BIOASSAYS OF HARRIS CORPORATION, ELECTRONIC SYSTEMS DIVISION

BREVARD COUNTY, FLORIDA

(NPDES # FL0034681)

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Biological Section
Bureau of Water Analysis
April 21, 1981

INTRODUCTION

The Harris Corporation, Electronic Systems Division, is a manufacturer of electronic components, specifically, printed circuit boards and semiconductor wafers. This facility began operations in 1960 and is located near the City of Palm Bay, in Brevard County, Florida (Fig. 1). The Harris Corporation, Electronic Systems Division, generates an average of 0.921 MGD of wastewater from the following sources: process rinse water from electroplating of products, regeneration wastes from cationic/anionic resin exchange systems, process water from production of semiconductor microelectronic units, and exhaust air scrubber and non-contact cooling water. Prior to discharge, wastewater is treated with both caustic and lime in two mixing and settling ponds. After treatment, effluent is discharged to an unnamed ditch that flows to Turkey Creek, a tributary of the Indian River (Fig. 2).

Based on limitations established in the Harris Corporation's NPDES Permit, and on previous analyses performed on this facility's discharge, many potentially toxic substances may be present. Constituents include: copper, chromium, lead, fluoride, nickel, cadmium, zinc, ammonia and cyanide. In January and February 1980, the Biological Section obtained samples of Harris Corporation's effluent and performed bioassays to determine the possible existence of toxicity to biota of the receiving waters. Results of the January bioassay (FDER 1980) indicated the sample was toxic to the water fleas (Daphnia pulex), but no mortality was observed in the fathead minnows (Pimephales promelas). The February bioassay indicated toxicity to Daphnia pulex (48 hour LC_{50} = 64%). The toxicity was attributed to high concentrations of ammonia found in the sample.

To further evaluate the toxicity of this effluent, additional bioassays were performed on 11 to 13 February, 1981. The results of these latest bioassays are presented in this report.

