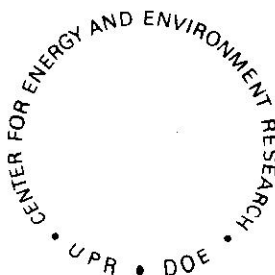


CEER - A67

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH  
NORTH WEST COAST POWER PLANT  
QUALITY ASSURANCE MANUAL

FEBRUARY 1980



CENTER FOR ENERGY AND ENVIRONMENT RESEARCH  
UNIVERSITY OF PUERTO RICO -- U.S. DEPARTMENT OF ENERGY

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QUALITY ASSURANCE MANUAL

February 1980

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QUALITY ASSURANCE MANUAL

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## NORTH WEST COAST PROJECT QUALITY ASSURANCE PROGRAM

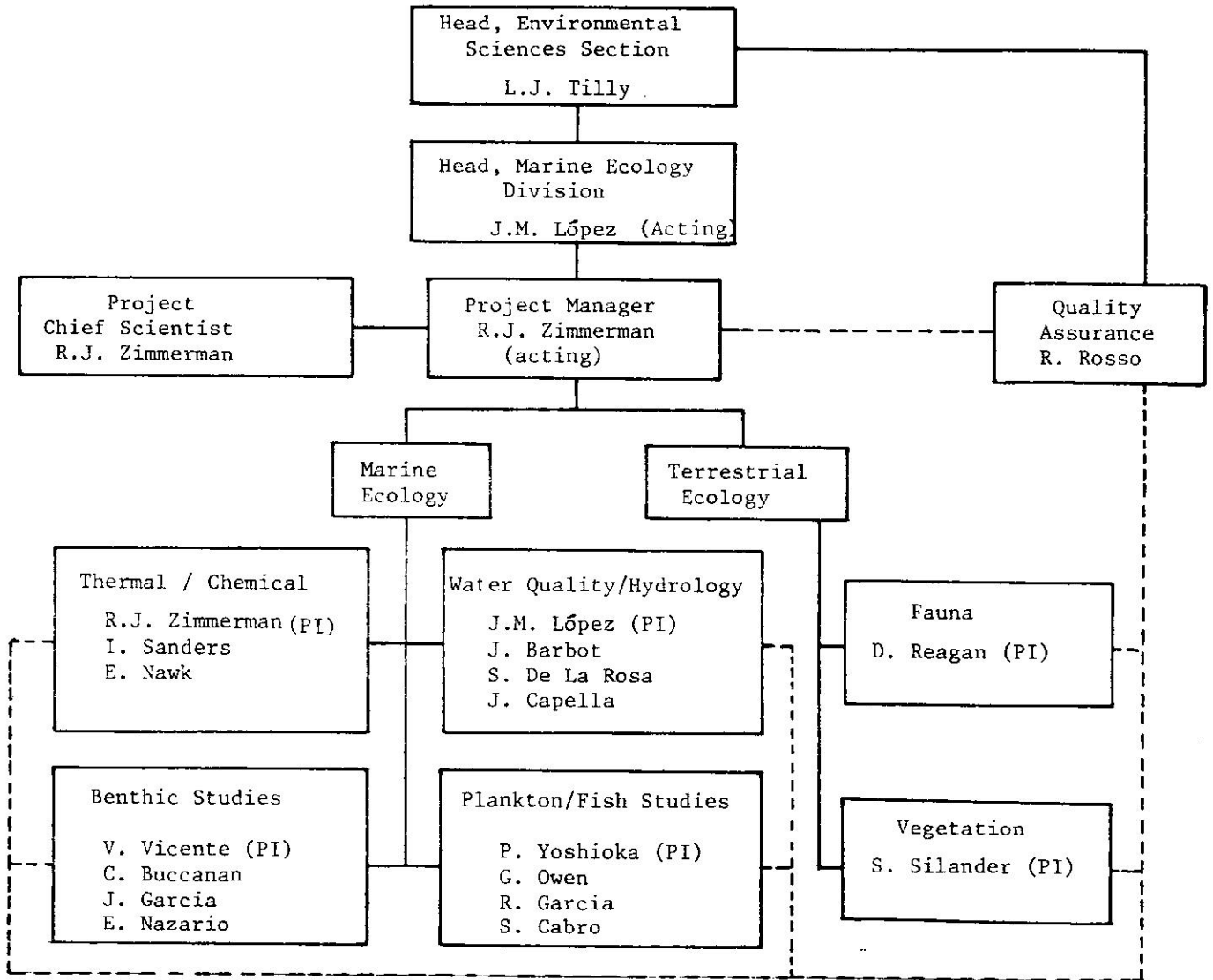
### I. Organization

The organization of the CEER / North West Coast (NWCO) Project group consists of the project office, including the project leader and a small administrative staff, a small logistics action group which handles field operations on shore and at sea, and a number of scientific functional units, each led by a qualified scientist who is specifically trained and experienced in the portion of the scientific investigation which he directs. Within the scientific units are more junior scientists and assistants, all of whom have some training and/or experience in scientific work. Each leader of an individual scientific unit has responsibility for detailed planning of the investigations that fall within his area of expertise, for scheduling the appropriate field and laboratory activities and directing the efforts of his people toward accomplishing the research. All CEER scientific unit leaders are field experienced and routinely participate in field work as well as in laboratory work.

The organigram of Figure 1 depicts the project organization and identifies certain key people, including the leader of scientific units.

The Quality Assurance Program will be directed by a Q. A. Supervisor reporting to the Head, Environmental Sciences Section. The Q. A. Supervisor will audit the various research activities of

**Center for Energy and Environment Research  
Puerto Rico Electric Power Authority North West Coast  
(NWCO) Project**



——— Direction and Coordination  
 - - - - - Audit  
 (P.I.) Principal Investigator

**Quality Assurance Program Implementation  
Organigram For NWCO Project**

Feb 28, 1980

Submitted *Ruben Rosso*  
 Ruben Rosso

Figure I

Approved *J. J. Tilly* for  
 J. J. Tilly

the NWCO Project and submit monthly reports to the Director, CEER and to the Head, Environmental Sciences Section as outlined in "CEER Audit Program Plan."

## II. Quality Assurance Program

The primary function of the CEER Quality Assurance Program will be to ensure management attention to key elements of the PREPA program for environmental investigations for Power Plant siting at NWCO. The "CEER Audit Program Plan" serves as a "Q. A. Manual" for this research contract. This function will be carried out by means of a CEER audit program according to an audit program plan which will:

1. Identify the individual responsible for the audits
2. Provide for a monthly audit
3. List all activities subject to audit and identify specific activities to be audited in any one month
4. Describe methods to obtain corrective actions on findings
5. Specify documentation and reporting requirements

## III. Design Control

The CEER Quality Assurance Program is designed to insure that scientific research work, the schedule for performing the various sections of the work and preparation of reports shall accomplish the objectives of the PREPA Program for environmental investigations. The specific research tasks and the methods to accomplish them are

outlined in the Specifications for General Performance Requirements (4) provided by the PREPA.

IV. Control of Documents, Records and Reports

The leader of each scientific unit in the project is responsible for the proper use of the necessary forms, data sheets, log books and other records to fulfill the needs for scheduling and for recording of field trips, samples collected and processed, data taken in the field and taken from field material when processed in the laboratory. The records shall include date, time and location for each sample or measurement. Where appropriate, depth will be recorded. Field notes, adequately identified to permit keying to data and samples, will contain other relevant information such as description of the site, current conditions such as weather, etc.

The nature of the records shall be tailored to the kind of material treated, the type of measurements and methods of sampling and laboratory handling of materials and data. In all cases they shall be such that the leader of the scientific unit can determine upon what raw data all final results are based, i.e. what the raw data values were, and when, where and how they were taken. The raw data values shall be preserved for the life of the contract, and final disposition shall be determined in conjunction with PREPA.

The leader of such scientific unit is also responsible for controlling the labelling, storage, and handling of his sample



material from original collection until all data have been extracted from it and recorded. The system used shall be consistent with the rest of his record system and shall permit accomplishment of the stated objectives of identification.

The project leader, assisted by the project office staff, is responsible for assembling data and total scientific contributions from all the functional units into the necessary reports to meet the project schedule.

