PROJECT DESCRIPTION

BIOLOGICAL MONITORING PROGRAM

ALLENS CREEK NUCLEAR GENERATING STATION SITE

HOUSTON LIGHTING & POWER

Charlie Tarpley

Nov. 1973

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

Page

PROJECT DESCRIPTION

BIOLOGICAL MONITORING PROGRAM

ALLENS CREEK NUCLEAR GENERATING STATION SITE

FOR

HOUSTON LIGHTING & POWER COMPANY

INTRODUCTION

A biological survey was conducted in the Fall of 1972 to establish baseline conditions of the aquatic and terrestrial ecosystems at the proposed Allens Creek Nuclear Generating Station (ACNGS) site near Sealy, Texas. The results of this survey were submitted in our report dated May 22, 1973 and included in the Environmental Report submitted to the Atomic Energy Commission in August, 1973.

Houston Lighting & Power Company has recently authorized a one-year biological monitoring program to be performed basically as outlined in Chapter 6 of the Environmental Report. The objective of this project description is to further define the monitoring program. The program defined herein is intended to be flexible to allow adjustment of the dynamic nature of both aquatic and terrestrial ecosystems. Consequently, if data obtained reveal sensitive areas within either system, sampling schedules and techniques can be adjusted to meet these situations.

PURPOSE

The purposes of the biological monitoring program will be to:

1. Develop a comprehensive one-year baseline inventory of the site environment.
2. Refine the monitoring programs outlined in Chapter 6 of the Environmental Report on the basis of the baseline inventory.
3. Define, in conjunction with HL&P, methods of performing the necessary long-term monitoring program.

SCOPE

GENERAL

The scope of the monitoring program will be essentially that as outlined in Section 6.1 of the Environmental Report. The general items considered in the initial one-year program are presented in the following paragraphs.

VEGETATION

A detailed species description will be completed and estimates of production for the basic vegetative habitats will be accomplished in spring and fall.

AVIFAUNA

Avifauna are potentially the most important biotic groups in the site area. Bird studies will be oriented to identifying species, their occurrence at various times of the year and providing estimates of

abundance. Migratory waterfowl, quail, mourning dove, sandhill crane, and the white-tailed kite will be emphasized because of their game or rare status. Crop samples will be analyzed to compare with available literature and determine food relationships on the site. Nesting studies will be performed for game species to determine the availability of nesting and the success of nesting in the areas to be inundated.

MAMMALS

Emphasis will be placed on population estimates of rodents and omnivores. Rodents will be studied primarily as sources of food for the higher trophic level carnivores. Special emphasis will be placed on locating beaver colonies on Allens Creek. Deer census will be performed to estimate abundance of this game species. Survey routes along the creek bottoms and river bottom areas will be emphasized. Stomach samples will be collected and analyzed to relate feeding habitats of animals to the Allens Creek site and particularly to those areas that will be inundated.

HERPETOFAUNA

To evaluate populations of amphibians and reptiles, survey routes will be established on the Brazos River, Allens Creek, and along representative sites within and on the periphery of the flooded area. These surveys will be conducted quarterly and observations will also be made during the more frequent bird observations. Species will be identified and any rare or endangered herpetofauna will be investigated.

SOILS

Soils in selected areas of the site will be analyzed to evaluate gross chemical nutrient parameters and levels of pesticide residue. These data will be useful in predicting water quality in the reservoir after flooding.

WATER QUALITY (ALLENS CREEK)

Water quality parameters will be ascertained in Allens Creek to provide a basis for completing a description of the Allens Creek biotic potential and quality of water that will enter the cooling lake.

WATER QUALITY (BRAZOS RIVER)

Brazos River water quality parameters will be ascertained in relation to biotic production and will identify any stresses prior to construction.

AQUATIC BIOTA (ALLENS CREEK)

The Allens Creek program is designed to; substantiate the initial bio-survey results, estimate the extent and importance of the crayfish population, estimate the extent of use of Allens Creek as a spawning area for Brazos River fish, analyze stomach contents of selected fishes to determine food webs, and estimate the relative contribution of plankton and benthic macroinvertebrates to the productivity of the creek.

AQUATIC BIOTA (BRAZOS RIVER)

The Brazos River program is designed to; identify and map aquatic habitats available in the Brazos River at the site, estimate species composition and seasonal fluctuations in abundance of phytoplankton, zooplankton, macrophytes, benthic macroinvertebrates and fish, provide a basis for determining which species of biotic groups will be most useful as indicators for long-term studies, determine food web relationships from food habit analyses and estimate age and growth parameters for the major forage and sport fish species.

SAMPLING LOCATIONS

GENERAL

A total of 26 monitoring stations have been selected to allow sampling of representative aquatic and terrestrial habitats. These stations have also been selected to represent the various vegetative and associated animal communities within and outside the area to be affected by plant construction. Eleven terrestrial stations were sampled during the initial survey. Five additional stations have been selected for study during this program. The sampling stations on Allens Creek have been increased from three to five while those on the Brazos River have been increased from two to five. The locations of all terrestrial and aquatic sampling stations are shown on Figures 1 and 2, respectively.

CRITERIA FOR SELECTION

Terrestrial

Terrestrial sampling stations were selected on the basis of the following criteria:

1. Selection of areas both in the zone to be flooded and outside this zone to facilitate "before and after" comparisons.
2. Selection of areas disturbed by agricultural activities and areas with limited recent disturbance.
3. Selection of areas believed to be of relatively special ecological interest. These include:
   a. stations 12, 13 and 15 located in pasture areas to the north, northwest and south of the cooling lake (Figure 1). These stations were selected to establish the natural variation within a biotic type;
   b. station 14, which will serve to monitor the native prairie north of the Mixville Road;
   c. station 16, located in the wooded area between the Brazos River and the cooling lake, was selected to provide coverage east of the lake and to increase representation of woodland areas outside the impacted areas.

As fluvial woodlands are well represented from the initial survey, Station 6 has been changed from its initial location and re-established

in native prairie west of State Highway 36. This change accomplishes two objectives: (1) it provides better coverage on the west side of the proposed generating facilities; and (2) it increases coverage of native prairie in the area.

Aquatic

Sampling stations were selected on Allens Creek to characterize:

1. areas outside the direct influence of the proposed cooling lake;
2. areas within the future inundated portion of the creek;
3. a tributary stream receiving domestic waste effluent;
4. that portion of the creek below the proposed cooling lake dam.

Brazos River sampling stations were selected to represent:

1. areas that will be physically undisturbed by plant construction or operation;
2. the mixing area below Allens Creek and the cooling lake spillway;
3. areas where complete mixing of cooling lake effluent with river water is anticipated;
4. areas near the proposed makeup water pumping station.

