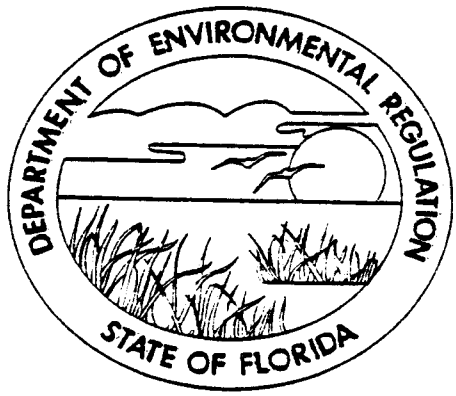


BIOASSAYS OF FARMLAND INDUSTRIES, INC.

BARTOW, POLK COUNTY, FLA.

NPDES #FL0000752

SAMPLED 8/8/83

Biology Section
Bureau of Water Analysis
September 13, 1983

BIOASSAYS OF FARMLAND INDUSTRIES, INC.

BARTOW, POLK COUNTY, FLA.

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EXECUTIVE SUMMARY

Farmland Industries, Bartow, NPDES #FL0000752, on 9 to 11 August, 1983

The sample of process wastewater effluent (Outfall #001) from this phosphate and fertilizer manufacturer was not toxic to the test organisms, *Daphnia pulex*, *Pimephales promelas*, *Notropis leedsi*, and *Heterandria formosa*. Only a few random *N. leedsi* mortalities were noted during the 48 hour static tests. The significant amount of total ammonia detected in the effluent (25.3 mg/l), apparently did not have a toxic effect on the test organisms. Since the effluent was not acutely toxic, chemical analyses were not performed.

INTRODUCTION

Farmland Industries is primarily a fertilizer manufacturer operating from the Green Bay Plant on Pebbledale Road, approximately 6 miles southwest of Bartow, Polk County, Florida (Fig. 1). The plant produces various fertilizers, including diammonium phosphate, triple superphosphate and ammonium sulfate, in addition to phosporic, superphosphoric and sulfuric acids. A uranium recovery plant is also located in the complex. Maximum combined production of these commodities is approximately 7000 tons per day. Raw materials for this production are phosphate rock, sulfur and ammonia.

The complex has two NPDES permitted discharges, #001, cosisting of process wastewater that is discharged west of the plant through an unnamed ditch to the North Prong of the Alafia River, and #002, consisting of noncontact cooling water that is discharged east of the plant to Six Mile Creek (Fig. 2). Process wastewater is treated in a holding area (surge pond) where it is neutralized by adding pulverized quicklime to obtain a predetermined pH. The overflow enters a settling pond where the water is raised to a higher pH to complete precipitation of impurities. Overflow from this pond enters a final pond which discharges intermittantly when the facility can no longer maintain surge capacity in the previous retention ponds. This is also dependent on the volume of rainfall. Components of the discharge may include high concentrations of phosphates and fluorides, in addition to radium and other impurities of phosphate rock.

The Biology Section has previously performed static bioassay tests on effluent from Outfall #001, on 23 to 25 June, 1981. At that time, the effluent was extremely toxic to the test organisms, Daphnia pulex and Pimephales promelas, producing 48 hour LC_{50} values of 23.8% and 19.4%, respectively (FDER 1981). The toxicity was directly attributed to the substantial concentrations of total and unionized ammonia (196.0 mg/l and 1.53 mg/l, respectively) detected in the effluent at that time.

To again evaluate the effects of this discharge on the biota of the receiving waters, the Biology Section performed four additional static acute toxicity bioassays on a grab sample from Outfall #001, on 9 to 11 August, 1983. The results of these latest tests are presented in this report. Those involved in performing the tests and in preparing this report were: C. W. Dye and M. L. Roll.

