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ECOLOGICAL RISK ANALYSIS FOR SOLID WASTE MANAGEMENT UNIT 3 LANDFILL C BURN AND DISPOSAL AREA WITH TRANSMITTAL CSS PANAMA CITY FL
10/1/2002
TETRA TECH

0003

Ecological Risk Analysis
for
Solid Waste Management Unit (SWMU) 3, Landfill C, Burn and Disposal Area

CSS Panama City
Panama City, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888
Contract Task Order 0184

October 2002

28 340592

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TTNUS/TAL-02-063/0184-3.2

October 8, 2002

Project Number 02834

Commander, Southern Division
Naval Facilities Engineering Command
ATTN: Mr. Phil McGinnis (Code ES31)
2155 Eagle Drive
North Charleston, South Carolina 29419-9010

Reference: Clean Contract No. N62467-94-D0888
Contract Task Order No. 0184

Subject: Submission of Ecological Risk Analysis Solid Waste Management Unit (SWMU) 3, Landfill C, Burn and Disposal Area, Coastal System Station Panama City, Panama City, Florida.

Dear Mr. McGinnis:

Enclosed are two copies of the of the Ecological Risk Analysis Solid Waste Management Unit (SWMU) 3, Landfill C, Burn and Disposal Area, Coastal System Station Panama City, Panama City. Electronic copies of this document were forwarded to you yesterday via E-mail. This document was completed as a stand alone publication, however, we understand that it is to be included as an appendix in the CSS Panama City RCRA Facility Investigation Addendum completed by SOUTHDIV.

If you have any questions regarding this document or require further information, please contact me at (850) 385-9899.

Sincerely,

Gerald Walker

Gerald Walker, P.G.
Task Order Manager

gw/gw

Enclosure (2)

c: Dan Waddill, (1 copy)
Debra Wroblewski, (Cover letter only)
Mark Perry/ File, (1 copy)
Rick Samuels, (1 copy)
Tallahassee file, (1 copy)

ECOLOGICAL RISK ANALYSIS
FOR
SOLID WASTE MANAGEMENT UNIT (SWMU) 3,
LANDFILL C, BURN AND DISPOSAL AREA

CSS PANAMA CITY
PANAMA CITY, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive

North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, PA 15220-2745

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0184

OCTOBER 2002

PREPARED UNDER THE SUPERVISION OF:

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1.0 INTRODUCTION

This ecological risk analysis is performed in support of the RCRA Facility Investigation Addendum for solid waste management unit (SWMU) number 3 located at the United States Navy's Coastal System Station (CSS) in Panama City, Florida. The objective of this analysis is to ascertain whether there is a potential for adverse effects on reproduction, growth, or survival of ecological populations associated with concentrations of chemicals detected in sediment at SWMU 3. This objective is accomplished through the performance of risk analyses using methods described in Ecological Risk Assessment for Superfund (USEPA, 1997a). The performed risk analysis combines aspects of screening level risk assessments and baseline risk assessments. While screening-level risk assessments use only maximum contaminant concentrations, conservative screening guidelines, and conservative exposure parameter assumptions, this risk analysis also evaluates risks at average concentrations using average exposure parameter assumptions and incorporating site-specific considerations.

1.1 PROBLEM FORMULATION

1.1.1 Site Description

SWMU 3, Landfill C, Burn and Disposal Area, is located northeast of the Amphibious Assault Landing Craft Area on the beach of St. Andrews Bay at the CSS, Panama City, Florida (Figure 1-1). The site is bordered on the east by St. Andrew Bay, on the north by a small tidal inlet and pond leading to St. Andrews Bay, and on the west by Building 292. The site area is shown in plan view on Figure 1-2.

SWMU 3 is reported to be 150 feet long by 50 feet wide by 12 feet deep in the RFI (ABB-ES, 1996). It is unclear from previous reports exactly where the landfill was located. According to reports in the Initial Assessment Study (IAS), the landfill extended from the fence-line on the north side of the Amphibious Assault Landing Craft Area for 150 feet to the south, along the waterline of St. Andrews Bay. Historical aerial photographs confirm this approximate location but suggest the site was larger than reported in the IAS. The entire area adjacent to the Amphibious Assault Landing Craft Area is covered with concrete riprap. A grassy area lies beyond the riprap and fence line to the north, around the tidal inlet.

SWMU 3 was used for waste disposal from 1953 to 1959. Disposed wastes included general household garbage, scrap lumber and metal, tree limbs, paint, paint thinner and solvent cans

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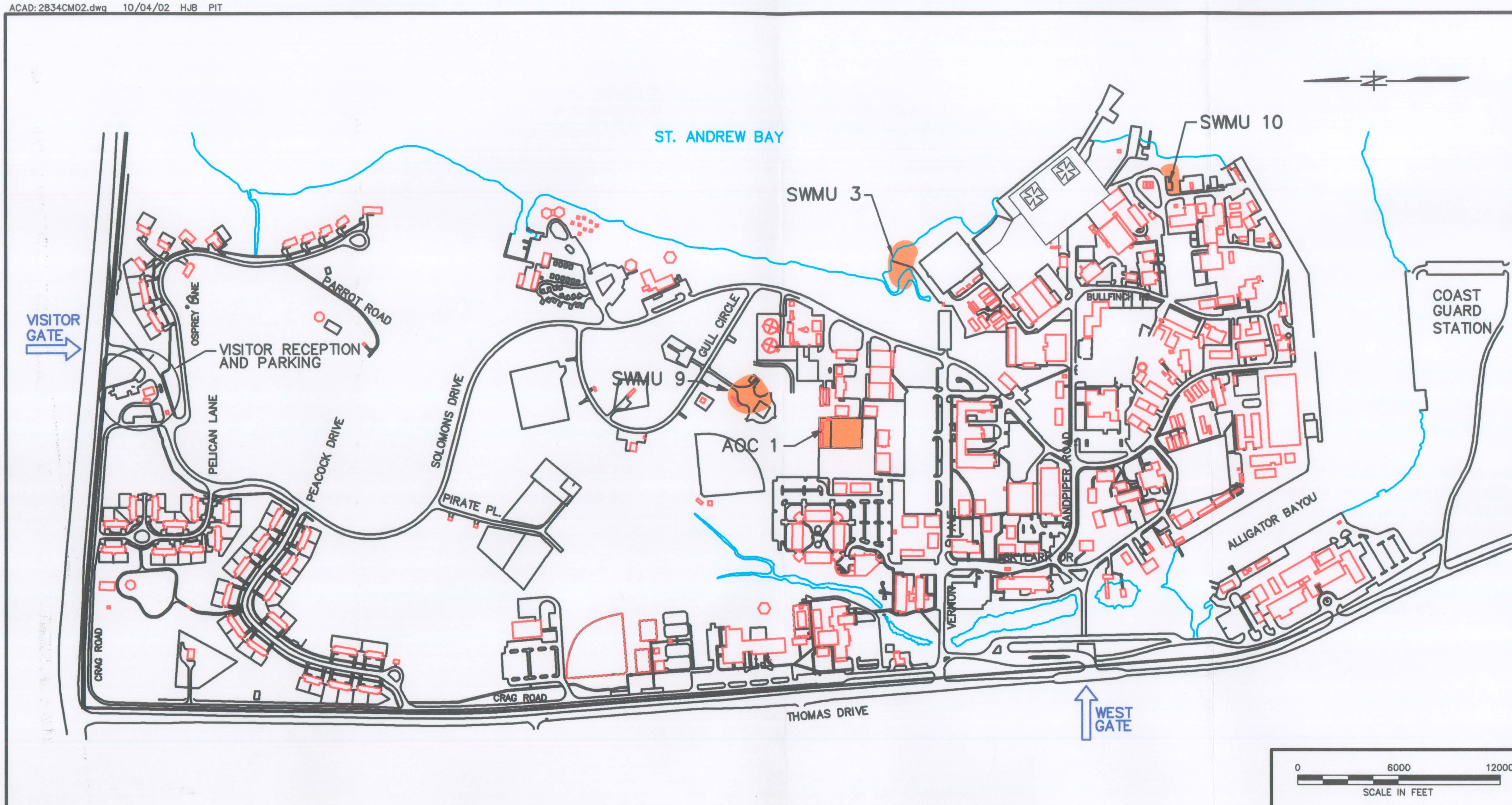

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 10/4/02
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

LOCATIONS OF SOLID WASTE MANAGEMENT UNITS (SWMUs) AND AREAS OF CONCERN (AOCs)
RFI ADDENDUM
COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

CONTRACT NO. 2834
APPROVED BY DATE
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REV. 0

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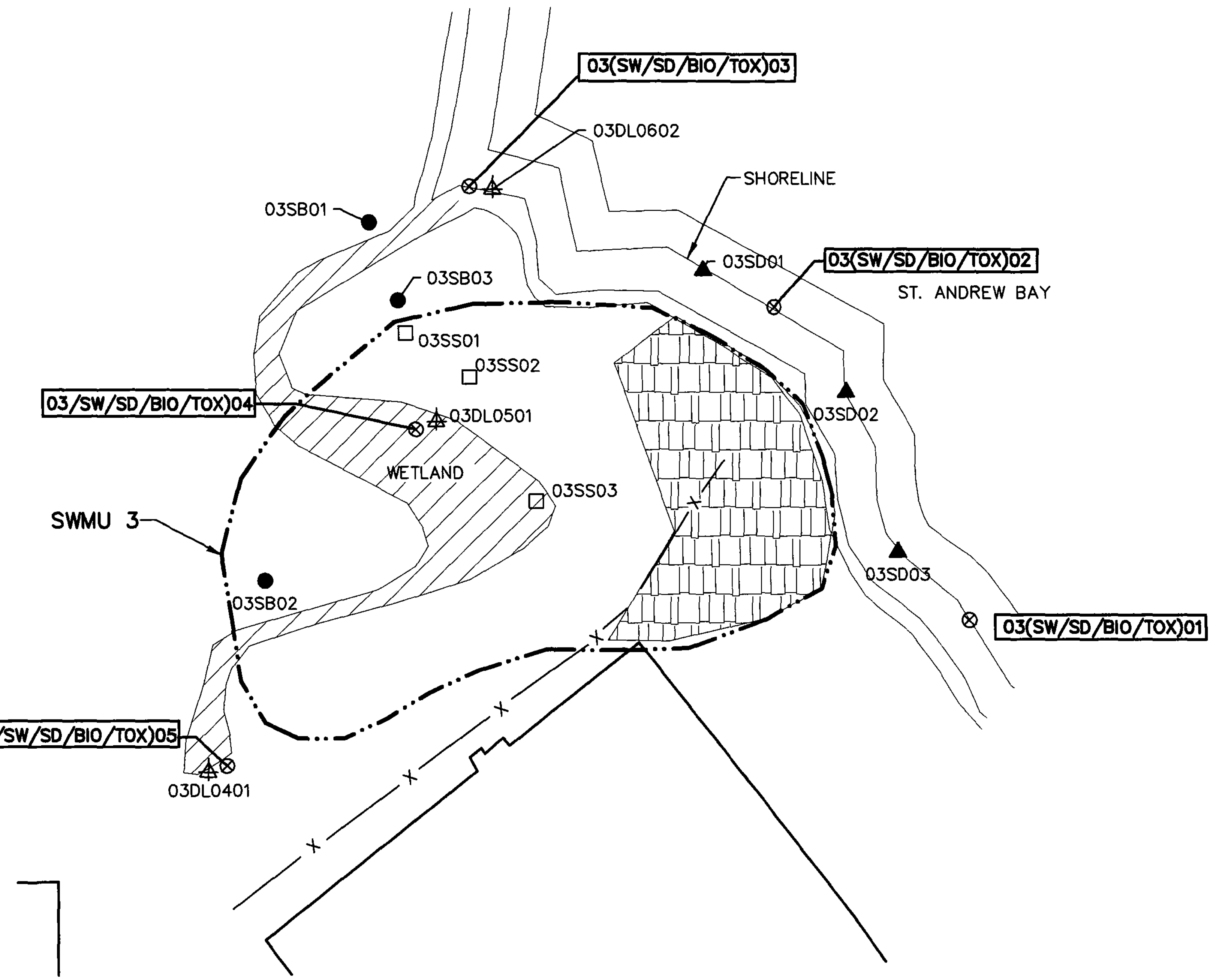

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LEGEND:

- SURFACE WATER/SEDIMENT SAMPLE (RFI ADDENDUM–2002)
- SURFACE WATER/SEDIMENT SAMPLE (RFI PHASE 2)
- SEDIMENT SAMPLE (RFI PHASE 1)
- SURFACE SOIL SAMPLE LOCATION (RFI PHASE 2)
- SUBSURFACE SOIL SAMPLE LOCATION (RFI PHASE 2)
- BIO BENTHIC MACROINVERTEBRATE SAMPLE
- TOX SEDIMENT TOXICITY SAMPLE
- FABRIC FORMED CONCRETE RIPRAP
- APPROXIMATE SOLID WASTE MANAGEMENT UNIT (SWMU) BOUNDARY
- WETLAND AREA
- —X— FENCELINE

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SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

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SCALE AS NOTED

SOLID WASTE MANAGEMENT AREA (SWMU) 3
SITE AREA AND PROPOSED SEDIMENT SAMPLING LOCATIONS FOR THE RFI ADDENDUM
COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

CONTRACT NO. 2834
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APPROVED BY DATE
DRAWING NO. FIGURE 1–2
REV. 0

FORM CADD NO. SDIV_BH.DWG – REV 0 – 1/20/98 (mostly empty or with residue), bilge water, and waste oil (possibly transformer oil containing PCBs). The IAS indicates that between 24 and 48 cubic yards of waste were brought to the site each day, and burning took place once per month. Bulldozers were used to push piles to a height of approximately 25 feet. The piles were then doused with gasoline and ignited. The resulting ash piles were covered with sand.

Aerial photographs, dated 1956 and 1959, show a bulldozed area along the beach with apparent debris and waste extending in width from the bay to a point approximately halfway to Solomon Drive, which parallels the shore. The area extends in length along the beach from a line parallel to the back of the supply warehouses (Buildings 99 and 100) at the north end, to Vernon Street on the south. When the Amphibious Assault Landing Craft Area was constructed, a natural wetland was destroyed. Under the requirements of Section 404 of the Clean Water Act, it was replaced by constructing the tidal inlet visible today. During low tide, evidence of waste disposal at SWMU 3 was apparent (ABB-ES,1993). Wastes were apparently filled into the bay itself, and debris could be seen in the water in this area.

In November 1997, a removal action was performed by the Navy Public Works Center Pensacola. The action included the removal of debris (metal parts, concrete, etc.) from the SWMU 3 shoreline, as recommended in the CMS. Debris was removed manually without the use of heavy mechanical equipment along 250 linear feet of shoreline and extending from the shoreline approximately 15 to 32 feet into St. Andrews Bay. The depth of the removal was 6 inches below St. Andrews Bay's bottom surface. Approximately 5 tons of non-hazardous debris was removed and disposed of at a Subtitle D landfill (Navy Public Works Center, 1997). Sampling and analysis of soils, sediment, or groundwater was not included in this removal action.

1.1.2 Source Characterization and Migration Pathways

Historic sampling information indicates that SWMU 3 is a source for SVOC and metals contamination. The potential source for these constituents appears to be the materials historically disposed of at the site. The presence of pesticides at the site appears to be associated with historic applications at CSS Panama City. As previously discussed in Section 1.1.1, construction and removal actions have been perfomed at SWMU 3 reducing potential sources of contaminants.

Site chemicals released from a primary source area typically enter the surrounding environment (e.g. soils, the secondary source) through infiltration. Soluble contaminants in the soil may become dissolved in percolating water, transported downgradient in groundwater and eventually discharge to surface water. The results of the original RFI however determined that this was not occuring, and consequently that groundwater was not a viable transport or exposure pathway at the site.

Constituents may be transported through volatilization from surficial material or become airborne via wind erosion and be transported to surface water and sediment. Additionally, both soluble compounds and adsorbed insoluble compounds may be transported to surface water and sediment via storm water runoff.

Some contaminants may have been incorporated into biological tissues. This is most important for contaminants that accumulate in higher concentrations in tissue than they do in environmental media. Metals like methyl mercury and organic compounds like pesticides and PCBs can accumulate in substantial concentrations in invertebrate tissue and in the higher trophic animals consuming that tissue.

1.1.3 Assessment and Measurement Endpoints

An assessment endpoint is defined as "an explicit expression of actual environmental values (e.g., ecological resources) that are to be protected" (USEPA, 1997a). A measurement endpoint is a "measurable biological response to a stressor that can be related to the valued characteristics chosen as the assessment endpoint" (USEPA, 1997a).

The ecological risk assessment addresses protection of the following ecological resource groups. The viability of the protected groups, in terms of successful growth and reproduction and long-term survival, is the assessment endpoint. The groups assessed in this report are listed below.

Assessment Endpoint	Surrogate Receptor	Measurement Endpoint
Benthic organisms, water column organisms	None	Site concentrations ÷ threshold concentrations[1]
Fish	None	Modeled fish tissue ÷ TRVs based on tissue levels[2]
Insectivorous birds	Spotted Sandpiper	Calculated doses ÷ oral TRVs[3]
Piscivorous bird	Great Blue Heron	Calculated doses ÷ oral TRVs

[1] State of Florida Department of Environmental Protection sediment screening guidelines
[2] Derived fish TRVs (Appendix B)
[3] Oral TRVs (Appendix A)
TRV - Toxicity Reference Value

The surrogate receptor species used as the basis for contaminant dose calculations were selected using the following criteria: their potential presence at the site, their small body size, ecological importance based on the identified ecosystems, the availability of life history data including increased sensitivity at certain life stages, and conceptual site model considerations including potential pathways of exposure to chemical constituents. Additionally, the surrogate receptor species (sandpiper and heron) were selected due to their evaluation in a previous ecological risk assessment for the site.

Measurement endpoints are direct observations or toxicity data that relate to the assessment endpoints. The measurement endpoints used in this assessment include concentrations in sediment and modeled in fish tissue. These concentrations were used to calculate oral doses for wildlife receptors. The site concentrations are compared to conservative screening levels (where available) to assess direct toxicity. The oral doses are compared to published doses above which survival, growth, and/or reproductive success of individuals may be altered to assess indirect, or food-chain, effects.

Benthic macroinvertebrate characterization and sediment toxicity testing were included in the ecological risk assessment for SMWU 3. Sediment samples collected in the tidal inlet, associated wetland, and St. Andrews Bay were submitted for characterization of types and numbers of organisms and for laboratory testing of sediment toxicity using a marine amphipod. The objectives of the analyses were to evaluate the potential impact of the site on the benthos and to characterize the macroinvertebrate community in the inlet and wetland.

1.1.4 Conceptual Site Model

A conceptual site model is designed to identify potentially exposed receptor populations and applicable exposure pathways, based on the physical nature of the site and the potential contaminant source areas. Actual or potential exposures of ecological receptors associated with SWMU 3 are determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has three components: (1) a source of chemicals that can be released to the environment, (2) a route of contaminant transport through an environmental medium, and (3) an exposure or contact point for an ecological receptor. A general conceptual model is presented in Figure 1-3, which contains all theoretically complete exposure pathways for SWMU 3.

1.2 EXPOSURE ASSESSMENT

Two types of exposures and associated effects are assumed for this screening: (1) direct exposure to contaminants in sediment resulting in toxicity to potential receptors, and (2) toxic responses of wildlife to contamination through diet. Maximum and mean concentrations of all detected chemical constituents were used as inputs for direct-toxicity screening while maximum and mean detected concentrations of bioaccumulative constituents only were used for food-chain model (FCM) screening.

Three sediment samples were collected at SWMU 3 to determine whether concentrations of potentially ecotoxic contaminants have been increasing over time. The three sediment samples collected were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Tables 1-1 and 1-2 illustrate the analytical results and site statistics, respectively. The results of the chemical analyses indicated that the maximum concentrations of SVOC, pesticide, PCB, and metal contaminants were found at locations 03DLO0401 (inland near the outfall) and 03DLO0501 (in the downstream wetland). Only one contaminant (toluene) had its maximum concentration at location 03DLO0601, at the junction of the tidal inlet and St. Andrews Bay.

Benthic invertebrates, aquatic plants, and water column organisms are assumed to be exposed directly to chemical constituents in the sediment, and exposure is measured as the maximum and mean concentrations of the chemical constituents in the sediment.

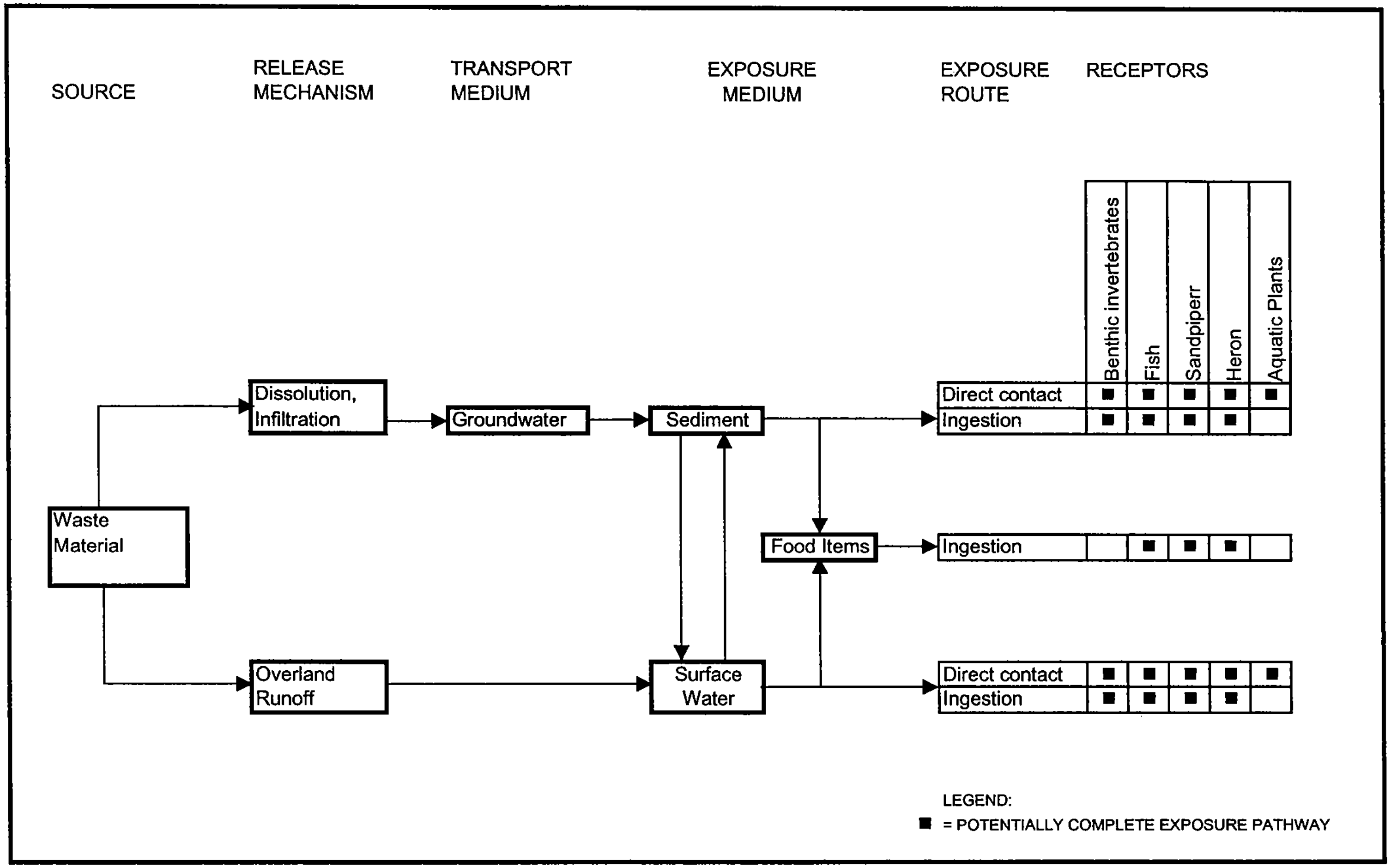


FIGURE 1-3
GENERAL CONCEPTUAL SITE MODEL
SWMU 3
CSS PANAMA CITY, FLORIDA

TABLE 1-1
SEDIMENT SAMPLE ANALYTICAL DATA
SWMU - 3
CSS PANAMA CITY, FLORIDA

location	03DL0401	03DL0501	03DL0601
nsample	03DL0401	03DL0501	03DL0601
sample_dat	4/17/2002	4/17/2002	4/17/2002
swmu	03	03	03
matrix	SD	SD	SD
depth_rang	0 - 1	0 - 1	0 - 1
sacode	NORMAL	NORMAL	NORMAL
Volatile Organics (ug/kg)			
TOLUENE	8.8 U	7.6 U	4.2 J
Semivolatile Organics (ug/kg)			
BENZO(A)ANTHRACENE	630	451 J	400 U
BENZO(A)PYRENE	913	972	67.7 J
BENZO(B)FLUORANTHENE	829	749	59.5 J
BENZO(G,H,I)PERYLENE	668	744	63.9 J
BENZO(K)FLUORANTHENE	474	445	39.1 J
BIS(2-ETHYLHEXYL)PHTHALATE	174 J	252 J	400 U
BUTYL BENZYL PHTHALATE	1440	480 U	400 U
CARBAZOLE	144 J	480 U	400 U
CHRYSENE	1850	1100	400 U
DIBENZO(A,H)ANTHRACENE	102	114	81 U
FLUORANTHENE	1920	973	400 U
INDENO(1,2,3-CD)PYRENE	716	660	61.9 J
PHENANTHRENE	434 J	510 U	400 U
PYRENE	1720	1430	400 U
TOTAL PAHs	10256 J	7638 J	292 J
TOTAL PHTHALATES	1614 J	252 J	400 U
Pesticides/PCBs (ug/kg)			
4,4'-DDD	56.9	23.1 J	4.3 U
4,4'-DDE	37.8 J	53.9	4.3 U
TOTAL DDT	94.7 J	77 J	4.3 U
AROCLOR-1254	50 U	1820	43 U
TOTAL PCBs	50 U	1820	43 U
DIELDRIN	19.5 J	25 U	2.2 U
TOTAL 'DRINS'	19.5 J	25 U	2.2 U
Inorganics (mg/kg)			
ALUMINUM	563	1900	165
ARSENIC	0.32 U	1.8	0.35 U
BARIUM	1.1	3.4	0.94
CADMIUM	0.17 U	0.47	0.032 U
CALCIUM	135 J	530 J	159 J
CHROMIUM	21.8 J	11.9 J	1.0 J
COPPER	4.7 J	52.9 J	37.6 J
IRON	769	2800	685
LEAD	76.6 J	49.8 J	27.2 J
MAGNESIUM	94.0	719	381
MANGANESE	3.1 J	11.8 J	1.8 J
MERCURY	0.014 U	0.15	0.060
NICKEL	0.66 U	5.5	0.68 U
SODIUM	170	2530	2100
VANADIUM	0.90	5.4	0.77
ZINC	49.0	146	21.7
Miscellaneous Parameters			
PERCENT SOLIDS %	65.4	66.7	79.1

