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INTERIM FINAL PRELIMINARY REMEDIATION GOALS REPORT

PART I – HUMAN HEALTH
PART II – ECOLOGICAL

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

INTERIM FINAL – PRELIMINARY REMEDIATION GOALS REPORT
PART I – HUMAN HEALTH

CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

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INTERIM FINAL –PRELIMINARY REMEDIATION GOALS
PART I – HUMAN HEALTH

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1.0 INTRODUCTION

MACTEC Engineering and Consulting, Inc. (MACTEC) is pleased to provide this report documenting the derivation of human health risk-based preliminary remediation goals (PRGs) for fish tissue and sediment (related to human health risks associated with fish consumption) as well as the derivation of PRGs for direct contact with sediments, bank soil, and surface soil (industrial/commercial land use) for the Centredale Manor Restoration Project Superfund Site in North Providence, Rhode Island. The Site and identified exposure areas are shown in Figure 1-1. It is assumed that the Remedial Action Objectives (RAOs) for the Site will address, in part, the human health exposure pathways that are associated with cancer and/or noncancer risks above the EPA's risk management criteria as identified in the Baseline Human Health Risk Assessment (BHHRA). Those exposure pathways are identified below. This human health PRG document is Part I of the Draft Preliminary Remediation Goals Report. Ecological risk-based PRGs are presented in Part II.

1.1 DOCUMENT THE NEED FOR PRGS – SUMMARY OF BASELINE HUMAN HEALTH RISK ASSESSMENT RESULTS

The *Baseline Human Health Risk Assessment – Interim Final, Centredale Manor Restoration Project Superfund Site, North Providence, Rhode Island (MACTEC, 2004)* evaluated the human health risks for Residents Living Along the River, Visiting Recreational Anglers, and Industrial/Commercial Employees at the Fogarty Center (surface soil only). The Baseline Human Health Risk Assessment (BHHRA) characterized human health cancer and noncancer risks associated with the following exposures: consumption of a combined fish diet consisting of fish caught from the Woonasquatucket River, incidental ingestion and dermal contact with sediments and surface water of the Woonasquatucket River and associated impoundments (wading for the Visiting Recreational Angler and a combination of wading and swimming for the Resident Living Along the River), incidental ingestion and dermal contact with bank soil (Allendale Pond reach only); and incidental ingestion and dermal contact with surface soils (Fogarty Center employees). Risks were calculated for each chemical in each medium, and risks for all potential exposures for a given receptor were combined into a cumulative receptor risk. The BHHRA evaluated both Reasonable Maximum Exposure (RME) and Central Tendency (CT) scenarios.

In the BHHRA, the results from the carcinogenic risk assessment were compared to acceptable risk ranges established by the USEPA. The USEPA's guidelines, established in the National Hazardous Substances and Pollution Contingency Plan (NCP) identify acceptable exposure levels as those concentration levels "that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} [one in ten thousand]and 10^{-6} [one in one million] using information on the relationship between dose and response" (USEPA, 1990). The selection of the actual upper limit cancer risk target is a risk management decision that can vary on a case-by-case basis. This PRG document is intended to provide information to support that decision.

The BHHRA also included an evaluation of noncarcinogenic risks. As defined by USEPA (USEPA, 1989), a hazard index (HI) of less than 1 indicates that noncarcinogenic toxic effects are unlikely. An HI greater than 1 indicates a greater possibility of a noncarcinogenic toxic effect occurring, but the circumstances must be evaluated on a case-by-case basis. EPA typically considers the need for remediation if the HI is greater than one.

In addition to evaluating total risks, the BHHRA also includes an evaluation of incremental risk. It is possible that receptors at the site may be exposed to chemicals of concern both at the site and at other locations; incremental risk is a means of quantifying that portion of the total risk to the receptor that is site related. For the purpose of this assessment, incremental risks were defined as the total risk associated with the site, minus the risks calculated for the upstream background area, Greystone Mill Pond. This calculation was done for each receptor at each exposure point. The resulting incremental risks were compared to the Superfund cancer risk range of 10^{-6} to 10^{-4} and to a noncancer Hazard Index value of 1. The summary of noncancer and cancer risk calculations for the Interim Final BHHRA are presented in Tables 1-1 and 1-2 respectively. Assapumpset Pond and Brook was identified as a potential input to Lyman Mill Pond, if any contamination inconsistent with the upstream areas was discovered in Lyman Mill Pond. Assapumpset Pond and Brook flow into Lyman Mill Pond downstream of Allendale Pond. Assapumpset Pond and Brook are not directly upstream of the site and the pond and brook are not riverine as is Greystone Mill Pond. Therefore, Assapumpset Pond and Brook are not considered to represent an upstream background condition and are not utilized in calculating incremental risks associated with the site

The cumulative receptor RME and CT cancer and noncancer risks were above the Superfund cancer risk range and the Hazard Index benchmark of one respectively for the Resident Living Along the River and the Visiting Recreational Angler. The noncancer and cancer risks for the employee of the Fogarty Center were below a Hazard Index benchmark of one and the upper end of the Superfund cancer risk range respectively. The cancer risk for the Fogarty Center employee was greater than the lower end of the Superfund cancer risk range (10^{-6}).

1.1.1 Summary of Medium-Specific Risks

The RME and CT incremental (above background) noncancer risks associated with fish consumption are considerably higher than the non-cancer Hazard Index benchmark of one for the Resident Living Along the River and the Visiting Recreational Angler. The medium-specific Hazard Index is below one for the RME and CT scenarios for all other exposure media evaluated in the interim Final BHHRA. The incremental RME and CT cancer risks associated with fish consumption are also considerably higher than the upper end of the Superfund risk range for both receptor groups. The incremental RME cancer risk associated with incidental ingestion and dermal contact with sediment for the Resident Living Along the River is also above the upper end of the Superfund risk range for Allendale Pond and Lyman Mill Pond. The RME and CT cancer and noncancer risks are within the Superfund cancer risk range and below a Hazard Index benchmark value of one for adult worker surface soil exposures at the Fogarty Center. The RME and CT cancer risks associated with surface water exposures for the Resident Living Along the River and the Visiting Recreational Angler are within or below the Superfund cancer risk range at all exposure areas evaluated.

1.2 Identification of Media Requiring PRGs and Chemicals of Concern for Each of the Media

Human health PRG development activities include development of PRGs for fish tissue and sediment because human health risk associated with fish consumption is above Superfund risk limits. The persistent, bioaccumulating substances in fish tissue that are the major contributors to

human health risk (primarily dioxins and PCBs) are typically present in fish as the result of bioaccumulation from sediments. The BHHRA has documented that dioxins (specifically 2,3,7,.8-TCDD) and PCBs (specifically Aroclor-1254) are present in sediments at elevated (relative to the background area at Greystone Mill Pond) concentrations at the exposure areas adjacent to and downstream of the Centredale Manor source area and the incremental (above background) human health cancer and noncancer risks associated with fish consumption scenarios for the Resident Living Along the River and the Visiting Recreational Angler are above Superfund risk limits. Therefore, dioxins and PCBs in sediments are considered the primary risk drivers associated with the fish consumption scenarios.

The results and conclusions of the BHHRA have identified the chemicals that most significantly contribute to human health risks for the biota consumption pathway. Consistent with USEPA Risk Assessment Guidance for Superfund (RAGS) Part D (USEPA, 2001), Standard Table 10s in the BHHRA identified those chemicals that are considered chemicals that require further evaluation in the Feasibility Study for the Site. These chemicals are referred to as Chemicals of Concern (COCs) and these COCs were identified in Table 10s as chemicals with cancer risk greater than 10^{-6} and/or Hazard Quotient greater than 1. As indicated in RAGS Part D, the concentration associated with a lifetime cancer risk of 1 x 10^{-6} is considered a point of departure. Subsequently, other factors are considered to determine where within the acceptable risk range the actual remediation goals for a given COC will be established. Table 1-3 presents a summary of COCs for the fish consumption pathway, and separately, for exposure to sediment, bank soil, surface soil, and surface water (no COCs) for each of the four exposure points that are adjacent to or downstream of the Centredale Manor source area. For those chemicals in biota tissue that are associated with an excess lifetime cancer risk greater than one-in-one-million and/or a noncancer hazard quotient greater than 1, biota tissue concentrations associated with various risk levels (cancer risk of 10^{-6}, 10^{-5}, 10^{-4}, and hazard quotients of 0.1, 1, and 10) are identified (fish tissue PRGs).

The development of risk-based PRGs has been conducted consistent with *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals), Interim* (USEPA, 1991). The PRGs are also being developed consistent with the USEPA's *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (USEPA, 2002a) and Risk Assessment Guidance for Superfund (RAGS): Part D, Volume 1 - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments) Final (USEPA, 2001). PRGs can be either generic or site-specific. Generic or default PRGs have been developed and published by USEPA based on default exposure assumptions and for various media, including fish tissue, however, values for sediment have not been developed (USEPA, 2002b). In addition, although default values are useful for screening purposes, site-specific PRGs are more appropriate for use in the remedial decision-making process. Therefore, the PRGs developed for the Site have been based on the site-specific baseline human health risk assessment (BHHRA) that has been conducted for the Site and the physical and chemical conditions at the Site.

The sediment PRGs for human health based on fish consumption and transfer of COCs from sediment to biota are derived by dividing the risk-specific tissue concentrations by biota-sediment accumulation factors (BSAFs).

MACTEC developed human health PRGs for the six receptors (three age groups for the Resident Living Along the River and three age groups for the Visiting Recreational Angler) for a combined fish diet consisting of multiple target species. Intermediate calculations identified (for each species separately) sediment PRGs based on a fish consumption diet consisting of 100 percent of each of the target species that comprise the combined fish diet. The PRGs were developed for each of the exposure areas (Greystone Mill Pond, Assapumpset Pond, Allendale Pond, Lyman Mill Pond, Manton Pond, and Dyerville Pond).

1.3 COCs FOR ENVIRONMENTAL MEDIA

Because the identification of Chemicals of Concern (COCs) is based on site-specific, exposure point specific risks compared to target risk levels, the list of COCs varies by exposure point and by receptor. The following text and Table 1-3 identify and discuss the identified human health risk-based COCs.

1.3.1 Combined Fish Diet

In general, for the fish consumption pathway, the chemicals that contributed cancer risk greater than 10^{-6}, in descending order of associated cancer risk, are: dioxins and furans (reported as 2,3,7,8-TCDD equivalents or TEQ), dioxin-like PCBs (TEQ), Aroclor-1254, technical chlordane, dieldrin, 4,4-DDE, benzo(a)pyrene, and Aroclor-1268. Also, for the fish consumption pathway, the chemicals that contributed noncancer risk (Hazard Index greater than 0.1), in descending order of associated risk, are: Aroclor-1254, technical chlordane, and Aroclor-1268. In most instances, only Aroclor-1254 was associated with a Hazard Index greater than 1.

Technical chlordane in sediment and biota tissue does not appear to be site-related. Figure 27 of the Interim Final BHHRA indicates the following arithmetic mean concentrations of technical chlordane in sediments: 108 ug/kg at Assapumpset Pond reference area; 401 ug/kg at the Greystone Mill Pond upstream background area; 515 ug/kg at the Allendale Pond site exposure area; and 1,251 ug/kg at the Lyman Mill Pond site exposure area. As shown in Table 3-4 of this report, technical chlordane tissue concentrations are reasonably consistent among the reference area, background area, and site exposure areas. For largemouth bass, geometric mean lipid-normalized concentrations of technical chlordane were 8.83 mg/kg, 2.97 mg/kg, and 7.09 mg/kg for Assapumpset Pond, Greystone Mill Pond and Manton Pond respectively. For American eel, geometric mean lipid-normalized concentrations of technical chlordane were 1.03 mg/kg, 1.84 mg/kg, 1.76 mg/kg, and 2.52 mg/kg for Assapumpset Pond, Greystone Mill Pond, Allendale Pond, and Dyerville Reach respectively. For white sucker,/brown bullhead, mean lipid-normalized concentrations of technical chlordane were 3.88 mg/kg, 2.84 mg/kg, and 4.31 mg/kg for Assapumpset Pond, Greystone Mill Pond, and Allendale Pond respectively. The PRGs for dioxins and dioxin-like PCBs are based on cancer risk only because a noncancer Reference Dose (RfD) is not available for dioxins and the noncancer effects associated with the dioxin-like PCBs have been evaluated as a component of the assessment of the reported Aroclors. The PRGs for Aroclor-1254 are based on both cancer risk and noncancer risk.

The primary dioxin-like PCBs that contribute to cancer risk associated with fish consumption, are in a typical descending order of risk contribution, PCB-126, PCB-118, PCB-156, PCB-105, and PCB-169. PCB-126 and PCB-118 combined typically accounted for more than 50% of the TEQ for dioxin-like PCBs.

1.3.2 Sediment Direct Contact

As shown in Table 1-3, the COCs identified for at least one receptor and one exposure area for sediment direct contact RME exposures include 2,3,7,8-TCDD equivalents, arsenic, benzo(a)pyrene, dibenz(a,h)anthracene, dioxin-like PCBs, and N-nitrosodi-n-propylamine. Most of these COCs are associated with the Resident Living Along the River. For the Visiting Recreational Angler, only 2,3,7,8-TCDD equivalents is a COC for direct contact with sediments (Allendale Pond, Lyman Mill Pond, and Manton Pond).

1.3.3 Bank Soil

As shown in Table 1-3, the COC identified for Allendale Pond bank soil is 2,3,7,8-TCDD equivalents for the resident Living Along the River only.

1.3.4 Surface Soil

As shown in Table 1-3, at the Fogarty Center: arsenic and benzo(a)pyrene were identified as COCs in surface soil for the Industrial/Commercial employee.

2.0 TECHNICAL APPROACH AND PROCEDURE FOR DEVELOPMENT OF PRGs

Section 2 presents the technical approach and procedure for the calculation of human health risk-based PRGs for sediment (based on fish consumption), for sediment (based on direct contact), for surface soil at the Fogarty Center (based on direct contact), and for bank soil at Allendale Pond reach (based on direct contact). Following the description of the technical approach and procedures, the documentation of the derivation of and the presentation of the human health risk-based PRGs is included in Section 3 of the document.

The PRGs for direct contact with sediments, bank soil, and surface soil were been calculated using RAGS Part B equations or modified RAGS Part B equations. The modifications to the RAGS Part B equations were made to account for the evaluation of two or three age groups in the calculation of cumulative receptor risk. The equations used in the calculation of those direct exposure PRGs, the fish tissue PRGs, and the sediment PRGs based on biota consumption and biota/sediment accumulation factors (BSAFs) are presented in Appendix B.

2.1 SEDIMENT PRGs BASED ON COMBINED FISH DIET

For each exposure point, the following tasks were components of the development of the fish consumption sediment PRGs for the identified COCs:

1. Calculate human health **fish tissue** PRGs for cancer and noncancer risk for each of the COCs for the combined fish diet and for the species with the highest calculated risks (Largemouth bass) for the Resident Living Along the River and for the Visiting Recreational Angler (note, the two receptors have the same fish consumption rates and therefore, will have the same fish tissue PRGs at a given exposure point).
2. Identify lipid-normalized fish tissue concentrations for COCs for all samples of each of the fish species collected at that exposure point.
3. Calculate mean lipid-normalized concentration of COCs in the tissue of each fish species at that exposure point (also characterize the variability in the values by identifying a coefficient of variation).
4. Identify total organic carbon-normalized sediment concentrations of COCs in each sediment sample at the exposure point.
5. Calculate mean organic carbon-normalized sediment concentrations for each COC at the exposure point (also characterize the variability in the values by identifying a coefficient of variation).
6. Calculate the BSAF for each COC and each fish species at the exposure point.
7. Calculate the human health **sediment** PRGs for each COC at each exposure point for each fish species (assuming that species is the only component of the recreational angler diet).
8. Calculate the human health **sediment** PRGs for each COC at each exposure point for the combined fish diet.
9. Compile all of the calculated PRGs into a single summary table.

Step 1) The **fish tissue** PRG was developed based on the Reasonable Maximum Exposure scenario for the Resident Living Along the River and the Visiting Recreational

Angler for each of the COCs. This is a chemical-specific, receptor-specific PRG that depends primarily on the toxicity of each COC and fish consumption rate for the receptor. The PRGs, for cancer and noncancer risk respectively, are calculated using an equation based on the RME risk calculations in the BHHRA for the Resident Living Along the River and the Visiting Recreational Angler, as follows:

For cancer risk,

$$PRG_{fish} = \frac{TR_{receptor} \times AT}{CF \times CSF_o \left(\frac{EF_{child} \times ED_{child} \times IR_{child}}{BW_{child}} + \frac{EF_{elderchild} \times ED_{elderchild} \times IR_{elderchild}}{BW_{elderchild}} + \frac{EF_{adult} \times ED_{adult} \times IR_{adult}}{BW_{adult}} \right)}$$

where:

$PRG_{fish,cancer}$ = PRG for fish tissue based on cancer risk (mg chemical/kg fish tissue).
$TR_{receptor}$ = Target cancer risk for the COC for fish consumption (combined diet) by all age groups of the Resident Living Along the River (dimensionless).
CSFo = Cancer slope factor for oral exposure (1/(mg/kg/day).

IR = Average daily fish consumption rate during the exposure period (dimensions: mass/time, typical units: gram/day).
EF = Number of days during the exposure period divided by the number of days in the exposure period - assumed to be one based on the use of average daily fish consumption rate (dimensions: events/time, typical units: days/year).
ED = Duration of the exposure period (dimensions: time, typical units: years).
CF = Appropriate units conversion factor(s).
BW = Body weight of the receptor of concern during the averaging period (dimensions: mass, typical units: kg).
AT = Averaging Time (dimension: time, typical units: days).

The noncancer risk component of the PRG for fish tissue consumption is calculated for each age group of each receptor as follows:

$$PRG_{fish,\,agegroup} = \frac{THI_{agegroup} \times RfD \times AT \; x \; BW_{agegroup}}{CF \times EF_{agegroup} \times ED_{agegroup} \times IR_{agegroup}}$$

where:

$PRG_{fish,agegroup}$ = PRG for fish tissue based on noncancer risk (mg chemical/kg fish tissue).
$THI_{agegroup}$ = Target Hazard Index for the COC for fish consumption (combined diet) by all age groups of the Resident Living Along the River (dimensionless).
RfD = Reference Dose (mg chemical/kg bodyweight per day).

Step 2) Lipid-normalized chemical fish tissue concentrations were calculated for each species at each exposure point consistent with the equation shown below.

$$[C]_{fish,\,ln} = \frac{[C]_{fish}}{[Lipid]_{fish}} x \frac{1}{CF1}$$

where:

$[C]_{fish,ln}$ = Lipid-normalized chemical concentration in fish tissue (mg chemical/kg lipid).
$[C]_{fish}$ = Chemical concentration in fish tissue (mg chemical/kg fish tissue as wet weight).
$[Lipid]_{fish}$ = Lipid concentration in fish tissue (mg lipid/kg fish tissue).
CF1 = Units conversion factor (0.000001 kg lipid/mg lipid).

Step 3) Mean lipid-normalized concentrations of each COC in each species at each exposure point were calculated and compiled. Coefficient of variation will be identified for each COC, species, and exposure point combination.

Step 4) Organic carbon-normalized sediment concentrations were calculated for sediment at each exposure point consistent with the equation shown below.

$$[C]_{sed,ocn} = \frac{[C]_{sed}}{[TOC]_{sed}} x \frac{1}{CF2}$$

where:

$[C]_{sed,ocn}$ = Organic carbon-normalized chemical concentration in sediment (mg chemical/kg organic carbon in sediment.
$[C]_{sed}$ = Chemical concentration in sediment (mg chemical/kg sediment as dry weight).
$[TOC]_{sed}$ = Total organic carbon concentration in sediment (mg total organic carbon/kg sediment as dry weight).
CF2 = Units conversion factor (0.000001 kg TOC/mg TOC).

Step 5) The mean organic carbon-normalized sediment concentrations for each COC at each exposure point were calculated and compiled. The coefficient of variation will be identified for each COC and exposure point combination.

Step 6) Calculate BSAFs. The general equation for calculation of a BSAF is shown below.

$$BSAF = \frac{[C]_{fish,ln}}{[C]_{sed,ocn}}$$

where:

BSAF = Biota-sediment accumulation factor (unitless).
$[C]_{fish,ln}$ = Lipid-normalized chemical concentration in fish tissue reported as wet weight (mg chemical/kg lipid in fish tissue).
$[C]_{sed,ocn}$ = Organic carbon-normalized chemical concentration in sediment reported as dry-weight (mg chemical/kg organic carbon in sediment).

Step 7) The **sediment** PRG was calculated for each COC at each exposure point for each fish species per the equation shown below.

$$PRG_{sed} = \frac{[C]_{target,fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

where:

$[C]_{target,fish}$ = Risk-based target chemical concentration in fish tissue (mg/kg).
$[TOC]_{sed}$ = Mean total organic carbon concentration in sediment at exposure point reported as dry weight (mg total organic carbon/kg sediment).
BSAF = Species-specific biota-sediment accumulation factor for the exposure point (unitless).
$[Lipid]_{fish}$ = Mean lipid concentration in fish species at the exposure point (mg lipid/kg fish tissue).

Step 8) The **sediment** PRG was calculated for each COC at each exposure point for the combined fish diet per the equation shown below. The PRG for the combined diet is the mean of the PRGs for individual species (the PRG based on a given species assumes the entire diet is comprised of that species).

$$PRG_{sed,combined} = \frac{\sum_{1}^{n} PRG_{sed,fish\ i}}{n}$$

where:

$PRG_{sed,combined}$ = Preliminary sediment remediation goal based on a combined fish diet, including fish species 1 through n (mg/kg).
$PRG_{sed,fish\ i}$ = Preliminary remediation goal based on a diet composed entirely of fish species I (mg/kg).
n = number of fish species included in the combined diet at a given exposure point.

Step 9) The calculated PRGs were initially be calculated for target cancer risk of 1×10^{-6} and hazard index of one. In addition, PRGs will also be calculated based on a cancer risk of 1×10^{-5} and at 1×10^{-4}. PRGs for COCs with noncancer effects (such as Aroclor-1254) will also be calculated at Hazard Index values of 0.1 and 10. All of the calculated PRGs will be compiled into a single summary table.

2.2 SEDIMENT PRGS BASED ON DIRECT CONTACT EXPOSURES

The direct contact-based sediment PRGs are calculated by rearranging the equations from the Interim Final BHHRA. Specifically, the Hazard Quotient or Cancer risk was assumed to be equal to the target Hazard Quotient or the target cancer risk, and the equation was solved for the sediment concentration. The cancer risk-based PRG incorporates exposures (incidental ingestion and dermal contact) for all three age groups. The Hazard Quotient-based PRG is calculated

separately for each age group, since the Hazard Quotients are not additive or cumulative among the age groups. The equations used to calculate the PRGs (at three cancer risk levels and at three Hazard Quotient values) are shown in the PRG calculation tables that are presented in Section 3.3.4.3 below. These equations are consistent with RAGS Part B equations, but have been modified to account for the three age groups that have been evaluated in the interim Final BHHRA. Those tables also document the exposure assumptions and toxicity values used in the calculations. The direct contact sediment PRGs are calculated separately for the Resident Living Along the River and the Visiting Recreational Angler using RME exposure assumptions. Because the sediment exposure assumptions for sediment contact were assumed to be consistent among the exposure areas for a given receptor, for a given chemical and receptor, the PRGs are consistent among the exposure areas.

2.3 BANK SOIL PRGS BASED ON DIRECT CONTACT EXPOSURES

The Interim Final BHHRA identified 2,3,7,8-TCDD as the only COC for bank soils along the Allendale Pond reach (Resident Living Along the River). Therefore, risk-based PRGs have been developed for direct contact bank soil exposures (incidental ingestion and dermal contact) for the Resident Living Along the River and separately for the Visiting Recreational Angler (the latter to provide additional perspective only, since 2,3,7,8-TCDD was not identified as a COC (cancer risk was not greater than 10^{-6}) for that receptor.

The direct contact-based bank soil PRGs are calculated by rearranging the equations from the Interim Final BHHRA, setting the Hazard Quotient or Cancer risk equal to the target Hazard Quotient or the target cancer risk, and solving for the bank soil concentration. The cancer risk-based PRG incorporates exposures (incidental ingestion and dermal contact) for all three age groups. The Hazard Quotient-based PRG is calculated separately for each age group, since the Hazard Quotients are not additive or cumulative among the age groups. The equations used to calculate the PRGs (at three cancer risk levels and at three Hazard Quotient values) are shown in the PRG calculation tables that are presented in Section 3.3.4.5 below. These equations are consistent with RAGS Part B equations, but have been modified to account for the three age groups that have been evaluated in the interim Final BHHRA. Those tables also document the exposure assumptions and toxicity values used in the calculations.

The bank soil direct contact PRGs are dependent on exposure and toxicity parameters, but not on sediment organic carbon content or other parameters that may vary among the exposure areas. Since the soil exposure assumptions for soil contact were assumed to be consistent among the exposure areas for a given receptor, for a given chemical and receptor, unlike the fish-consumption-based sediment PRGs, the bank soil PRGs would be consistent among the exposure areas.

2.4 SURFACE SOIL PRGS BASED ON DIRECT CONTACT EXPOSURES

The Interim Final BHHRA identified arsenic and benzo(a)pyrene as the only COCs for surface soils at the property at 220 Woonasquatucket Avenue on the eastern shore of Lyman Mill Pond (adult industrial/commercial worker). The Fogarty Center is currently operating at this property. Risk-based PRGs have been developed for direct contact surface soil exposures (incidental ingestion and dermal contact) for the adult industrial/commercial worker. Although arsenic and benzo(a)pyrene were identified as COCs for surface soil (cancer risk greater than 10^{-6}), the

concentrations of these COCs may not be directly related to the site. Background surface soil concentrations of arsenic and benzo(a)pyrene in the area have not been characterized. A review of the site history did not identify arsenic or benzo(a)pyrene as chemicals that were used, manufactured, or disposed at the Site.

The direct contact-based surface soil PRGs are calculated by rearranging the equations from the Interim Final BHHRA, setting the Hazard Quotient or Cancer risk equal to the target Hazard Quotient or the target cancer risk, and solving for the surface soil concentration. The cancer risk-based PRG incorporates exposures (incidental ingestion and dermal contact) for the adult industrial/commercial worker. The Hazard Quotient-based PRG is calculated for the adult employee. The equations used to calculate the PRGs (at three cancer risk levels and at three Hazard Quotient values) are shown in the PRG calculation tables that are presented in Section 3.3.4.4 below. These equations are consistent with RAGS Part B equations and the risk calculations presented in the Interim Final BHHRA. Those tables also document the exposure assumptions and toxicity values used in the calculations.

3.0 CALCULATION AND PRESENTATION OF PRGs

3.1 EVALUATION OF DATA (AND OUTLIER ANALYSIS) AND SELECTION OF DATA FOR DERIVING BSAFS AND PRGS

An outlier analysis was performed for normalized chemical concentration data in biota and sediment samples being considered for use in calculating biota-sediment accumulation factors (BSAFs). For each COC, the lipid-normalized concentrations for each fish species (white sucker, American eel, and largemouth bass) and the organic carbon-normalized concentrations for sediment were plotted (grouped by exposure area). The plots for the lipid-normalized COC concentrations in fish tissue and the organic carbon-normalized COC concentrations in sediment are presented in Appendix A.

The plots were visually inspected to determine if there were any concentrations that appeared to be inconsistent with the remainder of the concentrations reported for that COC in that medium at a particular exposure area. This analysis was conducted to identify and remove "outliers" that might otherwise have an inordinate and unexplained impact on the estimated BSAF for that COC at a particular exposure area (the area-specific BSAFs are geometric means of the individual data points at that exposure area). In general, based on professional judgment and review of all of the distribution plots, a concentration that was at least five times higher (or lower) than any of the other concentrations for that exposure area was identified as an outlier. In Appendix A, those plots that contain outlier concentrations are presented in the first section. The second section of Appendix A documents the plots for the remainder of the COCs, even though no outliers were identified in those plots. The removal of outliers from the development of BSAFs was conducted to minimize the impact of atypical concentration values on the model that relates sediment concentrations and fish tissue concentrations at the site. The understanding of that relationship is critical to the development of fish consumption-based sediment PRGs.

Table 3-1 lists those results that were determined to be outliers through this evaluation. These data were not included in the calculation of BSAFs. Sediment sample APB-SD-4010-0000-01 appears to have consistently elevated organic carbon-normalized pesticide and polychlorinated biphenyl (PCB) normalized concentrations due to a low total organic carbon percentage (1.24%). This sample has been considered an outlier for all organic parameters.

3.2 EVALUATION OF THE IMPACT OF THE BREACH OF ALLENDALE DAM ON ENVIRONMENTAL DATA

MACTEC (2004) has previously evaluated the potential impacts of the May 2001 breach of the Allendale Dam on the development of sediment PRGs (particularly sediment PRGs that are based on potential human health and ecological risks associated with fish species). More specifically, the sediment and fish tissue chemical data collected both before the dam breach (pre-breach data) and after the dam breach (post-breach data) have been compared and contrasted to evaluate whether the available sediment and fish data from Allendale Pond and Lyman Mill Pond are representative of current site conditions and whether the collection of additional sediment and/or fish tissue sampling and analysis would be appropriate for the completion of the development of the sediment PRGs for the site.

Based upon the evaluation of the pre-breach and post-breach data, an evaluation of fish tissue concentrations, and the literature values for BSAFs for dioxin TEQ and Aroclor-1254, the following recommendations were developed.

- Sediment PRGs should not be calculated based on BSAFs developed for Lyman Mill Pond. The BSAFs for the exposure areas other than Lyman Mill Pond appear to be consistent. (This report does not use BSAFs developed for Lyman Mill Pond as discussed in subsequent sections of this report.)
- The calculation of BSAFs and sediment PRGs for white sucker and largemouth bass should include an outlier analysis for chemical concentration data in sediments and fish tissue. Outliers should be removed from the data sets prior to calculation of BSAFs and PRGs. Alternatively, geometric mean concentrations of both the organic carbon normalized sediment concentrations and of the lipid normalized fish tissue concentrations could be used in the BSAF calculations in order to minimize the impacts of outliers in the data sets.
- Based on the evaluation of the data from pre-breach and post-breach conditions and a comparison of draft sediment PRGs to background sediment concentrations, the available data appear to be sufficient for PRG development and additional sampling and analysis is not recommended at this time.

Because it was concluded that BSAF data from Lyman Mill Pond should not be used, the arithmetic mean BSAF for each fish species (for Assapumpset, Greystone Mill Pond, Allendale, Manton, and Dyerville) for each COC has been used in the derivation of species-specific fish-consumption-based sediment PRGs for Lyman Mill Pond. The PRGs for Lyman Mill Pond based on the combined fish diet are based on the arithmetic mean of the PRGs for the three individual fish species collected at the other exposure areas (largemouth bass, white sucker, and American eel). This approach assumes that each of the three species comprises one-third of the combined fish diet consumption rate.

3.3 CALCULATION OF BSAFS AND PRGS

3.3.1 Lipid-Normalized Biota Tissue Concentrations

An interim calculation step for the derivation of BSAFs and PRGs is the calculation of lipid-normalized biota tissue concentrations as described in Step 2 above. Table 3-2 presents a summary of the lipid-content of biota tissue data (by species and exposure area) used in the calculations as well as the organic carbon content of sediments in the various exposure areas. Table 3-3 identifies those sediment samples for which Total Organic Carbon (TOC) data are available. The data from these samples were used in the derivation of BSAFs. Table 3-4 summarizes the organic carbon-normalized sediment concentrations for the human health COCs in each of the exposure areas.

3.3.2 Organic Carbon-Normalized Sediment Concentrations

Another interim calculation step for the derivation of BSAFs and PRGs is the calculation of organic carbon-normalized sediment concentrations. Table 3-2 presents a summary of the organic carbon-content for sediment samples used in the BSAF and PRG calculations. Organic

carbon-normalized concentrations were calculated only for those samples that were analyzed for total organic carbon (TOC).

3.3.3 Calculation of Biota-Sediment Accumulation Factors

The BSAF "is the lipid-normalized concentration of the chemical in the organism with respect to the organic carbon-normalized concentration in the sediments" (Cook et al., 1996). The BSAF defines the relationship between concentrations in biological tissue and sediments. Using the concept of steady-state conditions between lipophilic substances in sediment and fish tissue, sediment concentrations can be calculated based on measured or estimated fish tissue concentrations.

The BSAFs have been calculated in a manner consistent with the equation presented in Step 6 of Section 2.1. For each of the COCs and each exposure area, the geometric mean organic carbon-normalized sediment COC concentration is identified. For each COC, each exposure area, and each biota species, the geometric mean lipid-normalized tissue COC concentration is also identified (Table 3-4). The geometric mean of the organic carbon-normalized sediment COC concentrations and the geometric mean of the lipid-normalized tissue COC concentrations have been used in the BSAF derivation in order to minimize the impact of outliers or single atypical values on the calculated BSAFs. Largemouth bass (fillet) chemical data were available to derive BSAFs for Assapumpset Pond and Brook, Greystone Mill Pond, and Manton Pond. American eel chemical data were available to derive BSAFs for Assapumpset Pond and Brook, Greystone Mill Pond, Allendale Pond, and Dyerville Pond. White sucker chemical tissue data were available to derive BSAFs for Greystone Mill Pond, and Allendale Pond. Brown bullhead chemical tissue data were available to derive BSAFs for Assapumpset Pond and Brook (where white sucker were not available for collection). Here and throughout the remainder of this report, the brown bullhead data for Assapumpset Pond and Brook are used as surrogates for data for white sucker at that exposure area. Using this normalized sediment and tissue chemical data in the equation shown in Step 7 above, for each COC and each species, BSAFs are calculated for each of the six exposure areas. BSAFs have not been calculated using Lyman Mill Pond fish tissue data per the recommendations of the *Comparison of Pre-Breach and Post-Breach Data and the Potential Impact of the 2001 Allendale Dam Breach on Preliminary Remediation Goal (PRG) Development (MACTEC, 2005)*. In the development of PRGs, the arithmetic mean of the BSAFs for all other exposure areas has been assigned to Lyman Mill Pond.

The calculated BSAFs for 2,3,7,8-TCDD and Aroclor-1254 were reasonably consistent with the BSAF values reported in the literature for the same or similar fish species. This also suggests that the site-specific BSAFs and PRGs are technically supported.

3.3.4 Calculation of PRGs

3.3.4.1 Fish tissue PRGs

As described in Step 2 above, the calculation of fish tissue PRGs is an interim calculation step in the derivation of BSAF-based sediment PRGs. The fish tissue PRGs are the risk-based tissue concentrations that correspond to specific cancer and noncancer risk levels for the combined fish diet for the Resident Living Along the River and the Visiting Recreational Angler. The fish consumption parameters are identical for the two receptor groups. The fish tissue PRGs have been calculated based on the Reasonable Maximum Exposure (RME) exposure parameters and

the toxicity values used in the Interim Final BHHRA. The fish tissue PRGs were calculated for three cancer risk levels (10^{-6}, 10^{-5}, and 10^{-4}) and three noncancer Hazard Quotient values (0.1, 1, and 10). The cancer risk-based PRGs were calculated for all three age groups combined (child, older child, and adult) and the Hazard Quotient based PRGs were calculated for each of the age groups separately. Table 3-5 presents the calculation of the risk-based fish tissue PRGs for the human health COCs, including the equations, the exposure parameters, and the toxicity dose-response values that are used to calculate the fish tissue PRGs.

In subsequent calculations of sediment PRGs, the fish tissue Hazard Quotient-based PRGs for each of the three age group have been utilized. It should be noted, however, as shown in Table 3-5, the fish tissue Hazard Quotient–based PRG for the child is consistently lower (more conservative) than the corresponding PRGs for the older child and adult age groups.

3.3.4.2 Sediment PRGS (fish consumption-based)

The sediment PRGs based on fish consumption for each COC at each exposure area have been calculated as described by the equation in Step 7 above. The inputs to that equation include the target fish tissue concentration (the fish tissue PRG identified in Step 2 above), the exposure area-specific, chemical-specific BSAF (from Step 6), the geometric mean lipid content for the biota species at the exposure area (shown in Table 3-2), and the geometric mean organic carbon content of sediments at the exposure area (shown in Table 3-2).

As described in Step 7 above, sediment (fish consumption-based) PRGs have been calculated for each COC for each exposure area for each species of fish collected at that exposure point at each of the three target cancer risk levels (10^{-6}, 10^{-5}, and 10^{-4}) and at each of the target Hazard Quotients (0.1, 1, and 10). The calculated sediment (fish consumption-based) PRGs (assuming each species comprises 100% of the receptors' fish diet) are presented in Table 3-6 (largemouth bass), Table 3-7 (white sucker/brown bullhead), and Table 3-8 (American eel). The species-specific fish diet-based sediment PRGs for largemouth bass, white sucker, and American eel for Lyman Mill Pond were calculated in a slightly different manner than described in Step 7 above, as shown in the following paragraphs.

Due to uncertainties in the relationship between Lyman Mill Pond sediments analytical data and fish tissue data collected from Lyman Mill Pond, the BSAFs that are estimated from these data have not been used in developing sediment PRGs. This recommendation was made in the April 2005 "Comparison of pre-Breach and Post-Breach Data and the Potential Impact of the 2001 Allendale Dam Breach on PRG Development – Centredale Manor Superfund Site" (MACTEC, 2005b). The average BSAF for each COC at the other exposure areas, background area, and reference area were considered to be representative of Lyman Mill Pond for the purpose of calculating species-specific fish diet sediment PRGs as described in step 7 above. The species-specific fish diet sediment PRGs for Lyman Mill Pond as shown in Tables 3-6 through 3-9 were calculated for individual fish species using the calculated fish tissue PRGs, the geometric mean TOC content of the Lyman Mill Pond sediments, and the geometric mean lipid content for the fish species at Lyman Mill Pond, and the arithmetic average BSAFs (for Assapumpset, Greystone, Allendale, Manton, and Dyerville as data were available).

The sediment (combined fish diet-based) PRGs for each COC at each exposure point have been calculated as the arithmetic average of the PRGs derived for the individual species that were

sampled and analyzed at each exposure point as described in Step 8 above. The sediment PRGs based on the combined fish diet are presented in Table 3-9 (cancer risk basis for all three age groups combined), Table 3-10 (noncancer Hazard Quotient basis for adults), Table 3-11 (noncancer Hazard Quotient basis for the older child), and Table 3-12 (noncancer Hazard Quotient basis for the child).

It has been assumed that a combined fish diet is comprised of equal portions of the fish species that were sampled and analyzed at a given exposure area. However, the same number of species was not consistently collected at all areas. The combined fish diet PRGs, as presented in Tables 3-9 through 3-12, are based on: American eel, white sucker/brown bullhead, and largemouth bass collected at Assapumpset Pond and Greystone Mill Pond; American eel and white sucker/brown bullhead collected at Allendale Pond; largemouth bass collected at Manton Pond; and American eel collected at Dyerville Pond. The combined fish sediment PRGs for Lyman Mill Pond were calculated in a slightly different manner, because the BSAFs from Lyman Mill Pond were considered uncertain. Section 4.0 presents an alternative approach to the derivation of the combined fish diet sediment PRG for Allendale Pond as a means of evaluating the impact of variable availability of fish species at exposure areas on the combined fish diet sediment PRG.

3.3.4.3 Sediment PRGs (direct contact)

The direct contact-based sediment PRGs for the Resident Living Along the River and for the Visiting Recreational Angler are presented and documented in Table 3-13. That table presents the exposure parameters, the toxicity values, and the equations that have been used to calculate those PRGs.

3.3.4.4 Surface Soil PRGs (direct contact)

The direct contact-based sediment PRGs for the employee of the Fogarty Center are presented and documented in Table 3-14. That table presents the exposure parameters, the toxicity values, and the equations that have been used to calculate those PRGs.

3.3.4.5 Bank Soil PRGs (direct contact)

The direct contact-based bank soil PRGs for the Resident Living Along the River and for the Visiting Recreational Angler are presented and documented in Table 3-15. That table presents the exposure parameters, the toxicity values, and the equations that have been used to calculate those PRGs.

3.4 SUMMARY OF PRGS

The derivation of the PRGs for sediment (based on fish consumption), sediment (based on direct contact), surface soil (incidental ingestion and dermal contact), and bank soil (incidental ingestion and dermal contact has been documented in the tables associated with Sections 3.1 through 3.3 of this document. All of these PRGs (without all of the supporting documentation) are summarized in Table 3-16. In that table, for each COC in each of the media, PRGs associated with target cancer risks of 10^{-6}, 10^{-5}, and 10^{-4} as well as PRGs associated with noncancer Hazard Quotients of 0.1, 1, and 10 are presented.

4.0 DISCUSSION OF UNCERTAINTIES

The uncertainties in the calculated human health risk-based PRGs are generally similar to those identified for the risk estimates for the Interim Final BHHRA. Those uncertainties, briefly summarized, include:

- Not all COCs are necessarily "site-related". It appears that some of the COCs, such as benzo(a)pyrene, dieldrin, and technical chlordane, although they were associated with risks sufficient to identify them as COCs, may not be associated with releases at the Centredale Manor site but may rather be associated with other regional sources. The review of the Site history that was presented in the Interim Final BHHRA did not identify the use or disposal of benzo(a)pyrene, dieldrin, and technical chlordane. Figure 22 and 27 of the Interim Final BHHRA graphically present the sediment concentrations of benzo(a)pyrene, dieldrin and chlordane at the reference area, the upstream background area, and the four Site-related exposure areas. Those figures do not indicate a substantial source of those compounds at the Site. In addition, Figures 24, 25, and 26 present PAH (including benzo(a)pyrene) concentrations in fish tissue among the areas, with no obvious source at the site. Tables 3.1.RME through 3.3.RME of the Interim Final BHHRA present the same information, in tabular form, for benzo(a)pyrene, dieldrin, and technical chlordane in fish tissue at the reference area, the upstream background area, and the four Site-related exposure areas. These tables do not indicate a source of these compounds at the Site.
- Toxicity Data for Dioxins. Based on information in USEPA's Reassessment Document for Dioxin, the cancer slope factor for 2,3,7,8-TCDD that was utilized in the Interim Final BHHRA and in the derivation of the sediment PRGs could be revised, possibly upwards, by a factor of approximately 7. Such a revision would suggest that the cancer risk-based PRGs should be lowered by a factor of approximately 7. This would likely result in PRGs that are below reported background conditions for the site. In addition, there is currently not a noncancer Reference Dose upon which a noncancer risk-based sediment PRG for 2,3,7,8-TCDD could be derived.
- Breach of Allendale Dam. The breach of the Allendale Dam may have had an impact on the distribution of fish between Allendale Pond and Lyman Mill Pond and the relationship between biota tissue concentrations and associated sediment concentrations. In order to minimize the impact of the dam breach on PRG development, fish tissue data from Lyman Mill Pond (immediately downstream of the Allendale Dam) were not used to develop BSAFs that were utilized in the PRG development. The BSAFs were reasonably consistent among the exposure areas, suggesting that the data utilized in BSAF and PRG development were appropriate.
- Additional investigation of sediment and fish tissue appears to be appropriate rather than applying the combined fish diet-based PRGs for Manton Pond and Dyerville Pond (each based on a limited number of fish samples for a single fish species) for remedial decision-making purposes at those two exposure areas at this time.

The combined fish diet-based sediment PRGs for Allendale Pond were based on individual fish species PRGs for the two fish species that were collected at that area: American eel; and white sucker only. More specifically, it was assumed that those two species each comprised 50% of the combined fish diet, and the combined fish diet sediment PRG was calculated as the geometric

mean (and also separately as the arithmetic mean) of the sediment PRGs for the two species. At Assapumpset Pond and Greystone Mill Pond, the combined fish diet-based sediment PRGs are the average of the PRGs for all three representative fish species. The potential impact on the combined diet-based sediment PRG for Allendale Pond of having only two species available at Allendale Pond has been evaluated.

A hypothetical scenario was evaluated in which it is assumed that all three representative species are present at Allendale Pond and that all three species should be represented in the calculation of the combined fish diet-based PRGs. It was assumed that largemouth bass were present at Allendale Pond and that the largemouth bass fish diet sediment PRG for Allendale Pond could be represented by the average of the corresponding largemouth bass PRGs for Assapumpset Pond, Greystone Mill Pond and Manton Pond (the areas where largemouth bass were collected and analyzed). Table 4-1, which is analogous to Table 3-9, presents the derivation of the combined fish diet PRGs (based on cancer risk) for Allendale Pond using this alternative averaging approach. Tables 4-2, 4-3, and 4-4, which are analogous to Tables 3-10, 3-11, and 3-12, present the derivation of the combined fish diet PRGs for the child, older child and adult Resident Living Along the River (based on noncancer risk) for Allendale Pond, also using the alternative averaging approach. A comparison of the combined fish diet PRGs for the COCs in Tables 4-1 through 4-4 to those presented in Tables 3-9 through 3-12 indicates that the unavailability of largemouth bass tissue data at Allendale Pond does have some impact on the value of the combined fish diet-based sediment PRGs at Allendale Pond.

Using the alternative approach, the sediment PRGs for Allendale Pond are approximately two to four times higher for dioxin TEQ and Aroclor-1254 respectively. For dioxin TEQ, the sediment PRG at 10^{-4} cancer risk was 0.000043 mg/kg and the alternative approach identified a corresponding PRG of 0.00009 mg/kg. For Aroclor-1254, the sediment PRG at HI=1 (for the age group with the lowest PRG (child)) was 0.028 mg/kg and the alternative approach identified a corresponding PRG of 0.090 mg/kg. For Aroclor-1254, the sediment PRG at 10^{-4} cancer risk was 0.22 mg/kg and the alternative approach identified a corresponding PRG of 0.73 mg/kg. These differences indicate that the absence of largemouth bass data for Allendale Pond and the relatively high (compared to other species) BSAFs for white sucker at Allendale Pond for Aroclor-1254 and dioxin TEQ contribute to potentially "biased low" combined fish diet sediment PRGs for Allendale Pond.

5.0 COMPARISON OF PRGs TO BACKGROUND CONDITIONS

Consistent with the results of the BHHRA, some of the calculated sediment PRGs for the COCs are lower than the representative sediment concentrations at the upstream background area, Greystone Mill Pond. Table 5-1 provides a comparison of COC sediment PRGs (based on combined fish diet for the Resident Living Along the River and the Visiting Recreational Angler) to the corresponding sediment concentrations at the background area Greystone Mill Pond. In Table 5-1, for a given COC, the geometric mean of the PRGs for all six exposure areas (including Assapumpset Pond and Greystone Mill Pond) is used as the "representative" PRG (separately for cancer risk at 10^{-6}, 10^{-5}, and 10^{-4} as well as a noncancer Hazard Quotient of one). As shown in Table 5-1, for all of the COCs, the PRG based on cancer risk of 10^{-6} is lower than the maximum sediment concentration detected in the upstream background area Greystone Mill Pond. For only 2,3,7,8-TCDD equivalents and dioxin-like (or coplanar) PCB (equivalents), the sediment PRG based on cancer risk of 10^{-4} is below the maximum sediment concentration reported for the upstream background area. However, the 2,3,7,8-TCDD equivalents sediment PRG based on 10^{-4} cancer risk is slightly higher than the average concentration of 2,3,7,8-TCDD equivalents in sediment at the upstream background area.

Considering the sediment PRG based on noncancer Hazard Quotient of one, only Aroclor-1254 and Aroclor-1268 have PRGs that are below the corresponding maximum reported concentrations in the upstream background area. The Hazard Quotient-based sediment PRG for Aroclor-1254 is actually lower than the average sediment Aroclor-1254 concentration at the upstream background area. This suggests that background conditions may be a limiting factor in setting a site-specific sediment remedial goal for Aroclor-1254.

An alternative approach for comparison of the combined fish diet-based sediment PRGs to background conditions has also been employed. Because the planned Feasibility Study will focus on remedial alternatives for sediments of Allendale Pond and Lyman Mill Pond only, the sediment PRGs developed for those two exposure areas only have been summarized and have been compared to background conditions. This summary and comparison is presented in Table 5-2. Although there is some change to the geometric and arithmetic mean PRGs when only Allendale Pond and Lyman Mill Pond are considered, the relationship of the geometric mean PRGs to the background concentrations are very similar to that described above for the set of sediment PRGs that was derived for all six exposure areas, background area, and reference area.

As shown in Table 5-2, for all of the COCs, the PRG based on cancer risk of 10^{-6} is lower than the maximum sediment concentration detected in the upstream background area Greystone Mill Pond. For only 2,3,7,8-TCDD equivalents and dioxin-like (or coplanar) PCB (equivalents), the sediment PRG based on cancer risk of 10^{-4} is below the maximum sediment concentration reported for the upstream background area. However, the 2,3,7,8-TCDD equivalents sediment PRG based on 10^{-4} cancer risk is slightly higher than the average concentration of 2,3,7,8-TCDD equivalents in sediment at the upstream background area.

Considering the sediment PRG based on noncancer Hazard Quotient of one, only Aroclor-1254 and Aroclor-1268 have PRGs that are below the corresponding maximum reported concentrations in the upstream background area. The Hazard Quotient-based sediment PRG for Aroclor-1254 is actually lower than the average sediment Aroclor-1254 concentration at the upstream background

area. This suggests that background conditions may be a limiting factor in setting a site-specific sediment remedial goal for Aroclor-1254.

One additional comparison of combined fish diet-based sediment PRGs to background concentrations has been conducted. The comparison shown in Table 5-2 has been modified slightly to incorporate the alternative approach for calculating the combined fish diet PRG for Allendale Pond that was discussed in Section 4.0. The alternative approach includes sediment PRGs for Allendale Pond that are based on three fish species (largemouth bass PRG is estimated from the other exposure areas). The Allendale Pond largemouth bass sediment PRGs and the alternative combined diet sediment PRGs for Allendale Pond were previously presented in Tables 4-1 through 4-4. Table 5-3 includes those alternative PRGs for Allendale Pond in a comparison of PRGs for Allendale Pond and Lyman Mill Pond to the background sediment concentrations at Greystone Mill Pond. The results are very similar to those observed for the comparisons in Tables 5-1 and 5-2.

As shown in Table 5-3, for all of the COCs, the PRG based on cancer risk of 10^{-6} is lower than the maximum sediment concentration detected in the upstream background area Greystone Mill Pond. For only 2,3,7,8-TCDD equivalents and dioxin-like (or coplanar) PCB (equivalents), the sediment PRG based on cancer risk of 10^{-4} is below the maximum sediment concentration reported for the upstream background area. However, the 2,3,7,8-TCDD equivalents sediment PRG based on 10^{-4} cancer risk is slightly higher than the average concentration of 2,3,7,8-TCDD equivalents in sediment at the upstream background area.

Considering the sediment PRG based on noncancer Hazard Quotient of one, only Aroclor-1254 and Aroclor-1268 have PRGs that are below the corresponding maximum reported concentrations in the upstream background area. The Hazard Quotient-based sediment PRG for Aroclor-1254 is actually lower than the average sediment Aroclor-1254 concentration at the upstream background area. This suggests that background conditions may be a limiting factor in setting a site-specific sediment remedial goal for Aroclor-1254.

Figures 5-1 through 5-15 present graphically a comparison of human health risk-based sediment PRGs, ecological risk-based sediment PRGs (summarized from Part II of this Preliminary Remediation Goals Report), and sediment concentrations at the background area Greystone Mill Pond. These figures address all of the COCs identified for sediments by the Baseline Human Health Risk Assessment and/or the Baseline Ecological Risk Assessment. These figures all have similar content and format. Figure 5-1 is typical of the information provided in these PRG summary and comparison figures. Figure 5-1 presents the minimum, maximum, and mean sediment concentrations of 2,3,7,8-TCDD at the upstream background area Greystone Mill Pond. Concentrations range from 0.43 ng/kg to 86.6 ng/kg with a mean of 14.7 ng/kg. Figure 5-1 also summarizes the combined diet –based sediment PRGs and the direct contact-based sediment PRGs. PRGs based on cancer risk levels of 10^{-4}, 10^{-5}, and 10^{-6} and based on a Hazard Index of 1 (if noncancer risk-based PRGs are calculated) are presented for the combined fish diet (the PRGs for the Resident Living Along the River and for the Visiting Recreational Angler are identical). For each exposure pathway, health endpoint, and risk level; the minimum, maximum, and mean PRGs calculated for Allendale Pond and Lyman Mill Pond are presented in the figure. As shown in Figure 5-1, the combined fish diet-based sediment PRGs for all three cancer risk levels are below the maximum detected 2,3,7,8-TCDD sediment concentration at the upstream background area Greystone Mill Pond. A single direct contact-based sediment PRG value is presented for

6.0 COMPARISON OF SITE CONCENTRATIONS TO PRGs

In order to provide a general sense of the distribution of COC sediment concentrations relative to the calculated sediment PRGs (combined fish diet-based), seven figures have been prepared. In these figures, the geometric mean sediment PRG (combined fish diet-based) across the six areas for each of the three target risk levels and for a target Hazard Quotient of one have been identified as the points of comparison for all of the exposure areas. These geometric mean PRGs are the same values that were previously compared to background sediment concentrations as shown in Table 5-1. In other words, these figures do not compare sediment concentrations to exposure area-specific sediment PRGs, but rather to a mean PRG value.

As expected, sediment concentrations of 2,3,7,8-TCDD equivalents and Aroclor-1254 that exceed PRGs are more widespread than concentrations exceeding PRGs of the other COCs. Also, sediment concentrations that exceed PRGs that are based on a target cancer risk of 10^{-4} (high end of the Superfund risk range) are limited primarily to concentrations of 2,3,7,8-TCDD equivalents (Allendale Pond, Lyman Mill Pond, and to a lesser degree in Manton Pond), Aroclor-1254 (Allendale Pond and to a somewhat lesser extent in Lyman Mill Pond), and to a limited extent, dioxin-like PCBs (Greystone Mill Pond and Lyman Mill Pond based on limited data) as shown in Figures 6-1, 6-2, and 6-3 respectively. As shown in Figure 6-2, sediment concentrations that exceed PRGs that are based on a noncancer target Hazard Quotient of one are basically limited to Aroclor-1254. As shown in Figures 6-4 through 6-8, sediment concentrations of Aroclor-1268, Technical Chlordane, dieldrin, 4,4'-DDE, and benzo(a)pyrene in site-related exposure areas sporadically exceed the more conservative PRGs (set at cancer risk of 10^{-6} or 10^{-5}) but generally do not exceed the PRG set at the upper end of the Superfund cancer risk range (10^{-4}). As shown in Figure 6-7, sediment concentrations of 4,4'-DDE in the Site-related exposure areas are almost all below even the most conservative PRGs. The information provided in Figures 6-1 through 6-8 suggests that 2,3,7,8-TCDD equivalent concentrations and Aroclor-1254 concentrations in sediment will likely be most important in identifying areas of sediment that should be the focus of the Feasibility Study from a human health perspective.

7.0 REFERENCES

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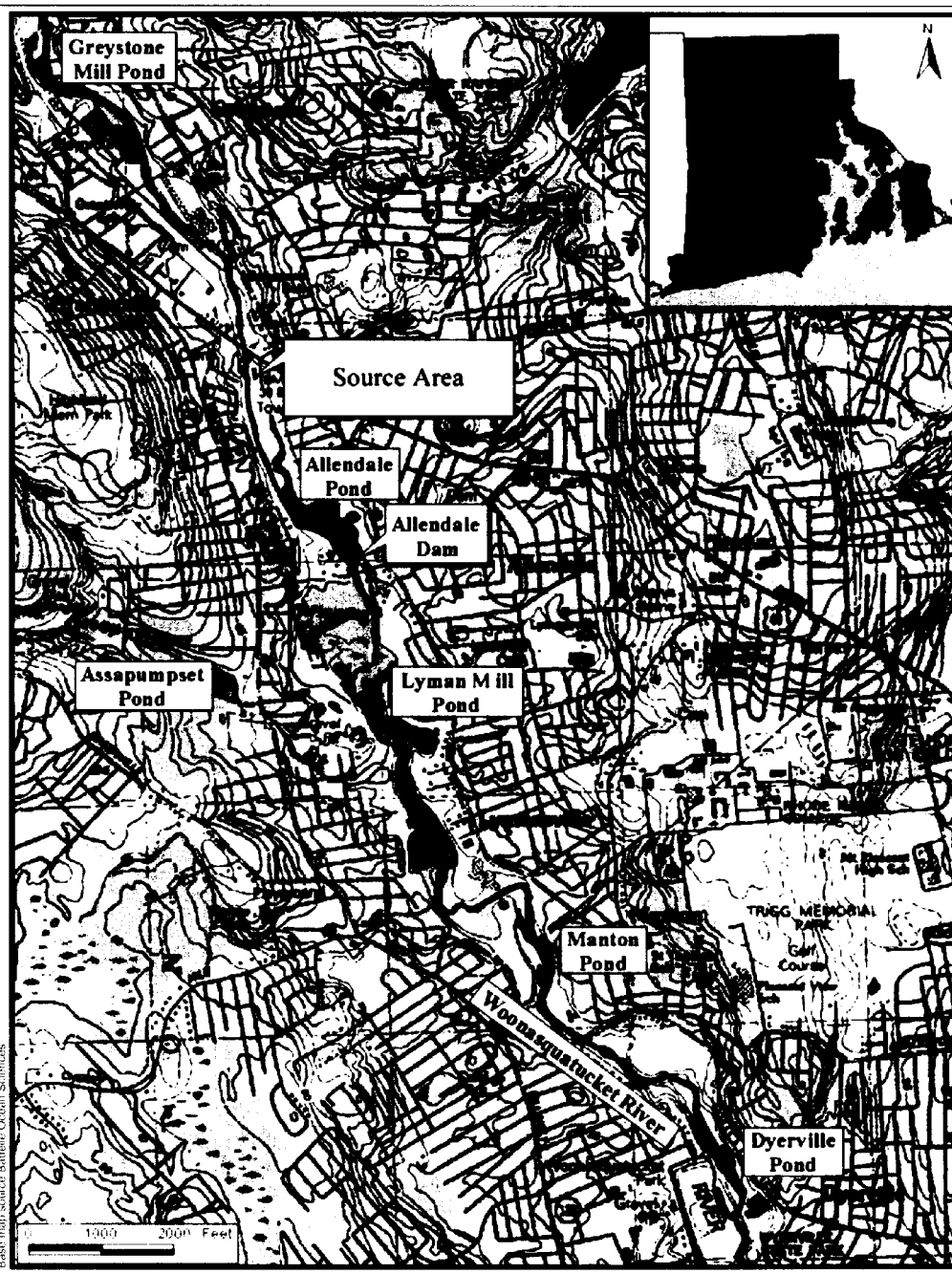
FIGURES



Base map source Battelle Ocean Sciences

MACTEC

MACTEC Engineering and Consulting, Inc.
107 Audubon Road, Suite 301 - Wakefield, Massachusetts

Site Locus Map
Preliminary Remediation Goals Report

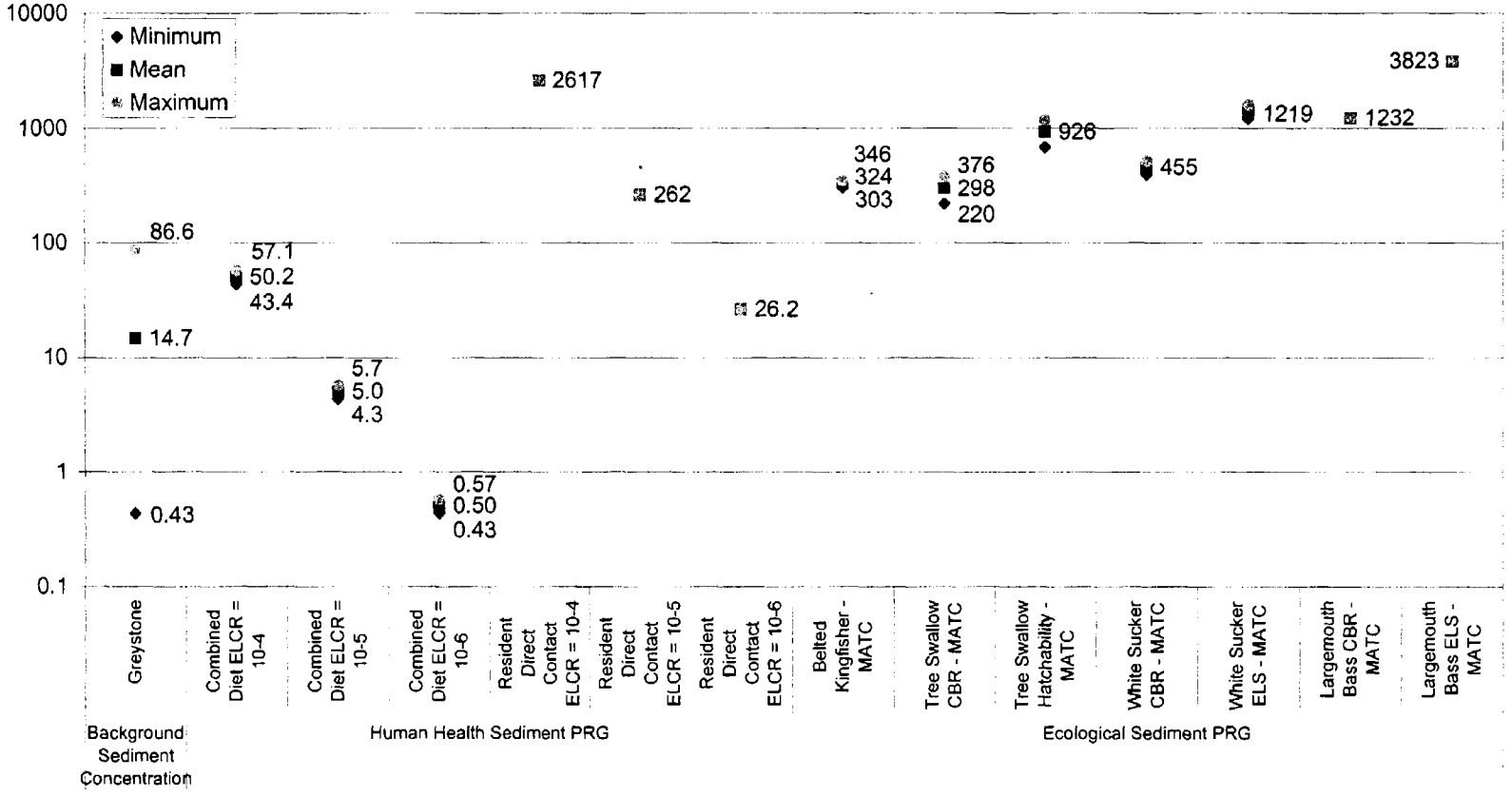
Centredale Manor Restoration Project Superfund
North Providence, Rhode Island

FIGURE
1-1

DRAWN	JOB NUMBER	FILE NUMBER	DATE	REVISED DATE
BGF	51226-26	W2004027c	5/04	07/28/05

Fi(5-1
Summary of Sedime... RGs for 2,3,7,8-TCDD
Allendale and Lyman Mill (ng/kg or parts per trillion)

Preliminary Remediation Goals Report
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



ELCR - Excess Lifetime Cancer Risk
MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue
ELS - Early Lifestage Testing

Although the PRGs are based on mammalian, fish, and bird Toxicity Equivalence Factors (TEFs), they are comparable because the predominant contributor is 2,3,7,8-TCDD which has a TEF of 1 for mammals, fish, and birds.

10/24/2005
Prepared by: KJC
Checked by: MJM

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PRG Graphs-APB-LPX rev. TCDD

Fig 5-2

Summary of Sediment PRGs for Aroclor 1254
Allendale and Lyman Mill (mg/kg or parts per million)

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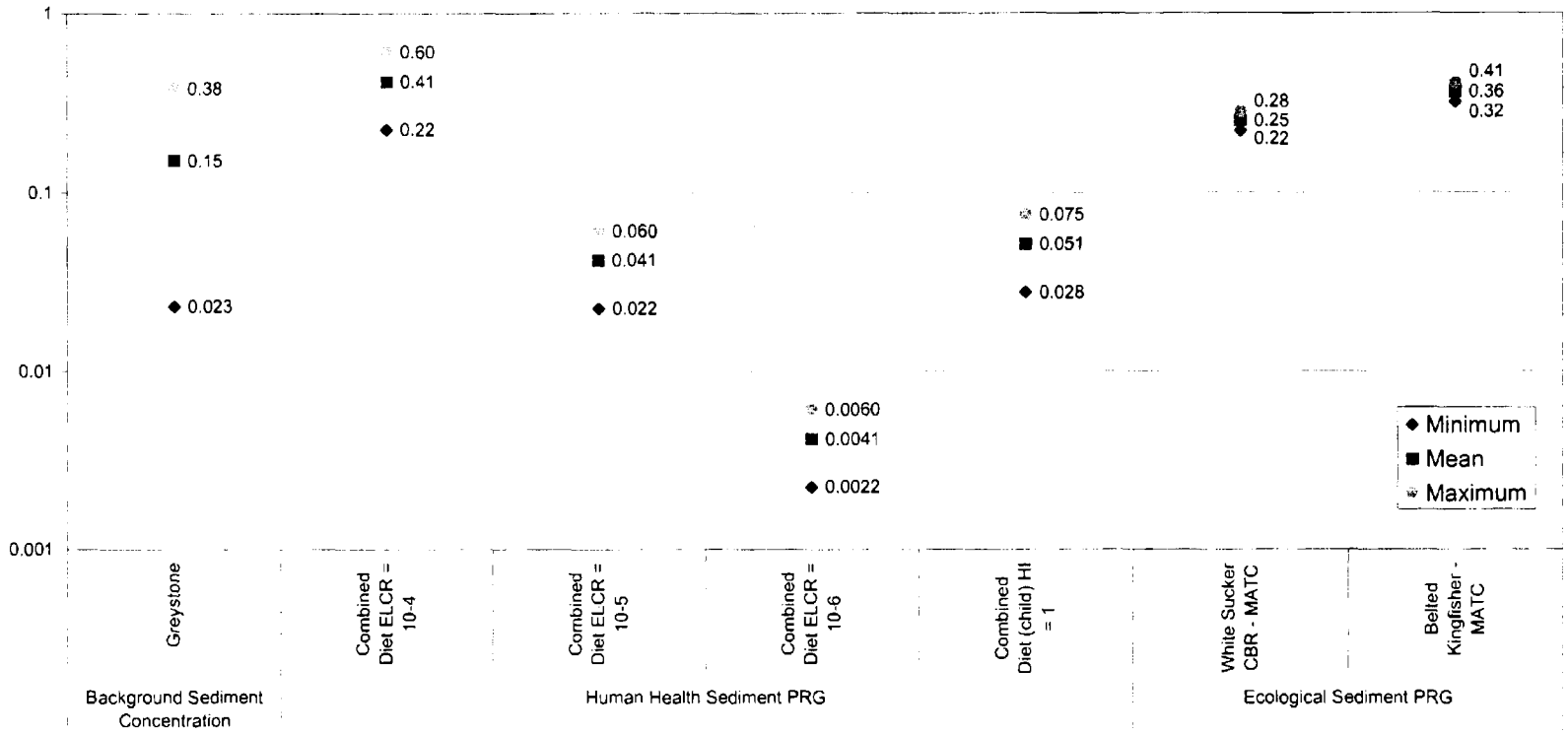
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



ELCR - Excess Lifetime Cancer Risk
HI - Hazard Index
MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue

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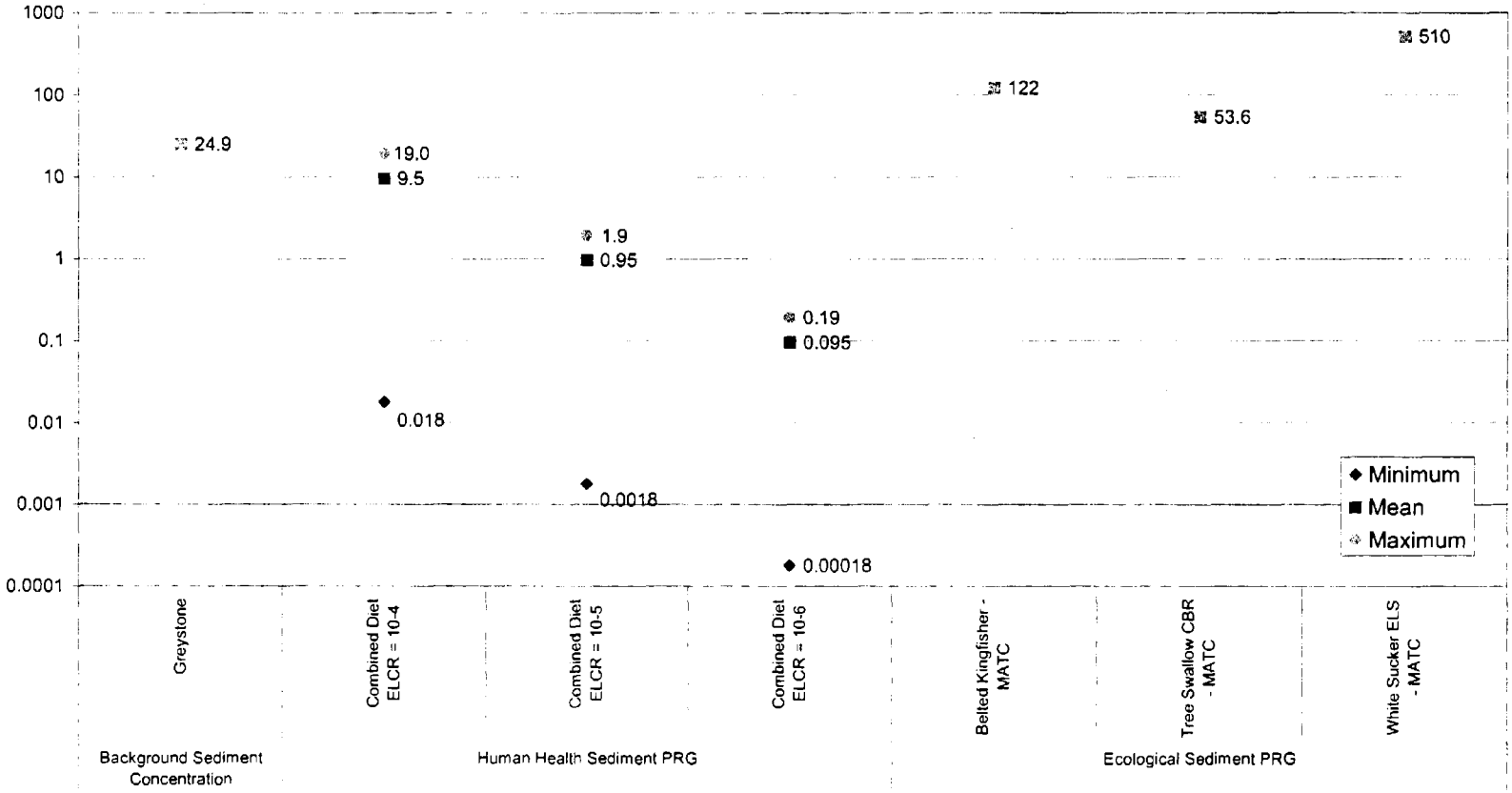
PRG Graphs-APB-LPX rev.xls, Aroclor 1254

10/22/2005
Prepared by: KJC
Checked by: MJM

Fi(5-3
Summary of Sediment PR.. for Coplanar PCBs (TEQ)
Allendale and Lyman Mill (ng/kg or parts per trillion)

Preliminary Remediation Goals Report
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



ELCR - Excess Lifetime Cancer Risk
MATC - Maximum Allowable Toxicant Concentration
ELS - Early Lifestage Testing

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PRG Graphs-APB-LPX rev.xls, PCBC

10/22/2005
Prepared by: KJC
Checked by: MJM

Fig( )-4
Summary of Sediment PRGs for Aroclor 1268
Allendale and Lyman Mill (mg/kg or parts per million)

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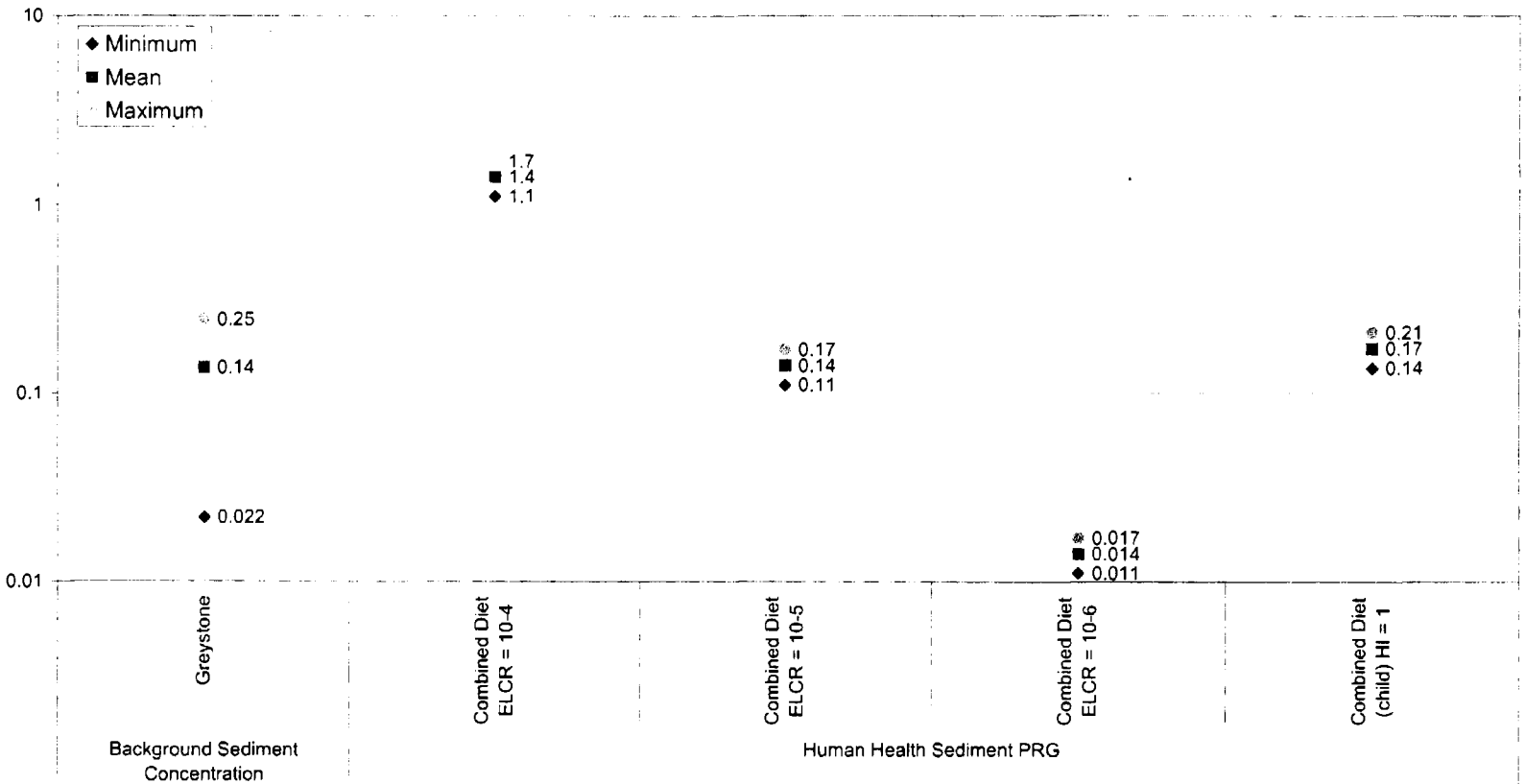
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



ELCR - Excess Lifetime Cancer Risk
HI - Hazard Index

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PRG Graphs-APB-LPX rev.xls, Aroclor 1268

10/22/2005
Prepared by: KJC
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Fig(5-5
Summary of Sediment PRGs for Technical Chlordane
Allendale and Lyman Mill (mg/kg or parts per million)

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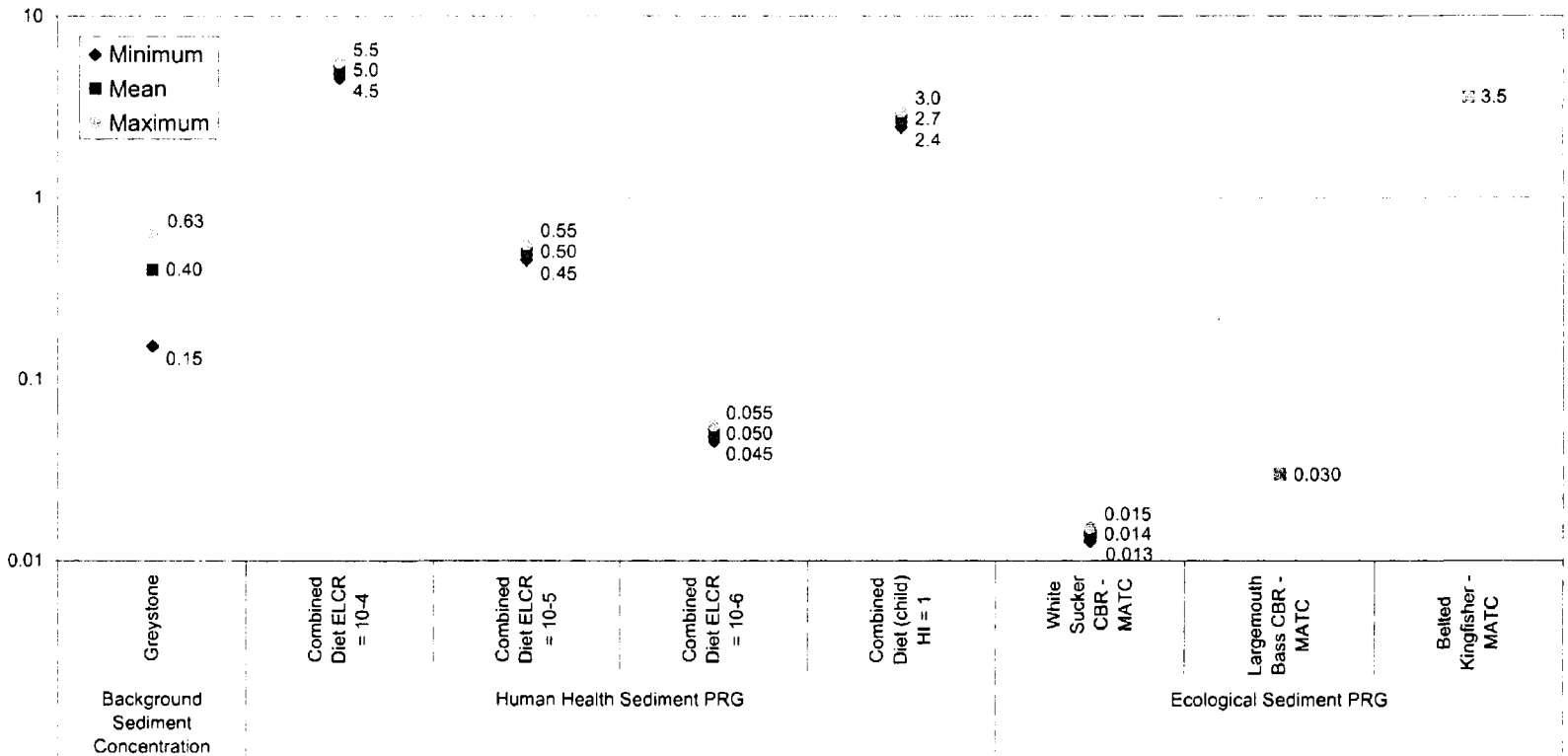
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



ELCR - Excess Lifetime Cancer Risk
HI - Hazard Index
MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue

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PRG Graphs-APB-LPX rev xls, Technical Chlordane

10/22/2005
Prepared by: KJC
Checked by: MJM

Figure 5-6
Summary of Sediment PRGs for Dieldrin
Allendale and Lyman Mill (mg/kg or parts per million)

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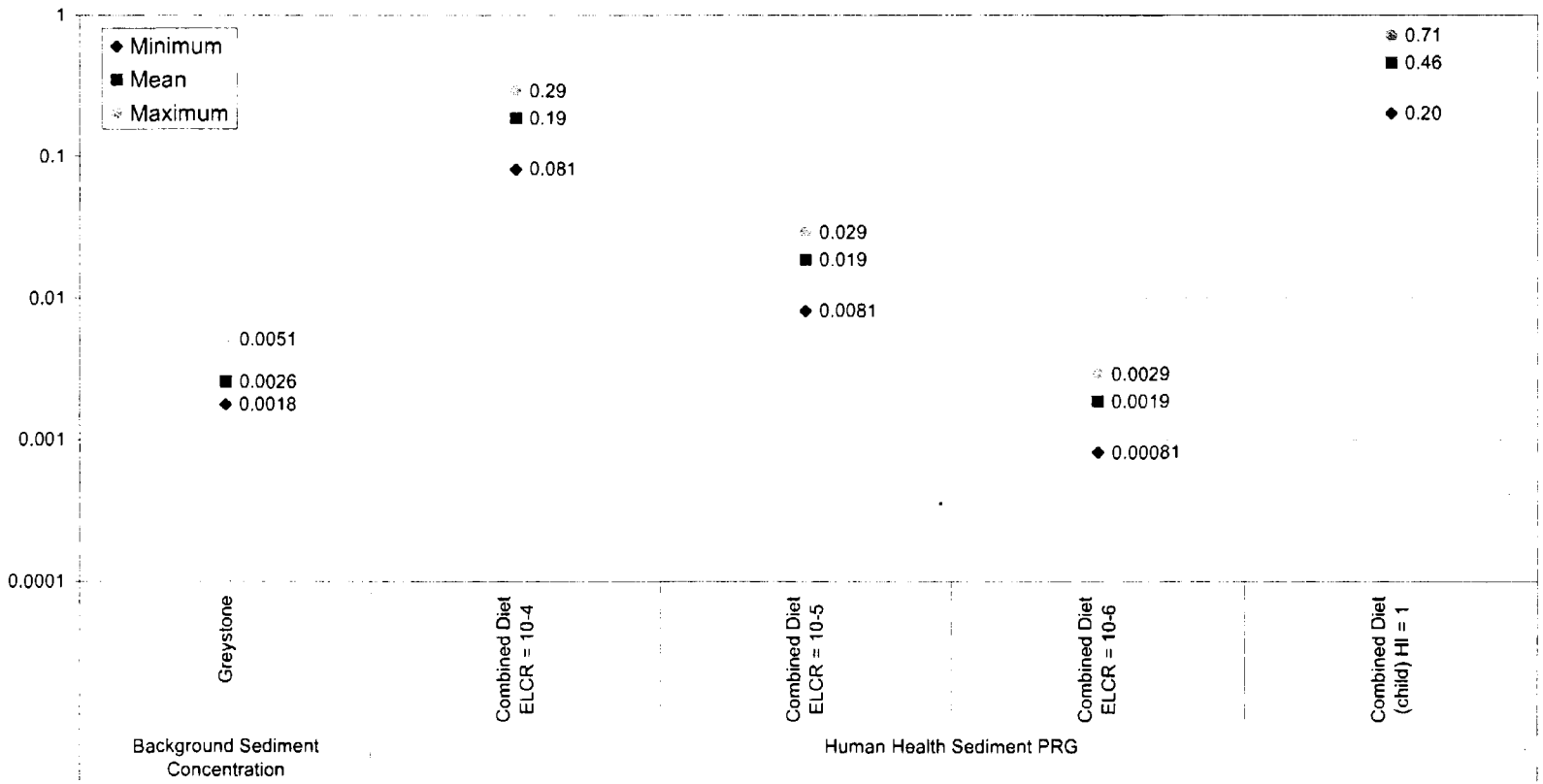
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



ELCR - Excess Lifetime Cancer Risk
HI - Hazard Index

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PRG Graphs-APB-LPX rev.xls, Dieldrin

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Checked by: MJM

Fig 5-7

Summary of Sediment PRGs for Benzo(a)pyrene
Allendale and Lyman Mill (mg/kg or parts per million)

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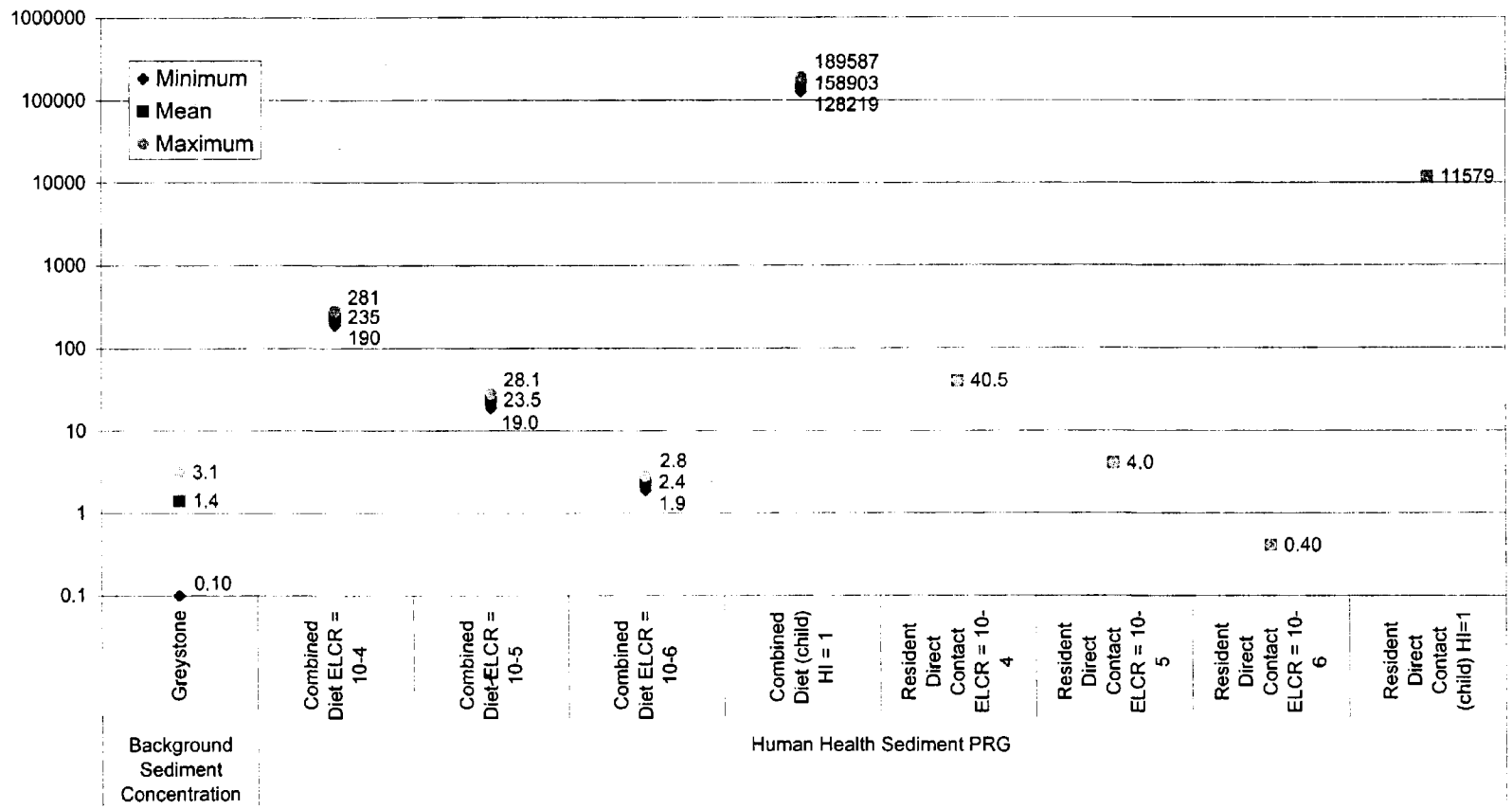
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



ELCR - Excess Lifetime Cancer Risk
HI - Hazard Index

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PRG Graphs-APB-LPX rev. BAP

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Figure 5-8
Summary of Sediment PRGs for 4,4'-DDE
Allendale and Lyman Mill (mg/kg or parts per million)

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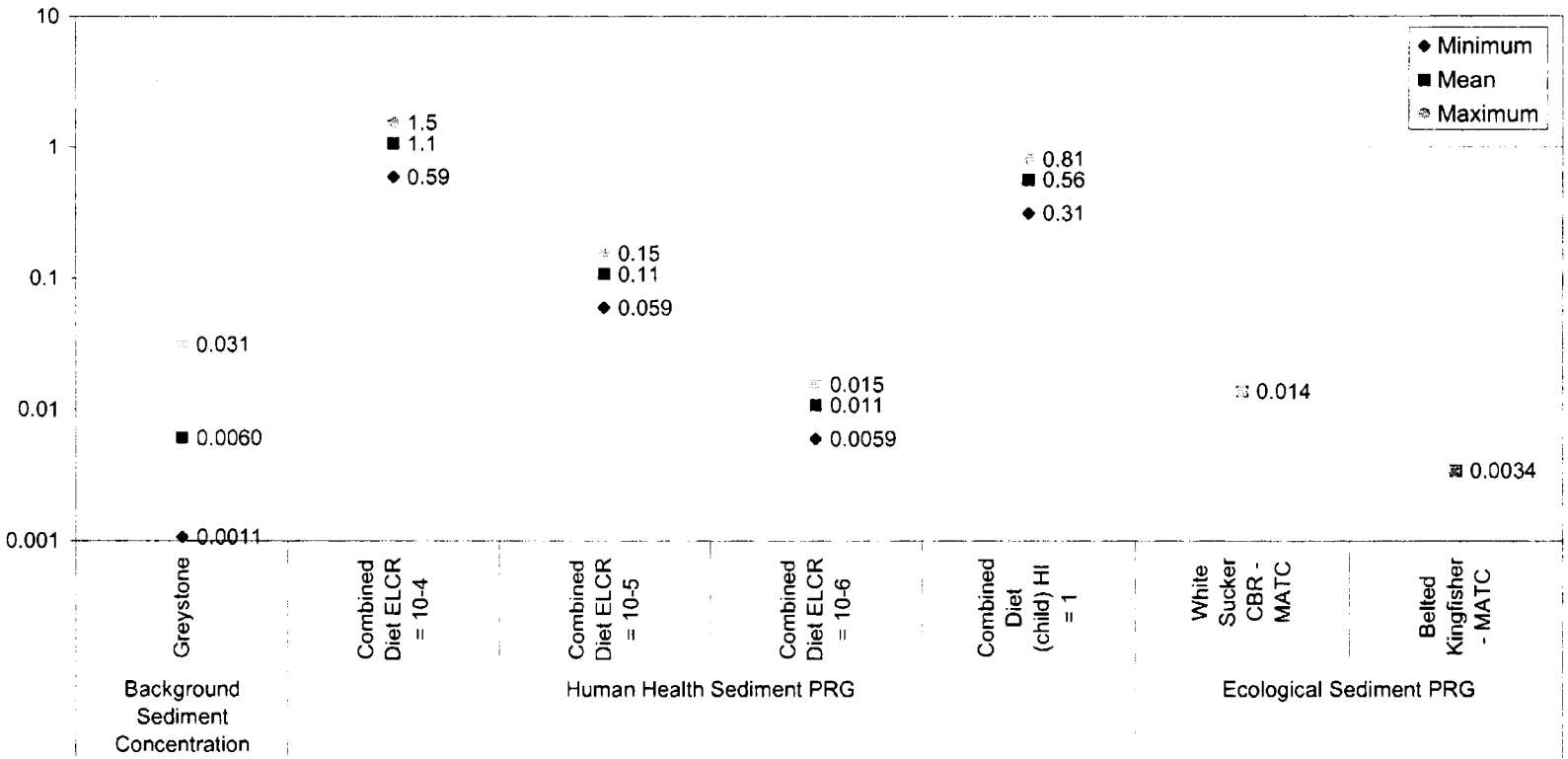
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



ELCR - Excess Lifetime Cancer Risk
HI - Hazard Index
MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue

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PRG Graphs-APB-LPX rev.xls, DDE

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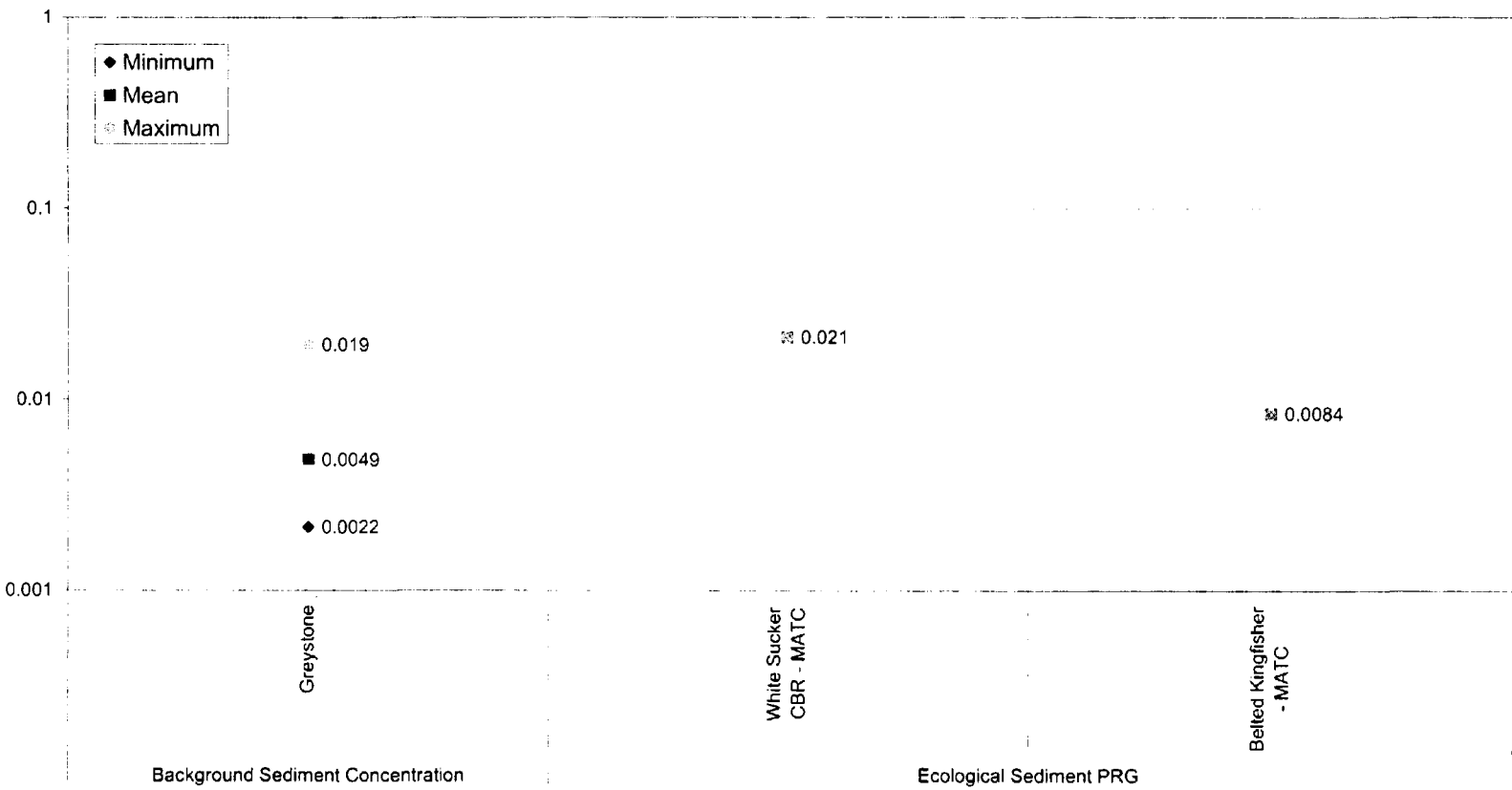
Fig 5-9
Summary of Sediment PRGs for 4,4'-DDD
Allendale and Lyman Mill (mg/kg or parts per million)

Preliminary Remediation Goals Report
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue

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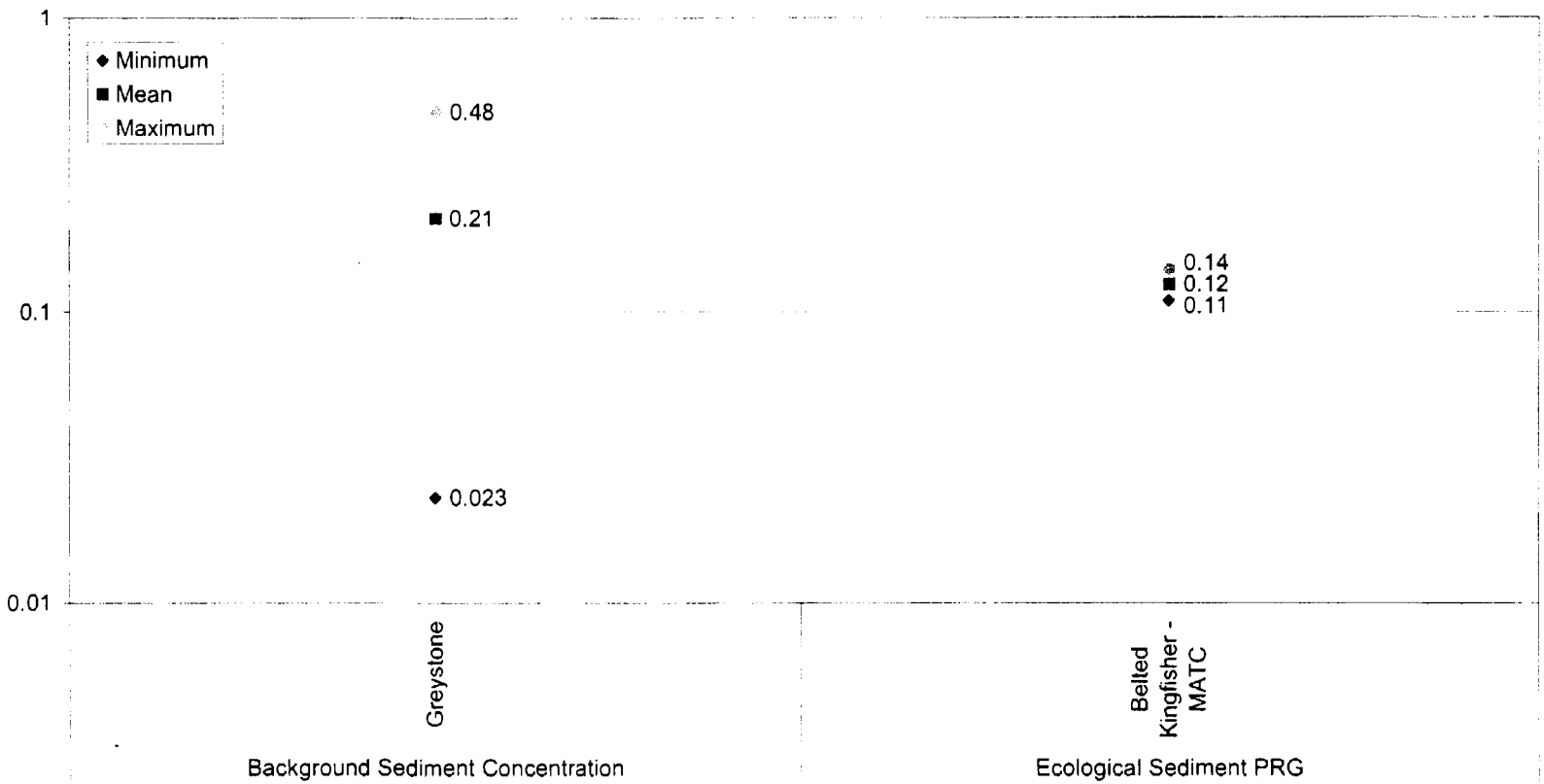
Checked by: MJM

Figure 5-10
Summary of Sediment PRGs for Aroclor, Total
Allendale and Lyman Mill (mg/kg or parts per million)

Preliminary Remediation Goals Report
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue

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PRG Graphs-APB-LPX rev.xls, Aroclor, Total

10/22/2005
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Checked by: MJM

Figure 7-11
Summary of Sediment PRGs for Aluminum
Allendale and Lyman Mill (mg/kg or parts per million)

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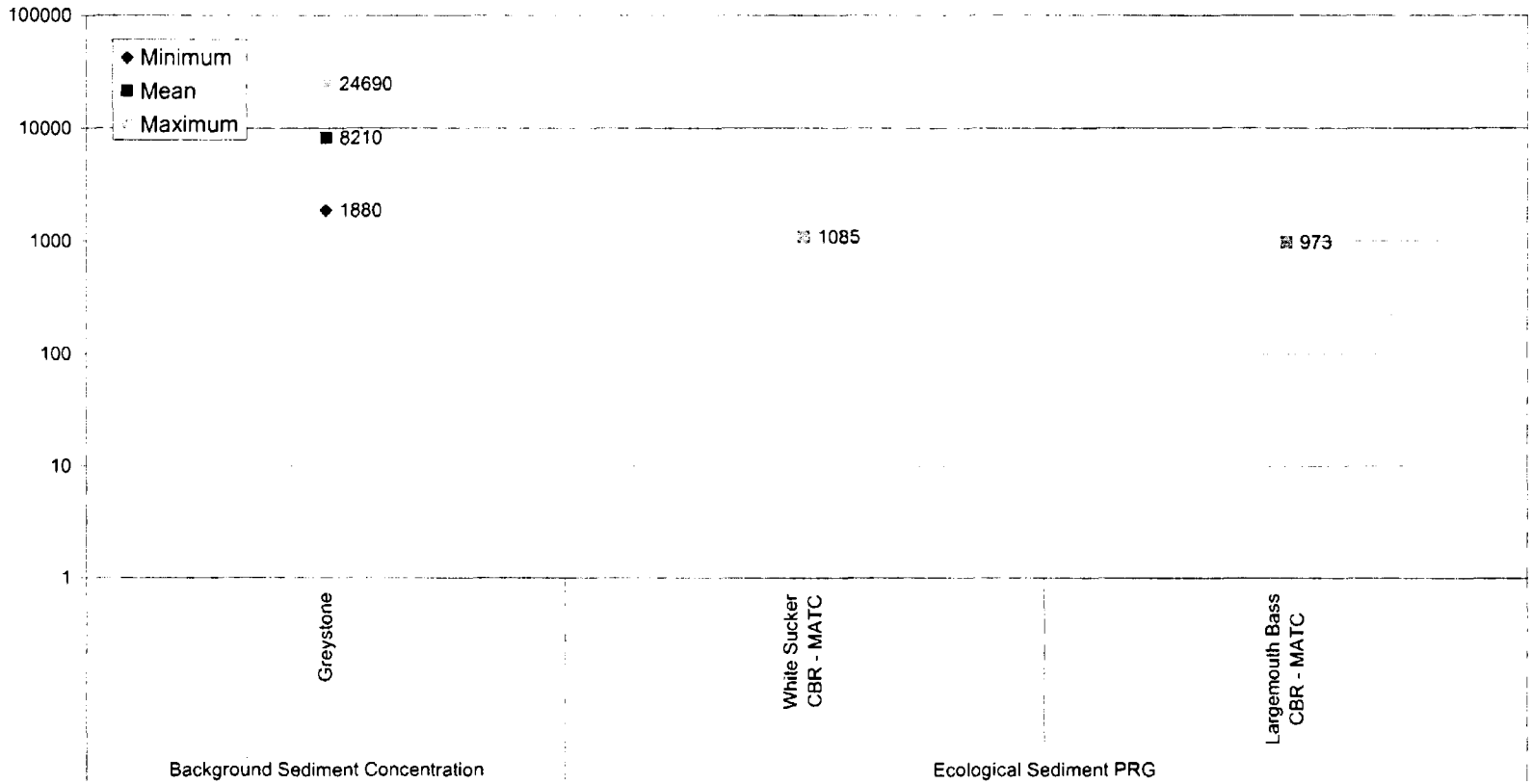
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue

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PRG Graphs-APB-LPX rev.xls, Aluminum

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Figure 12

Summary of Sediment PRGs for Barium
Allendale and Lyman Mill (mg/kg or parts per million)

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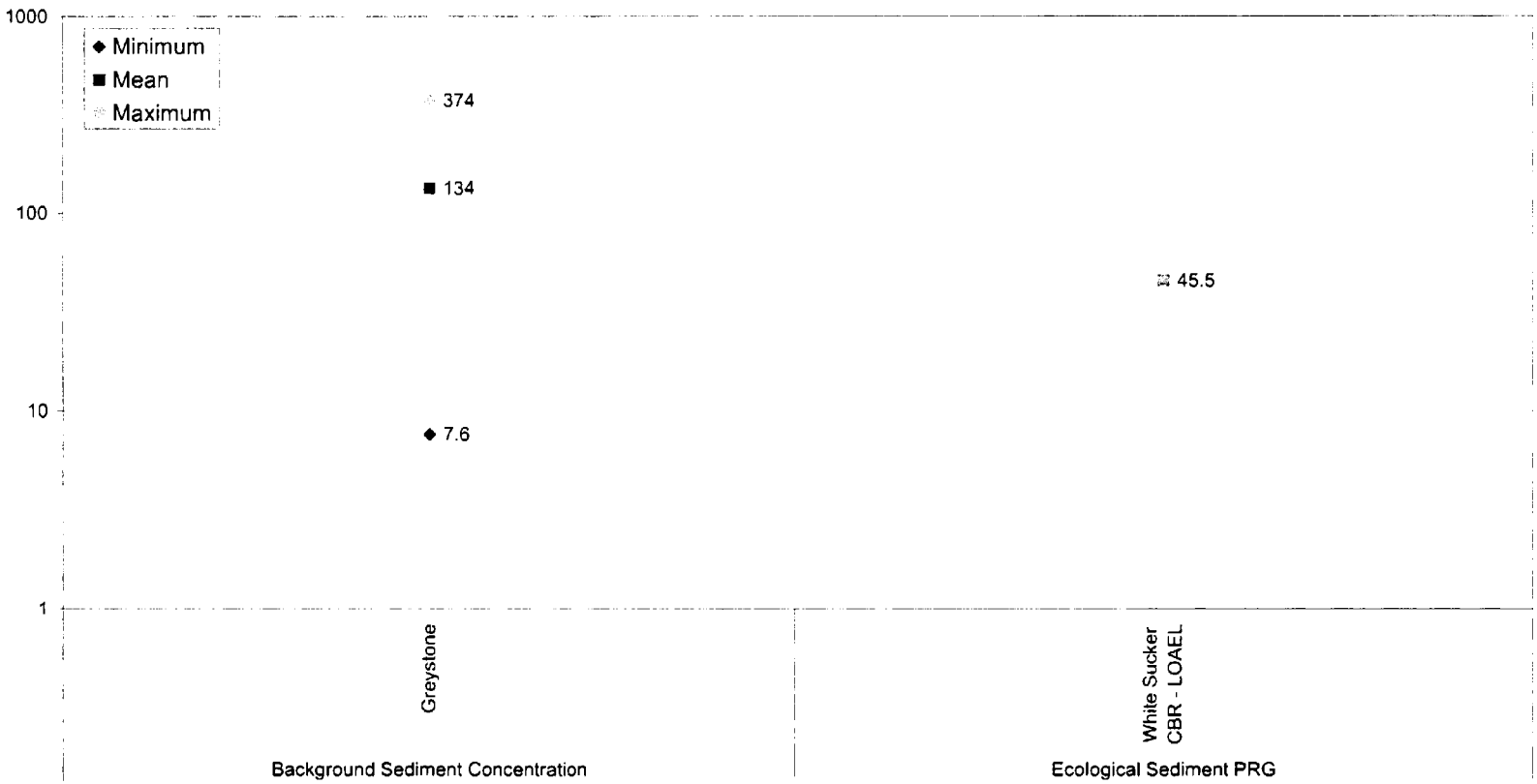
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



LOAEL - Lowest Observed Adverse Effect Level
CBR - Critical Body Residue

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PRG Graphs-APB-LPX rev.xls, Barium

10/22/2005
Prepared by: KJC
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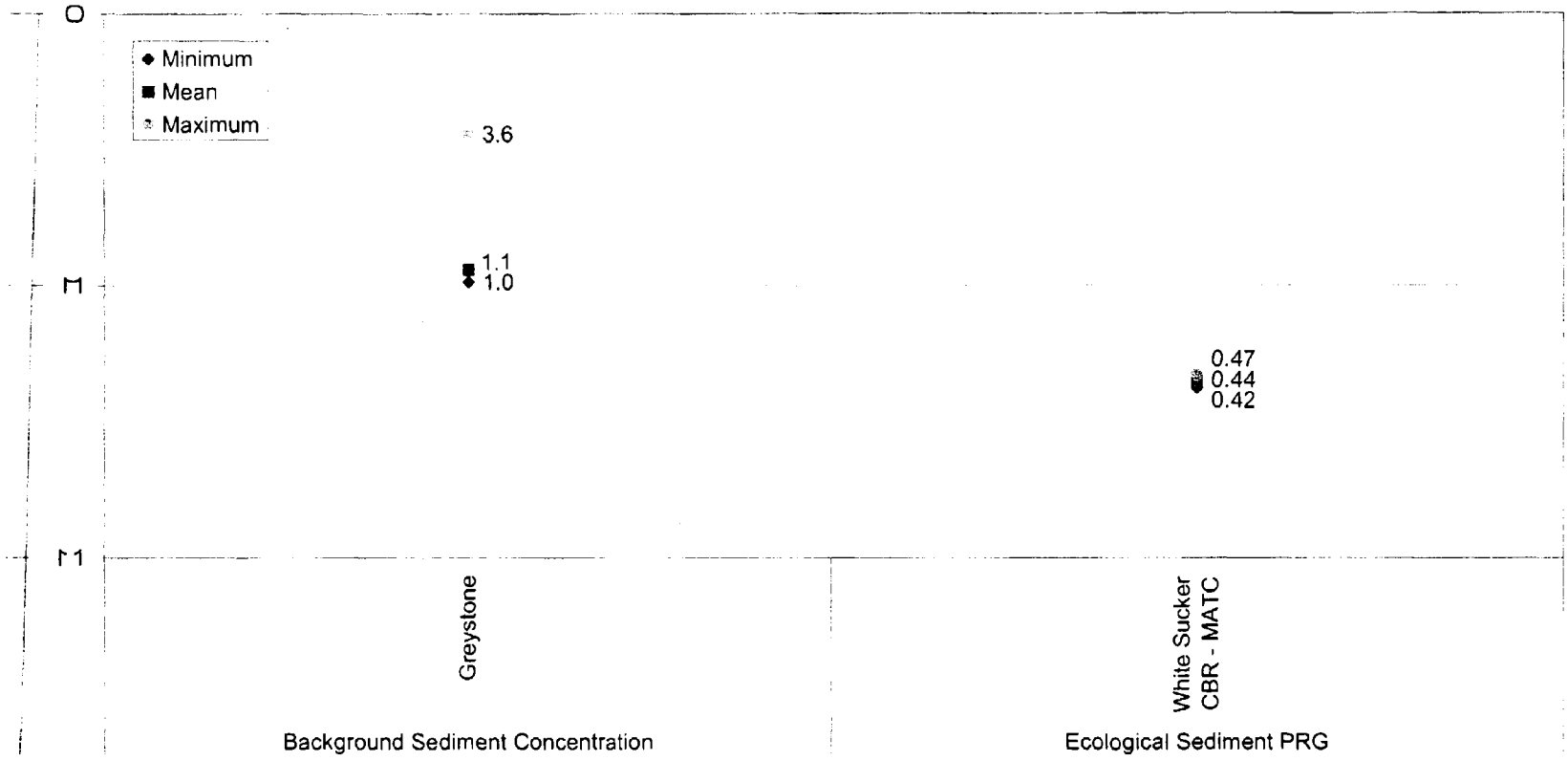
Figu .-13
Summary of Sediment PRGs for Selenium
Allendale and Lyman Mill (mg/kg or parts per million)

Preliminary Remediation Goals Report
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue

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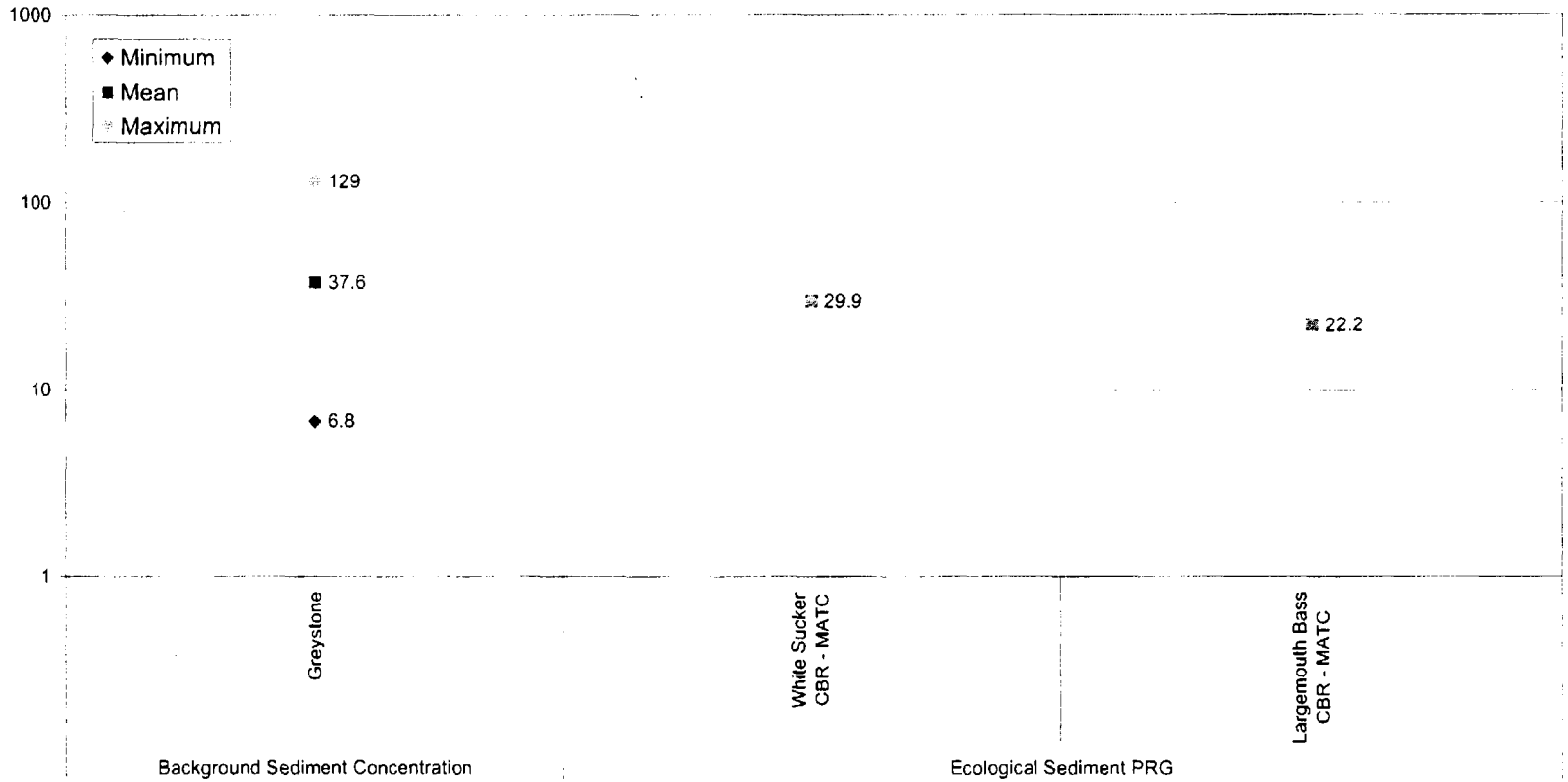
PRG Graphs-APB-LPX rev.xls, Selenium

10/22/2005
Prepared by: KJC
Checked by: MJM

Figu(14
Summary of Sediment PRGs for Vanadium
Allendale and Lyman Mill (mg/kg or parts per million)

Preliminary Remediation Goals Report
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue

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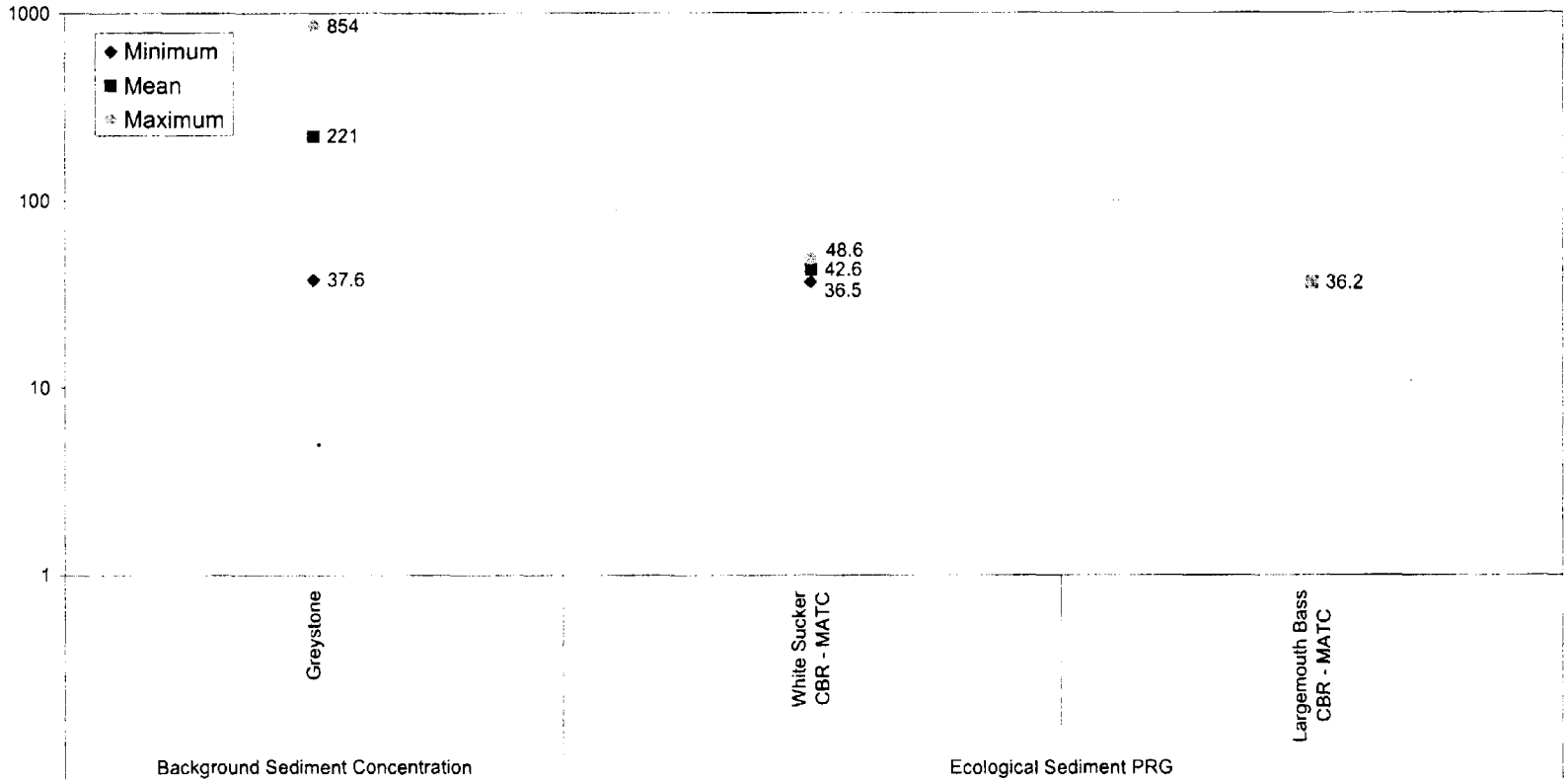
PRG Graphs-APB-LPX rev.xls, Vanadium

10/22/2005
Prepared by: KJC
Checked by: MJM

Figure 15
Summary of Sediment PRGs for Zinc
Allendale and Lyman Mill (mg/kg or parts per million)

Preliminary Remediation Goals Report
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island



MATC - Maximum Allowable Toxicant Concentration
CBR - Critical Body Residue

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PRG Graphs-APB-LPX rev.xls, Zinc

10/22/2005
Prepared by: KJC
Checked by: MJM

LEGEND

Range of Detected Concentrations: 4.22E-7 to 0.073 mg/Kg

- Concentrations less than PRG for ELCR = 10-6 (0.0000048)
- Concentrations greater than PRG for ELCR = 10-6 (0.0000048)
- Concentrations greater than PRG for ELCR = 10-4 (0.000048)
- Concentrations greater than PRG for ELCR = 10-5 (0.0000048)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-1
Summary of 2,3,7,8-TCDD Toxicity Equivalent (Mammal) Concentrations in Sediment Relative to Fish Consumption-Based Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/TASK27-HHPRGs/HH PRGs JULY 2005/SURFER/TEQ-M PRG.SRF

LEGEND

Range of Detected Concentrations: 0.011 to 27 mg/Kg

- Concentrations less than PRG for ELCR = 10-6 (0.0046)
- Concentrations greater than PRG for ELCR = 10-6 (0.0046)
- Concentrations greater than PRG for ELCR = 10-5 (0.046)
- Concentrations greater than PRG for ELCR = 10-4 (0.46)
- Concentrations greater than PRG for HQ = 1 (0.056)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-2
Summary of Aroclor-1254 Concentrations in Sediment
Relative to Fish Consumption-Based Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/TASK27-HHPRGs/HH PRGs JULY 2005/SURFER/1254 PRG.SRF

LEGEND

Range of Detected Concentrations: 2.53 E-8 to 6.49 E-5 mg/Kg

- Concentrations less than PRG for ELCR = 10-6 (0.0000000043)
- Concentrations greater than PRG for ELCR = 10-6 (0.0000000043)
- Concentrations greater than PRG for ELCR = 10-5 (0.000000043)
- Concentrations greater than PRG for ELCR = 10-4 (0.00000043)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

Figure 6-3
Summary of Coplanar PCB TEQ Concentrations in Sediment
Relative to Fish Consumption-Based Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island
Baseline Human Health Risk Assessment

MACTEC

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/TASK27-HHPRGs/HH PRGs JULY 2005/SURFER/PCBTEQ PRG.SRF

LEGEND

Range of Detected Concentrations: 0.00455 to 0.31379 mg/Kg

- Concentrations less than PRG for ELCR = 10-6 (0.012)
- Concentrations greater than PRG for ELCR = 10-6 (0.012)
- Concentrations greater than PRG for ELCR = 10-5 (0.12)
- Concentrations greater than PRG for ELCR = 10-4 (1.2)
- Concentrations greater than PRG for HQ = 1 (0.14)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-4
Summary of Aroclor-1268 Concentrations in Sediment Relative to Fish Consumption-Based Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/TASK27-HHPRGs/HH PRGs JULY 2005/SURFER/1268 PRG.SRF

MACTEC

Figure 6-5
Summary of Technical Chlordane Concentrations in Sediment Relative to Fish Consumption-Based Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/TASK27-HHPRGs/HH PRGs JULY 2005/SURFER/TechnicalChlordane PRG.SRF

LEGEND

Range of Detected Concentrations: 0.00062 to 0.11297 mg/Kg

- Concentrations less than PRG for ELCR = 10-6 (0.0016)
- Concentrations greater than PRG for ELCR = 10-6 (0.0016)
- Concentrations greater than PRG for ELCR = 10-5 (0.016)
- Concentrations greater than PRG for ELCR = 10-4 (0.16)
- Concentrations greater than PRG for HQ = 1 (0.40)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

Figure 6-6
Summary of Dieldrin Concentrations in Sediment Relative to Fish Consumption-Based Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

MACTEC

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/TASK27-HHPRGs/HH PRGs JULY 2005/SURFER/Dieldrin PRG.SRF

MACTEC

Figure 6-7
Summary of 4,4-DDE Concentrations in Sediment Relative to Fish Consumption-Based Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/TASK27-HHPRGs/HH PRGs JULY 2005/SURFER/DDE PRG.SRF

LEGEND

Range of Detected Concentrations: 0.032 to 9.2 mg/Kg

- Concentrations less than PRG for ELCR = 10-6 (1.4)
- Concentrations greater than PRG for ELCR = 10-6 (1.4)
- Concentrations greater than PRG for ELCR = 10-5 (14)
- Concentrations greater than PRG for ELCR = 10-4 (140)
- Concentrations greater than PRG for HQ = 1 (94,756)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-8
Summary of Benzo(a)pyrene Concentrations in Sediment Relative to Fish Consumption-Based Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/TASK27-HHPRGs/HH PRGs JULY 2005/SURFER/BAP PRG.SRF

TABLES

Summary of Non-Cancer Risks

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Non-Carcinogenic Risk			Combined Fish Diet		Sediment		Surface Water		Bank Soil		Hazard Index		Incremental Hazard Index	
			CT	RME	CT	RME	CT	RME	CT	RME	CT	RME	CT	RME
Resident Living Along River														
Current & Future	Assapumpset													
		Child	0.5	2	0.02	0.2	0.003	0.009	NA	NA	0.5	2	--	--
		Older Child	0.3	1	0.002	0.02	0.003	0.009	NA	NA	0.3	1	--	--
		Adult	0.3	1	0.001	0.01	0.003	0.007	NA	NA	0.3	1	--	--
	Greystone													
		Child	3	5	0.07	0.5	0.003	0.008	0.2	1	4	7	--	--
		Older Child	2	4	0.006	0.07	0.003	0.008	0.03	0.2	2	4	--	--
		Adult	2	3	0.003	0.04	0.003	0.006	0.02	0.1	2	4	--	--
	Allendale													
		Child	19	30	0.2	0.8	0.04	0.1	NC	NC	19	31	16	24
		Older Child	13	20	0.02	0.1	0.04	0.09	NC	NC	13	20	10	16
		Adult	12	19	0.009	0.06	0.03	0.07	NC	NC	12	19	10	16
	Lyman Mill													
		Child	21	34	0.08	0.4	0.01	0.04	NA	NA	22	34	18	27
		Older Child	14	22	0.007	0.05	0.01	0.03	NA	NA	14	22	12	18
		Adult	14	21	0.004	0.03	0.01	0.02	NA	NA	14	22	11	18
	Manton													
		Child	4	5	0.005	0.03	0.01	0.04	NA	NA	4	6	0	0
		Older Child	1	4	0.0004	0.004	0.01	0.03	NA	NA	1	4	0	0
		Adult	1	3	0.0003	0.002	0.01	0.02	NA	NA	1	4	0	0
	Dyerville													
		Child	4	8	0.05	0.5	0.01	0.04	NA	NA	4	8	0.5	1
		Older Child	3	5	0.004	0.07	0.01	0.03	NA	NA	3	5	0.4	1
		Adult	3	5	0.003	0.04	0.01	0.02	NA	NA	3	5	0.4	1
Visiting Recreational Angler														
Current & Future	Assapumpset													
		Child	0.5	2	NA	NA	NA	NA	NA	NA	0.5	2	--	--
		Older Child	0.3	1	0.0004	0.004	0.0003	0.0009	NA	NA	0.3	1	--	--
		Adult	0.3	1	0.0003	0.002	0.0003	0.0008	NA	NA	0.3	1	--	--
	Greystone													
		Child	3	5	NA	NA	NA	NA	NA	NA	3	5	--	--
		Older Child	2	4	0.001	0.01	0.0003	0.0008	0.002	0.02	2	4	--	--
		Adult	2	3	0.0008	0.007	0.0003	0.0007	0.001	0.01	2	3	--	--
	Allendale													
		Child	19	30	NA	NA	NA	NA	NA	NA	19	30	16	25
		Older Child	13	20	0.004	0.03	0.004	0.009	NC	NC	13	20	10	16
		Adult	12	19	0.002	0.01	0.003	0.008	NC	NC	12	19	10	16
	Lyman Mill													
		Child	21	34	NA	NA	NA	NA	NA	NA	21	34	18	28
		Older Child	14	22	0.002	0.01	0.001	0.003	NA	NA	14	22	12	19
		Adult	14	21	0.001	0.006	0.001	0.002	NA	NA	14	22	11	18
	Manton													
		Child	2	5	NA	NA	NA	NA	NA	NA	2	5	0	0
		Older Child	1	4	0.0001	0.0007	0.001	0.003	NA	NA	1	4	0	0
		Adult	1	3	0.00008	0.0004	0.001	0.002	NA	NA	1	3	0	0
	Dyerville													
		Child	4	8	NA	NA	NA	NA	NA	NA	4	8	0.7	2
		Older Child	3	5	0.001	0.01	0.001	0.003	NA	NA	3	5	0.4	2
		Adult	3	5	0.0006	0.007	0.001	0.002	NA	NA	3	5	0.4	2
Commercial/Industrial Employee														
Current & Future	Fogarty Center [1]		NA	NA	NA	NA	NA	NA	0.01	0.07	0.01	0.07	NB	NB

[1] Surface Soil
CT = Central Tendency
RME = Reasonable Maximum Exposure
NC = Not Calculated - Only dioxin data available for bank soil. No Hazard Index calculated.
NB = No background information for surface soil. Incremental Risk not calculated.
NA = Not Applicable - Medium not assessed for this exposure area
Incremental Receptor Risk = Difference in risk between the exposure point and the background exposure point.
-- = Incremental risk is not calculated for background on reference areas.
BOLDED incremental risk are above the Superfund Noncancer Hazard Index benchmark of 1.

