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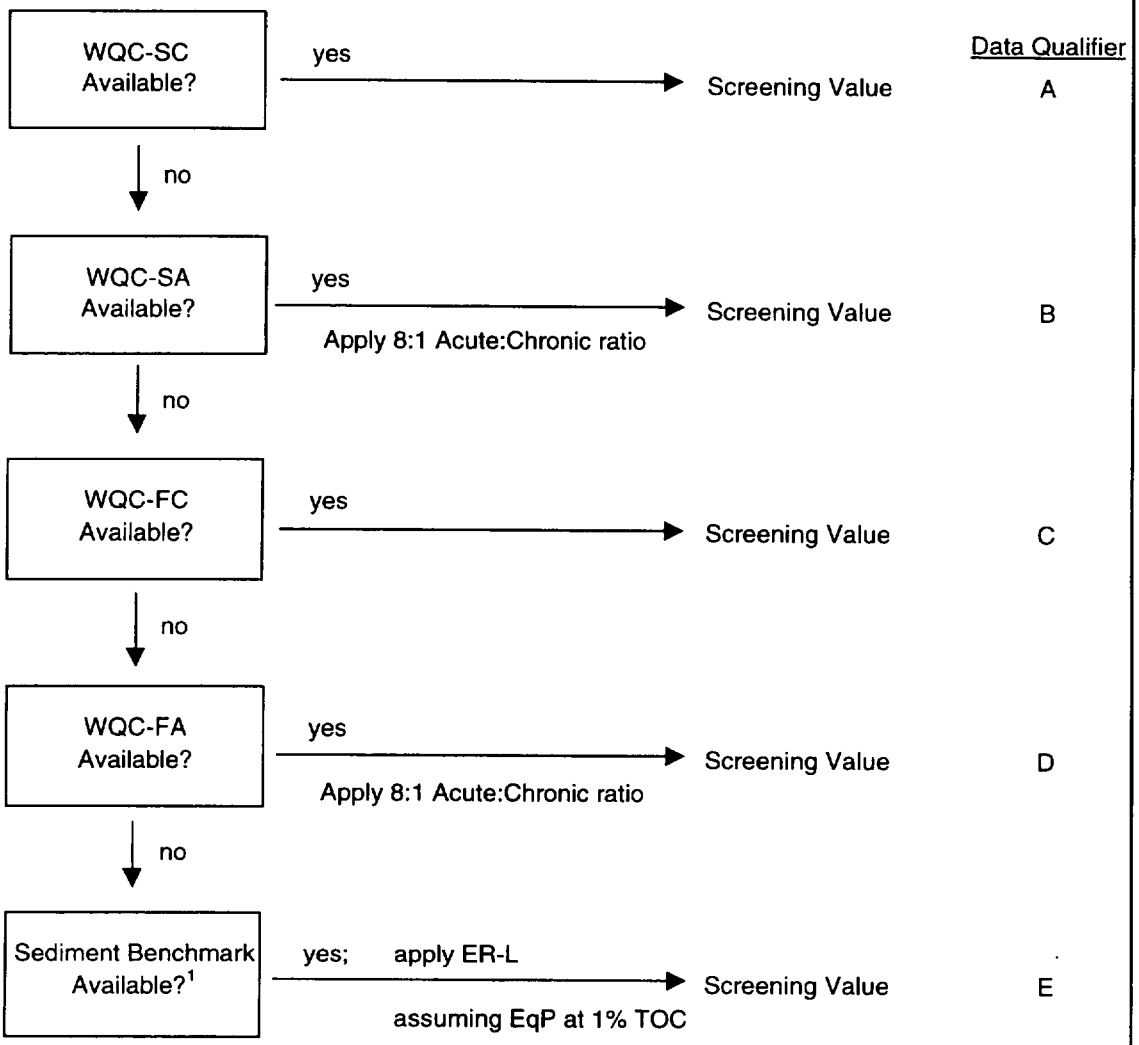
Figure 6.1-1. Water Quality Screening Criteria Value Selection Process and Associated Data Qualifiers.



1 - Apply for WQC-SA: (ER-L/(Koc x 0.01)) x 8.

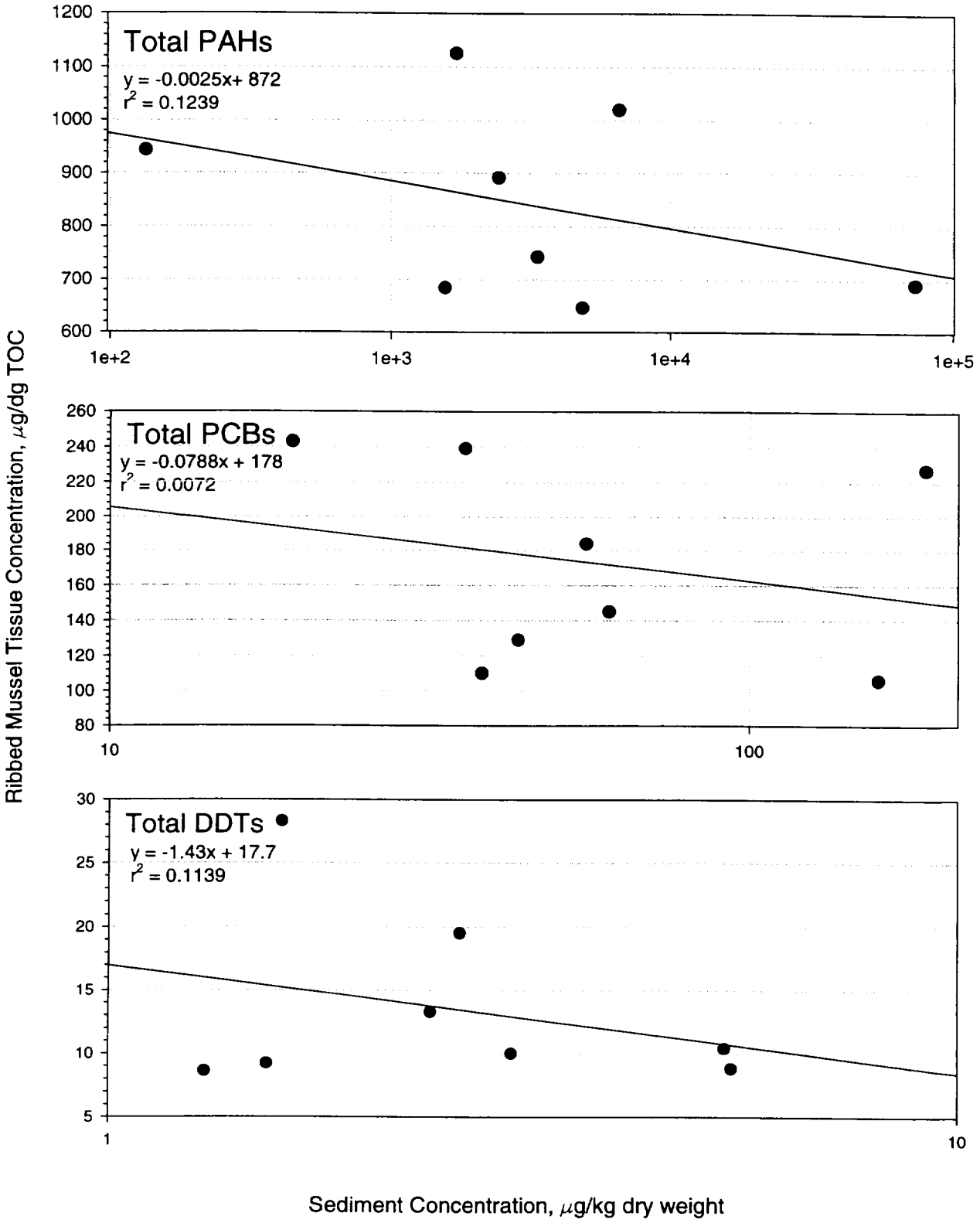


Figure 6.2-1. Comparison of concentrations in ribbed mussels versus concentrations in surface sediments for Total PCBs, Total PAHs, and Total DDTs in the Raymark study area.

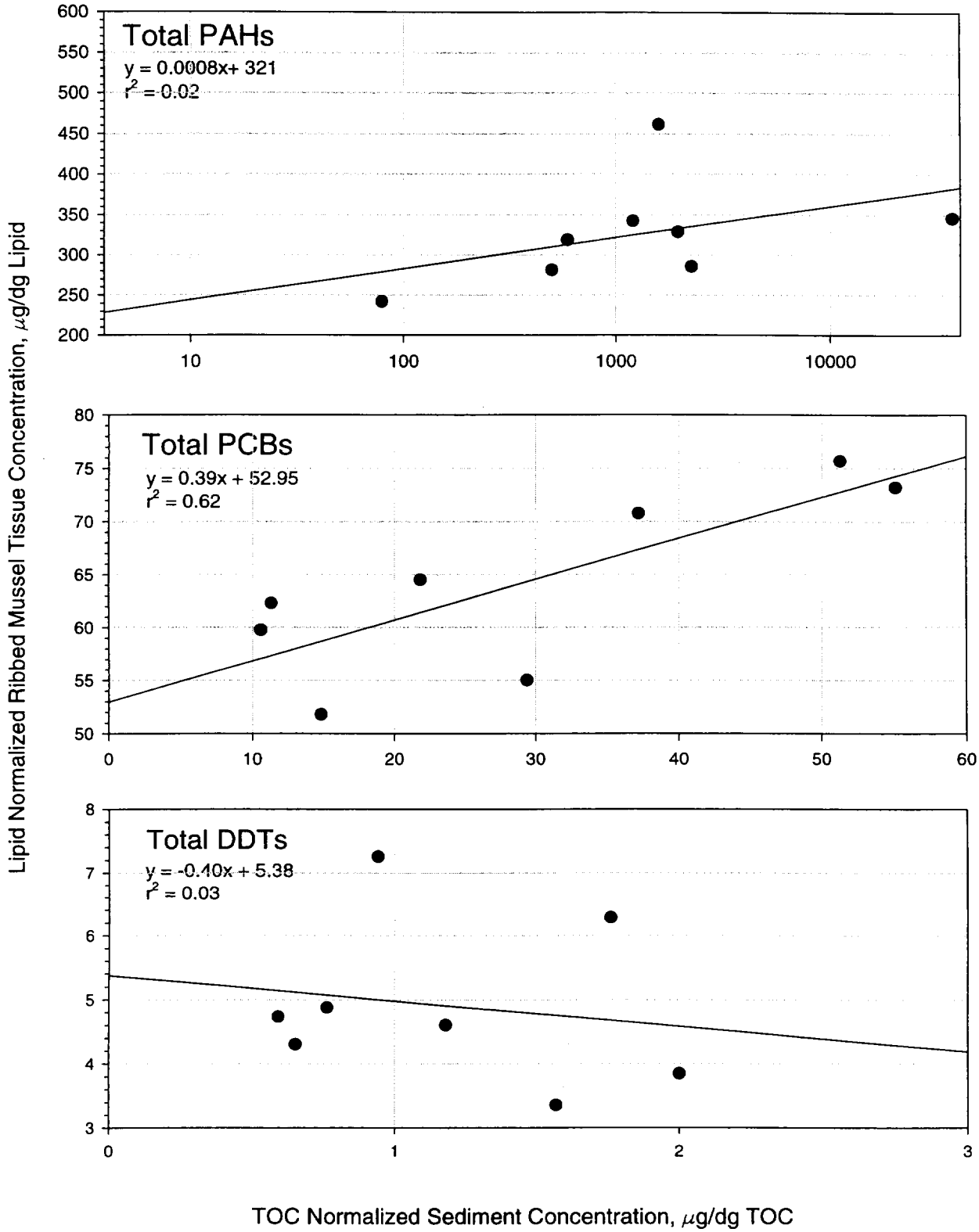


Figure 6.2-2. Comparison of lipid normalized concentrations in ribbed mussels versus TOC normalized concentrations in surface sediments for Total PCBs, Total PAHs, and Total DDTs in the Raymark study area. Note: Only measured tissue concentrations used.

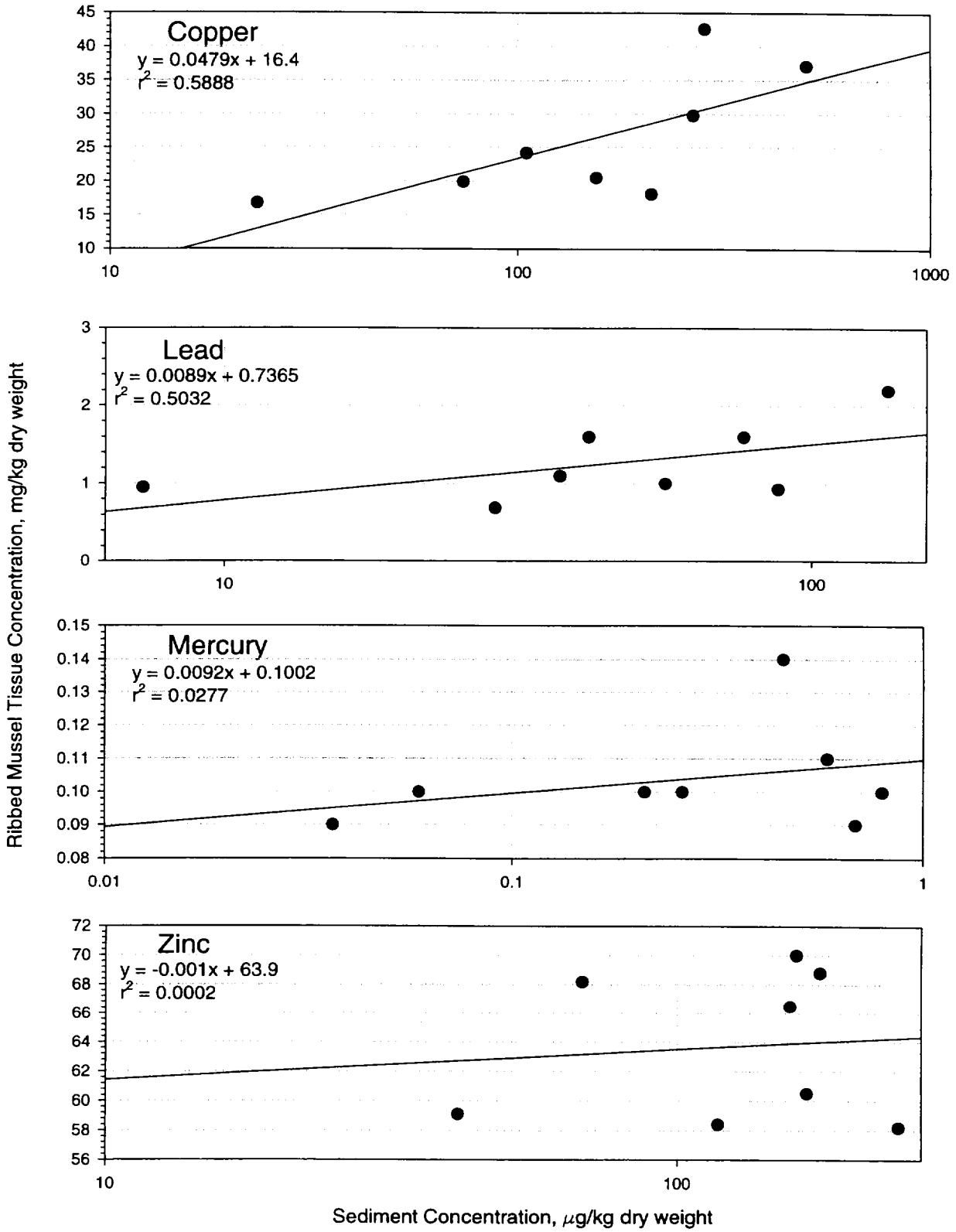


Figure 6.2-3. Comparison of trace metal concentrations in ribbed mussels versus surface sediments from the Raymark study area.