TABLE 1- 2
SEDIMENT ANALYTICAL DATA STATISTICS
SWMU - 3
CSS PANAMA CITY, FLORIDA

cas	parameter	units	fraction	frequency	range	min_qual	max_qual	range_nd	samp_max	avg_pos	avg_all
108-88-3	TOLUENE	UG/KG	OV	1/3	4.2	J	J	7.6 - 8.8	03DL0601	4.2	4.13333
56-55-3	BENZO(A)ANTHRACENE	UG/KG	OS	2/3	451 - 630	J		400	03DL0401	540.5	427
50-32-8	BENZO(A)PYRENE	UG/KG	OS	3/3	67.7 - 972	J		NA	03DL0501	650.9	650.9
205-99-2	BENZO(B)FLUORANTHENE	UG/KG	OS	3/3	59.5 - 829	J		NA	03DL0401	545.83333	545.83333
191-24-2	BENZO(G,H,I)PERYLENE	UG/KG	OS	3/3	63.9 - 744	J		NA	03DL0501	491.96667	491.96667
207-08-9	BENZO(K)FLUORANTHENE	UG/KG	OS	3/3	39.1 - 474	J		NA	03DL0401	319.36667	319.36667
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	OS	2/3	174 - 252	J	J	400	03DL0501	213	208.66667
85-68-7	BUTYL BENZYL PHTHALATE	UG/KG	OS	1/3	1440			400 - 480	03DL0401	1440	626.66667
	TOTAL PHTHALATES	UG/KG	OS	2/3	252 - 1614	J	J	400	03DL0401	933	688.66667
86-74-8	CARBAZOLE	UG/KG	OS	1/3	144	J	J	400 - 480	03DL0401	144	194.66667
218-01-9	CHRYSENE	UG/KG	OS	2/3	1100 - 1850			400	03DL0401	1475	1050
53-70-3	DIBENZO(A,H)ANTHRACENE	UG/KG	OS	2/3	102 - 114			81	03DL0501	108	85.5
206-44-0	FLUORANTHENE	UG/KG	OS	2/3	973 - 1920			400	03DL0401	1446.5	1031
193-39-5	INDENO(1,2,3-CD)PYRENE	UG/KG	OS	3/3	61.9 - 716	J		NA	03DL0401	479.3	479.3
85-01-8	PHENANTHRENE	UG/KG	OS	1/3	434	J	J	400 - 510	03DL0401	434	296.33333
129-00-0	PYRENE	UG/KG	OS	2/3	1430 - 1720			400	03DL0401	1575	1116.66667
	TOTAL PAHs	UG/KG	OS	3/3	292 - 10256	J	J	NA	03DL0401	6062	6062
72-54-8	4,4'-DDD	UG/KG	PES	2/3	23.1 - 56.9	J		4.3	03DL0401	40	27.38333
72-55-9	4,4'-DDE	UG/KG	PES	2/3	37.8 - 53.9	J		4.3	03DL0501	45.85	31.28333
	TOTAL DDT	UG/KG	PES	2/3	77 - 94.7	J	J	4.3	03DL0401	85.85	57.95
11097-69-1	AROCLOR-1254	UG/KG	PES	1/3	1820			43 - 50	03DL0501	1820	622.16667
	TOTAL PCBs	UG/KG	PES	1/3	1820			43 - 50	03DL0501	1820	622.16667
60-57-1	DIELDRIN	UG/KG	PES	1/3	19.5	J	J	2.2 - 25	03DL0401	19.5	11.03333
	TOTAL 'DRINS'	UG/KG	PES	1/3	19.5	J	J	2.2 - 25	03DL0401	19.5	11.03333
7429-90-5	ALUMINUM	MG/KG	M	3/3	165 - 1900			NA	03DL0501	876	876
7440-38-2	ARSENIC	MG/KG	M	1/3	1.8			0.32 - 0.35	03DL0501	1.8	0.71167
7440-39-3	BARIUM	MG/KG	M	3/3	0.94 - 3.4			NA	03DL0501	1.81333	1.81333
7440-43-9	CADMIUM	MG/KG	M	1/3	0.47			0.032 - 0.17	03DL0501	0.47	0.19033
7440-70-2	CALCIUM	MG/KG	M	3/3	135 - 530	J	J	NA	03DL0501	274.66667	274.66667
7440-47-3	CHROMIUM	MG/KG	M	3/3	1 - 21.8	J	J	NA	03DL0401	11.56667	11.56667
7440-50-8	COPPER	MG/KG	M	3/3	4.7 - 52.9	J	J	NA	03DL0501	31.73333	31.73333
7439-89-6	IRON	MG/KG	M	3/3	685 - 2800			NA	03DL0501	1418	1418
7439-92-1	LEAD	MG/KG	M	3/3	27.2 - 76.6	J	J	NA	03DL0401	51.2	51.2
7439-95-4	MAGNESIUM	MG/KG	M	3/3	94 - 719			NA	03DL0501	398	398
7439-96-5	MANGANESE	MG/KG	M	3/3	1.8 - 11.8	J	J	NA	03DL0501	5.56667	5.56667
7439-97-6	MERCURY	MG/KG	M	2/3	0.06 - 0.15			0.014	03DL0501	0.105	0.07233
7440-02-0	NICKEL	MG/KG	M	1/3	5.5			0.66 - 0.68	03DL0501	5.5	2.05667
7440-23-5	SODIUM	MG/KG	M	3/3	170 - 2530			NA	03DL0501	1600	1600
7440-62-2	VANADIUM	MG/KG	M	3/3	0.77 - 5.4			NA	03DL0501	2.35667	2.35667
7440-66-6	ZINC	MG/KG	M	3/3	21.7 - 146			NA	03DL0501	72.23333	72.23333
TTNUS291	PERCENT SOLIDS	%	MIS	3/3	65.4 - 79.1			NA	03DL0601	70.4	70.4

Potential exposure of vertebrates to chemical constituents occurs mainly through ingestion. Food-chain effects are seen in wildlife, usually in response to chemicals that are more highly concentrated in food items than the media to which they are exposed.

Some chemicals are not known to bioaccumulate in environmental systems. The USEPA (2000) has published a list of important bioaccumulative compounds. The chemicals on this list were included in the food-chain modeling while those not listed were not. Based upon the USEPA's list, the following constituents (that were detected in sediment) were not included in the food-chain modeling even though their potential toxic effects were evaluated in direct toxicity analyses:

Toluene	Iron
Carbazole	Magnesium
Phthalates	Manganese
Aluminum	Sodium
Barium	Vanadium
Calcium	

All food item concentrations were estimated using biological accumulation factors (BAFs) or biota-sediment accumulation factors (BSAFs) that were applied to substrate (sediment) concentrations providing a conservative estimate of food item concentrations. This was done because no tissue data have been collected for SWMU 3. The data used to derive BAFs and BSAFs, and the use of these factors in estimating prey item concentrations, are presented in Appendix A (Tables FCM-4 through FCM-6).

Sediment-to-benthic invertebrate BSAFs were obtained from two sources. For metals, Thomann et al.'s (1995) modeled BSAFs are used because there is both a theoretical and empirical basis for them. In cases where no modeled BSAF was available for a particular metal, the highest median BSAF (between mussel and oyster data) is used because it is the most conservative of the available values (Thomann et al., 1995). For organic compounds, the USEPA (1997b) BSAF values for fish are used.

Due to the absence of site-specific fish tissue data, the assumptions used in Thomann's model for invertebrates were evaluated for their applicability to fish. Thomann's model used sediment-to-water partition coefficients and water-to-biota concentration factors to predict invertebrate metal concentrations. This approach appears to be applicable to fish as well, to conservatively estimate fish concentrations. As with the estimation of invertebrate concentrations, if no modeled BSAF was available, the highest median BSAF was used (Thomann et al., 1995). For organic compounds, the USEPA (1997b) BSAF values are used to estimate fish tissue concentrations.

Food-chain effect thresholds used in this assessment are ingested doses. For the FCMs, ingested doses were calculated according to the following equation:

$$PD = \{[(I_f - I_s) \times C_f] + (I_s \times C_s)\}/BW$$

where:

PD	=	predicted dose from the ingestion of food and the incidental ingestion of substrate (soil or sediment) (mg/kg/day)
I_f	=	ingestion rate for food (kg/day)
I_s	=	ingestion rate for substrate (kg/day)
C_f	=	chemical concentration in food item (mg/kg)
C_s	=	chemical concentration in substrate (mg/kg
BW	=	body weight of receptor (kg)

The food chain models assumed that drinking water was obtained from a clean fresh water source (not St. Andrews Bay) consequently, a calculation term for water ingestion is not included in the model.

Exposure parameters used in the FCMs were derived from data in the USEPA (1993) *Wildlife Exposure Factors Handbook.* The highest food ingestion rate to body weight ratio is typically used to maximize dose for conservative purposes. Maximum substrate concentrations and conservative feeding parameters, as well as mean substrate concentrations and average feeding parameters are used in the screening. For the screening, contaminants are presumed to be 100% bioavailable. The dietary composition is assumed to be 100% of the most contaminated dietary component. Area use factors are evaluated by comparing site surface area (in acres) to the average home range of the selected receptors.

For SWMU 3, the assessment endpoints based on protection of birds define the only food-chain pathways of concern. Estimation of exposure through the foodchain is calculated using the equation presented earlier; this dose equation uses terms for chemical concentration, ingestion rate, and body weight. Chemical concentration data are the same for each receptor, but they are modified by accumulation factors to estimate chemical concentrations in prey. Accumulation factors were available for the sediment-to-invertebrate/fish pathways. The tables containing the food-chain modeling data are attached in A (Tables FCM-1 through FCM-3).

1.3 ECOLOGICAL EFFECTS CHARACTERIZATION

Screening of sediment concentrations was performed using either USEPA Region IV screening levels, National Oceanic and Atmospheric Administration (NOAA) Effects Range Low (ER-L) and Effects Range Median (ER-M), and State of Florida Department of Environmental Protection (FDEP) Threshold Effect Levels (TELs) and Probable Effects Levels (PELs). Preference was given to FDEP levels, where available, as they tended to be the most conservative guidelines. In the absence of FDEP guidelines, guidelines from the other cited sources were used if available (Table 1-3).

Ecotoxicity screening values used in food-chain evaluations were based on no-observed-adverse-effect-levels (NOAELS) and lowest-observed-adverse-effect-levels (LOAELS) researched from the literature. The use of NOAELS is appropriate for screening-level assessments to ensure that risk is not underestimated. If NOAELS were not available for particular chemicals and/or receptors but LOAELS were available, the LOAEL was divided by an uncertainty factor of 10 to develop a conservative NOAEL-based ecotoxicity value per EPA guidance (USEPA, 1997a). Selection of NOAELS (and LOAELS) from the literature was based on the species tested, the route of exposure, the duration of the study, and the measured effect. Priority was given to studies evaluating ecological effects that impact populations, including adverse effects on development, reproduction, and survivorship. The toxicity reference values used for each modeled receptor (other than fish) are listed in Appendix A.

For fish, TRVs were derived from databases (Jarvinen and Ankley, 1999; WES, 2000) that list effects from toxicity tests along with tissue concentrations of the organisms being tested. LOAELs from these data, in terms of tissue concentrations, were typically log-normally distributed, and this property was used to develop lower 5 percent and 50 percent LOAEL values for the distributions. The data and calculations used to derive fish TRVs are shown in Appendix B. The lower 5 percent LOAEL TRV represents negligible risk, whereas the 50 percent TRV represents probable effects. Both the 5 percent and the 50 percent TRVs were used to assess potential risk to fish at SWMU 3.

For chemicals with insufficient data to calculate TRVs for fish, the lowest LOAEL and the lowest NOAEL (of NOAELs paired with a LOAEL) were identified, and the lowest of these two values was used to help interpret fish body burden estimates. Only the single value was used, rather than the 5 percent and 50 percent TRVs calculated for chemicals with more data.

An evaluation of potential impacts from SWMU 3 on macroinvertebrates in the tidal inlet was done by comparing invertebrate community characteristics at sampling locations adjacent to the site with the location downstream of the site in St. Andrews Bay. Comparisons were also made to results from the earlier macroinvertebrate study performed by ABB.

Sediment samples were collected for toxicity testing and submitted to Tetra Tech Inc.'s Biological Research Facility in Owings Mills, Maryland, for 10-day survival toxicity testing, using the marine

TABLE 1-3
DIRECT-TOXICITY GUIDELINES - SEDIMENT
SWMU - 3
CSS PANAMA CITY, FLORIDA

Chemical	EPA Region 4 Screening Level (mg/kg)	FDEP TEL (mg/kg)	NOAA ER-L (mg/kg)	Value Used in this Assessment	FDEP PEL (mg/kg)	NOAA ER-M (mg/kg)	Value Used in this Assessment	Notes
Volatile Organic Compounds								
Toluene	NA	NA	NA	NA	NA	NA	NA	
Semivolatile Organic Compounds								
Benzo(a)anthracene	0.33	0.075	0.261	0.075	0.693	1.6	0.693	
Benzo(a)pyrene	0.33	0.089	0.43	0.089	0.763	1.6	0.763	
Benzo(b)fluoranthene	0.655	NA	NA	0.655	NA	NA	NA	EPA Region IV value for high molecular weight PAH
Benzo(g,h,i)perylene	0.655	NA	NA	0.655	NA	NA	NA	EPA Region IV value for high molecular weight PAH
Benzo(k)fluoranthene	0.655	NA	NA	0.655	NA	NA	NA	EPA Region IV value for high molecular weight PAH
Bis(2-ethylhexyl)phthalate	0.182	0.182	NA	0.182	2.647	NA	2.647	
Butylbenzyl phthtalate	NA	NA	NA	NA	NA	NA	NA	
Carbazole	NA	NA	NA	NA	NA	NA	NA	
Chrysene	0.33	0.108	0.384	0.108	0.846	2.8	0.846	
Dibenzo(a,h)anthracene	0.33	0.0062	0.063	0.006	0.135	0.260	0.135	
Fluoranthene	0.33	0.113	0.6	0.113	1.494	5.1	1.494	
Ideno(1,2,3-CD)pyrene	0.655	NA	NA	0.655	NA	NA	NA	EPA Region IV value for high molecular weight PAH
Phenanthrene	0.33	0.087	0.240	0.087	0.544	1.500	0.544	
Pyrene	0.33	0.153	0.665	0.153	1.398	2.6	1.398	
Total Phthalate	NA	NA	NA	NA	NA	NA	NA	
Total PAHs	1.684	1.684	4.02	1.684	16.77	44.8	16.77	
Pesticides and PCBs								
4,4'-DDD	0.003	0.001	NA	0.001	0.0078	NA	0.0078	
4,4'-DDE	0.003	0.002	0.002	0.002	0.374	0.027	0.374	
Dieldrin	0.003	0.0007	0.0000	0.0007	0.0043	0.008	0.0043	
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA	
DDTR	0.003	0.004	0.0016	0.004	0.052	0.046	0.052	
Total 'Drins	NA	NA	NA	NA	NA	NA	NA	
Total PCBs	0.033	0.022	0.023	0.022	0.189	0.18	0.189	
Metals and Inorganic Compounds								
Aluminum	NA	NA	NA	NA	NA	NA	NA	
Arsenic	7	7.24	8.2	7.24	41.6	70	41.6	
Barium	NA	NA	NA	NA	NA	NA	NA	
Cadmium	1	0.68	1.2	0.68	4.21	9.6	4.21	
Calcium	NA	NA	NA	NA	NA	NA	NA	
Chromium	52.3	52.3	81	52.3	160	370	160	
Copper	18.7	18.7	34	18.7	108	270	108	
Iron	NA	NA	NA	NA	NA	NA	NA	
Lead	30.2	30.2	46.7	30.2	112	218	112	
Magnesium	NA	NA	NA	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	NA	NA	NA	
Mercury	0.13	0.13	0.15	0.13	0.7	0.71	0.7	
Nickel	15.9	15.9	20.9	15.9	42.8	51.6	42.8	
Sodium	NA	NA	NA	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	NA	NA	NA	
Zinc	124	124	150	124	271	410	271	

Florida Department of Environmental Protection; Threshold Effects Level, Probable Effects Level, from MacDonald et al. (1994)
National Oceanic and Atmospheric Administration; Effects Range Low, Effects Range Median from Long et al. (1995)

amphipod *Leptocheirus plumulosus (Leptocheirus).* A total of three sediment samples that were co-located with chemical and benthic macroinvertebrate samples were submitted for testing. The data collected from these samples was analyzed to determine if any of the samples produced adverse effects to *Leptocheirus*. Submitted samples were analyzed in accordance with American Society for Testing and Materials (ASTM) procedures detailed in: *Standard Guide for Conducting 10-day Static Sediment Toxicity Tests with Marine and Estuarine Amphipods. E1367-99. In Annual Book of ASTM Standards, Volume 11.05.*). Survival was the endpoint measured for each sample. Results from the test sediments were compared to the response of organisms in a laboratory control. Each of the tests consisted of five replicates with 20 test organisms per replicate. Statistical comparisons among the control and SWMU 3 test samples were used to assess the likelihood that a toxic response had occurred in each sample.

1.4 RISK CHARACTERIZATION

In the direct-toxicity analysis, risk is characterized by comparing mean and maximum exposure concentrations to direct toxicity guideline levels. In the food-chain models, estimated doses are compared to threshold toxicity doses in order to characterize risk. In both cases, the "quotient method" was used to describe risk. Hazard quotients (HQs) were calculated by dividing the maximum and mean environmental concentrations for each contaminant by the selected TELs and PELs respectively. For the food-chain model, HQs were calculated by dividing mean doses by LOAELs and maximum doses by NOAELs. For fish, the modeled maximum fish tissue concentration was divided by the 5% TRV to estimate a chronic HQ, and the modeled mean fish tissue concentration was divided by the 50% TRV to estimate an acute HQ.

An HQ less than 1.0 for direct toxicity indicates that risk is unlikely to occur while an HQ greater than 1.0 indicates potential risk. Like the direct toxicity HQ, a NOAEL HQ less than 1.0 in the food-chain modeling and a 5% TRV HQ less than one in fish indicates unlikely risk.

1.4.1 Direct-Toxicity

Table 1-4 illustrates the results of the direct-toxicity analysis for sediment. The following analytes had mean TEL and maximum PEL HQs (respectively) greater than 1.0 and are considered contaminants of concern (COCs): benzo(a)pyrene (7.31, 1.27), chrysene (9.72, 2.19), fluoranthene (9.12, 1.29), pyrene (7.32, 1.23), 4,4'-DDD (22.5, 7.31), dieldrin (15.28, 4.54), total DDT (DDTR) (14.5, 1.83), and total PCBs (28.27, 9.63). The following analytes also had mean TEL hazard quotients greater than 1.0 but maximum PEL HQs less than 1.0 and are considered COCs: benzo(a)anthracene (5.73), bis(2-ethylhexyl)phthalate (1.15), dibenzo(a,h)anthracene (13.87), phenathrene (3.41), total PAHs (3.6), 4,4'-DDE (15.5), copper (1.7), and lead (1.7).

TABLE 1-4
SITE CONCENTRATIONS COMPARED TO GUIDELINES FOR DIRECT TOXICITY - SEDIMENT
SWMU - 3
CSS PANAMA CITY, FLORIDA

Chemical	Frequency of Detection	Range of Detection (mg/kg)		Mean (mg/kg)	Location of Maximum	TEL Guideline (mg/kg)	Maximum TEL Hazard Quotient	Mean TEL Hazard Quotient	PEL Guideline (mg/kg)	Maximum PEL Hazard Quotient	COC?	Notes
		Min.	Max.									
Volatile Organic Compounds												
Toluene	1/3	0.004	0.004	0.004	03DL0601	NA	NA	NA	NA	NA	Y	no guideline
Semivolatile Organic Compounds												
Benzo(A)anthracene	2/3	0.451	0.63	0.43	03DL0401	0.075	**8.40**	5.73	0.693	0.909	Y	
Benzo(A)pyrene	3/3	0.068	0.972	0.651	03DL0501	0.089	**10.92**	7.31	0.763	**1.274**	Y	
Benzo(B)fluoranthene	3/3	0.0595	0.829	0.546	03DL0401	0.655	**1.27**	0.83	NA	NA	Y	EPA Region IV value for high molecular weight PAH
Benzo(G,H,I)perylene	3/3	0.064	0.744	0.492	03DL0501	0.655	**1.14**	0.75	NA	NA	Y	EPA Region IV value for high molecular weight PAH
Benzo(K)fluoranthene	3/3	0.039	0.474	0.319	03DL0401	0.655	0.72	0.49	NA	NA		EPA Region IV value for high molecular weight PAH
Bis(2-ethylhexyl)phthalate	2/3	0.174	0.252	0.209	03DL0501	0.182	**1.38**	**1.15**	2.647	0.095	Y	
Butylbenzyl phthtalate	1/3	1.44	1.44	0.627	03DL0401	NA	NA	NA	NA	NA	Y	no guideline
Carbazole	1/3	0.144	0.144	0.144	03DL0401	NA	NA	NA	NA	NA	Y	no guideline
Chrysene	2/3	1.1	1.85	1.05	03DL0401	0.108	**17.13**	**9.72**	0.846	**2.187**	Y	
Dibenzo(A,H)anthracene	2/3	0.102	0.114	0.086	03DL0501	0.006	**18.39**	**13.87**	0.135	0.844	Y	
Fluoranthene	2/3	0.973	1.92	1.03	03DL0401	0.113	**16.99**	**9.12**	1.494	**1.285**	Y	
Ideno(1,2,3-CD)pyrene	3/3	0.062	0.716	0.479	03DL0401	0.655	**1.09**	0.73	NA	NA	Y	EPA Region IV value for high molecular weight PAH
Phenanthrene	1/3	0.434	0.434	0.296	03DL0401	0.087	**5.01**	**3.41**	0.544	0.798	Y	
Pyrene	2/3	1.43	1.72	1.12	03DL0401	0.153	**11.24**	**7.32**	1.398	**1.230**	Y	
Total Phthalate	2/3	0.252	1.614	0.689	03DL0401	NA	NA	NA	NA	NA		no guideline
Total PAHs	3/3	0.292	10.256	6.06	03DL0401	1.684	**6.09**	**3.6**	16.77	0.612	Y	
Pesticides and PCBs												
4,4'-DDD	2/3	0.023	0.057	0.027	03DL0401	0.001	**47.50**	**22.5**	0.0078	**7.308**	Y	
4,4'-DDE	2/3	0.0378	0.0539	0.031	03DL0501	0.002	**26.95**	**15.5**	0.374	0.144	Y	
Dieldrin	1/3	0.0195	0.0195	0.011	03DL0401	0.0007	**27.08**	**15.28**	0.0043	**4.535**	Y	
Aroclor-1254	1/3	1.82	1.82	0.622	03DL0501	NA	NA	NA	NA	NA	Y	no guideline
DDTR	2/3	0.077	0.095	0.058	03DL0401	0.004	**23.75**	**14.5**	0.052	**1.827**	Y	
Total 'Drins	1/3	0.0195	0.0195	0.011	03DL0401	NA	NA	NA	NA	NA	Y	no guideline
Total PCBs	1/3	1.82	1.82	0.622	03DL0501	0.022	**82.73**	**28.27**	0.189	**9.630**	Y	
Metals and Inorganic Compounds												
Aluminum	3/3	165	1900	876	03DL0501	NA	NA	NA	NA	NA	Y	no guideline
Arsenic	1/3	1.8	1.8	0.712	03DL0501	7.24	0.2	0.1	41.6	0.043		
Barium	3/3	0.94	3.4	1.810	03DL0501	NA	NA	NA	NA	NA	Y	no guideline
Cadmium	1/3	0.47	0.47	0.19	03DL0501	0.68	0.7	0.28	4.21	0.112		
Calcium	3/3	135	530	275	03DL0501	NA	NA	NA	NA	NA		nutrient
Chromium	3/3	1	21.8	11.57	03DL0401	52.3	0.4	0.22	160	0.136		
Copper	3/3	4.7	52.9	31.730	03DL0501	18.7	**2.8**	**1.7**	108	0.490	Y	
Iron	3/3	27.2	76.6	51	03DL0501	NA	NA	NA	NA	NA	Y	no guideline
Lead	3/3	27.2	76.6	51.2	03DL0401	30.2	**2.5**	**1.7**	112	0.684	Y	
Magnesium	3/3	94	719	398	03DL0501	NA	NA	NA	NA	NA		nutrient
Manganese	3/3	1.8	11.8	5.6	03DL0501	NA	NA	NA	NA	NA	Y	no guideline
Mercury	2/3	0.06	0.15	0.072	03DL0501	0.13	**1.2**	0.55	0.7	0.214		
Nickel	1/3	5.5	5.5	2.06	03DL0501	15.9	0.3	0.13	42.8	0.129		
Sodium	3/3	170	2530	1600	03DL0501	NA	NA	NA	NA	NA		nutrient
Vanadium	3/3	0.77	5.4	2.360	03DL0501	NA	NA	NA	NA	NA	Y	no guideline
Zinc	3/3	21.7	146	72.23	03DL0501	124	**1.2**	0.58	271	0.539	Y	

NA - None Available
If hazard quotients are greater than 1, then they are bolded and considered COCs.

