BASELINE ECOLOGICAL RISK ASSESSMENT FOR THE UPLAND AT THE LCP CHEMICAL SITE IN BRUNSWICK, GEORGIA

Site Investigation/Analysis
And Risk Characterization
(Final)

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SUMMARY

This document presents the results of the "Site Investigation/Analysis" Phase and "Risk Characterization" Phase (Steps 6 and 7) of a baseline ecological risk assessment (BERA) conducted for the upland (Operating Unit 3) at the Linden Chemicals and Plastics (LCP) Site, located in Brunswick, Georgia. The chemicals of potential concern (COPC) addressed in the upland BERA consist of four primary COPC, so described because they were the COPC identified in the more extensive BERA for the estuary at the LCP Site – mercury (including inorganic mercury and methylmercury), Aroclor 1268, lead, and polycyclic aromatic hydrocarbons (PAHs). Five additional COPC (referred to as secondary COPC) were also assessed – antimony, copper, nickel, vanadium, and zinc.

The upland BERA was designed to address 15 assessment endpoints, in accordance with Steps 3 and 4 of the project plans approved by Region 4, U. S. Environmental Protection Agency (EPA). The first of these endpoints addressed the viability of soil invertebrates, as evaluated by toxicological responses of surrogate earthworms exposed in the laboratory to soil collected from the upland. The other 14 assessment endpoints addressed the viability of birds and mammals of different trophic guilds, as estimated by food-web exposure models of varying complexity.

The field investigation for the BERA was conducted primarily during October of 2007, although some parts of the investigation were performed in May 2008. The site investigation was based on a sampling framework that focused on that part of the upland that had not been remediated by removal of contaminated soil during the period of 1994 through 1997; and which did not support a mature maritime forest, in which operations of the LCP Facility never occurred. Consequently, sampling of abiotic and biotic environmental media occurred exclusively in open fields (and bordering ecotones) where previous soil sampling indicated a range (gradient) of concentrations of primary COPC.

The results of the BERA indicate no ecological risk to soil invertebrates (Assessment Endpoint 1), as determined by the absence of toxicological responses of surrogate earthworms (*Eisenia faetida*) exposed in the laboratory to surface soil from the upland. In addition, concentrations of COPC in upland soil seldom exceeded the generic Eco-Soil Screening Levels (SSLs) that have been derived for exposure of soil invertebrates (i. e., SSLs for lead, antimony, copper, nickel, and zinc).

Potential risk to wildlife was evaluated qualitatively through hazard quotients (HQs) generated by food-web exposure models based on environmental samples for which paired data were obtained for concentrations of COPC in soil and associated body burdens of food items of wildlife (data generated in the field study conducted as part of this Upland BERA). This qualitative evaluation occurred for six species of wildlife (three avian and three mammalian species) that were modeled to feed exclusively on terrestrial food items, and, also, eight species (five avian and three mammalian species) that were modeled to feed at least partly on estuarine food. Potential risk to terrestrial-feeding grainivorous birds (Assessment Endpoint 2), as evaluated by food-web exposure models for the mourning dove (*Zenaida macroura*), is judged to be low. Potential risk to terrestrial-feeding insectivorous

birds (Assessment Endpoint 3), as assessed by food-web exposure models for the Carolina wren (*Thryothorus ludovicianus*), is also judged to be low. Finally, potential risk is deemed to be low for terrestrial-feeding carnivorous birds (Assessment Endpoint 4), as evaluated by food-web exposure models for the broad-winged hawk (*Buteo platpterus*).

In the case of mammals that feed exclusively on terrestrial food, potential risk to grainivorous mammals (Assessment Endpoint 5), as evaluated by food-web exposure models for the meadow vole (*Microtus pennsylvanicus*), is judged to be moderate. Potential risk to insectivorous mammals (Assessment Endpoint 6), as evaluated by food-web exposure models for the short-tailed shrew (*Blarina carolinesis*), is also judged to be moderate. Finally, potential risk to terrestrial-feeding carnivorous mammals (Assessment Endpoint 7), as assessed by food-web exposure models for the long-tailed weasel (*Mustela frenata*) is deemed to be low.

Potential risk to wildlife feeding at least partially on estuarine food was not interpreted, as in the case of terrestrial-feeding wildlife, because HQs derived for estuarine-dependent wildlife in this Upland BERA are unlikely to be representative of the more voluminous and spatially expanded data ultimately identified in the Estuarine BERA. However, mean and maximum HQs for the common yellowthroat (*Geothlypis trichas*), representing insectivorous birds (Assessment Endpoint 8), exposed to all primary COPC were < unity (1). For the willet (*Geothlypis trichas*), representing insectivorous-crustaceovorous birds (Assessment Endpoint 9), only the maximum HQ for lead was > unity (1), and that by only a marginal amount (HQ = 1.02). The pied-billed grebe (*Podilymbus podiceps*), representing insectivorous-piscivorous birds (Assessment Endpoint 10), generated mean and maximum HQs of about 2 for exposure to methylmercury and a maximum HQ of about the same magnitude for exposure to lead. The clapper rail (*Rallus longirostris*), representing crustaceovorous birds (Assessment Endpoint 11), exhibited maximum HQs of about 2 for exposure to methylmercury and lead. Finally, the belted kingfisher (*Ceryle alcyon*), representing piscivorous birds (Assessment Endpoint 12), generated a mean HQ that was slightly > unity (1) for methylmercury and a maximum methylmercury HQ of about 2.

In the case of mammals that feed at least partly on estuarine food, the only HQ > unity (1) for the little brown bat (*Myotis lucifugus*), representing insectivorous mammals (Assessment Endpoint 13), was for maximum exposure to Aroclor 1268 (HQ = 1.05). The raccoon, representing omnivorous mammals (Assessment Endpoint 14), generated mean and maximum HQs for Aroclor 1268 of about 2 and 4, respectively. Finally, the mink (*Neovison vison*), representing carnivorous mammals (Assessment Endpoint 15), generated mean and maximum HQs for Aroclor 1268 of about 2 and 5, respectively. It is important to note that all HQs for mammals exposed to Aroclor 1268 are based on TRVs for the presumably more toxic Aroclor 1254.

Potential risk to wildlife exposed to primary COPC was documented <u>quantitatively</u> by a two-part strategy. In this strategy, HQs were calculated for all wildlife exposed to COPC assuming maximum estimated environmental exposure (EEE) of wildlife to COPC (including their food items). After this screening process, wildlife characterized by a HQ > unity (1) for a COPC were evaluated further for the full spectrum of nodal (Node 1 to Node 7) preliminary remedial goals (PRGs) by the "back-calculation" procedure.

The lowest PRGs derived by this two-fold strategy for exposure of terrestrial-feeding wildlife to methylmercury were for the broad-winged hawk (*B. platpterus*), with a nodal range of from 3.5 to 10 mg/kg total mercury, assuming a 50% body burden of methylmercury in its sole food item of small mammals. The lowest PRG for exposure of wildlife to inorganic mercury occurred for the short-tailed shrew (*B. carolinesis*), with a single value of 2.8 mg/kg total mercury. The short-tailed shrew also generated the lowest PRGs for Aroclor 1268 (based on TRVs for the presumably more toxic Aroclor 1254), with values ranging from 0.21 to 2.1. For lead, the mourning dove (*Z. macroura*) generated PRGs that ranged from 135 to 400 mg/kg.

Nodal PRGs were also estimated for estuary-feeding wildlife, but are based on an experimental design that mandated the collection of a limited number of samples located relatively near the upland, and are not considered to be representative of the overall estuary.

The above-referenced site-specific nodal PRGs for terrestrial feeding wildlife exposed to primary COPC, and site-specific PRGs and generic Eco-SSL criteria for secondary COPC, were graphically compared to all soil data identified in the Human Health Baseline Risk Assessment for Upland Soils, thereby estimating the potential for upland ecological risk on a comprehensive basis. These comparisons indicate that PRGs for COPC were sometimes exceeded in upland soil.

A major potential source of uncertainty in the BERA for the upland at the LCP Site pertains to the conceptual model for the assessment; in particular, the rationale for evaluating wildlife that prey in whole or in part on estuarine biota since there is no practical remediation of the upland, as contrasted to the estuary, that could ensure environmentally protective conditions for wildlife potentially threatened because of feeding on estuarine food. The experimental design of the assessment introduced a number of mostly unavoidable uncertainties pertaining to selection of a reference area, use of authoritative (not random) sampling of environmental media, and number of samples of media.

However, most uncertainty in the upland BERA is associated with results of food-web exposure modeling for wildlife. Use of different, but reasonable, exposure assumptions, as well as toxicity reference values (TRVs), could have a dramatic effect on HQ values and the subsequent derivation of PRGs for COPC in upland soil. In particular, a major uncertainty involves the use of TRVs for Aroclor 1254 in food-web exposure models for mammals potentially exposed to Aroclor 1268 since Aroclor 1254 appears to be more toxic to biota than Aroclor 1268.

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LIST OF ACRONYMS, ABBREVIATIONS AND DEFINITIONS

AET – apparent effects threshold
ASTM – American Society for Testing and Materials
AUF – area-use factor
BAF – bioaccumulation factor
BERA – baseline ecological risk assessment
BW – body weight
CF1 … CP2 – concentration of COPC in various food items of wildlife
cm – centimeter
COPC – chemical of potential concern
CS – concentration of COPC in soil/sediment
CW – concentration of COPC in water
D1 … D2 – percentage of each food item in diet of predator
dw – dry weight
Eco-SSL – ecological soil screening level
EEE – estimated environmental exposure
EPA – Environmental Protection Agency
ESV – ecological screening value
FIR – food ingestion rate
g – gram
GMAEL – geometric mean adverse effect level (Node 4 level)
ha -- hectare
HQ – hazard quotient
IHg – inorganic mercury
Kow – octanol-water partition coefficient
kg – kilogram
L – liter
LCP – Linden Chemicals and Plastics
LOAEL – lowest observed adverse effect level
MATC – maximum acceptable toxicant concentration
MeHg -- methylmercury
mg – milligram
µg – microgram
mg/kg or µg/g – parts per million
µg/L – parts per billion
mS/cm – milliSiemens per centimeter
NOAA – National Oceanic and Atmospheric Administration
NOAEL – no observed adverse effect level
ns –nonsignificant (from a statistical perspective)
NTU – nephelometric turbidity unit
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PERSG – preliminary ecological remedial sediment goal
ppt – parts per thousand

LIST OF ACRONYMS, ABBREVIATIONS AND DEFINITIONS – Continued

PRG – preliminary remedial goal
r – replicate
R^2 – coefficient of determination
SIR – soil/sediment ingestion rate
spp. – more than one species
TEL – threshold effect level
tHg – total mercury
TOC – total organic carbon
TRV – toxicity reference value
TUF – time-use factor
UF – uptake factor
WIR – water ingestion rate
wt – weight
ww – wet weight
x – mean

1. INTRODUCTION

This document presents the results of the "Site Investigation/Analysis" Phase and "Risk Characterization" Phase (Steps 6 and 7) of a baseline ecological risk assessment (BERA) conducted for the upland (Operating Unit 3) at the Linden Chemicals and Plastics (LCP) Site, located in Brunswick, Georgia (Figure 1). This BERA is based on a document previously submitted to Region 4, U. S. Environmental Protection Agency (EPA) that addressed Problem Formulation (Step 3), Work Plan and Sampling/Analysis Plan (Step 4) and Field Verification (Step 5), Quality Assurance Project Plan (QAPP), and Data Quality Objective Summary Report for the upland (Environmental Planning Specialists and CDR Environmental Specialists; 2008).

The chemicals of potential concern (COPC) addressed in the upland BERA consist of four primary COPC, so described because they were the COPC identified in the more extensive BERA for the estuary at the LCP Site (CDR Environmental Specialists and Environmental Planning Specialists, 2008) – mercury (including inorganic mercury and methylmercury), Aroclor 1268, lead, and polycyclic aromatic hydrocarbons (PAHs). Five additional COPC (referred to as secondary COPC) unique to the upland were also assessed – antimony, copper, nickel, vanadium, and zinc.

The upland BERA was designed to address 15 assessment endpoints, in accordance with Steps 3 and 4 project plans approved by Region 4, EPA. (Thoms, 2007a) The first of these endpoints addressed the viability of soil invertebrates, as evaluated by toxicological responses of earthworms exposed in the laboratory to soil collected from the upland. The other 14 assessment endpoints addressed the viability of birds and mammals of different trophic guilds, as estimated by food-web exposure models of varying complexity.

This BERA consists of a summary and main text, as well as associated figures and tables. A series of appendices are also presented that support the main body of the BERA. All environmental data pertaining to the upland at the LCP Site are maintained in an electronic data base (Environmental Planning Specialists, 2008). The data presented in this document are typically identified according to the coding employed in the electronic data base, although data "rounding" protocols between the two sets of data may be different.

2. SITE HISTORY

The upland at the LCP Site (Figure 1) consists of about 46 ha (114 acres), from which large volumes of contaminated soil were removed between 1994 and 1997. Consequently, this BERA addresses natural ecological habitats (as contrasted to paved areas and building structures) associated with a largely uncontaminated upland. Ecosystems in the upland consist of: 1) open fields; 2) a maritime forest; and 3) a transitional community (Univ. Georgia, 1996).

The open fields account for about half of the natural upland, and consist primarily of Bermuda and rye grasses. The fields serve as potential foraging and nesting habitats for a variety of reptiles, birds, and mammals. The maritime forest occurs primarily in the northeastern and southeastern corners of the upland, and is characterized by the presence of pines, oaks, and magnolias. (There are also smaller, more isolated stands of trees throughout the upland that can best be characterized as disturbed maritime forest.) The transitional community is the zone between the tidal marsh and the upland which, as elevation increases, grades from herbaceous plants (e. g., groundsel and marsh elder) to woody plants (e. g., cabbage palmetto and cedars). This zone is extremely limited in the upland at the site since the marsh typically grades into open fields or maritime forest.

3. PROCEDURES

The BERA for the upland at the LCP Site was designed to address 15 pairs of assessment and measurement endpoints:

Assessment Endpoint 1 – Viability of soil invertebrates, as evaluated by toxicological responses of earthworms (*Eisen faetida*) exposed in the laboratory to surface soil from the upland.

Assessment Endpoint 2 – Viability of grainivorous birds that feed exclusively on terrestrial organisms, as evaluated by food-web exposure models for the mourning dove (*Zenaida macroura*).

Assessment Endpoint 3 – Viability of insectivorous birds that prey exclusively on terrestrial organisms, as evaluated by food-web exposure models for the Carolina wren (*Thryothorus ludovicianus*).

Assessment Endpoint 4 – Viability of carnivorous birds that prey exclusively on terrestrial organisms, as evaluated by food-web exposure models for the broad-winged hawk (*Buteo platpterus*).

