

ATHENS/GULF BREEZE ENVIRONMENTAL PROTECTION AGENCY
COOPERATIVE INDUSTRIAL WASTEWATER BIOMONITORING PROJECT

Status Report: Through FY1978

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Surveillance and Analysis Division
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UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
SCIENCE AND ECOSYSTEM SUPPORT DIVISION
REGION 4



EPA

ALAN G. AUWARTER, PH.D.

Ecological Assessment Branch

980 COLLEGE STATION RD.
ATHENS, GA 30605-2720
AUWARTER.ALAN@EPAMAIL.EPA.GOV

(706) 355-8704
FAX (706) 355-8726

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INTRODUCTION

Flow-through acute toxicity tests have been conducted on industrial wastewaters at twenty-one sites throughout the coastal Southeast from the inception of this interlaboratory effort through Fiscal 1978. Static acute toxicity tests, effluent toxicity evaluations using luminescent bacteria and chemical characterizations were run in parallel with flow-through tests on-site or at the Athens laboratory in some cases. Algal assays were conducted at the Gulf Breeze Laboratory on effluent samples shipped from most sites.

The scope of this report is limited to providing basic information pertaining to methods used, applicability of Cyprinodon and Mysidopsis, the relative toxicity of wastewaters evaluated to test animals, and early evaluation of a bacterial assay method in use over the past 6 months.

CULTURE AND HANDLING OF SALT WATER TEST ANIMALS

1. Static Culture Methods

Salt water static culture facilities have been established at the EPA laboratory in Athens, Georgia, for the purpose of supplying animals for our on-site acute toxicity testing. Sheepshead minnows (Cyprinodon variegatus) and a species of mysid shrimp (Mysidopsis bahia) were selected as test organisms. Original and supplemental stocks have been supplied as necessary from the Gulf Breeze Laboratory.

Athens cultures were originally established using synthetic salts (Instant Ocean^R and Rila Marine Mix^R) dissolved in locally available well water. A poor hatching rate of sheepshead minnow eggs prompted a culture medium change to natural seawater.

To establish and maintain cultures in natural seawater, full-strength seawater was periodically transported from coastal areas to Athens and diluted with well water to culture salinities. Originally, unfiltered seawater was used, but introduction of miscellaneous marine organisms dictated a need for filtration. Filtered (1 micron) seawater has proven to be a satisfactory culture medium, assuming no contamination from the seawater source.

A. Cyprinodon variegatus

Sheepshead culture in Athens involves three distinct steps:

1. Brood fish are held in 70-liter aquaria (61 x 33 x 41 cm) at a stocking rate of 1-2 males and 5-6 females per aquarium. An external power filter using activated carbon/plastic floss media and a heater is used in each aquarium. Water

temperature is maintained at 28-30°C. Egg collection trays are formed by sewing together two layers of Nitex^R screening of different mesh sizes. Trays cover the floor of each aquarium, and are weighted with lengths of stainless steel tubing attached underneath. Eggs are demersal and slightly adhesive on the screening; they fall through the larger mesh of the uppermost layer and are held between this and the lower, smaller-mesh layer. Predation on eggs by adults has not been observed using this type of tray. To collect eggs, a tray is withdrawn from its aquarium, inverted over a shallow glass pan containing salt water of the appropriate salinity to a depth of about 3 cm, and agitated gently. Eggs fall to the bottom of the pan from which they may be easily collected with a pipette. Eggs may be counted as they are removed from the pan or their number estimated by volume displacement: 100 eggs have been found to displace about 0.21 ml. Sheepshead in Athens cultures are depositing 80-100 eggs per female per week. Eggs are collected twice each week. Adult sheepshead are fed frozen brine shrimp (Artemia sp.) to satiation daily. To avoid dietary deficiencies, the brine shrimp diet is supplemented with a commercial tropical fish flake food.

2. Eggs are incubated and hatched in 4-liter wide-mouthed glass jars. Jars are immersed in a water bath heated to 28-30°C; vigorous aeration within jars keeps eggs and hatched fish in suspension. A population of newly-hatched brine shrimp is

maintained in each jar to feed developing fry.

3. Fry are held in 7-liter all-glass aquaria segregated by date of egg collection and salinity from the time they are two weeks of age until they are either used in tests or otherwise disposed of. These aquaria are supplied with bubble-up type activated carbon/plastic floss filters; water temperature stays at about 17°C. These fish are fed newly-hatched brine shrimp daily. Unusually large individuals are removed from each aquarium periodically to avoid predation on smaller fish.

B. Mysidopsis bahai

Complete life cycles of this mysid shrimp species are maintained in 70-liter aquaria at about 17°C. Each aquarium has a commercially available under-gravel filter which is covered with about 5 cm of small, smooth shell fragments (4-15) mm in length). To avoid extensive algal growth, the walls of the aquaria and filter standpipes are scraped and shell substrate is periodically turned over to partially bury the existing algae. Velocity of water returned through filter standpipes is sufficient to maintain a moderate current in the aquarium. The shrimp often orient themselves into this current. Mysids are fed with newly-hatched brine shrimp twice daily. Frequent feeding is necessary to avoid cannibalism.

2. Transportation

Two days prior to departure for a bio-assay trip, standard size (36 X 30 X 30 cm) styrofoam coolers are prepared for the transport of test animals. Each cooler is supplied with two doubled plastic bags (56 X 32 cm), and each bag is filled with 1-3 gallons of synthetic salt water at a salinity of either 10 or 15 parts per thousand. Mysid shrimp are bagged by culture salinity, 50-200 individuals per bag. Sheepshead are bagged by culture salinity and age grouping, 200 to 500 fry per bag. All bags are moderately aerated with air stones powered by a Silent Giant^R for these two days.

The morning of departure, minnows and shrimp are carefully netted from culture or holding tanks and released into the appropriate pre-labeled plastic bag. Each bag is liberally stocked with newly-hatched brine shrimp to serve as food for test animals during transport. An additional supply of hatched brine shrimp and eggs is transported in a well-aerated gallon jar to prevent a lapse in food supply before *Artemia* cultures can be established at the test site. Air supply to the plastic bags is rerouted from the AC-powered pump to battery-powered aerators and the bags are closed with pipe cleaners. Animals are transported in a passenger vehicle rather than the test trailer to reduce temperature fluctuations and other environmental disturbances.

After arrival on-site, test organisms are transferred to the trailer where they are once again aerated with an AC pump. If necessary, additional laboratory-hatched brine shrimp are added to ensure an adequate interim food supply, and a fresh brine shrimp culture is started on-site.

3. Acclimation

On site acclimation of animals to local water is initiated as soon as suitable marine dilution water source has been located. A five-gallon sample of this seawater is transported to the trailer and diluted with well water (from the Athens laboratory or supplied by the plant being tested) to salinities of 10 and 15 parts per thousand. Half of the water volume from each bag of test organisms is removed and replaced with an equal volume of dilution water of the appropriate salinity. Partial volumes should be replaced in this way so that the holding medium for test animals is changed from 100% laboratory holding water to close to 100% locally available dilution water over a period of 24 hours. Organisms should be exposed to 100% dilution water for at least 24 hours prior to testing.

MOBILE TOXICITY TEST TRIP PROTOCOL

1. Preparations

Trip preparations include packing truck, trailer and test organisms for travel. A pre-trip check of equipment and supplies packed is made against a detailed checklist.

Upon arrival at an industry, in addition to immediate electrical hookup, suitable dilution water is sought, and where possible, collected that day. This water should be low in suspended particulate matter and industrial contaminants to the extent possible to determine in the field. When adjusted to proper salinity (if necessary) using suitable well water, this water is used for the acclimation of test animals and in the formulation of solutions for toxicity testing.

Twenty-four hour range-finding static bio-assays using a limited number of animals and wastewater concentrations are initiated as soon as possible after arrival on-site. Results of these tests serve to establish the concentration range(s) to be used for definitive toxicity tests.

2. Flow-Through Testing

The formal flow-through test begins on the third day. Ten shrimp or fish are counted out into each of 12 plastic weigh boats. Animals are observed for signs of abnormal behavior or other indications of poor physiological condition, and any such individuals are replaced. Individuals markedly larger or smaller than the population mean within each boat are likewise replaced to limit predation. One boat of test animals is then released into a screened chamber within each of the 12 aquaria used in toxicity testing. Aquaria containing 100 percent effluent are

infrequently used in testing since most effluents result from fresh water used in industrial processes, and therefore cannot be expected to support marine life without addition of or dilution by salt water. Animals are observed frequently on the first day of testing so that early counts can be taken for the purpose of LC50 calculation if the effects of the effluent are severe, and early mortality rates high. Counts of animals surviving in each test chamber are made routinely at the end of each of the four 24-hour periods comprising one 96-hour test.

3. Static Testing

One day prior to the initiation of the 96-hour flow-through test, an Isco Model 1580 sampler is set up to collect a 24-hour effluent composite totalling approximately 20 gallons. Up to fifteen gallons of this composite are sent to the Gulf Breeze laboratory for additional toxicity testing; five gallons are used on-site to formulate static test effluent concentrations reflecting those produced by the flow-through diluter system. Sheepshead minnows are tested in quart jars containing 750 ml of solution; mysid shrimp are tested in gallon jars containing 3000 ml of solution. Ten organisms are placed in each effluent concentration and static containers are slowly aerated (single-bubble) throughout the testing period. Statics are conducted for 96 hours. Initial water quality parameters, including dissolved oxygen, salinity and temperature are recorded for each test container. Dissolved oxygen values are monitored daily, and values for pH and total alkalinity are collected at the conclusion of the 96-hour testing period.

4. Chemical Analyses

Chemical analyses of test water involves continuous monitoring of undiluted effluent and daily aquarium checks. At sites where effluent flow to the trailer is sufficient, flow to the diluter is split and a portion is passed through a Schneider monitor/strip recorder to track pH, temperature, dissolved oxygen and conductivity of incoming effluent during the course of the study. Also a set of remote probes for temperature and pH is used in a selected test aquarium. This monitor system is electronically calibrated in Athens, and field checked both before beginning and periodically during each study. In addition to continuous monitoring, dissolved oxygen, temperature and salinity are recorded from each test aquarium and samples are taken from each effluent concentration for determination of pH and total alkalinity each day during the course of the flow-through testing.

5. Data Analysis

Post-test data analysis includes mathematical evaluation of the extent of wastewater toxicity to test animals. Whenever the pattern of mortality over test concentration permits, LC50 values calculated by probit analysis are reported including 95 percent confidence limits. Where probit analysis is inappropriate, LC50 values are determined by graphical interpolation using the log-concentration-versus-percent survival method. Where mortality exists but is too heavy or light to be described by standard LC50 values, a value such as 80/5.6 is reported: 80 percent mortality in 5.6 percent wastewater after an indicated exposure period.

TEST RESULTS AND DISCUSSION

Information pertinent to these on-site studies is summarized in Table 1. Entries are arranged in order of decreasing toxicity on the basis of 96-hour flow-through mysid test results. Test results from the SCM Cooperation are eliminated from the following considerations since temperature regulation problems resulting from trailer air-conditioning failure during summer temperatures in Florida created impossible conditions under which to conduct a valid study.

The degree of toxicity of wastewater apparently cannot be grouped by industrial category. Wastewater from the four kraft paper producers showed a high degree of toxicity (Container Corp., Westvaco), an intermediate degree of toxicity (International), and no toxicity (Brunswick) to mysid shrimp as compared to other industrial wastewaters tested. Further, of wastes from the two kraft producers demonstrating the highest toxicity to mysids, one (Container Corp.) showed high toxicity and the other (Westvaco) showed no toxicity to sheepshead. The two plants having wastes influenced primarily by dyestuffs are similarly split between the high (Verona) and low (dePoortere) ends of the scale of waste toxicity to mysids. Of the two Dacron/Dacron precursor plants visited, wastewater from one (Hercofina) was highly toxic, wastewater from the other (duPont) was non-toxic to the animals tested. The two plants producing agriculturally-related products discharged wastewaters that were among the most toxic to mysids. One (Grace), a fertilizer producer, was also highly toxic to sheepshead; the other (Stauffer, Cold Creek), a biocide producer, was non-toxic to sheepshead. Toxicity to specific aquatic organisms, or, specifically the lethality of

Table
Summary of Information From the first two years of the
Athens/Gulf Breeze EPA Cooperative Industrial On-site Acute Toxicity Testing Program^a