Several analytes had only maximum TEL HQs greater than 1.0 and are retained as COCs including: benzo(b)fluoranthene (1.27), benzo(g,h,I)perylene (1.14), ideno(1,2,3-cd)pyrene (1.09) mercury (1.2), and zinc (1.2)

The following contaminants had no guideline so they therefore cannot be eliminated as COCs based on comparison to guidelines: toluene, butylbenzyl phthalate, carbazole, total phthalate, Aroclor-1254, total drins, aluminum, barium, iron, manganese, and vanadium.

Iron and aluminum are abundant elements in the earth's crust, soil, and surface waters. They are usually toxic only at low pH (or at high pH for aluminum), consequently iron and aluminum toxicity are not expected and are not considered COCs.

Screening values were not available for the inorganic nutrients calcium, magnesium, potassium, and sodium. These metals are not considered candidates for inclusion as COCs because they are well tolerated by most biota (and in fact are essential nutrients at modest concentrations) and not toxic except at extremely elevated levels.

1.4.2 Food-Chain Modeling

To evaluate risks to wildlife at the screening level, simple food-chain models were used. Contaminants were eliminated as potential COCs by this modeling if NOAEL and LOAEL HQs for all receptors were less than 1.0, and if 5% and 50% HQs for fish were less than 1.0. The results of the food-chain modeling are summarized in Table 1-5. Spreadsheets of food-chain modeling data are presented in Appendix A. Table 1-6 shows a list of all detected contaminants that were identified as COCs based on the direct-toxicity and food-chain model analyses.

Food-chain modeling for the aquatic receptors produced NOAEL HQs greater than or equal to 1.0 for the following receptors and constituents:

- In the sandpiper, benzo(a)anthracene (HQ = 1.1), benzo(a)pyrene (HQ = 1.7), benzo(b)fluoranthene (HQ = 1.45), benzo(g,h,I)perylene (HQ = 1.3), chrysene (HQ = 3.23), fluoranthene (HQ = 3.36), ideno(1,2,3-CD)pyrene (HQ = 1.25), pyrene (HQ = 3.01), 4,4'-DDE (HQ = 5.03), Aroclor-1254 and total PCBs (HQ = 27), total DDT (HQ = 8.86), copper (HQ = 1.22), lead (HQ = 3.4), mercury (HQ = 3.23), and zinc (HQ = 19). All other NOAEL and LOAEL HQs were less than 1.0 for the sandpiper.

TABLE 1-5
HAZARD QUOTIENTS FOR FOOD CHAIN MODEL RECEPTORS
SWMU - 3
CSS PANAMA CITY, FLORIDA

Ecological Contaminant of Concern	Sandpiper NOAEL HQn	Sandpiper LOAEL HQ_l	Great Blue Heron NOAEL HQ_n	Great Blue Heron LOAEL HQ_l	Fish TRV $HQ_{5\%}$	Fish TRV $HQ_{50\%}$	Fish Lowest
Semivolatile Organic Compounds							
Benzo(a)anthracene	**1.10E+00**	7.52E-02	3.93E-01	2.68E-02	**NED**	**NED**	4.3E-01
Benzo(a)pyrene	**1.70E+00**	1.14E-01	6.07E-01	4.06E-02	**NED**	**NED**	6.7E-01
Benzo(b)fluoranthene	**1.45E+00**	9.55E-02	5.17E-01	3.41E-02	**NED**	**NED**	5.7E-01
Benzo(g,h,i)perylene	**1.30E+00**	8.60E-02	4.64E-01	3.07E-02	**NED**	**NED**	5.1E-01
Benzo(k)fluoranthene	8.29E-01	5.58E-02	2.96E-01	1.99E-02	**NED**	**NED**	3.2E-01
Carbazole	**NA**	**NA**	**NA**	**NA**	**NED**	**NED**	9.9E-02
Chrysene	**3.23E+00**	1.84E-01	**1.15E+00**	6.55E-02	**NED**	**NED**	**1E+00**
Dibenzo(a,h)anthracene	1.99E-01	1.50E-02	7.12E-02	5.37E-03	**NED**	**NED**	7.8E-02
Fluoranthene	**3.36E+00**	1.80E-01	**1.20E+00**	6.43E-02	**NED**	**NED**	**1E+00**
Ideno(1,2,3-CD)pyrene	**1.25E+00**	8.38E-02	4.47E-01	2.99E-02	**NED**	**NED**	4.9E-01
Phenanthrene	7.59E-01	5.18E-02	2.71E-01	1.85E-02	**NED**	**NED**	3.0E-01
Pyrene	**3.01E+00**	1.96E-01	**1.07E+00**	6.99E-02	**NED**	**NED**	**1E+00**
Total Phthalate	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total PAHs	**NA**	**NA**	**NA**	**NA**	**NED**	**NED**	**7.0E+00**
Pesticides and PCBs							
4,4'-DDD	2.15E-01	1.02E-02	7.64E-02	3.62E-03	8.6E-02	1.4E-03	
4,4'-DDE	**5.03E+00**	2.89E-01	**1.93E+00**	1.11E-01	**2.2E+00**	4.3E-02	
Dieldrin	5.04E-01	2.84E-02	1.91E-01	1.08E-02	**NED**	**NED**	1.5E-01
Aroclor-1254	**2.07E+01**	7.06E-01	**7.86E+00**	2.68E-01	**1.7E+01**	9.1E-02	
DDTR	**8.86E+00**	5.41E-01	**3.40E+00**	2.08E-01	**4.0E+00**	8.0E-02	
Total 'Drins	5.04E-01	2.84E-02	1.91E-01	1.08E-02	**NED**	**NED**	1.5E-01
Total PCBs	**2.07E+01**	7.06E-01	**7.86E+00**	2.68E-01	**1.7E+01**	9.1E-02	
Metals and Inorganic Compounds							
Arsenic	2.23E-01	2.94E-02	4.00E-02	5.27E-03	2.2E-01	3.5E-02	
Cadmium	3.52E-01	1.03E-02	6.56E-02	1.92E-03	**1.2E+01**	1.9E-01	
Chromium	8.37E-01	8.88E-02	9.26E-02	9.83E-03	**NED**	**NED**	7.8E-02
Copper	**1.22E+00**	5.59E-01	2.28E-01	1.04E-01	**7.8E+01**	**4.8E+00**	
Lead	**3.40E+00**	2.27E-01	4.39E-01	2.94E-02	**NED**	**NED**	5.0E-01
Mercury	**3.23E+00**	1.55E-01	5.40E-01	2.59E-02	3.4E-02	2.2E-03	
Nickel	3.93E-03	1.06E-03	5.28E-04	1.43E-04	**NED**	**NED**	
Zinc	**1.09E+01**	5.99E-01	**2.04E+00**	1.12E-01	**NED**	**NED**	**4.8E+00**

NA - not available
NED - not enough data to caculate

TABLE 1-6
COCs FOR
SWMU-3
CSS PANAMA CITY, FLORIDA

	DIRECT TOXICITY	FOOD CHAIN MODEL		
Chemical	**Sediment**			
Volatile Organic Compounds				**Notes**
Toluene	(X)			
Semivolatile Organic Compounds				
Benzo(A)anthracene	X		X	sandpiper
Benzo(A)pyrene	X		X	sandpiper
Benzo(B)fluoranthene	X		X	sandpiper
Benzo(G,H,I)perylene	X		X	sandpiper
Benzo(K)fluoranthene				
Bis(2-ethylhexyl)phthalate	X			
Butylbenzyl phthtalate	(X)			
Carbazole	(X)		(X)	sandpiper, heron, fish
Chrysene	X		X	sandpiper, heron, fish
Dibenzo(A,H)anthracene	X			
Fluoranthene	X		X	sandpiper, heron, fish
Ideno(1,2,3-CD)pyrene	X		X	sandpiper
Phenanthrene	X			
Pyrene	X		X	sandpiper, heron, fish
Total Phthalate	(X)		(X)	
Total PAHs	X		X	fish
Pesticides and PCBs				
4,4'-DDD	X			
4,4'-DDE	X		X	sandpiper, heron, fish
Dieldrin	X			
Aroclor-1254	(X)		X	sandpiper, heron, fish
DDTR	X		X	sandpiper, heron, fish
Total 'Drins	(X)			
Total PCBs	X		X	fish
Metals and Inorganic Compounds				
Aluminum				
Arsenic				
Barium	(X)			
Cadmium			X	fish
Calcium				
Chromium				
Copper	X		X	sandpiper, fish
Iron				
Lead	X		X	sandpiper
Magnesium				
Manganese	(X)			
Mercury	X		X	sandpiper
Nickel			(X)	fish
Sodium				
Vanadium	(X)			
Zinc	X		X	sandpiper, heron, fish

(X) - No screening value
X - HQ>1

- In the heron, chrysene (HQ = 1.15), fluoranthene (HQ = 1.20), pyrene (HQ = 1.07), 4,4'-DDE (HQ = 1.93), Aroclor-1254 and total PCBs (HQ = 7.86), total DDT (HQ = 3.40), and zinc (HQ = 2.04). All other NOAEL and LOAEL HQs were less than 1.0.

- In modeled fish tissue, HQs greater than or equal to 1.0 were found for: chrysene (HQ = 1.00), fluoranthene (HQ = 1.00), pyrene (HQ = 1.00), and total PAHs (HQ = 7.00), 4,4'-DDE (HQ = 2.2), Aroclor-1254 and total PCBs (HQ = 17), total DDT (HQ = 4.0), cadmium (HQ = 12), and zinc (HQ = 4.8). Copper demonstrated both a 5% HQ (78) and 50% HQ (4.8) indicating potential chronic and acute risks. All other HQs for modeled fish tissue were less than 1.0.

Based on these results, potential chronic effects to the modeled ecological receptors are possible. However, at the LOAEL level of toxicity, unacceptable risks are unlikely (except for copper which demonstrated potential acute and chronic risks to fish).

TRVs were not available for the following chemicals so potential risks associated with food-chain exposure could not be estimated: bis(2-ehtylhexyl)phthalate in fish, butylbenzyl phthalate and total phthalates for all receptors, carbazole for avian receptors, total PAHs and total PCBs for avian receptors, and nickel for fish.

1.4.3 Benthic Macroinvertebrate Analysis

The results of the benthic macroinvertebrate analysis, performed as part of the RFI Addendum, are illustrated in Table 1-7. As can be seen by the results, the numbers of observed organisms increased, moving from the most inland sampling location downstream toward the bay. No organisms were detected at sampling location 03GLM0401, which was collected in the tidal inlet near the outfall at the most inland location. Only two organisms (of the same taxa) were detected at the next downstream location 03GLM0501, which was collected in the wetland. The highest numbers of organisms and the greatest number of different taxa were found at location which was collected at the junction of the tidal inlet with the bay. A review of the chemical analytical data indicates that the maximum concentration of most detected contaminants was found at either location 03GLM0401 or 03GLM0501. A correlation may exist between contaminant concentrations and numbers of observed benthic macroinvertebrate organisms; however, other site conditions may have affected the numbers and types of organisms found. Field observations indicated that sample location 03GLM0401 had an extremely high organic content and a noticeable hydrogen sulfide odor indicating a potentially anaerobic environment that might be unsuitable for benthic macroinvertebrate survival. No reference sample locations were collected for the RFI Addendum so comparisons to background/reference are not possible.

TABLE 1-7
RESULTS OF BENTHIC MACROINVERTEBRATE STUDY
SWMU - 3
CSS PANAMA CITY, FLORIDA

SAMPLE LOCATION	03GLM0401	03GLM0501	03GLM0601
SPECIES			
NEMATODA			27
MOLLUSCA			
Bivalvia			
Tellinidae			
Tellina texana			4
ANNELIDA			
Polychaeta			
Capitellidae			
Heteromastus filiformis			6
Nereidae			
Laeonereis culveri		2	
Spionidae			3
Spio sp.			
ARTHROPODA			
Crustacea			
Decapoda			
Ocypodidae			
Uca sp.			1
Insecta			
Diptera			
Dolichopodidae			2
TOTAL NO. OF ORGANISMS	0	2	43
TOTAL NO. OF TAXA	0	1	6

(From Pennigton and Associates)

1.4.3.1 Previous Benthic Macroinvertebrate Study

In contrast to the results of the RFI Addendum benthic macroinvertebrate results, the previous sampling and analysis performed by ABB demonstrated a higher number of total organisms and taxa at the same sampling locations. The highest number of organisms and taxa (417 and 51, respectively) in the ABB study were found at location 03BIO04, which is co-located with RFI Addendum sample 03GLMO0501. The lowest number of organisms in the ABB study (196 organisms, 39 taxa) were found at location 03BIO03, which is co-located with RFI Addendum sample 03GLMO0601. This location had the highest number of organisms and taxa (43 and 6, respectively) in the RFI Addendum sampling event. ABB sample 03BIO05, located at the outfall discharge point into the inlet, had 282 organisms representing 17 taxa, while the co-located RFI Addendum sample (03GLM0401) had no organisms detected. A comparison of the co-located sample results from both studies with the results from reference locations collected during the ABB study indicate that both the numbers of organisms and the number of taxa were lower in site samples than in reference samples, suggesting potential impact.

The potential causes for the differences in results between the two studies is unknown. Differences may be associated with seasonal variations, sampling methods, and inexact replication of sampling locations.

1.4.4 <u>Sediment Toxicity Testing</u>

The results of the sediment toxicity testing are illustrated in Table 1-8. A copy of the laboratory report is included in Appendix C. The performed tests met the minimum mean control survival criteria of 80% for test organisms in the control sediment. All test water quality parameters were within acceptable limits. As can be seen by the results, the highest survival (91%) was found in the sediment sample collected in the wetland (03GLM0501); the next highest survival (83%) was found at the outfall location (03GLM0401), and the lowest survival (62%) was found at the sample collected from the junction of the inlet and the bay (03GLM0601). Statistical analysis indicated that survival in 03GLM0601 was significantly lower than in the control or at site 03GLM0501. There was no significant difference between survival at the control and at locations 03GLM0401 and 03GLM0501. There does not appear to be a correlation between survival and contaminant concentrations; locations with the highest survival also had the highest chemical concentrations, and the location with the lowest survival had the lowest concentrations.

TABLE 1-8
RESULTS OF SEDIMENT TOXICITY TESTING
SWMU - 3
CSS PANAMA CITY, FLORIDA

Site	Original Number of Organisms	Percent Survival
Control	100	98
03-GLM-0401	100	83
03-GLM-0501	100	91
03-GLM-0601	100	62

(From Tetra Tech Inc.'s Biological Research Facility Owings Mills, Maryland)

1.4.4.1 Previous Sediment Toxicity Study

The results of the sediment toxicity testing performed by ABB at the co-located sample locations indicated significantly lower survival at all locations within the inlet in comparison to the control. In contrast to the RFI Addendum sampling and analysis, the ABB toxicity tests demonstrated higher test organism survival at the bay location (63%) with survival decreasing in the wetland location (25%), and the lowest survival (19%) at the most inland location at the outfall.

Comparisons between the results of the RFI Addendum toxicity test and the previous analysis by ABB are difficult due to the differences in test methodologies and test organisms. (ABB used *Ampelisca abdita*, TtNUS used *Leptocheirus plumulosus*. Both tests demonstrated significantly lower survival in comparison to controls for sediment collected at the junction between the inlet and the bay (RFI Addendum 03GLM0601 and ABB 03TOX 03). However, lower survival was seen in the inlet in the ABB study while higher survival was demonstrated in the RFI Addendum tests. The results of the ABB study appear to be somewhat correlated to chemical concentrations in the sediment while the results of the RFI Addendum tests do not.

1.4.5 Summary

Sediment samples were collected from three locations in the tidal inlet adjacent to SWMU 3 at CSS Panama City as part of the RFI Addendum, in order to ascertain potential impacts upon ecological receptors. Samples were collected in the inlet at an inland location adjacent to an outfall, downstream in a wetland area, and at the junction of the inlet with St. Andrews Bay (Figure 1-2). All samples were submitted for chemical analyses, as well as benthic macroinvertebrate characterization and sediment toxicity testing.

The results of the chemical analyses indicated that the maximum concentrations of SVOC, pesticide, PCB, and metal contaminants were found at locations 03DLO0401 (inland near the outfall) and 03DLO0501 (in the downstream wetland). Only one contaminant (toluene) had its maximum concentration at location 03DLO0601, at the junction of the tidal inlet and St. Andrews Bay.

The maximum and mean concentrations of all detected contaminants were screened for direct-toxicity and food-chain effects. The results of this screening identified contaminants of concern at SWMU 3, as illustrated in Table 1-6. COCs identified by the direct-toxicity screen included: 11 PAHs (and total PAHs), one phthalate, three pesticides, one PCB (as total PCBs), and four metals. Toluene, three SVOCs, two pesticides, and several metals contaminants did not have screening guidelines and could not be eliminated as COCs on the basis of direct toxicity.

The food-chain model identified eight PAHs (and total PAHs), one pesticide, one PCB, and five metals with HQs greater than 1.0. Based on these results, potential chronic effects to the sandpiper and heron are possible. However, at the LOAEL level of toxicity, unacceptable food chain risks are unlikely.

The results of the benthic macroinvertebrate study indicated that contamination could potentially be impacting the community of benthic organisms within the tidal inlet. The observation of decreased numbers of organisms could be related to elevated contaminant concentrations but could also be associated with other factors, such as potentially anaerobic conditions within sediment. The earlier (ABB) benthic macroinvertebrate study results showed greater numbers of organisms and taxa than in the RFI Addendum sampling.

Sediment toxicity testing results indicated significantly lower survival in a sample collected at the junction of the tidal inlet and the bay than in the control sample. Samples collected at the wetland and at the inland outfall did not show significantly lower survival than the control. The results of the toxicity test do not correlate with the chemical analyses instead showing higher survival at more contaminated locations and lower survival at less contaminated locations. The potential exists that survival may be a function of other factors such as sediment matrix rather than chemical concentration. Comparison with the earlier (ABB) toxicity test results indicated significantly lower survival in comparison to controls for sediment collected at the junction between the inlet and the bay; however, lower survival was seen in the inlet and wetlands in the ABB study while higher survival was demonstrated in the RFI Addendum tests. The results of the ABB study appear to be more closely correlated to chemical concentrations in the sediment while the results of the RFI Addendum tests do not.

1.5 UNCERTAINTY ANALYSIS

Sources of uncertainty are described below for all stages of the risk assessment, but they emphasize exposure and toxicity as the two essential components. Where appropriate, each source of uncertainty is described in terms of its effect on the outcome of the assessment. Specific sources of uncertainty include the following:

- The sampling of environmental media may not accurately represent the actual distribution of chemical concentrations at the site and nearby habitats. As an example, the collection of samples from locations of known impact tend to make the data sets biased high, and they would overestimate risk.

- When a chemical is not detected by the analytical laboratory, there is uncertainty about the risk that may exist from the chemical. While the great majority of chemicals have negligible risk at their detection limits, some detection limits may have exceeded guideline concentrations and risks may be underestimated as a consequence.

- The bioaccumulation factors used in the food-chain model may not be appropriate for the site. A default value of 1.0 was used in the absence of any data. The actual bioavailability of contaminants to invertebrates and fish is not known.

- Summing individual chemical concentrations in groups like "total PAHs" or "total phthalates" creates some uncertainty. For example, if effects were actually being caused by an individual chemical in a group, then the influence of the other members of the group would be to increase exposure estimates. The TRV may also be lower because the lowest TRV available is selected for the group. In this example, the group approach is likely to increase risk estimates relative to the causative agent.

- Toxicity thresholds for wildlife are uncertain. The avian toxicity values were essentially the lowest numbers found that were appropriate. Although choosing the lowest numbers is a conservative choice, the level of conservativeness is not quantified.

- There are uncertainties in applying ecotoxicological information across taxonomic divisions and from the laboratory to the field.

- The threshold values used for wildlife in this risk assessment reflected impacts to individual organisms. It is uncertain how effects seen in individuals may bring about impacts to populations, communities, and higher levels of ecological organization. For example, loss of individuals from small areas may or may not affect their populations, or the larger community.

- Chemical interactions contribute to uncertainty. It is possible that two or more contaminants may act on the same target organ(s), resulting in additive toxicity that may be underestimated by limiting the hazard analysis to separate chemicals. Also, synergistic and antagonistic reactions may occur among environmental contaminants, resulting in underestimates and overestimates of risk.

- The macroinvertebrate study is not well-suited for showing effects other than obvious ones, especially in systems such as this, where overall biotic diversity is low. For example, stable systems often develop more diverse animal communities, which often include species sensitive to pollution. The absence of such species can indicate impacts. In estuaries, changes in water velocity, turbidity, food supply, and salinity, caused daily by tides and randomly by storms, may largely limit fauna to tolerant species.

- The sediment toxicity test was performed under controlled laboratory conditions designed to simulate field conditions at the site as closely as possible. But it is not possible to exactly duplicate field conditions in a laboratory.

1.6 CONCLUSIONS

Consideration of the results of all of the analyses allows the following conclusions to be made:

- While the results of the direct-toxicity analysis indicates potential risks to benthic invertebrates, the results of the toxicity testing do not establish a relationship between elevated contaminant concentrations and decreased survival. The screening guidelines in direct toxicity analyses are extremely conservative and are used to predict potential effects. They only indicate an effect (toxicity) may occur if they are exceeded. The use of site-specific testing provides a better indication of the potential risks from exposure to contaminants in sediment. The results of these tests did not demonstrate risks to benthic invertebrates in the areas of highest contamination.

- The low numbers of benthic macroinvertebrates and associated taxa observed in the RFI Addendum sampling may be correlated with contaminant concentrations. In consideration of the sediment toxicity tests however, it appears that other factors may be mediating the low number of organisms found. While the sample locations with the fewest organisms and taxa were also the locations of the highest contaminant concentrations, the results of the sediment toxicity tests at these same locations were acceptable. This would indicate factors other than sediment contamination affecting the numbers and types of organisms found. The presence of an anaerobic environment in the sampled sediments as well as how and where the samples were collected may have impacted the numbers and types of organisms observed.

- The food chain models using maximum contaminant concentrations and conservative NOAELs indicated potential chronic risk to the sandpiper and heron from ingestion of contaminated food items and contaminated sediment. In consideration of the uncertainities and the associated potential to overestimate risks, a more realistic portrayal of potential food chain risks may be indicated by the use of average site concentrations and less conservative LOAELs where estimated risks were found to be acceptable.

