	29	21.3739	19.6	23.2

LOCATION=STATION F YEAR=76 MONTH=3

OBS	DAY	MEAN	LOW	HIGH
1	1	22.7250	20.8	25.0
2	2	24.1750	22.0	26.2
3	3	23.9500	22.6	25.6
4	4	25.6250	23.2	26.2
5	5	23.5750	22.6	24.4
6	6	23.1250	21.4	24.4
7	7	21.8000	19.6	25.0
8	8	20.7250	17.8	22.6
9	9	19.4250	14.8	22.0
10	10	14.7759	12.4	20.8
11	11	20.2766	17.8	25.0
12	12	22.1250	21.4	23.8
13	13	19.7000	15.4	21.4
14	14	15.3750	13.6	19.0
15	15	16.1304	13.0	20.8
16	16	15.7750	10.6	20.0
17	17	10.2500	9.4	10.6
18	18	11.9250	9.4	14.2
19	19	13.5250	10.0	17.8
20	20	15.7750	11.8	20.2
21	21	17.4000	16.0	19.0
22	22	15.0182	14.2	16.0
23	23			
24	24			
25	25			
26	26			
27	27			
28	28			
29	29			
30	30	23.2600	21.4	24.4
31	31	23.4000	22.0	25.0

LOCATION=STATION F YEAR=76 MONTH=4

OBS	DAY	MEAN	LOW	HIGH
1	1	21.1000	19.0	24.4
2	2	16.2500	17.8	19.0
3	3	20.3750	16.6	26.2
4	4	22.4000	20.2	23.8
5	5	19.3750	17.8	22.0
6	6	21.4500	19.0	25.0
7	7	23.3750	21.4	25.6
8	8	23.6000	22.0	25.0
9	9	19.3700	17.2	23.8
10	10	18.0250	15.4	21.4
11	11	20.3500	16.6	22.6
12	12	19.8609	16.6	22.6
13	13	22.5256	19.0	25.6
14	14	23.9750	22.6	25.0
15	15	24.7250	22.6	27.4
16	16	25.7500	24.4	27.4
17	17	25.8000	23.8	28.0
18	18	26.3500	25.0	28.6
19	19	27.0250	25.0	29.2
20	20	27.8500	26.2	29.2
21	21	27.4500	26.2	28.0
22	22	27.4750	26.2	28.6
23	23	27.1250	25.0	29.8
24	24	28.3000	27.4	29.8
25	25	26.0174	23.8	27.4
26	26	23.6000	22.0	24.4
27	27	23.2261	21.4	26.2
28	28	23.0750	20.8	25.0
29	29	24.2500	22.0	27.4
30	30	25.3750	23.8	26.8

LOCATION=STATION F YEAR=76 MONTH=5

OBS	DAY	MEAN	LOW	HIGH
1	1	23.975	22.6	26.2
2	2	22.900	22.0	24.4
3	3	21.800	20.8	23.2
4	4	20.350	18.4	23.8
5	5	24.150	20.8	26.8
6	6	25.900	23.8	27.4
7	7	26.425	25.0	28.0
8	8	24.125	22.0	27.4
9	9	23.625	20.8	28.0
10	10	25.625	23.2	28.6

H.B. ROBINSON CONTINUOUS RECORDERS: CENTIGRADE

CP&L EXHIBIT 2.3

Black Creek Water Temperature Data:

Above the Impoundment (US 1) and

Below the Impoundment (SC-23)

1959, 1960, 1972, 1973, 1974

STATISTICAL ANALYSIS SYSTEM

------------- YEAR=59 -------------

OBS	DAY	TEMP_US1	TEMPSC23
1	62	49	50
2	65	51	58
3	69	52	50
4	72	51	52
5	76	54	56
6	79	52	54
7	83	55	58
8	86	62	64
9	93	56	62
10	97	66	65
11	100	67	70
12	104	52	62
13	107	58	59
14	111	67	63
15	114	57	66
16	118	68	66
17	121	66	70
18	125	68	70
19	128	66	72
20	132	66	74
21	135	63	74
22	139	66	74
23	142	68	74
24	146	68	75
25	149	66	74
26	153	70	74
27	156	66	74
28	160	68	78
29	163	68	78
30	166	66	76
31	170	66	76
32	174	70	76
33	177	72	76
34	181	74	78
35	183	75	81
36	188	68	83
37	191	71	81
38	195	70	80
39	197	72	80
40	202	74	80
41	205	74	81
42	207	74	82
43	212	74	83
44	216	74	83
45	219	74	81
46	223	70	82
47	226	72	82
48	230	75	82
49	233	73	82
50	237	75	82
51	240	75	82
52	244	74	82
53	247	74	82

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

------------- YEAR=59 -------------

OBS	DAY	TEMP_US1	TEMPSC23
54	251	72	60
55	254	70	60
56	258	68	77
57	261	66	73
58	265	64	71
59	268	66	71
60	272	69	76
61	275	70	76
62	279	68	74
63	282	71	[illegible]
64	286	68	[illegible]
65	289	60	70
66	293	56	70
67	296	60	64
68	300	56	60
69	303	56	59
70	307	54	60
71	310	60	64
72	314	48	57
73	315	52	58
74	321	55	59
75	324	42	55
76	328	52	56
77	335	58	48
78	338	44	49
79	342	40	47
80	345	42	48
81	349	48	49
82	352	54	52
83	356	39	39
84	362	50	48
85	365	44	46

------------- YEAR=60 -------------

OBS	DAY	TEMP_US1	TEMPSC23
1	5	44	48
2	8	44	49
3	12	48	48
4	15	54	54
5	19	47	49
6	22	37	44
7	26	38	47
8	29	47	47
9	62	38	41
10	79	41	44
11	77	40	44
12	61	47	47
13	64	49	48
14	88	56	50
15	41	56	54
16	45	60	58

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

------------- YEAR=80 -------------

OBS	DAY	TEMP_US1	TEMPSC23
17	98	62	60
18	102	59	58
19	105	65	60
20	109	68	64
21	112	68	67
22	116	72	68

STATISTICAL ANALYSIS SYSTEM

------------ YEAR=72 ------------

OBS	DAY	TEMP_US1	TEMPSC23
1	6	50	50
2	12	54	60
3	17	34	51
4	28	47	50
5	34	45	54
6	40	40	55
7	48	38	58
8	55	45	55
9	63	55	60
10	68	52	58
11	74	60	65
12	83	53	63
13	88	55	63
14	97	62	64
15	103	64	66
16	109	64	76
17	117	60	71
18	122	61	68
19	130	66	73
20	138	64	77
21	145	66	73
22	151	70	70
23	165	64	62
24	174	68	77
25	179	74	62
26	187	72	82
27	194	74	63
28	200	76	67
29	208	75	66
30	215	78	65
31	220	78	66
32	225	76	66
33	235	74	68
34	244	61	71
35	251	62	79
36	258	58	70
37	264	60	76
38	270	70	74
39	277	60	72
40	286	60	73
41	298	53	63
42	305	54	66
43	310	60	73
44	321	42	52
45	328	48	60
46	332	42	50
47	341	49	56
48	349	51	62
49	354	43	58
50	363	45	52

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

------------- YEAR=73 -------------

OBS	DAY	TEMP_US1	TEMPSC23
1	4	49	57
2	12	35	46
3	18	41	49
4	26	43	54
5	32	42	52
6	40	47	55
7	46	45	52
8	53	45	50
9	61	48	55
10	68	59	61
11	75	69	67
12	87	56	61
13	94	65	63
14	102	57	61
15	110	65	65
16	115	67	68
17	123	69	69
18	130	69	72
19	136	63	71
20	143	68	74
21	150	71	74
22	159	67	64
23	165	73	61
24	172	80	65
25	179	74	61
26	186	76	66
27	193	75	68
28	201	74	67
29	214	78	66
30	219	75	67
31	227	78	68
32	233	74	68
33	240	75	65
34	248	77	66
35	255	73	66
36	263	69	63
37	269	72	64
38	275	73	63
39	283	75	63
40	289	71	62
41	296	60	73
42	304	55	67
43	311	53	70
44	317	50	65
45	324	55	67
46	333	58	65
47	339	55	62
48	346	40	56
49	352	38	53
50	365	51	66

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

------------- YEAR=74 -------------

_OBS	DAY	TEMP_US1	TEMPSC23
3	1	51	53
4	10	50	65
5	17	52	63
6	24	56	63
7	29	58	66
8	39	66	63
9	57	43	56
10	66	61	63
11	72	52	65
12	79	58	64
13	86	50	67
14	94	65	66
15	100	57	65
16	108	63	71
17	115	60	70
18	122	68	60
19	129	63	73
20	137	69	75
21	144	68	79
22	151	72	77
23	158	71	78
24	164	73	82
25	170	72	81
26	177	68	67
27	183	72	61
28	191	73	85
29	198	72	86
30	206	62	64
31	212	76	87
32	220	73	63
33	234	73	65
34	242	74	86
35	249	75	77
36	254	71	81
37	263	65	83
38	269	62	75
39	282	59	72
40	286	61	73
41	289	63	71
42	296	52	67
43	310	61	72
44	313	64	
45	325	54	64
46	331	46	58
47	339	43	55
48	346	50	55
49	352	40	55
50	359	49	57

CP&L EXHIBIT 2.4

CP&L Analytical Methods as of January 1, 1976

Results of Water Chemistry Analyses, and

Recommended Water Quality Goals for Various Water Quality Constituents

March 1973 to February 1976

ANALYTICAL METHODS USED BY THE ANALYTICAL LABORATORY

Parameter	Method of Analysis	Container	Preservation Technique	Holding Time	Routine Laboratory Reporting Limit
Alkalinity, (as $CaCO_3$)	ASTM Standards, pt. 23, 1972, D1067 Method A (Electrometric Titration)-Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 102 (potentiometric method for low alkalinity)	P,G	Cool, 4°C	24 Hrs.	0.5 mg/L
Aluminum (Al) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3 - HCl)	P,G	Cool, 4°C HNO to pH < 2	6 Mos.	0.1 mg/L
Aluminum, (Al) Dissolved	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 103B (Eriochrome Cyanine R Method) or filtration through 0.45 micron membrane filter followed by Atomic Absorption methods	P,G	Fil[illegible]ion [illegible] by [illegible] < 2	6 Mos.	0.1 mg/L
Ammonia, (as N)	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 132-132C (Distillation followed by phenate method or ammonia selection electrode)	P,G	[illegible]ool, 4°C	24 Hrs.	0.02 mg/L
Calcium, (Ca) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3-HCl)	P,G	Cool, 4°C HNO_3 to pH < 2	6 Mos.	0.05 mg/L
Chemical Oxygen Demand, (COD)	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 220	P,G	H_2SO_4 to pH < 2	7 Days	1.0 mg/L

Parameter	Method of Analysis	Container	Preservation Technique	Holding Time	Routine Laboratory Reporting Limit
Chloride, (Cl^-)	ASTM Standards, pt. 23, 1972, D512, Reference Method A (mercuric Nitrate Titration)	P,G	Cool, 4°C	7 Days	0.25 mg/L
Chromium, (Cr^{+6}) Hexavalent	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 117A (s-diphenyl-carbazide method)	P,G	Cool, 4°C	72 Hrs.	0.05 mg/L
Copper, (Cu) Total	Method for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 83-85 (Atomic absorption methods-direct or chelation - extraction)	P,G	Cool, 4°C HNO_3, pH < 2	6 Mos.	0.05 mg/L
Copper, (Cu) Dissolved	Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 83-85 (Filtration through 0.45 micron filter followed by atomic absorption methods - direct or chelation-extraction)	P,G	Filtration followed by HNO_3 to pH < 2	6 Mos.	0.05 mg/L
Hardness, (as $CaCO_3$)	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA 122B (EDTA Titrimetric Method)	P,G	Cool, 4°C	7 Days	2.0 mg/L
Iron, (Fe) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3-HCl)	P,G	Cool, 4°C HNO_3 to pH < 2	6 Mos.	0.05 mg/L

arameter	Method of Analysis	Container	Preservation Technique	Holding Time	Routine Laboratory Reporting Limit
ead, (Pb) Total	Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 105-106 (Atomic absorption methods - direct or chelation - extraction)	P,G	Cool, 4°C HNO_3 to pH < 2	6 Mos.	0.05 mg/L
agnesium, (Mg) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3-HCl)	P,G	Cool, 4°C HNO_3 to pH < 2	6 Mos.	0.05 mg/L
anganese, (Mn) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3-HCl)	P,G	Cool, 4°C HNO_3 to pH < 2	6 Mos.	0.05 mg/L
ercury, (Hg) Total	Methods for Chemical Analysis of Water and Waste, 1971, EPA, pp. 121-130 (Coldvapor technique)	P,G	Cool, 4°C HNO_3 to pH < 2	1 Mo.	0.001 mg/L
ickel, (Ni) Total	Method for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 115-116 (Atomic absorption methods - direct or chelation - extraction)	P,G	Cool, 4°C HNO_3 to pH < 2	6 Mos.	0.05 mg/L

arameter	Method of Analysis	Container	Preservation Technique	Holding Time	Routine Laboratory Reporting Limit
ickel, (Ni) Dissolved	Method for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, BK.5, Ch. A-1, Techniques of Water-Resources Investigations of the United States Geological Survey, pp. 115-116 (Filtration through 0.45 micron filter followed by atomic absorption methods-direct or chelation - extraction)	P,G	Filtration followed by HNO_3 to pH < 2	6 Mos.	0.05 mg/L
itrate (as N)	Methods for Chemical Analysis of Water and Wastes, 1971, EPA, pp. 170-174 (Brucine-Sulfate Method)	P,G	Cool to $4^{o}C$ H_2SO_4 to pH < 2	24 Hrs.	0.05 mg/L
itrogen, (N)	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA Art 135, 132C- Digestion and distillation followed by phenate method or ammonia select-ion electrode (Ammonia Nitrogen plus Organic Nitrogen = Total or Kjeldahl Nitrogen)	P,G	Cool to $4^{o}C$ H_2SO_4 to pH < 2	24 Hrs.	0.02 mg/L
rthophosphate, (as P) Total Dissolved	Standard Methods for the Examination of Water and Wastewater 13th ed., 1971, APHA, Art 223 (Filtration followed by Ascorbic Acid Method)	P,G	Filtration Cool to $4^{o}C$	24 Hrs.	0.01 mg/L

Parameter	Method of Analysis	Container	Preservation Technique	Holding Time	Routine Laboratory Reporting Limit
Orthophosphate, (as P) Total	Standard Methods for the Examination of Water and Wastewater, 13th Ed., 1971, APHA, Art 223 (Ascorbic Acid Method)	P,G	Cool to 4°C	24 Hrs.	0.01 mg/L
pH	Methods for Chemical Analysis of Water and Wastes, 1971, EPA pp. 230-231 (Electrometric)	P,G	Cool to 4°C	6 Hrs.	0.1 pH
Phosphate, (as P)	Standard Methods for the Examination of Water and Wastewater, 13th Ed., 1971, APHA, Art 223 (Filtration and Persulfate Digestion followed by Ascorbic Acid Method)	P,G	Filtration Cool to 4°C	24 Hrs.	0.01 mg/L
Phosphate, (as P) Total	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 223 (Persulfate Digestion followed by Ascorbic Acid Method)	P,G	Cool to 4°C	24 Hrs.	0.01 mg/L
Silica, (as SiO_2) Dissolved	Standard Methods for the Examination of Water and Wastewater, 13th Ed., 1971, APHA, Art 151B-151C (Heteropoly Blue Method)	P only	Cool to 4°C	7 Days	1.0 mg/L
Sodium, (Na) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3-HCl)	P,G	Cool to 4°C HNO_3 to pH < 2	6 Mos.	0.05 mg/L
Solids, Total Dissolved (Filterable)	Methods for Chemical Analysis of Water and Wastes, 1971, EPA, pp. 275-277 (Glass Fiber Filtration Method, 180°C) - Data reported below 10 mg/liter for all solids is not really significant, but indicates order of magnitude	P,G	Cool to 4°C	7 Days	1.0 mg/L

arameter	Method of Analysis	Container	Preservation Technique	Holding Time	Routine Laboratory Reporting Limit
olids, Total Suspended (non-filterable)	Methods for Chemical Analysis of Water and Wastes, 1971, EPA, pp. 278-279 (Glass Fiber Filtration Method, 103-105°C)	P,G	Cool to 4°C	7 Days	1.0 mg/L
Solids, Total Volatile	Methods for Chemical Analysis of Water and Wastes, 1971, EP , pp. 282-283 (Gravimetric Method, 550°C)	P,G	Cool to 4°C	7 Days	1.0 mg/L
olids, Total	Methods for Chemical Analysis of Water and Wastes, 1971, EPA, pp. 280-281 (Gravimetric Method, 103-105°C)	P,G	Cool to 4°C	7 Days	1.0 mg/L
ulfate	ASTM Standards, pt. 23, 1972, D516, Reference Method A (Turbidimetric Method)	P,G	Cool to 4°C	7 Days	1.0 mg/L
annin & Lignin	Standard Methods for the Examination of Water and Wastewater 13th Ed., 1971, APHA, Art 160	P,G	Cool to 4°C	7 Days	0.1 mg/L
urbidity	Methods for Chemical Analysis of Water and Wastes, USEPA, pg. 295 (Nephelometric measurement)	P,G	Cool to 4°C	7 Days	0.1 NTU
inc, (Zn) Dissolved	Atomic Absorption Spectrophotometer (Filtration through 0.45 micron filter)	P,G	Filtration followed by HNO_3 pH < 2	6 Mos.	0.05 mg/L
inc, (Zn) Total	Atomic Absorption Spectrophotometer (Digestion with HNO_3-HCl)	P,G	Cool, 4°C HNO_3 pH < 2	6 Mos.	0.05 mg/L

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

FIELD PH

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06										
07										
08										
09	5.9	5.5	5.8	5.5	5.2	4.8	5.8	5.6		
10	6.1	6.1	6.3	5.8	5.5	5.4	5.7	5.4		
11	6.0	5.7	6.0	5.7	5.7	5.8	6.0			
12	5.8	5.8	5.8	5.8	5.2	5.1	5.8	5.0		
74										
01	4.6	4.4	4.5	4.5	4.4	4.6	4.4	4.4		
02										
03	5.0	5.4	5.0	5.0	5.0	5.0		5.0		
04			5.6	5.4	5.5	5.3	5.3			
05	5.7	5.6	4.7	4.7	5.5	5.7	6.2	6.6		
06										
07	5.1	5.6	5.1	5.4	5.6	5.1	5.5	5.2		
08										
09	4.5	4.2	4.1	4.6	4.9	5.1	6.7	4.4	5.4	5.4
10	5.4	5.2	5.8	5.3	5.5	5.4	4.8	4.8	5.5	5.0
11	4.6	4.9	5.4	5.5	5.5	5.4	5.5	5.4	5.5	5.3
12	4.5	4.5	4.6	4.7	4.1	3.9	4.2	4.2		4.0
75										
01	5.7	5.4	5.5	5.3	4.9	5.0	5.4			5.5
02	5.1	5.1	5.1	5.1	4.6	4.8	5.0	4.7		4.9
03	5.1	5.1	5.1	5.0	5.0	4.9	5.0	4.7		5.0
04	4.8	4.9	4.8	4.9	4.8	4.8	4.8	4.4		4.8
05										
06	5.7	5.6	5.6	5.6	5.5	5.4	4.9	4.4		5.9
07	6.1	5.9	5.9	6.1	6.0	5.5	5.8	6.6		5.8
08	5.7	5.6	5 4	5.4	5.4	5.4	5.4	5.2		5.3
09	5.5	5.4	.4	5.5	5.5	5.5	5.4	5.2		4.9
10	6.0	5.2	5.5	5.2	6.3	5.4	5.2	5.0		5.2
11	5.5	5.1	5.5	5.4	5.1	5.3	5.0	5.2		5.4
12	5.4	4.9	4.8	5.0	4.8	4.9	4.8	4.9		4.8
76										
01	5.3	5.4	5.3	5.2	4.6	4.6	5.0	4.8		5.0
02	5.4	5.0	5.2	5.2	5.1	5.2	4.9	5.1		4.9

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

KJELDAHL NITROGEN-AS N (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22		
05	0.28	0.62	0.17	0.28	0.56	0.17	0.34	0.34		
06	0.20	0.90	0.90	0.20	0.54	0.31	0.43	0.31		
07	0.56	0.56	0.45	0.45	0.34	0.22	0.45	0.34		
08	1.34	0.18	0.56	0.15	1.60	0.65	4.33	1.02		
09	0.30	0.42	0.40	0.50	0.40	0.27	0.30	0.44		
10	0.46	0.29	0.46	0.48	0.23	0.37	0.19	0.17		
11	0.24	0.29	0.14	0.19	0.40	0.21	0.38	0.25		
12	0.50	0.45	0.48	0.49	0.31	0.36	0.50	0.31		
74										
01	0.39	0.49	0.41	0.36	0.34	0.71	0.17	0.38		
02	0.35	0.33	0.34	0.17	0.36	0.46	0.41	0.10		
03	0.38	0.41	0.40	0.30	0.27	0.29	0.31	0.30		
04	0.24	0.04	0.22	0.22	0.22	0.40	0.04	0.30		
05	0.07	0.13	0.13	0.07	0.07	0.02	0.09	0.36		
06	0.40	0.25	0.13	0.25	0.17	0.17	0.23	0.34		
07										
08	0.11	0.67	3.13	0.1[illegible]	0.56	4.70	0.34	0.34		
09	0.49	0.22	0.20	0.46	0.18	-0.1	-0.1	-0.1	0.16	0.12
10		0.39		0.38	0.36	0.64	0.41	0.26	0.20	0.30
11	0.09	0.15	0.10	0.13	0.08	0.11	0.10	0.06	0.06	0.09
12	0.15	0.14	0.14	0.16	0.13	0.15	0.13	0.11		0.14
75										
01	0.14	0.12	0.11	0.12	0.15	0.15	0.11	0.93		0.13
02	0.09	0.08	0.08	0.09	0.11	0.22	0.11	0.10		0.11
03	0.24	0.22	0.24	0.24	0.72	1.10	0.15	0.12		0.18
04	0.07	0.05	0.05	0.05	0.10	0.06	0.04	0.05		0.05
05	0.34	0.35	0.62	0.21	0.31	0.17	0.19	0.26		0.39
06	0.19	0.22	0.20	0.21	0.22	0.26	0.27	0.35		1.78
07	0.45	0.88	0.63	0.60	0.68	0.27	0.29	0.53		0.27
08	0.80	0.56	0.27	0.29	0.35	0.29	0.29	0.37		0.27
09	0.32	0.42	0.30	0.33	0.32	0.29	0.18	0.15		0.20
10	0.35	0.40	0.42	0.24	0.24	0.22	0.24	0.23		0.25
11	0.09	0.10	0.10	0.09	0.09	0.10	0.10	0.10		0.10
12	0.24	0.31	0.25	0.25	0.22	0.17	0.27	0.19		0.29
76										
01	0.49	0.40	0.26	0.28	0.29	0.72	0.57	0.26		0.47
02	0.25	0.18	0.16	0.27	0.15	0.14	0.15	0.11		0.11

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

NITRATE-AS N (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	0.06	0.08	0.05	0.05	0.03	0.03	0.03	0.05		
05	0.05		0.06	0.02	0.02	0.03	0.02	0.05		
06	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01		
07	0.07	0.07	0.08	0.07	0.06	0.09	0.06	0.05		
08	0.19	0.14	0.14	0.18	0.14	0.14	0.11	0.50		
09	0.15	0.12	0.13	0.16	0.12	0.09	0.16	0.22		
10	0.06	0.06	0.05	0.04	0.04	0.04	0.04	0.07		
11	0.12	0.05	0.05	0.11	0.19	0.05	0.07	0.10		
12	0.10	0.08	0.15	0.12	-0.01	-0.01	0.10	-0.01		
74										
01	0.21	0.18	0.15	0.13	0.10	0.10	0.13	0.11		
02	0.38	0.28	0.23	0.36	0.24	0.43	0.43	0.26		
03	0.38	0.40	0.40	0.36	0.54	0.43	0.33	0.57		
04	0.95	0.34	0.75	0.66	0.80	0.62	0.59	0.41		
05	0.40	0.52	0.56	0.41	0.49	0.41	0.40	0.44		
06										
07										
08	0.15	0.10	0.07	0.07	0.11	0.10	0.09	0.15		
09	0.05	0.04	0.07	0.13	0.03	0.10	0.15	0.14	2.78	1.20
10	0.29	0.35	0.46	0.41	0.41	0.35	0.38	0.23	0.39	0.39
11	0.41	0.31	0.42	0.35	0.37	0.32	0.40	0.50	0.40	0.37
12	0.10	0.13	0.20	0.22	0.44	0.24	0.26	0.15		0.26
75										
01	0.30	0.21	0.21	0.18	0.21	0.19	0.27	0.32		0.29
02	0.20	0.29	0.49	0.23	0.14	0.14	0.19	0.35		0.16
03	0.24	0.33	0.33	0.28	0.19	0.12	0.28	0.15		0.32
04	0.18	0.26	0.23	0.31	0.17	0.26	0.29	0.20		0.33
05	0.21	0.18	0.25	0.22	0.18	0.33	0.29	0.19		0.26
06	0.17	0.19	0.22	0.13	0.15	0.09	0.18	0.07		0.26
07	0.12	0.12	0.11	0.09	0.13	0.06	0.09	0.11		0.11
08	0.36	0.34	0.27	0.29	0.14	0.14	0.19	0.20		0.50
09	0.07	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	0.05		0.06
10	0.44	0.62	0.54	0.71	0.56	0.51	0.70	0.10		0.40
11	0.13	0.10	0.09	0.04	0.01	0.01	0.06	0.09		[illegible]
12	0.32	0.32	0.42	0.37	0.37	0.40	0.47	0.45		[illegible]
76										
01	0.52	0.49	0.52	0.52	0.36	0.49	0.58	0.58		0.58
02	0.34	0.26	0.29	0.29	0.26	0.20	0.32	0.29		0.14

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

AMMONIA-AS N (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
07	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
08	0.18	0.16	0.24	0.15	0.08	0.11	0.88	0.64		
09	-0.05	-0.05	-0.05	0.09	0.05	0.10	0.10	0.06		
10	0.04	0.03	0.02	0.06	0.02	0.01	0.02	0.01		
11	-0.01	0.03	0.04	0.03	0.03	-0.01	0.02	0.02		
12	0.06	0.08	0.07	0.07	0.03	0.04	0.08	0.03		
74										
01	0.02	0.07	0.03	0.05	0.03	0.05	-0.01	0.04		
02	0.03	0.02	0.04	0.06	0.05	0.02	0.06	0.04		
03	0.03	0.06	0.09	-0.01	-0.01	0.04	0.02	0.05		
04	0.02	0.02	0.02	0.03	0.02	0.02	0.04	0.03		
05	0.07	0.13	0.13	0.07	0.07	0.02	0.09	0.06		
06	0.08	0.05	0.09	0.05	0.03	0.02	0.04	0.02		
07										
08	-0.1	0.11	0.78	-01	-0.1	2.24	-0.1	-0.1		
09	0.15	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
10		-0.1		-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
11	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
12	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02		-0.02
75										
01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02		-0.02
02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02		-0.02
03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02		-0.02
04	-0.02	-0.02	0.02	-0.02	0.02	-0.02	-0.02	-0.02		-0.02
05	-0.02	0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02		-0.02
06	0.02	0.02	0.02	-0.02	0.03	0.04	0.07	-0.02		0.70
07	-0.02	0.09	0.03	-0.02	-0.02	-0.02	-0.02	0.06		-0.02
08	-0.02	0.11	-0.02	-0.02	0.03	-0.02	0.03	-0.02		-0.02
09	-0.02	0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02		-0.02
10	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02		-0.02
11	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02		-0.02
12	-0.02	0.03	0.03	0.03	-0.02	-0.02	0.03	-0.02		0.03
76										
01	-0.02	0.03	-0.02	0.02	-0.02	-0.02	0.02	-0.02		-0.02
02	-0.02	0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02		-0.02