V. General Project Instructions

All leaders of scientific units receive the basic documents which provide guidelines for objectives and methods of the investigation and formats for obtaining and presenting results, e.g.:

1. Specification for General Performance Requirements for Aquatic Baseline Studies for Puerto Rico Electric Power Authority, (PREPA).
2. Specification for General Performance Requirements for Terrestrial Ecological Investigation and Analysis for PREPA.
3. Specification for General Performance Requirements for Thermal and Chemical Tolerance Studies for PREPA.
4. Specification for General Performance Requirements for Tides and Currents Hydrological Data Collection for PREPA.

5. North West Coast (NWC) Project Quality Assurance Manual Item (1), (2), (3) and (4) constitute the prime standard for the research program.

Copies of reports generated by the project office are distributed to all interested unit leaders.

Contract-specified schedule dates for reporting are the accepted standard for preparation and submission of data by scientific units, with allowance for final preparation time in the project office. In addition, the project office keeps unit leaders abreast of dates relevant to their individual functions. Earlier reporting is done when data is available.

General operating procedures regarding logistics, communication, safety, etc. are distributed as the need arises by memo from the project office to all unit leaders. Information and discussion meetings for all project scientists are held at appropriate points in the progress of the work.

#### VI. Control of Equipment

The functional unit leader is responsible for keeping up with the whereabouts and condition of his equipment, giving it proper care and having repairs, servicing and calibration done when necessary.

Where calibration or standardization of measuring equipment can be done satisfactorily by unit personnel, the unit leader insures that such check procedures are accomplished at the proper

times and provides the necessary instructions to the people who perform the checks. Where the calibration or standardization procedures is beyond the capabilities of unit personnel and facilities, the unit leader establishes an appropriate schedule based on manufacturer literature, operating experience, etc. The unit leader is responsible for making the necessary arrangements and insuring that the checks are made on this schedule or at any other time when a discrepancy in operation is suspected.

#### VII. Measuring and Test Equipment Records

A record of all equipment supplying quantitative data inputs to the NWCO Program will be set-up. These records will include the serial number of each piece of equipment, field and off-site calibration methods, records of calibration, and other pertinent data on the equipment. The unit leader will keep these records up-to-date to insure that data are produced by calibrated equipment.

#### VIII. Audits

The individual responsible for the audit program will assure that an auditor will review a specified part of the list of activities to be audited, together with additional items such as suspected weaknesses or follow-up on previous findings. Where possible, the auditor will not be responsible for work in the area being audited. The auditor will prepare an audit check list for his own use during

the audit. In all cases, the auditor will arrange the audit to minimize disruption of work in progress. An audit will be conducted once each month.

Conducting the Audit - the auditor will use the check list as a guide during the audit, but will not limit his review to the specific points listed. For example, in reviewing sample data, the auditor may find data that is inconsistent; this may lead to questions on instrumentation. The auditor may obtain information by review of documents, by discussions with personnel, and by direct observation of activities. Again, the audit will be conducted to minimize interference with work in progress. Immediately following the audit, the auditor will review with cognizant CEER individuals the findings and recommendations resulting from the audit.

Documentation - each audit by CEER will be reported in a brief, concise audit report. This report will:

1. Identify areas covered by the audit
2. Report findings in each area
3. Recommend action, if any, to be taken on findings, and
4. Report understandings reached during the audit and subsequent review regarding any intended corrective action.

Schedule - while the primary function of the audit program is to ensure proper technical control, audits may identify scheduler problems. Also, constructive audits will define areas where progress can be improved. Review of audits by senior CEER scientists should include consideration of progress and schedules.

Scientific peer review - The scientific data generated by the environmental study are subjected to critical review by other scientists in the appropriate disciplines.

The Q. A. Supervisor will maintain a record of actions agreed upon, the individual responsible for carrying out the changes and the states of corrective action. It is emphasized that the documentation involved in this effort should not be cumbersome, but should enable senior CEER scientists to assess the effectiveness of the program.

IX. Program Records

The following records will be maintained by the CEER Quality Assurance Program:

1. North West Coast Project Quality Assurance Manual and any amendments to it,
2. CEER Audit Program Plan and amendments to it,
3. Schedule of audits of various activities and records of dates when audits were actually accomplished.
4. Completed Audit Check List pertaining to each audit
5. Monthly Audit Reports
6. Internal Correspondence with scientists and supervisors relating to audit program and follow-ups on recommended actions,
7. Correspondence between PREPA and CEER related to the Quality Assurance Program

8. Administrative correspondence related to operation of CEER  
Q. A. Program.

X. Corrective Action

Corrective action will be carried out as stated in the "CEER Audit Program Plan".

QUALITY ASSURANCE GUIDE-TASK PROCEDURES

The procedures or methods to be used are those presented in the specifications provided by PREPA. Details for performing various tasks are included in the following pages.

I. Thermal and Chemical Tolerance

1. Checklist of Equipment and Materials

1.1 Equipment

- 1.1.1 LAUDA Model K-2/R circulating bath units, or suitable equivalents.
- 1.1.2 ASTM certified mercury thermometers.
  - a. -8°C to +32°C, total immersions
  - b. +25°C to +55°C, total immersion
- 1.1.3 PEARBODY RYAN Model "J" thermographs, or equivalent recorders.
- 1.1.4 YELLOW SPRINGS INSTRUMENTS Model 57 dissolved oxygen meter, or equivalent, equipped with YSI 5739 probe, or suitable equivalent.
- 1.1.5 YELLOW SPRINGS INSTRUMENTS Model 33 salinity-conductivities-temperature meter or equivalent with YSI 3310 or YSI 3311 probe, or suitable equivalent.
- 1.1.6 MASTER FLEX variable speed pump drives, Model WZIROL57, or 7564-10, or suitable equivalents, with pump Models 7013, or 7014, or 7015, or 7016, or 7017, or 7018, or suitable equivalents.
- 1.1.7 METTLER Type K5 or K7 top loading balance, or suitable equivalent.
- 1.1.8 MARKSON digital stopwatch - No. 11065, or suitable equivalent.

1.2 Materials

- 1.2.1 Non-metallic (polyethylene, or similar) collecting and transport containers.
- 1.2.2 Aquaria in an assortment of sizes ranging from, but not limited to, 3.8 liters to 37.8 liters in volume.
- 1.2.3 Metric rules and calipers or equivalent length measuring devices.



- 1.2.4 Flowing seawater, in a climate controlled laboratory. Open or closed circulation provided from not less than 4,000 liter seawater reservoir, as needed.
- 1.2.5 Laboratory work tables with drains, designed for flow-through seawater experiments.
- 1.2.6 Artificial aeration pumps for aquaria, as needed.
- 1.2.7 Field and laboratory notebooks and data entry forms.

## 2. Important Procedural Steps

### 2.1 Field collection and laboratory holding.

- Organisms will be collected live in the field using appropriate entrapment gear, species by species (as determined by the project scientist).
- Organisms will be transported to the laboratory within the same day as collected in special containers clearly marked, "For Live Organisms, Use Seawater Only, No Chemicals". Small species such as copepods and amphipods may be placed in Zip-lock bags (new, double rinsed in seawater) in turn placed into larger insulated containers (not less than 15 liters) with seawater.
- During transport organisms will not be excessively crowded or handled, nor will temperature be allowed to rise beyond 1°C above ambient, nor oxygen allowed to deplete to less than 60% of saturation.
- Transfer of organisms to laboratory tanks will take place after replacing 25%, 50% and 100% of field collected seawater with laboratory seawater. In no case, during transfer will organisms be subject to more than 3°C temperature change or 3ppt salinity change in any 12 hour period (EPA specifications. See EPA-600/4-78-012, July 1978).
- All organisms will be collected during the week prior to testing. During holding and acclimation, each species will be fed, with food type and quantity determined by a specialist.

## 2.2 Acclimation

-The pretest acclimation period will not be less than 48 hours, and typically will be 72 hours. If more than 5% of the organisms die within that period, or if they appear to be diseased or otherwise stressed (as determined by the researcher), the entire group will be discarded and a new group obtained (EPA standards; op.cit.).

### 2.2.1 During acclimation and testing:

2.2.1.1 live weight loading within each aquarium will not exceed 2.5 grams per liter.