Industry & Address	Major Products	Study Dates	Plant Discharge Volume (MGD)	Receiving Waterway	Test Results ^{b,c}				Recommended Action ^d
					<i>Cyprinodon variegatus</i> ^d		<i>Mysidopsis bahia</i> ^e		
					Flow-through Test	Static Test	Flow-through Test	Static Test	
R. Grace & Co. Wilmington, NC	agricultural fertilizers	7/26 to 8/6 1977	0.07-0.11	N. E. Cape Fear River	96 h = 15.6 72 h = 17.0 48 h = 18.0 24 h = 32.9 Sub-adult 96 h = 38.8 72 h = 38.3 48 h = 38.3 24 h = 42.6	48 h = 20/60 24 h = N.M.	96 h = 100/5.6 72 h = 95/5.6 48 h = 80/5.6 24 h = 11.6 Young 24 h = 100/5.6	48 h = 20.0 24 h = 60.0	A
Duffer Chem. Co. Old Creek Plant Oaks, AL	agricultural chem., herbicides and pesticides	9/9 to 9/15 1977	0.11-0.40	Mobile River	N.S.M. ^f	---	96 h = 75/5.6 72 h = 13.3 48 h = 26.0 24 h = 28.1 Young 72 h = 12.2 48 h = 17.6 24 h = 30.9	---	A
Container Corp. Grandma Beh.	kraft paper	2/2 to 2/9 1978	18.0-21.1	Amelia River	96 h = 7.7 72 h = 7.7 48 h = 30.1 24 h = 42.3	N.M. ^g	96 h = 5.9 72 h = 5.9 48 h = 18.0 24 h = 19.3	72 h = 50/56	B
American Color d Chem. Co. Beco, SC	dye intermediates	12/9 to 12/16 1977	0.25-0.33	Campbell's Creek	96 h = 5/32 72 h = 5/56 48 h = N.M. 24 h = N.M. Fish 26-28 days old 96 h = 43.6 72 h = 48.9 48 h = 49.0 24 h = 5/56	---	96 h = 6.3 72 h = 6.4 48 h = 19.1 24 h = 42.3 96 h = 80/10 72 h = 60/10 48 h = 11.0 24 h = 23.9 72 h = 8.0 ⁱ 48 h = 15.7 24 h = 21.7	---	C
Stivaco Corp. Soft Division Charleston, SC	unbleached kraft paper, process chemical reclamation	4/29 to 5/6 1977	27-30	Cooper River	N.M.	---	96 h = 8.7 72 h = 13.1	---	A
Acrofin Corp. Wilmington, NC	TPA & DMH (two Dacron precursors)	7/19 to 7/24 1977	0.18-0.25	Cape Fear and N. E. Cape Fear Rivers	96 h = 21.3 72 h = 24.1 48 h = 25.7 24 h = 39.7	N.M. ^j	96 h = 9.6 72 h = 9.6 48 h = 9.6 24 h = 12.9 Young 48 h = 7.1 24 h = 7.4	---	A

Table continued									
Industry & Address	Major Products	Study Dates	Plant Discharge Volume (MGD)	Receiving Waterway	Test Results ^{bc}				Recommended Action ⁿ
					Cyprinodon variegatus ^d		Mysidopsis bahia ^e		
					Flow-through Test	Static Test	Flow-through Test	Static Test	
Mobay Chem. Corp. Verona Dyestuff Division Charleston, SC	dyes	5/23 to 5/29 1977	3.5-5.2	Cooper River	96 h = 16.4 72 h = 28.0 48 h = 34.8 24 h = 46.7	---	96 h = 22.5 72 h = 24.0 48 h = 29.2 24 h = 75.0	---	A
International Paper Co. Georgetown, SC	bleached and unbleached kraft, neutral sulfite process paper	8/12 to 8/18 1977	29-31 (60-9- min. release, twice daily)	Sampit River	96 h = 15/56 72 h = 15/56 48 h = 15/56 24 h = 15/56	N.M.	96 h = 28.8 ^k 72 h = 31.8 48 h = 33.6 24 h = 38.3	N.S.M.	None
Gardiner Chem. Tampa, FL	phosphoric products	6/14 to 6/22 1978	#001: 21.6-23.2 #005: 18.8 #006: 0.18-0.30	Alafia River	N.M.	N.M. (3 tests)	96 h = 43.5 72 h = 82.5	---	D
Stauffer Chem. Co. LeMayne Plant Axis, AL	Industrial grade chem., H ₂ SO ₄ , CCl ₄ , Cl ₂ , CS ₂ NaOH and others	9/15 to 9/22 1977	1.5-2.0	Mobile River	N.M.	---	96 h = 45.4 ^k 72 h = 45.4 48 h = 15/56 24 h = 10/56	---	None
Reichhold Chemical Bay Minette, AL	tall oil products	5/1 to 5/8 1978	0.018-0.041	Hollinger Creek	N.M.	N.M.	96 h = 50.0 72 h = 40.0 48 h = 32.0	72 h = 40.0	E
Olin Chemical St. Marks, FL	smokeless powder, nitro-glycerine	1/12 to 1/19 1978	0.33-0.52	Big Boggy Branch	N.M.	N.M. (2 tests)	96 h = 45/56 72 h = 15/56 48 h = 30/56 24 h = 25/56	---	None
Georgetown Steel Georgetown, SC	steel wire and rod	3/20 to 3/27 1978	0.65-0.67	Sampit River	N.M.	N.M.	96 h = 20/56	N.S.M.	None
Pfizer Chemical Southport, NC	citric acid	7/6 to 7/13 1978	0.71-2.43	Cape Fear River	N.M.	N.M.	96 h = 20/56	---	None
Virginia Chem. Bucks, AL	sodium hydrosulfite, aliphatic amines	4/24 to 5/1 1978	0.009-0.011	Cold Creek	N.M.	N.S.M.	96 h = 15/56	---	F
Brunswick Pulp and Paper Brunswick, GA	bleached & unbleached market kraft paper	8/7 to 8/13 1978	54-59	Turtle River	N.M.	N.M. ¹	N.S.M.	N.S.M.	None
E. I. duPont de Nemours & Co. Wilmington, NC	TPA, DMI and Dacron polyester fiber	8/1 to 8/7 1977	1.7-1.9	Cape Fear River	N.S.M. ^m	N.M.	N.S.M. ^k	N.S.M.	None

Table continued									
Industry & Address	Major Products	Study Dates	Plant Discharge Volume (MGD)	Receiving Waterway	Test Results ^{bc}				Recommended Action ⁿ
					Cyprinodon variegatus ^d		Mysidopsis bahia ^e		
					Flow-through Test	Static Test	Flow-through Test	Static Test	
dePoortere Corporation Wilmington, NC	woven & knitted fabrics; dyeing	11/4 to 11/10 1977	1.04-1.22	Smith Creek	N.M.	---	---	---	None
Diamond Shamrock Castle Hayne, NC	sodium bichromate, chromic acid	7/13 to 7/20 1978	0.48-0.60	N. E. Cape Fear River	N.M.	N.M.	---	---	None
General Electric Wilmington, NC	nuclear fuel pellets, metal fuel pellets	11/11 to 11/17 1977	0.62-0.70	N. E. Cape Fear River	N.M.	N.M.	---	---	None
----- Test Results Inconclusive -----									
SCM Corp. Glidden-Darkee Div. Organic Chem. Group Jacksonville, FL	scents, flavorings	6/23 to 6/29 1977	2.7-3.3	Moncrief Creek	Test Results Inconclusive: Random Mortality Throughout Concentration Range.				None

- a. Unless otherwise indicated, all information presented in this table has been reported in individual industry toxicity test reports.
- b. Single values reported are LC50 values.
- c. Where LC50 values could not be mathematically derived, the percent of test animals that died at the lowest test concentration in which mortality occurred is given and is to be read as follows: 20/5.6 represents 20 percent mortality in the 5.6 percent concentration of wastewater.
- d. Unless otherwise stated, all Cyprinodon used were 1-3 weeks old. "Sub-adult" Cyprinodon were 13-20 mm in length, age unknown.
- e. Unless otherwise stated, all Mysidopsis used had reached full length (6-8 mm) and were not further identified by sex or age. "Young" mysids were 1.5-2 mm in length and 1-3 days old.
- f. N.S.M. = No significant mortality.
- g. N.M. = No mortality.
- h. A 70:10 mixture of Mysidopsis bigelowi and Neomysis americana was used in this test.
- j. Test conducted in Athens using well water collected on November 10, 1977, substituting 6-month-old Lepomis macrochirus for Cyprinodon variegatus as the test organism.
- k. Test conducted substituting 1-3-day-old Daphnia magna for Mysidopsis bahia.
- l. Additional static tests were conducted with fresh water species (effluent salinity 3 mg/ml or less). Pimephales promelas: no mortality after 96 hours. Daphnia pulex: 48 hour LC50 = 32.0 percent.
- m. Test conducted using fingerling Lctalurus punctatus for Cyprinodon variegatus as the test organism.
- n. See following page.

Table med

Specific Actions Recommended to EPA Enforcement Division for
Region IV Discharges Based on Results of On-site Acute Toxicity Tests.

- A. Recommended action:
 - require the industry to determine how rapidly and uniformly their wastewater mixes with the receiving water.
 - if wastewater is not undergoing rapid mixing, require industry to install diffuser pipes in the receiving water.
- B. Recommended action:
 - require the company to conduct dye studies to determine the isopleths of wastewater concentration and submit the results displayed on a map of the receiving water.
 - require the company to provide EPA with their daily wastewater discharge flow in MGD.
 - once the wastewater concentration (toxicity limit) at the boundary of the mixing zone has been established, an effluent toxicity screening test should be required of the company using the calculated toxicity limit.
- C. Recommended action:
 - company should conduct dye studies to define the flow characteristics (plot isopleth of wastewater concentrations) of the wastewater as it enters and mixes with the receiving water.
- D. Recommended action:
 - require that the wastewater be discharged via a diffuser pipe for rapid and homogeneous mixture in the receiving water.
 - compute the 7Q10 flow at a point in the Alafia River near the plant outfall for use in determining the extent of dilution of wastewater.
 - from the extent of dilution determine the zone (area) of chronic toxicity.
 - the information on the area affected by chronic toxicity can be used by the regulatory agency to determine if and how much reduction of wastewater toxicity may be required by the plant.
- E. Recommended action:
 - company should provide EPA with calculated dilution ratios of their wastewater based on low flow conditions at selected locations downstream from their discharge.
- F. Recommended action:
 - no further biomonitoring unless the company's wastewater characteristics change due to plant production changes.

industrial wastes, is more likely related to the interaction of several factors including:

- wastes produced,
- in-plant waste treatment,
- final concentration of wastes when released, and
- species-specific physiological response to each complex effluent mixture.

Characterization of organics in wastewater using GC/MS analysis is reported for three plants in addition to those reported last year (Table 2). These three followed a trend established as a result of GC/MS characterizations for the six previous samples: wastewater toxicity seems to be related to both the number and total concentration of identified organic compounds. Organic analyses were discontinued as of September, 1977. Results of inorganic analyses are given in Table 3.

Recommendations to Region IV's Enforcement Division, based on these test results ranged from no action to the determination of isopleths depicting waste flow into the receiving waterway, determination of 7Q10 values at the point of discharge, possible installation of diffuser pipes in receiving waterway, further toxicity testing and possible reduction of toxicity of effluents based on the resultant information, each to be conducted by the industry (Table 1).

Flow-through tests have produced much more information to date in this project than have static tests. Of all flow-through tests conducted with salt-water animals, 63% have produced reportable toxicity (mortality relatable to wastewater concentration), and 51% have been at least toxic enough for the calculation of LC50 values. Of all on-site static tests

Table 2

GC/MS Characterization of Wastewater and Dilution Water Used for Testing at Each Industrial Site

Industry	Compound	Concentration(mg/l)	
		Effluent	Dilution
Westvaco	Di(2-ethyl hexyl) Phthalate	330	<5
	Phenylacetic Acid ^T	110	ND
	5 unidentified fatty acids	approx. 5	ND
	2 unidentified resin acids	approx. 5	ND
	oil	unspecified	ND
	grease	unspecified	ND
Verona	Chloroaniline	52	ND
	Chloronitrobenzene	180	ND
	1,3,3-trimethyl-2-methylene indoline	170	ND
	Dimethyl-2-methylene indoline	5.9	ND
	1,3,3-trimethyl oxindole	220	ND
	Unidentified Phthalate	58	ND
SCM	organic samples discarded: toxicity test results inconclusive		
Hercofina	Ethyl hexanoic acid	180	ND
	P-Cresol	190	ND
	Phenyl acetic acid	200	ND
	Phenol	110	ND
	Indole	95	ND
	Alkyl C ₃ Benzenes ^T	60	ND
	di(2-ethyl hexyl) Phthalate	19	trace(<5)
	Isobutyric Acid ^T	130	ND
	n-Butyric Acid ^T	160	ND
	Valeric Acid ^T	560	ND
	Lauric Acid ^T	130	ND
Grace	Phenyl Isoeyanate ^T	140	--
duPont	no organics present within detectable limits		
International Paper	Ethyl Toluene	8.5	ND
	Xylene	1.5	ND
	N-Propyl Benzene	1.8	ND
	N-Pentene ^T	10	ND
	Dimethyl Butane ^T	10	ND
	Unidentified Phthalate	28	29
	Lube-type oil	unspecified	ND

Table 2, continued

GC/MS Characterization of Wastewater and Dilution Water Used for Testing at Some Industrial Sites

Industry	Compound	Concentration (ug/l)	
		Effluent	Dilution
Stauffer (Cold Creek)	Cycloate	19	NA
	Fonophos	3.2	NA
	Phosmet	ND	ND
	Triethylphosphate	45	NA
	Bis (2-ethyl hexyl) phthalate	2.3	NA
	EPTC	37	NA
	Butylate	2.4	NA
	Vernolate	7.7	NA
	Pebulate	0.71	NA
	Molinate	40	NA
Stauffer (LeMoyne)	Cycloate	1.2	NA
	Fonophos	ND	NA
	Phosmet	ND	ND
	Triethylphosphate	ND	NA
	Bis (2-ethyl hexyl) phthalate	6.6	NA
	EPTC	1.2	NA
	Butylate	0.11	NA
	Vernolate	0.18	NA
	Pebulate	ND	NA
	Molinate	4.9	NA
American Color	Methyl phenol (isomer)	14	ND
	Benzamide	120	ND
	Phenyl carbamic acid, methylester and/or isocyanatobenzene	21	ND
	Dihydroxy anthraquinone	81	ND
	Aniline	2500	ND
	Methyl aniline (isomer)	500	ND
	Chloroaniline (isomer)	270	ND
	N-nitrosodiphenyl amine and/or diphenyl amine	23	ND
	Nitro aniline	40	ND
	Di-n-butyl phthalate	6	ND
	Anthraquinone	20	ND
	Aminoanthraquinone	86	ND

T = tentative identification

NA = not analyzed

ND = not detected

Table 3
Inorganic Analyses for Samples of Industrial Wastewater and Dilution Water^{ab}

<u>Industry</u>	<u>Sample</u>	<u>NH₃-N (mg/l)</u>	<u>TOC (mg/l)</u>	<u>Phenols (mg/l)</u>	<u>Zinc (mg/l)</u>	<u>Chromium^m (mg/l)</u>	<u>Copper (mg/l)</u>	<u>Lead (mg/l)</u>	<u>Cadmium (mg/l)</u>
Westvaco	Eff.	0.39	94	17	-	-	-	-	-
	Dil.	0.02	8	15	-	-	-	-	-
Verona	Eff.	6.70	44	75	-	-	-	-	-
	Dil.	0.03	9	14	-	-	-	-	-
SCM	Eff.	-	-	-	-	<80	57	-	-
	Dil.	-	-	-	-	<80	34	-	-
Hercofina	Eff.	6.0	-	-	43	31	<20	101	<20
	Dil.	ND	-	-	56	50	35	247	22
Grace	Eff.	14	-	-	-	-	-	-	-
	Dil.	0.31	-	-	-	-	-	-	-
duPont	Eff.	0.04	-	-	43	88	-	-	-
	Dil. ^c	0.04	-	-	55	<50	-	-	-
International Paper	Eff.	1.10	330	21	75	<80	24	<80	<10
	Dil.	0.20	3.3	<5	80	<80	45	296	28

- a. Effluent samples are of unadulterated material.
- b. Dilution water is either estuarine water collected at the necessary tidal phase to be within the range of, usually, 15-18ppt salinity or is a mixture of higher salinity seawater and well water to provide a solution within the same salinity range.
- c. Flow-through tests were run using fresh water. Dilution water characterization given is, therefore, for fresh dilution water. Values for dilution salt water, used in static tests, are non-detectable, 22 and 41 mg/l for NH₃-N, zinc and chromium, respectively.

conducted with salt water animals, 17% have produced reportable toxicity and 8% have been toxic enough for the calculation of LC50 values.