REFERENCES

ABB-ES (ABB Environmental Services, Inc.), 1996. "RCRA Facility Investigation, Coastal Systems Station, Panama City, Florida"; prepared for SOUTHNAVFACENGCOM; North Charleston, South Carolina. January.

ABB-ES, 1993. "Contamination Assessment Report, Coastal Systems Station, Panama City, Site 278, Panama City, Florida"; prepared for SOUTHNAVFACENGCOM; North Charleston, South Carolina. July.

Jarvinen, A.W. and G.T. Ankley. 1999. Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals. SETAC Press, Pensacola, FL.

Lincer, J.L. 1975. "DDE-Induced Eggshell Thinning in the American Kestrel: A Comparison of the Field Situation and Laboratory Results", Journal of Applied Ecology, Volume 12, pp. 781-793. (cos)

Long, E.R., et al., 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1):81-97.

Mac Donald D.D. et al., 1994. Development and evaluation of an approach to the assessment of sediment quality in Florida coastal waters. Prepared for Florida Department of Environmental Protection Tallahassee, FL.

Navy Public Works Center, 1997. Interim Measures Removal Report, Solid Waste Management Unit 3, Shoreline Debris Removal, Coastal System Station Panama City Florida, November.

ORNL (Oak Ridge National Laboratories), 1996. Sample, B.E., D. M. Opresko, and G. W. Suter II. Toxicological Benchmarks for Wildlife, 1996 Revision. Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Thomann, R.V., J. D. Mahony, and R. Mueller. 1995. Steady-state model of biota sediment accumulation factor for metals in two marine bivalves. Environmental Toxicology and Chemistry 14:1989-1998.

Trust, K.A., Fairbrother, A., and M. J. Hooper. 1993. "Effects of 7,12-dimethylbenz(a)anthracene on immune function and mixed-function oxygenase activity in the European starling." Environmental Toxicology and Chemistry, 13 (5): 821-830.

USEPA (U.S. Environmental Protection Agency), 1993. Wildlife Exposure Factors Handbook, EPA/600/R-93/187. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

USEPA , 1997a. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Edison, New Jersey. June.

USEPA, 1997b. The Incidence and Severity of Sediment Contamination in Surface Waters of the United States. Volume 1: National Sediment Quality Survey. Office of Science and Technology, Washington, D.C. EPA 823-R-97-006.

USEPA, 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Status and Needs, EPA-823-R-00-001.. Office of Water, Office of Solid Waste. February.

Waterways Experiment Station (WES), 2000. The U.S. Army Corps of Engineers/U.S. Environmental Protection Agency Environmental Residue-Effects Database (ERED).

APPENDIX A

FOOD-CHAIN MODELING

LOWEST OBSERVED ADVERSE EFFECT LEVELS (mg/kg.day)
SWMU 3
CSS PANAMA CITY, FLORIDA

Chemical	Bird	Source	
Semivolatile Organic Compounds			
Benzo(a)anthracene	2	Trust et al. (1993)	
Benzo(a)pyrene	2	Trust et al. (1993);	
Benzo(b)fluoranthene	2	Trust et al. (1993);	
Benzo(g,h,i)perylene	2	Trust et al. (1993);	
Benzo(k)fluoranthene	2	Trust et al. (1993);	
Carbazole	NA		
Chrysene	2	Trust et al. (1993);	
Dibenzo(a,h)anthracene	2	Trust et al. (1993);	
Fluoranthene	2	Trust et al. (1993);	
Ideno(1,2,3-CD)pyrene	2	Trust et al. (1993);	
Phenanthrene	2	Trust et al. (1993);	
Pyrene	2	Trust et al. (1993);	
Total Phthalate	NA		
Total PAHs	NA		
Pesticides and PCBs			
4,4'-DDD	0.9	Lincer (1975) for DDE;	
4,4'-DDE	0.9	Lincer (1975) for DDE;	
Dieldrin	0.77	Mendenhall et al. (1983) in ORNL 1996	
Aroclor-1254	1.8	Dahlgren et al. ('72) in ORNL (1996)	
DDTR	0.9	bird: Lincer (1975) for DDE;	
Total 'Drins	0.77	Mendenhall et al. (1983) in ORNL 1996	
Total PCBs	1.8	Dahlgren et al. ('72) in ORNL (1996)	
Metals and Inorganic Compounds			
Arsenic	7.38	USFWS (1969) in ORNL, 1996	
Cadmium	20	White and Finley (1978) in ORNL, 1996	
Chromium	5	Haseltine et. al in ORNL, 1996	
Copper	61.7	Mehring et. Al (1960) in ORNL, 1996	
Lead	11.3	Edens et. Al (1976) in ORNL, 1996	
Mercury	0.064	Heinz (1979) in ORNL, 1996 (methyl)	
Nickel	107	Cain and Pafford (1981) in ORNL, 1996	

TABLE FCM-1
CONTAMINANT CONCENTRATIONS IN SEDIMENT AND AQUATIC PREY ITEMS
SWMU - 3
CSS PANAMA CITY, FLORIDA

AQUATIC FOOD CHAIN Ecological Contaminant of Concern	MAXIMUM SITE SEDIMENT CONCENTRATION (mg/kg-dw)	MEAN SITE SEDIMENT CONCENTRATION (mg/kg-dw)	MAXIMUM INVERTEBRATE CONCENTRATION (mg/kg-ww)	MEAN INVERTEBRATE CONCENTRATION (mg/kg-ww)	MAXIMUM FISH CONCENTRATION (mg/kg-ww)	MEAN FISH CONCENTRATION (mg/kg-ww)	FISH TRV (mg/kg-ww)		
							5% EP	50% EP	Lowest[1]
Semivolatile Organic Compounds									
Benzo(a)anthracene	0.63	0.43	0.21	0.14	0.4312	0.2943	NED	NED	1.00
Benzo(a)pyrene	0.972	0.651	0.33	0.22	0.6652	0.4455	NED	NED	1.00
Benzo(b)fluoranthene	0.829	0.546	0.28	0.18	0.5674	0.3737	NED	NED	1.00
Benzo(g,h,i)perylene	0.744	0.492	0.25	0.17	0.5092	0.3367	NED	NED	1.00
Benzo(k)fluoranthene	0.474	0.319	0.16	0.11	0.3244	0.2183	NED	NED	1.00
Carbazole	0.144	0.144	0.05	0.05	0.0986	0.0986	NED	NED	1.00
Chrysene	1.85	1.05	0.62	0.35	1.2661	0.7186	NED	NED	1.00
Dibenzo(a,h)anthracene	0.114	0.086	0.04	0.03	0.0780	0.0589	NED	NED	1.00
Fluoranthene	1.92	1.03	0.64	0.35	1.3140	0.7049	NED	NED	1.00
Ideno(1,2,3-CD)pyrene	0.716	0.479	0.24	0.16	0.4900	0.3278	NED	NED	1.00
Phenanthrene	0.434	0.296	0.15	0.10	0.2970	0.2026	NED	NED	1.00
Pyrene	1.72	1.12	0.58	0.38	1.1772	0.7665	NED	NED	1.00
Total Phthalate	1.614	0.689	1.87	0.80	3.8090	1.6260	NED	NED	NED
Total PAHs	10.256	6.06	3.44	2.03	7.0192	4.1475	NED	NED	1.00
Pesticides and PCBs									
4,4'-DDD	0.057	0.027	0.02	0.01	0.0377	0.0178	0.436	13.2	
4,4'-DDE	0.0539	0.031	0.48	0.28	0.9795	0.5633	0.436	13.2	
Dieldrin	0.0195	0.011	0.04	0.02	0.0828	0.0467	NED	NED	0.55
Aroclor-1254	1.82	0.622	3.90	1.33	7.9461	2.7157	0.468	29.7	
DDTR	0.095	0.058	0.85	0.52	1.7263	1.0540	0.436	13.2	
Total 'Drins	0.0195	0.011	0.04	0.02	0.0828	0.0467	NED	NED	0.55
Total PCBs	1.82	0.622	3.90	1.33	7.9461	2.7157	0.468	29.7	
Metals and Inorganic Compounds									
Arsenic	1.8	0.712	0.52	0.21	0.5184	0.2051	2.39	5.82	
Cadmium	0.47	0.19	0.53	0.21	0.5271	0.2131	0.0441	1.15	
Chromium	21.8	11.57	0.08	0.04	0.0785	0.0417	NED	NED	1
Copper	52.9	31.730	59.32	35.58	59.3221	35.5820	0.761	7.46	
Lead	76.6	51.2	1.24	0.83	1.2409	0.8294	NED	NED	2.5
Mercury	0.15	0.072	0.02	0.01	0.0165	0.0079	0.48	3.52	
Nickel	5.5	2.06	0.12	0.04	0.1188	0.0445	NED	NED	NED
Zinc	146	72.23	163.72	81.00	163.724	80.9987	NED	NED	34

TRV = Toxicity Reference Value
EP = Effect Probability
NED = Not Enough Data to calculate
[1]Lowest of LOAELs and NOAELs that are paired with LOAELs (low confidence)
-- = not needed because 0.05 and 0.5 EPs preferred

TABLE FCM-2
SANDPIPER
SWMU 3
CSS PANAMA CITY, FLORIDA

Sandpiper

Body Weight	0.04 kg
Food Ingestion Rate [1]	0.0389 kg/day
Sediment Ingestion Rate	0.0014 kg/day (20%)
Site Use Factor	1 (2.13 acre site/0.62 acre mean home range)

Ecological Contaminant of Concern	MAXIMUM SITE SEDIMENT CONCENTRATION (mg/kg-dw)	MEAN SITE SEDIMENT CONCENTRATION (mg/kg-dw)	MAXIMUM INVERTEBRATE CONCENTRATION (mg/kg-ww)	MEAN INVERTEBRATE CONCENTRATION (mg/kg-ww)	Maximum Dose (mg/kg/day)	Mean Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Maximum NOAEL HQn	Mean LOAEL HQl
Semivolatile Organic Compounds										
Benzo(a)anthracene	0.63	0.43	0.2115	0.1443	0.22030	0.15037	0.2	2	**1.10E+00**	7.52E-02
Benzo(a)pyrene	0.972	0.651	0.3263	0.2185	0.33990	0.22765	0.2	2	**1.70E+00**	1.14E-01
Benzo(b)fluoranthene	0.829	0.546	0.2783	0.1833	0.28989	0.19093	0.2	2	**1.45E+00**	9.55E-02
Benzo(g,h,i)perylene	0.744	0.492	0.2497	0.1651	0.26017	0.17205	0.2	2	**1.30E+00**	8.60E-02
Benzo(k)fluoranthene	0.474	0.319	0.1591	0.1071	0.16575	0.11155	0.2	2	8.29E-01	5.58E-02
Carbazole	0.144	0.144	0.0483	0.0483	0.05036	0.05036	NA	NA	NA	NA
Chrysene	1.85	1.05	0.6210	0.3525	0.64693	0.36717	0.2	2	**3.23E+00**	1.84E-01
Dibenzo(a,h)anthracene	0.114	0.086	0.0383	0.0289	0.03986	0.03007	0.2	2	1.99E-01	1.50E-02
Fluoranthene	1.92	1.03	0.6445	0.3457	0.67140	0.36018	0.2	2	**3.36E+00**	1.80E-01
Ideno(1,2,3-CD)pyrene	0.716	0.479	0.2403	0.1608	0.25038	0.16750	0.2	2	**1.25E+00**	8.38E-02
Phenanthrene	0.434	0.296	0.1457	0.0994	0.15177	0.10351	0.2	2	7.59E-01	5.18E-02
Pyrene	1.72	1.12	0.5774	0.3759	0.60147	0.39165	0.2	2	**3.01E+00**	1.96E-01
Total Phthalate	1.614	0.689	1.8682	0.7975	1.80790	0.77177	NA	NA	NA	NA
Total PAHs	10.256	6.06	3.4426	2.0342	3.58642	2.11912	NA	NA	NA	NA
Pesticides and PCBs										
4,4'-DDD	0.057	0.027	0.0185	0.0088	0.01931	0.00915	0.09	0.9	2.15E-01	1.02E-02
4,4'-DDE	0.0539	0.031	0.4804	0.2763	0.45225	0.26011	0.09	0.9	**5.03E+00**	2.89E-01
Dieldrin	0.0195	0.011	0.0406	0.0229	0.03877	0.02187	0.077	0.77	5.04E-01	2.84E-02
Aroclor-1254	1.82	0.622	3.8972	1.3319	3.71736	1.27044	0.18	1.8	**2.07E+01**	7.06E-01
DDTR	0.095	0.058	0.8467	0.5169	0.79710	0.48665	0.09	0.9	**8.86E+00**	5.41E-01
Total 'Drins	0.0195	0.011	0.0406	0.0229	0.03877	0.02187	0.077	0.77	5.04E-01	2.84E-02
Total PCBs	1.82	0.622	3.8972	1.3319	3.71736	1.27044	0.18	1.8	**2.07E+01**	7.06E-01
Metals and Inorganic Compounds										
Arsenic	1.8	0.712	0.5184	0.2051	0.54900	0.21716	2.46	7.38	2.23E-01	2.94E-02
Cadmium	0.47	0.19	0.5271	0.2131	0.51057	0.20640	1.45	20	3.52E-01	1.03E-02
Chromium	21.8	11.57	0.0785	0.0417	0.83658	0.44400	1	5	8.37E-01	8.88E-02
Copper	52.9	31.730	59.3221	35.5820	57.46593	34.46870	47	61.7	**1.22E+00**	5.59E-01
Lead	76.6	51.2	1.2409	0.8294	3.84436	2.56960	1.13	11.3	**3.40E+00**	2.27E-01
Mercury	0.15	0.072	0.0165	0.0079	0.02069	0.00993	0.0064	0.064	**3.23E+00**	1.55E-01
Nickel	5.5	2.06	0.1188	0.0445	0.30388	0.11382	77.4	107	3.93E-03	1.06E-03
Zinc	146	72.23	163.7244	80.9987	158.60163	78.46435	14.5	131	**1.09E+01**	5.99E-01

FCM-3
GREAT BLUE HERON
SWMU 3
CSS PANAMA CITY, FLORIDA

Great Blue Heron
(Average Inputs)

Body Weight	2.3	kg
Food Ingestion Rate	0.41571	kg/day
Sediment Ingestion Rate	0.0083	kg/day (2%)
Site Use Factor	1	(2.13 acre site/1.5 acre mean home range)

Ecological Contaminant of Concern	MAXIMUM SITE SEDIMENT CONCENTRATION (mg/kg-dw)	MEAN SITE SEDIMENT CONCENTRATION (mg/kg-dw)	MAXIMUM FISH CONCENTRATION (mg/kg-ww)	MEAN FISH CONCENTRATION (mg/kg-ww)	Maximum Dose (mg/kg/day)	Mean Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Maximum NOAEL HQn	Mean LOAEL HQl
Semivolatile Organic Compounds										
Benzo(a)anthracene	0.63	0.43	0.4312	0.2943	0.07865	0.05368	0.2	2	3.93E-01	2.68E-02
Benzo(a)pyrene	0.972	0.651	0.6652	0.4455	0.12134	0.08127	0.2	2	6.07E-01	4.06E-02
Benzo(b)fluoranthene	0.829	0.546	0.5674	0.3737	0.10349	0.06816	0.2	2	5.17E-01	3.41E-02
Benzo(g,h,i)perylene	0.744	0.492	0.5092	0.3367	0.09288	0.06142	0.2	2	4.64E-01	3.07E-02
Benzo(k)fluoranthene	0.474	0.319	0.3244	0.2183	0.05917	0.03982	0.2	2	2.96E-01	1.99E-02
Carbazole	0.144	0.144	0.0986	0.0986	0.01798	0.01798	NA	NA	NA	NA
Chrysene	1.85	1.05	1.2661	0.7186	0.23095	0.13108	0.2	2	**1.15E+00**	6.55E-02
Dibenzo(a,h)anthracene	0.114	0.086	0.0780	0.0589	0.01423	0.01074	0.2	2	7.12E-02	5.37E-03
Fluoranthene	1.92	1.03	1.3140	0.7049	0.23969	0.12858	0.2	2	**1.20E+00**	6.43E-02
Ideno(1,2,3-CD)pyrene	0.716	0.479	0.4900	0.3278	0.08939	0.05980	0.2	2	4.47E-01	2.99E-02
Phenanthrene	0.434	0.296	0.2970	0.2026	0.05418	0.03695	0.2	2	2.71E-01	1.85E-02
Pyrene	1.72	1.12	1.1772	0.7665	0.21472	0.13982	0.2	2	**1.07E+00**	6.99E-02
Total Phthalate	1.614	0.689	3.8090	1.6260	0.68054	0.29051	NA	NA	NA	NA
Total PAHs	10.256	6.06	7.0192	4.1475	1.28036	0.75653	NA	NA	NA	NA
Pesticides and PCBs										
4,4'-DDD	0.057	0.027	0.0377	0.0178	0.00688	0.00326	0.09	0.9	7.64E-02	3.62E-03
4,4'-DDE	0.0539	0.031	0.9795	0.5633	0.17369	0.09990	0.09	0.9	**1.93E+00**	1.11E-01
Dieldrin	0.0195	0.011	0.0828	0.0467	0.01474	0.00832	0.077	0.77	1.91E-01	1.08E-02
Aroclor-1254	1.82	0.622	7.9461	2.7157	1.41410	0.48328	0.18	1.8	**7.86E+00**	2.68E-01
DDTR	0.095	0.058	1.7263	1.0540	0.30614	0.18691	0.09	0.9	**3.40E+00**	2.08E-01
Total 'Drins	0.0195	0.011	0.0828	0.0467	0.01474	0.00832	0.077	0.77	1.91E-01	1.08E-02
Total PCBs	1.82	0.622	7.9461	2.7157	1.41410	0.48328	0.18	1.8	**7.86E+00**	2.68E-01
Metals and Inorganic Compounds										
Arsenic	1.8	0.712	0.5184	0.2051	0.09832	0.03889	2.46	7.38	4.00E-02	5.27E-03
Cadmium	0.47	0.19	0.5271	0.2131	0.09506	0.03843	1.45	20	6.56E-02	1.92E-03
Chromium	21.8	11.57	0.0785	0.0417	0.09257	0.04913	1	5	9.26E-02	9.83E-03
Copper	52.9	31.730	59.3221	35.5820	10.69890	6.41732	47	61.7	2.28E-01	1.04E-01
Lead	76.6	51.2	1.2409	0.8294	0.49624	0.33169	1.13	11.3	4.39E-01	2.94E-02
Mercury	0.15	0.072	0.0165	0.0079	0.00346	0.00166	0.0064	0.064	5.40E-01	2.59E-02
Nickel	5.5	2.06	0.1188	0.0445	0.04089	0.01532	77.4	107	5.28E-04	1.43E-04
Zinc	146	72.23	163.724	80.9987	29.52816	14.60835	14.5	131	**2.04E+00**	1.12E-01

FCM - 4
ESTIMATION OF INVERTEBRATE CONCENTRATIONS
SWMU - 3
CSS PANAMA CITY, FLORIDA

AQUATIC FOOD CHAIN PRELIMINARY CHEMICAL OF CONCERN	MAXIMUM SITE SEDIMENT CONCENTRATION (mg/kg-dw)	MEAN SITE SEDIMENT CONCENTRATION (mg/kg-dw)	INVERTEBRATE BSAF[1] (dw/ww)	SITE BSAF[2] (dw/ww)	MAXIMUM INVERTEBRATE CONCENTRATION (mg/kg-ww)	MEAN INVERTEBRATE CONCENTRATION (mg/kg-ww)
Semivolatile Organic Compounds						
Benzo(a)anthracene	0.63	0.43	0.29	0.3357	0.2115	0.1443
Benzo(a)pyrene	0.972	0.651	0.29	0.3357	0.3263	0.2185
Benzo(b)fluoranthene	0.829	0.546	0.29	0.3357	0.2783	0.1833
Benzo(g,h,i)perylene	0.744	0.492	0.29	0.3357	0.2497	0.1651
Benzo(k)fluoranthene	0.474	0.319	0.29	0.3357	0.1591	0.1071
Carbazole	0.144	0.144	0.29	0.3357	0.0483	0.0483
Chrysene	1.85	1.05	0.29	0.3357	0.6210	0.3525
Dibenzo(a,h)anthracene	0.114	0.086	0.29	0.3357	0.0383	0.0289
Fluoranthene	1.92	1.03	0.29	0.3357	0.6445	0.3457
Ideno(1,2,3-CD)pyrene	0.716	0.479	0.29	0.3357	0.2403	0.1608
Phenanthrene	0.434	0.296	0.29	0.3357	0.1457	0.0994
Pyrene	1.72	1.12	0.29	0.3357	0.5774	0.3759
Total Phthalate	1.614	0.689	1.00	1.1575	1.8682	0.7975
Total PAHs	10.256	6.06	0.29	0.3357	3.4426	2.0342
Pesticides and PCBs						
4,4'-DDD	0.057	0.027	0.28	0.3241	0.0185	0.0088
4,4'-DDE	0.0539	0.031	7.7	8.9126	0.4804	0.2763
Dieldrin	0.0195	0.011	1.8	2.0835	0.0406	0.0229
Aroclor-1254	1.82	0.622	1.85	2.1413	3.8972	1.3319
DDTR	0.095	0.058	7.7	8.9126	0.8467	0.5169
Total 'Drins	0.0195	0.011	1.8	2.0835	0.0406	0.0229
Total PCBs	1.82	0.622	1.85	2.1413	3.8972	1.3319
Metals and Inorganic Compounds						
Arsenic	1.8	0.712	0.288	0.288	0.5184	0.2051
Cadmium	0.47	0.19	1.1214	1.1214	0.5271	0.2131
Chromium	21.8	11.57	0.0036	0.0036	0.0785	0.0417
Copper	52.9	31.730	1.1214	1.1214	59.3221	35.5820
Lead	76.6	51.2	0.0162	0.0162	1.2409	0.8294
Mercury	0.15	0.072	0.1098	0.1098	0.0165	0.0079
Nickel	5.5	2.06	0.0216	0.0216	0.1188	0.0445
Zinc	146	72.23	1.1214	1.1214	163.7244	80.9987

[1]Invertebrate BSAFs are derived in Table FCM-6

[2]Site BSAF = Invertebrate BSAF X Avg. Mussel Watch (1986-1998) Lipid (1.47%ww) / Sediment TOC (1.27%) [organics only]

FCM - 5
ESTIMATION OF FISH CONCENTRATIONS
SWMU - 3
CSS PANAMA CITY, FLORIDA

AQUATIC FOOD CHAIN PRELIMINARY CHEMICAL OF CONCERN	MAXIMUM SITE SEDIMENT CONCENTRATION (mg/kg-dw)	MEAN SITE SEDIMENT CONCENTRATION (mg/kg-dw)	FISH BSAF[1] (dw/ww)	SITE BSAF[2] (dw/ww)	MAXIMUM FISH CONCENTRATION (mg/kg-ww)	MEAN FISH CONCENTRATION (mg/kg-ww)
Semivolatile Organic Compounds						
Benzo(a)anthracene	0.63	0.43	0.29	0.6844	0.4312	0.2943
Benzo(a)pyrene	0.972	0.651	0.29	0.6844	0.6652	0.4455
Benzo(b)fluoranthene	0.829	0.546	0.29	0.6844	0.5674	0.3737
Benzo(g,h,i)perylene	0.744	0.492	0.29	0.6844	0.5092	0.3367
Benzo(k)fluoranthene	0.474	0.319	0.29	0.6844	0.3244	0.2183
Carbazole	0.144	0.144	0.29	0.6844	0.0986	0.0986
Chrysene	1.85	1.05	0.29	0.6844	1.2661	0.7186
Dibenzo(a,h)anthracene	0.114	0.086	0.29	0.6844	0.0780	0.0589
Fluoranthene	1.92	1.03	0.29	0.6844	1.3140	0.7049
Ideno(1,2,3-CD)pyrene	0.716	0.479	0.29	0.6844	0.4900	0.3278
Phenanthrene	0.434	0.296	0.29	0.6844	0.2970	0.2026
Pyrene	1.72	1.12	0.29	0.6844	1.1772	0.7665
Total Phthalate	1.614	0.689	1.00	2.36	3.8090	1.6260
Total PAHs	10.256	6.06	0.29	0.6844	7.0192	4.1475
Pesticides and PCBs						
4,4'-DDD	0.057	0.027	0.28	0.6608	0.0377	0.0178
4,4'-DDE	0.0539	0.031	7.7	18.172	0.9795	0.5633
Dieldrin	0.0195	0.011	1.8	4.248	0.0828	0.0467
Aroclor-1254	1.82	0.622	1.85	4.366	7.9461	2.7157
DDTR	0.095	0.058	7.7	18.172	1.7263	1.0540
Total 'Drins	0.0195	0.011	1.8	4.248	0.0828	0.0467
Total PCBs	1.82	0.622	1.85	4.366	7.9461	2.7157
Metals and Inorganic Compounds						
Arsenic	1.8	0.712	0.288	0.288	0.5184	0.2051
Cadmium	0.47	0.19	1.1214	1.1214	0.5271	0.2131
Chromium	21.8	11.57	0.0036	0.0036	0.0785	0.0417
Copper	52.9	31.730	1.1214	1.1214	59.3221	35.5820
Lead	76.6	51.2	0.0162	0.0162	1.2409	0.8294
Mercury	0.15	0.072	0.1098	0.1098	0.0165	0.0079
Nickel	5.5	2.06	0.0216	0.0216	0.1188	0.0445
Zinc	146	72.23	1.1214	1.1214	163.724	80.9987