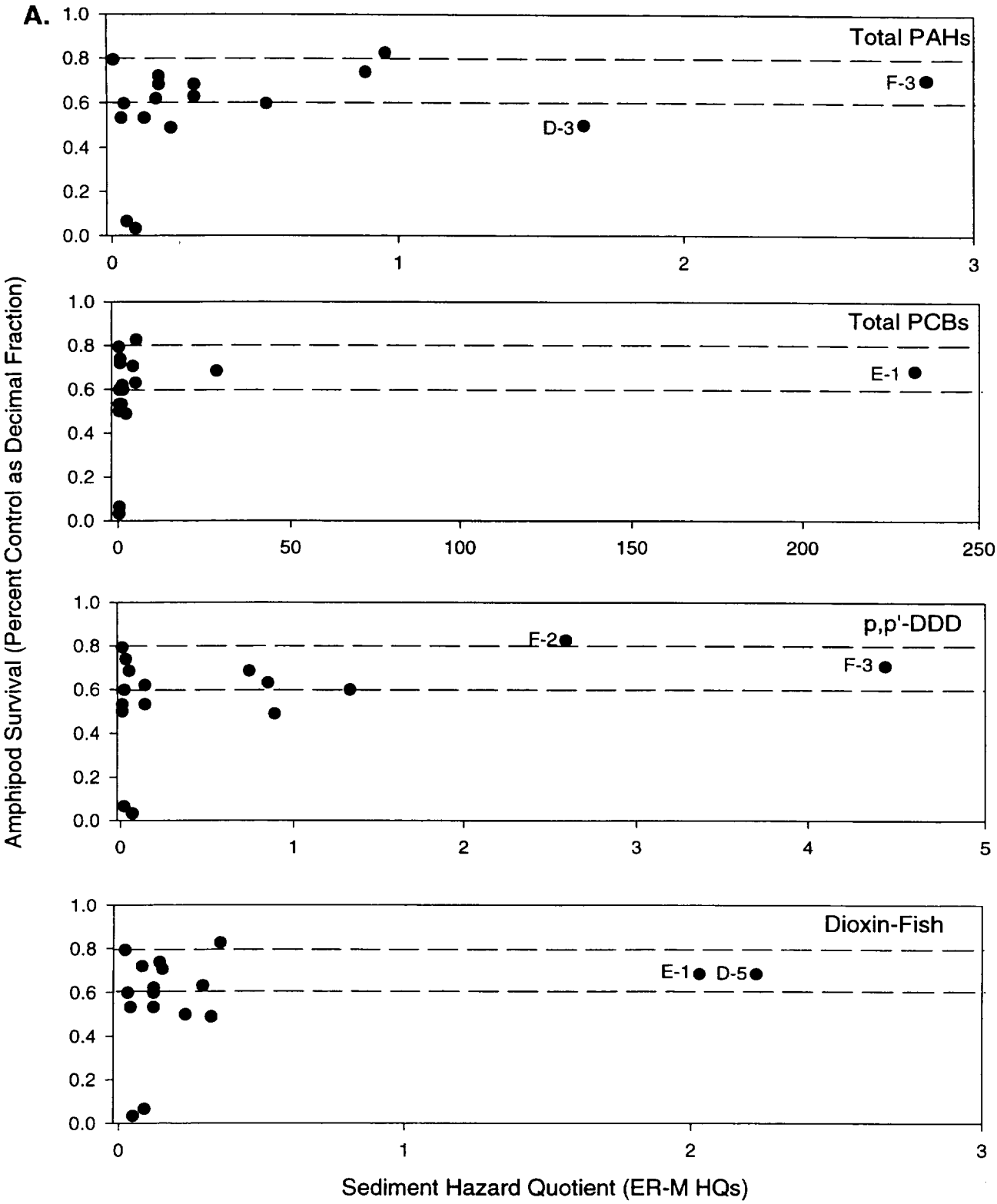


Figure 6.4-1. Amphipod (*Ampelisca*) survival versus Organic Sediment ER-M Hazard Quotients for CoCs in bulk surface sediments from the Raymark study area. Dashed lines indicate interpretive threshold values for possible (80%) and probable (60%) impact on amphipod survival. A) sediment HQs of Total PAHs, Total PCBs, p,p'-DDD, Dioxin-Fish (2,3,7,8 TCDD Equivalent Conc. (WHO, 1998)) and B) their concentrations normalized to TOC.

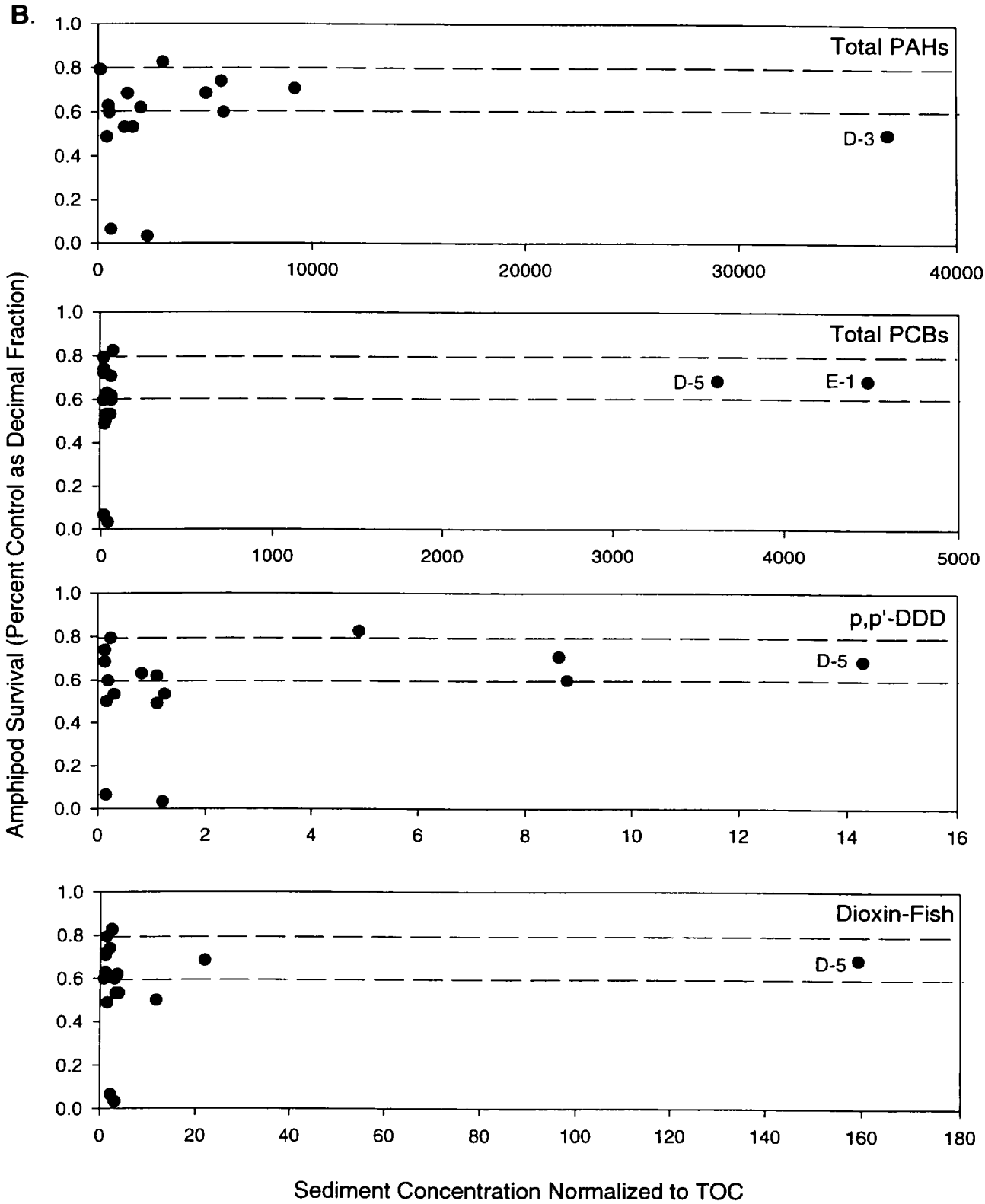


Figure 6.4-1 (continued). Amphipod (*Ampelisca*) survival versus Organic Sediment ER-M Hazard Quotients for CoCs in bulk surface sediments from the Raymark study area. Dashed lines indicate interpretive threshold values for possible (80%) and probable (60%) impact on amphipod survival. A) sediment HQs of Total PAHs, Total PCBs, p,p'-DDD, Dioxin-Fish (2,3,7,8 TCDD Equivalent Conc. (WHO, 1998)) and B) their concentrations normalized to TOC.

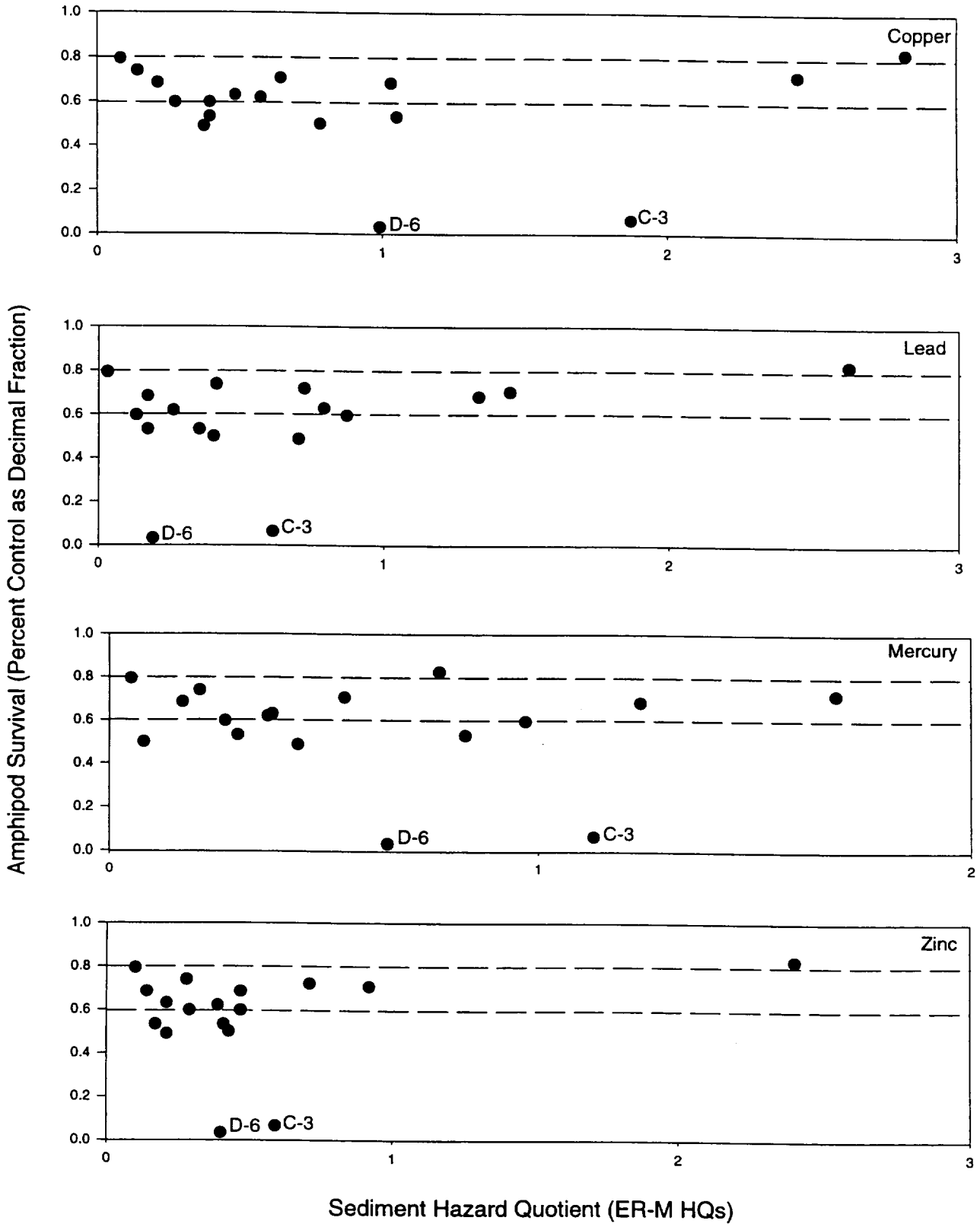


Figure 6.4-2. Amphipod (*Ampelisca*) survival versus Inorganic Sediment ER-M Hazard Quotients for CoCs in bulk surface sediments from the Raymark study area. Dashed lines indicate interpretive threshold values for possible (80%) and probable (60%) impact on amphipod survival.