Assessment Endpoint 5 – Viability of grainivorous mammals that feed exclusively on terrestrial organisms, as evaluated by food-web exposure models for the meadow vole (*Microtus pennsylvanicus*).

Assessment Endpoint 6 – Viability of insectivorous mammals that prey exclusively on terrestrial organisms, as evaluated by food-web exposure models for the short-tailed shrew (*Blarina carolinensis*).

Assessment Endpoint 7 – Viability of carnivorous mammals that prey exclusively on terrestrial organisms, as evaluated by food-web exposure models for the long-tailed weasel (*Mustela frenata*).

Assessment Endpoint 8 – Viability of insectivorous birds that feed on both terrestrial and estuarine organisms, as evaluated by food-web exposure models for the common yellowthroat (*Geothlypis trichas*).

Assessment Endpoint 9 – Viability of insectivorous/crustaceovorous birds that prey exclusively on estuarine organisms, as evaluated by food-web exposure models for the willet (*Catoptrophorus semiplamatus*).

Assessment Endpoint 10 – Viability of insectivorous/piscivorous birds that prey exclusively on estuarine organisms, as evaluated by food-web exposure models for the pied-billed grebe (*Podilymbus podiceps*).

Assessment Endpoint 11 – Viability of crustaceovorous birds that prey exclusively on estuarine organisms, as evaluated by food-web exposure models for the clapper rail (*Rallus longirostris*).

Assessment Endpoint 12 – Viability of piscivorous birds that prey exclusively on estuarine organisms, as evaluated by food-web exposure models for the belted kingfisher (*Ceryle alcyon*).

Assessment Endpoint 13 – Viability of insectivorous mammals that prey exclusively on estuarine organisms, as evaluated by food-web exposure models for the little brown bat (*Myotis lucifugus*).

Assessment Endpoint 14 – Viability of omnivorous mammals that prey exclusively on estuarine organisms, as evaluated by food-web exposure models for the raccoon (*Procyon lotor*).

Assessment Endpoint 15 – Viability of carnivorous mammals that prey on both terrestrial and estuarine organisms, as evaluated by food-web exposure models for the mink (*Neovison vison*).

The field investigation designed to address the above-identified assessment and measurement endpoints was conducted primarily during October of 2007, although some parts of the investigation were performed in May 2008 (collection of spiders; as recommended by Region 4, EPA; 2008). The site investigation was based on a sampling framework that focused on that part of the upland that had not been remediated by removal of contaminated soil during the period of 1994 through 1997 and which did not support a mature maritime forest, in which operations of the LCP Facility never occurred. Consequently, upland sampling of abiotic and biotic environmental media occurred exclusively in open fields (and bordering ecotones) where previous soil sampling (Environmental Planning Specialists and CDR Environmental Specialists; 2008) indicated a range (gradient) of concentrations of primary COPC (Figure 1).

In addition to the above-described evaluations of the potentially impacted upland, similar assessments were conducted at a reference area in the northeastern corner of the LCP Site. This area had historically been employed as a commercial drive-in theater, and previous sampling in the area (Environmental Planning Specialists and CDR Environmental Specialists; 2008) indicated that COPC were characteristically present in surface soil at concentrations less than ecological screening values (ESVs) promulgated by Region 4, EPA. In order to distinguish reference levels of COPC from background levels, subsurface soil samples were collected on May 28, 2008, at each reference location where surface soil had previously been obtained in October 2007.

Since a number of food-web exposure models were conducted with wildlife that feed partly or wholly on estuarine organisms, concentrations (body burdens) of primary COPC were evaluated in those organisms, as well as in associated surface sediment. Estuarine organisms were collected from locations proximal to the shoreline of the upland and were employed in modeling of both potentially impacted and reference wildlife.

Water and surface sediment samples were also collected from a freshwater pond located at the extreme northern end of the property immediately west of the reference area. Water from this source was employed for exposure modeling of uptake of drinking water by potentially impacted and reference wildlife.

No signs of aquatic life – including aquatic insects – were observed in the freshwater pond. Aquatic insects were to be employed in food-web exposure models for the common yellowthroat (*G. trichas*), willet (*C. semiplamatus*), pied-billed grebe (*P. podiceps*), and little brown bat (*M. lucifugus*). As an alternative to the use of aquatic insects in food-web modeling for these species, terrestrial insects (which contained some aquatic forms) were employed with the common yellowthroat, willet, and little brown bat. For the pied-billed grebe, spiders obtained from along the shoreline of the pond were employed as a substitute for aquatic insects. Region 4, EPA, had recommended the collection of spiders when it became evident that aquatic insects could not be collected from the pond. Consequently, it was believed appropriate to employ spiders as a food item for at least one species of wildlife, while utilizing the better-replicated terrestrial insects (containing some aquatic forms) for the other wildlife species.

The basic experimental design for the BERA is reviewed in Table 1. Surface soil and surface sediment from the biologically active zone (0 – 30 cm for soil and 0 – 15 cm for sediment) were collected with decontaminated shovels or corers. (Subsurface samples of soil were obtained at a depth of 30 - 45 cm.) All soil and sediment samples were single "grab" samples from different sampling stations except in the case of soil samples obtained where the berries of plants (employed in some wildlife food-web exposure models) were collected, in which case five samples were randomly collected within 1 m of the base of each plant and composited into a single sample for chemical analyses.

Terrestrial food items employed in wildlife food-web exposure models were: 1) grass (Poaceae; shoots and roots); 2) berries from plants (primarily, southern bayberry [*Morella cerifera*]); 3) insects (collected in the terrestrial environment, but containing some freshwater forms); 4) spiders; and 5) earthworms. (The "berries" from *M. cerifera* are more scientifically termed "drupes." In addition, berries from an additional plant species [greenbrier, *Similax bona-nox*] were occasionally substituted for bayberry drupes when the latter were not available at a particular location [Sampling Stations 17 and 24 in the potentially impacted part of the LCP Site; Figure 1]. Greenbrier berries are widely recognized as a food item for birds and other small animals.)

Most of these food items were collected manually. However, some insects were obtained through use of an insect electrocutor, as well as by sweep nets. Earthworms were not present at the site; consequently, soil from the site was sent to a toxicology laboratory (Aqua Survey), where worms (*Eisenia faetida*) obtained from a pristine location were exposed to site soil to evaluate uptake of COPC and, secondarily, toxicity of soil. Small mammals were also employed as a terrestrial food item in wildlife food-web models but, like earthworms, could not be collected at the site despite a substantial effort with live and "dead" traps. Consequently, three simple "small-mammal" submodels were utilized for this purpose (refer to Appendix C of this document).

Estuarine food items employed in wildlife food-web exposure models were: 1) fiddler crabs (*Uca* spp.); 2) and fish (mummichogs; *Fundulus heteroclitus*). Fiddler crabs were collected manually, and mummichogs were obtained in minnow traps.

Wildlife food collected from the site was placed in plastic bags, frozen, and transported by overnight courier to a Chemistry Laboratory (Columbia Analytical) for chemical analyses. This laboratory also performed chemical analyses on all other environmental media.

Finally, a nodal evaluation of preliminary remedial goals (PRGs) was conducted based on a two-part strategy recommended by Region 4, EPA (2009a, Comment 1; 2009b, General Comment 3). In this strategy, hazard quotients (HQs) were calculated for all wildlife exposed to primary COPC assuming maximum estimated environmental exposure (EEE) of wildlife to COPC (including their food items). After this screening process, wildlife characterized by a HQ > unity (1) for a COPC were evaluated further for PRGs by the "back-calculation" procedure.

4. ECOLOGICAL EXPOSURE AND EFFECTS EVALUATION

This section of the document addresses the presence of chemicals (primary and secondary COPC) in environmental media of the upland at the LCP Site, including surrogate earthworms (*E. faetida*). It also addresses the toxicological responses of those earthworms to surface soil from the upland. Finally, food-web exposure models are presented for upland wildlife.

4.1 Presence of Chemicals in Environmental Media

The presence of COPC in abiotic and biotic environmental media is sequentially addressed.

4.1.1 Abiotic Media

Abiotic media evaluated were from the freshwater pond, as well as upland soil and selected estuarine sediment.

4.1.1.1 Freshwater Pond

Surface water and surface sediment of the freshwater pond were evaluated.

a) Surface Water

General water-quality characteristics of the freshwater pond were unremarkable except for elevated salinity and specific conductance, as well as lower pH and dissolved oxygen content, in the first sample (Replicate 1) of water obtained from the pond (Table 2). Concentrations of mercury, Aroclor 1268, and lead in Replicate 1 were also substantially higher than in the other two replicates. At the time that Replicate 1 was collected, the surface of the pond was covered by a dense growth of duck weed and no aquatic life was observed even after extensive efforts to catch (hook-and-line) and trap (minnow traps) fishes.

Concentrations of COPC in surface water of the pond never exceeded EPA's chronic ambient water quality criteria for the chemicals except for Replicate 1 (and associated mean value) for total mercury. (A criterion has not been developed for vanadium, and a specific criterion is not available for Aroclor 1268.)

b) Surface Sediment

Surface sediment of the freshwater pond was characterized by a texture that was predominantly sand and a total organic content (TOC) of about 1%. Mean concentrations of COPC in surface sediment of the pond never exceeded the National Oceanic and Atmospheric Administration's (NOAA's) threshold effects levels (TELs) for the chemicals. (TELs have not been developed for antimony, vanadium, or total PAHs; and a specific criterion is not available for Aroclor 1268. However, an upper effects threshold (UET) of 12 mg/kg (dw) has been established for total PAHs, which is three orders-of-magnitude higher than total PAH levels observed in sediment of the pond.)

4.1.1.2 Upland Soil

Upland surface soil was evaluated at all sampling stations where terrestrial biota (food) were obtained for use in wildlife food-web exposure models (Table 3). Soil from some of these stations was also employed in toxicity/bioaccumulation tests conducted with earthworms in the laboratory.

Use of the old drive-in theater in the northeastern part of the LCP Site as a reference area was largely validated by analyses of upland soil. The only primary COPC to be potentially problematic at all of the three reference locations (Stations 1, 2, and 3) in terms of EPA Region 4's ESVs was Aroclor 1268, for which a specific ESV is not available. Lead and total PAHs were marginally greater than their respective ESVs at just one reference station (Station 1).

In the case of concentrations of secondary COPC in soil from the reference area, only vanadium was potentially problematic in terms of EPA Region 4's ESVs. However, vanadium was also present at similar concentrations in background samples (Table 3). EPA's Eco-Soil Screening Levels (SSLs) for plants, soil invertebrates, birds, and mammals were exceeded in reference soil only for vanadium and birds (at Station 1), but an even higher concentration of vanadium occurred in background soil.

As previously referenced, soil sampling at the primary potentially impacted stations was designed to reflect a range (gradient) of concentrations of primary COPC (except PAHs) on the basis of previous soil sampling. It was believed that a different set of stations might generate the gradient for each of these COPC. This did not occur since a single station (Station 13) generated the highest concentration for the three COPC (Table 3). The major implication of this result is that the earthworm toxicity/bioaccumulation study discussed in Section 4.2 of this document was performed with a sample of soil (out of nine potentially impacted samples) that allowed an evaluation of the synergistic biological effects of relatively high concentrations of all three COPC.

It is also important to note that several of the metals preliminarily identified as secondary COPC in the Problem Formulation phase of this BERA (Environmental Planning Specialists and CDR Environmental Specialists; 2008) would not be so designated based on the more pragmatic results presented for soil at potentially impacted locations in Table 3. Copper and nickel were never present in soil at potentially impacted stations at concentrations greater than applicable ESVs or Eco-SSLs. In addition, all vanadium concentrations were similar to background levels. However, antimony and zinc substantially exceeded ESVs and Eco-SSLs (antimony in mammals and zinc in birds) at one of nine potentially impacted stations (Station 13).

4.1.1.3 Estuarine Sediment

Estuarine surface sediment was evaluated for primary COPC at all sampling stations where estuarine biota (food) were obtained for use in wildlife food-web exposure models for the upland (Table 4). Sediment concentrations derived for these stations have an incidental use to the upland assessment by providing a means of estimating if estuarine sediment has the potential to be hazardous to estuarine biota according to protocols developed in the Estuarine BERA for the LCP Site (CDR Environmental Specialists and Environmental Planning Specialists, 2008). Concentrations of COPC in estuarine sediment clearly have limited use for addressing ecological risk in the upland. (This is the primary function of evaluation of the relationships between body burdens of COPC in food items of wildlife and upland soil.)

Review of Table 4 (including footnotes) indicates that lead has the greatest potential to pose a hazard to wildlife evaluated in the estuarine BERA, with potential hazard most acute in creek sediment associated with mummichogs (*F. heteroclitus*). Some potential hazard to estuarine wildlife is predicted for total mercury, but none is predicted for Aroclor 1268. (Total PAHs are not considered in this evaluation since they do not characteristically biomagnify in wildlife.)

A secondary and speculative point raised by the results of Table 4 (with footnotes) is that fiddler crabs (*U.* spp.) – employed as estuarine food items for some wildlife in this Upland BERA – are themselves sometimes identified as being potentially threatened by lead and total PAHs as judged by apparent effects thresholds (AETs) developed for benthos exposed to these two COPC in the Estuarine BERA for the LCP Site.

4.1.2 Biotic Media

Body burdens of COPC in terrestrial and estuarine food items employed in food-web exposure models of upland wildlife are sequentially presented.

4.1.2.1 Terrestrial Food Items of Wildlife

Terrestrial food items for upland wildlife evaluated in food-web exposure models included (Table 5): grass (both shoots and roots) in the family Poaceae; berries from plants; insects (containing some aquatic species); and spiders (obtained from the shore of the freshwater pond). Earthworms and small mammals, also considered to be food of modeled wildlife, could not be collected at the LCP Site and are considered in later parts of this document.

Grass obtained from potentially impacted sampling stations (Stations 8 – 16) was characterized by higher mean concentrations of primary COPC than grass from reference stations (Stations 1 – 3), although elevated levels occurred at just a few stations (Table 5). There were few substantial differences in concentrations of secondary COPC at potentially impacted vs. reference stations.

Berries from the southern bayberry (and limited material from several additional species of plants) obtained from potentially impacted stations (Stations 17 – 26) and reference stations (Stations 4 – 7) exhibited no substantial and meaningful differences in concentrations of primary or secondary COPC. In particular, methylmercury and vanadium were never detected in berries; and Aroclor 1268 and antimony were infrequently detected in berries.

Insects from potentially impacted stations (Stations 8, 10 – 13, and 16) were characterized by higher body burdens of Aroclor 1268 and, to a lesser extent, mercury and lead than insects from the center of the reference area (Station C). Otherwise, meaningful differences in body burdens of primary or secondary COPC between the two areas were not apparent.