Prepared by: RAR
Checked by: KJA

Table 1-2
Summary of Cancer Risks

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Carcinogenic Risk		Combined Fish Diet		Sediment		Surface Water		Bank Soil		Receptor Total [2]		Incremental Receptor Risk [2]	
		CT	RME	CT	RME	CT	RME	CT	RME	CT	RME	CT	RME
Resident Living Along River (all age groups)													
Current & Future	Assapumpset	6E-06	5E-05	2E-07	6E-06	1E-08	1E-07	NA	NA	6E-06	6E-05	--	--
	Greystone	2E-05	8E-05	1E-06	2E-05	1E-08	1E-07	2E-06	4E-05	2E-05	1E-04	--	--
	Allendale	1E-03	5E-03	2E-05	2E-04	5E-07	6E-06	1E-06	2E-05	1E-03	5E-03	1E-03	5E-03
	Lyman Mill	1E-03	6E-03	6E-06	3E-04	3E-07	1E-05	NA	NA	1E-03	6E-03	1E-03	6E-03
	Manton	2E-04	5E-04	1E-06	4E-05	3E-07	1E-05	NA	NA	2E-04	5E-04	2E-04	4E-04
	Dyerville	2E-04	1E-03	7E-07	2E-05	3E-07	1E-05	NA	NA	2E-04	1E-03	1E-04	1E-03
Visiting Recreational Angler (all age groups)													
Current & Future	Assapumpset	6E-06	5E-05	1E-06	4E-07	3E-10	3E-09	NA	NA	6E-06	5E-05	--	--
	Greystone	2E-05	8E-05	5E-06	2E-06	3E-10	3E-09	6E-06	2E-06	2E-05	9E-05	--	--
	Allendale	1E-03	5E-03	8E-07	1E-05	1E-06	2E-07	3E-06	7E-07	1E-03	5E-03	9E-04	5E-03
	Lyman Mill	1E-03	8E-03	3E-07	2E-05	2E-08	3E-07	NA	NA	1E-03	6E-03	1E-03	6E-03
	Manton	2E-04	5E-04	6E-08	2E-06	2E-08	3E-07	NA	NA	2E-04	5E-04	2E-04	4E-04
	Dyerville	2E-04	1E-03	3E-08	1E-06	2E-08	3E-07	NA	NA	2E-04	1E-03	1E-04	1E-03
Commercial/Industrial Employee													
Current & Future	Fogarty Center [1]	NA	NA	NA	NA	NA	NA	8E-07	2E-05	8E-07	2E-05	NB	NB

[1] Surface Soil
[2] Receptor Total and Incremental Receptor Risk do not include surface water.
CT = Central Tendency
RME = Reasonable Maximum Exposure
NB = No background information for surface soil. Incremental Risk not calculated.
NA = Not Applicable - Medium not assessed for this exposure area
TBD = To Be Determined. The surface water dermal exposures and cancer risks are under revision.
Incremental Receptor Risk = Difference in risk between the exposure point and the background exposure point.
-- = Incremental risk is not calculated for background on reference areas.
BOLDED Incremental risk are above the high end of the Superfund Cancer risk Range (1E-04 to 1E-06).

Prepared by: KJA
Checked by: RAR

Table 1-3
Summary of Chemicals of Concern (COCs) - RME Scenario

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR	EXPOSURE MEDIUM	CHEMICALS OF CONCERN			
		Allendale	Lyman Mill	Manton	Dyerville
Resident Living Along the River	Fish consumption	dioxins and furans, Aroclor-1254, Aroclor-1268, dioxin-like PCBs, dieldrin, and technical chlordane	dioxins and furans, Aroclor-1254, Aroclor-1268, dioxin-like PCBs, dieldrin, technical chlordane, 4,4'-DDE, and benzo(a)pyrene	dioxins and furans, 4,4-DDE, Aroclor-1254, Aroclor-1268, dieldrin, technical chlordane	dioxins and furans, Aroclor-1254, dieldrin, and technical chlordane,
	Sediment	dioxins and furans, benzo(a)pyrene, dibenz(a,h)anthracene, and arsenic	dioxins and furans, benzo(a)pyrene, dibenz(a,h)anthracene, N-nitroso-di-n-propylamine, and arsenic	dioxins and furans	dioxins and furans and benzo(a)pyrene
	Surface water	None	None	None	None
	Bank soil	2,3,7,8-TCDD	None	None	None
Visiting Recreational Angler	Fish consumption	dioxins and furans, Aroclor-1254, Aroclor-1268, dioxin-like PCBs, dieldrin, and technical chlordane	dioxins and furans, Aroclor-1254, Aroclor-1268, dioxin-like PCBs, dieldrin, technical chlordane, 4,4'-DDE, and benzo(a)pyrene	dioxins and furans, 4,4-DDE, Aroclor-1254, Aroclor-1268, dieldrin, technical chlordane	dioxins and furans, Aroclor-1254, dieldrin, and technical chlordane
	Sediment	dioxins and furans	dioxins and furans	dioxins and furans	None
	Surface water	None	None	None	None
	Bank soil	None	None	None	None
Adult Worker, ty Center	Surface Soil	None	arsenic, benzo(a)pyrene	None	None

Table 3-1

Lipid-Normalized or Organic Carbon- Normalized Analytical Results Determined to be Outliers by Parameter and Media

Preliminary Remediation Goals Report – Human Health

Centredale Manor Restoration Project Superfund Site

North Providence, Rhode Island

Brown Bullhead	Assapumpset	RAB-BB-5002-0000-01-W	Benzo(a)pyrene
White Sucker	Greystone	GMP-WS-5005-0000-01-W	Dieldrin
		GMP-WS-5009-0000-01-W	Vanadium
American Eel	Greystone	GMP-AE-5008-0000-01-W	Benzo(a)pyrene
		GMP-AE-5001-0000-01-W	4,4'-DDE Aroclor 1268 Mercury (methyl)
	Allendale	APC-AE-4007-0000-01-W	Technical Chlordane
Largemouth Bass	Manton	MAP-LB-4002-0000-01-W	Aroclor 1268 Barium
Sediment	Allendale	APB-SD-4010-0000-01	Dieldrin Technical Chlordane Aroclor 1254 Aroclor, Total
		WRC-SD-2014-01	2,3,7,8-TCDD TEQs Dioxin

Table 3-2
Summary of Sediment Organic Carbon and Biota Lipid Content

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Total Organic Carbon Sediment

Exposure Area	Frequency of Detection		Maximum Detect mg/kg	ArithMean mg/kg	Variance mg/kg	Coefficient of Variation %	GeoMean mg/kg	GeoMean % TOC
Assapumpset	5	6	4.45E+04	3.20E+04	2.39E+08	48.3	2.67E+04	2.67
Greystone	7	7	1.41E+05	7.25E+04	2.68E+09	71.5	5.38E+04	5.38
Allendale	39	39	2.02E+05	7.02E+04	2.28E+09	67.9	4.44E+04	4.44
Lyman Mill	32	32	2.29E+05	7.56E+04	2.46E+09	65.7	4.70E+04	4.70
Manton	3	3	4.18E+04	1.91E+04	4.01E+08	105	1.25E+04	1.25
Dyerville	3	3	4.60E+04	2.26E+04	5.02E+08	99.2	1.08E+04	1.08

American Eel Lipid Content

Exposure Area	Frequency of Detection		Maximum Detect mg/kg	ArithMean mg/kg	Variance mg/kg	Coefficient of Variation %	GeoMean mg/kg [1]	GeoMean % Lipid
Assapumpset	6	6	1.94E+05	1.17E+05	1.82E+05	0.37	1.11E+05	11.10
Greystone	10	10	1.98E+05	1.45E+05	1.90E+05	0.30	1.36E+05	13.58
Allendale	10	10	1.77E+05	1.31E+05	1.06E+05	0.25	1.27E+05	12.71
Lyman Mill							1.24E+05	12.37
Manton	0	0	NA	NA	NA		NE	NE
Dyerville	3	3	1.35E+05	1.21E+05	1.42E+04	0.098	1.21E+05	12.10

White Sucker/Brown Bullhead Lipid Content [2]

Exposure Area	Frequency of Detection		Maximum Detect mg/kg	ArithMean mg/kg	Variance mg/kg	Coefficient of Variation %	GeoMean mg/kg [1]	GeoMean % Lipid
Assapumpset	3	3	3.59E+04	2.64E+04	9.85E+03	0.38	2.51E+04	2.51
Greystone	10	10	1.49E+05	1.04E+05	1.19E+05	0.33	9.75E+04	9.75
Allendale	10	10	8.72E+04	6.12E+04	1.17E+04	0.18	6.04E+04	6.04
Lyman Mill							6.10E+04	6.10
Manton	0	0	NA	NA	NA	NE	NE	NE
Dyerville	0	0	NA	NA	NA	NE	NE	NE

Largemouth Bass (Fillet) Lipid Content

Exposure Area	Frequency of Detection		Maximum Detect mg/kg	ArithMean mg/kg	Variance mg/kg	Coefficient of Variation %	GeoMean mg/kg [1]	GeoMean % Lipid
Assapumpset	4	4	8.98E+03	7.63E+03	2.09E+02	0.19	7.51E+03	0.75
Greystone	10	10	9.31E+03	6.94E+03	4.82E+02	0.32	6.58E+03	0.66
Allendale	0	0	NA	NA	NA	NE	NE	NE
Lyman Mill							6.45E+03	0.65
Manton	3	3	7.77E+03	5.47E+03	4.02E+02	0.37	5.25E+03	0.53
Dyerville	0	0	NA	NA	NA	NE	NE	NE

Table 3-2
Summary of Sediment Organic Carbon and Biota Lipid Content

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Short-tailed shrew								
Exposure Area	Frequency of Detection		Maximum Detect mg/kg	ArithMean mg/kg	Variance mg/kg	Coefficient of Variation %	GeoMean mg/kg [1]	GeoMean % Lipid
Assapumpset	4	4	8.98E+03	7.63E+03	2.09E+02	0.19	7.51E+03	0.75
Greystone	10	10	9.31E+03	6.94E+03	4.82E+02	0.32	6.58E+03	0.66
Allendale	0	0	NA	NA	NA	NE	NE	NE
Lyman Mill	3	3	7.77E+03	5.47E+03	4.02E+02	0.37	6.45E+03	0.65
Manton	3	3	7.77E+03	5.47E+03	4.02E+02	0.37	5.25E+03	0.53
Dyerville	0	0	NA	NA	NA	NE	NE	NE

Notes:
NA = No data available
NE = Not evaluated
Shading indicates data not used
[1] Data for Lyman Mill were not used in GeoMean calculations. GeoMean values for Lyman Mill are the average of the GeoMeans for Assapumpset, Greystone, Allendale, Manton and Dyerville where those values are available.
[2] Data for Assapumset were complied using brown bullhead. Data for Greystone and Allendale were complied using white sucker.

Prepared by: BJR
Checked by: KJA

ArithMean = arithmetic mean
GeoMean = geometric mean
mg/kg = milligrams per kilogram

Table 3-3
Samples Used in the Preliminary Remediation Goals Report - Human Health

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Media	Area	Sample ID	Date Sampled
Sediment	Assapumpset	RAB-FP-3004-01	11/10/1999
		RAB-SD-2069-01	9/18/2000
		RAB-SD-2070-01	9/18/2000
		RAB-SD-3004-01	11/10/1999
		RAB-SD-5004-0000-01	7/12/2001
		RAB-SD-5008-0000-01	7/9/2001
	Greystone	GMP-SD-5002-0000-01	7/11/2001
		GMP-SD-5007-0000-01	7/9/2001
		RCC-FP-3001-01	11/10/1999
		RCC-FP-3002-01	11/10/1999
		RCC-SD-3001-01	11/10/1999
		RWR-SD-5003-0000-01	7/12/2001
		RWR-SD-5004-0000-01	7/12/2001
	Allendale	APB-FP-2028-000.5-01	10/28/1999
		APB-FP-2031-01	10/28/1999
		APB-FP-2032-01	10/28/1999
		APB-FP-2033-000.5-01	10/28/1999
		APB-SD-2030-01	10/22/1999
		APB-SD-2034-01	11/3/1999
		APB-SD-2037-01	10/22/1999
		APB-SD-4008-0000-01	7/9/2001
		APB-SD-4009-0000-01	7/9/2001
		APB-SD-4010-0000-01	7/10/2001
		APC-SD-2035-000.5-01	11/3/1999
		CMS-FP-4001-0000-01	7/18/2001
		CMS-FP-4002-0000-01	7/18/2001
		CMS-FP-4003-0000-01	7/19/2001
		CMS-FP-4005-0000-01	7/20/2001
		CMS-SD-4003-0000-01	7/12/2001
		CMS-SD-4006-0000-01	7/12/2001
		CMS-SD-4007-0000-01	7/12/2001
		CMW-FP-2027-01	10/28/1999
		CMW-SD-2016-01	10/26/1999
		CMW-SD-2023-01	10/27/1999
		CMW-SD-2024-01	10/27/1999
		CMW-SD-2025-000.5-01	10/28/1999
		DAM002-SD	10/23/1998
		SD-20	9/9/1998
		SD-22	9/9/1998
		SD-23	9/9/1998
		SD-24	9/9/1998
		SD-25	9/9/1998
		SD-26	9/9/1998
		SD-27	9/9/1998
		SD-28	9/9/1998
		SD-29	9/9/1998
		WRC-SD-2009-01	11/1/1999
		WRC-SD-2013-000.5-01	11/1/1999
		WRC-SD-2014-01	11/1/1999
		WRC-SD-2015-01	11/1/1999
		WRL-SD-2039-01	10/25/1999
		WRL-SD-2044-000.5-01	11/9/1999
	Lyman Mill	DAM003-SD	10/23/1998
		LPX-SD-2045-01	11/8/1999
		LPX-SD-2046-000_5-01	11/8/1999
		LPX-SD-2047-01	11/8/1999

Table 3-3
Samples Used in the Preliminary Remediation Goals Report - Human Health

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

	Lyman Mill	LPX-SD-2049-01	11/5/1999
		LPX-SD-2050-01	11/5/1999
		LPX-SD-2051-01	11/4/1999
		LPX-SD-2052-000_5-01	11/4/1999
		LPX-SD-4001-0000-01	7/12/2001
		LPX-SD-4002-0000-01	7/12/2001
		LPX-SD-4004-0000-01	7/12/2001
		LPX-SD-4011-0000-01	7/10/2001
		LPX-SD-4012-0000-01	7/10/2001
		LPX-SD-4013-0000-01	7/10/2001
		SD-10	9/9/1998
		SD-11	9/9/1998
		SD-12	9/9/1998
		SD-13	9/9/1998
		SD-14	9/9/1998
		SD-15	9/9/1998
		SD-16	9/9/1998
		SD-17	9/9/1998
		SD-18	9/9/1998
		SD-19	9/9/1998
		WRL-SD-2041-01	10/25/1999
		WRL-SD-2042-01	11/2/1999
		WRL-SD-2043-01	11/8/1999
		WRL-SD-4005-0000-01	7/12/2001
		WRM-SD-2055-01	9/20/2000
		WRM-SD-2057-01	9/20/2000
		WRM-SD-2062-01	9/19/2000
	Manton	MAP-SD-2058-01	9/20/2000
		MAP-SD-2059-01	9/20/2000
		MAP-SD-2060-01	9/20/2000
	Dyerville	DAM005-SD	10/23/1998
		DYP-SD-2065-01	9/19/2000
		DYP-SD-2066-01	9/19/2000

Prepared by: BJR
Checked by: KJA

Table [illegible]
Derivation of Biota-Sediment Accumulation Factors (BSAFs)

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Benzo(a)pyrene	TOC - Normalized Sediment Concentration							Lipid-Normalized Biota Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detected (mg/kg)	Arithmetic Mean (mg/kg)	Variance (mg/kg)	Coefficient of Variation (%)	Geometric Mean (mg/kg)	Geometric Mean in Largemouth Bass (mg/kg)	BSAF Largemouth Bass	Geometric Mean American Eel (mg/kg)	BSAF American Eel	Geometric Mean White Sucker (mg/kg)	BSAF White Sucker	Geometric Mean Brown Bullhead (mg/kg)	BSAF Brown Bullhead
Assapumpset	4	4	1.27E+02	4.28E+01	3.14E+03	131	2.44E+01	1.01E-01	4.13E-03	5.95E-03	2.44E-04	NS	NE	3.12E-02	1.28E-03
Greystone	4	4	4.19E+01	1.99E+01	2.40E+02	78.0	1.57E+01	6.85E-02	4.35E-03	6.46E-03	4.11E-04	1.07E-02	6.84E-04	NS	NE
Allendale	24	26	2.04E+02	5.28E+01	2.69E+03	98.1	2.89E+01	NS	NE	5.22E-03	1.81E-04	1.14E-02	3.94E-04	NS	NE
Lyman Mill							NE [1]	NE [1]	6.03E-03	NE [1]	2.29E-04	NE [1]	7.86E-04	NS	NE
Manton	3	3	1.14E+01	9.39E+00	3.28E+00	19.3	9.27E+00	8.89E-02	9.59E-03	NS	NE	NS	NE	NS	NE
Dyerville	3	3	2.30E+02	1.25E+02	9.50E+03	78.1	9.71E+01	NS	NE	7.77E-03	8.00E-05	NS	NE	NS	NE

4,4'-DDE	TOC - Normalized Sediment Concentration							Lipid-Normalized Biota Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detected (mg/kg)	Arithmetic Mean (mg/kg)	Variance (mg/kg)	Coefficient of Variation (%)	Geometric Mean (mg/kg)	Geometric Mean in Largemouth Bass (mg/kg)	BSAF Largemouth Bass	Geometric Mean American Eel (mg/kg)	BSAF American Eel	Geometric Mean White Sucker (mg/kg)	BSAF White Sucker	Geometric Mean Brown Bullhead (mg/kg)	BSAF Brown Bullhead
Assapumpset	2	5	3.77E-01	1.57E-01	1.58E-02	80.1	1.29E-01	5.17E-01	4.02E+00	1.43E-01	1.11E+00	NS	NE	4.26E-01	3.32E+00
Greystone	4	7	2.62E-01	1.02E-01	6.84E-03	80.8	7.64E-02	7.40E-01	9.68E+00	1.97E-01	2.57E+00	4.20E-01	5.50E+00	NS	NE
Allendale	19	38	1.01E+00	1.77E-01	6.04E-02	139	8.91E-02	NS	NE	1.46E-01	1.64E+00	4.05E-01	4.54E+00	NS	NE
Lyman Mill							NE [1]	NE [1]	7.21E+00	NE [1]	1.40E+00	NE [1]	4.45E+00	NS	NE
Manton	0	3	6.17E-01	2.99E-01	8.24E-02	96.1	2.01E-01	1.59E+00	7.92E+00	NS	NE	NS	NE	NS	NE
Dyerville	2	3	1.48E+00	6.28E-01	5.66E-01	120	3.14E-01	NS	NE	8.70E-02	2.77E-01	SN	NE	NS	NE

Aroclor-1254	TOC - Normalized Sediment Concentration							Lipid-Normalized Biota Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detected (mg/kg)	Arithmetic Mean (mg/kg)	Variance (mg/kg)	Coefficient of Variation (%)	Geometric Mean (mg/kg)	Geometric Mean in Largemouth Bass (mg/kg)	BSAF Largemouth Bass	Geometric Mean American Eel (mg/kg)	BSAF American Eel	Geometric Mean White Sucker (mg/kg)	BSAF White Sucker	Geometric Mean Brown Bullhead (mg/kg)	BSAF Brown Bullhead
Assapumpset	3	5	3.77E+00	1.53E+00	1.67E+00	84.3	1.21E+00	8.83E-01	7.28E-01	1.76E-01	1.45E-01	NS	NE	3.88E-01	3.19E-01
Greystone	7	7	7.93E+00	3.22E+00	7.35E+00	84.3	2.39E+00	4.26E+00	1.79E+00	1.48E+00	6.19E-01	2.00E+00	8.40E-01	NS	NE
Allendale	35	38	4.80E+01	9.50E+00	1.26E+02	118	4.73E+00	NS	NE	2.48E+00	5.24E-01	2.16E+01	4.57E+00	NS	NE
Lyman Mill							NE [1]	NE [1]	3.84E+00	NE [1]	3.60E-01	NE [1]	1.91E+00	NS	NE
Manton	0	3	5.56E+00	2.77E+00	6.43E+00	91.6	1.93E+00	1.74E+01	9.01E+00	NS	NE	NS	NE	NS	NE
Dyerville	2	3	1.11E+02	4.68E+01	3.28E+03	122	1.55E+01	NS	NE	3.01E+00	1.95E-01	NS	NE	NS	NE

Table 3-4
Derivation of Biota-Sediment Accumulation Factors (BSAFs)

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Aroclor-1268	TOC - Normalized Sediment Concentration							Lipid-Normalized Biota Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detected (mg/kg)	Arithmetic Mean (mg/kg)	Variance (mg/kg)	Coefficient of Variation (%)	Geometric Mean (mg/kg)	Geometric Mean in Largemouth Bass (mg/kg)	BSAF Largemouth Bass	Geometric Mean American Eel (mg/kg)	BSAF American Eel	Geometric Mean White Sucker (mg/kg)	BSAF White Sucker	Geometric Mean Brown Bullhead (mg/kg)	BSAF Brown Bullhead
Assapumpset	2	2	9.69E-01	5.36E-01	3.75E-01	114	3.15E-01	8.83E-01	2.80E+00	9.39E-02	2.98E-01	NS	NE	3.88E-01	1.23E+00
Greystone	4	4	2.06E+00	1.69E+00	1.76E-01	24.8	1.64E+00	3.25E+00	1.98E+00	6.42E-01	3.91E-01	4.91E-01	2.99E-01	NS	NE
Allendale	10	10	1.85E+00	1.18E+00	2.89E-01	45.5	1.05E+00	NS	NE	7.99E-02	7.59E-02	4.57E-01	4.34E-01	NS	NE
Lyman Mill							NE [1]	NE [1]	2.39E+00	NE [1]	1.99E-01	NE [1]	6.55E-01	NS	NE
Manton	0	0	NA	NA	NA	NA	NA	4.70E+00	NE	NS	NE	NS	NE	NS	NE
Dyerville	1	1	2.61E+00	2.61E+00			2.61E+00	NS	NE	7.77E-02	2.98E-02	NS	NE	NS	NE

Dieldrin	TOC - Normalized Sediment Concentration							Lipid-Normalized Biota Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detected (mg/kg)	Arithmetic Mean (mg/kg)	Variance (mg/kg)	Coefficient of Variation (%)	Geometric Mean (mg/kg)	Geometric Mean in Largemouth Bass (mg/kg)	BSAF Largemouth Bass	Geometric Mean American Eel (mg/kg)	BSAF American Eel	Geometric Mean White Sucker (mg/kg)	BSAF White Sucker	Geometric Mean Brown Bullhead (mg/kg)	BSAF Brown Bullhead
Assapumpset	2	5	3.77E-01	1.25E-01	2.14E-02	117	7.19E-02	7.09E-02	9.87E-01	1.04E-02	1.45E-01	NS	NE	3.11E-02	4.32E-01
Greystone	4	7	1.04E-01	6.00E-02	1.21E-03	57.8	5.13E-02	4.33E-02	8.44E-01	2.29E-02	4.45E-01	1.23E-02	2.40E-01	NS	NE
Allendale	16	34	2.34E+00	3.11E-01	2.60E-01	164	1.30E-01	NS	NE	3.80E-02	2.93E-01	7.79E-02	6.01E-01	NS	NE
Lyman Mill							NE [1]	NE [1]	7.61E-01	NE [1]	2.56E-01	NE [1]	4.24E-01	NS	NE
Manton	0	3	6.17E-01	2.99E-01	8.24E-02	96.1	2.01E-01	9.07E-02	4.52E-01	NS	NE	NS	NE	NS	NE
Dyerville	1	3	1.48E+00	7.52E-01	4.69E-01	91.1	4.91E-01	NS	NE	6.89E-02	1.40E-01	NS	NE	NS	NE

Technical Chlordane	TOC - Normalized Sediment Concentration							Lipid-Normalized Biota Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detected (mg/kg)	Arithmetic Mean (mg/kg)	Variance (mg/kg)	Coefficient of Variation (%)	Geometric Mean (mg/kg)	Geometric Mean in Largemouth Bass (mg/kg)	BSAF Largemouth Bass	Geometric Mean American Eel (mg/kg)	BSAF American Eel	Geometric Mean White Sucker (mg/kg)	BSAF White Sucker	Geometric Mean Brown Bullhead (mg/kg)	BSAF Brown Bullhead
Assapumpset	2	2	3.55E+00	2.49E+00	2.23E+00	60.0	2.26E+00	8.83E+00	3.91E+00	1.03E+00	4.57E-01	NS	NE	3.88E+00	1.72E+00
Greystone	4	4	1.12E+01	7.06E+00	9.56E+00	43.8	6.60E+00	2.97E+00	4.50E-01	1.84E+00	2.78E-01	2.84E+00	4.30E-01	NS	NE
Allendale	9	9	1.30E+01	8.36E+00	6.64E+00	30.8	7.97E+00	NS	NE	1.76E+00	2.21E-01	4.31E+00	5.41E-01	NS	NE
Lyman Mill							NE [1]	NE [1]	2.18E+00	NE [1]	3.19E-01	NE [1]	8.96E-01	NS	NE
Manton	0	0	NA	NA	NA	NA	NA	7.09E+00	NE	NS	NE	NS	NE	NS	NE
Dyerville	0	0	NA	NA	NA	NA	NA	NS	NE	2.52E+00	NE	NS	NE	NS	NE

Table 4
Derivation of Biota-Sediment Accumulation Factors (BSAFs)

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Toxicity Equivalency (PCB) - Mammals	TOC - Normalized Sediment Concentration							Lipid-Normalized Biota Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detected (mg/kg)	Arithmetic Mean (mg/kg)	Variance (mg/kg)	Coefficient of Variation (%)	Geometric Mean (mg/kg)	Geometric Mean in Largemouth Bass (mg/kg)	BSAF Largemouth Bass	Geometric Mean American Eel (mg/kg)	BSAF American Eel	Geometric Mean White Sucker (mg/kg)	BSAF White Sucker	Geometric Mean Brown Bullhead (mg/kg)	BSAF Brown Bullhead
Assapumpset	0	0	NA	NA	NA	NA	NA	NS	NE	NS	NE	NS	NE	NS	NE
Greystone	1	1	1.24E-03	1.24E-03		0	1.24E-03	1.14E-03	9.24E-01	4.22E-05	3.40E-02	2.67E-04	2.15E-01	NS	NE
Allendale	2	2	1.47E-06	1.47E-06		0	1.47E-06	NS	NE	3.26E-04	2.21E+02	3.22E-04	2.18E+02	NS	NE
Lyman Mill							NE [1]	NE [1]	9.24E-01	NE [1]	1.86E+02	NE [1]	1.09E+02	NS	NE
Manton	0	0	NA	NA	NA	NA	NA	NS	NE	NS	NE	NS	NE	NS	NE
Dyerville	2	2	5.50E-07	5.50E-07		0	5.50E-07	NS	NE	1.86E-04	3.38E+02	NS	NE	NS	NE

2,3,7,8-TCDD	TOC - Normalized Sediment Concentration							Lipid-Normalized Biota Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detected (mg/kg)	Arithmetic Mean (mg/kg)	Variance (mg/kg)	Coefficient of Variation (%)	Geometric Mean (mg/kg)	Geometric Mean in Largemouth Bass (mg/kg)	BSAF Largemouth Bass	Geometric Mean American Eel (mg/kg)	BSAF American Eel	Geometric Mean White Sucker (mg/kg)	BSAF White Sucker	Geometric Mean Brown Bullhead (mg/kg)	BSAF Brown Bullhead
Assapumpset	3	4	5.12E-04	1.75E-04	5.48E-08	134	6.62E-05	9.00E-05	1.36E+00	1.59E-06	2.41E-02	NS	NE	1.31E-05	1.97E-01
Greystone	4	6	7.94E-04	1.53E-04	9.88E-08	205	4.29E-05	6.47E-06	1.51E-01	9.25E-07	2.15E-02	6.14E-06	1.43E-01	NS	NE
Allendale	28	30	2.60E-01	4.21E-02	2.95E-03	129	1.61E-02	NS	NE	6.04E-04	3.76E-02	4.26E-03	2.65E-01	NS	NE
Lyman Mill							NE [1]	NE [1]	5.45E-01	NE [1]	5.77E-02	NE[1]	2.02E-01	NS	NE
Manton	3	3	2.69E-02	2.24E-02	2.72E-05	23.3	2.19E-02	2.70E-03	1.23E-01	NS	NE	NS	NE	NS	NE
Dyerville	2	3	9.56E-02	3.42E-02	2.83E-03	156	2.72E-03	NS	NE	4.00E-04	1.47E-01	NS	NE	NS	NE

Prepared by: BJR
Checkedy by: KJA

NS - not sampled
NE - not evaluated
[1] Data for Lyman Mill were not used in BSAF calculations. BSAF values for Lyman Mill are the average of the BSAFs for Assapumpset, Greystone, Allendale, Manton and Dyerville where those values are available.
NA - not analyzed
mg/kg = milligrams per kilogram

Table 3-5
Derivation of Fish Tissue Based Human Health Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: BIOTA
EXPOSURE MEDIUM: COMBINED FISH DIET

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE
INGESTION	RESIDENT	ADULT	ASSAPUMPSET POND	IR-B	INGESTION RATE OF BIOTA	14	g/day	Exposure Assessment[2]
			GREYSTONE MILL POND	EF	EXPOSURE FREQUENCY	350	day/yr	USEPA, 1994
			ALLENDALE POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[1]
			LYMAN MILL POND	BW	BODY WEIGHT	70	kg	USEPA, 1997
			MANTON REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
			DYERVILLE REACH	AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1997
		ADOLESCENT	ASSAPUMPSET POND	IR-B	INGESTION RATE OF BIOTA	9.3	g/day	Exposure Assessment[2]
			GREYSTONE MILL POND	EF	EXPOSURE FREQUENCY	350	day/yr	USEPA, 1994
			ALLENDALE POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[1]
			LYMAN MILL POND	BW	BODY WEIGHT	45	kg	USEPA, 1997
			MANTON REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
			DYERVILLE REACH	AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1997
		CHILD	ASSAPUMPSET POND	IR-B	INGESTION RATE OF BIOTA	4.7	g/day	Exposure Assessment[2]
			GREYSTONE MILL POND	EF	EXPOSURE FREQUENCY	350	day/yr	USEPA, 1994
			ALLENDALE POND	ED	EXPOSURE DURATION	6	yr	USEPA, 1994[1]
			LYMAN MILL POND	BW	BODY WEIGHT	15	kg	USEPA, 1997
			MANTON REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
			DYERVILLE REACH	AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1997
				CF	CONVERSION FACTOR	0.001	kg/g	

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)", Office of Emergency and Remedial Response, EPA-540/1-89/002 (interim final), Washington, D.C., December.
USEPA, 1994. "Risk Updates No. 2"; USEPA Region I, Waste Management Division, August. Values from "Attachment 2" to Risk Updates No. 2.
USEPA, 1997. "*Exposure Factors Handbook, Volume I*"; *Office of Research and Development, EPA-600/P-95/002Fa*; Washington, D.C.; August.

[1] = The total RME exposure duration is 30 years, consistent with USEPA, 1994. The allocation of exposure duration for the three age groups is based on professional judgement.
[2] = Values derived in the Exposure Assessment section of this report.

Based on cancer risk,

$$PRG_{fish} = \frac{TR_{receptor} \times AT}{CF \times CSFo \left(\frac{EF_{child} \times ED_{child} \times IR_{child}}{BW_{child}} + \frac{EF_{adolescent} \times ED_{adolescent} \times IR_{adolescent}}{BW_{adolescent}} + \frac{EF_{adult} \times ED_{adult} \times IR_{adult}}{BW_{adult}} \right)}$$

COMPOUND OF POTENTIAL CONCERN	ORAL SLOPE FACTOR (mg/kg/day)-1	PRG ELCR = 10^{-4} (mg/Kg)	PRG ELCR = 10^{-5} (mg/Kg)	PRG ELCR = 10^{-6} (mg/Kg)
Benzo(a)pyrene	7.3	0.15	0.015	0.0015
4,4-DDE	0.34	3.2	0.32	0.032
Aroclor-1254	2	0.54	0.054	0.0054
Aroclor-1268	2	0.54	0.054	0.0054
Dieldrin	16	0.067	0.0067	0.00067
Technical Chlordane	0.35	3.1	0.31	0.031
Coplanar PCB TEQ	150000	0.0000072	0.00000072	0.000000072
2,3,7,8-TCDD	150000	0.0000072	0.00000072	0.000000072

NC - not carcinogenic
— No PRG calculated

Table 3-5
Derivation of Fish Tissue Based Human Health Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: BIOTA
EXPOSURE MEDIUM: COMBINED FISH DIET

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE
INGESTION	RESIDENT	ADULT	ASSAPUMPSET POND	IR-B	INGESTION RATE OF BIOTA	14	g/day	Exposure Assessment[2]
			GREYSTONE MILL POND	EF	EXPOSURE FREQUENCY	350	day/yr	USEPA, 1994
			ALLENDALE POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[1]
			LYMAN MILL POND	BW	BODY WEIGHT	70	kg	USEPA, 1997
			MANTON REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
			DYERVILLE REACH	AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1997
		ADOLESCENT	ASSAPUMPSET POND	IR-B	INGESTION RATE OF BIOTA	9.3	g/day	Exposure Assessment[2]
			GREYSTONE MILL POND	EF	EXPOSURE FREQUENCY	350	day/yr	USEPA, 1994
			ALLENDALE POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[1]
			LYMAN MILL POND	BW	BODY WEIGHT	45	kg	USEPA, 1997
			MANTON REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
			DYERVILLE REACH	AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1997
		CHILD	ASSAPUMPSET POND	IR-B	INGESTION RATE OF BIOTA	4.7	g/day	Exposure Assessment[2]
			GREYSTONE MILL POND	EF	EXPOSURE FREQUENCY	350	day/yr	USEPA, 1994
			ALLENDALE POND	ED	EXPOSURE DURATION	6	yr	USEPA, 1994[1]
			LYMAN MILL POND	BW	BODY WEIGHT	15	kg	USEPA, 1997
			MANTON REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
			DYERVILLE REACH	AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1997
				CF	CONVERSION FACTOR	0.001	kg/g	

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C., December.
USEPA, 1994. "Risk Updates No. 2"; USEPA Region I, Waste Management Division; August. Values from "Attachment 2" to Risk Updates No. 2.
USEPA, 1997. "Exposure Factors Handbook, Volume I"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.

[1] = The total RME exposure duration is 30 years, consistent with USEPA, 1994. The allocation of exposure duration for the three age groups is based on professional judgement.
[2] = Values derived in the Exposure Assessment section of this report.

Based on non-cancer risk.

$$PRG_{ian\ exposure} = \frac{THI_{exposure} \times RfD \times AT \times BW_{exposure}}{CF \times EF_{exposure} \times ED_{exposure} \times IR_{exposure}}$$

COMPOUND OF POTENTIAL CONCERN	ORAL CHRONIC REFERENCE DOSE mg/kg/day	PRG ADULT HI = 0.1 (mg/Kg)	PRG ADULT HI = 1 (mg/Kg)	PRG ADULT HI = 10 (mg/Kg)	PRG ADOLESCENT HI = 0.1 (mg/Kg)	PRG ADOLESCENT HI = 1 (mg/Kg)	PRG ADOLESCENT HI = 10 (mg/Kg)	PRG CHILD HI = 0.1 (mg/Kg)	PRG CHILD HI = 1 (mg/Kg)	PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	0.03	15.6	156	1564	15.1	151	1514	10.0	99.8	998
4,4-DDE	0.0005	0.26	2.6	26.1	0.25	2.5	25.2	0.17	1.7	16.6
Aroclor-1254	0.00002	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Aroclor-1268	0.00002	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Dieldrin	0.00005	0.026	0.3	2.6	0.025	0.25	2.5	0.017	0.17	1.7
Technical Chlordane	0.0005	0.26	2.6	26.1	0.25	2.5	25.2	0.17	1.7	16.6
Coplanar PCB TEQ	NA	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	NA	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated

Prepared by: KJA
Checked by: MJM

Table 3-6
Derivation of Sediment Human Health Preliminary Remediation Goals based on Large Mouth Bass

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

COMPOUND OF POTENTIAL CONCERN	PRG_{sed} ELCR = 10-4 (mg/Kg)	PRG_{sed} ELCR = 10-5 (mg/Kg)	PRG_{sed} ELCR = 10-6 (mg/Kg)
Benzo(a)pyrene	0.15	0.015	0.0015
4,4-DDE	3.2	0.32	0.032
Aroclor-1254	0.54	0.054	0.0054
Aroclor-1268	0.54	0.054	0.0054
Dieldrin	0.067	0.0067	0.00067
Technical Chlordane	3.1	0.31	0.031
Coplanar PCB TEQ	0.0000072	0.00000072	0.000000072
2,3,7,8-TCDD	0.0000072	0.00000072	0.000000072

NC - not carcinogenic
--- No PRG calculated

	GEOMEAN LIPID $[Lipid]_{LMB}$ (mg/Kg) [1]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{sed}$ (mg/Kg)
Assapumpset	7514	26648
Greystone	6585	53781
Allendale	NA	44385
Lyman Mill	6450	47041
Manton	5252	12450
Dyerville	NA	10820

Based on cancer risk, $$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

	ASSAPUMPSET				GREYSTONE				ALLENDALE			
COMPOUND OF POTENTIAL CONCERN	BSAF LMB	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF LMB	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF LMB	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)
Benzo(a)pyrene	4.13E-03	127	12.7	1.3	4.35E-03	278	27.8	2.8	NE	NE	NE	NE
4,4-DDE	4.02E+00	2.8	0.28	0.028	9.68E+00	2.7	0.27	0.027	NE	NE	NE	NE
Aroclor-1254	7.28E-01	2.6	0.26	0.026	1.79E+00	2.5	0.25	0.025	NE	NE	NE	NE
Aroclor-1268	2.80E+00	0.68	0.068	0.0068	1.98E+00	2.2	0.22	0.022	NE	NE	NE	NE
Dieldrin	9.87E-01	0.24	0.024	0.0024	8.44E-01	0.65	0.065	0.0065	NE	NE	NE	NE
Technical Chlordane	3.91E+00	2.8	0.28	0.028	4.50E-01	55.9	5.6	0.56	NE	NE	NE	NE
Coplanar PCB TEQ	NE	NE	NE	NE	9.34E-01	0.000064	0.0000064	0.00000064	NE	NE	NE	NE
2,3,7,8-TCDD	1.36E+00	0.000019	0.0000019	0.00000019	1.51E-01	0.00039	0.000039	0.0000039	NE	NE	NE	NE

NC - not carcinogenic
--- No PRG calculated
NE - not evaluated

	LYMAN MILL				MANTON				DYERVILLE			
COMPOUND OF POTENTIAL CONCERN	BSAF LMB [2]	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF LMB	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF LMB	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)
Benzo(a)pyrene	6.03E-03	179	17.9	1.8	9.59E-03	36.6	3.7	0.37	NE	NE	NE	NE
4,4-DDE	7.21E+00	3.2	0.32	0.032	7.92E+00	0.95	0.095	0.0095	NE	NE	NE	NE
Aroclor-1254	3.84E+00	1.0	0.10	0.010	9.01E+00	0.14	0.014	0.0014	NE	NE	NE	NE
Aroclor-1268	2.39E+00	1.6	0.16	0.016	NE	NE	NE	NE	NE	NE	NE	NE
Dieldrin	7.61E-01	0.65	0.065	0.0065	4.52E-01	0.35	0.035	0.0035	NE	NE	NE	NE
Technical Chlordane	2.18E+00	10.3	1.0	0.10	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	9.24E-01	0.000057	0.0000057	0.00000057	NE	NE	NE	NE	NE	NE	NE	NE
2,3,7,8-TCDD	5.45E-01	0.000096	0.0000096	0.00000096	1.23E-01	0.00014	0.000014	0.0000014	NE	NE	NE	NE

NC - not carcinogenic
--- No PRG calculated
NE - not evaluated

Table 3-6
Derivation of Sediment Human Health Preliminary Remediation Goals based on Large Mouth Bass

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

COMPOUND OF POTENTIAL CONCERN	COMBINED FISH PRG ADULT HI = 0.1 (mg/Kg)	COMBINED FISH PRG ADULT HI = 1 (mg/Kg)	COMBINED FISH PRG ADULT HI = 10 (mg/Kg)	COMBINED FISH PRG ADOLESCENT HI = 0.1 (mg/Kg)	COMBINED FISH PRG ADOLESCENT HI = 1 (mg/Kg)	COMBINED FISH PRG ADOLESCENT HI = 10 (mg/Kg)	COMBINED FISH PRG CHILD HI = 0.1 (mg/Kg)	COMBINED FISH PRG CHILD HI = 1 (mg/Kg)	COMBINED FISH PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	15.6	156	1564	15.1	151	1514	10.0	99.8	998
4,4-DDE	0.26	2.6	26.1	0.25	2.5	25.2	0.17	1.7	16.6
Aroclor-1254	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Aroclor-1268	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Dieldrin	0.026	0.3	2.6	0.025	0.25	2.5	0.017	0.17	1.7
Technical Chlordane	0.26	2.6	26.1	0.25	2.5	25.2	0.17	1.7	16.6
Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated

Based on non-cancer risk, $$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

		ASSAPUMPSET								
COMPOUND OF POTENTIAL CONCERN	BSAF LMB	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	4.13E-03	13452	134524	1345238	13018	130184	1301844	8587	85866	858663
4,4-DDE	4.02E+00	0.23	2.3	23.0	0.22	2.2	22.3	0.15	1.5	14.7
Aroclor-1254	7.28E-01	0.051	0.51	5.1	0.049	0.49	4.9	0.032	0.32	3.2
Aroclor-1268	2.80E+00	0.013	0.13	1.3	0.013	0.13	1.3	0.0084	0.084	0.84
Dieldrin	9.87E-01	0.094	0.94	9.4	0.091	0.91	9.1	0.060	0.60	6.0
Technical Chlordane	3.91E+00	0.24	2.4	23.7	0.23	2.3	22.9	0.15	1.5	15.1
Coplanar PCB TEQ	NE	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	1.36E+00	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

		GREYSTONE								
COMPOUND OF POTENTIAL CONCERN	BSAF LMB	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	4.35E-03	29345	293454	2934539	28399	283988	2839876	18731	187311	1873110
4,4-DDE	9.68E+00	0.22	2.2	22	0.21	2.1	21.3	0.14	1.4	14.0
Aroclor-1254	1.79E+00	0.048	0.48	4.8	0.046	0.46	4.6	0.030	0.30	3.0
Aroclor-1268	1.98E+00	0.043	0.43	4.3	0.042	0.42	4.2	0.027	0.27	2.7
Dieldrin	8.44E-01	0.252	2.52	25.2	0.244	2.44	24.4	0.161	1.61	16.1
Technical Chlordane	4.50E-01	4.7	47.3	473	4.6	45.8	458	3.02	30.2	302
Coplanar PCB TEQ	9.24E-01	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	1.51E-01	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

Table 3-6
Derivation of Sediment Human Health Preliminary Remediation Goals based on Large Mouth Bass

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

	ALLENDALE									
COMPOUND OF POTENTIAL CONCERN	BSAF LMB	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1254	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Dieldrin	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

NA - not available
--- No PRG calculated
NE - not evaluated

	LYMAN MILL									
COMPOUND OF POTENTIAL CONCERN	BSAF LMB [2]	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	6.03E-03	18935	189349	1893486	18324	183241	1832406	12086	120861	1208608
4,4-DDE	7.21E+00	0.26	2.6	26.4	0.26	2.6	25.5	0.17	1.7	16.8
Aroclor-1254	3.84E+00	0.020	0.20	2.0	0.019	0.19	1.9	0.013	0.13	1.3
Aroclor-1268	2.39E+00	0.032	0.32	3.2	0.031	0.31	3.1	0.020	0.20	2.0
Dieldrin	7.61E-01	0.25	2.5	25.0	0.24	2.4	24.2	0.16	1.6	15.9
Technical Chlordane	2.18E+00	0.87	8.72	87.2	0.84	8.4	84.3	0.56	5.6	55.6
Coplanar PCB TEQ	9.24E-01	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	5.45E-01	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

	MANTON									
COMPOUND OF POTENTIAL CONCERN	BSAF LMB	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	9.59E-03	3867	38666	386639	3742	37419	374186	2468	24680	246804
4,4-DDE	7.92E+00	0.078	0.78	7.8	0.076	0.76	7.6	0.050	0.50	5.0
Aroclor-1254	9.01E+00	0.0027	0.027	0.27	0.0027	0.027	0.27	0.0018	0.018	0.18
Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Dieldrin	4.52E-01	0.14	1.4	13.7	0.13	1.3	13.2	0.087	0.87	8.7
Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	NE	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	1.23E-01	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

Table 3-6
Derivation of Sediment Human Health Preliminary Remediation Goals based on Large Mouth Bass

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

	DYERVILLE									
COMPOUND OF POTENTIAL CONCERN	BSAF LMB	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1254	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Dieldrin	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

NA - not available
--- No PRG calculated
NE - not evaluated

[1] Data for Lyman Mill were not used in GeoMean calculations. GeoMean values for Lyman Mill are the average of the GeoMeans for Assapumpset, Greystone, Allendale, Manton and Dyerville where those values are available.

[2] Data for Lyman Mill were not used in BSAF calculations. BSAF values for Lyman Mill are the average of the BSAFs for Assapumpset, Greystone, Allendale, Manton and Dyerville where those values are available.

Table 3-7
Derivation of Sediment Human Health Preliminary Remediation Goals based on White Sucker and Brown Bullhead

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

COMPOUND OF POTENTIAL CONCERN	PRG_{fish} ELCR = 10-4 (mg/Kg)	PRG_{fish} ELCR = 10-5 (mg/Kg)	PRG_{fish} ELCR = 10-6 (mg/Kg)
Benzo(a)pyrene	0.15	0.015	0.0015
4,4-DDE	3.2	0.32	0.032
Aroclor-1254	0.54	0.054	0.0054
Aroclor-1268	0.54	0.054	0.0054
Dieldrin	0.067	0.0067	0.00067
Technical Chlordane	3.1	0.31	0.031
Coplanar PCB TEQ	0.0000072	0.00000072	0.000000072
2,3,7,8-TCDD	0.0000072	0.00000072	0.000000072

NC - not carcinogenic
--- No PRG calculated

	GEOMEAN LIPID $[Lipid]_{fish}$ (mg/Kg) [1]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{sed}$ (mg/Kg)
Assapumpset	23051	26688
Greystone	97539	53781
Allendale	60405	44385
Lyman Mill	60999	47041
Manton	NA	12450
Dyerville	NA	10820

Based on cancer risk,

$$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

	ASSAPUMPSET				GREYSTONE				ALLENDALE			
COMPOUND OF POTENTIAL CONCERN	BSAF BB	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF WS	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF WS	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)
Benzo(a)pyrene	1.28E-03	123	12.3	1.2	6.84E-04	119	11.9	1.2	3.94E-04	276	27.6	2.8
4,4-DDE	3.32E+00	1.0	0.10	0.010	5.50E+00	0.32	0.032	0.0032	4.54E+00	0.51	0.051	0.0051
Aroclor-1254	3.19E-01	1.8	0.18	0.018	8.40E-01	0.35	0.035	0.0035	4.57E+00	0.087	0.0087	0.00087
Aroclor-1268	1.23E+00	0.47	0.047	0.0047	2.99E-01	1.0	0.10	0.010	4.34E-01	0.91	0.091	0.009)
Dieldrin	4.32E-01	0.17	0.017	0.0017	2.40E-01	0.16	0.016	0.0016	6.01E-01	0.082	0.0082	0.00082
Technical Chlordane	1.72E+00	1.9	0.19	0.019	4.30E-01	4.0	0.40	0.040	5.41E-01	4.2	0.42	0.042
Coplanar PCB TEQ	NE	NE	NE	NE	2.15E-01	0.000018	0.0000018	0.00000018	2.18E+02	0.000000024	0.0000000024	0.00000000024
2,3,7,8-TCDD	1.97E-01	0.000039	0.0000039	0.00000039	1.43E-01	0.000028	0.0000028	0.00000028	2.65E-01	0.000020	0.0000020	0.00000020

NC - not carcinogenic
--- No PRG calculated
NE - not evaluated

	LYMAN MILL				MANTON				DYERVILLE			
COMPOUND OF POTENTIAL CONCERN	BSAF WS [2]	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF WS	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF WS	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)
Benzo(a)pyrene	7.86E-04	145	14.5	1.5	NE	NE	NE	NE	NE	NE	NE	NE
4,4-DDE	4.45E+00	0.55	0.055	0.0055	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1254	1.91E+00	0.22	0.022	0.0022	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1268	6.53E-01	0.64	0.064	0.0064	NE	NE	NE	NE	NE	NE	NE	NE
Dieldrin	4.24E-01	0.12	0.012	0.0012	NE	NE	NE	NE	NE	NE	NE	NE
Technical Chlordane	8.96E-01	2.7	0.27	0.027	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	1.09E+02	0.000000051	0.0000000051	0.00000000051	NE	NE	NE	NE	NE	NE	NE	NE
2,3,7,8-TCDD	2.02E-01	0.000027	0.0000027	0.00000027	NE	NE	NE	NE	NE	NE	NE	NE

NC - not carcinogenic
--- No PRG calculated
NE - not evaluated

Table 3-7
Derivation of Sediment Human Health Preliminary Remediation Goals based on White Sucker and Brown Bullhead

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

COMPOUND OF POTENTIAL CONCERN	COMBINED FISH PRG ADULT HI = 0.1 (mg/Kg)	COMBINED FISH PRG ADULT HI = 1 (mg/Kg)	COMBINED FISH PRG ADULT HI = 10 (mg/Kg)	COMBINED FISH PRG ADOLESCENT HI = 0.1 (mg/Kg)	COMBINED FISH PRG ADOLESCENT HI = 1 (mg/Kg)	COMBINED FISH PRG ADOLESCENT HI = 10 (mg/Kg)	COMBINED FISH PRG CHILD HI = 0.1 (mg/Kg)	COMBINED FISH PRG CHILD HI = 1 (mg/Kg)	COMBINED FISH PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	15.6	156	1564	15.1	151	1514	10.0	99.8	998
4,4-DDE	0.26	2.6	26.1	0.25	2.5	25.2	0.17	1.7	16.6
Aroclor-1254	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Aroclor-1268	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Dieldrin	0.026	0.3	2.6	0.025	0.25	2.5	0.017	0.17	1.7
Technical Chlordane	0.26	2.6	26.1	0.25	2.5	25.2	0.17	1.7	16.6
Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated

Based on non-cancer risk, $$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

ASSAPUMPSET

COMPOUND OF POTENTIAL CONCERN	BSAF BB	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	1.28E-03	13016	130159	1301588	12596	125960	1259601	8308	83080	830801
4,4-DDE	3.32E+00	0.084	0.84	8.4	0.081	0.81	8.1	0.053	0.53	5.3
Aroclor-1254	3.19E-01	0.035	0.35	3.5	0.034	0.34	3.4	0.022	0.22	2.2
Aroclor-1268	1.23E+00	0.0090	0.090	0.90	0.0087	0.087	0.87	0.0058	0.058	0.58
Dieldrin	4.32E-01	0.064	0.64	6.4	0.062	0.62	6.2	0.041	0.41	4.1
Technical Chlordane	1.72E+00	0.16	1.6	16.2	0.16	1.6	15.6	0.10	1.0	10.3
Coplanar PCB TEQ	NE	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	1.97E-01	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

GREYSTONE

COMPOUND OF POTENTIAL CONCERN	BSAF WS	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	6.84E-04	12615	126148	1261482	12208	122079	1220789	8052	80520	805201
4,4-DDE	3.50E+00	0.026	0.26	2.6	0.025	0.25	2.5	0.017	0.17	1.7
Aroclor-1254	8.40E-01	0.0068	0.068	0.68	0.0066	0.066	0.66	0.0044	0.044	0.44
Aroclor-1268	2.99E-01	0.019	0.19	1.9	0.019	0.19	1.9	0.012	0.12	1.2
Dieldrin	2.40E-01	0.060	0.60	6.0	0.058	0.58	5.8	0.038	0.38	3.8
Technical Chlordane	4.30E-01	0.33	3.3	33.4	0.32	3.2	32.3	0.21	2.1	21.3
Coplanar PCB TEQ	2.15E-01	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	1.43E-01	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

Table 3-7
Derivation of Sediment Human Health Preliminary Remediation Goals based on White Sucker and Brown Bullhead

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

		ALLENDALE								
COMPOUND OF POTENTIAL CONCERN	BSAF WS	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	3.94E-04	29199	291993	2919929	28257	282574	2825738	18638	186378	1863785
4,4-DDE	4.54E+00	0.042	0.42	4.2	0.041	0.41	4.1	0.027	0.27	2.7
Aroclor-1254	4.57E+00	0.0017	0.017	0.17	0.0016	0.016	0.16	0.0011	0.011	0.11
Aroclor-1268	4.34E-01	0.018	0.18	1.8	0.017	0.17	1.7	0.011	0.11	1.1
Dieldrin	6.01E-01	0.032	0.32	3.2	0.031	0.31	3.1	0.020	0.20	2.0
Technical Chlordane	3.41E-01	0.35	3.5	35.4	0.34	3.4	34.3	0.23	2.3	22.6
Coplanar PCB TEQ	2.18E+02	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	2.65E-01	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

		LYMAN MILL								
COMPOUND OF POTENTIAL CONCERN	BSAF WS [2]	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	7.86E-04	15350	153496	1534962	14854	148545	1485447	9798	97976	979763
4,4-DDE	4.45E+00	0.045	0.45	4.5	0.044	0.44	4.4	0.029	0.29	2.9
Aroclor-1254	1.91E+00	0.0042	0.042	0.42	0.0041	0.041	0.41	0.0027	0.027	0.27
Aroclor-1268	6.55E-01	0.012	0.12	1.2	0.012	0.12	1.2	0.0078	0.078	0.78
Dieldrin	4.24E-01	0.047	0.47	4.7	0.046	0.46	4.6	0.030	0.30	3.0
Technical Chlordane	8.96E-01	0.22	2.2	22.4	0.22	2.2	21.7	0.14	1.4	14.3
Coplanar PCB TEQ	1.09E+02	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	2.02E-01	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

		MANTON								
COMPOUND OF POTENTIAL CONCERN	BSAF WS	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1254	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Dieldrin	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

NA - not available
--- No PRG calculated
NE - not evaluated

Table 3-7
Derivation of Sediment Human Health Preliminary Remediation Goals based on White Sucker and Brown Bullhead

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

		DYERVILLE								
COMPOUND OF POTENTIAL CONCERN	BSAF WS	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1254	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Dieldrin	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

NA - not available
--- No PRG calculated
NE - not evaluated

Prepared by: KJA
Checked by: MJM

[1] Data for Lyman Mill were not used in GeoMean calculations. GeoMean values for Lyman Mill are the average of the GeoMeans for Assapumpset, Greystone, Allendale, Manton and Dyerville where those values are available.

[2] Data for Lyman Mill were not used in BSAF calculations. BSAF values for Lyman Mill are the average of the BSAFs for Assapumpset, Greystone, Allendale, Manton and Dyerville where those values are available.

Table 3-8
Derivation of Sediment Human Health Preliminary Remediation Goals based on American Eel

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

COMPOUND OF POTENTIAL CONCERN	PRG_{fish} ELCR = 10-4 (mg/Kg)	PRG_{fish} ELCR = 10-5 (mg/Kg)	PRG_{fish} ELCR = 10-6 (mg/Kg)
Benzo(a)pyrene	0.15	0.015	0.0015
4,4-DDE	3.2	0.32	0.032
Aroclor-1254	0.54	0.054	0.0054
Aroclor-1268	0.54	0.054	0.0054
Dieldrin	0.067	0.0067	0.00067
Technical Chlordane	3.1	0.31	0.031
Coplanar PCB TEQ	0.0000072	0.00000072	0.000000072
2,3,7,8-TCDD	0.0000072	0.00000072	0.000000072

NC - not carcinogenic
--- No PRG calculated

	GEOMEAN LIPID $[Lipid]_{AE}$ (mg/Kg) [1]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{sed}$ (mg/Kg)
Assapumpset	111029	26688
Greystone	135763	53781
Allendale	127090	44385
Lyman Mill	123709	47041
Manton	NA	12450
Dyerville	120955	10820

Based on cancer risk,

$$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

	ASSAPUMPSET				GREYSTONE				ALLENDALE			
COMPOUND OF POTENTIAL CONCERN	BSAF AE	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF AE	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF AE	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)
Benzo(a)pyrene	2.44E-04	146	14.6	1.5	4.11E-04	143	14.3	1.4	1.81E-04	286	28.6	2.9
4,4-DDE	1.11E+00	0.69	0.069	0.0069	2.57E+00	0.49	0.049	0.0049	1.64E+00	0.68	0.068	0.0068
Aroclor-1254	1.45E-01	0.89	0.089	0.0089	6.19E-01	0.35	0.035	0.0035	5.24E-01	0.36	0.036	0.0036
Aroclor-1268	2.98E-01	0.44	0.044	0.0044	3.91E-01	0.35	0.035	0.0035	7.59E-02	2.5	0.25	0.025
Dieldrin	1.45E-01	0.11	0.011	0.0011	4.45E-01	0.060	0.0060	0.00060	2.93E-01	0.080	0.0080	0.00080
Technical Chlordane	4.57E-01	1.6	0.16	0.016	2.78E-01	4.4	0.44	0.044	2.21E-01	4.9	0.49	0.049
Coplanar PCB TEQ	NE	NE	NE	NE	3.40E-02	0.000084	0.0000084	0.00000084	2.21E+02	0.000000011	0.0000000011	0.00000000011
2,3,7,8-TCDD	2.41E-02	0.000072	0.0000072	0.00000072	2.15E-02	0.00013	0.000013	0.0000013	3.76E-02	0.000067	0.0000067	0.00000067

NC - not carcinogenic
--- No PRG calculated
NE - not evaluated

	LYMAN MILL				MANTON				DYERVILLE			
COMPOUND OF POTENTIAL CONCERN	BSAF AE [2]	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF AE	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)	BSAF AE	SEDIMENT PRG ELCR = 10-4 (mg/Kg)	SEDIMENT PRG ELCR = 10-5 (mg/Kg)	SEDIMENT PRG ELCR = 10-6 (mg/Kg)
Benzo(a)pyrene	2.29E-04	246	24.6	2.5	NE	NE	NE	NE	8.00E-03	163	16.5	1.7
4,4-DDE	1.40E+00	0.86	0.086	0.0086	NE	NE	NE	NE	2.77E-01	1.0	0.10	0.010
Aroclor-1254	3.60E-01	0.57	0.057	0.0057	NE	NE	NE	NE	1.95E-01	0.25	0.025	0.0025
Aroclor-1268	1.99E-01	1.0	0.10	0.010	NE	NE	NE	NE	2.98E-02	1.6	0.16	0.016
Dieldrin	2.56E-01	0.10	0.010	0.0010	NE	NE	NE	NE	1.40E-01	0.043	0.0043	0.00043
Technical Chlordane	3.19E-01	3.7	0.37	0.037	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	1.86E+02	0.000000015	0.0000000015	0.00000000015	NE	NE	NE	NE	3.38E+02	0.0000000019	0.0000000019	0.00000000019
2,3,7,8-TCDD	5.77E-02	0.000047	0.0000047	0.00000047	NE	NE	NE	NE	1.47E-01	0.0000044	0.00000044	0.000000044

NC - not carcinogenic
--- No PRG calculated
NE - not evaluated

Table 3-8
Derivation of Sediment Human Health Preliminary Remediation Goals based on American Eel

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

COMPOUND OF POTENTIAL CONCERN	COMBINED FISH PRG ADULT HI = 0.1 (mg/Kg)	COMBINED FISH PRG ADULT HI = 1 (mg/Kg)	COMBINED FISH PRG ADULT HI = 10 (mg/Kg)	COMBINED FISH PRG ADOLESCENT HI = 0.1 (mg/Kg)	COMBINED FISH PRG ADOLESCENT HI = 1 (mg/Kg)	COMBINED FISH PRG ADOLESCENT HI = 10 (mg/Kg)	COMBINED FISH PRG CHILD HI = 0.1 (mg/Kg)	COMBINED FISH PRG CHILD HI = 1 (mg/Kg)	COMBINED FISH PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	15.6	156	1564	15.1	151	1514	10.0	99.8	998
4,4-DDE	0.26	2.6	26.1	0.25	2.5	25.2	0.17	1.7	16.6
Aroclor-1254	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Aroclor-1268	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Dieldrin	0.026	0.3	2.6	0.025	0.25	2.5	0.017	0.17	1.7
Technical Chlordane	0.26	2.6	26.1	0.25	2.5	25.2	0.17	1.7	16.6
Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated

Based on non-cancer risk, $$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

ASSAPUMPSET

COMPOUND OF POTENTIAL CONCERN	BSAF AE	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	2.44E-04	15398	153978	1539784	14901	149011	1490114	9828	98284	982841
4,4-DDE	1.11E+00	0.036	0.36	3.64	0.055	0.55	5.5	0.036	0.36	3.6
Aroclor-1254	1.45E-01	0.017	0.17	1.7	0.017	0.17	1.7	0.011	0.11	1.1
Aroclor-1268	2.98E-01	0.0084	0.084	0.84	0.0083	0.083	0.83	0.0054	0.054	0.54
Dieldrin	1.45E-01	0.043	0.43	4.3	0.042	0.42	4.2	0.028	0.28	2.8
Technical Chlordane	4.57E-01	0.14	1.4	13.7	0.13	1.3	13.3	0.087	0.87	8.7
Coplanar PCB TEQ	NE	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	2.41E-02	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

GREYSTONE

COMPOUND OF POTENTIAL CONCERN	BSAF AE	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	4.11E-04	15086	150858	1508583	14599	145992	1459919	9629	96293	962925
4,4-DDE	2.57E+00	0.040	0.40	4.0	0.039	0.39	3.9	0.026	0.26	2.6
Aroclor-1254	6.19E-01	0.0067	0.067	0.67	0.0065	0.065	0.65	0.0043	0.043	0.43
Aroclor-1268	3.91E-01	0.011	0.11	1.1	0.010	0.10	1.0	0.0067	0.067	0.67
Dieldrin	4.45E-01	0.023	0.23	2.3	0.022	0.22	2.2	0.015	0.15	1.5
Technical Chlordane	2.78E-01	0.37	3.7	37.1	0.36	3.6	35.9	0.24	2.4	23.7
Coplanar PCB TEQ	3.40E-02	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	2.15E-02	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

Table 3-8
Derivation of Sediment Human Health Preliminary Remediation Goals based on American Eel

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

		ALLENDALE								
COMPOUND OF POTENTIAL CONCERN	BSAF AE	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	1.81E-04	30205	302047	3020473	29230	292304	2923038	19280	192796	1927961
4,4-DDE	1.64E+00	0.055	0.55	5.5	0.054	0.54	5.4	0.035	0.35	3.5
Aroclor-1254	5.24E-01	0.0069	0.069	0.69	0.0067	0.067	0.67	0.0044	0.044	0.44
Aroclor-1268	7.59E-02	0.048	0.48	4.8	0.046	0.46	4.6	0.031	0.31	3.1
Dieldrin	2.93E-03	0.031	0.31	3.1	0.030	0.30	3.0	0.020	0.20	2.0
Technical Chlordane	2.21E-01	0.41	4.1	41.1	0.40	4.0	39.8	0.26	2.6	26.3
Coplanar PCB TEQ	2.21E+02	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	3.76E-02	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

		LYMAN MILL								
COMPOUND OF POTENTIAL CONCERN	BSAF AE [2]	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	2.29E-04	25978	259784	2597837	25140	251404	2514035	16582	165819	1658194
4,4-DDE	1.40E+00	0.071	0.71	7.1	0.068	0.68	6.8	0.045	0.45	4.5
Aroclor-1254	3.60E-01	0.011	0.11	1.1	0.011	0.11	1.1	0.0070	0.070	0.70
Aroclor-1268	1.99E-01	0.020	0.20	2.0	0.019	0.19	1.9	0.013	0.13	1.3
Dieldrin	2.56E-01	0.039	0.39	3.9	0.037	0.37	3.7	0.025	0.25	2.5
Technical Chlordane	3.19E+01	0.31	3.1	31.1	0.30	3.0	30.1	0.20	2.0	19.8
Coplanar PCB TEQ	1.86E+02	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	5.77E-02	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

		MANTON								
COMPOUND OF POTENTIAL CONCERN	BSAF AE	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1254	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Dieldrin	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

NA - not available
--- No PRG calculated
NE - not evaluated

Table 3-8
Derivation of Sediment Human Health Preliminary Remediation Goals based on American Eel

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

	DYERVILLE									
COMPOUND OF POTENTIAL CONCERN	BSAF AE	SEDIMENT PRG ADULT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADULT HI = 1 (mg/Kg)	SEDIMENT PRG ADULT HI = 10 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 0.1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 1 (mg/Kg)	SEDIMENT PRG ADOLESCENT HI = 10 (mg/Kg)	SEDIMENT PRG CHILD HI = 0.1 (mg/Kg)	SEDIMENT PRG CHILD HI = 1 (mg/Kg)	SEDIMENT PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	8.00E-05	17482	174825	1748250	16919	169185	1691854	11139	111390	1113904
4,4-DDE	2.77E-01	0.084	0.84	8.4	0.081	0.81	8.1	0.054	0.54	5.4
Aroclor-1254	1.95E-01	0.0048	0.048	0.48	0.0046	0.046	0.46	0.0031	0.031	0.31
Aroclor-1268	2.98E-02	0.031	0.31	3.1	0.030	0.30	3.0	0.020	0.20	2.0
Dieldrin	1.40E-01	0.017	0.17	1.7	0.016	0.16	1.6	0.011	0.11	1.1
Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Coplanar PCB TEQ	3.38E+02	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	1.47E-01	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated
NE - not evaluated

Prepared by: KJA
Checked by: MJM

[1] Data for Lyman Mill were not used in GeoMean calculations. GeoMean values for Lyman Mill are the average of the GeoMeans for Assapumpsct, Greystone, Allendale, Manton and Dyerville where those values are available.

[2] Data for Lyman Mill were not used in BSAF calculations. BSAF values for Lyman Mill are the average of the BSAFs for Assapumpsct, Greystone, Allendale, Manton and Dyerville where those values are available.

Table 3-9
Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet - Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG (1)		
		ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)
ASSAPUMPSET	Benzo(a)pyrene	146	14.6	1.5	123	12.3	1.2	127	12.7	1.3	132	13.2	1.3
	4,4-DDE	0.69	0.069	0.0069	1.0	0.10	0.010	2.8	0.28	0.028	1.5	0.15	0.015
	Aroclor-1254	0.89	0.089	0.0089	1.8	0.18	0.018	2.6	0.26	0.026	1.8	0.18	0.018
	Aroclor-1268	0.44	0.044	0.0044	0.47	0.047	0.0047	0.68	0.068	0.0068	0.53	0.053	0.0053
	Dieldrin	0.11	0.011	0.0011	0.17	0.017	0.0017	0.24	0.024	0.0024	0.17	0.017	0.0017
	Technical Chlordane	1.6	0.16	0.016	1.9	0.19	0.019	2.8	0.28	0.028	2.1	0.21	0.021
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	2,3,7,8-TCDD	0.000072	0.0000072	0.00000072	0.000039	0.0000039	0.00000039	0.000019	0.0000019	0.00000019	0.000043	0.0000043	0.00000043
GREYSTONE	Benzo(a)pyrene	143	14.3	1.4	119	11.9	1.2	278	27.8	2.8	180	18.0	1.8
	4,4-DDE	0.49	0.049	0.0049	0.32	0.032	0.0032	2.7	0.27	0.027	1.2	0.12	0.012
	Aroclor-1254	0.35	0.035	0.0035	0.35	0.035	0.0035	2.5	0.25	0.025	1.1	0.11	0.011
	Aroclor-1268	0.55	0.055	0.0055	1.0	0.10	0.010	2.2	0.22	0.022	1.3	0.13	0.013
	Dieldrin	0.060	0.0060	0.00060	0.16	0.016	0.0016	0.65	0.065	0.0065	0.29	0.029	0.0029
	Technical Chlordane	4.4	0.44	0.044	4.0	0.40	0.040	55.9	5.6	0.56	21.4	2.1	0.21
	Coplanar PCB TEQ	0.00008	0.000008	0.0000008	0.000018	0.0000018	0.00000018	0.000064	0.0000064	0.00000064	0.000055	0.0000055	0.00000055
	2,3,7,8-TCDD	0.00013	0.000013	0.0000013	0.000028	0.0000028	0.00000028	0.00039	0.000039	0.0000039	0.00018	0.000018	0.0000018
ALLENDALE	Benzo(a)pyrene	286	28.6	2.9	276	27.6	2.8	NE	NE	NE	281	28.1	2.8
	4,4-DDE	0.68	0.068	0.0068	0.51	0.051	0.0051	NE	NE	NE	0.59	0.059	0.0059
	Aroclor-1254	0.36	0.036	0.0036	0.087	0.0087	0.00087	NE	NE	NE	0.22	0.022	0.0022
	Aroclor-1268	2.5	0.25	0.025	0.91	0.091	0.0091	NE	NE	NE	1.7	0.17	0.017
	Dieldrin	0.080	0.0080	0.00080	0.082	0.0082	0.00082	NE	NE	NE	0.081	0.0081	0.00081
	Technical Chlordane	4.9	0.49	0.049	4.2	0.42	0.042	NE	NE	NE	4.5	0.45	0.045
	Coplanar PCB TEQ	0.000000011	0.0000000011	0.00000000011	0.000000024	0.0000000024	0.00000000024	NE	NE	NE	0.000000018	0.0000000018	0.00000000018
	2,3,7,8-TCDD	0.000067	0.0000067	0.00000067	0.000020	0.0000020	0.00000020	NE	NE	NE	0.000043	0.0000043	0.00000043
LYMAN MILL	Benzo(a)pyrene	246	24.6	2.5	145	14.5	1.5	179	17.9	1.8	190	19.0	1.9
	4,4-DDE	0.86	0.086	0.0086	0.55	0.055	0.0055	3.2	0.32	0.032	1.5	0.15	0.015
	Aroclor-1254	0.57	0.057	0.0057	0.22	0.022	0.0022	1.0	0.10	0.010	0.60	0.060	0.0060
	Aroclor-1268	1.0	0.10	0.010	0.64	0.064	0.0064	1.6	0.16	0.016	1.1	0.11	0.011
	Dieldrin	0.10	0.010	0.0010	0.12	0.012	0.0012	0.65	0.065	0.0065	0.29	0.029	0.0029
	Technical Chlordane	3.7	0.37	0.037	2.7	0.27	0.027	10.3	1.0	0.10	5.5	0.55	0.055
	Coplanar PCB TEQ	0.000000015	0.0000000015	0.00000000015	0.000000051	0.0000000051	0.00000000051	0.000057	0.0000057	0.00000057	0.000019	0.0000019	0.00000019
	2,3,7,8-TCDD	0.000047	0.0000047	0.00000047	0.000027	0.0000027	0.00000027	0.00010	0.000010	0.0000010	0.000057	0.0000057	0.00000057

Table 3-9
Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet - Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG (1)		
		ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)
MANTON	Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	36.6	3.7	0.37	36.6	3.7	0.37
	4,4-DDE	NE	NE	NE	NE	NE	NE	1.0	0.10	0.010	1.0	0.10	0.010
	Aroclor-1254	NE	NE	NE	NE	NE	NE	0.14	0.014	0.0014	0.14	0.014	0.0014
	Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dieldrin	NE	NE	NE	NE	NE	NE	0.35	0.035	0.0035	0.35	0.035	0.0035
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	0.00014	0.000014	0.0000014	0.00014	0.000014	0.0000014
DYERVILLE	Benzo(a)pyrene	165	16.5	1.7	NE	NE	NE	NE	NE	NE	165	16.5	1.7
	4,4-DDE	1.0	0.10	0.010	NE	NE	NE	NE	NE	NE	1.0	0.10	0.010
	Aroclor-1254	0.25	0.025	0.0025	NE	NE	NE	NE	NE	NE	0.25	0.025	0.0025
	Aroclor-1268	1.6	0.16	0.016	NE	NE	NE	NE	NE	NE	1.6	0.16	0.016
	Dieldrin	0.043	0.0043	0.00043	NE	NE	NE	NE	NE	NE	0.043	0.0043	0.00043
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	0.0000000019	0.00000000019	0.000000000019	NE	NE	NE	NE	NE	NE	0.0000000019	0.00000000019	0.000000000019
	2,3,7,8-TCDD	0.0000044	0.00000044	0.000000044	NE	NE	NE	NE	NE	NE	0.0000044	0.00000044	0.000000044

Notes:

-- No PRG calculated

NE - not evaluated

mg/Kg - milligrams per kilogram

(1) PRG for Combined Fish Diet is the arithmetic mean of the PRGs for the individual species.

Individual species PRGs were derived assuming that species is the sole component of the fish diet.

Chemical of Potential Concern	Geometric Mean Combined Fish Diet Sediment PRG		
	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)
Benzo(a)pyrene	140	14.0	1.4
4,4-DDE	1.1	0.11	0.011
Aroclor-1254	0.46	0.046	0.0046
Aroclor-1268	1.2	0.12	0.012
Dieldrin	0.16	0.016	0.0016
Technical Chlordane	5.8	0.58	0.058
Coplanar PCB TEQ	0.00000043	0.000000043	0.0000000043
2,3,7,8-TCDD	0.000048	0.0000048	0.00000048

Table 3-10
Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Adults - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based *Sediment PRG*			White Sucker / Brown Bullhead *Sediment PRG*			Largemouth Bass *Sediment PRG*			Combined Fish Diet *Sediment PRG*		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
ASSAPUMPSET	Benzo(a)pyrene	15398	153978	1539784	13016	130159	1301588	13452	134524	1345238	13955	139554	1395537
	4,4-DDE	0.056	0.56	5.6	0.084	0.84	8.4	0.23	2.3	23.0	0.12	1.2	12.3
	Aroclor-1254	0.017	0.17	1.7	0.035	0.35	3.5	0.051	0.51	5.1	0.034	0.34	3.4
	Aroclor-1268	0.0084	0.084	0.84	0.0090	0.090	0.90	0.013	0.13	1.3	0.010	0.10	1.0
	Dieldrin	0.043	0.43	4.3	0.064	0.64	6.4	0.094	0.94	9.4	0.067	0.67	6.7
	Technical Chlordane	0.14	1.4	13.7	0.16	1.6	16.2	0.24	2.4	23.7	0.18	1.8	17.8
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---
GREYSTONE	Benzo(a)pyrene	15086	150858	1508583	12615	126148	1261482	29345	293454	2934539	19015	190153	1901535
	4,4-DDE	0.040	0.40	4.0	0.026	0.26	2.6	0.22	2.2	22.0	0.095	0.95	9.5
	Aroclor-1254	0.0067	0.067	0.67	0.0068	0.068	0.68	0.048	0.48	4.8	0.020	0.20	2.0
	Aroclor-1268	0.011	0.11	1.1	0.019	0.19	1.9	0.043	0.43	4.3	0.024	0.24	2.4
	Dieldrin	0.023	0.23	2.3	0.060	0.60	6.0	0.25	2.5	25.2	0.11	1.1	11.2
	Technical Chlordane	0.37	3.7	37.1	0.33	3.3	33.4	4.7	47.3	473	1.8	18.1	181
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---
ALLENDALE	Benzo(a)pyrene	30205	302047	3020473	29199	291993	2919929	NE	NE	NE	29702	297020	2970201
	4,4-DDE	0.055	0.55	5.5	0.042	0.42	4.2	NE	NE	NE	0.049	0.49	4.9
	Aroclor-1254	0.0069	0.069	0.69	0.0017	0.017	0.17	NE	NE	NE	0.0043	0.043	0.43
	Aroclor-1268	0.048	0.48	4.8	0.018	0.18	1.8	NE	NE	NE	0.033	0.33	3.3
	Dieldrin	0.031	0.31	3.1	0.032	0.32	3.2	NE	NE	NE	0.031	0.31	3.1
	Technical Chlordane	0.41	4.1	41.1	0.35	3.5	35.4	NE	NE	NE	0.38	3.8	38.3
	Coplanar PCB TEQ	---	---	---	---	---	---	NE	NE	NE	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	NE	NE	NE	---	---	---
LYMAN MILL	Benzo(a)pyrene	25978	259784	2597837	15350	153496	1534962	18935	189349	1893486	20088	200876	2008761
	4,4-DDE	0.071	0.71	7.1	0.045	0.45	4.5	0.26	2.6	26.4	0.13	1.3	12.7
	Aroclor-1254	0.011	0.11	1.1	0.0042	0.042	0.42	0.020	0.20	2.0	0.012	0.12	1.2
	Aroclor-1268	0.020	0.20	2.0	0.012	0.12	1.2	0.032	0.32	3.2	0.021	0.21	2.1
	Dieldrin	0.039	0.39	3.9	0.047	0.47	4.7	0.25	2.5	25.0	0.11	1.1	11.2
	Technical Chlordane	0.31	3.1	31.1	0.22	2.2	22.4	0.87	8.7	87.2	0.47	4.7	46.9
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---

Table 3-10
Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Adults - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
MANTON	Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	3867	38666	386659	3867	38666	386659
	4,4-DDE	NE	NE	NE	NE	NE	NE	0.078	0.78	7.8	0.078	0.78	7.8
	Aroclor-1254	NE	NE	NE	NE	NE	NE	0.0027	0.027	0.27	0.0027	0.027	0.27
	Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dieldrin	NE	NE	NE	NE	NE	NE	0.14	1.4	13.7	0.14	1.4	13.7
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
	2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
DYERVILLE	Benzo(a)pyrene	17482	174825	1748250	NE	NE	NE	NE	NE	NE	17482	174825	1748250
	4,4-DDE	0.084	0.84	8.4	NE	NE	NE	NE	NE	NE	0.084	0.84	8.4
	Aroclor-1254	0.0048	0.048	0.48	NE	NE	NE	NE	NE	NE	0.0048	0.048	0.48
	Aroclor-1268	0.031	0.31	3.1	NE	NE	NE	NE	NE	NE	0.031	0.31	3.1
	Dieldrin	0.017	0.17	1.7	NE	NE	NE	NE	NE	NE	0.017	0.17	1.7
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---
	2,3,7,8-TCDD	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---

Notes:
--- No PRG calculated
NE - not evaluated
mg/Kg - milligrams per kilogram
(1) PRG for Combined Fish Diet is the arithmetic mean of the PRGs for the individual species. Individual species PRGs were derived assuming that species is the sole component of the fish diet.

Table 3-11
Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Adolescents - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
ASSAPUMPSET	Benzo(a)pyrene	14901	149011	1490114	12596	125960	1259601	130184	1301844	13505	135052	1350520	
	4,4-DDE	0.055	0.55	5.5	0.081	0.81	8.1	0.22	2.2	22.3	0.12	1.2	11.9
	Aroclor-1254	0.017	0.17	1.7	0.034	0.34	3.4	0.049	0.49	4.9	0.033	0.33	3.3
	Aroclor-1268	0.0081	0.081	0.81	0.0087	0.087	0.87	0.013	0.13	1.3	0.0099	0.099	0.99
	Dieldrin	0.042	0.42	4.2	0.062	0.62	6.2	0.091	0.91	9.1	0.065	0.65	6.5
	Technical Chlordane	0.13	1.3	13.3	0.16	1.6	15.6	0.23	2.3	22.9	0.17	1.7	17.3
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---
GREYSTONE	Benzo(a)pyrene	14599	145992	1459919	12208	122079	1220789	28399	283988	2839876	18402	184019	1840195
	4,4-DDE	0.039	0.39	3.9	0.025	0.25	2.5	0.21	2.1	21.3	0.092	0.92	9.2
	Aroclor-1254	0.0065	0.065	0.65	0.0066	0.066	0.66	0.046	0.46	4.6	0.020	0.20	2.0
	Aroclor-1268	0.010	0.10	1.0	0.019	0.19	1.9	0.042	0.42	4.2	0.023	0.23	2.3
	Dieldrin	0.022	0.22	2.2	0.058	0.58	5.8	0.24	2.4	24.4	0.11	1.1	10.8
	Technical Chlordane	0.36	3.6	35.9	0.32	3.2	32.3	4.6	45.8	458	1.8	17.5	175
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---
ALLENDALE	Benzo(a)pyrene	29230	292304	2923038	28257	282574	2825738	NE	NE	NE	28744	287439	2874388
	4,4-DDE	0.054	0.54	5.4	0.041	0.41	4.1	NE	NE	NE	0.047	0.47	4.7
	Aroclor-1254	0.0067	0.067	0.67	0.0016	0.016	0.16	NE	NE	NE	0.0042	0.042	0.42
	Aroclor-1268	0.046	0.46	4.6	0.017	0.17	1.7	NE	NE	NE	0.032	0.32	3.2
	Dieldrin	0.030	0.30	3.0	0.031	0.31	3.1	NE	NE	NE	0.030	0.30	3.0
	Technical Chlordane	0.40	4.0	39.8	0.34	3.4	34.3	NE	NE	NE	0.37	3.7	37.0
	Coplanar PCB TEQ	---	---	---	---	---	---	NE	NE	NE	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	NE	NE	NE	---	---	---
LYMAN MILL	Benzo(a)pyrene	25140	251404	2514035	14854	148545	1485447	18324	183241	1832406	19440	194396	1943963
	4,4-DDE	0.068	0.68	6.8	0.044	0.44	4.4	0.26	2.6	25.5	0.12	1.2	12.2
	Aroclor-1254	0.011	0.11	1.1	0.0041	0.041	0.41	0.019	0.19	1.9	0.011	0.11	1.1
	Aroclor-1268	0.019	0.19	1.9	0.012	0.12	1.2	0.021	0.21	2.1	0.021	0.21	2.1
	Dieldrin	0.037	0.37	3.7	0.046	0.46	4.6	0.242	2.4	24.2	0.11	1.1	10.8
	Technical Chlordane	0.30	3.0	30.1	0.22	2.2	21.7	0.84	8.4	84.3	0.45	4.5	45.4
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---

Table 3-11
Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Adolescents - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
MANTON	Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	3742	37419	374186	3742	37419	374186
	4,4-DDE	NE	NE	NE	NE	NE	NE	0.076	0.76	7.6	0.076	0.76	7.6
	Aroclor-1254	NE	NE	NE	NE	NE	NE	0.0027	0.027	0.27	0.0027	0.027	0.27
	Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dieldrin	NE	NE	NE	NE	NE	NE	0.13	1.3	13.2	0.13	1.3	13.2
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
	2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
DYERVILLE	Benzo(a)pyrene	16919	169185	1691854	NE	NE	NE	NE	NE	NE	16919	169185	1691854
	4,4-DDE	0.081	0.81	8.1	NE	NE	NE	NE	NE	NE	0.081	0.81	8.1
	Aroclor-1254	0.0046	0.046	0.46	NE	NE	NE	NE	NE	NE	0.0046	0.046	0.46
	Aroclor-1268	0.030	0.30	3.0	NE	NE	NE	NE	NE	NE	0.030	0.30	3.0
	Dieldrin	0.016	0.16	1.6	NE	NE	NE	NE	NE	NE	0.016	0.16	1.6
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---
	2,3,7,8-TCDD	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---

Notes:
--- No PRG calculated
NE - not evaluated
mg/Kg - milligrams per kilogram
(1) PRG for Combined Fish Diet is the arithmetic mean of the PRGs for the individual species. Individual species PRGs were derived assuming that species is the sole component of the fish diet.

Table 3-12
Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Children - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
ASSAPUMPSET	Benzo(a)pyrene	9828	98284	982841	8308	83080	830801	8587	85866	858663	8908	89077	890768
	4,4-DDE	0.036	0.36	3.6	0.053	0.53	5.3	0.15	1.5	14.7	0.079	0.79	7.9
	Aroclor-1254	0.011	0.11	1.1	0.022	0.22	2.2	0.032	0.32	3.2	0.022	0.22	2.2
	Aroclor-1268	0.0054	0.054	0.54	0.006	0.058	0.58	0.0084	0.084	0.84	0.0065	0.065	0.65
	Dieldrin	0.028	0.28	2.8	0.041	0.41	4.1	0.060	0.60	6.0	0.043	0.43	4.3
	Technical Chlordane	0.087	0.87	8.7	0.10	1.0	10	0.15	1.5	15.1	0.11	1.1	11.4
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---
GREYSTONE	Benzo(a)pyrene	9629	96293	962925	8052	80520	805201	18731	187311	1873110	12137	121375	1213745
	4,4-DDE	0.026	0.26	2.6	0.017	0.17	1.7	0.14	1.4	14	0.061	0.61	6.1
	Aroclor-1254	0.0043	0.043	0.43	0.0044	0.044	0.44	0.030	0.30	3.0	0.013	0.13	1.3
	Aroclor-1268	0.0067	0.067	0.67	0.012	0.12	1.2	0.027	0.27	2.7	0.015	0.15	1.5
	Dieldrin	0.015	0.15	1.5	0.038	0.38	3.8	0.16	1.6	16	0.071	0.71	7.1
	Technical Chlordane	0.24	2.4	23.7	0.21	2.1	21.3	3.0	30.2	302	1.2	11.6	116
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---
ALLENDALE	Benzo(a)pyrene	19280	192796	1927961	18638	186378	1863785	NE	NE	NE	18959	189587	1895873
	4,4-DDE	0.035	0.35	3.5	0.027	0.27	2.7	NE	NE	NE	0.031	0.31	3.1
	Aroclor-1254	0.0044	0.044	0.44	0.0011	0.011	0.11	NE	NE	NE	0.0028	0.028	0.28
	Aroclor-1268	0.031	0.31	3.1	0.011	0.11	1.1	NE	NE	NE	0.021	0.21	2.1
	Dieldrin	0.020	0.20	2.0	0.020	0.20	2.0	NE	NE	NE	0.020	0.20	2.0
	Technical Chlordane	0.26	2.6	26.3	0.23	2.3	22.6	NE	NE	NE	0.24	2.4	24.4
	Coplanar PCB TEQ	---	---	---	---	---	---	NE	NE	NE	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	NE	NE	NE	---	---	---
LYMAN MILL	Benzo(a)pyrene	165822	165819	1658194	9798	97976	979763	120861	120861	1208608	12822	128219	1282188
	4,4-DDE	0.045	0.45	4.5	0.029	0.29	2.9	0.17	1.7	16.8	0.081	0.81	8.1
	Aroclor-1254	0.0070	0.070	0.70	0.0027	0.027	0.27	0.013	0.13	1.3	0.0075	0.075	0.75
	Aroclor-1268	0.013	0.13	1.3	0.0078	0.078	0.78	0.020	0.20	2.0	0.014	0.14	1.4
	Dieldrin	0.025	0.25	2.5	0.030	0.30	3.0	0.16	1.6	15.9	0.071	0.71	7.1
	Technical Chlordane	0.20	2.0	19.8	0.14	1.4	14.3	0.56	5.6	55.6	0.30	3.0	30
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---

Table 3-12
Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Children - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
MANTON	Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	2468	24680	246804	2468	24680	246804
	4,4-DDE	NE	NE	NE	NE	NE	NE	0.050	0.50	5.0	0.050	0.50	5.0
	Aroclor-1254	NE	NE	NE	NE	NE	NE	0.0018	0.018	0.18	0.0018	0.018	0.18
	Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dieldrin	NE	NE	NE	NE	NE	NE	0.087	0.87	8.7	0.087	0.87	8.7
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
	2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	--	---	---	---	---	---
DYERVILLE	Benzo(a)pyrene	11159	111590	1115904	NE	NE	NE	NE	NE	NE	11159	111590	1115904
	4,4-DDE	0.054	0.54	5.4	NE	NE	NE	NE	NE	NE	0.054	0.54	5.4
	Aroclor-1254	0.0031	0.031	0.31	NE	NE	NE	NE	NE	NE	0.0031	0.031	0.31
	Aroclor-1268	0.020	0.20	2.0	NE	NE	NE	NE	NE	NE	0.020	0.20	2.0
	Dieldrin	0.011	0.11	1.1	NE	NE	NE	NE	NE	NE	0.011	0.11	1.1
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---
	2,3,7,8-TCDD	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---

Notes:
-- No PRG calculated
NE - not evaluated
mg/Kg - milligrams per kilogram

(1) PRG for Combined Fish Diet is the arithmetic mean of the PRGs for the individual species.
Individual species PRGs were derived assuming that species is the sole component of the fish diet.

Chemical of Potential Concern	Geometric Mean Combined Fish Diet *Sediment PRG* HI = 1 (mg/Kg)
Benzo(a)pyrene	94756
4,4-DDE	0.56
Aroclor-1254	0.056
Aroclor-1268	0.14
Dieldrin	0.40
Technical Chlordane	3.1
Coplanar PCB TEQ	---
2,3,7,8-TCDD	---

Table 3-13
Derivation of Sediment Based Human Health Preliminary Remediation Goals - Direct Contact

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE
INGESTION	RESIDENT	ADULT	ASSAPUMPSET POND	IR-S	INGESTION RATE OF SEDIMENT	100	mg/day	USEPA, 1994[1]
			GREYSTONE MILL POND	FI	FRACTION INGESTED	1	unitless	Professional Judgement[2]
		(ages 19 and above)	ALLENDALE POND	EF	EXPOSURE FREQUENCY	39	day/yr	Professional Judgement[3]
			LYMAN MILL POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4,5]
			MANTON REACH	BW	BODY WEIGHT	70	kg	USEPA, 1994
			DYERVILLE REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		ADOLESCENT	ASSAPUMPSET POND	IR-S	INGESTION RATE OF SEDIMENT	100	mg/day	USEPA, 1994[1]
			GREYSTONE MILL POND	FI	FRACTION INGESTED	1	unitless	Professional Judgement[2]
		(ages 7 - 18)	ALLENDALE POND	EF	EXPOSURE FREQUENCY	39	day/yr	Professional Judgement[3]
			LYMAN MILL POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4]
			MANTON REACH	BW	BODY WEIGHT	45	kg	USEPA, 1997[6]
			DYERVILLE REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		CHILD	ASSAPUMPSET POND	IR-S	INGESTION RATE OF SEDIMENT	200	mg/day	USEPA, 1994[7]
			GREYSTONE MILL POND	FI	FRACTION INGESTED	1	unitless	Professional Judgement[2]
		(ages 1 - 6)	ALLENDALE POND	EF	EXPOSURE FREQUENCY	52	day/yr	Professional Judgement[3]
			LYMAN MILL POND	ED	EXPOSURE DURATION	6	yr	USEPA, 1994[4]
			MANTON REACH	BW	BODY WEIGHT	15	kg	USEPA, 1994
			DYERVILLE REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	
DERMAL	RESIDENT	ADULT	ASSAPUMPSET POND	AF	ADHERENCE FACTOR	0.07	mg/cm2	USEPA, 2001[8]
		(ages 19 and above)	GREYSTONE MILL POND	ABF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[9]
		(Wading)	ALLENDALE POND	SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	4860	cm2/day	USEPA, 1997[7]
			LYMAN MILL POND	EV	EVENT DAY	1	unitless	Professional Judgement
			MANTON REACH	EF	EXPOSURE FREQUENCY	39	day/yr	Professional Judgement[3]
			DYERVILLE REACH	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4,5]
				BW	BODY WEIGHT	70	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		ADOLESCENT	ASSAPUMPSET POND	AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[8]
		(ages 7 - 18)	GREYSTONE MILL POND	ABF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[9]
		(Wading)	ALLENDALE POND	SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	3574	cm2/day	USEPA, 1997[7]
			LYMAN MILL POND	EV	EVENT DAY	1	unitless	Professional Judgement
			MANTON REACH	EF	EXPOSURE FREQUENCY	39	day/yr	Professional Judgement[3]
			DYERVILLE REACH	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4]
				BW	BODY WEIGHT	45	kg	USEPA, 1997[6]
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		CHILD	ASSAPUMPSET POND	AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[8]
		(ages 1 - 6)	GREYSTONE MILL POND	ABF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[9]
		(Wading)	ALLENDALE POND	SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	2800	cm2/day	USEPA, 2001[10]
			LYMAN MILL POND	EV	EVENT DAY	1	unitless	Professional Judgement
			MANTON REACH	EF	EXPOSURE FREQUENCY	52	day/yr	Professional Judgement[3]
			DYERVILLE REACH	ED	EXPOSURE DURATION	6	yr	USEPA, 1994[4]
				BW	BODY WEIGHT	15	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C., December.

USEPA, 1994. *"Risk Updates No. 2"; USEPA Region I, Waste Management Division; August. Values from "Attachment 2" to Risk Updates No. 2.*

USEPA, 1997. "Exposure Factors Handbook, Volume 1"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.

USEPA, 2001. *"Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.*

1 - Soil ingestion rate used because ingestion rates for sediment are not available.

2 - 50% of daily incidental intake of soil and sediment is attributable to incidental sediment ingestion.

3 - Receptor assumed to visit area to wade or swim 4 days per week, June through August. Wading is expected to occur 3 of the 4 days each week and swimming 1 of the days each week. Sediment contact would only occur during wading (not swimming) activities. The child value is based on assumed wading exposure 4 days per week, June through August (the child is assumed to wade while adolescents and adults are swimming).

4 - Representing ages 19 and above of a 30-year residential exposure duration.

5 - The total RME exposure duration is 30 years, consistent with USEPA, 1994. The allocation of exposure duration for the three age groups is based on professional judgement.

Table 3-13
Derivation of Sediment Based Human Health PreMinary Remediation Goals - Direct Contact

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE

6 - Values are the average of 50th percentile body weights for males and females ages 7 through 18.
7 - Values are the average of 50th percentile body surface areas (sum of areas for hands, lower legs, and feet) for males in the various age groups indicated.
8 - Values for residential exposure to soil used as conservative estimate of potential sediment adherence; sediment is submerged, so adherence is unlikely.
9 - Values are provided (Table 3-4 of USEPA, 2001) for arsenic, cadmium, chlordane, 2,4-D, DDT (used for DDD, DDE), TCDD, lindane (used for other BHC isomers), PAHs, PCBs, and pentachlorophenol. A single value is listed for all other SVOCs. No values are listed for VOCs, other pesticides, or other inorganics and, subsequently, no value will be assigned to the ABSd term for COPCs falling into those categories.
10 - Value is the residential soil RME value; it is used to accommodate the possibility that a young child may play in shallow water and contact sediment over more body parts than just feet, lower legs, and hands.
11 - Value based on assumed exposure 1 day per week, June through August. Potential contact with surface water and sediment would not occur during months when the weather and water temperature are colder.
12 - Value based on assumed exposure 8 days per week, May through September. Potential contact with surface water and sediment would not occur during months when the weather and water temperature are colder.

mg - milligrams
cm^2 - square centimeters
kg - kilograms

Based on cancer risk,

$$PRG_{sed,c} = \frac{TR_{sed}}{\left[\left(\frac{CSF_o \times IR_{child} \times FI \times EF_{child} \times ED_{child} \times CF}{BW_{child} \times AT}\right) + \left(\frac{CSF_o \times IR_{elderchild} \times FI \times EF_{elderchild} \times ED_{elderchild} \times CF}{BW_{elderchild} \times AT}\right) + \left(\frac{CSF_o \times IR_{adult} \times FI \times EF_{adult} \times ED_{adult} \times CF}{BW_{adult} \times AT}\right)\right] + \left[\left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{child} \times ED_{child} \times EF_{child} \times SA_{child}}{BW_{child} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{elderchild} \times ED_{elderchild} \times EF_{elderchild} \times SA_{elderchild}}{BW_{elderchild} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]}$$

COMPOUND OF POTENTIAL CONCERN	ORAL SLOPE FACTOR (mg/kg/day)-1	DERMAL SLOPE FACTOR (mg/kg/day)-1	DERMAL ABSORPTION FACTOR [AbF]	PRG ELCR = 10^{-4} (mg/Kg)	PRG ELCR = 10^{-5} (mg/Kg)	PRG ELCR = 10^{-6} (mg/Kg)
Benzo(a)pyrene	7.3	7.3	0.13	40.5	4.0	0.40
Dibenzo(a,h)anthracene	7.3	7.3	0.13	40.5	4.0	0.40
Ni-nitroso-di-n-propylamine	7	7	0.1	45.6	4.6	0.46
Arsenic	1.5	1.5	0.03	262	26.2	2.6
2,3,7,8-TCDD	150000	150000	0.03	0.0026	0.00026	0.000026

NC - not carcinogenic
--- No PRG calculated

Based on non-cancer risk,

$$PRG_{sed,nc} = \frac{THI}{\left[\left(\frac{CF \times IR_{agegroup} \times FI \times EF_{agegroup} \times ED_{agegroup}}{RfD_o \times BW_{agegroup} \times AT}\right) + \left(\frac{AF \times ABS \times CF \times EV_{agegroup} \times ED_{agegroup} \times EF_{agegroup} \times SA_{agegroup}}{RfD_d \times BW_{agegroup} \times AT}\right)\right]}$$

COMPOUND OF POTENTIAL CONCERN	ORAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL ABSORPTION FACTOR [AbF]	PRG ADULT HI = 0.1 (mg/Kg)	PRG ADULT HI = 1 (mg/Kg)	PRG ADULT HI = 10 (mg/Kg)	PRG ADOLESCENT HI = 0.1 (mg/Kg)	PRG ADOLESCENT HI = 1 (mg/Kg)	PRG ADOLESCENT HI = 10 (mg/Kg)	PRG CHILD HI = 0.1 (mg/Kg)	PRG CHILD HI = 1 (mg/Kg)	PRG CHILD HI = 10 (mg/Kg)
Benzo(a)pyrene	0.03	0.03	0.13	13627	136271	1362712	6549	65490	654901	1158	11579	115786
Dibenzo(a,h)anthracene	0.03	0.03	0.13	13627	136271	1362712	6549	65490	654901	1158	11579	115786
Ni-nitroso-di-n-propylamine	NA	NA	0.1	---	---	---	---	---	---	---	---	---
Arsenic	0.0003	0.0003	0.03	178	1783	17834	104	1040	10404	15	146	1457
2,3,7,8-TCDD	NA	NA	0.03	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated

Table 3-13
Derivation of Sediment Based Human Health Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE
INGESTION	RECREATIONAL ANGLER	ADULT (ages 19 and above)	ASSAPUMPSET POND	IR-S	INGESTION RATE OF SEDIMENT	100	mg/day	USEPA, 1994[1]
			GREYSTONE MILL POND	FI	FRACTION INGESTED	0.5	unitless	Professional Judgement[2]
			ALLENDALE POND	EF	EXPOSURE FREQUENCY	13	day/yr	Professional Judgement[11]
			LYMAN MILL POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[5]
			MANTON REACH	BW	BODY WEIGHT	70	kg	USEPA, 1994
			DYERVILLE REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		ADOLESCENT (ages 7 - 18)	ASSAPUMPSET POND	IR-S	INGESTION RATE OF SEDIMENT	100	mg/day	USEPA, 1994[1]
			GREYSTONE MILL POND	FI	FRACTION INGESTED	0.5	unitless	Professional Judgement[2]
			ALLENDALE POND	EF	EXPOSURE FREQUENCY	13	day/yr	Professional Judgement[11]
			LYMAN MILL POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[5]
			MANTON REACH	BW	BODY WEIGHT	45	kg	USEPA, 1997[6]
			DYERVILLE REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	
DERMAL	RECREATIONAL ANGLER	ADULT (ages 19 and above)	ASSAPUMPSET POND	AF	ADHERENCE FACTOR	0.07	mg/cm2	USEPA, 2001[8]
			GREYSTONE MILL POND	ABF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[9]
			ALLENDALE POND	SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	4860	cm2/day	USEPA, 1997[7]
			LYMAN MILL POND	EV	EVENT DAY	1	unitless	Professional Judgement
			MANTON REACH	EF	EXPOSURE FREQUENCY	13	day/yr	Professional Judgement[11]
			DYERVILLE REACH	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[5]
				BW	BODY WEIGHT	70	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		ADOLESCENT (ages 7 - 18)	ASSAPUMPSET POND	AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[8]
			GREYSTONE MILL POND	ABF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[9]
			ALLENDALE POND	SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	3374	cm2/day	USEPA, 1997[7]
			LYMAN MILL POND	EV	EVENT DAY	1	unitless	Professional Judgement
			MANTON REACH	EF	EXPOSURE FREQUENCY	13	day/yr	Professional Judgement[11]
			DYERVILLE REACH	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[5]
				BW	BODY WEIGHT	45	kg	USEPA, 1997[6]
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C., December.

USEPA, 1994. "Risk Updates No. 2"; USEPA Region I, Waste Management Division; August. Values from "Attachment 2" to Risk Updates No. 2.

USEPA, 1997. "Exposure Factors Handbook, Volume 1"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.

USEPA, 2001. *"Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.*

1 - Soil ingestion rate used because ingestion rates for sediment are not available.

2 - 50% of daily incidental intake of soil and sediment is attributable to incidental sediment ingestion.

3 - Receptor assumed to visit area to wade or swim 4 days per week, June through August. Wading is expected to occur 3 of the 4 days each week and swimming 1 of the days each week. Sediment contact would only occur during wading (not swimming) activities. The child value is based on assumed wading exposure 4 days per week, June through August (the child is assumed to wade while adolescents and adults are swimming).

4 - Representing ages 19 and above of a 30-year residential exposure duration.

5 - The total RME exposure duration is 30 years, consistent with USEPA, 1994. The allocation of exposure duration for the three age groups is based on professional judgement.

6 - Values are the average of 50th percentile body weights for males and females ages 7 through 18.

7 - Values are the average of 50th percentile body surface areas (sum of areas for hands, lower legs, and feet) for males in the various age groups indicated.

8 - Values for residential exposure to soil used as conservative estimate of potential sediment adherence; sediment is submerged, so adherence is unlikely.

9 - Values are provided (Table 3-4 of USEPA, 2001) for arsenic, cadmium, chlordane, 2,4-D, DDT (used for DDD, DDE), TCDD, lindane (used for other BHC isomers), PAHs, PCBs, and pentachlorophenol. A single value is listed for all other SVOCs. *No values are listed for VOCs, other pesticides, or other inorganics and, subsequently, no value will be assigned to the ABSd term for COPCs falling into those categories.*

10 - Value is the residential soil RME value; it is used to accommodate the possibility that a young child may play in shallow water and contact sediment over more body parts than just feet, lower legs, and hands.

11 - Value based on assumed exposure 1 day per week, June through August. *Potential contact with surface water and sediment would not occur during months when the weather and water temperature are colder.*

12 - Value based on assumed exposure 6 days per week, May through September. Potential contact with surface water and sediment would not occur during months when the weather and water temperature are colder.

mg - milligrams
cm^2 - square centimeters
kg - kilograms

Table 3-13
Derivation of Sediment Based Human Health Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SEDIMENT
EXPOSURE MEDIUM: SEDIMENT

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE

Based on cancer risk,

$$PRG_{sed,c} = \frac{TR_{ind}}{\left[\left(\frac{CSF_o \times IR_{elderchild\ d} \times FI \times EF_{elderchild} \times ED_{elderchild} \times CF}{BW_{elderchild} \times AT}\right) + \left(\frac{CSF_o \times IR_{adult} \times FI \times EF_{adult} \times ED_{adult} \times CF}{BW_{adult} \times AT}\right)\right] + \left[\left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{elderchild} \times ED_{elderchild} \times EF_{elderchild} \times SA_{elderchild}}{BW_{elderchild} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]}$$

COMPOUND OF POTENTIAL CONCERN	ORAL SLOPE FACTOR (mg/kg/day)-1	DERMAL SLOPE FACTOR (mg/kg/day)-1	DERMAL ABSORPTION FACTOR (ABF)	PRG ELCR = 10^{-5} (mg/Kg)	PRG ELCR = 10^{-4} (mg/Kg)	PRG ELCR = 10^{-4} (mg/Kg)
Benzo(a)pyrene	7.3	7.3	0.13	496	49.6	5.0
Dibenzo(a,h)anthracene	7.3	7.3	0.13	496	49.6	5.0
Ni-nitroso-di-n-propylamine	7	7	0.1	600	60.0	6.0
Arsenic	1.5	1.5	0.03	4461	446	44.6
2,3,7,8-TCDD	150000	150000	0.03	0.045	0.0045	0.00045

NC - not carcinogenic
--- No PRG calculated

Based on non-cancer risk,

$$PRG_{sed,nc} = \frac{THI}{\left(\frac{CF \times IR_{agegroup} \times FI \times EF_{agegroup} \times ED_{agegroup}}{RfD \times BW_{agegroup} \times AT}\right) + \left(\frac{AF \times ABS \times CF \times EV_{agegroup} \times ED_{agegroup} \times EF_{agegroup} \times SA_{agegroup}}{RfD \times BW_{agegroup} \times AT}\right)}$$

COMPOUND OF POTENTIAL CONCERN	ORAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL ABSORPTION FACTOR (AbF)	PRG ADULT HI = 0.1 (mg/Kg)	PRG ADULT HI = 1 (mg/Kg)	PRG ADULT HI = 10 (mg/Kg)	PRG ADOLESCENT HI = 0.1 (mg/Kg)	PRG ADOLESCENT HI = 1 (mg/Kg)	PRG ADOLESCENT HI = 10 (mg/Kg)
Benzo(a)pyrene	0.03	0.03	0.13	62575	625746	6257460	26520	265203	2652028
Dibenzo(a,h)anthracene	0.03	0.03	0.13	62575	625746	6257460	26520	265203	2652028
Ni-nitroso-di-n-propylamine	NA	NA	0.1	---	---	---	---	---	---
Arsenic	0.0003	0.0003	0.03	979	9793	97933	531	5305	53054
2,3,7,8-TCDD	NA	NA	0.03	---	---	---	---	---	---

Prepared by: KJA
Checked by: MJM

Table 3-14
Derivation of Surface Soil Human Health Preliminary Remediation Goals - Industrial/Commercial Land Use

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SOIL
EXPOSURE MEDIUM: SURFACE SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE
INGESTION	COMMERCIAL / INDUSTRIAL WORKER	ADULT	FOGARTY CENTER	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table
				IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994[1]
				FI	FRACTION INGESTED	0.5	unitless	Professional Judgement[2]
				EF	EXPOSURE FREQUENCY	150	day/yr	USEPA, 1994
				ED	EXPOSURE DURATION	25	yr	USEPA, 1994
				BW	BODY WEIGHT	70	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	9125	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	
DERMAL	COMMERCIAL / INDUSTRIAL WORKER	ADULT	FOGARTY CENTER	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table
				AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[3]
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[3]
				SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	3300	cm2/day	USEPA, 2001
				EV	EVENT DAY	1	unitless	Professional Judgement
				EF	EXPOSURE FREQUENCY	150	day/yr	USEPA, 1994
				ED	EXPOSURE DURATION	25	yr	USEPA, 1994
				BW	BODY WEIGHT	70	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	9125	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; *Office of Emergency and Remedial Response*; EPA-540/1-89/002 *(interim final)*; Washington, D.C., December.

USEPA, 1994. "Risk Updates No. 2"; USEPA Region I, Waste Management Division; August. Values from "Attachment 2" to Risk Updates No. 2.

USEPA, 1997. "Exposure Factors Handbook, Volume 1"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C ; August.

USEPA, 2001. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

1 - Soil ingestion rate used.

2 - 50% of daily incidental intake of soil and sediment is attributable to incidental ingestion of soil at bank

3 - Values are provided (Table 3-4 of USEPA, 2001) for arsenic, cadmium, chlordane, 2,4-D, DDT (used for DDD, DDE), TCDD, lindane (used for other BHC isomers), PAHs, PCBs, and pentachlorophenol. A single value is listed for all other SVOCs. *No values are listed for VOCs, other pesticides, or other inorganics and, subsequently, no value will be assigned to the ABSd term for COPCs falling into those categories.*

mg - milligrams
cm^2 - square centimeters
kg - kilograms

Table 3-14
Derivation of Surface Soil Human Health Preliminary Remediation Goals - Industrial/Commercial Land Use

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SOIL
EXPOSURE MEDIUM: SURFACE SOIL

Based on cancer risk,

$$PRG_{ind,c} = \frac{TR_{ind}}{\left[\left(\frac{CSF_o \times IR_{adult} \times FI \times EF_{adult} \times ED_{adult} \times CF}{BW_{adult} \times AT}\right)\right] + \left[\left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]}$$

COMPOUND OF POTENTIAL CONCERN	ORAL SLOPE FACTOR (mg/kg/day)-1	DERMAL SLOPE FACTOR (mg/kg/day)-1	DERMAL ABSORPTION FACTOR (AbF)	PRG ELCR = 10^{-4} (mg/Kg)	PRG ELCR = 10^{-5} (mg/Kg)	PRG ELCR = 10^{-6} (mg/Kg)
Benzo(a)pyrene	7.3	7.3	0.13	48.1	4.8	0.48
Arsenic	1.5	1.5	0.03	456	45.6	4.6

NC - not carcinogenic
--- No PRG calculated

Based on non-cancer risk,

$$PRG_{ind,nc} = \frac{THI}{\left[\left(\frac{CF \times IR_{agegroup} \times EF_{agegroup} \times ED_{agegroup}}{RfD_o \times BW_{agegroup} \times AT}\right) + \left(\frac{AF \times ABS \times CF \times EV_{agegroup} \times ED_{agegroup} \times EF_{agegroup} \times SA_{agegroup}}{RfD_d \times BW_{agegroup} \times AT}\right)\right]}$$

COMPOUND OF POTENTIAL CONCERN	ORAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL ABSORPTION FACTOR (AbF)	PRG ADULT HI = 0.1 (mg/Kg)	PRG ADULT HI = 1 (mg/Kg)	PRG ADULT HI = 10 (mg/Kg)
Benzo(a)pyrene	0.03	0.03	0.13	3763	37629	376289
Arsenic	0.0003	0.0003	0.03	73.2	732	7321

NA - not available
--- No PRG calculated

Prepared by: KJA
Checked by: MJM

Table 3-15
Derivation of Bank Soil Based Human Health Preliminary Remediation Goals - Direct Contact

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: BANK SOIL
EXPOSURE MEDIUM: BANK SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE
INGESTION	RESIDENT	ADULT	GREYSTONE MILL POND	IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994[1]
			ALLENDALE POND	FI	FRACTION INGESTED	1	unitless	Professional Judgement
		(ages 19 and above)		EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4,5]
				BW	BODY WEIGHT	70	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		ADOLESCENT	GREYSTONE MILL POND	IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994[1]
			ALLENDALE POND	FI	FRACTION INGESTED	1	unitless	Professional Judgement
		(ages 7 - 18)		EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4]
				BW	BODY WEIGHT	45	kg	USEPA, 1997[6]
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		CHILD	GREYSTONE MILL POND	IR-S	INGESTION RATE OF SOIL	200	mg/day	USEPA, 1994[1]
			ALLENDALE POND	FI	FRACTION INGESTED	1	unitless	Professional Judgement
		(ages 1 - 6)		EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]
				ED	EXPOSURE DURATION	6	yr	USEPA, 1994[3]
				BW	BODY WEIGHT	15	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	
DERMAL	RESIDENT	ADULT	GREYSTONE MILL POND	AF	ADHERENCE FACTOR	0.07	mg/cm2	USEPA, 2001[7]
		(ages 19 and above)	ALLENDALE POND	AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]
		(Wading)		SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	5700	cm2/day	USEPA, 2001[10]
				EV	EVENT DAY	1	unitless	Professional Judgement
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4,5]
				BW	BODY WEIGHT	70	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		ADOLESCENT	GREYSTONE MILL POND	AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[8]
		(ages 7 - 18)	ALLENDALE POND	AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[8]
		(Wading)		SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	4800	cm2/day	USEPA, 1997[9]
				EV	EVENT DAY	1	unitless	Professional Judgement
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[4]
				BW	BODY WEIGHT	45	kg	USEPA, 1997[6]
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		CHILD	GREYSTONE MILL POND	AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[8]
		(ages 1 - 6)	ALLENDALE POND	AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[8]
		(Wading)		SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	2800	cm2/day	USEPA, 2001[10]
				EV	EVENT DAY	1	unitless	Professional Judgement
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[2]
				ED	EXPOSURE DURATION	6	yr	USEPA, 1994[3]
				BW	BODY WEIGHT	15	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C., December.
USEPA, 1994. "Risk Updates No. 2"; USEPA Region I, Waste Management Division; August. Values from "Attachment 2" to Risk Updates No. 2.
USEPA, 1997. "Exposure Factors Handbook, Volume 1"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.
USEPA, 2001. "Risk Assessment Guidance for Superfund. *Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.*
1 - Soil ingestion rate used.
2 - 50% of daily incidental intake of soil and sediment is attributable to incidental ingestion of soil at bank.
3 - Value based on exposure during wading, swimming, and walking/exploring banks (4 days per week June - August), and walking/exploring banks (2 days per week May, Sept, Oct).
4 - Representing ages 19 and above of a 30-year residential exposure duration.
5 - The total RME exposure duration is 30 years, consistent with USEPA, 1994. The allocation of exposure duration for the three age groups is based on professional judgement.
6 - Values are the average of 50th percentile body weights for males and females ages 7 through 18.

