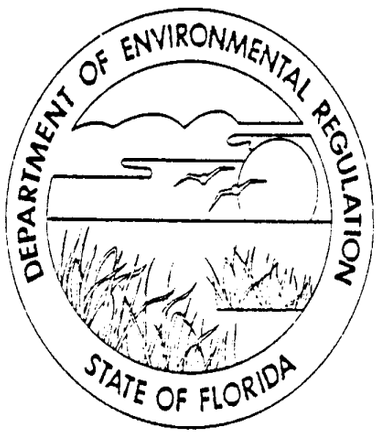
BIOASSAYS OF THE [redacted]BERRY WASTEWATER TREATMENT PLANT

MERRITT ISLAND, BREVARD COUNTY, FLORIDA

NPDES #FL0026816

SAMPLED 4/13/82

Biological Section
Bureau of Water Analysis
July 2, 1982



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EXECUTVE SUMMARY

Fortenberry WWTP, NPDES #FL0026816, on 14 to 16 April, 1982

The samples of pre-chlorinated, chlorinated and de-chlorinated effluents from this discharger, a municipal waste treatment facility located in Merritt Island, were all acutely toxic to the test organism, Mysidopsis bahia, with 48 hour LC_{50} values of 12%, 12% and 13%, respectively. Significant amounts of total and unionized ammonia were determined in these effluents. However, the concentrations present could not have been solely responsible for the observed toxicity. Chemical analyses indicated the presence of 0.78 µg/l of the pesticide lindane, which probably caused most of the observed toxicity. Also present were significant but sub-lethal concentrations of Malathion and a small amount of zinc.

INTRODUCTION

The Fortenberry Wastewater Treatment Plant is located at the corner of South Plumosa and Fortenberry Roads, in Merritt Island, Brevard County, Florida (Fig. 1). This relatively small facility (design capacity of 0.8 MGD) treats an average of 0.69 MGD of domestic waste from a population of approximately 10,000. According to the NPDES permit, no industrial wastes are treated at this facility. However, the plant has been in violation for exceeding BOD, TSS and fecal coliform limitations. Effluents are discharged to Fortenberry Ditch which flows to Sykes Creek, a tributary of Newfound Harbor. Newfound Harbor is a portion of the Banana River (Fig. 1).

To evaluate the existence and extent of toxicity of these samples of effluent to the biota of the receiving waters, the Biological Section performed static acute toxicity bioassays on grab samples on 14 to 16 April, 1982. The results of these tests are presented in this report.