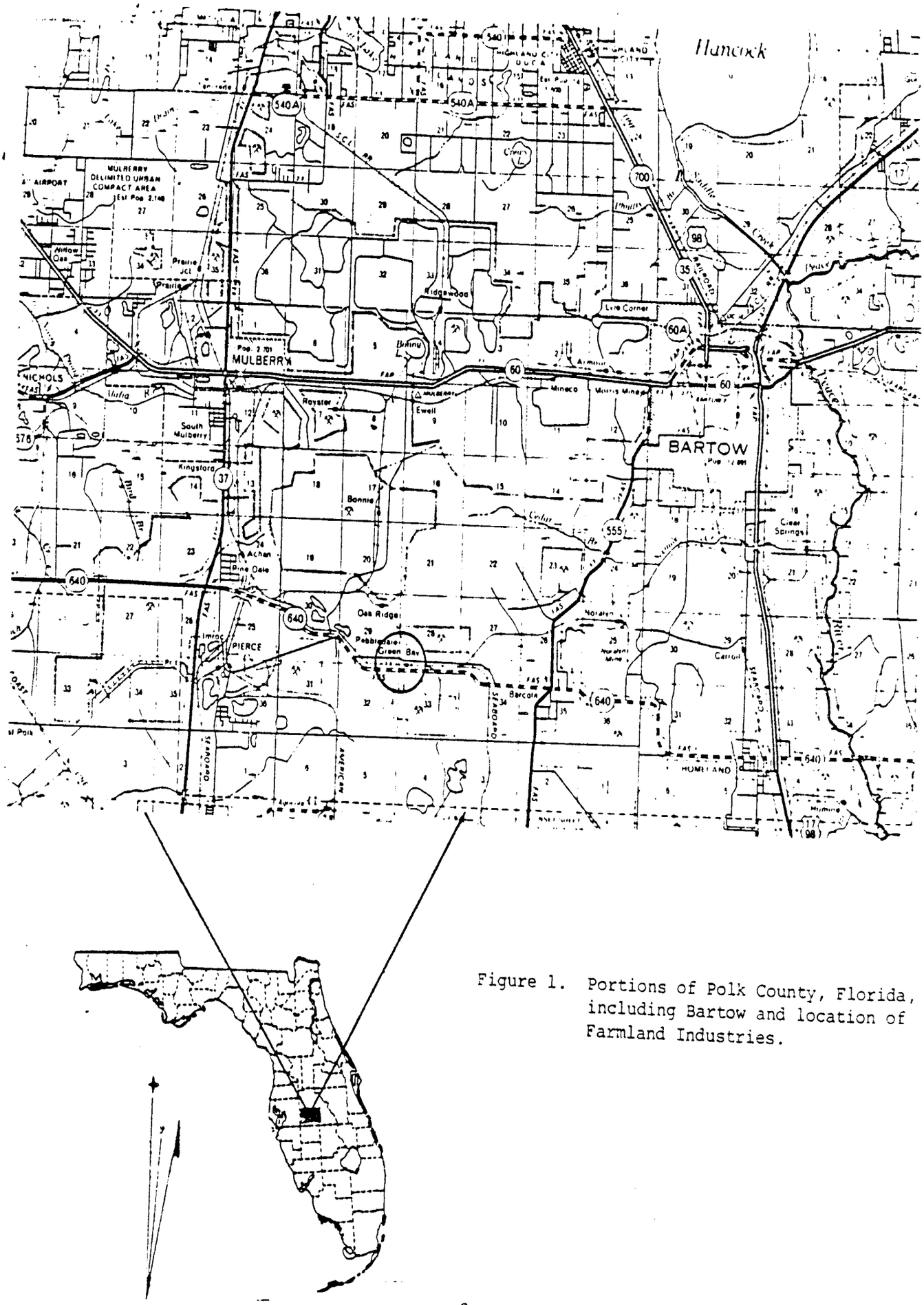


Figure 1. Portions of Polk County, Florida, including Bartow and location of Farmland Industries.