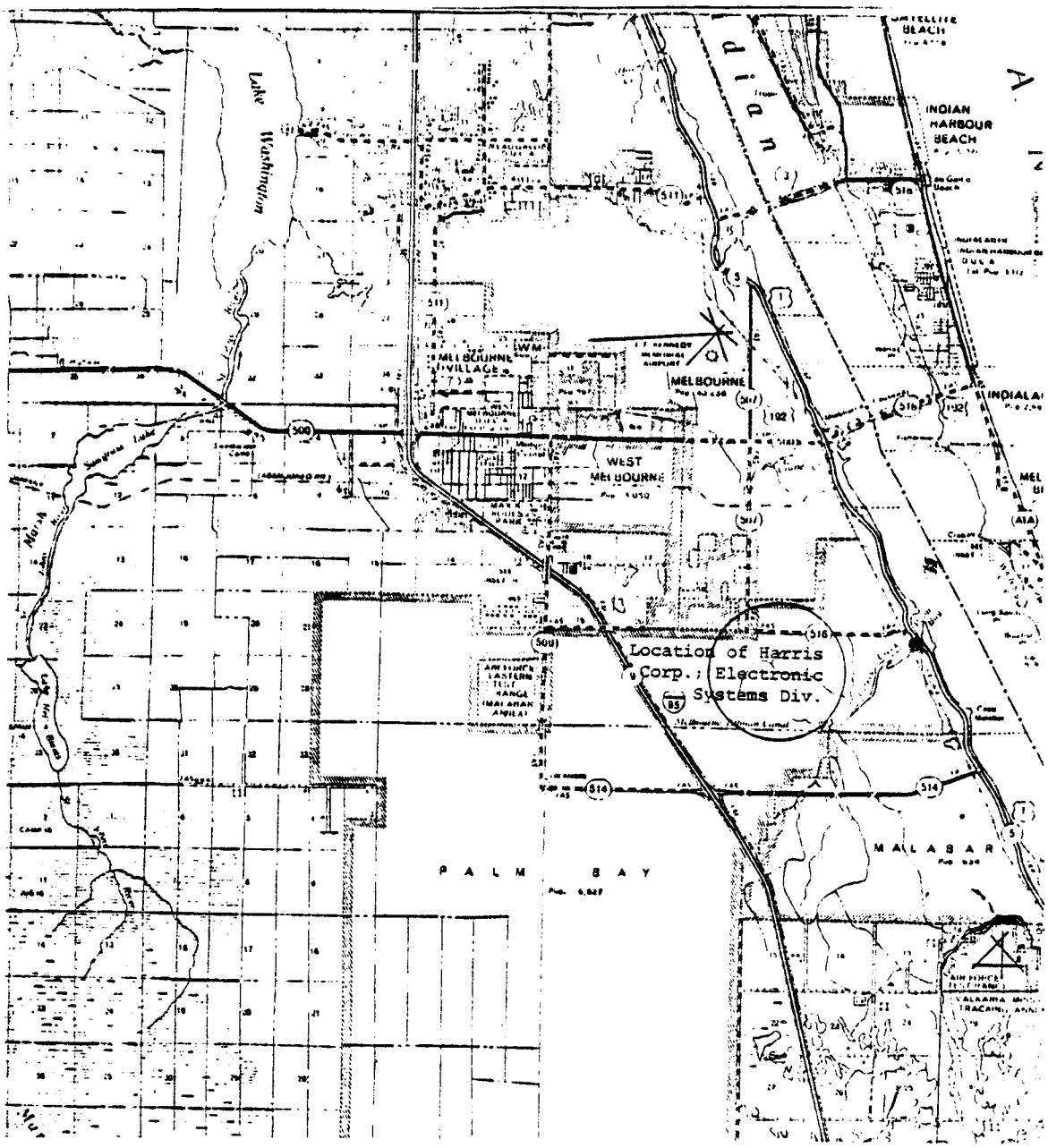


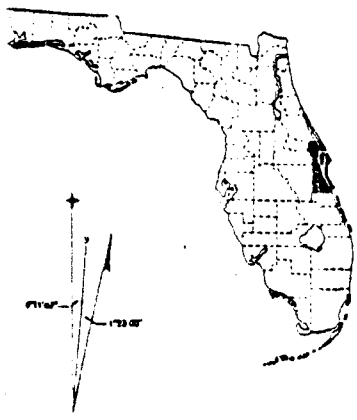
Figure I. Portions of **BREVARD COUNTY**
including study area
FLORIDA

PREPARED BY THE
PHOTOGRAMMETRIC DIVISION
FOR THE
TRAFFIC AND PLANNING DIVISION
FLORIDA STATE ROAD DEPARTMENT
IN COOPERATION WITH THE
U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