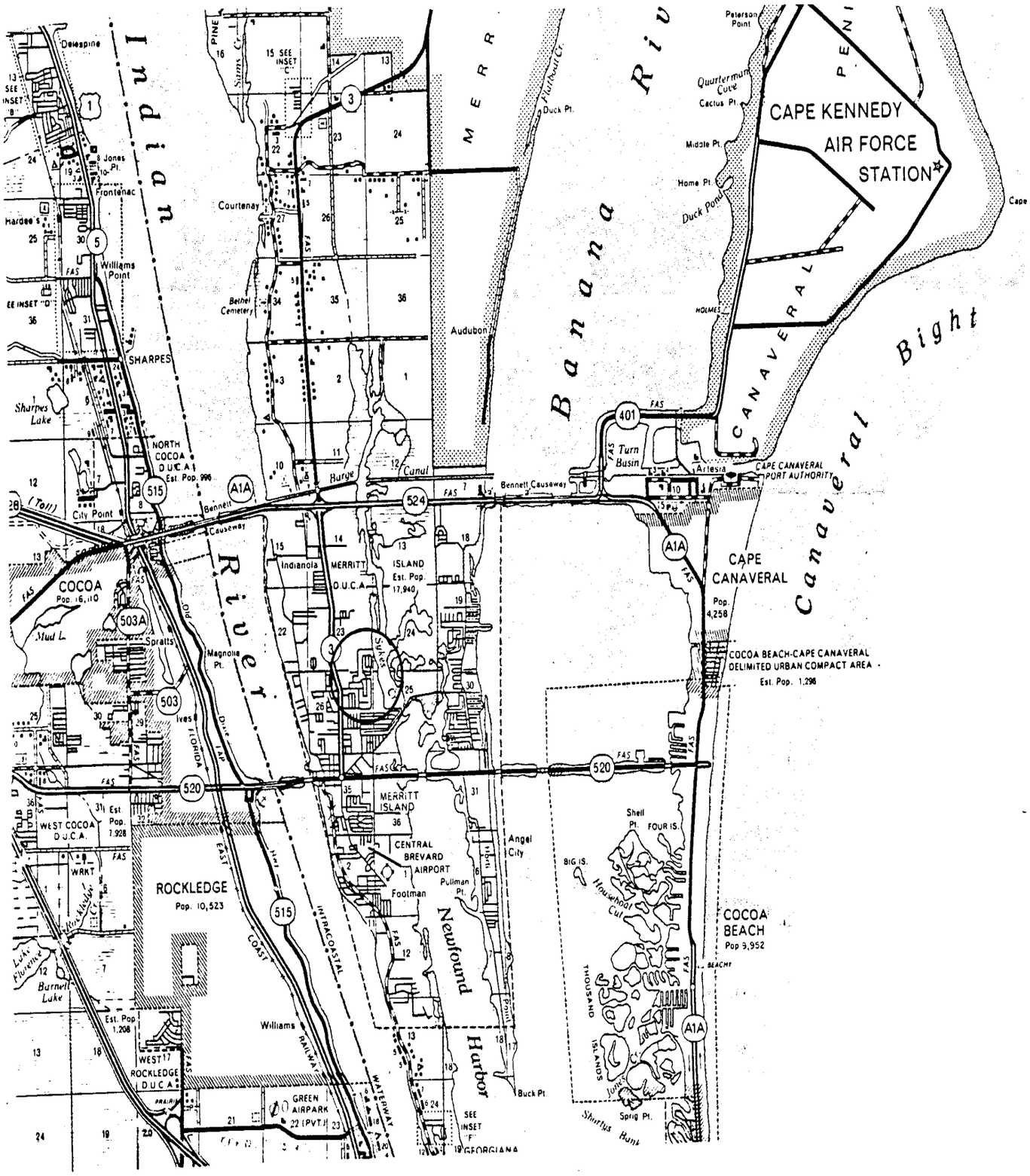


Figure 1. Portions of Brevard County, Florida, including City of Merritt Island and study area.

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 those recommended by Peltier (1978) and the U.S.EPA (1978). The life history and maintenance procedures used to culture the organism 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 EPA laboratory in Gulf Breeze, Florida. The mysids are cultured under a 16:8 hour light-dark cycle 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 dilution 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° plus or minus 1°C. Ten to fifteen day old (three-quarter adult size) mysids were used in this test.

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 acute toxicity bioassays were performed on pre-chlorinated, chlorinated and de-chlorinated effluents from the Fortenberry WWTP. The tests were performed from 1330 hours on 14 April to 1330 hours on 16 April, 1982.

The samples were collected by Mr. R. A. Day of DER's St. Johns River District at 1530 hours on 13 April, 1982, using standard wastewater sampling procedures. Separate samples were obtained for chemical and biological testing. Samples for metal analysis were preserved with HNO_3. Samples for organic chemical analysis and for the bioassays were unpreserved. The samples were iced and transported to the DER laboratory in Tallahassee for analysis 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. De-chlorination was accomplished by adding a calculated amount of 0.025 N sodium thiosulfate. 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 = 27 ppt). This saltwater diluent was then adjusted to the salinity of the receiving body of water (Sykes Creek = 22 ppt) by adding an appropriate amount of DER well water. For test concentrations of 56% and below, this adjusted diluent was mixed directly with the effluent, achieving a range of final salinities (10.5 ppt to 20 ppt). For the 100% effluent test concentrations, freshly autoclaved artificial sea salts (Ocean 50®) were added until salinities of approximately 7 ppt were achieved (the lower limit of mysid shrimp salinity tolerance). A series of 5 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: adjusted Turkey Point seawater (salinity = 22 ppt), artificial sea salt (Ocean 50®) adjusted well water (salinity = 7 ppt), and a salinity control consisting of Turkey Point seawater and well water (salinity = 10 ppt). Additionally, two control groups were added consisting of sea salt adjusted 100% sample and sea salt adjusted well water, with their pH's adjusted with hydrochloric acid to the original pH of the sample. Since sea salts increase the pH, thereby increasing the amount of toxic unionized ammonia, these additional controls were necessary to ensure that any mortality was not the result of an artificial rise in pH. The concentration series selected for this study (Table 1) is that recommended by the APHA (1980).

