BIOASSAYS OF HARRIS CORPORATION, ELECTRONIC SYSTEMS DIVISION

BREVARD COUNTY, FLORIDA

NPDES PERMIT #FL0034681

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Biological Section
Bureau of Water Analysis
April 21, 1980

INTRODUCTION

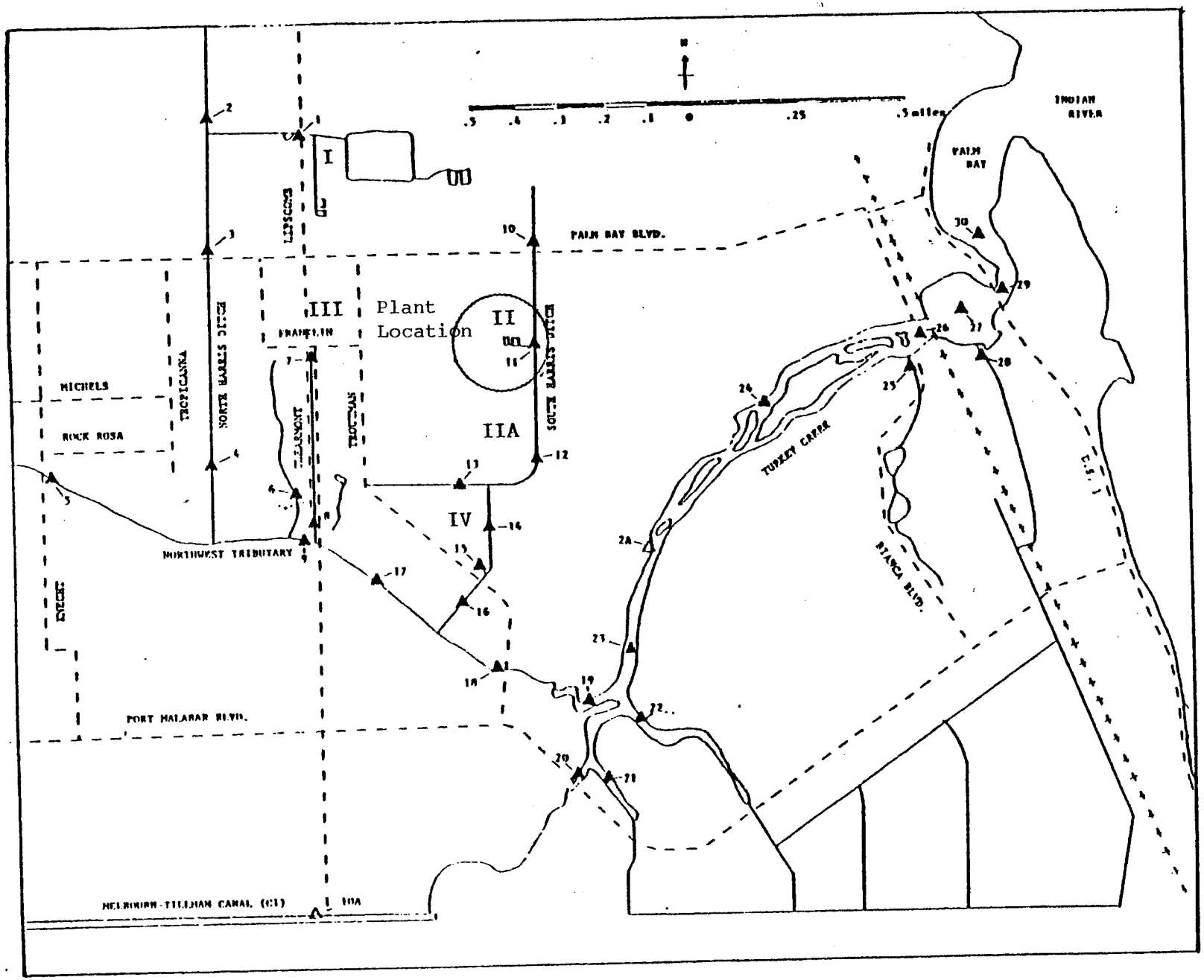
The Harris Corporation, Electronic Systems Division, is a manufacturer of electronic components. This facility is located near Palm Bay in Brevard County, Florida (Fig. 1). An average of 0.921 MGD of wastewater is generated by this plant from the following sources: process rinse water from electroplating of printed electronic circuit boards and other components, regeneration waste from cationic/anionic resin exchange systems, process water from production of semiconductor microelectronic units, exhaust air scrubber water and once through 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 then to Turkey Creek (Class III waters). Turkey Creek then flows into the Indian River (Fig. 2). Permit limitations are listed in Table 1.