Table 3-15
Derivation of Bank Soil Based Human Health Preliminary Remediation Goals - Direct Contact

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: BANK SOIL
EXPOSURE MEDIUM: BANK SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE

7 - Values are the average of 50th percentile body surface areas (sum of areas for face, hands, forearms, lower legs, and feet) for males in the various age groups indicated.
8 - Values for residential exposure to soil used as conservative estimate of potential soil adherence associated with recreational walking/exploring.
9 - Values are provided (Table 3-4 of USEPA, 2001) for arsenic, cadmium, chlordane, 2,4-D, DDT (used for DDD, DDE), TCDD, lindane (used for other BHC isomers), PAHs, PCBs, and pentachlorophenol. A single value is listed for all other SVOCs.
No values are listed for VOCs, other pesticides, or other inorganics and, subsequently, no value will be assigned to the ABSd term for COPCs falling into those categories.
10 - Values for residential exposure to soil used as conservative estimate of potential surface area exposed to soil during recreational walking/exploring.
11 - Contact with soil assumed to occur when accessing water bodies for angling (assumed exposure 1 day per week, June through August).
12 - Contact with soil assumed to occur when accessing water bodies for angling; this is assumed to occur 8 days per week, April through November.

mg - milligrams
cm^2 - square centimeters
kg - kilograms

Based on cancer risk,

$$PRG_{soil-v} = \frac{TR_{soil}}{\left[\left(\frac{CSF_o \times IR_{child} \times FI \times EF_{child} \times ED_{child} \times CF}{BW_{child} \times AT}\right) + \left(\frac{CSF_o \times IR_{olderchild} \times FI \times EF_{olderchild} \times ED_{olderchild} \times CF}{BW_{olderchild} \times AT}\right) + \left(\frac{CSF_o \times IR_{adult} \times FI \times EF_{adult} \times ED_{adult} \times CF}{BW_{adult} \times AT}\right)\right] + \left[\left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{child} \times ED_{child} \times EF_{child} \times SA_{child}}{BW_{child} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{olderchild} \times ED_{olderchild} \times EF_{olderchild} \times SA_{olderchild}}{BW_{olderchild} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]}$$

COMPOUND OF POTENTIAL CONCERN	ORAL SLOPE FACTOR (mg/kg/day)-1	DERMAL SLOPE FACTOR (mg/kg/day)-1	DERMAL ABSORPTION FACTOR [AbF]	PRG ELCR = 10^{-6} (mg/Kg)	PRG ELCR = 10^{-5} (mg/Kg)	PRG ELCR = 10^{-4} (mg/Kg)
2,3,7,8-TCDD	150000	150000	0.03	0.0016	0.00016	0.000016

NC - not carcinogenic
--- No PRG calculated

Based on non-cancer risk,

$$PRG_{soil,nc} = \frac{THI}{\left[\left(\frac{CF \times IR_{agegroup} \times FI \times EF_{agegroup} \times ED_{agegroup}}{RfD \times BW_{agegroup} \times AT}\right) + \left(\frac{AF \times ABS \times CF \times EV_{agegroup} \times ED_{agegroup} \times EF_{agegroup} \times SA_{agegroup}}{RfD \times BW_{agegroup} \times AT}\right)\right]}$$

COMPOUND OF POTENTIAL CONCERN	ORAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL ABSORPTION FACTOR [AbF]	PRG ADULT HI = 0.1 (mg/Kg)	PRG ADULT HI = 1 (mg/Kg)	PRG ADULT HI = 10 (mg/Kg)	PRG ADOLESCENT HI = 0.1 (mg/Kg)	PRG ADOLESCENT HI = 1 (mg/Kg)	PRG ADOLESCENT HI = 10 (mg/Kg)	PRG CHILD HI = 0.1 (mg/Kg)	PRG CHILD HI = 1 (mg/Kg)	PRG CHILD HI = 10 (mg/Kg)
2,3,7,8-TCDD	NA	NA	0.03	---	---	---	---	---	---	---	---	---

NA - not available
--- No PRG calculated

Table 3-15
Derivation of Bank Soil Based Human Health Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: BANK SOIL
EXPOSURE MEDIUM: BANK SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE
INGESTION	RECREATIONAL ANGLER	ADULT (ages 19 and above)	ASSAPUMPSET POND	IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994[1]
			GREYSTONE MILL POND	FI	FRACTION INGESTED	0.5	unitless	Professional Judgement[2]
			ALLENDALE POND	EF	EXPOSURE FREQUENCY	13	day/yr	Professional Judgement[11]
			LYMAN MILL POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3]
			MANTON REACH	BW	BODY WEIGHT	70	kg	USEPA, 1994
			DYERVILLE REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		ADOLESCENT (ages 7 - 18)	ASSAPUMPSET POND	IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994[1]
			GREYSTONE MILL POND	FI	FRACTION INGESTED	0.5	unitless	Professional Judgement[2]
			ALLENDALE POND	EF	EXPOSURE FREQUENCY	13	day/yr	Professional Judgement[11]
			LYMAN MILL POND	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3]
			MANTON REACH	BW	BODY WEIGHT	45	kg	USEPA, 1997[6]
			DYERVILLE REACH	AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	
DERMAL	RECREATIONAL ANGLER	ADULT (ages 19 and above)	ASSAPUMPSET POND	AF	ADHERENCE FACTOR	0.07	mg/cm2	USEPA, 2001[8]
			GREYSTONE MILL POND	AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[9]
			ALLENDALE POND	SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	5700	cm2/day	USEPA, 2001[10]
			LYMAN MILL POND	EV	EVENT DAY	1	unitless	Professional Judgement
			MANTON REACH	EF	EXPOSURE FREQUENCY	13	day/yr	Professional Judgement[11]
			DYERVILLE REACH	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3]
				BW	BODY WEIGHT	70	kg	USEPA, 1994
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
		ADOLESCENT (ages 7 - 18)	ASSAPUMPSET POND	AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[8]
			GREYSTONE MILL POND	AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[9]
			ALLENDALE POND	SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	4800	cm2/day	USEPA, 1997[7]
			LYMAN MILL POND	EV	EVENT DAY	1	unitless	Professional Judgement
			MANTON REACH	EF	EXPOSURE FREQUENCY	13	day/yr	Professional Judgement[11]
			DYERVILLE REACH	ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3]
				BW	BODY WEIGHT	45	kg	USEPA, 1997[6]
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989
				CF	CONVERSION FACTOR	0.000001	kg/mg	

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final): Washington, D.C., December.

USEPA, 1994. "Risk Updates No. 2"; USEPA Region I, Waste Management Division; August. Values from "Attachment 2" to Risk Updates No. 2.

USEPA, 1997. "Exposure Factors Handbook, Volume 1"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.

USEPA, 2001. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

1 - Soil ingestion rate used.

2 - 50% of daily incidental intake of soil and sediment is attributable to incidental ingestion of soil at bank.

3 - Value based on exposure during wading, swimming, and walking/exploring banks (4 days per week June - August), and walking/exploring banks (2 days per week May, Sept, Oct).

4 - Representing ages 19 and above of a 30-year residential exposure duration.

5 - The total RME exposure duration is 30 years, consistent with USEPA, 1994. The allocation of exposure duration for the three age groups is based on professional judgement.

6 - Values are the average of 50th percentile body weights for males and females ages 7 through 18.

7 - Values are the average of 50th percentile body surface areas (sum of areas for face, hands, forearms, lower legs, and feet) for males in the various age groups indicated.

8 - Values for residential exposure to soil used as conservative estimate of potential soil adherence associated with recreational walking/exploring.

9 - Values are provided (Table 3-4 of USEPA, 2001) for arsenic, cadmium, chlordane, 2,4-D, DDT (used for DDD, DDE), TCDD, lindane (used for other BHC isomers), PAHs, PCBs, and pentachlorophenol. A single value is listed for all other SVOCs. No values are listed for VOCs, other pesticides, or other inorganics and, subsequently, no value will be assigned to the ABSd term for COPCs falling into those categories.

10 - Values for residential exposure to soil used as conservative estimate of potential surface area exposed to soil during recreational walking/exploring.

11 - Contact with soil assumed to occur when accessing water bodies for angling (assumed exposure 1 day per week, June through August).

12 - Contact with soil assumed to occur when accessing water bodies for angling; this is assumed to occur 6 days per week, April through November.

mg - milligrams
cm^2 - square centimeters
kg - kilograms

Table 3-15
Derivation of Bank Soil Based Human Health Preliminary Remediation Goals

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE MEDIUM: BANK SOIL EXPOSURE MEDIUM: BANK SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE

Based on cancer risk,

$$PRG_{soil,\,c} = \frac{TR_{soil}}{\left[\left(\frac{CSF_o \times IR_{olderchild\,d} \times FI \times EF_{olderchild} \times ED_{olderchild} \times CF}{BW_{olderchild} \times AT}\right) + \left(\frac{CSF_o \times IR_{adult} \times FI \times EF_{adult} \times ED_{adult} \times CF}{BW_{adult} \times AT}\right)\right] + \left[\left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{olderchild} \times ED_{olderchild} \times EF_{olderchild} \times SA_{olderchild}}{BW_{olderchild} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]}$$

COMPOUND OF POTENTIAL CONCERN	ORAL SLOPE FACTOR (mg/kg/day)-1	DERMAL SLOPE FACTOR (mg/kg/day)-1	DERMAL ABSORPTION FACTOR [AbF]	PRG ELCR = 10^{-5} (mg/Kg)	PRG ELCR = 10^{-4} (mg/Kg)	PRG ELCR = 10^{-6} (mg/Kg)
2,3,7,8-TCDD	150000	150000	0.03	0.041	0.0041	0.00041

NC - not carcinogenic
--- No PRG calculated

Based on non-cancer risk,

$$PRG_{soil,nc} = \frac{THI}{\left[\left(\frac{CF \times IR_{agegroup} \times FI \times EF_{agegroup} \times ED_{agegroup}}{RfD \times BW_{agegroup} \times AT}\right) + \left(\frac{AF \times ABS \times CF \times EV_{agegroup} \times ED_{agegroup} \times EF_{agegroup} \times SA_{agegroup}}{RfD \times BW_{agegroup} \times AT}\right)\right]}$$

COMPOUND OF POTENTIAL CONCERN	ORAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL CHRONIC REFERENCE DOSE (mg/kg/day)	DERMAL ABSORPTION FACTOR [AbF]	PRG ADULT HI = 0.1 (mg/Kg)	PRG ADULT HI = 1 (mg/Kg)	PRG ADULT HI = 10 (mg/Kg)	PRG ADOLESCENT HI = 0.1 (mg/Kg)	PRG ADOLESCENT HI = 1 (mg/Kg)	PRG ADOLESCENT HI = 10 (mg/Kg)
2,3,7,8-TCDD	NA	NA	0.03	---	---	---	---	---	---

Table 3-16
PRGs for Fish Tissue, Sediment, Banks Soil, and Surface Soil

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Fish Tissue (human consumption) PRGs
Resident Living Along the River and Visiting Recreational Angler

COMPOUND OF POTENTIAL CONCERN	PRG ELCR = 10-4 (mg/kg)	PRG ELCR = 10-5 (mg/kg)	PRG ELCR = 10-6 (mg/kg)	PRG ADULT HI = 0.1 (mg/kg)	PRG ADULT HI = 1 (mg/kg)	PRG ADULT HI = 10 (mg/kg)	PRG ADOLESCENT HI = 0.1 (mg/kg)	PRG ADOLESCENT HI = 1 (mg/kg)	PRG ADOLESCENT HI = 10 (mg/kg)	PRG CHILD HI = 0.1 (mg/kg)	PRG CHILD HI = 1 (mg/kg)	PRG CHILD HI = 10 (mg/kg)
Benzo(a)pyrene	0.15	0.015	0.0015	15.6	156	1564	15.3	153	1514	10.0	100	998
4,4-DDE	1.2	0.12	0.012	0.26	2.6	26	0.25	2.5	25.2	0.17	1.7	16.6
Aroclor-1254	0.54	0.054	0.0054	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Aroclor-1268	0.54	0.054	0.0054	0.010	0.10	1.0	0.010	0.10	1.0	0.0067	0.067	0.67
Dieldrin	0.063	0.0063	0.00063	0.026	0.26	2.6	0.025	0.25	2.5	0.017	0.17	1.7
Technical Chlordane	1.1	0.11	0.011	0.26	2.6	26.1	0.25	2.5	25.2	0.17	1.7	16.6
Coplanar PCB TEQ	0.00000072	0.000000072	0.0000000072	---	---	---	---	---	---	---	---	---
2,3,7,8-TCDD	0.00000072	0.000000072	0.0000000072	---	---	---	---	---	---	---	---	---

NC - not carcinogenic
--- No PRG calculated

Sediment (combined fish diet) PRGs
Resident Living Along the River and Visiting Recreational Angler

COMPOUND OF POTENTIAL CONCERN	PRG ELCR = 10-4 (mg/kg)	PRG ELCR = 10-5 (mg/kg)	PRG ELCR = 10-6 (mg/kg)	PRG ADULT HI = 0.1 (mg/kg)	PRG ADULT HI = 1 (mg/kg)	PRG ADULT HI = 10 (mg/kg)	PRG ADOLESCENT HI = 0.1 (mg/kg)	PRG ADOLESCENT HI = 1 (mg/kg)	PRG ADOLESCENT HI = 10 (mg/kg)	PRG CHILD HI = 0.1 (mg/kg)	PRG CHILD HI = 1 (mg/kg)	PRG CHILD HI = 10 (mg/kg)
Benzo(a)pyrene	1.69	0.169	0.0169	138.15	1382.51	13824.96	1.1366	11.366	113.66.28	0.475	0.475	0.475
4,4-DDE	13	1.3	0.133	0.068	0.68	6.8	0.0567	0.567	5.76	0.0395	0.395	3.9
Aroclor-1254	6.10	0.610	0.0610	0.0265	0.265	2.65	0.0221	0.221	2.21	0.00156	0.0156	0.156
Aroclor-1268	6.10	0.610	0.0610	0.0265	0.265	2.65	0.0221	0.221	2.21	0.0154	0.154	1.54
Dieldrin	0.716	0.0716	0.00716	0.0663	0.663	6.63	0.0552	0.552	5.51	0.0385	0.385	3.85
Technical Chlordane	8.8	0.88	0.088	0.249	2.49	19	0.207	2.07	17.4	0.144	1.44	12.1
Coplanar PCB TEQ	0.000000815	0.0000000815	0.00000000815									
2,3,7,8-TCDD	0.000000815	0.0000000815	0.00000000815									

NC - not carcinogenic
--- No PRG calculated

Sediment Direct Contact PRGs
Resident Living Along the River

COMPOUND OF POTENTIAL CONCERN			PRG ELCR = 10-4 (mg/kg)	PRG ELCR = 10-5 (mg/kg)	PRG ELCR = 10-6 (mg/kg)	PRG ADULT HI = 0.1 (mg/kg)	PRG ADULT HI = 1 (mg/kg)	PRG ADULT HI = 10 (mg/kg)	PRG ADOLESCENT HI = 0.1 (mg/kg)	PRG ADOLESCENT HI = 1 (mg/kg)	PRG ADOLESCENT HI = 10 (mg/kg)	PRG CHILD HI = 0.1 (mg/kg)	PRG CHILD HI = 1 (mg/kg)	PRG CHILD HI = 10 (mg/kg)
Benzo(a)pyrene			0.15	0.015	0.0015	13.62	136.271	1,362.712	6,430	65,490	654,901	1,158	11,570	115,786
Dibenz(a,h)anthracene			0.15	0.015	0.0015	13.62	136.271	1,362.712	6,430	65,490	654,901	1,158	11,570	115,786
N-nitrosodi-n-propylamine			45.6	4.6	0.46	---	---	---	---	---	---	---	---	---
Arsenic			26.2	26.2	2.6	178	1,783	17,834	104	1,026	10,404	15	146	1,457
2,3,7,8-TCDD			0.00026	0.00026	0.00026	---	---	---	---	---	---	---	---	---

NC - not carcinogenic
--- No PRG calculated

Table 3-16
PRGs for Fish Tissue, Sediment, Banks Soil, and Surface Soil

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Sediment Direct Contact PRGs
Visiting Recreational Angler

COMPOUND OF POTENTIAL CONCERN			PRG ELCR = 10-4 (mg/kg)	PRG ELCR = 10-5 (mg/kg)	PRG ELCR = 10-6 (mg/kg)	PRG ADULT HI = 0.1 (mg/kg)	PRG ADULT HI = 1 (mg/kg)	PRG ADULT HI = 10 (mg/kg)	PRG ADOLESCENT HI = 0.1 (mg/kg)	PRG ADOLESCENT HI = 1 (mg/kg)	PRG ADOLESCENT HI = 10 (mg/kg)
Benzo(a)pyrene			406	40.6	5.0	62,375	623,746	6,247,460	26,520	265,203	2,652,028
Dibenz(a,h)anthracene			406	40.6	4.0	62,375	623,746	6,247,460	26,520	265,203	2,652,028
N-nitroso-di-n-propylamine			600	60.0	6.0	...	...	...	...	...	...
Arsenic			4465	446	44.6	970	9,701	97,055	531	5,305	53054
2,3,7,8-TCDD			0.0045	0.00045	0.000045	...	...	...	...	...	...

NC = not carcinogenic
--- No PRG calculated

Surface Soil Direct Contact PRGs
Worker at Fogarty Center

COMPOUND OF POTENTIAL CONCERN			PRG ELCR = 10-4 (mg/kg)	PRG ELCR = 10-5 (mg/kg)	PRG ELCR = 10-6 (mg/kg)	PRG ADULT HI = 0.1 (mg/kg)	PRG ADULT HI = 1 (mg/kg)	PRG ADULT HI = 10 (mg/kg)
Benzo(a)pyrene			48.1	4.8	0.48	3,765	37,629	376,289
Arsenic			456	45.6	4.6	23.21	232.09	2,321

NC = not carcinogenic
--- No PRG calculated

Bank Soil Direct Contact PRGs
Resident

COMPOUND OF POTENTIAL CONCERN	PRG ELCR = 10-4 (mg/kg)	PRG ELCR = 10-5 (mg/kg)	PRG ELCR = 10-6 (mg/kg)	PRG ADULT HI = 0.1 (mg/kg)	PRG ADULT HI = 1 (mg/kg)	PRG ADULT HI = 10 (mg/kg)	PRG ADOLESCENT HI = 0.1 (mg/kg)	PRG ADOLESCENT HI = 1 (mg/kg)	PRG ADOLESCENT HI = 10 (mg/kg)	PRG CHILD HI = 0.1 (mg/kg)	PRG CHILD HI = 1 (mg/kg)	PRG CHILD HI = 10 (mg/kg)
2,3,7,8-TCDD	0.0016	0.00016	0.000016	...	...	...	...	...	...	...	...	...

NC = not carcinogenic
--- No PRG calculated

Bank Soil Direct Contact PRGs
Visiting Recreational Angler

COMPOUND OF POTENTIAL CONCERN	PRG ELCR = 10-4 (mg/kg)	PRG ELCR = 10-5 (mg/kg)	PRG ELCR = 10-6 (mg/kg)	PRG ADULT HI = 0.1 (mg/kg)	PRG ADULT HI = 1 (mg/kg)	PRG ADULT HI = 10 (mg/kg)	PRG ADOLESCENT HI = 0.1 (mg/kg)	PRG ADOLESCENT HI = 1 (mg/kg)	PRG ADOLESCENT HI = 10 (mg/kg)	PRG CHILD HI = 0.1 (mg/kg)	PRG CHILD HI = 1 (mg/kg)	PRG CHILD HI = 10 (mg/kg)
2,3,7,8-TCDD	0.041	0.0041	0.00041	...	...	...	...	...	...	...	...	...

NC = not carcinogenic
--- No PRG calculated

Prepared by: BJR
Checked by: KJA

Table 4-1
Derivation of Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet - Cancer Risk - Alternate Approach for Allendale Pond

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG (1)		
		ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)
ASSAPUMPSET	Benzo(a)pyrene	146	14.6	1.5	123	12.3	1.2	127	12.7	1.3	132	13.2	1.3
	4,4-DDE	0.69	0.069	0.0069	1.0	0.10	0.010	2.8	0.28	0.028	1.5	0.15	0.015
	Aroclor-1254	0.89	0.089	0.0089	1.8	0.18	0.018	2.6	0.26	0.026	1.8	0.18	0.018
	Aroclor-1268	0.44	0.044	0.0044	0.47	0.047	0.0047	0.68	0.068	0.0068	0.53	0.053	0.0053
	Dieldrin	0.11	0.011	0.0011	0.17	0.017	0.0017	0.24	0.024	0.0024	0.17	0.017	0.0017
	Technical Chlordane	1.6	0.16	0.016	1.9	0.19	0.019	2.8	0.28	0.028	2.1	0.21	0.021
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	2,3,7,8-TCDD	0.000072	0.0000072	0.00000072	0.000039	0.0000039	0.00000039	0.000019	0.0000019	0.00000019	0.000043	0.0000043	0.00000043
GREYSTONE	Benzo(a)pyrene	143	14.3	1.4	119	11.9	1.2	278	27.8	2.8	180	18.0	1.8
	4,4-DDE	0.49	0.049	0.0049	0.32	0.032	0.0032	2.7	0.27	0.027	1.2	0.12	0.012
	Aroclor-1254	0.35	0.035	0.0035	0.35	0.035	0.0035	2.5	0.25	0.025	1.1	0.11	0.011
	Aroclor-1268	0.55	0.055	0.0055	1.0	0.10	0.010	2.2	0.22	0.022	1.3	0.13	0.013
	Dieldrin	0.060	0.0060	0.00060	0.16	0.016	0.0016	0.65	0.065	0.0065	0.29	0.029	0.0029
	Technical Chlordane	4.4	0.44	0.044	4.0	0.40	0.040	55.9	5.6	0.56	21.4	2.1	0.21
	Coplanar PCB TEQ	0.00008	0.0000008	0.0000008	0.000018	0.0000018	0.00000018	0.0000064	0.0000064	0.00000064	0.000055	0.0000055	0.00000055
	2,3,7,8-TCDD	0.00013	0.000013	0.0000013	0.000028	0.0000028	0.00000028	0.00039	0.000039	0.0000039	0.00018	0.000018	0.0000018
ALLENDALE	Benzo(a)pyrene	286	28.6	2.9	276	27.6	2.8	147.1	14.7	1.5	236	23.6	2.4
	4,4-DDE	0.68	0.068	0.0068	0.51	0.051	0.0051	2.1	0.21	0.021	1.11	0.111	0.0111
	Aroclor-1254	0.36	0.036	0.0036	0.087	0.0087	0.00087	1.7	0.17	0.017	0.73	0.073	0.0073
	Aroclor-1268	2.5	0.25	0.025	0.91	0.091	0.0091	1.5	0.15	0.015	1.6	0.16	0.016
	Dieldrin	0.080	0.0080	0.00080	0.082	0.0082	0.00082	0.4	0.042	0.004	0.193	0.0193	0.00193
	Technical Chlordane	4.9	0.49	0.049	4.2	0.42	0.042	29.4	2.9	0.29	12.8	1.28	0.128
	Coplanar PCB TEQ	0.000000011	0.0000000011	0.00000000011	0.0000000024	0.00000000024	0.000000000024	0.00006	0.00001	0.0000006	0.0000212	0.0000021	0.00000021223
	2,3,7,8-TCDD	0.000067	0.0000067	0.00000067	0.000020	0.0000020	0.00000020	0.00018	0.00002	0.0000018	0.000090	0.0000090	0.00000090
LYMAN MILL	Benzo(a)pyrene	246	24.6	2.5	145	14.5	1.5	179	17.9	1.8	190	19.0	1.9
	4,4-DDE	0.86	0.086	0.0086	0.55	0.055	0.0055	3.2	0.32	0.032	1.5	0.15	0.015
	Aroclor-1254	0.57	0.057	0.0057	0.22	0.022	0.0022	1.0	0.10	0.010	0.60	0.060	0.0060
	Aroclor-1268	1.0	0.10	0.010	0.64	0.064	0.0064	1.6	0.16	0.016	1.1	0.11	0.011
	Dieldrin	0.10	0.010	0.0010	0.12	0.012	0.0012	0.65	0.065	0.0065	0.29	0.029	0.0029
	Technical Chlordane	3.7	0.37	0.037	2.7	0.27	0.027	10.3	1.0	0.10	5.5	0.55	0.055
	Coplanar PCB TEQ	0.000000015	0.0000000015	0.00000000015	0.0000000051	0.00000000051	0.000000000051	0.0000057	0.0000057	0.00000057	0.0000019	0.0000019	0.00000019
	2,3,7,8-TCDD	0.000047	0.0000047	0.00000047	0.000027	0.0000027	0.00000027	0.00010	0.000010	0.0000010	0.000057	0.0000057	0.00000057

Table 4-1
Derivation of Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet - Cancer Risk - Alternate Approach for Allendale Pond

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG (1)		
		ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)
MANTON	Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	36.6	3.7	0.37	36.6	3.7	0.37
	4,4-DDE	NE	NE	NE	NE	NE	NE	1.0	0.10	0.010	1.0	0.10	0.010
	Aroclor-1254	NE	NE	NE	NE	NE	NE	0.14	0.014	0.0014	0.14	0.014	0.0014
	Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dieldrin	NE	NE	NE	NE	NE	NE	0.35	0.035	0.0035	0.35	0.035	0.0035
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	0.00014	0.000014	0.0000014	0.00014	0.000014	0.0000014
DYER VILLE	Benzo(a)pyrene	165	16.5	1.7	NE	NE	NE	NE	NE	NE	165	16.5	1.7
	4,4-DDE	1.0	0.10	0.010	NE	NE	NE	NE	NE	NE	1.0	0.10	0.010
	Aroclor-1254	0.25	0.025	0.0025	NE	NE	NE	NE	NE	NE	0.25	0.025	0.0025
	Aroclor-1268	1.6	0.16	0.016	NE	NE	NE	NE	NE	NE	1.6	0.16	0.016
	Dieldrin	0.043	0.0043	0.00043	NE	NE	NE	NE	NE	NE	0.043	0.0043	0.00043
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	0.000000019	0.0000000019	0.00000000019	NE	NE	NE	NE	NE	NE	0.000000019	0.0000000019	0.00000000019
	2,3,7,8-TCDD	0.0000044	0.000000044	0.00000000044	NE	NE	NE	NE	NE	NE	0.0000044	0.000000044	0.00000000044

Notes

--- No PRG calculated

NE - not evaluated

mg/Kg - milligrams per kilogram

(1) PRG for Combined Fish Diet is the arithmetic mean of the PRGs for the individual species.

Individual species PRGs were derived assuming that species is the sole component of the fish diet.

Shaded cells reflect assumed PRGs for largemouth bass at Allendale Pond (average of PRGs for Assapumpset Pond, Greystone Mill Pond, and Manton Pond)

Chemical of Potential Concern	Geometric Mean Combined Fish Diet Sediment PRG		
	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-5} (mg/Kg)	ELCR = 10^{-6} (mg/Kg)
Benzo(a)pyrene	136	13.6	1.4
4,4-DDE	1.2	0.12	0.012
Aroclor-1254	0.56	0.056	0.0056
Aroclor-1268	1.1	0.11	0.011
Dieldrin	0.19	0.019	0.0019
Technical Chlordane	7.5	0.75	0.075
Coplanar PCB TEQ	0.000000255	0.0000000255	0.00000000255
2,3,7,8-TCDD	0.000054	0.0000054	0.00000054

Table 4-2
Derivation of Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Children - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
ASSAPUMPSET	Benzo(a)pyrene	9828	98284	982841	8308	83080	830801	8587	85866	858663	8908	89077	890768
	4,4-DDE	0.036	0.36	3.6	0.053	0.53	5.3	0.15	1.5	14.7	0.079	0.79	7.9
	Aroclor-1254	0.011	0.11	1.1	0.022	0.22	2.2	0.032	0.32	3.2	0.022	0.22	2.2
	Aroclor-1268	0.0054	0.054	0.54	0.006	0.058	0.58	0.0084	0.084	0.84	0.0065	0.065	0.65
	Dieldrin	0.028	0.28	2.8	0.041	0.41	4.1	0.060	0.60	6.0	0.043	0.43	4.3
	Technical Chlordane	0.087	0.87	8.7	0.10	1.0	10	0.15	1.5	15.1	0.11	1.1	11.4
	Coplanar PCB TEQ	...	...	...	...	...	...	...	...	...	...	...	...
	2,3,7,8-TCDD	...	...	...	...	...	...	...	...	...	...	...	...
GREYSTONE	Benzo(a)pyrene	9629	96293	962925	8052	80520	805201	18731	187311	1873110	12137	121375	1213745
	4,4-DDE	0.026	0.26	2.6	0.017	0.17	1.7	0.14	1.4	14	0.061	0.61	6.1
	Aroclor-1254	0.0043	0.043	0.43	0.0044	0.044	0.44	0.030	0.30	3.0	0.013	0.13	1.3
	Aroclor-1268	0.0067	0.067	0.67	0.012	0.12	1.2	0.027	0.27	2.7	0.015	0.15	1.5
	Dieldrin	0.015	0.15	1.5	0.038	0.38	3.8	0.16	1.6	16	0.071	0.71	7.1
	Technical Chlordane	0.24	2.4	23.7	0.21	2.1	21.3	3.0	30.2	302	1.2	11.6	116
	Coplanar PCB TEQ	...	...	...	...	...	...	...	...	...	...	...	...
	2,3,7,8-TCDD	...	...	...	...	...	...	...	...	...	...	...	...
ALLENDALE	Benzo(a)pyrene	19280	192796	1927961	18638	186378	1863785	9928.6	99285.9	992858.7	15949	159487	1594868
	4,4-DDE	0.035	0.35	3.5	0.027	0.27	2.7	0.1	1.1	17.2	0.058	0.58	5.8
	Aroclor-1254	0.0044	0.044	0.44	0.0011	0.011	0.11	0.0	0.2	2.2	0.0090	0.090	0.90
	Aroclor-1268	0.031	0.31	3.1	0.011	0.11	1.1	0.0	0.2	1.8	0.020	0.20	2.0
	Dieldrin	0.020	0.20	2.0	0.020	0.20	2.0	0.1	1.0	10.3	0.048	0.48	4.8
	Technical Chlordane	0.26	2.6	26.3	0.23	2.3	22.6	1.6	15.8	158.4	0.69	6.9	69.1
	Coplanar PCB TEQ	...	...	...	...	...	...	...	...	...	...	...	...
	2,3,7,8-TCDD	...	...	...	...	...	...	...	...	...	...	...	...
LYMAN MILL	Benzo(a)pyrene	16582	165819	1658194	9798	97976	979763	12086	120861	1208608	12822	128219	1282188
	4,4-DDE	0.045	0.45	4.5	0.029	0.29	2.9	0.17	1.7	16.8	0.081	0.81	8.1
	Aroclor-1254	0.0070	0.070	0.70	0.0027	0.027	0.27	0.013	0.13	1.3	0.0075	0.075	0.75
	Aroclor-1268	0.013	0.13	1.3	0.0078	0.078	0.78	0.020	0.20	2.0	0.014	0.14	1.4
	Dieldrin	0.025	0.25	2.5	0.030	0.30	3.0	0.16	1.6	15.9	0.071	0.71	7.1
	Technical Chlordane	0.20	2.0	19.8	0.14	1.4	14.3	0.56	5.6	55.6	0.30	3.0	30
	Coplanar PCB TEQ	...	...	...	...	...	...	...	...	...	...	...	...
	2,3,7,8-TCDD	...	...	...	...	...	...	...	...	...	...	...	...

Table 4-2
Derivation of Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Children - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
MANTON	Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	2468	24680	246804	2468	24680	246804
	4,4-DDE	NE	NE	NE	NE	NE	NE	0.050	0.50	5.0	0.050	0.50	5.0
	Aroclor-1254	NE	NE	NE	NE	NE	NE	0.0018	0.018	0.18	0.0018	0.018	0.18
	Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dieldrin	NE	NE	NE	NE	NE	NE	0.087	0.87	8.7	0.087	0.87	8.7
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
	2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
DYERVILLE	Benzo(a)pyrene	11159	111590	1115904	NE	NE	NE	NE	NE	NE	11159	111590	1115904
	4,4-DDE	0.054	0.54	5.4	NE	NE	NE	NE	NE	NE	0.054	0.54	5.4
	Aroclor-1254	0.0031	0.031	0.31	NE	NE	NE	NE	NE	NE	0.0031	0.031	0.31
	Aroclor-1268	0.020	0.20	2.0	NE	NE	NE	NE	NE	NE	0.020	0.20	2.0
	Dieldrin	0.011	0.11	1.1	NE	NE	NE	NE	NE	NE	0.011	0.11	1.1
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---
	2,3,7,8-TCDD	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---

Notes:

--- No PRG calculated

NE - not evaluated

mg/Kg - milligrams per kilogram

(1) PRG for Combined Fish Diet is the arithmetic mean of the PRGs for the individual species

Individual species PRGs were derived assuming that species is the sole component of the fish diet.

Shaded cells reflect assumed PRGs for largemouth bass at Allendale Pond (average of PRGs for Assapumpset Pond, Greystone Mill Pond, and Manton Pond)

Chemical of Potential Concern	Geometric Mean Combined Fish Diet Sediment PRG
	HI = 1 (mg/Kg)
Benzo(a)pyrene	92064
4,4-DDE	0.63
Aroclor-1254	0.068
Aroclor-1268	0.14
Dieldrin	0.46
Technical Chlordane	4.1
Coplanar PCB TEQ	---
2,3,7,8-TCDD	---

Table 4-3
Derivation of Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Adolescents - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
ASSAPUMPSET	Benzo(a)pyrene	14901	149011	1490114	12596	125960	1259601	13018	130184	1301844	13505	135052	1350520
	4,4-DDE	0.055	0.55	5.5	0.081	0.81	8.1	0.22	2.2	22.1	0.12	1.2	11.9
	Aroclor-1254	0.017	0.17	1.7	0.034	0.34	3.4	0.049	0.49	4.9	0.033	0.33	3.3
	Aroclor-1268	0.0081	0.081	0.81	0.0087	0.087	0.87	0.013	0.13	1.3	0.0099	0.099	0.99
	Dieldrin	0.042	0.42	4.2	0.062	0.62	6.2	0.091	0.91	9.1	0.065	0.65	6.5
	Technical Chlordane	0.13	1.3	13.3	0.16	1.6	15.6	0.23	2.3	22.9	0.17	1.7	17.3
	Coplanar PCB TEQ	...	...	...	...	...	...	...	...	...	...	...	...
	2,3,7,8-TCDD	...	...	...	...	...	...	...	...	...	...	...	...
GREYSTONE	Benzo(a)pyrene	145999	1459992	14599919	122078	1220789	12207889	28399	283988	2839876	18402	184019	1840195
	4,4-DDE	0.039	0.39	3.9	0.025	0.25	2.5	0.21	2.1	21.3	0.092	0.92	9.2
	Aroclor-1254	0.0065	0.065	0.65	0.0066	0.066	0.66	0.046	0.46	4.6	0.020	0.20	2.0
	Aroclor-1268	0.010	0.10	1.0	0.019	0.19	1.9	0.042	0.42	4.2	0.023	0.23	2.3
	Dieldrin	0.022	0.22	2.2	0.058	0.58	5.8	0.24	2.4	24.4	0.11	1.1	10.8
	Technical Chlordane	0.36	3.6	35.9	0.32	3.2	32.3	4.6	45.8	458	1.8	17.5	175
	Coplanar PCB TEQ	...	...	...	...	...	...	...	...	...	...	...	...
	2,3,7,8-TCDD	...	...	...	...	...	...	...	...	...	...	...	...
ALLENDALE	Benzo(a)pyrene	29230	292304	2923038	28257	282574	2825738	**15053.0**	**150530.2**	**1505301.9**	**24180**	**241803**	**2418026**
	4,4-DDE	0.054	0.54	5.4	0.041	0.41	4.1	**0.2**	**1.7**	**17.0**	**0.088**	**0.88**	**8.8**
	Aroclor-1254	0.0067	0.067	0.67	0.0016	0.016	0.16	**0.0**	**0.3**	**3.3**	**0.0137**	**0.137**	**1.37**
	Aroclor-1268	0.046	0.46	4.6	0.017	0.17	1.7	**0.0**	**0.3**	**2.7**	**0.030**	**0.30**	**3.0**
	Dieldrin	0.030	0.30	3.0	0.031	0.31	3.1	**0.2**	**1.6**	**15.6**	**0.072**	**0.72**	**7.2**
	Technical Chlordane	0.40	4.0	39.8	0.34	3.4	34.3	**2.4**	**24.0**	**240.2**	**1.05**	**10.5**	**104.8**
	Coplanar PCB TEQ	...	...	...	...	...	...	...	...	...	...	...	...
	2,3,7,8-TCDD	...	...	...	...	...	...	...	...	...	...	...	...
LYMAN MILL	Benzo(a)pyrene	25140	251404	2514035	14854	148545	1485447	18324	183241	1832406	19440	194396	1943963
	4,4-DDE	0.068	0.68	6.8	0.044	0.44	4.4	0.26	2.6	25.5	0.12	1.2	12.2
	Aroclor-1254	0.011	0.11	1.1	0.0041	0.041	0.41	0.019	0.19	1.9	0.011	0.11	1.1
	Aroclor-1268	0.019	0.19	1.9	0.012	0.12	1.2	0.031	0.31	3.1	0.021	0.21	2.1
	Dieldrin	0.037	0.37	3.7	0.046	0.46	4.6	0.242	2.4	24.2	0.11	1.1	10.8
	Technical Chlordane	0.30	3.0	30.1	0.22	2.2	21.7	0.84	8.4	84.3	0.45	4.5	45.4
	Coplanar PCB TEQ	...	...	...	...	...	...	...	...	...	...	...	...
	2,3,7,8-TCDD	...	...	...	...	...	...	...	...	...	...	...	...

Table 4-3
Derivation of Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Adolescents - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
MANTON	Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	3742	37419	374186	3742	37419	374186
	4,4-DDE	NE	NE	NE	NE	NE	NE	0.076	0.76	7.6	0.076	0.76	7.6
	Aroclor-1254	NE	NE	NE	NE	NE	NE	0.0027	0.027	0.27	0.0027	0.027	0.27
	Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dieldrin	NE	NE	NE	NE	NE	NE	0.13	1.3	13.2	0.13	1.3	13.2
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
	2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
DYERVILLE	Benzo(a)pyrene	16919	169185	1691854	NE	NE	NE	NE	NE	NE	16919	169185	1691854
	4,4-DDE	0.081	0.81	8.1	NE	NE	NE	NE	NE	NE	0.081	0.81	8.1
	Aroclor-1254	0.0046	0.046	0.46	NE	NE	NE	NE	NE	NE	0.0046	0.046	0.46
	Aroclor-1268	0.030	0.30	3.0	NE	NE	NE	NE	NE	NE	0.030	0.30	3.0
	Dieldrin	0.016	0.16	1.6	NE	NE	NE	NE	NE	NE	0.016	0.16	1.6
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---
	2,3,7,8-TCDD	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---

Notes:
--- No PRG calculated
NE - not evaluated
mg/Kg - milligrams per kilogram
(1) PRG for Combined Fish Diet is the arithmetic mean of the PRGs for the individual species. Individual species PRGs were derived assuming that species is the sole component of the fish diet.
Shaded cells reflect assumed PRGs for largemouth bass at Allendale Pond (average of PRGs for Assapumpset Pond, Greystone Mill Pond, and Manton Pond)

Table 4-4
Derivation of Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Adults - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
ASSAPUMPSET	Benzo(a)pyrene	15308	153078	1530784	130116	1301589	13015888	13452	134524	1345238	13955	139584	1395837
	4,4-DDE	0.056	0.56	5.6	0.084	0.84	8.4	0.23	2.3	23.0	0.12	1.2	12.3
	Aroclor-1254	0.017	0.17	1.7	0.035	0.35	3.5	0.051	0.51	5.1	0.034	0.34	3.4
	Aroclor-1268	0.0084	0.084	0.84	0.0090	0.090	0.90	0.013	0.13	1.3	0.010	0.10	1.0
	Dieldrin	0.043	0.43	4.3	0.064	0.64	6.4	0.094	0.94	9.4	0.067	0.67	6.7
	Technical Chlordane	0.14	1.4	13.7	0.16	1.6	16.2	0.24	2.4	23.7	0.18	1.8	17.8
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---
GREYSTONE	Benzo(a)pyrene	15086	150858	1508583	126115	1261482	12614882	29345	293454	2934539	19015	190153	1901535
	4,4-DDE	0.040	0.40	4.0	0.026	0.26	2.6	0.22	2.2	22.0	0.095	0.95	9.5
	Aroclor-1254	0.0067	0.067	0.67	0.0068	0.068	0.68	0.048	0.48	4.8	0.020	0.20	2.0
	Aroclor-1268	0.011	0.11	1.1	0.019	0.19	1.9	0.043	0.43	4.3	0.024	0.24	2.4
	Dieldrin	0.023	0.23	2.3	0.060	0.60	6.0	0.25	2.5	25.2	0.11	1.1	11.2
	Technical Chlordane	0.37	3.7	37.1	0.33	3.3	33.4	4.7	47.3	473	1.8	18.1	181
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---
ALLENDALE	Benzo(a)pyrene	302095	3020947	30209473	291999	2919993	29199929	15554.8	155547.9	1555478.7	24986	249863	2498627
	4,4-DDE	0.055	0.55	5.5	0.042	0.42	4.2	0.2	1.8	17.6	0.091	0.91	9.1
	Aroclor-1254	0.0069	0.069	0.69	0.0017	0.017	0.17	0.0	0.3	3.4	0.0141	0.141	1.41
	Aroclor-1268	0.048	0.48	4.8	0.018	0.18	1.8	0.0	0.3	2.8	0.031	0.31	3.1
	Dieldrin	0.031	0.31	3.1	0.032	0.32	3.2	0.2	1.6	16.1	0.075	0.75	7.5
	Technical Chlordane	0.41	4.1	41.1	0.35	3.5	35.4	2.5	24.8	248.2	1.08	10.8	108.3
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---
LYMAN MILL	Benzo(a)pyrene	25978	259784	2597837	15350	153496	1534962	18935	189349	1893486	20088	200876	2008761
	4,4-DDE	0.071	0.71	7.1	0.045	0.45	4.5	0.26	2.6	26.4	0.13	1.3	12.7
	Aroclor-1254	0.011	0.11	1.1	0.0042	0.042	0.42	0.020	0.20	2.0	0.012	0.12	1.2
	Aroclor-1268	0.020	0.20	2.0	0.012	0.12	1.2	0.032	0.32	3.2	0.021	0.21	2.1
	Dieldrin	0.039	0.39	3.9	0.047	0.47	4.7	0.25	2.5	25.0	0.11	1.1	11.2
	Technical Chlordane	0.31	3.1	31.1	0.22	2.2	22.4	0.87	8.7	87.2	0.47	4.7	46.9
	Coplanar PCB TEQ	---	---	---	---	---	---	---	---	---	---	---	---
	2,3,7,8-TCDD	---	---	---	---	---	---	---	---	---	---	---	---

Table 4-4
Derivation of Sediment Human Health Preliminary Remediation Goals Based on Combined Fish Diet for Adults - Non-Cancer Risk

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Scenario Timeframe: Current/Future
Medium: Biota
Exposure Medium: Combined Fish Diet

Exposure Point	Chemical of Potential Concern	American Eel based Sediment PRG			White Sucker / Brown Bullhead Sediment PRG			Largemouth Bass Sediment PRG			Combined Fish Diet Sediment PRG		
		HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)	HI = 0.1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 10 (mg/Kg)
MANTON	Benzo(a)pyrene	NE	NE	NE	NE	NE	NE	3867	38666	386659	3867	38666	386659
	4,4-DDE	NE	NE	NE	NE	NE	NE	0.078	0.78	7.8	0.078	0.78	7.8
	Aroclor-1254	NE	NE	NE	NE	NE	NE	0.0027	0.027	0.27	0.0027	0.027	0.27
	Aroclor-1268	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dieldrin	NE	NE	NE	NE	NE	NE	0.14	1.4	13.7	0.14	1.4	13.7
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
	2,3,7,8-TCDD	NE	NE	NE	NE	NE	NE	---	---	---	---	---	---
DYERVILLE	Benzo(a)pyrene	17482	174825	1748250	NE	NE	NE	NE	NE	NE	17482	174825	1748250
	4,4-DDE	0.084	0.84	8.4	NE	NE	NE	NE	NE	NE	0.084	0.84	8.4
	Aroclor-1254	0.0048	0.048	0.48	NE	NE	NE	NE	NE	NE	0.0048	0.048	0.48
	Aroclor-1268	0.031	0.31	3.1	NE	NE	NE	NE	NE	NE	0.031	0.31	3.1
	Dieldrin	0.017	0.17	1.7	NE	NE	NE	NE	NE	NE	0.017	0.17	1.7
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Coplanar PCB TEQ	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---
	2,3,7,8-TCDD	---	---	---	NE	NE	NE	NE	NE	NE	---	---	---

Notes:
--- No PRG calculated
NE - not evaluated
mg/Kg - milligrams per kilogram
(1) PRG for Combined Fish Diet is the arithmetic mean of the PRGs for the individual species. Individual species PRGs were derived assuming that species is the sole component of the fish diet.
Shaded cells reflect assumed PRGs for largemouth bass at Allendale Pond (average of PRGs for Assapumpset Pond, Greystone Mill Pond, and Manton Pond)

Table 5-1
Comparison of Combined Fish Diet Sediment Preliminary Remediation Goals (PRGs) (All Exposure Areas)
to Background Sediment Concentrations

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Geometric Mean Combined Fish Diet Sediment PRG				Background Sediment Data Greystone Mill Pond		
	ELCR = 10-4 (mg/Kg)	ELCR = 10-5 (mg/Kg)	ELCR = 10-6 (mg/Kg)	HI = 1 (mg/Kg)	Minimum (mg/Kg)	Maximum (mg/Kg)	Mean (mg/Kg)
Benzo(a)pyrene	140	14.0	1.4	94,756	0.10	3.1	1.4
4,4-DDE	1.1	0.11	0.01	0.56	0.0011	0.031	0.0060
Aroclor-1254	0.46	0.05	0.005	0.056	0.023	0.28	0.15
Aroclor-1268	1.2	0.12	0.012	0.14	0.022	0.25	0.14
Dieldrin	0.16	0.02	0.002	0.40	0.0018	0.0051	0.0026
Technical Chlordane	5.8	0.58	0.058	3.1	0.15	0.63	0.40
Coplanar PCB TEQ	4.3E-07	4.3E-08	4.3E-09	—	2.5E-05	2.5E-05	2.5E-05
2,3,7,8-TCDD	4.8E-05	4.8E-06	4.8E-07	—	4.3E-07	8.7E-05	1.5E-05

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background dataset.
mg/Kg - milligrams per kilogram

Chemical of Potential Concern	Combined Fish Diet Sediment PRG						Geometric Mean Combined Fish Diet Sediment PRG	Arithmetic Mean Combined Fish Diet Sediment PRG
	Assapumpset Pond	Greystone Mill Pond	Allendale Pond	Lyman Mill Pond	Manton Pond	Dyerville Pond		
	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)
Benzo(a)pyrene	132	180	281	190	36.6	165	140	164.1
4,4-DDE	1.5	1.2	0.59	1.5	1.0	1.0	1.1	1.1
Aroclor-1254	1.8	1.1	0.22	0.60	0.14	0.25	0.46	0.7
Aroclor-1268	0.53	1.3	1.7	1.1	NE	1.6	1.2	1.2
Dieldrin	0.17	0.29	0.081	0.29	0.35	0.043	0.16	0.2
Technical Chlordane	2.1	21.4	4.5	5.5	NE	NE	5.8	8.4
Coplanar PCB TEQ	NE	5.5E-05	1.8E-08	1.9E-05	NE	1.9E-09	4.3E-07	1.9E-05
2,3,7,8-TCDD	4.3E-05	1.8E-04	4.3E-05	5.7E-05	1.4E-04	4.4E-06	4.8E-05	7.8E-05

Chemical of Potential Concern							Geometric Mean Combined Fish Diet Sediment PRG	Arithmetic Mean Combined Fish Diet Sediment PRG
	Assapumpset Pond	Greystone Mill Pond	Allendale Pond	Lyman Mill Pond	Manton Pond	Dyerville Pond		
	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)
Benzo(a)pyrene	89,077	121,375	189,587	128,219	24,680	111,590	94,756	110,755
4,4-DDE	0.79	0.61	0.31	0.81	0.50	0.54	0.56	0.59
Aroclor-1254	0.22	0.13	0.028	0.075	0.018	0.031	0.056	0.083
Aroclor-1268	0.065	0.15	0.21	0.14	NE	0.20	0.14	0.15
Dieldrin	0.43	0.71	0.20	0.71	0.87	0.11	0.40	0.51
Technical Chlordane	1.1	11.6	2.4	3.0	NE	NE	3.1	4.5
Coplanar PCB TEQ	---	---	---	---	---	---	---	
2,3,7,8-TCDD	---	---	---	---	---	---	---	

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background dataset.

Table 5-2
Comparison of Combined Fish Diet Sediment Preliminary Remediation Goals (PRGs) (Allendale Pond and Lyman Mill Pond Only) to Background Sediment Concentrations

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Geometric Mean Combined Fish Diet Sediment PRG				Background Sediment Data Greystone Mill Pond		
	ELCR = 10-4 (mg/Kg)	ELCR = 10-5 (mg/Kg)	ELCR = 10-6 (mg/Kg)	HI = 1 (mg/Kg)	Minimum (mg/Kg)	Maximum (mg/Kg)	Geometric Mean (mg/Kg)
Benzo(a)pyrene	231	23.1	2.3	155,912	0.10	3.1	1.4
4,4-DDE	0.96	0.10	0.01	0.50	0.0011	0.031	0.0060
Aroclor-1254	0.37	0.04	0.004	0.045	0.023	0.38	0.15
Aroclor-1268	1.37	0.14	0.014	0.169	0.022	0.25	0.14
Dieldrin	0.15	0.02	0.002	0.379	0.0018	0.0051	0.0026
Technical Chlordane	5.01	0.50	0.050	2.7	0.15	0.63	0.40
Coplanar PCB TEQ	5.0E-07	5.0E-08	5.0E-09	—	2.5E-05	2.5E-05	2.5E-05
2,3,7,8-TCDD	5.0E-05	5.0E-06	5.0E-07	—	4.3E-07	8.7E-05	1.5E-05

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background dataset.
mg/Kg - milligrams per kilogram

Chemical of Potential Concern	Combined Fish Diet Sediment PRG						Geometric Mean Combined Fish Diet Sediment PRG	Arithmetic Mean Combined Fish Diet Sediment PRG
	Assapumpset Pond	Greystone Mill Pond	Allendale Pond	Lyman Mill Pond	Manton Pond	Dyerville Pond		
	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)
Benzo(a)pyrene			281	190			231	235.4
4,4-DDE			0.59	1.5			0.96	1.1
Aroclor-1254			0.22	0.60			0.37	0.4
Aroclor-1268			1.7	1.1			1.37	1.4
Dieldrin			0.081	0.29			0.15	0.2
Technical Chlordane			4.5	5.5			5.01	5.0
Coplanar PCB TEQ			1.8E-08	1.9E-05			5.0E-07	9.5E-06
2,3,7,8-TCDD			4.3E-05	5.7E-05			5.0E-05	5.0E-05

Chemical of Potential Concern							Geometric Mean Combined Fish Diet Sediment PRG	Arithmetic Mean Combined Fish Diet Sediment PRG
	Assapumpset Pond	Greystone Mill Pond	Allendale Pond	Lyman Mill Pond	Manton Pond	Dyerville Pond		
	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)
Benzo(a)pyrene			189,587	128,219			155,912	158,903
4,4-DDE			0.31	0.81			0.50	0.56
Aroclor-1254			0.028	0.075			0.045	0.051
Aroclor-1268			0.21	0.14			0.169	0.17
Dieldrin			0.20	0.71			0.379	0.46
Technical Chlordane			2.4	3.0			2.7	2.7
Coplanar PCB TEQ			—	—			—	
2,3,7,8-TCDD			—	—			—	

Table 5-3
Comparison of Combined Fish Diet Sediment Preliminary Remediation Goals (PRGs) (All Exposure Areas) to Background Sediment Concentrations Using *the Alternative Combined Diet Approach for Allendale Pond*

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential *Concern*	Geometric Mean Combined Fish Diet Sediment PRG				Background Sediment Data Greystone Mill Pond		
	ELCR = 10-4 (mg/Kg)	ELCR = 10-5 (mg/Kg)	ELCR = 10-6 (mg/Kg)	HI = 1 (mg/Kg)	Minimum (mg/Kg)	Maximum (mg/Kg)	Mean (mg/Kg)
Benzo(a)pyrene	136	13.6	**1.4**	92,064	0.16	3.1	1.4
4,4-DDE	1.2	0.12	**0.01**	0.63	0.0011	0.031	0.0066
Aroclor-1254	0.56	**0.06**	**0.006**	**0.068**	0.023	0.38	0.15
Aroclor-1268	1.1	**0.11**	**0.011**	**0.14**	0.022	0.25	0.14
Dieldrin	0.187	0.02	**0.002**	0.46	0.0018	0.0051	0.0026
Technical Chlordane	7.5	0.75	**0.075**	4.1	0.15	0.63	0.40
Coplanar PCB TEQ	**2.6E-06**	**2.6E-07**	**2.6E-08**	—	2.5E-05	2.5E-05	2.5E-05
2,3,7,8-TCDD	**5.4E-05**	**5.4E-06**	**5.4E-07**	—	4.3E-07	8.7E-05	1.5E-05

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background dataset

mg/Kg - milligrams per kilogram

Chemical of Potential Concern	Combined Fish Diet Sediment PRG						Geometric Mean *Combined Fish Diet* Sediment PRG	Arithmetic Mean *Combined Fish Diet* Sediment PRG
	Assapumpset Pond	Greystone Mill Pond	Allendale Pond	Lyman Mill Pond	Manton Pond	Dyerville Pond		
	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)
Benzo(a)pyrene	132	180	**236**	190	36.6	165	136	156.7
4,4-DDE	1.5	1.2	1.11	1.5	1.0	1.0	1.2	1.2
Aroclor-1254	1.8	1.1	**0.73**	0.60	0.14	0.25	0.56	0.76
Aroclor-1268	0.53	1.3	**1.6**	1.1	NE	1.6	1.1	1.2
Dieldrin	0.17	0.29	**0.193**	0.29	0.35	0.043	0.187	0.224
Technical Chlordane	2.1	21.4	**12.8**	5.5	NE	NE	7.5	10.5
Coplanar PCB TEQ	NE	5.5E-05	**2.1E-05**	1.9E-05	NE	1.9E-09	2.6E-06	2.4E-05
2,3,7,8-TCDD	4.3E-05	1.8E-04	9.0E-05	5.7E-05	1.4E-04	4.4E-06	5.4E-06	8.6E-05

Chemical of Potential Concern							Geometric Mean Combined Fish Diet Sediment PRG	Arithmetic Mean Combined Fish Diet Sediment PRG
	Assapumpset Pond	Greystone Mill Pond	*Allendale* Pond	Lyman Mill Pond	Manton Pond	Dyerville Pond		
	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)
Benzo(a)pyrene	89,077	121,375	159,487	128,219	24,680	111,590	92,064	105,738
4,4-DDE	0.79	0.61	0.58	0.81	0.50	0.54	0.63	0.64
Aroclor-1254	0.22	0.13	0.090	0.075	0.018	0.031	0.068	0.094
Aroclor-1268	0.063	0.15	0.20	0.14	NE	0.20	0.14	0.15
Dieldrin	0.43	0.71	0.48	0.71	0.87	0.11	0.46	0.55
Technical Chlordane	1.1	11.6	6.9	3.0	NE	NE	4.1	5.7
Coplanar PCB TEQ	---	---	---	---	---	---	---	
2,3,7,8-TCDD	---	---	---	---	---	---	---	

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background dataset

Shaded cells reflect assumed PRGs for largemouth bass at Allendale Pond (average of PRGs for Assapumpset Pond, Greystone Mill Pond, and Manton Pond)

Table 5-4
Comparison of Combined Fish Diet Sediment Preliminary Remediation Goals (PRGs) (Allendale Pond and Lyman Mill Pond Only) to Background Sediment Concentrations Using the Alternative Combined Diet Approach for Allendale Pond

Preliminary Remediation Goals Report - Human Health
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Geometric Mean Combined Fish Diet Sediment PRG				Background Sediment Data Greystone Mill Pond		
	ELCR = 10-4 (mg/Kg)	ELCR = 10-5 (mg/Kg)	ELCR = 10-6 (mg/Kg)	HI = 1 (mg/Kg)	Minimum (mg/Kg)	Maximum (mg/Kg)	Geometric Mean (mg/Kg)
Benzo(a)pyrene	212	21.2	2.1	143,001	0.10	3.1	1.4
4,4-DDE	1.31	0.13	0.01	0.69	0.0011	0.031	0.0060
Aroclor-1254	0.67	0.07	0.007	0.082	0.023	0.78	0.15
Aroclor-1268	1.34	0.13	0.013	0.165	0.022	0.25	0.14
Dieldrin	0.24	0.02	0.002	0.583	0.0018	0.0051	0.0026
Technical Chlordane	8.43	0.84	0.084	4.5	0.15	0.63	0.40
Coplanar PCB TEQ	2.0E-05	2.0E-06	2.0E-07	---	2.5E-05	2.5E-05	2.5E-05
2,3,7,8-TCDD	7.2E-05	7.2E-06	7.2E-07	---	4.3E-07	8.7E-05	1.5E-05

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background dataset.
mg/Kg - milligrams per kilogram

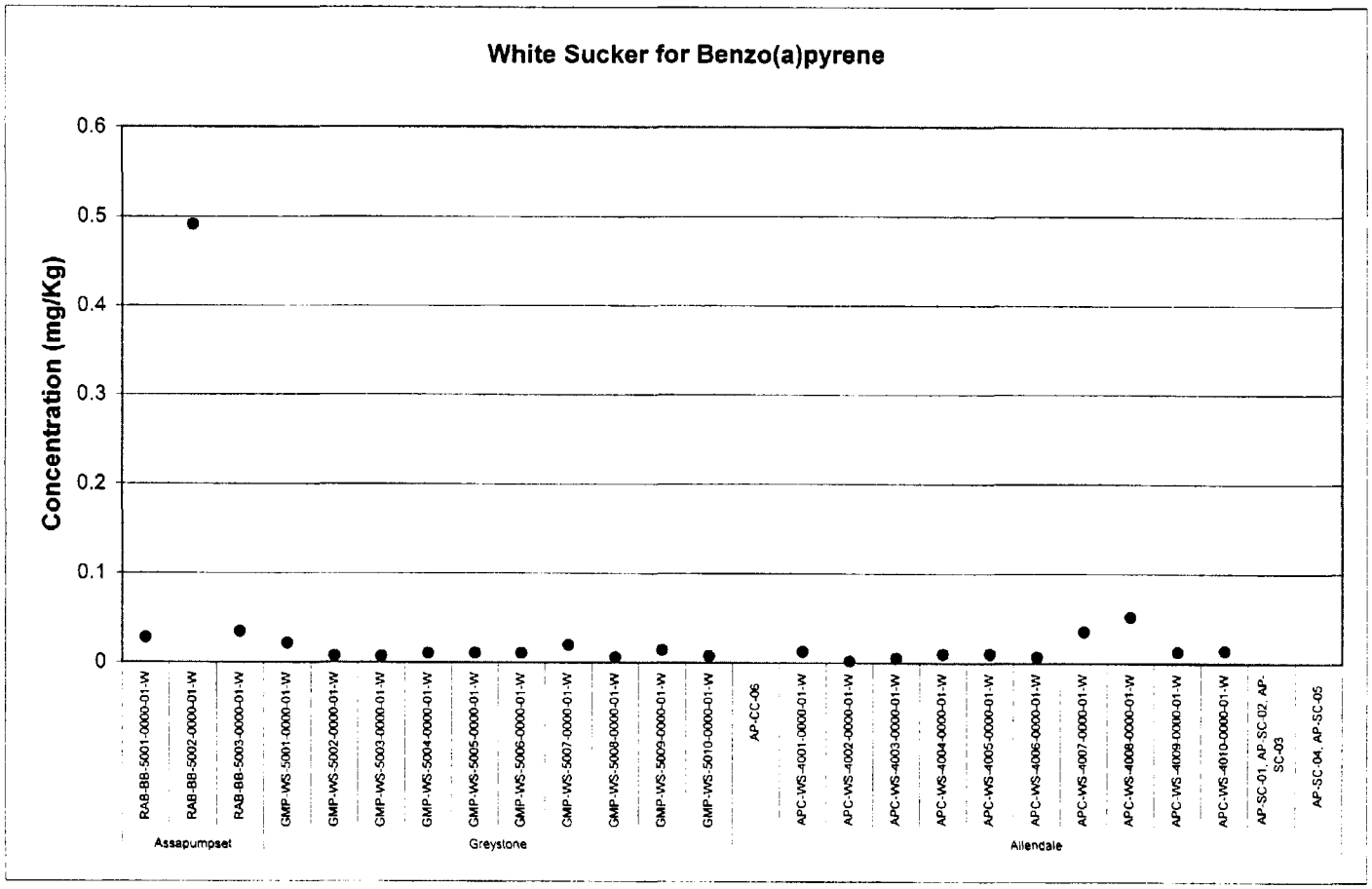
Chemical of Potential Concern	Combined Fish Diet Sediment PRG						Geometric Mean Combined Fish Diet Sediment PRG	Arithmetic Mean Combined Fish Diet Sediment PRG
	Assapumpset Pond	Greystone Mill Pond	Allendale Pond	Lyman Mill Pond	Manton Pond	Dyerville Pond		
	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)	ELCR = 10^{-4} (mg/Kg)
Benzo(a)pyrene			236	190			212	213.1
4,4-DDE			1.11	1.5			1.31	1.3
Aroclor-1254			0.73	0.60			0.67	0.7
Aroclor-1268			1.6	1.1			1.34	1.4
Dieldrin			0.193	0.29			0.24	0.2
Technical Chlordane			12.8	5.5			8.43	9.2
Coplanar PCB TEQ			2.1E-05	1.9E-05			2.0E-05	2.0E-05
2,3,7,8-TCDD			9.0E-05	5.7E-05			7.2E-05	7.3E-05

Chemical of Potential Concern							Geometric Mean Combined Fish Diet Sediment PRG	Arithmetic Mean Combined Fish Diet Sediment PRG
	Assapumpset Pond	Greystone Mill Pond	Allendale Pond	Lyman Mill Pond	Manton Pond	Dyerville Pond		
	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)	HI = 1 (mg/Kg)
Benzo(a)pyrene			159,487	128,219			143,001	143,853
4,4-DDE			0.58	0.81			0.69	0.70
Aroclor-1254			0.090	0.075			0.082	0.082
Aroclor-1268			0.20	0.14			0.165	0.17
Dieldrin			0.48	0.71			0.583	0.60
Technical Chlordane			6.9	3.0			4.5	5.0
Coplanar PCB TEQ			---	---			---	
2,3,7,8-TCDD			---	---			---	

Shaded cells reflect assumed PRGs for largemouth bass at Allendale Pond (average of PRGs for Assapumpset Pond, Greystone Mill Pond, and Manton Pond)

APPENDIX A
OUTLIER ANALYSIS FOR LIPID-NORMALIZED BIOTA COC CONCENTRATIONS AND ORGANIC CARBON-NORMALIZED SEDIMENT COC CONCENTRATIONS

LIPID-NORMALIZED BIOTA COC CONCENTRATIONS AND ORGANIC CARBON-NORMALIZED SEDIMENT CONCENTRATIONS WITH DETERMINED OUTLIERS



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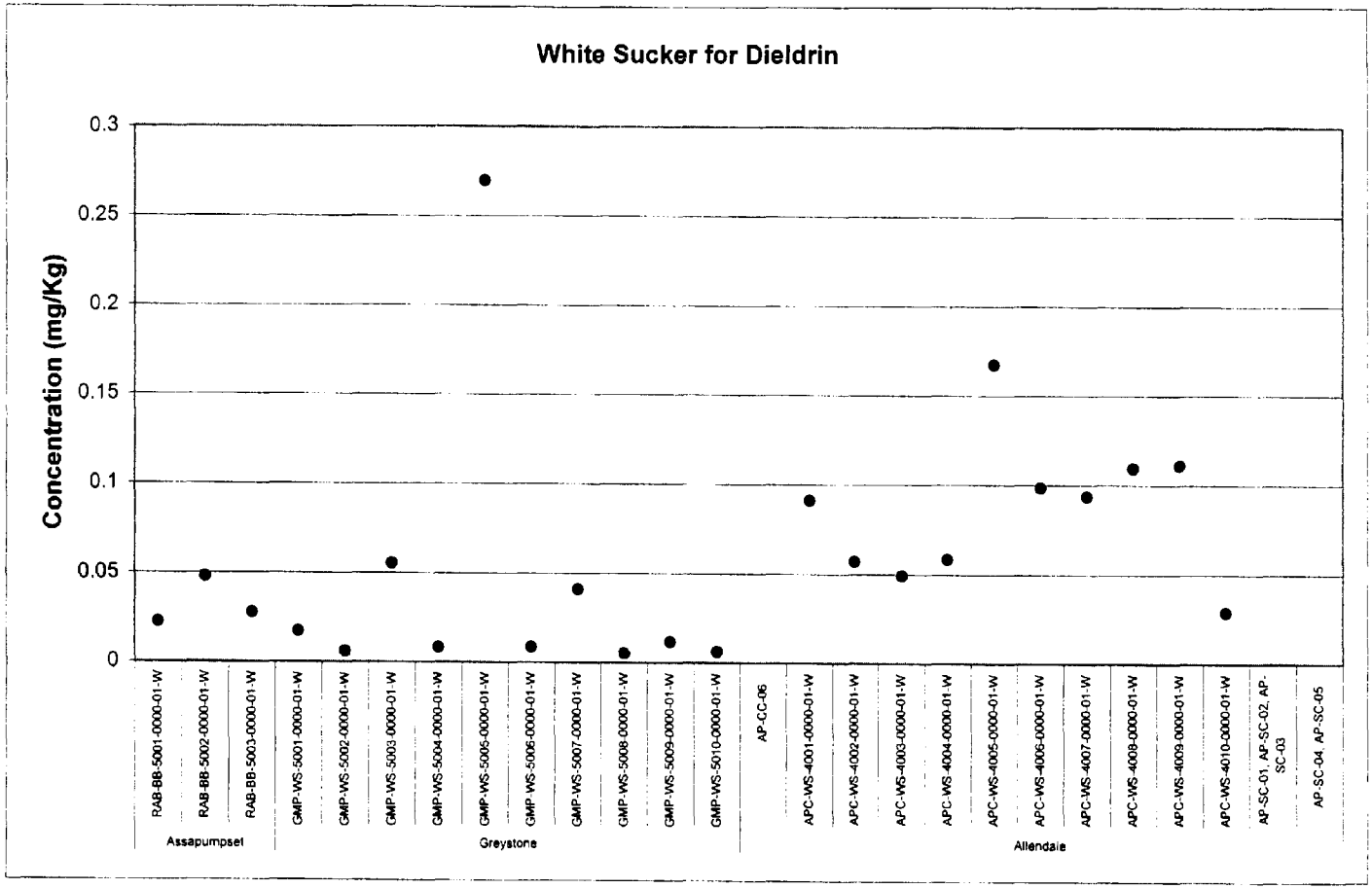
White Sucker2, WS Benzo(a)pyrene

Prepared by: BJR
Checked by: KJA



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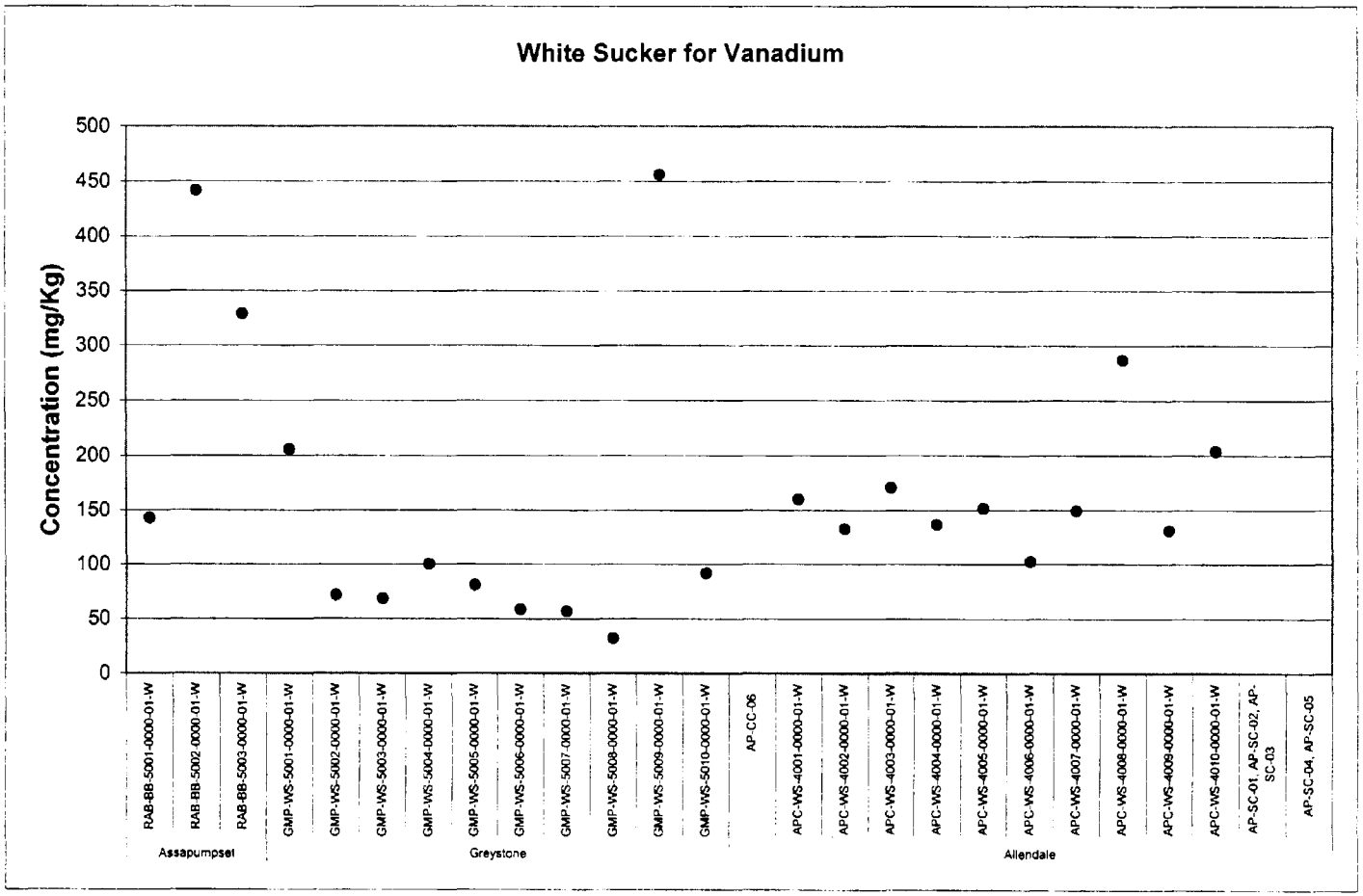
White Sucker2, WS Dieldrin

Prepared by: BJR
Checked by: KJA



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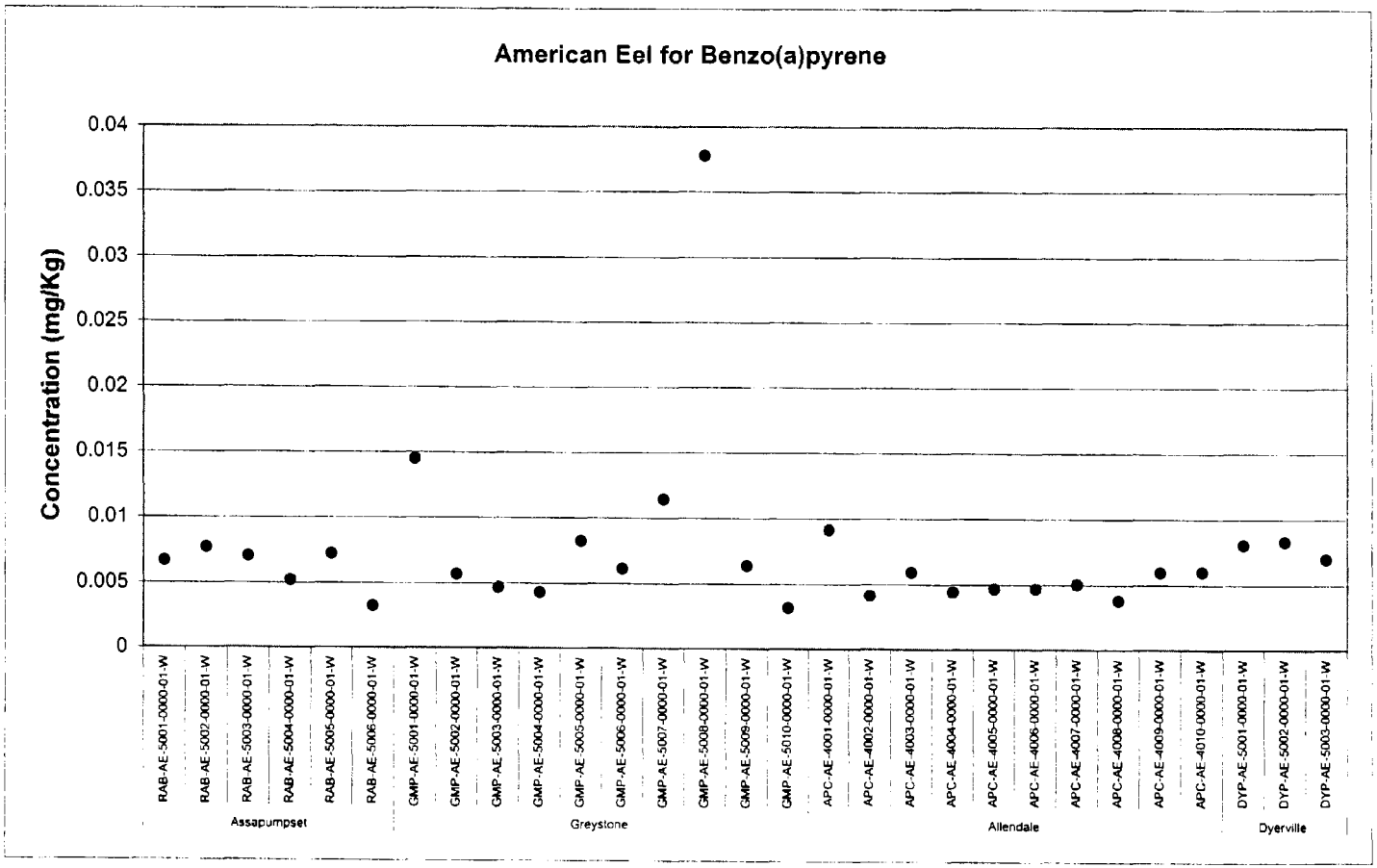
White Sucker2, WS Vanadium

Prepared by: BJR
Checked by: KJA



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American Eel2,AE Benzo(a)pyrene

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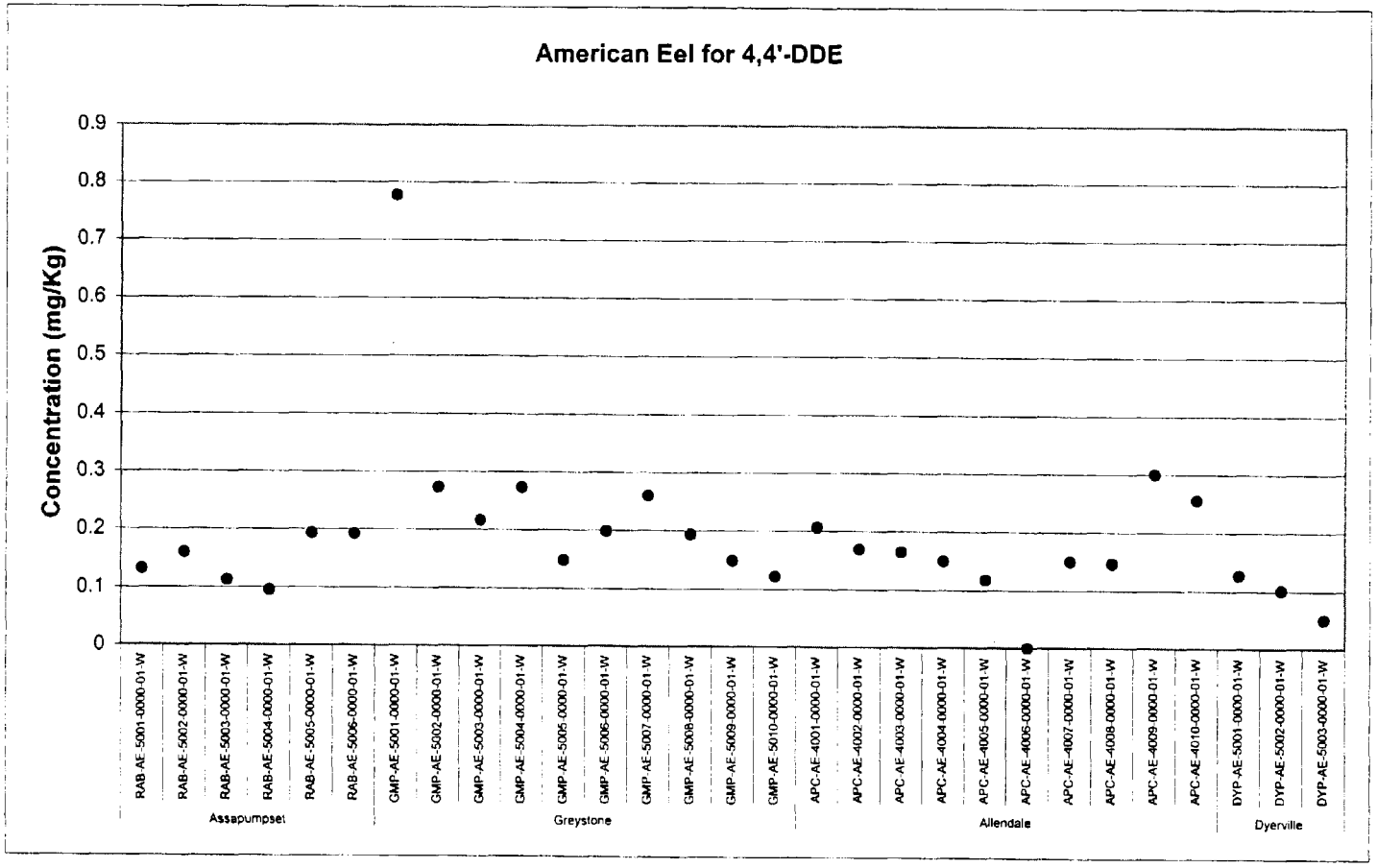
Checked by: KJA



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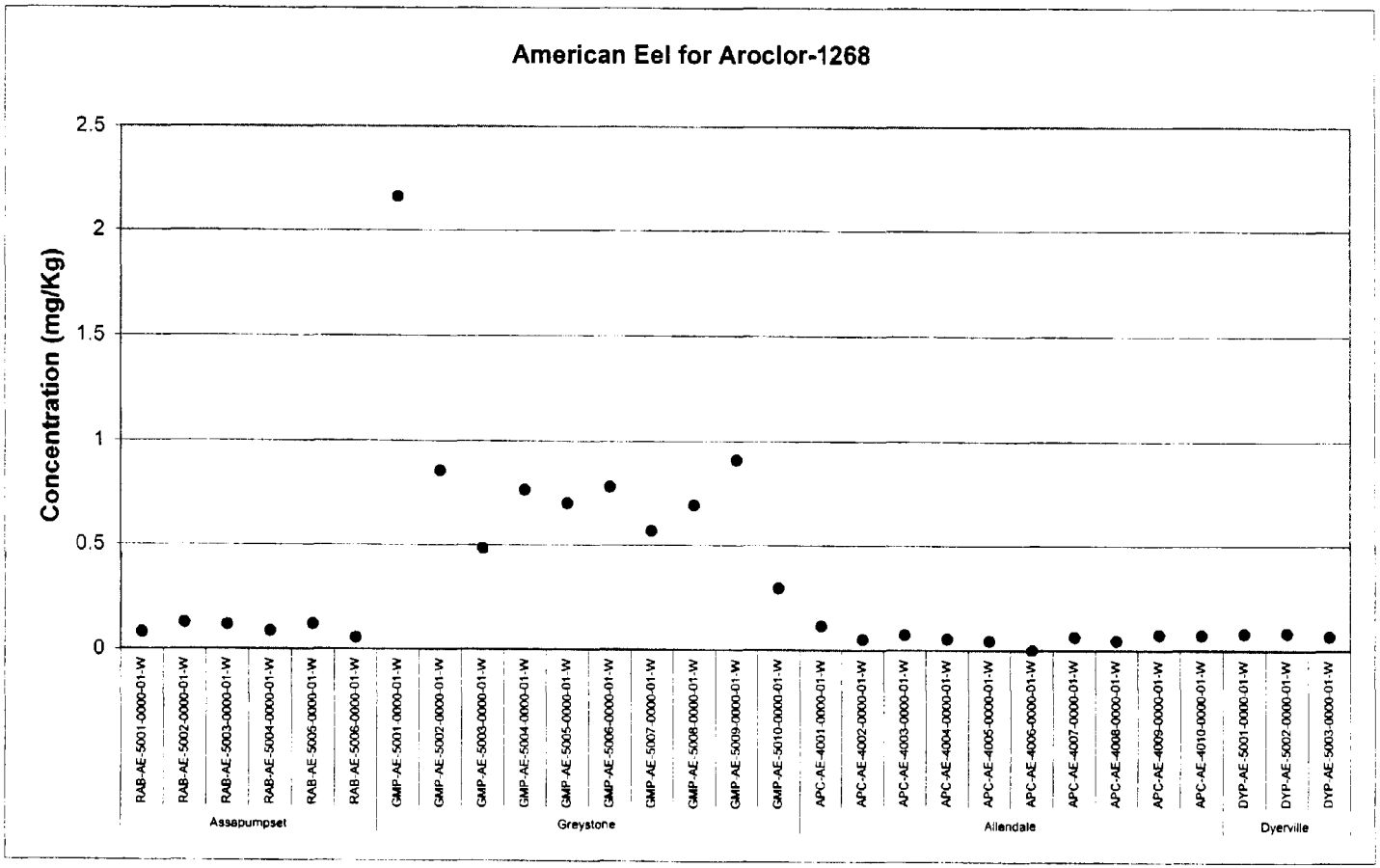
American Eel2,AE 4,4'-DDE

Prepared by: BJR
Checked by: KJA



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American Eel? AE Aroclor-1268

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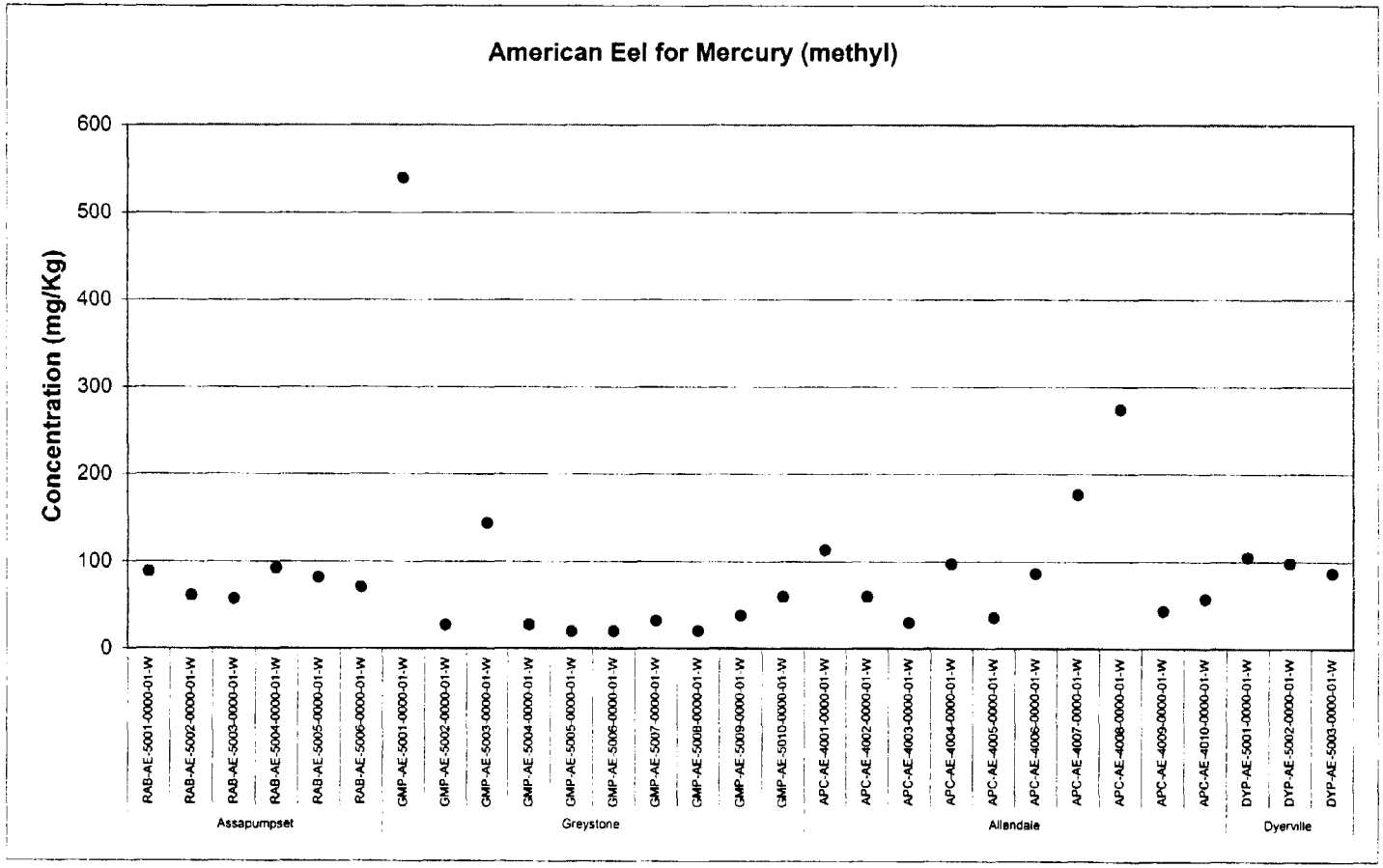

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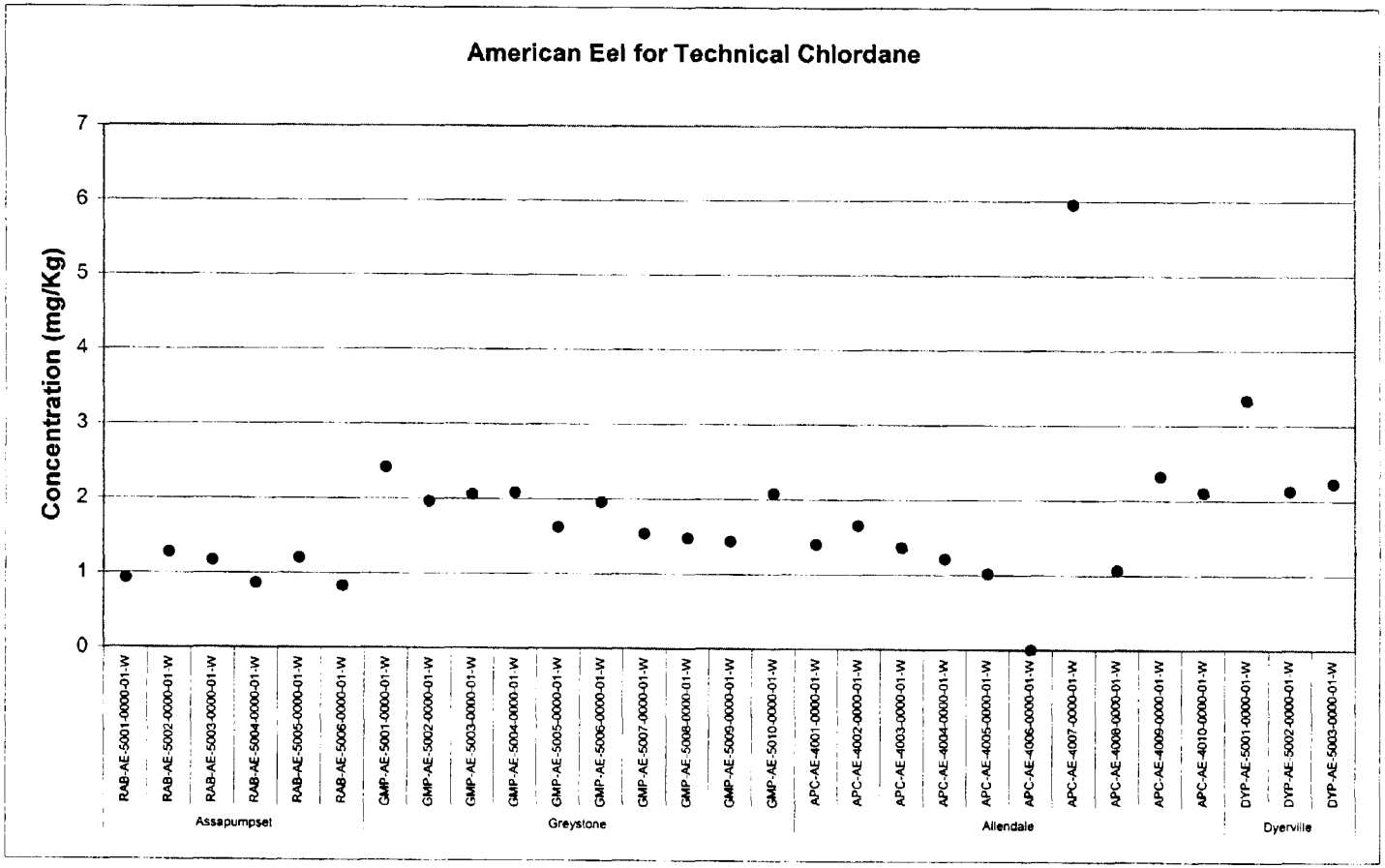
American Eel2,AE Mercury(methyl)

Prepared by: BJR
Checked by: KJA



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American Eel\ AE Technical Chlordane

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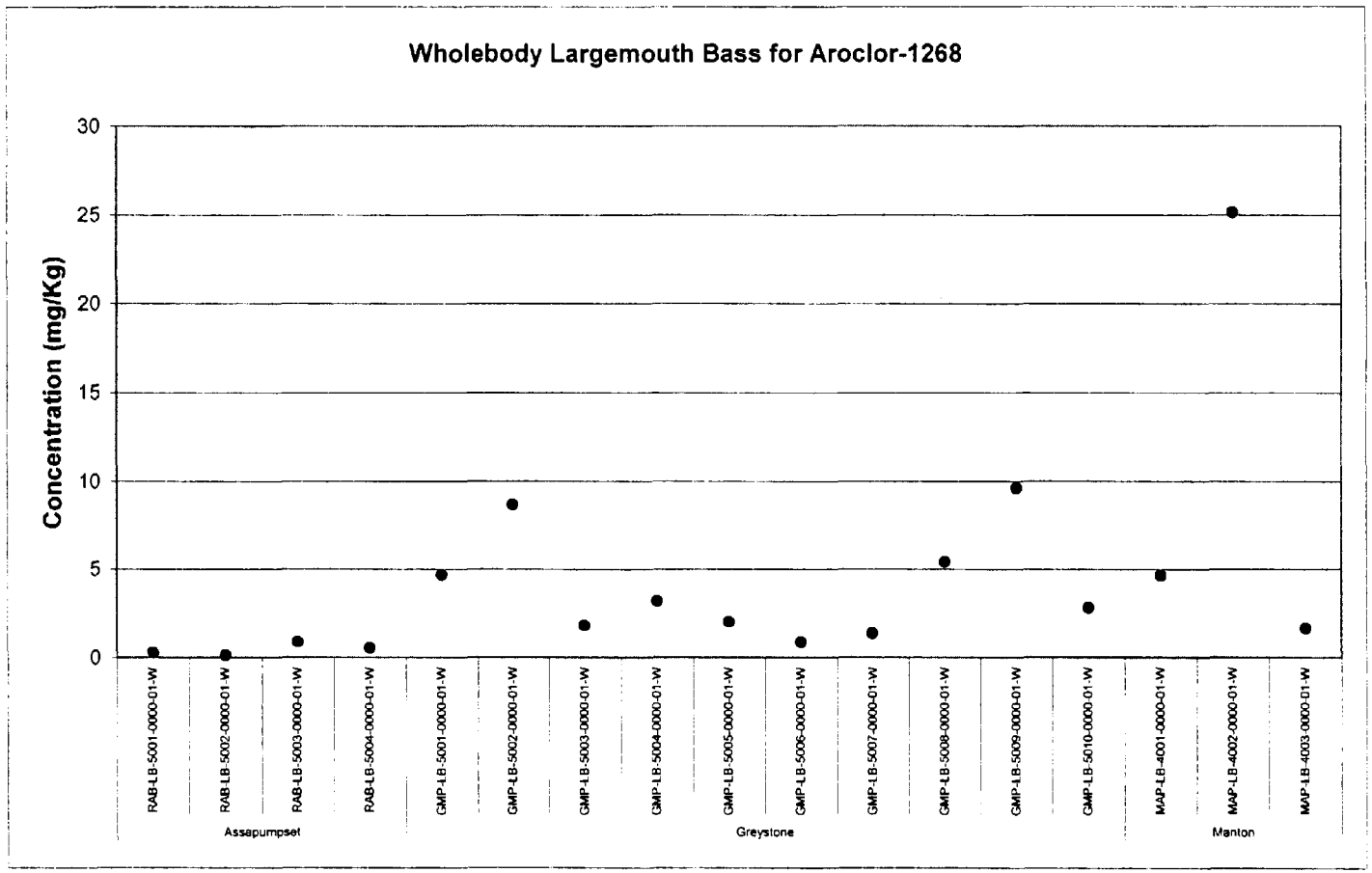
Checked by: KJA



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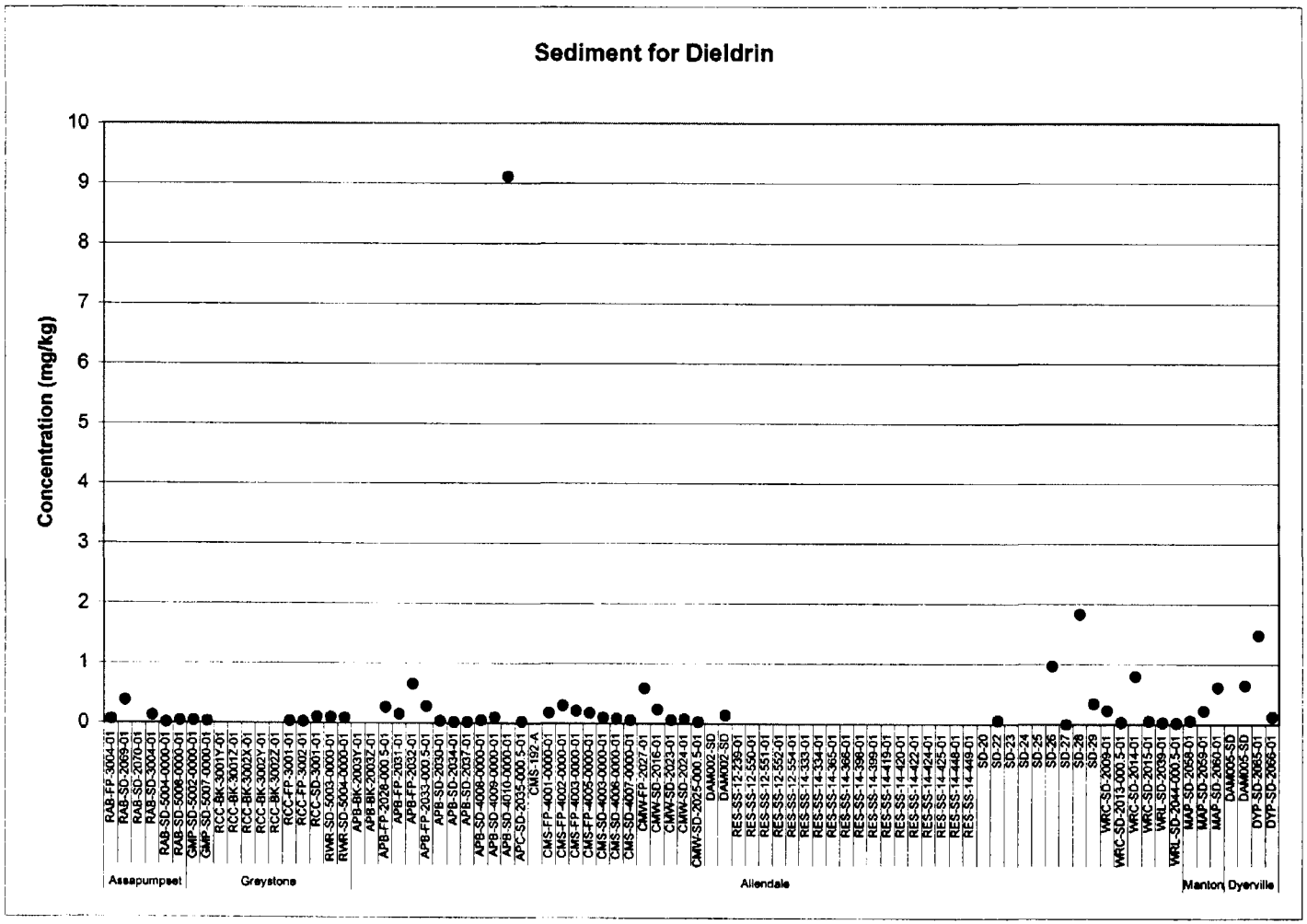
Largemouth Bass W2, LMW Aroclor-1268

Prepared by: BJR
Checked by: KJA



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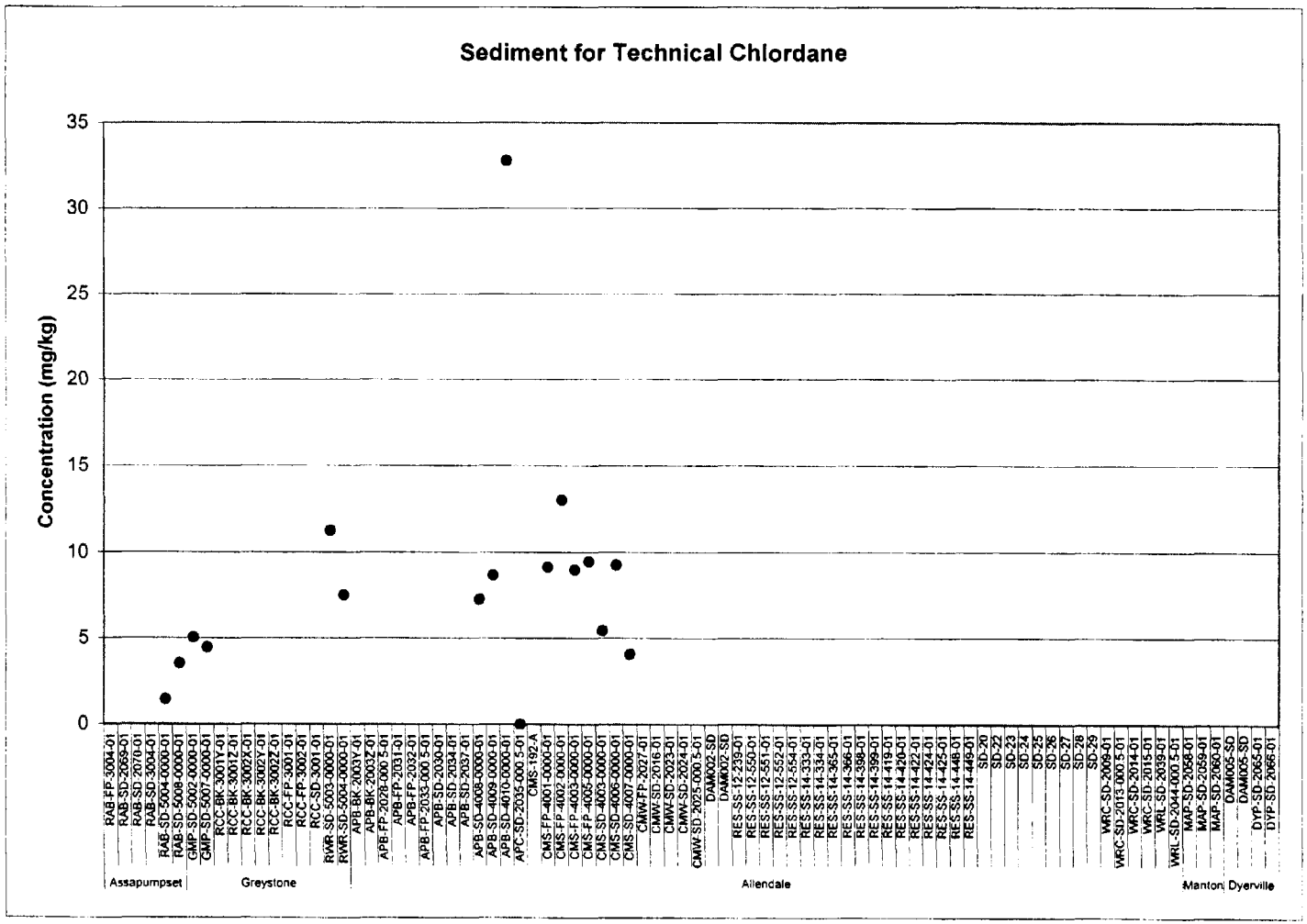
Sedimen[illegible] SD Dieldrin

Prepared by: BJR
Checked by: KJA



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Sediment2, SD Technical Chlordane

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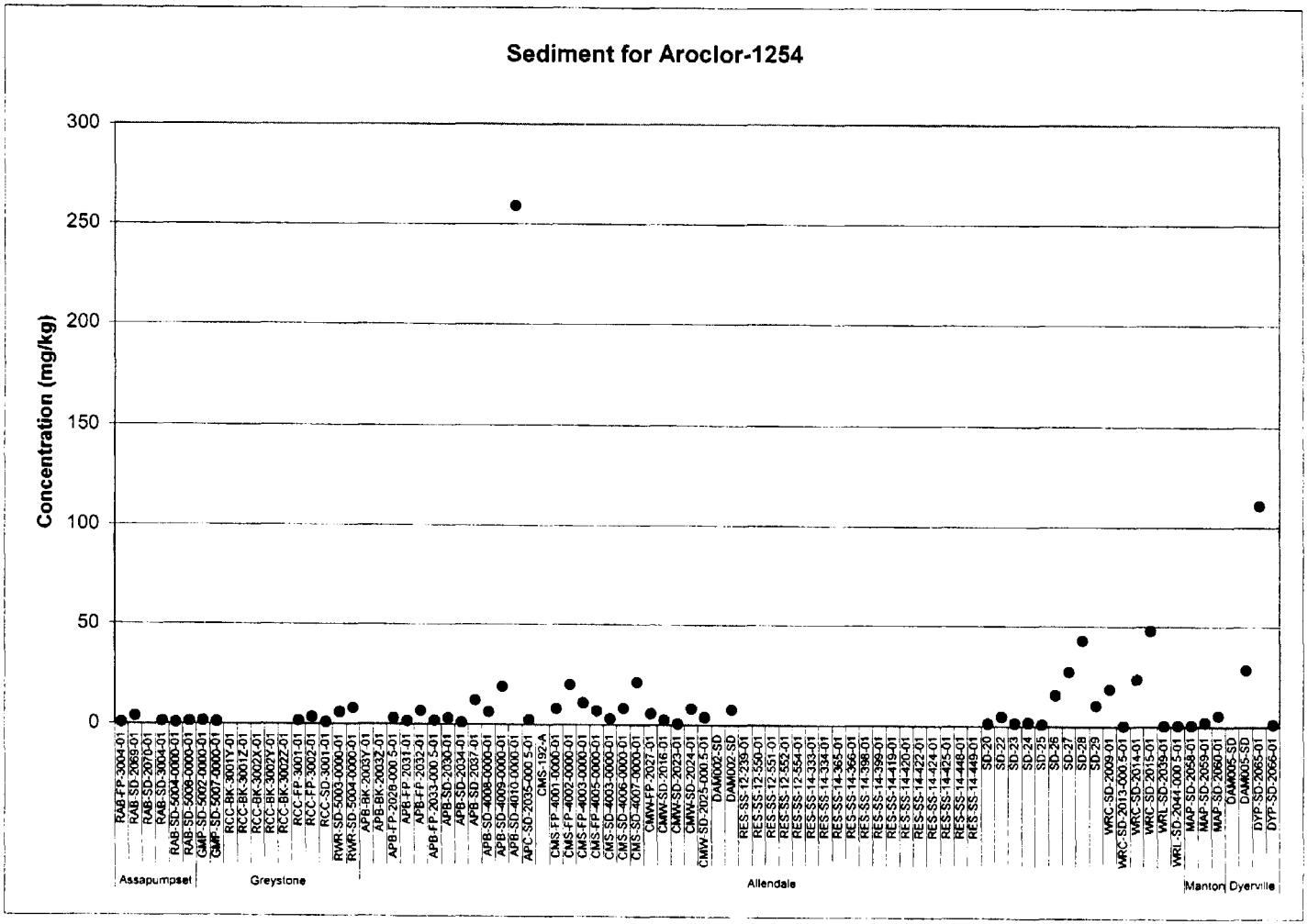
Checked by: KJA



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Sediment2, SD Aroclor-1254

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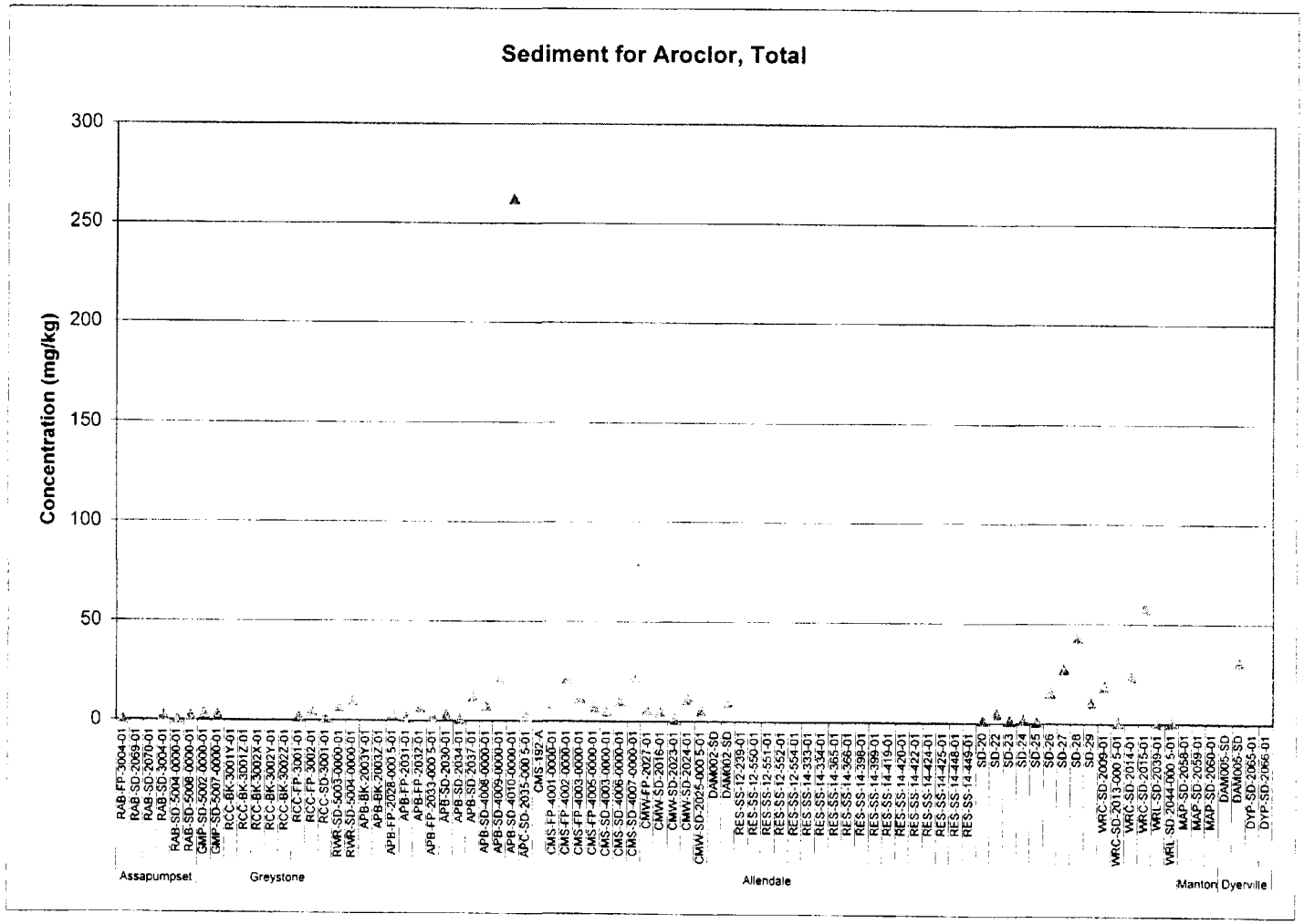
Checked by: KJA



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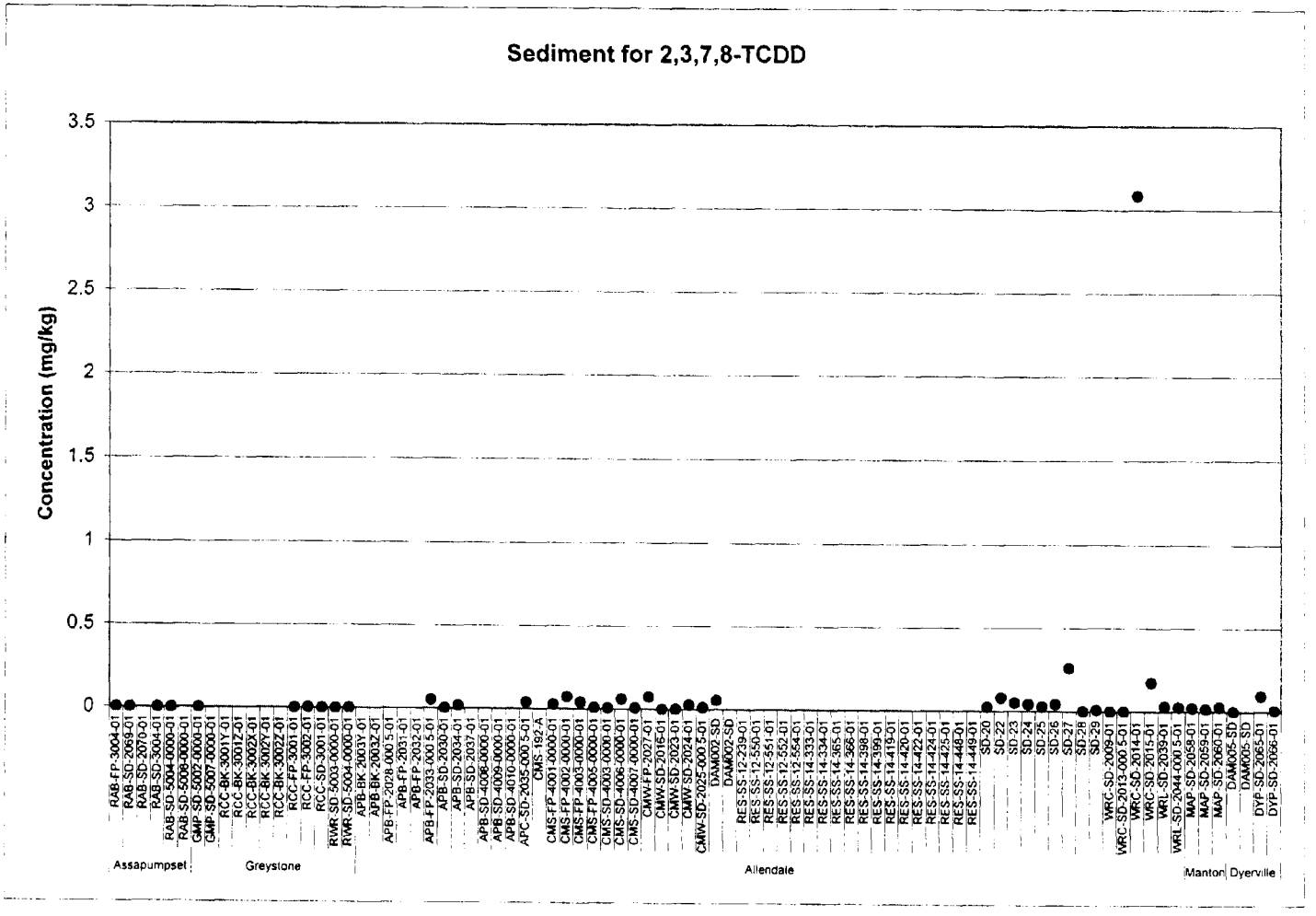
Sediment2, SD Aroclor, Total

Prepared by: BJR
Checked by: KJA



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Sediment2, SD 2,3,7,8-TCDD

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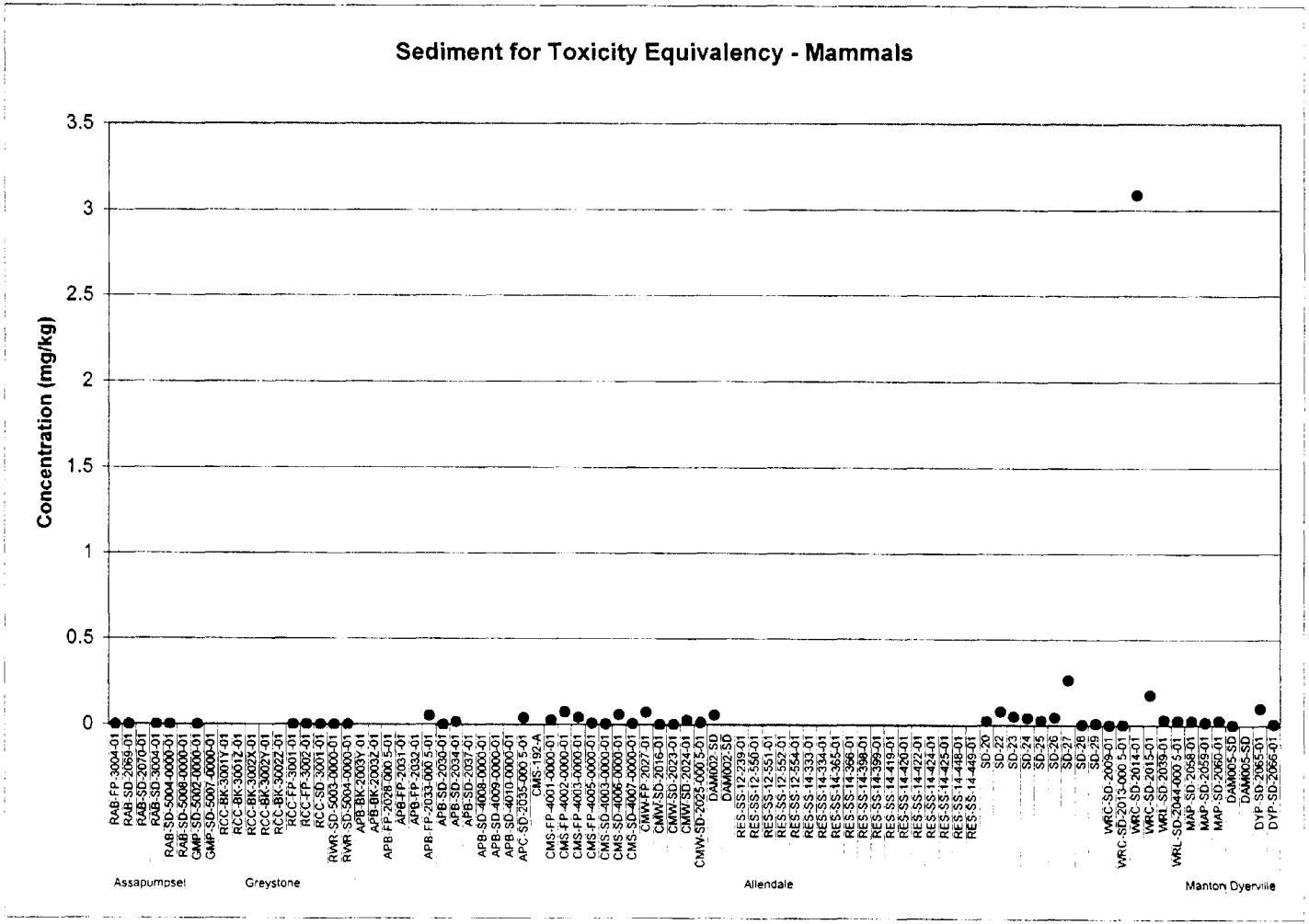
Checked by: KJA

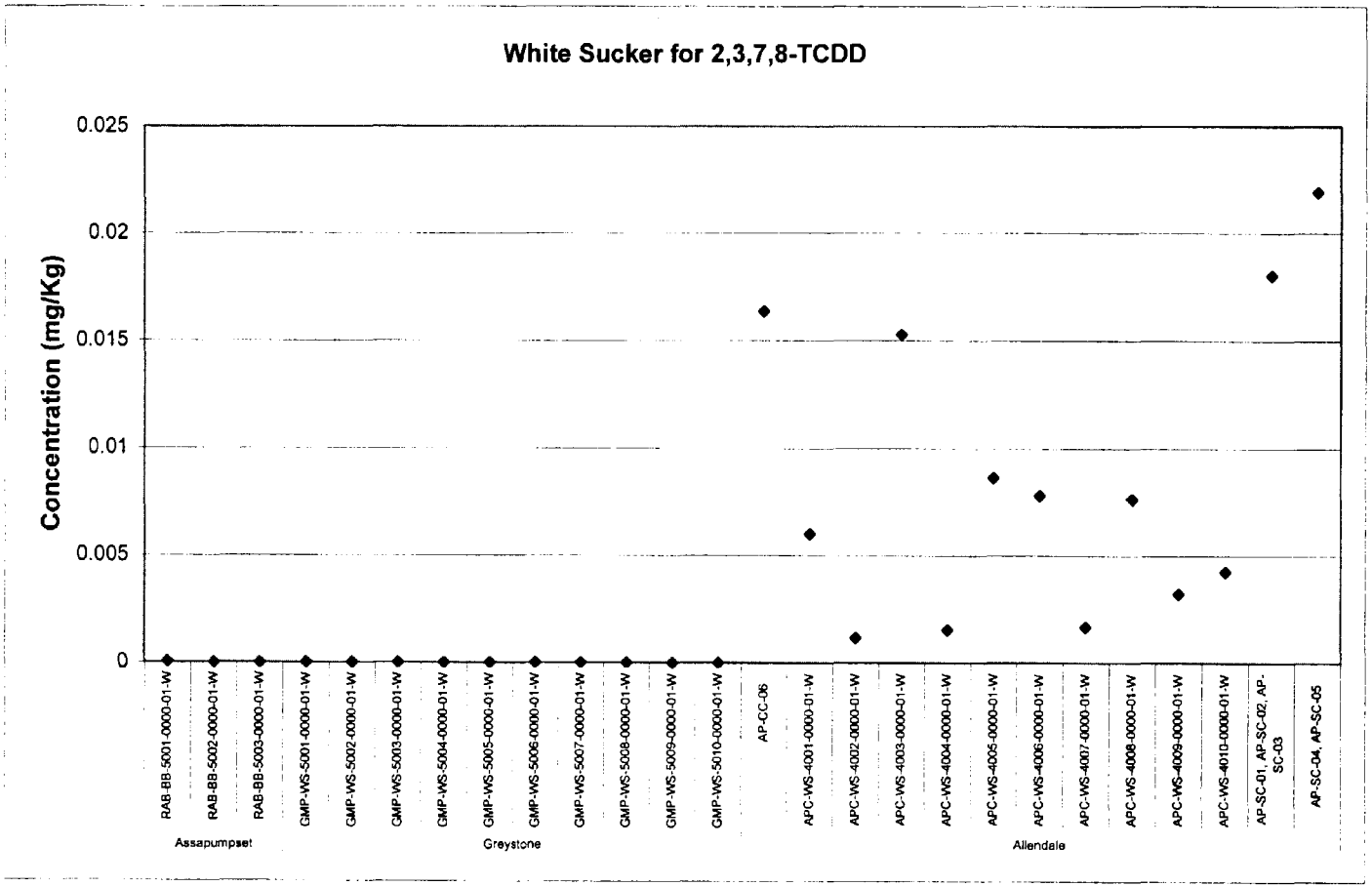


P:\W9-GVT\COE-NAE\Battelle\Centredale\Task27-HH PRGs\Outlier\
Sediment2, SD Toxicity Equivalency Mammals

