BIOASSAYS OF CAPE KENNEDY NASA IV

WASTEWATER TREATMENT PLANT

J. F. KENNEDY SPACE CENTER

BREVARD COUNTY, FLORIDA

NPDES #FL0022594

SAMPLED 2/8/83

Biology Section
Bureau of Water Analysis
March 30, 1983

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EXECUTIVE SUMMARY

Cape Kennedy NASA IV WWTP, NPDES #FL0022594, on 9 to 11 February, 1983.

The samples of pre-chlorinated, chlorinated and de-chlorinated effluents from this U.S. government facility varied significantly in both toxicity and in characteristics. The pre-chlorinated sample exhibited a substantial BOD by hour 24 of the test, resulting in greatly reduced dissolved oxygen (<2.0 mg/l) in the highest test concentration. This may have caused the observed toxicity to Mysidopsis bahia. Upon aeration of these test chambers, no additional mortality was observed. The chlorinated sample, in which BOD and dissolved oxygen were not factors, produced 24 and 48 hour LC_{50} values of 24.0%. This toxicity can be attributed to the significant concentrations of total residual chlorine (1.13 mg/l to 1.5 mg/l) measured in this sample. The de-chlorinated sample was not acutely toxic to Mysidopsis bahia, and only one of 10 shrimp died in the 100% test concentration. Significant concentrations of total and unionized ammonia (5.3 mg/l to 6.8 mg/l and 0.07 mg/l to 0.94 mg/l, respectively) were detected in these samples, but the amounts measured may have contributed only slightly to the observed toxicity. Since the toxicities of the pre-chlorinated and chlorinated samples were attributed to decreased dissolved oxygen and total residual chlorine, respectively, chemical analyses were not performed.

INTRODUCTION

The Cape Kennedy NASA IV Wastewater Treatment Plant is a U.S. government installation located in the Kennedy Space Center, Brevard County, Florida (Fig. 1). The facility serves nearby Air Force and Naval Air Station personnel and their operations, including treatment of wastewater from cooling towers, heat plants and vehicle maintenance facilities. The plant has a maximum capacity of 0.108 MGD and discharges from a final polishing pond through Banana Creek into the Indian River.

The Biology Section has previously performed static toxicity bioassays on samples of effluent from the Cape Kennedy NASA IV Plant on 11 to 13 March, 1981. The results of those tests indicated that although the chlorinated sample was acutely toxic to Mysidopsis bahia (24 and 48 hour LC_{50} values of 13.4%), neither the pre-chlorinated nor the de-chlorinated samples exhibited any significant lethality (FDER 1981).

To again evaluate the toxicity of these effluents to the biota of the receiving waters, the Biology Section performed additional 48 hour static bioassays on samples of pre-chlorinated, chlorinated and de-chlorinated effluents from this facility, on 9 to 11 February, 1983. The results of these latest tests are presented in this report.