SAMPLING METHODS

TERRESTRIAL ECOSYSTEM

Biotic Sampling

The biotic sampling program will emphasize vegetation, mammals, birds and invertebrates. The following section provides descriptions of sampling techniques to be employed and appropriate analyses. Sampling methods are summarized in Table 1 and a schedule of sampling periods is provided in Figure 3.

Vegetation - Three physiognomic (growth forms) types of vegetation are recognized for the ACNGS site: herbaceous, woody shrubs and vines, and trees. Herbaceous vegetation includes grasses, sedges and forbes. Shrubs will be defined as woody plants less than three m in height and having a diameter at breast height (d.b.h.) less than five cm. Trees will be defined as those woody species taller than three m and with a d.b.h. greater than five cm.

The diverse growth forms at the site create a vegetation mosaic which must be stratified into units of maximum homogeneity and these units studied independently. Homogeneity within each unit is a prime consideration in determining the number of samples considered adequate. Therefore, the number of quadrats or points to be utilized at any sampling station will be determined in the field by inspection

of the data on the most heterogeneous station. Cover and composition will be used to characterize vegetation of the herbaceous communities and to evaluate effects of various ecological factors such as fire, drought, grazing or other disturbances. Basal cover is that portion of the ground occupied by vegetation and expressed as a percentage of total area. Point sampling will be used to determine basal cover in accordance with Hutchings & Pace, 1963.

Frequence and plant diversity with respect to time and space will be estimated for herbaceous vegetation by utilizing 50 cm by 50 cm quadrats in accordance with Greig-Smith, 1964.

Quadrats will be randomly distributed throughout each station and plant species within each quadrat will be identified and recorded. The shrub communities will be evaluated by using 5 m by 5 m quadrats at each station (Greig-Smith, 1964).

Seasonal production will be estimated at each station during the spring and summer seasons and end-of-season production will be estimated in the fall. Estimates will be based upon clipping of all herbaceous vegetation at ground level within several randomly distributed quadrats ($\frac{1}{4}$ m^2) in accordance with Daubenmire, 1968.

Plant specimens will be collected in the field during each season to establish a plant list for all seasons. Thus, it can be assured important plant species will be collected in the phenological condition required for proper identification.

Woody communities will be evaluated using the point-centered quadrat technique (Cottam and Curtis, 1956). Analyses include:

$$\text{Mean Distance} = \frac{\text{Sum of Distances}}{\text{Total Number of Distances}}$$

$$\text{Mean Area} = (\text{Mean Distance})^2$$

$$\text{Density of Trees per Hectare} = \frac{10{,}000\ m^2}{\text{Mean Area}}$$

$$\text{Relative Frequency} = \frac{\text{Number of points of occurrence of a species}}{\text{Number of Occurrence of all species}} \times 100$$

$$\text{Relative Density} = \frac{\text{Number of individuals of species}}{\text{Number of individuals of all species}} \times 100$$

$$\text{Relative Dominance} = \frac{\text{Total basal area of species}}{\text{Total basal area of all species}} \times 100$$

$$\text{Basal Area per Tree} = \frac{\text{Total basal area}}{\text{Number of trees}}$$

Basal area will be determined with a metric diameter tape by measuring the (d.b.h.) at 1.3m and converting to area. An importance value is obtained from the sum of the relative frequency, relative density, and relative dominance values for all tree species at each sampling station. These values will provide a comparison of the most important species within each station and among stations.

Qualitative estimates of epiphyte infestations will be evaluated by visual observation in winter as these plants are evergreen and their deciduous hosts have dropped their leaves.

Mammals - Small mammal populations will be evaluated by live trapping in each habitat type utilizing a mark-recapture technique established by Blair (1944). Sherman live-traps will be placed in grids at the sampling stations and trapping will be accomplished for seven days followed by two days of snap trapping. Grid sizes will be altered to accommodate the conditions and total area available within any sampling station under investigation. Population estimates will be based on the Lincoln-Peterson Index (Rupp, 1966) which is calculated from the formula:

$$N = \frac{(n)(m)}{X}$$

where:

N = population

m = first sample (live trapping)

n = second sample (snap trapping)

X = number of marked animals in second sample.

This method incorporates three assumptions:

1. a random, mixed population;
2. each individual having an equal probability of being captured; and,
3. no significant replacement of the population by unmarked animals occurring between sampling periods.

Large mammal (coyote size and smaller) populations will be evaluated by live trapping. Traps will be established in grids in areas representative of all habitat types, in the fall of 1973.

Game mammals of special importance (sports species) include the white-tailed deer and eastern gray squirrel. Densities will be estimated by strip census for deer (Hahn, 1945) and live trapping squirrels (Flyger, 1959).

Birds - Permanent transects will be established, with stations representing each vegetation type. These transects will represent the baseline for the strip census (Graber, 1963; Emlen, 1971). Birds observed within 60 m on either side of the line for a distance of 853 m for a total area of 10.2 hectares will be recorded. The strip census will be conducted to establish species diversity by season and area usage.

The waterfowl survey was initiated at the ACNGS site October 11, 1973. Waterfowl migratory habits will be observed twice weekly each week during the fall of 1973 until the optimum populations have been reached. Observations will then be reduced to one day per week until the migratory populations begin to decline in the spring. The schedule of two days per week will then be re-established until the waterfowl leave the area. Observations will include species diversity, population estimates, and area utilization on the site for such activities as feeding and resting.

Prairies and fields will be monitored in the fall to estimate sandhill crane populations and their utilization of the area.

The woodland-open field ecotone will be monitored in the spring and fall to observe the white-tailed kite population known to exist in the area. Spring observations will be most crucial as it is necessary

to establish the number of nesting pairs in the area. Nest locations will be observed during the nesting season and the number of young which leave the nest recorded.

The bob-white quail and mourning dove are important game species in the area, therefore suitable habitats will be surveyed to estimate density of these species.

Invertebrates - A survey will be conducted in late June to early July to evaluate the diversity of terrestrial invertebrates on the site. Standard sweepnet procedures will be utilized for sampling aerial habitats while litter samples will be used for soil invertebrates (Peterson, 1953).

Boll weevil populations will be monitored and correlated with pesticide use in the area. Monitoring will be conducted by field inspection of cotton squares (young flower buds) and bolls during the critical period of the growing season. Squares and bolls will be collected in the field and inspected for damage and expressed as percent of bolls damaged. The county agent will be contacted regarding use of pesticides for weevil control.

Mosquitoes also will be monitored throughout the summer and fall to determine breeding locations and extent of infestation. Impounded waters will be inspected for the presence of mosquito larvae and sweepnet samples will provide estimates of abundance of adult mosquitoes.