Mysidopsis bahia has been a much more useful test species than Cyprinodon variegatus. Of all on-site toxicity tests conducted with Mysidopsis, 78% have produced reportable toxicity, and 63% have been at least toxic enough for the calculation of LC50 values. Of all on-site toxicity tests conducted with Cyprinodon, 24% have produced reportable toxicity, and 16% have been toxic enough for the calculation of LC50 values.

On-site sheepshead statics have never resulted in mortality sufficient for the calculation of LC50 values, and in only one test (6%) of the sixteen conducted has any toxicity been demonstrated through mortality. Sheepshead flow-through testing produced reportable toxicity in 36% of all tests conducted, and LC50 values could be calculated for 27% of the tests. Mysid statics have resulted in reportable toxicity in 38% of tests conducted, and LC50 values could be calculated for 25% of the tests. Mysid flow-through tests have resulted in reportable toxicity in 95% of the tests conducted, and LC50 values could be calculated for 74% of the tests.

AN EARLY EVALUATION OF AN ACUTE TOXICITY TEST USING LUMINESCENT BACTERIA

The Microtox™ is a specialized photometer being developed by Beckman Instruments, Inc. and evaluated by this and other laboratories for its applicability as a new acute toxicity testing system. Essentially, a nearly instantaneous response is recorded as percent light increase or decrease from a suspension of luminescent bacteria upon exposure to a potential toxicant. Potential benefits to a regulatory agency or discharger conscientiously evaluating toxic effects of a wastewater would include savings of time and therefore expense and manpower, and a degree of uniformity of test organisms greater than that possible with current popular test organisms. Tests can take 30 minutes to 3 hours as opposed to conventional 96-hour tests that may take a total of 8 days in the field. Standard, cultured bacteria may be supplied from a pure culture maintained in a single, centralized laboratory. Vials of lyophilized bacteria are easily stored and shipped.

This test system is in an evaluative phase in its development, and problems do exist. One concerns data interpretation. A decrease in the amount of light emitted by the bacteria can easily be interpreted as a deleterious or "toxic" effect. An increase in the amount of emitted light, analagous to "stimulation" in an algal assay, is more difficult to categorize. Does such "stimulation" represent an enrichment of the environment, and if so, should such be regarded as deleterious, accelerating eutrophication, or should it be regarded as a desirable situation.

A comparison of results of the bacterial test with results of standard on-site flow-through tests with Cyprinodon variegatus and Mysidopsis bahia is given in Table 4. Entries are listed in order of decreasing wastewater toxicity to Mysidopsis. The wastewater most toxic to mysids

Table 4

Comparison of Results Between On-site Toxicity Testing With
Luminescent Bacteria and Flow-through Testing With Standard Test Organisms^a

Industry	Test Organism		
	Sheepshead Minnow (96-hr exposure)	Mysid Shrimp (96-hr exposure)	Luminescent Bacteria (10-min exposure)
Reichhold	0/56	32	41/50
Gardinier	0/100	44	13% stimulation ^b
Pfizer	0/56	20/56	18/50
Virginia	0/56	15/56	2% stimulation ^c
Brunswick	0/56	0/56	10/50

- a. Single values represent LC50 (sheepshead, mysids) or EC50 (bacteria) values in percent effluent, unless otherwise indicated. Slashed values, used when test mortality was insufficient for calculation of LC50's or EC50's, represent:

$\frac{\text{percent mortality}}{\text{highest effluent concentration tested}}$ for sheepshead and mysids or

$\frac{\text{percent light decrease}}{\text{highest effluent concentration tested}}$ for bacteria.

- b. Increase in light output after 10 min. exposure to the highest test concentration of wastewater (33%).
- c. Increase in light output after 10 min. exposure to the highest test concentration of wastewater (50%).

(Reichhold) was also most toxic in the bacterial test. If a "toxic" bacterial test result may be defined absolute deviation from no effect, then Virginia Chemical and Brunswick Pulp and Paper wastewaters were shown to be the least toxic by both the mysid shrimp test and the bacterial test. If bacterial stimulation is defined to be other than a toxic or deleterious effect, the comparison between mysid and bacterial tests for these first five field-tested industries is not as direct. Sheepshead minnow test results for these industries is included in Table 4 to illustrate the relative insensitivity of this test species.

APPENDIX

Data Collected On-site to Date as Part
of Athens/Gulf Breeze EPA Cooperative Project

Table #	Table
I.	Biological Data and Chemical Parameters Recorded by Test Aquarium During a Flow-through 96-hour Acute Toxicity Study Conducted at Westvaco Corporation, North Charleston, SC, April 29-May 6, 1977.
II.	Biological Data and Chemical Parameters Recorded by Test Aquarium During a Flow-through 96-hour Acute Toxicity Study Conducted at Verona Dyestuff Division of Mobay Chemical Corporation, Charleston, SC, May 23-29, 1977.
III.	Biological Data and Chemical Parameters Recorded by Test Aquarium During a Flow-through 96-hour Acute Toxicity Study Conducted at the Glidden-Durkee Division of SCM Corp., Jacksonville, FL 32201.
IV.	Survival Data Recorded for Wastewater Concentrations During a Flow-through Toxicity Study Conducted at Hercofina Corporation, Wilmington, North Carolina, July 20-24, 1977.
V.	Chemical Parameters Recorded for Wastewater Concentrations During a Flow-through 96-hour Acute Toxicity Study at Hercofina Corporation, Wilmington, NC, July 20-24, 1977.
VI.	Survival Data Recorded by Test Aquarium During a Flow-through Acute Toxicity Study Conducted at W. R. Grace & Co., Wilmington, NC, July 25-August 2, 1977.
VII.	Survival Data Recorded During 48-hour Static Acute Toxicity Testing Conducted at W. R. Grace & Co., Wilmington, NC, July 25-August 2, 1977.
VIII.	Ranges of Values for Chemical Parameters Monitored Periodically for Each Wastewater Concentration Tested During a Flow-through Acute Toxicity Study at W. R. Grace & Co., Wilmington, NC, July 25-August 2, 1977.
IX.	Survival Data Recorded by Test Aquarium During an Acute Toxicity Study Conducted at E. I. duPont de Nemours and Company, Wilmington, NC, August 2-6, 1977.
X.	Chemical Monitoring Data Recorded by Test Aquarium During Flow-through Acute Toxicity Testing at E. I. duPont de Nemours and Company, Wilmington, NC, August 2-6, 1977.

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Table

XI.	Survival Data for Acute Toxicity Tests Conducted at International Paper Company, Georgetown, SC, August 14-18, 1977.
XII.	Chemical Parameters Recorded by Test Aquarium During a Flow-through Toxicity Study Conducted at International Paper Company, Georgetown, SC, August 14-18, 1977.
XIII.	Biological Data Recorded by Test Aquarium During a Flow-through 96-hour Acute Toxicity Study Conducted at the Cold Creek Plant of Stauffer Chemical Company, Bucks, Alabama, September 11-15, 1977.
XIV.	Chemical Parameters Recorded by Test Aquarium During a Flow-through 96-hour Acute Toxicity Study Conducted at the Cold Creek Plant of Stauffer Chemical Company, Bucks, Alabama, September 11-15, 1977.
XV.	Biological Data and Chemical Parameters Recorded by Test Aquaria During a Flow-through 96-hour Acute Toxicity Study Conducted at the LeMoyne Plant of Stauffer Chemical Company, Axis, Alabama, September 16-20, 1977.
XVI.	Biological Data and Chemical Parameters Recorded by Test Aquarium During a Flow-through 96-hour Acute Toxicity Study Conducted at dePoortere Corporation, Wilmington, NC, November 7-11, 1977.
XVII.	Biological Parameters Recorded for Wastewater Concentrations During a Flow-through Study Conducted at American Color and Chemical Corporation, Lobeco, SC, December 9-17, 1977.
XVIII.	Chemical Parameters Recorded for Wastewater Concentrations During a Flow-through Acute Toxicity Study Conducted at American Color and Chemical Corporation, Lobeco, SC, December 9-17, 1977.
XIX.	Survival Data Recorded by Test Aquarium During an Acute Toxicity Study Conducted at the Olin Corporation, Smokeless Powder Division, St. Marks, FL, January 15-19, 1978.
XX.	Chemical Parameters Recorded by Flow-through Test Aquarium During an Acute Toxicity Study Conducted at the Olin Corporation, Smokeless Powder Division, St. Marks, FL, January 15-19, 1978.
XXI.	Survival Data Recorded by Test Aquarium During Acute Toxicity Testing Conducted at the Container Corporation of America, Fernandian Beach, Florida, February 6-10, 1978.
XXII.	Chemical Parameters Recorded by Test Aquarium During Flow-through Acute Toxicity Testing Conducted at the Container Corporation of America, Fernandina Beach, Florida, February 6-10, 1978.

Table #	Table
XXIII.	Survival Data Collected by Test Aquarium During an Acute Toxicity Study at the Georgetown Steel Corporation, Georgetown, SC March 22-26, 1978.
XXIV.	Chemical Parameters Recorded by Flow-through Test Aquarium During an Acute Toxicity Study Conducted at the Georgetown Steel Corporation, Georgetown, SC, March 22-26, 1978.
XXV.	Survival Data Recorded by Test Aquarium During Acute Toxicity Testing Conducted at Virginia Chemicals Incorporated, Mobile, Alabama, April 27-May 1, 1978.
XXVI.	Chemical Parameters Recorded by Test Aquarium During Flow-through Acute Toxicity Testing Conducted at Virginia Chemicals Incorporated, Mobile, Alabama, April 27-May 1, 1978.
XXVII.	Survival Data Recorded by Test Aquarium During Acute Toxicity Testing Conducted at Reichold Chemicals, Inc., Newport Division, Bay Minette, Alabama, April 28-May 7, 1978.
XVIII.	Chemical Parameters Recorded by Test Aquarium During Flow-through Acute Toxicity Testing Conducted at Reichold Chemicals, Inc., Newport Division, Bay Minette, Alabama, April 28-May 7, 1978.
XXIX.	Survival Data Recorded by Test Container During Acute Toxicity Testing Conducted at Gardinier, Inc., Tampa, Florida, June 17-21, 1978.
XXX.	Chemical Parameters Recorded by Test Aquarium During Flow-through Acute Toxicity Testing Conducted at Gardinier, Inc., Tampa, Florida, June 17-21, 1978.
XXXI.	Survival Data Recorded by Test Aquarium During Acute Toxicity Testing Conducted at Pfizer, Inc., Southport, NC, July 8-12, 1978.
XXXII.	Chemical Data Recorded by Test Aquarium During Flow-through Acute Toxicity Testing Conducted at Pfizer, Inc., Southport, NC, July 8-12, 1978.
XXXIII.	Survival Data Recorded by Test Aquarium During Acute Toxicity Testing at Diamond Shamrock - Chrome Chemicals Plant, Castle Hayne, NC, July 12-19, 1978.
XXXIV.	Chemical Parameters Recorded by Test Aquarium During Flow-through Acute Toxicity Testing Conducted at Diamond Shamrock - Chrome Chemicals Plant, Castle Hayne, NC, July 12-19, 1978.

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| XXXV. | Survival Data Collected by Test Aquarium During an Acute Toxicity Study at the Brunswick Pulp and Paper Company, Brunswick, Georgia, August 7-13, 1978. |
| XXXVI. | Chemical Parameters Recorded by Flow-through Test Aquarium During an Acute Toxicity Study Conducted at the Brunswick Pulp and Paper Company, Brunswick, Georgia, August 7-13, 1978. |

Table I.