SCALE

SCALE FOR INSETS

MARCH, 1966

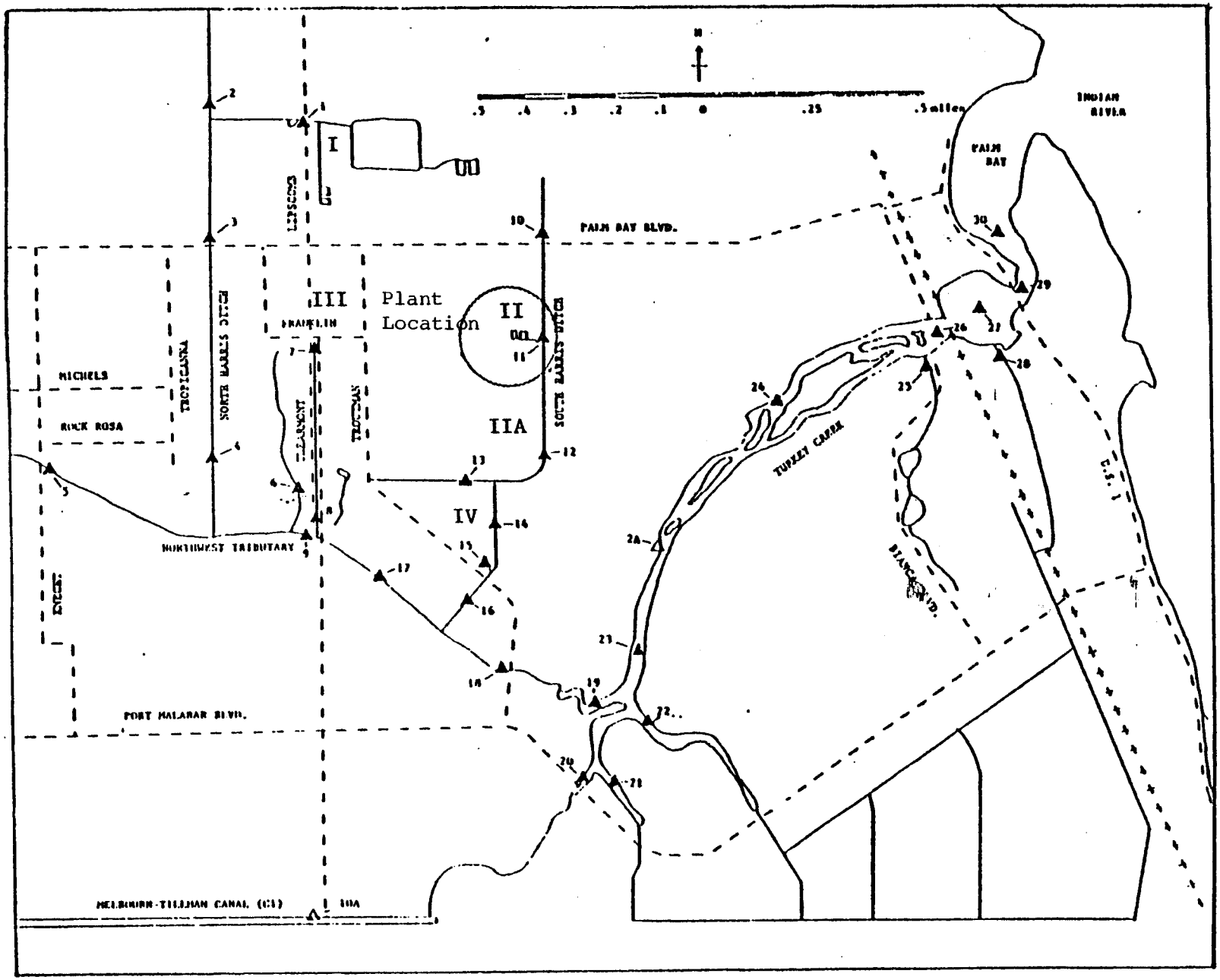


1 COCOA IS 6°11'09" EAST OF TRUE NORTH
NATELY 1°30' EAST OF TRUE NORTH IN DECEMBER, 1966
2 CHANGE IS APPROXIMATELY 1° WESTWARD

REVISIONS	
FEATURE	DATE
State Maintained Roads and City Limits	December 1966
SR 500, 516	March, 1968
MELBOURNE City Limits	Feb., 1971
US 192	Feb., 1971
US, SR 405	Jan., 1973

REPRINTED JANUARY, 1975

Figure 2. Station Location Map. Harris Corporation, Electronic Systems Division, Palm Bay, Brevard County, Florida



I: North Harris Plant (semi-conductor) II: South Harris Plant (communications)
IIA: South Harris Plant (future POD) III: Harris Plant
IV: Port Malabar STP

METHODS AND MATERIALS

Test methods used to conduct these static bioassays are extensively described by Peltier (1978). The organisms selected for this study include species recommended by Peltier (1978) and the U.S. EPA (1978). Additionally, the Biological Section maintains cultures of several species of organisms indigenous to the State of Florida. Life histories of these test organisms and maintenance procedures used to culture them are detailed below.

History and Maintenance of Bioassay Organisms

Daphnia pulex (water flea) - A breeding culture of Daphnia pulex was obtained from the EPA laboratory in Athens, Georgia in March, 1979. This culture has been maintained since its arrival, in 2½ gallon all glass aquaria filled with unchlorinated DER well water, using a 16:8 hour light-dark cycle. Organisms are fed a liquified blend of Purina Trout Chow® and Cerophyl® twice daily, and are kept at a constant temperature of $22^{\circ} \pm 1^{\circ}C$. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess daphnids. They are then refilled with fresh aerated well water. Additional measures are taken and/or new cultures started in the event of abnormal circumstances such as: declining populations, ephippia formation, or excessive fungal or bacterial growth.