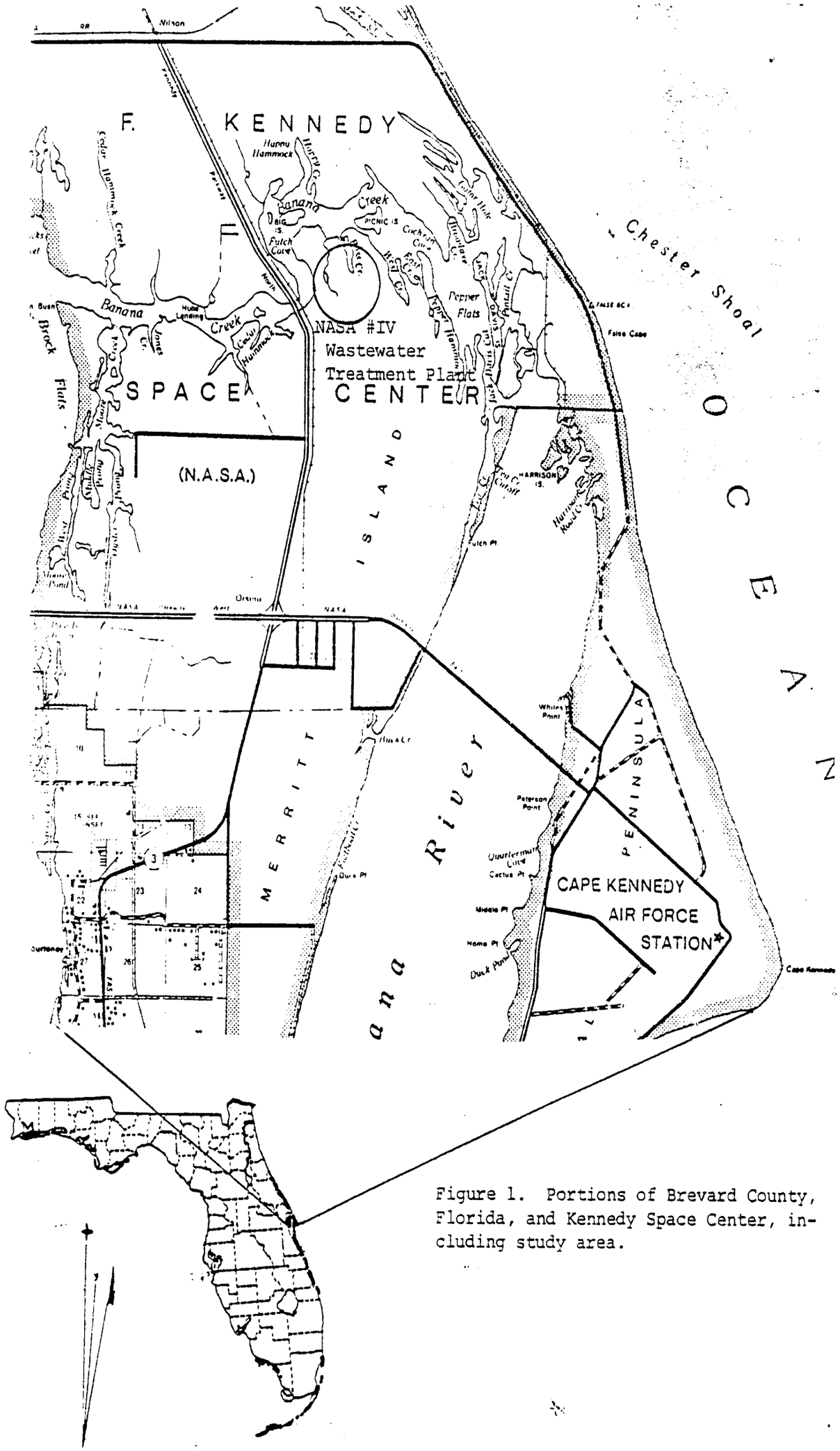


Figure 1. Portions of Brevard County, Florida, and Kennedy Space Center, including study area.

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 Biology 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 samples of pre-chlorinated, chlorinated and de-chlorinated effluents from the NASA IV facility. The tests were performed from 1315 hours on February 9 to 1430 hours on February 11, 1983. The samples were collected by Mr. Guy Hadley and Mr. Louis Ley of DER's Orlando office at 1500 hours on February 8, 1983, 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 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 = 27.0 ppt). For test concentrations of 56% and below, this diluent was mixed directly with the effluent, achieving a range of final salinities (13.0 ppt to 25.2 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). Four 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:

1) Diluent Control - Turkey Point water (27.0 ppt). This represents the highest concentration of Turkey Point water used in the bioassays, and tests for toxicity in the diluent. This is also the highest salinity used in the bioassays, and therefore tests the tolerance of the organisms to this salinity.

2) Sea Salts Control - Well water, adjusted with artificial sea salts (Ocean 50®) to approximately 7 ppt salinity. This tests for toxicity of the highest concentration of artificial sea salts used in the bioassays, as well as for tolerance of the organisms to the lowest salinity used in the bioassays.

3) pH Adjusted Effluent Control - Effluent (100%) which has been adjusted to a salinity of approximately 7 ppt using Ocean 50®, and which has then been pH adjusted using hydrochloric acid to the original pH of the effluent prior to salinity adjustment. This test ensures that toxicity observed in the bioassay is not merely due to a change in pH caused by the sea salts.

4) Acid Control - Well water, adjusted with Ocean 50® to a salinity of approximately 7 ppt, with an amount of hydrochloric acid added equal to that added in the pH Adjusted Effluent Control. This tests for toxicity in the pH Adjusted Effluent Control due to the hydrochloric acid.

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, 20 ppt and 25 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 the unionized fraction (expressed in mg/l as $NH_3 + NH_4$ and as NH_3, respectively), were recorded in the Sea Salts control 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 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
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 the Cape Kennedy NASA IV WWTP, Brevard County, Florida, NPDES #FL0022594, on 9 to 11 February, 1983.

