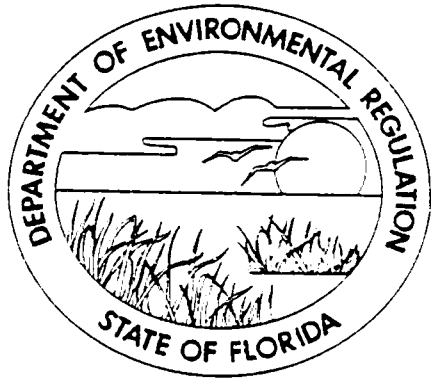



# FLOW THROUGH BIOASSAYS OF MRI CORPORATION

TAMPA, HILLSBOROUGH COUNTY, FLORIDA

NPDES #FL0001775

Biological Section
Bureau of Water Analysis
August 17, 1981

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## INTRODUCTION

The MRI Corporation (a subsidiary of American Can Corporation) is a tin electrowinning plant located at 9220 Stannum St., Tampa, Hillsborough County, Florida (Figure 1). Electrowinning is a physical and chemical process by which certain metals can be recovered from solution using electrolysis. An elaborate wastewater treatment system is employed, including double lined retention ponds, a calcium hypochlorite rinse, acidification with sulfuric acid, rotating drum vacuum filtration and final neutralization. This wastewater is then copiously diluted with non-contact cooling water prior to discharge. However, the effluent may still contain a variety of toxic substances associated with the complex electrowinning process, including heavy metals, cyanide, oil and grease, and contaminants from the raw metal materials. Discharge of the approximately 0.044 MGD effluent is to an unnamed ditch adjacent to the MRI Corporation, which flows into the Six Mile Creek, and ultimately to Tampa Bay.

The Biological Section has performed several static toxicity bioassays on this facility in the past (FDER 1980 and 1981). Results indicated that the effluent was acutely toxic to several of the test species used. However, concurrent static bioassays conducted by consultants employed by MRI Corporation (Environmental Science and Engineering, and Environmental Associates, Inc.) exhibited no acute toxicity.

To definitively evaluate the toxicity of MRI's effluent, at the request of Mr. William Hennessey, DER's Southwest District Manager, the Biological Section performed 96 hour flow through bioassays using our mobile laboratory. On 19 May, 1981, members of the Biological Section visited MRI Corporation to select a site for the mobile laboratory and to collect a sample of effluent for a preliminary static rangefinding test. On 31 May to 4 June, 1981, the actual flow through bioassay was performed. The results of these tests, as well as results from a 48 hour static test and of four Standard Reference Toxicant Bioassays performed during the flow through test, are presented in this report.

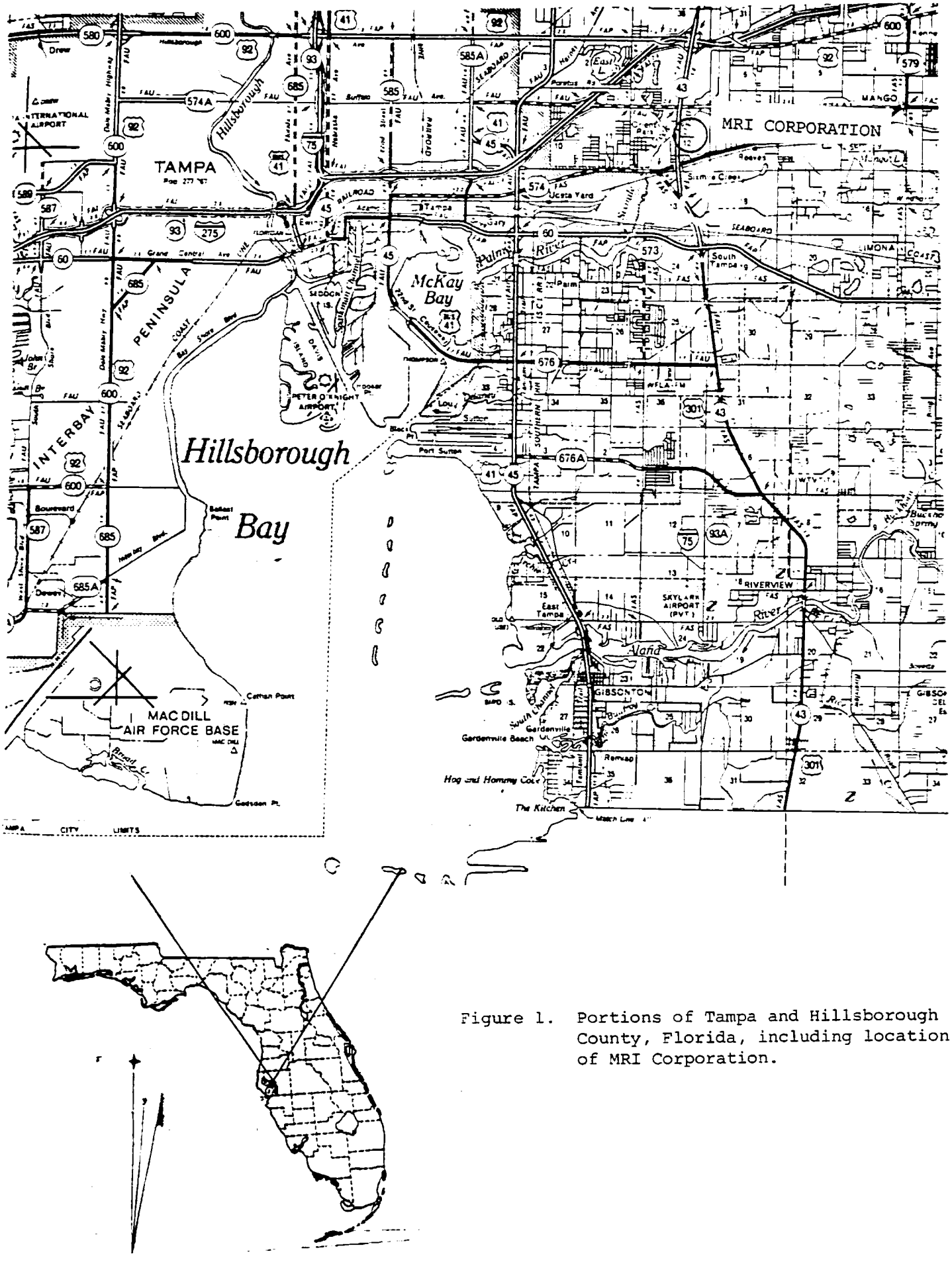



Figure 1. Portions of Tampa and Hillsborough County, Florida, including location of MRI Corporation.

## METHODS AND MATERIALS

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

### History and Maintenance of Bioassay Organisms

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. The fish have been maintained in four 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 fish have been reared at a temperature of 22° ± 2°C under a 16:8 hour light-dark cycle. These fish are fed Glencoe Mills Trout Chow® and frozen Artemia (brine shrimp) at a rate of 0.75 g/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 all 1 to 3 weeks old at the time of the test.

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 2½ gallon all glass aquaria filled with unchlorinated DER well water, using 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° ± 1°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess daphnids. 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.