The following is a report of bioassays performed to determine the existence and extent of toxicity of this effluent.

Table 1. NPDES Permit limitations of toxic components in wastewater from Harris Corporation, Electronic Systems Division.

Component	Daily Average	Daily Maximum
Copper	0.2mg/l	0.4mg/l
Chromium	0.2mg/l	0.4mg/l
Lead	0.05mg/l	0.1mg/l
Fluoride as F	5mg/l	10mg/l
Nickel	0.2mg/l	0.4mg/l
Cadmium	5µg/l	10µg/l
Cyanide	5µg/l	15µg/l
pH	7.5 - 9.0	-

Figure 1. 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

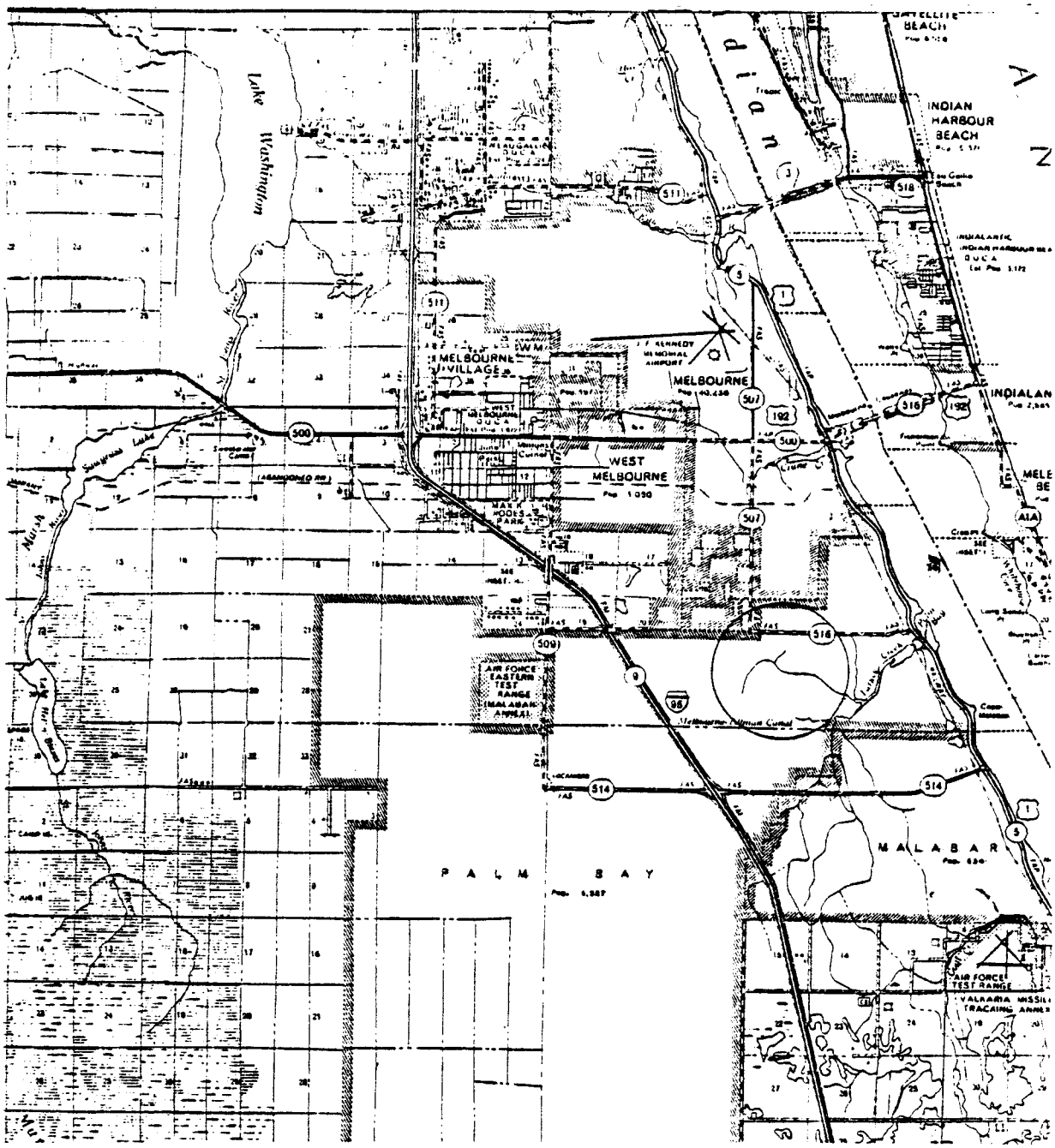


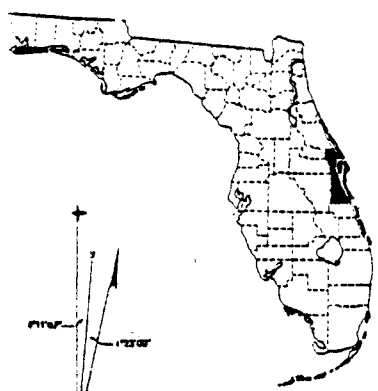
Figure 2. Portions of **BREVARD COUNTY**
including study area
FLORIDA

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



REVISIONS	
FEATURE	DATE
State Maintained Roads and City Limits	December 1968
SR 500, 514	March, 1969
MELBOURNE City Limits	Jan. 1971
US 192	Jan. 1971
I-95, SR 404	Jan. 1973

REPRINTED JANUARY, 1973

METHODS AND MATERIALS

Test methods used for conducting these static bioassays are extensively described by Peltier (1978). The organisms selected for this study are among those recommended by Peltier (1978) and the U.S. EPA (1978). 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 on March 9, 1979. This culture has been maintained continually since its arrival, in 2½ gallon all glass aquaria using a 16:8 hour light-dark cycle. Organisms have been fed a liquified blend of Purina Trout Chow^{R} and Cerophyl^{R} twice daily. Daphnia used in this bioassay were siphoned into a large culture dish through a series of nested stainless steel screens to isolate the proper size and age organisms (neonates). These neonates were then pipetted individually from the culture dish and placed randomly into the test chambers at the beginning of the test.

Pimephales promelas (fathead minnow)

A breeding culture of approximately 100 adult fathead minnows were obtained from the EPA laboratory in Cincinnati, Ohio on 12 May 1979. The fish were transferred to four 125 gallon aquaria filled with unchlorinated City of Tallahassee well water and reared at 24-25^{o}C under 16:8 hour light-dark cycle. Water circulation, aeration and purification were accomplished with heavy-duty outside motor filters. These fish were fed Purina Trout Chow^{R} at a rate of .75g/30 fish twice daily. Breeding was encouraged by placing several halved clay pots in each tank to serve as a substrate for eggs and to provide cover for the fish. Tanks were examined twice daily (at feeding time) for egg production. Clay pots containing egg clusters were immediately transferred to 15 gallon aerated aquaria for hatching. A new aquarium was prepared for each week's production of eggs thereby segregating fish into even age groups to be used for testing. After hatching fathead fry were fed twice daily with freshly hatched Artemia (brine shrimp). The fish used in this test were all 3 months old at the time of the test.