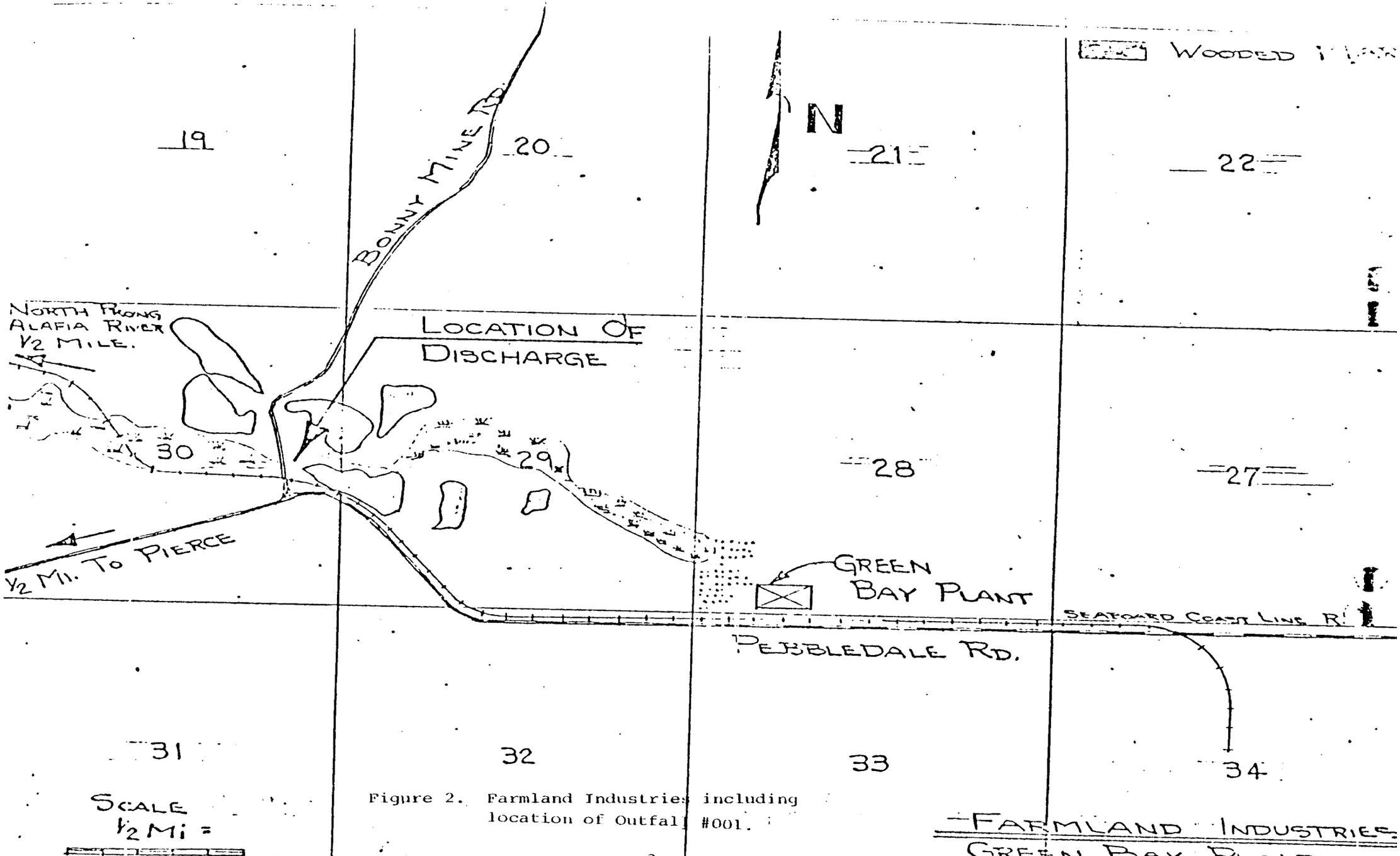


Figure 2. Farmland Industries including location of Outfall #001.

METHODS AND MATERIALS

Test methods used to conduct these static bioassays are extensively described by Peltier (1978) and the FDER Biology Section (1983). The organisms selected for this study include species recommended by Peltier (1978), the U.S. EPA (1978), and the FDER Biology Section (1983). Additionally, the Biology Section maintains cultures of several species of organisms indigenous to the State of Florida. Two of these indigenous species were also selected for testing. Life histories of these test organisms and maintenance procedures used to culture them are detailed below.