Heterandria formosa (least killifish) — Approximately 100 adult killifish were obtained from a wild population in the St. Marks Wildlife Refuge (Wakulla County, Florida) during August, 1980. The fish have been maintained in 2½ to 5 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 fish have been reared at 22° ± 2°C under a 16:8 hour light-dark cycle and are fed freshly hatched Artemia (brine shrimp) twice daily. New born fish are initially maintained in the adult tanks, but are removed at weekly intervals, thereby segregating fish into even age groups. The fish used in this test were 2 to 3 weeks old.

Simocephalus serrulatus (water flea) — An indigenous breeding population of S. serrulatus was collected from Lake Jackson, Leon County, Florida, in March, 1980, by personnel from DER's Biological Section. Positive identification of the organism was performed by Mr. Jeff Foran of the Department of Environmental Engineering Sciences, University of Florida in Gainesville. The cultures are maintained in 2½ gallon all glass aquaria, filled with unchlorinated DER well water, under a 16:8 hour light-dark cycle. The organisms are fed a liquified blend of Purina Trout Chow® and Cerophyl® twice daily, and are kept at a constant temperature of 22° ± 1°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess population. They are then refilled with fresh aerated well water. Additional measures are taken and/or new cultures started in the event of abnormal circumstances.

To ensure the uniform sensitivity of these test organisms to toxic substances, the Biological Section conducts monthly Standard Reference Toxicant Bioassays using sodium lauryl sulfate as the reference toxicant.

## Test Method

### Preliminary Visit and Rangefinding Test

On 19 May, 1981, Mr. Charles Biedermann and Mr. Martin Roll of DER's Biological Section visited MRI Corporation in Tampa to select a suitable location for the mobile bioassay trailer and to collect samples of the facility's effluent and well water. Effluent was collected to conduct a static rangefinding test to determine the approximate concentration series to be used in the flow through bioassay. Well water was collected for two purposes: 1) to conduct a duplicate rangefinding test using MRI's well water as the diluent instead of the DER well water which is normally used, and 2) to acclimate the test organisms to MRI's well water if the rangefinding test proved that MRI's well water had no adverse affects on the test organisms. This test was conducted from 1130 hours on 20 May 1981 to 1130 hours on 22 May 1981.

This extra test was necessary since there was no suitable source of diluent water at the MRI complex except for the well water. Concern was expressed that MRI's well water contained excessive amounts of iron and ammonia and was considerably harder than DER's well water. Therefore, it was necessary to determine, prior to the flow through testing, if MRI's well water was a suitable diluent.

The water flea, Daphnia pulex, was selected as the test organism for the rangefinding tests. Each test consisted of two replicates of four concentrations and a control. The concentration series used in these tests (Table 1) is an abbreviated version of that recommended by APHA (1976). 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 through a stainless steel screen to isolate the proper size and age organisms (neonates). These neonates were then transferred individually by glass pipette and were loaded 10 per chamber, resulting in 20 per test concentration.

Dissolved oxygen, pH, temperature, 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 were recorded at the beginning of the test for the controls and the 100% effluent concentration. Specific conductance was recorded for each test concentration at the beginning of the test. Additionally, ammonia concentrations [1], including total (expressed in mg/l as N) and unionized (expressed in mg/l as $NH_3$) fractions, were recorded for the controls and 100% concentrations at the beginning and end of the test. These values were recorded on the bioassay data forms and are presented in Tables 2 and 3. Organisms were not fed during these tests.

### Flow Through Bioassay

DER's mobile bioassay laboratory was constructed following EPA design specifications (Peltier, 1978) and is equipped with two solenoid valve operated, flow-through, proportional dilutor systems. The mobile lab also has suitable working area for performing static tests concurrently with the flow-through tests.

[1] Total ammonia concentration was determined using an Orion specific ion probe. The unionized fraction was then calculated from the total ammonia concentration, pH, temperature and salinity.

The mobile laboratory was transported by commercial mover from its base in Tallahassee to the MRI Corporation located in Tampa, Florida on May 30, 1981. The trailer was positioned adjacent to the wastewater sump (Figure 2) and power hook-up was then accomplished by plant electricians.

During the flow-through test the effluent sampling pump was submerged just below the water level in the sump and the effluent conveyed directly and continuously from the source to the proportional dilutor system. A 500 gallon Nalgene® tank was used as a reservoir for the diluent water which was obtained from the well on the plant grounds. To assure an adequate supply of diluent water in the reservoir throughout the test period, 200 gallons of fresh well-water were conveyed, by truck, daily from the well to the reservoir tank. The diluent sampling pump was submerged in the reservoir for a continuous flow to the dilutor system.

Calibration of the proportional dilutor was performed as soon as the pumps were connected and were determined to be operating properly. Additionally, calibration was verified at the end of the 96 hour test. These concentrations and volumes are presented in Table 1. Flow rates were adjusted to operate the dilutor at approximately 7 cycles per hour, which provided for a complete volume change in the 8 liter flow-through aquaria approximately every 86 minutes. The dilutor system was operated for approximately 24 hours before the introduction of the test organisms at the beginning of the test at 12:30 p.m. on 31 May, 1981.

Two replicates of six concentrations and a control were used for the flow-through test. All four test species were tested simultaneously in the same aquaria by segregating them into separate retention chambers within the tanks. The fish retention chambers consisted of standard 10 cm glass petri dishes to which 25 cm high cylinders of Nitex® screen (243 micron mesh size) were attached by silicone cement. The water flea retention chambers were similarly constructed using 5 cm glass petri dishes with 12 cm high Nitex® screens. Ten fish of each species (Pimephales promelas and Heterandria formosa) were individually pipetted into their respective retention chambers in each of the 14 aquaria. This resulted in 40 fish (20 of each species) in each test concentration. Ten water fleas of each species (Daphnia pulex and Simocephalus serrulatus) were placed by glass pipette into their respective retention chambers in each of the 14 aquaria. This resulted in 40 water fleas (20 of each species) in each test concentration. This arrangement allowed for a significant number of test organisms (10 each of four species per aquarium) without interfering with water flow or exceeding loading rates suggested by Peltier (1978).

The number of live organisms, dissolved oxygen, pH, temperature and specific conductance were recorded at 0, 24, 48, 72 and 96 hours for each aquarium. Total alkalinity and total hardness (as $CaCO_3$) were recorded at 0, 24 and 96 hours for the controls, low, mid and 100% test concentrations. Total chlorine residuals (Hach DPD method) in the 100% effluent were recorded daily. Additionally, ammonia concentrations, including total and unionized fractions, in the controls, low, mid and 100% test concentrations, were recorded daily. These values appear in Tables 4 and 5. Organisms used in these tests were not fed during, or 24 hours prior to, the test, as recommended by Peltier (1978).