2.2.1.2 seawater flow rates into aquaria will not be less than one volume exchange each two hour period.

2.2.1.3 dissolved oxygen will not be allowed to become lower than 40% of saturation. (each of above are EPA standards)

### 2.2.2 During thermal tolerance testing, three acclimation temperatures are to be used for each species examined:

2.2.2.1 28°C

2.2.2.2 31°C (28°C + 3°C)

2.2.2.3 25°C (28°C - 3°C)

Deviation from these acclimation temperatures can be instituted if the extremes are found to be too low or too low or too high for a particular species.

During chemical tolerance testing, all acclimations will be at 28°C.

## 2.3 Tests

### 2.3.1 Thermal Tolerances

-After an acclimation period of 72 hours at 31°C, 28°C or 25°C, organisms are to be placed abruptly into test temperatures at:

- a. 32°C
- b. 35°C
- c. 38°C
- d. 41°C
- e. acclimation control

Deviation from these test temperatures may be allowed if the scientist in charge deems them inappropriate for the species being tested.

-During the test period, diurnal variation in the test should not exceed  $\pm 0.5^{\circ}\text{C}$  for more than 5% of the time. A continuous recording of test temperature will serve as a monitor. Temperature will be maintained by precision heating-cooling, both units equipped with variably adjustable thermal regulators positioned in test aquaria. In addition, the laboratory will be temperature controlled to increase precision.

-Test duration will be for 96 hours or until all tests have attained 50% mortality (excluding the control). If more than 5% of the control organisms die within the period, the entire test will be abandoned.

-Data will be entered onto prescribed forms similar to or the same as those appended to this document-designed:

- a. mortality data
- b. physical test parameters
- c. equipment check

-These tests are to be considered acute thermal shock experiments for the upper incipient thermal limit - as distinguished from lower incipient limit and critical thermal maxima (CTM) experiments. (See: V. H. Hutchison. Thermal Ecology II. ERDA Series 40. pages 12 and 13. 1976).

### 2.3.2 Chemical Tolerance

-After an acclimation period of 72 hours at 28°C, organisms are to be placed abruptly into 4 test of a metal (to be designated) differing by one order of magnitude (x10) each. A separate test without metal ion in detectable levels will serve as a control.

-Mortality will be recorded on data forms (similar to those of thermal tolerance tests) over a 96 hours

period. The test will terminate when, or if, 50 mortality is attained in all test concentration. The test run will be abandoned if control mortality is beyond 5% during the 96 hours period.

-Tests with three different metals will be run for each species.

-Each metal will be batch mixed week by week at a concentration higher than that of the highest test concentration in a 4,000 liter tank. This reservoir will serve as a bioassay test effluent to be mixed in know quantities , using peristaltic pumps into seawater flowing at a given rate into test aquaria. The metallic ion concentration in the effluent reservoir will be predetermined by mixing a given quantity of metal salt, assuming a known dissociation constant, into seawater. Periodically, samples will be taken of the seawater in each test concentration and cross-checked with a Atomic Absorption spectrophotometer.

-In general, all procedures for chemical tolerance testing will adhere, when applicable, to EPA standards as set forth in Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms (EPA-600/4-78-012, July, 1978).

### 3. Report Forms and Notes

-Laboratory data will be entered onto prescribed data forms similar to, or the same as those appended to this document. The researcher entering data in each case will be clearly identified by his or her signature in a column designated signature or researcher.

-Field notes will be entered onto water resistant paper in a standard Engineers Level Book (No. S410V) or a suitable equivalent. Each page will be initiated by the researcher taking notes.

-All original data will be replicated on a good quality copy machine filed in at least two different places. Pages numbers on each data form will be consecutive and no original data forms regardless of quality will be discarded. If pages are inadvertently lost or destroyed, a full written and signed explanation by the researcher(s) will be inserted in place off.

4. Disposition of Samples and Results

4.1 Samples

-Organisms collected from the field will be used only once during experiments. Those remaining alive at the end of the 96 hour test will be released into a nearby habitat similar to that from which they were originally taken. Dead organisms will be removed from the test aquaria measured as to size and/or weight and disposed of through regular sanitary disposal pickup or into a sink equipped with an ordinary garbage disposal.

-All effluent seawater from the flow-through system will be directed through an activated charcoal bed before returning to the environment.

-All original data sheets and note books will be deposited with the Environmental licensing Engineer for filing, with copies of data sheets attached to progress reports to the Utility (PREPA). Copies of all data and reports as well as communications will be kept on file at CEER.

5. Task Responsibilities of Individuals

5.1 Principal Investigator or Scientist - in charge (60% effort). Duties included:

-design of experiments and decisions regarding modification, if necessary.

-service as specialist on tropical invertebrates; select organisms for study.

-supervision of Research Associates performing experiments.

-official communication by direct or indirect means with all other individuals or organizations.

-service as the individuals ultimately responsible for all data collected and research performed.

5.2 Research Associates (two researchers at 100% effort). Duties included:

-all field collection

- all laboratory culturing and monitoring of organisms.
- maintenance and organization of laboratory according to accepted scientific standard.
- monitoring and data entry for all thermal tolerance and chemical tolerance experiments.
- monitoring and maintenance of equipment calibration.
- preparation statistical analyses of data and literature review.
- provide consultation and assistance to principal investigator in writing the final report.

### 5.3 Service technician

- clean laboratory daily
- maintain ground immediately outside of laboratory
- assist in maintaining all non scientific equipment in the laboratory.
- assist research associates in physical duties.

## 6. Maintenance or Calibration of Equipment

- 6.1 Thermal circulation bath units will be checked daily against ASTM Certified Mercury thermometers with deviations noted.
- 6.2 Thermographs will be calibrated initially during a test run with ASTM Certified Mercury thermometers, and checked periodically against the same thermometers to assure repeatable performance.
- 6.3 YSI oxygen meters and probes will be calibrated by the manufacturer initially. A periodic check on performance will be run using Winkler oxygen titrations (set forth in Strickland and Parsons, Standard Methods, 1965).
- 6.4 YSI Model 33 Salinity-conductivity-temperature meter will be calibrated against a standard using I.A.P.S.O. Standard seawater and the manufacturers specifications, and checked weekly.

- 6.5 MASTERFLEX variable speed drives and peristaltic pumps will be checked daily, and flow rates determined using PYREX graduated cylinders calibrated by the manufacturer in milliliters, and a digital stopwatch (manufacturer calibrated) measuring in not less than 0.1 second intervals.
- 6.6 METTLER top loading balance to be calibrated prior to use by a certified manufacturer's technician.

Unless otherwise specified, maintenance and calibration of equipment will follow manufacturer's specifications.

TEST ORGANISM \_\_\_\_\_

INITIAL NUMBER OF INDIVIDUALS \_\_\_\_\_

LIFE STAGE \_\_\_\_\_

SIZES ( $\bar{x}$ ,  $\pm$ SD, range) \_\_\_\_\_

DATES: INITIAL \_\_\_\_\_ FOR \_\_\_\_\_ HRS.

ACCLIMATION TEMP. \_\_\_\_\_ . COMPLETE \_\_\_\_\_

TEST TEMP. \_\_\_\_\_

EFFLUENT \_\_\_\_\_ . CONC. \_\_\_\_\_

TEST NO. \_\_\_\_\_ . REPLICATE NO. \_\_\_\_\_

HOUR CHECK	TIME	# ALIVE	% MORTALITY	OBSERVATION	RESEARCHER
0					
1					
3					
6					
9					
12					
18					
24					
30					
36					
48					
72					
96					



APPENDIX  
THERMAL/CHEMICAL STUDIES  
FORMAT II

TEST NO. \_\_\_\_\_, REP. NO. \_\_\_\_\_ (CONT.)

TEST PARAMETERS:

HOUR CHECK	TIME	TEMP.	O <sub>2</sub>	SALINITY	EFFLUENT CONC.	SIGNATURE RESEARCHER
1						
3						
6						
9						
12						
18						
24						
30						
36						
48						
72						
96						

## II. Benthic Studies

### 1. Checklist of Equipment and Materials

#### 1.1 Equipment

1.1.1 SCUBA gear: tanks, regulators, accessories

1.1.2 Underwater communication system: Wet phone-Sound wave System, Inc.

1.1.3 Underwater camera: Nikonos Model III

1.1.4 Underwater strobe: Model Sunpack marine

1.1.5 Microscopes

1.1.5.1 Compound: Americal Optical: Series H10 Microstar Model XH10 TM - J.W.:  
With Camera

Attachment 1053, 35 mm with magnification factors of 2.8 x and 5.0 x. With exposure meter series 1066, Expostar Control units (115-120v, 60 Hz, series 1190.