Abiotic Sampling

Micro-Meteorological Sensing Program - A micro-meteorological sensing program will be established to monitor air and soil temperature, and relative humidity. Standard cottonbelt weather shelters will be erected and equipped with a hygrothermograph. These data will then be correlated with possible changes in plant composition, density and yields.

Pesticide Monitoring - Agronomic practices in the area dictate that a pesticide monitoring program be established and correlated with times of pesticide application and surface samples taken from zero to eight centimeters will be utilized to determine pesticide concentrations. Other soil parameters will include pH, conductivity, and cation exchange capacity.

AQUATIC ECOSYSTEM

Biotic Sampling

General - The biotic sampling program will concentrate on plankton, periphyton, aquatic macrophytes, benthic macroinvertebrates and fish. The following section provides detailed descriptions of sampling techniques and then appropriate analyses. A summary of methods appears in Table 2 and a schedule of sampling events is provided in Figure 4.

Plankton - Replicate mid-depth plankton samples will be collected with a 2.1 liter Van Dorn water sampler at Stations A1, A5,

B1, B4 and B5. The contribution of nanoplankton will be determined by evaluating total and net plankton. Total plankton will be collected from 2.1 liter samples. As zooplankton are usually low in abundance, a larger volume of water is required to obtain an adequate sample. Samples of net zooplankton will be collected initially by filtering 24.3 liters of water through a Wisconsin plankton net. Samples will be preserved with a Merthiolate preservative as recommended by EPA (Weber, 1973). Phytoplankton samples will be stored in a darkened room to prevent cells from fading.

Periphyton - Artificial substrate samples will be used to collect periphyton (Mason, et al, 1967). Basket samples will be submerged at Stations A1, A4, B1, and B5 throughout the year, with retrievals at intervals of four to six weeks. Hester-Dendy multi-plate samplers will be employed at selected stations to obtain additional periphyton data (Hester and Dendy, 1962; Beak, et al, 1973).

Macrophytes - Aquatic macrophyte sampling in the Brazos River and Allens Creek will be limited to qualitative collections to determine species composition and relative abundance of submergent and emergent macrophytes on the site. Bio-survey observations made during the fall indicate a paucity of aquatic plants. Sampling efforts will therefore be opportunistic, according to the phenology of the particular species sampled. Plants will be preseed and identified on a preliminary basis in the field. Subsequent confirmation of initial identification will be made in the laboratory.

Benthic Macroinvertebrates - Community structure of benthic macroinvertebrates will be determined through use of Ekman and Ponar dredges. The Ekman and Surber samples will be used primarily in Allens Creek and the Ponar in the Brazos. Samples will be washed through a No. 30 mesh bucket sieve in the field, and preserved in a buffered Formalin solution. Sampling will be conducted monthly at Stations A1, A2, A4, A5, B1, B3 and B5. Triplicate samples will be collected initially and later revised if necessary so that a sufficient number of organisms are collected to approximate asymptotic species diversity. Sampling points within each station will be chosen to represent a variety of habitat types, including any or all of the following: riffle (sand); riffle (gravel); pool-slow (mud and debris); pool-slow (sand or other substrate); pool-fast (mud); pool-fast (sand or other substrate). Qualitative samples will be collected along the edges of pools and banks with a D-frame apron net. Drift organisms will be sampled each week with drift nets for 12-hour periods during spring and summer months. Species diversity ($\bar{d}$) will be collected using the formula, $\bar{d} = -\Sigma\ (N_i/N)\ \text{Log}_2\ (N_i/N)$, as proposed by Wilhm and Dorris (1968).

Fish - Fish sampling will be conducted quarterly (Table 2). Gear to be used in the Brazos River includes experimental gill nets (80 ft x 6 ft, ½-inch to 5-inch square mesh panels) beach-haul seine (120 ft x ½-inch, with ¼-inch mesh bag); backpack electroshocker; fyke nets; small mesh seines and small minnow traps. Sampling in Allens

Creek will be limited to use of small mesh seines, small minnow traps and backpack electroshocker. Larger gear will be used in the Brazos River. Gill nets and/or fyke nets will be used as conditions at each station allow. Fishing efforts at each station will be kept consistent so that catch-per-unit effort indices can be used to evaluate seasonal changes in relative abundance of species. Shoreline seining of the Brazos River will be conducted with the haul seine, both during day and night.

The frequency of fish sampling in Allens Creek will be increased in early spring to determine the extent of utilization of Allens Creek as a spawning area by Brazos River fishes. Water temperatures, measured during physical-chemical sampling, will determine when additional effort is required to collect early spawning fishes. Sampling throughout the spring months can be adjusted according to the continuing results of field efforts. Night sampling will be included as one aspect of this program.

Length and weight will be recorded on all fish. Scale or spine samples will be taken from selected sport and forage species, including the catfishes, smallmouth buffalo and white crappie. Condition factors will be calculated in addition to growth histories to further characterize the overall suitability of the aquatic environment. Additionally, the occurrence of any external or internal parasites will be noted. Parasites will be identified to species when possible.

Limited marking studies of young fish will be conducted in the Brazos River during spring and summer to aid in the evaluation of early estimates of potential losses to the makeup water pumping facility. Additional tagging studies, using conventional tagging methods, will be conducted on adult sport fish to aid in determining their movement between stations.

Evaluation of major trophic relationships of selected forage and sport fishes will be made through food habit studies.

Bi-weekly fisherman spot checks will be made during prime fishing months. A measured distance on the Brazos River will be traversed at specified times and the catch of bank and boat fishermen will be recorded.

Water Quality

Monthly

~~Weekly~~ in situ instrumental measurements of dissolved oxygen, specific conductance, temperature and pH will be taken initially at all stations. Sampling frequency at Stations A2, A3, A4, A5, B2, and B4 may be reduced at a later date after basic relationships between stations have been established. Measurements will be recorded at about the same time of day so that data are comparable.

~~Diurnal measurements of dissolved oxygen will be conducted bi-weekly at Station B4 to identify periods of low oxygen stress.~~

Other water quality parameters to be estimated are listed in Table 3 with their respective sampling frequency. Pesticide analyses

will be conducted monthly to establish residual levels. Spring sampling will be scheduled to coincide with periods of agricultural pesticide applications.

LABORATORY TESTING

TERRESTRIAL

Laboratory analyses for the terrestrial program are limited as the monitoring program is basically field oriented.

Production samples will be oven dried for 48 hours at 80° C and the dry-weight recorded.

Voucher specimens of plant species will be dried in a plant press. Identification and nomenclature will follow Correll and Johnson (1970). The specimens will be mounted on standard herbarium mounts labeled and stored for future reference.