Pimephales promelas (fathead minnows) - A breeding culture of approximately 100 adult fathead minnows was obtained from the EPA laboratory in Cincinnati, Ohio in May, 1979. The fish have been maintained in four 125 gallon all glass aquaria equipped with a flow through water exchange system using unchlorinated well water obtained from a deep well near the DER laboratory. The fish have been reared at a temperature of $22^{\circ} \pm 2^{\circ}C$ under a 16:8 hour light-dark cycle. These fish are fed Glencoe Mills Trout Chow® and frozen Artemia (brine shrimp) at a rate of 0.75 g/30 fish, twice daily. Breeding has been encouraged by placing several halved clay pots in each tank to serve as substrates for eggs and to provide cover for the fish. Tanks are examined twice daily (at feeding time) for egg production. Clay pots containing egg clusters are immediately transferred to 15 gallon aerated aquaria for hatching. A new aquarium is prepared for each week's production of eggs, thereby segregating fish into even age groups to be used for testing. After hatching, fathead minnow fry are fed twice daily with freshly hatched Artemia. The fish used in this test were all <3 weeks old at the time of the test.

Simocephalus serrulatus (water flea) - An indigenous breeding population of S. serrulatus was collected from Lake Jackson, Leon County, Florida, in March, 1980, by personnel from DER's Biological Section. Positive identification of the organism was performed by Mr. Jeff Foran of the Department of Environmental Engineering Sciences, University of Florida in Gainesville. The cultures are maintained in 2½ gallon all glass aquaria, filled with unchlorinated DER well water, under a 16:8 hour light-dark cycle. The organisms are fed a liquified blend of Purina Trout Chow® and Cerophyl® twice daily, and are kept at a constant temperature of $22^{\circ} \pm 1^{\circ}C$. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess population. They are then refilled with fresh aerated well water. Additional measures are taken and/or new cultures started in the event of abnormal circumstances.

To ensure the uniform sensitivity of these test organisms to toxic substances, the Biological Section conducts monthly Standard Reference Toxicant Bioassays using sodium lauryl sulfate as the reference toxicant.

Test Methods

Three separate 48 hour static bioassays were conducted from 1100 hours on 11 February, 1981 to 1145 hours on 13 February, 1981 on a grab sample of effluent from outfall #001. The sample was collected by Mr. Louis Ley of the DER's St. Johns River District, at 1440 hours on 10 February, 1981, using standard wastewater sampling procedures. The unpreserved sample was iced and transported to the DER laboratory in Tallahassee within 24 hours of collection.

Freshwater for dilution of the effluent sample was obtained from the same DER deep well that is used to culture the test organisms. The concentration series selected for this study (Table 1) is that recommended by APHA (1976).

Two replicates, each with six concentrations and a control, were used to test with Daphnia pulex and Simocephalus serrulatus. Flint glass jars of 250 ml capacity were used as test chambers, and 200 ml of the appropriate test concentration was placed in each chamber. Daphnia and Simocephalus were siphoned into respective large culture dishes through nested stainless steel screens to isolate the proper size and age organisms (neonates). These neonates were then transferred individually by glass pipette and loaded 10 per chamber, resulting in 20 per test concentration.

Two replicates, of six concentrations and a control, were used for the fathead minnow bioassay. The fish were transferred individually or by twos, by net, into wide mouth quart jars containing 500 ml each of the appropriate test concentration. Fathead minnows were loaded 5 per chamber resulting in 10 per concentration.

Dissolved oxygen, pH, temperature and the number of live organisms were recorded for each test chamber at 0 hours, 24 hours, and 48 hours. Total alkalinity and total hardness were determined at the beginning of the test for the controls and the 100% effluent concentration. Specific conductance was determined at the beginning of the test for each effluent concentration. Additionally, total ammonia (reported as mg/l N) and unionized ammonia (reported as mg/l NH_3) concentrations were determined for a control, mid-range and 100% effluent concentration. These values were recorded on the bioassay data forms and are presented in Tables 2, 3 and 4. Organisms were not fed during these tests.

