WSRC-TR-96-0261

Toxicity of Water Samples Collected in the Vicinity of F and H Seepage Basin 1990-1995

by

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TOXICITY OF WATER SAMPLES COLLECTED IN THE VICINITY OF THE F/H SEEPAGE BASINS, 1990-1995 (U)

by
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Publication Date: September 1996

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1.0 EXECUTIVE SUMMARY

Water and contaminants from the F- and H-Area Seepage Basins (904-41G, 904-42G, 904-43G, 904-44G, 904-45G, 904-46G, and 904-56G) outcrop as shallow groundwater seeps downgradient from the basins. In 1990, 1991, 1993, 1994, and 1995, toxicity tests were performed on water collected from a number of these seeps, as well as from several locations in Fourmile Branch and several uncontaminated reference locations. In all, water from 21 locations was tested. The results of the toxicity tests indicated that most of the seeps were toxic to some extent, but that water from Fourmile Branch in the vicinity of the F/H seeps was usually not toxic. The toxicity of the seeps appeared to be variable, probably due to dilution by rainfall. Most of the reference locations were also toxic, but usually were less toxic than the F/H seeps. Toxicity Identification Evaluations (TIE's) performed on representative seeps in 1994 and 1995 indicated that the toxicity at the F-Area seeps was due to aluminum, cadmium, and possibly iron. The toxicity at the H-Area seeps was most likely due to a volatile toxicant, but the specific toxicant could not be identified because the toxicity disappeared midway through the TIE. Toxicity investigations conducted on water from Fourmile Branch upstream from all SRS inputs, and on an uncontaminated reference seep indicated that both locations were toxic due to naturally occurring concentrations of iron.

2.0 INTRODUCTION

From 1955 until 1988, wastewater from F- and H-Area Seepage Basins (904-41G, 904-42G, 904-43G, 904-44G, 904-45G, 904-46G, and 904-56G; Figures 1 and 2) of the Savannah River Site (SRS) was discharged to the F and H seepage basins. Water and contaminants from the basins continue to outcrop as shallow groundwater seeps downgradient from the basins and flow into Fourmile Branch (FMB). In order to determine if the seep water from the basins is impacting FMB or its adjacent wetlands, toxicity tests were performed on water samples collected from 11 of the seeps, and five locations in FMB between 1990 and 1995. In addition, five uncontaminated locations were tested for reference purposes.

3.0 SITE DESCRIPTION

3.1 F/H Seepage Basins

The F- and H-Area Seepage Basins consisted of seven seepage basins that occupied approximately 22 acres in the General Separations Area (GSA) of the Savannah River Site (SRS). The basins were constructed and began operations in 1955. The F-Area Seepage Basins consisted of three unlined basins that were hydraulically connected by vitrified clay process sewers. The F-Area basins received wastewater discharges from the tritium cooling water facilities, nitric acid recovery overheads, general purpose evaporator overheads, and retention basin transfers (Killian et al., 1987a). Discharges to the F-Area basins ceased in 1988 and the basins were drained and covered with impermeable clay caps in 1990.

The H-Area Seepage Basins also consisted of three unlined basins. In 1962, however, one basin was replaced by a fourth basin. The H-Area basins received wastewater from the same sources as the F-Area basins, but in addition, received discharges from the two H-Area tank farm evaporators and the receiving basins for Offsite Fuels Facility (Killian et al., 1987b). Discharges to the H-Area basins terminated in 1988 and the basins were capped in 1991.

The F/H seepage basins received discharges of solutions containing sodium hydroxide, nitric acid, low levels of radionuclides (mostly tritiated water) and some metals as part of normal operations (Killian et al., 1987a,b). Because the basins were unlined, chemical and radiological constituents from the basin seeped to the underlying water table. In 1990 and 1991, the basins were closed and capped; however, contaminated groundwater continues to outcrop as seeps in areas downgradient from the basins. Numerical simulations of flow in the hydrologic system underlying the basins indicate that travel times for unretarded constituents from the basins to FMB is on the order of ten years (Haselow et al., 1990)

Looney et al. (1988) collected water samples from FMB and its associated seeps. They concluded that sodium, nitrate, and hydrogen ions had migrated from the seepage basins to the seeps and were affecting the bulk chemistry of the seepwater. They also reported that several elements (most notably aluminum, calcium and copper) were leaching from the soil, due to low pH that resulted from releases of nitric acid to the basins.

Haselow et al. (1990) collected soil cores and water samples from FMB and its seeps in 1988 and 1989 as a follow-up to the Looney et al. (1988) study. This study found elevated concentrations of aluminum, cadmium, iron, manganese, sodium, and nitrate, as well as elevated levels tritium, gross alpha, non-volatile beta, and several radionuclides. These studies confirmed that contaminants migrating from the seepage basins were impacting the water chemistry along the F- and H-Area seeplines and FMB.

Water quality surveys of FMB and its associated seeps conducted in the vicinity of the F/H seepage basins in 1993 and 1994 indicated elevated levels of tritium, aluminum, barium, calcium, iron, magnesium, manganese, sodium, zinc, chloride, and nitrate at numerous sampling locations (Chapell et al., 1995).

3.2 Description of the Environment

The F/H area occupies approximately 194 acres on a nearly flat divide between Upper Three Runs (UTR) to the north and FMB to the south. The surface topography generally slopes to the south. The environment in the vicinity of the F/H seepage basins provides habitat for a diverse flora and fauna. Immediately downslope from the basins is old field herbaceous scrub/shrub habitat which transitions into upland forest. The upland forest intergrades into lowland forest vegetation at the seepline where groundwater surfaces and flows into bottomland wetlands that are adjacent to FMB. FMB is a second order blackwater stream that originates east of Road F and flows generally southwest to the Savannah River. The stream currently receives effluent discharges from F and H Areas and treated sanitary discharges from most of the SRS. From 1955 to 1985, it also received thermal discharges from C-Reactor, which were discharged to the stream approximately 7 km downstream from the F/H Seepage Basins area.

4.0 SAMPLING LOCATIONS AND DATES

Between 1990 and 1994, water samples for toxicity testing were collected from a total of 21 locations, including five seeps in the vicinity of the F-Area seepage basins, six seeps in the vicinity of the H-Area seepage basins, five locations in FMB, one reference location in UTR, and four reference seep locations (Table 1; Figures 1 through 3).

Table 1. Sampling Locations for F/H Seepline Toxicity Testing

Sampling Locations	**SRS Coordinates**	
	North	**East**
FSP-012 (F-5)	73602	49644
FSP-032 (F-6)	73367	50258
FSP-047	73609	50607
FSP-204	73281	48801
FSP-256	73435	47770
HSP-008	71005	56990
HSP-020	71142	56489
HSP-043 (H-4)	71644	55722
HSP-060	71629	55190
HSP-103	72448	53665
H-6	71041	56394
FMC-001F (SCE&G power line)	70350	57050
FMC-001H (Road 4)	72600	53000
FMC-002H (Road C)	72200	43900
FMC Road C-4	72610	48812
FMC-Road A-7	69279	40079
UTR-022	74990	61270
UTR-029	74855	60792
UTR-116	79665	59050
BGW-045 (BGS-003)	94651	82775
UTR Railroad Bridge near Rd. C	83358	51854

FSP = F-Area seeps
HSP = H-Area seeps
UTR = Upper Three Runs and reference seeps in UTR drainage
BGW = Background Water (reference location)

Toxicity tests were first conducted in 1990 at six locations, including two F-Area seeps, two H-Area seeps, and two locations in FMB (Table 2). The seep locations were selected to be representative seeps, based on water chemistry analyses conducted by Haselow et al. (1990). Fourmile Branch at Road C was selected because it was downstream from the H-Area seeps, but upstream from the F-Area seeps, while FMB at Road C-4 was selected because it was downstream from the H-Area seeps and most of the F-Area seeps.

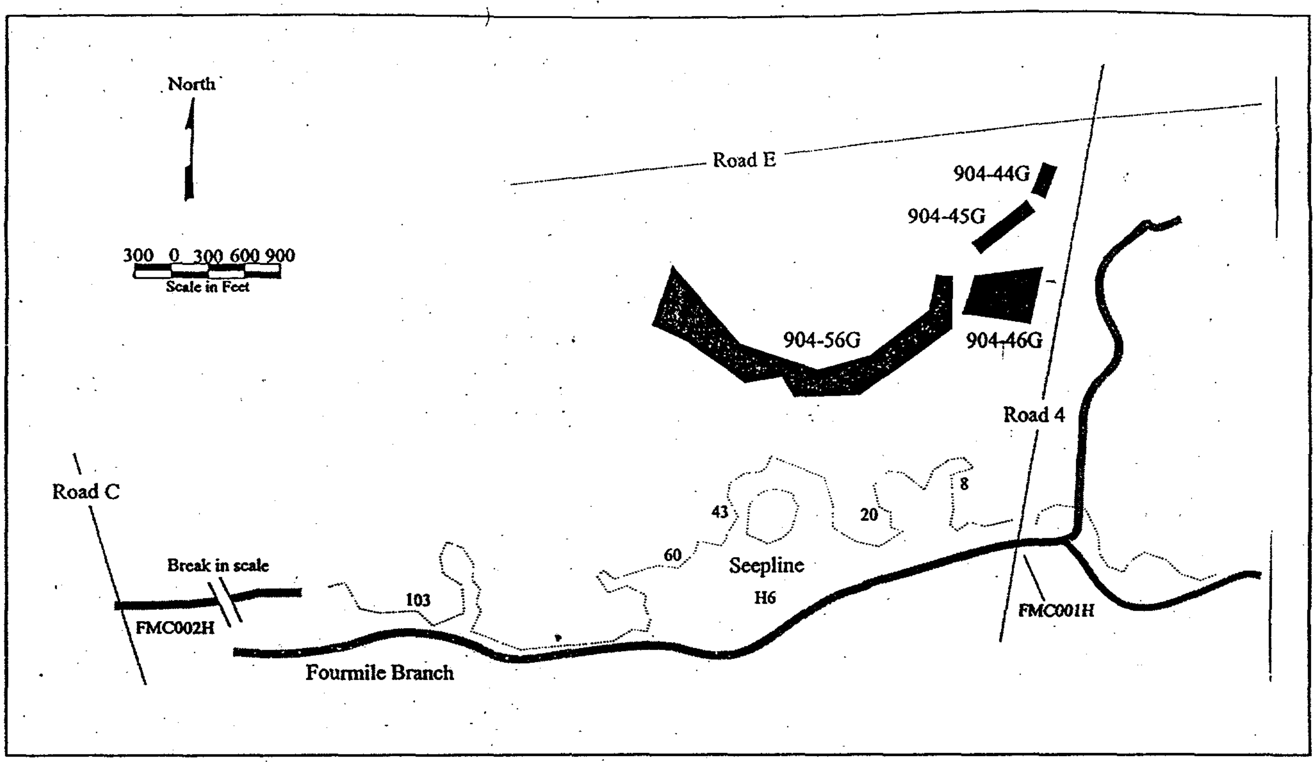

Figure 1. Sampling Locations for Toxicity Testing along the H-Area Seepline

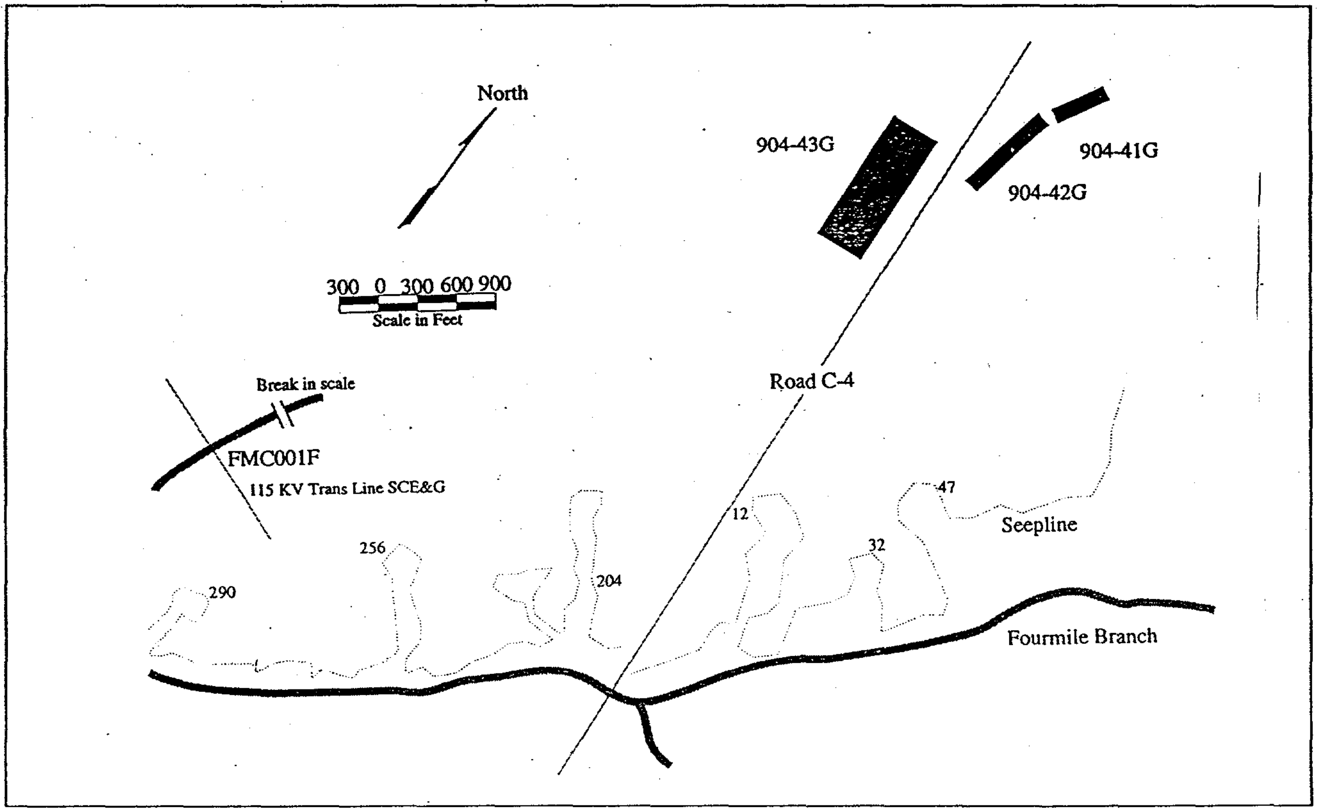

Figure 2. Sampling Locations for Toxicity Testing along the F-Area Seepline

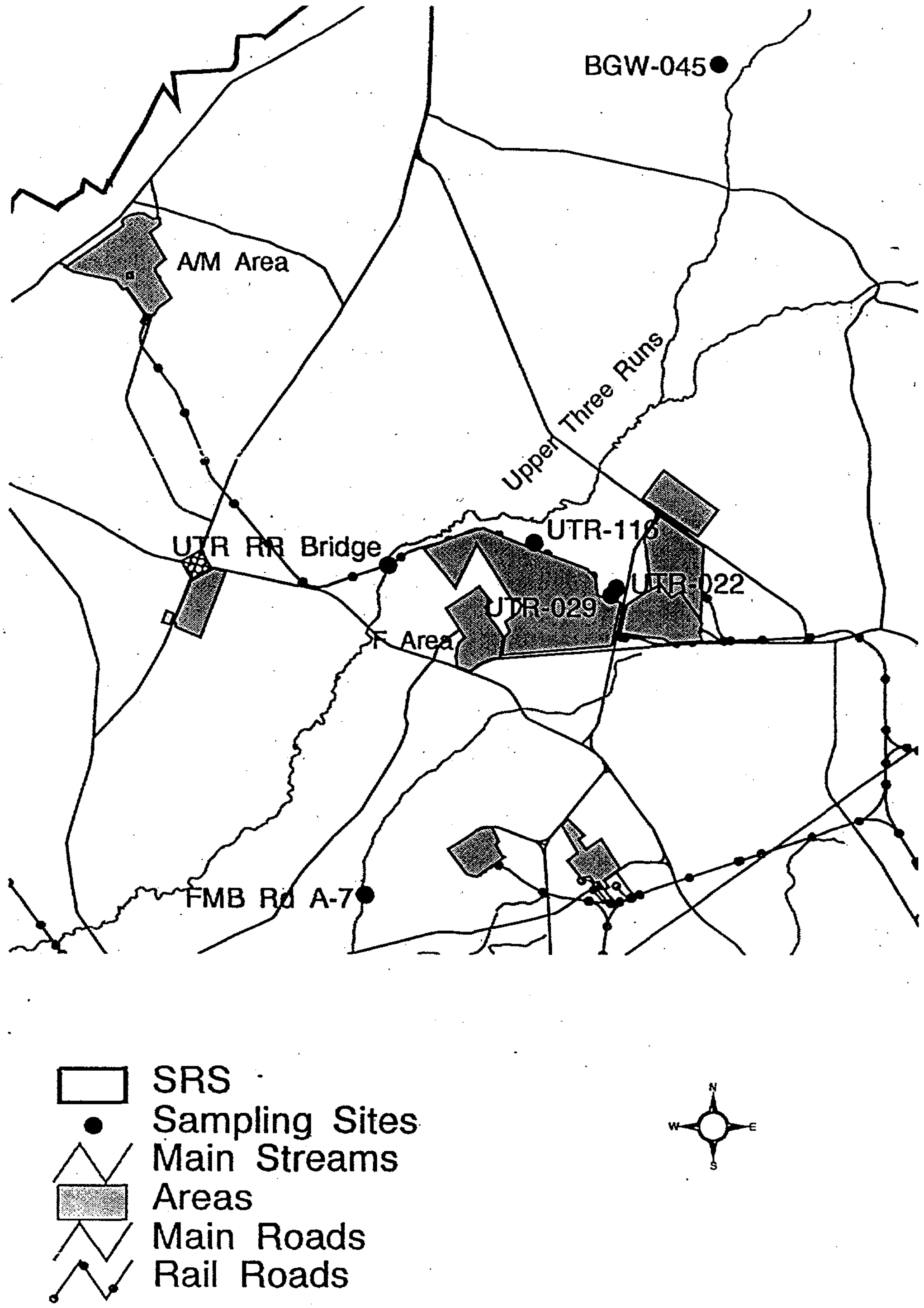

Figure 3. Sampling Locations for Toxicity Testing in Fourmile Branch, Upper Three Runs, and Reference Seeps

Table 2. **Toxicity Testing Locations and Dates, 1990-1994**

Location	May-Jun 90	Nov-Dec 90	Jul-91	Sep-93	Apr-Jun 94
FSP-012	x	x	-	x	x
FSP-032	x	x	-	x	-
FSP-047	-	-	-	x	-
FSP-204	-	-	-	x	x
FSP-256	-	-	-	x	-
HSP-008	-	-	-	x	x
HSP-020	-	-	-	x	-
HSP-043	x	x	-	-	-
HSP-060	-	-	-	x	-
HSP-103	-	-	-	x	x
H-6	x	x	-	-	-
FMB Road 4	-	-	-	x	-
FMB Road C	x	x	-	x	-
FMB Road C-4	x	-	-	x	-
FMB SCE&G Line	-	-	-	-	x
FMB Road A-7	-	x	x	x	-
UTR-022	-	-	-	-	x
UTR-029	-	-	-	-	x
UTR-116	-	-	-	-	x
BGW-045	-	-	-	-	x
UTR RR Bridge	-	-	-	-	x

FSP = F-Area seeps
HSP = H-Area seeps
FMC = Fourmile Branch
UTR = Upper Three Runs/reference seeps in UTR drainage
BGW = Background Water (reference location)

Subsequent testing was conducted at most of these same locations in November-December 1990 (Korthals, 1991), except that FMB was sampled at Road A-7 rather than at Road C-4 because Road A-7 is downstream from all of the F and H-Area seepage areas. In July 1991, a toxicity test was repeated at Road A-7 (Normandeau, 1991) because this creek location had failed the toxicity test conducted in November and we wanted to determine if the seeps were routinely causing toxicity in FMB.

In September 1993, toxicity tests were conducted at five F-Area seeps, four H-Area seeps, and four locations in FMB (Table 2; Shealy, 1993a, 1993b). The seep locations were selected based on water chemistry results of Dixon et al., (1993) and included several locations that were tested in 1990. The creek locations were selected to be upstream of all F- and H-Area seeps (Road 4), between the F- and H-Area seeps (Road C), immediately downstream of most of the seeps (Road C-4), and downstream of all seeps (Road A-7).

In April-June 1994 (ETT, 1994a), toxicity tests were repeated at four of the locations that were sampled in September 1993, including two F-Area seeps and two H-Area seeps. In addition, a sample was collected from FMB at the SCE&G power line, which is located downstream from all of the F- and H-Area seeps, but closer to the seep areas than is Road A-7. In addition, toxicity tests were performed on water collected from four uncontaminated reference seeps and one uncontaminated location in UTR (Table 2) to determine if uncontaminated locations were toxic to the test species.

In order to determine the cause of observed toxicity, Toxicity Identification Evaluations (TIE's) were performed on three representative seeps, including one located downgradient from the F-Area Seepage Basins (FSP-204), one located downgradient from the H-Area Seepage Basins (HSP-103), and a reference (uncontaminated) seep (UTR-029). In addition, as part of another study, a TIE was performed on water collected from FMB at Road F, which is upstream from all SRS discharges to the creek.

5.0 METHODS

5.1 Sample Collection

In accordance with EPA protocol (Weber et al., 1989), water samples were collected three times during a 7-day period at each location, such that the holding time of the water used for toxicity testing never exceeded 72 hours. For each collection, two 2-liter plastic bottles of water were collected, placed on ice immediately and shipped to the testing laboratory via an express carrier.

5.2 Toxicity Testing

Definitive chronic toxicity tests were conducted on *Ceriodaphnia dubia* using EPA methods (Weber et al. 1989). Test conditions are specified in Table 3. Toxicity tests were performed on a series of dilutions, (generally 0, 6.3%, 13%, 25%, 50%, and 100% sample water), using 10 test organisms per concentration; however, in some of the early tests, somewhat different dilutions were used and twenty organisms per concentration were used (see Appendices A through E for test specifics). At the end of the 7-day test the reproductive success (number of young produced) of organisms exposed to each dilution was compared statistically to that the control group (0%) in order to determine if reproduction was impaired. The results of the tests were reported as NOEC's (No Observed Effect Concentration), which was the highest concentration tested that did not cause a significant reduction in reproduction. If there was no reproductive impact, the NOEC was 100%. In addition, any mortality that occurred during the test was also recorded.

Water quality parameters routinely measured during the toxicity tests included temperature, pH, hardness, alkalinity and specific conductance.

5.3 Toxicity Identification Evaluations

Toxicity Identification Evaluations (TIE's) were conducted on samples collected from representative seeps (UTR-029, HSP-103, FSP-204) and FMB at Road F in accordance with U.S. EPA methods developed for chronically toxic effluents (Norberg-King et al., 1991, Durhan et al., 1993; see Appendices F through I for test specifics). For FSP-204, a complete TIE was performed because an examination of the water chemistry data did not clearly indicate the source of toxicity, based on EPA water quality criteria. However, for UTR-029 and HSP-103, one or more metals greatly exceeded EPA water quality criteria for one or more metals and it was very likely that metals were responsible for the observed toxicity. Therefore, partial TIE's were performed at these locations, using only the portions of a TIE that focus on metals (EDTA chelation, pH adjustment/filtration, and sodium thiosulfate addition).

Table 3. Test Conditions for Conducting a 7-day Definitive Water Toxicity Test with *Ceriodaphnia dubia*

Parameter	Conditions
Test type	Static renewal
Temperature	25 ± 1°C
Light quality	Ambient laboratory illumination
Light intensity	50 - 100 foot candles
Photoperiod	16L:8D
Test chamber size	30 ml
Test solution volume	15 ml
Renewal of test water	Daily.
Age of test organisms	Less than 24 h at start of test; all released within a 12 h period
# neonates/test chamber	1
# Neonates/concentration	10
Feeding regime	0.1 ml YCT and algal suspension/test chamber/day
Aeration	None
Dilution water	Diluted mineral water
Number of dilutions	5 and a control

6.0 RESULTS

6.1 Toxicity Tests

6.1.1 General Overview

Table 4 summarizes the results of the water toxicity tests that were performed from 1990 through 1994. Appendices A through E contain more detailed results of the tests.

6.1.2 Background Locations

Uncontaminated reference locations included UTR-022, UTR-029, UTR-116, BGW-045, and UTR RR Bridge. Toxicity tests were performed on water collected from these locations in April 1994. As shown in Table 4, all but one of the toxicity tests conducted on water from the four reference seeps was toxic to some extent, with NOEC's of 50%. Only BGW-045 and UTR RR Bridge were not toxic. These results indicated that uncontaminated seeps on the SRS were somewhat toxic to *Ceriodaphnia dubia*.

6.1.3 F and H-Area Seeps

Toxicity tests conducted on seeps downgradient from the F- and H-Area Seepage Basins had NOEC's ranging from 3% to 100% (Table 4). Of the eleven seeps that were tested, only two showed no evidence of toxicity (HSP-008 and H-6). The remaining eight seeps were all toxic on at least one occasion. The degree of toxicity at some seeps appears to vary temporally. The variation is probably related to the amount of rainfall in the week or two prior to sample collection. Rainfall can dilute the seeps directly and can also infiltrate the shallow groundwater, causing further dilution of the seeps.

6.1.4 Fourmile Branch

Between 1990 and 1994 toxicity tests were performed at a total of five locations in FMB (Table 4). Two of the locations were tested three times, one of the locations was tested twice, and two of the locations were tested once. Of the ten toxicity tests that were performed on water from FMB, only one of the tests showed evidence of toxicity (Road A-7, November-December 1990), with an NOEC of 60%. Toxicity testing performed as

Table 4. No Observed Effect Concentrations (NOEC's) for Toxicity Testing Locations, 1990-1994

Location	May-Jun 90	Nov-Dec 90	Jul-91	Sep-93	Apr-Jun 94
FSP-012	60%	60%	-	10%	100%
FSP-032	100%	10%	-	30%	-
FSP-047	-	-	-	30%	-
FSP-204	-	-	-	30%	25%
FSP-256	-	-	-	30%	-
HSP-008	-	-	-	100%	100%
HSP-020	-	-	-	3%	-
HSP-043	60%	60%	-	-	-
HSP-060	-	-	-	10%	-
HSP-103	-	-	-	3%	12.5%
H-6	100%	100%	-	-	-
FMB Road 4	-	-	-	100%	-
FMB Road C	100%	100%	-	100%	-
FMB Road C-4	100%	-	-	100%	-
FMB SCE&G	-	-	-	-	100%
FMB Road A-7	-	60%	100%	100%	-
UTR-022	-	-	-	-	50%
UTR-029	-	-	-	-	50%
UTR-116	-	-	-	-	50%
BGW-045	-	-	-	-	100%
UTR RR Bridge	-	-	-	-	100%

part of another study at an additional location in FMB that is upstream of all SRS discharges (Road F) indicated that the water from the stream was often toxic, due to a naturally occurring toxicant (see Section 6.3.4). It cannot be determined if the toxicity observed in FMB at Road A-7 was due to naturally occurring conditions or to inputs from the F-Area seeps. However, no toxicity has been observed in FMB below the F-or H-Area seeps since 1990, which suggests that the seeps are not presently causing toxicity in FMB.

6.2 Water Chemistry

6.2.1 Routine Water Chemistry Parameters

Water quality parameters that were measured in conjunction with the toxicity tests include dissolved oxygen, total hardness, alkalinity, and pH. In general, *Ceriodaphnia* does not do well in water that has a pH of less than 5.5. An examination of the water quality data presented in the toxicity reports (Appendices A through E) indicated that, with very few exceptions, the pH of the samples was generally in the range of 6.0 to 7.5. Therefore low pH does not appear to be responsible for most of the observed toxicity.

6.2.2 Metals

The U.S. EPA (1991) has issued freshwater water quality criteria for many metals. The toxicity of most cationic metals is inversely related to water hardness. For a few metals, such as aluminum, toxicity is also pH dependent. Table 5 lists the EPA freshwater water quality criteria or other relevant criteria for metals that were sampled at the F/H seepline sampling locations. The hardness of FMB is approximately 10 mg/l as $CaCO_3$. Therefore, a hardness of 10 mg/l was used in calculating the criteria for metals for which the toxicity is hardness dependent.

Table 5. U.S. EPA Freshwater Chronic Water Quality Criteria for Selected Metals (U.S. EPA, 1991)

Metal	Criterion
Aluminum	87[a]
Cadmium	0.19[b]
Copper	1.65[b]
Iron	1000
Lead	0.17[b]
Mercury	0.012
Zinc	15[b]

all concentrations are in µg/l
[a] U.S. EPA chronic screening value (U.S. EPA 1995)
[b] Criterion is based on a water hardness of 10 mg/l

Table 6 presents metals data from some of the F/H seepline sampling locations. An examination of the data indicates that metal concentrations at many of the F/H seeps exceeded the ambient water quality criteria. In particular, aluminum and iron appear to be present at potentially toxic concentrations at many of the seeps. The highest aluminum and iron concentrations reported were 90,000 and 28,300 µg/l, respectively. Although some of the very high concentrations were probably due to suspended soil particles in the samples, many of the seeps appear to have consistently elevated concentrations of one or more metals.

Table 6. Metal Concentrations (µg/l) at F and H Seeps and Fourmile Branch 1993-1994

January-February 1993

Metal	FMC001F	FMC002H	FSP-012	FSP-032	FSP-047	FSP-204	HSP-008	HSP-043	HSP-060
Al	99	110	462	1660	412	3790	388	857	657
Cd	3.5	4.7	<2	4.6	<2	3.6	<2	4.1	15.9
Cu	<4	5.8	5.4	7.6	11.4	4.6	<4	7.1	7.7
Fe	225	362	23,950	257	10,650	894	302	345	620
Pb	<3	<3	<3	<3	<3	<3	<3	<3	10.8
Mg	621	570	1395	1050	961	5255	1500	179	411
Mn	116	26	2440	575	811	1640	195	19	362
Hg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Zn	15.6	21.8	29.2	55.8	96.4	35.2	110	136	35.2

July 1993

Metal	FMC001F	FMC002H	FSP-012	FSP-032	FSP-047	FSP-204	HSP-008	HSP-043	HSP-060
Al	124	119	161	518	46	371	90,000	-	-
Cd	5.49	<2	2.2	14.6	<2	4.9	<2	-	-
Cu	10.1	<4	<4	7.6	<4	9.6	10.1	-	-
Fe	527	1330	28,300	173	1350	328	7570	-	-
Pb	4.0	<3	<3	<3	<3	5.43	23.2	-	-
Mg	628	599	1960	951	1060	4175	3370	-	-
Mn	61	307	2760	1250	588	486	157	-	-
Hg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.76	-	-
Zn	39.1	16.6	22.1	57	16.6	184	222	-	-

April 1994

Metal	FMC001F	FMC002H	FSP-012	FSP-032	FSP-047	FSP-204	HSP-008	HSP-043	HSP-060
Al	109	97	153	398	156	5650	342	-	1340
Cd	<2	<2	<2	<2	<2	4.6	-	-	<2
Cu	<4	6.5	<4	<4	<4	<4	<4	-	<4
Fe	536	500	17,000	1090	5280	14	794	-	1200
Pb	<3	<3	<3	3.2	<3	<3	<3	-	<3
Mg	589	446	1180	560	1230	5300	1140	-	305
Mn	41	31	1660	577	507	1260	106	-	85
Hg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	<0.2
Zn	2.4	20.5	<2	5.6	8.5	18.7	<2	-	<2

Source: Chappell et al. (1995)

6.3 Toxicity Identification Evaluations (TIE's)

6.3.1 UTR-029

In April 1993, a water sample from reference seep UTR-029 was analyzed for a large number of organic and inorganic parameters (Dixon and Cummins, 1994). The results indicated elevated levels of total aluminum (5.93 mg/l), iron (17.7 mg/l), manganese (1.9 mg/l), zinc (32.5 mg/l)and TSS (308 mg/l) and a moderately high hardness (59 mg/l). In April 1994, a chronic toxicity test conducted on water collected from seep

UTR-029 indicated that undiluted seep water (100%) was acutely toxic to *Ceriodaphnia dubia*.

Because the water chemistry data from Dixon and Cummins (1994) indicated elevated levels of heavy metals, but no organic compounds were detected at levels above background concentrations or believed to be present at this reference location, a partial Phase I TIE was conducted on water from the seep, using only those TIE treatments that are effective at reducing or removing metals toxicity (see Appendix H for details). Specifically, the UTR-029 seep was subjected to four treatments: 1) adjustment to pH 10, followed by filtration; 2) addition of sodium thiosulfate; 3) chelation with disodium ethylenediamine tetraacetate (EDTA); and 4) graduated pH. The purpose of this first phase of the TIE was to determine if the toxicity of the seep was caused by a metal or metals, by assessing if treatments for metal removal were effective in removing toxicity.

A single grab sample was collected from UTR-029 on November 14, 1994 and a TIE was initiated on November 16, 1994 (ETT, 1994b). Metal analyses performed on a portion of the water sample used for the TIE indicate that the sample contained 2.09 mg/l of iron, 0.71 mg/l of manganese, and 17.1 mg/l of zinc.

Details of the TIE test conditions are presented in Appendix F. The results of the Phase I tests indicate that pH 10/filtration, sodium thiosulfate, and EDTA chelation all reduced toxicity (Table 7) and that the toxicity was slightly greater at pH 8.5 than at 6.0.

Table 7. Results of UTR-029 Phase I Treatments on Reproductive Rates of *Ceriodaphnia dubia*

Treatment	Number of Young Produced
Control	26
Untreated UTR-029	13
pH 10/filtration	21
Sodium thiosulfate (1mg/l)	25
EDTA chelation (3 mg/l)	27
Graduated pH (6.0)	8
Graduated pH (8.5)	5

pH 10 adjustment/filtration - The solubility of most cationic metals decreases with increasing pH; thus an increase in pH results in precipitation of the metal and reduced bioavailability. If the pH is raised and the sample is filtered prior to neutralization, the precipitated metals are retained on the filter. In this test, an orange precipitate was left on the filter, which suggest that the metal removed is most likely iron.

Sodium thiosulfate addition - Sodium thiosulfate is effective at removing some cationic metals. The EPA TIE methods manual (Norberg-King et al., 1991) states that sodium thiosulfate will remove zinc, but not manganese. It does not specify whether iron responds to this treatment.

EDTA addition - EDTA reduces the bioavailability of many cationic metals by chelation. EDTA has been documented to be effective in reducing the toxicity of iron, manganese, and zinc (Norberg-King et al., 1991).

Graduated pH - Some, but not all cationic metals are more toxic at low pH, because the metals are present as free ions, which are often the most toxic form of the metal. However, some metals, such as zinc, are more toxic at pH 8.0 than at 6.5 (Norberg-King et al., 1991). The EPA manual does not present data on the effect of pH on iron toxicity.

Each test, except the graduated pH test, was effective at removing chronic toxicity. These results are consistent with the responses that would be expected if the toxicant were a metal. The orange precipitate that resulted when the pH was adjusted to 10 and filtered strongly suggests that the toxicity is due to iron.

Following the Phase I partial TIE for cationic metals, Phase II TIE studies were initiated on a water sample collected from UTR-029 on January 5, 1995 (ETT, 1995a). In the Phase II studies, water from the seep was adjusted to pH 10 and filtered to remove cationic metals. Samples of the treated water where then spiked with iron (2.1 mg/l), with zinc (17 μg/l), and with iron (2.1 mg/l), zinc (17μg/l) and manganese (0.71 mg/l). These spiked samples were then subjected to the same treatments that removed toxicity in the Phase I tests (filtration at pH 10, sodium thiosulfate addition, and EDTA chelation).
The results indicate that 2.1 mg/l of iron produces a chronic toxic effect of similar magnitude to that observed in the seep sample (Table 8). The addition of zinc to a concentration of 17 μg/l did not increase the toxicity, which suggests that the amount of zinc present in the UTR-029 seep water is not great enough to produce toxicity. Similarly, the addition of manganese and zinc to the sample that had been spiked with iron did not increase the toxicity. The results of the Phase II TIE therefore confirm that the observed toxicity of UTR-029 is due to the presence of iron in the water. Because UTR-029 is a reference seep that has not been impacted by SRS operations, the iron is

Table 8. Results of Phase II Treatments on the Toxicity of Water from UTR-029

Treatment	Number of Young Produced
Control	16[a]
Untreated	15
Treated	15
Fe spiked (2.1 mg/l)	0
Zn spiked (17 μg/l)	14
Fe, Mn, Zn spiked (2.1 mg/l, 0.71 mg/l and 17 μg/l)	2

[a]Control reproduction was unusually low; 20% seep water produced 24 young, which is what would be expected in the control.

believed to be naturally occurring iron that probably has been leached from soil particles by the relatively low pH (5.49) of the groundwater.

6.3.2 FSP-204

Toxicity tests conducted on water collected from seep FSP-204 in September 1993 and June 1994 demonstrated that the seep water was toxic to *Ceriodaphnia dubia*. In November 1994 and July 1995, metal analyses were conducted on a sample of water collected from the seep (Table 9). These results indicated that the seep water contained potentially toxic concentrations of aluminum, cadmium, iron, lead, and zinc.

In January 1995, a TIE was initiated, using chronic test procedures (Tier I and Tier II; Table 10; ETT, 1995e). Details of the TIE can be found in Appendix G. Most of the treatments utilized in Phase I were ineffective in removing toxicity. Treatments that were effective included adjustment to pH 10, aeration at pH 3 and pH 6, filtration, and filtration with a C-18 Solid Phase Extraction (SPE) column. The seep water was also found to be less toxic at pH 8.5 than at pH 6.0. EDTA chelation, which is effective in removing many cationic metals (including Cd, Cu, Fe, Pb, Mn, and Zn), was not effective in reducing toxicity. Based on the results of the initial Phase I TIE studies, potential toxicants include the following: cationic metals not chelatable by EDTA , hydrogen sulfide, total dissolved solids, and non-polar organics (which are removed by a C-18 SPE column).

Table 9. Metal Concentrations (µg/l) in Water Collected from FSP-204, November 1994 and July 1995

Metal	Nov 1994	July 1995
Al	10,600	9,150
As	<5	<5
Cd	6.9	7.2
Cr	<5	<20
Cu	<5	<10
Fe	27	1,070
Pb	3.6	<5
Mn	1,670	1,760
Hg	<0.1	<0.1
Zn	33.9	30.8

In March 1995, a methanol elution was performed to distinguish between the removal of non-polar organics (which can typically be eluted by methanol) and cationic metals. The results indicated that the toxicants were not eluted by the methanol, which indicates that the toxicity was not due to non-polar organics.

Additional Phase I testing was conducted in July 1995 to confirm the results of the January 1995 Phase I tests, as well as to employ additional treatments to remove toxicity. These treatments included aeration at the initial pH and at pH 3, a graduated pH test, filtration through glass fiber filters and membrane filters and treatment with an anionic and a cationic exchange resin. The results of the Phase I tests indicated that aeration at the initial pH or at pH 3 did not reduce toxicity, which indicated that the toxicity was not due to a volatile compound (hydrogen sulfide). Filtration through a glass fiber filter or membrane filter did not reduce toxicity, which suggested that toxicity was not due to particulate contaminants. The anionic exchange resin reduced toxicity slightly, but the cationic resin removed all of the toxicity, which suggested that most of the toxicity was due to a cation. The graduated pH test indicated that the seep water was considerably less toxic at pH 8.0 than at 6.5, which would suggest one or more of the following toxicants: aluminum, copper, hydrogen sulfide or lead. Since copper and lead are chelatable by EDTA and EDTA did not reduce toxicity in the first round of Phase I tests, the results suggest that cationic metals not chelatable by EDTA (probably aluminum) was the primary class of toxicants. However, some residual toxicity remained with most of the treatments that reduced toxicity. The presence of residual toxicity indicated that other toxicants, with different characteristics, also contributed to the toxicity.

Table 10. Results of Tier I and Tier II Toxicity Tests Conducted on Water from FSP-204 (Number of Young Produced)

	Concentration of FSP-204 Seep Water					
Treatment	0%	40%	60%	80%	100%	Result
Baseline	7.6	X[a]	X	X	X	Sample toxic to 40%; volatile affected control
pH 3	13.0	5.0	9.2	X	X	Slight reduction in toxicity
pH 10	15.0	12.4	12.4	10.4	2.2	Toxicity reduced
Aeration	0.0	12.0	3.2	1.0	X	Slight reduction in toxicity
Aeration pH 3	9.0	9.8	8.2	6.3	1.6	Toxicity reduced
Aeration pH10	11.0	2.0	1.4	X	X	Slight reduction in toxicity
Filtration	0.0	2.4	2.0	0.2	0.6	Toxicity reduced
Filtration pH 3	6.0	X	X	X	X	No reduction in toxicity
Filtration pH 10	1.0	X	X	X	X	No reduction in toxicity
SPE C-18	6.0	8.6	8.8	4.6	3.6	Toxicity reduced; SPE treatment affected controls
SPE C-18 pH 3	9.4	6.6	6.8	7.0	3.6	Toxicity reduced
SPE C-18 pH 9	X	2.6	2.4	5.6	X	Toxicity reduced; SPE treatment affected controls
Na thiosulfate (1 mg/l)	0.0		9.6	5.8	X	Slight reduction in toxicity
Na thiosulfate (5 mg/l)	6.0		7.2	3.0	X	Slight reduction in toxicity
Na thiosulfate (10 mg/l)	0.0		X	X	X	No reduction in toxicity
EDTA (0.5 mg/l)	19.0		X	X	X	No reduction in toxicity
EDTA (3 mg/l)	22.0		X	X	X	No reduction in toxicity
EDTA (8 mg/l)	8.0		X	X	X	No reduction in toxicity
Graduated pH (6.0)	12.0	X	X	X	X	No reduction in toxicity
Graduated pH (8.5)	0.0	5.4	2.6	X	X	Less toxic at pH 8.5 than at pH 6.5

[a]X = 100% mortality

Phase II tests were initiated in August 1995 (ETT, 1995e). These studies were designed to remove metals from the seep water to eliminate the toxicity. Metals were then spiked back into the water to confirm that the toxicity returned at expected levels. A cationic exchange resin was used to remove cationic metals from the water. Most of the cationic metals were removed by the resin (Table 11). Toxicity was removed in the 20, 40, 60 and 80% concentrations of seep water, but the undiluted seep sample continued to be toxic following treatment with the resin (Table 12). However, since the resin also removes essential cations, such as calcium and magnesium, the remaining toxicity in the undiluted sample may have reflected the absence of these essential ions. Aluminum, iron, cadmium, and manganese were separately spiked back into the treated samples and all four metals were spiked together into a single treated sample. The results of the spiking indicated that aluminum and cadmium were the primary toxicants in FSP-204, and that iron may also have contributed to the toxicity (Table 13).

Table 11. Metal Concentrations (µg/l) in Untreated Water from FSP-204 and Water Treated by a Cationic Exchange Resin

Metal	Untreated Water	Treated Water
Al	9,150	70
Cd	7.24	<5
Fe	1,070	<20
Mn	1,760	<50
Zn	30.8	no data

Table 12. Mortality Rates in Untreated, Treated, and Treated/Spiked Water[a] from FSP-204

Treatment	Test Dilution Control	20%	40%	60%	80%	100%
Baseline	5%	70%	90%	100%	100%	100%
Treated	0%	0%	0%	0%	0%	100%
Fe spiked	0%				60%	
Cd spiked					100%	
Al spiked					100%	
Mn spiked					10%	
Al/Cd/Fe/ Mn spiked					100%	

[a]Water was spiked to the concentrations present in the untreated seep sample

6.3.3 HSP-103

Toxicity tests conducted on water collected from seep HSP-103 in September 1993 and June 1994 demonstrated that the seep water was toxic to *Ceriodaphnia dubia*, with NOEC's of 3% and 12.5%, respectively. In January 1995, a full TIE was initiated on a sample of water collected from HSP-103 (ETT, 1995f). The only treatment that

Table 13. Mortality Rates in Treated Water from FSP-204 Spiked to Different Concentrations of Metals[a]

Fe					
Concentration	0	100 µg/l	200 µg/l	500 µg/l	1008 µg/l
% Mortality	0	10%	5%	20%	60%
Cd					
Concentration	0	0.5µg/l	1 µg/l	2 µg/l	5 µg/l
% Mortality	0	100%	100%	100%	100%
Al					
Concentration	0	1 mg/l	2 mg/l	5 mg/l	9.34 mg/l
% Mortality	0%	0%	100%	100%	100%
Mn					
Concentration	0	200 µg/l	500 µg/l	1000 µg/l	1780 µg/l
% Mortality	0%	25%	10%	30%	10%

[a]Highest concentration tested equals the concentration present in FSP-204

removed the toxicity was aeration at pH 3 (see Appendix H for details). These results suggest that the toxicant was either volatilized or oxidized to a less toxic form at an acidic pH. Possible toxicants that would be less toxic after aeration at pH 3 include sulfide/hydrogen sulfide, and possibly cationic metals that were not chelatable by EDTA and/or acid volatile organics which could not be removed by a C-18 SPE column.

In May 1995, additional TIE tests were conducted on water collected from HSP-103 (ETT, 1995b). These tests included aeration and nitrogen sparging. Aeration is typically effective at removing toxicity of volatiles, toxicants that are more toxic in a reduced state than in an oxidized state, and physical removal of toxicants (typically surfactants) through adherence of the toxicants to the sides of the aeration vessel. In order to determine if the mode of action was oxidation or sparging, a series of toxicity tests was conducted on samples that were aerated or sparged at the ambient pH, as well as at pH values of 3 and 10. Treatments were as follows: baseline test (untreated seep water); pH adjustment tests (pH 3 and 10); aeration at initial pH, pH 3 and pH 10; and nitrogen sparging at initial pH, pH 3, and pH 10. The results indicated that the only treatment that removed the toxicity was nitrogen sparging at the initial pH; however, all of the aeration and sparging treatments reduced the toxicity to some extent (Appendix H). These results suggest that the toxicant was a volatile compound. It is unlikely that the toxicant would be hydrogen sulfide, since its toxicity would be expected to be reduced more by aeration than by sparging with nitrogen. Since volatile organic compounds have not been found in the HSP seeps at concentrations that would be toxic to *Ceriodaphnia dubia* (Chappell et al., 1995), and because the toxicity was not removed by a C-18 SPE column, the toxicity is not likely to be due to a volatile organic compound. High concentrations of nitrate in the seep water may be reduced to ammonia under anoxic conditions. Ammonia toxicity is pH and temperature dependent.

Toxicity would be expected at approximately 2 mg/l under the pH and temperature conditions that were present at HSP-103. However, Chapell et al. (1995), did not report ammonia concentrations at H-Area seeps that approached 2 mg/l. No other source of volatile toxicants is known for the H-Area seeps.

Additional samples were collected from HSP-103 on two occasions during the summer of 1995. However, neither sample was found to be toxic when a baseline toxicity test was initiated prior to beginning additional TIE tests. Therefore, it was not possible to definitively determine the source of the toxicity at HSP-103. However, it appears that the source of the toxicity has been reduced or eliminated over time. In September 1993, the NOEC was 3%, in June 1994, the NOEC was 12.5%, in January 1995, when the TIE was initiated the NOEC was 60%, and by the late summer 1995, the water was no longer toxic. These results suggest that the toxicity was due to constituents from the H-Area basins that have reduced or eliminated by the capping of the basins.

6.3.4 Fourmile Branch

As part of another investigation conducted in 1994, water samples from FMB were used to culture *Ceriodaphnia dubia* (Specht, 1994). Results indicated that water from FMB was usually chronically toxic to *C. dubia*. Acute toxicity was also noted on an intermittent basis. In order to determine the cause of the toxicity, a full TIE was initiated on water collected from FMB at Road F on June 19, 1995 (ETT, 1995c; see Appendix I for details). This location is near the headwaters of the stream and is upstream from all SRS discharges to the stream. The treatments in Table 14 were used in the Phase I investigations of the TIE.

Table 14. Treatments Used for Phase I TIE on Fourmile Branch

Treatment	Potential Toxicants Removed	Result
Adjust to pH 3	Insoluble at low pH	Toxicity increased
Adjust of pH 10	Insoluble at high pH	No change in toxicity
Aerate at initial pH	Volatile; oxidizable	No change in toxicity
Aerate at pH 3	Volatile; oxidizable at low pH	No change in toxicity
Aerate at pH 10	Volatile; oxidizable at high pH	No change in toxicity
Filter at initial pH	Total suspended solids	Toxicity removed
Filter at pH 3	Insoluble at low pH	Toxicity reduced
Filter at pH 10	Cationic metals; insoluble at high pH	Toxicity reduced
C-18 column at initial pH	Non-polar organics; metals	Toxicity removed
C-18 column at pH 3	Non-polar organics	No change in toxicity
C-18 column at pH 9	Non-polar organics; metals	Toxicity reduced
Sodium thiosulfate addition	Residual chlorine; some metals	
1 mg/l		Toxicity reduced
5 mg/l		No change in toxicity
10 mg/l		No change in toxicity
EDTA chelation	Some metals; surfactants	
1 mg/l		No change in toxicity
5 mg/l		Toxicity reduced
10 mg/l		Toxicity removed
Graduated pH	Ammonia; some metals; sulfide	No change in toxicity at pH 6, 8.5

Treatments that were effective in reducing or removing toxicity included filtration, C-18 column, sodium thiosulfate addition at 1 mg/l, and EDTA addition at ≥ 5 mg/l. With the exception of filtration at neutral pH, these treatments were all generally effective in removing cationic metals, which suggests that the toxicity in FMB was probably due to a metal.

Phase II TIE studies were initiated in July 1995 to identify and confirm the source of toxicity in FMB (ETT, 1995d; Appendix I). A sample of water from FMB was collected on July 25, 1995. An analysis for iron indicated that the sample contained 6.2 mg/l total iron. Sodium hydroxide was added to a portion of the water sample to adjust the pH to 9.0. The sample was then filtered through a 0.45 micron membrane filter to remove the metals that were precipitated and the pH was adjusted back to the initial pH of the sample. A baseline toxicity test was conducted on untreated water to confirm that the untreated water was toxic. An aliquot of the treated sample was tested for chronic toxicity to confirm that the toxicity had been removed. The remainder of the treated sample was spiked with iron to concentrations of 1, 2, 4, and 6.2 mg/l and toxicity tests were conducted on each spiked sample to determine if they were toxic.

The results of the Phase II investigations confirmed that the untreated sample was toxic and that adjustment to pH 9.0 and filtration removed the toxicity (Figure 4). When iron was spiked back into the sample at concentrations exceeding 2 mg/l, toxicity was again observed. These results confirm that iron was the source of the toxicity in water collected from FMB. Because the sample was collected upstream from all SRS discharges to the stream, it appears that the toxicity was due to naturally occurring iron. The iron was probably leached from surrounding soil by the low pH resulting from naturally occurring humic and fulvic acids that are characteristic of blackwater streams.

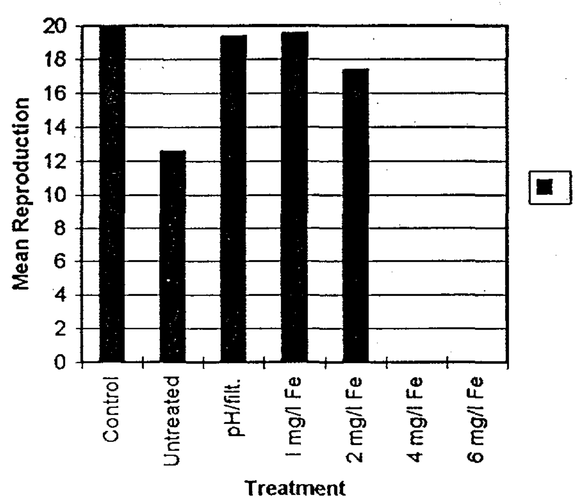

Figure 4. Mean Reproduction of *Ceriodaphnia* in Treated and Untreated Water from Fourmile Branch and in Treated Water from Fourmile Branch that was Spiked with Iron.

7.0 CONCLUSIONS

Toxicity tests conducted on seeps located downgradient from the F- and H-Area Seepage Basins indicated that most of the seeps were toxic to some extent, but that water from FMB in the vicinity of the F/H seeps was not usually toxic. The toxicity of the seeps appeared to be variable, probably due to dilution by rainfall. Most of the unimpacted reference locations were also toxic, but usually were less toxic than the F/H seeps.

Toxicity Identification Evaluations (TIE's) performed on representative seeps indicated that the toxicity at the F-Area seeps was due to aluminum, cadmium, and possibly iron. These results indicated that the F-Area seeps were toxic and that the toxicity was due, at least in part, to constituents that have probably leached from the soil as a result of operation of the F-Area Seepage Basins. The toxicity at the H-Area seeps was most likely due to a volatile toxicant. The specific toxicant could not be identified because the toxicity disappeared after Phase I of the TIE. Therefore, it was not determined whether the H-Area Seepage Basins were the source of the toxicity. However, the toxicity of the H-Area seeps appears to have declined over time, to the point that they are no longer toxic. These results suggest that the toxicity was due to contaminants from the H-Area Seepage Basins, but that capping the basins has reduced the concentrations of the contaminants to the point that toxicity has diminished or been eliminated.

Toxicity investigations conducted on water from FMB upstream from all SRS inputs, and on an uncontaminated reference seep indicated that both of these locations were toxic due to naturally occurring concentrations of iron. These results indicate that toxicity results from SRS streams and seeps must be interpreted with extreme caution, since the toxicity may not be due to SRS operations.

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APPENDIX A

May-June 1990 Toxicity Tests (from Trapp, 1990)

Assessment of the Toxicity of seepage from F and H Seepage Basins located on the Savannah River Site

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November 1990

Table 2-1. Summary of test conditions: *Ceriodaphnia dubia*[a] 7-d Static Renewal Chronic Toxicity Test

1.	Test temperature	$25 \pm 1^{\circ}C$
2.	Light quality	Ambient illumination
3.	Light intensity	Ambient laboratory levels
4.	Photoperiod	16L:8D
5.	Test vessel size/ solution volume	30-mL/15 mL
6.	Number of organisms per vessel	1
7.	Number of replicates	20 per concentration
8.	Age of organisms	$\leq$ 24 h
9.	Total number of organisms per concentration	20
10.	Aeration	None
11.	Diluent	Four Mile Creek water
12.	Test duration	7 d
13.	Effect measured	Mortality, young production
14.	Chemical parameters measured on diluent and sample	DO, temperature, pH, conductivity (new solutions); DO, temperature, pH (daily on old solutions)

[a]Adapted from Weber et al., 1989.

Table 3-1. Summary of initial basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the C4 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (^{o}C)	pH	Conductivity (mS/cm)
CONTROL	7.46 ± 0.42 6.70 - 8.00 7	24.0 ± 0.0 24.0 - 24.0 7	6.58 ± 0.17 6.42 - 6.84 7	0.028 ± 0.002 0.025 - 0.031 7
1%	7.58 ± 0.35 6.85 - 7.95 7	24.0 ± 0.0 24.0 - 24.0 7	6.64 ± 0.14 6.37 - 6.82 7	0.029 ± 0.002 0.027 - 0.033 7
3%	7.50 ± 0.25 7.20 - 7.9 7	24.0 ± 0.0 24.0 - 24.0 7	6.73 ± 0.11 6.62 - 6.9 7	0.031 ± 0.003 0.028 - 0.036 7
10%	7.57 ± 0.32 7.15 - 8.00 7	24.0 ± 0.0 24.0 - 24.0 7	6.76 ± 0.11 6.61 - 6.92 7	0.033 ± 0.002 0.030 - 0.037 7
30%	7.59 ± 0.34 7.10 - 8 7	24.0 ± 0.0 24.0 - 24.0 7	6.85 ± 0.10 6.72 - 6.99 7	0.042 ± 0.003 0.039 - 0.048 7
60%	7.69 ± 0.31 7.05 - 8 7	24.0 ± 0.0 24.0 - 24.0 7	6.96 ± 0.08 6.88 - 7.1 7	0.055 ± 0.003 0.053 - 0.059 7
100%	7.82 ± 0.37 7.35 - 8.40 7	24.1 ± 0.2 24.0 - 24.4 7	7.12 ± 0.10 7.00 - 7.24 7	0.073 ± 0.001 0.072 - 0.075 7

Table 3-2. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the C4 Seepage Basin; 24 h readings. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (^oC)	pH
CONTROL	7.41 ± 0.32 6.90 - 7.90 7	24.0 ± 0.0 24.0 - 24.0 7	6.99 ± 0.20 6.76 - 7.35 7
1%	7.48 ± 0.31 6.95 - 7.75 7	24.0 ± 0.0 24.0 - 24.0 7	7.04 ± 0.14 6.82 - 7.27 7
3%	7.37 ± 0.30 7.00 - 7.8 7	24.0 ± 0.0 24.0 - 24.0 7	7.07 ± 0.10 6.89 - 7.21 7
10%	7.41 ± 0.36 6.90 - 7.80 7	24.0 ± 0.0 24.0 - 24.0 7	7.13 ± 0.08 7.02 - 7.25 7
30%	7.39 ± 0.30 7.00 - 7.8 7	24.0 ± 0.0 24.0 - 24.0 7	7.17 ± 0.10 7.01 - 7.30 7
60%	7.51 ± 0.20 7.20 - 7.75 7	24.0 ± 0.0 24.0 - 24.0 7	7.23 ± 0.10 7.05 - 7.36 7
100%	7.38 ± 0.23 6.95 - 7.60 7	24.0 ± 0.0 24.0 - 24.0 7	7.32 ± 0.09 7.24 - 7.47 7

Table 3-3. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the C4 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALES
control	20	0.000	22.000	13.200	68.589	8.282	0	25
1%	20	0.000	23.000	13.450	85.629	9.254	0	30
3%	20	0.000	22.000	14.500	76.789	8.763	0	25
10%	20	0.000	23.000	13.450	86.892	9.322	0	30
30%	20	0.000	25.000	17.100	64.726	8.045	0	15
60%	20	0.000	25.000	13.700	112.958	10.628	0	35
100%	20	0.000	27.000	21.150	59.713	7.727	0	10

Table 3-4. Results of a Chi Square Goodness of Fit test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from the C4 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	9.380	33.880	53.480	33.880	9.380
OBSERVED	15	21	51	53	0

Calculated Chi-Square goodness of fit test statistic = 28.5490
Table Chi-Square value (alpha = 0.01) = 13.277

Data FAIL normality test.

Table 3-5. Results of a Steel's Many One test performed on the number of young produced by *Ceriodaphnia* *dubia* exposed to a sample collected from the C4 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah river Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Ho: $\mu_1 > \mu_2 > \mu_3 > \mu_4 > \mu_5 > \mu_6 > \mu_7$

Ha: The mean number of young produced by *C. dubia* exposed to the control is not greater than that of organisms exposed to a sample collected from the C4 Seepage Basin.