Stomachs will be removed from small mammals captured during snap trapping periods and preserved in 10 percent formalin (Cwik, 1970). Each stomach is opened along the ventral margin and the contents placed in a shallow petri dish with sufficient distilled water added to move the material freely in the dish. The contents are then examined beneath a dissecting scope and the various components identified.

Specimens will be collected of plants suspected of being utilized as food by the small mammals and reference slides will be prepared of epidermal tissue for identification purposes using the techniques described by Cameron (1971).

Birds normally feed at early morning and in the evening. Quail and mourning dove will be collected during these time periods. The crop will be removed and examined for food content. Food particles will be identified to determine the basic diet items of the important game species.

Pesticide residues in soils will be tested by using standard extraction techniques and concentrations determined on a gas chromatograph. Standard soil test laboratory procedures will be used to estimate pH, conductivity, and cation exchange capacity.

AQUATIC

Preliminary laboratory examination of plankton samples require either dilution or concentration to facilitate identification and enumeration. It is anticipated that samples will require concentration, in which case a modified centrifuge method will be used (Weber, 1970).

Plankters will be identified and enumerated from samples placed in a Sedgwick-Rafter cell (McAlice, 1971). Proportional diatom counts will be made from permanent slides prepared from the plankton centrates as outlined by Weber (1970). Additionally, volumetric measurements of total plankton and zooplankton will be made. Density and volume will be estimated.

Chlorophyll *a* constitutes approximately one to two percent of the dry weight of organic matter in all algae, and provides a useful estimate of algae biomass. Chlorophyll *a* concentration will be determined

spectrophotometrically from acetone extracts of plankton samples (Odum et al , 1958; Parsons and Strickland, 1963).

Benthic macroinvertebrates will be enumerated in the laboratory. A dissecting microscope will be used to identify organisms to genus, although some groups, e.g., chironomids, will be identified by making detailed dissections and permanent slides.

Laboratory methods for analyzing fish age and growth, food habits and fecundity will be basically those described by Lagler (1956) and Ricker (1967).

Laboratory analyses and sampling frequency for water quality parameters, including heavy metals and pesticides, are outlined in Table 3. All routine chemical and bio-chemical analyses will adhere to procedures set forth by the American Public Health Association (1971). Heavy metal analyses will be conducted with atomic absorption techniques.

EQUIPMENT

Equipment employed in the biological monitoring program will be standard for such sampling programs and will include the following:

FIELD EQUIPMENT

Terrestrial

Sherman Live Traps
Tomahawk Live Traps
Rat Traps
Platform Balance
Metric Diameter Tape

Measuring Tape 30m
Grass Shears
Point Quadrat Pins
Quadrat Frames
Plant Presses and Blotters
Sweep Nets (Heavy and Light)
Killing Jars
Berlese Funnels and Light Board
Dissecting Kits
Camera Equipped with Telephoto Lens
Binoculars
Tape Recorder
Spotting Scope
Weather Station (equipped with hygrothermograph)
3-Probe Soil Temperature Recorder
Bulk Density Soil Sampler
4-Wheel Drive Vehicle
Marsh Buggy (to be used during inclement weather)

Aquatic

Van Dorn water sampler
Kemmerer water sampler
Wisconsin plankton net
Ponar dredge
Eckman dredge
Surber sampler
Drift nets
D-frame apron net
Dissolved oxygen meter and probe
S-C-T meter
pH meter
Thermistor
Sounding line
Secchi disc
Backpack electro-shocker
Gill nets
Fyke nets
Beach-haul seive
Minnow traps
Tape recorder
Boat
Outboard moter
Boat trailer
4-wheel drive vehicle

LABORATORY EQUIPMENT

Terrestrial

Compound Microscope
Dissecting Microscope
Dissecting Trays
Watch Glasses
Drying Oven
Calculator

Aquatic

Compound microscope
Dissecting microscope
Microscope projector
Petri dishes
Dissecting kits
Drying oven
Scale press

REPORTING

Progress reports will be submitted to Houston Lighting & Power Company at a 60-day frequency. These reports will consist primarily of a presentation of data collected to a date 30 days prior to the report submitted. Thus, the initial report will present data collected during the first 30-day field effort, the second will contain data collected through the first 90 days, etc. A written progress report will be submitted following the first six-month data collection. Any recommended modifications to the program will be identified at that time.

A formal report will be submitted upon completion of the one-year program and will include all data, analyses, interpretations, and recommendations for future programs. This report will be suitable for

submittal to the AEC as an appendix to the Environmental Report. The format will be generally similar to the format used in our report entitled "Fall Biological Survey of the Proposed Allens Creek Site," dated May 22, 1973. Schedule for reporting is as follows:

60 day report;

January 1, 1974
March 1, 1974
May 1, 1974
July 1, 1974
September 1, 1974
November 1, 1974

interim report;

June 1, 1974

final report;

January 15, 1975.

TABLE 1

TERRESTRIAL MONITORING PROGRAM
SPECIES DENSITY, DIVERSITY AND FREQUENCY

ITEM SAMPLED	METHODOLOGY	SAMPLING LOCATION		ANNUAL SAMPLING SCHEDULE	
		DIRECT	INDIRECT	PRE-OPERATIONAL	OPERATIONAL
✓ Vegetation Herbaceous and shrub communities	Basal cover, quadrat count & clipping for plant species composition, density & biomass	Stations 1 through 6	Stations 7 through 16	Spring, Summer and Fall	Fall
Woody	Point-centered quadrat	Woodlands and brushy areas	Woods and brushy areas	Fall	Periodic sampling on a 5-year interval
✓ Epiphytes	Qualitative i.e., visual estimate of concentrations, e.g. scarce, occasional and abundant	Infested areas	Infested areas	Winter	Winter
✓ Mammals Small	Live trap grid 4 lines with 20 traps 15 m intervals between traps, mark recaptures for 7 days, snap trap 2 days estimate abundance with Lincoln-Peterson Index	All habitat types	All habitat types	Fall	Fall
✓ Medium	Live trap grid in upland & lowland, size of grid to be determined. Observation of beaver along Allens Creek, and track counts for locations and numbers of species	All habitat types	All habitat types	Fall	Fall
✓ Large (Deer)	Observation and track counts for density	All habitat types	All habitat types	All 4 seasons	All 4 seasons
✓ Birds	Observations and strip census	All habitat types	All habitat types	All 4 seasons	All 4 seasons
Species of special interest					
✓ Waterfowl	Observation for counts	Cooling Lake (after filling)	Grain fields and plowed ground	Fall & Winter	Fall & Winter

TABLE 1 (Continued)