1.1.5.2 Dissecting: Baush and Lomb: Sterozoom 7, from Baush and Lomb Inc.

#### 1.2 Materials

1.2.1 Cement blocks

1.2.2 Asbestos panels

1.2.3 Chains

1.2.4 Buoys

1.2.5 Chemicals

1.2.6 Containers

### 2. Important Procedural Steps

The specifications established by the engineer for the study of the benthic flora and fauna at the Rincón and

Carrizal sites are stated in pages 23-28 of '85. There are three major specifications for both sites: A. Benthic Mapping; B. Sampling Stations and C. Artificial Substrates. The methods to meet these requirements are given below.

2.1 BENTHIC MAP: The methods to create a benthic map for both sites are given below.

2.1.1 Aerial Photography: Aerial photographs will be used for (a) general reconnaissance of each site; (b) determining general shoreline features; (c) determining the approximate location of submerged reef structures; submerged rock platforms and rock outcrops in relation to clear (i.e. sandy) bottoms. Both black and white film (Plus X, ASA 125) and color film (Kodachrome, ASA 64) will be used for this purpose. PREPA's helicopter or an airplane (preferably from West Wing Flying School, since it is close to both sites) is required.

2.1.2 Bottom Profiles: Bottom profiles will be determined aboard the R/V SULTANA. The instrument, already installed on board is a Ross Fisherman Depth Finder and Recorder. The advantage of this instrument is that, in addition, it will provide information on substrate type since it can distinguish between soft and hard bottom: a soft or silty bottom will appear on the chart as a relatively narrow bottom line due to absorption of the acoustic signal, a hard or rocky bottom will have a much wider line at the same sensitivity setting due to higher bottom reflectivity of the acoustic signal.

2.1.3 Underwater Transects: Underwater transects are required by the engineer at both sites (pages 23-25 of 85) "to evaluate substrate type, biotic associations, and zonation" (page 25 of 85). These transects will be useful for creating benthic maps at both sites. The consultant proposes the following methodology to comply with these specifications. The location and direction of each transect is given in Fig. 2.1.1 (Rincón) and in Fig. 2.1.2 (Carraizal). Transect lines will be 300 m long marked at 20 m intervals. They will run from shore to offshore. A format (FORMAT I, Appended) has been prepared to meet

FORMAT I

Bearings Beg. of Tr: \_\_\_\_\_ Date: \_\_\_\_\_  
 Bearings end of Tr: \_\_\_\_\_ Station: \_\_\_\_\_  
 Depth Range: \_\_\_\_\_ Type of Sample: \_\_\_\_\_  
 Signature: \_\_\_\_\_

<u>Distance(m)</u>	<u>Depth(ft)</u>	<u>Substrate</u>	<u>DOM-COMM</u>	<u>Conspicuous Species</u>
OM				
0 - 20				
20 - 40				
40 - 60				
60 - 80				
80 - 100				
100 - 120				
120 - 140				
140 - 160				
160 - 180				
180 - 200				
200 - 220				
220 - 240				
240 - 260				
260 - 280				
280 - 300				
300 m				

FORMAT II

Bearings of Station: \_\_\_\_\_

Date: \_\_\_\_\_

Depth Range: \_\_\_\_\_

Station: \_\_\_\_\_

Distance from Shore: \_\_\_\_\_

Type of Sample: \_\_\_\_\_

Signature: \_\_\_\_\_

Depth	Substrate	DOM-COMM	Conspicuous Species

the specifications mentioned above. U/W photography will also be used to characterize the bottom. Samples of conspicuous, unrecognizable organisms will be collected.

- 2.1.4 Spot Dives: As many spot dives (hereby defined as dives at preselected spots) as seem necessary to fulfill the information required to construct a benthic map will be made. A format (FORMAT II) has been prepared to document, underwater, the specified information. Underwater photography as well as samples of conspicuous, unrecognizable species, will be taken.
- 2.2 Sampling Stations: Sampling stations on predetermined locations have been selected by the engineer to provide information on more specific aspects of benthic community structure and dynamics: a) species present (invertebrate, algae, fish; b) species interaction of major species present; c) seasonal changes in biotic components; d) changes in the biotic components and 3) population densities of conspicuous species (pages 26-27 of 85). In order to meet these requirements, the engineer proposes a 10 m x 2 m transect as the major sampling area. The consultant proposes the following methodology to meet the requirements of the engineer utilizing the 10 m x 2 m transect proposed.

Three 10 m long chains spaced 1 m apart from the central chain, each running parallel to each other, will be permanently secured to the substrate so as to provide the 10 m x 2 m area specified by the engineer in page 26 of 85. At every meter a transverse line will be placed, and secured, so as to provide twenty, 1 m<sup>2</sup> plots in two rows: ROW I and ROW II, each consisting of 10, 1 m<sup>2</sup> plots. Each plot is enumerated as illustrated in Figure 1 (Appended). At each sampling station, ROW I will be photographed twice yearly; at the beginning of the study and 12 months after the beginning of the study, and the area described in detail so as to note any changes in biotic components as specified in page 26 of 85. Random collections during the year will be obtained. Ten, 1/16 m<sup>2</sup>, quadrats will be taken at the beginning of the study and 12 months after the beginning of the study. Counts (population density) of conspicuous plants and animals will be determined within the 10 m x 2 m transect, at the beginning of the study, and 12 months after the beginning of the study.

FIGURE I

ROW 1	ROW 2
1	11
2	12
3	13
4	14
5	15
6	16
7	17
8	18
9	19
10	20

2.3 ARTIFICIAL SUBSTRATES: In section 2.2.1.4 pages 27-28 of 85 the engineer specifies the requirement of an artificial substrate study in order to give an idea of the potential for recolonization at predetermined stations. The Duratex panels will be tied to the surface of the cement blocks and will cover the same surface area as the surface of each block. The blocks will be aligned in two rows: one of 7 blocks and another row of 6 blocks. A chain will run through the holes of the blocks through the whole length of the row and secured to the substrate. The sampling procedure has already been established by the engineer (pages 27-28 of 85). The Rincón site is a high wave energy environment, and modifications of securing the blocks to the substrate may be necessary.

3. Report Forms and Notes

Report forms and notes have already been specified in "Specification for General Performance Requirements for Aquatic Ecology and Water Quality: Aquatic Baseline Studies" Section 6, pages 61-85 of 85, Revision 2. The report forms are given in Fig. 6.1.1 and 6.3.1 and the species code assignments in Table 6.3.2

4. Disposition of Samples and Results

As specified in Section 2.2.24: Benthic Flora and Fauna (Contractor's Specification), all specimens collected in the field will be taken to the laboratory and identified to species. A list of all reference used and systematists consulted will be reported to the owner and the engineer by the consultant. All species data shall be recorded on the Biological Analysis Report forms provided by the environmental licensing engineer (Appended). Specimens collected will be kept in the laboratory, preserved in the proper agents (formalin, ethanol) and labeled for station number and date. A reference collection for each group will be set up.

5. Task Responsibility of Individuals

5.1 Principal Investigator. In charge of designing field studies, supervision of all aspects concerning the benthic studies; laboratory responsibilities also include taxonomy of the Porifera; submission of monthly reports.



- 5.2 Scientific Research Associate III. In charge of all invertebrate taxonomy and coordinator of laboratory duties (proper labeling of specimens, proper allocation of samples).
  - 5.3 Lab. Tech II. In charge of the taxonomy of all macrophytes; field assistant when necessary.
  - 5.4 Lab. Tech. I. In charge of obtaining and preparing all field materials. Principal field assistant in all phases of SCUBA diving activities.
6. Maintenance and Calibration

Maintenance and calibration of equipment will follow manufacturers specifications.

