BIOASSAYS OF FORT LAUDERDALE B SEWAGE TREATMENT PLANT

FORT LAUDERDALE, BROWARD COUNTY, FLORIDA

NPDES #FL0020524

SAMPLED 7/21/81

Biological Section
Bureau of Water Analysis
August 11, 1981

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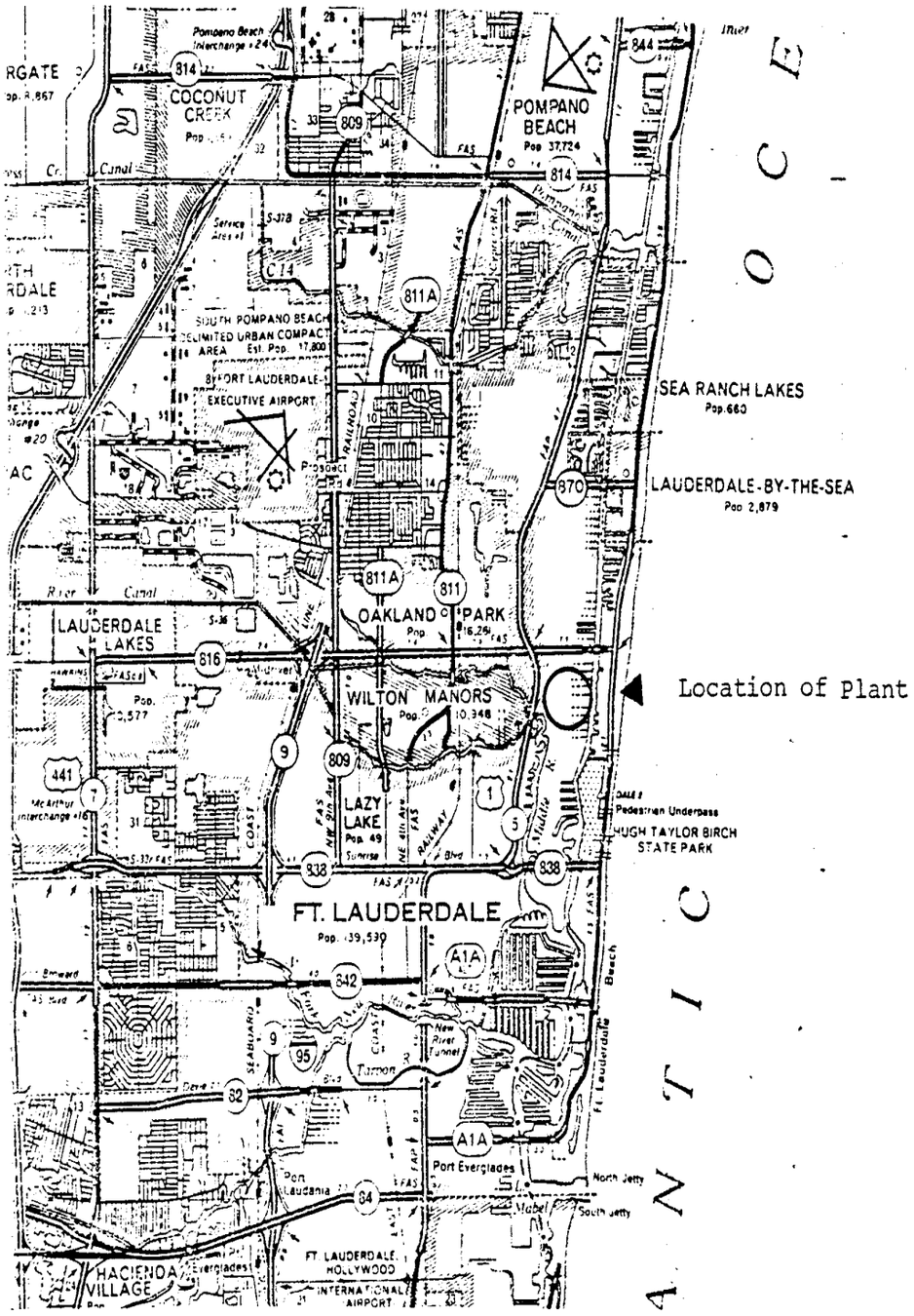
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INTRODUCTION

