Mike Penko

Draft

Evaluation of Raymark Superfund Data for PRG Development

Prepared By
Science Applications International Corporation
165 Dean Knauss Drive
Narragansett, RI 02882

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF APPENDICES (continued)

LIST OF APPENDICES (continued)

1.0. INTRODUCTION

The purpose of this study is to evaluate historical and recently collected chemistry and toxicity data for development of Preliminary Remediation Goals for Raymark-related Contaminants of Concern (CoCs). PRG's are risk-based chemical criteria which are intended to be protective of site biota. PRGs require site-specific evaluation because either applicable criteria are not available for important CoCs, or available literature values are not considered to be adequately protective under site-specific conditions.

Three primary components of PRG development include assessment of CoC-related risks due to chemical exposure via aquatic, terrestrial and human health exposure pathways. This report focuses primarily on the development of PRGs for protection of aquatic life; a final section involves the assessment of potential impacts of bioaccumulative CoCs (i.e., dioxins, PCBs) on avian predators consuming fish from the Raymark study area. Human health risks are beyond the scope of the present investigation.

PRG development for protection of aquatic life involves the inspection of existing or new data containing paired chemistry-toxicity measurements. These data form the basis of "exposure-response" relationships, where increasing adverse effects are observed with increasing chemical concentration. The CoC-specific PRG is developed by selecting the contaminant concentration that results in an unacceptable adverse effect. Multiple CoCs are evaluated in a similar manner and inter-compared to determine which PRG is most protective, considering both the concentration and the associated uncertainty about the estimate. In instances like Raymark where a mixed waste contains multiple CoCs, the selection process would typically yield a few PRGs which may be applied to the site depending on station-specific CoC concentrations. These PRGs are assumed to be protective for effects due to the mixed waste as a whole, i.e., other CoCs at lower effects-based concentrations would be remediated in association with the clean-up based on the selected PRGs.

The method for application of the PRG to the site for delineation of areas concern requires consideration of CoC spatial distributions; this step, however, is beyond the scope of the present objectives.

2.0. MATERIALS AND METHODS

Collection (Section 2.1), chemical evaluation (Section 2.2) and toxicity testing (Section 2.3) methodologies for sediments are presented in the sections below.

2.1. Field Collection Methodology

Sample locations for the present evaluation included 19 locations in the Raymark study area and one reference location (Figure 2.1-1). Sediments were collected over a three day period in August 1997. The majority of sediments were sampled by hand with scoops from just above the tide line within two hours of low tide. Four subtidal sampling locations in the lower Ferry Creek area were sampled from a small boat equipped with a davit and modified 0.1 m^2 Young grab sampler. Both intertidal and subtidal samples were collected to approximately 6" depth until 5 gal. of wet sediment were obtained. Care was taken to prevent loss of fines as well as to minimize the entrainment of excess water into the sample. Clean techniques were employed during all sampling procedures and chain of custody procedures were followed. After each day of collection, samples were placed on ice and transported by van to the SAIC Environmental Testing Laboratory (ETC) in Narragansett, RI and stored at 4°C until needed.

Fish samples were also taken at three Raymark stations (SD26, A3SD10, MF03) and at the reference location (GM08; Figure 2.1-1). Minnow traps were baited with bread and placed in the subtidal zone at low tide and connected via line to a shoreline stake. Minnow traps were checked twice daily at low tide until sufficient numbers of the target species (*Fundulus heteroclitus*) were obtained for chemical analysis. Fish were transferred from the traps to clean glass jars after each collection and placed on ice for transport to the ETC. At the laboratory, arriving samples were subsequently composited (within station) with previous samples and frozen at -20°C until needed.

2.2. Chemical Analytical Methods.

Chemical analyses included evaluations of bulk sediment (Section 2.2.1), sediment porewater (Section 2.2.2) and fish tissue (Section 2.2.3), and supporting non-CoC parameters (DOC, TOC, lipids; Section 2.2.4).

2.2.1. Bulk Sediment Analyses

PCBs. Given the need to collect both PCB congener/homolog and the more traditional Aroclor data, two different procedures were employed. The PCB congener and homolog analyses were conducted using a modification of EPA Method 680. Briefly, it is a GC/MS procedure that employs a low resolution mass spectrometer in the selected ion monitoring (SIM) mode. For the purposes of this project, that method has been modified so as to obtain results for the various PCB congener and homologs in Table 1. As modified, the PCBs are separated by the GC and quantitated using an isotope dilution procedure that requires that stable isotopically-labeled analogs representing at least one PCB congener in each homolog be added to the sample prior to the start of the extraction procedure.

The Aroclor data were generated using a modification of the U.S. EPA Contract Laboratory Program (CLP) Statement of Work (SOW) for organic analyses, OLM03.0. The CLP SOW employs a GC/EC instrument to separate and quantify the Aroclor mixtures. Analyses of Aroclor mixtures are highly dependant on the interpretive skill of the analyst, although the CLP method requires that 3 to 5 characteristic peaks for each Aroclor be used to quantitate the sample results. One significant modification of the CLP was the addition of Aroclors 1262 and 1268 to the series of standards prior to sample analysis. The results of those analyses were used by the analyst for the purposes of pattern recognition, and to choose the characteristic peaks that are used for quantitation.

SVOCs. SVOC analyses were performed following the protocols specified in the CLP SOW OLM03.0 (with revisions). The percent moisture of the sediment samples was determined prior to sample extraction or analysis and sample volumes adjusted to achieve desired quantitation limits (dry basis) for all sediment samples regardless of the high moisture content of the samples. Samples were maintained at 4 degrees C (± 2 degrees C) consistent with the CLP instruction procedures for sample storage.

Metals. The metal analysis were performed by the U.S. EPA CLP SOW for Inorganic Analysis, Multi-media, Multi-concentration ILM03.0 (and revisions) without modification. The percent moisture of the sediment samples was determined prior to sample extraction or analysis and sample volumes adjusted to achieve desired quantitation limits (dry basis) for all sediment samples regardless of the high moisture content of the samples.

2.2.2. Sediment Porewater Analyses

Fifteen of the twenty samples were selected for detailed chemical and toxicological analysis. The primary criterion for selection for further analysis was the observation of significant toxicity (<80% survival) using the 10-day solid phase test with the amphipod *Ampelisca abdita* (discussed below). This test is an accepted indicator of the potential for toxic risk and the test protocol method is an EPA standard (USEPA, 1994).

Organics Sample Preparation - All reagents used were of pesticide grade or better. Fifty mL (50 mL) of sample was spiked with internal standards, PCBs 103 and 198, for use in quantifying the chlorinated pesticides, DDT and metabolites, and PCB congeners. For PAHs, 5 alpha androstane was used as the internal standard.

Porewater samples were collected using the syringe extraction technique of Winger and Lassier (1991). Samples were sonicated for 1 minute with 10 mL of extraction solvent in a 40 mL centrifuge tube and centrifuged for 5 minutes. The solvent was removed and reserved, and the procedure repeated for a total of three times yielding 30 mL of extract per sample. Each extract was combined in a bottle with 70 mL of 2% sodium sulfate in deionized water washed with solvent. The solvent - sodium sulfate solution was triple extracted using 10 mL each time of extracting solvent compatible with the analytes of interest. The resulting extract was dried over sodium sulfate to remove any water in the extract, and reduced in volume to approximately 5 mL by nitrogen evaporation. A 300 mm X 10 mm i.d. liquid chromatography column with reservoir, stopcock, and coarse fritted disk was packed with 3.5 g of florisil and topped with 1.5 g of sodium sulfate for organochlorine and PCB compounds. For PAH compounds the column was packed with 10 g of silica gel in methylene chloride and topped with 2 g of sodium sulfate. For organochlorine and PCB compounds the column was washed with 20 mL hexane. For PAHs the column was washed with 20 mL of pentane. When the hexane (or pentane) had nearly reached the top of the sodium sulfate. the 5 mL of sample extract was quantitatively transferred to the column. For chlorine and PCB compounds, the column was eluted with 40 mL of 10% ethyl ether in hexane. For PAHs the column was eluted first with 20 mL of petroleum ether, followed by 40 mL of 10% methylene chloride in petroleum ether. The samples were collected from each column and reduced in volume to 1 mL by nitrogen evaporation in concentrator tubes. The extract was transferred to a GC autosampler vial, sealed, and stored until analysis.

Inorganics Sample Preparation- Samples were prepared using microwave digestion. Three to five g of sample was treated with 5 mL concentrated nitric acid, 2 mL of concentrated hydrochloric acid, and 3 mL of deionized water. The digest was allowed to cool, and volumetrically diluted to a final volume of 100 mL.

Instrumental Analyses - MDLs (method detection limits) were established for each analyte before analyses were conducted. MDLs was obtained for the procedures outlined in 40 CFR part 136, and in Standard Methods for the Examination of Water and Wastewater.. Water MDLs for organic and inorganic compounds were reported as µg/L.

All analyses for organics were performed using Hewlett-Packard model 5890 series II or 6890 series capillary GCs equipped with dual autosamplers. Splitless injection was used. Fused silica capillary columns used for each channel of the GC for organochlorine and PCB analyses were 60 m, 0.25 mm i.d., with a 0.25 micron film thickness DB-5 or equivalent. PAH analyses columns were 30 m, 0.25 mm i.d., with a 0.25 micron film thickness DB-5 or equivalent. Ultra high purity Helium was the carrier gas in each GC. For each sample batch of ten, a three point calibration curve was established.

For organochlorine/PCB analyses, the GC was equipped with dual electron capture detectors (ECDs), injection ports, and autosampler. Temperature programming was used to chromatograph the samples. The injector temperature was 280 degrees C and the detector temperature was 310 degrees C. For PAH analyses, the GC was equipped with a flame ionization detector (FID), set at the correct hydrogen and air flow rates. The injector temperature was 300 degrees C and the detector temperature was 325 degrees C. As with Organochlorine/PCB analyses, temperature programming was used to chromatograph the samples.

For metal analyses, a Varian SpectrAA 20 flame atomic absorption spectrophotometer and a Varian SpectrAA 400 Zeeman graphite furnace atomic absorption spectrophotometer were used to determine the concentration of trace metals. Each unit was equipped with data stations and autosamplers. For all metal analyses, a three point calibration curve plus blank was established.

2.2.3. *Fish Tissue Analyses*

As part of this project, data on polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in fish tissue samples was required. The analytical method employed was EPA Method 1613B. In addition to the 17 2,3,7,8-substituted PCDDs/PCDFs addressed in that method, data also were obtained the "total" concentrations in each level of chlorination, e.g., total TCDD. Method 1613B includes procedures for acid/base back extraction, gel permeation chromatography (GPC), silica gel, alumina, and activated carbon column cleanups, and an anthropogenic isolation column for the removal of lipids. For the purposes of this project, the analysis methods of the fish tissue samples were selected to meet the MDLs for the solid samples, e.g., 1 ng/kg for TCDD, up to 10 ng/kg for OCDD. Any sample in which 2,3,7,8-TCDF was observed above the MDL was confirmed by analysis on a second column, as described in Section 16.5 of Method 1613B.

2.2.4. *DOC/TOC/Lipid Analyses*

Finally, in order to assess the bioavailability of these contaminants, measurements are needed of the dissolved organic carbon (DOC) in the pore water samples (EPA Method 415.1), the total organic carbon (TOC) of the sediments (EPA Method 415.1), and the lipid content of the tissue samples (Bligh and Dyer, 1959).

2.3. Toxicity Testing

Toxicity analyses included evaluations of bulk sediment (Section 2.2.1), sediment porewater (Section 2.2.2) and chemically fractionated porewater (Section 2.2.3).

2.3.1. *Bulk Sediment Tests*

For whole sediment tests, the 5 gal samples were homogenized using stainless steel paddles. Bulk sediments were evaluated in the 10-day solid-phase amphipod test using the marine amphipod, *Ampelisca abdita* according to EPA procedures (USEPA, 1994). The test was conducted for 10 days using 1 L glass jars containing 175 mL of homogenized sediment and 800 mL of overlying seawater collected from lower Narragansett Bay, RI. Exposure was static at 20°C with a continuous lighting. Test chambers were aerated to maintain acceptable oxygen levels. Twenty subadult test organisms per chamber, which were not fed during the test, were used. Water quality parameters were monitored: pore water ammonia was measured at the beginning of the test; overlying water ammonia, pH, salinity, and dissolved oxygen was measured at the beginning and the end of the test; and temperature was recorded daily in one chamber and continuously in the water bath. Survival, measured as the number live retrieved at the end of the test compared to the number added, was determined. Survival was compared to a "clean" laboratory performance control sediment.

2.3.2. Sediment Porewater Tests

For pore water tests, samples were collected according to methods described by Winger and Lasier (1991). Briefly, sediments were homogenized as described above and interstitial water was collected using a vacuum-operated pore water extractor constructed from fused glass airstones attached to a 60 cc syringe. The airstone was inserted into the sediment and a vacuum was created by retracting and bracing the syringe plunger.

Pore waters were used to determine survival effects to *Ampelisca abdita* in 48-hour and 96-hour water-only tests and development effects to the marine bivalve, *Mulinia lateralis*, in 48-hour water-only tests. A concentration series was used so that a threshold concentration (i.e., LC50 for the amphipod test and EC50 for the bivalve test) could be determined.

Water-only tests using *Ampelisca abdita* were performed according to EPA procedures (USEPA, 1996). The test was conducted for 48 or 96 hours using 30 mL plastic cups and 15 mL of sample. A concentration series (e.g., 0, 10, 50 and 100% or 0, 6.25, 12.5, 25, 50, and 100% sample) with natural seawater collected from lower Narragansett Bay as diluent. Exposure was static at 20°C with a 16 hour light and 8 hour dark cycle. Five subadult test organisms per chamber, which were not fed during the test, were used. Ammonia, salinity, and pH were measured in the samples. Survival, measured as the number live retrieved at the end of the test compared to the number added, was determined. The LC50, the concentration at which survival was reduced by 50%, was calculated using ToxCalc®.

Tests using *Mulinia lateralis* were also performed according to EPA procedures (USEPA, 1996). The test was conducted for 48 hours using 30 mL plastic cups and 10 mL of sample. A concentration series (e.g., 0, 10, 50 and 100% or 0, 6.25, 12.5, 25, 50, and 100% sample) with natural seawater collected from lower Narragansett Bay as diluent. Exposure was static at 20°C with a 16 hour light and 8 hour dark cycle. Three hundred embryos were added to each chamber. Embryos were not fed during the test. Ammonia, salinity, and pH were measured in the samples. Development, measured as the number of normal embryos out of 100 embryos counted, was determined. The EC50, the concentration at which normal development was reduced by 50%, was calculated using ToxCalc®.

2.3.3. Fractionated Porewater Tests

Pore waters were amended or fractionated using marine toxicity identification evaluation (TIE) methodologies (USEPA, 1996). Three amending procedures were performed using the pore water to identify potential contaminants of toxicological concern: the C18 solid-phase extraction column (SPEC) was used to remove nonionic organic compounds, EDTA (ethylenediaminetetraacetic acid) was used to bind divalent cationic metals (e.g., copper, nickel, lead, zinc, cadmium, and mercury), and the macroalgae *Ulva lactuca* or sea lettuce was used to remove ammonia (ULVA). Amended samples were evaluated using the aqueous phase amphipod and bivalve tests. Threshold concentrations for fractionated samples were compared to non-fractionated sample responses.

SPEC. Methanol (25 mL) and DI (25 mL) were used to prepare columns for sample passage. A continuous flow rate 7-10 mL/min was used. Natural seawater passed through the column served as a laboratory performance control and was used to prepare dilutions of amended pore waters.

EDTA. EDTA (25 g EDTA in 1 L of DI)) was added to each sample so that the final concentration was 60 mg or 0.22 mmol EDTA per L of sample. The sample was mixed thoroughly. Test organisms were added after three hours. EDTA was added to natural seawater to serve as a laboratory performance control and for dilutions of amended pore waters.

ULVA. *Ulva lactuca* was collected from Narragansett Bay just prior to use. Debris and white or yellow tips were discarded. Sea lettuce samples were rinsed in clean seawater, patted dry and added to salinity adjusted samples so that each 60 mL of sample contained 5 g of lettuce. Sample salinity was adjusted using brine (i.e., 2X GP2 in natural seawater) prepared according to EPA (1994). Samples with *Ulva* were aerated gently under laboratory lights for five hours. Lettuce was removed and animals were added. Ammonia was measured before and after treatment with *Ulva*. Natural seawater was treated with sea lettuce to serve as a laboratory performance control and for dilutions of amended pore waters.

3.0. RESULTS AND DISCUSSION

3.1. Toxicity Testing

3.1.1. Bulk Sediment Toxicity

Results of bulk sediment tests with amphipods are summarized in Table 3.1-1. Of the 20 sediment samples tested, 5 samples exhibited survival > 85% and were excluded from further analyses. Among the remaining 15 samples, four samples were non-toxic (exhibiting survival ≥ 80%; "-"), four samples were slightly toxic (survival between 50-80%; "+"), five samples were moderately toxic (survival between 20-50%; "++"), and two samples were highly toxic (survival < 20%; " +++"). Some the samples had relatively high total and un-ionized ammonia concentrations, exceeding the NOEC values for this species (30 and 0.4 mg/L, respectively). However, the affected samples (SD07, SD08, and SD28) were no more than slightly toxic, such that ammonia did not appear to be a significant confounding factor in interpretation of results of these bulk sediment tests. Hence, the observed range of survival was expected to provide an adequate range of toxicity and associated chemical concentration in sediment porewaters for TIE evaluations, discussed below.

3.1.2. Porewater/TIE Toxicity

Porewater toxicity results for *Ampelisca* (survival) and *Mulinia* (larval development), discussed below, are expressed as the concentration of porewater required to affect 20% of the test population (i.e., EC20). A 20% effect level was selected as being more environmentally conservative than a 50% reduction (e.g., LC50 or EC50) as organisms can be exposed to 100% porewater in the field, and because the approach provided a more dynamic range in the data set (multiple values with LC50 values ">100%" can have lower and different values as LC20 estimates). This calculation is an interpolated value based on exposure-response results of the 48hr porewater exposures for the control (0% porewater) and each of five dilution series (6.25%, 12.5%, 25%, 50% and 100%) as summarized in Appendix Tables B-1 to B-4.

<u>*Ampelisca* Toxicity</u>. Results of sediment porewater tests with *Ampelisca* are reported in Table 3.1-2. The data include tests with whole porewater (PW), as well as chemically-treated porewater to selectively remove organics (C18) and metals (EDTA).

An initial comparison of porewater EC20 results with that of bulk sediment tests relative to overall sample toxicity (High, Intermediate, Low, Non-toxic) indicate that two of 15 samples (A3SD10 and HB3A) were significantly lower in toxicity (two categories lower toxicity in porewater than sediment), while two additional samples (SD08 and SD37) were significantly higher in toxicity (two categories higher toxicity in porewater than sediment). Hence, the majority of samples exhibited comparable toxicity between sediment and porewater exposures.

The LC20 results for *Ampelisca* in whole porewater ranged from a low of 25.0% (SD18) to a high of 100% (e.g., non-toxic, SD28). Stations ranked with highest toxicity ("++"; SD01, SD08, SD18 and SD37) for the porewater treatment also tended to have the highest total and/or unionized ammonia concentrations in porewater bioassays which were about 2-fold greater than the NOEC concentration. An increase in ammonia concentration is believed to have occurred during holding between the time of bulk sediment and porewater extraction.

Inspection of the EDTA and C18 fractionation results for amphipods (Table 3.1-2) indicates results for 9 of 15 stations did not change from the corresponding porewater result (i.e., LC20 within 10%), while five samples (A3SD10, GM08, SD01, SD08 and SD37) had a similar reduction in toxicity (i.e., +10% change in LC20 for both EDTA and C18 treatment vs. PW treatment). Among the remaining samples, C18 treatment increased toxicity in one sample (HB3A), but decreased toxicity in another (SD07). Thus on the basis of toxicity results alone, the TIE fractionation tests with *Ampelisca* were inconclusive with respect to the relative role of metals vs. organics in CoC-related impacts. However, these results will be explored further when toxicity results are compared to matching porewater chemical analyses (Section 3.4).

As discussed in the methods section, a porewater collection technique using syringe extraction was preferred as it presented the best approach for minimizing handling artifacts with regard to the bioavailability of CoCs in the sample. Because of the concern over potential non-

CoC toxicity related to ammonia/sulfides, an aeration experiment with *Ampelisca* was conducted to assess the effect of sample oxidation on toxicity. The non-aerated exposure portion of the test employed the same test methods as the previous porewater test, while split samples were taken and bubbled with air for 60 minutes prior to testing.

Although direct sulfide measurements on the preparations were not performed, those samples with increased high ammonia are also expected to contain sulfides because ammonia production is a precursor to sulfide generation in sediments. Hence, porewaters which are highest in ammonia should be most susceptible to an aeration effect resulting in increased toxicity if the oxidation of sulfides are allowing metals in solution to become bioavailable, or alternatively, decrease in toxicity if ammonia concentration is the primary constituent caused adverse impact.

Results presented in Table 3.1-3 show that five of 15 samples (SD07, SD13, SD14, SD24 and SD37) increased in toxicity, while only one sample (SD28) decreased in toxicity as a result of aeration. Another four samples (HB3A, SD01, SD18 and SD23) remained completely toxic, thus leaving open the possibility that aeration could have increased CoC bioavailability, although it cannot be proven without performing testing on diluted samples. Still, those samples which increased in toxicity also had relatively high ammonia whereas the three non-toxic samples (A3SD10, CSD1, GM08) which were low in ammonia were unaffected by aeration.

These results are consistent with the hypothesis that aeration increases toxicity because sulfide oxidation allows previously bound metals in solution to become bioavailable. Hence, the anoxic nature of sediments (whether naturally or anthropogenically induced) under existing conditions in the Raymark study area may presently afford a substantial degree of protection to indigenous biota to metals toxicity.

Mulinia toxicity. Results of larval development tests with *Mulinia* exposed to whole porewater and TIE fractions (EDTA, C18) are presented in Table 3.1-4. The *Mulinia* results generally indicated higher levels of effects than did *Ampelisca*; the EC20 values for whole porewater range from 0.4 - 55.7%, indicating that all porewater samples resulted in reduction in larval development success, and over half (9 of 15) samples had high (EC20 < 10%) toxicity. This enhanced toxicity is at least partially attributed to the fact that the *Mulinia* test is a sub-lethal, larval stage test, whereas the *Ampelisca* endpoint is survival of the adult stage. As observed for *Ampelisca*, measured ammonia concentrations were above the LC50 values for both total (13 mg/L) and unionized (0.2 mg/L) forms, such that a portion of toxicity may not be directly related to CoC concentration.

The EDTA and C18 treatment of split samples and retesting with *Mulinia* resulted in a comparable range of EC20 values. There was a general trend for the EDTA treatment to reduce sample toxicity as compared to that for whole porewater; three samples (A3SD10, GM08 and SD07) exhibited a > 10% reduction in toxicity, while only one sample (SD23) appeared to have a comparable increase in toxicity. As discussed for the amphipod results, reduced toxicity is expected if the EDTA treatment was effective in sequestering metals from solution. A similar result was observed for the C18 treatment; three samples exhibited reduced toxicity (SD18, SD2: and SD24). Because EDTA and C18 treatments affected different samples and the general trend was to reduced toxicity, it would appear that the TIE results hold promise for segregating metals vs. organics toxicity. The significance of these results will be further evaluated from examinatior of exposure-response relationships from which CoC-specific contributions may be discerned.

Ulva Treatments. Ulva treatments of porewater were conducted to address residual toxicity associated with ammonia in the sample. For *Ampelisca*, test durations were extended to 96 hr so as to increase the threshold of detection toxicity related to CoC in the sample. Results presented in Table 3.1-5 show that only 5 of 15 samples (HB3A, SD01, SD14, SD18, and SD21) remained toxic after *Ulva* treatment. (Note the reduction in ammonia concentration relative to the whole porewater tests). The lack of toxicity does not contraindicate the possibility of CoC related toxicity in whole porewater samples since *Ulva* may be capable of uptaking the CoCs and hence reducing chemical bioavailability (see Section 3.2, below). Rather the data do suggest that those samples which remain toxic after *Ulva* treatment are likely to have CoCs at effect-causing concentrations without masking due to ammonia effects; these data will be utilized further in PRG development discussed in Section 4.

Ulva treatments of porewater were also conducted using *Mulinia* as had been done for Ampelisca (split samples). Results presented in Table 3.1-5 show that the majority of samples exhibited comparable toxicity between non-*Ulva* and *Ulva*-treated porewater, while three of 15 samples (GM08, SD13 and SD28) were more toxic after *Ulva* treatment. The continued toxicity of the samples despite ammonia removal indicates that CoCs are likely to be present at toxic concentrations. The cause of increased toxicity is uncertain, although laboratory studies have demonstrated that Ulva may release exudates which are toxic to *Mulinia* (Johnson and Welsh, 1985).

3.2. Chemical Analytical Results

Results for chemical analysis of bulk sediment, porewater and tissue samples respectively are reported in Sections 3.2.1, 3.2.2 and 3.2.3., below.

3.2.1. Bulk Sediment Chemistry

Data presented in Table 3.2-1 provides a brief description of sediment concentrations relative to NOAA ER-M benchmarks (expressed as Hazard Quotients, HQ) for Raymark sampling locations selected for TIE analyses. Among the metals, copper, nickel, lead and zinc were found at concentrations which exceeded the respective ER-M benchmarks. Complete results are presented in Appendix Table A-2-1.1. The results were qualitatively scaled so as to facilitate the data presentation as follows: concentrations < ER-M were flagged as "-", values 1> ER-M <2 were flagged as "+", values 2 < ER-M <10 were flagged as "++", and values > 10X ER-M were flagged as "+++". Lead was the most pervasive CoC in exceedence of the ER-M

(12 of 15 stations), followed by copper (10 of 15 stations), nickel and zinc (8 of 15 stations). Chromium and mercury also exceeded the ER-M on two occasions. With regard to the magnitude of contamination, one station in particular (HB3A) stands apart with HQs for copper and lead >> 100, while a second station (A3SD10) has a copper and lead HQs of 9.5 and 15.1, respectively. The remainder of stations have relatively lower CoC concentrations, with Hazard Index (sum of metal-specific HQs) values in the range of 4-18.

As for PAHs, the Hazard Index for four stations (SD07, SD13, SD14 and SD23) had dibenz(a,h)anthracene, fluorene, and phenanthrene concentrations exceeding the ER-M by more than two-fold, and corresponding HI > 20. PCB concentrations also appeared substantially elevated at a number of stations.

Because only six of the quantified congeners are in common with the 18 congeners used by NOAA for the Total PCB determination, there existed uncertainty in the sum of congeners estimate of Total PCBs for comparison against the NOAA ER-M benchmark. To address this issue, six samples were selected for additional congener quantitation to obtain the full NS&T congener complement. Regression analysis of Total PCBs by congener method (sum of NS&T congeners x 2) against sum of PCB homologs revealed a linear relationship Figure 3.2-2). This excellent agreement permitted prediction of Total PCBs for comparison against the ER-M benchmark, discussed below.

The results of PCB ERM-HQs show patterns similar results as for the metals; Station HB3A stands apart with the PCB HQ = 1762, while two additional stations (A3SD10 and SD01) have HQs >> 100. Except for Station GM08 and SD37 (HQ < 1.5), the remaining stations have HQs in the range of 5 - 50. Finally, the pesticide p,p'-DDE was quantified for three stations (HB3A, SD07 and SD21) and was not found to be present in high concentrations (HQ << 1).

SEM:AVS measurements on bulk sediments were performed to assess potential divalent metal bioavailability and associated potential toxicity to benthic infauna. Numerical values for SEM constituents (Cu, Cd, Ni, Pb and Zn) are presented in Appendix Table A-5; results are presented graphically in Figure 3.2-1. Among the 15 sampling locations, three stations (A3SD10, HB3A, SD18) were noted to have sum SEM concentrations (μMol/g dry wt) which exceeded AVS concentration (noted by asterisk), hence indicating potential toxicity. These stations, among others, were founded to be toxic to amphipods as discussed above (Table 3.1-1). The relationship between SEM concentrations and concentrations of metals in porewater will be discussed in Section 3.4.5.

3.2.2. Porewater Chemistry

Data presented in Table 3.2-2 provides a similar description of porewater concentrations and Hazard Quotients as discussed for sediments, above. Complete results are presented in Appendix Table A-2-2.1. In this analysis, however, porewater concentrations are compared to Water Quality Screening Values (WQSV, units = μg/L) with CoC-specific benchmarks being obtained from amphipod LC50 values where available, or otherwise taken from EPA Water Quality Chronic Values. Among the metals, copper clearly emerges as the principal CoC of concern, with HQs > 1 at all but one station (SD18). Arsenic exceed the WQSV at four stations (CSD1, SD07, SD08, and SD13), while zinc exhibited HQs > 1 at two locations (A3SD10, GM08). With regard to the magnitude of contamination, Station HB3A stands apart an HQ for copper ≃30, while a second station (A3SD10) has a copper and lead HQs of 9.5 and 15.1, respectively. The remainder of stations have relatively lower CoC concentrations, with Hazard Index (sum of metal-specific HQs) values in the range of 2-10. Station SD18 was the only location with an HI < 1.

Porewater PAH concentrations were less than the Method Detection Limit of 1 µg/L at almost all of the stations. The sole exception was found for benzo(a,h)anthracene at Station SD13 (HQ =40). These results would generally suggest that PAHs are an unlikely contributor to porewater toxicity, although uncertainty exists for those PAHs with WQSV values < 1 µg/L. PCB concentrations were substantially elevated at six stations, including CSD1, SD07, SD08, SD13, SD23 and SD28), while concentrations at the remaining stations were below detection (1 µg/L). As was done for sediments, the sum of congeners x 2 was calculated for comparison against the EPA benchmark, although in this case, the 18 congeners used by NOAA for the Total PCB determination were employed. Three stations (SD07, SD08 and SD24) had Total PCB HQs of ~50, two stations (CSD1, SD23) were ~ 30, and one station (SD13) was ~13. The fact that these data do not appear to correlate well with the respective sediment based concentrations is attributed mainly to differences in congeners quantified for the respective analyses. A more detailed analysis is presented in Section 4, below.

3.2.3. TIE Chemistry

Based on results of porewater metals analyses, samples were selected for chemical analyses following further TIE manipulation including C18, EDTA, and ULVA treatment. Sample selection was prioritized for those samples where analytes were present at concentrations exceeding detection and with porewater HQs > 1.

Samples treated with EDTA for metals reduction were analyzed for PCBs: results are reported in Appendix Table A-1-2.2 for the six PCB samples which had detectable concentrations in porewater. Results show that detectable PCB concentrations were found in only three of the six samples, and total concentrations were reduced by a factor of 10 or more. This unexpected result could not be explained by preferential removal of certain PCB congeners, as the congener mixtures did not change in any predictable manner. One consistent relationship that was observed was the correlation between the retention of PCBs in the sample and the presence of higher DOC (Appendix Table A-1-5), and silt/clay content (Appendix Table A-1-4).

Samples treated with C18 for organics reduction were analyzed for seven metals; concentrations and associated Hazard Quotients results are reported in Appendix Tables A-1-2.3 and A-2-2.3, respectively. Copper was the most prevalent CoC with concentrations exceeding the WQSV; HQs > 1 were observed for eight of 15 stations. The highest observed HQ was found for Station HB3A (HQ = 4.10), while remaining exceedances had HQs < 2. Arsenic also was found to exceed the WQSV at four locations (CSD1, SD07, SD08, and SD28) with HQs 1-2. Finally, zinc concentrations exceeded the WQSV at two locations, Station A3SD10 (HQ = 7.0) and Station GM08 (HQ= 1.49). Additional samples were also analyzed for PCB concentrations to confirm the C18 removal efficiency (Appendix Table A-2-4.); concentrations were almost entirely less than the MDL (1 μg/L) in almost all samples.

A final set of samples were subjected to *Ulva* treatment for purposes of ammonia reduction. Samples were analyzed prior to and after *Ulva* treatment, and included both PCB and selected metals. The effectiveness for removal of ammonia by *Ulva* was previously demonstrated by data presented in Table 3.1-4. Results are reported in Appendix Table A-1-2.4. With the exception of Station SD01, PCB concentrations were below detection in all samples. As for metals, results were generally within two-fold concentration difference for respective *Ulva* and non-*Ulva* treated samples and no apparent trend due to treatment was observed. Hence it was concluded that the *Ulva* treatment should provide adequate data for the assessment of metals related toxicity without interference by PCB or ammonia.

3.3. Trophic Transfer Assessment

Not completed.

3.4. PRG Development

The objective of PRG development is to derive class- and/or analyte-specific criteria for metals and organics contaminants in sediments related to the Raymark site. For the PRG to be site-specific, it necessary to assess both the inherent toxicity of the chemical in the sediment mixture as well as the contribution the CoC makes to the overall toxicity of the sample. Because there is a lack of knowledge of how site-specific conditions may modify chemical bioavailability and the nature of non-linear interactions among CoCs which may modify toxicity, it is not possible to complete this evaluation using solely literature-based values. Rather re-testing of sediments is required in a manner which permits developing quantitative relationships between the toxicity of the sample and the concentration of the site-related CoCs.

Toxicity Identification Evaluation (TIE) involves chemical manipulation of field samples to separate CoC classes, such that CoC-specific exposure-response relationships can be developed. The work performed includes testing of both whole sediment and whole porewater collected from stations of suspected toxicity as well as the partitioning of CoCs in porewater into metals and organics fractions for separate characterization.

As noted above, *Ampelisca* was chosen for these tests because of its amenability to this type of short-term exposure. The bivalve, *Mulinia lateralis*, was chosen for the TIE testing because of its ease of handling and culture in the laboratory, its wide range of salinity tolerance, and the ability to produce embryos for testing on-demand. This last characteristic is the most compelling reason in the selection of this species as a surrogate for the oyster, *Crassostrea virginica*. It also is more appropriate to utilize a ubiquitous eastern bivalve as a surrogate for *C. virginica* than to use the west coast species *C. gigas* which was previously used in the Raymark Ecological Risk Assessment (NOAA, 1996).

As discussed above, porewater fractionation (TIE) procedures included two primary manipulation methods: EDTA chelation to bind metals and effectively remove them from the mixture; and C18 column extraction to remove organic compounds. The interpretation of the TIE data with regards to identifying the chemicals responsible for causing observed toxicity was accomplished according to the following approach:

- Assess the magnitude of porewater CoC exceedence of benchmarks in relation to sample toxicity was used to derive thresholds below which adverse effects would be unexpected, called the Threshold Effect Quotient (TEQ; Section 3.4.1);
- Separately determine TEQs for CoCs in TIE fractions (Section 3.4.2);
- Intercompare whole porewater and TIE TEQs for the species tested to identify primary CoCs for PRG development, and select range of appropriate porewater concentrations that do not pose a toxic risk (Section 3.4.3);
- Translate TEQ values to whole sediment concentrations to determine Aquatic Preliminary Remediation Goals and assess selected PRGs against sediment based results and results of the Ecological Risk Assessment to verify PRG effectiveness aquatic for risk reduction (Section 3.4.4).

A brief description of each step in the interpretive framework is provided below.

3.4.1. Porewater Toxic Units (TUs)

As discussed above, two test species were utilized as surrogates for aquatic Receptors of Concern at the Raymark site. The bivalve *Mulinia lateralis* was employed as a surrogate for the American oyster and the amphipod *Ampelisca abdita* as a surrogate for appropriately sensitive benthic organisms. *Ampelisca* was also the organism used in the whole sediment tests and thus provides a common basis for relating sediment to porewater toxicity, particularly because species-specific data are available as to the concentration of individual chemicals in undiluted porewater sample ($[PW_{CoC}]$) expected to cause 50% reduction in survival (LC50) in single toxicant laboratory bioassays. These data are used to quantify the overall toxicity of samples from a chemical perspective as the number of "toxic units" for the CoC ($IWTU_{CoC}$) as follows:

$$1)\ IWTU_{CoC} = [PW_{CoC}]/LC50_{CoC};$$

The above procedure is repeated for each of the CoCs of interest in the sample and IWTUs summed to obtain the ΣIWTU (Sum Interstitial Water Toxic Units) for the sample. Because species-specific data for *Mulinia* are not available, LC50 values for *Ampelisca* were assumed to be comparable.

Results of IWTU and ΣIWTU calculations for porewater exposure to *Ampelisca* and *Mulinia* is reported separately for metals and organics in Table 3.4-1. For the metals, only arsenic, cadmium, copper and zinc were found to occur at concentrations in porewater that were at least 10% of the LC50 value (i.e.. IWTU > 0.1); other analytes were excluded from analysis since these CoCs were unlikely to substantially contribute to the toxicity of the sample. The Table includes ranked toxicity results paired with corresponding IWTUs, segregated by degree of toxicity (High, Intermediate. Low, Non-toxic). A Threshold Effect Quotient (TEQ) is also calculated for each CoC and used as a point of reference to identify CoCs and associated concentrations which might be contributing to increased sample toxicity. The TEQ is taken as the maximum IWTU value of the least toxic sample group, or where this IWTU value is less than unity, a TEQ = 1 was adopted. It is expected that site-specific conditions in sediments of the Raymark study area might result in TEQ values greater than one as a given CoC could be less toxic in the field sample than under the water only, single toxiciant test conditions in which the LC50 values were derived. Similarly, it was assumed that field conditions would not increase the toxicity of a given CoC to levels greater than that afforded in the laboratory tests, such that TEQ values < 1 would be considered spurious (and leading to a minimum TEQ = 1).

Results of exposure-response analyses for *Ampelisca* in whole porewater are presented in Table 3.4-1A. Among the metals, 46% of the samples were above the ΣIWTU TEQ (4.5) with copper and arsenic providing the majority contribution to the total. Copper and arsenic also had the highest frequency of TEQ exceedence; 31% of samples exceeding the TEQ were toxic. In contrast, none of the toxic samples were associated with elevated PAH or PCB concentration. Toxic units calculated for total ammonia did indicate that elevated toxicity in some samples (23%), might be unrelated to CoC exposure; however in only one of the six samples (Station SD01) did metal-related toxicity also coincide with elevated ammonia (TU > 1.0). Hence it is concluded that copper and arsenic may be the primary CoCs contributing to porewater toxicity to amphipods.

A similar exposure-response analysis for *Mulinia* is presented in Table 3.4-1B. In this instance, all samples exhibited some toxicity; although results for Station SD28 (EC20 = 55.7) were clearly less toxic than the remainder of samples. Using the SD28 result as the basis of comparison, 57% of the samples were above the metal ΣIWTU TEQ (4.1) with copper and arsenic providing the majority (amount and frequency) contribution to the total. As observed for Ampelisca, none of the toxic samples were associated with elevated PAH or PCB concentration. Again, toxic units calculated for total ammonia did indicate that elevated toxicity in a number of samples (57%), but still the predicted contribution from metals was more than twice that for ammonia, such that it may reasonably concluded that metals are the primary contributors to sample toxicity. Results of TIE analyses presented below will more directly address the relati\ contribution of ammonia to overall sample toxicity.

