

BIOASSAYS OF THE BUCKMAN STREET SEWAGE TREATMENT PLANT INCLUDING 96 HOUR FLOW-THROUGHS, 48 HOUR STATICS, STANDARD REFERENCE TOXICANT AND TEN IN-STREAM RAW SEWAGE SAMPLES

JACKSONVILLE, DUVAL COUNTY, FLORIDA

NPDES #FL0026000

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Biology Section
Division of Environmental Programs

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EXECUTIVE SUMMARY

Buckman Street STP, Jacksonville, Flow-throughs and statics, NPDES #FL0026000, on 19 to 23 October, 1986.

The Buckman Street domestic and industrial wastewater treatment facility was the subject of extensive and innovative bioassay testing by the FDER Biology Section and by Jacksonville's Buckman Street laboratory. The Biology Section performed standard 96 hour flow-through bioassays, using Notropis leedsi and Daphnia pulex, on pre-chlorinated effluent sampled from the facility's final clarifier. Eight 48 hour static bioassays, using N. leedsi, D. pulex, and Ceriodaphnia dubia, were also performed on Buckman Street's treated effluents, including pre-chlorinated, final chlorinated, and de-chlorinated samples. Additionally, the Biology Section performed Daphnia pulex and Notropis leedsi screening tests (10% and 50% concentrations) on 10 samples of raw in-stream sewage collected from around the city of Jacksonville. Preliminary rangefinding bioassays and concurrent on-site Standard Reference Toxicant bioassays were also performed. The results of all the Biology Section's tests are presented in the following table.

DATE	TYPE OF TEST	SAMPLE	ORGANISMS	LC_{50}
25-27 Sep	48 hr Rangefinding	Pre-chlorinated	N. leedsi	Not Toxic
	"	"	D. pulex	Some Mortality
	"	Raw Sewage-Station 1	N. leedsi	10%
	"	"	D. pulex	$50\% < LC_{50} < 100\%$
	"	Final chlorinated	D. pulex	$< 10\%$
	"	"	N. leedsi	$10\% < LC_{50} < 50\%$
19-23 Oct	96 hr Flow-Through	Pre-chlorinated	N. leedsi	Not toxic
	"	"	D. pulex	61.0%
19-21 Oct	48 hr Static	Pre-chlorinated	C. dubia	49.5%
21-23 Oct	"	"	C. dubia	40.4%
20-23 Oct	48 hr Static	Final chlorinated	N. leedsi	52.2%
	"	"	D. pulex	74.8%
	"	"	C. dubia	48.2%
20-22 Oct	48 hr Static	De-chlorinated	N. leedsi	62.2%
	"	"	D. pulex	Not toxic
	"	"	C. dubia	58.4%
19-21 Oct	48 hr Static	Standard Reference Toxicant	N. leedsi	7.1 ppm
	"	"	D. pulex	4.1 ppm
	"	"	C. dubia	2.9 ppm

21-22 Oct	24 hr Statics	Raw Sewage-LC_{50}'s =	*N. leedsi*	*D. pulex*
	"	Station 1	$10\% < LC_{50} < 50\%$	$> 50\%$
	"	Station 2	$10\% < LC_{50} < 50\%$	$> 50\%$
	"	Station 3	$> 50\%$	$> 50\%$
	"	Station 4	$10\% < LC_{50} < 50\%$	$> 50\%$
	"	Station 5	$10\% < LC_{50} < 50\%$	$> 50\%$
	"	Station 6	$< 10\%$	$\sim 10\%$
	"	Station 7	$10\% < LC_{50} < 50\%$	$\sim 50\%$
	"	Station 8	$10\% < LC_{50} < 50\%$	$> 50\%$
	"	Station 9	$10\% < LC_{50} < 50\%$	$> 50\%$
	"	Station 10	$10\% < LC_{50} < 50\%$	$10\% < LC_{50} < 50\%$

The above data indicated that all of the Buckman Street treated wastewaters, including pre-chlorinated (flow-through and static), chlorinated, and de-chlorinated samples were acutely toxic to one or more test organisms. The results of the Standard Reference Toxciant bioassays suggested that the sensitivities of all three test organisms were within both the EPA's and DER's recommended ranges, using sodium lauryl sulfate as the toxicant.

The results of the raw sewage bioassays suggested that the sample from Station 6 was most toxic (LC_{50}'s of approximately 10%). Toxicity was also indicated at Stations 7 and 10 to *D. pulex*. The increased sensitivity of *N. leedsi* to these samples was likely due to the presence of ammonia in the raw wastewater streams. The Buckman Street laboratory performed concurrent bioassays on aliquots of these same 10 samples that had been spiked with bacterial slurry from the facility's biological treatment system then aerated for four hours to simulate treatment received in the plant. Results indicated that only the sample from Station 10 remained toxic after this simulated treatment, producing an LC_{50} of between 10% and 50% using *D. pulex* (Mr. Charles Logue, personal communication). This result correlated well with the DER results at Station 10. Apparently, the toxicity of the raw sewage of Stations 6 and 7 was mitigated by the biological treatment. Station 10 receives primarily industrial discharges from the SCM Corporation (Mr. Charles Logue, personal communication).

We recommend that the Buckman Street facility continue their efforts to isolate and identify the source of the toxicity, then implement a pre-treatment program to reduce or eliminate it. Also, since the toxicity of the final effluent was enhanced by the presence of residual chlorine, de-chlorination is recommended.

INTRODUCTION

The Buckman Sewage Treatment Plant is located at 2221 Buckman Street, in Jacksonville, Duval County, Florida (Fig. 1). This 35 MGD capacity activated sludge treatment plant serves a population of approximately 200,000, and provides secondary treatment for wastes from a variety of major and minor industrial sources. Treatment consists of primary sedimentation, sludge aeration, secondary clarification and chlorination. Discharge is to the St. John's River, 500 feet from shore. The Buckman Street facility had recently increased its treatment capacity to approximately 54 MGD with the construction of two new final clarifiers. A chlorine contact chamber has also been added to the end of the treatment facilities.

In October, 1979, the Biology Section performed a static acute toxicity biaossay on pre-chlorinated effluent collected from the secondary clarifer to determine the toxicity of effluent from this facility. Results indicated a 48 hour LC_{50} of 50%, based on the test organism, Mysidopsis bahia (FDER 1979). Because of the complex nature of the effluent, toxicity could not be attributed to a single component.

In August, 1981, additional bioassays were performed on samples of pre-chlorinated, chlorinated and de-chlorinated effluents from this facility, to further evaluate their toxicity. The results of those tests inidcated that the pre-chlorinated and chlorinated effluents were acutely toxic to Mysidopsis bahia (approximate LC_{50}'s were 64% and 52%, respectively), while the de-chlorinated effluent was lethal to a number of shrimp (FDER 1981).

In June and July, 1982, five additional bioassays were performed on pre-chlorinated, chlorinated and de-chlorinated effluents from the Buckman Street facility. Those tests were performed using freshwater test organisms, since the salinity of the normally saline St. Johns River at that time had decreased to approximately 1 ppt. The effluents were variously lethal to the test organisms, most notable were the 48 hour LC_{50}'s of 6.3% for Daphnia pulex (chlorinated effluent), and 77.5% for Simocephalus serrulatus (de-chlorinated). The toxicity at that time was attributed to total residual chlorine and to the presence of a variety of chemical constituents (FDER 1982).

In August, 1983, three additional bioassays were performed on samples of pre-chlorinated, chlorinated and de-chlorinated effluents from this facility, using Mysidopsis bahia as the test organism. Acute toxicity was noted in the pre-chlroinated sample (48 hour LC_{50} = 99.3%) and in the chlorinated sample (48 hour LC_{50} = 14.3%), while some mortality was also noted in the de-chlorinated sample (FDER 1983). Four unidentified organic compounds were detected in the effluent at that time.

A fifth series of bioassays was performed in October, 1984, on final chlorinated and de-chlorinated effluents, using M. bahia and Notropis leedsi as test organisms. Both effluents were acutely toxic to M. bahia (LC_{50}'s of 7.0% and 62.5%, respectively), but only the chlorinated effluent was acutely toxic to N. leedsi (LC_{50} of <100%). Toxicity was attributed to chlorine and to unidentified components (FDER 1985a).

Since effluent from the Buckman Street STP has been shown to exhibit a continued toxicity problem, the facility was selected for more definitive on-site bioassay testing, with the cooperation and advice of the DER Northeast District and the City of Jacksonville's Water Services Division Buckman Street personnel. In addition to the Standard on-site 96 hour flow-through the 48 hour static bioassays on treated effluents, the Biology Section chose to perform tests on ten selected in-stream raw sewage samples collected from significant trunk lines and lift stations (Fig. 2). These sites were selected by Mr. Charles Logue of the Buckman facility since each receives specific industrial or domestic inputs from areas around the city of Jacksonville (Table 1). The results of latest tests are presented in this report. Those involved in performing these tests and in preparation of this report were: C. W. Dye, R. B. Frydenborg, and M. L. Roll.

In addition to the DER tests, the Buckman Street personnel performed concurrent bioassay tests on the samples from the ten in-stream raw sewage stations. These tests consisted of spiking the raw sewage with aliquots of mixed bacterial slurry from the facility's biological treatment system, and aerating for four hours to simulate treatment received in the plant. These results are also presented here.