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	control	13.200				
2	1%	13.450	431.50	325.00	20.00	
3	3%	14.500	447.50	325.00	20.00	
4	10%	13.450	434.50	325.00	20.00	
5	30%	17.100	493.00	325.00	20.00	
6	60%	13.700	451.00	325.00	20.00	
7	100%	21.150	552.50	325.00	20.00	

Critical values use k = 6, are 1 tailed, and alpha = 0.05

Table 3-9. Summary of inital basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from Four Mile Creek at the Road C bridge. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (mS/cm)
CONTROL	7.51 ± 0.23 7.20 - 7.80 7	24.0 ± 0.0 24.0 - 24.0 7	6.65 ± 0.08 6.55 - 6.79 7	0.027 ± 0.002 0.025 - 0.031 7
1%	7.34 ± 0.28 7.00 - 7.80 7	24.0 ± 0.0 24.0 - 24.0 7	6.74 ± 0.10 6.56 - 6.86 7	0.028 ± 0.002 0.026 - 0.032 7
3%	7.50 ± 0.38 6.95 - 8 7	24.0 ± 0.0 24.0 - 24.0 7	6.79 ± 0.12 6.58 - 6.96 7	0.029 ± 0.001 0.027 - 0.031 7
10%	7.51 ± 0.33 7.00 - 7.95 7	24.0 ± 0.0 24.0 - 24.0 7	6.82 ± 0.13 6.59 - 6.94 7	0.033 ± 0.006 0.029 - 0.046 7
30%	7.60 ± 0.22 7.20 - 7.9 7	24.0 ± 0.0 24.0 - 24.0 7	6.90 ± 0.14 6.70 - 7.07 7	0.040 ± 0.006 0.036 - 0.054 7
60%	7.52 ± 0.30 7.00 - 7.9 7	24.0 ± 0.0 24.0 - 24.0 7	7.04 ± 0.13 6.79 - 7.18 7	0.052 ± 0.010 0.047 - 0.074 7
100%	7.66 ± 0.40 6.90 - 8.15 7	24.1 ± 0.2 24.0 - 24.4 7	7.18 ± 0.13 6.93 - 7.31 7	0.069 ± 0.012 0.062 - 0.096 7

Table 3-10. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from Four Mile Creek at the Road C bridge; 24 h readings. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (^oC)	pH
CONTROL	7.46 ± 0.20 7.10 - 7.70 7	24.0 ± 0.0 24.0 - 24.0 7	6.97 ± 0.16 6.65 - 7.16 7
1%	7.52 ± 0.23 7.10 - 7.70 7	24.0 ± 0.0 24.0 - 24.0 7	7.04 ± 0.15 6.72 - 7.19 7
3%	7.46 ± 0.25 7.00 - 7.75 7	24.0 ± 0.0 24.0 - 24.0 7	7.04 ± 0.15 6.76 - 7.20 7
10%	7.46 ± 0.25 7.00 - 7.70 7	24.0 ± 0.0 24.0 - 24.0 7	7.10 ± 0.17 6.74 - 7.25 7
30%	7.46 ± 0.15 7.20 - 7.65 7	24.0 ± 0.0 24.0 - 24.0 7	7.18 ± 0.14 6.90 - 7.32 7
60%	7.51 ± 0.17 7.25 - 7.70 7	24.0 ± 0.0 24.0 - 24.0 7	7.28 ± 0.15 6.99 - 7.49 7
100%	7.48 ± 0.26 7.00 - 7.75 7	24.0 ± 0.0 24.0 - 24.0 7	7.38 ± 0.22 6.93 - 7.62 7

Table 3-11. Summary statsistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on samples of Four Mile Creek collected at the Road C bridge. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALES
control	20	0.000	19.000	7.550	66.471	8.153	0	50
1%	20	0.000	21.000	10.900	85.884	9.267	0	40
3%	20	0.000	23.000	16.100	43.989	6.632	0	10
10%	20	0.000	22.000	15.350	22.871	4.782	5	5
30%	20	6.000	25.000	18.150	19.503	4.416	0	0
60%	20	18.000	28.000	22.850	8.766	2.961	0	0
100%	20	12.000	33.000	23.900	27.779	5.271	0	0

Table 3-12. Results of a Chi Square Goodness of Fit test and Bartlett's test for homogeneity of variances performed on the number of young produced by _Ceriodaphnia dubia_ exposed to a sample of Four Mile Creek collected at the Road C bridge. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	9.380	33.880	53.480	33.880	9.380
OBSERVED	8	32	46	48	6

Calculated Chi-Square goodness of fit test statistic = 8.4562
Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test.

Bartletts test for homogeneity of variance

Calculated B statistic = 31.17
Table Chi-square value = 16.81 (alpha = 0.01)
Table Chi-square value = 12.59 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 19.00
Used for Chi-square table value ==> df (#groups-1) = 6

Data FAIL homogeneity test at 0.01 level.

Table 3-13. Results of a Steel's Many One test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample of Four Mile Creek collected at the Road C bridge. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Ho: $\mu_1 > \mu_2 > \mu_3 > \mu_4 > \mu_5 > \mu_6 > \mu_7$

Ha: The mean number of young produced by *C. dubia* exposed to the control is not greater than that of organisms exposed to a sample collected from Four Mile Creek.

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	control	7.550				
2	1%	10.900	465.50	325.00	20.00	
3	3%	16.100	527.50	325.00	20.00	
4	10%	15.350	518.00	325.00	20.00	
5	30%	18.150	565.00	325.00	20.00	
6	60%	22.850	606.00	325.00	20.00	
7	100%	23.900	596.50	325.00	20.00	

Critical values use k = 6, are 1 tailed, and alpha = 0.05

Table 3-14. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample of Four Mile Creek collected at the Road C bridge. Males not included in analyses. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD
control	10	6.000	19.000	15.100	13.656	3.695
1%	12	14.000	21.000	18.167	4.333	2.082
3%	18	10.000	23.000	17.889	15.281	3.909
10%	19	10.000	22.000	16.158	10.363	3.219
30%	20	6.000	25.000	18.150	19.503	4.416
60%	20	18.000	28.000	22.850	8.766	2.961
100%	20	12.000	33.000	23.550	23.524	4.850

Table 3-17. Summary of inital basic water chemistry for a _Ceriodaphnia dubia_ 7-day chronic static renewal toxicity test performed on a sample collected from the F5 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (mS/cm)
CONTROL	7.33 ± 0.20 7.00 - 7.65 7	24.0 ± 0.0 24.0 - 24.0 7	6.57 ± 0.12 6.32 - 6.68 7	0.028 ± 0.002 0.026 - 0.031 7
1%	7.48 ± 0.23 7.10 - 7.75 7	24.0 ± 0.0 24.0 - 24.0 7	6.72 ± 0.16 6.42 - 6.89 7	0.033 ± 0.006 0.030 - 0.045 7
3%	7.46 ± 0.24 7.15 - 7.75 7	24.0 ± 0.0 24.0 - 24.0 7	6.80 ± 0.16 6.53 - 6.96 7	0.038 ± 0.010 0.034 - 0.060 7
10%	7.52 ± 0.26 7.05 - 7.80 7	24.0 ± 0.0 24.0 - 24.0 7	6.92 ± 0.18 6.63 - 7.11 7	0.055 ± 0.011 0.048 - 0.081 7
30%	7.58 ± 0.24 7.25 - 7.9 7	24.0 ± 0.0 24.0 - 24.0 7	7.13 ± 0.17 6.85 - 7.31 7	0.098 ± 0.003 0.094 - 0.102 7
60%	7.58 ± 0.35 7.10 - 7.95 7	24.0 ± 0.0 24.0 - 24.0 7	7.32 ± 0.23 7.03 - 7.64 7	0.170 ± 0.006 0.157 - 0.175 7
100%	7.53 ± 0.41 7.00 - 8.15 7	24.1 ± 0.2 24.0 - 24.4 7	7.41 ± 0.18 7.10 - 7.64 7	0.278 ± 0.013 0.269 - 0.306 7

Table 3-18. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the F5 Seepage Basin; 24 h readings. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperrature (^{o}C)	pH
CONTROL	7.49 ± 0.27 7.00 - 7.80 7	24.1 ± 0.2 24.0 - 24.5 7	6.94 ± 0.13 6.72 - 7.11 7
1%	7.54 ± 0.23 7.30 - 7.95 7	24.0 ± 0.0 24.0 - 24.0 7	7.02 ± 0.15 6.72 - 7.21 7
3%	7.51 ± 0.17 7.30 - 7.7 7	24.0 ± 0.0 24.0 - 24.0 7	7.10 ± 0.14 6.83 - 7.25 7
10%	7.59 ± 0.23 7.30 - 7.95 7	24.0 ± 0.0 24.0 - 24.0 7	7.24 ± 0.14 6.99 - 7.48 7
30%	7.56 ± 0.21 7.30 - 7.95 7	24.0 ± 0.0 24.0 - 24.0 7	7.53 ± 0.14 7.24 - 7.70 7
60%	7.45 ± 0.20 7.15 - 7.7 7	24.0 ± 0.0 24.0 - 24.0 7	7.81 ± 0.15 7.53 - 8.02 7
100%	7.42 ± 0.21 7.10 - 7.70 7	24.0 ± 0.0 24.0 - 24.0 7	8.08 ± 0.08 7.98 - 8.23 7

Table 3-19. Summary statsistics for a <u>Ceriodaphnia dubia</u> 7-day chronic static renewal toxicity test performed on a sample collected from the F5 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALES
control	20	0.000	20.000	15.100	30.516	5.524	0	10
1%	20	0.000	23.000	12.400	33.832	5.816	0	10
3%	20	0.000	20.000	14.750	22.513	4.745	0	5
10%	20	0.000	20.000	16.600	19.095	4.370	0	5
30%	20	0.000	24.000	17.300	25.168	5.017	0	5
60%	20	4.000	23.000	15.400	23.305	4.828	5	0
100%	20	0.000	17.000	10.800	38.484	6.204	10	10

Table 3-20. Results of a Chi Square Goodness of Fit test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from the F5 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	9.380	33.880	53.480	33.880	9.380
OBSERVED	13	14	63	48	2

Calculated Chi-Square goodness of fit test statistic = 26.4480

Table Chi-Square value (alpha = 0.01) = 13.277

Data FAIL normality test.

Table 3-21. Results of a Steel's Many One test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from the F5 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Ho: $\mu_1 > \mu_2 > \mu_3 > \mu_4 > \mu_5 > \mu_6 > \mu_7$

Ha: The mean number of young produced by *C. dubia* exposed to the control is not greater than that of organisms exposed to a sample collected from the F5 Seepage Basin.

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	control	15.100				
2	1%	12.400	339.00	325.00	20.00	
3	3%	14.750	387.50	325.00	20.00	
4	10%	16.600	446.00	325.00	20.00	
5	30%	17.300	466.50	325.00	20.00	
6	60%	15.400	410.00	325.00	20.00	
7	100%	10.800	297.00	325.00	20.00	*

Critical values use k = 6, are 1 tailed, and alpha = 0.05

Table 3-25. Summary of inital basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the F6 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (^{o}C)	pH	Conductivity (mS/cm)
CONTROL	7.64 ± 0.26 7.40 - 8.10 7	24.0 ± 0.0 24.0 - 24.0 7	6.64 ± 0.16 6.45 - 6.97 7	0.027 ± 0.002 0.025 - 0.032 7
1%	7.57 ± 0.35 7.20 - 8.10 7	24.0 ± 0.0 24.0 - 24.0 7	6.77 ± 0.16 6.56 - 7.06 7	0.029 ± 0.002 0.027 - 0.031 7
3%	7.60 ± 0.28 7.30 - 8.15 7	24.0 ± 0.0 24.0 - 24.0 7	6.81 ± 0.15 6.65 - 7.1 7	0.030 ± 0.002 0.029 - 0.034 7
10%	7.61 ± 0.32 7.20 - 8.20 7	24.0 ± 0.0 24.0 ± 24.0 7	6.82 ± 0.16 6.64 - 7.11 7	0.037 ± 0.003 0.035 - 0.041 7
30%	7.62 ± 0.35 7.20 - 8.15 7	24.0 ± 0.0 24.0 - 24.0 7	7.19 ± 1.16 6.55 - 9.8 7.	0.053 ± 0.002 0.051 - 0.056 7
60%	7.57 ± 0.34 7.20 - 8.15 7	24.0 ± 0.0 24.0 - 24.0 7	6.72 ± 0.22 6.32 - 7.04 7	0.188 ± 0.269 0.078 - 0.798 7
100%	7.66 ± 0.58 6.50 - 8.40 7	24.1 ± 0.2 24.0 - 24.4 7	6.57 ± 0.18 6.21 - 6.78 7	0.116 ± 0.004 0.110 - 0.121 7

Table 3-26. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the F6 Seepage Basin; 24 h readings. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH
CONTROL	7.38 ± 0.33 6.85 - 7.75 7	24.3 ± 0.6 24.0 - 25.5 7	7.07 ± 0.25 6.83 - 7.60 7
1%	7.46 ± 0.29 7.10 - 7.90 7	24.1 ± 0.4 24.0 - 25.0 7	7.13 ± 0.25 6.84 - 7.65 7
3%	7.43 ± 0.31 7.10 - 8 7	24.2 ± 0.6 24.0 - 25.5 7	7.14 ± 0.29 6.82 - 7.75 7
10%	7.46 ± 0.27 7.10 - 7.80 7	24.2 ± 0.6 24.0 - 25.5 7	7.11 ± 0.33 6.78 - 7.80 7
30%	7.47 ± 0.26 7.10 - 7.75 7	24.2 ± 0.6 24.0 - 25.5 7	7.15 ± 0.44 6.76 - 8.10 7
60%	7.46 ± 0.21 7.10 - 7.7 7	24.2 ± 0.6 24.0 - 25.5 7	7.13 ± 0.53 6.73 - 8.30 7
100%	7.44 ± 0.21 7.10 - 7.60 7	24.2 ± 0.6 24.0 - 25.5 7	7.13 ± 0.65 6.76 - 8.60 7

Table 3-27. Summary statsistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the F6 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALES
control	20	0.000	20.000	11.400	56.358	7.507	5	25
1%	20	0.000	21.000	10.350	79.608	8.922	0	40
3%	20	0.000	23.000	9.200	85.221	9.232	5	45
10%	20	0.000	27.000	12.900	84.516	9.193	0	30
30%	20	0.000	22.000	14.800	57.221	7.564	5	15
60%	20	0.000	20.000	12.550	59.629	7.722	0	25
100%	20	0.000	22.000	8.450	85.208	9.231	10	45

Table 3-28. Results of a Chi Square Goodness of Fit test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from the F6 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	9.380	33.880	53.480	33.880	9.380
OBSERVED	13	36	28	62	1

Calculated Chi-Square goodness of fit test statistic = 44.4953
Table Chi-Square value (alpha = 0.01) = 13.277

Table 3-29. Results of a Steel's Many One test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from the F6 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Ho: $\mu_1 > \mu_2 > \mu_3 > \mu_4 > \mu_5 > \mu_6 > \mu_7$

Ha: The mean numbers of young produced by *C. dubia* exposed to the control is not greater than that of organisms exposed to a sample collected from the F6 Seepage Basin.

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	control	11.400				
2	1%	10.350	406.00	325.00	20.00	
3	3%	9.200	389.50	325.00	20.00	
4	10%	12.900	440.50	325.00	20.00	
5	30%	14.800	482.00	325.00	20.00	
6	60%	12.550	434.00	325.00	20.00	
7	100%	8.450	378.50	325.00	20.00	

Critical values use k = 6, are 1 tailed, and alpha = 0.05

Table 3-33. Summary of inital basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the H4 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperrature (^{o}C)	pH	Conductivity (mS/cm)
CONTROL	7.40 ± 0.10 7.30 - 7.55 7	24.0 ± 0.0 24.0 - 24.0 7	6.61 ± 0.02 6.57 - 6.64 7	0.029 ± 0.004 0.026 - 0.037 7
1%	7.53 ± 0.21 7.20 - 7.80 7	24.0 ± 0.0 24.0 - 24.0 7	6.74 ± 0.09 6.63 - 6.91 7	0.073 ± 0.113 0.027 - 0.328 7
3%	7.58 ± 0.20 7.25 - 7.9 7	24.0 ± 0.0 24.0 - 24.0 7	6.86 ± 0.10 6.73 - 7.04 7	0.034 ± 0.005 0.031 - 0.046 7
10%	7.58 ± 0.23 7.25 - 7.90 7	24.0 ± 0.0 24.0 - 24.0 7	7.00 ± 0.11 6.82 - 7.15 7	0.046 ± 0.011 0.041 - 0.070 7
30%	7.41 ± 0.26 7.10 - 7.8 7	24.0 ± 0.0 24.0 - 24.0 7	7.24 ± 0.13 7.09 - 7.49 7	0.169 ± 0.258 0.069 - 0.754 7
60%	7.54 ± 0.31 7.10 - 7.95 7	24.0 ± 0.0 24.0 - 24.0 7	7.45 ± 0.17 7.27 - 7.7 7	0.120 ± 0.008 0.114 - 0.137 7
100%	7.45 ± 0.53 6.70 - 8.10 7	24.0 ± 0.0 24.0 - 24.0 7	7.50 ± 0.20 7.23 - 7.74 7	0.159 ± 0.062 0.018 - 0.188 7

[illegible] River [illegible]
[illegible] served as the control and diluent. 29 [illegible]

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH
CONTROL	7.40 ± 0.28 7.04 - 7.80 7	24.1 ± 0.2 24.0 - 24.5 7	6.97 ± 0.08 6.87 - 7.11 7
1%	7.44 ± 0.22 7.20 - 7.80 7	24.1 ± 0.2 24.0 - 24.5 7	7.06 ± 0.11 6.86 - 7.22 7
3%	7.49 ± 0.25 7.15 - 7.8 7	24.1 ± 0.2 24.0 - 24.5 7	7.15 ± 0.09 6.98 - 7.27 7
10%	7.34 ± 0.21 7.10 - 7.60 7	24.1 ± 0.2 24.0 - 24.5 7	7.33 ± 0.10 7.17 - 7.48 7
30%	7.44 ± 0.16 7.25 - 7.7 7	24.1 ± 0.2 24.0 - 24.5 7	7.66 ± 0.12 7.44 - 7.81 7
60%	7.41 ± 0.22 7.00 - 7.7 7	24.1 ± 0.2 24.0 - 24.5 7	7.91 ± 0.14 7.66 - 8.14 7
100%	7.35 ± 0.16 7.15 - 7.60 7	24.1 ± 0.2 24.0 - 24.5 7	8.11 ± 0.10 7.97 - 8.31 7

Table 3-35. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the H4 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALES
control	20	0.000	18.000	8.500	63.947	7.997	0	45
1%	20	0.000	20.000	13.550	55.629	7.458	0	20
3%	20	0.000	21.000	11.050	88.050	9.383	0	40
10%	20	0.000	21.000	8.800	77.011	8.776	0	45
30%	20	0.000	20.000	9.500	79.947	8.941	5	40
60%	20	0.000	17.000	4.700	38.853	6.233	0	55
100%	20	0.000	18.000	4.800	29.221	5.406	0	40

Table 3-36. Results of a Chi Square Goodness of Fit test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from the H4 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	9.380	33.880	53.480	33.880	9.380
OBSERVED	4	55	26	51	4

Calculated Chi-Square goodness of fit test statistic = 42.1084
Table Chi-Square value (alpha = 0.01) = 13.277

Data FAIL normality test.

Table 3-37. Results of a Steel's Many One test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from the H4 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Ho: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Ha: The mean number of young produced by *C. dubia* exposed to the control is not greater than that of organisms exposed to a sample collected from the H4 Seepage Basin.

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	control	8.500				
2	1%	13.550	500.50	325.00	20.00	
3	3%	11.050	467.00	325.00	20.00	
4	10%	8.800	423.00	325.00	20.00	
5	30%	9.500	440.00	325.00	20.00	
6	60%	4.700	360.50	325.00	20.00	
7	100%	4.800	370.50	325.00	20.00	

Critical values use k = 6, are 1 tailed, and alpha = 0.05

Table 3-41. Summary of inital basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the H6 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (mS/cm)
CONTROL	7.51 ± 0.15 7.35 - 7.70 7	24.0 ± 0.0 24.0 - 24.0 7	6.60 ± 0.09 6.44 - 6.73 7	0.028 ± 0.002 0.026 - 0.031 7
1%	7.45 ± 0.40 6.65 - 7.85 7	24.1 ± 0.2 24.0 - 24.5 7	6.63 ± 0.05 6.53 - 6.68 7	0.029 ± 0.002 0.027 - 0.031 7
3%	7.56 ± 0.37 6.90 - 7.9 7	24.1 ± 0.2 24.0 - 24.5 7	6.70 ± 0.08 6.60 - 6.84 7	0.032 ± 0.000 0.032 - 0.033 7
10%	7.57 ± 0.36 6.90 - 7.85 7	24.1 ± 0.2 24.0 - 24.5 7	6.77 ± 0.08 6.67 - 6.88 7	0.045 ± 0.003 0.042 - 0.052 7
30%	7.44 ± 0.40 6.85 - 7.8 7	24.0 ± 0.0 24.0 - 24.0 7	6.89 ± 0.06 6.78 - 6.96 7	0.174 ± 0.248 0.075 - 0.736 7
60%	7.46 ± 0.47 6.55 - 7.95 7	24.1 ± 0.2 24.0 - 24.5 7	7.08 ± 0.10 6.90 - 7.17 7	0.129 ± 0.007 0.122 - 0.144 7
100%	7.51 ± 0.51 6.50 - 8.10 7	24.1 ± 0.2 24.0 - 24.4 7	7.28 ± 0.14 6.99 - 7.42 7	0.199 ± 0.006 0.190 - 0.209 7

Table 3-42. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the H6 Seepage Basin; 24 h readings. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH
CONTROL	7.47 ± 0.31 7.05 - 7.85 7	24.1 ± 0.2 24.0 - 24.5 7	6.80 ± 0.41 5.90 - 7.07 7
1%	7.49 ± 0.30 7.00 - 7.85 7	24.1 ± 0.2 24.0 - 24.5 7	7.01 ± 0.07 6.92 - 7.10 7
3%	7.45 ± 0.24 7.05 - 7.7 7	24.1 ± 0.2 24.0 - 24.5 7	7.05 ± 0.07 6.96 - 7.15 7
10%	7.52 ± 0.29 7.10 - 7.90 7	24.1 ± 0.2 24.0 - 24.5 7	7.11 ! 0.07 6.98 - 7.20 7
30%	7.53 ± 0.29 7.10 - 7.9 7	24.1 ± 0.2 24.0 - 24.5 7	7.19 ± 0.09 7.06 - 7.33 7
60%	7.57 ± 0.16 7.30 - 7.75 7	24.1 ± 0.2 24.0 - 24.5 7	7.29 ± 0.12 7.14 - 7.48 7
100%	7.57 ± 0.29 7.20 - 7.95 7	24.1 ± 0.2 24.0 - 24.5 7	7.45 ± 0.09 7.32 - 7.59 7

Table 3-43. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the H6 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALES
control	20	0.000	21.000	14.050	23.839	4.883	10	0
1%	20	12.000	19.000	16.550	3.524	1.877	0	0
3%	20	0.000	19.000	13.450	48.787	6.985	0	20
10%	20	0.000	20.000	11.000	71.684	8.467	0	35
30%	20	0.000	21.000	11.550	94.997	9.747	0	40
60%	20	0.000	23.000	16.500	27.737	5.267	5	5
100%	20	0.000	22.000	17.550	20.261	4.501	5	0

Table 3-44. Results of a Chi Square Goodness of Fit test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from the H6 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	9.380	33.880	53.480	33.880	9.380
OBSERVED	10	23	55	52	0

Calculated Chi-Square goodness of fit test statistic = 22.6492
Table Chi-Square value (alpha = 0.01) = 13.277

Data FAIL normality test.

Table 3-45. Results of a Steel's Many One test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from the H6 Seepage Basin. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

Ho: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Ha: The mean numbers of young produced by *C. dubia* exposed to the control is not greater than that of organisms exposed to a sample collected from the H6 Seepage Basin.

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	control	14.050				
2	1%	16.550	489.50	325.00	20.00	
3	3%	13.450	450.50	325.00	20.00	
4	10%	11.000	402.00	325.00	20.00	
5	30%	11.550	431.50	325.00	20.00	
6	60%	16.500	505.00	325.00	20.00	
7	100%	17.550	535.00	325.00	20.00	

Critical values use k = 6, are 1 tailed, and alpha = 0.05

Table 3-46. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from the H6 Seepage Basin. Males not included in analyses. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 29 May to 6 June, 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD
control	20	0.000	21.000	14.050	23.839	4.883
1	20	12.000	19.000	16.550	3.524	1.877
3%	16	15.000	19.000	16.813	1.496	1.223
10%	13	13.000	20.000	16.923	4.910	2.216
30%	12	17.000	21.000	19.250	2.386	1.545
60%	19	5.000	23.000	17.368	13.357	3.655
100%	20	0.000	22.000	17.550	20.261	4.501

4.0 DISCUSSION

Laboratory toxicity tests were conducted to assess the chronic toxicity of water seeping from basins located in the F and H Areas on the Savannah River Site. A sample of water was also collected from Four Mile Creek above the Road C bridge to determine if seepage entering the creek might adversely impact organisms inhabiting the creek.

The results of tritium analyses performed on the various test samples indicated that a rainfall event during the collection period had significantly diluted the samples. Despite the dilution, the WSRC technical representative determined that performing these tests would still provide some indication of the potential toxicity of these samples.

Although C. dubia had been cultured in water collected from Four Mile Creek for approximately 8 months prior to the initiation of these tests, the presence of males in the control population exceeded 20% in 4 of the 6 tests performed during this study. While the production of males in low numbers in laboratory cultures is believed to be a normal occurrence, high numbers (e.g. $\geq$ 20%) are thought to indiicate that the culture population is physiologically stressed. However, factors triggering male production are not well understood. Side-by-side studies performed in this laboratory have indicated that exposure to some sources of surface water can induce male production. C. dubia chronic toxicity tests have been performed by NAI using water collected from Lake Erie, near Ashtabula, OH. Twenty individuals were exposed to Lake Erie water while another 20 individuals from the same culture were exposed to laboratory culture water. The presence of males among individuals exposed to water from Lake Erie exceeded 20% while no males were observed among organisms exposed to the labortory water. The fact that both sets of organisms came from the same culture suggests that exposure of neonates to the Lake Erie water apparently induced the expression of male characteristics in the test population. A similar phenomenon may have occurred when C. dubia neonates were exposed to water collected from Four Mile Creek.

It is apparent that the presence of males in the control treatments for the tests performed on samples collected from the F5, F6, H4, and H6 Seepage Basins exceeded the 20% maximumestablished by EPA for a valid chronic test. However, analyses were still performed on these data to determine if exposure to these rainwater-diluted samples resulted in a chronic, toxic effect.As discussed in Section 3.1, data sets were statistically analysed with and without the inclusion of males to determine if the high incidence of males in the test population altered the determination of the NOEC and LOEC for the various samples. The results of theses analyses

LOEC for the various samples. The results of theses analyses are summarized in Table 4-1. With the exception of the sample of H6 seepage, the presence or absence of males in the data set did not alter the the determination of the NOEC (Table 4-1).

The results of these tests indicated that the samples of C4, F6, and H6 seepage water were not chronically to C. dubia; the NOEC for these samples equalled 100% (Table 4-1). A NOEC of 100% was also determined for the sample of Four Mile Creek water collected near the Road C bridge. When males where included in the data set generated from the test performed on the H4 seepage sample, the NOEC equalled 100%. When males were excluded, the NOEC equalled 60% (Table 4-1). It is impossible to conclusively determine which of the two NOEC values (60% vs. 100%) is the "correct" value. It is probable that the 60% NOEC may in fact reflect the true value. It is also possible that the determination of a 60% NOEC may be associated with the high number of males present in the test population (Table 3-35); eliminating the males resulted in a rather unbalanced data set that could have led to a "false" determination of a 60% NOEC.

Only the test performed on the F6 Seepage Basin sample indicated that the sample was chronically toxic. The LOEC and NOEC equalled 60% and 100%, respectively, regardless of whether or not males were included in data set during

Table 4-1. Summary of NOEC and LOEC values determined from statistical analyses performed on data generated during *Ceriodaphnia dubia* 7-d static renewal chronic toxicity tests.

Sample Location	Males included in analyses		Males excluded from analyses	
	NOEC	LOEC	NOEC	LOEC
C4	100%	na	100%	na
C Road	100%	na	100%	na
F5	60%	100%	60%	100%
F6	100%	na	100%	na
H4	100%	na	60%	100%
H6	100%	na	100%	na

In summary, test results suggested that samples of seepage from the C4, F6, and H6 Basins and a sample of Four Mile Creek water collected near the Road C bridge were not chronically toxic to _C_. _dubia_. Results of analyses performed on the H4 seepage sample were contradictory; when males were included in the statistical analyses, the NOEC equalled 100%. When males were excluded from the data set, analyses indicated that the NOEC equalled 60%. All analyses (males included and excluded from the data set) performed on the data generated during the test performed on the F6 seepage sample indicated that the NOEC and LOEC equalled 60% and 100%, respectively.

APPENDIX B

November-December 1990 Toxicity Tests (from Korthals, 1991)

Assessment of the Toxicity of Seepage from F and H Seepage Basins located on the Savannah River Site

E. T. Korthals

Normandeau Associates, Inc.
P.O. Box 1393
Aiken, South Carolina 29802

8 January 1991

NAI Project No.: 11651.00

Table 3-1. Summary of initial basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from Four Mile Creek at Road A-7. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (µS/cm)	Alkalinity (mg/L)	Hardness (mg/L)
Control	7.62±0.29 7.30-8.10 7	24.1± 0.4 24.0-25.0 7	5.66±0.12 5.55-5.85 7	25.4 ±3.2 22.3 -31.2 7	2.7 ±1.2 1.0 -5.0 7	6.0 ±1.6 4.0 -8.0 7
0.3%	7.59±0.21 7.35-7.40 7	24.1± 0.4 24.0-25.0 7	5.64±0.12 5.50-5.84 7	25.6 ±1.8 22.5 -27.2 7	---	---
1.0%	7.60±0.19 7.40-7.85 7	24.1± 0.4 24.0-25.0 7	5.73±0.10 5.53-5.82 7	24.1 ±1.2 22.2 -25.3 7	---	---
3.0%	7.67±0.20 7.35-7.95 7	24.1± 0.4 24.0-25.0 7	5.79±0.08 5.68-5.91 7	25.8 ±3.0 22.4 -29.6 7	---	---
10%	7.64±0.23 7.30-7.95 7	24.1± 0.2 24.0-24.5 7	5.86±0.07 5.75-5.94 7	30.3 ±5.2 25.7 -38.9 7	---	---
30%	7.67±0.23 7.30-8.00 7	24.1± 0.4 24.0-25.0 7	6.05±0.06 5.97-6.14 7	38.8 ±4.4 35.2 -47.3 7	---	---
60%	7.64±0.30 7.20-8.00 7	24.0± 0.0 --- 7	6.21±0.12 6.05-6.34 7	53.5 ±3.2 50.3 -57.2 7	7.1 ±1.2 6.0 -8.0 7	9.3 ±1.6 4.0 -8.0 7
100%			6.42 --- 1	75.0 --- 1	9.0 --- 1	11.0 --- 1

Table 3-2. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from Four Mile Creek at Road A-7; 24 h readings. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH
Control	7.04 ± 0.18 6.75 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	5.83 ± 0.47 5.56 - 6.88 7
0.3%	7.03 ± 0.13 6.85 - 7.20 7	24.5 ± 0.5 24.0 - 25.0 7	6.21 ± 0.27 6.02 - 6.78 7
1.0%	7.13 ± 0.11 7.00 - 7.8 7	24.6 ± 0.4 24.0 - 25.0 7	6.12 ± 0.11 6.02 - 6.33 7
3.0%	7.06 ± 0.14 6.85 - 7.25 7	24.6 ± 0.5 24.0 - 25.0 7	6.11 ± 0.10 5.99 - 6.28 7
10%	7.04 ± 0.14 6.80 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	6.15 ± 0.10 6.05 - 6.35 7
30%	7.10 ± 0.15 6.95 - 7.35 7	24.5 ± 0.5 24.0 - 25.0 7	6.29 ± 0.12 6.17 - 6.53 7
60%	7.10 ± 0.15 6.95 - 7.35 7	24.5 ± 0.5 24.0 - 25.0 7	6.29 ± 0.12 6.17 - 6.53 7

Table 3-3. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected at Road A-7. Males were not included in analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALE
control	20	16.0	41.0	30.6	40.7	6.4	0	0
0.3%	18	10.0	41.0	30.4	49.1	7.0	0	10
1 %	20	19.0	39.0	29.7	29.6	5.4	5	0
3 %	20	5.0	39.0	30.2	52.2	7.2	5	0
10 %	19	16.0	41.0	31.3	44.4	6.7	0	5
30 %	20	28.0	49.0	40.4	29.7	5.4	0	0
60 %	20	4.0	52.0	41.0	103.5	10.2	10	0

Table 3-4. Results of a Fisher's Exact test performed on the mortality of Ceriodaphnia dubia exposed to a sample collected at Road A-7. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	b VALUE	CRITICAL VALUE	SIGNIFICANT (P = 0.05)
0.3%	20	15	N
1 %	19	15	N
3 %	19	15	N
10 %	20	15	N
30 %	20	15	N
60 %	18	15	N

Table 3-5. Results of a Chi Square Goodness of Fit test and Bartlett's test for Homogeneity of Variances performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected at Road A-7. Males were not included in analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	9.179	33.154	52.334	33.154	9.179
OBSERVED	12	21	60	40	4

Calculated Chi-Square goodness of fit test statistic = 10.7812
Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test.

Bartletts test for homogeneity of variance

Calculated B statistic = 10.94
Table Chi-square value = 16.81 (alpha = 0.01)
Table Chi-square value = 12.59 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 18.57
Used for Chi-square table value ==> df (#groups-1) = 6

Data PASS homogeneity test at 0.01 level.

Table 3-6. Results of a one way analysis of variance test and Dunnett's test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected at Road A-7. Males were not included in statistical analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Ho: $\mu_1 > \mu_2 > \mu_3 > \mu_4 > \mu_5 > \mu_6 > \mu_7$

Ha: The mean number of young produced by *C. dubia* exposed to both the control is not greater than that of organisms exposed to a sample collected at Road A-7.

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	6	3023.211	503.868	10.089
Within (Error)	130	6492.629	49.943	
Total	136	9515.839		

Critical F value = 2.18 (0.05,6,120)
Since F > Critical F REJECT Ho:All groups equal

Table 3-6.(continued). Results of a one way analysis of variance test and Dunnett's test performed on the number of young produced by Ceriodaphnia dubia exposed to a sample collected at Road A-7. Males not were not included in analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

DUNNETT'S TEST - TABLE 1 OF 2 Ho:Control>Treatment

IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
control	30.600	30.600		
0.3%	30.444	30.444	0.068	
1%	29.700	29.700	0.403	
3%	30.250	30.250	0.157	
10%	31.263	31.263	-0.293	
30%	40.400	40.400	-4.385	
60%	41.050	41.050	-4.676	

Bonferroni T table value = 2.32 (1 Tailed Value, P=0.05, df=120,6)

Table 3-6 (continued). Results of a one way analysis of variance test and Dunnett's test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected at Road A-7. Males not were not included in analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

DUNNETT'S TEST - TABLE 2 OF 2 Ho:Control>Treatment

IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
control	20			
0.3%	18	5.327	17.4	0.156
1%	20	5.185	16.9	0.900
3%	20	5.185	16.9	0.350
10%	19	5.252	17.2	-0.663
30%	20	5.185	16.9	-9.800
60%	20	5.185	16.9	-10.450

Table 3-7. Summary of initial basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from Four Mile Creek at the Road C bridge. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (µS/cm)	Alkalinity (mg/L)	Hardness (mg/L)
CONTROL	7.62±0.29 7.30-8.10 7	24.1± 0.4 24.0-25.0 7	5.66±0.12 5.55-5.85 7	25.4 ±3.2 22.3 -31.2 7	2.7 ±1.2 1.0 -5.0 7	6.0 ±1.6 4.0 -8.0 7
1.0%	7.73±0.24 7.35-8.00 6	24.1± 0.2 24.0-24.5 6	5.66±0.09 5.56-5.78 6	24.5 ±3.2 21.4 -28.9 6	---	---
3.0%	7.69±0.21 7.30-8.00 7	24.1± 0.2 24.0-24.5 7	5.85±0.08 5.74-5.94 7	26.1 ±2.4 23.6 -28.9 7	---	---
10%	7.58±0.23 7.20-7.90 7	24.1± 0.2 24.0-24.5 7	6.01±0.07 5.91-6.09 7	29.2 ±1.8 27.4 -32.8 7	---	---
30%	7.64±0.29 7.20-7.95 7	24.1± 0.2 24.0-24.5 7	6.25±0.08 6.15-6.35 7	42.1 ±3.0 38.4 -46.4 7	---	---
60%	7.67±0.40 7.20-8.40 7	24.1± 0.2 24.0-24.5 7	7.52±0.08 6.43-6.61 7	61.6 ±5.8 56.8 -74.2 7	---	---
100%	7.71±0.34 7.25-8.30 7	24.1± 0.4 24.0-24.5 7	6.74±0.12 6.55-6.79 7	89.4 ±3.2 22.3 -31.2 7	18.9 ± 1.3 18.0 -20.0 7	10.3 ± 1.6 9.00-11.0 7

Table 3-8. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from Four Mile Creek at the Road C bridge; 24 h readings. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (^{o}C)	pH
CONTROL	7.04 ± 0.18 6.75 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	5.83 ± 0.47 5.56 - 6.88 7
1.0%	7.01 ± 0.14 6.80 - 7.15 7	24.6 ± 0.5 24.0 - 25.0 7	6.22 ± 0.30 5.94 - 6.82 7
3.0%	6.91 ± 0.16 6.60 - 7.10 7	24.6 ± 0.5 24.0 - 25.0 7	6.22 ± 0.18 6.05 - 6.53 7
10%	7.01 ± 0.13 6.80 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	6.30 ± 0.11 6.17 - 6.46 7
30%	6.99 ± 0.18 6.70 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	6.50 ± 0.10 6.35 - 6.64 7
60%	7.00 ± 0.17 6.65 - 7.15 7	24.6 ± 0.5 24.0 - 25.0 7	6.74 ± 0.11 6.59 - 6.93 7
100%	7.00 ± 0.17 6.65 - 7.15 7	24.6 ± 0.5 24.0 - 25.0 7	6.74 ± 0.11 6.59 - 6.93 7

Table 3-9. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a sample collected from Four Mile Creek at Road C. Males were not included in analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	N	MIN	MAX.	MEAN	VARIANCE	SD	% MORTALITY	% MALE
control	18	14.0	35.0	25.4	38.2	6.2	0	10
1 %	19	12.0	32.0	24.0	33.3	5.8	0	5
3 %	20	0.0	34.0	25.3	89.6	9.5	10	0
10 %	20	19.0	35.0	26.8	23.9	4.9	0	0
30 %	20	20.0	40.0	27.5	30.5	5.5	5	0
60 %	20	18.0	41.0	30.6	26.9	5.2	5	0
100 %	20	10.0	45.0	36.9	62.7	7.9	5	0

Table 3-10. Results of a Fisher's Exact test performed on the mortality of *Ceriodaphnia dubia* exposed to a sample collected from Four Mile Creek at Road C. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	b VALUE	CRITICAL VALUE	SIGNIFICANT (P = 0.05)
1 %	20	15	N
3 %	18	15	N
10 %	20	15	N
30 %	19	15	N
60 %	19	15	N
100 %	19	15	N

Table 3-11. Results of a Chi Square Goodness of Fit test and Bartlett's test for Homogeneity of Variances performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from Four Mile Creek at Road C. Males were not included in analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	9.179	33.154	52.334	33.154	9.179
OBSERVED	9	25	58	39	6

Calculated Chi-Square goodness of fit test statistic = 4.7542
Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test.

Bartletts test for homogeneity of variance

Calculated B statistic = 13.77
Table Chi-square value = 16.81 (alpha = 0.01)
Table Chi-square value = 12.59 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 18.57
Used for Chi-square table value ==> df (#groups-1) = 6

Data PASS homogeneity test at 0.01 level.

Table 3-12. Results of a one way analysis of variance test and Dunnett's test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from Four Mile Creek at Road C. Males were not included in statistical analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Ho: $\mu_1 > \mu_2 > \mu_3 > \mu_4 > \mu_5 > \mu_6 > \mu_7$

Ha: The mean number of young produced by *C. dubia* exposed to both the control is not greater than that of organisms exposed to a sample collected from Four Mile Creek at Road C.

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	6	2315.587	385.931	8.819
Within (Error)	130	5688.778	43.769	
Total	136	8004.365		

Critical F value = 2.18 (0.05,6,120)
Since F > Critical F REJECT Ho:All groups equal

Table 3-12.(continued). Results of a one way analysis of variance test and Dunnett's test performed on the number of young produced by <u>Ceriodaphnia dubia</u> exposed to a sample collected from Four Mile Creek at Road C. Males not were not included in analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

DUNNETT'S TEST - TABLE 1 OF 2 Ho:Control>Treatment

IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
control	25.389	25.389		
1%	24.000	24.000	0.638	
3%	25.300	25.300	0.041	
10%	26.850	26.850	-0.680	
30%	27.500	27.500	-0.982	
60%	30.550	30.550	-2.401	
100%	36.900	36.900	-5.356	

Bonferroni T table value = 2.32 (1 Tailed Value, P=0.05, df=120,6)

Table 3-12 (continued). Results of a one way analysis of variance test and Dunnett's test performed on the number of young produced by *Ceriodaphnia dubia* exposed to a sample collected from Four Mile Creek at Road C. Males not were not included in analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

DUNNETT'S TEST - TABLE 2 OF 2 Ho:Control>Treatment

IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
control	18			
1%	19	5.048	19.9	1.389
3%	20	4.986	19.6	0.089
10%	20	4.986	19.6	-1.461
30%	20	4.986	19.6	-2.111
60%	20	4.986	19.6	-5.161
100%	20	4.986	19.6	-11.511

Table 3-13. Summary of initial basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an F5 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (µS/cm)	Alkalinity (mg/L)	Hardness (mg/L)
Control	7.62±0.29 7.30-8.10 7	24.2± 0.4 24.0-25.0 7	5.66±0.12 5.55-5.85 7	25.8±3.7 22.3-31.2 7	2.7±1.2 1.0-5.0 7	6.0±1.6 4.0-8.0 7
0.3%	7.71±0.32 7.30-8.20 7	24.1± 0.2 24.0-24.5 7	5.65±0.11 5.52-5.78 7	26.7±2.9 23.5-30.8 7	---	---
1.0%	7.71±0.40 7.15-8.35 7	24.1± 0.2 24.0-24.5 7	5.76±0.07 5.63-5.85 7	30.2±2.0 26.9-33.6 7	---	---
3.0%	7.71±0.39 7.20-8.30 7	24.1± 0.2 24.0-24.5 7	5.86±0.06 5.75-5.93 7	38.2±5.4 32.8-47.8 7	---	---
10%	7.74±0.38 7.30-8.40 7	24.1± 0.2 24.0-24.5 7	6.02±0.05 5.94-6.07 7	58.7±4.5 52.9-66.0 7	---	---
30%	7.66±0.28 7.25-8.00 7	24.1± 0.2 24.0-24.5 7	6.25±0.06 6.16-6.36 7	106.1±41.9 111.7-130.0 7	---	---
60%	7.58±0.28 7.30-7.95 7	24.1± 0.4 24.0-24.5 7	6.38±0.12 6.35-6.49 7	222.7±3.7 222.1-232.0 7	22.6±1.2 20.0-25.0 7	51.6±1.6 48.0-54.0 7
100%			6.71 --- 1	366.0 --- 1	42.0 --- 1	81.0 --- 1

Table 3-14. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an F5 seep sample; 24 h readings. This study was performed for Westinghouse-Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH
CONTROL	7.04 ± 0.18 6.75 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	5.83 ± 0.47 5.56 - 6.88 7
0.3%	7.02 ± 0.08 6.90 - 7.10 7	24.7 ± 0.4 24.0 - 25.0 7	5.91 ± 0.16 5.77 - 6.15 7
1.0	7.06 ± 0.06 7.00 - 7.15 7	24.6 ± 0.5 24.0 - 24.5 7	5.90 ± 0.26 5.42 - 6.24 7
3.0%	7.10 ± 0.10 6.90 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	6.05 ± 0.12 5.92 - 6.28 7
10%	7.07 ± 0.06 7.00 - 7.15 7	24.6 ± 0.5 24.0 - 25.0 7	6.26 ± 0.13 6.14 - 6.48 7
30%	7.06 ± 0.05 7.00 - 7.15 7	24.6 ± 0.4 24.0 - 25.0 7	6.64 ± 0.13 6.49 - 6.84 7
60%	7.06 ± 0.05 7.00 - 7.15 7	24.6 ± 0.4 24.0 - 25.0 7	6.64 ± 0.13 6.49 - 6.84 7

Table 3-15. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an F5 seep sample. Males were not included in analysis of reproduction. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALE
control	8	16.0	32.0	24.8	49.6	7.0	0	60
0.3%	14	17.0	38.0	27.8	43.2	6.6	0	30
1 %	7	21.0	35.0	30.7	25.2	5.0	0	65
3 %	9	33.0	44.0	38.1	15.1	3.9	0	55
10 %	11	36.0	47.0	42.2	12.2	3.5	0	45
30 %	11	16.0	48.0	36.6	105.0	10.2	5	45
60 %	5	29.0	39.0	36.2	16.7	4.1	0	75

Table 3-16. Results of a Fisher's Exact test performed on the mortality of *Ceriodaphnia dubia* exposed to an F5 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	b VALUE	CRITICAL VALUE	SIGNIFICANT ($P = 0.05$)
0.3%	20	15	N
1 %	20	15	N
3 %	20	15	N
10 %	20	15	N
30 %	19	15	N
60 %	20	15	N

Table 3-17. Summary of initial basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an F6 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (µS/cm)	Alkalinity (mg/L)	Hardness (mg/L)
Control	7.62± 0.3 7.30-8.10 7	24.2± 0.4 24.0-25.0 7	5.66±0.13 5.55-5.88 7	25.8 ±3.7 22.3 -31.2 7	2.9 ±1.6 1.0 -6.0 7	6.0 ±1.6 4.0 -8.0 7
0.3%	7.69± 0.4 7.25-8.25 7	24.1± 0.2 24.0-24.5 7	5.64±0.16 5.49-5.97 7	28.4 ±5.8 23.1 -38.4 7	---	---
1.0%	7.72± 0.4 7.30-8.30 7	24.1± 0.2 24.0-24.5 7	5.64±0.15 5.41-5.87 7	27.9 ±4.9 22.7 -34.5 7	---	---
3.0%	7.74± 0.4 7.35-8.40 7	24.1± 0.4 24.0-25.0 7	5.65±0.13 5.45-5.89 7	30.9 ±4.3 25.9 -37.0 7	---	---
10%	7.61± 0.3 7.20-7.90 7	24.1± 0.4 24.0-25.0 7	5.65±0.12 5.54-5.88 7	41.6 ±3.7 37.0 -48.6 7	---	---
30%	7.61± 0.3 7.15-7.95 7	24.1± 0.4 24.0-25.0 7	5.51±0.11 5.37-5.66 7	71.1 ±14.6 43.5 -91.4 7	---	---
60%	7.58± 0.4 6.95-8.15 7	24.0± 0.0 --- 7	5.23±0.19 5.19-5.61 7	136.1 ±3.7 121.7 -154.3 7	1.8 ± 1.1 1.0 -4.0 7	19.8 ± 1.2 18.0 -22.0 7
100%			5.15 --- 1	206.0 --- 1	3.0 --- 1	30.0 --- 1

Table 3-18. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an F6 seep sample; 24 h readings. Work was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (^oC)	pH
Control	7.04 ± 0.18 6.75 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	5.83 ± 0.47 5.59 - 6.88 7
0.3%	7.07 ± 0.13 6.90 - 7.25 7	24.7 ± 0.4 24.0 - 25.0 7	5.81 ± 0.12 5.62 - 5.98 7
1.0%	7.09 ± 0.15 6.80 - 7.20 7	24.7 ± 0.4 24.0 - 25.0 7	5.79 ± 0.10 5.64 - 5.92 7
3.0%	7.09 ± 0.11 6.95 - 7.30 7	24.7 ± 0.4 24.0 - 25.0 7	5.77 ± 0.11 5.59 - 5.89 7
10%	7.05 ± 0.21 6.75 - 7.30 7	24.6 ± 0.5 24.0 - 25.0 7	5.78 ± 0.09 5.62 - 5.91 7
30%	7.09 ± 0.14 6.90 - 7.30 7	24.6 ± 0.5 24.0 - 25.0 7	5.78 ± 0.09 5.65 - 5.94 7
60%	7.09 ± 0.14 6.90 - 7.30 7	24.6 ± 0.5 24.0 - 25.0 7	5.78 ± 0.09 5.65 - 5.94 7

Table 3-19. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an F6 seep sample. One mechanical death in the control was not included in data analysis. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALE
control	19	0.0	33.0	22.4	59.1	7.7	5.3	0
0.3%	20	9.0	37.0	21.4	54.1	7.4	10	0
1 %	20	4.0	33.0	19.0	52.5	7.2	0	0
3 %	20	8.0	30.0	19.3	56.3	7.5	5	0
10 %	20	0.0	34.0	20.4	81.3	9.0	10	0
30 %	20	0.0	31.0	15.4	82.8	9.1	20	0
60 %	20	0.0	17.0	9.0	23.1	4.8	25	0

Table 3-20. Results of a Fisher's Exact test performed on the mortality of *Ceriodaphnia dubia* exposed to an F6 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	b VALUE	CRITICAL VALUE	SIGNIFICANT (P = 0.05)
0.3%	1	<0	N
1 %	18	15	N
3 %	18	13	N
10 %	1	<0	N
30 %	1	<0	N
60 %	1	0	N

Table 3-21. Results of a Chi Square Goodness of Fit test and Bartlett's test for Homogeneity of Variances performed on the number of young produced by *Ceriodaphnia dubia* exposed to an F6 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	9.313	33.638	53.098	33.638	9.313
OBSERVED	11	30	55	35	8

Calculated Chi-Square goodness of fit test statistic = 1.0074
Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test.

Bartletts test for homogeneity of variance

Calculated B statistic = 8.54
Table Chi-square value = 16.81 (alpha = 0.01)
Table Chi-square value = 12.59 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 18.86
Used for Chi-square table value ==> df (#groups-1) = 6

Data PASS homogeneity test at 0.01 level.

Table 3-22. Results of a one way analysis of variance test and Dunnett's test performed on the number of young produced by *Ceriodaphnia dubia* exposed to an F6 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Ho: $\mu_1 > \mu_2 > \mu_3 > \mu_4 > \mu_5 > \mu_6 > \mu_7$

Ha: The mean number of young produced by *C. dubia* exposed to both the control is not greater than that of organisms exposed to an F6 seep sample.

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	6	2490.293	415.049	7.100
Within (Error)	132	7716.671	58.460	
Total	138	10206.964		

Critical F value = 2.18 (0.05,6,120)
Since F > Critical F REJECT Ho:All groups equal

Table 3-22.(continued). Results of a one way analysis of variance test and Dunnett's test performed on the number of young produced by *Ceriodaphnia dubia* exposed to an F6 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

DUNNETT'S TEST - TABLE 1 OF 2 Ho:Control>Treatment

IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
control	22.368	22.368		
0.3%	21.350	21.350	0.416	
1%	18.950	18.950	1.396	
3%	19.300	19.300	1.253	
10%	20.400	20.400	0.804	
30%	15.400	15.400	2.845	*
60%	9.050	9.050	5.437	*

Bonferroni T table value = 2.32 (1 Tailed Value, P=0.05, df=120,6)

Table 3-22 (continued). Results of a one way analysis of variance test and Dunnett's test performed on the number of young produced by <u>Ceriodaphnia dubia</u> exposed to an F6 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

DUNNETT'S TEST - TABLE 2 OF 2 Ho:Control>Treatment

IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
control	19			
0.3%	20	5.683	25.4	1.018
1%	20	5.683	25.4	3.418
3%	20	5.683	25.4	3.068
10%	20	5.683	25.4	1.968
30%	20	5.683	25.4	6.968
60%	20	5.683	25.4	13.318

Table 3-23. Summary of initial basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an H4 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (µS/cm)	Alkalinity (mg/L)	Hardness (mg/L)
Control	7.62±0.29 7.30-8.10 7	24.1± 0.4 24.0-25.0 7	5.66±0.12 5.55-5.85 7	25.4 ±3.2 22.3 -31.2 7	2.7 ±1.2 1.0 -5.0 7	6.0 ±1.6 4.0 -8.0 7
1.0%	7.59±0.29 7.15-7.85 7	24.1± 0.2 24.0-24.5 7	5.71±0.06 5.60-5.80 7	26.9 ±3.3 22.5 -32.3 7	---	---
3.0%	7.62±0.21 7.35-7.85 7	24.1± 0.2 24.0-24.5 7	5.86±0.15 5.54-5.96 7	30.6 ±4.1 25.2 -36.2 7	---	---
10%	7.70±0.40 7.30-8.40 7	24.1± 0.2 24.0-24.5 7	6.11±0.05 6.05-6.17 7	37.6 ±2.1 34.6 -40.9 7	---	---
30%	7.65±0.22 7.30-8.00 7	24.1± 0.2 24.0-24.5 7	6.49±0.06 6.41-6.60 7	69.6 ±5.5 62.1 -78.8 7	---	---
60%	7.64±0.30 7.20-8.00 7	24.1± 0.2 24.0-24.5 7	6.84±0.07 6.77-6.94 7	116.1 ±6.3 108.8 -128.0 7	---	---
100%	7.60±0.36 6.95-8.00	24.1± 0.4 24.0-24.5 7	6.96±0.12 6.81-7.11 7	184.6 ±3.2 176.8 -195.8 7	48.3 ± 1.2 47.0 -50.0 7	3.4 ±1.6 4.0 -8.0 7

Table 3-24. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an H4 seep sample; 24 h readings. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperrature (°C)	pH
Control	7.04 ± 0.18 6.75 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	5.83 ± 0.47 5.59 - 6.88 7
1.0%	7.13 ± 0.14 7.00 - 7.40 7	24.5 ± 0.5 24.0 - 25.0 7	6.23 ± 0.21 5.94 - 6.54 7
3.0	7.09 ± 0.08 6.95 - 7.20 7	24.5 ± 0.5 24.0 - 25.0 7	6.28 ± 0.14 6.11 - 6.50 7
10%	7.13 ± 0.09 6.95 - 7.20 7	24.5 ± 0.5 24.0 - 25.0 7	6.45 ± 0.10 6.37 - 6.61 7
30%	7.07 ± 0.10 6.90 - 7.20 7	24.5 ± 0.5 6.71 - 6.97 7	6.86 ± 0.08 6.71 - 6.97 7
60%	7.10 ± 0.12 6.85 - 7.20 7	24.5 ± 0.5 24.0 - 25.0 7	7.28 ± 0.05 7.19 - 7.33 7
100%	7.10 ± 0.12 6.85 - 7.20 7	24.5 ± 0.5 24.0 - 2505 7	7.28 ± 0.05 7.19 - 7.33 7

Table 3-25. Summary statistics for a _Ceriodaphnia dubia_ 7-day chronic static renewal toxicity test performed on an H4 seep sample. Males were not included in analysis of reproduction. One mechanical death in the 10% exposure was not included in data analysis. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALE
control	12	13.0	42.0	27.5	62.1	7.9	0	40
1 %	6	20.0	33.0	27.7	30.3	5.5	0	70
3 %	8	20.0	39.0	30.4	50.8	7.1	0	60
10 %	6	22.0	40.0	33.5	37.1	6.1	0	68.4
30 %	5	26.0	38.0	35.2	26.7	5.2	0	75
60 %	7	19.0	38.0	29.8	59.1	7.7	0	65
100 %	NA	NA	NA	NA	NA	NA	100	NA

Table 3-26. Results of a Fisher's Exact test performed on the mortality of <u>Ceriodaphnia dubia</u> exposed to an H4 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	b VALUE	CRITICAL VALUE	SIGNIFICANT (P = 0.05)
1 %	20	15	N
3 %	20	15	N
10 %	19	15	N
30 %	20	15	N
60 %	20	15	N
100 %	0	15	Y

Table 3-27. Summary of initial basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on a H6 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (µS/cm)	Alkalinity (mg/L)	Hardness (mg/L)
Control	7.62±0.29 7.30-8.10 7	24.2± 0.4 24.0-25.0 7	5.66±0.12 5.55-5.85 7	25.8 ±3.7 22.3 -31.2 7	2.7 ±1.2 1.0 -5.0 7	6.0 ±1.6 4.0 -8.0 7
1.0%	7.64±0.33 7.20-8.15 7	24.1± 0.2 24.0-24.5 7	5.75±0.10 5.65-5.90 7	27.4 ±3.5 23.5 -32.6 7	---	---
3.0%	7.64±0.39 7.30-8.35 7	24.1± 0.2 24.0-24.5 7	5.89±0.08 5.78-6.00 7	29.0 ±2.5 26.2 -33.2 7	---	---
10%	7.66±0.38 7.20-8.30 7	24.1± 0.2 24.0-24.5 7	6.14±0.06 6.05-6.19 7	44.0 ±7.1 38.9 -58.9 7	---	---
30%	7.71±0.31 7.30-8.30 7	24.1± 0.2 24.0-24.5 7	6.48±0.06 6.36-6.54 7	69.6 ±5.4 65.2 -90.0 7	---	---
60%	7.59±0.31 7.20-7.90 7	24.1± 0.2 24.0-24.5 7	6.84±0.07 6.73-6.94 7	117.7 ± 5.2 110.6 -124.3 7	---	---
100%	7.57±0.40 7.00-8.10 7	24.0± 0.0 --- 7	7.11±0.12 7.00-7.11 7	179.0 ±3.7 171.2 -189.1 7	39.7 ± 1.2 39.0 -40.0 7	5.0 ±0.8 4.0 -6.0 7

Table 3-28. Summary of basic water chemistry for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an H6 seep sample; 24 h readings. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Values are the mean, standard deviation, range and number of observations. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH
Control	7.04 ± 0.18 6.75 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	5.83 ± 0.47 5.59 - 6.88 7
1.0%	7.11 ± 0.13 7.00 - 7.35 7	24.7 ± 0.4 24.0 - 25.0 7	6.20 ± 0.22 5.85 - 6.50 7
3.0%	7.12 ± 0.13 6.90 - 7.30 7	24.7 ± 0.4 24.0 - 25.0 7	6.22 ± 0.20 5.96 - 6.50 7
10%	7.09 ± 0.11 6.95 - 7.30 7	24.6 ± 0.4 24.0 - 25.0 7	6.41 ± 0.12 6.27 - 6.63 7
30%	7.15 ± 0.15 6.90 - 7.35 7	24.6 ± 0.5 24.0 - 25.0 7	6.79 ± 0.10 6.70 - 6.99 7
60%	7.09 ± 0.12 6.85 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	7.17 ± 0.05 7.09 - 7.25 7
100%	7.09 ± 0.12 6.85 - 7.20 7	24.6 ± 0.5 24.0 - 25.0 7	7.17 ± 0.05 7.09 - 7.25 7

Table 3-29. Summary statistics for a *Ceriodaphnia dubia* 7-day chronic static renewal toxicity test performed on an H6 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	N	MIN	MAX	MEAN	VARIANCE	SD	% MORTALITY	% MALE
control	20	12.0	36.0	24.8	50.8	7.1	0	0
1 %	20	0.0	41.0	30.2	118.5	10.9	10	0
3 %	20	12.0	39.0	28.8	61.5	7.8	0	0
10 %	20	26.0	45.0	35.7	31.5	5.6	0	0
30 %	20	34.0	50.0	42.1	15.8	4.0	0	0
60 %	20	27.0	52.0	41.2	28.1	5.3	0	0
100 %	20	21.0	33.0	25.0	8.8	3.0	5	0

Table 3-30. Results of a Fisher's Exact test performed on the mortality of *Ceriodaphnia dubia* exposed to an H6 seep sample. This study was performed for Westinghouse Savannah River Company, Savannah River Laboratory, Aiken, SC. Four Mile Creek water served as the control and diluent. 30 November - 7 December 1990.

IDENTIFICATION	b VALUE	CRITICAL VALUE	SIGNIFICANT ($P = 0.05$)
1 %	18	15	N
3 %	20	15	N
10 %	20	15	N
30 %	20	15	N
60 %	20	15	N
100 %	20	15	N

Table 5-1. A summary of NOEC and LOEC values determined from statistical analyses performed on data generated during *Ceriodaphnia dubia* 7-d static renewal chronic toxicity tests.