The Fort Lauderdale B Sewage Treatment Plant is a municipal facility operated by the City Utilities Department. It is located on N.E. 40th and 25th Avenue, in the town of Coral Ridge, Broward County, Florida (Fig. 1). The plant, operating since 1965, presently has a design capacity of 8.0 MGD and serves a population of approximately 80,000. The plant is primarily an activated sludge treatment plant (7.0 MGD), but also has a 1.0 MGD trickling filter and a 1.0 MGD "Cantex" contact stabilization unit for increased capacity. Domestic wastewater purification consists of comminution, vacuum floatation, degritting, activated sludge treatment, final clarification and chlorination. Discharge of the average 6.77 MGD effluent is to the Intercoastal Waterway through a 36" pipe sixty feet from shore.

This facility is scheduled to cease discharging when the new Central Region sludge facility begins operating. In the past, the plant has received several notices for exceeding its permit limitations for biochemical oxygen demand (BOD) and total suspended solids (TSS).

To evaluate the effects of this discharge on the biota of the receiving waters, the Biological Section performed static acute bioassays on grab samples of effluent from 22 to 24 July, 1981. The result of these tests are presented in this report.



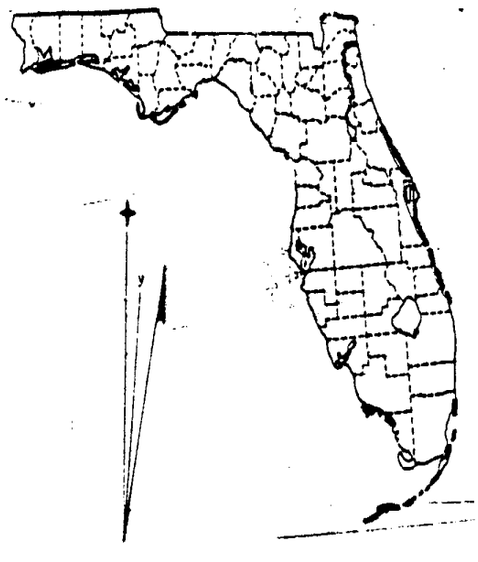


Figure 1. Portions of Broward County, Florida, including approximate location of Fort Lauderdale B Sewage Treatment Plant.

METHODS AND MATERIALS

Test methods used to conduct these static bioassays are extensively described by Peltier (1978). The organism selected for this study is among these recommended by Peltier (1978) and the U.S. EPA (1978). The life history and maintenance procedures used to culture them are detailed below.

History and Maintenance of Bioassay Organisms

Mysidopsis bahia (mysid shrimp) - In September, 1978, approximately 300 adult mysid shrimp were obtained from the Gulf Breeze EPA Laboratory in Pensacola, Florida. The mysids have been cultured under continuous lighting in 10 and 15 gallon all glass aquaria equipped with undergravel filtration and aeration. The mysid shrimp are cultured over a wide range of salinities (10-30 ppt) to minimize acclimation periods to low or high salinity effluents. Seawater is obtained from the FSU Marine Laboratory located at Turkey Point, Florida (salinity range 17-31 ppt) and partial water changes are performed weekly. Freshwater, for dilutuion of the seawater as necessary, is obtained from a deep well near the DER laboratory. The mysids are fed twice daily with freshly hatched Artemia (brine shrimp) and are kept at a constant temperature of $22^{o} \pm 1^{o}C$. Immediately prior to the bioassay, a suitable number of mysids were transferred by net to a culture dish for observation and selection of individuals for the test. Fifteen day old (three-quarter adult size) mysids were used in this test. Organisms selected for testing were transferred individually by glass tube and randomly placed in the test chambers.