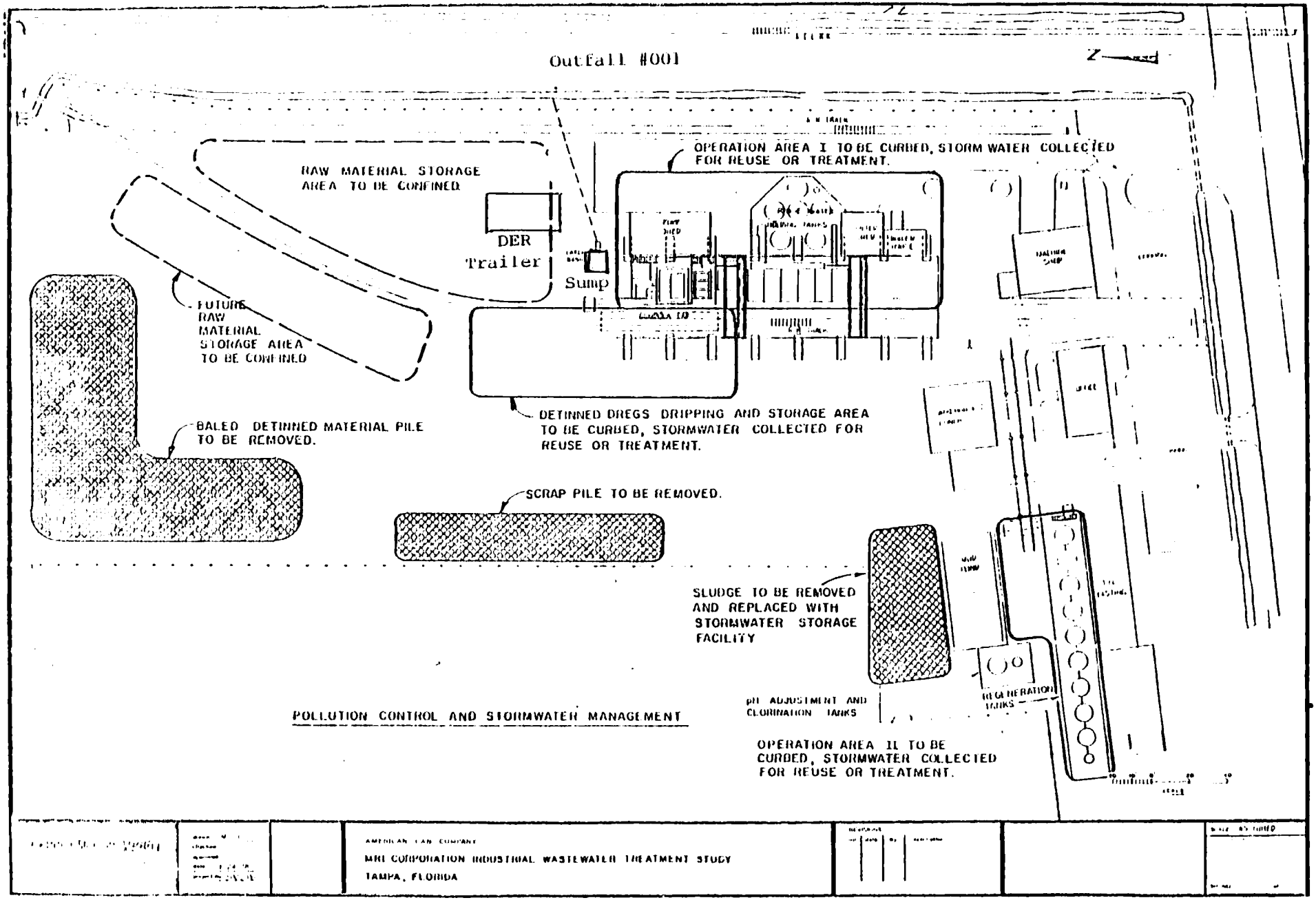



Figure 2. Portions of the MRT Corporation complex, Tampa, including locations of the wastewater sump, NPDES Outfall #001, and the DER Mobile Bioassay Trailer,

MRI 48 Hour Static Bioassay

A 48 hour static toxicity bioassay was performed concurrently with the flow-through bioassay, in the mobile laboratory. The test was conducted from 1100 hours on 2 June, 1981, to 1210 hours on 4 June, 1981, using Daphnia pulex as the test organism. Effluent for this test was taken from the same source used for the flow through test. Diluent was taken from the same reservoir (MRI well water) used for the flow-through test. The concentration series selected for this test (Table 1) is that recommended by APHA (1976).

Two replicates, each with six concentrations and a control, were used to test with 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 through a stainless steel screen to isolate the proper size and age organisms (neonates). These neonates were then transferred individually by glass pipette and were loaded 10 per chamber, resulting in 20 per test concentration.

Dissolved oxygen, pH, temperature, and the number of live organisms were recorded for each test chamber at 0 hours, 24 hours, and 48 hours. Conductivities were recorded at the beginning and end of the test for the controls and the 100% effluent concentration. These values were recorded on the bioassay data forms and are presented in Table 6. Organisms were not fed during this test.

Standard Reference Toxicant Bioassays

Concurrent with the flow-through test, a Standard Reference Toxicant bioassay was performed on each of the four test species, using sodium lauryl sulfate as the toxicant. These tests ensured that the sensitivities of the test organisms used for the flow-through test were not significantly different from: 1) the sensitivities of organisms kept in the Tallahassee laboratory, determined from previous Standard Reference bioassays, or 2) the sensitivities suggested by the EPA (William Peltier, personal communication).

One gram of sodium lauryl sulfate was diluted with deionized water until a concentration of 100 ppm was achieved. MRI well water was then used as the diluent to obtain a concentration series of 0 — control (well water), 3.2 ppm, 5.6 ppm, 10 ppm and 18 ppm sodium lauryl sulfate. Due to a shortage of test chambers, concentrations above 10 ppm were not used in the water flea reference assays. The exact volumes used are presented in Table 1. Test methods to conduct these bioassays were the same as those used for all previous static tests. The tests were performed from 1145 hours on 1 June, 1981, to 1145 hours on 3 June, 1981. The number of live organisms and all data were recorded on the bioassay data forms and are presented in Tables 7 through 10. Organisms were not fed during these tests.

Table 1. Concentration Series and Volumes Used for these Bioassays

1. Rangefinding Tests (Daphnia pulex)

| Concentration | Dilution Water[a] | Effluent | Total Vol. |
|---|---|---|---|
| Control | 200 ml | ---- | 200 ml |
| 18.0% | 164 ml | 36 ml | 200 ml |
| 32.0% | 136 ml | 64 ml | 200 ml |
| 56.0% | 88 ml | 112 ml | 200 ml |
| 100% | ---- | 200 ml | 200 ml |

2. Flow-Through Bioassay

| Diluent | Effluent | Total Vol.[b] | Final Concentration |
|---|---|---|---|
| 894 | 0 | 894 | 0% - Control |
| 863 | 50 | 913 | 5.8% - (5.2%)[c] |
| 627 | 72 | 699 | 11.5% - (9.4%)[c] |
| 613 | 135 | 748 | 18.0% - (17.6%)[c] |
| 628 | 292 | 920 | 31.7% - (31.3%)[c] |
| 393 | 449 | 842 | 53.3% - (52.4%)[c] |
| 0 | 900 | 900 | 100% - (100%)[c] |

3. MRI 48 hour static bioassay (Daphnia pulex)

| Concentration | Dilution Water[d] | Effluent | Total Vol. |
|---|---|---|---|
| Control | 200 ml | ---- | 200 ml |
| 5.6% | 188.8 ml | 11.2 ml | 200 ml |
| 10.0% | 180 ml | 20 ml | 200 ml |
| 18.0% | 164 ml | 36 ml | 200 ml |
| 32.0% | 136 ml | 64 ml | 200 ml |
| 56.0% | 88 ml | 112 ml | 200 ml |
| 100% | ---- | 200 ml | 200 ml |

[a] One test used DER's well water as the diluent while the second test used MRI's well water as the diluent.

