BIOASSAYS OF THE BOCA RATON

SEWAGE TREATMENT PLANT

PALM BEACH COUNTY, FLORIDA

NPDES #FL0026344

SAMPLED 7/29/86

SEPTEMBER 22, 1986

Biology Section
Division of Environmental Programs

BIOASSAYS OF THE BOCA RATON SEWAGE TREATMENT PLANT PALM BEACH COUNTY, FLORIDA NPDES #FL0026344

Biology Section
Bureau of Laboratories and
Special Programs
September 22, 1986

EXECUTIVE SUMMARY

Boca Raton STP, NPDES #FL0026344, on 30 July to 1 August, 1986.

Six separate 48 hour static acute toxicity bioassays were performed on samples of final chlorinated and de-chlorinated effluents from this domestic waste treatment facility, which discharges approximately 1 mile into the Atlantic Ocean. The chlorinated effluent proved to be acutely toxic to all three species of test organisms, Daphnia pulex, Ceriodaphnia dubia, and Notropis leedsi, producing 48 hour LC_{50}'s of 21.3%, < 50%, and 35.3%, respectively. This toxicity, however, can only be partially attributed to the residual chlorine (0.4 mg/l) measured in the sample. The de-chlorinated effluent was acutely toxic to C. dubia (48 hour LC_{50} = 70.7%), but was not toxic to D. pulex or N. leedsi. This supports the suggestion that toxic components other than chlorine may be present in the Boca Raton effluent.

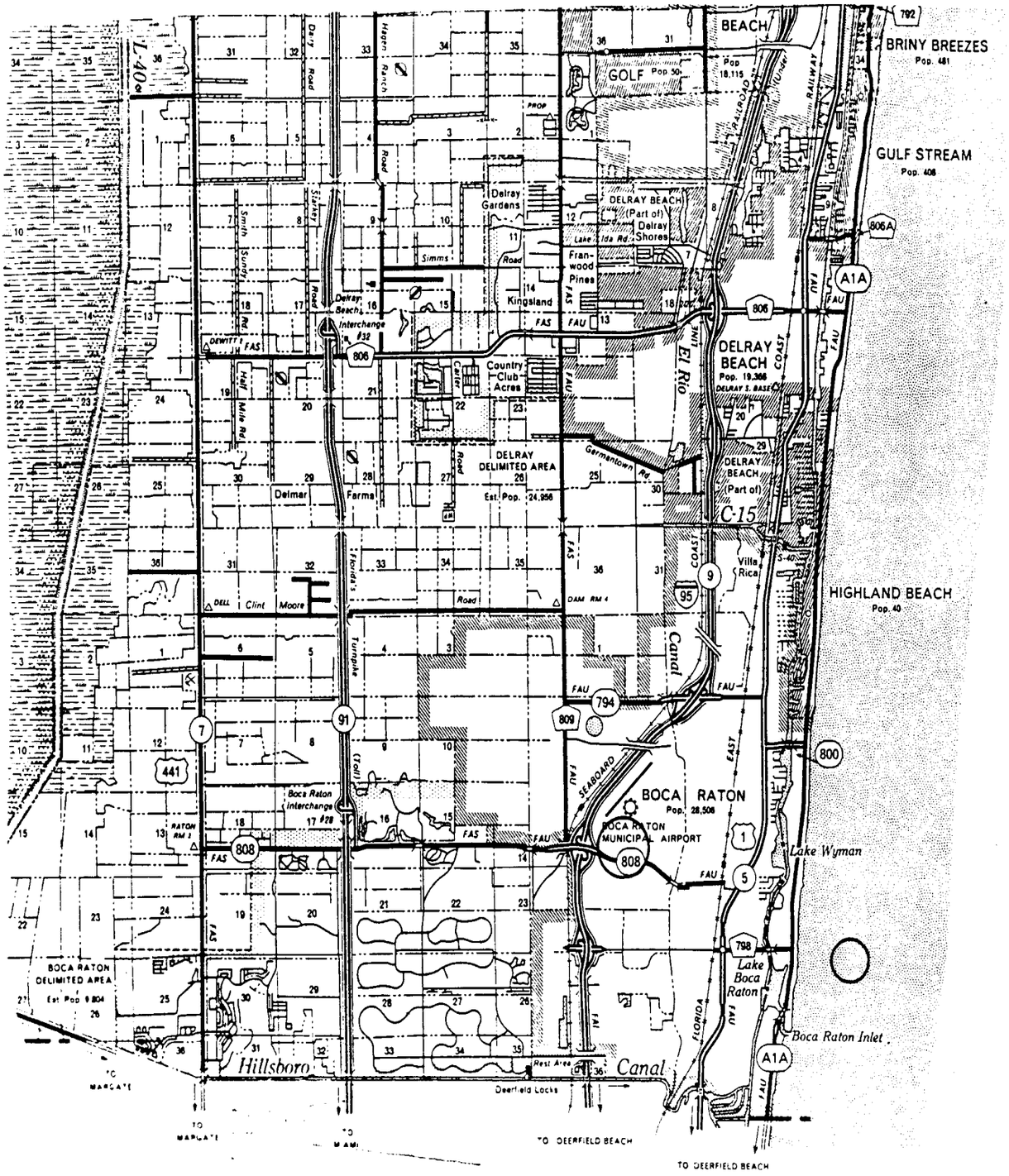
The results of chemical analyses indicated the presence of several unidentified organic compounds, and the metals silver (1 ug/l) and zinc (18 ug/l). These chemical constituents may have contributed to the toxicity.