Table 1. Concentration Series and Volumes Used for These Static Bioassays

Water fleas (Daphnia pulex and Simocephalus serrulatus)

Concentration	Dilution Water	Effluent	Total Vol.
Control	200 ml	---	200 ml
5.6%	188.8 ml	11.2 ml	200 ml
10.0%	180 ml	20 ml	200 ml
18.0%	164 ml	36 ml	200 ml
32.0%	136 ml	64 ml	200 ml
56.0%	88 ml	112 ml	200 ml
100%	----	200 ml	200 ml

Fathead minnows (Pimephales promelas)

Concentration	Dilution Water	Effluent	Total Vol.
Control	500 ml	---	500 ml
5.6%	472 ml	28 ml	500 ml
10.0%	450 ml	50 ml	500 ml
18.0%	410 ml	90 ml	500 ml
32.0%	340 ml	160 ml	500 ml
56.0%	220 ml	280 ml	500 ml
100%	---	500 ml	500 ml

Table 2. Data recorded during 48 hour, Daphnia pulex, static acute toxicity bioassay of Harris Corp., Electronic Systems Division, Palm Bay, Brevard County, Florida, NPDES #FL0034681, Outfall #001, on 11 to 13 February 1981.

Conc. or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Total Alkalinity (mg/ℓ as $CaCO_3$)		Total Hardness (mg/ℓ as $CaCO_3$)		Temperature (°C)			NH_3/NH_3+NH_4[a] (mg/ℓ)		Conductivity (μmhos)
	0	24	48	0	24	48	0	24	48	0	48	0	48	0	24	48	0[a]	48	0
Control	10	10	10	8.9	9.1	8.3	7.9	8.3	8.4	116		117		20.5	20.0	21.2			
Control	10	10	10	8.9	9.1	8.3	7.9	8.3	8.4								0/.04		202
5.6%	10	10	9	8.8	9.1	8.1	8.3	8.4	8.3					20.6	19.8	20.9			
5.6%	10	10	10	8.8	9.1	8.1	8.3	8.4	8.3										290
10.0%	10	10	10	8.5	9.1	8.2	8.5	8.4	8.3					21.5	19.8	20.5			
10.0%	10	10	9	8.5	9.1	8.2	8.5	8.4	8.3										380
18.0%	10	10	10	8.6	9.1	8.2	8.7	8.5	8.3					21.2	19.7	20.4			
18.0%	10	10	10	8.6	9.1	8.1	8.7	8.5	8.3										510
32.0%	10	10	10	8.4	9.1	8.3	9.1	8.7	8.4					21.2	19.5	20.4			
32.0%	10	10	10	8.4	9.2	8.4	9.1	8.6	8.4								.07/.154		780
56.0%	10	10	10	7.9	9.1	8.4	9.5	9.0	8.5					21.2	19.5	20.4			
56.0%	10	10	9	7.9	9.1	8.4	9.5	9.0	8.5										1200
100%	10	10	10	7.0	9.1	8.3	10.1	9.3	8.7	95		204		22.0	19.5	20.8			
100%	10	10	10	7.1	9.1	8.3	10.1	9.5	8.7								.99/.95		1910

Remarks: [a]Total ammonia is expressed as mg/l as N and unionized ammonia is expressed as mg/l as NH_3.

Table 3. Data recorded during 48 hour, Simocephalus serrulatus, static acute toxicity bioassay of Harris Corporation, Electronic Systems Division, Palm Bay, Brevard County, Florida, NPDES #FL0034681, Outfall #001, on 11 to 13 February 1981.