[b] All volumes are averages of three values.

[c] Numbers in parentheses are concentrations at end of test — 96 hours.

[d] MRI well water used as dilution water.

Table I.(continued)

4. Standard Reference Toxicant Bioassays

A. Fish (Pimephales promelas and Heterandria formosa)

| Concentration | Dilution Water[e] | Toxicant[f] | Total Vol. |
|---|---|---|---|
| Control | 500 ml | --- | 500 ml |
| 3.2% | 484 ml | 16 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 |

B. Water flea (Daphnia pulex and Simocephalus serrulatus)

| Concentration | Dilution Water[e] | Toxicant[f] | Total Vol. |
|---|---|---|---|
| Control | 200 ml | --- | 200 ml |
| 3.2% | 193.6 ml | 6.4 ml | 200 ml |
| 5.6% | 188.8 ml | 11.2 ml | 200 ml |
| 10.0% | 180 ml | 20 ml | 200 ml |

[e] MRI well water used as diluent.

[f] The toxicant used was a 100ppm solution of sodium lauryl sulfate.

Table 2. Data recorded during 48 hour, Daphnia pulex, static acute toxicity bioassay of MRI Corporation, Tampa, Hillsborough County, Florida NPDES #FL0001775. Rangefinding test, DER well water as diluent. 20 to 22 May, 1981.

| 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) | | | $NH_3/NH_3+NH_4$ (mg/l) | | Conductivity (µmhos) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 48 | 0 | 48 | 0 | 24 | 48 | 0 | 48 | 0 |
| Control | 10 | 10 | 10 | 8.3 | 9.5 | 8.9 | 7.9 | 8.1 | 8.3 | 107 | | 118 | | 20.7 | 19.7 | 20.0 | 0/.06 | .01/.14 | |
| Control | 10 | 10 | 10 | 8.3 | 9.5 | 8.9 | 7.9 | 8.1 | 8.3 | | | | | | | | | | 218 |
| 18% | 10 | 10 | 10 | 7.7 | 9.0 | 8.4 | 8.4 | 8.3 | 8.3 | | | | | 20.6 | 19.7 | 19.8 | | | |
| 18% | 10 | 10 | 10 | 7.7 | 9.0 | 8.4 | 8.4 | 8.3 | 8.3 | | | | | | | | | | 398 |
| 32% | 10 | 10 | 9[a] | 7.3 | 8.6 | 7.7 | 8.6 | 8.5 | 8.3 | | | | | 20.5 | 19.7 | 20.0 | | | |
| 32% | 10 | 10 | 10 | 7.3 | 8.7 | 7.6 | 8.6 | 8.5 | 8.3 | | | | | | | | | | 590 |
| 56% | 10 | 10 | 10 | 6.9 | 7.8 | 6.4 | 8.7 | 8.6 | 8.4 | | | | | 20.4 | 19.7 | 19.7 | | | |
| 56% | 10 | 10 | 10 | 6.8 | 7.8 | 6.3 | 8.7 | 8.6 | 8.4 | | | | | | | | | | 850 |
| 100% | 10 | 10 | 10 | 5.7 | 6.0 | 4.6 | 8.9 | 8.7 | 8.4 | 364 | | 239 | | 20.2 | 19.8 | 19.7 | .14/.46 | .01/.13 | |
| 100% | 10 | 10 | 10 | 5.7 | 6.1 | 4.2 | 8.9 | 8.7 | 8.4 | | | | | | | | | | 1280 |
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Remarks: [a]Dead organism not found.

Table 3. Data recorded during 48 hour, Daphnia pulex, static acute toxicity bioassay of MRI Corporation, Tampa, Hillsborough County, Florida. NPDES #FL0001775. Rangefinding test, MRI well water as diluent. 20 to 22 May, 1981.

| 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) | | | $NH_3/NH_3+NH_4$ (mg/ℓ) | | Conductivity (µmhos) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 48 | 0 | 48 | 0 | 24 | 48 | 0 | 48 | 0 |
| Control | 10 | 10 | 10 | 7.8 | 9.3 | 8.6 | 7.7 | 8.3 | 8.5 | 229 | | 252 | | 20.4 | 19.5 | 20.3 | .01/.57 | .04/.27 | |
| Control | 10 | 10 | 10 | 7.7 | 9.3 | 8.5 | 7.7 | 8.3 | 8.4 | | | | | | | | | | 420 |
| 18% | 10 | 10 | 10 | 7.5 | 8.8 | 7.7 | 8.0 | 8.4 | 8.5 | | | | | 20.3 | 19.4 | 20.2 | | | |
| 18% | 10 | 10 | 10 | 7.5 | 8.8 | 7.8 | 8.0 | 8.4 | 8.5 | | | | | | | | | | 610 |
| 32% | 10 | 10 | 10 | 7.2 | 8.4 | 7.1 | 8.2 | 8.4 | 8.5 | | | | | 20.3 | 19.4 | 20.1 | | | |
| 32% | 10 | 10 | 10 | 7.2 | 8.3 | 7.1 | 8.2 | 8.4 | 8.5 | | | | | | | | | | 730 |
| 56% | 10 | 10 | 10 | 6.7 | 7.2 | 6.2 | 8.5 | 8.5 | 8.4 | | | | | 20.1 | 19.4 | 20.0 | | | |
| 56% | 10 | 10 | 10 | 6.7 | 7.2 | 6.1 | 8.5 | 8.5 | 8.5 | | | | | | | | | | 920 |
| 100% | 10 | 9a | 9 | 5.9 | 6.3 | 4.1 | 8.9 | 8.7 | 8.5 | 364 | | 239 | | 19.1 | 19.6 | 19.9 | | | |
| 100% | 10 | 10 | 10 | 5.9 | 6.3 | 4.1 | 8.9 | 8.7 | 8.5 | | | | | | | | .14/.46 | ---- | 1250 |
| | | | | | | | | | | | | | | | | | | | |
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Remarks: [a] Dead organism not found.