Since toxicity was partially attributed to chlorine, we recommend the installation of a de-chlorination unit at the Boca Raton facility. Also, investigations should be made as to the source and possible elimination of the remaining toxicity and of the chemical components in the wastewater. A biomonitoring plan should be incorporated into the Boca Raton permit.

INTRODUCTION

The Boca Raton Sewage Treatment Plant is located at 1501 West Glades Road, in Boca Raton, Palm Beach County, Florida (Fig. 1). The facility uses an activated sludge system to treat domestic wastes from a population of approximately 150,000, and light industrial wastes from the surrounding area. The design capacity of the plant is 10 MGD and the volume of wastewater treated approaches this amount. The final treated wastewater is chlorinated and piped several miles to the Atlantic Ocean where it is discharged through a 30" pipe one mile from shore in approximately 100' of water.

To evaluate the toxicity of this discharge, the Southeast District requested that acute toxicity bioassays be performed. Six separate 48 hour static tests were performed from 30 July to 1 August, 1985. The results of these tests are presented in this report. Those involved in performing the tests and in preparation of this report were: R. B. Frydenborg, M. L. Roll, and P. G. Weiland.



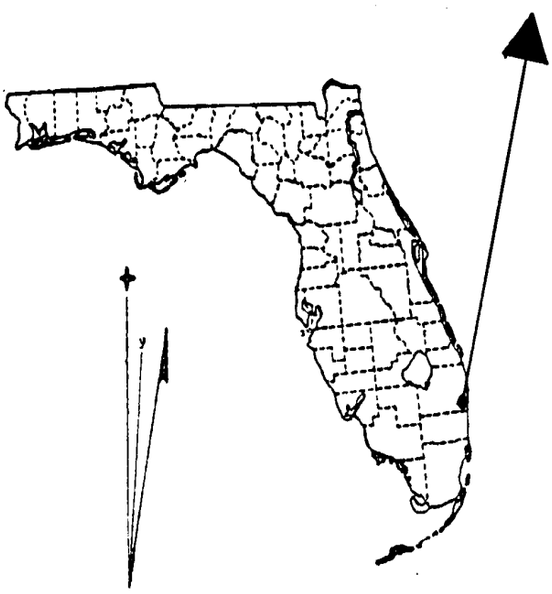


Figure 1. Portions of Palm Beach County, Florida, including Boca Raton and the locations of the sewage plant and Atlantic Ocean outfall.

METHODS AND MATERIALS

Test methods used to conduct these static bioassays are extensively described by Peltier and Weber (1985) and the FDER Biology Section (1985). The organisms selected for this study include species recommended by Peltier and Weber (1985), the U.S. EPA (1978), and the FDER Biology Section (1985). Additionally, the Biology Section maintains cultures of several species of organisms indigenous to the State of Florida. One of these indigenous species was also selected for testing. 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 2 1/2 gallon all-glass aquaria, filled with unchlorinated DER well water, under a 16:8 hour light-dark cycle. Organisms are fed a liquified blend of Purina Trout Chow® and Cerophyl® twice daily, once daily on weekends, and are kept at a constant temperature of 22° ± 2°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess organisms, and then refilling 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.