Prepared by: BJR
Checked by: KJA

PARAMETER	Average	APB-SD-4010-0000-01 7/10/2001 NORMAL
Semivolatile Organics (mg/Kg)		
Benzo(a)pyrene	2.307846	1.17966
Pesticides/PCBs (mg/Kg)		
4,4'-DDD	0.0060	0.01676 J
4,4'-DDE	0.016	0.01604
Dieldrin	0.0090	0.11297 J
Technical Chlordane	0.52	0.40648
Aroclor-1254	1.51	3.21148
Aroclor-1268	0.079	0.04036
Aroclor, Total	1.53	3.25184
Inorganics (mg/Kg)		
Aluminum	10038	5759 J
Barium	138	39.5 J
Mercury (methyl)	0.00080	0.000196 J
Selenium	1.06	0.245 U
Vanadium	36.2	17.4
Zinc	354	131 J
Total Organic Carbon		
Total Organic Carbon **(mg/Kg)**	72320	
Total Organic Carbon **(%)**	6.41	1.24

LIPID-NORMALIZED BIOTA COC CONCENTRATIONS AND ORGANIC CARBON-NORMALIZED SEDIMENT CONCENTRATIONS WITH NO OUTLIERS DETERMINED



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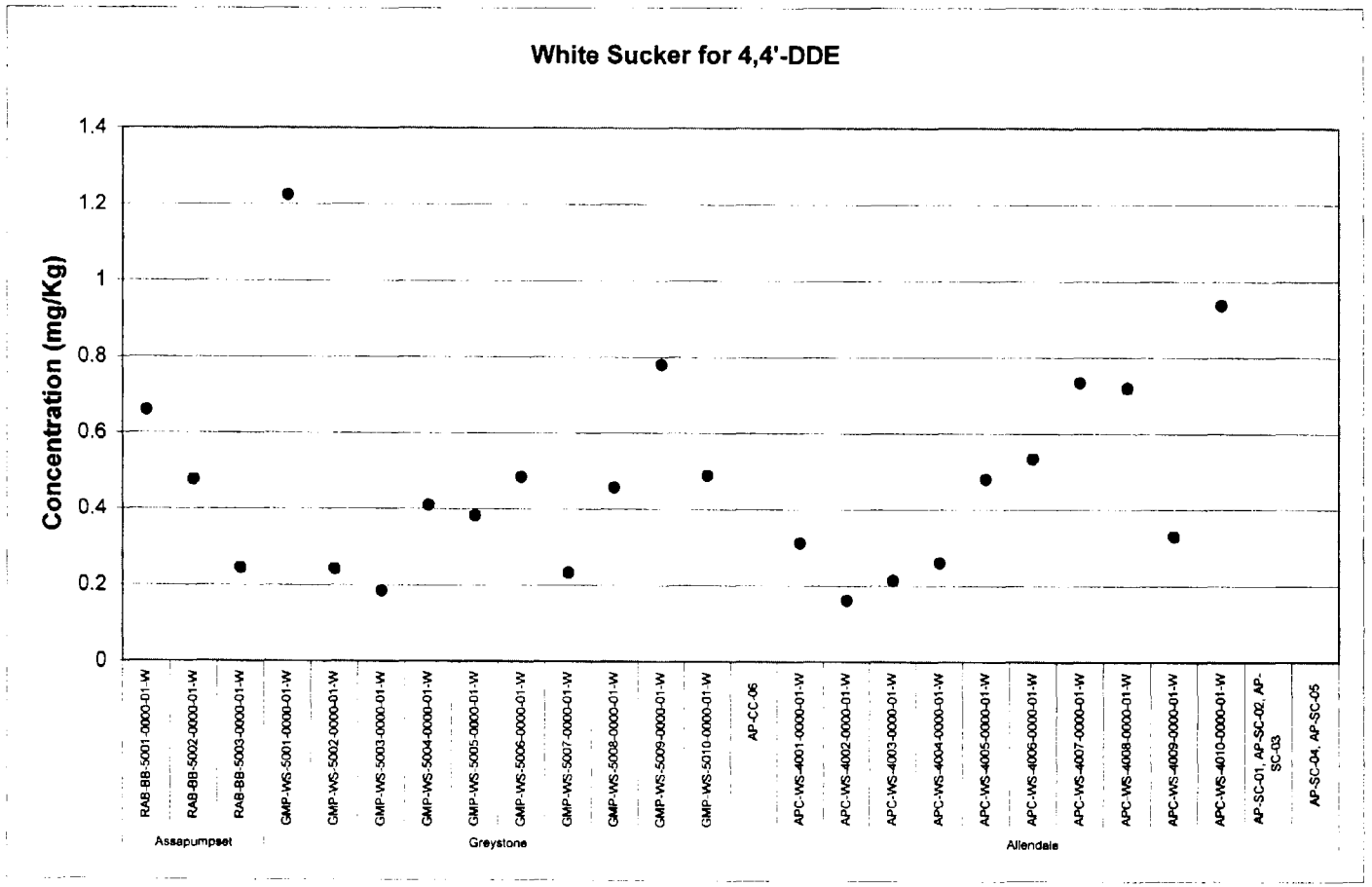
White Sucker2, WS 2,3,7,8-TCDD



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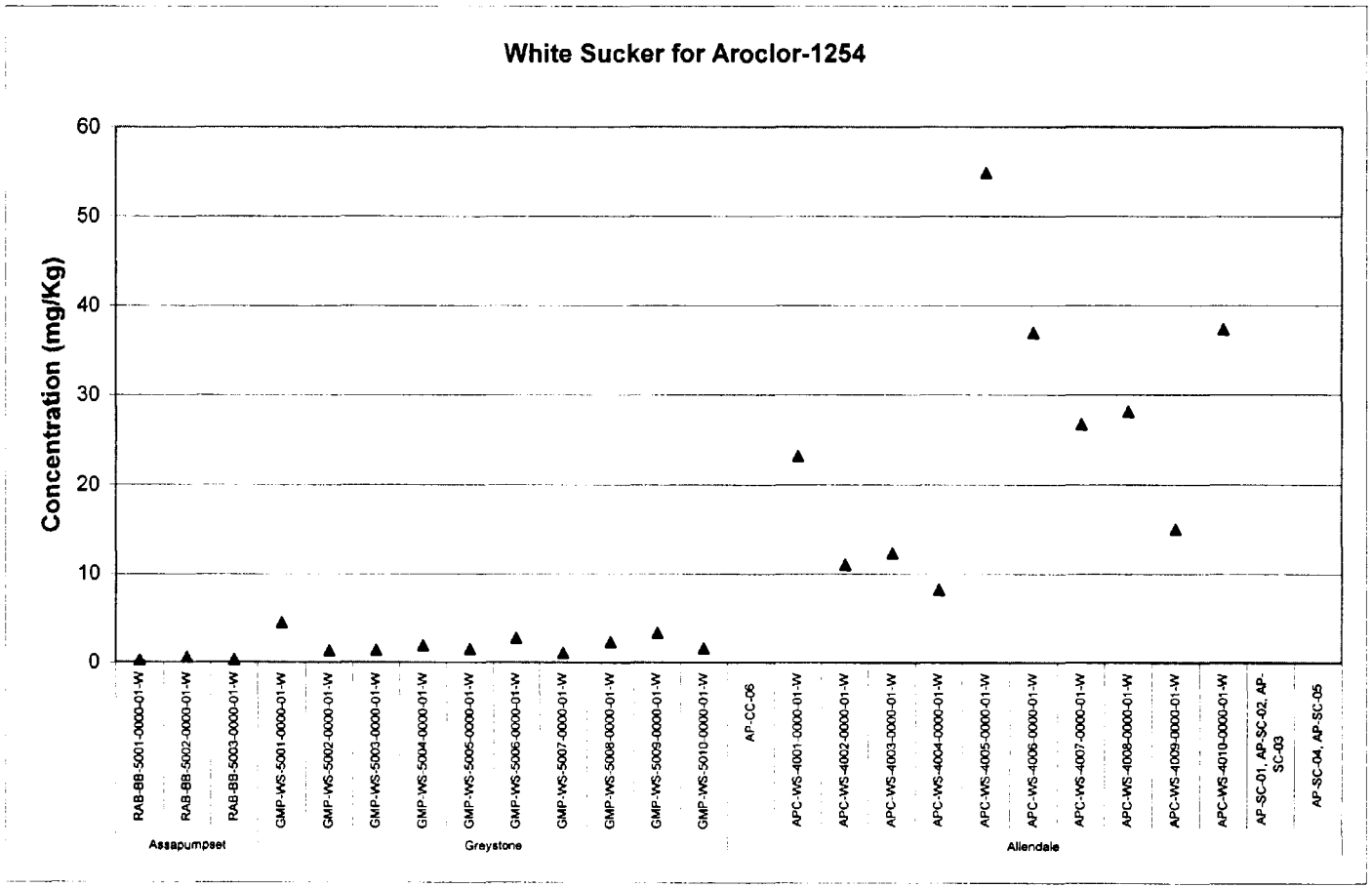
White Sucker WS 4,4'-DDE



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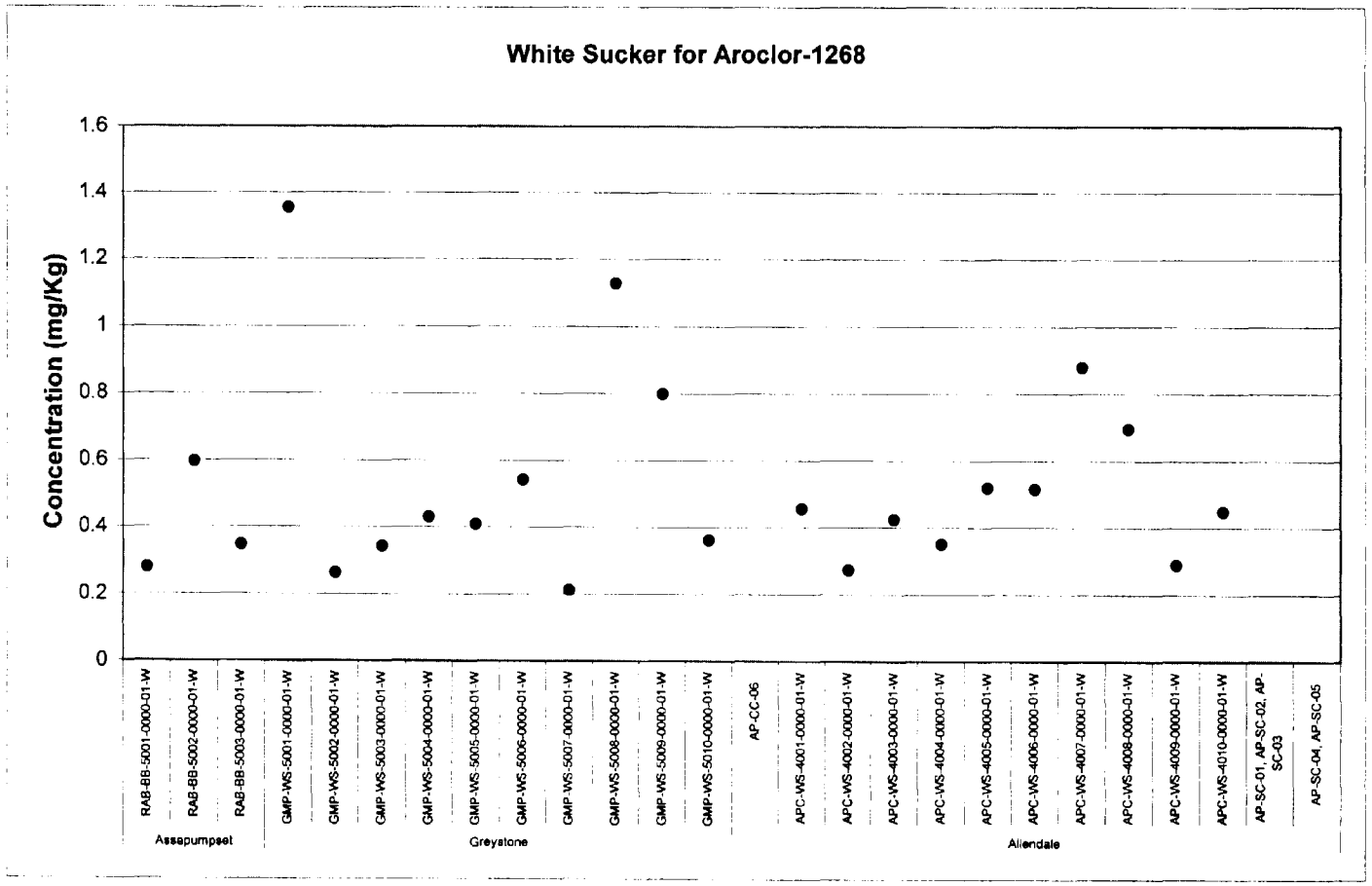
White Sucker2, WS Aroclor-1254



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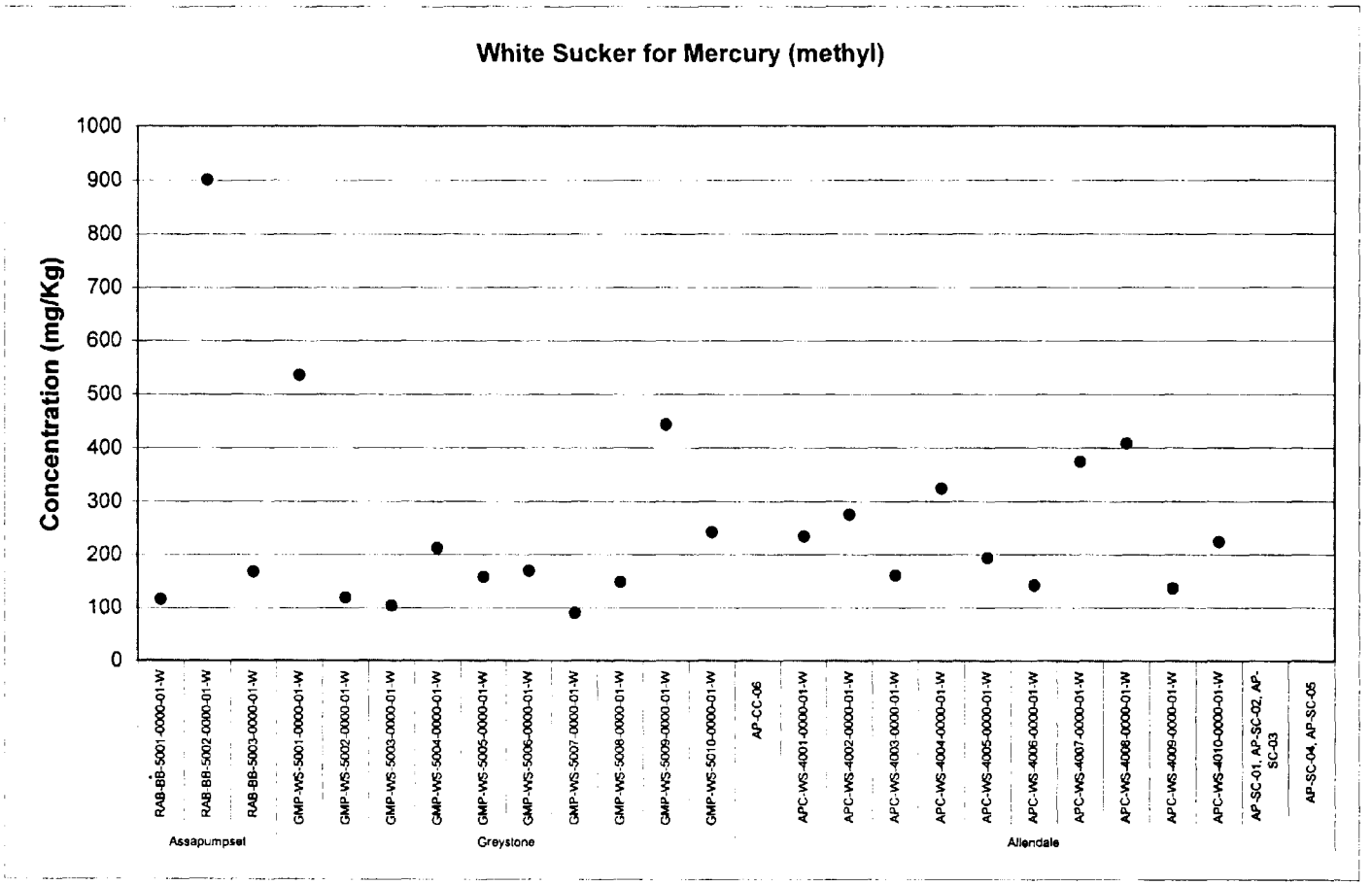
White Sucker WS Aroclor-1268



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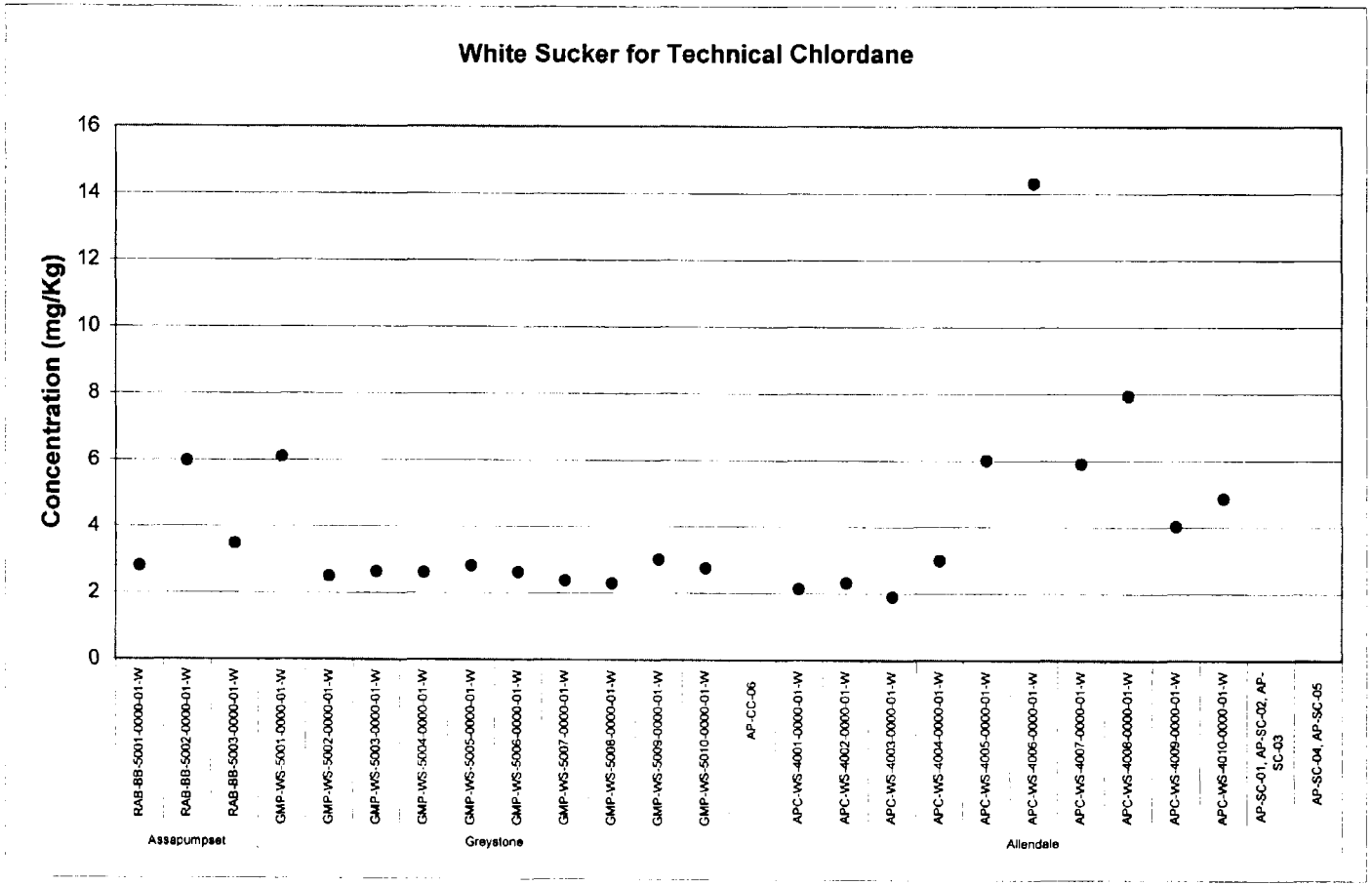
White Sucker2, WS mercury(methyl)



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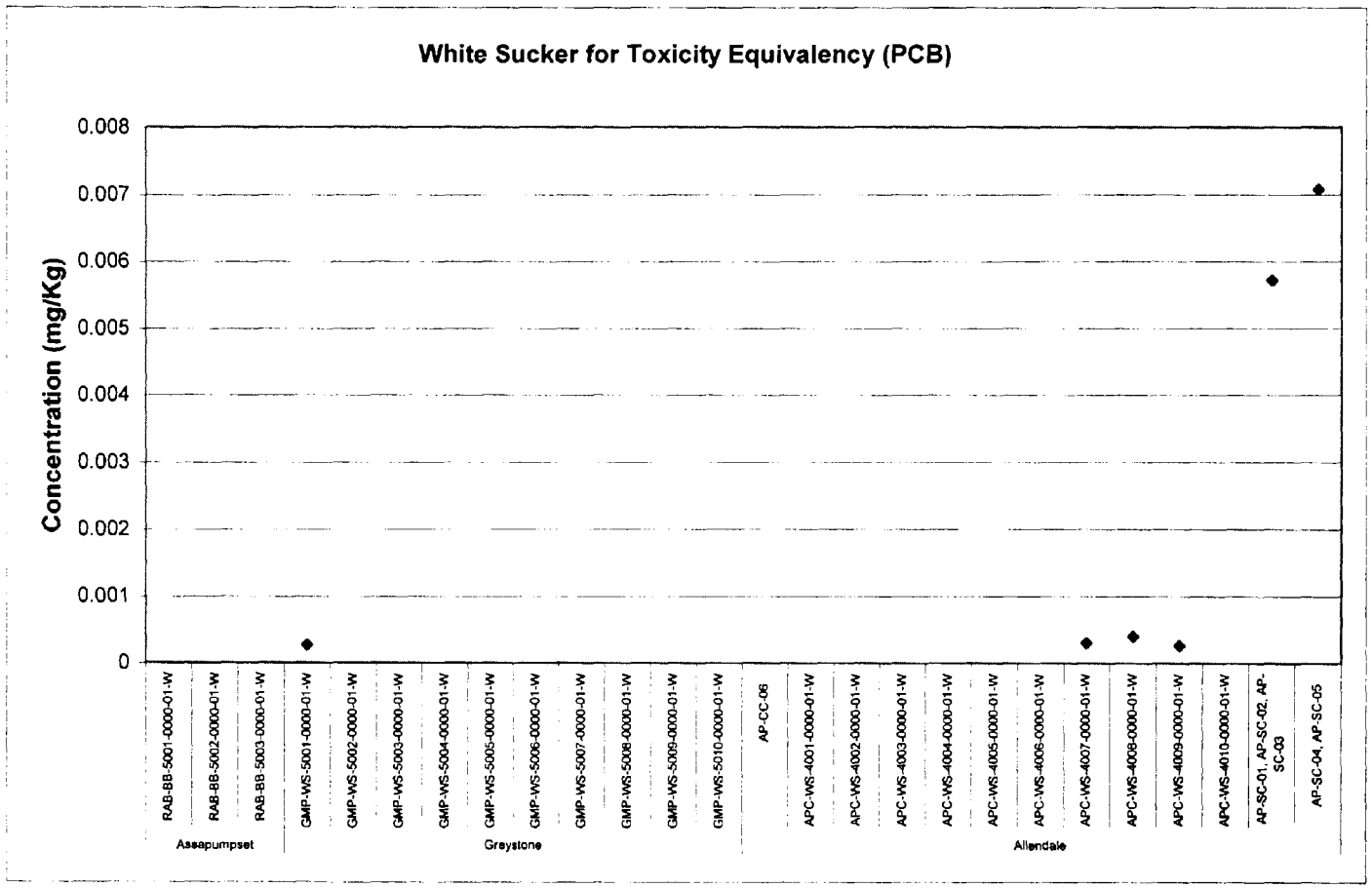
White Sucker2, WS technical chlordane



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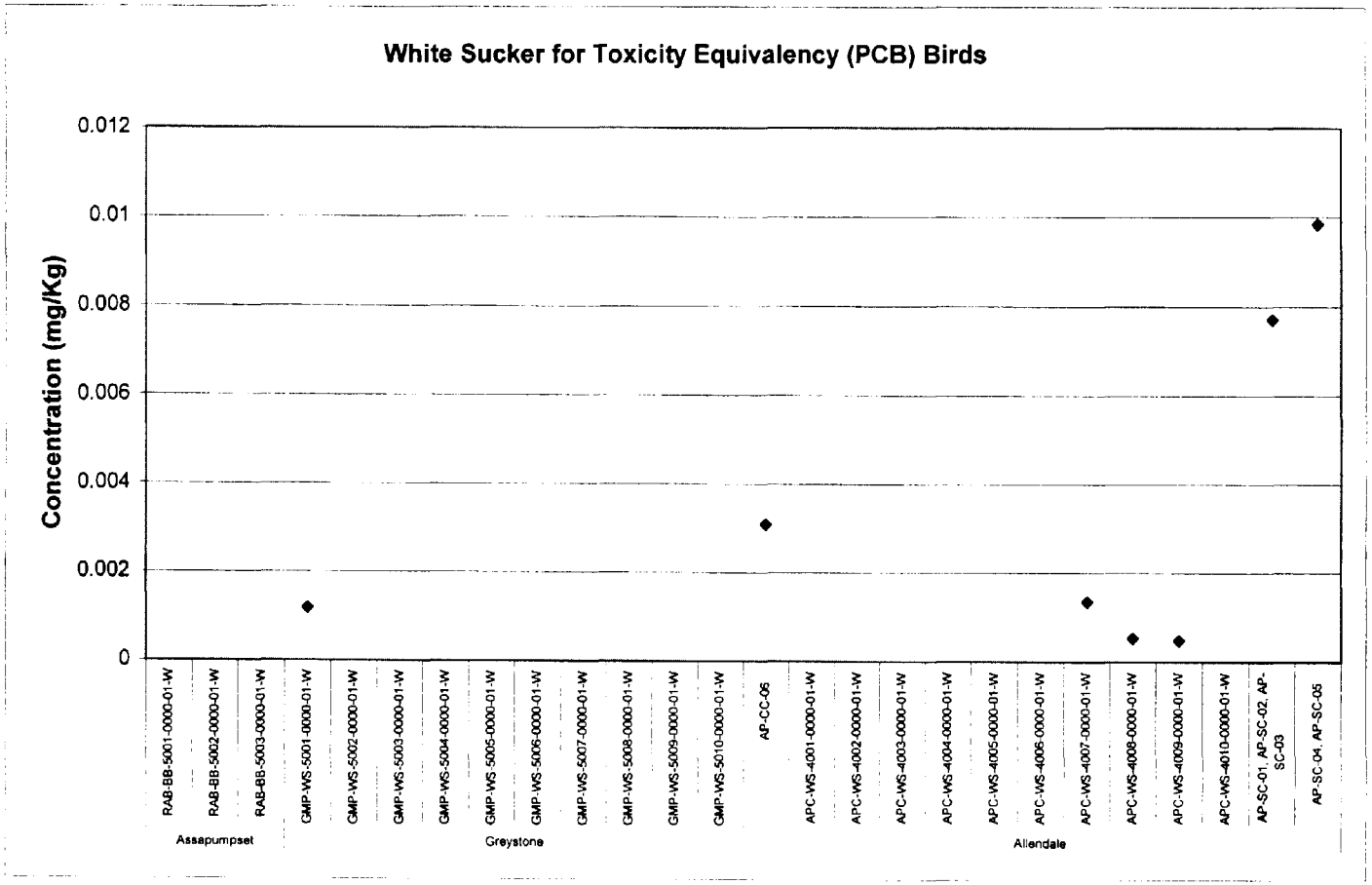
White Sucker2. WS toxicity equivalency (PCB)



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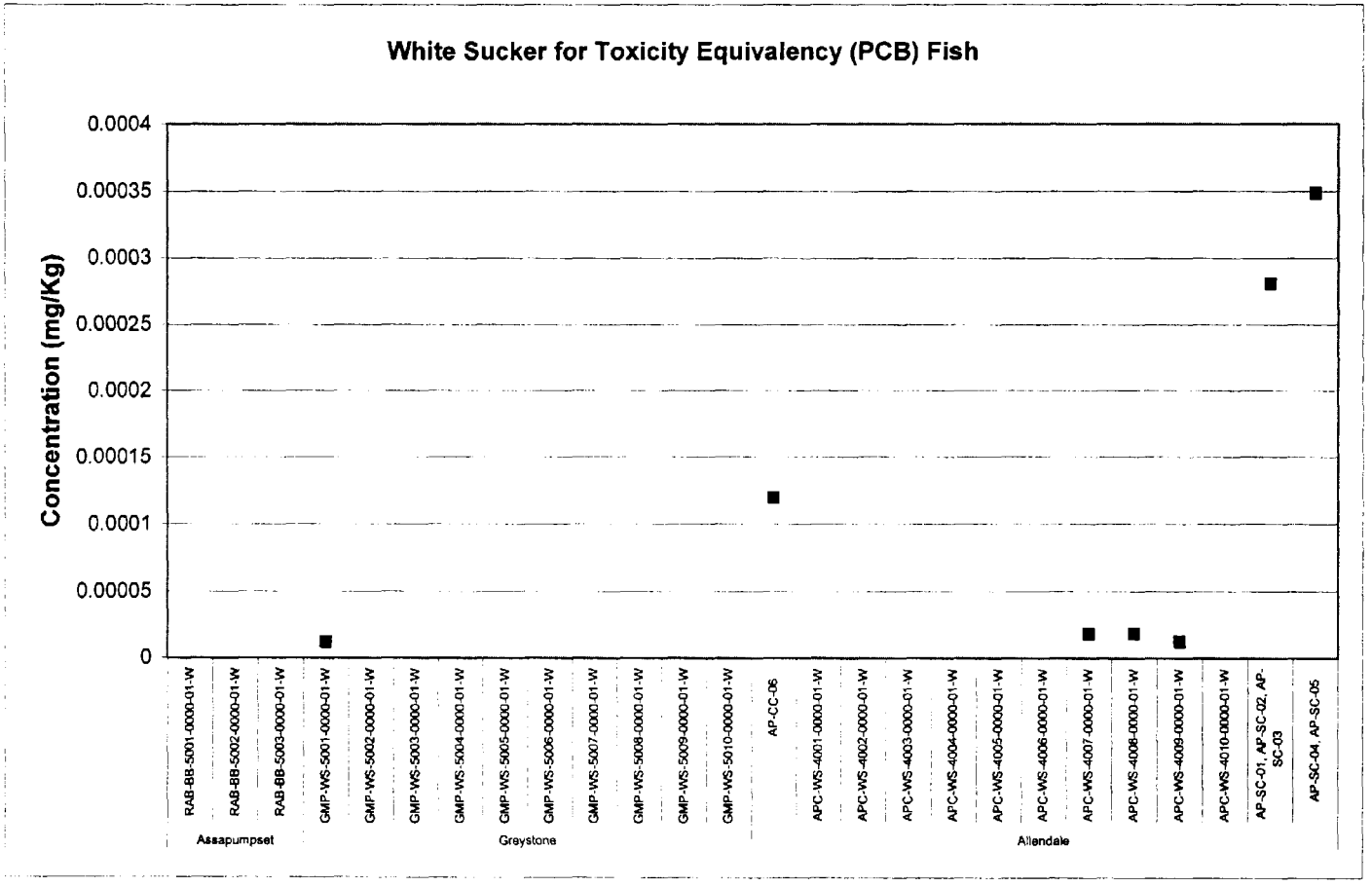
White Sucker_WS toxicity equivalency (PCB)B



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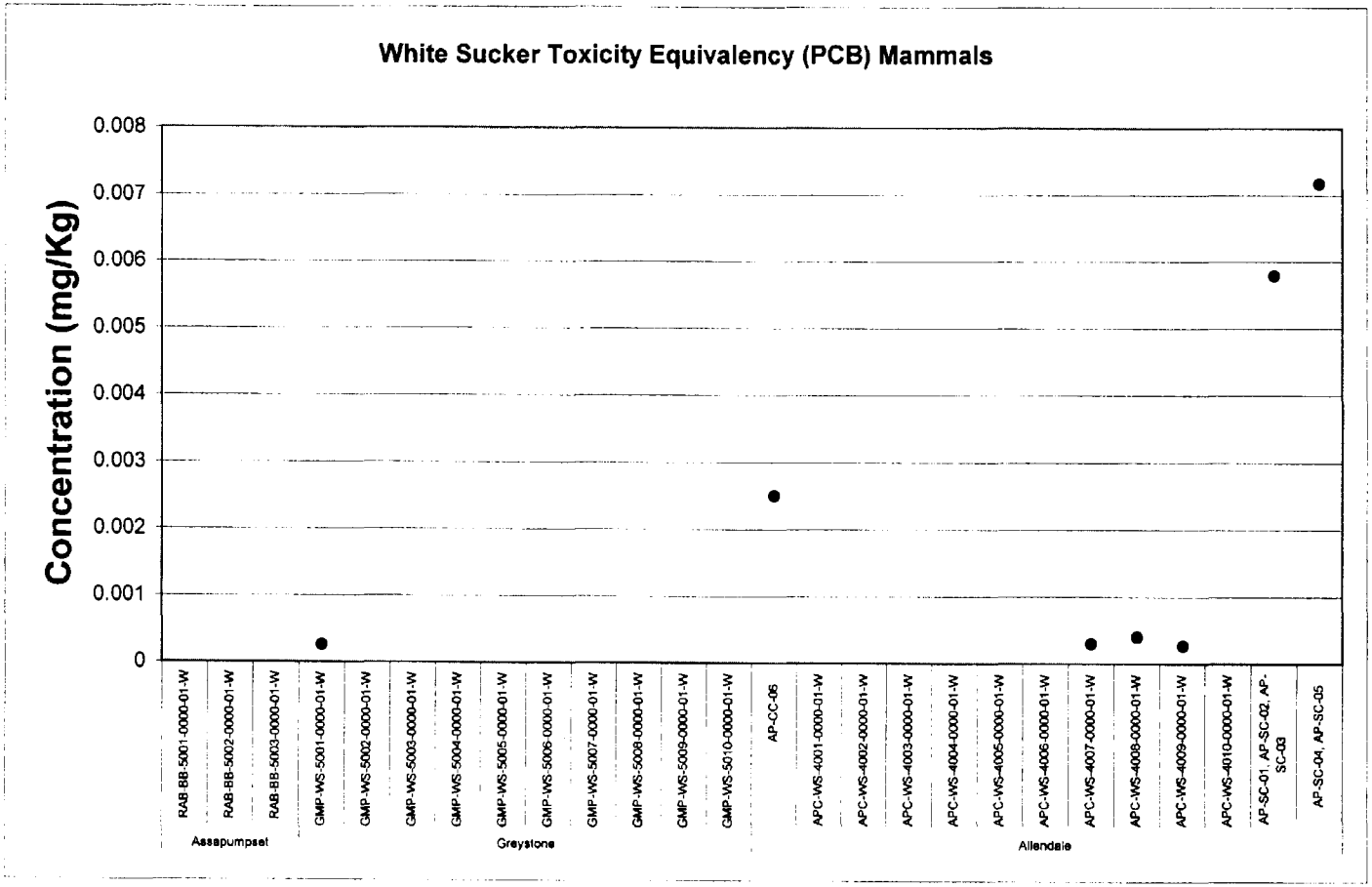
White Sucker2, WS toxicity equivalency (PCB)F



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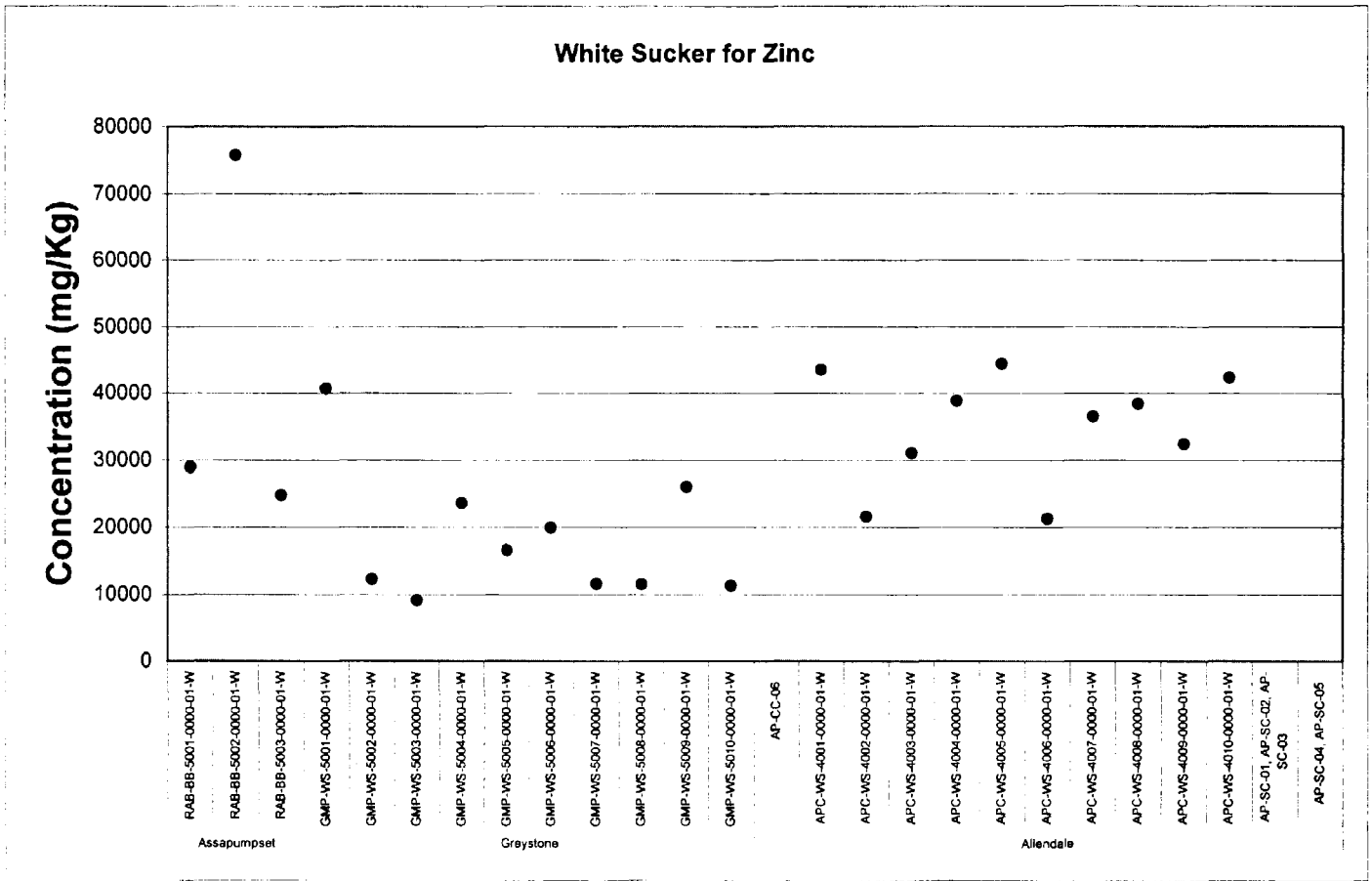
White Sucker2, WS toxicity equivalency (PCB)M



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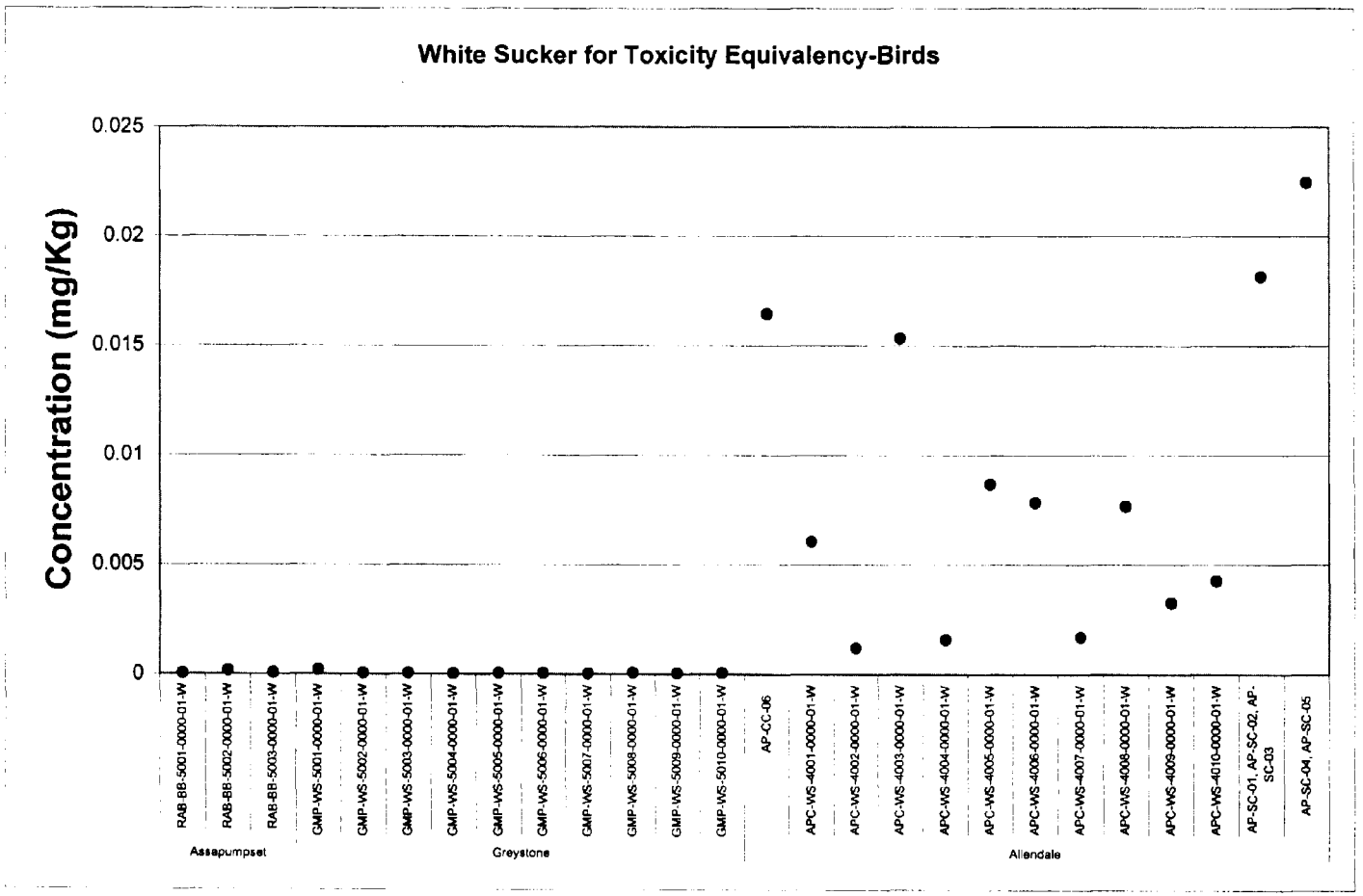
White Sucker2, WS zinc



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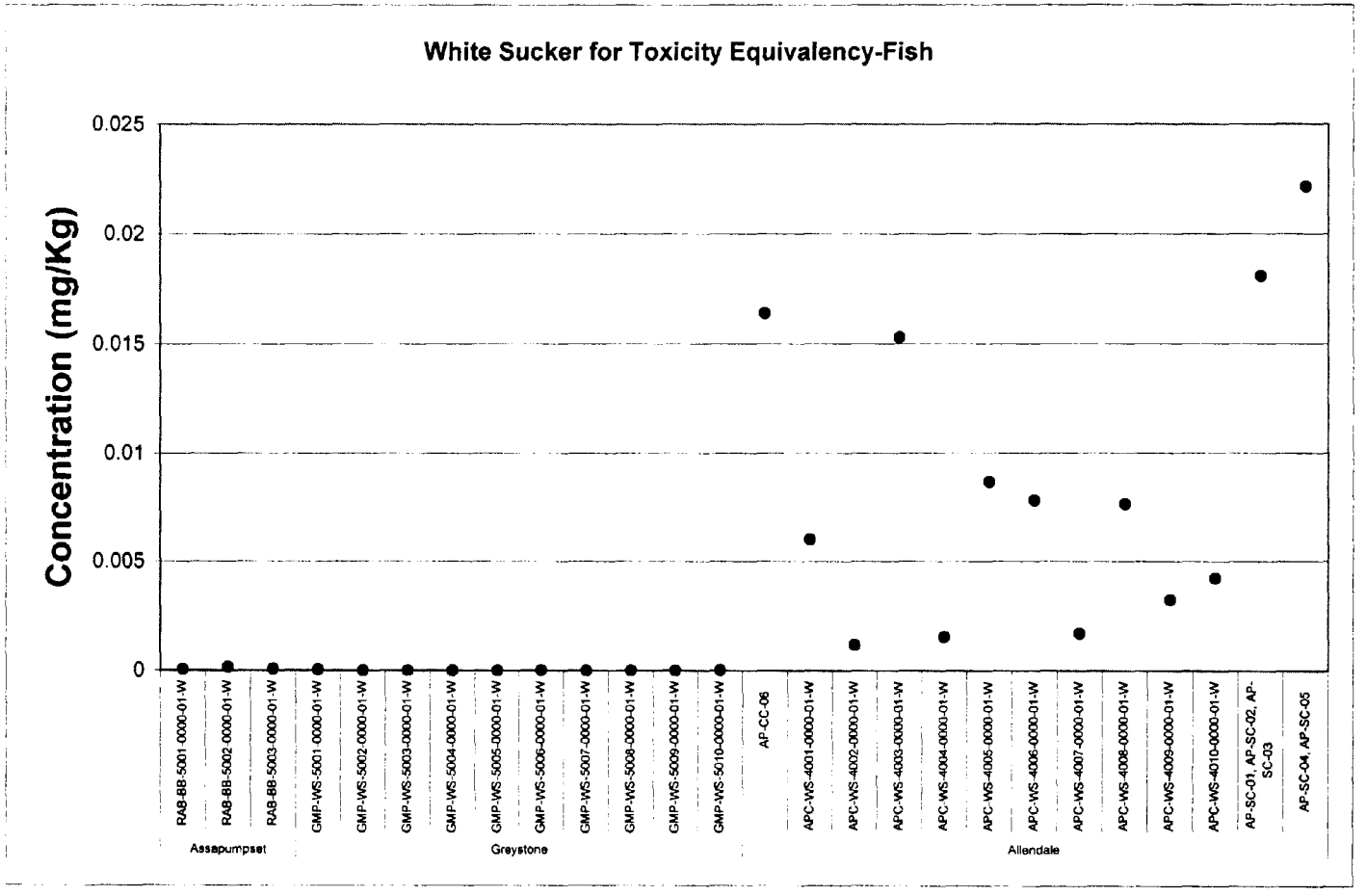
White Sucker WS Toxicity Equivalency Birds



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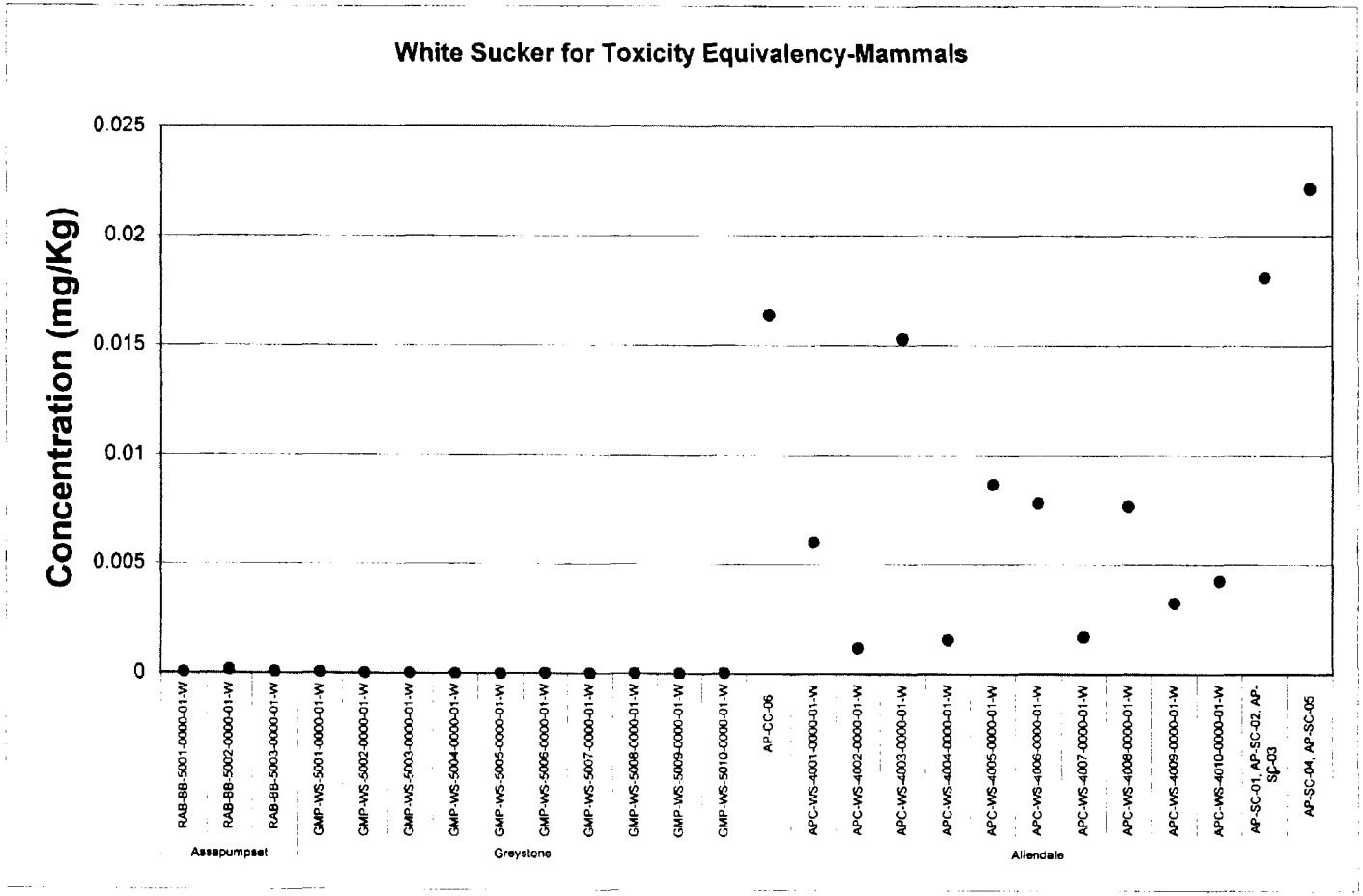
White Sucker2, WS Toxicity Equivalency Fish



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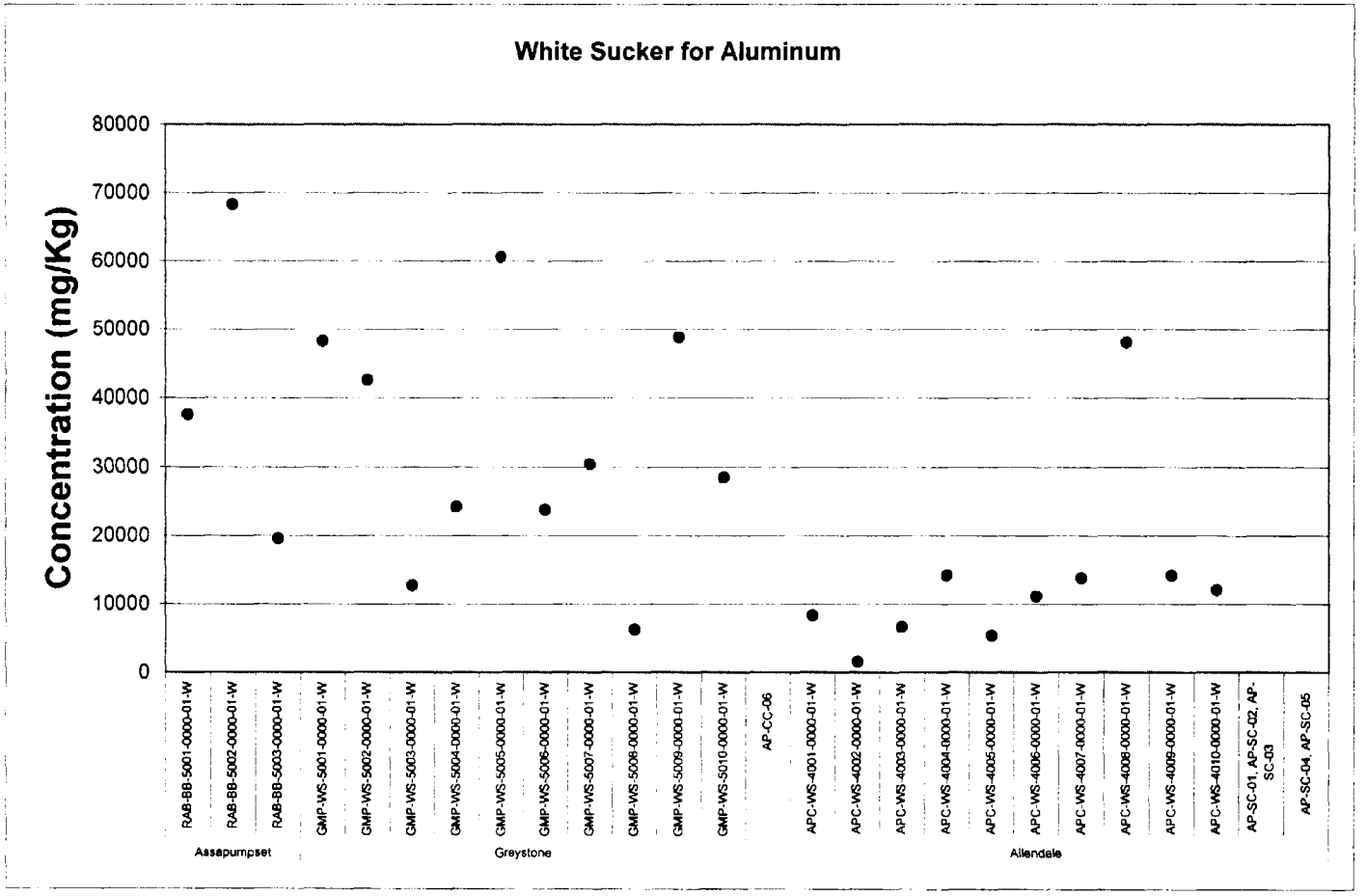
White Suc' 'WS Toxicity Equivalency-Mammals



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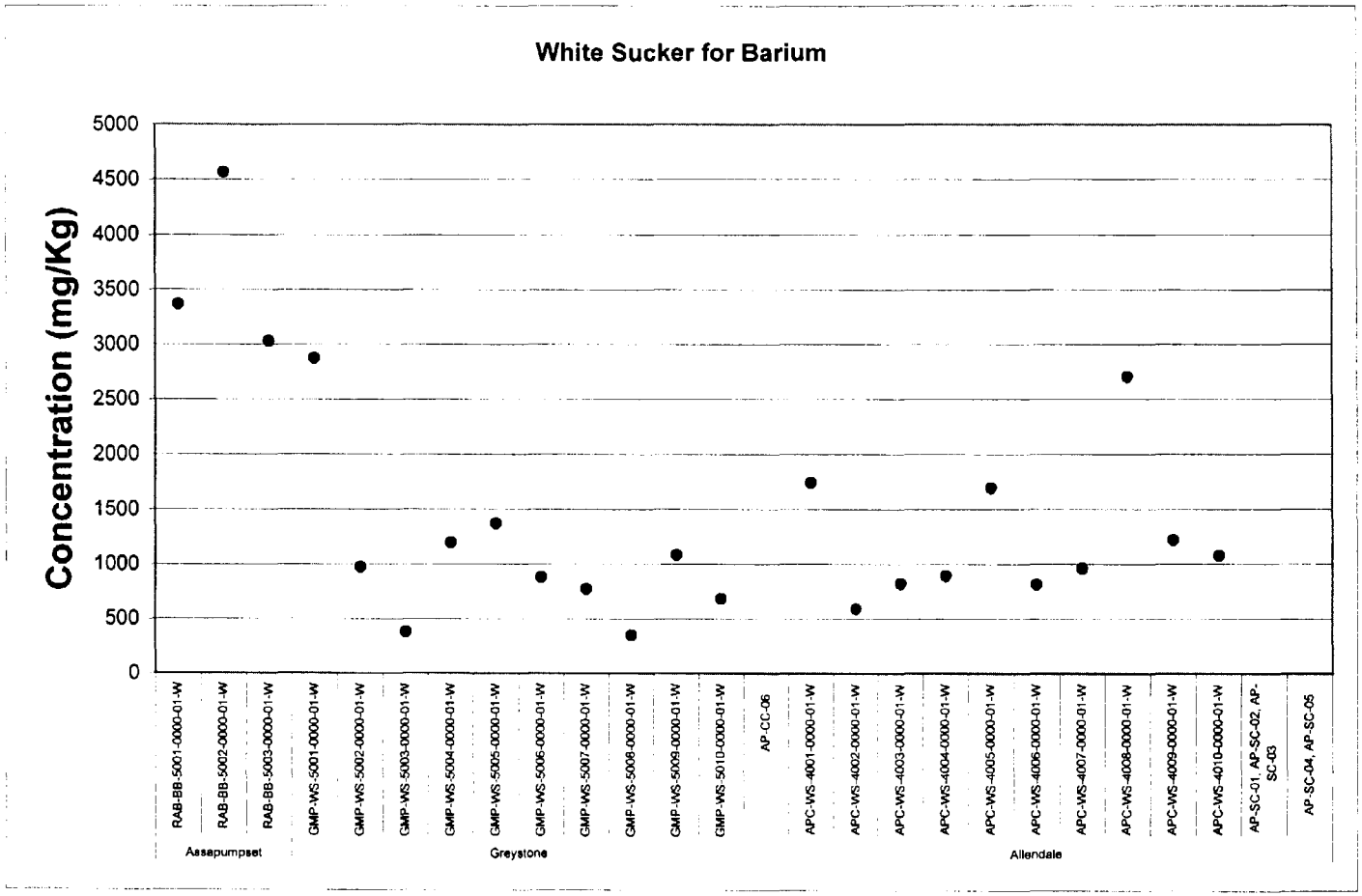

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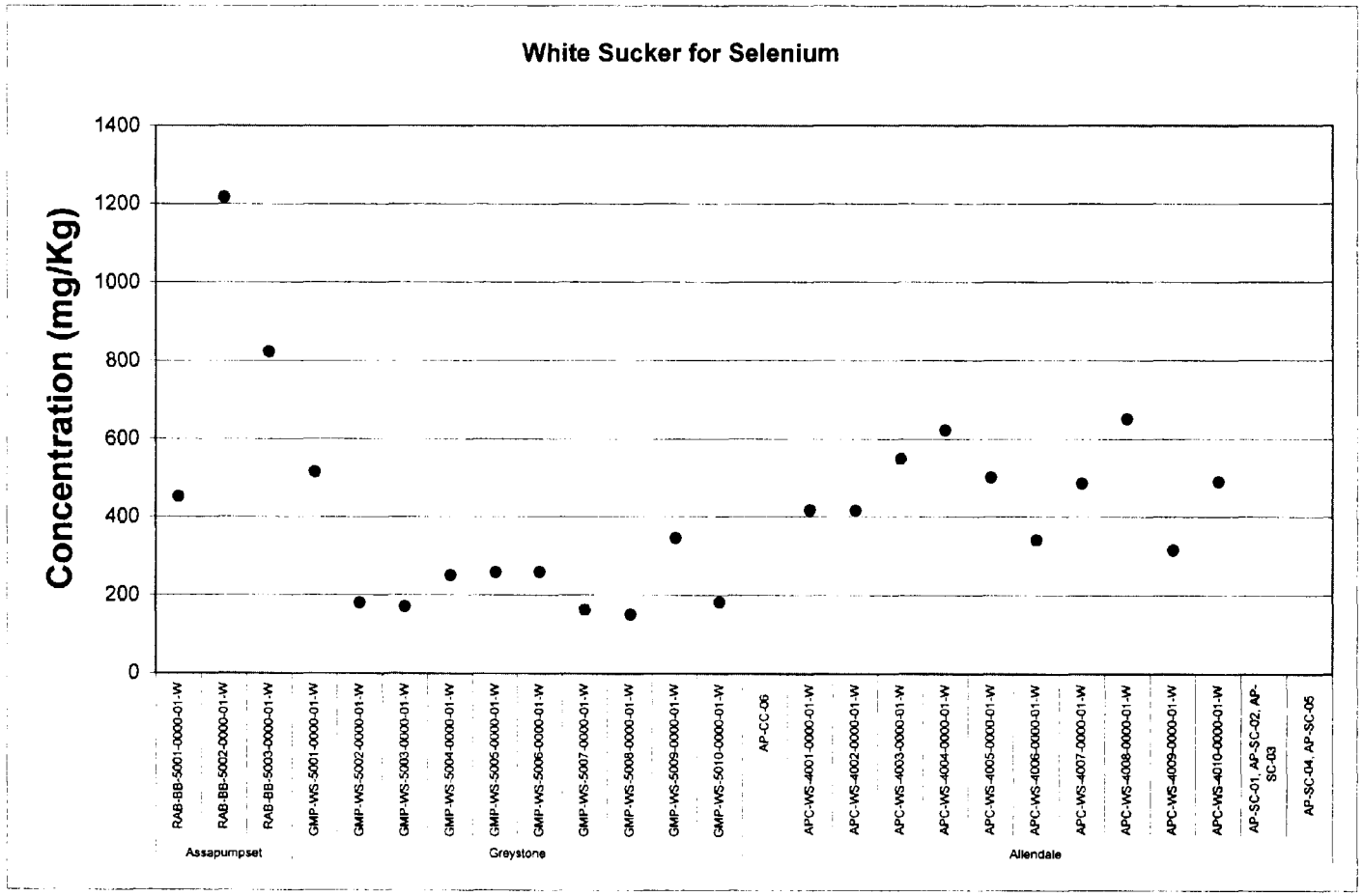
White Suck[illegible] WS Barium



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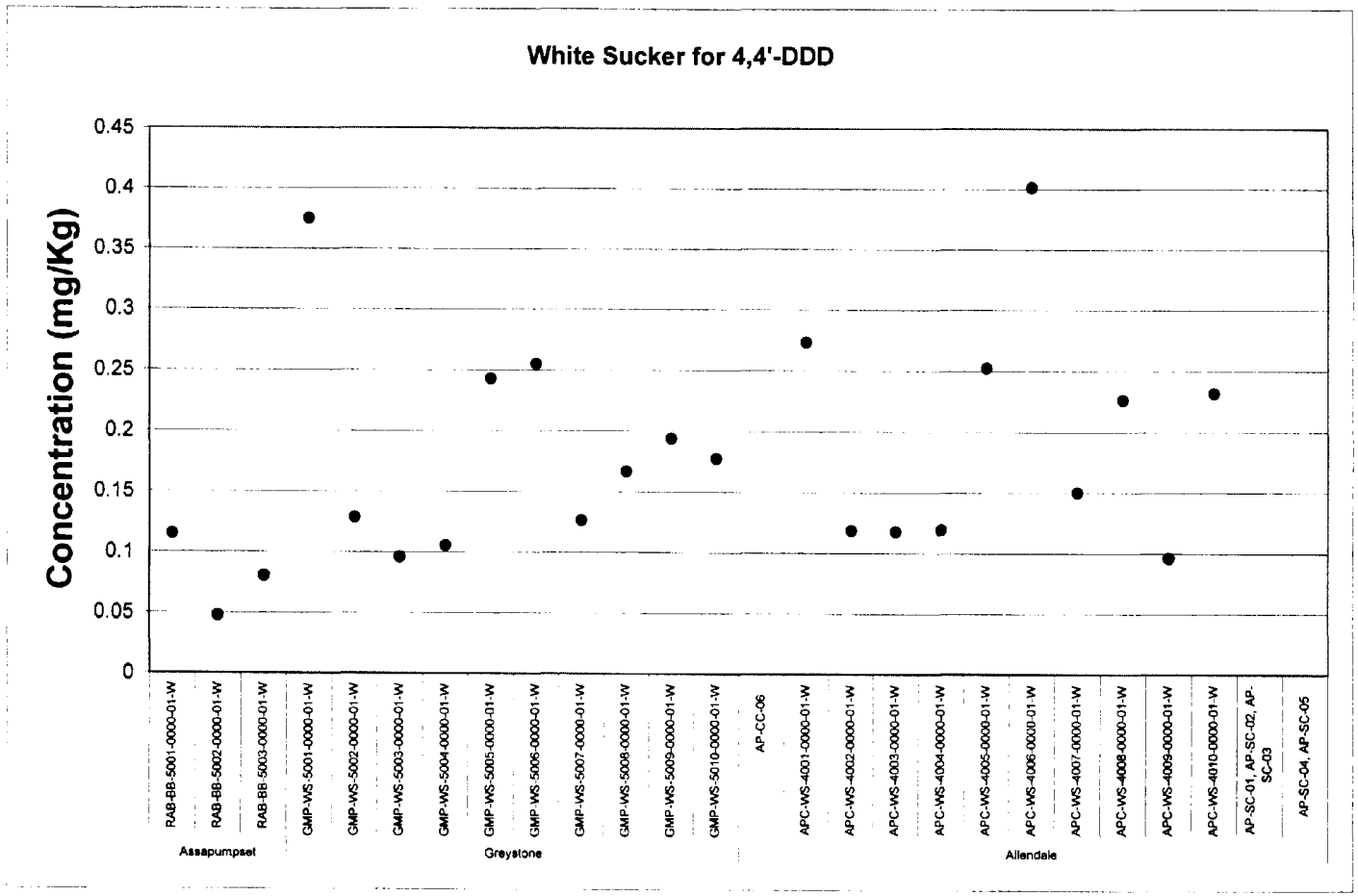
White Sucker2, WS Selenium



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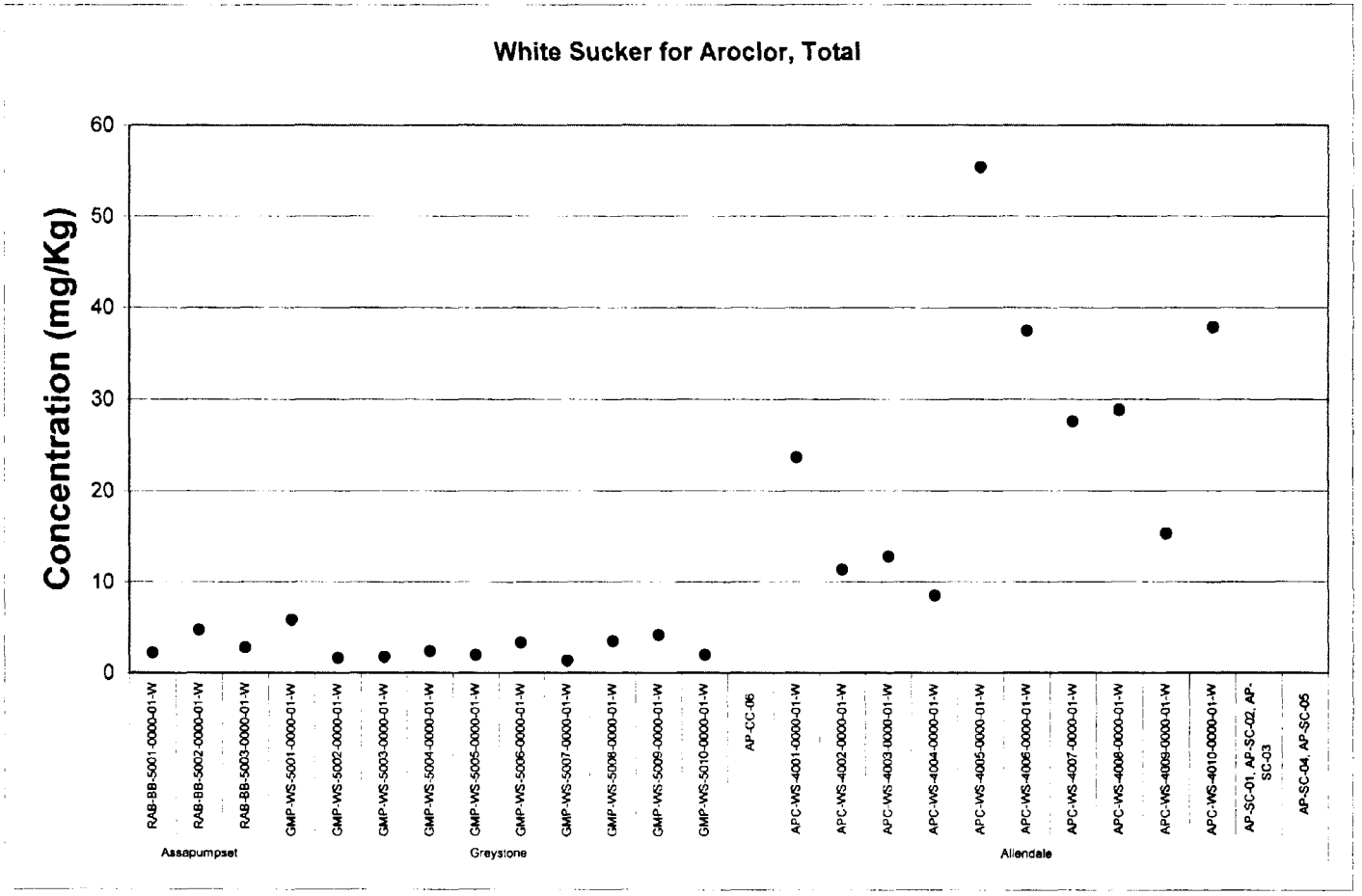
White Sucker WS 4,4'-DDD



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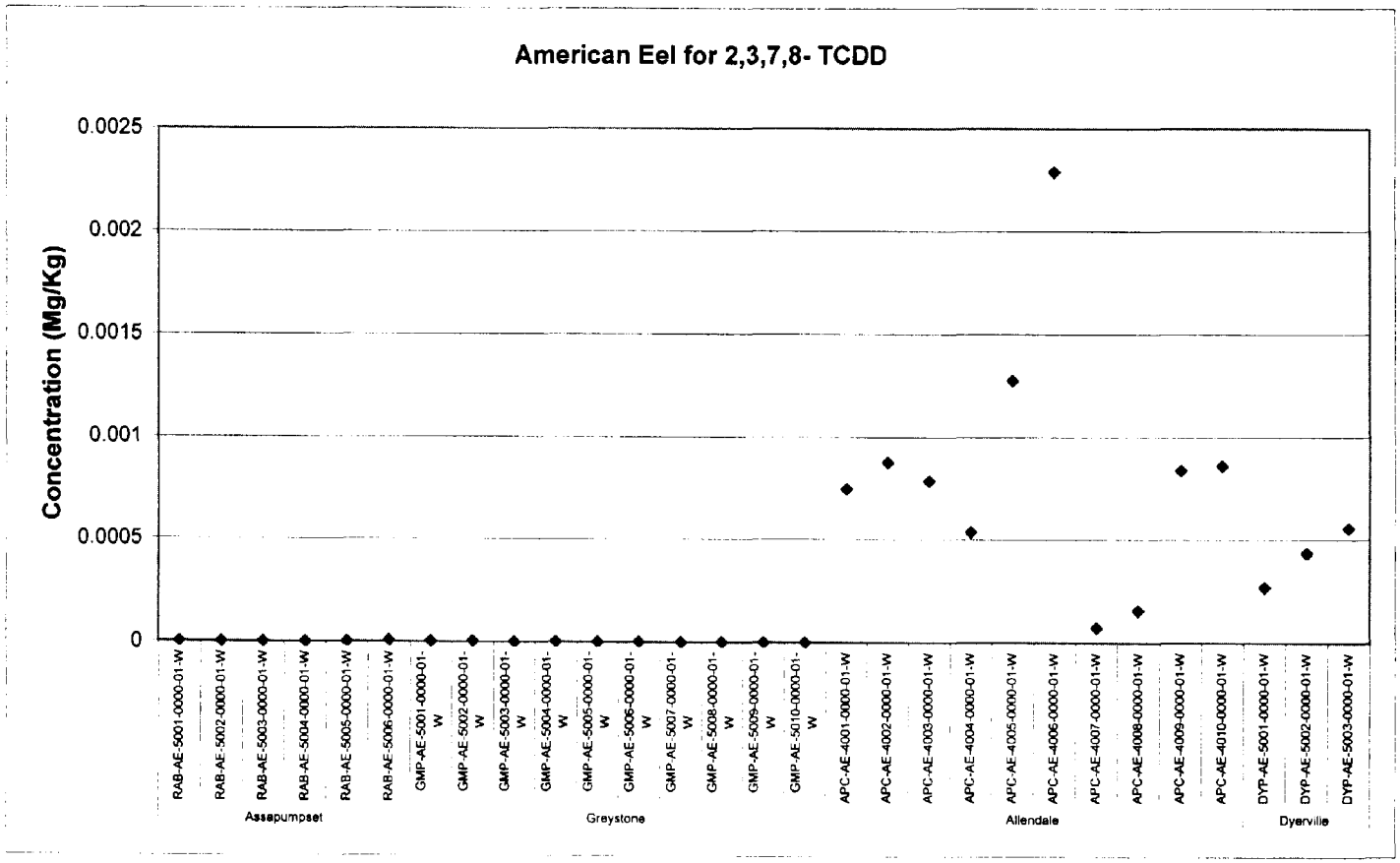
White Sucker2, WS Aroclor, Total



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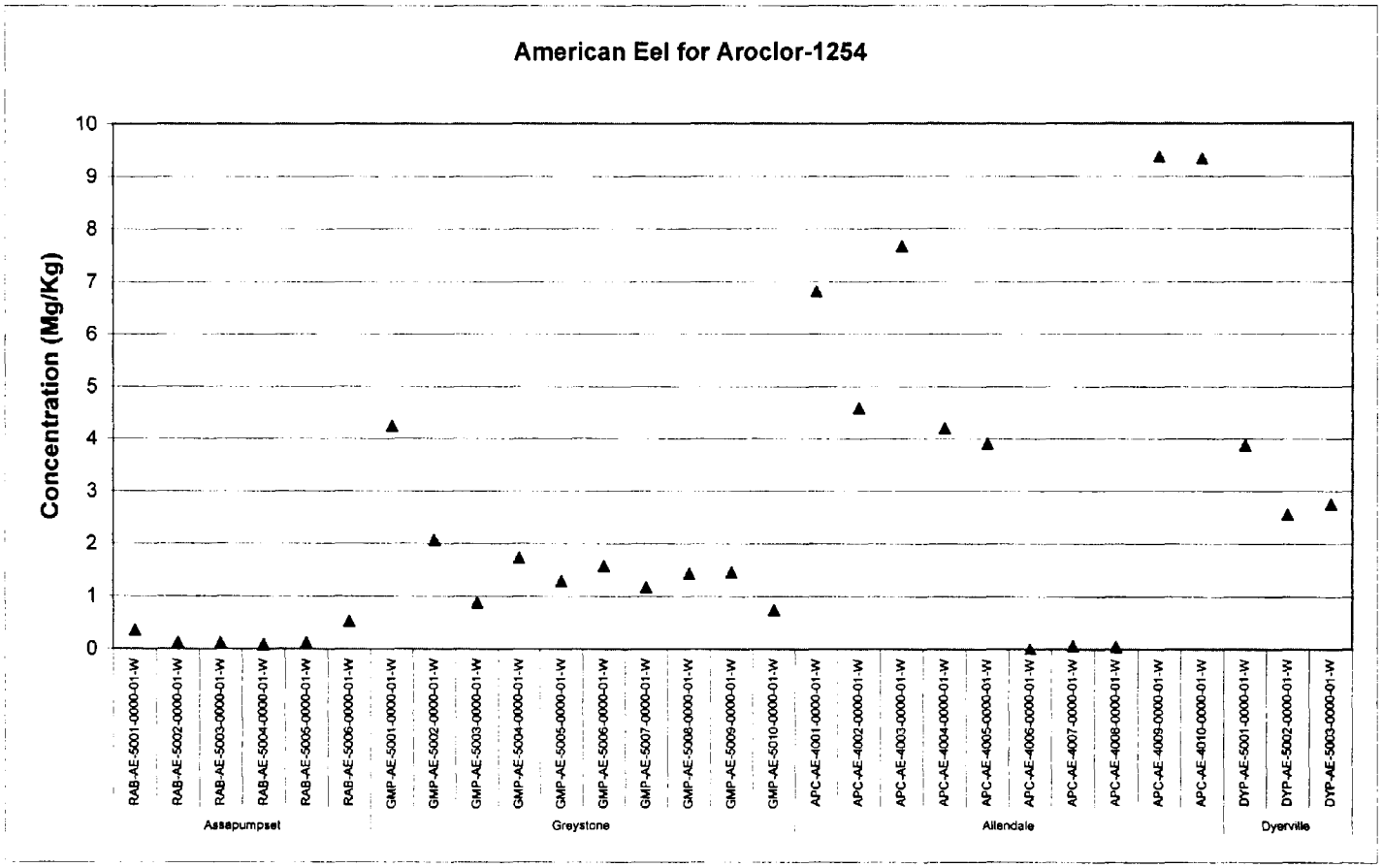
American Eel\2 AE 2,3,7,8-TCDD



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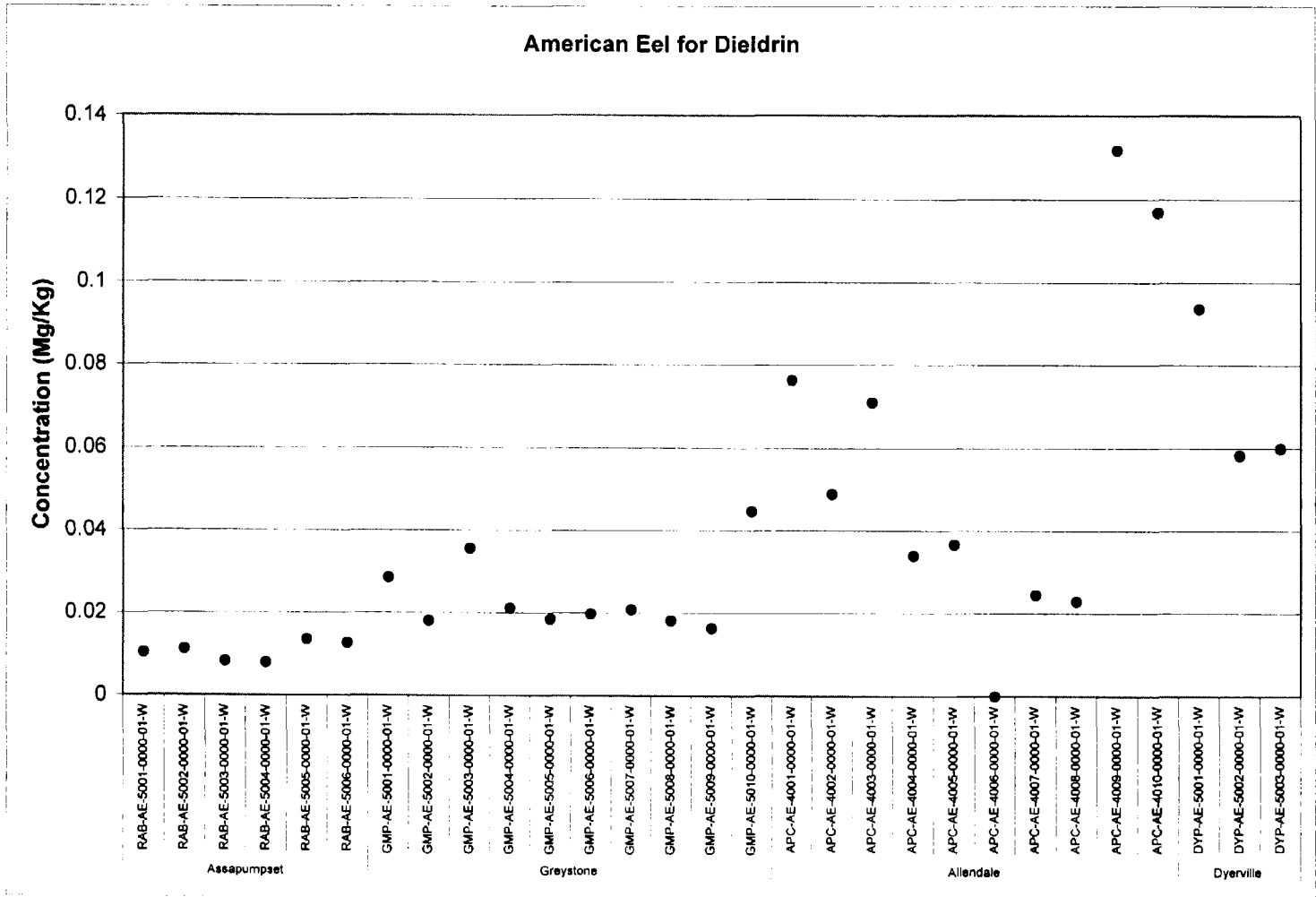
American Eel2,AE Aroclor-1254


American Eel for Dieldrin
Concentration (Mg/Kg)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
RAB-AE-5001-0000-01-W
RAB-AE-5002-0000-01-W
RAB-AE-5003-0000-01-W
RAB-AE-5004-0000-01-W
RAB-AE-5005-0000-01-W
RAB-AE-5006-0000-01-W
GMP-AE-5001-0000-01-W
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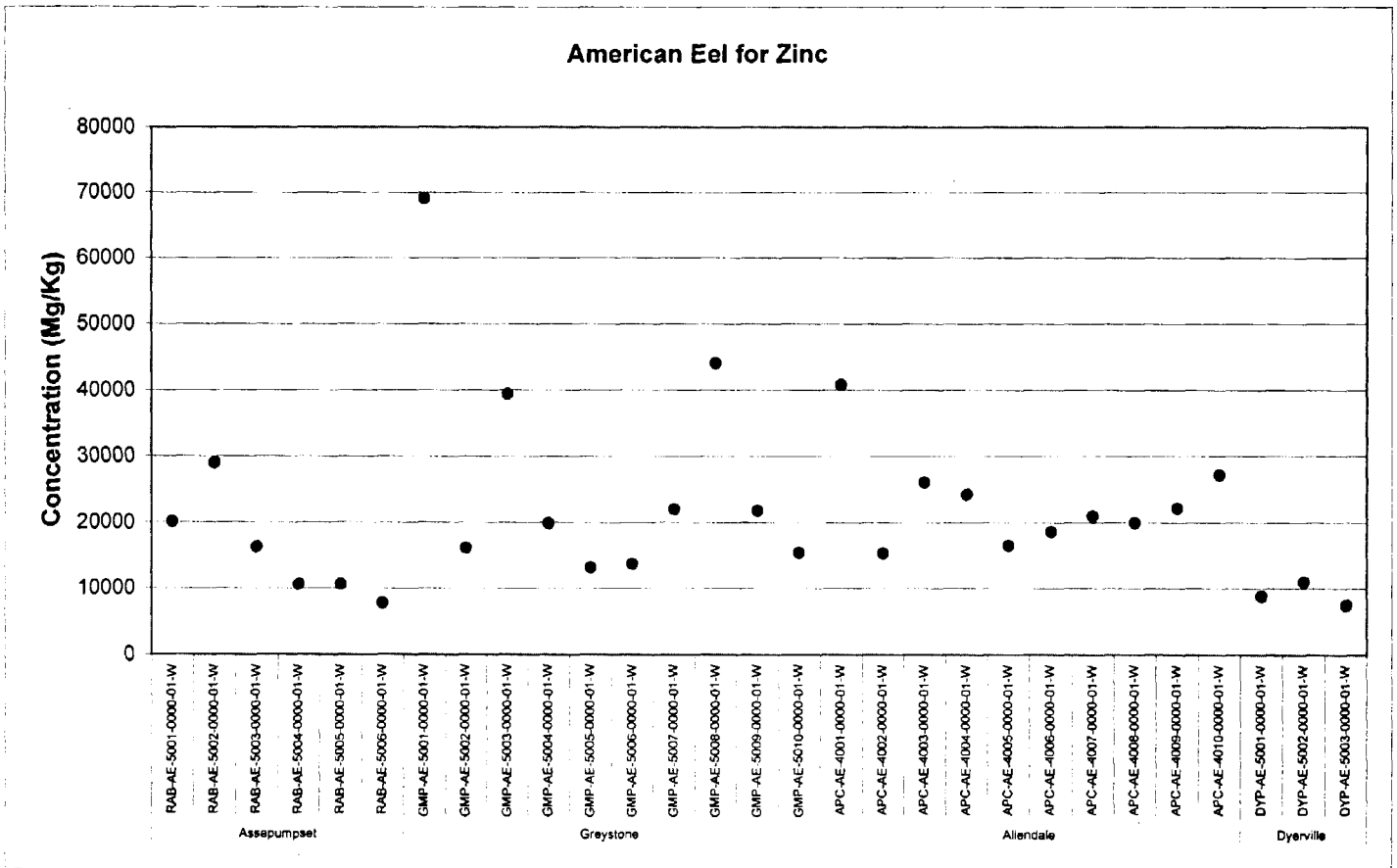
Assapumpset
Greystone
Allendale
Dyerville



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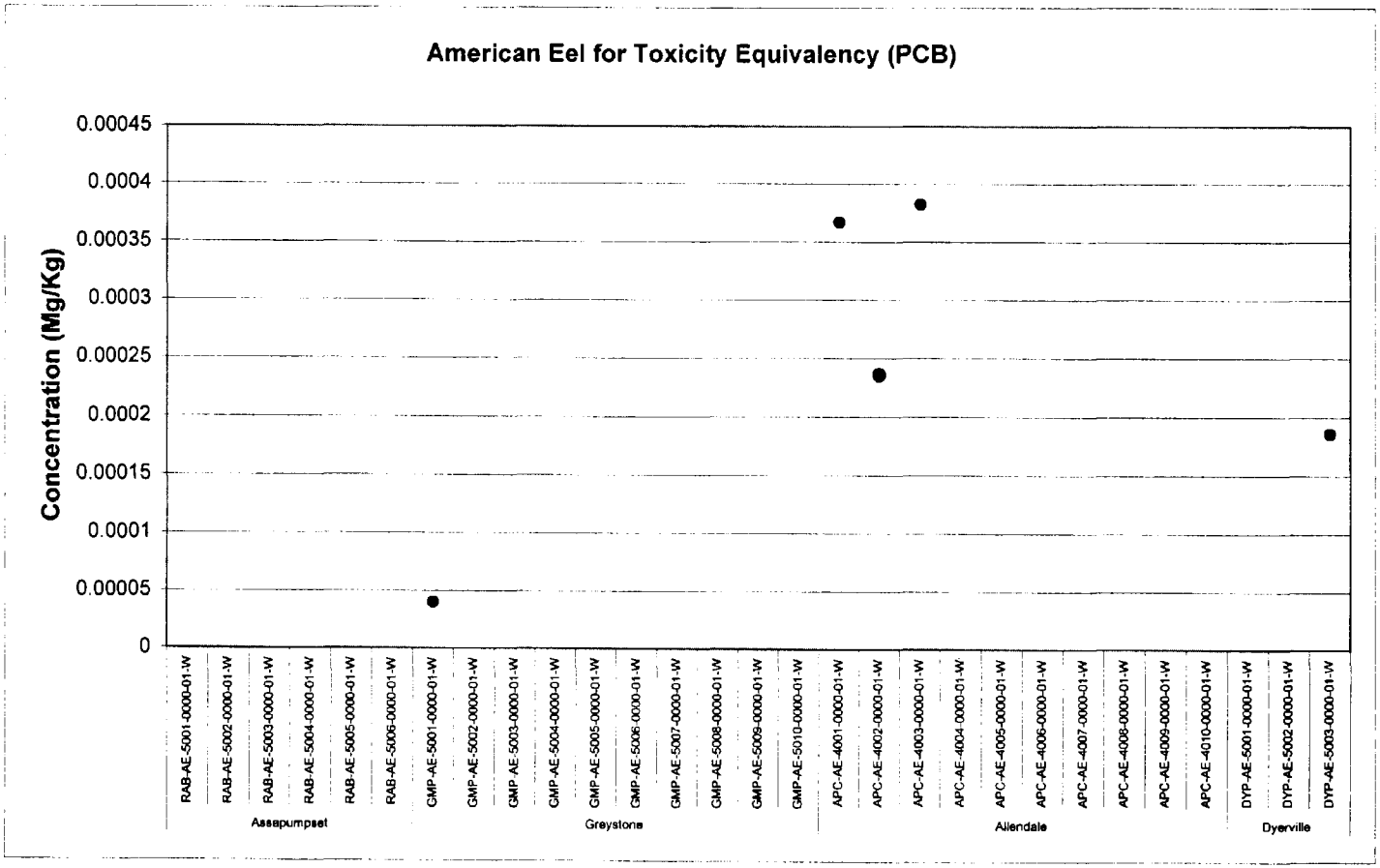
American Eel2,AE Zinc



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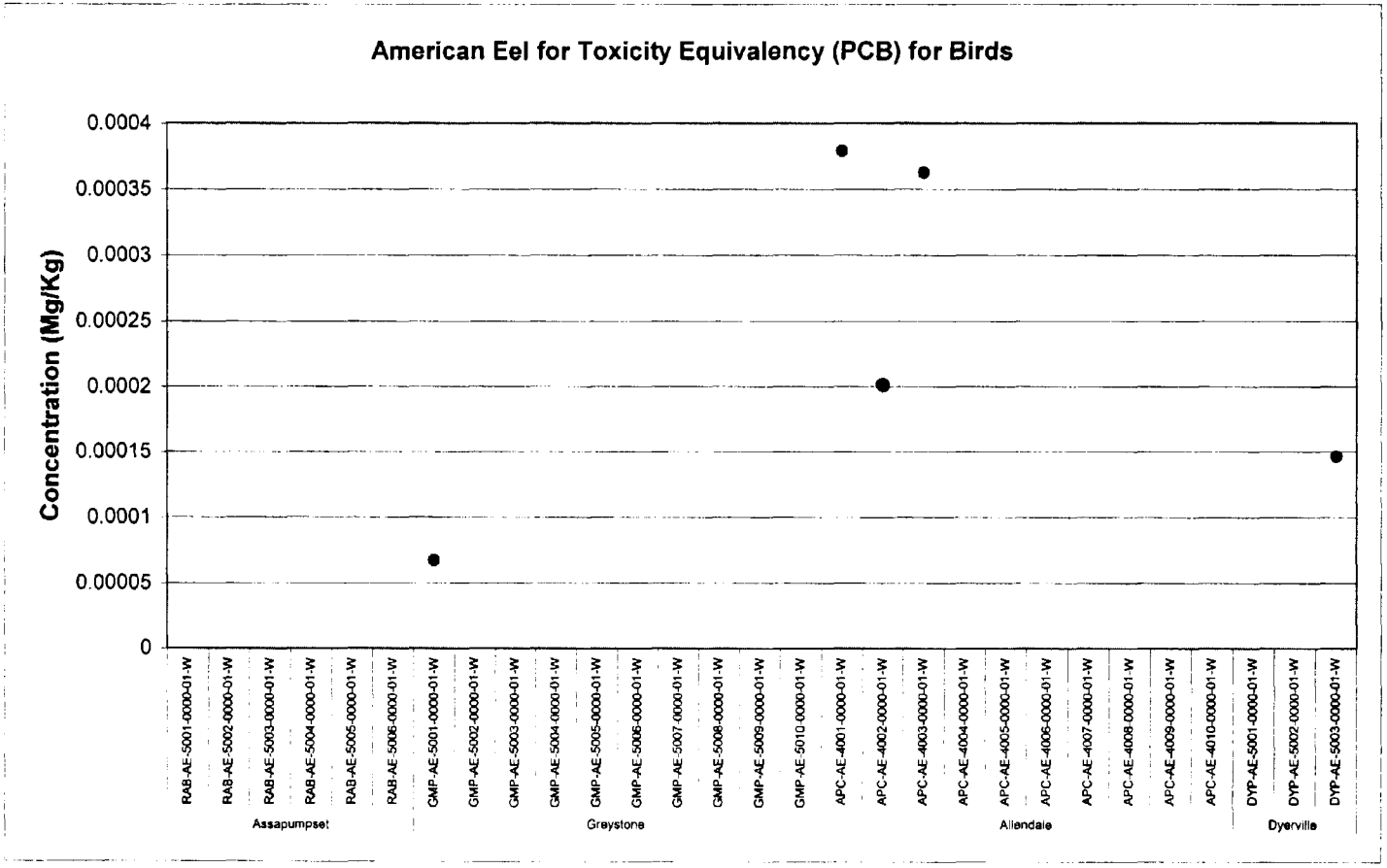
American Eel AE Toxicity Equivalency (PCB)



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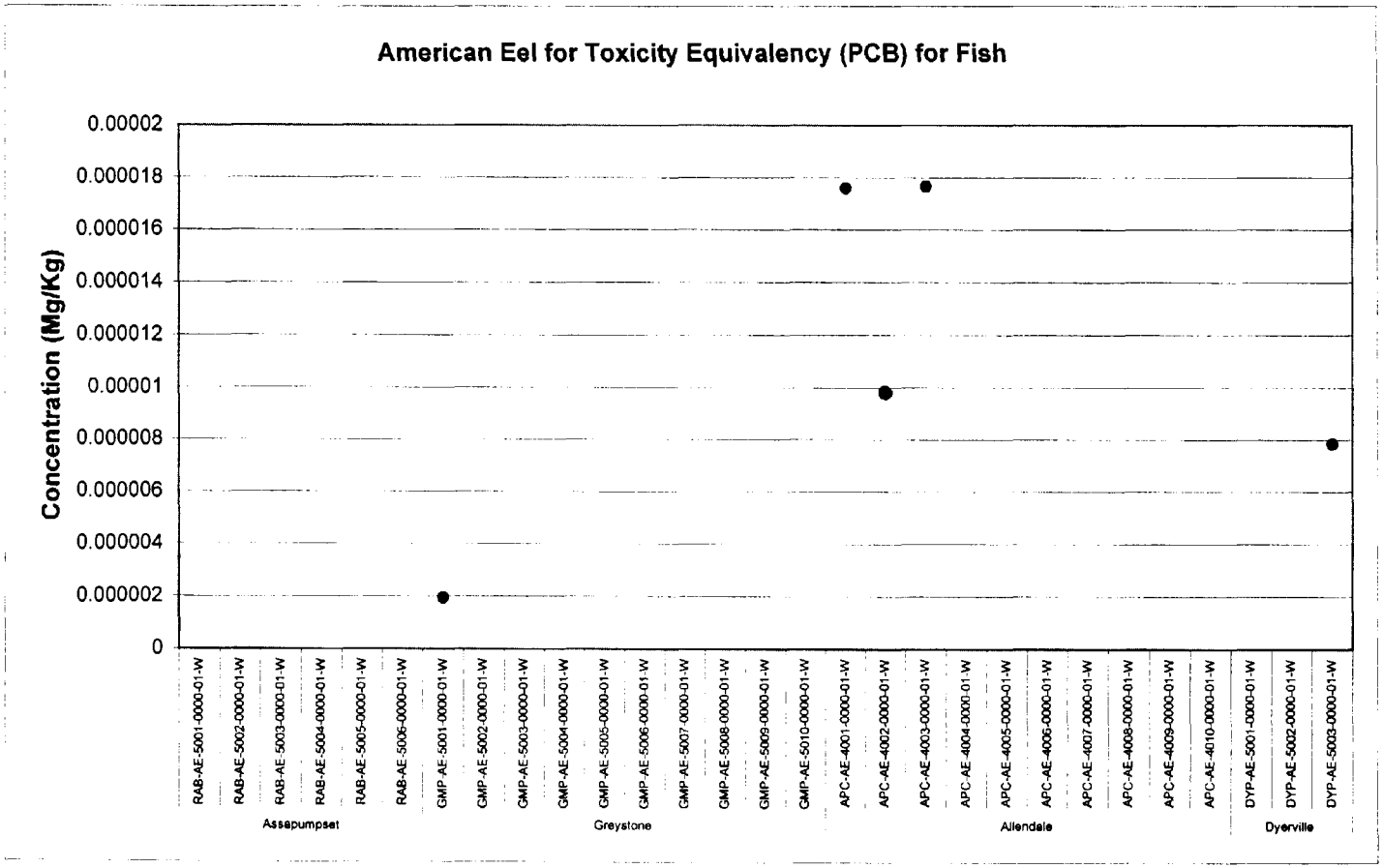
American Eel2.AE ToxicityEquivalency (PCB)B



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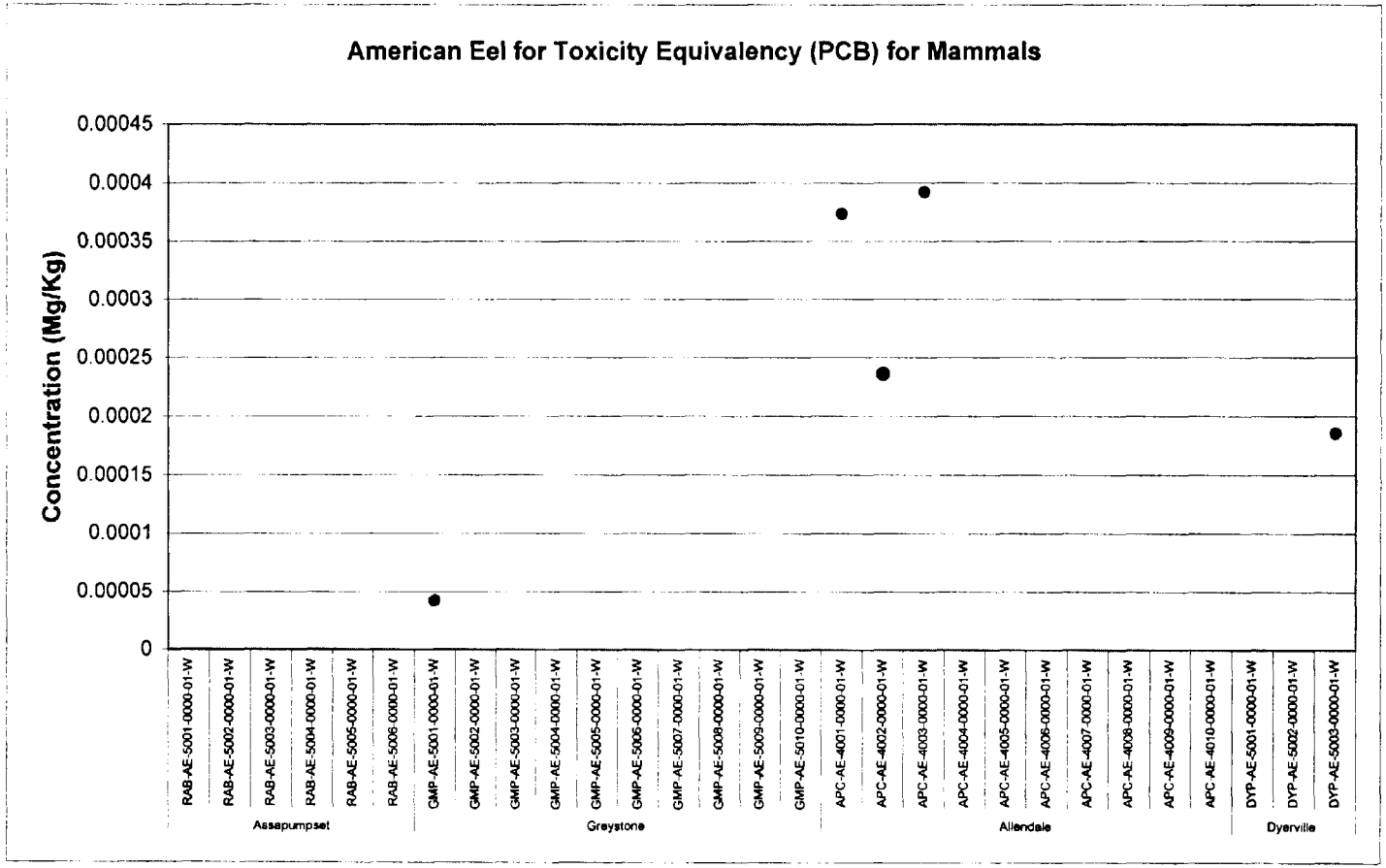
American E[illegible]AE Toxicity Equivalency (PCB)F



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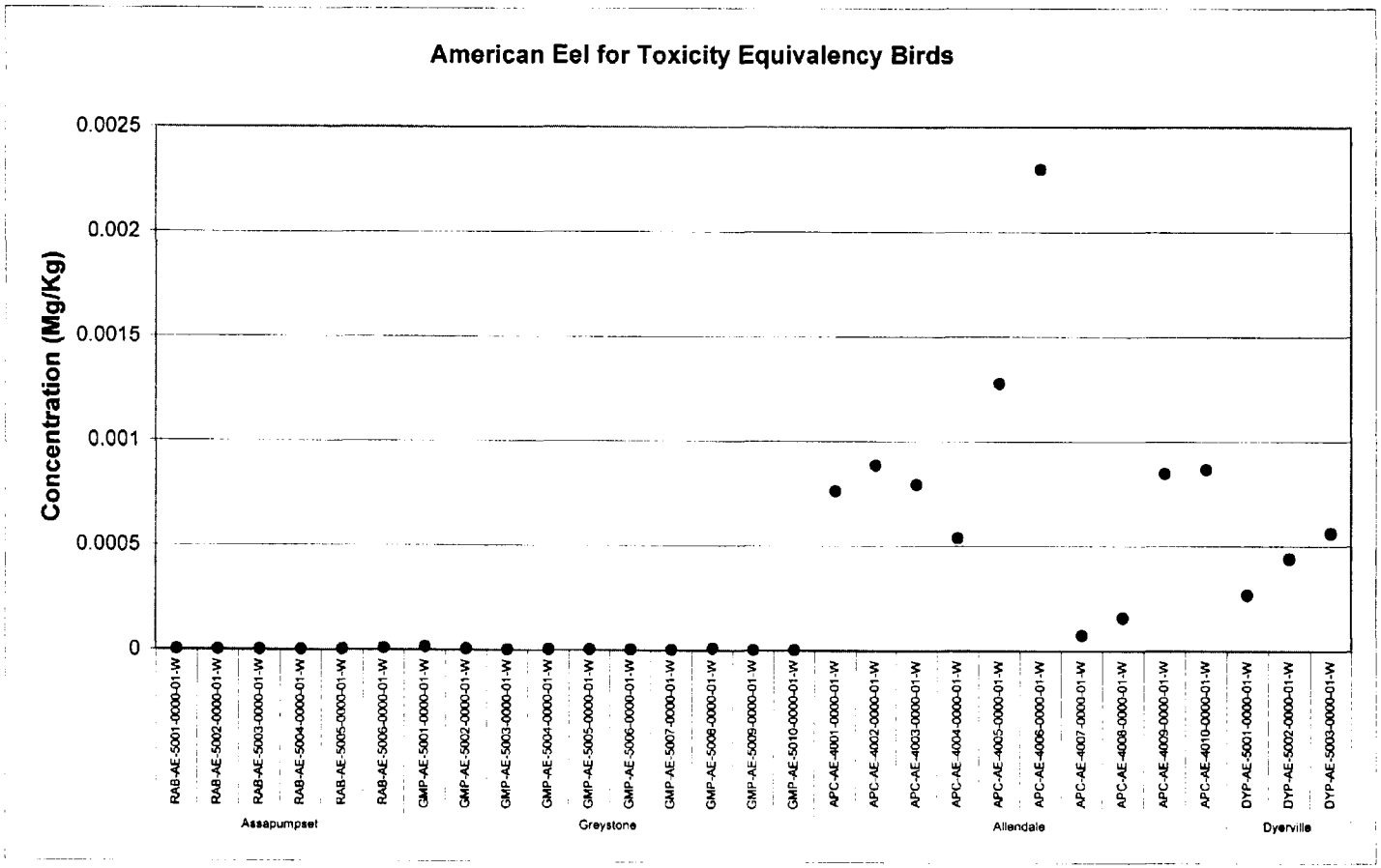
American Eel2.AE Toxicity Equivalency (PCB)M



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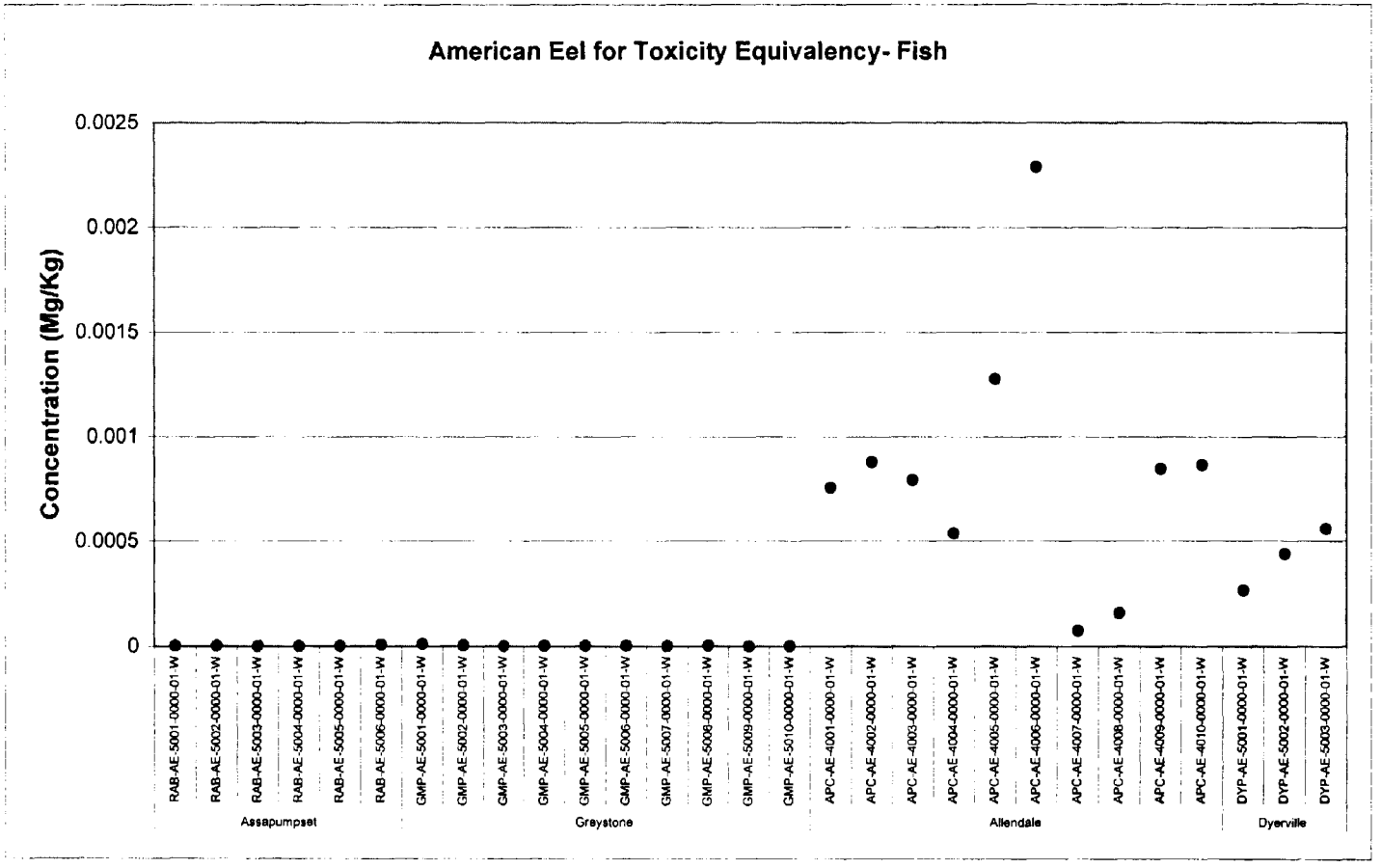
American Eel? AE Toxicity Equivalency Birds



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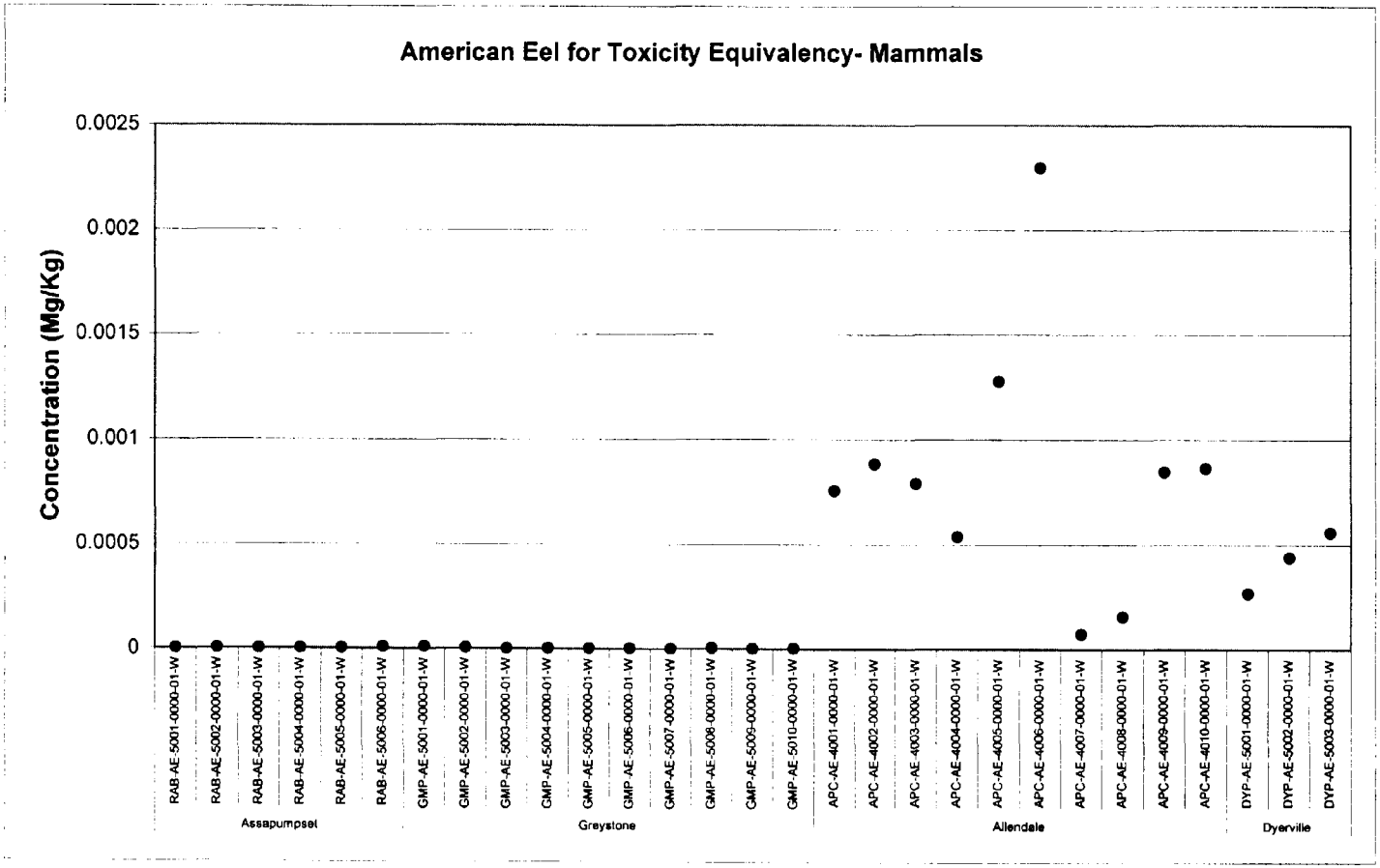
American Eel2,AE Toxicity Equivalency-Fish



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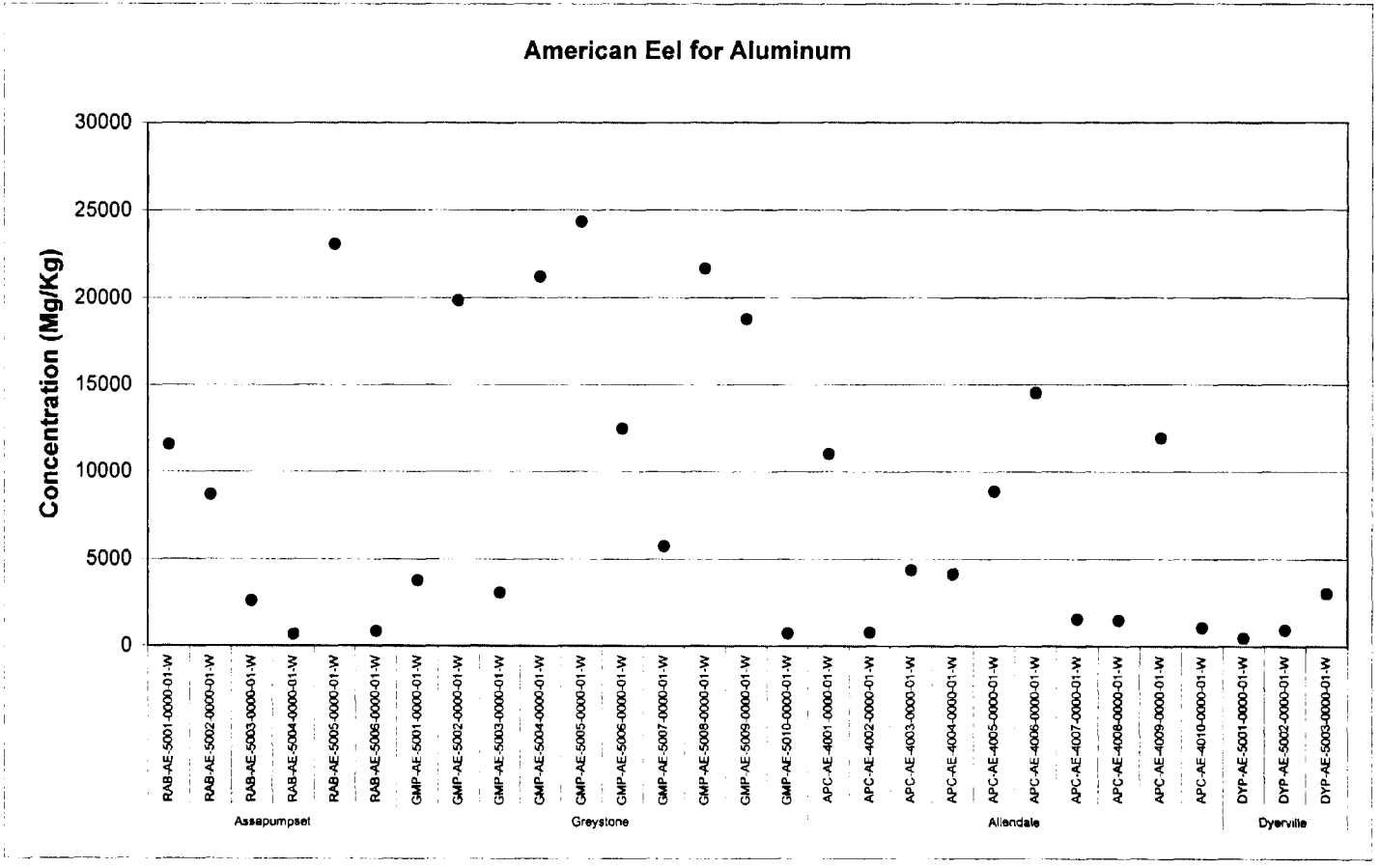
American Eel\AE Toxicity Equivalency Mammals



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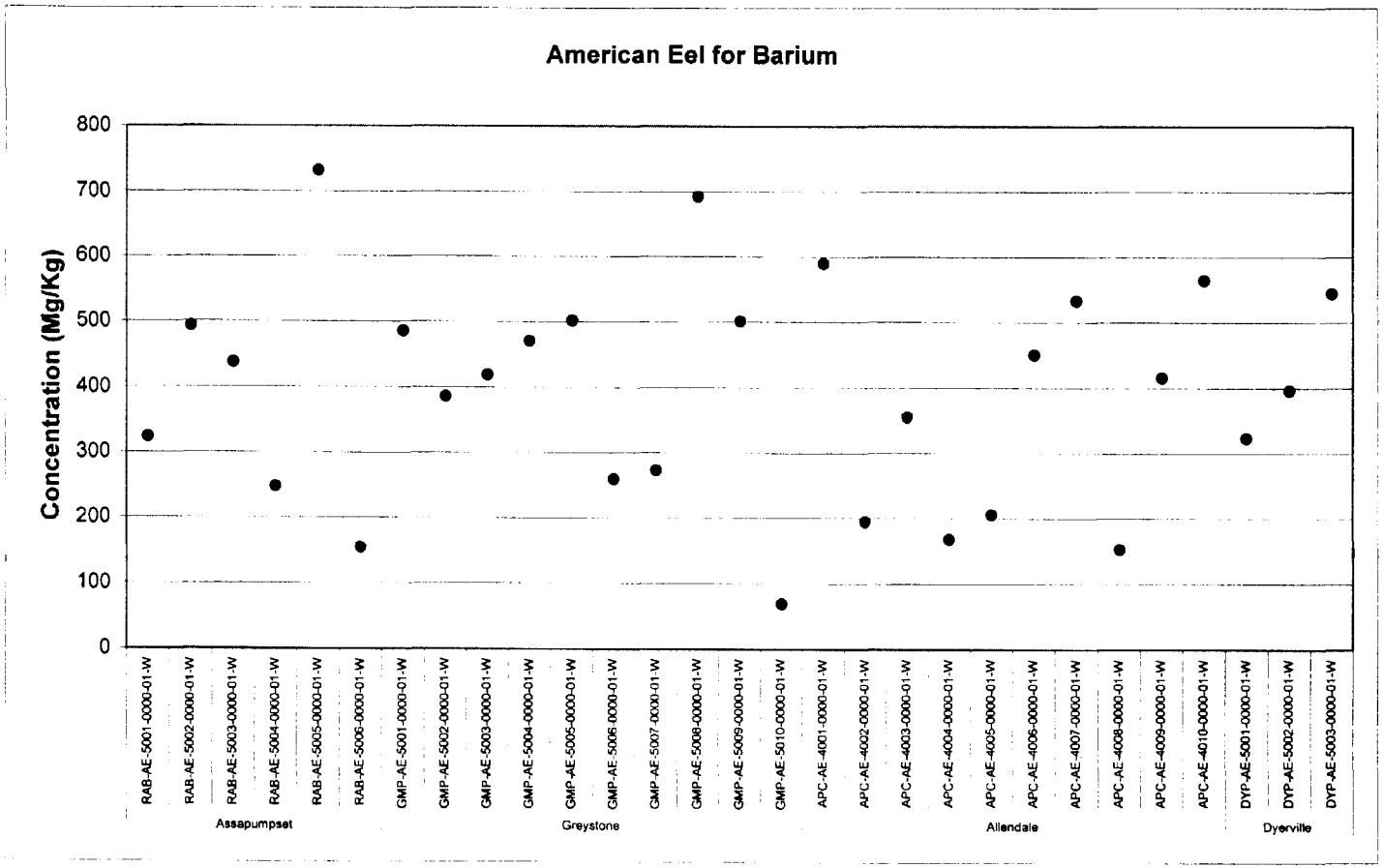
American Eel2,AE Aluminum