Test Methods

The Biological Section obtained samples of effluent from Harris Corporation, Electronic Systems Division, to determine the existence and extent of toxicity. Static bioassays were conducted on two separate grab samples of effluent from outfall #001 of this facility. The initial sample of effluent was collected on 21 January 1980 by Mr. Mark Johnson and Mr. Steve Palmer of the Bureau of Water Analysis. A second sample of effluent from this outfall was collected by Mr. Johnson on 25 February 1980. Standard wastewater sampling procedures were used in each case. The initial sample was tested using both Daphnia pulex and fathead minnow (Pimephales promelas) in two separate bioassays (Tables 3 and 4). The second effluent sample was tested with Daphnia pulex in a single bioassay (Table 5). Separate samples were obtained for chemical and biological testing. Samples for metal analysis were preserved with HNO_3 (2ml/liter). Samples for organic chemical analysis and the bioassays were unpreserved. The samples were 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 City of Tallahassee well that is used to culture the test organisms. The concentration series selected for this study are those recommended by APHA (1976) (Table 2).

Two replicates of six concentrations and a control were used for the fathead bioassay. The fish were transferred individually or by twos by net into wide mouth quart jars containing 500ml each of the appropriate test concentration (Table 2). Fatheads were loaded 5 per chamber resulting in 10 per concentration.

Two replicates each with six concentrations and a control were used to test with Daphnia pulex. Flint glass jars of 250 ml capacity were used as test chambers; 200 ml of the appropriate test concentration was placed in each chamber (Table 2). Daphnia were transferred individually by glass pipette and were loaded 10 per chamber, resulting in 20 per test concentration.

Dissolved oxygen, pH, and the number of live organisms were recorded for each test chamber at 0 hours, 24 hours, and 48 hours. Total alkalinity, total hardness and conductivity were recorded at the beginning of the test for the controls and the 100% effluent concentration. These values were recorded daily on the bioassay data forms and are presented in Tables 3, 4, and 5. Organisms were not fed during these tests.

TABLE 2. CONCENTRATION SERIES AND VOLUMES USED FOR THESE STATIC BIOASSAYS

Fathead Minnow (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

Water flea (Daphnia pulex)

Concentration	Dilution Water	Effluent	Total Vol.
Control	200 ml	-	200 ml
5.6%	189 ml	11 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

Table 3. Data recorded during 48-hour, *Daphnia pulex*, static acute toxicity bioassay performed on Harris Corporation, Electronic Systems Division, Palm Bay, Brevard Co., Florida. 22 January to 24 January 1980. NPDES Permit #FL0034681. Outfall #001.

Conc. or %	Test Container Number	Number of Live Organisms					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l as $CaCO_3$)					Total Hardness (mg/l as $CaCO_3$)					Conductivity (umhos)				
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
Control	A	10	10	10			8.7	8.9	8.8			8.0	7.7	8.1			125					135					300				
Control	B	10	10	10			8.7	8.8	8.8			8.0	7.7	8.1																	
5.6	A	10	10	10			8.8	8.7	8.7			8.2	7.7	8.0																	
5.6	B	10	8	7			8.7	8.7	8.8			8.2	7.7	8.0																	
10.0	A	10	10	10			8.8	8.7	9.0			8.1	7.7	8.0																	
10.0	B	10	10	10			8.7	8.7	9.0			8.2	7.7	8.0																	
18.0	A	10	10	10			8.5	8.6	8.9			8.3	7.7	7.9																	
18.0	B	10	10	10			8.6	8.6	8.9			8.3	7.7	8.0																	
32.0	A	10	9	9			8.4	8.4	8.9			8.4	7.7	7.9																	
32.0	B	10	10	10			8.3	8.3	8.8			8.4	7.7	7.9																	
56.0	A	10	10	9			8.1	8.3	8.8			8.5	7.8	7.9																	
56.0	B	10	10	10			8.1	8.2	8.7			8.6	7.8	7.9																	
100	A	10	9	9			7.2	8.0	8.7			8.7	7.9	7.9			20 as phenolpthalein														
100	B	10	7	7			7.3	7.8	8.6			8.7	7.9	7.8			110 total					420					2250				

Remarks:

Temperature range for test period: 22.5° to 23.5°C.

Total chlorine residual of 100% effluent = 0.0mg/l.

Table 4. Data recorded during 48-hour, Pimephales promelas, static acute toxicity bioassay performed on Harris Corporation, Electronic Systems Division, Palm Bay, Brevard Co., Florida. 22 January to 24 January 1980. NPDES Permit #FL0034681. Outfall #001.