[1]Fish BSAFs are derived in Table FCM-6
[2]Site BSAF = Fish BSAF X Avg. Fish Lipid (3%ww) / (1.27%) TOC [organics only]
NA = None Available

FCM - 6
SEDIMENT TO INVERTEBRATE AND FISH BSAFS
SWMU- 3
CSS PANAMA CITY, FLORIDA

	Sediment to Invertebrate BSAF[1]				Sediment BSAF	Sediment to Fish BSAF[1]		
	Mussel Watch median		Thomann model		EPA (1997)			
Chemical	oyster	mussel	dw/dw	dw/ww[2]	%TOC/%lipid	dw/ww		Notes
Metals								
Arsenic	1.6	1		0.288		0.288		Highest median BSAF between mussel and oyster used
Cadmium	22.6	6.6	6.23	1.1214		1.1214		
Chromium	0.02	0.02	0.02	0.0036		0.0036		
Copper	9.2	0.4	6.23	1.1214		1.1214		
Lead	0.03	0.07	0.09	0.0162		0.0162		
Mercury	1.6	0.74	0.61	0.1098		0.1098		
Nickel	0.17	0.07	0.12	0.0216		0.0216		
Zinc	28.2	2.1	6.23	1.1214		1.1214		
Semivolatile Organic Compounds								
Benzo(a)anthracene					0.29			
Benzo(a)pyrene					0.29			
Benzo(b)fluoranthene					0.29			
Benzo(g,h,i)perylene					0.29			
Benzo(k)fluoranthene					0.29			
Carbazole					0.29			
Chrysene					0.29			
Dibenzo(a,h)anthracene					0.29			
Fluoranthene					0.29			
Ideno(1,2,3-CD)pyrene					0.29			
Phenanthrene					0.29			
Pyrene					0.29			
Total Phthalate					1.00			
Total PAHs					0.29			
Pesticides and PCBs								
4,4'-DDD					0.28			
4,4'-DDE					7.7			
Dieldrin					1.8			
Aroclor-1254					1.85			
DDTR					7.7			
Total 'Drins					1.8			
Total PCBs					1.85			

[1]Thomann et al., 1995 used for both invertebrate and fish

[2] Dry weight (dw) to wet weight (ww) conversions based on 82% moisture content (EPA, 1993)

BSAFs for organic compounds based on fish tissue, not invertebrate tissue

EPA (1997) values used for invertebrates, and for fish

APPENDIX B

FISH TOXICITY REFERENCE VALUE DERIVATION

The toxicity data used for fish were collected from two data bases: the Corps of Engineers Waterways Experiment Station's (WES) effect data (http://www.wes.army.mil/el/ered/index.html) and a collection published by Jarvinen and Ankley (1999). These data bases consist of the results of toxicity tests and associated tissue concentrations from the tested animals. The WES data base appears to have undergone less critical evaluation than the Jarvinen and Ankley data. For example, enzyme induction studies are included in the WES data, while Jarvinen and Ankley limited their data to effects related to survival, growth, and reproduction. For finding these studies in the following tables, they have "physiological" as the effect and typically "injection" as the exposure route, although other types of studies may also have these characteristics. Enzyme induction is primarily a measure of exposure and relationships to biological effects are not clear. However, some type of response may be assumed from exposure. When an organism commits resources to detoxifying contaminants, they are not available for other functions. For this investigation, enzyme induction studies were included. For most chemicals the inclusion of these data did not appear to bias the data. However, they produce a significantly low bias in the statistics for PCBs, so PCB TRVs were calculated both with and without enzyme induction data. The lower (biased) PCB TRVs were used in the risk assessment for conservativeness; the alternate TRVs should be kept in mind for a balanced perspective.

The data for each contaminant were reduced and classified in order to develop meaningful statistics. Within each study, the lowest value associated with an effect (LOAEL) and the highest value associated with no effect (NOAEL) were selected for each fish species. Tables were prepared that included entries for species, LOAEL (mg/kg wet weight), NOAEL (mg/kg ww), life stage of the fish, number of fish associated with the LOAEL/NOAEL, the specific effect (mortality, growth, etc.), exposure route, study reference, and data base source. The LOAELs were then examined to see if they were distributed normally or log-normally, by viewing plots of the data. Because the LOAEL distributions were all log-normal, logs were used to calculate a mean and a standard deviation (sd) in each case.

Standard techniques, including the use of *t* values based on the number of samples, were used to develop concentrations representing the following points in the distribution: the lower five percent and the midpoint (50 percent) of the data. Because logs were used, they were transformed back to normal units after the 5 and 50 percent points were calculated. Some of the LOAELs were ranges; a mean ("avg. range") of the two values indicating the range was used for calculating statistics. The means and standard deviations of the logs are shown in the "TRV calculation" portion of the following tables. The *t* value (one-tailed) associated with a probability of 0.05 and the applicable number of data points is multiplied by the standard deviation and subtracted from the mean to yield the 5 percent level.

Total PAHs, lead, and zinc had insufficient data to calculate TRVs for fish. Dieldrin also had insufficient data to calculate a TRV, but a TRV was calculated for endrin, so the TRV value for endrin was used for total 'drins. For those chemicals with insufficient data, the lowest LOAEL and the lowest no observed adverse effect level (NOAEL) [of NOAELs paired with a LOAEL for the same species in the same study] were identified, and the lowest of these two values was used to help interpret fish body burden estimates. Only the single value was used, rather than the 5 percent and 50 percent TRVs calculated for chemicals with more data. Confidence in these single values is low, based on the small amount of data used to set them.

SUMMARY OF FISH TISSUE TRV VALUES

	Fish TRVs (mg/kg)		
Chemical	**0.05 EP**	**0.5 EP**	**Lowest[1]**
PAHs	NED	NED	1
BHC	NED	NED	5.2
Chlordane	NED	NED	1.4
DDTs	0.436	13.2	--
Dieldrin	NED	NED	0.55
Endosulfan	0.0140	0.210	--
Endrin	0.0513	0.718	--
Heptachlor	0.0115	2.09	--
Methoxychlor	NED	NED	0.2
PCBs	0.468	29.7	--
Arsenic	2.39	5.82	--
Cadmium	0.0441	1.15	--
Chromium	NED	NED	1
Copper	0.761	7.46	--
Mercury	0.48	3.52	--
Nickel	NED	NED	NED
Lead	NED	NED	2.5
Selenium	0.428	2.45	--
Silver	NED	NED	NED
Zinc	NED	NED	34

TRV = Toxicity Reference Value
EP = Effect Probability
NED = Not Enough Data to calculate
[1]Lowest of LOAELs and NOAELs that are paired with LOAELs (low confidence)
-- = not needed because 0.05 and 0.5 EPs preferred

APPENDIX FTRV

BHC TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Pinfish	5.22		1		Mortality	Combined	Mature	Schimmel, et al., 1976	WES
Fathead minnow	9.53	6.13	1		Mortality	Absorption	Immature	Macek, et al., 1976	WES
Pinfish	48.6			4	Mortality	Water	55-89mm	394	J & A (1999)
Sheepshead minnow	79			4	Mortality	Water	17-21mm	394	J & A (1999)
Sheepshead minnow	79		1		Mortality	Combined	Mature	Schimmel, et al., 1976	WES
Salmon - Atlantic		1.7	1		Mortality	Absorption	Immature	Carlberg, et al., 1986	WES
Golden Ide		18.6	1	3	Mortality	Absorption	NA	Freitag, et al., 1985	WES
Goldfish		2.3	5		Behavior	Absorption	Immature	Gakstatter and Weiss, 1967	WES

Lowest value (of pairs, for NOAELs)	5.22	6.13

APPENDIX FTRV

PAH TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Sand Sole	2.1			6	Mort., Develop.	Water	Egg-larvae	212	J & A (1999)
Gizzard Shad	10	1	27		Physiological	Injection	Adult	Levine, et al., 1994	WES
Trout - Rainbow	12.3			36	Growth	Sed-to-water	Alevin	167	J & A (1999)
Catfish-Channel	100		1		Physiological	Injection	Immature	Fingerman and Short, 1983	WES
Trout - Rainbow		10.2		31	Mortality	Sed-to-water	Egg	167	J & A (1999)
Golden Ide		88	1		Mortality	Absorption	NA	Freitag, et al., 1985	WES

Lowest value (of pairs, for NOAELs)	2.1	1

APPENDIX FTRV
MERCURY TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

Species	LOAEL (mg/kg)	Ranking	NOAEL (mg/kg)	n	Duration (days)	Effect	Lifestage	Reference	Source
Walleye	0.25	1	0.25	22		Development	6 mo. (30-45 g)	Friedmann, et al. (1996)	USACEWES
Fathead minnow	1.31	2	0.8	6		Growth	Adult	Snarski and Olson (1982)	USACEWES
Fathead minnow	1.36	3	0.8		287	Growth	Larvae-adult	Snarski and Olson (1982)	J & A (1999)
Winter Flounder	2	4		1		Physiological	Adult	Manen, et al. (1976)	USACEWES
Trout - Rainbow	2	5	2	6		Mortality	Immature	Hawryshyn and Mackay (1979)	USACEWES
Trout - Brook	2.2	6			84	Mortality	Embryo-alevin, 3rd gen	McKim, et al. (1976)	J & A (1999)
Trout - Rainbow	2.4	7	1.6		4	Mortality	Fingerling	MacLoed and Pessah (1973)	J & A (1999)
Trout - Rainbow	3.1	8			15 dtd	Mortality	Subadult	Niimi and Kissoon (1994)	J & A (1999)
Trout - Rainbow	3.7	9	1.91		15	Mortality	10-20 mm	Hawryshyn and Mackay (1979)	J & A (1999)
Grayling	3.8	10	0.63			Development	Fry	Fjeld, et al. (1998)	
Fathead minnow	4.47	11	2.84		287	Reproduction	Larvae-adult	Snarski and Olson (1982)	J & A (1999)
Chum salmon	5.8	12	0.5		6(56)	Growth	Fry-juvenile	Koeller and Wallace (1977)	J & A (1999)
Trout - Rainbow	6.2	13			8 dtd	Mortality	Subadult	Niimi and Kissoon (1994)	J & A (1999)
Bluegill	6.5	14			12.5	Mortality	Juvenile	Cember et al. (1978)	J & A (1999)
Trout - Rainbow	6.9	15	4.8		4	Mortality	Fingerling	Wobeser (1975a)	J & A (1999)
Northern Pike	7	16		9		Physiological	Adult	Lockhart, et al. (1972)	USACEWES
Trout - Rainbow	7.1	17			130	Mortality	Subadult	Niimi and Kissoon (1994)	J & A (1999)
Trout - Rainbow	8.6	18	7.6		84	Growth	Fingerling	Rodgers and Beamish (1982)	J & A (1999)
Trout - Brook	10.2	19	4.9		756	Repr, Gr, Mrt	Embryo-adult, 2nd gen	McKim, et al. (1976)	J & A (1999)
Pike	12.5	20			10-41	Mortality	Adult	Miettinen et al. (1970)	J & A (1999)
Eel	13.4	21			32	Mortality	100 g	Noel-Lambot and Bouquegneau (1977)	J & A (1999)
Trout - Rainbow	18	22			22 dtd	Mortality	Subadult, .1-.15kg	Niimi and Kissoon (1994)	J & A (1999)
Trout - Rainbow	19	23	12.5		105	Growth	Fingerling	Wobeser (1975b)	J & A (1999)
Walleye	20	24			314	Mortality	Yearling	Scherer et al. (1975)	J & A (1999)
Yellow perch			0.135	30		Growth	Adult	Weiner, et al. (1990)	USACEWES
Carp			0.28		34	Growth	Yearling	Yediler and Jacobs (1995)	J & A (1999)
Trout - Rainbow			0.5	8		Growth	Immature	Boudou and Ribeyre (1985)	USACEWES
Trout - Rainbow			8.63		24	Growth	Fingerling, 3-10g	Phillips and Buhler (1978)	J & A (1999)
Trout - Rainbow			10.4		84	Growth	Juvenile	Lock (1975)	J & A (1999)
Fathead minnow			10.9		336	Growth	Larvae-adult	Olson et al. (1975)	J & A (1999)
Trout - Rainbow			12		75	Mortality	Subadult	Niimi and Lowe-Jinde (1984)	J & A (1999)

dtd = days to death
? = see notes on this study
J & A (1999) = Jarvinen, A.W. and G.T. Ankley, 1999. Linkage of effects to tissue residues. SETAC Press, Pensacola, FL.
USACEWES = U.S. Army Corps of Engineers/U.S. EPA Environmental Residue-Effects Database (http://www.wes.army.mil/el/ered/index.html)

APPENDIX FTRV

CHLORDANE TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source	Notes
Pinfish	16.6		2		Mortality	Combined	Adult	Parrish et al., 1976	WES	Estimated Loed - No Statistical Summary In Text
Sheepshead minnow	3.6 - 5.6		2		Behavior	Water	Egg-embryo	Goodman, et al., 1977	WES	Exposed to 65% Heptachlor and 24% chlordane.
Sheepshead minnow	3.18	1.38	2		Reprod., Mortality	Combined	Adult	Parrish et al., 1976	WES	
Sheepshead minnow	1.2		1		Mortality	Combined	Mature	Schimmel et al., 1976	WES	ED35; Exposure Media 65% Heptachlor
Sheepshead minnow	0.01 - 0.019		1		Mortality	Combined	Mature	Schimmel et al., 1976	WES	ED5; Exposure Media 65% Heptachlor
Spot	0.16 - 0.55	0.01	1		Mortality	Combined	Mature	Schimmel et al., 1976	WES	ED25; Exposure Media 65% Heptachlor

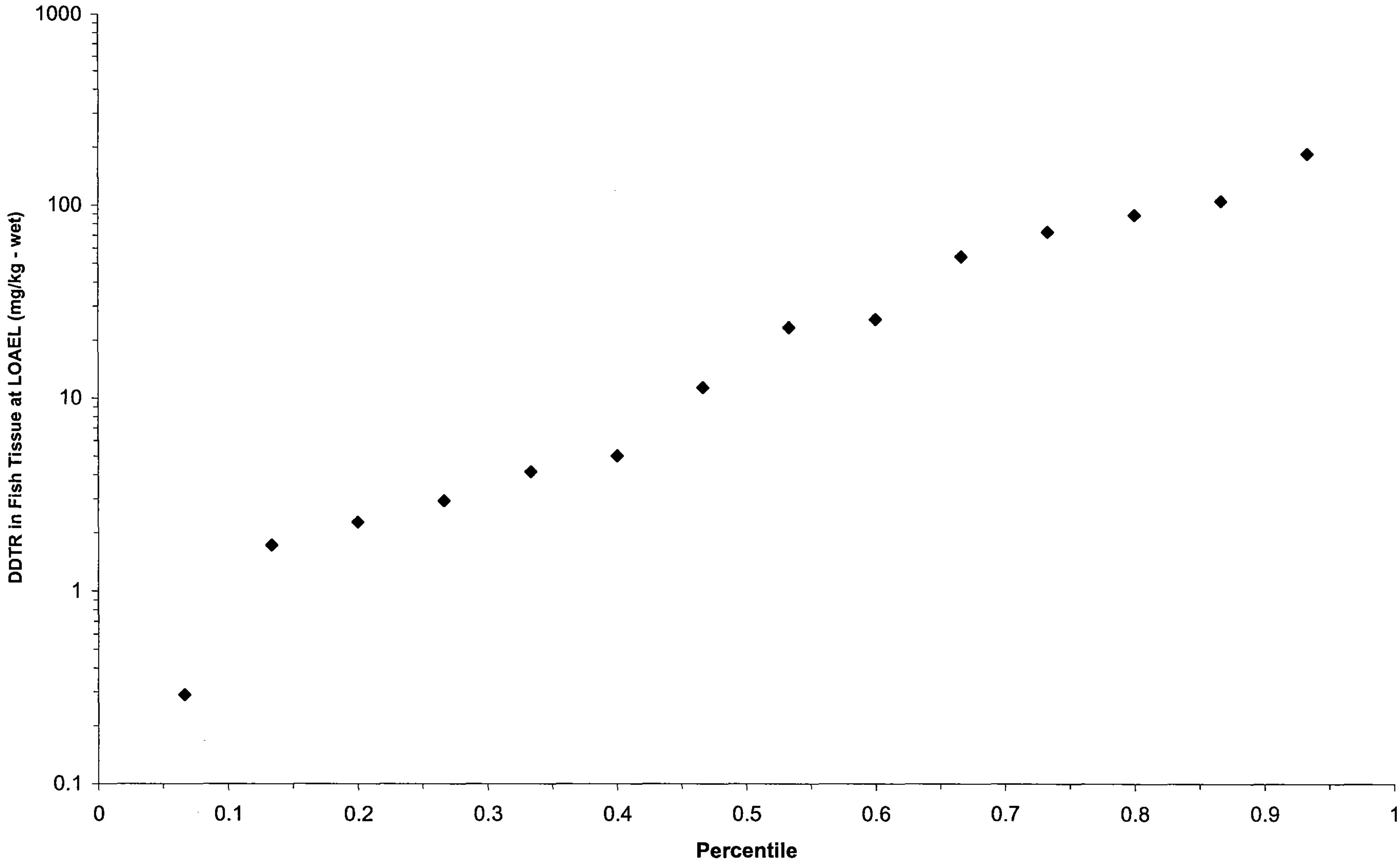
Most of data set inadequate - estimated Loed, most exposure to heptachlor, ED5 use questionable, apparent lack of screening in WES data base

APPENDIX FTRV

DDT TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Trout - lake	0.29			176	Mortality	Water, diet	Fry	28	J & A (1999)
Mummichog	1.73			2	Mortality	Water	Adult	96	J & A (1999)
Atlantic salmon	0.89-5.03			(105)	Mortality	Adults, 2.8-7.6 mg/kg	Embryo-fry	265	J & A (1999)
Trout -Lake	0.9 - 3.66		1		Mortality	Combined	Egg-embryo	Burdick, et al., 1964	WES
Bluegill	4.2		5		Behavior	Absorption	Immature	Gakstatter and Weiss, 1967	WES
Goldfish	5.1		5		Behavior	Absorption	Immature	Gakstatter and Weiss, 1967	WES
Chinook salmon	11.6	11.4		40	Mortality	Diet	Fingerling, 1.1 g	62	J & A (1999)
Sunfish-green, -p'seed	24			90	Mortality	Water	Juvenile	161	J & A (1999)
Mosquitofish	26.5			16	Mortality	Water	NA	363	J & A (1999)
Fathead minnow	57	40		266	Mortality	Water, diet	Juvenile-adult	218, 219	J & A (1999)
Sailfin molly	77.3	43		21	Growth, Mort	Water	3 d	27	J & A (1999)
Salmon-coho	95		1	31	Mortality	Ingestion	Immature	Buhler and Shanks, 1970	WES
Coho salmon	113	16.6		60	Mortality	Diet	Fingerling, 3.7 g	62	J & A (1999)
Goldfish	200	130		38-58	Mortality	Water, diet	Adult	370	J & A (1999)
Golden shiner		3.6		15	Mortality	Water	1.9 g	94	J & A (1999)
Trout - lake		2.68		176	Growth	Water, diet	Fry	28	J & A (1999)
Salmon - Atlantic		3	8		Morphology	Injection	Immature	Addison, et al., 1976	WES
Trout - Brook		25.6		120	Mortality	Diet	Juvenile	267	J & A (1999)
Trout - Rainbow		4.67		140	Growth, Mort	Diet	Juvenile, 15 g	269	J & A (1999)
Atlantic menhaden		24		48	Growth	Diet	Larvae-juvenile	480	J & A (1999)
Golden Ide		95	1	3	Mortality	Absorption	NA	Freitag, et al., 1985	WES
Mosquito fish		5.3	1	3	Mortality	Combined	NA	Metcalf, 1974	WES
Spiny Dogfish		0.1	4	1	Mortality	Injection	NA	Guarino and Arnold, 1979	WES
Trout - Brook		2.8-7.6		156	Growth, Mort	Diet	Yearling-adult	265	J & A (1999)

DDTR LOAELs as Percentiles for Fish Tissue 'MATC'



APPENDIX FTRV

DERIVATION OF DDT TOXICITY VALUES FOR FISH

%ile	LOAEL (mg/kg) input	LOAEL (mg/kg) avg. range	LOAEL log10
0.067	0.29	0.29	-0.537602
0.133	1.73	1.73	0.238046
0.200	0.9 - 3.66	2.28	0.357935
0.267	0.89-5.03	2.96	0.471292
0.333	4.2	4.2	0.623249
0.400	5.1	5.1	0.70757
0.467	11.6	11.6	1.064458
0.533	24	24	1.380211
0.600	26.5	26.5	1.423246
0.667	57	57	1.755875
0.733	77.3	77.3	1.888179
0.800	95	95	1.977724
0.867	113	113	2.053078
0.933	200	200	2.30103

TRV calculation	TRVs
All data	
n	14
mean	1.1217
sd	0.8368
mean-sd*1.771	-0.3602
0.05 probability untrns	**0.436**
mean untransformed	**13.235**

5 percent TRV = 0.436
50 percent TRV = 13.235

APPENDIX FTRV

DIELDRIN TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Bluegill	3.7		5		Behavior	Absorption	Immature	Gakstatter and Weiss, 1967	WES, 2000
Goldfish	3.8		5		Behavior	Absorption	Immature	Gakstatter and Weiss, 1967	WES, 2000
Trout, rainbow	5.65	0.548		4	Mortality	Water	Juvenile	406	J & A (1999)
Sheepshead minnow	34	12.8	2		Mortality	Combined	Immature	Parrish, et al.	WES, 2000
Trout, rainbow		0.36		112	Growth	Water	Juvenile	406	J & A (1999)
Spiny Dogfish		1	4		Mortality	Injection	NA	Guarino and Arnold, 1979	WES, 2000
Trout, rainbow		2.13		140	Mort., Growth	Diet	Juvenile, 15g	269	J & A (1999)
Mosquito fish		28	1		Mortality	Combined	NA	Metcalf, 1974	WES, 2000
Golden Ide		151	1		Mortality	Absorption	NA	Freitag, et al., 1985	WES, 2000

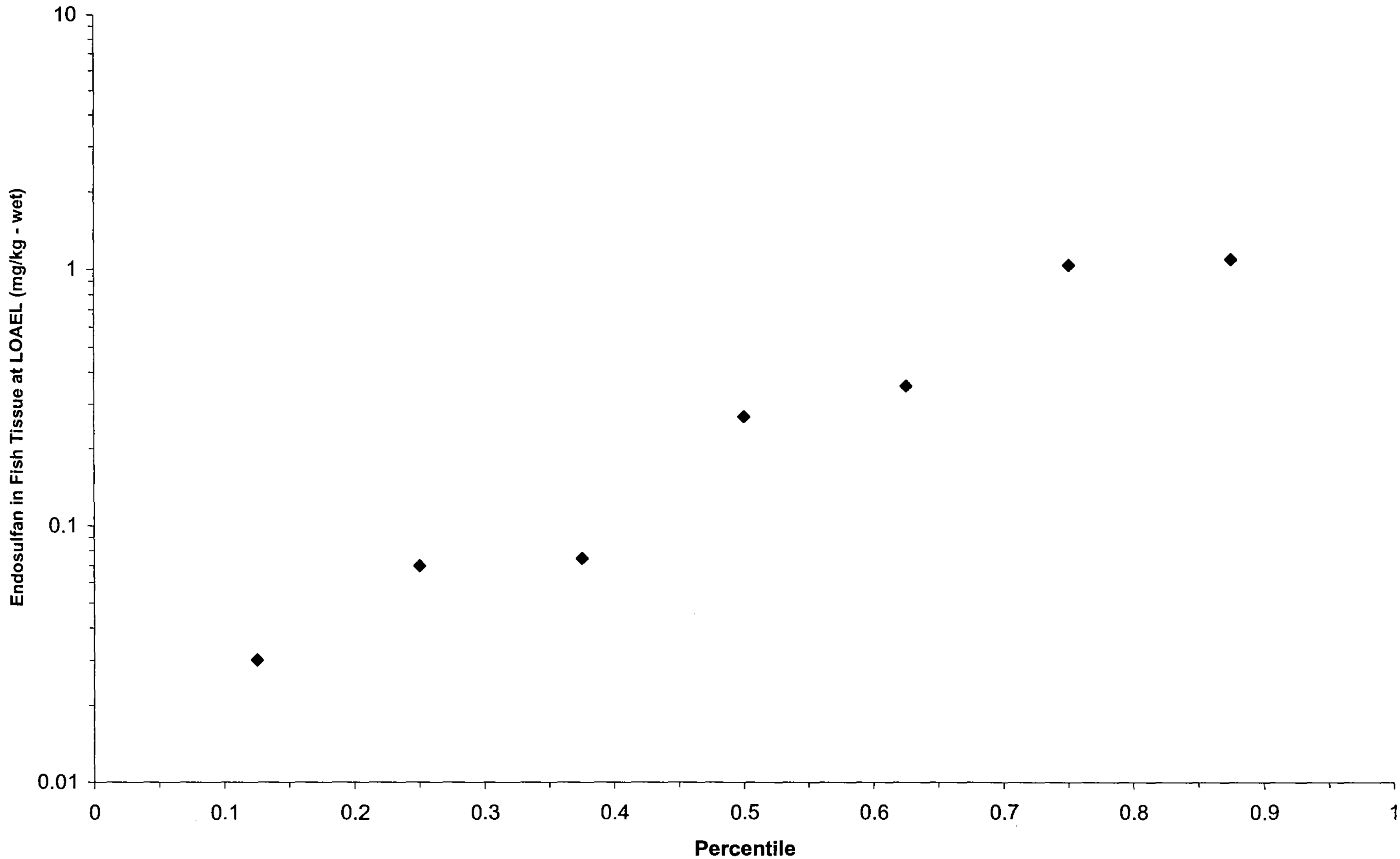
Lowest value (of pairs, for NOAELs)	3.7	0.548