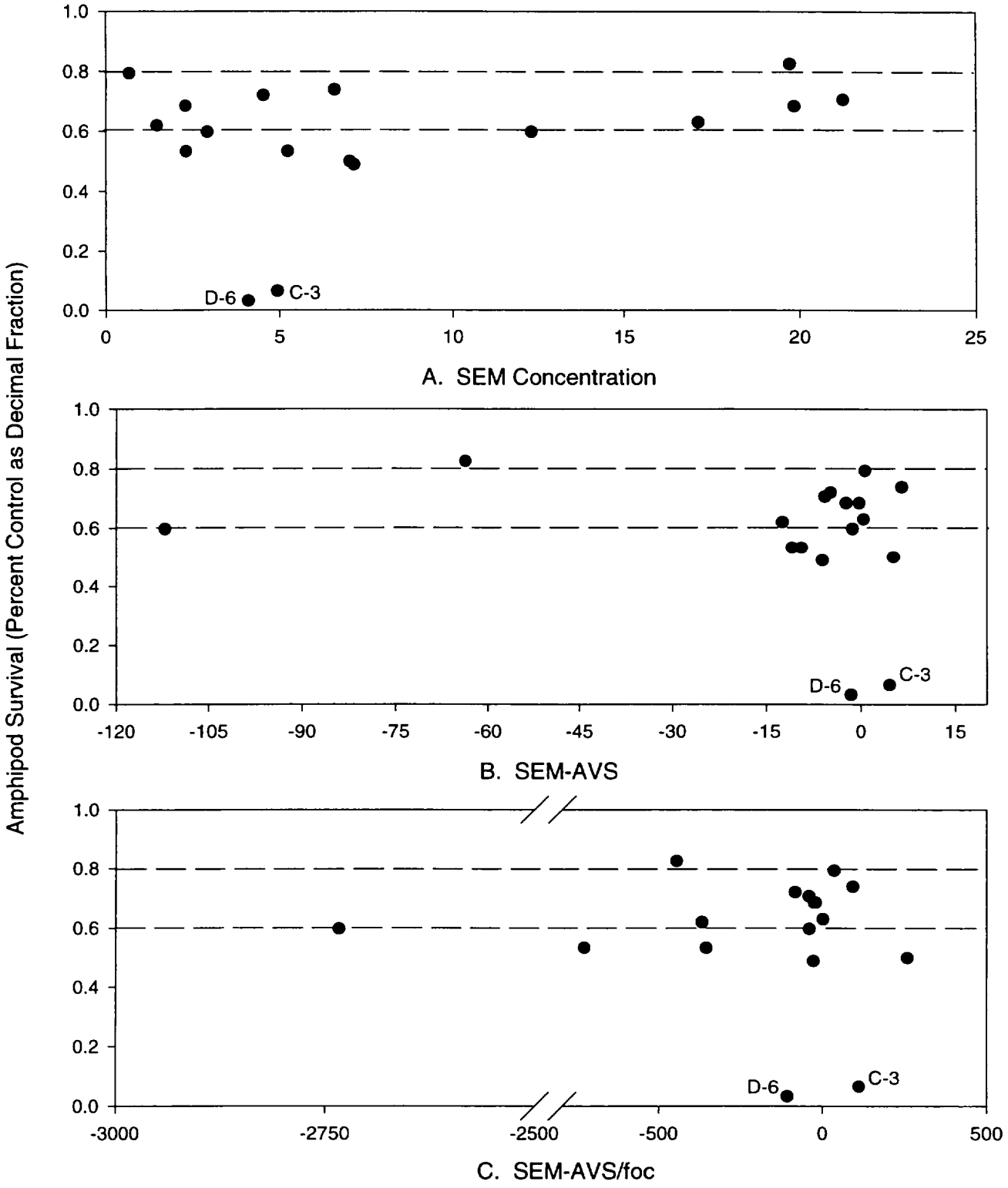


Figure 6.4-3. Amphipod (*Ampelisca*) survival versus A) SEM Concentration, B) SEM-AVS, and C) SEM-AVS/foc (μmol/g) in whole sediments collected from the Raymark study area. Dashed lines indicate interpretive threshold values for possible (80%) and probable (60%) impact on amphipod survival (see Text Section 6.4).

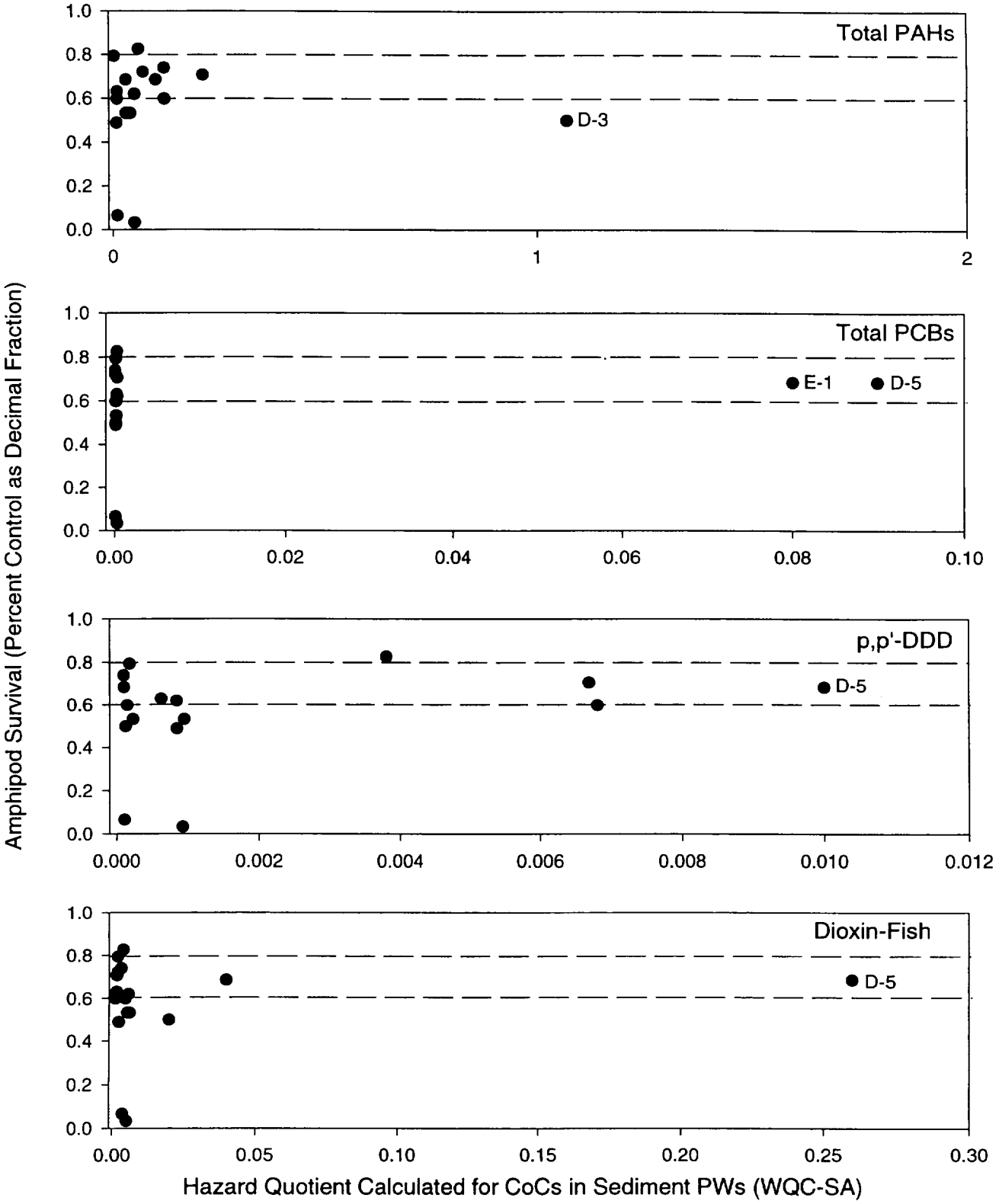


Figure 6.4-4. Amphipod (*Ampelisca*) survival versus Organic Sediment Porewater WQC-SA Hazard Quotients for CoCs in bulk surface sediments from the Raymark study area. Dashed lines indicate interpretive threshold values for possible (80%) and probable (60%) impact on amphipod survival. Note: Dioxin-Fish = 2,3,7,8 TCDD Equivalent Conc. (WHO, 1998).

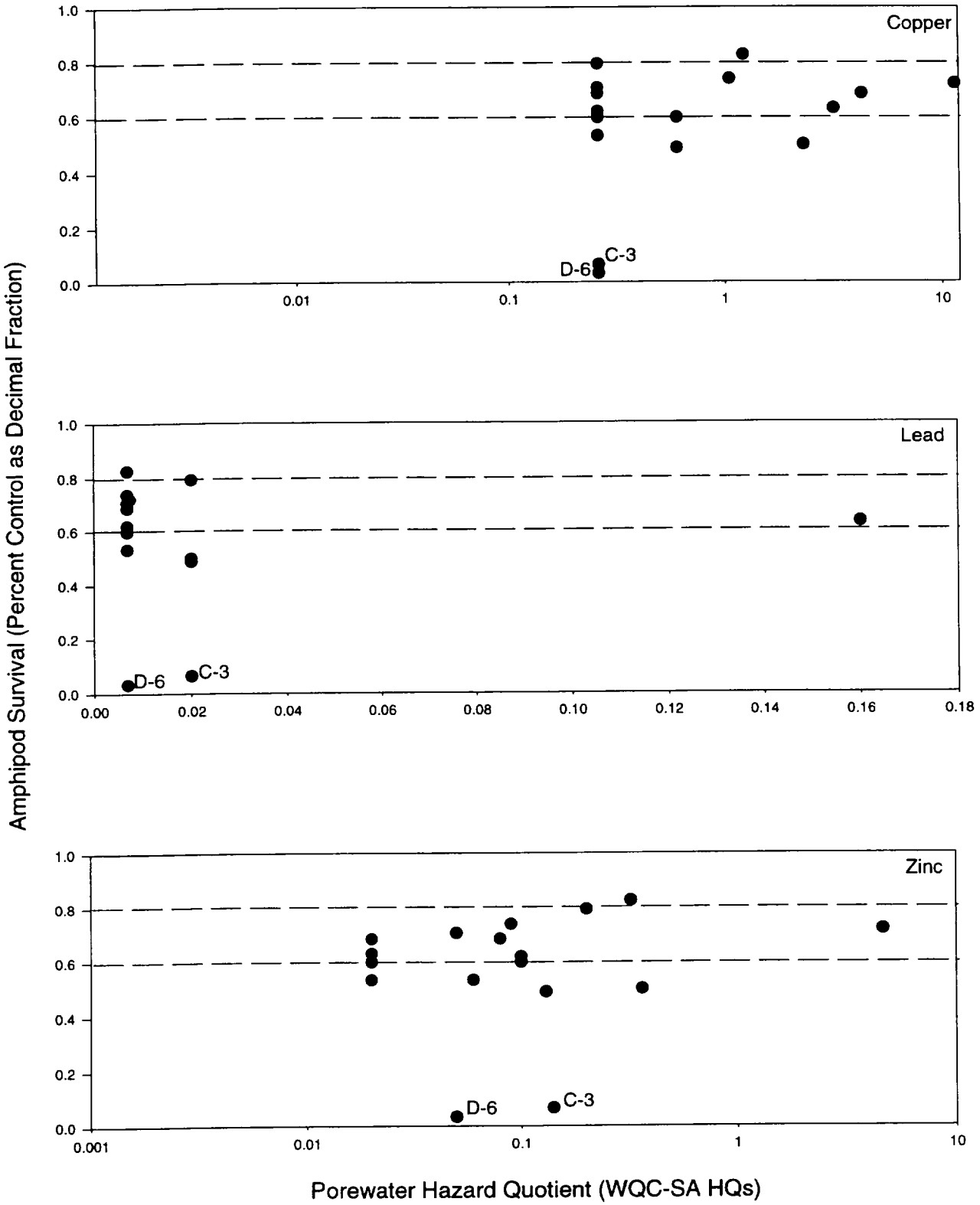


Figure 6.4-5. Amphipod (*Ampelisca*) survival versus Inorganic Sediment Porewater WQC-SA Hazard Quotients for CoCs in bulk surface sediments from the Raymark study area. Dashed lines indicate interpretive threshold values for possible (80%) and probable (60%) impact on amphipod survival.

Table 6.0-1. Indicator-specific and Overall Weight of Evidence Rankings for Exposure Characterization.

Weight of Evidence		Bedded Sediment			Bioconcentration
		Sediment HQs	SEM Bioavailability	Porewater HQs	
Indicator/ Test Specific Rankings	Baseline ("-")	Sediment Conc. < ER-L (ERL-HQ < 1)	SEM Conc. < 5 µmol/g; SEM:AVS < 0 µmol/g	Porewater Conc. < WQC-SC (WQC-SC HQ < 1)	Tissue Conc. < Reference (TCR ≤ 3)
	Low ("+")	Sediment Conc. Between ER-L and ER-M (ERL-HQ > 1)	SEM Conc. ≥ 5 µmol/g; SEM:AVS ≥ 0 µmol/g	Porewater Conc. Between WQC-SC and WQC-SA (WQC-SC HQ > 1)	Tissue Conc. > Reference (TCR > 3)
	Intermediate ("++")	Sediment Conc. ≥ ER-M (ERM-HQ > 1)	SEM Conc. ≥ 10 µmol/g; SEM:AVS ≥ 5 µmol/g	Porewater Conc. ≥ WQC-SA (WQC-SA HQ > 1)	Tissue Conc. > 10X Reference (TCR > 10)
	High ("+++")	Sediment Conc. ≥ 2X ER-M (ERM-HQ > 1)	SEM Conc. ≥ 20 µmol/g; SEM:AVS ≥ 10 µmol/g	Porewater Conc. ≥ 2X WQC-SA (WQC-SA HQ > 1)	Tissue Conc. > Reference (TCR > 40)
Overall Exposure Rankings	Baseline ("-")	Low (+) exposure observed for only one analyte or baseline (-) exposure for all analytes.	Same as Sediment HQ.	Same as Sediment HQ.	Low (+) exposure observed for only one analyte or baseline (-) exposure for all analytes.
	Low ("+")	Low (+) exposure observed for two or more analyte or intermediate (++) exposure for one analyte.	Same as Sediment HQ.	Same as Sediment HQ.	Low (+) exposure observed for two or more analytes or intermediate (++) exposure for one analyte.
	Intermediate ("++")	Intermediate (++) exposure observed for two or more analytes or high (+++) exposure for one analyte.	Same as Sediment HQ.	Same as Sediment HQ.	Intermediate (++) exposure observed for two or more analytes or high (+++) exposure for one analyte.
	High ("+++")	High (+++) exposure observed in two or more analytes.	Same as Sediment HQ.	Same as Sediment HQ.	High (+++) exposure observed in two or more analyte.