Spiders, because of limited body mass, were analyzed for COPC in only one composite sample (from the shoreline of the freshwater pond). Consequently, these body-burden data are employed to only a limited degree in wildlife food-web exposure modeling presented in later sections of this document.

4.1.2.2 Estuarine Food Items of Wildlife

Estuarine food items for upland wildlife evaluated in food-web exposure models were (Table 6): fiddler crabs (*U.* spp.) and mummichogs (*F. heteroclitus*). Both of these biota were collected close to the shoreline of the upland, where they would be potentially available for consumption by upland wildlife. In all cases, body burdens of primary COPC in fiddler crabs and mummichogs from potentially impacted sampling stations were greater than in organisms from a reference station in Troup Creek. (Body burdens of secondary COPC were not evaluated in estuarine organisms because potential hazard posed by these COPC to wildlife was evaluated by simple food-web models based on Eco-SSLs, which are applicable only to soil and wildlife food items associated with soil.)

4.2 Responses of Surrogate Earthworms Exposed to Upland Soil

Surrogate earthworms (*E. faetida*) collected from a pristine location were evaluated in the laboratory for toxicity and potential to accumulate primary and secondary COPC after exposure to surface soil from the upland at the LCP Site.

4.2.1 Toxicity

Surrogate earthworms exposed for 28 days in the laboratory to surface soil from the upland exhibited no apparent evidence of toxicity (Table 7). Mean survival of worms from the reference area and potentially impacted area of the LCP Site averaged, respectively, 97.3 and 95.2%, which is superior to the 80% survival rate considered acceptable for control organisms in many chronic toxicity tests. In addition, no sublethal effects were observed in any of the worms.

Toxicological effects were absent in earthworms despite being exposed to soil concentrations that ranged as high as (in dw):

- Total mercury: 12 mg/kg (ESV = 0.1),
- Aroclor 1268: 8.9 mg/kg (ESV = 0.02 for PCBs),
- Lead: 740 mg/kg (ESV = 50),
- Antimony: 9.9 mg/kg (ESV = 3.5),
- Copper: 8.8 mg/kg (ESV = 40),

- Nickel: 6.8 mg/kg (ESV = 30),
- Vanadium: 29 mg/kg (ESV = 2.0), and
- Zinc: 80 mg/kg (ESV = 50).

As shown above, maximum concentrations of total mercury, Aroclor 1268 (based on PCBs in general), lead, antimony, vanadium, and zinc were greater than EPA Region 4's ESVs for the chemicals.

The absence of toxicity observed in the earthworm tests (which were designed primarily to evaluate bioaccumulation) must be interpreted in the context of the absence of earthworms at the LCP Site. One explanation would be that site sediment is toxic to earthworms and results of the toxicity tests are artifacts. Another, somewhat related, explanation is that the toxicity tests were characterized by a major artifact – the addition of water to soil in test cylinders to allow earthworms to move to areas of optimum moisture, as required by testing protocols. Moist soil was not encountered at the LCP Site during the time of this investigation. Consequently, the most plausible conclusion to this seeming paradox is that the arid soil present at the site at the time of the investigation was incompatible with the presence of earthworms, and that the soil is not toxic to the worms.

4.2.2 <u>Potential for Bioaccumulation</u>

Body burdens of primary COPC in pre-test earthworms and surrogate earthworms exposed for 28 days in the laboratory typically increased in value from lowest levels in pre-test worms to highest levels in worms from the potentially impacted area (Table 7). For secondary COPC, there were no dramatic differences in body burdens among any of the four groups of earthworms.

4.3 <u>Food-Web Exposure Models for Wildlife</u>

Approaches and results for wildlife food-web modeling for primary and secondary COPC are sequentially presented. Toxicity profiles for both categories of COPC are presented in Appendix A. Life histories of modeled wildlife (14 species) are reviewed in Appendix B.

4.3.1 <u>Primary Chemicals of Potential Concern</u>

Derivation of HQs for primary COPC is described, followed by derivation of PRGs of primary COPC in substrate (soil and/or sediment) at the LCP Site.

4.3.1.1 <u>Derivation of Hazard Quotients</u>

Exposure assumptions and toxicity reference values (TRVs) employed in wildlife food-web modeling for primary COPC are addressed, followed by associated HQs. Exposure assumptions and TRVs were recommended for use by Region 4, EPA (Thoms; 2007a, 2007b, 2008; Region 4, 2010).

a) Identification of Exposure Assumptions

Two types of wildlife were selected for food-web exposure modeling – wildlife that feed exclusively on terrestrial food and those that feed partially or completely on estuarine food (Table 8). Within each of these categories, birds and mammals representing various trophic guilds were modeled. The resulting 14 species of wildlife were considered to constitute measurement endpoints representing the 14 assessment endpoints addressed in the evaluation of potential hazard of primary COPC to wildlife.

The diet of several species of modeled wildlife was modified slightly when food initially planned for inclusion in the modeling effort could not be collected in the upland at the LCP Site (refer to Footnote b in Table 8).

b) Identification of Toxicity Reference Values

Lowest-observed-adverse-effect-level (LOAEL) and no-observed-adverse-effect-level (NOAEL) TRVs were identified for birds and mammals exposed to two forms of mercury (inorganic mercury and methylmercury), Aroclor 1268, and lead (Table 9). The TRVs employed for mammals exposed to inorganic mercury (Heath et al., 2009) are contemporary values, and their use with terrestrial mammals will be shown (Table 10) to sometimes result in HQs greater than those derived for methylmercury. In addition, the TRVs recommended for exposure of mammals to Aroclor 1268 were actually derived from a study of Aroclor 1254, a PCB with greater "dioxin-like" effects that is considered more toxic to biota than dioxin-like effects from Aroclor 1268 (Appendix A.1.2).

c) Identification of Hazard Quotients

Basic assumptions and data employed in wildlife food-web modeling for primary COPC are presented in Appendix C. Resulting HQs (Table 10) were derived by the equation:

$$HQ = \frac{\{[(CF1 \times P1) + (CF2 \times P2)]\,[FIR] + [CS]\,[SIR] + [CW]\,[WIR]\}\ \{AUF\}\ \{TUF\}\ /\ BW}{TRV}$$

with CF1 and CF2 = concentrations of COPC in various food items of wildlife (mg/kg, dw); P1 and P2 = percentage of each food item in diet of wildlife (total for all food items = 100%); FIR = food ingestion rate (kg dw/day); CS = concentration of COPC in soil/sediment (mg/kg, dw); SIR = soil/sediment ingestion rate (kg dw/day); CW = concentration of COPC in water (mg/L); WIR = water ingestion rate (L/day); AUF = area-use factor; TUF = time-use factor; BW = body weight of wildlife (kg ww); and TRV = toxicity reference value (mg/kg BW/day). In this wildlife modeling, AUFs and TUFs were conservatively estimated to be unity (1).

HQs equal to, or less than, unity (1) are classically interpreted as indicating the absence of potential hazard to wildlife, whereas values greater than unity suggest the potential for an undefined degree of hazard. Although HQs derived from LOAEL and NOAEL TRVs are presented in Table 10, emphasis is placed on HQs based on the geometric means of LOAEL and NOAEL TRVs (termed GMAEL HQs). This practice of employing GMAEL HQs as theoretically reasonable and conservative HQs reflects the use by Region 4, EPA (Thoms, 2006) of Node 4 in the "Rule of Five" (Charters and Greenburg, 2004) protocol to identify PRGs that lie between LOAEL and NOAEL values.

The following embedded table presents GMAEL HQs based on mean and maximum values for EEE of wildlife to primary COPC at the LCP Site. (Refer to Appendix Table C-1 for identification of data employed to derive mean and maximum environmental exposure.)

Mean and Maximum GMAEL HQs for Wildlife Exposed to Primary COPC at LCP Site (from Table 10)								
	Inorganic mercury		Methylmercury		Aroclor 1268		Lead	
Wildlife species	Mean	Max.	Mean	Max.	Mean	Max.	Mean	Max.
Terrestrial Feeders								
1. Mourning dove	0.20	**1.50**	0.02	0.14	0.03	0.26	0.47	**3.33**
2. Carolina wren	0.0003	0.20	0.28	0.71	0.02	0.10	0.10	0.73
3. Broad-winged hawk (10 / 50 / 100% MeHg in small mammal food)	0.06 /0.04 /0.017	0.28 /0.20 /0.09	0.08 /0.40 /0.77	0.43 **/2.06** **/4.00**	0.03	0.21	0.17	0.76
4. Meadow vole	0.49	**4.05**	0.01	0.08	**1.16**	**9.16**	0.14	0.84
5. Short-tailed shrew	0.65	**5.14**	0.15	0.55	**1.89**	**9.05**	0.18	**1.08**
6. Long-tailed weasel (10 / 50 / 100% MeHg in small mammal food)	0.11 /0.07 /0.03	0.54 /0.35 /0.13	0.03 /0.15 /0.29	0.15 /0.76 /**1.55**	0.74	**5.89**	0.03	0.20
Estuarine Feeders								
7. Common yellowthroat	0.05	0.20	0.24	0.63	0.02	0.09	0.11	0.77
8. Willet	0.04	0.15	0.29	0.69	0.02	0.09	0.17	**1.02**
9. Pied-billed grebe	0.03	0.05	**2.29**	**2.43**	0.07	0.12	0.38	**2.12**
10. Clapper rail	0.02	0.06	0.94	**2.00**	0.07	0.23	0.26	**2.12**
11. Belted kingfisher	0.03	0.04	**1.29**	**2.17**	0.22	0.32	0.01	0.01
12. Little brown bat	0.03	0.10	0.06	0.15	0.32	**1.05**	0.002	0.01
13. Raccoon	0.03	0.07	0.19	0.36	**1.79**	**3.68**	0.06	0.33
14. Mink (10 / 50 / 100% MeHg in small mammal food)	0.08 /0.06 /0.05	0.30 /0.24 /0.15	0.14 /0.18 /0.24	0.26 /0.49 /0.77	**2.00**	**4.95**	0.07	0.34
Total HQs > 1.00:	0	3	2	6	4	6	0	5
Note: HQs > 1.00 are indicated in **bold** print.								

Several general patterns are apparent from the above-presented HQs. First, inorganic mercury and lead pose the least overall potential risk to wildlife at the LCP Site, at least in the case of mean HQs. This is understandable since inorganic mercury and lead, unlike other primary

COPC, do not characteristically biomagnify in the ecological food web. Second, potential risk related to Aroclor 1268 is restricted to mammals, perhaps because the TRV on which mammalian HQs are based pertains to Aroclor 1254, a presumably more toxic PCB (Appendix A.1.2). Third, potential risk associated with methylmercury most commonly occurs for birds, usually estuarine feeders. Finally, potential risk attributable to inorganic mercury, although infrequently indicated, pertains to some terrestrial feeders, usually mammals.

It is also the case that interpretation of site-related HQs is not confounded by the inability to discriminate between site and reference HQs (Table 10). All HQs derived for wildlife potentially exposed to primary COPC in the reference area (the old drive-in theater area) were always less (usually substantially less) than unity (1). This result is another indication of the suitability of the old drive-in theater area as a reference area.

4.3.1.2 Derivation of Remedial Goal Objectives for Substrate

PRGs for substrate were derived by the back-calculation procedure for all wildlife identified as being sensitive to COPC in a screening evaluation.

a) Screening Evaluation

The screening evaluation (Table 11) identified all exclusively terrestrial-feeding wildlife except the Carolina wren (*T. ludovicianus*) as exhibiting HQs > unity (1) for at least one COPC. In the case of the broad-winged hawk (*B. platypterus*) and long-tailed weasel (*M. frenata*), all body burdens of methylmercury and associated body burdens of inorganic mercury in their single modeled food item of small mammals were addressed. The HQs derived for these terrestrial-feeding wildlife ranged up to about 9, with these highest values occurring for mammals exposed to Aroclor 1268 (based on a TRV for Aroclor 1254; Appendix A.1.2).

For those wildlife modeled to feed at least partly in the estuary, HQs > unity (1) were generated for at least one COPC in all cases except for the common yellowthroat (*G. trichas*). All modeled body burdens of the mercury species in the single small-mammal food item of the mink (*N. vison*) were evaluated. The HQs derived for these estuarine-feeding wildlife ranged up to about 5, with that value (and all values > ~ 2) occurring for mammals exposed to Aroclor 1268 (based on a TRV for Aroclor 1254; Appendix A.1.2).

All combinations of wildlife and COPC modeled to exhibit HQs > unity (1) were further evaluated for potential hazard by the back-calculation procedure, designed to estimate PRGs for COPC, with the qualification that more reliable evaluations of hazard to estuarine feeders are to be expected from the more voluminous data ultimately derived in the Estuarine BERA.

b) Back-Calculated Values

Back-calculated PRGs for wildlife (Table 12) are estimated across the nodal spectrum (Charters and Greenburg, 2004) from Node 1 values (based on NOAEL TRVs) to Node 7 values (based on LOAEL TRVs). The derivation of these PRGs is detailed in Appendix D of this document. This appendix presents the calculations employed in these derivations and the bioaccumulation factors (BAFs) that form the basis of the calculations; it also addresses the reliability of the back-calculation procedure by comparing it to a simplified procedure for estimating PRGs. The BAFs are based on mean concentrations of COPC in surface substrate and body burdens in food items of wildlife, as contrasted to regression equations (Burkhard, 2006). In addition, submodels were employed to estimate body burdens of COPC in small mammals theoretically consumed by apex predators (i. e., the broad-winged hawk, long-tailed weasel, and mink) All other BAFs were generated by samples of food items collected at the LCP Site.

The PRGs for estuary-feeding wildlife (Table 12) are based on an experimental design that mandated the collection of a limited number of samples located relatively near the upland, and are not considered to be representative of the overall estuary.

4.3.2 Secondary Chemicals of Potential Concern

Although secondary COPC are not considered to have the potential to bioaccumulate in plants and animals to the same degree as primary COPC (in particular, mercury and Aroclor 1268), they were screened for this potential and, if warranted, evaluated in simple models predicated on the approach employed to identify Eco-SSLs for biota.