Conc. or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Total Alkalinity (mg/ℓ as $CaCO_3$)		Total Hardness (mg/ℓ as $CaCO_3$)		Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Conductivity (µmhos)
	0	24	48	0	24	48	0	24	48	0	48	0	48	0	24	48	0[b]	48	0
Control	10	10	9	8.8	9.0	9.2	7.9	8.3	8.4	116		117		20.5	19.2	20.0			
Control	10	9	8	8.8	9.1	9.3	7.9	8.3	8.3								0/.04		195
5.6%	10	9	8	8.7	9.1	9.2	8.3	8.3	8.3					20.5	19.2	20.0			
5.6%	10	10	8	8.7	9.2	9.1	8.3	8.3	8.4										295
10.0%	10	10	9	8.6	9.2	9.1	8.5	8.4	8.4					20.6	19.0	20.1			370
10.0%[a]	-	-	-	-	-	-	-	-	-										
18.0%	10	10	8	8.6	9.2	9.1	8.7	8.5	8.3					20.9	19.0	20.0			
18.0%	10	9	7	8.6	9.2	9.0	8.7	8.5	8.3										490
32.0%	10	10	9	8.4	9.2	9.2	9.1	8.7	8.4					20.9	19.0	20.4			
32.0%	10	10	9	8.4	9.2	9.2	9.1	8.7	8.4								.07/.154		750
56.0%	10	10	10	8.0	9.2	9.2	9.5	9.0	8.5					21.4	19.0	20.7			
56.0%	10	10	8	8.0	9.2	9.0	9.5	9.0	8.6										1200
100%	10	8	7	7.0	9.3	9.1	10.1	9.3	8.8	95		204		22.3	19.0	21.0	.99/.95		
100%	10	9	8	7.0	9.3	8.9	10.1	9.3	8.7										1950

Remarks: a. Container spilled.
b. Total ammonia is expressed as mg/l as N and unionized ammonia is expressed as mg/l as NH_3.

Table 4. Data recorded during 48 hour, Pimephales promelas, static acute toxicity bioassay of Harris Corporation, Electronic Systems Division, Palm Bay, Brevard County, Florida, NPDES #FL0034681, Outfall #001, on 11 to 13 February 1981.

Conc. or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Total Alkalinity (mg/ℓ as $CaCO_3$)		Total Hardness (mg/ℓ as $CaCO_3$)		Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Conductivity (μmhos)
	0	24	48	0	24	48	0	24	48	0	48	0	48	0	24	48	0[a]	48[b]	0
Control	5	5	5	8.7	8.3	8.5	8.0	8.0	8.2	116		117		20.4	19.2	19.5	0/.04	.01/.126	
Control	5	5	5	8.7	8.0	8.5	8.0	8.0	8.1										205
5.6%	5	5	5	8.8	8.3	8.6	8.3	8.1	8.1					20.4	19.0	19.6			
5.6%	5	5	5	8.8	8.1	8.4	8.3	8.2	8.1										295
10.0%	5	5	5	8.8	8.1	8.6	8.5	8.1	8.1					20.5	19.0	19.7			
10.0%	5	5	5	8.8	8.2	8.7	8.5	8.1	8.1										370
18.0%	5	5	5	8.7	8.3	8.8	8.8	8.2	8.1					20.7	19.0	19.7			
18.0%	5	5	5	8.6	8.3	8.7	8.8	8.3	8.1										550
32.0%	5	5	4	8.3	8.2	8.5	9.1	8.6	8.2					21.1	19.0	19.8			
32.0%	5	5	5	7.9	8.2	8.3	9.1	8.6	8.2										800
56.0%	5	4	4	7.9	8.2	8.3	9.5	9.0	8.4					21.5	19.0	19.9			
56.0%	5	5	5	7.9	8.2	8.4	9.5	9.0	8.5										1210
100%	5	4	4	7.2	8.2	8.2	10.1	9.3	8.7	95		204		22.0	19.0	20.1	.99/95	.34/1.92	
100%	5	0	0	7.3	8.5	-	10.1	9.3	-										2000

Remarks:

The fish used in this bioassay weighed an average of 0.0143 g each.

a. Total ammonia is expressed as mg/l as N and unionized ammonia is expressed as mg/l as NH_3.
b. To ensure that the unionized ammonia excreted by the test fish did not reach toxic concentrations, the ammonia concentration was also determined at the end of the test in the control and the 100% effluent concentration.