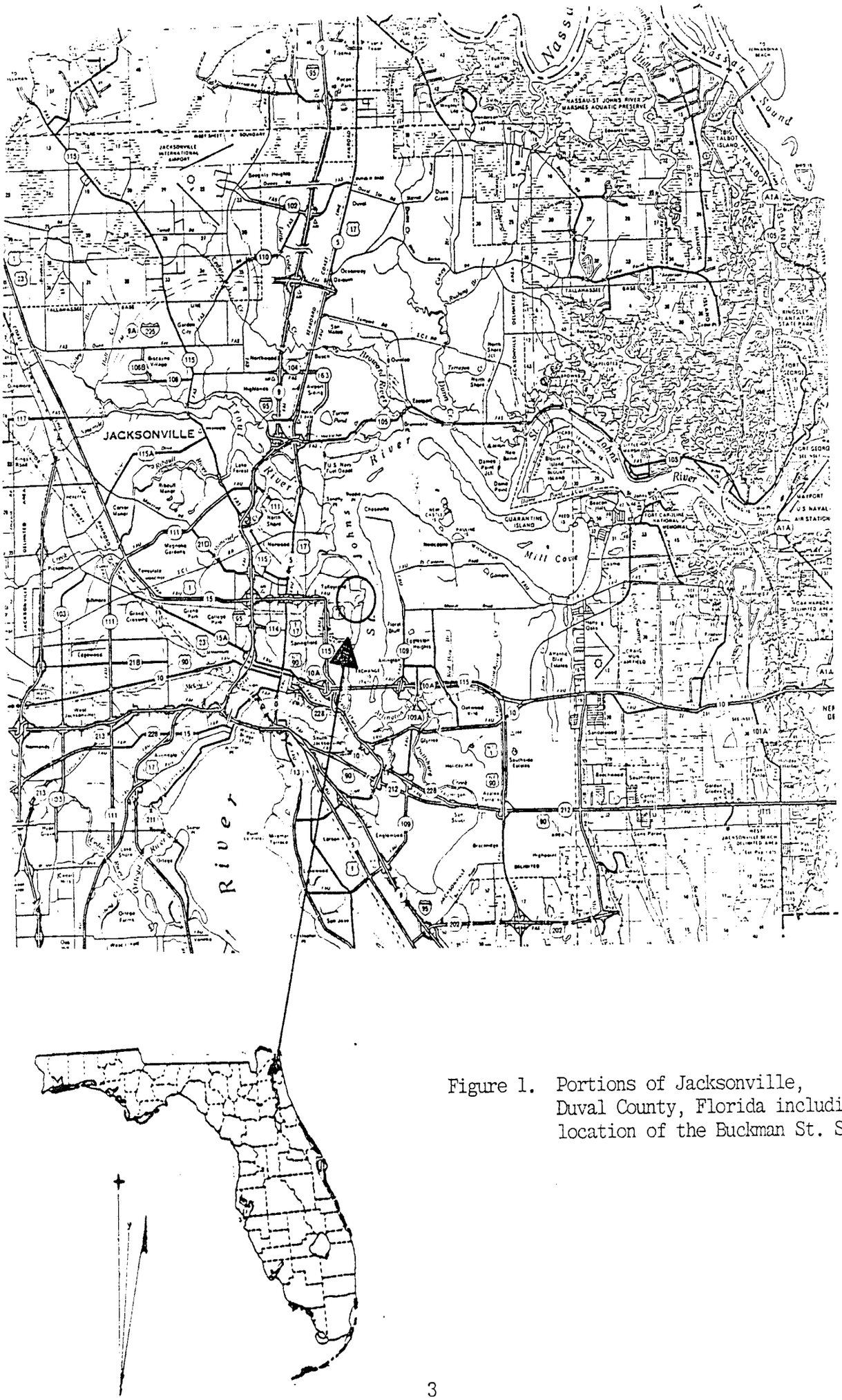


Figure 1. Portions of Jacksonville, Duval County, Florida including location of the Buckman St. STP.

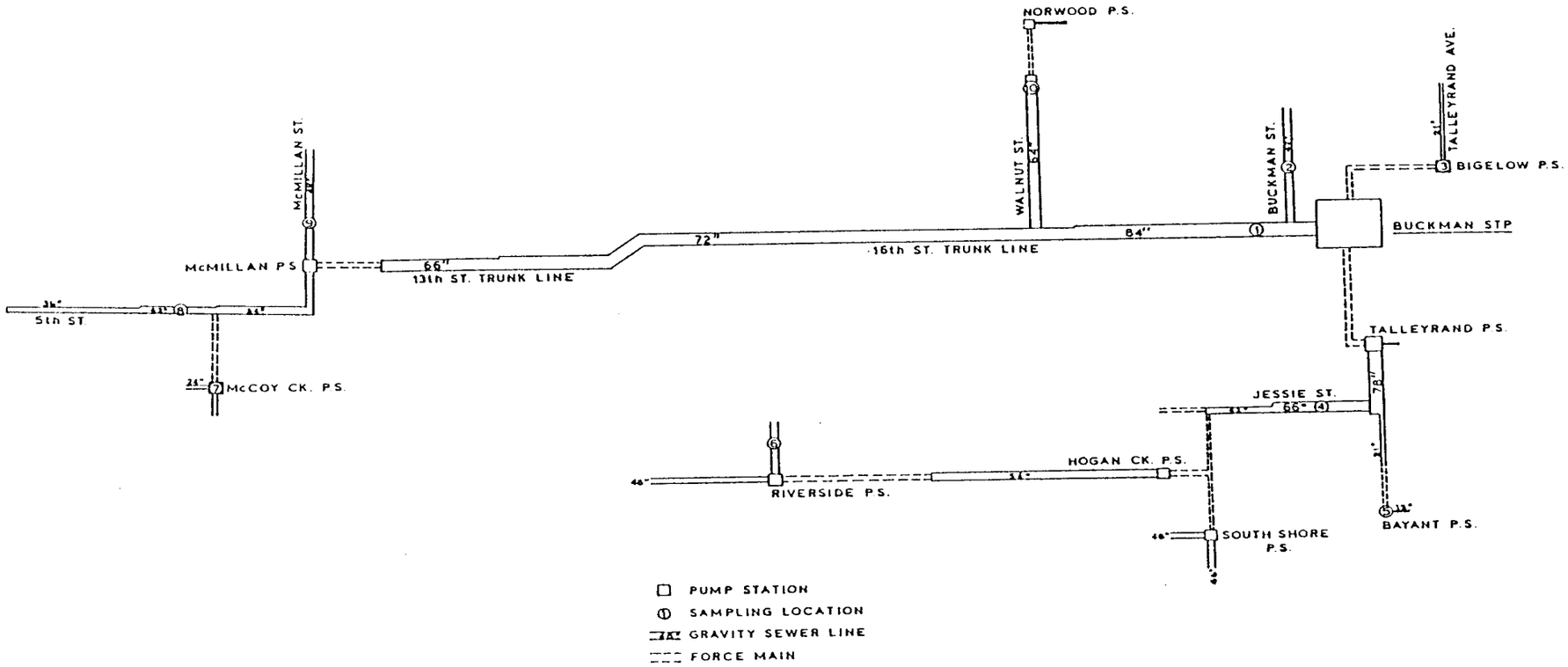


FIGURE 2. Locations of the Ten Sampling Points for the Raw In-stream Sewage Tests

TABLE 1

Collection System Toxicity Screening

Buckman STP

Sampling Location	Source	Flow (gpd)
1)	Recieves flow from Stations 7, 8, 9, and 10	?
2)	US Gypsum	55,000
3)	Tank farm area	?
4)	Maxwell House	325,000
	Jacksonville Shipyards	162,000
	Crown Plating	66,000
5)	Conversion Technology	9,000
	Tank farm area	?
6)	No major inputs	
7)	Drapers Poultry	80,000
	Fototek, Inc.	1,500
8)	Paramount Poultry	475,000
	Metal Container Corp.	180,000
	National Can Corp.	110,000
	Union Camp	100,000
9)	Seaboard Allied Milling Co.	18,000
	GMC - Electromotive Div.	8,000
10)	SCM	76,000

METHODS AND MATERIALS

Test methods used to conduct these flow-through and static bioassays are extensively described by Peltier and Weber (1985) and the FDER Biology Section (1985a). The organism selected for this study include species recommended by Peltier and Weber (1985), the U.S. EPA (1978), and the FDER Biology Section (1985b). 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.

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, 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.

The D. pulex used in the Buckman Street tests were obtained by siphoning individuals from each of our culturing aquaria into two separate one gallon glass jars, containing well water obtained from the Buckman Street facility during a preliminary site visit. This well water was used as diluent for the on-site tests and, therefore, the organisms were pre-acclimated to this dilution water. The jars were transported to the site by state vehicle and immediately transferred to the mobile bioassay lab, and therefore, did not undergo any significant temperature change or disturbance. The D. pulex were fed prior to transport, and daily thereafter, and there was no observed mortality of these organisms prior to test.

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. The C. dubia used in these tests were treated the same as were the Daphnia, except they were transported to the test site in a single one gallon jar.

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 N. leedsi used in the Buckman Street test began hatching in the Tallahassee lab on approximately September 30, 1986, in 2-1/2 gallon all-glass aquaria. Water was replaced in these aquaria over a period of days with Buckman Street well water (to be used as diluent in the on-site tests). Therefore, the fish were pre-acclimated to this dilution water. The fish were fed daily with live, freshly hatched Artemia and were acclimated to 20°C in the mobile lab prior to the test. The fish did not undergo any significant temperature change or disturbance, nor was there any mortality observed prior to the test. The fish were approximately 20 days old at the start 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. Additionally, on-site reference toxicant tests were performed in the mobile bioassay lab using Notropis leedsi, Daphnia pulex, and Ceriodaphnia dubia, to evaluate the sensitivity of these organisms after their transportation to the site and under the conditions in the mobile lab. The results of these tests would indicate whether the sensitivities of the organisms used in the tests had changed significantly from that experienced in the Tallahassee lab or had deviated from the recommended EPA and DER sensitivity ranges.

