DEPARTMENT OF ENVIRONMENTAL REGULATION

STATE OF FLORIDA

BIOASSAYS OF THE FLORIDA POWER AND LIGHT

MARTIN COUNTY STEAM POWER PLANT

WASTEWATER TREATMENT PLANT

INDIANTOWN, MARTIN COUNTY, FLORIDA

NPDES #FL0030988

SAMPLED 9/14/87

FEBRUARY 10, 1988

Biology Section
Division of Environmental Programs

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Biology Section
Bureau of Laboratories and
Special Programs
February 10, 1988

EXECUTIVE SUMMARY

Florida Power and Light, Martin County Steam Generating Plant WWTP, Indiantown, Martin County, Florida, NPDES #FL0030988, on 15 to 17 September, 1987.

The Florida Power and Light, Martin County Steam Generating Wastewater Treatment Plant at Indiantown treats sanitary waste from approximately 145 people working in the facility. The reclaimed wastes had a high chlorine residual of 2.5 mg Cl_2/L by the Hach Method and 3.9 mg Cl_2/L by the Iodometric Method. The discharge had a high unionized ammonia of 1.16 mg/L.

Complete mortality occurred within 24 hours in both water fleas, Ceriodaphnia dubia and Daphnia pulex, and the bannerfin shiner, Notropis leedsi. The Microtox® Assay also showed extreme toxicity, with an EC_{50} of 1.1% sample concentration. The high chlorine residual is the cause of the extreme toxicity.

When a portion of the discharge was de-chlorinated, the discharge was still acutely toxic, with a 48 hours LC_{50} for the water flea, Ceriodaphnia dubia, between the lowest screening concentration of 50% sample and 100% sample and a 24 hour LC_{50} between 50% and 100% for the fish, Notropis leedsi. There were partial mortalities to the other species of water flea, but not enough to fall in the acutely toxic range. The most likely cause of the the death of the organisms in the de-chlorinated samples is the high unionized ammonia concentration of 1.46 mg/l.

The toxicity of this reclaimed waste is due to high chlorine and ammonia levels. Since chemical samples were not taken, backup chemistry could not be performed and further identification of additional toxicants could not be made.

INTRODUCTION

The Florida Power and Light, Martin County Steam Generating Wastewater Treatment Plant (Figure 1) treats the sanitary wastes from approximately 145 people working in the facility. It is an extended aeration plant with a design capacity of 16,000 GPD. High flows may reach only 8000 GPD. The WWTP discharges to the power plant cooling reservoir which occasionally discharges to the St. Lucie canal.

The Southeast District requested the Ecotoxicology Laboratory to perform static acute screening bioassays to evaluate the existence and extent of toxicity of the reclaimed water discharge to the receiving water biota. Static acute screening bioassays and Microtox® Assays were performed in September, 1987. Results are presented in this report. Those involved in performing the tests and in report preparation were: D. A. Chasteen, J. H. Epler, J. M. Faircloth, R. B. Frydenborg, K. M. Lurding, and L. A. Williams.