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL PHOSPHATE-AS P (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	0.19	0.22	0.90	0.23	0.30	0.20	0.31	0.25		
05	0.95	0.81	0.90	1.71	1.20	1.26	1.10	1.21		
06	0.04	0.04	0.08	0.07	0.04	0.03	0.03	0.10		
07	-0.01	-0.01	-0.01	0.01	-0.01	-0.01	-0.01	-0.01		
08	0.01	0.02	0.03	0.04	0.04	0.01	0.01	0.04		
09	0.01	0.02	0.02	0.02	0.02	0.03	0.02	0.02		
10	0.02	0.01	0.03	0.02	0.01	0.02	0.02	0.01		
11	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.01		
12	0.01	0.02	0.01	0.02	-0.01	-0.01	0.02	0.01		
74										
01	0.01	0.02	0.02	0.01	0.01	0.06	0.01	0.01		
02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
03	0.03	0.01	0.03	0.02	0.04	0.02	0.02	0.02		
04	0.02	0.01	0.01	0.02	0.02	0.05	0.01	0.03		
05	0.01	0.01	0.01	0.01	0.02	0.04	0.03	0.03		
06	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02		
07										
08	-0.01	-0.01	-0.01	-0.01	0.03	-0.01	-0.01	-0.01		
09	0.01	0.01	0.02	0.59	0.04	0.54	0.06	0.54	0.02	0.23
10	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01
11	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.02
12	0.01	0.01	0.01	0.01	-0.01	0.01	0.01	0.01		0.01
75										
01	0.04	0.03	0.02	0.02	0.03	0.02	0.01	0.02		0.01
02	0.01	0.01	0.01	0.01	0.13	0.01	0.02	0.18		0.01
03	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01	0.01		-0.01
04	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.03		0.03
05	0.03	0.02	0.04	0.02	0.03	0.03	0.03	0.03		0.03
06	0.04	0.08	0.03	0.04	0.04	0.03	0.04	0.04		0.08
07	0.03	0.02	0.04	[illegible]	0.03	0.03	0.03	0.03		0.03
08	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.04		0.02
09	0.04	0.03	[illegible]	0.07	0.07	0.06	0.04	0.05		0.05
10	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.01		0.02
11	0.03	0.02	[illegible]	0.02	0.02	0.02	0.04	0.02		0.03
12	0.04	0.06	[illegible]	0.04	0.03	0.03	0.04	0.03		0.04
76										
01	0.04	0.02	0.02	0.02	-0.01	0.02	0.04	-0.01		0.02
02	-0.01	0.01	-0.01	-0.01	0.01	0.01	-0.01	-0.01		-0.01

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL DISSLOVED PHOSPHATE-AS P (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06										
07										
08	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03		
09	0.09	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
10	0.01	0.01	0.01	0.01	-0.01	-0.01	0.01	0.01		
11	0.01	0.01	-0.01	0.01	-0.01	-0.01	-0.01	-0.01		
12	-0.01	-0.01	0.01	0.01	-0.01	-0.01	-0.01	-0.01		
74										
01	0.01	0.01	-0.01	0.01	-0.01	0.01	0.01	-0.01		
02	0.01	-0.01	-0.01	-0.01	0.01	0.01	-0.01	0.01		
03	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.02		
04	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.03		
05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
06	0.01	0.01	0.01	0.01	-0.01	0.01	0.01	0.01		
07										
08										
09										
10	0.01	0.01	0.01	0.01	-0.01	-0.01	-0.01	0.01	0.01	0.01
11										
12										
75										
01										
02										
03										
04	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.03		0.03
05	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01		0.02
06	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03		0.04
07	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02
08	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02		0.02
09	0.05	0.04	0.03	0.05	0.06	0.04	0.05	0.04		0.03
10	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01		0.01
11	-0.01	-0.01	-0.01	0.01	-0.01	-0.01	0.01	0.01		0.01
12	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02
76										
01										
02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL ORTHOPHOSPHATE-AS P (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	0.19	0.15	0.90	0.23	0.30	0.18	0.31	0.24		
05	0.52	0.52	0.67	0.45	0.51	0.56	0.55	0.49		
06	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01		
07	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
08	-0.01	0.01	0.01	-0.01	-0.01	0.01	-0.01	0.01		
09	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.01		
10	0.01	0.01	0.01	0.02	0.01	0.01	0.01	-0.01		
11	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-0.01		
12	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
74										
01	0.01	0.01	-0.01	0.01	0.01	0.04	0.01	0.01		
02	0.01	0.01	0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
03	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
04	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
05	-0.01	-0.01	-0.01	-0.01	0.01	0.01	-0.01	0.01		
06	-0.01	-0.01	-0.01	-0.01	0.01	0.01	-0.01	-0.01		
07										
08	-0.01	-0.01	-0.01	-0.01	-0.01	0.03	-0.01	-0.01		
09	0.01	0.01	0.02	0.04	0.03	0.04	0.04	0.04	0.02	0.03
10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-0.01	-0.01	0.01
11	0.01	0.01	0.01	0.01	-0.01	-0.01	0.01	-0.01	-0.01	0.01
12	-0.0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
75										
01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.01
02	0.01	0.01	0.01	0.01	0.10	0.01	0.02	0.15		0.01
03	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01		-0.01
04	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
05	0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
06	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01		0.01
07	0.02	-0.01	0.01	-0.01	-0.01	-0.01	-0.01	0.01		0.02
08	0.01	-0.01	-0.01	0.01	-0.01	0.01	-0.01	0.01		-0.01
09	0.01	0.02	0.01	0.02	0.01	0.01	0.01	-0.01		-0.01
10	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01	-0.01		-0.01
11	-0.01	0.01	0.01	-0.01	-0.01	-0.01	0.01	-0.01		-0.01
12	-0.01	0.01	-0.01	-0.01	-0.01	-0.01	0.01	-0.01		-0.01
76										
01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
02										

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL DISSLOVED ORTHOPHOSPHATE-AS P (NEGATIVE SIGN SHOULD BE READ AS'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06										
07										
08	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
09	.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
10	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
11	0.01	0.01	-0.01	0.01	-0.01	-0.01	-0.01	-0.01		
12	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
74										
01	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
02	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
03	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
04	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
05	0.01	0.01	-0.01	0.01	0.01	-0.01	0.01	0.01		
06	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
07										
08										
09										
10	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01
11										
12										
75										
01										
02										
03										
04	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
05	-0.01	-0.01	-0.01	0.01	-0.01	-0.01	-0.01	-0.01		-0.01
06	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
07	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
08	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
09	0.01	0.02	0.01	0.01	0.02	0.01	0.02	-0.01		-0.01
10	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
11	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
12	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		-0.01
76										
01										
02										

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL ALKALINITY-AS CACO3 (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05	6.0	8.0	6.0	6.0	4.0	5.0	4.0	6.0		
06	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0		
07	2.0	2.0	3.0	2.0	2.0	2.0	2.0	2.0		
08	0.0	3.6	3.6	3.6	1.8	9.0	1.8	0.9		
09	1.0	10.0	10.0	10.0	1.0	2.0	2.0	2.0		
10	4.0	3.0	3.0	13.0	5.0	1.0	10.0	10.0		
11	1.0	1.5	1.5	2.0	1.5	1.0	10.0	10.0		
12	1.0	2.0	3.0	1.0	-1.0	-1.0	1.0	-1.0		
74										
01	1	-1	1	1	1	-1	-1	-1		
02	-1	-1	1	-1	-1	-1	-1	-1		
03	-1	-1	2	1	1	-1	-1	1		
04	1	2	-1	-1	-1	-1	-1	-1		
05	2	1	2	1	-1	-1	-1	-1		
06										
07										
08	2	2	2	4	1	1	2	-1		
09	2	2	2	2	3	2	2	2	2	3
10	-1	-1	-1	-1	-1	-1	1	-1	1	-1
11	-1	-1	-1	-1	-1	-1	-1	-1	1	1
12	1	1	1	1	-1	-1	1	-1		1
75										
01	1	1	1	1	1	1	1	2		1
02	-1	-1	1	1	-1	-1	1	1		-1
03	-1	-1	-1	-1	-1	-1	-1	-1		-1
04	-1	-1	-1	-1	-1	-1	-1	-1		-1
05	-1	-1	-1	-1	2	-1	-1	1		-1
06	1.2	0.7	0.5	1.2	1.2	0.8	1.0	1.0		4.6
07	0.4	1.3	0.7	0.9	0.9	0.4	1.0	8.4		0.5
08	2.0	1.8	1.3	1.1	0.3	0.7	0.8	0.8		1.3
09	0.5	0.6	0.3	0.5	0.5	0.4	0.6	0.2		-0.1
10	0.3	0.1	0.7	0.3	1.6	0.9	0.4	0.8		0.1
11	0.1	0.1	1.1	5.3	0.3	0.4	1.0	0.8		0.9
12	1.5	0.7	0.1	0.2	0.1	0.5	-0.1	0.1		-0.1
76										
01	-0.5	-0.5	0.7	0.7	-0.5	-0.5	-0.5	-0.5		0.7
02	-1.	-1.	-1.	-1.	-1.	-1.	-1.	-1.		-1.

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

HARDNESS-AS CACO3 (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06										
07										
08										
09										
10										
11										
12										
74										
01	4.	7.	8.	6.	8	7	6.	7.		
02	4.	4.	4.	4.	5	6	6.	6.		
03	7.0	6.	6.	6.	6	6	7.	6.		
04	5.0	9.0	7.0	7.0	5.0	5.0	5.0	9.0		
05	6.0	6.0	4.0	5.2	3.2	5.2	6.0	6.0		
06										
07										
08	5.	5.	4.	5.	5	3	4.	4.		
09	3.	5.	5.	3.	3	3	5.	5.	4.	4.
10	11.	11.	11.	7.	9	5	7.	9.	5	7
11	-1.	-1.	-1.	-1.	-1	-1	1.	-1	-1	-1
12	23	22	16	20	22	29	37	41		52
75										
01	6.	4.	4.	5.	4.	4.	5.	6.		6.
02	4.	2.	2.	3.	3.	2.	2.	2.		2.
03	6.	6.	6.	6.	5.	5.	6.	6.		6.
04	4.	3.	2.	3.	2.	2.	7.	5.		5.
05	3.	4.	5.	6.	4.	6.	4.	5.		4.
06	2.	5.	4.	3.	2.	2.	5.	3.		7.
07	5.9	3.9	3.2	1.9	1.9	1.6	2.8	1.9		2.4
08	4.	4.	4.	4.	4.	4.	4.	4.		5.
09	8.	5.	6.	4.	4.	4.	6.	3.		6.
10	6.	6.	4.	4.	4.	5.	6.	6.		5.
11	6.	6.	6.	6.	6.	4.	6.	5.		5.
12	4.	4.	4.	4.	4.	6.	4.	4.		5.
76										
01	6.	4.	6.	6.	4.	6.	4.	4.		4.
02	6.	6.	6.	6.	6.	6.	6.	6.		6.

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL CALCIUM

MONTH/STATION	AS	AB	BS	BB	GS	GB	HS	IS	JS	[illegible]
73										
04	1.38	1.36	1.51	1.26	1.12	1.28	1.48	1.41		
05	1.43	1.10	1.23	1.17		0.86	1.23			
06	1.19	1.14	1.34	1.22	1.10	1.01	1.49			
07	1.06	0.64	1.03	1.09	1.13	1.03	1.11	1.18		
08	1.06	1.15	1.00	0.96	0.43	0.94	0.94	0.62		
09	0.76	1.21	0.97	0.95	0.49	0.49	1.02	0.72		
10	1.03	0.98	0.98	1.00	0.40	0.41	0.81	0.40		
11	1.19	1.10	1.01	1.03	0.93	0.84	1.09	0.26		
12	0.75	0.69	0.66	0.68	0.59	0.73	0.83	0.84		
74										
01	0.75	0.37	0.73	0.71	0.57	0.36	0.73	0.61		
02	0.49	0.30	0.58	0.47	0.51	0.47	0.46	0.45		
03	0.92	0.94	0.96	1.03	0.82	0.78	1.01	0.85		
04	1.15	1.16	1.45	1.34	0.59	0.66	0.92	0.83		
05	0.90	0.83	0.84	0.75	0.60	0.55	0.83	0.47		
06										
07										
08	0.53	0.43	0.52	0.46	0.46	0.42	0.42	0.39		
09	1.1	1.4	0.95	0.95	0.68	0.56	0.95	0.90	0.90	1.1
10	1.75	1.39	2.73	1.65	1.53	1.23	1.54	1.11	1.06	1.67
11	1.40	1.73	0.98	1.30	0.70	0.92	1.30	0.92	1.03	1.20
12	0.89	1.03	0.97	1.01	0.51	0.92	0.98	0.85		0.93
75										
01	1.89	1.08	1.11	1.66	1.32	4.40	2.27	2.11		1.61
02	1.6	1.6	1.6	1.5	1.7	1.8	1.6	1.5		1.6
03	1.10	1.10	1.10	1.20	0.90	0.90	1.20	0.9[illegible]		1.10
04	1.34	1.39	1.[illegible]1	1.33	1.31	1.00	1.56	1.23		1.63
05	1.10	1.04	1.22	1.21	0.92	0.85	1.13	0.93		1.08
06										
07	1.24	1.27	1.26	1.22	1.14	0.75	1.30	0.98		1.25
08			4.9							
09										
10										
11										
12										
76										
01										
02										

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL MAGNESIUM

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	0.43	0.44	0.45	0.43	0.35	0.38	0.46	0.41		
05	0.43	0.51	0.40	0.41		0.30	0.43			
06	0.40	0.45	0.41	0.41	0.41	0.38	0.44			
07	0.45	0.47	0.44	0.47	0.44	0.42	0.49	0.60		
08	0.49	0.53	0.54	1.55	0.39	0.55	0.48	0.43		
09	0.43	0.81	0.49	0.57	0.33	0.37	0.49	0.37		
10	0.58	0.60	0.56	0.63	0.46	0.45	0.65	0.39		
11	0.46	0.41	0.43	0.44	0.37	0.39	0.46	0.39		
12	0.39	0.40	0.40	0.40	0.56	0.57	0.43	0.63		
74										
01	0.36	0.39	0.40	0.39	0.36	0.37	0.41	0.37		
02	0.39	0.43	0.47	0.43	0.47	0.54	0.44	0.57		
03	0.48	0.47	0.48	0.37	0.41	0.41	0.50	0.49		
04	0.42	0.69	0.68	0.42	0.35	0.35	0.46	0.39		
05	0.45	0.47	0.49	0.46	0.36	0.28	0.47	0.39		
06										
07										
08	0.44	0.41	0.41	0.43	0.46	0.40	0.45	0.44		
09	0.44	0.44	0.48	0.42	0.38	0.37	0.46	0.46	0.41	0.57
10	0.45	0.41	0.44	0.49	0.43	0.37	0.47	0.36	0.33	0.50
11	0.64	0.57	0.42	0.56	0.32	0.49	0.55	0.47	0.59	0.65
12	0.47	0.46	0.50	0.45	0.29	0.65	0.47	0.62		0.47
75										
01	0.58	0.54	0.53	0.54	0.51	0.68	0.58	0.54		0.49
02	0.50	0.52	0.51	0.52	0.51	0.52	0.54	0.53		0.55
03	0.43	0.45	0.47	0.46	0.41	0.42	0.48	0.77		0.44
04	0.47	0.48	0.46	0.46	0.43	0.36	0.54	0.47		0.56
05	0.46	0.45	0.48	1.44	0.42	0.36	0.48	0.44		0.48
06	0.47	0.47	0.49	0.47	0.36	0.31	0.50	0.37		0.56
07	0.49	0.48	0.49	0.48	0.45	0.31	0.53	0.40		0.50
08	0.52	0.49	0.54	0.52	0.48	0.45	0.52	0.52		0.54
09	0.48	0.48	0.46	0.47	0.43	0.45	0.48	0.38		0.50
10	0.54	0.54	0.54	0.56	0.56	0.54	0.56	0.54		0.57
11	0.43	0.44	0.43	0.45	0.50	0.48	0.49	0.51		0.51
12	0.42	0.45	0.40	0.43	0.34	0.38	0.46	0.38		0.46
76										
01	0.51	0.45	0.49	0.57	0.53	0.54	0.52	0.54		0.62
02	0.54	0.52	0.54	0.54	0.52	0.52	0.55	0.54		0.56

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICE DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL SODIUM

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	2.51	2.55	[illegible]	2.52	2.33	2.34	2.39	2.57		
05	2.26	2.63	2.25	2.07		1.92	2.25			
06	2.47	2.17	2.27	3.21	2.78	2.48	3.23			
07	1.87	1.97	1.95	1.93	2.12	2.15	2.07	2.70		
08	1.90	1.91	1.85	1.99	1.76	1.74	1.99	1.79		
09	1.88	2.84	2.02	2.06	1.54	1.71	2.17	1.87		
10	2.07	2.13	2.01	2.36	1.70	1.82	2.11	1.64		
11	1.96	1.88	1.87	1.94	1.80	1.89	1.75	1.56		
12	1.59	1.70	1.62	1.65	1.60	1.82	1.95	2.03		
74										
01	1.69	1.78	1.82	1.76	1.85	1.89	1.83	1.92		
02	1.71	1.81	1.78	1.76	1.78	1.83	1.75	1.92		
03	2.34	2.23	2.07	2.14	2.05	1.96	2.02	2.25		
04	1.93	[illegible]	2.32	2.04	1.83	1.71	1.83	1.90		
05	1.29	1.92	1.88	1.71	1.51	1.51	1.78	1.68		
0										
07										
08	[illegible]	1.6	1.8	1.6	1.5	1.4	1.6	1.3		
09	1.0	1.7	2.1	1.5	1.4	1.3	1.6	1.3	1.3	2.4
10	2.6	2.4	2.0	2.8	2.8	2.4	2.7	2.4	2.3	2.7
11	3.00	3.68	2.65	2.4	1.77	[illegible]	2.98	2.11	2.96	3.25
12	2.1	2.5	2.6	2.0	1.7	2.1	2.1	2.1		2.1
75										
01	2.6	2.5	2.8	2.9	2.7	2.7	2.8	2.6		3.6
02	2.3	2.9	2.8	2.7	2.9	2.2	2.6	2.6		2.7
03	1.90	2.00	2.20	2.20	2.00	1.90	3.10	1.80		2.00
04	2.10	1.90	2.00	2.20	2.10	1.50	2.20	2.00		2.10
05	1.66	1.62	1.62	1.64	1.51	1.64	1.67	1.73		1.72
06	1.62	1.64	1.68	[illegible]	1.49	1.36	4.44	1.59		33.
07	1.59	1.56	1.97	1.59	1.49	1.19	1.58	2.75		1.55
08	1.72	1.52	1.73	1.64	1.92	1.57	1.71	2.09		1.72
09	1.60	1.59	1.66	1.47	1.60	1.41	1.77	1.19		1.55
10	1.51	1.44	1.61	1.65	1.52	1.34	1.52	1.43		1.54
11	1.64	1.71	1.83	1.75	1.53	1.45	1.70	1.60		1.44
12	1.65	1.67	1.66	1.64	1.43	1.48	1.70	1.43		1.73
76										
01	1.71	1.64	1.80	1.69	1.72	1.59	1.71	1.62		1.62
02	1.54	1.67	1.46	1.46	1.43	1.39	1.53	1.42		1.57

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL IRON

MONTH/STATION	AS	AB	E3	EB	GS	GB	HS	IS	JS	KS
73										
04	0.30	0.25	0.34	0.41	0.33	0.41	0.47	0.42		
05	0.51	0.86	0.47	0.46		0.33	0.52			
06	0.56	0.91	0.74	0.71	0.74	0.90	0.65			
07	1.55	3.19	1.83	1.78	1.48	1.33	1.51	1.31		
08	1.49	1.71	1.56	1.73	1.84	0.72	1.11	0.42		
09	1.04	1.52	1.09	1.05	0.56	1.14	1.25	0.59		
10	0.92	1.01	1.00	1.72	0.39	0.45	1.17	0.45		
11	0.81	0.68	0.65	0.66	0.61	0.40	0.69	1.44		
12	0.62	0.67	0.73	0.60	0.25	0.20	0.57	0.23		
74										
01	0.35	1.21	0.47	0.44	0.35	0.63	0.48	0.31		
02	0.46	0.94	0.58	0.52	0.32	0.42	0.50	0.41		
03	0.54	0.62	0.68	0.65	0.61	0.68	0.63	0.66		
04	0.36	0.34	0.38	0.56	0.36	0.38	0.33	0.38		
05	0.62	1.01	0.81	0.69	0.76	0.93	0.64	0.79		
06										
07										
08	2.28	0.92	0.87	1.11	0.84	3.85	1.05	1.08		
09	1.2	1.1	1.1	2.3	1.2	1.1	1.4	1.3	1.0	1.4
10	0.97	1.28	0.90	1.10	0.77	0.63	1.04	0.55	1.06	1.06
11	1.15	1.01	0.78	1.13	0.48	0.68	0.97	0.86	0.66	1.02
12	0.59	0.67	0.70	0.60	0.18	0.38	0.70	0.34		0.67
75										
01	0.39	0.79	0.44	0.41	0.36	0.66	0.47	0.36		0.41
02	0.55	0.53	0.46	0.44	0.39	0.70	0.53	0.37		0.49
03	0.23	0.30	0.26	0.26	0.17	0.18	0.34	0.18		0.32
04	0.54	0.59	0.58	0.61	1.13	0.62	1.16	0.90		1.23
05	0.78	1.15	0.98	0.81	1.02	0.72	0.67	0.88		0.76
06	1.00	1.10	1.05	1.07	0.95	0.60	1.08	0.77		1.11
07	1.03	1.34	1.09	1.03	0.92	0.53	1.16	0.76		1.06
08	1.11	2.27	1.31	1.37	1.16	1.24	1.26	1.21		1.26
09	1.17	1.32	1.28	1.26	1.12	1.04	1.27	0.72		1.33
10	0.92	1.25	1.27	1.13	0.56	0.60	1.17	0.66		1.11
11	0.95	1.05	1.02	0.99	0.86	0.78	1.24	0.85		1.13
12	0.77	0.86	0.69	0.73	0.52	0.36	0.88	0.37		0.83
76										
01	0.58	0.67	0.53	0.57	0.29	0.25	0.65	0.33		0.60
02	0.31	0.31	0.33	0.30	0.25	0.30	0.34	0.39		0.39

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

DISSLOVED SILICA-AS SIO4 (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	BS	BB	GS	[illegible]	HS	IS	JS	KS
73										
04	1.0	2.0	2.0	1.0	1.0	1.0	1.0	2.0		
05	3.0		3.0	3.0	5.0	5.0	3.0	6.0		
06	1.0	1.0	1.0	1.0	2.0	2.0	1.0	3.0		
07	3.0	4.0	3.0	3.0	3.0	4.0	3.0	6.0		
08	0.9	0.9	0.9	0.9	0.4	3.2	0.4	0.9		
09	0.2	-0.1	0.2	4.7	7.3	0.8	7.7	0.6		
10	3.9	3.8	3.5	0.1	3.7	4.0	4.4	7.7		
11	3.5	3.9	4.2	6.	4.1	4.0	4.2	4.2		
12	5.8	5.3	5.8	5.9	5.9	7.0	6.6	6.9		
74										
01	6.0	5.1	5.7	5.3	3.6	3.4	5.4	4.6		
02	8.2	6.4	6.4	6.3	4.3	5.1	6.2	6.2		
03	4.0	5.0	4.4	4.4	2.1	2.1	4.0	3.0		
04	2.0	2.0	2.1	2.1	2.0	2.0	2.0	3.0		
05	3.0	3.0	2.0	2.0	3.0	3.0	3.0	3.0		
06	4.0	4.0	4.0	4.0	4.0	4.0	4.0	5.0		
07										
08	4.	3.	3.	3.	5.	5.	4.	4.		
09	4.	3.	5.	4.	5.	5.	5.	6.	6.	5.
10	5.4	5.4	4.4	5.7	5.2	5.2	5.4	5.7	5.7	5.4
11	0.6	0.4	0.1	-0.1	0.8	1.8	0.8	0.3	0.5	1.1
12	0.13	0.14	0.06	0.08	0.34	0.06	0.34	0.77		0.13
75										
01	1.5	1.3	0.5	1.2	0.5	0.9	0.3	0.4		0.4
02	1.2	0.8	0.7	1.0	0.2	0.3	1.1	0.5		1.0
03	3.3	4.0	4.0	3.1	0.8	1.1	3.4	0.9		3.4
04	2.4	2.4	2.0	2.1	0.9	2.0	2.2	1.2		1.9
05	1.8	3.0	1.5	1.5	3.3	4.1	1.2	3.7		1.2
06	2.2	2.0	2.2	2.3	3.3	4.1	2.0	4.2		2.2
07	2.7	2.1	2.4	2.4	2.6	3.0	3.2	4.0		3.0
08	3.1	5.2	5.0	5.6	6.1	5.0	6.4	5.2		5.2
09	4.1	4.9	5.2	5.2	5.1	4.5	4.9	5.2		5.2
10	6.0	5.3	5.0	5.4	5.5	5.8	6.3	5.8		5.0
11	5.6	5.4	5.7	5.4	5.4	5.7	5.7	5.9		6.1
12	5.1	5.6	5.3	5.6	5.0	4.9	5.2	5.2		5.5
76										
01	2.4	2.0	2.2	2.3	2.6	2.6	3.0	2.9		3.1
02	3.5	3.1	3.1	3.1	-1.0	-1.0	3.1	1.6		3.6

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

CHLORIDE-AS CL-

MONTH/STATION	AS	AB	ES	EB	GS	[illegible]	HS	IS	JS	KS
73										
04										
05										
06	4.0	3.0	4.0	4.0	5.0	3.0	4.0	4.0		
07	3.0	4.0	4.0	4.0	4.0	2.0	3.0	4.0		
08	3.6	3.8	4.7	3.8	4.3	3.3	5.8	5.1		
09	2.5	3.0	3.3	3.5	3.4	2.8	3.0	3.2		
10	2.3	2.0	2.0	1.8	1.5	1.3	1.5	1.3		
11	1.5	1.5	1.5	2.0	1.8	2.5	1.8	1.8		
12	2.3	1.6	2.1	2.6	2.6	2.1	1.8	2.6		
74										
01	2.3	2.3	1.5	1.5	2.0	2.3	2.0	2.0		
02	1.8	1.8	1.5	2.0	1.8	2.3	1.9	2.9		
03	2.3	2.1	2.6	2.2	2.3	2.0	2.0	2.2		
04	2.7	2.3	2.2	2.3	1.9	2.0	2.2	2.7		
05	2.0	2.6	2.3	2.3	1.5	1.7	2.2	2.1		
06										
07										
08	4.	4.	4.	4.	3.	4.	4.	4.		
09	7.	7.	7.	8.	6.	7.	8.	8.	7.	7.
10	2.6	3.1	2.9	2.9	2.6	2.2	2.5	2.2	2.1	2.6
11	2.8	2.0	2.4	2.9	2.0	1.9	1.4	2.5	2.1	2.3
12	2.7	2.3	2.5	2.6	2.0	3.2	2.3	3.3		2.4
75										
01	2.8	2.7	2.9	2.8	3.0	2.4	2.7	2.5		2.7
02	5.6	2.9	3.0	2.9	2.3	2.8	3.0	2.9		2.6
03	2.3	2.3	2.3	2.3	2.3	1.9	2.3	2.6		2.6
04	2.8	2.0	2.0	1.6	2.5	1.4	2.5	2.4		2.3
05	2.4	2.2	1.7	2.0	4.5	1.4	2.4	2.2		1.9
06	2.4	2.5	2.6	2.1	2.3	2.0	7.2	2.4		5.2
07	2.5	2.3	2.4	2.1	2.1	1.9	2.1	2.2		2.1
08	1.7	2.0	1.8	2.0	2.2	2.0	1.8	3.0		2.4
09	3.3	2.0	2.1	2.0	2.3	2.1	2.1	1.8		2.2
10	1.8	1.9	2.3	1.8	2.2	2.0	2.3	2.4		2.1
11	0.9	1.9	1.7	1.7	2.5	2.4	1.7	2.4		2.0
12	2.2	2.2	2.0	2.4	2.0	1.4	2.4	2.4		2.4
76										
01	1.8	1.6	2.0	1.6	2.0	2.0	1.8	1.8		2.0
02	2.2	2.1	2.0	1.8	2.1	2.0	2.1	2.2		2.2