Sample Location	NOEC	LOEC
Road A-7	60%	>60%
Road C	100%	na
F5	60%	>60%
F6	10%	30%
H4	60%	100%
H6	100%	na

na = not applicable

APPENDIX C

July 1991 Toxicity Test (from Normandeau, 1991)

Summary Report:
Results of a 7-d Static Renewal
Chronic Toxicity Test Performed on
A Water Sample from Four Mile Creek

Performed for:

Westinghouse Savannah River Co.
Savannah River Site
Aiken, SC

Sample Location: Road A-7

Prepared by:

Normandeau Associates, Inc.
P.O. Box 1393
Aiken, South Carolina 29802

16 August 1991

NAI Project No: 12486.01

Table 1. SUMMARY OF TEST CONDITIONS: *Ceriodaphnia dubia*[a]
7-d Static Renewal Chronic Toxicity Test

1.	Test temperature	25 ± 1 °C
2.	Light quality	Ambient illumination
3.	Light intensity	Ambient laboratory levels
4.	Photoperiod	16L:8D
5.	Test vessel size	30-mL
6.	Number of organisms per vessel	1
7.	Number of replicates	20 per concentration
8.	Age of organisms	≤ 24 h
9.	Total number of organisms per concentration	20
10.	Aeration	None, unless DO is ≤ 40% saturation
11.	Diluent	Four Mile Creek @ Road E-1
12.	Test duration	7 d
13.	Effect measured	Mortality, young production
14.	Chemical parameters measured on diluent and highest test concentration	DO, °C, alkalinity, hardness, pH, conductivity (new solutions); TRC (on each undiluted effluent sample)
15.	Chemical parameters measured on all test solutions	DO, °C, pH, conductivity (new solutions); DO, °C, pH (daily on old solutions)

[a]Adapted from Weber et al. 1989.

Table 2. Results of a 7-d *Ceriodaphnia dubia* static renewal toxicity test conducted on Four Mile Creek water collected at Road A-7. This study was performed for Westinghouse Savannah River Co. Water collected from Road E-1 served as the control and diluent for this test. DMW served as the laboratory control. 18-25 July 1991.

Concentration (%)	Mortality[a] (%)	Mean # young/female
DMW Control	10	20.3
E-1 Control	100[b]	NA
3.0	100[b]	NA
10	75[b]	NA
30	60[b]	NA
60	0	35.7
100	0	27.4

[a]Twenty organisms were initially exposed to each concentration.
[b]Mortality was determined to be significant by Fisher's Exact test.

NOEL = 100% effluent LOEL = >100% effluent

Table 3. Summary of initial basic water chemistry for a 7-d Ceriodaphnia dubia chronic static renewal toxicity test conducted on water from Four Mile Creek at Road A-7. Values are the mean, standard deviation, range and number of observations. Water collected from Road E-1 served as the control and diluent. DMW served as the laboratory control. 18-25 July 1991.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH	Conductivity (mS/cm)	Alkalinity (mg/L)[a]	Hardness (mg/L)[a]	Total Residual Chlorine (mg/L)
DMW	7.57 ± 0.33 (7.26-8.22) n = 7	24.5 ± 0.6 (24.0-25.6) n = 7	7.88 ± 0.11 (7.70-8.00) n = 7	0.193 ± 0.007 (0.180-0.200) n = 7	63.6 ± 1.5 (62.0-65.0) n = 7	80.6 ± 1.1 (80.0-83.0) n = 7	--
E-1	7.56 ± 0.40 (6.93-8.16) n = 7	24.6 ± 0.7 (24.0-25.9) n = 7	5.69 ± 0.16 (5.40-5.90) n = 7	0.022 ± 0.003 (0.020-0.025) n = 7	4.45 ± 0.93 (2.00-6.00) n = 6	5.00 ± 0.89 (4.00-6.00) n = 6	<0.02 (<0.02-<0.02) n = 3
3	7.56 ± 0.37 (7.15-8.12) n = 7	24.6 ± 0.5 (24.0-25.1) n = 7	5.51 ± 0.28 (5.10-5.75) n = 7	0.024 ± 0.002 (0.020-0.025) n = 7	---	---	--
10	7.54 ± 0.34 (7.14-7.91) n = 7	24.6 ± 0.5 (24.1-25.5) n = 7	5.75 ± 0.26 (5.20-6.00) n = 7	0.025 ± 0.003 (0.020-0.030) n = 7	---	---	--
30	7.51 ± 0.36 (6.91-7.83) n = 7	24.4 ± 0.4 (24.0-25.2) n = 7	5.86 ±0.22 (5.50-6.05) n = 7	0.029 ± 0.003 (0.025-0.035) n = 7	---	---	--
60	7.49 ± 0.34 (7.07-7.86) n = 7	24.7 ± 0.3 (24.1-25.1) n = 7	6.09 ±0.20 (5.80-6.20) n = 7	0.039 ± 0.006 (0.030-0.045) n = 7	---	---	--
100	7.52 ± 0.32 (6.97-7.97) n = 7	24.8 ± 0.4 (24.2-25.4) n = 7	6.29 ± 0.14 (6.10-6.40) n = 7	0.095 ± 0.113 (0.030-0.350) n = 7	6.29 ± 1.70 (4.0-8.0) n = 7	9.86 ± 1.21 (8.0-12.0) n = 7	0.02 ± 0.006 (0.02-0.03) n = 3

[a]mg/L as $CaCO_3$

Table 4. Summary of basic water chemistry for a 7-d *Ceriodaphnia dubia* chronic static renewal toxicity test; 24-h readings, conducted on water from Four Mile Creek at Road A-7. Values are the mean, standard deviation, range and number of observations. Water collected at Road E-1 served as the control and diluent. DMW served as the laboratory control. 18-25 July 1991.

Concentration (%)	Dissolved Oxygen (mg/L)	Temperature (°C)	pH
DMW	7.48 ± 0.30 (7.03-7.82) n = 7	24.5 ± 0.6 (24.0-25.4) n = 7	7.93 ± 0.11 (7.80-8.05) n = 7
E-1	7.41 ± 0.27 (7.04-7.85) n = 7	24.6 ± 0.4 (24.0-25.0) n = 7	6.36 ± 0.58 (5.20-6.85) n = 7
3	7.45 ± 0.31 (7.07-7.86) n = 7	24.7 ± 0.2 (24.5-24.9) n = 7	6.05 ± 0.42 (5.30-6.45) n = 7
10	7.48 ± 0.24 (7.21-7.85) n = 7	24.9 ± 0.3 (24.6-25.5) n = 7	6.09 ± 0.26 (5.60-6.40) n = 7
30	7.41 ± 0.28 (7.11-7.89) n = 7	24.8 ± 0.4 (24.0-25.4) n = 7	6.22 ± 0.29 (5.75-6.50) n = 7
60	7.38 ± 0.35 (6.91-7.97) n = 7	24.8 ± 0.4 (24.4-25.6) n = 7	6.40 ± 0.30 (6.00-6.70) n = 7
100	7.42 ± 0.21 (7.15-7.72) n = 7	24.8 ± 0.4 (24.4-25.6) n = 7	6.66 ± 0.24 (6.30-6.90) n = 7

APPENDIX D

1993 Toxicity Tests (from Shealy Environmental Services, Inc., 1993a, 1993b)

7-DAY CHRONIC TOXICITY TESTS
PERFORMED ON
FMB AND FSP SAMPLES FROM
WESTINGHOUSE SAVANNAH RIVER COMPANY

SEPTEMBER 14 - 20, 1993

Subcontract No.: 7901-222-SC-BDDM

Document No.: 7901-222-SC-BDFG

Submitted To:

WESTINGHOUSE SAVANNAH RIVER COMPANY

Aiken, South Carolina

Prepared By:

SHEALY ENVIRONMENTAL SERVICES, INC.
106 Vantage Point Drive
Cayce, South Carolina 29033

SCDHEC Laboratory Certification No. 26103

Laura F. Shealy, Vice President - Toxicological Services

Table 1. Summary of Effluent Toxicity Test Conditions for the *Ceriodaphnia* Survival and Reproduction Test

1.	Test Type:	Static Renewal
2.	Temperature (^{o}C):	25 ± 1^{o}C
3.	Light Quality:	Ambient laboratory illumination
4.	Light Intensity:	10-20 uE/m^{2}/s (50-100 ft-c) (ambient laboratory levels)
5.	Photoperiod:	16 h light, 8 h darkness
6.	Test chamber size:	30 mL
7.	Test solution volume	15 mL
8.	Renewal of test concentrations:	Daily
9.	Age of test organism	Less than 24 h; and all released within a 12-h period.
10.	No. neonates per test chamber:	1
11.	No. Replicate test chambers per concentration:	10
12.	No neonates per test concentration:	10
13.	Feeding regime:	Feed 0.1 mL of YCT and algae suspension per test chamber daily.
14.	Aeration:	None
15.	Dilution water:	Receiving water
16.	Effluent concentrations:	5 concentrations and a control.

Table 1. **Summary of Effluent Toxicity Test Conditions for the *Ceriodaphnia* Survival and Reproduction Test**

1.	Test Type:	Static Renewal
2.	Temperature (^oC):	25 $\pm$ 1^oC
3.	Light Quality:	Ambient laboratory illumination
4.	Light Intensity:	10-20 uE/m^2/s (50-100 ft-c) (ambient laboratory levels)
5.	Photoperiod:	16 h light, 8 h darkness
6.	Test chamber size:	30 mL
7.	Test solution volume	15 mL
8.	Renewal of test concentrations:	Daily
9.	Age of test organism	Less than 24 h; and all released within a 12-h period.
10.	No. neonates per test chamber:	1
11.	No. Replicate test chambers per concentration:	10
12.	No neonates per test concentration:	10
13.	Feeding regime:	Feed 0.1 mL of YCT and algae suspension per test chamber daily.
14.	Aeration:	None
15.	Dilution water:	Receiving water
16.	Effluent concentrations:	5 concentrations and a control.

Table 1. Summary of Effluent Toxicity Test Conditions for the *Ceriodaphnia* Survival and Reproduction Test

1.	Test Type:	Static Renewal
2.	Temperature (°C):	25 ± 1°C
3.	Light Quality:	Ambient laboratory illumination
4.	Light Intensity:	10-20 uE/m^2/s (50-100 ft-c) (ambient laboratory levels)
5.	Photoperiod:	16 h light, 8 h darkness
6.	Test chamber size:	30 mL
7.	Test solution volume	15 mL
8.	Renewal of test concentrations:	Daily
9.	Age of test organism	Less than 24 h; and all released within a 12-h period.
10.	No. neonates per test chamber:	1
11.	No. Replicate test chambers per concentration:	10
12.	No neonates per test concentration:	10
13.	Feeding regime:	Feed 0.1 mL of YCT and algae suspension per test chamber daily.
14.	Aeration:	None
15.	Dilution water:	Receiving water
16.	Effluent concentrations:	5 concentrations and a control.

Table 1. Summary of Effluent Toxicity Test Conditions for the *Ceriodaphnia* Survival and Reproduction Test (Continued)

17.	Dilution factor:	0.3 or 0.5
18.	Test duration:	Until 60% of control females have three broods (6 - 7 days).
19.	Endpoints:	Survival and reproduction
20.	Test Acceptability:	80% or greater survival and an average of 15 or more young/surviving female in the control solutions. At least 60% of surviving females in control should have produced their third brood.
21.	Sampling requirement:	Three samples were collected (Monday, Wednesday, and Friday)

SECTION 4.0. RESULTS

Results for the Ceriodaphnia chronic toxicity tests performed for the FSP and FMB samples September 14 - 20, 1993, are summarized below in Table 2 with individual data reports given in Appendix B. Copies of benchsheets for these tests are given in Appendix C.

Table 2: Summary of Results from Chronic Ceriodaphnia Toxicitiy Tests Performed for WESTINGHOUSE SAVANNAH RIVER COMPANY's FSP and FMB samples collected the week of September 13, 1993.

Sample Location	NOEC (% Sample)	LOEC (% Sample)	ChV (% Sample)
FSP-012	10	30	13.3
FSP-032	30	100	54.8
FSP-047	30	100	54.8
FSP-204	30	100	54.8
FSP-256	30	100	54.8
FMB Road 4	100	Not Observed	Not Observed (>100%)
FMB Road C	100	Not Observed	Not Observed (>100%)
FMB Road C-4	100	Not Observed	Not Observed (>100%)
FMB Road A-7	100	Not Observed	Not Observed (>100%)

Results from these tests indicated that the FMB samples were not acutely or chronically toxic to the test organism during the sampling period. No Observed Effect Concentrations (NOEC's) for these tests were all 100% sample. The results for the FSP samples; however, revealed some chronic toxicity to the Ceriodaphnia. NOEC's for these samples were all 54.8% except for the FSP-012 sample which had an NOEC of 13.3%.

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Sample Location FMB - Road C-4

Date Reported: 09/27/93
Date/Time Started: 09/14/93 / 1800
Date/Time Ended: 09/21/93 / 1545

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/13/93 / 1105	45004	09/14/93, 09/15/93
2	09/15/93 / 0900	45128	09/16/93, 09/17/93
3	09/17/93 / 1045	45257	09/18/93, 09/19/93, 09/20/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
0%	20.9	0
6.25%	21.4	0
12.5%	21.0	10
25.0%	18.0	10
50.0%	17.8	10
100%	18.5	0

Comments:

Judy L. Ford

QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy

Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test — No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 2.42
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 4.98
(Homogeneous Variances)

Dunnett's Critical T Values
Critical Value = 2.31

Concentration	T Statistic
Control	
6.25	-0.174
12.5	-0.035
25.0	1.01
50.0	1.08
100.0	0.833

NOEC (No Observed Effect Concentration) 100%
LOEC (Lowest Observed Effect Concentration) Not Observed
ChV (Chronic Value) >100%

REPRODUCTION/MORTALITY DATA
(FMB-Road C-4)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	4	0	6	6	5	6	6	4	2
5	5	10	5	9	11	10	8	7	6	9
6	5	4	10	11	12	11	9	12	8	4
7										
TOTAL	14	18	15	26	29	26	23	25	18	15
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X} =$ 20.9

Treatment 1 (6.25%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	6	3	5	3	5	3	6	6	2	7
5	6	10	8	13	10	10	10	8	4	10
6	2	0	12	6	14	14	11	9	11	0
7										
TOTAL	14	13	25	22	29	27	27	23	17	17
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X} =$ 21.4

REPRODUCTION/MORTALITY DATA CONTINUED
(FMB-Road C-4)

Treatment 2 (12.5%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	7	3	7	6	3	3	D/0	3	5
5	9	12	9	8	10	6	8	_	9	8
6	2	11	5	10	11	13	10	_	13	10
7										
TOTAL	20	30	17	25	27	22	21	0	25	23
ADULT	L	L	D	L	L	L	L	D	L	L

L=Live
D=Dead $\bar{X} =$ 21.0

Treatment 3 (25%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	D/0	0	0	0	0	0	0	0
3	0	0	_	0	0	0	0	0	0	0
4	5	7	_	4	5	3	4	5	3	4
5	8	10	_	8	8	4	6	6	10	10
6	0	10	_	12	10	6	12	8	12	0
7										
TOTAL	13	27	0	24	23	13	22	19	25	14
ADULT	L	L	D	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X} =$ 18.0

REPRODUCTION/MORTALITY DATA CONTINUED
(FMB-Road C-4)

Treatment 4 (50%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	3	3	6	5	6	3	4	6	6
5	7	3	5	8	6	7	9	7	5	10
6	D/0	4	6	13	8	10	11	7	6	0
7										
TOTAL	11	10	14	27	19	23	23	18	17	16
ADULT	D	L	L	L	L	L	L	L	L	L

L=Live

D=Dead $\bar{X}$ = 17.8

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	6	5	3	6	7	5	6	4	5
5	9	7	5	11	8	6	5	8	6	6
6	0	4	6	12	10	6	10	7	8	0
7										
TOTAL	13	17	16	26	24	19	20	21	18	11
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live

D=Dead $\bar{X}$ = 18.5

WATER CHEMISTRY DATA
(FMB - Road C-4)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	25.8		25.5		24.3		25.6		24.5		24.3				
0%	D.O. (ppm)	7.80	9.10	9.10	8.50	8.60	8.50	10.60	8.20	8.20	8.60	8.60	8.50			
	pH (SU)	6.90	6.72	6.70	6.88	6.97	7.06	6.89	6.72	6.78	6.86	6.87	6.86			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.9		26.0		24.1		24.9		24.3		24.2				
6.25%	D.O. (ppm)	8.00	9.30	9.40	8.30	8.60	8.20	9.00	8.30	8.20	8.60	8.80	8.80			
	pH (SU)	6.83	6.70	6.75	7.15	7.19	6.28	6.33	6.71	6.75	6.91	6.96	6.88			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.0		25.6		25.9		25.4		24.3		24.3				
25%	D.O. (ppm)	8.10	9.40	9.70	8.50	8.80	8.10	8.70	8.40	8.40	8.80	8.80	8.50			
	pH (SU)	6.92	6.84	6.85	7.19	7.21	6.48	6.62	6.80	6.90	7.08	7.23	6.91			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.2		24.8		24.7		25.1		25.0		24.5				
100%	D.O. (ppm)	8.60	9.70	10.70	8.60	9.60	8.10	8.60	8.30	8.80	8.80	8.80	8.20			
	pH (SU)	7.05	6.91	6.84	7.23	7.11	6.73	6.86	7.04	6.90	7.34	7.32	7.01			

		100% Effluent		
Sample ID:	Control	45004	45128	45257
Alkalinity (mg/l)	71	14	18	15
Hardness (mg/l)	88	26	21	38
Conductivity (umhos/cm)	233	96	88	84

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility: WESTINGHOUSE SAVANNAH RIVER COMPANY

Sample Location: FMB - Road C

Date Reported: 09/27/93

Date/Time Started: 09/14/93 / 1805

Date/Time Ended: 09/21/93 / 1600

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/13/93 / 1010	45005	09/14/93, 09/15/93
2	09/15/93 / 0945	45124	09/16/93, 09/17/93
3	09/17/93 / 0971	45257	09/18/93, 09/19/93, 09/20/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
0%	20.5	10
6.25%	22.3	0
12.5%	19.8	10
25.0%	20.3	0
50.0%	18.5	0
100%	16.1	0

Comments:

Judy L. Ford

QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy

Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 7.30
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 2.63
(Homogeneous Variances)

Dunnett's Critical T Values
Critical Value = 2.31

Concentration	T Statistic
Control	
6.25	-0.590
12.5	0.230
25.0	0.066
50.0	0.660
100.0	1.45

NOEC (No Observed Effect Concentration) 100%
LOEC (Lowest Observed Effect Concentration) Not Observed
ChV (Chronic Value) >100%

REPRODUCTION/MORTALITY DATA
(FMB-Road C)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	4	6	4	3	4	3	2	3	4
5	9	7	8	7	8	8	7	7	7	6
6	0	14	12	12	D/1	15	14	13	13	0
7										
TOTAL	13	25	26	23	12	27	24	22	23	10
ADULT	L	L	L	L	D	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 20.5

Treatment 1 (6.25%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	2	3	3	2	5	3	4	6	5	3
5	7	3	10	7	11	9	5	7	13	10
6	1	10	12	12	14	15	16	16	11	0
7										
TOTAL	10	16	23	21	30	27	25	29	29	13
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 22.3

REPRODUCTION/MORTALITY DATA CONTINUED
(FMB-Road C)

Treatment 2 (12.5%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	5	5	3	5	5	5	3	4	4
5	7	10	9	10	7	9	5	D/0	8	2
6	0	13	0	15	16	14	13	_	9	8
7										
TOTAL	11	28	14	28	28	28	23	3	21	14
ADULT	L	L	L	L	L	L	L	D	L	L

L=Live
D=Dead $\bar{X}$ = 19.8

Treatment 3 (25%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	3	0	0	0	0	0	0	0	0
4	5	4	5	3	4	4	4	3	3	4
5	5	3	10	6	7	4	7	7	8	7
6	2	11	0	14	14	14	17	10	14	1
7										
TOTAL	12	21	15	23	25	22	28	20	25	12
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 20.3

REPRODUCTION/MORTALITY DATA CONTINUED
(FMB-Road C)

Treatment 4 (50%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	5	4	4	4	5	5	6	3	4	4
5	5	6	6	5	7	7	8	4	9	7
6	0	0	10	8	9	13	11	12	14	0
7										
TOTAL	10	10	20	17	21	25	25	19	27	11
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 18.5

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	2	4	5	3	2	3	4	2	4	5
5	3	4	4	5	9	7	6	7	3	7
6	0	0	10	8	10	9	10	13	12	0
7										
TOTAL	5	8	19	16	21	19	20	22	19	12
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 16.1

WATER CHEMISTRY DATA
(FMB - Road C)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.6		25.9		25.5		25.3		24.5		24.1				
0%	D.O. (ppm)	8.00	8.60	8.20	8.60	8.50	8.60	8.50	8.00	7.90	8.00	7.90	8.60			
	pH (SU)	6.80	7.01	6.98	7.10	7.14	6.91	6.99	6.80	6.78	6.80	6.91	6.71			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.9		24.9		25.8		25.1		24.4		24.2				
6.25%	D.O. (ppm)	8.00	8.60	8.30	9.00	8.80	8.70	8.70	8.00	8.00	8.00	8.20	8.90			
	pH (SU)	6.43	6.67	6.63	6.82	7.02	6.40	6.52	6.97	7.00	6.92	7.06	6.63			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.9		24.2		24.7		24.7		24.0		24.3				
25%	D.O. (ppm)	8.00	8.90	8.40	9.00	9.00	8.80	8.80	8.00	8.00	8.00	8.20	8.90			
	pH (SU)	6.30	6.70	6.67	6.69	6.72	6.19	6.26	7.17	7.14	7.21	6.94	6.73			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.7		25.3		25.1		25.8		25.2		24.0				
100%	D.O. (ppm)	7.80	8.60	8.20	8.50	9.80	9.00	10.00	8.00	8.10	8.00	8.40	8.40			
	pH (SU)	6.77	6.75	6.74	7.07	6.62	7.06	6.80	7.34	7.13	7.21	7.02	7.00			

100% Effluent

Sample ID:	Control	45005	45124	45253
Alkalinity (mg/l)	71	19	30	32
Hardness (mg/l)	88	24	13	24
Conductivity (umhos/cm)	233	88	82	77

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Sample Location FMB - Road A-7

Date Reported: 09/27/93
Date/Time Started: 09/14/93 / 1825
Date/Time Ended: 09/21/93 / 1630

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/13/93 / 0955	45006	09/14/93, 09/15/93
2	09/15/93 / 0940	45126	09/16/93, 09/17/93
3	09/17/93 / 1125	45255 #	09/18/93, 09/19/93, 09/20/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
0%	20.0	0
6.25%	20.4	0
12.5%	16.8	0
25.0%	15.0	0
50.0%	15.5	20
100%	19.5	0

Comments:

Judy L. Ford

QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy

Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 3.14
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 7.31
(Homogeneous Variances)

Dunnett's Critical T Values
Critical Value = 2.31

Concentration	T Statistic
Control	
6.25	-0.130
12.5	1.04
25.0	1.62
50.0	1.46
100.0	0.162

NOEC (No Observed Effect Concentration) 100%
LOEC (Lowest Observed Effect Concentration) Not Observed
ChV (Chronic Value) >100%

REPRODUCTION/MORTALITY DATA
(FMB-Road A-7)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	2	5	7	6	6	5	5	6	6	4
5	5	3	0	9	4	6	6	7	0	4
6	5	8	16	13	11	16	6	10	11	8
7										
TOTAL	12	16	23	28	21	27	17	23	17	16
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 20.0

Treatment 1 (6.25%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	3	4	7	6	6	5	3	4	5	4
5	10	7	5	9	8	9	6	11	8	4
6	7	14	2	12	8	12	2	13	10	0
7										
TOTAL	20	25	14	27	22	26	11	28	23	8
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 20.4

REPRODUCTION/MORTALITY DATA CONTINUED
(FMB-Road A-7)

Treatment 2 (12.5%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	2	4	5	5	5	6	7	5	6	3
5	5	9	10	4	7	6	9	8	D/0	10
6	0	6	8	10	12	9	4	0	_	3
7										
TOTAL	7	19	23	19	24	21	20	13	6	16
ADULT	L	L	L	L	L	L	L	L	D	L

L=Live
D=Dead $\bar{X}$ = 16.8

Treatment 3 (25%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	3	5	4	5	5	3	6	7	5
5	10	6	5	0	4	9	7	6	6	7
6	2	3	12	2	3	9	0	10	2	0
7										
TOTAL	16	12	22	6	12	23	10	22	15	12
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 15.0

REPRODUCTION/MORTALITY DATA CONTINUED
(FMB-Road A-7)

Treatment 4 (50%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	D/0	5	4	D/0	6	5	4	4	5	6
5	_	7	9	_	11	12	9	11	10	8
6	_	2	0	_	10	13	0	0	13	1
7										
TOTAL	0	14	13	0	27	30	13	15	28	15
ADULT	D	L	L	D	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 15.5

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	7	6	4	5	6	5	4	3	3
5	4	9	4	9	8	12	8	9	13	7
6	3	0	9	10	4	11	4	11	6	7
7										
TOTAL	11	16	19	23	17	29	17	24	22	17
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 19.5

WATER CHEMISTRY DATA
(FMB - Road A-7)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.5		24.4		24.4		24.8		24.2		24.3				
0%	D.O. (ppm)	8.00	8.50	8.30	8.60	8.50	8.20	8.60	8.10	8.20	8.00	8.40	8.50			
	pH (SU)	6.76	7.05	7.01	7.30	7.27	6.94	6.83	6.86	6.73	6.91	6.99	7.04			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.4		25.1		25.3		24.5		24.1		24.5				
6.25%	D.O. (ppm)	8.00	8.90	8.70	8.90	8.70	8.60	8.90	8.40	8.20	8.20	8.40	8.50			
	pH (SU)	6.95	6.71	6.61	7.13	6.99	6.78	6.83	6.96	7.00	7.11	6.98	6.89			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.9		24.3		25.5		25.4		24.5		24.6				
25%	D.O. (ppm)	8.20	9.00	8.90	8.90	8.80	8.50	9.10	8.30	8.20	8.40	8.30	8.50			
	pH (SU)	7.02	6.36	6.33	6.72	6.52	6.91	6.91	7.05	7.08	7.19	7.10	6.57			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.0		25.0		25.4		25.8		24.0		24.2				
100%	D.O. (ppm)	8.80	8.70	10.20	8.90	9.50	8.30	10.40	8.30	8.80	8.20	8.60	8.10			
	pH (SU)	7.16	7.01	7.01	6.95	6.94	7.04	6.92	7.17	7.02	7.14	6.91	6.91			

100% Effluent

Sample ID:	Control	45006	45126	45255
Alkalinity (mg/l)	71	29	14	13
Hardness (mg/l)	88	16	15	35
Conductivity (umhos/cm)	233	75	75	71

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Sample Location FMB - Road 4

Date Reported: 09/27/93
Date/Time Started: 09/14/93 / 1800
Date/Time Ended: 09/21/93 / 1600

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/13/93 / 1130	45002	09/14/93, 09/15/93
2	09/15/93 / 0940	45125	09/16/93, 09/17/93
3	09/17/93 / 1140	45254	09/18/93, 09/19/93, 09/20/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
0%	23.9	10
6.25%	20.3	20
12.5%	24.6	0
25.0%	18.3	10
50.0%	18.2	0
100%	19.1	10

Comments:

Elizabeth W. Thompson for
QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy
Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 5.10
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 9.00
(Homogeneous Variances)

Dunnett's Critical T Values
Critical Value = 2.31

Concentration	T Statistic
Control	
6.25	0.938
12.5	-0.182
25.0	1.199
50.0	1.149
100.0	1.25

NOEC (No Observed Effect Concentration) 100%
LOEC (Lowest Observed Effect Concentration) Not Observed
ChV (Chronic Value) >100%

REPRODUCTION/MORTALITY DATA
(FMB-Road 4)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	5	3	D/0	5	5	6	6	5	5
5	9	11	6	_	5	0	5	0	4	6
6	0	0	0	_	0	12	0	11	0	0
7	15	18	13	_	13	12	13	11	15	16
TOTAL	28	34	22	0	23	29	24	28	24	27
ADULT	L	L	L	D	L	L	L	L	L	L

L=Live

D=Dead $\bar{X}$ = 23.9

Treatment 1 (6.25%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	D/0	0	0	0	0	0	0
4	3	3	2	_	0	D/0	2	4	6	4
5	9	5	3	_	11	_	0	10	0	4
6	0	0	0	_	10	_	12	0	10	0
7	9	18	13	_	16	_	11	15	8	15
TOTAL	21	26	18	0	37	0	25	29	24	23
ADULT	L	L	L	D	L	D	L	L	L	L

L=Live

D=Dead $\bar{X}$ = 20.3

REPRODUCTION/MORTALITY DATA CONTINUED
(FMB-Road 4)

Treatment 2 (12.5%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	2	3	4	2	5	3	3	7	3
5	9	3	4	4	8	9	0	0	0	9
6	0	0	0	0	11	0	9	1	12	6
7	16	10	12	14	17	12	12	9	14	10
TOTAL	29	15	19	22	38	26	24	12	33	28
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 24.6

Treatment 3 (25%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	D/0	0	0	0	0
2	0	0	0	0	0	_	0	0	0	0
3	0	0	0	0	0	_	0	0	0	0
4	3	4	3	2	0	_	0	2	2	0
5	6	9	10	3	0	_	2	0	0	4
6	0	9	0	10	11	_	8	0	11	0
7	16	12	12	8	9	_	8	10	11	8
TOTAL	25	34	25	23	20	0	18	12	24	12
ADULT	L	L	L	L	L	D	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 19.3

REPRODUCTION/MORTALITY DATA CONTINUED
(FMB-Road 4)

Treatment 4 (50%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	5	3	3	4	3	0	3	4	2	3
5	0	2	4	6	0	9	11	2	3	0
6	0	1	0	4	1	0	0	2	10	1
7	14	10	9	11	12	10	10	5	6	9
TOTAL	19	16	16	25	16	19	24	13	21	13
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 18.2

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	D/0	0	0	0	0	0	0
2	0	0	0	_	0	0	0	0	0	0
3	0	0	0	_	0	0	0	0	0	0
4	2	2	2	_	0	0	0	3	2	0
5	5	4	6	_	8	7	9	2	7	10
6	0	0	0	_	5	9	6	6	7	8
7	12	14	12	_	8	5	10	8	7	5
TOTAL	19	20	20	0	21	21	25	19	23	23
ADULT	L	L	L	D	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 19.1

WATER CHEMISTRY DATA
(FMB - Road 4)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.8		24.7		24.6		24.5		24.4		24.9		25.4		
0%	D.O. (ppm)	8.00	8.40	8.60	8.50	8.60	8.60	8.70	8.10	8.20	8.00	8.40	8.60	8.70	8.20	
	pH (SU)	6.73	6.93	6.95	7.05	6.91	7.02	6.71	6.94	6.84	6.99	7.04	6.92	6.85	7.03	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.3		25.5		24.2		24.9		24.2		24.6		24.2		
6.25%	D.O. (ppm)	8.00	8.40	8.60	8.60	8.60	8.40	8.60	8.20	8.20	8.00	8.20	8.70	9.00	8.60	
	pH (SU)	6.69	7.05	7.12	6.94	7.03	6.70	6.76	6.91	7.22	7.11	7.03	6.71	6.61	7.18	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.8		25.6		25.3		24.8		24.2		24.3		25.4		
25%	D.O. (ppm)	8.20	8.60	8.80	8.40	8.70	8.40	9.00	8.20	8.30	8.00	8.20	8.60	9.00	8.60	
	pH (SU)	6.76	7.19	7.14	7.11	7.14	6.83	6.86	7.25	7.29	7.11	6.98	6.48	6.41	7.34	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.6		25.4		25.7		25.1		24.2		24.1		25.2		
100%	D.O. (ppm)	9.00	8.40	9.70	8.40	9.00	8.40	9.60	8.30	8.60	8.20	8.50	8.70	10.80	8.50	
	pH (SU)	6.84	7.20	6.96	7.24	7.09	6.98	6.96	7.01	7.21	7.11	7.03	6.96	6.95	7.44	

100% Effluent

Sample ID:	Control	45002	45125	45254
Alkalinity (mg/l)	71	10	16	13
Hardness (mg/l)	88	13	13	30
Conductivity (umhos/cm)	233	66	75	83

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Sample Location FSP-204

Date Reported: 09/27/93
Date/Time Started: 09/14/93 / 1815
Date/Time Ended: 09/21/93 / 1330

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/13/93 / 1120	45003	09/14/93, 09/15/93
2	09/15/93 / 0910	45127	09/16/93, 09/17/93
3	09/17/93 / 1053	45256	09/18/93, 09/19/93, 09/20/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
Control	19.5	20
1%	25.0	0
3%	22.0	10
10%	24.9	0
30%	21.4	0
100%	1.5	40

Comments:

Judy L. Ford

QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy

Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic + 2.72
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 28.9
(Homogeneous Variances)

Steel's Many One Rank Test
(Critical Value = 75.0)

Concentration	Rank Sum
1%	125.6
3%	120.5
10%	125.0
30%	109.0
100%	55.0

NOEC (No Observed Effect Concentration)	30%
LOEC (Lowest Observed Effect Concentration)	100%
ChV (Chronic Value)	54.77%

REPRODUCTION/MORTALITY DATA
(FSP-204)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	3	0	0	4	4	7
5	8	9	D/6	7	0	0	6	0	0	0
6	8	D/3	_	7	0	12	6	6	12	11
7	0	_	_	8	9	11	10	13	12	13
TOTAL	16	12	6	22	12	23	22	23	28	31
ADULT	L	D	D	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 19.5

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	3	0	2	4	2	5	3
5	0	7	0	0	0	0	0	5	0	0
6	8	11	8	11	10	11	9	10	12	9
7	10	12	11	15	D/6	13	15	14	13	11
TOTAL	18	30	19	29	16	26	28	31	30	23
ADULT	L	L	L	L	D	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 25.0

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-204)

Treatment 2 (3%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	D/0	0	0	0	0	0	0	0
3	0	0	_	0	0	0	0	0	0	0
4	5	0	_	4	5	2	0	3	3	0
5	0	0	_	0	0	0	5	0	1	7
6	11	9	_	12	9	12	11	10	14	9
7	7	8	_	13	12	11	11	12	14	0
TOTAL	23	17	0	29	26	25	27	25	32	16
ADULT	L	L	D	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 22.0

Treatment 3 (10%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	2	0	0	4	4	0	2	3	4	4
5	0	5	5	0	0	7	0	0	0	0
6	8	7	6	8	10	12	10	8	9	9
7	12	13	10	11	12	11	12	14	14	13
TOTAL	22	25	21	23	26	30	24	25	27	26
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 24.9

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-204)

Treatment 4 (30%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	2	3	0	2	0	2	3
5	0	0	6	0	0	3	0	4	0	0
6	7	10	9	11	8	8	7	9	8	9
7	10	12	9	12	8	9	10	9	9	15
TOTAL	17	22	24	25	19	20	19	22	19	27
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 21.4

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	D/0	0	0	D/0	0	D/0	0	0	0
3	0	_	0	0	_	0	_	0	0	0
4	0	_	0	0	_	D/0	_	0	0	0
5	0	_	0	0	_	_	_	2	0	D/0
6	0	_	0	4	_	_	_	3	3	_
7	0	_	0	0	_	_	_	0	0	_
TOTAL	0	0	0	4	0	0	0	5	3	0
ADULT	L	D	L	L	D	D	D	L	L	D

L=Live
D=Dead $\bar{X}$ = 1.5

WATER CHEMISTRY DATA
(FSP-204)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.4		25.6		24.9		24.5		25.4		25.0		24.6		
0%	D.O. (ppm)	7.90	8.20	8.40	8.00	8.20	8.50	8.60	8.10	7.90	7.40	7.60	8.40	8.40	8.10	
	pH (SU)	6.63	6.77	6.88	6.87	6.76	6.89	6.78	6.51	7.23	7.10	7.20	6.95	6.84	7.12	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.5		25.5		25.3		24.2		24.5		24.8		24.4		
1%	D.O. (ppm)	7.90	8.30	8.40	8.30	8.40	8.30	8.40	8.00	8.00	7.20	7.90	8.40	8.40	8.20	
	pH (SU)	6.73	6.93	7.00	6.90	6.90	6.83	6.87	7.31	7.37	7.40	7.59	7.16	7.09	7.22	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.5		24.7		24.6		24.5		24.6		25.0		24.1		
10%	D.O. (ppm)	8.10	8.30	8.40	8.40	8.20	8.30	8.50	8.10	8.00	7.20	7.40	8.40	8.30	8.10	
	pH (SU)	6.82	7.03	7.03	6.97	6.97	6.94	6.96	7.39	7.40	7.58	7.59	7.24	7.22	7.28	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.8		24.7		24.8		24.3		24.2		24.8		24.0		
100%	D.O. (ppm)	7.40	8.40	8.40	8.00	6.80	8.20	9.60	8.10	7.50	7.30	7.50	8.90	8.00	8.00	
	pH (SU)	6.45	6.95	6.83	7.09	6.62	6.99	6.58	7.33	7.17	7.41	7.67	7.02	7.25	7.39	

100% Effluent

Sample ID:	Con	45003	45127	45256
Alkalinity (mg/l)	71	<5	40	37
Hardness (mg/l)	88	76	44	53
Conductivity (umhos/cm)	233	521	432	394

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Sample Location FSP-032

Date Reported: 09/27/93
Date/Time Started: 09/14/93 / 1815
Date/Time Ended: 09/21/93 / 1335

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/13/93 / ----	45008	09/14/93, 09/15/93
2	09/15/93 / 1005	45123	09/16/93, 09/17/93
3	09/17/93 / 1053	45259	09/18/93, 09/19/93, 09/20/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
Control	20.2	10
1%	15.5	20
3%	17.7	30
10%	13.8	10
30%	16.9	10
100%	N/A	40

Comments:

Judy L. Ford
QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy
Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test Significant mortality oberved at the 100% effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 9.37
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 2.74
(Homogeneous Variances)

Bonferroni T-Test
(Critical Value = 2.33)

Concentration	T Statistic
Control	
1%	1.38
3%	0.74
10%	1.88
30%	0.95
100%	N/A

NOEC (No Observed Effect Concentration)	30%
LOEC (Lowest Observed Effect Concentration)	100%
ChV (Chronic Value)	54.77%

REPRODUCTION/MORTALITY DATA
(FSP-032)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	2	0	0	0	0	0	0	0	4	3
5	0	6	6	8	D/0	6	6	6	5	0
6	6	8	9	11	_	10	11	9	10	10
7	14	9	8	0	_	11	4	8	0	12
TOTAL	22	23	23	19	0	27	21	23	19	25
ADULT	L	L	L	L	D	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 20.2

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	5	2	0	0	0	0	0	0	0	0
5	0	0	6	5	5	6	D/0	6	2	6
6	9	10	11	10	10	11	_	10	9	11
7	D/7	14	0	0	0	0	_	0	0	0
TOTAL	21	26	17	15	15	17	0	16	11	17
ADULT	D	L	L	L	L	L	D	L	L	L

L=Live
D=Dead

$\bar{X}$ = 15.5

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-032)

Treatment 2 (3%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	D/0	0
4	3	0	0	0	5	D/0	0	3	_	0
5	0	4	4	0	0	_	4	0	_	4
6	8	10	11	9	9	_	9	11	_	D/10
7	11	11	10	10	9	_	15	7	_	_
TOTAL	22	25	25	19	23	0	28	21	0	14
ADULT	L	L	L	L	L	D	L	L	D	D

L=Live
D=Dead $\bar{X}$ = 17.7

Treatment 3 (10%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	2	3	2	0	0	0	0	0	0	0
5	1	0	0	5	D/3	4	6	0	5	0
6	8	9	8	10	_	10	0	10	7	8
7	10	10	4	0	_	10	3	0	0	0
TOTAL	21	22	14	15	3	24	9	10	12	8
ADULT	L	L	L	L	D	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 13.8

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-032)

Treatment 4 (30%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	*	0	0	0	0	0	0	0
2	0	0	_	0	0	0	0	0	0	0
3	0	0	_	0	0	0	0	0	0	0
4	3	3	_	2	0	0	0	0	0	0
5	0	0	_	0	0	2	D/2	4	4	0
6	7	8	_	8	10	6	_	8	7	9
7	10	9	_	10	10	6	_	9	9	6
TOTAL	20	20	_	20	20	14	2	21	20	15
ADULT	L	L	Lost	L	L	L	D	L	L	L

L=Live

D=Dead $\bar{X}$ = 16.9

* Animal lost in transfer

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	D/0	0	0	0	0	0	0	0	0	0
2	_	0	0	0	0	0	0	0	0	0
3	_	0	0	0	0	0	0	0	0	0
4	_	D/0	0	0	0	0	0	0	0	0
5	_	_	0	0	0	0	0	0	0	0
6	_	_	0	0	0	0	D/0	0	0	0
7	_	_	0	0	0	D/0	_	0	0	0
TOTAL	0	0	0	0	0	_	_	0	0	0
ADULT	D	D	L	L	L	D	D	L	L	L

L=Live

D=Dead $\bar{X}$ = N/A

WATER CHEMISTRY DATA
(FSP-032)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.0		24.7		26.0		25.0		24.0		25.3		24.1		
0%	D.O. (ppm)	7.90	8.20	8.20	8.10	8.40	8.60	8.40	8.30	8.10	7.50	7.50	8.50	8.60	8.10	
	pH (SU)	6.18	6.59	6.77	7.01	6.90	7.00	6.72	7.27	7.29	7.52	7.58	7.20	7.20	7.30	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.1		25.3		26.0		25.0		25.1		25.2		24.6		
1%	D.O. (ppm)	8.00	8.00	8.30	8.20	8.40	8.60	8.60	8.10	8.20	7.20	7.60	8.60	8.70	8.10	
	pH (SU)	6.38	7.01	7.09	7.00	7.10	6.96	7.00	7.42	7.48	7.60	7.63	7.26	7.35	7.44	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.3		24.1		24.8		24.2		25.3		24.5		26.0		
10%	D.O. (ppm)	8.10	8.20	8.40	8.40	8.30	8.40	8.50	8.20	8.20	7.30	7.40	8.30	8.50	8.00	
	pH (SU)	6.59	7.14	7.14	6.71	6.76	7.03	7.06	7.51	7.51	7.65	7.65	7.32	7.29	7.47	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.1		24.9		24.0		25.9		25.7		25.2		25.7		
100%	D.O. (ppm)	8.30	8.10	8.70	8.30	8.40	8.40	8.90	8.20	8.00	7.40	7.30	8.60	8.80	8.10	
	pH (SU)	6.62	7.26	7.08	6.83	6.89	7.21	7.01	7.68	7.27	7.74	7.63	7.36	7.16	7.54	

100% Effluent

Sample ID:	Con	45010	45129	45261
Alkalinity (mg/l)	71	<5	9	6
Hardness (mg/l)	88	80	14	20
Conductivity (umhos/cm)	233	40	36	35

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Sample Location FSP-047

Date Reported: 09/27/93
Date/Time Started: 09/14/93 / 1800
Date/Time Ended: 09/21/93 / 1345

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/13/93 / ----	45009	09/14/93, 09/15/93
2	09/15/93 / 1310	45130	09/16/93, 09/17/93
3	09/17/93 / 1015	45260	09/18/93, 09/19/93, 09/20/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
Control	23.2	0
1%	22.2	0
3%	23.1	0
10%	21.8	10
30%	17.4	10
100%	N/A	60

Comments:

Judy L. Ford

QA/QC By: Judy L. Ford, Assistant Laboratory Director

Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test Significant mortality oberved at the 100% effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 3.56
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 7.28
(Homogeneous Variances)

Bonferroni T-Test
(Critical Value = 2.33)

Concentration	T Statistic
Control	
1%	1.95
3%	0.669
10%	0.875
30%	3.139

NOEC (No Observed Effect Concentration)	10%
LOEC (Lowest Observed Effect Concentration)	30%
ChV (Chronic Value)	17.32%

REPRODUCTION/MORTALITY DATA
(FSP-047)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	3	4	0	4	4	2	4	5	5	3
5	8	0	6	5	0	7	0	0	0	0
6	0	10	9	0	10	0	11	12	9	8
7	12	12	8	13	10	13	13	13	10	9
TOTAL	23	26	23	22	24	22	28	30	24	20
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 23.2

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	5	2	3	6	3	5	0	6	0	2
5	8	6	0	0	9	0	5	0	0	2
6	0	0	8	4	0	0	7	10	0	9
7	14	12	10	13	15	11	11	12	0	10
TOTAL	27	20	21	23	27	16	23	28	**	23
ADULT	L	L	L	L	L	L	L	L	Male	L

L=Live
D=Dead $\bar{X}$ = 23.1

** Males not included in reproduction data

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-047)

Treatment 2 (3%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	2	4	5	3	3	3	6	3	4	4
5	5	6	5	0	8	6	7	6	0	4
6	0	0	0	0	0	0	0	0	2	0
7	15	15	16	13	15	14	15	11	10	12
TOTAL	22	25	26	16	26	23	28	20	16	20
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X} =$ 22.2

Treatment 3 (10%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	5	3	5	5	2	6	2	3	4
5	9	5	4	4	6	0	0	0	0	3
6	0	1	2	0	0	9	9	D/11	0	6
7	13	11	14	14	13	10	12	—	11	12
TOTAL	26	22	23	23	24	21	27	13	14	25
ADULT	L	L	L	L	L	L	L	D	L	L

L=Live
D=Dead

$\bar{X} =$ 21.8

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-047)

Treatment 4 (30%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	3	3	4	2	3	3	4	3	5	4
5	D/0	4	5	6	4	4	6	0	4	6
6	_	0	0	0	0	0	0	6	0	0
7	_	11	12	11	11	6	15	10	10	9
TOTAL	3	18	21	19	18	13	25	19	19	19
ADULT	D	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 17.4

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	D/0	D/0	0	D/0	0	0	0	0	0	0
2	_	_	0	_	0	0	0	0	0	0
3	_	_	0	_	D/0	0	0	D/0	0	0
4	_	_	0	_	_	0	D/0	_	0	0
5**										
6										
7										
TOTAL	0	0	0	0	0	0	0	0	0	0
ADULT	D	D	L	D	D	L	D	D	L	L

L=Live
D=Dead $\bar{X}$ = N/A
** Test terminated

WATER CHEMISTRY DATA
(FSP-047)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.1		24.5		24.2		24.8		24.7		25.2		25.3		
0%	D.O. (ppm)	7.80	8.30	8.20	8.10	8.30	8.60	8.40	8.20	8.20	7.50	7.60	8.80	8.90	8.40	
	pH (SU)	6.82	6.93	6.90	7.00	6.92	6.85	6.82	7.09	7.16	7.40	7.20	7.00	7.10	7.30	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.1		24.5		24.6		24.5		24.1		25.3		24.0		
1%	D.O. (ppm)	7.90	8.30	8.40	8.30	8.00	8.60	8.30	8.20	8.20	7.30	7.80	8.80	8.90	8.20	
	pH (SU)	6.89	6.85	6.84	7.04	7.00	6.91	6.94	7.27	7.32	7.33	7.52	7.05	7.15	7.30	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.5		24.0		24.6		24.3		24.7		24.9		25.1		
10%	D.O. (ppm)	7.60	8.20	8.20	8.40	8.30	8.40	8.30	8.20	8.20	7.30	7.60	8.10	8.80	7.90	
	pH (SU)	6.87	6.88	6.83	7.07	6.79	6.98	6.95	7.41	7.38	7.52	7.52	7.32	7.17	7.42	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.6		24.0		24.2		24.5		**		**		**		
100%	D.O. (ppm)	5.30	8.10	7.80	8.40	8.50	8.60	8.50	8.20							
	pH (SU)	6.18	6.83	6.40	6.88	6.74	7.03	6.77	7.49							

		100% Effluent		
Sample ID:	Control	45009	45130	45260
Alkalinity (mg/l)	71	10	32	11
Hardness (mg/l)	88	25	40	160
Conductivity (umhos/cm)	233	42	43	44

**Test terminated due to high mortality

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Date Reported: 09/27/93

Sample Location FSP-012

Date/Time Started: 09/14/93 / 1755

Date/Time Ended: 09/21/93 / 1315

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/13/93 / ----	45007	09/14/93, 09/15/93
2	09/15/93 / 1020	45122	09/16/93, 09/17/93
3	09/17/93 / 1040	45258	09/18/93, 09/19/93, 09/20/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
Control	17.8	10
1%	14.4	10
3%	16.1	0
10%	18.5	0
30%	9.1	0
100%	0.4	30

Comments: 1% Concentration was abberrant

Judy L. Ford

QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy

Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 17.01
(Data not normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 29.96
(Data does not have homogeneous variance)

Wilcoxon Rank Sum Test With Bonferroni Adjustment

Concentration	Rank Sum	Critical Value
1%	73.5	74.0
3%	94.5	74.0
10%	103.0	74.0
30%	55.0	74.0
100%	45.0	61.0

NOEC (No Observed Effect Concentration) 10%
LOEC (Lowest Observed Effect Concentration) 30%
ChV (Chronic Value) 17.32%

REPRODUCTION/MORTALITY DATA
(FSP-012)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	4	4	0	0	0	0	0	0	0
5	6	0	0	6	4	6	7	7	5	6
6	6	9	8	10	9	7	9	9	10	9
7	6	8	7	5	8	D/3	0	0	0	0
TOTAL	18	21	19	21	21	16	16	16	15	15
ADULT	L	L	L	L	L	D	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 17.8

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	5	5	6	5	6	0	0	3	4	5
6	8	8	8	12	11	11	12	9	12	8
7	0	0	0	0	0	6	0	0	D/0	0
TOTAL	13	13	14	17	17	17	12	12	16	13
ADULT	L	L	L	L	L	L	L	L	D	L

L=Live
D=Dead $\bar{X}$ = 14.4

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-012)

Treatment 2 (3%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	2	2	0	0	0	0
5	5	7	5	6	0	0	5	0	0	5
6	10	10	8	11	11	10	6	7	10	9
7	0	0	0	0	10	12	10	0	0	0
TOTAL	15	17	13	17	23	24	21	7	10	14
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 16.1

Treatment 3 (10%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	4	0	0	0	0	3	0	0	0
5	4	0	4	3	0	0	0	4	0	5
6	9	11	10	12	8	9	12	8	7	10
7	0	11	0	10	10	10	11	0	10	0
TOTAL	13	26	14	25	18	19	26	12	17	15
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 18.5

REPRODUCTION/MORTALITY DATA
(FSP-012)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	4	4	0	0	0	0	0	0	0
5	6	0	0	6	4	6	7	7	5	6
6	6	9	8	10	9	7	9	9	10	9
7	6	8	7	5	8	D/3	0	0	0	0
TOTAL	18	21	19	21	21	16	16	16	15	15
ADULT	L	L	L	L	L	D	L	L	L	L

L=Live

D=Dead $\bar{X}$ = 17.8

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	5	5	6	5	6	0	0	3	4	5
6	8	8	8	12	11	11	12	9	12	8
7	0	0	0	0	0	6	0	0	D/0	0
TOTAL	13	13	14	17	17	17	12	12	16	13
ADULT	L	L	L	L	L	L	L	L	D	L

L=Live

D=Dead $\bar{X}$ = 14.4

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-012)

Treatment 2 (3%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	2	2	0	0	0	0
5	5	7	5	6	0	0	5	0	0	5
6	10	10	8	11	11	10	6	7	10	9
7	0	0	0	0	10	12	10	0	0	0
TOTAL	15	17	13	17	23	24	21	7	10	14
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 16.1

Treatment 3 (10%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	4	0	0	0	0	3	0	0	0
5	4	0	4	3	0	0	0	4	0	5
6	9	11	10	12	8	9	12	8	7	10
7	0	11	0	10	10	10	11	0	10	0
TOTAL	13	26	14	25	18	19	26	12	17	15
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 18.5

REPRODUCTION/MORTALITY DATA
(FSP-012)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	4	4	0	0	0	0	0	0	0
5	6	0	0	6	4	6	7	7	5	6
6	6	9	8	10	9	7	9	9	10	9
7	6	8	7	5	8	D/3	0	0	0	0
TOTAL	18	21	19	21	21	16	16	16	15	15
ADULT	L	L	L	L	L	D	L	L	L	L

L=Live
D=Dead $\bar{X} =$ 17.8

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	5	5	6	5	6	0	0	3	4	5
6	8	8	8	12	11	11	12	9	12	8
7	0	0	0	0	0	6	0	0	D/0	0
TOTAL	13	13	14	17	17	17	12	12	16	13
ADULT	L	L	L	L	L	L	L	L	D	L

L=Live
D=Dead $\bar{X} =$ 14.4

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-012)

Treatment 4 (30%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	3	4	5	3	0	0	3	4	0	4
6	0	4	2	5	4	3	4	5	5	3
7	3	5	0	0	6	6	0	5	5	0
TOTAL	6	13	7	8	10	9	7	14	10	7
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 9.1

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	*	D/0	0	0	0	0	0	0
3	0	0	_	_	0	0	0	0	0	0
4	0	0	_	_	0	0	D/0	0	0	0
5	0	0	_	_	0	D/0	_	0	0	0
6	2	0	_	_	0	_	_	0	2	0
7	0	0	_	_	0	_	_	0	0	0
TOTAL	2	0	0	0	0	0	0	0	2	0
ADULT	L	L	Lost	D	L	D	D	L	L	L

L=Live
D=Dead $\bar{X}$ = 0.4
* Animal lost in transfer

WATER CHEMISTRY DATA
(FSP-012)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.5		25.0		25.2		24.1		25.6		25.4		24.6		
0%	D.O. (ppm)	7.90	8.20	8.30	8.50	8.70	8.20	8.30	7.90	7.90	7.60	8.00	8.20	8.00	7.80	
	pH (SU)	6.57	6.80	6.76	6.72	6.96	6.82	6.69	6.81	6.90	6.85	7.00	6.78	6.94	7.04	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.4		24.9		24.6		24.8		24.9		25.6		24.4		
1%	D.O. (ppm)	8.00	8.40	8.40	8.40	8.50	8.30	8.30	8.00	8.00	7.50	7.80	8.40	8.50	7.90	
	pH (SU)	6.67	6.76	6.75	7.06	7.10	6.73	6.78	6.85	6.89	7.10	7.16	6.93	6.91	7.12	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.7		24.3		24.4		24.0		24.1		24.9		24.0		
10%	D.O. (ppm)	7.70	8.30	8.40	8.40	8.60	8.20	8.40	8.20	8.00	7.40	7.50	8.30	8.30	7.80	
	pH (SU)	6.74	6.83	6.85	7.11	7.09	6.84	6.84	7.03	7.05	7.22	7.24	7.02	7.01	7.16	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.3		24.1		24.8		25.6		25.1		25.1		25.9		
100%	D.O. (ppm)	5.10	8.00	7.40	8.40	8.40	8.20	8.40	8.00	6.90	7.60	7.80	8.60	8.10	7.80	
	pH (SU)	6.31	6.86	6.47	7.01	6.70	6.91	6.55	7.07	6.63	7.28	7.35	6.70	6.98	7.19	

100% Effluent

Sample ID:	Con	45007	45122	45258
Alkalinity (mg/l)	71	29	18	17
Hardness (mg/l)	88	100	36	240
Conductivity (umhos/cm)	233	50	49	48

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Date Reported: 09/27/93

Sample Location FSP-256

Date/Time Started: 09/14/93 / 1830

Date/Time Ended: 09/21/93 / 1355

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/13/93 / ——	45010	09/14/93, 09/15/93
2	09/15/93 / 1325	45129	09/16/93, 09/17/93
3	09/17/93 / 0950	45261	09/18/93, 09/19/93, 09/20/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
Control	24.1	10
1%	21.6	0
3%	22.3	0
10%	22.1	0
30%	19.2	10
100%	15.0	10

Comments:

QA/QC By: Judy L. Ford, Assistant Laboratory Director

Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 20.78
(Data not normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 6.32
(Homogeneous Variances)

Steel's Many One Rank Test
(Critical Value = 75.0)

Concentration	Rank Sum
1%	81
3%	89
10%	88.5
30%	78.5
100%	65.5

NOEC (No Observed Effect Concentration)	30%
LOEC (Lowest Observed Effect Concentration)	100%
ChV (Chronic Value)	54.77%

REPRODUCTION/MORTALITY DATA
(FSP-256)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	3	2	0	2	0	0	0	0	3	0
5	0	6	8	0	7	7	6	3	0	4
6	11	8	10	10	10	11	9	8	10	11
7	12	9	10	11	10	11	12	D/0	10	7
TOTAL	26	25	28	23	27	29	27	11	23	22
ADULT	L	L	L	L	L	L	L	D	L	L

L=Live
D=Dead $\bar{X}$ = 24.1

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	3	0	0	0	0	0	0	0	0
5	6	0	6	5	5	0	5	6	4	6
6	8	11	9	10	10	11	11	9	8	8
7	8	11	7	0	10	10	9	11	9	0
TOTAL	22	25	22	15	25	21	25	26	21	14
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 21.6

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-256)

Treatment 2 (3%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	2	0	0	2	0	0	0	3	0	0
5	2	0	6	2	5	6	5	0	0	5
6	10	9	9	8	9	13	9	9	9	7
7	10	12	12	10	11	9	10	10	9	0
TOTAL	24	21	27	22	25	28	24	22	18	12
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 22.3

Treatment 3 (10%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	2	3	0
5	5	3	5	4	4	5	5	0	0	5
6	9	8	9	11	10	9	10	12	9	7
7	10	10	11	12	0	12	10	10	9	2
TOTAL	24	21	25	27	14	26	25	24	21	14
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 22.1

REPRODUCTION/MORTALITY DATA CONTINUED
(FSP-256)

Treatment 4 (30%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	2	0	2	0	0	2	0	D/0	0
5	0	0	4	2	4	3	4	4	_	4
6	8	6	6	7	8	9	8	12	_	5
7	10	12	10	12	9	10	12	12	_	5
TOTAL	18	20	20	23	21	22	26	28	0	14
ADULT	L	L	L	L	L	L	L	L	D	L

L=Live
D=Dead $\bar{X}$ = 19.2

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	3	0	3	5	3	D/0
6	6	7	4	8	6	6	9	9	7	_
7	9	10	0	10	9	8	10	9	9	_
TOTAL	15	17	4	18	18	14	22	23	19	0
ADULT	L	L	L	L	L	L	L	L	L	D

L=Live
D=Dead $\bar{X}$ = 15.0

WATER CHEMISTRY DATA
(FSP-256)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.5		24.8		25.9		24.6		24.4		24.7		24.6		
0%	D.O. (ppm)	8.10	7.80	8.10	8.50	8.60	8.60	8.40	8.20	8.30	7.80	7.90	8.60	8.70	8.10	
	pH (SU)	6.40	6.93	6.74	7.06	6.90	6.80	6.91	6.99	7.16	6.87	6.95	6.81	6.90	7.40	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.5		24.4		26.0		24.5		25.0		25.9		24.7		
1%	D.O. (ppm)	8.10	8.00	8.20	8.40	8.60	8.50	8.80	8.20	8.30	7.70	8.00	8.70	8.60	8.10	
	pH (SU)	6.55	6.71	6.72	6.83	6.84	7.01	7.05	7.29	7.43	6.94	6.99	6.68	6.90	7.43	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.5		25.2		24.1		25.3		25.5		24.1		24.7		
10%	D.O. (ppm)	8.10	8.10	8.40	8.40	8.60	8.70	8.80	8.20	8.20	7.60	7.90	8.60	8.80	7.90	
	pH (SU)	6.67	6.74	6.79	6.89	6.90	7.10	7.10	7.49	7.49	7.12	7.14	6.91	6.90	7.50	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.5		25.1		24.1		25.4		24.4		24.0		24.1		
100%	D.O. (ppm)	8.30	8.20	8.60	8.50	8.00	8.40	9.00	8.00	6.80	7.60	7.80	8.60	8.60	8.00	
	pH (SU)	6.66	6.84	6.80	7.03	7.00	7.21	7.02	7.62	7.23	7.24	7.05	7.10	7.30	7.58	

100% Effluent

Sample ID:	Con	45010	45129	45261
Alkalinity (mg/l)	71	52.8	85.1	50.4
Hardness (mg/l)	88	95	34	160
Conductivity (umhos/cm)	233	124	112	115

7-DAY CHRONIC TOXICITY TESTS PERFORMED ON MET LAB BASIN AND HSP SAMPLES FROM WESTINGHOUSE SAVANNAH RIVER COMPANY

TESTS PERFORMED SEPTEMBER 23 - 30, 1993

Subcontract No.: 7901-222-SC-BDDM

Document No.: 7901-222-SC-BDFG

Submitted To:

WESTINGHOUSE SAVANNAH RIVER COMPANY

Aiken, South Carolina

Prepared By:

SHEALY ENVIRONMENTAL SERVICES, INC.
106 Vantage Point Drive
Cayce, South Carolina 29033

SCDHEC Laboratory Certification No. 26103

Laura F. Shealy

Laura F. Shealy, Vice President - Toxicological Services

Table 1. Summary of Effluent Toxicity Test Conditions for the *Ceriodaphnia* Survival and Reproduction Test

1.	Test Type:	Static Renewal
2.	Temperature (^oC):	25 ± 1^oC
3.	Light Quality:	Ambient laboratory illumination
4.	Light Intensity:	10-20 $uE/m^2/s$ (50-100 ft-c) (ambient laboratory levels)
5.	Photoperiod:	16 h light, 8 h darkness
6.	Test chamber size:	30 mL
7.	Test solution volume	15 mL
8.	Renewal of test concentrations:	Daily
9.	Age of test organism	Less than 24 h; and all released within a 12-h period.
10.	No. neonates per test chamber:	1
11.	No. Replicate test chambers per concentration:	10
12.	No neonates per test concentration:	10
13.	Feeding regime:	Feed 0.1 mL of YCT and algae suspension per test chamber daily.
14.	Aeration:	None
15.	Dilution water:	Receiving water
16.	Effluent concentrations:	5 concentrations and a control.