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 1000 hours on 22 July, 1981, to 1010 hours on 24 July 1981. Grab samples of chlorinated effluent (Outfall #001) and of effluent collected prior to chlorination were obtained by Mr. Mike Nichols and Mr. Kevin Ruddick of DER's Port St. Lucie office at 1020 hours on 21 July, 1981, using standard wastewater sampling procedures. The unpreserved samples were iced and transported to the DER laboratory in Tallahassee within 24 hours of collection.

To differentiate between the toxicity resulting from chlorine and the toxicity associated with some other component of the effluent, the Biological Section adopted the following test procedure:

Test #1. Pre-Chlorinated Effluent (Table 2). This test was performed on an effluent sample collected at the end of the treatment process but prior to chlorination. And, was intended to evaluate the toxicity of the effluent without the added toxic effects of chlorine.

Test #2. Chlorinated Effluent (Table 3). This test was performed on an effluent sample collected at the point of discharge.

Test #3. De-Chlorinated Effluent (Table 4). This test was performed on a subsample of the chlorinated effluent sample in which the chlorine had been neutralized[1]. This test was intended to evaluate the combined toxicity of the effluent and the chlorine reaction products.

Saltwater for dilution of the effluent samples was obtained from the FSU Marine Laboratory at Turkey Point (salinity = 30.5 ppt). The salinity of this saltwater diluent was similar to the salinity of the receiving body of water (Intercoastal Waterway = 30 ppt), therefore, no adjustment was necessary. For test concentrations of 56% and below, this diluent was mixed directly with the effluent, achieving a range of final salinities (14 ppt to 28 ppt). For the 100% effluent test concentrations, freshly autoclaved artificial sea salts (Ocean 50®) were added until salinities of approximately 6 ppt were achieved, the lower limit of mysid shrimp salinity tolerances. A series of three control groups (Table 5) were then used to ensure that any mortality in the test organisms was not the result of toxic properties associated with the diluent, the artificial sea salts, or the salinity range. The control groups included: Turkey Point seawater (salinity = 30.5 ppt), artificial sea salt (Ocean 50®) adjusted DER well water (salinity = 5.5 ppt), and a salinity control consisting of Turkey Point seawater and DER well water (salinity = 13.5 ppt).

Two replicates of each test concentration and the controls were used in these static tests. Immediately prior to the bioassays, a suitable number of mysids were transferred by net from the 10 ppt, 15 ppt, 20 ppt, 25 ppt, and 30 ppt, salinity aquaria to culture dishes for observation and selection of individuals for the tests. Individual mysid shrimp were siphoned via glass tube, carefully examined for injury, and transferred to wide mouth quart jars, each containing 500 ml of the appropriate concentration. For each concentration, the mysid shrimp were pre-acclimated to within 4 ppt salinity. The concentration series selected for this study (Table 1) are those recommended by the APHA (1976).

Five organisms were loaded per test chamber, giving ten per concentration. Temperature, pH, dissolved oxygen, and the number of live organisms were recorded at 0, 24, and 48 hours for each test chamber (Tables 2 through 5). Additionally, ammonia concentrations, including total (expressed in mg/l as N) and unionized (expressed in mg/l as NH_3) fractions, were determined for the 100% test concentrations at the beginning and end of the bioassays.[2]

[1] De-chlorination was accomplished by adding a calculated amount of sodium thiosulfate.

[2] The total ammonia concentration was determined using an Orion specific ion probe. The unionized fraction was then calculated based on the pH, temperature and salinity of the sample.

According to EPA (1978), "Although it is generally undesirable to feed most fish and macroinvertebrates during static toxicity tests, an exception is necessary for M. bahia". Therefore, the mysids were fed brine shrimp (Artemia) nauplii at the rate of approximately 10 to 20 per mysid shrimp to minimize cannibalism.

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

Mysidopsis bahia (mysid shrimp)

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, *Mysidopsis bahia*, static acute toxicity bioassay of Fort Lauderdale B Sewage Treatment Plant, Fort Lauderdale, Broward County, Florida, NPDES #FL0020524 on 22 to 24 July, 1981.