Ceriodaphnia dubia (water flea) - A breeding culture of Ceriodaphnia dubia was obtained from the EPA laboratory in Athens, Georgia, in June, 1985. The culture is maintained in 2-1/2 gallon all-glass aquaria, filled with unchlorinated DER well water, under a 16:8 hour light-dark cycle. Organisms are fed a liquified blend of Purina Trout Chow®, Cerophyl® and Fleischmann's® yeast twice daily, once daily on weekends, and are kept at a constant temperature of 26° ± 2°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess organisms, and then refilling 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.

Notropis leedsi (bannerfin shiner) - Approximately 40 adult bannerfin shiners were obtained from an indigenous population in the upper Suwannee River during October, 1981. The breeding stock is maintained in 30 and 125 gallon all-glass aquaria equipped with a flow-through water exchange system. Water for this system is unchlorinated and is pumped from the DER deep well. The bannerfin shiners are reared at 22° ± 2°C under a 16:8 hour light-dark cycle and are fed Tetra-Min® and frozen Artemia (brine shrimp) twice daily, and once daily on weekends. Breeding and egg hatching are encouraged at 25°C. The eggs are laid between stacked red ceramic tiles separated by a 3mm bead of silicone. Most of the eggs adhere to the tiles and are easily removed to heated, aerated hatching tanks. The narrow space between the tiles eliminates egg predation by

adult fish. New hatching tanks are started regularly to segregate fry into even age groups. Newly hatched fry are fed a liquefied blend of Purina Trout Chow® and Cerophyl® twice daily. After one week, feeding is augmented with newly hatched Artemia nauplii and finely crushed Tetra Min®. The fish used in this test were approximately 17 days old at the time of the test.

To ensure the uniform sensitivity of these test organisms to toxic substances, the Biology Section conducts monthly standard reference toxicant bioassays using sodium lauryl sulfate as the reference toxicant.

Test Methods

Methods used to perform acute toxicity bioassays are described by Peltier and Weber (1985) and the FDER Biology Section (1985). Some of the methods described below are more specific than those of Peltier and Weber. These will be noted in more detail.

Sampling Methods and Test Dates

Six separate 48 hour static acute toxicity bioassays were performed on samples of final chlorinated effluent and de-chlorinated effluent collected from the outfall pipe of the Boca Raton STP. The tests were performed from 1000 hours 30 July to 1000 hour on 1 August, 1986.

The samples were collected by Mr. William Thiel of DER's Southeast District at 1545 hours on 28 July, 1986 using standard wastewater sampling procedures. Separate samples were obtained for chemical and biological testing. Samples for metal analyses were preserved with HNO_3. Samples for organic chemical analyses and for the bioassays were unpreserved. The samples were iced and transported to the DER laboratory in Tallahassee for analyses within 48 hours of collection.

Test Temperature

Upon arrival of the iced (4°C) bioassay samples in the Tallahassee laboratory, the containers were placed in warm water and the temperature of the samples allowed to rise to 20° $\pm$ 2°C. Although this temperature may be different than the temperature of the sample during collection, it is the temperature range to which the test organisms are acclimatized and is the range recommended in the above referenced bioassay protocols. This avoids stressful effects caused by exposure to unusually cold or warm samples.

Total Residual Chlorine

Since many wastewaters are chlorinated, especially those originating from sewage treatment facilities, it is often desirable to differentiate between the toxicity resulting from chlorine and the toxicity associated with other components of the wastewater. To accomplish this, the Biology Section performed concurrent bioassays on a sample of chlorinated wastewater in which the chlorine had been neutralized. De-chlorination was accomplished by adding a calculated amount of 0.025N sodium thiosulfate. The total residual chlorine concentrations of the tested effluents are given on the bioassay data forms. A comparison of the results of these tests will distinguish between the toxicity due solely to residual chlorine and the toxicity inherently contained in the wastewater.

Freshwater Tests

Freshwater for dilution of the effluent samples 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 an abbreviated version of that recommended by APHA (1980).