APPENDIX FTRV

ENDOSULFAN TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Spot	0.03			4	Mortality	Water	Juvenile	396	J & A (1999)
Clarias	0.07			3	Mortality	Water	Juvenile	276	J & A (1999)
Trout - Rainbow	0.075		16		Physiological	Injection	Immature	Jensen, et al., 1991	WES
Pinfish	0.27	0.2		4	Mortality	Water	Juvenile	396	J & A (1999)
Striped mullet	0.36			4	Mortality	Water	Juvenile	396	J & A (1999)
Haplochromis	1.08			3	Mortality	Water	Juvenile	276	J & A (1999)
Serranochromis	1.15			3	Mortality	Water	Juvenile	276	J & A (1999)

Endosulfan LOAELs as Percentiles for Fish Tissue 'MATC'



APPENDIX FTRV

DERIVATION OF ENDOSULFAN TOXICITY VALUES FOR FISH

%ile	LOAEL (mg/kg) input	LOAEL (mg/kg) avg. range	LOAEL log10
0.125	0.03	0.03	-1.522879
0.250	0.07	0.07	-1.154902
0.375	0.075	0.075	-1.124939
0.500	0.27	0.27	-0.568636
0.625	0.36	0.36	-0.443697
0.750	1.08	1.08	0.033424
0.875	1.15	1.15	0.060698

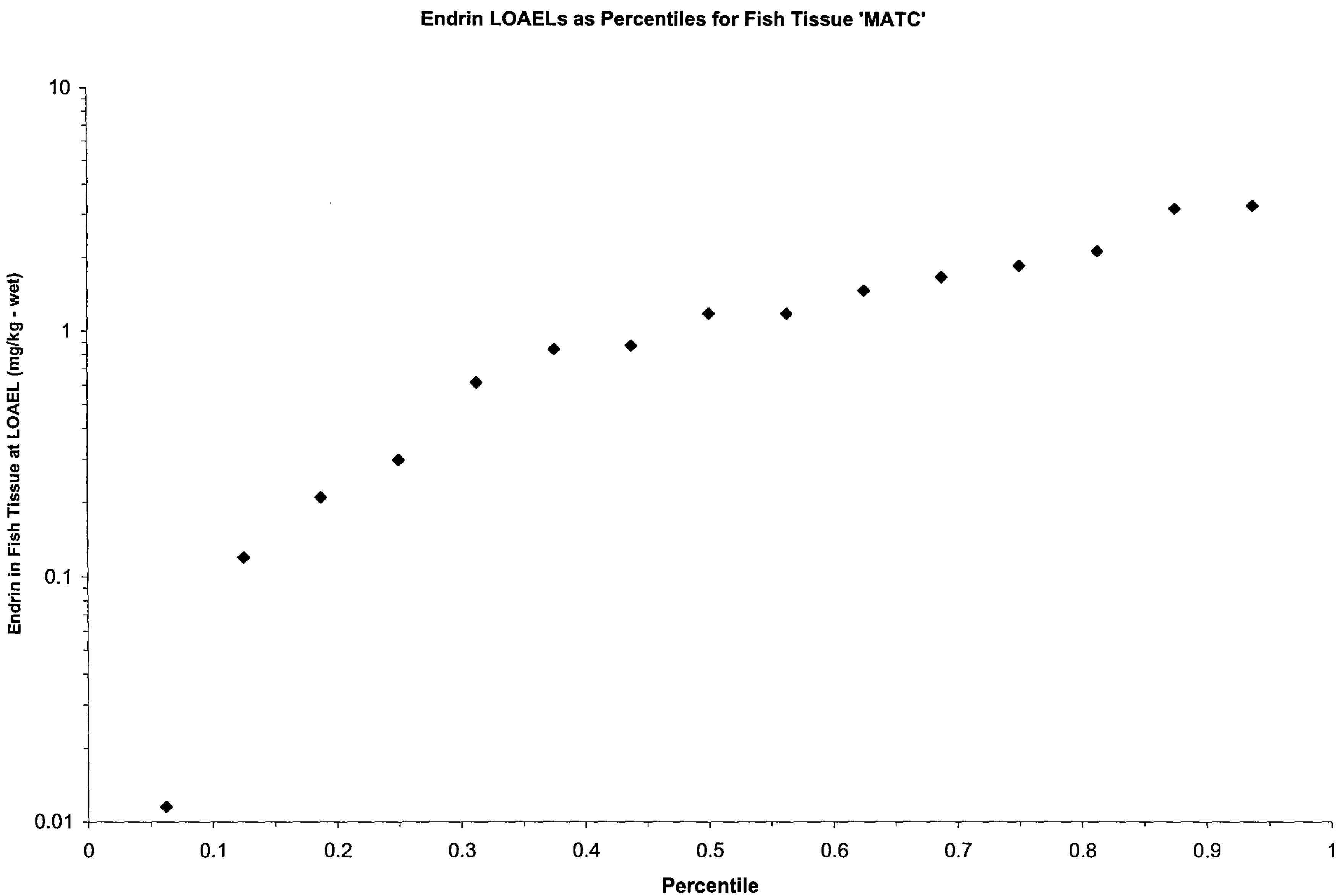
TRV calculation	TRVs
All data	
n	7
mean	-0.6744
sd	0.6137
mean-sd*1.943	-1.8668
0.05 probability untrns	**0.014**
mean untransformed	**0.212**

5 percent TRV = 0.014
50 percent TRV = 0.212

APPENDIX FTRV

ENDRIN TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Largemouth bass	0.0115			20	Mortality	Water	Fingerling	132	J & A (1999)
Trout - Rainbow	0.12	0.019	5		Behavior	Ingestion	Adult	Grant and Mehrle, 1973	WES
Trout - Rainbow	0.21	0.12	5		Growth	Ingestion	Adult	Grant and Mehrle, 1973	WES
Bluegill	0.3	0.08		1	Mortality	Water	NA	23	J & A (1999)
Sheepshead minnow	0.62	0.77	1		Growth	Absorption	Egg-embryo	Hansen and Parrish, 1977	WES
Channel catfish	0.7-1	0.41		54	Mortality	Water	Fingerling	15	J & A (1999)
Sheepshead minnow	0.88	0.29		140	Mortality	Water	Embryo-adult	176	J & A (1999)
Fathead minnow	1.2	1		300	Mortality	Water, diet	Juvenile-adult	221	J & A (1999)
Golden shiner	1.2	0.4		0.25	Mortality	Water	Adult	262	J & A (1999)
Sheepshead minnow	1.5	0.3	1		Mortality	Combined	Mature	Schimmel, et al., 1975	WES
Sailfin molly	1.7	0.26	1		Mortality	Combined	Mature	Schimmel, et al., 1975	WES
Black bullhead	1.6-2.2			5	Mortality	Water	Juvenile	12	J & A (1999)
Flagfish	2.2	1.7		140	Reproduction	Water	Larvae-juvenile	193	J & A (1999)
Flagfish	2.1-4.5	1.6-3.3		110	Growth, repro.	Water	Larvae-adult	190	J & A (1999)
Mosquito fish	3.4		1		Behavior, mort.	Combined	NA	Metcalf, et al., 1973	WES


Endrin LOAELs as Percentiles for Fish Tissue 'MATC'
10
1
0.1
0.01
Endrin in Fish Tissue at LOAEL (mg/kg - wet)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

APPENDIX FTRV

DERIVATION OF ENDRIN TOXICITY VALUES FOR FISH

%ile	LOAEL (mg/kg) input	LOAEL (mg/kg) avg. range	LOAEL log10
0.063	0.0115	0.0115	-1.939302
0.125	0.12	0.12	-0.920819
0.188	0.21	0.21	-0.677781
0.250	0.3	0.3	-0.522879
0.313	0.62	0.62	-0.207608
0.375	0.7-1	0.85	-0.070581
0.438	0.88	0.88	-0.055517
0.500	1.2	1.2	0.079181
0.563	1.2	1.2	0.079181
0.625	1.5	1.5	0.176091
0.688	1.7	1.7	0.230449
0.750	1.6-2.2	1.9	0.278754
0.813	2.2	2.2	0.342423
0.875	2.1-4.5	3.3	0.518514
0.938	3.4	3.4	0.531479

TRV calculation	TRVs
All data	
n	15
mean	-0.1439
sd	0.6506
mean-sd*1.761	-1.2895
0.05 probability untrns	**0.051**
mean untransformed	**0.718**

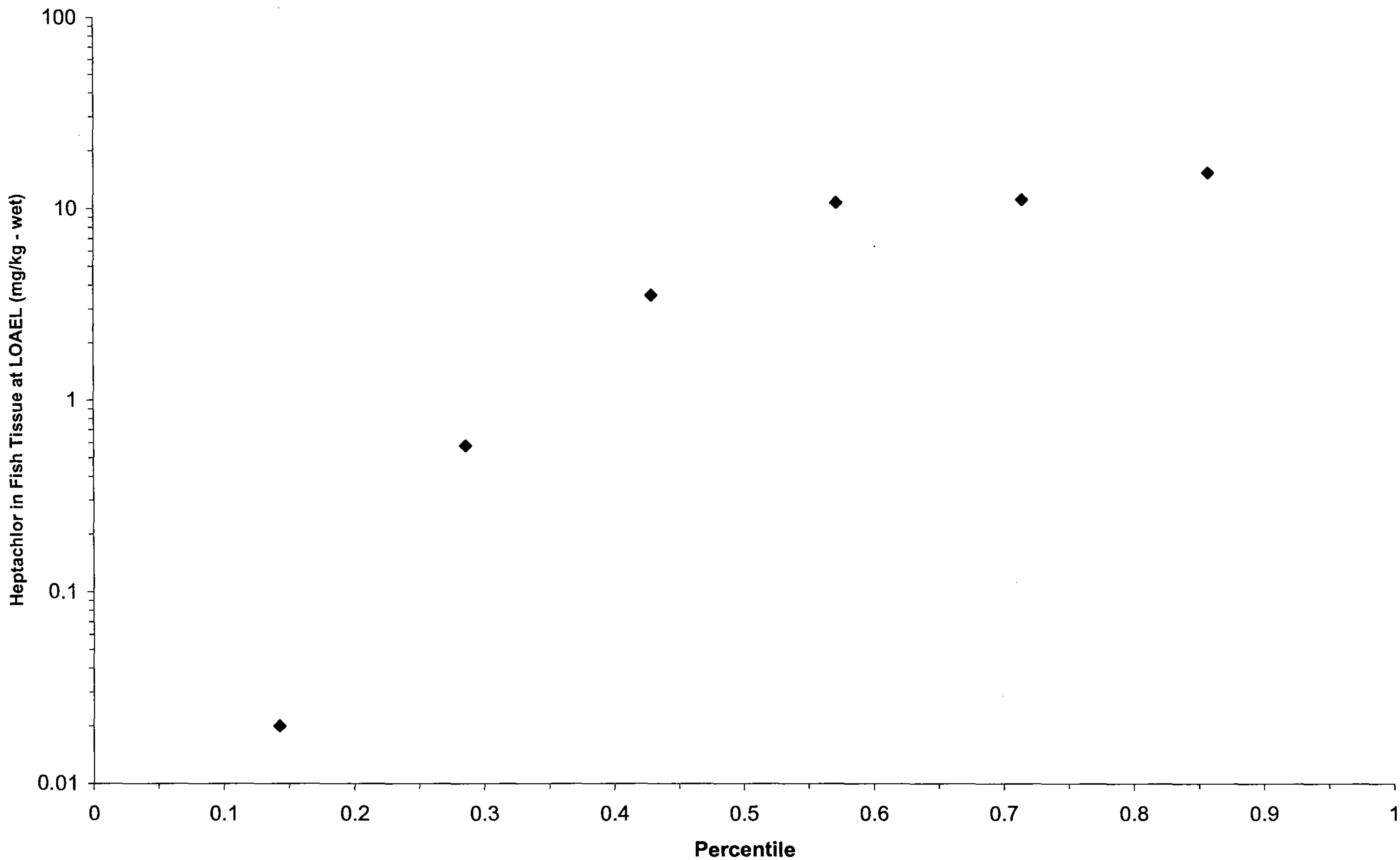
5 percent TRV = 0.051
50 percent TRV = 0.718

APPENDIX FTRV

HEPTACHLOR TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Sheepshead minnow	0.02		1		Mortality	Combined	Mature	Schimmel, et al., 1976	WES, 2000
Spot	0.58	0.016	1		Mortality	Combined	Mature	Schimmel, et al., 1976	WES, 2000
Sheepshead minnow	3.6		1		Behavior	Absorption	Egg-embryo	Goodman, et al., 1977	WES, 2000
Pinfish	11	3.2	1		Mortality	Combined	Mature	Schimmel, et al., 1976	WES, 2000
Spot	11.5	5.3		3-24	Mortality	Water	Juvenile	393	J & A (1999)
Sheepshead minnow	16		1		Mortality	Absorption	Egg-embryo	Hansen and Parrish, 1977	WES, 2000

Heptachlor LOAELs as Percentiles for Fish Tissue 'MATC'



APPENDIX FTRV

DERIVATION OF HEPTACHLOR TOXICITY VALUES FOR FISH

%ile	LOAEL (mg/kg) input	LOAEL (mg/kg) avg. range	LOAEL log10
0.143	0.02	0.02	-1.69897
0.286	0.58	0.58	-0.236572
0.429	3.6	3.6	0.556303
0.571	11	11	1.041393
0.714	11.5	11.5	1.060698
0.857	16	16	1.20412

log TRV calculation	TRVs
All data	
n	6
mean	0.3212
sd	1.1218
mean-sd*2.015	-1.9393
0.05 probability untrns	**0.011**
mean untransformed	**2.095**

5 percent TRV =	**0.011**
50 percent TRV =	**2.095**

APPENDIX FTRV

DERIVATION OF HEPTACHLOR TOXICITY VALUES FOR FISH

	LOAEL (mg/kg)		LOAEL
%ile	input	avg. range	log10
0.143	0.02	0.02	-1.69897
0.286	0.58	0.58	-0.236572
0.429	3.6	3.6	0.556303
0.571	11	11	1.041393
0.714	11.5	11.5	1.060698
0.857	16	16	1.20412

log TRV calculation	
	TRVs
All data	
n	6
mean	0.3212
sd	1.1218
mean-sd*2.015	-1.9393
0.05 probability untrns	**0.011**
mean untransformed	**2.095**

5 percent TRV = 0.011
50 percent TRV = 2.095

APPENDIX FTRV

METHOXYCHLOR TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Striped mullet	1.64	0.2		4	Mortality	Water	Young juvenile	252	J & A (1999)
Sheepshead minnow	2.6		1		Reproduction	Absorption	Egg-embryo	Hansen and Parrish, 1977	WES
Mosquito fish		0.128	1	3	Mortality	Combined	NA	Metcalf, 1974	WES
Trout - Brook		1.4	6	1	Behavior	Combined	Immature	Peterson, 1973	WES
Trout - Brook		2.5		30	Growth	Diet	Yearling	338	J & A (1999)
Trout - Rainbow		6.07		2	Mortality	Water	Fingerling	401	J & A (1999)

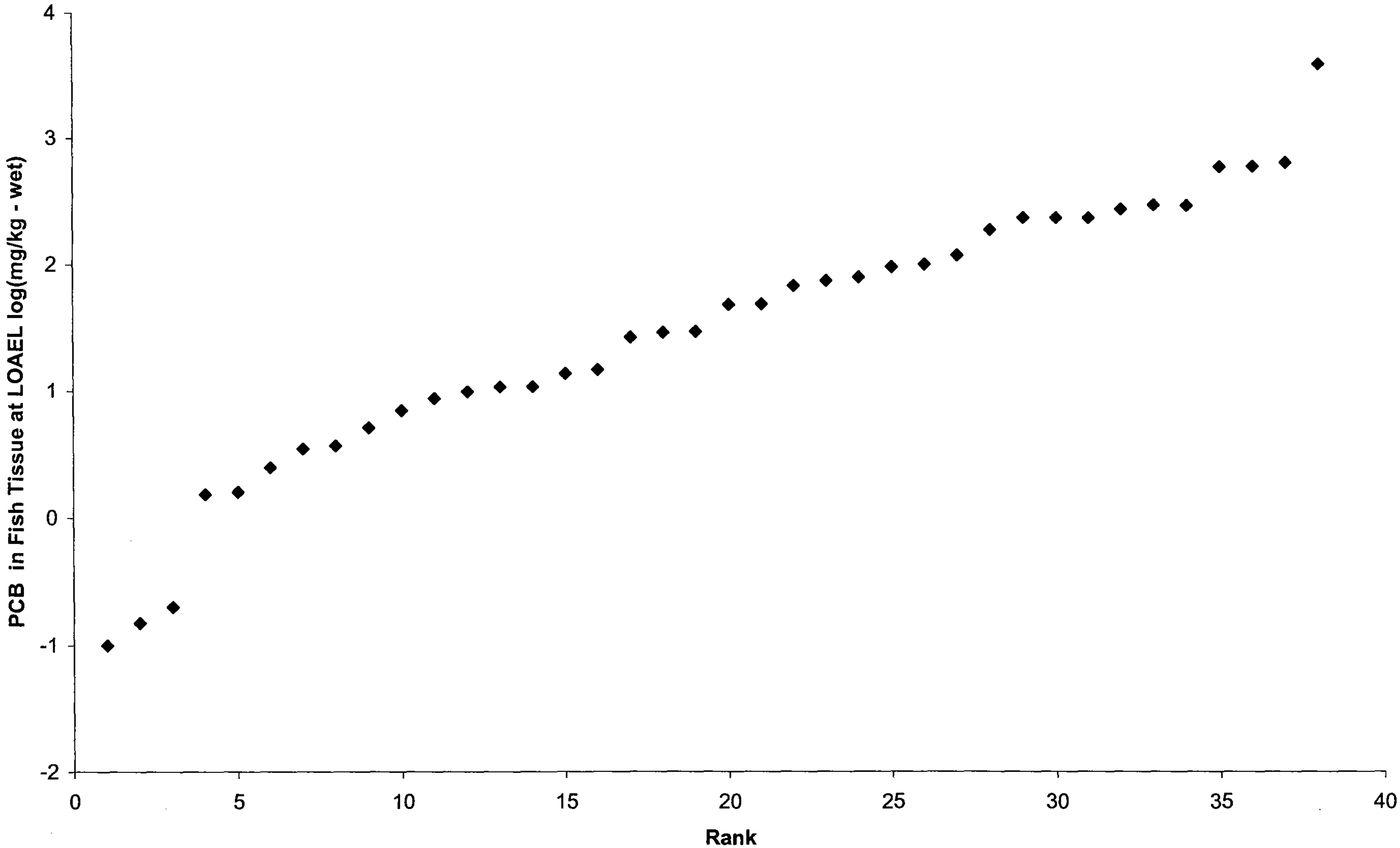
Lowest value (of pairs, for NOAELs)	1.64	0.2

APPENDIX FTRV

PCB TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH
DATA SET, STATISTICAL TEST, AND TRV CALCULATION

whole-body data Species	Salmonid	LOAEL (mg/kg)	LOAEL log(mg/kg)	Embryo/ larvae	Effect	Exposure route	Chemical	Median test Injection	Median test Balance	TRV calculation	TRVs
Carp	N	0.1	-1	N	Physiological	Injection	PCBs	0.008			
Salmon-coho	Y	0.15	-0.8239	N	Development	Injection	PCBs	0.063			
Trout-Rainbow	Y	0.2	-0.6990	N	Physiological	Injection	PCBs			**All data**	
Trout-Lake	Y	1.53	0.1847	N	Mortality	Combined	A-1254			mean	1.4721
Minnow	N	1.6	0.2041	N	Behavior	Diet	PCBs			sd	1.0698
Fatheadminnow	N	2.49	0.3962	N	Mortality	Water	A-1268			mean-sd*1.684	-0.3295
Salmon-Chinook	Y	3.5	0.5441	N	Cellular	Diet	PCBs			0.05 prob. untrns.	0.468
Salmon-Chinook	Y	3.7	0.5682	N	Mortality	Water	HexCB			mean untransfrmd	29.7
Fatheadminnow	N	5.18	0.7143	N	Mortality	Water	A-1260				
WinterFlounder	N	7.1	0.8513	Y	Growth	Combined	PCBs				
Trout-Lake	Y	8.8	0.9445	N	Mortality	Water	HexCB			**Data w/o Injection**	
Mummichog	N	10	1.0000	N	Physiological	Injection	PCBs	median		mean	1.6865
Fatheadminnow	N	10.9	1.0374	N	Mortality	Water	A-1242		0.005	sd	0.8995
Sheepsheadminnow	N	11	1.0414	Y	Mortality	Adultfish	A-1254			mean-sd*1.697	0.1601
Pinfish	N	14	1.1461	N	Mortality	Water	A-1254		0.035	0.05 prob. untrns.	1.446
Minnow	N	15	1.1761	N	Reproduction	Diet	PCBs			mean untransfrmd	48.6
Trout-Lake	Y	27.2	1.4346	Y	Mortality	Water	PentaCB				
Trout-Rainbow	Y	30	1.4771	N	Physiological	Injection	PCBs				
Fatheadminnow	N	30.5	1.4843	N	Growth	Water	A-1248				
Trout-Rainbow	Y	50	1.6990	N	Physiological	NA	PCBs				
Salmon-coho	Y	50.8	1.7059	N	Physiological	Injection	PCBs	0.063			
Trout-Brook	Y	71	1.8513	N	Growth	Water	A-1254		median		
Trout-Brook	Y	77.9	1.8915	Y	Mortality	Adultfish	A-1254				
Spot	N	83	1.9191	N	Mortality	Water	A-1254				
SandFlathead	N	100	2.0000	N	Physiological	Injection	PCBs	0.008			
Pinfish	N	106	2.0253	N	Mortality	Water	PCBs				
Trout-Brook	Y	125	2.0969	N	Mortality	Water	A-1254				
Sheepsheadminnow	N	200	2.3010	Y	Mortality	Water	A-1016		0.035		
Goldfish	N	250	2.3979	N	Mortality	Water	PCBs				
Goldfish	N	250	2.3979	N	Behavior	Water	PCBs		0.005		
Goldfish	N	250	2.3979	N	Morphology	Water	PCBs				
Guppy	N	295	2.4698	N	Mortality	Diet	OCB				
Guppy	N	318	2.5024	N	Mortality	Diet	HexCB				
Fatheadminnow	N	318	2.5024	N	Reproduction	Water	A-1254				
Salmon-coho	Y	645	2.8096	N	Mortality	Diet	PCBs				
Salmon-coho	Y	652	2.8142	N	Growth	Diet	A-1254				
Fatheadminnow	N	697	2.8432	N	Mortality	Water	A-1254				
Zebrafish	N	4300	3.6335	N	Mortality	Water	PCBs				

Ranked PCB LOAELs for Fish Tissue 'MATC'