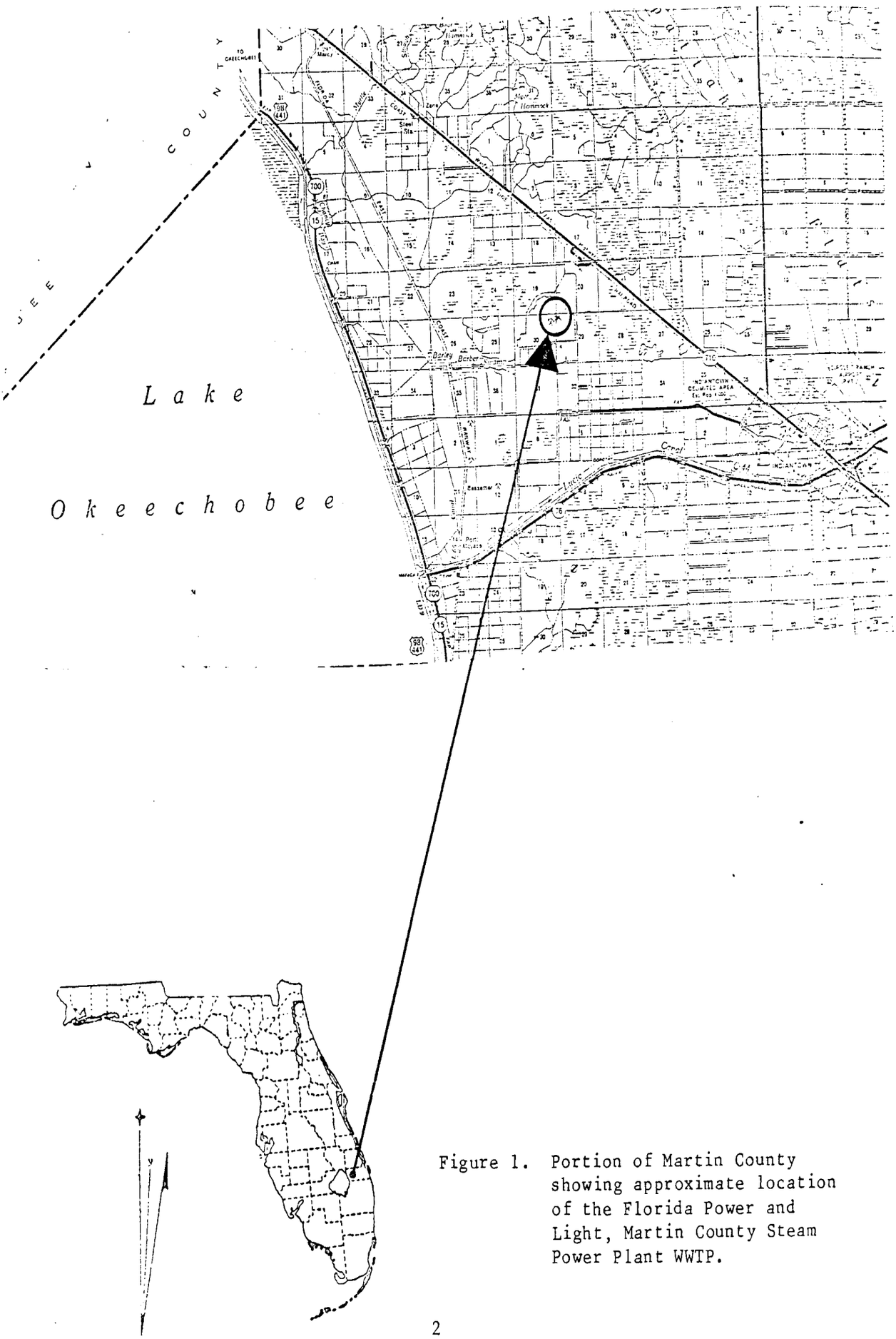


Figure 1. Portion of Martin County showing approximate location of the Florida Power and Light, Martin County Steam Power Plant WWTP.

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) 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.

The Microtox® assay was run according to the manufacturer's protocol described in the Microtox® System Operating Manual (Beckman 1982).

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 June, 1987. 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 26 days old at the time of the test.

Photobacterium phosphoreum, a luminescent marine bacterium, is maintained as a freeze-dried culture, purchased from Microbics Corporation. Lot number M-603 was used in this assay. Immediately prior to the assay, the culture is rehydrated with 1.0 ml of specially purified water (Microtox® Reconstitution Solution).

Standard Reference Toxicity Assays

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

Three static acute toxicity bioassays and one Microtox® Assay were performed on both the reclaimed water and a de-chlorinated sample portion of the reclaimed water from the Florida Power and Light, Indiantown WWTP. The tests were performed from 1120 hours on 15 September to 1130 hours on 17 September, 1987.

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 collected by Mr. Paul Strauss at 1015 hours on 14 September, 1987, using standard wastewater sampling procedures. The samples were iced and transported to the DER laboratory in Tallahassee for analyses within 26 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 reclaimed waters 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 reclaimed water. To accomplish this, the Biology Section performed concurrent bioassays on a sample of chlorinated reclaimed water 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 sample of reclaimed water 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 reclaimed water.

Freshwater Tests

Freshwater for dilution of the recovered water samples was obtained from the same DER deep well that is used to culture the test organisms. The concentration series selected for this study is given in Table 1.

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 (for C. dubia) or 250 ml (for D. pulex) capacity were used as test chambers, and either 50 ml or 200 ml 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 this 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% reclaimed water 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% reclaimed water test concentration 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 and 3.

Microtox® Test

Upon receipt at the DER laboratory, a 20 ml subsample was collected in a small beaker. The sample was adjusted to 2% salinity with reagent grade dry sodium chloride to maintain the osmotic balance of the test bacterium during the assay. Four two fold dilutions were made of the test sample resulting in a test range of 97%, 49.5%, 24.75%, 12.38%, and 0%. An incubation temperature of 15°C was maintained throughout the assay. Ten microliters of bacterial suspension was added to each of the 1.0 ml test dilutions. Light output (luminescence) was read after 5 and 15 minutes incubation, using the Microtox® analyzer and recorded on a Perkin-Elmer strip chart recorder. In the presence of a toxicant, the luminescence of the test organisms will decrease. In the presence of a stimulant, the luminescence will increase. Toxicity is calculated as a function of the light lost in the test sample, normalized to the control, and is reported as the effective concentration at which a 50% reduction, of light output is determined in 15 minutes (EC_{50}). Results are given in Table 4.

RESULTS AND DISCUSSION

The reclaimed water from the FPL Martin County Steam Generating Facility was extremely toxic to all test organisms. The 24 hour LC_{50} was less than 10% sample concentration for the two species of water fleas, (Class Crustacea: Order Cladocera) Ceriodaphnia dubia and Daphnia pulex, as well as to the representative fish test species, the bannerfin shiner (Notropis leedsi). The Microtox® Assay indicated extreme toxicity to the bacterium, Photobacterium phosphoreum, producing an EC_{50} of 1.1%. The chlorine residual was quite high measuring 2.5 mg Cl_2/L by the Hach Method and 3.9 mg Cl_2/L by the Iodometric Method. The calculated unionized ammonia (NH_3) was 1.16 mg NH_3/L. Total ammonia in the sample was 26.1 mg^N/L. The levels of both chlorine and ammonia (U.S. EPA 1985) are in the range considered to be extremely toxic as single compounds. Ammonia levels as low as 0.2 mg/L have been demonstrated (Thurston et al. 1981) to be acutely toxic to fish and .54 mg/L for the water flea Daphnia magna. Ammonia and chlorine produce synergistic effects on fish causing severe gill hyperplasia in the channel catfish (Ictalurus punctatus) (Mitchell and Cech, Jr. 1983). Chlorine is even more toxic at similar levels. Much of the toxicity could be removed by de-chlorination.