Two replicates, of each concentration and a control, were used to test with the water fleas, Ceriodaphnia dubia and Daphnia pulex. Flint glass jars of either 60 ml (C. dubia) or 250 ml (D. pulex) capacity were used as test chambers, and either 50 ml (C. dubia) or 200 ml (D. pulex) of the appropriate test concentration was placed in each chamber. Ceriodaphnia were siphoned into a large culture dish and neonates were transferred by glass pipette, and loaded 10 per chamber, resulting in 20 per test concentration. Daphnia were siphoned into a large culture dish to isolate the proper size and age organisms (neonates). To accomplish this, the Daphnia were siphoned through a stainless steel screen. The trapped adults were then discarded. These neonates were then transferred by glass pipette, examined for injury, and were loaded 10 per chamber, resulting in 20 per test concentration. Water fleas were not fed during these tests.

Two replicates, of each concentration and a control, were used for the Notropis leedsi (bannerfin shiner) bioassay. The fish were transferred individually or by twos, into wide mouth quart jars containing 500 ml each of the appropriate test concentration, and were loaded 5 per chamber, resulting in 10 per concentration. Fish were not fed during these tests.

Test Parameters

Dissolved oxygen (YSI Model 57 oxygen meter), pH (Corning Model 7 pH meter with Orion Ross® combination electrode), temperature (NBS calibrated glass thermometer), and the number of live organisms were recorded for each test concentration at 0 hours, 24 hours, and 48 hours. Total alkalinity and total hardness (measured as $CaCO_3$ using HACH Chemical Company reagents) were recorded at the beginning of the test for the controls and the 100% effluent concentration. The specific conductance (YSI Model 33 S-C-T meter) of each test concentration was recorded at the beginning and end of the test. All instruments were calibrated daily according to manufacturer's recommendations. Ammonia concentrations, including the total and unionized fraction (expressed in mg/l as N and as NH_3, respectively), were recorded in the controls and the 100% effluent test concentrations at the beginning of the test. Total ammonia concentrations were determined using an Orion® specific ion probe and an Orion Ionalyzer®. The unionized fraction was then calculated based on the total ammonia concentration, and the pH, temperature, and salinity of the sample. These values were recorded on the bioassay data forms and are presented in Tables 2 through 7.

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

Ceriodaphnia dubia (water flea)

Concentration	Dilution Water	Effluent	Total Volume
Control	50.0 ml	--------	50.0 ml
50.0%	25.0 ml	25.0 ml	50.0 ml
100.0%	-------	50.0 ml	50.0 ml

Daphnia pulex (water flea)

Concentration	Dilution Water	Effluent	Total Volume
Control	200.0 ml	--------	200 ml
10.0%	180.0 ml	20.0 ml	200 ml
32.0%	136.0 ml	64.0 ml	200 ml
56.0%	88.0 ml	112.0 ml	200 ml
100.0%	--------	200.0 ml	200 ml

Notropis leedsi (bannerfin shiner)

Concentration	Dilution Water	Effluent	Total Volume
Control	500 ml	--------	500 ml
10.0%	450 ml	50 ml	500 ml
32.0%	340 ml	160 ml	500 ml
56.0%	220 ml	280 ml	500 ml
100.0%	------	500 ml	500 ml

Table 2. Data recorded during 48 hour, Daphnia pulex, static acute toxicity bioassay of Boca Raton STP, NPDES #FL0026344, on 30 July to 1 August, 1986.

Chlorinated Effluent[a]

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	8.9	8.8	8.4	8.1	8.0	7.9	21.3	19.8	21.0		
Control	10	10	10	8.9	8.8	8.4	8.1	8.0	7.9				200	210
10.0%	10	10	10	8.8	8.8	8.5	8.0	8.0	7.9	21.2	19.7	20.8		
10.0%	10	10	10	8.8	8.8	8.5	8.0	8.0	7.9				222	233
32.0%	10	10	1	8.7	8.8	8.5	7.7	7.9	7.9	21.2	19.6	20.6		
32.0%	10	9	2	8.7	8.8	8.5	7.7	7.9	7.9				270	282
56.0%	10	0	0	8.3	8.8	-[b]	7.4	7.8	-[b]	21.4	19.6	-[b]		
56.0%	10	0	0	8.3	8.8	-	7.4	7.8	-				325	-[b]
100.0%	10	0	0	7.5	8.6	-	7.1	7.7	-	21.5	19.6	-		
100.0%	10	0	0	7.5	8.6	-	7.1	7.7	-				422	-