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

SULFATE-AS SO4= (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	2.0	3.0	0.0	1.0	3.0	5.0	3.0	3.0		
05	1.0		3.0	1.0	3.0	3.0	2.0	2.0		
06	2.0	2.0	7.0	5.0	3.0	2.0	2.0	1.0		
07	12.0	11.0	11.0	7.0	12.0	12.0	12.0	11.0		
08	2.6	2.6	2.3	2.6	1.0	1.0	3.2	1.0		
09	3.7	2.4	[illegible]	[illegible]	1.0	-0.1	3.5	-0.1		
10	2.6	2.4	2.2	2.5	0.3	0.3	3.2	0.3		
11	3.5	2.7	2.4	2.2	2.1	-1.0	4.6	-1.0		
12	1.4	1.3	5.6	1.9	3.4	3.0	2.5	3.5		
74										
01	5.1	5.4	6.9	5.4	3.2	3.2	6.6	8.2		
02	5.0	5.0	3.0	6.0	5.0	5.0	4.0	5.0		
03	3.0	3.2	3.5	3.7	2.2	1.7	3.3	2.2		
04	[illegible]	3.0	3.0	3.0	2.0	2.0	4.0	1.9		
05	3.0	4.0	4.0	4.0	2.0	2.0	4.0	3.0		
06	2.0	3.0	2.0	2.0	1.0	1.0	4.0	2.0		
07										
08	4.	5.	5.	5.	5.	3.	6.	4.		
09	2.	2.	2.	2.	6.	7.	8.	8.	7.	7.
10	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.0	3.0
11	2.0	1.0	3.0	1.0	1.0	1.0	2.0	1.0	1.0	2.0
12	3.0	6.0	6.0	2.0	4.0	4.0	3.0	4.0		3.0
75										
01	2.0	1.6	2.0	[illegible]	1.6	1.8	2.0	1.6		2.7
02	1.1	1.1	1.4	1.1	1.6	1.9	1.6	1.8		1.9
03	2.5	2.0	2.0	2.3	1.6	1.4	2.5	1.6		2.0
04	2.5	2.7	2.2	2.5	2.0	-1.0	3.6	1.8		3.3
05	3.3	2.2	2.9	2.9	2.1	1.1	0.6	4.5		4.4
06	3.4	2.5	3.3	2.2	1.0	1.0	3.3	-1.0		4.8
07	3.6	2.7	3.6	3.0	3.4	1.6	3.9	1.6		3.8
08	5.3	3.3	5.4	4.0	3.4	5.2	4.8	2.9		4.5
09	2.5	3.8	4.0	2.9	2.0	1.6	2.9	-1.0		4.1
10	4.0	2.0	3.0	3.0	2.0	3.0	5.0	4.0		4.0
11	2.5	2.5	2.0	2.5	-1.0	-1.0	2.0	-1.0		2.0
12	0.8	0.8	1.2	1.0	1.0	0.6	1.1	0.7		1.2
76										
01	1.0	1.2	1.3	1.7	3.9	1.0	1.3	1.0		1.3
02	1.0	1.0	1.0	1.0	-1.0	-1.0	1.1	-1.0		1.0

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

COD (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	13	8	7	8	9	8	12	9		
05	7	18	15	11	4	7	7	7		
06	4	12	12	8	16	28	16	20		
07	24	24	28	28	24	24	28	28		
08	12	8	20	40	4	28	4	4		
09	36	36	43	44	32	44	44	29		
10	42	39	37	8	39	12	8	4		
11	19	15	8	23	15	23	19	19		
12	26	22	29	15	29	29	7	7		
74										
01	63	52	55	55	52	33	88	52		
02	22	37	22	52	15	15	11	22		
03	27	23	31	27	27	47	12	16		
04	27	19	81	97	97	89	34	69		
05	24	24	20	29	24	33	33	20		
06	16	24	24	29	24	16	61	20		
07										
08	31	20	31	66	51	57	31	57		
09	38	34	31	38	23	15	38	31	15	23
10	26	11	11	15	19	14	11	4	4	11
11	7	26	18	18	11	7	18	4	4	22
12	22	22	22	18	18	47	29	25		18
75										
01	23	19	15	15	19	19	12	12		8
02	35	38	35	35	38	42	19	23		38
03	15	15	26	19	15	19	23	8		4
04	43	43	39	39	51	47	35	39		27
05	35	8	31	4	12	12	20	31		12
06	39	12	12	12	16	16	16	20		35
07	19	11	15	11	11	11	7	15		7
08	35	43	27	27	27	27	23	27		23
09	15	20	12	16	20	12	39	39		39
10	12	39	31	62	27	23	16	- 27		23
11	25	17	21	21	17	17	17	-1		17
12	120	31	27	23	19	4	23	-1		19
76										
01	4	8	8	12	8	12	12	8		8
02	30	40	40	32	30	11	11	11		11

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TURBIDITY (NTU)

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06										
07										
08										
09										
10										
11										
12										
74										
01										
02										
03										
04										
05										
06										
07										
08										
09										
10										
11										
12	3.0	3.0	3.5	3.0	1.3	2.6	3.1	1.6		2.8
75										
01	1.5	9.5	2.0	2.0	2.3	3.3	2.5	2.2		1.5
02	4.3	3.7	4.0	3.5	2.5	1.8	3.4	1.8		3.5
03	2.8	4.0	3.7	3.0	1.8	2.5	3.5	1.8		3.1
04	2.6	3.0	2.4	3.2	5.5	3.2	4.8	2.5		6.0
05	2.0	3.7	3.4	3.8	4.2	4.1	3.0	4.2		2.5
06	2.6	4.9	3.8	3.3	5.9	3.8	3.8	6.4		5.0
07	3.0	3.5	5.6	[illegible]	3.5	4.8	4.3	3.6		3.5
08	3.3	6.0	5.5	5.5	4.3	4.7	4.8	5.1		4.1
09	2.7	4.5	3.5	3.5	3.8	3.3	3.5	4.0		3.9
10	2.6	5.5	3.5	4.3	3.5	3.7	4.0	3.0		3.5
11	2.8	4.9	[illegible]	3.4	3.3	3.3	5.5	2.4		3.7
12	3.4	5.9	3.0	3.0	2.5	2.7	4.0	2.5		3.2
76										
01	3.3	3.6	3.5	3.5	2.5	2.5	3.5	2.0		3.3
02	2.0	2.4	2.5	2.5	3.1	3.8	2.5	2.1		2.0

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL SOLIDS

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	46	21	22	41	29	27	18	27		
05	66	116	164	81	76	81	216	96		
06	10	26	26	34	49	72	60	82		
07	33	29	24	35	34	170	40	55		
08	37	37	46	35	34	47	34	42		
09	113	114	130	118	71	85	134	130		
10	151	184	150	164	166	178	176	170		
11	48	40	34	35	74	67	59	55		
12	121	119	111	136	113	97	87	94		
74										
01	199	211	193	190	189	231	137	160		
02	52	35	44	55	53	63	36	28		
03	184	126	124	155	159	138	102	128		
04	201	126	106	123	134	166	133	150		
05	201	192	199	207	222	271	103	206		
06	158	155	172	151	143	177	138	136		
07										
08	60	47	55	45	43	103	116	66		
09	51	60	66	90	60	58	48	53	58	39
10	170	157	163	228	171	204	181	179	188	178
11	106	108	132	125	117	139	97	66	99	130
12	77	164	135	103	80	160	130	130		100
75										
01	267	293	268	273	256	276	340	243		252
02	91	87	100	104	118	160	90	110		115
03	133	157	132	147	107	125	134	220		187
04	283	265	314	294	289	267	291	303		314
05	109	108	85	80	76	91	67	71		92
06	153	191	206	176	164	208	237	222		372
07	206	235	245	220	213	239	231	257		234
08	197	182	173	211	123	139	201	143		206
09	209	210	206	192	193	204	188	182		191
10	141	141	140	117	129	116	195	195		171
11	372	388	396	398	406	394	308	364		410
12	94	144	144	125	119	124	127	133		119
76										
01	199	217	228	158	160	141	152	153		146
02	147	148	150	139	132	133	135	133		122

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL VOLATILE SOLIDS

MONTH/STATION	AS	AS +	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	32	22	11	39	15	24	9	20		
05	51	72	142	59	53	65	184	44		
06	4	10	19	16	42	44	24	71		
07	24	16	16	25	30	71	27	39		
08	25	24	25	17	21	28	22	25		
09	107	85	84	110	53	69	85	79		
10	84	90	83	109	111	112	90	101		
11	27	26	31	33	68	38	23	12		
12	109	106	106	122	103	83	74	81		
74										
01	42	35	121	24	130	171	125	51		
02	20	21	27	10	46	16	16	11		
03	50	45	63	50	62	64	58	49		
04	114	48	101	104	112	133	115	15		
05	75	54	74	60	76	84	63	64		
06	129	87	91	103	51	101	54	96		
07										
08	29	36	20	26	14	74	50	28		
09	24	28	47	32	37	45	19	29	28	25
10	158	113	102	112	117	121	108	119	130	129
11	77	81	75	74	62	79	51	52	58	75
12	29	110	96	69	13	117	86	87		64
75										
01	147	152	148	128	118	142	184	113		111
02	79	77	89	77	85	112	88	82		81
03	123	145	126	127	97	101	104	157		137
04	136	120	123	102	80	88	89	96		91
05	79	76	47	47	43	61	35	37		64
06	147	188	200	168	159	172	197	174		274
07	154	165	179	169	152	168	171	190		182
08	158	147	137	155	102	110	149	118		140
09	134	137	139	124	129	91	124	96		111
10	44	47	41	37	47	47	33	41		44
11	278	310	250	228	172	256	210	246		262
12	91	137	137	106	102	115	111	103		83
76										
01	169	175	185	133	119	118	118	128		117
02	79	87	112	99	99	94	114	116		117

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL SUSPENDED SOLIDS

MONTH/STATION	AS	[illegible]	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	4	9	7	2	4	5	11	7		
05	4	8	10	4	7	7	20	4		
06	2	4	2	4	5	12	11	11		
07	2	4	5	6	2	124	5	5		
08	14	18	12	16	12	12	12	14		
09	17	20	2[illegible]	18	14	21	9	17		
10	13	9	14	11	5	11	12	14		
11	3	10	1	2	4	4	1	12		
12	4	9	8	9	4	4	6	3		
74										
01	17	16	7	7	5	82	4	5		
02	11	15	21	15	10	27	10	13		
03	23	26	27	29	31	28	29	30		
04	7	6	9	14	12	46	6	15		
05	144	144	145	145	150	225	146	156		
06	6	3	3	5	4	5	2	4		
07										
08	1	1	2	19	9	66	10	11		
09	11	14	22	44	24	22	24	24	18	30
10	13	32	14	22	24	26	22	14	16	6
11	6	24	14	26	22	28	34	20	22	28
12	4	18	28	22	14	17	26	18		20
75										
01	151	162	148	146	147	148	150	171		150
02	5	5	7	5	5	46	13	7		5
03	8	10	9	13	12	11	16	9		13
04	5	4	4	9	5	3	6	6		6
05	15	21	23	25	28	23	21	29		26
06	24	35	30	29	35	44	32	33		36
07	21	30	28	22	48	64	58	66		54
08	24	34	26	18	12	18	18	18		20
09	24	30	34	36	36	36	32	36		24
10	10	16	16	22	10	8	6	8		10
11	18	22	18	24	20	24	22	22		20
12	22	42	32	36	18	21	46	22		34
76										
01	11	11	12	11	8	12	13	12		11
02	5	12	9	13	12	12	12	11		12

4/73 - 7/73: 0.75 - 1.25 μ filter; 8/73 - 12/75: 1.20 μ filter

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL DISSOLVED SOLIDS

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	44	22	15	39	25	32	7	30		
05	62	108	154	77	69	74	196	92		
06	8	22	24	30	44	60	49	71		
07	31	25	19	29	32	46	35	50		
08	23	26	27	28	43	36	8	17		
09	82	103	67	83	68	82	112	87		
10	130	92	60	79	57	126	95	113		
11	47	27	30	25	42	4	3	22		
12	77	55	62	63	76	47	44	56		
74										
01	158	144	122	112	88	147	77	86		
02	31	23	9	26	22	51	23	23		
03	119	119	94	82	92	87	84	73		
04	110	123	103	121	117	107	93	123		
05	193	176	159	197	203	215	181	201		
06	139	115	95	136	118	84	100	70		
07										
08	59	46	53	26	34	37	106	54		
09	40	46	44	46	36	36	24	29	40	9
10	52	58	46	51	59	62	49	53	62	60
11	98	96	126	102	90	116	80	54	60	79
12	67	124	112	86	67	117	108	109		84
75										
01	204	181	176	209	203	202	275	204		205
02	60	59	60	55	57	57	34	71		47
03	113	149	109	115	94	106	101	100		107
04	228	232	244	231	238	99	113	104		103
05	35	33	31	33	37	42	31	27		27
06	125	108	82	122	99	116	120	138		238
07	174	182	139	189	162	168	218	240		220
08	128	150	170	202	76	106	138	132		200
09	150	198	140	132	150	150	158	150		180
10	104	122	120	98	106	100	170	170		158
11	322	362	372	376	376	338	290	322		314
12	85	108	136	112	115	102	92	92		100
76										
01	177	174	180	140	152	118	117	118		127
02	125	112	117	115	102	96	81	94		98

4/73 - 7/73: 0.75 - 1.25 μ filter; 8/73 - 12/75: 1.20 μ filter

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

HEXAVALENT CHROMIUM (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
05	-0.050	-0.050	-0.050	-0.050		-0.050	-0.050			
06	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
07	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
08	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
09	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
10	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005		
11	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.050		
12	-0.005	-0.005	-0.005	-0.005	-0.005	-0 05	-0.005	-0.005		
74										
01	-0.005	-0.005	-0.005	-0.005	-0.005	-.005	-.005	-.005		
02	-0.005	-0.005	-0.005	-0.005	-0.005	-.005	-.005	-.005		
03	-0.005	-0.005	-0.005	-0.005	-0.005	-.005	-.005	-.005		
04	-0.005	-0.005	-0.005	-0.005	-0.005	-.005	-.005	-.005		
05	-0.005	-0.005	-0.005	-0.005	-0.005	-.005	-.005	-.005		
06										
07										
08	-0.05	-0.05	-0.05	-0.05	-.05	-.05	-.05	-0.05		
09	-0.05	-0.05	-0.05	-0.05	-.05	-.05	-.05	-0.05	-0.05	-0.05
10	-0.005	-0.005	-0.005	-0.005	-.005	-.005	-.005	-0.005	-0.005	-0.005
11	-0.005	-0.005	-0.005	-0.005	-.005	-.005	-.005	-0.005	-0.005	-0.005
12	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005		-0.005
75										
01	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005		-0.005
02	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005		-0.005
03	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005		-0.005
04	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005		-0.005
05	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005		-0.005
06	-0.005	-0.005	-0.005	-0.005	-0.005	-0.0[illegible]	-0.005	-0.005		-0.005
07	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
08	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		-0.050
09	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		-0.050
10	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		-0.050
11	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
12	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
76										
01	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL MERCURY (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	[illegible]	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001			
07	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
08	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
09	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
10	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
11	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
12	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
74										
01	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
02	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
03	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
04	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
05	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
06	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		
07										
08	-0.001	-0.001	-0.001	-0.001	0.001	-0.001	-0.001	-0.001		
09	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
10	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
11	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
12	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
75										
01	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
02	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
03	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
04	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
05	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
06	0.001	0.003	-0.001	0.001	0.002	0.002	0.001	0.001		0.001
07	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
08	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
09	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
10	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
11	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.001		0.001
12	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
76										
01	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001
02	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001		-0.001

CAROL R & LIGHT COMPANY
OPSC CES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL COPPER (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
05	-0.050	-0.050	0.050	0.050		-0.050	-0.050			
06	0.050	0.070	0.050	0.050	0.060	0.050	0.050			
07	0.090	0.090	0.100	0.100	0.100	0.080	0.070	0.100		
08	0.100	0.110	0.070	0.070	-0.050	-0.050	-0.050	-0.050		
09	-0.050	0.190	0.050	0.050	-0.050	0.130	0.060	-0.050		
10	0.050	0.060	0.070	0.060	-0.050	-0.050	-0.050	-0.050		
11	0.09	0.08	0.07	0.08	-0.05	-0.05	0.06	-0.05		
12	-0.050	-0.050	-0.050	-0.050	-0.05	-0.05	-0.050	-0.05		
74										
01	0.08	0.09	0.09	0.09	0.07	0.08	0.10	0.04		
02	-0.05	0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
04	0.05	0.10	0.18	-0.05	-0.05	-0.05	-0.05	-0.05		
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
06										
07										
08	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04		
09	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
10	0.07	0.07	-0.05	-0.05	-0.05	-0.05	0.07	-0.05	-0.05	0.07
11	0.08	0.04	0.07	0.09	-0.05	-0.05	0.07	-0.05	-0.05	0.06
12	-0.05	-0.05	0.05	0.05	-0.05	-0.05	-0.05	-0.05		-0.05
75										
01	-0.05	0.05	0.05	0.06	-0.05	-0.05	-0.05	-0.05		-0.05
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
03	-0.05	-0.05	0.05	-0.05	-0.05	-0.05	0.05	-0.05		-0.05
04	0.05	-0.05	0.05	0.05	-0.05	-0.05	-0.05	-0.05		-0.05
05	-0.05	-0.05	0.05	0.05	-0.05	-0.05	-0.05	-0.05		-0.05
06	-0.05	0.05	[illegible]	0.04	-0.05	-0.05	0.06	-0.05		0.10
07	0.07	0.07	0.08	0.08	0.08	-0.05	0.06	-0.05		0.06
08	0.05	-0.05	0.09	0.06	-0.05	-0.05	0.05	-0.05		-0.05
09	0.11	0.09	0.08	0.08	0.06	0.06	0.06	-0.05		0.06
10	0.06	0.06	0.06	0.06	-0.05	-0.05	-0.05	-0.05		0.05
11	0.07	0.09	0.09	0.09	-0.05	-0.05	0.08	-0.05		0.11
12	0.05	0.05	0.05	0.07	-0.05	-0.05	0.06	-0.05		0.05
76										
01	0.06	0.07	0.07	0.07	-0.05	-0.05	0.05	-0.05		0.05
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

DISSLOVED COPPER (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS		HS	IS	JS	KS
73										
04										
05										
06										
07	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
08	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
09	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
10	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
11	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
12	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005		
74										
01	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.050	-0.05		
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.050	-0.05		
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.050	-0.05		
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.050	-0.05		
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
06										
07										
08										
09										
10										
11										
12										
75										
01										
02										
03										
04										
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
06	-0.05	-0.05	-0.05	0.13	-0.05	-0.05	-0.05	-0.05		0.09
07	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
08										
09	0.05	-0.05	0.05	0.05	-0.05	-0.05	-0.05	-0.05		-0.05
10	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
11	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
12	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
76										
01	0.06	-0.05	0.07	0.06	-0.05	-0.05	0.06	-0.05		0.06
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL ZINC (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	0.040	0.080	-0.050	-0.050	-0.050	-0.050	-0.050	0.150		
05	1.050	0.070	0.060	0.110		0.050	0.050			
06	0.180	0.100	0.060	0.080	0.080	0.060	0.090			
07	-0.050	0.050	0.060	0.060	0.050	-0.050	0.050	0.070		
08	-0.060	0.060	0.050	0.060	-0.050	-0.050	-0.050	-0.050		
09	-0.050	0.050	0.060	0.060	-0.050	-0.050	0.050	-0.050		
10	0.050	0.050	0.050	0.060	-0.050	-0.050	0.050	-0.050		
11	0.07	-0.05	-0.05	0.05	0.05	-0.05	-0.05	0.05		
12	-0.05	-0.05	-0.05	0.07	-0.05	-0.05	-0.05	0.11		
74										
01	-0.05	0.05	-0.05	-0.05	0.06	-0.05	-0.05	-0.05		
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
06										
07										
08	1.01	0.07	0.13	0.09	-0.05	0.47	0.09	0.11		
09	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
10	0.06	0.05	0.18	0.07	0.06	-0.05	0.05	-0.05	-0.05	0.05
11	0.08	0.10	0.05	0.18	0.05	0.05	0.07	0.22	0.06	0.07
12	-0.05	0.06	0.06	0.05	-0.05	-0.05	-0.05	-0.05		-0.05
75										
01	0.13	0.05	0.05	0.11	0.07	0.04	0.18	0.16		0.11
02	0.07	0.08	0.08	0.07	0.09	0.11	0.07	0.05		0.07
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
05	0.06	-0.05	0.05	0.05	-0.05	-0.05	-0.05	-0.05		-0.05
06										
07	0.06	0.05	0.07	0.06	0.05	-0.05	0.08	0.11		0.07
08			0.10							
09										
10			0.05							
11			0.07							
12			0.05							
76										
01										
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

DISSLOVED ZINC (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06										
07	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
08	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
09	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
10	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
11	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
12	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
74										
01	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.050	-0.05		
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.050	-0.05		
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.050	-0.05		
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.050	-0.05		
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.050	-0.05		
06										
07										
08										
09										
10										
11										
12										
75										
01										
02										
03										
04										
05										
06										
07	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
08										
09										
10										
11										
12										
76										
01										
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL ALUMINUM (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	0.300	0.320	0.430	0.290	0.230	0.300	0.480	0.260		
05	0.35	0.310	0.270	0.310		0.210	0.400			
06	0.300	0.260	0.280	0.280	0.310	0.340	0.310			
07	0.24	1.70	0.41	0.43	0.29	0.29	0.40	0.33		
08	0.32	0.42	0.41	0.70	0.31	0.54	0.25	0.12		
09	0.26	0.78	0.34	0.41	0.41	0.73	0.37	0.26		
10	0.24	0.48	0.38	0.99	0.32	0.26	0.38	0.32		
11	0.23	0.19	0.23	0.25	0.43	0.20	0.24	0.14		
12	0.25	0.29	0.29	0.24	0.20	0.20	0.28	0.22		
74										
01	0.12	0.66	0.20	0.21	0.16	0.51	0.23	0.20		
02	0.14	0.77	0.14	0.1[illegible]	0.23	0.21	0.11	0.19		
03	0.30	0.22	0.25	0.23	0.30	0.27	0.22	0.25		
04	0.20	0.20	0.25	0.45	0.28	0.27	0.23	0.25		
05	0.22	0.17	0.18	0.25	0.25	0.93	0.25	0.45		
06										
07										
08	0.34	0.82	2.42	1.60	1.60	4.95	1.40	1.64		
09	-0.25	-0.25	-0.25	0.50	-0.25	-0.25	-0.25	0.39	-0.25	-0.25
10	0.19	0.19	0.18	0.13	0.12	0.18	0.17	0.15	0.12	0.30
11	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.2
12	0.20	0.40	0.20	0.20	0.20	0.30	0.20	0.20		0.20
75										
01	0.1	0.6	0.2	0.2	0.2	0.4	0.3	0.2		0.2
02	0.17	1.26	0.18	0.17	0.18	0.57	0.28	0.17		0.18
03	0.20	0.30	0.30	0.20	0.10	0.20	0.30	0.10		0.30
04	0.17	0.25	0.22	0.18	0.23	0.16	0.30	0.21		0.35
05	0.29	0.30	0.32	0.30	0.25	0.22	0.29	0.33		0.30
06	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4		0.4
07	0.3	0.3	0.2	0.2	0.3	0.3	0.4	0.4		0.3
08	0.2	0.4	0.3	0.4	0.3	0.3	0.3	0.4		0.3
09	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.2		0.3
10	0.3	0.4	0.3	0.3	0.2	0.3	0.3	0.3		0.3
11	0.2	0.5	0.3	0.3	0.3	0.3	0.5	0.3		0.3
12	0.3	0.4	0.2	0.3	0.2	0.2	0.4	0.2		0.3
76										
01	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.1		0.3
02	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2		-0.1

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

DISSLOVED ALUMINUM (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06										
07										
08										
09										
10	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100		
11	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
12	0.02	0.02	0.02	0.02	0.08	0.07	0.02	0.07		
74										
01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
02	-0.01	-0.01	-0.01	-0.01	0.01	0.02	-0.01	0.02		
03	-0.01	-0.01	-0.01	-0.01	0.01	0.01	0.01	0.01		
04										
05										
06										
07										
08										
09										
10										
11										
12										
75										
01										
02										
03										
04										
05	0.07	0.08	0.07	0.06	0.08	0.06	0.08	0.05		0.06
06	0.1	0.1	0.1	0.1	0.1	-0.1	0.1	0.1		0.1
07	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1		-0.1
08	-0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1
09	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.1	-0.1		0.1
10	0.1	0.1	0.1	0.1	0.1	0.1	-0.1	0.1		-0.1
11	0.1	0.1	0.1	0.1	0.2	0.1	-0.1	0.1		0.1
12	0.1	0.1	0.1	0.1	0.1	-0.1	-0.1	-0.1		0.1
76										
01	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1		0.1
02	0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1		-0.1

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL NICKEL (NEGATIVE SIGN SHOULD BE READ AS "LESS THAN")

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06										
07										
08										
09										
10										
11										
12										
74										
01										
02										
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
06										
07										
08	0.20	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1		
09	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
10	-0.05	-0.05	-0.05	-0.05	-0.1	-0.05	-0.05	-0.05	-0.05	-0.05
11	-0.05	-0.05	-0.05	-0.05	-0.1	-0.05	-0.05	-0.05	-0.05	-0.05
12	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
75										
01	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
06										
07	-0.05	-0.05	-0.05	0.05	-0.05	-0.05	-0.05	-0.05		-0.05
08			-0.05							
09										
10			-0.05							
11			-0.05							
12			-0.05							
76										
01										
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

DISSLOVED NICKEL (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04										
05										
06										
07	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
08	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
09	-0.050	-0.050	-0.050	-0.010	-0.050	-0.050	-0.050	-0.050		
10	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100		
11	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1		
12	-0.05	-0.05	-0.05	0.05	-0.05	-0.05	-0.05	-0.05		
74										
01	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1		
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
06										
07										
08										
09										
10										
11										
12										
75										
01										
02										
03										
04										
05										
06										
07	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
08										
09										
10										
11										
12										
76										
01										
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL LEAD (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100		
05	-0.100	-0.100	-0.100	-0.100		-0.100	-0.100			
06	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100			
07	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100		
08	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100		
09	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100		
10	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100		
11	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1		
12	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01		
74										
01	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1		
02	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1		
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
06										
07										
08	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1		
09	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
10	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
11	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
12	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
75										
01	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
06										
07	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
08			-0.05							
09										
10			-0.05							
11										
12										
76										
01										
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05