3.4.2. *Relative Toxicity of Metals and Organics*

The EDTA and C18 column manipulations (USEPA, 1996) were used to segregate the relative contributions to total toxicity from either metals or organic compounds, respectively. Presented in Table 3.4-2 are toxicity and IWTU data obtained after passing of the whole porewater sample through a carbon-activated (C18) column to remove organic contaminants. Only the ammonia data were not directly measured after C18/EDTA treatments.

Metals. The exposure-response analysis for *Ampelisca* in C18-treated porewater is presented in Table 3.4-2A. As a whole, the samples were generally less toxic in comparison to the whole porewater treatment results (perhaps due to ammonia removal). Copper exceeded the TEQ (1.46) in 20% of the cases, whereas arsenic, cadmium and zinc IWTUs were not associatec with toxic samples. It is also noted that the total IWTU value was not predictive of toxicity in any of the samples, which suggests that CoCs other than copper are not substantially contributin to sample toxicity.

The corresponding exposure-response analysis for *Mulinia* in C18-treated porewater is presented in Table 3.4-2B. The range of observed toxicity was also somewhat less than that observed for the whole porewater treatment results (again, perhaps due to ammonia removal), bı still, copper is identified as the primary CoC exceeding the TEQ (1.37), with arsenic and zinc being secondary but significant contributors to overall sample toxicity as noted from the total IWTU values.

Organics. The exposure-response analysis for *Ampelisca* in EDTA-treated porewater is presented in Table 3.4-3A. As a whole, the samples exhibited similar toxicity in comparison to the whole porewater treatment results. Two treated samples were found to have PCB concentrations above the TEQ, however, the degree of observed toxicity was comparable or less than that of other samples where PCB concentrations were below detection. Hence it is concluded that PCBs and PAHs are not likely to be primary contributors of toxicity in the samples and that non-CoC constituents such as ammonia are the cause of reduced toxicity.

The exposure-response analysis for *Mulinia* in EDTA-treated porewater is presented in Table 3.4-3B. In general, the samples exhibited slightly lower toxicity in comparison to the whole porewater treatment results. The distribution of toxicity followed the *Ampelisca* EDTA results in that two treated samples were found to have PCB concentrations above the TEQ, but again, the degree of observed toxicity was comparable to or even less than that of other samples where PCB concentrations were below detection. Hence it is again concluded that PCBs and PAHs are not likely to be primary contributors of toxicity in the samples and that non-CoC constituents such as ammonia are the cause of reduced toxicity in these samples.

Ammonia. A final TIE analysis was conducted to more directly assess the contribution of ammonia to overall sample toxicity. Results reported in Table 3.4-4 for *Ampelisca* and *Mulinia* include a comparison of toxicity responses between sample porewater treated with *Ulva* to remove ammonia and the untreated response as previously reported in Table 3.4-1.

Four samples selected for chemical analyses show comparable chemical concentrations before and after *Ulva* treatment and highly effective ammonia removal in the *Ulva* treatment as expected (Table 3.4-4). For *Ampelisca* (Table 3.4-4A), copper was again identified as the primary CoC contributing to toxicity in the Ulva treatment, with zinc contributing a minor fraction to the sample Total IWTU at Station HB3A. In addition, the estimated TEQ values were highly comparable between Ulva and non-Ulva exposures. Hence, it is concluded that the presence of ammonia in the samples did not significantly alter the TEQs derived from the data.

As with *Ampelisca*, copper was again identified as the primary CoC contributing to toxicity to *Mulinia* in the Ulva treatment (Table 3.4-4B), and zinc also contributed slightly to Total IWTU at one location (Station HB3A). More importantly, ammonia removal did not result in reduced toxicity, and because the estimated TEQ values were comparable between Ulva and non-Ulva exposures, it is concluded that the presence of ammonia in the samples did not significantly alter the TEQs derived from the data.

3.4.3. TEQ Intercomparisons

Table 3.4-5 provides a summary of TEQ values and frequency of exceedence as derived from *Ampelisca* and *Mulinia* exposures to whole porewater, C18 and EDTA treatments. For metals, TEQ values over the entire data set range from 1.0-2.6, with the copper TEQ exceeded most frequently (26.1%) among the 15 sampled locations. For some CoCs, the frequency of exceedence was so low as to merit rejection as PRGs; PCBs, cadmium, and zinc were observed above the TEQ value less than 10% of the time. The arsenic TEQ appeared potentially more relevant to *Mulinia* than to *Ampelisca* as deduced from frequency of exceedence, although the species and test-specific estimates were within two-fold magnitude of each other. In addition, arsenic was not one of the CoCs identified as being elevated in sediments (discussed in Section 3.2); half of the samples were less than the ER-L concentration, and the highest value was less than 3 fold higher than the ER-L (Station A3SD10, ERL-HQ = 2.91). Hence, the data would suggest that copper is the primary constituent in porewater causing toxicity, with a threshold for effects in the range of 1.4 (*Mulinia*, C18 treatment) to 2.7 (*Mulinia* and *Ampelisca:* whole porewater treatment) times the LC50 value (20.5 µg/L). The section below presents calculations used to derive the PRG (sediment equivalent concentration) comparable to this copper TEQ value.

3.4.4. Calculating Sediment-based PRG Concentrations

During the present investigation, results of bulk sediment testing with *Ampelisca* have identified eleven toxic sediments with three of the sediments having SEM-AVS concentrations exceeding unity, hence the likelihood for metals-related effects. The fact that more sediments did not exhibit SEM-related toxicity is most certainly due to high acid volatile sulfides in the samples which generally ranged from 6-12 μMol/g dry weight. Because of sample volume requirements and concern over the vertical representation of surface samples, the sampling depth was extended to approximately 12-15 cm below the sediment water interface. Field observations noted a very shallow apparent Redox Potential Depth (RPD), such that collected sediments were in many cases anoxic and hence likely to retain sulfides. Hence it is likely that measured toxicity may have under-represented the true potential toxicity of sediments in the oxygenated sediment-water interface zone where AVS would be oxidized and less available to bind divalent metals. In addition, seasonality and resuspension events may cause AVS concentrations to fluctuate (Peterson *et al.*, 1996).

As discussed in Section 3.2, the predominant metals found in the SEM fraction of sediment were zinc and lead at concentrations 2-6 μMol/g dry weight. In contrast, nickel generally contributes < 1 μMol/g dry wt, while cadmium and copper combined contribute less than 0.1 μMol/g dry wt. Hence in presence of reduced AVS concentration, zinc, lead and to a lesser extent, nickel, may combine to produce total SEM concentrations which exceed AVS, such that PRG concentrations corresponding to the SEM conditions would be desirable.

Relationships presented in Figure 3.4-1 demonstrate that SEM concentrations of lead, zinc and nickel (as discerned from the slope of the curves) are approximately 0.2%, 0.5% and 0.1% of the respective analyte concentrations in bulk sediment. These relationships can be used to estimate SEM concentrations from bulk sediment data, as follows:

2) SEM (μMol/g dry) = 0.002[Pb] + 0.005[Zn] + 0.001[Ni],

where [Pb], [Zn] and [Ni] are the bulk sediment concentrations of lead, nickel and zinc, respectively. For example, a sediment containing 1000 ppm each of the three metals would have and equivalent SEM concentration of 8 μMol/g dry weight. Oxidized sediments would not be expected to have AVS > 1 μMol/g, such that the hypothetical sediment SEM-AVS would be > seven, representing a free SEM concentration expected to be toxic. Thus sediment based PRGs should be selected for these three metals, and could be derived from a statistical probability distribution of the entire site data set collected as part of the FS investigation. It is noted that results of the Ecological Risk Assessment as analyzed in SAIC, (1997) show reduced diversity and number of species at SEM concentrations > 10 μMol/g dry wt.

Porewater and TIE testing has directed the focus on copper as the primary CoC of concern, with the upper range of no to low toxic effects determined for two species/life stages (*Ampelisca* survival, *Mulinia* larval development success). Relationships between copper concentrations in porewater and corresponding concentrations measured in bulk sediment are depicted in Figure 3.4-2. The strongest relationship is apparent between porewater concentration and the TOC normalized sediment concentration ($y = 0.23X+29.1$; $r^2 = 0.99$). This result is in agreement with findings of Mahony *et al.* (1996) which showed that porewater concentrations of divalent metals, particularly copper, may be strongly influenced by the TOC content of sediment. Interpolating the copper TEQ range of 1.4-2.7 (28.7 - 55 µg/L), the corresponding sediment concentration can be estimated in the range of 4.2 - 111.6 µg Cu/mg TOC. Subsequently, the median site-wide concentration of TOC in sediment (7.8% = 78 mg TOC/g sediment; Appendix A-1-4.2) can be applied to approximate the sediment-based PRG concentration (329 µg/g to 8700 µg/g dry wt). Perusal of copper concentrations in sediment (Appendix A-1-1) finds that 66% (10/15) of the sediments exceed the more conservative PRG estimate. As discussed above for SEM data, a more detailed analysis of the entire copper data set collected as part of the FS investigation could provide a statistical probability distribution to determine the potentially affected area.

Finally, data on sediment dioxin concentrations were collected primarily to support assessment of potential food chain transfer to fish and aquatic birds (discussed in Section 3.4.3). Apart from the potential risks to fish and wildlife, an analysis was conducted to further evaluate the potential exposure response relationship between amphipod survival and dioxin concentration deduced from the ERA (as reported in SAIC 1997). The results of the analysis is presented in Figure 3.4-3, where all amphipod samples exhibited intermediate toxicity (< 50% survival) at Total Toxicity Equivalency concentrations > 150 ng/g dry weight. Perusal of the dioxin data reported in Appendix A-1-6) finds that 33% (5/15) of the sediments exceed this threshold for amphipod toxicity. As discussed above for the SEM/ data, a more detailed analysis of the entire dioxin data set should be performed to determine the potentially affected area and need for adopting a sediment-based PRG for dioxin.

4.0 SUMMARY

Toxicity Testing

- Bulk sediment tests with *Ampelisca* identified 15 stations (out of 20) with mean survival less than 85%. These locations were selected for subsequent porewater and TIE evaluations.

- Good agreement was found between *Ampelisca* bulk sediment survival and porewater EC20 endpoints with respect to sampling location and qualitative extent of toxicity;

- On the basis of toxicity results alone, the EDTA and C18 TIE fractionation tests with *Ampelisca* were inconclusive with respect to the relative role of metals vs. organics in CoC-related impacts.

- Porewater aeration of high ammonia samples increased sample toxicity; it is postulated that this effect may be caused by release of metals during acid volatile sulfide oxidation.

- Unlike *Ampelisca* exposures, EDTA and C18 TIE fractionation tests with *Mulinia* caused differential reductions in sample toxicity, hence providing valuable data for segregating metals vs. organics effects.

Chemical Analytical Results

- In sediments, copper, nickel, lead and zinc were found at concentrations which often exceeded the respective ER-M benchmarks. In contrast, arsenic, chromium and mercury only occasionally exceeded ER-L benchmarks. Four of 15 sampling locations had PAH analyte concentrations exceeding ER-M concentrations. Thirteen of 15 sampling locations had Total PCB concentrations exceeding ER-M values; however uncertainty exist due to the composition of congeners used in the calculation.

- For sediment porewaters, concentrations were normalized to Water Quality Screening Values (*Ampelisca* LC50, EPA WQC- Saltwater Chronic Values) to derive Interstitial Water Toxic Units (IWTUs). Among the metals, copper clearly emerges as the principal CoC of concern, with IWTUs > 1 at all but one station, followed by arsenic (four stations) and zinc (two stations). PCBs were substantially elevated at six stations, but non-detect in the remaining samples. PAHs were almost entirely less than 1 µg/L in all samples.

- In samples treated with EDTA for metals reduction, detectable PCB concentrations were found in only three of the six samples, and total concentrations were reduced by a factor of 10 or more.

- In samples treated with C18 for organics reduction, copper was the most prevalent CoC with concentrations exceeding the WQSV for eight of 15 stations; PCBs were non-detect in all samples.

- Samples were subjected to *Ulva* treatment for purposes of ammonia reduction. Samples chemically analyzed after *Ulva* treatment had substantial PCB loss; concentrations were below detection in all samples while metals were generally within two-fold of non-*Ulva* treated samples.

PRG Development

- The magnitude and frequency of porewater CoC exceedence of benchmarks in relation to sample toxicity was used to derive CoC-specific values below which adverse effects would be unexpected, called the Threshold Effect Quotient (TEQ).

- Results of porewater exposure-response analyses for *Ampelisca* and *Mulinia* suggest that copper and arsenic were the primary CoCs with IWTUs above the TEQ, whereas none of the toxic samples had elevated PAH or PCB IWTUs.

- The C18 treatment of porewater were used to separately address the relative contributions to total toxicity from individual metals. For *Ampelisca*, only copper was associated with toxic samples above the TEQ (1.46; 20% frequency). For Mulinia assays, copper was the main CoC exceeding the TEQ (1.37; 25% frequency), while exceedences of the arsenic TEQ (1.47; 16.7% frequency) and zinc TEQ (1.0, 16.7% frequency) were also noted.

- The EDTA treatment of porewater were used to separately address the relative contributions to total toxicity from individual organic compounds. For *Ampelisca*, only PCBs were occasionally associated with toxic samples above the TEQ (1.00; 16.7% frequency). Similarly for *Mulinia*, only PCBs were occasionally associated with toxic samples above the TEQ (1.00; 15.4% frequency). In both cases, however, the degree of observed toxicity was comparable or less than that of other samples where PCB concentrations were below detection, such that it was concluded that PCBs are not likely to be primary contributors of toxicity.

- A final TIE analysis using Ulva-treated porewater to more the contribution of ammonia to overall sample toxicity. Chemical analyses show comparable metals concentrations before and after *Ulva* treatment and complete ammonia removal in the *Ulva* treatment. Copper was again identified as the primary CoC contributing to toxicity in the *Ulva* treatment for both *Ampelisca* and *Mulinia* tests, and estimated TEQ values were comparable between *Ulva* and non-*Ulva* exposures. Hence, it is concluded that the presence of ammonia in the samples did not significantly alter the TEQs derived from the data.

- In considering TEQ values and frequency of exceedence as derived from *Ampelisca* and *Mulinia* exposures to whole porewater, C18 and EDTA treatments; the data suggest that copper is the primary constituent in porewater causing toxicity, with a threshold for effects in the range of 1.4 to 2.7 times the LC50 value (20.5 µg/L).

- With regard to the bioavailability of sediment metals, the potential for reduced AVS concentration in surface sediments raises concern that presently bound SEM metals could become toxic. A modelwas developed to predict SEM concentration from bulk sediment concentrations such that PRGs for lead and zinc can be evaluated.

- A TOC-dependent model relating copper concentrations in porewater and corresponding bulk sediment concentrations was developed for calculation of the copper PRG. From the model, a the sediment-based PRG concentration of 329 µg/g to 8700 µg/g dry wt. Approximately 66% (10/15) of the sediments collected from the present investigation exceed the more conservative PRG estimate.

- Finally, data on sediment dioxin concentrations were evaluated to assess potential risks to aquatic birdsfrom consumption of sediment and fish. An exposure response relationship between amphipod survival and dioxin concentration was observed where Total Toxicity Equivalency (Teq) concentrations > 150 ng/g dry weight were associated with intermediate to high toxicity. About 33% (5/15) of the sediments exceed this threshold for amphipod toxicity.

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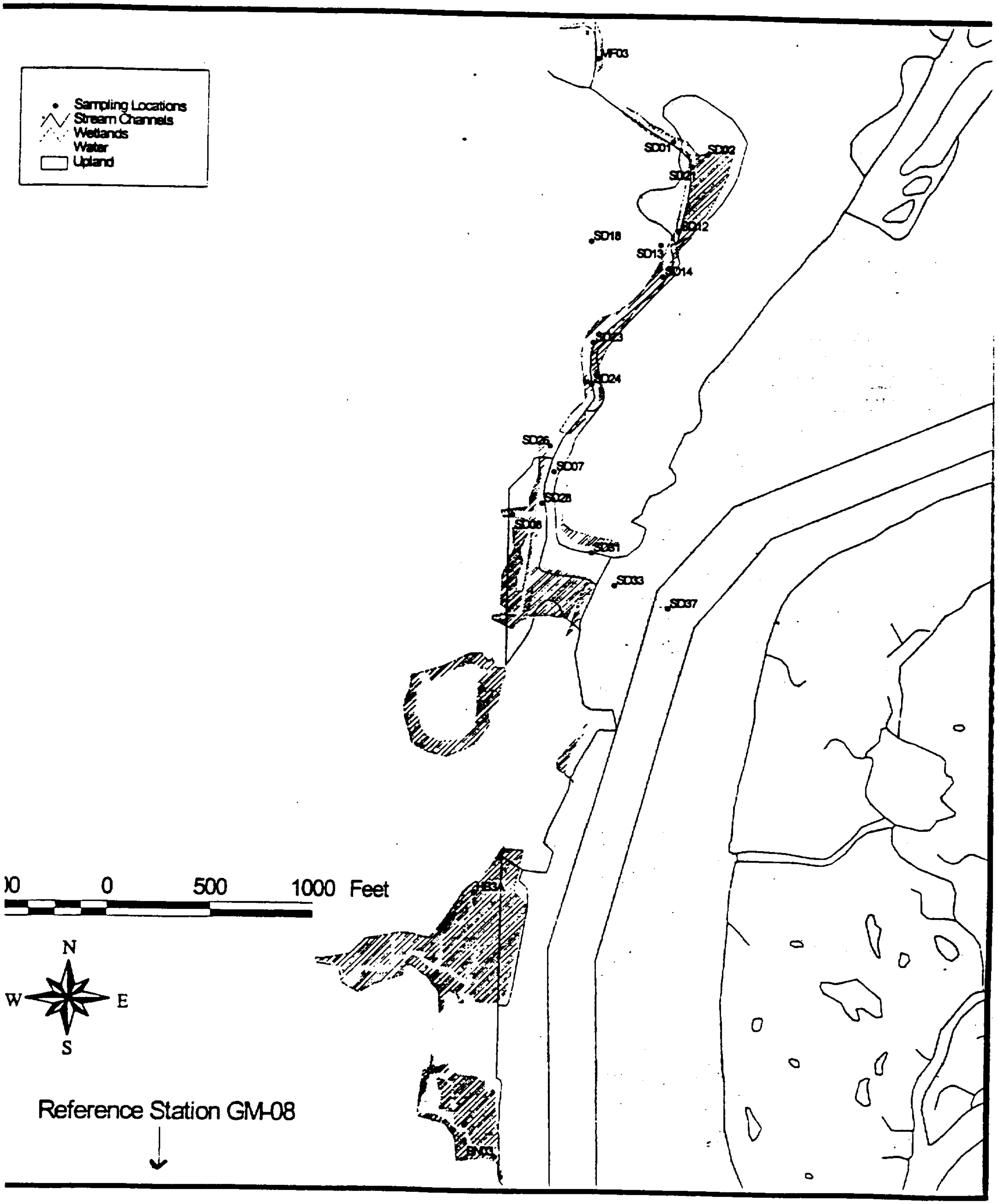
Figure 2-1.1. PRG Sampling Locations in the vicinity of the Raymark Facility Superfund Site in Stratford, CT
All Stations



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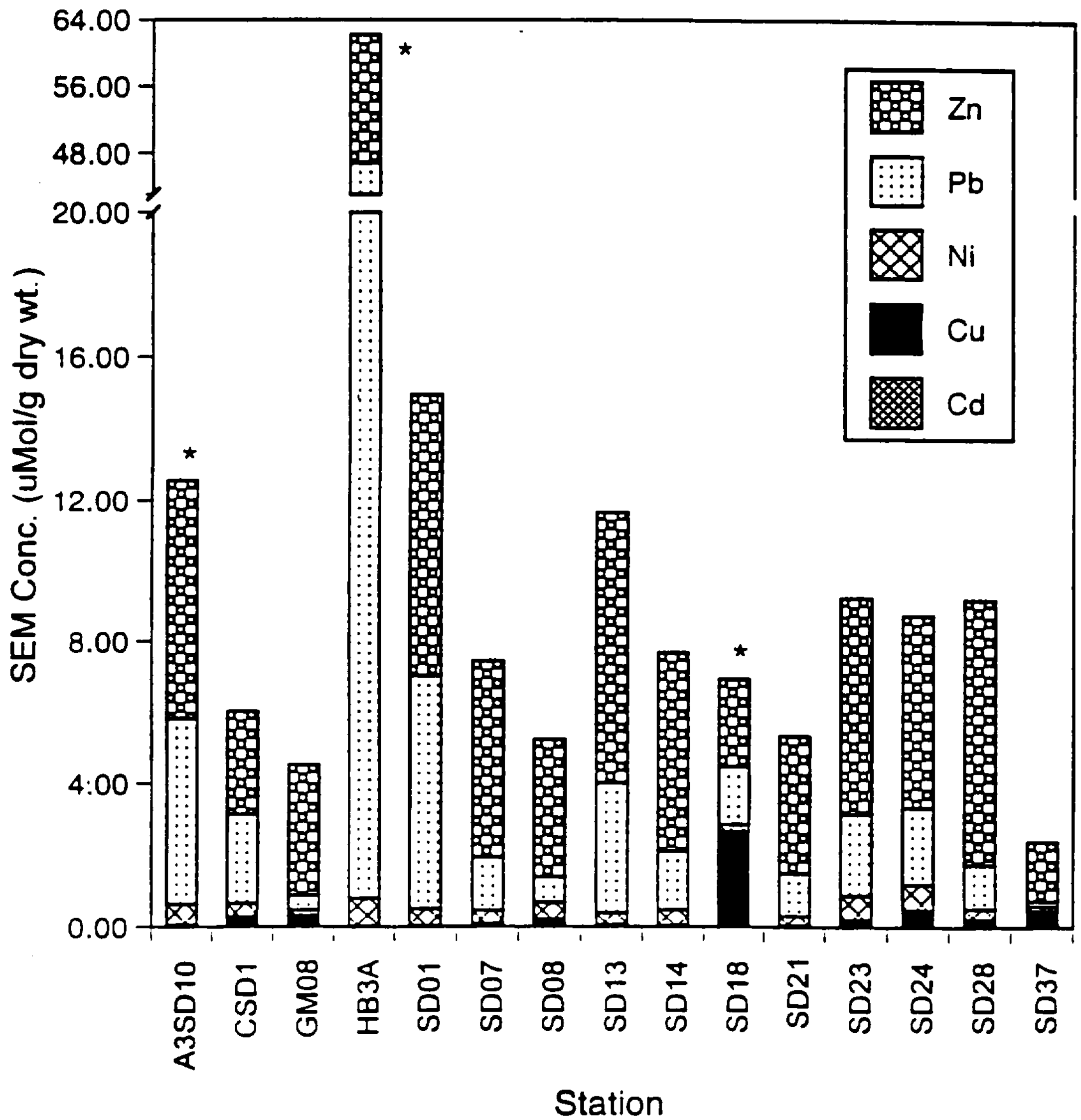


Figure 3.2-1. SEM concentrations (μMol/g dry) of divalent metals in whole sediments collected from Raymark study area. Asterisk indicate SEM-AVS > 0, hence the potential for metal-related toxicity to infauna.

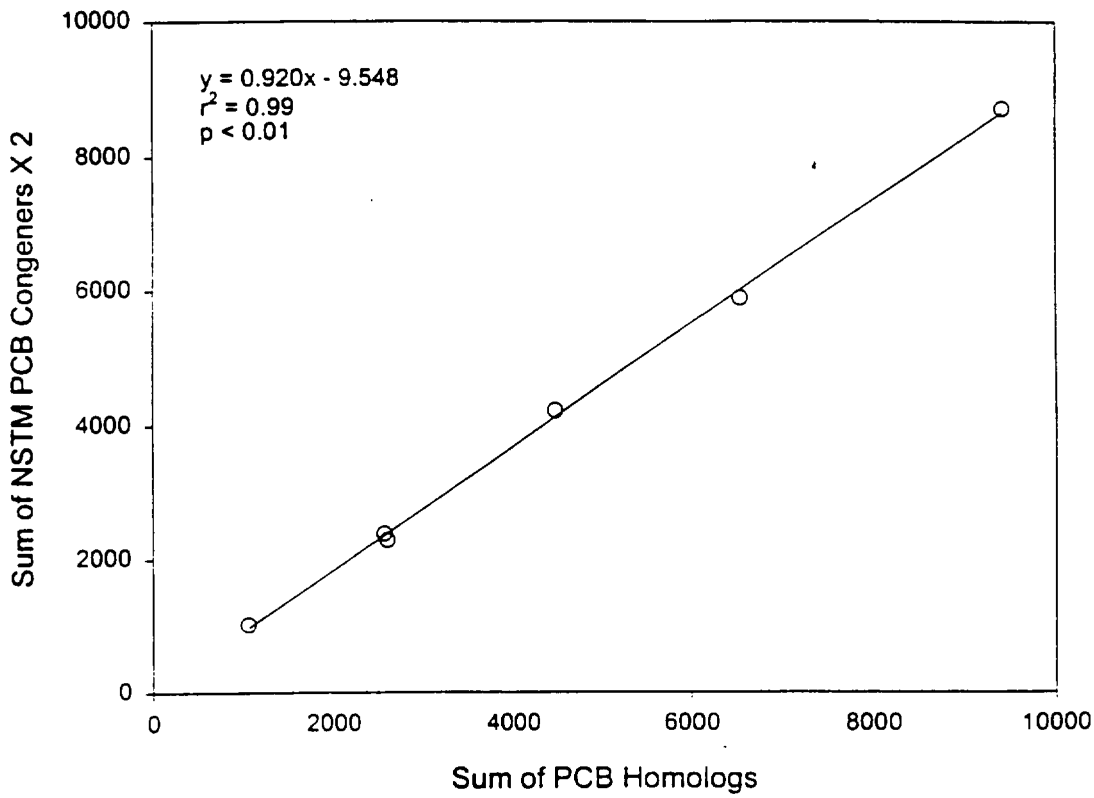
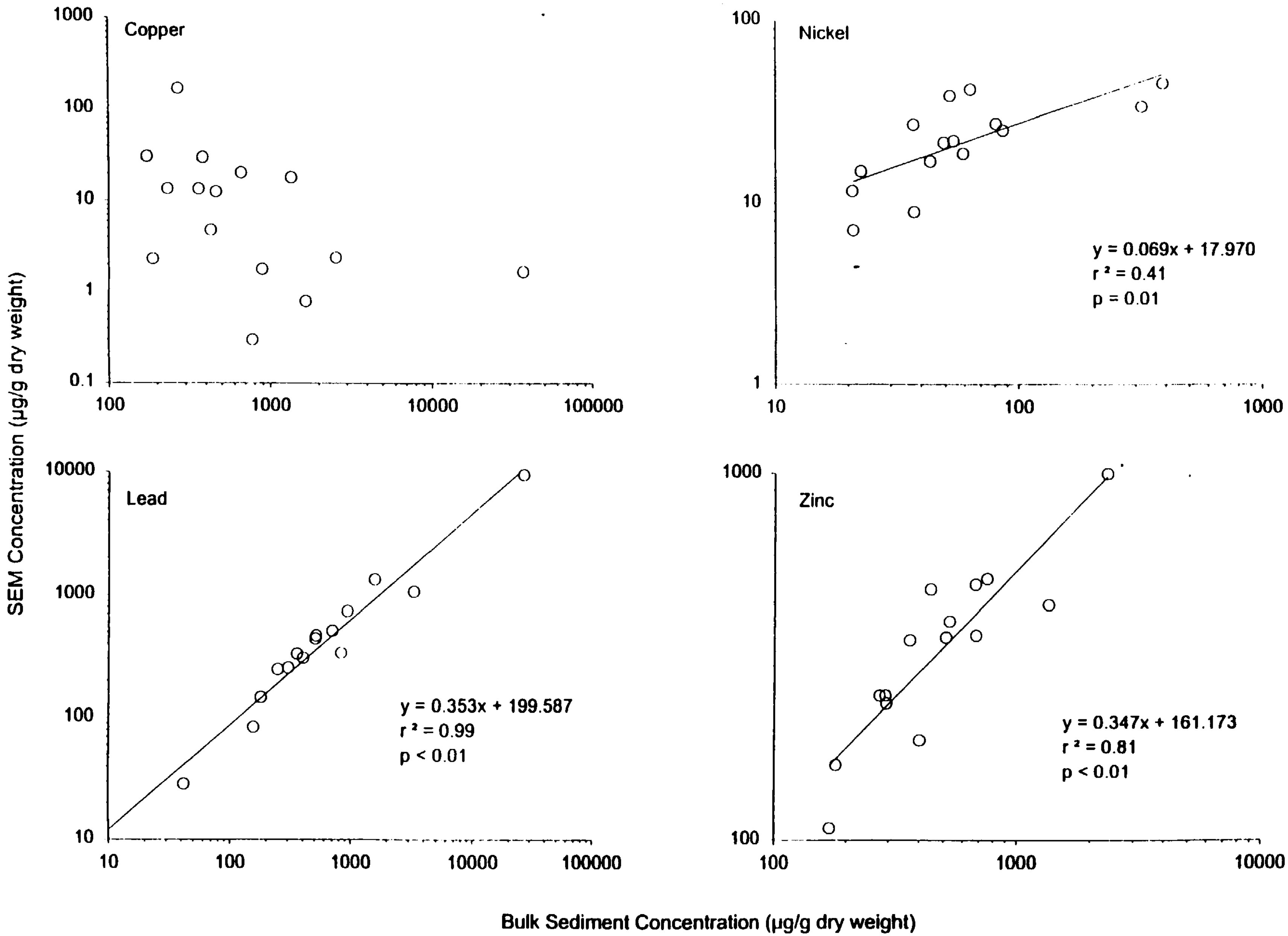


Figure 3.2-2. Relationship between congener-based and homolog-based estimates of Total PCB concentrations in sediments collected from the Raymark study area.



Copper
Nickel
y = 0.069x + 17.970
r² = 0.41
p = 0.01
Lead
y = 0.353x + 199.587
r² = 0.99
p < 0.01
Zinc
y = 0.347x + 161.173
r² = 0.81
p < 0.01
SEM Concentration (µg/g dry weight)
Bulk Sediment Concentration (µg/g dry weight)

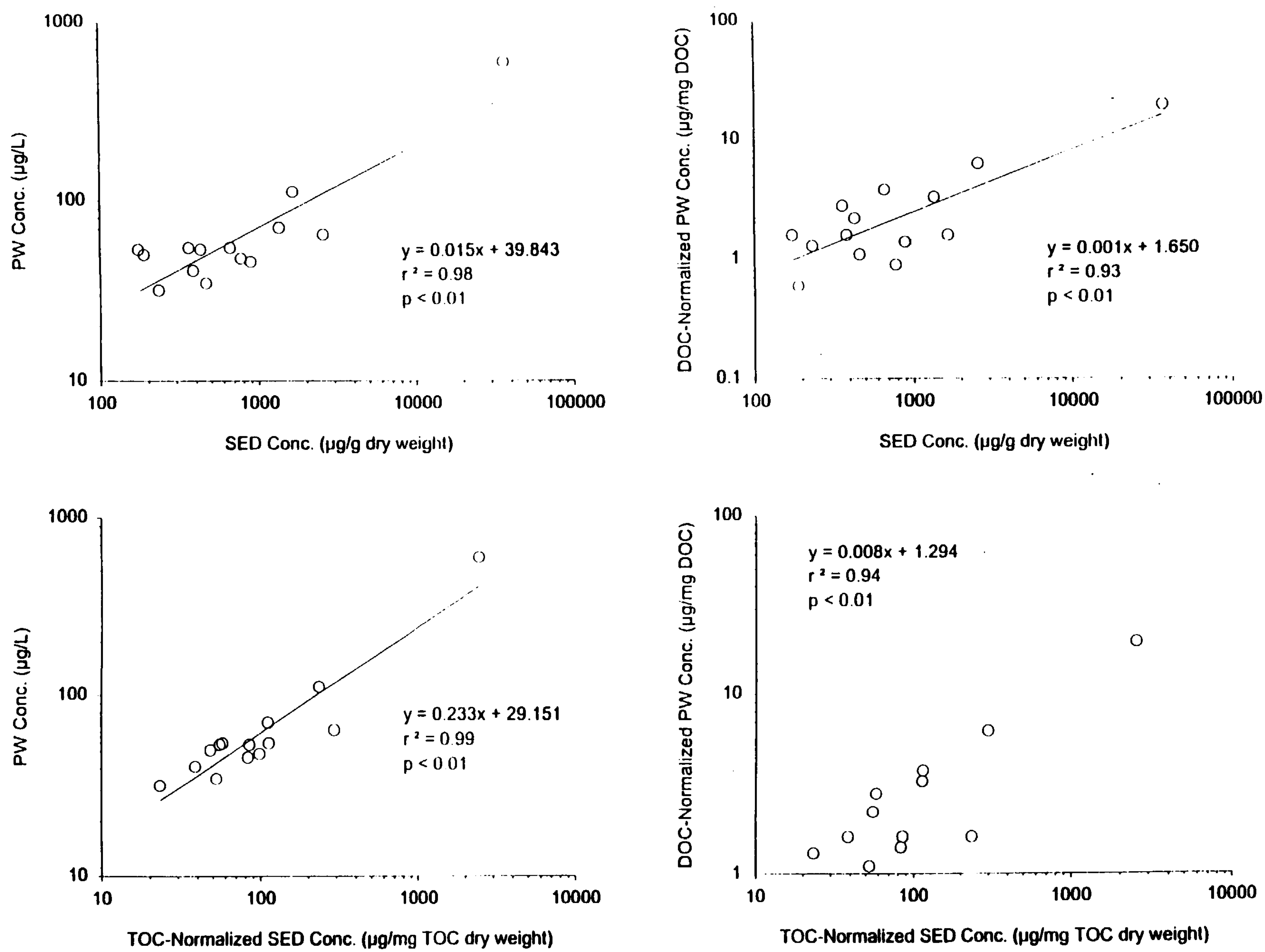


Figure 3.4-2. Whole and DOC-normalized porewater (PW) concentrations versus whole and TOC-normalized sediment (SED)

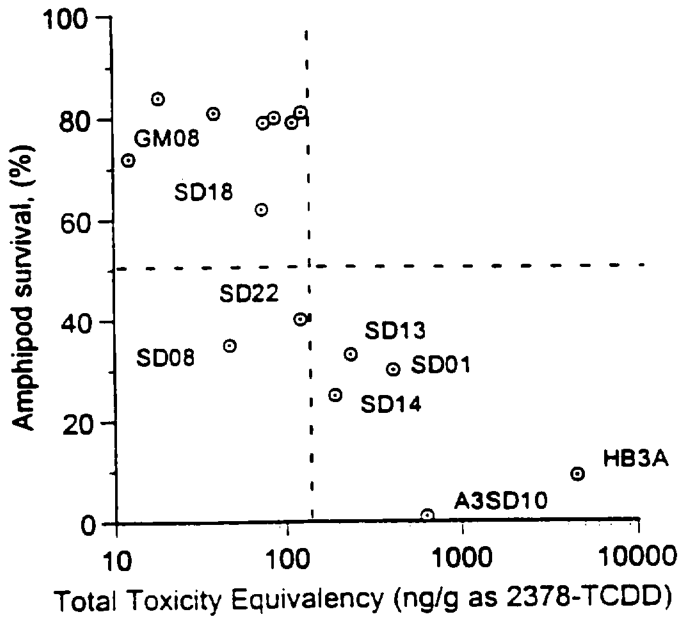


Figure 3.4-3. Exposure - response relationship between amphipod survival and dioxin toxicity relative to 2378-TCDD.

Table 3.1-1. Results of *Ampelisca abdita* survival tests with bulk sediments collected from the Raymark study area.

			Survival	
	Ammonia (mg/L)[1]		Bulk Sediment	
Station	Total	Unionized	% Control[2]	Flag[3]
A3SD10	2.05	0.01	1.00	+++
CSD1	8.92	0.06	81.0	-
GM08	2.04	0.01	72.0	+
HB3A	6.43	0.11	9.00	+++
SD01	6.59	0.10	30.0	++
SD07	26.1	0.38	79.0	+
SD08	23.8	0.20	81.0	-
SD13	18.3	0.27	33.0	++
SD14	13.4	0.16	25.0	++
SD18	7.12	0.02	62.0	+
SD21	8.43	0.08	35.0	++
SD23	6.69	0.08	40.0	++
SD24	3.65	0.05	80.0	-
SD28	15.6	0.43	79.0	+
SD37	8.51	0.11	84.0	-
BN03[4]	6.67	0.09	87.0	-
MF03[4]	17.8	0.21	97.0	-
SD26[4]	8.24	0.12	100	-
SD31[4]	11.8	0.16	95.0	-
SD33[4]	4.47	0.10	86.0	-

1 - Ammonia measurements from overlying water column.

2 - Survival in Long Island Sound sediment used as control response for all treatments.

3 - Rankings for impacts to *Ampelisca* survival:
High (+++) <20 %; Intermediate (++) ≥20 and <50%; Low (+) ≥50 and <80%;
Non-toxic (-) >80%.

4 - Stations with > 85% survival not selected for further TIE analysis.

Table 3.1-2. Results of *Ampelisca abdita* survival tests with sediment porewaters collected from the Raymark study area.

	Whole Porewater Ammonia (mg/L)		Survival[1]					
			Whole Porewater		EDTA-Treated Porewater		C18-Treated Porewater	
Station	Total	Unionized	LC20[2] (%)	Flag[3]	LC20[2] (%)	Flag[3]	LC20[2] (%)	Flag
A3SD10	19.6	0.12	77.3	+	100	-	100	-
CSD1	16.5	0.33	64.3	+	70.0	+	83.3	-
GM08	12.3	0.06	80.0	-	100	-	100	-
HB3A	16.0	0.13	66.7	+	60.0	+	22.7	++
SD01	34.3	0.30	40.0	++	60.0	+	55.6	+
SD07	31.4	0.64	60.0	+	62.5	+	83.3	-
SD08	29.3	0.36	43.5	++	60.0	+	60.0	+
SD13	37.0	0.41	60.0	+	60.0	+	60.0	+
SD14	27.4	0.27	60.0	+	55.6	+	60.0	+
SD18	44.1	0.09	25.0	++	18.0	+++	18.0	+++
SD21	35.6	0.28	60.7	+	60.0	+	60.0	+
SD23	23.5	0.51	60.0	+	60.0	+	60.0	+
SD24	23.3	0.37	51.7	+	61.1	+	60.0	+
SD28	23.0	0.51	100	-	100	-	100	-
SD37	49.6	0.80	28.1	++	57.9	+	55.0	+

Shaded values indicate ≥ 10% change from whole porewater response.

1 - Control value for experiment, assumed for all treatments, is 0% porewater.

2 - Lethal Concentration - 20% (concentration of porewater causing 20% reduction in survival).

3 - Rankings for impacts to *Ampelisca* survival:

High (+++) <20 %; Intermediate (++) ≥20 and <50%; Low (+) ≥50 and <80%; Non-toxic (-) >80%.