Comparisons of generic environmentally protective Eco-SSLs for secondary COPC to maximum concentrations recorded in upland soil at the LCP Site are as follow:

Comparisons of Generic Environmentally Protective Eco-SSLs and Maximum Recorded Concentrations of Secondary COPC in Upland Soil at LCP Site

	Generic environmentally Protective concentrations (Eco-SSLs) for biota exposed to upland soil (mg/kg, dw)				Maximum concentrations recorded in upland soil evaluated during BERA field study (Table 3; mg/kg, dw)	
Secondary COPC (and lead)	Plants	Soil Inverte-brates	Birds	Mammals	Reference area (r = 3 except lead = 7)	Potentially impacted area (r = 9 except lead = 19)
(Lead)	120	1,700	11	56	58	740 (3 of 19 values > 120)
Antimony	ND	78	ND	0.27	0.060	9.9 (only value > 0.27)
Copper	70	80	28	49	4.8	8.8
Nickel	38	280	210	130	5.4	6.8

Vanadium	ND	ND	7.8	280	12 (values = 4.3, 5.8, and 12)	29 (2 values > 7.8)
Zinc	160	120	46	79	24	80 (only value > 46 and 79)
Note: ND indicates that an Eco-SSL has not been derived.						

Several issues are apparent regarding the Eco-SSL approach for evaluating the potential hazard of secondary COPC (and lead) in soil to biota. First, most comparisons support the selection of the old drive-in theater in the northeastern corner of the LCP Site as a reference area for this BERA. However, in the case of potential exposure of birds to lead and vanadium, respective Eco-SSLs are exceeded at reference stations (Table 3) – but also at background stations. The slight difference in the Eco-SSL for mammals exposed to lead and the maximum recorded concentration of lead in the reference area was discounted.

In terms of biota exposed to lead in the potentially impacted part of the upland, there was the suggestion of possible hazard to plants, although this is difficult to reconcile with the lush vegetation observed in the upland. There was no indication of lead-related hazard to soil invertebrates, which is consistent with results generated in the earthworm toxicity tests (Section 4.2.1). Potential hazard of lead to birds and mammals is addressed above (Section 4.3.1) in the definitive food-web exposure modeling for both types of wildlife.

Copper and nickel were eliminated from further consideration in this Eco-SSL evaluation since maximum concentrations recorded in soil during the BERA field study were substantially less than Eco-SSLs for all four types of biota potentially exposed to the two metals. Vanadium was discounted for further consideration since all concentrations observed in surface soil at the LCP Site during the BERA field study were similar to background (subsurface) levels.

Additional evaluations were conducted for antimony and zinc because concentrations of these metals in soil were occasionally substantially greater than Eco-SSLs for wildlife. In the case of antimony, this concern pertained to mammals; for zinc, the issue was birds.

Three mammals were modeled as feeding exclusively on terrestrial items associated with soil, which is a prerequisite for use of the Eco-SSL approach. However, the most appropriate of the terrestrial mammals to evaluate for exposure to, in this case, antimony, was judged to be the meadow vole (*M. pennsylvanicus*). The short-tailed shrew (*B. carolinensis*) was not selected because of limited replication of data pertaining to one of its food items (insects) and laboratory-based evaluation of the other food item (earthworms). The long-tailed weasel (*M. frenata*) was not selected because its sole food item, small mammals, could not be obtained at the LCP Site and alternative efforts at modeling were judged to be characterized by at least moderate uncertainty.

Although the diet of the meadow vole was routinely modeled as consisting of equal amounts of grass and berries (Table 8), antimony was seldom detected in berries (Table 5). Therefore, in this case, food-web modeling based on the Eco-SSL approach was predicated on a diet of

100% grass. The resulting HQ for the meadow vole exposed to maximum concentrations of antimony in soil and grass was 3.04 (Table 13). The mean BAF for concentration of antimony in soil and grass was 0.086 (Figure 2). This relationship was employed to back-calculate a PRG (to HQ of 1) of antimony in upland soil at the LCP Site of 2.2 mg/kg (Table 13; Footnote b).

In the Eco-SSL approach for evaluating potential hazard of exposure of birds to zinc, the most appropriate of three terrestrial species to assess was judged to be the Carolina wren (*T. ludovicianus*). The wren was selected over the mourning dove (*Z. macroura*) because food (Table 5) of the former species (insects), despite its limited replication, was characterized by higher concentrations of zinc than foods of the latter species (grass and berries). The broad-winged hawk (*B. platpterus*) was not selected because its food (small mammals) could not be obtained at the LCP Site and alternative efforts at modeling were judged to be characterized by atypical uncertainty.

The resulting HQ for the Carolina wren exposed to maximum concentrations of zinc in soil and insects was 1.24 (Table 13). The mean BAF for concentration of zinc in soil and insects was 11.75 (Figure 3). This relationship was employed to generate a PRG (HQ = 1) of zinc in upland soil at the LCP Site of 22 mg/kg (Table 13; Footnote c).

A review of the above-derived PRGs of secondary COPC in soil – 2.2 mg/kg for mammals exposed to antimony and 22 mg/kg for birds exposed to zinc – in the context of EPA Region 4's ESVs and generic Eco-SSLs reveal both similarities and differences. In the case of mammalian exposure to antimony, the site-specific PRG of 2.2 mg/kg corresponds closely to the ESV of 3.5 mg/kg, although not to the generic mammalian Eco-SSL of 0.27 mg/kg. For avian exposure to zinc, the site-specific PRG of 22 mg/kg compares to an ESV of 50 mg/kg and a generic avian Eco-SSL of 46 mg/kg.

5. RISK CHARACTERIZATION

This section of the document consists of a risk estimation for COPC in the upland at the LCP Site and an uncertainty analysis for the assessment.

5.1 Risk Estimation

Qualitative and quantitative risk estimations are sequentially presented.

5.1.1 Qualitative Risk Estimation

This risk assessment addresses the potential effects of primary and secondary COPC on soil invertebrates and on 14 types of wildlife with different trophic characteristics. It is termed "qualitative" only in the sense that it is based on GMAEL-based HQs unadjusted to unity (1), as contrasted to protocols for quantifying PRGs for COPC in substrate.

5.1.1.1 Soil Invertebrates (Assessment Endpoint 1)

There is no risk to the viability of soil invertebrates as indicated by the absence of toxicological responses of earthworms (*E. faetida*) exposed in the laboratory to surface soil from the upland. In addition, concentrations of primary and secondary COPC for which generic Eco-SSLs have been derived for exposure of soil invertebrates – lead, antimony, copper, nickel, and zinc – seldom exceeded their respective Eco-SSLs (refer to Section 5.1.2 of this document and Appendix E).

5.1.1.2 Wildlife Feeding on Terrestrial Food

Risk characterizations are presented for birds and mammals that feed exclusively on terrestrial food items. These risk characterizations are, as indicated above, qualitative in nature – and are based strictly on the toxicity-related data (e. g., soil data and body-burden data of food items of wildlife) generated in field study conducted as part of this Upland BERA. These characterizations are expanded to address all soil data identified in the Human Health Baseline Risk Assessment for Upland Soils (Environmental Planning Specialists, 2010) in Section 5.1.2 of this document and Appendix E.

a) Birds

Three types of terrestrial-feeding birds with different trophic characteristics were evaluated.

i) Grainivorus Birds (Assessment Endpoint 2)

Mean and maximum GMAEL HQs for primary COPC and terrestrial-feeding grainivorous birds, as evaluated by food-web exposure models for the mourning dove (*Z. macroura*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Terrestrial Feeding Grainivorous Birds		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.20	**1.50**
Methylmercury	0.02	0.14
Aroclor 1268	0.03	0.26
Lead	0.47	**3.33**

Mean (typical) exposure of the mourning dove to all primary COPC generated HQs that were < unity (1). In the case of the maximum exposure scenario, inorganic mercury and lead generated HQs that were incrementally > unity. Consequently, overall potential risk to terrestrial-feeding grainivorous birds is theoretically (based on modeling efforts) judged to be low.

ii) Insectivorous Birds (Assessment Endpoint 3)

Mean and maximum GMAEL HQs for primary COPC and terrestrial-feeding insectivorous birds, as evaluated by food-web exposure models for the Carolina wren (*T. ludovicianus*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Terrestrial-Feeding Insectivorous Birds		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.0003	0.20
Methylmercury	0.28	0.71
Aroclor 1268	0.02	0.10
Lead	0.10	0.73

Mean and maximum exposure of the Carolina wren to all primary COPC generated HQs that were < unity (1). In addition, the Carolina wren generated a maximum HQ of just 1.24 for exposure to zinc (a secondary COPC). Consequently, overall potential risk to terrestrial-feeding insectivorous birds is also judged to be low.

iii) Carnivorous Birds (Assessment Endpoint 4)

Mean and maximum GMAEL HQs for primary COPC and terrestrial-feeding carnivorous birds, as evaluated by food-web exposure models for the broad-winged hawk (*B. platpterus*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Terrestrial-Feeding Carnivorous Birds		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury (50% of tHg in small-mammal diet)	0.04	0.20
Methylmercury (50% of tHg in small-mammal diet)	0.40	**2.06**
Aroclor 1268	0.03	0.21
Lead	0.17	0.76

Mean and maximum exposure of the broad-winged hawk to all primary COPC except for one scenario for maximum methylmercury exposure generated HQs that were < unity (1). Consequently, the potential risk to terrestrial-feeding carnivorous birds is deemed to be low.

b) Mammals

Three types of terrestrial-feeding mammals with different trophic characteristics were evaluated.

i) Grainivorous Mammals (Assessment Endpoint 5)

Mean and maximum GMAEL HQs for primary COPC and terrestrial-feeding grainivorous mammals, as evaluated by food-web exposure models for the meadow vole (*M. pennsylvanicus*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Terrestrial-Feeding Grainivorous Mammals		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.49	**4.05**
Methylmercury	0.01	0.08
Aroclor 1268	**1.16**	**9.16**
Lead	0.14	0.84

Mean exposure of the meadow vole to Aroclor 1268 generated a HQ that was marginally > unity (1). In the case of the maximum exposure scenario, inorganic mercury and Aroclor 1268 generated HQs that were substantially higher. This concern is less for Aroclor 1268 than for inorganic mercury since the TRV employed in the HQ calculation for Aroclor 1268 was based on toxicity of Aroclor 1254, a presumably more toxic PCB (Appendix A.1.2). In addition, the meadow vole was judged to be sensitive (HQ = 3.04) to antimony (a secondary COPC). In summary, overall potential risk to terrestrial-feeding grainivorous mammals is judged to be moderate.

ii) Insectivorous Mammals (Assessment Endpoint 6)

Mean and maximum GMAEL HQs for primary COPC and terrestrial-feeding insectivorous mammals, as evaluated by food-web exposure models for the short-tailed shrew (*B. carolinensis*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Terrestrial-Feeding Insectivorous Mammals

Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.65	**5.14**
Methylmercury	0.15	0.55
Aroclor 1268	**1.89**	**9.05**
Lead	0.18	**1.08**

Mean exposure of the short-tailed shrew to Aroclor 1268 generated a HQ that was incrementally > unity (1). In the case of the maximum exposure scenario, inorganic mercury and Aroclor 1268 generated HQs that were substantially higher. This concern is less for Aroclor 1268 than inorganic mercury since the TRV employed in the HQ calculation for Aroclor 1268 was based on toxicity of Aroclor 1254, a presumably more toxic PCB (Appendix A.1.2). In addition, maximum exposure of the shrew to lead generated a HQ that only marginally exceeded unity. Consequently, overall potential risk to terrestrial-feeding insectivorous mammals is judged to be moderate.

iii) Carnivorous Mammals (Assessment Endpoint 7)

Mean and maximum GMAEL HQs for primary COPC and terrestrial-feeding carnivorous mammals, as evaluated by food-web exposure models for the long-tailed weasel (*M. frenata*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Terrestrial-Feeding Carnivorous Mammals

Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury (50% of tHg in small-mammal diet)	0.07	0.35
Methylmercury (50% of tHg in small-mammal diet)	0.15	0.76
Aroclor 1268	0.74	**5.89**
Lead	0.03	0.20

Mean exposure of the long-tailed weasel to all primary COPC generated HQs that were < unity (1). In the case of the maximum exposure scenario, a HQ in excess of unity occurred for Aroclor 1268, but the TRV employed in its derivation was based on toxicity of Aroclor 1254

(Appendix A.1.2). The overall potential risk to terrestrial-feeding carnivorous mammals is judged to be low.

5.1.1.3 Wildlife Feeding on Estuarine Food

Risk characterizations are presented for birds and mammals that feed at least partially on estuarine food. All characterizations of estuarine feeders have limited relevance to the upland since there is no practical remediation of the upland that could ensure environmentally protective conditions if the cause of potential hazard originates with biota (food of wildlife) in the estuary. Also, it is clear that the HQs derived for estuary-feeding wildlife in this Upland BERA are unlikely to be representative of the more voluminous and spatially expanded data ultimately identified in the Estuarine BERA (e. g., Region 4 EPA, 2009b; General Comment 1). Consequently, even in the following qualitative assessment, potential risk will not be characterized further than the identification of HQs.

a) Birds

Five types of birds with different trophic characteristics were evaluated.

i) Insectivorous Birds (Assessment Endpoint 8)

Mean and maximum GMAEL HQs for partly estuarine-feeding insectivorous birds potentially exposed to primary COPC, as evaluated by food-web exposure models for the common yellowthroat (*Geothlypis trichas*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Estuarine-Feeding Insectivorous Birds

Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.05	0.20
Methylmercury	0.24	0.63
Aroclor 1268	0.02	0.09
Lead	0.11	0.77

Mean and maximum exposure of the common yellowthroat to all primary COPC generated HQs that were < unity (1).

ii) Insectivorous-Crustaceovorous Birds (Assessment Endpoint 9)

Mean and maximum GMAEL HQs for wholly estuarine-feeding insectivorous-crustaceovorous birds, as evaluated by food-web exposure models for the willet (*C. semiplamatus*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Estuarine-Feeding Insectivorous-Crustaceovorous Birds		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.04	0.15
Methylmercury	0.29	0.69
Aroclor 1268	0.02	0.09
Lead	0.17	**1.02**

Only the maximum HQ for lead was > unity (1) for the willet, and that by only a marginal amount.

iii) Insectivorous-Piscivorous Birds (Assessment Endpoint 10)

Mean and maximum GMAEL HQs for wholly estuarine-feeding insectivorous-piscivorous birds, as evaluated by food-web exposure models for the pied-billed grebe (*P. podiceps*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Estuarine-Feeding Insectivorous-Piscivorous Birds		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.03	0.05
Methylmercury	**2.29**	**2.43**
Aroclor 1268	0.07	0.12
Lead	0.38	**2.12**

Estimation of potential risk in this case is particularly uncertain. This is because spiders from the shoreline of the freshwater pond were substituted for aquatic insects in the diet of the grebe. Only one replicate of spiders could be obtained from the shoreline, and body burden of methylmercury in that replicate was at least an order-of-magnitude greater than methylmercury levels in other potential food of wildlife (Tables 5, 6, and 7). In addition, those spiders can also be considered to be "reference" spiders since the freshwater pond borders the terrestrial reference area. Only methylmercury generated a mean HQ > unity (1).