CAROLINA POWER & LIGHT COMPANY
SPECIAL SERVICES DEPARTMENT

ROBINSON WATER CHEMISTRY

TOTAL MANGANESE (NEGATIVE SIGN SHOULD BE READ AS 'LESS THAN')

MONTH/STATION	AS	AB	ES	EB	GS	GB	HS	IS	JS	KS
73										
04	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
05	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050			
06	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050			
07	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
08	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
09	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
10	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050		
11	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
12	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005		
74										
01	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
06										
07										
08	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		
09	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
10	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
11	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
12	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
75										
01	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
06										
07	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05
08			-0.05							
09										
10										
11										
12										
76										
01										
02	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05		-0.05

Recommended Water Quality Goals for Various Water Quality Constituents, All Values mg/l

Water Quality Constituent	EPA Recommended 1983 Goal Freshwater Aquatic Life	Freshwater Aquatic Life			Public Water Supply		
		EPA	NAS	NTAC	EPA	NAS	NTAC
Phosphorus	Limit eutrophication	-	maintain NO_3-P ratio maintain NH_4-P ratio	-	-	-	-
Sulfates	NL	-	-	-	250.0	250.0	250.0
Chloride	NL	-	-	-	-	-	-
Dissolved Solids	NL	Bioassays	-	50 millimoles, 1/3 increase	NL	NL	500.0
Hardness	Carbonate hardness is equal to alkalinity	See dissolved dissolved solids	-	NL	NL	NL	-
Suspended and Settleable Solids	25.0(5) 25.0-80.0(6)) 80.0-400.0(7))	80.0	25.0 80.0 400.0	no addition	-	-	NL
Turbidity and Light Penetration	See suspended solids discussion	10% change in compensation point	10% change in compensation point	Streams 50 JTU(3) 10 JTU(4) Lakes 25 JTU(3) 10 JTU(4)	-	-	-

Recommended Water Quality Goals for Various Water Quality Constituents, All Values mg/l

Water Quality Constituent	EPA Recommended 1983 Goal Freshwater Aquatic Life	Freshwater Aquatic Life			Public Water Supply		
		EPA	NAS	NTAC	EPA	NAS	NTAC
Aluminum	NL	-	NL	-	-	-	-
Chromium	0.3	0.05	0.05	0.02	0.5	0.5	0.5
Copper	0.1X 96 hr. LC_{50} (0.018)	1/10 LC_{50}	1/10 LC_{50}	1/10 TL_m 1/30 TL_m	1.0	1.0	1.0
Iron	1.0	-	-	-	0.3	0.3	0.3
Lead	.01X 96 hr. LC_{50} (0.238)	0.03	0.03	-	0.05	0.05	0.05
Manganese	NL Marine Only	-	-	-	0.05	0.05	0.5
Mercury	0.00005	0.2 Total 0.05 Ave. 0.50 body burden	0.2 Total 0.05 Ave. 0.50 body burden	-	0.002	0.002	-
Nickel	0.1	1/50 LC_{50}	1/50 LC_{50}	-	NL	NL	-
Sodium	NL	-	-	-	0.05	NL	0.05

Recommended Water Quality Goals for Various Water Quality Constituents, All Values mg/l

Water Quality Constituent	EPA Recommended 1983 Goal Freshwater Aquatic Life	Freshwater Aquatic Life			Public Water Supply		
		EPA	NAS	NTAC	EPA	NAS	NTAC
Zinc	0.01 x 96 hr. LC_{50} (0.078)	1/200 LC_{50}	1/200 LC_{50}	1/100 LC_{50}	5.0	5.0	5.0
pH	6.5-9.0	6-9	6.5-8.5(1) 6.0-8.0(1) 6.0-9.0(2) 5.5-9.5(2)	6.0-9.0	5-9	5-9	6-8.5
Alkalinity	20.0	75% of natural	75% of natural	20.0	NL	NL	NL
Ammonia	0.02 (as unionized Ammonia)	1/20 LC_{50} (0.02 mg/l)	EPA	Flow through Bioassay	0.5	0.5	0.5
Nitrates	NL	-	maintain NO_3-P ratio maintain NH_4-P ratio	-	10 1	10 1	10 1
Nitrites	NL	-	maintain NO_3-P ratio maintain NH_4-P ratio	-	-	-	-

Recommended Water Quality Goals for Various Water Quality Constituents, All Values mg/l

Water Quality Constituent	EPA Recommended 1983 Goal Freshwater Aquatic Life	Freshwater Aquatic Life			Public Water Supply		
		EPA	NAS	NTAC	EPA	NAS	NTAC
Temperature	Limiting temp. related to sensitive species and season	complex EPA & NAS essentially same	complex	complex avoid disrupting natural patterns	not to detract from palatability or interfere w/ treatment	no fixed critera	-
Dissolved Oxygen	Level dependent on seasonal conditions and use of water	-	Four levels of protection 4.0 minimum	complex	NL	NL	4.0 monthly 3.0 indiv. sample

[1]Δ ≤ 0.5 units, [2]Δ ≤ 1.5 units, [3]Warm water, [4]Cold water, [5]For excellent fisheries,

[6]For good to moderate fisheries: [7]For fair to poor fisheries, NL - No limit specified.

EPA: U.S. Environmental Protection Agency, Quality Criteria for Water, Washington, D. C. (1975).

NAS: Water Quality Criteria, 1972. National Academy of Sciences and National Academy of Engineering. U.S. government Printing Office, Washington, D. C. (1974).

NTAC: Water Quality Criteria, A Report of the National Technical Advisory Committee to the Secretary of the Interior. U.S. Government Printing Office, Washington, D. C. (1968).

Recommended Water Quality Goals for Various Water Quality Constituents, All Values mg/l

Water Quality Constituent	EPA Recommended 1983 Goal Freshwater Aquatic Life	Freshwater Aquatic Life EPA	Freshwater Aquatic Life NAS	Freshwater Aquatic Life NTAC	Public Water Supply EPA	Public Water Supply NAS	Public Water Supply NTAC
Temperature	Limiting temp. related to sensitive species and season	complex (EPA & NAS essentially same)	complex	complex avoid disrupting natural patterns	not to detract from palatability or interfere w/ treatment	no fixed critera	-
Dissolved Oxygen	Level dependent on seasonal conditions and use of water	-	Four levels of protection 4.0 minimum	complex	NL	NL	4.0 monthly 3.0 indiv. sample

[1]$\Delta \leq 0.5$ units, [2]$\Delta \leq 1.5$ units, [3]Warm water, [4]Cold water, [5]For excellent fisheries,
[6]For good to moderate fisheries; [7]For fair to poor fisheries, NL - No limit specified.

EPA: U.S. Environmental Protection Agency, Quality Criteria for Water, Washington, D. C. (1975).

NAS: Water Quality Criteria, 1972. National Academy of Sciences and National Academy of Engineering. U.S. government Printing Office, Washington, D. C. (1974).

NTAC: Water Quality Criteria, A Report of the National Technical Advisory Committee to the Secretary of the Interior. U.S. Government Printing Office, Washington, D. C. (1968).

CP&L EXHIBIT 2.5

Dissolved Oxygen Concentrations (mg/l) and

Percent Saturation

April 1973 to March 1976

DISSOLVED OXYGEN AND PERCENTAGE SATURATION

	A		B		C		D		E		F		G	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
April 18, 1973														
Surface	8.8	91	8.2	86	10.4	106	8.9	95	8.5	92	7.7	82	7.9	83
Middle	8.4	86	8.1	82	8.4	85	---	--	---	--	---	--	---	--
Bottom	8.6	88	8.6	86	7.6	76	8.5	91	7.7	84	7.6	78	6.9	67
May 22, 1973														
Surface	7.6	88	7.5	87	7.4	87	6.6	81	7.3	97	7.5	91	7.9	88
Middle	---	--	---	--	---	--	---	--	8.2	105	---	--	---	--
Bottom	7.2	81	6.4	71	6.7	75	6.9	78	7.6	91	7.5	81	6.0	61
June 7, 1973														
Surface	6.9	92	6.6	88	6.7	89	6.5	89	6.3	91	6.9	96	6.1	74
Middle	6.4	81	---	--	---	--	---	--	---	--	---	--	---	--
Bottom	5.4	64	6.6	78	6.6	79	6.1	78	5.7	83	5.4	66	5.8	66

DISSOLVED OXYGEN AND PERCENTAGE SATURATION

JULY 31, 1973

Transect	A						B					
Station	1		2		3		1		2		3	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.6	88	6.6	88	6.6	89	6.4	85	6.4	86	6.4	86
3	6.4	85	6.4	85	6.4	85	6.2	84	6.2	83	6.4	85
6	6.2	83	6.2	83	6.1	81	6.0	80	6.0	80	6.0	80
9	6.2	83	6.0	80	6.1	81	5.8	77	6.0	80	6.0	80
12	5.4	71	5.8	77	5.2	69	5.7	75	5.0	66	5.3	71
15	5.4	71	5.4	71	4.7	62	4.6	60	4.5	59	4.7	62
18	---	--	4.6	60	4.3	56	4.5	59	4.9	64	4.5	59
21	---	--	3.9	51	4.1	54	4.1	54	4.4	58	4.0	52
24	---	--	3.4	45	3.0	39	2.8	36	3.0	40	3.2	42
27	---	--	2.8	36	---	--	1.7	22	1.6	21	---	--
30	---	--	---	--	---	--	0.02	0.3	0.7	9	---	--
33	---	--	---	--	---	--	---	--	0.7	9		

Transect	C						D					
Station	1		2		3		1		2		3	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.2	84	6.4	86	6.1	82	5.4	76	5.4	76	5.4	75
3	6.0	80	6.2	84	6.0	81	5.4	75	5.6	78	5.4	75
6	6.0	80	6.0	81	6.0	80	5.9	81	4.7	64	---	--
9	---	--	5.9	79	5.8	77	5.4	73	5.5	74	---	--
12	---	--	5.4	72	5.7	76	4.5	60	4.9	66	---	--
15	---	--	4.7	63	4.7	63	3.5	46	---	--	---	--
18	---	--	3.8	50	3.6	47	2.8	36	---	--	---	--
21	---	--	2.2	29	2.4	31	---	--	---	--	---	--
24	---	--	1.3	17	1.7	22	---	--	---	--	---	--
27	---	--	0.8	10	---	--	---	--	---	--	---	--
30	---	--	---	--	---	--	---	--	---	--	---	--
33	---	--	---	--	---	--	---	--	---	--	---	--

Transect	E						F		G	
Station	1		2		3					
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	4.4	64	4.4	64	4.5	65	5.5	75	6.1	76
3	4.3	62	4.5	65	5.0	71	6.0	81	5.8	71
6	4.5	71	4.9	70	5.5	79	4.7	60	5.8	67
9	4.6	60	4.7	63	5.2	73	4.4	55	---	--
12	3.9	51	4.0	52	---	--	---	--	---	--

ROBINSON DISSOLVED OXYGEN AND PER CENT SATURATION
AUGUST 22, 1973

Transect	A						B					
Station	1		2		3		1		2		3	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.3	85	6.3	84	6.4	85	6.2	84	6.3	85	6.3	85
3	6.4	86	6.3	84	6.4	86	6.25	84	6.4	86	6.4	86
6	6.4	86	6.3	84	6.4	86	6.2	84	6.5	88	6.4	86
9	6.3	85	6.3	85	6.4	86	6.2	84	6.5	88	6.3	85
12	6.3	85	6.2	84	6.2	84	6.2	84	6.4	86	6.2	84
15	---	--	6.2	84	---	--	6.2	83	6.3	85	---	--
18	---	--	6.2	8[illegible]	---	--	6.2	84	6.25	84	---	--
21	---	--	6.2	84	---	--	6.2	83	6.1	82	---	--
24	---	--	---	--	---	--	---	--	6.1	82	---	--
27	---	--	---	--	---	--	---	--	6.1	82	---	--
30	---	--	---	--	---	--	---	--	6.1	82	---	--

Transect	C						D					
Station	1		2		3		1		2		3	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.5	88	6.4	86	6.3	86	7.0	99	6.6	92	6.5	93
3	6.5	88	6.4	86	6.25	86	7.0	99	6.7	94	6.5	93
6	---	--	6.4	86	6.25	86	7.0	99	6.7	94	---	--
9	---	--	6.3	85	6.25	86	7.0	97	6.3	86	---	--
12	---	--	6.3	85	6.2	85	6.7	92	---	--	---	--
15	---	--	6.2	84	6.2	84	6.7	92	---	--	---	--
18	---	--	6.2	84	---	--	6.4	88	---	--	---	--
21	---	--	6.2	84	---	--	---	--	---	--	---	--
24	---	--	6.2	84	---	--	---	--	---	--	---	--

Transect	E						F		G		H	
Station	1		2		3							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.2	85	6.0	86	6.0	88	7.2	93	7.3	84	6.6	89
3	6.4	89	6.1	88	5.9	87	6.8	88	7.2	83	6.6	89
6	6.6	89	6.1	88	6.0	88	7.0	88	7.0	81	---	--
9	6.3	82	---	--	6.0	90	---	--	---	--	---	--
12	6.3	81	---	--	6.0	90	---	--	---	--	---	--

Transect	I		J	
	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.9	82	6.4	71
3	6.2	73	6.4	71
6	6.1	72	---	--
9	5.9	70	---	--

ROBINSON DISSOLVED OXYGEN AND PER CENT SATURATION
SEPTEMBER 26, 1973

Transect	A						B					
Station	1		2		3		1		2		3	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.7	85	6.5	82	6.5	82	6.3	80	6.6	82	6.8	86
3	6.6	83	6.4	81	6.5	82	6.3	80	6.4	81	6.7	85
6	6.6	83	6.4	81	6.6	84	6.4	81	6.3	80	6.6	85
9	6.6	83	6.4	81	6.6	84	6.3	80	6.3	81	6.5	84
12	6.6	83	6.4	81	6.6	84	6.3	80	6.3	81	6.2	79
15	---	--	6.4	81	6.5	82	6.1	77	6.2	79	---	--
18	---	--	6.4	81	6.6	84	6.0	76	6.2	79	---	--
21	---	--	6.4	81	---	--	5.9	74	6.2	78	---	--
24	---	--	6.4	81	---	--	5.4	68	5.8	74	---	--
27	---	--	5.6	71	---	--	5.2	66	1.1	14	---	--
30	---	--	4.4	56	---	--	0.2	3	0.2	3	---	--
33	---	--	3.3	42	---	--	---	--	---	--	---	--

Transect	C						D					
Station	1		2		3		1		2		3	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.7	85	6.4	81	6.6	83	6.0	74	6.2	81	6.4	85
3	6.7	85	6.4	81	6.5	84	5.9	74	6.2	81	6.4	85
6	---	--	6.6	83	6.4	82	5.8	73	6.0	79	---	--
9	---	--	6.6	83	6.3	81	5.6	71	---	--	---	--
12	---	--	6.6	83	6.3	81	4.8	61	---	--	---	--
15	---	--	---	--	6.2	80	3.0	37	---	--	---	--
18	---	--	---	--	6.2	80	---	--	---	--	---	--
21	---	--	---	--	---	--	---	--	---	--	---	--
24	---	--	---	--	---	--	---	--	---	--	---	--
27	---	--	---	--	---	--	---	--	---	--	---	--

Transect	E						F		G		H	
Station	1		2		3							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.3	83	6.0	83	5.8	82	6.6	83	6.8	77	7.5	95
3	6.2	81	5.8	82	6.0	83	6.6	83	6.7	76	7.4	94
6	5.8	75	5.1	69	6.0	83	6.2	75	6.6	75	---	--
9	5.3	67	---	--	---	--	6.2	75	---	--	---	--

Station	I	
	D.O.	% Sat.
Depth 0	7.9	83
3	6.8	83
6	6.8	83

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
OCTOBER 24, 1973

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	10.8	125	10.8	125	11.2	127	10.9	125	10.8	123	11.0	124
3	10.8	126	10.6	123	11.2	129	10.9	126	10.8	125	11.0	127
6	10.5	123	10.6	123	11.2	129	10.8	125	10.7	124	10.8	125
9	10.6	124	10.6	123	11.2	129	10.7	123	10.7	124	10.8	125
12	10.6	124	10.7	124	----	---	10.6	123	10.6	123	10.8	.125
15	10.6	124	10.7	124	----	---	----	---	10.6	123	10.8	125
18	10.7	125	10.8	125	----	---	----	---	10.6	123	10.8	125
21	10.6	124	10.7	124	----	---	----	---	10.6	123	10.8	125
24	10.6	124	10.8	125	----	---	----	---	10.6	123	10.7	123
27	----	---	10.8	125	----	---	----	---	10.6	123	10.6	121
30	----	---	10.8	125	----	---	----	---	----	---	----	---

Transect	C						D					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	10.8	125	10.4	120	10.8	125	10.4	125	9.8	117	10.4	125
3	10.8	125	10.4	120	10.8	126	10.3	125	9.8	120	10.4	125
6	10.7	123	10.4	120	10.8	127	----	---	9.8	115	10.0	120
9	10.7	123	10.4	120	----	---	----	---	9.8	109	9.8	117
12	10.6	123	10.4	120	----	---	----	---	----	---	8.8	104
15	10.6	123	10.4	120	----	---	----	---	----	---	6.7	77
18	10.6	123	10.4	120	----	---	----	---	----	---	6.3	70
21	10.4	120	----	---	----	---	----	---	----	---	----	---

Transect	E											
Station	3		2		1		F		G		H	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	10.2	136	10.0	125	9.9	120	10.8	122	10.6	108	11.4	114
3	10.2	136	9.8	127	10.0	126	10.8	123	10.7	108	----	---
6	----	---	9.9	122	9.2	106	10.8	123	10.7	108	----	---
9	----	---	----	---	9.4	104	----	---	----	---	----	---

Transect	I	
	D.O.	% Sat.
Depth 0	10.6	111
3	10.8	110
6	10.4	106

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

November 27, 1973

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	7.5	82	7.5	82	7.9	85	7.9	86	7.6	83	7.9	86
3	7.5	82	7.5	82	7.8	84	7.6	82	7.6	83	7.8	85
6	7.5	82	7.4	80	7.5	80	7.4	80	7.5	82	7.8	85
9	7.5	80	7.2	77	---	--	7.4	80	7.4	79	7.6	83
12	6.6	71	6.9	74	---	--	7.2	77	7.2	77	7.6	83
15	6.0	65	6.6	71	---	--	7.0	75	7.0	75	7.4	80
18	---	--	7.2	66	---	--	5.8	63	6.6	70	6.9	74
21	---	--	6.2	55	---	--	5.5	58	5.5	58	---	--
24	---	--	---	--	---	--	---	--	5.3	56	---	--
27	---	--	---	--	---	--	---	--	4.7	50	---	--
30	---	--	---	--	---	--	---	--	3.2	34	---	--
33	---	--	---	--	---	--	---	--	3.0	37	---	--

Transect	C						D					
Station	3		2		1		3		2		1	
	D.O	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	7.9	87	7.7	84	7.8	85	8.0	87	8.0	87	7.9	87
3	7.9	87	7.8	85	7.8	85	8.0	87	8.0	87	7.9	87
6	7.9	87	7.7	84	7.8	85	---	--	7.9	86	7.8	85
9	7.5	81	7.6	83	---	--	---	--	7.7	84	7.7	84
12	7.5	81	7.6	83	---	--	---	--	---	--	7.7	84
15	6.2	67	7.5	82	---	--	---	--	---	--	5.9	84
18	---	--	7.5	82	---	--	---	--	---	--	---	--
21	---	--	7.5	82	---	--	---	--	---	--	---	--

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat	D.O.	% Sat.
Depth 0	7.1	77	7.2	79	7.1	70	7.5	83	7.4	79	9.0	98
3	7.1	77	7.1	78	7.1	72	7.4	80	7.4	79	8.9	97
6	7.0	76	7.1	78	7.0	72	7.0	74	7.0	73	---	--
9	7.0	76	7.0	77	6.8	68	---	--	---	--	---	--
12	7.0	76	---	--	6.9	65	---	--	---	--	---	--

Transect	I	
	D.O.	% Sat.
Depth 0	8.0	84
3	7.8	82
6	7.6	79

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
DECEMBER 19, 1973

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O	% Sat.
Depth 0	9.3	85	8.8	78	9.2	83	9.0	84	9.0	83	8.8	80
3	9.0	83	8.7	80	9.0	83	8.9	85	8.9	82	8.6	78
6	8.9	82	8.6	78	9.1	84	8.8	84	8.8	83	8.5	78
9	8.8	81	8.6	78	---	---	8.8	84	8.8	83	8.6	78
12	8.8	81	8.6	78	---	---	8.8	84	8.8	83	8.6	78
15	8.8	81	8.6	78	---	---	9.0	84	8.8	83	8.8	81
18	8.8	81	8.6	78	---	---	---	---	8.9	84	8.8	81
21	8.8	81	8.6	78	---	---	---	---	8.9	83	8.8	81
24	8.8	81	8.8	81	---	---	---	---	9.0	84	8.8	81
27	8.9	82	8.8	81	---	---	---	---	9.0	84	8.8	81
30	8.9	82	8.8	81	---	---	---	---	9.0	83	8.8	81
33	8.9	82	8.8	81	---	---	---	---	9.0	83	9.0	83
36	9.0	83	8.9	82	---	---	---	---	9.0	83	---	---

Transect	C						D					
Station	3		2		1		0		2		1	
	D.O.	% Sat.	D.O	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	8.8	84	8.8	81	8.6	78	8.0	88	8.5	84	7.6	72
3	8.6	83	8.7	81	8.4	76	8.6	87	8.4	85	7.5	71
6	8.6	83	8.7	81	8.6	78	8.8	88	8.5	83	7.6	73
9	8.6	83	8.7	81	8.7	78	---	---	8.6	84	7.8	73
12	8.6	82	8.7	81	---	---	---	---	---	---	8.0	74
15	8.6	81	---	---	---	---	---	---	---	---	8.0	74
18	---	---	---	---	---	---	---	---	---	---	8.3	73
21	---	---	---	---	---	---	---	---	---	---	8.4	74
24	---	---	---	---	---	---	---	---	---	---	8.4	74

Transect	E											
Station	3		2		1		F		G		H	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	7.2	88	7.6	81	7.3	75	8.4	72	10.2	80	10.1	91
3	7.0	86	7.8	83	7.3	75	8.7	75	10.3	82	10.1	92
6	7.2	88	8.0	83	7.8	76	9.8	86	10.2	81	10.3	94
9	---	---	---	---	9.8	84	9.8	85	---	---	---	---
12	---	---	---	---	9.3	83	---	---	---	---	---	---

Transect	I											
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	11.3	84										
3	11.0	82										
6	10.9	81										

ROBINSON DISSOLVED OXYGEN AND PER CENT SATURATION
January 22, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	---*	--*	7.4	77	---*	--*	6.6	70	7.4	79	8.3	90
3	---*	--*	---*	--*	---*	--*	7.0	75	7.5	80	8.4	89
6	---*	--*	---*	--*	---*	--*	7.0	74	7.6	81	8.2	87
9	---*	--*	---*	--*	---*	--*	7.0	73	7.7	80	8.0	85
12	---*	--*	---*	--*	---*	--*	7.0	73	7.5	78	7.7	80
15	---*	--*	---*	--*	---*	--*	6.9	71	7.6	79	7.6	78
18	---*	--*	---*	--*	---*	--*	6.9	71	7.2	75	7.7	80
21	---*	--*	---*	--*	---*	--*	6.8	70	6.7	68	7.6	77
24	---*	--*	---*	--*	---*	--*	6.6	67	6.7	63	7.0	73
27	---*	--*	---*	--*	---*	--*	6.4	65	6.6	67	6.6	69
30	---*	--*	---*	--*	---*	--*	6.1	62	6.[illegible]	69	6.3	64
33	---*	--*	---*	--*	---*	--*	---	--	---	--	6.2	63
36	---*	--*	6.2	63	---	--	---	--	---	--	---	--

Transect	C						D					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	6.8	74	6.9	75	6.9	75	6.7	75	6.6	74	6.3	73
3	7.2	77	7.0	76	7.0	75	6.8	75	6.8	76	6.6	75
6	6.9	74	7.0	75	7.0	74	6.7	73	7.0	77	7.0	77
9	6.9	73	7.0	74	---	--	---	--	7.0	75	5.9	73
12	6.9	73	7.0	73	---	--	---	--	7.0	73	6.8	71
15	6.9	72	6.9	71	---	--	---	--	6.8	70	6.7	69
18	6.5	67	6.6	67	---	--	---	--	6.8	65	6.5	66
21	6.4	65	6.4	64	---	--	---	--	---	--	---	--
24	6.0	61	6.4	64	---	--	---	--	---	--	---	--
27	6.0	60	6.0	60	---	--	---	--	---	--	---	--

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	7.0	84	7.3	87	7.4	86	8.3	88	10.2	100	---*	--*
3	6.8	82	7.4	88	7.6	90	8.4	86	10.0	97	---*	--*
6	6.7	79	7.4	86	7.7	89	8.9	91	9.8	94	---*	--*
9	---	--	---	--	8.4	88	8.9	89	---	--	---	--
12	---	--	---	--	8.3	85	---	--	---	--	---	--

Transect	I	
	D.O.	% Sat.
Depth 0	6.9	68
3	7.3	72
6	7.2	70

*Malfunction of DO meter prevented sampling.