Table 3.1-3. Results of *Ampelisca abdita* survival tests with aerated and non-aerated sediment porewaters collected from the Raymark study area.

	Survival			
	Non-Aerated Porewater		Aerated Porewater	
Station	% Control[2]	Flag[3]	% Control[2]	Flag[3]
A3SD10	100	-	100	-
CSD1	100	-	100	-
GM08	100	-	100	-
HB3A	0.00	+++	0.00	+++
SD01	0.00	+++	0.00	+++
SD07	90.0	-	0.00	+++
SD08	80.0	-	80.0	-
SD13	30.0	++	10.0	+++
SD14	10.0	+++	0.00	+++
SD18	0.00	+++	0.00	+++
SD21	20.0	++	10.0	+++
SD23	0.00	+++	0.00	+++
SD24	80.0	-	0.00	+++
SD28	80.0	-	100.0	-
SD37	40.0	++	0.00	+++

Shaded values indicate ≥ 10% change from non-aerated porewater response.

1 - Ammonia measurements from overlying water column.

2 - Survival in Long Island Sound sediment used as control response for all treatments.

3 - Rankings for impacts to *Ampelisca* survival:

High (+++) <20 %; Intermediate (++) ≥20 and <50%; Low (+) ≥50 and <80%; Non-toxic (-) >80%.

Table 3.1-4. Results of *Mulinia* larval development tests with sediment porewaters collected from the Raymark study area.

	Whole Porewater Ammonia (mg/L)		Normal Larval Development[1]					
			Whole Porewater		EDTA-Treated Porewater		C18-Treated Porewater	
Station	Total	Unionized	EC20[2] (%)	Flag[3]	EC20[2] (%)	Flag[3]	EC20[2] (%)	Flag[3]
A3SD10	19.6	0.12	0.41	+++	17.0	++	2.05	+++
CSD1	16.5	0.33	11.7	++	11.2	++	2.46	+++
GM08	12.3	0.06	14.8	++	58.0	+	15.9	++
HB3A	16.0	0.13	8.26	+++	16.9	++	18.0	++
SD01	34.3	0.30	9.21	+++	15.9	++	18.0	++
SD07	31.4	0.64	7.20	+++	17.2	++	2.63	+++
SD08	29.3	0.36	3.20	+++	2.71	+++	3.09	+++
SD13	37.0	0.41	20.7	++	17.8	++	16.7	++
SD14	27.4	0.27	13.8	++	15.9	++	17.4	++
SD18	44.1	0.09	1.25	+++	2.00	+++	20.6	++
SD21	35.6	0.28	7.58	+++	15.2	++	16.9	++
SD23	23.5	0.51	31.3	++	12.1	++	49.2	+
SD24	23.3	0.37	14.9	++	21.1	++	45.7	+
SD28	23.0	0.51	55.7	+	55.7	+	46.8	+
SD37	49.6	0.80	7.39	+++	10.7	++	10.5	++

Shaded values indicate ≥ 10% change from whole porewater response.

1 - Control value for experiment, assumed for all treatments, is 0% porewater.

2 - Effect Concentration - 20% (concentration of porewater causing 20% reduction in test response).

3 - Rankings for impacts to *Mulinia* normal larval development:

High (+++) <10 %; Intermediate (++) ≥10 and <40%; Low (+) ≥40 and <70%; Non-toxic (-) ≥70%.

Table 3.1-5. Results of *Ampelisca abdita* survival and *Mulinia lateralis* larval development tests with *Ulva lactula* treated porewater collected from the Raymark study area.

Station	Ammonia (mg/L)		ULVA-treated Porewater Toxicity[1] Amphipod Survival		Bivalve Development	
	Total	Unionized	96-H LC20 (%)[2]	Flag[3]	48-H EC20 (%)[4]	Flag[5]
A3SD10	1.38	0.01	100	-	1.25	+++
CSD1	0.47	0.03	100	-	2.67	+++
GM08	0.12	0.00	100	-	1.25	+++
HB3A	1.55	0.03	24.0	++	1.25	+++
SD01	1.11	0.03	72.8	+	2.14	+++
SD07	1.88	0.09	100	-	1.64	+++
SD08	0.53	0.03	100	-	11.1	++
SD13	0.70	0.02	100	-	10.8	++
SD14	1.50	0.04	43.6	++	10.3	++
SD18	4.20	0.09	20.0	+++	5.91	+++
SD21	1.00	0.04	46.9	++	1.25	+++
SD23	2.82	0.04	100	-	0.38	+++
SD24	0.86	0.03	100	-	2.78	+++
SD28	0.86	0.04	100	-	13.8	++
SD37	3.00	0.11	100	-	2.24	+++

Shaded values indicate ≥ 10% change from whole porewater response.

1- See Appendix B-4 for toxicity data.

2 - Lethal Concentration - 50% (concentration of porewater causing 50% mortality in test species).

3 - Rankings for *Ampelisca* survival:

High (+++) < 20 %; Intermediate (++) < 50%; Low (+) < 80%; Non-toxic (-) ≥ 80%.

4 - Effect Concentration - 20% (concentration of porewater causing 20% reduction in test response).

3 - Rankings for impacts to *Mulinia* normal larval development:

High (+++) <10 %; Intermediate (++) ≥10 and <40%; Low (+) ≥40 and <70%; Non-toxic (-) ≥70%.

Table 3.2-1. Summary of sediment chemistry for the Raymark study area. HQ benchmark = ER-M reference data.

Class	Analyte	A3SD10			CSD1			GM08			HB3A			SD01			SD07		
		Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]
Metals	Silver	2.00	0.54	-	3.00	0.81	-	3.00	0.81	-	2.40	0.65	-	1.40	0.38	-	1.50	0.41	-
	Arsenic	23.9	0.34	-	11.2	0.16	-	17.9	0.26	-	9.20	0.13	-	7.00	0.10	-	10.60	0.15	-
	Cadmium	8.30	9.2E-3	-	1.20	1.3E-3	-	1.50	1.7E-3	-	1.00	1.1E-3	-	5.50	6.1E-3	-	4.40	4.9E-3	-
	Chromium	463	1.25	+	402	1.09	+	231	0.62	-	290	0.78	-	89.7	0.24	-	99.9	0.27	-
	Copper	2550	9.44	++	1350	5.00	++	661	2.45	++	36400	135	+++	1650	6.11	++	430	1.59	+
	Mercury	0.43	0.61	-	0.77	1.08	+	1.20	1.69	+	0.47	0.66	-	0.22	0.31	-	0.32	0.45	-
	Nickel	317	6.14	++	54.0	1.05	+	37.4	0.72	-	386	7.48	++	80.7	1.56	+	49.2	0.95	-
	Lead	3290	15.1	+++	703	3.22	++	158	0.72	-	26500	122	+++	1570	7.20	++	403	1.85	+
	Zinc	1340	3.27	++	399	0.97	-	292	0.71	-	2320	5.66	++	750	1.83	+	508	1.24	+
	Metals Hazard Index[4]		36.7			13.4			7.99			272			17.7			6.92	
PAHs	2-Methylnaphthalene	1000	1.49	+	660	0.99	-	660	0.99	-	660	0.99	-	710	1.06	+	650	0.97	-
	Acenaphthene	1000	2.00	+	660	1.32	+	660	1.32	+	660	1.32	+	140	0.28	-	160	0.32	-
	Acenaphthylene	190	0.30	-	200	0.31	-	660	1.03	+	660	1.03	+	350	0.55	-	330	0.52	-
	Anthracene	120	0.11	-	190	0.17	-	660	0.60	-	660	0.60	-	520	0.47	-	520	0.47	-
	Benzo(a)anthracene	1500	0.94	-	560	0.35	-	190	0.12	-	660	0.41	-	2500	1.56	+	2700	1.69	+
	Benzo(a)pyrene	1700	1.06	+	660	0.41	-	230	0.14	-	120	0.08	-	2400	1.50	+	2200	1.38	+
	Chrysene	2800	1.00	-	850	0.30	-	400	0.14	-	180	0.06	-	4000	1.43	+	4000	1.43	+
	Dibenz(a,h)anthracene	260	1.00	-	190	0.73	-	74.0	0.28	-	660	2.54	++	460	1.77	+	530	2.04	++
	Fluoranthene	950	0.19	-	470	0.09	-	390	0.08	-	660	0.13	-	1400	0.27	-	4200	0.82	-
	Fluorene	1400	2.59	++	730	1.35	+	220	0.41	-	1100	2.04	++	3800	7.04	++	3900	7.22	++
	Naphthalene	240	0.11	-	660	0.31	-	660	0.31	-	660	0.31	-	430	0.20	-	520	0.25	-
	Phenanthrene	4500	3.00	++	1200	0.80	-	330	0.22	-	280	0.19	-	5600	3.73	++	4500	3.00	++
	Pyrene	1000	0.38	-	660	0.25	-	660	0.25	-	660	0.25	-	190	0.07	-	260	0.10	-
	PAH Hazard Index[4]		14.2			7.40			5.90			9.95			19.9			20.2	
PCBs	Total PCBs	27081	150	+++	6006	33.4	+++	247	1.37	+	317183	1762	+++	20718	115	+++	2355	13.1	+++
	Sum of Aroclors[5]										39526						1760		
PSTs	p,p'-DDE										3.60	0.13	-				7.20	0.27	-

1 - Concentration units: metals = µg/g dry weight; PAHs, PCBs, pesticides = ng/g dry weight. See Appendix A-1-1 for sediment concentrations.

2 - Hazard Quotients calculated as sediment concentration/ER-M benchmark (Long *et al.*, 1995).

3 - HQ Ranking: "-" = HQ<1; "+" = HQ>1; "++" = HQ>2; "+++" = HQ>10.

4 - Hazard Index calculated as sum of analyte-specific Hazard Quotients.

5 - ER-M benchmarks not availabe for these analytes. Rankings reflect concentrations as follows: "-" = <100 ng/g; "+" = >100 ng/g; "++" = >1000 ng/g; +++ = >10000 ng/g.

Table 3.2-1 (continued). Summary of sediment chemistry for the Raymark study area. HQ benchmark = ER-M reference data.

Class	Analyte	SD08			SD13			SD14			SD18			SD21			SD23		
		Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]
Metals	Silver	1.40	0.38	-	1.40	0.38	-	0.88	0.24	-	0.44	0.12	-	0.54	0.14	-	0.93	0.25	-
	Arsenic	6.50	0.09	-	9.00	0.13	-	9.20	0.13	-	3.70	0.05	-	3.90	0.06	-	8.80	0.13	-
	Cadmium	1.40	1.5E-3	-	7.60	8.4E-3	-	7.60	8.4E-3	-	0.80	8.8E-4	-	3.20	3.5E-3	-	6.30	7.0E-3	-
	Chromium	84.4	0.23	-	91.5	0.25	-	116	0.31	-	31.8	0.09	-	37.3	0.10	-	91.7	0.25	-
	Copper	232	0.86	-	890	3.30	++	775	2.87	++	271	1.00	+	188	0.70	-	462	1.71	+
	Mercury	0.37	0.52	-	0.28	0.39	-	0.49	0.69	-	0.16	0.23	-	0.16	0.22	-	0.28	0.39	-
	Nickel	37.1	0.72	-	59.1	1.15	+	86.3	1.67	+	20.8	0.40	-	22.6	0.44	-	52.1	1.01	+
	Lead	181	0.83	-	934	4.28	++	833	3.82	++	357	1.64	+	249	1.14	+	514	2.36	++
	Zinc	290	0.71	-	671	1.64	+	676	1.65	+	181	0.44	-	274	0.67	-	525	1.28	+
	Metals Hazard Index[4]		4.34			11.5			11.4			3.97			3.46			7.39	
PAHs	2-Methylnaphthalene	660	0.99	-	1000	1.49	+	1700	2.54	++	610	0.91	-	615	0.92	-	990	1.48	+
	Acenaphthene	660	1.32	+	200	0.40	-	200	0.40	-	610	1.22	+	85.0	0.17	-	160	0.32	-
	Acenaphthylene	130	0.20	-	410	0.64	-	440	0.69	-	140	0.22	-	165	0.26	-	340	0.53	-
	Anthracene	140	0.13	-	680	0.62	-	640	0.58	-	250	0.23	-	305	0.28	-	570	0.52	-
	Benzo(a)anthracene	670	0.42	-	4000	2.50	++	3800	2.38	++	800	0.50	-	1450	0.91	-	2900	1.81	+
	Benzo(a)pyrene	640	0.40	-	4000	2.50	++	3600	2.25	++	790	0.49	-	1400	0.88	-	2900	1.81	+
	Chrysene	1000	0.36	-	10000	3.57	++	9200	3.29	++	1200	0.43	-	2000	0.71	-	4500	1.61	+
	Dibenz(a,h)anthracene	190	0.73	-	1100	4.23	++	1000	3.85	++	320	1.23	+	345	1.33	+	940	3.62	++
	Fluoranthene	380	0.07	-	9100	1.78	+	8400	1.65	+	600	0.12	-	895	0.18	-	1800	0.35	-
	Fluorene	990	1.83	+	5300	9.81	++	4800	8.89	++	1100	2.04	++	1950	3.61	++	4400	8.15	++
	Naphthalene	120	0.06	-	610	0.29	-	550	0.26	-	160	0.08	-	270	0.13	-	550	0.26	-
	Phenanthrene	1500	1.00	-	11000	7.33	++	11000	7.33	++	1500	1.00	-	3450	2.30	++	7900	5.27	++
	Pyrene	660	0.25	-	220	0.08	-	360	0.14	-	75.0	0.03	-	140	0.05	-	220	0.08	-
	PAH Hazard Index[4]		7.76			35.3			34.2			8.49			11.7			25.8	
PCBs	Total PCBs	967	5.37	++	8661	48.1	+++	4642	25.79	+++	2428	13.49	+++	1268	7.04	++	4119	22.88	+++
	Sum of Aroclors[5]													954					
PSTs	p,p'-DDE													5.40	0.20	-			

1 - Concentration units: metals = µg/g dry weight; PAHs, PCBs, pesticides = ng/g dry weight. See Appendix A-1-1 for sediment concentrations.

2 - Hazard Quotients calculated as sediment concentration/ER-M benchmark (Long *et al.*, 1995).

3 - HQ Ranking: "-" = HQ<1; "+" = HQ>1; "++" = HQ>2; "+++" = HQ>10.

4 - Hazard Index calculated as sum of analyte-specific Hazard Quotients.

5 - ER-M benchmarks not availabe for these analytes. Rankings reflect concentrations as follows: "-" = <100 ng/g; "+" = >100 ng/g; "++" = >1000 ng/g; +++ = >10000 ng/g.

Table 3.2-1 (continued). Summary of sediment chemistry for the Raymark study area. HQ benchmark = ER-M reference data.

Class	Analyte	SD24			SD28			SD37		
		Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]
Metals	Silver	0.62	0.17	-	1.60	0.43	-	0.60	0.16	-
	Arsenic	8.20	0.12	-	8.10	0.12	-	4.50	0.06	-
	Cadmium	2.60	2.9E-3	-	4.20	4.6E-3	-	0.51	5.6E-4	-
	Chromium	97.4	0.26	-	107	0.29	-	59.2	0.16	-
	Copper	383	1.42	+	361	1.34	+	173	0.64	-
	Mercury	0.28	0.39	-	0.27	0.38	-	0.17	0.24	-
	Nickel	63.3	1.23	+	43.4	0.84	-	21.0	0.41	-
	Lead	506	2.32	++	303	1.39	+	42.3	0.19	-
	Zinc	363	0.89	-	439	1.07	+	171	0.42	-
	Metals Hazard Index[4]		6.80			5.86			2.29	
PAHs	2-Methylnaphthalene	660	0.99	-	1000	1.49	+	570	0.85	-
	Acenaphthene	660	1.32	+	1000	2.00	+	570	1.14	+
	Acenaphthylene	110	0.17	-	200	0.31	-	84.0	0.13	-
	Anthracene	150	0.14	-	300	0.27	-	120	0.11	-
	Benzo(a)anthracene	890	0.56	-	1700	1.06	+	430	0.27	-
	Benzo(a)pyrene	960	0.60	-	1900	1.19	+	470	0.29	-
	Chrysene	1600	0.57	-	3400	1.21	+	900	0.32	-
	Dibenz(a,h)anthracene	310	1.19	+	600	2.31	++	150	0.58	-
	Fluoranthene	670	0.13	-	1100	0.22	-	820	0.16	-
	Fluorene	1200	2.22	++	2300	4.26	++	540	1.00	-
	Naphthalene	160	0.08	-	310	0.15	-	570	0.27	-
	Phenanthrene	2400	1.60	+	4900	3.27	++	860	0.57	-
	Pyrene	83.0	0.03	-	130	0.05	-	570	0.22	-
	PAH Hazard Index[4]		9.60			17.8			5.92	
PCBs	Total PCBs	4865	27.03	+++	2383	13.24	+++	104.5	0.58	-
	Sum of Aroclors[5]									
PSTs	p,p'-DDE									

Table 3.2-2. Summary of porewater chemistry for the Raymark study area.

Class	Analyte	A3SD10			CSD1			GM08			HB3A			SD01		
		Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]
Metals	Silver	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-
	Arsenic	19.9	0.55	-	58.7	1.63	+	20.1	0.56	-	33.5	0.93	-			
	Cadmium	5.60	0.16	-	3.68	0.10	-	0.17	4.7E-3	-	3.17	8.8E-2	-	2.83	7.9E-2	-
	Chromium	1.47	2.9E-2	-	2.64	5.3E-2	-	1.69	3.4E-2	-	0.84	1.7E-2	-	3.24	6.5E-2	-
	Copper	65.0	3.17	++	71.0	3.46	++	55.0	2.68	++	599	29.2	+++	112	5.46	++
	Nickel	244	0.10	-	14.2	5.9E-3	-	32.0	1.3E-2	-	112	4.7E-2	-	27.3	1.1E-2	-
	Lead	1.40	4.6E-4	-	1.44	4.8E-4	-	1.56	5.2E-4	-	13.2	4.4E-3	-	2.80	9.3E-4	-
	Zinc	1540	4.49	++	260	0.76	-	420	1.22	+	170	0.50	-	170	0.50	-
	Metals Hazard Index[4]		8.50			6.01			4.52			30.8			6.12	
PAHs	PAH Hazard Index[4]															
PCBs	Total PCBs				1093	27.3	+++									

1 - Concentration units: µg/L. See Appendix A-1-2 for porewater concentrations.

2 - Hazard Quotients calculated as sediment concentration/WQSV benchmark (see Appendix A-2-2).

3 - HQ Ranking: "-" = HQ<1; "+" = HQ>1; "++" = HQ>2; "+++" = HQ>10.

4 - Hazard Index calculated as sum of analyte-specific Hazard Quotients.

Table 3.2-2 (continued). Summary of porewater chemistry for the Raymark study area.

Class	Analyte	SD07			SD08			SD13			SD14			SD18		
		Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]
Metals	Silver	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-
	Arsenic	95.2	2.64	++	80.8	2.24	++	73.6	2.04	++	17.5	0.49	-	15.7	0.22	-
	Cadmium	3.86	0.11	-	1.60	4.4E-2	-	2.78	7.7E-2	-	3.27	9.1E-2	-	3.45	1.8E-2	-
	Chromium	1.05	2.1E-2	-				2.81	5.6E-2	-	3.14	6.3E-2	-	1.33	3.8E-2	-
	Copper	54.0	2.63	++	32.0	1.56	+	46.0	2.24	++	48.0	2.34	++	52.0		
	Nickel	15.3	6.4E-3	-	41.0	1.7E-2	-	4.00	1.7E-3	-	31.0	1.3E-2	-	16.4	5.3E-3	-
	Lead	0.75	2.5E-4	-	1.72	5.7E-4	-	0.75	2.5E-4	-	3.56	1.2E-3	-	1.96	3.3E-4	-
	Zinc	150	0.44	-	200	0.58	-	140	0.41	-	270	0.79	-	130	0.12	-
	Metals Hazard Index[4]		5.85			4.45			4.8			3.78			0.40	
PAHs	PAH Hazard Index[4]								40.4	+++						
PCBs	Total PCBs	2084	52.1	+++	2000	50.0	+++	504	12.6	+++						

1 - Concentration units: µg/L. See Appendix A-1-2 for porewater concentrations.

2 - Hazard Quotients calculated as sediment concentration/WQSV benchmark (see Appendix A-2-2).

3 - HQ Ranking: "-" = HQ<1; "+" = HQ>1; "++" = HQ>2; "+++" = HQ>10.

4 - Hazard Index calculated as sum of analyte-specific Hazard Quotients.

Table 3.2-2 (continued). Summary of porewater chemistry for the Raymark study area.

Class	Analyte	SD21			SD23			SD24			SD28			SD37		
		Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]	Conc[1]	HQ[2]	Rank[3]
Metals	Silver	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-
	Arsenic	12.0	0.33	-	34.6	0.96	-	11.8	0.33	-	19.1	0.53	-	18.0	0.50	-
	Cadmium	3.41	9.5E-2	-	3.33	9.2E-2	-	2.80	7.8E-2	-	3.71	0.10	-	2.95	8.2E-2	-
	Chromium	0.67	1.3E-2	-	3.24	6.5E-2	-	2.36	4.7E-2	-						
	Copper	50.5	2.46	++	35.0	1.71	+	41.0	2.00	+	55.0	2.68	++	54.0	2.63	++
	Nickel	15.0	6.3E-3	-	9.50	4.0E-3	-	14.9	6.2E-3	-	7.40	3.1E-3	-			
	Lead	2.26	7.5E-4	-	3.92	1.3E-3	-	4.40	1.5E-3	-	2.76	9.1E-4	-	8.96	3.0E-3	-
	Zinc	115	0.34	-	60.0	0.17	-	50.0	0.15	-	260	0.76	-	50.0	0.15	-
	Metals Hazard Index[4]		3.25			3.01			2.61			4.08			3.37	
PAHs	PAH Hazard Index[4]															
PCBs	Total PCBs				1144	28.6	+++				2212	55.3	+++			

1 - Concentration units: µg/L. See Appendix A-1-2 fo 1 - Concentration units: µg/L. See Appendix A-1-2 for porewater concentrations.

2 - Hazard Quotients calculated as sediment concentration/WQSV benchmark (see Appendix A-2-2).

3 - HQ Ranking: "-" = HQ<1; "+" = HQ>1; "++" = HQ>2; "+++" = HQ>10.

4 - Hazard Index calculated as sum of analyte-specific Hazard Quotients.

Table 3.4-1. Exposure-response analysis for **porewater**-related CoC toxicity: A) *Ampelisca*.

	Toxicity		Interstitial Water Toxic Units (100% Porewater Conc./LC_{50})								
			Metals					Organics			
Station	EC20%	Tox-GRP[2]	Arsenic	Cadmium	Copper	Zinc	$\Sigma IWTU_{PW}$	PCBs	PAHs	$\Sigma IWTU_{PW}$	NH_4-TOT
SD18	25.0	I	0.2	0.0	0.0	0.1	0.4	0.0	0.0	0.0	1.5
SD37	28.1	I	0.5	0.1	2.6	0.1	3.4	0.0	0.0	0.0	**1.7**
SD01	40.0	I	0.0	0.1	**5.5**	0.5	**6.0**	0.0	0.0	0.0	**1.1**
SD08	43.5	I	**2.2**	0.0	1.6	0.6	4.4	50.0	0.0	50.0	1.0
SD24	51.7	L	0.3	0.1	2.0	0.1	2.6	0.0	0.0	0.0	0.8
SD07	60.0	L	**2.6**	0.1	2.6	0.4	**5.8**	52.1	0.0	52.1	1.0
SD13	60.0	L	**2.0**	0.1	2.2	0.4	**4.8**	12.6	0.0	12.6	1.2
SD14	60.0	L	0.5	0.1	2.3	0.8	3.7	0.0	0.0	0.0	0.9
SD23	60.0	L	1.0	0.1	1.7	0.2	2.9	28.6	0.0	28.6	0.8
SD21	60.7	L	0.3	0.1	2.5	0.3	3.2	0.0	0.0	0.0	**1.2**
CSD1	64.3	L	**1.6**	0.1	**3.5**	0.8	**6.0**	27.3	0.0	27.3	0.5
HB3A	66.7	L	0.9	0.1	**29.2**	0.5	**30.7**	0.0	0.0	0.0	0.5
A3SD10	77.3	L	0.6	0.2	**3.2**	**4.5**	**8.4**	0.0	0.0	0.0	0.7
GM08	80.0	N	0.6	0.0	2.7	1.2	4.5	0.0	0.0	0.0	0.4
SD28	100	N	0.5	0.1	2.7	0.8	4.1	55.7	0.0	63.2	0.8
Threshold Effects Quotient[1]			1.0	1.0	2.7	1.2	4.5	55.7	1.0	63.2	1.0
% > TEQ			30.8%	0.0%	30.8%	7.7%	46.2%	0.0%	0.0%	0.0%	23.1%

Bolded values indicate HQs exceeding TEQ.

1- TEQ selected as the greater of 1.0 and the maximum value of least toxic sample group.

2- Toxicity Group Classification:

High (H) <20 %; Intermediate (I) ≥20 and <50%; Low (L) ≥50 and <80%; Non-toxic (N) >80%.

Table 3.4-1 (continued). Exposure-response analysis for **porewater**-related CoC toxicity: B) *Mulinia*.

	Toxicity		Interstitial Water Toxic Units (100% Porewater Conc./LC_{50})								
			Metals					Organics			
Station	EC20%	Tox-GRP[2]	Arsenic	Cadmium	Copper	Zinc	$\Sigma IWTU_{PW}$	PCBs	PAHs	$\Sigma IWTU_{PW}$	NH_4-TOT
A3SD10	0.41	H	0.6	0.2	**3.2**	**4.5**	**8.4**	0.0	0.0	0.0	1.5
SD18	1.25	H	0.2	0.0	0.0	0.1	0.4	0.0	0.0	0.0	**3.3**
SD08	3.20	H	**2.2**	0.0	1.6	0.6	**4.4**	50.0	0.0	50.0	**2.2**
SD07	7.20	H	**2.6**	0.1	2.6	0.4	**5.8**	52.1	0.0	52.1	**2.3**
SD37	7.39	H	0.5	0.1	2.6	0.1	3.4	0.0	0.0	0.0	**3.7**
SD21	7.58	H	0.3	0.1	2.5	0.3	3.2	0.0	0.0	0.0	**2.7**
HB3A	8.26	H	0.9	0.1	**29.2**	0.5	**30.7**	0.0	0.0	0.0	1.2
SD01	9.21	H	0.0	0.1	**5.5**	0.5	**6.0**	0.0	0.0	0.0	**2.6**
CSD1	11.7	I	**1.6**	0.1	**3.5**	0.8	**6.0**	27.3	0.0	27.3	1.2
SD14	13.8	I	0.5	0.1	2.3	0.8	3.7	0.0	0.0	0.0	**2.0**
GM08	14.8	I	0.6	0.0	2.7	**1.2**	**4.5**	0.0	0.0	0.0	0.9
SD24	14.9	I	0.3	0.1	2.0	0.1	2.6	0.0	0.0	0.0	1.7
SD13	20.7	I	**2.0**	0.1	2.2	0.4	**4.8**	12.6	0.0	12.6	**2.8**
SD23	31.3	I	1.0	0.1	1.7	0.2	2.9	28.6	0.0	28.6	1.8
SD28	55.7	L	0.5	0.1	2.7	0.8	4.1	55.7	0.0	55.7	1.7
Threshold Effects Quotient[1]			1.0	1.0	2.7	1.0	4.1	55.7	1.0	55.7	1.8
% > TEQ			28.6%	0.0%	28.6%	14.3%	57.1%	0.0%	0.0%	0.0%	57.1%

Bolded values indicate HQs exceeding TEQ.

1- TEQ selected as the greater of 1.0 and the maximum value of least toxic sample group.

2- Toxicity Group Classification:

High (H) <10 %; Intermediate (I) ≥10 and <40%; Low (L) ≥40 and <70%; Non-toxic (N) ≥70%.

Table 3.4-2. Exposure-response analysis for **C18-treated** (e.g., metals-related) porewater: A) *Ampelisca*.

			Interstitial Water Toxic Units (100% Porewater Conc./LC_{50})				
	Toxicity		Metals				
Station	EC20%	TOX-GRP[2]	Arsenic	Cadmium	Copper	Zinc	$\Sigma IWTU_{PW}$
SD18	18.0	H	0.06	0.03	0.00	0.20	0.29
HB3A	22.7	I	0.03	0.14	**4.10**	0.67	4.95
SD37	55.0	L	0.15	0.16	**1.51**	0.17	2.00
SD01	55.6	L	0.00	0.09	0.73	0.50	1.32
SD08	60.0	L	1.61	0.16	0.93	0.26	2.96
SD13	60.0	L	0.15	0.10	1.02	0.35	1.63
SD14	60.0	L	0.00	0.13	0.88	0.41	1.41
SD21	60.0	L	0.04	0.12	0.54	0.22	0.91
SD23	60.0	L	0.28	0.13	1.37	0.12	1.90
SD24	60.0	L	0.00	0.10	0.88	0.15	1.13
CSD1	83.3	N	1.14	0.24	0.93	0.29	2.59
SD07	83.3	N	1.77	0.15	1.46	0.20	3.58
A3SD10	100	N	0.02	0.26	1.12	7.00	8.40
GM08	100	N	0.06	0.18	1.37	1.49	3.09
SD28	100	N	1.47	0.26	1.27	0.20	3.20
Threshold Effects Quotient[1]			1.77	1.00	1.46	7.00	8.40
% > TEQ			0.0%	0.00%	20.0%	0.00%	0.00%

Bolded values indicate HQs exceeding TEQ.

1- TEQ selected as the greater of 1.0 and the maximum value of least toxic sample group.

2- Toxicity Group Classification:

High (H) <20 %; Intermediate (I) ≥20 and <50%; Low (L) ≥50 and <80%; Non-toxic (N) >80%.

Table 3.4-2 (continued). Exposure-response analysis for **C18-treated** (e.g., metals-related) porewater: B) *Mulinia*.

	Toxicity		Interstitial Water Toxic Units (100% Porewater Conc./LC_{50})				
			Metals				
Station	EC20%	TOX-GRP[2]	Arsenic	Cadmium	Copper	Zinc	$\Sigma IWTU_{PW}$
A3SD10	2.05	H	0.02	0.26	1.12	**7.00**	**8.40**
CSD1	2.46	H	1.14	0.24	0.93	0.29	2.59
SD07	2.63	H	**1.77**	0.15	**1.46**	0.20	**3.58**
SD08	3.09	H	**1.61**	0.16	0.93	0.26	2.96
SD21	16.9	I	0.04	0.12	0.54	0.22	0.91
SD37	10.5	I	0.15	0.16	**1.51**	0.17	2.00
GM08	15.9	I	0.06	0.18	1.37	**1.49**	3.09
SD13	16.7	I	0.15	0.10	1.02	**0.35**	1.63
SD14	17.4	I	0.00	0.13	0.88	**0.41**	1.41
HB3A	18.0	I	0.03	0.14	**4.10**	0.67	**4.95**
SD01	18.0	I	0.00	0.09	0.73	0.50	1.32
SD18	20.6	I	0.06	0.03	0.00	0.20	0.29
SD24	45.7	L	0.00	0.10	0.88	0.15	1.13
SD28	46.8	L	1.47	0.26	1.27	0.20	3.20
SD23	49.2	L	0.28	0.13	1.37	0.12	1.90
Threshold Effects Quotient[1]			1.47	1.00	1.37	1.00	3.20
% > TEQ			16.7%	0.00%	25.0%	16.7%	25.0%

Bolded values indicate HQs exceeding TEQ.

1- TEQ selected as the greater of 1.0 and the maximum value of least toxic sample group.

2- Toxicity Group Classification:

High (H) <10 %; Intermediate (I) ≥10 and <40%; Low (L) ≥40 and <70%; Non-toxic (N) ≥70%.

Table 3.4-3. Exposure-response analysis for **EDTA-treated** (e.g., organics-related) porewater: A) *Ampelisca*.

	Toxicity		Interstitial Water Toxic Units (100% Porewater Conc./LC_{50})		
			Organics		
Station	EC20%	Tox-GRP[2]	PCBs	PAHs	$\Sigma IWTU_{PW}$
SD18	18.0	H	0.00	0.00	0.00
SD14	55.6	I	0.00	0.00	0.00
SD37	57.9	I	0.00	0.00	0.00
HB3A	60.0	I	0.00	0.00	0.00
SD01	60.0	I	0.00	0.00	0.00
SD08	60.0	I	0.32	0.00	0.32
SD13	60.0	I	**3.74**	0.00	**3.74**
SD21	60.0	I	0.00	0.00	0.00
SD23	60.0	I	**1.58**	0.00	**1.58**
SD24	61.1	I	0.00	0.00	0.00
SD07	62.5	I	0.00	0.00	0.00
CSD1	70.0	I	0.00	0.00	0.00
SD28	100	N	0.00	0.00	0.00
A3SD10	100	N	0.00	0.00	0.00
GM08	100	N	0.00	0.00	0.00
Threshold Effects Quotient[1]			1.00	1.00	1.00
% > TEQ			16.7%	0.00%	16.7%

Bolded values indicate HQs exceeding TEQ.

1- TEQ selected as the greater of 1.0 and the maximum value of least toxic sample group.

2- Toxicity Group Classification:

High (H) <20 %; Intermediate (I) ≥20 and <50%; Low (L) ≥50 and <80%; Non-toxic (N) >80%.

Table 3.4-3 (continued). Exposure-response analysis for **EDTA-treated** (e.g., organics-related) porewater: B) *Mulinia*.

	Toxicity		Interstitial Water Toxic Units (100% Porewater Conc./LC_{50}) Organics		
Station	EC20%	Tox-GRP[2]	PCBs	PAHs	$\Sigma IWTU_{PW}$
SD18	2.00	H	0.00	0.00	0.00
SD08	2.71	H	0.32	0.00	0.32
SD37	10.7	H	0.00	0.00	0.00
CSD1	11.2	I	0.00	0.00	0.00
SD23	12.1	I	**1.58**	0.00	**1.58**
SD21	15.2	I	0.00	0.00	0.00
SD01	15.9	I	0.00	0.00	0.00
SD14	15.9	I	0.00	0.00	0.00
HB3A	16.9	I	0.00	0.00	0.00
A3SD10	17.0	I	0.00	0.00	0.00
SD07	17.2	I	0.00	0.00	0.00
SD13	17.8	I	**3.74**	0.00	**3.74**
SD24	21.1	I	0.00	0.00	0.00
SD28	55.7	L	0.00	0.00	0.00
GM08	58.0	L	0.00	0.00	0.00
Threshold Effects Quotient[1]			1.00	1.00	1.00
% > TEQ			15.4%	0.00%	15.4%

Bolded values indicate HQs exceeding TEQ.

1- TEQ selected as the greater of 1.0 and the maximum value of least toxic sample group.

2- Toxicity Group Classification:

High (H) <10 %; Intermediate (I) ≥10 and <40%; Low (L) ≥40 and <70%; Non-toxic (N) ≥70%.

Table 3.4-4. Exposure-response analysis for *Ulva*-treated (e.g., non-ammonia-related) porewater: A) *Ampelisca*.

		Toxicity		Interstitial Water Toxic Units (100% Porewater Conc./LC_{50})								
				Metals					Organics			
Station	Treatment	EC20%	Tox-GRP[2]	Arsenic	Cadmium	Copper	Zinc	$\Sigma IWTU_{PW}$	PCBs	PAHs	$\Sigma IWTU_{PW}$	NH_4-TOT
HB3A	Non-*Ulva*	77.3	I	0.71	0.08	**30.6**	**2.65**	**34.1**	0.00	0.00	0.00	0.53
SD01	Non-*Ulva*	40.0	I	0.07	0.09	1.37	0.23	1.76	0.16	0.00	0.16	**1.14**
A3SD10	Non-*Ulva*	77.3	L	0.66	0.14	2.00	0.23	3.03	0.00	0.00	0.00	0.65
SD28	Non-*Ulva*	100	N	0.41	0.07	2.59	0.29	3.36	0.00	0.00	0.00	0.77
Threshold Effects Quotient[1]				1.00	1.00	2.59	1.00	3.36	1.00	1.00	1.00	1.00
HB3A	*Ulva*	24.0	H	0.56	0.06	**18.1**	**1.55**	**20.3**	0.00	0.00	0.00	0.05
SD01	*Ulva*	72.8	L	0.02	0.07	1.95	0.20	2.25	0.52	0.00	0.52	0.04
A3SD10	*Ulva*	100	N	0.52	0.13	3.41	0.35	4.41	0.00	0.00	0.00	0.05
SD28	*Ulva*	100	N	0.22	0.08	3.12	0.15	3.57	0.00	0.00	0.00	0.03
Threshold Effects Quotient[1]				1.00	1.00	3.41	1.00	4.41	1.00	1.00	1.00	1.00

Bolded values indicate HQs exceeding TEQ.

1- TEQ selected as the greater of 1.0 and the maximum value of least toxic sample group.

2- Toxicity Group Classification:

High (H) <20 %; Intermediate (I) ≥20 and <50%; Low (L) ≥50 and <80%; Non-toxic (N) >80%.

Table 3.4-4 (continued). Exposure-response analysis for *Ulva*-treated (e.g., non-ammonia-related) porewater: B) *Mulinia*.

		Toxicity		Interstitial Water Toxic Units (100% Porewater Conc./LC_{50}) Metals					Organics			
Station	Treatment	EC20%	Tox-GRP[2]	Arsenic	Cadmium	Copper	Zinc	$\Sigma IWTU_{PW}$	PCBs	PAHs	$\Sigma IWTU_{PW}$	NH_4-TOT
A3SD10	Non-*Ulva*	0.41	H	0.66	0.14	2.00	0.23	**3.0**	0.00	0.00	0.00	1.46
HB3A	Non-*Ulva*	8.26	H	0.71	0.08	**30.6**	**2.65**	34.07	0.00	0.00	0.00	1.19
SD01	Non-*Ulva*	9.21	H	0.07	0.09	1.37	0.23	1.76	0.16	0.00	0.16	2.56
SD28	Non-*Ulva*	55.7	L	0.41	0.07	2.59	0.29	3.36	0.00	0.00	0.00	1.72
Threshold Effects Quotient[1]				1.00	1.00	2.6	1.00	3.36	1.00	1.00	1.00	1.72
A3SD10	*Ulva*	1.25	H	0.52	0.13	**3.41**	0.35	**4.4**	0.00	0.00	0.00	0.10
HB3A	*Ulva*	1.25	H	0.56	0.06	**18.1**	**1.55**	20.3	0.00	0.00	0.00	0.12
SD01	*Ulva*	2.14	H	0.02	0.07	1.95	0.20	2.25	0.52	0.00	0.52	0.08
SD28	*Ulva*	13.8	I	0.22	0.08	3.12	0.15	3.57	0.00	0.00	0.00	0.06
Threshold Effects Quotient[1]				1.00	1.00	3.1	1.00	3.6	1.00	1.00	1.00	1.00

Bolded values indicate HQs exceeding TEQ.

1- TEQ selected as the greater of 1.0 and the maximum value of least toxic sample group.