WQC-SC = Water Quality Criteria-Saltwater Chronic
WQC-SA = Water Quality Criteria-Saltwater Acute
TCR = Tissue Concentration Ratio

Table 6.0-2. Indicator-specific and Overall Weight of Evidence Rankings for Effects Characterization.

Weight of Evidence		Sediment Toxicity	Tissue Residue Effects	Trophic Transfer Effects
Indicator/ Test Specific Rankings	**Baseline ("-")**	*Ampelisca* Survival > 80% of Control	Tissue Conc. < Benchmark TSC-HQ/CBR-HQ ≤ 1 or TSC-HQ/CBR-HQ = 1	TRV HQ < 1
	Low ("+")	*Ampelisca* Survival Between 60 and 80% of Control	TSC-HQ > 1 CBR-HQ > 1	TRV HQ > 1
	Intermediate ("++")	*Ampelisca* Survival Between 20 and 60% of Control	TSC-HQ > 10 CBR-HQ > 3	TRV HQ > 10
	High ("+++")	*Ampelisca* Survival < 20% of Control	TSC-HQ > 40 CBR-HQ > 10	TRV HQ > 40
Overall Effects Rankings	**Baseline ("-")**	Baseline (-) effect observed.	Low (+) effect observed for only one analyte or baseline (-) effect for all analytes.	Low (+) effect observed for only one species or baseline (-) effect for both species.
	Low ("+")	Low (+) effect observed.	Low (+) effect observed for two or more analytes or intermediate (++) effect for one analyte.	Low (+) effect observed for one or more species or intermediate (++) effect for one species.
	Intermediate ("++")	Intermediate (++) effect observed.	Intermediate (++) effect observed for two or more analytes or high (+++) effect for one analyte.	Intermediate (++) effect observed for one or more species or high (+++) effect for one species.
	High ("+++")	High (+++) effect observed.	High (+++) effect observed in two or more analytes.	High (+++) effect observed in one or more species.

CBR = Critical Body Residue
TCR = Tissue Concentration Ratio

Table 6.1-1. Summary of Hazard Quotients for Sediments for the Raymark Phase III Ecological Risk Assessment Investigation[1,2].

Station[3]	Metals							PAHs																						PCBs	PST				Dioxins	
	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	1,6,7-Trimethylnaphthalene	1-Methylnaphthalene	1-Methylphenanthrene	2,6-Dimethylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b+k)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	HMW PAHs[4]	Indeno(1,2,3-cd)pyrene	LMW PAHs[5]	Perylene	Phenanthrene	Pyrene	Sum PAHs	Total PCBs[6]	o,p'-DDE	p,p'-DDD	p,p'-DDE	p,p'-DDT	Dioxin-Fish[7]	Exposure Ranking[8]
C-1-SED-SMP	-	-	+	-	+	-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	+	-	-	-	-	-	+
C-2-SED-SMP	-	-	++	+	+	-	+					+	+	+	+	-				-	-	+	+	+		+		+	+	+	+	-	+	-	-	-	+
C-3-SED-SMP	-	-	++	+	++	-	+					-	-	-	-	-				-	-	-	-	-		-		-	-	-	+	-	-	-	-	-	++
D-1-SED-SMP	-	-	-	-	-	-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-
D-2-SED-SMP	-	-	+	-	+	-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	+	-	-	-	-	-	+
D-3-SED-SMP	+	-	+	+	-	-	+					+	+	+++	+++	+++				++	+++	+++	+	+++		+++		+++	+++	++	+	-	-	-	-	-	+++
D-4-SED-SMP	-	+	+	+	+	+	+					+	+	+	+	+				+	+	+	+	+		+		+	+	+	++	-	+	-	-	-	+
D-5-SED-SMP	-	-	+	-	-	-	-					-	+	+	+	+				+	+	+	-	+		+		-	+	+	+++	-	+	-	-	+++	+++
D-6-SED-SMP	-	-	+	-	+	-	+					-	+	+	+	-				-	-	-	-	-		-		-	-	-	+	-	+	-	-	-	+
E-1-SED-SMP	-	+	++	++	++	+	+					+	+	+	+	+				+	+	+	+	+		+		+	+	+	+++	-	-	-	-	+++	+++
E-2-SED-SMP	-	-	+	+	+	-	-					-	+	+	+	+				+	+	+	-	+		+		+	+	+	+++	+	+	+	+	-	++
E-3-SED-SMP	-	-	+	+	+	-	-					+	+	+	+++	++				++	++	++	+	++		++		++	+++	+	+	-	-	+	-	-	+++
E-4-SED-SMP	-	-	+	+	+	-	-					-	+	+	+	+				+	+	+	-	+		+		+	+	+	+++	+	+	+	+	-	++
F-1-SED-SMP	-	-	+	+	+	-	+					+	+	+	++	++				+	++	+	+	+		+		++	++	+	++	+	++	-	+	-	++
F-2-SED-SMP	-	++	+++	+++	+	++	+++					+	++	+	++	+++				++	+++	++	+	++		++		++	+++	+	+++	+	+++	++	+	-	+++
F-3-SED-SMP	-	-	+	++	+	+	+					+++	++	+++	+++	+++				+++	+++	+++	++	+++		+++		+++	+++	+++	+++	+	+++	+++	+	-	+++
Reference	+	+	+++	+	++	+	+					+	+	+	-	-				-	++	-	+	-		+		-	-	+	+					-	++

1 - See Table 3.3-1 for Metals, PCBs, PAHs and PST Benchmarks.
2 - Hazard Quotient Codes for Sediment Exposure: < ER-L = "-" ; ER-L to ER-M = "+" ; >=ER-M = "++"; >=2x ER-M = "+++".
3 - Reference Station - GM08 (SAIC, 1998).
4 - Sum of High Molecular Weight PAHs - Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, and Perylene; Perylene not available for reference.
5 - Sum of Low Molecular Weight PAHs - 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, and Phenanthrene.
6 - Total PCBs = Sum of Congeners x 2.
7 - 2,3,7,8-TCDD equivalent concentration for prediction of impacts on fish (WHO, 1998).
8 - Exposure Ranking:
Baseline ("-") - Low (+) exposure observed for only one analyte or baseline (-) exposure for all analytes;
Low ("+") - Low (+) exposure observed for two or more analytes or intermediate (++) exposure for one analyte;
Intermediate ("++") - Intermediate (++) exposure observed for two or more analytes or high (+++) exposure for one analyte; and
High ("+++") - High (+++) exposure observed in two or more analytes.

Table 6.1-2. Summary of Kow and Koc values used in calculations of organic contaminant concentrations in porewaters by equilibrium partitioning for the Raymark Phase III Ecological Risk Assessment Investigation.

Class	Analyte	CAS No.	Full Analyte Name	$Log_{10}K_{ow}$	Source[1]	$Log_{10}K_{oc}$[2]	K_{oc}
PAH	T235NAP	2245387	1,6,7-Trimethylnaphthalene				
	M1NAPH	90120	1-Methylnaphthalene	3.97	b	3.90	7994
	M1PHEN	832699	1-Methylphenanthrene	5.08	b	4.99	98610
	D26NAPH	581420	2,6-Dimethylnaphthalene	4.61	b	4.53	34034
	ACENAPL	208968	Acenaphthylene	4.05	b	3.98	9581
	ANTHRAC	120127	Anthracene	4.55	a	4.47	29712
	BENAAN	56553	Benzo(a)anthracene	5.70	a	5.60	401218
	BENAPYR	50328	Benzo(a)pyrene	6.11	a	6.01	1014869
	BENBFLU+BENKFLU		Benzo(b+k)fluoranthene	6.20	a	6.09	1244171
	BENEPYR	192972	Benzo(e)pyrene	6.11	b	6.01	1014869
	BGHIPER	191242	Benzo(g,h,i)perylene	6.70	a	6.59	3858158
	CHRYSEN	218019	Chrysene	5.70	a	5.60	401218
	DBAHANT	53703	Dibenz(a,h)anthracene	6.69	a	6.58	3771812
	FLUORAN	206440	Fluoranthene	5.12	a	5.03	107954
	HMW PAHs	999999484	HMW PAHs[3]	5.88	d	5.78	596218
	I123CDP	193395	Indeno(1,2,3-cd)pyrene	6.65	a	6.54	3445323
	LMW PAHs	999999502	LMW PAHs[3]	4.05	d	3.98	9581
	PERYL	198550	Perylene	6.05	b	5.95	885992
	PHENAN	85018	Phenanthrene	4.55	a	4.47	29712
	PYRENE	129000	Pyrene	5.11	a	5.02	105538
	TOTPAH	NA	Total PAHs[4]	4.96	d	4.88	75582
PCB	PCB3	2051618	3 (4)	4.69	c	4.61	40790
	PCB8	34883437	8 (2 4)	5.07	c	4.98	96403
	PCB15	2050682	15 (4 4')	5.30	c	5.21	162248
	PCB18	37680652	18 (2 2'5)	5.24	c	5.15	141645
	PCB28	7012375	28 (2 4 4')	5.67	c	5.57	374878
	PCB29	15862074	29 (2 4 5)	5.60	c	5.51	319948
	PCB44	41464395	44 (2 2'3 5')	5.75	c	5.65	449293
	PCB50	62796650	50 (2 2' 4 6)	5.63	c	5.53	342429
	PCB52	35693993	52 (2 2'5 5)	5.84	c	5.74	550808
	PCB66	32598100	66 (2 3'4 4')	6.20	c	6.09	1244171
	PCB87	38380028	87 (2 2' 3 4 5')	6.29	c	6.18	1525281
	PCB101	37680732	101 (2 2'4 5 5')	6.38	c	6.27	1869907
	PCB105	32598144	105 (2 3 3'4 4')	6.65	c	6.54	3445323
	PCB114	74472370	114 (2 3 4 4' 5)	6.65	c	6.54	3445323
	PCB118	31508006	118 (2 3'4 4'5)	6.74	c	6.63	4223767
	PCB123	65510443	123 (2' 3 4 4' 5)	6.74	c	6.63	4223767
	PCB126	57465288	126 (3 3'4 4'5)	6.89	c	6.77	5931301
	PCB128	39380073	128 (2 2'3 3'4 4')	6.74	c	6.63	4223767
	PCB138	35065282	138 (2 2'3 4 4'5)	6.83	c	6.71	5178095
	PCB153	35065271	153 (2 2'4 4'5 5')	6.92	c	6.80	6348045
	PCB156/157	NA		7.18	c	7.06	11434574
	PCB167	52663726	167 (2 3' 4 4' 5 5')	7.27	c	7.15	14018127
	PCB169	32774166	169 (3 3' 4 4' 5 5')	7.42	c	7.29	19685208
	PCB170	35065306	170 (2 2'3 3'4 4'5)	7.27	c	7.15	14018127
	PCB180	35065293	180 (2 2'3 4 4'5 5')	7.36	c	7.24	17185414
	PCB187	52663680	187 (2 2'3 4'5 5'6)	7.17	c	7.05	11178667
	PCB188	74487857	188 (2 2' 3 4' 5 6 6')	6.82	c	6.70	5062208
	PCB189	39635319	189 (2 3 3' 4 4' 5 5')	7.71	c	7.58	37949844
	PCB195	52663782	195 (2 2'3 3'4 4'5 6)	7.56	c	7.43	27024645
	PCB200	40186718	200 (2 2' 3 3' 4 5 6 6')	7.27	c	7.15	14018127
	PCB206	40186729	206 (2 2'3 3'4 4'5 5'6)	8.09	c	7.95	89691234
	PCB209	2051243	209 (2 2'3 3'4 4'5 5'6 6')	8.18	c	8.04	109956270
Dioxins	2,3,7,8-TCDD Equivalent	NA		7.00	e	6.88	7608166
Pesticides	DDE_OP	3424826	o,p'-DDE	6.76	a	6.65	4419366
	DDD_PP	72548	p,p'-DDD	6.10	a	6.00	992156
	DDE_PP	72559	p,p'-DDE	6.76	a	6.65	4419366
	DDT_PP	50293	p,p'-DDT	6.53	a	6.42	2625851

1 - Literature source of $Log_{10}K_{ow}$ values:

a - Karickhoff and Long, 1995;

b - Karickhoff *et al.*, 1989;

c - Hawker and Connell, 1988;

d - Calculated value; and

e - U.S. EPA, 1993d.

2 - $log_{10}K_{oc} = 0.00028 + 0.983 * log_{10}K_{ow}$; Karickhoff *et al.*, 1989.

3 - Sum of High Molecular Weight PAHs - Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, and Perylene;

Sum of Low Molecular Weight PAHs - 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, and Phenanthrene;

LMW PAH, HMW PAH $log_{10}Kow$ = median of analyte specific Kow.

4 - Total PAH Log10Kow = median of LMW $Log_{10}K_{ow}$ and HMW PAHs $Log_{10}K_{ow}$ (NOAA, 1991).

5 - Sum of Congeners X 2.

NA= not applicable

Table 6.1-3. Water Quality Screening Values used as benchmarks for porewater Hazard Quotient development.