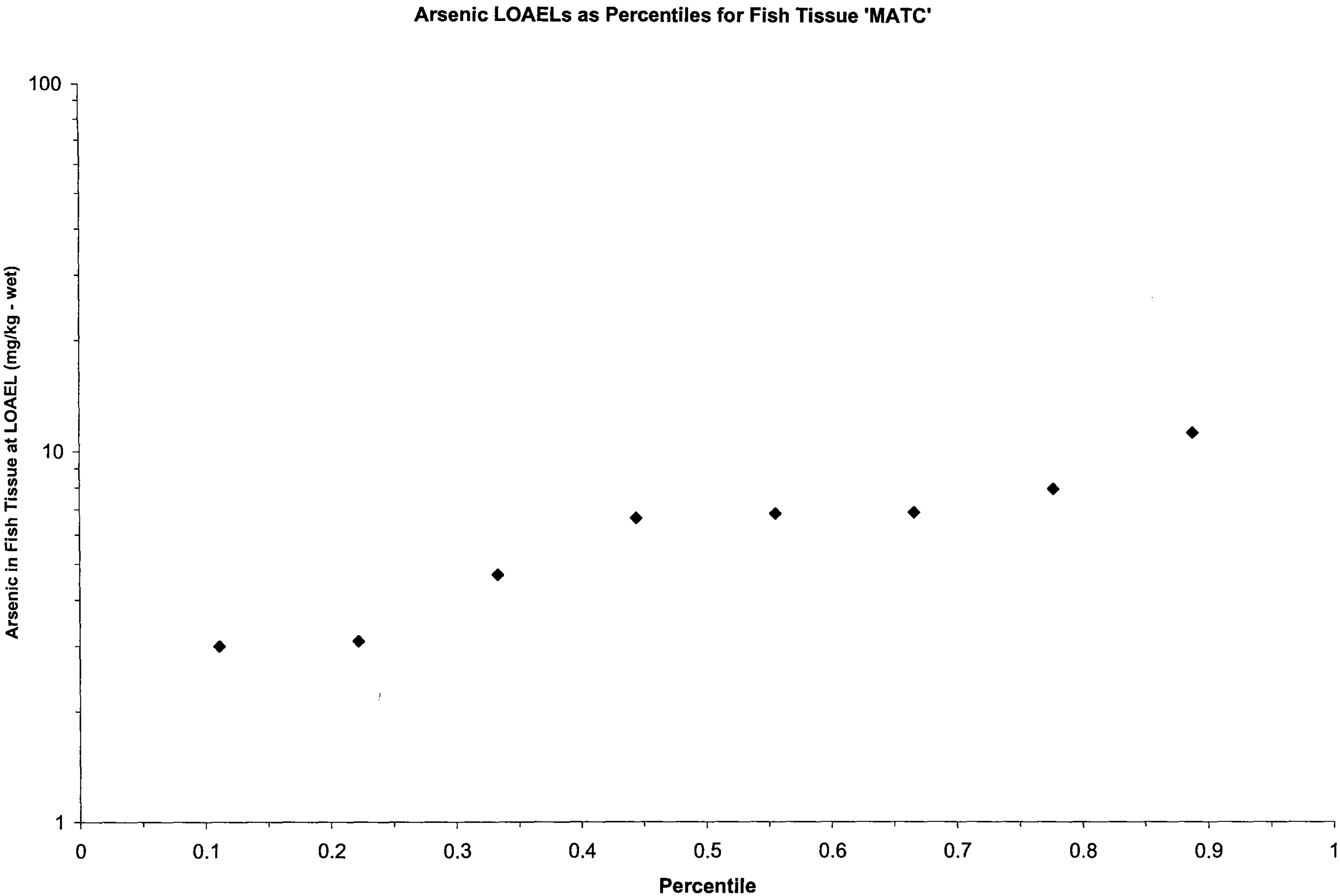


APPENDIX FTRV

ARSENIC TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Trout - Rainbow	3	1		77	Growth	Water	Fingerling, 5.7 g	286	J & A (1999)
Trout - Rainbow	3.1	0.9		56	Growth	Diet	Juvenile	87	J & A (1999)
Trout - Rainbow	4.7	3	15		Mortality	Absorption	Immature	Dixon and Sprague, 1981	USACEWES
Sunfish - Green	6.7			5	Mortality	Water	NA	416	J & A (1999)
Trout - Rainbow	6.9	0.9		56	Growth	Diet	Juvenile	87	J & A (1999)
Trout - Rainbow	8.1			7	Mortality	Water	Fingerling, 1.5 g	287	J & A (1999)
Bluegill	11.6	5.5		112	Growth, Mort	Water	Adult	149	J & A (1999)
Bluegill	2.24-11.7	1.8		112	Growth, Mort	Water	Juvenile	149	J & A (1999)
Trout - Rainbow		2.6-4.7		21	Growth, Mort	Water	Juvenile	116	J & A (1999)

NA = not available


Arsenic LOAELs as Percentiles for Fish Tissue 'MATC'
100
10
1
Arsenic in Fish Tissue at LOAEL (mg/kg - wet)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

APPENDIX FTRV

DERIVATION OF ARSENIC TOXICITY VALUES FOR FISH

	LOAEL (mg/kg)		LOAEL
%ile	input	avg. range	log10
0.111	3	3	0.477121
0.222	3.1	3.1	0.491362
0.333	4.7	4.7	0.672098
0.444	6.7	6.7	0.826075
0.555	6.9	6.9	0.838849
0.666	2.24-11.7	6.97	0.843233
0.777	8.1	8.1	0.908485
0.888	11.6	11.6	1.064458

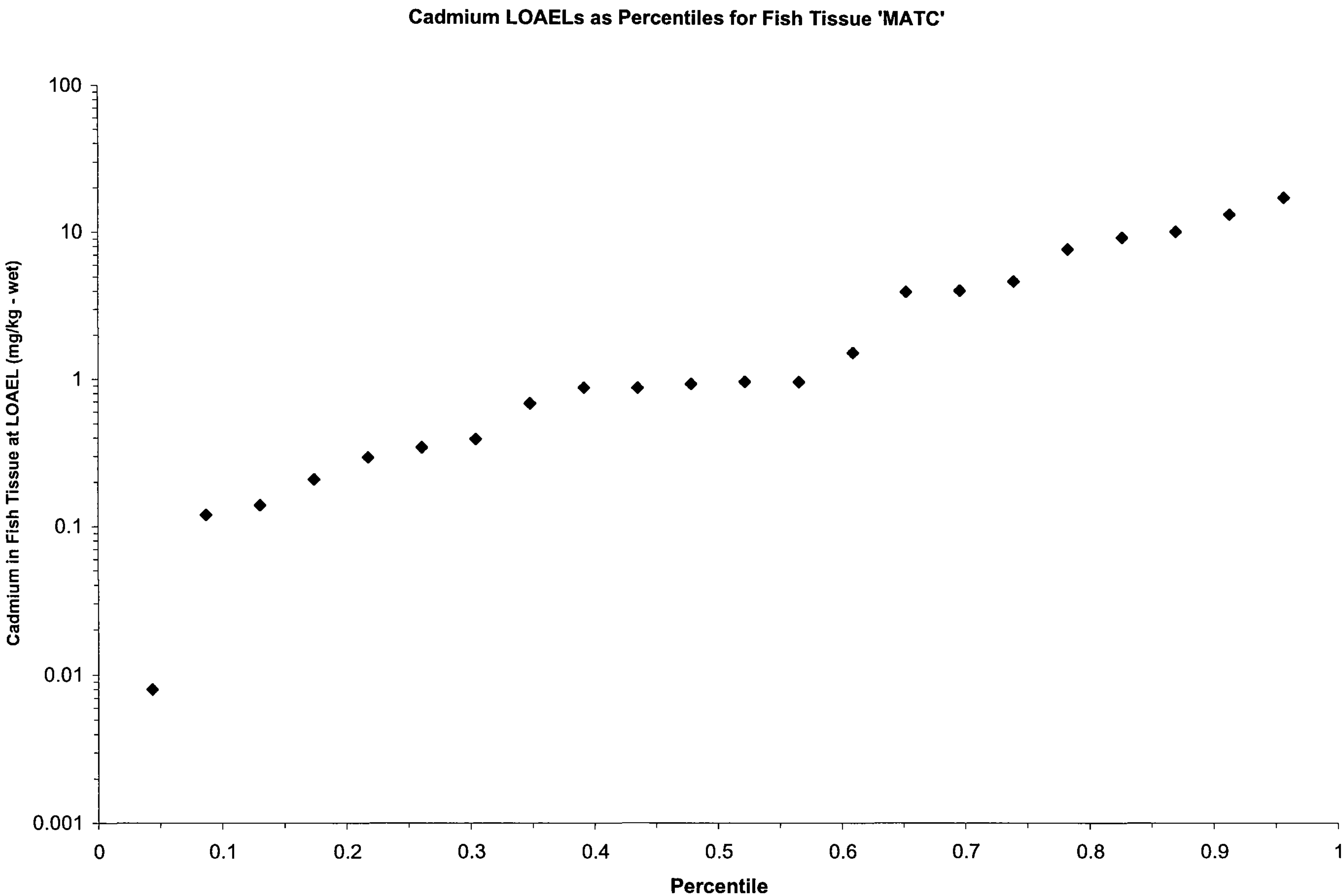
TRV calculation	
	TRVs
All data	
n	8
mean	0.7652
sd	0.2042
mean-sd*1.895	0.3782
0.05 probability untrns	**2.389**
mean untransformed	**5.824**

5 percent TRV = 2.389
50 percent TRV = 5.824

APPENDIX FTRV

CADMIUM TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Largemouth bass	0.008	0.004		120	Mortality	Water	Juvenile	81	J & A (1999)
Atlantic salmon	0.12	0.06		92	Growth	Water	Embryo-alevin	379	J & A (1999)
Trout - Brook	0.14			30	Mortality	Water	2-3 mo, 5 g	163, 164	J & A (1999)
Trout - Rainbow	0.21		3		Mort., Morphol.	Absorption	Egg-embryo	Beattie and Pascoe, 1978	WES
Stickleback	0.3			7	Mortality	Water	1.2 g	491	J & A (1999)
Bluegill	0.35	0.036		180	Mortality	Water	Juvenile	81	J & A (1999)
American flagfish	0.4	0.09 - 0.4	2		Mortality	Combined	Immature	Spehar, et al.,1978	WES
Trout - Rainbow	0.7			29	Mortality	Water	5-15 g	350	J & A (1999)
Sheepshead minnow	0.9		3		Development	Absorption	Egg-embryo	Meteyer, et al., 1988	WES
Stickleback	0.9			79	Mortality	Water	0.97 g	351	J & A (1999)
Trout - Rainbow	0.96	0.54		210	Growth	Water	3.1 g	248	J & A (1999)
Winter Flounder	1		4		Physiological	Injection	NA	Chan, et al., 1989	WES
Trout - Rainbow	1.6	0.47		84	Growth	Diet	3.1 g	248	J & A (1999)
Seabass	4.2	2.5		16	Mortality	Water	Larvae-juvenile	405	J & A (1999)
Spot	8.3	5.6		8	Mortality	Water	Larvae	300	J & A (1999)
Trout - Rainbow	10		1		Physiological	Injection	Adult	Bonham, et al., 1987	WES
Baltic Herring	19	11		15	Mortality	Water	Embryo	485	J & A (1999)
Guppy	0.8-1.2	0.8		30	Mortality	Diet	19 d	181	J & A (1999)
Garpike	10-19	7-11		25	Mortality	Water	Embryo	483	J & A (1999)
Trout - Rainbow	2.2 - 6.4		4		Mortality	Combined	Adult	Pascoe, et al., 1986	WES
Flagfish	2-8	1.2-5		100	Reproduction	Water	Embryo-adult	418	J & A (1999)
Flounder	4-18	2-6		17	Mortality	Water	Embryo-larvae	482	J & A (1999)
Largemouth bass		0.008		120	Growth	Water	Juvenile	81	J & A (1999)
Trout - Rainbow		0.0599	7		Mortality	Absorption	Adult	Handy, 1992	WES
Perch		0.075		40	Mortality	Water	Fingerling	126	J & A (1999)
Bluegill		0.35		180	Growth	Water	Juvenile	81	J & A (1999)
Eel		0.56		60	Mortality	Water	100 g	331	J & A (1999)
Dace		0.69		112	Growth, Mort	Water	1.1 g	248	J & A (1999)
Bluegill		1.33		28	Growth	Water	Juvenile	92	J & A (1999)
Stone loach		2.3		4	Mortality	Water	2.7 g	120	J & A (1999)
American flagfish		6	2		Repro., Growth	Combined	Immature	Spehar, et al.,1978	WES
Flounder		8-18		17	Growth	Water	Embryo-larvae	482	J & A (1999)


Cadmium LOAELs as Percentiles for Fish Tissue 'MATC'
Cadmium in Fish Tissue at LOAEL (mg/kg - wet)
100
10
1
0.1
0.01
0.001
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

APPENDIX FTRV

DERIVATION OF CADMIUM TOXICITY VALUES FOR FISH

%ile	LOAEL (mg/kg) input	avg. range	LOAEL log10
0.043	0.008	0.008	-2.09691
0.087	0.12	0.12	-0.920819
0.130	0.14	0.14	-0.853872
0.174	0.21	0.21	-0.677781
0.217	0.3	0.3	-0.522879
0.261	0.35	0.35	-0.455932
0.304	0.4	0.4	-0.39794
0.348	0.7	0.7	-0.154902
0.391	0.9	0.9	-0.045757
0.435	0.9	0.9	-0.045757
0.478	0.96	0.96	-0.017729
0.522	0.8-1.2	1	0
0.565	1	1	0
0.609	1.6	1.6	0.20412
0.652	4.2	4.2	0.623249
0.696	2.2 - 6.4	4.3	0.633468
0.739	2-8	5	0.69897
0.783	8.3	8.3	0.919078
0.826	10	10	1
0.870	4-18	11	1.041393
0.913	10-19	14.5	1.161368
0.957	19	19	1.278754

TRV calculation	TRVs
All data	
n	22
mean	0.0623
sd	0.8237
mean-sd*1.721	-1.3554
0.05 probability untrns	**0.044**
mean untransformed	**1.154**

5 percent TRV = 0.044
50 percent TRV = 1.154

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage
Mudskipper	1		6		Cellular	Injection	NA
Trout - Rainbow	8.7	5.5	4		Mortality	Absorption	Immature

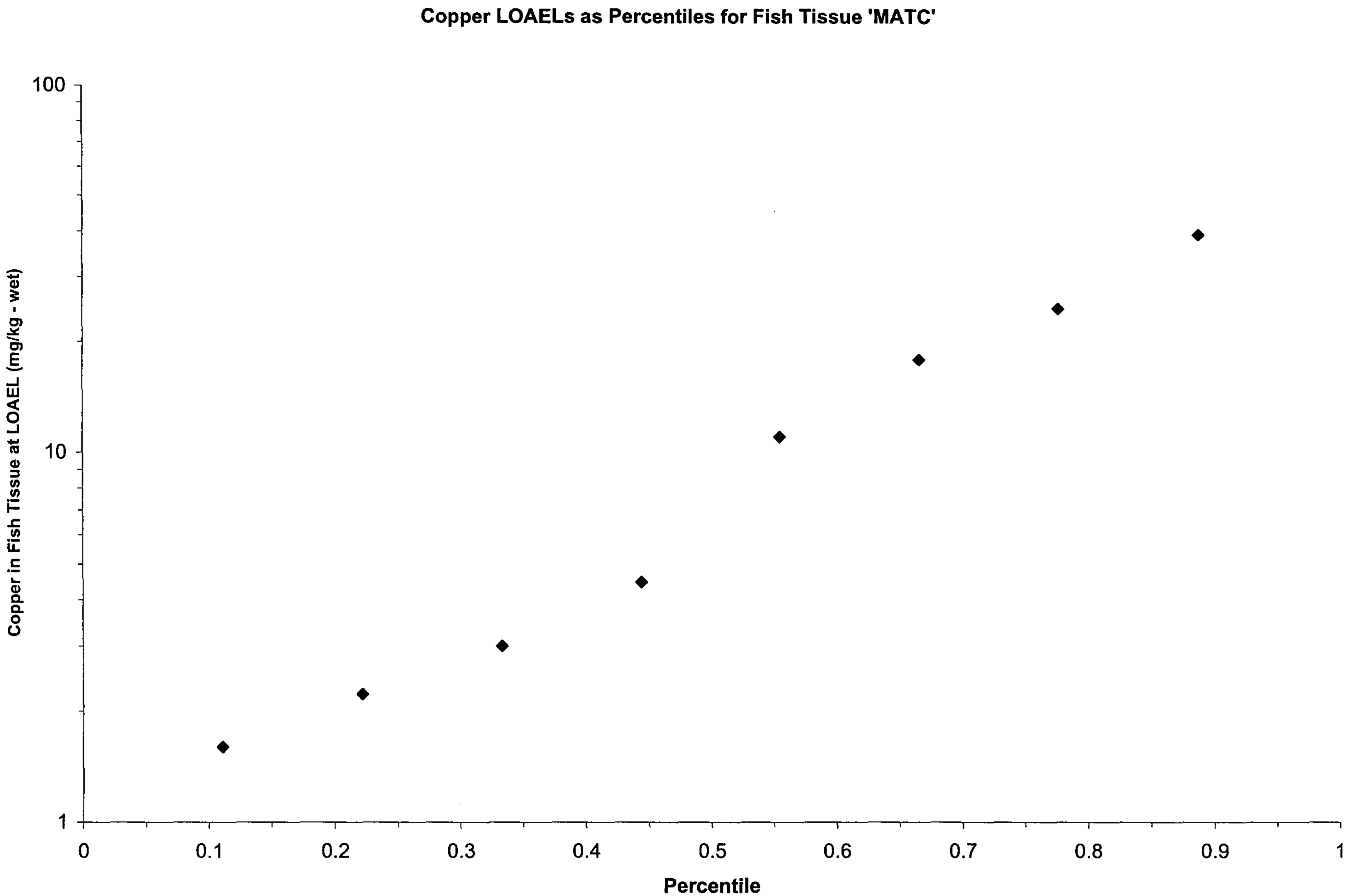
Lowest value (of pairs, for NOAELs)	1	5.5

Use 1 mg/kg as single TRV

APPENDIX FTRV

COPPER TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Trout - Rainbow	1.6		10		Mortality	Absorption	Immature	Dixon and Sprag	WES
Trout - Rainbow	2.22		7		Mortality	Absorption	Adult	Handy, 1992	WES
Spot	3		4		Reproduction	Absorption	Egg-embryo	Engel and Sunda	WES
Trout - Rainbow	4.48	3.92	3		Survival	Combined	Immature	Mount, et al., 199	WES
Carp	11.1	7.4		4	Mortality	Water	Larvae	432	J & A (1999)
Trout - Rainbow	18.1		12		Growth	Water	Fry	Marr, et al., 1996	WES
Silverside - Atlantic	25		5		Reproduction	Absorption	Egg-embryo	Engel and Sunda	WES
Trout - Rainbow	40		1		Physiological	Injection	Adult	Bonham, et al., 1	WES


Copper LOAELs as Percentiles for Fish Tissue 'MATC'
100
10
1
Copper in Fish Tissue at LOAEL (mg/kg - wet)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Percentile

APPENDIX FTRV

DERIVATION OF COPPER TOXICITY VALUES FOR FISH

%ile	LOAEL (mg/kg) input	avg. range	LOAEL log10
0.111	1.6	1.6	0.20412
0.222	2.22	2.22	0.346353
0.333	3	3	0.477121
0.444	4.48	4.48	0.651278
0.555	11.1	11.1	1.045323
0.666	18.1	18.1	1.257679
0.777	25	25	1.39794
0.888	40	40	1.60206

TRV calculation	TRVs
All data	
n	8
mean	0.8727
sd	0.5231
mean-sd*1.895	-0.1185
0.05 probability untrns	**0.761**
mean untransformed	**7.460**

5 percent TRV = 0.761
50 percent TRV = 7.460

Nothing in either J&A or WES data bases for whole body fish

APPENDIX FTRV

LEAD TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

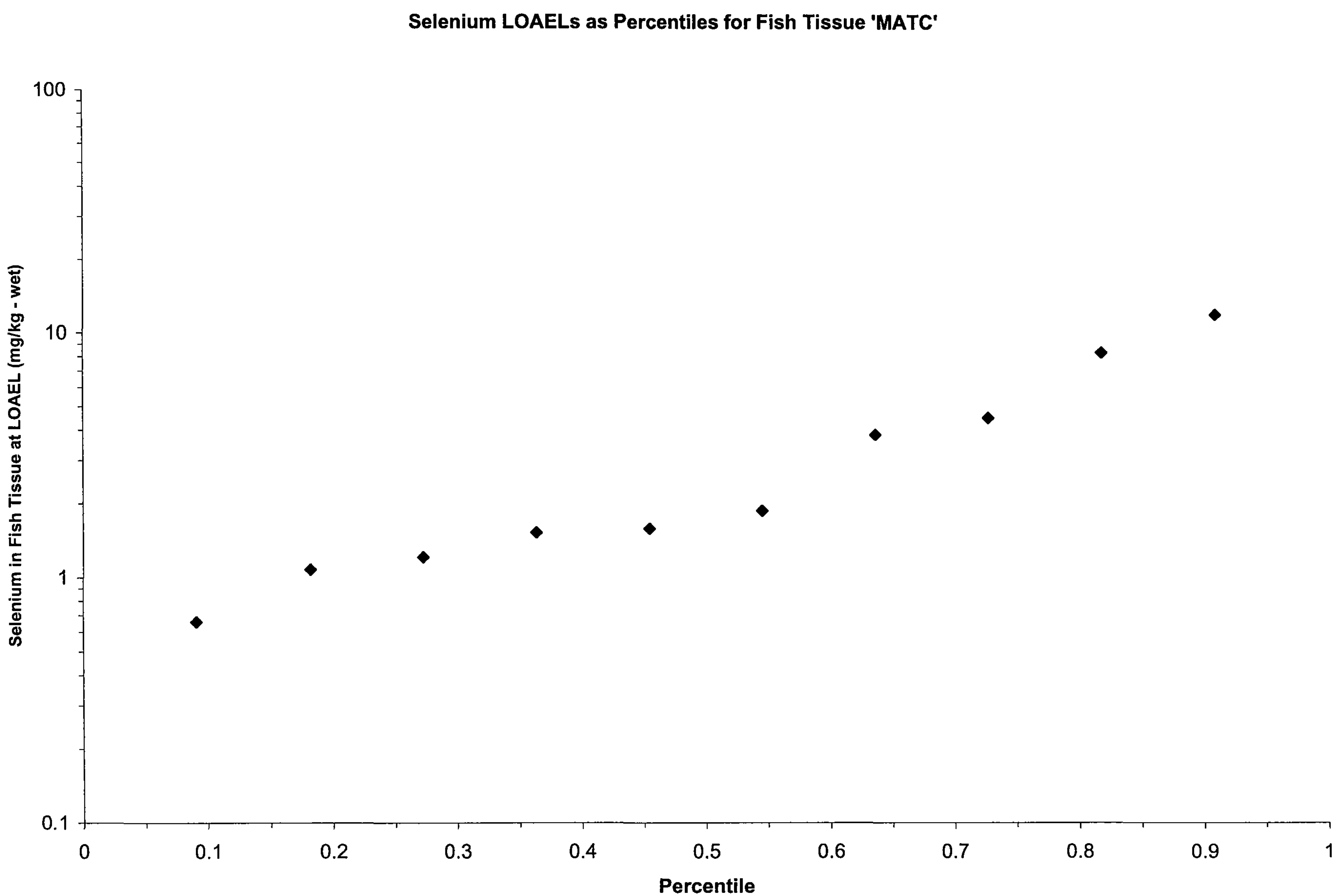
whole-body data **Species**	**LOAEL (mg/kg)**	**NOAEL (mg/kg)**	**n**	**Duration (days)**	**Effect**	**Exposure route**	**Lifestage**	**Reference**	**Source**
Trout - Brook	4-8.8	2.5-5.1		84	Growth	Adults, water	Embryo-juvenile	207	J & A (1999)
Fathead minnow	26.2	44.2	2		Behavior	Absorption	Immature	Weber, et al	WES