Conc. or %	Test Container Number	Number of Live Organisms					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l as $CaCO_3$)					Total Hardness (mg/l as $CaCO_3$)					Conductivity (umhos)				
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
Control	A	5	5	5			8.2	5.2	5.8			8.1	8.0	7.7			125					135					300				
Control	B	5	5	5			8.2	4.9	6.0			8.1	8.0	7.7																	
5.6	A	5	5	5			8.2	3.6	5.0			8.2	7.9	7.5																	
5.6	B	5	5	5			8.2	4.4	5.6			8.2	7.9	7.6																	
10.0	A	5	5	5			8.2	5.1	5.8			8.2	8.0	7.5																	
10.0	B	5	5	5			8.2	3.7	4.8			8.2	7.9	7.5																	
18.0	A	5	5	5			8.2	4.7	6.0			8.3	8.0	7.5																	
18.0	B	5	5	5			8.2	3.7	5.0			8.3	7.9	7.5																	
32.0	A	5	5	5			8.1	4.0	6.0			8.4	7.9	7.4																	
32.0	B	5	5	5			8.1	3.5	5.2			8.5	7.9	7.4																	
56.0	A	5	5	5			7.9	2.9	4.8			8.6	7.9	7.3																	
56.0	B	5	5	5			7.8	3.6	4.6			8.6	7.8	7.3																	
100	A	5	5	5			7.1	2.4	5.1			8.8	8.0	7.2			20 phenolphthalein														
100	B	5	5	5			7.1	3.8	5.4			8.8	8.0	7.2			110 total					420					2250				

Remarks:

After 24 hours all chambers were aerated to near saturation.

Total chlorine residual of 100% effluent = 0.0mg/l.

Temperature range for test period: 22.5 to 23.5°C.

Table 5. Data recorded during 48-hour, Daphnia pulex, static acute toxicity bioassay performed on Harris Corporation, Electronic Systems Division, Palm Bay, Brevard Co., Florida. 27 February to 29 February 1980. NPDES Permit #FL0034681. Outfall #001.

Conc. or %	Test Container Number	Number of Live Organisms					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l as $CaCO_3$)					Total Hardness (mg/l as $CaCO_3$)					Conductivity (umhos)				
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
Control	A	10	10	10			7.8	8.7	9.0			8.1	8.2	8.1			125					125					230				
Control	B	10	10	10			7.7	8.7	9.0			8.2	8.2	8.1																	
5.6	A	10	10	10			7.8	8.5	9.0			8.6	8.3	8.2																	
5.6	B	10	10	10			7.7	8.5	9.0			8.7	8.3	8.2																	
10.0	A	10	10	10			7.8	8.5	8.8			8.7	8.4	8.2																	
10.0	B	10	9	9			7.8	8.6	8.8			8.9	8.4	8.2																	
18.0	A	10	9	9			7.9	8.5	8.6			8.9	8.6	8.2																	
18.0	B	10	10	9			7.9	8.4	8.6			9.0	8.6	8.2																	
32.0	A	10	10	10			7.8	7.9	8.4			9.3	8.7	8.2																	
32.0	B	10	10	9			7.7	8.0	8.4			9.3	8.7	8.2																	
56.0	A	10	8	7			7.3	8.6	8.4			9.7	8.9	8.2																	
56.0	B	10	10	10			7.3	8.7	8.4			9.7	8.9	8.2																	
100	A	10	1	0			6.6	8.7	8.3			10.5	9.6	8.9																	
100	B	10	0	0			6.4	8.8	-			10.6	9.6	-								125					2000				

Remarks:

Temperature range for test period: 22.0°to 23.0°C.

RESULTS AND DISCUSSION

Forty-eight hour static bioassays were conducted on each of two grab samples of effluent collected from outfall #001 at the Harris Corporation, Electronic Systems Division. The initial sample, collected January 21, 1980, was tested with both Daphnia pulex and fathead minnows (Pimephales promelas). This sample of effluent was not found to be toxic to either of these test organisms. A single Daphnia bioassay was conducted on a second grab sample from this outfall, collected February 25, 1980. Results of the test indicated that this sample was toxic. The calculated LC_{50} for Daphnia was 72% at 24 hours exposure and 64% at 48 hours. Although results of these bioassays indicate only slight toxicity, results of chemical analyses performed on samples of this effluent collected the same week, but not the same day as the bioassay samples, indicate that there were several components present in potentially toxic concentrations. Ammonia values of 5.86mg/l and 5.96mg/l were reported, respectively, for the January and February 24 hour composite samples.