Table 1. Summary of Effluent Toxicity Test Conditions for the *Ceriodaphnia* Survival and Reproduction Test (Continued)

17.	Dilution factor:	0.3 or 0.5
18.	Test duration:	Until 60% of control females have three broods (6 - 7 days).
19.	Endpoints:	Survival and reproduction
20.	Test Acceptability:	80% or greater survival and an average of 15 or more young/surviving female in the control solutions. At least 60% of surviving females in control should have produced their third brood.
21.	Sampling requirement:	Three samples were collected (Monday, Wednesday, and Friday)

SECTION 4.0. RESULTS

Results for the Ceriodaphnia chronic toxicity tests performed for the Met Lab Basin and HSP samples September 23 - 30, 1993, are summarized below in Table 2 with individual data reports given in Appendix B. Copies of benchsheets for these tests are given in Appendix C.

Table 2: Summary of Results from Chronic Ceriodaphnia Toxicitiy Tests Performed for WESTINGHOUSE SAVANNAH RIVER COMPANY's Met Lab Basin and HSP samples collected the September 23, 27, and 28, 1993.

Sample Location	NOEC (% Sample)	LOEC (% Sample)	ChV (% Sample)
Met Lab Basin #1	50	100	70.7
Met Lab Basin #2	25	50	35.4
HSP-008	100	Not Observed	>100
HSP-20	3	10	5.5
HSP-60	10	30	17.3
HSP-103	3	10	5.5

Results from tests performed on HSP samples indicated that the HSP-008 sample was not acutely or chronically toxic to the test organism during the sampling period. The No Observed Effect Concentration (NOEC) for this test was 100% sample. The results for all other HSP samples; however, revealed some acute and/or chronic toxicity to the *Ceriodaphnia* with NOEC's ranging from 3% to 100%. Results for tests performed on Met Lab Basin #1 and #2 samples revealed NOEC's of 50 and 25%, respectively. Table 3 gives the detailed summary of reproduction and mortality data obtained for toxicity tests performed for the HSP and Met Lab Basin samples.

Table 3. Summary of Reproduction and Mortality Data Obtained from Toxicity Tests performed September 23 - 30, 1993, on Met Lab Basin and HSP Samples.

Sample ID	Treatment	$\bar{X}$ No. Young Produced	% Mortality
Met Lab Basin #1	Control	15.9	20
	6.25	15.1	20
	12.5	12.8	10
	25	13.4	0
	50	10.4	0
	100	--	100
Met Lab Basin #2	Control	15.9	10
	6.25	15.3	0
	12.5	14.9.	0
	25	11.8	0
	50	5.8	0
	100	5.5	10
HSP-008	Control	21.2	0
	1	26.7	0
	3	28.6	0
	10	27.3	10
	30	25.9	0
	100	17.9	30
HSP-20	Control	29.8	0
	1	27.7	10
	3	30.3	0
	10	25.7	0
	30	12.4	0
	100	1.6	0
HSP-60	Control	26.7	0
	1	25.6	0
	3	25.5	0
	10	23.5	10
	30	19.3	0
	100	10.5	10
HSP-103	Control	15.8	0
	1	15.2	0
	3	12.3	0
	10	12.2	0
	30	7.6	10
	100	7.2	0

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Date Reported: 10/04/93

Sample Location HSP - 008

Date/Time Started: 09/23/93 / 1040

Date/Time Ended: 09/29/93 / 1400

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/22/93 / 1115	45429	09/23/93, 09/24/93
2	09/24/93 / 1030	45562	09/25/93, 09/26/93, 09/27/93
3	09/27/93 / 1030	45608	09/28/93, 09/29/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
Control	21.2	0
1.0%	26.7	0
3.0%	28.6	0
10%	27.3	10
30%	25.9	0
100%	17.9	30

Comments:

Judy L. Ford

QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy

Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test: No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 1.56
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic 15.5
(No homogeneous variance)

Wilcoxon Rank Sum Test With Bonferronni Adjustment

Concentration	Rank Sum	Critical Value
Control		
1%	134	74.0
3%	141	74.0
10%	121	61.0
30%	133	74.0
100%	100	74.0

NOEC (No Observed Effect Concentration) 100%
LOEC (Lowest Observed Effect Concentration) Not observed
ChV (Chronic Value) > 100%

REPRODUCTION/MORTALITY DATA
(HSP-008)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	3	3	3
4	6	6	5	5	4	2	5	0	0	0
5	11	10	11	12	11	9	8	11	10	7
6	0	0	2	0	0	14	11	11	16	16
7										
TOTAL	17	16	18	17	15	25	24	25	29	26
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 21.2

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	-0-	0	0	4	0	0	5	0
4	5	4	6	5	5	0	6	6	0	1
5	11	9	10	11	9	9	10	8	8	8
6	0	12	16	14	11	14	17	14	12	17
7										
TOTAL	16	25	32	30	25	27	33	28	25	26
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 26.7

REPRODUCTION/MORTALITY DATA CONTINUED
(HSP - 008)

Treatment 2 (3%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	3	2	3	3	3
4	5	6	6	5	4	0	0	0	0	0
5	10	10	11	10	7	7	9	11	8	10
6	18	17	19	16	9	16	17	15	16	10
7										
TOTAL	33	33	36	31	20	26	28	29	27	23
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live

D=Dead $\bar{X}$ = 28.6

Treatment 3 (10%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	*	0
3	4	4	-5-	0	3	4	0	0	--	0
4	0	0	0	5	0	0	5	4	--	4
5	9	10	10	8	7	9	11	10	--	8
6	16	16	14	15	D/5	16	12	17	--	15
7										
TOTAL	29	30	29	28	15	29	28	31	*	27
ADULT	L	L	L	L	D	L	L	L	Lost	L

L=Live

D=Dead $\bar{X}$ = 27.3

* Animal lost in transfer

REPRODUCTION/MORTALITY DATA CONTINUED
(HSP-008)

Treatment 4 (30%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	5	3	4	3	4	4	4	3	0	0
4	0	0	0	0	0	0	1	0	0	4
5	9	6	8	10	7	7	8	10	10	8
6	14	13	15	14	15	12	13	17	16	12
7										
TOTAL	28	22	27	27	26	23	26	30	26	24
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X} =$ 25.9

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	D/0	0	0	0	0	0	0	0	0	0
3	--	5	-3	4	4	4	5	3	3	0
4	--	0	0	0	0	0	0	0	5	4
5	--	8	5	5	6	8	8	D/5	8	D/3
6	--	13	12	13	10	12	12	--	11	--
7										
TOTAL	0	26	20	22	20	24	25	8	27	7
ADULT	D	L	L	L	L	L	L	D	L	D

L=Live
D=Dead $\bar{X} =$ 17.9

WATER CHEMISTRY DATA
(HSP-008)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.7		24.7		24.3		24.5		24.8		24.3				
0%	D.O. (ppm)	8.30	8.20	8.30	7.60	7.60	8.00	8.00	8.30	8.40	7.40	7.40	8.40			
	pH (SU)	6.61	7.31	7.25	6.94	6.95	7.02	6.97	6.83	6.85	6.75	6.87	7.04			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.0		25.3		24.6		24.8		25.2		24.4				
1%	D.O. (ppm)	8.40	8.30	8.40	7.60	7.70	8.00	8.00	8.20	8.20	7.60	7.60	8.70			
	pH (SU)	6.78	6.99	6.89	7.02	6.99	7.02	6.96	7.21	7.13	6.75	6.74	7.04			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.4		24.1		24.4		24.6		25.5		24.5				
10%	D.O. (ppm)	8.20	8.20	8.30	7.60	7.70	8.00	8.10	8.20	8.20	7.60	7.70	8.70			
	pH (SU)	6.91	6.69	6.64	7.14	7.08	7.07	7.02	7.42	7.37	6.86	6.83	7.10			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.6		24.1		24.5		24.5		24.7		25.2				
100%	D.O. (ppm)	7.20	8.10	8.00	7.40	7.00	8.00	7.90	8.30	8.60	7.60	7.20	8.90			
	pH (SU)	6.92	7.04	6.98	7.25	7.15	7.25	7.14	7.49	7.38	7.08	6.93	7.26			

100% Effluent

Sample ID:	Control	45429	45562	45608
Alkalinity (mg/l)	70	104	126	142
Hardness (mg/l)	90	60	28	18
Conductivity (umhos/cm)	183	335	360	381

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Date Reported: 10/04/93

Sample Location: HSP - 020

Date/Time Started: 09/23/93 / 1100

Date/Time Ended: 09/29/93 / 1345

	Effluent Sampling Data		
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/22/93 / 1100	45430	09/23/93, 09/24/93
2	09/24/93 / 1015	45563	09/25/93, 09/26/93, 09/27/93
3	09/27/93 / 1030	45609	09/28/93, 09/29/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
Control	29.8	0
1.0%	27.7	10
3.0%	30.3	0
10%	25.7	0
30%	12.4	0
100%	1.6	0

Comments:

Judy L. Ford

QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy

Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test: No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 6.16
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic 26.6
(No homogeneous variance)

Wilcoxon Rank Sum Test With Bonferronni Adjustment

Concentration	Rank Sum	Critical Value
Control		
1%	102	74.0
3%	112	74.0
10%	68.5	74.0
30%	55.0	74.0
100%	45.0	61.0

NOEC (No Observed Effect Concentration)	3%
LOEC (Lowest Observed Effect Concentration)	10%
ChV (Chronic Value)	5.48%

REPRODUCTION/MORTALITY DATA
(HSP-020)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	5	4	6	5	6	6	6	5	7	5
5	10	7	0	9	11	0	0	11	10	0
6	0	0	8	0	0	11	11	0	0	9
7	17	14	15	16	16	12	16	15	11	14
TOTAL	32	25	29	30	33	29	33	31	28	28
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 29.8

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	4	4	7	6	5	5	5	5	3
5	0	8	9	0	1	0	0	1	8	7
6	2	2	0	13	9	11	12	10	0	0
7	17	16	15	14	17	16	15	15	D/0	12
TOTAL	23	30	28	34	33	32	32	31	13	22
ADULT	L	L	L	L	L	L	L	L	D	L

L=Live
D=Dead $\bar{X}$ = 27.7

REPRODUCTION/MORTALITY DATA CONTINUED
(HSP - 020)

Treatment 2 (3%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	5	5	5	4	4	5	5	6	4
5	11	9	6	10	8	10	0	7	0	0
6	1	4	0	0	1	0	11	0	10	11
7	17	16	15	17	15	11	17	17	16	16
TOTAL	33	34	26	32	28	25	33	29	32	31
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 30.3

Treatment 3 (10%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	-0-	0	0	0	0	0	0	0
4	5	3	4	5	6	4	6	5	3	5
5	0	7	0	1	5	1	8	0	0	0
6	10	0	10	10	0	11	0	11	10	9
7	12	13	11	12	14	10	12	16	10	8
TOTAL	27	23	25	28	25	26	26	32	23	22
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 25.7

REPRODUCTION/MORTALITY DATA CONTINUED
(HSP-020)

Treatment 4 (30%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	3	2	4	4	5	5	4	4	3	3
5	0	1	0	3	2	0	0	0	0	0
6	0	0	0	0	0	5	2	3	2	4
7	8	7	7	6	4	5	8	6	6	8
TOTAL	11	10	11	13	11	15	14	13	11	15
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 12.4

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	*	0
2	0	0	0	0	0	0	0	0	--	0
3	0	0	0	0	0	0	0	0	--	0
4	0	0	2	0	0	0	0	0	--	0
5	0	0	0	0	0	0	0	0	--	0
6	0	0	0	0	0	0	0	0	--	0
7	3	0	0	0	3	3	2	0	--	2
TOTAL	3	0	2	0	3	3	2	0	*	2
ADULT	L	L	L	L	L	L	L	L	Lost	L

L=Live
D=Dead $\bar{X}$ = 1.6

WATER CHEMISTRY DATA
(HSP-020)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.4		24.5		24.7		25.3		24.8		24.4		24.2		
0%	D.O. (ppm)	8.40	8.40	8.40	7.80	7.70	8.20	8.10	8.30	8.40	7.70	7.70	8.40	8.20	7.80	
	pH (SU)	6.85	7.41	7.38	7.11	7.10	7.22	7.18	7.32	7.24	7.06	6.99	6.89	6.94	6.89	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.9		25.1		25.2		25.9		25.3		25.1		24.3		
1%	D.O. (ppm)	8.40	8.60	8.50	7.60	7.80	8.20	8.20	8.20	8.40	7.70	7.70	8.60	8.40	7.90	
	pH (SU)	6.75	7.19	7.10	7.24	7.19	7.34	7.27	7.21	7.13	7.24	7.18	7.07	6.90	6.83	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.8		25.1		24.7		25.8		25.9		25.7		24.6		
10%	D.O. (ppm)	8.20	8.40	8.60	7.80	7.60	8.00	8.10	8.40	8.00	7.70	7.60	8.50	8.50	7.90	
	pH (SU)	6.77	6.74	6.51	7.30	7.24	7.42	7.39	7.54	7.51	7.34	7.23	7.20	7.00	6.95	

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.7		24.9		25.6		25.2		25.4		25.9		24.3		
100%	D.O. (ppm)	6.80	8.20	8.30	7.20	6.00	7.70	7.20	7.60	6.00	7.20	6.30	7.80	7.30	7.80	
	pH (SU)	6.70	7.07	7.02	7.08	7.06	7.29	7.19	7.18	7.15	7.16	7.06	6.96	6.77	7.10	

100% Effluent

Sample ID:	Control	45430	45563	45609
Alkalinity (mg/l)	70	42	94	72
Hardness (mg/l)	90	140	60	60
Conductivity (umhos/cm)	183	112	141	146

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Date Reported: 10/04/93

Sample Location: HSP - 060

Date/Time Started: 09/23/93 / 1100

Date/Time Ended: 09/29/93 / 1400

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/22/93 / 1030	45431	09/23/93, 09/24/93
2	09/24/93 / 1000	45564	09/25/93, 09/26/93, 09/27/93
3	09/27/93 / 1000	45610	09/28/93, 09/29/93

Reproduction/Mortality Data		
	Average #	%
Conc.	Offspring	Mortality
Control	26.7	0
1.0%	25.6	0
3.0%	25.5	0
10%	23.5	10
30%	19.3	0
100%	10.5	10

Comments:

Judy L. Ford

QA/QC By: Judy L. Ford, Assistant
Laboratory Director

Laura F. Shealy

Reported By: Laura F. Shealy,
Vice-President of
Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test: No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 4.67
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 26.5
(No homogeneous variance)

Steel's Many One Rank Test
(Critical Value = 75.0)

Concentration	Rank Sum
Control	
1%	89.0
3%	89.5
10%	92.5
30%	57.5
100%	55.5

NOEC (No Observed Effect Concentration)	10%
LOEC (Lowest Observed Effect Concentration)	30%
ChV (Chronic Value)	17.32%

REPRODUCTION/MORTALITY DATA
(HSP-060)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	5	0	0	0	0	4	3	3	4	5
4	0	5	6	6	4	0	0	0	3	2
5	11	10	10	9	9	10	8	11	9	5
6	13	12	13	10	14	14	14	12	13	10
7										
TOTAL	29	27	29	25	27	28	25	26	29	22
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 26.7

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	5	4	4	4	4	4	5	4	0	5
4	0	0	0	0	0	0	0	0	4	0
5	7	9	10	11	9	10	8	10	10	9
6	10	12	14	12	14	11	12	13	9	13
7										
TOTAL	22	25	28	27	27	25	25	27	23	27
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 25.6

REPRODUCTION/MORTALITY DATA CONTINUED
(HSP - 060)

Treatment 2 (3%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	5	5	4	5	8	5	6	5	5	6
5	11	9	10	8	9	8	7	12	10	7
6	9	13	10	13	15	8	11	12	11	8
7										
TOTAL	25	27	24	26	32	21	24	29	26	21
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 25.5

Treatment 3 (10%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	-0-	3	0	D/0	0	0	0	0
4	4	3	5	0	4	--	3	3	5	3
5	9	8	10	11	8	--	9	13	10	9
6	11	13	14	12	12	--	15	14	13	11
7										
TOTAL	24	24	29	26	24	0	27	30	28	23
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 23.5

REPRODUCTION/MORTALITY DATA CONTINUED
(HSP-060)

Treatment 4 (30%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	5	4	0	5	3	3	3	4	3	3
5	7	9	9	7	8	7	6	9	10	8
6	9	10	2	10	7	6	9	8	11	8
7										
TOTAL	21	23	11	22	18	16	18	21	24	19
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead $\bar{X}$ = 19.3

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	4	4	3	3	3	4	3	4	5	4
5	2	0	0	5	6	3	7	5	6	4
6	3	0	2	0	2	0	6	6	11	D/0
7										
TOTAL	9	4	5	8	11	7	16	15	22	8
ADULT	L	L	L	L	L	L	L	L	L	D

L=Live
D=Dead $\bar{X}$ = 10.5

WATER CHEMISTRY DATA
(HSP-060)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.8		24.7		24.7		24.8		24.8		24.5				
0%	D.O. (ppm)	8.30	8.40	8.40	7.60	7.80	8.20	8.20	8.50	8.20	7.70	7.80	8.40			
	pH (SU)	6.63	7.11	7.25	7.09	6.91	7.14	7.06	6.87	6.92	6.94	6.95	6.99			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.1		25.2		25.5		25.5		25.0		26.0				
1%	D.O. (ppm)	8.20	8.30	8.40	7.70	7.80	8.30	8.30	8.20	8.30	7.80	7.90	8.50			
	pH (SU)	6.82	7.49	7.48	7.29	7.19	7.31	7.23	7.31	7.32	6.99	7.04	7.11			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.4		24.7		25.1		25.9		24.7		24.9				
10%	D.O. (ppm)	8.30	8.40	8.30	7.60	7.80	8.20	8.20	8.50	8.20	7.80	7.80	8.40			
	pH (SU)	7.05	7.58	7.51	7.38	7.31	7.42	7.37	7.58	7.57	7.11	7.16	7.27			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.9		24.3		25.7		25.7		24.5		25.1				
100%	D.O. (ppm)	8.20	8.20	8.40	7.60	7.60	8.20	8.60	8.40	8.20	7.90	8.10	8.30			
	pH (SU)	7.09	7.55	7.11	7.25	7.25	7.08	6.97	7.71	7.36	7.36	7.28	7.67			

100% Effluent

Sample ID:	Control	45431	45564	45610
Alkalinity (mg/l)	70	20	<5	44
Hardness (mg/l)	90	26	20	20
Conductivity (umhos/cm)	183	211	174	156

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test

Facility WESTINGHOUSE SAVANNAH RIVER COMPANY

Sample Location HSP - 103

Date Reported: 10/04/93
Date/Time Started: 09/23/93 / 1030
Date/Time Ended: 09/29/93 / 1430

Effluent Sampling Data			
Sample	Date/Time Collected	Lab I.D.	When Used
1	09/22/93 / 1000	45232	09/23/93, 09/24/93
2	09/24/93 / 0930	45565	09/25/93, 09/26/93, 09/27/93
3	09/27/93 / 0930	45611	09/28/93, 09/29/93

Reproduction/Mortality Data		
Conc.	Average # Offspring	% Mortality
Control	15.8	0
1%	15.2	0
3%	12.3	0
10%	12.2	0
30%	7.6	10
100%	7.2	0

Comments:

Judy L Ford
QA/QC By: Judy L. Ford, Assistant Laboratory Director

Laura F. Shealy
Reported By: Laura F. Shealy, Vice-President of Toxicological Services

SHEALY ENVIRONMENTAL SERVICES, INC.

South Carolina Ceriodaphnia Serial Dilution Chronic Toxicity Test
Statistical Analyses

Fisher's Exact Test No significant mortality observed at any effluent concentration.

Chi-Square Goodness of Fit Test
Test Statistic = 2.2
(Data normally distributed)

Bartlett's Test for Homogeneity of Variances
Bartlett's B Statistic = 19.0
(No homogeneous variance)

Wilcoxon Rank Sum Test With Bonferronni Adjustment

Concentration	Rank Sum	Critical Value
Control		
1%	94.5	74.0
3%	64.0	61.0
10%	74.0	74.0
30%	59.0	74.0
100%	55.0	74.0

NOEC (No Observed Effect Concentration)	3%
LOEC (Lowest Observed Effect Concentration)	10%
ChV (Chronic Value)	5.50%

REPRODUCTION/MORTALITY DATA
(HSP-103)

Control (0%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	6	5	5	6	4	5	4	5	4	5
5	7	10	8	7	6	9	5	6	7	10
6	4	0	0	5	7	3	6	2	3	2
7										
TOTAL	17	15	13	18	17	17	15	13	16	17
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 15.8

Treatment 1 (1%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	5	5	5	4	5	6	5	4	6	6
5	5	7	9	10	7	6	5	7	9	7
6	3	0	2	0	2	4	6	5	3	4
7										
TOTAL	13	12	16	14	14	16	16	16	18	17
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 15.2

REPRODUCTION/MORTALITY DATA CONTINUED
(HSP-103)

Treatment 4 (30%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	D/0	0	0	0	0
4	3	5	4	2	0	–	4	3	4	4
5	4	6	5	3	3	–	5	4	4	3
6	0	4	0	0	0	–	4	0	2	0
7										
TOTAL	7	15	9	5	3	0	13	7	10	7
ADULT	L	L	L	L	L	D	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 7.6

Treatment 5 (100%)

Day	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	3	3	2	3	0	3	0	4	2	0
5	2	3	3	2	3	0	3	3	2	3
6	0	0	3	4	5	4	5	0	4	3
7										
TOTAL	5	6	8	9	8	7	8	7	8	6
ADULT	L	L	L	L	L	L	L	L	L	L

L=Live
D=Dead

$\bar{X}$ = 7.2

WATER CHEMISTRY DATA
(HSP-103)

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Control	Temp. (deg.C)	24.5		24.5		25.0		25.1		24.5		24.5				
0%	D.O. (ppm)	8.00	8.50	8.40	7.70	7.90	8.20	8.30	8.40	8.40	7.80	8.30	8.70			
	pH (SU)	6.92	7.41	7.48	7.17	7.05	7.08	6.92	7.34	7.43	7.03	7.10	7.57			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.1		25.9		25.6		25.0		25.0		24.7				
1%	D.O. (ppm)	8.10	8.70	8.40	7.70	7.80	8.20	8.20	8.40	8.30	7.80	7.80	8.60			
	pH (SU)	6.83	7.66	7.55	7.34	7.31	7.32	7.22	7.59	7.57	7.22	7.30	7.72			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	24.8		25.4		24.9		25.9		26.0		25.2				
10%	D.O. (ppm)	8.30	8.60	8.40	7.70	7.60	8.20	8.00	8.50	8.30	7.80	7.80	8.80			
	pH (SU)	6.76	7.64	7.58	7.36	7.31	7.36	7.28	7.66	7.57	7.40	7.40	7.77			

			Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Conc.	Parameter	Init	old	new	old	new	old	new	old	new	old	new	old	new	old	new
Dilution	Temp. (deg.C)	25.1		25.3		25.6		25.8		25.5		25.3				
100%	D.O. (ppm)	7.70	8.40	8.10	7.40	5.70	7.90	6.40	8.20	5.90	7.50	6.20	8.60			
	pH (SU)	6.49	7.51	6.98	7.09	7.09	7.05	7.00	7.58	6.97	7.49	6.96	7.89			

100% Effluent

Sample ID:	Control	45432	45565	45611
Alkalinity (mg/l)	70	12	40	32
Hardness (mg/l)	90	32	95	60
Conductivity (umhos/cm)	183	67	93	68

APPENDIX E

1994 Toxicity Tests (from ETT Environmental, Inc., 1994a)

DEFINITIVE SURVIVAL AND REPRODUCTION

Client:WSRC	Sample ID: FSP 012	Start Date: 4-28-94	Start Time: 3:00 PM
Log #: T2439		End Date: 5-07-94	End Time: 3:00 PM

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.6		8.2
3	0	0	0	0	0	0	0	0	0	0	8.5	8.2	8.0	8.1
4	0	0	0	0	0	0	0	0	0	0	8.3	8.2	8.0	8.2
5	0	0	4	4	0	0	0	0	1	0	8.4	8.6	8.2	8.0
6	L	0	9	7	4	X	0	0	0	0	8.6	8.5	8.2	8.2
7	L	0	0	0	0	X	0	0	0	0	8.2	8.5	7.9	8.0
8	L	6	0	0	0	X	6	5	6	4	8.8	8.7	7.9	8.0
9	L	12	10	13	8	X	10	12	10	14	8.8		7.8	
TOT	0	18	23	24	12	0	16	17	17	18	16			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.1		7.7
3	0	0	0	0	0	0	0	0	0	0	8.5	8.3	7.9	7.7
4	0	6	0	0	0	4	0	0	0	3	8.4	8.4	8.1	8.0
5	2	0	7	7	7	0	0	7	6	6	8.7	8.7	8.1	8.0
6	7	0	11	15	0	0	0	0	0	0	8.4	8.4	7.8	7.4
7	0	0	0	4	8	4	0	15	0	16	8.6	8.6	7.9	7.9
8	0	5	10	0	4	0	2	11	0	0	8.8	8.8	8.1	7.9
9	14	7	0	0	0	15	7	0	14	0	8.4		8.3	
TOT	23	18	28	26	19	23	9	33	20	25	22			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.1		7.6
3	0	0	0	0	0	0	0	0	0	0	8.4	8.4	8.1	7.8
4	0	3	3	2	0	0	3	5	3	0	8.6	8.2	8.2	8.1
5	8	9	3	4	6	6	6	6	3	8	8.7	8.7	8.1	8.1
6	11	0	12	10	0	0	0	0	0	0	8.6	8.6	7.8	7.6
7	0	5	0	0	10	18	17	5	9	14	8.6	8.6	8.1	8.0
8	7	0	0	0	0	10	0	10	0	10	8.8	8.8	8.1	8.0
9	0	0	0	0	16	0	0	0	9	0	8.6		8.3	
TOT	26	17	18	16	32	34	26	26	24	32	25			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.4
3	0	0	0	0	0	0	0	0	0	0	8.4	8.4	8.0	7.7
4	0	5	0	0	0	5	5	4	4	3	8.2	8.4	8.2	8.1
5	8	10	8	10	10	9	7	0	11	8	8.8	8.8	8.1	8.1
6	12	0	14	12	0	0	0	10	0	0	8.6	8.6	7.8	7.6
7	0	13	12	0	10	13	15	5	11	13	8.6	8.6	8.0	7.9
8	10	0	0	0	10	0	0	10	0	0	8.9	8.9	8.1	8.0
9	0	0	0	0	0	0	0	0	0	0	8.8		8.1	
TOT	30	28	34	22	30	27	27	29	26	24	28			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.0		7.1
3	0	0	0	0	0	0	0	0	0	0	8.3	8.4	7.8	7.4
4	0	4	0	4	5	2	4	2	0	0	8.4	8.2	8.1	8.0
5	7	9	6	8	9	9	6	9	9	7	8.7	8.7	8.0	7.9
6	0	0	12	11	0	0	0	0	11	0	8.5	8.5	7.8	7.5
7	0	11	10	0	13	10	12	11	0	16	8.8	8.8	7.8	7.9
8	10	0	0	0	0	0	0	0	10	8	8.7	8.8	7.9	7.9
9	0	0	0	0	0	0	0	0	0	0	8.6		8.2	
TOT	17	24	28	23	27	21	22	22	30	31	25			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		7.7		6.2
3	0	0	0	0	0	0	0	0	0	0	8.4	8.4	7.3	6.7
4	0	0	3	0	3	3	3	2	0	0	8.2	8.4	7.5	7.4
5	3	0	7	4	0	5	4	8	2	0	8.6	8.6	7.5	7.5
6	5	0	10	6	0	0	0	0	0	0	8.4	8.4	7.4	7.2
7	0	0	0	0	6	0	10	0	0	7	8.6	8.6	7.6	7.5
8	10	4	0	12	14	10	0	10	12	10	8.7	8.7	7.5	7.3
9	0	12	0	0	0	0	0	0	0	0	8.6		7.8	
TOT	18	16	20	22	23	18	17	20	14	17	19			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	25.3	03:00 PM	Day 2	25.3	09:15 AM	Day 4	25.2	11:55 AM	Day 6	24.8	04:15 PM
Day 1	25.7	01:30 PM	Day 3	25.7	12:40 PM	Day 5	25.2	04:30 PM	Day 7	24.3	02:30 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec.Temp.
Dilution Water	20%DMW	4-28-94		100	82.51	232		
Final Eff. 1	Grab	4-27-94	12:30PM	7.84	13.38	30.6	<0.05	4.8°C
Final Eff. 2	Grab	4-29-94	9:00AM	7.84	13.38	36.1	0.08	3.8°C
Final Eff. 3	Grab	5-02-94	9:00AM	9.8	11.15	32.5	0.15	2.9°C

Results

Client: WSRC	Sample ID: FSP 012	IWC:
Log # : T2439	Start Date: 4-28-94	Time: 3:00 PM

CHRONIC EFFECTS

	Control	Effluent				
TEST CONCENTRATION	SC.DMW	6.25%	12.5%	25%	50%	100%
Average young / female:	16.1	22.4	25.1	27.7	24.5	18.5
Standard Deviation:	7.03	6.5	6.47	3.37	4.4	2.76
t =		-2.6	-3.7	-4.7	-3.4	-0.98
Steel's =		137	140	153	142	118

MSD= 5.64

Normality: Data Not Normal W = 0.87

Homogeneity:Data Homogeneous B = 11.3

Test Used: Steel's Test
Critical Steel's Value: 75
Critical t Value: 2.31

Chronic Toxicity

6.25%	No Chronic Toxicity
12.5%	No Chronic Toxicity
25%	No Chronic Toxicity
50%	No Chronic Toxicity
100%	No Chronic Toxicity

No-Observed-Effect Concentration (NOEC): >100%
Lowest-Observed-Effect Concentration (LOEC): >100%
7 Day EC50: >100%

DEFINITIVE SURVIVAL AND REPRODUCTION

Client:WSRC		Start Date: 6-23-94	Start Time: 3:30 PM
Log #: T2674	Sample ID: FSP204	End Date: 6-30-94	End Time: 4:15 PM IWC:

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.6		7.9
1	0	0	0	0	0	0	0	0	0	0	8.9	8.4	7.8	8.0
2	0	0	0	0	0	0	0	0	0	0	8.3	8.5	7.8	7.9
3	0	0	0	0	0	0	0	0	0	0	8.5	8.5	8.2	8.2
4	2	5	4	4	4	5	2	4	4	4	8.8	8.5	8.1	8.0
5	9	7	0	9	9	13	7	10	0	0	8.6	8.6	7.8	8.2
6	0	0	10	0	0	0	1	0	10	6	8.5	8.2	7.8	8.1
7	16	14	16	15	13	17	18	14	14	15	8.6		7.9	
TOT	27	26	30	28	26	35	28	28	28	25	28			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.5		7.7
1	0	0	0	0	0	0	0	0	0	0	8.5	8.5	7.8	7.8
2	0	0	0	0	0	0	0	0	0	0	8.4	8.4	7.9	7.8
3	0	0	0	0	0	4	0	0	0	0	8.4	8.4	8.1	8.2
4	4	5	5	6	5	0	5	7	5	5	8.8	8.6	7.6	7.7
5	9	9	1	10	10	12	0	10	0	7	8.8	8.9	7.6	7.7
6	0	0	9	0	0	0	8	0	8	2	8.0	8.2	8.1	8.2
7	12	16	12	14	13	14	10	15	13	12	8.5		8.1	
TOT	25	30	27	30	28	30	23	32	26	26	28			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.5		7.6
1	0	0	0	0	0	0	0	0	0	0	8.6	8.6	7.9	7.8
2	0	0	0	0	0	0	0	0	0	0	8.6	8.8	7.9	7.7
3	0	0	0	0	0	0	0	0	0	0	8.2	8.3	8.2	8.2
4	6	6	6	5	7	6	3	5	6	5	8.7	8.8	7.7	7.7
5	10	7	0	7	11	10	0	11	0	9	8.8	9.1	7.7	7.7
6	0	0	10	0	0	0	10	0	6	0	8.2	8.2	8.2	8.2
7	16	14	15	10	15	12	17	12	13	14	8.4		8.1	
TOT	32	27	31	22	33	28	30	28	25	28	28			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.4		7.4
1	0	0	0	0	0	0	0	0	0	0	8.7	8.6	7.8	7.5
2	0	0	0	0	0	0	0	0	0	0	8.5	8.6	8.0	7.5
3	0	0	0	0	0	0	0	0	0	0	8.2	8.4	8.2	8.1
4	6	5	6	7	5	6	6	7	6	6	9.2	9.2	7.7	7.6
5	9	8	9	10	8	10	10	9	11	10	8.8	9.1	7.8	7.5
6	0	0	0	0	0	0	0	0	0	0	8.2	8.2	8.1	8.1
7	12	14	17	16	12	15	12	11	14	14	8.4		8.1	
TOT	27	27	32	33	25	31	28	27	31	30	29			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8		6.9
1	0	0	0	0	0	0	0	0	0	0	8.8	8.8	7.7	7.1
2	0	0	0	0	0	0	0	0	0	0	8.6	8.7	8.0	7.2
3	0	0	0	0	0	0	0	0	0	0	8.4	8.3	8.2	8.1
4	6	5	2	4	4	6	3	6	5	6	8.6	8.3	7.6	7.3
5	8	0	9	6	6	8	3	3	0	0	8.4	8.2	7.7	7.1
6	0	0	7	0	0	0	10	0	6	0	8.2	8.3	8.1	8.0
7	13	14	12	9	10	10	11	10	10	12	8.5		8.0	
TOT	27	19	30	19	20	24	27	19	21	18	22			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.6		5.4
1	X	X	X	X	X	X	X	X	X	X	8.8		6.3	
2	X	X	X	X	X	X	X	X	X	X				
3	X	X	X	X	X	X	X	X	X	X				
4	X	X	X	X	X	X	X	X	X	X				
5	X	X	X	X	X	X	X	X	X	X				
6	X	X	X	X	X	X	X	X	X	X				
7	X	X	X	X	X	X	X	X	X	X				
TOT	0	0	0	0	0	0	0	0	0	0	0			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	24.1	04:00 PM	Day 2	25.4	10:00 AM	Day 4	25.4	01:00 PM	Day 6	25.3	02:30 PM
Day 1	25.0	01:30 PM	Day 3	25.0	11:00 PM	Day 5	24.3	03:00 PM	Day 7	25.0	04:15 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec.Temp.
Dilution Water	20%DMW	6-21-94		99.0	95.22	260		
Final Eff. 1	Grab	6-22-94	11:00AM	59.2	2.1	411	<0.05	8.4°C
Final Eff. 2	Grab	6-24-94	10:30AM	57.4	12.4	373	<0.05	6.1°C
Final Eff. 3	Grab	6-27-94	10:00AM	59.2	14.5	362	<0.05	3.6°C

Results

Client: WSRC	Sample ID: FSP204	IWC:
Log # : T2674	Start Date: 6-23-94	Time: 3:30 PM

CHRONIC EFFECTS

	Control	Effluent				
TEST CONCENTRATION	SC.DMW	6.25%	12.5%	25%	50%	100%
Average young / female:	28.1	27.7	28.4	29.1	22.4	0
Standard Deviation:	2.81	2.79	3.31	2.64	4.27	0.00
t =		0.28	-0.2	-0.7	3.96	0.00

MSD= 3.21

Normality: Data Normal W = 1.66

Homogeneity:Data Homogeneous B = 2.91

Test Used: Dunnett's t Test
Critical Steel's Value: 75
Critical t Value: 2.23

Chronic Toxicity

6.25%	No Chronic Toxicity
12.5%	No Chronic Toxicity
25%	No Chronic Toxicity
50%	Chronically Toxic
100%	Chronically Toxic

No-Observed-Effect Concentration (NOEC): 25%
Lowest-Observed-Effect Concentration (LOEC): 50%
7 Day EC50: 70.71%

DEFINITIVE SURVIVAL AND REPRODUCTION

Client:WSRC	Start Date: 6-23-94	Start Time: 4:00 PM	
Log #: T2684 Sample ID: HSP-008	End Date: 6-30-94	End Time: 4:00 PM	IWC:

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.6		7.9
1	0	0	0	0	0	0	0	0	0	0	8.9	8.4	7.8	8.0
2	0	0	0	0	0	0	0	0	0	0	8.3	8.5	7.8	7.9
3	0	0	0	3	5	0	0	0	0	0	8.5	8.5	8.2	8.2
4	3	4	5	1	0	7	4	2	3	4	8.8	8.5	8.1	8.0
5	8	5	9	8	7	10	10	8	10	11	8.6	8.6	7.8	8.2
6	0	0	0	0	0	0	0	0	0	0	8.5	8.2	7.8	8.1
7	16	16	14	13	11	17	17	10	15	14	8.6		7.9	
TOT	27	25	28	25	23	34	31	20	28	29	27			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.8		7.3
1	0	0	0	0	0	0	0	0	0	0	8.6	9.7	7.4	7.6
2	0	0	0	0	0	0	0	0	0	0	8.4	8.3	8.3	8.4
3	0	0	6	0	5	0	0	0	0	5	8.6	8.2	8.3	8.3
4	5	6	0	3	0	4	6	6	5	0	8.4	8.1	7.8	7.8
5	12	11	11	9	8	9	9	10	10	7	8.3	8.0	7.8	7.7
6	0	0	0	0	0	0	0	0	0	0	8.4	8.4	8.2	8.2
7	14	15	15	11	12	12	11	13	13	16	8.4		8.1	
TOT	31	32	32	23	25	25	26	29	28	28	28			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.8		7.2
1	0	0	0	0	0	0	0	0	0	0	8.8	8.6	7.7	7.5
2	0	0	0	0	0	0	0	0	0	0	8.4	8.3	8.4	8.3
3	0	5	4	4	5	0	0	7	4	4	8.5	8.3	8.4	8.2
4	5	0	0	0	0	6	7	0	0	0	8.4	8.0	7.9	7.8
5	7	14	10	13	13	12	10	9	10	12	8.6	8.0	8.0	7.7
6	0	0	0	0	0	0	0	0	0	0	8.4	8.3	8.2	8.2
7	22	19	13	19	9	12	12	14	11	11	8.2		8.1	
TOT	34	38	27	36	27	30	29	30	25	27	30			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
1	0	0	0	0	0	0	0	0	0	0		8.8		7.3
2	0	0	0	0	0	0	0	0	0	0	8.8	8.8	7.8	7.8
3	0	0	0	0	0	0	0	0	0	0	8.6	8.2	8.4	8.3
4	0	5	5	5	6	6	5	0	6	0	8.8	8.4	8.5	8.2
5	5	0	0	0	0	0	0	6	0	5	8.2	8.0	7.8	7.7
6	10	14	10	12	12	12	12	0	12	8	8.5	8.0	8.0	7.6
7	0	0	0	0	0	0	0	5	0	0	8.4	8.3	8.2	8.2
8	15	15	17	18	15	23	16	9	14	16	8.4		8.1	
TOT	30	34	32	35	33	41	33	20	32	29	32			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.8		7.0
1	0	0	0	0	0	0	0	0	0	0	8.8	8.8	7.8	7.4
2	0	0	0	0	0	0	0	0	0	0	8.4	8.4	8.3	8.2
3	0	0	5	3	4	4	4	6	6	4	8.8	8.2	8.3	8.1
4	5	5	0	0	0	0	0	0	0	0	8.2	8.0	7.8	7.6
5	13	13	10	10	11	13	8	11	13	13	8.3	7.6	7.9	7.3
6	0	0	0	0	14	0	0	0	0	0	8.2	8.3	8.2	8.1
7	16	16	17	17	2	16	18	16	20	18	8.2		8.1	
TOT	34	34	32	30	31	33	30	33	39	35	33			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
0	0	0	0	0	0	0	0	0	0	0		8.8		6.7
1	0	0	0	0	0	0	0	0	0	0	8.9	9.0	7.7	7.0
2	0	0	0	0	0	0	0	0	0	0	8.4	8.4	8.3	8.1
3	6	5	5	4	3	3	9	7	4	4	8.6	8.3	8.2	8.0
4	L	0	0	0	0	0	0	0	0	0	8.0	8.0	7.7	7.2
5	L	14	13	12	8	10	14	10	10	9	8.2	6.8	7.7	7.0
6	L	0	0	0	0	0	0	0	0	L	8.0	8.0	8.2	8.0
7	L	20	17	13	15	12	18	18	20	L	8.2		8.1	
TOT	6	39	35	29	26	25	41	35	34	13	33			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	24.1	04:00 PM	Day 2	25.4	10:30 AM	Day 4	25.4	02:00 PM	Day 6	25.3	03:00 PM
Day 1	25.0	03:00 PM	Day 3	25.0	11:00 PM	Day 5	24.3	04:00 PM	Day 7	25.0	04:00 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec.Temp.
Dilution Water	20%DMW	6-21-94		99.0	95.22	260		
Final Eff. 1	Grab	6-22-94	11:00AM	38.9	55.9	186.4	<0.05	1.1°C
Final Eff. 2	Grab	6-24-94	10:00AM	42.6	74.5	197.5	<0.05	.7°C
Final Eff. 3	Grab	6-27-94	10:00AM	37.0	89.0	211	.06	.3°C

Results

Client: WSRC	Sample ID: HSP-008	IWC:
Log # : T2684	Start Date: 6-23-94	Time: 4:00 PM

CHRONIC EFFECTS

	Control	Effluent				
TEST CONCENTRATION	SC.DMW	6.25%	12.5%	25%	50%	100%
Average young / female:	27	27.9	30.3	31.9	33.1	33
Standard Deviation:	4	3.14	4.32	5.3	2.69	5.83
t =		-0.5	-1.7	-2.6	-3.2	-2.95
Steel's =		55	55	105	86	55

MSD= 4.49

Normality: Data Not Normal W = 0.72

Homogeneity:Data Homogeneous B = 6.74

Test Used: Steel's Test
Critical Steel's Value: 75
Critical t Value: 2.31

Chronic Toxicity

6.25%	No Chronic Toxicity
12.5%	No Chronic Toxicity
25%	No Chronic Toxicity
50%	No Chronic Toxicity
100%	No Chronic Toxicity

No-Observed-Effect Concentration (NOEC): 100%
Lowest-Observed-Effect Concentration (LOEC): >100%
7 Day EC50: >100%

DEFINITIVE SURVIVAL AND REPRODUCTION

Client:WSRC	Sample ID: HSP 103	Start Date: 4-28-94	Start Time: 4:00 PM
Log #: T2441		End Date: 5-07-94	End Time: 3:15 PM

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.6		8.2
3	0	0	0	0	0	0	0	4	0	0	8.5	8.2	8.0	8.1
4	0	0	2	0	0	0	4	0	0	0	8.3	8.2	8.0	8.2
5	3	3	5	3	3	4	0	6	3	4	8.4	8.6	8.2	8.0
6	0	0	10	0	4	10	0	8	0	0	8.6	8.5	8.2	8.2
7	0	8	0	9	0	2	6	0	0	0	8.2	8.5	7.9	8.0
8	9	0	13	10	11	12	10	0	8	9	8.8	8.7	7.9	8.0
9	8	18	0	0	0	0	0	0	14	14	8.8		7.8	
TOT	20	29	30	22	18	28	20	18	25	27	24			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.5
3	0	0	0	0	2	7	4	5	0	0	8.4	8.4	7.8	7.7
4	0	0	0	0	1	1	3	0	0	0	8.6	8.6	8.2	8.1
5	2	2	3	6	9	10	11	X	4	2	8.8	8.8	7.8	7.7
6	0	0	0	0	0	11	0	X	L	0	8.6	8.5	7.9	7.6
7	0	0	0	9	0	0	0	X	L	0	8.6	8.4	7.8	7.7
8	5	7	0	0	0	0	0	X	L	2	8.9	9.0	8.1	8.0
9	8	10	14	12	0	0	0	X	L	16	8.8		8.3	
TOT	15	19	17	27	12	29	18	5	4	20	18			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		6.8
3	0	0	0	0	0	3	3	5	0	0	8.2	8.1	7.8	7.6
4	0	0	0	2	0	0	3	0	0	0	8.2	8.0	8.3	8.1
5	4	3	8	7	0	6	10	6	8	2	8.6	8.6	7.9	7.7
6	0	0	0	0	8	9	0	0	12	3	8.6	8.6	8.0	7.6
7	7	6	11	10	0	0	14	14	10	0	8.8	8.8	7.9	7.8
8	7	12	14	0	0	0	0	0	0	0	8.8	8.8	8.1	8.0
9	0	0	0	0	16	0	0	0	0	13	8.8		8.2	
TOT	18	21	33	19	24	18	30	25	30	18	24			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.3
3	0	0	0	0	1	0	0	4	0	0	8.3	8.3	7.7	7.3
4	0	0	0	3	13	0	0	0	0	0	8.4	8.4	8.3	8.1
5	8	2	4	7	0	4	2	0	2	2	8.8	8.8	7.9	7.8
6	0	0	0	0	13	14	9	9	1	0	8.6	8.6	8.0	7.5
7	X	3	1	12	0	0	0	X	X	0	8.8	8.8	8.0	7.8
8	X	10	0	0	0	0	0	X	X	0	8.8	8.8	8.2	8.0
9	X	0	14	0	0	0	10	X	X	16	8.6		8.3	
TOT	8	15	19	22	27	18	21	13	3	18	16			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.0		6.9
3	0	0	0	2	0	2	0	0	3	0	8.3	8.3	7.5	7.0
4	0	0	3	4	3	0	2	0	0	2	8.4	8.4	8.2	8.0
5	3	1	6	0	6	4	6	5	5	0	8.8	'8.	7.9	7.8
6	0	0	0	0	14	11	0	8	12	7	8.6	8.6	7.9	7.0
7	11	X	11	0	0	0	12	0	0	X	8.8	8.8	7.9	7.7
8	13	X	0	14	0	0	0	10	0	X	8.8	8.8	8.1	8.0
9	0	X	0	0	0	0	0	0	0	X				
TOT	27	1	20	20	23	17	20	23	20	9	17			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.0		5.7
3	0	0	X	X	X	X	3	0	0	0	8.0	8.2	7.2	6.8
4	X	X	X	X	X	X	0	0	0	1	8.4	8.4	8.0	7.8
5	X	X	X	X	X	X	0	0	0	0	8.3	8.2	7.0	6.8
6	X	X	X	X	X	X	X	0	0	X	8.4	8.4	7.3	6.0
7	X	X	X	X	X	X	X	0	0	X	8.7	8.7	7.8	7.4
8	X	X	X	X	X	X	X	X	X	X	8.8	8.8	8.0	7.8
9	X	X	X	X	X	X	X	X	X	X				
TOT	0	0	0	0	0	0	3	0	0	1	0			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	25.3	04:00 PM	Day 2	25.3	03:30 PM	Day 4	25.2	03:00 PM	Day 6	24.8	04:30 PM
Day 1	25.7	02:30 PM	Day 3	25.7	11:30 AM	Day 5	25.2	03:15 PM	Day 7	24.3	02:45 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec.Temp.
Dilution Water	20%DMW	4-28-94		100	82.51	232		
Final Eff. 1	Grab	4-27-94	1:10PM	5.67	40.3	11.15	<0.05	6.0°C
Final Eff. 2	Grab	4-29-94	10:00AM	5.67	51.2	8.92	<0.05	4.0°C
Final Eff. 3	Grab	5-02-94	10:00AM	3.78	46.8	13.38	<0.05	3.5°C

DEFINITIVE SURVIVAL AND REPRODUCTION

Client: WSRC	Sample ID: FMC 001F	Start Date: 4-28-94	Start Time: 4:00 PM
Log #: T2440		End Date: 5-07-94	End Time: 3:30 PM

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.6		8.2
3	0	0	0	0	0	0	0	4	0	0	8.5	8.2	8.0	8.1
4	0	0	2	0	0	0	4	0	0	0	8.3	8.2	8.0	8.2
5	3	3	5	3	3	4	0	6	3	4	8.4	8.6	8.2	8.0
6	0	0	10	0	4	10	0	8	0	0	8.6	8.5	8.2	8.2
7	0	8	0	9	0	2	6	0	0	0	8.2	8.5	7.9	8.0
8	9	0	13	10	11	12	10	0	8	9	8.8	8.7	7.9	8.0
9	8	18	0	0	0	0	0	0	14	14	8.8		7.8	
TOT	20	29	30	22	18	28	20	18	25	27	24			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.7
3	0	0	0	0	0	6	3	4	X	0	8.2	8.2	7.9	7.8
4	3	0	4	3	0	0	0	0	X	0	8.4	8.4	8.3	8.1
5	7	5	8	8	0	7	0	5	X	0	8.5	8.3	7.8	7.6
6	0	0	0	0	0	8	0	0	X	0	8.6	8.6	7.9	7.6
7	15	12	12	L	6	0	7	11	X	0	8.5	8.5	8.0	7.8
8	0	10	0	L	1	0	13	0	X	1	9.0	9.0	8.1	8.0
9	0	0	0	L	14	0	0	0	X	0	8.8		8.3	
TOT	25	27	24	11	21	21	23	20	0	1	18			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.7
3	0	3	4	2	0	5	4	3	4	0	8.4	8.4	7.9	7.7
4	0	0	0	0	0	0	3	0	0	0	8.6	8.4	8.4	8.1
5	2	6	9	6	5	8	8	10	8	3	8.8	8.6	8.0	7.8
6	0	0	0	0	0	12	0	11	12	0	8.5	8.5	8.0	7.7
7	0	11	12	13	5	0	14	0	0	13	8.6	8.5	7.9	7.8
8	0	0	0	0	0	0	0	0	0	10	9.0	9.0	8.1	8.0
9	16	0	0	0	13	0	0	0	0	0	8.6		8.3	
TOT	18	20	25	21	23	25	29	24	24	26	24			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.7
3	4	4	4	4	0	4	1	6	4	0	8.2	8.2	7.8	7.5
4	0	0	0	0	0	0	2	0	0	0	8.2	8.4	8.3	8.2
5	7	6	7	6	9	5	9	12	8	8	8.8	8.8	8.0	7.8
6	0	0	0	0	X	10	0	13	9	12	8.4	8.4	8.0	7.7
7	16	14	14	13	X	0	13	0	0	0	8.6	8.6	7.9	7.8
8	0	0	0	0	X	0	0	0	0	0	8.7	8.7	8.1	8.0
9	0	0	0	0	X	0	0	0	0	0	8.8		8.2	
TOT	27	24	25	23	9	19	25	31	21	20	22			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.3		7.5
3	4	1	4	0	3	6	5	1	4	4	8.4	8.4	7.6	7.3
4	0	0	0	0	0	0	0	3	0	0	8.4	8.2	8.3	8.1
5	10	8	6	6	9	8	11	9	8	10	8.6	8.4	8.0	7.8
6	0	0	14	0	12	12	13	13	13	10	8.4	8.3	7.9	7.8
7	18	15	0	8	0	0	0	0	0	0	8.6	8.6	7.8	7.7
8	0	0	0	0	0	0	0	0	0	0	9.0	9.0	8.1	7.9
9	0	0	0	0	0	0	0	0	0	0	8.8		8.0	
TOT	32	24	24	14	24	26	29	26	25	24	25			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.4		6.8
3	4	4	3	4	4	0	6	3	3	4	8.2	8.6	7.5	7.4
4	0	0	0	0	0	4	0	0	0	0	8.4	8.4	8.1	8.0
5	8	12	8	7	6	5	11	7	7	6	8.6	8.3	7.7	7.6
6	0	0	11	0	0	10	9	9	10	11	8.7	8.6	7.8	7.6
7	14	12	0	15	8	0	0	0	0	0	8.6	8.6	7.8	7.3
8	0	0	0	0	0	0	0	0	0	0	9.0	9.0	7.9	7.6
9	0	0	0	0	0	0	0	0	0	0	8.6		7.6	
TOT	26	28	22	26	18	19	26	19	20	21	23			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	25.3	04:00 PM	Day 2	25.3	10:00 PM	Day 4	25.2	02:15 PM	Day 6	24.8	03:30 PM
Day 1	25.7	02:00 PM	Day 3	25.7	11:30 AM	Day 5	25.2	04:00 PM	Day 7	24.3	05:00 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec.Temp.
Dilution Water	20%DMW	4-28-94		100	82.51	232		
Final Eff. 1	Grab	4-27-94	12:45PM	11.34	17.84	69.1	<0.05	5.9°C
Final Eff. 2	Grab	4-29-94	9:20AM	9.45	13.38	68.1	<0.05	3.5°C
Final Eff. 3	Grab	5-02-94	9:10AM	9.45	13.38	66.9	0.13	2.0°C

Results

Client: WSRC	Sample ID: FMC 001F	IWC:
Log # : T2440	Start Date: 4-28-94	Time: 4:00 PM

CHRONIC EFFECTS

	Control	Effluent				
TEST CONCENTRATION	SC.DMW	6.25%	12.5%	25%	50%	100%
Average young / female:	23.7	18	23.5	22.4	24.8	22.5
Standard Deviation:	4.64	10.2	3.17	5.87	4.61	3.66
t =		2.17	0.08	0.51	-0.4	0.47
Steel's =		88	104	102	111	97

MSD= 5.94

Normality: Data Not Normal W = 0.81

Homogeneity:Data Not Homogeneous B = 15.9

Test Used: Steel's Test
Critical Steel's Value: 75
Critical t Value: 2.31

Chronic Toxicity

6.25%	No Chronic Toxicity
12.5%	No Chronic Toxicity
25%	No Chronic Toxicity
50%	No Chronic Toxicity
100%	No Chronic Toxicity

No-Observed-Effect Concentration (NOEC): >100%
Lowest-Observed-Effect Concentration (LOEC): >100%
7 Day EC50: >100%

DEFINITIVE SURVIVAL AND REPRODUCTION

Client:WSRC Sample ID: UTR 022

Log #: T2434

Start Date: 4-28-94 Start Time: 3:30 PM

End Date: 5-07-94 End Time: 3:30 PM

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.6		8.2
3	2	1	0	0	0	0	0	0	0	0	8.5	8.2	8.0	8.1
4	0	0	0	0	5	0	0	3	0	0	8.3	8.2	8.0	8.2
5	X	0	3	2	9	3	4	0	4	2	8.4	8.6	8.2	8.0
6	X	0	0	0	0	0	0	0	0	0	8.6	8.5	8.2	8.2
7	X	0	0	0	9	1	2	0	0	0	8.2	8.5	7.9	8.0
8	X	10	7	5	0	7	12	6	7	8	8.8	8.7	7.9	8.0
9	X	14	10	11	0	2	0	10	8	16	8.8		7.8	
TOT	2	25	20	18	23	13	18	19	19	26	18			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.0		7.7
3	0	0	0	0	2	3	3	0	0	0	8.2	8.2	7.9	7.8
4	0	0	0	0	0	0	0	0	0	0	8.4	8.4	8.3	8.1
5	3	4	2	6	3	5	5	3	6	6	8.6	8.4	8.0	7.7
6	7	0	8	10	0	0	0	5	0	0	8.5	8.5	7.8	7.5
7	0	0	0	0	0	0	5	0	0	0	8.6	8.6	7.8	7.7
8	0	0	12	0	11	8	6	4	0	0	9.0	9.0	8.1	7.9
9	10	16	0	6	0	0	0	0	12	9	8.6		8.2	
TOT	20	20	22	22	16	16	19	12	18	15	18			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.1		7.6
3	0	0	4	0	0	5	1	0	0	0	8.3	8.3	7.9	7.7
4	0	0	0	0	0	0	0	0	0	0	8.4	8.2	8.5	8.1
5	0	3	2	0	9	5	3	5	8	6	8.4	8.4	7.8	7.7
6	9	0	0	6	0	0	0	0	0	0	8.6	8.6	7.9	7.6
7	X	0	0	0	7	0	0	5	0	0	8.8	8.8	7.9	7.8
8	X	3	3	2	5	0	3	0	0	0	8.8	8.8	8.1	8.0
9	X	13	6	15	0	11	10	6	6	12	8.6		8.2	
TOT	9	19	15	23	21	21	17	16	14	18	17			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.1		7.5
3	3	0	4	4	5	0	3	0	0	0	8.4	8.4	7.8	7.4
4	0	0	0	0	0	0	0	2	0	0	8.4	8.6	8.4	8.1
5	2	3	7	0	6	7	10	0	3	3	8.7	8.6	7.9	7.9
6	0	0	4	9	0	0	0	6	0	0	8.5	8.5	7.9	7.5
7	8	2	0	0	0	0	7	5	0	0	8.7	8.7	7.5	7.8
8	0	0	0	0	0	0	0	0	0	0	8.8	8.8	8.1	8.0
9	0	10	8	14	6	1	0	0	14	12	8.4		8.2	
TOT	13	15	23	27	17	8	20	13	17	15	17			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.1		7.1
3	0	0	1	4	0	6	0	0	0	0	8.2	8.3	7.6	7.2
4	0	0	0	0	0	0	3	2	0	0	8.0	8.2	8.2	8.1
5	2	6	2	5	7	0	9	5	0	0	8.6	8.6	7.9	7.7
6	8	0	0	8	0	0	0	0	0	0	8.4	8.8	7.8	7.2
7	0	6	4	0	5	0	0	0	0	0	8.6	8.6	7.8	7.7
8	9	9	9	0	0	0	10	4	0	0	8.8	8.8	8.0	7.9
9	0	0	0	0	8	9	0	6	0	4	8.6		8.1	
TOT	19	21	16	17	20	15	22	17	0	4	15			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		7.9		6.3
3	1	0	0	4	5	3	0	0	3	0	8.2	8.3	7.4	6.7
4	4	3	0	0	0	X	4	4	0	3	8.2	8.2	8.1	7.9
5	0	5	5	2	6	X	6	0	7	5	8.4	8.4	7.6	7.5
6	1	0	0	2	0	X	4	4	0	0	8.2	8.2	7.6	6.8
7	0	0	0	0	0	X	X	0	0	0	8.6	8.6	7.6	7.4
8	2	0	0	0	0	X	X	0	0	0	8.8	8.8	7.9	7.7
9	0	0	6	6	0	X	X	4	0	0	8.6		7.9	
TOT	8	8	11	14	11	3	14	12	10	8	10			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	25.3	03:30 PM	Day 2	25.3	03:00 PM	Day 4	25.2	03:00 PM	Day 6	24.8	04:00 PM
Day 1	25.7	01:00 PM	Day 3	25.7	11:00 PM	Day 5	25.2	02:30 PM	Day 7	24.3	03:45 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec.Temp.
Dilution Water	20%DMW	4-28-94		100	82.51	232		
Final Eff. 1	Grab	4-26-94	1:50PM	9.8	17.84	55	<0.05	5.5°C
Final Eff. 2	Grab	4-28-94	12:50PM	11.76	26.76	70.8	<0.05	5.0°C
Final Eff. 3	Grab	5-01-94	12:30PM	15.68	26.76	62.4	<0.05	2.2°C

Results

Client: WSRC	Sample ID: UTR 022	IWC:
Log # : T2434	Start Date: 4-28-94	Time: 3:30 PM