History and Maintenance of Bioassay Organisms

Daphnia pulex (water flea) - A breeding culture of Daphnia pulex was obtained from the EPA laboratory in Athens, Georgia, in March, 1979. This culture has been maintained since its arrival in 2 1/2 gallon all-glass aquaria, filled with unchlorinated DER well water, under a 16:8 hour light-dark cycle. Organisms are fed a liquified blend of Purina Trout Chow® and Cerophyl® twice daily, and are kept at a constant temperature of 22° plus or minus 2°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess organisms. They are then refilled 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.

Pimephales promelas (fathead minnows) - A breeding culture of approximately 100 adult fathead minnows was obtained from the EPA laboratory in Cincinnati, Ohio, in May, 1979. This breeding population is augmented with fry hatched in our laboratory and with additional adult fish from EPA as required. The fish are maintained in three 125 gallon all-glass aquaria, equipped with a flow-through water exchange system, using unchlorinated well water obtained from a deep well near the DER laboratory. The fathead minnows are reared at a temperature of 22° plus or minus 2°C under a 16:8 hour light-dark cycle. These fish are fed Glencoe Mills "#3 size enriched trout fry granules", Tetra-Min®, and frozen Artemia (brine shrimp) at a rate of 0.75g/30 fish, twice daily. Breeding has been encouraged by placing several halved clay pots in each tank to serve as substrates for eggs and to provide cover for the fish. Tanks are examined twice daily (at feeding time) for egg production. Clay pots containing egg clusters are immediately transferred to 15 gallon aerated aquaria for hatching. A new aquarium is prepared for each week's production of eggs, thereby segregating fish into even age groups to be used for testing. After hatching, fathead minnow fry are fed twice daily with freshly hatched Artemia. The fish used in this test were 19 to 26 days old at the time of the test.

Heterandria formosa (least killifish) - Approximately 100 adult least killifish were obtained from a wild population in the St. Marks Wildlife Refuge (Wakulla County, Florida) during August, 1980. The fish are maintained in two and one-half to 15 gallon all-glass aquaria equipped with a flow-through water exchange system. Water for this system is unchlorinated and is pumped from a deep well near the DER laboratory. The least killifish are reared at 22° plus

or minus 2°C under a 16:8 hour light-dark cycle and are fed freshly hatched Artemia (brine shrimp) and Tetra-Min® twice daily. New born fish are initially maintained in the adult tanks, but are transferred to separate aquaria at weekly intervals, thereby segregating fish into even age groups. The fish used in this test were 14 to 28 days old.

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° plus or minus 2°C under a 16:8 hour light cycle and are fed Tetra-Min® and frozen Artemia (brine shrimp) twice daily. Breeding and egg hatching are encouraged at 25°C. The eggs are laid under a 1" thick slab of marble raised 3 mm above a removable horizontal pane of glass. Most of the eggs adhere to the glass and are easily removed to an aerated hatching tank. The narrow space between the marble slab and glass eliminates egg predation by adult fish. New hatching tanks are started weekly to segregate fry into even age groups. Newly hatched fry are fed a liquefied blend of Purina Trout Chow ® and Cerophyl® twice daily. After one week, feeding is augmented with newly hatched Artemia nauplii and finely crushed Tetra Min®. The fish used in this test were approximately 26 days old at the time of the test.

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

Test Methods

Four separate 48 hour static acute toxicity bioassays were performed on process wastewater effluent (Outfall #001) from Farmland Industries. The tests were performed from 1030 hours on 9 August to 1055 hours on 11 August, 1983. The sample was collected by Mr. Matt McCann of DER's Tampa office at 1100 hours on 8 August, 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.

Freshwater for dilution of the effluent sample was obtained from the same DER deep well that is used to culture the test organisms. The concentration series selected for this study (Table 1) is that recommended by APHA (1980).