TERRESTRIAL MONITORING PROGRAM
SPECIES DENSITY, DIVERSITY AND FREQUENCY

ITEM SAMPLED	METHODOLOGY	SAMPLING LOCATION		ANNUAL SAMPLING SCHEDULE	
		DIRECT	INDIRECT	PRE-OPERATIONAL	OPERATIONAL
Birds					
Bobwhite Quail	Nest locations during spring for brood size; strip census in fall	Tree and brush savannahs	Tree and brush savannahs	Spring & Fall	Spring & Fall
Mourning Dove	Nest locations in spring for brood size; strip census in fall	Woodland	Woodland	Spring & Fall	Spring & Fall
Sandhill Crane	Observation counts	Prairies and fields	Prairies and fields	Fall & Winter	Spring & Fall
White-tailed Kite	Nest locations in spring for brood size, habitat range inventories in fall for numbers	Woodland-open field Ecotone	Woodland-open field Ecotone	Spring, fall in early morning and late afternoon	Spring & Fall
Herpetofauna	Observations for location and relative abundance	All habitat types	All habitat types	All seasons	All seasons
Alligators		"Alligator hole" Cooling Lake	Brazos River banks	Summer	Summer
Insects	Sweepnet and soil litter for species diversity	All habitat types	All habitat types	Summer	Summer
Boll Weevil	Monitoring of damage throughout cotton-growing season, primarily to relate infestation with pesticide application	Cotton fields	Cotton fields	Summer	Summer
Mosquitos	Observations for locations	Impounded waters and areas of warm, moist ground	Impounded waters and areas of warm, moist ground	Summer & Fall	Summer & Fall

TABLE 2

SAMPLING METHODS FOR AQUATIC MONITORING PROGRAM

TYPE OF ORGANISM	BRAZOS RIVER	ALLENS CREEK	SAMPLING SCHEDULE
Fish	Gill nets, seines, electro-shocker, minnow traps, fyke nets.	Seines, electro-shocker, minnow traps	Quarterly. Weekly as needed in Allens Creek during spring.
Benthic-Macro Invertebrates	Ponar dredge, Surber sampler, dipnets (qualitative), drift nets.	Eckman dredge, Surber sampler, dipnets (qualitative), drift nets.	Monthly. Drift nets once each week during spring and summer.
Periphyton	Artificial substrate sampler submerged for four to six week periods.	Same as Brazos River method.	Continuous with removal every four to six weeks.
Phytoplankton	Replicate one liter mid-depth samples taken with Van Dorn or Kemmerer sampler. Entire sample preserved.	Same as Brazos River method.	Bi-weekly.
Zooplankton	Replicate 24.3 liter samples filtered through #30 standard mesh net.	Same as Brazos River method.	Bi-weekly.
Aquatic Macro-phytes	Qualitative sampling.	Same as Brazos River method.	Flowering period.

TABLE 3

PHYSICAL AND CHEMICAL PARAMETERS FOR AQUATIC MONITORING

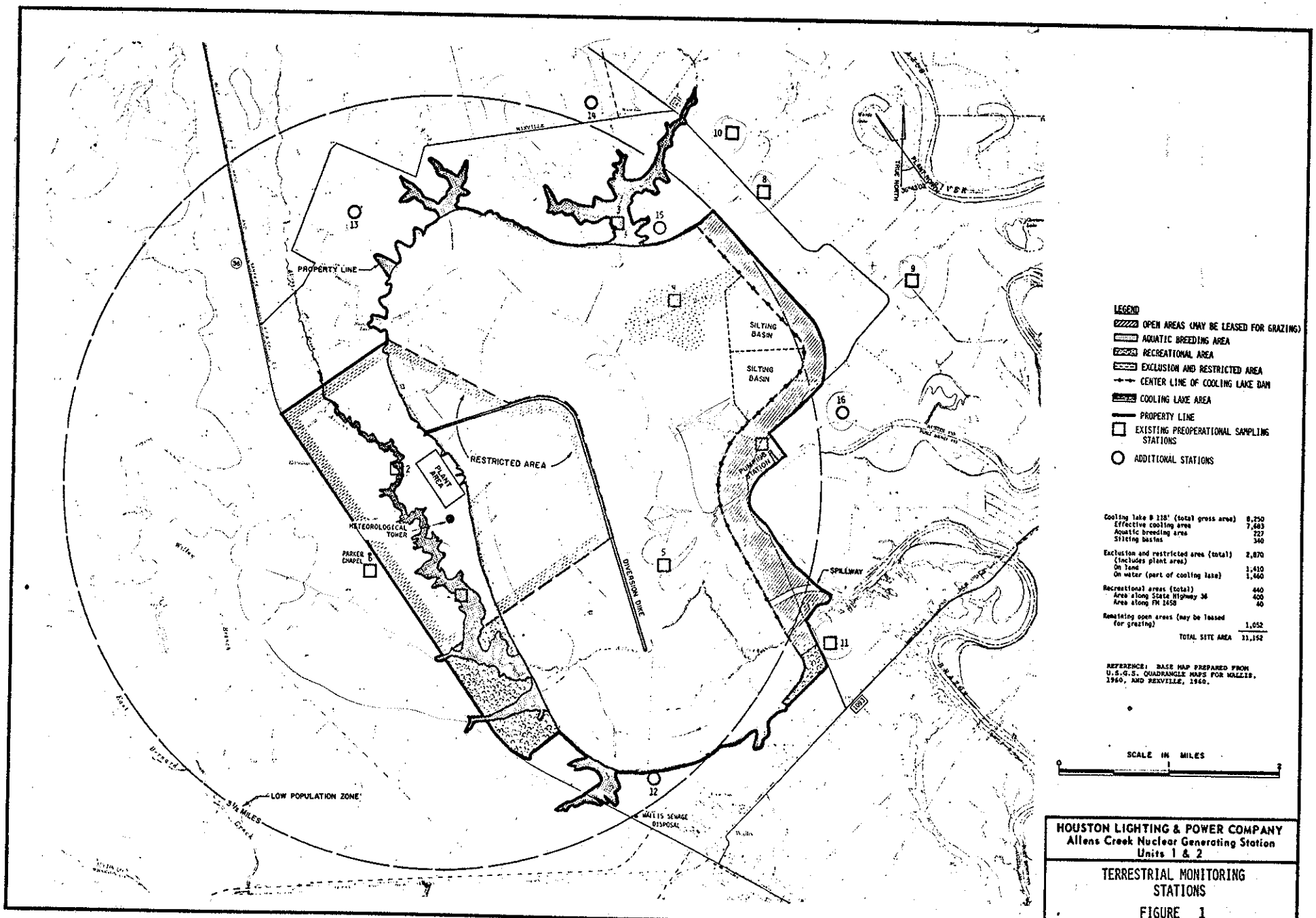
TYPE OF ANALYSES	PARAMETER	STATION	FREQUENCY OF MEASUREMENT	METHOD OF MEASUREMENT	ACCURACY OR LIMITS OF DETECTION
Physical	Temperature	All Stations	Weekly Field	Martek Thermometer	± 1.5%
	Specific Conductance	All Stations	Weekly Field	Electrical Resistivity	
	Transparency	All Stations	Weekly Field	Secchi Disc	
	Turbidity	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Turbidimeter	
Chemical	Total Solids	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Evaporation and Filtration	0.1 ppm
	Suspended	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Evaporation anf Filtration	Standard Methods
	Dissolved	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Evaporation and Filtration	Standard Methods
	Silica	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Calcium	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Magnesium	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Sodium	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Potassium	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Bicarbonate	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Carbonate	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Alkalinity	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Sulfate (Sulfide)	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Chloride	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Fluoride	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Nitrogen	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Nitrate	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Nitrite	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Phosphate (Orthophosphate)	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Ammonia	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Iron	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Sodium Absorption Radio(A1)	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Coliform	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	Chemical Oxygen Demand (COD)	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods

TABLE 3 (Cont.)

PHYSICAL AND CHEMICAL PARAMETERS FOR AQUATIC MONITORING

TYPE OF ANALYSES	PARAMETER	STATION	FREQUENCY OF MEASUREMENT	METHOD OF MEASUREMENT	ACCURACY OR LIMITS OF DETECTION
Chemical (Cont.)	Bio-chemical Oxygen Demand (BOD)	(A1, A5, B1, B3, B5)	Bi-weekly Laboratory	Standard Methods	Standard Methods
	pH	All Stations	Weekly Field	Bechman pH Meter	pH + 0.1
	Dissolved Oxygen	All Stations	Weekly Field	YSI 54A	± 1%
Pesticide	Aldrin	(A1, B1)	Monthly Laboratory	Gas Chromatography	0.1 ppb
	Chlordane	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	DDD	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	DDT	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	Dieldrin	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	Endrin	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	Heptachlor Epoxide	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	Heptachlor	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	Lindane	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	2, 4-D	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	2, 4, 5-T	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
	Silvex	(A1, B1)	Monthly Laboratory	Gas Chromatography	*
Heavy Metals	Copper	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.1 ppm
	Lead	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.05 ppm
	Strontium	(A1, B1)	Monthly Laboratory	Atomic Absorption	*
	Zinc	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.02 ppm
	Arsenic	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.1 ppm
	Boron	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 1.0 ppm
	Cadmium	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.1 ppm
	Chromium	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.08 ppm
	Iron (filterable)	(A1, B1)	Monthly Laboratory	Atomic Absorption	*
	Molybdenum	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.05 ppm
	Manganese	(A1, B1)	Monthly Laboratory	Atomic Absorption	*
	Mercury	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.1 ppm
	Nickel	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.01 ppb
	Cobalt	(A1, B1)	Monthly Laboratory	Atomic Absorption	± 0.5 ppm