Two replicates of each test concentration and of the controls were used to test with Mysidopsis bahia. Immediately prior to the bioassays, a suitable number of mysids were transferred by net from the 10 ppt, 15 ppt and 20 ppt salinity aquaria to culture dishes for observation and selection of individuals for the tests. Ten to fifteen day old (three-quarter adult size) mysids were used in these tests. Individual mysid shrimp were siphoned using a 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. Five organisms were loaded per test chamber, giving ten per concentration. Based on the recommendations of EPA (1978), the mysids were fed brine shrimp (Artemia) nauplii at the rate of approximately 10 to 20 nauplii per mysid per day to minimize cannibalism.

Dissolved oxygen, pH, temperature, and the number of live organisms were recorded for each test chamber at 0 hours, 24 hours, and 48 hours. The salinity of each test concentration was recorded at the beginning and end of the test. Ammonia concentrations, including total and unionized fractions (expressed in mg/l as N and as NH_3, respectively), were recorded in the seawater control and the 100% effluent test concentrations at the beginning and end of the test. Total ammonia concentrations were determined using an Orion® specific ion probe and an Orion Ionalyzer®. The unionized fraction was then determined 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 5.

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

Mysidopsis bahia (mysid shrimp)

Concentration	Dilution Water	Effluent	Total Volume
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
100.0%	---	500 ml	500 ml

Table 2. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Fortenberry WWTP, Merritt Island, Brevard County, Florida, NPDES #FL0026816, on 14 to 16 April, 1982.

Test #1 Pre-Chlorinated Effluent

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Salinity (o/oo)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	
5.6%	5	5	5	7.6	7.1	6.5	7.9	7.8	7.8	20.3	19.5	19.6				
5.6%	5	5	4	7.7	7.1	6.4	7.9	7.8	7.8						19.0	19.0
10.0%	5	5	4	7.5	7.0	6.2	7.9	7.8	7.8	20.2	19.6	19.7				
10.0%	5	5	2(3)[a]	7.5	7.0	6.2	7.9	7.9	7.8						19.8	19.7
18.0%	5	4	0	7.6	6.9	6.3	7.9	7.8	7.8	20.2	19.6	19.8				
18.0%	5	4	2	7.5	6.9	6.4	7.8	7.8	7.8						18.8	18.8
32.0%	5	3	0	7.6	7.1	6.7	7.8	7.8	7.8	20.2	19.5	19.8				
32.0%	5	1	0	7.6	7.1	6.7	7.8	7.8	7.8						16.0	16.0
56.0%	5	0	0	7.5	7.3	7.0	7.6	7.9	7.9	20.4	19.6	19.7				
56.0%	5	0	0	7.5	7.2	7.0	7.6	7.9	7.9						10.5	10.5
100.0%	5	0	0	7.5	6.9	6.8	7.9	7.9	8.0	20.6	19.6	19.7	.27/9.6	.20/5.4		
100.0%	5	0	0	7.5	6.9	6.8	7.8	7.9	8.0						7.0	7.2

Remarks: [a] Number in parentheses used in calculations since one organism jumped out between 24 and 48 hours.

Table 3. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Fortenberry WWTP, Merritt Island, Brevard County, Florida, NPDES #FL0026816, on 14 to 16 April, 1982.

Test #2 Chlorinated Effluent[a]

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	7.4	6.9	6.1	7.9	7.8	7.8	20.2	19.3	19.5				
5.6%	5	5	5	7.5	6.9	6.1	7.9	7.9	7.8						20.2	20.0
10.0%	5	5	5	7.6	6.9	6.2	7.9	7.9	7.8	20.1	19.3	19.4				
10.0%	5	5	3	7.6	6.8	6.3	8.0	7.9	7.8						19.7	19.5
18.0%	5	5	0	7.6	6.9	6.6	7.9	7.9	7.8	20.1	19.3	19.4				
18.0%	5	5	0	7.7	7.0	6.6	7.9	7.9	7.8						18.2	18.0
32.0%	5	4	0	7.9	7.0	6.8	7.8	7.9	7.8	20.2	19.2	19.4				
32.0%	5	4	0	7.9	7.1	6.9	7.8	7.9	7.9						15.0	15.0
56.0%	5	0	0	8.1	7.3	7.1	7.7	7.9	7.9	20.4	19.3	19.5				
56.0%	5	0	0	8.1	7.2	7.1	7.7	7.9	7.9						10.5	10.2
100.0%	5	0	0	8.3	7.2	7.0	8.1	8.0	8.0	20.8	19.3	19.6	.50/10.1	.22/6.0		
100.0%	5	0	0	8.3	7.1	7.0	8.1	8.0	8.0						7.1	7.0

Remarks: [a] Total Residual Chlorine: 0.06 mg/l (HACH DPD Method).