Test Methods

Dilution Water

Water used to acclimate the organisms prior to the test, and as dilution water in the flow-through and static tests, was obtained from an on-site deep well at the Buckman Street facility. This water was characterized by a pH of approximately 7.8 standard units, and a conductivity of 500 to 550, and alkalinity and hardness of approximately 140 and 440 (as $CaCo_3$), respectively.

Pre-test Conditions and Preparations

Approximately one month prior to the flow-through test, on September 24, 1986, a preliminary site visit and inspection of the Buckman Street facility was made by Mr. Martin Roll of the Biology Section. Samples of pre-chlorinated effluent, final chlorinated effluent, and one raw sewage sample (Station 1) were collected to perform preliminary rangefinding tests in the Tallahassee laboratory. These tests were performed from 25 to 27 September, 1986. The results are presented in Tables 3, 4, and 5. Additionally, sufficient dilution water was obtained from the Buckman Street deep well to acclimate the test organisms in the Tallahassee laboratory. A site for the mobile bioassay trailer was also selected.

DER's mobile bioassay laboratory was constructed following EPA design specifications (Peltier and Weber 1985) and is equipped with a solenoid valve operated, flow-through, proportional dilutor system (Fig. 3). The mobile lab also has suitable working area for performing static tests concurrently with the flow-through tests. The mobile laboratory was transported by commerical mover from Tallahassee to Jacksonville on October 17, 1986. The trailer was positioned adjacent to one of the Buckman Street's final clarifiers. Electric power for the mobile lab was supplied by Buckman Street personnel.

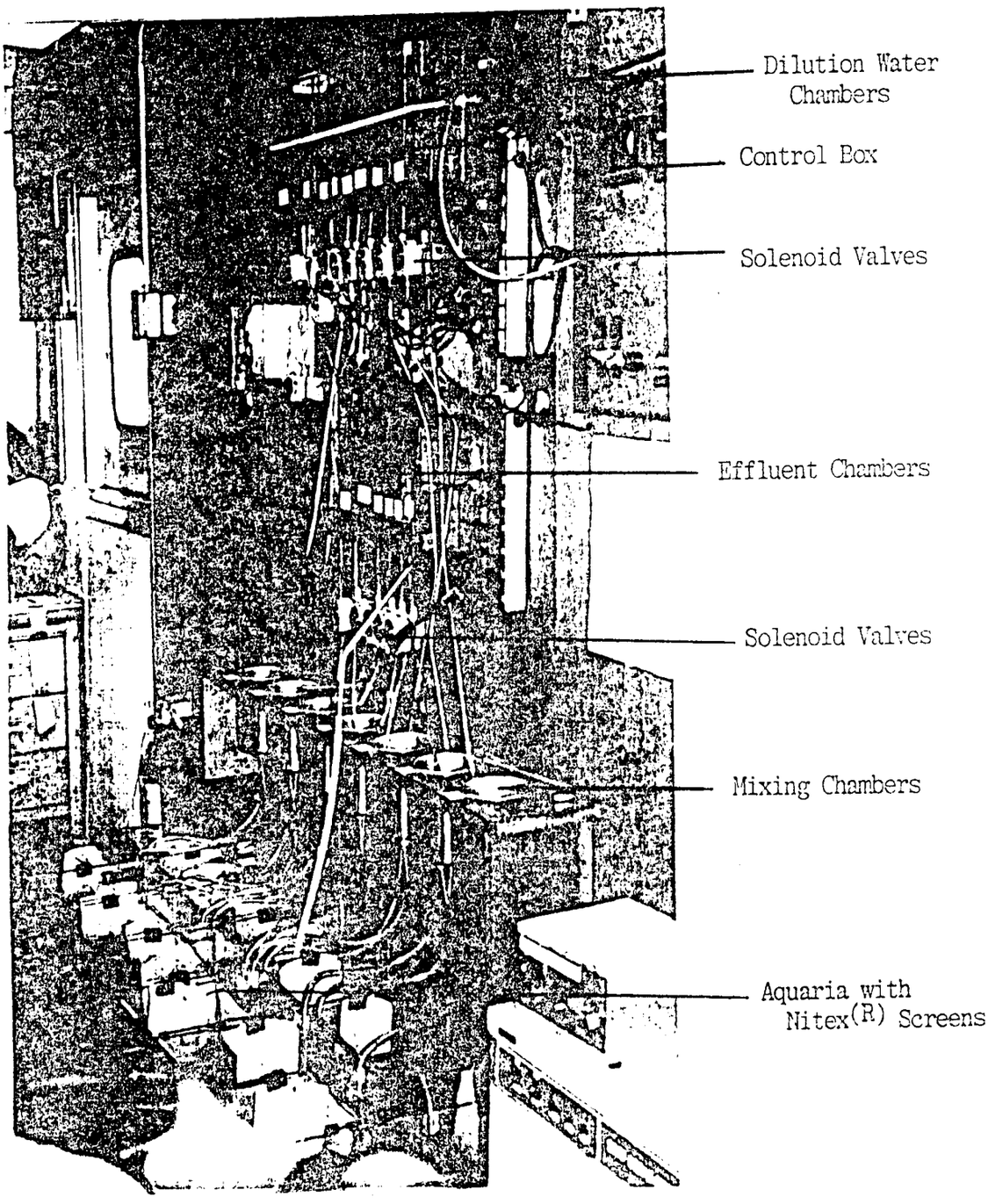
An effluent sampling pump was suspended into the wastewater stream along the inside wall of the clarifier and was positioned approximately 0.3 meters beneath the surface. Effluent was conveyed directly and continously to the mobile bioassay lab via a 100' length of braided reinforced Tygon® hose. Dilution water was transferred to a 350 gallon Nalgene® tank positioned near the mobile lab. A similar sampling pump was submerged in this tank and dilution water was conveyed directly and continously to the mobile lab via a 10' length of identical Tygon® hose. Upon entering the mobile lab, both effluent and dilution water sampling lines passed through a water bath adjusted to approximately 20°C. This water bath maintained the temperature of the effluent and dilution water at 22° $\pm$ 2°C.

Calibration of the proportional dilutor was performed in Tallahassee prior to transport to Jacksonville. Additionally, calibration was verified again just prior to the beginning of the test and at the end of the 96 hour tests. The concentrations and volumes produced by the flow-through dilutor system are presented in Table 2. Flow rates were adjusted to operate the dilutor at approximately 10.5 cycles per hour, which provided for approximately 15 complete volume changes in the 8 liter flow-through aquaria every 24 hours. The dilutor system was operated for approximately 21 hours before the introduction of the test organisms at the beginning of the test at 0900 hours on Sunday, October 19, 1986. The test was concluded at 0900 hours on Thursday, October 23, 1986.

Flow-Through Methods and Parameters

Two replicates of six concentrations and a control were used for the *Notropis leedsi* flow-through test. To facilitate counting, the organisms were pipetted from culture dishes into retention chambers, which consisted

Figure 3. Inside of DER's Mobile Bioassay Lab Showing Solenoid Valve Operated Flow-Through Dilutor System and Aquaria.



of glass petri dishes to which cylinders of Nitex® screen (243 micron mesh size) were attached by silicone cement. These Nitex® retention chambers allowed much easier counting of test organisms when lifted from the test aquaria, while not retarding water flow in the aquaria. Ten organisms were loaded per retention chamber per aquarium, resulting in 20 test organisms per test concentration.

Two replicates of four concentrations and a control were used for the Daphnia pulex flow-through test. Similar, but smaller, Nitex® retention chambers were used to contain the organisms. Ten organisms were loaded per chamber, resulting in 20 organisms per test concentration.

The number of live organisms, dissolved oxygen, pH, temperature and conductivity were recorded at 0, 24, 48, 72, and 96 hours for each aquarium. Ammonia concentrations, including total and unionized fractions (expressed in mg/l as N and NH_3, respectively), in the 100% test concentration, were also recorded daily. Total alkalinity and total hardness were also measured daily in the control and 100% concentration. These values appear in Tables 6 and 7. The Notropis leedsi were fed Artemia nauplii prior to transport and several times throughout the 96 hour test. Daphnia were fed just prior to and once during the 96 hour test.

Static Tests

1. Ceriodaphnia dubia - Pre-chlorinated effluent

During the first two and last two days of the flow-through test, a C. dubia 48 hour static bioassays was performed, using four test concentrations (effluent and dilution water) obtained directly from the flow-through aquaria.

Two replicates, of each of the flow-through concentrations and the control, were used to test with the water fleas. Flint glass jars of 60 ml capacity were used as test chambers, and 50 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. Data for these tests are presented in Tables 8 and 9.

2. Ceriodaphnia dubia, Daphnia pulex, and Notropis leedsi - Chlorinated Effluent.

On 20 to 22 October, during the flow-through test, three 48 hour static tests were performed on a sample of final chlorinated effluent collected from the Buckman Street discharge line. Four test concentrations were selected for these tests (Table 2). The C. dubia were tested as described above. For the D. pulex test, flint glass jars of 250 ml capacity were used, each containing 200 ml of the appropriate test concentration. 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 these tests. For the N. leedsi test, quart size glass jars were used, each containing 500 ml of the appropriate test concentration. Five fish were siphoned into each jar, resulting in 10 fish per concentration. The fish were not fed during the test. Test data are reported in Tables 10, 11, and 12.