A de-chlorinated portion of the sample was still acutely toxic to the water flea, Ceriodaphnia dubia, producing a 48 hour LC_{50} between 50% and 100% discharge concentration. A lab error prevented the fish, Notropis leedsi, bioassay to run for the full 48 hours but at 24 hours all the 100% test concentration had died and the 50% concentration had 30% mortality. The 100% test concentration of the water flea, Daphnia pulex, bioassay had 6 out of 20 organisms die and no mortality at the 50% concentration. This is not acutely toxic but probably indicates chronic sublethal effects of toxicant stress. The Microtox® assay was slightly stimulatory and non toxic. This is a result of high ammonia values which act as a nutrient to the bacterium, Photobacterium phosphoreum. The acute toxicity of the de-chlorinated discharge to the water flea, Ceriodaphnia dubia, and the fish, Notropis leedsi, is likely due to the high ammonia concentration.

The high ammonia toxicity will receive additional treatment in the cooling water reservoir but will cause nutrient enriched conditions as it is bacterially converted to nitrates. Nutrient enrichment will cause problems with algal blooms and wide swings in diel oxygen concentrations in the reservoir. Discharges from the reservoir will most likely not contain residual toxicants from the WWTP but will cause similar enrichment impacts.

Since water samples for chemical analysis were not obtained, other potential toxicants were not identified.

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

Ceriodaphnia dubia (water flea)

Concentration	Dilution Water	Sample	Total Volume
Control	50.0 ml	--------	50 ml
50.0%	25.0 ml	25.0 ml	50 ml
100.0%	-------	50.0 ml	50 ml

Daphnia pulex (water flea)

Concentration	Dilution Water	Sample	Total Volume
Control	200.0 ml	--------	200 ml
50.0%	100.0 ml	100.0 ml	200 ml
100.0%	--------	200.0 ml	200 ml

Notropis leedsi (bannerfin shiner)

Concentration	Dilution Water	Sample	Total Volume
Control	500 ml	--------	500 ml
50.0%	250 ml	250 ml	500 ml
100.0%	------	500 ml	500 ml

Table 2. Data and results of 48 hour static acute toxicity screening bioassays of the chlorinated reclaimed water from the Florida Power and Light Martin County Steam Generating Plant Wastewater Treatment Plant, Indiantown, Martin County, Florida, NPDES #FL0030988, 15 to 17 September, 1987.

Facility:	Florida Power and Light - Indiantown WWTP			NPDES # FL0030988		Facility Type:	Municipal WWTP
Location:	Martin County			Contact/District:	SE/Paul Strauss		
Sample Collection Date:	9/14/87	Time:	1015	Test type:	Static screening		
Test Beginning Date:	9/15/87	Time:	1130	# tests:	3	Receiving Water:	Cooling reservoir
Test Ending Date:	9/17/87	Time:	1130	Chlorination Type:	Chlorinated		to St. Lucie Canal

Parameter		
Total Residual Cl2:	2.5	3.9
Method:	Hach	Iodometric
By:	JMF/RBF	JMF/RBF
Salinity:	0	

Ammonia:	Control Water	100% Sample
Unionized NH3:	0.00	1.16
Total NH3:	0	26.1

Organism: *Ceriodaphnia dubia* — Age/Life stage: Neonates
LC50: < 10% — Binomial: — Moving Average: — Probit:

Concentrations	SURVIVAL # at 0 hour	Live at 24 hr	Live at 48 hr	Dissolved Oxygen 0 hour	24 hour	48 hour	pH 0 hour	24 hour	48 hour	Temperature 0 hour	24 hour	48 hour	Conductivity 0 hour	48 hour
Control	10	10	10	8.3	8.4	9.4	8.1	8	8	19.8	19.7	19.5		
Control	10	10	10	8.4	8.5	9.4	8.1	8	8					
10%	10	0	-	8.4	8.3	-	8	8	-	19.6	19.6	-		
10%	10	0	-	8.4	8.3	-	8	8	-					
50%	10	0	-	8.4	8.4	-	8	8.2	-	19.4	19.6	-		
50%	10	0	-	8.4	8.4	-	8	8.2	-					

	Control water	100% sample
Alkalinity:	113	200
Hardness:	111	168

Organism: *Daphnia pulex* — Age/Life stage: Neonates
LC50: < 10% — Binomial: — Moving Average: — Probit:

Concentrations	SURVIVAL # at 0 hour	Live at 24 hr	Live at 48 hr	Dissolved Oxygen 0 hour	24 hour	48 hour	pH 0 hour	24 hour	48 hour	Temperature 0 hour	24 hour	48 hour	Conductivity 0 hour	48 hour
Control	10	10	10	8.2	8.4	9.4	8.1	7.8	8	20	19.5	19.4		
Control	10	10	10	8.3	8.5	9.4	8.1	7.8	8				190	190
10%	10	0	-	8.5	8.7	-	8	7.9	-	20	19.4	-		
10%	10	0	-	8.5	8.7	-	8	7.9	-				255	-
50%	10	0	-	8.5	8.8	-	8	8	-	19.7	19.3	-		
50%	10	0	-	8.5	8.8	-	8	8	-				490	-

	Control water	100% sample
Alkalinity:	113	200
Hardness:	111	168

Organism: *Notropis leedsi* — Age/Life stage: 26 days
LC50: <10% — Binomial: — Moving Average: — Probit:

Concentrations	SURVIVAL # at 0 hour	Live at 24 hr	Live at 48 hr	Dissolved Oxygen 0 hour	24 hour	48 hour	pH 0 hour	24 hour	48 hour	Temperature 0 hour	24 hour	48 hour	Conductivity 0 hour	48 hour
Control	5	5	5	8.2	7.9	9.5	7.9	7.7	7.8	20.6	19.5	19		
Control	5	5	5	8.2	8	9.5	7.9	7.7	7.8				205	200
10%	5	0	0	8	8.3	-	7.8	7.8	-	20.6	19.3	-		
10%	5	0	0	8.1	8.3	-	7.8	7.9	-				270	-
50%	5	0	0	8.1	8.5	-	7.9	8	-	20	19.3	-		
50%	5	0	0	8.3	8.5	-	7.9	8	-				500	-

	Control water	100% sample
Alkalinity:	113	200
Hardness:	111	168

Table 3. Data and results of 48 hour static acute toxicity screening bioassays of the de-chlorinated reclaimed water from the Florida Power and Light Martin County Steam Generating Wastewater Treatment Plant, Indiantown, Martin County, Florida, NPDES #FL0030988, 15 to 17 September, 1987.

Facility:	**Florida Power and Light - Indiantown WWTP**			NPDES # **FL0030988**		Facility Type:	**Municipal WWTP**
Location:	Martin County			Contact/District:	SE/Paul Strauss		
Sample Collection Date:	9/14/87	Time:	1015	Test type:	Static screening		
Test Beginning Date:	9/15/87	Time:	1130	# tests:	3	Receiving Water:	Cooling reservoir to St. Lucie Canal
Test Ending Date:	9/17/87	Time:	1130	Chlorination Type:	Dechlorinated		

Parameter		
Total Residual Cl2:	N.D.	
Method:	Hach	
By:	RBF	
Salinity:	0	
Ammonia:	Control Water	100% Sample
Unionized NH3:	0.00	1.46
Total NH3:	0	26.1

Organism: ***Ceriodaphnia dubia*** Age/Life stage: Neonates

LC50: Binomial: Moving Average: Probit:

<100%

	SURVIVAL			Dissolved Oxygen			pH			Temperature			Conductivity	
Concentrations	# at 0 hour	Live at 24 hr	Live at 48 hr	0 hour	24 hour	48 hour	0 hour	24 hour	48 hour	0 hour	24 hour	48 hour	0 hour	48 hour
Control	10	10	10	8.3	8.2	9.5	8.3	8	8	19.9	19.7	19.5		
Control	10	10	10	8.3	8.2	9.5	8.3	8	8					
50%	10	10	10	8.3	8.3	9.5	8.1	8.1	8	19.7	19.7	19.5		
50%	10	10	10	8.3	8.3	9.5	8.1	8.1	8					
100%	10	7	5	8.4	8.4	9.4	8.1	8.1	8.1	19.6	19.9	19.5		
100%	10	8	4	8.3	8.3	9.5	8.1	8.1	8.1					

	Control water	100% sample
Alkalinity:	113	200
Hardness:	111	168

Organism: ***Daphnia pulex*** Age/Life stage: Neonates

LC50: Binomial: Moving Average: Probit:

not acutely toxic

	SURVIVAL			Dissolved Oxygen			pH			Temperature			Conductivity	
Concentrations	# at 0 hour	Live at 24 hr	Live at 48 hr	0 hour	24 hour	48 hour	0 hour	24 hour	48 hour	0 hour	24 hour	48 hour	0 hour	48 hour
Control	10	9	10	8.2	8.5	9.4	8.3	8	8	20.1	19.5	19.3		
Control	10	10	10	8.3	8.5	9.4	8.3	8	8				200	198
50%	10	10	10	8.4	8.5	9.5	8.1	8	8	19.9	19.5	19		
50%	10	10	10	8.4	8.5	9.4	8.1	8	8				485	480
100%	10	8	6	8.5	8.5	9.4	8.1	8.1	8.1	19.3	19.5	19		
100%	10	10	8	8.5	8.5	9.3	8.1	8.1	8.1				890	850

	Control water	100% sample
Alkalinity:	113	200
Hardness:	111	168

Organism: ***Notropis leedsi*** Age/Life stage: 26 days

LC50: Binomial: Moving Average: Probit:

<100%

	SURVIVAL			Dissolved Oxygen			pH			Temperature			Conductivity	
Concentrations	# at 0 hour	Live at 24 hr	Live at 48 hr	0 hour	24 hour	48 hour	0 hour	24 hour	48 hour	0 hour	24 hour	48 hour	0 hour	48 hour
Control	5	5	-	8.3	8.2	9	7.8	7.8	7.7	20.4	19.5	18.9		
Control	5	5	-	8.3	8.2	9	7.8	7.8	7.8				205	200
50%	5	3	-	8.5	8	7.9	8	7.9	7.9	19.9	19.4	18.8		
50%	5	4	-	8.4	8	7.6	8	7.9	7.9				550	500
100%	5	0	-	8.4	7.8	-	8.1	8	8	19.3	19.4	18.8		
100%	5	0	-	8.4	7.8	-	8.1	8	7.9				900	900

	Control water	100% sample
Alkalinity:	113	200
Hardness:	111	168

Table 4. Microtox test results, F.P.L. - Indiantown WWTP discharge, Martin County, NPDES #FL0030988, on 15 September, 1987.

Microtox Test Culture Lot # M-603

Final Reclaimed Water

% Sample	Chlorinated		Dechlorinated	
	5-min	15-min	5-min	15-min
0	87	50	93	62
0	82	48	94	64
0	83	49	92	62
12.38	12	2	87	56
12.38	11	2	91	58
12.38	11	2	94	61
24.75	4	0.5	89	57
24.75	4	0.4	92	60
24.75	4	0.45	84	53.5
49.5	0.7	0.2	82	49
49.5	0.6	0.2	77	47
49.5	0.8	0.2	81	50
99	0.3	0.15	61	33
99	0.3	0.15	59	32
99	0.3	0.15	63	35.5

EC50 Chlorinated (15 minute, 15 degrees C) = 1.10% sample
EC50 Dechlorinated (15 minute, 15 degree C) > 100%

EC50 (15 minute, 15 degrees C) is calculated using the Data Reduction Computer Program developed by Microbics Corporation for the Sharp Model EL-5100 (Microbics) Systems Operating Manual, 1982.

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. Applicable portions of the F.A.C. are: 17-3.021(1), 17-3.021(4), 17-3.051(1)(d), 17-3.061(3)(p), 17-3.402(1), 17-4.244(4), and 17-4.244(6).

The particular restrictions applied to a given discharger depend upon the type of discharge, the type of water body which is impacted, and the type of mixing zone, if any, which has been permitted. The most stringent toxicity limitations which apply to the various combinations of these factors are listed below, specified in terms of the most dilute concentration of effluent which is allowed to kill 50% of the test organisms in 96 hours. Note that any listed concentration greater than 100% is extrapolated from toxicity curves determined from testing various effluent concentrations of 100% or less. Violations of the toxicity standards occur in the following conditions.

I. Discharges to Surface Water

A. With no mixing zone, or with only a dredge and fill mixing zone the discharge may not exhibit an $LC_{50} \leq 2000\%$ at the point of discharge.

B. With a non-dredge and fill mixing zone the discharge may not exhibit an $LC_{50} \leq 100\%$ at the point of discharge and may not exhibit an $LC_{50} \leq 2000\%$ at the edge of the mixing zone.

C. With a non-dredge and fill mixing zone, and either discharging to the open ocean through multiport diffusers or meeting the provisions of 17-4.244(4)(b) the LC_{50} at the point of discharge cannot exceed 30% sample concentration.

II. Discharges to ground water may not exceed an LC_{50} of 300% at the point of contact with surface waters

A violation of these provisions occurs if toxicity is found at a more dilute concentrations of the sampled discharge than allowed above.

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U.S. Environmental Protection Agency. 1985. Water Quality Criteria, Federal Register. 50(145):30784-30796.

Industry/Toxicant: FPL - Indiantown STP
Address: Martin Co.
Contact/District: SE
Effluent Serial Number:
NPDES Permit Number:

BIOASSAY DATA FORM

Test Number: 1 of 6
Test Type: (Static) Renewal, (Screening) Conventional
Other: Cl2

Sample Collection: Date 9-14-87 Time 1015
Test Beginning: Date 9-15-87 Time 1120
Test Ending: Date 9-17-87 Time 1120
Test Organism: C. dubia
Age/Life Stage: neonate

Conc. or %	Test Container Number	Number of Live Organisms 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 0	24	48	72	96	Temperature °C 0	24	48	72	96	0	24	48	72	96
Control	92	10	10	10			8.3	8.4	9.4			8.1	8.0	8.0			19.8	19.7	19.5							
Control	65	10	10	10			8.4	8.5	9.4			8.1	8.0	8.0												
10%	85	10	0	—			8.4	8.3	—			8.0	8.0	—			19.6	19.6	—							
10%	83	10	0	—			8.4	8.3	—			8.0	8.0	—												
50%	4	10	0	—			8.4	8.4	—			8.0	8.2	—			19.4	19.6	—							
50%	1	10	0	—			8.4	8.4	—			8.0	8.2	—												
Initial of Investigator		JMF	RBF	RBF			RBF	RBF	JE			RBF	RBF	JE			RBF	RBF	RBF							