2- Toxicity Group Classification:

High (H) <10 %; Intermediate (I) ≥10 and <40%; Low (L) ≥40 and <70%; Non-toxic (N) ≥70%.

Table 3.4-5. Summary of exposure-response analyses for porewater and Toxicity Identification Evaluation (TIE) testing for the Raymark study area.

			Threshold Effects Quotient (Interstitial Water Toxic Units, Frequency of Exceedence)								
			Metals					Organics			
TRT	SPP	Statistic	Arsenic	Cadmium	Copper	Zinc	$\Sigma IWTU_{PW}$	PCBs	PAHs	$\Sigma IWTU_{PW}$	NH_4-TOT
PW	AMP	TEQ	1.00	1.00	2.68	1.22	4.47	55.7	1.00	63.2	1.00
	MUL	TEQ	1.00	1.00	2.68	1.00	4.07	55.7	1.00	55.7	1.75
	AMP	%>TEQ	30.8%	0.00%	30.8%	7.7%	46.2%	0.00%	0.00%	0.00%	23.1%
	MUL	%>TEQ	28.6%	0.00%	28.6%	14.3%	57.1%	0.00%	0.00%	0.00%	57.1%
	MEDIAN	*TEQ*	1.00	1.00	2.68	1.11	4.27	*55.7*	*1.00*	*59.5*	*1.38*
		%>TEQ	29.7%	0.00%	29.7%	11.0%	51.6%	*0.0%*	*0.00%*	*0.00%*	*40.1%*
EDTA	AMP	TEQ						1.00	1.00	1.00	0.00
	MUL	TEQ						1.00	1.00	1.00	0.00
	AMP	%>TEQ						16.7%	0.00%	16.7%	0.00%
	MUL	%>TEQ						15.4%	0.00%	15.4%	0.00%
	MEDIAN	*TEQ*						*1.00*	*1.00*	*1.00*	*0.00*
		%>TEQ						*16.0%*	*0.00%*	*16.0%*	*0.00%*
C18	AMP	TEQ	1.77	1.00	1.46	7.00	8.40				0.00
	MUL	TEQ	1.47	1.00	1.37	1.00	3.20				0.00
	AMP	%>TEQ	0.00%	0.00%	20.0%	0.00%	0.00%				0.00
	MUL	%>TEQ	16.7%	0.00%	25.0%	16.7%	25.0%				0.00
	MEDIAN	*TEQ*	1.62	1.00	1.41	4.00	5.80				*0.00*
		%>TEQ	8.33%	0.00%	22.5%	8.3%	12.5%				*0.00%*
	Overall	*Mimimum*	1.00	1.00	1.41	1.11	4.27	1.00	1.00	1.00	0.00
		Maximum	1.62	1.00	2.68	4.00	5.80	55.7	1.00	59.5	1.38
		%>TEQ	19.0%	0.00%	26.1%	9.66%	32.1%	8.01%	0.00%	8.01%	13.4%

PW = untreated porewater extracted from sediment, EDTA = treatment for metal chelation experiment, C18 = treatment for organics removal experiment
AMP = Ampelisca, MUL = Mulinia
TEQ = Threshold Effects Quotient = highest observed no effect ratio of porewater concentration to LC50 benchmark
%>TEQ = percentage of stations with IWTU values exceeding the TEQ.
IWTU = Interstitial water toxic units; see Section 4 text.

Appendix A-1-1. Results of chemical analyses of whole sediments collected in the Raymark study area.

Chemical Class	Analyte	A3SD10	A3SD10 (B)	CSD1	GM08	HB3A	HB3A(B)	SD01	SD07	SD08	SD13	SD14	SD18	SD21(A)	SD21(B)	SD23	SD24	SD24 (B)	SD28	SD37
Dioxins	Dibenzofuran	1000.00		660.00	660.00	660.00		89.00	100.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2,3,7,8-TCDD	4.58		2.58	0.99	6.91		2.67	1.75	1.59	2.61	3.64	1.27	1.35	2.08	3.23	2.77		1.57	1.54
	1,2,3,7,8-PeCDD	19.30		7.75	2.18	50.70		11.60	13.90	5.56	18.30	11.70	10.10	5.60	7.69	15.50	9.72		11.60	4.68
	1,2,3,4,7,8-HxCDD	14.60		7.84	2.04	28.50		15.80	24.90	8.19	17.80	15.20	15.00	5.59	8.75	14.70	10.10		10.60	3.8
	1,2,3,6,7,8-HxCDD	86.40		27.00	4.70	113.00		52.70	70.50	20.50	70.30	61.20	39.00	20.60	28.90	58.50	32.50		35.40	8.2
	1,2,3,7,8,9-HxCDD	43.50		18.10	4.72	84.70		30.30	61.00	15.60	41.80	36.60	32.00	14.90	21.60	39.80	22.30		27.50	7.70
	1,2,3,4,6,7,8-HpCDD	1520.00		524.00	72.30	1730.00		703.00	1550.00	472.00	1580.00	1310.00	608.00	419.00	517.00	1220.00	625.00		754.00	156.00
	OCDD	15800.00		5380.00	1330.00	7820.00		4780.00	8700.00	4300.00	14000.00	10500.00	3570.00	3450.00	4110.00	9950.00	5390.00		6940.00	3740.00
	2,3,7,8-TCDF	210.00		80.70	8.05	3890.00		408.00	47.30	15.60	201.00	129.00	42.30	13.90	31.40	65.10	31.20		35.90	8.67
	2,3,7,8-TCDF Confirm	488.00		144.00	21.20	3590.00		434.00	76.10	78.00	198.00	157.00	60.80	28.10	40.30	90.30	99.70		64.40	11.50
	1,2,3,7,8-PeCDF	172.00		48.90	3.35	1850.00		211.00	23.30	8.19	106.00	72.60	25.10	7.71	18.50	31.70	21.80		21.20	3.4
	2,3,4,7,8-PeCDF	464.00		109.00	5.56	4990.00		455.00	59.20	16.20	204.00	159.00	50.40	19.20	38.40	80.60	49.40		45.70	6.22
	1,2,3,4,7,8-HxCDF	1080.00		116.00	4.98	6750.00		410.00	69.50	20.70	203.00	184.00	57.70	21.20	43.50	89.50	105.00		54.30	5.1
	1,2,3,6,7,8-HxCDF	307.00		46.70	4.80	1610.00		158.00	39.00	13.00	89.30	68.70	24.70	10.70	21.30	41.90	35.00		26.10	3.77
	2,3,4,6,7,8-HxCDF	905.00		101.00	7.53	4500.00		311.00	73.00	20.90	159.00	148.00	50.10	20.60	40.70	75.60	86.80		49.20	9.47
	1,2,3,7,8,9-HxCDF	29.20		6.54	1.78	65.90		9.58	8.58	2.79	8.07	8.58	9.24	3.59	5.54	14.90	5.17		4.43	2.4
	1,2,3,4,6,7,8-HpCDF	5540.00		639.00	49.90	16500.00		1240.00	544.00	192.00	827.00	766.00	283.00	144.00	233.00	504.00	598.00		354.00	65.30
	1,2,3,4,7,8,9-HpCDF	76.80		14.80	2.98	181.00		28.50	29.90	11.70	27.20	28.60	- 9.48	7.19	11.40	22.10	18.30		17.60	5.6
	OCDF	4180.00		2200.00	173.00	4510.00		474.00	835.00	403.00	982.00	944.00	269.00	240.00	326.00	829.00	668.00		797.00	255.00
	Sum of Dioxins	31452		9900	2339	55339		9388	13249	6188	19535	16145	6708	5025	6078	14048	8369		10188	4857
Dioxin CDDs	Total TCDD	55.80		24.50	3.00	124.00		11.60	22.70	9.91	21.90	25.40	1.27	5.36	4.08	28.50	24.20		20.60	3.80
	Total PeCDD	59.00		36.10	8.19	63.30		18.30	46.90	11.50	72.70	70.90	9.32	21.60	27.30	63.00	22.10		52.30	8.94
	Total HxCDD	510.00		244.00	59.70	988.00		289.00	453.00	179.00	429.00	384.00	238.00	128.00	188.00	351.00	218.00		265.00	73.10
	Total HpCDD	2960.00		1330.00	220.00	3300.00		1320.00	2850.00	1200.00	3510.00	2570.00	1250.00	783.00	967.00	2290.00	1300.00		1690.00	379.00
	Sum of CDDs	3584.80		1634.60	290.89	4475.30		1638.90	3372.60	1400.41	4033.60	3050.30	1498.59	937.96	1186.38	2732.50	1562.30		2027.90	464.90
Dioxin CDFs	Total TCDF	1330.00		368.00	42.10	10900.00		1350.00	264.00	91.00	728.00	614.00	193.00	81.00	188.00	359.00	211.00		200.00	48.80
	Total PeCDF	3450.00		834.00	36.30	20600.00		2270.00	500.00	161.00	1190.00	959.00	349.00	140.00	290.00	555.00	416.00		365.00	53.80
	Total HxCDF	7180.00		759.00	53.60	30300.00		2240.00	783.00	226.00	1350.00	1200.00	443.00	197.00	347.00	717.00	755.00		475.00	83.90
	Total HpCDF	7420.00		1170.00	87.40	18300.00		1770.00	1060.00	368.00	1440.00	1380.00	461.00	290.00	458.00	975.00	1010.00		674.00	137.00
	Sum of CDFs	19380.00		2929.00	219.40	80100.00		7630.00	2617.00	844.00	4708.00	4153.00	1446.00	708.00	1281.00	2606.00	2392.00		1714.00	303.50
	Toxicity Equivalency Factor	627.65		126.29	12.30	4505.21		412.21	111.88	38.99	236.28	191.44	73.55	46.98		122.35	88.10		76.04	18.50
Metals	Silver	2.00		3.00	3.00	2.40		1.40	1.50	1.40	1.40	0.88	0.44	0.42	0.65	0.93	0.62		1.60	0.60
	Arsenic	23.90		11.20	17.90	9.20		7.00	10.60	6.50	9.00	9.20	3.70	3.80	4.00	8.80	8.20		8.10	4.50
	Barium	2710.00		271.00	65.70	12200.00		1130.00	222.00	57.80	533.00	549.00	168.00	98.70	108.00	270.00	478.00		172.00	38.00
	Cadmium	8.30		1.20	1.50	1.00		5.50	4.40	1.40	7.60	7.60	0.80	3.20	3.20	8.30	2.60		4.20	0.51
	Chromium	463.00		402.00	231.00	290.00		89.70	99.90	84.40	91.50	116.00	31.80	35.60	39.00	91.70	97.40		107.00	59.20
	Copper	2550.00		1350.00	881.00	36400.00		1650.00	430.00	232.00	890.00	775.00	271.00	191.00	185.00	462.00	383.00		361.00	173.00
	Mercury	0.43		0.77	1.20	0.47		0.22	0.32	0.37	0.28	0.49	0.18	0.14	0.17	0.28	0.28		0.27	0.17
	Nickel	317.00		54.00	37.40	386.00		80.70	49.20	37.10	59.10	86.30	20.80	20.10	25.00	52.10	63.30		43.40	21.00
	Lead	3290.00		703.00	158.00	26500.00		1570.00	403.00	181.00	934.00	833.00	357.00	268.00	231.00	514.00	508.00		303.00	42.30
	Zinc	1340.00		309.00	292.00	2320.00		750.00	508.00	290.00	871.00	676.00	181.00	270.00	277.00	625.00	363.00		439.00	171.00
PAHs	2-Methylnaphthalene	1000.00		860.00	660.00	660.00		710.00	850.00	680.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Acenaphthene	1000.00		660.00	660.00	660.00		140.00	160.00	660.00	200.00	200.00	610.00	81.00	89.00	160.00	660.00		1000.00	570.00
	Acenaphthylene	190.00		200.00	660.00	660.00		350.00	330.00	130.00	410.00	440.00	140.00	160.00	170.00	340.00	110.00		200.00	84.00
	Anthracene	120.00		190.00	660.00	660.00		520.00	520.00	140.00	680.00	640.00	250.00	280.00	330.00	570.00	150.00		300.00	120.00
	Benzo(a)anthracene	1500.00		560.00	190.00	660.00		2500.00	2700.00	670.00	4000.00	3800.00	800.00	1400.00	1500.00	2900.00	890.00		1700.00	430.00
	Benzo(a)pyrene	1700.00		660.00	230.00	120.00		2400.00	2200.00	640.00	4000.00	3600.00	790.00	1300.00	1500.00	2900.00	960.00		1900.00	470.00
	Benzo(b)fluoranthene	2800.00		850.00	400.00	180.00		4000.00	4000.00	1000.00	10000.00	9200.00	1200.00	1800.00	2200.00	4500.00	1600.00		3400.00	900.00
	Benzo(g,h,i)perylene	260.00		190.00	74.00	660.00		460.00	530.00	190.00	1100.00	1000.00	320.00	360.00	330.00	940.00	310.00		800.00	150.00
	Benzo(k)fluoranthene	950.00		470.00	390.00	660.00		1400.00	4200.00	380.00	9100.00	8400.00	600.00	790.00	1000.00	1800.00	670.00		1100.00	820.00
	Chrysene	1400.00		730.00	220.00	1100.00		3800.00	3900.00	990.00	5300.00	4800.00	1100.00	1900.00	2000.00	4400.00	1200.00		2300.00	540.00
	Dibenz(a,h)anthracene	240.00		660.00	660.00	660.00		430.00	520.00	120.00	610.00	550.00	160.00	280.00	280.00	550.00	160.00		310.00	570.00
	Fluoranthene	4500.00		1200.00	330.00	280.00		5600.00	4500.00	1500.00	11000.00	11000.00	1500.00	3000.00	3900.00	7900.00	2400.00		4900.00	860.00
	Fluorene	1000.00		660.00	660.00	660.00		190.00	280.00	660.00	220.00	360.00	75.00	140.00	140.00	220.00	83.00		130.00	570.00
	Indeno(1,2,3-cd)pyrene	880.00		400.00	110.00	78.00		1500.00	1700.00	370.00	2200.00	2000.00	580.00	860.00	910.00	1800.00	620.00		1200.00	280.00
	Naphthalene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Phenanthrene	710.00		310.00	120.00	150.00		2500.00	2200.00	610.00	2800.00	3800.00	840.00	1500.00	1700.00	2800.00	980.00		1500.00	330.00
	Pyrene	3600.00		1300.00	410.00	930.00		5900.00	6700.00	1300.00	6900.00	5900.00	1900.00	2700.00	2900.00	6200.00	1400.00		3500.00	840.00
	Total PAHs	23130.00		10440.00	7094.00	9438.00		33110.00	34720.00	10880.00	60520.00	59080.00	12085.00	17771.00	20180.00	38080.00	13513.00		26040.00	8474.00

Units: metals = µg/g dry weight, PAHs, PCBs, pesticides, dioxins = ng/g dry weight

Appendix A-1-1 (continued). Results of chemical analyses of sediments collected in the Raymark study area.

Chemical Class	Analyte	A3SD10	A3SD10 (B)	CSD1	GH08	HB3A	HB3A(B)	SD01	SD07	SD08	SD13	SD14	SD18	SD21(A)	SD21(B)	SD23	SD24	SD24 (B)	SD28	SD37
PCBs	3 (4)	1.10	1.10	0.35	0.08	4.00	2.30	1.70	0.28	0.34	0.49	0.51	0.08	0.21	0.14	0.32	0.15	0.20	0.25	0.03
	8 (2 4')*			0.78					0.98	3.00	2.90					1.80			1.00	
	15 (4 4')	10.00	10.00	2.30	1.80	10.00	7.40	10.00	2.10	3.60	4.30	4.60	0.42	1.70	1.10	3.20	1.50	1.90	1.90	0.32
	18 (2 2'5)*			7.50					5.00	8.30	11.00					6.30			6.70	
	28 (2 4 4')*	34.00	34.00	13.00	5.80	26.00	21.00	37.00	7.40	9.70	16.00	16.00	1.40	4.60	3.60	10.00	4.90	4.80	8.50	1.30
	44 (2 2'3 5')*			4.70					2.00	1.40	3.40					2.30			3.10	
	52 (2 2'5 5')*			34.00					24.00	13.00	38.00					30.00			3.50	
	66 (2 3'4 4')*			43.00					16.00	10.00	17.00					11.00			16.00	
	77 (3 3' 4 4')	5.00	5.00	3.30	1.70	3.40	3.50	3.10	1.30	1.70	2.20	1.40	0.30	0.40	0.48	1.30	0.98	1.20	1.20	0.30
	101 (2 2'4 5 5')*			16.00					22.00	13.00	37.00					28.00			23.00	
	105 (2 3 3'4 4')*	25.00	25.00	12.00	6.40	18.00	12.00	15.00	7.30	5.90	12.00	12.00	2.00	5.20	3.90	10.00	8.20	5.90	6.70	1.10
	114 (2 3 4 4'5)	1.80	1.60	0.54	0.22	3.20	2.40	1.10	0.00	0.32	0.73	0.76	0.11	0.23	0.24	0.58	0.36	0.00	0.38	0.06
	118 (2 3' 4 4'5)*	65.00	65.00	24.00	11.00	52.00	42.00	37.00	20.00	15.00	28.00	30.00	6.20	14.00	10.00	27.00	15.00	14.00	18.00	2.80
	123 (2' 3 4 4'5)	2.00	2.00	1.40	0.32	1.90	2.20	1.40	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.33	0.33	0.05
	126 (3 3' 4 4' 5)	3.80	3.80	1.20	0.09	46.00	20.00	2.20	0.00	0.59	3.00	1.70	0.24	0.00	0.00	0.00	0.00	0.95	0.96	0.08
	128 (2 2'3 3'4 4')*																			
	138 (2 2'3 4 4'5)*			61.00					31.00	19.00	67.00					45.00			30.00	
	153 (2 2'4 4'5 5')*			180.00					88.00	28.00	250.00					110.00			86.00	
	156/157 (2 3 3'4 4'5/2 3 3' 4 4'5')	13.00	13.00	4.60	1.40	32.00	25.00	7.20	3.10	2.20	5.60	5.40	1.40	2.30	1.70	4.80	2.90	3.20	2.20	0.4
	167 (2 3 4 4' 5 5')	13.00	13.00	4.00	0.48	88.00	72.00	11.00	1.80	1.20	5.30	3.70	1.00	1.10	0.84	2.60	2.60	2.20	1.50	0.19
	169 (3 3'4 4'5 5')	20.00	20.00	4.60	0.00	190.00	180.00	110.00	12.00	4.30	50.00	25.00	1.10	5.60	7.80	20.00	32.00	29.00	1.50	0.03
	170 (2 2'3 3'4 4'5)*	130.00	130.00	44.00	1.80	4200.00	3000.00	170.00	18.00	7.20	87.00	37.00	14.00	8.80	8.50	31.00	26.00	27.00	17.00	1.50
	180 (2 2'3 4 4'5 5')*	2800.00	3200.00	780.00	8.20	52000.00	42000.00	2800.00	270.00	89.00	1100.00	540.00	280.00	140.00	160.00	490.00	580.00	590.00	250.00	7.80
	187 (2 2'3 4'5 5'6)*			830.00					340.00	110.00	1400.00					590.00			360.00	
	189 (2 3 3'4 4'5 5')	15.00	15.00	4.40	0.00	120.00	92.00	11.00	0.00	0.00	4.90	2.50	1.10	0.00	0.00	1.90	0.00	2.60	0.00	0.00
	195 (2 2'3 3'4 4'5 6)*			78.00					28.00	9.30	110.00					55.00			21.00	
	206 (2 2'3 3'4 4'5 5'6)*			680.00					300.00	150.00	1100.00					600.00			280.00	
	209 (2 2'3 3'4 4'5 5'6 6')*	500.00	500.00	83.00	1.30	2100.00	1800.00	210.00	32.00	18.00	100.00	83.00	34.00	17.00	18.00	80.00	110.00	110.00	33.00	0.86
	Sum of PCB Congeners			2941					1190	608	4358					2108			1142	
	Total PCBs (Sum of Congeners X 2)	27081	27081	6008	247	353783	280604	20718	2355	987	8681	4842	2428	1217	1319	4119	4888	4845	2383	105
PCB Homologs	Total MonoCBs	2.00	2.00	0.35	0.12	15.0	8.50	6.10	0.81	0.34	1.20	1.30	0.24	0.44	0.17	1.00	0.78	0.64	0.47	0.09
	Total DiCBs	24.0	24.0	6.20	2.60	40.0	26.0	35.0	8.20	11.0	13.0	16.0	1.40	9.30	3.40	8.50	12.0	3.70	9.10	0.92
	Total TriCBs	180	180	53.0	20.0	140	120	200	53.0	50.0	100	99.0	8.20	37.0	27.0	68.0	33.0	32.0	51.0	8.00
	Total TetraCBs	600	600	300	110	440	460	250	100	73.0	180	150	28.0	81.0	48.0	130	75.0	70.0	160	22.0
	Total PentaCBs	740	740	180	66.0	1900	1400	340	150	87.0	240	140	52.0	96.0	65.0	200	130	120	150	19.0
	Total HexaCBs	1900	1900	600	42.0	38000	27000	1900	230	100	790	480	200	130	120	390	370	350	230	25.0
	Total HeptaCBs	13000	13000	3000	28.0	230000	180000	11000	1100	330	4400	2200	1300	490	580	1900	2100	2100	1100	34.0
	Total OctaCBs	8300	8300	1300	5.40	71000	58000	4800	460	180	1900	1000	580	250	300	870	1200	1200	480	9.40
	Total NonaCBs	6700	6700	1100	4.60	43000	38000	4000	470	220	1800	900	480	260	300	920	1400	1400	420	7.60
	Sum of PCB Homologs	29448	29448	6539	279	384535	305015	22530	2570	1061	9424	5058	2650	1333	1444	4488	5321	5278	2601	124
	Total PCBs	30000	30000	6600	280	390000	310000	23000	2600	1100	9500	5100	2700	1300	1500	4500	5400	5400	2600	120
PCB Aroclors	Aroclor 1016					66.00			65.00					54.00						
	Aroclor 1221					130.00			130.00					110.00						
	Aroclor 1232					66.00			65.00					54.00						
	Aroclor 1242					66.00			65.00					54.00						
	Aroclor 1248					66.00			65.00					54.00						
	Aroclor 1254					66.00			65.00					54.00						
	Aroclor 1260					66.00			65.00					54.00						
	Aroclor 1262					24000.00			680.00					320.00						
	Aroclor 1268					15000.00			560.00					200.00						
	Sum of Aroclors					39526.00			1760.00					954.00						
Pesticides	4,4'-DDD					11.00			9.50					5.40						
	4,4'-DDT					6.60			6.50					5.40						
	Aldrin					3.40			3.40					0.97						
	Alpha chlordane					3.40			18.00					5.70						
	Alpha BHC					3.40			3.40					2.80						
	Beta-BHC					3.40			3.40					2.80						
	Delta-BHC					3.40			1.20					0.61						
	Dieldrin					0.81			8.50					5.40						

Units: metals = µg/g dry weight, PAHs, PCBs, pesticides, dioxins = ng/g dry weight

* indicates congeners included in Sum of PCB Congeners and Total PCBs (Sum of Congeners X 2) calculation

Additional Total PCBs (Sum of Congeners X 2) values calculated from regression analysis as 0.920*(Sum of PCB Homologs) - 9.548

Appendix A-1-1 (continued). Results of chemical analyses of sediments collected in the Raymark study area.

Chemical Class	Analyte	A3SD10	A3SD10 (B)	CSD1	GA08	HB3A	HB3A(B)	SD01	SD07	SD08	SD13	SD14	SD16	SD21(A)	SD21(B)	SD23	SD24	SD24 (B)	SD28	SD37
Pesticides continued	Endosulfan I					3.40			0.66					0.45						
	Endosulfan II					6.60			1.60					0.92						
	Endosulfan sulfate					120.00			6.50					5.40						
	Endrin					6.60			6.50					5.40						
	Endrin aldehyde					2300.00			20.00					20.00						
	Endrin ketone					6.60			6.50					5.40						
	Gamma chlordane					5.30			8.10					4.90						
	Gamma BHC (Lindane)					3.40			3.40					2.80						
	Heptachlor					3.40			3.40					2.80						
	Heptachlor epoxide					3.40			3.40					2.80						
	Hexachlorobenzene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Toxaphene					340.00			340.00					280.00						
	p,p' DDE					3.60			7.20					5.40						
	p,p' Methoxychlor					34.00			34.00					28.00						
VOAs	1,2,4 Trichlorobenzene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	1,2 Dichlorobenzene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	1,3 Dichlorobenzene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	1,4 Dichlorobenzene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2,2'-Oxybis(1-chloropropane)	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2,4,5-Trichlorophenol	2500.00		1700.00	1700.00	1700.00		1800.00	1600.00	1700.00	2600.00	4400.00	1500.00	1600.00	1500.00	2500.00	1700.00		2500.00	1400.00
	2,4,6-Trichlorophenol	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2,4 Dichlorophenol	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2,4 Dimethylphenol	1000.00		660.00	660.00	230.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2,4 Dinitrophenol	2500.00		1700.00	1700.00	1700.00		1800.00	1600.00	1700.00	2600.00	4400.00	1500.00	1600.00	1500.00	2500.00	1700.00		2500.00	1400.00
	2,4 Dinitrotoluene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2,6 Dinitrotoluene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2 Chloronaphthalene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2 Chlorophenol	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2 Methylphenol	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	2 Nitroaniline	2500.00		1700.00	1700.00	1700.00		1800.00	1600.00	1700.00	2600.00	4400.00	1500.00	1600.00	1500.00	2500.00	1700.00		2500.00	1400.00
	2 Nitrophenol	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	3,3'-Dichlorobenzidine	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	3 Nitroaniline	2500.00		1700.00	1700.00	1700.00		1800.00	1600.00	1700.00	2600.00	4400.00	1500.00	1600.00	1500.00	2500.00	1700.00		2500.00	1400.00
	4,6-Dinitro-2-methylphenol	2500.00		1700.00	1700.00	1700.00		1800.00	1600.00	1700.00	2600.00	4400.00	1500.00	1600.00	1500.00	2500.00	1700.00		2500.00	1400.00
	4 Bromophenyl phenyl ether	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	4 Chloro-3 methylphenol	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	4 Chloroaniline	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	4 Chlorophenyl phenyl ether	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	4 Methylphenol	1000.00		660.00	660.00	660.00		1300.00	67.00	660.00	1000.00	1700.00	9900.00	430.00	470.00	990.00	660.00		1000.00	570.00
	4 Nitroaniline	2500.00		1700.00	1700.00	1700.00		1800.00	1600.00	1700.00	2600.00	4400.00	1500.00	1600.00	1500.00	2500.00	1700.00		2500.00	1400.00
	4 Nitrophenol	2500.00		1700.00	1700.00	1700.00		1800.00	1600.00	1700.00	2600.00	4400.00	1500.00	1600.00	1500.00	2500.00	1700.00		2500.00	1400.00
	Butyl benzyl phthalate	1000.00		660.00	660.00	660.00		540.00	1700.00	660.00	810.00	470.00	250.00	110.00	91.00	870.00	210.00		280.00	570.00
	Carbazole	110.00		660.00	660.00	660.00		410.00	390.00	83.00	430.00	550.00	140.00	230.00	230.00	410.00	130.00		220.00	570.00
	Di-n-butyl phthalate	1000.00		660.00	660.00	660.00		84.00	650.00	660.00	170.00	1700.00	610.00	95.00	110.00	990.00	660.00		1000.00	570.00
	Di-n-octyl phthalate	1000.00		660.00	660.00	660.00		2200.00	2000.00	87.00	3300.00	3300.00	120.00	660.00	1000.00	2400.00	180.00		740.00	570.00
	Dibenzofuran	1000.00		660.00	660.00	660.00		89.00	100.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Diethyl phthalate	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Dimethyl phthalate	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	220.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Hexachlorobutadiene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Hexachlorocyclopentadiene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Hexachloroethane	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Isophorone	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	N-Nitroso-di-n-propylamine	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	N Nitrosodiphenylamine(1)	1000.00		110.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Nitrobenzene	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	Pentachlorophenol	2500.00		1700.00	1700.00	1700.00		1800.00	1600.00	1700.00	2600.00	4400.00	1500.00	1600.00	1500.00	2500.00	1700.00		2500.00	1400.00
	Phenol	1000.00		660.00	660.00	120.00		240.00	110.00	660.00	180.00	240.00	1000.00	620.00	610.00	170.00	660.00		1000.00	570.00
	bis(2-Chloroethoxy)methane	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	bis(2 Chloroethyl)ether	1000.00		660.00	660.00	660.00		710.00	650.00	660.00	1000.00	1700.00	610.00	620.00	610.00	990.00	660.00		1000.00	570.00
	bis(2 Ethylhexyl)phthalate	1400.00		230.00	140.00	130.00		6000.00	5200.00	420.00	6700.00	15000.00	2000.00	3500.00	3900.00	5800.00	1500.00		4300.00	320.00

Units: metals = µg/g dry weight; PAHs, PCBs, pesticides, dioxins = ng/g dry weight

Appendix A-1-2.1. Results of chemical analyses of sediment porewaters collected from the Raymark study area.

Chemical Class	Analyte	A3SD10	CSD1	GM08	HB3A	SD01	SD07	SD08	SD13	SD14	SD18	SD21(A)	SD21(B)	SD23	SD24	SD28	SD37
Metals	Aluminum	250.00	0.00	1670.00	1380.00	250.00	0.00	210.00	0.00	0.00	0.00	0.00	330.00	0.00	290	230.00	0.00
	Silver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Arsenic	19.90	58.70	20.10	33.50	0.00	95.20	80.80	73.60	17.50	7.80	15.70	8.20	34.60	11.80	19.10	18.00
	Barium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cadmium	5.60	3.68	0.17	3.17	2.83	3.86	1.60	2.78	3.27	0.65	3.45	3.36	3.33	2.80	3.71	2.95
	Chromium	1.47	2.64	1.69	0.84	3.24	1.05	0.00	2.81	3.14	1.88	1.33	0.00	3.24	2.36	0.00	0.00
	Copper	65.00	71.00	55.00	599.00	112.00	54.00	32.00	48.00	48.00	0.00	52.00	49.00	35.00	41.00	55.00	54.00
	Iron	170.00	520.00	470.00	340.00	610.00	170.00	310.00	220.00	250.00	12540.00	280.00	310.00	120.00	3700.00	120.00	200.00
	Nickel	243.80	14.20	32.00	111.80	27.30	15.30	41.00	4.00	31.00	12.70	16.40	13.60	9.50	14.90	7.40	0.00
	Lead	1.40	1.44	1.56	13.24	2.80	0.75	1.72	0.75	3.56	1.00	1.98	2.56	3.92	4.40	2.76	8.96
	Zinc	1540.00	260.00	420.00	170.00	170.00	150.00	200.00	140.00	270.00	40.00	130.00	100.00	60.00	50.00	260.00	50.00
PAHs	1-Methylnaphthalene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1-Methylphenanthrene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2,3,5-Trimethylnaphthalene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2,6-Dimethylnaphthalene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-Methylnaphthalene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Acenaphthene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Acenaphthylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Anthracene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Benzo(a)anthracene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Benzo(a)pyrene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Benzo(b)fluoranthene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Benzo(e)pyrene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Benzo(g,h,i)perylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Benzo(k)fluoranthene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Biphenyl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Chrysene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dibenz(a,h)anthracene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fluoranthene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fluorene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Indeno(1,2,3-cd)pyrene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Naphthalene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Perylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Phenanthrene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Pyrene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sum of PAHs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCBs	8 (2 4')*	0.00	0.00	0.00	0.00	0.00	877.10	748.80	212.70	0.00	0.00	0.00	0.00	471.90	0.00	807.30	0.00
	18 (2 2'5')*	0.00	0.00	0.00	0.00	0.00	85.10	189.00	0.00	0.00	0.00	0.00	0.00	64.40	0.00	163.40	0.00
	28 (2 4 4')*	0.00	29.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55.80	0.00
	44 (2 2'3 5')*	0.00	195.60	0.00	0.00	0.00	24.00	17.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	125.70	0.00
	52 (2 2'5 5')*	0.00	321.30	0.00	0.00	0.00	55.80	44.90	11.70	0.00	0.00	0.00	0.00	35.90	0.00	145.40	0.00
	66 (2 3'4 4')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	77(3 3'4 4')	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.40	0.00
	101 (2 2'4 5 5')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.50	0.00
	105 (2 3 3'4 4')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	118 (2 3'4 4'5)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	126 (3 3'4 4'5)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	128 (2 2'3 3'4 4')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	138 (2 2'3 4 4'5')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	153 (2 2'4 4'5 5')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	170 (2 2'3 3'4 4'5)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	180 (2 2'3 4 4'5 5')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	187 (2 2'3 4'5 5'6)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	195 (2 2'3 3'4 4'5 6)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	206 (2 2'3 3'4 4'5 5'6)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	209 (2 2'3 3'4 4'5 5'6 6')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total PCBs (Sum of Congeners X 2)	0.00	1093.00	0.00	0.00	0.00	2084.00	2000.20	503.60	0.00	0.00	0.00	0.00	1144.40	0.00	2212.20	0.00

Units: µg/L. * indicates congeners included in Total PCBs calculation.

Appendix A-1-2.2. Results of chemical analyses of EDTA-treated sediment porewaters collected from the Raymark study area.

Chemical Class	Analyte	CSD1	SD07	SD08	SD13	SD23	SD28
PCBs	8 (2 4')*	0.00	0.00	0.00	143.19	126.15	0.00
	18 (2 2'5)*	0.00	0.00	0.00	0.00	0.00	0.00
	28 (2 4 4')*	0.00	0.00	8.30	0.00	0.00	0.00
	44 (2 2'3 5')*	0.00	0.00	4.62	0.00	0.00	0.00
	52 (2 2'5 5)*	0.00	0.00	0.00	0.00	0.00	0.00
	66 (2 3'4 4')*	0.00	0.00	0.00	0.00	0.00	0.00
	77(3 3' 4 4')	0.00	0.00	0.00	0.00	0.00	0.00
	99	0.00	0.00	0.00	0.00	0.00	0.00
	101 (2 2'4 5 5')*	0.00	0.00	0.00	0.00	0.00	0.00
	105 (2 3 3'4 4')*	0.00	0.00	0.00	0.00	0.00	0.00
	118 (2 3'4 4'5)*	0.00	0.00	0.00	0.00	0.00	0.00
	126 (3 3' 4 4' 5)	0.00	0.00	0.00	0.00	0.00	0.00
	128 (2 2'3 3'4 4')*	0.00	0.00	0.00	0.00	0.00	0.00
	138 (2 2'3 4 4'5)*	0.00	0.00	0.00	0.00	0.00	0.00
	153 (2 2'4 4'5 5')*	0.00	0.00	0.00	0.00	0.00	0.00
	170 (2 2'3 3'4 4'5)*	0.00	0.00	0.00	0.00	0.00	0.00
	180 (2 2'3 4 4'5 5')*	0.00	0.00	0.00	0.00	0.00	0.00
	187 (2 2'3 4'5 5'6)*	0.00	0.00	0.00	0.00	0.00	0.00
	195 (2 2'3 3'4 4'5 6)*	0.00	0.00	0.00	0.00	0.00	0.00
	206 (2 2'3 3'4 4'5 5'6)*	0.00	0.00	0.00	6.50	0.00	0.00
	209 (2 2'3 3'4 4'5 5'6 6')*	0.00	0.00	0.00	0.00	0.00	0.00
	Total PCBs (Sum of Congeners X 2)	0.00	0.00	25.84	299.38	252.30	0.00

Units: μg/L. * indicates congeners included in Total PCBs calculation.

Appendix A-1-2.3. Results of chemical analyses of C18-treated sediment porewaters collected from the Raymark study area.

Chemical Class	Analyte	A3SD10	CSD1	GM08	HB3A	SD01	SD07	SD08	SD13	SD14	SD18	SD21(A)	SD21(B)	SD23	SD24	SD28	SD37
Metals	Arsenic	0.84	40.98	2.00	1.24	0.00	63.54	57.98	5.28	0.00	2.24	1.14	1.46	10.12	0.00	52.86	5.54
	Cadmium	9.32	8.48	6.62	5.16	3.39	5.48	5.76	3.75	4.52	1.01	3.13	5.66	4.85	3.74	9.42	5.78
	Chromium	0.00	0.38	0.00	0.00	1.44	0.00	0.00	0.00	1.03	0.51	0.00	0.00	0.94	0.36	0.00	0.21
	Copper	23.00	19.00	28.00	84.00	15.00	30.00	19.00	21.00	18.00	0.00	13.00	9.00	28.00	18.00	26.00	31.00
	Nickel	6.58	0.00	0.00	0.00	12.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Lead	0.00	0.00	0.00	3.30	0.00	0.00	0.00	0.00	4.38	0.00	0.00	4.96	4.18	0.00	0.00	0.00
	Zinc	2400.00	100.00	510.00	230.00	170.00	70.00	90.00	120.00	140.00	70.00	80.00	70.00	40.00	50.00	70.00	60.00

Units: µg/L.

Appendix A-1-2.4. Results of chemical analyses of *Ulva* and non-*Ulva* sediment porewaters collected from the Raymark study area.

		Ulva				Non-*Ulva*			
Chemical Class	Analyte	A3SD10	HB3A	SD01	SD28	A3SD10	HB3A	SD01	SD28
Metals	Arsenic	18.56	20.15	0.89	8.05	23.69	25.47	2.64	14.86
	Cadmium	4.58	2.12	2.48	2.86	5.01	2.87	3.14	2.57
	Chromium	na	na	na	na	na	na	na	na
	Copper	70.00	371.00	40.00	64.00	41.00	628.00	28.00	53.00
	Nickel	na	na	na	na	na	na	na	na
	Lead	na	na	na	na	na	na	na	na
	Zinc	120.00	530.00	70.00	50.00	80.00	910.00	80.00	100.00
PCBs	8 (2 4')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18 (2 2'5')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	28 (2 4 4')*	0.00	0.00	10.49	0.00	0.00	0.00	0.00	0.00
	44 (2 2'3 5')*	0.00	0.00	0.00	0.00	0.00	0.00	3.21	0.00
	52 (2 2'5 5')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	66 (2 3'4 4')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	77(3 3' 4 4')	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	101 (2 2'4 5 5')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	105 (2 3 3'4 4')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	118 (2 3'4 4'5)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	126 (3 3' 4 4' 5)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	128 (2 2'3 3'4 4')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	138 (2 2'3 4 4'5)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	153 (2 2'4 4'5 5')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	170 (2 2'3 3'4 4'5)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	180 (2 2'3 4 4'5 5')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	187 (2 2'3 4'5 5'6)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	195 (2 2'3 3'4 4'5 6)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	206 (2 2'3 3'4 4'5 5'6)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	209 (2 2'3 3'4 4'5 5'6 6')*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total PCBs (Sum of Congeners X 2)	0.00	0.00	20.98	0.00	0.00	0.00	6.43	0.00

Units: µg/L. na=not applicable. * indicates congeners included in Total PCBs calculation.