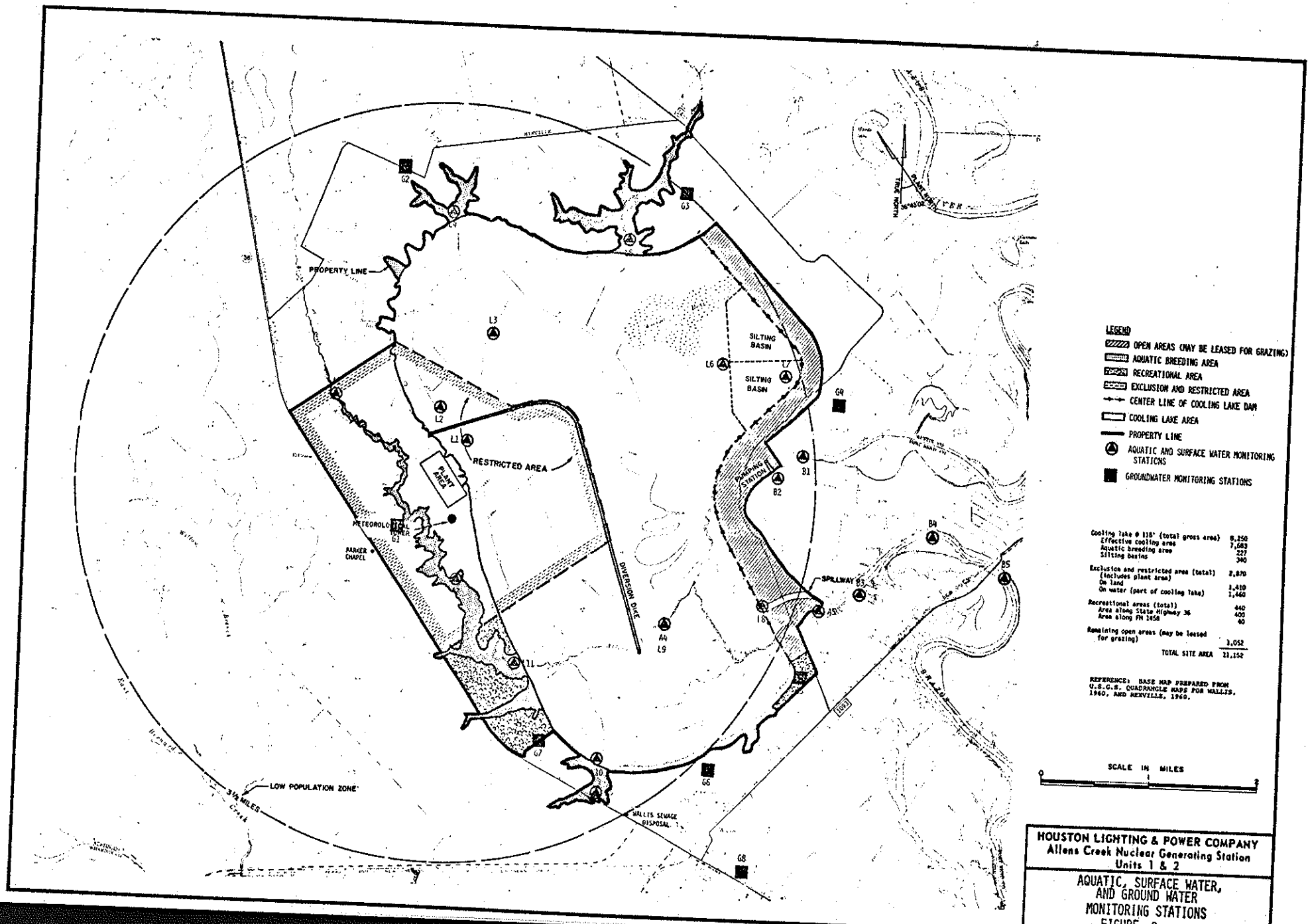
* To be supplied

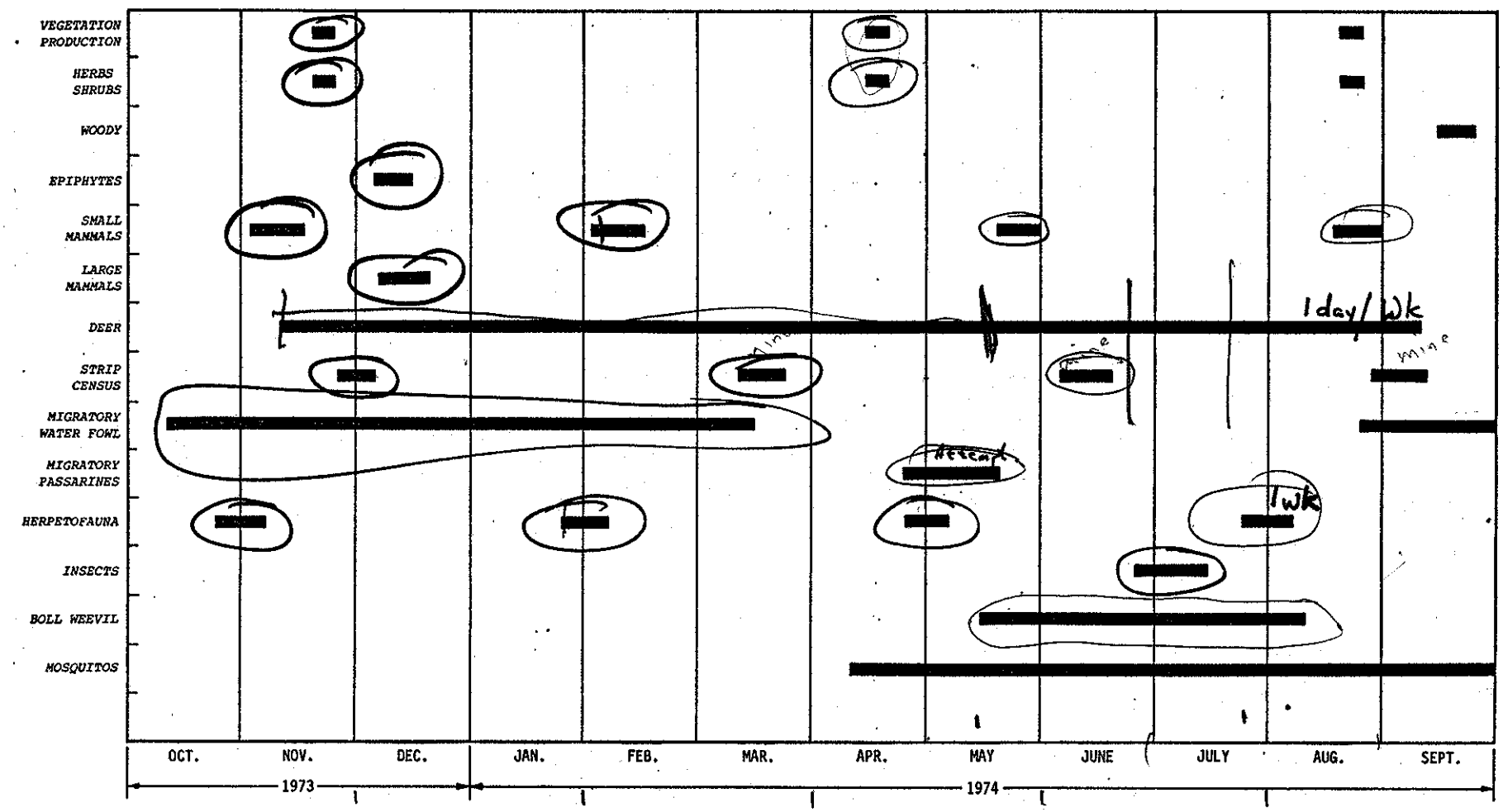


HOUSTON LIGHTING & POWER COMPANY
Allens Creek Nuclear Generating Station
Units 1 & 2