RESULTS AND DISCUSSIONS

The results of toxicity tests on the Harris Corporation, Electronic Systems Division's effluent, using the water flea Daphnia pulex, demonstrated some random mortality at 48 hours (Table 2). The 48 hours LC_{50} calculated by the probit method of analysis (Table 5) is $>$ 100%. Tests performed with the indigenous water flea Simocephalus serrulatus resulted in more mortality at both 24 and 48 hours (Table 3). The 24 and 48 hour LC_{50}'s for this organism calculated by the probit method (Table 5) were however, also >100%. Tests performed with the fathead minnow (Pimephales promelas) resulted in measureable toxicity (Table 4), with 24 and 48 hour LC_{50}'s ranging from 90 to 93% (Table 5). The 96 hour LC_{50} would therefore be $\leq$ 93%.

Because no chemical analyses were performed on the Harris Corporation, Electronic Systems Division's effluent, a definite cause for the fathead minnow mortality cannot be suggested. However, it appears that the 100% effluent concentration contained a large amount of ammonia (Table 4). This concentration of ammonia, in combination with the high pH of the effluent (pH=10.1), may have caused some of the observed mortality (USEPA 1976,1977).

Chapter 17-3.051, Florida Administrative Code, indicates that "all waters of the State shall.at all places and at all times be free from...components of discharges which...are acutely toxic." "Acute toxicity" is defined in Chapter 17-3.021(1) to mean "the presence of one or more substances... in amounts which are greater than one-third (1/3) of the amount lethal to 50% of the test organisms in 96 hours (96 hour LC_{50})...". In the absence of a mixing zone, this 1/3 of the 96 hour LC_{50} applies at the point of discharge. Chapter 17-4.244(4) states that "in no event shall the maximum concentration of wastes in the mixing zone exceed the amount lethal to 50% of the test organisms in 96 hours (96 hour LC_{50}) for a species significant to the indigenous aquatic community..." This criterion applies at the point of discharge if there is a mixing zone. The distinction between presence or absence of a mixing zone is not relevant here, however, since the testing procedure used does not involve effluent concentration. The 1/3 of the 96 hour LC_{50} criterion is three times as stringent as the 96 hour LC_{50} criterion, and therefore, in the absence of a mixing zone, the procedure used is very lenient. The procedure followed is also lenient in that testing is only done for 48 hours. The 96 hour LC_{50} derived from this testing is therefore reported as "less than or equal to" the 48 hour measurement. The value found after 48 hours can never be more restrictive than the value found after 96 hours. It must be noted that all organisms used in these tests are significant to the indigenous aquatic community since they are sensitive to toxic substances which may be expected to impact the indigenous community.

The toxicity reported here is in excess of allowable limits.

Table 5. LC_{50} Data for Bioassays of the Harris Corporation, Electric Systems Division on 11 to 13 February 1981.

Organism	Method of Data Analysis	24 hour LC_{50} and 95% confidence intervals	48 hour LC_{50} and 95% confidence intervals
Pimephales promelas	Binomial	89.9%(56 and ∞), B	89.9%(56 and ∞), B
	Moving average	89.9%(70 and 300), B	89.9%(70 and 300), B
	Probit	90.8%(71 and 161), B	93% (67 and 263), B,C
Daphnia pulex	Binomial		A
	Moving average	No Mortality	A
	Probit		>100%, B
Simocephalus serrulatus	Binomial	A	A
	Moving average	A	A
	Probit	>100%, B	>100%, B

A. Due to an insufficient number of dead organisms, or to the irregular distribution of mortality, an LC_{50} value cannot be calculated using this method of statistical analysis.

B. Due to the distribution of mortality, the LC_{50} value calculated by this method of statistical analysis does not meet the criteria established by the Committee on Methods for Toxicity Tests with Aquatic Organisms.

C. This LC_{50} is the one generated by our standard statistical procedures. In this case, due to the distribution of mortality, the value calculated at 24 hours more accurately reflects the 48 hour toxicity level than does the value calculated at 48 hours.

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