Appendix A-3. Results of chemical analyses of tissues collected from fish in the Raymark study area.

Chemical Class	Analyte	A3SD10	GM08	MF03	SD26
Dioxins	2,3,7,8-TCDD	0.20	0.33	0.27	0.22
	1,2,3,7,8-PeCDD	0.33	0.82	0.49	0.32
	1,2,3,4,7,8-HxCDD	0.09	0.16	0.12	0.12
	1,2,3,6,7,8-HxCDD	0.25	0.41	0.31	0.33
	1,2,3,7,8,9-HxCDD	0.11	0.14	0.13	0.18
	1,2,3,4,6,7,8-HpCDD	2.27	1.39	2.48	7.14
	OCDD	17.80	10.90	17.40	42.00
	2,3,7,8-TCDF	1.38	3.19	1.22	1.69
	2,3,7,8-TCDF Confirm.	2.02	4.18	1.56	2.30
	1,2,3,7,8-PeCDF	0.43	0.35	0.15	0.15
	2,3,4,7,8-PeCDF	1.24	1.09	0.50	0.69
	1,2,3,4,7,8-HxCDF	0.51	0.16	0.16	0.30
	1,2,3,6,7,8-HxCDF	0.35	0.14	0.09	0.12
	1,2,3,7,8,9-HxCDF	0.70	0.42	0.35	0.47
	2,3,4,6,7,8-HxCDF	0.09	0.11	0.06	0.12
	1,2,3,4,6,7,8-HpCDF	2.07	1.63	3.24	2.36
	1,2,3,4,7,8,9-HpCDF	0.15	0.30	0.21	0.27
	OCDF	8.61	7.77	17.80	10.30
	Sum of Dioxins	36.57	29.30	44.98	66.77
Dioxin CDDs	Total TCDD	0.20	0.33	0.45	0.28
	Total PeCDD	0.33	0.01	0.49	0.32
	Total HxCDD	0.62	0.26	0.88	1.41
	Total HpCDD	3.55	2.69	4.31	15.50
	Sum of CDDs	4.69	3.29	6.13	17.51
Dioxin CDFs	Total TCDF	3.40	3.27	1.53	3.36
	Total PeCDF	4.44	2.71	0.95	1.71
	Total HxCDF	3.57	1.30	1.83	0.99
	Total HpCDF	3.83	6.67	13.90	8.12
	Sum of CDFs	15.24	13.95	18.21	14.18
	Toxicity Equivalency Factor	1.42	1.82	1.11	1.21
PCBs	3 (4)	0.00	0.00	0.00	0.00
	15 (4 4')	0.00	0.00	0.00	0.00
	28 (2 4 4')	2.50	13.00	3.30	3.40
	77 (3 3' 4 4')	0.00	1.30	0.00	0.00
	105 (2 3 3'4 4')	3.20	14.00	3.70	4.30
	114 (2 3 4 4'5)	0.18	0.62	0.30	0.31
	118 (2 3' 4 4'5)	11.00	36.00	12.00	14.00
	123 (2' 3 4 4'5)	0.00	0.38	0.00	0.00
	126 (3 3' 4 4' 5)	0.00	0.00	0.00	0.00
	156/157 (2 3 3'4 4'5/2 3 3' 4 4'5')	0.85	2.70	1.30	1.10
	167 (2 3'4 4' 5 5')	0.80	1.80	0.69	0.77
	169 (3 3'4 4'5 5')	0.37	0.00	0.22	0.00
	170 (2 2'3 3'4 4'5)	3.30	2.90	2.40	3.70
	180 (2 2'3 4 4'5 5')	58.00	11.00	39.00	40.00
	189 (2 3 3'4 4'5 5')	0.00	0.00	0.00	0.00
	209 (2 2'3 3'4 4'5 5'6 6')	2.20	0.37	1.80	1.50
	Sum of PCB Congeners	82.40	84.07	64.71	69.08
	Sum of PCB Congeners X 2	164.80	168.14	129.42	138.16
PCB Homologs	Total MonoCBs	0.13	0.00	0.00	0.00
	Total DiCBs	0.62	0.42	1.60	0.00
	Total TriCBs	18.00	31.00	47.00	14.00
	Total TetraCBs	68.00	180.00	120.00	94.00
	Total PentaCBs	77.00	170.00	88.00	89.00
	Total HexaCBs	77.00	120.00	64.00	85.00
	Total HeptaCBs	200.00	43.00	130.00	130.00
	Total OctaCBs	62.00	5.00	74.00	64.00
	Total NonaCBs	40.00	0.00	25.00	24.00
	Sum of PCB Homologs	542.75	549.42	549.60	500.00
	Total PCBs	540.00	550.00	550.00	500.00
Tissue Lipid Content (%)		2.10	3.60	1.60	1.70

Units: PCBs, dioxins = ng/g dry weight.

Appendix A-1-4.1. Grain size analysis for sediments collected from the Raymark study area.

Sample ID	% Sand	% Silt	% Clay	%Silt 63-15.6μ	%Silt <15.6μ
A3SD10	35.6	64.4	0.00	24.3	40.1
CSD1	84.9	15.1	0.00	3.50	11.6
GM03	78.3	21.7	0.00	8.18	13.5
HB3A	20.5	78.1	1.38	29.1	50.4
SD01	33.0	65.6	1.39	20.1	46.9
SD07	73.3	25.9	0.75	9.51	17.2
SD08	66.6	33.4	0.00	17.2	16.2
SD13	54.7	44.0	1.30	11.3	34.0
SD13-RP[1]	54.7	45.3	0.00	15.6	29.8
SD14	57.0	42.0	0.96	14.3	28.7
SD14-RP[1]	57.0	42.2	0.76	16.5	26.4
SD18	16.7	83.3	0.00	27.6	55.7
SD21(A)	22.3	75.5	2.14	31.0	46.7
SD21(B)[2]	20.7	75.2	4.10	30.1	49.2
SD23	52.0	46.9	1.07	18.2	29.8
SD24	57.1	36.5	6.42	20.8	22.1
SD28	78.5	15.7	5.90	6.49	15.1
SD37	28.4	71.6	0.00	22.5	49.1

1 - Lab duplicate.

2 - Field duplicate.

Appendix A-1-4.2. Analysis for Organic Carbon in sediments and sediment porewaters collected from the Raymark study area.

Sample ID	Sediment Total Organic Carbon (%)	Porewater Dissolved Organic Carbon (mg/L)
A3SD10	8.76	10.3
A3SD10-DUP[1]		9.90
CSD1	12.1	21.3
GM03	5.86	14.3
HB3A	14.9	30.4
SD01	7.07	69.0
SD07	7.77	24.1
SD08	10.0	24.6
SD13	10.7	33.6
SD14	7.86	51.1
SD18	6.36	459
SD21(A)	4.56	81.9
SD21(B)[2]	3.25	88.7
SD21-AVG	3.91	85.3
SD23	8.78	30.7
SD24	9.91	25.0
SD28	6.26	19.7
SD37	2.03	34.2
Median	7.77	30.6

1 - Lab duplicate.

2 - Field duplicate.

Note: mg/g dry weight = % X 10

Appendix A-1-5. Summary of SEM and AVS concentrations in sediments collected from the Raymark study area.

Sample Name	AVS (µmol/g dry)	SEM Concentration (µmol/g dry) Cd	Cu	Ni	Pb	Zn	Sum of SEM Conc	SEM-AVS (µmol/g dry)
A3SD10	2.07	0.02	0.04	0.58	5.18	6.74	12.6	**10.5**
CSD1	31.6	7.3E-3	0.28	0.37	2.48	2.89	6.03	-25.5
GM08	9.40	1.1E-2	0.32	0.15	0.41	3.64	4.53	-4.9
HB3A	54.7	3.9E-3	0.03	0.78	46.1	15.3	62.2	**7.5**
SD01	77.7	0.03	1.2E-2	0.46	6.51	7.93	14.9	-62.7
SD07	117	0.02	0.08	0.37	1.49	5.49	7.44	-109.2
SD07-RP[1]	128	0.02	0.05	0.36	1.38	5.23	7.04	-121.3
SD08	85.2	1.4E-2	0.21	0.46	0.71	3.82	5.23	-79.9
SD13	90.5	0.04	0.03	0.32	3.62	7.65	11.7	-78.9
SD14	63.5	0.05	2.4E-3	0.43	1.63	5.56	7.67	-55.8
SD18	0.68	6.7E-3	2.66	0.20	1.60	2.46	6.94	**6.3**
SD18-RP[1]	0.76	7.1E-3	2.63	0.20	1.70	2.58	7.11	**6.3**
SD21A	90.8	0.02	0.06	0.28	1.19	3.75	5.29	-85.5
SD21B	99.3	0.02	0.02	0.24	1.20	3.89	5.36	-94.0
SD23	164	0.03	0.20	0.66	2.27	6.08	9.24	-154.7
SD24	109	0.02	0.47	0.72	2.13	5.40	8.74	-100.3
SD28	105	0.02	0.21	0.29	1.23	7.43	9.19	-95.3
SD37	10.1	3.1E-3	0.48	0.12	0.14	1.65	2.39	-7.7

1 - RP designates replicate analysis.
SEM = Simultaneously Extractable Metals; AVS = Acid Volatile Sulfides.

Appendix A-2-1.1. Hazard Quotients (HQs) and Hazard Indices (HIs) for contaminants in sediments for the Raymark study area. Benchmark = ER-L reference data.

Chemical Class	Analyte	ER-L[1]	A3SD10	CSD1	GM08	HB3A	SD01	SD07	SD08	SD13	SD14	SD18	SD21	SD23	SD24	SD28	SD37
Metals	Silver	1.00	2.00	3.00	3.00	2.40	1.40	1.50	1.40	1.40	0.88	0.44	0.54	0.93	0.62	1.60	0.60
	Arsenic	8.20	2.91	1.37	2.18	1.12	0.85	1.29	0.79	1.10	1.12	0.45	0.48	1.07	1.00	0.99	0.55
	Barium																
	Cadmium	1.20	6.92	1.00	1.25	0.83	4.58	3.67	1.17	6.33	6.33	0.67	2.67	5.25	2.17	3.50	0.43
	Chromium	81.0	5.72	4.96	2.85	3.58	1.11	1.23	1.04	1.13	1.43	0.39	0.46	1.13	1.20	1.32	0.73
	Copper	34.0	75.0	39.7	19.4	1071	48.5	12.6	6.82	26.2	22.8	7.97	5.53	13.6	11.3	10.6	5.09
	Mercury	0.15	2.87	5.13	8.00	3.13	1.47	2.13	2.47	1.87	3.27	1.07	1.03	1.87	1.87	1.80	1.13
	Nickel	20.9	15.2	2.58	1.79	18.5	3.86	2.35	1.78	2.83	4.13	1.00	1.08	2.49	3.03	2.08	1.00
	Lead	46.7	70.4	15.1	3.38	567	33.6	8.63	3.88	20.0	17.8	7.64	5.32	11.0	10.8	6.49	0.91
	Zinc	150	8.93	2.66	1.95	15.5	5.00	3.39	1.93	4.47	4.51	1.21	1.82	3.50	2.42	2.93	1.14
	Metals Hazard Index[2]		190	75.5	43.8	1683	100	36.8	21.3	65.3	62.3	20.8	18.9	40.8	34.4	31.3	11.6
PAHs	2-Methylnaphthalene	70.0	14.3	9.43	9.43	9.43	10.1	9.29	9.43	14.3	24.3	8.71	8.79	14.1	9.43	14.3	8.14
	Acenaphthene	16.0	62.5	41.3	41.3	41.3	8.75	10.0	41.3	12.5	12.5	38.1	5.31	10.0	41.3	62.5	35.6
	Acenaphthylene	44.0	4.32	4.55	15.0	15.0	7.95	7.50	2.95	9.32	10.0	3.18	3.75	7.73	2.50	4.55	1.91
	Anthracene	85.3	1.41	2.23	7.74	7.74	6.10	6.10	1.64	7.97	7.50	2.93	3.58	6.68	1.76	3.52	1.41
	Benzo(a)anthracene	261	5.75	2.15	0.73	2.53	9.58	10.3	2.57	15.3	14.6	3.07	5.56	11.1	3.41	6.51	1.65
	Benzo(a)pyrene	430	3.95	1.53	0.53	0.28	5.58	5.12	1.49	9.30	8.37	1.84	3.26	6.74	2.23	4.42	1.09
	Chrysene	384	7.29	2.21	1.04	0.47	10.4	10.4	2.60	26.0	24.0	3.13	5.21	11.7	4.17	6.85	2.34
	Dibenz(a,h)anthracene	63.4	4.10	3.00	1.17	10.4	7.26	8.36	3.00	17.4	15.8	5.05	5.44	14.8	4.89	9.46	2.37
	Fluoranthene	600	1.58	0.78	0.65	1.10	2.33	7.00	0.63	15.2	14.0	1.00	1.49	3.00	1.12	1.83	1.37
	Fluorene	19.0	73.7	38.4	11.6	57.9	200	205	52.1	279	253	57.9	103	232	63.2	121	28.4
	Naphthalene	160	1.50	4.13	4.13	4.13	2.69	3.25	0.75	3.81	3.44	1.00	1.69	3.44	1.00	1.94	3.58
	Phenanthrene	240	18.8	5.00	1.38	1.17	23.3	18.75	6.25	45.8	45.8	8.25	14.4	32.9	10.0	20.4	3.58
	Pyrene	665	1.50	0.99	0.99	0.99	0.29	0.39	0.99	0.33	0.54	0.11	0.21	0.33	0.12	0.20	0.86
	PAH Hazard Index[2]		201	116	95.6	152	294	302	126	456	433	132.3	161	354	145	260	92.3
PCBs	Total PCBs	22.7	1193	265	10.9	13973	913	104	42.6	382	205	107	55.8	181	214	105	4.61
	Sum of Aroclors																
PST	p,p'-DDE	2.20				1.64		3.27					2.45				

Hazard Quotients calculated as sediment concentration/benchmark.

Shaded cells indicate HQs and HIs>1.

See Appendix A-1-1 for sediment concentrations.

1 - All benchmarks from Long *et al.*, 1995.

2 - Hazard Index calculated as sum of analyte-specific Hazard Quotients

Appendix A-2-1.2. Hazard Quotients (HQs) and Hazard Indices (HIs) for contaminants in sediments for the Raymark study area. Benchmark = ER-M reference data.

Chemical Class	Analyte	ER-M[1]	A3SD10	CSD1	GM08	HB3A	SD01	SD07	SD08	SD13	SD14	SD18	SD21	SD23	SD24	SD28	SD37
Metals	Silver	3.70	0.54	0.81	0.81	0.65	0.38	0.41	0.38	0.38	0.24	0.12	0.14	0.25	0.17	0.43	0.16
	Arsenic	70.0	0.34	0.16	0.26	0.13	0.10	0.15	0.09	0.13	0.13	0.05	0.06	0.13	0.12	0.12	0.06
	Barium																
	Cadmium	906	9.2E-3	1.3E-3	1.7E-3	1.1E-3	6.1E-3	4.9E-3	1.5E-3	8.4E-3	8.4E-3	8.8E-4	3.5E-3	7.0E-3	2.9E-3	4.6E-3	5.6E-4
	Chromium	370	1.25	1.09	0.62	0.78	0.24	0.27	0.23	0.25	0.31	0.09	0.10	0.25	0.26	0.29	0.16
	Copper	270	9.44	5.00	2.45	135	6.11	1.59	0.86	3.30	2.87	1.00	0.70	1.71	1.42	1.34	0.64
	Mercury	0.71	0.61	1.08	1.69	0.66	0.31	0.45	0.52	0.39	0.69	0.23	0.22	0.39	0.39	0.38	0.24
	Nickel	51.6	6.14	1.05	0.72	7.48	1.56	0.95	0.72	1.15	1.67	0.40	0.44	1.01	1.23	0.84	0.41
	Lead	218	15.1	3.22	0.72	122	7.20	1.85	0.83	4.28	3.82	1.64	1.14	2.38	2.32	1.39	0.19
	Zinc	410	3.27	0.97	0.71	5.86	1.83	1.24	0.71	1.64	1.65	0.44	0.67	1.28	0.89	1.07	0.42
	Metals Hazard Index[2]		36.7	13.4	7.99	272	17.7	6.92	4.34	11.5	11.4	3.97	3.46	7.39	6.80	5.86	2.29
PAHs	2-Methylnaphthalene	670	1.49	0.99	0.99	0.99	1.06	0.97	0.99	1.49	2.54	0.91	0.92	1.48	0.99	1.49	0.85
	Acenaphthene	500	2.00	1.32	1.32	1.32	0.28	0.32	1.32	0.40	0.40	1.22	0.17	0.32	1.32	2.00	1.14
	Acenaphthylene	640	0.30	0.31	1.03	1.03	0.55	0.52	0.20	0.64	0.69	0.22	0.26	0.53	0.17	0.31	0.13
	Anthracene	1100	0.11	0.17	0.60	0.60	0.47	0.47	0.13	0.62	0.58	0.23	0.28	0.52	0.14	0.27	0.11
	Benzo(a)anthracene	1600	0.94	0.35	0.12	0.41	1.56	1.69	0.42	2.50	2.38	0.50	0.91	1.81	0.56	1.06	0.27
	Benzo(a)pyrene	1600	1.06	0.41	0.14	0.08	1.50	1.38	0.40	2.50	2.25	0.49	0.88	1.81	0.60	1.19	0.29
	Chrysene	2800	1.00	0.30	0.14	0.06	1.43	1.43	0.36	3.57	3.29	0.43	0.71	1.61	0.57	1.21	0.32
	Dibenz(a,h)anthracene	260	1.00	0.73	0.28	2.54	1.77	2.04	0.73	4.23	3.85	1.23	1.33	3.62	1.19	2.31	0.58
	Fluoranthene	5100	0.19	0.09	0.08	0.13	0.27	0.82	0.07	1.78	1.65	0.12	0.18	0.35	0.13	0.22	0.16
	Fluorene	540	2.59	1.35	0.41	2.04	7.04	7.22	1.83	9.81	8.89	2.04	3.61	8.16	2.22	4.26	1.00
	Naphthalene	2100	0.11	0.31	0.31	0.31	0.20	0.25	0.06	0.29	0.26	0.08	0.13	0.26	0.08	0.15	0.27
	Phenanthrene	1500	3.00	0.80	0.22	0.19	3.73	3.00	1.00	7.33	7.33	1.00	2.30	5.27	1.60	3.27	0.57
	Pyrene	2600	0.38	0.25	0.25	0.25	0.07	0.10	0.25	0.08	0.14	0.03	0.05	0.08	0.03	0.05	0.22
	PAH Hazard Index[2]		14.2	7.40	5.90	9.95	19.9	20.2	7.76	35.3	34.2	8.49	11.7	25.6	9.60	17.8	6.92
PCBs	Total PCBs	180	150	33.4	1.37	1762	115	13.1	5.37	48.1	25.8	13.5	7.04	22.9	27.0	13.2	0.58
	Sum of Aroclors																
PST	p,p'-DDE	27.0				0.13		0.27					0.20				

Hazard Quotients calculated as sediment concentration/benchmark.

Shaded cells indicate HQs and HIs>1.

See Appendix A-1-1 for sediment concentrations.

1 - All benchmarks from Long *et al.*, 1995.

2 - Hazard Index calculated as sum of analyte-specific Hazard Quotients.

Appendix A-2-2.1. Hazard Quotients (HQs) and Hazard Indices (HIs) for contaminants in WHOLE porewaters for the Raymark TIE.

Chemical Class	Analyte	WQSV[1,2]	Source[3]	A3SD10	CSD1	GM08	HB3A	SD01	SD07	SD08	SD13	SD14	SD18	SD21	SD23	SD24	SD28	SD37
Metals	Silver	0.92	a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Arsenic	36.0	a	0.55	1.63	0.56	0.93	0.00	2.64	2.24	2.04	0.49	0.22	0.33	0.96	0.33	0.53	0.50
	Barium	3.80	d	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cadmium	36.0	c	0.16	0.10	0.00	0.09	0.08	0.11	0.04	0.08	0.09	0.02	0.09	0.09	0.08	0.10	0.08
	Chromium	50.0	a	0.03	0.05	0.03	0.02	0.06	0.02	0.00	0.06	0.06	0.04	0.01	0.06	0.05	0.00	0.00
	Copper	20.5	c	3.17	3.46	2.68	29.2	5.46	2.63	1.56	2.24	2.34	0.00	2.46	1.71	2.00	2.68	2.63
	Nickel	2400	c	0.10	0.01	0.01	0.05	0.01	0.01	0.02	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.00
	Lead	3020	c	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Zinc	343	c	4.49	0.76	1.22	0.50	0.50	0.44	0.58	0.41	0.79	0.12	0.34	0.17	0.15	0.76	0.15
	Metals Hazard Index[4]			8.50	6.01	4.52	30.8	6.12	5.85	4.45	4.83	3.78	0.40	3.25	3.01	2.61	4.08	3.37
PAHs	2-Methylnaphthalene	1.22	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Acenaphthene	1125	c	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Acenaphthylene	0.64	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Anthracene	0.40	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Benzo(a)anthracene	0.05	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Benzo(a)pyrene	0.027	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Chrysene	0.13	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dibenz(a,h)anthracene	0.013	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fluoranthene	66.9	c	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fluorene	0.14	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Naphthalene	620	b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Phenanthrene	4.60	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Pyrene	1.21	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PAH Hazard Index[4]			0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCBs	Total PCBs	40.0	c	0.00	27.3	0.00	0.00	0.00	52.1	50.0	12.6	0.00	0.00	0.00	28.6	0.00	55.3	0.00

See Appendix A-1-2 for porewater concentrations.

HQ=sediment porewater concentration/WQSV. Blank cells indicate HQs not calculated due to non-detect or zero porewater concentrations.

1 - See text for description of WQSV derivation process.

2 - Benchmark units: µg/L.

3 - Water Quality Screening Value (WQSV) sources

a - U.S. EPA Water Quality Criteria - Saltwater Chronic (USEPA, 1986);

b - U.S. EPA Water Quality Criteria - Freshwater Chronic (USEPA, 1986);

c - literature LC50 values for *Ampelisca* (Berry *et al.*, 1996 (Cd, Cu, Pb, Ni, Zn); Ho *et al.*, 1997 (PCBs));

d - literature values for Daphnids (Suter, 1996 (Ba))

e - EqP partitioning of ER-L sediment benchmark into porewater at 1% TOC

4 - Hazard Index = class-specific sum of Hazard Quotients.

Appendix A-2-2.2. Hazard Quotients (HQs) and Hazard Indices (HIs) for contaminants in C-18 and EDTA-treated porewaters for the Raymark TIE.

Chemical Class	Analyte	WQSV[1,2]	Source[3]	A3SD10	CSD1	GM08	HB3A	SD01	SD07	SD08	SD13	SD14	SD18	SD21	SD23	SD24	SD28	SD37
Metals	Arsenic	36.0	a	0.02	1.14	0.06	0.03		1.77	1.61	0.15		0.06	0.04	0.28		1.47	0.15
	Cadmium	36.0	c	0.26	0.24	0.18	0.14	0.09	0.15	0.16	0.10	0.13	0.03	0.12	0.13	0.10	0.26	0.16
	Chromium	50.0	a		7.6E-3			2.9E-2				2.1E-2	1.0E-2		1.9E-2	7.2E-3		4.2E-3
	Copper	20.5	c	1.12	0.93	1.37	4.10	0.73	1.46	0.93	1.02	0.88		0.54	1.37	0.88	1.27	1.51
	Nickel	2400	c	2.7E-3				5.3E-3										
	Lead	3020	c				1.1E-3					1.5E-3		8.2E-4	1.4E-3			
	Zinc	343	c	7.00	0.29	1.49	0.67	0.50	0.20	0.26	0.35	0.41	0.20	0.22	0.12	0.15	0.20	0.17
	Metals Hazard Index[4]			8.40	2.60	3.09	4.95	1.36	3.58	2.96	1.63	1.43	0.30	0.91	1.92	1.13	3.20	2.01
PCBs	Total PCBs	40.0	c							0.65	7.48				6.31			

See Appendix A-1-2 for porewater concentrations.

HQ=sediment porewater concentration/WQSV. Blank cells indicate HQs not calculated due to non-detect or zero porewater concentrations.

1 - See text for description of WQSV derivation process.

2 - Benchmark units: µg/L

3 - Water Quality Screening Value (WQSV) sources:

a - U.S. EPA Water Quality Criteria - Saltwater Chronic (USEPA, 1986);

b - U.S. EPA Water Quality Criteria - Freshwater Chronic (USEPA, 1986);

c - literature LC50 values for *Ampelisca* (Berry *et al.*, 1996 (Cd, Cu, Pb, Ni, Zn); Ho *et al.*, 1997 (PCBs));

d - literature values for Daphnids (Suter, 1996 (Ba))

e - EqP partitioning of ER-L sediment benchmark into porewater at 1% TOC

4 - Hazard Index = class-specific sum of Hazard Quotients

Appendix A-2-2.3. Hazard Quotients (HQs) and Hazard Indices (HIs) for contaminants in *Ulva*- and non-*Ulva*-treated porewaters collected from the Raymark study area.

				Ulva				Non-*Ulva*			
Chemical Class	Analyte	WQSV[1,2]	Source[3]	A3SD10	HB3A	SD01	SD28	A3SD10	HB3A	SD01	SD28
Metals	Arsenic	36.0	a	0.52	0.56	0.02	0.22	0.66	0.71	0.07	0.41
	Cadmium	36.0	c	0.13	0.06	0.07	0.08	0.14	0.08	0.09	0.07
	Chromium	50.0	a								
	Copper	20.5	c	3.41	18.1	1.95	3.12	2.00	30.6	1.37	2.59
	Nickel	2400	c								
	Lead	3020	c								
	Zinc	343	c	0.35	1.55	0.20	0.15	0.23	2.65	0.23	0.29
PCBs	Total PCBs	40.0	c			0.52				0.16	

See Appendix A-1-2 for porewater concentrations.

HQ=sediment porewater concentration/WQSV. Blank cells indicate HQs not calculated due to non-detect or zero porewater concentrations.

1 - See text for description of WQSV derivation process.

2 - Benchmark units: µg/L.

3 - Water Quality Screening Value (WQSV) sources:

a - U.S. EPA Water Quality Criteria - Saltwater Chronic (USEPA, 1986);

b - U.S. EPA Water Quality Criteria - Freshwater Chronic (USEPA, 1986);

c - literature LC50 values for *Ampelisca* (Berry *et al*., 1996 (Cd, Cu, Pb, Ni, Zn); Ho *et al*., 1997 (PCBs));

d - literature values for Daphnids (Suter, 1996 (Ba)).

e - EqP partitioning of ER-L sediment benchmark into porewater at 1% TOC

4 - Hazard Index = class-specific sum of Hazard Quotients.

Appendix A-2-3. Hazard Quotients (HQs) for *Ampelisca* and *Mulinia* exposed to ammonia in sediment porewaters from the Raymark study area.

Treat	Class	Analyte	Benchmark[1,2]	A3SD10	CSD1	GM08	HB3A	SD01	SD07	SD08	SD13	SD14	SD18	SD21	SD23	SD24	SD28	SD37
PW	AMPAM	Total Ammonia	30.0	0.65	0.55	0.41	0.53	1.14	1.05	0.98	1.23	0.91	1.47	1.19	0.78	0.78	0.77	1.65
		Un-ionized Ammonia	0.40	0.30	0.84	0.16	0.32	0.75	1.60	0.89	1.03	0.68	0.23	0.70	1.29	0.94	1.27	2.01
	MULAM	Total Ammonia	13.4	1.46	1.23	0.92	1.19	2.56	2.34	2.19	2.76	2.05	3.29	2.65	1.75	1.74	1.72	3.70
		Un-ionized Ammonia	0.09	1.31	3.72	0.70	1.41	3.34	7.12	3.96	4.59	3.04	1.02	3.09	5.71	4.17	5.64	8.94
ULVA	AMPAM	Total Ammonia	30.0	0.05	0.02	0.00	0.05	0.04	0.06	0.02	0.02	0.05	0.14	0.03	0.09	0.03	0.03	0.10
		Un-ionized Ammonia	0.40	0.04	0.08	0.01	0.07	0.08	0.23	0.07	0.06	0.11	0.23	0.09	0.10	0.08	0.09	0.27
	MULAM	Total Ammonia	13.4	0.10	0.04	0.01	0.12	0.08	0.14	0.04	0.05	0.11	0.31	0.07	0.21	0.06	0.06	0.22
		Un-ionized Ammonia	0.09	0.16	0.35	0.05	0.29	0.35	1.03	0.32	0.26	0.49	1.03	0.41	0.46	0.34	0.40	1.20

AMPAM=*Ampelisca*; MULAM=*Mulinia*.
Benchmark units: mg/L.
1 - Benchmark for *Ampelisca*: NOEC = No Observable Effect Concentration.
2 - Benchmark for *Mulinia* larval Development: LOEC (Carr, et al., 1996)
3 - Hazard Index = sum of class-specific Hazard Quotients

Appendix Table B-1.1. *Ampelisca* survival in whole porewater from the Raymark study area.

Station	Method[4]	Concentration Porewater (%)						LC50[2]	LC2
		0[1]	6.25	12.5	25	50	100	(%)	(%
A3SD10	a	100	100	100	100	86.7	73.3	>100	77.
CSD1	a	100	100	100	93.3	100	53.3	>100	64.
GM08	c	100	100	100	100	100	66.7	>100	80.
HB3A	c	100	86.7	100	93.3	100	40.0	91.7	66.
SD01	b	100	100	100	100	66.7	0.00	56.1	40.
SD07	b	100	100	100	100	100	0.00	70.7	60.
SD08	a	100	100	86.7	93.3	86.7	0.00	59.2	43.
SD13	b	100	100	93.3	100	100	0.00	70.7	60.
SD14	b	100	100	93.3	100	100	0.00	70.7	60.
SD18	b	100	100	100	80.0	0.00	0.00	31.0	25.
SD21	c	100	100	100	100	100	6.67	76.8	60.
SD23	b	91.7	100	100	100	100	0.00	70.7	60.
SD24	b	93.3	93.3	100	100	80.0	0.00	62.7	51.
SD28	c	100	100	100	100	100	100	>100	10[illegible]
SD37	b	91.7	100	93.3	80.0	100	0.00	41.4	28.

Shading indicates values excluded from calculations.

1 - Control value for experiment, assumed for all treatments, is 0% porewater.

2 - Lethal Concentration - 50% (concentration of porewater causing 50% reduction in survival).

3 - Lethal Concentration - 20% (concentration of porewater causing 20% reduction in survival).

4 - Calculation method:

a - LC50 and LC20 calculated using Maximum Likelihood-Probit method.

b - LC50 calculated using Trimmed Spearman-Karber method; LC20 calculated using Linear Interpolation (IC20).

c - LC50 and LC20 calculated using Linear Interpolation (IC50 and IC20).

Appendix Table B-1.2. *Mulinia* normal larval development in whole porewater from the Raymark study area.

		Concentration Porewater (%)						EC50[2]	EC20[3]
Station	Method[4]	0[1]	6.25	12.5	25	50	100	(%)	(%)
A3SD10	a	97.7	2.00	0.33	0.00	0.00	0.00	0.91	0.41
CSD1	a	97.7	90.0	49.0	12.3	0.00	0.00	17.3	11.7
GM08	a	96.0	96.3	89.0	12.7	0.00	0.00	18.5	14.8
HB3A	a	95.7	93.0	20.7	0.00	0.00	0.00	10.2	8.26
SD01	a	95.3	92.0	49.7		0.00	0.00	12.7	9.21
SD07	a	96.3	85.0	24.7	0.00	0.00	0.00	9.73	7.20
SD08	a	97.0	41.3	10.7	92.0	0.00	0.00	5.55	3.20
SD13	a	97.0	91.7	84.3	67.0	21.3	0.00	32.4	20.7
SD14	a	96.7	88.3	82.7		0.00	0.00	17.1	13.8
SD18	c	93.0	0.00	0.00		0.00	0.00	3.13	1.25
SD21	a	98.0	78.3	56.7	0.00	0.00	0.00	11.4	7.58
SD23	c	94.7	89.0	83.3	78.7	67.0	0.00	64.7	31.3
SD24	a	98.3	92.0	89.0	28.3	3.67	0.00	21.2	14.9
SD28	c	96.0	94.7	96.3	91.0	86.7	0.00	72.3	55.7
SD37	a	95.3	88.7	12.0	0.00	0.00	0.00	9.23	7.39

1 - Control value for experiment, assumed for all treatments, is 0% porewater.

2 - Effect Concentration - 50% (concentration of porewater causing 50% reduction in test response).

3 - Effect Concentration - 20% (concentration of porewater causing 20% reduction in test response).

4 - Calculation method:

a - EC50 and EC20 calculated using Maximum Likelihood-Probit method.

b - EC50 calculated using Trimmed Spearman-Karber method; EC20 calculated using Linear Interpolation (IC20).

c - EC50 and EC20 calculated using Linear Interpolation (IC50 and IC20).

Appendix Table B-2.1. *Ampelisca* survival in C-18 treated porewater from the Raymark study area.

Station	Method[4]	Concentration Porewater (%)				LC50[2]	LC20[3]
		0[1]	10	50	100	(%)	(%)
A3SD10	c	100	100	100	90.0	>100	100.0
CSD1	c	100	100	100	70.0	>100	83.3
GM08	c	100	100	100	100	>100	100.0
HB3A	a	100	100	30.0	40.0	52.2	22.7
SD01	b	100	100	90.0	0.00	63.0	55.6
SD07	c	100	100	100	70.0	>100	83.3
SD08	c	80.0	100	100	0.00	75.0	60.0
SD13	b	90.0	100	100	0.00	70.7	60.0
SD14	b	100	100	100	0.00	70.7	60.0
SD18	b	100	100	0.00	0.00	22.4	18.0
SD21	c	100	100	100	0.00	75.0	60.0
SD23	b	100	100	100	0.00	70.7	60.0
SD24	b	100	100	100	0.00	70.7	60.0
SD28	c	100	100	100	100	>100	100
SD37	c	100	90.0	90.0	0.00	68.0	55.0

1 - Control value for experiment, assumed for all treatments, is 0% porewater.
2 - Lethal Concentration - 50% (concentration of porewater causing 50% reduction in survival).
3 - Lethal Concentration - 20% (concentration of porewater causing 20% reduction in survival).
4 - Calculation method:
a - LC50 and LC20 calculated using Maximum Likelihood-Probit method.
b - LC50 calculated using Trimmed Spearman-Karber method; LC20 calculated using Linear Interpolation (IC20).
c - LC50 and LC20 calculated using Linear Interpolation (IC50 and IC20).

Appendix Table B-2.2. *Mulinia* normal larval development in C-18 treated porewater from the Raymark study area.

Station	Method[4]	Concentration Porewater (%) 0[1]	10	50	100	EC50[2] (%)	EC20[3] (%)
A3SD10	c	96.0	2.33	0.00	0.00	5.12	2.05
CSD1	c	93.3	17.3	0.00	0.00	6.14	2.46
GM08	a	95.3	89.7	33.0	47.0	57.7	15.9
HB3A	c	88.0	90.7	0.00	0.00	30.0	18.0
SD01	c	95.3	96.0	0.00	0.00	30.0	18.0
SD07	c	97.7	23.3	0.00	0.00	6.57	2.63
SD08	c	96.3	34.0	0.00	0.00	7.73	3.09
SD13	c	96.3	92.7	0.00	0.00	29.2	16.7
SD14	c	94.0	92.3	0.00	0.00	29.6	17.4
SD18	c	89.7	94.0	22.3	0.00	36.4	20.6
SD21	c	92.7	89.7	0.00	0.00	29.3	16.9
SD23	a	94.7	93.0	73.3	64.3	>100	49.2
SD24	a	97.7	94.0	58.0	0.00	52.1	45.7
SD28	a	97.7	93.7	69.7	3.33	59.5	46.8
SD37	c	97.3	82.7	0.00	0.00	12.8	10.5

1 - Control value for experiment, assumed for all treatments, is 0% porewater.

2 - Effect Concentration - 50% (concentration of porewater causing 50% reduction in test response).

3 - Effect Concentration - 20% (concentration of porewater causing 20% reduction in test response).

4 - Calculation method:

a - EC50 and EC20 calculated using Maximum Likelihood-Probit method.

b - EC50 calculated using Trimmed Spearman-Karber method; EC20 calculated using Linear Interpolation (IC20).

c - EC50 and EC20 calculated using Linear Interpolation (IC50 and IC20).

Appendix Table B-3.1. *Ampelisca* survival in EDTA-treated porewater from the Raymark study area.

Station	Method[4]	Concentration Porewater (%)				LC50[2]	LC20[3]
		0[1]	10	50	100	(%)	(%)
A3SD10	c	100	100	100	100	>100	100
CSD1	c	100	100	100	50.0	>100	70.0
GM08	a	100	100	90.0	80.0	>100	100
HB3A	c	90.0	100	100	0.00	75.0	60.0
SD01	b	100	100	100	0.00	70.7	60.0
SD07	b	100	100	100	20.0	77.1	62.5
SD08	c	100	100	100	0.00	75.0	60.0
SD13	b	100	100	100	0.00	70.7	60.0
SD14	b	100	100	90.0	0.00	63.0	55.6
SD18	b	100	100	0.00	0.00	22.4	18.0
SD21	c	100	100	100	0.00	75.0	60.0
SD23	b	87.5	90.0	100	0.00	70.7	60.0
SD24	b	100	100	100	10.0	73.5	61.1
SD28	c	100	100	100	90.0	>100	100
SD37	b	100	90.0	100	0.00	69.4	57.9

1 - Control value for experiment, assumed for all treatments, is 0% porewater.

2 - Lethal Concentration - 50% (concentration of porewater causing 50% reduction in survival).

3 - Lethal Concentration - 20% (concentration of porewater causing 20% reduction in survival).

4 - Calculation method:

a - LC50 and LC20 calculated using Maximum Likelihood-Probit method.

b - LC50 calculated using Trimmed Spearman-Karber method; LC20 calculated using Linear Interpolation (IC20).

c - LC50 and LC20 calculated using Linear Interpolation (IC50 and IC20).

Appendix Table B-3.2. *Mulinia* normal larval development in EDTA-treated porewater from the Raymark study area.

Station	Method[4]	Concentration Porewater (%) 0[1]	10	50	100	EC50[2] (%)	EC20[3] (%)
A3SD10	c	98.3	95.3	0.00	0.00	29.4	17.0
CSD1	c	95.3	78.7	0.33	0.00	25.8	11.2
GM08	c	94.7	97.7	87.7	20.7	79.5	58.0
HB3A	c	95.7	92.7	0.00	0.00	29.4	16.9
SD01	c	97.7	91.7	0.00	0.00	28.7	15.9
SD07	c	94.7	92.3	0.00	0.00	29.5	17.2
SD08	c	95.7	25.0	0.00	0.00	6.77	2.71
SD13	c	93.7	93.0	0.00	0.00	29.9	17.8
SD14	c	99.0	93.0	0.00	0.00	28.7	15.9
SD18	c	99.0	0.00	0.00	0.00	5.00	2.00
SD21	c	95.7	88.0	0.00	0.00	28.3	15.2
SD23	c	94.0	79.3	0.00	0.00	26.3	12.1
SD24	b	96.3	96.3	26.7	0.00	30.8	21.1
SD28	a	96.3	93.3	85.3	5.67	68.4	55.7
SD37	c	93.7	76.3	0.00	0.00	25.5	10.7

1 - Control value for experiment, assumed for all treatments, is 0% porewater.