APPENDIX: BENTHIC STUDIES



FIGURE 6.1-1 BIOLOGICAL FIELD COLLECTION REPORT FORM

1. JOB \_\_\_\_\_ LOCATION \_\_\_\_\_ STATION \_\_\_\_\_ DATA TYPES COLLECTED WO P Z I S  
2 3 4 5 6

DATE DA \_\_\_\_\_ MO \_\_\_\_\_ YR \_\_\_\_\_ COLLECTOR \_\_\_\_\_ SIGNATURE \_\_\_\_\_

WIND SPEED \_\_\_\_\_ DIRECTION \_\_\_\_\_ FROM N=1 NE=2 E=3 SE=4  
WAVE HEIGHT \_\_\_\_\_ DIRECTION \_\_\_\_\_ S=5 SW=6 W=7 NW=8

CLOUD COVER \_\_\_\_\_ PRECIPITATION \_\_\_\_\_ SECHCHI DISP \_\_\_\_\_ M

TOTAL DEPTH \_\_\_\_\_ TIDE \_\_\_\_\_ SPECIAL CODES \_\_\_\_\_  
A B C D E F G H I

TIDAL STAGE (ESTIMATE FROM USCGS TABLES) \_\_\_\_\_

(LOW = 1 RISING LESS THAN 1/2 TIDE 2 RISING MORE THAN 1/2 TIDE 3  
HIGH = 4 FALLING LESS THAN 1/2 TIDE 5 FALLING MORE THAN 1/2 TIDE 6)

BOTTLE SAMPLING

SAMPLE DEPTH \_\_\_\_\_ UNITS \_\_\_\_\_ # OF BOTTLES \_\_\_\_\_ TIME \_\_\_\_\_

SAMPLE DEPTH \_\_\_\_\_ UNITS \_\_\_\_\_ # OF BOTTLES \_\_\_\_\_ TIME \_\_\_\_\_

SAMPLE DEPTH \_\_\_\_\_ UNITS \_\_\_\_\_ # OF BOTTLES \_\_\_\_\_ TIME \_\_\_\_\_

SAMPLE DEPTH \_\_\_\_\_ UNITS \_\_\_\_\_ # OF BOTTLES \_\_\_\_\_ TIME \_\_\_\_\_

(UNITS ENTER IN FORM)

NET TOWS		DEPTH	UNIT	TIME		METER READING	
REP #	_____	_____	_____	END	_____	END	_____
METER #	_____			START	_____	START	_____
CAL F	_____			TOTAL	_____	TOTAL	_____ NM _____ RS _____
REP #	_____	_____	_____	END	_____	END	_____
METER #	_____			START	_____	START	_____
CAL F	_____			TOTAL	_____	TOTAL	_____ NM _____ RS _____
REP #	_____	_____	_____	END	_____	END	_____
METER #	_____			START	_____	START	_____
CAL F	_____			TOTAL	_____	TOTAL	_____ NM _____ RS _____
REP #	_____	_____	_____	END	_____	END	_____
METER #	_____			START	_____	START	_____
CAL F	_____			TOTAL	_____	TOTAL	_____ NM _____ RS _____
REP #	_____	_____	_____	END	_____	END	_____
METER #	_____			START	_____	START	_____
CAL F	_____			TOTAL	_____	TOTAL	_____ NM _____ RS _____

BOTTOM SAMPLES

GEAR \_\_\_\_\_ REP \_\_\_\_\_ TIME \_\_\_\_\_ P CODE \_\_\_\_\_ 1 = ENTIRE SAMPLE PRESERVED

GEAR \_\_\_\_\_ REP \_\_\_\_\_ TIME \_\_\_\_\_ P CODE \_\_\_\_\_ 2 = SAMPLE SIEVED

GEAR \_\_\_\_\_ REP \_\_\_\_\_ TIME \_\_\_\_\_ P CODE \_\_\_\_\_ 3 = \_\_\_\_\_

STATION NOTES

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APPENDIX: BENTHIC STUDIES



Figure 6.3-1

**BIOLOGICAL ANALYSIS REPORT FORM**

JOB \_\_\_\_\_ LOCATION \_\_\_\_\_ STATION \_\_\_\_\_ DEPTH \_\_\_\_\_ D UNIT \_\_\_\_\_ REP \_\_\_\_\_

S DATE DAY \_\_\_\_\_ MO \_\_\_\_\_ YR \_\_\_\_\_ COLL \_\_\_\_\_ A DATE DAY \_\_\_\_\_ MO \_\_\_\_\_ YR \_\_\_\_\_ AM \_\_\_\_\_

EL TIME DAYS \_\_\_\_\_ HR \_\_\_\_\_ SAMPLE VOL \_\_\_\_\_ ml. ALIQUOT VOL \_\_\_\_\_ ml. CH AREA \_\_\_\_\_

AREA COUNTED \_\_\_\_\_ SPECIAL CODES \_\_\_\_\_  
A B C D E F G H I

\_\_\_\_\_  
SIGNATURE

GENUS-SPECIES CODE	GENUS SPECIES	S	TOTAL COUNT

APPENDIX: BENTHIC STUDIES

TABLE 6.3.2  
SPECIES CODE ASSIGNMENTS

/ / / / / / /  
1 2 3 4 5 6

- (1) The first space will tell the computer what general group the species belongs to:
1. not used
  2. not used (signifies water quality)
  3. Phytoplankton
  4. Zooplankton
  5. Ichthyoplankton
  6. Benthic Fauna
  7. Fish
  8. Benthic Flora
- (2,3,4) Spaces 2, 3 and 4 are used to designate the genus order for each particular group
- (5, 6) Spaces 5 and 6 are used to designate species within each genus.

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### III. Water Quality / Hydrology

#### 1. Checklist of Equipment and Materials

##### 1.1 Equipment

- 1.1.1 Secchi Disk, standard 20 cm diameter oceanographic type
- 1.1.2 YSI Model 57 Dissolved oxygen meter or equivalent
- 1.1.3 DRT-200 Turbidimeter or equivalent
- 1.1.4 Corning pH meter or equivalent
- 1.1.5 YSI Model 33 Salinity-Conductivity-Temperature meter or equivalent
- 1.1.6 Millipore Bacteriological Analysis kit or equivalent
- 1.1.7 Precision Scientific Freas 815 Incubator or equivalent
- 1.1.8 Mettler H 542 Analytical balance or equivalent
- 1.1.9 Kontes MicroKjeldahl digestion system or equivalent
- 1.1.10 Technicon Auto Analyzer II or equivalent
- 1.1.11 Perkin Elmer Model 303 Atomic Absorption Spectrophotometer and accessories or equivalent
- 1.1.12 Coleman/Perkin Elmer MAS 50 Mercury Analyzer or equivalent
- 1.1.13 Niskin Water Bottles 5l capacity - non metallic or equivalent
- 1.1.14 Millipore vacuum filtration pump or equivalent
- 1.1.15 Soxhlet Extraction System for COD or equivalent
- 1.1.16 Beckman Model 3600 UV/VIS Spectrophotometer or equivalent
- 1.1.17 Millipore Milli R04 water purification or equivalent

## 1.2 Materials

- 1.2.1 Polyethylene sample storage bottles, cubitainers
- 1.2.2 BOD bottles numbered (glass)
- 1.2.3 Glass sample storage bottles for COD
- 1.2.4 Millipore filter holders and 0.45 um pore size membrane filters or equivalent
- 1.2.5 Burettes, beakers, volumetric flasks and other glassware
- 1.2.6 AA Standard Solutions for Trace Metals (Fisher certified or equivalent)
- 1.2.7 Analytical Grade reagents as required in Standard Methods for all analyses.

## 2. Important Procedural Steps

### 2.1 Field Collections--Rincon: Water Samples

Water samples for analysis of water quality parameters, will be collected monthly at Station 0230 as described in the licensing engineer's specifications surface (nominal depth of 0.5 m) and near the bottom (8.0 m) depth at Station 0230 as in specifications. Replicate samples will be collected in sequential bottle casts. A non-metallic water sampler such as a poly vinyl chloride Niskin type sampler will be utilized. The capacity of the sampler will be of sufficient volume to collect all necessary sample aliquots in a single cast. The capacity of the sampler will be large enough to allow collection of a 500 ml sample aliquot for phytoplankton enumeration and plant pigment samples at Station 0230 (as in specifications) surface.