Table 4. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Fortenberry WWTP, Merritt Island, Brevard County, Florida, NPDES #FL0026816, on 14 to 16 April, 1982.

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	0	24	48	0	48	0	48
5.6%	5(4)[a]	4	4	7.6	6.8	6.0	8.0	7.8	7.7	20.4	19.5	19.6				
5.6%	5	5	4	7.6	6.8	6.1	8.0	7.8	7.7						20.0	20.0
10.0%	5	5	4	7.7	6.5	6.1	8.0	7.8	7.7	20.3	19.3	19.5				
10.0%	5	5	4(5)[b]	7.7	6.4	6.2	8.0	7.8	7.7						20.0	19.8
18.0%	5	4	0	7.8	6.7	6.5	8.0	7.9	7.8	20.5	19.3	19.5				
18.0%	5	5	1	7.8	6.8	6.5	8.0	7.9	7.8						19.0	18.5
32.0%	5	2	0	8.0	6.7	6.7	8.0	7.9	7.8	20.8	19.3	19.4				
32.0%	5	1	1	8.0	6.7	6.8	7.9	7.9	7.8						15.2	15.0
56.0%	5	0	0	8.2	6.8	7.0	7.8	7.9	7.9	21.5	19.2	19.4				
56.0%	5	0	0	8.2	6.7	7.1	7.8	7.9	7.9						11.0	10.7
100.0%	5	0	0	8.3	6.9	7.1	8.2	8.1	7.9	21.9	19.2	19.5	.67/10.1	.16/5.6		
100.0%	5	0	0	8.3	6.9	7.1	8.2	8.1	7.9						7.0	7.0

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.

Table 5. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of Fortenberry WWTP, Merritt Island, Brevard County, Florida, NPDES #FL0026816, on 14 to 16 April, 1982.

Control Series

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Salinity (o/oo)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0	
Seawater Control	5	5	5	7.6	7.1	7.2	7.9	7.8	7.8	20.3	19.8	20.1	.03/.90	.02/.75		
Seawater Control	5	5	5	7.6	7.0	7.2	7.9	7.8	7.8						21.8	22.0
Sea Salt Control	5	5	5	8.3	7.5	7.6	8.5	8.3	8.2	20.4	19.6	19.8				
Sea Salt Control	5	5	5	8.3	7.5	7.6	8.5	8.3	8.2						6.8	7.3
Salinity Control	5	5	5	8.0	7.5	7.4	8.0	8.0	8.0	20.6	19.6	19.6				
Salinity Control	5	5	5	8.0	7.5	7.4	8.0	7.9	8.0						10.0	10.2
pH Adj. Sea Salt	5	5	5	8.2	7.2	7.5	7.4	7.9	7.9	21.0	19.5	19.5				
pH Adj. Sea Salt	5	5	5	8.2	7.2	7.5	7.3	7.8	7.9						7.2	7.3
pH Ad. Effluent[a]	5	0	0	7.5	7.0	6.8	7.3	7.9	7.9	20.6	19.6	19.7	.08/9.6	.16/5.5		
pH Adj. Effluent	5	0	0	7.6	6.9	6.8	7.3	7.8	7.9						7.0	7.2

Remarks: [a] Pre-chlorinated effluent used.

Table 6. LC_{50} Data for Bioassays of Fortenberry WWTP, Merritt Island, NPDES #FL0026816, on 14 to 16 April, 1982.

Organism	Method of Data Analysis	24 LC_{50} and 95% Confidence Intervals	48 Hour LC_{50} and 95% Confidence Intervals
Test #1: *M. bahia* Pre-chlorinated Sample	Binomial	27.9% (10 and 56)	12.6% (5.6 and 32)
	Moving Average	26.1% (19 and 36)	11.9% (8.6 and 16)
	Probit	26.7% (21 and 34)	11.8% (8.8 and 15)
Test #2: *M. bahia* Chlorinated Sample	Binomial	38.2% (18 and 56)	12.0% (5.6 and 18)
	Moving Average	a	a
	Probit	a	a
Test #3: *M. bahia* De-chlorinated Sample	Binomial	26.7% (18 and 56)	13.4% (10 and 18)
	Moving Average	26.4% (19 and 37)	13.4% (8.9 and 20)
	Probit	26.8% (21 and 34)	13.3% (9.8 and 18)

[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.