2 - Effect Concentration - 50% (concentration of porewater causing 50% reduction in test response).

3 - Effect Concentration - 20% (concentration of porewater causing 20% reduction in test response).

4 - Calculation method:

a - EC50 and EC20 calculated using Maximum Likelihood-Probit method.

b - EC50 calculated using Trimmed Spearman-Karber method; EC20 calculated using Linear Interpolation (IC20).

c - EC50 and EC20 calculated using Linear Interpolation (IC50 and IC20).

Appendix Table B-4.1. *Ampelisca* survival in *Ulva*-treated porewater from the Raymark study area.

Station	Method[4]	Concentration Porewater (%)						LC50[2] (%)	LC20[3] (%)
		0[1]	6.25	12.5	25	50	100		
A3SD10	c	100	100	100	100	100	100	>100	100
CSD1	c	100	100	100	100	100	100	>100	100
GM08	c	100	100	100	100	93.3	100	>100	100
HB3A	a	100	93.3	93.3	100	53.3	0.00	45.5	24.0
SD01	a	100	100	100	100	93.3	60.0	>100	72.8
SD07	c	100	100	100	100	100	100	>100	100
SD08	c	100	100	100	100	100	100	>100	100
SD13	c	100	100	100	100	100	100	>100	100
SD14	a	100	100	100	93.3	66.7	53.3	93.8	43.6
SD18	a	100	100	80.0	77.5	65.0	0.00	40.8	20.0
SD21	a	100	100	100	100	66.7	45.0	80.8	46.9
SD23	c	100	100	100	100	100	93.3	>100	100
SD24	c	100	100	100	100	100	93.3	>100	100
SD28	c	100	100	100	100	100	100	>100	100
SD37	c	100	100	100	100	100	93.3	>100	100

1 - Control value for experiment, assumed for all treatments, is 0% porewater.

2 - Lethal Concentration - 50% (concentration of porewater causing 50% reduction in survival).

3 - Lethal Concentration - 20% (concentration of porewater causing 20% reduction in survival).

4 - Calculation method:

a - LC50 and LC20 calculated using Maximum Likelihood-Probit method.

b - LC50 calculated using Trimmed Spearman-Karber method; LC20 calculated using Linear Interpolation (IC20).

c - LC50 and LC20 calculated using Linear Interpolation (IC50 and IC20).

Appendix Table B-4.2. *Mulinia* normal larval development in *Ulva*-treated porewater from the Raymark study are

		Concentration Porewater (%)						EC50[2]	EC20[3]
Station	Method[4]	0[1]	6.25	12.5	25	50	100	(%)	(%)
A3SD10	c	95.7	0.00	0.00	0.00	0.00	0.00	3.13	1.25
CSD1	c	95.7	5.00	6.00	0.00	0.00	0.00	6.67	2.67
GM08	c	95.7	0.00	0.00	0.00	0.00	0.00	3.13	1.25
HB3A	c	95.7	0.33	0.00	0.00	0.00	0.00	3.14	1.25
SD01	a	95.7	0.33	16.7	12.7	0.00	0.00	5.28	2.14
SD07	a	95.7	0.00	10.3	4.33	0.00	0.00	3.80	1.64
SD08	a	95.7	7.50	62.0	47.5	1.00	0.00	19.0	11.1
SD13	a	95.7		66.0	46.5	17.5	0.00	21.4	10.8
SD14	a	95.7		64.0	41.0	3.50	1.00	18.6	10.3
SD18	a	95.7		44.0		21.0	0.00	12.0	5.91
SD21	c	95.7	0.33	0.00	0.00	0.00	0.00	3.14	1.25
SD23	a	95.7	6.33	4.00	0.00	0.00	0.00	1.08	0.38
SD24	c	95.7	0.00	9.67	0.00	0.00	0.00	6.95	2.78
SD28	a	95.7		67.0	61.0	0.00	0.00	22.3	13.8
SD37	a	95.7	35.0	27.7	4.00	0.33	0.00	5.23	2.24

Shading indicates values excluded from calculations.

1 - Control value for experiment, assumed for all treatments, is 0% porewater. No control data available for *Ulva* treatment; control value taken as average of controls from whole, EDTA, and C18 treatments.

2 - Effect Concentration - 50% (concentration of porewater causing 50% reduction in test response).

3 - Effect Concentration - 20% (concentration of porewater causing 20% reduction in test response).

4 - Calculation method:

a - EC50 and EC20 calculated using Maximum Likelihood-Probit method.

b - EC50 calculated using Trimmed Spearman-Karber method; EC20 calculated using Linear Interpolation (IC20).

c - EC50 and EC20 calculated using Linear Interpolation (IC50 and IC20).

Final Report:

Evaluation of Ecological Risk to Avian and Mammalian Receptors in the Vicinity of Upper and Middle Ferry Creek, Stratford, CT

September 1999

Prepared by:
SAIC
221 Third Street
Newport, RI 02840

for
USACE-NED
Waltham, MA

Table of Contents

List of Tables

List of Tables (continued)

1. Introduction

This report presents results of an ecological risk assessment for avian and mammalian receptors associated with Ferry Creek and the Housatonic River in Stratford, CT. The Ferry Creek system received wastewater discharges from an industrial manufacturer via runoff from a culvert in upper Ferry Creek as well as from erosion of wetland/fill created from industrial sludge and placed along the creek banks. The scope of this assessment is to address potential CoC-related risks to receptors utilizing habitat in upper Ferry Creek (Area of Concern A1) and Middle Ferry Creek (AoC A3). The spatial delineations of these areas are addressed in the Remedial Investigation report (TtNUS, in prep).

The content of this section draws heavily from the avian assessment performed by NOAA (1998), and retains much of the same approach, content, and general findings as was reported in their study. The present analysis differs from the NOAA investigation in three main ways: 1) additional spatial resolution of the Ferry Creek system is presented; 2) updated exposure parameters for avian modeling have been employed; and 3) an assessment of a semi-aquatic mammal receptor has been added to the evaluation.

Exposure of avian receptors to CoCs depends upon the fate and transport characteristics of the CoCs, distribution of the waste materials throughout the area of concern, and the natural history of the avian indicator species. Avian and mammalian exposure to CoCs within Middle and Upper Ferry Creek and the reference area was evaluated using a food-web modeling approach. Elements of the model (taken from NOAA, 1998) are presented in Section 2. Results of the analysis and discussion of significance including uncertainty are presented in Sections 3, 4, and 5 respectively.

2. Methods

Parameters and assumptions used in the food-web exposure model are derived from natural history information compiled from the literature for each species (Table 2-1). Also, site-specific or regional information for avian receptors was obtained through contracts with local wildlife officials. Specific exposure parameters and the rationale for their selection are discussed in the following sections.

The food-web exposure model was used to estimate the exposure of the receptor species through diet, expressed as a total daily dose. In the literature, most TRVs for terrestrial species are reported as the threshold daily dose to an individual. Estimating a site-specific dose (IR_T) allows for direct comparison of exposure estimates with TRVs. Contaminant body-burden data from the sampling of mummichog, fiddler crabs, and insects, plus water concentrations of CoCs, were used for input into the models. Incidental sediment ingestion was also used as an input variable where appropriate. The basic structure of the exposure model is:

Equation 1) $$IR_{Total} = \sum_{X} IR_X = \sum_{X} [\sum_{M} [\frac{(C_{XM} \bullet IR_M) \bullet BF_{XM} \bullet HR}{BW}]]$$

Where:
IR_{TOTAL} = total ingestion rate of all contaminants (mg/kg bw/day wet weight)
IR_X = ingestion rate of contaminant X from all media
C_{XM} = concentration of CoC_X in $medium_M$ (mg/kg wet weight)
IR_M = ingestion rate of $medium_M$ (kg/day wet weight)
BF_{XM} = dietary bioavailability factor of CoC_X in $medium_M$ (percent)
HR = proportion of contaminated site relative to receptor species' home range (i.e., exposure fraction) (unitless)
BW = body weight of receptor species (kg)

Ingestion Rate. Precise information on nutrition requirements and energetics of selected receptor species (heron, blackbirds, and raccoon) were not available from the literature. Instead, daily food and water intake rates have been estimated using an allometric equation based on their body weight in grams (Nagy, 1987). These equations for food ingestion, F, in units of grams dry weight per day (Equations 2, 3, and 4), are as follows:

Red-winged Blackbird:	$FCR = 0.398 \times bw^{0.85}$	Equation 2
Black-crowned night heron	$FCR = 0.648 \times bw^{0.651}$	Equation 3
Raccoon	$FCR = 0.235 \times bw^{0.822}$	Equation 4

In addition, water ingestion, W, in units of liters per day (Equations 5 and 6) were calculated from bw (kg) using the generic models presented below:

Bird Water ingestion	$WIR = 0.059 \times bw^{0.67}$	Equation 5
Mammal Water ingestion	$WIR = 0.099 \times bw^{0.9}$	Equation 6

Data on CoC concentrations in sediment, surface water, and key prey of the receptor species were incorporated into the model to estimate total chemical doses ingested according to their respective intake rates. The daily ingestion intake rates used in the dietary model are presented in Table 2-1, which also details other exposure parameters used in equations above. Average body weights were also used in equations.

To account for ingestion of different food types by a given receptor, the ingestion dose of all prey items, plus sediment and water are summed. Hence, the term ($C_{XM} \times IR_M$) was expanded to specify each ingested medium (Equation 7):

$$\sum (C_{XM} \bullet I_{RM}) = (C_{fish} \bullet I_{fish}) + (C_{crab} \bullet I_{crab}) + (C_{insects} \bullet I_{insects}) + (C_{water} \bullet I_{water}) + (C_{sediment} \bullet I_{sediment})$$

Black-crowned night herons are opportunistic feeders that consume a variety of aquatic species and even small terrestrial mammals. Table 2-2 presents information on the composition of their diet. The fraction of fish, crustaceans, and insects in the black-crowned heron diet are 53%, 21%, and 1.5%, respectively, as reported by NOAA (1998), constituting 75% of total dietary requirements. Hence, ingestion rates of measured prey items were elevated to account for the unsampled items in the heron diet. The remaining 25% of unsampled dietary components was assumed to be as equally contaminated as the 75% for which measurements were available.

To estimate dietary exposure to the black-crowned night heron, samples of crab, fish, and insects were collected from appropriate habitats. Fiddler crabs were collected from all sampling areas, mummichogs were collected from Upper Ferry Creek and a reference area (Great Meadows), and terrestrial insects were collected from Upper Ferry Creek and the reference area (Milford Point).

The diet and feeding behavior of the herons suggests that incidental sediment ingestion does occur and therefore may be a significant exposure pathway (Beyer, pers. comm., 1995; Ohlendorf, pers. comm., 1995). Sediment ingestion was assumed to be equivalent to 5% of the total dietary intake. Also, the herons were estimated to consume 0.05 L of water per day based on their body size (Equation 5). Total concentrations of CoCs in surface water were used to estimate the dose for this component for the food-web model.

As for dietary composition, the NOAA ERA summarized the percent plant and animal matter in red-winged blackbird diets (Table 5-3; NOAA, 1998). During the spring and summer, insects comprise approximately half of the blackbird diet (Martin et al., 1951). Because adults nest during summer and feed their nestlings only insects, this assessment models an exposure diet for the nestlings consisting totally of insects (100%). Because of the preference for terrestrial insects, incidental sediment ingestion does not appear to be a significant component of the CoC exposure pathway for this species. Red-winged blackbirds were estimated to consume 12 g of food per day (dry weight) based on allometric equations using body weight (Equation 2. The dietary water requirements were estimated to be 0.0083 L of water per day based on their body size (Equation 5).

The diet and feeding behavior of raccoons is remarkably similar to that of herons, in that fish, crustaceans and insects are primary foods (U.S. EPA, 1993) and incidental sediment ingestion does occur (Beyer, 1994). Dietary fractions for this species are reported in Table 2-1 and a summary of food consumption parameters are found in Table 2-2.

Bioavailability Factors. To account for differences in bioavailability of CoCs, a dietary bioavailability factor (BF) was applied for particular CoCs to adjust the estimated total daily dose. Dietary studies in which the dose was administered in the food source were targeted. Avian studies cited by Ammerman et al. (1995) found that 44% of copper and only 61% of zinc in plant food sources was absorbed by chickens. Using primarily animal protein sources, bioavailability of copper and zinc in chickens increased to 65% and 85%, respectively. For this assessment, the latter copper value was assumed for heron and blackbirds. For all other CoCs, the maximum assimilation in birds encountered (85%) was assumed for the bioavailability factor (Bf_{XM}). For raccoons, bioavailability was assumed to be 100%.

Home Range. The nearest black-crowned night heron colony is about 3.5 miles (5.6 km) from the Raymark facility. This species has been observed foraging in the tidal areas within 1.9 miles (3 km) of the facility, and along Middle and Upper Ferry Creek. Since information pertaining to home range and feeding territory were not available from the literature, assumptions were made regarding habitat use for the food-web model. Although it is generally accepted that black-crowned night herons defend a feeding territory, no information was available on territory size, making it difficult to arrive at a home-range exposure factor (HR) for the food-web model. With regard to wading birds, the size of the feeding territory depends on the bird's ability to defend it, which is positively correlated with body size. Territory size is also dependent on prey distribution, dictating the size of the area a bird must defend to obtain adequate food in an energy-efficient manner (Kushlan, 1978). Consequently, the feeding territory of herons depends upon the physical conditions of the habitat. Black-crowned night herons will return to the same area to feed (Parsons, pers. comm., 1995). Due to their body size and site fidelity, it was assumed that the birds spent 100% of their time feeding in these areas. Accordingly, a home-range (HR) exposure factor of 1.0 was used in the food-web model.

During the breeding season, red-winged blackbirds maintain territories around their nest that contain at least some of the food supplies for breeding (Oriens, 1987). For this species, breeding territory size is always less than the wetland/marsh it is nesting in. The size of the nesting territory varies depending on the size of the marsh and the density of the red-winged blackbird population (Bent, 1958). Red-winged blackbirds do not stay exclusively within the nesting territory to forage for insects. During the nesting season, most food is obtained from the marsh, although blackbirds also forage in upland areas. Therefore, it was realistic to assume that the red-winged blackbird spends 90% (HR = 0.9) of its time foraging in the areas of interest.

A raccoon's home range is dependant upon its sex and age, habitat, food sources, and the season (Sanderson, 1987). It's most common home range appears to be a few hundred hectares, although values from a few hectares to more than a few thousand hectares have been reported. Winter ranges are smaller than ranges at other times of the year for both male and female raccoons, however, home ranges of males are larger than those of females, while the home range of females with young is restricted. Thus, it was realistic to assume that the raccoon spends up to 100% of its time foraging in area of interest.

Body weight. For body weights of avian receptors, the maximum weight reported in U.S. EPA (1993) was used. For the raccoon, the average adult body weight was used. Both avian and raccoon data represent mean values for both males and females.

Toxicity Reference Values. The literature was reviewed for TRVs for birds and mammals for all CoCs at the Raymark facility. These NOELs and LOELs were obtained from the primary literature, U.S. EPA review documents, and an on-line database (IRIS). Tables 2-3a and 2-3b for birds and raccoons, respectively, presents the TRVs used as benchmarks in the food-web model. These TRVs are expressed as daily doses of contaminants normalized to the body weight of the test species. Values were not available for all CoCs. NOELs were available for many, but not all, CoCs. For mercury, an avian LOEL was used with a one-half extrapolation factor (from U.S. EPA, 1993) to arrive at a NOEL value. For all other LOEL-to-NOEL extrapolation values found that half the ratios are less than a factor of 3 (U.S. EPA, unpubl.). Therefore, the factor of one-tenth used here for all contaminants (except mercury) should be adequately conservative. Data are rarely available for the wildlife species of interest, and most often must be extrapolated from other species (e.g., chicken, mallard). Because of this, the same TRVs were used for both heron and blackbirds; no allometric scaling of the TRVs between heron and blackbird were applied. TRVs for raccoon were also assumed equal to that of the test species (after Sample and Arenal, 1998).

Data treatment. Data were analyzed statistically to arrive at mean and maximum concentrations for each data type (i.e., sediment, fish, crustacean, and insect tissues) for input into the food-web model calculations. Where only one measurement per area was available, the mean and maximum were assumed equal. Also, where measurements were lacking for one Ferry Creek area, data were used as measured in the other Ferry Creek Area.

3. Results

Dietary Component CoC Concentrations. Mean and maximum concentrations of CoCs in the diet of receptor species are summarized by media and sampled area and are presented in Table 3-1 and Table 3-2, respectively. The relevance of these data to lower food chain species were addressed in the NOAA ERA. Here, these exposure data are compared with avian/mammalian TRVs to assess the potential for adverse effects on these receptors.

Black-crowned night heron. The results of the food-web model for black-crowned night heron, expressed as mean and maximum Hazard Quotients (HQs), are presented for Middle and Upper Ferry Creek and the reference station in Tables 3-3 and 3-4. The contribution of each exposure media to the heron diet is shown, with the resulting total dietary dose. This total contaminant dose in the diet was then compared with the TRVs listed in Table 2-3a to calculate HQs for each CoC. HQs for each CoC were then summed and expressed as a Hazard Index (HI) to estimate the risk from the total cumulative dietary exposure.

Doses of Pb to heron based on mean and maximum dietary concentrations calculated for Middle and Upper Ferry Creek resulted in HQs exceeding 1. The mean HQ for Pb were 4.93 and 2.14 (Table 3-3a and 3-3b, respectively), whereas the maximum HQs were 30.1 and 7.3 (Table 3-4a and 3-4b, respectively). Fish consumption accounted for one-third of the total estimated amount of Pb ingested as food (excluding sediment) for Middle and Upper Ferry Creek. Estimated incidental ingestion of sediment in Middle and Upper Ferry Creek accounted for most (>90%) of the total modeled concentration of Pb ingested.

Mean HQs for Zn also approached or slightly exceeded 1 for Middle and Upper Ferry Creek (1.05 and 0.93, respectively) while maximum HQs for these areas were within two-fold of mean values (1.95 and 1.1, respectively). Maximum dose of Cu calculated for Middle Ferry Creek also resulted in a HQ exceeding 1; the value was 2.1, whereas the mean HQ was below one.

The mean HQ for DDT exceeded one only at the reference station with a value of 1.38; maximum HQs for DDT exceeded one at Middle Ferry Creek and at the reference station (3.81 and 1.83, respectively). For PCBs, only the maximum exposure scenario for Middle Ferry Creek resulted in HQs greater than unity (HQ=2.37).

The above assessment estimated the risk associated with each CoC individually. Certain combinations of contaminants are known to have synergistic or antagonistic impacts in concert. In particular, the chlorinated compounds, DDT, PCB, and TCDD, are known to have certain interactions. Thus, a summation of these compounds allows some estimate of potential impact (the Hazard Index, or HI).

The HI for Middle and Upper Ferry Creek for mean dose rates were 8.1 and 4.7, respectively, whereas the HI for these same areas assuming maximum exposure were 42.6 and 13.96, respectively. In contrast, the HI for the reference station for the mean and maximum ingestion rates were 3.82 and 4.46, respectively. The Pb HQ accounted for 45-70% of the HI for Middle and Upper Ferry Creek; for the reference area, the Pb contribution was less than 10%. The second largest contribution was DDT/PCBs; these analytes accounted for 6-10% of the HI value for Ferry Creek stations, whereas DDT was the greatest contributor to the HI for the reference station (41-48%).

In all cases, CoC exposure via ingested sediment is the major contributing pathway for risk to black-crowned night heron. Given that sediment contamination of Middle and Upper Ferry Creek is moderately widespread, and that some of the primary CoC risk drivers have similar environmental behavior (e.g., biomagnification, extreme persistence) and biological impacts (e.g., reproductive impairment), it is possible that these CoCs in combination might have cumulative impacts.

Red-winged black bird. Results of the HQ calculations for the red-winged black bird for Middle and Upper Ferry Creek and the reference area are presented in Table 3-5 and Table 3-6. For this assessment, it was assumed that the entire food diet was insects. Red-winged blackbirds feed their nestlings primarily insects. The total dietary dosage also included water as an exposure route. Assimilation efficiencies of CoCs used were the same as those for the heron: 65% for copper, and 85% for all other CoCs. A home range factor of 90% was incorporated as well.

Due to limited data, assumptions of similarity in prey species concentrations (insects) for both Ferry Creek areas were required. The results of the food-web model for blackbirds indicate only Zn exposure was sufficient to predict possible risk although the Middle/Upper Ferry Creek HQ for Zn (2.21) was lower than the reference station (2.48). Similarly, the HI for Middle and Upper Ferry Creek (5.39) were also lower than the HI for the reference station (6.51).

Raccoon. Results of the food-web model for raccoons are presented for Middle and Upper Ferry Creek and the reference station in Tables 3-7 and 3-8. As for avian receptors, the contribution of each exposure media to the raccoon diet is shown, along with the resulting total dietary dose, benchmarks and HQs under mean and maximum exposure scenarios.

Mean HQs calculated for Middle and Upper Ferry Creek greater than one were observed for two metals (Cu and Pb). The sum of HQs resulted in HIs exceeding 1 for both areas. These metals were by far the largest contributors to overall risk at these areas, accounting for 20-35% of the total risk (HI=4.8 and 2.5, respectively).

Lead. Pb was observed to have HQ values above unity; the mean HQ was 1.7 at Middle Ferry Creek while maximum HQs of 11.5 and 2.5 were observed for Middle and Upper Ferry Creek, respectively. As a contributor to the total risk, this CoC accounted for 36-53% and 25-31% at Middle and Upper Ferry Creek areas, respectively. In contrast to Ferry Creek sites, the reference area HQ for Pb was less than unity.

Copper. The metal Cu also contributed to risk, although to a lesser extent than Pb. The mean HQs for Cu at Middle and Upper Ferry Creek areas were 1.7 and 0.7, respectively; while the maximum HQs were 7.6 and 2.7, respectively. In contrast, HQ values at reference areas were much less than one (0.3-0.4). As a percentage of total risk, Cu contributed between 28-37% of the HI value at Ferry Creek areas. The remaining metals (Cd, Cr, Hg and Zn) were not observed to have HQs exceeding unity under mean and/or maximum exposure scenarios.

PCBs. PCBs in the diet of raccoons were also a potentially relevant source of exposure for raccoons. While mean HQs for PCBs at Middle and Upper Ferry Creek areas were less than one, the maximum HQ for Middle Ferry Creek (4.03) as higher than that observed for the reference area (0.1).

4. Discussion

In this study, potential risk to avian and mammalian receptor species was evaluated using an HQ approach, based on doses derived from a food-web model (HIs in Table 4-1 and Table 4-2). Total daily ingestion by each receptor species and CoC was estimated for Middle and Upper Ferry Creek and the reference area. The total daily dose for each CoC was compared with its TRV to calculate an HQ (total daily dose/TRV). If the HQ exceeded 1, that CoC was considered to pose some level of risk. The magnitude of the HQ provides an approximate, qualitative indication of the potential risk to the receptor. However, the relationship between the HQ ratio and risk may not be linear, and therefore the magnitude of risk is uncertain.

Black-crowned night heron. Exposure of black-crowned night heron was evaluated by considering consumption of fish, crabs, terrestrial insects, and sediment. To estimate dietary exposure, fiddler crabs were collected from all sampling areas while fish and terrestrial insects were collected from Middle and Upper Ferry Creek only. It was assumed that the birds spent 100% of their time feeding at each area (i.e., Middle and Upper Ferry Creek and the reference area), therefore a home range exposure factor of 1 was used in the food-web model.

Results of the food-web model indicated possible adverse effects to the black-crowned night heron. The principal CoC of concern appeared to be Pb where HQ values between 2-30 were observed at Ferry Creek areas while corresponding HQs at the reference area were less than one. About sixty percent of the lead exposure came from sediment; this matrix is incidentally ingested during feeding and accounts for approximately 5% of the herons' dietary ingestion rate. When considering maximum exposure scenarios, Cu and PCBs may also appear to be an important source of incremental exposure; for Middle Ferry Creek the maximum HQ for PCBs (2.37) exceeded unity and were eight-fold greater than the reference area. Thus, it is concluded that Pb, and to a lesser extent, Cu and PCBs are important CoCs contributing to risk to black-crowned night heron in Middle and Upper Ferry Creek.

Red-winged blackbirds. Exposure of red-winged blackbirds was evaluated by considering consumption of terrestrial insects that may have emerged from an aquatic life stage completed in the Middle and Upper Ferry Creek wetlands. Because of a lack of insect data for Upper Ferry Creek and that the species does not consume sediment, the exposures were assumed to be the same. Also assumed was that red-winged blackbirds spend 90% of their time feeding in the wetlands. Only one CoC exhibited an HQ which was marginally above unity (zinc, max HQ = 2.21) and this value was less than risks posed by this CoC at the reference location (max HQ= 2.48) (see Tables 3-5 and 3-6). Thus, based on the results of this assessment, the red-winged blackbird does not appear to be at significant risk of adverse effects from exposure to CoCs from consumption of terrestrial insects present in the wetlands along Middle and Upper Ferry Creek.

Raccoon. Results of the food-web model indicated possible adverse effects to the raccoon. The largest CoC contributor to aggregate risk was Pb in Middle Ferry Creek which exceeded the reference area under the mean exposure scenario. In contrast to Pb, the calculated risks observed for Cu and PCBs were higher than the reference area only under the maximum exposure scenario. Thus, Cu and PCBs may be potentially important CoCs in contributing incremental risk to the raccoon, although to a lesser extent than Pb.

Thus, based on the results of this assessment, the raccoon does appear to be at possible risk of adverse effects from exposure to CoCs while feeding in the Middle and Upper Ferry Creek areas. As observed for heron, Pb, and to a lesser extent, Cu and PCBs are the most important CoCs contributing to incremental risk.

5. Uncertainty

The above assessments were based on conservative assumptions with regard to home range of receptors within the food-web model. Considering that this area is urbanized with houses close to Middle and Upper Ferry Creek, it is probably not a preferred foraging area for herons or raccoons. Also, as there are several other good avian foraging sites near Charles Island, herons may not feed exclusively near the Raymark facility. Considering the magnitude of the HQs, plus the distance from the heron colony and the other feeding grounds within that distance, exposure to CoCs is not likely to pose substantial risk to the herons. Possible risks to raccoon cannot be as easily dismissed. While this species may prefer more urbanized food sources, observed HI values are sufficiently large that even if the AoCs account for 1% of the home range, possible risks are still apparent.

Results of surveys of chemicals in sediments suggest that receptors may be at risk even at reference areas due to high CoC concentrations. The mean Pb exposure to heron at Upper and Middle Ferry Creek AOC's greatly (e.g., ten-fold) exceeded HQs found for Great Meadows. Similarly, for raccoons, only Pb, Cu, and PCBs appear to exhibit risk more than three-fold above mean exposure levels occurring at the reference area.

Very limited data on assimilation efficiency of contaminants were available. In the present study, the maximum value assumed, 85%, was applied to all CoCs (except copper, for which a literature value maximum of 65% was available). Compared with assimilation-efficiency factors reviewed for other taxa (e.g., fish), these assumptions appear to be high and thus may be overly conservative. Assimilation values observed on fish and other taxa area apparently on the order of 55% to 65% for hydrophobic organic contaminants, and lower for super-hydrophobics such as dioxins and some PCBs (Gobas et al., 1988; Barber et al., 1991; Nichols, pers. comm., 1997). Still, TRV values are derived from observed test species responses at measured exposure concentrations such that the CoC-specific bioavailability is inherent in the benchmark.

The true risk to arsenic to raccoons may be overestimated by an order of magnitude since the toxic fraction (i.e., the organic component) is typically about 10% of the total arsenic content (U.S. FDA, 1993). Further, a review of the literature regarding the methodology used to derive the TRV value (extrapolated from mice), reveals that the route of exposure evaluated was arsenic in drinking water. Since arsenic was administered in soluble form it is likely to be far more bioavailable than arsenic bound to sediment particles.

Perhaps the greatest source of uncertainty is the extent of sediment ingestion for the receptors. Black-crowned night heron are opportunistic, general predators; therefore their diet can change dramatically (U.S. EPA, 1995). One study of birds on the coastline indicates a diet of 80% fish with the remainder composed primarily of annelids (chiefly *Nereis virens*), crustaceans, and a few insects. Yet another study in an inland marsh indicates a diet of only 30% fish, composed mostly of young birds (primarily gull chicks), beetles, and other terrestrial prey (U.S. EPA, 1995). Diet is apparently dependent on local availability of prey. These feeding studies are also based on small sample sizes. Factors such as these obviously lead to higher uncertainties in estimates of doses.

There is disagreement among sources referenced about the amount of feeding by red-winged blackbirds in a wetland once nesting has started (90% was assumed). Also, it was assumed that the insects fed to nestlings were the same species and the same relative proportions as those caught by net and analyzed for CoC content. This uncertainty is minor, given that absolute risks to the species appear negligible.

For raccoons, the fact that this species may prefer more urbanized food sources (i.e. garbage) might limit true CoC exposure be at the site. Recalling however, that the raccoon was selected as a surrogate for other aquatic mammals (e.g., shrew, muskrat, otter, mink) that also might inhabit the area, the species particular feeding preferences should not be carelessly used to rule out risks to this receptor group as a whole.

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Table 2-1. Food web exposure parameters for the Raymark Ferry Creek Ecological Risk Assessment.

SPECIES	BODY Weight (g)	DIETARY INTAKE PARAMETERS: Total Food[1] (g/day dry)	ORGANISMS: FISH % Diet[2]	FISH g/day dry[3]	CRUSTACEANS % Diet[2]	CRUSTACEANS g/day dry[3]	INSECTS % Diet[2]	INSECTS g/day dry[3]	Sampled Fraction (%)	INCIDENTAL SEDIMENT %Diet	INCIDENTAL SEDIMENT (g/day dw)	WATER[5] (L/day)	HOME RANGE	BIOAVAILABILITY FACTOR
Red-winged blackbird	54	11.8	0.0%	0.0	0.0%	0.0	50.0%	5.9	50.0%	0.0%	0.00	0.0083	0.9	COC specific
adjusted ration[4]			0.0%	0.0	0.0%	0.0	100.0%	11.8					0.9	
Black-crowned night he	883	53.6	52.5%	28.2	21.0%	11.3	1.5%	0.8	75.0%	5.0%	2.68	0.054	1	COC specific
adjusted ration[4]			70.0%	37.5	28.0%	15.0	2.0%	1.1					1	
Raccoon[3]	6000	299.7	2.3%	6.9	14.3%	42.9	27.3%	81.8	43.9%	9.4%	28.17	0.497	1	COC specific
adjusted ration[4]			5.2%	15.7	32.6%	97.6	62.2%	186.4					1	

na - not applicable.

1- Dry weight dietary requirements derived from body weight-dependent equations of Nagy presented in Section 2.

2- Dietary fractions obtained from literature; see Section 2.

3- Dry weight diet fraction 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 2.

Table 2-2. Percent occurrence of food items in the diet of the raccoon, black-crowned night heron, and the red-winged black bird.

		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	
Night herons	Average	21	1.5	53		NOAA, 1998
Red winged black bird	Average		100			NOAA, 1998

Table 2-3a. Documentation of Toxicity Reference Values used for calculation of risks to black-crowned night heron and the red-winged black bird in the Raymark study area.

Contaminant of Concern	Test Species: Common Name	BW, kg[1]	Condition Evaluated[2]	Endpoint Value[3]	Endpoint	Reference	Receptor Extrapolation: Extrapolation Factor[4]	Benchmark NOAEL[5]	TRV[A,7]
Arsenic	mallard	1.00	M	5.14	Chronic NOEL	USFWS 1964	1.00	5.14	5.14
Cadmium	mallard	1.15	R	1.45	Chronic NOEL bounded	White and Finley 1978	1.00	1.45	1.45
Chromium	black duck	1.25	R	1.00	Chronic NOEL	Haseltine et al., unpub.	1.00	1.00	1.00
Copper	chicken	0.53	G,M	28.13	Chronic NOEL bounded	Mehring et al. 1960	1.00	28.13	28.13
Lead	American kestrel	0.13	R	2.05		Pattee 1984	1.00	2.05	2.05
Mercury	mallard	1.00	R	0.06	LOEL unbounded	Heinz et al. 1979	0.50	0.03	0.03
Nickel	mallard	0.78	M,G	77.40	Chronic NOEL bounded	Cain and Pafford 1981	1.00	77.40	77.40
Silver	chickens	0.40	G	12.50	Subchronic NOEL	Hill and Matrone 1970	1.00	12.50	12.50
Zinc	chicken	1.90	M	11.30	Chronic NOEL	Gasaway and Buss 1972	1.00	11.30	11.30
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-05
Acenaphthene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Acenaphthylene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Anthracene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Benz(a)anthracene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Benzo(a)pyrene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Benzo(b)fluoranthene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Chrysene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Dibenz(a,h)anthracene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Fluoranthene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Flourene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
2-Methylnaphthalene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Naphthalene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Phenanthrene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
Pyrene	mallard	1.30	M	338	Chronic LOEL	Patton and Dieter 1980	0.10	33.80	33.80
DDT	brown pelican	3.50	R	0.03	Chronic LOEL	EPA 1993	0.10	2.80E-03	2.80E-03
PCBs	pheasant	1.00	R	1.80	Chronic LOEL	EPA 1993	0.10	0.18	0.18

1 - body weight,
2 - M: mortality; R: reproduction; G: growth.
3 - (mg CoC/kg-dw diet/day);
4 - EPA, 1993: 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 - test species NOAEL= Receptor NOAEL (Sample and Arenal, 1998);
Benchmark NOAEL * (Test species BW/ Receptor of Concern BW).
A) Based on Arochlor 1254 toxicity;
B) assumed to be in the form of sodium arsenite; 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 - Data same as NOAEL value; no body weight scaling factor applied.

Table 2-3b. Documentation of Toxicity Reference Values used for calculation of risks to raccoons in the Raymark Study Area.

Contaminant of Concern	RECEPTOR		Test Species Data						Receptor Extrapolation		
	RoC[C]	BW[1] (kg)	Common Name	BW, kg[1]	Condition Evaluated[2]	Endpoint Value[3]	Endpoint	Reference	Extrapolation Factor[4]	Benchmark NOAEL[5]	RoC TRV-DOSE[6]
Arsenic[B]	Raccoon	6.00	Mouse	0.03	R	0.13	Chronic NOAEL	Sample et al. 1996	1.00	0.13	0.13
Cadmium[C]	Raccoon	6.00	Rat	0.35	R	1.00	Chronic NOAEL	Sample et al. 1996	1.00	1.00	1.00
Chromium[D]	Raccoon	6.00	Rat	0.35	G	3.28	Chronic NOAEL	Sample et al. 1996	1.00	3.28	3.28
Copper[E]	Raccoon	6.00	Mink	1.00	R	11.71	Chronic NOAEL	Sample et al. 1996	1.00	11.71	11.71
Lead[F]	Raccoon	6.00	Rat	0.35	R	8.00	Chronic NOAEL	Sample et al. 1996	1.00	8.00	8.00
Mercury[G]	Raccoon	6.00	Rat	0.35	R	0.03	Chronic NOAEL	Sample et al. 1996	1.00	0.03	0.03
Nickel[H]	Raccoon	6.00	Rat	0.35	R	40.00	Chronic NOAEL	Sample et al. 1996	1.00	40.00	40.00
Silver	Raccoon	6.00	Mouse	0.03	G	18.10	125 Day NOAEL	ATSDR 1989a	1.00	18.10	18.10
Zinc[I]	Raccoon	6.00	Rat	0.35	R	160	Chronic NOAEL	Sample et al. 1996	1.00	160	160
2,3,7,8-TCDD	Raccoon	6.00	Rat	0.35	R	1.00E-03	Chronic NOAEL	ATSDR 1997	1.00	1.00E-03	1.00E-03
Acenaphthene	Raccoon	6.00	Mouse	0.35	R	350	13 wk. NOAEL	ATSDR 1993	0.50	175	175
Acenapthylene	Raccoon	6.00	Rat	0.35	M	51.40	10 Day NOAEL	See Acenaphthene	0.50	25.70	25.70
Anthracene	Raccoon	6.00	Mouse	0.35	R	1000	13 wk. NOAEL	ATSDR 1993	0.50	500	500
Benz(a)anthracene	Raccoon	6.00	Mouse	0.03	M	1.50	5 wk. LOAEL	ATSDR 1993	0.30	0.45	0.45
Benzo(a)pyrene[J]	Raccoon	6.00	Mouse	0.03	R	1.00	Chronic NOAEL	Sample et al. 1996	1.00	1.00	1.00
Benzo(b)fluoranthene[K]	Raccoon	6.00									
Chrysene[L]	Raccoon	6.00									
Dibenz(a,h)anthracene	Raccoon	6.00	Rat	0.35	M	15.40	10 Day NOAEL	ATSDR 1993	0.50	7.70	7.70
Fluoranthene[M]	Raccoon	6.00	Rat	0.35	R	500	13 wk. NOAEL	ATSDR 1995	0.10	50.00	50.00
Fluorene	Raccoon	6.00	Mouse	0.35	R	500	13 wk. NOAEL	ATSDR 1993	0.50	250	250
2-Methylnaphthalene	Raccoon	6.00	Dog	12.70	M	1525	Acute ED_{50}	See Naphthalene	0.10	153	153
Naphthalene	Raccoon	6.00	Dog	12.70	M	1525	Acute EC_{50}	ATSDR 1989b	0.10	153	153
Phenanthrene	Raccoon	6.00	Rat	0.35	M	514	10 Day NOAEL	ATSDR 1993	0.50	257	257
Pyrene	Raccoon	6.00	Rat	0.35	M	437	10 Day NOAEL	ATSDR 1993	0.50	219	219
Total PAHs											
DDE	Raccoon	6.00	Mouse	0.03	R	19.00	78 wk. LOAEL	ATSDR 1992	0.50	9.50	9.50
Total Aroclor[A]	Raccoon	6.00	Mink	1.00	R	0.14	Chronic NOAEL	Sample et al. 1996	1.00	0.14	0.14

1 - body weight
2 - M: mortality; R: reproduction; G: growth; C: Carcinogeni
3 - mg CoC/kg
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; anc
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); an
Benchmark NOAEL * Extrapolation factor
6 - test species NOAELx(bw test/bw Roc)1.0 (mean body weight for receptor (adult raccoon) = 6.0 kg, (EPA, 1993)) (after Sample and Arenal, 199[
Benchmark NOAEL * (Test species BW/ Receptor of Concern BW)
A) Based on Aroclor 1254 toxicity; Aulerich and Ringer, 1977
B) assumed to be in the form of arsenite: Schroeder and Mitchner, 1971; C) assumed to be in the form of cadmium chloride; Sutou et al., 198
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., 198
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., 19
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, 19
J) MacKenzie and Angevine, 1981; K) No Data; McCann and Ames, 197
L) No Data; McCann and Ames, 1975; M) Kingsbury et al., 197

Table 3-1a. Mean concentrations of CoCs used as inputs to the food web model for each exposure media.