Lowest value (of pairs, for NOAELs)	4	2.5

APPENDIX FTRV

SELENIUM TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Salmon-Chinook	0.66	0.2		60	Growth	Diet	Larvae, swim-up	162	J & A (1999)
Bluegill	1.08	0.8		60	Mortality	Water	Juvenile	85	J & A (1999)
Fathead minnow	1.22	1		137	Growth	Diet	Adult	336	J & A (1999)
Bluegill	1.54	1.16		180	Mortality	Combined	Juvenile	256	J & A (1999)
Salmon-Chinook	1.6	0.8		120	Growth	Diet	Fingerling	162	J & A (1999)
Trout - Rainbow	1.9	1.3		28	Mortality	Water	3 - 6 g	152	J & A (1999)
Fathead minnow	3.91		4		Morphology	Combined	Larval	Schultz and Hermanutz, 1990	WES
Bluegill	4.6		6	356	Growth, Mort	Water	Adult	192	J & A (1999)
Fathead minnow	8.6	12.2		7	Growth	Diet	Larvae	24	J & A (1999)
Fathead minnow	9.5 - 15.2			25	Growth	Water	Larvae	117	J & A (1999)
Fathead minnow		0.12	1		Growth	Water	Adult	Tessier and Blais, 1996	WES
Fathead minnow		0.44		56	Growth	Combined	Adult	29	J & A (1999)
Trout - Rainbow		0.44		308	Growth	Water	Egg-juvenile	203	J & A (1999)
Bluegill		2.4	5		Mortality	Water	Immature	Barrows, et al., 1980	WES
Bluegill		2.7		90	Mortality	Diet	Juvenile	85	J & A (1999)
Largemouth Bass		3.1	3		Mortality	Water	Immature	Lemly, 1982	WES
Bluegill		4.54		320	Repro., Growth	Water	Adult	191	J & A (1999)
Bluegill		19		140	Repro., Growth	Combined	Adult	95	J & A (1999)
Bluegill		4.4 - 4.8		120	Mortality	Water	Juvenile	255	J & A (1999)


Selenium LOAELs as Percentiles for Fish Tissue 'MATC'
100
10
1
0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Selenium in Fish Tissue at LOAEL (mg/kg - wet)
Percentile

APPENDIX FTRV

DERIVATION OF SELENIUM TOXICITY VALUES FOR FISH

%ile	LOAEL (mg/kg) input	LOAEL (mg/kg) avg. range	LOAEL log10
0.091	0.66	0.66	-0.180456
0.182	1.08	1.08	0.033424
0.273	1.22	1.22	0.08636
0.364	1.54	1.54	0.187521
0.455	1.6	1.6	0.20412
0.545	1.9	1.9	0.278754
0.636	3.91	3.91	0.592177
0.727	4.6	4.6	0.662758
0.818	8.6	8.6	0.934498
0.909	9.5 - 15.2	12.35	1.091667

TRV calculation	TRVs
All data	
n	10
mean	0.3891
sd	0.4132
mean-sd*1.833	-0.3684
0.05 probability untrns	**0.428**
mean untransformed	**2.450**

5 percent TRV = 0.428
50 percent TRV = 2.450

MERCURY TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH - SORTED BY AUTHOR

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Bluegill		0.06		180	Growth	Water	Young of year	88	J & A (1999)

APPENDIX FTRV

ZINC TISSUE DATA ASSOCIATED WITH EFFECTS IN FISH

whole-body data Species	LOAEL (mg/kg)	NOAEL (mg/kg)	n	Duration (days)	Effect	Exposure route	Lifestage	Reference	Source
Flagfish	40	34		100	Growth	Water	Larvae-adult	418	J & A (1999)
Trout - Rainbow	40		1		Physiological	Injection	Adult	Bonham, et al., 1987	WES
Flagfish	59.6-68			100	Mortality	Water	Embryo-adult	420	J & A (1999)
Atlantic salmon		60		80	Growth, Mort	Water	Juvenile	134	J & A (1999)
Trout - Brook		4.5		84	Growth, Mort	Adults, water	Embryo-larvae	206	J & A (1999)
Guppy		280		134	Repr, Gr, Mrt	Water	Fry	362	J & A (1999)

Lowest value (of pairs, for NOAELs)	40	34

Case scenarios with resulting trigger values for various evaluation techniques of fish tissue data at Hideaway Pond.

	n	range	Distribution		0.05 (LTV)		0.50 (HTV)		Case Description
			normal	log-norm	%Prob.	%Rank	%Prob.	%Rank	
Case 0	24	0.25 - 20	yes	yes	0.88	1.31	4.72	6.00	-excludes behavioral effects study (like previous presentation)
Case 1	25	0.25 - 20	yes	yes	0.63	0.48	4.20	5.80	-includes behavioral effects study (grayling newly hatched fry added)
Case 2	13	0.20 - 20	no	yes	0.32	0.26	3.19	4.47	-includes behavioral effects study -excludes trout studies
Case 3	12	0.25 - 19	no	yes	0.30	0.26	2.84	4.14	-includes behavioral effects study -excludes mortality effects studies
Case 4	9	0.25 – 7	yes	yes	0.23	0.26	1.76	2.00	-includes behavioral effects study -excludes trout studies -excludes mortality effects studies
Case 5	8	0.25 - 7	yes	yes	0.37	0.62	2.23	2.90	-excludes behavioral effects study -excludes trout studies -excludes mortality effects studies
Case 6	12	0.25 - 20	no	yes	0.52	0.83	3.39	5.14	-excludes behavioral effects study -excludes trout studies
Case 7	11	0.25 - 19	no	yes	0.48	0.78	3.52	4.47	-excludes behavioral effects study -excludes mortality effects studies -(three trout studies remain in set)
Notes: Concentration in fish tissue in mg/kg; %Probabilities based on log-normal distribution.									

Case 7 was selected as the best approach, using probabilities. Therefore, the 0.05 TRV is 0.48 mg/kg wet weight and the 0.50 TRV is 3.52 mg/kg wet weight.

APPENDIX C

SEDIMENT TOXICITY TESTING REPORT

28341187

Results of 10 day Sediment Toxicity Tests with *Leptocheirus plumulosus* for Panama City, FL – Tetra Tech NUS

Submitted to:
Ms. Amy Thomson
Tetra Tech NUS
661 Andersen Drive, Foster Plaza 7
Pittsburgh, Pennsylvania 15220-2745

Prepared by:
Tetra Tech, Inc.
10045 Red Run Boulevard
Owings Mills, Maryland 21117

May 10, 2002

SUMMARY

CLIENT: Tetra Tech NUS

TEST FACILITY: Panama City, Florida

TEST MATERIAL: Sediment from 3 sites, plus control

DATE(S) COLLECTED: 17 April, 2002

DATE(S) RECEIVED: 18 April, 2002

COLLECTED BY: Client

CONTROL/DILUTION WATER: Artificial Seawater

TYPE OF TEST(S): 10-Day Sediment Toxicity with *Leptocheirus plumulosus*

TEST DATE(S): 26 April - 6 May, 2002

TEST RESULTS:
TABLE 1. SUMMARY OF TEST RESULTS

Site	Original Number of Organisms	% Survival
Control	100	98
03-GLM-0401	100	83
03-GLM-0501	100	91
03-GLM-0601	100	62

MATERIALS AND METHODS

TEST MATERIAL

One gallon of sediment for each of 3 sites was collected by Tetra Tech NUS personnel. The samples were transported in one gallon plastic ziploc bags on ice to Tetra Tech's Biological Research Facility. Upon arrival, the sample identification, collection date and time were recorded on the sample chain-of-custody sheet (see "Chain-of-Custody" section of this report). Temperature of sediment was recorded upon arrival by measuring the temperature blank (water) packed with sediment. Temperature in blank was < 4° C and was recorded on the chain-of-custody sheet.

OVERLYING WATER AND CONTROL SEDIMENT

The overlying water used for the *L. plumulosus* 10-day sediment toxicity test was artificial seawater with a salinity of approximately 21 ppt. This is Tetra Tech's standard marine culture and testing water.

The control sediment was from the York River in Virginia. This sediment is from a clean source and used by Tetra Tech's organism supplier for breeding and maintaining mass cultures of *L. plumulosus*.

TEST ORGANISMS/SIZE

Leptocheirus plumulosus, 2 to 4 mm, were obtained from ABS (Aquatic BioSystems Inc.). All organisms appeared healthy and disease free.

TEST METHODS

Samples were thoroughly homogenized in the lab in a stainless steel bowl with a Teflon spoon. During homogenization, the sediments were inspected for indigenous organisms and if found they were removed.

ASTM. 2001. Standard Guide for Conducting 10-day Static Sediment Toxicity Tests with Marine and Estuarine Amphipods. E1367-99. In Annual Book of ASTM Standards, Vol. 11.05, Philadelphia, PA.

TEST CONDITIONS

A summary of the test conditions for the *L. plumulosus* 10-day sediment toxicity test is on page 6.

AERATION OF TEST

Slow aeration was provided, as per the ASTM guidelines.

MODIFICATIONS TO PROTOCOLS

None

COMMENTS CONCERNING TEST

None

TABLE 2. Summary of Test Conditions for *Leptocheirus plumulosus* 10-day Whole Sediment Toxicity Test.

PARAMETER		CONDITIONS
1.	Test type	Whole-sediment toxicity test
2.	Test duration	10-D
3.	Temperature	25°C ± 1°C daily mean temperature, 25 ± 3°C instantaneous temperature
4.	Light quality	Wide-spectrum fluorescent lights
5.	Light intensity	~ 500-1000 lux
6.	Photoperiod	24h light
7.	Test chamber size	1000 mL high-form lipless beaker
8.	Sediment volume	175 mL
9.	Overlying water volume	750 mL
10.	Renewal of overlying water	None
11.	Size of test organisms:	2 - 4 mm
12.	No. organisms per test chamber	20
13.	No. replicate chambers per sample	5
14.	No. organisms per sample	100
15.	Feeding regime	Not Fed
16.	Test chamber cleaning	No Cleaning
17.	Aeration	Slow aeration was provided as per ASTM guidelines.
18.	Overlying water	Artificial Seawater
19.	Overlying water quality	Salinity, pH, and ammonia at the beginning and end of a test. Temperature and dissolved oxygen daily.
20.	Endpoint	Survival
21.	Sampling and sample holding requirements	Samples used within 14 days of receipt. Samples stored in the dark at 4°C in sealed containers with no air space.
22.	Sample volume required	one gallon
23.	Test acceptability	Minimum mean control survival of 80% and measurable growth of test organisms in the control sediment.

RESULTS

OVERLYING WATER PHYSICAL/CHEMICAL RESULTS

The physical/chemical results of the overlying water including: salinity, ammonia, dissolved oxygen, pH, and temperature, are summarized in Table 3. Overlying water quality was similar among all sites. See "Laboratory Bench Sheets" section of this report for all physicochemical data.

LEPTOCHEIRUS PLUMULOSUS RESULTS

Results of the 10-Day Sediment Toxicity Test are presented in Figure 1 and 2 in the "Statistical Analysis" section of this report. Survival in site 03-GLM-0601 was significantly lower than the controls and site 03-GLM-0501 (Anova, Duncan Multiple Range Test, $p<0.05$). There was no significant difference among sites 03-GLM-0401 and 0601 in comparison to the controls.

COMMENTS CONCERNING TEST RESULTS

Test acceptability criteria were met for *L. plumulosus* for this test as evidenced by >80% survival in the controls and performance in the standard reference toxicant test. Standard reference toxicant test data is presented in the "Quality Assurance / Quality Control" section of this report.

TABLE 3. SUMMARY OF WATER QUALITY AND TEST DATA FOR *Leptocheirus plumulosus* 10-DAY SEDIMENT TOXICITY TEST

Client: Tetra Tech NUS		
Experiment ID: Tt NUS 4/26/02 L. plumulosus	Start Test	4-26-02
Sample Tested: Panama City, Florida	End Test	5-06-02

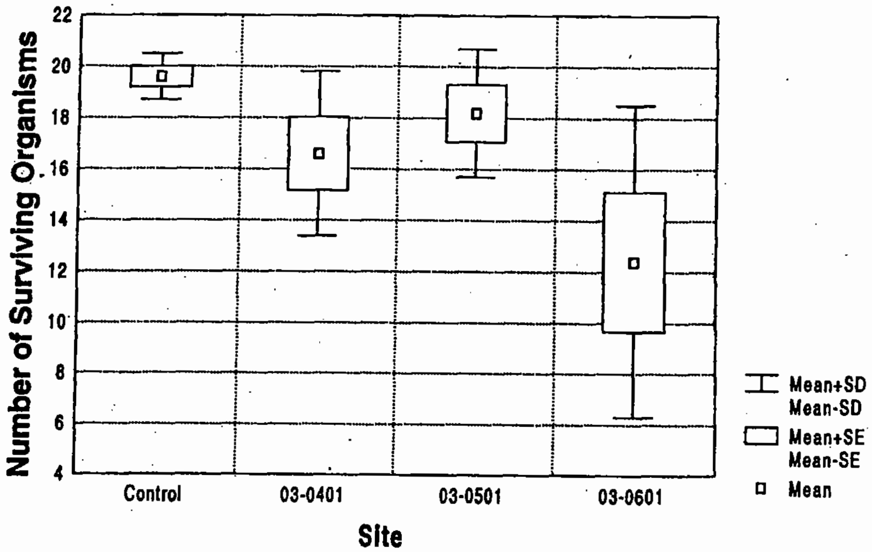
RESULTS

WATER CHEMISTRY ANALYSIS (RANGE)					
Site	Salinity (ppt)	Dissolved Oxygen (mg/L)	pH	Temp. (°C) Instantaneous	Ammonia (mg/L)
Control	20.9 - 21.6	5.8 - 6.7	7.6	25.0 - 25.4	1.0 - 2.75
03-GLM-0401	18.7 - 19.1	5.6 - 6.6	7.4 - 7.8	25.0 - 25.5	0.75 - 1.25
03-GLM-0501	21.2 - 22.0	5.4 - 6.8	7.6 - 8.0	25.1 - 25.4	0 - 1.5
03-GLM-0601	21.9 - 22.4	5.0 - 6.8	7.6 - 8.0	25.1 - 25.5	0 - 0.75

A. STATISTICAL ANALYSIS

Survival of *L. plumulosus* in 10-Day Static Acute Toxicity Tests

Panama City, FL -- Tetra Tech NUS



Duncan Multiple Range Test; Variable: Organism Survival				
Marked differences are significant at p < .05000				
	{1}	{2}	{3}	{4}
	M=19.600	M=16.600	M=18.200	M=12.400
Control {1}		0.24114	0.5576	*0.01101
03-0401 {2}	0.24114		0.50347	0.0913
03-0501 {3}	0.5576	0.50347		*0.03068
03-0601 {4}	*0.01101	0.0913	*0.03068	

B. LABORATORY BENCH SHEETS

Leptocheirus plumulosus 10 Day Toxicity Test

Test No. TtNUS-control-Lp-041 Start Date 4-26-02 End Date 5/6/02 Client: NUS

Organism L. plumulosus Batch No. ABS 4/26/02 Age 2-4mm Scientists: CEB, MB

Water Type/Location Artificial Seawater No. Organisms/Conc. 100

Site	Day	Replicate 1	2	3	4	5	Temp. °C	DO mg/L	Salinity ppt	Ammonia mg/L	pH SU	Renewed	Fed	Initial
Ctrl. W	0	20	20	20	20	20	25.0	5.8	21.6	1.00	7.6			CED
	1							6.8						DP
	2							6.7						CED
	3						25.4	6.5	21.2					
	4							6.5						
	5							6.3						CED
	6							6.2						CED
	7							5.9						CED
	8							6.1						CED
	9						25.1	6.0	20.9	2.75	7.6			CED
	10	20	18	20	20	20		6.1						

Test No. TtNUS-030401-Lp-4/26/02 Start Date 4/26/02 End Date 5/6/02 Client: NUS

Organism L. plumulosus Batch No. ABS 4/26/02 Age 2-4mm Scientists: CEB, MB

Water Type/Location Artificial Seawater No. Organisms/Conc. 100

Site	Day	Replicate 1	2	3	4	5	Temp. °C	DO mg/L	Salinity ppt	Ammonia mg/L	pH SU	Renewed	Fed	Initial
0401	0	20	20	20	20	20	25.0	6.6	19.1	0.75	7.4			CEB
	1													CEB
	2							5.5						MB
	3						25.5	6.0	18.7					MB
	4							6.5						CEB
	5							6.6						CEB
	6							6.4						CEB
	7													
	8													
	9							6.0	18.9	1.25	7.8			CEB
	10	20	19	17	15	12	25.2	5.7						[illegible]

Leptocheirus plumulosus 10 Day Toxicity Test

Test No. TtNUS-03-0501-Lp 4/26/02 Start Date 4/26/02 End Date 5/6/02 Client: TtNUS

Organism L. plumulosus Batch No. ABS 4/24/02 Age 2-4 mm Scientists: NB, CEB

Water Type/Location : Artificial Seawater No. Organisms/Conc. 100

Site	Day	Replicate 1	2	3	4	5	Temp. °C	DO mg/L	Salinity ppt	Ammonia mg/L	pH SU	Renewed	Fed	Initial
0501	0	20	20	20	20	20	25.1	5.4	21.5	1.5	7.6			CEB
	1													
	2							6.4						NB
	3						25.4	6.5	21.2					NB
	4							6.8						CEB
	5							6.7						CEB
	6							6.5						CEB
	7													CEB
	8													NB
	9							5.9	22.0	0	8.0			NB
	10	16	20	15	20	20	25.2	6.0	22.0	0				CEB

Test No. TtNUS-03-0601-Lp 4/26/02 Start Date 4/26/02 End Date 5/6/02 Client: TtNUS

Organism L. plumulosus Batch No. ABS 4/24/02 Age 2-4 mm Scientists: NB, CEB

Water Type/Location : Artificial Seawater No. Organisms/Conc. 100

Site	Day	Replicate 1	2	3	4	5	Temp. °C	DO mg/L	Salinity ppt	Ammonia mg/L	pH SU	Renewed	Fed	Initial
0601	0	20	20	20	20	20	25.1	5.0	22.4	0	7.6			CEB
	1													
	2							5.0						NB
	3						25.5	6.1	21.9		7.7			NB
	4							6.6						CEB
	5							6.8						CEB
	6							6.7						CEB
	7													CEB
	8													NB
	9							6.3	22.3	0.75	8.0			NB
	10	20	14	4	9	15	25.2	6.4						CEB

C. CHAIN-OF-CUSTODY

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Airbill # 8311 5052 8751

CHAIN-OF-CUSTODY RECORD

Project Manager or Client Contact: Bill OLSON

Address/Phone: TETRA TECH, NUS
1401 OVEN PARK DR SUITE 201
TALLAHASSEE FL 32312

Contact Name/Phone: 850-385-9899

Project Number: N2834 Project Name: PCY RFI

Page 1 of 1 Sample Location: AOC 1

Type of Analyses Requested: Benthic Macroinvertebrate Count

Shaded area for Tt use only: Sample check-in: DO ___ T 1°C pH ___ Cond/Salinity ___ Chlorine ___ Appearance ___

Date	Time	Sample Identification/Station	Preservative (Y/N)	Number of Containers	Benthic Macroinvertebrate Count							Collection Method	Log Number
4/17/02	11:05	03GLM0601	N	1	1	✓							
↓	11:25	03GLM0501	N	1	1	✓							
↓	11:55	03GLM0401	N	1	1	✓							

Sampled by: (signature)	Date/Time:	Relinquished by: (signature)	Date/Time:	Received by: (signature)	Date/Time:
[signature]	4/17/02	[signature]		[signature]	4-18-02 1000
Received by: (signature)	Date/Time:	Received by: (signature)	Date/Time:	Received by: (signature)	Date/Time:

BRF/FORM/CHAIN/1/23/04

FORM DISTRIBUTION: White - Tt BRF Yellow - Report Pink - Sampler

D. QUALITY ASSURANCE / QUALITY CONTROL

-96 Hr Survival

Start Date:	4/26/02 12:00	Test ID:	1Lep5/02	Sample ID:	REF-Ref Toxicant
End Date:	4/30/02 12:00	Lab ID:	Tt BRF	Sample Type:	CDCL-Cadmium chloride
Sample Date:		Protocol:		Test Species:	Leptocheirus plumulosus
Comments:	April 2002, Leptocheirus, CdCl, Reftox				

Conc-mg/L	1	2
B-Control	0.9000	1.0000
0.25	1.0000	1.0000
0.5	0.9000	0.9000
1	0.7000	0.6000
2	0.3000	0.1000
4	0.0000	0.0000

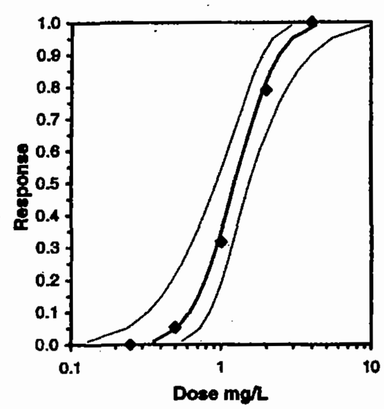
			Transform: Arcsin Square Root					Number	Total
Conc-mg/L	Mean	N-Mean	Mean	Min	Max	CV%	N	Resp	Number
B-Control	0.9500	1.0000	1.3305	1.2490	1.4120	8.661	2	1	20
0.25	1.0000	1.0526	1.4120	1.4120	1.4120	0.000	2	0	20
0.5	0.9000	0.9474	1.2490	1.2490	1.2490	0.000	2	2	20
1	0.6500	0.6842	0.9386	0.8861	0.9912	7.916	2	7	20
2	0.2000	0.2105	0.4507	0.3218	0.5796	40.461	2	16	20
4	0.0000	0.0000	0.1588	0.1588	0.1588	0.000	2	20	20

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Normality of the data set cannot be confirmed				
Equality of variance cannot be confirmed				

Maximum Likelihood-Probit

Parameter	Value	SE	95% Fiducial Limits		Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Slope	4.32311	0.92087	2.5182	6.12802	0.05	1.20628	7.81472	0.75	0.09111	0.23131	3
Intercept	4.60612	0.24075	4.13425	5.07799							
TSCR	0.02954	0.02684	-0.0231	0.08215							

Point	Probits	mg/L	95% Fiducial Limits	
EC01	2.674	0.35727	0.12899	0.55639
EC05	3.355	0.51361	0.23727	0.72869
EC10	3.718	0.62326	0.32698	0.84492
EC15	3.964	0.71018	0.40481	0.93632
EC20	4.158	0.78783	0.47851	1.01845
EC25	4.326	0.86118	0.55103	1.09723
EC40	4.747	1.07773	0.77449	1.34407
EC50	5.000	1.23342	0.93525	1.54334
EC60	5.253	1.41161	1.11012	1.80288
EC75	5.674	1.76657	1.41722	2.43144
EC80	5.842	1.93104	1.54327	2.77013
EC85	6.036	2.14217	1.69433	3.24413
EC90	6.282	2.44092	1.89305	3.98357
EC95	6.645	2.96204	2.21176	5.44817
EC99	7.326	4.25824	2.91733	9.95042



 ToxCalc v5.0.23 Reviewed by: [signature]

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TOXICITY TEST DATA SHEET

PAGE 1 OF ____

Experiment I.D. #. Zeflco-Lp-4/26/02 NPDES Permit #. — Client: TE NUS Outfall/Station No. —

Effluent/Sample: KCl CaCl$_2$ Sample Container: plastic Project Scientist: NB, CVB QC Officer: E. Peters

~~Sample Type:~~
~~Grab ____~~
~~Collection Date ____ Time ____~~
~~Composite ____ Flow ____ Time ____~~
~~Collected from: Date ____ Time ____~~
~~Collected to: Date ____ Time ____~~

Test Organism:
Species: L. plumulosus
Source: ABS, Inc.
Batch#: ABS 4/26/02
~~Age~~: 2-4 mm

No. of organisms/conc. 20

Test Mode: S Static
Test Start Date: 4/26/02
Test End Date: 4/30/02
Test Temperature: 25±1°C
Dilution Water Used: Artificial Seawater

Test Duration: 96 hours
Time: 12:00
Time: 12:00

Concentration mg/L	Replicate	Number of Live Organisms					Dissolved Oxygen (mg/L)					pH					Alkalinity (mg/L as		Hardness CaCO3)		SALINITY ppt ~~Conductivity (µmhos)~~					Temperature (°C)				
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	48	0	48	0	24	48	72	96	0	24	48	72	96
0	A	10	10	10	10	9	7.7			6.4	6.6	7.9			7.9	8.0	—	—	—	—	22.1			21.9	22.2	25.1			25.9	25.3
0	B	10	10	10	10	10																								
0.25	A	10	10	10	10	10	7.1			6.5	6.8	8.0			7.9	8.0	—	—	—	—	22.2			22.1	22.2	25.2			25.5	25.3
0.25	B	10	10	10	10	10																								
0.5	A	10	10	9	9	9	7.3			6.6	6.9	8.0			8.0	8.0	—	—	—	—	22.3			22.1	22.5	25.0			25.5	25.3
0.5	B	10	10	10	9	9																								
1.0	A	10	10	9	9	7	7.4			6.7	6.5	8.0			8.0	8.0	—	—	—	—	22.2			22.3	22.4	25.1			25.5	25.3
1.0	B	10	10	9	7	6																								
2.0	A	10	10	7	4	3	7.3			6.6	6.8	8.0			7.9	8.0	—	—	—	—	22.2			22.3	22.4	25.0			25.5	25.3
2.0	B	10	8	7	4	1																								
4.0	A	10	7	5	3	0	7.5			5.9	6.8	8.0			7.8	7.8	—	—	—	—	22.3			21.9	22.3	25.0			25.5	25.3
4.0	B	10	8	5	1	0																								
Time:		12:00																												
Recorded by:		AB																												