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	7.5	6.9	4.3	8.2	8.0	7.7	19.7	19.6	19.8				
5.6%	5	5	4(5)[a]	7.5	6.9	4.3	8.2	8.0	7.7						25.2	26.0
10.0%	5	5	5	7.3	6.8	4.2	8.1	8.0	7.7	19.4	19.4	19.7				
10.0%	5	5	5	7.3	6.9	4.2	8.1	8.0	7.7						24.2	24.5
18.0%	5	5	5	6.8	6.7	3.2	8.1	8.0	7.6	19.3	19.3	19.5				
18.0%	5	5	5	6.8	6.8	3.1	8.1	7.9	7.6						22.5	22.5
32.0%	5	5	5	6.3	6.5	2.5	7.9	7.9	7.5	19.3	19.2	19.5				
32.0%	5	5	5	6.3	6.6	2.7	7.9	7.9	7.5						19.2	19.2
56.0%	5	5	5	5.0	3.3[b]	7.8	7.7	7.7	8.0	19.7	19.3	19.5				
56.0%	5	5	5	5.0	3.0[b]	7.8	7.7	7.7	8.0						13.0	13.0
100.0%	5	2	2	4.5	7.3[c]	6.7	8.3	7.9	8.2	20.1	19.4	19.7	.44/6.1	--		
100.0%	5	0	0	4.2	6.6[c]	6.8	8.3	7.9	8.2						7.5	7.8

Remarks:

[a] Number in parentheses used in calculations since one organism had jumped from container between 24 and 48 hours.

[b] Slow aeration was started in these containers to prevent dissolved oxygen decreasing further.

[c] The dissolved oxygen in these containers had decreased to less than 2.0 mg/l, thereby invalidating this test concentration. Aeration was immediately started, increasing the dissolved oxygen to the values shown.

Table 3. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of the Cape Kennedy NASA IV WWTP, Brevard County, Florida, NPDES #FL0022594, on 9 to 11 February, 1983.

Test #2 Chlorinated Sample[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	7.7	6.9	6.1	8.2	8.0	7.9	19.5	19.5	19.7				
5.6%	5	5	5	7.7	6.9	5.8	8.2	8.0	7.9						25.2	25.8
10.0%	5	5	5	7.7	7.2	6.5	8.1	8.0	7.9	19.4	19.3	19.4				
10.0%	5	5	5	7.7	7.2	6.1	8.1	8.0	7.9						24.3	24.5
18.0%	5	5	5	7.8	7.5	6.8	8.1	8.0	8.0	19.3	19.2	19.4				
18.0%	5	5	5	7.8	7.5	6.9	8.1	8.0	8.0						22.3	22.8
32.0%	5	0	0	7.8	7.7	--[b]	8.0	8.0	--[b]	19.5	19.1	19.4				
32.0%	5	0	0	7.8	7.7	--	8.0	8.0	--						19.2	--[b]
56.0%	5	0	0	8.0	8.0	--	7.9	8.0	--	19.8	19.1	19.4				
56.0%	5	0	0	8.0	8.0	--	7.9	8.0	--						13.0	--
100.0%	5	0	0	8.2	8.3	--	8.5	8.2	--	20.0	19.2	19.5	.58/5.3	--		
100.0%	5	0	0	8.2	8.3	--	8.5	8.2	--						7.5	--

Remarks: [a] Total Residual Chlorine = 1.5 mg/l (HACH DPD Method), 1.13 mg/l (Iodometric Method I).

[b] Remaining parameters were not recorded since all organisms were dead by hour 24 of the test.

Table 4. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of the Cape Kennedy NASA IV WWTP, Brevard County, Florida, NPDES #FL0022594, on 9 to 11 February, 1983.

Test #3 De-chlorinaed Sample[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	7.6	6.0	3.5	8.2	7.9	7.6	19.4	19.4	19.8				
5.6%	5	5	5	7.6	6.7	3.9	8.2	8.0	7.7						25.2	25.8
10.0%	5	5	5	7.7	6.6	3.8	8.2	8.0	7.7	19.3	19.3	19.7				
10.0%	5	5	5	7.7	6.7	4.0	8.2	8.0	7.7						24.2	24.0
18.0%	5	5	5	7.8	6.7	3.0	8.1	8.0	7.6	19.3	19.3	19.7				
18.0%	5	5	5	7.8	6.7	3.0	8.1	8.0	7.6						22.5	23.8
32.0%	5	5	5	7.9	6.7	2.8	8.1	7.9	7.6	19.5	19.3	19.3				
32.0%	5	5	5	7.9	6.7	2.8	8.1	7.9	7.6						19.2	19.2
56.0%	5	5	5	8.1	6.8	4.1	8.0	7.9	7.7	19.7	19.5	19.4				
56.0%	5	5	5	8.1	6.8	4.4	8.0	7.9	7.7						13.0	12.0
100.0%	5	5	4	8.4	6.3	6.0	8.6	8.2	8.0	20.5	19.7	19.5	.94/6.8	--		
100.0%	5	5	5	8.4	6.3	6.1	8.6	8.2	8.0						7.5	7.5

Remarks: [a] Total Residual Chlorine = <0.02 mg/1 (HACH DPD Method).