iv) Crustaceovorous Birds (Assessment Endpoint 11)

Mean and maximum GMAEL HQs for wholly estuarine-feeding crustaceovorous birds, as evaluated by food-web exposure models for the clapper rail (*R. longirostris*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Estuarine-Feeding Crustaceovorous Birds		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.02	0.06
Methylmercury	0.94	**2.00**
Aroclor 1268	0.07	0.23
Lead	0.26	**2.12**

No mean HQs were > unity (1). The maximum HQs for methylmercury and lead were incrementally > 1.

v) Piscivorous Birds (Assessment Endpoint 12)

Mean and maximum GMAEL HQs for wholly estuarine-feeding piscivorous birds, as evaluated by food-web exposure models for the belted kingfisher (*C. alcyon*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Estuarine-Feeding Piscivorous Birds		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.03	0.04
Methylmercury	**1.29**	**2.17**
Aroclor 1268	0.22	0.32
Lead	0.01	0.01

Only the mean and maximum HQs for methylmercury were > unity (1).

b) Mammals

Three types of estuarine-feeding mammals with different trophic characteristics were evaluated.

i) Insectivorous mammals (Assessment Endpoint 13)

Mean and maximum GMAEL HQs for wholly estuarine-feeding insectivorous mammals, as evaluated by food-web exposure models for the little brown bat (*M. lucifugus*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Estuarine-Feeding Insectivorous Mammals		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.03	0.10
Methylmercury	0.06	0.15
Aroclor 1268	0.32	**1.05**
Lead	0.002	0.01

Only the maximum HQ for Aroclor 1268 was > unity (1), and that marginally increased HQ was based on a TRV for Aroclor 1254 (Appendix A.1.2 of this document).

ii) Omnivorous Mammals (Assessment Endpoint 14)

Mean and maximum GMAEL HQs for wholly estuarine-feeding omnivorous mammals, as evaluated by food-web exposure models for the raccoon (*P. lotor*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Estuarine-Feeding Omnivorous Mammals		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury	0.03	0.07
Methylmercury	0.19	0.36
Aroclor 1268	**1.79**	**3.68**
Lead	0.06	0.33

Only the HQs for Aroclor 1268 were > unity (1), and those HQ were based on a TRV for the presumably more toxic Aroclor 1254 (Appendix A.1.2 of this document).

iii) Carnivorous Mammals (Assessment Endpoint 15)

Mean and maximum GMAEL HQs for wholly estuarine-feeding carnivorous mammals, as evaluated by food-web exposure models for the mink (*N. vison*), were:

Mean and Maximum GMAEL HQs for Primary COPC and Estuarine-Feeding Carnivorous Mammals		
Primary COPC	Mean HQ	Maximum HQ
Inorganic mercury (50% of tHg in small-mammal diet)	0.06	0.24
Methylmercury (50% of tHg in small-mammal diet)	0.18	0.49
Aroclor 1268	**2.00**	**4.95**
Lead	0.07	0.34

Once more, the only HQs > unity (1) were for Aroclor 1268, a concern mitigated by the use of a TRV for Aroclor 1254 (Appendix A.1.2).

5.1.2 Quantitative Risk Assessment

This risk assessment is considered "quantitative" since it generates specific estimates of PRGs for COPC in substrate, as contrasted to the above-presented less empirical derivation of GMAEL-based HQs unadjusted to values of unity (1).

The back-calculated nodal PRGs for primary COPC in upland soil are presented in Table 12 and addressed above in Section 4.3.1.2.b of this document. In addition, PRGs derived for two secondary COPC are:

- Antimony: 2.2 mg/kg in soil (for the meadow vole, based on the Eco-SSL value for mammals exposed to antimony), and
- Zinc: 22 mg/kg in soil (for the Carolina wren, based on the Eco-SSL value for birds exposed to zinc).

Site-specific PRGs and generic Eco-SSL criteria previously identified (Section 4.3.2 of this document) for all secondary COPC – antimony, zinc, copper, nickel, and vanadium – are graphically compared to all soil data identified in the Human Health Baseline Risk Assessment for Upland Soils (Environmental Planning Specialists, 2010) – not just data developed during the field study for the Upland BERA – in Appendix E. Another primary COPC – total PAHs – is not considered a threat to wildlife via biomagnification, and was found (together with all chemicals in soil, whether identified or unidentified) to be nontoxic to soil invertebrates, as determined in the previously referenced earthworm toxicity tests.

5.2 Uncertainty Analysis

Major potential sources of uncertainty in the BERA for the upland at the LCP Site are the conceptual model for the assessment, the experimental design of the assessment, and the wildlife modeling studies conducted as part of the assessment.

5.2.1 Conceptual Model for Assessment

The conceptual model for the upland BERA – in particular, the 15 assessment and measurement endpoints, exposure assumptions, and TRVs – was largely recommended for use by Region 4, EPA (Thoms, 2007a, 2007b, 2008; U. S. EPA, 2008; Region 4 EPA, 2010). A large number assessment/measurement endpoints were evaluated for the upland, in comparison to the lesser number (eight sets of endpoints) addressed for the LCP estuary (CDR Environmental Specialists and Environmental Planning Specialists, 2008), an environment with the potential for seemingly greater environmental hazard. Consequently, the potential for incorrectly identifying hazardous conditions in the upland (analogous to a Type I statistical error) is a concern. In addition, the rationale for evaluating wildlife that feed in whole or in part on estuarine biota is uncertain since there is no practical remediation of the upland, as contrasted to the estuary, which could ensure environmentally protective conditions for wildlife potentially threatened because of feeding on estuarine food items.

The evaluation of potential hazard in only the open-field areas and associated ecotones of the upland, as contrasted to inclusion of the mature forested area, introduced a limited degree of uncertainty.

Finally, the use of food-web exposure models for evaluating hazard to wildlife, although a standard practice, is subject to a large number of uncertainties, as described later in this section of the document.

5.2.2 Experimental Design of Assessment

Implementation of the experimental design of the upland BERA introduced a number of mostly unavoidable uncertainties. The selection of the old drive-in theater as a reference area was potentially problematic because of its nearness to the potentially impacted area of the LCP Site. However, there were no other practical alternatives for a reference area, and most information generated during the BERA – e. g., comparisons of concentrations of COPC in soil at the drive-in theater to ESVs, results of toxicity and bioaccumulation tests with surrogate earthworms exposed to soil from the area, and HQs derived for the area (HQs ≤ 1.0) – supported the use of the drive-in theater as a reference area.

A basic statistical uncertainty is the extent to which sampling data, which were generated by authoritative (not random) sampling, are representative of (not biased indicators of) environmental conditions in the upland.

The number of environmental samples collected during the BERA is also a source of concern since it affects the statistical precision and reliability of resulting data. For example, a major objective of soil sampling was to allow development of relationships between concentrations of COPC in soil and associated body burdens of food items consumed by wildlife, thereby providing a basis for "back-calculating" results of HQs to estimate PRGs for COPC in soil. Although the number of soil samples employed to generate PRGs was appropriately limited to those samples for which paired data were obtained for associated body burdens of COPC in food items of wildlife, the resulting PRGs were ultimately compared to all soil data identified in the Human Health Baseline Risk Assessment for Upland Soils (Environmental Planning Specialists, 2010), thereby estimating the potential for upland ecological risk on a comprehensive basis.

Another source of uncertainty is how detection limits may alter estimates of risk and development of wildlife PRGs especially when the detected and non-detected concentrations in surface soil are within the same range. Much of the upland soil data were collected in the late 1990s and had high detection limits for Aroclor 1268; consequently, many of the detection limits are above the estimated soil PRGs for small mammals (Appendix E, Figures E-8 through E-10). Therefore, there is high uncertainty in estimates of the extent of soil contamination above wildlife PRGs.

5.2.3 <u>Wildlife Modeling in Assessment</u>

The preponderance of uncertainty in the upland BERA is associated with results of food-web exposure modeling for wildlife. Use of different, but reasonable, exposure assumptions (particularly pertaining to diet of wildlife and AUFs), as well as TRVs, could have a dramatic effect on HQ values and the subsequent derivation of PRGs for COPC in upland soil.

Several details pertaining to the uncertainty of wildlife modeling merit particular attention. Earthworms, the modeled food of one species of wildlife feeding on terrestrial food (the short-tailed shrew [*B. carolinensis*]), were not present in upland soil perhaps because of the arid nature of the soil. Consequently, surrogate worms (*E. faetida*) were exposed under laboratory conditions to soil from the upland to provide an estimate of uptake of COPC for use in the shrew model. Aquatic insects could not be obtained from the freshwater pond. Therefore, the diet of several wildlife species that was intended to include aquatic insects was modified by substituting terrestrial insects (which included some aquatic forms), adjusting the diet in minor ways to include greater amounts of other food items, or substituting spiders for aquatic insects (refer to Appendix C for further details regarding these issues).

Small mammals could not be collected in the upland despite extensive efforts with live and "dead" traps, so simple submodels were employed to estimate body burdens of COPC in small mammals, which were then employed in exposure models for carnivorous birds and mammals assumed to prey on small mammals (Appendix C). The models used to estimate inorganic mercury body burdens in the meadow vole and short-tailed shrew resulted in predicted levels of 1.5 mg/kg and 1.9 mg/kg, respectively (based on maximum soil mercury concentrations). These levels fall within the range of measured concentrations in a cotton rat (0.09 mg/kg) and Norway rat (7.4 mg/kg) collected from the site area from 1974 to 1976 (Gardner *et al*. 1978). The wide range in mercury body burdens suggests that the models may under- or over-estimate risks to these small mammals.

The Gardner *et al* (1978) study also reported a total mercury concentration in muscle tissues in an opossum of 6.4 mg/kg, 5.7 mg/kg in a raccoon, and an average of 5 mg/kg in the clapper rail. Cumbee *et al*. (2008) also reported an average muscle mercury concentration in clapper rails from the estuary of 5.9 mg/kg. The submodels used in this BERA for the raccoon and clapper rail estimated maximum body burdens of 0.025 mg/kg and 0.04 mg/kg, respectively which suggest an underestimation of risks to these receptors. Also, in the Gardner *et al* (1978) study, the percentage of mercury in the form of methylmercury was less than 10% in the cotton rat and was between 48 and 78 percent in the other mammals sampled, and 99% in the clapper rail. The percentage of methylmercury in tissues depends on their diet and the proportion of their diet from the aquatic food chain. The assumption of 50 percent methylmercury in the tissues of small mammals from the site is reasonable. Methylmercury risks to small mammals and rails may be underestimated if 10 percent methylmercury (as a percent of total mercury) is assumed.

The estimation of Aroclor 1268 in small mammals using the sub-model 3 algorithm based on Travis and Arms (1988) is also a major source of uncertainty. The model is based on a regression relationship between biotransfer factors in beef with various organochlorine compounds and their octanol-water partition coefficients (K_{ow}). This model was used assuming the herbivorous meadow vole was the only prey species consumed by carnivorous birds and mammals. If the carnivores consumed omnivorous small mammals (that have a diet consisting of 50% grass and 50% earthworms), the risks would be higher by a factor of approximately 2.5.

Cumbee *et al*. (2008) reported Aroclor 1268 concentrations in muscle tissue of clapper rails (collected from the estuary) ranging from 1.7 to 71 mg/kg with an average of 21.9 mg/kg. The maximum modeled Aroclor 1268 concentration used in the BERA was 0.52 mg/kg, suggesting an underestimation of potential risk to the clapper rail. However, based on contaminant distribution, tissue concentrations in receptors from the upland area are expected to be somewhat lower than receptors collected from the estuary.

The relationships between concentrations of COPC in surface substrate and body burdens of food items of wildlife were usually illustrated by logarithmic regression because the asymptotic character of this type of regression seemed theoretically appropriate. These curves sometimes underestimated data points for body burdens of COPC in food items. (Discrepancies between regression curves or lines vs. associated data are to be expected unless a perfect fit [$R^2 = 1$] occurs between independent and dependent variables.) However, the BAFs employed in deriving back-calculated PRGs for COPC in substrate were not based on these logarithmic relationships, but rather on modeled mean values for the actual data (Burkhard, 2006). These mean values can be interpreted by linear regression in which the regression line is not forced through the origin of the graph. The R^2 values for these linear regressions often indicated a better fit to data than the logarithmic R^2 values; but, partially because of limited sample size, were statistically significant in only a few cases (refer to Appendix D of this document).

A major uncertainty in the BERA for the upland at the LCP Site was the use of TRVs for Aroclor 1254 in food-web exposure models for mammals potentially exposed to Aroclor 1268. Aroclor 1254 is known to contain specific congeners that interfere with the aryl hydrocarbon receptor (Ah-R) that generate dioxin-like toxic effects. Very few of these congeners are detected in Aroclor 1268 suggesting that it would generate less dioxin-like toxicity (Appendix A.1.2). In general, of the 10 homologues characteristic of all PCBs, the most toxic for all modes of action are the tetra-, penta-, and hexa-CBs. The makeup of

Aroclor 1254 vs. Aroclor 1268 regarding these homologues is as follows – Aroclor 1254: 22%, 48%, and 24%, respectively, of tetra-, penta-, and hexa-CB; Aroclor 1268: 0.5%, 3%, and 2%, respectively, of tetra-, penta-, and hexa-CB.

More specifically, the relative potency (REP) of Aroclor 1268 vs. Aroclor 1254 for mammals, based on dioxin-like total toxic equivalents (TEQs), is 0.06 (Burkhard and Lukasewycz, 2008). The following embedded table shows the effects of this difference in REP (a 17-fold difference; 1/0.06 = 16.7) on PRGs estimated for the short-tailed shrew (*B. carolinesis*), which generated the lowest nodal PRGs when these differences were not considered (Table 12).

Other modes of PCB toxicity other than that affecting the Ah receptor include effects on homeostasis, neurotoxicity, carcinogenicity, and endocrine disruption. In addition, other chemicals in Aroclor mixtures such as chlorinated naphthalenes and polychlorinated diphenyl ethers may contribute to non dioxin-like toxicity. Given the very few specific toxicity tests with Aroclor 1268 to small mammals and birds, the potential non-dioxin toxic effects are largely unknown.