Alkalinity/Hardness (mg/l as $CaCO_3$)
Control Water: 113/111
100% Sample: 200/168
Other:
Measured by: KML

Ammonia unionized/total (mg/l as NH_3/N)
Hour 0
Control Water:
100% Sample:
Other:
Hour
Control Water:
100% Sample:
Other:
Measured by:

Signatures:
KMLurding
Russel Frederking
Jose Fandiño
JMF

Instrument Calibrations:

	pH Meter:	DO Meter:	S-C-T Meter:
0 Hours	7at7; 9at9	8.6 at 22°C	11.5 at 10; 30 at 30
24 Hours	7at7; 9at9	9.0 at 21°C	
48 Hours	7at7; 9at9	9.2 at 20°C	10 at 10; 29 at 30
72 Hours			
96 Hours			

Remarks:

Total Residual Chlorine:
Field data: 0.1 mg/l Method:
Lab: 3.5 Method: HACH
Lab: 3.9 Method: Iodometric

Dechlorinated:
Measurements by: JMF; RBF

Reviewed by:
Date: 2/7/88

Industry/Toxicant FPL - Indiantown
Address
Contact/District
Effluent Serial Number
NPDES Permit Number

BIOASSAY DATA FORM

Test Number: 2 of 6
Test Type: Static Renewal, Screening Conventional
Other: Cl_2

Sample Collection: Date 9-14-87 Time 1015
Test Beginning: Date 9-15-87 Time 1120
Test Ending: Date Time
Test Organism 1). pulex
Age/Life Stage neonate

Conc. or %	Test Container Number	Number of Live Organisms 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 0	24	48	72	96	Temperature °C 0	24	48	72	96	Conductivity 0	24	48	72	96
ontrol	3	10	10	10			8.2	8.4	9.4			8.1	7.8	8.0			20.0	19.5	19.4				195			
ontrol	55	10	10	10			8.3	8.5	9.4			8.1	7.8	8.0								190	190			
10%	7	10	0	—			8.5	8.7	—			8.0	7.9	—			20.0	19.4	—							
10%	64	10	0	—			8.5	8.7	—			8.0	7.9	—								255	—			
50%	13	10	0	—			8.5	8.8	—			8.0	8.0	—			19.7	19.3	—							
50%	50	10	0	—			8.5	8.8	—			8.0	8.0	—								490	—			
Initial of Investigater		RBF	KM	RBF			RBF	RBF	JE			RBF	RBF	JE			RBF	RBF	RBF			RBF	RBF			

Alkalinity/Hardness (mg/l as $CaCO_3$)

Control Water:
100% Sample:
Other:
Measured by:

Ammonia unionized/total (mg/l as NH_3/N)
Hour 0

Control Water:
100% Sample:
Other:

Hour

Control Water:
100% Sample:
Other:
Measured by:

Signature: KM Lyding
Russel Frydenborg
Joseph Hamelink
Jeff Eppler

Instrument Calibrations:

	pH Meter:	DO Meter:	S-C-T Meter:
0 Hours			
24 Hours			
48 Hours			
72 Hours			
96 Hours			

Remarks:

Total Residual Chlorine:

Field data: Method:
Lab: Method:
Lab: Method:

Dechlorinated:
Measurements by:

Reviewed by:
Date: 2/9/88

Industry/Toxicant FPL - Indiantown

Address

Contact/District

Effluent Serial Number

NPDES Permit Number

Test Number: 3 of 6

Test Type: Static / Renewal, Screening / Conventional

Other: Cl2

Sample Collection: Date 9-14-87 Time 1015

Test Beginning: Date 9-15-87 Time 1105

Test Ending: Date Time

Test Organism N. Reedsi

Age/Life Stage 36 days

Conc. or %	Test Container Number	Number of Live Organisms 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 0	24	48	72	96	Temperature °C 0	24	48	72	96	Conductivity 0	48	72	96
Control	86	5	5	5			8.2	7.9	9.5			7.9	7.7	7.8			20.6	19.5	19.0						
Control	—	5	5	5			8.2	8.0	9.5			7.9	7.7	7.8								205	200		
10%	10	5	0	—			8.0	8.3	—			7.8	7.8	—			20.6	19.3	—						
10%	285	5	0	—			8.1	8.3	—			7.8	7.9	—								270	—		
50%	34	5	0	—			8.1	8.5	—			7.9	8.0	—			20.0	19.3	—						
50%	6	5	0	—			8.3	8.5	—			7.9	8.0	—								500	—		
Initial of Investigator		KWL	KWL	RBF			RBF	RBF	JE			RBF	RBF	JE			RBF	RBF	RBF			RBF	RBF		

Alkalinity/Hardness (mg/l as $CaCO_3$)

Control Water:
100% Sample:
Other:
Measured by:

Ammonia unionized/total (mg/l as NH_3/N)
Hour 0

Control Water:
100% Sample:
Other:

Hour

Control Water:
100% Sample:
Other:
Measured by:

Signatures:
K.W. Lurding
Russel Frydenborg
Joseph Landreth
J. H. Gobb

Instrument Calibrations:

	pH Meter:	DO Meter:	S-C-T Meter:
0 Hours			
24 Hours			
48 Hours			
72 Hours			
96 Hours			