Fish Tissue Data

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)[1]	Reference (GM)
Inorganics (mg/kg, dry wt)	Arsenic	2.36	2.36	2.05
	Cadmium	0.36	0.36	0.05
	Chromium	5.95	5.95	7.14
	Copper	50.91	50.91	24.91
	Lead	26.00	26.00	2.09
	Mercury	0.05	0.05	0.06
	Nickel	2.95	2.95	1.64
	Silver	0.10	0.10	0.16
	Zinc	228	228	186
Dioxins (ng/kg, dry wt)	2,3,7,8-TCDD	5.91	5.91	2.82
PAHs (µg/kg, dry wt)	Acenaphthene	22.73	22.73	11.36
	Acenaphthylene	11.36	11.36	11.36
	Anthracene	36.36	36.36	11.36
	Benz(a)anthracene	127	127	11.36
	Benzo(a)pyrene	209	209	22.73
	Benzo(b)fluoranthene	518	518	31.82
	Chrysene	282	282	11.36
	Dibenz(a,h)anthracene	31.82	31.82	11.36
	Fluoranthene	391	391	11.36
	Fluorene	11.36	11.36	11.36
	2-Methylnaphthalene	11.36	11.36	11.36
	Naphthalene	27.27	27.27	11.36
	Phenanthrene	250	250	11.36
	Pyrene	282	282	11.36
DDTs (µg/kg,dry wt)	DDT	5.68	5.68	136
PCBs (µg/kg, dry wt)	Total Aroclors	500	500	500

Data from NOAA, 1998.

1- Metals data for Upper Ferry Creek (A1) not available;
assumed to be the same as measured in Middle Ferry Creek (A3).

4- Dry weight concentration calculated as Wet weight conc. / (1- % moisture content/100);
fish- 78.7%; crabs- 68%; insects- 48%.

Table 3-1b. Mean concentrations of CoCs used as inputs to the food web model for each exposure media.

Crab Tissue Data

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)[1]	Reference (GM)
Inorganics (mg/kg, dry wt)	Arsenic	2.44	2.44	5.31
	Cadmium	3.94	3.94	0.28
	Chromium	6.09	6.09	11.65
	Copper	226	226	165
	Lead	49.50	49.50	11.45
	Mercury	0.06	0.06	0.07
	Nickel	10.38	10.38	8.58
	Silver			
	Zinc	85.53	85.53	73.37
Dioxins (ng/kg, dry wt)	2,3,7,8-TCDD	13.38	13.38	7.16
PAHs (µg/kg, dry wt)	Acenaphthene	7.81	7.81	7.81
	Acenaphthylene	7.81	7.81	7.81
	Anthracene	7.81	7.81	7.81
	Benz(a)anthracene	62.50	62.50	7.81
	Benzo(a)pyrene	93.75	93.75	18.75
	Benzo(b)fluoranthene	103	103	28.13
	Chrysene	96.88	96.88	7.81
	Dibenz(a,h)anthracene	31.25	31.25	7.81
	Fluoranthene	166	166	7.81
	Fluorene	7.81	7.81	7.81
	2-Methylnaphthalene			
	Naphthalene	18.75	18.75	15.63
	Phenanthrene	50.00	50.00	7.81
	Pyrene	169	169	7.81
DDTs (µg/kg,dry wt)	DDT	17.19	17.19	10.94
PCBs (µg/kg, dry wt)	Total Aroclors	1019	1019	188

Data from NOAA, 1998

1- Data for Upper Ferry Creek (A1) not available;
assumed to be the same as measured in Middle Ferry Creek (A3).

Table 3-1c. Mean concentrations of CoCs used as inputs to the food web model for each exposure media.

Insect Tissue Data

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)[1]	Reference (GM)
Inorganics (mg/kg, dry wt)	Arsenic	0.46	0.46	0.48
	Cadmium	1.81	1.81	1.46
	Chromium	2.00	2.00	3.33
	Copper	53.85	53.85	57.10
	Lead	4.27	4.27	13.85
	Mercury	0.04	0.04	0.03
	Nickel	1.73	1.73	1.50
	Silver			
	Zinc	149	149	167
Dioxins (ng/kg, dry wt)	2,3,7,8-TCDD	4.29	4.29	2.65
PAHs (µg/kg, dry wt)	Acenaphthene	19.23	19.23	19.23
	Acenaphthylene	19.23	19.23	19.23
	Anthracene	19.23	19.23	19.23
	Benz(a)anthracene	96.15	96.15	96.15
	Benzo(a)pyrene	96.15	96.15	96.15
	Benzo(b)fluoranthene	96.15	96.15	96.15
	Chrysene	96.15	96.15	96.15
	Dibenz(a,h)anthracene	96.15	96.15	96.15
	Fluoranthene	19.23	19.23	19.23
	Fluorene			
	2-Methylnaphthalene			
	Naphthalene	19.23	19.23	19.23
	Phenanthrene	50.00	50.00	90.38
	Pyrene	19.23	19.23	19.23
DDTs (µg/kg,dry wt)	DDT	23.08	23.08	23.08
PCBs (µg/kg, dry wt)	Total Aroclors	331	331	269

Data from NOAA, 1998

1- Data for Upper Ferry Creek (A1) not available;
assumed to be the same as measured Middle Ferry Creek (A3).

Table 3-1d. Mean concentrations of CoCs used as inputs to the food web model for each exposure media.

Sediment Data

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)	Reference (GM)
Inorganics (mg/kg, dry wt)	Arsenic	8.00	5.86	7.41
	Cadmium	6.23	4.06	0.31
	Chromium	154	157	60.75
	Copper	4038	947	161
	Lead	3270	1056	71.83
	Mercury	0.45	0.45	0.62
	Nickel	129	50.24	20.45
	Silver	0.68	1.08	0.53
	Zinc	881	342	134
Dioxins (ng/kg, dry wt)	2,3,7,8-TCDD	2.21	2.55	0.02
PAHs (µg/kg, dry wt)	Acenaphthene	1394	303	615
	Acenaphthylene	1361	516	615
	Anthracene	1371	468	578
	Benz(a)anthracene	2362	1497	2015
	Benzo(a)pyrene	2131	1353	1703
	Benzo(b)fluoranthene	4108	3004	3291
	Chrysene	2952	1900	1938
	Dibenz(a,h)anthracene	1412	404	753
	Fluoranthene	5628	3664	3771
	Fluorene	987	337	615
	2-Methylnaphthalene	1416	557	615
	Naphthalene	1024	526	615
	Phenanthrene	2243	1592	1900
	Pyrene	5110	2882	2486
DDTs (µg/kg,dry wt)	DDT	14.34	6.57	1.98
PCBs (µg/kg, dry wt)	Total Aroclors	15862	2620	84.56

Data from TtNUS (1998).

Table 3-1e. Mean concentrations of CoCs used as inputs to the food web model for each exposure media.

Surface Water Data

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)[1]	Reference (GM)
Inorganics (µg/L)	Arsenic	21.60	21.60	12.80
	Cadmium	1.20	1.20	0.96
	Chromium	12.40	12.40	5.33
	Copper	121	121	20.00
	Lead	13.70	13.70	4.29
	Mercury	0.55	0.55	0.16
	Nickel	11.70	11.70	4.54
	Silver	1.70	1.70	5.58
	Zinc	127	127	29.62
Dioxins (ng/L)	2,3,7,8-TCDD			
PAHs (µg/L)	Acephthene	5.00	5.00	5.00
	Acephthylene	5.00	5.00	5.00
	Anthracene	5.00	5.00	5.00
	Benz(a)anthracene	5.00	5.00	5.00
	Benzo(a)pyrene	5.00	5.00	5.00
	Benzo(b)fluoranthene	5.00	5.00	5.00
	Chrysene	5.00	5.00	5.00
	Dibenz(a,h)anthracene	5.00	5.00	5.00
	Fluoranthene	5.00	5.00	5.00
	Fluorene	5.00	5.00	5.00
	2-Methylphthalene	5.00	5.00	5.00
	Phthalene	5.00	5.00	5.00
	Phenanthrene	5.00	5.00	5.00
	Pyrene	5.00	5.00	5.00
DDTs (µg/L)	DDT	0.10	0.10	0.12
PCBs (µg/L)	Total Aroclors	2.10	2.10	1.69

Data from NOAA, 1998.

1- Data for Upper Ferry Creek (A1) not available;
assumed to be the same as measured in Middle Ferry Creek (A3).

Table 3-2a. Maximum concentrations of CoCs used as inputs to the food web model for each exposure media.

Fish Tissue Data

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)[1]	Reference (GM)
Inorganics (mg/kg, dry wt)	Arsenic	2.50	2.50	2.18
	Cadmium	0.64	0.64	0.08
	Chromium	10.55	10.55	10.14
	Copper	74.82	74.82	31.00
	Lead	53.77	53.77	2.91
	Mercury	0.07	0.07	0.07
	Nickel	4.86	4.86	2.05
	Silver	0.12	0.12	0.16
	Zinc	259	259	195
Dioxins (ng/kg, dry wt)	2,3,7,8-TCDD	8.64	8.64	3.06
PAHs (µg/kg, dry wt)	Acenaphthene	6.45	22.73	11.36
	Acenaphthylene	22.73	11.36	11.36
	Anthracene	11.36	36.36	11.36
	Benz(a)anthracene	36.36	127	11.36
	Benzo(a)pyrene	127	209	22.73
	Benzo(b)fluoranthene	209	518	31.82
	Chrysene	518	282	11.36
	Dibenz(a,h)anthracene	282	31.82	11.36
	Fluoranthene	31.82	391	11.36
	Fluorene	391	11.36	11.36
	2-Methylnaphthalene	11.36	11.36	11.36
	Naphthalene	11.36	27.27	11.36
	Phenanthrene	27.27	250	11.36
	Pyrene	250	282	11.36
DDTs (µg/kg,dry wt)	DDT	282	50.45	136
PCBs (µg/kg, dry wt)	Total Aroclors	1759	1759	1759

Data from NOAA, 1998.

1- Data for Upper Ferry Creek (A1) not available;
assumed to be the same as measured in Middle Ferry Creek (A3).

2- Only one data point available max. values assumed = mean.

Table 3-2b. Maximum concentrations of CoCs used as inputs to the food web model for each exposure media.

Crab Tissue Data[1,2]

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)[1]	Reference (GM)
Inorganics (mg/kg, dry wt)	Arsenic	2.44	2.44	5.31
	Cadmium	3.94	3.94	0.28
	Chromium	6.09	6.09	11.65
	Copper	226	226	165
	Lead	49.50	49.50	11.45
	Mercury	0.06	0.06	0.07
	Nickel	10.38	10.38	8.58
	Silver			
	Zinc	13.38	13.38	7.16
Dioxins (ng/kg, dry wt)	2,3,7,8-TCDD	13.38	13.38	7.16
PAHs (µg/kg, dry wt)	Acenaphthene	7.81	7.81	7.81
	Acenaphthylene	7.81	7.81	7.81
	Anthracene	7.81	7.81	7.81
	Benz(a)anthracene	62.50	62.50	7.81
	Benzo(a)pyrene	93.75	93.75	18.75
	Benzo(b)fluoranthene	103	103	28.13
	Chrysene	96.88	96.88	7.81
	Dibenz(a,h)anthracene	31.25	31.25	7.81
	Fluoranthene	166	166	7.81
	Fluorene	7.81	7.81	7.81
	2-Methylnaphthalene			
	Naphthalene	18.75	18.75	15.63
	Phenanthrene	50.00	50.00	7.81
	Pyrene	169	169	7.81
DDTs (µg/kg,dry wt)	DDT	17.19	17.19	10.94
PCBs (µg/kg, dry wt)	Total Aroclors	1019	1019	188

Data from NOAA, 1998.

1- Data for Upper Ferry Creek (A1) not available;
assumed to be the same as measured in Middle Ferry Creek (A3).

2- Only one data point available max. values assumed = mean.

Table 3-2c. Maximum concentrations of CoCs used as inputs to the food web model for each exposure media.

Insect Tissue Data (dry wt.)

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)[1]	Reference (GM)
Inorganics (mg/kg, dry wt)	Arsenic	0.46	0.46	0.48
	Cadmium	1.81	1.81	1.46
	Chromium	2.00	2.00	3.33
	Copper	53.85	53.85	57.10
	Lead	4.27	4.27	13.85
	Mercury	0.04	0.04	0.03
	Nickel	1.73	1.73	1.50
	Silver			
	Zinc	149	149	167
Dioxins (ng/kg, dry wt)	2,3,7,8-TCDD	4.29	4.29	2.65
PAHs (µg/kg, dry wt)	Acenaphthene	19.23	19.23	19.23
	Acenaphthylene	19.23	19.23	19.23
	Anthracene	19.23	19.23	19.23
	Benz(a)anthracene	96.15	96.15	96.15
	Benzo(a)pyrene	96.15	96.15	96.15
	Benzo(b)fluoranthene	96.15	96.15	96.15
	Chrysene	96.15	96.15	96.15
	Dibenz(a,h)anthracene	96.15	96.15	96.15
	Fluoranthene	19.23	19.23	19.23
	Fluorene			
	2-Methylnaphthalene			
	Naphthalene	19.23	19.23	19.23
	Phenanthrene	50.00	50.00	90.38
	Pyrene	19.23	19.23	19.23
DDTs (µg/kg,dry wt)	DDT	23.08	23.08	23.08
PCBs (µg/kg, dry wt)	Total Aroclors	331	331	269

Data from NOAA, 1998.

1- Data for Upper Ferry Creek (A1) not available;
assumed to be the same as measured in Middle Ferry Creek (A3).

2- Only one data point available max. values assumed = mean.

Table 3-2d. Maximum concentrations of CoCs used as inputs to the food web model for each exposure media.

Sediment Data

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)	Reference (GM)
Inorganics (mg/kg, dry wt)	Arsenic	19.10	13.10	14.20
	Cadmium	22.50	18.50	0.33
	Chromium	501	900	107.00
	Copper	21000	6780	336.00
	Lead	22900	4790	141.00
	Mercury	1.70	3.10	1.20
	Nickel	427	162	33.90
	Silver	1.50	3.20	0.65
	Zinc	4800	1040	192.00
Dioxins (ng/kg, dry wt)	2,3,7,8-TCDD	16.79	2.55	0.02
PAHs (μg/kg, dry wt)	Acenaphthene	8500	800	1450.00
	Acenaphthylene	8500	1500	1450.00
	Anthracene	8500	1100	1300.00
	Benz(a)anthracene	5000	3200	7000.00
	Benzo(a)pyrene	6100	3200	5800.00
	Benzo(b)fluoranthene	9900	7300	12000.00
	Chrysene	6900	3900	6700.00
	Dibenz(a,h)anthracene	8500	730	2000.00
	Fluoranthene	12000	8000	14000.00
	Fluorene	4450	800	1450.00
	2-Methylnaphthalene	8500	1700	1450.00
	Naphthalene	4450	1700	1450.00
	Phenanthrene	5500	4200	6700.00
	Pyrene	11000	6600	9300.00
DDTs (μg/kg,dry wt)	DDT	80.00	15.00	4.4
PCBs (μg/kg, dry wt)	Total Aroclors	134500	11765	90

Data from TtNUS (1998).

Table 3-2e. Maximum concentrations of CoCs used as inputs to the food web model for each exposure media.

Surface Water Data

		Middle Ferry Creek (A3)	Upper Ferry Creek (A1)[1,2]	Reference (GM)
Inorganics (µg/L)	Arsenic	21.60	21.60	33.00
	Cadmium	1.20	1.20	1.00
	Chromium	12.40	12.40	22.30
	Copper	121	121	51.80
	Lead	13.70	13.70	21.00
	Mercury	0.55	0.55	0.49
	Nickel	11.70	11.70	5.00
	Silver	1.70	1.70	18.00
	Zinc	127	127	63.00
Dioxins (ng/L)	2,3,7,8-TCDD	0.00E+00	0.00E+00	0.00E+00
PAHs (µg/L)	Acephthene	5.00	5.00	5.00
	Acephthylene	5.00	5.00	5.00
	Anthracene	5.00	5.00	5.00
	Benz(a)anthracene	5.00	5.00	5.00
	Benzo(a)pyrene	5.00	5.00	5.00
	Benzo(b)fluoranthene	5.00	5.00	5.00
	Chrysene	5.00	5.00	5.00
	Dibenz(a,h)anthracene	5.00	5.00	5.00
	Fluoranthene	5.00	5.00	5.00
	Flourene	5.00	5.00	5.00
	2-Methylphthalene	5.00	5.00	5.00
	phthalene	5.00	5.00	5.00
	Phenthrene	5.00	5.00	5.00
	Pyrene	5.00	5.00	5.00
DDTs (µg/L)	DDT	0.10	0.10	0.25
PCBs (µg/L)	Total Aroclors	2.10	2.10	2.50

Data from NOAA, 1998.
1- Data for Upper Ferry Creek (A1) not available;
assumed to be the same as measured in Middle Ferry Creek (A3).
2- Only one data point available max. values assumed = mean.

Table 3-3a. Mean ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the black-crowned night heron.

Middle Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	88.7	36.6	0.5	21.5	1.17E-03	125.2	141.8	5.14	0.03
	Cadmium	13.7	59.1	1.9	16.7	6.51E-05	77.7	88.0	1.45	0.06
	Chromium	223.5	91.5	2.1	413.4	6.73E-04	621.0	703.3	1.00	0.70
	Copper	1911.1	3389.4	57.8	10827.7	6.57E-03	13758.1	15581.1	28.13	0.55
	Lead	976.0	743.3	4.6	8767.2	7.44E-04	8917.5	10099.0	2.05	4.93
	Mercury	2.0	0.9	0.0	1.2	2.99E-05	3.6	4.1	0.03	0.13
	Nickel	110.9	155.8	1.9	346.1	6.35E-04	522.5	591.7	77.4	7.64E-03
	Silver	3.8			1.8	9.23E-05	4.7	5.4	12.5	4.30E-04
	Zinc	8548.9	1284.3	160.1	2361.3	6.89E-03	10501.4	11892.9	11.30	1.05
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0		3.7E-04	4.2E-04	1.40E-05	0.03
PAHs	Acenaphthene	0.9	0.1	0.0	3.7	2.71E-04	4.0	4.6	33.80	1.35E-04
	Acenaphthylene	0.4	0.1	0.0	3.7	2.71E-04	3.6	4.1	33.8	1.20E-04
	Anthracene	1.4	0.1	0.0	3.7	2.71E-04	4.4	5.0	33.80	1.48E-04
	Benz(a)anthracene	4.8	0.9	0.1	6.3	2.71E-04	10.3	11.7	33.80	3.46E-04
	Benzo(a)pyrene	7.8	1.4	0.1	5.7	2.71E-04	12.8	14.5	33.80	4.29E-04
	Benzo(b)fluoranthene	19.5	1.5	0.1	11.0	2.71E-04	27.3	30.9	33.80	9.15E-04
	Chrysene	10.6	1.5	0.1	7.9	2.71E-04	17.0	19.3	33.80	5.71E-04
	Dibenz(a,h)anthracene	1.2	0.5	0.1	3.8	2.71E-04	4.7	5.3	33.80	1.58E-04
	Fluoranthene	14.7	2.5	0.0	15.1	2.71E-04	27.4	31.1	33.80	9.19E-04
	Fluorene	0.4	0.1		2.6	2.71E-04	2.7	3.1	33.80	9.09E-05
	2-Methylnaphthalene	0.4			3.8	2.71E-04	3.6	4.1	33.80	1.20E-04
	Naphthalene	1.0	0.3	0.0	2.7	2.71E-04	3.5	3.9	33.80	1.16E-04
	Phenanthrene	9.4	0.8	0.1	6.0	2.71E-04	13.8	15.6	33.8	4.62E-04
	Pyrene	10.6	2.5	0.0	13.7	2.71E-04	22.8	25.8	33.80	7.64E-04
	Sum PAHs	83.0	12.3	0.7	89.8	3.80E-03	158.0	178.9		5.29E-03
DDTs	DDT	0.2	0.3	0.0	0.0	5.65E-06	0.5	0.5	2.80E-03	0.18
PCBs	Total Aroclors	18.8	15.3	0.4	42.5	1.14E-04	65.4	74.1	0.18	0.41
									Hazard Index	8.09

1- Home range Factor of 1.0 applied; see Table 2-1.

2 - Body weight (BW) of 0.883 kg assumed, see text.

Table 3-3b. Mean ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the black-crowned night heron.

Upper Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day)					Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
		Fish	Crab	Insects	Sediment	Water				
Inorganics	Arsenic	88.7	36.6	0.5	15.7	1.17E-03	120.3	136.2	5.14	0.03
	Cadmium	13.7	59.1	1.9	10.9	6.51E-05	72.8	82.4	1.45	0.06
	Chromium	223.5	91.5	2.1	420.7	6.73E-04	627.2	710.3	1.00	0.71
	Copper	1911.1	3389.4	57.8	2539.8	6.57E-03	6713.3	7602.9	28.13	0.27
	Lead	976.0	743.3	4.6	2831.3	7.44E-04	3871.9	4385.0	2.05	2.14
	Mercury	2.0	0.9	0.0	1.2	2.99E-05	3.6	4.1	0.03	0.13
	Nickel	110.9	155.8	1.9	134.7	6.35E-04	342.8	388.2	77.4	5.02E-03
	Silver	3.8			2.9	9.23E-05	5.7	6.4	12.5	5.13E-04
	Zinc	8548.9	1284.3	160.1	918.1	6.89E-03	9274.6	10503.6	11.30	0.93
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0		3.7E-04	4.2E-04	1.40E-05	0.03
PAHs	Acenaphthene	0.9	0.1	0.0	0.8	2.71E-04	1.5	1.7	33.80	5.14E-05
	Acenaphthylene	0.4	0.1	0.0	1.4	2.71E-04	1.7	1.9	33.8	5.55E-05
	Anthracene	1.4	0.1	0.0	1.3	2.71E-04	2.3	2.7	33.80	7.85E-05
	Benz(a)anthracene	4.8	0.9	0.1	4.0	2.71E-04	8.4	9.5	33.80	2.80E-04
	Benzo(a)pyrene	7.8	1.4	0.1	3.6	2.71E-04	11.0	12.5	33.80	3.70E-04
	Benzo(b)fluoranthene	19.5	1.5	0.1	8.1	2.71E-04	24.8	28.1	33.80	8.30E-04
	Chrysene	10.6	1.5	0.1	5.1	2.71E-04	14.6	16.6	33.80	4.91E-04
	Dibenz(a,h)anthracene	1.2	0.5	0.1	1.1	2.71E-04	2.4	2.7	33.80	8.12E-05
	Fluoranthene	14.7	2.5	0.0	9.8	2.71E-04	23.0	26.0	33.80	7.69E-04
	Fluorene	0.4	0.1		0.9	2.71E-04	1.2	1.4	33.80	4.12E-05
	2-Methylnaphthalene	0.4			1.5	2.71E-04	1.6	1.8	33.80	5.47E-05
	Naphthalene	1.0	0.3	0.0	1.4	2.71E-04	2.3	2.6	33.80	7.80E-05
	Phenanthrene	9.4	0.8	0.1	4.3	2.71E-04	12.3	13.9	33.8	4.12E-04
	Pyrene	10.6	2.5	0.0	7.7	2.71E-04	17.7	20.1	33.80	5.94E-04
	Sum PAHs	83.0	12.3	0.7	51.0	3.80E-03	125.0	141.5		4.19E-03
DDTs	DDT	0.2	0.3	0.0	0.0	5.65E-06	0.4	0.5	2.80E-03	0.18
PCBs	Total Aroclors	18.8	15.3	0.4	7.0	1.14E-04	35.2	39.9	0.18	0.22
									Hazard Index	4.70

1- Home range Factor of 1.0 applied; see Table 2-1.

2 - Body weight (BW) of 0.883 kg assumed, see text.

Table 3-3c. Mean ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the black-crowned night heron.

Great Meadows

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	76.8	79.8	0.5	19.9	6.95E-04	150.4	170.4	5.14	0.03
	Cadmium	1.7	4.1	1.6	0.8	5.20E-05	7.0	7.9	1.45	5.47E-03
	Chromium	267.9	174.9	3.6	162.9	2.89E-04	517.9	586.5	1.00	0.59
	Copper	935.1	2470.5	61.2	431.0	1.09E-03	3313.1	3752.1	28.13	0.13
	Lead	78.5	171.9	14.9	192.6	2.33E-04	389.1	440.7	2.05	0.21
	Mercury	2.2	1.1	0.0	1.7	8.45E-06	4.2	4.8	0.03	0.15
	Nickel	61.4	128.9	1.6	54.8	2.47E-04	209.8	237.5	77.4	3.07E-03
	Silver	6.0			1.4	3.03E-04	6.3	7.1	12.5	5.69E-04
	Zinc	6979.0	1101.7	179.6	360.0	1.61E-03	7327.3	8298.2	11.30	0.73
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0		1.8E-04	2.1E-04	1.40E-05	0.01
PAHs	Acenaphthene	0.4	0.1	0.0	1.6	2.71E-04	1.9	2.1	33.80	6.31E-05
	Acenaphthylene	0.4	0.1	0.0	1.6	2.71E-04	1.9	2.1	33.8	6.31E-05
	Anthracene	0.4	0.1	0.0	1.5	2.71E-04	1.8	2.0	33.80	6.02E-05
	Benz(a)anthracene	0.4	0.1	0.1	5.4	2.71E-04	5.1	5.8	33.80	1.72E-04
	Benzo(a)pyrene	0.9	0.3	0.1	4.6	2.71E-04	4.9	5.6	33.80	1.65E-04
	Benzo(b)fluoranthene	1.2	0.4	0.1	8.8	2.71E-04	9.0	10.2	33.80	3.00E-04
	Chrysene	0.4	0.1	0.1	5.2	2.71E-04	5.0	5.6	33.80	1.66E-04
	Dibenz(a,h)anthracene	0.4	0.1	0.1	2.0	2.71E-04	2.3	2.6	33.80	7.59E-05
	Fluoranthene	0.4	0.1	0.0	10.1	2.71E-04	9.1	10.3	33.80	3.04E-04
	Fluorene	0.4	0.1		1.6	2.71E-04	1.9	2.1	33.80	6.25E-05
	2-Methylnaphthalene	0.4			1.6	2.71E-04	1.8	2.0	33.80	5.91E-05
	Naphthalene	0.4	0.2	0.0	1.6	2.71E-04	2.0	2.2	33.80	6.64E-05
	Phenanthrene	0.4	0.1	0.1	5.1	2.71E-04	4.9	5.5	33.8	1.63E-04
	Pyrene	0.4	0.1	0.0	6.7	2.71E-04	6.1	7.0	33.80	2.06E-04
	Sum PAHs	7.2	2.1	0.7	57.7	3.80E-03	57.5	65.2		1.93E-03
DDTs	DDT	5.1	0.2	0.0	0.0	6.59E-06	4.5	5.1	2.80E-03	1.83
PCBs	Total Aroclors	18.8	2.8	0.3	0.2	9.20E-05	18.8	21.3	0.18	0.12
									Hazard Index	3.82

1- Home range Factor of 1.0 applied; see Table 2-1.

2 - Body weight (BW) of 0.883 kg assumed, see text.

Table 3-4a. Maximum ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the black-crowned night heron.

Middle Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	93.8	36.6	0.5	51.2	1.17E-03	154.8	175.4	5.14	0.03
	Cadmium	23.9	59.1	1.9	60.3	6.51E-05	123.5	139.9	1.45	0.10
	Chromium	395.9	91.5	2.1	1343.4	6.73E-04	1558.0	1764.4	1.00	1.76
	Copper	2808.7	3389.4	57.8	56309.9	6.57E-03	53180.9	60227.5	28.13	2.14
	Lead	2018.6	743.3	4.6	61404.6	7.44E-04	54545.4	61772.9	2.05	30.13
	Mercury	2.6	0.9	0.0	4.6	2.99E-05	6.9	7.8	0.03	0.24
	Nickel	182.6	155.8	1.9	1145.0	6.35E-04	1262.4	1429.7	77.4	0.02
	Silver	4.4			4.0	9.23E-05	7.2	8.1	12.5	6.51E-04
	Zinc	9704.1	200.8	160.1	12870.8	6.89E-03	19495.4	22078.6	11.30	1.95
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0	0.00E+00	4.9E-04	5.5E-04	1.40E-05	0.04
PAHs	Acenaphthene	0.2	0.1	0.0	22.8	2.71E-04	19.7	22.3	33.80	6.60E-04
	Acenaphthylene	0.9	0.1	0.0	22.8	2.71E-04	20.2	22.9	33.8	6.77E-04
	Anthracene	0.4	0.1	0.0	22.8	2.71E-04	19.9	22.5	33.80	6.65E-04
	Benz(a)anthracene	1.4	0.9	0.1	13.4	2.71E-04	13.4	15.2	33.80	4.50E-04
	Benzo(a)pyrene	4.8	1.4	0.1	16.4	2.71E-04	19.2	21.8	33.80	6.45E-04
	Benzo(b)fluoranthene	7.8	1.5	0.1	26.5	2.71E-04	30.6	34.7	33.80	1.03E-03
	Chrysene	19.5	1.5	0.1	18.5	2.71E-04	33.6	38.0	33.80	1.13E-03
	Dibenz(a,h)anthracene	10.6	0.5	0.1	22.8	2.71E-04	28.9	32.7	33.80	9.67E-04
	Fluoranthene	1.2	2.5	0.0	32.2	2.71E-04	30.5	34.5	33.80	1.02E-03
	Fluorene	14.7	0.1		11.9	2.71E-04	22.7	25.7	33.80	7.61E-04
	2-Methylnaphthalene	0.4			22.8	2.71E-04	19.7	22.4	33.80	6.61E-04
	Naphthalene	0.4	0.3	0.0	11.9	2.71E-04	10.8	12.2	33.80	3.61E-04
	Phenanthrene	1.0	0.8	0.1	14.7	2.71E-04	14.1	16.0	33.8	4.72E-04
	Pyrene	9.4	2.5	0.0	29.5	2.71E-04	35.2	39.9	33.80	1.18E-03
	Sum PAHs	72.7	12.3	0.7	289.1	3.80E-03	318.6	360.8		0.01
DDTs	DDT	10.6	0.3	0.0	0.2	5.65E-06	9.4	10.7	2.80E-03	3.81
PCBs	Total Aroclors	66.0	15.3	0.4	360.7	1.14E-04	376.0	425.8	0.18	2.37
									Hazard Index	42.62

1- Home range Factor of 1.0 applied; see Table 2-1.

2 - Body weight (BW) of 0.883 kg assumed, see text.

Table 3-4b. Maximum ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the black-crowned night heron.

Upper Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	93.8	36.6	0.5	35.1	1.17E-03	141.2	159.9	5.14	0.03
	Cadmium	23.9	59.1	1.9	49.6	6.51E-05	114.4	129.5	1.45	0.09
	Chromium	395.9	91.5	2.1	2413.3	6.73E-04	2467.4	2794.3	1.00	2.79
	Copper	2808.7	3389.4	57.8	18180.1	6.57E-03	20770.5	23522.6	28.13	0.84
	Lead	2018.6	743.3	4.6	12844.0	7.44E-04	13268.9	15027.1	2.05	7.33
	Mercury	2.6	0.9	0.0	8.3	2.99E-05	10.1	11.4	0.03	0.36
	Nickel	182.6	155.8	1.9	434.4	6.35E-04	658.4	745.7	77.4	9.63E-03
	Silver	4.4			8.6	9.23E-05	11.1	12.5	12.5	1.00E-03
	Zinc	9704.1	200.8	160.1	2788.7	6.89E-03	10925.6	12373.3	11.30	1.09
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0	0.00E+00	4.6E-04	5.2E-04	1.40E-05	0.04
PAHs	Acenaphthene	0.9	0.1	0.0	2.1	2.71E-04	2.7	3.0	33.80	8.93E-05
	Acenaphthylene	0.4	0.1	0.0	4.0	2.71E-04	3.9	4.4	33.8	1.31E-04
	Anthracene	1.4	0.1	0.0	2.9	2.71E-04	3.8	4.3	33.80	1.27E-04
	Benz(a)anthracene	4.8	0.9	0.1	8.6	2.71E-04	12.2	13.9	33.80	4.10E-04
	Benzo(a)pyrene	7.8	1.4	0.1	8.6	2.71E-04	15.2	17.3	33.80	5.11E-04
	Benzo(b)fluoranthene	19.5	1.5	0.1	19.6	2.71E-04	34.6	39.2	33.80	1.16E-03
	Chrysene	10.6	1.5	0.1	10.5	2.71E-04	19.2	21.8	33.80	6.44E-04
	Dibenz(a,h)anthracene	1.2	0.5	0.1	2.0	2.71E-04	3.2	3.6	33.80	1.06E-04
	Fluoranthene	14.7	2.5	0.0	21.5	2.71E-04	32.8	37.2	33.80	1.10E-03
	Fluorene	0.4	0.1		2.1	2.71E-04	2.3	2.6	33.80	7.66E-05
	2-Methylnaphthalene	0.4			4.6	2.71E-04	4.2	4.8	33.80	1.42E-04
	Naphthalene	1.0	0.3	0.0	4.6	2.71E-04	5.0	5.7	33.80	1.68E-04
	Phenanthrene	9.4	0.8	0.1	11.3	2.71E-04	18.2	20.6	33.8	6.11E-04
	Pyrene	10.6	2.5	0.0	17.7	2.71E-04	26.2	29.7	33.80	8.78E-04
	Sum PAHs	83.0	12.3	0.7	119.9	3.80E-03	183.6	207.9		6.15E-03
DDTs	DDT	1.9	0.3	0.0	0.0	5.65E-06	1.9	2.1	2.80E-03	0.76
PCBs	Total Aroclors	66.0	15.3	0.4	31.5	1.14E-04	96.3	109.0	0.18	0.61
									Hazard Index	13.96

1- Home range Factor of 1.0 applied; see Table 2-1.

2 - Body weight (BW) of 0.883 kg assumed, see text.

Table 3-4c. Maximum ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the black-crowned night heron.

Great Meadows

Class	Chemical of Concern	Dietary Intake, (µg CoC/day)					Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
		Fish	Crab	Insects	Sediment	Water				
Inorganics	Arsenic	81.9	79.8	0.5	38.1	1.79E-03	170.2	192.8	5.14	0.04
	Cadmium	3.1	4.1	1.6	0.9	5.43E-05	8.2	9.3	1.45	6.42E-03
	Chromium	380.5	174.9	3.6	286.9	1.21E-03	719.0	814.3	1.00	0.81
	Copper	1163.7	2470.5	61.2	901.0	2.81E-03	3906.9	4424.6	28.13	0.16
	Lead	109.2	171.9	14.9	378.1	1.14E-03	572.9	648.8	2.05	0.32
	Mercury	2.6	1.1	0.0	3.2	2.66E-05	5.8	6.6	0.03	0.21
	Nickel	76.8	128.9	1.6	90.9	2.71E-04	253.5	287.0	77.4	3.71E-03
	Silver	6.0			1.7	9.77E-04	6.6	7.4	12.5	5.94E-04
	Zinc	7303.2	107.5	179.6	514.8	3.42E-03	6889.3	7802.2	11.30	0.69
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0	0.00E+00	1.9E-04	2.2E-04	1.40E-05	0.02
PAHs	Acenaphthene	0.4	0.1	0.0	3.9	2.71E-04	3.8	4.3	33.80	1.27E-04
	Acenaphthylene	0.4	0.1	0.0	3.9	2.71E-04	3.8	4.3	33.8	1.27E-04
	Anthracene	0.4	0.1	0.0	3.5	2.71E-04	3.4	3.9	33.80	1.15E-04
	Benz(a)anthracene	0.4	0.1	0.1	18.8	2.71E-04	16.5	18.7	33.80	5.53E-04
	Benzo(a)pyrene	0.9	0.3	0.1	15.6	2.71E-04	14.3	16.2	33.80	4.78E-04
	Benzo(b)fluoranthene	1.2	0.4	0.1	32.2	2.71E-04	28.8	32.6	33.80	9.65E-04
	Chrysene	0.4	0.1	0.1	18.0	2.71E-04	15.8	17.9	33.80	5.30E-04
	Dibenz(a,h)anthracene	0.4	0.1	0.1	5.4	2.71E-04	5.1	5.8	33.80	1.71E-04
	Fluoranthene	0.4	0.1	0.0	37.5	2.71E-04	32.4	36.7	33.80	1.09E-03
	Fluorene	0.4	0.1		3.9	2.71E-04	3.8	4.3	33.80	1.26E-04
	2-Methylnaphthalene	0.4			3.9	2.71E-04	3.7	4.2	33.80	1.23E-04
	Naphthalene	0.4	0.2	0.0	3.9	2.71E-04	3.9	4.4	33.80	1.30E-04
	Phenanthrene	0.4	0.1	0.1	18.0	2.71E-04	15.8	17.9	33.8	5.30E-04
	Pyrene	0.4	0.1	0.0	24.9	2.71E-04	21.7	24.5	33.80	7.26E-04
	Sum PAHs	7.2	2.1	0.7	193.2	3.80E-03	172.7	195.6		5.79E-03
DDT	DDT	5.1	0.2	0.0	0.0	1.36E-05	4.5	5.1	2.80E-03	1.83
PCB	PCBs	66.0	2.8	0.3	0.2	1.36E-04	59.0	66.8	0.18	0.37
									Hazard Index	4.46

1- Home range Factor of 1.0 applied; see Table 2-1.

2 - Body weight (BW) of 0.883 kg assumed, see text.

Table 3-5a. Mean ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the red-winged black bird.

Middle Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	0.0	0.0	5.5	0.0	1.80E-04	4.2	77.3	5.14	0.02
	Cadmium	0.0	0.0	21.4	0.0	1.00E-05	16.3	302.6	1.45	0.21
	Chromium	0.0	0.0	23.6	0.0	1.04E-04	18.1	334.7	1.00	0.33
	Copper	0.0	0.0	636.2	0.0	1.01E-03	486.7	9012.4	28.13	0.32
	Lead	0.0	0.0	50.4	0.0	1.14E-04	38.6	714.6	2.05	0.35
	Mercury	0.0	0.0	0.5	0.0	4.59E-06	0.3	6.4	0.03	0.20
	Nickel	0.0	0.0	20.4	0.0	9.77E-05	15.6	289.7	77.4	3.74E-03
	Silver	0.0			0.0	1.42E-05	0.0	0.0	12.5	1.61E-08
	Zinc	0.0	0.0	1763.1	0.0	1.06E-03	1348.8	24977.2	11.30	2.21
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0		4.3E-05	8.0E-04	1.40E-05	0.06
PAHs	Acenaphthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Acenaphthylene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.8	9.52E-05
	Anthracene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Benz(a)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(a)pyrene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(b)fluoranthene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Chrysene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Dibenz(a,h)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Fluoranthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Fluorene	0.0	0.0		0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	2-Methylnaphthalene	0.0			0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	Naphthalene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Phenanthrene	0.0	0.0	0.6	0.0	4.17E-05	0.5	8.4	33.8	2.48E-04
	Pyrene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Sum PAHs	0.0	0.0	7.6	0.0	5.84E-04	5.8	108.2		3.20E-03
DDTs	DDT	0.0	0.0	0.3	0.0	8.68E-07	0.2	3.9	2.80E-03	1.38
PCBs	Total Aroclors	0.0	0.0	3.9	0.0	1.75E-05	3.0	55.4	0.18	0.31
									Hazard Index	5.39

1- Home range Factor of 0.9 applied; see Table 2-1.