CHRONIC EFFECTS

	Control	Effluent				
TEST CONCENTRATION	SC.DMW	6.25%	12.5%	25%	50%	100%
Average young / female:	18.3	18	17.3	16.8	15.1	9.9
Standard Deviation:	6.86	3.23	4.08	5.43	7.31	3.31
t =		0.13	0.42	0.63	1.35	3.55
Steel's =		97	93.5	91	89.5	67

MSD= 5.47

Normality: Data Not Normal W = 0.84

Homogeneity:Data Homogeneous B = 10.6

Test Used: Steel's Test
Critical Steel's Value: 75
Critical t Value: 2.31

Chronic Toxicity

6.25%	No Chronic Toxicity
12.5%	No Chronic Toxicity
25%	No Chronic Toxicity
50%	No Chronic Toxicity
100%	Chronically Toxic

No-Observed-Effect Concentration (NOEC): 50%
Lowest-Observed-Effect Concentration (LOEC): 100%
7 Day EC50: >100%

DEFINITIVE SURVIVAL AND REPRODUCTION

Client:WSRC	Sample ID: UTR 029	Start Date: 4-28-94	Start Time: 2:30 PM
Log #: T2435		End Date: 5-07-94	End Time: 3:45 PM

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.6		8.2
3	0	0	0	0	0	0	0	0	0	0	8.5	8.2	8.0	8.1
4	4	4	2	4	0	0	2	0	0	2	8.3	8.2	8.0	8.2
5	6	5	3	0	5	4	5	6	3	7	8.4	8.6	8.2	8.0
6	0	0	0	7	8	8	0	10	7	0	8.6	8.5	8.2	8.2
7	0	0	0	0	0	0	0	0	0	0	8.2	8.5	7.9	8.0
8	0	0	0	0	0	0	X	0	0	0	8.8	8.7	7.9	8.0
9	10	9	12	11	0	6	X	13	7	8	8.8		7.8	
TOT	20	18	17	22	13	18	7	29	17	17	18			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.4		7.7
3	0	0	0	0	0	0	0	0	0	0	8.4	8.4	7.9	7.8
4	5	5	4	5	2	0	0	0	4	0	8.2	8.4	8.3	8.2
5	7	8	0	0	7	0	5	3	4	4	8.7	8.7	8.0	8.0
6	0	0	9	10	10	1	7	8	0	0	8.5	8.5	8.0	7.6
7	9	10	9	9	0	9	7	0	10	8	8.4	8.4	7.9	7.9
8	0	0	0	0	0	9	0	10	0	9	9.0	8.8	8.2	7.8
9	0	0	0	0	0	0	0	0	0	0	9.0		8.3	
TOT	21	23	22	24	19	19	19	21	18	21	21			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.1		7.6
3	0	0	0	0	0	0	0	0	0	0	8.3	8.2	8.0	7.8
4	5	4	8	7	8	3	4	0	1	5	8.2	8.2	8.2	8.2
5	8	7	0	0	0	0	0	5	8	0	8.7	8.7	8.1	8.0
6	8	0	6	10	10	7	6	0	0	0	8.6	8.6	8.0	7.7
7	5	0	9	0	9	0	0	4	8	0	8.4	8.4	8.0	7.9
8	0	10	0	0	0	0	0	10	10	0	9.5	9.0	8.3	7.9
9	0	0	0	12	0	13	12	0	0	10	9.0		8.4	
TOT	26	21	23	29	27	23	22	19	27	15	23			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.0		7.4
3	0	0	0	0	0	0	0	0	0	0	8.3	8.4	8.0	7.8
4	3	6	4	3	6	5	4	4	0	4	8.4	8.6	8.2	8.1
5	6	7	0	0	0	0	0	9	8	8	8.7	8.7	8.1	8.1
6	0	0	11	10	8	0	0	0	0	0	8.4	8.2	8.0	7.5
7	9	5	10	12	9	8	7	5	9	8	8.3	8.3	7.9	7.9
8	0	0	0	0	0	9	10	0	7	0	9.5	9.0	8.4	7.9
9	0	0	0	0	0	0	0	0	0	0	8.7		8.3	
TOT	18	18	25	25	23	22	21	18	24	20	21			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	X	0	0	0	0	0	0	0	0	0		8.2		6.9
3	X	0	0	0	0	0	0	0	0	0	8.6	8.6	8.0	7.7
4	X	5	10	10	4	5	4	5	5	4	8.6	8.4	8.1	8.0
5	X	7	0	0	8	7	8	6	7	9	8.7	8.7	8.0	8.0
6	X	0	9	8	7	0	0	0	0	0	8.4	8.4	7.9	7.3
7	X	8	9	8	9	0	9	7	8	9	8.4	8.4	7.7	7.7
8	X	0	0	0	0	10	0	0	0	X	9.5	8.9	8.3	7.8
9	X	0	0	0	0	0	0	0	0	X	9.0		7.9	
TOT	0	20	28	26	28	22	21	18	20	22	21			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	X	X	X	X	X	X	X	X		8.2		6.2
3	0	0	X	X	X	X	X	X	X	X	8.4	8.4	7.6	7.4
4	6	4	X	X	X	X	X	X	X	X	8.6	8.4	7.6	7.6
5	0	X	X	X	X	X	X	X	X	X	8.7	8.7	7.7	7.7
6	X	X	X	X	X	X	X	X	X	X	8.2	8.2	7.6	6.7
7	X	X	X	X	X	X	X	X	X	X	8.3	8.2	7.6	7.5
8	X	X	X	X	X	X	X	X	X	X	8.2		7.9	
9	X	X	X	X	X	X	X	X	X	X				
TOT	6	4	0	0	0	0	0	0	0	0	1			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	25.3	02:30 PM	Day 2	25.3	08:00 PM	Day 4	25.2	01:15 PM	Day 6	24.8	02:10 PM
Day 1	25.7	01:00 PM	Day 3	25.7	12:15 PM	Day 5	25.2	05:00 PM	Day 7	24.3	04:30 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec. Temp.
Dilution Water	20%DMW	4-28-94		100	82.51	232		
Final Eff. 1	Grab	4-26-94	2:00PM	21.56	20.07	106.4	<0.05	3.7°C
Final Eff. 2	Grab	4-28-94	1:00PM	25.48	17.84	98.2	<0.05	4.3°C
Final Eff. 3	Grab	5-01-94	12:50PM	21.56	26.76	89.6	0.07	2.0°C

Results

Client: WSRC	Sample ID: UTR 029	IWC:
Log # : T2435	Start Date: 4-28-94	Time: 2:30 PM

CHRONIC EFFECTS

	Control	Effluent				
TEST CONCENTRATION	SC.DMW	6.25%	12.5%	25%	50%	100%
Average young / female:	17.8	20.7	23.2	21.4	20.5	1
Standard Deviation:	5.67	1.95	4.24	2.84	7.99	2.16
t =		-1.3	-2.4	-1.6	-1.2	0.00
Steel's =		117	131	117	122	57
MSD= 5.12						

Normality: Data Not Normal W = 0.92

Homogeneity:Data Not Homogeneous B = 18.9

Test Used: Steel's Test
Critical Steel's Value: 75
Critical t Value: 2.23

Chronic Toxicity

6.25%	No Chronic Toxicity
12.5%	No Chronic Toxicity
25%	No Chronic Toxicity
50%	No Chronic Toxicity
100%	Chronically Toxic

No-Observed-Effect Concentration (NOEC): 50%
Lowest-Observed-Effect Concentration (LOEC): 100%
7 Day EC50: 65.98%

DEFINITIVE SURVIVAL AND REPRODUCTION

Client:WSRC	Sample ID: UTR 116	Start Date: 4-28-94	Start Time: 3:30 PM
Log #: T2436		End Date: 5-07-94	End Time: 3:45 PM

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	L	L		8.6		8.2
3	2	1	0	0	0	0	0	0	L	L	8.5	8.2	8.0	8.1
4	0	0	0	0	5	0	0	3	L	L	8.3	8.2	8.0	8.2
5	X	0	3	2	9	3	4	0	L	L	8.4	8.6	8.2	8.0
6	X	0	0	0	0	0	0	0	L	L	8.6	8.5	8.2	8.2
7	X	0	0	0	9	1	2	0	L	L	8.2	8.5	7.9	8.0
8	X	10	7	5	0	7	12	6	L	L	8.8	8.7	7.9	8.0
9	X	14	10	11	0	2	0	10	L	L	8.8		7.8	
TOT	2	25	20	18	23	13	18	19	0	0	17			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	L	L		8.2		7.6
3	4	0	0	0	0	0	0	0	L	L	8.2	8.2	7.9	7.7
4	0	0	0	0	0	0	0	0	L	L	8.0	8.2	8.3	8.0
5	2	0	7	0	3	3	2	2	L	L	8.4	8.4	7.8	7.7
6	8	0	0	3	0	0	0	0	L	L	8.3	8.2	7.8	7.7
7	0	2	2	0	0	2	1	3	L	L	8.7	8.7	7.9	7.9
8	9	5	0	0	0	0	0	0	L	L	8.8	8.8	8.0	8.0
9	0	14	0	8	12	9	8	12	L	L	8.6		8.1	
TOT	23	21	9	11	15	14	11	17	0	0	15			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	L	L		8.1		7.6
3	0	0	5	0	3	3	0	0	L	L	8.2	8.2	7.9	7.6
4	0	5	0	0	0	0	0	0	L	L	8.4	8.2	8.4	8.0
5	0	0	4	6	5	7	0	0	L	L	8.8	8.6	8.0	7.8
6	11	0	0	6	0	13	0	0	L	L	8.2	8.2	7.9	7.7
7	5	0	0	0	10	0	0	0	L	L	8.7	8.7	7.9	7.8
8	0	L	0	0	0	0	0	0	L	L	8.8	8.8	8.1	8.1
9	10	L	8	4	0	0	0	0	L	L	8.4		8.1	
TOT	26	5	17	16	18	23	0	0	0	0	14			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	L	L		8.1		7.5
3	3	0	5	0	0	5	0	0	L	L	8.2	8.2	7.8	7.5
4	0	0	0	0	0	0	5	3	L	L	8.2	8.2	8.4	8.1
5	0	4	5	0	0	12	9	5	L	L	8.8	8.8	8.0	7.8
6	3	0	3	0	2	0	0	0	L	L	8.2	8.2	7.8	7.8
7	11	0	5	0	0	10	3	0	L	L	8.6	8.6	7.9	7.8
8	0	0	0	0	0	0	2	9	L	L	8.7	8.7	8.1	8.0
9	0	0	0	0	4	0	0	0	L	L	8.4		8.2	
TOT	17	4	18	0	6	27	19	17	0	0	14			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	L	L		8.2		7.2
3	2	0	5	3	2	5	4	0	L	L	8.2	8.3	7.6	7.1
4	0	5	0	0	0	0	0	5	L	L	8.4	8.4	8.4	8.0
5	6	6	0	3	5	7	13	9	L	L	8.8	8.6	7.9	7.8
6	8	0	0	8	0	9	0	0	L	L	8.1	8.1	7.7	7.4
7	12	10	0	0	5	0	15	10	L	L	8.6	8.6	7.8	7.7
8	0	0	0	0	12	0	0	0	L	L	8.8	8.8	8.0	7.9
9	0	0	12	0	0	0	0	0	L	L	8.6		8.0	
TOT	28	21	17	14	24	21	32	24	0	0	23			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	L	L		8.2		5.5
3	0	0	0	0	0	0	0	0	L	L	8.2	8.2	7.0	6.0
4	0	0	0	0	0	0	0	1	L	L	8.0	8.0	8.3	8.0
5	0	0	0	0	0	0	0	0	L	L	8.3	8.3	7.2	7.2
6	0	7	0	0	0	0	0	0	L	L	8.1	8.1	7.5	6.6
7	0	0	0	0	0	0	0	5	L	L	8.5	8.5	7.1	6.9
8	0	0	0	0	0	0	0	0	L	L	8.8	8.8	7.6	7.2
9	0	0	0	0	0	2	0	0	L	L	8.6		7.6	
TOT	0	7	0	0	0	2	0	6	0	0	2			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	25.3	03:30 PM	Day 2	25.3	04:00 PM	Day 4	25.2	02:30 PM	Day 6	24.8	05:00 PM
Day 1	25.7	01:30 PM	Day 3	25.7	11:00 PM	Day 5	25.2	03:00 PM	Day 7	24.3	03:00 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec.Temp.
Dilution Water	20%DMW	4-28-94		100	82.51	232		
Final Eff. 1	Grab	4-26-94	2:30PM	1.96	6.69	17.84	0.06	4.1°C
Final Eff. 2	Grab	4-28-94	1:20PM	1.96	4.46	20.6	<0.05	4.3°C
Final Eff. 3	Grab	5-01-94	1:00PM	5.88	6.69	23.5	0.06	2.2°C

Results

Client: WSRC	Sample ID: UTR 116	IWC:
Log # : T2436	Start Date: 4-28-94	Time: 3:30 PM

CHRONIC EFFECTS

	Control	Effluent				
TEST CONCENTRATION	SC.DMW	6.25%	12.5%	25%	50%	100%
Average young / female:	17.3	15.1	13.3	13.5	22.6	1.875
Standard Deviation:	7.13	4.97	10	9.15	5.76	2.95
t =		0.6	1.13	1.06	-1.5	4.34
Steel's =		94.5	93.5	93.5	119	70.5

MSD= 8.19

Normality: Data Not Normal W = 0.87

Homogeneity:Data Homogeneous B = 11.1

Test Used: Steel's Test

Critical Steel's Value: 75

Critical t Value: 2.31

Chronic Toxicity

6.25%	No Chronic Toxicity
12.5%	No Chronic Toxicity
25%	No Chronic Toxicity
50%	No Chronic Toxicity
100%	Chronicalyy Toxic

No-Observed-Effect Concentration (NOEC): 50%

Lowest-Observed-Effect Concentration (LOEC): 100%

7 Day EC50: 64.8%

DEFINITIVE SURVIVAL AND REPRODUCTION

Client: WSRC	Sample ID: BGW 045	Start Date: 4-28-94	Start Time: 3:30 PM
Log #: T2437		End Date: 5-07-94	End Time: 3:00 PM

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.6		8.2
3	0	0	0	0	0	0	0	0	0	0	8.5	8.2	8.0	8.1
4	4	4	2	4	0	0	2	0	0	2	8.3	8.2	8.0	8.2
5	6	5	3	0	5	4	5	6	3	7	8.4	8.6	8.2	8.0
6	0	0	0	7	8	8	0	10	7	0	8.6	8.5	8.2	8.2
7	0	0	0	0	0	0	0	0	0	0	8.2	8.5	7.9	8.0
8	0	0	0	0	0	0	X	0	0	0	8.8	8.7	7.9	8.0
9	10	9	12	11	0	6	X	13	7	8	8.8		7.8	
TOT	20	18	17	22	13	18	7	29	17	17	18			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.7
3	0	0	0	0	0	0	0	0	0	0	8.2	8.2	8.0	7.8
4	4	5	4	6	0	2	4	3	0	5	8.4	8.0	8.1	8.0
5	X	5	0	0	3	0	0	0	3	0	8.4	8.5	8.2	8.2
6	X	0	5	3	0	0	0	0	0	0	8.4	8.4	8.0	7.8
7	X	12	2	0	0	0	11	12	0	0	8.7	8.7	8.1	8.1
8	X	0	0	0	0	0	13	14	13	6	9.1	8.9	8.0	7.9
9	X	0	6	10	14	13	0	0	0	10	8.4		8.3	
TOT	4	22	17	19	17	15	28	29	16	21	19			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.5
3	0	0	0	0	0	0	0	0	0	0	8.2	8.2	8.0	7.8
4	6	6	5	4	0	2	0	1	0	5	8.4	8.2	8.3	8.1
5	0	9	0	0	3	0	3	3	2	7	8.5	8.5	8.2	8.2
6	0	0	0	0	0	0	0	0	0	0	8.7	8.5	8.1	7.7
7	12	0	0	8	0	1	1	0	0	6	8.6	8.6	8.1	8.1
8	15	0	9	0	0	0	0	0	10	0	9.0	8.8	8.0	7.4
9	0	10	6	7	14	10	6	9	11	0	8.6		8.2	
TOT	33	25	20	19	17	13	10	13	23	18	19			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.5
3	0	0	0	0	0	0	0	0	0	0	8.4	8.4	8.0	7.7
4	6	4	2	5	0	5	5	3	0	3	8.4	8.4	8.2	8.1
5	6	5	0	0	3	0	5	0	3	7	8.4	8.4	8.1	8.1
6	0	0	2	13	0	0	0	0	10	0	8.4	8.2	8.0	7.7
7	6	0	0	0	0	0	14	12	0	8	8.6	8.6	8.1	8.0
8	3	0	0	0	0	0	0	0	0	0	9.2	8.9	8.0	7.9
9	0	6	12	3	9	12	0	6	16	0	8.6		8.1	
TOT	21	15	16	21	12	17	24	21	29	18	19			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	L	0	0	0	0	0		8.2		7.1
3	0	0	0	0	L	0	0	0	0	0	8.2	8.2	7.8	7.4
4	6	6	6	6	L	5	5	5	5	5	8.4	8.4	8.0	8.0
5	7	X	X	0	L	6	5	8	9	6	8.5	8.5	7.9	8.0
6	0	X	X	12	L	10	0	0	14	0	8.4	8.4	7.9	7.5
7	12	X	X	14	L	0	15	13	0	13	8.6	8.6	7.9	7.8
8	0	X	X	0	L	0	0	0	0	0	8.9	8.9	7.9	7.7
9	0	X	X	0	L	0	0	0	0	0	8.5		7.5	
TOT	25	6	6	32	0	21	25	26	28	24	21			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		7.5		5.4
3	0	0	0	0	0	0	0	0	0	0	8.2	8.3	6.4	5.8
4	6	3	6	6	3	3	1	4	1	4	8.4	8.2	7.1	7.0
5	4	7	0	0	0	0	3	0	4	0	8.6	8.6	6.7	6.7
6	0	0	8	10	11	7	X	0	0	0	8.2	8.2	6.7	6.1
7	9	10	12	11	12	0	X	10	11	10	8.6	8.6	7.1	6.9
8	0	0	0	0	0	10	X	X	9	11	9.0	8.9	6.8	6.4
9	0	0	0	0	0	X	X	X	0	0	8.4		6.0	
TOT	19	20	26	27	26	20	4	14	25	25	21			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	25.3	03:30 PM	Day 2	25.3	08:00 AM	Day 4	25.2	11:30 AM	Day 6	24.8	04:30 PM
Day 1	25.7	11:30 AM	Day 3	25.7	01:00 PM	Day 5	25.2	04:30 PM	Day 7	24.3	01:00 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec.Temp.
Dilution Water	20%DMW	4-28-94		100	82.51	232		
Final Eff. 1	Grab	4-26-94	2:50PM	<1 mg/L	4.46	46.7	<0.05	5.4°C
Final Eff. 2	Grab	4-28-94	2:00PM	<1 mg/L	4.46	39.9	<0.05	4.4°C
Final Eff. 3	Grab	5-01-94	1:30PM	<1 mg/L	6.69	32.4	<0.05	1.9°C

Results

Client: WSRC	Sample ID: BGW 045	IWC:
Log # : T2437	Start Date: 4-28-94	Time: 3:30 PM

CHRONIC EFFECTS

	Control	Effluent				
TEST CONCENTRATION	SC.DMW	6.25%	12.5%	25%	50%	100%
Average young / female:	17.8	18.8	19.1	19.4	21.4	20.6
Standard Deviation:	5.67	7.08	6.72	4.88	9.25	7.15
t =		-0.3	-0.4	-0.5	-1.2	-0.91
Steel's =		103	102	104	119	122

MSD= 7.14

Normality: Data Not Normal W = 0.89

Homogeneity:Data Homogeneous B = 3.9

Test Used: Steel's Test
Critical Steel's Value: 75
Critical t Value: 2.31

Chronic Toxicity

6.25%	No Chronic Toxicity
12.5%	No Chronic Toxicity
25%	No Chronic Toxicity
50%	No Chronic Toxicity
100%	No Chronic Toxicity

No-Observed-Effect Concentration (NOEC): >100%
Lowest-Observed-Effect Concentration (LOEC): >100%
7 Day EC50: >100%

DEFINITIVE SURVIVAL AND REPRODUCTION

Client:WSRC Sample ID: UTR RR Bridge	Start Date: 4-28-94 Start Time: 3:00 PM
Log #: T2438	End Date: 5-07-94 End Time: 3:00 PM

TEST CONCENTRATION: 0%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.6		8.2
3	0	0	0	0	0	0	0	0	0	0	8.5	8.2	8.0	8.1
4	0	0	0	0	0	0	0	0	0	0	8.3	8.2	8.0	8.2
5	0	0	4	4	0	0	0	0	1	0	8.4	8.6	8.2	8.0
6	L	0	9	7	4	X	0	0	0	0	8.6	8.5	8.2	8.2
7	L	0	0	0	0	X	0	0	0	0	8.2	8.5	7.9	8.0
8	L	6	0	0	0	X	6	5	6	4	8.8	8.7	7.9	8.0
9	L	12	10	13	8	X	10	12	10	14	8.8		7.8	
TOT	0	18	23	24	12	0	16	17	17	18	16			

TEST CONCENTRATION: 6.25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.8
3	0	0	0	0	0	0	0	0	0	0	8.2	8.2	8.1	7.8
4	0	3	0	2	0	0	3	2	0	0	8.2	8.2	8.2	8.2
5	1	0	2	2	5	0	1	0	0	6	8.7	8.6	8.1	8.0
6	0	0	10	8	0	0	0	0	0	0	8.3	8.2	7.9	7.6
7	0	1	0	0	0	0	2	0	0	5	8.4	8.4	8.1	8.1
8	0	0	0	7	8	6	6	0	10	0	8.8	8.9	8.0	7.9
9	16	11	14	0	14	13	0	13	13	16	8.6		8.2	
TOT	17	15	26	19	27	19	12	15	23	27	20			

TEST CONCENTRATION 12.5%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.2		7.7
3	0	0	X	0	0	0	0	0	0	0	8.5	8.5	8.1	7.8
4	0	0	X	4	0	0	4	1	0	0	8.6	8.4	8.3	8.2
5	1	0	X	3	0	0	0	6	1	0	8.6	8.6	8.1	8.0
6	0	0	X	4	0	0	0	0	0	0	8.4	8.4	7.9	7.7
7	0	0	X	0	11	6	0	4	6	10	9.0	9.0	8.2	7.8
8	4	8	X	0	0	9	5	6	9	X	8.8	8.8	8.0	8.0
9	12	8	X	14	7	11	6	0	0	X	8.8		8.2	
TOT	17	16	0	25	18	26	15	17	16	10	16			

TEST CONCENTRATION 25%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.4		7.8
3	0	0	0	0	0	0	0	0	0	0	8.3	8.3	7.9	7.9
4	0	5	0	3	0	0	0	0	0	0	8.2	8.4	8.3	8.2
5	1	0	0	8	0	7	0	3	X	2	8.6	8.6	8.1	8.0
6	0	0	14	12	0	0	0	0	X	0	8.4	8.4	7.9	7.7
7	0	6	13	0	4	5	5	11	X	1	8.6	8.6	8.1	8.0
8	6	0	0	0	0	0	0	0	X	0	8.8	8.8	8.1	8.0
9	9	11	0	0	10	13	12	0	X	14	8.6		8.2	
TOT	16	22	27	23	14	25	17	14	0	17	18			

TEST CONCENTRATION 50%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.4		7.6
3	0	0	0	0	0	0	0	0	0	0	8.3	8.3	7.7	7.9
4	2	0	1	2	0	1	3	3	3	5	8.2	8.4	8.1	8.0
5	0	7	6	4	1	3	X	1	4	5	8.8	8.8	7.9	7.9
6	11	0	10	12	0	0	X	0	0	0	8.4	8.4	7.8	7.6
7	0	9	10	0	0	0	X	6	X	14	8.6	8.6	8.0	7.9
8	8	10	0	0	0	5	X	11	X	0	9.0	9.0	8.1	7.9
9	0	0	0	0	11	10	X	0	X	0	8.8		8.0	
TOT	21	26	27	18	12	19	3	21	7	24	18			

TEST CONCENTRATION 100%

Day	A	B	C	D	E	F	G	H	I	J	D.O old	D.O new	pH old	pH new
2	0	0	0	0	0	0	0	0	0	0		8.4		6.2
3	0	0	0	0	0	0	0	0	0	0	8.4	8.4	6.5	7.2
4	0	0	2	2	1	3	4	4	0	0	8.6	8.4	7.4	7.3
5	2	6	0	0	0	7	5	7	5	4	8.8	8.8	7.0	6.9
6	9	8	8	10	0	0	0	0	0	0	8.5	8.5	7.4	7.3
7	0	10	10	0	7	10	10	2	10	12	8.6	8.6	7.6	7.3
8	10	0	0	9	9	0	0	9	13	10	8.7	8.8	7.6	7.4
9	0	0	0	0	0	0	0	0	0	0	8.4		7.9	
TOT	21	24	20	21	17	20	19	22	28	26	22			

	TEM. °C	Time		TEM. °C	Time		TEM. °C	Time		TEM. °C	Time
Day 0	25.3	03:00 PM	Day 2	25.3	04:00 PM	Day 4	25.2	01:30 PM	Day 6	24.8	03:00 PM
Day 1	25.7	10:30 AM	Day 3	25.7	12:00 PM	Day 5	25.2	05:00 PM	Day 7	24.3	02:00 PM

SAMPLING INFORMATION

	Type	Start Date	Time	Hardness Mg/L	Alkalinity	Conductivity	Res. Cl	Rec.Temp.
Dilution Water	20%DMW	4-28-94		100	82.51	232		
Final Eff. 1	Grab	4-26-94	3:50PM	9.8	8.92	29.1	<0.05	4.7°C
Final Eff. 2	Grab	4-28-94	2:45PM	3.92	6.69	18.51	<0.05	5.2°C
Final Eff. 3	Grab	5-01-94	2:00PM	5.88	4.46	18.69	<0.05	2.9°C

Results

Client: WSRC	Sample ID: UTR RR Bridge	IWC:
Log # : T2438	Start Date: 4-28-94	Time: 3:00 PM

CHRONIC EFFECTS

	Control	Effluent				
TEST CONCENTRATION	SC.DMW	6.25%	12.5%	25%	50%	100%
Average young / female:	16.1	20	16	17.5	17.8	21.8
Standard Deviation:	7.03	5.46	7.3	7.68	8.04	3.33
t =		-1.3	0.04	-0.5	-0.6	-1.86
Steel's =		109	87	98	108	123.5

MSD= 7.07

Normality: Data Not Normal W = 0.84

Homogeneity:Data Homogeneous B = 7.38

Test Used: Steel's Test

Critical Steel's Value: 75

Critical t Value: 2.31

Chronic Toxicity

6.25% No Chronic Toxicity

12.5% No Chronic Toxicity

25% No Chronic Toxicity

50% No Chronic Toxicity

100% No Chronic Toxicity

No-Observed-Effect Concentration (NOEC): >100%

Lowest-Observed-Effect Concentration (LOEC): >100%

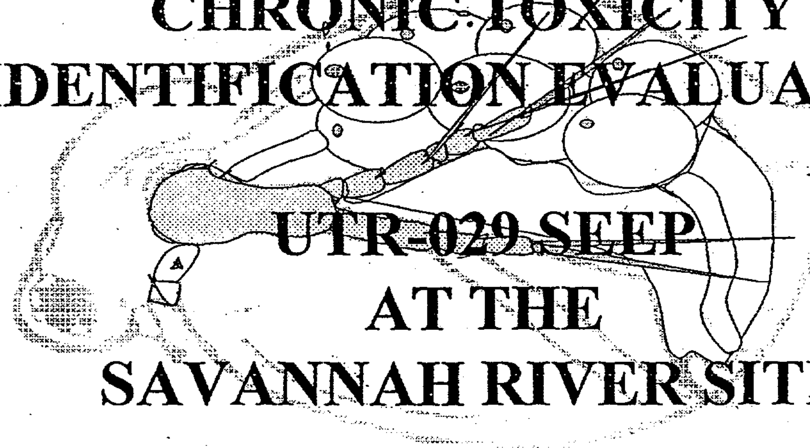
7 Day EC50: >100%

APPENDIX F

UTR-029 TIE Studies (from ETT Environmental, 1994b, 1995a)

ETT Environmental, inc.

CHRONIC TOXICITY IDENTIFICATION EVALUATION



UTR-029 SEEP AT THE SAVANNAH RIVER SITE

Prepared for Westinghouse Savannah River Company
(Subcontract #AB53050N)

November 1994

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1.0 INTRODUCTION

In April 1993 a water sample from seep UTR-029 was analyzed for a large number of inorganic and organic parameters as part of the program for *Sampling and Analysis of Water from Upper Three Runs Creek and Its Wetlands Near Tank 16 and the Mixed Waste Management Facility.* That study demonstrated the presence of elevated levels of aluminum (5.93 mg/L), iron (17.7 mg/L), manganese (1.9 mg/L), TSS (308 mg/L), and zinc (32.5 mg/L), and a moderately high hardness (59 mg/L). A year later, in April 1994, a chronic survival and reproduction toxicity test with *Ceriodaphnia dubia* was conducted on the UTR-029 seep water by ETT Environmental, Inc. This test showed the sample to be acutely and chronically toxic at 100% concentration, although toxicity was removed through dilution to 50% concentration.

The presence of acute and chronic toxicity in UTR-029 seep water triggered a partial chronic Toxicity Identification Evaluation (TIE), of which Phase I was initiated in November 1994. Due to the detection of elevated levels of several heavy metals in April 1993, a sample of UTR-029 seep water was analyzed for a series of metals immediately prior to the start of the TIE. This study confirmed high levels of dissolved (or colloidal) iron (2.09 mg/L). Other metals, such as aluminum, manganese, and zinc, which were demonstrated to be elevated in April 1993, were found to be present at much lower concentrations in November 1994.

As a result of data indicating elevated levels of several heavy metals in the seep samples, only those TIE treatments effective at reducing or removing metals toxicity were conducted. Specifically, the UTR-029 sample was subjected to four treatments; 1) adjustment to pH 10 followed by filtration, 2) addition of sodium thiosulfate, 3) chelation with diSodium EDTA, 4) graduated pH. Chronic toxicity tests were conducted on all treated samples. The purpose of this first Phase of the TIE was to determine if the toxicity in the seep sample was consistent with identity as a heavy metal, by assessing if treatments for metals were effective at removing toxicity.

2.0 SAMPLING

A single grab sample of the UTR-029 seep water was collected by WSRC personnel on November 14, 1994. The sample was shipped by overnight delivery to ETT Environmental, where the TIE was conducted.

3.0 SAMPLE TREATMENTS

The sample was subjected to a series of treatments to attempt to remove toxicity. Each treated sample was used in a chronic definitive toxicity test to determine the effectiveness of the treatment. The treatments and results of the associated toxicity tests are summarized as follows:

Treatment	Start Date	Sample ID	Toxicants removed
Filtered/pH 10 Adjustment	11/16/94	TI3278-8	metals insoluble at pH 10
Na Thiosulfate Addition	11/16/94	TI3278-15	residual chlorine; some metals
EDTA Chelation	11/17/94	TI3278-25	some metals; surfactants
Graduated pH	11/16/94	TI3278-26	ammonia; metals; sulfide

Baseline tests, in which the seep sample was untreated, were set on the 16th and 17th of November. The initial pH of the UAR-029 samples was 5.55. This value was considered to be near the lower pH tolerance limit for *Ceriodaphnia dubia.* Therefore the pH of all undiluted test solutions was adjusted somewhat higher, to pH 6.00, so that toxicity due to pH would not confound the results.

At test initiation it was not known whether the sample would demonstrate acute toxicity. If the sample proved to be acutely toxic, and the toxicant was a metal, it is likely that the amounts of EDTA added for chronic treatments (0.5 - 8.0 mg/L) would be insufficient to remove toxicity. Therefore, an EDTA addition treatment at an acute level was also performed, using levels of EDTA high enough to remove acute toxicity due to a metal, but chronically toxic to *Ceriodaphnia dubia* (45-190 mg/L).

Methodology for the individual treatments is discussed below by treatment.

3.1 Filtration/Adjustment to pH 10

A 2000 mL aliquot of the sample was adjusted to pH 10.09 with 0.25 mL of NaOH. A 200 mL aliquot of dilution water was adjusted to pH 10.00 with 0.74 mL of NaOH, to serve as a control. Both the pH adjusted control and the pH adjusted sample were filtered through a Gelman Type A/E glass fiber filter. The control was filtered first. After filtration the pH was recorded. The pH of the control was readjusted to 8.04 with 1.25 mL of H_2SO_4 and the pH of the sample was readjusted to 6.08 with 0.45 mL of H_2SO_4. This treated sample was used for the toxicity test identified as Filtration/pH 10 Adjustment.

3.2 Oxidant Reduction

A 2.5 g/L stock solution of sodium thiosulfate was prepared. This stock solution was added to aliquots of undiluted sample water as follows;

Amt. Sodium Thiosulfate	Amount Sample	Final Concentration
200 µL	500 mL	1.0 mg/L
1000 µL	500 mL	5.0 mg/L
2000 µL	500 mL	10.0 mg/L

After addition of the sodium thiosulfate, the test solutions were allowed to sit for two hours. In the same manner dilution water controls were treated with sodium thiosulfate, as follows;

Amt. Sodium Thiosulfate	Amount 20% DMW	Final Concentration
40 µL	100 mL	1.0 mg/L
200 µL	100 mL	5.0 mg/L
400 µL	100 mL	10.0 mg/L

Effluent test solutions were re-adjusted to pH 6.0 ± 0.05, and control test solutions to approximately pH 8.00 ±0.05, after addition of sodium thiosulfate.

3.3 EDTA Chelation

A 15 g/L stock solution of diSodium EDTA was prepared by adding 7.5 g to 500 mL of demineralized water. This stock solution was used to prepare aliquots of sample with 45 mg/L, 19 mg/L, and 9 mg/L. These aliquots were used for an acute definitive test. A 2.5 g/L stock solution of EDTA was prepared by adding 16.7 mL of the 15 g/L stock solution to 100 mL of demineralized water. This stock solution was used to prepare aliquots of sample with 0.5, 3.0, and 8.0 mg/L of EDTA. These aliquots were used for a chronic definitive toxicity test. Dilution water controls were prepared in the same manner. After addition of the EDTA the solutions were adjusted to the initial pH (8.0 for dilution water; 6.0 for UTR-029). Aliquots of sample with EDTA added were left for 24 hours prior to use in testing, because equilibration times can be relatively slow for some metals. Immediately prior to testing pH values were readjusted to the initial measured pH.

3.4 Graduated pH Test

An effluent test was to be conducted at pH 6.0 and pH 8.5. A 1.5 L aliquot of effluent to be used for the test at pH 6.0 was treated by adding 1.21 g/L of MES buffer to stabilize the pH. After MES addition the aliquot was adjusted to pH 5.96 with 0.85 mL of NaOH. A 1.5 L aliquot of effluent to be used for the test at pH 8.5 was treated by adding 2.3 g/L of POPSO buffer to stabilize the pH. After POPSO addition the aliquot was adjusted to pH 8.46 with 0.6 mL of NaOH. Buffers were also added to controls to check for buffer toxicity.

4.0 TOXICITY TESTING METHODS

Chronic (3 brood) survival and reproduction toxicity tests were set with all treated effluent samples. The baseline test, the pH 10 adjustment/filtration test, and the graduated pH test were set with dilutions of 20%, 40%, 60%, 80% and 100% seep water. Dilutions of 25%, 50% and 100% were used for each EDTA treatment test, and dilutions of 20%, 60%, and 100% were used for each treatment of the sodium thiosulfate addition test. The test organism was *Ceriodaphnia dubia*. The dilution water was 20% diluted mineral water (20% DMW) with a hardness of 80-100 mg/L. Each test dilution was comprised of five replicate test organisms. A treated control (one replicate) was prepared for each treatment set, where dilution water was subjected to the same treatment as the seep samples.

Initially the treatment test solutions were to be renewed on the second and fifth day after test initiation, except in the graduated pH test, where test solutions were to be renewed daily in conjunction with pH adjustment. However, by Day 4 of the test it was clear that no acute toxicity was present in the sample, and chronic toxicity appeared to be present in undiluted sample of the graduated pH test but not in the baseline test. These data led to the conclusion that daily renewals were necessary for toxicity to be manifest. Therefore it was decided to change test solutions daily from Test Day 4 through the end of the test, to maximize exposure of test organisms to toxicants. In addition, the 20% and 40% test concentrations were discontinued on Test Day 5, due to lack of chronic toxicity.

pH was measured at test initiation, test termination, and before and after test solution renewal, for the control treatments and the 100% dilution treatments.

An acute toxicity test on seep sample chelated with diSodium EDTA was set with two replicates of ten test organisms at dilutions of 20%, 40%, 60%, 80%, and 100%. The length of the test was 48 hours.

4.0 RESULTS

A summary of the results is provided below. All treatments were effective at substantially reducing or removing toxicity except the graduated pH test.

Treatment	Date	Sample ID	Result
Filtered/pH 10 Adjustment	11/16/94	TI3278-8	Toxicity reduced
Na Thiosulfate Addition	11/16/94	TI3278-15	Toxicity reduced
EDTA Chelation	11/17/94	TI3278-25	Toxicity reduced
Graduated pH	11/16/94	TI3278-26	Toxicity slightly greater at pH 8.5

4.1 Baseline Test

The baseline test indicated that the UAR-029 seep sample did not affect the survival of *Ceriodaphnia dubia*. Thus, the sample used in this study was not as toxic as the samples collected in April 1994. No chronic toxicity was noted in 20% and 40% dilutions prior to Day 5 of the test, when these dilutions were terminated. Production of first and second broods by test organisms exposed to these dilutions was similar to that noted in the controls. In the 60% and 80% dilutions reproduction over the course of the test was only slightly lower than in the control (Table 1). This slight decrease was not considered to be significant. A substantial reduction in reproduction was noted, however, in 100% UAR-029 sample. This reduction was primarily observed in the third brood, formed after daily renewals were instituted. Due to one replicate with particularly low reproduction, the coefficient of variation (CV) for the effluent was relatively high (45%). The CV for the control was low (18%). Although pH readings in the 100% effluent started at pH 6.0 at each renewal, pH levels drifted upward between renewals, reaching a maximum of 8.44 on Test Day 5.

4.2 Filtered / pH 10 Adjustment Treatment

Adjustment of the pH of the sample to a value of 10.09 resulted in a change in the color of the sample from clear to a pale orange color. When the adjusted sample was filtered an orange precipitate was left on the filters, which rapidly became clogged. Three separate filters were needed to complete filtration of the 3 L of sample. The filtrate was clear.

Reproduction decreased only slightly with increasing sample concentration, reaching a minimum of 21.2 young per female in the 100% dilution (Table 1). This represented a maximum reduction in reproduction of 17%, which is not considered to be significant. It is clear that adjustment of the pH to 10.09, in conjunction with filtration, greatly reduced toxicity and likely removed it completely.

4.3 Sodium Thiosulfate Addition Test

Treated control data indicated no chronic toxicity was imparted by addition of either 1, 5, or 10 mg/L of sodium thiosulfate. As noted above, 100% UTR-029 sample was chronically toxic to the test organisms, with a mean reproduction of 12.8 young per female. Addition of 1 mg/L of sodium thiosulfate increased mean reproduction to 25.0 young per female (Table 2), which was approximately the same as the dilution water control (25.8). Thus, sodium thiosulfate (at 1 mg/L) was effective at removing chronic toxicity from the seep water. At higher additions of sodium thiosulfate (5-10 mg/L), the sodium thiosulfate itself appears to have been chronically toxic. It should be noted that although 5-10 mg/L of sodium thiosulfate in the seep sample was chronically toxic, the same amount in dilution water was not chronically toxic. This suggests that characteristics of the dilution water, such as higher hardness and alkalinity, may have mitigated the toxicity of sodium thiosulfate.

4.4 EDTA Chelation

Treatment controls at 0.5 and 3.0 mg/L of EDTA addition indicated suppressed reproduction. Dissimilarly, the 8.0 mg/L control showed mean reproduction equivalent to the untreated control. It is not clear why the lower EDTA addition treatments demonstrated chronic toxicity. The same pattern was evident in the 50% sample dilution (Table 3), but not in the 100% sample concentration. At 100% sample concentration the 0.5 mg/L addition of EDTA increased mean reproduction slightly (15.8) as compared to the untreated sample (12.8), but the reproduction remained substantially lower than in the untreated control (25.8). The addition of 3.0 mg/L of EDTA was effective at removing toxicity from the sample. At higher levels of EDTA (8.0 mg/L) the EDTA itself appeared to be chronically toxic.

Acute toxicity testing using 45-190 mg/L indicated that 90 mg/L and higher amounts of EDTA were acute toxic to the test organisms. No acute toxicity was removed since none was present.

4.5 Graduated pH Test

UAR-029 seep water was chronically toxic at 100% concentration both at pH 6.0 and pH 8.5 (Table 4). There was also a slight reduction in reproduction at 80% dilution in both pH regimes. It is likely that the presence of chronic toxicity at 80% concentration, which was absent in the baseline test, is related to the daily water renewals throughout the test. The reduction in reproduction in the 100% concentration was greater at pH 8.5 than at pH 6.0. The MES buffer held the pH steady in the pH 6.0 treatment. However, the POPSO buffer did not prevent the pH from falling slightly by 0.1 unit over each 24 hour cycle.

5.0 DISCUSSION

Analyses of dissolved metals prior to the TIE treatments and tests, as discussed above, showed the presence of 2.09 mg/L of iron, 0.71 mg/L of manganese, and 17.1 µg/L of zinc. Acute toxicity data generated at ETT Environmental have shown acute toxicity from iron (spiked as ferric nitrate into 20% diluted mineral water) to *Ceriodaphnia dubia* at levels as low as 0.26 mg/L, from manganese (spiked as manganese chloride into 20% diluted mineral water) at levels as low as 62 mg/L, and from zinc (spiked as zinc sulfate into 20% diluted mineral water) at levels as low as 50 µg/L. It is likely, due to the relatively low hardness and probable low levels of humic and fulvic acids in the seep water, that these metals would be more toxic in UTR-029 water than in 20% diluted mineral water. If toxicity of metals is similar in the two types of water, there appears to be more than enough iron present in the seep water, depending upon bioavailability, to be toxic to the test organisms. It also appears that levels of manganese and zinc are too low to cause acute toxicity, although there may be enough zinc to produce chronic toxicity. The color change noted with pH adjustment to pH 10, and the orange precipitate left on the filters, is also consistent with the presence of iron.

Each test, except the graduated pH test was effective at removing chronic toxicity. These results are consistent with the expectation that the toxicant would be a metal. Most cationic metals are less soluble at an alkaline pH than at an acidic or neutral pH where the aquo ion form predominates. Thus, an increase in pH tends to precipitate out metals and remove them from bioavailability. If the pH of a sample is raised to 10-11, and the sample is filtered before the pH is brought back to neutral, the metals can be removed in the precipitate on the filter. It is thought that this is what occured in the pH 10 adjustment/filtration test, and based on the color of the precipitate, iron is the most likely metal. EDTA is known to be effective at reducing the bioavailability of a number of cationic metals, including iron, manganese and zinc (EPA 600/6-91/003; EPA 600/R-92/080). These EPA documents also note that zinc is removed from bioavailability by sodium thiosulfate, that manganese is not, and do not specify whether iron responds to this treatment. The effectiveness of the sodium thiosulfate addition also testifies to the presence of a cationic metal toxicant, and suggests that manganese is probably not the metal of concern. It may have been expected that chronic toxicity would have been less at pH 8.5 than at pH 6.0, due to reduced bioavailability of metals such as iron and zinc. However, EPA documents (EPA 600/6-91/003) suggest that zinc is in fact more toxic at pH 8.0 than at pH 6.5, and no data is presented on the effect of pH on iron toxicity.

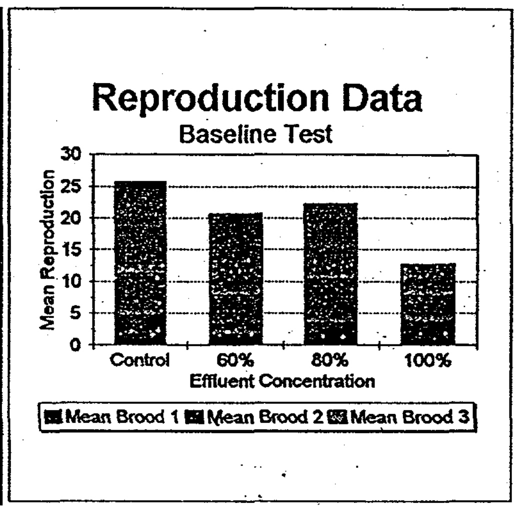
In light of the above discussion, it appears that chronic toxicity is likely due to cationic metals, and iron is the probable primary toxicant.

6.0 RECOMMENDATIONS

It is recommended that a TIE Phase II be conducted in order to identify and confirm the cationic metal causing the chronic toxicity in the UTR-029 seep water. This would involve preparation of treated or simulated seep water which would then be spiked with the level of iron measured in the effluent and tested to determine if the level of toxicity is parallel to that noted in the untreated sample.

Table 1
UTR-029 Chronic TIE Test Results
Baseline Test and pH 10 Adjustment with Filtration Test
Westinghouse Savannah River Company
November 1994

Baseline Test	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	25	26	17	17
Replicate B	29	30	19	3
Replicate C	18	18	23	16
Replicate D	27	21	19	16
Replicate E	30	14	34	12
Mean Brood 1	4.6	1.6	3.4	3.6
Mean Brood 2	6.6	6.2	7.0	4.2
Mean Brood 3	14.6	13.0	12.0	5.0
Mean	25.8	21.8	22.4	12.8
Std. Dev.	4.76	6.34	6.84	5.81
Coeff. of Var.	18%	29%	31%	45%
Mean pH (old)	7.98			7.60
Mean pH (new)	8.04			6.02



pH 10 Adj. Filtration	Reproduction by Test ~~Dilution~~			
	Control	60%	80%	100%
Replicate A	25	22	16	23
Replicate B	29	24	25	22
Replicate C	18	21	25	21
Replicate D	27	28	21	18
Replicate E	30	24	26	22
Mean Brood 1	4.6	3.6	2.8	3.0
Mean Brood 2	6.6	5.6	5.0	5.4
Mean Brood 3	14.6	14.6	14.8	12.8
Mean	25.8	23.8	22.6	21.2
Std. Dev.	4.76	2.68	4.16	1.92
Coeff. of Var.	18%	11%	18%	9%
Mean pH (old)	8.55			7.78
Mean pH (new)	8.04			6.07

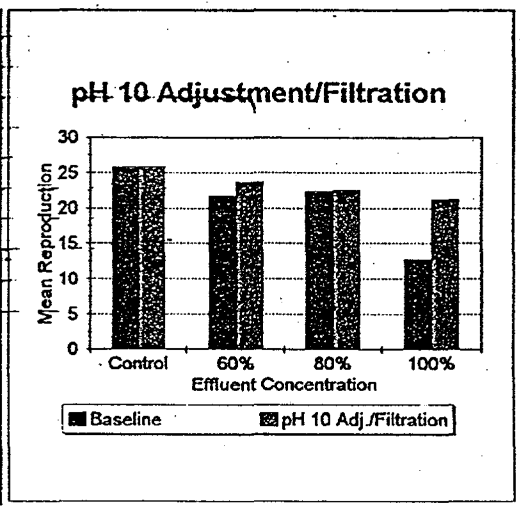
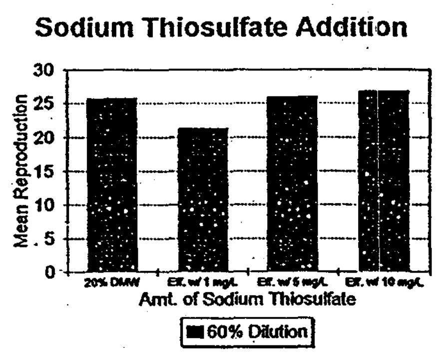


Table 2
UTR-029 Chronic TIE Test Results
Sodium Thiosulfate Addition Test
Westinghouse Savannah River Company
November 1994

Sodium Thiosulfate Addition	Reproduction at 60% Dilution			
	20% DMW Dilution Water	60% Effluent with 1 mg/L Na Thiosulfate	60% Effluent with 5 mg/L Na Thiosulfate	60% Effluent with 10 mg/L Na Thiosulfate
Replicate A	25	21	21	27
Replicate B	29	30	no replicate	31
Replicate C	18	25	29	21
Replicate D	27	23	30	32
Replicate E	30	8	24	23
Mean Brood 1	4.6	4.4	5.7	4.0
Mean Brood 2	6.6	8.6	6.3	7.2
Mean Brood 3	14.6	8.4	14.0	15.6
Mean	25.8	21.4	26.0	26.8
Std. Dev.	4.76	8.20	4.24	4.82
Coeff. of Var.	18%	38%	16%	18%
Mean pH (old)				
Mean pH (new)				



Sodium Thiosulfate Addition	Reproduction at 100% Dilution			
	20% DMW Dilution Water	100% Effluent with 1 mg/L Na Thiosulfate	100% Effluent with 5 mg/L Na Thiosulfate	100% Effluent with 10 mg/L Na Thiosulfate
Replicate A	25	25	24	5
Replicate B	29	27	13	6
Replicate C	18	31	25	10
Replicate D	27	23	9	7
Replicate E	30	19	20	no replicate
Mean Brood 1	4.6	4.2	2.2	2.2
Mean Brood 2	6.6	9.6	7.8	3.4
Mean Brood 3	14.6	11.2	8.2	0.0
Mean	25.8	25.0	18.2	7.0
Std. Dev.	4.76	4.47	6.98	2.16
Coeff. of Var.	18%	18%	38%	31%
Mean pH (old)	8.55	7.30	7.57	7.45
Mean pH (new)	8.04	6.02	6.00	5.98

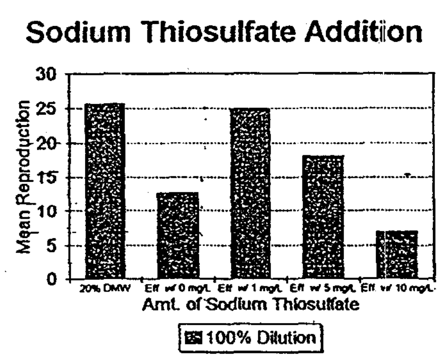
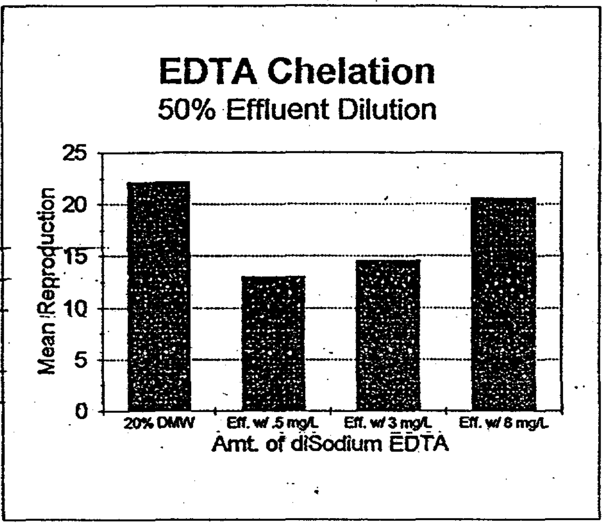


Table 3
UTR-029 Chronic TIE Test Results
EDTA Chelation Addition Test
Westinghouse Savannah River Company
November 1994

EDTA Chelation (11/17/94)	Reproduction at 50% Dilution			
	Untreated 20% DMW Dilution Water	50% Effluent with 0.5 mg/L diSodium EDTA	50% Effluent with 3 mg/L diSodium EDTA	50% Effluent with 8 mg/L diSodium EDTA
Replicate A	20	22	10	19
Replicate B	15	4	22	25
Replicate C	22	4	18	18
Replicate D	28	16	6	19
Replicate E	26	19	17	22
Mean Brood 1	3.4	4.2	4.2	3.8
Mean Brood 2	7.0	3.4	4.8	7.0
Mean Brood 3	11.8	5.4	5.6	9.8
Mean	22.2	13.0	14.6	20.6
Std. Dev.	5.12	8.49	6.47	2.88
Coeff. of Var.	23%	65%	44%	14%
Mean pH (old)				
Mean pH (new)				



EDTA Chelation (11/18/94)	Reproduction at 100% Dilution			
	Untreated 20% DMW Dilution Water	100% Effluent with 0.5 mg/L diSodium EDTA	100% Effluent with 3 mg/L diSodium EDTA	100% Effluent with 8 mg/L diSodium EDTA
Replicate A	30	9	30	26
Replicate B	20	23	33	25
Replicate C	32	17	26	23
Replicate D	37	2	25	27
Replicate E	29	28	21	9
Mean Brood 1	5.2	2.8	3.2	2.0
Mean Brood 2	8.8	4.4	8.0	8.0
Mean Brood 3	15.6	8.6	15.8	12.0
Mean	29.6	15.8	27.0	22.0
Std. Dev.	6.19	10.47	4.64	7.42
Coeff. of Var.	21%	66%	17%	34%
Mean pH (old)	7.79	7.53	7.43	7.28
Mean pH (new)	8.03	5.97	6.03	5.99

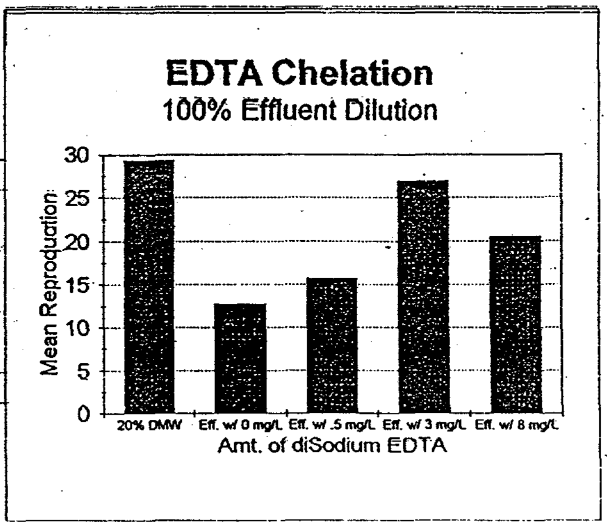
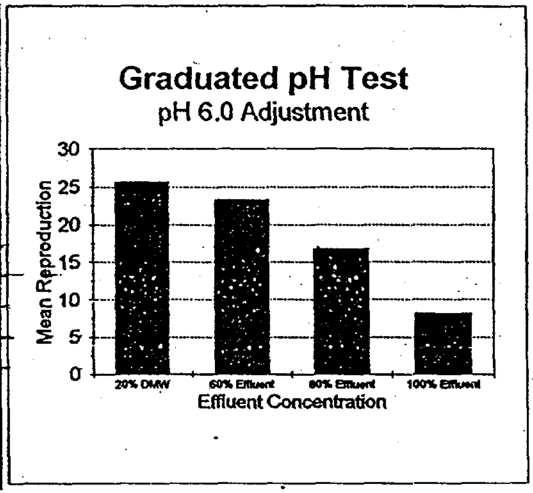
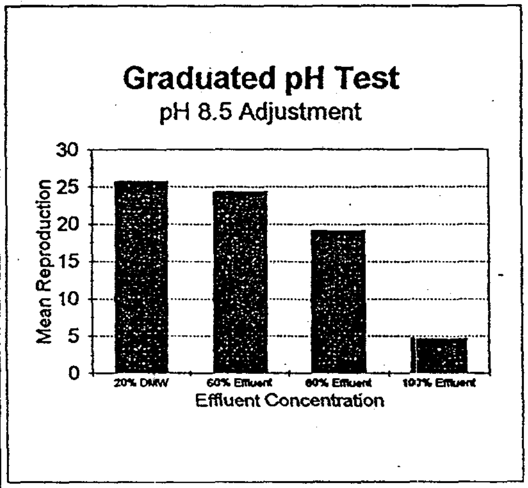


Table 4
UTR-029 Chronic TIE Test Results
Graduated pH Test
Westinghouse Savannah River Company
November 1994

	20% DMW Untreated Dilution Water	60% Effluent Adjusted to pH 6.0	80% Effluent Adjusted to pH 6.0	100% Effluent Adjusted to pH 6.0
Replicate A	25	22	16	13
Replicate B	29	31	26	2
Replicate C	18	22	17	4
Replicate D	27	20	18	no replicate
Replicate E	30	22	7	22
Mean Brood 1	4.6	4.4	3.0	1.8
Mean Brood 2	6.6	5.8	6.6	1.6
Mean Brood 3	14.6	13.2	7.2	4.8
Mean	25.8	23.4	16.8	8.2
Std. Dev.	4.76	4.34	6.76	9.18
Coeff. of Var.	18%	19%	40%	112%
Mean pH (old)	7.98	6.23	6.06	5.97
Mean pH (new)	8.04	6.03	6.00	6.00

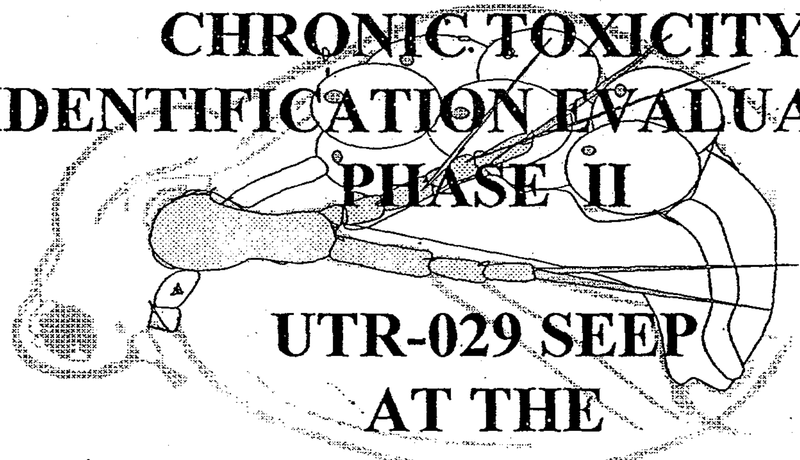


	20% DMW Untreated Dilution Water	60% Effluent Adjusted to pH 8.5	80% Effluent Adjusted to pH 8.5	100% Effluent Adjusted to pH 8.5
Replicate A	25	23	19	5
Replicate B	29	27	25	4
Replicate C	18	28	23	11
Replicate D	27	21	11	1
Replicate E	30	23	18	3
Mean Brood 1	4.6	4.6	3.2	3.2
Mean Brood 2	6.6	7.2	5.4	1.6
Mean Brood 3	14.6	12.6	10.6	0.0
Mean	25.8	24.4	19.2	4.8
Std. Dev.	4.76	2.97	5.40	3.77
Coeff. of Var.	18%	12%	28%	79%
Mean pH (old)	7.98	8.36	8.38	8.39
Mean pH (new)	8.04	8.49	8.49	8.49



ETT nvironmental, inc.

CHRONIC TOXICITY IDENTIFICATION EVALUATION PHASE II



UTR-029 SEEP AT THE SAVANNAH RIVER SITE

Prepared for Westinghouse Savannah River Company
(Subcontract No. #AB53050N / Specification #Q-SPP-G-0010)

January 1995

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1.0 INTRODUCTION

A Chronic Toxicity Identification Evaluation (TIE) Phase I was conducted in November 1994 using Savannah River Site Outfall UTR-029 seep water. Phase I testing indicated that cationic metals (particularly iron) were the probable toxicants. This conclusion was reached as a result of the effectiveness of EDTA chelation and filtration at pH 10 in removing toxicity from the seep water, and the observation of orange precipitate on the filters (probably iron hydroxide). Cationic metal was though to be enhanced by the low hardness and alkalinity of the effluent.

The current phase of the toxicity identification evaluation was conducted with the objective of identifying and confirming iron, and possibly zinc or manganese, as toxicants in the effluent.

2.0 SAMPLING

A grab sample of the effluent was collected by Westinghouse Savannah River Company personnel on January 5, 1995. The sample was shipped by overnight delivery to ETT Environmental, where the TIE was conducted. The pH of the sample upon receipt was 5.49.