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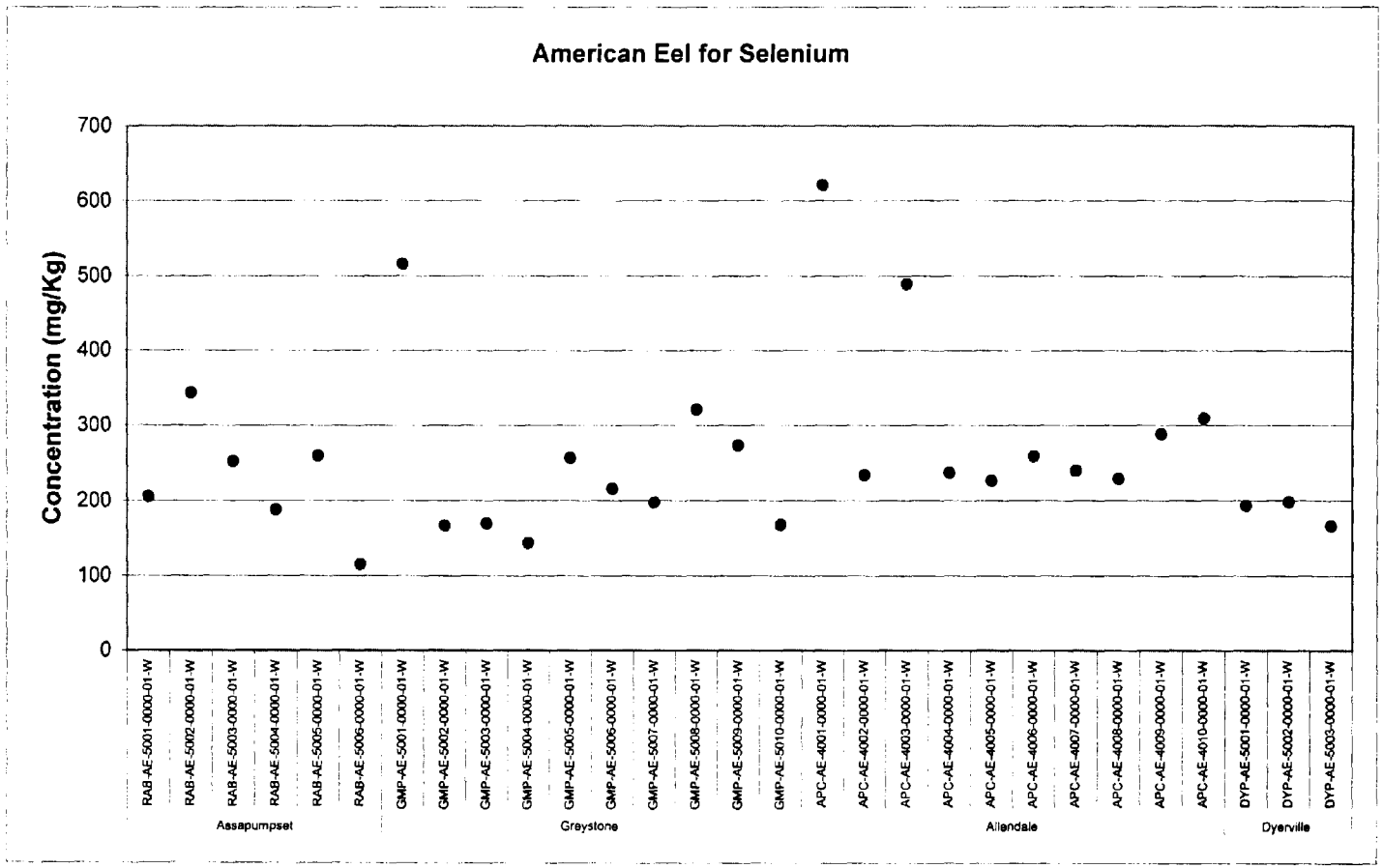
American E-'' AE Barium



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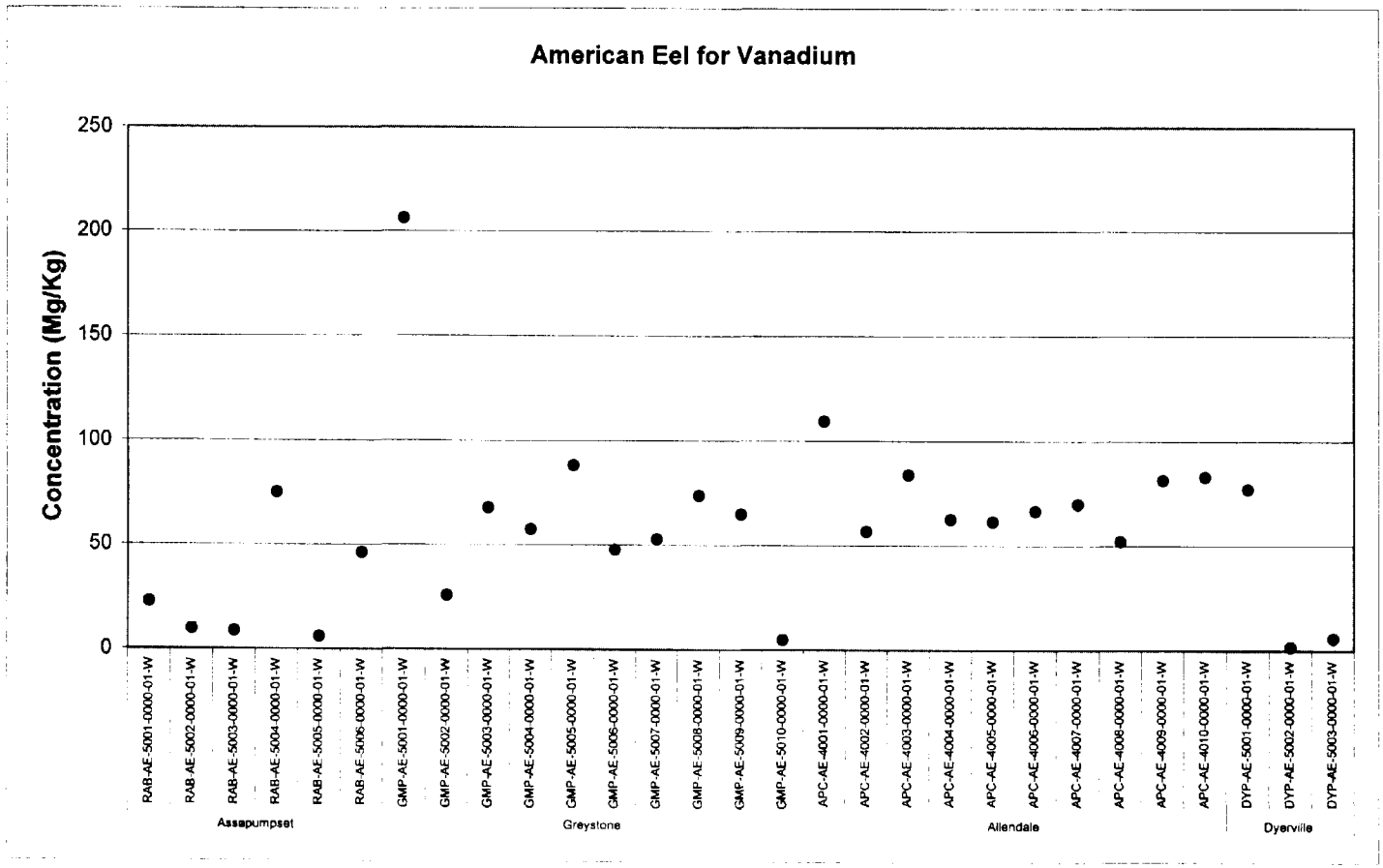
American Eel2.AE Selenium



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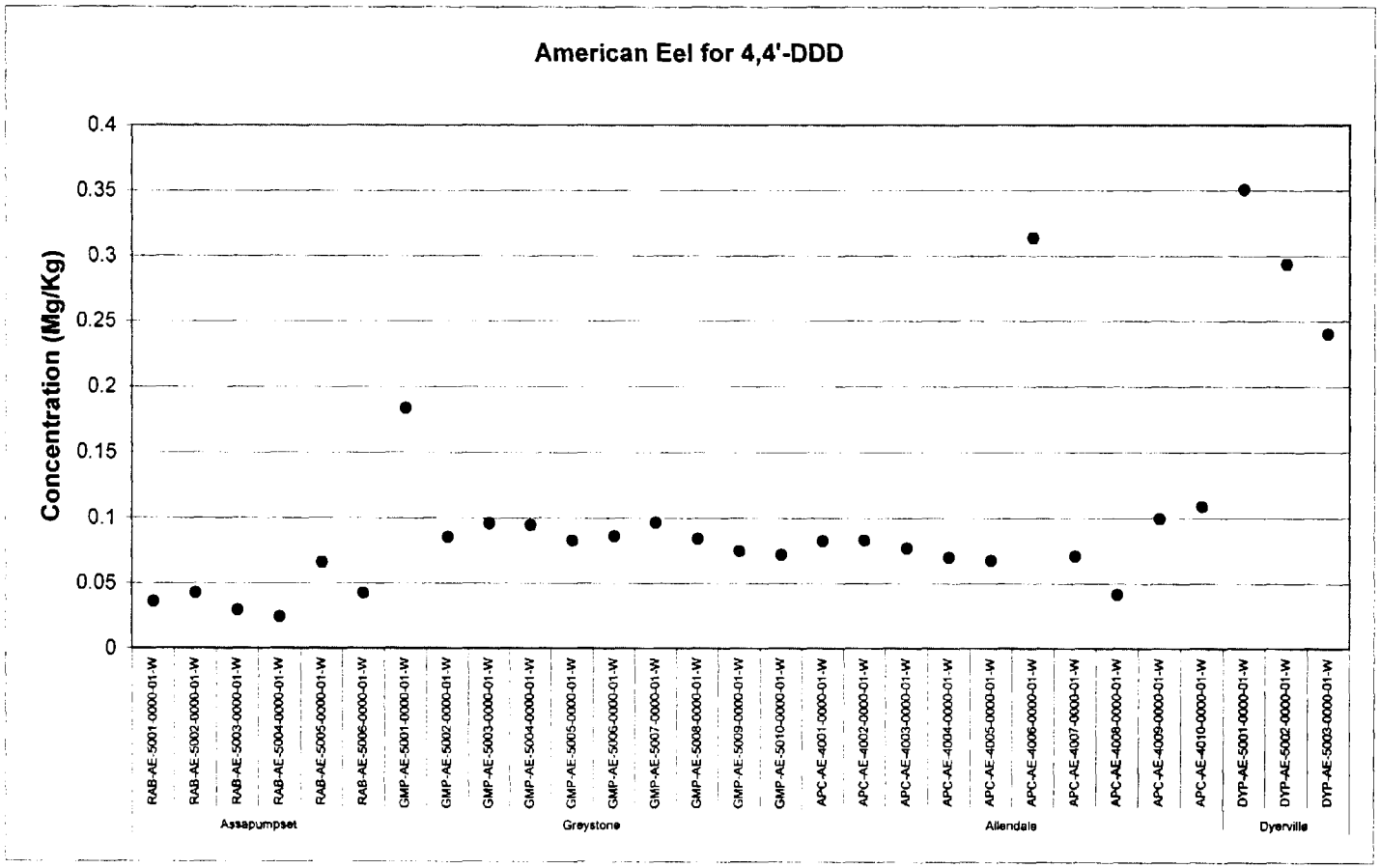
American E[illegible]AE Vanadium



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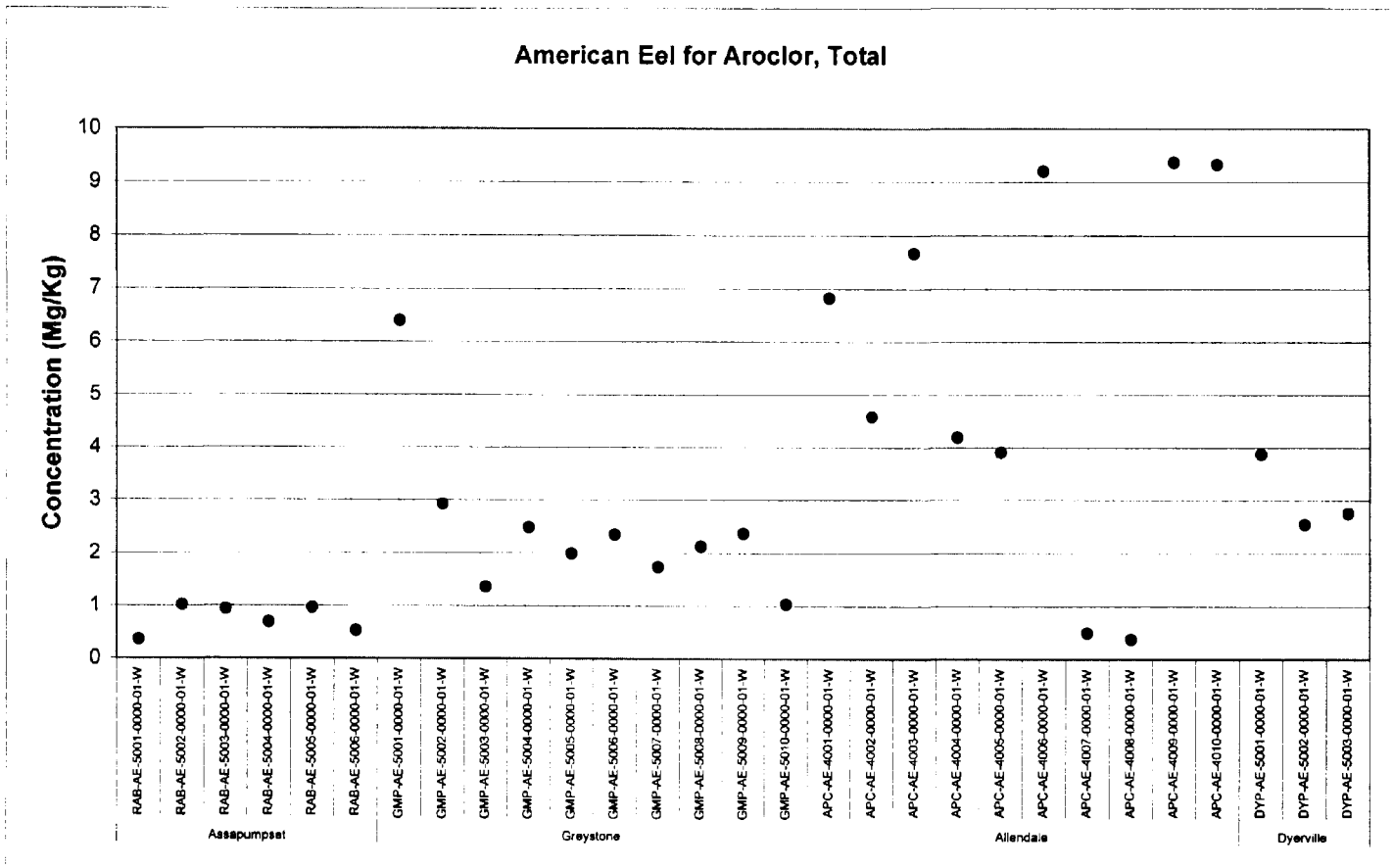
American Eel2,AE 4,4'-DDD



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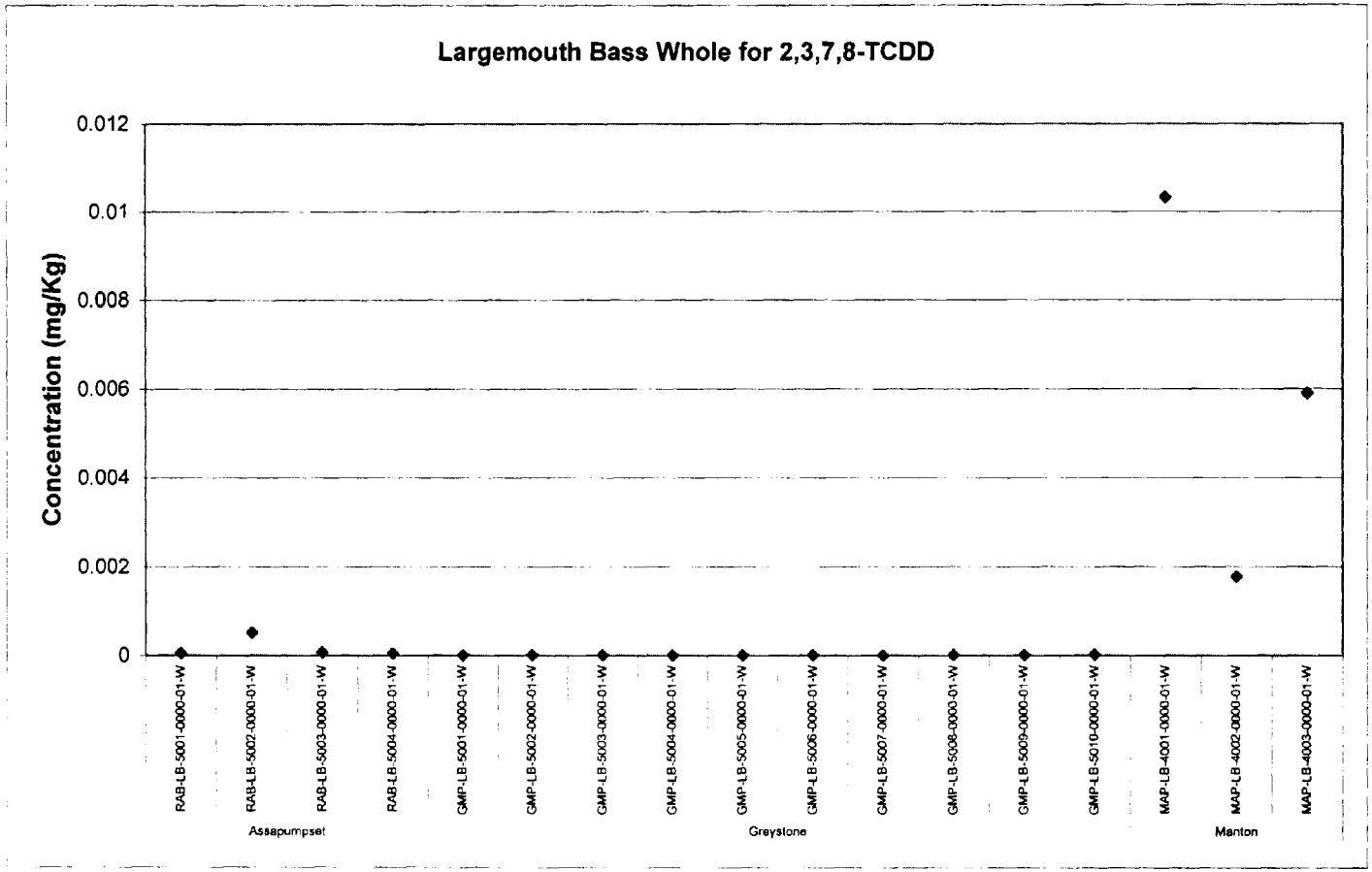
American Eel AE Aroclor, Total



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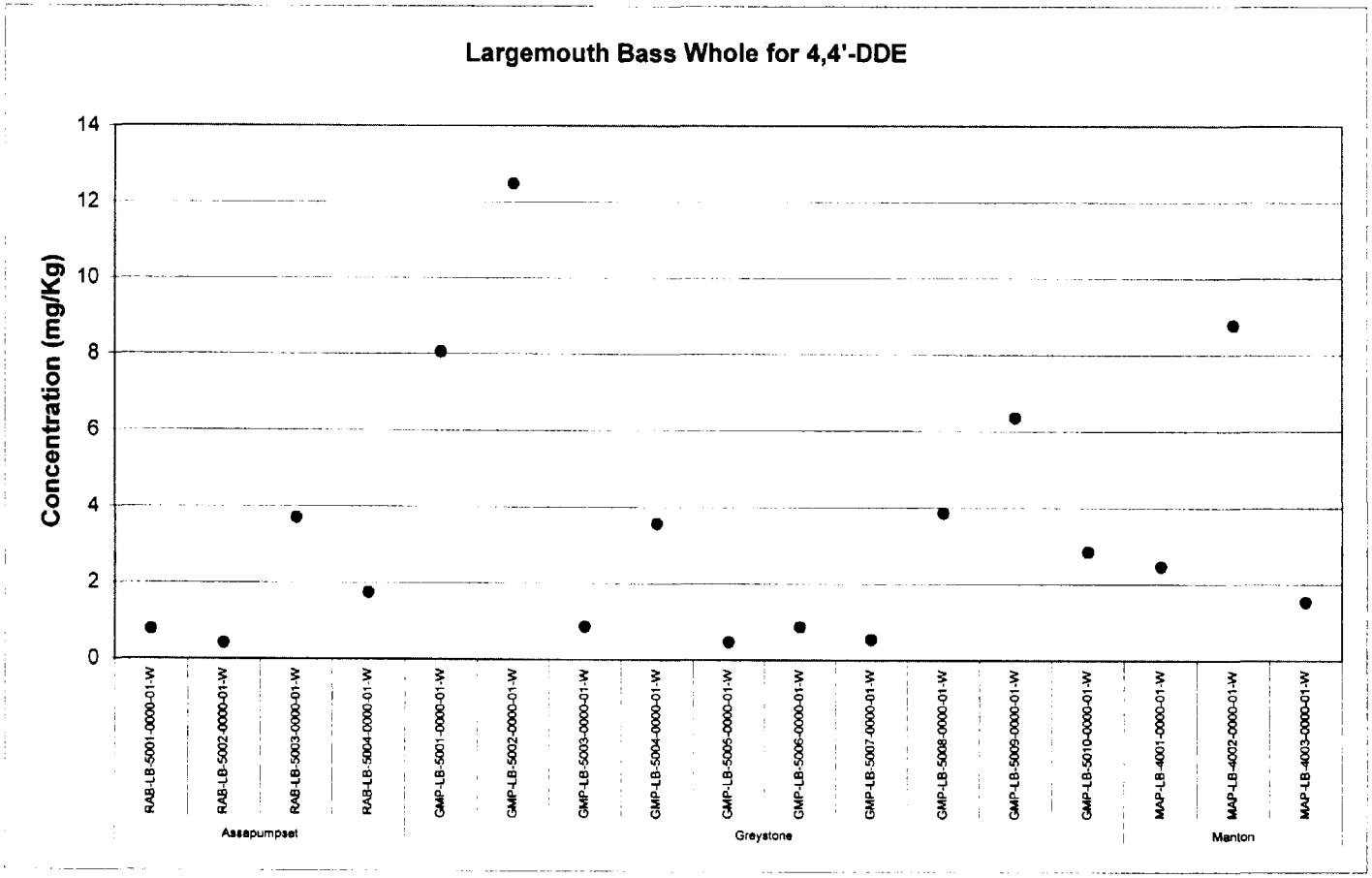
Largemouth Bass W2, LMW 2,3,7,8-TCDD



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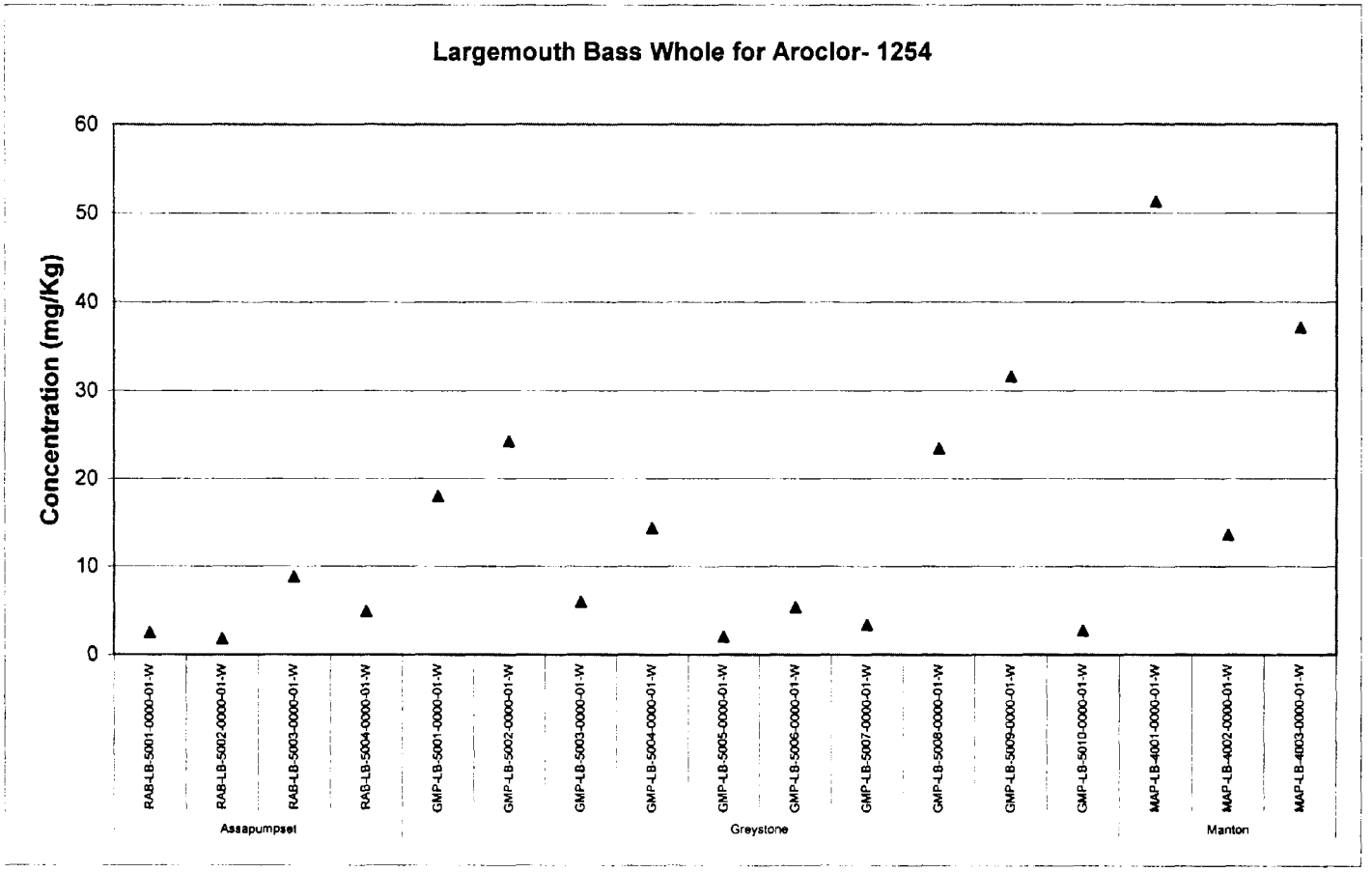
Largem- 'h Bass W2, LMW 4,4'-DDE



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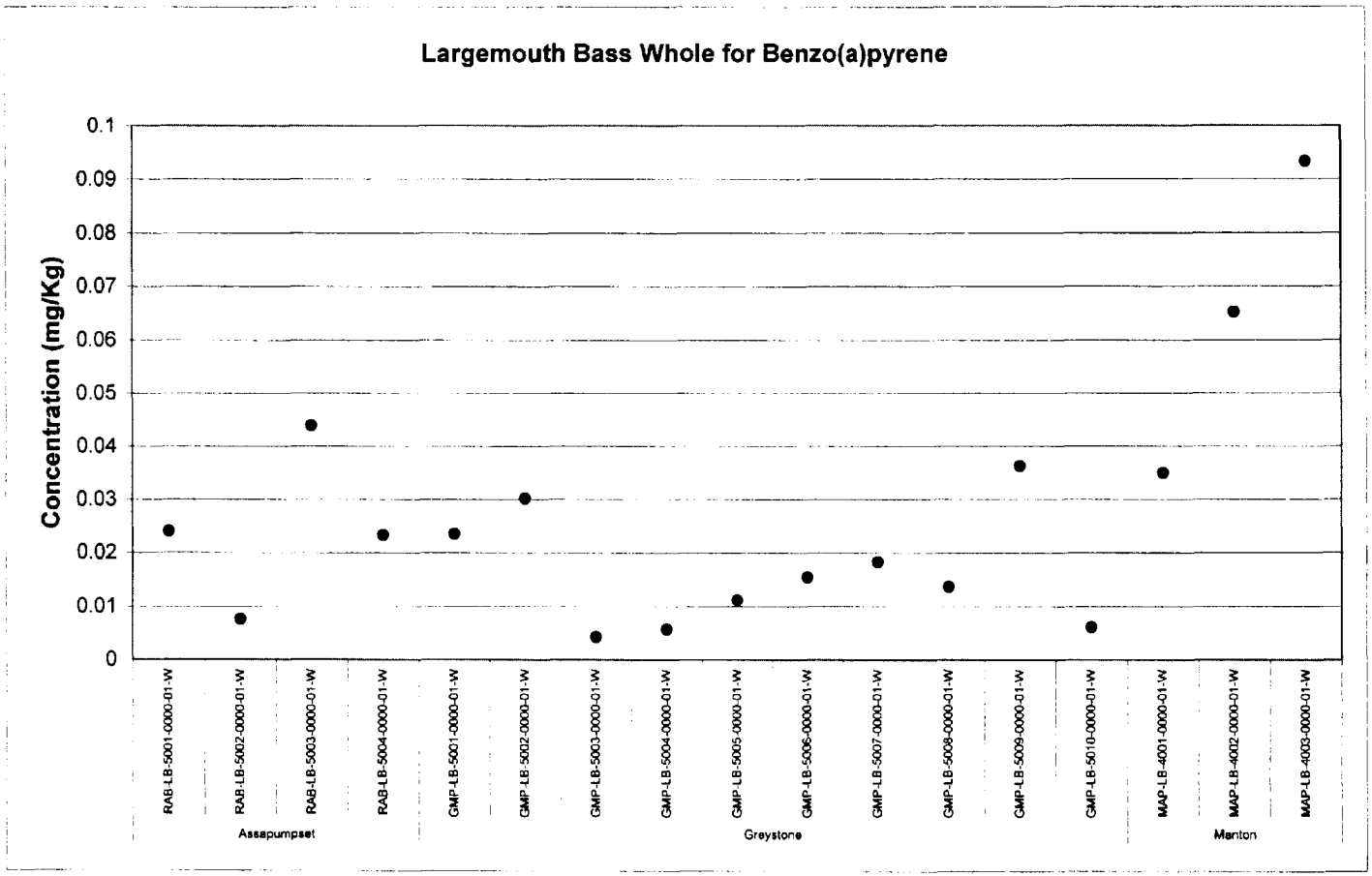
Largemouth Bass W2, LMW Aroclor-1254



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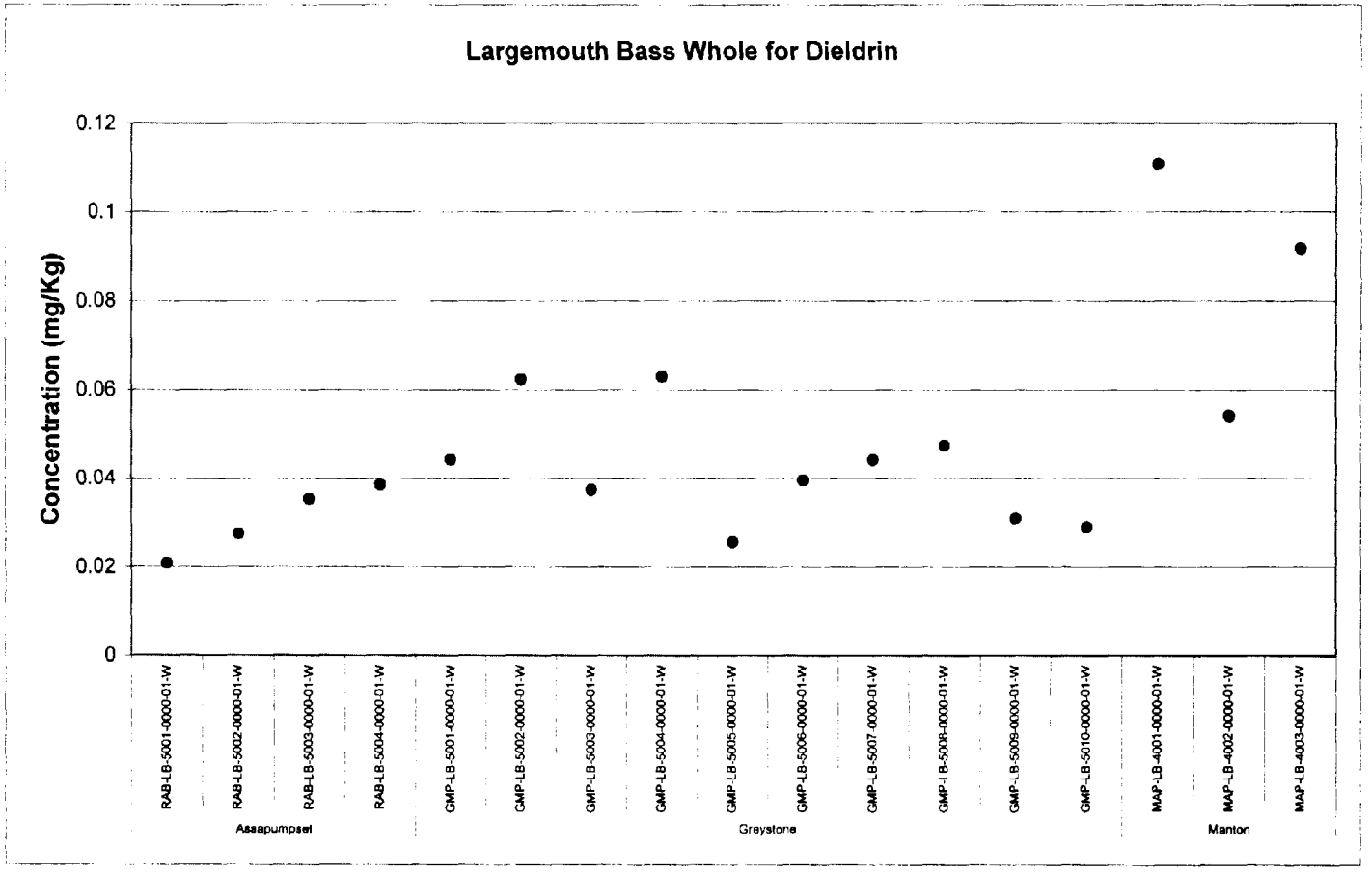
Largemouth Bass W2, LMW benzo(a)pyrene



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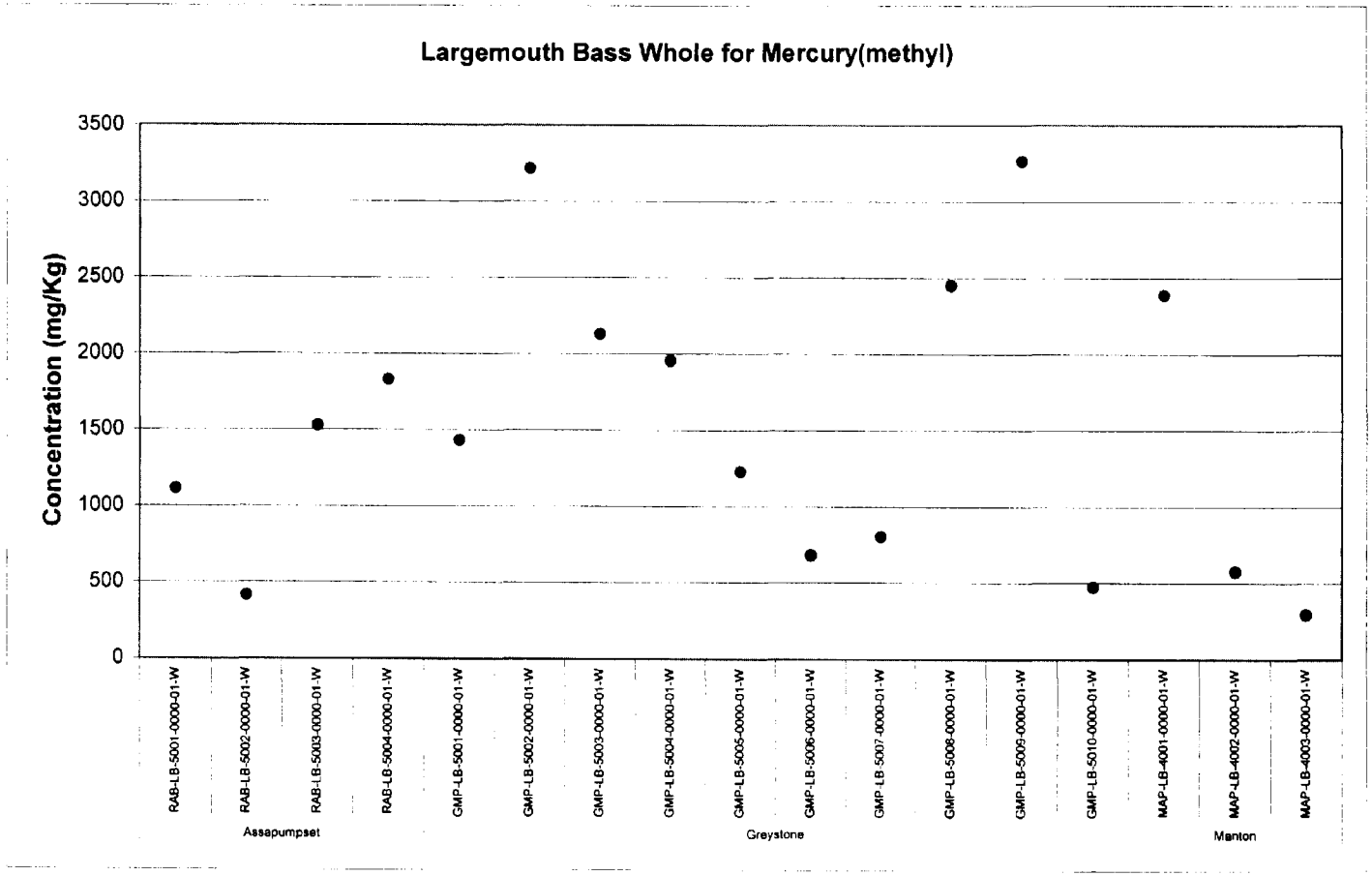
Largemouth Bass W2, LMW Dieldrin



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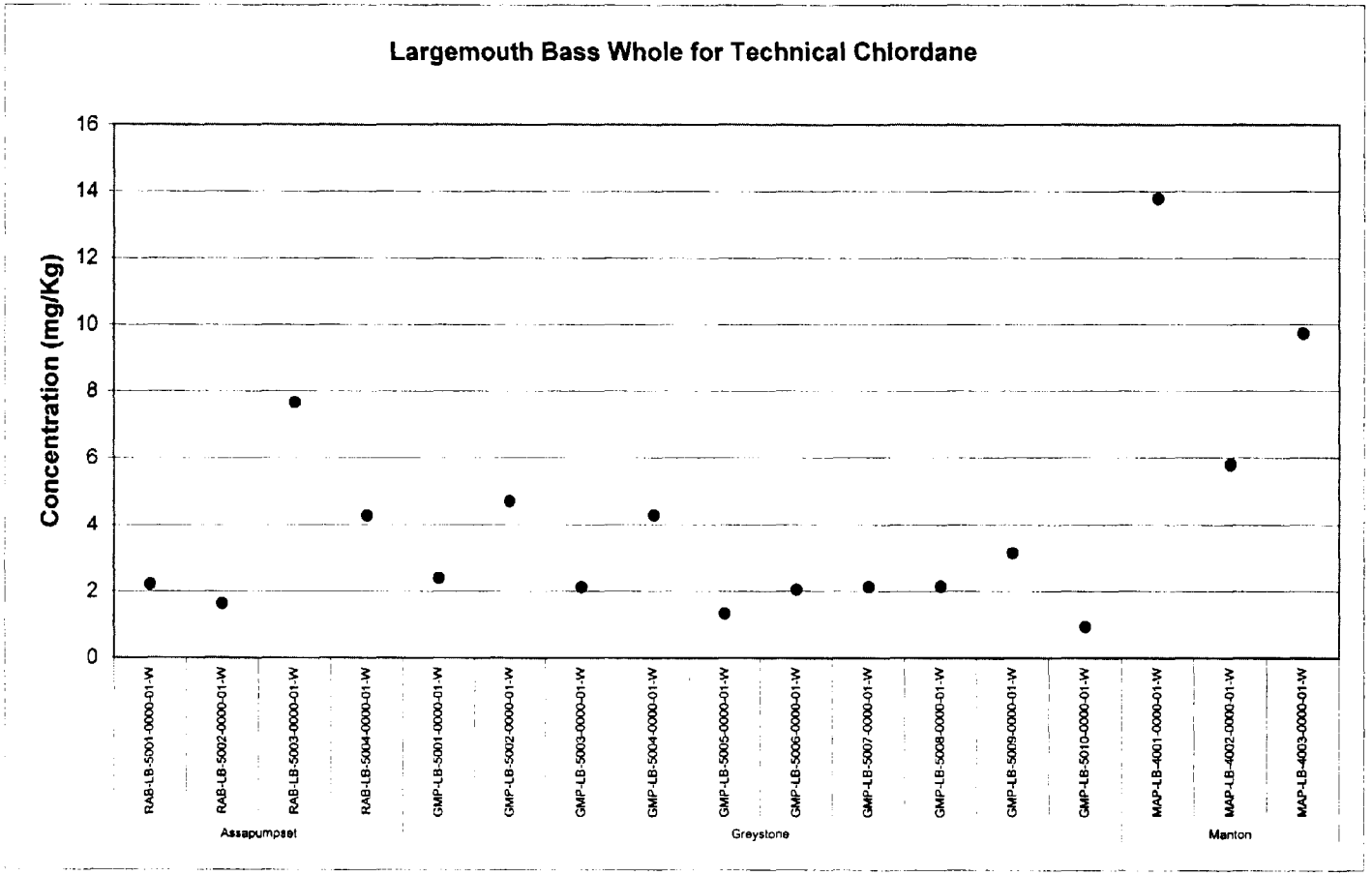
Largemouth Bass W2, LMW mercury(methyl)



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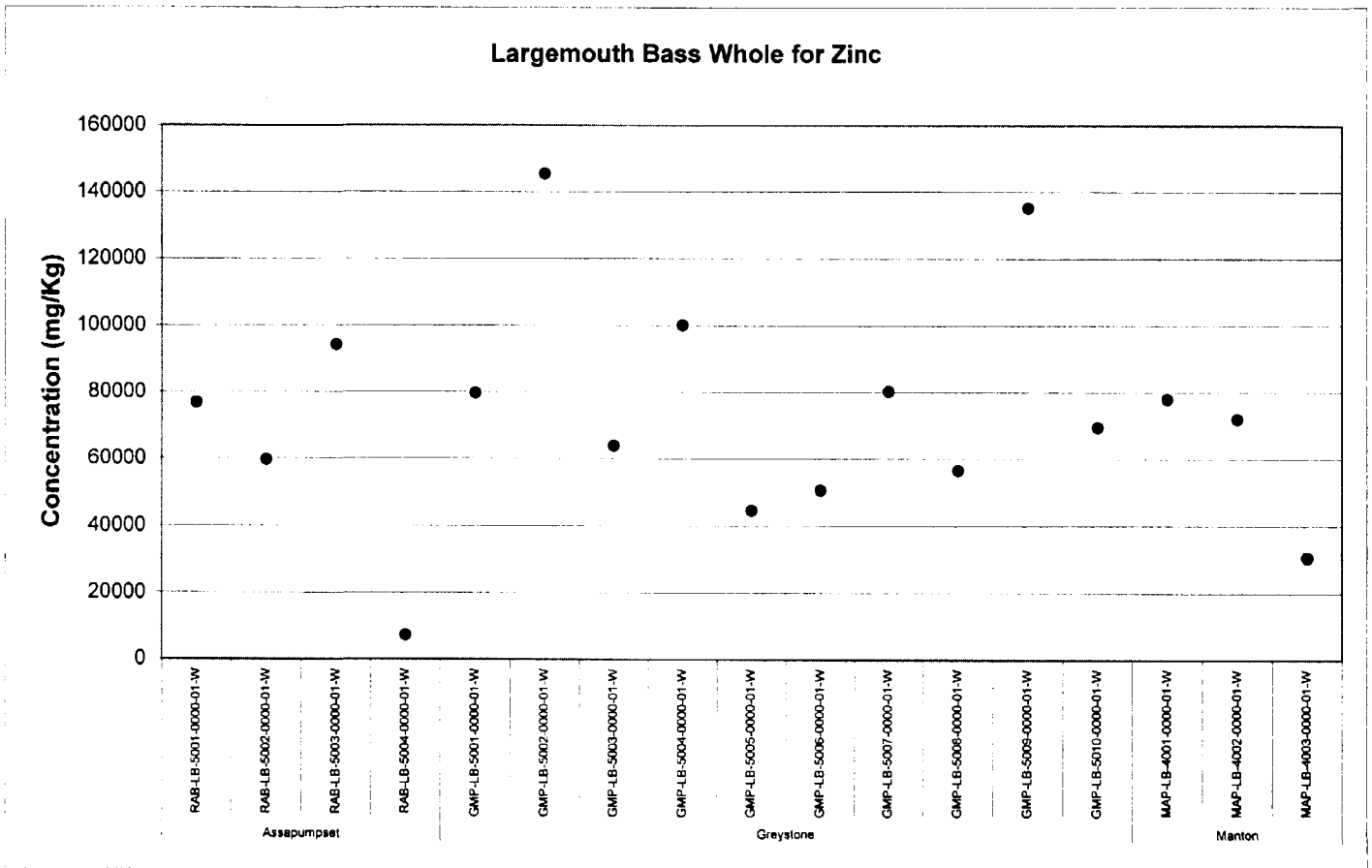
Largemouth Bass W2, LMW technical chlordane



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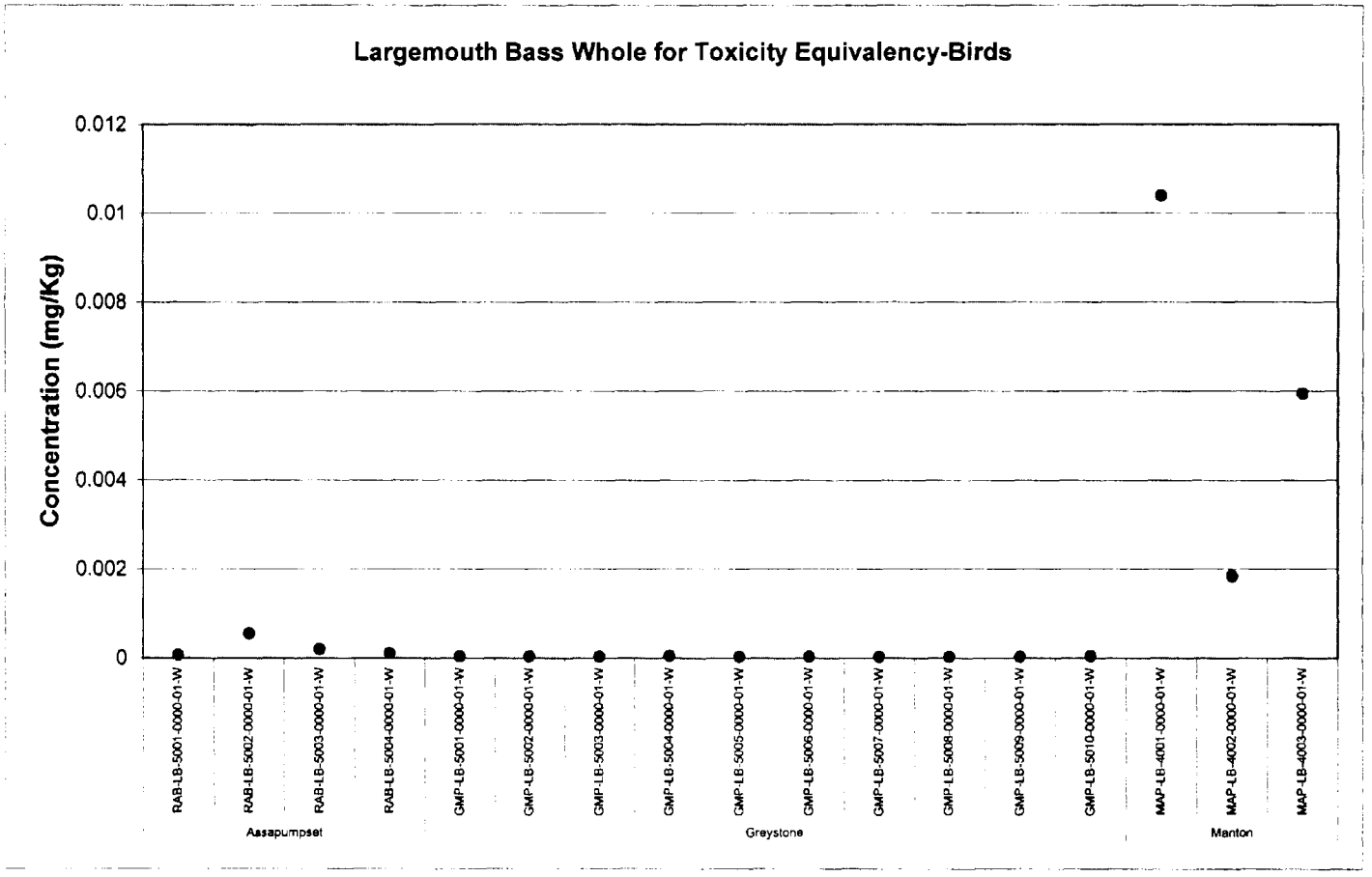
Largem[illegible]h Bass W2, LMW zinc



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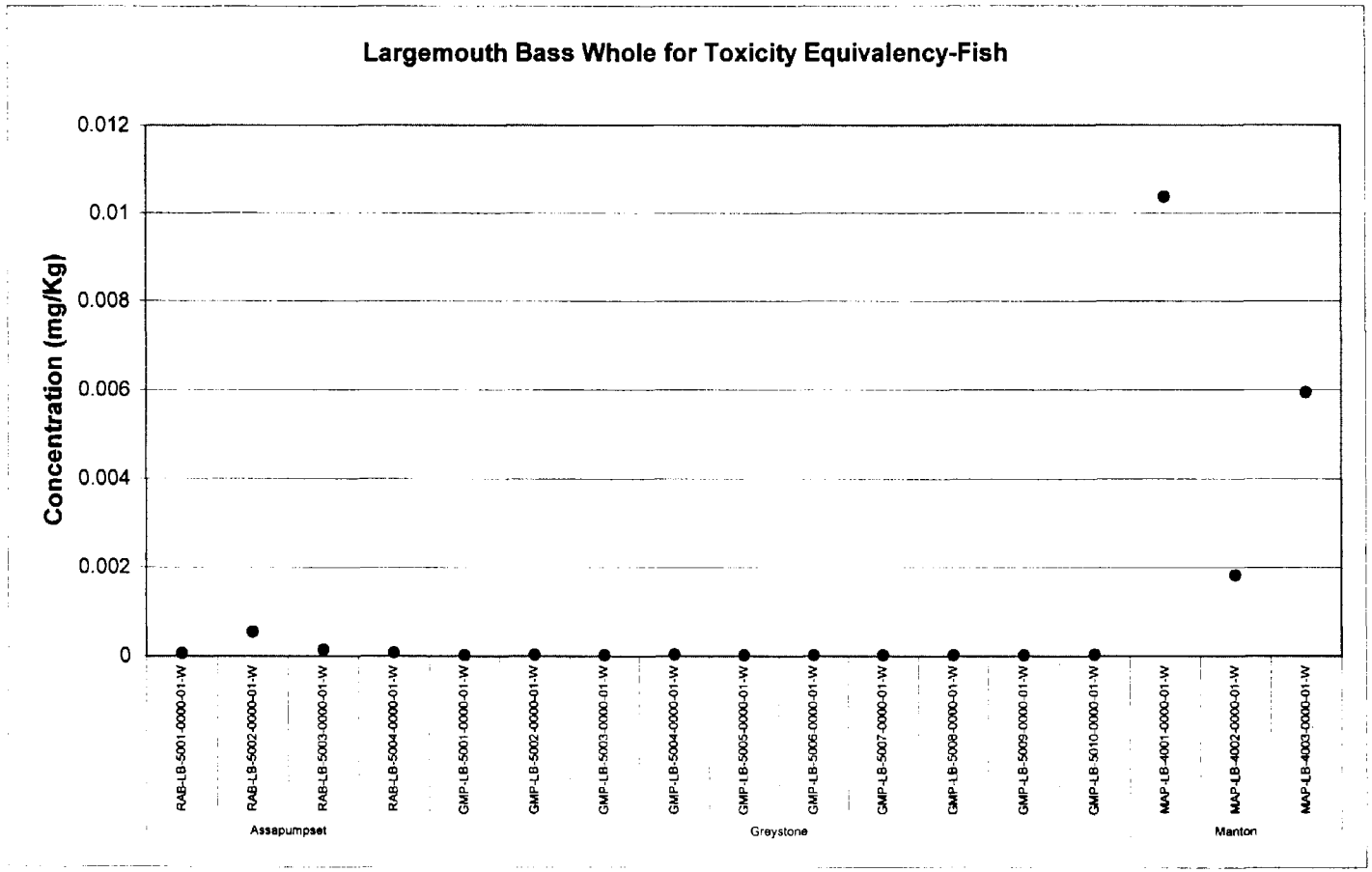
Largemouth Bass W2, LMW Toxicity Equivalency-Birds



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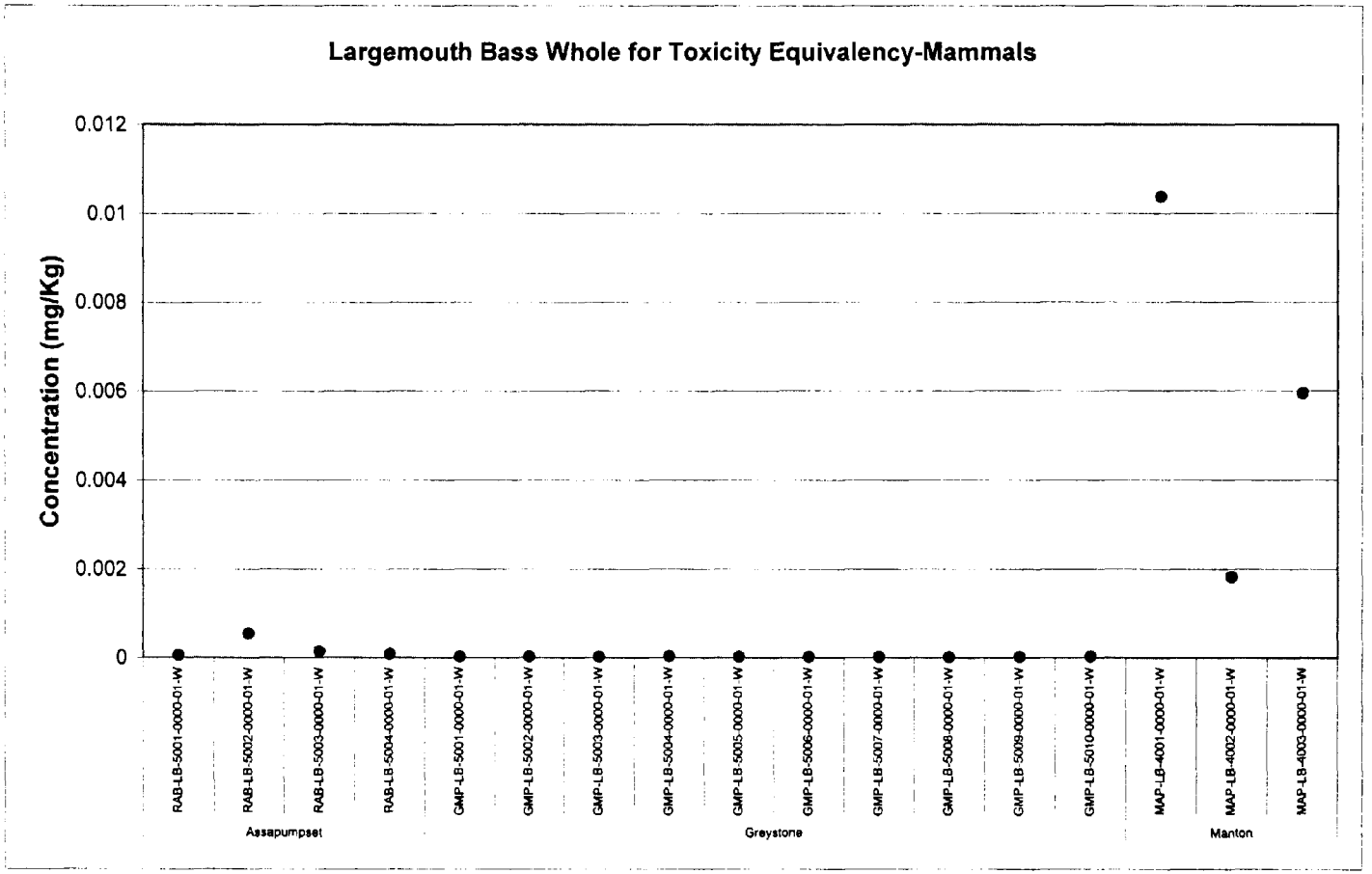
Largemouth Bass W2, LMW Toxicity Equivalency-Fish



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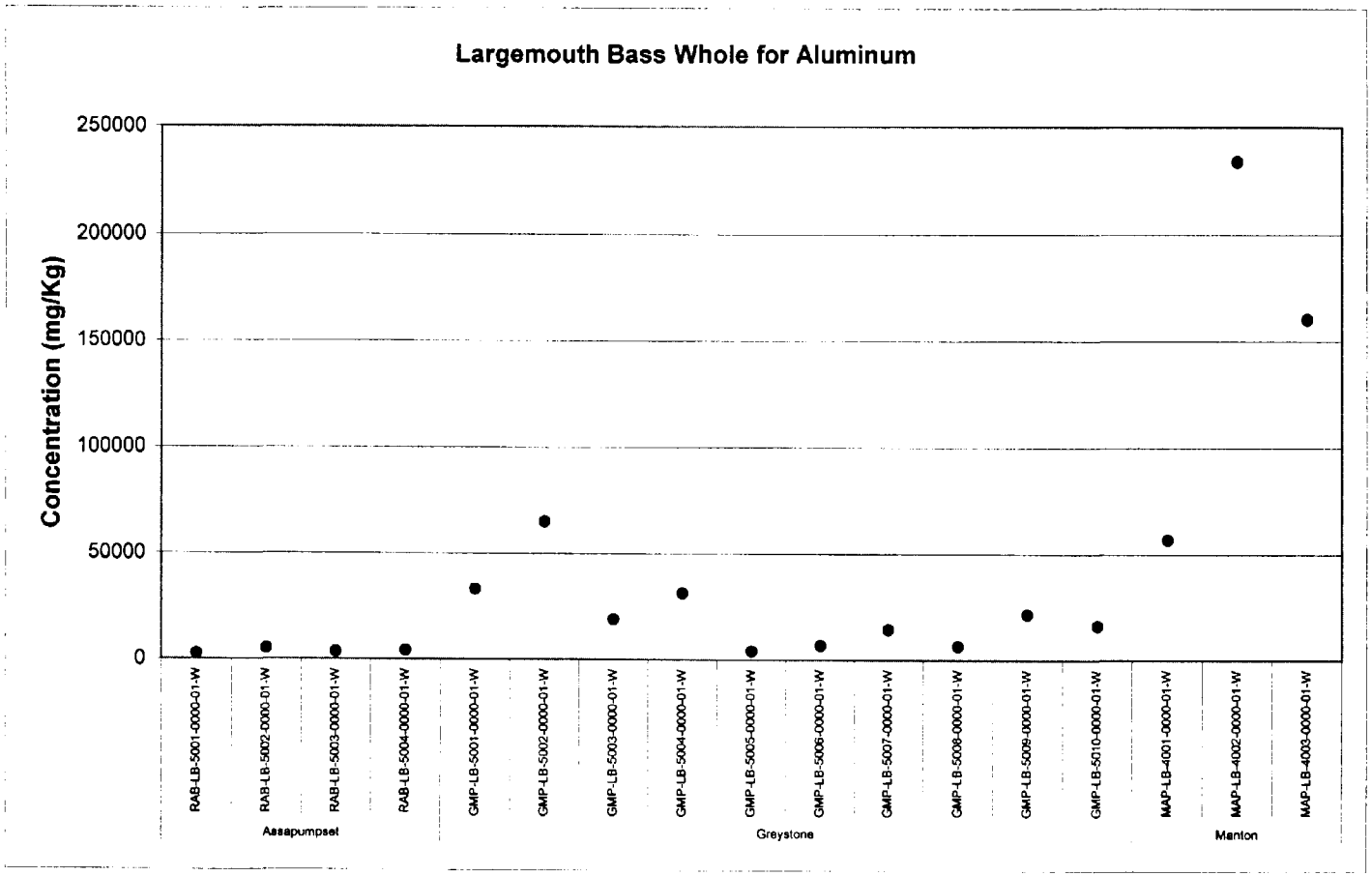
Largemouth Bass W2, LMW Toxicity Equivalency-Mammal



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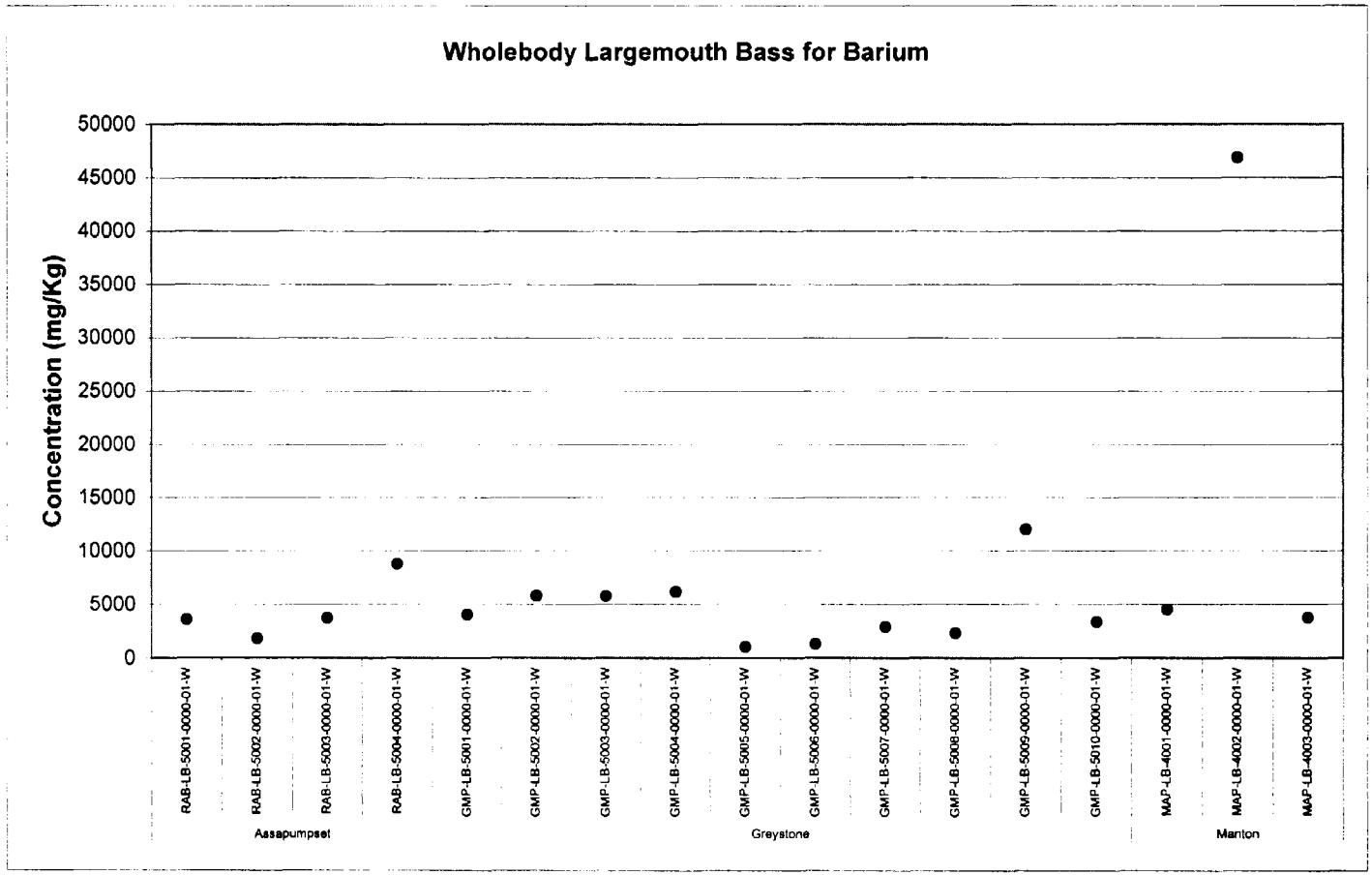

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Largemouth Bass W2, LMW Barium

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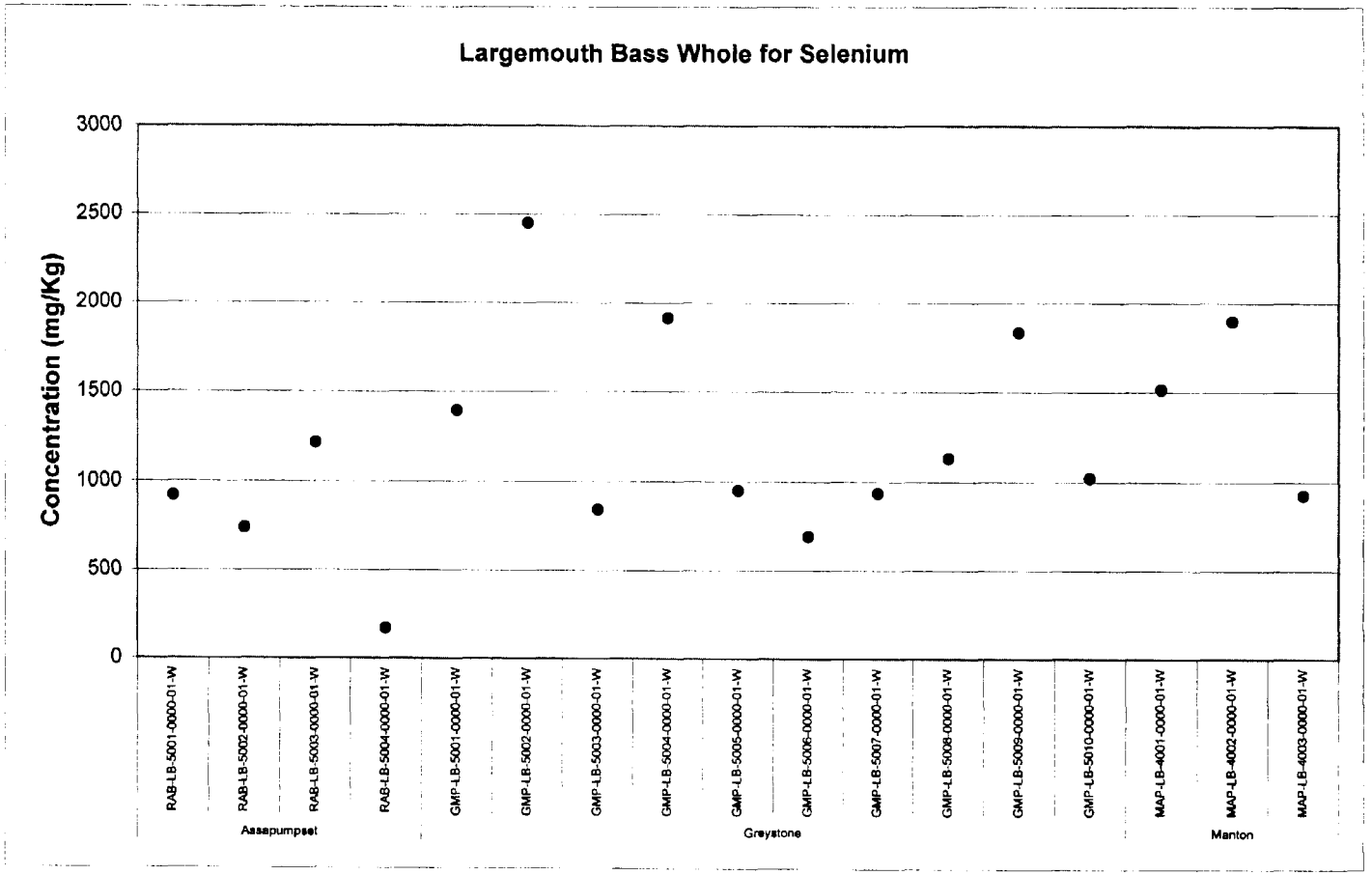
Checked by: KJA



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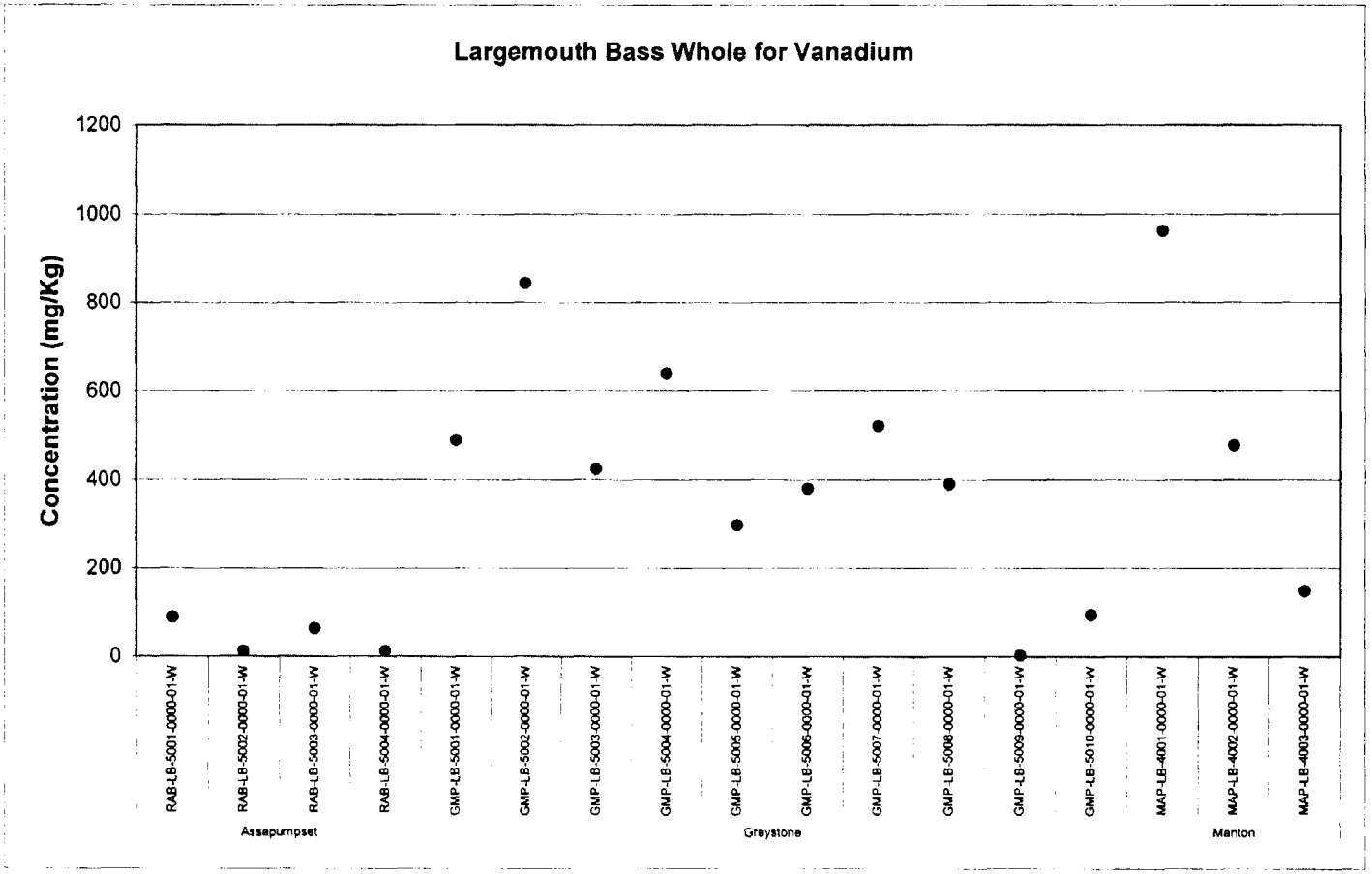

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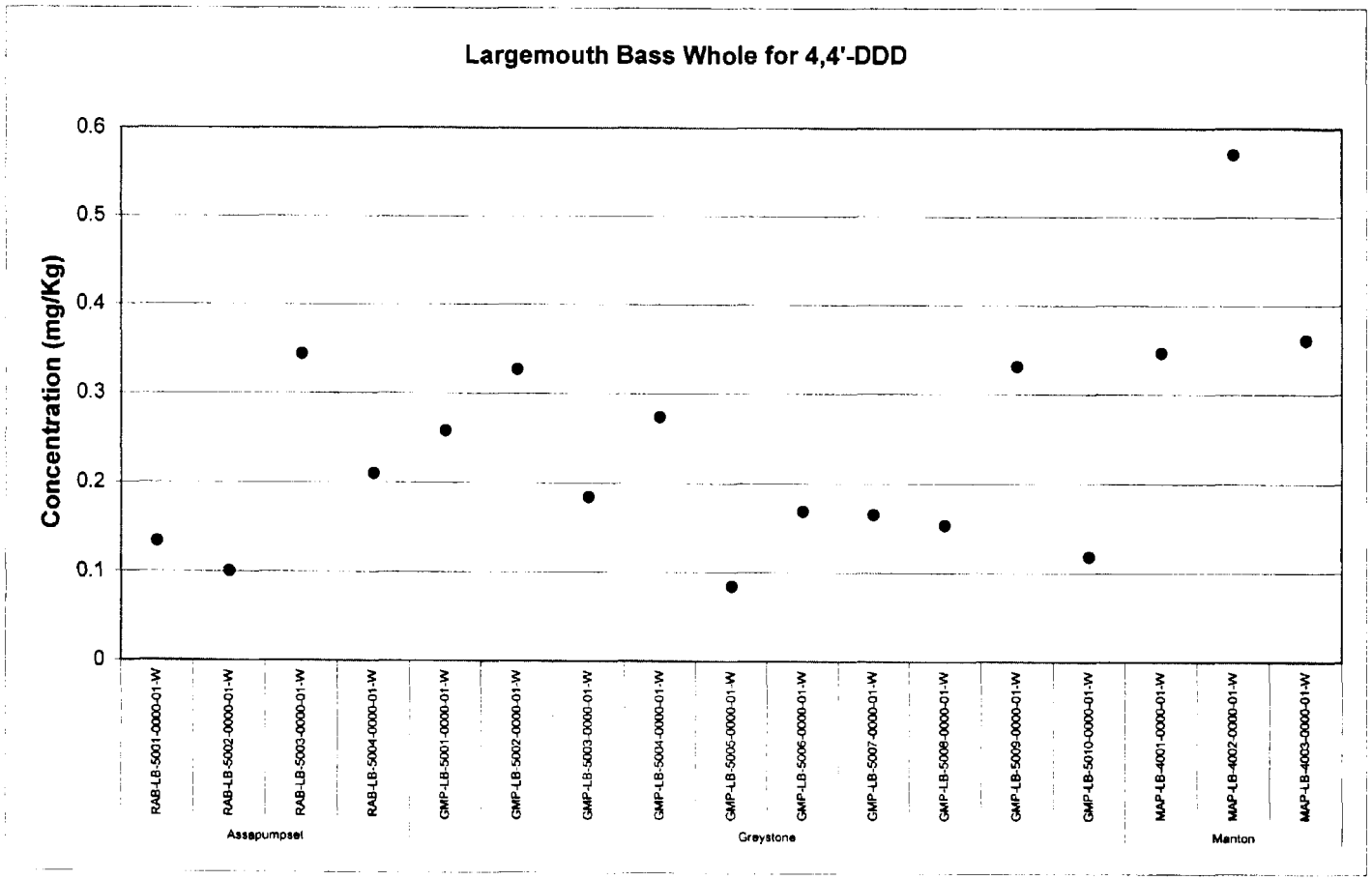

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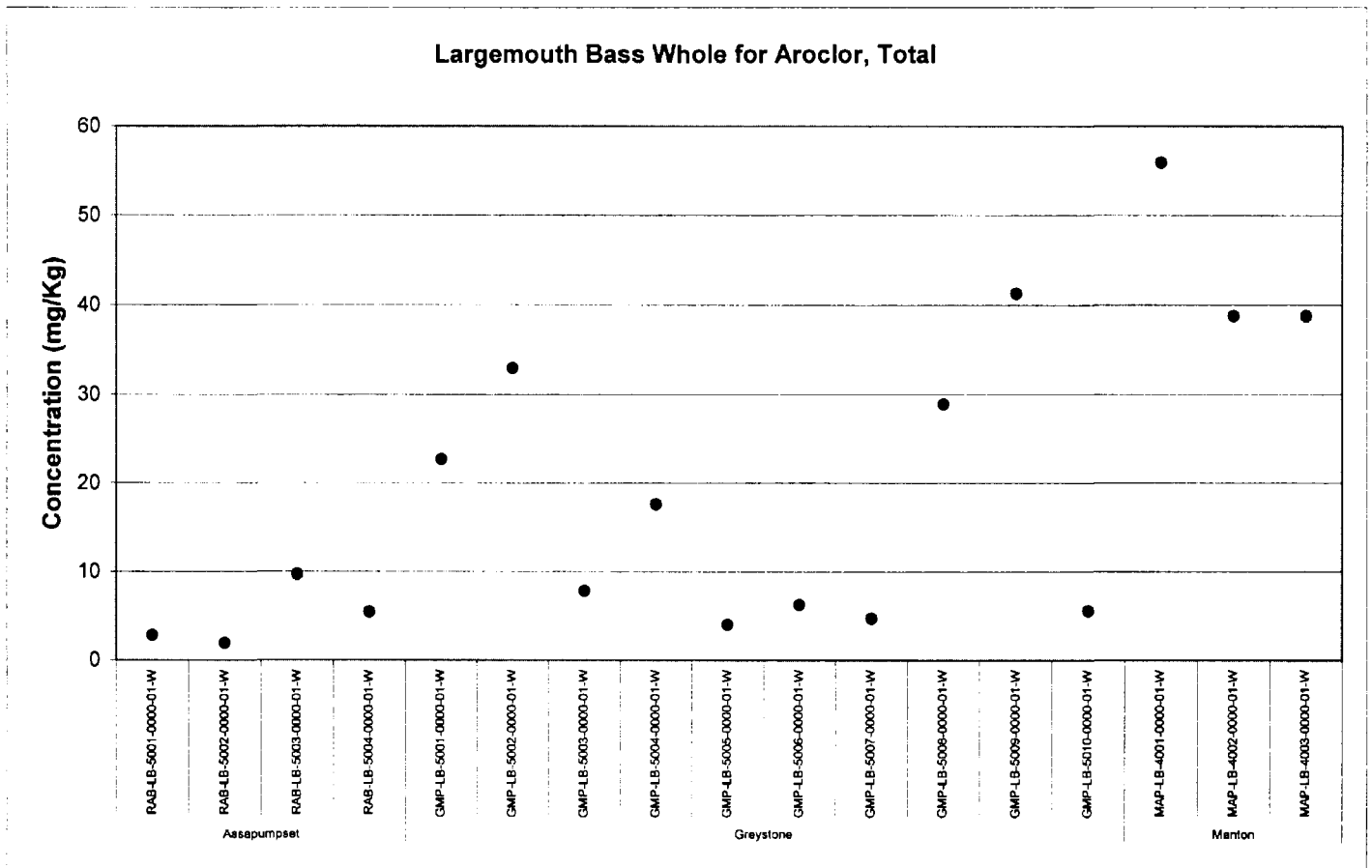

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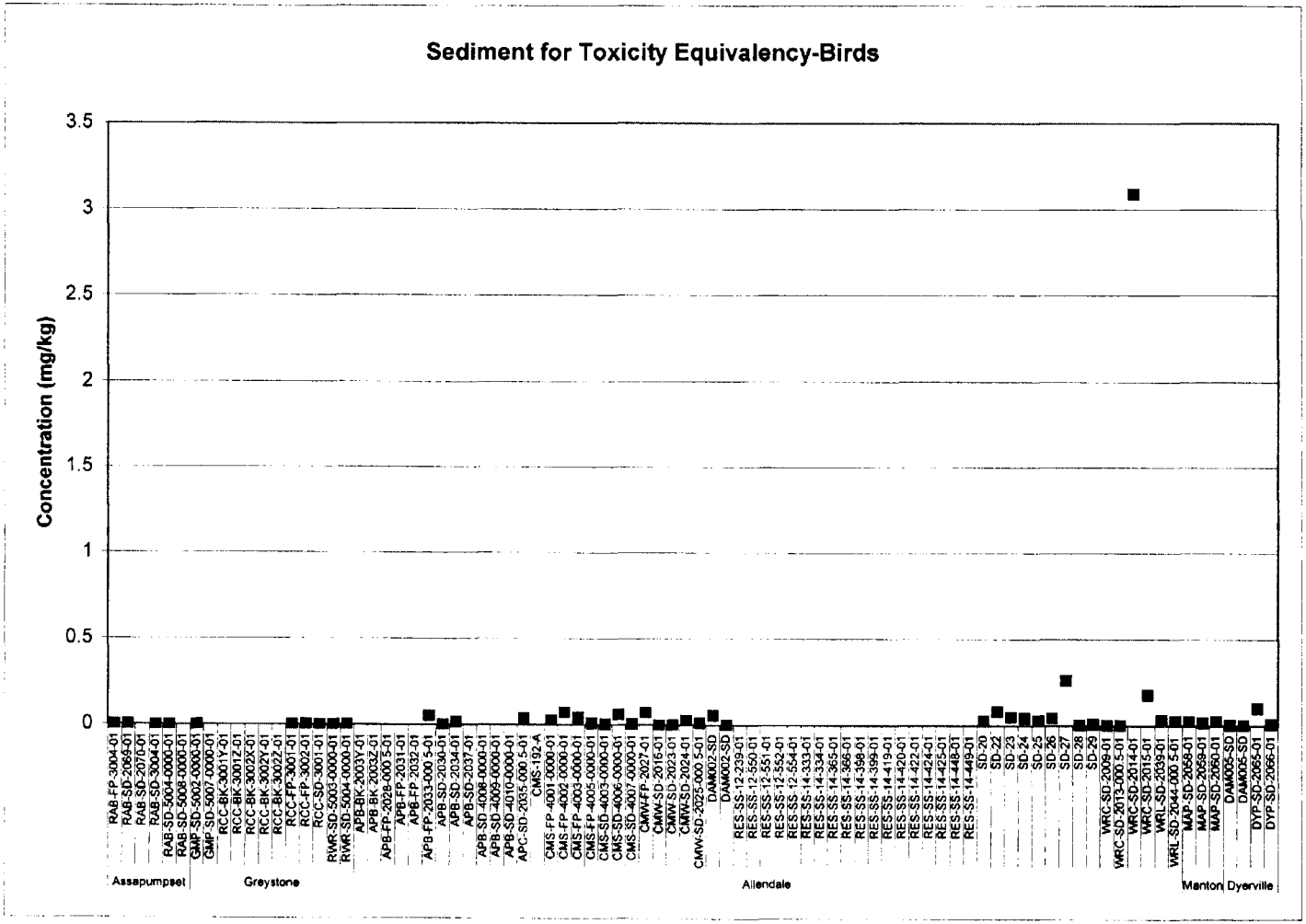

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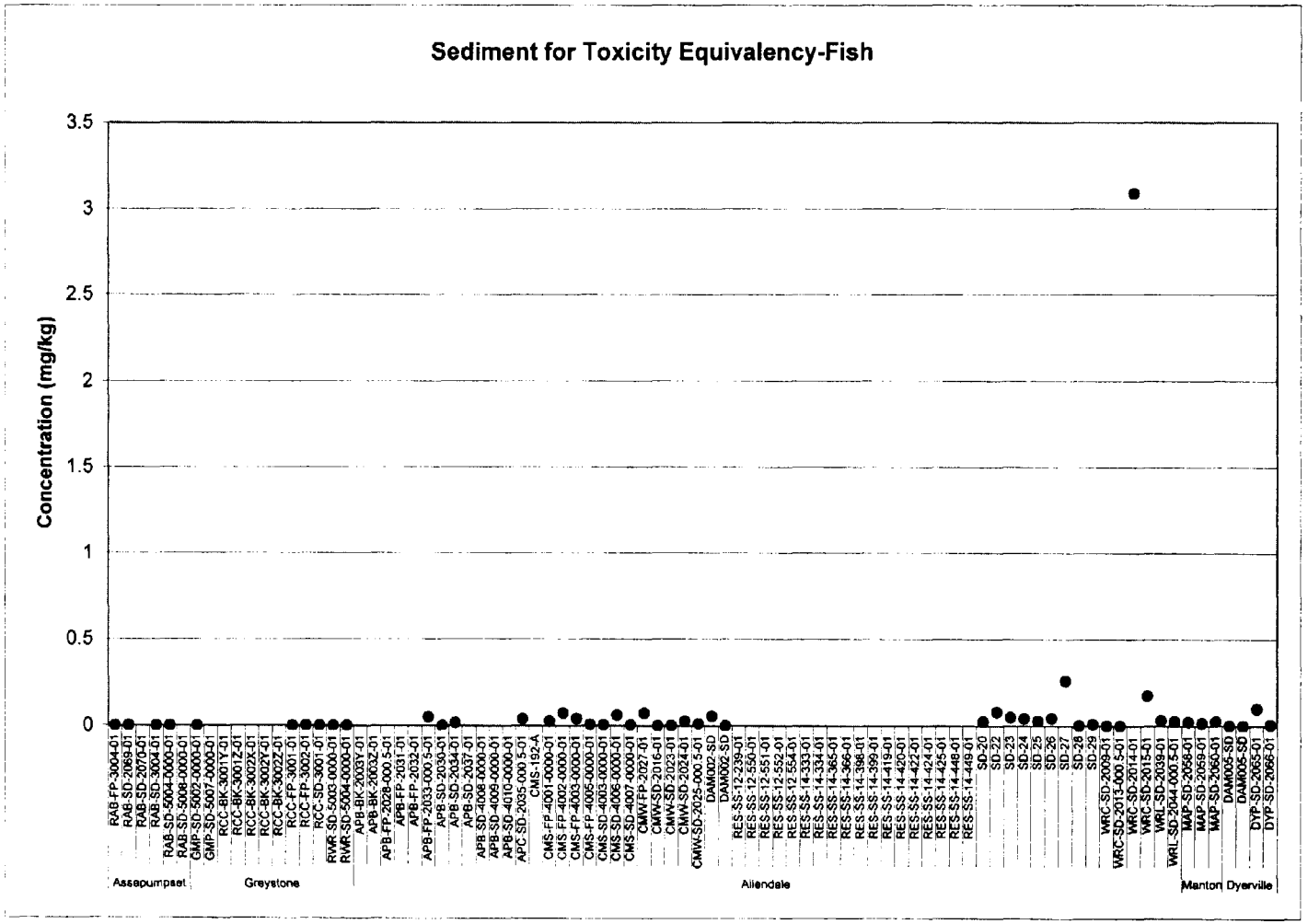
Sediment SD Toxicity Equivalency-Birds



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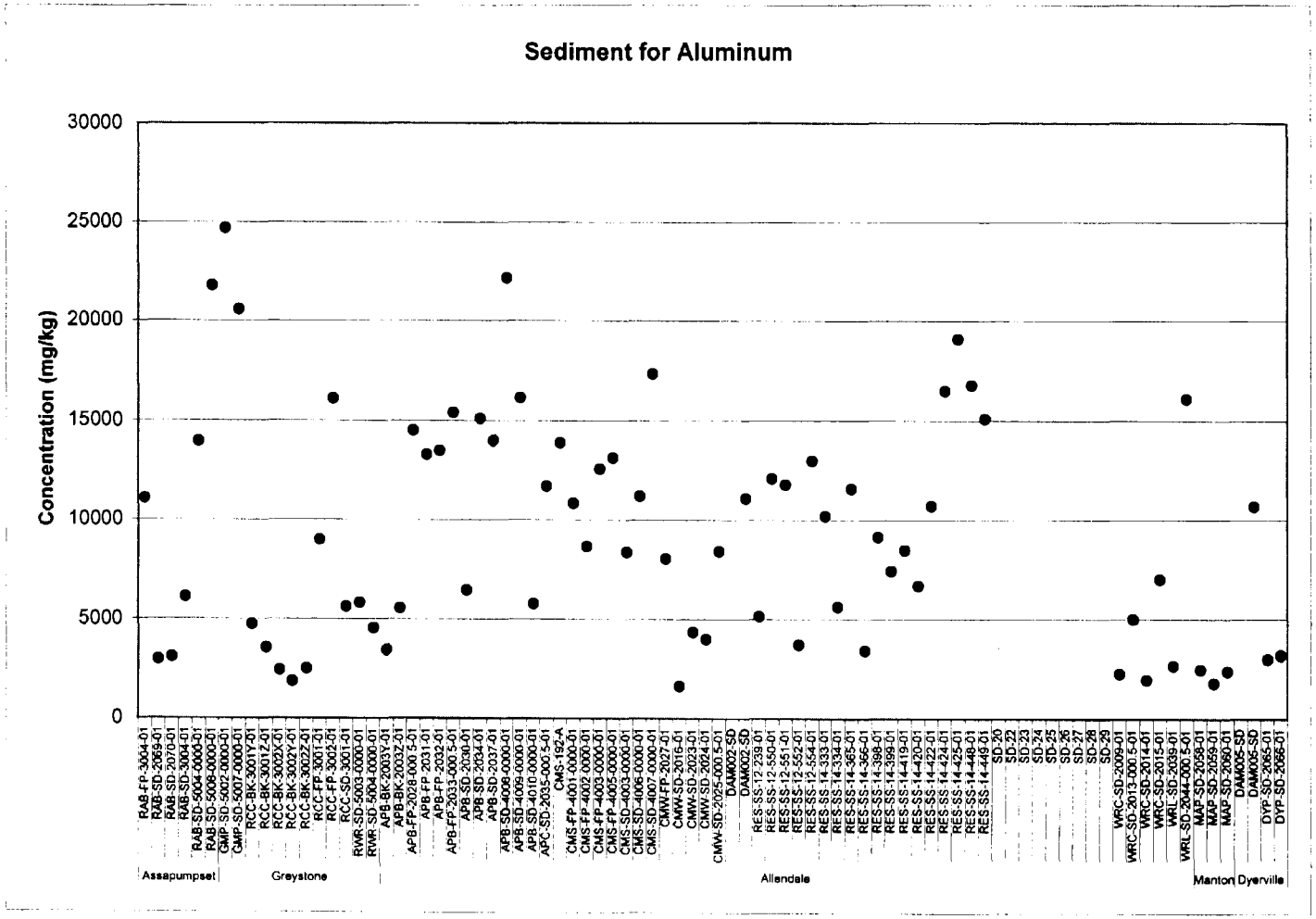

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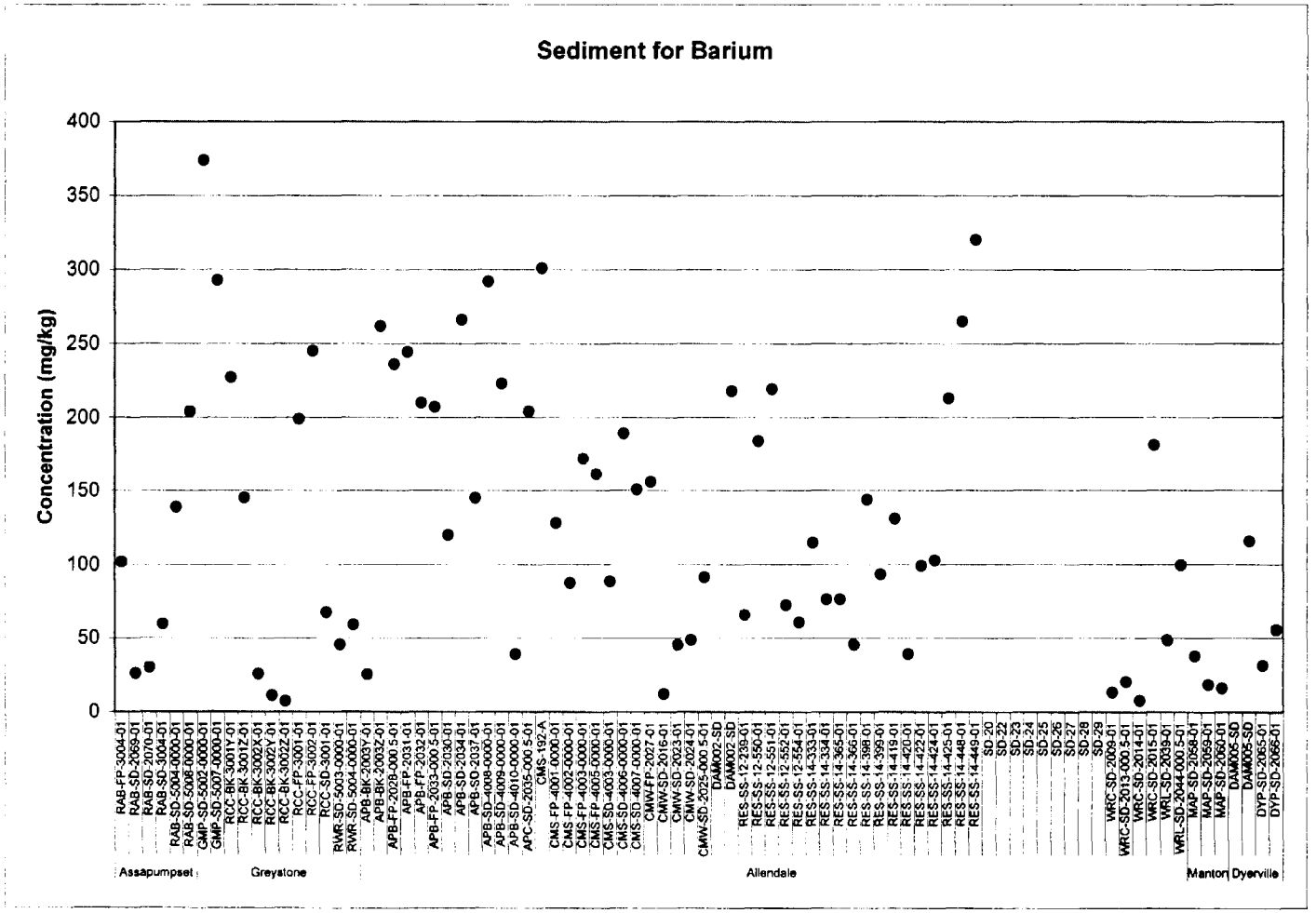
Sediment\ SD Aluminum



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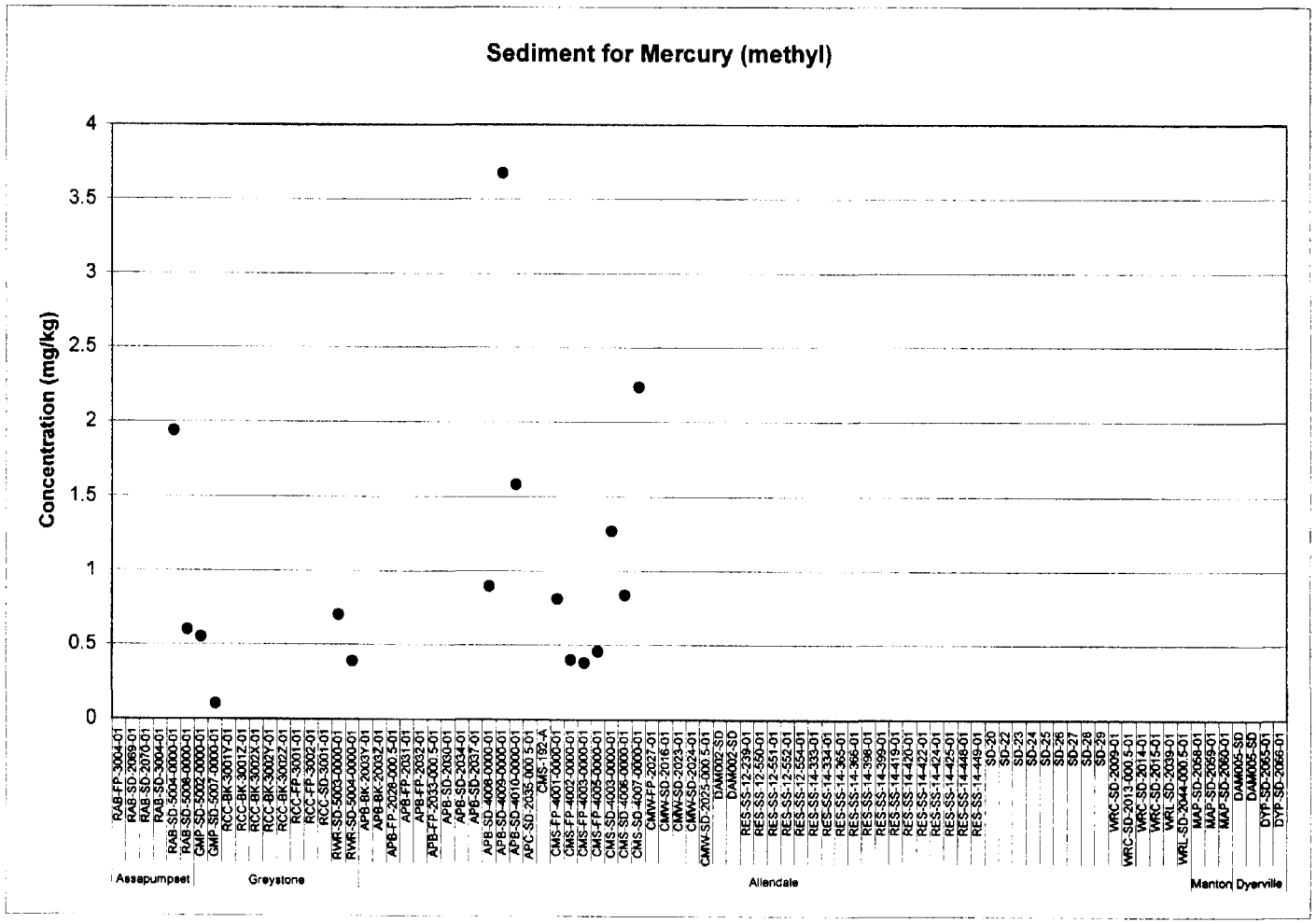

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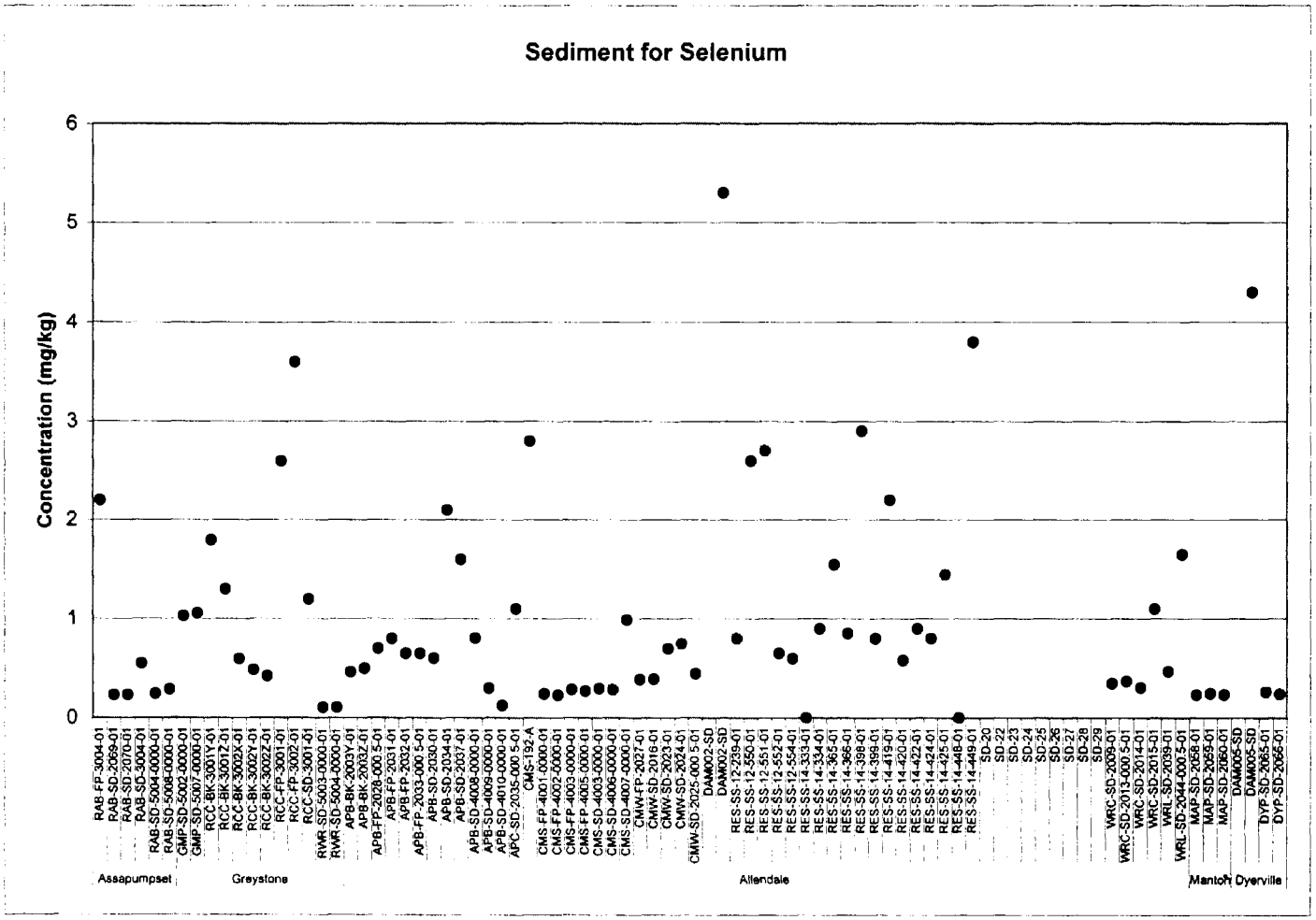

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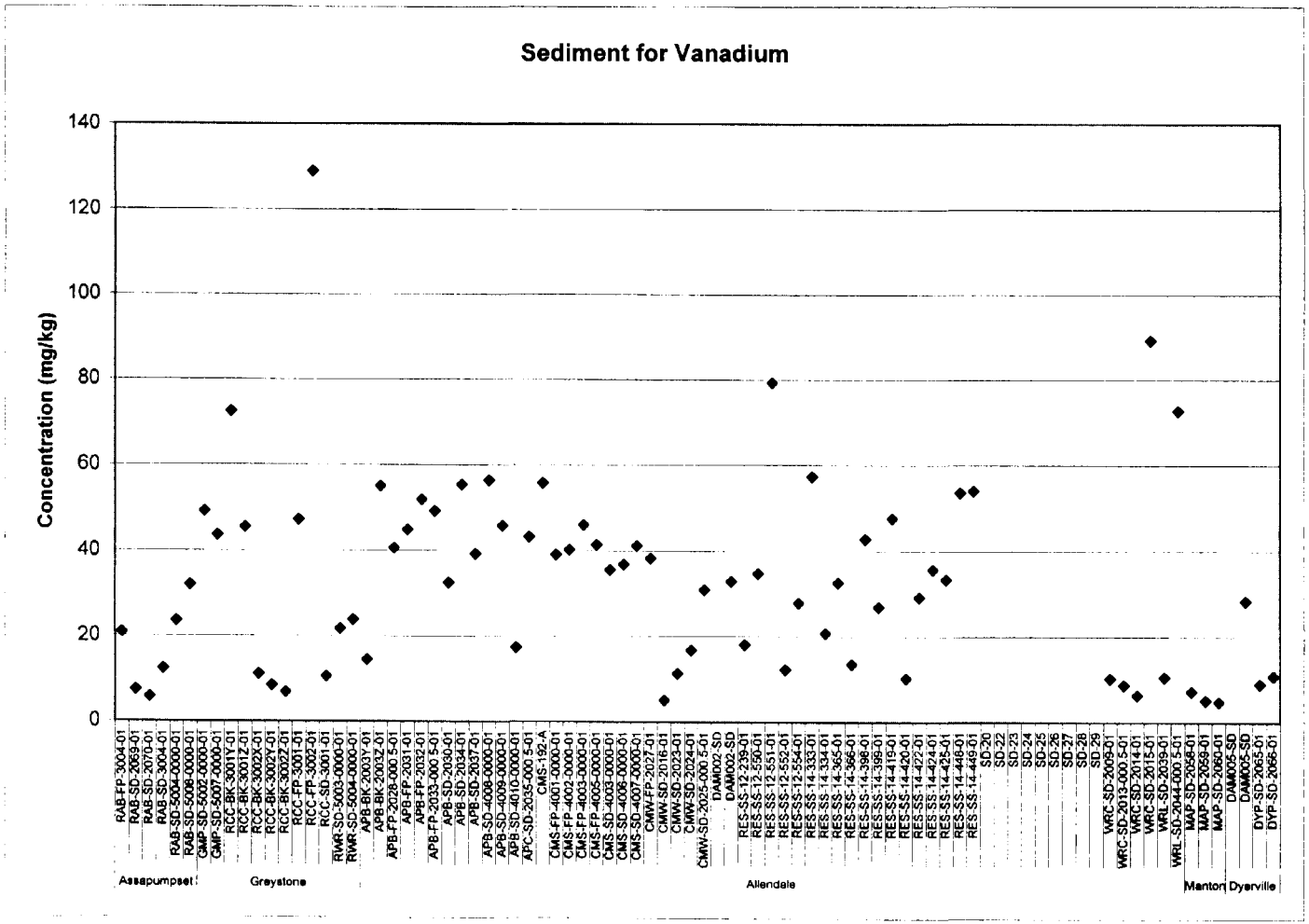

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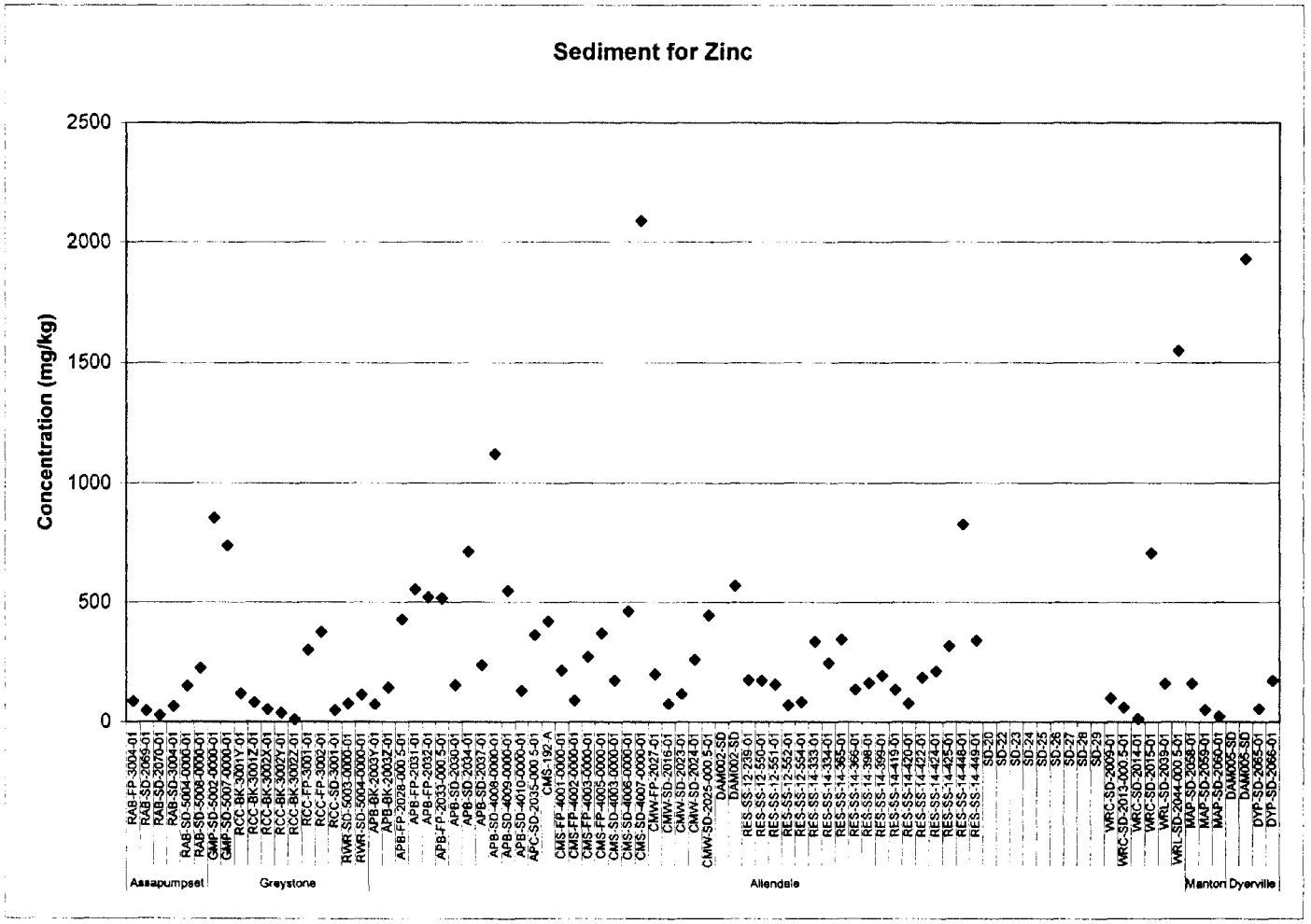
Sediment SD Vanadium



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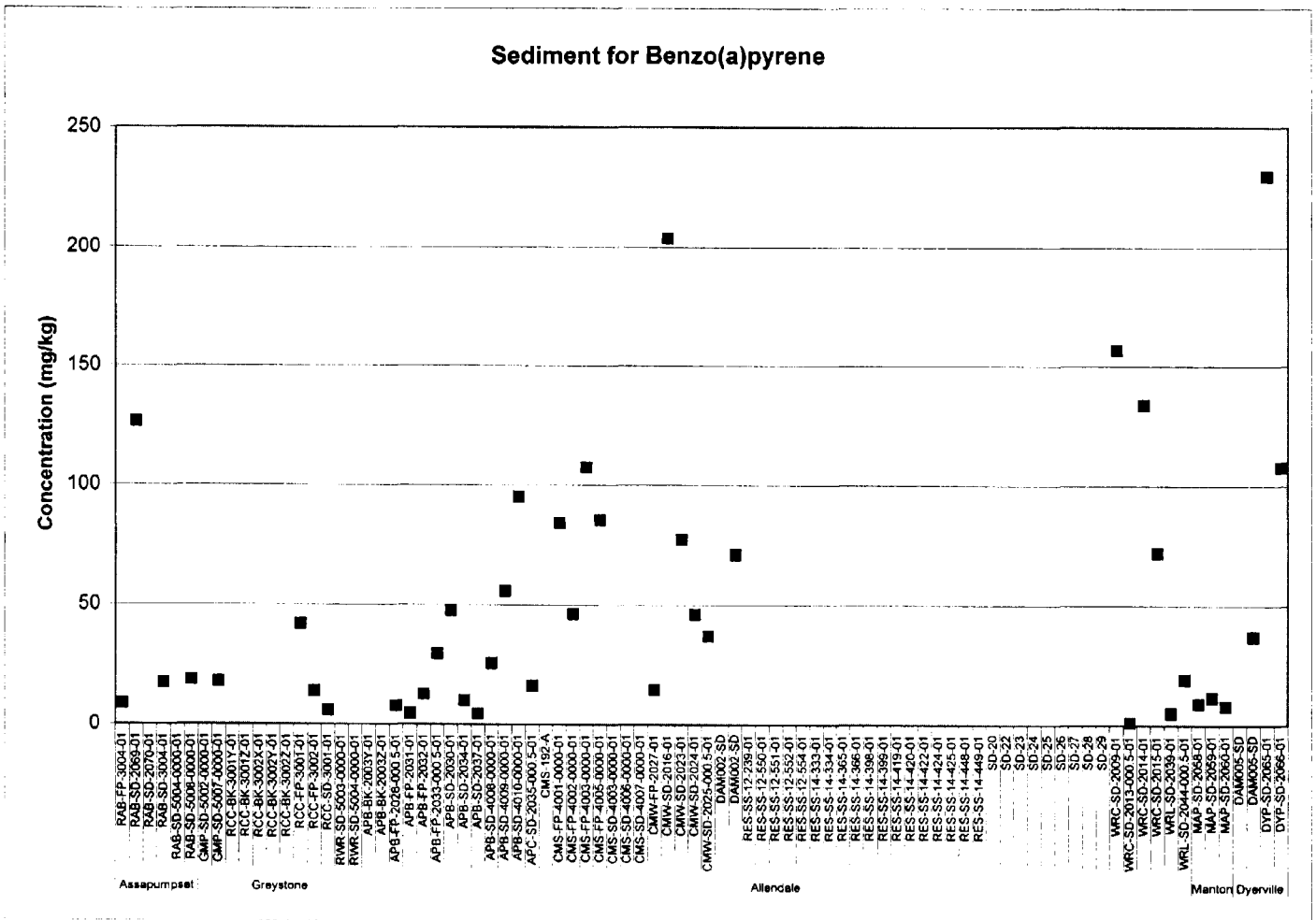

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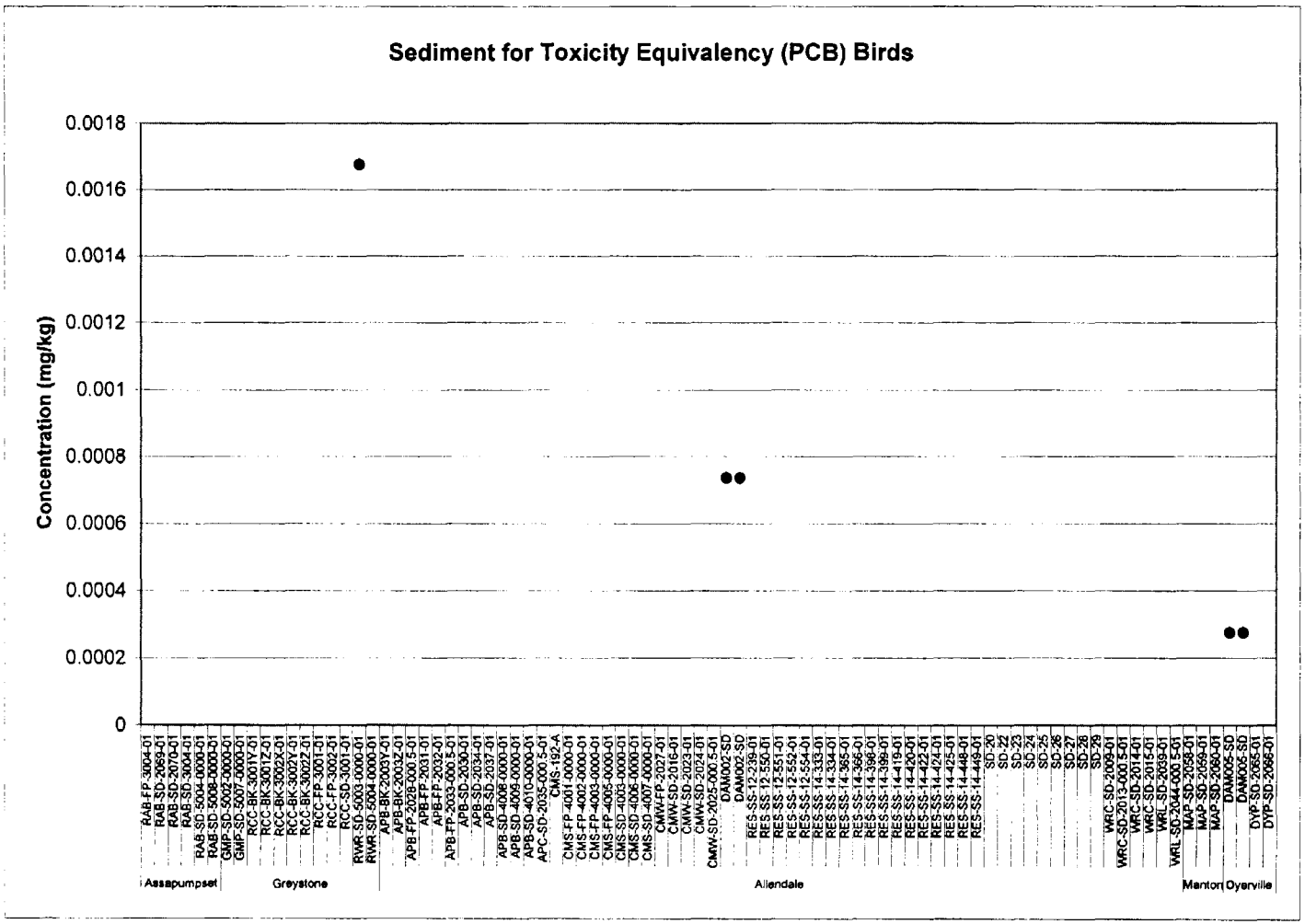

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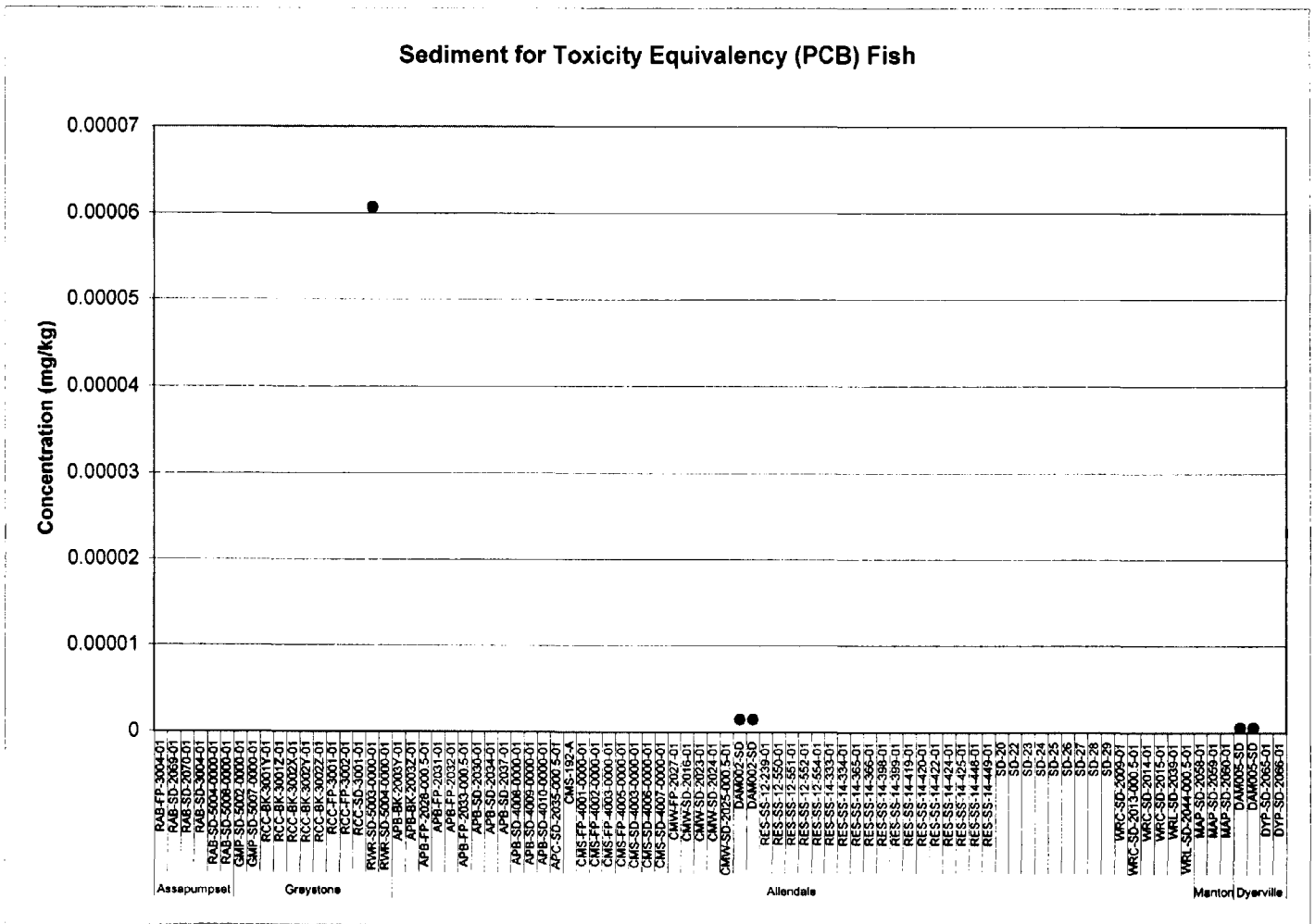