3. Ceriodaphnia dubia, Daphnia pulex, and Notropis leedsi - De-chlorinated Effluent.

Also on 20 to 22 October, during the flow-through test three 48 hour static screening tests (50% and 100% test concentrations) were performed on a sample of final chlorinated effluent that had been de-chlorinated by the addition of sodium thiosulfate. Test conditions were similar to as described above. Test data are reported in Table 13.

48 Hour Standard Reference Toxicant Bioassays

During the first two days of the flow-through bioassay 19 to 21 October, 1986) three Standard Reference Toxicant bioassays were performed on-site, in the bioassay trailer. Sodium lauryl sulfate was used as the reference toxicant, in a stock concentration of 100 ppm. This stock concentration was diluted in Tallahassee well water to obtain a concentration series (Table 1) of from 1 to 10 ppm. Two replicates of each concentration was used, each containing either 10 water fleas or 5 fish.

These tests would indicate if the sensitivities of the organisms used in these tests were significantly different from sensitivities obtained in previous tests in the Tallahassee labortory. 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 conductivitiy of each test concentration was recorded at the beginning and end of the test. All data recorded during these tests are presented in Tables 14, 15, and 16. The organisms were not fed during the tests.

In-stream Raw Sewage Samples

On 21 to 22 October, 20 separate static screening tests (10% and 50% concentrations) were performed on 10 samples of raw sewage collected from strategic locations around the city of Jacksonville, using D. pulex and N. leedsi as test organisms. Test conditions were similar as described above, except that these tests were performed in the Buckman Street labortory. Test chambers were aerated as needed. Test data are reported in Tables 17 through 22.

City of Jacksonville Buckman Street Raw Sewage Tests

On 21 to 23 October, Buckman Street plant personnel performed static bioassays on split samples of the raw sewage, that had been spiked with aliquots of bacterial slurry obtained from the plant's biological treatment system, then aerated for four hours to simulate treatment received in the plant. Three D. pulex were exposed to each of the treated raw sewage samples in small, plastic cups. Results of these tests are presented in Table 23.

Table 1. Diluent and Effluent Volumes, and Final Concentrations used in Flow-Through and Static Bioassays of Buckman Street STP (19 to 23 October, 1986).

1. Flow-Through Bioassay (19 to 23 October, 1986), Notropis leedsi and Daphnia pulex

Diluent[a]		Effluent[a]		Total Volume[a]		Final Concentration[a]		Average Concentration
0 Hours	96 Hours	0 Hours	96 Hours	0 Hours	96 Hours	0 Hours	96 Hours	
978 ml	1000 ml	0 ml	0 ml	978 ml	1000 ml	0%	0%	0%
910 ml	909 ml	53 ml	48 ml	963 ml	957 ml	5.5%	5.0%	5.3%
939 ml	935 ml	102 ml	96 ml	1041 ml	1031 ml	9.8%	9.3%	9.6%
735 ml	725 ml	160 ml	148 ml	895 ml	873 ml	17.9%	16.9%	17.4%
660 ml	654 ml	323 ml	304 ml	983 ml	958 ml	32.9%	31.7%	31.7%
418 ml	418 ml	503 ml	480 ml	921 ml	898 ml	55.0%	53.4%	54.2%
0 ml	0 ml	878 ml	900 ml	878 ml	900 ml	100.0%	100.0%	100.0%

2. Statics (C. dubia, D. pulex, and N. leedsi) (19 to 23 October, 1986)

Ceriodaphnia dubia (water flea)[b]

Daphnia pulex (water flea)

Concentration[a]	Dilution Water	Effluent	Total Volume
Control	200.0 ml	--------	200 ml
10.0%	180.0 ml	20.0 ml	200 ml
32.0%	136.0 ml	64.0 ml	200 ml
50.0%	100.0 ml	100.0 ml	200 ml
56.0%	88.0 ml	112.0 ml	200 ml
100.0%	---------	200.0 ml	200 ml

Notropis leedsi (bannerfin shiner)

Concentration[a]	Dilution Water	Effluent	Total Volume
Control	500 ml	--------	500 ml
10.0%	450 ml	50 ml	500 ml
32.0%	340 ml	160 ml	500 ml
50.0%	250 ml	250 ml	500 ml
56.0%	220 ml	280 ml	500 ml
100.0%	------	500 ml	500 ml

3. Notropis leedsi Standard Reference Toxicant Test (19 to 21 October, 1986)

Concentration	Dilution Water	Toxicant	Total Volume
Control	500 ml	-----	500 ml
1.0 ppm	495 ml	5 ml	500 ml
5.0 ppm	475 ml	25 ml	500 ml
10.0 ppm	450 ml	50 ml	500 ml

Daphnia pulex Standard Reference Toxicant Test (19 to 21 October, 1986)

Concentration	Dilution Water	Toxicant	Total Volume
Control	200 ml	-----	200 ml
1.0 ppm	198 ml	2 ml	200 ml
5.0 ppm	190 ml	10 ml	200 ml
10.0 ppm	180 ml	20 ml	200 ml

Ceriodaphnia dubia Standard Reference Toxicant Test (19 to 21 October, 1986)

Concentration	Dilution Water	Toxicant	Total Volume
Control	50.0 ml	-----	50 ml
1.0 ppm	49.5 ml	0.5 ml	50 ml
5.0 ppm	47.5 ml	2.5 ml	50 ml
10.0 ppm	45.0 ml	5.0 ml	50 ml

[a] All values are the average of two or more replicates. Final concentrations are to nearest 0.1%. Not every concentration was used in all the tests.

[b] C. dubia test concentrations were obtained directly from the flow-through test aquaria (control, 9.6%, 32.3%, 54.2%, and 100.0%).

Table 3. Data recorded during 48 hour, *Daphnia pulex* and *Notorpis leedsi*, static acute toxicity bioassay of Buckman Street STP, Jacksonville, Ranefinding Tests on 25 to 27 September, 1986.

Concentration or %	Number of Live Organisms 0	24	48	Dissolved Oxygen (mg/l) 0	24	48	pH 0	24	48	Temperature (°C) 0	24	48	0	48
Daphnia pulex - Pre-chlorinated Effluent														
Control	10	10	10	8.8	8.8		8.2	7.8		20.8	20.0			
Control	10	10	10	8.8	8.8		8.2	7.8					190	
50.0%	10	10	10	7.3	8.4		7.6	7.9		20.6	19.7			
50.0%	10	9	9	7.3	8.4		7.6	7.9					650	
100.0%	10	10	10	5.6	8.3		7.4	7.9		20.4	19.7			
100.0%	10	10	6	5.6	8.3	7.8	7.4	7.9					1020	
Notropis leedsi - Pre-chlorinated Effluent														
Control	5	5	5	8.3	7.5		7.6	7.8		21.5	19.7			
Control	5	5	4	8.3	7.5		7.6	7.8					195	
50.0%	5	5	5	8.3	7.5		7.6	7.8		21.0	19.5			
50.0%	5	4	4	6.9	7.3		7.4	7.7					650	
100.0%	5	5	5	5.4	6.5		7.3	7.7		20.5	19.4			
100.0%	5	5	5	5.4	6.5		7.3	7.7					1030	

Control Water

NH_3(as NH_3)(mg/l) 0

Total Alkalinity 120 (mg/l $CaOO_3$)

Total ammonia (as N)(mg/l) 0

Total Hardness 121 (mg/l $CaOO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) 0.076

Total Alkalinity 232 (mg/l $CaOO_3$)

Total ammonia (as N)(mg/l) 6.2

Total Hardness 251 (mg/l $CaOO_3$)

Table 4. Data recorded during 48 hour, Daphnia pulex and Notropis leedsi, static acute toxicity bioassay of Buckman Street STP, Jacksonville, Rangefinding Tests on 25 to 27 September, 1986.

Concentration or %	Number of Live Organisms 0	24	48	Dissolved Oxygen (mg/l) 0	24	48	pH 0	24	48	Temperature (°C) 0	24	48	0	48
Daphnia pulex - Chlorinated Effluent[a]														
Control	10	10	10	8.6	8.5		8.1	8.0		21.3	19.7			
Control	10	10	10	8.6	8.5		8.1	8.0					189	
10.0%	10	0	0	8.6	8.7		7.9	8.0		21.1	19.7			
10.0%	10	0	0	8.6	8.7		7.9	8.0					280	
50.0%	10	0	0	8.1	8.8		7.5	8.0		21.0	19.7			
50.0%	10	0	0	8.1	8.8		7.5	8.0					650	
Notorpis leedsi - Chlorinated Effluent[a]														
Control	5	5	5	8.3	7.5		7.6	7.8		21.5	19.7			
Control	5	5	4	8.3	7.5		7.6	7.8					195	
10.0%	5	5	5	8.2	8.0		7.5	7.9		21.8	19.5			
10.0%	5	5	5	8.2	8.0		7.5	7.9					275	
50.0%	5	0	0	8.0	8.1		7.4	7.8		21.4	19.5			
50.0%	5	0	0	8.0	8.1		7.4	7.8					700	

Control Water

NH_3(as NH_3)(mg/l) 0

Total ammonia (as N)(mg/l) 0

Total Alkalinity (mg/l $CaCO_3$) 120

Total Hardness (mg/l $CaCO_3$) 121

100% Effluent

NH_3(as NH_3)(mg/l) 0.09

Total ammonia (as N)(mg/l) 6.8

Total Alkalinity (mg/l $CaCO_3$) 176

Total Hardness (mg/l $CaCO_3$) 189

[a] Total Residual Chlorine: 0.75 mg/l

Table 5. Data recorded during 48 hour, Daphnia pulex and Notropis leedsi, static acute toxicity bioassay of Buckman Street STP, Jacksonville, Rangefinding Tests on 25 to 27 September, 1986.