3.0 DESIGN OF IDENTIFICATION AND CONFIRMATION TESTS

3.1 *Preparation of Simulated Seep Samples*

The first objective of this phase of testing was to prepare a simulated seep sample. This simulated seep sample was then to be spiked with different metals of concern at the same levels as measured in untreated seep water. Spiked seep sample was then to be treated with sodium thiosulfate, EDTA chelation, and filtration at pH 10, so that the effectiveness of the treatments could be compared to the results of Phase I.

The simulated seep sample was prepared by treating 15 liters of UTR-029 seep water by filtration at pH 10. Gelman 0.45 micron membrane filters were used. The treatment was conducted to remove cationic metals through precipitation. After treatment, three different spiked simulated seep samples were prepared; 1) simulated seep water spiked with 2.1 mg/L of iron, 2) simulated seep water spiked with 17 µg/L of zinc, and 3) simulated seep water spiked with 2.1 mg/L Fe, 0.17 µg/L Zn, and 0.71 mg/L Mn. Iron was spiked as iron nitrate, zinc was spiked as zinc sulfate, and manganese was spiked as manganese chloride.

3.2 *Treatments of Spiked Simulated Seep Samples*

In order to confirm iron, manganese, and zinc as toxicants in the UTR-029 seep water a series of treatments was conducted on the simulated seep samples. Treatments included were those which proved to be most effective in Phase I of the toxicity identification evaluation; filtration at pH 10, sodium thiosulfate addition and EDTA chelation.

Filtration at pH 10

A 600 mL portion of each spiked seep sample was adjusted to pH 10 and filtered through a 0.45 micron membrane filter. After filtration the pH was readjusted to a pH of 6.0 ± 0.05 with H_2SO_4. A chronic toxicity test was conducted upon each treated sample

Sodium Thiosulfate Addition

A 2.5 g/L stock solution of sodium thiosulfate was prepared. Three 400 mL aliquots of each simulated seep sample were prepared. One aliquot of each was brought to 1 mg/L of sodium thiosulfate by adding 160 µL of stock solution. A second aliquot of each was brought to 5 mg/L of sodium thiosulfate by adding 800 µL of stock solution. The third aliquot of each was brought to 10 mg/L of sodium thiosulfate by adding 1600 µL of stock solution.

EDTA Chelation

A 2.5 g/L stock solution of disodium EDTA was prepared. Three 375 mL aliquots of each simulated seep sample were prepared. One aliquot of each was brought to 0.5 mg/L of EDTA by adding 75 µL of stock solution. A second aliquot of each was brought to 3 mg/L of sodium thiosulfate by adding 450 µL of stock solution. The third aliquot of each was brought to 8 mg/L of sodium thiosulfate by adding 1200 µL of stock solution. After addition of the EDTA the solutions were adjusted to pH 6.0 ± 0.05 with NaOH and allowed 24 hours of chelation prior to use in testing.

3.3 *Toxicity Testing*

Seven day / 3 brood definitive survival and reproduction toxicity tests were set with all treated samples. The test organism species was *Ceriodaphnia dubia.* The dilution water was 20% diluted mineral water (20% DMW) with a hardness of approximately 80 mg/L. Each test was set with five replicate test organisms at each dilution. A treated control, in which dilution water was subjected to the same treatment as the effluent, was prepared for each treatment set.

4.0 Results

4.1 *Baseline Test*

The mean reproduction of test organisms in 100% untreated UTR-029 was 14.8 young per female, only slightly less than the mean control reproduction (Table 1). Higher reproduction (21-24 young per female) was noted at effluent dilutions of 20%, 40%, 60% and 80%. Results indicate that the January sample was only slightly toxic at a chronic level. However, because this sample was to treated to remove toxicity the relative lack of toxicity was not considered a problem.

4.2 *UTR-029 Seep Sample Treated by Filtration at pH 10*

Treatment of the UTR-029 sample by filtration at pH 10 improved reproduction in 100% concentration by only a small amount (Table 1), from a mean of 14.8 to a mean of 15.2.

4.3 *Treatments for Iron*

When 2.1 mg/L of iron was spiked into the filtered UTR-029, all the test organisms died within 24 hours (Tables 1,2). No acute or chronic effect was noted at 50% dilution (1.05 mg/L Fe). This confirmed that iron, at the level measured in the effluent immediately prior to Phase I, can account for the toxicity noted in the UTR-029 sample used for Phase I. The greater degree of toxicity noted in this test than noted for the seep sample in the Phase I baseline test (which was chronically toxic but not acutely toxic) may reflect difference in the form of iron being added, or residual iron left in the effluent after filtration treatment.

When EDTA was added to the filtration treated/Fe spiked sample, acute toxicity was removed. 8 mg/L of EDTA was most effective, resulting in a mean reproduction of 6.2 mg/L. Chronic toxicity remained. In Phase I of the TIE the EDTA chelation treatment removed all chronic toxicity. The remaining chronic toxicity noted in this part of the study tends to corroborate the above hypothesis that residual iron left after filtration added to the spiked iron resulted in a total iron concentration (in this Phase II study) higher than was present in the Phase I sample.

Addition of sodium thiosulfate to the filtration treated/Fe spiked sample reduced acute toxicity but did not remove it (Table 2). Some reproduction by surviving test organisms was noted.

Filtration of the filtration treated/Fe spiked seep sample removed acute toxicity from the sample and was relatively effective at removing chronic toxicity. Three out of the five replicates reproduced comparably to the baseline control.

4.4 *Treatments for Zinc*

Addition of 0.17 µg/L of zinc to the filtered seep sample did not cause acute or chronic toxicity in the seep sample filtered at pH 10 (Table 3). It is clear from the results that the amount of zinc in UTR-029 is not high enough to account for the toxicity noted during Phase I.

4.5 *Treatments for Combined Iron, Manganese and Zinc*

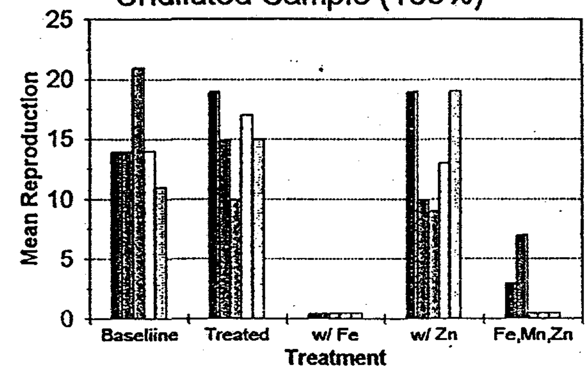
Addition of 2.1 mg/L of iron, 0.71 mg/L of manganese, and 17 µg/L of zinc to the filtered effluent resulted in chronic toxicity (Table 4), reducing reproduction to only 2.0 young per female. This toxic effect was less pronounced than that noted spiking iron alone. Addition of EDTA at 0.5 mg/L removed chronic toxicity from the filtration treated/Fe,Mn,Zn spiked seep sample, raising mean reproduction to 14.8 young per female. Greater amounts of EDTA were not as effective. Sodium thiosulfate addition enhanced the toxicity of the sample, resulting in acute toxicity. However, surviving test organisms did reproduce relatively well. The same effect was noted for filtration of the sample at pH 10.

Table 1
UTR-029 Chronic Phase II TIE Test Results
Cationic Metals: Fe, Mn, and Zn Spiked Sample Tests
Westinghouse Savannah River Company
January 1995

Baseline Test	Reproduction by Test Dilution					
	Control	20%	40%	60%	80%	100%
Replicate A	22	24	24	19	23	14
Replicate B	14	26	25	21	21	14
Replicate C	29	23	25	25	19	21
Replicate D	3	22	18	22	20	14
Replicate E	13	26	16	18	23	11
Mean	16.2	24.2	21.6	21.0	21.2	14.8
Mean pH (old)						6.96
Mean pH (new)						6.02

Treated UTR-029	Reproduction by Test Dilution					
	Control	20%	40%	60%	80%	100%
Replicate A	24			26	14	19
Replicate B	24			26	16	15
Replicate C	26			no rep	14	10
Replicate D	24			20	9	17
Replicate E	18			16	19	15
Mean	23.2			17.6	14.4	15.2
Mean pH (old)	7.48					7.08
Mean pH (new)	7.93					6.02

Fe Spiked UTR-029	Reproduction by Test Dilution					
	Control	1%	5%	10%	50%	100%
Replicate A		0	28	19	22	X
Replicate B		32	17	14	7	X
Replicate C		27	25	10	17	X
Replicate D		4	12	26	21	X
Replicate E		3	6	16	9	X
Mean		13.2	17.6	17.0	15.2	0.0
Mean pH (old)						6.53
Mean pH (new)						6.03



Zn Spiked UTR-029	Reproduction by Test Dilution					
	Control	20%	40%	60%	80%	100%
Replicate A		21	22	22	22	19
Replicate B		22	22	23	22	10
Replicate C		22	5	6	19	9
Replicate D		16	19	21	18	13
Replicate E		24	14	23	21	19
Mean		21.0	16.4	19.0	20.4	14.0
Mean pH (old)						7.62
Mean pH (new)						6.04

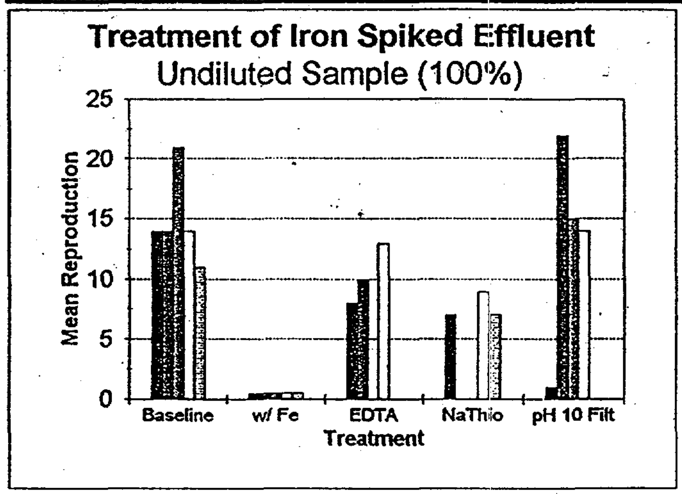
Fe,Mn,Zn Spiked	Reproduction by Test Dilution					
	Control	1%	5%	10%	50%	100%
Replicate A		20	26	18	22	3
Replicate B		23	23	27	20	7
Replicate C		7	7	4	2	0
Replicate D		14	10	4	11	0
Replicate E		9	9	21	9	0
Mean				14.8	12.8	2.0
Mean pH (old)						7.61
Mean pH (new)						6.01

Table 2
UTR-029 Chronic Phase II TIE Test Results
Cationic Metals: Fe Spiked Treatment Tests
Westinghouse Savannah River Company
January 1995

Baseline Test	Reproduction by Test Dilution					
	Control	20%	40%	60%	80%	100%
Replicate A	22	24	24	19	23	14
Replicate B	14	26	25	21	21	14
Replicate C	29	23	25	25	19	21
Replicate D	3	22	18	22	20	14
Replicate E	13	26	16	18	23	11
Mean	16.2	24.2	21.6	21.0	21.2	14.8
Mean pH (old)						6.96
Mean pH (new)						6.02

Fe Spiked UTR-029	Reproduction by Test Dilution					
	Control	1%	5%	10%	50%	100%
Replicate A		0	28	19	22	X
Replicate B		32	17	14	7	X
Replicate C		27	25	10	17	X
Replicate D		4	12	26	21	X
Replicate E		3	6	16	9	X
Mean		13.2	17.6	17.0	15.2	0.0
Mean pH (old)						6.53
Mean pH (new)						6.03

Fe Spiked EDTA Addition	Reproduction by Test Dilution					
	0.5 mg/L EDTA		3 mg/L EDTA		8 mg/L EDTA	
	50%	100%	50%	100%	50%	100%
Replicate A	31	0	23	0	27	8
Replicate B	4	0	21	0	24	10
Replicate C	29	0	27	0	27	0
Replicate D	29	7	30	0	29	13
Replicate E	31	0	26	0	24	0
Mean	24.8	1.4	25.4	0.0	26.2	6.2
Mean pH (old)		7.72		7.80		7.31
Mean pH (new)		6.06		6.00		6.04



Fe Spiked Na Thiosulfate Addition	Reproduction by Test Dilution					
	1.0 mg/L NaThio		5 mg/L NaThio		10 mg/L NaThio	
	60%	100%	60%	100%	60%	100%
Replicate A	17	10	10	8	20	7
Replicate B	20	X	29	6	12	X
Replicate C	21	X	24	0	5	X
Replicate D	27	3X	3	4X	13	9
Replicate E	5	X	13	X	5	7
Mean	18.0	2.6	15.8	3.6	11	4.6
Mean pH (old)		7.06		6.99		7.28
Mean pH (new)		6.04		6.04		6.03

Fe Spiked pH 10 Filtration	Effluent Concentration					
	0%			60%	80%	100%
Replicate A	15			17	24	1
Replicate B	23			24	24	22
Replicate C	24			16	22	15
Replicate D	27			25	18	14
Replicate E	24			20	20	0
Mean	22.6			20.4	21.6	10.4
Mean pH (old)				7.76	7.75	6.96
Mean pH (new)						6.02

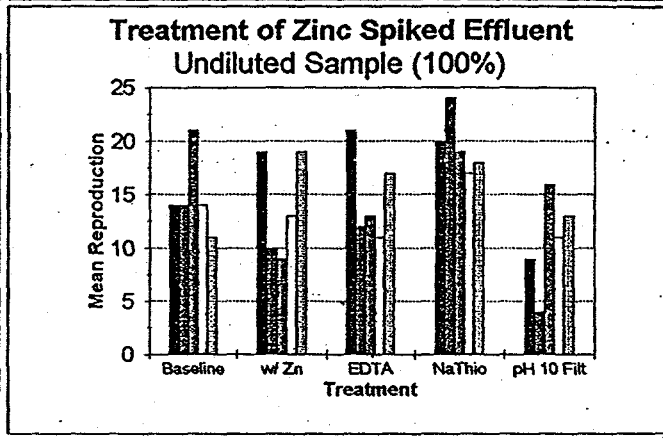
Iron was spiked into 100% effluent at 2.1 mg/L.

Table 3
UTR-029 Chronic Phase II TIE Test Results
Cationic Metals: Zn Spiked Treatment Tests
Westinghouse Savannah River Company
January 1995

Baseline Test	Reproduction by Test Dilution					
	Control	20%	40%	60%	80%	100%
Replicate A	22	24	24	19	23	14
Replicate B	14	26	25	21	21	14
Replicate C	29	23	25	25	19	21
Replicate D	3	22	18	22	20	14
Replicate E	13	26	16	18	23	11
Mean	16.2	24.2	21.6	21.0	21.2	14.8
Mean pH (old)						6.96
Mean pH (new)						6.02

Zn Spiked UTR-029	Reproduction by Test Dilution					
	Control	20%	40%	60%	80%	100%
Replicate A	24	21	22	22	22	19
Replicate B	24	22	22	23	22	10
Replicate C	26	22	5	6	19	9
Replicate D	24	16	19	21	18	13
Replicate E	18	24	14	23	21	19
Mean	23.2	21.0	16.4	19.0	20.4	14.0
Mean pH (old)						7.62
Mean pH (new)						6.04

Zn Spiked EDTA Addition	Reproduction by Test Dilution					
	0.5 mg/L EDTA		3 mg/L EDTA		8 mg/L EDTA	
	50%	100%	50%	100%	50%	100%
Replicate A	11	21	9	15	15	5
Replicate B	22	12	23	20	19	3
Replicate C	24	13	22	14	20	6
Replicate D	18	11	12	9X	29	5
Replicate E	24	17	25	15	20	8
Mean	19.8	14.8	18.2	14.6	20.6	5.4
Mean pH (old)		7.76		7.50		7.66
Mean pH (new)		6.02		6.03		6.04



Zn Spiked Na Thiosulfate Addition	Reproduction by Test Dilution					
	1.0 mg/L NaThio		5 mg/L NaThio		10 mg/L NaThio	
	50%	100%	60%	100%	60%	100%
Replicate A	8X	13	21	20	20	9
Replicate B	18	10	24	24	21	11
Replicate C	22	7	25	19	20	7
Replicate D	26	19	21	17	22	7
Replicate E	2	20	16	18	26	15
Mean	15.2	13.8	21.4	19.6	21.8	9.8
Mean pH (old)		6.80		6.84		7.08
Mean pH (new)		6.05		6.01		6.01

Zn Spiked pH 10 Filtration	Effluent Concentration					
	0%			60%	80%	100%
Replicate A	15			22	11X	9
Replicate B	23			20	17	4
Replicate C	24			22	23	16
Replicate D	27			31	15	11
Replicate E	24			26	18	13
Mean	22.6			24.2	16.8	10.6
Mean pH (old)						7.06
Mean pH (new)						6.04

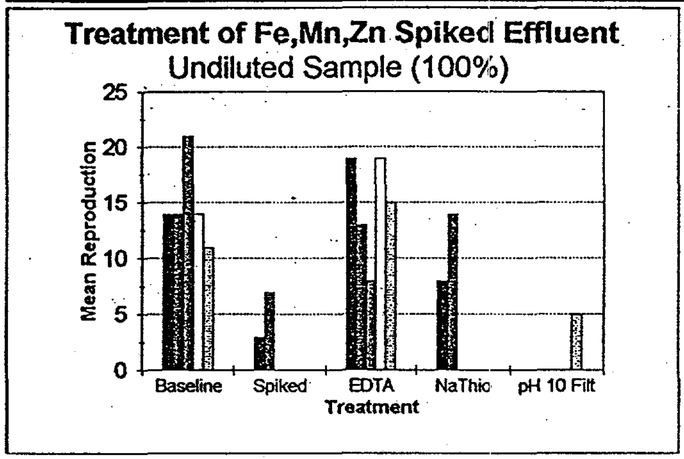
Zinc was spiked into 100% effluent at 17 µg/L.

Table 4
UTR-029 Chronic Phase II TIE Test Results
Cationic Metals: Fe, Mn, Zn Spiked Treatment Tests
Westinghouse Savannah River Company
January 1995

Baseline Test	Reproduction by Test Dilution					
	Control	20%	40%	60%	80%	100%
Replicate A	22	24	24	19	23	14
Replicate B	14	26	25	21	21	14
Replicate C	29	23	25	25	19	21
Replicate D	3	22	18	22	20	14
Replicate E	13	26	16	18	23	11
Mean	16.2	24.2	21.6	21.0	21.2	14.8
Mean pH (old)						6.96
Mean pH (new)						6.02

Fe,Mn,Zn Spiked	Reproduction by Test Dilution					
	Control	1%	5%	10%	50%	100%
Replicate A		20	26	18	22	3
Replicate B		23	23	27	20	7
Replicate C		7	7	4	2	0
Replicate D		14	10	4	11	0
Replicate E		9	9	21	9	0
Mean		14.6	15.0	14.8	12.8	2.0
Mean pH (old)						7.61
Mean pH (new)						6.01

Fe,Mn,Zn Spiked EDTA Addition	Reproduction by Test Dilution					
	0.5 mg/L EDTA		3 mg/L EDTA		8 mg/L EDTA	
	50%	100%	50%	100%	50%	100%
Replicate A	21	19	20	9	16	7
Replicate B	14	13	14	X	21	6
Replicate C	16	8	20	X	11	5
Replicate D	14	19	23	15	23	13
Replicate E	21	15	25	X	21	8
Mean	17.2	14.8	20.5	4.8	18.4	7.8
Mean pH (old)		7.37		6.98		7.42
Mean pH (new)		6.03		6.01		6.01



Fe,Mn,Zn Spiked Na Thiosulfate Addition	Reproduction by Test Dilution					
	1.0 mg/L NaThio		5 mg/L NaThio		10 mg/L NaThio	
	50%	100%	60%	100%	60%	100%
Replicate A	25	8	22	X	23	0
Replicate B	33	14	25	X	28	X
Replicate C	25	X	25	X	15	X
Replicate D	30	X	29	X	30	X
Replicate E	20	X	24	X	25	1
Mean	26.6	4.4	25.0	0.0	24.2	0.2
Mean pH (old)		7.47		7.46		7.39
Mean pH (new)		6.04		6.04		6.01

Fe,Mn,Zn Spiked pH 10 Filtration	Effluent Concentration					
	0%			60%	80%	100%
Replicate A	23			26	17	X
Replicate B	21			26	24	X
Replicate C	1			22	24	X
Replicate D	22			22	27	4X
Replicate E	14			13	7	5
Mean	16.2			21.8	19.8	1.8
Mean pH (old)						7.51
Mean pH (new)						6.01

Iron was spiked into 100% effluent at 2.1 mg/L, Zinc at 17 µg/L, ~~and Manganese at 0.71 mg/L~~.

5.0 DISCUSSION

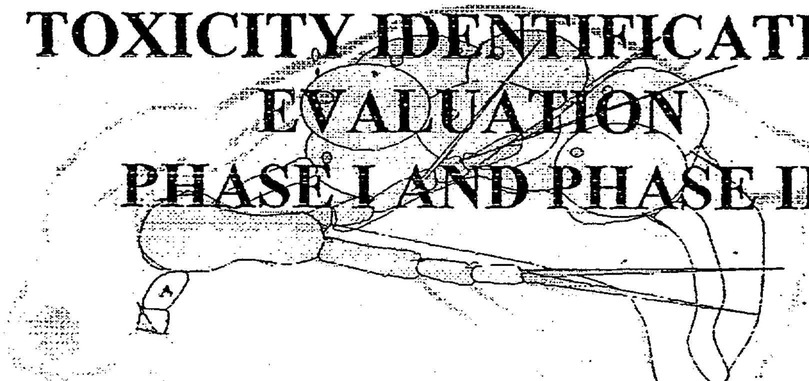
Phase I of the TIE for UTR-029 seep water indicated that metals were the most likely toxicants present, and the three metals detected at levels high enough to potentially cause toxicity were iron, zinc, and manganese. In this second phase of the TIE the results clearly point to iron as the metal of concern. No toxicity was produced in the sample when levels of zinc measured for Phase I (17 µg/L) were spiked into treated effluent. Similarly, the addition of manganese to iron and zinc did not increase the amount of toxicity. In fact, manganese appeared to mitigate the toxicity attributable to iron. In both Phase I and Phase II EDTA and filtration at pH 10 were found to effectively remove or reduce toxicity. Sodium thiosulfate was less effective at removing toxicity in Phase II than in Phase I. The combination of all three metals produced a similar degree of toxicity to that produced by iron alone.

APPENDIX G

FSP-204 TIE Studies (from ETT Environmental, 1995e)

ETT nvironmental, inc.

TOXICITY IDENTIFICATION EVALUATION PHASE I AND PHASE II



Savannah River Site Seep FSP-204

Prepared for Westinghouse Savannah River Company
Subcontract No. AB53050N

August 1995

P.O. Box 16414 Greenville, SC 29606 Tel #:(803)877-6942 FAX (803) 877-6938

ACUTE TOXICITY IDENTIFICATION EVALUATION
PHASE II

Client: Westinghouse Savannah River Company
Sample ID: UTR-029 Effluent

January 1995

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1.0 INTRODUCTION

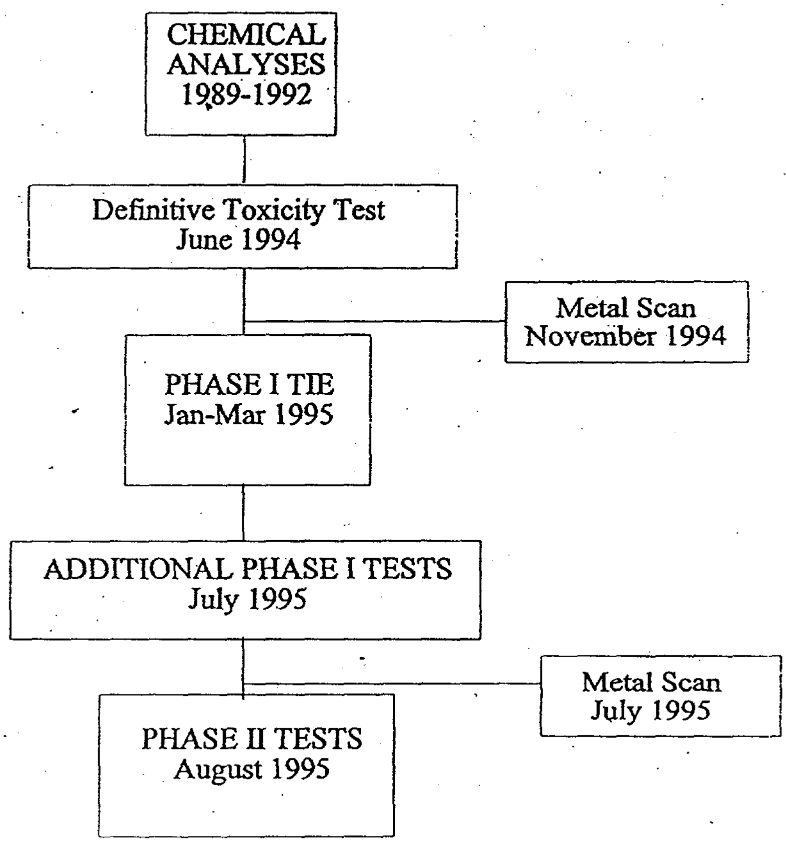
Toxicity testing of seep FSP-204 conducted in June 1994 by ETT Environmental demonstrated that the seep water was acutely toxic to *Ceriodaphnia dubia* at 100% concentration. Acute toxicity was not observed at concentrations of 50% or less. In order to determine the identity of the toxicant in FSP-204, a Toxicity Identification Evaluation (TIE) was initiated in November 1994. Initially a scan for metals was conducted, to determine whether concentrations of metals were high enough to account for sample toxicity. In January 1995 a complete Phase I TIE was conducted using chronic test procedures (Tier I and Tier II). Most of the treatments utilized in Phase I were ineffective at removing toxicity. January testing was followed by methanol elution of C-18 SPE columns which had been used to treat the seep water, and toxicity testing of diluted eluate,. Additional Phase I testing was conducted in July 1995, to confirm results of January 1995 Phase I tests as well as employ additional treatments to remove toxicity. Based upon the results of Phase I testing, indicating that cationic metals not chelatable by EDTA are the primary toxicants, Phase II testing was conducted in August 1995.

Laboratory analyses of multiple chemical and radiological parameters for FSP-204 seep water were conducted in 1989 and 1992 (WSRC-TR-93-289; *Semi-Annual Sampling of Fourmile Branch and its Seeplines in the F and H Areas: July 1992*). Review of these data indicated relatively high levels of aluminum (0.443 - 35.9 mg/L), cadmium (7.3 µg/L), iron (0.7 mg/L), manganese (2.56 mg/L), and zinc (103-107 µg/L). The November 1994 metal scan indicated the presence of 10.6 mg/L of aluminum, 6.9 µg/L of cadmium, 27 µg/L of iron, 1.67 mg/L of manganese, and 33.9 µg/L of zinc.

A flow chart of the course of the investigation is presented in Figure 1.

Figure 1

Flowchart of WSRC Seep FSP-204 Toxicity Identification Evaluation



2.0 SAMPLING

The Toxicity Identification Evaluation (TIE) was initiated with a sample for metal analysis, collected on October 28, 1994. Phase I testing was initiated with a grab sample of FSP-204 seep water collected on January 26, 1995 by Westinghouse Savannah River Company personnel. On March 16, 1995 another grab sample of FSP-204 seep water was collected for treatment by C-18 SPE column followed by methanol elution and toxicity testing. On June 22, 1995 another grab sample was collected, which was used for additional Phase I testing, metals analyses, and Phase II testing. Samples for use in toxicity testing were preserved at 4°C. Samples for metal analysis were preserved with nitric acid. All samples were collected by WSRC personnel and shipped by overnight delivery to ETT Environmental, where treatments and toxicity testing were conducted. Metal analyses were conducted by TMA Eberline of New Ellenton, South Carolina.

3.0 METHODS

3.1 TIE Phase I - Initial Treatments (January 1995)

The seep sample was subjected to a series of treatments to attempt to remove toxicity. Each treated sample was used in a chronic definitive toxicity test to determine the effectiveness of the treatment. The treatments of the associated toxicity tests are summarized as follows:

Treatment	Start Date	Sample ID	Potential Toxicants Removed
Adjust to pH 3	1/31/95	TI3517-1	Insoluble at low pH
Adjust to pH 10	1/31/95	TI3517-2	Insoluble at high pH
Aerated at Initial pH	1/31/95	TI3517-3	Volatile; oxidizable
Aerated at pH 3	1/31/95	TI3517-4	Volatile, oxidizable at low pH
Aerated at pH 10	1/31/95	TI3517-5	Volatile, oxidizable at high pH
Filtered at Initial pH	1/31/95	TI3517-6	TSS
Filtered at pH 3	1/31/95	TI3517-7	Insoluble at low pH
Filtered at pH 10	1/31/95	TI3517-8	metals; insoluble at pH 10
C-18 SPE at Initial pH	1/31/95	TI3517-9	non-polar organics, metals
C-18 SPE at pH 3	1/31/95	TI3517-10	non-polar organics.
C-18 SPE at pH 9	1/31/95	TI3517-11	non-polar organics, metals
Na Thiosulfate Addition	1/31/95	TI3517-12	residual chlorine; some metals
EDTA Chelation	1/31/95	TI3517-13	some metals; surfactants
Graduated pH	1/31/95	TI3517	ammonia; metals; sulfide

A baseline test, in which the seep sample was untreated, was also set on the 31st of January. The initial pH of the FSP-204 sample was between 5.5 and 6.0. This value was considered to be near the lower pH tolerance limit for *Ceriodaphnia dubia*. Therefore the pH of all undiluted test solutions was adjusted somewhat higher, to pH 6.00, so that toxicity due to pH would not confound the results.

Methodology for the individual treatments is discussed below by treatment.

3.1.1 Adjustment to pH 3

An aliquot of the sample was adjusted to pH 3 with H_2SO_4. An aliquot of dilution water also was adjusted to pH 3 with H_2SO_4, to serve as a control. The pH of part of the pH 3.0 control was readjusted to pH 8.0 with NaOH. The pH of part of the pH 3 sample was readjusted to 6.0 with NaOH. This treated sample was used for the toxicity test identified pH 3 Adjustment. The remaining volume of pH 3 sample was used for additional treatments.

3.1.2 Adjustment to pH 10

An aliquot of the sample was adjusted to pH 10.0 with NaOH. An aliquot of dilution water also was adjusted to pH 10.0 with NaOH, to serve as a control. The pH of part of the pH 10.0 control was readjusted to 8.0 with H_2SO_4. The pH of part of the pH 10 sample also was readjusted to 6.0 with H_2SO_4. This treated sample was used for the toxicity test identified pH 10 Adjustment. The remaining volume of the pH 10 sample was used for additional treatments.

3.1.3 Aeration at Initial pH

An aliquot of the untreated sample was vigorously aerated for a period of one hour with air pumped by a diaphragm aerator. A 200 mL aliquot of dilution water was also aerated for the same length of time. The pH of the aerated sample was re-adjusted to pH 6.0 with H_2SO_4 and NaOH, and the pH of the aerated dilution water was re-adjusted to 8.0.

3.1.4 Aeration at pH 3

An aliquot of sample which had been adjusted to pH 3 was vigorously aerated for a period of one hour with air pumped by a diaphragm aerator. Aeration increased the pH slightly. An aliquot of pH 3 adjusted dilution water was also aerated for the same length of time. The pH of the aerated sample was re-adjusted to pH 6.0 with NaOH and the pH of the aerated dilution water was re-adjusted to 8.0.

3.1.5 Aeration at pH 10

An aliquot of sample which had been adjusted to pH 10 was vigorously aerated for a period of one hour with air pumped from a diaphragm aerator. Aeration decreased the pH slightly. An aliquot of pH 10 adjusted dilution water was also aerated for the same length of time. The pH of the aerated sample was re-adjusted to pH 6.0 with H_2SO_4 and the pH of the aerated dilution water was re-adjusted to 8.0.

3.1.6 Filtration at Initial pH

An aliquot of untreated sample was filtered through a glass fiber "TSS" type filter which had been pre-rinsed with deionized water. Filtration changed the pH slightly. After filtration the pH of a portion of the filtered sample was adjusted to 6.0. The remaining volume was set aside for treatment by a C-18 SPE column. An aliquot of dilution water was filtered in the same manner, to serve as a treated control. A portion of the filtered control was readjusted to pH 8.0. The remaining treated control aliquot was set aside for treatment by a C-18 SPE column.

3.1.7 Filtration at pH 3

An aliquot of sample which had been adjusted to pH 3 was filtered through a glass fiber "TSS" type filter which had been pre-rinsed with dilute H_2SO_4. Filtration changed the pH slightly. After filtration the pH of a portion of the sample was readjusted to 6.0 with NaOH. The remaining volume was set aside for treatment by a C-18 SPE column. An aliquot of dilution water was filtered in the same manner, to serve as a treated control. Part of the filtered control was readjusted to pH 8.0 after filtration. The remaining treated control aliquot was set aside for treatment by a C-18 SPE column.

3.1.8 Filtration at pH 10

An aliquot of sample which had been adjusted to pH 10 was filtered through a glass fiber "TSS" type filter which had been pre-rinsed with deionized water. Filtration lowered the pH slightly. After filtration the pH of part of the sample was readjusted to 6.0 with H_2SO_4. The remaining volume was set aside for treatment by a C-18 SPE column. An aliquot of dilution water was filtered in the same manner, to serve as a treated control. Some of the filtered control was readjusted to pH 6.0 after filtration. The remaining treated control aliquot was set aside for treatment by a C-18 SPE column.

3.1.9 C-18 SPE Column at Initial pH

An aliquot of the filtered sample at initial pH was pumped through a Baker 6 mL C-18 SPE column at a rate of 10 mL per minute. Positive pressure was provided by a chemical metering pump. The column was initially pre-conditioned with 25 mL of methanol and 25 mL of ultra-pure water. After conditioning a 150 mL aliquot of dilution water was run through the column. The first 50 mL of dilution water were not kept, and the last 100 mL were readjusted to pH 8.0 and used as a treated control for toxicity testing. After the dilution water the aliquot of filtered effluent was run through the same column. The first 300 mL were readjusted to pH 6.0 and used for toxicity testing. The second 300 mL were adjusted to pH 6.0 and used for another toxicity test. The second aliquot was run to determine if the capacity of the column had been exhausted.

3.1.10 C-18 SPE Column at pH 3

An aliquot of the sample which had been adjusted to pH 3 and filtered was pumped through a Baker 6 mL C-18 SPE column at a rate of 10 mL per minute. Positive pressure was provided by a chemical metering pump. The column was initially pre-conditioned with 25 mL of methanol and 25 mL of ultra-pure water. After conditioning a 150 mL aliquot of dilution water was run through the column. The first 50 mL of dilution water were not kept, and the last 100 mL were readjusted to pH 8.0 and used as a treated control for toxicity testing. After the dilution water the aliquot of pH 3 filtered seep sample was run through the same column. The first 300 mL were readjusted to pH 6.00 and used for a toxicity test. The second 300 mL were also adjusted to pH 6.0 and used for a toxicity test. The second aliquot was run to determine if the capacity of the column had been exhausted.

3.1.11 C-18 SPE Column at pH 10

An aliquot of the sample which had been adjusted to pH 10 and filtered was readjusted to pH 9.0 and pumped through a Baker 6 mL C-18 SPE column at a rate of 10 mL per minute. Positive pressure was provided by a chemical metering pump. The column was initially pre-conditioned with 25 mL of methanol and 25 mL of ultra-pure water. After conditioning a 150 mL aliquot of dilution water was run through the column. The first 10 mL of dilution water were not kept, and the last 90 mL were readjusted to pH 8.0 and used as a treated control for toxicity testing. After the dilution water an aliquot of pH 9 filtered effluent was run through the same column. The first 300 mL were readjusted to pH 6.0 and used for a toxicity test. The second 300 mL also were adjusted to pH 6.0 and used for a toxicity test. The second aliquot was run to determine if the capacity of the column had been exhausted.

3.1.12 Oxidant Reduction

A 2.5 g/L stock solution of sodium thiosulfate was prepared. This stock solution was added to aliquots of undiluted sample water as follows;

Amt. Sodium Thiosulfate	Amount Sample	Final Concentration
280 µL	700 mL	1.0 mg/L
1400 µL	700 mL	5.0 mg/L
2800 µL	700 mL	10.0 mg/L

After addition of the sodium thiosulfate, the test solutions were allowed to sit for two hours. In the same manner dilution water controls were treated with sodium thiosulfate, as follows;

Amt. Sodium Thiosulfate	Amount 20% DMW	Final Concentration
40 µL	100 mL	1.0 mg/L
200 µL	100 mL	5.0 mg/L
400 µL	100 mL	10.0 mg/L

Effluent test solutions were re-adjusted to pH 6.0, and control test solutions to approximately pH 8.0, after addition of sodium thiosulfate.

3.1.13 EDTA Chelation

A 2.5 g/L stock solution of diSodium EDTA was prepared by adding 0.625 g to 250 mL of demineralized water. This stock solution was used to prepare aliquots of sample with 0.5, 3.0, and 8.0 mg/L of EDTA. These aliquots were used for a chronic definitive toxicity test. Dilution water controls were prepared in the same manner. After addition of the EDTA the solutions were adjusted to the initial pH (8.0 for dilution water; 6.0 for FSP-204). Aliquots of sample with EDTA added were left for 24 hours prior to use in testing, because equilibration times can be relatively slow for some metals. Immediately prior to testing pH values in treated effluent and the control were readjusted to the initial measured pH.

3.1.14 Graduated pH Test

An effluent test was to be conducted at pH 6.0 and pH 8.5. A 1.5 L aliquot of effluent to be used for the test at pH 6.0 was treated by adding 1.2 g/L of MES buffer to stabilize the pH. After MES addition the aliquot was adjusted from pH 4.35 to pH 6.00 with 3 mL of NaOH. A 1.5 L aliquot of effluent to be used for the test at pH 8.5 was treated by adding 2.3 g/L of POPSO buffer to stabilize the pH. After POPSO addition the aliquot was adjusted from pH 4.12 to pH 8.56 with 1.5 mL of NaOH. Buffers were also added to controls to check for buffer toxicity.

3.2 Toxicity Testing Methods - Phase I

Chronic (3 brood) survival and reproduction toxicity tests were set with all treated samples during Phase I in January 1995.. The baseline test, the pH adjustment tests, the aeration tests, the filtration tests, the C-18 SPE treatment tests, and the graduated pH test were set with dilutions of 40%, 60%, 80% and 100% seep water. Dilutions of 25%, 50% and 100% were used for each EDTA treatment test, and dilutions of 25%, 50%, and 100% were used for each treatment of the sodium thiosulfate addition test. The test organism was *Ceriodaphnia dubia*. The dilution water was 20% diluted mineral water (20% DMW) with a hardness of 70-90 mg/L. Each test dilution was comprised of five replicate test organisms. A treated control (five replicates) was prepared for each treatment set, where dilution water was subjected to the same treatment as the seep samples. Treatment test solutions were renewed on Day 1 and Day 4 of the test. pH was measured at test initiation, test termination, and before and after test solution renewal, for the control treatments and the 100% dilution treatments.

3.3 Methanol Elution (March 1995)

Methanol elution was used to attempt to elute potential non-polar organic compounds which may have become bound to the column matrix during treatment with a C-18 SPE column. Experience has shown that with methanol elution non-polar organics will be eluted from the C-18 SPE column, whereas cationic metals will not. The procedure involved preparing 25, 50, 75, 80, 85, 90, 95, and 100% methanol solutions, diluted with deionized water. A 1000 mL aliquot of seep water was pumped through a 6 mL Baker C-18 SPE column in order to remove non-polar organic compounds as the seep water passed through the column (after the column had been conditioned). Then, two 1.5 mL aliquots of each methanol solution were pumped through the column. Both aliquots of each dilution were combined and diluted with 20% DMW to the original seep water concentration. Each diluted methanol eluate was subjected to a chronic definitive toxicity test with five replicates per test concentration.

3.4 Additional Phase I Treatments (July 1995)

Two treatments used in Phase I testing in January 1995 were repeated in July 1995; filtration and graduated pH. Due to the extensive acute toxicity noted in Phase I, however, treated samples were subjected to acute toxicity testing rather than chronic. In July 1995, the filtration procedure was modified. At both initial pH (6.0) and at pH 11, the seep sample was filtered with two types of filters; a glass fiber (TSS) type filter, and a membrane (0.45 μ) filter. This was done to determine if the size of the filter pore affected removal of toxicity. The graduated pH test involved adjusting the pH of the seep water to three pH values; 6.5, 7.5, and 8.0. pH values were stabilized by use of the buffers MOPS, MES and POPSO.

New treatments used in July 1995, which were not used in January 1995, included treating the seep water with activated carbon, humic acid, anion exchange resin, and cation exchange resin. Humic acid was added at a concentration of 10 mg/L. Anionic and cationic resin treatments consisted of a resin columns of 1 cm x 25 cm, through which the seep water was trickled. Aeration of the sample was designed so that air pumped through the seep water was collected and forced through 20% DMW in a second vessel. This was done to determine if toxicity was volatile and could be transferred to another solution by volatilization.

Acute toxicity tests conducted on each of these treatments involved dilutions of 20, 40, 60, 80, and 100% seep water, with two replicates of five test organisms at each test concentration.

3.5 Phase II Treatments

The first objective of this phase of testing was to prepare a seep sample which had cationic metals removed, but other ions and components left intact. The only treatment found to be effective at removing most of the cationic metals was cationic exchange resin. Even this treatment, however, was found to leave a residual amount of acute toxicity in undiluted effluent. Prior to treatment an acute definitive toxicity test was conducted to determine the baseline toxicity. Then, an aliquot of FSP-204 seep water was treated with cation exchange resin. This solution also was subjected to an acute definitive toxicity test, with two replicates of five test organisms at each test concentration. Measured concentrations of Al, Cd, Fe, and Mn were determined. The treated solution was then to be spiked with different metals of concern at the same levels as measured in untreated seep water. Each metal was spike individually and the sample tested for acute toxicity, and all metals were spiked together and the sample tested for acute toxicity. Measured concentrations of spiked solutions were also analyzed.

After cation exchange resin treatment, the maximum amounts of each metal spiked into solution corresponded to the amount measured in untreated seep water. The amounts spiked are summarized as follows;

Metal of Concern	Concentrations Tested
Aluminum	0, 1.0, 2.0, 5.0, 9.15 mg/L
Cadmium	0, 0.5, 1.0, 2.0, 5.0 µg/L
Iron	0, 0.1, 0.2, 0.5, 1.07 mg/L
Manganese	0, 0.2, 0.5, 1.0, 1.8 mg/L
Combined Metals	
Treatment 1	Al (1.0 mg/L), Cd (0.5 µg/L), Fe (0.1 mg/L) Mn (0.2 mg/L)
Treatment 2	Al (2.0 mg/L), Cd (1.0 µg/L), Fe (0.2 mg/L) Mn (0.5 mg/L)
Treatment 3	Al (5.0 mg/L), Cd (2.0 µg/L), Fe (0.5 mg/L) Mn (1.0 mg/L)
Treatment 4	Al (9.15 mg/L), Cd (5.0 µg/L), Fe (1.07 mg/L) Mn (1.8 mg/L)

Aluminum, and iron were spike from acidic metal standards for use in metal analysis. Thus both were in the nitrate form. Cadmium and manganese were spiked in the chloride form from standards made up from salt crystals in deionized water.

4.0 RESULTS AND DISCUSSION

4.1 Metal Analyses

The results of analyses of cationic metals of concern conducted before and during the TIE are summarized as follows;

TABLE 1
Cationic Metal Analysis Results 1989-1995
Sample: WSRC Seep FSP-204

Metal	1989	July 92	November 94	July 95
Aluminum (mg/L)	35.9	0.44	10.6	9.15
Cadmium (µg/L)	7.3	2.0	6.9	7.2
Iron (mg/L)	no data	0.7	0.027	1.07
Manganese (mg/L)	no data	2.56	1.67	1.76
Zinc (µg/L)	107	103	33.90	30.8

Arsenic, chromium, copper, lead, and mercury were consistently found to be present at below detection limits. Detection limits were 50 µg/L for arsenic, 20 µg/L for chromium, 10 µg/L for copper, 50 µg/L for lead, and 0.1 µg/L for mercury.

The data indicate levels of aluminum remain consistently high, except for the July 1992 value. It was anticipated that much of the aluminum would be complexed in colloidal form and might not be biologically available. Cadmium levels remained fairly constant at about 7 µg/L, again except for the July 1992 sample. Iron levels fluctuated considerably, reaching a maximum of 1.07 mg/L in July 1995. Manganese ranged from 1.67-2.56 mg/L. During the two earlier studies zinc levels were about 100 µg/L; however, these levels fell during 1994-1995 to about 30 µg/L.

Based upon the results of metal analyses, aluminum, cadmium, iron, and manganese were all considered to be at concentrations which could contribute to seep water toxicity, although this would be dependent upon the form of the metals present. Under normal hardness regimes, insufficient zinc was present to cause acute toxicity. However, at very low hardness and alkalinity levels, zinc could not be discounted.

4.2 Phase I TIE Testing (January 1995)

Phase I TIE results are summarized in Table II. Several treatments were found to be effective at reducing toxicity in the seep water. These included adjustment to pH 10, aeration at pH 3 and pH 6, filtration, and filtration with a C-18 SPE column. The seep water was also found to be less toxic at pH 8.5 than at pH 6.0. EDTA chelation was not effective at removing or reducing toxicity. Several controls in the Phase I test demonstrated poor reproduction, and it was suspected that volatiles in the seep water may have had an effect due to volatilization through vigorous aeration.

These initial Phase I tests did not definitively identify the type of toxicant present in the seep water. Cationic metals chelatable by EDTA appeared to be excluded as potential toxicants. This would include cadmium, copper, iron, lead, manganese, and zinc. Cationic metals not chelateable by EDTA (aluminum) , hydrogen sulfide (which would be effectively removed by aeration at pH 3), TDS, and non-polar organics remained as potential candidates.

TABLE 2

SUMMARY OF CHRONIC TIE PHASE I RESULTS

Sample: WSRC FSP-204

Subcontract number: AB53050N

February 1995

Treatment	Mortality		Mean Reproduction					Comments
	0%	100%	0%	40%	60%	80%	100%	
Baseline	0%	100%	7.6	X	X	X	X	Sample toxic to 40%; volatile affected control
pH 3	0%	80%	13.0	5.0	9.2	X	X	Slight reduction in toxicity
pH 10	100%	40%	15.0	12.4	12.4	10.4	2.2	Toxicity reduced
Aeration	0%	100%	0.0	12.0	3.2	1.0	X	Slight reduction in toxicity
Aeration pH 3	0%	80%	9.0	9.8	8.2	6.3	1.6	Toxicity reduced
Aeration pH 10	100%	100%	11.0	2.0	1.4	X	X	Slight reduction in toxicity
Filtration	100%	40%	0.0	2.4	2.0	0.2	0.6	Toxicity reduced
Filtration pH 3	0%	100%	6.0	X	X	X	X	No reduction in toxicity
Filtration pH 10	0%	100%	1.0	X	X	X	X	No reduction in toxicity
SPE C-18	0%	20%	6.0	8.6	8.8	4.6	3.6	Toxicity reduced; SPE treatment affected controls
SPE C-18 pH 3	20%	40%	9.4	6.6	6.8	7.0	3.6	Toxicity reduced
SPE C-18 pH 9	0%	60%	X	2.6	2.4	5.6	0.2	Toxicity reduced; SPE treatment affected controls
Sodium Thiosulfate (1 mg/L)	0%	100%	0.0		9.6	5.8	X	Slight reduction in toxicity
Sodium Thiosulfate (5 mg/L)	0%	100%	6.0		7.2	3.0	X	Slight reduction in toxicity
Sodium Thiosulfate (10 mg/L)	0%	100%	0.0		X	X	X	No reduction in toxicity
EDTA (0.5 mg/L)	0%	100%	19.0		X	X	X	No reduction in toxicity
EDTA (3.0 mg/L	0%	100%	22.0		X	X	X	No reduction in toxicity
EDTA (8.0 mg/L)	0%	100%	8.0		X	X	X	No reduction in toxicity
Graduated pH (6.0)	0%	100%	12.0	X	X	X	X	No reduction in toxicity
Graduated pH (8.5)	0%	100%	0.0	5.4	2.6	X	X	Less toxic at pH 8.5 than at pH 6.0

SUMMARY

Several treatments were effective at removing the toxicity of the seep water sample. These include the C-18 column, adjustment to pH 10, aeration at pH 3, and addition of 1-5 mg/L of sodium thiosulfate. There was less toxicity when the sample was adjusted to pH 8.5 than at pH 6.0. It should be noted that the baseline control showed poor reproduction. It appears that this may be attributed to volatiles released by the FSP-204 sample, which was in the same test tray. Likewise, aeration of the initial pH and pH 10 controls was conducted immediately following the aeration of the pH 3 control. Volatiles from the pH 3 aerated control seem to have impacted the initial pH and pH 10 controls. The most likely toxicants are non-polar organics, volatiles, hydrogen sulfide, and metals not-chelated by EDTA.

4.3 Methanol Elution (March 1995)

As a result of the reduction in toxicity noted in Phase I with the use of a C-18 SPE column, methanol elution of C-18 SPE columns was conducted. The purpose was to distinguish between removal of non-polar organics (which typically can be eluted by methanol) and cationic metals (which tend not to elute in methanol). Results of methanol are summarized as follows;

Reproduction by Test Dilution

Treatments	Control	20%	40%	60%	80%	100%
Baseline (Untreated)	7.6		0.0	0.0	0.0	0.0
Treated w/ C-18 SPE	22.8	4.4	10.2	0.0	0.0	0.0
25% Methanol Fraction	10.4				3.6	9.6
50% Methanol Fraction	13.2				11.8	7.2
75% Methanol Fraction	13.6				14.6	11.0
80% Methanol Fraction	11.0				16.2	12.8
85% Methanol Fraction	11.6				15.4	10.8
90% Methanol Fraction	13.6				11.6	11.3
95% Methanol Fraction	14.8				14.8	11.6
100% Methanol Fraction	16.8				7.2	9.6

The results of the methanol elution test series again indicated that some toxicity was removed by use of the C-18 SPE column, as evidenced by the reproduction noted at 40% concentration. In untreated seep water at 40% concentration, no test organisms survived to reproduce. C-18 SPE treatment imparted a slight amount of chronic toxicity to dilution water controls, reducing reproduction to approximately 10-13 neonates per female. Elution of 80% and 100% effluent methanol fractions showed no substantial reduction in survival or reproduction as compared to the controls. Thus, it appears that the toxicity in the C-18 SPE column was not effectively eluted in any methanol fraction. This indicated that the toxicant was unlikely to be a non-polar organic. The data were consistent with a cationic metal toxicant, which would not be expected to elute from the column.

4.4 Additional Phase I Treatments (July 1995)

Confirmation of the results of previous Phase I tests and exploration of other treatments which might be effective at removing toxicity were conducted in July 1995. A baseline acute definitive toxicity test was initiated on July 28, 1995 (Table 3). The results confirmed the seep water was acutely toxic, with mortality of all test organisms at all dilutions down to a 20% concentration.

Aeration of the seep water at initial pH and pH 3 did not remove or reduce toxicity at 48 hours. These results conflicted with results of aeration treatment during initial Phase I testing. 20% DMW which was aerated with air used to aerate the seep water did not demonstrate any toxicity. This suggested that no transfer of toxicity through volatilization occurred. There was no evidence that volatiles such as hydrogen sulfide played a role in sample toxicity. The discrepancy with earlier Phase I findings may reflect either anomalous results in the first round of Phase I tests or a change in the toxicity of the sample between the two rounds of testing. A volatile such as hydrogen sulfide may have been present in greater concentrations in January 1995 than in July 1995.

The graduated pH test indicated that seep water is considerably less toxic at a pH of 8.0 than at a pH of 6.5. 24 Hour results at 50% concentration were particularly clear, showing 20% mortality at pH 8.0, 80% mortality at pH 7.5, and 100% mortality at pH 6.5. The results confirmed the graduated pH treatment results from January 1995. Toxicants which are typically less toxic at pH 8.0 than at pH 6.5 include aluminum, copper, hydrogen sulfide, and lead. The presence of these toxicants would be consistent with the graduated pH data. On the other hand, ammonia, cadmium, nickel, and zinc are typically more toxic at pH 8.0 than at pH 6.5, and would appear to be less likely to be primary contributors to toxicity.

Filtration of the seep water with both glass fiber filters and membrane filters and membrane filters showed that neither type of filter was effective at removing sample toxicity, either at pH 6 or at pH 11. This suggests that toxicity is not in the particulate phase. It is though that aluminum toxicity is directly related to the amount of aluminum which passes through a membrane filter.

Table 3

Summary of Results of Additional Phase I TIE Testing
Sample : WSRC Effluent FSP-204
Subcontract Number: AB53050N
July 1995

	24 Hour Cumulative Mean Mortality						
Treatment	0%	20%	40%	50%	60%	80%	100%
Baseline	0%	50%	75%		100%	100%	100%
Graduated pH (6.5)	0%			100%			100%
Graduated pH (7.5)	0%			80%			80%
Graduated pH (8.0)	0%			20%			70%
Sample Aerated at pH 3	0%	100%	100%		100%	100%	100%
Sample Aerated at pH 6	10%	0%	0%		0%	0%	45%
20% DMW Aerated with Air from Effluent (pH 3)							0%
20% DMW Aerated with Air from Effluent (pH 6)							0%
Glass Fiber Filtered (pH 11)	0%	100%	100%		100%	100%	100%
Glass Fiber Filtered (pH 6)	0%	100%	100%		100%	100%	100%
Membrane Filtration (pH 11)	0%	0%	0%		0%	0%	0%
Membrane Filtration (pH 6)	0%	100%	100%		100%	100%	100%
Activated Carbon	0%	0%	0%		0%	0%	0%
Humic Acid	0%	100%	100%		100%	100%	100%
Anion Exchage Resin	50%	10%	0%		0%	0%	0%
Cation Exchange Resin	0%	0%	0%		0%	0%	0%

	48 Hour Cumulative Mean Mortality						
Treatment	0%	20%	40%	50%	60%	80%	100%
Baseline	0%	100%	100%		100%	100%	100%
Sample Aerated at pH 3	0%	100%	100%		100%	100%	100%
Sample Aerated at pH 6	10%	100%	100%		100%	100%	100%
20% DMW Aerated with Air from Effluent (pH 3)							0%
20% DMW Aerated with Air from Effluent (pH 6)							0%
Glass Fiber Filtered (pH 11)	0%	100%	100%		100%	100%	100%
Glass Fiber Filtered (pH 6)	0%	100%	100%		100%	100%	100%
Membrane Filtration (pH 11)	55%	90%	100%		100%	100%	100%
Membrane Filtration (pH 6)	0%	100%	100%		100%	100%	100%
Activated Carbon	0%	85%	75%		95%	70%	100%
Humic Acid	0%	100%	100%		100%	100%	100%
Anion Exchage Resin	90%	50%	40%		60%	50%	40%
Cation Exchange Resin	0%	10%	20%		0%	50%	40%

Carbon treatment of the sample was largley ineffective at reducing toxicity in the sample at 48 hours. Acute toxicity was removed at 24 hours, but at 48 hours complete mortality was noted even in the 20% dilution.

Addition of 10 mg/L of humic acid to FSP-204 seep water was not effective at reducing toxicity. It was thought that, if aluminum was the primary toxicant in the sample, humic acid might bind aluminum and remove it from biological availability. There was no evidence that this occurred with this treatment.

The final treatments used in Phase I tests were anion and cation exchange resins. Anion exchange resin treatment results are difficult to interpret for two reasons. First, anion exchange resin treatment produced acute toxicity in the controls, and second, the anion exchange resin was not 100% pure. The anion exhcange resin was separated from a mixed bed resin, and a small amount of cation exchange resin remained after separation. Nevertheless, it appears that some toxicity was removed by the anion exchange resin. The cation exchange resin was the most effective treatment for removing acute toxiciy. After 48 hours all significant acute toxicity was removed from concentrations of 20-60% seep water, and 40-50% mortality remained in 80-100% seep water. The results indicate that most of the toxicity can be attribted to cations of some type.

In sum, the results of July 1995 Phase I testing indicate that the primary toxicants in FSP-204 are cations which are more toxic at pH 6.5 than at pH 8.0, are not volatile, and are not readily chelatable by EDTA. The potential toxicant best fitting this description is aluminum. However, residual toxiciy left by most of the treatments suggests that other toxicants, with different characteristics, also play a role in toxicity. Based on the results Phase II was designed to spike metals measured at potentially toxic levels into treated seep water.

4.5 Phase II Treatments (August 1995)

A baseline test of the sample of FSP-204 seep water collected on 6/22/95 confirmed that acute toxicity in the sample had not degraded over time (Table 4; Figure 1). All test organisms died in 48 hours at sample concentrations of 60% and greater, and mortality was 70% even at a 20% dilution. This sample was once again treated with cation exchange resin. Toxicity was removed at concentrations or 20, 40, 60, and 80% FSP-204. However, toxicity remained in the undiluted treated sample. Measured concentrations of several metals were analyzed to determine the effectiveness of resin treatment in metal removal. Results are summarized as follows;

Cationic Metal	Amount in Untreated Sample (mg/L)	Amount in Treated Sample (mg/L)
Aluminum	9.15	0.07
Cadmium	0.00724	<0.005
Iron	1.07	<0.02
Manganese	1.76	<0.05
Zinc	0.0308	no data

Iron and manganese were removed to levels below detection limits. Below detection limits neither iron nor manganese are likely to be toxic. Although more than 99% of the aluminum was removed by cation exchange resin, 70 μg/L remained. Aluminum would not be expected to be toxic at a concentration of 70 μg/L. Cadmium was reduced from over 7 μg/L to below the detection limit of 5 μg/L. The EPA water quality criterion for cadmium in water of a hardness of 70 mg/L (the FSP-204 water hardness) is 0.86 μg/L, although the EPA also reports chronic effects on *Daphnia magna* at 0.15 μg/L. Clearly cadmium is toxic at levels well below a detection limit of 5 μg/L. Whether toxic levels of cadmium remained after cation exchange treatment is not known. What is apparent is that cation exchange resin markedly reduced levels of cationic metals in the sample and also removed most of the acute toxicity. The resin also is likely to have removed essential cations such as Ca^{2+}, Mg^{2+}, and K^{+}. It is possible that much of the toxicit noted in undiluted effluent after treatment may reflect the absence of these essential cations.

After cation exchange resin treatment aluminum, iron, cadmium, and manganese were separately spiked into treated samples, and all four metals were spiked together into a single treated sample. Results of toxicity tests on iron spiked samples showed that a nominal concentration of 1.08 mg/L (measured concentration 1.07 mg/L) did produce significant acute toxicity. However, only 60% of the test organisms were killed by that concentration of iron, and lower concentrations produced only a small amount of toxicity. This indicates that sufficient iron is present in FSP-204 to contribute toxicity, but that iron is unlikely to be the primary toxicant. As noted previously, iron is removed by EDTA chelation; thus another toxicant would seem to account for toxicity once iron is removed. Manganese was found not to be toxic at the levels present in the seep water, at least on an acute toxicity level. The highest nominal concentration of manganese spiked into treated sample was 1.76 mg/L (measured concentration 1.78 mg/L).

Aluminum was spiked into effluent at nominal concentrations of 9.15, 5.0, 2.0, and 1.0 mg/L. At 2 mg/L and above, all test organisms were killed by aluminum. A measured concentration of 9.34 mg/L confirms that aluminum was spiked correctly, and incorporates the aluminum remaining after treatment. Mortality was 40% at an aluminum concentration of 1.0 mg/L. These data indicate that aluminum is a primary toxicant in FSP-204 seep water. As noted above, aluminum toxicity also fits the Phase I data, in which EDTA chelation was ineffective, and toxicity was less at pH 8.0 than at pH 6.5. Cadmium also was found to be acutely toxic at all concentrations spiked into the effluent (0.5 - 5.0 µg/L). It appears that cadmium also is a primary toxicant in the seep water, perhaps the most important component. Cadmium would be expected to be removed by EDTA chelation, however, once removed, there is sufficient aluminum to account for toxicity down to an effluent concentration of 20% (as was observed).