Two replicates, each with six randomly arranged concentrations and a control, were used to test with the water flea, Daphnia pulex. Flint glass jars of 250 ml capacity were used as test chambers, and 200 ml of the appropriate test concentration was placed in each chamber. Daphnia were siphoned into a large culture dish to isolate the proper size and age organisms (neonates). To accomplish this, the water fleas 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 this test.

Two replicates, of six randomly arranged concentrations and a control, were used for the Pimephales promelas (fathead minnow), the Heterandria formosa (least killifish), and the Notropis leedsi (bannerfin shiner) bioassays. The fish were transferred individually or by twos, into wide mouth quart jars containing 500 ml each of the appropriate test concentration, and were loaded 5 per chamber, resulting in 10 per concentration. Fish were not fed during these tests.

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 chamber at 0 hours, 24 hours, and 48 hours. Total alkalinity and total hardness (measured as $CaCO_3$ using HACH Chemical Company reagents) were recorded at the beginning of the test for the controls and the 100% effluent concentration. The specific conductance (YSI Model 33 S-C-T meter) of each test concentration was recorded at the beginning and end of the test. All instruments were calibrated daily according to manufacturer's recommendations. Ammonia concentrations, including the total and unionized fraction (expressed in mg/l as N and as NH_3, respectively), were recorded in the controls and the 100% effluent test concentrations at the beginning of the test. Total ammonia concentrations were determined using an Orion® specific ion probe and an Orion Ionalyzer®. The unionized fraction was then calculated based on the total ammonia concentration, and the pH, temperature, and salinity of the sample. These values were recorded on the bioassay data forms and are presented in Tables 2 through 5.

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

Daphnia pulex (water flea)

Concentration	Dilution Water	Effluent	Total Volume
Control	200.0 ml	--------	200 ml
5.6%	188.8 ml	11.2 ml	200 ml
10.0%	180.0 ml	20.0 ml	200 ml
18.0%	164.0 ml	36.0 ml	200 ml
32.0%	136.0 ml	64.0 ml	200 ml
56.0%	88.0 ml	112.0 ml	200 ml
100.0%	--------	200.0 ml	200 ml

Pimephales promelas (fathead minnow)

Heterandria formosa (least killifish)

Notropis leedsi (bannerfin shiner)

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, Daphnia pulex, static acute toxicity bioassay of Farmland Industries, Bartow, Polk County, Florida, NPDES #FL0000752, OUtfall #001, on 9 to 11 August, 1983.

Conc. or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Total Alkalinity (mg/l as $CaCO_3$)		Total Hardness (mg/l as $CaCO_3$)		Temperature (^oc)			NH_3/N (mg/l)		Conductivity (µmhos)	
	0	24	48	0	24	48	0	24	48	0	48	0	48	0	24	48	0	48	0	48
Control	10	10	10	8.9	9.1	8.5	7.7	8.2	8.2	104		112		19.9	18.5	18.7	0/.10	--		
Control	10	10	10	8.9	9.2	8.5	7.7	8.2	8.2										198	195
5.6%	10	10	10	8.9	9.2	8.5	7.7	8.1	8.1					20.0	18.5	18.6				
5.6%	10	10	10	8.9	9.3	8.5	7.7	8.1	8.1										282	280
10.0%	10	10	10	8.8	9.3	8.4	7.6	8.1	8.0					20.0	18.5	18.6				
10.0%	10	10	10	8.8	9.3	8.4	7.6	8.1	8.0										355	350
18.0%	10	10	10	8.7	9.2	8.4	7.6	8.0	8.0					20.1	18.5	18.6				
18.0%	10	10	10	8.7	9.2	8.4	7.6	8.0	8.0										471	468
32.0%	10	10	10	8.6	9.2	8.4	7.5	7.9	7.9					20.0	18.6	18.7				
32.0%	10	10	10	8.6	9.2	8.4	7.5	7.9	7.9										750	720
56.0%	10	10	10	8.5	9.2	8.4	7.3	7.7	7.8					19.9	18.6	18.7				
56,0%	10	10	10	8.5	9.2	8.4	7.3	7.7	7.8										1120	1100
100.0%	10	10	10	8.2	9.0	8.3	6.7	7.1	7.1	18		330		19.8	18.9	18.9	.06/25.3	--		
100.0%	10	10	10	8.2	9.0	8.3	6.7	7.1	7.1										1780	1750