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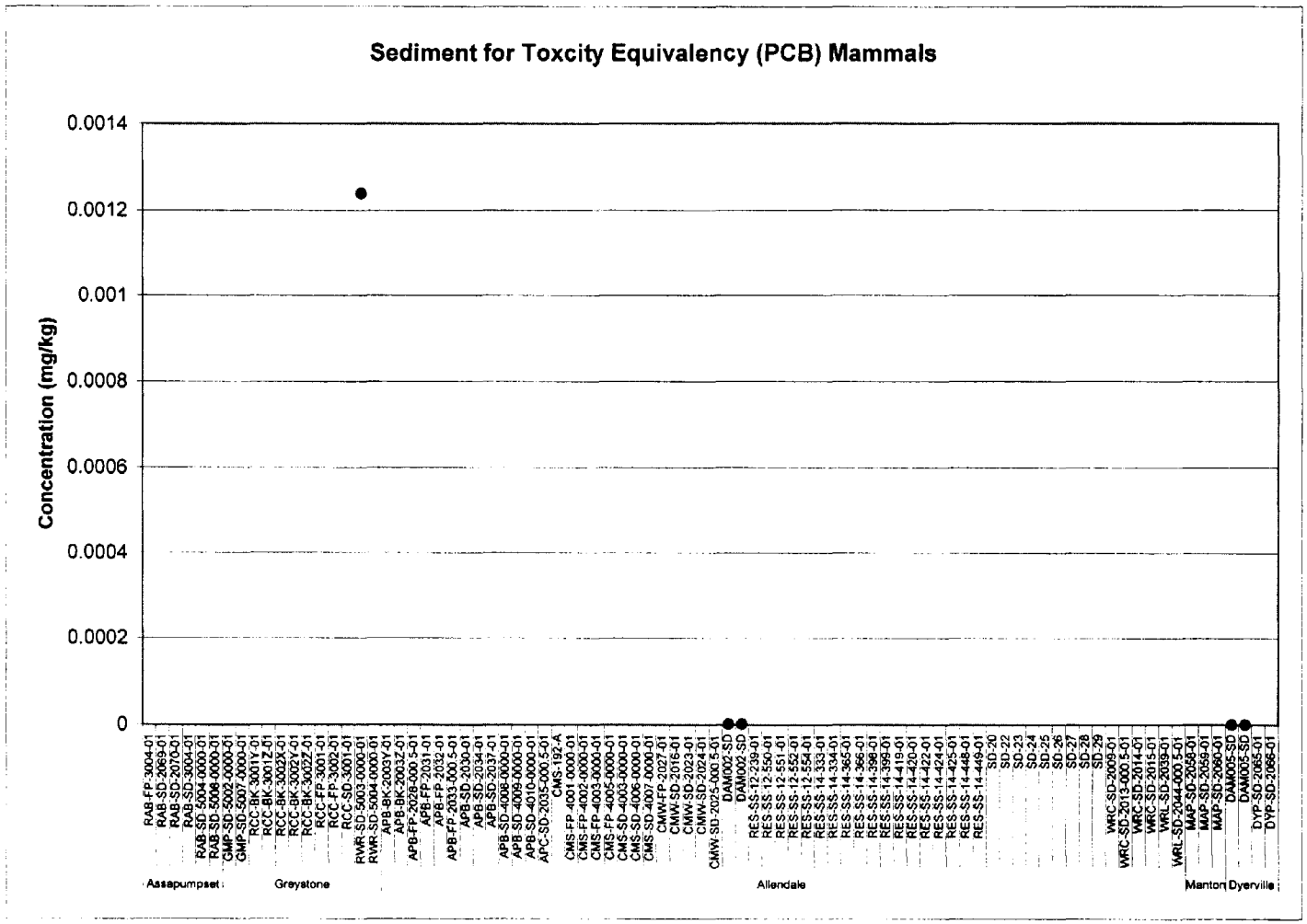

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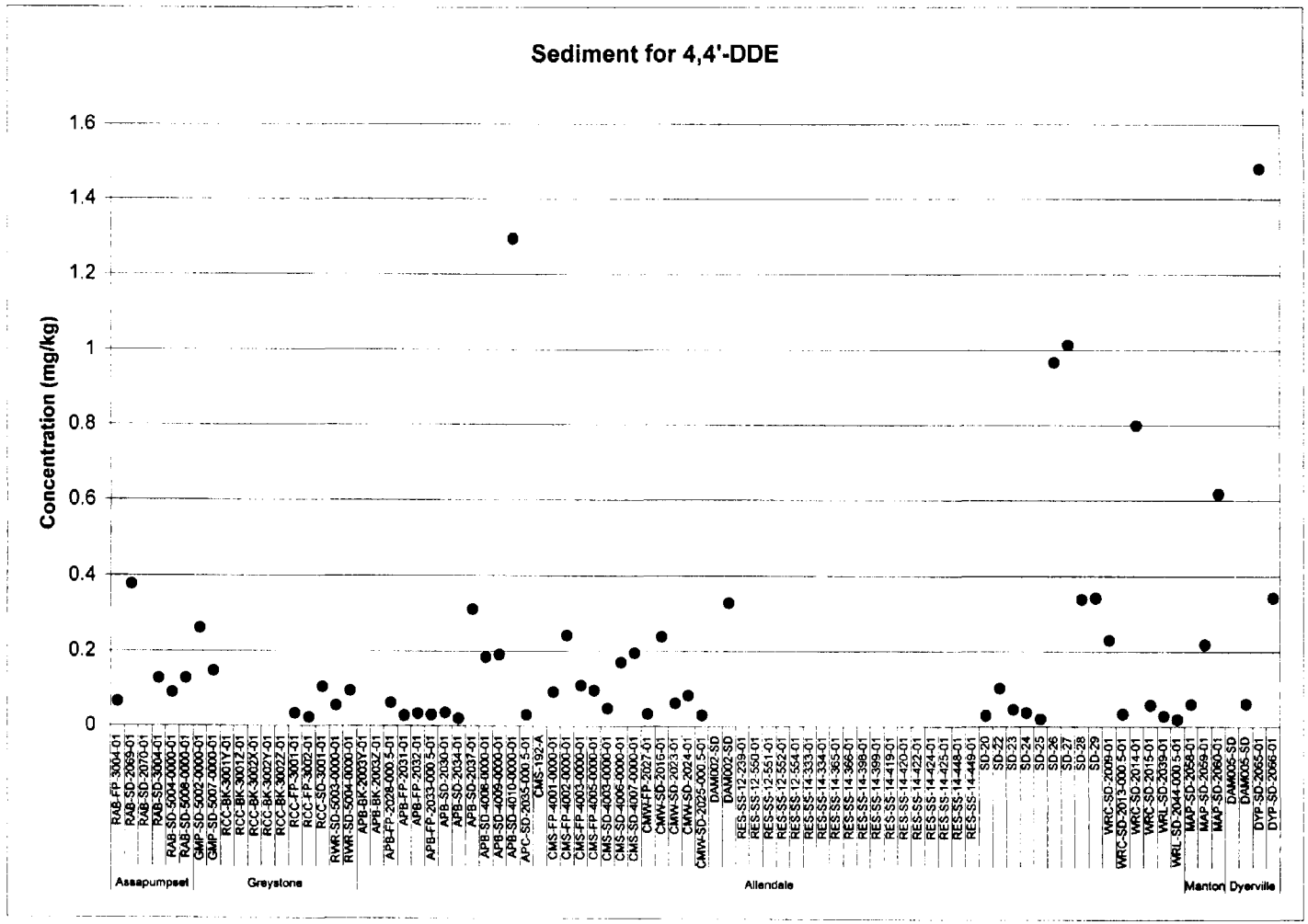

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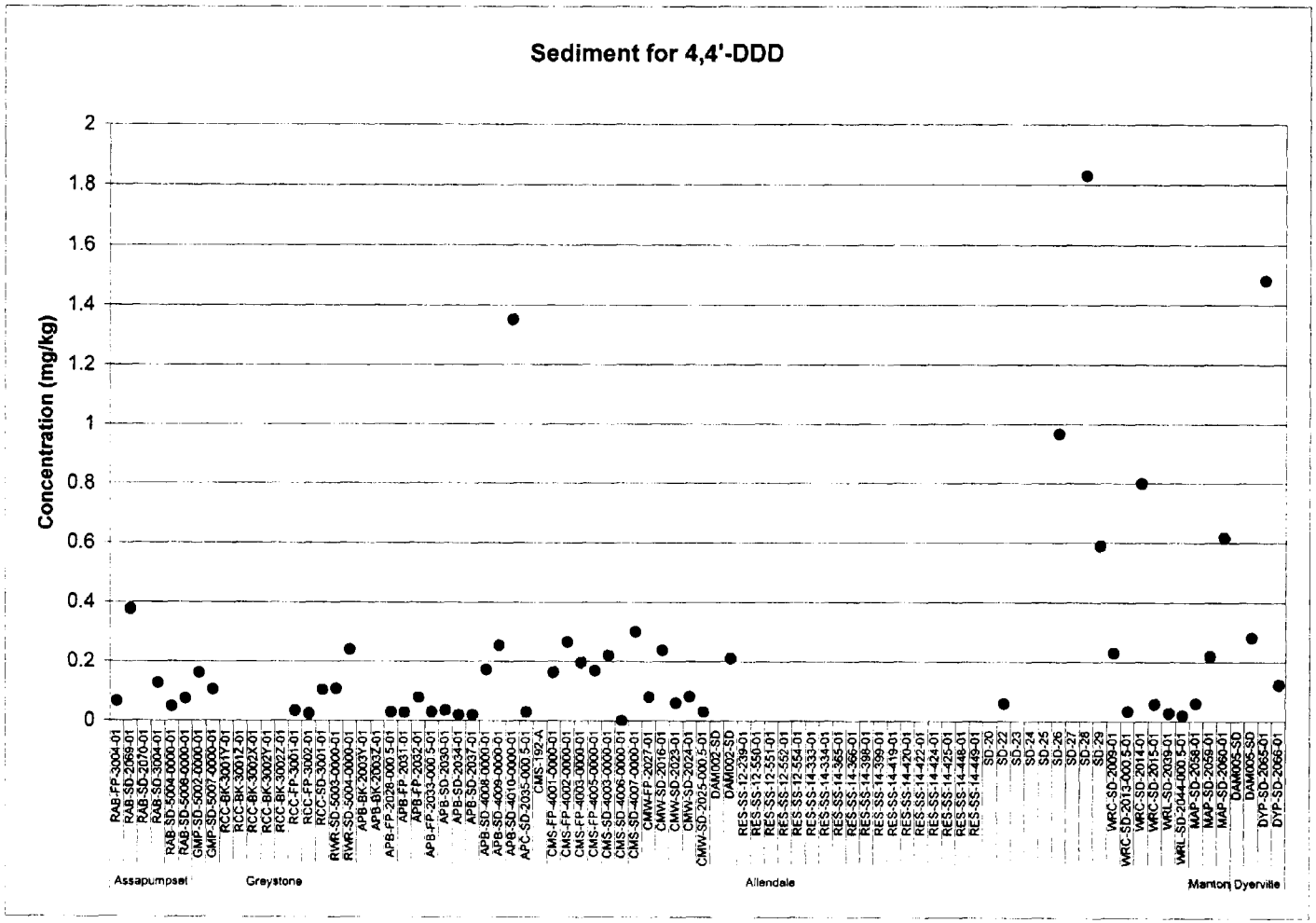

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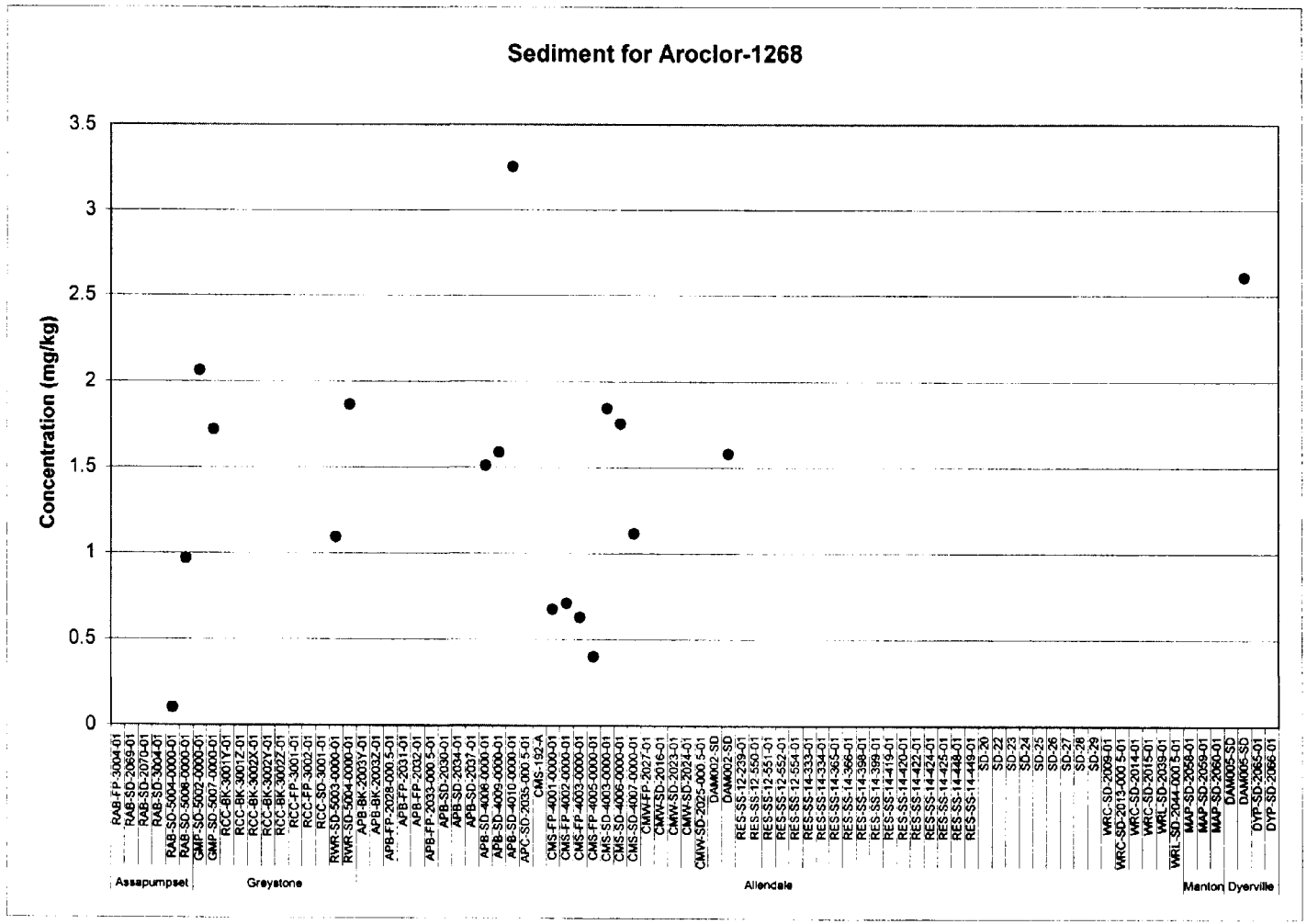

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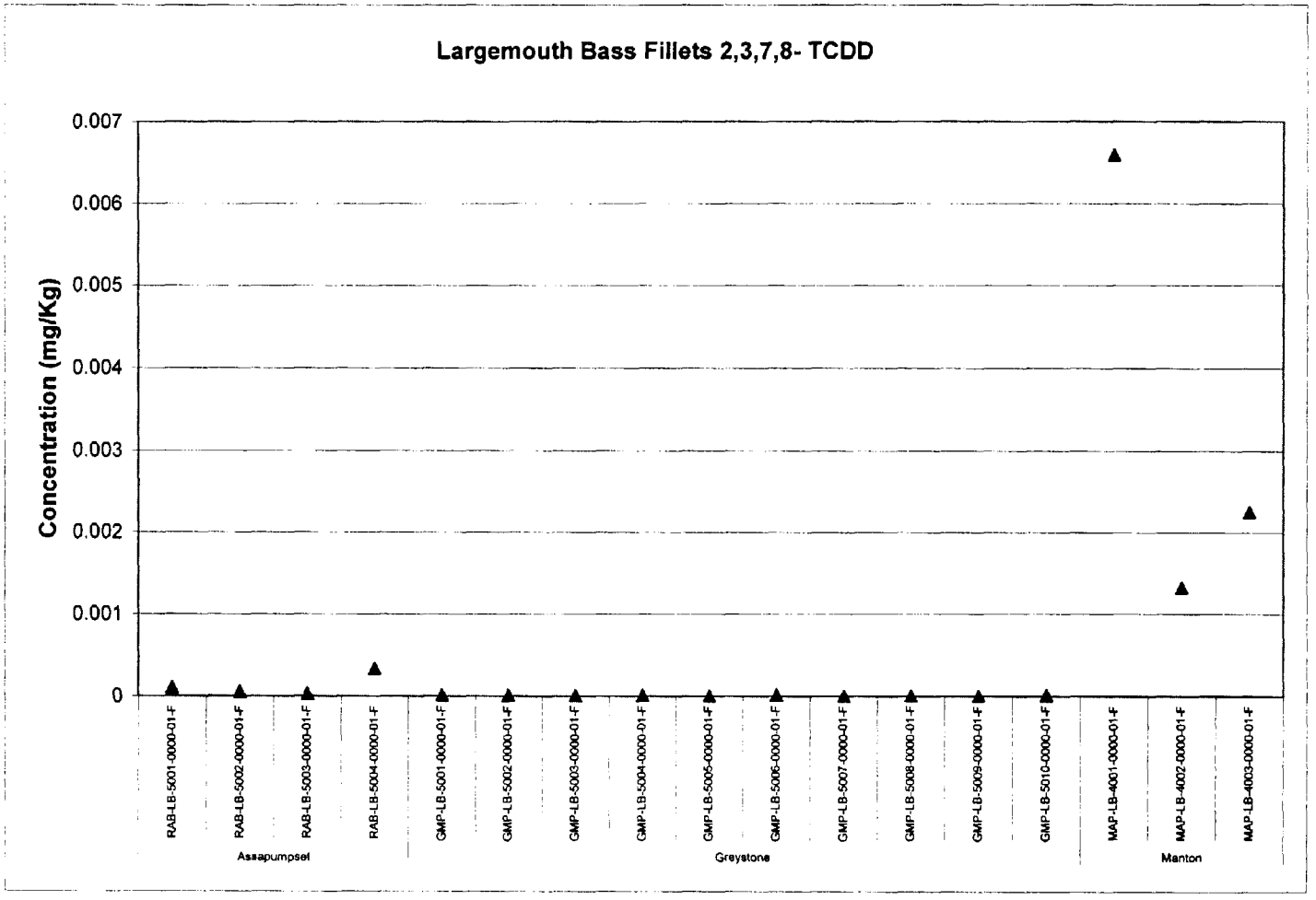

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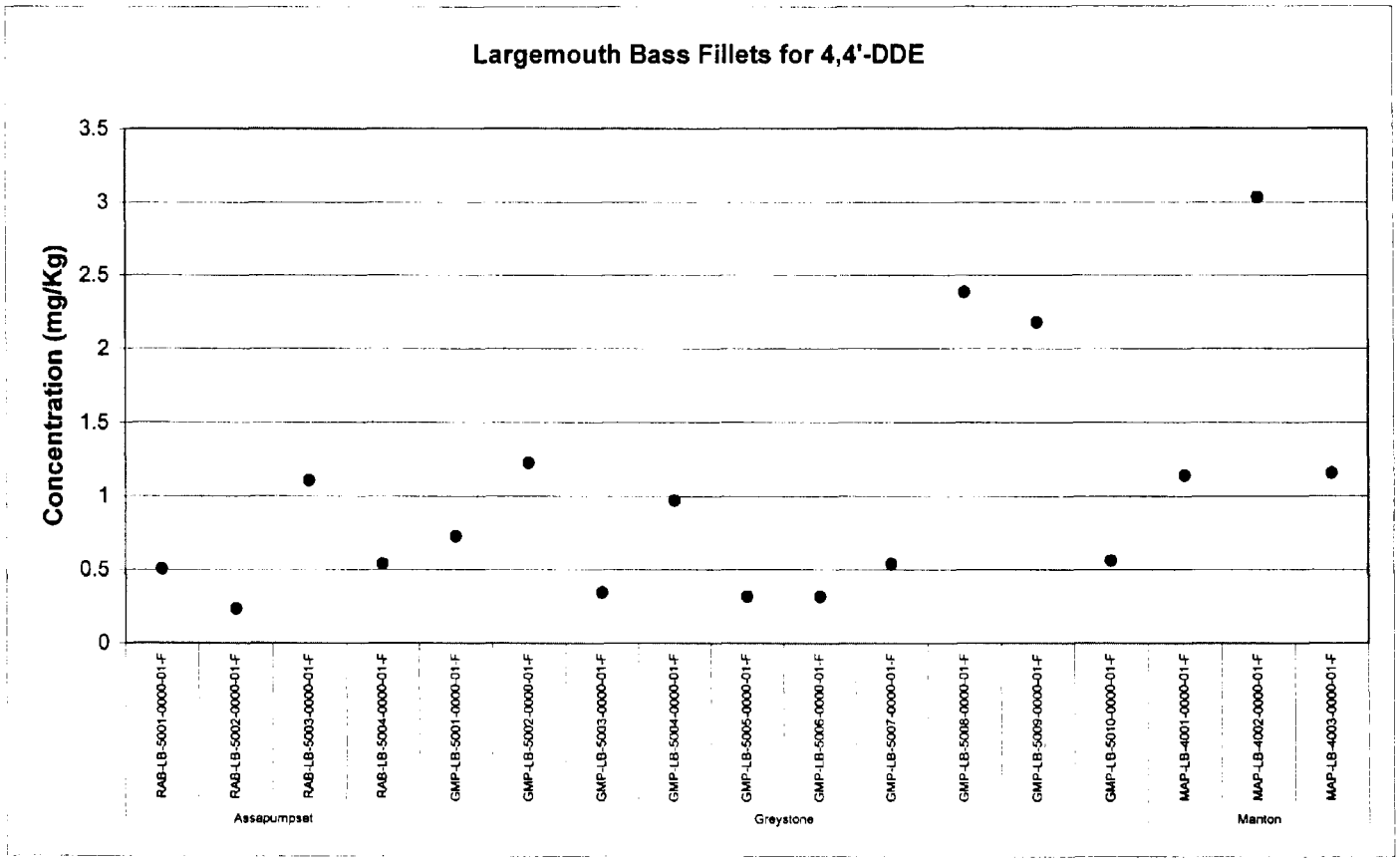
Largemouth Bass F2, LBF 2,3,7,8 TCDD



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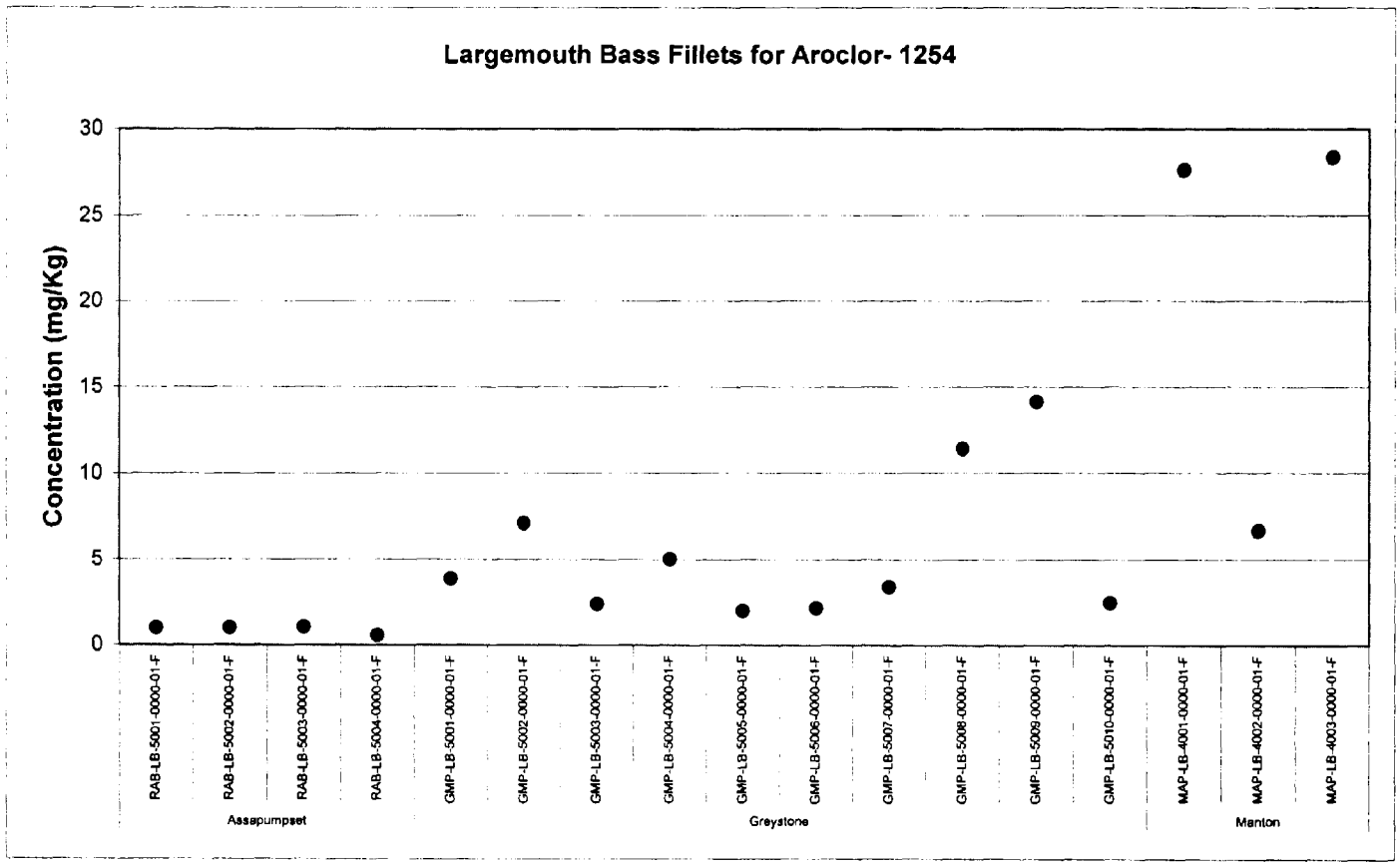

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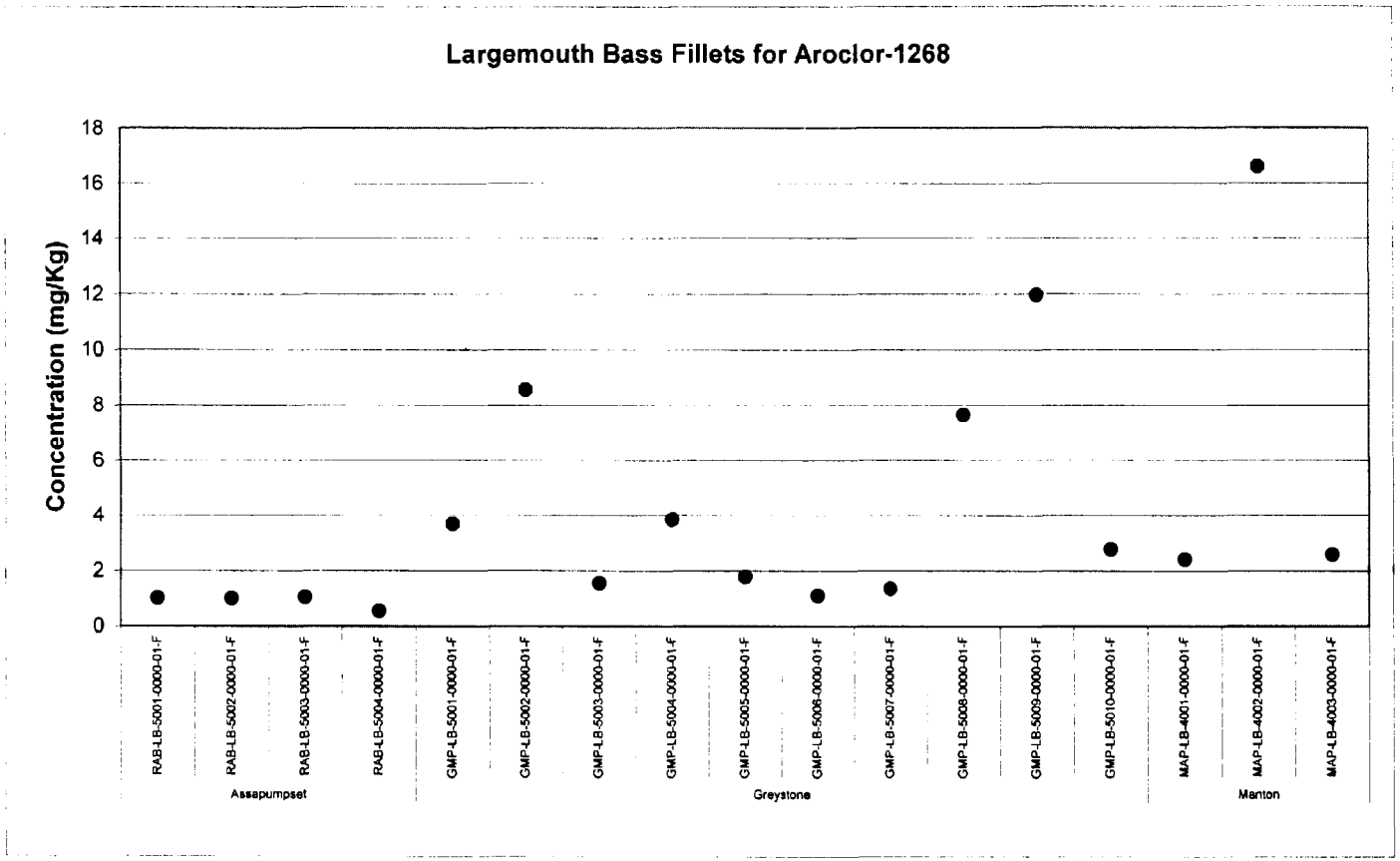
Largemouth Bass F2, LBF Aroclor-1254



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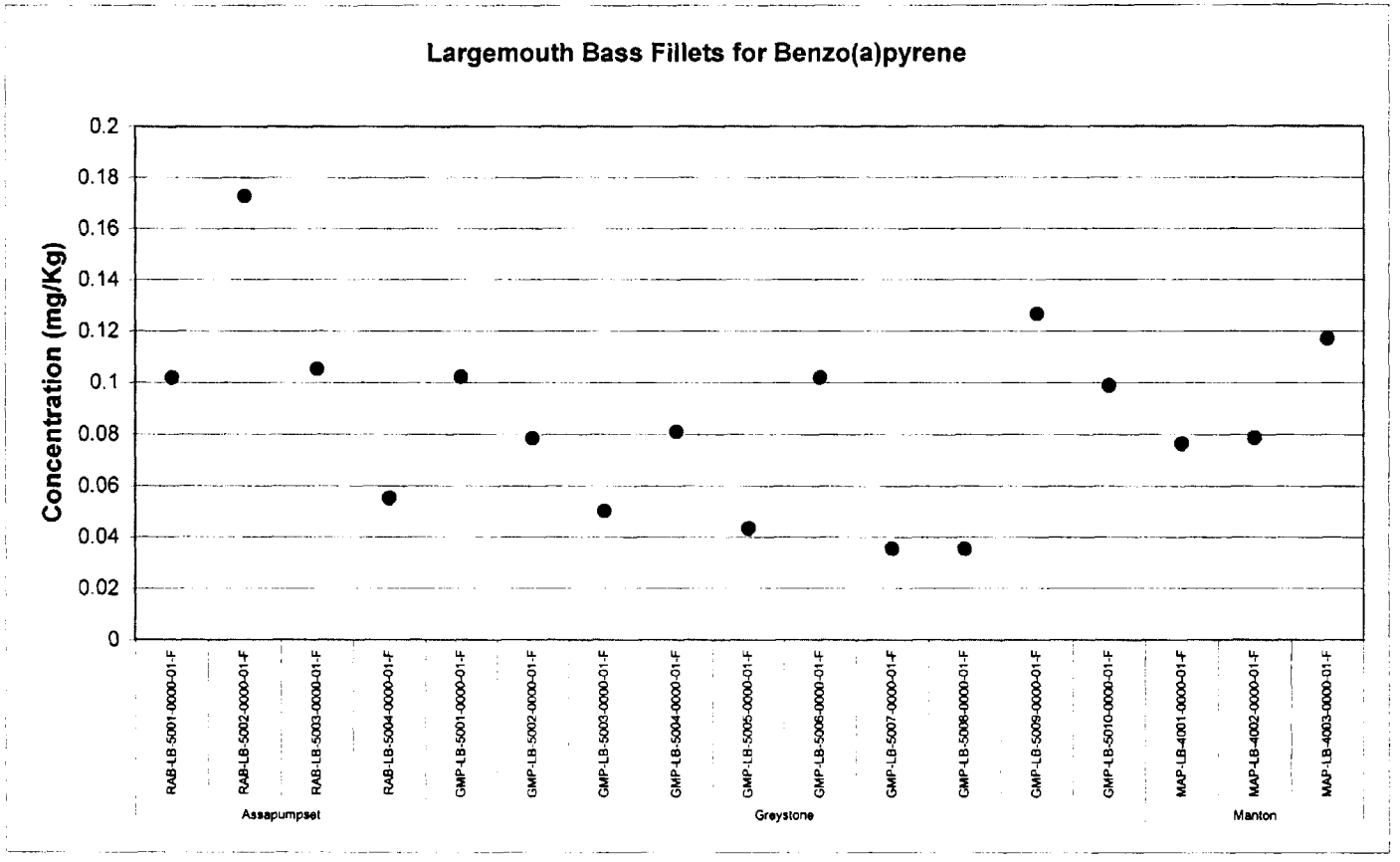
Largemouth Bass F2, LBF Aroclor-1268



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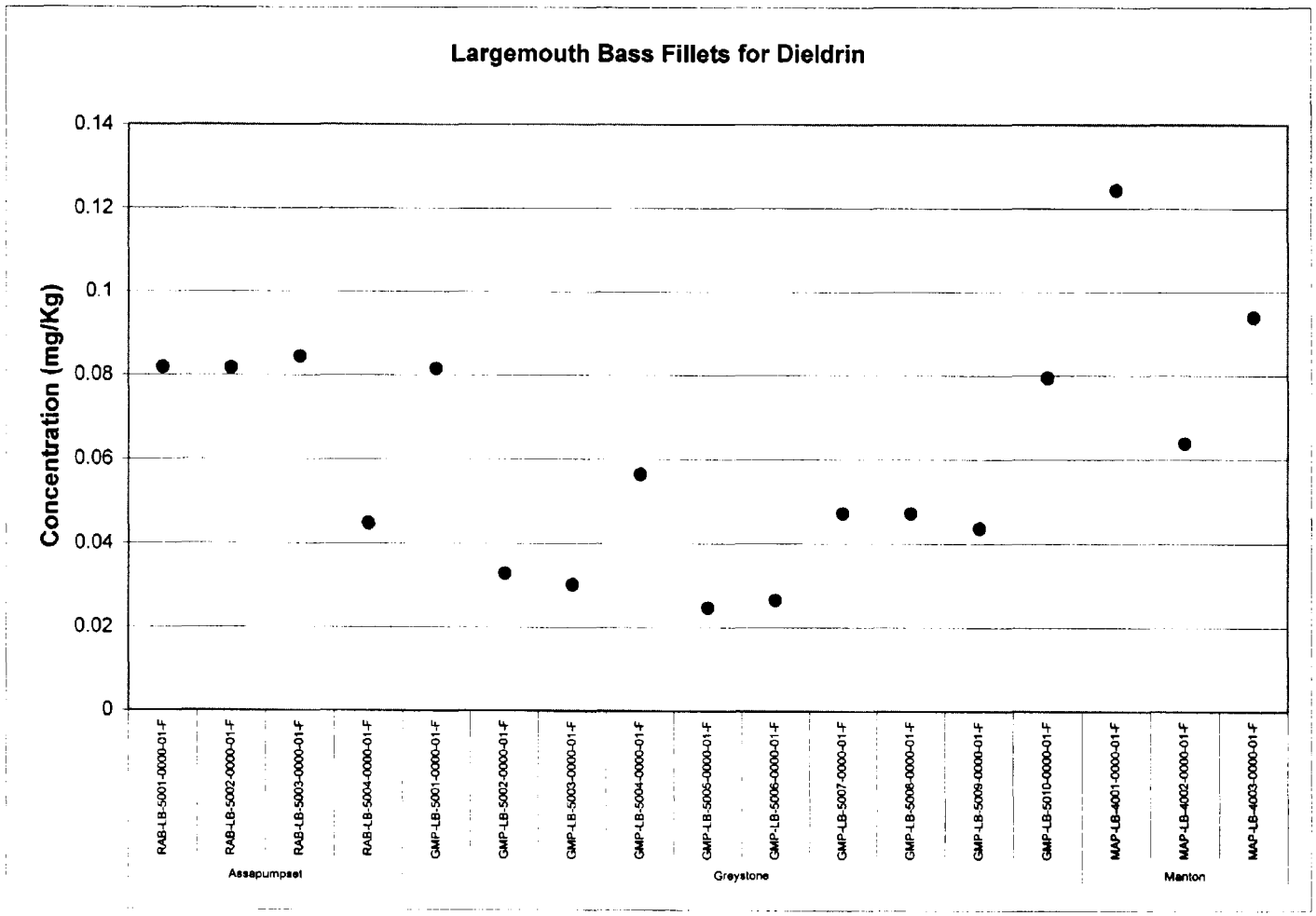

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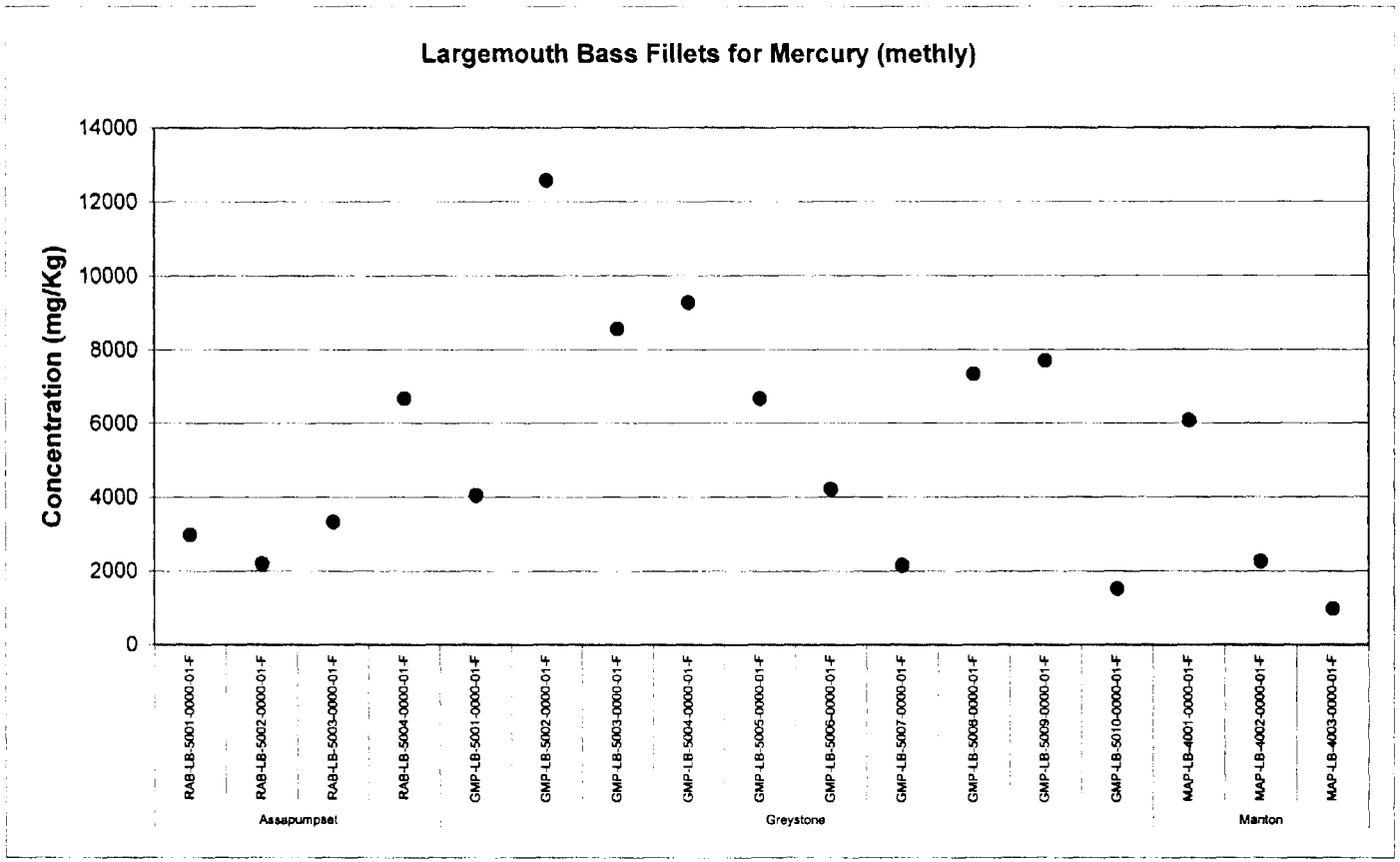
Largem··· ·h Bass F2, Dieldrin



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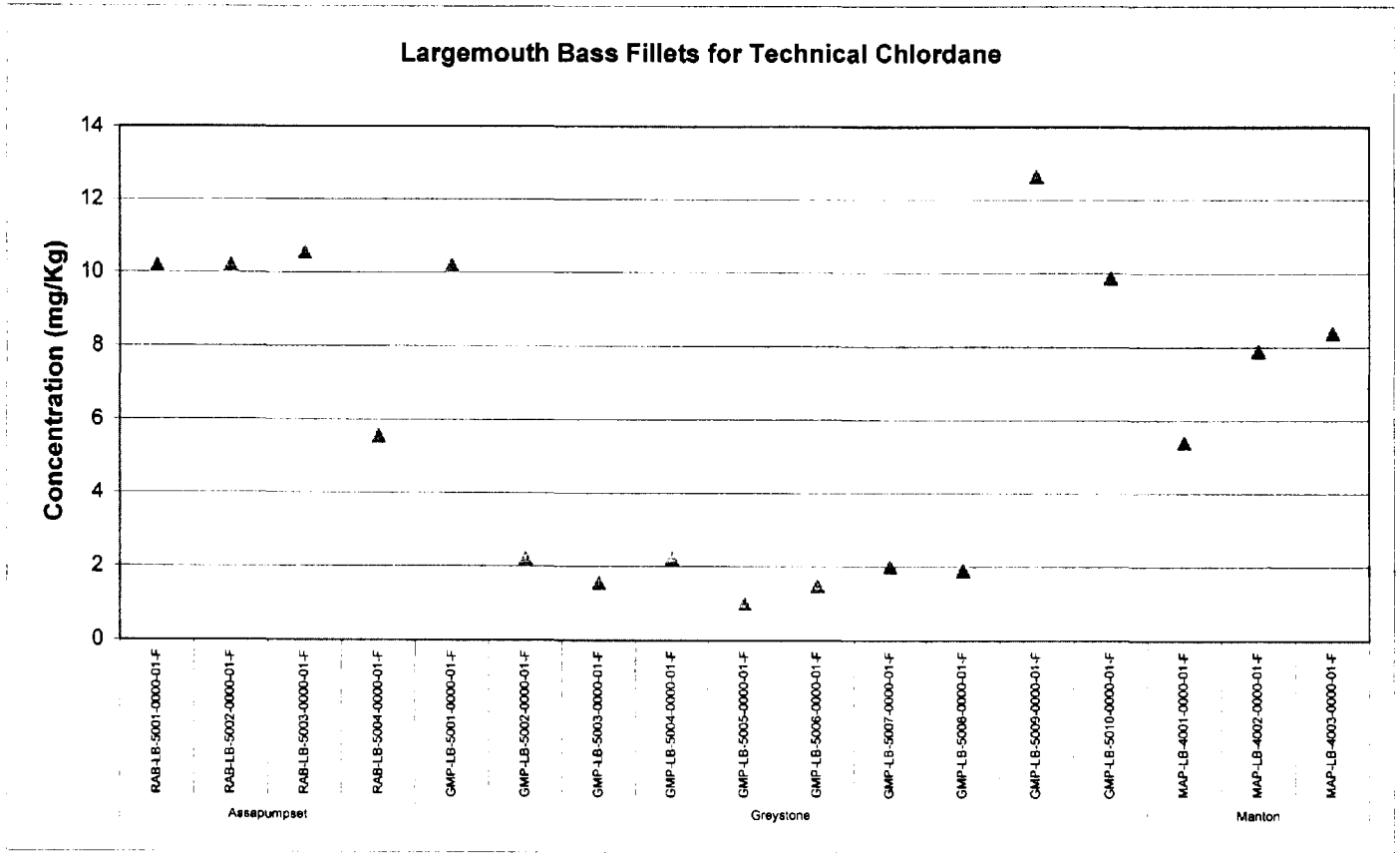

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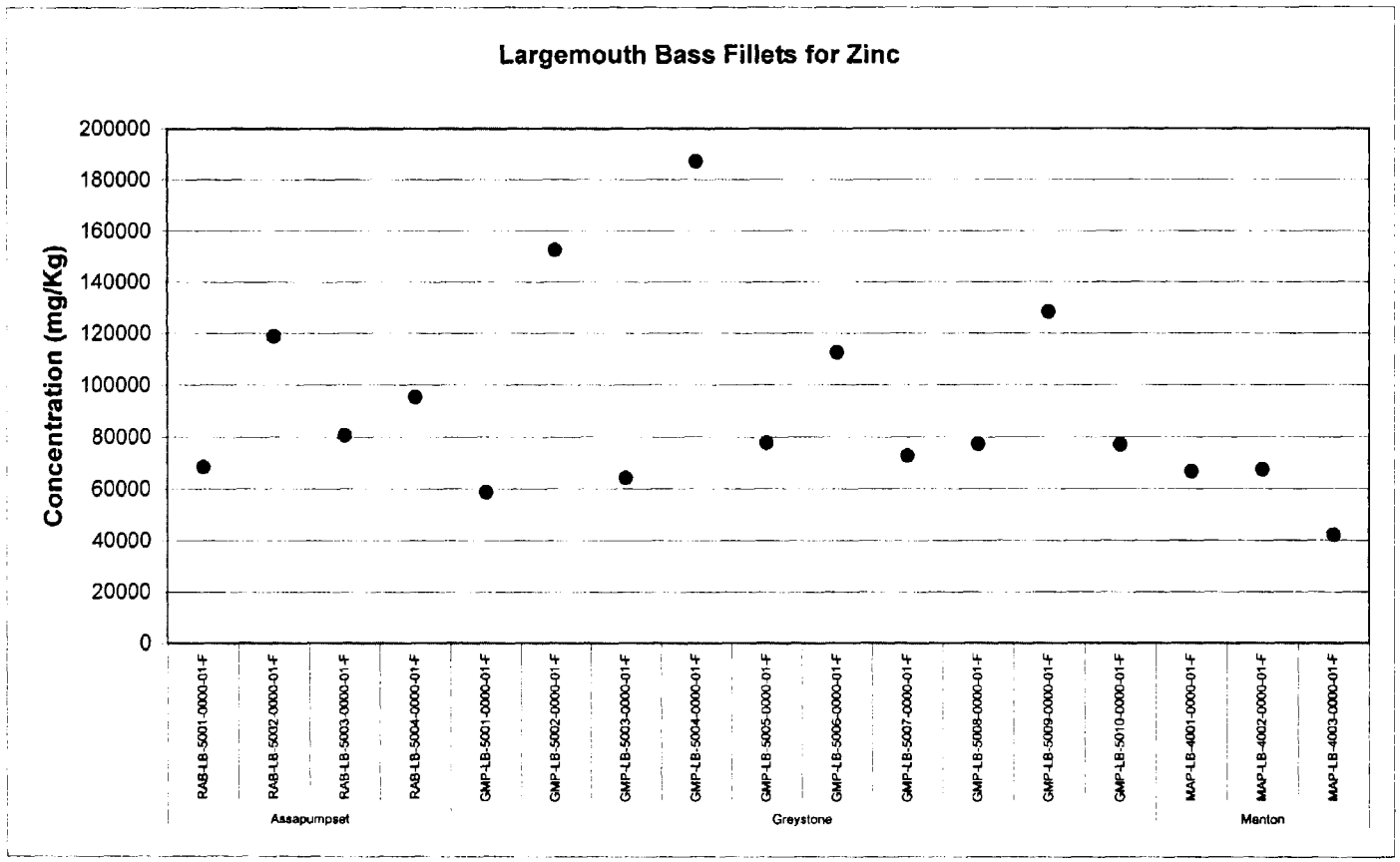

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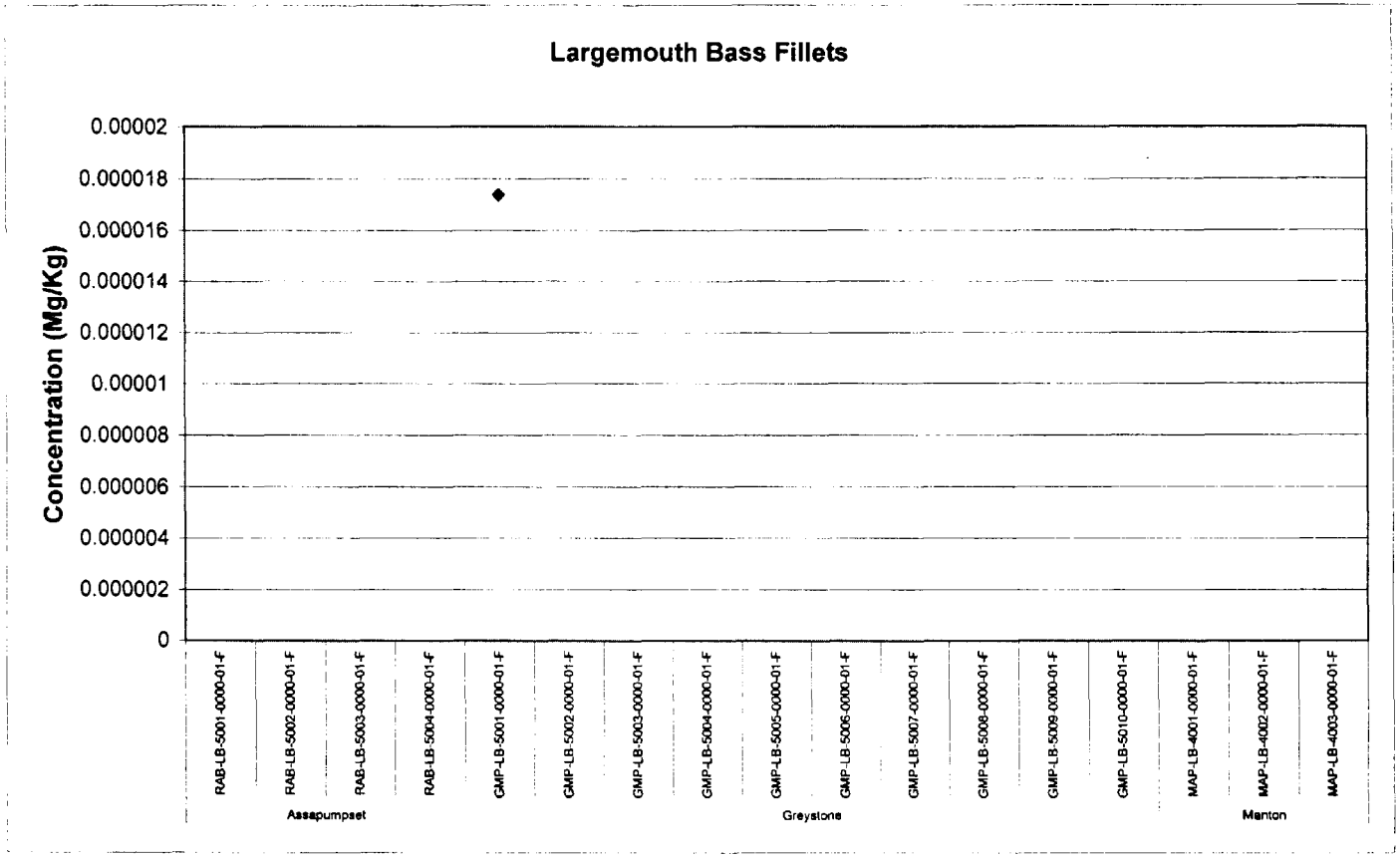
Largemouth Bass F2, LBF Zinc



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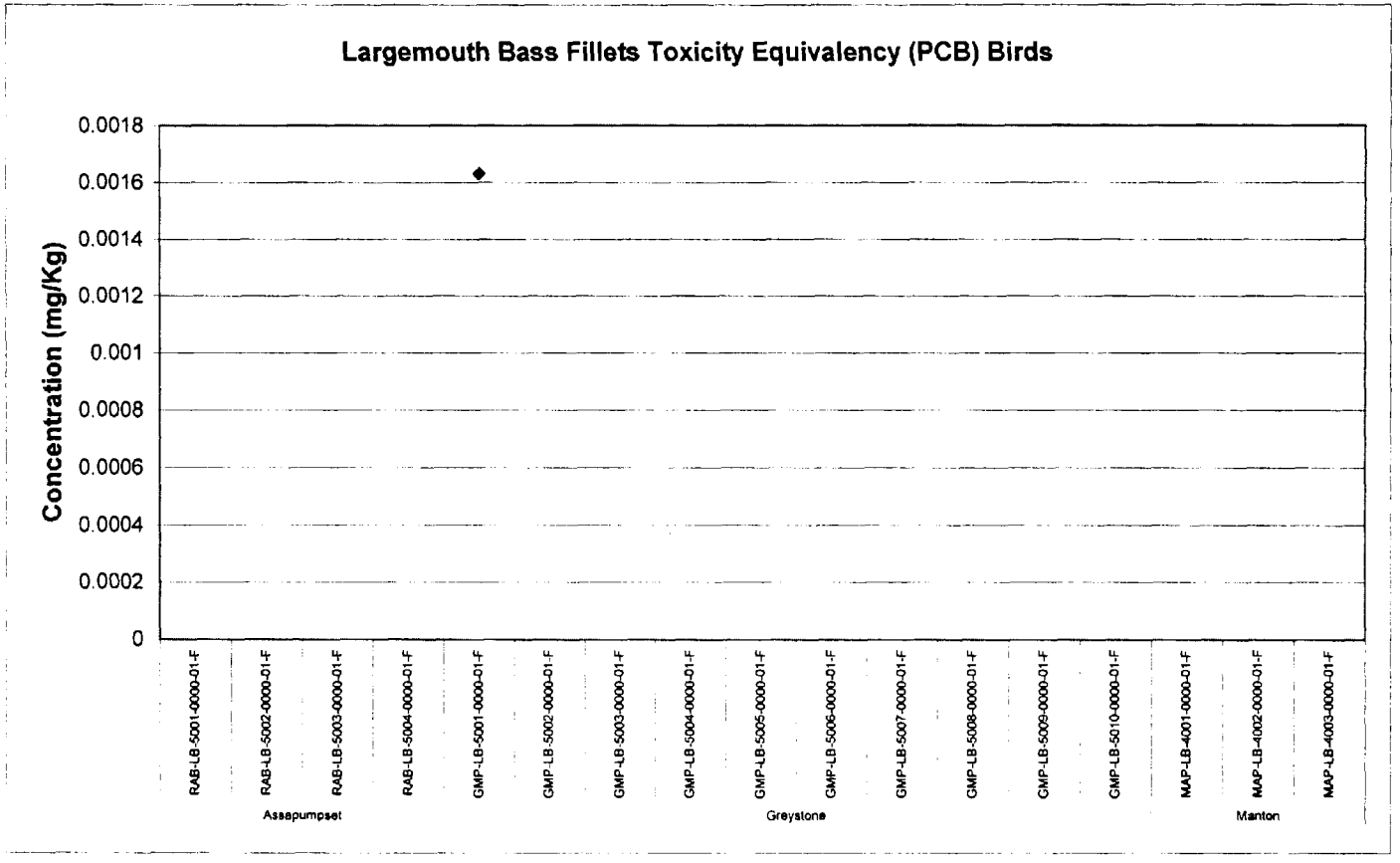
Largemouth Bass F2, LBF Toxicity Equivalency (PCB)



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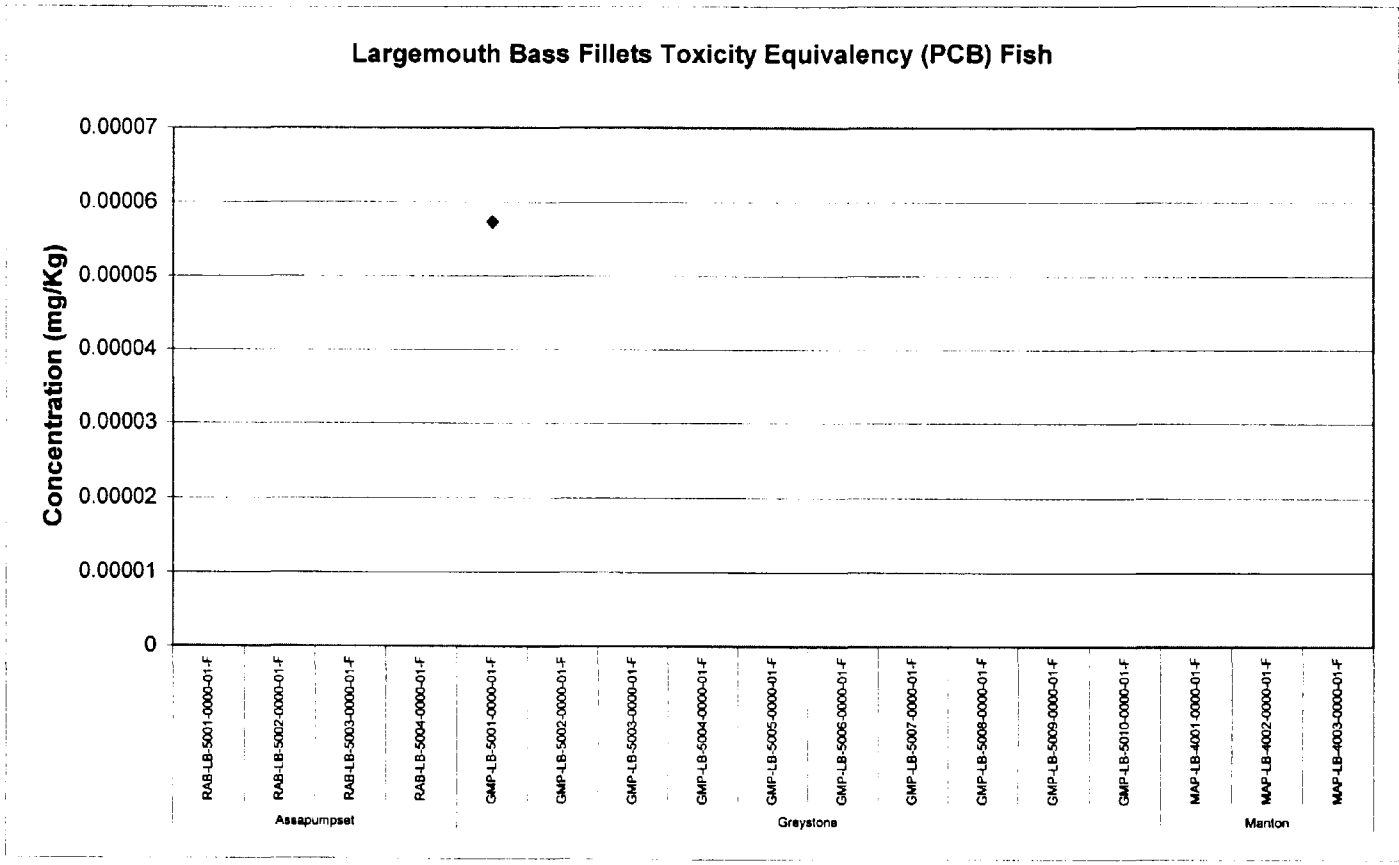
Largemouth Bass F2, LBF Toxicity Equivalency (PCB)B



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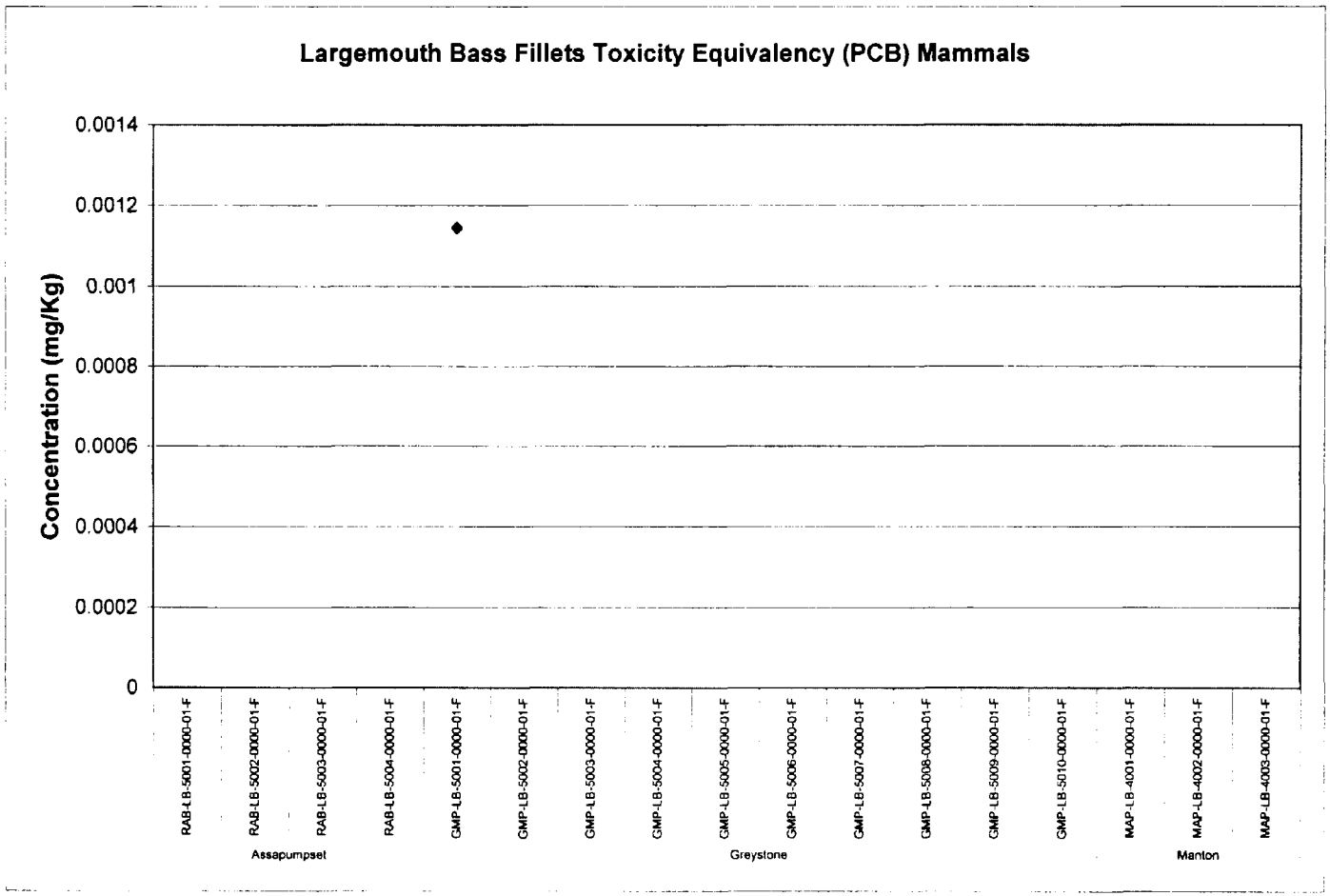
Largemouth Bass F2, LBF Toxicity Equivalency (PCB)F



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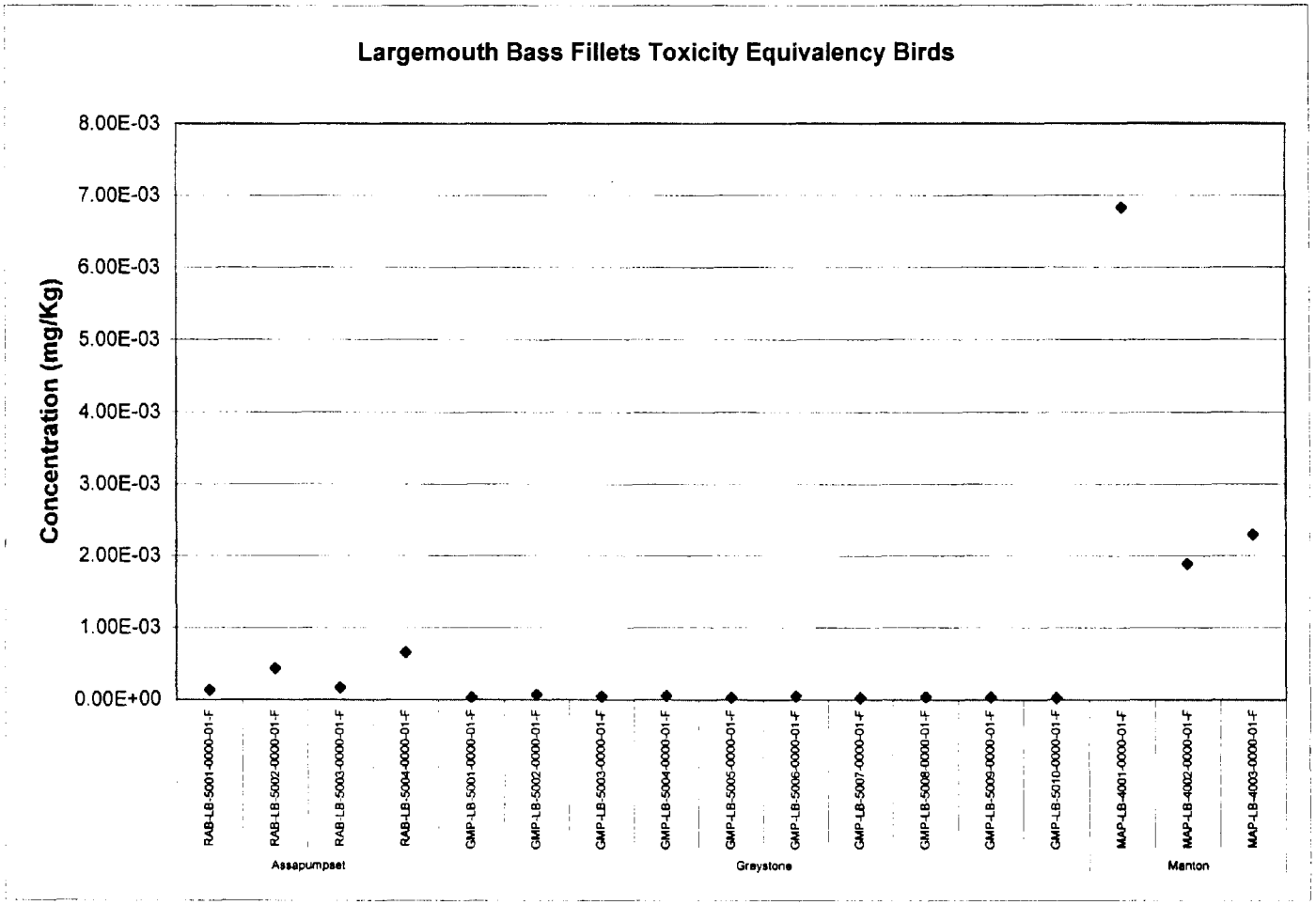
Largemouth Bass F2, LBF Toxicity Equivalency (PCB)M



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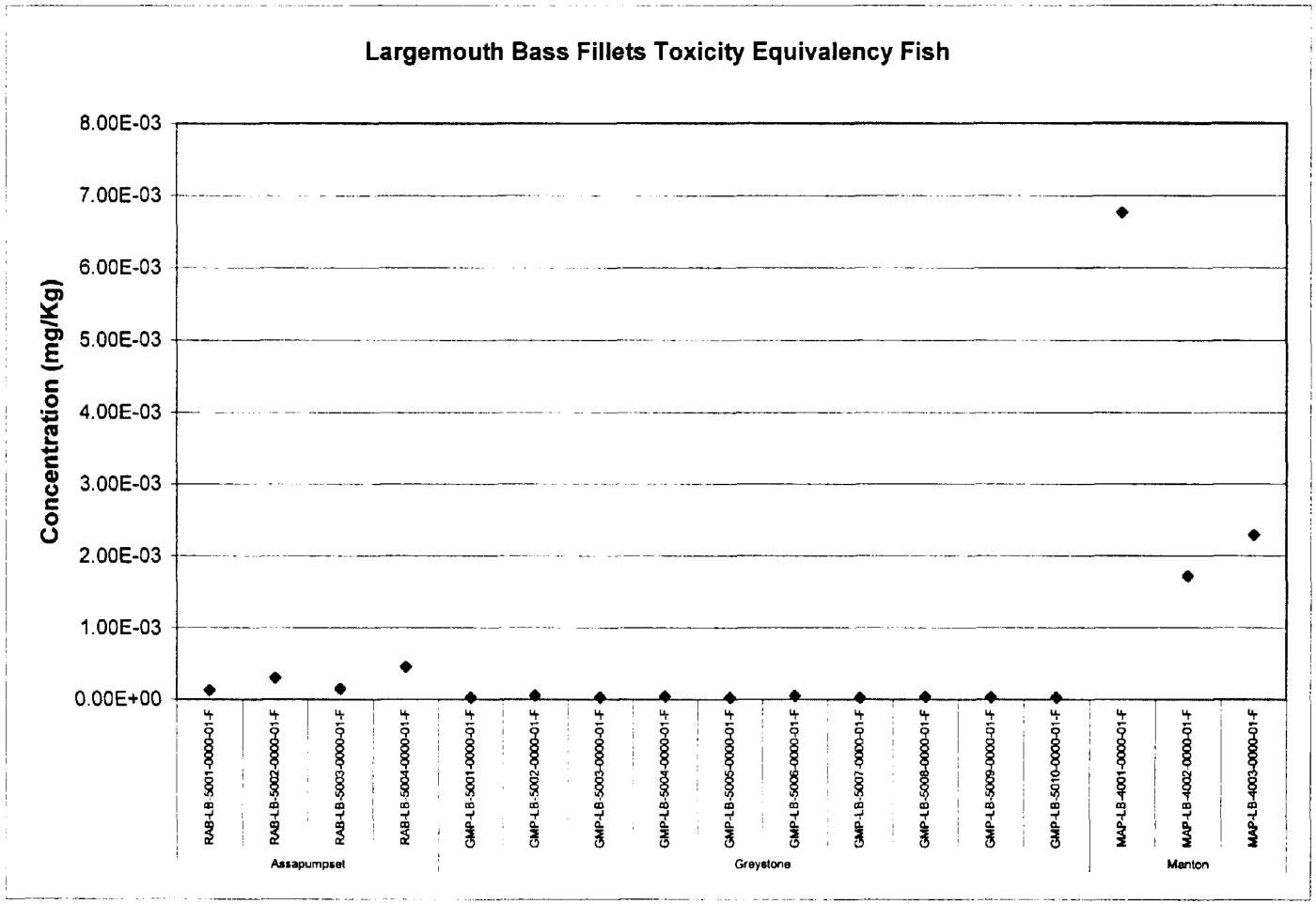
Largemouth Bass F2, LBF Toxicity Equivalency Birds



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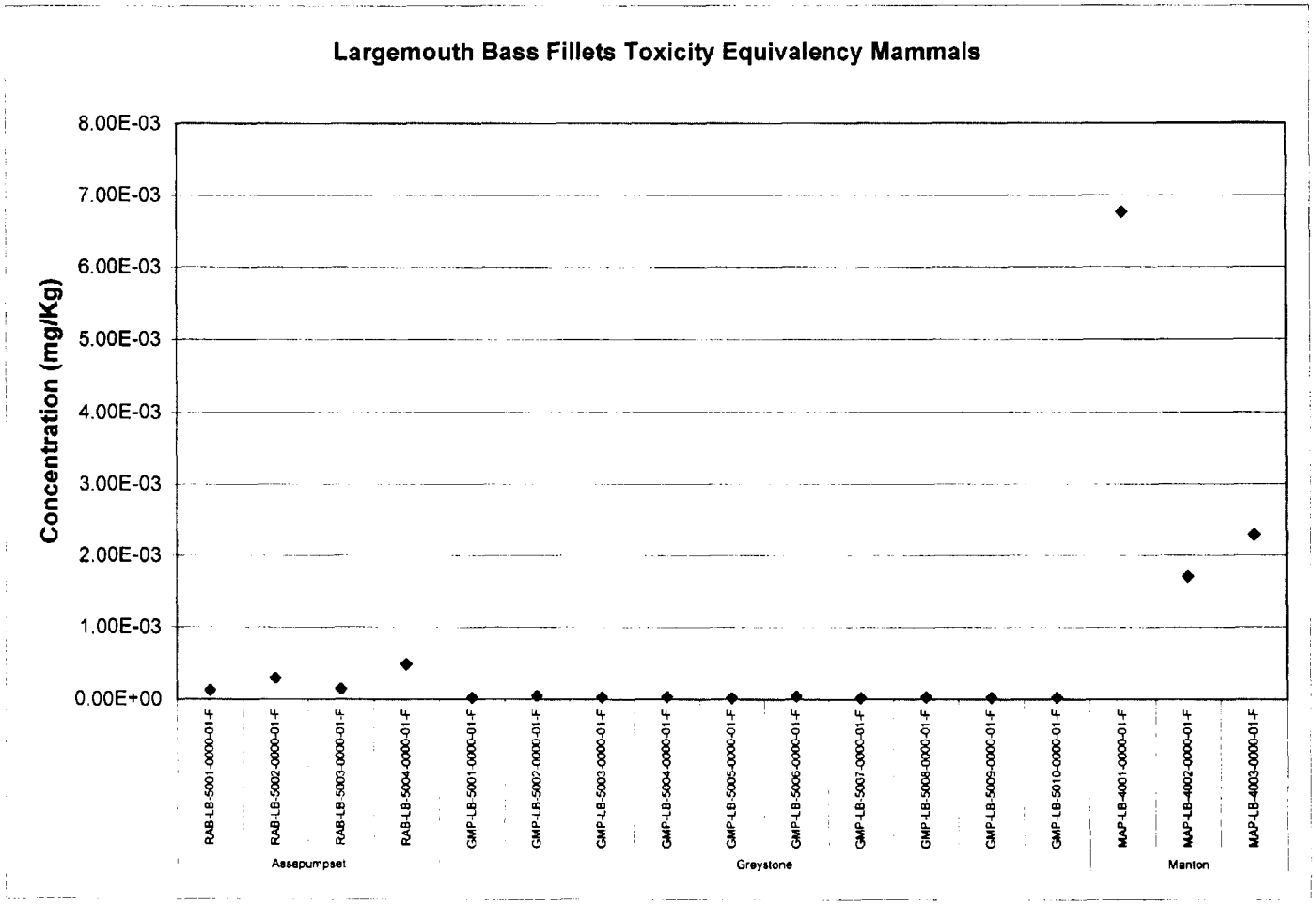
Largemouth Bass F2, LBF Toxicity Equivalency Fish



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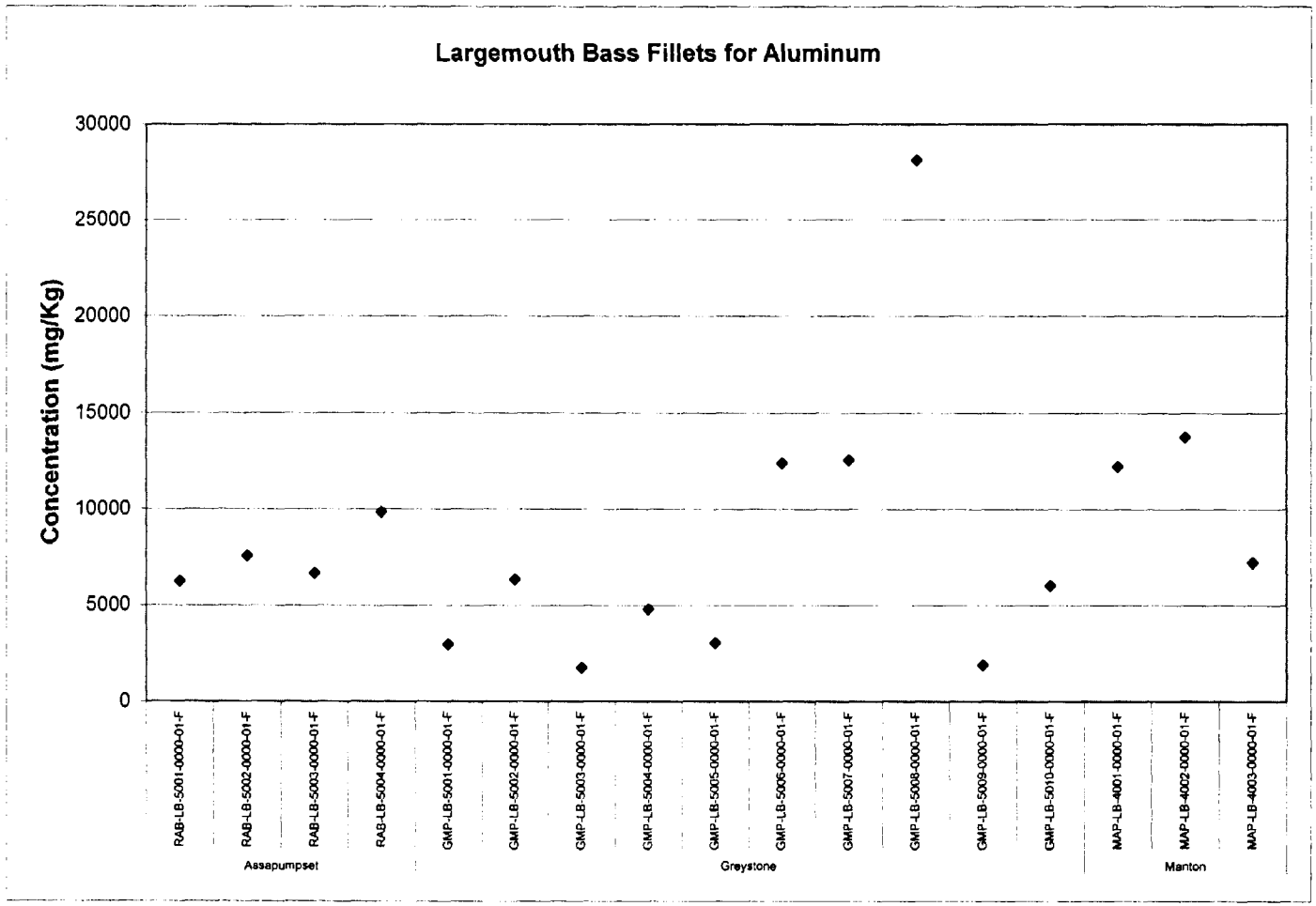
Largem[illegible]h Bass F2, LBF Toxicity Equivalency Mammal



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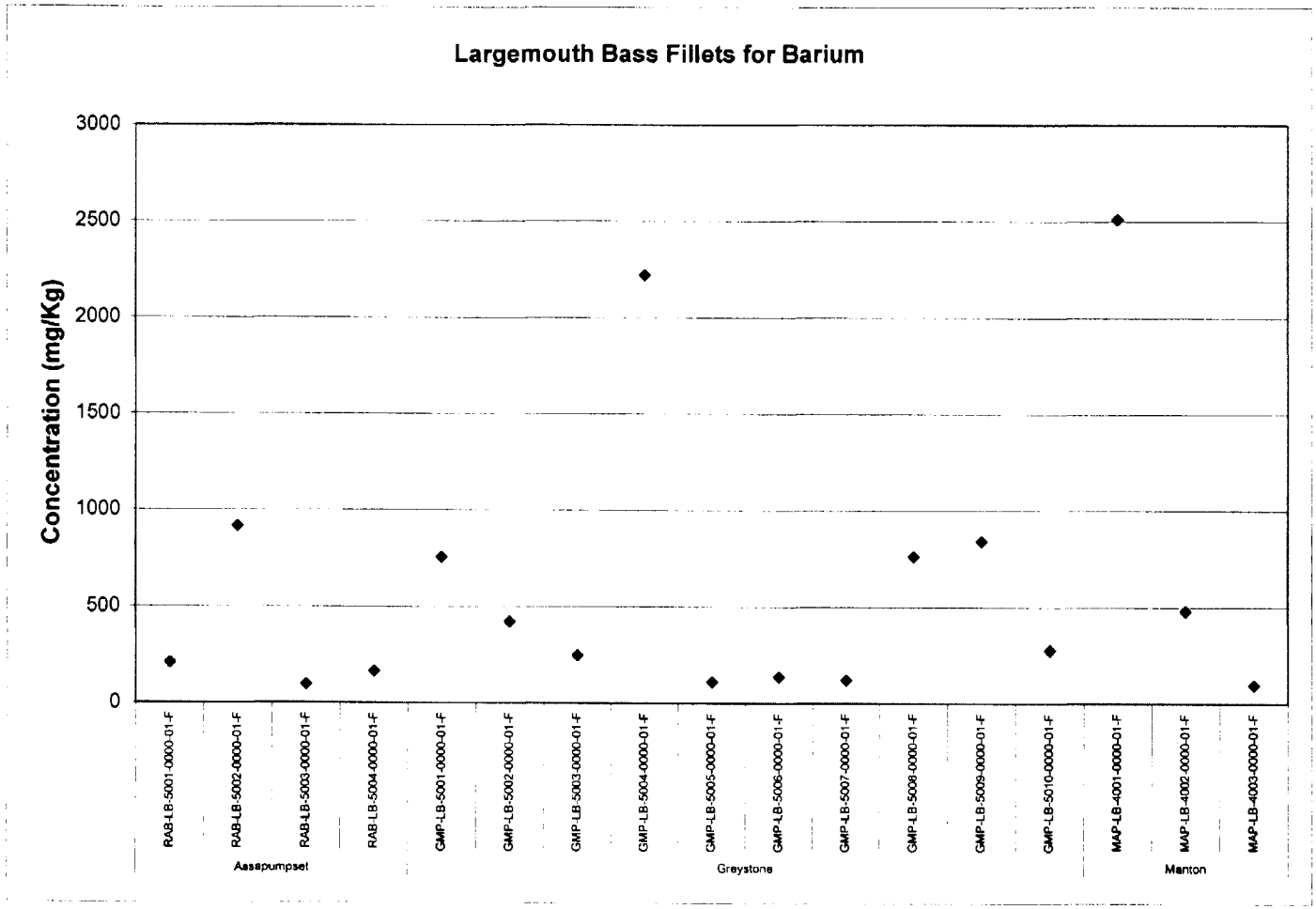
Largemouth Bass F2, LBF Aluminum



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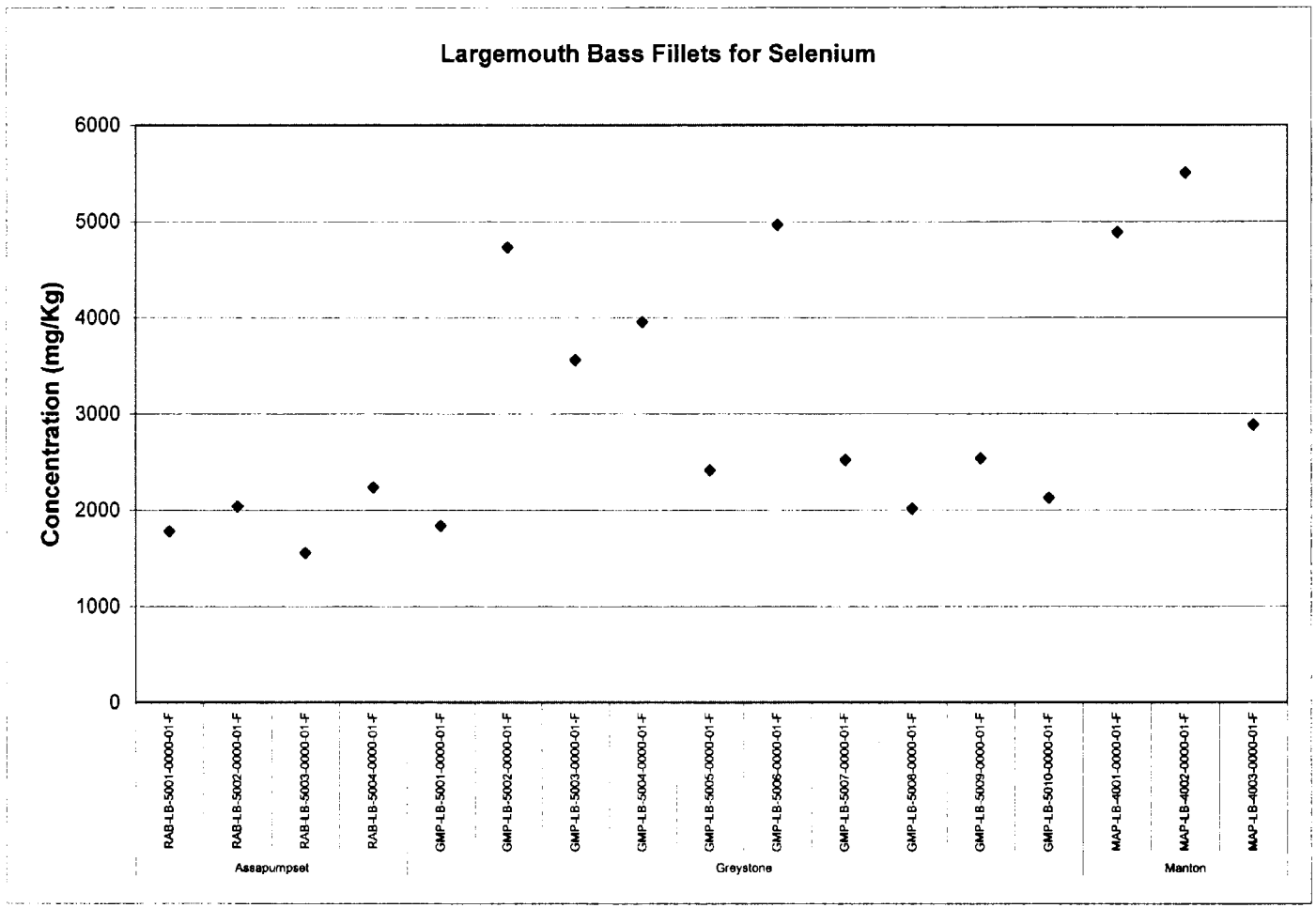
Largemouth Bass F2, LBF Barium



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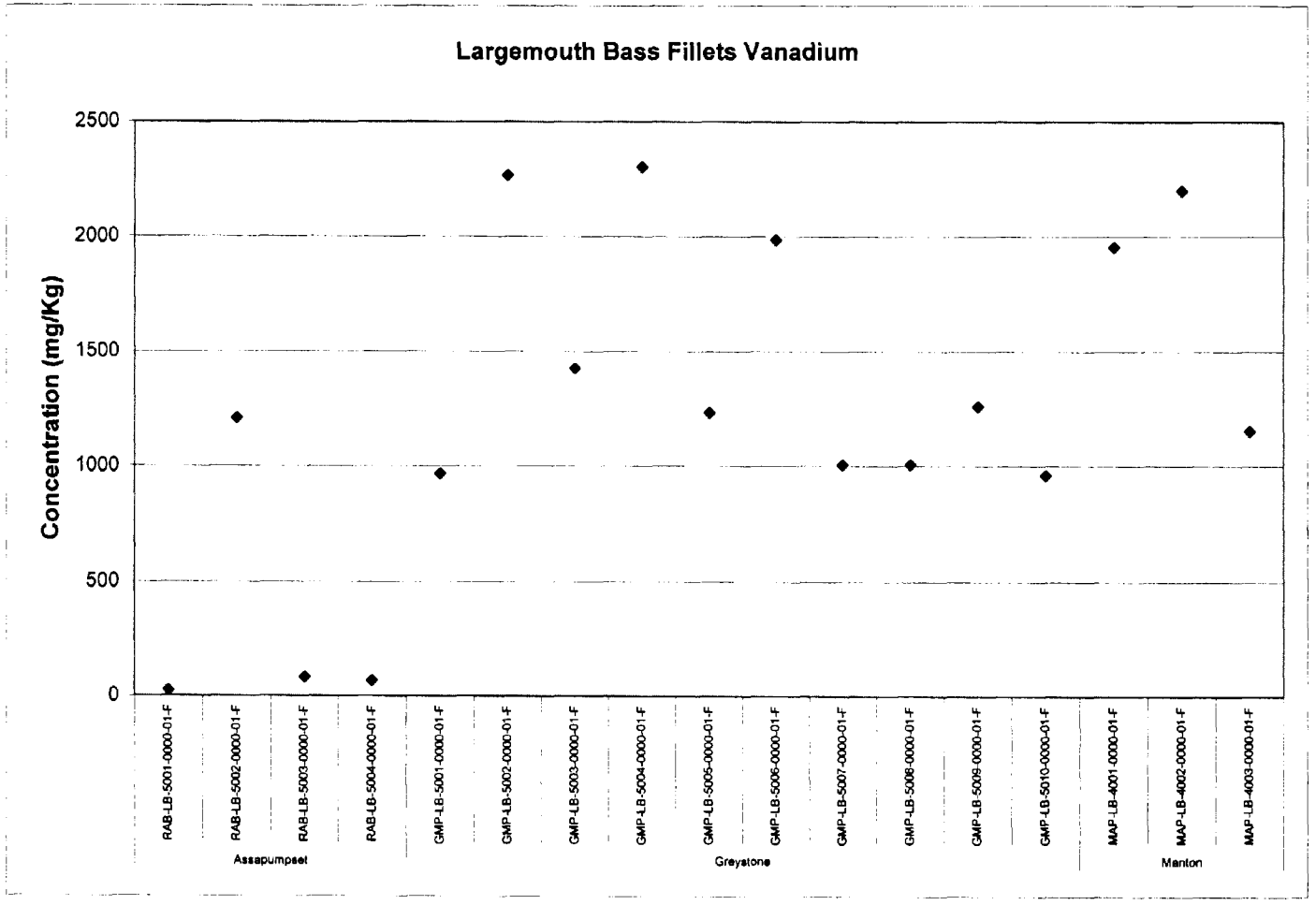
Largemouth Bass F2, LBF Selenium



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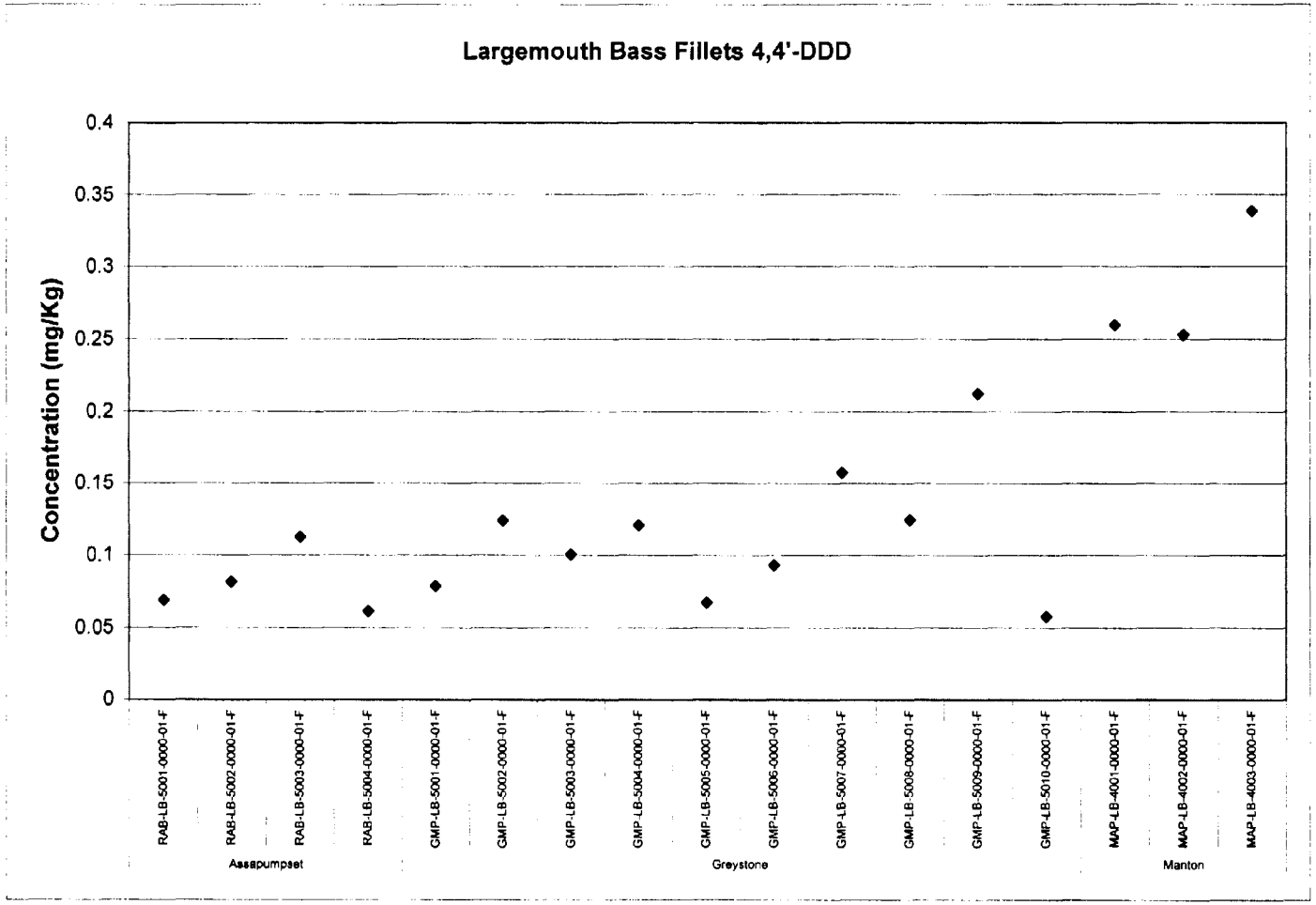
Largemouth Bass F2, LBF Vanadium



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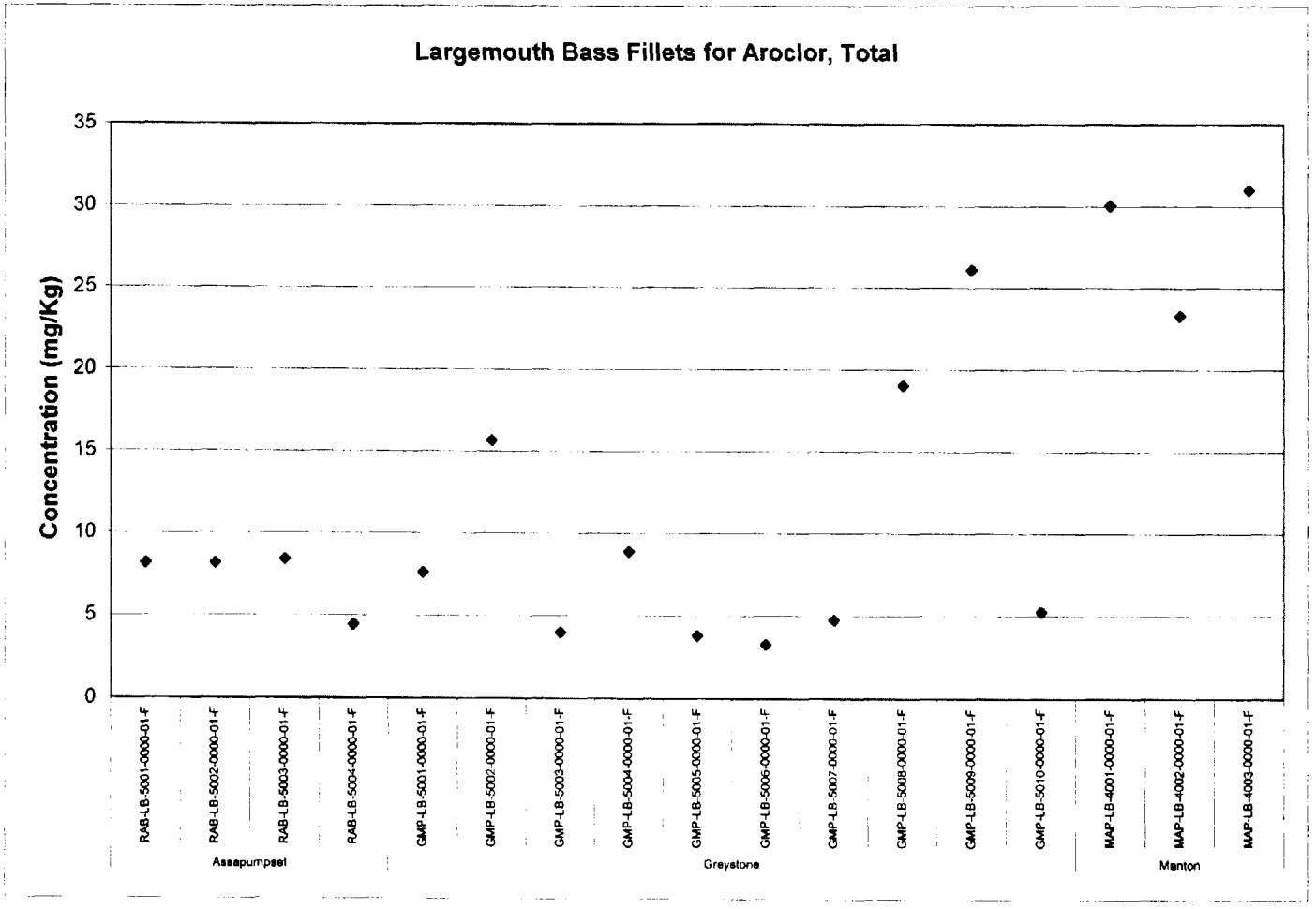
Largemouth Bass F2, LBF 4,4'-DDD



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Largemouth Bass F2, LBF Aroclor, Total

APPENDIX B

EQUATIONS USED TO DERIVE HUMAN HEALTH PRGS

APPENDIX B – EQUATIONS USED TO DERIVE HUMAN HEALTH PRGs

FISH TISSUE PRGs – BIOTA CONSUMPTION BY HUMANS

Receptor Cancer Risk = (child cancer risk + older child cancer risk + adult cancer risk)

$$CR_{receptor} = CR_{child} + CR_{olderchild} + CR_{adult}$$

$$CR_{child} = \frac{[C]_{fish} \times EF_{child} \times ED_{child} \times CF \times CSF_o \times IR_{child}}{BW_{child} \times AT}$$

where:

$[C]_{fish}$	=	Exposure point concentration of the COC in fish tissue (dimensions: mass/mass, typical units: mg/kg).
IR	=	Average daily fish consumption rate during the exposure period (dimensions: mass/time, typical units: grams/day)
EF	=	Number of days of exposure during the exposure period divided by the number of days in the exposure period (dimensions: events/time, typical units: days/year).
ED	=	Duration of the exposure period (dimensions: time, typical units: years).
C	=	Appropriate units conversion factor(s).
BW	=	Body weight of the receptor of concern during the averaging period (dimensions: mass, typical units: kg).
AT	=	Averaging Time (dimension: time, typical units: days).

$$CR_{olderchild} = \frac{[C]_{fish} \times EF_{olderchild} \times ED_{olderchild} \times CF \times CSF_o \times IR_{olderchild}}{BW_{olderchild} \times AT}$$

$$CR_{adult} = \frac{[C]_{fish} \times EF_{adult} \times ED_{adult} \times CF \times CSF_o \times IR_{adult}}{BW_{adult} \times AT}$$

$$CR_{receptor} = \frac{[C]_{fish} \times CF \times CSF_o}{AT}\left(\frac{EF_{child} \times ED_{child} \times IR_{child}}{BW_{child}} + \frac{EF_{olderchild} \times ED_{olderchild} \times IR_{olderchild}}{BW_{olderchild}} + \frac{EF_{adult} \times ED_{adult} \times IR_{adult}}{BW_{adult}}\right)$$

substituting $TR_{receptor}$(target risk) for $CR_{receptor}$ and PRG_{fish} (preliminary remediation goal for fish tissue) for $[C]_{fish}$,

$$TR_{receptor} = \frac{PRG_{fish} \times CF \times CSF_o}{AT}\left(\frac{EF_{child} \times ED_{child} \times IR_{child}}{BW_{child}} + \frac{EF_{olderchild} \times ED_{olderchild} \times IR_{olderchild}}{BW_{olderchild}} + \frac{EF_{adult} \times ED_{adult} \times IR_{adult}}{BW_{adult}}\right)$$

and then solving for PRG_{fish},

APPENDIX B – EQUATIONS USED TO DERIVE HUMAN HEALTH PRGs

$$PRG_{fish} = \frac{TR_{receptor} \times AT}{CF \times CSF_o \left(\frac{EF_{child} \times ED_{child} \times IR_{child}}{BW_{child}} + \frac{EF_{olderchild} \times ED_{olderchild} \times IR_{olderchild}}{BW_{olderchild}} + \frac{EF_{adult} \times ED_{adult} \times IR_{adult}}{BW_{adult}} \right)}$$

The noncancer risk component of the PRG for fish tissue consumption is calculated for each age group of each receptor,

$$PRG_{fish,\ agegroup} = \frac{THI_{agegroup} \times RfD \times AT \times BW_{agegroup}}{CF \times EF_{agegroup} \times ED_{agegroup} \times IR_{agegroup}}$$

APPENDIX B – EQUATIONS USED TO DERIVE HUMAN HEALTH PRGs

SEDIMENT PRGs – INGESTION AND DERMAL CONTACT

Soil and Sediment Direct Contact Exposures

The ADD received by a receptor via direct contact with soil (ADD_{soil}) is the sum of the ADDs for exposure via the routes of dermal contact with the contaminated soil and ingestion of the contaminated soil. The same approach is used for evaluation of sediment contact. Possible inhalation exposures are evaluated as described below. Thus,

$$ADD_{soil} = ADD_{dermal} + ADD_{ingestion}$$

Dermal Contact. The ADD due to dermal contact with COC-contaminated soil and sediment ($ADD_{dermal\ absorption}$) may be calculated:

$$ADD_{dermal\ absorption} = \frac{DA_{event} \times SA \times EF \times ED}{BW \times AT}$$

and:

$$DA_{event} = [COC]_{soil} \times AF \times ABS \times C$$

Where:

$ADD_{dermal\ absorption}$	=	Average daily dose of COC received through dermal contact with soil or sediment during the period of exposure (dimensions: mass/mass×time, typical units: mg/kg×day).
DA_{event}	=	Dose of COC absorbed during each exposure event (dimensions: mg/cm^2)
$[COC]_{soil}$	=	EPC of COC in the soil or sediment at the exposure point during the period of exposure (dimensions: mg/kg)
SA	=	Skin surface area in contact with the soil or sediment on days exposed (dimensions: cm^2/day)
AF	=	Mass of soil or sediment adhered to the unit surface area of skin exposed (dimensions: mg/cm^2)
ABS	=	Absorption Factor; represents the fraction of COC that may be absorbed through the skin from soil or sediment (unitless)
EF	=	Exposure Frequency: the number of exposure events during the exposure period divided by the number of days in the exposure period (dimensions: days/year)
ED	=	Exposure Duration: the period of time over which exposure may occur (dimension: years)
BW	=	Body Weight of the receptor of concern during the exposure duration dimension: kg)
AT	=	Averaging Time (dimension: days)
C	=	Appropriate units conversion factor(s)

Ingestion. The ADD due to the incidental ingestion of COC contaminated soil or sediment ($ADD_{ingestion}$) may be calculated:

$$ADD_{ingestion} = \frac{[COC]_{soil} \times IR \times EF \times ED \times C}{BW \times AT}$$

Where:

$ADD_{ingestion}$	=	Average daily dose of COC received through the ingestion of soil or sediment during the period of exposure (dimensions: mass/mass×time, typical units: mg/kg×day).
$[COC]_{soil}$	=	EPC of the COC in soil or sediment (dimensions: mass/mass, typical units: mg/kg).
IR	=	Daily soil ingestion rate on days exposed during the exposure period (dimensions: mass/time, typical units: mg/day)
EF	=	Number of exposure events during the exposure period divided by the number of days in the exposure period (dimensions: events/time, typical units: days/year).
ED	=	Duration of the exposure period (dimensions: time, typical units: years).
C	=	Appropriate units conversion factor(s)
BW	=	Body weight of the receptor of concern during the averaging period (dimensions: mass, typical units: kg).
AT	=	Averaging Time (dimension: time, typical units: days).

$$\textbf{Cancer risk}_{child,\ ing.\ derm} = \left[\left(\frac{CSF_o \times [COC]_{sed} \times IR_{child} \times EF_{child} \times ED_{child}}{BW_{child} \times AT}\right) + \left(\frac{CSF_d \times DA_{event,\ child} \times EV_{child} \times ED_{child} \times EF_{child} \times SA_{child}}{BW_{child} \times AT}\right)\right]$$

APPENDIX B – EQUATIONS USED TO DERIVE HUMAN HEALTH PRGs

$$\text{Cancer risk}_{\text{olderchild, ing, derm}} = \left[\left(\frac{CSF_o \times [COC]_{sed} \times IR_{olderchild} \times \text{EF}_{olderchild} \times \text{ED}_{olderchild}}{\text{BW}_{olderchild} \times AT}\right) + \left(\frac{CSF_d \times DA_{event,\,olderchild} \times EV_{olderchild} \times ED_{olderchild} \times EF_{olderchild} \times SA_{olderchild}}{BW_{olderchild} \times AT}\right)\right]$$

$$\text{Cancer risk}_{\text{adult, ing, derm}} = \left[\left(\frac{CSF_o \times [COC]_{sed} \times IR_{adult} \times \text{EF}_{adult} \times \text{ED}_{adult}}{\text{BW}_{adult} \times AT}\right) + \left(\frac{CSF_d \times DA_{event,\,adult} \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]$$

$$DA_{event} = [COC]_{sed} \times AF \times ABS \times CF$$

$$\textit{Cancer risk}_{receptor} = [COC]_{sed}\left[\left[\left(\frac{CSF_o \times IR_{child} \times \text{EF}_{child} \times \text{ED}_{child}}{\text{BW}_{child} \times AT}\right) + \left(\frac{CSF_o \times IR_{olderchild} \times \text{EF}_{olderchild} \times \text{ED}_{olderchild}}{\text{BW}_{olderchild} \times AT}\right) + \left(\frac{CSF_o \times IR_{adult} \times \text{EF}_{adult} \times \text{ED}_{adult}}{\text{BW}_{adult} \times AT}\right)\right] + \left[\left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{child} \times ED_{child} \times EF_{child} \times SA_{child}}{BW_{child} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{olderchild} \times ED_{olderchild} \times EF_{olderchild} \times SA_{olderchild}}{BW_{olderchild} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]\right]$$

Rearranging, substituting PRG_{sed} for $[COC]_{sed}$ and Target Risk for Cancer $risk_{receptor}$, and solving for the cancer risk component of PRG_{sed},

APPENDIX B – EQUATIONS USED TO DERIVE HUMAN HEALTH PRGs

$$PRG_{sed,c} = \frac{TR_{sed}}{\left[\left[\left(\frac{CSF_o \times IR_{child} \times \mathrm{EF}_{child} \times \mathrm{ED}_{child} \times CF}{\mathrm{BW}_{child} \times AT}\right)+\left(\frac{CSF_o \times IR_{olderchild} \times \mathrm{EF}_{olderchild} \times \mathrm{ED}_{olderchild} \times CF}{\mathrm{BW}_{olderchild} \times AT}\right)+\left(\frac{CSF_o \times IR_{adult} \times \mathrm{EF}_{adult} \times \mathrm{ED}_{adult} \times CF}{\mathrm{BW}_{adult} \times AT}\right)\right]+\left[\left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{child} \times ED_{child} \times EF_{child} \times SA_{child}}{BW_{child} \times AT}\right)+\left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{olderchild} \times ED_{olderchild} \times EF_{olderchild} \times SA_{olderchild}}{BW_{olderchild} \times AT}\right)+\left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]\right]}$$

The noncancer (Hazard Index) component of the sediment PRGs are calculated as follows:

$$\textbf{Hazard Index}_{agegroup,\,ing,\,derm} = \left[\left(\frac{[COC]_{sed} \times IR_{agegroup} \times \mathrm{EF}_{agegroup} \times \mathrm{ED}_{agegroup}}{RfD_o \times \mathrm{BW}_{agegroup} \times AT}\right)+\left(\frac{DA_{event,\,agegroup} \times EV_{agegroup} \times ED_{agegroup} \times EF_{agegroup} \times SA_{agegroup}}{RfD_o \times BW_{agegroup} \times AT}\right)\right]$$

Rearranging and substituting $[COC]_{sed} \times AF \times ABS \times CF$ for $DA_{event,agegroup}$,

$$\textbf{Hazard Index}_{agegroup,\,ing,\,derm} = [COC]_{sed}\left[\left(\frac{IR_{agegroup} \times \mathrm{EF}_{agegroup} \times \mathrm{ED}_{agegroup}}{RfD_o \times \mathrm{BW}_{agegroup} \times AT}\right)+\left(\frac{AF \times ABS \times CF \times EV_{agegroup} \times ED_{agegroup} \times EF_{agegroup} \times SA_{agegroup}}{RfD_o \times BW_{agegroup} \times AT}\right)\right]$$

Substituting Target Hazard Index (**THI**) for $\textbf{Hazard Index}_{agegroup,ing,derm}$ and $\mathbf{PRG_{sed,nc}}$ for $[COC]_{sed}$, and solving for $PRG_{sed,nc}$,

$$PRG_{sed,nc} = \frac{THI}{\left[\left(\frac{CF \times IR_{agegroup} \times \mathrm{EF}_{agegroup} \times \mathrm{ED}_{agegroup}}{RfD_o \times \mathrm{BW}_{agegroup} \times AT}\right)+\left(\frac{AF \times ABS \times CF \times EV_{agegroup} \times ED_{agegroup} \times EF_{agegroup} \times SA_{agegroup}}{RfD_d \times BW_{agegroup} \times AT}\right)\right]}$$

APPENDIX B – EQUATIONS USED TO DERIVE HUMAN HEALTH PRGs

SEDIMENT PRGs – BASED ON FISH CONSUMPTION AND BIOTA/SEDIMENT ACCUMULATION FACTORS

The derivation of the sediment PRGs based on fish consumption and biota/sediment accumulation factors is a multi-step process. The steps are identified below.

Step 1) Lipid-normalized chemical fish tissue concentrations will be calculated for each species at each exposure point consistent with the equation shown below.

$$[C]_{fish,ln} = \frac{[C]_{fish}}{[Lipid]_{fish}} x \frac{1}{CF1}$$

where:

$[C]_{fish,ln}$ = Lipid-normalized chemical concentration in fish tissue (mg chemical/kg lipid)
$[C]_{fish}$ = Chemical concentration in fish tissue (mg chemical/kg fish tissue as wet weight)
$[Lipid]_{fish}$ = Lipid concentration in fish tissue (mg lipid/kg fish tissue)
CF1 = Units conversion factor (0.000001 kg lipid/mg lipid)

Step 2) Mean lipid-normalized concentrations of each COC in each species at each exposure point will be calculated and compiled. Coefficient of variation will be identified for each COC, species, and exposure point combination.

Step 3) Organic carbon-normalized sediment concentrations will be calculated for sediment at each exposure point consistent with the equation shown below. These concentrations are essentially chemical concentrations in sediment organic carbon.

$$[C]_{sed,ocn} = \frac{[C]_{sed}}{[TOC]_{sed}} x \frac{1}{CF2}$$

where:

$[C]_{sed,ocn}$ = Organic carbon-normalized chemical concentration in sediment (mg chemical/kg organic carbon in sediment
$[C]_{sed}$ = Chemical concentration in sediment (mg chemical/kg sediment as dry weight)
$[TOC]_{sed}$ = Total organic carbon concentration in sediment (mg total organic carbon/kg sediment as dry weight)
CF2 = Units conversion factor (0.000001 kg TOC/mg TOC)

Step 4) The mean organic carbon-normalized sediment concentrations for each COC at each exposure point will be calculated and compiled. The coefficient of variation will be identified for each COC and exposure point combination.

Step 5) Calculate BSAFs. The general equation for calculation of a BSAF is shown below

$$BSAF = \frac{[C]_{fish,ln}}{[C]_{sed,ocn}}$$

where:

BSAF = Biota-sediment accumulation factor (unitless)
$[C]_{fish,ln}$ = Lipid-normalized chemical concentration in fish tissue reported as wet weight (mg chemical/kg lipid in fish tissue)

$[C]_{sed.ocn}$ = Organic carbon-normalized chemical concentration in sediment reported as dry-weight (mg chemical/kg organic carbon in sediment)

Step 6) The **sediment** PRG will be calculated for each COC at each exposure point for each fish species per the equation shown below.

$$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

where:

PRG_{fish} = Risk-based target chemical concentration in fish tissue or preliminary remediation goal (mg/kg)
$[TOC]_{sed}$ = Mean total organic carbon concentration in sediment at exposure point reported as dry weight (mg total organic carbon/kg sediment)
BSAF = Species-specific biota-sediment accumulation factor for the exposure point (unitless)
$[Lipid]_{fish}$ = Mean lipid concentration in fish species at the exposure point (mg lipid/kg fish tissue)

Step 7) The **sediment** PRG will be calculated for each COC at each exposure point for the combined fish diet per the equation shown below. Assuming equal contribution of each species to the combined fish diet, the average of the species-specific sediment PRGs is the combined diet-based sediment PRG.

$$PRG_{sed,combined} = \frac{\sum_{1}^{n} PRG_{sed,species}}{n}$$

where:

$PRG_{sed,species}$ = Preliminary remediation goal (risk-based target chemical concentration in sediment) for an individual fish species (mg/kg)
n = Number of fish species at the exposure point for which a species-specific sediment PRG was developed.

APPENDIX B – EQUATIONS USED TO DERIVE HUMAN HEALTH PRGs

SURFACE SOIL AND BANK SOIL PRGs

The cancer risk-based component of the soil PRG for the Fogarty Center is calculated as follows. Each of the parameters in these equations have previously been identified in the section addressing sediment direct contact PRGs.

$$\textbf{Cancer risk}_{adult,\ ing,\ derm} = \left[\left(\frac{CSF_o \times [COC]_{soil} \times IR_{adult} \times \textbf{EF}_{adult} \times \textbf{ED}_{adult}}{\textbf{BW}_{adult} \times AT}\right) + \left(\frac{CSF_d \times [COC]_{soil} \times DA_{event,\ adult} \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]$$

Rearranging and substituting $[COC]_{sed} \times AF \times ABS \times CF$ for DA_{event}

$$\textbf{Cancer risk}_{adult,\ ing,\ derm} = [COC]_{soil}\left[\left(\frac{CSF_o \times IR_{adult} \times \textbf{EF}_{adult} \times \textbf{ED}_{adult}}{\textbf{BW}_{adult} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]$$

Substituting Target Risk (TR) for $\textbf{Cancer risk}_{adult,ing,derm}$, $\textbf{PRG}_{soil,c}$ for $\textbf{[COC]}_{soil}$, and solving for $\textbf{PRG}_{soil,c}$,

$$PRG_{soil,\ c} = \frac{TR}{\left[\left(\frac{CSF_o \times IR_{adult} \times \textbf{EF}_{adult} \times \textbf{ED}_{adult}}{\textbf{BW}_{adult} \times AT}\right) + \left(\frac{CSF_d \times AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]}$$

The noncancer (Hazard Index) component of the soil PRG is calculated based on the following equations.

$$\textbf{Hazard Index}_{agegroup,\ ing,\ derm} = \left[\left(\frac{[COC]_{soil} \times IR_{adult} \times \textbf{EF}_{adult} \times \textbf{ED}_{adult}}{RfD_o \times \textbf{BW}_{adult} \times AT}\right) + \left(\frac{DA_{event,\ adult} \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{RfD_o\ x\ BW_{adult} \times AT}\right)\right]$$

Rearranging and substituting $[COC]_{soil} \times AF \times ABS \times CF$ for $DA_{event,agegroup}$,

$$\textbf{Hazard Index}_{agegroup,\ ing,\ derm} = [COC]_{soil}\left[\left(\frac{IR_{adult} \times \textbf{EF}_{adult} \times \textbf{ED}_{adult}}{RfD_o \times \textbf{BW}_{adult} \times AT}\right) + \left(\frac{AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{BW_{adult} \times AT}\right)\right]$$

Substituting Target Hazard Index (**THI**) for $Hazard\ Index_{agegroup,ing,derm}$ and $PRG_{soil,nc}$ for $[COC]_{soil}$, and solving for $PRG_{soil,nc}$,

$$\textbf{PRG}_{soil,\ nc} = \frac{\textbf{THI}}{\left[\left(\frac{IR_{adult} \times \textbf{EF}_{adult} \times \textbf{ED}_{adult}}{RfD_o \times \textbf{BW}_{adult} \times AT}\right) + \left(\frac{AF \times ABS \times CF \times EV_{adult} \times ED_{adult} \times EF_{adult} \times SA_{adult}}{RfD_o\ x\ BW_{adult} \times AT}\right)\right]}$$

INTERIM FINAL – PRELIMINARY REMEDIATION GOALS REPORT
PART II – ECOLOGICAL

CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
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INTERIM FINAL – PRELIMINARY REMEDIATION GOALS REPORT
PART II – ECOLOGICAL

CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

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1.0 INTRODUCTION

Ecologically-based Preliminary Remediation Goals (PRGs) were derived for the Centredale Manor Restoration Project (CMRP) Superfund Site based on risks identified in the Baseline Ecological Risk Assessment (BERA) (MACTEC, 2004). PRGs were calculated for chemicals of concern (COCs) in sediment, floodplain soil, and biota based on risks to the most sensitive receptors identified for each pathway and/or endpoint evaluated in the BERA. The PRGs that were developed relate specifically to bioaccumulation hazards, which are the primary hazards posed by the COCs to ecological receptors at the Site.

The PRGs also incorporate risks associated with direct contact and incidental ingestion exposures. This ecological PRG document is Part II of the Preliminary Remediation Goals Report. Human health-based PRGs are presented in Part I. The following section summarizes the conclusions of the BERA, which were used as a basis for PRG development.

1.1 CONCLUSIONS OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

The BERA evaluated potential risks to ecological receptors in four reaches of the Woonasquatucket River (Allendale, Lyman Mill, Manton, and Dyerville) (Figure 1-1 of Part I) Allendale, Lyman Mill and Manton contain riverine, palustrine, and lacustrine habitats. Although lacustrine habitat existed in the Dyerville Reach when this section of the river was impounded, it has been primarily riverine in nature since the breaching of the former dam. Risks were evaluated based on direct contact with and/or incidental ingestion of surface water, sediment, and floodplain soil, and the consumption of contaminated biota. Six assessment endpoint receptors were evaluated:

- Aquatic and floodplain invertebrate communities
- Demersal, omnivorous fish populations
- Pelagic, piscivorous fish populations
- Piscivorous wildlife populations
- Insectivorous and vermivorous wildlife populations
- Omnivorous wildlife populations

Results of the risk evaluation indicated that the following endpoint receptors are possibly or probably at substantial risk of harm from exposure to site-related COCs in surface water, tissue residues, sediment, and/or floodplain soil as follows:

- Aquatic invertebrate communities in lentic (but not lotic) habitats appear to be at substantial risk of harm. (Floodplain invertebrate communities were not found to be at substantial risk of harm.) COCs associated with the greatest risks to aquatic invertebrate communities at the Site relative to the background area included dioxins and furans, Aroclors, pesticides, and polycyclic aromatic hydrocarbons (PAHs).

- Demersal, omnivorous fish populations may be at substantial risk of harm. Risks were based on an evaluation of the white sucker (*Catostomus commersoni*). COCs associated with the greatest risks to demersal fish populations at the Site relative to

the background area included dioxins and furans, dioxin-like polychlorinated biphenyls (PCBs), technical chlordane, aluminum, barium, vanadium, and zinc.

- Pelagic, piscivorous fish populations may be at substantial risk of harm. Risks were evaluated for largemouth bass (*Micropterus salmoides)*. COCs associated with the greatest risks to pelagic fish populations at the Site relative to the background area included dioxins and furans, dioxin-like PCBs, Aroclors, technical chlordane, selenium, zinc, 4,4'-DDE, 4,4'-DDD, aluminum, barium, selenium, and vanadium.

- Piscivorous mammal and bird populations may be at substantial risk of harm. Risks were evaluated for the great blue heron (*Ardea herodias*), belted kingfisher (*Ceryle alcyon*), and the river otter (*Lutra canadensis*). COCs associated with the greatest risks to piscivorous wildlife at the Site relative to the background area included dioxins and furans, dioxin-like PCBs, and Aroclors. Risks were highest for the belted kingfisher.

- Insectivorous and vermivorous wildlife populations appear to be at substantial risk of harm. Risks were evaluated for the insectivorous tree swallow (*Tachycineta bicolor*) and little brown bat (*Myotis lucifugus*), and the vermivorous American woodcock (*Scolopax minor*) and short-tailed shrew (*Blarina brevicauda*). Dioxins and furans were the COCs associated with the greatest risks to insectivorous and vermivorous wildlife populations at the Site relative to the background area. Among insectivorous receptors, risks were highest for the little brown bat. Among vermivorous receptors, risks were highest for the short-tailed shrew.

Omnivorous wildlife populations were determined not to be at substantial risk of harm from exposure to site-related contaminants. In general, the largest risks at the Site were associated with the consumption of contaminated biota resulting from the bioaccumulation and trophic transfer of persistent contaminants originating from sediment, and, to a lesser extent, floodplain soil. Risks associated with the ingestion of contaminants in surface water were relatively low (i.e., less than 1% of overall risks estimated for wildlife receptors).

1.2 IDENTIFICATION OF MEDIA REQUIRING PRGS AND CHEMICALS OF CONCERN FOR EACH MEDIUM/RECEPTOR GROUPING

Based on the results of the BERA, PRGs were developed for sediment and floodplain soil. PRGs were developed for these media because it was concluded that ecological receptors exposed to contaminants in these media, either directly or through biological uptake, are at substantial risk of harm. PRGs were not developed for surface water because risks associated with this medium were found to constitute only a small fraction of overall risks to vertebrate wildlife receptors and because of the impracticality of remediating surface water. In addition, because contaminants in surface water apparently originate primarily from the sediments, remediation of the sediments would be expected to address surface water quality issues.