Table 4

FSP-204 Phase II TIE (Acute) Test Results
Cationic Metals: Al, Cd, Fe, and Mn Spiked Sample Tests
Westinghouse Savannah River Company
August 1995

Baseline Test	Mortality by Test Dilution (48 Hr)					
	Control	20%	40%	60%	80%	100%
Replicate A	0%	60%	100%	100%	100%	100%
Replicate B	0%	100%	100%	100%	100%	100%
Replicate C	20%	60%	60%	100%	100%	100%
Replicate D	0%	60%	100%	100%	100%	100%
Mean	5%	70%	90%	100%	100%	100%
Mean pH (old)						
Mean pH (new)						

Treated FSP-204	Mortality by Test Dilution (48 Hr)					
	Control	20%	40%	60%	80%	100%
Replicate A	0%			0%	0%	100%
Replicate B	0%			0%	0%	100%
Mean	0%	0%	0%	0%	0%	100%
Mean pH (old)						
Mean pH (new)						

Fe Spiked FSP-204	48 Hr Mortality in 80% w/ Fe (mg/L)					
	Control		0.10	0.20	0.50	1.08
Replicate A	0%		0%	0%	0%	60%
Replicate B	0%		20%	0%	20%	60%
Replicate C	0%		0%	0%	20%	80%
Replicate D	0%		20%	20%	40%	40%
Mean	0%		10%	5%	20%	60%
Mean pH (old)						
Mean pH (new)						

Cd Spiked FSP-204	48 Hr Mortality in 80% w/ Cd (µg/L)					
	Control		0.50	1.00	2.00	5.00
Replicate A	0%		100%	100%	100%	100%
Replicate B	0%		100%	100%	100%	100%
Replicate C	0%		100%	100%	100%	100%
Replicate D	0%		100%	100%	100%	100%
Mean	0%		100%	100%	100%	100%
Mean pH (old)						
Mean pH (new)						

Al Spiked FSP-204	48 Hr Mortality in 80% w/ Al (mg/L)					
	Control		1.00	2.00	5.00	9.34
Replicate A	0%		80%	100%	100%	100%
Replicate B	0%		20%	100%	100%	100%
Replicate C	0%		0%	100%	100%	100%
Replicate D	0%		60%	100%	100%	100%
Mean	0%		40%	100%	100%	100%
Mean pH (old)						
Mean pH (new)						

Mn Spiked FSP-204	48 Hr Mortality in Spiked w/ Mn (mg/L)					
	Control		0.20	0.50	1.00	1.78
Replicate A	0%		40%	0%	20%	0%
Replicate B	0%		20%	0%	40%	0%
Replicate C	0%		40%	40%	60%	0%
Replicate D	0%		0%	0%	0%	40%
Mean	0%		25%	10%	30%	10%
Mean pH (old)						
Mean pH (new)						

Note: Due to residual toxicity in 100% treated sample, it was necessary to spike metals into non-toxic 80% concentration

Table 4 (cont'd)

FSP-204 Acute Phase II TIE Test Results
Cationic Metals: Combined Metal Spiked Treatment Tests
Westinghouse Savannah River Company
August 1995

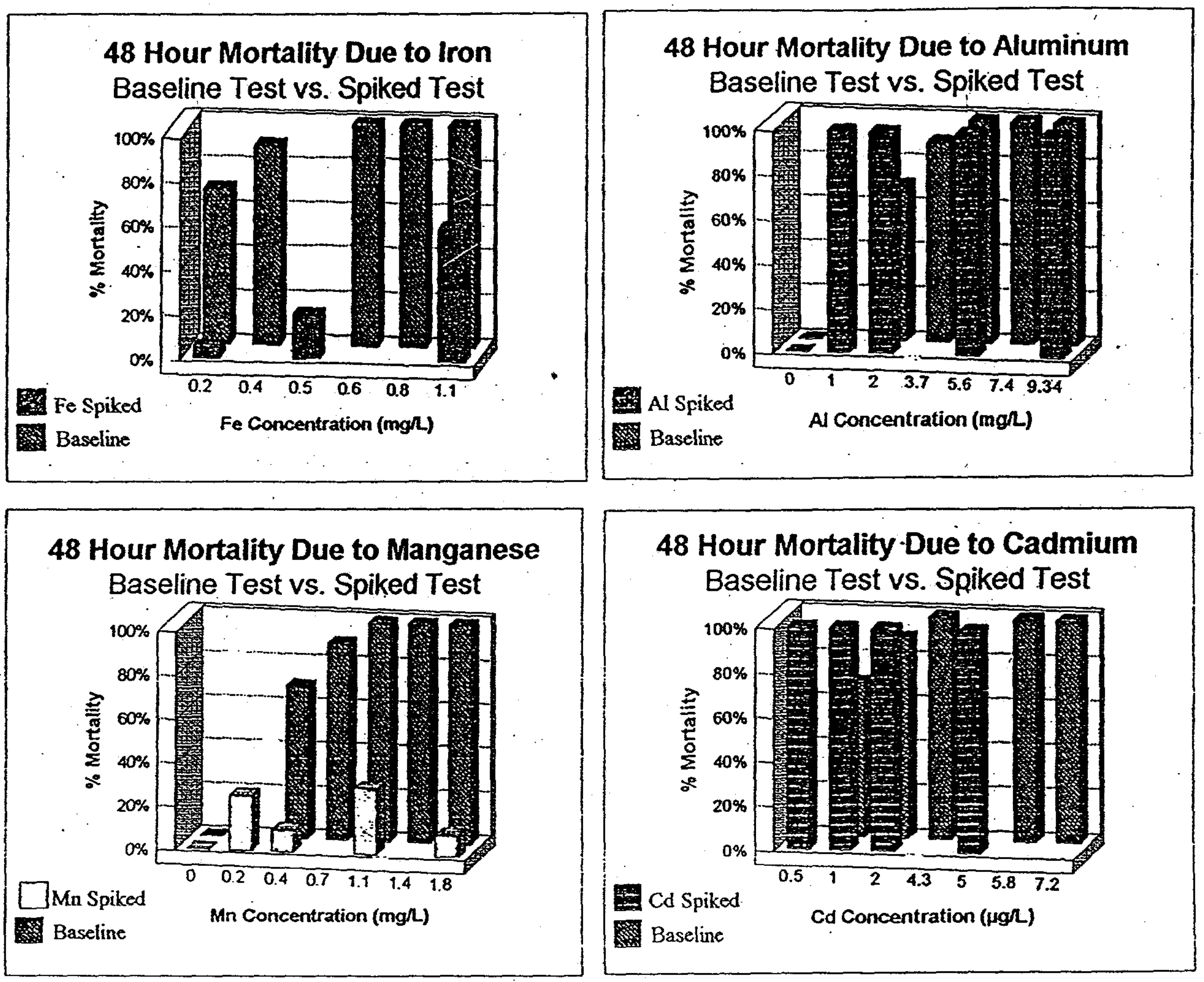
Baseline Test	% Mortality by Test Dilution					
	Control	20%	40%	60%	80%	100%
Replicate A	0%	60%	100%	100%	100%	100%
Replicate B	0%	100%	100%	100%	100%	100%
Replicate C	20%	60%	60%	100%	100%	100%
Replicate D	0%	60%	100%	100%	100%	100%
Mean	5%	70%	90%	100%	100%	100%
Mean pH (old)						
Mean pH (new)						

Al,Cd,Fe,Mn Spiked	% Mortality by Test Treatment					
	Control		Trt 1	Trt 2	Trt 3	Trt 4
Al spiked (mg/L)	<1		1.00	2.00	5.00	8.91
Cd spiked (µg/L)	<1		1.00	2.00	5.00	7.20
Fe spiked (mg/L)	<1		0.10	0.20	0.50	1.05
Mn spiked (mg/L)	<1		0.20	0.50	1.00	1.76
Replicate A	0%		100%	100%	100%	100%
Replicate B	5%		100%	100%	100%	100%
Mean pH (old)						
Mean pH (new)						

Note: The test in which the four metals were spiked together used 80% treated sample because 100% treated sample retained residual toxicity.

Figure 2

FSP-204 Phase II TIE (Acute) Test Results
Cationic Metals: Al, Cd, Fe, and Mn Spiked Sample Tests
Westinghouse Savannah River Company
August 1995



5.0 CONCLUSIONS

The results of the Toxicity Identification Evaluation lead to the following conclusions;

- Volatiles, non-polar organics, manganese, and ammonia do not contribute to FSP-204 toxicity.

- Elevated levels of aluminum and cadmium are the principal causes of toxicity in FSP-204 water. Both metals individually are sufficiently concentrated to render the seep water acutely toxic when diluted to a 20% concentration. Both metals can be largely removed by cation exchange resin, although some toxicity remains. Residual toxicity may be due to small amounts of cadmium or removal by the resin of essential ions such as calcium, magnesium, and potassium.

- Iron is a minor contributor to FSP-204 toxicity. Iron levels appear to fluctuate in the seep and when levels fall below 1.0 mg/L toxicity due to iron is probably absent.

6.0 REFERENCES

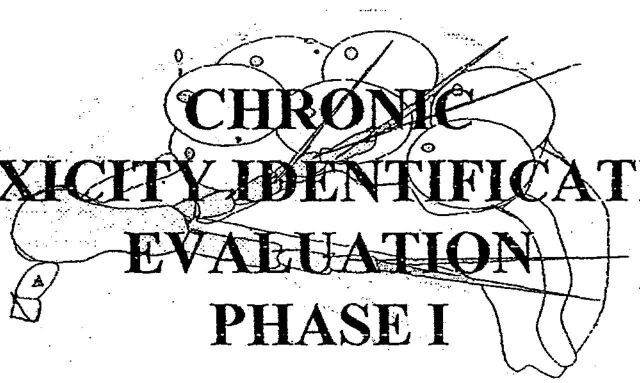
EPA 600/6-91/003. Methods for Aquatic Toxicity Identification Evaluations. Phase I Toxicity Characterization Procedures. 2nd Ed.

EPA 600/R-92/080. Methods for Aquatic Toxicity Identification Evaluations. Phase II Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity.

APPENDIX H

HSP-103 TIE Studies (from ETT Environmental, 1995b and 1995f)

ETT nvironmental, inc.



CHRONIC TOXICITY IDENTIFICATION EVALUATION PHASE I

Client: Westinghouse Savannah River Company

Sample ID: HSP-103 Seep

January 1995

P.O. Box 16414 Greenville, SC 29606 Tel #:(803)877-6942 FAX (803) 877-6938

CHRONIC TOXICITY IDENTIFICATION EVALUATION
PHASE I

Client: Westinghouse Savannah River Company
Sample ID: HSP-103 Seep

January 1995

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2.0 SAMPLING

A single grab sample of the HSP-103 seep water was collected by WSRC personnel on January 5, 1995. The sample was shipped by overnight delivery to ETT Environmental, where the TIE was conducted.

3.0 SAMPLE TREATMENTS

The sample was subjected to a series of treatments to attempt to remove toxicity. Each treated sample was used in a chronic definitive toxicity test to determine the effectiveness of the treatment. The treatments and results of the associated toxicity tests are summarized as follows:

Treatment	Start Date	Sample ID	Toxicants removed
Adjust to pH 3	1/9/95	TI3419-1	Insoluble at low pH
Adjust to pH 10	1/9/95	TI3419-2	Insoluble at high pH
Aerated at Initial pH	1/9/95	TI3419-3	Volatile; oxidizable
Aerated at pH 3	1/9/95	TI3419-4	Volatile, oxidizable at low pH
Aerated at pH 10	1/9/95	TI3419-5	Volatile, oxidizable at high pH
Filtered at Initial pH	1/9/95	TI3419-6	TSS
Filtered at pH 3	1/9/95	TI3419-7	Insoluble at low pH
Filtered at pH 10	1/9/95	TI3419-8	metals; insoluble at pH 10
C-18 SPE at Initial pH	1/9/95	TI3419-9	non-polar organics, metals
C-18 SPE at pH 3	1/9/95	TI3419-10	non-polar organics
C-18 SPE at pH 9	1/9/95	TI3419-11	non-polar organics, metals
Na Thiosulfate Addition	1/9/95	TI3419-12	residual chlorine; some metals
EDTA Chelation	1/10/95	TI3419-13	some metals; surfactants
Graduated pH	1/9/95	TI3419	ammonia; metals; sulfide

A baseline test, in which the seep sample was untreated, was set on the 9th of January. The initial pH of the HSP-103 samples was 5.37. This value was considered to be near the lower pH tolerance limit for *Ceriodaphnia dubia*. Therefore the pH of all undiluted test solutions was adjusted somewhat higher, to pH 6.00, so that toxicity due to pH would not confound the results.

Methodology for the individual treatments is discussed below by treatment.

3.1 Adjustment to pH 3

A 3200 mL aliquot of the sample was adjusted to pH 3.03 with 0.1 mL of H_2SO_4. An 800 mL aliquot of dilution water was adjusted to pH 3.07 with H_2SO_4, to serve as a control. The pH of 200 mL of the pH 3 control was readjusted to 8.06 with 0.5 mL of NaOH. The pH of 800 mL of the pH 3 sample was readjusted to 6.08 with 0.35 mL of NaOH. This treated sample was used for the toxicity test identified pH 3 Adjustment. The remaining 2400 mL of pH 3 sample was used for additional treatments.

3.2 Adjustment to pH 10

A 3200 mL aliquot of the sample was adjusted to pH 10.07 with 0.75 mL of NaOH. An 800 mL aliquot of dilution water was adjusted to pH 10.03 with NaOH, to serve as a control. The pH of 200 mL of the pH 10 control was readjusted to 7.99 with H_2SO_4. The pH of 800 mL of the pH 10 sample was readjusted to 5.95 with 0.5 mL of H_2SO_4. This treated sample was used for the toxicity test identified pH 10 Adjustment. The remaining 2400 mL of the pH 10 sample was used for additional treatments.

3.3 Aeration at Initial pH

An 800 mL aliquot of the untreated sample was vigorously aerated for a period of one hour with air pumped by a diaphragm aerator. Aeration increased the pH from 6.07 to 7.85. A 200 mL aliquot of dilution water was also aerated for the same length of time. The pH of the aerated sample was re-adjusted to pH 5.95 with 0.25 mL of H_2SO_4 and the pH of the aerated dilution water was re-adjusted to 7.95.

3.4 Aeration at pH 3

A 800 mL aliquot of sample which had been adjusted to pH 3 was vigorously aerated for a period of one hour with air pumped by a diaphragm aerator. Aeration increased the pH to 3.28. A 200 mL aliquot of pH 3 adjusted dilution water was also aerated for the same length of time. The pH of the aerated sample was re-adjusted to pH 6.05 with 0.25 mL of NaOH and the pH of the aerated dilution water was re-adjusted to 7.95.

3.5 Aeration at pH 10

A 800 mL aliquot of sample which had been adjusted to pH 10 was vigorously aerated for a period of one hour with air pumped from a diaphragm aerator. Aeration decreased the pH to 8.12. A 200 mL aliquot of pH 10 adjusted dilution water was also aerated for the same length of time. The pH of the aerated sample was re-adjusted to pH 6.05 with 0.45 mL of H_2SO_4 and the pH of the aerated dilution water was re-adjusted to 7.94.

3.6 Filtration at Initial pH

A 1400 mL aliquot of untreated sample was filtered through a 0.45 µm membrane filter which had been pre-rinsed with deionized water. Filtration changed the pH slightly, to 5.95. After filtration the pH of 800 mL of the filtered samples was readjusted to 6.00 with 0.35 mL of NaOH. The remaining 600 mL was set aside for treatment by a C-18 SPE column. A 900 mL aliquot of dilution water was filtered in the same manner, to serve as a treated control. 100 mL of the filtered control was readjusted to pH 8.03 after filtration. The remaining treated control aliquot was set aside for treatment by a C-18 SPE column.

3.7 Filtration at pH 3

A 1400 mL aliquot of sample which had been adjusted to pH 3 was filtered through a 0.45 µm membrane filter which had been pre-rinsed with dilute H_2SO_4. Filtration changed the pH slightly, to 3.09. After filtration the pH of 800 mL was readjusted to 5.99 with 0.25 mL of NaOH. The remaining 600 mL was set aside for treatment by a C-18 SPE column. A 900 mL aliquot of dilution water was filtered in the same manner, to serve as a treated control. 100 mL of the filtered control was readjusted to pH 8.04 after filtration. The remaining treated control aliquot was set aside for treatment by a C-18 SPE column.

3.8 Filtration at pH 10

A 1400 mL aliquot of sample which had been adjusted to pH 10 was filtered through a 0.45 μm membrane filter which had been pre-rinsed with deionized water. Filtration lowered the pH to 8.69. After filtration the pH of 800 mL was readjusted to 5.99 with 0.25 mL of NaOH. The remaining 600 mL was set aside for treatment by a C-18 SPE column. A 900 mL aliquot of dilution water was filtered in the same manner, to serve as a treated control. 100 mL of the filtered control was readjusted to pH 7.91 after filtration. The remaining treated control aliquot was set aside for treatment by a C-18 SPE column.

3.9 C-18 SPE Column at Initial pH

A 600 mL aliquot of the filtered sample at initial pH was pumped through a Baker 6 mL C-18 SPE column at a rate of 10 mL per minute. Positive pressure was provided by a chemical metering pump. The column was initially pre-conditioned with 25 mL of methanol and 25 mL of ultra-pure water. After conditioning a 100 mL aliquot of dilution water was run through the column. The first 10 mL of dilution water were not kept, and the last 90 mL were readjusted to pH 7.85 and used as a treated control for toxicity testing. After the dilution water the 600 mL aliquot of filtered effluent was run through the same column. The first 300 mL were readjusted to pH 5.97 and used for the toxicity test labelled as TI3419-9A. The second 300 mL were adjusted to pH 6.02 and used for the toxicity test labelled as TI3419-9B. The second aliquot was run to determine if the capacity of the column had been exhausted.

3.10 C-18 SPE Column at pH 3

A 600 mL aliquot of the sample which had been adjusted to pH 3 and filtered was pumped through a Baker 6 mL C-18 SPE column at a rate of 10 mL per minute. Positive pressure was provided by a chemical metering pump. The column was initially pre-conditioned with 25 mL of methanol and 25 mL of ultra-pure water. After conditioning a 100 mL aliquot of dilution water was run through the column. The first 10 mL of dilution water were not kept, and the last 90 mL were readjusted to pH 8.03 and used as a treated control for toxicity testing. After the dilution water the 600 mL aliquot of pH 3 filtered effluent was run through the same column. The pH after C-18 SPE treatment was 3.06. The first 300 mL were readjusted to pH 5.99 and used for the toxicity test labelled as TI3419-10A. The second 300 mL were adjusted to pH 5.97 and used for the toxicity test labelled as TI3419-10B. The second aliquot was run to determine if the capacity of the column had been exhausted.

3.11 C-18 SPE Column at pH 10

A 600 mL aliquot of the sample which had been adjusted to pH 10 and filtered was readjusted to pH 9.00 and pumped through a Baker 6 mL C-18 SPE column at a rate of 10 mL per minute. Positive pressure was provided by a chemical metering pump. The column was initially pre-conditioned with 25 mL of methanol and 25 mL of ultra-pure water. After conditioning a 100 mL aliquot of dilution water was run through the column. The first 10 mL of dilution water were not kept, and the last 90 mL were readjusted to pH 8.00 and used as a treated control for toxicity testing. After the dilution water the 600 mL aliquot of pH 9 filtered effluent was run through the same column. The pH after C-18 SPE treatment was 8.31. The first 300 mL were readjusted to pH 6.01 and used for the toxicity test labelled as TI3419-11A. The second 300 mL were adjusted to pH 6.02 and used for the toxicity test labelled as TI3419-11B. The second aliquot was run to determine if the capacity of the column had been exhausted.

3.12 Oxidant Reduction

A 2.5 g/L stock solution of sodium thiosulfate was prepared. This stock solution was added to aliquots of undiluted sample water as follows;

Amt. Sodium Thiosulfate	Amount Sample	Final Concentration
280 µL	700 mL	1.0 mg/L
1400 µL	700 mL	5.0 mg/L
2800 µL	700 mL	10.0 mg/L

After addition of the sodium thiosulfate, the test solutions were allowed to sit for two hours. In the same manner dilution water controls were treated with sodium thiosulfate, as follows;

Amt. Sodium Thiosulfate	Amount 20% DMW	Final Concentration
40 µL	100 mL	1.0 mg/L
200 µL	100 mL	5.0 mg/L
400 µL	100 mL	10.0 mg/L

Effluent test solutions were re-adjusted to pH 6.0 ± 0.05, and control test solutions to approximately pH 8.00 ±0.05, after addition of sodium thiosulfate.

3.13 EDTA Chelation

A 2.5 g/L stock solution of diSodium EDTA was prepared by adding 0.625 g to 250 mL of demineralized water. This stock solution was used to prepare aliquots of sample with 0.5, 3.0, and 8.0 mg/L of EDTA. These aliquots were used for a chronic definitive toxicity test. Dilution water controls were prepared in the same manner. After addition of the EDTA the solutions were adjusted to the initial pH (8.0 for dilution water; 8.0 for HSP-103). Aliquots of sample with EDTA added were left for 24 hours prior to use in testing, because equilibration times can be relatively slow for some metals. Immediately prior to testing pH values in treated effluent and the control were readjusted to the initial measured pH.

3.14 Graduated pH Test

An effluent test was to be conducted at pH 6.0 and pH 8.5. A 1.5 L aliquot of effluent to be used for the test at pH 6.0 was treated by adding 1.8 g/L of MES buffer to stabilize the pH. After MES addition the aliquot was adjusted to pH 6.00 with 0.35 mL of NaOH. A 1.5 L aliquot of effluent to be used for the test at pH 8.5 was treated by adding 3.4 g/L of POPSO buffer to stabilize the pH. After POPSO addition the aliquot was adjusted to pH 8.55 with 0.6 mL of NaOH. Buffers were also added to controls to check for buffer toxicity.

4.0 TOXICITY TESTING METHODS

Chronic (3 brood) survival and reproduction toxicity tests were set with all treated effluent samples. The baseline test, the pH adjustment tests, the aeration tests, the filtration tests, the C-18 SPE treatment tests, and the graduated pH test were set with dilutions of 20%, 40%, 60%, 80% and 100% seep water. Dilutions of 60%, 80% and 100% were used for each EDTA treatment test, and dilutions of 60%, 80%, and 100% were used for each treatment of the sodium thiosulfate addition test. The test organism was *Ceriodaphnia dubia.* The dilution water was 20% diluted mineral water (20% DMW) with a hardness of 80-100 mg/L. Each test dilution was comprised of five replicate test organisms. A treated control (one replicate) was prepared for each treatment set, where dilution water was subjected to the same treatment as the seep samples.

Treatment test solutions were renewed daily for the first four days of the test. pH was measured at test initiation, test termination, and before and after test solution renewal, for the control treatments and the 100% dilution treatments.

5.0 RESULTS

Upon arrival the sample was observed to have a beige to brown coloration, with a small amount of suspended detritus. The seep water was acidic when received, with a pH of 5.37. Both the hardness (9.6 mg/L) and alkalinity (38 mg/L) were low. In order to confirm that undiluted, untreated sample was chronically toxic, five 72 hour old *Ceriodaphnia dubia* which had been cultured in laboratory dilution water were placed in HSP-103 seep water for 96 hours. These test organisms failed to reproduce normally and died within 96 hours. This result was considered to confirm toxicity and the TIE Phase I was initiated. The initial pH of all seep water used for testing was assigned as pH 6.00. A summary of the results is provided below. Only aeration at pH 3 was effective at removing all toxicity from the seep water.

Treatment	Date	Sample ID	Result
pH 3 Adjustment	1/9/95	TI3419-1	Toxicity not reduced
pH 10 Adjustment	1/9/95	TI3419-2	Toxicity not reduced
Aeration at Initial pH	1/9/95	TI3419-3	Toxicity not reduced
Aeration at pH 3	**1/9/95**	**TI3419-4**	**Toxicity removed**
Aeration at pH 10	1/9/95	TI3419-5	Toxicity increased
Filtration at Initial pH	1/9/95	TI3419-6	Toxicity not reduced
Filtration at pH 3	1/9/95	TI3419-7	Toxicity not reduced
Filtration at pH 10	1/9/95	TI3419-8	Toxicity increased
C-18 SPE at Initial pH	1/10/95	TI3419-9	Toxicity not reduced
C-18 SPE at pH 3	1/10/95	TI3419-10	Toxicity not reduced
C-18 SPE at pH 9	1/10/95	TI3419-11	Toxicity increased
Na Thiosulfate Addition	1/9/95	TI3419-12	
1.0 mg/L	1/9/95		Toxicity not reduced
5.0 mg/L	1/9/95		Toxicity not reduced
10.0 mg/L	1/9/95		Toxicity not reduced
EDTA Chelation	1/10/95	TI3419-13	
1.0 mg/L	1/10/95		Toxicity not reduced
5.0 mg/L	1/10/95		Toxicity not reduced
10.0 mg/L	1/10/95		Toxicity not reduced
Graduated pH	1/10/95	TI3419	Toxicity remains at pH 6, 8.5

5.1 Baseline Test

The baseline test indicated that the untreated HSP-103 seep sample did not affect the survival of *Ceriodaphnia dubia* (Table 1). This was dissimilar to the results of the screening test initiated upon sample arrival, which indicated the presence of acute toxicity. The discrepancy may reflect greater sensitivity to the toxicant among 72 hour old daphnids used in the screening test than among 24 hour old neonates used in the baseline test. It could also mean that toxicity decreased over time. The baseline test was set 72 hours later than the screening test. Based upon the results of the baseline test the sample used in this study was not as toxic as the samples collected in April 1994. Chronic toxicity was present, however, in the 100% and 80% dilutions. Mean reproduction in the 20% DMW control water was 23.2 young per female. This decreased to 18.8 young per female in the 80% dilution and 14.0 young per female in undiluted (100%) sample. The decrease in brood size was observed among first, second, and third brood organisms.

5.2 pH 3 Adjustment Test

The pH 3 adjustment test showed that acidifying the sample to pH 3 and returning the sample to the initial pH did not reduce sample toxicity (Table 2). At 100% concentration, the pH adjusted seep sample was considerably more toxic than untreated HSP-103. The pH 3 adjusted control did not reproduce well, producing only three neonates during the test. As this was a single replicate it may simply reflect a weak test organism.

5.3 pH 10 Adjustment Test

The pH 10 adjustment test showed that modifying the sample to pH 10 and returning the sample to the initial pH did not reduce sample toxicity (Table 2). Undiluted effluent which was treated in this manner was more toxic than untreated effluent. A change in the color of the sample was noted during treatment. When NaOH was added to the sample and the pH reached 10, the color of the sample gradually became a dark brown. The mean reproduction of the treated control (22) was approximately the same as baseline test control (23.2).

5.4 Aeration Treatment Tests

Aeration of the sample at the initial pH and at pH 10 was not effective at removing sample toxicity (Tables 3 & 4). Aeration at pH 10 (and readjustment to the initial pH) increased the toxicity of undiluted sample. However, aeration of the sample at pH 3, followed by readjustment to the initial pH, removed all toxicity from HSP-103. Mean reproduction in the 100% sample dilution (aerated at pH 3) was 22.6 young per female. Controls aerated at the three pH values all demonstrated excellent reproduction, with means ranging from 22.0 to 33.0 young per female.

5.5 Filtration Treatment Tests

Filtration of the sample at the initial pH and at pH 3 was not effective at removing sample toxicity (Tables 3 & 5). Aeration at pH 10 (and readjustment to the initial pH) increased the toxicity of undiluted sample. Controls filtered at the initial pH and pH 3 demonstrated excellent reproduction, with means of 24.0 and 22.0 respectively. The control filtered at pH 10 reproduced poorly during the test.

5.6 C-18 SPE Column Treatment Tests

Treatment of the sample with a C-18 SPE column at the initial pH, pH 3, and pH 9 was not effective at removing sample toxicity (Tables 6 & 7). Treatment at pH 3 and pH 9 (and readjustment to the initial pH) increased the toxicity of undiluted sample. Controls filtered through the C-18 SPE columns at the initial pH and pH 3 demonstrated poor reproduction, indicating chronic toxicity was imparted by the columns. However, the control treated at pH 10 reproduced well during the test.

5.7 Sodium Thiosulfate Addition Test

Treated control data indicated no chronic toxicity was imparted by addition of either 1, 5, or 10 mg/L of sodium thiosulfate (Table 8). As noted above, 100% untreated HSP-003 sample was chronically toxic to the test organisms, with a mean reproduction of 14.0 young per female. Addition of 1,5 or 10 mg/L of sodium

sodium thiosulfate did not increased mean reproduction above this baseline level. Thus, sodium thiosulfate was not effective at removing chronic toxicity from the seep water.

5.8 EDTA Chelation

EDTA addition of between 0.5 and 8.0 g/L was not effective in reducing sample toxicity (Table 9). Addition of 0.5 g/L to 100% HSP-103 resulted in reproduction similar to that in the baseline test. 3.0 g/L of EDTA reduced reproduction below the baseline level. 8.0 g/L of EDTA eliminated all reproduction by the test organisms in the 100% sample dilution. Similarly, 8.0 g/L of EDTA added to a dilution water control produced chronic toxicity.

5.9 Graduated pH Test

HSP-103 seep water was acutely and chronically toxic at 100% concentration both at pH 6.0 and pH 8.5 (Table 10). Thus both tests showed greater toxicity than the baseline test. There are two possible explanations for this phenomenon. First, in the baseline test the pH of all dilutions was allowed to drift between renewals. As a result, the pH drifted up to as high as 8.5 over time. In the graduated pH test the pH 6.0 adjustment test was maintained between pH 5.99 and 6.14, and thus the mean pH was much lower. Second, the buffers may have imparted some toxicity. The buffer controls indicated only a slight effect by the POPSO buffer on reproduction at pH 8.5 but a substantial effect by the MES buffer at pH 6.0 (reproduction was reduced to 3 young during the test). It would appear then that the sample was more toxic at pH 8.5 than at a more neutral pH, and, if toxicity at pH 6.0 was not simply an artifact of the use of buffers, the sample may also have been more toxic at pH 6.0 than at a more neutral pH.

6.0 DISCUSSION

The results of the Phase I Toxicity Identification Evaluation of seep HSP-103 indicate the presence of a toxicant (or more than one toxicant) which is pH sensitive and which can be either volatilized or oxidized to a less toxic form at an acidic pH. It appears that the toxicant is not a cationic metal which can be removed from bioavailability through EDTA chelation. The ineffectiveness of the graduated pH test and sodium thiosulfate treatment suggest that ammonia nitrogen and residual chlorine are not toxicants.

Possible toxicants which might fit the pattern of toxicity in the different treatments would include 1) sulfide/hydrogen sulfide, 2) cationic metals which are not removed from bioavailability by EDTA chelation, 3) acid volatile organics which are not removed by a C-18 SPE column. Sulfide fits the pattern because at pH 3 it would be in the form of H_2S, which is volatile. Conversely, the hydrosulfide ion (HS^{1-}), the form present at higher pH values, is soluble and non-volatile. Metals such as aluminum, chromium, selenium, and arsenic are not chelatable by EDTA, and are not excluded from consideration by the results of testing. The color of the effluent suggests the presence of humic or tannic acids. The presence of these natural organic ligands undoubtably affects the toxicity, form, and bioavailability of either organic or metal toxicants in the seep water.

7.0 RECOMMENDATIONS

Additional testing will be necessary to determine the identity of the toxicant. Chemical analyses of the seep water which should be conducted include sulfides, nitrites, cyanide, aluminum, and chromium. The aeration at pH 3 treatment and test should be repeated to confirm the effectiveness of the treatment. This should be done by both nitrogen sparging and by aeration, in order to differentiate between volatilization and oxidation of the effluent. Elution of the SPE columns with methanol should be conducted to determine if the toxicant can be eluted from the column. Spiking of metals such as aluminum, iron, or manganese in combination with humic acid may provide information with regard to the color changes noted during pH adjustment. Results of these analyses will provide valuable information for deciding the course of the TIE from this point.

TABLES

Table 1
HSP-103 Chronic TIE Test Results
Baseline Test
Westinghouse Savannah River Company
January 1995

Baseline Test	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	24	25	25	9
Replicate B	24	23	20	19
Replicate C	26	27	2	12
Replicate D	24	30	33	15
Replicate E	18	30	14	15
Mean Brood 1	4.2	4.4	2.6	2.2
Mean Brood 2	9.0	9.2	7.0	5.6
Mean Brood 3	10.0	13.4	9.2	6.2
Mean	23.2	27.0	18.8	14.0
Std. Dev.	3.03	3.08	11.69	3.74
Coeff. of Var.	13%	11%	62%	27%
Mean pH (old)	7.48			8.46
Mean pH (new)	7.93			6.02

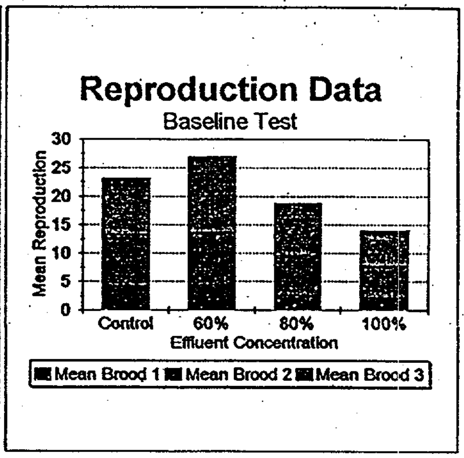
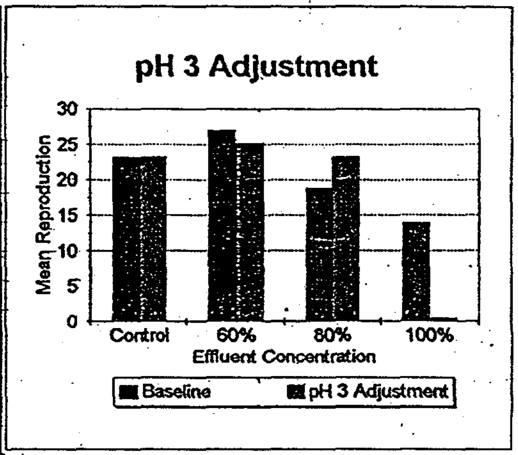


Table 2
HSP-103 Chronic TIE Test Results
pH 3 and pH 10 Adjustment Tests
Westinghouse Savannah River Company
January 1995

Adjusted to pH 3	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	24	28	18	0
Replicate B	24	22	22	0
Replicate C	26	27	23	0
Replicate D	24	23	27	2
Replicate E	18	26	26	0
Mean Brood 1	4.2	4.4	4.4	0.4
Mean Brood 2	9.0	8.6	6.8	0.0
Mean Brood 3	10.0	12.2	12.0	0.0
Mean	23.2	25.2	23.2	0.4
Std. Dev.	3.03	2.59	3.56	0.89
Coeff. of Var.	13%	10%	15%	224%
Mean pH (old)	7.48			7.60
Mean pH (new)	7.93			6.02



Adjusted to pH 10	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	24	25	26	X
Replicate B	24	27	28	X
Replicate C	26	34	27	X
Replicate D	24	24	27	X
Replicate E	18	32	26	X
Mean Brood 1	4.2	3.0	3.4	0.0
Mean Brood 2	9	9.6	8.4	0.0
Mean Brood 3	10	15.8	15.0	0.0
Mean	23.2	28.4	26.8	0
Std. Dev.	3.03	4.39	0.84	0.00
Coeff. of Var.	13%	15%	3%	0%
Mean pH (old)	7.48			7.65
Mean pH (new)	7.93			5.99

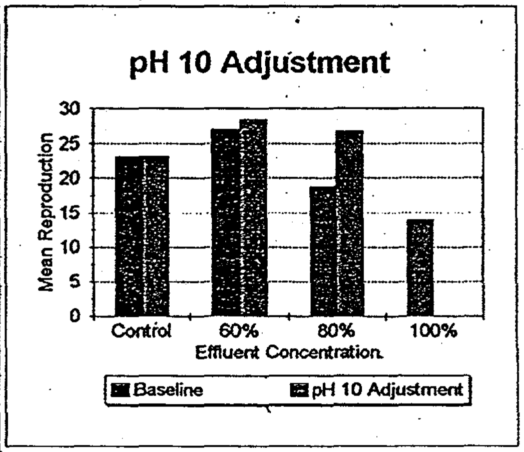
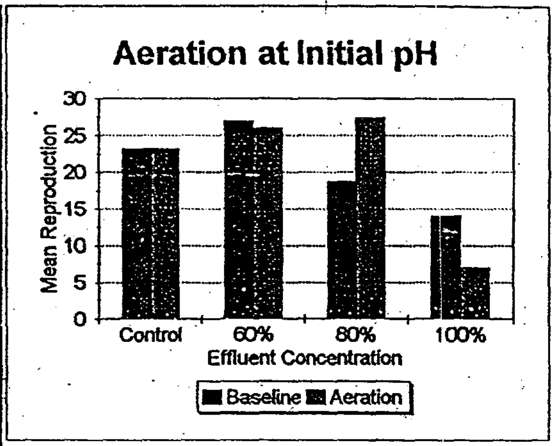


Table 3
HSP-103 Chronic TIE Test Results
Aeration and Filtration at Initial pH Tests
Westinghouse Savannah River Company
January 1995

Aerated at Initial pH	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	24	29	29	0
Replicate B	24	25	23	10
Replicate C	26	30	25	6
Replicate D	24	23	31	7
Replicate E	18	23	29	12
Mean Brood 1	4.2	3.4	3.6	3.2
Mean Brood 2	9.0	7.2	8.2	3.0
Mean Brood 3	10.0	15.4	15.6	0.0
Mean	23.2	26.0	27.4	7.0
Std. Dev.	3.03	3.32	3.29	4.58
Coeff. of Var.	13%	13%	12%	65%
Mean pH (old)	7.48			7.24
Mean pH (new)	7.93			5.97



Filtration at Initial pH	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	24	25	22	0
Replicate B	24	29	23	19
Replicate C	26	23	24	21
Replicate D	24	31	19	24
Replicate E	18	10	11	14
Mean Brood 1	4.2	4.0	4.0	2.8
Mean Brood 2	9	8.4	6.8	4.4
Mean Brood 3	10	11.2	9.0	8.4
Mean	23.2	23.6	19.8	15.6
Std. Dev.	3.03	8.23	5.26	9.45
Coeff. of Var.	13%	35%	27%	0%
Mean pH (old)	7.48			7.19
Mean pH (new)	7.93			6.01

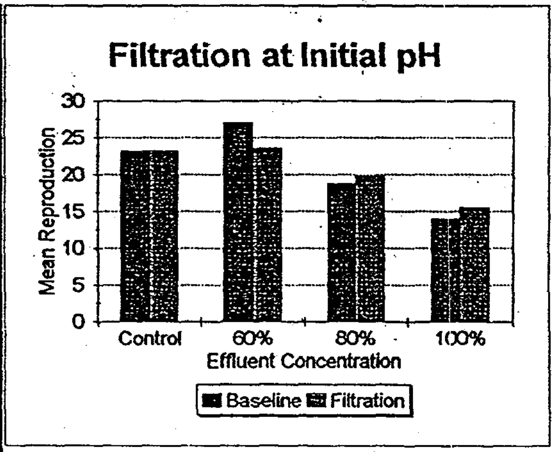
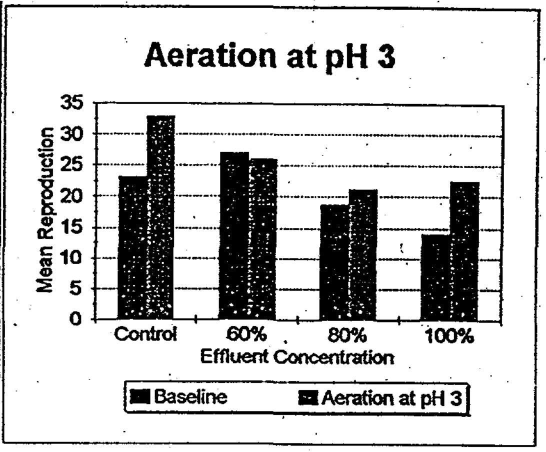


Table 4
HSP-103 Chronic TIE Test Results
Aeration at pH 3 and pH 10 Tests
Westinghouse Savannah River Company
January 1995

Aerated at pH 3	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	33	29	0	28
Replicate B		27	29	21
Replicate C		30	27	19
Replicate D		27	27	22
Replicate E		17	23	23
Mean Brood 1	6.0	4.0	3.0	2.8
Mean Brood 2	12.0	9.8	7.0	7.0
Mean Brood 3	15.0	12.2	11.2	12.8
Mean	33.0	26.0	21.2	22.6
Std. Dev.	0.00	5.20	12.05	3.36
Coeff. of Var.	0%	20%	57%	15%
Mean pH (old)	6.98			7.58
Mean pH (new)	7.98			5.99



Aeration at pH 10	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	24	25	23	X
Replicate B		21	29	X
Replicate C		24	23	X
Replicate D		23	26	X
Replicate E		28	24	X
Mean Brood 1	5	3.8	3.2	0.0
Mean Brood 2	7	8.6	8.6	0.0
Mean Brood 3	16	11.8	13.2	0.0
Mean	28	24.2	25	0
Std. Dev.	0.00	2.59	2.55	0.00
Coeff. of Var.	0%	11%	10%	0%
Mean pH (old)	7.36			7.44
Mean pH (new)	7.98			6.03

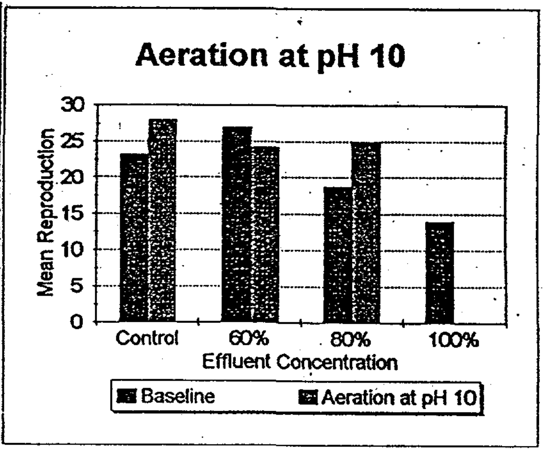
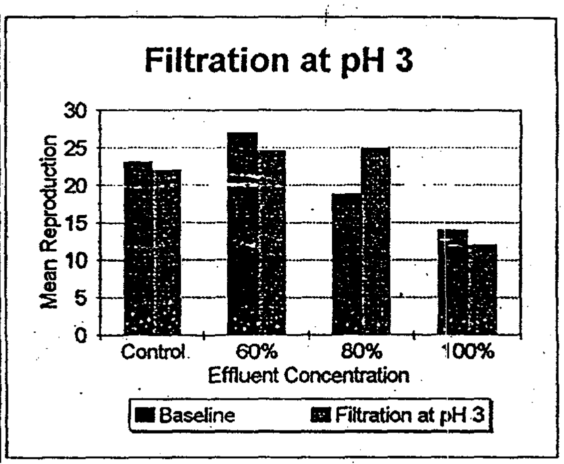


Table 5
HSP-103 Chronic TIE Test Results
Filtration at pH 3 and pH 10 Tests
Westinghouse Savannah River Company
January 1995

Filtered at pH 3	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	22	34	28	13
Replicate B		21	30	14
Replicate C		33	32	20
Replicate D		25	21	13
Replicate E		10	14	0
Mean Brood 1	6.0	4.6	4.2	2.6
Mean Brood 2	8.0	7.6	9.2	3.2
Mean Brood 3	12.0	12.4	11.6	6.2
Mean	22.0	24.6	25	12.0
Std. Dev.	0.00	9.81	7.42	7.31
Coeff. of Var.	0%	40%	30%	61%
Mean pH (old)	7.48			7.10
Mean pH (new)	8.02			6.00



Filtered at pH 10	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	7	13	7	X
Replicate B		20	15	X
Replicate C		17	13	X
Replicate D		17	19	X
Replicate E		14	20	X
Mean Brood 1	4	4.2	3.2	0.0
Mean Brood 2	3	7.2	5.0	0.0
Mean Brood 3	0	4.8	6.6	0.0
Mean	7	16.2	14.8	0
Std. Dev.	0.00	2.77	5.22	0.00
Coeff. of Var.	0%	17%	35%	0%
Mean pH (old)	7.55			7.45
Mean pH (new)	7.94			6.05

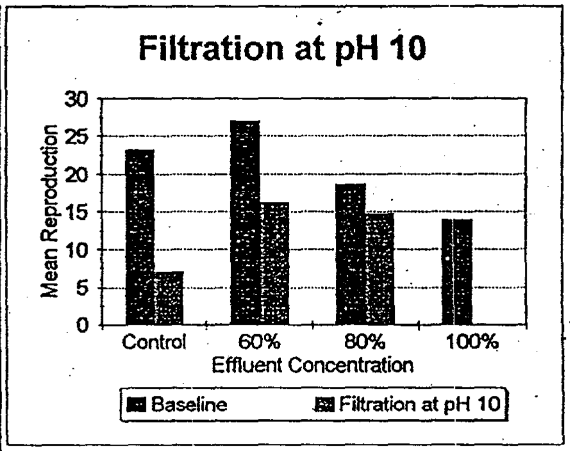
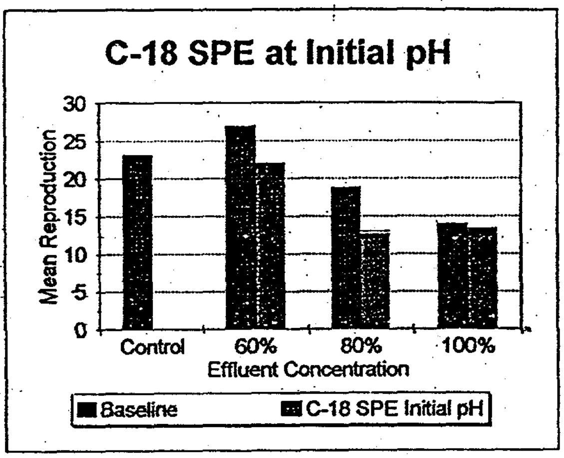


Table 6
HSP-103 Chronic TIE Test Results
C-18 Solid Phase Extraction at Initial pH and pH 3 Test
Westinghouse Savannah River Company
January 1995

Last Portion Initial pH	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	0	14	15	9
Replicate B		23	10	13
Replicate C		24	0	5
Replicate D		26	27	20
Replicate E		23	12	20
Mean Brood 1	0.0	1.0	2.4	4.8
Mean Brood 2	0.0	8.6	6.0	5.2
Mean Brood 3	0.0	12.4	4.4	3.4
Mean	0.0	22.0	12.8	13.4
Std. Dev.	0.00	4.64	9.73	6.66
Coeff. of Var.	0%	21%	76%	50%
Mean pH (old)				8.04
Mean pH (new)				6.00



Last Portion pH 3	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	0	16	13	3
Replicate B		19	26	1
Replicate C		18	31	2
Replicate D		27	33	2
Replicate E		23	22	4
Mean Brood 1	0	2.2	3.6	1.4
Mean Brood 2	0	8.0	9.2	1.0
Mean Brood 3	0	10.4	12.2	0.0
Mean	0	20.6	25	2.4
Std. Dev.	0.00	4.39	7.97	1.14
Coeff. of Var.	0%	21%	32%	48%
Mean pH (old)				7.47
Mean pH (new)				5.96

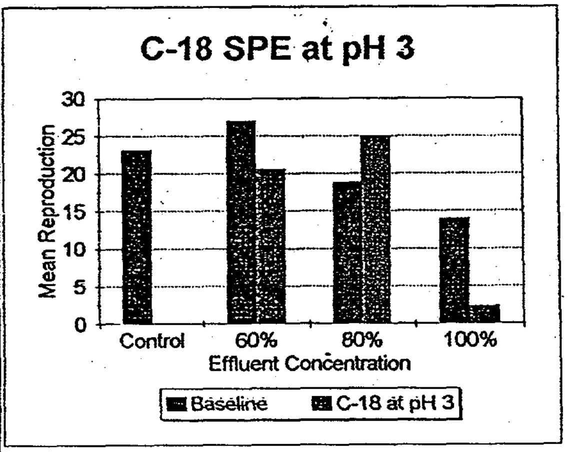


Table 7
HSP-103 Chronic TIE Test Results
C-18 Solid Phase Extraction at pH 9 Test
Westinghouse Savannah River Company
January 1995

Last Portion pH 9	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	23	21	8	X
Replicate B		7	6	X
Replicate C		6	6	X
Replicate D		5	10	X
Replicate E		10	8	X
Mean Brood 1	6.0	2.6	0.0	0.0
Mean Brood 2	3.0	4.0	7.4	0.0
Mean Brood 3	14.0	3.2	0.2	0.0
Mean	23.0	9.8	7.6	0.0
Std. Dev.	0.00	6.53	1.67	0.00
Coeff. of Var.	0%	67%	22%	0%
Mean pH (old)				7.53
Mean pH (new)				6.03

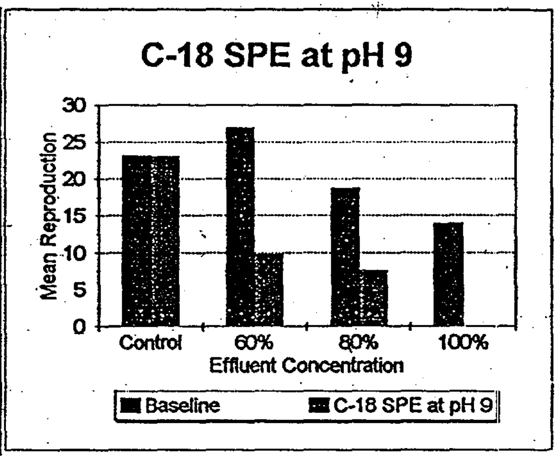
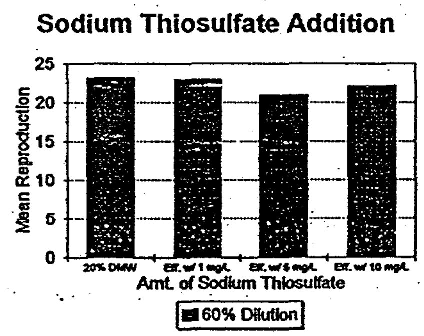


Table 8
HSP-103 Chronic TIE Test Results
Sodium Thiosulfate Addition Test
Westinghouse Savannah River Company
January 1995

Sodium Thiosulfate Addition	Reproduction at 60% Dilution			
	20% DMW Dilution Water	60% Effluent with 1 mg/L Na Thiosulfate	60% Effluent with 5 mg/L Na Thiosulfate	60% Effluent with 10 mg/L Na Thiosulfate
Replicate A	24	22	26	20
Replicate B	24	29	20	26
Replicate C	26	21	21	29
Replicate D	24	21	20	19
Replicate E	18	22	18	17
Mean Brood 1	4.2	2.8	1.6	3.2
Mean Brood 2	9.0	8.0	8.6	9.2
Mean Brood 3	10	12.2	10.8	9.8
Mean	23.2	23	21.0	22.2
Std. Dev.	3.03	3.39	4.24	5.07
Coeff. of Var.	13%	15%	20%	23%
Mean pH (old)	7.48			
Mean pH (new)	7.93			



Sodium Thiosulfate Addition	Reproduction at 100% Dilution			
	20% DMW Dilution Water	100% Effluent with 1 mg/L Na Thiosulfate	100% Effluent with 5 mg/L Na Thiosulfate	100% Effluent with 10 mg/L Na Thiosulfate
Replicate A	24	18	20	0
Replicate B	24	12	13	20
Replicate C	26	5	23	15
Replicate D	24	0	0	13
Replicate E	18	10	14	21
Mean Brood 1	4.2	2.6	3.2	3.4
Mean Brood 2	9	2.2	3.6	4.0
Mean Brood 3	10	4.2	7.2	6.4
Mean	23.2	9.0	14	13.8
Std. Dev.	3.03	6.86	8.86	8.52
Coeff. of Var.	13%	76%	63%	62%
Mean pH (old)	7.48	7.29	7.43	7.37
Mean pH (new)	7.93	6.00	6.00	5.98

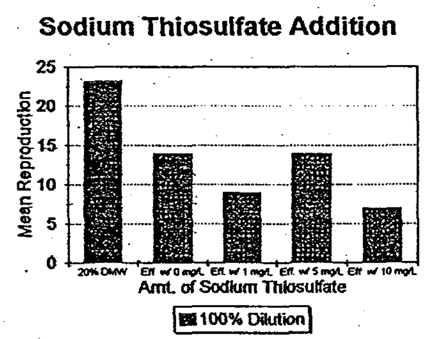
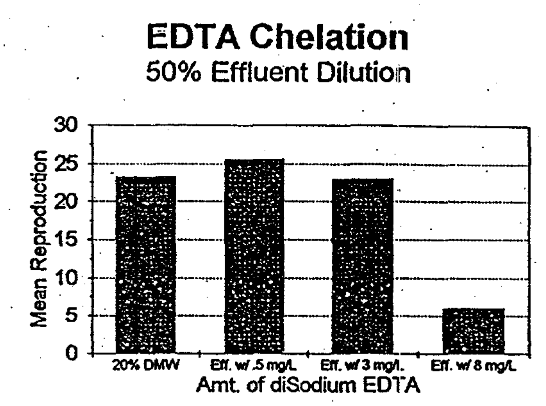


Table 9
HSP-103 Chronic TIE Test Results
EDTA Chelation Addition Test
Westinghouse Savannah River Company
January 1995

EDTA Chelation	Reproduction at 60% Dilution			
	Untreated 20% DMW Dilution Water	50% Effluent with 0.5 mg/L diSodium EDTA	50% Effluent with 3 mg/L diSodium EDTA	50% Effluent with 8 mg/L diSodium EDTA
Replicate A	24	23	19	14
Replicate B	24	27	24	8
Replicate C	26	29	27	0
Replicate D	24	22	23	4
Replicate E	18	27	22	4
Mean Brood 1	4.2	4.6	4.2	4.4
Mean Brood 2	9.0	10.6	7.2	1.6
Mean Brood 3	10	10.4	11.6	0.0
Mean	23.2	25.6	23	6
Std. Dev.	3.03	2.97	2.92	5.29
Coeff. of Var.	13%	12%	13%	88%
Mean pH (old)				
Mean pH (new)				



EDTA Chelation	Reproduction at 100% Dilution			
	Untreated 20% DMW Dilution Water	100% Effluent with 0.5 mg/L diSodium EDTA	100% Effluent with 3 mg/L diSodium EDTA	100% Effluent with 8 mg/L diSodium EDTA
Replicate A	24	13	9	0
Replicate B	24	17	8	0
Replicate C	26	9	0	0
Replicate D	24	25	7	0
Replicate E	18	0	10	0
Mean Brood 1	4.2	3.2	3.8	0.0
Mean Brood 2	9.0	5.2	3.0	0.0
Mean Brood 3	10.0	4.4	0.0	0.0
Mean	23.2	12.8	6.8	0.0
Std. Dev.	3.03	9.28	3.96	0.00
Coeff. of Var.	13%	73%	58%	0%
Mean pH (old)	7.48	7.67	7.46	7.49
Mean pH (new)	7.93	6.00	6.00	6.00

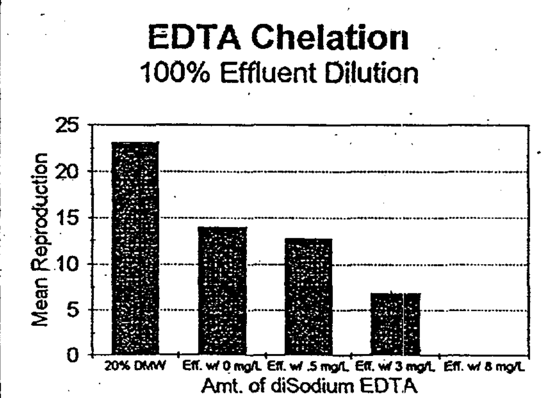
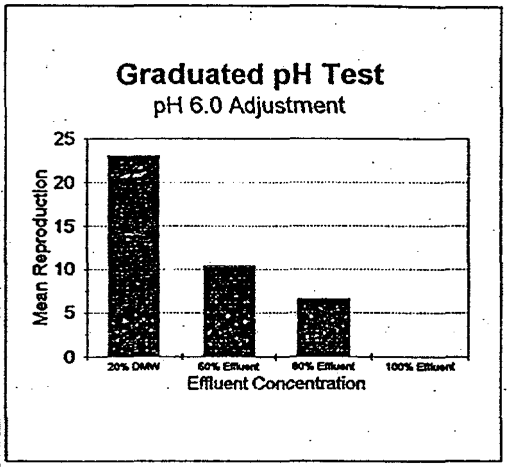
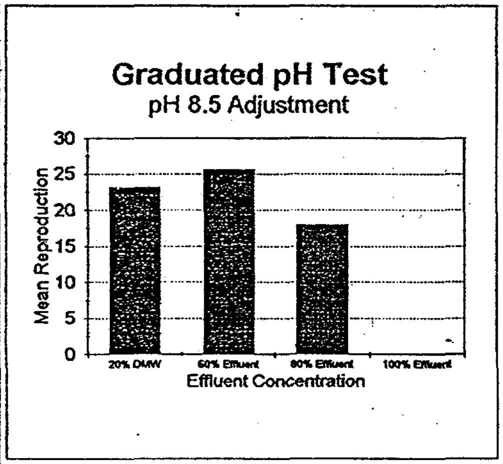


Table 10
HSP-103 Chronic TIE Test Results
Graduated pH Test
Westinghouse Savannah River Company
January 1995

	20% DMW Untreated Dilution Water	60% Effluent Adjusted to pH 6.0	80% Effluent Adjusted to pH 6.0	100% Effluent Adjusted to pH 6.0
Replicate A	24	18	0	X
Replicate B	24	8	0	X
Replicate C	26	7	0	X
Replicate D	24	18	22	x
Replicate E	18	1	11	X
Mean Brood 1	4.2	2.4	1.8	0.0
Mean Brood 2	9.0	3.2	3.4	0.0
Mean Brood 3	10	4.8	1.4	0.0
Mean	23.2	10.4	6.6	0
Std. Dev.	3.03	7.44	9.84	0.00
Coeff. of Var.	13%	72%	149%	0%
Mean pH (old)	7.48	6.14	6.10	5.99
Mean pH (new)	7.93	6.01	6.03	6.02



	20% DMW Untreated Dilution Water	60% Effluent Adjusted to pH 8.5	80% Effluent Adjusted to pH 8.5	100% Effluent Adjusted to pH 8.5
Replicate A	24	23	13	X
Replicate B	24	25	24	X
Replicate C	26	26	14	X
Replicate D	24	23	16	X
Replicate E	18	31	23	X
Mean Brood 1	4.2	3.4	3.0	0.0
Mean Brood 2	9.0	9.0	7.4	0.0
Mean Brood 3	10	13.2	7.6	0.0
Mean	23.2	25.6	18.0	0.0
Std. Dev.	3.03	3.29	5.15	0.00
Coeff. of Var.	13%	13%	29%	0%
Mean pH (old)	7.48	8.17	8.08	8.05
Mean pH (new)	7.93	8.53	8.53	8.52



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CHRONIC TOXICITY TESTING OF AERATED AND NITROGEN SPARGED HSP-103 SEEP WATER FROM THE SAVANNAH RIVER SITE

Prepared for Westinghouse Savannah River Company

May 1995

P.O. Box 16414 Greenville, SC 29606 Tel #:(803)877-6942 FAX (803) 877-6938

1.0 INTRODUCTION

Phase I Toxicity Identification Evaluation testing indicated that aeration of HSP-103 seep water at pH 3 was effective in reducing chronic toxicity. Aeration treatment is typically effective at removing toxicity either through sparging volatiles, oxidation, or physical removal through adherence of toxicants to the sides of the aeration vessel (surfactants). Surfactants are not considered a possible source of toxicity in this seep water. In order to determine if the mode of action is oxidation or sparging, a series of chronic tests of HSP-103 seep water aerated and sparged at varying pH values was conducted. Seep water was first screened on May 2-9, 1995 to confirm that untreated sample was chronically toxic. Aeration and sparging treatments/tests were performed on May 15-22, 1995, as follows;

Baseline Test (Untreated Effluent)
Adjustment to pH 3 Test
Adjustment to pH 10 Test
Aeration at Initial pH Test
Aeration at pH 3 Test
Aeration at pH 10 Test
Nitrogen Sparging at Initial pH Test
Nitrogen Sparging at pH 3 Test
Nitrogen Sparging at pH 10 Test

2.0 METHODS

pH Adjustment of the seep sample was conducted through addition of 1-5 N H_2SO_4 and NaOH, as necessary.