Remarks:

Table 3. Data recorded during 48 hour, *Pimephales promelas*[a], static acute toxicity bioassay of Farmland Industries, Bartow, Polk County, Florida, NPDES #FL0000752, Outfall #001, on 9 to 11 August, 1983.

Conc. or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Total Alkalinity (mg/l as $CaCO_3$)		Total Hardness (mg/l as $CaCO_3$)		Temperature (°c)			NH_3/N (mg/l)		Conductivity (µmhos)	
	0	24	48	0	24	48	0	24	48	0	48	0	48	0	24	48	0	48	0	48
Control	5	5	5	8.8	9.3	8.6	7.7	8.1	8.1	104		112		19.9	18.1	18.3	0/.10	--		
Control	5	5	5	8.8	9.3	8.6	7.7	8.1	8.1										198	190
5.6%	5	5	5	8.8	9.3	8.5	7.7	8.0	8.0					20.4	18.3	18.4				
5.6%	6[b]	6	6	8.8	9.3	8.5	7.7	8.0	8.0										290	277
10.0%	5	5	5	8.7	9.2	8.4	7.7	8.0	8.0					20.5	18.0	18.3				
10.0%	5	5	5	8.7	9.2	8.4	7.7	8.0	8.0										362	348
18.0%	5	5	5	8.6	9.1	8.4	7.6	7.9	7.9					20.4	18.2	18.3				
18.0%	5	5	5	8.6	9.1	8.4	7.6	7.9	7.9										482	465
32.0%	5	5	5	8.5	9.1	8.3	7.5	7.8	7.9					20.3	18.0	18.3				
32.0%	6[b]	6	6	8.5	9.1	8.3	7.5	7.8	7.9										760	720
56.0%	5	5	5	8.3	8.9	8.2	7.2	7.6	7.7					20.1	18.0	18.5				
56.0%	5	5	5	8.3	8.9	8.2	7.2	7.6	7.7										1120	1100
100.0%	5	5	5	8.0	8.8	8.3	6.6	7.0	7.2	18		330		19.9	18.0	18.5	.048/25.3	--		
100.0%	5	5	5	8.0	8.8	8.3	6.6	7.0	7.1										1780	1710

Remarks: [a] Weight of fish: 2.76 mg each, average of 8 fish.

[b] Extra organism loaded by mistake, allowed to remain.

Table 4. Data recorded during 48 hour, Heterandria formosa,[a] static acute toxicity bioassay of Farmland Industries, Bartow, Polk County, Florida, NPDES #FL0000752, Outfall #001, on 9 to 11 August, 1983.

Conc. or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Total Alkalinity (mg/l as $CaCO_3$)		Total Hardness (mg/l as $CaCO_3$)		Temperature (°c)			NH_3/N (mg/l)		Conductivity (µmhos)	
	0	24	48	0	24	48	0	24	48	0	48	0	48	0	24	48	0	48	0	48
Control	5	5	5	8.8	9.0	8.4	7.7	8.0	8.1	104		112		20.4	17.9	18.5	0/.10	--		
Control	5	5	5	8.8	9.0	8.1	7.7	8.0	8.1										199	189
5.6%	5	5	5	8.8	9.0	8.4	7.7	8.0	8.0					20.4	17.8	18.4				
5.6%	5	5	5	8.8	9.0	8.4	7.7	8.0	8.0										290	262
10.0%	5	5	5	8.7	8.9	8.4	7.7	7.9	7.9					20.5	17.7	18.4				
10.0%	5	5	5	8.7	8.9	8.4	7.7	7.9	7.9										360	345
18.0%	5	5	5	8.7	8.8	8.2	7.6	7.9	7.9					20.4	18.0	18.5				
18.0%	6[b]	6	6	8.7	8.8	8.2	7.6	7.9	7.9										481	465
32.0%	5	5	5	8.6	8.8	8.2	7.5	7.8	7.8					20.3	17.7	18.4				
32.0%	5	5	5	8.6	8.8	8.2	7.5	7.8	7.8										770	710
56.0%	5	5	5	8.5	8.7	8.1	7.2	7.6	7.7					20.1	18.0	18.3				
56.0%	5	5	5	8.5	8.7	8.1	7.2	7.6	7.7										1120	1090
100.0%	5	5	5	8.1	8.6	8.1	6.6	7.0	7.1	18		330		19.8	17.8	18.2	.048/25.3			
100.0%	5	5	5	8.1	8.6	8.1	6.6	7.0	7.1										1780	1700