Biological Data and Chemical Parameters Recorded by Test Aquarium During a Flow-Through 96-hour Acute Toxicity Study;
Conducted at Westvaco Corporation, North Charleston, SC, April 29 - May 6, 1977

Exposure	No. of Minnows Surviving					No. of Shrimp Surviving					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Conductivity (µmhos/cm)				
	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
	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr
0.0	10	10	10	10	10	5	5	5	5	5	7.3	7.2	6.4	6.5	6.6	7.6	7.6	7.6	7.8	7.8	75	73	71	70	70	16.5	16.5	15.5	15.5	
0.0	10	10	10	10	10	5	5	4	4	4	7.6	7.1	6.3	6.1	6.6	7.6	7.6	7.6	7.8	7.8	75	72	70	69	70	16.5	16.5	15.5	15.5	
5.6	10	10	10	10	10	5	5	5	2	2	7.3	7.0	5.9	5.9	6.0	7.6	7.5	7.6	7.7	7.7	89	85	88	77	89	15	15.5	15.5	14.5	
5.6	10	10	10	10	10	5	4	4	4	4	7.3	6.9	5.8	5.9	6.0	7.6	7.6	7.6	7.7	7.7	89	85	87	81	87	15	15.5	15.5	15.5	
10.0	10	10	10	10	10	5	5	4	3	2	7.3	6.9	5.7	5.9	5.9	7.5					93					15	15	14.5	14	
10.0	10	10	10	10	10	5	5	4	4	2	6.7	6.7	5.5	5.4	5.8	7.6					95					15	15	14.5	14	
18.0	10	10	10	10	10	5	5	5	2	1	6.9	6.6	5.1	5.3	5.1	7.6	7.5	7.6	7.7	7.7	105	106	103	89	109	14	14	14	13	
18.0	10	10	10	10	10	5	5	4	2	1	6.9	6.5	5.1	5.3	5.2	7.6	7.5	7.6	7.7	7.7	105	102	110	90	111	14	14	14	13	
32.0	10	10	10	10	10	5	5	5	1	1	6.3	5.9	4.1	4.2	5.3	7.6					130					12	12	12	11	
32.0	10	10	10	10	10	5	5	3	0	0	6.1	5.8	4.2	4.3	5.5	7.6					130					12	12	12	11	
56.0	10	10	10	10	10	5	5	0	0	0	5.3	4.6	2.8	2.6	4.3	7.6	7.5	7.5	7.5	7.5	175	172	198	201	197	8	8	8	8	
56.0	10	10	10	10	10	5	4	0	0	0	5.3	4.7	2.8	2.6	4.4	7.6	7.5	7.5	7.5	7.7	175	173	195	203	195	8	8	8	8	

Table II.

Biological Data and Chemical Parameters Recorded by Test Aquarium During a Flow-Through 96-hour Acute Toxicity Study
Conducted at Verona Dyestuff Division of Mobay Chemical Corporation, Charleston, SC, May 23-29, 1977

% Wastewater	No. of Minnows Surviving					No. of Shrimp Surviving					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Salinity (mg/l)				
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr
0.0	20	20	19	19	19						7.4	5.3	7.6	8.3		7.6	7.6	7.7	7.7	7.8	80	81	76	75	75	16	16			
0.0	20	20	19	19	19	5	5	5	5	5	7.5	8.5	7.4	8.4		7.6	7.7	7.7	7.7	7.8	79	81	78	75	75	16	16			
5.6	20	20	20	19	17						6.8	7.7	7.4	7.9		7.6	7.6	7.7	7.7	7.7	77	80	75	76	76	16	16			
5.6	20	20	19	18	16	5	5	4	4	4	6.8	7.7	7.2	8.1		7.5	7.7	7.7	7.6	7.7	77	78	76	75	76	16	16			
10.0	20	20	20	19	15						6.3	7.3	7.1	7.8		7.5					77					15	14			
10.0	20	20	19	17	8	5	5	5	5	5	6.6	7.1	6.9	7.5		7.6					77					15	14			
18.0	20	20	20	19	16						6.0	6.7	6.6	6.8		7.5	7.6	7.5	7.4	7.4	77	75	74	75	76	14	13			
18.0	20	20	19	19	14	5	5	5	5	4	5.7	6.3	6.0	7.1		7.4	7.5	7.5	7.4	7.4	77	76	74	75	75	14	13			
32.0	20	19	12	5	4						4.9	7.0	6.3	7.4		7.4					71					12	12			
32.0	20	20	11	4	2	5	4	2	0	0	4.4	6.5	6.9	7.8		7.4					72					12	12			
56.0	20	7	6	1	1						2.3	7.7	6.3	6.8		7.4	7.3	7.4	7.4	7.4	69	69	71	74	74	10	9			
56.0	20	0	0	0	0	2	2	0	0	0	4.1	7.4	6.8			7.3	7.4	7.4	7.4	7.5	68	71	72	75	75	10	9			
100.0	14	0	0	0	0						1.8	7.5				7.0					58	65				5	4			
100.0	14	0	0	0	0	2	0	0	0	0	1.7	6.3				7.0					57	63				5	4			

Table III.

Biological Data and Chemical Parameters Recorded for Test Aquarium During a Flow-Through 96-hour Acute Toxicity Study
Conducted at the Glidden-Durkee Division of SCM Corp., Jacksonville, FL 32201

Wastewater	No. of Fish Surviving					Shrimp Survival					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/L CaCO ₃)					Salinity (g/L)				
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr
0.0	10	9	7	7	5	10	9	9	8	8	6.3	6.7	7.1	5.7	5.8	7.5	7.8	7.7	7.8	7.8	81	92	96	98	94	18	18	18	18	18
0.0	10	9	7	6	5	10	10	9	7	7	6.4	6.6	7.0	5.6	5.7	7.6	7.8	7.7	7.7	7.8	82	96	96	95	96	18	18	18	18	18
5.6	10	8	7	6	3	10	9	8	8	5	6.2	6.4	6.8	5.6	5.4	7.6	7.9	7.8	7.7	7.8	85	96	98	95	104	17	17	17	18	18
5.6	10	10	8	4	4	10	7	7	5	5	6.1	6.3	7.0	5.5	5.6	7.6	7.9	7.8	7.7	7.8	85	94	93	93	98	17	18	17	18	19
10.0	10	8	8	5	4	10	10	7	8	8	5.9	5.9	6.5	5.1	5.1	7.6					90					16	16	17	18	17
10.0	10	9	9	8	8	10	10	10	8	8	5.9	6.0	6.5	5.2	5.2	7.6					89					16	16	17	18	17
18.0	10	9	7	6	6	10	10	6	6	6	5.7	5.7	6.1	5.1	5.0	7.7	7.9	7.8	7.7	7.8	98	104	103	93	111	15	15	16	18	16
18.0	10	10	9	8	6	10	10	9	7	7	6.0	5.7	6.1	5.2	5.0	7.7	7.9	7.8	7.7	7.8	99	98	102	100	106	15	15	16	18	16
32.0	10	9	9	9	5	8	7	6	6	6	5.6	5.4	5.2	5.0	4.4	7.8					108					13	13	13	16	14
32.0	10	9	8	6	4	8	8	8	6	6	5.4	5.2	5.0	4.9	4.2	7.8					108					13	13	13	17	14
56.0	10	10	8	7	3	6	5	5	4	4	5.4	5.3	4.9	4.8	4.0	7.9	8.1	8.0	7.6	8.0	112	127	136	100	140	13	10	9	15	11
56.0	10	9	7	6	5	6	6	5	5	3	5.6	5.3	4.7	5.0	4.1	7.9	8.1	8.0	7.6	8.0	112	130	129	99	138	12	10	10	14	10
100.0											6.2	5.7	5.3	4.6	5.4	8.4	8.5	8.3	8.4	8.5	165	158	167	179	185	1	2	1	2	3
100.0											5.4	5.7	5.8	4.6	3.9	8.4	8.5	8.3	8.4	8.3	173	170	176	185	185	1	2	1	2	3

Table IV.

Survival Data Recorded for Wastewater Concentrations During
a Flow-Through Toxicity Study Conducted at Hercofina Corporation
Wilmington, North Carolina, July 20-24, 1977

Concentration of Wastewater (%)	No. of sheepshead minnows surviving					No. of adult mysid shrimp surviving					No. of young mysid shrimp surviving		
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr
0.0	10	9	9	8	8	10	10	10	10	10	10	10	10
0.0	10	10	7	5	5	10	10	10	10	10	--	--	--
5.3	10	10	10	10	10	10	9	9	9	9	10	10	10
5.3	10	10	10	10	10	10	10	10	10	10	--	--	--
9.6	10	10	10	10	6	10	9	0	0	0	10	1	0
9.6	10	10	10	10	7	10	10	10	10	10	--	--	--
18.0	10	10	10	10	9	10	0	0	0	0	10	0	0
18.0	10	10	10	10	5	10	0	0	0	0	--	--	--
32.0	10	10	0	0	0	10	0	0	0	0	10	6	0
32.0	10	8	2	0	0	10	0	0	0	0	--	--	--
56.0	10	0	0	0	0	10	0	0	0	0	10	0	0
56.0	10	0	0	0	0	10	0	0	0	0	--	--	--

Table V.

Chemical Parameters Recorded for Wastewater Concentrations During a Flow-Through 96-hour
Acute Toxicity Study Conducted at Hercofina Corporation, Wilmington, NC
July 20-24, 1977

Concentration of Wastewater (%)	Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Salinity (ng/ml)				
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr
0.0		6.2	6.1	5.9	5.9	7.4	7.4	7.8	7.5	7.5	70	67	79	88	77	20	20	20	22	21
0.0		6.2	6.1	5.9	6.1	-	-	-	-	-	-	-	-	-	-	-	20	20	22	21
5.3		7.2	6.4	5.8	5.9	7.2	7.3	7.5	7.6	7.5	165	155	179	99	150	19	18	18	21	20
5.3		6.8	6.2	5.7	5.9	-	-	-	-	-	-	-	-	-	-	-	19	18	21	20
9.6		6.9	6.4	6.0	5.9	7.2	7.2	7.5	7.5	7.5	195	183	185	102	182	18	18	19	22	20
9.6		6.4	6.3	5.9	5.7	-	-	-	-	-	-	-	-	-	-	-	18	19	21	19
18.0		6.7	6.2	5.7	5.7	7.2	7.3	7.4	7.6	7.6	331	301	310	144	352	16	17	17	21	18
18.0		6.3	6.2	5.5	5.8	-	-	-	-	-	-	-	-	-	-	-	17	18	21	18
32.0		6.4	6.5	5.0	5.8	7.2	7.3	7.4	7.6	7.6	555	541	523	306	566	13	13	14	18	14
32.0		6.2	6.2	5.4	5.8	-	-	-	-	-	-	-	-	-	-	-	14	14	20	14
56.0		6.3	6.3	5.0	6.3	7.3	7.2	7.3	7.5	7.6	865	753	828	756	898	10	10	12	13	10
6.0		6.3	5.9	5.1	6.0	-	-	-	-	-	-	-	-	-	-	-	10	11	13	10
100.0		7.8	6.6	4.7	7.1	7.5	7.6	7.6	7.7	7.7	1308	1208	1214	1406	1428	2	2	4	4	3
100.0		7.7	7.4	4.8	6.6	-	-	-	-	-	-	-	-	-	-	-	2	3	4	4

Survival Data Recorded by Test Aquarium ng a Flow-Through Acute Toxicity Study
Conducted at W. R. Grace & Co., Wilmington, NC
July 25 - August 2, 1977

* Results of this test have been included in this report in spite of unacceptably high control mortality, since the pattern of mortality vs. concentration for all test concentrations is typical of mortality tests in general. Results are to be interpreted with caution.

Table VII.

Survival Data Recorded During 48-hour Static Acute Toxicity Testing
 Conducted at W. R. Grace & Co., Wilmington, NC
 July 25 - August 2, 1977

Concentration of Wastewater (%)	No. of Mysid Shrimp Adults Surviving			No. of Young Sheepshead Minnows (5-10 mm) Surviving		
	0 hr	24 hr	48 hr	0 hr	24 hr	48 hr
0	10	10	10	10	10	10
1	10	10	10	10	10	10
3	10	10	10	10	10	10
10	10	10	10	10	10	10
30	10	8	2	10	10	10
60	10	5	0	10	10	8

Table VIII.

Ranges of Values for Chemical Parameters Monitored Periodically
for Each Wastewater Concentration Tested During a Flow-through
Acute Toxicity Study at W. R. Grace & Co., Wilmington, NC
July 25 - August 2, 1977

Parameter	Concentration of Wastewater (%)					
	0	5.6	10	18	32	56
Dissolved oxygen (mg/l)	6.3-6.9	6.1-6.7	5.9-6.6	6.0-6.4	6.0-6.4	6.0-6.4
pH	7.7-8.1	7.8-8.1	7.8-8.1	7.9-8.2	8.1-8.3	8.2-8.5
Total Alkalinity (mg/l CaCO_3)	65-75	67-70	61-70	61-65	52-55	39-44
Salinity (mg/ml)	18-23	16-20	16-20	15-18	12-16	8-10

Table IX.