Chemical Class	Analyte	EPA Water Quality Criteria[1]				Sediment	WQSV[1,2]	
		WQC-FA	WQC-FC	WQC-SA	WQC-SC	Benchmark[6]	Conc.	DQ
Metals	Cadmium	4.30	2.20	42.00	9.30	1.20	9.30	A
	Chromium	16.00	11.00	1100	50.00	81.00	50.00	A
	Copper	13.00	9.00	4.80	3.10	34.00	3.10	A
	Lead	65.00	2.50	210	8.10	46.70	8.10	A
	Mercury	1.40	0.77	1.80	0.94	0.15	0.94	A
	Nickel	470	52.00	74.00	8.20	20.90	8.20	A
	Zinc	120	120	90.00	81.00	150	81.00	A
PAHs	1,6,7-Trimethylnaphthalene							NA
	1-Methylnaphthalene							NA
	1-Methylphenanthrene							NA
	2,6-Dimethylnaphthalene							NA
	Acenaphthylene					44.00	0.46	E
	Anthracene					85.30	0.29	E
	Benzo(a)anthracene					261	0.07	E
	Benzo(a)pyrene					430	0.04	E
	Benzo(b)fluoranthene							NA
	Benzo(e)pyrene							NA
	Benzo(g,h,i)perylene							NA
	Chrysene					384	0.10	E
	Dibenz(a,h)anthracene					63.40	1.68E-03	E
	Fluoranthene					6200	5.74	G
	HMW PAHs[3]					1700	0.29	E
	Indeno(1,2,3-cd)pyrene							NA
	LMW PAHs[3]					552	5.76	E
	Perylene							NA
	Phenanthrene					1800	6.06	G
	Pyrene					665	0.63	E
	Total PAHs[4]					4022	5.32	E
PCBs	Total PCBs	2.00	0.01	10.00	0.03	22.70	0.03	A
Dioxins	Mammals				1.00E-03	2.50	1.00E-03	A
	Fish				1.00E-03	60.00	1.00E-03	A
	Birds				1.00E-03	21.00	1.00E-03	A
Pesticides	o,p'-DDE[5]			0.13	1.00E-03	2.20	1.00E-03	A
	p,p'-DDD[5]			0.13	1.00E-03	1.58	1.00E-03	A
	p,p'-DDE[5]			0.13	1.00E-03	2.2	1.00E-03	A
	p,p'-DDT			0.13	1.00E-03	1.58	1.00E-03	A

DQ = Data Qualifier (see Figure 6.1-1).
WQC-FA = Water Quality Criteria = Freshwater Acute Value.
WQC-FC = Water Quality Criteria = Freshwater Chronic Value.
WQC-SA = Water Quality Criteria = Saltwater Acute Value.
WQC-SC = Water Quality Criteria = Saltwater Chronic Value.
WQSV = Water Quality Screening Value.
WQSV CODES:
NA= Benchmark not available to derive Screening Value;
A- WQC-SC VALUE;
E- EqP PARTITIONING OF SEDIMENT BENCHMARK INTO POREWATER AT 1% TOC;
G - EqP PARTITIONING OF EPA SEDIMENT QUALITY CRITERIA (U.S. EPA, 1993a,b,c);
1 - Units: µg/L.
2 - See text and Figure 6.1-1 for WQSV derivation process.
3 - LMW PAH = six 2-ring & 3-ring PAHs; HMW-PAH = seven 4-ring and 5-ring PAHs;
Sum of NOAA High Molecular Weight PAHs - Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, and Perylene;
Sum of NOAA Low Molecular Weight PAHs - 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, and Phenanthrene; and
LMW PAH, HMW PAH $\log_{10}$Kow = median of analyte specific Kow, Total PAH Kow = mean of LMW, HMW PAH Kow.
4 - Total PAH = median of LMW and HMW PAHs (NOAA, 1991).
5 - Assumed to be the same as DDT.
6 - Majority of values are NOAA ER-Ls, refer to Table 3.3-1 for benchmarks.

Table 6.1-4. Summary of Hazard Quotients for Porewater for the Raymark Phase III Ecological Risk Assessment Investigation[1,2].

Station[3]	Metals							PAHs																							PCBs	PST				Dioxins	
	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	1,6,7-Trimethylnaphthalene	1-Methylnaphthalene	1-Methylphenanthrene	2,6-Dimethylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b+k)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	HMW PAHs[4]	Indeno(1,2,3-cd)pyrene	LMW PAHs[5]	Perylene	Phenanthrene	Pyrene	Sum PAHs	Total PCBs[6]	o,p'-DDE	p,p'-DDD	p,p'-DDE	p,p'-DDT	Dioxin-Fish[7]	Exposure Ranking[8]
C-1-SED-SMP	-	-	-	-		-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-
C-2-SED-SMP	-	-	-	-		-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-
C-3-SED-SMP	-	-	-	-		-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-
D-1-SED-SMP	-	-	-	-		-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-
D-2-SED-SMP	-	-	-	-		-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-
D-3-SED-SMP	-	-	+++	-		-	-					-	+	++	++	+				+	+	-	++	+++		+		+	++	++	-	-	-	-	-	-	+++
D-4-SED-SMP	-	-	-	-		-	-					-	-	-	-	-				-	-	-	-	+		-		-	-	-	-	-	-	-	-	-	-
D-5-SED-SMP	-	-	-	-		-	-					-	+	+	+	-				+	+	-	-	+		-		-	+	-	+	-	+	-	-	+	+
D-6-SED-SMP	-	-	-	-		-	-					-	-	-	-	-				-	-	-	-	+		-		-	-	-	-	-	-	-	-	-	-
E-1-SED-SMP	-	-	+++	-		-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	+	-	-	-	-	-	++
E-2-SED-SMP	-	-	+++	+		-	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	-	-	-	-	-	-	++
E-3-SED-SMP	-	-	++	-		+	-					-	+	+	+	-				+	+	-	+	+		-		-	+	-	-	-	-	-	-	-	+
E-4-SED-SMP	-	-	-	-		+	-					-	-	-	-	-				-	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-
F-1-SED-SMP	-	-	-	-		-	-					-	+	+	+	+				+	+	-	+	+		-		-	+	-	-	-	-	-	-	-	+
F-2-SED-SMP	-	-	++	-		-	-					-	+	-	-	-				-	-	-	-	+		-		-	-	-	-	-	-	-	-	-	+
F-3-SED-SMP	-	-	-	-		-	-					-	+	+	+	+				+	+	-	+	+		-		-	+	+	-	-	-	-	-	-	+
Reference	-	-	+++	-		+	+++					-	+	-	-	-				-	-	-	+	-		-		-	-	-	-					-	+++

1 - Benchmark for Metals, PCBs, PAHs, PST = WQSV (WQS-SC equivalent concentration) (Table 6.1-3).
2 - Hazard Quotient Codes for Porewater Exposure: < WQC-Chronic = "-" ; WQC-Chronic to Acute = "+" ; > WQC-Acute = "++"; "+++" = > 2 x WQC-Acute.
3 - Reference Station - GM08 (SAIC, 1998).
4 - Sum of High Molecular Weight PAHs - Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, and Perylene; Perylene not available for reference.
5 - Sum of Low Molecular Weight PAHs - 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, and Phenanthrene.
6 - Total PCBs = Sum of Congeners x 2.
7 - 2,3,7,8-TCDD equivalent concentration for prediction of impacts on fish (WHO, 1998).
8 - Exposure Ranking:
Baseline ("-") - Low (+) exposure observed for only one analyte or baseline (-) exposure for all analytes;
Low ("+") - Low (+) exposure observed for two or more analytes or intermediate (++) exposure for one analyte;
Intermediate - ("++") Intermediate (++) exposure observed for two or more analytes or high (+++) exposure for one analyte; and
High - ("+++") High (+++) exposure observed in two or more analytes.

Table 6.1-5. Summary of Bedded Sediment Exposure Indices for the Raymark Phase III Ecological Risk Assessment Investigation.

CHEMICAL SOURCE	BEDDED SEDIMENT			
Station	Bulk Sediment[1A]	SEM:AVS[1B]	Porewater[1C]	Ranking[2]
C-1	+	-	-	-
C-2	+	-	-	-
C-3	++	-	-	+
D-1	-	-	-	-
D-2	+	-	-	-
D-3	+++	+	+++	+++
D-4	+	-	-	-
D-5	+++	-	+	++
D-6	+	-	-	-
E-1	+++	+	++	++
E-2	++	+	++	++
E-3	+++	+	+	++
E-4	++	-	-	+
F-1	++	+	+	+
F-2	+++	+	+	++
F-3	+++	++	+	++
Reference	++	-	+++	++

1A - Sediment HQs; see Table 6.1-1.

1B - SEM:AVS exposure rankings; see Table 4.3-1.

1C - Porewater HQs; see Table 6.1-4.

2 - Exposure Ranking: Baseline ("-") - Low (+) exposure observed for only one indicator or baseline (-) exposure for all indicators; Low ("+") - Low (+) exposure observed for two or more indicators or intermediate (++) exposure for one indicator; Intermediate ("++") - Intermediate (++) exposure observed for two or more indicators or high (+++) exposure for one indicator; and High ("+++") - High (+++) exposure observed in two or more indicators.

Table 6.2-1. Tissue Concentration Ratio (TCR) Rankings for Target Receptors for the Raymark Phase III Ecological Risk Assessment Investigation[1].

Station	Species[2]	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	1,6,7-Trimethylnaphthalene	1-Methylnaphthalene	1-Methylphenanthrene	2,6-Dimethylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b+k)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	HMW PAHs[3]	Indeno(1,2,3-cd)pyrene	LMW PAHs[4]	Perylene	Phenanthrene	Pyrene	Sum PAHs	Total PCBs[5]	o,p'-DDE	p,p'-DDD	p,p'-DDE	p,p'-DDT	Dioxin-Fish[6]	Risk Ranking[7]
C-1-TISS-SMP	MUS	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			+	-	-	++					-	+
C-2-TISS-SMP	MUS	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			+	-	-	++					-	+
C-3-TISS-SMP	MUS	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			+	-	-	++					-	+
D-1-TISS-SMP	MUS	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			+	+	-	++					-	+
D-2-TISS-SMP	MUS	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			+	+	-	++					-	+
D-3-TISS-SMP	MUS	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			+	-	-	++					+	+
D-4-TISS-SMP	MUS	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			+	-	-	++					-	+
D-5	Predicted	-	-	-	-	-	-	-					-	-	-	++	++	+			++	-	++	-		++			+	++	+	+++					+++	+++
D-6-TISS-SMP	MUS	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			+	-	-	++					-	+
E-1	Predicted	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	+	-		+			+	-	-	+++					++	++
E-2	Predicted	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			-	-	-	++					-	+
E-3	Predicted	-	-	-	-	-	-	-					-	-	-	++	++	+			++	-	++	-		++			++	++	+	++					-	++
E-4	Predicted	-	-	-	-	-	-	-					-	-	-	-	-	-			-	-	-	-		-			-	-	-	++					-	+
F-1	Predicted	-	-	-	-	-	-	-					-	-	-	++	++	+			++	-	++	-		++			++	++	+	+++					-	++
F-2	Predicted	-	-	-	+	-	-	+					-	-	-	+	+	+			+	-	+	-		++			+	+	-	+++					-	++
F-3	Predicted	-	-	-	-	-	-	-					-	-	+	++	++	+			++	-	++	-		++			++	++	+	+++					-	++

TCR = ratio of CoC concentration in an organism at the sampling location to the same organism at the reference location.

1 - Species/Station-specific Rankings: TCR>40 = "+++"; TCR>10 = "++"; TCR>3 = "+"; TCR<3 or TCR=3 = "-"; see Appendix D-4.

2 - Species: Ribbed Mussels

Tissue conc. predicted for stations: D-5, E-1 to E-4, F-1 to F-3, and Ref (GM08) (see Appendix D-3-5).

3 - Sum of High Molecular Weight PAHs - Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, and Perylene.

4 - Sum of Low Molecular Weight PAHs - 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, and Phenanthrene.

5 - Total PCBs = Sum of Congeners x 2.

6 - 2,3,7,8-TCDD equivalent concentration for prediction of impacts on fish (WHO, 1998).

7 - Sample-specific Tissue Residue Exposure Ranking:

Baseline ("-") - Low (+) exposure observed for only one analyte or baseline (-) exposure for all analytes;

Low ("+") - Low (+) exposure observed for two or more analytes or intermediate (++) exposure for one analyte;

Intermediate ("++") - Intermediate (++) exposure observed for two or more analytes or high (+++) exposure for one analyte; and

High ("+++") - High (+++) exposure observed in two or more analytes.

Table 6.2-2. Tissue Screening Concentration (TSC) benchmarks for evaluation of CoC impacts on target species for the Raymark Phase III Ecological Risk Assessment Investigation.

Chemical Class	Analyte	WQSV[1] (µg/L)	Criterion Basis[2]	Acute Chronic Ratio	BCF[3] (L/kg)	Tissue Screening Conc.[4], (µg/g wet)
Metals	Cadmium	9.30	WQC-SC		64.00	0.60
	Chromium	50.00	WQC-SC		16.00	0.80
	Copper	3.10	WQC-SC		200	0.62
	Lead	8.10	WQC-SC		49.00	0.40
	Mercury	0.94	WQC-SC		4994	4.69
	Nickel	8.20	WQC-SC		47.00	0.39
	Zinc	81.00	WQC-SC		47.00	3.81
PAHs	1,6,7-Trimethylnaphthalene					NA
	1-Methylnaphthalene					NA
	1-Methylphenanthrene					NA
	2,6-Dimethylnaphthalene					NA
	Acenaphthene	520	FC	3.1	242	126
	Acenaphthylene	300	PAHMA	8	119	4.46
	Anthracene	300	PAHMA	8	478	17.93
	Benzo(a)anthracene	300	PAHMA	8	4620	173
	Benzo(a)pyrene	300	PAHMA	8	11100	416
	Benzo(b+k)fluoranthene	300	PAHMA	8	11100	416
	Benzo(e)pyrene					NA
	Benzo(g,h,i)perylene	300	PAHMA	8	26900	1009
	Chrysene	300	PAHMA	8	4620	173
	Dibenz(a,h)anthracene	300	PAHMA	8	4460	167
	Fluoranthene	16	MC		1150	18.40
	Fluorene	300	PAHMA	8	282	10.58
	HMW PAHs					NA
	Indeno(1,2,3-cd)pyrene	300	PAHMA	8	26900	1009
	LMW PAHs					NA
	Perylene					NA
	Phenanthrene	4.6	MC		2630	12.10
	Pyrene	300	PAHMA	8	1110	41.63
	Total PAHs					NA
PCBs	Sum PCB Congeners x 2	0.01	FC		31200	0.44
Dioxins[5]	Dioxin-Mammal					0.70
	Dioxin-Fish					50.00
	Dioxin-Bird					6.00
Pesticides	o,p'-DDE	1.00E-03	FC		53600	0.05
	p,p'-DDD	1.00E-03	FC		53600	0.05
	p,p'-DDE	1.00E-03	FC		53600	0.05
	p,p'-DDT	1.00E-03	FC		53600	0.05

1 - Water Quality Screening Value: For Metals see Table 6.1-3; Organics derived from Shepard, 1998.