TERRESTRIAL MONITORING STATIONS

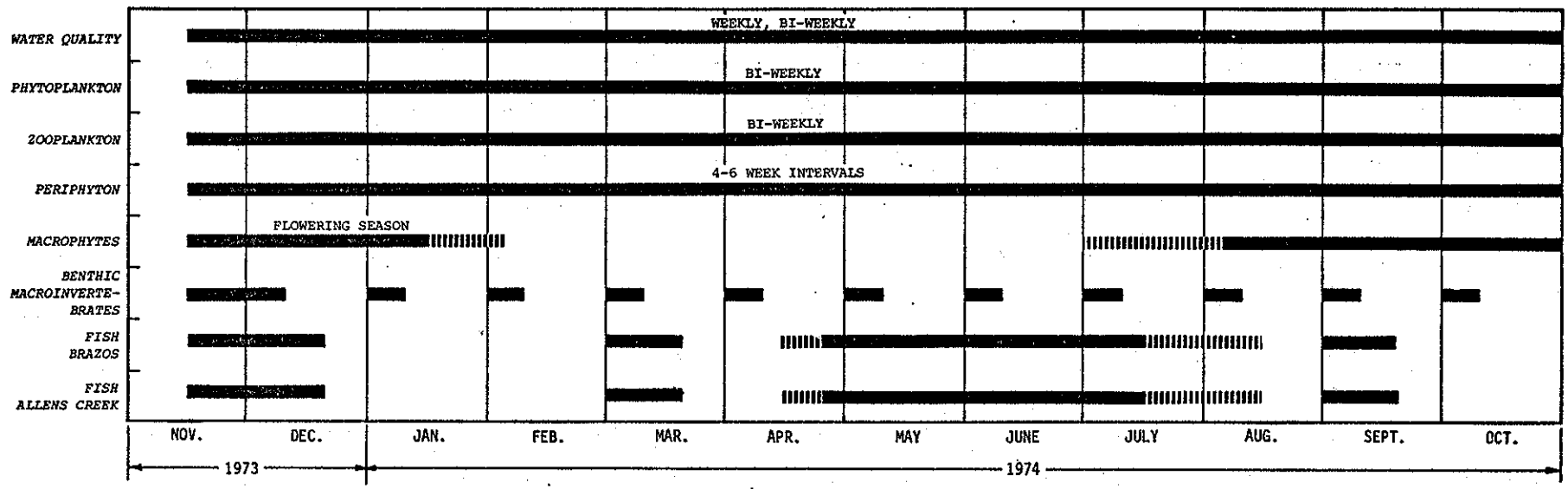
FIGURE 1


PROPERTY LINE
RESTRICTED AREA
PLANT AREA
METEOROLOGICAL TOWER
PARKER CHAPEL
DIVERSION DIKE
SILTING BASIN
SILTING BASIN
PUMPING STATION
SPILLWAY
LOW POPULATION ZONE
3½ MILES
WALLIS SEWAGE DISPOSAL
TRUE NORTH
G1
G2
G3
G4
G5
G6
G7
G8
L1
L2
L3
L4
L5
L6
L7
L8
L9
L10
L11
A1
A2
A3
A4
A5
B1
B2
B3
B4
B5
LEGEND
OPEN AREAS (MAY BE LEASED FOR GRAZING)
AQUATIC BREEDING AREA
RECREATIONAL AREA
EXCLUSION AND RESTRICTED AREA
CENTER LINE OF COOLING LAKE DAM
COOLING LAKE AREA
PROPERTY LINE
AQUATIC AND SURFACE WATER MONITORING STATIONS
GROUNDWATER MONITORING STATIONS
Cooling lake @ 118' (total gross area) 8,250
Effective cooling area 7,683
Aquatic breeding area 227
Silting basins 340
Exclusion and restricted area (total) 2,870
(includes plant area)
On land 1,410
On water (part of cooling lake) 1,460
Recreational areas (total) 440
Area along State Highway 36 400
Area along FM 1458 40
Remaining open areas (may be leased for grazing) 3,052
TOTAL SITE AREA 11,152
REFERENCE: BASE MAP PREPARED FROM U.S.G.S. QUADRANGLE MAPS FOR WALLIS, 1960, AND ROSHVILLE, 1960.
SCALE IN MILES
0
1
2
HOUSTON LIGHTING & POWER COMPANY
Allens Creek Nuclear Generating Station
Units 1 & 2
AQUATIC, SURFACE WATER, AND GROUND WATER MONITORING STATIONS
FIGURE 2



HOUSTON LIGHTING & POWER COMPANY
Allens Creek Nuclear Generating Station
Units 1 & 2

PROPOSED TERRESTRIAL SAMPLING SCHEDULE FOR ACNGS BIOLOGICAL MONITORING PROGRAM
FIGURE 3



HOUSTON LIGHTING & POWER COMPANY
Allens Creek Nuclear Generating Station
Units 1 & 2

PROPOSED AQUATIC SAMPLING SCHEDULE FOR ACNGS BIOLOGICAL MONITORING PROGRAM
FIGURE 4

REFERENCES

American Public Health Association. 1971. Standard methods for the examination of water and wastewater. 13th Ed. Amer. Pub. Health Assoc., Washington, D. C. 874 pp.

Baumgartner, L. L. 1944. Trapping, handling and marking fox squirrels. J. Wildl. Manage. 4: 444-450.

Beak, T. W., T. C Griffing, and A. G. Appleby. 1973. Use of artifical substrate samples to assess water pollution. pp. 227-241. In, J. Cairns, Jr., and K. L. Dickson (eds.) Biological methods for the assessment of water quality. American Society for Testing and Materials, Philadelphia.

Blair, F. W. 1944. Techniques for the study of mammal populations. J. Mamm. 22: 148-157.

Cameron, G. N. 1971. Niche overlap and competition in wood rats. J. Mamm. 52: 290-292.

Correll, D. S. and N. C. Johnston, 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Winner, Texas.

Cottam, G. and J. T. Curtis, 1956. The use of distance measures in phytosociological sampling. Ecology. 37: 451-460.

Cwik, M. J. 1970. Identification of insects and density determinations of the stomach contents of small mammals. U. S. International Biological Program-Technical Report No. 53.

Dames & Moore, 1973. Fall biological survey of the proposed Allens Creek site. Environmental Report.

Daubenmiere, R. F. 1968. Plant communities. Harper & Rowe, New York.

Emlen, J. T. 1971. Population densities of birds derived from transect counts. Auk. 88: 323-342.

Flyger, V. W. 1959. A comparison of methods for estimating squirrel populations. J. Wildl. Manage. 23: 220-223.

Graber, R. R. and J. W. Graber 1963. A comparative study of bird population in Illinois, 1906-1909 and 1956-1958. Ill. Nat. Hist. Sur. Bull. 28. p. 380-528.

Greig-Smith, P. 1964. Quantitative plant ecology. Academic Press, New York.

Hahn, H. C. 1945. The white-tailed deer in the Edwards Plateau Region of Texas. Texas Game, Fish & Oyster Comm., Austin, Texas. 50 p.

Hester, F. E., and J. S. Dendy, 1962. A multiple-plate sampler for aquatic macro-invertebrates. Trans. Amer. Fish. Soc., 91: 420-421.

Lagler, K. F. 1956. Freshwater fishery biology. Wm. C. Brown Co., Dubuque, Iowa. 421 pp.

Mason, W. T., Jr., J. B. Anderson, and G. E. Morrison. 1967. A limestone-filled, artifical substrate sampler-float unit for collecting macro-invertebrates in large streams. Prog. Fish-Cult., 29(2): 74.

McAlice, B. J. 1971. Phytoplankton sampling with the Sedgwick-Rafter celt. Limnol. Oceangr. 16(1): 19-27.

Odum, H. T., W. McConnell and W. Abbott. 1958. The chlorophyll "A" content of communities. Publ. Inst. Mar. Sci., Univ. of Texas. 5: 65-96.

Parsons, T. R., and J. D. H. Strickland. 1963. Discussion of spectrophotometric determination of marine-plant pigments, with revised equations for ascertaining chlorophylls and carotenoids. J. Mar. Res. 21(3): 155-163.

Peterson, A. N. 1953. A manual of entomological techniques. Ohio St. Univ., Columbus, Ohio.

Range Research Methods. 1963. U. S. Dep. Agr. Misc. Pub. 940.

Ricker, W. E. 1967.

Rupp, R. S. 1966. Generalized equation for the ratio method of estimating population abundance. J. Wildl. Manage. 30: 523-526.

Weber, C. I. 1970. Methods of collection and analysis of plankton and periphyton samples in the Water Pollution Surveillance System. Federal Water Pollution Control Administration, Div. Water Qual. Res., Analytical Quality Control Lab. Cincinnati, Oh. 27 pp.

Welch, P. S. 1948. Limnological methods. McGraw-Hill, New York. 381 pp.

Wilhm, J. and T. C. Dorris. 1968. Biological parameters for water quality criteria. Bioscience 18: 477-481.

Woodbury, A. M. 1953. Methods of field study in reptiles. Herpetologica. 9: 87-92.