Survival Data Recorded by Test Aquarium During an Acute Toxicity Study
 Conducted at E. I. duPont de Nemours and Company, Wilmington, NC, August 2-6, 1977

Fresh-water Flow-Through Tests										Salt-water Static Tests								
Concentration of Wastewater (%)	No. of <u>Ictalurus</u> <u>punctatus</u> surviving					No. of <u>Daphnia</u> <u>magna</u> surviving				Concentration of Wastewater (%)	No. of <u>Mysidopsis</u> <u>bahia</u> surviving				No. of <u>Cyprinodon</u> <u>variegatus</u> surviving			
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr		0 hr	24 hr	48 hr	72 hr	0 hr	24 hr	48 hr	72 hr
0.0	10	10	10	10	10	10	10	10	10	0	15	15	15	15	10	10	10	10
0.0	10	10	10	10	10	10	10	10	10									
5.6	10	10	10	9	9	10	10	10	10	5	15	14	14	13	10	10	10	10
5.6	10	10	10	10	10	10	10	10	10									
10.0	10	10	10	10	10	10	10	10	9	10	15	14	14	14	10	10	10	10
10.0	10	10	10	10	10	10	10	10	10									
18.0	10	10	10	10	9	10	10	10	10	20	15	15	15	14	10	10	10	10
18.0	10	10	10	10	10	10	10	10	10									
32.0	10	10	10	10	10	10	10	9	8	30	15	14	14	14	10	10	10	10
32.0	10	10	10	10	10	10	10	10	10									
56.0	10	10	10	10	10	10	10	10	9	50	15	15	15	15	10	10	10	10
56.0	10	10	10	10	10	10	10	9	9									
100.0	10	10	10	10	10	10	10	10	10									
100.0	10	10	10	10	10	7	7	7	7									

Table A.

Chemical Monitoring Data Recorded by Test Aquarium During Flow-through Acute Toxicity Testing
at E. I. duPont de Nemours and Company, Wilmington, NC, August 2-6, 1977

% Wastewater	Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Hardness (mg/l)				
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr
0.0	7.1	6.8	6.8	6.4	6.3	7.2	7.5	7.5	7.5	7.6	33	31	35	39	38	40	38	38	--	38
0.0	7.2	6.8	6.7	6.3	6.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5.6	7.2	6.6	6.6	6.2	6.1	7.7	7.6	7.8	7.9	--	63	43	72	75	--	41	40	36	--	40
5.6	7.1	6.7	6.4	6.1	6.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10.0	7.1	6.6	6.3	6.1	6.0	7.7	7.6	7.8	7.9	7.9	63	40	73	75	74	41	39	37	--	38
10.0	7.1	6.6	6.4	6.2	6.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18.0	7.2	6.6	6.4	6.0	6.0	8.0	7.8	8.0	8.0	--	101	62	115	121	--	41	40	37	--	40
18.0	7.1	6.7	6.2	6.0	6.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
32.0	7.1	6.5	5.9	6.0	5.8	8.1	8.1	8.2	8.3	8.2	164	101	187	204	195	40	39	36	--	37
32.0	7.1	6.6	6.1	5.9	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
56.0	7.1	6.1	5.9	5.7	5.8	8.2	8.1	8.3	8.4	--	231	125	279	294	--	40	40	36	--	38
56.0	7.1	6.3	5.8	5.7	5.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
100.0	7.2	6.3	5.4	6.5	6.5	8.3	8.6	8.5	8.6	8.5	366	371	379	457	463	38	30	32	--	39
100.0	7.3	6.4	6.2	6.5	6.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table XI.

Survival Data for Acute Toxicity Tests Conducted at
International Paper Company, Georgetown, SC, August 14-18, 1977

Flow-Through Tests											Static Tests				
Concentration of Wastewater (%)	Minnows Surviving					Shrimp Surviving *					Concentration of Wastewater (%)	Minnows Surviving		Shrimp Surviving	
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr		0 hr	48 hr	0 hr	48 hr
0	10	10	10	10	10	10	10	10	10	10	0	10	10	10	10
0	10	10	10	10	10	10	10	10	10	10					
5.6	10	10	10	10	10	10	10	10	10	10	5	10	10	10	10
5.6	10	10	10	10	10	10	9	9	9	9					
10.0	10	10	10	9	9	10	10	9	9	9	10	10	10	10	9
10.0	10	10	10	10	10	10	10	10	10	10					
18.0	10	10	10	10	10	10	9	9	7	7	20	10	10	10	10
18.0	10	9	9	9	9	10	8	8	8	8					
32.0	10	10	10	10	10	10	7	7	7	7	30	10	10	10	10
32.0	10	10	10	10	10	10	3	0	0	0					
56.0	10	7	7	7	7	10	4	4	4	3	60	10	10	10	10
56.0	10	10	10	10	10	10	3	3	3	2					

* Although the data from which these values were calculated presented a credible pattern of mortality with respect to lethality concentration, this set of values was not included in the industry report since a short-term drop in dissolved oxygen in some aquaria may have prejudiced the results.

XII.

Chemical Parameters Recorded by Test Aquarium During a Flow-Through 96-hour Acute Toxicity Study
Conducted at International Paper Company, Georgetown, SC, August 14-18, 1977

Concentration of Wastewater	Dissolved Oxygen (mg/L)					pH					Total Alkalinity (mg/L CaCO ₃)					Salinity (mg/mL)				
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr
0.0	7.7	6.7	6.6	6.3	6.3	8.0	8.0	8.0	8.0	8.0	83	84	94	95	98	18	19	19	19	19
0.0	7.6	6.8	6.4	6.3	6.1	-	-	-	-	-	-	-	-	-	-	18	19	19	19	19
5.6	7.0	6.0	5.7	5.5	5.2	7.9	7.9	7.9	7.8	7.9	91	101	100	105	107	18	18	18	18	18
5.6	7.0	6.1	5.5	5.5	5.3	-	-	-	-	-	-	-	-	-	-	18	18	18	18	18
10.0	6.9	5.8	5.3	5.1	4.7	7.9	7.9	7.9	7.8	7.8	91	101	100	107	110	17	18	17	16	17
10.0	7.0	5.9	5.4	5.4	5.3	-	-	-	-	-	-	-	-	-	-	17	18	17	16	17
18.0	6.2	4.5	6.4	5.9	5.9	7.8	7.7	7.8	7.9	7.9	99	112	112	115	120	16	14	14	15	15
18.0	6.2	4.8	7.0	5.4	6.0	-	-	-	-	-	-	-	-	-	-	16	14	14	15	15
32.0	4.9	2.2	6.6	5.4	5.3	7.7	7.6	7.9	7.8	7.7	112	139	136	132	139	12	9	8	12	12
32.0	4.8	2.0	6.6	5.0	5.1	-	-	-	-	-	-	-	-	-	-	12	9	8	12	12
56.0	5.3	1.9	6.0	4.6	4.9	7.7	7.6	7.9	7.8	7.7	130	152	148	152	162	8	7	7	8	8
56.0	5.3	2.2	6.3	4.7	5.2	-	-	-	-	-	-	-	-	-	-	8	7	7	8	8
100.0	1.4	-	2.2	-	-	7.7	7.7	7.7	7.7	7.7	163	154	156	195	207	2	2	1	2	2
100.0	3.5	-	2.4	-	-	-	-	-	-	-	-	-	-	-	-	2	2	1	2	2

Table XIII.

Biological Data Recorded by Test Aquarium During a Flow-Through 96-Hour Acute
Toxicity Study Conducted at the Cold Creek Plant of
Stauffer Chemical Company, Bucks, Alabama, September 11-15, 1977

% Wastewater	No. of sheephead minnows surviving					No. of adult mysid shrimp surviving					No. of newly hatched mysid shrimp surviving			
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr
0.0	10	10	10	10	10	10	10	9	9	9	10	10	10	10
0.0	10	10	10	10	10	10	10	9	9	9	--	--	--	--
5.6	10	10	10	10	10	10	10	9	8	3	10	10	9	8
5.6	10	10	10	10	10	10	10	9	4	2	--	--	--	--
10.0	10	10	10	10	10	10	10	7	3	0	10	10	7	6
10.0	10	10	10	10	10	10	10	8	0	0	--	--	--	--
18.0	10	10	10	10	10	10	10	1	0	0	10	10	6	5
18.0	10	10	10	10	10	10	9	4	0	0	--	--	--	--
32.0	10	10	10	10	10	10	2	0	0	0	10	3	3	0
32.0	10	10	10	10	10	10	3	0	0	0	--	--	--	--
56.0	10	10	9	9	9	10	0	0	0	0	10	1	0	0
56.0	10	10	10	10	10	10	1	0	0	0	--	--	--	--

Chemical Parameters Recorded by Test Aquarium During a Flow-Through 96-hour Acute Toxicity Study Conducted at the Cold Creek Plant of Stauffer Chemical Company, Bucks, Alabama, September 11-15, 19

[illegible]

Table XV.

Biological Data and Chemical Parameters Recorded by Test Aquaria During a Flow-Through 96-hour Acute Toxicity Study
Conducted at the Lefloynne Plant of Stauffer Chemical Company, Axis, Alabama
September 16-20, 1977

Leading to Concentration of Waste- water (%)	Minnows Surviving					Shrimp Surviving					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Salinity (g/m ³)				
	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
	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr
0.0	10	10	10	10	10	10	9	9	9	9	8.0	7.8	8.0	6.9	7.0	7.9	7.9	8.1	8.0	7.7	71	72	72	72	71	17	18	15	15	16
9.0	10	10	10	10	10	10	9	9	9	9	7.9	7.8	8.0	6.8	7.1	-	-	-	-	-	-	-	-	-	-	17	18	15	15	16
5.6	10	10	10	10	10	10	10	10	10	10	7.5	7.2	6.0	6.1	6.7	7.9	7.8	7.7	7.8	7.6	66	66	64	64	66	16	16	14	14	16
5.6	10	10	10	10	10	10	10	10	10	10	7.3	6.8	5.8	5.7	6.6	-	-	-	-	-	-	-	-	-	-	16	16	14	14	16
10.0	10	10	10	10	10	10	10	10	10	10	7.2	6.8	5.2	5.6	6.5	7.9	7.6	7.6	7.8	7.7	63	63	64	64	65	16	16	14	14	15
10.0	10	10	10	10	10	10	10	10	10	10	7.2	6.7	5.2	5.4	6.5	-	-	-	-	-	-	-	-	-	-	16	16	14	14	15
18.0	10	10	10	10	10	10	10	10	10	10	7.1	6.1	6.2	6.5	6.3	7.8	7.6	7.5	7.8	7.4	63	58	57	58	60	15	16	14	14	15
13.0	10	10	10	10	10	10	10	10	10	10	6.3	5.9	6.2	6.7	6.4	-	-	-	-	-	-	-	-	-	-	15	16	14	14	15
32.0	10	10	10	10	10	10	10	10	10	10	5.4	7.3	7.5	6.4	5.7	7.2	7.4	7.4	7.6	7.2	45	44	38	48	47	12	14	12	12	13
32.0	10	10	10	10	10	10	10	10	10	10	5.3	7.5	4.5	6.3	5.6	-	-	-	-	-	-	-	-	-	-	12	14	12	12	13
56.0	10	10	10	10	10	10	8	8	0	0	3.4	6.2	3.4	5.8	4.3	6.8	6.6	6.3	6.9	6.9	28	19	15	22	30	10	12	8	8	10
56.0	20	20	20	20	20	10	10	9	4	4	3.3	6.4	3.5	5.9	4.8	-	-	-	-	-	-	-	-	-	-	10	12	8	8	10
100.0											5.5	3.2	0.5	3.2	-	5.6	4.2	6.2	3.6	4.1	3	-	12	-	-	3	4	3	3	-
100.0											5.0	5.1	1.0	3.9	-	-	-	-	-	-	-	-	-	-	-	3	4	3	3	-

Ta I.

Biological Data and Chemical Parameters Recorded by Test Aquarium During a Flow-through 96-hour Acute Toxicity Study Conducted at dePoortere Corporation, Wilmington, NC, November 7-11, 1977.

Wastewater Concentra- tion (%)	# of Sheepshead Minnows Surviving					Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Salinity (ppt)				
	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
	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr
0.0	10	10	10	10	10	6.8	7.6	6.5	8.6	7.7	7.9	8.0	8.1	8.0	7.9	152	152	153	136	132	16	15	16	16	16
0.0	10	10	10	10	10	6.9	7.5	6.5	8.6	7.5	-	-	-	-	-	-	-	-	-	-	16	16	16	16	15
5.6	10	10	10	10	10	7.0	6.7	6.7	8.0	7.4	7.9	8.0	8.0	8.0	8.0	144	143	147	136	131	15	16	15	15	14
5.6	10	10	10	10	10	7.6	6.8	5.9	8.2	7.5	-	-	-	-	-	-	-	-	-	-	15	15	15	15	15
10.0	10	10	10	10	10	6.8	6.9	6.5	8.3	7.5	7.9	8.0	8.0	8.0	7.9	142	143	146	133	129	15	15	15	14	14
10.0	10	10	10	10	10	6.7	6.9	6.4	8.0	7.3	-	-	-	-	-	-	-	-	-	-	14	14	14	14	14
18.0	10	10	10	10	10	6.5	6.8	6.2	7.6	7.1	7.8	7.9	8.0	7.9	7.9	132	135	138	123	124	14	14	14	13	14
18.0	10	10	10	10	10	6.7	6.2	6.2	6.9	7.1	-	-	-	-	-	-	-	-	-	-	13	13	14	13	14
32.0	10	10	10	10	10	6.6	6.3	6.2	7.9	7.6	7.8	7.9	7.9	7.9	7.9	117	126	124	109	115	11	12	12	11	12
32.0	10	10	10	10	10	6.5	6.3	6.4	7.6	7.4	-	-	-	-	-	-	-	-	-	-	11	12	12	10	12
56.0	10	10	10	10	10	6.4	6.6	6.0	6.9	6.6	7.7	7.6	7.7	7.7	7.7	95	97	96	90	100	10	8	9	8	8
56.0	10	10	10	10	10	6.2	6.4	6.1	7.4	7.4	-	-	-	-	-	-	-	-	-	-	10	8	8	8	8
100.0	*					6.2	5.9	4.0	5.3	4.9	7.3	7.5	7.2	7.2	7.1	37	33	36	38	31	0	0	0	0	0
100.0						6.7	5.9	5.7	6.8	5.0	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0

* Estuarine or marine organisms cannot be tested in undiluted, nonsaline wastewater.