Control Water

NH_3(as NH_3)(mg/l): 0

Total ammonia (as N)(mg/l): 0

Total Alkalinity (mg/l $CaCO_3$): 113

Total Hardness (mg/l $CaCO_3$): 112

100% Effluent

NH_3(as NH_3)(mg/l): 0.001

Total ammonia (as N)(mg/l): 0.14

Total Alkalinity (mg/l $CaCO_3$): 82

Total Hardness (mg/l $CaCO_3$): 90

[a] Total Residual Chlorine: 0.4 mg/l (HACH), 0.49 mg/l (Iodometric I).

[b] Remaining parameters were not recorded since all organisms were dead by 24 hours.

Table 3. Data recorded during 48 hour, Ceriodaphnia dubia, static acute toxicity bioassay of Boca Raton STP, NPDES #FL0026344, on 30 July to 1 August, 1986.

Chlorinated Effluent[a]

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	8.7	8.7	8.4	8.1	8.0	8.0	20.8	19.6	20.6		
Control	10	10	10	8.7	8.7	8.4	8.1	8.0	8.0				200	210
50.0%	10	5	0	8.3	8.8	8.3	7.5	7.9	7.9	20.8	19.5	20.5		
50.0%	10	4	0	8.3	8.8	8.3	7.5	7.9	7.9					
100.0%	10	0	0	7.4	8.7	-b	7.1	7.9	-b	20.9	19.3	-b		
100.0%	10	0	0	7.4	8.7	-b	7.1	7.9	-b				422	-b

Control Water

NH_3(as NH_3)(mg/l) 0

Total ammonia (as N)(mg/l) 0

Total Alkalinity (mg/l $CaCO_3$) 113

Total Hardness (mg/l $CaCO_3$) 112

100% Effluent

NH_3(as NH_3)(mg/l) 0.001

Total ammonia (as N)(mg/l) 0.14

Total Alkalinity (mg/l $CaCO_3$) 82

Total Hardness (mg/l $CaCO_3$) 92

[a] Total Residual Chlorine: 0.4 mg/l (HACH), 0.49 mg/l (Iodometric I).

[b] Remaining parameters were not recorded since all organisms were dead by 24 hours.

Table 4. Data recorded during 48 hour, Notropis leedsi, static acute toxicity bioassay of Boca Raton STP, NPDES #FL0026344, on 30 July to 1 August, 1986.

Chlorinated Effluent[a]

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)		
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	
Control	5	4	4	8.4	8.7	8.2	7.7	7.8	7.7	21.6	19.5	20.3			Control Water
Control	5	5	5	8.4	8.7	8.2	7.7	7.8	7.7				205	210	NH_3(as NH_3)(mg/l) 0 / Total Alkalinity 113 (mg/l $CaOO_3$)
10.0%	5	5	5	8.4	8.8	8.3	7.6	7.8	7.8	21.6	19.4	20.3			
10.0%	5	4	4	8.4	8.8	8.3	7.6	7.8	7.8				229	233	
32.0%	5	5	5	8.2	8.8	8.3	7.5	7.8	7.7	21.6	19.4	20.3			Total ammonia (as N)(mg/l) 0 / Total Hardness 112 (mg/l $CaOO_3$)
32.0%	5	4	4	8.2	8.8	8.3	7.5	7.8	7.7				279	288	
56.0%	5	0	0	8.0	8.6	-b	7.4	7.7	-b	21.7	19.4	-b			
56.0%	5	0	0	8.0	8.6	-b	7.4	7.7	-				333	-b	
100.0%	5	0	0	7.6	8.3	-	7.1	7.5	-	21.6	19.5	-			
100.0%	5	0	0	7.6	8.3	-	7.1	7.5	-				422	-	100% Effluent
															NH_3(as NH_3)(mg/l) 0.001 / Total Alkalinity 82 (mg/l $CaOO_3$)
															Total ammonia (as N)(mg/l) 0.14 / Total Hardness 90 (mg/l $CaOO_3$)

[a] Total Residual Chlorine: 0.4 mg/l (HACH), 0.49 mg/l (Iodometric 1).