2 - Body weight (BW) of 0.054 kg assumed, see text.

Table 3-5b. Mean ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the red-winged black bird.

Upper Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day)					Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
		Fish	Crab	Insects	Sediment	Water				
Inorganics	Arsenic	0.0	0.0	5.5	0.0	1.80E-04	4.2	77.3	5.14	0.02
	Cadmium	0.0	0.0	21.4	0.0	1.00E-05	16.3	302.6	1.45	0.21
	Chromium	0.0	0.0	23.6	0.0	1.04E-04	18.1	334.7	1.00	0.33
	Copper	0.0	0.0	636.2	0.0	1.01E-03	486.7	9012.4	28.13	0.32
	Lead	0.0	0.0	50.4	0.0	1.14E-04	38.6	714.6	2.05	0.35
	Mercury	0.0	0.0	0.5	0.0	4.59E-06	0.3	6.4	0.03	0.20
	Nickel	0.0	0.0	20.4	0.0	9.77E-05	15.6	289.7	77.4	3.74E-03
	Silver	0.0			0.0	1.42E-05	0.0	0.0	12.5	1.61E-08
	Zinc	0.0	0.0	1763.1	0.0	1.06E-03	1348.8	24977.2	11.30	2.21
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0		4.3E-05	8.0E-04	1.40E-05	0.06
PAHs	Acenaphthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Acenaphthylene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.8	9.52E-05
	Anthracene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Benz(a)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(a)pyrene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(b)fluoranthene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Chrysene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Dibenz(a,h)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Fluoranthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Fluorene	0.0	0.0		0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	2-Methylnaphthalene	0.0			0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	Naphthalene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Phenanthrene	0.0	0.0	0.6	0.0	4.17E-05	0.5	8.4	33.8	2.48E-04
	Pyrene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Sum PAHs	0.0	0.0	7.6	0.0	5.84E-04	5.8	108.2		3.20E-03
DDTs	DDT	0.0	0.0	0.3	0.0	8.68E-07	0.2	3.9	2.80E-03	1.38
PCBs	Total Aroclors	0.0	0.0	3.9	0.0	1.75E-05	3.0	55.4	0.18	0.31
									Hazard Index	5.39

1- Home range Factor of 0.9 applied; see Table 2-1.

2 - Body weight (BW) of 0.054 kg assumed, see text.

Table 3-5c. Mean ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the red-winged black bird.

Great Meadows

Class	Chemical of Concern	Dietary Intake, (µg CoC/day)					Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
		Fish	Crab	Insects	Sediment	Water				
Inorganics	Arsenic	0.0	0.0	5.7	0.0	1.07E-04	4.3	80.5	5.14	0.02
	Cadmium	0.0	0.0	17.3	0.0	7.99E-06	13.2	244.6	1.45	0.17
	Chromium	0.0	0.0	39.3	0.0	4.45E-05	30.1	556.8	1.00	0.56
	Copper	0.0	0.0	674.6	0.0	1.67E-04	516.0	9556.4	28.13	0.34
	Lead	0.0	0.0	163.6	0.0	3.58E-05	125.1	2317.5	2.05	1.13
	Mercury	0.0	0.0	0.3	0.0	1.30E-06	0.3	4.8	0.03	0.15
	Nickel	0.0	0.0	17.7	0.0	3.79E-05	13.6	251.1	77.4	3.24E-03
	Silver	0.0			0.0	4.66E-05	0.0	0.0	12.5	5.28E-08
	Zinc	0.0	0.0	1977.8	0.0	2.47E-04	1513.0	28018.9	11.30	2.48
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0		2.7E-05	4.9E-04	1.40E-05	0.04
PAHs	Acenaphthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Acenaphthylene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.8	9.52E-05
	Anthracene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Benz(a)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(a)pyrene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(b)fluoranthene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Chrysene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Dibenz(a,h)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Fluoranthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Fluorene	0.0	0.0		0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	2-Methylnaphthalene	0.0			0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	Naphthalene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Phenanthrene	0.0	0.0	1.1	0.0	4.17E-05	0.8	15.1	33.8	4.48E-04
	Pyrene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Sum PAHs	0.0	0.0	8.1	0.0	5.84E-04	6.2	114.9		3.40E-03
DDTs	DDT	0.0	0.0	0.3	0.0	1.01E-06	0.2	3.9	2.80E-03	1.38
PCBs	Total Aroclors	0.0	0.0	3.2	0.0	1.41E-05	2.4	45.1	0.18	0.25
									Hazard Index	6.51

1- Home range Factor of 0.9 applied; see Table 2-1.

2 - Body weight (BW) of 0.054 kg assumed, see text.

Table 3-6a. Maximum ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the red-winged black bird.

Middle Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	0.0	0.0	5.5	0.0	1.80E-04	4.2	77.3	5.14	0.02
	Cadmium	0.0	0.0	21.4	0.0	1.00E-05	16.3	302.6	1.45	0.21
	Chromium	0.0	0.0	23.6	0.0	1.04E-04	18.1	334.7	1.00	0.33
	Copper	0.0	0.0	636.2	0.0	1.01E-03	486.7	9012.4	28.13	0.32
	Lead	0.0	0.0	50.4	0.0	1.14E-04	38.6	714.6	2.05	0.35
	Mercury	0.0	0.0	0.5	0.0	4.59E-06	0.3	6.4	0.03	0.20
	Nickel	0.0	0.0	20.4	0.0	9.77E-05	15.6	289.7	77.4	3.74E-03
	Silver	0.0			0.0	1.42E-05	0.0	0.0	12.5	1.61E-08
	Zinc	0.0	0.0	1763.1	0.0	1.06E-03	1348.8	24977.2	11.30	2.21
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0	0.00E+00	4.3E-05	8.0E-04	1.40E-05	0.06
PAHs	Acenaphthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Acenaphthylene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.8	9.52E-05
	Anthracene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Benz(a)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(a)pyrene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(b)fluoranthene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Chrysene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Dibenz(a,h)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Fluoranthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Fluorene	0.0	0.0		0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	2-Methylnaphthalene	0.0			0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	Naphthalene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Phenanthrene	0.0	0.0	0.6	0.0	4.17E-05	0.5	8.4	33.8	2.48E-04
	Pyrene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Sum PAHs	0.0	0.0	7.6	0.0	5.84E-04	5.8	108.2		3.20E-03
DDTs	DDT	0.0	0.0	0.3	0.0	8.68E-07	0.2	3.9	2.80E-03	1.38
PCBs	Total Aroclors	0.0	0.0	3.9	0.0	1.75E-05	3.0	55.4	0.18	0.31
									Hazard Index	5.39

1- Home range Factor of 0.9 applied; see Table 2-1

2 - Body weight (BW) of 0.054 kg assumed, see text.

Table 3-6b. Maximum ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the red-winged black bird.

Upper Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	0.0	0.0	5.5	0.0	1.80E-04	4.2	77.3	5.14	0.02
	Cadmium	0.0	0.0	21.4	0.0	1.00E-05	16.3	302.6	1.45	0.21
	Chromium	0.0	0.0	23.6	0.0	1.04E-04	18.1	334.7	1.00	0.33
	Copper	0.0	0.0	636.2	0.0	1.01E-03	486.7	9012.4	28.13	0.32
	Lead	0.0	0.0	50.4	0.0	1.14E-04	38.6	714.6	2.05	0.35
	Mercury	0.0	0.0	0.5	0.0	4.59E-06	0.3	6.4	0.03	0.20
	Nickel	0.0	0.0	20.4	0.0	9.77E-05	15.6	289.7	77.4	3.74E-03
	Silver	0.0			0.0	1.42E-05	0.0	0.0	12.5	1.61E-08
	Zinc	0.0	0.0	1763.1	0.0	1.06E-03	1348.8	24977.2	11.30	2.21
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0	0.00E+00	4.3E-05	8.0E-04	1.40E-05	0.06
PAHs	Acenaphthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Acenaphthylene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.8	9.52E-05
	Anthracene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Benz(a)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(a)pyrene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(b)fluoranthene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Chrysene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Dibenz(a,h)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Fluoranthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Fluorene	0.0	0.0		0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	2-Methylnaphthalene	0.0			0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	Naphthalene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Phenanthrene	0.0	0.0	0.6	0.0	4.17E-05	0.5	8.4	33.8	2.48E-04
	Pyrene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Sum PAHs	0.0	0.0	7.6	0.0	5.84E-04	5.8	108.2		3.20E-03
DDTs	DDT	0.0	0.0	0.3	0.0	8.68E-07	0.2	3.9	2.80E-03	1.38
PCBs	Total Aroclors	0.0	0.0	3.9	0.0	1.75E-05	3.0	55.4	0.18	0.31
									Hazard Index	5.39

1- Home range Factor of 0.9 applied; see Table 2-1.

2 - Body weight (BW) of 0.054 kg assumed, see text.

Table 3-6c. Maximum ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the red-winged black bird.

Great Meadows

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	0.0	0.0	5.7	0.0	2.75E-04	4.3	80.5	5.14	0.02
	Cadmium	0.0	0.0	17.3	0.0	8.35E-06	13.2	244.6	1.45	0.17
	Chromium	0.0	0.0	39.3	0.0	1.86E-04	30.1	556.8	1.00	0.56
	Copper	0.0	0.0	674.6	0.0	4.32E-04	516.0	9556.4	28.13	0.34
	Lead	0.0	0.0	163.6	0.0	1.75E-04	125.1	2317.5	2.05	1.13
	Mercury	0.0	0.0	0.3	0.0	4.09E-06	0.3	4.8	0.03	0.15
	Nickel	0.0	0.0	17.7	0.0	4.17E-05	13.6	251.1	77.4	3.24E-03
	Silver	0.0			0.0	1.50E-04	0.0	0.0	12.5	1.70E-07
	Zinc	0.0	0.0	1977.8	0.0	5.26E-04	1513.0	28018.9	11.30	2.48
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0	0.00E+00	2.7E-05	4.9E-04	1.40E-05	0.04
PAHs	Acenaphthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Acenaphthylene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.8	9.52E-05
	Anthracene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Benz(a)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(a)pyrene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Benzo(b)fluoranthene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Chrysene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Dibenz(a,h)anthracene	0.0	0.0	1.1	0.0	4.17E-05	0.9	16.1	33.80	4.76E-04
	Fluoranthene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Fluorene	0.0	0.0		0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	2-Methylnaphthalene	0.0			0.0	4.17E-05	0.0	0.0	33.80	1.75E-08
	Naphthalene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Phenanthrene	0.0	0.0	1.1	0.0	4.17E-05	0.8	15.1	33.8	4.48E-04
	Pyrene	0.0	0.0	0.2	0.0	4.17E-05	0.2	3.2	33.80	9.52E-05
	Sum PAHs	0.0	0.0	8.1	0.0	5.84E-04	6.2	114.9		3.40E-03
DDTs	DDT	0.0	0.0	0.3	0.0	2.09E-06	0.2	3.9	2.80E-03	1.38
PCBs	Total Aroclors	0.0	0.0	3.2	0.0	2.09E-05	2.4	45.1	0.18	0.25
									Hazard Index	6.51

1- Home range Factor of 0.9 applied; see Table 2-1.

2 - Body weight (BW) of 0.054 kg assumed, see text.

Table 3-7a. Mean ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the raccoon.

Middle Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day)					Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
		Fish	Crab	Insects	Sediment	Water				
Inorganics	Arsenic	37.1	238.0	86.0	225.4	1.07E-02	498.5	83.1	0.13	0.66
	Cadmium	5.7	384.4	336.9	175.6	5.96E-04	767.3	127.9	1.00	0.13
	Chromium	93.5	594.9	372.8	4343.5	6.16E-03	4594.0	765.7	3.28	0.23
	Copper	799.4	22036.7	10036.0	113764.7	6.01E-02	124641.4	20773.6	11.71	1.77
	Lead	408.3	4832.6	795.7	92115.5	6.80E-03	83429.3	13904.9	8.00	1.74
	Mercury	0.9	6.1	7.2	12.7	2.73E-04	22.8	3.8	0.03	0.12
	Nickel	46.4	1012.9	322.6	3636.5	5.81E-03	4265.6	710.9	40.0	0.02
	Silver	1.6			19.2	8.44E-04	17.6	2.9	18.1	1.62E-04
	Zinc	3575.9	8350.3	27814.1	24809.8	6.31E-02	54867.7	9144.6	160	0.06
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0		1.9E-03	3.2E-04	1.00E-03	3.20E-04
PAHs	Acenaphthene	0.4	0.8	3.6	39.3	2.48E-03	37.4	6.2	175	3.56E-05
	Acenaphthylene	0.2	0.8	3.6	38.4	2.48E-03	36.4	6.1	25.7	2.36E-04
	Anthracene	0.6	0.8	3.6	38.6	2.48E-03	37.0	6.2	500	1.23E-05
	Benz(a)anthracene	2.0	6.1	17.9	66.5	2.48E-03	78.7	13.1	0.45	0.03
	Benzo(a)pyrene	3.3	9.2	17.9	60.0	2.48E-03	76.8	12.8	1.00	0.01
	Naphthalene	0.4	1.8	3.6	28.9	2.48E-03	29.5	4.9	153	3.22E-05
	Phenanthrene	3.9	4.9	9.3	63.2	2.48E-03	69.1	11.5	257.0	4.48E-05
	Pyrene	4.4	16.5	3.6	144.0	2.48E-03	143.2	23.9	219	1.09E-04
	Sum PAHs	46.0	109.7	159.9	1226.1	4.47E-02	1310.4	515.9		0.04
DDTs	DDE	0.1	1.7	4.3	0.4	5.16E-05	5.5	0.9	9.50	9.65E-05
PCBs	Total Aroclors	7.9	99.5	61.6	446.9	1.04E-03	523.5	87.2	0.14	0.62
									Hazard Index	5.39

1- Home range Factor of 1.0 applied; see Table 2-1

2 - Body weight (BW) of 6.00 kg assumed, see text.

3 - No TRV Data Available.

Table 3-7b. Mean ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the raccoon.

Upper Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	37.1	238.0	86.0	165.0	1.07E-02	447.2	74.5	0.13	0.59
	Cadmium	5.7	384.4	336.9	114.4	5.96E-04	715.3	119.2	1.00	0.12
	Chromium	93.5	594.9	372.8	4420.7	6.16E-03	4659.6	776.6	3.28	0.24
	Copper	799.4	22036.7	10036.0	26685.0	6.01E-02	50623.6	8437.3	11.71	0.72
	Lead	408.3	4832.6	795.7	29747.8	6.80E-03	30416.7	5069.5	8.00	0.63
	Mercury	0.9	6.1	7.2	12.6	2.73E-04	22.7	3.8	0.03	0.12
	Nickel	46.4	1012.9	322.6	1415.5	5.81E-03	2377.8	396.3	40.0	9.91E-03
	Silver	1.6			30.6	8.44E-04	27.3	4.6	18.1	2.51E-04
	Zinc	3575.9	8350.3	27814.1	9646.0	6.31E-02	41978.5	6996.4	160	0.04
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0		1.9E-03	3.2E-04	1.00E-03	3.22E-04
PAHs	Acenaphthene	0.4	0.8	3.6	8.5	2.48E-03	11.3	1.9	175	1.07E-05
	Acenaphthylene	0.2	0.8	3.6	14.5	2.48E-03	16.2	2.7	25.7	1.05E-04
	Anthracene	0.6	0.8	3.6	13.2	2.48E-03	15.4	2.6	500	5.13E-06
	Benz(a)anthracene	2.0	6.1	17.9	42.2	2.48E-03	58.0	9.7	0.45	0.02
	Benzo(a)pyrene	3.3	9.2	17.9	38.1	2.48E-03	58.2	9.7	1.00	9.70E-03
	Naphthalene	0.4	1.8	3.6	14.8	2.48E-03	17.6	2.9	153	1.92E-05
	Phenanthrene	3.9	4.9	9.3	44.9	2.48E-03	53.5	8.9	257.0	3.47E-05
	Pyrene	4.4	16.5	3.6	81.2	2.48E-03	89.8	15.0	219	6.85E-05
	Sum PAHs	46.0	109.7	159.9	817.7	4.47E-02	963.3	458.1		0.03
DDTs	DDE	0.1	1.7	4.3	0.2	5.16E-05	5.3	0.9	9.50	9.33E-05
PCBs	Total Aroclors	7.9	99.5	61.6	73.8	1.04E-03	206.4	34.4	0.14	0.25
									Hazard Index	2.75

1- Home range Factor of 1.0 applied; see Table 2-1.

2 - Body weight (BW) of 6.00 kg assumed, see text.

3 - No TRV Data Available.

Table 3-7c. Mean ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the raccoon.

Great Meadows

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	32.1	518.8	89.6	208.8	6.36E-03	721.9	120.3	0.13	0.95
	Cadmium	0.7	26.9	272.4	8.6	4.75E-04	262.4	43.7	1.00	0.04
	Chromium	112.1	1137.3	620.1	1711.5	2.65E-03	3043.8	507.3	3.28	0.15
	Copper	391.1	16062.1	10641.8	4528.8	9.93E-03	26880.3	4480.0	11.71	0.38
	Lead	32.8	1117.4	2580.7	2023.5	2.13E-03	4891.3	815.2	8.00	0.10
	Mercury	0.9	7.0	5.4	17.5	7.73E-05	26.2	4.4	0.03	0.14
	Nickel	25.7	838.0	279.6	576.1	2.26E-03	1461.5	243.6	40.0	6.09E-03
	Silver	2.5			14.9	2.77E-03	14.8	2.5	18.1	1.36E-04
	Zinc	2919.3	7163.1	31201.2	3783.0	1.47E-02	38306.6	6384.4	160	0.04
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0		1.1E-03	1.8E-04	1.00E-03	1.75E-04
PAHs	Acenaphthene	0.2	0.8	3.6	17.3	2.48E-03	18.6	3.1	175	1.77E-05
	Acenaphthylene	0.2	0.8	3.6	17.3	2.48E-03	18.6	3.1	25.7	1.20E-04
	Anthracene	0.2	0.8	3.6	16.3	2.48E-03	17.7	2.9	500	5.89E-06
	Benz(a)anthracene	0.2	0.8	17.9	56.8	2.48E-03	64.3	10.7	0.45	0.02
	Benzo(a)pyrene	0.4	1.8	17.9	48.0	2.48E-03	57.9	9.6	1.00	9.64E-03
	Dibenz(a,h)anthracene	0.2	0.8	17.9	21.2	2.48E-03	34.1	5.7	7.70	7.37E-04
	Fluoranthene	0.2	0.8	3.6	106.2	2.48E-03	94.1	15.7	50.00	3.14E-04
	Fluorene	0.2	0.8		17.3	2.48E-03	15.5	2.6	250	1.04E-05
	2-Methylnaphthalene	0.2			17.3	2.48E-03	14.9	2.5	153	1.63E-05
	Naphthalene	0.2	1.5	3.6	17.3	2.48E-03	19.2	3.2	153	2.10E-05
	Phenanthrene	0.2	0.8	16.8	53.5	2.48E-03	60.6	10.1	257.0	3.93E-05
	Pyrene	0.2	0.8	3.6	70.0	2.48E-03	63.4	10.6	219	4.83E-05
	Sum PAHs	14.2	43.2	167.4	888.2	4.47E-02	946.1	455.2		0.03
DDTs	DDE	2.1	1.1	4.3	0.1	6.03E-05	6.4	1.1	9.50	1.13E-04
PCBs	Total Aroclors	7.9	18.3	50.2	2.4	8.41E-04	66.9	11.2	0.14	0.08
									Hazard Index	1.94

1- Home range Factor of 1.0 applied; see Table 2-1.

2 - Body weight (BW) of 6.00 kg assumed, see text.

3 - No TRV Data Available.

Table 3-8a. Maximum ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the raccoon.

Middle Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	39.3	238.0	86.0	538.1	1.07E-02	766.2	127.7	0.13	1.01
	Cadmium	10.0	384.4	336.9	633.9	5.96E-04	1160.4	193.4	1.00	0.19
	Chromium	165.6	594.9	372.8	14114.8	6.16E-03	12960.9	2160.1	3.28	0.66
	Copper	1174.8	22036.7	10036.0	591637.0	6.01E-02	531152.0	88525.3	11.71	7.56
	Lead	844.4	4832.6	795.7	645166.1	6.80E-03	553893.0	92315.5	8.00	11.54
	Mercury	1.1	6.1	7.2	47.9	2.73E-04	52.9	8.8	0.03	0.28
	Nickel	76.4	1012.9	322.6	12030.0	5.81E-03	11425.5	1904.3	40.0	0.05
	Silver	1.9			42.3	8.44E-04	37.5	6.2	18.1	3.45E-04
	Zinc	4059.1	1305.8	27814.1	135231.3	6.31E-02	143148.8	23858.1	160	0.15
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0	0.00E+00	2.3E-03	3.8E-04	1.00E-03	3.84E-04
PAHs	Acenaphthene	0.1	0.8	3.6	239.5	2.48E-03	207.3	34.6	175	1.97E-04
	Acenaphthylene	0.4	0.8	3.6	239.5	2.48E-03	207.6	34.6	25.7	1.35E-03
	Anthracene	0.2	0.8	3.6	239.5	2.48E-03	207.4	34.6	500	6.91E-05
	Benz(a)anthracene	0.6	6.1	17.9	140.9	2.48E-03	140.6	23.4	0.45	0.05
	Benzo(a)pyrene	2.0	9.2	17.9	171.9	2.48E-03	170.8	28.5	1.00	0.03
	Naphthalene	0.2	1.8	3.6	125.4	2.48E-03	111.3	18.6	153	1.22E-04
	Phenanthrene	0.4	4.9	9.3	155.0	2.48E-03	144.1	24.0	257.0	9.35E-05
	Pyrene	3.9	16.5	3.6	309.9	2.48E-03	283.8	47.3	219	2.16E-04
	Sum PAHs	41.6	109.7	159.9	3415.4	4.47E-02	3167.7	527.9		0.09
DDTs	DDE	4.4	1.7	4.3	2.3	5.16E-05	10.8	1.8	9.50	1.89E-04
PCBs	Total Aroclors	27.6	99.5	61.6	3789.3	1.04E-03	3381.3	563.6	0.14	4.03
									Hazard Index	25.55

1- Home range Factor of 1 applied; see Table 2-1.

2 - Body weight (BW) of 6.00 kg assumed, see text.

3 - No TRV Data Available.

Table 3-8b. Maximum ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the raccoon.

Upper Ferry Creek

Class	Chemical of Concern	Dietary Intake, (µg CoC/day) Fish	Crab	Insects	Sediment	Water	Total Assimilated[1] (µg CoC/day)	Total Assimilated[2] (µg CoC/kg Bw/day)	TRV (mg CoC/kg Bw/day)	Hazard Quotient
Inorganics	Arsenic	39.3	238.0	86.0	369.1	1.07E-02	622.5	103.7	0.13	0.82
	Cadmium	10.0	384.4	336.9	521.2	5.96E-04	1064.7	177.4	1.00	0.18
	Chromium	165.6	594.9	372.8	25355.9	6.16E-03	22515.8	3752.6	3.28	1.14
	Copper	1174.8	22036.7	10036.0	191014.2	6.01E-02	190622.6	31770.4	11.71	2.71
	Lead	844.4	4832.6	795.7	134949.6	6.80E-03	120209.0	20034.8	8.00	2.50
	Mercury	1.1	6.1	7.2	87.3	2.73E-04	86.4	14.4	0.03	0.45
	Nickel	76.4	1012.9	322.6	4564.1	5.81E-03	5079.5	846.6	40.0	0.02
	Silver	1.9			90.2	8.44E-04	78.2	13.0	18.1	7.20E-04
	Zinc	4059.1	1305.8	27814.1	29300.1	6.31E-02	53107.3	8851.2	160	0.06
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0	0.00E+00	2.0E-03	3.3E-04	1.00E-03	3.28E-04
PAHs	Acenaphthene	0.4	0.8	3.6	22.5	2.48E-03	23.2	3.9	175	2.21E-05
	Acenaphthylene	0.2	0.8	3.6	42.3	2.48E-03	39.8	6.6	25.7	2.58E-04
	Anthracene	0.6	0.8	3.6	31.0	2.48E-03	30.5	5.1	500	1.02E-05
	Benz(a)anthracene	2.0	6.1	17.9	90.2	2.48E-03	98.8	16.5	0.45	0.04
	Benzo(a)pyrene	3.3	9.2	17.9	90.2	2.48E-03	102.4	17.1	1.00	0.02
	Naphthalene	0.4	1.8	3.6	47.9	2.48E-03	45.7	7.6	153	4.99E-05
	Phenanthrene	3.9	4.9	9.3	118.3	2.48E-03	116.0	19.3	257.0	7.52E-05
	Pyrene	4.4	16.5	3.6	185.9	2.48E-03	178.9	29.8	219	1.36E-04
	Sum PAHs	46.0	109.7	159.9	1638.6	4.47E-02	1661.0	276.8		0.06
DDTs	DDE	0.8	1.7	4.3	0.4	5.16E-05	6.1	1.0	9.50	1.07E-04
PCBs	Total Aroclors	27.6	99.5	61.6	331.5	1.04E-03	442.2	73.7	0.14	0.53
									Hazard Index	8.47

1- Home range Factor of 1 applied; see Table 2-1.

2 - Body weight (BW) of 6.00 kg assumed, see text.

3 - No TRV Data Available.

Table 3-8c. Maximum ingestion rates and doses of CoCs, by media, with Hazard Quotient calculations for the raccoon.

Great Meadows

Class	Chemical of Concern	Dietary Intake, (µg CoC/day)					Total Assimilated[1]	Total Assimilated[2]	TRV	Hazard Quotient
		Fish	Crab	Insects	Sediment	Water	(µg CoC/day)	(µg CoC/kg Bw/day)	(mg CoC/kg Bw/day)	
Inorganics	Arsenic	34.3	518.8	89.6	400.1	1.64E-02	886.3	147.7	0.13	1.17
	Cadmium	1.3	26.9	272.4	9.3	4.97E-04	263.4	43.9	1.00	0.04
	Chromium	159.2	1137.3	620.1	3014.5	1.11E-02	4191.4	698.6	3.28	0.21
	Copper	486.8	16062.1	10641.8	9466.2	2.57E-02	31158.4	5193.1	11.71	0.44
	Lead	45.7	1117.4	2580.7	3972.4	1.04E-02	6558.7	1093.1	8.00	0.14
	Mercury	1.1	7.0	5.4	33.8	2.43E-04	40.2	6.7	0.03	0.21
	Nickel	32.1	838.0	279.6	955.1	2.48E-03	1789.1	298.2	40.0	7.45E-03
	Silver	2.5			18.3	8.94E-03	17.7	2.9	18.1	1.63E-04
	Zinc	3054.9	698.7	31201.2	5409.3	3.13E-02	34309.4	5718.2	160	0.04
Dioxins	2,3,7,8-TCDD	0.0	0.0	0.0	0.0	0.00E+00	1.1E-03	1.8E-04	1.00E-03	1.76E-04
PAHs	Acenaphthene	0.2	0.8	3.6	40.9	2.48E-03	38.6	6.4	175	3.67E-05
	Acenaphthylene	0.2	0.8	3.6	40.9	2.48E-03	38.6	6.4	25.7	2.50E-04
	Anthracene	0.2	0.8	3.6	36.6	2.48E-03	35.0	5.8	500	1.17E-05
	Benz(a)anthracene	0.2	0.8	17.9	197.2	2.48E-03	183.7	30.6	0.45	0.07
	Benzo(a)pyrene	0.4	1.8	17.9	163.4	2.48E-03	156.0	26.0	1.00	0.03
	Naphthalene	0.2	1.5	3.6	40.9	2.48E-03	39.2	6.5	153	4.29E-05
	Phenanthrene	0.2	0.8	16.8	188.8	2.48E-03	175.6	29.3	257.0	1.14E-04
	Pyrene	0.2	0.8	3.6	262.0	2.48E-03	226.6	37.8	219	1.73E-04
	Sum PAHs	14.2	43.2	167.4	2408.2	4.47E-02	2238.1	373.0		0.10
DDTs	DDE	2.1	1.1	4.3	0.1	1.24E-04	6.5	1.1	9.50	1.14E-04
PCBs	Total Aroclors	27.6	18.3	50.2	2.5	1.24E-03	83.8	14.0	0.14	0.10
									Hazard Index	2.46

1- Home range Factor of 1 applied; see Table 2-1.

2 - Body weight (BW) of 6.00 kg assumed, see text.

3 - No TRV Data Available.

Table 4.1. Hazard Indices of black crowned night heron, red-winged black bird, and raccoon for the Middle and Upper Ferry Creek and reference area.

	Animal	Middle Ferry Creek	Upper Ferry Creek	Reference
Mean	Black-crowned night heron	8.1	4.7	3.8
	Red-winged black bird	5.4	5.4	6.5
	Raccoon	5.4	2.8	1.9
Maximum	Black-crowned night heron	42.6	14.0	4.5
	Red-winged black bird	5.4	5.4	6.5
	Raccoon	25.6	8.5	2.5

Table 4-2a. Mean Hazard Quotient values and percent Hazard Quotient of Hazard Indices for heron, blackbird, and raccoon[1,2].

Black-crowned night heron

Class	Chemical of Concern	Middle Ferry Creek HQ	Middle Ferry Creek %HQ of HI	Upper Ferry Creek HQ	Upper Ferry Creek %HQ of HI	Great Meadows HQ	Great Meadows %HQ of HI
Inorganics	Arsenic	0.03	0.34%	0.03	0.56%	0.03	0.87%
	Cadmium	0.06	0.75%	0.06	1.21%	5.47E-03	0.14%
	Chromium	0.70	8.69%	0.71	15.12%	0.59	15.34%
	Copper	0.55	6.85%	0.27	5.75%	0.13	3.49%
	Lead	4.93	60.89%	2.14	45.53%	0.21	5.62%
	Mercury	0.13	1.57%	0.13	2.71%	0.15	3.93%
	Nickel	7.64E-03	0.09%	5.02E-03	0.11%	3.07E-03	0.08%
	Silver	4.30E-04	0.01%	5.13E-04	0.01%	5.69E-04	0.01%
	Zinc	1.05	13.01%	0.93	19.79%	0.73	19.21%
Dioxins	2,3,7,8-TCDD	0.03	0.37%	0.03	0.64%	0.01	0.39%
PAHs	Sum PAHs	5.29E-03	0.00%	4.19E-03	0.00%	1.93E-03	0.00%
DDTs	DDT	0.18	2.27%	0.18	3.76%	1.83	47.78%
PCBs	Total Aroclors	0.41	5.09%	0.22	4.72%	0.12	3.09%
	Hazard Index	8.09		4.70		3.82	

Red-winged blackbird

Class	Chemical of Concern	Middle Ferry Creek HQ	Middle Ferry Creek %HQ of HI	Upper Ferry Creek HQ	Upper Ferry Creek %HQ of HI	Great Meadows HQ	Great Meadows %HQ of HI
Inorganics	Arsenic	0.02	0.3%	0.02	0.3%	0.02	0.24%
	Cadmium	0.21	3.9%	0.21	3.9%	0.17	2.59%
	Chromium	0.33	6.2%	0.33	6.2%	0.56	8.55%
	Copper	0.32	5.9%	0.32	5.9%	0.34	5.22%
	Lead	0.35	6.5%	0.35	6.5%	1.13	17.36%
	Mercury	0.20	3.7%	0.20	3.7%	0.15	2.32%
	Nickel	3.74E-03	0.1%	3.74E-03	0.1%	3.24E-03	0.05%
	Silver	1.61E-08	0.0%	1.61E-08	0.0%	5.28E-08	0.00%
	Zinc	2.21	41.0%	2.21	41.0%	2.48	38.07%
Dioxins	2,3,7,8-TCDD	0.06	1.1%	0.06	1.1%	0.04	0.54%
PAHs	Sum PAHs	3.20E-03	0.1%	3.20E-03	0.1%	3.40E-03	0.05%
DDTs	DDT	1.38	25.6%	1.38	25.6%	1.38	21.18%
PCBs	Total Aroclors	0.31	5.7%	0.31	5.7%	0.25	3.84%
	Hazard Index	5.39		5.39		6.51	

Raccoon

Class	Chemical of Concern	Middle Ferry Creek HQ	Middle Ferry Creek %HQ of HI	Upper Ferry Creek HQ	Upper Ferry Creek %HQ of HI	Great Meadows HQ	Great Meadows %HQ of HI
Inorganics	Arsenic	0.66	12.22%	0.59	21.49%	0.95	49.35%
	Cadmium	0.13	2.37%	0.12	4.33%	0.04	2.26%
	Chromium	0.23	4.33%	0.24	8.60%	0.15	7.99%
	Copper	1.77	32.89%	0.72	26.18%	0.38	19.77%
	Lead	1.74	32.22%	0.63	23.02%	0.10	5.27%
	Mercury	0.12	2.20%	0.12	4.30%	0.14	7.05%
	Nickel	0.02	0.33%	9.91E-03	0.36%	6.09E-03	0.31%
	Silver	1.62E-04	0.00%	2.51E-04	0.01%	1.36E-04	0.01%
	Zinc	0.06	1.06%	0.04	1.59%	0.04	2.06%
Dioxins	2,3,7,8-TCDD	3.20E-04	0.01%	3.22E-04	0.01%	1.75E-04	0.01%
PAHs	Sum PAHs	0.04	0.82%	0.03	1.18%	0.03	F
DDTs	DDT	9.65E-05	0.00%	9.33E-05	0.00%	1.13E-04	0.01%
PCBs	Total Aroclors	0.62	11.55%	0.25	8.93%	0.08	4.12%
	Hazard Index	5.39		2.75		1.94	

1 - Hazard Quotients and Hazard Indices are found in Tables 3-3, 3-6, and 3-8.

2 - % HQ of HI = HQ/HI.

Table 4-2b. Maximum Hazard Quotient values and percent Hazard Quotient of Hazard Indices for heron, blackbird, and raccoon[1,2].

Black-crowned night heron

Class	Chemical of Concern	Middle Ferry Creek		Upper Ferry Creek		Great Meadows	
		HQ	%HQ of HI	HQ	%HQ of HI	HQ	%HQ of HI
Inorganics	Arsenic	0.03	0.08%	0.03	0.22%	0.04	0.84%
	Cadmium	0.10	0.23%	0.09	0.64%	6.42E-03	0.14%
	Chromium	1.76	4.14%	2.79	20.02%	0.81	18.25%
	Copper	2.14	5.02%	0.84	5.99%	0.16	3.53%
	Lead	30.13	70.70%	7.33	52.51%	0.32	7.09%
	Mercury	0.24	0.57%	0.36	2.55%	0.21	4.64%
	Nickel	0.02	0.04%	9.63E-03	0.07%	3.71E-03	0.08%
	Silver	6.51E-04	0.00%	1.00E-03	0.01%	5.94E-04	0.01%
	Zinc	1.95	4.58%	1.09	7.84%	0.69	15.48%
Dioxins	2,3,7,8-TCDD	0.04	0.09%	0.04	0.26%	0.02	0.35%
PAHs	Sum PAHs	0.01	0.03%	6.15E-03	0.04%	5.79E-03	0.13%
DDTs	DDT	3.81	8.94%	0.76	5.46%	1.83	41.00%
PCBs	Total Aroclors	2.37	5.55%	0.61	4.34%	0.37	8.32%
	Hazard Index	42.62		13.96		4.46	

Red-winged blackbird

Class	Chemical of Concern	Middle Ferry Creek		Upper Ferry Creek		Great Meadows	
		HQ	%HQ of HI	HQ	%HQ of HI	HQ	%HQ of HI
Inorganics	Arsenic	0.02	0.28%	0.02	0.28%	0.02	0.24%
	Cadmium	0.21	3.87%	0.21	3.87%	0.17	2.59%
	Chromium	0.33	6.21%	0.33	6.21%	0.56	8.55%
	Copper	0.32	5.94%	0.32	5.94%	0.34	5.22%
	Lead	0.35	6.47%	0.35	6.47%	1.13	17.36%
	Mercury	0.20	3.73%	0.20	3.73%	0.15	2.32%
	Nickel	3.74E-03	0.07%	3.74E-03	0.07%	3.24E-03	0.05%
	Silver	1.61E-08	0.00%	1.61E-08	0.00%	1.70E-07	0.00%
	Zinc	2.21	41.01%	2.21	41.01%	2.48	38.07%
Dioxins	2,3,7,8-TCDD	0.06	1.06%	0.06	1.06%	0.04	0.54%
PAHs	Sum PAHs	3.20E-03	0.06%	3.20E-03	0.06%	3.40E-03	0.05%
DDTs	DDT	1.38	25.59%	1.38	25.59%	1.38	21.18%
PCBs	Total Aroclors	0.31	5.71%	0.31	5.71%	0.25	3.84%
	Hazard Index	5.39		5.39		6.51	

Raccoon

Class	Chemical of Concern	Middle Ferry Creek		Upper Ferry Creek		Great Meadows	
		HQ	%HQ of HI	HQ	%HQ of HI	HQ	%HQ of HI
Inorganics	Arsenic	1.01	3.97%	0.82	9.72%	1.17	47.67%
	Cadmium	0.19	0.76%	0.18	2.09%	0.04	1.79%
	Chromium	0.66	2.58%	1.14	13.50%	0.21	8.66%
	Copper	7.56	29.59%	2.71	32.02%	0.44	18.03%
	Lead	11.54	45.16%	2.50	29.56%	0.14	5.56%
	Mercury	0.28	1.08%	0.45	5.31%	0.21	8.50%
	Nickel	0.05	0.19%	0.02	0.25%	7.45E-03	0.30%
	Silver	3.45E-04	0.00%	7.20E-04	0.01%	1.63E-04	0.01%
	Zinc	0.15	0.58%	0.06	0.65%	0.04	1.45%
Dioxins	2,3,7,8-TCDD	3.84E-04	0.00%	3.28E-04	0.00%	1.76E-04	0.01%
PAHs	Sum PAHs	0.09	0.35%	0.06	0.66%	0.10	3.95%
DDTs	DDT	1.89E-04	0.00%	1.07E-04	0.00%	1.14E-04	0.00%
PCBs	Total Aroclors	4.03	15.75%	0.53	6.21%	0.10	4.06%
	Hazard Index	25.55		8.47		2.46	

1 - Hazard Quotients and Hazard Indices are found in Tables 3-3, 3-6, and 3-8.
2 - % HQ of HI = HQ/HI.