Table XVII.

Biological Parameters Recorded for Wastewater Concentrations During a Flow-Through
Acute Toxicity Study Conducted at American Color and Chemical Corporation, Lobeco, SC

December 9-17, 1977

% ste- water	No. of <u>Cyprinodon variegatus</u> surviving										No. of mysid shrimp surviving													
	I. 12-15 day old minnows					II. 26-28 day old minnows					I. <u>Mysidopsis bahia</u>					II. <u>Mysidopsis bahia</u>					III. mysid mixture*			
	Dec 12	Dec 13	Dec 14	Dec 15	Dec 16	Dec 13	Dec 14	Dec 15	Dec 16	Dec 17	Dec 12	Dec 13	Dec 14	Dec 15	Dec 16	Dec 13	Dec 14	Dec 15	Dec 16	Dec 17	Dec 14	Dec 15	Dec 16	Dec 17
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	9	9	9
0.0	10	10	10	10	10	-	-	-	-	-	10	10	10	10	10	10	10	10	10	10	10	10	10	9
5.6	10	10	10	10	10	10	10	10	10	10	10	10	9	7	7	-	-	-	-	-	10	9	9	4
5.6	10	10	10	10	10	10	10	10	10	10	10	10	6	6	5	-	-	-	-	-	10	9	9	6
10.0	10	10	10	10	10	10	10	10	10	10	10	10	9	1	1	5	4	3	2	1	10	10	9	9
10.0	10	10	10	10	10	10	10	10	10	10	10	10	9	1	1	-	-	-	-	-	10	9	6	0
18.0	10	10	10	10	10	10	10	10	10	10	10	10	5	0	0	5	4	0	0	0	10	4	0	0
18.0	10	10	10	10	10	10	10	10	10	10	10	10	6	0	0	-	-	-	-	-	10	8	7	4
.0	10	10	10	10	10	10	10	10	10	9	10	10	0	0	0	5	1	0	0	0	10	0	0	0
32.0	10	10	10	10	9	10	10	10	9	9	10	10	1	0	0	-	-	-	-	-	10	4	1	1
56.0	10	10	10	10	10	10	10	4	4	2	10	0	0	0	0	5	0	0	0	0	10	0	0	0
56.0	10	10	10	9	4	10	9	3	2	1	10	0	0	0	0	-	-	-	-	-	10	0	0	0

* A 70:30 mixture of Mysidopsis bigelowi and Neomysis americana was used in this test.

Table XVIII.

Chemical Parameters Recorded for Wastewater Concentrations During a Flow-Through
Acute Toxicity Study Conducted at American Color and Chemical Corporation, Lobeco, SC
December 9-17, 1977

	Dissolved Oxygen (mg/l)						pH						Total Alkalinity (mg/l CaCO ₃)						Salinity (mg/ml)						Temperature (°C)					
	Dec 12	Dec 13	Dec 14	Dec 15	Dec 16	Dec 17	Dec 12	Dec 13	Dec 14	Dec 15	Dec 16	Dec 17	Dec 12	Dec 13	Dec 14	Dec 15	Dec 16	Dec 17	Dec 12	Dec 13	Dec 14	Dec 15	Dec 16	Dec 17	Dec 12	Dec 13	Dec 14	Dec 15	Dec 16	Dec 17
0.0	9.47	9.97	9.47	7.77	6.64	4.2	7.98	8.28	8.08	7.98	8.0	147	148	148	148	149	-	18	15	18	17	16	17	16.0	-	22.7	22.5	17.7	24.2	
0.0	9.68	0.07	9.47	8.79	4.4		-	-	-	-	-	-	-	-	-	-	-	18	15	18	18	16	17	15.9	21.9	22.4	22.2	17.7	23.9	
5.6	9.36	7.64	4.26	0.38			7.98	8.28	0.78	7.87	8.78	198	197	195	192	188	-	18	15	18	18	16	16	15.8	22.0	22.5	22.5	18.1	24.0	
5.6	8.87	0.64	4.15	2.37			-	-	-	-	-	-	-	-	-	-	-	18	15	18	18	16	17	15.5	20.0	22.4	22.2	17.7	23.7	
10.0	8.56	4.67	4.55	7.35			7.98	8.28	0.79	7.87	8.78	210	224	218	214	214	-	18	15	18	17	16	17	15.8	21.9	23.5	22.4	17.9	24.0	
10.0	8.26	4.54	4.25	8.31			-	-	-	-	-	-	-	-	-	-	-	18	15	17	18	16	16	15.5	21.9	22.2	22.2	18.0	23.7	
18.0	7.66	3.56	4.36	3.41			7.98	3.82	8.08	0.80	8.0	275	294	278	266	265	-	18	15	17	16	16	16	15.8	22.0	22.6	22.3	17.9	23.8	
18.0	7.06	4.57	3.96	2.32			-	-	-	-	-	-	-	-	-	-	-	18	15	17	17	16	16	15.6	22.0	22.4	22.2	18.0	23.6	
32.0	5.84	4.29	4.25	8.42			8.08	3.81	18.18	0.81		381	404	397	359	360	-	18	15	16	16	16	15	15.9	22.2	22.8	22.4	18.1	23.9	
32.0	6.15	2.44	3.15	6.42			-	-	-	-	-	-	-	-	-	-	-	18	15	16	16	16	16	15.9	22.1	22.7	22.4	18.1	23.8	
56.0	5.14	9.32	3.55	4.40			8.18	3.82	28.28	3.81		512	536	518	488	485	-	17	14	16	16	15	16	16.0	22.3	23.1	22.4	18.1	24.0	
56.0	4.84	9.35	3.55	6.40			-	-	-	-	-	-	-	-	-	-	-	17	14	16	16	15	15	16.1	22.4	23.0	22.7	18.2	23.9	
100.0	2.90	6.60	2.60	7.10	1.0		8.28	4.81	18.28	2.78		866	856	813	766	-	-	16	14	15	14	14	14	15.3	-	23.6	22.8	18.5	24.2	
100.0	2.60	5.50	2.60	6.6	-		-	-	-	-	-	-	-	-	-	-	-	15	14	15	14	14	14	15.0	-	23.4	22.8	18.8	24.0	

Table XIX.

Survival Data Recorded by Test Aquarium During an Acute Toxicity Study Conducted at the
Olin Corporation, Smokeless Powder Division, St. Marks, FL, January 15-19, 1978

Wastewater Concentration (%)	Flow-through Tests										Static Tests									
	Site 1 Wastewater*										Site 1 Wastewater*					Site 2 Wastewater*				
	Mysid Shrimp Alive					Sheepshead Minnows Alive					Sheepshead Minnows Alive					Sheepshead Minnows Alive				
	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
0.0	10	10	10	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5.6	10	10	10	10	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5.6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10.0	10	10	9	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
18.0	10	10	9	9	8	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	10	10	10	10	10	10	10	10	10	10	10	10
32.0	10	10	9	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
32.0	10	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
56.0	10	7	7	7	5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
56.0	10	8	7	6	6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Collection sites for wastewater used for toxicity testing:

1. Just prior to spray irrigation - wastewater tapped from pump station between holding pond and sprayfield.
2. From sprayfield drainage ditch leading to Big Boggy Branch - wastewater was dipped from a bridge crossing the ditch on Olin property.

Table XX.

Chemical Parameters Recorded by Flow-through Test Aquarium During an Acute Toxicity Study
Conducted at the Olin Corporation, Smokeless Powder Division, St. Marks, FL, January 15-19, 1978

Wastewater concentration	Dissolved Oxygen					pH					Total Alkalinity					Salinity					Temperature				
	(mg/l)										(mg/l CaCO ₃)					(mg/ml)					(°C)				
	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
(%)	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr
0.0	9.2	8.5	7.9	8.6	8.7	8.1	8.1	8.1	8.1	8.2	115	113	116	109	113	16	15	15	20	20	12.3	18.8	20.1	18.5	18.2
0.0	9.3	8.3	7.9	8.5	8.6	-	-	-	-	-	-	-	-	-	-	16	15	15	20	20	11.3	18.6	20.1	17.7	18.1
5.6	9.3	7.0	7.4	8.4	8.5	8.1	8.1	8.1	8.0	8.1	133	133	132	113	112	14	14	14	20	20	11.6	18.9	20.8	18.0	17.7
5.6	9.2	7.1	7.6	8.4	8.5	-	-	-	-	-	-	-	-	-	-	15	14	14	20	20	11.3	19.0	20.7	18.0	17.8
10.0	9.2	7.3	7.5	8.4	8.6	8.1	8.1	8.1	8.1	8.1	138	139	135	111	112	14	14	14	20	20	11.4	19.2	21.4	18.2	17.4
10.0	9.0	7.2	7.4	8.3	8.3	-	-	-	-	-	-	-	-	-	-	15	14	14	20	20	11.6	19.0	20.8	17.8	17.8
18.0	8.9	7.2	7.2	8.0	8.0	8.1	8.1	8.1	8.0	8.1	154	155	154	154	138	14	13	12	18	18	12.0	19.1	20.9	18.2	18.1
18.0	8.9	7.3	7.4	8.0	8.1	-	-	-	-	-	-	-	-	-	-	13	13	13	18	18	11.8	19.6	21.5	18.8	17.7
32.0	8.6	7.0	6.6	7.6	7.3	8.2	8.2	8.1	8.0	8.0	191	191	189	190	194	11	12	11	15	15	12.8	19.8	21.2	18.8	18.4
32.0	8.6	7.1	6.4	7.6	7.2	-	-	-	-	-	-	-	-	-	-	11	11	11	14	15	12.8	19.8	21.3	19.0	18.3
56.0	8.3	6.8	5.4	6.6	6.3	8.3	8.2	8.1	8.0	8.0	252	251	249	245	252	8	8	8	11	11	14.2	20.8	21.6	19.7	18.7
56.0	8.3	6.8	5.4	6.6	6.0	-	-	-	-	-	-	-	-	-	-	8	8	8	10	10	14.3	20.5	21.5	19.4	18.6
100.0	8.3	6.1	4.2	5.9	6.0	8.5	8.6	8.4	8.4	8.5	364	366	367	365	367	1	3	3	4	2	16.0	18.2	19.0	16.7	18.6

Table XXI.

Survival Data Recorded by Test Aquarium During
Acute Toxicity Testing Conducted at the Container Corporation
of America, Fernandina Beach, Florida
February 6-10, 1978

Wastewater Concentration (%)	Flow-through tests										Static Tests							
	Sheepshead Minnows					Mysid Shrimp					Sheepshead Minnows				Mysid Shrimp			
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	0 hr	24 hr	48 hr	72 hr
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	4	4	4	4
3.0	10	10	10	10	10	10	10	10	10	10								
5.6	10	10	10	10	10	10	10	9	4	4	10	10	10	10	4	4	3	3
5.6	10	10	10	10	10	10	10	10	6	6								
10.0						10	10	10	4	4	10	10	10	10	4	4	4	4
10.0	10	10	9	1	1	10	10	9	1	1								
18.0	10	10	9	0	-	10	6	6	0	-	10	10	10	10	4	4	3	3
18.0	10	10	10	0	-	10	4	4	0	-								
32.0	10	10	0	-	-	10	2	0	-	-	10	10	10	10	4	4	4	4
32.0	10	10	9	0	-	10	0	-	-	-								
56.0	10	0	-	-	-	10	0	-	-	-	10	10	10	10	4	3	2	2
56.0	10	0	-	-	-	10	0	-	-	-								

Table XXII.

Chemical Parameters Recorded by Test Aquarium During Flow-Through
Acute Toxicity Testing Conducted at the Container Corporation of America,
Fernandina Beach, Florida, February 6-10 1978

	Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Salinity (mg/ml)					Temperature (°C)				
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr
Wastewater																									
0.0	7.9	8.7	8.6	8.3	7.1	7.7	7.8	7.9	7.8	7.9	113	113	107	84	115	13	16	16	16	18	13.0	12.4	16.7	18.8	19.3
0.0	7.9	8.7	8.7	8.3	7.1											13	16	16	16	18	12.7	12.0	15.0	18.0	18.7
5.6	7.7	8.2	6.6	5.5	7.8	7.5	7.6	7.6	7.4	7.9	130	134	125	105	125	12	15	15	14	16	13.2	12.5	15.6	18.0	19.0
5.6	7.6	7.7	6.2	5.0	7.8											12	15	15	14	16	12.8	12.3	15.4	18.0	19.0
10.0	7.6	8.2	7.6	5.2	7.8	7.4	7.6	7.6	7.3	7.9	135	137	128	105	125	12	15	15	12	16	13.0	12.1	14.7	17.8	18.7
10.0	6.4	8.0	7.6	5.7	7.8											12	14	14	12	16	13.0	12.1	14.7	17.5	18.0
18.0	7.1	7.7	7.7	5.0	5.8	7.4	7.6	7.5	7.3	7.4	154	162	145	132	139	11	14	13	12	15	13.5	12.5	14.9	17.4	19.0
18.0	7.7	8.1	7.9	5.7	5.7											11	14	13	12	15	13.8	12.2	14.9	18.1	18.7
32.0	7.4	7.7	8.1	6.3	4.8	7.3	7.5	7.4	7.5	7.2	192	197	179	172	163	10	12	11	10	13	14.8	12.9	15.6	18.5	19.2
32.0	7.3	8.2	8.0	5.2	5.5											9	11	11	9	13	14.7	12.7	15.7	18.2	19.0
56.0	6.6	8.5	7.7	5.0	3.7	7.2	7.5	7.4	7.6	7.2	238	252	227	236	196	7	8	8	6	8	16.7	13.7	16.7	19.0	19.8
56.0	6.1	8.1	7.8	5.4	4.4											6	8	7	7	8	16.2	13.4	16.9	18.8	19.6
100.0	6.9	9.7	8.1	6.5	5.4	7.4	7.6	7.6	7.2	7.1	379	361	339	302	235	0	0	0	0	0	23.9	18.4	22.9	26.0	21.8

Table XXIII.
Survival Data Collected by Test Aquarium During an Acute Toxicity Study at the
Georgetown Steel Corporation, Georgetown, SC, March 22-26, 1978

Waste water Concen- tration (%)	Flow-through Tests										Static Tests									
	Minnows* Alive					Shrimp** Alive					Minnows* Alive					Shrimp** Alive				
	0hr	24hr	48hr	72hr	96hr	0hr	24hr	48hr	72hr	96hr	0hr	24hr	48hr	72hr	96hr	0hr	24hr	48hr	72hr	96hr
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		9		9
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
5.6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		10		10
5.6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
10.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		10		10
10.0	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	10	10	10	10	10	10	10	10		10		10
18.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
32.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		9		9
32.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
56.0	10	10	10	10	10	10	10	8	7	7	10	10	10	10	10	10		10		10
56.0	10	10	10	10	10	10	10	10	9	9	10	10	10	10	10	10				

* Cyprinodon variegatus

** Mysidopsis bahia

Table XXIV.