ROBINSON DISSOLVED OXYGEN AND PER CENT SATURATION
February 12, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	9.4	93	9.2	92	9.1	90	9.2	93	8.8	88	8.8	88
3	9.0	90	9.0	90	9.0	90	8.9	90	8.8	89	8.7	88
6	8.8	88	9.0	90	8.8	88	8.9	90	8.9	90	8.8	89
9	8.8	88	9.0	90	8.9	89	8.8	88	8.9	90	8.8	89
12	8.8	88	9.0	90	8.9	89	8.9	90	9.1	93	8.9	90
15	8.8	88	8.8	88	8.8	87	8.9	90	9.0	92	8.8	89
18	8.7	87	8.9	89	9.0	89	9.0	92	8.8	89	9.0	90
21	8.7	87	8.8	88	9.0	90	9.0	90	8.9	90	8.9	89
24	8.7	87	8.8	87	---	--	9.0	90	9.0	90	8.9	89
27	8.7	87	8.7	87	---	--	9.0	90	9.0	90	8.8	88
30	8.7	87	8.8	87	---	--	9.0	90	8.9	89	8.8	88
33	8.7	87	8.8	87	---	--	8.8	88	8.8	88	8.6	87
36	8.7	88	8.8	87	---	--	8.8	88	8.8	88	---	--

Transect	C						D					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	8.8	91	9.0	93	8.8	90	8.8	93	8.6	90	8.8	94
3	8.9	92	9.0	93	9.0	93	8.8	94	8.6	92	8.8	95
6	9.0	93	9.0	93	9.0	93	8.6	90	8.6	92	9.0	95
9	9.0	93	9.0	93	8.9	91	---	--	8.6	89	8.8	91
12	8.8	89	8.9	91	---	--	---	--	8.6	89	9.0	92
15	8.6	89	8.8	88	---	--	---	--	---	--	8.9	87
18	8.8	89	8.8	89	---	--	---	--	---	--	8.9	87
21	8.7	89	8.8	88	---	--	---	--	---	--	---	--
24	8.7	89	8.8	89	---	--	---	--	---	--	---	--
27	---	--	8.8	88	---	--	---	--	---	--	---	-

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	8.1	94	8.3	94	8.1	92	8.9	93	11.8	102	10.6	107
3	8.0	93	8.2	94	8.1	92	11.5	101	12.0	102	10.5	105
6	8.2	96	8.4	95	8.6	97	11.4	99	12.0	101	----	---
9	8.2	97	---	--	11.1	103	11.2	97	----	---	----	---
12	8.6	102	---	--	11.1	102	---	--	----	---	----	---
14	8.8	104	---	--	----	---	---	--	----	---	----	---

Transect	1	
	D.O.	% Sat.
Depth 0	12.0	98
3	11.8	93
6	11.5	93
9	11.4	92
12	11.2	90

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
March 18, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	10.2	107	10.0	105	10.1	106	9.7	104	9.7	105	10.0	109
3	10.2	107	10.1	106	10.2	108	10.0	107	10.2	110	10.3	110
6	10.3	107	10.2	106	10.3	107	10.1	110	10.3	107	10.4	109
9	10.3	107	10.2	106	10.4	107	10.2	107	10.1	105	10.2	107
12	10.2	105	10.0	103	10.2	105	10.1	105	10.1	105	10.0	105
15	10.2	105	9.8	100	10.2	105	10.0	106	10.0	104	10.0	105
18	10.2	105	9.9	100	---	---	10.0	106	10.0	104	9.8	103
21	10.0	103	9.8	100	---	---	10.0	106	9.9	103	10.0	105
24	10.0	103	9.8	100	---	---	10.0	106	9.8	101	9.8	103
27	NA	NA	NA	NA	---	---	NA	NA	NA	NA	NA	NA
30	↓	↓	NA	NA	---	---	↓	↓	NA	NA	↓	↓
33			NA	NA	---	---			NA	NA		
36			8.2	NA	---	---			9.3	NA		

Transect	C						D					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	10.0	105	9.8	108	9.6	105	9.7	110	9.8	110	9.8	110
3	10.3	110	10.2	110	10.1	108	10.0	110	10.0	105	9.8	110
6	10.4	110	10.1	107	10.2	106	10.4	113	9.8	106	9.7	105
9	10.2	107	10.1	107	---	---	---	---	9.6	103	10.0	107
12	10.0	104	9.9	104	---	---	---	---	9.4	100	10.1	108
15	10.0	104	9.9	103	---	---	---	---	---	---	10.1	108
18	9.8	[illegible]	9.9	103	---	---	---	---	---	---	10.0	107
21	10.0	104	9.9	103	---	---	---	---	---	---	9.8	105
24	9.8	102	9.0	95	---	---	---	---	---	---	9.8	105
27	---	---	[illegible]	NA	---	---	---	---	---	---	NA	NA

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	9.0	110	9.4	113	8.7	104	9.6	104	10.5	99	11.4	122
3	9.1	111	9.6	115	9.0	107	10.2	105	10.4	97	11.4	120
6	9.3	113	10.0	116	9.3	105	10.2	98	10.4	96	---	---
9	9.4	113	---	---	10.8	108	10.9	105	---	---	---	---
12	9.3	117	---	---	10.8	107	---	---	---	---	---	---
15	8.8	115	---	---	---	---	---	---	---	---	---	---

Transect	I				
	D.O.	% Sat.		D.O.	% Sat.
Depth 0	12.7	122	Depth 9	12.4	117
3	12.7	122	12	12.4	117
6	12.5	119			

NA - not available

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
April 24, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	7.2	82	7.8	87	8.0	91	7.8	89	7.8	89	8.0	92
3	7.7	86	7.8	87	7.8	89	7.8	89	7.8	89	7.8	89
6	8.0	90	7.8	87	8.0	91	7.8	89	7.8	89	7.8	89
9	7.9	89	7.8	88	7.9	90	7.7	87	7.9	91	7.8	89
12	8.0	90	7.9	89	7.9	90	7.8	89	7.8	89	7.8	89
15	8.0	90	7.9	89	---	--	7.8	89	7.8	89	7.8	89
18	8.0	90	8.0	90	---	--	7.8	88	7.8	89	7.8	89
21	8.0	90	7.9	89	---	--	7.7	87	7.7	88	7.8	89
24	8.0	90	8.0	90	---	--	7.2	81	7.8	89	7.8	89
27	---	--	8.0	90	---	--	7.1	81	7.6	86	7.6	87
30	---	--	8.0	90	---	--	7.0	79	7.0	80	7.3	83
33	---	--	8.1	91	---	--	6.9	78	---	--	7.2	81
36	---	--	8.0	90	---	--	---	--	---	--	---	--

Transect	C						D					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	7.6	87	7.5	87	7.8	90	7.2	87	7.2	87	7.4	89
3	7.5	87	7.6	87	7.8	90	7.1	87	7.2	89	7.4	89
6	7.6	89	7.8	90	7.9	92	7.2	87	7.2	87	7.4	89
9	7.6	89	7.8	90	---	--	7.2	84	7.2	85	7.4	88
12	7.6	89	7.7	91	---	--	---	--	---	--	7.5	87
15	7.6	89	7.6	88	---	--	---	--	---	--	7.4	87
18	7.8	91	7.7	90	---	--	---	--	---	--	7.4	85
21	7.6	86	7.8	91	---	--	---	--	---	--	---	--
24	7.5	86	7.8	90	---	--	---	--	---	--	---	--
27	7.4	86	7.8	90	---	--	---	--	---	--	---	--

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0	7.0	93	8.2	85	7.0	86	8.0	90	8.0	86	8.6	96
3	7.1	93	8.2	87	7.0	87	8.0	88	8.0	86	8.6	96
6	7.1	93	8.2	86	7.0	86	8.4	93	8.0	86	9.1	102
9	---	--	---	--	7.5	87	8.2	90	---	--	---	--
12	---	--	---	--	7.2	85	---	--	---	--	---	--

Transect	I	
Depth 0	8.1	87
3	8.2	88
6	8.1	87

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

May 23, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.6	78	6.9	83	6.8	80	6.6	78	6.4	76	6.5	77
3'	6.6	78	6.9	83	6.8	80	6.5	77	6.4	76	6.5	77
6'	6.6	78	6.9	83	6.8	80	6.5	77	6.4	76	6.4	76
9'	6.6	78	6.9	83	6.7	81	6.5	76	6.4	76	6.3	76
12'	6.6	78	6.9	83	6.8	82	6.5	76	6.5	77	6.0	72
15'	6.6	78	6.8	81	6.7	81	6.6	78	6.4	76	6.2	74
18'	6.4	76	6.8	81	6.8	82	6.6	78	6.0	71	6.2	74
21'	5.6	67	6.6	78	---	--	[illegible]	61	5.8	68	5.2	61
24'	---	--	5.0	60	---	--	[illegible]	54	4.9	58	4.7	56
27'	---	--	5.0	59	---	--	4.4	52	4.4	51	4.4	52
30'	---	--	4.2	48	---	--	4.2	49	3.8	54	4.2	49
33'	---	--	4.0	47	---	--	---	--	2.6	30	3.2	38

Transect	C						D					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.8	83	6.8	82	6.8	81	6.8	81	6.7	80	6.5	78
3'	6.8	83	6.8	82	6.7	80	6.7	78	6.6	78	6.4	76
6'	6.8	83	6.8	82	6.7	80	6.6	79	6.6	78	6.5	77
9'	6.7	81	6.8	82	---	--	---	--	6.6	78	6.5	77
12'	6.8	82	6.8	82	---	--	---	--	6.6	78	6.5	77
15'	6.7	81	6.8	82	---	--	---	--	6.6	78	6.3	75
18'	6.5	77	6.8	82	---	--	---	--	5.8	68	6.7	80
21'	5.8	69	6.8	82	---	--	---	--	---	--	---	--
24'	4.1	48	4.4	53	---	--	---	--	---	--	---	--
27'	---	--	4.0	49	---	--	---	--	---	--	---	--

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.3	67	6.0	75	6.4	79	6.2	75	6.8	81	6.7	78
3'	5.3	67	6.1	76	6.4	78	6.2	75	6.6	76	6.7	78
6'	5.3	67	6.2	77	6.4	78	6.4	76	6.0	68	---	--
9'	---	--	---	--	5.7	67	5.4	63	---	--	---	--
12'	---	--	---	--	5.3	63	---	--	---	--	---	--

Transect	I	
	D.O.	% Sat.
Depth 0'	7.0	78
3'	6.8	77
6'	6.8	77
9'	6.8	77

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

June 27, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.5	80	6.5	81	6.4	77	7.5	91	7.4	90	6.4	77
3'	6.4	77	6.5	80	6.3	76	7.4	90	7.4	90	6.4	77
6'	6.4	77	6.4	77	6.3	76	7.1	87	7.5	91	6.5	80
9'	6.3	76	6.4	77	6.3	76	6.9	84	7.5	91	6.5	80
12'	6.3	76	6.4	77	6.2	75	6.8	83	7.5	91	6.5	80
15'	6.3	76	6.4	77	---	--	6.7	82	7.5	91	6.4	77
18'	6.3	76	6.4	77	---	--	6.6	80	7.6	93	6.4	77
21'	6.3	76	6.4	77	---	--	6.4	77	7.6	93	6.5	80
24'	6.2	75	6.4	77	---	--	6.4	77	7.6	93	6.4	77
27'	---	--	6.3	76	---	--	6.3	77	7.6	93	6.6	80
30'	---	--	6.3	76	---	--	---	--	7.5	92	6.6	80
33'	---	--	6.3	76	---	--	---	--	7.4	90	---	--
36'	---	--	6.3	76	---	--	---	--	---	--	---	--

Transect	C						D					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.4	77	6.7	81	6.8	82	6.0	73	7.0	86	6.4	76
3'	6.4	77	6.6	80	6.6	80	6.0	75	6.9	85	6.2	75
6'	6.4	77	6.0	73	---	--	---	--	6.9	85	6.2	75
9'	6.4	77	6.5	79	---	--	---	--	6.9	84	6.2	75
12'	6.5	78	6.6	80	---	--	---	--	6.9	84	6.2	75
15'	6.5	78	6.6	80	---	--	---	--	6.6	80	6.1	74
18'	6.5	79	6.6	80	---	--	---	--	6.5	78	6.0	73
21'	6.4	77	6.6	80	---	--	---	--	---	--	---	--
24'	6.4	77	6.6	80	---	--	---	--	---	--	---	--

Transect	E						F		G		H	
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.6	86	7.0	90	7.1	89	7.1	84	7.0	79	---*	--*
3'	6.6	86	6.8	88	7.1	89	7.0	83	6.9	79	---*	--*
6'	7.0	91	---	--	7.0	90	6.9	82	6.9	80	---*	--*
9'	---	--	---	--	6.9	84	6.8	80	---	--	---*	--*
12'	---	--	---	--	6.8	83	---	--	---	--	---*	--*

Transect	I	
	D.O.	% Sat.
Depth 0'	---*	--*
3'	---*	--*
6'	---*	--*

*Malfunction of D.O. meter prevented sampling.

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

July 11, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.3	97	7.2	96	7.0	94	6.7	90	6.9	93	7.2	96
3'	7.0	94	7.1	95	6.7	89	6.7	90	7.0	94	7.1	95
6'	6.9	92	6.8	90	6.8	90	6.7	90	6.9	93	6.9	93
9'	6.9	92	6.9	92	6.9	93	6.7	90	6.7	89	6.9	93
12'	6.9	92	6.6	88	6.8	90	6.7	90	6.7	89	6.8	90
15'	6.9	92	6.7	89	---	--	6.6	86	6.7	87	6.7	87
18'	6.8	90	6.7	89	---	--	6.2	80	6.4	83	6.5	85
21'	6.8	90	6.7	87	---	--	6.1	78	6.0	77	6.4	82
24'	---	--	5.4	72	---	--	3.9	49	5.0	64	5.3	67
27'	---	--	5.0	64	---	--	3.8	48	3.9	48	3.6	45
30'	---	--	4.2	52	---	--	2.4	30	2.4	29	2.3	27
33'	---	--	3.3	40	---	--	1.5	5	1.1	13	0.7	1

Transect	C						D					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.2	98	7.2	97	7.4	100	6.3	90	6.1	86	6.4	90
3'	6.9	94	7.0	95	7.1	97	6.3	89	6.1	86	6.4	90
6'	6.7	91	6.9	94	6.9	93	5.9	83	5.9	83	6.3	88
9'	6.7	91	6.8	90	---	---	---	--	5.1	67	6.1	80
12'	6.5	87	6.6	88	---	---	---	--	4.3	55	4.4	56
15'	5.9	77	6.5	84	---	---	---	--	2.8	34	3.6	45
18'	5.9	76	5.8	75	---	---	---	--	2.6	32	2.9	36
21'	5.5	70	5.4	69	---	---	---	--	---	--	---	--
24'	4.7	60	---	--	---	---	---	--	---	--	---	--
27'	2.6	32	---	--	---	---	---	--	---	--	---	--

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.3	97	6.0	89	5.9	86	6.7	90	6.6	85	7.7	100
3'	6.0	92	5.6	83	5.7	84	6.5	88	6.5	84	7.7	101
6'	5.9	90	5.5	81	5.1	74	6.0	80	5.8	69	7.6	100
9'	---	--	---	--	5.0	63	5.4	66	---	--	---	---
12'	---	--	---	--	4.1	50	---	--	---	--	---	---

Transect	I	
Depth 0'	---	--
3'	---	--
6'	---	--

H.B. ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
August 29, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.5	72	6.0	77	5.8	75	5.8	75	5.8	77	5.9	77
3'	6.2	82	6.0	77	6.0	78	5.8	75	5.7	76	5.8	77
6'	6.2	82	5.9	77	6.2	82	5.5	73	5.7	76	5.8	77
9'	6.1	82	5.8	76	6.3	83	5.4	71	5.7	75	5.8	77
12'	6.1	82	6.0	77	---	--	5.4	71	5.6	74	5.7	76
15'	5.7	75	6.0	77	---	--	5.4	70	5.6	74	5.6	75
18'	5.0	65	5.8	76	---	--	4.8	63	4.4	57	5.1	67
21'	3.8	50	4.1	53	---	--	3.7	50	3.7	50	4.5	60
24'	3.3	43	2.8	37	---	--	2.8	37	3.1	41	3.4	47
27'	---	--	2.3	29	---	--	2.3	29	2.1	28	2.9	38
30'	---	--	1.8	23	---	--	1.2	14	1.1	14	3.1	41
33'	---	--	1.5	19	---	--	---	--	---	--	---	--
36'	---	--	1.4	17	---	--	---	--	---	--	---	--

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.9	78	5.8	77	5.9	77	5.8	77	5.9	78	5.9	78
3'	5.9	78	5.8	77	6.0	80	6.0	80	6.0	81	6.0	80
6'	5.9	78	5.8	77	6.1	81	6.0	80	5.9	78	6.0	80
9'	5.9	78	5.7	76	---	--	---	--	5.9	78	6.3	84
12'	5.9	78	5.8	77	---	--	---	--	5.9	77	---	--
15'	5.8	77	5.6	75	---	--	---	--	5.4	73	---	--
18'	4.4	57	5.0	67	---	--	---	--	5.4	72	---	--
21'	2.6	34	3.6	47	---	--	---	--	3.6	48	---	--
24'	1.6	21	2.0	26	---	--	---	--	---	--	---	--

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.4	74	5.2	71	5.6	78	4.5	68	4.6	68	4.2	60
3'	5.4	74	5.4	74	5.4	75	4.5	68	4.6	67	4.2	60
6'	5.4	74	5.4	74	5.4	75	4.7	72	5.0	73	4.4	65
9'	---	--	5.4	74	5.4	73	4.8	73	5.5	73	4.8	67
12'	---	--	5.0	68	5.0	67	4.8	74	---	55	---	--
15'	---	--	---	--	4.2	57	---	--	---	--	---	--

Station	F		G		H		I		J		K	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.2	70	6.3	80	6.6	87	7.3	88	6.8	82	5.6	72
3'	5.2	72	6.4	81	6.6	87	7.0	86	6.8	80	6.0	79
6'	4.8	60	5.8	73	---	--	6.8	81	6.8	79	5.6	73
9'	---	--	5.6	67	---	--	---	--	---	--	---	--
12'	---	--	5.6	67	---	--	---	--	---	--	---	--

H. B. ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
September 4, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.7	74	5.3	68	5.3	68	5.7	74	5.4	69	5.5	70
3'	5.6	72	5.2	67	5.3	68	5.7	74	5.4	69	5.5	70
6'	5.6	72	5.3	68	5.4	69	5.7	74	5.4	69	5.4	69
9'	5.6	72	5.3	68	5.4	69	5.6	72	5.4	69	5.4	69
12'	5.6	72	5.3	68	5.8	75	5.6	72	5.4	69	5.4	69
15'	5.6	72	5.2	67	---	--	5.6	72	5.4	69	5.4	69
18'	5.6	72	5.2	67	---	--	5.7	74	5.4	69	5.4	69
21'	5.5	70	5.2	67	---	--	5.7	74	5.4	69	5.3	67
24'	---	--	4.9	63	---	--	5.6	72	5.4	69	5.4	69
27'	---	--	4.4	56	---	--	5.6	72	5.3	67	5.4	69
30'	---	--	4.2	54	---	--	2.5	34	2.2	29	4.4	57
33'	---	--	4.2	54	---	--	---	--	0.3	3	0.2	2

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.8	77	5.8	75	6.1	77	5.8	77	5.5	73	5.7	75
3'	5.8	77	5.8	75	6.0	76	5.8	77	5.4	71	5.6	73
6'	5.8	77	5.8	75	6.1	78	5.7	77	5.4	71	5.6	73
9'	5.7	75	5.8	75	6.2	78	5.8	77	5.4	71	5.6	73
12'	5.7	75	5.8	75	---	--	---	--	5.8	77	5.7	75
15'	5.8	77	5.8	75	---	--	---	--	5.8	77	5.6	73
18'	5.7	75	5.8	75	---	--	---	--	5.5	72	5.5	71
21'	5.2	67	---	--	---	--	---	--	5.5	72	---	--
24'	5.2	67	---	--	---	--	---	--	5.4	70	---	--

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.5	76	5.4	73	0.5	74	4.5	65	4.9	71	5.2	74
3'	5.5	76	5.2	71	5.5	74	4.8	70	4.9	71	5.2	74
6'	5.5	75	5.0	68	5.6	76	5.0	68	5.5	77	5.1	72
9'	---	--	5.2	68	5.5	73	---	--	4.9	65	5.3	70
12'	---	--	5.6	73	5.4	70	---	--	---	--	4.9	63
15'	---	--	5.2	68	4.4	57	---	--	---	--	---	--

Station	F		G		H		I		J		K	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.0	80	5.8	70	6.7	84	5.6	64	5.6	64	5.8	71
3'	6.0	78	5.8	70	6.6	83	5.6	64	5.6	64	5.7	73
6'	5.8	76	5.6	67	6.7	84	5.6	64	5.6	64	6.3	75
9	4.9	62	---	--	---	--	5.6	64	---	--	---	--

H. B. ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
October 16, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.4	83	7.6	85	7.7	86	7.6	86	7.5	83	7.8	87
3'	7.3	81	7.6	85	7.7	86	7.6	86	7.4	83	7.7	88
6'	7.3	81	7.5	83	7.7	86	7.5	84	7.4	83	7.7	88
9'	7.3	81	7.5	83	7.6	85	7.5	84	7.4	83	7.6	87
12'	7.2	80	7.4	82	7.5	84	7.6	86	7.3	82	7.6	87
15'	6.9	77	7.4	82	---	--	7.5	84	7.2	80	7.6	87
18'	5.2	57	6.8	76	---	--	7.4	84	7.1	79	6.7	75
21'	4.6	50	5.2	57	---	--	7.3	82	6.7	73	6.0	66
24'	---	--	3.4	40	---	--	5.0	55	6.0	67	5.7	63
27'	---	--	2.8	30	---	--	3.8	41	3.6	39	2.3	25
30'	---	--	2.7	28	---	--	3.7	40	3.5	38	2.8	30
33'	---	--	---	--	---	--	---	--	---	--	2.8	30

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.1	93	7.9	89	7.7	87	7.7	89	7.8	90	7.7	89
3'	8.0	91	7.9	89	7.8	88	7.7	89	7.6	88	7.6	88
6'	7.9	90	7.9	89	7.7	87	7.7	89	7.7	89	7.7	89
9'	7.9	90	7.8	88	---	--	7.7	88	7.6	88	7.7	89
12'	7.9	90	7.8	88	---	--	7.8	89	7.4	86	7.7	89
15'	7.8	89	7.8	88	---	--	---	--	7.4	84	7.7	87
18'	7.3	83	7.8	88	---	--	---	--	6.6	73	7.2	82
21'	6.4	70	6.9	76	---	--	---	--	6.0	67	5.6	62
24'	4.0	44	5.1	56	---	--	---	--	---	--	---	--

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.0	83	7.0	83	7.0	85	5.2	67	5.3	67	5.7	72
3'	7.0	83	6.9	82	7.0	85	5.2	68	5.3	68	5.7	73
6'	7.0	83	7.0	83	7.0	85	5.2	68	5.5	69	5.7	72
9'	---	--	7.0	83	7.0	84	5.2	68	---	--	6.4	79
12'	---	--	---	--	7.1	84	5.2	68	---	--	---	--
15'	---	--	---	--	7.1	80	---	--	---	--	---	--

Station		F		G		H		I*		J		K*	
		D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth	0'	6.6	80	7.8	88	8.3	92	7.3	73	7.9	81	7.3	78
	3'	6.7	82	7.6	87	8.3	92	7.3	73	7.9	81	7.1	76
	6'	7.4	86	7.8	34	---	--	7.1	71	---	--	7.1	76

*October 17, 1974

H. B. ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
November 13, 1974

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.5	79	8.0	87	7.6	81	7.5	78	8.2	88	8.2	88
3'	7.5	80	8.0	87	7.7	82	7.5	79	8.1	83	8.2	88
6'	7.5	80	8.1	87	7.7	82	7.5	80	8.0	87	8.2	90
9'	7.6	81	8.0	87	7.8	83	7.6	81	8.1	87	8.1	88
12'	7.6	81	8.1	88	8.0	87	7.6	81	8.0	86	8.0	87
15'	7.6	81	8.1	88	---	--	7.6	81	7.9	85	8.0	85
18'	7.5	80	8.2	89	---	--	7.6	81	7.9	85	8.0	86
21'	---	--	8.1	88	---	--	7.5	80	7.9	85	8.0	86
24'	---	--	8.1	88	---	--	---	--	7.9	85	7.9	85
27'	---	--	8.0	87	---	--	---	--	7.8	84	7.9	85
30'	---	--	8.0	87	---	--	---	--	7.8	84	7.8	84
33'	---	--	7.9	84	---	--	---	--	---	--	7.2	77

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.3	90	8.1	88	8.5	94	8.5	95	8.2	91	8.0	89
3'	8.1	88	8.1	88	8.5	94	8.2	92	8.2	93	8.0	90
6'	8.1	88	8.1	88	8.5	94	7.9	88	8.2	93	7.9	88
9'	8.0	87	8.2	90	---	--	7.4	81	7.8	87	7.8	86
12'	7.9	86	7.9	86	---	--	6.9	75	7.6	83	7.8	86
15'	7.9	86	7.9	86	---	--	6.9	75	7.2	78	---	--
18'	7.9	86	7.9	86	---	--	---	--	7.4	80	---	--
21'	7.7	83	8.0	87	---	--	---	--	6.5	71	---	--
24'	7.7	83	8.0	87	---	--	---	--	---	--	---	--

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.1	93	7.9	90	7.9	92	7.6	97	7.5	93	7.2	88
3'	8.0	90	7.9	92	7.9	92	7.6	98	7.6	94	7.5	90
6'	7.9	88	7.7	87	7.9	92	7.6	98	8.2	97	7.9	93
9'	---	--	7.7	87	7.6	85	---	--	---	--	8.9	91
12'	---	--	7.5	83	7.6	84	---	--	---	--		
15'	---	--	---	--	7.0	77	---	--	---	--		

Station		F		G		H*		I*		J		K	
		D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth	0'	7.9	84	9.1	86	8.0	83	9.5	85	9.7	85	7.1	74
	3'	8.2	86	9.2	86	8.2	85	9.4	84	9.7	85	7.1	74
	6'	8.6	85	9.2	86	---	--	9.3	83	---	--	7.4	77

* on November 14, 1974

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

December 11, 1974

Transect		A						B					
Station		3		2		1		3		2		1	
		D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
December	Depth 0'	10.6	99	9.6	88	10.8	102	10.6	103	10.6	101	10.6	100
	3'	10.5	98	9.6	89	10.8	102	10.5	102	10.5	102	10.5	100
	6'	10.4	97	9.6	89	10.7	101	10.4	100	10.4	100	10.4	99
	9'	10.4	97	9.8	92	10.6	99	10.4	100	10.4	100	10.4	99
	12'	10.4	97	9.8	92	10.6	99	10.3	99	10.4	100	10.4	99
	15'	10.4	97	9.8	92	10.6	99	10.3	99	10.4	100	10.4	99
	18'	10.4	97	9.9	93	--	--	10.3	99	10.4	98	10.4	99
	21'	10.4	97	9.9	93	--	--	10.4	99	10.4	98	10.4	99
	24'	10.4	97	10.0	94	--	--	10.6	101	10.4	98	10.4	99
	27'	--	--	10.1	95	--	--	10.4	99	10.6	100	10.4	99
	30'	--	--	10.1	95	--	--	10.4	99	10.6	100	10.4	99
	33'	--	--	--	--	--	--	--	--	--	--	10.4	99

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	10.6	103	10.6	102	10.6	101	10.4	106	9.9	98	9.9	98
3'	10.6	103	10.4	100	10.6	100	10.6	106	10.2	103	10.4	102
6'	10.5	102	10.4	100	10.6	100	10.8	106	10.5	103	10.4	102
9'	10.5	102	10.4	100	--	--	10.8	106	10.3	103	10.5	102
12'	10.5	102	10.4	100	--	--	10.6	103	10.1	97	10.5	102
15'	10.5	102	10.4	100	--	--	10.6	102	10.1	97	10.4	101
18'	10.4	100	10.4	100	--	--	10.2	97	10.1	96	10.4	101
21'	9.8	93	10.4	87	--	--	--	--	10.1	95	--	--
24'	9.6	92	9.2	86	--	--	--	--	--	--	--	--

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	10.1	107	9.4	98	9.8	103	10.2	114	9.2	102	9.0	99
3'	10.4	108	9.4	97	9.8	103	10.2	115	9.4	102	9.0	100
6'	10.4	107	10.4	107	10.6	104	10.2	116	10.2	105	9.4	102
9'	--	--	10.4	101	10.8	107	--	--	--	--	12.2	110
12'	--	--	10.4	100	10.8	105	--	--	--	--	12.2	109
15'	--	--	--	--	11.2	104	--	--	--	--	--	--
18'	--	--	--	--	11.2	103	--	--	--	--	--	--

Station	F		G		H		I		K			
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	10.8	106	13.8	112	10.1	97	12.7	120	10.1	98		
3'	12.8	110	13.5	108	10.0	95	12.4	114	10.0	96		
6'	12.5	107	13.4	107	10.0	95	12.2	113	9.8	93		
9'	--	--	--	--	--	--	11.7	97	--	--		

The Dissolved Oxygen Meter was checked and recalibrated upon its return to the Apex Laboratory. No significant variation was noted. Therefore, it is assumed that field readings were correct, and supersaturation existed in both the impoundment and Black Creek.