Test #1. Pre-Chlorinated Sample.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
5.6%	5	5	5	6.8	5.9	5.3	7.8	7.5	7.5	20.0	19.5	19.8				
5.6%	5	5	4	6.8	5.9	5.4	7.8	7.5	7.5						27.0	28.0
10%	5	5	5	6.8	5.8	5.3	7.8	7.5	7.5	20.0	19.5	19.8				
10%	5	5	5	6.8	5.8	5.3	7.8	7.5	7.5						26.5	27.0
18%	5	5	5	6.8	5.9	5.3	7.7	7.5	7.5	20.2	19.5	19.8				
18%	5	5	5	6.8	5.9	5.3	7.7	7.5	7.5						25.0	25.5
32%	5	5	4	6.7	5.8	5.1	7.7	7.5	7.5	20.6	19.5	19.7				
32%	5	5	4	6.6	5.7	5.4	7.7	7.5	7.5						21.0	21.0
56%	5	5	3	6.3	5.9	5.4	7.6	7.5	7.5	20.6	19.6	19.8				
56%	5	5	5	6.3	5.9	5.3	7.6	7.5	7.5						14.0	14.5
100%	5	4	3	6.2	6.0	5.7	7.7	7.6	7.6	20.7	19.7	20.0	0/.09	0/.21		
100%	5	4	2(3)[a]	6.1	6.0	6.0	7.8	7.6	7.6						5.5	5.0

Remarks: [a] Number in parentheses used in calculations since one organism jumped out.

Table 3. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Fort Lauderdale B Sewage Treatment Plant, Fort Lauderdale, Broward County, Florida, NPDES #FL0020524, on 22 to 24 July, 1981.

Test #2. Chlorinated Sample.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
5.6%	5	4	3	7.1	6.7	5.9	7.8	7.5	7.6	20.2	19.5	19.7				
5.6%	5	5	5	7.1	6.8	5.6	7.8	7.6	7.6						28.5	28.0
10%	5	5	5	7.0	7.1	6.0	7.8	7.6	7.6	20.2	19.4	19.7				
10%	5	4	4	7.0	7.1	6.0	7.8	7.7	7.6						27.5	27.0
18%	5	1	0	7.0	7.2	6.6	7.7	7.7	7.7	20.1	19.4	19.6				
18%	5	0	-	7.0	7.2	--[a]	7.7	7.7	--[a]						26.5	25.0
32%	5	0	-	7.2	7.4	--	7.6	7.7	--	20.3	19.4	-[a]				
32%	5	0	-	7.2	7.5	--	7.6	7.7	--						21.5	--[a]
56%	5	0	-	7.3	7.7	--	7.4	7.7	--	20.3	19.4	-				
56%	5	0	-	7.3	7.7	--	7.4	7.7	--						14.5	--
100%	5	0	-	7.6	8.0	--	7.6	7.8	--	22.3	19.4	-	.02/1.4	.02/1.54		
100%	5	0	-	7.5	8.0	--	7.6	7.8	--						5.5	--

Remarks: a. Remaining parameters not measured since all organisms had been dead for 24 hours.

Total Chlorine Residuals (Hach DPD Method): 5.6% = 0.11 mg/l; 10% = 0.18 mg/l; 18% = 0.38 mg/l; 32% = 0.67 mg/l; 56% = 1.25 mg/l; 100%=1.85 mg/l

Table 4. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Fort Lauderdale B Sewage Treatment Plant, Fort Lauderdale, Broward County, Florida, NPDES #FL0020524 on 22 to 24 July, 1981.