Aeration was conducted using diaphragm-type aerators, tubing, and airstones. The duration of aeration was one hour. After aeration samples were re-adjusted to the initial pH of the seep water (pH 6.0).

Nitrogen sparging was conducted using compressed nitrogen gas, tubing, and airstones. The duration of nitrogen sparging was one hour. After sparging samples were re-adjusted to the initial pH of the seep water (pH 6.0).

Toxicity tests were conducted as Pass/Fail chronic survival and reproduction tests with the test organism *Ceriodaphnia dubia*. Each test consisted of twenty replicates of treated seep water and twenty replicates of a treated control. 20% Diluted Mineral Water (DMW) was used as dilution water for the controls.

3.0 RESULTS AND DISCUSSION

The "screening" test conducted on May 2-9, 1995 demonstrated that the seep water continued to demonstrate chronic toxicity to aquatic invertebrates. Two weeks later the baseline test indicated no reduction in toxicity over time. Adjustment of the pH to 10 did not change the toxicity of the seep water. Results of the test on seep water adjusted to pH 3 were anomalous. The control reproduction was suppressed to a mean of 12.8 and the seep water test organisms had reproduction enhanced to a mean of 19.0. Possible explanations would include contamination of the control sample, removal of sample toxicity through pH adjustment, or accidental switching of the control and effluent samples. In as much as no clear explanation of this test result is available, the result is best viewed with suspicion.

Aeration of the sample at any pH was effective at reducing chronic toxicity. Nitrogen sparging proved to slightly more effective at reducing toxicity than aeration. This is thought to be a result of the rate of sparging. Sparging with nitrogen was administered at a more vigorous rate than sparging with air. As a whole, results suggest that the mechanism of toxicity reduction is sparging, rather than oxidation. This is concluded because nitrogen sparging was as effective as aeration. The results are thus consistent with a volatile chemical as the toxicant of concern.

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TABLE 1

SUMMARY OF AERATION AND NITROGEN SPARGING TREATMENTS/TESTS
Effluent: WSRC HSP-103
May 1995

pH Adjustment	Date	Reproduction		Comments
		Control	Effluent	
Untreated Effluent (pH 6.0)	5/2/95	19.4	7.1	Effluent chronically toxic
Untreated Effluent (pH 6.0)	5/15/95	16.3	6.3	No decrease in toxicity over time
Effluent Adjusted to pH 3	5/15/95	12.8	19.0	Anomalous results - ?
Effluent Adjusted to pH 10	5/15/95	15.1	5.9	No reduction in toxicity.

Aeration	Date	Reproduction		Comments
		Control	Effluent	
Untreated Effluent (pH 6)	5/15/95	16.3	6.5	Effluent chronically toxic
Aerated at Initial pH	5/15/95	17.4	12.8	Slight decrease in toxicity
Aerated at pH 3	5/15/95	17.3	10.9	Slight decrease in toxicity
Aerated at pH 10	5/15/95	17.4	11.4	Slight decrease in toxicity

Nitrogen Sparged	Date	Reproduction		Comments
		Control	Effluent	
Untreated Effluent (pH 6)	5/15/95	16.3	6.5	Effluent chronically toxic
Sparged at Initial pH	5/15/95	18.2	18.3	Toxicity removed
Sparged at pH 3	5/15/95	18.4	10.8	Slight decrease in toxicity
Sparged at pH 10	5/15/95	17.4	15.5	Slight decrease in toxicity

APPENDIX I

Fourmile Branch TIE Studies
(from ETT Environmental, 1995c and 1995d)

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CHRONIC TOXICITY IDENTIFICATION EVALUATION PHASE I

Client: Westinghouse Savannah River Company
Sample ID: Four Mile Branch

June 1995

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1.0 INTRODUCTION

During 1994 surface water samples from Four Mile Branch were used to culture *Ceriodaphnia dubia* in a study conducted by ETT Environmental, Inc. Records of seven day reproduction were maintained during the period of study. Results indicated that surface water from Four Mile Branch was usually chronically toxic to *C. dubia*. Significant acute toxicity was also noted on an intermittent basis.

The presence of acute and chronic toxicity in Four Mile Branch surface water triggered a chronic Toxicity Identification Evaluation (TIE), Phase I of which is presented in this report.

Chronic toxicity tests were conducted on all treated samples. The purpose of this first Phase of the TIE was to determine the characteristics of the toxicant(s), and thereby assess the class of toxicant, e.g., metal, non-polar organic, or TDS, present in the stream water. In order to verify that chronic toxicity was present in the sample prior to conducting all the treatments, test organisms (*Ceriodaphnia dubia*) were placed in undiluted effluent for two days to determine if survival or reproduction were impaired.

2.0 SAMPLING

A single grab sample of the Four Mile Branch surface water was collected by WSRC personnel on June 19, 1995. The sample was shipped by overnight delivery to ETT Environmental, where the TIE was conducted.

3.0 SAMPLE TREATMENTS

The sample was subjected to a series of treatments to attempt to remove toxicity. Each treated sample was used in a chronic definitive toxicity test to determine the effectiveness of the treatment. The treatments of the associated toxicity tests are summarized as follows:

Treatment	Start Date	Sample ID	Potential Toxicants Removed
Adjust to pH 3	6/22/95	TI4177 -1	Insoluble at low pH
Adjust to pH 10	6/22/95	TI4177 -2	Insoluble at high pH
Aerated at Initial pH	6/22/95	TI4177 -3	Volatile; oxidizable
Aerated at pH 3	6/22/95	TI4177 -4	Volatile, oxidizable at low pH
Aerated at pH 10	6/22/95	TI4177 -5	Volatile, oxidizable at high pH
Filtered at Initial pH	6/22/95	TI4177 -6	TSS
Filtered at pH 3	6/22/95	TI4177 -7	Insoluble at low pH
Filtered at pH 10	6/22/95	TI4177 -8	metals; insoluble at pH 10
C-18 SPE at Initial pH	6/22/95	TI4177 -9	non-polar organics, metals
C-18 SPE at pH 3	6/22/95	TI4177 -10	non-polar organics
C-18 SPE at pH 9	6/22/95	TI4177 -11	non-polar organics, metals
Na Thiosulfate Addition	6/22/95	TI4177 -12	residual chlorine; some metals
EDTA Chelation	6/22/95	TI4177 -13	some metals; surfactants
Graduated pH	6/23/95	TI4177	ammonia; metals; sulfide

A baseline test, in which the seep sample was untreated, was set on the 22nd of June. The initial pH of the Four Mile Branch sample was between 5.5 and 6.0. This value was considered to be near the lower pH tolerance limit for *Ceriodaphnia dubia*. Therefore the pH of all undiluted test solutions was adjusted somewhat higher, to pH 6.00, so that toxicity due to pH would not confound the results.

Methodology for the individual treatments is discussed below by treatment.

3.1 Adjustment to pH 3

A 3200 mL aliquot of the sample was adjusted to pH 3.01 with 1 mL of H_2SO_4. An 800 mL aliquot of dilution water was adjusted to pH 3.02 with H_2SO_4, to serve as a control. The pH of 200 mL of the pH 3 control was readjusted to 8.01 with NaOH. The pH of 600 mL of the pH 3 sample was readjusted to 6.03 with 1 mL of NaOH. This treated sample was used for the toxicity test identified pH 3 Adjustment. The remaining 2400 mL of pH 3 sample was used for additional treatments.

3.2 Adjustment to pH 10

A 3200 mL aliquot of the sample was adjusted to pH 9.95 with 0.75 mL of NaOH. An 800 mL aliquot of dilution water was adjusted to pH 9.95 with NaOH, to serve as a control. The pH of 200 mL of the pH 10 control was readjusted to 6.35 with H_2SO_4. The pH of 600 mL of the pH 10 sample was readjusted to 6.30 with 0.4 mL of H_2SO_4. This treated sample was used for the toxicity test identified pH 10 Adjustment. The remaining 2400 mL of the pH 10 sample was used for additional treatments.

3.3 Aeration at Initial pH

An 800 mL aliquot of the untreated sample was vigorously aerated for a period of one hour with air pumped by a diaphragm aerator. Aeration decreased the pH from 5.50 to 3.96. A 200 mL aliquot of dilution water was also aerated for the same length of time. The pH of the aerated sample was re-adjusted to pH 5.98 with 0.5 mL of NaOH and the pH of the aerated dilution water was re-adjusted to 7.96.

3.4 Aeration at pH 3

An 800 mL aliquot of sample which had been adjusted to pH 3 was vigorously aerated for a period of one hour with air pumped by a diaphragm aerator. Aeration increased the pH to 3.46. A 200 mL aliquot of pH 3 adjusted dilution water was also aerated for the same length of time. The pH of the aerated sample was re-adjusted to pH 6.00 with 0.6 mL of NaOH and the pH of the aerated dilution water was re-adjusted to 7.94.

3.5 Aeration at pH 10

A 800 mL aliquot of sample which had been adjusted to pH 10 was vigorously aerated for a period of one hour with air pumped from a diaphragm aerator. Aeration decreased the pH to 8.76. A 200 mL aliquot of pH 10 adjusted dilution water was also aerated for the same length of time. The pH of the aerated sample was re-adjusted to pH 5.95 with 0.75 mL of H_2SO_4 and the pH of the aerated dilution water was re-adjusted to 8.1.

3.6 Filtration at Initial pH

A 1400 mL aliquot of untreated sample was filtered through a glass fiber "TSS" type filter which had been pre-rinsed with deionized water. Filtration changed the pH slightly, from 5.81 to 6.05. After filtration the pH of 800 mL of the filtered sample was kept at 6.05. The remaining 600 mL was set aside for treatment by a C-18 SPE column. An 800 mL aliquot of dilution water was filtered in the same manner, to serve as a treated control. 100 mL of the filtered control was readjusted to pH 8.16 after filtration. The remaining treated control aliquot was set aside for treatment by a C-18 SPE column.

3.7 Filtration at pH 3

A 1400 mL aliquot of sample which had been adjusted to pH 3 was filtered through a glass fiber "TSS" type filter which had been pre-rinsed with dilute H_2SO_4. Filtration changed the pH slightly, to 3.06. After filtration the pH of 800 mL was readjusted to 6.04 with 1.1 mL of NaOH. The remaining 600 mL was set aside for treatment by a C-18 SPE column. An 800 mL aliquot of dilution water was filtered in the same manner, to serve as a treated control. 100 mL of the filtered control was readjusted to pH 7.94 after filtration. The remaining treated control aliquot was set aside for treatment by a C-18 SPE column.

3.8 Filtration at pH 10

A 1400 mL aliquot of sample which had been adjusted to pH 10 was filtered through a glass fiber "TSS" type filter which had been pre-rinsed with deionized water. Filtration lowered the pH to 9.31. After filtration the pH of 800 mL was readjusted to 6.28 with 0.6 mL of H_2SO_4. The remaining 600 mL was set aside for treatment by a C-18 SPE column. An 800 mL aliquot of dilution water was filtered in the same manner, to serve as a treated control. 100 mL of the filtered control was readjusted to pH 6.34 after filtration. The remaining treated control aliquot was set aside for treatment by a C-18 SPE column.

3.9 C-18 SPE Column at Initial pH

A 600 mL aliquot of the filtered sample at initial pH was pumped through a Baker 6 mL C-18 SPE column at a rate of 10 mL per minute. Positive pressure was provided by a chemical metering pump. The column was initially pre-conditioned with 25 mL of methanol and 25 mL of ultra-pure water. After conditioning a 150 mL aliquot of dilution water was run through the column. The first 50 mL of dilution water were not kept, and the last 100 mL were readjusted to pH 7.85 and used as a treated control for toxicity testing. After the dilution water the 600 mL aliquot of filtered effluent was run through the same column. The first 300 mL were readjusted to pH 5.94 and used for the toxicity test labelled as TI4177-9A. The second 300 mL were adjusted to pH 6.05 and used for the toxicity test labelled as TI4177-9B. The second aliquot was run to determine if the capacity of the column had been exhausted.

3.10 C-18 SPE Column at pH 3

A 600 mL aliquot of the sample which had been adjusted to pH 3 and filtered was pumped through a Baker 6 mL C-18 SPE column at a rate of 10 mL per minute. Positive pressure was provided by a chemical metering pump. The column was initially pre-conditioned with 25 mL of methanol and 25 mL of ultra-pure water. After conditioning a 150 mL aliquot of dilution water was run through the column. The first 50 mL of dilution water were not kept, and the last 100 mL were readjusted to pH 8.05 and used as a treated control for toxicity testing. After the dilution water the 600 mL aliquot of pH 3 filtered effluent was run through the same column. The pH after C-18 SPE treatment was 3.13. The first 300 mL were readjusted to pH 6.03 and used for the toxicity test labelled as TI4177-10A. The second 300 mL were adjusted to pH 6.04 and used for the toxicity test labelled as TI4177-10B. The second aliquot was run to determine if the capacity of the column had been exhausted.

3.11 C-18 SPE Column at pH 10

A 600 mL aliquot of the sample which had been adjusted to pH 10 and filtered was readjusted to pH 9.05 and pumped through a Baker 6 mL C-18 SPE column at a rate of 10 mL per minute. Positive pressure was provided by a chemical metering pump. The column was initially pre-conditioned with 25 mL of methanol and 25 mL of ultra-pure water. After conditioning a 100 mL aliquot of dilution water was run through the column. The first 10 mL of dilution water were not kept, and the last 90 mL were readjusted to pH 8.19 and used as a treated control for toxicity testing. After the dilution water the 600 mL aliquot of pH 9 filtered effluent was run through the same column. The pH after C-18 SPE treatment was 7.62. The first 300 mL were readjusted to pH 6.01 and used for the toxicity test labelled as TI4177-11A. The second 300 mL were adjusted to pH 6.07 and used for the toxicity test labelled as TI4177-11B. The second aliquot was run to determine if the capacity of the column had been exhausted.

3.12 Oxidant Reduction

A 2.5 g/L stock solution of sodium thiosulfate was prepared. This stock solution was added to aliquots of undiluted sample water as follows;

Amt. Sodium Thiosulfate	Amount Sample	Final Concentration
280 µL	700 mL	1.0 mg/L
1400 µL	700 mL	5.0 mg/L
2800 µL	700 mL	10.0 mg/L

After addition of the sodium thiosulfate, the test solutions were allowed to sit for two hours. In the same manner dilution water controls were treated with sodium thiosulfate, as follows;

Amt. Sodium Thiosulfate	Amount 20% DMW	Final Concentration
40 µL	100 mL	1.0 mg/L
200 µL	100 mL	5.0 mg/L
400 µL	100 mL	10.0 mg/L

Effluent test solutions were re-adjusted to pH 6.28 ± 0.05, and control test solutions to approximately pH 8.04 - 8.14, after addition of sodium thiosulfate.

3.13 EDTA Chelation

A 2.5 g/L stock solution of diSodium EDTA was prepared by adding 0.625 g to 250 mL of demineralized water. This stock solution was used to prepare aliquots of sample with 0.5, 3.0, and 8.0 mg/L of EDTA. These aliquots were used for a chronic definitive toxicity test. Dilution water controls were prepared in the same manner. After addition of the EDTA the solutions were adjusted to the initial pH (8.0 for dilution water; 6.0 for Four Mile Branch). Aliquots of sample with EDTA added were left for 24 hours prior to use in testing, because equilibration times can be relatively slow for some metals. Immediately prior to testing pH values in treated effluent and the control were readjusted to the initial measured pH.

3.14 Graduated pH Test

An effluent test was to be conducted at pH 6.0 and pH 8.5. A 1.5 L aliquot of effluent to be used for the test at pH 6.0 was treated by adding 1.2 g/L of MES buffer to stabilize the pH. After MES addition the aliquot was adjusted from pH 4.35 to pH 6.00 with 3 mL of NaOH. A 1.5 L aliquot of effluent to be used for the test at pH 8.5 was treated by adding 2.3 g/L of POPSO buffer to stabilize the pH. After POPSO addition the aliquot was adjusted from pH 4.12 to pH 8.56 with 1.5 mL of NaOH. Buffers were also added to controls to check for buffer toxicity.

4.0 TOXICITY TESTING METHODS

Chronic (3 brood) survival and reproduction toxicity tests were set with all treated effluent samples. The baseline test, the pH adjustment tests, the aeration tests, the filtration tests, the C-18 SPE treatment tests, and the graduated pH test were set with dilutions of 40%, 60%, 80% and 100% seep water. Dilutions of 25%, 50% and 100% were used for each EDTA treatment test, and dilutions of 25%, 50%, and 100% were used for each treatment of the sodium thiosulfate addition test. The test organism was *Ceriodaphnia dubia.* The dilution water was 20% diluted mineral water (20% DMW) with a hardness of 70-90 mg/L. Each test dilution was comprised of five replicate test organisms. A treated control (five replicates) was prepared for each treatment set, where dilution water was subjected to the same treatment as the seep samples.

Treatment test solutions were renewed on Day 1 and Day 4 of the test. pH was measured at test initiation, test termination, and before and after test solution renewal, for the control treatments and the 100% dilution treatments.

5.0 RESULTS

Upon arrival the sample was observed to have a reddish-brown coloration, with a small amount of suspended detritus. The stream water was acidic when received, with a pH of 5.50-6.00. Both the hardness (19.6 mg/L) and alkalinity (4.1 mg/L) were low. The initial pH of all Four Mile Branch water used for testing was assigned as pH 6.00. A summary of the results is provided below.

Treatment	Date	Sample ID	Result
pH 3 Adjustment	6/22/95	TI4177-1	Toxicity increased
pH 10 Adjustment	6/22/95	TI4177-2	Toxicity not reduced
Aeration at Initial pH	6/22/95	TI4177-3	Toxicity not reduced
Aeration at pH 3	6/22/95	TI4177-4	Toxicity not reduced
Aeration at pH 10	6/22/95	TI4177-5	Toxicity not reduced
Filtration at Initial pH	**6/22/95**	**TI4177-6**	**Toxicity removed**
Filtration at pH 3	**6/22/95**	**TI4177-7**	**Toxicity reduced**
Filtration at pH 10	**6/22/95**	**TI4177-8**	**Toxicity reduced**
C-18 SPE at Initial pH	**6/22/95**	**TI4177-9**	**Toxicity removed**
C-18 SPE at pH 3	6/22/95	TI4177-10	Toxicity not reduced
C-18 SPE at pH 9	**6/22/95**	**TI4177-11**	**Toxicity reduced**
Na Thiosulfate Addition	6/22/95	TI4177-12	
1.0 mg/L	**6/22/95**		**Toxicity reduced**
5.0 mg/L	6/22/95		Toxicity not reduced
10.0 mg/L	6/22/95		Toxicity not reduced
EDTA Chelation	6/23/95	TI4177-13	
1.0 mg/L	6/23/95		Toxicity not reduced
5.0 mg/L	**6/23/95**		**Toxicity reduced**
10.0 mg/L	**6/23/95**		**Toxicity removed**
Graduated pH	6/23/95	TI4177	Toxicity remains at pH 6, 8.5

Treatments which were effective in removing or reducing toxicity included filtration, C-18 SPE, sodium thiosulfate addition at 1.0 mg/L, and EDTA addition at 5 mg/L and greater. Filtration was most effective at the initial pH. The C-18 SPE treatment afforded no additional reduction in toxicity beyond the reduction produced by filtration.

5.1 **Baseline Test (Table 1)**

The baseline test indicated that the untreated Four Mile Branch water was chronically toxic to *Ceriodaphnia dubia* (Table 1). Chronic toxicity was present in the both the 100% and 80% dilutions. Mean reproduction in the 20% DMW control water was 18.2 young per female. This increased to 20.8 young per female in the 60% dilution and decreased to 12.4 young per female in the 80% dilution, and 1.6 young per female in undiluted (100%) sample. It was noted that after renewal of the test solution on Day 1, the pH of the 100% effluent treatment decreased gradually to 5.32. This low pH likely contributed to the reduction in reproduction. Reproduction in the 100% effluent dilution was not only reduced but also delayed, with first broods not being released until Day 6.

5.2 **pH 3 Adjustment Test (Table 2)**

The pH 3 adjustment test showed that acidifying the sample to pH 3 and returning the sample to the initial pH did not reduce sample toxicity (Table 2). It was noted that a yellow-brown precipitate (floc) formed during the treatment, although the toxicity was not affected. Undiluted treated effluent was acutely toxic, and it appears that the treatment may have enhanced toxicity. Surviving test organisms in undiluted treated effluent were smaller in size than those in other test concentrations.

5.3 **pH 10 Adjustment Test (Table 2)**

The pH 10 adjustment test showed that modifying the sample to pH 10 and returning the sample to the initial pH did not substantially reduce sample toxicity (Table 2). The mean reproduction of the treated control (4.6) was poor. Surviving test organisms in undiluted treated effluent were smaller in size than those in other test concentrations. Treated effluent exhibited a darker yellow color than untreated effluent.

5.4 **Aeration Treatment Tests (Tables 3,4)**

Aeration of the sample at the initial pH, at pH 3, and at pH 10 was not effective at removing sample toxicity (Tables 3 & 4). Surviving test organisms in undiluted treated (aerated at initial pH) effluent were smaller in size than those in other test concentrations. Aeration of the sample at pH 3, followed by readjustment to the initial pH, resulted in a yellow-brown precipitate, as noted in the pH 3 adjusted treatment. Controls aerated at the initial pH and pH 10 reproduced adequately. However, the control aerated at pH 3 reproduced poorly, with a mean of 5.2 young per female.

5.5 Filtration Treatment Tests (Tables 3,5)

Filtration of the sample at the initial pH, pH 3, and pH 10 were all effective at removing or reducing sample toxicity. Filtration at the initial pH was the most effective, and removed all sample toxicity. Controls filtered at the initial pH demonstrated excellent reproduction. The controls filtered at pH 3 and pH 10 reproduced poorly during the test.

5.6 C-18 SPE Column Treatment Tests (Tables 6 & 7)

Treatment of the sample with filtration and a C-18 SPE column at the initial pH was effective at removing sample toxicity (Tables 6 & 7). It is apparent, however, that toxicity was removed by filtration prior to treatment with the C-18 SPE column. The C-18 SPE column provided no additional treatment. Similarly, treatment of the sample with filtration and a C-18 SPE column at pH 10 reduced sample toxicity but did not completely removed. Again, toxicity was likely removed by filtration prior to treatment with the C-18 SPE column. The C-18 SPE column provided no additional treatment. Treatment of the sample with filtration and a C-18 SPE column at pH 3 was not effective at removing sample toxicity. In fact, the column seems to have added toxicity. Our experience shows that it is not unusual for C-18 SPE columns to impart chronic toxicity when used at low pH values. This is confirmed by the control treated by the C-18 SPE column at pH 3.

5.7 Sodium Thiosulfate Addition Test (Table 8)

Treated control data indicated no chronic toxicity was imparted by addition of either 1, 5, or 10 mg/L of sodium thiosulfate. Addition of 1 mg/L of sodium thiosulfate slightly increased mean reproduction above the baseline level. Addition of 5 mg/L of sodium thiosulfate did not reduce chronic toxicity. Addition of 10 mg/L of sodium thiosulfate was acutely toxic to the test organisms.

5.8 EDTA Chelation (Table 9)

Reduction in chronic toxicity became increasingly effective with increasing amounts of EDTA. Addition of 8 g/L to 100% Four Mile Branch stream water resulted in reproduction similar to that in the baseline test control. It is possible that greater amounts of EDTA may have enhanced reproduction in Four Mile Branch water to an even greater degree. 3.0 g/L of EDTA increased reproduction slightly, and 0.5 mg/L did not improve reproduction above the baseline level. Greater than 0.5 mg/L of EDTA in control dilution water was chronically toxic.

5.9 Graduated pH Test

Four Mile Branch water was acutely and chronically toxic at 100% concentration both at pH 6.0 and pH 8.5 (Table 10). Thus both tests showed greater toxicity than the baseline test. It would appear that the toxicant is less toxic at a neutral pH than at either pH 6.0 or at pH 8.5. Use of buffers appeared to contribute some chronic toxicity (as evidenced by the treated controls), particularly the POPSO buffer.

6.0 DISCUSSION

The results presented above show that filtration and EDTA chelation were effective at removing or reducing toxicity. Addition of 1 mg/L of sodium thiosulfate also mitigated toxicity to a minor degree. Aeration and pH adjustment did not reduce toxicity, and treatment with a C-18 SPE column provided no additional treatment beyond the effect of filtration. This pattern of treatment effectiveness is consistent with cationic metals as a likely class of toxicants. Due to the effectiveness of filtration, it appears that the cationic metals may be bound to filterable suspended solids. The precipitate observed when Four Mile Branch water was adjusted to pH 3 was notable. Metal hydroxide precipitates are normally associated with alkaline pH values. The precipitate may have been humic acid, which by definition is the fraction of humic substances which is soluble in alkaline solution but is precipitated by acidification.

7.0 RECOMMENDATIONS

It is recommended that a TIE Phase II be conducted in order to identify and confirm the cationic metal causing the chronic toxicity in the Four Mile Branch surface water. This would be preceded by analyses of metals in the creek water, to determine which metals may be present at potentially toxic levels.

TABLES

Table 1
Four Mile Branch Chronic TIE Test Results
Baseline Test
Westinghouse Savannah River Company
June 1995

Baseline Test	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	20	22	14	2
Replicate B	17	23	13	2
Replicate C	19	18	13	1
Replicate D	18	20	20	3
Replicate E	19	21	2	0
Mean Brood 1	2.8	3.8	2.4	1.6
Mean Brood 2	6.6	7.8	4.0	0.0
Mean Brood 3	9.2	9.2	6.0	0.0
Mean	18.6	20.8	12.4	1.6
Std. Dev.	1.14	1.92	6.50	1.14
Coeff. of Var.	6%	9%	52%	71%
Mean pH (old)				5.40
Mean pH (new)	8.4			

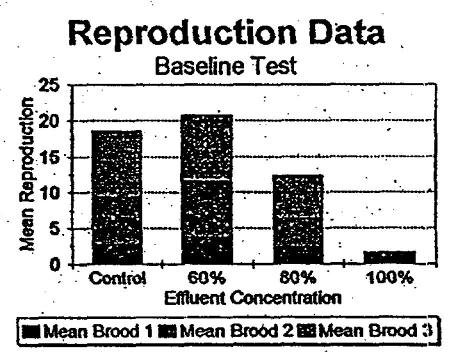
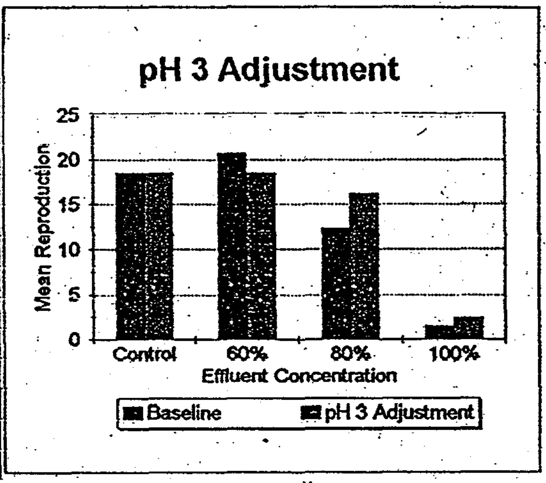


Table 2
Four Mile Branch Chronic TIE Test Results
pH 3 and pH 10 Adjustment Tests
Westinghouse Savannah River Company
June 1995

Adjusted to pH 3	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	19	20	16	0
Replicate B	19	16	12	6
Replicate C	18	21	19	6
Replicate D		20	16	0
Replicate E		16	18	0
Mean Brood 1	3.3	3.4	3.0	0.4
Mean Brood 2	7.3	5.0	6.2	2.0
Mean Brood 3	8.0	8.6	7.0	0.0
Mean	18.7	18.6	16.2	2.4
Std. Dev.	0.58	2.41	2.68	3.29
Coeff. of Var.	3%	13%	17%	137%
Mean pH (old)				6.62
Mean pH (new)				6.01



Adjusted to pH 10	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	3	16	20	9
Replicate B	7	15	15	8
Replicate C	5	16	17	4
Replicate D	5	16	18	0
Replicate E	3			4
Mean Brood 1	3.3	3.3	3.0	2.0
Mean Brood 2	7.3	6.5	5.5	2.6
Mean Brood 3	8.0	6.0	9.0	0.4
Mean	4.6	15.8	17.5	5.0
Std. Dev.	0.58	7.06	8.03	3.61
Coeff. of Var.	3%	45%	46%	0%
Mean pH (old)				6.58
Mean pH (new)				5.97

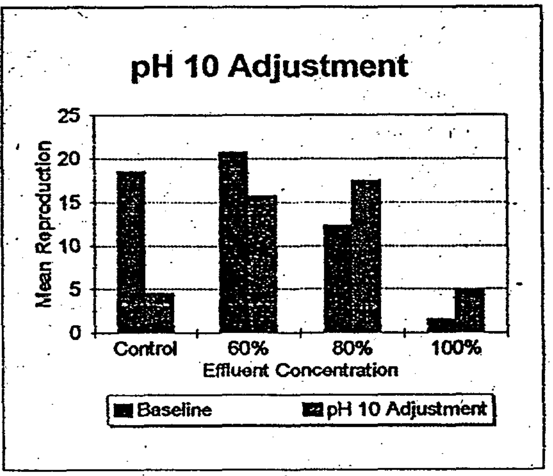
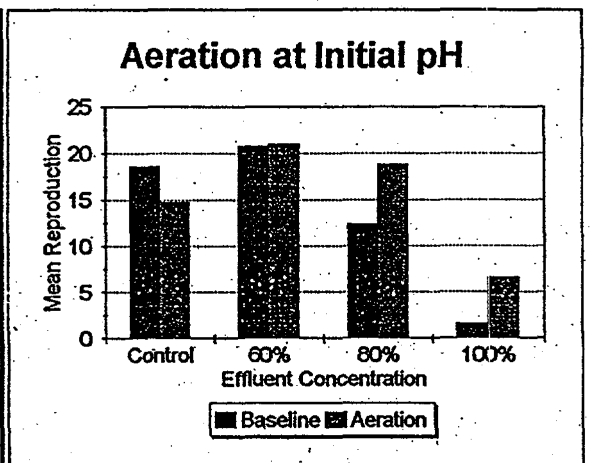


Table 3
Four Mile Branch Chronic TIE Test Results
Aeration and Filtration at Initial pH Tests
Westinghouse Savannah River Company
June 1995

Aerated at Initial pH	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	17	16	19	10
Replicate B	8	19	18	11
Replicate C	17	21	19	12
Replicate D	17	22	17	0
Replicate E		27	21	0
Mean Brood 1	2.5	3.4	3.2	1.2
Mean Brood 2	5.0	6.8	6.6	2.6
Mean Brood 3	7.3	10.8	9.0	2.8
Mean	14.8	21.0	18.8	6.6
Std. Dev.	4.50	4.06	1.48	6.07
Coeff. of Var.	31%	19%	8%	92%
Mean pH (old)				6.15
Mean pH (new)				6.00



Filtration at Initial pH	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	16	15	20	14
Replicate B	19	21	12	15
Replicate C	17	18	16	14
Replicate D	19	20	18	17
Replicate E		18	12	19
Mean Brood 1	3	3.4	3.0	4.8
Mean Brood 2	4.5	5.8	6.2	5.2
Mean Brood 3	9.5	9.2	6.4	5.8
Mean	17.8	18.4	15.6	15.8
Std. Dev.	1.50	2.30	3.58	2.17
Coeff. of Var.	31%	13%	23%	0%
Mean pH (old)				7.22
Mean pH (new)				6.04

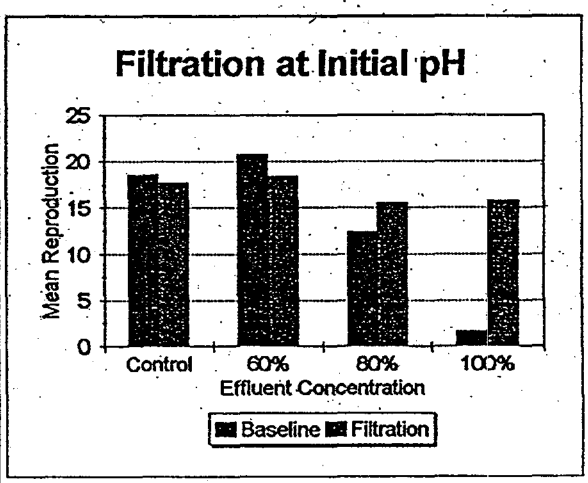
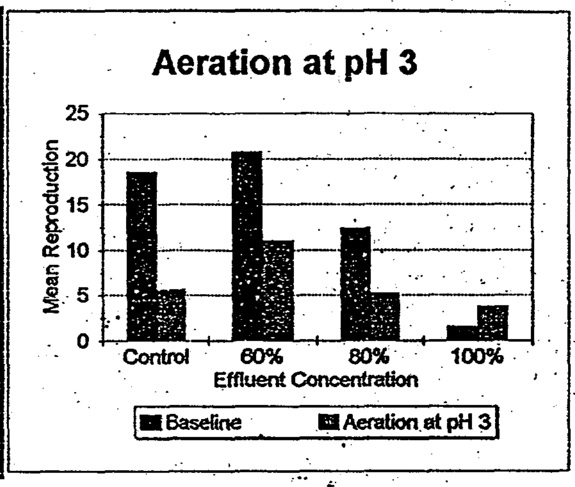


Table 4
Four Mile Branch Chronic TIE Test Results
Aeration at pH 3 and pH 10 Tests
Westinghouse Savannah River Company
June 1995

Aerated at pH 3	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	11	12	7	10
Replicate B	12	4	11	2
Replicate C	0	12	2	0
Replicate D	0	14	5	1
Replicate E	5	13	1	6
Mean Brood 1	1.8	2.2	1.8	1.6
Mean Brood 2	1.8	3.8	2.4	2.2
Mean Brood 3	2.0	5.0	1.0	0.0
Mean	5.6	11.0	5.2	3.8
Std. Dev.	5.77	4.00	4.02	4.15
Coeff. of Var.	103%	36%	77%	109%
Mean pH (old)				6.77
Mean pH (new)				5.96



Aeration at pH 10	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	17	16	17	2
Replicate B	17	18	18	0
Replicate C	19	16	14	10
Replicate D	19	19	17	12
Replicate E		15	14	9
Mean Brood 1	3.7	3.6	3.6	2.2
Mean Brood 2	6.0	5.8	5.0	3.0
Mean Brood 3	8.3	7.4	7.4	1.4
Mean	18	16.8	16.0	6.6
Std. Dev.	1.15	1.64	1.87	5.27
Coeff. of Var.	6%	10%	12%	80%
Mean pH (old)				6.54
Mean pH (new)				6.06

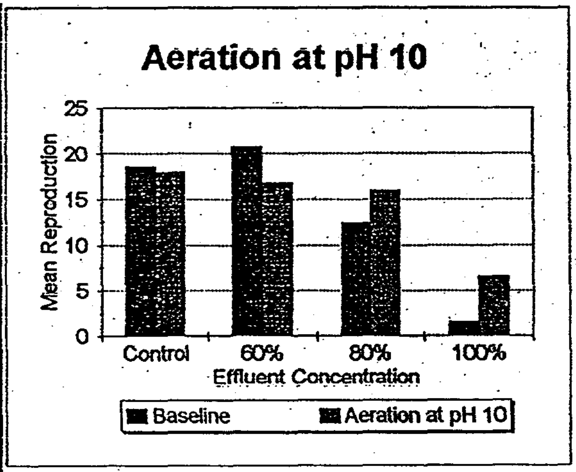
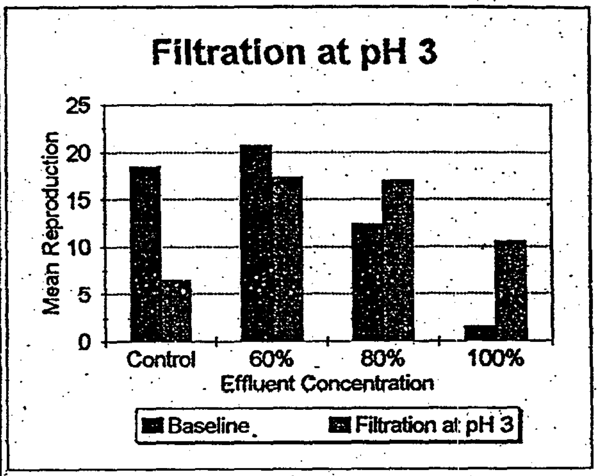


Table 5
Four Mile Branch Chronic TIE Test Results
Filtration at pH 3 and pH 10 Tests
Westinghouse Savannah River Company
June 1995

Filtered at pH 3	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	4	20	19	14
Replicate B	3	18	16	15
Replicate C	4	17	16	10
Replicate D	19	17	17	10
Replicate E	3	15		4
Mean Brood 1	3.6	3.8	4.2	3.6
Mean Brood 2	1.0	5.8	5.8	3.6
Mean Brood 3	2.0	7.8	7.0	3.4
Mean	6.6	17.4	17	10.6
Std. Dev.	6.95	1.82	1.41	4.34
Coeff. of Var.	105%	10%	8%	41%
Mean pH (old)				5.98
Mean pH (new)				6.07



Filtered at pH 10	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	5	16	17	9
Replicate B	2	16	15	13
Replicate C	4	17	16	12
Replicate D	0	13	17	8
Replicate E	2	17		12
Mean Brood 1	1.2	3.6	4.0	3.4
Mean Brood 2	1.4	5.4	4.8	3.8
Mean Brood 3	0	6.8	7.5	3.6
Mean	2.6	15.8	16.3	10.8
Std. Dev.	6.95	1.64	7.31	2.17
Coeff. of Var.	105%	10%	45%	0%
Mean pH (old)				6.94
Mean pH (new)				6.07

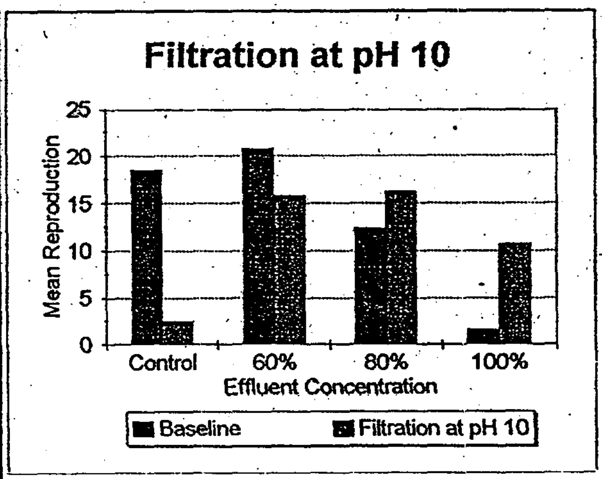
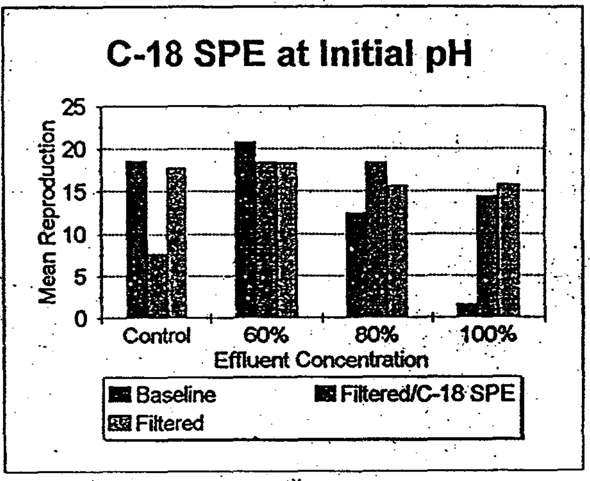


Table 6
Four Mile Branch Chronic TIE Test Results
Filtration / C-18 SPE at pH 3 and Initial pH
Westinghouse Savannah River Company
June 1995

Filtered/C-18 SPE at Initial pH	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	9	17	20	15
Replicate B	7	19	15	12
Replicate C	11	22	21	13
Replicate D	6	16	15	21
Replicate E	5		21	11
Mean Brood 1	2.4	3.8	3.0	3.8
Mean Brood 2	4.0	5.8	5.6	5.2
Mean Brood 3	1.2	9.0	9.8	5.4
Mean	7.6	18.5	18.4	14.4
Std. Dev.	2.41	2.65	3.13	3.97
Coeff. of Var.	32%	14%	17%	28%
Mean pH (old)				6.75
Mean pH (new)				6.04



Filtered/ C-18 SPE at pH 3	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	0	11	12	2
Replicate B	0	3	0	4
Replicate C	3	15	0	0
Replicate D	0	24	5	6
Replicate E	1	4	12	7
Mean Brood 1	0.8	3.4	3.4	2.2
Mean Brood 2	0	3.8	2.4	1.6
Mean Brood 3	0	4.2	0.0	0.0
Mean	0.8	11.4	5.8	3.8
Std. Dev.	1.30	8.62	6.02	2.86
Coeff. of Var.	163%	76%	104%	75%
Mean pH (old)				5.77
Mean pH (new)				6.00

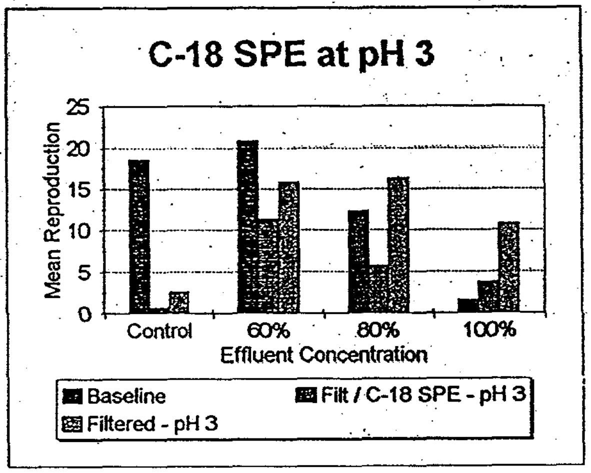


Table 7
Four Mile Branch Chronic TIE Test Results
Filtration / C-18 SPE at pH 9
Westinghouse Savannah River Company
June 1995

Filtered/C-18 SPE at Initial pH	Reproduction by Test Dilution			
	Control	60%	80%	100%
Replicate A	17	19	23	19
Replicate B	17	17	20	12
Replicate C	16	19	9	10
Replicate D	21	15	10	16
Replicate E	18	23	12	10
Mean Brood 1	3.4	3.6	3.4	3.8
Mean Brood 2	6.4	6.0	6.8	5.8
Mean Brood 3	8.0	9.0	4.6	3.8
Mean	17.8	18.6	14.8	13.4
Std. Dev.	1.92	2.97	6.30	3.97
Coeff. of Var.	11%	16%	43%	30%
Mean pH (old)				7.17
Mean pH (new)				6.00

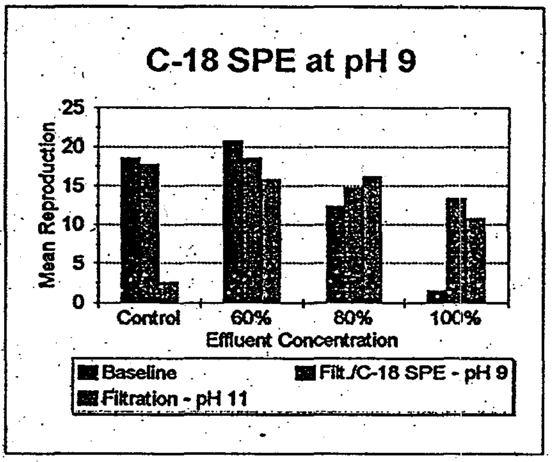
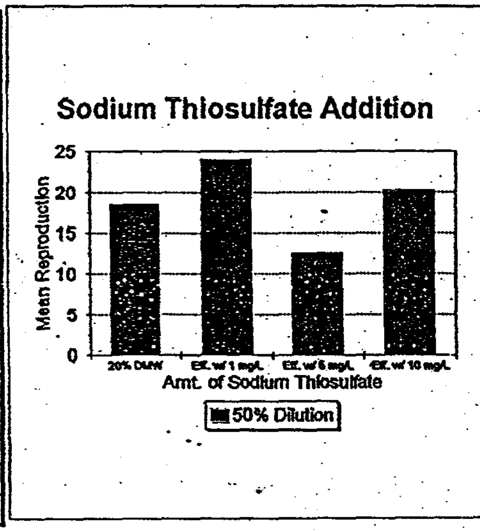


Table 8
Four Mile Branch Chronic TIE Test Results
Sodium Thiosulfate Addition Test
Westinghouse Savannah River Company
June 1995

Sodium Thiosulfate Addition	Reproduction at 50% Dilution			
	20% DMW Dilution Water	50% Effluent with 1 mg/L Na Thiosulfate	50% Effluent with 5 mg/L Na Thiosulfate	50% Effluent with 10 mg/L Na Thiosulfate
Replicate A	20	23	17	22
Replicate B	17	23	21	12
Replicate C	19	24	3	25
Replicate D	18	24	18	20
Replicate E	19	26	4	22
Mean Brood 1	2.8	4.0	3.4	4.6
Mean Brood 2	6.6	7.6	3.2	7.2
Mean Brood 3	9.2	12.4	6.0	8.4
Mean	18.6	24	12.6	20.2
Std. Dev.	1.14	1.22	8.44	4.92
Coeff. of Var.	6%	5%	67%	24%
Mean pH (old)				6.68
Mean pH (new)				6.07



Sodium Thiosulfate Addition	Reproduction at 100% Dilution			
	100% Effluent without Na Thiosulfate	100% Effluent with 1 mg/L Na Thiosulfate	100% Effluent with 5 mg/L Na Thiosulfate	100% Effluent with 10 mg/L Na Thiosulfate
Replicate A	2	10	0	0
Replicate B	2	6	6	0
Replicate C	1	8	3	0
Replicate D	3	12	1	0
Replicate E	0	11	3	0
Mean Brood 1	1.6	2.6	1.8	0.0
Mean Brood 2	0	2.2	0.8	0.0
Mean Brood 3	0	4.2	0.0	0.0
Mean	1.6	9.4	2.6	0.0
Std. Dev.	1.14	2.41	2.30	0.00
Coeff. of Var.	71%	26%	89%	N/A
Mean pH (old)		6.57		6.95
Mean pH (new)		6.05		6.05

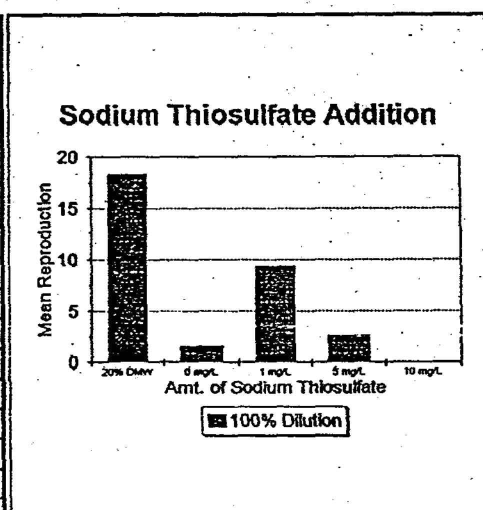
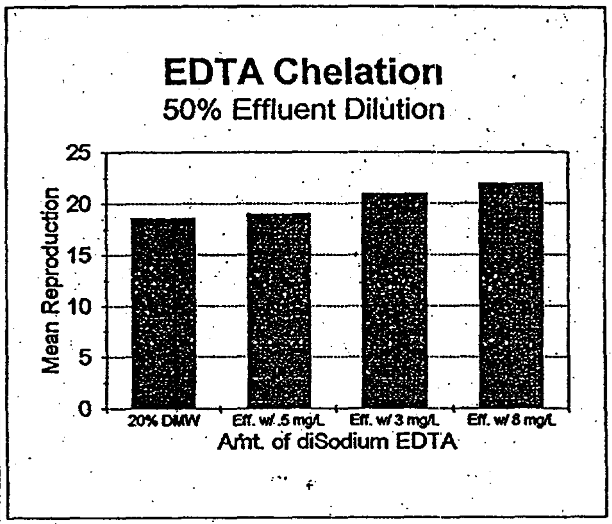


Table 9
Four Mile Branch Chronic TIE Test Results
EDTA Chelation Addition Test
Westinghouse Savannah River Company
June 1995

EDTA Chelation	Reproduction at 50% Dilution			
	Untreated 20% DMW Dilution Water	50% Effluent with 0.5 mg/L diSodium EDTA	50% Effluent with 3 mg/L diSodium EDTA	50% Effluent with 8 mg/L diSodium EDTA
Replicate A	20	21	17	20
Replicate B	17	14	24	16
Replicate C	19	19	23	25
Replicate D	18	20	20	24
Replicate E	19	21		25
Mean Brood 1	2.8	3.8	4.0	3.4
Mean Brood 2	6.6	5.2	6.5	7.0
Mean Brood 3	9.2	10.0	10.5	11.6
Mean	18.6	19.0	21	22
Std. Dev.	1.14	2.92	3.16	3.94
Coeff. of Var.	6%	15%	15%	18%
Mean pH (old)				
Mean pH (new)				



EDTA Chelation	Reproduction at 100% Dilution			
	100% Effluent without diSodium EDTA	100% Effluent with 0.5 mg/L diSodium EDTA	100% Effluent with 3 mg/L diSodium EDTA	100% Effluent with 8 mg/L diSodium EDTA
Replicate A	2	5	10	16
Replicate B	2	1	6	15
Replicate C	1	5	11	14
Replicate D	3	5	7	13
Replicate E	0		8	14
Mean Brood 1	1.6	1.4	3.2	2.2
Mean Brood 2	0.0	1.8	4.4	5.2
Mean Brood 3	0.0	0.0	0.8	7.0
Mean	1.6	4.0	8.4	14.4
Std. Dev.	1.14	2.00	2.07	1.14
Coeff. of Var.	71%	50%	25%	8%
Mean pH (old)		6.65	6.73	6.82
Mean pH (new)	6.03	5.99	5.96	6.04

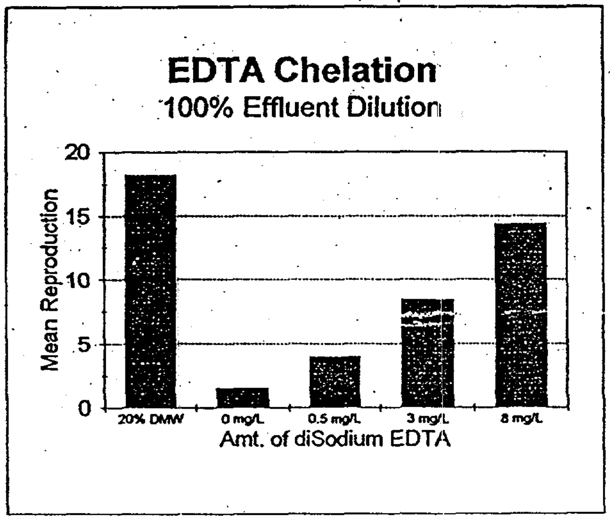
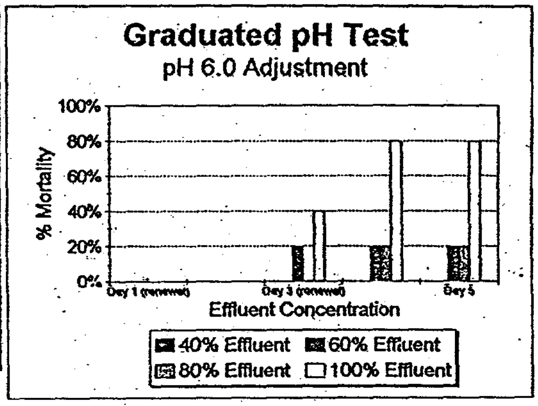


Table 10
Four Mile Branch Chronic TIE Test Results
Graduated pH Test
Westinghouse Savannah River Company
June 1995

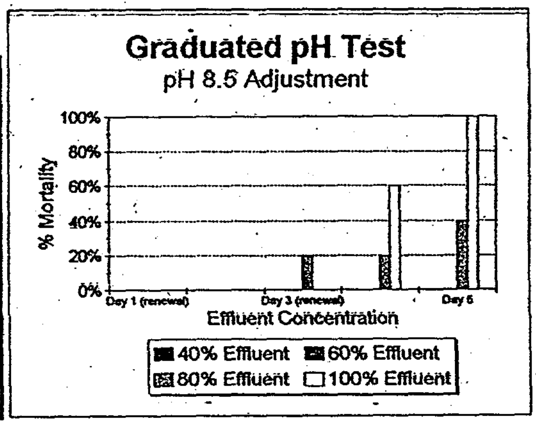
Cumulative % Mortality

pH 6.0	40% Effluent Adjusted to pH 6.0	60% Effluent Adjusted to pH 6.0	80% Effluent Adjusted to pH 6.0	100% Effluent Adjusted to pH 6.0
Day 1 (renewal)	0%	0%	0%	0%
Day 2	0%	0%	0%	0%
Day 3 (renewal)	0%	20%	0%	40%
Day 4	0%	20%	20%	80%
Day 5	0%	20%	20%	80%
Day 6	0%	20%	20%	80%
Day 7	0%	20%	20%	80%
Mean pH (old)	6.11	6.09	6.23	6.12
Mean pH (new)	6.01	6.04	6.03	6.03



Cumulative % Mortality

pH 8.5	40% Effluent Adjusted to pH 8.5	60% Effluent Adjusted to pH 8.5	80% Effluent Adjusted to pH 8.5	100% Effluent Adjusted to pH 8.5
Day 1 (renewal)	0%	0%	0%	0%
Day 2	0%	0%	0%	0%
Day 3 (renewal)	0%	0%	20%	0%
Day 4	0%	0%	20%	60%
Day 5	0%	0%	40%	100%
Day 6	0%	0%	40%	100%
Day 7	0%	0%	40%	100%
Mean pH (old)	8.41	8.39	8.47	8.37
Mean pH (new)	8.43	8.47		8.47



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ACUTE TOXICITY IDENTIFICATION EVALUATION PHASE II

Client: Westinghouse Savannah River Company
Sample ID: Four Mile Branch

July 1995

1.0 INTRODUCTION

A Chronic Toxicity Identification Evaluation (TIE) Phase I was conducted in June 1995 using Four Mile Branch Water from the Savannah River Site. Phase I testing indicated that cationic metals (particularly iron) were the probable toxicants. This conclusion was reached in consideration of the effectiveness of EDTA chelation and filtration in removing toxicity from the seep water as well as the orange-brown color. Cationic metal toxicity was thought to be enhanced by the low hardness and alkalinity of the effluent.

The current phase of the toxicity identification evaluation was conducted with the objective of identifying and confirming iron as the primary toxicant in the effluent.

2.0 SAMPLING

A grab sample of the effluent was collected by Westinghouse Savannah River Company personnel on July 25, 1995. The sample was shipped by overnight delivery to ETT Environmental, where the TIE was conducted.

3.0 DESIGN OF IDENTIFICATION AND CONFIRMATION TESTS

3.1 *Sample Preparation*

The first objective of this phase of testing was to remove the toxicant (thought to be iron) to produce a non-toxic sample, and then to spike the toxicant back into the solution in order reproduce the initial toxicity.

The non-toxic sample was prepared by treating 2 liters of Four Mile Branch water by filtration at pH 9. pH was adjusted by adding NaOH dropwise until the pH was raised to 9.00 ± 0.05. Gelman 0.45 micron membrane filters were used to filter the pH adjusted sample. An aliquot of the pH adjusted and filtered sample was tested for chronic toxicity to confirm that toxicity had been removed. The remainder of the pH adjusted and filtered sample was adjusted back to the initial pH and spiked with iron. Iron was spiked at concentrations of 1.0, 2.0, 4.0, and 6.2 mg/L. This range was chosen so as to start at the measured concentration of iron (6.2 mg/L) and determine the level at which iron would exhibit no toxicity. Iron was spiked from an acidic solution of 1000 ppm iron standard (iron nitrate).

3.2 *Toxicity Testing*

Three chronic definitive toxicity tests were set; 1) a baseline test of untreated effluent to confirm the presence of toxicity, 2) a test of pH adjusted / filtered effluent to confirm that the treatment removed toxicity, and 3) a test with a series of different spiked concentrations of iron. Seven day / 3 brood definitive survival and reproduction toxicity tests were set with all treated samples. The test organism species was *Ceriodaphnia dubia*. Each test was set with five replicate test organisms at each dilution.

4.0 Results

4.1 *Baseline Test*

The mean reproduction of test organisms in the dilution water control (20% DMW) was 19.6 young per female (Table 1). Higher reproduction (23.2 young per female) was noted at the 60% sample concentration. At the 80% sample concentration reproduction was essentially the same as in the dilution water control . However, at 100% (undiluted) sample concentration chronic toxicity was noted, with reproduction reduced to a mean of 12.6 neonates per female. No acute toxicity was noted.

4.2 *Four Mile Branch Adjusted to pH 9.0 and Filtered*

Treatment of the Four Mile Branch sample by filtration at pH 9 removed chronic toxicity, improving reproduction in 100% concentration from a mean of 12.6 neonates to a mean of 19.4. This confirmed the effectiveness of filtration in removing toxicity.

4.3 *pH Adusted / Filtered Four Mile Branch Sample Spiked with Iron*

Iron spiked at 1 - 2 mg/L into Four Mile Branch water was not acutely or chronically toxic. However, iron spiked at 4 - 6.2 mg/L resulted in acute toxicity in the sample.

5.0 DISCUSSION

Phase I of the TIE for Four Mile Branch water indicated that metals were the most likely toxicants present, and iron was detected at levels high enough to cause toxicity. In this second phase of the TIE the results support the identification of iron as the toxicant of concern. When iron was spiked into non-toxic sample at levels measured in Four Mile Branch water (6.2 mg/L), toxicity was noted. Toxicity in spiked sample was in fact greater than the original amount of toxicity. This may be attributed to the inability to exactly reproduce the proportions of particulate vs. dissolved metal in the spiked sample.

Table 1
Four Mile Branch Chronic Phase II TIE Test Results
Cationic Metals: Fe Spiked Treatment Tests
Westinghouse Savannah River Company
July - August 1995

Dilution Water (20% DMW)	Reproduction by Test Dilution					
	Day 3	Day 4	Day 5	Day 6	Day 7	Total
Replicate A	0	4	0	6	10	20
Replicate B	0	4	0	5	12	21
Replicate C	0	3	0	5	9	17
Replicate D	0	3	0	8	10	21
Replicate E	0	0	3	8	10	21
Mean	0.0	2.8	0.6	6.4	10.2	20.0
Mean pH (old)						8.09
Mean pH (new)						8.01

Four Mile Br. Untreated	Reproduction by Test Dilution					
	Control			60%	80%	100%
Replicate A	25			25	23	17
Replicate B	17			24	16	7
Replicate C	23			24	21	14
Replicate D	18			21	19	14
Replicate E	15			22	18	11
Mean	19.6			23.2	19.4	12.6
Mean pH (old)	8.09					7.51
Mean pH (new)	8.01					7.24

Four Mile Br. pH 9 Filtered	Reproduction by Test Dilution					
	20%DMW					100%
Replicate A	20					20
Replicate B	21					18
Replicate C	17					21
Replicate D	21					19
Replicate E	21					19
Mean	20.0					19.4
Mean pH (old)						
Mean pH (new)						

Four Mile Br. pH 9 Filtered Fe Spiked	Reproduction by Test Dilution Amount of Fe Spiked					
	Unspiked		1.0	2.0	4.0	6.2
Replicate A	18		23	17	0	0
Replicate B	18		18	18	0	0
Replicate C	18		19	23	0	0
Replicate D	19		21	11	0	0
Replicate E	15		17	18	0	0
Mean	17.6		19.6	17.4	0.0	0.0
Mortality	0%		0%	0%	100%	100%
Mean pH (old)			7.63	7.36	7.01	7.41
Mean pH (new)			6.53	6.60	6.38	6.44