Effects of Relative Potency Differences Between Aroclor 1268 and Aroclor 1254 on Preliminary Remedial Goals (PRGs, mg/kg in Soil) for the Short-Tailed Shrew

Relative Potency Difference	Node 1 (NOAEL-based) PRG	Node 2 PRG	Node 3 PRG	Node 4 (GMAEL-based) PRG	Node 5 PRG	Node 6 PRG	Node 7 (LOAEL-based) PRG
None (A1268 equal to A1254)	0.21	0.31	0.45	0.66	0.98	1.4	2.1
A1268 17-fold less potent than A1254	3.6	5.3	7.6	11	17	24	36

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Figure 1._The LCP Site with Upland and Estuarine Sampling Stations

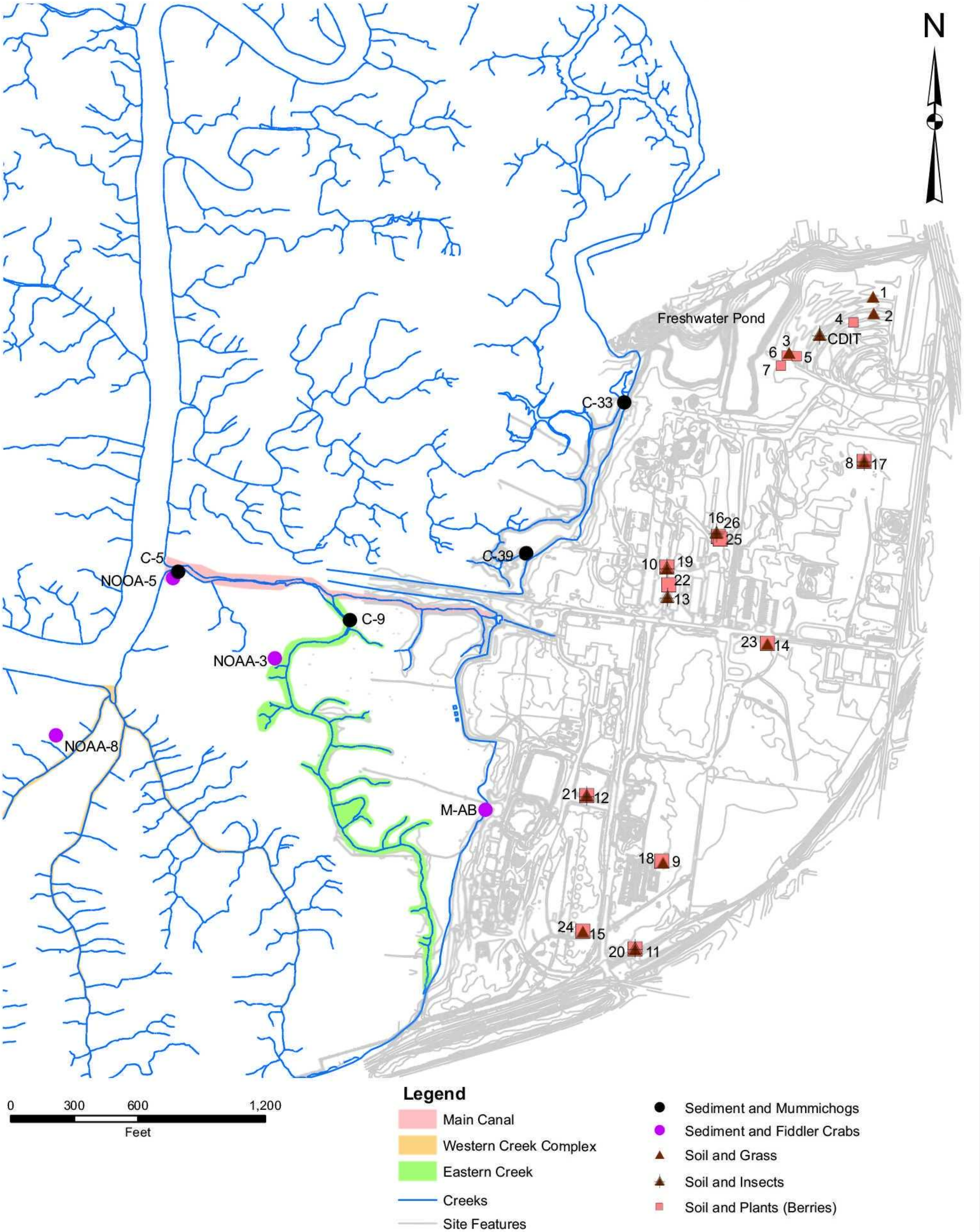

Figure 2.__ Relationship between concentrations of antimony in surface soil and grass in upland at LCP Site

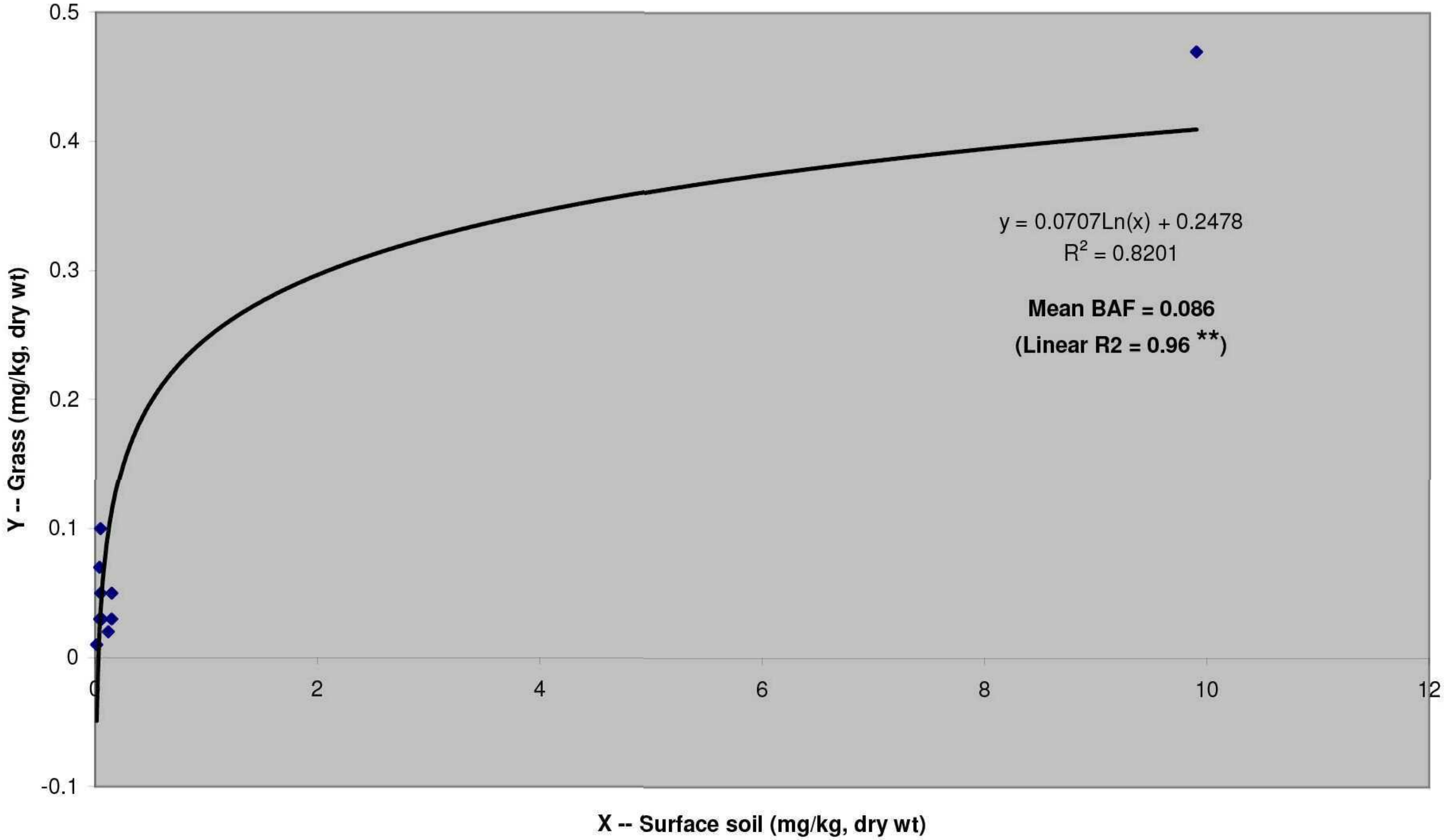

Figure 3.__ Relationship between concentrations of zinc in surface soil and insects in upland at LCP Site

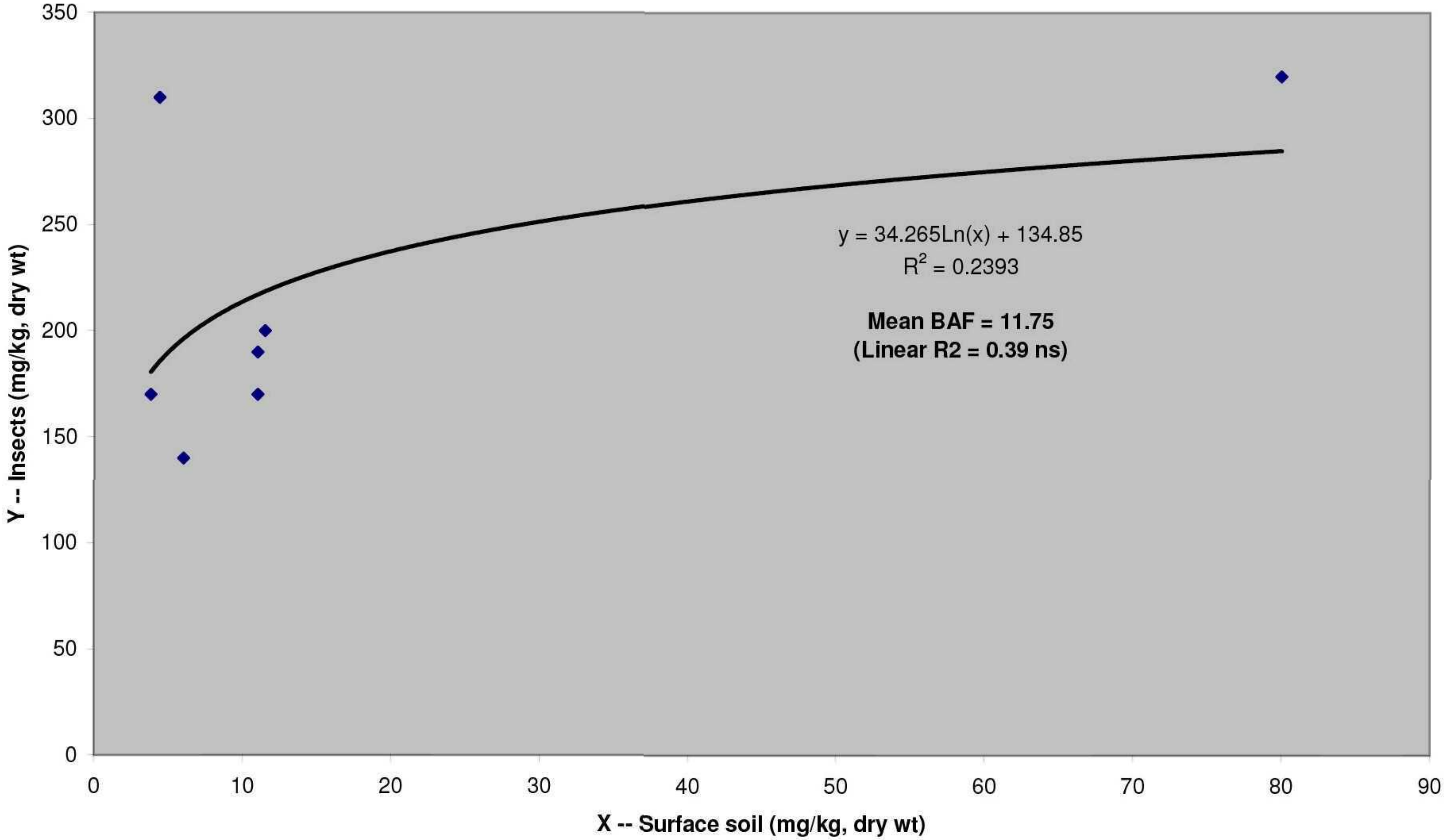

Table 1.__Basic experimental design for data generation and analysis in Baseline Ecological Risk Assessment (BERA) for upland at LCP Site

Measurement	Number of sampling stations[a]	Analytical method[b]	Typical detection limit	Other details
		Surface Water Chemistry -- Freshwater Pond		
General water quality characteristics	3	Hydrolab	-----	Temperature, salinity, specific conductance, turbidity, pH, and dissolved oxygen evaluated
Total mercury	3	1631E	0.08 ng/L	Total and dissolved mercury evaluated by "clean-hands" methods
Methylmercury	3	1630	0.05 ng/L	-----
Aroclor 1268	3	8082	0.001 ug/L	Other Aroclors also evaluated
Lead	3	200.8	0.006 ug/L	Total and dissolved lead evaluated
Antimony	2	200.8	0.02 ug/L	Total and dissolved antimony evaluated
Copper	2	200.8	0.03 ug/L	Total and dissolved copper evaluated
Nickel	2	200.8	0.04 ug/L	Total and dissolved nickel evaluated
Vanadium	2	200.8	0.08 ug/L	Total and dissolved vanadium evaluated
Zinc	2	200.8	0.1 ug/L	Total and dissolved zinc evaluated
		Surface Soil Chemistry -- Upland[c,d]		
Grain-size distribution	26	ASTM D-422	1% passing sieve	-----
pH	26	9045C	-----	-----
Total organic carbon	26	ASTM D4129-82M	0.02% (dry wt)	-----
Total mercury	26	1631E	0.0002 mg/kg (dry wt)	-----
Methylmercury	26	CAS SOP	0.00004 mg/kg (dry wt)	-----
Aroclor 1268	26	8082	0.0017 mg/kg (dry wt)	Other Aroclors also evaluated
Lead	26	6020	0.05 mg/kg (dry wt)	-----
PAHs	12	8270C	Variable	18 different PAHs evaluated
Antimony	12	6020	0.05 mg/kg (dry wt)	-----
Copper	12	6020	0.1 mg/kg (dry wt)	-----
Nickel	12	6020	0.03 mg/kg (dry wt)	-----
Vanadium	12	6020	0.04 mg/kg (dry wt)	-----
Zinc	12	6020	0.5 mg/kg (dry wt)	-----
		Surface Sediment Chemistry -- Freshwater Pond and Estuary[e]		
Grain-size distribution	13	ASTM D-422	1% passing sieve	-----
Total organic carbon	13	ASTM D4129-82M	0.02% (dry wt)	-----
Total mercury	13	1631E	0.0002 mg/kg (dry wt)	-----
Methylmercury	13	CAS SOP	0.00004 mg/kg (dry wt)	
Aroclor 1268	13	8082	0.0017 mg/kg (dry wt)	Other Aroclors also evaluated
Lead	13	6020	0.05 mg/kg (dry wt)	-----
PAHs	11	8270C	Variable	18 different PAHs evaluated
Antimony	2	6020	0.05 mg/kg (dry wt)	-----
Copper	2	6020	0.1 mg/kg (dry wt)	-----
Nickel	2	6020	0.03 mg/kg (dry wt)	-----
Vanadium	2	6020	0.04 mg/kg (dry wt)	-----
Zinc	2	6020	0.5 mg/kg (dry wt)	-----