Raw Sewage[a] Station 1

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)		
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	
Daphnia pulex															
Control	10	10	10	8.7	8.3		8.0	7.8		24.3	25.0				
Control	10	10	8	8.7	8.3		8.0	7.8					202		
10.0%	10	9	9	8.5	3.9		8.0	7.7		24.5	24.7				
10.0%	10	9	8	8.5	4.2		8.0	7.7					300		
50.0%	10	10	10	7.5	6.8[b]		7.8	8.0		24.5	24.5				
50.0%	10	9	9	7.5	7.2[b]		7.8	8.0					740		
100.0%	10	0	0	6.2	7.0[b]		7.8	8.2		24.5	24.2				
100.0%	10	1	0	6.2	7.0[b]		7.8	8.2					1200		
Notropis leedsi															
10.0%	5	2	2	8.4	4.7		7.7	7.8		24.4	25.0				
10.0%	5	4	4	8.4	4.7		7.7	7.8					310		
50.0%	5	0	0	7.1	7.0[b]		7.8	8.1		24.3	25.0				
50.0%	5	0	0	7.1	7.5[b]		7.8	8.1					780		
100.0%	5	0	0	6.4	7.4[b]		7.8	8.3		24.5	25.2				
100.0%	5	0	0	6.4	7.4[b]		7.8	8.3					1220		

Control Water

NH_3(as NH_3)(mg/l) 0

Total ammonia (as N)(mg/l) 0

Total Alkalinity (mg/l $CaCO_3$) 120

Total Hardness (mg/l $CaCO_3$) 121

100% Effluent

NH_3(as NH_3)(mg/l) 0.43

Total ammonia (as N)(mg/l) 10.5

Total Alkalinity (mg/l $CaCO_3$) 220

Total Hardness (mg/l $CaCO_3$) 245

[a] Raw sewage sample was aerated from 1.5 mg/l to 6.5 mg/l prior to the start of the test.

[b] These jars were aerated starting from hour 6 of the test.

Table 6. Data recorded during 96 hour, Notropis leedsi, flow-through bioassay of Buckman Street STP, Jacksonville, NPDES #FL0026000, Pre-chlorinated effluent, 19 to 23 October, 1986.

Conc. or %	Test Container Number	Number of Live Organisms					Dissolved Oxygen (mg/l)					pH					Conductivity (umhos)					Temperature (°C)					Alkalinity, Hardness ($CaCO_3$) and Ammonia Control and 100% Effluent				
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
Control		10	10	10	10	10	9.0	8.9	8.5	7.2	7.1	7.8	7.8	7.5	7.7	7.8	550	505	550	510	520	21.1	20.3	20.7	21.0	21.4	Alkalinity(mg/l)Control:				
Contorl		10	10	10	10	10	9.0	8.9	8.5	7.2	7.1	7.8	7.8	7.6	7.7	7.8	550	510	550	510	520	21.3	20.6	21.3	21.4	22.2	139	137	145	143	135
5.3%		10	10	10	10	10	8.9	8.7	8.1	6.7	6.7	7.8	7.8	7.7	7.9	7.8	600	580	600	570	580	21.3	20.5	20.7	21.1	21.5	Akalinity(mg/l)100% Eff:				
5.3%		10	10	10	10	10	8,9	8.7	8.1	7.0	6.9	7.8	7.8	7.7	7.9	7.8	600	580	600	570	580	21.5	20.8	21.3	21.6	22.3	250	245	251	232	252
9.6%		10	10	10	10	10	8.6	8.5	7.5	6.5	6.6	7.8	7.7	7.7	7.9	7.7	650	605	620	600	600	21.4	20.7	20.7	21.2	21.5	Hardness(mg/l) Control:				
9.6%		10	10	10	10	10	8.5	8.5	7.5	6.5	6.6	7.8	7.7	7.7	7.9	7.7	650	605	630	600	600	21.5	21.0	21.3	21.6	22.2	435	445	457	432	493
17.4%		10	10	10	10	10	8.5	8.3	7.2	6.3	6.2	7.7	7.7	7.7	7.9	7.7	700	690	700	790	680	21.6	21.0	21.4	21.5	21.7	Hardness(mg/l)100% Eff:				
17.4%		10	10	10	10	10	8.5	8.3	7.2	6.3	6.2	7.7	7.7	7.7	7.9	7.7	700	690	710	790	680	21.8	21.4	22.0	22.0	22.5	435	490	529	463	495
32.3%		10	10	10	10	10	8.0	7.9	6.7	5.4	5.3	7.6	7.6	7.6	7.8	7.6	810	800	850	800	790	22.0	21.3	21.7	21.8	21.9					
32.3%		10	10	10	10	10	7.9	7.8	6.7	5.6	5.6	7.6	7.6	7.6	7.8	7.6	810	800	850	800	790	22.1	21.5	22.0	22.1	22.4	Ammonia, union total, Control:				
54.2%		10	10	10	10	10	7.1	7.1	6.3	4.6	4.5	7.5	7.6	7.5	7.7	7.5	1000	1000	1050	1000	940	22.6	21.8	22.3	22.3	22.3	.002/.07	0/0	.002/.10	.001/.044	-
54.2%		10	10	10	10	10	7.1	7.1	6.2	4.6	4.5	7.5	7.6	7.5	7.7	7.5	1000	1000	1050	1000	940	22.8	22.1	22.6	22.5	22.7	Ammonia, union total,100% eff				
100.0%		10	10	10	10	10	6.2	5.3	5.2	4.2	3.4	7.4	7.4	7.5	7.6	7.4	1380	1390	1500	1400	1300	23.8	22.8	23.7	23.3	22.9	0.18/11.2	0.17/11.3	0.20/10.4	0.32/13.3	0.16/11.2
100.0%		10	9	9	9	9	6.2	6.3	5.7	4.2	3.4	7.4	7.4	7.5	7.6	7.4	1380	1395	1500	1400	1300	23.9	23.1	24.0	23.6	23.5					

Table 7. Data recorded during 96 hour, Daphnia pulex, flow-through bioassay of Buckman Street STP, Jacksonville, NPDES #FL0026000, Pre-chlorinated effluent, on 19 to 23 October, 1986.

Conc. or %	Test Container Number	Number of Live Organisms					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l as $CaCO_3$)					Total Hardness (mg/l as $CaCO_3$)					Temperature				
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
Control		10	10	10	10	10																								
Control		10	10	10	10	8																								
9.6%		10	10	10	10	10																								
9.6%		10	10	10	10	9																								
32.3%		10	8	8	8	8																								
32.3%		10	10	10	10	10																								
54.2%		10	10	10	10	8																								
54.2%		10	10	9	9	8																								
100.0%		10	8	2	0	0																								
100.0%		10	9	3	0	0																								

Remarks: All parameters same as in N. leedsi test.

Table 8. Data recorded during 48 hour, Ceriodaphnia dubia, static bioassay of Buckman Street STP, Jacksonville, NPDES #FL0026000 on 19 to 21 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	9.0	8.1	8.2	7.8	7.8	8.0	21.1	19.3	21.9	550	
Control	10	10	10	9.0	8.1	8.2	7.8	7.8	8.0	21.3			550	
9.6%	10	10	10	8.6	8.0	8.0	7.8	7.9	8.1	21.4	18.9	21.7	650	
9.6%	10	10	10	8.5	8.0	8.0	7.8	7.9	8.1	21.5			650	
32.3%	10	10	10	8.0	8.0	8.0	7.6	7.9	8.1	22.0	18.8	21.5	810	
32.3%	10	10	10	7.9	8.0	8.0	7.6	7.9	8.1	22.1			810	
54.2%	10	8	3	7.1	8.0	7.9	7.5	8.0	8.1	22.6	18.9	21.7	1000	
54.2%	10	9	4	7.1	8.0	7.9	7.5	8.0	8.1	22.8			1000	
100.0%	10	3	0	6.2	8.0	7.8	7.4	8.2	8.2	22.3	19.0	21.7	1380	
100.0%	10	4	0	6.2	8.0	7.8	7.4	8.2	8.2	23.9			1380	

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

Table 9. Data recorded during 48 hour Ceriodaphnia dubia, static bioassay of Buckman Street STP,, Jacksonville, NPDES #FL0026000, on 21 to 23 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	8.5	7.8	8.0	7.5	8.6	8.3	20.7	21.8	22.7	550	
Control	10	9	9	8.5	7.8	8.0	7.6	8.6	8.3	21.3			550	
9.6%	10	10	10	7.5	7.9	8.1	7.7	8.6	8.3	20.7	21.6	22.5	620	
9.6%	10	10	10	7.5	8.0	8.1	7.7	8.6	8.3	21.3			630	
32.3%	10	10	10	6.7	8.0	8.1	7.6	8.6	8.4	21.7	21.5	22.2	850	
32.3%	10	10	9	6.7	8.0	8.1	7.6	8.6	8.4	22.0			850	
54.2%	10	2	0	6.3	8.0	8.0	7.5	8.7	8.4	22.3	21.4	22.2	1050	
54.2%	10	8	0	6.2	8.0	8.0	7.5	8.7	8.4	22.6			1050	
100.0%	10	1	0	5.2	8.1	8.0	7.5	8.7	8.4	23.7	21.4	22.0	1500	
100.0%	10	0	0	5.7	8.1	8.0	7.5	8.7	8.4	24.0			1500	

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

Table 10. Data recorded during 48 hour, Ceriodaphnia dubia, static bioassay of Buckman Street STP, Jacksonville, NPDES #FL0026000, Final Chlorinated Effluent[a], on 20 to 22 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	8.2	7.9	7.7	7.6	7.9	8.2	22.5	21.0	21.1		
Control	10	10	10	8.2	7.9	7.7	7.6	7.9	8.2					
10.0%	10	10	10	8.1	7.9	7.8	7.7	7.9	8.3	22.9	21.0	21.0		
10.0%	10	10	10	8.1	7.9	7.8	7.7	7.9	8.3					
32.0%	10	10	10	8.1	7.9	7.9	7.7	8.0	8.4	23.4	21.0	20.9		
32.0%	10	10	10	8.1	7.9	7.9	7.7	8.0	8.4					
56.0%	10	10	2	8.1	8.0	7.9	7.7	8.1	8.5	24.1	21.0	20.8		
56.0%	10	10	3	8.0	8.0	7.9	7.7	8.1	8.5					
100.0%	10	0	0	8.0	8.2	7.9	7.6	8.3	8.5	25.1	20.9	20.8		
100.0%	10	0	0	8.0	8.2	7.9	7.6	8.3	8.5					

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

[a] Total Residual Chlorine: 0.7 mg/l (HACH DPD Method).