Sediment or floodplain soil PRGs were developed for the following endpoint receptors, which were determined to be potentially at substantial risk of harm from exposure to site-related contaminants (specific receptor of concern identified in parentheses):

1. Demersal fish (white sucker, American eel)
2. Pelagic fish (largemouth bass)
3. Piscivorous wildlife (belted kingfisher)
4. Insectivorous wildlife (tree swallow)
5. Vermivorous wildlife (short-tailed shrew)

Sediment PRGs for demersal and pelagic fish are based on data for the white sucker, American eel, and largemouth bass, because these were the representative species evaluated in the BERA. Data for the belted kingfisher and short-tailed shrew were used to develop PRGs for piscivorous and vermivorous wildlife, respectively, because these species had the highest risks among the species evaluated in their respective receptor groups (MACTEC, 2004). Data for the tree swallow were used to develop sediment PRGs for insectivorous wildlife because the tree swallow was determined to be a relatively sensitive receptor for which extensive site-specific exposure and effects data exist. Although risks to the little brown bat were higher than those identified for the tree swallow in the BERA, no site-specific population level data were collected for the little brown bat. PRGs were not derived for omnivorous wildlife because the BERA concluded that this group of receptors is not at risk of substantial harm. PRGs were not developed for aquatic invertebrate receptors because COCs at the Site were determined to pose primarily bioaccumulation hazards; thus posing greater risks to receptors at higher trophic levels.

Risks to the benthic macroinvertebrate community were assessed in the BERA based on toxicity testing, a benthic macroinvertebrate community study, critical body residues, and surface water and sediment screening benchmarks. The BERA concluded that benthic macroinvertebrates in low gradient (i.e., lentic) habitats were at substantial risk of harm from exposure to site-related contaminants, i.e., primarily from exposure to TCDD TEQ, PAHs, pesticides, and Aroclors. (Macroinvertebrates in lotic habitats were not determined to be at substantial risk of harm based on results of the benthic community study). The COPCs for benthic macroinvertebrates were identified based on comparisons of surface water and sediment concentrations to screening benchmarks for these media. In addition, results of toxicity testing indicated strong negative correlations between survival and concentrations of PAHs, pesticides (i.e., dieldrin), and Aroclors. Although TCDD TEQ was identified as a COPC for benthic invertebrates in the BERA, the screening value used was not specific to invertebrates, but rather was based on toxicity to fish. As noted in the BERA, the potential toxicity of TCDD to invertebrates is questionable given the general absence of the Ah receptor (important in TCDD's mode of toxicity) in this group. Of the primary COPCs identified for benthic macroinvertebrates (i.e., TCDD TEQ, PAHs, pesticides, and Aroclors), TCDD TEQ, pesticides, and Aroclors are known to be bioaccumulative, and therefore, these COPCs would be expected to result in greater toxicity at higher trophic levels (Therefore PRGs developed for these COPCs for higher trophic level receptors would be expected to be protective of benthic invertebrates).

As seen in Figures 52 and 55 of the BERA, areas with elevated concentrations of total PAHs are located within areas of elevated dioxin TEQ concentrations. Therefore, remedial actions to address risks associated with dioxin exposures would also address risks associated with PAH exposures, for which no PRGs were developed. Elevated concentrations of Aroclors and pesticides, which are other primary COPCs for benthic invertebrates, are also located with areas of elevated dioxin TEQ which would be expected to be remediated (Figures 52, 54, 56).

Table 1-1 provides a summary of the PRGs that were developed for each endpoint receptor and for each exposure area (Allendale, Lyman Mill, Manton, and Dyerville). In general, the COCs for which PRGs were developed are those that resulted in the highest incremental risk for a given species in the given exposure area relative to the background area (as summarized in the incremental risk tables in the BERA). These chemicals included dioxins and furans, dioxin-like PCBs, PCB Aroclors, pesticides (technical chlordane, 4,4'-DDE, and 4,4'-DDD), and several inorganics.

PRGs were developed based on measurement endpoints used in the BERA. For demersal and pelagic fish, PRGs were developed using (1) tissue threshold concentrations based on literature-derived Critical Body Residues (CBRs) and (2) from the site-specific Early Life Stage (ELS) study (Table 1-1). PRGs for piscivorous and vermivorous wildlife are based on food chain exposure modeling. PRGs for insectivorous wildlife were developed in two ways: (1) using tissue threshold concentrations based on literature-derived CBRs and (2) from concentration-response data (i.e., egg tissue concentration/percent field measured hatchability) from the 4-year site-specific tree swallow population study. The toxic equivalency (TEQ) approach was used to derive a single PRG for dioxins and furans (and as necessary, dioxin-like PCBs).

2.0 TECHNICAL APPROACH AND PROCEDURE FOR DEVELOPMENT OF PRGS

Site-specific PRGs were developed based on the conclusions of the BERA and the physical and chemical conditions at the Site. Sediment PRGs were developed for each of the four exposure areas (Allendale, Lyman Mill, Manton, and Dyerville). Floodplain soil PRGs were developed for the Allendale and Lyman Mill exposure areas only (Table 1-1). Floodplain soil PRGs were not developed for Manton and Dyerville because these areas have very limited floodplain habitat, and therefore no floodplain soil data were collected from these areas.

PRGs were developed consistent with *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals), Interim* (USEPA, 1991) and with USEPA's *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (USEPA, 2002a) and *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (USEPA, 2005). To the extent possible, ecological PRGs were derived consistent with the procedures used to derive human health PRGs for the Site.

In general, sediment and floodplain soil PRGs for ecological receptors were derived by dividing the risk threshold concentrations for prey tissue by site-specific biota-sediment accumulation factors (BSAFs) appropriate for each receptor of concern. Risk threshold concentrations for demersal and pelagic fish tissue were divided by the appropriate BSAFs to derive sediment PRGs protective of these endpoint receptors. BSAFs were calculated for individual exposure areas and were derived using the geometric mean concentrations of the Total Organic Carbon (TOC)-normalized sediment (or surface soil) concentrations and of the lipid-normalized biota tissue concentrations[1].

For each COC, for a given endpoint receptor, exposure area, and measurement endpoint, PRGs were calculated for both No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) endpoints where available. The geometric mean of the NOAEL and LOAEL values (i.e., Maximum Allowable Toxicant Concentration [MATC]) was also calculated. For each of these endpoints (NOAEL, LOAEL, and MATC), PRGs were calculated based on target Hazard Quotient (HQ) values of 0.1, 1.0, and 10.

Specific procedures used to derive PRGs for each of the endpoint receptors of concern are detailed in the following sections.

2.1 PROCEDURE FOR DEVELOPMENT OF SEDIMENT PRGS PROTECTIVE OF DEMERSAL AND PELAGIC FISH

The following procedure was used to develop sediment PRGs protective of demersal and pelagic fish for the COCs identified in Table 1-1.

1. Ecological fish tissue PRGs were developed for each of the COCs based on (a) literature-derived CBRs and (b) the site-specific ELS threshold Effect Concentration 10 (EC_{10}) and EC_{25} values. To derive ELS-based fish tissue PRGs, a maternal/egg transfer factor was

[1] For organic COCs only; in the case of inorganic COCs, geometric means for unnormalized data were used.

used to estimate the whole body fish tissue concentrations associated with the EC_{10} and EC_{25} values established for fish eggs;

2. Lipid-normalized fish tissue concentrations of each organic COC were identified for each fish species sample collected at that exposure point (unnormalized fish tissue concentrations were identified for each inorganic COC);
3. The geometric mean lipid normalized concentration of each organic COC was calculated for each fish species at that exposure point (for inorganic COCs, the geometric mean unnormalized concentrations were calculated); the variability in the values was characterized by identifying a coefficient of variation;
4. TOC-normalized sediment concentrations of each organic COC were identified in each sediment sample at the exposure point (unnormalized sediment concentrations were identified for inorganic COCs);
5. The geometric mean TOC-normalized sediment concentration was calculated for each organic COC at the exposure point (for inorganic COCs, the geometric mean unnormalized concentrations were calculated); the variability in the values was characterized by identifying a coefficient of variation;
6. The BSAF, the steady state ratio between the contaminant concentration in the organism (lipid-normalized) and the contaminant concentration in the sediment (TOC-normalized), was calculated for each COC at the exposure point (for inorganic COCs, this ratio was expressed using unnormalized data); and
7. The ecological sediment PRGs were calculated for each COC at each exposure point for each fish species.

Details associated with each of these steps are described below.

Step 1) (a) Fish tissue PRGs based on the literature-derived CBRs were calculated using NOAEL and LOAEL-based CBR values and the geometric mean of these values as follows:

$$PRG_{fish} = THQ \times CBR$$

where:

PRG_{fish}	=	PRG for fish tissue (mg chemical/kg fish tissue)
THQ	=	Target Hazard Quotient for the COC for fish consumption (dimensionless); PRGs were calculated using THQs of 0.1, 1.0, and 10.
CBR	=	Critical Body Residue (mg chemical/kg fish tissue). NOAEL- and LOAEL-based CBR values were obtained from Table G-1 of the BERA (MACTEC, 2004) (all effects data used). The MATC-based CBR is the geometric mean of the NOAEL and LOAEL-based values.

The CBR-based fish tissue PRGs for demersal and pelagic fish are calculated in Table 2-1.

Step 1) (b) Fish tissue PRGs based on the ELS study were calculated using EC_{10} and EC_{25} values identified from the study and the geometric mean of these values (MATC). Because the ELS study evaluated toxicity effect concentrations for fish eggs, a maternal/egg

transfer factor was used to estimate the corresponding whole body fish tissue concentrations. The fish tissue PRGs were calculated as follows:

$$PRG_{fish} = \frac{THQ \times ELS_{Thresh}}{METF}$$

where:

PRG_{fish} = PRG for fish tissue (mg chemical/kg fish tissue)
THQ = Target Hazard Quotient for the COC for fish consumption (dimensionless); PRGs were calculated using THQs of 0.1, 1.0, and 10.
ELS_{Thresh} = Early Life Stage-Based Threshold (mg chemical/kg egg tissue). EC_{10} and EC_{25}-based values were obtained from Appendix H (Early Life Stage Toxicity Report) of the BERA (MACTEC, 2004). The MATC-based value is the geometric mean of the EC_{10} and EC_{25}-based values.
METF = Maternal/Egg Transfer Factor. Percentage of the contaminant concentration in the adult female fish that is transferred to the egg. A literature-based value of 0.7 (70%) was used.

The ELS-based fish tissue PRGs for demersal and pelagic fish are calculated in Table 2-2.

Step 2) Lipid-normalized fish tissue concentrations of each organic COC were calculated for each species at each exposure point consistent with the equation shown below (concentrations of inorganic chemicals in fish tissue were not lipid normalized).

$$[C]_{fish,ln} = \frac{[C]_{fish}}{[Lipid]_{fish}} x \frac{1}{CF1}$$

where:

$[C]_{fish,ln}$ = Lipid-normalized chemical concentration in fish tissue (mg chemical/kg lipid)
$[C]_{fish}$ = Chemical concentration in fish tissue (mg chemical/kg fish tissue as wet weight)
$[Lipid]_{fish}$ = Lipid concentration in fish tissue (mg lipid/kg fish tissue)
CF1 = Units conversion factor (0.000001 kg lipid/mg lipid)

Step 3) Geometric mean lipid-normalized concentrations of each organic COC at each exposure point were calculated and compiled (geometric mean concentrations were also calculated for unnormalized concentrations of inorganic COCs in fish tissue). The coefficient of variation was identified for each COC and exposure point combination. These data are presented in Tables 2-3 and 2-4 for demersal fish (white sucker and American eel) and pelagic fish (largemouth bass), respectively. The variability in these values is discussed in the uncertainty section of this report.

Step 4) TOC-normalized concentrations of organic COCs in sediment were calculated for each exposure point consistent with the equation shown below. These concentrations are essentially chemical concentrations in sediment organic carbon (concentrations of inorganic chemicals in sediment were not TOC-normalized).

$$[C]_{sed,\,ocn} = \frac{[C]_{sed}}{[TOC]_{sed}} x \frac{1}{CF2}$$

where:

$[C]_{sed,ocn}$	=	TOC-normalized chemical concentration in sediment (mg chemical/kg organic carbon in sediment
$[C]_{sed}$	=	Chemical concentration in sediment (mg chemical/kg sediment as dry weight)
$[TOC]_{sed}$	=	TOC concentration in sediment (mg total organic carbon/kg sediment as dry weight)
CF2	=	Units conversion factor (0.000001 kg organic carbon/mg organic carbon)

Step 5) The geometric mean TOC-normalized sediment concentrations for each organic COC and the geometric mean unnormalized sediment concentrations for each inorganic COC at each exposure point were calculated and compiled. The coefficient of variation was identified for each COC and exposure point combination. Data are presented in Tables 2-3 and 2-4. The variability in these values is discussed in the uncertainty section of this report.

Step 6) BSAFs for organic COCs were calculated using the following equation:

$$BSAF = \frac{[C]_{fish,\,ln}}{[C]_{sed,\,ocn}}$$

where:

BSAF	=	Biota-sediment accumulation factor (kg organic carbon in sediment/kg lipid in fish)
$[C]_{fish,ln}$	=	Lipid-normalized chemical concentration in fish tissue reported as wet weight (mg chemical/kg lipid in fish tissue) (Geometric mean used)
$[C]_{sed,ocn}$	=	TOC-normalized chemical concentration in sediment reported as dry-weight (mg chemical/kg organic carbon in sediment) (Geometric mean used)

For inorganic COCs, the BSAF was calculated by dividing the unnormalized chemical concentration in the fish tissue by the unnormalized chemical concentration in the sediment (using geometric mean values).

BSAFs calculated for demersal fish (white sucker and American eel) and pelagic fish (largemouth bass) are summarized in Tables 2-3 and 2-4, respectively.

Step 7) Sediment PRGs were calculated for each organic COC at each exposure point for each fish species using the equation below.

$$PRG_{sed} = \frac{PRG_{fish} \, x \, [TOC]_{sed}}{BSAF \, x \, [Lipid]_{fish}}$$

where:

PRG_{sed}	=	PRG for sediment that is protective of the given fish species (mg chemical/kg sediment)
PRG_{fish}	=	PRG for fish tissue calculated in Step 1 (mg chemical/kg fish tissue)
$[TOC]_{sed}$	=	Geometric mean TOC concentration in sediment at exposure point reported as dry weight (mg organic carbon/kg sediment) (Table 2-5)
BSAF	=	Species-specific biota-sediment accumulation factor for the exposure point (kg organic carbon/kg lipid)
$[Lipid]_{fish}$	=	Geometric mean lipid concentration in fish species at the exposure point (mg lipid/kg fish tissue) (Table 2-5)

Sediment PRGs for inorganic COCs were calculated by dividing the Fish PRG by the corresponding BSAF.

The PRGs were calculated based on target HQ values of 0.1, 1.0, and 10.

Sediment PRGs for demersal fish are presented in Tables 2-6 and 2-7 for CBR and ELS-based thresholds, respectively. Sediment PRGs for pelagic fish are presented in Tables 2-8 and 2-9 for CBR and ELS-based thresholds, respectively.

2.2 PROCEDURE FOR DEVELOPMENT OF SEDIMENT PRGS PROTECTIVE OF PISCIVOROUS WILDLIFE

The following steps were followed to develop sediment PRGs protective of piscivorous wildlife for the COCs identified in Table 1-1.

1. Ecological fish tissue PRGs were calculated that are protective of the belted kingfisher fish ingestion pathway for each of the COCs in fish tissue;
2. Lipid-normalized fish tissue concentrations of each organic COC were identified for each fish prey sample collected at that exposure point (unnormalized fish tissue concentrations were identified for each inorganic COC);
3. The geometric mean lipid normalized concentration of each organic COC was calculated for fish tissue at that exposure point (for inorganic COCs, the geometric mean unnormalized concentrations were calculated); the variability in the values was characterized by identifying a coefficient of variation);
4. TOC-normalized sediment concentrations of each organic COC were identified in each sediment sample at the exposure point (unnormalized sediment concentrations were identified for inorganic COCs);
5. The geometric mean TOC-normalized sediment concentration was calculated for each organic COC at the exposure point (for inorganic COCs, the geometric mean unnormalized concentrations were calculated); the variability in the values was characterized by identifying a coefficient of variation;
6. The BSAF was calculated for each COC at the exposure point; and

7. Ecological sediment PRGs were calculated for each COC at each exposure point for the belted kingfisher.

Details associated with each of these steps are described below.

Step 1) Fish tissue PRGs were developed based on the Central Tendency Exposure scenario for the belted kingfisher for each of the COCs. The fish tissue PRGs depend primarily on the toxicity of each COC and the fish consumption rate for the receptor. (The belted kingfisher's diet consists entirely of fish.) Data for white sucker were preferentially used in the development of fish tissue PRGs because of its benthic feeding habits and consequently substantial direct exposure to sediments. The PRGs were derived based on food chain exposure modeling using NOAEL and LOAEL-based Toxicity Reference Values (TRVs) and the geometric mean of these values as follows:

$$PRG_{fish} = \frac{THQ \times TRV \times BW}{IR_{food}}$$

where:

PRG_{fish}	=	PRG for fish tissue (mg chemical/kg fish tissue).
THQ	=	Target Hazard Quotient for the COC for fish consumption (dimensionless). PRGs were calculated using THQs of 0.1, 1.0, and 10.
TRV	=	Toxicity Reference Value. Receptor-specific literature-based toxicity threshold value. NOAEL and LOAEL-based TRV values were obtained from Table D-4 (Appendix D) of the BERA (MACTEC, 2004). The MATC-based TRV is the geometric mean of the NOAEL and LOAEL-based values.
BW	=	Kingfisher body weight (0.147 kg). Literature-based value obtained from Table I-2 of the BERA (MACTEC, 2004).
IR_{food}	=	Food (fish) ingestion rate (0.047 kg/day). Literature-based value obtained from Table I-2 of the BERA (MACTEC, 2004).

The fish tissue PRGs protective of the belted kingfisher are calculated in Table 2-10.

Step 2) Lipid-normalized concentrations of each organic COC in fish tissue were calculated at each exposure point using the equation provided in Step 2 of Section 2.1 (concentrations of inorganic chemicals in fish tissue were not lipid normalized). Exposure area-specific white sucker data were used for Allendale. Exposure area-specific largemouth bass and American eel data were used for Manton and Dyerville, respectively, for which no white sucker data were available. Lipid-normalized chemical fish tissue concentrations were not calculated for Lyman Mill due to uncertainties associated with data collected from that area (as described in Section 3.1 of this report).

Step 3) Geometric mean lipid-normalized concentrations of each COC at each exposure point were calculated and compiled (Geometric mean concentrations were also calculated for unnormalized concentrations of inorganic COCs in fish tissue). The coefficient of variation was identified for each COC and exposure point combination. These data are

presented in Tables 2-3 and 2-4 for demersal and pelagic fish, respectively. The variability in these values is discussed in the uncertainty section of this report.

Step 4) TOC-normalized concentrations of organic COCs in sediment were calculated for each exposure point consistent with the equation provided in Step 4 of Section 2.1 (concentrations of inorganic chemicals in sediment were not TOC-normalized). Exposure area-specific data were not evaluated for Lyman Mill as described in Section 3.1.

Step 5) The geometric mean TOC-normalized sediment concentrations for each organic COC and the geometric mean unnormalized sediment concentrations for each inorganic COC at each exposure point were be calculated and compiled. The coefficient of variation was identified for each COC and exposure point combination. Data are presented in Tables 2-3 and 2-4. The variability in these values is discussed in the uncertainty section of this report.

Step 6) BSAFs for organic COC were calculated using the equation provided in Step 6 of Section 2.1. For inorganic COCs, the BSAF was calculated by dividing the unnormalized chemical concentration in the fish tissue by the unnormalized chemical concentration in the sediment. Exposure area-specific BSAFs were calculated for Allendale (using white sucker data), Manton (using largemouth bass data), and Dyerville (using American eel data). For the Lyman Mill exposure area, the arithmetic mean of the white sucker BSAFs for the other exposure areas was used (Tables 2-3 and 2-4).

Step 7) Sediment PRGs were calculated for each COC at each exposure point using the equation provided in Step 7 for demersal/pelagic fish.

Sediment PRGs for inorganic COCs were calculated by dividing the fish tissue PRG by the corresponding BSAF.

PRGs were calculated based on target HQ values of 0.1, 1.0, and 10.

Sediment PRGs protective of the belted kingfisher are presented in Table 2-11.

2.3 PROCEDURE FOR DEVELOPMENT OF SEDIMENT PRGS PROTECTIVE OF INSECTIVOROUS WILDLIFE

The embryo was identified as the most sensitive life stage of the tree swallow. Therefore, PRGs were developed for the COCs indicated in Table 1-1 based on protection of embryological effects (as determined based on literature-derived CBRs and by hatchability effects measured in the 4-year study of local populations conducted by the U.S. Geological Survey [USGS] [Appendix M of the BERA (MACTEC, 2004)]). Dioxins and furans and dioxin-like PCBs were identified as the only significant contributors to risk to tree swallows and PRGs for these COCs were developed using the following procedure:

1. Ecological swallow egg tissue PRGs were developed based on (a) literature-derived CBRs and (b) the site-specific swallow population study;

2. Lipid-normalized egg tissue concentrations of each COC were identified for each tree swallow egg sample collected at that exposure point. Note: as described in Custer, 2004 (in Appendix M of the BERA [MACTEC, 2004]), some eggs were switched between contaminated exposure areas and uncontaminated background/reference areas. Data for these transferred eggs were not used to develop PRGs, as these eggs reflect exposures from both contaminated and reference areas rather than from a particular exposure area. Use of these data would add uncertainty to accumulation factors used to develop the PRGs;
3. The geometric mean lipid normalized concentration of each COC in swallow egg tissue was calculated at that exposure point; the variability in the values was characterized by identifying a coefficient of variation);
4. Lipid-normalized tissue concentrations of each COC were identified for each invertebrate prey sample collected at that exposure point (including both emerging insects and stomach contents obtained from swallow nestlings);
5. The geometric mean lipid normalized concentration was calculated for each COC in invertebrate tissue at that exposure point; the variability in the values was characterized by identifying a coefficient of variation;
6. A Biomagnification Factor (BMF) was calculated for each COC at the exposure point; the BMF is used to estimate the transfer of a contaminant from the invertebrate prey tissue to the egg tissue of the tree swallow;
7. TOC-normalized sediment concentrations of each COC were identified in each sediment sample at the exposure point;
8. The geometric mean TOC-normalized sediment concentration was calculated for each COC at the exposure point; the variability in the values was characterized by identifying a coefficient of variation;
9. The BSAF was calculated for each COC at the exposure point; and
10. The ecological sediment PRGs were calculated for each COC at each exposure point.

Details associated with each of these steps are described below.

Step 1) (a) Tree Swallow egg tissue PRGs based on the literature-derived CBRs were calculated using NOAEL and LOAEL-based CBR values and the geometric mean (MATC) of these values as follows:

$$PRG_{egg} = THQ \times CBR$$

where:

PRG_{egg}	=	PRG for bird egg tissue (mg chemical/kg egg tissue).
THQ	=	Target Hazard Quotient (dimensionless); PRGs were calculated using THQs of 0.1, 1.0, and 10.
CBR	=	Critical Body Residue (mg chemical/kg bird egg tissue). NOAEL- and LOAEL-based CBR values were obtained from Tables 134 through 138 of the BERA (MACTEC, 2004). The MATC-based CBR is the geometric mean of the NOAEL and LOAEL-based values.

The CBR-based bird egg tissue PRGs are calculated in Table 2-12.

Step 1(b) Tree swallow egg tissue PRGs based on percent hatchability data were calculated using NOAEL, LOAEL, and MATC values derived from the site-specific tree swallow population study (Battelle, 2005). The egg tissue PRGs were calculated as follows:

$$PRG_{egg} = THQ \times EHT$$

where:

PRG_{egg}	=	PRG for swallow egg tissue (mg chemical/kg egg tissue).
THQ	=	Target Hazard Quotient (dimensionless); PRGs were calculated using THQs of 0.1, 1.0, and 10.
EHT	=	Egg Hatchability Threshold (mg chemical/kg egg tissue). NOAEL, LOAEL, and MATC values (5.16E-04, 5.62E-04, and 5.39E-04, respectively) were obtained from Attachment A of the revised ecological technical approach document (Battelle, 2005).

The hatchability-based egg tissue PRGs are calculated in Table 2-13.

Step 2) Lipid-normalized chemical egg tissue concentrations of each COC were calculated at each exposure point using the equation provided in Step 2 of Section 2.1 (replacing the chemical concentration in the fish tissue with the chemical concentration in the egg tissue and the lipid concentration in the fish tissue with the lipid concentration in the egg tissue). Only tissue samples for eggs that were not transferred between nests were included in these calculations.

Step 3) Geometric mean lipid-normalized concentrations of each COC in egg tissue at each exposure point were calculated and compiled. The coefficient of variation was identified for each COC and exposure point combination. These data are presented in Table 2-14. The variability in these values is discussed in the uncertainty section of this report.

Step 4) Lipid-normalized tissue concentrations of each COC were identified for each invertebrate prey sample collected at that exposure point (including both emerging insects and stomach contents obtained from swallow nestlings).

Step 5) The geometric mean lipid normalized concentration was calculated for each COC in invertebrate tissue at that exposure point; the variability in the values was characterized by identifying a coefficient of variation (Table 2-14). The variability in these values is discussed in the uncertainty section of this report.

Step 6) BMFs were calculated for each COC at each exposure point to estimate the transfer between invertebrate prey concentrations consumed by the adult female tree swallow and the resulting concentration in the tissue of the eggs that the female produces. The equation used to estimate BMFs for tree swallow eggs is described as follows:

$$BMF = \frac{[C]_{swallowegg,\,ln}}{[C]_{invertebrate,\,ln}}$$

where:

BMF = Biomagnification Factor (kg invertebrate lipid/kg swallow egg lipid)
$[C]_{swallow\ egg,\ ln}$ = Lipid-normalized chemical concentration in egg tissue reported as wet weight (mg chemical/kg lipid in egg tissue) (Geometric mean used)
$[C]_{invertebrate,\ ln}$ = Lipid-normalized chemical concentration in invertebrate tissue reported as wet weight (mg chemical/kg lipid in invertebrate tissue) (Geometric mean used)

BMFs are calculated in Table 2-14.

Step 7) TOC-normalized concentrations of COCs in sediment were calculated for each exposure point consistent with the equation provided in Step 4 of Section 2.1.

Step 8) The geometric mean TOC-normalized sediment concentrations for each organic COC at each exposure point were calculated and compiled. The coefficient of variation was identified for each COC and exposure point combination. These data are presented in Table 2-15. The variability in these values is discussed in the uncertainty section of this report.

Step 9) The BSAF for invertebrate prey (emerging insects/stomach contents) was calculated for each COC at the exposure point by dividing the geometric mean lipid normalized chemical concentration in the emerging insect or stomach content tissue by the geometric mean TOC-normalized chemical concentration in the sediment. Emerging insect/stomach content BSAFs are calculated in Table 2-15.

Step 10) Sediment PRGs protective of tree swallow embryos were calculated for each COC at each exposure point using the following equation:

$$PRG_{sed} = \frac{PRG_{egg} \times [TOC]_{sed}}{BSAF \times BMF \times [Lipid]_{egg}}$$

where:

PRG_{sed} = PRG for sediment that is protective of tree swallow embryos (mg chemical/kg sediment).
PRG_{egg} = PRG for tree swallow eggs calculated in Step 1 (mg chemical/kg egg tissue).
$[TOC]_{sed}$ = Geometric mean TOC concentration in sediment at exposure point reported as dry weight (mg organic carbon/kg sediment).
BSAF = Biota-sediment accumulation factor for emerging insect prey calculated for each exposure point (kg organic carbon/kg lipid).
BMF = Biomagnification Factor (kg invertebrate lipid/kg swallow egg lipid).
$[Lipid]_{egg}$ = Geometric mean lipid concentration in tree swallow egg tissue at the exposure point (mg lipid/kg egg tissue).

PRGs were calculated based on target HQ values of 0.1, 1.0, and 10. Sediment PRGs protective of tree swallow embryos are presented in Tables 2-16 and 2-17 for CBR and egg hatchability-based thresholds, respectively.

2.4 PROCEDURE FOR DEVELOPMENT OF FLOODPLAIN SOIL PRGS PROTECTIVE OF VERMIVOROUS WILDLIFE

Floodplain soil PRGs protective of vermivorous wildlife were developed for the COCs identified in Table 1-1. PRGs were developed based on food chain exposure modeling for the short-tailed shrew receptor of concern and were derived assuming (1) the shrew's diet comprises approximately 86% earthworms and approximately 14% plants (as per Table 1-8 of the BERA); and (2) contaminants concentrations in earthworm and plant tissues may be attributed entirely to uptake from the soil and therefore may be calculated using chemical and biota-specific biota-soil accumulation factors. The soil PRGs were calculated using the following procedure:

1. Lipid-normalized earthworm tissue concentrations of each organic COC were identified for each earthworm sample collected at that exposure point (unnormalized earthworm tissue samples were identified for each inorganic COC);
2. The geometric mean lipid-normalized concentration of each organic COC in earthworm tissue was calculated (for inorganic COCs, the geometric mean unnormalized concentrations were calculated); the variability in the values was characterized by identifying a coefficient of variation;
3. TOC-normalized concentrations of each organic COC were identified in each floodplain soil sample at the exposure point (unnormalized concentrations in floodplain soil were identified for inorganic COCs);
4. The geometric mean TOC-normalized floodplain soil concentration was calculated for each organic COC at the exposure point (for inorganic COCs, the geometric mean unnormalized concentrations were calculated); the variability in the values was characterized by identifying a coefficient of variation;
5. The earthworm BSAF was calculated for each COC at the exposure point; and
6. The ecological floodplain soil PRGs were calculated for each COC at each exposure point.

Details associated with each of these steps are described below.

Step 1) Lipid-normalized concentrations of each organic COC in earthworm samples were calculated at each exposure point using the equation provided in Step 2 of Section 2.1, except replacing the chemical concentration in the fish tissue with the chemical concentration in the earthworm tissue and replacing the lipid concentration in the fish tissue with the lipid concentration in the earthworm tissue. Concentrations of inorganic chemicals in earthworm tissue were not lipid normalized.

Step 2) Geometric mean lipid-normalized concentrations of each COC in earthworm tissue at each exposure point were calculated and compiled (Geometric mean concentrations were also calculated for unnormalized concentrations of inorganic COCs in earthworm). The coefficient of variation was identified for each COC and exposure point

combination. These data are presented in Table 2-18. The variability in these values is discussed in the uncertainty section of this report.

Step 3) TOC-normalized concentrations of organic COCs in floodplain soil were calculated for each exposure point consistent with the equation provided in Step 4 of Section 2.1, except using floodplain soil data rather than sediment data (Concentrations of inorganic chemicals in floodplain soil were not TOC-normalized).

Step 4) The geometric mean TOC-normalized floodplain soil concentrations for each organic COC and the geometric mean unnormalized floodplain soil concentrations for each inorganic COC at each exposure point were calculated and compiled. The coefficient of variation was identified for each COC and exposure point combination. These data are presented in Table 2-18. The variability in these values is discussed in the uncertainty section of this report.

Step 5) Earthworm BSAFs for organic COCs were calculated by dividing the lipid normalized chemical concentrations in earthworm tissue by the TOC-normalized concentration in the floodplain soil. For inorganic COCs, the BSAF was calculated by dividing the unnormalized chemical concentration in the earthworm tissue by the unnormalized chemical concentration in the soil. Earthworm BSAFs are presented in Table 2-18. BSAFs were not calculated for plants, as no site-specific plant tissue samples were collected (literature-based values were used for plants instead).

Step 6) Floodplain soil PRGs protective of the short-tailed shrew were calculated for each organic COC at each exposure point using the following equation:

$$PRG_{soil} = \frac{THQ \times TRV \times BW}{\left(BAF_{plant} \times IR_{food} \times P_{plant} \times SFF \times EF\right) + \left(\frac{BSAF_{ew} \times [LIPID]_{ew}}{[TOC]_{soil}} \times IR_{food} \times P_{ew} \times SFF \times EF\right) + \left(IR_{soil} \times SFF \times EF\right)}$$

where:

PRG_{soil} = PRG for floodplain soil that is protective of the short-tailed shrew (mg chemical/kg sediment).

THQ = Target Hazard Quotient (dimensionless); PRGs were calculated using THQs of 0.1, 1.0, and 10.

TRV = Toxicity Reference Value. Receptor-specific literature-based toxicity threshold value. NOAEL and LOAEL-based TRV values were obtained from Table D-4 (Appendix D) of the BERA (MACTEC, 2004). The MATC-based TRV is the geometric mean of the NOAEL and LOAEL-based values.

BW = Short-tailed shrew body weight (0.0174 kg). Literature-based value obtained from Table I-8 of the BERA (MACTEC, 2004).

BAF_{plant} = Chemical specific, literature-based plant biota accumulation factor (mg ww tissue/kg dw soil). Plant BAFs obtained from Table J-1 (Appendix J) of the BERA (MACTEC, 2004).

IR_{food} = Food ingestion rate used for the short-tailed shrew (0.01284 kg/day). Literature-based value obtained from Table I-8 of the BERA (MACTEC, 2004).

P_{plant} = Percent Plants in diet (14.2%). Value from Table I-8 of the BERA (MACTEC, 2004).

P_{ew} = Percent earthworms in diet (85.4%). Value from Table I-8 of the BERA (MACTEC, 2004).

SFF = Site Foraging Frequency (100%). Value from Table I-8 of the BERA (MACTEC, 2004).

EF = Exposure Frequency (100%). Value from Table I-8 of the BERA (MACTEC, 2004).

$BSAF_{ew}$ = Chemical and exposure area specific earthworm biota soil accumulation factor (kg organic carbon/kg lipid).

$[LIPID]_{ew}$ = Geometric mean lipid concentration in earthworm tissue at exposure point (mg lipid/kg earthworm tissue).

$[TOC]_{soil}$ = Geometric mean TOC concentration in floodplain soil at exposure point, reported as dry weight (mg organic carbon/kg sediment).

For inorganic chemicals, the soil PRG was calculated using the above equation but excluding the $[LIPID]_{ew}$ and $[TOC]_{soil}$ terms.

Floodplain soil PRGs protective of the short-tailed shrew are calculated in Table 2-19.

Tables 2-20 through 2-22 summarize the sediment and floodplain soil PRGs calculated for each of the relevant receptors for HQs of 0.1, 1.0, and 10, respectively.

3.0 CALCULATION AND PRESENTATION OF PRGS

3.1 DATA EVALUATED

The COCs for which PRGs were developed are identified in Table 1-1. The process used to select COCs for PRG development is described in Section 1.2.

As described in Section 3.1 of the human health component of this report (Part I), an outlier analysis was performed for lipid- and TOC-normalized chemical concentration data in fish tissue and sediment samples being considered for use in calculating BSAFs and BMFs. Table 3-1 of Part I lists samples with concentration data that appear to be outside the typical range of concentrations; these outlying data were not used in the development of PRGs.

Based on an evaluation of pre-breach and post-breach data, as described in Section 3.2 of Part I of this report, fish and sediment data from Lyman Mill were not used in the development of BSAFs for the Lyman Mill exposure area. Instead, for this exposure area, an arithmetic mean of the BSAFs calculated for the other exposure areas was used for each fish species and COC. Exposure-area specific data were used to develop BSAFs for the other exposure areas.

TOC concentration data were not available for some sediment and floodplain soil samples collected from the Site. These samples were not used to develop PRGs for organic COCs (only TOC-normalized data were used to evaluate organic COCs). However, the samples lacking TOC data were used in the development of PRGs for inorganic COCs. Table 3-1 (of Part II) lists the sediment, floodplain soil, and biota samples that were used in the development of ecological PRGs.

Although data for brown bullhead *(Ictalurus nebulosus)* were available for the Site, only data for white sucker (and American eel for the Dyerville exposure area only) were used in the calculation of BSAFs for demersal fish. Only tissue data for largemouth bass were used to calculate BSAFs for pelagic fish. Brown bullhead data are only available for Assapumpset (for which no white sucker data are available). Assapumpset largemouth bass data were used in the calculation of piscivorous fish BSAFs for Lyman Mill (Table 2-4). However, to avoid averaging data for two different fish species (i.e., white sucker and brown bullhead), Assapumpset brown bullhead data were not used in the calculation of a demersal fish BSAF for Lyman Mill.

3.2 CALCULATION OF BSAFS AND BMFS

As described in Section 2.0, BSAFs were calculated for white sucker, American eel, largemouth bass, emerging insects, and earthworms as interim steps in the development of PRGs. BSAFs were calculated as described in Section 2.1. In addition, BMFs were calculated to estimate the transfer of COCs from emerging insect tissue and tree swallow stomach contents to tree swallow egg tissue, as described in Section 2.3. Table 2-5 presents a summary of lipid concentrations in biota tissue data used in the calculations, as well as a summary of the TOC concentrations in sediment and floodplain soil samples that were evaluated. Tables 2-3 and 2-4 present BSAFs calculated for demersal fish (white sucker and American eel) and pelagic fish (largemouth bass), respectively. In cases where a COC was not detected in sediment samples but was detected in corresponding biota samples, the BSAF was calculated using one half the detection limit for the

sediment sample concentrations. With the exception of BSAFs used for Lyman Mill (which were calculated using data from other exposure areas, as described in Section 3.1), exposure area-specific BSAFs (and consequently PRGs) were not calculated if the COC was not analyzed for in the sediment and/or biota samples or if the COC was not detected in the biota samples. Literature-derived BSAFs were not used in instances where site-specific BSAFs could not be calculated due to a general scarcity of available literature values and because of large uncertainties associated with the use of these values (i.e., due to site and study-related differences). COC concentrations in largemouth bass (whole body) used in the BSAF calculations were estimated based on measured concentrations of COCs in fillet and offal tissues. Table 2-14 presents BMFs used in the calculation of sediment PRGs protective of tree swallow embryos. Tables 2-15 and 2-18 present BSAFs calculated for emerging insects and earthworms, respectively.

3.2.1 Comparison of Calculated BSAFs with Published BSAFs for the Same Species

BSAFs calculated for use in the derivation of ecological PRGs were compared to available BSAFs from the literature for the same or related species (Table 3-2). Limited BSAF data from the literature are available for the species and COCs evaluated for the Site. Available relevant published BSAFs were limited to values for organic COCs for the white sucker and largemouth bass (or related species). No relevant published BSAF data were available for American eel, emerging/aquatic insects, and earthworms.

For the white sucker, calculated BSAFs for 4,4'-DDD and 4,4'-DDE are similar to available values from the literature. The average site BSAF for 4,4'-DDD for white sucker is 2.04 compared to corresponding literature values for *Catostomus* species of 2.72 (white sucker) and 4.40 (largescale sucker). The average site BSAF for 4,4'-DDE for white sucker is 5.02 compared to literature values for *Catostomus* species ranging from 4.36 (bridgelip sucker) to 18.3 (largescale sucker). Calculated BSAFs for technical chlordane were compared to published BSAFs for the cis (alpha) and trans (gamma) isomers of chlordane (components of technical chlordane) due to the lack of published BSAFs for technical chlordane. The average site BSAF for technical chlordane is 0.486 compared to literature BSAF values for alpha- and gamma-chlordane ranging from 0.59 (gamma) to 2.52 (alpha). Site BSAFs for Aroclor-1254 and dioxin TEQ are similar to comparable literature-based values, with values generally differing by less than an order of magnitude, while site BSAFs for PCBs are approximately an order of magnitude lower than literature-based values. Literature BSAFs for Aroclor-1254 range from 0.27 to 1.9 compared to site values of 0.84 to 4.57. Literature BSAFs for 2,3,7,8-TCDD range from 0.043 to 0.28 compared to site BSAFs for dioxin TEQ of 0.058 to 0.389. Published BSAFs for total PCBs for white sucker are variable and range from 1.8 to 11 compared to the site BSAF for white sucker of 0.2.

For the largemouth bass, calculated BSAFs for technical chlordane and dioxin TEQ were compared to published BSAFs for similar chemicals. One published BSAF was identified for chlordane (based on uptake of alpha-chlordane by smallmouth bass). Four published BSAFs were identified for dioxin; these values were based on uptake of 2,3,7,8-TCDD, and concentrations were measured in specific organs tissues, rather than in whole body tissue. The average site BSAF for technical chlordane of 0.903 is approximately 7 times lower than the published value used for comparison. Calculated BSAFs for dioxin TEQ differ from the corresponding published values by generally less than an order of magnitude. The differences in

values between the calculated and published BSAFs may be explained by the different types of tissue evaluated (i.e., whole body versus specific organ tissues) and/or by variations in the chemicals used in the studies.

3.3 CALCULATION OF PRGS

3.3.1 PRGs Protective of Demersal and Pelagic Fish

3.3.1.1 Fish Tissue PRGs – Demersal and Pelagic

Fish tissue PRGs were calculated as an interim step in the derivation of sediment PRGs protective of demersal and pelagic fish. As described in Section 2.1, and as indicated in Table 1-1, PRGs for demersal and pelagic fish were developed based on (1) literature-based CBRs and (2) threshold toxicity effect concentrations identified in the site-specific ELS study. The fish tissue PRGs were calculated as described in Step 1 of Section 2.1.

CBR-based fish tissue PRGs were calculated for NOAEL, LOAEL, and MATC endpoints and for HQs of 0.1, 1.0, and 10. The CBR values are for whole body fish tissues and are from published studies involving various species of fish (as indicated in Appendix G of the BERA [MACTEC, 2004]).

ELS-based fish tissue PRGs were calculated for EC_{10}, EC_{25}, and MATC endpoints and for HQs of 0.1, 1.0, and 10. The ELS study measured effects to embryos of the channel catfish (*Ictalurus punctatus*) (MACTEC, 2004 – Appendix H). A maternal/egg transfer factor was used to estimate the whole body fish tissue concentrations associated with the EC_{10} and EC_{25} values established for fish eggs.

Fish tissue PRGs based on CBR and ELS thresholds are presented in Tables 2-1 and 2-2, respectively.

3.3.1.2 Sediment PRGs – Demersal Fish

Sediment PRGs protective of demersal fish were calculated for the COCs and exposure areas listed in Table 1-1, using the procedure and equations described in Section 2.1. Data for the white sucker were used to develop sediment PRGs for the Allendale and Lyman Mill exposure areas. American eel data were used to develop sediment PRGs for Dyerville (based on the ELS threshold), where no white sucker data were collected. Sediment PRGs protective of demersal fish were not derived for Manton, due to the lack of demersal fish data collected from this area.

Sediment PRGs for demersal fish are presented in Tables 2-6 and 2-7 for CBR and ELS-based thresholds, respectively. These PRGs were developed for the same endpoints and HQs as the fish tissue PRGs.

3.3.1.3 Sediment PRGs – Pelagic Fish

Sediment PRGs protective of pelagic fish were developed using data for the largemouth bass. These PRGs were calculated for the COCs listed in Table 1-1 for the Manton and Lyman Mill exposure areas. The PRGs were developed in the same manner as for demersal fish (Section 2.1).

Sediment PRGs protective of pelagic fish were not developed for Allendale and Dyerville due to a lack of largemouth bass data collected from these areas.

Sediment PRGs for pelagic fish are presented in Tables 2-8 and 2-9 for CBR and ELS-based thresholds, respectively. These PRGs were developed for the same endpoints and HQs as the fish tissue PRGs.

3.3.2 PRGs Protective of Piscivorous Wildlife

3.3.2.1 Fish Tissue PRGs

Fish tissue PRGs were calculated as an interim step in the derivation of sediment PRGs protective of the belted kingfisher. These PRGs were derived based on food chain exposure modeling, using the procedure and equations described in Section 2.2. The PRGs were calculated for NOAEL, LOAEL, and MATC endpoints and for HQs of 0.1, 1, and 10, and are presented in Table 2-10.

3.3.2.2 Sediment PRGs

Sediment PRGs protective of the belted kingfisher were calculated for the COCs and exposure areas listed in Table 1-1, using the procedure and equations described in Section 2.2. Data for white sucker were used to derive PRGs for Allendale and Lyman Mill; data for largemouth bass were used to derive PRGs for Manton (for which no demersal fish data were available); and data for American eel were used to derive PRGs for Dyerville.

Sediment PRGs protective of the belted kingfisher are presented in Table 2-11 for NOAEL, LOAEL, and MATC endpoints, and for HQs of 0.1, 1, and 10.

3.3.3 PRGs Protective of Insectivorous Wildlife

3.3.3.1 Tree Swallow Egg Tissue PRGs

As described in Section 2.3, tree swallow egg tissue PRGs were calculated as an interim step in the derivation of sediment PRGs protective of insectivorous wildlife. PRGs for tree swallow eggs were developed based on (1) literature-derived CBRs and (2) site-specific tree swallow percent hatchability data. The PRGs were calculated as described in Step 1 of Section 2.3. The CBR and percent hatchability-based egg tissue PRGs were calculated for NOAEL, LOAEL, and MATC endpoints and for HQs of 0.1, 1, and 10. These PRGs are presented in Tables 2-12 and 2-13 for CBR and percent hatchability-based thresholds, respectively.

3.3.3.2 Sediment PRGs

Sediment PRGs protective of the tree swallow embryos were calculated for the COCs and exposure areas listed in Table 1-1, using the procedure and equations described in Section 2.3. The PRGs were calculated for NOAEL, LOAEL, and MATC endpoints and for HQs of 0.1, 1, and 10. These PRGs are presented in Tables 2-16 and 2-17 for CBR and egg hatchability-based thresholds, respectively.

3.3.4 PRGs Protective of Vermivorous Wildlife

3.3.4.1 Floodplain Soil PRGs

Floodplain soil PRGs were developed for the COCs and exposure areas listed in Table 1-1 based on food chain exposure modeling for the short-tailed shrew. The PRGs were calculated for NOAEL, LOAEl, and MATC endpoints and for HQs of 0.1, 1, and 10 using the procedure and equations described in Section 2.4. These PRGs are presented in Table 2-19.

3.3.5 Summary of Sediment and Floodplain Soil PRGs

Tables 2-20 through 2-22 summarize the sediment and floodplain soil PRGs calculated for each of the endpoint receptors for HQs of 0.1, 1, and 10, respectively. For each COCs, PRGs are shown for NOAEL, LOAEL, and MATC endpoints (or EC_{10}, EC_{25}, and MATC endpoints) for each of the endpoint receptors and exposure areas evaluated. Table 2-21 (which presents PRGs calculated for an HQ of 1) also shows, for each COC, receptor, and endpoint, the geometric mean of the corresponding PRGs for all the exposure areas. Overall, sediment PRGs for dioxins and furans were lowest for tree swallow embryos (CBR-based PRGs); sediment PRGs for 4,4'-DDD, 4,4'-DDE, and total Aroclor were lowest for the belted kingfisher; sediment PRGs for technical chlordane, Aroclor-1254, and selenium were lowest for white sucker (CBR-based PRGs); sediment PRGs for dioxin-like PCBs were lowest for American eel; and sediment PRGs for the other metals evaluated (aluminum, barium, vanadium, and zinc) were lowest for largemouth bass (CBR-based PRGs). Floodplain soil PRGs were developed only for the short-tailed shrew.

4.0 UNCERTAINTIES ASSOCIATED WITH DEVELOPED PRGS

Uncertainties associated with the calculated ecological PRGs are generally similar to those identified for the risk estimates in the BERA. These uncertainties, briefly summarized below, have been grouped based on their potential biases in order to evaluate their overall effect on the calculated PRGs.

Uncertainties with Potentially Conservative Biases:

- Considerable uncertainties are associated with the sediment PRGs for dioxin-like PCBs that were calculated for the American eel. These PRGs are the lowest for this COC among those for all the endpoint receptors evaluated. However, these PRGs are based on analytical results for a single eel tissue sample (Table 2-3), and therefore the results are questionable. In addition, because the American eel is highly mobile, the BSAFs calculated for this species are not likely reflective of true exposure point-specific uptakes (i.e., the calculated BSAFs assume the receptor spends all of its time within a given exposure area). It should be noted that the BSAF calculated for American eel for dioxin-like PCBs is considerably higher (i.e., close to 2 orders of magnitude higher) than those calculated for white sucker, the other demersal fish species evaluated; therefore it is likely that the resultant PRG calculated for the American eel is overly conservative. Because it was assumed that the belted kingfisher consumes American eel in the Dyerville exposure area, these uncertainties also apply to the sediment PRGs for dioxin-like PCBs developed for the belted kingfisher for that exposure area.

- Sediment PRGs for the belted kingfisher were calculated based on uptake and tissue data for large fish (i.e., white sucker, largemouth bass) rather than on small fish on which the kingfisher is likely to forage. Large piscivorous fish, such as the largemouth bass, would be expected to have higher concentrations of bioaccumulating contaminants than would smaller fish, and therefore PRGs based on data for these larger piscivorous fish are likely overprotective. In addition, the kingfisher typically forages near the water surface, whereas uptake and tissue data are based on demersal (benthic-feeding) fish (except in the Manton exposure area where no demersal fish were collected). Demersal fish, which have benthic feeding habits, typically have higher exposures to contaminated sediments than pelagic fish which forage in the water column. These two factors likely result in sediment PRGs that are overprotective for the belted kingfisher.

- The ELS threshold for the channel catfish was used to develop PRGs for white sucker, largemouth bass, and American eel. However, the threshold concentrations for channel catfish are not necessarily the same as those for the other species. The channel catfish was used in the ELS study due to its relative sensitivity to dioxin relative to other species (Elonen et al., 1998). Therefore, it is a fairly conservative model for local fish populations in the Woonasquatucket River.

- Uncertainties are also associated with the maternal/egg transfer factor used to derive ELS-based PRGs. A transfer factor of 0.7 was used (consistent with values from the literature) rather than the calculated transfer factor of 0.35 (Appendix H of the BERA [MACTEC, 2004]). The literature-based transfer factor was conservatively used because

the calculated transfer factor was based on concentrations measured in a single white sucker female and its eggs.

- The CBR values used to develop sediment PRGs for demersal and pelagic fish are based on literature values for fish. There are uncertainties associated with these values because they are not site-specific, and they are not necessarily specific to white sucker or largemouth bass, the species for which PRGs were developed. The CBR values that were used pertain to some fish species that may not occur in the study area. For example, the NOAEL CBR value for technical chlordane is based on a study involving spot (*Leiostomus xanthurus*), a saltwater fish, while the LOAEL CBR value for this COC is based on a study involving the sheepshead minnow (*Cyprinodon variegates*), an estuarine species (Table G-3 of the BERA [MACTEC, 2004]). The CBRs for dioxin TEQ are based on a study involving lake trout (*Salvelinus namaycush*), a cold water fish (Table G-9 of the BERA [MACTEC, 2004]). Similar uncertainties are associated with bird egg CBR values used to develop sediment PRGs for tree swallow eggs. Because CBR-based sediment PRGs for demersal and pelagic fish are lower than corresponding PRGs calculated using the ELS-thresholds (which, as described above, involve conservative assumptions), the CBR values used for fish are likely conservative.

- The kingfisher dioxin TEQ TRV is based on a chronic study involving interperitoneal injection of 2,3,7,8-TCDD to the ring-necked pheasant (*Phasianus colchicus*) (Table D-4 of the BERA [MACTEC, 2004]). Measurement endpoints were egg production and hatchability. Because the dose was administered via interperitoneal injection, rather than in the diet, the TRV used is likely to be conservative, although the relative sensitivities of the belted kingfisher and the ring-necked pheasant to 2,3,7,8-TCDD are uncertain.

Uncertainties with Potentially Under-protective Biases:

- The receptors for which PRGs were developed are not necessarily the most sensitive receptors present in the exposure areas evaluated. In general, PRGs were developed for the most sensitive species evaluated in the BERA; however other species not evaluated in the BERA may be more sensitive to exposures to COCs at the site. In addition, it should be noted that PRGs for insectivorous wildlife were developed for the tree swallow (due to the extensive data available for this species); however, incremental risks calculated in the BERA were generally higher for the little brown bat. Therefore, the ecological PRGs may not be protective of population effects in bats.

- Surface water exposures were not evaluated in the development of PRGs. However, risks to wildlife receptors from surface water exposures were found to constitute only a very small fraction of overall risks.

- Floodplain soil PRGs protective of the short-tailed shrew were calculated using literature-based plant BAFs rather than site-specific plant tissue data; thus there are uncertainties associated with the BAFs used. In addition, no plant BAF was available for dioxin TEQ. Therefore, the PRGs developed for dioxin TEQ take into account only dietary exposures from earthworms and likely result in an under-protective PRG. However, because plants constitute only a minor percentage of the shrew's diet (i.e., approximately 14%) these uncertainties are unlikely to significantly impact the calculated PRGs.

- The short-tailed shrew dioxin TEQ TRV is based on a chronic study involving administration of 2,3,7,8-TCDD to rats in their diet (Table D-4 of the BERA [MACTEC, 2004]). Effects on fertility and neonatal survival were measured. This study was appropriate in that it used relevant measurement endpoints, was chronic, and involved administration of the contaminant in the diet. However, the rat may be a less sensitive receptor than the short-tailed shrew due to its selection/breeding for laboratory use, general tolerance of urban conditions, and general lack of other environmental stressors to which the shrew and other wild small mammals would be exposed, potentially resulting in a TRV that is under-protective.

- Uncertainties are associated with the use of Toxicity Equivalent Factors (TEFs) used to estimate wildlife exposures to dioxin, furan, and PCB congeners. This approach was used because there is not adequate toxicity testing for each of the hundreds of dioxin and furan congeners. Because 2,3,7,8-TCDD, the most toxic congener, is the predominant congener in environmental media at the four exposure areas, the use of TEFs is associated with fewer uncertainties than if 2,3,7,8-TCDD was not the predominant congener. The use of TEFs does not account for antagonistic or synergistic interactions between congeners and therefore may underestimate risks to wildlife.

  PRGs protective of the benthic macroinvertebrates community were not specifically developed; therefore there are uncertainties as to whether the calculated PRGs would be protective of this group. In general, COCs constituting the majority of risks at the site pose primarily bioaccumulation hazards; therefore, the PRGs protective of higher trophic levels will likely be protective of benthic macroinvertebrates. As noted in Section 1.2, locations with elevated concentrations of PAHs (a COPC specific to invertebrates) occur within locations with elevated concentrations of TCDD TEQ (the primary site contaminant of concern). Therefore, remedial actions to address risks due to dioxin exposure would also address risks associated with PAH exposures, for which no PRGs were developed.

- Uncertainties are associated with the use of EC_{10} and EC_{25} values to develop sediment PRGs protective of demersal and pelagic fish. The use of EC_{10} and EC_{25} values, which are less conservative than NOAEL- and LOAEL-based threshold values, may underestimate risks. However, the EC_{10} and EC_{25} values were derived from a site-specific study and therefore are likely to provide a more precise and relevant approximation of critical threshold concentrations for the site than would literature-based NOAEL and LOAEL values. Because other uncertainties associated with the ELS study have potentially conservative biases (i.e., the study involves a relatively sensitive fish species and uses a conservative maternal/egg transfer factor), results of the ELS study are likely to be overall conservatively biased.

Uncertainties with Neutral or Unknown Biases:

- The breach of the Allendale Dam may have impacted the distribution of fish between Allendale Pond and Lyman Mill Pond and the relationship between biota tissue concentrations and associated sediment concentrations. In order to minimize the impact of the dam breach on PRG development, fish tissue data from Lyman Mill Pond

(immediately downstream of the Allendale Dam) were not used to develop BSAFs for PRG development. The BSAFs were reasonably consistent among the exposure areas, suggesting that the data utilized in BSAF and PRG development were appropriate.

- The data for the four exposure areas that were used to develop PRGs may not be equally representative of true concentrations in those areas due to differences in the numbers of samples collected. For example, in Allendale, data for 13 white sucker tissue samples were used to develop BSAFs, while in Manton, BSAF values for largemouth bass are based on data from only three samples (Table 3-1). To minimize data uncertainties, geometric mean concentrations of both TOC-normalized sediment (or floodplain soil) and lipid-normalized biota tissue concentrations were used to calculate BSAFs and BMFs. (Geometric mean concentrations of unnormalized data were used to calculate BSAFs for inorganic COCs). In addition, apparent outlying data (i.e., data that appeared to be outside of the range of typical values) were not used in the development of PRGs.

- Uncertainties are associated with the BSAFs and BMFs used in the PRG calculations due to variability in detected concentrations of COCs in sediment/floodplain soil or biota samples collected from different locations (or different individuals) from a given exposure area. Generally, the BSAFs were reasonably consistent among the exposure areas, suggesting that the data utilized in BSAF and PRG development were appropriate. The variability in detected concentrations of COCs (as measured by the coefficient of variation) was generally highest for TOC-normalized concentrations of dioxin TEQ in sediment. Very high variability was associated with lipid-normalized concentrations of dioxin TEQ in tree swallow stomach content samples collected from Greystone; however because these data pertain to the background location they were not used to develop sediment PRGs. Where available, published BSAFs were generally consistent with the BSAFs calculated for the Site.

- Exposure parameters used to develop PRGs for the belted kingfisher and short-tailed shrew (e.g., dietary composition, ingestion rate, body weight, etc.) are based on average values from the literature for adult females. There are uncertainties associated with the use of these values, as natural populations may exhibit considerable variability in these parameters, and the average values used from the literature do not necessarily correspond to average values for the populations in the study area.

- Potential uncertainties are associated with the literature-derived toxicity reference values (TRVs) used in the development of PRGs for piscivorous wildlife (belted kingfisher) and vermivorous wildlife (short-tailed shrew). The TRVs used for the belted kingfisher are not specific to that species but rather were derived from studies involving other types of birds including chickens, pheasants, and pelicans. The TRVs used for the short-tailed shrew were derived from studies involving mice and rats. Chronic toxicological data were selected preferentially in developing TRVs; however these data were not always available. Therefore, there are uncertainties in extrapolating the results of shorter term exposures to chronic exposures assumed for receptors at the Site. Due to limited toxicological data, for some COCs, TRVs for surrogate chemicals were used (e.g., TRVs for 4,4'-DDT were used as a surrogate for 4,4'-DDD and 4,4'-DDE). Uncertainties are also associated with the extrapolation of literature-derived toxicity endpoints (especially laboratory-based studies) to endpoints for Site receptors because of discrepancies in

exposure conditions. (Note: uncertainties associated with TRVs for dioxin TEQ, the principle ecological stressor are discussed under separate bullets.)

- There is some variability in the two measures used to evaluate female tree swallow dietary exposures (i.e., emerging insect data versus tree swallow stomach content data). Dioxin TEQ concentrations measured in emerging insect tissue are approximately 3 times higher than concentrations measured in the stomach contents. Therefore, there are uncertainties associated with the adult female's dietary exposures, and subsequent uncertainties associated with the BSAFs and BMFs calculated. However, because the same emerging insect or stomach content concentrations are used to calculate both the BSAFs and BMFs, and the BSAF and BMF values are multiplied together to derive sediment PRGs, these concentration values cancel out. Therefore, the prey concentration data selected to calculate the BSAFs and BMFs have no overall effect on the calculated sediment PRGs.

Based on an evaluation of identified uncertainties, sediment PRGs calculated for demersal fish, pelagic fish, and the belted kingfisher are likely to be conservatively biased. Sediment PRGs for dioxins and furans were lowest for tree swallow embryos. However, because incremental risks in the BERA were higher for the little brown bat, these PRGs may not be protective of bat populations. Considerable uncertainties are associated with sediment PRGs that were calculated using data for the American eel; therefore, it is recommended that PRGs based on these data not be used to establish remediation levels.

5.0 COMPARISON OF PRGS TO BACKGROUND CONDITIONS

5.1 SEDIMENT COMPARISONS

Table 5-1 compares sediment PRGs calculated for each of the endpoint receptors to the corresponding sediment concentrations at the Greystone Mill Pond background area. These comparisons are made in order to identify analytes for which background conditions may be limiting factors in setting site-specific PRGs (i.e., In cases where the calculated PRG is below concentrations detected in the background, it may be more appropriate to remediate to background levels). For a given COC and endpoint receptor, the geometric mean of the PRGs for all the exposure areas is used as the representative PRG. The PRGs used for these comparisons are based on an HQ of 1.

MATC-based sediment PRGs for aluminum, selenium, vanadium, and zinc are below the respective average concentrations detected in the background area. In addition, the LOAEL-based PRGs for barium (the only endpoint calculated for this COC) are below the average background concentration of this COC. The lowest MATC-based PRGs for technical chlordane and 4,4'-DDE (i.e., those for the most sensitive receptors – white sucker and belted kingfisher, respectively) are less than the average concentrations of these COCs detected in the background area; and the lowest MATC-based PRGs for 4,4'-DDD, total Aroclors, Aroclor-1254, and dioxin-like PCBs (i.e., those for the belted kingfisher, white sucker, and white sucker/American eel) are less than the maximum (but not average) concentrations detected in the background area[1]. Therefore, background concentrations may be limiting factors in establishing sediment PRGs for metals, Aroclors, pesticides, and dioxin-like PCBs. Because PRGs derived for dioxin TEQ exceed the maximum concentrations detected in the background area, background concentrations are not limiting factors in establishing a PRG for this COC.

5.2 FLOODPLAIN SOIL COMPARISONS

Table 5-2 compares floodplain soil PRGs calculated for the short-tailed shrew to chemical concentrations detected in floodplain soil samples collected from the background area. The geometric mean PRGs used in the table are based on an HQ of 1. As seen in Table 5-2, MATC-based floodplain soil PRGs for arsenic, selenium, cadmium, and dioxin TEQ are below the respective average concentrations detected in the background area; therefore, background concentrations may be limiting factors in establishing PRGs for this COCs. The MATC-based PRG for Aroclor-1254 exceeds the maximum concentration detected at the background location; therefore background concentrations would be of less relevance in establishing a floodplain soil PRG for this COC.

[1] If sediment PRGs for dioxin-like PCBs for white sucker/American eel are not considered (due to uncertainties discussed in Section 4), PRGs for the next most sensitive receptor (i.e., tree swallow embryos) are still below the maximum concentrations detected in the background area.

6.0 COMPARISON OF SITE CONCENTRATIONS TO PRGS

6.1 SITE SEDIMENT CONCENTRATIONS VERSUS CALCULATED PRGS

Figures 6-1 through 6-12 compare the concentrations of COCs detected in sediment across the study area to the calculated PRGs. These figures are presented to provide a general overview of the areas presenting the greatest risks to ecological receptors from sediment-based exposures; thus showing where remediation efforts should be focused. For each COC evaluated, concentrations detected in sediment are compared to the geometric mean PRG (i.e., the geometric mean of the PRGs calculated for each of the exposure areas evaluated) for the most sensitive receptor and measurement endpoint for that COC. The PRGs shown in the figures are based on an HQ of 1. Comparisons are made to NOAEL-, LOAEL-, and MATC-based PRG values.

LOAEL-based PRGs for dioxin TEQ (Tree swallow egg CBR-based) are exceeded at numerous site locations (Figure 6-1) but the NOAEL- LOAEL- and MATC-based PRGs are not exceeded in the background area (Table 5-1). PRGs developed for the most sensitive receptors for dioxin-like PCBs, technical chlordane, 4,4'-DDD, 4,4'-DDE, Aroclor-1254, total Aroclors, aluminum, barium, selenium, vanadium, and zinc are exceeded at numerous site locations but are also exceeded at the Greystone background location (Figures 6-2 through 6-12; Table 5-1).

6.2 SITE FLOODPLAIN SOIL CONCENTRATIONS VERSUS CALCULATED PRGS

Figures 6-13 through 6-17 compare the concentrations of COCs detected in floodplain soil across the study area to the calculated floodplain soil PRGs. The floodplain soil PRGs are based on risks to the short-tailed shrew (the only receptor for which floodplain soil PRGs were developed). For each COC, concentrations detected in floodplain soil are compared to the geometric mean of the PRGs calculated for each of the exposure areas (i.e., Allendale and Lyman Mill). The PRGs shown in the figures are based on an HQ of 1. Comparisons are made to NOAEL-, LOAEL-, and MATC-based PRG values.

As seen in these figures, MATC- and LOAEL-based PRGs for dioxin TEQ, arsenic, and selenium are exceeded at a number of site floodplain soil sample locations (Figures 6-13, 6-15, 6-17). However, as noted in Section 5.2, these PRGs are also exceeded at the Greystone background location. Although the MATC-based PRG is exceeded for cadmium at a few site sample locations, this PRG is also exceeded at the background location (Figure 6-16; Table 5-2). MATC and LOAEL-based PRGs for Aroclor-1254 are exceeded at some site locations (Figure 6-14) but are not exceeded at the Greystone background area.

7.0 SUMMARY

Ecologically-based Preliminary Remediation Goals (PRGs) were derived for sediment and floodplain soil at the Centredale Manor Restoration Project (CMRP) Superfund Site based on risks identified in the Baseline Ecological Risk Assessment (BERA) (MACTEC, 2004). PRGs were developed for these media because ecological receptors exposed to contaminants in these media, either directly or through biological uptake, are apparently at substantial risk of harm.

In general, PRGs were developed based on measurement endpoints used in the BERA, and were calculated for No Observed Adverse Effect Level (NOAEL), Lowest Observed Adverse Effect Level (LOAEL), and Maximum Allowable Toxicant Concentration (MATC) endpoints where available. For each of these endpoints (NOAEL, LOAEL, and MATC), PRGs were calculated based on target Hazard Quotient (HQ) values of 0.1, 1.0, and 10.

Sediment PRGs were developed for demersal fish (white sucker and American eel), pelagic fish (largemouth bass), piscivorous wildlife (belted kingfisher), and insectivorous wildlife (tree swallow embryos). These PRGs were developed for four exposure areas (Allendale, Lyman Mill, Manton, and Dyerville) and for the following chemicals of concern (COCs): dioxins and furans, dioxin-like PCBs, Aroclor-1254, total Aroclors, technical chlordane, 4,4'-DDD, 4,4'-DDE, aluminum, barium, selenium, vanadium, and zinc. Overall, sediment PRGs for dioxins and furans are lowest for tree swallow embryos (CBR-based PRGs); sediment PRGs for 4,4'-DDD, 4,4'-DDE, and total Aroclor are lowest for the belted kingfisher; sediment PRGs for dioxin-like PCBs are lowest for the American eel; sediment PRGs for technical chlordane, Aroclor-1254, and selenium are lowest for white sucker (CBR-based PRGs); and sediment PRGs for the other metals evaluated (aluminum, barium, vanadium, and zinc) are lowest for largemouth bass (CBR-based PRGs). Although sediment PRGs for dioxin-like PCBs are lowest for American eel, there are considerable uncertainties associated with these PRGs because they are based on analytical data for a single American eel tissue sample. If PRGs for American eel are not evaluated, the lowest sediment PRGs for dioxin-like PCBs are those calculated for tree swallow embryos (CBR-based).

Floodplain soil PRGs were developed for vermivorous wildlife (short-tailed shrew) for the Allendale and Lyman Mill exposure areas. These PRGs were derived for dioxins and furans, Aroclor-1254, arsenic, cadmium, and selenium.

Sediment and floodplain soil PRGs were compared to chemical concentrations detected at the background location in these media. A geometric average of the PRGs for the different exposure areas was used in these comparisons. Detected concentrations of COCs in sediment and floodplain soil were also compared to the respective PRGs for these media in order to identify locations where the PRGs are exceeded.

Sediment PRGs for dioxins and furans exceed the maximum detected concentrations in the background area. These PRGs are exceeded at a number of sediment sample locations throughout the study area. Although sediment PRGs for metals, Aroclors, pesticides, and dioxin-like PCBs are exceeded at numerous Site locations, these PRGs are also exceeded at the background location; therefore, background concentrations may be limiting factors in establishing sediment PRGs for these COCs.

Floodplain soil PRGs for arsenic, selenium, and dioxin TEQ are exceeded at a number of Site locations but are also exceeded at the background location; therefore, background concentrations may be limiting factors in establishing floodplain soil PRGs for these COCs. PRGs for Aroclor-1254 are exceeded at some Site locations, but are not exceeded at the background location; therefore, background concentrations would be of less relevance in establishing a floodplain soil PRG for this COC.

8.0 REFERENCES

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FIGURES

LEGEND

Range of Detected Concentrations: 8.96E-8 to 0.073 mg/Kg

- Concentrations less than PRG for NOAEL (0.000099)
- Concentrations greater than PRG for NOAEL (0.000099)
- Concentrations greater than PRG for MATC (0.00017)
- Concentrations greater than PRG for LOAEL (0.00030)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-1
Summary of Dioxin Toxicity Equivalency - Birds Concentrations in Sediment Relative to Tree Swallow Egg Tissue CBR-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

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LEGEND

Range of Detected Concentrations: 1.27E-5 to 0.00021 mg/Kg

- Concentrations less than PRG for NOAEL (0.000034)
- Concentrations greater than PRG for NOAEL (0.000034)
- Concentrations greater than PRG for MATC (0.000043)
- Concentrations greater than PRG for LOAEL (0.000054)

PRGs calculated using White Sucker in Lyman Mill and American Eel in Dyerville.

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

Figure 6-2
Summary of Dioxin Toxicity Equivalency (PCB) - Fish Concentrations in Sediment Relative to Demersal Fish ELS-Based Preliminary Remediation Goals (HQ=1)

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Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

MACTEC

Prepared By: KJA
Checked By: BJR
Approved By: MJM

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LEGEND

Range of Detected Concentrations: 0.06385 to 2.21273 mg/Kg

× Concentrations less than PRG for NOAEL, LOAEL and MATC (0.014)

■ Concentrations greater than PRG for NOAEL, LOAEL and MATC (0.014)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-3
Summary of Technical Chlordane Concentrations in Sediment Relative to White Sucker CBR-Based Preliminary Remediation Goals (HQ=1)

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Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

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LEGEND

Range of Detected Concentrations: 0.00002 to 0.052 mg/Kg

- Concentrations less than PRG for NOAEL (0.0016)
- Concentrations greater than PRG for NOAEL (0.0016)
- Concentrations greater than PRG for MATC (0.0051)
- Concentrations greater than PRG for LOAEL (0.016)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-4
Summary of 4,4-DDD Concentrations in Sediment Relative to Belted Kingfisher-Based Preliminary Remediation Goals (HQ=1)

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Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: SGH

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LEGEND

Range of Detected Concentrations: 0.00031 to 0.2 mg/Kg

- Concentrations less than PRG for NOAEL (0.0011)
- Concentrations greater than PRG for NOAEL (0.0011)
- Concentrations greater than PRG for MATC (0.0036)
- Concentrations greater than PRG for LOAEL (0.011)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

Figure 6-5
Summary of 4,4-DDE Concentrations in Sediment Relative to Belted Kingfisher-Based Preliminary Remediation Goals (HQ=1)

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Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

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Prepared By: KJA
Checked By: BJR
Approved By: SGH

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LEGEND

Range of Detected Concentrations: 0.011 to 27 mg/Kg

- Concentrations less than PRG for NOAEL (0.20)
- Concentrations greater than PRG for NOAEL (0.20)
- Concentrations greater than PRG for MATC (0.25)
- Concentrations greater than PRG for LOAEL (0.31)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-6
Summary of Aroclor-1254 Concentrations in Sediment Relative to White Sucker CBR-Based Preliminary Remediation Goals (HQ=1)

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Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

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LEGEND

Range of Detected Concentrations: 0.011 to 27 mg/Kg

- Concentrations less than PRG for NOAEL (0.12)
- Concentrations greater than PRG for NOAEL (0.12)
- Concentrations greater than PRG for MATC (0.20)
- Concentrations greater than PRG for LOAEL (0.31)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

Figure 6-7
Summary of Aroclor, Total Concentrations in Sediment Relative to Belted Kingfisher-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

MACTEC

Prepared By: KJA
Checked By: BJR
Approved By: SGH

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GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

LEGEND

Range of Detected Concentrations: 1640 to 27773 mg/Kg

- Concentrations less than PRG for NOAEL (206)
- Concentrations greater than PRG for NOAEL (206)
- Concentrations greater than PRG for MATC (583)
- Concentrations greater than PRG for LOAEL (1648)

MAGNETIC

SCALE IN FEET:

0 300 600

MACTEC

Figure 6-8
Summary of Aluminum Concentrations in Sediment
Relative to Largemouth Bass CBR-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: SGH

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LEGEND

Range of Detected Concentrations: 7.6 to 380 mg/Kg

- Concentrations less than PRG for LOAEL (20.0)
- Concentrations greater than PRG for LOAEL (20.0)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

DYERVILLE POND

DYERVILLE DAM

Figure 6-9
Summary of Barium Concentrations in Sediment Relative to Largemouth Bass CBR-Based Preliminary Remediation Goals (HQ=1)

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Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

MACTEC

Prepared By: KJA
Checked By: BJR
Approved By: SGH

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MACTEC

Figure 6-10
Summary of Selenium Concentrations in Sediment Relative to White Sucker CBR-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
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LEGEND

Range of Detected Concentrations: 4.8 to 129 mg/Kg

- Concentrations less than PRG for NOAEL (3.1)
- Concentrations greater than PRG for NOAEL (3.1)
- Concentrations greater than PRG for MATC (14.1)
- Concentrations greater than PRG for LOAEL (63.9)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

Prepared By: KJA
Checked By: BJR
Approved By: SGH

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/Task26 - Ecological PRGs/ECO PRGs July 2005/SURFER/Vanadium PRG.SRF

MACTEC

Figure 6-11
Summary of Vanadium Concentrations in Sediment Relative to Largemouth Bass CBR-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

LEGEND

Range of Detected Concentrations: 4.8 to 129 mg/Kg

- Concentrations less than PRG for NOAEL (3.1)
- Concentrations greater than PRG for NOAEL (3.1)
- Concentrations greater than PRG for MATC (14.1)
- Concentrations greater than PRG for LOAEL (63.9)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-11
Summary of Vanadium Concentrations in Sediment Relative to Largemouth Bass CBR-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: SGH

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/Task26 - Ecological PRGs/ECO PRGs July 2005/SURFER/Vanadium PRG.SRF

LEGEND

Range of Detected Concentrations: 8.5E-7 to 0.281 mg/Kg

- Concentrations less than PRG for NOAEL (0.000011)
- Concentrations greater than PRG for NOAEL (0.000011)
- Concentrations greater than PRG for MATC (0.000036)
- Concentrations greater than PRG for LOAEL (0.00011)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

Figure 6-13
Summary of Dioxin Toxicity Equivalency - Mammals Concentrations in Floodplain Soil Relative to Short-tailed Shrew-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

MACTEC

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/Task26 - Ecological PRGs/ECO PRGs July 2005/SURFER/TEQM PRG.SRF

MACTEC

Figure 6-14
Summary of Arsenic Concentrations in Floodplain Soil Relative to Short-tailed Shrew-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/Task26 - Ecological PRGs/ECO PRGs July 2005/SURFER/Arsenic PRG.SRF

MACTEC

Figure 6-15
Summary of Cadmium Concentrations in Floodplain Soil Relative to Short-tailed Shrew-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/Task26 - Ecological PRGs/ECO PRGs July 2005/SURFER/Cadmium PRG.SRF

LEGEND

Range of Detected Concentrations: 0.48 to 1.4 mg/Kg

- Concentrations less than PRG for NOAEL (0.12)
- Concentrations greater than PRG for NOAEL (0.12)
- Concentrations greater than PRG for MATC (0.16)
- Concentrations greater than PRG for LOAEL (0.2)

SCALE IN FEET:

0 300 600

MAGNETIC

GREYSTONE MILL POND DAM

ALLENDALE POND

ALLENDALE DAM

ASSAPUMPSET BROOK

WOONASQUATUCKET RIVER

LYMAN MILL POND

LYMAN MILL DAM

MANTON POND

MANTON DAM

WOONASQUATUCKET RIVER

DYERVILLE POND

DYERVILLE DAM

MACTEC

Figure 6-16
Summary of Selenium Concentrations in Floodplain Soil Relative to Short-tailed Shrew-Based Preliminary Remediation Goals (HQ=1)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Prepared By: KJA
Checked By: BJR
Approved By: MJM

P:/W9-GVT/COE-NAE/BATTELLE/CENTREDALE/Task26 - Ecological PRGs/ECO PRGs July 2005/SURFER/SeleniumFP PRG.SRF

TABLES

Table 1-1
Summary of Preliminary Remediation Goals (PRGs) Developed for Ecological Receptors

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR	MEDIUM	RISK BASIS	Chemicals of Concern			
			Allendale	Lyman Mill	Manton	Dyerville
Demersal Fish/ White Sucker [1]	Sediment	Generic Critical Body Residue (CBR) threshold	dioxins and furans, Aroclor-1254, technical chlordane, selenium, zinc	dioxins and furans, Aroclor-1254, technical chlordane, 4,4'-DDE, 4,4'-DDD, aluminum, barium, selenium, vanadium, zinc	not evaluated (no demersal fish data)	not evaluated (no white sucker data)
		Site-specific Early Life Stage (ELS) threshold	dioxins and furans	dioxins and furans, dioxin-like PCBs	not evaluated (no demersal fish data)	dioxins and furans, dioxin-like PCBs (American eel data used)
Pelagic Fish/ Largemouth Bass	Sediment	Generic Critical Body Residue (CBR) threshold	not evaluated (no pelagic fish data)	dioxins and furans, technical chlordane, aluminum, barium, vanadium, zinc	aluminum, barium, vanadium	not evaluated (no pelagic fish data)
		Site-specific Early Life Stage (ELS) threshold	not evaluated (no pelagic fish data)	dioxins and furans	dioxins and furans	not evaluated (no pelagic fish data)
Piscivorous Wildlife/ Belted Kingfisher [1]	Sediment	Food chain exposure modeling (fish consumption)	dioxins and furans, Aroclor 1254, total Aroclors	dioxins and furans, dioxin-like PCBs, Aroclor 1254, total Aroclors, technical chlordane, 4,4'-DDE, 4,4'-DDD	dioxins and furans, 4,4'-DDE (largemouth bass data used)	dioxins and furans, Aroclor 1254, total Aroclors, 4,4'-DDE, 4,4'-DDD (American eel data used)
Insectivorous Wildlife/ Swallow Egg Tissue	Sediment	Generic Critical Body Residue (CBR) Threshold	dioxins and furans	dioxins and furans, dioxin-like PCBs	dioxins and furans	not evaluated (no emerging insect/stomach content data or egg data)
		Site-specific percent hatchability threshold	dioxins and furans	dioxins and furans	dioxins and furans	not evaluated (no emerging insect/stomach content data or egg data)
Vermivorous Wildlife/ Short-tailed Shrew	Floodplain Soil	Food chain exposure modeling (earthworm consumption)	dioxins and furans [2]	dioxins and furans, arsenic, cadmium, selenium	not evaluated (no floodplain soil data; minimal floodplain habitat)	not evaluated (no floodplain soil data; minimal floodplain habitat)

Note: Table derived from Table 1 of Battelle, 2005. Technical Approach for Deriving Ecological Preliminary Remediation Goals (PRGs), Centredale Manor Restoration Project Superfund Site. May 20.

[1] White sucker data used except as noted.
[2] Floodplain soil PRGs were not developed for Aroclor-1254 because this COPC is associated with samples that are located under areas that are currently paved or otherwise inaccessible.

Prepared by: SGH
Checked by: KJA

Table 2-1

Derivation of CBR-Based Fish Tissue Preliminary Remediation Goals for Demersal and Pelagic Fish

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: DEMERSAL AND PELAGIC FISH
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: CBR THRESHOLD

$$PRG_{fish} = THQ \times CBR$$

PRG_{fish} = Fish Tissue PRG
THQ = Target Hazard Quotient
CBR = Critical Body Residue

	Critical Body Residues (CBRs)		
CHEMICAL OF CONCERN	**NOAEL [1] (mg/Kg)**	**LOAEL [1] (mg/Kg)**	**MATC (mg/Kg)**
4,4-DDD	0.0080	0.60	0.069
4,4-DDE	0.042	0.29	0.11
Technical Chlordane	0.010	0.010	0.010
Aroclor-1254	0.98	1.53	1.22
Aroclor, Total	NA	NA	NA
Aluminum	1.0	8.0	2.83
Barium	NA	0.41	NA
Selenium	0.14	0.18	0.16
Vanadium	0.020	0.41	0.091
Zinc	3.9	4.5	4.19
Dioxin Toxicity Equivalency - Birds	NA	NA	NA
Dioxin Toxicity Equivalency - Fish	0.00015	0.00023	0.00019
Toxicity Equivalency (PCB) - Birds	NA	NA	NA
Toxicity Equivalency (PCB) - Fish	0.00015	0.00023	0.00019

Table 2-1

Derivation of CBR-Based Fish Tissue Preliminary Remediation Goals for Demersal and Pelagic Fish

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

CHEMICAL OF CONCERN	Calculated Fish Tissue PRGs (mg/Kg)								
	NOAEL			LOAEL			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
4,4-DDD	0.00080	0.0080	0.080	0.060	0.60	6.0	0.0069	0.069	0.69
4,4-DDE	0.0042	0.042	0.42	0.029	0.29	2.9	0.011	0.11	1.1
Technical Chlordane	0.0010	0.010	0.10	0.0010	0.010	0.10	0.0010	0.010	0.10
Aroclor-1254	0.098	0.98	9.8	0.15	1.5	15.3	0.12	1.2	12.2
Aroclor, Total	---	---	---	---	---	---	---	---	---
Aluminum	0.10	1.0	10.0	0.80	8.0	80.0	0.28	2.8	28.3
Barium	---	---	---	0.041	0.41	4.1	---	---	---
Selenium	0.014	0.14	1.4	0.018	0.18	1.8	0.016	0.16	1.6
Vanadium	0.0020	0.020	0.20	0.041	0.41	4.1	0.0091	0.091	0.91
Zinc	0.39	3.9	39	0.45	4.5	45.0	0.42	4.2	41.9
Dioxin Toxicity Equivalency - Birds	---	---	---	---	---	---	---	---	---
Dioxin Toxicity Equivalency - Fish	0.000015	0.00015	0.0015	0.000023	0.00023	0.0023	0.000019	0.00019	0.0019
Toxicity Equivalency (PCB) - Birds	---	---	---	---	---	---	---	---	---
Toxicity Equivalency (PCB) - Fish	0.000015	0.00015	0.0015	0.000023	0.00023	0.0023	0.000019	0.00019	0.0019

NA = Not Available
HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
--- = No PRG Calculated

Prepared by BJR
Checked by KJA

[1] Values from MACTEC, 2004. Baseline Ecological Risk Assessment - Interim Final. Centredale Manor Restoration Project Superfund Site North Providence, Rhode Island. Prepared under contract to Battelle for USACOE, Contract No. DACW33-01-D-0004. September 30. Table G-1. (all effects data used)

Table 2-2

Derivation of ELS-Based Fish Tissue Preliminary Remediation Goals for Demersal and Pelagic Fish

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: DEMERSAL AND PELAGIC FISH
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: ELS THRESHOLD

$$PRG_{fish} = \frac{THQ \times ELS_{Thresh}}{METF}$$

PRG_{fish} = Fish tissue PRG
THQ = Target Hazard Quotient
ELS_{Thresh} = Early Life Stage Based Threshold
METF = Maternal/Egg Transfer Factor

CHEMICAL OF CONCERN	Early Life Stage Thresholds (ELS_{thresh}) [1]		
	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)
Dioxin Toxicity Equivalency - Fish	0.000319	0.000510	0.000403
Toxicity Equivalency (PCB) - Fish	0.000319	0.000510	0.000403

Maternal / Egg Transfer Factor [2]
0.7

CHEMICAL OF CONCERN	Calculated Tish Tissue PRGs (mg/Kg)								
	EC_{10}			EC_{25}			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	0.0000456	0.000456	0.00456	0.0000729	0.000729	0.00729	0.0000576	0.000576	0.00576
Toxicity Equivalency (PCB) - Fish	0.0000456	0.000456	0.00456	0.0000729	0.000729	0.00729	0.0000576	0.000576	0.00576

EC_{10} = Effect Concentration for 10 % of tested organisms
EC_{25} = Effect Concentration for 25 % of tested organisms
HQ = Hazard Quotient
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of EC_{10} & EC_{25}
PRG = Preliminary Remediation Goal

Prepared by: KJA
Checked by: SGH

[1] EC_{10} and EC_{25} values are from Appendix H (Early Life Stage Toxicity Report) Table 3.11A of MACTEC, 2004. Baseline Ecological Risk Assessment - Interim Final. Centredale Manor Restoration Project Superfund Site North Providence, Rhode Island. Prepared under contract to Battelle for USACOE, Contract No. DACW33-01-D-0004. September 30.

[2] Literature-based value: the transfer factor is the percentage of the contamination concentration in the adult female fish tissue that is transferred to the egg (i.e., 70%)

Derivation of Biota Sediment Accumulation Factors (BSAFs) for Demersal Fish

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

4,4'-DDD	TOC - Normalized Sediment Concentration								Lipid - Normalized White Sucker Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect WSln mg/kg	ArithMean WSln mg/kg	Variance WSln mg/kg	Standard Deviation WSln mg/kg	Coefficient of Variation %	GeoMean WSln mg/kg	BSAF WS
Assapumpset	2	5	3.77E-01	1.38E-01	1.87E-02	1.37E-01	99.3	1.01E-01								NS	NE [3]
Greystone	4	7	2.41E-01	1.11E-01	5.57E-03	7.46E-02	67.5	8.58E-02	10	10	3.75E-01	1.87E-01	7.30E-03	8.55E-02	45.7	1.72E-01	2.00E+00
Allendale	13	33	1.83E+00	2.22E-01	1.32E-01	3.64E-01	163.7	8.65E-02	10	10	4.01E-01	1.99E-01	9.26E-03	9.62E-02	48.4	1.80E-01	2.08E+00
Lyman Mill								NE [1]								NE [1]	2.04E+00
Manton	0	3	ND	2.99E-01	8.24E-02	2.87E-01	96.1	2.01E-01								NS	NE [3]
Dyerville [2]	1	3	1.48E+00	6.29E-01	5.52E-01	7.43E-01	118.1	3.72E-01	3	3	4.07E-02	2.95E-01	3.05E-03	5.52E-02	18.7	2.91E-01	7.84E-01

4,4'-DDE	TOC - Normalized Sediment Concentration								Lipid - Normalized White Sucker Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect WSln mg/kg	ArithMean WSln mg/kg	Variance WSln mg/kg	Standard Deviation WSln mg/kg	Coefficient of Variation %	GeoMean WSln mg/kg	BSAF WS
Assapumpset	2	5	3.77E-01	1.57E-01	1.58E-02	1.26E-01	80.1	1.29E-01								NS	NE [3]
Greystone	4	7	2.62E-01	1.02E-01	6.84E-03	8.27E-02	80.8	7.64E-02	10	10	1.23E+00	4.89E-01	9.60E-02	3.10E-01	63.4	4.20E-01	5.50E+00
Allendale	19	38	1.01E+00	1.77E-01	6.04E-02	2.46E-01	139.0	8.91E-02	10	10	9.38E-01	4.69E-01	6.73E-02	2.59E-01	55.3	4.05E-01	4.54E+00
Lyman Mill								NE [1]								NE [1]	5.02E+00
Manton	0	3	ND	2.99E-01	8.24E-02	2.87E-01	96.1	2.01E-01								NS	NE [3]
Dyerville [2]	2	3	1.48E+00	6.28E-01	5.66E-01	7.52E-01	119.7	3.14E-01	3	3	0.01474	9.32E-02	1.50E-03	3.87E-02	41.6	8.70E-02	2.77E-01

Technical Chlordane	TOC - Normalized Sediment Concentration								Lipid - Normalized White Sucker Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect WSln mg/kg	ArithMean WSln mg/kg	Variance WSln mg/kg	Standard Deviation WSln mg/kg	Coefficient of Variation %	GeoMean WSln mg/kg	BSAF WS
Assapumpset	2	2	3.55E+00	2.49E+00	2.23E+00	1.49E+00	60.0	2.26E+00								NS	NE [3]
Greystone	4	4	1.12E+01	7.06E+00	9.56E+00	3.09E+00	43.8	6.60E+00	10	10	6.10E+00	2.96E+00	1.26E+00	1.12E+00	37.9	2.84E+00	4.30E-01
Allendale	9	9	1.30E+01	8.36E+00	6.64E+00	2.58E+00	30.8	7.97E+00	10	10	1.43E+01	5.24E+00	1.41E+01	3.75E+00	71.6	4.31E+00	5.41E-01
Lyman Mill								NE [1]								NE [1]	4.86E-01
Manton	0	0	NA	NA	NA	NA	NA	NA								NS	NE [3]
Dyerville [2]	0	0	NA	NA	NA	NA	NA	NA	3	3	3.88E-01	2.57E+00	4.53E-01	6.73E-01	26.2	2.52E+00	NE [3]

Table 2-3
Derivation of Biota Sediment Accumulation Factors (BSAFs) for Demersal Fish

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Aroclor-1254	TOC - Normalized Sediment Concentration								Lipid - Normalized White Sucker Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect WSln mg/kg	ArithMean WSln mg/kg	Variance WSln mg/kg	Standard Deviation WSln mg/kg	Coefficient of Variation %	GeoMean WSln mg/kg	BSAF WS
Assapumpset	3	5	3.77E+00	1.53E+00	1.67E+00	1.29E+00	84.3	1.21E+00								NS	NE [3]
Greystone	7	7	7.93E+00	3.22E+00	7.35E+00	2.71E+00	84.3	2.39E+00	10	10	4.52E+00	2.21E+00	1.17E+00	1.08E+00	49.0	2.00E+00	8.40E-01
Allendale	35	38	4.80E+01	9.50E+00	1.26E+02	1.12E+01	118.3	4.73E+00	10	10	5.49E+01	2.54E+01	2.16E+02	1.47E+01	57.8	2.16E+01	4.57E+00
Lyman Mill								NE [1]								NE [1]	2.71E+00
Manton	0	3	ND	2.77E+00	6.43E+00	2.54E+00	91.6	1.93E+00								NS	NE [3]
Dyerville [2]	2	3	1.11E+02	4.68E+01	3.28E+03	5.73E+01	122.3	1.55E+01	3	3	4.50E-01	3.06E+00	5.05E-01	7.10E-01	23.2	3.01E+00	1.95E-01

Aroclor, Total	TOC - Normalized Sediment Concentration								Lipid - Normalized White Sucker Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect WSln mg/kg	ArithMean WSln mg/kg	Variance WSln mg/kg	Standard Deviation WSln mg/kg	Coefficient of Variation %	GeoMean WSln mg/kg	BSAF WS
Assapumpset	3	4	2.60E+00	1.58E+00	1.05E+00	1.02E+00	64.8	1.31E+00								NS	NE [3]
Greystone	7	7	9.80E+00	4.31E+00	9.69E+00	3.11E+00	72.2	3.36E+00	10	10	5.88E+00	2.79E+00	2.04E+00	1.43E+00	51.2	2.51E+00	7.47E-01
Allendale	35	38	5.78E+01	1.03E+01	1.48E+02	1.22E+01	118.2	5.38E+00	10	10	5.54E+01	2.59E+01	2.18E+02	1.48E+01	57.0	2.21E+01	4.11E+00
Lyman Mill								NE [1]								NE [1]	2.43E+00
Manton	0	0	NA	NA	NA	NA	NA	NA								NS	NE [3]
Dyerville [2]	1	1	3.09E+01	3.09E+01				3.09E+01	3	3	4.50E-01	3.06E+00	5.05E-01	7.10E-01	23.2	3.01E+00	9.76E-02

Aluminum	Sediment Concentration (unnormalized)								White Sucker Tissue Concentration (unnormalized)							
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect WS mg/kg	ArithMean WS mg/kg	Variance WS mg/kg	Standard Deviation WS mg/kg	Coefficient of Variation %	GeoMean WS mg/kg	BSAF WS
Assapumpset	6	6	2.18E+04	9.84E+03	5.34E+07	7.31E+03	74.3	7.59E+03								NS	NE [3]
Greystone	13	13	2.47E+04	8.21E+03	5.51E+07	7.42E+03	90.4	5.93E+03	10	10	5.28E+01	3.03E+01	2.28E+02	1.51E+01	49.8	2.68E+01	4.51E-03
Allendale	51	51	2.22E+04	1.00E+04	2.50E+07	5.00E+03	49.8	8.54E+03	10	10	2.58E+01	8.02E+00	4.75E+01	6.89E+00	85.9	5.96E+00	6.98E-04
Lyman Mill								NE [1]								NE [1]	2.61E-03
Manton	3	3	2.47E+03	2.22E+03	1.34E+05	3.66E+02	16.5	2.20E+03								NS	NE [3]
Dyerville [2]	3	3	1.07E+04	5.63E+03	1.93E+07	4.39E+03	78.0	4.68E+03	1	3	4.12E+00	1.91E+00	3.72E+00	1.93E+00	100.9	1.35E+00	2.88E-04

Barium	Sediment Concentration (unnormalized)								White Sucker Tissue Concentration (unnormalized)							
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect WS mg/kg	ArithMean WS mg/kg	Variance WS mg/kg	Standard Deviation WS mg/kg	Coefficient of Variation %	GeoMean WS mg/kg	BSAF WS
Assapumpset	6	6	2.04E+02	9.36E+01	4.80E+03	6.93E+01	74.0	7.19E+01								NS	NE [3]
Greystone	13	13	3.74E+02	1.34E+02	1.48E+04	1.22E+02	90.8	7.62E+01	10	10	1.25E+00	9.13E-01	8.01E-02	2.83E-01	31.0	8.69E-01	1.14E-02
Allendale	48	51	3.20E+02	1.38E+02	7.31E+03	8.55E+01	62.1	1.04E+02	10	10	1.45E+00	7.44E-01	1.05E-01	3.25E-01	43.7	6.87E-01	6.61E-03
Lyman Mill								NE [1]								NE [1]	9.01E-03
Manton	3	3	3.81E+01	2.44E+01	1.43E+02	1.20E+01	49.1	2.26E+01								NS	NE [3]
Dyerville [2]	3	3	1.16E+02	6.78E+01	1.89E+03	4.34E+01	64.0	5.90E+01	3	3	7.35E-01	5.19E-01	3.62E-02	1.90E-01	36.6	4.98E-01	8.44E-03

Ta 3

Derivation of Biota Sediment Accumulation Factors (BSAFs) for Demersal Fish

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Selenium	Sediment Concentration (unnormalized)								White Sucker Tissue Concentration (unnormalized)								
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect WS mg/kg	ArithMean WS mg/kg	Variance WS mg/kg	Standard Deviation WS mg/kg	Coefficient of Variation %	GeoMean WS mg/kg	BSAF WS
Assapumpset	1	6	2.20E+00	6.25E-01	6.11E-01	7.81E-01	125.1	4.08E-01								NS	NE [3]
Greystone	7	13	3.60E+00	1.14E+00	1.03E+00	1.02E+00	89.1	7.41E-01	0	10	2.24E-01	2.24E-01	0.00E+00			2.24E-01	3.02E-01
Allendale	13	49	5.30E+00	1.06E+00	1.07E+00	1.03E+00	97.4	7.49E-01	10	10	3.49E-01	2.85E-01	1.59E-03	3.99E-02	14.0	2.82E-01	3.77E-01
Lyman Mill								NE [1]								NE [1]	3.40E-01
Manton	0	3	ND	2.37E-01	5.83E-05	7.64E-03	3.2	2.37E-01								NS	NE [3]
Dyerville [2]	0	3	ND	1.60E+00	5.47E+00	2.34E+00	146.1	6.45E-01	0	3	ND	2.24E-01	9.25E-18			2.24E-01	NE [3]

Vanadium	Sediment Concentration (unnormalized)								White Sucker Tissue Concentration (unnormalized)								
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect WS mg/kg	ArithMean WS mg/kg	Variance WS mg/kg	Standard Deviation WS mg/kg	Coefficient of Variation %	GeoMean WS mg/kg	BSAF WS
Assapumpset	6	6	3.20E+01	1.70E+01	1.05E+02	1.02E+01	60.1	1.43E+01								NS	NE [3]
Greystone	13	13	1.29E+02	3.76E+01	1.16E+03	3.41E+01	90.6	2.63E+01	6	9	1.13E-01	7.97E-02	4.33E-04	2.08E-02	26.1	7.70E-02	2.93E-03
Allendale	51	51	8.93E+01	3.62E+01	3.60E+02	1.90E+01	52.4	3.03E+01	4	10	1.54E-01	9.66E-02	5.29E-04	2.30E-02	23.8	9.46E-02	3.12E-03
Lyman Mill								NE [1]								NE [1]	3.03E-03
Manton	3	3	7.10E+00	5.70E+00	1.51E+00	1.23E+00	21.6	5.62E+00								NS	NE [3]
Dyerville [2]	3	3	2.84E+01	1.60E+01	1.16E+02	1.08E+01	67.1	1.40E+01	2	3	7.78E-03	3.31E-02	2.40E-03	4.90E-02	148.0	1.11E-02	7.92E-04

Zinc	Sediment Concentration (unnormalized)								White Sucker Tissue Concentration (unnormalized)								
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect WS mg/kg	ArithMean WS mg/kg	Variance WS mg/kg	Standard Deviation WS mg/kg	Coefficient of Variation %	GeoMean WS mg/kg	BSAF WS
Assapumpset	6	6	2.27E+02	1.01E+02	5.61E+03	7.49E+01	74.5	7.94E+01								NS	NE [3]
Greystone	12	13	8.54E+02	2.21E+02	7.66E+04	2.77E+02	125.3	1.12E+02	10	10	2.11E+01	1.62E+01	6.24E+00	2.50E+00	15.4	1.60E+01	1.43E-01
Allendale	50	51	2.09E+03	3.54E+02	1.42E+05	3.76E+02	106.4	2.39E+02	10	10	2.63E+01	2.09E+01	1.30E+01	3.61E+00	17.3	2.06E+01	8.62E-02
Lyman Mill								NE [1]								NE [1]	1.15E-01
Manton	3	3	1.61E+02	7.85E+01	5.31E+03	7.29E+01	92.8	5.76E+01								NS	NE [3]
Dyerville [2]	3	3	1.93E+03	7.19E+02	1.10E+06	1.05E+03	146.0	2.65E+02	0	3	ND	1.09E+01	1.73E+00	1.32E+00	12.0	1.09E+01	NE [3]

Table 2-3
Derivation of Biota Sediment Accumulation Factors (BSAFs) for Demersal Fish

Preliminary Remediation Goals Report - Ecological
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Toxicity Equivalency - Birds	TOC - Normalized Sediment Concentration								Lipid - Normalized White Sucker Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect WSln mg/kg	ArithMean WSln mg/kg	Variance WSln mg/kg	Standard Deviation WSln mg/kg	Coefficient of Variation %	GeoMean WSln mg/kg	BSAF WS
Assapumpset	4	4	1.70E-03	5.21E-04	6.21E-07	7.88E-04	151.2	2.30E-04								NS	NE [3]
Greystone	6	6	2.14E-03	7.45E-04	5.03E-07	7.09E-04	95.2	5.45E-04	10	10	2.07E-04	7.38E-05	2.38E-09	4.88E-05	66.2	6.49E-05	1.19E-01
Allendale	31	31	2.63E-01	4.17E-02	2.97E-03	5.45E-02	130.7	1.62E-02	13	13	2.25E-02	8.82E-03	4.97E-05	7.05E-03	79.9	6.06E-03	3.75E-01
Lyman Mill								NE [1]								NE [1]	2.47E-01
Manton	3	3	2.72E-02	2.26E-02	2.78E-05	5.28E-03	23.3	2.22E-02								NS	NE [3]
Dyerville [2]	4	4	1.02E-01	2.80E-02	2.46E-03	4.96E-02	177.0	1.35E-03	3	3	7.59E-05	4.24E-04	2.18E-08	1.48E-04	34.9	4.05E-04	3.01E-01

Toxicity Equivalency - Fish	TOC - Normalized Sediment Concentration								Lipid - Normalized White Sucker Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect WSln mg/kg	ArithMean WSln mg/kg	Variance WSln mg/kg	Standard Deviation WSln mg/kg	Coefficient of Variation %	GeoMean WSln mg/kg	BSAF WS
Assapumpset	4	4	1.09E-03	3.44E-04	2.50E-07	5.00E-04	145.5	1.51E-04								NS	NE [3]
Greystone	6	6	1.46E-03	4.53E-04	2.56E-07	5.05E-04	111.5	3.04E-04	10	10	4.78E-05	1.99E-05	1.38E-10	1.18E-05	59.2	1.74E-05	5.75E-02
Allendale	31	31	2.61E-01	4.13E-02	2.93E-03	5.41E-02	131.1	1.54E-02	13	13	2.22E-02	8.77E-03	4.89E-05	7.00E-03	79.8	6.01E-03	3.89E-01
Lyman Mill								NE [1]								NE [1]	2.23E-01
Manton	3	3	2.69E-02	2.25E-02	2.70E-05	5.20E-03	23.1	2.20E-02								NS	NE [3]
Dyerville [2]	4	4	9.85E-02	2.67E-02	2.31E-03	4.80E-02	180.2	1.01E-03	3	3	7.56E-05	4.23E-04	2.15E-08	1.47E-04	34.7	4.04E-04	4.00E-01

Toxicity Equivalency (PCB) - Birds	TOC - Normalized Sediment Concentration								Lipid - Normalized White Sucker Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect WSln mg/kg	ArithMean WSln mg/kg	Variance WSln mg/kg	Standard Deviation WSln mg/kg	Coefficient of Variation %	GeoMean WSln mg/kg	BSAF WS
Assapumpset	0	0	NA	NA	NA		NA	NA								NS	NE [3]
Greystone	1	1	1.68E-03	1.68E-03				1.68E-03	1	1	1.18E-03	1.18E-03				1.18E-03	7.02E-01
Allendale	0	0	NA	NA	NA		NA	NA	6	6	9.85E-03	3.83E-03	1.60E-05	4.00E-03	104.4	2.08E-03	NE [3]
Lyman Mill								NE [1]								NE [1]	7.02E-01
Manton	0	0	NA	NA	NA		NA	NA								NS	NE [3]
Dyerville [2]	2	2	2.76E-04	2.76E-04	0.00E+00	0.00E+00	0.0	2.76E-04	1	1	0.0000198	1.47E-04				1.47E-04	5.31E-01

Table 3

Derivation of Biota Sediment Accumulation Factors (BSAFs) for Demersal Fish

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Toxicity Equivalency (PCB) - Fish	TOC - Normalized Sediment Concentration								Lipid - Normalized White Sucker Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect WSln mg/kg	ArithMean WSln mg/kg	Variance WSln mg/kg	Standard Deviation WSln mg/kg	Coefficient of Variation %	GeoMean WSln mg/kg	BSAF WS
Assapumpset	0	0	NA	NA	NA		NA	NA								NS	NE [3]
Greystone	1	1	6.07E-05	6.07E-05				6.07E-05	1	1	1.20E-05	1.20E-05				1.20E-05	1.97E-01
Allendale	0	0	NA	NA	NA		NA	NA	6	6	3.48E-04	1.33E-04	2.19E-08	1.48E-04	111.2	6.03E-05	NE [3]
Lyman Mill								NE [1]								NE [1]	1.97E-01
Manton	0	0	NA	NA	NA		NA	NA								NS	NE [3]
Dyerville [2]	2	2	5.50E-07	5.50E-07	0.00E+00	0.00E+00	0.0	5.50E-07	1	1	1.06E-06	7.85E-06				7.85E-06	1.43E+01

NS = Not Sampled
NE = Not Evaluated
ND = Not Detected

Prepared by: BJR
Checked by: KJA

[1] Data for Lyman Mill were not used; BSAF values for Lyman Mill are arithmetic means of the BSAFs for the other exposure areas (excluding Dyerville where only American eel data were collected).

[2] Data for Dyerville are for American Eel.

[3] BSAF not evaluated because the chemical was not detected in biota tissue and/or was not analyzed for in sediment or biota tissue.

NA = Not Analyzed

Shading indicates no available data

ArithMean = arithmetic mean

GeoMean = geometric mean

SEDocn = organic carbon-normalized concentration in sediment

WSln = lipid-normalized concentration in white sucker

mg/kg = milligrams per kilogram

Notes: BSAFs were derived as the ratio of the lipid-normalized white sucker tissue and carbon-normalized sediment concentrations

All data extracted from site database (MACTEC, 2005)

Half of the detection limit was used to calculate mean, variance, standard deviation, coefficient of variation and geomean when the chemical was not detected.

Derivation of Biota Sediment Accumulation Factors (BSAFs) for Pelagic Fish

Preliminary Remediation Goals Report - Ecological
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4,4'-DDD	TOC - Normalized Sediment Concentration								Lipid - Normalized Largemouth Bass Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect LMBln mg/kg	ArithMean LMBln mg/kg	Variance LMBln mg/kg	Standard Deviation LMBln mg/kg	Coefficient of Variation %	GeoMean LMBln mg/kg	BSAF LMB
Assapumpset	2	5	3.77E-01	1.38E-01	1.87E-02	1.37E-01	99.3	1.01E-01	4	4	3.44E-01	1.97E-01	1.17E-02	1.08E-01	54.7	1.77E-01	1.75E+00
Greystone	4	7	2.41E-01	1.11E-01	5.57E-03	7.46E-02	67.5	8.58E-02	10	10	3.31E-01	2.07E-01	7.37E-03	8.58E-02	41.5	1.90E-01	2.21E+00
Allendale	13	33	1.83E+00	2.22E-01	1.32E-01	3.64E-01	163.7	8.65E-02								NS	NE
Lyman Mill								NE [1]								NE [1]	2.01E+00
Manton	0	3	ND	2.99E-01	8.24E-02	2.87E-01	96.1	2.01E-01	3	3	5.71E-01	4.26E-01	1.58E-02	1.26E-01	29.5	4.15E-01	2.07E+00
Dyerville	1	3	1.48E+00	6.29E-01	5.52E-01	7.43E-01	118.1	3.72E-01								NS	NE

4,4'-DDE	TOC - Normalized Sediment Concentration								Lipid - Normalized Largemouth Bass Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect LMBln mg/kg	ArithMean LMBln mg/kg	Variance LMBln mg/kg	Standard Deviation LMBln mg/kg	Coefficient of Variation %	GeoMean LMBln mg/kg	BSAF LMB
Assapumpset	2	5	3.77E-01	1.57E-01	1.58E-02	1.26E-01	80.1	1.29E-01	4	4	3.71E+00	1.67E+00	2.17E+00	1.47E+00	88.4	1.21E+00	9.41E+00
Greystone	4	7	2.62E-01	1.02E-01	6.84E-03	8.27E-02	80.8	7.64E-02	10	10	1.25E+01	3.99E+00	1.55E+01	3.93E+00	98.5	2.34E+00	3.06E+01
Allendale	19	38	1.01E+00	1.77E-01	6.04E-02	2.46E-01	139.0	8.91E-02								NS	NE
Lyman Mill								NE [1]								NE [1]	1.87E+01
Manton	0	3	ND	2.99E-01	8.24E-02	2.87E-01	96.1	2.01E-01	3	3	8.77E+00	4.26E+00	1.55E+01	3.93E+00	92.3	3.22E+00	1.60E+01
Dyerville	2	3	1.48E+00	6.28E-01	5.66E-01	7.52E-01	119.7	3.14E-01								NS	NE

Technical Chlordane	TOC - Normalized Sediment Concentration								Lipid - Normalized Largemouth Bass Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect LMBln mg/kg	ArithMean LMBln mg/kg	Variance LMBln mg/kg	Standard Deviation LMBln mg/kg	Coefficient of Variation %	GeoMean LMBln mg/kg	BSAF LMB
Assapumpset	2	2	3.55E+00	2.49E+00	2.23E+00	1.49E+00	60.0	2.26E+00	4	4	7.66E+00	3.95E+00	7.42E+00	2.72E+00	69.1	3.30E+00	1.46E+00
Greystone	4	4	1.12E+01	7.06E+00	9.56E+00	3.09E+00	43.8	6.60E+00	10	10	4.70E+00	2.52E+00	1.43E+00	1.20E+00	47.4	2.28E+00	3.45E-01
Allendale	9	9	1.30E+01	8.36E+00	6.64E+00	2.58E+00	30.8	7.97E+00								NS	NE
Lyman Mill								NE [1]								NE [1]	9.03E-01
Manton	0	0	NA	NA	NA	NA	NA	NA	3	3	1.38E+01	9.77E+00	1.59E+01	3.99E+00	40.8	9.20E+00	NE
Dyerville	0	0	NA	NA	NA	NA	NA	NA								NS	NE

Table 2-4
Derivation of Biota Sediment Accumulation Factors (BSAFs) for Pelagic Fish

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Aroclor-1254	TOC - Normalized Sediment Concentration								Lipid - Normalized Largemouth Bass Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect LMBln mg/kg	ArithMean LMBln mg/kg	Variance LMBln mg/kg	Standard Deviation LMBln mg/kg	Coefficient of Variation %	GeoMean LMBln mg/kg	BSAF LMB
Assapumpset	3	5	3.77E+00	1.53E+00	1.67E+00	1.29E+00	84.3	1.21E+00	4	4	8.82E+00	4.53E+00	9.94E+00	3.15E+00	69.5	3.77E+00	3.11E+00
Greystone	7	7	7.93E+00	3.22E+00	7.35E+00	2.71E+00	84.3	2.39E+00	10	10	3.17E+01	1.31E+01	1.15E+02	1.07E+01	81.7	8.83E+00	3.70E+00
Allendale	35	38	4.80E+01	9.50E+00	1.26E+02	1.12E+01	118.3	4.73E+00								NS	NE
Lyman Mill								NE [1]								NE [1]	7.40E+00
Manton	0	3	ND	2.77E+00	6.43E+00	2.54E+00	91.6	1.93E+00	3	3	5.13E+01	3.40E+01	3.62E+02	1.90E+01	55.9	2.96E+01	1.54E+01
Dyerville	2	3	1.11E+02	4.68E+01	3.28E+03	5.73E+01	122.3	1.55E+01								NS	NE

Aroclor, Total	TOC - Normalized Sediment Concentration								Lipid - Normalized Largemouth Bass Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect LMBln mg/kg	ArithMean LMBln mg/kg	Variance LMBln mg/kg	Standard Deviation LMBln mg/kg	Coefficient of Variation %	GeoMean LMBln mg/kg	BSAF LMB
Assapumpset	3	4	2.60E+00	1.58E+00	1.05E+00	1.02E+00	64.8	1.31E+00	4	4	9.72E+00	5.00E+00	1.21E+01	3.48E+00	69.6	4.15E+00	3.18E+00
Greystone	7	7	9.80E+00	4.31E+00	9.69E+00	3.11E+00	72.2	3.36E+00	10	10	4.13E+01	1.72E+01	1.85E+02	1.36E+01	79.1	1.24E+01	3.68E+00
Allendale	35	38	5.78E+01	1.03E+01	1.48E+02	1.22E+01	118.2	5.38E+00								NS	NE
Lyman Mill								NE [1]								NE [1]	3.43E+00
Manton	0	0	NA	NA	NA	NA	NA	NA	3	3	5.60E+01	4.45E+01	9.83E+01	9.91E+00	22.3	4.38E+01	NE
Dyerville	1	1	3.09E+01	3.09E+01				3.09E+01								NS	NE

Aluminum	Sediment Concentration (unnormalized)								Largemouth Bass Tissue Concentration (unnormalized)								
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect LMB mg/kg	ArithMean LMB mg/kg	Variance LMB mg/kg	Standard Deviation LMB mg/kg	Coefficient of Variation %	GeoMean LMB mg/kg	BSAF LMB
Assapumpset	6	6	2.18E+04	9.84E+03	5.34E+07	7.31E+03	74.3	7.59E+03	2	4	1.52E+00	8.08E-01	2.26E-01	4.75E-01	58.8	7.29E-01	9.60E-05
Greystone	13	13	2.47E+04	8.21E+03	5.51E+07	7.42E+03	90.4	5.93E+03	10	10	6.90E+00	3.53E+00	3.73E+00	1.93E+00	54.7	3.04E+00	5.13E-04
Allendale	51	51	2.22E+04	1.00E+04	2.50E+07	5.00E+03	49.8	8.54E+03								NS	NE
Lyman Mill								NE [1]								NE [1]	2.91E-03
Manton	3	3	2.47E+03	2.22E+03	1.34E+05	3.66E+02	16.5	2.20E+03	3	3	3.88E+01	2.39E+01	2.91E+02	1.71E+01	71.4	1.78E+01	8.11E-03
Dyerville	3	3	1.07E+04	5.63E+03	1.93E+07	4.39E+03	78.0	4.68E+03								NS	NE

Derivation of Biota Sediment Accumulation Factors (BSAFs) for Pelagic Fish

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Barium	Sediment Concentration (unnormalized)							Largemouth Bass Tissue Concentration (unnormalized)							
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect LMB mg/kg	ArithMean LMB mg/kg	Variance LMB mg/kg	Standard Deviation LMB mg/kg	Coefficient of Variation %	GeoMean LMB mg/kg	BSAF LMB
Assapumpset	6	6	2.04E+02	9.36E+01	4.80E+03	6.93E+01	74.0	7.19E+01	4	4	1.19E+00	7.76E-01	8.58E-02	2.93E-01	37.7	7.40E-01	1.03E-02
Greystone	13	13	3.74E+02	1.34E+02	1.48E+04	1.22E+02	90.8	7.62E+01	10	10	1.67E+00	7.63E-01	1.79E-01	4.24E-01	55.5	6.67E-01	8.76E-03
Allendale	48	51	3.20E+02	1.38E+02	7.31E+03	8.55E+01	62.1	1.04E+02								NS	NE
Lyman Mill								NE [1]								NE [1]	1.55E-02
Manton	3	3	3.81E+01	2.44E+01	1.43E+02	1.20E+01	49.1	2.26E+01	2	2	9.06E-01	6.64E-01	1.17E-01	3.42E-01	51.5	6.18E-01	2.73E-02
Dyerville	3	3	1.16E+02	6.78E+01	1.89E+03	4.34E+01	64.0	5.90E+01								NS	NE

Selenium	Sediment Concentration (unnormalized)							Largemouth Bass Tissue Concentration (unnormalized)							
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect LMB mg/kg	ArithMean LMB mg/kg	Variance LMB mg/kg	Standard Deviation LMB mg/kg	Coefficient of Variation %	GeoMean LMB mg/kg	BSAF LMB
Assapumpset	1	6	2.20E+00	6.25E-01	6.11E-01	7.81E-01	125.1	4.08E-01	3	4	2.18E-01	1.58E-01	8.19E-03	9.05E-02	57.4	1.18E-01	2.88E-01
Greystone	7	13	3.60E+00	1.14E+00	1.03E+00	1.02E+00	89.1	7.41E-01	10	10	2.87E-01	2.35E-01	2.29E-03	4.79E-02	20.4	2.30E-01	3.11E-01
Allendale	13	49	5.30E+00	1.06E+00	1.07E+00	1.03E+00	97.4	7.49E-01								NS	NE
Lyman Mill								NE [1]								NE [1]	4.70E-01
Manton	0	3	ND	2.37E-01	5.83E-05	7.64E-03	3.2	2.37E-01	1	3	2.24E-01	1.96E-01	2.30E-03	4.79E-02	24.4	1.92E-01	8.11E-01
Dyerville	0	3	ND	1.60E+00	5.47E+00	2.34E+00	146.1	6.45E-01								NS	NE

Vanadium	Sediment Concentration (unnormalized)							Largemouth Bass Tissue Concentration (unnormalized)							
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect LMB mg/kg	ArithMean LMB mg/kg	Variance LMB mg/kg	Standard Deviation LMB mg/kg	Coefficient of Variation %	GeoMean LMB mg/kg	BSAF LMB
Assapumpset	6	6	3.20E+01	1.70E+01	1.05E+02	1.02E+01	60.1	1.43E+01	4	4	1.93E-02	8.61E-03	6.36E-05	7.97E-03	92.9	5.79E-03	4.06E-04
Greystone	13	13	1.29E+02	3.76E+01	1.16E+03	3.41E+01	90.6	2.63E+01	2	10	8.95E-02	7.41E-02	1.09E-03	3.30E-02	44.5	4.61E-02	1.75E-03
Allendale	51	51	8.93E+01	3.62E+01	3.60E+02	1.90E+01	52.4	3.03E+01								NS	NE
Lyman Mill								NE [1]								NE [1]	4.08E-03
Manton	3	3	7.10E+00	5.70E+00	1.51E+00	1.23E+00	21.6	5.62E+00	2	3	8.95E-02	6.06E-02	7.27E-04	2.70E-02	44.5	5.66E-02	1.01E-02
Dyerville	3	3	2.84E+01	1.60E+01	1.16E+02	1.08E+01	67.1	1.40E+01								NS	NE

Table 2-4
Derivation of Biota Sediment Accumulation Factors (BSAFs) for Pelagic Fish

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Zinc	Sediment Concentration (unnormalized)								Largemouth Bass Tissue Concentration (unnormalized)								
Exposure Area	Frequency of Detection		Maximum Detect SED mg/kg	ArithMean SED mg/kg	Variance SED mg/kg	Standard Deviation SED mg/kg	Coefficient of Variation %	GeoMean SED mg/kg	Frequency of Detection		Maximum Detect LMB mg/kg	ArithMean LMB mg/kg	Variance LMB mg/kg	Standard Deviation LMB mg/kg	Coefficient of Variation %	GeoMean LMB mg/kg	BSAF LMB
Assapumpset	6	6	2.27E+02	1.01E+02	5.61E+03	7.49E+01	74.5	7.94E+01	3	4	1.76E+01	1.25E+01	6.02E+01	7.76E+00	62.1	8.08E+00	1.02E-01
Greystone	12	13	8.54E+02	2.21E+02	7.66E+04	2.77E+02	125.3	1.12E+02	10	10	1.88E+01	1.46E+01	4.74E+00	2.18E+00	14.9	1.45E+01	1.30E-01
Allendale	50	51	2.09E+03	3.54E+02	1.42E+05	3.76E+02	106.4	2.39E+02								NS	NE
Lyman Mill								NE [1]								NE [1]	1.16E-01
Manton	3	3	1.61E+02	7.85E+01	5.31E+03	7.29E+01	92.8	5.76E+01	0	3	ND	7.72E+00	4.66E-01	6.83E-01	8.8	7.70E+00	NE [2]
Dyerville	3	3	1.93E+03	7.19E+02	1.10E+06	1.05E+03	146.0	2.65E+02								NS	NE

Toxicity Equivalency - Birds	TOC - Normalized Sediment Concentration								Lipid - Normalized Largemouth Bass Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect LMBln mg/kg	ArithMean LMBln mg/kg	Variance LMBln mg/kg	Standard Deviation LMBln mg/kg	Coefficient of Variation %	GeoMean LMBln mg/kg	BSAF LMB
Assapumpset	4	4	1.70E-03	5.21E-04	6.21E-07	7.88E-04	151.2	2.30E-04	4	4	5.56E-04	2.33E-04	4.93E-08	2.22E-04	95.3	1.69E-04	7.35E-01
Greystone	6	6	2.14E-03	7.45E-04	5.03E-07	7.09E-04	95.2	5.45E-04	10	10	4.84E-05	3.69E-05	3.12E-11	5.59E-06	15.1	3.66E-05	6.71E-02
Allendale	31	31	2.63E-01	4.17E-02	2.97E-03	5.45E-02	130.7	1.62E-02								NS	NE
Lyman Mill								NE [1]								NE [1]	3.40E-01
Manton	3	3	2.72E-02	2.26E-02	2.78E-05	5.28E-03	23.3	2.22E-02	3	3	1.04E-02	6.07E-03	1.83E-05	4.28E-03	70.5	4.85E-03	2.19E-01
Dyerville	4	4	1.02E-01	2.80E-02	2.46E-03	4.96E-02	177.0	1.35E-03								NS	NE

Derivation of Biota Sediment Accumulation Factors (BSAFs) for Pelagic Fish

Preliminary Remediation Goals Report - Ecological
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Toxicity Equivalency - Fish	TOC - Normalized Sediment Concentration								Lipid - Normalized Largemouth Bass Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detect SEDocn mg/kg	ArithMean SEDocn mg/kg	Variance SEDocn mg/kg	Standard Deviation SEDocn mg/kg	Coefficient of Variation %	GeoMean SEDocn mg/kg	Frequency of Detection		Maximum Detect LMBln mg/kg	ArithMean LMBln mg/kg	Variance LMBln mg/kg	Standard Deviation LMBln mg/kg	Coefficient of Variation %	GeoMean LMBln mg/kg	BSAF LMB
Assapumpset	4	4	1.09E-03	3.44E-04	2.50E-07	5.00E-04	145.5	1.51E-04	4	4	5.42E-04	2.07E-04	5.13E-08	2.26E-04	109.6	1.40E-04	9.27E-01
Greystone	6	6	1.46E-03	4.53E-04	2.56E-07	5.05E-04	111.5	3.04E-04	10	10	3.74E-05	2.58E-05	3.60E-11	6.00E-06	23.3	2.52E-05	8.31E-02
Allendale	31	31	2.61E-01	4.13E-02	2.93E-03	5.41E-02	131.1	1.54E-02								NS	NE
Lyman Mill								NE [1]								NE [1]	4.10E-01
Manton	3	3	2.69E-02	2.25E-02	2.70E-05	5.20E-03	23.1	2.20E-02	3	3	1.04E-02	6.05E-03	1.83E-05	4.28E-03	70.7	4.83E-03	2.19E-01
Dyerville	4	4	9.85E-02	2.67E-02	2.31E-03	4.80E-02	180.2	1.01E-03								NS	NE

NS = Not Sampled
NE = Not Evaluated
ND = Not Detected
[1] Data for Lyman Mill were not used; BSAF values for Lyman Mill are arithmetic means of the BSAFs for the other exposure areas.
[2] BSAF not evaluated because the chemical was not detected in pelagic fish.
NA = Not Analyzed
ArithMean = arithmetic mean
GeoMean = geometric mean
SEDocn = organic carbon-normalized concentration in sediment
LMBln = lipid-normalized concentrations in largemouth bass
BSAF LMB = biota/sediment accumulation factor for largemouth bass
mg/kg = milligrams per kilogram
Notes: BSAFs were derived as the ratio of the lipid-normalized largemouth bass tissue and carbon-normalized sediment concentrations
All data extracted from site database (MACTEC, 2005)
Half of the detection limit was used to calculate mean, variance, standard deviation, coefficient of variation and geomean when the chemical was not detected.