Remarks: [a] Weight of fish: 10.22 mg each, average of 10 fish.

[b] Extra organism loaded by mistake, allowed to remain.

Table 5. Data recorded during 48 hour, *Notropis leedsi*,[a] static acute toxicity bioassay of Farmland Industries, Bartow, Polk County, Florida, NPDES #FL0000752, Outfall #001, on 9 to 11 August, 1983.

Conc. or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Total Alkalinity (mg/l as $CaCO_3$)		Total Hardness (mg/l as $CaCO_3$)		Temperature (°c)			NH_3/N (mg/l)		Conductivity (µmhos)	
	0	24	48	0	24	48	0	24	48	0	48	0	48	0	24	48	0	48	0	48
Control	5	5	5	8.8	9.5	8.9	7.7	8.1	8.1	104		112		20.4	18.2	18.4	0/.01	--		
Control	6[b]	5	5	8.8	9.5	8.9	7.7	8.1	8.1										200	187
5.6%	5	5	5	8.8	9.2	8.9	7.7	8.0	8.0					20.4	18.1	18.3				
5.6%	5	3	3	8.8	9.3	8.8	7.7	8.0	8.0										290	273
10.0%	5	5	5	8.7	9.1	8.8	7.7	8.0	8.0					20.5	18.0	18.3				
10.0%	5	5	5	8.7	9.1	8.8	7.7	8.0	8.0										360	340
18.0%	5	5	5	8.7	8.8	8.7	7.6	8.0	8.0					20.5	18.2	18.6				
18.0%	5	4	4	8.7	8.8	8.7	7.6	8.0	8.0										483	460
32.0%	5	4	3	8.7	8.9	8.6	7.5	7.8	7.9					20.3	18.1	18.4				
32.0%	5	4	3	8.7	8.9	8.6	7.5	7.8	7.9										780	720
56.0%	5	5	5	8.5	8.7	8.7	7.2	7.6	7.7					20.1	18.0	18.3				
56.0%	5	5	4	8.5	8.8	8.7	7.2	7.6	7.7										1130	1080
100.0%	5	5	5	8.2	8.7	8.6	6.6	7.0	7.2	18		330		19.9	18.1	18.3	.048/25.3	--		
100.0%	5	5	5	8.2	8.8	8.6	6.6	7.0	7.1										1780	1710

Remarks:
[a] Weight of fish: 1.87 mg each, average of 10 fish.
[b] Extra organism loaded by mistake, allowed to remain.

RESULTS AND DISCUSSION

The sample of process wastewater effluent from Farmland Industries' Outfall #001 was not toxic to the test organisms, Daphnia pulex, Pimephales promelas, Heterandria formosa, and Notropis leedsi. Only a few random N. leedsi mortalities were noted during the 48 hour static tests (Table 5). The significant amount of total ammonia measured in the effluent (25.3 mg/l) apparently did not have a toxic effect on the test organisms. The small concentrations of unionized ammonia measured, due to the low pH of the effluent, (0.048 mg/l to 0.06 mg/l) were insufficient to kill the test organisms. Since the effluent was not acutely toxic, chemical analyses were not performed.

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