Table 11. Data recorded during 48 hour, Daphnia pulex, static acute bioassay of Buckman Street STP, Jacksonville, NPDES #FL0026000, Final Chlorinated Effluent[a] on 20 to 22 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	8.0	6.7	7.0	7.8	7.9	8.2	22.2	21.2	20.9		
Control	10	10	10	8.0	6.7	7.0	7.9	7.9	8.2				500	520
10.0%	10	10	10	7.9	6.6	7.2	7.8	7.9	8.3	22.9	21.1	20.9		
10.0%	10	10	10	7.9	6.6	7.2	7.8	7.9	8.3				600	600
32.0%	10	10	10	7.8	6.5	7.2	7.7	8.0	8.3	23.2	21.0	20.8		
32.0%	10	10	10	7.8	6.5	7.2	7.7	8.0	8.3				800	780
56.0%	10	10	10	7.6	6.6	7.4	7.7	8.0	8.4	24.0	20.9	20.6		
56.0%	10	10	10	7.7	6.6	7.3	7.7	8.0	8.4				1000	980
100.0%	10	0	0	7.8	8.2	6.4	7.6	8.2	8.4	24.9	20.7	20.5		
100.0%	10	0	0	7.7	8.2	6.4	7.6	8.2	8.4				1350	1300

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

[a] Total Residual Chlorine: 0.7 mg/l (HACH DPD Method).

Table 12. Data recorded during 48 hour, Notropis leedsi, static acute toxicity bioassay of Buckman Street STP, Jacksonville, NPDES #FL0026000, Final Chlorinated Effluent[a], on 20 to 22 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	5	5	5	7.9	8.0	7.9	7.7	7.9	8.5	21.4	22.8	21.9		
Control	5	5	5	7.9	8.0	7.9	7.7	7.9	8.5				530	550
10.0%	5	5	5	8.0	8.1	7.8	7.8	8.0	8.5	22.5	21.6	21.0		
10.0%	5	5	5	8.0	8.1	7.8	7.8	8.0	8.5				600	610
32.0%	5	5	5	8.0	8.1	7.9	7.7	8.0	8.5	23.1	21.5	21.0		
32.0%	5	5	5	7.9	8.1	7.9	7.7	8.1	8.5				800	790
56.0%	5	4	2	7.7	8.1	7.9	7.7	8.1	8.5	23.8	21.5	20.9		
56.0%	5	5	2	7.7	8.1	7.9	7.7	8.1	8.5				1000	995
100.0%	5	0	0	7.6	8.2	7.7	7.6	8.1	8.5	24.5	21.5	20.9		
100.0%	5	0	0	7.5	8.2	7.6	7.6	8.1	7.6				1350	1320

Control Water

NH_3(as NH_3)(mg/l) _____

Total ammonia (as N)(mg/l) _____

Total Alkalinity _____ (mg/l $CaCO_3$)

Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____

Total ammonia (as N)(mg/l) _____

Total Alkalinity _____ (mg/l $CaCO_3$)

Total Hardness _____ (mg/l $CaCO_3$)

[a] Total Residual Chlorine: 0.7 mg/l (HACH DPD Method).

Table 13. Data recorded during 48 hour, Ceriodaphnia dubia, Daphnia pulex, and Notropis leedsi, static bioassays of Buckman Street STP, Jacksonville, De-chlorinated effluent, on 20 to 22 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)				
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Ceriodaphnia dubia - De-chlorinated Effluent														
Control	10	10	10	7.6	8.0	7.8	7.7	7.8	8.5	22.0	22.3	21.8		
Control	10	10	10	7.6	8.0	7.9	7.7	7.8	8.5					
50.0%	10	10	7	7.6	7.7	7.9	7.6	7.9	8.6	23.2	22.4	21.9		
50.0%	10	9	7	7.6	7.7	8.0	7.6	7.9	8.6					
100.0%	10	0	0	7.3	7.7	7.8	7.5	8.1	8.6	24.2	22.5	21.9		
100.0%	10	0	0	7.3	7.7	7.8	7.5	8.1	8.6					
Daphnia pulex - De-chlorinated Effluent														
Control	10	10	10	7.7	7.2	7.7	7.7	7.9	8.5	21.9	22.7	21.8		
Control	10	10	10	7.7	7.2	7.6	7.7	7.9	8.5				510	550
50.0%	10	10	9	7.4	6.9	7.4	7.6	7.9	8.5	23.5	22.7	21.8		
50.0%	10	10	10	7.4	6.9	7.3	7.6	7.9	8.5				950	920
100.0%	10	10	9	7.2	5.9	7.0	7.5	8.0	8.5	24.0	22.8	21.9		
100.0%	10	10	10	7.2	5.9	7.0	7.5	8.0	8.5				1430	1320
Notropis leedsi - De-chlorinated Effluent														
Control	5	5	5	7.9	8.0	7.9	7.7	7.9	8.5	21.4	22.8	21.9		
Control	5	5	5	7.9	8.0	7.9	7.7	7.9	8.5				530	550
50.0%	5	5	4	7.3	7.9	7.8	7.6	8.0	8.5	23.2	22.7	21.9		
50.0%	5	5	4	7.3	7.9	7.8	7.6	8.0	8.5				990	980
100.0%	5	0	0	6.9	7.6	7.4	7.4	8.0	8.5	24.5	22.7	21.9		
100.0%	5	1	0	6.9	7.6	7.4	7.4	8.0	8.5				1410	1370

Control Water	
NH_3(as NH_3)(mg/l) _____	Total Alkalinity (mg/l $CaOO_3$)
Total ammonia (as N)(mg/l) _____	Total Hardness (mg/l $CaOO_3$)

100% Effluent	
NH_3(as NH_3)(mg/l) _____	Total Alkalinity (mg/l $CaOO_3$)
Total ammonia (as N)(mg/l) _____	Total Hardness (mg/l $CaOO_3$)

Table 14. Data recorded during 48 hour, Ceriodaphnia dubia, static acute bioassay of sodium lauryl sulfate (Standard Reference Toxicant), at Buckman Street STP, on 19 to 21 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	8.5	9.4	8.0	7.5	7.9	7.8	20.6	18.8	22.0		
Control	10	10	10	8.5	9.4	8.0	7.5	7.9	7.8					
1.0 ppm	10	10	10	8.6	9.5	8.1	7.5	7.9	7.8	20.7	18.5	21.9		
1.0 ppm	10	10	10	8.6	9.5	8.1	7.5	7.9	7.8					
5.0 ppm	10	4	1	8.6	9.5	8.1	7.5	7.9	7.8	20.8	18.3	21.9		
5.0 ppm	10	5	1	8.6	9.5	8.1	7.5	7.9	7.8					
10.0 ppm	10	3	2	8.5	9.5	8.1	7.5	8.0	7.7	21.0	19.2	22.0		
10.0 ppm	10	4	1	8.5	9.5	8.1	7.5	8.0	7.7					

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

Table 15. Data recorded during 48 hour, Daphnia pulex, static acute toxicity bioassay of sodium lauryl sulfate (Standard Reference Toxicant), at Buckman Street STP, on 17 to 21 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	10	10	10	8.5	9.4	7.5	7.4	7.8	7.8	21.1	18.5	22.3		
Control	10	10	10	8.5	9.4	7.5	7.4	7.8	7.8				220	240
1.0 ppm	10	10	10	8.5	9.4	7.4	7.5	7.9	7.8	21.3	18.3	22.2		
1.0 ppm	10	10	10	8.5	9.4	7.4	7.5	7.9	7.8				227	245
5.0 ppm	10	10	4	8.5	9.4	7.1	7.5	7.9	7.8	21.4	18.1	22.2		
5.0 ppm	10	10	5	8.5	9.4	7.1	7.5	7.9	7.8				223	245
10.0 ppm	10	9	1	8.5	9.4	6.2	7.5	7.9	7.7	21.5	18.2	22.2		
10.0 ppm	10	7	0	8.5	9.4	6.2	7.5	7.9	7.7				223	245

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaOO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaOO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaOO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaOO_3$)

Table 16. Data recorded during 48 hour, Notropis leedsi, static acute toxicity bioassay of sodium lauryl sulfate (Standard Reference Toxicant), at Buckman Street STP, on 19 to 21 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	5	5	5	8.7	8.9	8.3	7.4	7.7	7.8	21.6	19.6	23.1		
Control	5	5	5	8.7	8.9	8.3	7.4	7.4	7.8				228	250
1.0 ppm	5	5	5	8.6	9.1	8.1	7.4	7.7	7.8	21.7	19.2	22.8		
1.0 ppm	5	5	5	8.6	9.1	8.1	7.4	7.8	7.8				230	250
5.0 ppm	5	5	5	8.5	9.2	7.6	7.4	7.8	7.8	21.8	18.8	22.7		
5.0 ppm	5	5	5	8.5	8.2	7.2	7.4	7.8	7.8				230	250
10.0 ppm	5	5	0	8.5	9.3	6.0	7.5	7.8	7.8	21.9	19.6	22.6		
10.0 ppm	5	5	0	8.5	8.3	6.1	7.5	7.8	7.8				228	250

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

Table 17. Data recorded during 24 hour, Daphnia pulex, static acute toxicity bioassays of Raw In-stream Sewage Samples, City of Jacksonville, on 21 to 22 October, 1986.