Table 4. Chemical/physical parameters recorded during 96 hour flow-through toxicity bioassay of MRI Corporation, Tampa, Hillsborough County, Florida. NPDES #FL0001775. 31 May to 4 June, 1981.

| Conc. or % | Dissolved Oxygen[a] (mg/l) | | | | | pH | | | | | Total Alkalinity (mg/l as $CaCO_3$) | | | Total Hardness (mg/l as $CaCO_3$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 24 | 48 | 72 | 96 | 0 | 24 | 48 | 72 | 96 | 0 | 24 | 96 | 0 | 24 | 96 |
| Control | 6.7 | 5.7 | 4.5 | 5.9 | 4.2 | 7.3 | 7.5 | 7.5 | 7.5 | 7.4 | 230 | 225 | 235 | 240 | 245 | 237 |
| Control | 6.9 | 5.8 | 4.9 | 6.0 | 4.6 | 7.5 | 7.6 | 7.6 | 7.6 | 7.4 | 230 | 225 | 235 | 240 | 245 | 237 |
| 5.8% | 6.0 | 4.7 | 5.5 | 6.5 | 5.6 | 7.5 | 7.6 | 7.6 | 7.7 | 7.6 | 235 | 235 | 240 | 240 | 255 | 240 |
| 5.8% | 6.5 | 5.3 | 6.3 | 7.8 | 7.0 | 7.5 | 7.6 | 7.7 | 7.8 | 7.7 | 235 | 235 | 240 | 240 | 255 | 240 |
| 11.5% | 6.4 | 5.1 | 5.8 | 5.5 | 4.1 | 7.5 | 7.6 | 7.7 | 7.8 | 7.5 | | | | | | |
| 11.5% | 6.4 | 5.1 | 6.2 | 6.6 | 5.5 | 7.6 | 7.6 | 7.7 | 7.8 | 7.6 | | | | | | |
| 18.0% | 6.0 | 4.3 | 3.8 | 6.7 | 6.1 | 7.6 | 7.6 | 7.7 | 7.9 | 7.7 | | | | | | |
| 18.0% | 6.1 | 4.7 | 6.2 | 6.2 | 5.2 | 7.6 | 7.6 | 7.7 | 7.8 | 7.7 | | | | | | |
| 31.7% | 5.5 | 3.7 | 5.6 | 6.0 | 4.4 | 7.5 | 7.6 | 7.8 | 7.8 | 7.7 | | | | | | |
| 31.7% | 5.6 | 3.5 | 5.9 | 5.4 | 3.5 | 7.5 | 7.6 | 7.8 | 7.8 | 7.7 | | | | | | |
| 53.3% | 5.5 | 3.4 | 5.6 | 3.5 | 1.9 | 7.5 | 7.7 | 7.9 | 7.8 | 7.8 | 264 | 270 | 300 | 240 | 255 | 235 |
| 53.3% | 5.5 | 3.1 | 5.7 | 4.7 | 3.1 | 7.5 | 7.7 | 7.9 | 7.9 | 7.9 | 264 | 270 | 300 | 240 | 255 | 235 |
| 100.0% | 6.1 | 3.2 | 2.6 | 3.5 | 2.6 | 7.5 | 8.4 | 7.9 | 7.9 | 8.4 | 277 | 290 | 350 | 240 | 250 | 232 |
| 100.0% | 5.8 | 3.5 | 4.8 | 4.0 | 3.9 | 7.5 | 8.1 | 8.0 | 7.9 | 8.4 | 277 | 290 | 350 | 240 | 250 | 232 |

Remarks: Total residual chlorine (Hach DPD method) in 100% effluent: 0 hr = N.D.; 24 hour = N.D.; 48 hr = 0.06 mg/l; 72 hr = 0.02 mg/l; 96 hr = 0.02 mg/l

[a] Each aquarium aerated, except controls and 5.8%, starting at 27.4 hours.

Table 4. (continued)

| Conc. or % | Temperature (°C) | | | | | Conductivity (µmhos) | | | | | Total Ammonia (mg/l as N) / Unionized Ammonia (mg/l as $NH_3$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 24 | 48 | 72 | 96 | 0 | 24 | 48 | 72 | 96 | 0 | 24 | 48 | 72 | 96 |
| Control | 21.8 | 23.0 | 22.7 | 22.8 | 22.1 | 430 | 450 | 430 | 450 | 440 | .39/.00 | .40/.01 | .35/.01 | .28/.01 | .28/.00 |
| Control | 22.5 | 23.3 | 22.7 | 23.0 | 22.1 | 430 | 450 | 430 | 450 | 440 | | | | | |
| 5.8% | 22.1 | 23.3 | 22.9 | 22.7 | 22.2 | 445 | 490 | 470 | 480 | 490 | .40/.01 | .39/.01 | .28/.01 | .21/.01 | .35/.01 |
| 5.8% | 22.5 | 23.3 | 22.6 | 22.8 | 22.4 | 445 | 490 | 470 | 480 | 495 | | | | | |
| 11.5% | 21.7 | 22.8 | 22.7 | 22.7 | 22.0 | 455 | 590 | 550 | 580 | 600 | | | | | |
| 11.5% | 22.5 | 23.4 | 22.7 | 22.7 | 22.4 | 455 | 590 | 550 | 550 | 600 | | | | | |
| 18.0% | 21.6 | 22.6 | 22.6 | 22.7 | 22.1 | 460 | 600 | 600 | 600 | 650 | | | | | |
| 18.0% | 22.0 | 23.0 | 22.7 | 23.0 | 22.1 | 460 | 600 | 600 | 600 | 650 | | | | | |
| 31.7% | 21.7 | 22.6 | 23.0 | 23.2 | 22.4 | 480 | 650 | 690 | 700 | 775 | | | | | |
| 31.7% | 22.0 | 22.7 | 22.9 | 23.2 | 22.4 | 480 | 650 | 690 | 700 | 775 | | | | | |
| 53.3% | 21.5 | 22.7 | 22.7 | 22.9 | 22.2 | 590 | 720 | 800 | 810 | 975 | .28/.00 | .28/.01 | .20/.01 | .20/.01 | .20/.01 |
| 53.3% | 22.0 | 23.0 | 23.0 | 23.3 | 22.6 | 590 | 720 | 800 | 810 | 975 | | | | | |
| 100.0% | 21.6 | 23.3 | 23.3 | 23.8 | 22.6 | 610 | 1380 | 1210 | 1110 | 1400 | .39/.01 | .21/.01 | .10/.01 | .21/.01 | .10/.01 |
| 100.0% | 22.0 | 22.7 | 23.1 | 24.2 | 22.9 | 610 | 1380 | 1210 | 1110 | 1425 | | | | | |

Remarks: [a]The total ammonia concentration was determined using an Orion specific ion electrode. The unionized fraction was then calculated based on the pH, temperature and salinity.