[b] Remaining parameters were not recorded since all organisms were dead by 24 hours.

Table 5. Data recorded during 48 hour, Daphnia pulex, static acute toxicity bioassay of Boca Raton STP, NPDES #FL0026344, on 30 July to 1 August, 1986.

De-chlorinated Effluent[a]

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	8.8	8.6	8.3	8.2	8.0	8.0	21.2	19.8	20.7		
Control	10	9	9	8.8	8.6	8.3	8.2	8.0	8.0				198	212
10.0%	10	10	10	8.7	8.6	8.4	8.1	8.0	7.9	21.0	19.8	20.7		
10.0%	10	10	10	8.7	8.6	8.4	8.1	8.0	7.9				221	238
32.0%	10	10	10	8.6	8.6	8.4	7.8	7.9	7.8	21.0	19.8	20.7		
32.0%	10	10	9	8.6	8.6	8.4	7.8	7.9	7.8				270	290
56.0%	10	10	10	8.2	8.4	8.4	7.5	7.8	7.7	21.2	19.8	20.7		
56.0%	10	10	10	8.2	8.4	8.4	7.5	7.8	7.7				328	350
100.0%	10	10	10	7.4	8.3	8.3	7.1	7.7	7.7	21.6	19.9	20.8		
100.0%	10	10	10	7.4	8.3	8.3	7.1	7.7	7.7				420	458

Control Water

NH_3(as NH_3)(mg/l) 0

Total ammonia (as N)(mg/l) 0

Total Alkalinity (mg/l $CaCO_3$) 113

Total Hardness (mg/l $CaCO_3$) 112

100% Effluent

NH_3(as NH_3)(mg/l) 0.001

Total ammonia (as N)(mg/l) 0.14

Total Alkalinity (mg/l $CaCO_3$) 84

Total Hardness (mg/l $CaCO_3$) 92

[a] Total Residual Chlorine: < 0.02 mg/l (HACH).

Table 6. Data recorded during 48 hour, Ceriodaphnia dubia, static acute toxicity bioassay of Boca Raton STP, NPDES #FL00026344, on 30 July to 1 August, 1986.

De-chlorinated[a]

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	8.7	8.6	8.1	8.2	8.0	8.0	20.9	20.1	20.9		
Control	10	10	10	8.7	8.6	8.1	8.2	8.0	8.0				198	212
50.0%	10	10	10	8.3	8.5	8.3	7.5	8.0	7.9	20.8	20.1	20.9		
50.0%	10	10	10	8.3	8.5	8.3	7.5	8.0	7.9					
100.0%	10	7	0	7.6	8.3	8.4	7.1	7.8	7.8	20.9	20.1	20.8		
100.0%	10	6	0	7.6	8.3	8.4	7.1	7.8	7.8				420	458

Control Water

NH_3(as NH_3)(mg/l): 0

Total Alkalinity (mg/l $CaOO_3$): 113

Total ammonia (as N)(mg/l): 0

Total Hardness (mg/l $CaOO_3$): 112

100% Effluent

NH_3(as NH_3)(mg/l): 0.001

Total Alkalinity (mg/l $CaOO_3$): 84

Total ammonia (as N)(mg/l): 0.14

Total Hardness (mg/l $CaOO_3$): 92

[a] Total Residual Chlorine: $\leq$0.02 mg/l(HACH).

Table 7. Data recorded during 48 hour, Notropis leedsi, static acute toxicity bioassay of Boca Raton STP, NPDES #FL0026344, on 30 July to 1 August, 1986.

De-chlorinated[a]

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/1)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	5	4	4	8.4	8.7	8.2	7.7	7.8	7.7	21.6	19.5	20.3		
Control	5	5	5	8.4	8.7	8.2	7.7	7.8	7.7				205	210
10.0%	5	5	5	8.4	8.6	8.4	7.6	7.8	7.8	21.8	19.8	20.5		
10.0%	5	5	5	8.4	8.6	8.4	7.6	7.8	7.8				228	235
32.0%	5	5	5	8.3	8.5	8.4	7.5	7.8	7.7	21.8	19.7	20.5		
32.0%	5	5	5	8.3	8.5	8.4	7.5	7.8	7.7				277	288
56.0%	5	5	5	8.0	8.2	8.5	7.3	7.7	7.7	21.8	19.7	20.5		
56.0%	5	5	5	8.0	8.2	8.5	7.3	7.7	7.7				331	349
100.0%	5	5	5	7.6	7.9	8.5	7.1	7.5	7.6	21.8	19.8	20.9		
100.0%	5	5	4	7.6	7.9	8.5	7.1	7.5	7.6				422	452