Controls and Stations 1, 2, and 3

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)		
	0	24	48	0	24	48	0	24	48	0	24	48	0		48
Control	10	10		8.8	7.7		7.6			21.9					
Control	10	10		8.8	7.7		7.6						500		
Control	10	10		8.8	7.7		7.6			22.0					
Control	10	10		8.7	7.7		7.6						500		
Station 1 10%	10	10		8.1	6.5		7.6			20.8					
10%	10	10		8.0	6.5		7.6						580		
50%	10	10		6.9	7.2		7.4			20.3					
50%	10	8		7.5	7.2		7.4						800		
Station 2 10%	10	10		8.2	3.8		7.2			20.7					
10%	10	10		8.2	4.7		7.2						695		
50%	10	10		8.5	0.5		6.5			20.0					
50%	10	10		8.6	0.5		6.5						1400		
Station 3 10%	10	10		8.7	7.3		7.7			20.9					
10%	10	10		8.7	7.3		7.7						580		
50%	10	10		9.0	3.9		8.0			20.4					
50%	10	10		8.9	3.1		8.0						870		

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

Table 18. Data recorded during 24 hour, Daphnia pulex, static acute toxicity bioassays of Raw In-stream Sewage Samples, City of Jacksonville, on 21 to 22 October, 1986.

Stations 4 through 7

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Station 4 10%	10	10		7.6	7.4		7.5			20.7				
10%	10	10		7.7	7.4		7.5						680	
50%	10	10		8.1	5.2		7.0			20.0				
50%	10	10		8.1	5.2		7.0						1280	
Station 5 10%	10	10		8.1	7.6		7.5			21.0				
10%	10	10		8.0	7.6		7.5						520	
50%	10	10		7.9	6.4		7.2			20.3				
50%	10	10		7.8	6.4		7.2						670	
Station 6 10%	10	4		7.9	6.9		7.8			20.8				
10%	10	7		8.0	6.9		7.8						550	
50%	10	0		7.9	1.7		8.1			20.0				
50%	10	0		8.2	1.7		8.1						720	
Station 7 10%	10	10		7.8	7.7		7.5			21.0				
10%	10	10		7.8	7.7		7.5						520	
50%	10	6		8.5	4.9		6.9			21.0				
50%	10	5		8.5	4.9		6.9						670	

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

Table 19. Data recorded during 24 hour, Daphnia pulex, static acute toxicity bioassays of Raw In-stream Sewage Samples, City of Jacksonville, on 21 to 22 October, 1986.

Stations 8 through 10

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Station 8 10%	10	10		7.3	6.5		7.6			21.1				
10%	10	10		7.2	7.0		7.6						610	
50%	10	10		6.1	1.2		7.3			20.4				
50%	10	10		8.4	0.9		7.3						1030	
Station 9 10%	10	10		7.6	7.9		7.6			21.2				
10%	10	10		7.7	7.9		7.6						520	
50%	10	10		8.3	7.0		7.4			20.4				
50%	10	10		8.4	7.0		7.4						600	
Station 10 10%	10	10		7.9	8.0		7.6			21.1				
10%	10	10		8.0	8.0		7.6						580	
50%	10	0		8.4	7.9		7.5			20.3				
50%	10	0		8.5	8.0		7.5						920	

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaCO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaCO_3$)

Table 20. Data recorded during 24 hour, Notropis leedsi, static acute toxicity bioassays of Raw In-stream Sewage Samples, City of Jacksonville, on 21 to 22 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)	
	0	24	48	0	24	48	0	24	48	0	24	48	0	48
Control	5	5		8.8	7.5		7.6			21.9				
Control	5	5		8.8	7.5		7.6						500	
Control	5	5		8.8	7.5		7.6			22.0				
Control	5	5		8.7	7.5		7.6						500	
Station 1 10%	5	5		8.1	6.2		7.6			20.8				
10%	5	4		8.0	6.0		7.6						580	
50%	5	0		6.9	7.8		7.4			20.3				
50%	5	0		7.5	7.8		7.4						800	
Station 2 10%	5	3		8.2	4.7		7.2			20.7				
10%	5	2		8.2	4.4		7.2						695	
50%	5	5		8.5	6.3		6.5			20.0				
50%	5	1		8.6	6.5		6.5						1400	
Station 3 10%	5	5		8.7	6.9		7.7			20.9				
10%	5	5		8.7	6.9		7.7						580	
50%	5	5		9.0	7.9		8.0			20.4				
50%	5	4		8.9	7.9		8.0						870	

Control Water	
NH_3(as NH_3)(mg/l) _____	Total Alkalinity (mg/l $CaCO_3$) _____
Total ammonia (as N)(mg/l) _____	Total Hardness (mg/l $CaCO_3$) _____

100% Effluent	
NH_3(as NH_3)(mg/l) _____	Total Alkalinity (mg/l $CaCO_3$) _____
Total ammonia (as N)(mg/l) _____	Total Hardness (mg/l $CaCO_3$) _____

Table 21. Data recorded during 24 hour, Notropis leedsi, static acute toxicity bioassays of Raw In-stream Sewage Samples, City of Jacksonville, on 21 to 22 October, 1986.

Stations 4 through 7

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)		
	0	24	48	0	24	48	0	24	48	0	24	48	0		48
Station 4 10%	5	5		7.6	7.0		7.5			20.7					
10%	5	4		7.7	7.0		7.5						680		
50%	5	0		8.1	7.9		7.0			20.0					
50%	5	0		8.1	7.9		7.0						1280		
Station 5 10%	5	4		8.1	7.2		7.5			21.0					
10%	5	5		8.0	7.2		7.5						520		
50%	5	0		7.9	8.1		7.2			20.3					
50%	5	0		7.8	8.1		7.2						670		
Station 6 10%	5	0		7.9	5.5		7.8			20.8					
10%	5	0		8.0	5.5		7.8						550		
50%	5	0		7.9	7.3		8.1			20.0					
50%	5	0		8.2	7.9		8.1						720		
Station 7 10%	5	4		7.8	6.2		7.5			21.0					
10%	5	5		7.8	6.5		7.5						520		
50%	5	0		8.5	7.7		6.9			20.1					
50%	5	0		8.5	7.8		6.9						670		

Control Water

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaOO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaOO_3$)

100% Effluent

NH_3(as NH_3)(mg/l) _____ Total Alkalinity _____ (mg/l $CaOO_3$)

Total ammonia (as N)(mg/l) _____ Total Hardness _____ (mg/l $CaOO_3$)

Table 22. Data recorded during 24 hour, Notropis leedsi, static acute toxicity bioassays of Raw In-stream Sewage Samples, City of Jacksonville, on 21 to 22 October, 1986.

Concentration or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Temperature (°C)			Conductivity (umhos)		
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	
Station 8 10%	5	5		7.3	6.0		7.6			21.1					Control Water
10%	5	5		7.2	6.1		7.6						610		NH_3(as NH_3)(mg/l) _____ Total Alkalinity (mg/l $CaCO_3$)
50%	5	0		6.1	7.6		7.3			20.4					
50%	5	0		8.4	8.0		7.3						1030		Total ammonia (as N)(mg/l) _____ Total Hardness (mg/l $CaCO_3$)
Station 9 10%	5	5		7.6	7.3		7.6			21.2					
10%	5	5		7.7	7.3		7.6						520		
50%	5	0		8.3	8.2		7.4			20.4					
50%	5	0		8.4	8.2		7.4						600		
Station 10 10%	5	5		7.9	6.3		7.6			21.1					
10%	5	5		8.0	6.3		7.6						580		100% Effluent
50%	5	0[a]		8.4	4.5		7.5			20.3					NH_3(as NH_3)(mg/l) _____ Total Alkalinity (mg/l $CaCO_3$)
50%	5	0[a]		8.5	4.5		7.5						920		
															Total ammonia (as N)(mg/l) _____ Total Hardness (mg/l $CaCO_3$)

[a] These fish were dead within minutes of being introduced to the wastewater.

Table 23. Results of City of Jacksonville's Buckman Street STP Laboratory Tests of 10 In-stream Raw Sewage Samples[a].

Station 1:	Not toxic
Station 2:	Not toxic
Station 3:	Not toxic
Station 4:	Not toxic
Station 5:	Not toxic
Station 6:	Not toxic
Station 7:	Not toxic
Station 8:	Not toxic
Station 9:	Not toxic
Station 10:	LC_{50} = < 50%

[a] Samples were spiked with aliquots of bacterial slurry then aerated for 4 hours. Data from Mr. Charles Logue, Buckman Street STP.