Table 5. Number of live organisms recorded during 96 hour flow-through toxicity bioassay of MRI Corporation, Tampa, Hillsborough County, Florida. NPDES #FL0001775. 31 May to 4 June, 1981.

| Conc. or % | Pimephales promelas[a] | | | | | Daphnia pulex | | | | | Heterandria formosa[e] | | | | | Simocephalus serrulatus | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | 10 | 10 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 8 | 9[d] | 6 |
| Control | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 8 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 5 | 5 |
| 5.8% | 10 | 10 | 10 | 10 | 10 | 10 | 7 | 6 | 6 | 6 | 11[b] | 11 | 11 | 11 | 11 | 10 | 10 | 7 | 7 | 6 |
| 5.8% | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 5 | 5 | 5 |
| 11.5% | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 7 | 8[d] | 8 |
| 11.5% | 11[b] | 11 | 11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 18.0% | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 11[c] | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 8 | 8 | 8 |
| 18.0% | 10 | 10 | 10 | 10 | 9 | 10 | 10 | 10 | 10 | 11[d] | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 8 | 7 | 7 |
| 31.7% | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 10[d] | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 7 | 7 | 6 |
| 31.7% | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 8 | 8 | 8 |
| 53.3% | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 11[b] | 11 | 11 | 11 | 11 | 10 | 6 | 6 | 3[f] | 3[f] |
| 53.3% | 10 | 10 | 10 | 10 | 10 | 11[b] | 10 | 9 | 9 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 100.0% | 11[b] | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 8 | 5 | 6[d] | 6[g] |
| 100.0% | 10 | 8 | 8 | 8 | 8 | 10 | 10 | 9 | 9 | 9 | 11[b] | 11 | 11 | 11 | 10 | 10 | 9 | 8 | 7 | 7 |

Remarks:
a. Fathead minnows weighed an average of 0.0054g and were 9 to 11 mm in length.
b. An extra organism was introduced into this container.
c. Two organisms were born during the test, they were not included in the $LC_{50}$ calculations.
d. One organism was born during the test, it was not included in the $LC_{50}$ calculations.
e. The least killifish weighed an average of 0.0057g and were 8 to 10 mm in length.
f. One death was the result of entrapment in the screen, it was not included in the $LC_{50}$ calculation.
g. Four organisms were born during the test, they were not included in the $LC_{50}$ calculations.

Table 6. Data recorded during 48 hour, Daphnia pulex, static acute toxicity bioassay of MRI Corporation, Tampa, Hillsborough County, Florida. NPDES #FL0001775. Conducted during flow-through test, on 2 to 4 June, 1981.

| 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) | | | $NH_3/NH_3+NH_4$ (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 | 4.3 | 8.3 | 7.5 | 7.5 | 8.1 | 8.2 | | | | | 22.9 | 20.9 | 20.9 | | | 430 | 430 |
| Control | 10 | 10 | 10 | 4.0 | 8.3 | 7.6 | 7.5 | 8.2 | 8.2 | | | | | | | | | | | |
| 5.6% | 10 | 10 | 10 | 5.0 | 8.6 | 8.1 | 7.6 | 8.3 | 8.3 | | | | | 22.9 | 21.0 | 20.8 | | | | |
| 5.6% | 10 | 10 | 10 | 5.0 | 8.6 | 8.1 | 7.6 | 8.3 | 8.3 | | | | | | | | | | | |
| 10% | 10 | 10 | 10 | 5.0 | 8.4 | 8.1 | 7.6 | 8.3 | 8.3 | | | | | 22.9 | 20.9 | 20.8 | | | | |
| 10% | 10 | 10 | 10 | 5.1 | 8.4 | 8.1 | 7.6 | 8.3 | 8.3 | | | | | | | | | | | |
| 18% | 10 | 9 | 9 | 4.2 | 7.9 | 8.0 | 7.6 | 8.3 | 8.3 | | | | | 23.1 | 20.9 | 20.6 | | | | |
| 18% | 10 | 10 | 10 | 4.3 | 7.9 | 8.0 | 7.6 | 8.3 | 8.3 | | | | | | | | | | | |
| 32% | 10 | 9 | 8 | 4.5 | 7.5 | 8.0 | 7.7 | 8.3 | 8.3 | | | | | 23.6 | 20.9 | 20.7 | | | | |
| 32% | 10 | 10 | 10 | 4.6 | 7.5 | 7.9 | 7.7 | 8.3 | 8.3 | | | | | | | | | | | |
| 56% | 10 | 10 | 9 | 5.0 | 7.0 | 7.8 | 7.9 | 8.3 | 8.4 | | | | | 23.6 | 20.9 | 21.5 | | | | |
| 56% | 10 | 9 | 9 | 5.0 | 6.9 | 7.5 | 7.9 | 8.3 | 8.4 | | | | | | | | | | | |
| 100% | 10 | 10 | 10 | 4.7 | 5.9 | 7.3 | 8.1 | 8.3 | 8.4 | | | | | 24.2 | 20.9 | 21.0 | | | 1190 | 1150 |
| 100% | 10 | 9[a] | 10 | 4.7 | 7.0 | 7.6 | 8.1 | 8.4 | 8.4 | | | | | | | | | | | |
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Remarks:

[a] 10th organism not found during counting at 24 hrs., ten organisms used in calculations.

Table 7. Data recorded during 48 hour, Daphnia pulex, static acute toxicity bioassay of sodium lauryl sulfate (Standard Reference Toxicant), performed during flow-through bioassay of MRI Corporation. 1 June to 3 June, 1981.

| 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) | | | $NH_3/NH_3+NH_4$ (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 | 6.1 | 7.8 | 8.2 | 7.5 | 8.1 | 8.1 | 238 | | 249 | | 23.8 | 20.3 | 20.5 | | | 450 | 420 |
| Control | 10 | 10 | 10 | 6.1 | 7.8 | 8.2 | 7.5 | 8.1 | 8.1 | | | | | | | | | | | |
| 3.2 ppm | 10 | 10 | 10 | 6.1 | 7.0 | 8.1 | 7.5 | 8.1 | 8.2 | | | | | 23.9 | 20.2 | 20.0 | | | 440 | 415 |
| 3.2 ppm | 10 | 10 | 9 | 6.2 | 7.0 | 8.1 | 7.5 | 8.1 | 8.2 | | | | | | | | | | | |
| 5.6 ppm | 10 | 10 | 8 | 6.2 | 6.3 | 8.1 | 7.5 | 8.1 | 8.2 | | | | | 24.0 | 20.1 | 20.0 | | | 430 | 420 |
| 5.6 ppm | 10 | 10 | 7 | 6.3 | 6.4 | 8.1 | 7.5 | 8.1 | 8.2 | | | | | | | | | | | |
| 10 ppm | 10 | 10 | 7 | 6.3 | 6.4 | 8.0 | 7.5 | 8.1 | 8.2 | 219 | | 228 | | 24.3 | 20.3 | 20.2 | | | 410 | 400 |
| 10 ppm | 10 | 10 | 8 | 6.3 | 6.4 | 8.1 | 7.5 | 8.1 | 8.2 | | | | | | | | | | | |
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Remarks:

Table 8. Data recorded during 48 hour, Simocephalus serrulatus, static acute toxicity bioassay of sodium lauryl sulfate (Standard Reference Toxicant) performed during flow-through bioassay of MRI Corporation. 1 June — 3 June, 1981.