Remarks:

Total Residual Chlorine:

Field data: Method:
Lab: Method:
Lab: Method:

De-chlorinated:
Measurements by:

Reviewed by:

Date: 2/9/88

Industry/Toxicant FPL-Indiantown
Address
Contact/District
Effluent Serial Number
NPDES Permit Number

BIOASSAY DATA FORM

Test Number: 4 of 6
Test Type: Static Renewal, Screening, Conventional
Other: De-Cl2

Sample Collection: Date 9-14-87 Time 1015
Test Beginning: Date 9-15-87 Time 1130
Test Ending: Date Time
Test Organism N. Leedsi C. dubia
Age/Life Stage neonate

Conc. or %	Test Container Number	Number of Live Organisms 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 0	24	48	72	96	Temperature °C 0	24	48	72	96					
ntrol	91	10	10	10			8.3	8.2	9.5			8.3	8.0	8.0			19.9	19.7	19.5							
ntrol	80	10	10	10			8.3	8.2	9.5			8.3	8.0	8.0												
50%	50	10	10	10			8.3	8.3	9.5			8.1	8.1	8.0			19.7	19.7	19.5							
50%	51	10	10	10			8.3	8.3	9.5			8.1	8.1	8.0												
100%	99	10	7	5			8.4	8.4	9.4			8.1	8.1	8.1			19.6	19.9	19.5							
100%	—	10	8	4			8.3	8.3	9.5			8.1	8.1	8.1												
Initial of Investigator		BMF	KMLKMLKML				RBF	RBF	JE			RBF	RBF	JE			RBF	RBF	RBF							

Alkalinity/Hardness (mg/l as $CaCO_3$)

Control Water:
100% Sample:
Other:
Measured by:

Ammonia unionized/total (mg/l as NH_3/N)
Hour 0

Control Water:
100% Sample:
Other:

Hour

Control Water:
100% Sample:
Other:
Measured by:

Signatures:
KM Lusding
Russell Frydenborg
Joseph Fawcett
Jill Epler

Instrument Calibrations:

	pH Meter:	DO Meter:	S-C-T Meter:
0 Hours			
24 Hours			
48 Hours			
72 Hours			
96 Hours			

Remarks:

Total Residual Chlorine:

Field data: Method:
Lab: N.D. Method: HACH
Lab: Method:

Dechlorinated:
Measurements by:

Reviewed by:
Date: 2/19/88

Industry/Toxicant: FPL-Indiantown
Address:
Contact/District:
Effluent Serial Number:
NPDES Permit Number:

EFFLUENT DATA FORM

Test Number: 5 of 6
Test Type: Static Renewal / Screening / Conventional
Other: De-Cl2

Sample Collection: Date 9-14-87 Time 1015
Test Beginning: Date 9-15-87 Time 1130
Test Ending: Date Time
Test Organism: D. pulex
Age/Life Stage: neonate

Conc. or %	Test Container Number	Number of Live Organisms 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 0	24	48	72	96	Temperature °C 0	24	48	72	96	Conductivity 0	24 48	48	72	96
Control	2	10	9	10			8.2	8.5	9.4			8.3	8.0	8.0			20.1	19.5	19.3							
Control	22	10	10	10			8.3	8.5	9.4			8.3	8.0	8.0								200	195			
50%	10	10	10	10			8.4	8.5	9.5			8.1	8.0	8.0			19.9	19.5	19.0							
50%	8	10	10	10			8.4	8.5	9.4			8.1	8.0	8.0								485	480			
100%	5	10	8	6			8.5	8.5	9.4			8.1	8.1	8.1			19.3	19.5	19.0							
100%	67	10	10	8			8.5	8.5	9.3			8.1	8.1	8.1								890	850			
Initial of Investigator		RBF	RBF KML	RBF			RBF	RBF	JE			RBF	RBF	JE			RBF	RBF	RBF			RBF	RBF			

Alkalinity/Hardness (mg/l as $CaCO_3$)

Control Water:
100% Sample:
Other:
Measured by:

Ammonia unionized/total (mg/l as NH_3/N)
Hour 0

Control Water: 0.0
100% Sample: 1.43/26.1
Other: RBF

Hour 0

Control Water:
100% Sample:
Other:
Measured by: KML

Signatures:
KMLurding
Russel Frydenborg
Joseph Faircloth
J H Gibbs

Instrument Calibrations:

	pH Meter:	DO Meter:	S-C-T Meter:
0 Hours			
24 Hours			
48 Hours			
72 Hours			
96 Hours			

Remarks:

Total Residual Chlorine:

Field data: Method:
Lab: Method:
Lab: Method:

De-chlorinated:
Measurements by:

Reviewed by:
Date: 2/9/88

Address
Contact/District
Effluent Serial Number
NPDES Permit Number

Test Number: 6 of 6
Test Type: Static Renewal, Screening Conventional
Other: De-Cl2

Sample Collection: Date 9-14-87 Time 1015
Test Beginning: Date 9-15-87 Time 1115
Test Ending: Date ____ Time ____
Test Organism N. seudi
Age/Life Stage 26 days