Water samples will be collected after three rinses of the sample bottles previously acid rinsed and distilled water rinsed. All water samples will be stored in a freezer on board the sampling vessel and frozen until analysis as a means of preservation.

All sample containers will be clearly labeled with location, code, station number, depth of collection, time, date and collector's initials.

Profiles and Field Measurements - The researcher will measure temperature and dissolved oxygen with a YSI Model 57 Dissolved Oxygen Meter, or an equivalent, at the surface (nominal depth 1.0 feet) and at 1.0 meter intervals to the bottom at Station 0230 (as in specifications) on a monthly basis. The researcher will measure Secchi Disk Transparency, Turbidity and pH at Station 0230 on a monthly basis. Profiles and field measurements will be made concurrently with water sample collections.

## 2.2 Field Collection - Carrizal

Water samples - Water samples for analysis of water quality parameters, shall be collected monthly at Stations 0130 and 0230 (as in specifications). In addition, at least, one collection for all physical and chemical parameters (described in specifications) will be made during a period in which Rio Culebrinas is in a flood condition. Collection will be made at the surface (nominal depth of 0.5 m) and near the bottom (8.0 m depth) at both Stations 0130 and 0230 (as in specifications). Methods and type of sampler will be the same for Rincon, however the capacity of the sampler will be large enough to collect water quality and phytoplankton samples at Station 0230 surface and bottom.

Profiles and Field Measurements - Measurements will be made at both Stations 0130 and 0230 (as described in specifications).

## 2.3 Analytical Methods

State of the art analytical techniques will be used. Water Quality parameters will be determined by methods prescribed in:

APHA, AWWA, WPCF "Standard Methods for the Examination of Water and Wastewater" Washington, D.C. 1976.

Strickland, J.D.H. and T.R. Parsons. "A Practical Handbook of Seawater Analysis" Bulletin 167 Fisheries Research Board of Canada, Ottawa (1968).

US EPA "Manual of Methods for Chemical Analysis of Water and Wastes" Office of Technology Transfer, Washington, 1972.

3. Report Forms and Notes

3.1 Field Notes - Field notes will be taken in conjunction with the water quality sampling. Water bottle sampling notes and Secci Disk Transparency Turbidity and pH will be recorded in No. 2 pencil on water proof field sheet the following information at each water quality sampling station: date, time of day (local 24-hour time) tidal stage from USCGS tables, wind speed and direction, wave height and direction and weather observations. Notes will be made of any unusual occurrences which might affect the quality of the samples collected. Temperature and dissolved oxygen profile data will be recorded in a water proof field notebook. Each log sheet and field notebook page will be signed or initiated by the individual responsible for the collection and handling of samples in the field.

4. Disposition of Samples and Reports

Water samples are kept frozen until analyses are performed and then are disposed of.

All original data sheets and notebooks will be deposited with the Environmental licensing Engineer for filing, with copies of the data sheets attached to progress reports to the owner. Copies of all data and reports as well as communications will be kept on file at CEER.

5. Task Responsibilities

5.1 Principal Investigator or Scientist in charge - Duties:

- Responsible for supervision of research associates performing sampling and analysis
- Serve as specialist in analytical, marine and environmental chemistry.
- Design and/or modification of sampling or analytical methods
- Official communication to all other individuals or organizations.

5.2 Research Associate

- Maintenance and organization of the laboratory



- Instrumental and wet chemical analyses
- Maintenance and equipment calibration
- Statistical analysis of data
- Assist principal investigator in report writing
- Field sample collection

### 5.3 Laboratory Technician

- Assist research associate and principal investigator in all aspects of field sampling measurements and laboratory analyses.

## 6. Maintenance and Calibration of Equipment

All calibrations to be performed on equipment will be in accordance with the manufacturer's specifications or using materials and methods that are traceable to the National Bureau of Standards and state of the art techniques.

IV. Plankton / Fish Studies

A. Zooplankton and Ichthyoplankton

1. Checklist of Equipment and Materials

1.1 Field Collections

1.1.1 Net frames, nets, flowmeters

1.1.2 bottles

1.1.3 labels

1.1.4 data sheets

1.1.5 stop watch

1.1.6 formalin

1.1.7 hose for washing nets

1.1.8 watch

1.2 Laboratory

1.2.1 microscopes

1.2.2 counters

1.2.3 counting tray

1.2.4 subsamples (Folsom splitter & Stempel  
pipette)

1.2.5 bottles

1.2.6 data sheets

2. Important Procedural steps

2.1 Field

2.1.1 Nets will be rigged according to manufacturers specifications.

2.1.2 Flowmeter will be read prior to launching of net.

- 2.1.3 time, depth, seastate will be noted on data sheets.
  - 2.1.4 nets will be lowered until proper depth is reached and will then be opened.
  - 2.1.5 nets will be towed until a minimum of 100m<sup>3</sup> of water is filtered.
  - 2.1.6 nets will be closed and raised to surface
  - 2.1.7 flowmeter will be read and time recorded
  - 2.1.8 nets will be rinsed
  - 2.1.9 sample will be placed in sample bottles containing labels and formalin
- 2.2 Laboratory
- 2.2.1 pH of samples will be checked as soon as possible after their return from the field
  - 2.2.2 Aliquots will be taken with the Stempel Folsom plankton splitter or pipette, depending upon the size of subsample required to count a sufficient number of plankton (> 300).
  - 2.2.3 Identifications will be listed on the data sheets and signed by the identifier.
3. Report forms and notes
- 3.1 Report forms and notes will be kept following the procedure outlined by the engineer.
4. Disposition of samples and reports
- 4.1 Zooplankton samples will be kept in a collection area
  - 4.2 Reports will be made available to the chief scientist to be relayed to the owner or engineer
5. Task Responsibility
- 5.1 Principal Investigator - administrative tasks, budget management, and overall scientific supervision of program

- 5.2 Scientist - supervise collection and processing of samples. Design of specific scientific studies. Analysis of data
  - 5.3 Laboratory techniques - process samples and record data. Cataloguing of samples. May aid in field collection.
  - 5.4 Field technician - aid in field collection, records some field notes, maintenance of equipment. Aids is equipment calibration.
6. Maintenance and Calibration

Maintenance and calibration of equipment will follow manufacturers specification.

B. Fish

1. Checklist of Equipment and Materials

1.1 Field

- 1.1.1 fish traps with lines and floats
- 1.1.2 diving equipment - tanks, regulators, backpacks masks, and fins - when transects are to be conducted
- 1.1.3 data sheets
- 1.1.4 plastic bags and labels

1.2 Laboratory

- 1.2.1 balance
- 1.2.2 meter stick
- 1.2.3 data sheets
- 1.2.4 bottles
- 1.2.5 formalin

2. Important Procedural Steps

2.1 Field

2.1.1 fish traps to be placed at sites designated by engineer

2.1.2 fish traps will be in place overnight or for 24 hours conditions permitting

3. Report Forms and Notes

Report forms and notes will be kept according to directions of the engineer, and will be available to the owner or engineer.

4. Disposition of Samples and Reports

Samples will be discarded following the formation of a reference collection. Reports will be given to the chief scientist to be forwarded to the owner or engineer.

5. Task Responsibility

5.1 Principal Investigator - Administration and budget management Scientific supervision of program.

5.2 Research Associate - Carries out program under supervision of PI. Carries out sampling program, identifies and weights fish. Fills out data sheets. Supervises field technician.

5.3 Field technician - Aids Research Associate, Maintains equipment. Records some field notes.

6. Maintenance and Calibration

Maintenance and calibration of equipment will follow manufacturers specifications.