Chemical Parameters Recorded by Flow-through Test Aquarium During an Acute Toxicity Study
Conducted at the Georgetown Steel Corporation, Georgetown, SC, March 22-26, 1978

Wastewater Concentration (%)	Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Salinity (mg/ml)					Temperature (°C)				
	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
	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr
0.0	8.4	8.1	7.7	8.1	8.2	7.8	7.8	7.8	7.8	7.8	63	69	67	63	64	18	20	20	18	20	19.4	20.5	22.7	20.4	21.0
0.0	8.6	8.4	8.0	8.3	8.3	-	-	-	-	-	-	-	-	-	-	18	19	20	18	20	19.8	20.2	22.7	20.1	20.9
5.6	8.5	8.4	8.0	8.5	8.2	7.8	7.8	7.8	7.8	7.8	66	65	66	62	63	18	18	19	18	19	19.9	20.1	23.2	19.8	21.0
5.6	8.6	8.5	8.1	8.4	8.3	-	-	-	-	-	-	-	-	-	-	18	18	18	18	19	19.9	20.0	22.9	19.8	20.7
10.0	8.6	8.7	8.2	8.6	8.3	7.8	7.8	7.7	7.8	7.8	67	65	63	61	64	18	18	18	17	19	19.7	20.0	23.1	19.7	20.9
10.0	8.6	8.7	8.1	8.6	8.4	-	-	-	-	-	-	-	-	-	-	18	17	18	17	19	20.3	20.0	23.2	19.7	21.0
18.0	8.7	8.6	8.1	8.6	8.3	7.8	7.8	7.7	7.8	7.8	68	64	62	59	63	17	16	17	16	19	20.1	20.3	23.0	19.9	20.7
18.0	8.9	9.1	8.1	8.6	8.4	-	-	-	-	-	-	-	-	-	-	16	16	18	16	19	20.4	20.3	23.6	19.8	21.0
32.0	9.0	8.8	8.1	8.6	8.3	7.7	7.8	7.7	7.8	7.8	69	63	61	57	63	14	13	15	13	19	20.6	20.7	23.4	20.1	20.8
32.0	8.9	8.8	7.9	8.6	8.4	-	-	-	-	-	-	-	-	-	-	14	13	15	13	19	20.6	20.7	23.1	20.1	21.0
56.0	8.8	8.5	7.7	8.4	7.7	7.7	7.7	7.6	7.7	7.7	71	59	55	55	60	10	10	10	10	19	20.7	21.1	23.1	20.8	21.0
56.0	8.7	8.6	7.8	8.2	8.0	-	-	-	-	-	-	-	-	-	-	10	10	10	10	19	20.9	21.2	23.3	20.6	20.0
100.0	8.7	8.6	8.3	8.3	7.6	7.6	7.4	7.5	7.6	7.3	72	54	45	53	44	0	0	0	0	1	22.9	22.0	23.8	20.2	19.0
100.0	8.4	8.3	8.3	8.1	7.1	-	-	-	-	-	-	-	-	-	-	0	0	0	0	1	23.8	22.6	22.7	20.3	19.6

Table XXV.

Survival Data Recorded by Test Aquaria During Acute Toxicity Testing Conducted at
Virginia Chemicals Incorporated, Mobile, Alabama April 27 - May 1, 1978

Wastewater Concentration · (%)	Flow-through Tests										Static Tests									
	Sheepshead minnows					Clyd shrimp					Sheepshead minnows					Clyd shrimp				
	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10
0.0	10	10	10	10	10	10	9	9	9	9	10	10	10	10	10	10	10	10	10	10
5.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10.0	10	10	10	10	10	10	10	10	8	8	10	10	10	10	10	10	10	10	10	10
10.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
13.0	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	10	10
18.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
32.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
32.0	10	10	10	10	10	10	10	10	9	8	10	10	10	10	10	10	10	10	10	10
50.0	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	10	10
50.0	10	10	10	10	10	10	10	10	9	8	10	10	10	10	10	10	10	10	10	10

Table XXVI.

Chemical Parameters Monitored by Test Equipment During Flow-Through Acute Toxicity Testing Conducted at
Virginia Chemicals Incorporated, Mobile, Alabama April 27 - May 1, 1978

Dissolved Oxygen (mg/l)	pH					Total Alkalinity (mg/l CaCO ₃)					Salinity (mg/ml)					Temperature (°C)				
	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
Concentration (%)	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr
0.0	7.7	7.9	9.0	7.1	6.9	7.4	7.4	7.6	7.6	7.6	60	60	60	60	60	18	17	18	17	17
0.0	7.8	8.3	9.2	7.4	7.2											18	17	18	17	17
5.6	8.0	8.9	9.5	7.3	8.0	7.6	7.5	7.6	7.6	7.7	79	69	64	62	62	18	17	18	17	16
5.6	8.0	9.0	9.6	7.5	8.1											18	17	18	17	16
10.0	-	9.3	9.7	7.6	8.2	7.7	7.6	7.6	7.5	7.7	96	77	71	60	65	18	16	18	16	16
10.0	8.2	9.4	9.6	7.6	8.1											17	16	18	17	16
18.0	8.6	9.6	9.7	7.6	7.9	7.8	7.7	7.6	7.5	7.6	122	89	84	67	71	16	16	16	16	15
18.0	9.0	9.7	9.7	7.9	7.8											16	15	17	17	15
32.0	9.3	10.2	9.1	7.6	7.1	8.0	7.8	7.7	7.6	7.6	172	93	106	80	78	14	14	16	16	14
32.0	9.9	10.4	9.4	7.7	7.2											14	14	16	16	14
56.0	10.1	10.0	8.0	5.7	7.4	8.3	8.1	8.0	7.8	7.8	246	194	173	139	93	12	12	12	14	11
56.0	10.3	10.8	10.0	7.3	8.6											12	12	12	15	11
100.0	12.7	10.5	16.0	11.2	9.8	8.6	8.9	8.6	8.7	8.2	393	388	310	210	113	6	6	6	5	6
100.0	12.6	10.5	13.8	10.2	6.3											6	6	6	5	6

Table XXVII.

Survival Data Recorded by Test Aquarium During Acute Toxicity Testing Conducted at
 Reichold Chemicals, Inc., Newport Division, Bay Minette, Alabama April 28 - May 7, 1978

Water Concentration (%)	Flow-through Tests										Static Tests									
	Mysid shrimp					Sheepshead minnows					Mysid shrimp					Sheepshead minnows				
	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0.0	10	9	9	9	9	10	10	10	10	10	10	10	*	10		10	10	10	10	
0.0	10	9	9	9	9	10	10	10	10	10										
5.6	10	10	10	10	10	10	10	10	10	10	10	10	*	10		10	10	10	10	
5.6	10	8	8	8	8	10	10	10	10	10										
10.0	10	10	10	10	10	10	10	10	10	10	10	9	*	8		10	10	10	10	
10.0	10	10	10	10	9	10	10	10	10	10										
18.0	10	10	10	10	10	10	10	10	10	10	10	*	*	10		10	10	10	10	
18.0	10	10	10	9	8	10	10	10	10	10										
32.0	10	9	9	8	5	10	10	10	10	10	10	*	*	7		10	10	10	10	
32.0	10	10	9	7	5	10	10	10	10	10										
56.0	10	8	3	0	-	10	10	10	10	10	10	*	*	2		10	10	10	10	
56.0	10	10	5	2	2	10	10	10	10	10										

* Solutions were too turbid to permit accurate counting of organisms.

Table XXVIII.

Chemical Parameters Recorded by Test Aquarium During Flow-Through Acute Toxicity Testing Conducted at
 Reichold Chemicals, Inc., Newport Division, Bay Minette, Alabama April 28 - May 7, 1978

Wastewater Concentration (%)	Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO_3)					Salinity (mg/ml)					Temperature (°C)				
	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
	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr
0.0	6.7	6.9	6.8	6.6	7.9	7.9	7.8	7.7	7.7	7.8	68	57	52	60	57	20	18	17	18	18	23.4	22.4	21.6	22.2	22.0
0.0	6.7	6.5	6.6	6.8	7.6											20	18	17	18	18	23.3	22.7	21.5	22.2	22.1
5.6	6.6	6.4	5.8	6.6	7.1	7.8	7.7	7.5	7.6	7.6	70	62	55	62	60	20	17	16	17	16	23.4	22.6	21.7	22.2	22.1
5.6	6.5	6.5	6.1	6.6	7.5											20	17	16	17	16	23.5	22.7	21.5	22.3	22.1
10.0	6.9	6.3	6.4	6.6	7.5	7.8	7.7	7.6	7.6	7.9	70	58	57	62	61	20	17	16	16	16	23.4	22.5	21.6	22.2	22.0
10.0	6.7	6.5	6.2	6.6	6.8											20	16	15	16	16	23.6	22.8	21.8	22.3	22.1
18.0	6.5	6.5	5.2	5.8	7.4	7.7	7.7	7.3	7.5	7.8	74	58	58	67	65	18	16	14	15	15	23.6	22.6	21.7	22.3	22.0
18.0	6.4	6.4	4.9	6.9	7.6											18	16	14	15	14	23.6	22.6	21.5	22.3	22.0
32.0	6.3	6.2	5.1	4.9	7.6	7.5	7.7	7.3	7.4	7.8	82	69	65	73	73	14	15	12	13	12	23.7	22.4	21.6	22.2	22.0
32.0	6.0	6.5	3.5	5.0	7.4											14	15	12	13	12	23.8	22.6	21.6	22.2	22.0
56.0	5.2	5.4	3.5	3.4	7.2	7.4	7.6	7.2	7.3	7.8	92	73	78	83	83	10	10	8	9	8	24.0	22.5	21.6	22.2	22.0
56.0	5.3	5.6	4.1	3.6	7.3											10	10	8	9	8	23.9	22.7	21.8	22.2	21.9
100.0	3.1	0.4	0.5	0.2	0.2	7.5	7.3	7.2	7.3	7.3	104	116	102	104	106	0	1	1	1	1	24.0	22.7	22.5	22.0	22.1
100.0	2.4	0.4	0.6	0.2	0.2											0	1	1	1	1	24.2	22.8	22.0	22.0	22.0

Table XXIX.

Survival Data Recorded by Test Container During Acute Toxicity Testing
Conducted at Gardinier, Inc., Tampa, Florida, June 17-21, 1978.

Wastewater Concentration (%)	Flow-through Tests										Static Tests														
	#001					#001					24-hour #001 composite					#005					#006				
	Hysid shrimp					Sheepshead minnows					Sheepshead minnows					Sheepshead minnows					Sheepshead minnows				
	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
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5.6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5.6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10										
10.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10.0	10	10	9	9	9	10	10	10	10	10	10	10	10	10	10										
18.0	10	9	9	9	9	10	10	10	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	10	10	10	10	10	10	10										
32.0	10	10	10	10	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
32.0	10	10	10	10	8	10	10	10	10	10	10	10	10	10	10										
56.0	10	10	10	8	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
56.0	10	9	9	8	1	10	10	10	10	10	10	10	10	10	10										
100.0	10	10	5	3	0	10	10	10	10	10	10	10	10	10	10										
100.0	10	9	6	4	0	10	10	10	10	10	10	10	10	10	10										

Table XXX.

Chemical Parameters Recorded by Test Aquarium During Flow-through Acute
Toxicity Testing Conducted at Gardinier, Inc., Tampa, Florida, June 17-21, 1978.