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

January 16, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.7	93	10.2	98	9.4	88	9.9	97	9.8	94	10.2	98
3'	9.4	91	10.0	97	9.6	91	9.8	96	9.7	96	9.8	96
6'	9.4	91	10.0	97	9.8	95	9.7	95	9.6	95	9.8	96
9'	9.4	92	10.0	97	10.0	94	9.6	94	9.6	95	9.8	96
12'	9.6	94	10.0	97	--	--	9.6	94	9.6	95	9.8	96
15'	9.6	94	10.0	97	--	--	9.6	94	9.7	96	9.8	96
18'	9.6	94	10.1	98	--	--	9.6	94	9.7	96	9.8	96
21'	9.6	93	10.1	98	--	--	9.6	94	9.7	96	9.8	96
24'	9.6	94	10.2	98	--	--	9.8	95	9.7	96	9.9	97
27'	--	--	10.2	98	--	--	9.8	95	9.8	97	9.9	97
30'	--	--	10.2	98	--	--	9.7	94	9.8	97	9.8	96
33'	--	--	10.2	98	--	--	9.6	93	9.8	97	9.8	96

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O	% Sat.
Depth 0'	9.9	98	9.9	97	9.7	96	9.9	99	9.9	99	9.8	100
3'	9.8	98	9.8	97	9.7	99	9.8	98	9.9	99	9.8	98
6'	9.7	96	9.7	95	9.6	94	9.8	98	9.8	98	9.8	98
9'	9.7	96	9.6	94	9.6	94	9.8	98	9.8	98	9.7	97
12'	9.7	96	9.7	96	--	--	9.6	97	9.8	98	9.7	97
15'	9.7	96	--	--	--	--	9.6	95	9.8	97	9.7	97
18'	9.7	96	--	--	--	--	9.4	93	9.6	95	9.5	94
21'	9.7	96	--	--	--	--	--	--	9.5	94	9.3	91
24'	9.7	96	--	--	--	--	--	--	9.5	94	9.2	90
27'	9.7	96	--	--	--	--	--	--	--	--	--	--

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.9	103	7.5	100	9.6	100	9.8	107	8.9	100	9.0	101
3'	9.9	103	9.5	100	9.6	101	9.6	105	9.0	100	9.0	103
6'	9.9	103	9.7	101	9.6	100	9.8	107	9.4	102	9.2	103
9'	9.8	102	9.8	101	9.6	98	11.4	118	--	--	11.4	112
12'	--	--	10.0	103	10.0	101	--	--	--	--	11.5	107
15'	--	--	--	--	10.5	100	--	--	--	--	12.0	107
18'	--	--	--	--	10.2	97	--	--	--	--	--	--
21'	--	--	--	--	10.0	95	--	--	--	--	--	--

Station	F		G		H		I		K	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	10.7	107	13.2	107	11.4	111	13.5	114	10.8	104
3'	12.8	112	13.2	107	11.5	112	13.5	112	10.8	104
6'	13.3	114	12.8	103	11.5	113	13.5	112	10.7	103
9'	13.3	112	12.8	103	11.6	114	13.0	110	---	---
12'	---	---	12.6	102	---	---	---	---	---	---

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

February 5, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.8	85	8.9	86	8.8	85	8.9	86	8.8	83	8.6	82
3'	8.7	84	8.8	85	8.8	85	8.8	85	8.8	85	8.6	82
6'	8.6	83	8.8	85	8.7	84	8.8	85	8.7	83	8.6	82
9'	8.6	83	8.7	84	8.7	84	8.8	85	8.8	85	8.6	82
12'	8.6	83	8.7	84	8.8	85	8.8	85	8.7	83	8.6	82
15'	8.6	83	8.7	84	8.7	84	8.8	85	8.7	83	8.6	82
18'	8.6	83	8.7	84	---	--	8.8	85	8.8	85	8.6	82
21'	8.7	84	8.7	84	---	--	8.8	85	8.8	85	8.6	82
24'	---	--	8.7	84	---	--	8.8	85	8.8	85	8.6	82
27'	---	--	8.7	84	---	--	8.8	85	8.8	85	8.6	82
30'	---	--	8.7	84	---	--	8.8	85	8.8	85	8.6	82

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.6	84	8.7	85	8.9	86	8.6	85	8.4	83	7.9	76
3'	8.6	84	8.7	85	8.8	85	8.5	85	8.4	83	7.9	76
6'	8.5	83	8.7	85	8.9	86	8.6	85	8.6	88	7.9	76
9'	8.5	82	8.7	85	---	--	8.6	85	8.8	85	8.3	78
12'	8.6	83	8.8	85	---	--	8.7	83	8.9	86	8.5	78
15'	8.6	83	8.8	85	---	--	---	--	8.9	86	8.5	78
18'	8.6	83	8.8	85	---	--	---	--	8.9	86	8.5	78
21'	8.6	83	8.8	85	---	--	---	--	8.9	86	8.5	78
24'	8.6	83	8.8	85	---	--	---	--	8.9	86	8.5	78

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.0	86	8.8	86	8.5	84	7.6	83	8.1	79	8.0	84
3'	8.8	87	8.6	84	8.3	81	7.7	84	8.4	87	7.6	80
6'	8.7	86	8.6	84	8.3	81	7.4	76	8.7	87	7.3	82
9'	8.7	85	8.6	84	8.5	83	---	--	---	--	10.7	94
12'	---	--	8.6	84	8.5	82	---	--	---	--	10.6	93
15'	---	--	---	--	8.5	82	---	--	---	--	----	--
18'	---	--	---	--	8.5	80	---	--	---	--	----	--

Station	F		G		H		I*		K	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.6	83	11.1	88	9.6	90	11.9	100	9.0	84
3'	10.8	[illegible]	11.0	87	9.8	91	11.6	96	9.1	85
6'	10.6	[illegible]	13.4	107	---	--	11.5	95	9.2	86
9'	---	--	14.0	112	---	--	11.4	95	9.2	87

* Sampled February 6, 1975

H. B. ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
March 5, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.4	84	8.5	83	8.4	82	8.4	84	8.5	84	8.2	79
3'	8.3	82	8.4	82	8.2	79	8.6	86	8.3	82	8.2	80
6'	8.2	81	8.3	81	8.0	77	8.6	84	8.3	81	8.2	78
9'	8.1	78	8.4	81	7.9	76	8.6	82	8.4	82	8.1	77
12'	8.1	77	8.3	80	7.9	76	8.5	82	8.4	81	8.1	77
15'	8.1	77	8.3	80	7.9	76	8.5	81	8.5	80	8.2	77
18'	8.2	78	8.2	78	7.9	76	8.4	81	8.5	82	8.0	76
21'	8.2	78	8.2	78	7.9	76	8.4	81	8.5	82	8.0	76
24'	---	--	8.2	78	---	--	8.4	81	8.4	81	8.1	77
27'	---	--	8.0	76	---	--	8.4	81	8.4	81	8.2	78
30'	---	--	8.0	76	---	--	8.2	78	8.4	81	8.2	77
33'	---	--	8.0	76	---	--	---	--	8.4	81	8.2	77
36'	---	--	---	--	---	--	---	--	---	--	7.8	73

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.4	87	8.8	90	8.8	89	8.3	89	8.6	92	8.4	87
3'	8.6	88	8.7	87	8.9	89	8.3	87	8.6	89	8.4	87
6'	8.7	87	8.7	86	9.0	88	8.4	84	9.0	90	8.8	88
9'	8.8	86	8.7	86	---	--	8.4	83	8.7	87	8.8	87
12'	8.7	85	8.6	84	---	--	---	--	8.6	85	8.8	87
15'	8.6	84	8.5	83	---	--	---	--	8.6	85	---	--
18'	8.6	84	---	--	---	--	---	--	8.8	86	---	--
21'	8.5	82	---	--	---	--	---	--	8.9	86	---	--
24'	8.4	80	---	--	---	--	---	--	8.8	85	---	--

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.4	92	7.6	82	7.8	85	8.4	97	7.4	[illegible]	6.7	73
3'	8.6	89	7.9	82	8.1	86	8.6	99	7.4	83	7.2	80
6'	8.6	87	8.2	84	8.3	84	8.7	100	8.0	87	7.0	75
9'	---	--	8.5	84	8.1	83	---	--	---	--	9.8	87
12'	---	--	---	--	8.1	82	---	--	---	--	9.5	86
15'	---	--	---	--	8.3	81	---	--	---	--	---	--
18'	---	--	---	--	8.2	77	---	--	---	--	---	--

Station	F		G		H*		I*		K*	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.9	68	10.4	95	11.2	105	9.6	87	11.1	112
3'	8.3	77	10.4	90	11.2	107	8.9	79	10.8	106
6'	9.2	77	10.2	88	11.6	111	8.4	73	10.4	102
9'	9.2	76	----	--	----	---	8.6	76	10.4	102
12'	9.0	75	----	--	----	---	---	--	----	---

*Sampled March 6, 1975

H. B. ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
March 20, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.9	101	9.9	101	10.2	105	9.9	102	9.9	102	10.0	101
3'	9.9	101	9.9	101	10.2	105	9.8	100	9.8	100	9.9	101
6'	9.9	101	10.0	102	10.1	104	9.8	100	9.8	100	9.8	100
9'	9.9	100	9.9	100	---	---	9.8	100	9.8	100	9.8	100
12'	9.9	100	9.9	100	---	---	9.8	100	9.8	100	9.6	100
15'	9.9	100	9.9	100	---	---	9.8	100	9.8	100	9.8	99
18'	9.9	100	10.0	102	---	---	9.8	100	9.8	100	9.8	99
21'	9.9	100	10.0	102	---	---	9.8	100	9.8	100	9.8	98
24'	---	---	10.0	102	---	---	9.8	100	9.8	100	9.8	98
27'	---	---	9.9	100	---	---	9.8	100	9.8	100	9.8	98
30'	---	---	9.9	100	---	---	9.8	100	9.7	98	9.8	98
33'	---	---	9.9	100	---	---	9.7	98	9.7	98	9.7	98
36'	---	---	9.9	100	---	---	---	---	---	---	---	---

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.8	101	9.7	100	9.5	99	9.4	100	9.4	100	9.5	101
3'	9.8	101	9.7	101	9.5	98	9.5	100	9.4	100	9.5	101
6'	9.8	101	9.8	102	9.7	100	9.8	101	9.5	102	9.5	101
9'	9.8	100	9.8	101	---	---	9.8	100	9.9	102	9.5	97
12'	10.0	102	9.8	101	---	---	---	---	9.9	102	9.9	101
15'	10.0	101	9.8	99	---	---	---	---	9.9	100	9.8	100
18'	10.0	101	9.8	99	---	---	---	---	9.8	99	---	---
21'	10.0	101	9.7	98	---	---	---	---	9.8	99	---	---
24'	9.8	98	---	---	---	---	---	---	9.6	97	---	---
27'	9.8	98	---	---	---	---	---	---	---	---	---	---

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.5	104	9.6	104	9.4	103	9.0	104	9.4	107	9.2	105
3'	9.5	104	9.6	104	9.4	103	9.0	104	9.4	106	9.1	105
6'	9.5	104	9.6	104	9.4	103	9.3	108	10.1	109	9.8	106
9'	---	---	9.5	102	9.4	102	---	---	10.5	105	11.3	109
12'	---	---	9.9	104	9.8	104	---	---	---	---	11.1	107
15'	---	---	9.9	102	9.8	101	---	---	---	---	---	---
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Station	F		G		H		I	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	10.9	106	10.5	101	11.8	124	11.6	115
3'	10.8	104	10.1	98	11.6	122	11.6	115
6'	10.8	104	10.1	97	11.5	120	11.4	114
9'	10.7	103	---	---	---	---	11.3	112

H. B. ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
May 12, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth* 0'	8.4	99	8.6	101	8.4	100	8.2	98	8.2	98	8.4	101
3'	8.3	96	8.8	101	8.6	102	8.4	100	8.4	100	8.6	103
7'	8.7	99	8.7	100	8.7	99	8.4	97	8.4	98	8.7	101
10'	8.7	99	8.6	98	8.5	97	8.2	94	8.3	95	8.4	96
13'	8.1	92	8.4	95	8.2	93	8.2	94	8.2	94	8.4	95
16'	8.1	92	8.2	93	8.1	92	8.1	93	8.2	94	8.3	94
20'	7.2	82	8.0	91	7.8	88	6.9	78	8.0	91	7.9	88
23'	6.9	78	7.1	80	---	---	6.9	78	7.5	85	7.3	83
26'	6.3	70	7.1	79	---	-	6.7	76	6.6	74	6.8	77
30'	---	--	5.9	66	---	---	6.0	67	6.0	67	5.8	65
33'	---	--	6.1	68	---	---	5.2	58	6.0	66	5.6	62
36'	---	--	5.2	58	---	---	---	---	5.4	60	3.5	39
39'	---	--	---	--	---	---	---	---	---	---	0.5	5

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.4	102	8.6	103	8.4	100	8.4	102	8.5	103	8.3	100
3'	8.6	103	8.7	104	8.6	104	8.6	103	8.6	104	8.7	107
7'	8.6	100	8.6	100	8.7	103	8.6	103	8.6	103	8.6	102
10'	8.6	99	8.6	98	---	---	8.5	100	7.8	89	8.3	96
13'	8.0	92	7.8	88	---	---	---	---	---	---	8.0	92
16'	7.9	89	7.4	84	---	---	---	---	---	---	7.6	86
20'	5.9	65	6.5	73	---	---	---	---	---	---	6.5	72
23'	5.6	62	5.0	56	---	---	---	---	---	---	6.3	69
26'	5.3	58	4.8	53	---	---	---	---	---	---	---	---

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.4	102	8.4	101	8.6	104	7.9	95	8.0	98	7.9	95
3'	8.6	104	8.5	102	8.6	104	8.0	96	8.1	96	8.1	97
7'	8.6	103	8.4	100	8.5	103	8.1	97	7.9	93	8.3	100
10'	---	---	8.3	97	8.0	91	8.1	97	---	--	7.3	79
13'	---	---	---	---	7.7	87	8.1	97	---	--	6.8	73
16'	---	---	---	---	6.2	68	7.9	94	---	--	---	---
20'	---	---	---	---	5.8	63	---	--	---	--	---	---

Station	F		G		H		I		J	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.4	100	8.8	105	9.4	107			8.4	96
3'	8.5	103	7.2	87	9.6	109			8.4	97
7'	7.5	81	7.1	73	9.5	107			8.5	97
10'	7.0	75	7.0	73	---	---			8.4	97

Dissolved oxygen was recorded at meter intervals.

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
May 27, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.0	99	7.6	96	7.8	97	8.1	102	8.1	102	8.1	102
3'	8.1	98	7.7	94	7.6	94	8.1	100	8.2	101	8.1	100
6'	8.0	96	7.9	96	7.8	95	7.9	96	7.8	95	8.0	97
9'	7.6	91	8.1	97	7.5	90	7.5	90	7.5	90	7.3	87
12'	7.4	88	7.8	93	7.4	88	7.4	87	7.2	85	7.3	87
15'	7.2	86	7.2	85	6.5	77	7.1	84	7.0	83	7.0	84
18'	6.9	81	6.6	78	-	-	6.7	78	6.7	78	6.7	77
21'	6.0	69	6.1	70	-	-	5.7	66	6.4	75	6.6	77
24'	-	-	5.6	64	-	-	5.7	66	5.7	66	6.1	70
27'	-	-	5.2	59	-	-	5.1	59	4.9	56	5.1	58
30'	-	-	4.6	52	-	-	3.0	34	2.9	32	2.9	[illegible]
33'	-	-	3.4	39	-	-	2.4	26	2.4	26	2.6	29
36'	-	-	1.8	20	-	-	-	-	-	-	-	-
39'	-	-	1.9	21	-	-	-	-	-	-	-	-

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.0	102	8.0	101	8.1	102	8.1	103	8.1	104	8.1	104
3'	8.0	101	8.0	100	8.0	98	8.0	100	7.9	98	8.0	103
6'	7.9	97	7.9	98	8.0	98	7.9	98	7.9	98	7.9	98
9'	7.4	90	7.5	91	-	-	7.0	86	7.0	85	7.4	90
12'	7.3	88	7.2	86	-	-	6.8	81	7.0	84	7.1	85
15'	6.8	81	6.8	80	-	-	5.9	82	6.7	80	6.3	74
18'	5.8	68	6.1	71	-	-	5.5	64	4.8	54	6.2	73
21'	5.1	59	4.8	56	-	-	4.6	52	4.5	53	-	-
24'	4.7	54	4.7	54	-	-	4.5	51	2.3	51	-	-
27'	3.1	35	-	-	-	-	-	-	-	-	-	-

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.8	102	7.9	102	8.0	84	6.9	88	7.9	103	7.9	103
3'	7.9	100	7.7	97	7.3	82	6.9	88	7.9	102	7.9	104
6'	7.3	94	7.5	94	7.4	82	6.9	88	7.5	95	7.5	94
9'	7.2	89	6.5	79	6.4	80	7.0	89	-	-	6.2	71
12'	-	-	6.1	72	6.2	76	6.9	88	-	-	5.8	66
15'	-	-	-	-	6.0	73	-	-	-	-	-	-
18'	-	-	-	-	4.9	73	-	-	-	-	-	-
21'	-	-	-	-	-	-	-	-	-	-	-	-

Station	F		G		H		I		K	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.9	104	8.1	105	8.8	107	7.5	93	6.5	75
3'	7.9	97	8.0	103	8.8	106	7.5	93	6.7	78
6'	7.3	88	6.0	68	8.9	107	6.3	77	6.5	74
9'	-	-	-	-	-	-	-	-	6.9	78

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

May 22, 197

Sampling Station	Surface		3'		6'		9'		12'		15'	
	D.O.	%	D.O.	%	D.O.	%	D.O.	%	D.O.	%	D.O.	%
1	8.0	105	7.7	98	7.3	91	7.2	89	6.5	82		
2	7.9	101	7.9	102	7.4	95	7.2	89	6.1	70	5.9	67
3	8.0	105	8.0	106	7.8	100	7.6	90	5.9	69		
4	8.0	101	8.0	106	7.7	100	7.7	97	6.9	78		
5	7.7	98	7.3	93	7.2	90	7.2	89				
6	8.0	103	8.0	103	7.2	90	7.1	89	5.9	67		
7	8.1	108	7.9	105	7.3	91	7.2	89	6.0	70		
9	8.0	104	7.8	100	6.9	85						
10	7.9	101	7.3	94	7.2	91	6.9	84				
11	7.9	101	7.8	100	7.3	91	7.1	88	5.8	63		
12	8.0	104	7.9	104	7.3	93	7.2	89	5.5	67		
13	8.0	105	7.9	104	7.9	104	7.0	85	3.4	38		
14	7.8	100	7.1	90	6.9	87						
15	8.0	105	7.4	96	7.1	90	7.0	90				
16	7.9	101	7.9	101	7.5	95						
17	7.9	101	7.9	101	7.4	94	7.0	83	5.5	62		
18	7.9	104	7.9	104	7.4	94	7.0	84	4.8	54		
19	7.7	100	7.2	91								
20	7.9	104	7.5	97								
21	7.9	104	7.8	103	7.2	90	6.2	72	5.9	68		
22	7.9	104	7.9	104	7.5	95	6.2	71	5.8	66		
23	7.9	104	7.9	105	7.1	90	7.0	84	5.8	66		
24	8.8	116										
25	8.3	109	8.2	109								
26	8.0	105	7.9	105	6.9	86	6.6	78	5.9	67		
27	7.8	102	7.8	102	7.1	80	6.2	71	6.0	68		
28	8.0	105	7.9	105	7.6	95						
29	8.0	105	7.8	100								
30	8.0	105	7.9	105	7.3	94	6.1	70	6.1	69		
31	7.9	105	7.9	105	7.8	96	6.5	76	5.4	62		
32	8.4	115										
33	7.8	102	7.7	101	7.3	90	6.1	70	6.0	70		
34	7.5	100	7.6	101	7.2	90	6.6	80	5.6	65		

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
June 10, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.1	100	7.8	98	8.0	100	8.2	103	8.1	102	7.8	98
3'	7.8	98	7.9	99	7.9	99	8.2	103	8.1	102	7.8	98
6'	8.0	100	7.7	97	7.9	99	8.2	103	8.2	103	7.8	98
9'	8.1	102	7.7	98	7.9	100	8.2	104	8.2	104	7.8	98
12'	8.1	102	7.5	94	8.0	101	8.1	103	8.2	103	7.9	100
15'	8.1	101	7.3	91	8.0	100	8.0	101	8.1	102	7.9	98
18'	8.1	101	7.6	96	–	–	8.0	100	8.1	102	7.7	97
21'	8.1	101	7.8	98	–	–	7.9	99	8.1	101	7.7	97
24'	8.1	102	7.9	99	–	–	7.9	100	7.9	100	7.6	96
27'	–	–	7.9	100	–	–	6.4	80	7.6	95	7.2	89
30'	–	–	–	–	–	–	–	–	3.7	45	7.0	88
33'	–	–	–	–	–	–	–	–	2.3	28	2.2	27

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.7	100	8.1	102	6.3	77	7.9	101	8.0	101	7.9	100
3'	7.8	102	8.1	102	6.5	82	7.8	97	8.0	101	7.9	97
6'	7.8	101	8.1	102	6.5	82	7.8	100	8.1	103	7.9	100
9'	7.7	100	8.1	103	–	–	7.8	100	8.1	100	7.9	100
12'	7.7	99	8.2	104	–	–	–	–	8.1	103	7.8	98
15'	7.8	98	8.2	104	–	–	–	–	8.1	103	7.8	97
18'	0.2	3	8.2	103	–	–	–	–	7.8	98	–	–
21'	0.2	3	8.2	104	–	–	–	–	7.2	89	–	–
24'	–	–	7.1	87	–	–	–	–	6.1	76	–	–
27'	–	–	6.8	84	–	–	–	–	–	–	–	–

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.7	102	7.7	104	7.8	101	7.5	110	7.5	108	7.6	108
3'	7.8	104	7.7	103	7.8	101	7.6	111	7.5	109	7.6	109
6'	7.6	100	7.4	94	7.6	97	7.6	112	7.3	100	7.6	105
9'	–	–	7.0	87	7.3	93	7.7	114	–	–	6.6	83
12'	–	–	5.5	69	6.6	83	7.7	114	–	–	4.9	60
15'	–	–	–	–	5.1	63	7.7	114	–	–	–	–
18'	–	–	–	–	3.2	40	–	–	–	–	–	–

Station	F		G		H		K	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.8	110	8.0	95	9.1	113	8.3	103
3'	8.1	105	7.9	93	9.2	114	8.2	101
6'	7.5	94	7.5	88	–	–	8.3	103
9'	6.8	84	–	–	–	–	–	–

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

June 10, 1975

Sampling Station	Surface D.O.	Surface %	3' D.O.	3' %	6' D.O.	6' %	9' D.O.	9' %	12' D.O.	12' %	15' D.O.	15' %
1	7.7	108	7.7	108	7.6	105	5.8	73				
2	7.5	105	7.7	106	6.9	90	5.6	70	4.4	55		
3	7.6	105	7.5	102	7.6	99	6.0	75	4.3	54		
4	7.8	106	7.6	102	7.4	95	6.6	83				
5	7.8	106	7.7	110	7.5	100	6.8	85				
6	7.6	104	7.7	105	7.7	109	7.2	90	4.2	52		
7	7.6	110	7.5	110	7.3	97	6.0	76	3.8	47		
9	7.8	107	7.7	106	7.7	105						
10	7.7	108	7.7	105	7.1	95	4.6	58				
11	7.4	106	7.7	105	7.4	100	5.5	69	3.9	49		
12	7.5	106	7.5	105	7.6	103	6.8	84	2.5	30		
13	7.6	105	7.6	105	7.6	103	6.3	80	0.9	10		
14	7.6	110	7.6	110	7.5	110						
15	7.6	110	7.6	110	7.5	105	5.2	65				
16	7.5	108	7.5	110	7.3	100						
17	7.5	105	7.5	105	7.5	103	6.6	83	2.0	24		
18	7.6	106	7.6	105	7.2	98	6.5	81	2.4	28		
19	7.7	110	7.7	111								
20	7.7	110	7.7	112								
21	7.6	109	7.5	108	7.6	102	6.8	86	2.9	35		
22	7.5	105	7.6	107	7.6	102	6.8	86	2.5	30		
23	7.6	106	7.6	107	7.6	102	6.3	80				
24	8.6	115										
25	7.8	110	7.6	109								
26	7.4	106	7.4	106	7.7	104	6.8	86	5.5	69		
27	7.6	108	7.6	109	7.6	104	6.6	84	4.9	60		
28	7.5	106	7.5	109	7.5	105						
29	7.5	106	7.3	103								
30	7.4	105	7.5	105	7.4	100	6.8	86	6.6	80		
31	7.6	107	7.5	105	7.5	104	6.3	80	5.5	70		
32	7.2	99										
33	7.5	105	7.5	105	7.6	104	6.9	86	6.6	81		
34	7.5	105	7.5	105	7.6	104	7.1	90				

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
July 1, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.7	102	7.7	102	7.7	101	7.7	103	7.7	103	7.7	102
3'	7.6	101	7.7	102	7.7	101	7.6	102	7.7	103	7.7	102
6'	7.6	101	7.7	102	7.6	100	7.5	100	7.6	101	7.7	102
9'	7.6	101	7.6	101	7.5	99	7.4	99	7.4	100	7.5	100
12'	7.6	100	7.6	101	7.5	99	7.3	97	7.4	98	7.5	100
15'	7.5	100	7.6	[illegible]	–	–	7.3	97	7.4	98	7.4	98
18'	7.5	99	7.5	100	–	–	7.2	95	7.3	98	7.4	98
21'	7.4	97	7.5	100	–	–	6.9	91	7.3	97	7.4	98
24'	7.1	94	7.5	100	–	–	6.7	89	7.1	94	7.1	98
27'	–	–	7.5	100	–	–	6.5	87	6.3	83	6.6	87
30'	–	–	7.2	95	–	–	5.4	71	5.2	67	4.0	53
33'	–	–	7.2	95	–	–	–	–	1.9	24	2.0	25
36'	–	–	2.0	26	–	–	–	–	–	–	–	–
39'	–	–	0.7	8	–	–	–	–	–	–	–	–

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.4	98	7.7	102	7.8	104	7.3	98	7.3	98	7.6	106
3'	7.5	100	7.6	100	7.7	103	7.2	97	7.4	100	7.5	100
6'	7.5	100	7.6	100	7.7	103	5.3	79	7.3	98	7.2	97
9'	7.3	97	7.4	98	–	–	–	–	6.8	90	6.6	89
12'	7.3	97	7.4	98	–	–	–	–	6.4	85	7.0	93
15'	6.8	90	7.3	96	–	–	–	–	5.6	74	7.0	93
18'	6.2	83	7.2	95	–	–	–	–	3.3	43	–	–
21'	2.9	37	5.8	76	–	–	–	–	2.4	30	–	–
24'	2.3	29	–	–	–	–	–	–	1.8	22	–	–
27'	2.1	27	–	–	–	–	–	–	–	–	–	–

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O	% Sat.
Depth 0'	7.3	103	7.3	103	7.4	103	7.9	123	7.6	116	7.5	104
3'	7.2	102	7.2	101	7.3	101	7.6	120	7.4	112	7.9	105
6'	5.3	74	6.3	84	7.0	95	7.6	120	7.9	114	6.8	95
9'	-	-	5.0	66	5.9	79	-	-	5.0	71	6.2	81
12'	-	-	4.0	53	5.0	66	-	-	3.9	50	3.6	45
15'	-	-	3.0	39	4.1	53	-	-	-	-	-	-
18'	-	-	-	-	2.7	47	-	-	-	-	-	-

Station	F		G		H		I		K	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.9	112	7.8	98	8.1	107	6.7	100	7.3	96
3'	8.0	112	7.8	98	8.1	107	8.8	101	7.3	96
6'	6.5	84	6.1	72	-	-	9.2	106	7.4	97
9'	6.0	76	-	-	-	-	-	-	-	-