Prepared by: BJR
Checked by: KJA

Table 2-5
Geometric Mean TOC and Lipid Concentrations in Sediment, Floodplain Soil, and Biota

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TOC Concentrations in Sediment

Exposure Area	Frequency of Detection		Maximum Detect TOC mg/kg	ArithMean TOC mg/kg	Variance TOC mg/kg	Coefficient of Variation %	GeoMean TOC mg/kg
Assapumpset	5	6	4.45E+04	3.20E+04	2.39E+08	48.32	26688
Greystone	7	7	1.41E+05	7.25E+04	2.68E+09	71.47	53781
Allendale	39	39	2.02E+05	7.02E+04	2.28E+09	67.94	44385
Lyman Mill	32	32	2.29E+05	7.56E+04	2.46E+09	65.68	47041
Manton	3	3	4.18E+04	1.91E+04	4.01E+08	104.87	12450
Dyerville	3	3	4.60E+04	2.26E+04	5.02E+08	99.21	10820

TOC Concentrations in Floodplain Soil

Exposure Area	Frequency of Detection		Maximum Detect TOC mg/kg	ArithMean TOC mg/kg	Variance TOC mg/kg	Coefficient of Variation %	GeoMean TOC mg/kg
Assapumpset	0	0	NA	NA	NA	NE	NE
Greystone	4	4	1.09E+05	8.15E+04	8.16E+04	0.35	109100
Allendale	4	4	8.47E+04	6.75E+04	1.39E+04	0.17	66788
Lyman Mill	3	3	7.13E+04	6.25E+04	2.23E+04	0.24	61209
Manton	0	0	NA	NA	NA	NE	NE
Dyerville	0	0	NA	NA	NA	NE	NE

Lipid Concentrations in Tree Swallow Egg Tissue

Exposure Area	Frequency of Detection		Maximum Detect Lipid mg/kg	ArithMean Lipid mg/kg	Variance Lipid mg/kg	Coefficient of Variation %	GeoMean Lipid mg/kg [2]
Assapumpset	0	0	NA	NA	NA	NE	NE
Greystone	3	3	1.70E+05	1.20E+05	2.18E+05	0.39	114136
Allendale	3	3	7.42E+04	4.70E+04	5.61E+04	0.50	43506
Lyman Mill	3	3	5.79E+04	5.14E+04	4.29E+03	0.13	51120
Manton	0	0	NA	NA	NA	NE	69587
Dyerville	0	0	NA	NA	NA	NE	NE

Lipid Concentrations in White Sucker Tissue

Exposure Area	Frequency of Detection		Maximum Detect Lipid mg/kg	ArithMean Lipid mg/kg	Variance Lipid mg/kg	Coefficient of Variation %	GeoMean Lipid mg/kg [1]
Assapumpset	0	0	NA	NA	NA	NE	NE
Greystone	10	10	1.49E+05	1.04E+05	1.19E+05	0.33	97539
Allendale	13	13	8.72E+04	5.07E+04	4.84E+04	0.43	53880
Lyman Mill							75710
Manton	0	0	NA	NA	NA	NE	NE
Dyerville	0	0	NA	NA	NA	NE	NE

Lipid Concentrations in American Eel Tissue

Exposure Area	Frequency of Detection		Maximum Detect Lipid mg/kg	ArithMean Lipid mg/kg	Variance Lipid mg/kg	Coefficient of Variation %	GeoMean Lipid mg/kg
Dyerville	3	3	1.35E+05	1.21E+05	1.42E+04	NE	120955

Table 2-5
Geometric Mean TOC and Lipid Concentrations in Sediment, Floodplain Soil, and Biota

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Lipid Concentrations in Largemouth Bass (Whole body) Tissue

Exposure Area	Frequency of Detection		Maximum Detect Lipid mg/kg	ArithMean Lipid mg/kg	Variance Lipid mg/kg	Coefficient of Variation %	GeoMean Lipid mg/kg [1]
Assapumpset	4	4	2.95E+04	2.01E+04	5.12E+03	0.36	19170
Greystone	10	10	3.01E+04	1.98E+04	3.66E+03	0.31	18879
Allendale	0	0	NA	NA	NA	NE	NE
Lyman Mill	[redacted]						17299
Manton	3	3	2.42E+04	1.51E+04	6.37E+03	0.53	13848
Dyerville	0	0	NA	NA	NA	NE	NE

Lipid Concentrations in Earthworm Tissue

Exposure Area	Frequency of Detection		Maximum Detect Lipid mg/kg	ArithMean Lipid mg/kg	Variance Lipid mg/kg	Coefficient of Variation %	GeoMean Lipid mg/kg
Assapumpset	0	0	NA	NA	NA	NE	NE
Greystone	4	4	5.16E+04	3.60E+04	1.26E+04	0.31	34824
Allendale	4	4	3.92E+04	2.95E+04	5.50E+03	0.25	28793
Lyman Mill	3	3	3.08E+04	2.53E+04	2.31E+03	0.19	24980
Manton	0	0	NA	NA	NA	NE	NE
Dyerville	0	0	NA	NA	NA	NE	NE

Notes:
NA = No data available
NE = Not evaluated
Shading indicates data not used
[1] Data from Lyman Mill were not used. Values for Lyman Mill are the arithmetic average of the GeoMeans for Assapumpset, Greystone, Allendale, and Manton where those values are available.
[2] GeoMean for Manton is an average of the GeoMeans for Greystone, Allendale and Lyman Mill.

Prepared by: BJR
Checked by: KJA

ArithMean = arithmetic mean
GeoMean = geometric mean
mg/kg = milligrams per kilogram
TOC = Total Organic Carbon

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RECEPTOR: DEMERSAL FISH - WHITE SUCKER
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: CBR THRESHOLD

For Organics,

$$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

PRG_{sed} = Preliminary Remediation Goal for sediment
PRG_{fish} = Preliminary Remediation Goals for fish
$[TOC]_{sed}$ = Geometric mean concentration of total organic carbon in sediment
$[Lipid]_{fish}$ = Geometric mean concentration of lipid in fish
BSAF = Biota/Sediment accumulation factor

For Inorganics,

$$PRG_{sed} = \frac{PRG_{fish}}{BSAF}$$

CHEMICAL OF CONCERN	Fish Tissue PRGs (mg/Kg) [1]								
	NOAEL			LOAEL			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
4,4'-DDD	0.00080	0.0080	0.080	0.069	0.69	6.9	0.0069	0.069	0.69
4,4'-DDE	0.0042	0.042	0.42	0.029	0.29	2.9	0.011	0.11	1.1
Technical Chlordane	0.0010	0.010	0.10	0.0010	0.10	1.0	0.0010	0.010	0.10
Aroclor-1254	0.098	0.98	9.8	0.35	1.5	15.3	0.12	1.2	12.2
Aluminum	0.10	1.0	10.0	0.80	8.0	80.0	0.28	2.8	28.3
Barium	---	---	---	0.041	0.41	4.1	---	---	---
Selenium	0.014	0.14	1.4	0.018	0.18	1.8	0.016	0.16	1.6
Vanadium	0.0020	0.020	0.20	0.041	0.41	4.1	0.0091	0.091	0.91
Zinc	0.39	3.9	39	0.45	4.5	45.0	0.42	4.2	41.9
Dioxin Toxicity Equivalency - Fish	0.000015	0.00015	0.0015	0.000023	0.00023	0.0023	0.000019	0.00019	0.0019

	GEOMEAN LIPID [Lipid] (mg/Kg) [2]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{sed}$ (mg/Kg) [2]
Allendale	53800	44365
Lyman Mill	55710	47041
Manton	NA	12450
Dyerville	NA	31820

CHEMICAL OF CONCERN	BSAF WS [3]	Calculated Sediment PRGs (mg/Kg) ALLENDALE								
		NOAEL			LOAEL			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
4,4'-DDD	2.08E+00	---	---	---	---	---	---	---	---	---
4,4'-DDE	4.54E+00	---	---	---	---	---	---	---	---	---
Technical Chlordane	5.41E+01	0.0015	0.015	0.15	0.0015	0.015	0.15	0.0015	0.015	0.15
Aroclor-1254	4.57E+00	0.018	0.18	0.028	0.28	2.8	0.022	0.22	2.2	
Aluminum	6.99E-04	---	---	---	---	---	---	---	---	---
Barium	6.61E-03	---	---	---	---	---	---	---	---	---
Selenium	3.77E+01	0.037	0.37	3.7	0.048	0.48	4.8	0.042	0.42	4.2
Vanadium	5.12E-03	---	---	---	---	---	---	---	---	---
Zinc	8.62E-02	4.5	45.3	453	5.2	52.2	522	4.9	48.6	486
Dioxin Toxicity Equivalency - Fish	3.89E+01	0.0000382	0.000382	0.00382	0.0000489	0.000489	0.00049	0.0000439	0.000439	0.00439

CHEMICAL OF CONCERN	BSAF WS [3]	Calculated Sediment PRGs (mg/Kg) LYMAN MILL								
		NOAEL			LOAEL			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
4,4'-DDD	2.08E+00	0.00024	0.0024	0.024	0.018	0.18	1.8	0.0021	0.021	0.21
4,4'-DDE	5.02E+00	0.00052	0.0052	0.052	0.0036	0.036	0.36	0.0014	0.014	0.14
Technical Chlordane	4.86E+01	0.0013	0.013	0.13	0.0013	0.013	0.13	0.0011	0.011	0.17
Aroclor-1254	2.71E+00	0.23	2.3	0.035	0.35	3.5	0.028	0.28	2.8	
Aluminum	2.61E-03	38.4	384	3837	307	3070	30,698	109	1085	10853
Barium	9.93E-03	---	---	---	4.6	45.5	455	---	---	---
Selenium	3.40E+01	0.041	0.41	4.1	0.053	0.53	5.3	0.047	0.47	4.7
Vanadium	3.03E-03	0.66	6.6	66.1	13.5	135	1354	9.0	299	2993
Zinc	1.15E-01	3.4	34.0	340	3.9	39.2	392	3.7	36.5	365
Dioxin Toxicity Equivalency - Fish	2.23E+01	0.00042	0.0042	0.042	0.00064	0.0064	0.064	0.00052	0.0052	0.052

Table 2-6
Derivation of Sediment Preliminary Remediation Goals for Demersal Fish Based on CBR Threshold

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: DEMERSAL FISH - WHITE SUCKER
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: CBR THRESHOLD

CHEMICAL OF CONCERN	BSAF WS	Calculated Sediment PRGs (mg/Kg) MANTON NOAEL HQ = 0.1	NOAEL HQ = 1	NOAEL HQ = 10	LOAEL HQ = 0.1	LOAEL HQ = 1	LOAEL HQ = 10	MATC HQ = 0.1	MATC HQ = 1	MATC HQ = 10
4,4'-DDD	NE	---	---	---	---	---	---	---	---	---
4,4'-DDE	NE	---	---	---	---	---	---	---	---	---
Technical Chlordane	NE	---	---	---	---	---	---	---	---	---
Aroclor-1254	NE	---	---	---	---	---	---	---	---	---
Aluminum	NE	---	---	---	---	---	---	---	---	---
Barium	NE	---	---	---	---	---	---	---	---	---
Selenium	NE	---	---	---	---	---	---	---	---	---
Vanadium	NE	---	---	---	---	---	---	---	---	---
Zinc	NE	---	---	---	---	---	---	---	---	---
Dioxin Toxicity Equivalency - Fish	NE	---	---	---	---	---	---	---	---	---

CHEMICAL OF CONCERN	BSAF WS	Calculated Sediment PRGs (mg/Kg) DYERVILLE NOAEL HQ = 0.1	NOAEL HQ = 1	NOAEL HQ = 10	LOAEL HQ = 0.1	LOAEL HQ = 1	LOAEL HQ = 10	MATC HQ = 0.1	MATC HQ = 1	MATC HQ = 10
4,4'-DDD	NE	---	---	---	---	---	---	---	---	---
4,4'-DDE	NE	---	---	---	---	---	---	---	---	---
Technical Chlordane	NE	---	---	---	---	---	---	---	---	---
Aroclor-1254	NE	---	---	---	---	---	---	---	---	---
Aluminum	NE	---	---	---	---	---	---	---	---	---
Barium	NE	---	---	---	---	---	---	---	---	---
Selenium	NE	---	---	---	---	---	---	---	---	---
Vanadium	NE	---	---	---	---	---	---	---	---	---
Zinc	NE	---	---	---	---	---	---	---	---	---
Dioxin Toxicity Equivalency - Fish	NE	---	---	---	---	---	---	---	---	---

NA = Not Available
NE = Not Evaluated
--- = No PRG calculated
BSAF = Biota Sediment Accumulation Factor
HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
WS = White Sucker
[1] Fish tissue PRGs are from Table 2-1
[2] Lipid and TOC values are from Table 2-5
[3] BSAF values for white sucker for the respective exposure areas are from Table 2-3
Note: PRG is calculated for analytes as indicated in Table 1-1

Prepared by KJA
Checked by SGH

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: DEMERSAL FISH - WHITE SUCKER
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: ELS THRESHOLD

$$PRG_{sed} = \frac{PRG_{fish} x\, [TOC]_{sed}}{BSAF\ x\ [Lipid]_{fish}}$$

PRG_{sed}= Preliminary Remediation Goal for sediment
PRG_{fish}= Preliminary Remediation Goals for fish
$[TOC]_{sed}$= Geometric mean concentration of total organic carbon in sediment
$[Lipid]_{fish}$= Geometric mean concentration of lipid in fish
BSAF= Biota/Sediment accumulation factor

CHEMICAL OF CONCERN	Fish Tissue PRGs (mg/Kg) [1]								
	EC_{10}			EC_{25}			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Toxicity Equivalency - Fish	0.0000456	0.000456	0.00456	0.0000729	0.000729	0.00729	0.0000576	0.000576	0.00576
Toxicity Equivalency (PCB) - Fish	0.0000456	0.000456	0.00456	0.0000729	0.000729	0.00729	0.0000576	0.000576	0.00576

	GEOMEAN LIPID [Lipid] (mg/Kg) [2]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{sed}$ (mg/Kg) [2]
Allendale	53880	44385
Lyman Mill	75710	47041
Manton	NA	12450
Dyerville	120955	10820

CHEMICAL OF CONCERN	BSAF WS [3]	Calculated Sediment PRGs (mg/Kg) ALLENDALE								
		EC_{10}			EC_{25}			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	3.89E-01	0.00010	0.0010	0.010	0.00015	0.0015	0.015	0.00012	0.0012	0.012
Toxicity Equivalency (PCB) - Fish	NE	---	---	---	---	---	---	---	---	---

CHEMICAL OF CONCERN	BSAF WS [3]	Calculated Sediment PRGs (mg/Kg) LYMAN MILL								
		EC_{10}			EC_{25}			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	2.23E-01	0.00013	0.0013	0.013	0.00020	0.0020	0.020	0.00016	0.0016	0.016
Toxicity Equivalency (PCB) - Fish	7.02E-01	0.000040	0.00040	0.0040	0.000064	0.00064	0.0064	0.000051	0.00051	0.0051

CHEMICAL OF CONCERN	BSAF WS [3]	Calculated Sediment PRGs (mg/Kg) MANTON								
		EC_{10}			EC_{25}			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	NE	---	---	---	---	---	---	---	---	---
Toxicity Equivalency (PCB) - Fish	NE	---	---	---	---	---	---	---	---	---

Table 2-7
Derivation of Sediment Preliminary Remediation Goals for Demersal Fish Based on ELS Threshold

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: DEMERSAL FISH - WHITE SUCKER
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: ELS THRESHOLD

CHEMICAL OF CONCERN	BSAF AE [4]	Calculated Sediment PRGs (mg/Kg) DYERVILLE								
		EC_{10}			EC_{25}			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	4.00E-01	0.000010	0.00010	0.0010	0.000016	0.00016	0.0016	0.000013	0.00013	0.0013
Toxicity Equivalency (PCBs) - Fish	1.43E+01	0.00000029	0.0000029	0.000029	0.00000046	0.0000046	0.000046	0.00000036	0.0000036	0.000036

NA = Not Available
NE = Not Evaluated
--- = No PRG calculated
BSAF = Biota Sediment Accumulation Factor
EC_{10} = Effect Concentration for 10 % of tested organisms
EC_{25} = Effect Concentration for 25 % of tested organisms
HQ = Hazard Quotient
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of EC_{10} and EC_{25}
PRG = Preliminary Remediation Goal
WS = White Sucker
AE = American Eel
[1] Fish tissue PRGs are from Table 2-2
[2] Lipid and TOC values are from Table 2-5
[3] BSAF values for the white sucker for the respective exposure areas are from Table 2-3
[4] BSAF values for the Dyerville were based on American eel, values are from Table 2-3
Note: PRGs calculated for analytes as indicated in Table 1-1

Prepared by KJA
Checked by SGH

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: PELAGIC FISH - LARGEMOUTH BASS
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: ELS THRESHOLD

For Organics:

$$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

PRG_{sed} = Preliminary Remediation Goal for sediment
PRG_{fish} = Preliminary Remediation Goals for fish
$[TOC]_{sed}$ = Geometric mean concentration of total organic carbon in sediment
$[Lipid]_{fish}$ = Geometric mean concentration of lipid in fish
BSAF = Biota-Sediment accumulation factor

For Inorganics:

$$PRG_{sed} = \frac{PRG_{fish}}{BSAF}$$

CHEMICAL OF CONCERN	Fish Tissue PRGs (mg/Kg) [1]								
	NOAEL			LOAEL			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Technical Chlordane	0.0010	0.010	0.10	0.0010	0.010	0.10	0.0010	0.010	0.10
Aluminum	0.10	1.0	10.0	0.80	8.0	80.0	0.28	2.8	28.3
Barium	---	---	---	0.041	0.41	4.1	---	---	---
Vanadium	0.0020	0.020	0.20	0.041	0.41	4.1	0.0091	0.091	0.91
Zinc	0.39	3.9	39	0.45	4.5	45.0	0.42	4.2	41.9
Dioxin Toxicity Equivalency - Fish	0.000015	0.00015	0.0015	0.000023	0.00023	0.0023	0.000019	0.00019	0.0019

	GEOMEAN LIPID [Lipid] (mg/Kg) [2]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{sed}$ (mg/Kg) [2]
Allendale	NA	44385
Lyman Mill	17299	47041
Manton	13848	12450
Dyerville	NA	10820

CHEMICAL OF CONCERN	BSAF	Calculated Sediment PRGs (mg/Kg) ALLENDALE								
		NOAEL			LOAEL			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Technical Chlordane	NE	---	---	---	---	---	---	---	---	---
Aluminum	NE	---	---	---	---	---	---	---	---	---
Barium	NE	---	---	---	---	---	---	---	---	---
Vanadium	NE	---	---	---	---	---	---	---	---	---
Zinc	NE	---	---	---	---	---	---	---	---	---
Dioxin Toxicity Equivalency - Fish	NE	---	---	---	---	---	---	---	---	---

CHEMICAL OF CONCERN	BSAF [3]	Calculated Sediment PRGs (mg/Kg) LYMAN MILL								
		NOAEL			LOAEL			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Technical Chlordane	9.03E-01	0.0030	0.030	0.30	0.0030	0.030	0.30	0.0030	0.030	0.30
Aluminum	2.91E-03	34.4	344	3441	275	2753	27530	97.3	973	9733
Barium	1.55E-02	---	---	---	2.7	26.5	265	---	---	---
Vanadium	4.08E-03	0.49	4.9	49.0	10.0	100	1005	2.2	22.2	222
Zinc	1.16E-01	3.4	33.7	337	3.9	38.9	389	3.6	36.2	362
Dioxin Toxicity Equivalency - Fish	4.10E-01	0.00010	0.0010	0.010	0.00015	0.0015	0.015	0.00012	0.0012	0.012

Table 2-8
Derivation of Sediment Preliminary Remediation Goals for Pelagic Fish Based on CBR Threshold

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: PELAGIC FISH - LARGEMOUTH BASS
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: ELS THRESHOLD

		Calculated Sediment PRGs (mg/Kg)								
		MANTON								
		NOAEL			LOAEL			MATC		
CHEMICAL OF CONCERN	BSAF [3]	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Technical Chlordane	NE	---	---	---	---	---	---	---	---	---
Aluminum	8.11E-03	12.3	123	1233	98.7	987	9866	34.9	349	3488
Barium	2.73E-02	---	---	---	1.5	15.0	150	---	---	---
Vanadium	1.01E-02	0.20	2.0	19.8	4.1	40.7	407	0.90	9.0	89.8
Zinc	NE	---	---	---	---	---	---	---	---	---
Dioxin Toxicity Equivalency - Fish	2.19E-01	---	---	---	---	---	---	---	---	---

		Calculated Sediment PRGs (mg/Kg)								
		DYERVILLE								
		NOAEL			LOAEL			MATC		
CHEMICAL OF CONCERN	BSAF	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Technical Chlordane	NE	---	---	---	---	---	---	---	---	---
Aluminum	NE	---	---	---	---	---	---	---	---	---
Barium	NE	---	---	---	---	---	---	---	---	---
Vanadium	NE	---	---	---	---	---	---	---	---	---
Zinc	NE	---	---	---	---	---	---	---	---	---
Dioxin Toxicity Equivalency - Fish	NE	---	---	---	---	---	---	---	---	---

NA = Not Available
NE = Not Evaluated
--- = No PRG calculated
BSAF = Biota Sediment Accumulation Factor
HQ = Hazard Quotient
LMB = Largemouth Bass
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
[1] Fish tissue PRGs are from Table 2-1
[2] Lipid and TOC values are from Table 2-5
[3] BSAF values for largemouth bass for the respective exposure areas are from Table 2-6
Note: PRGs calculated for analytes as indicated in Table 1-1

Prepared by KJA
Checked by SGH

Comparison of Sediment Preliminary Remediation Goals (PRGs)
to Background Sediment Concentrations

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Concern	Geometric Mean Sediment PRG Swallow Egg Tissue Hatchability-Based HQ = 1			Sediment Background Data Greystone Mill Pond		
	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	Min (mg/Kg)	Max (mg/Kg)	Average (mg/Kg)
4,4-DDD	NE	NE	NE	0.0022	0.019	0.0049
4,4-DDE	NE	NE	NE	0.0011	0.031	0.0060
Technical Chlordane	NE	NE	NE	0.15	0.63	0.40
Aroclor-1254	NE	NE	NE	0.023	0.38	0.15
Aroclor, Total	NE	NE	NE	0.023	0.48	0.21
Aluminum	NE	NE	NE	1880	24690	8210
Barium	NE	NE	NE	7.6	374	134
Selenium	NE	NE	NE	1.0	3.6	1.1
Vanadium	NE	NE	NE	6.8	129	37.6
Zinc	NE	NE	NE	37.6	854	221
Dioxin Toxicity Equivalency - Birds	0.00051	0.00056	0.00054	0.000034	0.000034	0.000034
Dioxin Toxicity Equivalency - Fish	NE	NE	NE	0.0000012	0.0000012	0.0000012
Toxicity Equivalency (PCB) - Birds	NE	NE	NE	0.0000054	0.00023	0.000045
Toxicity Equivalency (PCB) - Fish	NE	NE	NE	0.0000031	0.00016	0.000030

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background data set.
EC_{10} =Effect Concentration for 10 % of tested organisms
EC_{25} = Effect Concentration for 25 % of tested organisms
HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NE = Not Evaluated
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal

Prepared by: BJR
Checked by: KJA

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: PELAGIC FISH - LARGEMOUTH BASS
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: ELS THRESHOLD

$$PRG_{Sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

PRG_{sed}= Preliminary Remediation Goal for sediment
PRG_{fish}= Preliminary Remediation Goals for fish
$[TOC]_{sed}$= Geometric mean concentration of total organic carbon in sediment
$[Lipid]_{fish}$= Geometric mean concentration of lipid in fish
BSAF= Biota/Sediment accumulation factor

CHEMICAL OF CONCERN	Fish Tissue PRGs (mg/Kg) [1]								
	EC_{10}			EC_{20}			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	0.0000456	0.000456	0.00456	0.0000729	0.000729	0.00729	0.0000576	0.000576	0.00576
Toxicity Equivalency (PCB) - Fish	0.0000456	0.000456	0.00456	0.0000729	0.000729	0.00729	0.0000576	0.000576	0.00576

	GEOMEAN LIPID [Lipid] (mg/Kg) [2]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{sed}$ (mg/Kg) [2]
Allendale	NA	44385
Lyman Mill	17299	47041
Manton	13848	12450
Overville	NA	10820

CHEMICAL OF CONCERN	BSAF LMB [3]	Calculated Sediment PRGs (mg/Kg) ALLENDALE								
		EC_{10}			EC_{20}			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	NE	---	---	---	---	---	---	---	---	---
Toxicity Equivalency (PCB) - Fish	NE	---	---	---	---	---	---	---	---	---

CHEMICAL OF CONCERN	BSAF LMB [3]	Calculated Sediment PRGs (mg/Kg) LYMAN MILL								
		EC_{10}			EC_{20}			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	4.10E-01	0.00030	0.0030	0.030	0.00048	0.0048	0.048	0.00038	0.0038	0.038
Toxicity Equivalency (PCB) - Fish	NE	---	---	---	---	---	---	---	---	---

CHEMICAL OF CONCERN	BSAF LMB [3]	Calculated Sediment PRGs (mg/Kg) MANTON								
		EC_{10}			EC_{20}			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	2.19E-01	0.00019	0.0019	0.019	0.00030	0.0030	0.030	0.00024	0.0024	0.024
Toxicity Equivalency (PCB) - Fish	NE	---	---	---	---	---	---	---	---	---

Table 2-9
Derivation of Sediment Preliminary Remediation Goals for Pelagic Fish Based on ELS Threshold

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: PELAGIC FISH - LARGEMOUTH BASS
EXPOSURE MEDIUM: SEDIMENT
RISK BASIS: ELS THRESHOLD

CHEMICAL OF CONCERN	BSAF LMB	Calculated Sediment PRGs (mg/Kg)								
		DYERVILLE								
		EC_{10}			EC_{25}			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Fish	NE	---	---	---	---	---	---	---	---	---
Toxicity Equivalency (PCB) - Fish	NE	---	---	---	---	---	---	---	---	---

NA = Not Available
NE = Not Evaluated
--- = No PRG calculated
BSAF = Biota Sediment Accumulation Factor
EC_{10} = Effect Concentration for 10 % of tested organisms
EC_{25} = Effect Concentration for 25 % of tested organisms
HQ = Hazard Quotient
LMB = Largemouth Bass
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of EC_{10} and EC_{25}
PRG = Preliminary Remediation Goal
[1] Fish tissue PRGs are from Table 2-2
[2] Lipid and TOC values are from Table 2-5
[3] BSAF values for the largemouth bass from the respective exposure areas are from Table 2-4.
Note: PRGs calculated for analytes as indicated in Table 1-1.

Prepared by: KJA
Checked by: SGH

Table 2-10
Derivation of Fish Tissue Preliminary Remediation Goals for Piscivorous Wildlife

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: PISCIVOROUS WILDLIFE - BELTED KINGFISHER
EXPOSURE MEDIUM: FISH/SEDIMENT
RISK BASIS: FOOD CHAIN EXPOSURE MODELING

$$PRG_{fish} = \frac{THQ \times TRV \times BW}{IR_{food}}$$

$$PRG_{fish} = \frac{THQ \times C_{xfish}}{HQ_x}$$

where:

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	VALUE	RATIONALE/ REFERENCE	INTAKE EQUATION/MODEL NAME
INGESTION	PRG_{fish}	PRG FOR FISH TISSUE THAT IS PROTECTIVE OF THE BELTED KINGFISHER	mg/kg			
	EDI,fish	ESTIMATED DAILY INTAKE VIA FISH INGESTION GIVEN X CONCENTRATION OF CONTAMINANT IN FISH TISSUE	mg/kg-d	calculated		EDI,fish = $C_x$fish * IR_{food} * P_{fish} * SFF * EF * 1/BW
	$C_x$fish	CHEMICAL CONCENTRATION X OF CONTAMINANT IN FISH	mg/kg	chemical-specific		Where Cfish is derived from site-specific tissue data
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.047	[1]	
	P_{fish}	PERCENT FISH IN DIET	unitless	1	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	1	[2]	
	EF	EXPOSURE FREQUENCY	unitless	1	[3]	
	BW	BODY WEIGHT	kg	0.15	[2]	
	HQ_x	HAZARD QUOTIENT RESULTING FROM CONTAMINANT CONCENTRATION OF X IN FISH TISSUE	unitless	calculated		HQ_x = EDI,fish * 1/TRV
	THQ	TARGET HAZARD QUOTIENT	unitless	0.1, 1, 10		
	TRV	TOXICITY REFERENCE VALUE	mg/kg-d	chemical-specific	[4]	

	Toxicity Reference Value (TRV) (mg/Kg) [4]		
	NOAEL	LOAEL	MATC
4,4'-DDD	2.8E-03	2.8E-02	8.9E-03
4,4'-DDE	2.8E-03	2.8E-02	8.9E-03
Technical Chlordane	2.8E-01	2.8E+00	8.9E-01
Aroclor 1254	1.8E-01	1.8E+00	5.7E-01
Aroclor, Total	1.1E-01	2.8E-01	1.7E-01
Zinc	1.5E+01	1.3E+02	4.4E+01
Dioxin Toxicity Equivalency - Birds	1.4E-05	1.4E-04	4.4E-05
Toxicity Equivalency (PCB) - Birds	1.4E-05	1.4E-04	4.4E-05

Table 2-10
Derivation of Fish Tissue Preliminary Remediation Goals for Piscivorous Wildlife

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: PISCIVOROUS WILDLIFE - BELTED KINGFISHER
EXPOSURE MEDIUM: FISH/SEDIMENT
RISK BASIS: FOOD CHAIN EXPOSURE MODELING

	Calculated Fish Tissue PRGs (mg/Kg)								
	NOAEL			LOAEL			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
4,4'-DDD	0.00087	0.0087	0.087	0.0087	0.087	0.87	0.0028	0.028	0.28
4,4'-DDE	0.00087	0.0087	0.087	0.0087	0.087	0.87	0.0028	0.028	0.28
Technical Chlordane	0.088	0.88	8.8	0.877	8.77	87.7	0.277	2.77	27.7
Aroclor-1254	0.056	0.56	5.6	0.56	5.6	56.0	0.18	1.8	17.7
Aroclor, Total	0.034	0.34	3.4	0.09	0.9	8.6	0.05	0.5	5.4
Zinc	4.5	45.1	451	40.7	407	4074	13.6	136	1355
Dioxin Toxicity Equivalency - Birds	0.0000044	0.000044	0.00044	0.000044	0.00044	0.0044	0.000014	0.00014	0.0014
Toxicity Equivalency (PCB) - Birds	0.0000044	0.000044	0.00044	0.000044	0.00044	0.0044	0.000014	0.00014	0.0014

HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal

Prepared by KJA
Checked by SGH

[1] USEPA, 1993, Suter, 1993.
[2] Brooks and Davis, 1987
[3] Bent, 1940
[4] Table D-4 (Appendix D) of the BERA (MACTEC, 2004)

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Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: PISCIVOROUS WILDLIFE - BELTED KINGFISHER
EXPOSURE MEDIUM: FISH (1)/SEDIMENT
RISK BASIS: FOOD CHAIN EXPOSURE MODELING

For Organics,

$$PRG_{sed} = \frac{PRG_{fish} \times [TOC]_{sed}}{BSAF \times [Lipid]_{fish}}$$

PRG_{sed}= Preliminary Remediation Goal for sediment (1)
PRG_{fish}= Preliminary Remediation Goals for fish
$[TOC]_{sed}$= Geometric mean concentration of total organic carbon in sediment
$[Lipid]_{fish}$= Geometric mean concentration of lipid in fish
BSAF= Biota/Sediment accumulation factor

For Inorganics,

$$PRG_{sed} = \frac{PRG_{fish}}{BSAF}$$

CHEMICAL OF CONCERN	Fish Tissue PRGs (mg/Kg) [2]								
	NOAEL			LOAEL			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
4,4'-DDD	0.00087	0.0087	0.087	0.0087	0.087	0.87	0.0028	0.028	0.28
4,4'-DDE	0.00087	0.0087	0.087	0.0087	0.087	0.87	0.0028	0.028	0.28
Technical Chlordane	0.088	0.88	8.8	0.877	8.77	87.7	0.277	2.77	27.7
Aroclor-1254	0.056	0.56	5.6	0.56	5.6	56.0	0.18	1.8	17.7
Aroclor, Total	0.034	0.34	3.4	0.09	0.9	8.6	0.05	0.5	5.4
Zinc	4.5	45.1	451	40.7	407	4074	13.6	136	1355
Toxicity Equivalency - Birds	0.00000044	0.0000044	0.000044	0.0000044	0.000044	0.00044	0.0000014	0.000014	0.00014
Toxicity Equivalency (PCB) - Birds	0.00000044	0.0000044	0.000044	0.0000044	0.000044	0.00044	0.0000014	0.000014	0.00014

	GEOMEAN LIPID [Lipid] (mg/Kg) [3]	GEOMEAN TOTAL ORGANIC CARBON [TOC_{sed}] (mg/Kg) [4]
Allendale	53880	44385
Lyman Mill	75710	47041
Manton	13848	12450
Dyerville	120955	10820

CHEMICAL OF CONCERN	BSAF WS [5]	Calculated Sediment PRGs (mg/Kg) ALLENDALE								
		NOAEL			LOAEL			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
4,4'-DDD	2.08E+00	---	---	---	---	---	---	---	---	---
4,4'-DDE	4.54E+00	---	---	---	---	---	---	---	---	---
Technical Chlordane	5.41E+01	---	---	---	---	---	---	---	---	---
Aroclor-1254	4.57E+00	0.010	0.10	1.0	0.10	1.0	10.1	0.032	0.32	3.2
Aroclor, Total	4.11E+00	0.0099	0.099	0.99	0.017	0.17	1.7	0.011	0.11	1.1
Zinc	8.62E+02	---	---	---	---	---	---	---	---	---
Toxicity Equivalency - Birds	3.75E+01	0.00000096	0.0000096	0.000096	0.0000096	0.000096	0.00096	0.0000030	0.000030	0.00030
Toxicity Equivalency (PCB) - Birds	NE	---	---	---	---	---	---	---	---	---

CHEMICAL OF CONCERN	BSAF WS [6]	Calculated Sediment PRGs (mg/Kg) LYMAN MILL								
		NOAEL			LOAEL			MATC		
		HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
4,4'-DDD	2.04E+00	0.00027	0.0027	0.027	0.0027	0.027	0.27	0.00084	0.0084	0.084
4,4'-DDE	5.02E+00	0.00011	0.0011	0.011	0.0011	0.011	0.11	0.00034	0.0034	0.034
Technical Chlordane	4.86E+01	0.11	1.1	11.2	1.1	11.2	112	0.35	3.5	35.5
Aroclor-1254	2.71E+00	0.013	0.13	1.3	0.13	1.3	12.9	0.041	0.41	4.1
Aroclor, Total	2.43E+00	0.0088	0.088	0.88	0.022	0.22	2.2	0.014	0.14	1.4
Zinc	1.35E+01	---	---	---	---	---	---	---	---	---
Toxicity Equivalency - Birds	2.47E+01	0.000011	0.00011	0.0011	0.00011	0.0011	0.011	0.0000035	0.000035	0.00035
Toxicity Equivalency (PCB) - Birds	7.02E+01	0.00000039	0.0000039	0.000039	0.0000039	0.00039	0.0039	0.0000012	0.000012	0.0012

Table 2-11
Derivation of Sediment Preliminary Remediation Goals for Piscivorous Wildlife

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: PISCIVOROUS WILDLIFE - BELTED KINGFISHER
EXPOSURE MEDIUM: FISH [1]/SEDIMENT
RISK BASIS: FOOD CHAIN EXPOSURE MODELING

CHEMICAL OF CONCERN	BSAF LMB [7]	Calculated Sediment PRGs (mg/Kg) MANTON NOAEL HQ = 0.1	NOAEL HQ = 1	NOAEL HQ = 10	LOAEL HQ = 0.1	LOAEL HQ = 1	LOAEL HQ = 10	MATC HQ = 0.1	MATC HQ = 1	MATC HQ = 10
4,4'-DDD	2.07E+00	---	---	---	---	---	---	---	---	---
4,4'-DDE	1.60E+01	0.000049	0.00049	0.0049	0.00049	0.0049	0.049	0.00015	0.0015	0.015
Technical Chlordane	NE	---	---	---	---	---	---	---	---	---
Aroclor-1254	1.54E+01	---	---	---	---	---	---	---	---	---
Aroclor, Total	NE	---	---	---	---	---	---	---	---	---
Zinc	NE	---	---	---	---	---	---	---	---	---
Toxicity Equivalency - Birds	2.19E+01	0.000018	0.00018	0.0018	0.00018	0.0018	0.018	0.000057	0.00057	0.0057
Toxicity Equivalency (PCB) - Birds	NE	---	---	---	---	---	---	---	---	---

CHEMICAL OF CONCERN	BSAF AE [8]	Calculated Sediment PRGs (mg/Kg) DYERVILLE NOAEL HQ = 0.1	NOAEL HQ = 1	NOAEL HQ = 10	LOAEL HQ = 0.1	LOAEL HQ = 1	LOAEL HQ = 10	MATC HQ = 0.1	MATC HQ = 1	MATC HQ = 10
4,4'-DDD	2.84E+01	0.000099	0.00099	0.0099	0.00099	0.0099	0.099	0.00031	0.0031	0.031
4,4'-DDE	2.77E+01	0.00028	0.0028	0.028	0.0028	0.028	0.28	0.00089	0.0089	0.089
Technical Chlordane	NE	---	---	---	---	---	---	---	---	---
Aroclor-1254	1.95E+01	0.026	0.26	2.6	0.26	2.6	25.7	0.081	0.81	8.1
Aroclor, Total	9.76E+02	0.52	5.2	52	0.52	5.2	52	0.163	1.63	16.3
Zinc	NE	---	---	---	---	---	---	---	---	---
Toxicity Equivalency - Birds	3.01E+01	0.0000013	0.000013	0.00013	0.0000013	0.000013	0.00013	0.0000041	0.000041	0.00041
Toxicity Equivalency (PCB) - Birds	5.51E+01	---	---	---	---	---	---	---	---	---

NE = Not Evaluated
--- = No PRG calculated
BSAF = Biota Sediment Accumulation Factor
HQ = Hazard Quotient
LMB = Largemouth Bass
WS = White Sucker
AE = American Eel
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
[1] Sediment PRGs for Allendale and Lyman Mill based on a diet of white sucker. Sediment PRGs for Manton based on a diet of largemouth bass. Sediment PRGs for Dyerville based on a diet of American eel
[2] Fish tissue PRGs summarized from Table 2-10
[3] Concentrations for Allendale based on white sucker samples collected from that exposure area. Concentrations for Lyman Mill are the average white sucker samples collected from Greystone and Allendale
Concentrations for Manton are largemouth bass samples collected from that exposure area. Concentrations for Dyerville are American eel collected from that exposure area. Values are from Table 2-5
[4] TOC values are from Table 2-5
[5] BSAFs for the white sucker in Allendale, values are from Table 2-3
[6] BSAFs for the white sucker in Lyman Mill (average site BSAF values used), values are from Table 2-3
[7] BSAFs for the largemouth bass in Manton, values are from Table 2-4
[8] BSAFs for the American eel in Dyerville, values are from Table 2-3
Note: PRGs calculated for analytes as indicated in Table 1-1

Prepared by: KJA
Checked by: SGH

Table 2-12
Derivation of CBR Based Preliminary Remediation Goals for Tree Swallow Egg Tissue

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: INSECTIVOROUS WILDLIFE - TREE SWALLOW EGGS
EXPOSURE MEDIUM: EMERGING INSECTS/SEDIMENT
RISK BASIS: CBR THRESHOLD

$$PRG_{egg} = THQ \times CBR$$

PRG_{egg} = Egg Tissue PRG
THQ = Target Hazard Quotient
CBR = Critical Body Residue

CHEMICAL OF CONCERN	Critical Body Residues (CBRs)		
	NOAEL [1] (mg/Kg)	LOAEL [1] (mg/Kg)	MATC (mg/Kg)
Dioxin Toxicity Equivalency - Birds	0.00010	0.00030	0.00017
Toxicity Equivalency (PCB) - Birds	0.00010	0.00030	0.00017

CHEMICAL OF CONCERN	Calculated Egg Tissue PRGs (mg/Kg)								
	NOAEL			LOAEL			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	0.000010	0.00010	0.0010	0.000030	0.00030	0.0030	0.000017	0.00017	0.0017
Toxicity Equivalency (PCB) - Birds	0.000010	0.00010	0.0010	0.000030	0.00030	0.0030	0.000017	0.00017	0.0017

HQ = Hazard Quotient
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
PRG = Preliminary Remediation Goal
[1] Values from Tables 134 through 138 of MACTEC, 2004. Baseline Ecological Risk Assessment - Interim Final. Centredale Manor Restoration Project Superfund Site North Providence, Rhode Island. Prepared under contract to Battelle for USACOE, Contract No. DACW33-01-D-0004. September 30.

Prepared by: BJR
Checked by: SGH

Table 2-13
Derivation of Hatchability-Based Preliminary Remediation Goals for Tree Swallow Egg Tissue

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: INSECTIVOROUS WILDLIFE - TREE SWALLOW EGGS
EXPOSURE MEDIUM: EMERGING INSECTS/SEDIMENT
RISK BASIS: EGG HATCHABILITY THRESHOLD

$$PRG_{egg} = THQ \times EHT$$

PRG_{egg} = Egg Tissue PRG
THQ = Target Hazard Quotient
EHT = Egg Hatchability Threshold

	Egg Hatchability Threshold [1]		
CHEMICAL OF CONCERN	**NOAEL (mg/Kg)**	**LOAEL (mg/Kg)**	**MATC (mg/Kg)**
Dioxin Toxicity Equivalency - Birds	0.000516	0.000562	0.000539

	Calculated Egg Tissue PRGs (mg/Kg)								
	NOAEL			LOAEL			MATC		
CHEMICAL OF CONCERN	**HQ = 0.1**	**HQ = 1**	**HQ = 10**	**HQ = 0.1**	**HQ = 1**	**HQ = 10**	**HQ = 0.1**	**HQ = 1**	**HQ = 10**
Dioxin Toxicity Equivalency - Birds	0.0000516	0.000516	0.00516	0.0000562	0.000562	0.00562	0.0000539	0.000539	0.00539

HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
[1] Values from Attachment A of Battelle, 2005. Technical Approach for Deriving Ecological Preliminary Remediation Goals (PRGs).

Prepared by: BJR
Checked by: SGH

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Tree Swallow Biomagnification Factors (BMFs)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Dioxin Toxicity Equivalency - Birds	Lipid - Normalized Emerging Insect or Stomach Content Tissue Concentration								Lipid - Normalized Tree Swallow Egg Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect EI_{ln} (mg/kg)	ArithMean EI_{ln} (mg/kg)	Variance EI_{ln} (mg/kg)	Standard Deviation EI_{ln} (mg/kg)	Coefficient of Variation %	GeoMean EI_{ln} (mg/kg)	Frequency of Detection		Maximum Detect TS_{ln} (mg/kg)	ArithMean TS_{ln} (mg/kg)	Variance TS_{ln} (mg/kg)	Standard Deviation TS_{ln} (mg/kg)	Coefficient of Variation %	GeoMean TS_{ln} (mg/kg)	BMF TS
Assapumpset								NA								NS	NE
Greystone (Diet)	2	2	2.47E-04	1.49E-04	1.90E-08	1.13E-04	75.9	1.13E-04	17	17	4.13E-02	5.22E-03	1.26E-04	1.12E-02	214.7	9.06E-04	7.98E+00
Greystone (EI)	1	1	4.68E-04	4.68E-04				4.68E-04	17	17	4.13E-02	5.22E-03	1.26E-04	1.12E-02	214.7	9.06E-04	1.93E+00
Allendale (Diet)	2	2	8.44E-03	5.60E-03	1.62E-05	4.02E-03	71.8	4.82E-03	31	31	6.49E-02	1.36E-02	1.85E-04	1.36E-02	99.6	7.60E-03	1.58E+00
Lyman Mill (Diet)	1	1	4.86E-03	4.86E-03				4.86E-03	12	12	4.11E-02	1.78E-02	1.65E-04	1.28E-02	72.1	1.03E-02	2.12E+00
Lyman Mill (EI)	1	1	1.24E-02	1.24E-02				1.24E-02	12	12	4.11E-02	1.78E-02	1.65E-04	1.28E-02	72.1	1.03E-02	8.29E-01
Manton (Diet)	1	1	2.65E-03	2.65E-03				2.65E-03	4	4	1.52E-02	1.14E-02	8.93E-06	2.99E-03	26.1	1.11E-02	4.21E+00
Dyerville								NA								NS	NE

Toxicity Equivalency (PCB) - Birds	Lipid - Normalized Emerging Insect Tissue Concentration								Lipid - Normalized Tree Swallow Egg Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect EI_{ln} (mg/kg)	ArithMean EI_{ln} (mg/kg)	Variance EI_{ln} (mg/kg)	Standard Deviation EI_{ln} (mg/kg)	Coefficient of Variation %	GeoMean EI_{ln} (mg/kg)	Frequency of Detection		Maximum Detect TS_{ln} (mg/kg)	ArithMean TS_{ln} (mg/kg)	Variance TS_{ln} (mg/kg)	Standard Deviation TS_{ln} (mg/kg)	Coefficient of Variation %	GeoMean TS_{ln} (mg/kg)	BMF TS
Assapumpset								NA								NS	NE
Greystone (EI)	1	1	4.72E-04	4.72E-04				4.72E-04								NS	NE
Allendale								NA	3	3	7.00E-03	4.70E-03	3.96E-06	1.99E-03	42.3	4.45E-03	NE
Lyman Mill (EI)	1	1	1.05E-03	1.05E-03				1.05E-03	3	3	5.59E-03	4.09E-03	1.91E-06	1.38E-03	33.7	3.94E-03	3.74E+00
Manton								NA								NS	NE
Dyerville								NA								NS	NE

NS = Not Sampled
NE = Not Evaluated
NA = Not Analyzed
ArithMean = arithmetic mean
GeoMean = geometric mean
SD_{oc} = organic carbon-normalized concentration in sediment
EI_{ln} = lipid-normalized concentrations in emerging insect (or stomach content, as indicated)
TS_{ln} = lipid-normalized concentrations in tree swallow egg
BMF = Biomagnification Factor
Diet = Refers to tree swallow stomach content samples
EI = Refers to emerging insect samples
mg/kg = milligrams per kilogram
Notes: BMFs were derived as the ratio of the lipid-normalized tree swallow egg tissue and lipid-normalized emerging insect tissue or stomach content concentrations
All data extracted from site database (MACTEC, 2005)
Where available, BMFs based on stomach context samples were preferentially used to derive sediment PRGs.

Prepared by: BJR
Checked by: KJA

Table 2-15
Emerging Insect and Stomach Content Biota Sediment Accumulation Factors (BSAFs)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Dioxin Toxicity Equivalency - Birds	TOC - Normalized Sediment Concentration								Lipid - Normalized Emerging Insect or Stomach Content Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detect SD_{oen} (mg/kg)	ArithMean SD_{oen} (mg/kg)	Variance SD_{oen} (mg/kg)	Standard Deviation SD_{oen} (mg/kg)	Coefficient of Variation %	GeoMean SD_{oen} (mg/kg)	Frequency of Detection		Maximum Detect EI_{in} (mg/kg)	ArithMean EI_{in} (mg/kg)	Variance EI_{in} (mg/kg)	Standard Deviation EI_{in} (mg/kg)	Coefficient of Variation %	GeoMean EI_{in} (mg/kg)	BSAF EI or BSAF Diet
Assapumpset	4	4	1.70E-03	5.21E-04	6.21E-07	7.88E-04	151.2	2.30E-04								NA	NE
Greystone (Diet)	6	6	2.14E-03	7.45E-04	5.03E-07	7.09E-04	95.2	5.45E-04	2	2	2.47E-04	1.49E-04	1.90E-08	1.13E-04	75.9	1.13E-04	2.08E-01
Greystone (EI)	6	6	2.14E-03	7.45E-04	5.03E-07	7.09E-04	95.2	5.45E-04	1	1	4.68E-04	4.68E-04				4.68E-04	8.59E-01
Allendale (Diet)	31	31	2.63E-01	4.17E-02	2.97E-03	5.45E-02	130.7	1.62E-02	2	2	8.44E-03	5.60E-03	1.62E-05	4.02E-03	71.8	4.82E-03	2.98E-01
Lyman Mill (Diet)	30	30	1.00E-01	2.93E-02	9.51E-04	3.08E-02	105.3	1.42E-02	1	1	4.86E-03	4.86E-03				4.86E-03	3.42E-01
Lyman Mill (EI)	30	30	1.00E-01	2.93E-02	9.51E-04	3.08E-02	105.3	1.42E-02	1	1	1.24E-02	1.24E-02				1.24E-02	8.75E-01
Manton (Diet)	3	3	2.72E-02	2.26E-02	2.78E-05	5.28E-03	23.3	2.22E-02	1	1	2.65E-03	2.65E-03				2.65E-03	1.19E-01
Dyerville	4	4	1.02E-01	2.80E-02	2.46E-03	4.96E-02	177.0	1.35E-03								NA	NE

Toxicity Equivalency (PCB) - Birds	TOC - Normalized Sediment Concentration								Lipid - Normalized Emerging Insect Tissue Concentration							
Exposure Area	Frequency of Detection		Maximum Detect SD_{oen} (mg/kg)	ArithMean SD_{oen} (mg/kg)	Variance SD_{oen} (mg/kg)	Standard Deviation SD_{oen} (mg/kg)	Coefficient of Variation %	GeoMean SD_{oen} (mg/kg)	Frequency of Detection		Maximum Detect EI_{in} (mg/kg)	ArithMean EI_{in} (mg/kg)	Variance EI_{in} (mg/kg)	Standard Deviation EI_{in} (mg/kg)	Coefficient of Variation %	GeoMean EI_{in} (mg/kg)	BSAF EI
Assapumpset								NA								NA	NE
Greystone (EI)	1	1	1.68E-03	1.68E-03				1.68E-03	1	1	4.72E-04	4.72E-04				4.72E-04	2.81E-01
Allendale								NA								NA	NE
Lyman Mill (EI)	3	3	2.09E-03	1.43E-03	4.16E-07	6.45E-04	45.2	1.33E-03	1	1	1.05E-03	1.05E-03				1.05E-03	7.93E-01
Manton								NA								NA	NE
Dyerville	2	2	2.76E-04	2.76E-04				2.76E-04								NA	NE

NS = Not Sampled
NE = Not Evaluated
NA = Not Analyzed
ArithMean = arithmetic mean
ArithMean = arithmetic mean
GeoMean = geometric mean
SD_{oen} = organic carbon-normalized concentration in sediment
EI_{in} = lipid-normalized concentrations in emerging insect (of stomach content, as indicated)
TOC = Total Organic Carbon
BSAF = Biota Sediment Accumulation Factor
Diet = Refers to tree swallow stomach content samples
EI = Refers to emerging insect samples
mg/kg = milligrams per kilogram
Notes: BSAFs were derived as the ratio of the lipid-normalized emerging insect tissue and carbon-normalized sediment concentrations
All data extracted from site database (MACTEC, 2005)
Where available, BSAFs based on stomach context samples were preferentially used to derive sediment PRGs

Prepared by: BJR
Checked by: KJA

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: INSECTIVOROUS WILDLIFE - TREE SWALLOW EGGS
EXPOSURE MEDIUM: EMERGING INSECTS/SEDIMENT
RISK BASIS: CBR THRESHOLD

$$PRG_{sed} = \frac{PRG_{egg} \times [TOC]_{sed}}{BSAF \times BMF \times [Lipid]_{egg}}$$

PRG_{sed} = Preliminary Remediation Goal for sediment
PRG_{egg} = Tree swallow egg tissue PRG
$[TOC]_{sed}$ = Geometric mean concentration of total organic carbon in sediment
$[Lipid]_{egg}$ = Geometric mean concentration of lipid in egg
BSAF = Biota/Sediment accumulation factor for emerging insects or tree swallow stomach contents
BMF = Biomagnification factor

CHEMICAL OF CONCERN	Egg Tissue PRGs (mg/Kg) [1]								
	NOAEL			LOAEL			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	0.000010	0.00010	0.0010	0.000030	0.00030	0.0030	0.000017	0.00017	0.0017
Toxicity Equivalency (PCB) - Birds	0.000010	0.00010	0.0010	0.000030	0.00030	0.0030	0.000017	0.00017	0.0017

	GEOMEAN LIPID $[Lipid]_{egg}$ (mg/Kg) [3]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{sed}$ (mg/Kg) [2]
Allendale	43506	44385
Lyman Mill	51120	47041
Manton	69587	12450
Dyerville	NA	10820

CHEMICAL OF CONCERN	BSAF Diet [3]	BMF Diet [4]	Calculated Sediment PRGs (mg/Kg) ALLENDALE								
			NOAEL			LOAEL			MATC		
			HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	2.98E-01	1.58E+00	0.000022	0.00022	0.0022	0.000065	0.00065	0.0065	0.000038	0.00038	0.0038
Toxicity Equivalency (PCB) - Birds	NE	NE	---	---	---	---	---	---	---	---	---

CHEMICAL OF CONCERN	BSAF Diet BSAF EI [3]	BMF Diet BMF EI[4]	Calculated Sediment PRGs (mg/Kg) LYMAN MILL								
			NOAEL			LOAEL			MATC		
			HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	3.42E-01	2.12E+00	0.000013	0.00013	0.0013	0.000038	0.00038	0.0038	0.000022	0.00022	0.0022
Toxicity Equivalency (PCB) - Birds	7.93E-01	3.74E+00	0.0000031	0.000031	0.00031	0.0000093	0.000093	0.00093	0.0000054	0.000054	0.00054

CHEMICAL OF CONCERN	BSAF Diet [3]	BMF Diet [4]	Calculated Sediment PRGs (mg/Kg) MANTON								
			NOAEL			LOAEL			MATC		
			HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	1.19E-01	4.21E+00	0.0000036	0.000036	0.00036	0.000011	0.00011	0.0011	0.0000062	0.000062	0.00062
Toxicity Equivalency (PCB) - Birds	NE	NE	---	---	---	---	---	---	---	---	---

Table 2-16
Derivation of Sediment Preliminary Remediation Goals for Insectivorous Wildlife Based on CBR Threshold

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: INSECTIVOROUS WILDLIFE - TREE SWALLOW EGGS
EXPOSURE MEDIUM: EMERGING INSECTS/SEDIMENT
RISK BASIS: CBR THRESHOLD

			Calculated Sediment PRGs (mg/Kg)								
			DYERVILLE								
CHEMICAL OF CONCERN	BSAF	BMF	NOAEL			LOAEL			MATC		
			HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	NE	NE	---	---	---	---	---	---	---	---	---
Toxicity Equivalency (PCB) - Birds	NE	NE	---	---	---	---	---	---	---	---	---

--- = No PRG calculated
NA = Not Available
NE = Not Evaluated
BMF Diet = Biomagnification Factor for Tree Swallow Stomach Content
BMF EI = Biomagnification Factor for Emerging Insect
BSAF EI = Biota Sediment Accumulation Factor for Emerging Insect
BSAF Diet = Biota Sediment Accumulation Factor for Tree Swallow Stomach Content
HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
[1] Egg tissue PRGs are from Table 2-12.
[2] Lipid and TOC values are from Table 2-5.
[3] Emerging insect and stomach content BSAFs are from Table 2-15.
[4] Tree Swallow BMFs are from Table 2-14.
Note: PRGs calculated for analytes as indicated in Table 1-1.

Prepared by KJA
Checked by SGH

Table 2-17

Derivation of Sediment Preliminary Remediation Goals for Insectivorous Wildlife Based on Tree Swallow Egg Hatchability

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: INSECTIVOROUS WILDLIFE - TREE SWALLOW EGGS
EXPOSURE MEDIUM: EMERGING INSECTS/SEDIMENT
RISK BASIS: EGG HATCHABILITY THRESHOLD

$$PRG_{sed} = \frac{PRG_{egg} \times [TOC]_{sed}}{BSAF \times BMF \times [Lipid]_{egg}}$$

PRG_{sed} = Preliminary Remediation Goal for sediment
PRG_{egg} = Tree swallow egg tissue PRG
$[TOC]_{sed}$ = Geometric mean concentration of total organic carbon in sediment
$[Lipid]_{egg}$ = Geometric mean concentration of lipid in egg
BSAF= Biota/Sediment accumulation factor for tree swallow stomach contents
BMF= Biomagnification Factor

CHEMICAL OF CONCERN	Egg Tissue PRGs (mg/Kg) [1]								
	NOAEL			LOAEL			MATC		
	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	0.00001516	0.0001516	0.001516	0.00001562	0.0001562	0.001562	0.00001539	0.0001539	0.001539

	GEOMEAN LIPID $[Lipid]_{sed}$ (mg/Kg) [2]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{sed}$ (mg/Kg) [2]
Allendale	43500	44385
Lyman Mill	51120	47041
Manton	69587	124530
Dyerville	NA	10820

Calculated Sediment PRGs (mg/Kg)

ALLENDALE

CHEMICAL OF CONCERN	BSAF Diet [3]	BMF Diet [4]	NOAEL			LOAEL			MATC		
			HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	2.98E-01	1.58E+00	0.00011	0.0011	0.021	0.00012	0.0112	0.012	0.00012	0.0012	0.012

Calculated Sediment PRGs (mg/Kg)

LYMAN MILL

CHEMICAL OF CONCERN	BSAF Diet [3]	BMF Diet [4]	NOAEL			LOAEL			MATC		
			HI = 0.1	HI = 1	HI = 10	HI = 0.1	HI = 1	HI = 10	HI = 0.1	HI = 1	HI = 10
Dioxin Toxicity Equivalency - Birds	3.42E-01	2.12E+00	0.000065	0.00065	0.0065	0.000071	0.0071	0.071	0.000068	0.00068	0.0068

Calculated Sediment PRGs (mg/Kg)

MANTON

CHEMICAL OF CONCERN	BSAF Diet [3]	BMF Diet [4]	NOAEL			LOAEL			MATC		
			HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	1.19E-01	4.21E+00	0.000018	0.00018	0.0018	0.000020	0.00201	0.020	0.000019	0.00019	0.0019

Calculated Sediment PRGs (mg/Kg)

DYERVILLE

CHEMICAL OF CONCERN	BSAF [3]	BMF [4]	NOAEL			LOAEL			MATC		
			HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Dioxin Toxicity Equivalency - Birds	NE	NE	---	---	---	---	---	---	---	---	---

NA = Not Available
NE = Not Evaluated
--- = No PRG calculated
BMF = Biomagnification Factor
BSAF Diet = Biota Sediment Accumulation Factor for Tree Swallow Stomach Contents
HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
[1] Tree Swallow egg tissue PRGs are from Table 2-13
[2] Lipid and TOC values are from Table 2-5
[3] Tree Swallow stomach content BSAFs are from Table 2-15
[4] BMFs are from Table 2-14
Note: PRGs calculated for analytes as indicated in Table 1-1

Prepared by KJA
Checked by SGH

Earthworm Biota Soil Accumulation Factors (BSAFs)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Arsenic	Surface Soil Concentration (unnormalized)								Earthworm Tissue Concentration (unnormalized)								
Exposure Area	Frequency of Detection		Maximum Detect FP (mg/kg)	ArithMean FP (mg/kg)	Variance FP (mg/kg)	Standard Deviation FP (mg/kg)	Coefficient of Variation %	GeoMean FP (mg/kg)	Frequency of Detection		Maximum Detect EW (mg/kg)	ArithMean EW (mg/kg)	Variance EW (mg/kg)	Standard Deviation EW (mg/kg)	Coefficient of Variation %	GeoMean EW (mg/kg)	BSAF EW
Assapumpset																NS	NE
Greystone	4	4	1.22E+01	7.72E+00	9.17E+00	3.03E+00	39.3	7.34E+00	4	4	8.33E-01	6.01E-01	3.31E-02	1.82E-01	30.3	5.80E-01	7.90E-02
Allendale	4	4	5.01E+00	4.47E+00	2.14E-01	4.62E-01	10.4	4.45E+00	4	4	6.10E-01	5.67E-01	4.66E-03	6.82E-02	12.0	5.63E-01	1.27E-01
Lyman Mill	3	3	7.42E+00	5.53E+00	2.79E+00	1.67E+00	30.2	5.38E+00	3	3	1.17E+00	7.39E-01	1.40E-01	3.74E-01	50.6	6.84E-01	1.27E-01
Manton																NS	NE
Dyerville																NS	NE

Cadmium	Surface Soil Concentration (unnormalized)								Earthworm Tissue Concentration (unnormalized)								
Exposure Area	Frequency of Detection		Maximum Detect FP (mg/kg)	ArithMean FP (mg/kg)	Variance FP (mg/kg)	Standard Deviation FP (mg/kg)	Coefficient of Variation %	GeoMean FP (mg/kg)	Frequency of Detection		Maximum Detect EW (mg/kg)	ArithMean EW (mg/kg)	Variance EW (mg/kg)	Standard Deviation EW (mg/kg)	Coefficient of Variation %	GeoMean EW (mg/kg)	BSAF EW
Assapumpset																NS	NE
Greystone	4	4	3.46E+00	1.63E+00	1.55E+00	1.24E+00	76.4	1.35E+00	4	4	4.13E+00	2.97E+00	7.61E-01	8.73E-01	29.4	2.88E+00	2.13E+00
Allendale	4	4	2.01E+00	1.18E+00	4.50E-01	6.71E-01	57.0	1.00E+00	4	4	2.85E+00	2.37E+00	2.24E-01	4.74E-01	20.0	2.33E+00	2.33E+00
Lyman Mill	3	3	3.18E+00	1.80E+00	1.85E+00	1.36E+00	75.5	1.37E+00	3	3	7.78E+00	5.29E+00	5.72E+00	2.39E+00	45.2	4.92E+00	3.58E+00
Manton																NS	NE
Dyerville																NS	NE

Selenium	Surface Soil Concentration (unnormalized)								Earthworm Tissue Concentration (unnormalized)								
Exposure Area	Frequency of Detection		Maximum Detect FP (mg/kg)	ArithMean FP (mg/kg)	Variance FP (mg/kg)	Standard Deviation FP (mg/kg)	Coefficient of Variation %	GeoMean FP (mg/kg)	Frequency of Detection		Maximum Detect EW (mg/kg)	ArithMean EW (mg/kg)	Variance EW (mg/kg)	Standard Deviation EW (mg/kg)	Coefficient of Variation %	GeoMean EW (mg/kg)	BSAF EW
Assapumpset																NS	NE
Greystone	3	4	9.63E-01	7.04E-01	8.37E-02	2.89E-01	41.1	6.46E-01	4	4	9.96E-01	5.63E-01	1.00E-01	3.16E-01	56.2	4.98E-01	7.71E-01
Allendale	0	4	ND	2.58E-01	7.42E-04	2.72E-02	10.6	2.57E-01	4	4	3.82E-01	3.23E-01	3.32E-03	5.76E-02	17.8	3.19E-01	1.24E+00
Lyman Mill	1	3	7.79E-01	4.30E-01	9.25E-02	3.04E-01	70.7	3.68E-01	3	3	5.22E+00	2.00E+00	7.78E+00	2.79E+00	139.5	9.18E-01	2.49E+00
Manton																NS	NE
Dyerville																NS	NE

Table 2-18
Earthworm Biota Soil Accumulation Factors (BSAFs)

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Toxicity Equivalency - Mammals	TOC - Normalized Surface Soil Concentration								Lipid - Normalized Earthworm Tissue Concentration								
Exposure Area	Frequency of Detection		Maximum Detect FP_{ocn} (mg/kg)	ArithMean FP_{ocn} (mg/kg)	Variance FP_{ocn} (mg/kg)	Standard Deviation FP_{ocn} (mg/kg)	Coefficient of Variation %	GeoMean FP_{ocn} (mg/kg)	Frequency of Detection		Maximum Detect EW (mg/kg)	ArithMean EW (mg/kg)	Variance EW (mg/kg)	Standard Deviation EW_{ln} (mg/kg)	Coefficient of Variation %	GeoMean EW (mg/kg)	BSAF EW
Assapumpset																NS	NE
Greystone	4	4	9.99E-04	6.19E-04	7.33E-08	2.71E-04	43.7	5.80E-04	4	4	1.89E-04	1.06E-04	3.50E-09	5.92E-05	55.7	9.48E-05	1.63E-01
Allendale	4	4	7.28E-02	3.72E-02	7.48E-04	2.74E-02	73.5	2.84E-02	4	4	8.61E-03	6.19E-03	6.82E-06	2.61E-03	42.2	5.76E-03	2.03E-01
Lyman Mill	3	3	2.49E-02	9.42E-03	1.81E-04	1.35E-02	142.8	3.96E-03	3	3	3.66E-03	1.44E-03	3.67E-06	1.91E-03	132.5	7.43E-04	1.88E-01
Manton																NS	NE
Dyerville																NS	NE

NS = Not Sampled
NE = Not Evaluated
NA = Not Analyzed
ArithMean = arithmetic mean
GeoMean = geometric mean
FPocn = organic carbon-normalized concentration in floodplain soil
EWln = lipid-normalized concentrations in earthworm
mg/kg = milligrams per kilogram
BSAF = biota sediment accumulation factor
TOC = total organic carbon
FP = floodplain soil
Notes: BSAFs were derived as the ratio of the lipid-normalized earthworm tissue and carbon-normalized floodplain soil concentrations
All data extracted from site database (MACTEC, 2005)

Prepared by: BJR
Checked by: KJA

Table 2-19
Derivation of Floodplain Soil Preliminary Remediation Goals for Vermivorous Wildlife

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: VERMIVOROUS WILDLIFE - SHORT-TAILED SHREW
EXPOSURE MEDIUM: EARTHWORM / FLOODPLAIN SOIL
RISK BASIS: FOOD CHAIN EXPOSURE MODELING

$$PRG_{soil} = \frac{THQ \times TRV \times BW}{\left(BAF_{plant} \times IR_{food} \times P_{plant} \times SFF \times EF\right) + \left(\frac{BSAF_{ew} \times [LIPID]_{ew}}{[TOC]_{soil}} \times IR_{food} \times P_{ew} \times SFF \times EF\right) + \left(IR_{soil} \times SFF \times EF\right)}$$

where:

PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	VALUE	RATIONALE/
PRG_{soil}	SOIL PRG PROTECTIVE OF THE SHORT-TAILED SHREW	mg/kg		
THQ	TARGET HAZARD QUOTIENT	unitless	0.1, 1, 10	
TRV	LITERATURE-BASED TOXICITY REFERENCE VALUE (DIRECTLY COMPARABLE TO CALCULATED ESTIMATED DAILY INTAKE)	mg/kg-d	chemical-specific (see table below for values)	[1]
BAF_{plant}	LITERATURE-BASED PLANT BIOTA ACCUMULATION FACTOR	mg (ww tissue) / kg(dw soil)	chemical-specific	[2]
$BSAF_{ew}$	EXPOSURE AREA SPECIFIC EARTHWORM BIOTA SOIL ACCUMULATION FACTOR	kg (TOC in soil)/kg (lipid in worm)	chemical-specific	[3]
IR_{food}	INGESTION RATE OF FOOD	kg/day	0.013	[4]
IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.00064	assumption
P_{plant}	PERCENT PLANTS IN DIET	unitless	14%	[5]
P_{ew}	PERCENT EARTHWORMS IN DIET	unitless	85%	[5]
SFF	SITE FORAGING FREQUENCY	unitless	100%	[6]
EF	EXPOSURE FREQUENCY	unitless	100%	[4]
BW	BODY WEIGHT	kg	0.017	[7]
$[LIPID]_{ew}$	LIPID CONCENTRATION IN EARTHWORM TISSUE	mg (lipid)/kg (tissue)	exposure area specific	[8]
$[TOC]_{soil}$	TOTAL ORGANIC CARBON CONCENTRATION IN SOIL	mg (TOC)/kg (soil)	exposure area specific	[8]

Note: The above equation is for organic chemicals. For inorganic chemicals,
the PRG is calculated using the same equation but excluding the $[LIPID]_{ew}$ and $[TOC]_{soil}$ terms.

Table 2-19
Derivation of Floodplain Soil Preliminary Remediation Goals for Vermivorous Wildlife

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: VERMIVOROUS WILDLIFE - SHORT-TAILED SHREW
EXPOSURE MEDIUM: EARTHWORM / FLOODPLAIN SOIL
RISK BASIS: FOOD CHAIN EXPOSURE MODELING

	Toxicity Reference Value (TRV) (mg/Kg-d) [1]		
	NOAEL	LOAEL	MATC
Arsenic	1.3E-01	1.3E+00	4.0E-01
Cadmium	1.0E+00	1.0E+01	3.2E+00
Selenium	2.0E-01	3.3E-01	2.6E-01
Dioxin Toxicity Equivalency - Mammals	1.0E-06	1.0E-05	3.2E-06

	Terrestrial Plant BAFs [2]
	Literature Based
Arsenic	1.0E-02
Cadmium	4.4E-02
Selenium	1.3E-01
Dioxin Toxicity Equivalency - Mammals	NA

	GEOMEAN LIPID $[Lipid]_{ew}$ (mg/Kg) [8]	GEOMEAN TOTAL ORGANIC CARBON $[TOC]_{soil}$ (mg/Kg) [8]
Allendale	28793	66788
Lyman Mill	24980	61209
Manton	NA	NA
Dyerville	NA	NA

		Calculated Floodplain Soil PRGs (mg/Kg)								
		ALLENDALE								
		NOAEL			LOAEL			MATC		
CHEMICAL OF CONCERN	BSAF EW [3]	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Arsenic	1.27E-01	---	---	---	---	---	---	---	---	---
Cadmium	2.33E+00	---	---	---	---	---	---	---	---	---
Selenium	1.24E+00	---	---	---	---	---	---	---	---	---
Dioxin Toxicity Equivalency - Mammals [9]	2.03E-01	0.0000011	0.000011	0.00011	0.000011	0.00011	0.0011	0.0000034	0.000034	0.000344

		Calculated Floodplain Soil PRGs (mg/Kg)								
		LYMAN MILL								
		NOAEL			LOAEL			MATC		
CHEMICAL OF CONCERN	BSAF EW [3]	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10	HQ = 0.1	HQ = 1	HQ = 10
Arsenic	1.27E-01	0.11	1.1	10.8	1.1	10.8	108	0.34	3.4	34.1
Cadmium	3.58E+00	0.043	0.43	4.3	0.43	4.3	43.5	0.14	1.4	13.7
Selenium	2.49E+00	0.012	0.12	1.2	0.020	0.20	2.0	0.016	0.16	1.6
Dioxin Toxicity Equivalency - Mammals [9]	1.88E-01	0.0000012	0.000012	0.00012	0.000012	0.00012	0.0012	0.0000037	0.000037	0.00037

Table 2-19
Derivation of Floodplain Soil Preliminary Remediation Goals for Vermivorous Wildlife

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: VERMIVOROUS WILDLIFE - SHORT-TAILED SHREW
EXPOSURE MEDIUM: EARTHWORM / FLOODPLAIN SOIL
RISK BASIS: FOOD CHAIN EXPOSURE MODELING

CHEMICAL OF CONCERN	BSAF EW [3]	Calculated Floodplain Soil PRGs (mg/Kg) MANTON NOAEL HQ = 0.1	NOAEL HQ = 1	NOAEL HQ = 10	LOAEL HQ = 0.1	LOAEL HQ = 1	LOAEL HQ = 10	MATC HQ = 0.1	MATC HQ = 1	MATC HQ = 10
Arsenic	NE	---	---	---	---	---	---	---	---	---
Cadmium	NE	---	---	---	---	---	---	---	---	---
Selenium	NE	---	---	---	---	---	---	---	---	---
Dioxin Toxicity Equivalency - Mammals	NE	---	---	---	---	---	---	---	---	---

CHEMICAL OF CONCERN	BSAF EW [3]	Calculated Floodplain Soil PRGs (mg/Kg) DYERVILLE NOAEL HQ = 0.1	NOAEL HQ = 1	NOAEL HQ = 10	LOAEL HQ = 0.1	LOAEL HQ = 1	LOAEL HQ = 10	MATC HQ = 0.1	MATC HQ = 1	MATC HQ = 10
Arsenic	NE	---	---	---	---	---	---	---	---	---
Cadmium	NE	---	---	---	---	---	---	---	---	---
Selenium	NE	---	---	---	---	---	---	---	---	---
Dioxin Toxicity Equivalency - Mammals	NE	---	---	---	---	---	---	---	---	---

--- = No PRG calculated
NE = Not Evaluated
NA - not available
BSAF = Biota-Soil Accumulation Factor
EW = Earthworm
HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
Note: PRGs calculated for analytes as indicated in Table 1-1.
TOC = Total Organic Carbon

[1] Values from Table D-4 (Appendix D) of the BERA (MACTEC, 2004).
[2] Values from Table J-1 (Appendix J) of the BERA (MACTEC, 2004).
[3] Values from Table 2-18.
[4] USEPA, 1993.
[5] Feraro, 1963.
[6] Buckner, 1966.
[7] Guilday, 1957.
[8] Values from Table 2-5.
[9] Due to the lack of a plant BAF value for this chemical, the soil PRG is based solely on a diet of earthworms.

Table 2-19
Derivation of Floodplain Soil Preliminary Remediation Goals for Vermivorous Wildlife

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: VERMIVOROUS WILDLIFE - SHORT-TAILED SHREW
EXPOSURE MEDIUM: EARTHWORM / FLOODPLAIN SOIL
RISK BASIS: FOOD CHAIN EXPOSURE MODELING

The soil PRG may alternatively be calculated using the following equation:

$$PRG_{soil} = \frac{THQ \times C_{soil}}{CombinedHQ}$$

where:

PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	VALUE	RATIONALE/	INTAKE EQUATION/ MODEL NAME
Combined HQ	COMBINED HAZARD QUOTIENT	unitless			Combined HQ = $HQ_{plant} + HQ_{ew} + HQ_{soil}$
HQ_{plant}	HAZARD QUOTIENT BASED ON CONSUMPTION OF CONTAMINATED PLANT TISSUE	unitless			$HQ_{plant} = EDI_{plant} * 1/TRV$
HQ_{ew}	HAZARD QUOTIENT BASED ON CONSUMPTION OF CONTAMINATED EARTHWORM TISSUE	unitless			$HQ_{ew} = ED_{ew} * 1/TRV$
HQ_{soil}	HAZARD QUOTIENT BASED ON INCIDENTAL INGESTION OF SOIL	unitless			$HQ_{soil} = EDI_{soil} * 1/TRV$
EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
EDI_{plant}	ESTIMATED DAILY INTAKE VIA PLANT INGESTION	mg/kg-d	calculated		$EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF * 1/BW$
EDI_{ew}	ESTIMATED DAILY INTAKE VIA EARTHWORM INGESTION	mg/kg-d	calculated		$ED_{ew} = C_{ew} * IR_{food} * P_{ew} * SFF * EF * 1/BW$
C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		
C_{plant}	CHEMICAL CONCENTRATION IN PLANTS	mg/kg	chemical-specific		$C_{plant} = C_{soil} * BAF_{plant}$
C_{ew}	CHEMICAL CONCENTRATION IN EARTHWORMS	mg/kg	chemical-specific		$C_{ew} = C_{soil} * BSAF_{ew} * invertlipid\% * 1/soilTOC\%$

Concentrations in plant tissue and earthworm tissue (mg/kg) that are protective of the short-tailed shrew may be described using the following equations:

$$PRG_{plant} = PRG_{soil} \times BAF \qquad PRG_{ew} = \frac{PRG_{soil} \times BSAF \times [Lipid]_{EW}}{[TOC]_{soil}}$$

Table 2-19
Derivation of Floodplain Soil Preliminary Remediation Goals for Vermivorous Wildlife

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

RECEPTOR: VERMIVOROUS WILDLIFE - SHORT-TAILED SHREW
EXPOSURE MEDIUM: EARTHWORM / FLOODPLAIN SOIL
RISK BASIS: FOOD CHAIN EXPOSURE MODELING

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Prepared by: KJA
Checked by: SGH

Summary of Preliminary Remediation Goals for Ecological Receptors, HQ = 0.1

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Concern	Sediment PRG											
		Demersal Fish / White Sucker CBR Based [1]			Demersal Fish / White Sucker, American Eel ELS Based [2]			Pelagic Fish / Largemouth Bass CBR Based [3]			Pelagic Fish / Largemouth Bass ELS Based [4]		
		NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)
ALLENDALE	Technical Chlordane	0.0015	0.0015	0.0015	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	0.018	0.028	0.022	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	0.037	0.048	0.042	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	4.5	5.2	4.9	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	0.000032	0.000049	0.000039	0.00010	0.00015	0.00012	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
LYMAN MILL	4,4-DDD	0.00024	0.018	0.0021	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	0.00052	0.0036	0.0014	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	0.0013	0.0013	0.0013	NE	NE	NE	0.0030	0.0030	0.0030	NE	NE	NE
	Aroclor-1254	0.021	0.035	0.028	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	38.4	307	109	NE	NE	NE	34.4	275	97.3	NE	NE	NE
	Arsenic	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Barium	NE	4.6	NE	NE	NE	NE	NE	2.7	NE	NE	NE	NE
	Cadmium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	0.041	0.053	0.047	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Vanadium	0.66	11.5	3.0	NE	NE	NE	0.49	10.0	2.2	NE	NE	NE
	Zinc	3.4	3.9	3.7	NE	NE	NE	3.4	3.9	3.6	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	0.000042	0.000064	0.000052	0.00013	0.00020	0.00016	0.00010	0.00015	0.00012	0.00030	0.00048	0.00038
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	0.000040	0.000064	0.000051	NE	NE	NE	NE	NE	NE
MANTON	4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	12.3	98.7	34.9	NE	NE	NE
	Barium	NE	NE	NE	NE	NE	NE	NE	1.5	NE	NE	NE	NE
	Vanadium	NE	NE	NE	NE	NE	NE	0.20	4.1	0.90	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00019	0.00030	0.00024
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
DYERVILLE	4,4-DDD	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	0.000010	0.000016	0.000013	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	0.00000029	0.00000046	0.00000036	NE	NE	NE	NE	NE	NE

Table 2-20
Summary of Preliminary Remediation Goals for Ecological Receptors, HQ = 0.1

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Concern	Sediment PRG									Floodplain Soil PRG		
		Piscivorous Wildlife Belted Kingfisher [5]			Insectivorous Wildlife / Tree Swallow Egg Tissue CBR Based [6]			Insectivorous Wildlife / Tree Swallow Egg Tissue Hatchability Based [7]			Vermivorous Wildlife Short-tailed Shrew [8]		
		NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)
ALLENDALE	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	0.010	0.10	0.032	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	0.0069	0.017	0.011	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.0000096	0.000096	0.000030	0.000022	0.000065	0.000038	0.00011	0.00012	0.00012	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.0000011	0.000011	0.0000034
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
LYMAN MILL	4,4-DDD	0.00027	0.0027	0.00084	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	0.00011	0.0011	0.00034	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	0.11	1.1	0.35	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	0.013	0.13	0.041	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	0.0088	0.022	0.014	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Arsenic	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.11	1.1	0.34
	Barium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Cadmium	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.043	0.43	0.14
	Selenium	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.012	0.020	0.016
	Vanadium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.000011	0.00011	0.000035	0.000013	0.000038	0.000022	0.000065	0.000071	0.000068	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.0000012	0.000012	0.0000037
	Toxicity Equivalency (PCB) - Birds	0.0000039	0.000039	0.000012	0.0000031	0.0000093	0.0000054	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MANTON	4,4-DDE	0.000049	0.00049	0.00015	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Barium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Vanadium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.000018	0.00018	0.000057	0.0000036	0.000011	0.0000062	0.000018	0.000020	0.000019	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
OVERVILLE	4,4-DDD	0.000099	0.00099	0.00031	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	0.00028	0.0028	0.00089	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	0.026	0.26	0.081	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	0.032	0.079	0.050	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.0000013	0.000013	0.0000041	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Notes:
NE = Not Evaluated
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
EC_{10} = Effect Concentration for 10 % of tested organisms
EC_{25} = Effect Concentration for 25 % of tested organisms
CBR = Critical Body Residue
ELS = Early Life Stage

Footnotes:
[1] PRGs are from Table 2-6
[2] PRGs are from Table 2-7
[3] PRGs are from Table 2-8
[4] PRGs are from Table 2-9
[5] PRGs are from Table 2-11
[6] PRGs are from Table 2-16
[7] PRGs are from Table 2-17
[8] PRGs are from Table 2-19
Note: PRGs calculated for analytes as indicated in Table 1-1

Prepared by: BJR
Checked by: KJA

Summary of Preliminary Remediation Goals for Ecological Receptors, HQ = 1

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Concern	Sediment PRG											
		Demersal Fish / White Sucker CBR Based [1]			Demersal Fish / White Sucker, American Eel ELS Based [2]			Pelagic Fish / Largemouth Bass CBR Based [3]			Pelagic Fish / Largemouth Bass ELS Based [4]		
		NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)
ALLENDALE	Technical Chlordane	0.015	0.015	0.015	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	0.18	0.28	0.22	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	0.37	0.48	0.42	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	45.3	52.2	48.6	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	0.00032	0.00049	0.00039	0.0010	0.0015	0.0012	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
LYMAN MILL	4,4-DDD	0.0024	0.18	0.021	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	0.0052	0.036	0.014	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	0.013	0.013	0.013	NE	NE	NE	0.030	0.030	0.030	NE	NE	NE
	Aroclor-1254	0.23	0.35	0.28	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	384	3070	1085	NE	NE	NE	344	2753	973	NE	NE	NE
	Arsenic	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Barium	NE	45.5	NE	NE	NE	NE	NE	26.5	NE	NE	NE	NE
	Cadmium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	0.41	0.53	0.47	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Vanadium	5.6	135	29.9	NE	NE	NE	4.9	100	22.2	NE	NE	NE
	Zinc	34.0	39.2	36.5	NE	NE	NE	33.7	38.9	36.2	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	0.00042	0.00064	0.00052	0.0013	0.0020	0.0016	0.0010	0.0015	0.0012	0.0030	0.0048	0.0038
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	0.00040	0.00064	0.00051	NE	NE	NE	NE	NE	NE
MANTON	4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	123	987	349	NE	NE	NE
	Barium	NE	NE	NE	NE	NE	NE	NE	15.0	NE	NE	NE	NE
	Vanadium	NE	NE	NE	NE	NE	NE	2.0	40.7	9.0	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.0019	0.0030	0.0024
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
DYERVILLE	4,4-DDD	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	0.00010	0.00016	0.00011	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	0.0000029	0.0000046	0.0000036	NE	NE	NE	NE	NE	NE

Table 2-21
Summary of Preliminary Remediation Goals for Ecological Receptors, HQ = 1

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Concern	Sediment PRG											
		Demersal Fish / White Sucker CBR Based [1]			Demersal Fish / White Sucker, American Eel ELS Based [2]			Pelagic Fish / Largemouth Bass CBR Based [3]			Pelagic Fish / Largemouth Bass ELS Based [4]		
		NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)
GEOMEAN	4,4-DDD	0.0024	0.18	0.021	NE	NE	NE	NE	NE	NE	NE	NE	NE
ACROSS	4,4-DDE	0.0052	0.036	0.014	NE	NE	NE	NE	NE	NE	NE	NE	NE
AREAS	Technical Chlordane	0.014	0.014	0.014	NE	NE	NE	0.030	0.030	0.030	NE	NE	NE
	Aroclor-1254	0.20	0.31	0.25	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	384	3070	1085	NE	NE	NE	206	1648	583	NE	NE	NE
	Arsenic	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Barium	NE	45.5	NE	NE	NE	NE	NE	200	NE	NE	NE	NE
	Cadmium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	0.39	0.50	0.44	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Vanadium	6.6	135	29.9	NE	NE	NE	3.1	63.9	14.1	NE	NE	NE
	Zinc	39.2	45.3	42.1	NE	NE	NE	33.7	38.9	36.2	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	0.00036	0.00056	0.00045	0.00050	0.00080	0.00063	0.0010	0.0015	0.0012	0.0024	0.0038	0.0030
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	0.000034	0.000054	0.000043	NE	NE	NE	NE	NE	NE

Summary of Preliminary Remediation Goals for Ecological Receptors, HQ = 1

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Concern	Sediment PRG									Floodplain Soil PRG		
		Piscivorous Wildlife Belted Kingfisher [5]			Insectivorous Wildlife / Tree Swallow Egg Tissue CBR Based [6]			Insectivorous Wildlife / Tree Swallow Egg Tissue Hatchability Based [7]			Vermivorous Wildlife Short-tailed Shrew [8]		
		NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)
ALLENDALE	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	0.10	1.0	0.32	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	0.069	0.17	0.11	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.000096	0.00096	0.00030	0.00022	0.00065	0.00038	0.0011	0.0012	0.0012	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.000011	0.00011	0.000034
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
LYMAN MILL	4,4-DDD	0.0027	0.027	0.0084	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	0.0011	0.011	0.0034	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	1.1	11.2	3.5	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	0.13	1.3	0.41	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	0.088	0.22	0.14	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Arsenic	NE	NE	NE	NE	NE	NE	NE	NE	NE	1.1	10.8	3.4
	Barium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Cadmium	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.43	4.3	1.4
	Selenium	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.12	0.20	0.16
	Vanadium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.00011	0.0011	0.00035	0.00013	0.00038	0.00022	0.00065	0.00071	0.00068	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.000012	0.00012	0.000037
	Toxicity Equivalency (PCB) - Birds	0.000039	0.00039	0.00012	0.000031	0.000093	0.000054	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MANTON	4,4-DDE	0.00049	0.0049	0.0015	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Barium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Vanadium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.00018	0.0018	0.00057	0.000036	0.00011	0.000062	0.00018	0.00020	0.00019	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
DYERVILLE	4,4-DDD	0.00099	0.0099	0.0031	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	0.0028	0.028	0.0089	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	0.26	2.6	0.81	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	0.12	0.79	0.50	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.000013	0.00013	0.000041	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table 2-21
Summary of Preliminary Remediation Goals for Ecological Receptors, HQ = 1

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Concern	Sediment PRG									Floodplain Soil PRG		
		Piscivorous Wildlife Belted Kingfisher [5]			Insectivorous Wildlife / Tree Swallow Egg Tissue CBR Based [6]			Insectivorous Wildlife / Tree Swallow Egg Tissue Hatchability Based [7]			Vermivorous Wildlife Short-tailed Shrew [8]		
		NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)
GEOMEAN	4,4-DDD	0.0016	0.016	0.0051	NE	NE	NE	NE	NE	NE	NE	NE	NE
ACROSS	4,4-DDE	0.0011	0.011	0.0036	NE	NE	NE	NE	NE	NE	NE	NE	NE
AREAS	Technical Chlordane	1.1	11.2	3.5	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	0.15	1.5	0.47	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	0.12	0.31	0.20	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Arsenic	NE	NE	NE	NE	NE	NE	NE	NE	NE	1.1	10.8	3.4
	Barium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Cadmium	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.43	4.3	1.4
	Selenium	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.12	0.20	0.16
	Vanadium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.000070	0.00070	0.00022	0.000099	0.00030	0.00017	0.00051	0.00056	0.00054	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.000011	0.00011	0.000036
	Toxicity Equivalency (PCB) - Birds	0.000039	0.00039	0.00012	0.000031	0.000093	0.000054	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Notes:
NE = Not Evaluated
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Preliminary Remediation Goal
EC_{10} = Effect Concentration for 10 % of tested organisms
EC_{25} = Effect Concentration for 25 % of tested organisms
CBR = Critical Body Residue
ELS = Early life stage
Note: PRGs calculated for analytes as indicated in Table 1-1

Footnotes:
[1] PRGs are from Table 2-6.
[2] PRGs are from Table 2-7.
[3] PRGs are from Table 2-8.
[4] PRGs are from Table 2-9.
[5] PRGs are from Table 2-11.
[6] PRGs are from Table 2-16.
[7] PRGs are from Table 2-17.
[8] PRGs are from Table 2-19.

Prepared by: BJR
Checked by: KJA

Summary of Preliminary Remediation Goals for Ecological Receptors, HQ = 10

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Concern	Sediment PRG											
		Demersal Fish / White Sucker CBR Based [1]			Demersal Fish / White Sucker, American Eel ELS Based [2]			Pelagic Fish / Largemouth Bass CBR Based [3]			Pelagic Fish / Largemouth Bass ELS Based [4]		
		NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)
ALLENDALE	Technical Chlordane	0.15	0.15	0.15	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	1.8	2.8	2.2	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	3.7	4.8	4.2	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	433	522	486	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	0.0032	0.0049	0.0039	0.010	0.015	0.012	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
LYMAN MILL	4,4-DDD	0.024	1.8	0.21	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	0.052	0.36	0.14	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	0.13	0.13	0.13	NE	NE	NE	0.30	0.30	0.30	NE	NE	NE
	Aroclor-1254	2.3	3.5	2.8	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	3837	30698	10853	NE	NE	NE	3441	27530	9733	NE	NE	NE
	Arsenic	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Barium	NE	455	NE	NE	NE	NE	NE	265	NE	NE	NE	NE
	Cadmium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	4.1	5.3	4.7	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Vanadium	66.1	1354	299	NE	NE	NE	49.0	1005	222	NE	NE	NE
	Zinc	340	392	365	NE	NE	NE	337	389	362	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	0.0042	0.0064	0.0052	0.013	0.020	0.016	0.010	0.015	0.012	0.030	0.048	0.038
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	0.0040	0.0064	0.0051	NE	NE	NE	NE	NE	NE
MANTON	4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	1233	9866	3488	NE	NE	NE
	Barium	NE	NE	NE	NE	NE	NE	NE	150	NE	NE	NE	NE
	Vanadium	NE	NE	NE	NE	NE	NE	19.8	407	89.8	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.019	0.030	0.024
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
OVERVILLE	4,4-DDD	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	0.0010	0.0016	0.0013	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	0.000029	0.000046	0.000036	NE	NE	NE	NE	NE	NE

Table 2-22
Summary of Preliminary Remediation Goals for Ecological Receptors, HQ = 10

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Concern	Sediment PRG									Floodplain Soil PRG		
		Piscivorous Wildlife Belted Kingfisher [5]			Insectivorous Wildlife / Tree Swallow Egg Tissue CBR Based [6]			Insectivorous Wildlife / Tree Swallow Egg Tissue Hatchability Based [7]			Vermivorous Wildlife Short-tailed Shrew [8]		
		NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)
ALLENDALE	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	1.0	10.1	3.2	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	0.69	1.7	1.1	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Selenium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.00096	0.0096	0.0030	0.0022	0.0065	0.0038	0.011	0.012	0.012	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00011	0.0011	0.00034
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
LYMAN MILL	4,4-DDD	0.027	0.27	0.084	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	0.011	0.11	0.034	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	11.2	112	35.5	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	1.3	12.9	4.1	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	0.88	2.2	1.4	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Arsenic	NE	NE	NE	NE	NE	NE	NE	NE	NE	10.8	108	34.1
	Barium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Cadmium	NE	NE	NE	NE	NE	NE	NE	NE	NE	4.3	42.5	13.7
	Selenium	NE	NE	NE	NE	NE	NE	NE	NE	NE	1.2	2.0	1.6
	Vanadium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.0011	0.011	0.0035	0.0013	0.0038	0.0022	0.0065	0.0071	0.0068	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Mammal	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00012	0.0012	0.00037
	Toxicity Equivalency (PCB) - Birds	0.00039	0.0039	0.0012	0.00031	0.00093	0.00054	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
MANTON	4,4-DDE	0.0049	0.049	0.015	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Technical Chlordane	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aluminum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Barium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Vanadium	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.0018	0.018	0.0057	0.00036	0.0011	0.00062	0.0018	0.0020	0.0019	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
DYERVILLE	4,4-DDD	0.0099	0.099	0.031	NE	NE	NE	NE	NE	NE	NE	NE	NE
	4,4-DDE	0.028	0.28	0.089	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor-1254	2.6	25.7	8.1	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Aroclor, Total	3.2	7.9	5.0	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Birds	0.00013	0.0013	0.00041	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Dioxin Toxicity Equivalency - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Notes

NE = Not Evaluated

LOAEL = Lowest Observed Adverse Effect Level

MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL

NOAEL = No Observed Adverse Effect Level

PRG = Preliminary Remediation Goal

EC_{10} = Effect Concentration for 10 % of tested organisms

EC_{25} = Effect Concentration for 25 % of tested organisms

CBR = Critical Body Residue

ELS = Early life stage

Footnotes

[1] PRGs are from Table 2-6.

[2] PRGs are from Table 2-7

[3] PRGs are from Table 2-8.

[4] PRGs are from Table 2-9

[5] PRGs are from Table 2-11

[6] PRGs are from Table 2-16

[7] PRGs are from Table 2-17

[8] PRGs are from Table 2-19

Note: PRGs calculated for analytes as indicated in Table 1-1

Prepared by: HJR
Checked by: KJA

MACTEC Engineering and Consulting, Inc.

Table 3-1
Samples Used in the Preliminary Remediation Goals Report - Ecological

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Media	Area	Sample ID	Date Sampled	Inorganics Only
Floodplain Soil	Greystone	RWR-FP-5001-0000-01	7/17/2001	
		RWR-FP-5002-0000-01	7/16/2001	
		RWR-FP-5003-0000-01	7/17/2001	
		RWR-FP-5004-0000-01	7/19/2001	
	Allendale	CMS-FP-4001-0000-01	7/18/2001	
		CMS-FP-4002-0000-01	7/18/2001	
		CMS-FP-4003-0000-01	7/19/2001	
		CMS-FP-4005-0000-01	7/20/2001	
	Lyman Mill	LPX-FP-4004-0000-01	7/19/2001	
		LPX-FP-4006-0000-01	7/19/2001	
		LPX-FP-4007-0000-01	7/19/2001	
Sediment	Assapumpset	RAB-FP-3004-01	11/10/1999	
		RAB-SD-2069-01	9/18/2000	
		RAB-SD-2070-01	9/18/2000	
		RAB-SD-3004-01	11/10/1999	
		RAB-SD-5004-0000-01	7/12/2001	
		RAB-SD-5008-0000-01	7/9/2001	
	Greystone	GMP-SD-5002-0000-01	7/11/2001	
		GMP-SD-5007-0000-01	7/9/2001	
		RCC-BK-3001Y-01	10/22/1999	X
		RCC-BK-3001Z-01	10/22/1999	X
		RCC-BK-3002X-01	10/22/1999	X
		RCC-BK-3002Y-01	10/22/1999	X
		RCC-BK-3002Z-01	10/22/1999	X
		RCC-FP-3001-01	11/10/1999	
		RCC-FP-3002-01	11/10/1999	
		RCC-SD-3001-01	11/10/1999	
		RWR-SD-5003-0000-01	7/12/2001	
		RWR-SD-5004-0000-01	7/12/2001	
	Allendale	APB-FP-2028-000.5-01	10/28/1999	
		APB-BK-2003Y-01	10/21/1999	X
		APB-BK-2003Z-01	10/21/1999	X
		APB-FP-2031-01	10/28/1999	
		APB-FP-2032-01	10/28/1999	
		APB-FP-2033-000.5-01	10/28/1999	
		APB-SD-2030-01	10/22/1999	
		APB-SD-2034-01	11/3/1999	
		APB-SD-2037-01	10/22/1999	
		APB-SD-4008-0000-01	7/9/2001	
		APB-SD-4009-0000-01	7/9/2001	
		APB-SD-4010-0000-01	7/10/2001	
		APC-SD-2035-000.5-01	11/3/1999	
		CMS-192-A	6/30/1999	X
		CMS-FP-4001-0000-01	7/18/2001	

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Samples Used in the Preliminary Remediation Goals Report - Ecological

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Centredale Manor Restoration Project Superfund Site
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Media	Area	Sample ID	Date Sampled	Inorganics Only
Sediment (cont.)	Allendale (cont.)	CMS-FP-4002-0000-01	7/18/2001	
		CMS-FP-4003-0000-01	7/19/2001	
		CMS-FP-4005-0000-01	7/20/2001	
		CMS-SD-4003-0000-01	7/12/2001	
		CMS-SD-4006-0000-01	7/12/2001	
		CMS-SD-4007-0000-01	7/12/2001	
		CMW-FP-2027-01	10/28/1999	
		CMW-SD-2016-01	10/26/1999	
		CMW-SD-2023-01	10/27/1999	
		CMW-SD-2024-01	10/27/1999	
		CMW-SD-2025-000.5-01	10/28/1999	
		DAM002-SD	10/23/1998	
		RES-SS-12-239-01	11/16/1999	X
		RES-SS-12-550-01	11/16/1999	X
		RES-SS-12-551-01	11/16/1999	X
		RES-SS-12-552-01	11/16/1999	X
		RES-SS-12-554-01	11/16/1999	X
		RES-SS-14-333-01	11/15/1999	X
		RES-SS-14-334-01	11/15/1999	X
		RES-SS-14-365-01	11/15/1999	X
		RES-SS-14-366-01	11/15/1999	X
		RES-SS-14-398-01	11/15/1999	X
		RES-SS-14-399-01	11/15/1999	X
		RES-SS-14-419-01	11/19/1999	X
		RES-SS-14-420-01	11/19/1999	X
		RES-SS-14-422-01	12/2/1999	X
		RES-SS-14-424-01	12/2/1999	X
		RES-SS-14-425-01	12/2/1999	X
		RES-SS-14-448-01	11/15/1999	X
		RES-SS-14-449-01	12/2/1999	X
		SD-20	9/9/1998	
		SD-22	9/9/1998	
		SD-23	9/9/1998	
		SD-24	9/9/1998	
		SD-25	9/9/1998	
		SD-26	9/9/1998	
		SD-27	9/9/1998	
		SD-28	9/9/1998	
		SD-29	9/9/1998	
		WRC-SD-2009-01	11/1/1999	
		WRC-SD-2013-000.5-01	11/1/1999	
		WRC-SD-2014-01	11/1/1999	
		WRC-SD-2015-01	11/1/1999	
		WRL-SD-2039-01	10/25/1999	
		WRL-SD-2044-000.5-01	11/9/1999	
	Lyman Mill	DAM003-SD	10/23/1998	
		LPX-BK-2006X-01	10/21/1999	X
		LPX-BK-2006Y-01	10/21/1999	X
		LPX-BK-2006Z-01	10/21/1999	X
		LPX-BK-2008X-01	10/21/1999	X

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Preliminary Remediation Goals Report - Ecological
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Media	Area	Sample ID	Date Sampled	Inorganics Only
Sediment (cont.)	Lyman Mill (cont.)	LPX-BK-2008Y-01	10/21/1999	X
		LPX-BK-2008Z-01	10/21/1999	X
		LPX-SD-2045-01	11/8/1999	
		LPX-SD-2045B-02	7/25/2001	X
		LPX-SD-2046-000_5-01	11/8/1999	
		LPX-SD-2047-01	11/8/1999	
		LPX-SD-2049-01	11/5/1999	
		LPX-SD-2050-01	11/5/1999	
		LPX-SD-2051-01	11/4/1999	
		LPX-SD-2052-000_5-01	11/4/1999	
		LPX-SD-2072-01	7/25/2001	X
		LPX-SD-4001-0000-01	7/12/2001	
		LPX-SD-4002-0000-01	7/12/2001	
		LPX-SD-4004-0000-01	7/12/2001	
		LPX-SD-4011-0000-01	7/10/2001	
		LPX-SD-4012-0000-01	7/10/2001	
		LPX-SD-4013-0000-01	7/10/2001	
		SD-10	9/9/1998	
		SD-11	9/9/1998	
		SD-12	9/9/1998	
		SD-13	9/9/1998	
		SD-14	9/9/1998	
		SD-15	9/9/1998	
		SD-16	9/9/1998	
		SD-17	9/9/1998	
		SD-18	9/9/1998	
		SD-19	9/9/1998	
		WRL-BK-2004X-01	10/21/1999	X
		WRL-BK-2004Y-01	10/21/1999	X
		WRL-BK-2004Z-01	10/21/1999	X
		WRL-BK-2005X-01	10/21/1999	X
		WRL-BK-2005Y-01	10/21/1999	X
		WRL-BK-2005Z-01	10/21/1999	X
		WRL-SD-2041-01	10/25/1999	
		WRL-SD-2042-01	11/2/1999	
		WRL-SD-2042-02	7/24/2001	X
		WRL-SD-2043-01	11/8/1999	
		WRL-SD-2043-02	7/25/2001	X
		WRL-SD-2071-01	7/24/2001	X
		WRL-SD-4005-0000-01	7/12/2001	
		WRM-SD-2054-01	12/2/1999	X
		WRM-SD-2055-01	9/20/2000	
		WRM-SD-2057-01	9/20/2000	
		WRM-SD-2062-01	9/19/2000	
	Manton	MAP-SD-2058-01	9/20/2000	
		MAP-SD-2059-01	9/20/2000	
		MAP-SD-2060-01	9/20/2000	
	Dyerville	DAM005-SD	10/23/1998	
		DYP-SD-2065-01	9/19/2000	
		DYP-SD-2066-01	9/19/2000	

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Media	Area	Sample ID	Date Sampled	Inorganics Only
Earthworm	Greystone	RWR-EW-5001-0000-01	7/17/2001	
		RWR-EW-5002-0000-01	7/16/2001	
		RWR-EW-5003-0000-01	7/17/2001	
		RWR-EW-5004-0000-01	7/18/2001	
	Allendale	CMS-EW-4001-0000-01	7/18/2001	
		CMS-EW-4002-0000-01	7/18/2001	
		CMS-EW-4003-0000-01	7/19/2001	
		CMS-EW-4005-0000-01	7/20/2001	
		LPX-EW-4005-0000-01	7/20/2001	X
	Lyman Mill	LPX-EW-4004-0000-01	7/19/2001	
		LPX-EW-4006-0000-01	7/19/2001	
		LPX-EW-4007-0000-01	7/19/2001	
Emerging Insect and Tree Swallow Stomach Contents	Greystone	GMP-EI-5001-5005-0000-01	7/20/2001	
		DIET-GP	6/9/2001	
		Greystone Pond Diet	6/19/2000	
	Allendale	AllendalePondDiet	6/19/2000	
		DIET-AP	6/12/2001	
	Lyman Mill	LPX-EI-4006-4010-0000-01	7/20/2001	
		DIET-LP	6/12/2001	
	Manton	MANTON FOOD	6/14/2003	
Tree Swallow Egg	Greystone	GP-TS-02-P	5/26/2000	X
		GP-TS-06-P	5/26/2000	X
		GP-TS-17-P	5/26/2000	X
		GP-TS-18-P	5/26/2000	X
		GP-TS-19-P	5/26/2000	X
		GP-TS-23-P	5/26/2000	X
		GP-TS-29-P	5/26/2000	X
		G-TS-01-P	5/21/2001	
		G-TS-02-P	5/21/2001	X
		G-TS-04-P	5/28/2001	X
		G-TS-06-P	5/31/2001	
		G-TS-07-P	5/21/2001	X
		G-TS-19-P	6/11/2001	
		G-TS-21-P	5/25/2001	X
		G-TS-22-P	5/26/2001	X
		G-TS-29-P	5/26/2001	X
	Allendale	AP-TS-08-P	5/26/2000	X
		AP-TS-09-E	6/12/2000	X
		AP-TS-10-E&P	5/26/2000	X
		AP-TS-11-E	6/12/2000	X
		AP-TS-15-P	5/26/2000	X
		AP-TS-16-E	6/12/2000	X
		AP-TS-17-P	5/26/2000	X
		AP-TS-18-E	6/12/2000	X
		AP-TS-19-E&P	5/26/2000	X
		AP-TS-22-P	5/26/2000	X
		AP-TS-23-P	5/26/2000	X
		AP-TS-24-P	5/26/2000	X
		AP-TS-29-P	5/26/2000	X
		A-TS-33-P	6/9/2001	

Table 3-1
Samples Used in the Preliminary Remediation Goals Report - Ecological

Preliminary Remediation Goals Report - Ecological
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Media	Area	Sample ID	Date Sampled	Inorganics Only
Tree Swallow Egg (cont.)	Allendale (cont.)	A-TS-35-P	5/31/2001	X
		A-TS-38-P	5/25/2001	X
		A-TS-39-P	6/12/2001	
		A-TS-42A-P	6/9/2001	X
		A-TS-42B-P	6/7/2001	
		A-TS-45-P	6/8/2001	X
		A-TS-46-P	5/28/2001	X
		A-TS-47-P	6/22/2001	X
		A-TS-48-P	5/26/2001	X
		A-TS-49-P	5/30/2001	X
		A-TS-51-P	6/22/2001	X
		A-TS-52-P	6/9/2001	X
		A-TS-53-P	5/30/2001	X
		A-TS-54-P	6/11/2001	X
		A-TS-57-P	5/26/2001	X
	Lyman Mill	L-TS-62-P	5/27/2001	X
		L-TS-63-P	5/27/2001	X
		L-TS-65-P	6/14/2001	
		L-TS-67-P	6/18/2001	X
		L-TS-69-P	5/25/2001	X
		L-TS-70-P	5/26/2001	X
		L-TS-73-P	5/30/2001	
		L-TS-83-P	5/25/2001	X
		L-TS-84-P	5/28/2001	X
		L-TS-89-P	5/31/2001	X
		L-TS-90-P	5/26/2001	X
	Manton	RMP 120-E	5/27/2003	
		RMP 123-E	5/27/2003	
		RMP 124-E	5/27/2003	
		RMP 129-E	5/27/2003	
American Eel	Dyerville	DYP-AE-5001-0000-01-W	7/2/2001	
		DYP-AE-5002-0000-01-W	7/2/2001	
		DYP-AE-5003-0000-01-W	7/2/2001	
Largemouth Bass	Assapumpset	RAB-LB-5001-0000-01-W	6/26/2001	
		RAB-LB-5002-0000-01-W	6/26/2001	
		RAB-LB-5003-0000-01-W	6/27/2001	
		RAB-LB-5004-0000-01-W	6/27/2001	
	Greystone	GMP-LB-5001-0000-01-W	6/22/2001	
		GMP-LB-5002-0000-01-W	6/22/2001	
		GMP-LB-5003-0000-01-W	6/25/2001	
		GMP-LB-5004-0000-01-W	6/25/2001	
		GMP-LB-5005-0000-01-W	6/25/2001	
		GMP-LB-5006-0000-01-W	6/25/2001	
		GMP-LB-5007-0000-01-W	6/25/2001	
		GMP-LB-5008-0000-01-W	6/25/2001	
		GMP-LB-5009-0000-01-W	6/25/2001	
		GMP-LB-5010-0000-01-W	6/25/2001	
	Manton	MAP-LB-4001-0000-01-W	6/27/2001	
		MAP-LB-4002-0000-01-W	6/27/2001	
		MAP-LB-4003-0000-01-W	6/27/2001	

Table 3-1
Samples Used in the Preliminary Remediation Goals Report - Ecological

Preliminary Remediation Goals Report - Ecological
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Media	Area	Sample ID	Date Sampled	Inorganics Only
White Sucker	Greystone	GMP-WS-5001-0000-01-W	6/22/2001	
		GMP-WS-5002-0000-01-W	6/22/2001	
		GMP-WS-5003-0000-01-W	6/22/2001	
		GMP-WS-5004-0000-01-W	6/22/2001	
		GMP-WS-5005-0000-01-W	6/22/2001	
		GMP-WS-5006-0000-01-W	6/22/2001	
		GMP-WS-5007-0000-01-W	6/22/2001	
		GMP-WS-5008-0000-01-W	6/22/2001	
		GMP-WS-5009-0000-01-W	6/22/2001	
		GMP-WS-5010-0000-01-W	6/22/2001	
	Allendale	AP-CC-06	4/10/2001	
		APC-WS-4001-0000-01-W	6/20/2001	
		APC-WS-4002-0000-01-W	6/20/2001	
		APC-WS-4003-0000-01-W	6/20/2001	
		APC-WS-4004-0000-01-W	6/20/2001	
		APC-WS-4005-0000-01-W	6/20/2001	
		APC-WS-4006-0000-01-W	6/20/2001	
		APC-WS-4007-0000-01-W	6/20/2001	
		APC-WS-4008-0000-01-W	6/20/2001	
		APC-WS-4009-0000-01-W	6/20/2001	
		APC-WS-4010-0000-01-W	6/20/2001	
		AP-SC-01,AP-SC-02,AP-SC-03	4/10/2001	
		AP-SC-04,AP-SC-05	4/10/2001	

Prepared by: BJR
Checked by: KJA

Comparison of Calculated BSAFs to Published BSAFs

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
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White Sucker (*Catostomus commersoni*)

Chemical of Concern	Assapumpset BSAF	Greystone BSAF	Allendale BSAF	Manton BSAF	Average Site BSAF	Literature BSAF	Literature Basis: Species - Tissue Used - Chemical (if different)	Reference [1]
4,4'-DDD	NE	2.00	2.08	NE	2.04	2.72	*Catostomus commersoni* - Whole Body	Wong et al, 2001
						4.40	*Catostomus macrocheilus* - Whole Body	Wong et al, 2001
4,4'-DDE	NE	5.50	4.54	NE	5.02	10.4	*Catostomus commersoni* - Whole Body	Wong et al, 2001
						4.36	*Catostomus columbianus* - Whole Body	Wong et al, 2001
						18.3	*Catostomus macrocheilus* - Whole Body	Wong et al, 2001
Technical Chlordane	NE	0.430	0.541	NE	0.486	1.45	*Catostomus commersoni* - Whole Body - Chlordane-Gamma (trans)	Wong et al, 2001
						2.52	*Catostomus commersoni* - Whole Body - Chlordane-Alpha (cis)	Wong et al, 2001
						0.59	*Catostomus macrocheilus* - Whole Body - Chlordane-Gamma (trans)	Wong et al, 2001
Aroclor-1254	NE	0.84	4.57	NE	2.71	1.07	*Ameiurus melas* - filet	Lutz et al., 1994
						0.91 - 1.9	*Microstomus pacificus* - liver	Young et al., 1991
						0.27 - 1.6	*Microstomus pacificus* - muscle	Young et al., 1991
Aluminum	NE	0.004510	0.000698	NE	0.002610	NA		
Barium	NE	0.01140	0.00661	NE	0.00901	NA		
Selenium	NE	0.302	0.377	NE	0.340	NA		
Vanadium	NE	0.00293	0.00312	NE	0.00303	NA		
Zinc	NE	0.1430	0.0862	NE	0.1150	NA		
Dioxin Toxicity Equivalency - Fish	NE	0.058	0.389	NE	0.223	0.28	*Ameiurus melas* -Ovary - 2,3,7,8-TCDD	Schell et al., 1993
						0.043 - 0.074	*Ameiurus nebulosus* -Liver - 2,3,7,8-TCDD	Schell et al., 1993
Toxicity Equivalency (PCB) - Fish	NE	0.197	NE	NE	0.197	1.91 - 8.67	*Ameiurus melas* - Whole Body - Total PCB	Ankley et al., 1992
						1.8 - 11	*Catostomus commersoni* - Total PCB	Wong et al, 2001
						3.99	*Catostomus macrocheilus* - Whole Body - Total PCB	Wong et al, 2001

Table 3-2
Comparison of Calculated BSAFs to Published BSAFs

Preliminary Remediation Goals Report - Ecological
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Largemouth Bass (*Micropterus salmoides*)

Chemical of Concern	Assapumpset BSAF	Greystone BSAF	Allendale BSAF	Manton BSAF	Average Site BSAF	Literature BSAF	Literature Basis: Species - Tissue Used - Chemical (if different)	Reference [1]
Technical Chlordane	1.46	0.345	NE	NE	0.903	6.50	*Micropterus dolomieu* - Whole Body - Chlordane-Alpha (cis)	Wong et al, 2001
Aluminum	0.0000960	0.000513	NE	0.00811	0.00291	NA		
Barium	0.0103	0.00876	NE	0.0273	0.0155	NA		
Vanadium	0.000406	0.00175	NE	0.0101	0.00408	NA		
Zinc	0.102	0.130	NE	0.134	0.122	NA		
Dioxin Toxicity Equivalency - Fish	0.927	0.0831	NE	0.219	0.410	0.0690	*Micropterus salmoides* - Liver - 2,3,7,8-TCDD	Schell et al., 1993
						0.0380	*Micropterus salmoides* - Liver - 2,3,7,8-TCDD	Schell et al., 1993
						0.100	*Micropterus salmoides* - Liver - 2,3,7,8-TCDD	Schell et al., 1993
						0.0960	*Micropterus salmoides* - Ovary 2,3,7,8-TCDD	Schell et al., 1993
						0.0960	*Micropterus salmoides* - Gonads - 2,3,7,8-TCDD	Schell et al., 1993

Note: Published BSAF values not available for American eel, emerging insects, and earthworms for the chemicals evaluated.
[1] BSAF data obtained from the U.S. Army Corps of Engineers BSAF Database. Available from http://el.erdc.usace.army.mil/bsaf/. Database updated May 24, 2005.
BSAF = Biota - Sediment Accumulation Factor
NA = BSAF Not Available
NE = Not Evaluated

Ankley, G.T., P.M. Cook, A.R. Carlson, D.J. Call, J.A. Swenson, H.F. Corcora, 1992. Bioaccumulation of PCBs from Sediments by Oligochaetes and Fishes: Comparison of Laboratory and Field Studies, Canadian Journal of Fisheries and Aquatic Science, 49: 2080-2084.

Lutz, C.H., V.A. McFarland, and J.B. Mulhearn, 1994. PCB congener Sediment/Fish Distribution in the Chicago Confined Disposal Facility (CDF) Final Report to US Army Engineer District, Chicago, 34 pp.

Schell, J.D., Jr., D.M. Campbell and E. Lowe, 1993. Bioaccumulation of 2,3,7,8-Tetrachlorodibenzo-P-Dioxin In Feral Fish Collected From A Bleach-Kraft Paper Mill Receiving Stream, Environmental Toxicology and Chemistry,12(11): 2077-2082

Wong, Charles S., Paul D. Capel and Lisa H. Nowell, 2001. National-Scale, Field-Based Evaluation Of The Biota-Sediment Accumulation Factor Model, Environmental Science and Technology, 35(9):1709-1715

Young, D.R., A.J. Mearns, and R.W. Gossett (R.A. Baker, Ed)., 1991. Bioaccumulation of p,p-DDE and PCB 1254 by a flatfish bioindicator from highly contaminated marine sediments of southern California. *Organic Substances and Sediments in Water - Biological* , 3: 159-169.

Prepared by: BJR
Checked by: SGH

Comparison of Sediment Preliminary Remediation Goals (PRGs)
to Background Sediment Concentrations

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Concern	Geometric Mean Sediment PRG White Sucker CBR-Based HQ = 1			Geometric Mean Sediment PRG White Sucker/American Eel ELS-Based HQ = 1			Geometric Mean Sediment PRG Largemouth Bass CBR-Based HQ = 1		
	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	EC_{10} (mg/Kg)	EC_{15} (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)
4,4-DDD	**0.0024**	0.18	0.021	NE	NE	NE	NE	NE	NE
4,4-DDE	**0.0052**	0.036	**0.014**	NE	NE	NE	NE	NE	NE
Technical Chlordane	**0.014**	**0.014**	**0.014**	NE	NE	NE	**0.030**	**0.030**	**0.030**
Aroclor-1254	**0.20**	**0.31**	**0.25**	NE	NE	NE	NE	NE	NE
Aroclor, Total	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aluminum	**384**	**3070**	**1085**	NE	NE	NE	**206**	**1648**	**583**
Barium	NE	**45.5**	NE	NE	NE	NE	NE	**20.0**	NE
Selenium	**0.39**	**0.50**	**0.44**	NE	NE	NE	NE	NE	NE
Vanadium	**6.6**	135	**29.9**	NE	NE	NE	**3.1**	**63.9**	**14.1**
Zinc	**39.2**	**45.3**	**42.1**	NE	NE	NE	**33.7**	**38.9**	**36.2**
Dioxin Toxicity Equivalency - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE
Dioxin Toxicity Equivalency - Fish	0.00036	0.00056	0.00045	0.00050	0.00080	0.00063	0.0010	0.0015	0.0012
Toxicity Equivalency (PCB) - Birds	NE	NE	NE	NE	NE	NE	NE	NE	NE
Toxicity Equivalency (PCB) - Fish	NE	NE	NE	**0.000034**	**0.000054**	**0.000043**	NE	NE	NE

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background data set.

Table 5-1
Comparison of Sediment Preliminary Remediation Goals (PRGs)
to Background Sediment Concentrations

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Concern	Geometric Mean Sediment PRG Largemouth Bass ELS-Based HQ = 1			Geometric Mean Sediment PRG Belted Kingfisher HQ = 1			Geometric Mean Sediment PRG Swallow Egg Tissue CBR-Based HQ = 1		
	EC_{10} (mg/Kg)	EC_{25} (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)
4,4-DDD	NE	NE	NE	**0.0016**	**0.016**	**0.0051**	NE	NE	NE
4,4-DDE	NE	NE	NE	**0.0011**	**0.011**	**0.0036**	NE	NE	NE
Technical Chlordane	NE	NE	NE	1.1	11.2	3.5	NE	NE	NE
Aroclor-1254	NE	NE	NE	**0.15**	1.5	0.47	NE	NE	NE
Aroclor, Total	NE	NE	NE	**0.1**	0.3	**0.2**	NE	NE	NE
Aluminum	NE	NE	NE	NE	NE	NE	NE	NE	NE
Barium	NE	NE	NE	NE	NE	NE	NE	NE	NE
Selenium	NE	NE	NE	NE	NE	NE	NE	NE	NE
Vanadium	NE	NE	NE	NE	NE	NE	NE	NE	NE
Zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE
Dioxin Toxicity Equivalency - Birds	NE	NE	NE	0.000070	0.00070	0.00022	0.000099	0.00030	0.00017
Dioxin Toxicity Equivalency - Fish	0.0024	0.0038	0.0030	NE	NE	NE	NE	NE	NE
Toxicity Equivalency (PCB) - Birds	NE	NE	NE	**0.000039**	0.00039	**0.00012**	**0.000031**	**0.000093**	**0.000054**
Toxicity Equivalency (PCB) - Fish	NE	NE	NE	NE	NE	NE	NE	NE	NE

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background data set.

Table 5-2
Comparison of Floodplain Soil Preliminary Remediation Goals (PRGs) to Background Floodplain Soil Concentrations

Preliminary Remediation Goals Report - Ecological
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Concern	Geometric Mean Floodplain Soil PRG [1] For HQ = 1			Floodplain Soil Background Data Greystone Mill Pond		
	NOAEL (mg/Kg)	LOAEL (mg/Kg)	MATC (mg/Kg)	Min (mg/Kg)	Max (mg/Kg)	Average (mg/Kg)
Arsenic	**1.08**	**10.8**	**3.4**	5.6	12.2	7.7
Cadmium	**0.43**	4.3	**1.4**	0.71	3.5	1.6
Selenium	**0.12**	**0.20**	**0.16**	0.69	0.96	0.70
Dioxin Toxicity Equivalency - Mammal	**0.000011**	0.00011	**0.000036**	0.000023	0.00011	0.000055

Bolded PRG values indicate that they are lower than the maximum detected concentration in the background data set.

Prepared by: BJR
Checked by: KJA

[1] Values are geometric means of PRGs developed for the Allendale and Lyman Mill exposure areas based on risks to the short-tailed shrew.

HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
MATC (Maximum Allowable Toxicant Concentration) = geometric mean of NOAEL & LOAEL
NOAEL = No Observed Adverse Effect Level
PRG = Prliminary Remediation Goal