Table 1.__Continued

Measurement	Number of sampling stations[a]	Analytical method[b]	Typical detection limit	Other details
Bioaccumulation/Toxicity Tests of Surface Soil -- Soil Invertebrates[c]				
Earthworms	12	ASTM E1676-04	-----	Evaluation of survival; sublethal effects; and body burdens of primary and secondary Chemicals of Potential Concern (COPC) in worms after 28-day laboratory exposure to surface soil
Chemical Body Burdens of Potential Food Items of Modeled Wildlife				
Biota Collected				
Grass	12	-----	-----	1 replicate of shoots and roots combined
Berries of plants	14	-----	-----	1 replicate of primarily southern bayberry (*Myrica cerifera*)
Insects	7	-----	-----	1 replicate of composited species (moths, grasshoppers, beetles, and/or dragonflies)
Spiders	1	-----	-----	1 replicate collected along shoreline of freshwater pond
Fiddler crabs	5	-----	-----	3 replicates of about 20 - 35 composited crabs (mostly males)
Fish (Mummichogs)	5	-----	-----	3 replicates of 5 - 20 composited fish (about 45 - 97 mm in length)
Chemical Analyses Performed on Potential Food Items of Modeled Wildlife (Whole Bodies Analyzed)				
Total mercury	-----	1631E	0.0001 mg/kg (wet wt)	-----
Methylmercury	-----	CAS SOP	0.001 mg/kg (wet wt)	-----
Aroclor 1268	-----	8082	0.002 mg/kg (wet wt)	Other Aroclors also evaluated for earthworms and other terrestrial food items
Lead	-----	6020	0.001 mg/kg (wet wt)	-----
Antimony	-----	200.8	0.004 mg/kg (wet wt)	Evaluated for just earthworms and other terrestrial food items
Copper	-----	200.8	0.006 mg/kg (wet wt)	Evaluated for just earthworms and other terrestrial food items
Nickel	-----	200.8	0.006 mg/kg (wet wt)	Evaluated for just earthworms and other terrestrial food items
Vanadium	-----	200.8	0.008 mg/kg (wet wt)	Evaluated for just earthworms and other terrestrial food items
Zinc	-----	200.8	0.08 mg/kg (wet wt)	Evaluated for just earthworms and other terrestrial food items

[a]Number of sampling stations includes reference locations.

[b]Analytical methods are U. S. EPA methods unless otherwise indicated.

[c]Surface soil is defined as the biologically active zone between 0 and 30 cm in depth.

[d]Three (3) samples of subsurface soil (30 - 45 cm in depth) were also collected and evaluated for background concentrations of all chemicals assessed in surface soil.

[e]Surface sediment is defined as the biologically active zone between 0 and 15 cm in depth.

Table 2.__ General characteristics and chemicals of potential concern (COPC) in surface water and surface sediment in freshwater pond in upland at LCP Site[a]

Measurement (unit of measurement)	Sample (replicate) 1 (FWP [W])	2 (FWP-SW-1)	3 (FWP-SW-2)	Mean (x)
Surface Water				
Temperature (^{0}C)	27.0	24.5	24.8	-------
Salinity (ppt)	0.19	0.01	0	-------
Specific conductance (mS/cm)	3.81	0.24	0.24	-------
Turbidity (NTU)	>999	>999	>999	-------
pH (pH units)	7.21	8.35	8.34	-------
Dissolved oxygen (mg/L)	2.72	6.94	6.42	-------
Total mercury (µg/L)				
• Total	2.6	0.0057	0.020	0.875
• Dissolved	0.00020	0.0029	0.0016	0.00157
Methylmercury (µg/L)	0.0078	0.0025	0.00090	0.00373
Inorganic mercury (µg/L)[b]	2.6	0.0032	0.019	0.874
Aroclor 1268 (µg/L)	0.10	<0.0023	0.029	<0.044
Lead (µg/L)				
• Total	600	0.13	0.89	200
• Dissolved	0.79	0.063	0.056	0.303
Antimony (µg/L)				
• Total	-------	0.021	0.039	0.0300
• Dissolved	-------	0.032	0.029	0.0305
Copper (µg/L)				
• Total	-------	0.34	0.42	0.380
• Dissolved	-------	0.41	0.37	0.390
Nickel (µg/L)				
• Total	-------	0.51	0.62	0.565
• Dissolved	-------	0.53	0.60	0.565
Vanadium (µg/L)				
• Total	-------	0.13	0.36	0.245
• Dissolved	-------	0.16	0.30	0.230
Zinc (µg/L)				
• Total	-------	6.1	11	8.55
• Dissolved	-------	4.4	8.4	6.40

Table 2.__ Continued[a]

Measurement (unit of measurement)	Sample (replicate)			Mean (x)
	1 (SD-FWP)	2 (SD-1-FWP)	3 (SD-2-FWP)	
		Surface Sediment (dry wt)		
Gravel/sand/fines (%)	0.2/96.1/3.7	0.8/98.8/0.4	2.4/97.3/0.3	1.1/97.4/1.5
Total organic carbon (%)	0.78	1.0	1.3	1.03
Total mercury (mg/kg)	0.18	0.073	0.098	0.117
Methylmercury (mg/kg)	0.00018	0.0014	0.00047	0.00068
Inorganic mercury (mg/kg)[b]	0.18	0.072	0.098	0.117
Aroclor 1268 (mg/kg)	0.023	<0.017	0.029	<0.023
Lead (mg/kg)	2.5	11	3.0	5.5
PAHs (mg/kg)	0.012	-------	-------	0.012
Antimony (mg/kg)	-------	0.060	0.040	0.0500
Copper (mg/kg)	-------	2.3	0.75	1.53
Nickel (mg/kg)	-------	1.2	0.88	1.04
Vanadium (mg/kg)	-------	2.6	3.2	2.90
Zinc (mg/kg)	-------	4.5	2.6	3.55

[a] Replicate 1 of surface water and surface sediment was collected on, respectively, October 23 and 25, 2007. Replicates 2 and 3 of surface water and surface sediment were collected on April 10, 2008.

[b] Values for inorganic mercury were derived as the difference between measured values for total mercury and methylmercury.

Table 3.__General characteristics and chemicals of potential concern (COPC) in surface soil of upland at LCP Site (all measurements in dry weight)[a, b, c]

	General Characteristics			Primary COPC (mg/kg)					Secondary COPC (mg/kg)				
Sampling station	Gravel/ sand / fines (%)	pH (stand. units)	Total organic carbon (%)	Total mercury (and inorganic mercury)[d]	Methyl-mercury (% of total mercury)	Aroclor 1268	Lead	PAHs	Antimony	Copper	Nickel	Vanadium	Zinc
Background Levels (Subsurface Soil)													
1 (RI-15)	4.5/92.6/2.9	6.5	1.4	0.044	<0.000040	0.015	32	0.37	<0.040	2.4	6.8	**32**	6.0
2 (LC-601)	1.0/94.1/4.9	7.5	0.94	0.037	<0.000040	0.0028	16	0.26	<0.040	1.8	1.8	**4.9**	4.0
3 (LC-603)	0.2/96.6/3.2	6.4	0.57	0.041	<0.000040	0.0043	4.2	0.14	<0.040	0.82	1.2	**2.6**	2.1
Background mean (x):	-------	-------	0.97	0.0407	<0.000040	0.0074	17.4	0.257	<0.040	1.67	3.27	**13.2**	4.03
Reference Locations (Old Drive-In Theater Area)													
Main Stations (single soil samples associated with earthworm tests and grass and insects at site)													
1 (RI-15)	18.0/81.0/1.0	5.3	2.8	0.092	0.00061 (0.98)	**0.065**	**58**	**1.5**	0.060	4.8	5.4	**12**	24
2 (LC-601)	0.2/99.0/0.8	5.9	0.74	0.055	0.00007 (0.12)	**0.021**	11	0.044	0.040	1.3	1.6	**4.3**	6.5
3 (LC-603)	10.5/89.1/0.4	5.7	1.5	0.099	0.00035 (0.43)	**0.042**	12	0.12	0.050	1.5	1.8	**5.8**	4.0
Secondary Stations (composite soil samples associated with plants/berries at site)													
4 (S. bayberry near RI-15 and LC-601)	1.9/95.7/2.4	6.9	1.6	0.086	0.00066 (0.77)	**0.24**	45	-------	-------	-------	-------	-------	-------
5 (S. bayberry near LC-603)	31.4/67.6/0.8	5.9	1.8	**0.20**	0.00047 (0.24)	**0.57**	28	-------	-------	-------	-------	-------	-------
6 (greenbrier near LC-603)	24.3/75.0/0.7	5.3	2.3	**0.26**	0.00089 (0.34)	**0.21**	35	-------	-------	-------	-------	-------	-------
7 (laurel oak near LC-603)	1.9/97.2/0.9	4.8	3.9	**0.17**	0.00044 (0.26)	**0.16**	22	-------	-------	-------	-------	-------	-------
Grand reference mean (x):	-------	-------	2.09	**0.137**	0.000499	**0.187**	30.1	0.55	0.0500	2.53	2.93	7.37	11.50
Potentially Impacted Locations													
Main Stations (single soil samples associated with earthworm tests and grass and insects at site)													
8 (HG-1)	0.8/98.7/0.5	6.2	1.2	**0.11**	0.00045 (0.41)	**0.051**	20	0.44	0.050	1.9	1.6	**5.6**	11
9 (HG-2)	1.5/98.2/0.3	5.9	0.49	0.072	0.00013 (0.18)	**0.14**	3.7	**1.5**	0.050	0.64	0.49	**3.9**	4.0
10 (HG-3)	5.8/93.5/0.7	6.6	0.55	0.89	0.00040 (0.045)	**0.55**	9.7	0.43	0.15	1.3	1.1	**4.4**	4.4
11 (AC-1)	15.3/84.1/0.6	5.7	15	**0.80**	0.0013 (0.16)	**0.48**	32	**130**	0.12	6.3	2.6	**10**	11
12 (AC-2)	10.1/89.4/0.5	7.6	0.69	**0.61**	0.00050 (0.082)	**0.20**	8.8	0.12	0.050	0.82	0.99	**3.8**	6.0
13 (AC-3)	5.4/94.2/0.4	7.7	2.0	**12**	0.0076 (0.063)	8.9	**740**	**1.9**	**9.9**	8.8	6.8	**29**	**80**
14 (PB-1)	1.5/97.8/0.7	6.0	0.90	**0.26**	0.00028 (0.10)	**0.091**	4.4	0.099	0.040	1.7	0.53	**3.1**	7.6
15 (PB-2)	1.2/98.0/0.8	6.0	2.4	**1.2**	0.0012 (0.10)	**1.5**	440	0.86	0.15	3.8	3.2	**7.1**	36
16 (PB-3)	16.4/83.0/0.6	6.3	0.64	**0.21**	0.00014 (0.067)	**0.028**	5.5	0.036	0.015	1.0	0.57	**4.8**	3.8
Secondary Stations (composite soil samples associated with plants/berries at site)													
17 (greenbrier near HG-1)	0.7/96.8/2.5	5.9	1.8	**0.37**	0.0015 (0.41)	**0.18**	44	-------	-------	-------	-------	-------	-------
18 (S. bayberry near HG-2)	3.7/93.1/3.2	7.5	0.69	**0.58**	0.00069 (0.12)	**0.27**	32	-------	-------	-------	-------	-------	-------
19 (S. bayberry near HG-3)	0.8/95.6/3.6	6.6	0.83	3.0	0.00050 (0.017)	**0.57**	10	-------	-------	-------	-------	-------	-------
20 (S. bayberry near AC-1)	16.6/79.1/4.3	6.0	26	**1.0**	0.0014 (0.14)	**0.35**	**100**	-------	-------	-------	-------	-------	-------
21 (S. bayberry near AC-2)	0.7/96.7/2.6	7.3	1.1	**0.26**	0.00039 (0.15)	**0.16**	8.3	-------	-------	-------	-------	-------	-------
22 (S. bayberry near AC-3)	2.5/93.8/3.7	7.2	1.4	**9.6**	0.010 (0.10)	6.1	39	-------	-------	-------	-------	-------	-------
23 (S. bayberry near PB-1)	2.8/94.6/2.6	5.7	1.2	**0.76**	0.0014 (0.18)	**0.27**	7.8	-------	-------	-------	-------	-------	-------
24 (greenbrier near PB-2)	0.9/95.6/3.5	6.0	1.4	**0.86**	0.0014 (0.16)	**0.46**	180	-------	-------	-------	-------	-------	-------
25 (bayberry near PB-3)	1.2/96.0/2.8	6.2	1.3	**2.1**	0.0038 (0.18)	**0.20**	11	-------	-------	-------	-------	-------	-------
26 (Leguminacae near PB-3)	2.6/97.2/0.2	5.9	1.4	**9.1**	0.0048 (0.053)	**0.78**	38	-------	-------	-------	-------	-------	-------
Grand mean for potentially impacted area (x):	-------	-------	3.21	**2.304**	0.001994	**1.120**	**91.3**	**15.04**	1.169	2.92	1.99	**7.97**	18.20

Table 3.__ Continued[a, b, c]

Toxicological benchmarks	General Characteristics: Gravel/ sand / fines (%)	pH (stand. units)	Total organic carbon (%)	Primary COPC (mg/kg): Total mercury	Methyl-mercury	Aroclor 1268	Lead	PAHs	Secondary COPC (mg/kg): Antimony	Copper	Nickel	Vanadium	Zinc
EPA Region 4 ecological screening values (ESVs)	-------	-------	-------	0.1	0.67	0.02 (for PCBs)	50	1.0	3.5	40	30	2.0	50
EPA Eco-SSLs													
• Plants	-------	-------	-------	-------	-------	-------	120	-------	-------	70	38	-------	160
• Soil invertebrates	-------	-------	-------	-------	-------	-------	1,700	-------	78	80	280	-------	120
• Birds	-------	-------	-------	-------	-------	-------	11	-------	-------	28	210	7.8	46
• Mammals	-------	-------	-------	-------	-------	-------	56	-------	0.27	49	130	280	79

[a]Surface soil (0 - 30 cm in depth) was collected on April 10-11, 2008, at locations where terrestrial food (prey) of wildlife evaluated in food-web exposure models was collected. Selected samples of soil were also employed in earthworm toxicity/bioaccumulation tests. Background (subsurface) soil was obtained on May 28, 2008, at a depth of from 30 to 45 cm.