July 1, 1975

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

Sampling Station	Surface		3'		6'		9'		12'		15'	
	D.O.	%	D.O.	%	D.O.	%	D.O.	%	D.O.	%	D.O.	%
1	7.7	115	7.6	113	5.2	69	4.8	63				
2	7.6	115	7.4	104	5.9	78	5.5	71	4.3	55		
3	7.7	115	7.5	104	5.6	74	4.8	64	3.5	44	1.6	18
4	7.6	115	7.3	100	5.6	74	5.3	69	3.4	44		
5	7.6	115	7.7	115	5.0	67	6.4	83				
6	7.6	115	7.2	105	6.8	93	6.2	80	3.7	47		
7	7.7	118	7.6	117	6.7	91	5.8	76	4.3	54		
9	7.8	118	7.5	115	4.8	63						
10	7.7	117	7.6	114	6.2	81	4.4	57				
11	7.6	115	7.2	105	6.1	80	5.2	67	3.6	45		
12	7.6	115	7.5	117	6.6	89	5.3	68	3.0	38		
13	7.6	115	7.5	117	6.6	89	5.6	71	2.5	32		
14	7.8	120	7.6	119	7.6	119						
15	7.5	118	7.5	117	6.7	91	2.5	33				
16	7.6	116	7.4	114	7.9	118	5.0	65	3.9	50		
17	7.5	115	7.4	115	7.7	113	6.5	85	3.1	40		
18	7.6	115	7.6	116	6.5	89	5.0	65	1.5	24		
19	7.5	115	7.4	115								
20	7.5	115	7.5	115								
21	7.7	119	7.5	115	7.4	104	6.3	80	0.4	03		
22	7.5	116	7.9	105	6.8	95	6.2	80	3.6	45		
23	7.5	115	7.4	110	7.5	104	5.9	77	1.6	18		
24	8.1	120										
25	7.7	119										
26	7.7	119	7.5	115	7.1	98	6.3	80				
27	7.6	117	8.0	119	6.8	95	6.0	79	4.3	54		
28	7.7	117	7.8	118	6.0	80						
29	7.8	118	7.6	115								
30	7.5	115	7.7	116	7.0	97	6.1	79	4.7	59		
31	7.6	115	7.8	116	7.0	104	5.8	79	3.0	39		
32	7.7	115										
33	7.5	116	7.6	115	7.4	96	6.0	75				
34	7.5	115	7.9	117	7.5	105	6.0	79				

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
August 5, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.1	95	6.7	89	7.1	95	7.0	94	7.2	96	7.3	98
3'	7.2	95	7.0	93	7.0	94	7.1	95	6.9	93	7.3	98
6'	6.9	91	6.6	88	7.0	94	7.1	95	7.1	95	7.2	97
9'	6.9	91	6.9	83	6.9	93	6.9	93	7.2	96	6.9	93
12'	6.6	88	4.8	63	6.9	93	6.6	88	6.6	89	6.6	89
15'	4.4	57	2.9	37	–	–	5.3	68	4.7	62	5.9	77
18'	3.8	50	1.8	22	–	–	3.1	40	3.4	45	4.6	60
21'	1.7	21	0.8	9	–	–	1.9	24	0.8	29	2.4	30
24'	0.4	4	0.1	3	–	–	1.2	15	0.1	2	0.6	7
27'	–	–	0.1	2	–	–	0.7	8	0.1	1	0.1	1
30'	–	–	0.1	2	–	–	0.4	5	0.1	1	0.0	0
33'	–	–	0.0	0	–	–	–	–	0.0	0	0.0	0

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.2	99	7.2	98	7.2	98	6.9	95	7.1	97	6.9	96
3'	7.2	99	7.2	98	7.3	100	6.8	94	7.0	97	7.0	98
6'	7.2	99	7.3	99	7.1	97	6.8	94	6.8	94	6.9	96
9'	7.1	97	7.2	98	–	–	6.5	90	6.8	94	6.9	96
12'	6.3	84	6.3	84	–	–	6.1	84	6.4	88	6.8	94
15'	4.1	54	5.7	75	–	–	–	–	6.3	84	–	–
18'	3.7	48	4.1	54	–	–	–	–	5.8	77	–	–
21'	1.8	22	4.6	58	–	–	–	–	1.5	18	–	–
24'	0.5	6	1.5	18	–	–	–	–	0.6	7	–	–
27'	–	–	0.4	4	–	–	–	–	–	–	–	–

Transect	D						E					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.6	85	6.5	91	6.3	90	4.7	70	5.5	80	5.3	78
3'	6.3	80	6.1	86	6.2	88	4.6	69	5.4	80	5.2	77
6'	6.2	79	6.3	88	6.2	88	4.3	65	5.3	78	5.0	74
9'	–	–	5.7	80	5.8	80	4.2	64	4.9	67	5.0	67
12'	–	–	–	–	5.3	73	4.2	64	4.0	52	4.5	59
15'	–	–	–	–	4.1	55	–	–	–	–	–	–
18'	–	–	–	–	2.3	29	–	–	–	–	–	–

Station	F		G		H		I*		K	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.3	87	6.1	78	7.4	97	6.4	77	6.8	89
3'	6.4	85	5.3	65	7.5	98	6.4	77	7.0	93
6'	5.8	73	5.0	61	-	-	6.2	73	6.3	82
9'	4.6	57	-	-	-	-	6.4	76	-	-

*August 6, 1975

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

August 5, 1975

Sampling Station	Surface		3'		6'		9'		12'	
	D.O.	%	D.O.	%	D.O.	%	D.O.	%	D.O.	%
5	6.0	89	5.9	86	5.9	85	5.3	73		
6	5.7	84	5.7	84	5.5	78	5.3	74	3.7	49
7	5.6	84	5.3	78	5.2	75	5.0	69	4.1	53
14	5.3	81	5.4	81	4.8	73				
15	5.1	77	5.1	77	5.3	77	4.2	59		
16	5.5	81	5.4	80	5.3	79	4.9	68	4.0	53
17	5.5	81	5.3	80	5.3	80	5.1	70	1.3	17
18	5.6	84	5.5	81	5.6	83	4.6	64	3.4	44
24	5.4	81								
25	5.3	81								
26	5.2	79	5.1	78	4.9	71	4.9	66	4.0	53
27	5.3	78	5.2	78	5.0	75	5.0	67	4.5	59
28	5.3	80	5.3	80	5.1	76				
32	5.8	85								
33	5.4	80	5.2	76	5.3	77	4.9	64	4.6	64
34	5.5	80	5.5	80	5.6	81	4.7	63		
Lower Big Beaverdam Creek	6.3	90	6.2	89	6.4	91				
Middle Big Beaverdam Creek	6.1	84	5.3	65						

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
August 18, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.2	99	7.1	98	6.9	95	6.9	97	7.2	100	7.1	99
3'	7.2	99	7.1	98	7.2	99	6.7	93	7.2	100	7.3	102
6'	7.0	97	7.1	98	7.1	98	6.8	94	7.1	98	6.6	90
9'	7.0	95	7.0	96	7.1	97	6.8	93	6.8	91	6.5	87
12'	6.9	94	6.7	90	6.7	90	6.9	94	6.4	85	6.3	84
15'	6.4	86	6.4	84	6.4	85	6.4	86	6.4	85	6.3	84
18'	6.3	83	6.2	83	6.4	85	6.5	87	6.2	82	6.2	82
21'	6.2	82	6.2	83	-	-	6.0	80	6.3	84	6.2	82
24'	-	-	3.5	47	-	-	2.1	27	2.0	27	4.3	56
27'	-	-	0.5	5	-	-	0.7	7	1.1	13	1.3	15
30'	-	-	0.0	0	-	-	-	-	0.1	1	0.0	0
33'	-	-	0.0	0	-	-	-	-	-	-	0.0	0
36'	-	-	0.0	0	-	-	-	-	-	-	-	-

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.7	95	6.9	97	7.0	97	6.7	93	6.8	94	7.1	100
3'	7.0	100	6.9	97	7.1	98	6.7	93	6.8	96	6.9	95
6'	6.9	96	6.8	94	6.6	90	5.5	75	6.4	87	6.2	85
9'	6.6	87	6.8	91	-	-	-	-	6.3	85	6.3	84
12'	6.0	80	5.4	72	-	-	-	-	5.7	76	5.3	70
15'	5.2	68	4.4	57	-	-	-	-	4.7	62	-	-
18'	2.6	34	3.3	43	-	-	-	-	2.7	36	-	-
21'	2.0	26	1.4	17	-	-	-	-	1.4	17	-	-
24'	1.2	14	0.8	9	-	-	-	-	1.1	13	-	-
27'	0.1	1	0.2	2	-	-	-	-	-	-	-	-

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.3	82	6.4	92	6.3	83	6.5	95	6.9	98	7.0	100
3'	6.3	82	6.4	92	6.4	84	6.5	96	6.8	97	6.9	97
6'	4.3	60	5.4	73	6.3	87	5.0	70	5.7	78	5.3	73
9'	-	-	4.8	63	5.6	74	3.6	47	4.6	61	5.3	70
12'	-	-	4.0	53	4.1	54	-	-	2.9	38	3.8	50
15'	-	-	2.4	30	3.7	49	-	-	-	-	1.8	22
18'	-	-	1.7	20	2.4	30	-	-	-	-	-	-

Transect	E											
Station	3		2		1		F		G		H	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.5	84	5.9	89	6.1	93	6.8	95	7.0	9.	7.1	95
3'	5.5	85	5.9	89	6.0	91	7.0	96	6.9	88	6.9	93
6'	5.5	85	5.6	80	6.0	87	7.1	93	6.6	82	–	–
9'	5.5	85	4.8	64	5.0	66	5.9	74	–		–	–
12'	5.5	85	3.4	45	4.0	52						

Station	I		K	
	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.9	71	6.2	83
3'	6.3	76	6.1	80
6'	6.4	77	–	–
9'	–	–	–	–

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

August 18, 1975

Sampling Station	Surface D.O.	Surface %	3' D.O.	3' %	6' D.O.	6' %	9' D.O.	9' %	12' D.O.	12' %
5	6.5	96	6.5	96	5.4	75	4.4	60		
6	6.4	94	6.0	90	5.3	73	4.5	60	4.1	5
7	6.2	92	6.0	90	5.4	74	5.1	67	4.3	5
14	5.6	87	5.5	83	4.7	67				
15	5.7	89	5.7	85	5.3	72				
16	5.9	89	5.9	89	5.6	80	4.8	64	3.4	4
17	5.8	89	5.8	90	5.9	85	4.7	63	3.3	4
18	5.8	89	5.8	90	5.6	80	4.6	62	2.0	2
24	6.2	95								
25	5.9	91								
26	6.0	93	6.0	91	5.5	80	5.2	70	4.5	5
27	6.1	93	6.0	91	6.0	87	5.0	66	4.0	5
28	6.1	92	6.1	94	5.8	85				
32	6.2	94								
33	6.2	94	6.3	94	6.4	94	5.8	75		
34	6.4	97	6.4	95	6.2	90	5.3	73		
Lower Big Berverdam Creek	7.3	103	7.3	104	6.2	85	5.3	70		
Middle Big Beaverdam Creek	6.9	95	6.5	80						

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
September 9, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.3	97	7.3	98	7.3	97	7.3	97	7.5	100	7.0	93
3'	7.3	97	7.3	97	7.3	97	7.2	95	7.3	97	7.0	93
6'	7.2	96	7.2	96	7.2	96	6.7	88	7.0	94	7.0	93
9'	6.4	83	6.4	83	6.8	90	6.4	84	6.7	89	6.8	90
12'	6.2	82	6.2	82	6.6	87	5.8	75	6.4	84	5.9	77
15'	5.3	69	6.1	80	6.3	83	5.3	69	6.2	81	5.3	69
18'	5.1	67	4.[illegible]	64	–	–	4.3	55	5.5	72	5.2	68
21'	4.3	55	4.3	55	–	–	3.8	50	4.3	57	4.6	59
24'	3.8	50	3.7	47	–	–	1.7	21	2.6	33	3.8	49
27'	3.3	43	2.9	37	–	–	0.5	6	0.5	6	0.9	11
30'	1.6	20	1.6	19	–	–	–	–	0.2	3	0.1	1
33'	0.9	11	1.0	13	–	–	–	–	0.1	2	0.1	1
36'	–	–	0.3	3	–	–	–	–	–	–	–	–
39'	–	–	0.3	3	–	–	–	–	–	–	–	–
42'	–	–	0.2	2	–	–	–	–	–	–	–	–

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.9	92	7.0	94	7.0	93	6.9	95	7.0	[illegible]	7.0	95
3'	6.9	92	7.0	94	7.0	93	6.9	95	6.9	93	6.9	93
6'	6.8	90	6.9	91	6.8	91	6.9	93	6.8	90	6.9	93
9'	6.0	79	6.1	80	–	–	6.2	83	6.3	83	6.8	90
12'	5.0	67	5.0	67	–	–	5.5	73	6.1	80	6.1	80
15'	4.9	64	4.8	63	–	–	4[illegible]	63	4.1	53	–	–
18'	4.4	58	–	–	–	–	1.9	24	2.1	27	–	–
21'	3.3	43	–	–	–	–	–	–	0.7	8	–	–
24'	0.4	4	–	–	–	–	–	–	0.5	5	–	–
27'	0.1	1	–	–	–	–	–	–	–	–	–	–

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.4	90	6.4	91	6.6	93	6.7	97	6.9	97	7.2	100
3'	6.4	89	6.5	92	6.6	93	6.7	96	6.8	96	6.9	96
6'	5.3	72	6.0	80	6.3	85	5.1	70	6.0	82	5.4	71
9'	–	–	5.1	67	5.6	75	3.3	44	3.8	50	3.7	49
12'	–	–	4.2	54	4.3	57	3.1	40	3.8	49	2.9	37
15'	–	–	2.1	–	3.7	49	–	–	–	–	–	–
18'	–	–	–	–	2.6	33	–	–	–	–	–	–

Transect		E						F		G		H	
Station		3		2		1							
		D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth	0'	5.6	86	5.8	88	6.3	94	7.3	103	7.7	102	7.4	97
	3'	5.6	87	6.1	89	6.7	98	7.3	101	5.0	63	7.0	93
	6'	5.6	87	5.8	83	6.1	83	5.2	64	5.2	62	-	-
	9'	-	-	-	-	4.8	59	4.9	59	4.7	55	-	-
	12'	-	-	-	-	4.6	57	-	-	-	-	-	-

Station		I		K	
		D.O.	% Sat.	D.O.	% Sat.
Depth	0'	8.7	102	6.6	85
	3'	6.6	77	6.5	85
	6'	6.8	79	6.2	80
	9'	6.9	80	-	-

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

September 9, 1975

Sampling Station	Surface D.O.	Surface %	3' D.O.	3' %	6' D.O.	6' %	9' D.O.	9' %	12' D.O.	12' %
5	6.8	98	6.4	93	4.9	63	3.8	50		
6	6.5	95	6.2	90	5.7	76	3.9	50	3.9	49
7	6.4	94	6.4	95	5.3	70	3.1	39	3.9	49
14	5.7	8[illegible]	5.8	86	5.8	83				
15	5.8	88	5.9	90	5.5	74				
16	5.8	88	6.1	90	5.8	83				
17	6.5	97	6.4	95	5.5	74	4.8	60	4.7	59
18	6.5	97	6.5	96	5.0	66	4.4	56	4.4	55
24	6.5	97								
25	6.1	92								
26	6.3	94	6.4	95	6.3	90	4.7	55	4.5	56
27	6.3	94	6.7	99	6.1	82	4.8	60	4.6	57
28	6.5	97	6.5	[illegible]	4.1	55				
32	6.9	101								
33	6.9	101	6.6	96	6.7	95	5.2	64		
34	7.0	102	6.4	9[illegible]	6.6	90	4.4	54		
Lower Big Beaverdam Creek	7.5	103	7.1	97	5.8	77	5.2	68		
Middle Big Beaverdam Creek	6.5	85	6.2	71						
Upper Big Beaverdam Creek	8.8	101								

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
September 25, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.1	74	5.7	68	5.4	64	6.2	75	6.3	77	6.5	80
3'	5.8	70	5.7	68	5.4	65	6.0	73	6.2	75	6.4	78
6'	5.7	68	5.9	72	5.4	65	5.9	72	6.0	73	6.3	77
9'	5.8	70	5.8	70	5.5	67	5.3	65	5.3	65	6.2	76
12'	5.7	68	5.8	70	5.5	67	5.1	63	5.1	63	6.1	74
15'	5.7	68	5.8	70	--	--	5.1	63	5.1	63	5.5	67
18'	5.7	68	5.8	70	--	--	5.2	63	5.2	64	5.2	63
21'	5.6	67	5.8	70	--	--	5.4	65	5.3	65	5.1	67
24'	--	--	5.8	70	--	--	5.4	65	5.2	64	5.2	68
27'	--	--	5.8	70	--	--	1.8	21	5.1	62	4.8	63
30'	--	--	--	--	--	--	0	0	2.7	32	1.7	19
33'	--	--	--	--	--	--	--	--	1.2	14	1.1	12

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.4	80	6.5	82	6.6	82	6.6	84	6.3	81	6.6	83
3'	6.3	80	6.3	79	6.5	81	6.7	86	6.6	84	6.3	79
6'	6.2	77	5.9	75	6.5	81	5.5	68	6.1	75	5.8	71
9'	5.2	63	5.5	67	--	--	5.3	65	5.6	67	5.6	58
12'	4.8	58	5.6	69	--	--	5.2	63	5.5	67	5.5	67
15'	4.6	55	5.7	70	--	--	--	--	5.5	67	5.5	67
18'	4.5	54	5.7	70	--	--	--	--	5.5	67	--	--
21'	4.5	54	5.4	65	--	--	--	--	5.4	66	--	--
24'	4.3	52	5.3	63	--	--	--	--	5.5	67	--	--
27'	4.1	50	5.4	65	--	--	--	--	--	--	--	--

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.7	73	6.4	83	6.4	83	6.5	86	6.4	83	7.0	87
3'	5.8	74	6.4	8[illegible]	6.3	82	6.0	78	6.2	78	6.9	87
6'	4.5	56	5.7	7[illegible]	5.6	68	5.3	65	5.4	66	5.8	70
9'	--	--	4.8	58	5.4	66	3.0	35	4.0	49	4.1	49
12'	--	--	4.5	54	5.3	64	--	--	3.8	45	4.1	49
15'	--	--	3.1	37	3.8	46	--	--	3.6	42	4.0	48
18'	--	--	3.1	37	3.3	40	--	--	--	--	3.8	45
21'	--	--	2.7	32	3.1	37	--	--	--	--	2.1	25

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.0	84	5.7	77	6.3	83	4.6	53	5.0	56	7.1	86
3'	6.0	84	5.4	72	5.5	74	4.6	53	4.9	55	7.0	85
6'	5.9	83	4.4	53	4.3	52	4.4	50	4.8	54	6.9	84
9'	6.0	84	3.9	46	4.2	49	4.4	50	4.6	52	--	--
12'	6.0	84	--	--	4.2	49	--	--	4.6	52	--	--
15'	5.9	83	--	--								

Station	I		K	
	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.3	59	6.5	77
3'	5.3	59	6.5	77
6'	5.3	59	6.4	76
9'	5.3	59	6.4	76

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

September 25, 19

Sampling Station	Surface D.O.	Surface %	3' D.O.	3' %	6' D.O.	6' %	9' D.O.	9' %	12' D.O.	12' %
5	6.3	84	6.3	85	4.5	54	4.3	52	3.7	43
6	6.5	86	5.4	66	4.4	54	4.2	49	4.1	49
7	6.1	83	4.9	64						
14	5.8	78	5.4	71	2.9	35				
15	5.4	72	5.0	66	3.4	42	3.1	37		
16	5.7	77	5.4	72	4.4	54	3.9	46		
17	5.6	75	5.5	75	4.1	50	3.9	47	3.8	45
18	5.9	80	5.9	80	4.2	50	3.8	46		
24	6.2	86								
25	5.8	80	5.8	80						
26	6.2	85	5.9	80	4.6	55	4.3	50	4.3	50
27	6.3	85	5.5	74	4.3	51	4.2	50	4.2	50
28	6.2	84	6.1	81	4.2	52	4.1	50		
32	5.2	67								
33	6.5	87	6.0	79	4.6	54	4.5	53	4.4	52
34	6.8	91	6.5	89	5.0	60	4.4	52		
Lower Big Beaver-dam Creek	6.4	79	5.4	67	5.7	70	3.3	40	4.3	52
Middle Big Beaver-dam Creek	7.0	86	5.9	72						

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
October 13, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	%Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.4	90	7.5	94	7.0	87	7.4	93	7.4	93	7.4	93
3'	7.4	90	7.4	93	7.1	88	7.4	93	7.4	93	7.3	90
6'	7.3	90	[illegible]	90	6.9	84	7.2	88	7.2	88	7.2	87
9'	7.3	88	7.1	87	6.9	84	7.1	86	7.1	86	7.1	86
12'	7.2	87	7.1	86	7.1	86	7.0	85	6.9	83	6.9	84
15'	7.0	85	4.6	54	--	--	7.0	84	6.9	83	6.8	83
18'	4.8	57	[illegible]	37	--	--	4.9	57	5.2	62	5.4	64
21'	--	--	3.2	37	--	--	4.1	47	4.2	49	4.1	48
24'	--	--	[illegible]	35	--	--	2.2	25	2.8	32	2.6	29
27'	--	--	1.7	18	--	--	2.0	22	2.1	23	1.3	14
30'	--	--	1.0	10	--	--	--	--	1.2	13	0.8	8
33'	--	--	0.9	9	--	--	--	--	0.8	8	0.3	2

Transect	C						CA					
Station	3		2				3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.5	95	7.3	93	7.5	96	7.6	98	7.5	98	7.3	95
3'	7.6	96	7.5	95	7.5	96	7.2	92	7.4	94	7.3	92
6'	7.1	88	7.1	88	7.4	93	7.0	87	7.3	90	6.8	83
9'	6.8	83	6.4	78	--	--	6.5	79	6.7	81	6.6	80
12'	5.9	70	5.4	65	--	--	6.2	78	6.1	73	6.4	77
15'	4.9	58	5.1	60	--	--	4.6	54	5.4	64	--	--
18'	4.3	50	[illegible]	50	--	--	--	--	3.7	43	--	--
21'	4.0	46	3.9	45	--	--	--	--	3.3	37	--	--
24'	2.8	32	2.1	18	--	--	--	--	--	--	--	--
27'	2.6	29	1.5	16	--	--	--	--	--	--	--	--

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.1	93	7.1	93	7.3	96	6.7	89	6.9	90	7.3	96
3'	7.3	94	7.3	94	7.2	94	6.8	86	7.5	94	7.4	94
6'	6.9	86	6.8	84	6.8	83	6.8	85	6.8	84	7.0	87
9'	--	--	5.7	69	5.9	72	6.5	80	4.8	55	5.6	67
12'	--	--	4.8	57	5.4	64	5.1	60	4.4	51	5.0	57
15'	--	--	4.1	48	4.9	57	4.8	56	--	--	3.5	39
18'	--	--	--	--	--	--	--	--	--	--	--	--
21'	--	--	--	--	--	--	--	--	--	--	--	--

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	5.9	83	6.3	85	6.1	85	7.0	91	5.3	61	6.1	73
3'	5.9	83	6.2	85	6.1	85	7.3	87	4.9	53	6.0	72
6'	5.9	83	6.4	85	6.5	85	5.7	63	5.0	54	5.9	71
9'	5.8	83	--	--	4.9	56	--	--	--	--	--	--
12'	5.8	83	--	--	4.7	54	--	--	--	--	--	--
15'	5.8	83	--	--	--	--	--	--	--	--	--	--

Station	I		K	
	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	6.8	71	6.0	70
3'	6.8	71	5.8	68
6'	6.9	72	5.9	70
9'	7.0	73	5.8	68

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

October 13, 1975

Sampling Station	Surface D.O.	Surface %	3' D.O.	3' %	6' D.O.	6' %	9' D.O.	9' %	12' D.O.	12' %
5	6.9	93	6.7	88	6.5	79	4.6	54		
6	6.6	89	6.5	86	6.3	78	4.6	53	4.6	53
7	6.7	90	6.4	85	6.0	75	5.5	65	4.6	53
14	6.2	86	6.8	94	5.9	80				
15	6.5	89	6.2	85	6.0	75				
16	6.3	85	6.2	85	6.4	85				
17	6.3	85	6.2	85	6.0	74	5.2	60	5.0	57
18	6.5	90	6.3	87	5.7	71	4.9	56	4.6	53
24	6.1	85								
25	6.3	89	6.2	87						
26	6.2	87	6.8	90	6.1	77	5.0	60		
27	6.1	85	6.1	85	6.5	85	4.9	56	4.7	54
28	5.9	81	5.9	81	5.3	71				
32	6.8	91								
33	6.5	90	6.4	86	6.5	87	5.3	61	5.4	61
34	6.4	89	6.4	89	5.9	74	5.1	60		
Lower Big Beaverdam Creek	7.4	98	7.6	100	6.9	85	6.7	78	6.8	80
Middle Big Beaverdam Creek	7.3	94	5.7	64						
Upper Big Beaverdam Creek	7.6	86								

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
October 28, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.9	93	7.7	91	7.9	93	8.0	95	8.0	95	8.1	96
3'	7.8	92	7.0	83	7.9	93	7.9	94	7.9	94	7.9	88
6'	7.7	91	7.5	88	7.7	91	7.7	92	7.5	88	7.7	92
9'	7.7	91	7.6	89	7.7	91	7.6	91	7.5	88	7.6	89
12'	7.7	91	7.4	87	7.7	91	7.5	88	7.5	88	7.6	89
15'	7.7	91	7.7	91	7.7	91	7.4	87	7.5	88	7.6	89
18'	7.6	89	7.7	91	7.6	90	7.5	88	7.4	87	7.4	87
21'	7.6	89	7.7	91	–	–	7.4	87	7.4	87	7.1	83
24'	–	–	7.4	87	–	–	6.7	78	6.4	75	6.6	77
27'	–	–	7.7	91	–	–	6.3	74	6.1	70	6.1	70
30'	–	–	7.2	85	–	–	5.3	62	4.2	49	4.7	54
33'	–	–	7.2	85	–	–	–	–	–	–	3.4	39
36'	–	–	6.7	78	–	–	–	–	–	–	1.0	11

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.9	93	7.1	84	8.0	95	7.9	97	7.3	87	7.4	88
3'	7.9	93	7.9	94	7.9	93	7.8	95	7.3	87	7.6	90
6'	7.6	90	7.7	92	7.6	88	7.5	92	6.9	82	7.3	86
9'	7.6	90	7.6	90	–	–	7.7	92	6.9	81	6.9	80
12'	7.5	89	7.4	87	–	–	–	–	6.3	73	6.9	80
15'	6.9	81	7.4	87	–	–	–	–	5.0	58	7.0	82
18'	6.2	73	6.4	75	–	–	–	–	3.9	45	–	–
21'	4.2	48	3.2	36	–	–	–	–	3.9	43	–	–
24'	3.5	39	3.1	35	–	–	–	–	–	–	–	–
27'	3.5	39	3.1	35	–	–	–	–	–	–	–	–

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.9	99	7.9	99	7.9	99	7.6	97	8.0	98	8.1	98
3'	7.7	95	7.7	95	7.8	97	7.3	89	7.9	96	8.0	97
6'	6.8	80	7.3	87	7.3	87	5.3	63	6.5	77	6.7	78
9'	–	–	6.6	77	6.1	71	5.8	67	5.4	62	6.5	76
12'	–	–	4.9	56	5.4	63	–	–	5.8	64	5.8	64
15'	–	–	3.9	43	5.1	57	–	–	5.4	59	4.9	53
18'	–	–	–	–	4.	54	–	–	–	–	–	–