2 - WQC-SC - Water Quality Criteria Saltwater Chronic (Table 6.1-3); FA - Freshwater acute criterion; FC - Freshwater chronic criterion; MA - Marine acute criterion; MC - Marine chronic criterion; PAHMA - Polycyclic aromatic hydrocarbon marine acute criterion.

3 - BCF - Bioconcentration factor.

4 - TSC = WQSV x BCF. Shepard, 1995 and 1998.

5 - U.S. EPA, 1993d.

Table 6.2-3. Tissue Screening Concentration Hazard Quotients (TSC-HQ) Rankings for Target Receptors for the Raymark Phase III Ecological Risk Assessment Investigation[1].

Station	Species[2]	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	1,6,7-Trimethylnaphthalene	1-Methylnaphthalene	1-Methylphenanthrene	2,6-Dimethylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b + k)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	HMW PAHs[3]	Indeno(1,2,3-cd)pyrene	LMW PAHs[4]	Perylene	Phenanthrene	Pyrene	Total PAHs	Total PCBs[5]	o,p'-DDE	p,p'-DDD	p,p'-DDE	p,p'-DDT	Dioxin-Fish	Risk Ranking[6]
C-1-TISS-SMP	MUS	-	-	+	-	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
C-2-TISS-SMP	MUS	-	-	+	-	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
C-3-TISS-SMP	MUS	-	-	+	-	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
D-1-TISS-SMP	MUS	-	-	+	-	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
D-2-TISS-SMP	MUS	-	-	+	-	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
D-3-TISS-SMP	MUS	-	-	+	-	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
D-4-TISS-SMP	MUS	-	-	+	-	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
D-5	Predicted	-	-	+	-	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		+	-	-	-	-	-	-
D-6-TISS-SMP	MUS	-	-	+	-	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
E-1	Predicted	-	-	++	+	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		+	-	-	-	-	-	+
E-2	Predicted	-	-	+	+	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
E-3	Predicted	-	-	+	+	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
E-4	Predicted	-	-	+	+	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
F-1	Predicted	-	-	+	+	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	-
F-2	Predicted	-	+	+++	+	-	+	++					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	++
F-3	Predicted	-	-	++	+	-	-	+					-	-	-	-	-	-		-	-	-	-			-			-	-		-	-	-	-	-	-	+
Reference	Predicted	+	+	+++	+	-	+	++					-	-	-	-	-	-		-	-	-	-			-			-	-		-					-	++

TSC-HQ = CoC Tissue Wet Weight/TSC Benchmark (Appendix D-6-1). TSC Benchmarks are presented in Table 6.2-2.

1 - Species/Station-specific Rankings: TSC-HQ>40 = "+++"; TSC-HQ>10 = "++"; TSC-HQ>1 = "+"; TSC-HQ<1 or TSC-HQ=1 = "-".

2 - Species: Ribbed Mussel

Tissue conc. predicted for stations: D-5, E-1 to E-4, F-1 to F-3, and Reference (see Appendix D-3-5).

3 - Sum of High Molecular Weight PAHs - Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, and Perylene.

4 - Sum of Low Molecular Weight PAHs - 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, and Phenanthrene.

5 - Total PCBs = Sum of Congeners x 2.

6 - Sample-specific Tissue Residue Effects ranking = "+++" = higher effect (+++) observed for two or more analytes;
"++" = high (+++) effect observed for one analyte; "+" = intermediate (++) effect observed for one or more analytes; and
"-" = no effect for all analytes. See text in Section 6.6.

Table 6.2-4. Critical Body Residue (CBR) benchmarks used for assessment of risks to aquatic receptors from tissue residues for the Raymark Phase III Ecological Risk Assessment Investigation[1].

Compound	Mol. wt (µg/µMol)	*Test Species*	Group	Effect	CBR Chronic (µMol/g dry wt)	Comment	Reference
Cadmium	112.4	*Hyallela azteca*	Amphipod	80% mortality- 10wk	0.27		2
Chromium	52.0	*Daphnia magna*	Crustacean	10% density loss - 3wk	5.4		1
Copper	63.6	*Hyallela azteca*	Amphipod	71% mortality- 10wk	1.4	(a)	3
Lead	207.2	*Hyallela azteca*	Amphipod	69% mortality- 10wk	0.72	(a)	3
Mercury	200.6	*Hyallela azteca*	Amphipod	80% mortality- 10wk	0.45	(a)	3
Nickel	58.7	*Neanthes arenaceodentata*	polychaete worm	acute mortality- 10d	1.8	(b)	4
Zinc	65.4	*Hyallela azteca*	Amphipod	65% mortality- 10wk	62.5	(a)	1
Total PAHs	202.6	*Mytilus edulis*	bivalve mollusc	reduced feeding rate	0.40	(a)	5
p,p'-DDE	318	*Salmo truta*	fish	egg hatchability	1.1	(a,c)	6
Total PCBs	347.5	*Pimephales promelas*	fish	reduced fecundity	0.20	(a)	7

1 - Converted to dry weight assuming $CBR_{dry\ wt} = CBR_{wet\ wt} \times 5$:

(a) value reported on mass basis (*e.g.,* µg/g) - converted to molar basis (µMol/g);

(b) converted to chronic value assuming chronic CBR = acute CBR/10; and

(c) Reported concentration = NOAEL, converted to LOAEL, assuming LOAEL= NOAEL x 10.

References:

1 - Enserink *et al.*, 1991;

2 - Borgmann *et al.*, 1991;

3 - Borgmann, Norwood, and Clarke, 1993;

4 - Pesch *et al.*, 1995;

5 - Arnold and Biddinger, 1995;

6 - Mac *et al.*, 1981; and

7 - U.S. ACE, 1995.

Table 6.2-5. Critical Body Residue Hazard Quotients (CBR-HQ) Rankings for Target Receptors for the Raymark Phase III Ecological Risk Assessment Investigation[1].

		Metals							Organics[3]			
Station	Species[2]	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total PAHs	Total PCBs	p,p'-DDE	Risk Ranking[4]
C-1-TISS-SMP	MUS	-	-	-	-	-	-	-	-	-	-	-
C-2-TISS-SMP	MUS	-	-	-	-	-	-	-	-	-	-	-
C-3-TISS-SMP	MUS	-	-	-	-	-	-	-	-	-	-	-
D-1-TISS-SMP	MUS	-	-	-	-	-	-	-	-	-	-	-
D-2-TISS-SMP	MUS	-	-	-	-	-	-	-	-	-	-	-
D-3-TISS-SMP	MUS	-	-	-	-	-	-	-	-	-	-	-
D-4-TISS-SMP	MUS	-	-	-	-	-	-	-	-	-	-	-
D-5	Predicted	-	-	-	-	-	-	-	-	-	-	-
D-6-TISS-SMP	MUS	-	-	-	-	-	-	-	-	-	-	-
E-1	Predicted	-	-	+	-	-	-	-	-	-	-	-
E-2	Predicted	-	-	-	-	-	-	-	-	-	-	-
E-3	Predicted	-	-	-	-	-	-	-	-	-	-	-
E-4	Predicted	-	-	-	-	-	-	-	-	-	-	-
F-1	Predicted	-	-	-	-	-	-	-	-	-	-	-
F-2	Predicted	-	-	+	-	-	-	-	-	-	-	-
F-3	Predicted	-	-	-	-	-	-	-	-	-	-	-
Reference	Predicted	-	-	+	-	-	-	-	-	-		-

1 - CBR-HQ = measured CBR/CBR Benchmark (Appendix D-7-1a). CBR Benchmarks presented in Table 6.2-4.

2 - Species: Ribbed Mussel

Tissue conc. predicted for stations: D-5, E-1 to E-4, F-1 to F-3, and Reference; see Appendix D-3-5.

3 - Analyte-specific Rankings: CBR-HQ< 1= "-"; CBR-HQ>1 = +; CBR-HQ>3 = "++"; CBR-HQ>10 = "+++".

4 - Species/Station-specific Rankings = "+++" = higher effect (+++) observed for two or more analytes; "++" = high (+++) effect observed for one analyte; "+" = intermediate (++) effect observed for one or more analytes; and "-" = no effect for all analytes; see text in Section 6.6.

Table 6.2-6. Tissue Residue Effects Rankings for species collected from the Raymark Phase III Ecological Risk Assessment Investigation.

Station	Species[1]	TSC-HQ[2]	CBR-HQ[3]	Risk Ranking[4]
C-1-TISS-SMP	MUS	-	-	-
C-2-TISS-SMP	MUS	-	-	-
C-3-TISS-SMP	MUS	-	-	-
D-1-TISS-SMP	MUS	-	-	-
D-2-TISS-SMP	MUS	-	-	-
D-3-TISS-SMP	MUS	-	-	-
D-4-TISS-SMP	MUS	-	-	-
D-5	Predicted	-	-	-
D-6-TISS-SMP	MUS	-	-	-
E-1	Predicted	+	-	+
E-2	Predicted	-	-	-
E-3	Predicted	-	-	-
E-4	Predicted	-	-	-
F-1	Predicted	-	-	-
F-2	Predicted	++	-	++
F-3	Predicted	+	-	+
Reference	Predicted	++	-	++

1 - Species: Ribbed Mussel

Tissue conc. predicted for stations: D-5, E-1 to E-4, F-1 to F-3, and Ref.; see Appendix D-3-5.

2 - TSC-HQ = Tissue Screening Concentration Hazard Quotients; see Table 6.2-3.

3 - CBR-HQ = Critical Body Residue Hazard Quotients; see Table 6.2-5.

4 - Species-specific Tissue Residue Effects ranking = Maximum of indicator-specific rankings.

Table 6.3-1a. Food web exposure parameters for the Raymark Phase III Ecological Risk Assessment Investigation.

SPECIES	BODY Weight (g)	DIETARY INTAKE PARAMETERS Total Food[1] (g/day dry)	ORGANISM FISH % Diet[2]	ORGANISM FISH g/day dry[3]	Sampled Fraction (%)	INCIDENTAL SEDIMENT %Diet	INCIDENTAL SEDIMENT g/day dry[3]	WATER[7] (L/day)	HOME RANGE	BIOAVAILABILITY FACTOR
Black-crowned night heron	883	53.6	52.5%	28.2	52.5%	5.0%	2.7	0.05	1	COC specific
adjusted ration[5]			100%	53.6					1	
Raccoon	6000	299.7	2.3%	6.9	2.3%	9.4%	28.2	0.50	1	COC specific
adjusted ration[5]			100%	299.7					1	

1- Dry weight dietary requirements derived from body weight-dependent equations presented in Section 6.3.
2- Dietary fractions obtained from literature; see Section 6.3.
3- Dry weight diet fraction (Intake Factor) calculated as Total Food requirement x % diet.
4- Intake adjusted to obtain full dietary requirement (= [100%/percent sampled fraction] * prey-specific intake).
5- Water intake requirements derived from body weight-dependent equations of Nagy presented in Section 6.3.

Table 6.3-1b. Percent occurrence of food items in the diet of the raccoon and black-crowned night heron.

		Food Item (%)				
Animal	Season	Crustacean	Insects	Fish	Other	Reference
Raccoon	Spring	37	40	3	20	Llewellyn and Uhler, 1952
	Summer	8	39	2	51	
	Fall	3	18	trace	79	
	Winter	9	12	2	77	
	Average	14.3	27.3	2.3	56.8	
Black-crowned night herons	Average	21	1.5	52.5		NOAA, 1998a

Table 6.3-2a. Documentation of Toxicity Reference Values used for calculation of risks to black-crowned night heron for the Raymark Phase III Ecological Risk Assessment Investigation.

	Test Species						Receptor Extrapolation		
Contaminant of Concern	Test Species	BW, kg[1]	Condition Evaluated[2]	Endpoint Value (mg CoC/kg-dw diet/day)[3]	Endpoint	Reference	Extrapolation Factor[4]	Test NOAEL (mg/kg bw/day)[5]	RoC TRV[6,7]
Cadmium[C]	mallard	1.15	R	1.45	Chronic NOEL bounded	White and Finley, 1978	1.00	1.45	1450
Chromium[D]	black duck	1.25	R	1.00	Chronic NOEL	Haseltine *et al.*, unpub.	1.00	1.00	1000
Copper[E]	chicken	0.53	G,M	28.13	Chronic NOEL bounded	Mehring *et al.*, 1960	1.00	28.13	28130
Lead[F]	American kestrel	0.13	R	2.05		Pattee, 1984	1.00	2.05	2050
Mercury[G]	mallard	1.00	R	0.06	LOEL unbounded	Heinz, 1979	0.50	0.03	32.00
Nickel[H]	mallard	0.78	M,G	77.40	Chronic NOEL bounded	Cain and Pafford, 1981	1.00	77.40	77400
Zinc[I]	chicken	1.90	M	11.30	Chronic NOEL	Gasaway and Buss, 1972	1.00	11.30	11300
1,6,7-Trimethylnaphthalene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
1-Methylnaphthalene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
1-Methylphenanthrene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
2,6-Dimethylnaphthalene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Acenaphthene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Acenapthylene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Anthracene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Benz[a]anthracene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Benzo(a)pyrene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Benzo(b+k)fluoranthene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Benzo(e)pyrene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Benzo(g,h,i)perylene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Chrysene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Dibenz(a,h)anthracene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Fluoranthene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Fluorene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Indeno(1,2,3-cd)pyrene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Perylene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Phenanthrene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Pyrene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter, 1980	0.10	33.80	3.38E+07
Sum PAHs									
Total Aroclor[A]	pheasant	1.00	R	1.80	Chronic LOEL	U.S. EPA, 1993e	0.10	0.18	1.80E+05
2,3,7,8-TCDD	ringed-neck pheasants	1.00	R	1.40E-05	Chronic NOEL bounded	Noesek *et al.*, 1992	1.00	1.40E-05	1.40E+04
DDD[8]	brown pelican	3.50	R	0.03	Chronic LOEL	U.S. EPA, 1993e	0.10	2.80E-03	2.80E+03
DDE[8]	brown pelican	3.50	R	0.03	Chronic LOEL	U.S. EPA, 1993e	0.10	2.80E-03	2.80E+03
DDT	brown pelican	3.50	R	0.03	Chronic LOEL	U.S. EPA, 1993e	0.10	2.80E-03	2.80E+03

1 - BW = body weight.
2 - M: mortality; R: reproduction; G: growth.
3 - mg CoC/kg-dw diet/day.
4 - U.S. EPA, 1993e: LOEL to NOEL factor of two, rather than ten, was used for Hg because the LOEL appeared to be near the threshold for dietary effects.
5 - NOAEL = No Observable Effect Level (mg CoC/kg-RoC/day); NOAEL level for CoC concentration in food (mg CoC/kg diet dry weight); and Benchmark NOAEL * Extrapolation factor.
6 - NOAEL of test species = NOAEL of RoC; Sample and Arenal, 1998.
Benchmark NOAEL * (Test species BW/ Receptor of Concern BW).
A) Based on Arochlor 1254 toxicity;
C) assumed to be in the form of cadmium chloride;
D) assumed to be in the form of Cr(+3); E) assumed to be in the form of copper oxide;
F) assumed to be in the form of metal; G) assumed to be in the form of mercuric chloride;
H) assumed to be in the form of nickel sulfate; I) assumed to be in the form of zinc sulfate.
7 - Toxicity Reference Value. Units: Metals - ug CoC/kg RoC/day; Organics - ng CoC/kg RoC/day; Dioxins - pg CoC/kg RoC/day.
8 - DDT used for DDD and DDE.