RESULTS AND DISCUSSION

The three samples of effluent from the Fortenberry Wastewater Treatment Plant proved to be acutely toxic to the test organism, Mysidopsis bahia. Bioassays of the pre-chlorinated effluent resulted in 48 hour LC_{50} values of 11.8% to 12.6% (Table 6). The chlorinated effluent was as equally toxic, with a 48 hour LC_{50} of 12.0% (Table 6). The 48 hour LC_{50} values of 13.3% and 13.4% were determined for the de-chlorinated effluent (Table 6). The 96 hour LC_{50} values for these effluents would, therefore, be less than or equal to their 48 hour values.

The similar 48 hr. LC_{50} values of these three effluents suggests that similar compounds were present in the effluents that resulted in the parallel toxicity values. Significant concentrations of total ammonia (9.6 to 10.1 mg/l, Tables 2, 3 and 4) were determined in these effluents. However, these concentrations are below those reported to be toxic to certain freshwater aquatic organisms (Thurston et al., 1981). However, the rise in pH caused by adjusting the 100% effluent concentrations with artificial sea salts resulted in a substantial increase in the amounts of unionized ammonia present. The concentrations determined in these effluents (0.20 mg/l to 0.67 mg/l Tables 2, 3 and 4) have been reported as toxic to certain aquatic organisms (Thurston et al., 1981). Therefore, a control was included to ensure that any mortality in the effluent was not a result of an increase in unionized ammonia due to an artificial increase in pH. This control consisted of a salinity adjusted 100% pre-chlorinated effluent which had a pH of 7.9. The pH of this control was lowered with hydrochloric acid to the original pH of the effluent before salinity adjustment (7.3, Table 5). The concentrations of total and unionized ammonia in this effluent control were below the levels reported to be toxic to aquatic organisms. However, all ten organisms in this control were dead within 24 hours. These data suggest, therefore, that neither total nor unionized concentrations were solely responsible for the observed toxicity.

Chemical analyses for certain metals and organic compounds were performed by the DER Chemistry Section on samples of effluent from this facility. The results of these tests are presented in Table 7. The analyses for organic compounds determined the presence of two pesticides, Lindane and Malathion, at concentrations of 0.78 µg/l and 10.6 µg/l, respectively. Concentrations of Lindane significantly below 0.78 ug/l have been shown to be acutely toxic to certain marine invertebrates. A 48 hour LC_{50} of 0.4 µg/l Lindane was determined for the brown shrimp (Penaeus aztecus) and a 96 hour LC_{50} of 0.17 µg/l Lindane was determined for the pink shrimp (Penaeus duorarum) (U.S. EPA 1976). Therefore, the concentration of 0.78 µg/l Lindane in this effluent probably caused most of the observed toxicity in the effluents. The concentration of 10.6 µg/l Malathion determined in this effluent is below the reported acutely toxic levels for certain marine invertebrates (U.S. EPA 1976), however, it may have had an adverse effect on the test organisms. The analyses for metals determined the presence of 27 µg/l of zinc in the effluent, but this concentration is significantly below levels which might be toxic (U.S. EPA 1976).

Therefore, the toxicity of the three effluents from the Fortenberry WWTP was probably due to the lethal concentration of Lindane present, and to the presence of ammonia and Malathion.

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 (3), 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 one-twentieth 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 sustance 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, whether as 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)(o)); 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, but rather to the average of a number of points within 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 the mixing zone (i.e., at any point within the mixing zone), from exceeding the 96 hour LC_{50}. Therefore, at any point within a mixing zone, including the point of discharge, one-half of the test organisms cannot be killed in 96 hours.

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} standard. 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, 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.

TABLE 7. Results of Chemical Analyses Performed on Effluent from the Fortenberry WWTP, collected 13 April, 1982.

Organics

Parameter	Compound
Acid Extractables	N.D.
Base Neutral Extractables	N.D.
Pesticide Extractables	Lindane (0.78 µg/l)
	Malathion (10.6 µg/l)

Metals

Antimony	N.D.
Arsenic	N.D.
Beryllium	N.D.
Cadmium	N.D.
Chromium	N.D.
Copper	<25µg/l[a]
Lead	<2 µg/l[a]
Mercury	N.D.
Nickel	N.D.
Selenium	N.D.
Silver	N.D.
Thallium	N.D.
Zinc	27 µg/l

N.D. = None Detected

[a] Actual value is known to be less than value given.

LITERATURE CITED

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