C. Phytoplankton

1. Checklist of equipment and materials

1.1 Field

1.1.1 Niskin bottles

1.1.2 containers

1.1.3 formalin

- 1.1.4 vacuum pumps and filters
- 1.1.5  $MgCO_3$
- 1.1.6 envelopes
- 1.1.7 freezer, refrigerator, or ice chest
- 1.1.8 labels, field data sheets
- 2.1 Laboratory
  - 2.1.1 Inverted microscope
  - 2.1.2 settling chambers
  - 2.1.3 fluorometer
  - 2.1.4 acetone
  - 2.1.5 data sheets
- 2. Important Procedural Steps
  - 2.1 Utermohl procedure will be used to count phytoplankton.
  - 2.2 Fluorometer will be used to measure chlorophyll and phaeophyta following Strickland and Parsons.
- 3. Report Forms and Notes

Report forms and notes will be kept following procedures outlined by the engineer.
- 4. Disposition of samples

Samples will be discarded due to their degradation with time. Results will be relayed to the Chief Scientist.
- 5. Task responsibility
  - 5.1 Principal Investigator - supervise project, administration and budget management
  - 5.2 Phytoplankton taxonomist - count and enumerate phytoplankton

5.3 Laboratory technician - measure chlorophyll and phaeophyta concentrations on the fluorometer.

6. Maintenance and calibration of equipment

Fluorometer will be calibrated of against a spectrophotometer following manufacturers specifications.

V. Terrestrial Ecology - Vegetation and Fauna

1. Checklist of Equipment and Materials

1.1 Equipment

1.1.1 Tomahawk collapsible live traps (6 x 6 x 24 inches)

1.1.2 Sherman live traps (large)

1.1.3 Victor snap traps

1.1.4 Mist nets

1.1.5 binoculars

1.1.6 portable tape recorder

1.1.7 35 mm camera

1.1.8 headlight

1.1.9 quadrat frames

1.1.10 calipers

1.1.11 insect light traps

1.1.12 sticky traps

1.1.13 Tullgren extraction apparatus

1.1.14 plant press

1.2 Materials

1.2.1 bait (peanut butter, eggs, bird seed, etc.)

1.2.2 film

1.2.3 drafting supplies

1.2.4 tapes

1.2.5 herbarium materials

1.2.6 preservatives (formalin, alcohol)

1.2.7 drift fence and pit trap materials



## 2. Important Procedural Steps

The specifications established by the engineer for the study of terrestrial flora and fauna at the Rincon and Carrizal sites are stated on pages 5, 5A, and 6 of the Specifications (Revision 2) for Terrestrial Ecology Investigation and Analysis. Table I presents the sampling and report schedule. The methods which CEER's Terrestrial Ecology Division will employ to meet these specifications are given below:

### 2.1 Vegetation Map

2.1.1 Aerial photography (supplied by the owner) will be used for a general reconnaissance of each site, the ash disposal pile, and proposed rights-of-way. Additional photographs will be taken of the sites to document and map recent changes. PREPA's helicopter or airplane (preferably from West Wing Flying School) is required for 2-4 hours of overflight time. All photographs will be used to construct a map which indicates the distribution of vegetation types (including cropland), major topographic features, and areas of disturbance.

2.1.2 Ground-truthing surveys will be conducted to field check a draft map and identify "problem" features seen on aerial photos. These surveys will be conducted in conjunction with vegetation inventory surveys.

### 2.2 Biological Inventories

The major seasonal periods mentioned in the Specifications are hereby defined as Wet season (July-September) and Dry season (January-March). Intervening seasons are transitional between these and are defined as minor. Unless otherwise specified, all sampling locations will be randomly located using a grid (Phillips, 1959).

2.2.1 Vascular Plants - Limited sampling will be conducted during major and minor seasons (total of four surveys) to collect specimens and compile a detailed species list for each area of proposed development.

Vegetation types on each site and the ash disposal pile will be quantitatively sampled during the two

major seasons. A species-area curve will be constructed for each vegetation type to ensure that the species composition is adequately represented. The sample size will be considered adequate when an increase in 10% of the total area yields only 10% (or fewer) more species (Cain, 1938; Mueller-Dombois and Ellenberg, 1974).

Woody vegetation (trees and shrubs) will be sampled using the point-quarter method (Cottam et al., 1953). A minimum of five 50m transects (10 points each) will be sampled in each major season in each vegetation type dominated by woody species. Woody vegetation in other types will be mapped and total counts will be made. The species, point-to-plant distance, basal area (for trees), and crown diameter (for shrubs) will be recorded and used to calculate relative density, relative dominance, relative frequency, density, and total basal area (Phillips, 1959).

Herbaceous vegetation will be sampled using a minimum of twenty 1 m quadrats in each vegetation type. Data on cover, frequency, and density of species will be recorded and subsequently calculated according to standard methods (Cox, 1967).

Voucher specimens of plants which cannot be identified in the field will be collected and preserved according to standard procedures. These specimens will subsequently be identified by recognized experts.

#### 2.2.2 Faunal Inventories

Field sampling will be conducted during each of four seasons. Intensive sampling including trapping will be conducted during major seasons only and will be confined to the two proposed sites and associated ash disposal pile. All major habitats will be surveyed. Faunal habitats include all major vegetation types plus specialized areas such as wetlands, rocky outcrops, and caves. Less extensive surveys for most groups will be conducted quarterly to collect additional information on the presence and seasonal use of habitats by faunal species. Random observations of animals seen

within study areas will be recorded and used to augment standard sampling data.

Unless otherwise specified, all sampling locations will be randomly selected within each habitat type. Voucher specimens of selected animal species (except birds) will be collected and preserved according to standard museum procedures (Hall, 1962; Jacques, 1947). Species identifications will be made in the field whenever possible. Unusual individuals and specimens which are difficult to identify will be collected for subsequent verification by recognized experts. Records of threatened and endangered species occurrence will be documented by photographs and verified by experts to the extent practicable.

#### 2.2.2.1 Mammals

One or more traplines will be established in each major habitat type. Each line will consist of 10 live traps placed in a straight line at intervals of approximately 15 m. Traplines will be checked each morning for three or four consecutive days during each of the two intensive sampling periods. Captured individuals will be marked and released, and the traps will be rebaited at each trap check. The date of capture, species, location and habitat affinity of each individual will be recorded (Figure 1).

Minor habitats and habitats situated along rights-of-way (ROWS) will be sampled using selective live and snap trapping procedures. Live captured individuals will be marked and released.

Bats will be sampled by mist netting at selected locations within study areas. To the extent feasible, some individuals may be collected by shooting. Potential roosting areas (e.g. caves and abandoned buildings) will be visited to determine species presence and seasonal.

#### 2.2.2.2 Birds

Standard methods (Franzreb, 1977) will be used to gather information on the presence, habitat affinities, seasonal use, and general abundance of bird species. Replicate surveys will be conducted within each major habitat type during periods of breeding, migration and overwintering. Resident breeding species and seasonal migrants will be identified. Important avian habitats (e.g. wetlands) within one kilometer of designated study areas will be also be sampled.

Qualitative surveys will be conducted quarterly within each study area so that a more complete species list can be compiled. Survey methods may include walking surveys, the use of recorded calls, and limited mist netting. Sampling procedures may be notified to conform to existing conditions in each study area.

#### 2.2.2.3 Amphibians and Reptiles

Diurnal species such as anoles will be surveyed during the dry and rainy seasons along randomly located transects in each major habitat type. Intensive searches at selected locations within each study area will also be conducted to detect the presence and habitat affinities of secretive and fossorial forms. Surface debris will be established in selected locations to sample ground dwelling forms. Limited collecting may be required in order to verify species identifications.

Each study area will be visited at night during the rainy season to detect calling anurans (frog and toads). Most species identifications will be made in the field by trained observers. Calls not readily identifiable in the field will be recorded for subsequent expert verification. A few voucher specimens of amphibians and reptiles may be collected and preserved.

#### 2.2.2.4 Invertebrates

The sampling program for terrestrial invertebrates will concentrate on insects. Field surveys will be conducted quarterly. Light traps and sticky traps will be used to collect representative samples from each of the designated study areas. These techniques will be supplemented with netting, vacuum sampling, and surface collecting during the two major sampling periods.

Soils and leaf litter arthropod samples will be collected during the two intensive sampling surveys. Arthropods will be removed from samples using the funnel extraction techniques (Cox, 1967). Extracted organisms will be identified and counted.

Records will be kept on the habitat affinities and general abundance by major groups (e.g. families, important general, etc.) for each season. Insect collections will be examined by project staff, and identifications subsequently verified by recognized experts.

#### 2.3 Important Species

Lists of candidate important plant and animal species potentially inhabiting areas of proposed project development will be submitted within days after the first field visit. The list will be based on a review of published literature, discussion with regional authorities, and an observations made during a reconnaissance survey of the study areas. The list will be updated following each field survey.