Conc. or %	Test Container Number	Number of Live Organisms 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 0	24	48	72	96	Temperature °C 0	24	48	72	96	Conductivity 0	48	72	96
control	—	5	5	a			8.3	8.2	9.0			7.5	7.9	7.7			20.4	19.5	18.9						
control	42	5	5				8.3	8.2	9.0			7.8	7.8	7.8								25	200		
50%	68	5	3				8.5	8.0	7.9			8.0	7.9	7.9			19.9	19.4	18.8						
50%	47	5	4				8.4	8.0	7.6			8.0	7.9	7.9								550	500		
100%	37	5	0				8.4	7.8	—			8.1	8.0	8.0			19.3	19.4	18.8						
100%	52	5	0				8.4	7.8	—			8.1	8.0	7.9								900	900		
Initial of Investigator		KML	RBF				RBF	KML	JE			RBF	RBF	JE			RBF	RBF	RBF			RBF	RBF		

Alkalinity/Hardness (mg/l as $CaCO_3$)

Control Water:
100% Sample:
Other:
Measured by: ____

Ammonia unionized/total (mg/l as NH_3/N)
Hour 0

Control Water: 0.0
100% Sample: 1.43/26.1 RBF
Other:

Hour ____

Control Water:
100% Sample:
Other:
Measured by: KML/Jing RBF

Signatures:
KM Luiding
Russell Frydenborg
Joseph Fayleth
JE Epler

Instrument Calibrations:

	pH Meter:	DO Meter:	S-C-T Meter:
0 Hours			
24 Hours			
48 Hours			
72 Hours			
96 Hours			

Total Residual Chlorine:
Field data: ____ Method: ____
Lab: ____ Method: ____
Lab: ____ Method: ____

Reviewed by: [signature]
Date: 2/9/88

Dechlorinated:
Measurements by: ____

Remarks: a Lab error – data not recorded although it is my recollection that all were dead except control. RBF

015

MICROTOX™ Data Reduction Sheet

SOURCE: FPL - Indiantown

GRAPH / CALC EC 50 (15 MIN, 15 °C) = 1.1 (%SAMPLE) mg/L

SAMPLE DATA:

SAMPLE TYPE (EFFLUENT, LEACHATE, ETC.): effluent - Cl2

DATE ASSAYED: 1-15-87 TIME: 10:30 AM

VISUAL COLOR: none CORRECTION REQUIRED: YES (NO)

VISUAL TURBIDITY: none SEPARATION REQUIRED: YES (NO)

INITIAL pH: pH ADJUSTED TO: WITH:

OSMOTICALLY ADJUSTED WITH: MOAS (DRY NaCl) OTHER

PRIMARY DILUTION OF SAMPLE: none

OPERATOR: Scott Quillian REAGENT VIAL LOT NO. M-603

REMARKS:

MICROTOX™ 99% TEST

SAMPLE CUVETTE	% SAMPLE	READINGS 5 MIN	READINGS 15 MIN	Γ5	Γ15	NOTES
A1	0	87	50	X	X	
B1		82	48			
C1		83	49			
A2	12.38	12	2	6.41	23.5	
B2		11	2			
C2		11	2			
A3	24.75	4	.5	20.0	107.9	
B3		4	.4			
C3		4	45			
A4	49.5	.7	.2	119.0	244.0	
B4		.6	.2			
C4		.8	.2			
A5	99	.3	.15	279.0	325.7	
B5		.3	.15			
C5		.3	.15			
EC_{50} (MIN, °C)				4.81	1.10	

REVIEWED BY:
DATE: 2/9/87

016

MICROTOX™ Data Reduction Sheet

SOURCE: FPL Indiantown

GRAPH / (CALC) EC 50 (15 MIN, 15 °C) = >100 (%SAMPLE) mg/L

SAMPLE DATA:

SAMPLE TYPE (EFFLUENT, LEACHATE, ETC.): effluent - diff

DATE ASSAYED: 9-15-87 TIME: 10:50 AM

VISUAL COLOR: none CORRECTION REQUIRED: YES (NO)

VISUAL TURBIDITY: none SEPARATION REQUIRED: YES (NO)

INITIAL pH: pH ADJUSTED TO: WITH:

OSMOTICALLY ADJUSTED WITH: MOAS (DRY NaCl) OTHER

PRIMARY DILUTION OF SAMPLE: none

OPERATOR: Leslie Williams REAGENT VIAL LOT NO. M-603

REMARKS:

MICROTOX™ 99% TEST

SAMPLE CUVETTE	% SAMPLE	READINGS 5 MIN	READINGS 15 MIN	Γ5	Γ15	NOTES
A1	0	93	62	X	X	
B1		94	64			
C1		92	62			
A2	12.38	87	56	.03	.07	
B2		91	58			
C2		94	61			
A3	24.75	89	57	.05	.10	
B3		92	60			
C3		84	53.5			
A4	49.5	82	49	.16	.29	
B4		77	47			
C4		81	50			
A5	99	61	33	.52	.87	
B5		59	32			
C5		63	35.5			
EC_{50} (MIN, °C)				165.7	119.1	

REVIEWED BY:

DATE: 2/19/88