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Transect	E						F		G	
Station	3		2		1					
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.9	109	7.7	105	8.0	110	8.1	100	7.4	81
3'	7.9	110	7.7	103	8.1	109	8.1	97	7.3	78
6'	7.8	108	6.9	84	7.1	86	6.6	72	7.0	75
9'	7.8	108	6.8	77	6.8	76	6.5	70	-	-
12'	7.7	107	6.1	68	6.6	73	-	-	-	-
15'	-	-	5.4	60	-	-	-	-	-	-

Transect	H		K	
Station				
	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.9	93	7.5	88
3'	7.7	90	7.5	88
6'	-	-	7.7	90

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION October 28, 1975

Sampling Station	Surface D.O.	Surface %	3' D.O.	3' %	6' D.O.	6' %	9' D.O.	9' %	12' D.O.	12' %	15' D.O.	15' %
5	7.1	92	7.3	94	5.6	66	5.0	57				
6	7.5	96	7.4	95	7.7	93	7.5	85				
7	7.1	94	7.1	90	6.4	76	6.3	73	5.7	65		
14	7.8	105	7.7	104								
15	7.3	99	7.1	95	6.7	80						
16	7.7	105	7.7	103	6.9	84	6.8	77	6.1	68	5.4	60
17	8.1	107	7.9	105	6.8	81	6.6	74	3.9	43		
18	8.1	108	8.0	105	7.0	86	6.2	69				
24	8.1	110										
25	8.1	110										
26	8.1	110	7.9	101	7.0	85	6.4	70	6.2	68		
27	8.0	110	8.1	109	7.1	86	6.8	76	6.6	73		
28	8.2	111	8.1	109	5.8	67						
32	8.2	108										
33	8.2	110	8.1	108	7.9	100	6.7	75				
34	8.2	110	8.1	107	7.7	97	6.4	71				
Lower Big Beaverdam Creek	8.1	97	8.0	95	7.5	89	6.7	79				
Middle Big Beaverdam Creek	7.6	83	7.3	75								
Upper Big Beaverdam Creek	8.7	90										

ROBINSON DISSOLVED OXYGEN AND PERCENT SATUATION
November 12, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.4	94	8.4	94	8.4	94	8.5	96	8.4	94	8.5	96
3'	8.4	94	8.3	93	8.5	96	8.5	96	8.6	97	8.5	96
6'	8.3	93	8.3	93	6.5	96	8.4	94	8.7	97	8.5	96
9'	8.2	92	8.2	92	8.4	94	8.6	96	8.5	96	8.5	96
12'	8.1	91	8.2	92	8.4	94	8.5	95	8.4	94	8.5	96
15'	7.8	87	8.2	92	--	--	8.0	89	8.4	94	8.5	96
18'	7.6	84	8.1	91	--	--	7.2	80	8.3	93	8.5	96
21'	--	--	7.9	88	--	--	7.4	82	7.9	81	8.2	92
24'	--	--	7.3	81	--	--	7.2	79	7.3	81	7.7	87
27'	--	--	5.9	65	--	--	4.8	53	6.6	73	6.1	67
30'	--	--	4.7	52	--	--	3.0	32	3.7	40	3.6	39
33'	--	--	1.7	18	--	--	2.7	28	3.4	37	2.7	29
36'	--	--	1.7	18	--	--	--	--	--	--	--	--

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.5	97	8.6	97	8.6	97	8.3	94	8.4	95	8.4	95
3'	8.7	97	8.6	97	8.6	97	8.3	94	8.5	96	8.4	95
6'	8.5	96	8.6	97	8.7	98	8.3	94	8.4	94	8.4	95
9'	8.4	94	8.7	98	--	--	7.6	86	8.4	94	8.4	95
12'	8.4	94	8.6	97	--	--	6.5	72	8.3	93	8.4	95
15'	8.4	94	8.5	96	--	--	5.8	64	8.3	93	8.5	96
18'	6.3	70	5.5	60	--	--	--	--	5.6	62	4.9	54
21'	5.8	63	4.4	48	--	--	--	--	5.3	58	4.4	48
24'	5.0	55	4.0	43	--	--	--	--	5.1	56	--	--
27'	--	--	3.4	37	--	--	--	--	--	--	--	--

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.4	96	8.1	92	8.1	92	8.0	92	8.4	96	8.3	94
3'	8.4	96	8.0	91	8.3	94	8.1	93	8.3	95	8.3	94
6'	8.5	97	8.0	91	8.1	92	7.8	88	8.0	92	8.1	92
9'	7.7	86	8.0	91	8.1	92	6.5	72	8.0	91	8.3	94
12'	--	--	--	--	8.0	90	6.4	69	6.3	68	7.9	89
15'	--	--	--	--	5.4	63	1.5	16	4.4	48	3.6	36
18'	--	--	--	--	4.8	53	--	--	--	--	--	--

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.1	95	8.1	92	8.3	96	8.0	89	6.4	68	6.1	67
3'	8.0	94	7.8	90	8.2	95	7.9	85	6.4	68	6.3	69
6'	7.9	93	7.5	85	8.2	95	5.8	62	6.5	68	5.7	63
9'	7.9	93	6.3	68	6.7	73	--	--	--	--	--	--
12'	7.9	93	--	--	6.4	70	--	--	--	--	--	--
15'	7.9	93	--	--	--	--	--	--	--	--	--	--

Station	I		K	
	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	7.6	81	5.8	64
3'	7.9	83	6.1	67
6'	7.9	83	6.1	67
9'	7.9	83	--	--

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

November 12, 19[illegible]

Sampling Station	Surface		3'		6'		9'		12'		15'	
	DO	%	DO	%	DO	%	DO	%	DO	%	DO	%
5	8.1	94	8.1	93	7.7	87	5.8	65				
6	8.1	94	8.1	94	8.0	93	6.1	67	5.9	65		
7	7.9	91	7.9	91	7.9	91	6.6	73	6.2	68	5.6	61
14	8.0	95	7.9	93	7.8	90						
15	8.1	94	8.0	93	8.0	93	7.8	90				
16	8.1	95	7.8	90	7.5	85	6.3	70				
17	8.3	96	8.2	95	8.1	94	6.6	73	4.7	51		
18	8.3	96	8.2	95	8.2	95	8.1	94	5.9	65		
*25	8.3	98										
26	8.3	96	8.2	95	8.1	94	6.9	76	6.6	73		
27	8.3	96	8.2	95	8.2	95	6.7	74	6.4	70		
28	8.3	96	8.3	96	8.2	95						
32	8.6	100										
33	8.4	96	8.4	96	8.3	95	6.4	69				
34	8.4	96	8.3	96	8.3	96	6.3	70				
Lower Big Beaverdam Creek	8.3	95	8.3	95	8.3	94	8.2	94	7.7	85		
Middle Big Beaverdam Creek	8.5	92	8.5	86								
Upper Big Beaverdam Creek	8.7	94	8.6	93								

* Station 24 not taken, too shallow.

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
December 9, 1975

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.6	78	8.2	75	8.3	76	8.8	80	9.5	87	8.5	77
3'	8.5	77	8.2	75	8.6	78	8.8	80	9.4	87	8.4	77
6'	8.4	77	8.1	74	8.6	78	8.8	80	9.4	87	8.2	75
9'	8.3	77	8.0	73	8.3	77	8.6	78	9.4	87	8.2	75
12'	8.3	77	8.0	73	8.5	78	8.5	77	9.4	87	8.0	73
15'	8.4	77	8.0	73	-	-	8.5	77	9.4	87	8.0	73
18'	8.3	77	8.0	73	-	-	8.8	80	9.4	87	8.0	73
21'	8.3	77	7.9	73	-	-	8.3	77	9.2	84	8.0	73
24'	8.3	77	7.9	73	-	-	8.6	78	9.5	88	8.1	74
27'	8.3	77	7.9	73	-	-	8.7	79	9.0	82	8.1	74
30'	8.3	77	9.7	88	-	-	8.7	79	9.1	83	8.0	73
33'	8.2	76	9.5	87	-	-	-	-	-	-	8.0	73
36'	8.2	76	9.5	87	-	-	-	-	-	-	-	-
39'	8.2	76	-	-	-	-	-	-	-	-	-	-

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.6	88	8.7	80	8.4	77	9.0	83	9.1	84	9.1	84
3'	9.6	88	8.8	80	8.6	78	9.0	83	9.0	83	9.1	84
6'	9.3	85	8.7	80	-	-	9.1	84	8.8	81	8.9	82
9'	9.3	85	8.7	80	-	-	8.8	81	8.8	81	8.9	82
12'	9.1	83	8.6	78	-	-	-	-	8.8	81	8.8	81
15'	9.1	83	8.6	78	-	-	-	-	8.8	81	8.8	81
18'	9.2	84	8.6	78	-	-	-	-	8.7	80	8.8	81
21'	9.2	84	8.5	77	-	-	-	-	8.7	80	-	-
24'	9.2	84	8.6	78	-	-	-	-	8.7	80	-	-
27'	-	-	8.6	78	-	-	-	-	-	-	-	-

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.0	84	9.2	85	9.1	84	9.5	88	9.3	85	8.8	81
3'	8.9	82	9.2	85	9.0	83	9.3	86	9.2	84	8.8	81
6'	8.6	79	9.0	83	8.8	81	9.2	85	9.0	83	8.5	77
9'	-	-	9.0	83	8.9	82	9.1	84	8.9	82	8.5	77
12'	-	-	-	-	8.7	80	-	-	8.8	81	8.5	77
15	-	-	-	-	8.7	80	-	-	-	-	8.4	76
18'	-	-	-	-	8.7	80	-	-	-	-	-	-

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.6	89	9.1	87	9.6	88	9.5	82	9.5	81	10.8	99
3'	9.5	88	9.0	85	9.5	87	9.4	82	9.5	81	10.8	99
6'	9.3	83	8.8	80	9.3	83	9.2	79	9.2	78	10.7	98
9'	9.2	82	-	-	9.1	80	9.2	79	9.1	78	-	-
12'	9.2	81	-	-	9.2	81	-	-	-	-	-	-

Station	K	
	D.O.	% Sat.
Depth 0'	9.7	88
3'	9.8	88
6'	9.6	87

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

December 9, 1975

Sampling Station	Surface DO	Surface %Sat	3' DO	3' %Sat	6' DO	6' %Sat	9' DO	9' %Sat	12' DO	12' %Sat
5	9.3	86	9.4	88	9.3	86	9.5	89		
6	9.5	89	9.4	88	9.3	86	9.1	82		
7	9.4	88	9.2	86	9.0	84	8.7	83	8.9	79
14	9.4	90	9.5	92	9.0	84				
15	9.3	88	9.2	87	8.8	80				
16	9.1	87	9.0	85	8.8	78				
17	9.3	88	9.3	87	8.9	80	8.7	78	8.9	78
18	9.4	87	9.4	87	9.0	82	8.8	79		
24	9.7	88								
25	9.6	87								
26	9.6	89	9.5	88	9.3	83	9.2	83	9.2	81
27	9.6	89	9.5	88	9.3	83	9.1	82	9.2	81
28	9.7	90	9.4	87	8.8	80	8.4	74		
32	9.5	88								
33	9.5	87	9.3	85	9.1	82	9.0	80		
34	9.5	87	9.4	86	9.2	83	9.1	80		
Lower Big Beaverdam Creek	9.6	83	9.6	88	9.5	87	8.8	80		
Middle Big Beaverdam Creek	8.4	77	8.2	74						
Upper Big Beaverdam Creek	9.3	85	9.1	83						

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION

January 6, 1976

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	%Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	10.4	94	10.0	90	10.6	94	11.2	102	11.2	103	10.8	99
3'	10.4	93	10.0	90	10.4	92	11.7	107	11.2	104	10.8	100
6'	10.3	93	10.0	90	9.8	90	10.8	99	11.3	104	10.6	98
9'	10.2	93	10.0	90	9.8	87	11.0	101	11.6	108	10.7	100
12'	10.2	93	10.4	94	9.9	87	10.8	99	11.6	108	10.6	97
15'	10.3	94	10.4	94	9.9	87	11.2	104	11.6	108	10.6	97
18'	10.3	94	10.6	96	-	-	10.8	99	11.5	107	10.6	97
21'	-	-	12.6	113	-	-	11.2	103	11.6	108	10.6	97
24'	-	-	12.8	115	-	-	10.8	99	11.4	106	10.4	96
27'	-	-	12.4	112	-	-	11.2	103	11.6	107	10.4	96
30'	-	-	12.3	111	-	-	11.0	101	11.4	106	10.5	97
33'	-	-	-	-	-	-	-	-	11.0	103	10.6	97

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	10.6	100	10.4	97	10.4	97	10.6	102	10.7	101	10.6	100
3'	10.6	102	10.4	97	10.4	97	10.6	104	10.7	102	11.2	107
6'	10.1	97	10.4	97	10.0	94	10.5	103	10.4	99	10.4	98
9'	10.4	100	10.6	99	-	-	10.6	104	10.6	102	10.4	98
12'	10.2	97	10.5	98	-	-	-	-	10.4	98	10.4	98
15'	10.2	97	10.6	100	-	-	-	-	10.6	101	10.4	98
18'	10.2	97	10.6	100	-	-	-	-	10.2	97	-	-
21'	10.2	98	10.6	100	-	-	-	-	10.2	97	-	-
24'	10.2	97	10.6	100	-	-	-	-	-	-	-	-
27'	-	-	10.5	99	-	-	-	-	-	-	-	-

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	10.5	104	10.4	103	9.9	92	10.7	107	10.4	97	10.4	98
3'	10.5	105	10.3	102	9.9	93	10.7	109	10.4	101	10.4	100
6'	10.2	100	10.2	97	9.8	93	10.4	99	10.0	97	10.2	97
9'	-	-	10.4	93	10.0	95	10.6	98	10.0	97	10.3	98
12'	-	-	10.0	95	10.2	97	-	-	10.1	93	10.3	93
15'	-	-	-	-	9.7	91	-	-	10.1	93	10.4	94
18'	-	-	-	-	9.9	92	-	-	-	-	-	-
21'	-	-	-	-	9.6	88	-	-	-	-	-	-

Transect	E						F		G	
Station	3		2		3					
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	10.5	115	10.0	108	10.5	114	12.0	97	12.3	97
3'	10.4	115	10.0	106	10.3	107	12.0	98	12.3	96
6'	10.1	112	9.9	102	10.1	104	12.0	97	12.2	95
9'	–	–	10.2	95	10.5	94	12.0	97	12.2	.95
12'	–	–	–	–	10.5	93	–	–	–	

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION January 6, 1976

Sampling Station	Surface		3'		6'		9'		12'	
	D.O.	%	D.O.	%	D.O.	%	D.O.	%	D.O.	%
5	10.4	107	10.4	108	9.7	90	10.0	90		
6	10.5	107	10.4	106	10.0	97	9.8	88	9.9	88
7	10.2	105	9.9	101	9.7	87	9.8	86	10.1	88
14	10.6	115	10.6	116	10.4	115				
15	10.6	114	9.8	105	9.9	97				
16	10.0	108	10.0	105	9.9	101	10.2	93		
17	10.4	114	10.4	115		104	10.2	91	10.2	91
18	10.1	103	10.1	107		100	10.1	92	10.4	94
24	10.4	112								
25	10.4	112	10.4	114						
26	10.2	105	10.2	106	10.2	101	10.4	93	10.4	93
27	10.5	114	10.3	109	10.1	105	10.5	95	10.5	93
28	10.4	112	10.4	112	10.2	107	10.4	95		
32	11.0	118	10.9	116	10.4	105	10.4	95		
33	10.3	108	10.2	107	10.0	88	10.4	92		
34	10.6	114								
Lower Big Beaverdam Creek	10.6	98	10.6	100	10.4	97	10.4	95	10.2	90
Middle Big Beaverdam Creek	11.4	96	11.4	96						
Upper Big Beaverdam Creek	10.4	90								

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
February 17, 1976

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	%Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.4	95	9.4	96	9.3	94	9.4	97	9.3	94	9.4	97
3'	9.4	94	9.5	95	9.3	94	9.4	97	9.4	95	9.3	94
6'	9.5	95	9.8	98	9.3	94	9.4	96	9.8	99	9.4	96
9'	9.5	95	9.6	97	9.3	94	9.4	96	9.7	98	9.4	96
12'	9.6	96	9.8	97	9.3	90	9.3	93	9.	98	9.4	96
15'	8.9	92	9.8	98	9.3	90	9.5	96	9.7	98	9.3	94
18'	8.8	85	9.9	99	–	–	9.3	93	9.6	97	9.2	93
21'	–	–	9.0	87	–	–	9.3	93	9.6	96	9.2	94
24'	–	–	9.1	88	–	–	9.5	95	9.1	88	9.2	92
27'	–	–	9.2	88	–	–	9.3	91	9.0	87	9.0	87
30'	–	–	9.2	88	–	–	–	–	8.8	84	8.6	83
33'	–	–	9.0	86	–	–	–	–	8.7	84	8.4	80

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.1	95	9.2	96	9.4	98	9.1	97	8.8	95	9.1	98
3'	9.2	95	9.2	95	9.4	97	9.5	102	8.9	95	9.1	98
6'	9.3	97	9.6	99	9.5	98	9.4	100	9.0	97	9.1	98
9'	9.3	97	9.6	99	–	–	9.1	94	9.0	95	9.2	98
12'	9.3	97	9.9	102	–	–	9.3	95	9.2	96	9.1	97
15'	9.3	94	9.8	100	–	–	9.3	94	9.0	92	9.0	92
18'	9.3	94	9.3	93	–	–	9.0	90	9.2	93	–	–
21'	9.2	93	9.6	93	–	–	–	–	9.0	88	–	–
24'	8.3	80	9.4	90	–	–	–	–	8.6	84	–	–
27'	–	–	9.1	88	–	–	–	–	–	–	–	–

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.8	97	8.9	98	8.8	97	8.9	100	8.8	97	8.8	97
3'	8.9	98	9.0	101	8.8	97	8.8	97	8.8	98	8.9	97
6'	9.1	100	8.9	97	9.0	99	8.9	99	8.8	98	8.9	97
9'	9.1	99	–	–	9.0	99	8.8	95	8.8	98	8.9	97
12'	–	–	–	–	8.9	98	–	–	8.9	90	8.7	88
15'	–	–	–	–	8.7	94	–	–	8.8	87	8.7	85
18'	–	–	–	–	8.8	88	–	–	–	–	–	–
21'												

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.1	107	9.3	107	9.3	107	9.5	100	10.6	103	9.6	97
3'	9.1	107	9.3	107	9.3	107	9.4	98	10.5	102	9.6	95
6'	9.1	107	9.3	106	9.3	107	9.6	94	10.4	101	9.6	95
9'	–	–	9.2	98	9.2	93	9.4	91	–	–		
12'	–	–	9.4	95	–	–	–	–	–	–		

Transect	I		K	
Station				
	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.2	90	9.9	100
3'	9.3	91	9.6	97
6'	9.4	93	9.4	96
9'	9.3	90	–	–

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

February 17, 1976

Sampling Station	Surface D.O.	Surface %	3' D.O.	3' %	6' D.O.	6' %	9' D.O.	9' %	12' D.O.	12' %
5	8.8	98	8.7	97	8.7	96	8.7	93		
6	8.8	99	8.8	98	8.5	96	8.8	89		
7	8.6	98	8.8	101	8.9	101	8.8	95	8.9	90
14	8.9	105	8.9	105	8.7	103				
15	9.4	107	9.4	107	9.3	107				
16	9.3	107	9.3	107	9.3	107	9.2	98	9.4	96
17	9.4	107	9.4	107	9.3	107	9.3	97		
18	9.3	107	9.3	107	9.2	106	9.2	106		
2[illegible]	9.6	110								
25	9.5	110								
26	9.2	107	9.3	108	9.1	101	9.4	105		
27	9.3	107	9.3	103	9.3	107	9.2	94		
28	9.4	108	9.3	108						
32	9.2	100								
33	9.3	105	9.2	105	9.0	100	9.4	95		
34	9.3	106	9.3	105	9.2	105	9.5	97		
Lower Big Beaverdam Creek	8.9	99	8.9	99	8.9	99	8.8	97		
Middle Big Beaverdam Creek	8.9	90	9.0	91						
Upper Big Beaverdam Creek	9.2	94								

ROBINSON DISSOLVED OXYGEN AND PERCENT SATURATION
March 30, 1976

Transect	A						B					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	%Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.0	100	8.8	97	8.9	97	9.0	100	9.0	101	9.0	100
3'	9.0	100	8.9	98	8.9	97	9.0	100	9.0	101	9.0	100
6'	8.8	97	8.8	97	8.8	96	8.9	100	9.0	100	9.0	100
9'	8.8	97	8.8	96	8.8	96	8.8	98	8.9	99	8.9	99
12'	8.8	96	8.7	96	8.8	96	8.6	96	8.7	96	8.7	96
15'	8.8	96	8.7	95	--	--	8.6	95	8.8	97	8.7	96
18'	8.7	96	8.6	94	--	--	8.5	94	8.7	95	8.7	96
21'	8.4	91	8.6	93	--	--	8.5	93	8.7	95	8.7	96
24'	--	--	8.6	93	--	--	8.5	93	8.4	90	8.5	92
27'	--	--	8.4	90	--	--	8.2	88	8.2	87	8.3	90
30'	--	--	1	86	--	--	7.8	84	7.8	83	8.0	87
33'	--	--	7.9	84	--	--	--	--	7.7	82	7.8	83

Transect	C						CA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	9.0	102	8.9	102	8.9	99	8.8	103	8.8	104	8.8	103
3'	9.0	103	8.9	102	8.8	97	8.7	100	8.8	104	8.7	101
6'	8.9	100	8.9	102	8.9	99	8.8	100	8.8	104	8.8	100
9'	8.8	98	8.8	98	--	--	8.7	98	8.7	98	8.7	98
12'	8.8	98	8.7	97	--	--	8.6	97	8.5	97	8.6	98
15'	8.7	97	8.7	97	--	--	8.4	94	8.4	94	8.4	95
18'	8.3	92	8.8	88	--	--	--	--	8.0	88	--	
21'	7.8	85	7.8	86	--	--	--	--	7.9	87	--	
24'	7.7	83	7.7	83	--	--	--	--	--	--	--	
27'	7.3	78	--	--	--	--	--	--	--	--	--	

Transect	D						DA					
Station	3		2		1		3		2		1	
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.6	105	8.5	104	8.6	105	8.6	103	8.8	106	8.7	105
3'	8.6	105	8.5	104	8.6	105	8.6	103	8.7	105	8.7	105
6'	8.5	98	8.6	102	8.6	102	8.6	102	8.7	105	8.6	103
9'	8.4	97	8.6	99	8.7	101	8.3	96	8.6	99	8.4	97
12'	--	--	8.6	97	8.7	99	--	--	8.1	93	8.1	93
15'	--	--	8.4	96	8.2	93	--	--	7.2	78	6.9	75
18'	--	--	--	--	7.2	78	--	--	--	--	5.8	62

Transect	E						F		G		H	
Station	3		2		1							
	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.8	113	8.7	111	8.7	99	8.8	104	8.9	98	9.1	98
3'	8.8	113	8.6	111	8.7	99	8.8	104	8.6	91	9.1	98
6'	8.7	112	8.5	108	8.6	98	7.8	84	8.1	84	9.0	98
9'	8.7	114	8.1	94	7.8	89	7.8	83	--	--		
12'	--	--	7.8	89	7.8	88	--	--	--	--		

Transect	I		K	
Station				
	D.O.	% Sat.	D.O.	% Sat.
Depth 0'	8.7	91	8.4	90
3'	8.7	91	8.3	88
6'	8.7	90	8.4	90
9'	8.8	91	--	--

ROBINSON DISSOLVED OXYGEN
AND PERCENT SATURATION

March 30, 1976

Sampling Station	Surface D.O.	Surface %	3' D.O.	3' %	6' D.O.	6' %	9' D.O.	9' %	12' D.O.	12' %	15' D.O.	15' %
5	8.6	105	8.6	105	8.6	102	8.0	92				
6	8.6	107	8.6	107	8.3	100	8.3	96	7.5	84	6.6	73
7	8.7	110	8.6	110	8.4	100	8.1	94	7.7	87	6.8	75
14	8.7	112	8.6	109	8.6	104						
15	8.8	115	8.6	111	8.5	106	7.8	90				
16	8.7	111	8.6	111	8.5	108	8.1	94	7.8	89		
17	8.6	110	8.6	110	8.5	108	8.0	92	7.7	87		
18	8.5	110	8.5	109	8.4	106	8.0	92	7.2	80		
24	8.9	115										
25	8.8	114	8.4	105	8.1	100						
26	8.7	116	8.7	116	8.1	100	7.9	91	7.9	88		
27	8.7	99	8.7	99	8.6	98	7.8	89	7.8	88		
28	8.7	110	8.6	110								
32	8.7	107	8.7	107								
33	8.6	106	8.6	106	8.6	106	8.1	100	8.1	100		
34	8.6	107	8.6	107	8.6	107	7.8	89				
Lower Big Beaverdam Creek	8.8	105	8.8	105	8.8	105	8.5	98				
Middle Big Beaverdam Creek	7.6	85	8.7	91								
Upper Big Beaverdam Creek	8.6	95										

Exhibit 3.0 Fisheries

Alternate Analysis of Gill Net and Electrofishing Catch Data

In reviewing the gill net and electrofishing data, Dr. Charles H. Proctor, Professor of Statistics, North Carolina State University suggested alternative analyses may be more appropriate for structured data.

For the gill net data, mean squares from the following analysis of variance in the log transformation of catch per day (to better satisfy the variance heterogeneity assumption) were used in performing appropriate tests of significance.

ANALYSIS OF VARIANCE FOR VARIABLE LOGY MEAN 1.1855
(Gill Net Catches)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
TRAN	3	24.9732	8.3244
STA	1	0.1307	0.1307
TRAN*STA	3	6.5644	2.1881
SEA	5	0.9382	0.1876
TRAN*SEA	15	18.4442	1.2296
STA*SEA	5	4.5034	0.9007
TRAN*STA*SEA	15	9.6470	0.6431
DAY	1	0.6029	0.6029
TRAN*DAY	3	0.3899	0.1300
STA*DAY	1	0.1530	0.1530
TRAN*STA*DAY	3	1.5532	0.5177
SEA*DAY	5	1.8654	0.3731
TRAN*SEA*DAY	15	3.2149	0.2143
STA*SEA*DAY	5	0.3683	0.0737
TRAN*STA*SEA*DAY	15	8.7658	0.5844
CORRECTED TOTAL	95	82.1147	0.8644

CLASSES	VALUES
TRAN	A C E G
STA	1 3
SEA	FAL74 FAL75 SPR75 SUM74 SUM75 WIN75
DAY	1 2

The log transformation of electrofishing catches (per hour) were similarly examined. Mean squares from the following table were utilized in performing appropriate tests of significance.

ANALYSIS OF VARIANCE FOR VARIABLE LOGY MEAN 4.1273
(Electrofishing)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
MONTH	10	29.6708	2.9670
TRAN	2	18.5030	9.2514
TRAN*MONTH	20	14.6772	0.7338
STA	1	0.0055	0.0055
STA*MONTH	10	3.9085	0.3908
TRAN*STA	2	0.7695	0.3846
TRAN*STA*MONTH	20	5.8999	0.2950
CORRECTED TOTAL	65	73.4342	1.1298

CLASSES	VALUES
TRAN	A E G
STA	1 3
MONTH	APR DEC FEB JAN JUL JUN MAR MAY NOV OCT SEP