| 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) | | | $NH_3/NH_3+NH_4$ (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 | 6.1 | 7.8 | 8.3 | 7.6 | 8.2 | 8.2 | 238 | | 249 | | 23.7 | 20.3 | 20.1 | | | 450 | 420 |
| Control | 10 | 10 | 10 | 6.1 | 7.8 | 8.2 | 7.6 | 8.2 | 8.3 | | | | | | | | | | | |
| 3.2 ppm | 10 | 10 | 10 | 6.2 | 7.0 | 8.1 | 7.6 | 8.1 | 8.2 | | | | | 23.8 | 20.2 | 19.9 | | | 440 | 415 |
| 3.2 ppm | 10 | 10 | 10 | 6.2 | 7.0 | 8.2 | 7.6 | 8.1 | 8.2 | | | | | | | | | | | |
| 5.6 ppm | 10 | 10 | 8 | 6.2 | 6.2 | 8.1 | 7.6 | 8.1 | 8.3 | | | | | 24.2 | 20.3 | 20.0 | | | 430 | 420 |
| 5.6 ppm | 10 | 10 | 7 | 6.2 | 6.2 | 8.0 | 7.6 | 8.1 | 8.3 | | | | | | | | | | | |
| 10 ppm | 10 | 5 | 5 | 6.4 | 6.1 | 7.6 | 7.6 | 8.1 | 8.2 | | | | | 24.2 | 20.4 | 20.2 | | | 410 | 400 |
| 10 ppm | 10 | 5 | 5 | 6.5 | 6.1 | 7.4 | 7.6 | 8.1 | 8.2 | 219 | | 228 | | | | | | | | |
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Remarks:

Table 9 . Data recorded during 48 hour, Pimephales promelas, static acute toxicity bioassay of sodium lauryl sulfate (Standard Reference Toxicant), performed during flow-through bioassay of MRI Corporation. 1 June — 3 June, 1981.

| 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) | | | $NH_3/NH_3+NH_4$ (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 | 5.4 | 7.4 | 8.2 | 7.5 | 8.1 | 8.3 | 238 | | 249 | | 23.4 | 20.4 | 20.4 | | | 450 | 420 |
| Control | 5 | 5 | 5 | 5.9 | 7.4 | 8.0 | 7.5 | 8.1 | 8.3 | | | | | | | | | | | |
| 3.2 ppm | 5 | 5 | 5 | 6.4 | 6.5 | 8.1 | 7.6 | 8.0 | 8.3 | | | | | 23.9 | 20.2 | 20.3 | | | 440 | 415 |
| 3.2 ppm | 5 | 5 | 5 | 6.4 | 6.5 | 7.9 | 7.5 | 8.0 | 8.3 | | | | | | | | | | | |
| 5.6 ppm | 5 | 0 | 0 | 6.1 | 5.4 | --- | 7.5 | 8.0 | --- | | | | | 24.2 | 20.1 | --- | | | 430 | --- |
| 5.6 ppm | 5 | 1 | 1 | 6.3 | 5.5 | 7.7 | 7.5 | 8.0 | 8.2 | | | | | | | 20.7 | | | | 420 |
| 10 ppm | 5 | 0 | 0 | 6.3 | 4.9 | --- | 7.5 | 7.9 | --- | | | | | 24.1 | 20.1 | 20.7 | | | 410 | --- |
| 10 ppm | 5 | 0 | 0 | 6.2 | 4.3 | --- | 7.5 | 7.9 | --- | | | | | | | | | | | |
| 18 ppm | 5 | 0 | 0 | 6.4 | 4.9 | --- | 7.5 | 7.9 | --- | 200 | | 205 | | 24.1 | 20.3 | --- | | | 390 | --- |
| 18 ppm | 5 | 0 | 0 | 6.5 | 4.1 | --- | 7.5 | 7.9 | --- | | | | | | | | | | | |
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Remarks: These fish each weighed an average of 0.0054g and were 9 to 11mm long.

Table 10. Data recorded during 48 hour, Heterandria formosa, static acute toxicity bioassay of sodium lauryl sulfate (Standard Reference Toxicant), performed during flow-through bioassay of MRI Corporation. 1 June — 3 June, 1981.

| 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) | | | $NH_3/NH_3+NH_4$ (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 | 6.1 | 7.3 | 7.9 | 7.5 | 8.1 | 8.3 | 238 | | 249 | | 24.1 | 20.4 | 20.4 | | | 450 | 420 |
| Control | 5 | 5 | 5 | 6.0 | 7.2 | 7.9 | 7.5 | 8.1 | 8.3 | | | | | | | | | | | |
| 3.2 ppm | 5 | 5 | 5 | 6.3 | 6.4 | 7.7 | 7.5 | 8.0 | 8.3 | | | | | 24.2 | 20.4 | 20.1 | | | 440 | 415 |
| 3.2 ppm | 5 | 5 | 5 | 6.3 | 6.4 | 7.8 | 7.5 | 8.0 | 8.3 | | | | | | | | | | | |
| 5.6 ppm | 5 | 3 | 3 | 6.3 | 5.3 | 7.5 | 7.5 | 8.0 | 8.2 | | | | | 24.2 | 20.3 | 20.2 | | | 430 | 420 |
| 5.6 ppm | 5 | 5 | 5 | 6.2 | 5.3 | 7.5 | 7.5 | 8.0 | 8.2 | | | | | | | | | | | |
| 10 ppm | 5 | 0 | 0 | 6.4 | 2.7 | --- | 7.5 | 7.8 | --- | | | | | 24.2 | 20.3 | --- | | | 410 | --- |
| 10 ppm | 5 | 0 | 0 | 6.2 | 2.5 | --- | 7.5 | 7.8 | --- | | | | | | | | | | | |
| 18 ppm | 5 | 0 | 0 | 6.3 | 1.6 | --- | 7.5 | 7.7 | --- | 200 | | 205 | | 24.2 | 20.4 | --- | | | 390 | --- |
| 18 ppm | 5 | 0 | 0 | 6.4 | 0.5 | --- | 7.5 | 7.7 | --- | | | | | | | | | | | |
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Remarks: These fish each weighed an average of 0.0057g and were 8 to 10mm in length.

## RESULTS AND DISCUSSION

### Rangefinding Tests

The results of the static rangefinding tests, performed on a sample of MRI effluent collected during the preliminary visit on 19 May, 1981, indicated that the sample was not acutely toxic to Daphnia pulex (Tables 2, 3 and 11). Additionally, these tests indicated that the use of MRI well water for the diluent (Table 3) was not significantly different than using DER well water for the diluent (Table 2). Apparently, the high iron content and increased hardness of MRI well water did not increase the sensitivity of the test organisms, and therefore, this water was judged suitable for use in the flow-through tests.

This lack of toxicity was inconsistent with results of previous bioassays performed on effluent from MRI Corporation (FDER 1981). This may have been a function of the sampling difficulties encountered during the preliminary visit for this series of bioassays. The automatic effluent sampler next to the sump was plugged, necessitating the opening of the solid metal cover over the sump to manually obtain the sample. This may have been the first time in two years that the actual sump was inspected, according to Mr. Charles Meloy, MRI Plant Manager. A thick, flocculant material had precipitated on the walls and bottom of the sump, plugged the automatic sampler line, and was obviously interferring with the flow of effluent from the sump. Approximately six inches of foam had also accumulated in the sump. Mr. Meloy then obtained a hose and thoroughly cleaned the majority of the floc from the sump. He then suggested that we wait 20 minutes for the sump to clear before taking the sample. This cleaning of the sump may have removed some toxic material that had accumulated over the years.