Table 6.3-2b. Documentation of Toxicity Reference Values used for calculation of risks to raccoons for the Raymark Phase III Ecological Risk Assessment Investigation.

	Test Species						Receptor Extrapolation		
Contaminant of Concern	Test Species	BW, kg[1]	Condition Evaluated[2]	Endpoint Value[3]	Endpoint	Reference	Extrapolation Factor[4]	Test NOAEL (mg/kg bw/day)[5]	RoC TRV[6,7]
Cadmium[C]	Rat	0.35	R	1.00	Chronic NOAEL	Sample *et. al.*, 1996	1.00	1.00	1000
Chromium[D]	Rat	0.35	G	3.28	Chronic NOAEL	Sample *et. al.*, 1996	1.00	3.28	3280
Copper[E]	Mink	1.00	R	11.71	Chronic NOAEL	Sample *et. al.*, 1996	1.00	11.71	11710
Lead[F]	Rat	0.35	R	8.00	Chronic NOAEL	Sample *et. al.*, 1996	1.00	8.00	8000
Mercury[G]	Rat	0.35	R	0.03	Chronic NOAEL	Sample *et. al.*, 1996	1.00	0.03	32.00
Nickel[H]	Rat	0.35	R	40.00	Chronic NOAEL	Sample *et. al.*, 1996	1.00	40.00	40000
Zinc[I]	Rat	0.35	R	160	Chronic NOAEL	Sample *et. al.*, 1996	1.00	160	160000
1,6,7-Trimethylnaphthalene									0.00E+00
1-Methylnaphthalene	Mouse	0.03	G	425	13 Wk. LOAEL	Murata *et. al.*, 1993	1.00	425	4.25E+08
1-Methylphenanthrene									0.00E+00
2,6-Dimethylnaphthalene									0.00E+00
Acenaphthene	Mouse	0.35	R	350	13 wk. NOAEL	ATSDR, 1993	0.50	175	1.75E+08
Acenapthylene	Rat	0.35	M	51.40	10 Day NOAEL	See Acenaphthene	0.50	25.70	2.57E+07
Anthracene	Mouse	0.35	R	1000	13 wk. NOAEL	ATSDR, 1993	0.50	500	5.00E+08
Benz[a]anthracene	Mouse	0.03	M	1.50	5 wk. LOAEL	ATSDR, 1993	0.30	0.45	4.50E+05
Benzo[a]pyrene[J]	Mouse	0.03	R	1.00	Chronic NOAEL	Sample *et. al.*, 1996	1.00	1.00	1.00E+06
Benzo(b+k)fluoranthene[K]									0.00E+00
Benzo(e)pyrene									0.00E+00
Benzo(g,h,i)perylene									0.00E+00
Chrysene[L]									0.00E+00
Dibenz[a,h]anthracene	Rat	0.35	M	15.40	10 Day NOAEL	ATSDR, 1993	0.50	7.70	7.70E+06
Fluoranthene[M]	Rat	0.35	R	500	13 wk. NOAEL	ATSDR, 1995	0.10	50.00	5.00E+07
Fluorene	Mouse	0.35	R	500	13 wk. NOAEL	ATSDR, 1993	0.50	250	2.50E+08
Indeno(1,2,3-cd)pyrene									0.00E+00
Perylene									0.00E+00
Phenanthrene	Rat	0.35	M	514	10 Day NOAEL	ATSDR, 1993	0.50	257	2.57E+08
Pyrene	Rat	0.35	M	437	10 Day NOAEL	ATSDR, 1993	0.50	219	2.19E+08
Sum PAHs									
Total Aroclor[A]	Mink	1.00	R	0.14	Chronic NOAEL	Sample *et. al.*, 1996	1.00	0.14	1.40E+05
2,3,7,8-TCDD	Rat	0.35	R	1.00E-03	Chronic NOAEL	ATSDR, 1997	1.00	1.00E-03	1.00E+06
DDD[B]	Dog	12.70	M	50.00	14 Day LD50	Cueto, 1970	0.50	25.00	2.50E+07
DDE[B]	Mouse	0.03	R	19.00	78 wk. LOAEL	ATSDR, 1992	0.50	9.50	9.50E+06
DDT	Rat	0.35	R	3.75	36 Wk LOAEL	Jonsson et. al., 1976	1.50	5.63	5.63E+06

1 - BW = body weight.
2 - M: mortality; R: reproduction; G: growth; and C: Carcinogenic
3 - mg CoC/kg dry weight in diet.
4 - Conversion factor for non-Chronic NOAEL data:
125 Day NOAEL = 1.0 * Chronic NOAEL;
10 Day NOAEL = 0.5 * Chronic NOAEL;
78 Wk LOAEL = 0.5 * Chronic NOAEL
5 Wk LOAEL = 0.3 * Chronic NOAEL; and
Acute LD_{50}, ED_{50}, EC_{50} = 0.1 * Chronic NOAEL.
5 - NOAEL = No Observable Effect Level (mg CoC/kg-RoC/day); NOAEL level for CoC concentration in food (mg CoC/kg diet dry weight); and Benchmark NOAEL * Extrapolation factor.
6 - NOAEL of test species = NOAEL of RoC; Sample and Arenal, 1998.
Benchmark NOAEL * (Test species BW/ Receptor of Concern BW).
A) Based on Aroclor 1254 toxicity; Aulerich and Ringer, 1977;
C) assumed to be in the form of cadmium chloride; Sutou *et al.*, 1980;
D) assumed to be in the form of Cr(+6); MacKenzie *et al.*, 1958; E) assumed to be in the form of copper sulfate; Aulerich *et al.*, 1982;
F) assumed to be in the form of lead acetate; Azar *et al.*, 1973; G) assumed to be in the form of methyl mercury chloride; Verschuuren *et al.*, 1976;
H) assumed to be in the form of nickel sulfate hexahydrate; Ambrose *et al.*, 1976; I) assumed to be in the form of zinc oxide; Schlicker and Cox, 1968;
J) MacKenzie and Angevine, 1981; K) No Data; McCann and Ames, 1975;
L) No Data; McCann and Ames, 1975; M) Kingsbury *et al.*, 1979.
7 - Toxicity Reference Value. Units: Metals - ug CoC/kg RoC/day; Organics - ng CoC/kg RoC/day; Dioxins - pg CoC/kg RoC/day.

Table 6.3-3a. Qualitative summary of CoC risks to the Black-crowned night heron for the Raymark Phase III Ecological Risk Assessment.

Black -crowned night heron HQ (Benchmark = TRV-Dose)[1].

Station	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	1,6,7-Trimethylnaphthalene	1-Methylnaphthalene	1-Methylphenanthrene	2,6-Dimethylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b + k)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	HMW PAHs[2]	Indeno(1,2,3-cd)pyrene	LMW PAHs[3]	Perylene	Phenanthrene	Pyrene	Total PAHs	Total PCBs[4]	o,p'-DDE	p,p'-DDD	p,p'-DDE	p,p'-DDT	Dioxin-Bird[5]	Risk Ranking[6]
C-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
C-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
C-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
D-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
D-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
D-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
D-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
D-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		+	-	+	-	-	-	+
D-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
E-1	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		+	-	-	-	-	-	+
E-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
E-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
E-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	-
F-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	+	-	-	-	-
F-2	-	+	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	-	-	-	-	+
F-3	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-		-	-	+	+	-	-	+
Reference	-	+	-	-	+	-	-					-	-	-	-	-	-			-	-	-	-		-			-	-		-					-	+

TRV = Toxicity Reference Value; data from Table 6.3-2a. Data from Appendix A-3.

1 - HQ = Hazard Quotient = Total Assismilated/TRV; Total Assimilated = ((Heron Sed Dietary Intake + Heron Mussel Diet Intake) x Bioavailability Factor x Home Range Factor)/Body Weight;

Risk Ranking: HQ>1 = "+", HQ>10 = "++", HQ>40 = "+++" (Appendix D-5-3).

2 - sum of High Molecular Weight PAHs - Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, and Perylene.

3 - sum of Low Molecular Weight PAHs - 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, and Phenanthrene.

4 - Total PCBs = Sum of Congeners x 2.

5 - 2,3,7,8-TCDD equivalent concentration for prediction of impacts on birds (WHO, 1998).

6 - Risk Ranking: "+++" = intermediate (++) or higher exposure observed for two or more analytes, one of which indicates high (+++) exposure; "++" = intermediate (++) exposure observed for two or more analytes or high (+++) exposure for one analyte; "+" = low (+) exposure observed for two or more analytes or intermediate (++) exposure for one analyte; and "-" = low (+) exposure observed for only one analyte or no exposure for all analytes. See text in Section 6.5.

Table 6.3-3b. Qualitative summary of CoC risks to Raccoons consuming prey for the Raymark Phase III Ecological Risk Assessment Investigation.

Raccoon HQ (Benchmark = TRV-Dose)[1].

Station	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	1,6,7-Trimethylnaphthalene	1-Methylnaphthalene	1-Methylphenanthrene	2,6-Dimethylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b + k)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	HMW PAHs[2]	Indeno(1,2,3-cd)pyrene	LMW PAHs[3]	Perylene	Phenanthrene	Pyrene	Total PAHs	Total PCBs[4]	o,p'-DDE	p,p'-DDD	p,p'-DDE	p,p'-DDT	Dioxin-Mammal[5]	Risk Ranking[6]
C-1	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
C-2	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
C-3	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
D-1	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
D-2	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
D-3	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
D-4	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
D-5	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		+	-	-	-	-	-	-
D-6	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
E-1	-	-	-	-	+	-	-		-			-	-	-	-	-					-	-	-					-	-		+	-	-	-	-	-	+
E-2	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
E-3	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
E-4	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
F-1	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
F-2	-	-	+	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
F-3	-	-	-	-	-	-	-		-			-	-	-	-	-					-	-	-					-	-		-	-	-	-	-	-	-
Reference	-	-	+	-	+	-	-					-	-	-	-	-					-	-	-					-	-		-					-	+

TRV = Toxicity Reference Value; data from Table 6.3-2b. Data from Appendix A-3.

1 - HQ = Hazard Quotient = Total Assimilated/TRV; Total Assimilated = ((Raccoon Sed Dietary Intake + Raccoon Mussel Diet Intake) x Bioavailability Factor x Home Range Factor)/Body Weight;

Risk Ranking: HQ>1 = "+", HQ>10 = "++", HQ>40 = "+++" (Appendix D-5-4).

2 - sum of High Molecular Weight PAHs - Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, and Perylene.

3 - sum of Low Molecular Weight PAHs - 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, and Phenanthrene.

4 - Total PCBs = Sum of Congeners x 2.

5 - 2,3,7,8-TCDD equivalent concentration for prediction of impacts on mammals (WHO, 1998).

6 - Risk Ranking: "+++" = Intermediate (++) or higher exposure observed for two or more analytes, one of which indicates high (+++) exposure; "++" = intermediate (++) exposure observed for two or more analytes or high (+++) exposure for one analyte; "+" = low (+) exposure observed for two or more analytes or intermediate (++) exposure for one analyte; and "-" = low (+) exposure observed for only one anayte or no exposure for all analytes. See text in Section 6.5.

Table 6.3-4. Summary of Trophic Transfer Effects for the Raymark Phase III Ecological Risk Assessment Investigation.

	Trophic Transfer Effect Indicators[1]		
Station	Mammal Predator[2]	Avian Predator[2]	Effects Ranking[3]
C-1	-	-	-
C-2	-	-	-
C-3	-	-	-
D-1	-	-	-
D-2	-	-	-
D-3	-	-	-
D-4	-	-	-
D-5	-	+	+
D-6	-	-	-
E-1	+	+	+
E-2	-	-	-
E-3	-	-	-
E-4	-	-	-
F-1	-	-	-
F-2	-	+	+
F-3	-	+	+
Reference	+	+	+

Effects rankings for stations for which only one indicator observation was available are equal to the indicator observation ranking.

1 - Reduced fitness in field species exposed to sediments or sediment porewaters.

2 - Toxicity Reference Value Hazard Quotient (TRV-HQ); see Table 6.3-3a and 6.3-3b.

3 - Effects Ranking: "+++" = higher effect (+++) observed for one or more indicators;
"++" = intermediate (++) effect observed for one or more indicators;
"+" = low (+) effect observed for one or more indicators; and
"-" = no effect observed for both indicators; see text in Section 6.6.

Table 6.5-1. Overall Summary of Exposure and Effects-based Weights of Evidence and Characterization of Risk for the Raymark Phase III Ecological Risk Assessment Investigation.