Wastewater Concentration (%)	Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Salinity (mg/ml)					Temperature (°C)				
	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
	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr	hr
0.0	6.5	5.7	6.5	6.4	6.9	8.3	8.2	8.2	8.3	8.3	110	110	107	110	110	18	18	18	20	20	23.9	20.0	21.1	21.4	20.4
0.0	6.4	5.3	6.8	6.7	6.7											18	19	18	20	20	23.5	19.9	21.1	21.1	20.5
5.6	6.6	5.9	7.2	7.0	7.1	8.2	8.1	8.2	8.3	8.3	113	114	114	114	112	20	20	19	20	20	23.0	19.8	21.0	21.1	20.4
5.6	6.6	5.9	6.8	6.7	7.3											20	20	20	20	20	22.9	19.9	21.2	21.2	20.4
10.0	6.3	4.8	6.8	7.0	7.1	8.1	8.0	8.1	8.2	8.3	116	118	118	117	112	20	20	20	21	20	23.0	20.1	21.1	20.6	20.8
10.0	6.6	5.7	7.1	6.7	7.3											20	20	20	21	20	21.5	19.3	20.4	21.2	20.3
18.0	6.4	5.4	7.2	6.3	7.0	8.1	8.0	8.1	8.2	8.3	117	118	118	120	112	20	21	20	21	20	22.5	19.5	20.0	20.4	20.8
18.0	6.4	5.5	6.3	6.9	6.9											22	23	22	23	20	22.0	19.1	20.2	20.4	20.4
32.0	6.3	5.7	6.7	6.6	7.2	7.8	7.7	7.8	7.9	8.3	131	133	134	134	113	23	23	23	24	20	22.3	18.8	20.3	19.9	20.6
32.0	6.3	5.6	6.6	6.4	7.1											22	23	23	23	20	22.3	18.8	19.4	20.6	20.6
56.0	6.1	5.3	6.7	6.4	7.4	7.6	7.5	7.6	7.7	8.2	149	151	151	150	118	25	26	26	26	26	23.5	19.1	20.1	19.9	20.6
56.0	6.0	5.4	6.5	6.6	7.2											26	26	26	26	20	23.1	18.9	19.3	20.6	20.6
100.0	5.4	5.7	6.4	6.6	7.9	7.5	7.4	7.5	7.7	8.1	182	182	182	182	182	32	32	32	32	32	28.8	18.6	19.9	20.0	19.7
100.0	5.3	6.0	6.9	7.1	7.8											31	32	32	32	32	28.4	18.7	19.8	20.0	19.7

Table XXXI.

Survival Data Recorded by Test Aquarium During Acute
Toxicity Testing Conducted at Pfizer, Inc., Southport,
NC, July 8-12, 1978

Wastewater concentration (%)	Flow-through tests										Static tests				
	Sheepshead minnows					Mysid shrimp					Sheepshead minnows				
	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
0.0	10	10	10	10	10										
5.6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5.6	10	10	10	10	10										
10.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10.0	10	10	10	10	10										
18.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
18.0	10	10	10	10	10										
32.0	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10
32.0	10	10	10	10	10										
56.0	10	10	10	10	10	10	10	10	8	8	10	10	10	10	10
56.0	10	10	10	10	10										

e XXXII.

Chemical Data Recorded by Test Aquarium During Flow-through Acute Toxicity
Testing Conducted at Pfizer, Inc., Southport, NC July 8-12, 1978

Wastewater Concentration (%)	Dissolved Oxygen (mg/l)					pH					Salinity (mg/ml)					Temperature (°C)				
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr
0.0	7.9	6.6	6.6	8.2	7.2	6.8 ^a	7.7	7.7	8.0	7.6	20	20	20	16	17	20.0	23.4	22.7	20.2	21.0
0.0	7.3	6.6	6.6	8.2	7.3						20	20	20	16	17	20.0	22.5	22.7	19.0	21.0
5.6	8.1	7.2	7.0	8.3	7.2						19	19	19	16	16	20.0	22.5	22.7	19.2	21.5
5.6	8.0	6.9	6.9	8.4	7.2						19	19	19	16	16	20.0	22.5	22.7	19.2	21.3
10.0	7.9	6.3	6.3	7.9	6.7						18	18	18	15	15	20.0	22.2	22.8	19.2	21.7
10.0	7.9	6.6	6.3	7.8	6.7						18	18	18	15	15	20.0	22.2	22.8	19.2	21.4
18.0	7.9	6.5	6.1	7.6	6.7						16	16	16	14	14	20.0	22.2	22.8	19.1	21.5
18.0	7.7	6.3	5.9	7.1	6.5						16	16	16	14	14	20.0	22.1	22.8	19.3	21.5
32.0	7.5	6.2	5.8	6.9	6.2						13	14	14	12	12	20.0	22.2	22.8	19.1	21.5
32.0	7.4	6.3	5.9	7.1	6.4						13	14	14	12	12	20.0	22.2	22.8	19.3	21.4
56.0	7.6	6.1	6.1	7.3	6.4						10	10	11	10	10	20.0	22.5	22.8	19.6	21.0
56.0	7.3	6.0	6.1	7.9	6.3						10	10	11	10	10	20.0	22.5	22.8	19.8	21.0
100.0	7.4	7.0	6.9	7.4	6.4	7.2 ^a	7.7	7.8	8.0	7.7	4	3	4	2	3	19.5	22.0	22.4	22.7	20.8
100.0	7.8	5.6	5.6	7.5	6.9						4	3	4	2	3	20.0	22.2	22.4	22.5	20.5

^a pH probe broken.

Table XXXIII.

Survival Data Recorded by Test Aquarium During
Acute Toxicity Testing at Diamond Shamrock - Chrome
Chemicals Plant, Castle Hayne, North Carolina
July 12-19, 1978

wastewater concentration (%)	Flow-through Tests										Static Test				
	10-day-old sheepshead minnows					16-day-old sheepshead minnows					10-day-old sheepshead minnows				
	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
0.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5.6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5.6	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10.0	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	10	10	10	10	10	10	10
18.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
32.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
32.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
56.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
56.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
100.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
100.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Table XXXIV.

Chemical Parameters Recorded by Test Aquarium During Flow-Through
Acute Toxicity Testing Conducted At Diamond Shamrock - Chrome Chemicals
Plant, Castle Hayne, North Carolina, July 12-19, 1978

wastewater concentration (%)	Dissolved Oxygen (mg/l)					pH					Total Alkalinity (mg/l CaCO ₃)					Salinity (mg/l)					Temperature (°C)				
	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr	0 hr	24 hr	48 hr	72 hr	96 hr
0.0	7.2	8.2	8.4	8.3	8.7	8.6	8.7	8.0	8.0	8.0	97	97	141	145	144	15	16	16	16	16	23.2	18.7	19.8	19.8	20.3
0.0	7.2	8.1	8.2	8.4	8.5											15	16	16	16	16	23.2	18.8	19.8	19.9	20.2
5.6	7.2	8.2	8.3	8.5	8.6	8.6	8.7	8.0	8.0	8.0	98	95	139	143	139	14	16	16	16	16	23.0	18.3	19.5	19.7	20.1
5.6	7.1	8.2	8.3	8.2	8.6											14	16	16	16	16	23.4	18.4	19.4	19.8	20.0
10.0	7.2	8.2	8.1	8.4	8.5	8.6	8.7	7.9	7.9	8.0	90	94	138	144	138	14	15	15	15	15	23.0	18.5	19.2	19.5	20.0
10.0	7.2	8.3	8.3	8.5	8.6											14	15	15	15	15	23.5	18.4	19.5	19.8	20.0
18.0	7.2	8.2	8.2	8.5	8.5	8.6	8.6	7.9	8.0	8.0	85	99	131	140	134	13	15	14	14	14	23.1	18.5	19.2	19.6	20.1
18.0	7.2	8.1	7.9	8.5	8.4											13	15	14	14	14	23.5	18.5	19.3	19.9	20.0
32.0	7.2	8.1	7.6	8.2	8.2	8.5	8.6	7.9	8.0	8.0	76	81	120	152	128	12	14	13	14	13	23.1	18.4	19.2	19.8	20.1
32.0	7.2	8.0	7.3	8.2	8.1											12	14	13	14	13	23.4	18.6	19.2	19.9	20.0
56.0	7.2	8.0	7.1	8.1	8.1	8.3	8.4	7.8	8.0	7.9	61	64	106	157	115	10	12	11	12	11	23.3	18.5	19.1	19.9	20.1
56.0	7.1	8.0	6.9	8.0	8.0											10	11	11	12	11	23.3	18.7	19.2	20.1	20.1
100.0	7.4	8.5	7.7	8.0	8.3	7.9	7.5	7.6	8.2	7.9	21	25	48	184	86	6	7	8	6	8	24.3	18.0	19.6	21.4	19.9
100.0	7.3	8.5	7.3	8.0	8.7											6	7	8	6	8	24.8	18.1	19.2	21.7	19.7

Table XXXV.

SURVIVAL DATA COLLECTED BY TEST AQUARIUM DURING AN ACUTE TOXICITY
STUDY AT THE BRUNSWICK PULP AND PAPER COMPANY, BRUNSWICK, GEORGIA

AUGUST 07-13, 1978

FLOW---THROUGH---TESTS											-----STATIC TESTS (24-HOUR COMPOSITE SAMPLE)-----																			
ASTEWATER CONCENTR- LOCATION	NO. OF SHEEPS- HEAD MINNOWS SURVIVING					NO. OF MYSD SHRIMP SURVIVING					NO. OF SHEEPS- HEAD MINNOWS SURVIVING					NO. OF MYSD SHRIMP SURVIVING					NO. OF FATHEAD MINNOWS SURVIVING					NO. OF DAPHNIA PUXX SURVIVING				
PERCENT	0 HR	24 HR	48 HR	72 HR	96 HR	0 HR	24 HR	48 HR	72 HR	96 HR	0 HR	24 HR	48 HR	72 HR	96 HR	0 HR	24 HR	48 HR	72 HR	96 HR	0 HR	24 HR	48 HR	72 HR	96 HR	0 HR	24 HR	48 HR	72 HR	96 HR
0.0	10	10	10	10	10	10	10	9	9	9	10	10	10	10	10	10					09	10	10	10	10	10	10		09	
9.0	10	10	10	10	10	10	8	6	6	6	10	10	10	10	10	10					08	10	10	10	10	10	10	10	09	
5.6	10	10	10	10	10	10	7	7	7	7	10	10	10	10	10	10					08	10	10	10	10	10	10	10	09	
5.6	10	10	10	10	10	10	8	7	7	7	10	10	10	10	10	10					09	10	10	10	10	10	10	10	10	
10.0	10	10	10	10	10	10	8	8	8	8	10	10	10	10	10	10					09	10	10	10	10	10	10	10	10	
10.0	10	10	10	10	10	10	10	9	9	9	10	10	10	10	10	10					10	10	10	10	10	10	10	10	10	
10.0	10	10	10	10	10	10	10	9	9	9	10	10	10	10	10	10					10	10	10	10	10	10	10	10	10	
10.0	10	10	10	10	10	10	7	7	7	7	10	10	10	10	10	10					10	10	10	10	10	10	10	10	10	
32.0	10	10	10	10	10	10	8	8	5	5	10	10	10	10	10	10					10	10	10	10	10	10	10	10	05	
32.0	10	10	10	10	10	10	9	7	6	6	10	10	10	10	10	10					09	10	10	10	10	10	10	10	01	
50.0	10	10	10	10	10	10	9	8	8	8	10	10	10	10	10	10					09	10	10	10	10	10	10	10	01	
50.0	10	10	10	10	10	10	10	10	9	9																				
100.0	10	10	10	10	10	10																								
100.0	6	6	6	6	6																									

Table XXXVI.

CHEMICAL PARAMETERS RECORDED BY FLOW-THROUGH TEST AQUARIUM DURING AN ACUTE
TOXICITY STUDY CONDUCTED AT THE BRUNSWICK PULP AND PAPER COMPANY, BRUNSWICK, GEORGIA

AUGUST 07-13, 1978

WASTEWATER CONCENTRATION	DISSOLVED OXYGEN (MG/L)					PH					TOTAL ALKALINITY (MG/L CaCO ₃)					SALINITY (MG/ML)					TEMPERATURE (°C)				
	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
PERCENT	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR	HR
0.0	1.5	1.5	1.2	1.1	0.4	7.8	8.0	8.1	8.0	7.9	117	120	122	115	117	18	18	18	18	19	22	20.2	22.0	21.9	18.4
0.0	1.7	1.6	1.3	1.2	0.3	7.8	8.0	8.0	8.0	7.8	117	119	122	115	118	18	18	18	18	19	22	20.2	22.1	21.8	18.4
5.6	1.9	1.8	1.4	1.3	1.7	7.8	8.0	8.0	8.0	7.9	124	126	128	122	124	18	18	18	18	18	21	20.3	22.0	21.5	18.6
5.6	1.9	1.6	1.4	1.2	0.5	7.8	7.9	8.0	8.0	7.8	124	127	128	123	125	18	18	18	18	18	21	20.7	22.1	21.2	18.7
10.0	1.6	1.2	1.0	0.5	5.7	7.8					129					18	17	18	18	17	21	20.6	22.0	21.2	18.7
10.0	1.7	1.4	1.1	0.7	5.6	7.8					129					18	17	18	18	17	21	20.8	22.1	21.1	18.8
15.0	1.6	1.0	0.6	5.7	4.0	7.8	7.9	7.9	7.8	7.6	137	139	142	137	138	16	16	16	16	16	21	20.8	22.0	21.0	18.7
15.0	1.4	1.0	0.7	5.7	4.4	7.8	7.9	7.9	7.8	7.6	138	141	140	137	138	16	16	16	16	16	21	20.7	22.0	21.0	18.7
22.0	1.0	0.6	0.0	3.9	5.9	7.7					152					14	14	14	14	14	21	20.6	22.1	21.0	18.5
32.0	0.8	0.2	5.7	4.7	4.8	7.7					154					14	14	14	14	14	21	20.8	22.0	21.0	18.6
50.0	0.9	0.5	5.3	3.3	5.1	7.7					176					11	10	11	11	11	21	20.6	22.0	20.8	18.5
50.0	0.9	0.5	5.0	4.5	4.3	7.7					176					11	10	11	11	10	21	20.7	22.1	20.8	18.8
100.0	0.1	5.7	5.1	4.2	4	7.7	7.8	7.8	7.8	7.6	228	229	233	230	227	5	4	5	5	4	21	20.1	21.1	20.2	°
100.0	0.3	0.5	5.5	5.0	4.5	7.8	7.9	7.9	7.9	7.6	226	231	232	229	226	5	4	5	5	4	21	19.9	21.2	20.4	17.9

* DILUTION WATER ADDED TO TANK BEFORE READINGS WERE TAKEN.