This concentration of ammonia could be severely toxic to aquatic life if the pH of this effluent were to be increased above 7.5 for any reasonable time (EPA 1977). Because of the fugacity of NH_3 a flow-through assay would probably be more effective in detecting toxicity due to that compound. Additionally, it has been reported that fluoride concentrations as low as 1.5mg/l have affected hatching of fish eggs and 2.3mg/l, introduced as sodium fluoride, was lethal to rainbow trout (Salmo gairdneri) at 18°C (EPA 1977). Fluoride concentrations considerably in excess of those values were reported for each of the effluent samples analyzed (Table 7).

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 hr LC_{50})...". Mixing zones are not relevant to this criterion, and the restriction on acute toxicity, therefore, applies at the point of discharge. Essentially this provision means that an effluent at the point of discharge can not cause 50% mortality in the test organisms even if the effluent is concentrated three-fold. Since the testing procedure used here does not involve any concentrating of the effluent, and since mortality is only measured for 48 hours, any toxicity reported here may be considered to be substantially in excess of allowable limits.

Table 7. Results of chemical analyses conducted on Harris Corporation, Electronic Systems Division Wastewater Outfall

	23 January 1980		27 February 1980	
Parameter	Grab Sample	Composite Sample	Grab Sample	Composite Sample
Total Organic Carbon	15mg/l	-	11mg/l	15mg/l
Arsenic	<10µg/l	<10µg/l	<10µg/l	<10µg/l
Cadmium	< 1µg/l	2.7µg/l	3µg/l	24µg/l
Chromium	<10µg/l	<10µg/l	<10µg/l	<10µg/l
Copper	32.6µg/l	8.8µg/l	177µg/l	410µg/l
Lead	< 5µg/l	< 5µg/l	< 5µg/l	5µg/l
Mercury	<0.2µg/l	<0.2µg/l	<0.2µg/l	<0.2µg/l
Nickel	<10µg/l	<10µg/l	< 10µg/l	23µg/l
Silver	< 1µg/l	< 1µg/l	< 1µg/l	< 1µg/l
Zinc	<25µg/l	40µg/l	52µg/l	60µg/l
PCBs & Phthalates	N.D.	N.D.	N.D.	N.D.
Temperature	26°C	-	22°C	-
pH	8.7	-	5.4	-
Conductivity	2500 umhos	-	2500 umhos	-
Salinity	1.5o/oo	-	-	-
Dissolved Oxygen	5.0mg/l	-	5.6mg/l	-
BOD	34.3mg/l	28.2mg/l	25.9mg/l	31.6mg/l
Ammonia (N)	1.79mg/l	5.86mg/l	6.11mg/l	5.96mg/l
Organic nitrogen	0.37mg/l	0.43mg/l	0.26mg/l	0.29mg/l
Nitrate & nitrite nitrogen	1.10mg/l	2.17mg/l	1.79mg/l	1.90mg/l
Total nitrogen	3.26mg/l	8.46mg/l	8.16mg/l	8.15mg/l
Total phosphorus	0.81mg/l	265mg/l	288mg/l	1.84mg/l
Fluoride	5.41mg/l	11.8mg/l	15.7mg/l	14.1mg/l

Table 8. LC_{50} Data

Harris Corporation, Electronic Systems Division

Date of Sample	Organism	Type of test	Method of Data Analysis	24 hour LC_{50}	48 hour LC_{50}
01/21/80	Daphnia pulex	Static	-	>100%	>100%
01/21/80	Pimephales promelas	Static	-	No mortality	No Mortality
02/25/80	Daphnia pulex	Static	Binomial Test	73.0%	68.7%
			Moving Average Method	71.9%	64.6%
			Probit Method	70.5%	62.2%

LITERATURE CITED

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