Control Water

NH_3(as NH_3)(mg/1): 0

Total ammonia (as N)(mg/1):

Total Alkalinity (mg/1 $CaOO_3$): 113

Total Hardness (mg/1 $CaOO_3$): 112

100% Effluent

NH_3(as NH_3)(mg/1): 0.001

Total ammonia (as N)(mg/1): 0.14

Total Alkalinity (mg/1 $CaOO_3$): 84

Total Hardness (mg/1 $CaOO_3$): 92

[a] Total Residual Chlorine: 0.02 mg/1 (HACH).

Table 8. LC_{50} Data for Bioassays of the Boca Raton STP, NPDES #FL0026344, on 30 July to 1 August, 1986.

Organism	Method of Data Analysis	24 Hour LC_{50} and 95% Confidence Intervals	48 Hour LC_{50} and 95% Confidence Intervals
Chlorinated Effluent			
Daphnia pulex	Binomial	40.8% (32 and 56)	21.3% (10 and 32)
	Moving Average	a	a
	Probit	a	a
Ceriodaphnia dubia	Binomial		
	Moving Average	< 50%, b	< 50%, b
	Probit		
Notropis leedsi	Binomial	39.9% (32 and 56)	39.9% (32 and 56)
	Moving Average	35.3% (26.0 and 53.0)	35.3% (26.0 and 53.0), d
	Probit	33.3% (0 and ∞), c	33.3% (0 and ∞), c
De-chlorinated Effluent			
Daphnia pulex	Binomial		
	Moving Average	Random Mortality	Random Mortality
	Probit		
Ceriodaphnia dubia	Binomial	a	70.7% (50 and 100)
	Moving Average	a	a
	Probit	a	a
Notropis leedsi	Binomial		a
	Moving Average	No Mortality	a
	Probit		a

[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] At 24 hours, the LC_{50} is < 50% since more than half the test organisms were dead in this concentration. At 48 hours, the LC_{50} is significantly < 50% since all the test organisms were dead.

[c] Due to the distribution of mortality, results calculated using the probit method are not statistically sound.

[d] This LC_{50} is reported in the text since it is the most statistically conservative value of the data set.

Table 9. Results of Chemical Analyses of Wastewater Collected from the Boca Raton STP, NPDES #FL0026344, sampled 28 July, 1986.

Organics

Pesticide Extractables:	Several unidentified compounds

Metals

Cadmium	N.D.
Chromium	N.D.
Copper	N.D.
Lead	N.D.
Mercury	N.D.
Silver	1 ug/l
Zinc	18 ug/l

RESULTS AND DISCUSSION

The final chlorinated effluent from the Boca Raton STP was acutely toxic to all three bioassay test organisms, Daphnia pulex, Ceriodaphnia dubia, and Notropis leedsi, producing 48 hour LC_{50}'s of 21.3%, < 50%, and 35.3%, respectively (Table 8). This toxicity can only be partially attributed to the residual chlorine (0.4 mg/l) measured in the sample. The amount of ammonia detected in the sample, 0.14 mg/l total and 0.001 mg/l unionized, was insufficient to have contributed to the toxicity. The de-chlorinated effluent proved to be acutely toxic to C. dubia (48 hour LC_{50} = 70.7%), but was not toxic to D. pulex or N. leedsi. This supports the suggestion that toxic components other than chlorine may be present in Boca Raton's wastewater.

The results of chemical analyses (Table 9) indicated the presence of several unidentified organic compounds, and the metals silver (1 ug/l) and zinc (18 ug/l). These chemical constituents may have contributed to the toxicity.

Recommendation

Since a portion of the toxicity was evidently due to chlorine, we recommend the installation of a de-chlorination unit at the Boca Raton facility. Also, investigations should be made as to the source and possible elimination of the ramaining toxicity and of the chemical constituents in this wastewater. A biomonitoring program should be incorporated into the Boca Raton permit.