Table 24. LC_{50} Data for Preliminary Rangefinding Bioassays of Buckman Street STP samples, Jacksonville, on 25 to 27 September, 1986.

Organism	Method of Data Analysis	24 Hour LC_{50} and 95% Confidence Intervals	48 Hour LC_{50} and 95% Confidence Intervals
Pre-chlorinated Effluent			
Daphnia pulex	Binomial Moving Average Probit	a	a
Notropis leedsi	Binomial Moving Average Probit	Random Mortality	Random Mortality
Chlorinated Efflent			
D. pulex	Binomial Moving Average Probit	< 10.0%, b	< 10.0%, b
N. leedsi	Binomial Moving Average Probit	< 50.0%, b	< 50.0%, b
Raw Sewage			
D. pulex	Binomial Moving Average Probit	< 100.0%, b	< 100.0%, b
N. leedsi	Binomial Moving Average Probit	$\sim$ 10.0%	$\sim$ 10.0%

---

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 These LC_{50}'s are given since more than half of the test organisms died in these wastewater concentrations.

Table 25. LC_{50} Data for Flow-Through Bioassays of Buckman Street STP samples, Jacksonville, on 19 to 23 October, 1986.

Organism	Method of Data Analysis	48 Hour LC_{50} and 95% Confidence Intervals	96 Hour LC_{50} and 95% Confidence Intervals
Daphnia pulex	Binomial	82.0% (54.2 and 100)	65.6% (54.2 and 100)
	Moving Average	82.0% (76.6 and 96.5)	61.0% (53.2 and 70.9), b
	Probit	80.3% (0 and ∞)	59.2% (0 and ∞)
Notropis leedsi	Binomial	a	a
	Moving Average		
	Probit		

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 This LC_{50} is reported in the text since it is the most statistically conservative value of the data set.

Table 26. LC_{50} Data for Static Bioassays of Buckman Street STP samples, Jacksonville, on 19 to 23 October, 1986.

Organism	Method of Data Analysis	24 Hour LC_{50} and 95% Confidence Intervals	48 Hour LC_{50} and 95% Confidence Intervals
Pre-chlorinated Effluent (19-21 Oct)			
Ceriodaphnia dubia	Binomial	84.0% (54.2 and ∞)	49.5% (32.3 and 100)
	Moving Average	84.0% (69.7 and 117.4)	a
	Probit	84.8% (71.5 and 108.6)	a
(21-23 Oct.)			
C. dubia	Binomial	54.2% (32.3 and 100)	40.4% (32.3 and 54.2)
	Moving Average	57.6% (50.7 and 65.8)	a
	Probit	57.1% (49.6 and 66.7)	a
Chlorinated Effluent			
C. dubia	Binomial	74.8% (56 and 100)	48.2% (32 and 56)
	Moving Average	a	a
	Probit	a	a
Daphnia pulex	Binomial	74.8% (56 and 100)	74.8% (56 and 100)
	Moving Average	a	a
	Probit	a	a
Notropis leedsi	Binomial	70.4% (56 and 100)	52.2% (32 and 100)
	Moving Average	a	a
	Probit	a	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.

Table 27. LC_{50} Data for Static Bioassays of Buckman Street STP samples, Jacksonville, on 19 to 23 October, 1986.

Organism	Method of Data Analysis	24 Hour LC_{50} and 95% Confidence Intervals	48 Hour LC_{50} and 95% Confidence Intervals
De-chlorinated Effluent (20-22 Oct)			
Ceriodaphnia dubia	Binomial		58.4% (0 and 100)
	Moving Average		a
	Probit		a
Daphnia pulex	Binomial		a
	Moving Average		
	Probit		
Notropis leedsi	Binomial		62.2% (0 and 100)
	Moving Average		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.

Table 28. LC_{50} Data for Bioassays of Sodium Lauryl Sulfate (Standard Reference Toxicant), on 19 to 21 October, 1986.

Organism	Method of Data Analysis	24 Hour LC_{50} and 95% Confidence Intervals	48 Hour LC_{50} and 95% Confidence Intervals
Ceriodaphnia dubia	Binomial	4.5 ppm (1 and ∞)	2.7 ppm (1 and 5)
	Moving Average	5.4 ppm (3.7 and 8.6)	2.9 ppm (2.1 and 3.9), b
	Probit	5.8 ppm (4.0 and 8.7)	3.3 ppm (0 and ∞)
Daphnia pulex	Binomial	a	4.5 ppm (1 and 10)
	Moving Average	a	4.1 ppm (3.2 and 5.3), b
	Probit	a	4.7 ppm (2.7 and 5.9)
Notropis leedsi	Binomial	No Mortality	7.1 ppm (5 and 10)
	Moving Average		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 This LC_{50} is reported in the text since it is the most statistically conservative value of the data set.

Table 29. LC_{50} Data for Bioassays of Raw In-stream Sewage Samples, Untreated and Treated, City of Jacksonville, on 21 to 22 October, 1986.

	Untreated		Treated[b]
	Daphnia pulex	Notropis leedsi	Daphnia pulex
Station 1:	Not toxic[a]	$10\% < LC_{50} < 50\%$	Not toxic
Station 2:	Not toxic[a]	$10\% < LC_{50} < 50\%$	Not toxic
Station 3:	Not toxic[a]	Not toxic	Not toxic
Station 4:	Not toxic[a]	$10\% < LC_{50} < 50\%$	Not toxic
Station 5:	Not toxic[a]	$10\% < LC_{50} < 50\%$	Not toxic
Station 6:	10%	$< 10\%$	Not toxic
Station 7:	50%	$10\% < LC_{50} < 50\%$	Not toxic
Station 8:	Not toxic[a]	$10\% < LC_{50} < 50\%$	Not toxic
Station 9:	Not toxic[a]	$10\% < LC_{50} < 50\%$	Not toxic
Station 10:	$LC_{50} = < 50\%$	$10\% < LC_{50} < 50\%$	$10\% < LC_{50} < 50\%$

[a] Not toxic in highest test concentration (50%).

[b] Treatment consisted of spiking raw sample with aliquot of bacterial slurry from the Buckman treatment system and aerating for 4 hours. Tests performed and data supplied by Mr. Charles Logue, City of Jacksonville.

RESULTS AND DISCUSSION

The various effluents, pre-chlorinated, chlorinated, and de-chlorinated, from the Buckman Street sewage treatment plant, all proved to be acutely toxic to one or more bioassay organisms in laboratory and on-site tests performed by the Biology Section. The pre-chlorinated effluent, sampled from one of the facility's final clarifiers, was not acutely toxic during preliminary rangefinding tests, but was acutely toxic to Daphnia pulex during the on-site flow-through test (96 hour LC_{50} = 61.0%, Table 25). This same effluent also was acutely toxic to Ceriodaphnia dubia during two on-site static tests (48 hour LC_{50}'s = 49.5% and 40.4%, Table 26). The final chlorinated effluent was acutely toxic to these organisms, D. pulex and C. dubia, as well as to the fish species, Notropis leedsi, during on-site static tests (48 hour LC_{50}'s = 74.8%, 48.2%, and 52.2%, respectively, Table 26). This increased toxicity can be attributed to the presence of residual chlorine measured in the sample (0.7 mg/l). The sample of de-chlorinated effluent proved to be acutely toxic to C. dubia and to N. leedsi (48 hour LC_{50}'s of 58.4% and 62.2%, respectively, Table 27), but was not toxic to D. pulex. The toxicity exhibited in the pre-chlorinated and de-chlorinated samples suggests the presence of toxic components other than chlorine in the Buckman Street wastewater. The ammonia detected in this wastewater, up to 13.3 mg/l total and 0.32 mg/l unionized, may have contributed to the toxicity, but would likely, not account for all of it.

The results of the Standard Reference Toxicant (sodium lauryl sulfate) bioassays (Table 28) indicated that the sensitivities of all three test organisms used in the Buckman Street bioassays were within both the EPA and DER recommended ranges. This suggests that the organisms used in the Jacksonville tests were comparable to organsims normally used in static tests in the Tallahassee laboratory.

The results of the bioassays of raw sewage from 10 strategic locations from around the city of Jacksonville indicated that three of these Stations (#6, 7, and 10) exhibited toxicity to D. pulex (Table 29). Almost all of the samples proved to be toxic to N. leedsi, but this was likely due to the nature of the wastewater, containing suspected toxic components such as ammonia. Since toxicity was exhibited to D. pulex in the flow-through test of treated pre-chlorinated effluent, and not to N. leedsi, more emphasis is placed on the D. pulex tests of the raw sewage in attempting to identify the possible source of the toxicity.

More importantly, in the city of Jacksonville's tests of these raw sewage samples treated with bacterial slurry and aerated, only the sample from Station 10 demonstrated toxicity to D. pulex (Table 29). This is in agreement with the DER results, and may suggest that effluent discharged to Station 10 is the source of the Buckman Street toxicity problem. The Station 10 sewer line receives wastewater primarily from the SCM Corporation (Figure 2, Table 1). However, further investigation would be necessary to confirm this.

Recommendation

The Buckman Street facility should continue their efforts to isolate and identify the source of the toxicity as a means to elimiante it. A pre-treatment program designed to reduce or prohibit specific discharges responsible for the toxicity (once identified) is strongly recommended. Also, since toxicity was enhanced in the final effluent due to the presence of residual chlorine, the installation of a de-chlorination unit is recommended.

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 (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 onetwentieth 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 existence of a mixing zone, whetheras 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)(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}. 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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