Table 5. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of the Cape Kennedy NASA IV WWTP, Brevard County, Florida, NPDES #FL0022594, on 9 to 11 February, 1983.

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
Diluent Control	5	5	5	7.8	7.1	4.7	8.2	7.6	7.8	19.5	19.6	19.9				
Diluent Control	5	5	5	7.8	7.1	5.2	8.2	7.8	7.8						27.0	27.0
Sea Salts Control	5	5	5	8.2	7.7	7.3	8.7	8.3	8.2	20.1	19.5	19.7	0/0	--		
Sea Salts Control	5	5	5	8.4	7.7	7.3	8.7	8.4	8.2						7.5	7.8
pH Adj. Effluent[a]	5	0	0	5.2	7.3[c]	8.3	7.4	7.9	8.1	20.5	19.4	19.5	.07/6.1	--		
pH Adj. Effluent[a]	5	1	1	4.9	7.5[c]	5.2	7.2	8.0	7.8						7.5	7.0
Acid Control	5	5	5	8.4	7.9	6.9	7.4	8.2	7.9	21.7	19.6	19.8				
Acid Control	5(4)[b]	4	4	8.4	7.9	7.0	7.4	8.1	7.9						7.5	7.0

Remarks:

[a] 100% pre-chlorinated effluent used for this control.

[b] Number in parentheses used since one organism was cannibalized between 0 and 24 hours.

[c] The dissolved oxygen in these containers had decreased to less than 2.0 mg/l, thereby invalidating this control. Aeration was immediately started, increasing the dissolved oxygen to the values shown.

Table 6. LC_{50} Data for Bioassays of the Cape Kennedy NASA IV WWTP, NPDES #FL0022594, on 9 to 11 February, 1983.

Organism	Method of Data Analysis	24 Hour LC_{50} and 95% Confidence Intervals	48 Hour LC_{50} and 95% Confidence Intervals
Test #1: *M. bahia* Pre-chlorinated Sample	Binomial	b	b
	Moving Average		
	Probit		
Test #2: *M. bahia* Chlorinated Sample	Binomial	24.0% (18 and 32)	24.0% (18 and 32)
	Moving Average	a	a
	Probit	a	a
Test #3: *M. bahia* De-chlorinated Sample	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] Since the toxicity noted in this test was attributed to insufficient dissolved oxygen, the LC_{50} data are invalidated and therefore, not reported.

RESULTS AND DISCUSSION

The three samples of effluent from the NASA IV facility varied significantly in both toxicity and in characteristics. The pre-chlorinated effluent exhibited a substantial BOD by hour 24 of the test, resulting in greatly reduced dissolved oxygen concentrations (<2.0 mg/l) in the 100% chambers. The mortality noted in these chambers (8 of 10 Mysidopsis bahia) was probably due to insufficient dissolved oxygen, therefore, the LC_{50} data were invalidated and are not reported. Upon aeration of the affected test chambers, no additional mortality of Mysidopsis bahia was noted. The chlorinated sample, in which the dissolved oxygen concentrations remained sufficiently high throughout the test, produced 24 and 48 hour LC_{50} values of 24.0% (Table 6). The 96 hour LC_{50} for the chlorinated sample would, therefore, be less than or equal to 24.0%. This toxicity can be attributed to the significant concentration of total residual chlorine (1.13 mg/l and 1.5 mg/l, measured using the iodometric and DPD methods, respectively) in this sample. The de-chlorinated effluent was not acutely toxic to Mysidopsis bahia; only one of ten shrimp died in the 100% test concentration. Significant concentrations of total and unionized ammonia (5.3 mg/l to 6.8 mg/l and 0.07 mg/l to 0.94 mg/l, respectively) were detected in these samples, but the amounts measured probably contributed only slightly to the observed toxicity. Although most concentrations of unionized ammonia measured in these effluents were higher than values reported as being toxic to certain sensitive freshwater fish, our saltwater test organism, Mysidopsis bahia, is apparently significantly more resistant to ammonia, based on accumulated bioassay data. Since the toxicities of the pre-chlorinated and chlorinated samples were attributed to decreased dissolved oxygen and total residual chlorine, respectively, chemical analyses of the effluent were not performed. Additionally, the results obtained from these latest tests (chlorine toxicity) were consistent with the results obtained from the earlier DER bioassays, with the exception of the problem with decreased dissolved oxygen in the pre-chlorinated sample encountered during these latest tests.

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 17-3-3.021(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 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 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 existance of a mixing zone, whether as a specific part of the permit or based on the existance 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} 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 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.

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