Test #3: De-chlorinated sample.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	b	24	48	0	48	0	48
5.6%	5(4)[a]	4	4	6.9	6.1	5.6	7.8	7.6	7.5	20.4	20.0	20.1				
5.6%	5	5	5	6.9	6.1	5.5	7.8	7.6	7.5						29.0	28.0
10%	5	5	5	7.0	6.1	5.6	7.8	7.6	7.6	20.4	19.9	20.1				
10%	5	5	5	7.0	5.8	5.3	7.8	7.6	7.6						27.5	27.0
18%	5	5	4(5)[b]	6.9	5.6	5.3	7.7	7.6	7.5	20.5	19.9	20.1				
18%	5	5	5	7.0	5.6	5.0	7.7	7.5	7.5						26.0	25.0
32%	5	5	5	6.9	5.0	4.8	7.6	7.5	7.5	20.8	20.0	20.2				
32%	5	5	5	6.8	5.0	4.8	7.6	7.5	7.5						21.5	21.0
56%	5	5	5	7.1	5.2	5.1	7.5	7.5	7.5	21.4	20.0	20.1				
56%	5	5	4	7.1	5.2	5.0	7.5	7.5	7.5						15.0	14.0
100%	5	5	4	7.3	5.8	5.3	7.7	7.6	7.6	22.4	20.0	20.1	.02/1.4	.02/1.54		
100%	5	5	4	7.3	5.8	5.3	7.6	7.6	7.6						5.5	5.0

Remarks: a. Number in parentheses used in calculations since one organism jumped out between 0 and 24 hours.
b. Number in parentheses used in calculations since one organism jumped out between 24 and 48 hours.
Total Chlorine Residual of de-chlorinated sample: <0.02 mg/l (Hach DPD Method).

Table 5. Data recorded during 48 hour, *Mysidopsis bahia*, static acute toxicity bioassay of Fort Lauderdale B Sewage Treatment Plant, Fort Lauderdale, Broward County, Florida, NPDES #FL0020524 on 22 to 24 July, 1981.

Test #4: Control Series

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Salinity (ppt)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	48
Seawater Control	5	5	5	6.9	6.0	5.4	7.8	7.5	7.5	20.2	19.6	19.8				
Seawater Control	5	5	5	6.8	6.0	5.4	7.8	7.5	7.5						29.5	30.0
Sea Salts Control	5	5	5	9.2	7.8	5.5	8.1	7.6	7.7	21.7	19.5	19.6				
Sea Salts Control	5	5	5	9.2	7.8	5.6	8.2	7.8	7.7						5.5	5.0
Salinity Control	5	5	4	8.9	7.1	6.1	7.8	7.6	7.6	20.7	19.7	19.8				
Salinity Control	5	5	5	9.0	7.1	6.1	7.8	7.6	7.6						14.0	13.5

Remarks:

RESULTS AND DISCUSSION

Both the pre-chlorinated and de-chlorinated samples of effluent from the Fort Lauderdale B Sewage Treatment Plant were lethal to a significant number of Mysidopsis bahia. However, the calculated LC_{50} values were >100% (Table 6). The cause of this toxicity is unknown, since neither chlorine nor unionized ammonia were present in toxic concentrations.

The chlorinated sample, however, exhibited rapid toxicity to Mysidopsis bahia, with 24 hour LC_{50}'s ranging from 10.5% to 12.6% (Table 6). The 96 hour LC_{50} would therefore be ≤12.6%. The toxicity noted here can be attributed to chlorine, since the residuals presented in Table 3 are within the range reported to be toxic to aquatic marine organisms (U.S.EPA, 1976).

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 6. LC_{50} Data for Bioassays of Fort Lauderdale B Sewage Treatment Plant, NPDES #FL0020524, on 22 to 24 July, 1981.

Organism	Method of Data Analysis	24 hour LC_{50} and 95% confidence intervals	48 hour LC_{50} and 95% confidence intervals
Mysidopsis bahia	Binomial	A	A, B
Test #1	Moving Average	A	A, B
Pre-Chlorinated	Probit	A	>100%, B
Mysidopsis bahia	Binomial	13.4% (10 and 18)	12.6% (0 and 18)
Test #2	Moving Average	12.6% (9 and 17)	10.5% (7 and 14)
Chlorinated	Probit	12.3% (10 and 16)	10.8% (8 and 14)
Mysidopsis bahia	Binomial		A, B
Test #3	Moving Average	No mortality	A, B
De-Chlorinated	Probit		>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.

LITERATURE CITED

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