A species will be considered important if it is:

- 2.3.1 Commercially or recreationally valuable,
- 2.3.2 officially designated as threatened or endangered,
- 2.3.3 likely to affect the well being of an important species as defined in 1 or 2 above, or

- 2.3.4 sufficiently sensitive to induced environmental stress that it could serve as a stress indicator before significant effects on other important species occur.

Species which are thus defined will be emphasized during baseline characterization studies. If initial surveys indicate that project development may significantly affect the well being of one or more important species CEER would propose additional quantitative studies beyond the present workscope in order to determine the magnitude of the predicted impact.

3. Report Forms and Notes

All field report forms and notes will be dated and signed by the personnel responsible for collecting the data. Copies of all field notes will be maintained in a central file and originals handled in the manner indicated in the Specifications document. All field notes and data sheets will be initialed by the appropriate principal investigator to indicate that they have been approved.

4. Disposition of Samples and Results

All specimens will be properly preserved (e.g. plants on herbarium sheets, animal specimens in alcohol, formalin, or prepared as study skins) according to the museum techniques referenced in the appropriate methods sections. All voucher specimens and results will be maintained at CEER facilities in Mayaguez, Rio Piedras, or El Verde and supplied to the owner upon request.

5. Task Responsibilities of Individuals

- 5.1 The two principal investigator (PIs) will be Douglas Reagan (fauna) and Susan Silander (vegetation). Each PI will be responsible for conducting and supervising all aspects of their respective tasks.
- 5.2 Task leaders will be in charge of data collection, specimen preservation, and data analysis for their disciplines. Task leaders are: Susan Silander (vegetation studies), Robert Waide (birds), Douglas Reagan (mammals, reptiles, and amphibians), and Miguel Canals (invertebrates).
- 5.3 Technician level field assistance will be required, but individuals are not specified. Responsibilities will be to assist the task leaders in the conduct of the various tasks.

6. Maintenance and Calibration

All equipment will be properly maintained according to manufacturers's specifications.

#### LITERATURE CITED

- Cain, S.A., 1938. The species-area curve. Amer. Midland Natur. 19: 573-581.
- Cottam, G., J.T. Curtis and B.W. Hale, 1953. Some sampling characteristics of a population of randomly dispersed
- Cox, G.W., 1967. Laboratory manual of general ecology. W.E. Brown Co. Dubuque, Iowa.
- Franzreb, K., 1977. Inventory Techniques for sampling avian populations. Bureau of Land Mgmt. Tech.-Note 307.
- Hall, E.R., 1962. Collecting and preparing study specimens of vertebrates. University of Kansas, Lawrence, Kansas.
- Jaques, H.E., 1947. The insects, W.C. Brown Co., Dubuque, Iowa.
- Mueller-Dombois, D. and H. Ellenberg, 1947. Aims and methods of vegetation ecology. John Wiley and Sons, N. Y.
- Phillips, E.A., 1959. Methods of vegetation study. Holt, Rinehart and Winston, Inc., New York



TABLE I  
TERRESTRIAL ECOLOGY SCHEDULE

Task / Report	Date
Reconnaissance Survey	March 1-31, 1980
Submit Candidate Important Species List	within 15 days of reconnaissance trip
Spring Field Sampling (minor) <sup>2</sup>	April 15 - June 15, 1980
Wet Season Field Sampling (major) <sup>2</sup>	July 15 - Sept. 15, 1980
Fall Field Sampling (minor) <sup>2</sup>	Oct. 15 - Dec. 15, 1980
Submit Site Characterization Report	by November 30, 1980
Dry Season Field Sampling (major) <sup>2</sup>	January 15 - Feb. 15, 1981
Final Data Report	by March 31, 1981

1. Assumes contract issued March 1, 1980; 13 months required to complete project tasks
2. A seasonal biological inventory report will be submitted to the engineer within 30 days of completion of all field work.

IV. Proviso for Procedural Changes

Procedural changes that will affect results or data procured can be made with the approval of the Owner and Engineer.

Minor changes in procedures that will not affect the results or data outcome can be made at the discretion of the scientist-in-charge or of the principal investigator.

## CEER AUDIT PROGRAM PLAN

The Audit Program Plan is designed to fulfill the requirements of the PREPA Quality Assurance Program for the North West Coast (NWC) Project. The position responsible for the CEER Audit Program will be the Quality Assurance Supervisor who will report directly to Head, Environmental Sciences Section.

One of the activities listed below will be audited each month. The report of the Audit, with recommendations for further action, and follow up on previous recommendations will be available to the NWC Project Manager and to other concern scientists within three (3) weeks from the date of the audit.

I. The specific activities (scientific units) to be audited are:

1. Terrestrial Ecology - Vegetation and Fauna
2. Plankton / Fish Studies
3. Water Quality / Hydrology
4. Thermal / Chemical
5. Benthic Studies

The activities to be audited each month are as follows: March-#1, April - #2, May - #3, June - #4 and July - #5. The schedule will repeat this sequence unless experience shows the need for a change.

When an Audit shows that corrective action is necessary, the proposed corrective action will be discussed jointly with the leader of the scientific unit and the NWCO Project Manager. When a course of corrective action is agreed upon, it will be summarized in writing with copies for each person involved. If a course of corrective action cannot be agreed upon, the Head, Environmental Sciences Section will join the discussion and decide on what action if any is necessary. It is the responsibility of the Quality Assurance Supervisor to follow up in any corrective action to determine if it is accomplishing its objective.

Whenever an Audit results in corrective action in relation to the work of a scientific unit or other function of the NWCO Project, this corrective action will be followed up within two months either as part of a monthly Audit or directly. The extent of application of the corrective action and its effect will be included in the next Monthly Audit Report after the follow up action. The follow up results will be discussed with the individuals involved in the original decision for corrective action and any modifications to this corrective action made as agreed.

II. The following documents will be part of the Audit Program Plan:

1. Schedule of Audits
2. Completed Audit Check Lists
3. Summaries of corrective action agreed upon.
4. Monthly Audit Reports.

The Audit Check list will be used as the basis for each Audit.  
The topics covered by this list are as follows:

AUDIT CHECK LIST

- I. Does the leader of the scientific unit has the required basic documents? (Described in Section V of North West Coast Project Quality Assurance Program).
  
- II. Data Confidence
  - a) Are samples protected from loss, contamination or change?
  - b) Is the calibration of instruments adequate?
  - c) Is there statistical treatment of data where applicable?
  - d) Are data self-consistent; if not why?
  - e) Are the samples preserved carefully where needed?
  - f) Are the data kept carefully; log-books titled, dated and signed?
  
- III. Is the Program progressing according to schedule?
  
- IV. Is time scheduled for writing reports?
  
- V. Are report deadlines being met?
  
- VI. Review corrective action

AUDIT CHECK LIST

(sample)

SCIENTIFIC UNIT \_\_\_\_\_ DATE \_\_\_\_\_

SCIENTIST IN CHARGE \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

I. Does the leader of the scientific unit has the required basic documents as described in Section V of the North West Coast Project Quality Assurance Program?

II. Data Confidence

A. Are samples protected from:

1. Loss
2. Contamination
3. Change

B. Is calibration of instruments adequate?

1. Instruments calibrated at unit, list:

<u>Instrument</u>	<u>Date Last Calibrated</u>	<u>Calibration Interval</u>
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2. Instruments requiring outside calibration:

<u>Instrument</u>	<u>Date Last Calibration</u>	<u>Calibration Interval</u>
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3. Are calibration dates and intervals on individual  
Instruments?

C. Is there statistical treatment of data where applicable?

Re: Section 5.16.3 of PREPA specifications

D. Are data self-consistent?

If not, why?

E. Are samples preserved carefully after study where necessary?

F. Are data kept carefully?

1. Log books titled and dated?

2. Entries dated?

3. Entries signed?



III. Is the program progressing according to schedule?

VII. Is time scheduled for writing reports?

VIII. Are report deadlines being met?

IX. Review Corrective Action

1. Corrective action and date of agreement.

2. Current status of corrective action.

3. Further recommendations.

QUALITY ASSURANCE MEMORANDA

(Quality Assurance Memoranda will be distributed as it develops to all QA Manual holders, for incorporation in the same).