WEIGHT OF EVIDENCE SUMMARY								
	CHEMICAL EXPOSURE			BIOLOGICAL EFFECTS				RISK PROBABILITY
Station	Bedded Sediment[1]	Bioconcentration[2]	Ranking[6]	Sediment Toxicity[3]	Tissue Residue Effects[4]	Trophic Transfer Effects[5]	Ranking[6]	Ranking[7]
C-1	-	+	L	++	-	-	I	Intermediate
C-2	-	+	L	++	-	-	I	Intermediate
C-3	+	+	L	+++	-	-	H	Intermediate
D-1	-	+	L	+	-	-	L	Low
D-2	-	+	L	++	-	-	I	Intermediate
D-3	+++	+	H	++	-	-	I	High
D-4	-	+	L	+	-	-	L	Low
D-5	++	+++	H	+	-	+	L	Intermediate
D-6	-	+	L	+++	-	-	H	Intermediate
E-1	++	++	I	+	+	+	L	Intermediate
E-2	++	+	I	+	-	-	L	Intermediate
E-3	++	++	I	+	-	-	L	Intermediate
E-4	+	+	L	++	-	-	I	Intermediate
F-1	+	++	I	++	-	-	I	Intermediate
F-2	++	++	I	-	++	+	I	Intermediate
F-3	++	++	I	+	+	+	L	Intermediate
Reference	++		I	+	++	+	I	Intermediate

1 - Bedded Sediment Exposure Ranking based on sediment Hazard Quotients (HQs), SEM:AVS, and porewater HQs; see Table 6.1-5.
2 - Bioconcentration Ranking based on Tissue Concentration Ratios for ribbed mussels; see Table 6.2-1.
3 - Sediment Toxicity Risk Ranking based on sediment toxicity tests: see Table 5.2-1.
4 - Tissue-based Risk Ranking: Based on risks of CoCs in tissues to aquatic receptors; See Table 6.2-6.
5 - Trophic Transfer Effects Ranking: Based on results of avian and mammalian predator exposures; see Table 6.3-4.
6 - Exposure/Effects (E/E) Ranking: B = Baseline Risk; L = Low Risk Probability; I = Intermediate Risk Probability; H = High Risk Probability.
Rankings for stations are equal to the maximum of individual WoE ranking.
7 - Overall Risk Ranking:
Baseline = Baseline (B) ranking for E/E WoE summaries;
Low = No greater than Low (L) ranking for E/E WoE summaries, or Intermediate (I) ranking for one WoE summary and no greater than Low (L) ranking for the other WoE summary;
Intermediate = No greater than Intermediate (I) ranking for E/E WoE summaries, or High (H) ranking for one WoE and Low (L) ranking for the other WoE summary; and
High = High (H) ranking for both WoE summaries or High (H) ranking for one WoE and Intermediate (I) for the other WoE summary.

Table 6.6-1. Potential sources of uncertainty and relationship to true degree of adverse exposure as inferred from tests performed to support the Weight of Evidence (WoE) approach for the Raymark Phase III Ecological Risk Assessment Investigation.

Weight of Evidence	Sources of Uncertainty	Code
General		
	• Some proximal and distal contaminant sources, as well as potential sensitive receptors, may not be accounted for in conceptual exposure pathways.	↑↓
	• Knowledge of the chemical behavior of the CoCs is incomplete; test results may not reflect true CoC exposure conditions.	↑↓
	• Inadequate spatial and temporal representation of the evaluated habitat and site/reference zone by a limited number of sampling stations, and associated extrapolations (and assumptions) from point measurements to broader spatial areas.	↑↓
	• Representativeness of target analyte list leading to CoC selection may be inadequate, potentially resulting in an incomplete characterization of potentially significant adverse chemical exposure.	↓
	• The sediment sampling plan, including station selection, spatial (horizontal) and vertical (sediment layering) patterns, and sample representativeness may inadequately characterize true CoC distributions.	↑↓
Bedded Sediment		
Sediment Hazard Quotients	• Hazard Quotients for sediment and porewater not developed for all CoCs due to limited availability of benchmarks.	↓
	• Sediment benchmarks used to derive Hazard Quotients were derived from data where potential synergistic or antagonistic interactions among contaminants may have been present.	↑
Porewater Hazard Quotients	• Organic concentrations are predicted from EqP.	↑↓
	• Porewater Hazard Quotients for mercury not quantified.	↑↓
	• Bioavailability of CoCs in porewater may be less than would occur in laboratory, water-only tests.	↑
SEM and AVS	• Concentration of AVS may be reduced by sampling procedure, increasing apparent metal bioavailability.	↑
	• Other binding factors (e.g. organic carbon) may decrease metal bioavailability in conditions of low AVS.	↑
	• Seasonality in AVS concentration may alter metal availability.	
Bioconcentration		
	• Reference tissue residue concentrations used as benchmarks reflect generally urbanized conditions.	↓
	• Predicted residue concentrations used to fill spatial data gaps.	↑↓

Codes: ↑ = "false positive", *e.g.,* true degree of adverse exposure is likely to be overestimated by the test.
↓ = "false negative", e.g., true degree of adverse exposure is likely to be underestimated by the test.
↑↓ = true degree of adverse exposure may be either underestimated or overestimated by the test.

Table 6.6-2. Potential sources of uncertainty and relationship to true degree of adverse effects as inferred from tests performed to support the Weight of Evidence (WoE) approach for the Raymark Phase III Ecological Risk Assessment Investigation.

Weight of Evidence	Sources of Uncertainty	Code
General		
	• Appropriateness of selected bioassay and target species as surrogates for the indigenous community.	↑↓
	• Limited toxicological data for target receptor species.	↑↓
	• Incomplete knowledge of community ecology and of potential synergistic or antagonistic impacts of CoCs.	↑↓
Sediment Toxicity (*Ampelisca*)		
	• Sampling/test procedures may modify CoC bioavailability.	↑↓
	• Non-CoC responses (e.g. Ammonia) obscuring exposure-response relationships.	↑↓
	• Responses observed may not represent potential for chronic effects.	↑↓
	• Differences in CoC bioavailability and species/endpoint sensitivity between stations not fully accounted for in data interpretation.	↑↓
Tissue Residue Effects		
	• Variation in lipid content among target species as a factor governing bioavailability and potential effects.	↑↓
	• Limited number of Toxicity Reference Values (TRVs) available as benchmarks for assessment of tissue residue impacts.	↓
	• Extent to which metabolic activities in fish reduce parent PAH tissue residue concentrations to unmeasured constituents of potential toxicological significance.	↓
	• Lack of empirical evidence linking contaminant concentrations in tissue with presumed effects.	↑↓
Trophic Transfer Avian and Mammalian Predators		
	• Intake of contaminants via other exposure routes such as water and sediment ingestion not considered.	↓
	• Birds may not feed exclusively at the site.	↑
	• Prey species used in modeling may not be adequate surrogates for other organisms in the diet of raccoons or herons.	↑↓

Codes: ↑ = "false positive", *e.g.*, true degree of adverse effects is likely to be overestimated by the test.
↓ = "false negative", *e.g.*, true degree of adverse effects is likely to be underestimated by the test.
↑↓ = true degree of adverse effects may be either underestimated or overestimated by the test.

7.0. SUMMARY AND CONCLUSIONS

This section summarizes information collected for evaluation of potential risks from contaminants associated with Raymark to ecological receptors at the site. The U.S. EPA's ERA Framework (1992a) and applicable U.S. EPA, and EPA Region I guidance were used to generate and interpret the data required to complete this risk assessment (1997a, 1998a). The objectives of this ERA are as follows:

- Assess potential ecological risks to the aquatic environments of Areas C-F from chemical stressors associated with the Raymark Site;
- Develop information sufficient to support risk management decisions regarding site-specific remedial options; and
- Support communication to the public of the nature and extent of potential ecological risks associated with the Raymark site.

The following sections present and discuss the findings of this Marine Ecological Risk Assessment (ERA), including Problem Formulation, Site Characterization, Exposure and Ecological Effects Assessments, Characterization of Ecological Risks, Risk Synthesis and Uncertainty Analysis.

7.1. Synthesis of Study Findings

A summary of potential ecological risk for Raymark Areas C-F was presented in Table 6.5-1. The table includes a summary of the measurement on exposure-based endpoints. Estimated potential risks were grouped into four primary classes: baseline, low, intermediate and high, based on definitions outlined in Section 6.0.

The identified risks by station are based primarily upon summaries of each weight of evidence, with special attention paid to concordance between exposure- and effects-based weights of evidence. This evaluation of weights of evidence addresses only current conditions and levels of activity at the site, and does not address future use scenarios involving fundamentally different conditions and activities at the site.

High Risk Probability Stations. In the present investigation, only Station D-3 is categorized as a high risk station, given both high exposure and high effects rankings. In addition, some support for exposure-response relationships were observed given that toxicity was observed and PCB concentrations in sediment were well above ER-M thresholds.

Intermediate Risk Probability Stations. Stations which the WoE demonstrate intermediate risks include Stations C-1 to C-3, D-2, D-5, D-6, E-1 to E-4, F-1 to

F-3, and the reference. Multiple exposure- or effects-based weights of evidence were observed in the data, resulting in an intermediate Exposure and/or Effects ranking. However, quantitative exposure-response relationships were found to be lacking.

Low Risk Probability Stations. A low risk probability was indicated for the remaining Raymark stations (D-1 and D-4). Minimal impacts are suggested by the majority of exposure and effects-based weights of evidence, and no exposure response relationships were evident.

Baseline Risk Probability Stations. Baseline risk was not assigned for any of the Raymark stations.

7.2. Other Potential Sources of Stress and CoCs

Ongoing CoC transport into the Raymark study areas may occur from surface water runoff via storm drains from residential areas. It is also possible that Housatonic River water (via groundwater or surface water during floods) may carry CoCs into the study area. This ERA did not collect any data to address this possibility.

Contamination from other sources may potentially enter various Raymark areas via exchange with the Housatonic River. The City of Stratford sewage treatment plant outfall is located to the west of the site, and prevailing water circulation patterns would suggest the possibility of diluted effluent exposing Areas C and D, particularly during the flood tide. No contamination gradient was found along the Housatonic Boat Club banks or areas north and south of the site, even though elevated concentrations was observed (SAIC, 1999b). This provides some evidence that the river is a likely source of some CoCs in the study area.

Previous assessments have found evidence from core samples to suggest that high CoC concentrations exist at depths > 100 cm into the sediment. The existence of increasing concentrations of metals in subsurface sediment layers at certain relative to surface sediments may represent an increased potential risk for indigenous biota should resuspension of these buried sediments occur, depending on future use scenarios.

7.3. Limitations of the Assessment

The conclusions drawn in this assessment are based on an extensive database of sediment and tissue chemistry, biological indicators, and toxicity evaluations, supported by geophysical and hydrographic information, with broad spatial and temporal coverage. The data are internally consistent and supportive, and of high quality, meeting and exceeding, for example, detection limits as specified by the NOAA

Status and Trends Program. Therefore, the values can be interpreted with confidence for comparisons to commonly accepted guidelines, such as ER-L values (Long *et al.*, 1995).

The assessment of potential ecological risk is a process of minimizing uncertainty with regard to characterization of exposure and effects, and the integration of these data as cause-effect relationships. The risk conclusions reached in this study are based on weight of evidence; those areas exhibiting more numerous lines of evidence for or against adverse impact are associated with less uncertainty in the conclusion. This evaluation addresses only current conditions and levels of activity at the site, and does not address potential future use scenarios involving fundamentally different conditions and activities at the site. The present study provides extensive weights of evidence and spatial coverage for evaluation of potential risks in the Raymark study area proper; however, localized small areas, such as immediately adjacent to or directly beneath piers or bridges have not been specifically addressed and are of unknown concern. In addition, the present investigation was synoptic, not seasonal in design, and therefore uncertainty exists in that seasonal effects were not specifically considered.

7.4. Conclusions and Recommendations

Based on the results of the Marine Ecological Risk Assessment for Raymark Areas C-F, the following conclusions and recommendations are put forth for consideration in risk management:

- In the assessment of potential marine ecological risks to aquatic species of concern (mussels, oyster, fish, raccoon and seabirds), Station D-3 was determined to pose a high probability of ecological risk from Raymark-related Contaminants of Concern (CoCs). The principal CoCs responsible for elevated exposure rankings were PAHs in bedded sediments, copper and PAHs in pore water, and PCBs in mussel tissue. Based on the extent of adverse exposure and measured effects (sediment toxicity) and some support for exposure-response relationships observed, the assigned degree of potential risk is considered unacceptable from an ecological perspective, and thus this location should receive highest priority in the risk management decision process.

- Stations which the WoE demonstrate intermediate potential risks include Stations C-1 to C-3, D-2, D-5, D-6, E-1 to E-4, F-1 to F-3, and the reference. In general, the same aquatic receptors and CoCs as observed for high risk stations were of concern, but at lower levels. For Areas C and D, with the exception of D-5, risks are largely attributable to elevated concentrations of Cu, Hg, PAHs, and PCBs in sediment and reduced survival in sediment toxicity tests. At D-5, high sediment PCB and dioxin concentrations, PAHs, PCBs, and dioxins in porewater were predicted to cause high tissue concentration ratios for Total PCB and dioxin

exposure. In the remaining stations, a combination of exposure and effects indicators (*i.e.*, bedded sediment concentrations, tissue concentration ratios, and sediment toxicity) identified risks from PAHs, Total PCBs, copper, zinc. Given an indication of adverse exposure or effects but a lack of clear exposure-response relationships, the overall potential risk at these stations may be considered acceptable from an ecological perspective. However, the associated uncertainty is sufficiently high as to merit the evaluation of these stations in the risk management decision process.

- A low risk probability was indicated for the remaining Raymark stations (D-1 and D-4). Although the data for these stations suggest possible adverse exposure or effects, CoC concentrations were generally low and definitive exposure-response relationships were not observed. Based on these observations, the observed potential risks at these stations are considered acceptable from an ecological perspective, and relatively low priority should be given to these locations in the risk management decision process.

- A baseline probability of risk was not assigned to any of the stations examined in this study since none of the locations, including reference stations, can be considered to representative of relatively pristine environmental conditions. This is attributed to the fact that the Raymark study areas are in a location which is affected by many contaminants and other stressor sources, such as the Housatonic River, Stratford outfall, stormwater outfalls, and industrial/recreational operations in nearby Stratford.

8.0. REFERENCES

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