Discussion of the Toxicity Criteria

The toxicity standards of Chapters 17-3 and 17-4, F.A.C., are complex. Because of this complexity, they will be briefly reviewed here so that these test results may be more readily compared with the standards. For legal purposes, however, the language of the Florida Administrative Code should be consulted directly.

The two basic concepts utilized in the standards are acute and chronic toxicity (defined in 17-3.021(1) and (4), respectively). Simplifying the actual F.A.C. language somewhat, acute toxicity is defined as the presence of a substance in a concentration one-third as great as that concentration which kills one-half of the test organisms in 96 hours, i.e., one-third of the 96 hour LC_{50}. Chronic toxicity is similarly defined as onetwentieth of the 96 hour LC_{50}. Therefore, if a test solution kills one- half or more of a group of test organisms in 96 hours, it must contain at least three times the defined "acutely toxic" concentration and at least twenty times the "chronically toxic" concentration of some substance or substances. If a test solution causes that same mortality in less than 96 hours, (for example, in 24 or 48 hours), it is at least as toxic as the example given above, and actually is probably considerably more toxic.

The particular restrictions applied to a given discharger depend upon the existence of a mixing zone, whetheras a specific part of the permit or based on the existence of a currently valid permit predating the language in Chapter 17-4 requiring mixing zone designation. In the absence of a mixing zone, the general criteria for surface waters [17-3.061] are applicable at all points, beginning at the point of discharge. This section prohibits the discharge of substances in concentrations which are chronically toxic [17-3.061(2)(p)]; that is, the concentrations cannot exceed one-twentieth of the 96 hour LC_{50} as discussed above. If a mixing zone does exist, then this chronic toxicity standard is only applicable from the edge of the mixing zone and beyond. Within the mixing zone, the less stringent acute toxicity standard of the minimum criteria for all waters [17-3.051(1)(d)] applies: one-third of the 96 hour LC_{50}. The acute toxicity standard does not apply, however, to each point within a mixing zone not designated for dredge and fill permitting, but rather to the average of a number of points within such a mixing zone, based on the provisions of the surface water mixing zones section of Chapter 17-4 [17-4.244(4)]. At the same time, though, this same rule prohibits waste concentrations within such a mixing zone (i.e., at any point within the mixing zone), from exceeding the 96 hour LC_{50}. Therefore, at any point within such a mixing zone, including the point of discharge, one-half of the test organisms cannot be killed in 96 hours. Within a mixing zone designated for dredge and fill permitting, the acute toxicity standard (one-third of the 96 hour LC_{50}) applies at all points, including the point of discharge.

From the above discussion, it should be clear that if the least stringent toxicity standard, the 96 hour LC_{50}, is exceeded at any point, from the point of discharge outwards, by any discharger, then a violation of the standards has occurred. This is an important consideration since the test procedure here reported involves the measurement of the 50% lethal concentration, and not some fraction of that concentration. Any discharger required to meet the one-twentieth of the 96 hour LC_{50} standard is therefore being tested very leniently. Any reduction in the test period from 96 hours provides an added degree of leniency to a discharger.

A number of different dilutions were examined in order to determine by how much, if any, the discharge exceeds the 96 hour LC_{50}. For example, if the sample, after two-fold dilution with diluent (a 33% concentration), kills one-half of the test organisms after 96 hours, then the sample is three times as toxic as is allowed by that standard. Similarly, if a 5% solution of the sample kills 50% of the organisms, the sample is twenty times as toxic as is allowed. Toxicities are reported here in that manner, i.e., in terms of the percentage dilution of the test sample. The smaller the percentage which is reported means a correspondingly greater toxicity.

Note that even if a discharger receives a very large mixing zone not designated for dredge and fill permitting, the regulations require that the maximum toxicity at any point within the mixing zone be restricted to the 96 hour LC_{50}. The results here reported are based on actual effluent samples, representative of the effluent concentration which enters waters of the state at the point of discharge. If it is demonstrated that, under the conditions existing at the point of discharge, effluent concentrations will be less than at the actual sampling point (if the two points are different), the reported bioassay results will reflect the reduced discharge concentration.

With respect to the species of organisms used in these tests, the language of the F.A.C. indicates that they should be "significant to the indigenous aquatic community". All species 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.

LITERATURE CITED

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