### Flow-Through Bioassay

The results of the 96 hour flow-through bioassay suggest that the effluent discharged during the test was not acutely toxic to the test organisms, but did result in some mortality. Five fathead minnows, Pimephales promelas, three of these in the 100% effluent concentration, died during the 96 hour period (Table 5). However, this number of dead organisms was insufficient to calculate an $LC_{50}$ value (Table 11). Only one killifish, Heterandria formosa (in the 100% effluent) died during the test (Table 5). A significant number of water fleas, Daphnia pulex and Simocephalus serrulatus, died during the test (Table 5). However, an irregular distribution of mortality (random deaths) prevented the calculation of $LC_{50}$ values. Additionally, excessive control mortality invalidated the Simocephalus assay by hour 72 of the test.

Although the majority of organisms survived the 96 hour test, some effects were noted. Both species of fish lost most of their color soon after introducing them into the effluent. A large amount of white, flocculent material (presumably chemical) was observed in the effluent. This material twice caused the plugging of the effluent line, at 58.6 and 68 hours, necessitating shutdown for cleaning. The 100% effluent aquaria's out-flow lines also became plugged at 70.9 hours, causing an overflow. Another significant factor

noted was the lack of dissolved oxygen in the effluent. This became a serious problem Monday morning, June 1, when MRI plant operations started up, resulting in a dissolved oxygen drop to less than 40% saturation (approximately 3.2 mg/l). This low dissolved oxygen necessitated the continous aeration of all aquaria, except the controls and 5.8%, starting at 27.4 hours into the test. This was accomplished using a Silent Giant® air pump, a 14-outlet copper aeration manifold, and Tygon® tubing with air stones to each aquarium.

Only one mechanical failure was experienced during the test. The submersible pump in the 500 gallon Nalgene® diluent tank broke a seal at 72 hours and leaked oil. The remaining water was discarded and the 500 gallon tank was not used for the last 24 hours of the test. Instead, the 200 gallon transfer tank was filled with fresh well water and used for the remainder of the test. The pump was replaced and the flow-through was resumed within one hour, with little or no contamination of the system.

One difference was noticed at the MRI Corporation since the preliminary visit, 12 days earlier. A 2' X 2' hole had been cut into the solid metal cover on the sump and replaced with a metal grill. This allowed easier access to the effluent and to the sump for inspection and cleaning.

During the flow-through, Mr. Charles Biedermann collected biological samples upstream and downstream from the MRI point of discharge. These consisted of fish collected with a fine mesh net. There was no noticeable difference between the fish collected downstream and those collected upstream of the point of discharge. The predominant fish collected was the mosquitofish, Gambusia sp., with considerably lesser numbers of Jordanella sp., Fundulus sp., Poecilia sp., and Heterandria formosa.

48 Hour Static Bioassay

The results of the 48 hour static bioassay, performed during the last two days of the flow-through bioassay, suggested that the effluent was not acutely toxic to the test organism, Daphnia pulex. Although a number of Daphnia died during the test, the mortality occurred in the mid-effluent concentrations (18% to 56%, Table 8) and therefore, an $LC_{50}$ value could not be calculated.

Standard Reference Toxicant Bioassays

These bioassays were performed on all four test organisms used for the flow-through bioassay, using sodium lauryl sulfate as the toxicant. The results indicated that the 48 hour $LC_{50}$ for Daphnia pulex was 21.4 ppm (probit method, Table 11), significantly higher than previous $LC_{50}$'s of approximately 3.8 ppm (FDER 1981), and higher than the suggested EPA values for this organism of 1 to 10 ppm (William Peltier, U.S. EPA, personal communication). Likewise, a 48 hour $LC_{50}$ of 10 ppm was calculated for Simocephalus serrulatus, significantly higher than the 2.9 ppm obtained from previous Standard Reference Bioassays. The data suggest that the much greater hardness of MRI well water compared with DER well water (approximately 240 mg/l vs. 118 mg/l as $CaCO_3$) reduced the toxicity of sodium lauryl sulfate to the water fleas Daphnia and Simocephalus.

The results of the Standard Reference Toxicant bioassays on the fish were considerably different from those of the water fleas (Table 11). 48 hour $LC_{50}$'s for Pimephales promelas and Heterandria formosa were 4.5 ppm and 6.7 ppm, respectively. These values are comparable to previous values of 5.7 and 5.6 ppm obtained for these fish (FDER 1981).

Chemical Analyses

During the flow-through bioassay, various chemical parameters were recorded for the diluent and effluent (Table 4). Noteworthy is the observation that both pH and conductivity increased significantly in the 100% effluent when plant operations started up Monday morning. The pH rose approximately 0.8 units while the conductivity more than doubled, from 610 to 1380 µmhos. However, total chlorine residuals and ammonia concentrations, including total and unionized fractions, remained consistently low throughout the test.

Samples of the effluent were collected throughout the test for metal analysis by DER's Chemistry Section in Tallahassee. Metals analysis was also performed on MRI Corp's well water. These results are presented in Table 12.

Table 11. $LC_{50}$ Values for Bioassays Performed on MRI Corporation (Rangefinding, Flow-Through and Static) and on Sodium Lauryl Sulfate (Standard Reference Toxicant)

| Test | Organisms | $LC_{50}$ |
|---|---|---|
| Rangefinding #1 DER well water | Daphnia pulex | no mortality |
| Rangefinding #2 MRI well water | Daphnia pulex | no mortality |
| Flow-Through | Pimephales promelas, Daphnia pulex, Heterandria formosa, and Simocephalus serrulatus | A |
| 48 Hour Static | Daphnia pulex | A |
| Standard Reference Toxicant | Daphnia pulex | 21.5 ppm (probit method) |
| | Simocephalus serrulatus | 10.0 ppm (binomial method) |
| | Pimephales promelas | 4.5 ppm (binomial method) |
| | Heterandria formosa | 6.7 ppm (binomial method) |

A. Although mortality occurred in these tests, an insufficient number of organisms died to calculate an $LC_{50}$ value.

Table 12. Results of Metal Analyses of MRI Corp. Effluent and Well Water. Collected during the Flow-Through Bioassay, 31 May to 4 June, 1981.

| Date | Parameter | EFFLUENT Replicate #1 | Replicate #2 |
|---|---|---|---|
| 1 June 1981 | Copper | <25 ug/l | <25 ug/l |
| | Iron | 1208 ug/l | 1094 ug/l |
| | Aluminum | 2300 ug/l | 2110 ug/l |
| 2 June 1981 | Copper | <25 ug/l | ---- |
| | Iron | 993 ug/l | ---- |
| | Aluminum | 2690 ug/l | ---- |
| 3 June 1981 | Copper | <25 ug/l | ---- |
| | Iron | 979 ug/l | ---- |
| | Aluminum | 2000 ug/l | ---- |
| 4 June 1981 | Copper | <25 ug/l | <25 ug/l |
| | Iron | 977 ug/l | 967 ug/l |
| | Aluminum | 3660 ug/l | 3820 ug/l |
| | | MRI WELL WATER | |
| 4 June 1981 | Copper | <25 ug/l | |
| | Iron | 831 ug/l | |
| | Aluminum | <500 ug/l | |

## Acknowledgements

We wish to thank Mr. Charles Meloy, Plant Manager of MRI Corporation, and Mr. Robert Carpenter of the Hillsborough County Environmental Protection Commission, for their cooperation and helpful suggestions during the test.

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