[b]Concentrations of COPC that exceeded EPA Region 4's ecological screening values (ESVs) for soil are identified by **bold print**. EPA's ecological soil screening levels (Eco-SSLs) for evaluation of body burdens of COPC in various categories of biota are also presented for reference purposes.

[c]The highest concentrations of total mercury, Aroclor 1268, and lead in soil for each of their respective sampling categories (i. e., HG 1-3, AC 1-3, and PB 1-3) are identified by **bold red print**. Sampling design was based on preliminary soil sampling, which indicated that the highest concentrations of these COPC would occur at their respective "3" locations.

[d]Values for total mercury (the actual measurement) and inorganic mercury are considered to be essentially identical because of the relatively low values for methylmercury.

Table 4.__ General characteristics and chemicals of potential concern (COPC) in surface sediment of estuary at LCP Site (all sediment measurements in dry weight)[a]

	General Characteristics		Primary COPC				
			Mercury (mg/kg)				
Sampling station	Gravel/ sand/ fines (%)	Total organic content (%)	Total (and inorganic)[b, c]	Methyl (% total)	Aroclor 1268 (mg/kg)[d]	Lead (mg/kg)[e]	Total PAHs (mg/kg)[f]
Marsh stations where Fiddler Crabs (*Uca spp*.) were Collected							
R (reference station in Troup Creek)	10.3/3.3/86.4	4.7	0.081	-------	0.029	20	0.038
NOAA 5 (mouth of Main Canal)	10.8/49.0/40.2	3.8	0.36	0.0056 (1.6)	0.62	12	0.70
NOAA 3 (downstream Eastern Creek)	14.5/12.0/73.5	8.5	1.5	0.00090 (0.06)	1.1	**760**	**81**
NOAA 8 (mouth of Western Creek Complex)	6.6/10.1/83.3	11.0	1.0	0.010 (1.0)	0.51	20	0.12
M-AB (AB seep)	1.7/90.4/7.9	0.77	0.073	0.00049 (0.67)	0.053	3.7	0.0067
Potentially Impacted Area mean (x):	-------	5.75	0.60	0.0042	0.46	**163.1**	**16.4**
Creek stations where Mummichogs (*Fundulus heteroclitus*) were Collected							
MC-R (reference station in Troup Creek)	8.4/13.4/78.2	3.6	0.12	-------	0.065	18	0.040
C-5 (mouth of Main Canal)	8.9/5.4/85.7	4.9	**2.7**	0.00060 (0.02)	10.0	20	0.60
C-9 (downstream Eastern Creek)	6.8/6.9/86.3	4.7	1.1	0.00020 (0.02)	3.5	**200**	**6.7**
C-33 (old oil-processing site)	16.8/37.0/46.2	12	0.27	<0.00040	0.023	**1,600**	**36**
C-39 (NE base of road along Main Canal)	9.7/12.9/77.4	6.8	**2.5**	0.00090 (0.04)	0.54	**180**	0.55
Potentially Impacted Area mean (x):	-------	6.40	1.34	<0.00052	2.83	**403.6**	**8.8**

[a]Surface sediment (0 - 15 cm in depth) was collected during the period of October 16-18, 2007, at locations where estuarine food (prey) of wildlife evaluated in food-web exposure models was collected.

[b]Site-specific apparent effects threshold (AET) for protection of estuarine benthos from total mercury is 19 mg/kg (CDR Environmental Specialists and Environmental Planning Specialists, 2008), and preliminary ecological remedial sediment goal (PERSG) derived for protection of wildlife is 1.5 mg/kg (Thoms, 2006). Note **bold print** for values greater than the wildlife benchmark.

[c]Values for total mercury (the actual measurement) and inorganic mercury are considered to be essentially identical because of the relatively low values for methylmercury.

[d]Site-specific AET for protection of estuarine benthos from Aroclor 1268 is 43 mg/kg (CDR Environmental Specialists and Environmental Planning Specialists, 2008), and PERSG derived for protection of wildlife is 12.5 mg/kg (Thoms, 2006).

[e]Site-specific AET for protection of estuarine benthos from lead is 37 mg/kg (CDR Environmental Specialists and Environmental Planning Specialists, 2008), and PERSG derived for protection of wildlife is 55 mg/kg (Thoms, 2006). Note **bold print** for values greater that these benchmarks. .

[f]Site-specific AET for protection of estuarine benthos from total PAHs is 2.534 mg/kg (CDR Environmental Specialists and Environmental Planning Specialists, 2008). Note **bold print** for values greater that this benchmark. .

Table 5.__Body burdens of chemicals of potential concern (COPC) in potential terrestrial food items employed in wildlife food-web exposure models for upland at LCP Site (all body-burden measurements in dry weight)[a]

Sampling station	Primary COPC: Mercury (mg/kg) Total (and inorganic)[b]	Primary COPC: Mercury Methyl (% total)	Primary COPC: Aroclor 1268 (mg/kg)	Primary COPC: Lead (mg/kg)	Secondary COPC: Antimony (mg/kg)	Secondary COPC: Copper (mg/kg)	Secondary COPC: Nickel (mg/kg)	Secondary COPC: Vanadium (mg/kg)	Secondary COPC: Zinc (mg/kg)
Grass (Poaceae)									
1 (Reference RI-15)	0.062	<0.0030	0.065	12	0.030	6.1	1.2	1.3	120
2 (Reference LC-601)	0.031	<0.0025	0.059	8.4	0.070	6.2	1.8	0.70	160
3 (Reference LC-603)	0.058	<0.0026	0.086	6.3	0.030	6.2	1.5	1.0	93
Reference mean (x):	0.0503	<0.0027	0.0700	8.9	0.043	6.17	1.50	1.00	124
8 (HG-1)	0.069	0.0061 (8.8)	0.060	7.1	0.030	9.7	3.9	0.90	240
9 (HG-2)	0.034	< 0.0028	0.028	2.6	<0.20	6.0	0.87	0.60	53
10 (HG-3)	0.070	<0.0026	0.095	1.5	0.030	5.6	0.79	1.0	54
11 (AC-1)	0.11	0.0097 (8.8)	0.20	4.1	0.020	7.4	2.7	0.70	100
12 (AC-2)	0.13	< 0.0026	0.31	21	0.050	4.5	0.78	1.1	44
13 (AC-3)	12	0.072 (0.6)	7.1	40	0.47	15	4.3	4.2	200
14 (PB-1)	0.13	<0.0020	0.061	2.2	0.030	8.1	1.5	0.70	110
15 (PB-2)	0.063	<0.0030	0.055	140	0.050	7.3	2.0	1.0	530
16 (PB-3)	0.094	<0.0025	0.027	0.69	<0.02	5.3	0.84	0.40	43
Potentially impacted area mean (x):	1.4111	<0.0115	0.882	24.4	<0.119	7.66	1.96	1.18	153
Berries (from plants)									
4 (Reference - S. bayberry near RI-15 and LC-601)	0.016	<0.0050	<0.010	0.17	0.050	3.4	0.66	<0.20	14
5 (Reference - S. bayberry near LC-603)	0.014	<0.0050	<0.010	0.29	<0.02	3.4	0.75	<0.20	11
6 (Reference - greenbrier near LC-603)	0.0084	<0.0050	<0.010	0.12	<0.02	8.1	2.4	<0.20	20
7 (Reference - laurel oak near LC-603)	0.0020	<0.0050	<0.0099	0.14	<0.02	6.4	1.1	<0.20	9.3
Reference mean (x):	0.0101	<0.0050	<0.010	0.180	<0.028	5.33	1.23	<0.20	13.6
17 (greenbrier near HG-1)	0.012	<0.0050	<0.010	0.19	<0.02	16	0.97	<0.20	21
18 (S. bayberry near HG-2)	0.0061	<0.0050	0.0030	0.18	<0.02	4.6	0.99	<0.20	18
19 (S. bayberry near HG-3)	0.021	<0.0050	<0.010	0.15	<0.02	4.1	1.2	<0.20	18
20 (S. bayberry near AC-1)	0.0064	<0.0050	0.0034	0.30	<0.02	5.2	1.6	<0.20	13
21 (S. bayberry near AC-2)	0.0080	<0.0050	0.0044	0.24	<0.02	3.2	0.41	<0.20	16
22 (S. bayberry near AC-3)	0.020	<0.0050	0.0092	0.20	<0.02	7.9	1.7	<0.20	20
23 (S. bayberry near PB-1)	0.012	<0.0050	0.0084	0.22	<0.02	5.3	0.50	<0.20	23
24 (greenbrier near PB-2)	0.0087	<0.0050	<0.0099	0.84	<0.02	8.2	0.84	<0.20	21
25 (bayberry near PB-3)	0.012	<0.0050	<0.010	0.16	0.030	6.9	2.3	<0.20	17
26 (Leguminacae near PB-3)	0.0013	<0.0050	<0.010	0.16	<0.02	9.6	0.52	<0.20	28
Potentially impacted area mean (x):	0.0108	<0.0050	<0.078	0.264	<0.021	7.10	1.10	<0.20	19.5

Table 5.__ Continued[a]

Sampling station	Primary COPC: Mercury (mg/kg) Total mercury	Methyl (% total)	Aroclor 1268 (mg/kg)	Lead (mg/kg)	Secondary COPC: Antimony (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)
Insects[c, d]									
C (reference center; CDIT)	0.023	0.014 (61)	0.0091	0.19	<0.020	65	1.3	<0.090	200
8 (HG-1) -- G,D	0.092	0.0062 (7)	0.013	0.20	<0.020	46	2.6	<0.090	190
10 (HG-3) -- M,B,D	0.30	0.081 (27)	0.45	0.81	0.040	30	0.30	<0.090	310
11 (AC-1) -- G,M	0.038	0.022 (58)	0.011	0.20	<0.020	48	1.3	<0.090	170
12 (AC-2) -- G,M	0.016	0.0084 (53)	0.0077	0.082	<0.020	68	0.76	<0.090	140
13 (AC-3) -- M	0.28	0.097 (35)	0.63	0.95	0.050	25	0.19	<0.090	320
16 (PB-3) -- G,M	0.021	0.0097 (46)	0.012	0.11	<0.020	42	0.98	<0.090	170
Potentially impacted area mean (x):	0.1245	0.038 (31)	0.1873	0.39	<0.028	43.2	1.02	<0.090	216.7
Spiders[e]									
Shore of Freshwater Pond (results applied to potentially impacted area)	1.3	1.2 (92)	1.4	2.4	0.050	66	0.50	0.30	300

[a]Grass, seeds, and insects were collected during the period of October 20-25, 2007. Spiders were obtained on May 27-28, 2008.

[b]Values for total mercury (the actual measurement) in grass and berries are considered to be essentially identical to values for inorganic mercury because of the relatively low values for methylmercury.

[c]Insects collected at each sampling station are coded from most abundant to least abundant: moths (M), grasshoppers (G), beetles (B), and dragonflies (D).

[d]Insects were characterized by substantial body burdens of methylmercury; consequently, values for total mercury and inorganic mercury are not considered to be equivalent. Body burdens of inorganic mercury (considered to be the difference between values for total mercury and methylmercury) are (mg/kg, dry wt) -- Station C: 0.0090; Station 8: 0.086; Station 10: 0.22; Station 11: 0.016; Station 12: 0.0076; Station 13: 0.18; and Station 16: 0.011, with a site mean of 0.076 mg/kg.

[e]Spiders were characterized by substantial body burdens of methylmercury; consequently, values for total mercury and inorganic mercury are not considered to be equivalent. Body burden of inorganic mercury (considered to be the difference between values for total mercury and methylmercury) is 0.1 mg/kg (dry wt).

Table 6.__Body burdens of chemicals of potential concern (COPC) in potential estuarine food items employed in wildlife food-web exposure models for upland at LCP Site (all body-burden measurements in dry weight)[a]

Sampling station	Mercury (mg/kg) Total	Mercury (mg/kg) Methyl (% total)	Mercury (mg/kg) Inorganic[b]	Aroclor 1268 (mg/kg)	Lead (mg/kg)
	Fiddler Crabs (*Uca spp.*)				
R (reference station in Troup Creek)	0.057	-------	-------	<0.0084	0.77
NOAA 5 (mouth of Main Canal)	0.230	0.183 (80)	0.047	0.49	0.74
NOAA 3 (downstream Eastern Creek)	0.447	0.327 (73)	0.120	0.54	0.86
NOAA 8 (mouth of Western Creek Complex)	0.145	0.130 (90)	0.015	0.50	0.57
M-AB (AB seep)	0.960	0.793 (83)	0.167	4.6	2.0
Potentially impacted area mean (x):	0.446	0.3582 (80)	0.087	1.53	1.04
	Mummichogs (*Fundulus heteroclitus*)				
R (reference station in Troup Creek)	0.097	-------	-------	0.070	0.18
C-5 (mouth of Main Canal)	0.50	0.34 (68)	0.16	5.2	0.29
C-9 (downstream Eastern Creek)	0.91	0.67 (74)	0.24	6.4	0.26
C-33 (old oil-processing site)	0.33	0.20 (61)	0.13	2.7	0.83
C-39 (NE base of road along Main Canal)	0.52	0.38 (73)	0.14	3.2	0.55
Potentially impacted area mean (x):	0.565	0.398 (70)	0.1675	4.38	0.483

[a]Fiddler crabs and mummichogs were collected during the period of October 16-25, 2007.

[b]Values for inorganic mercury were derived as the difference between measured values for total mercury and methylmercury.

Table 7.__ Toxicity and bioaccumulation of chemicals of potential concern (COPC) in earthworms (*Eisenia faetida*) exposed in the laboratory to surface soil of upland at LCP Site[a]

	Toxicity of COPC[b]		Body burdens of COPC (mg/kg, dry wt)									
			Primary COPC					Secondary COPC				
			Mercury									
Sampling station	Survival (%)[c]	Sublethal effects	Total	Methyl (% total)	Inorganic[d]	Aroclor 1268	Lead	Antimony	Copper	Nickel	Vanadium	Zinc
Pre-test earthworms	----------	----------	0.018	0.004 (26)	0.013	<0.012	0.21	<0.007	9.8	1.7	<0.08	85
Control soil[e]	97.3 (96, 97, 99)	No sublethal effects (behavioral or pathological symptoms) were observed in worms exposed to soil from any sampling station. All worms burrowed into soil within 1 hr after initiation of tests and did not reappear on soil surface.	0.031	0.007 (23)	0.024	<0.012	0.42	0.009	15	5.7	0.28	94
1 (Reference RI-15)	99 (100, 99, 97)		0.57	0.098 (17)	0.47	0.12	64	<0.01	6.9	1.6	1.0	87
2 (Reference LC-601)	96 (94, 97, 97)		0.28	0.08 (26)	0.20	0.52	16	<0.01	7.3	1.5	0.63	85
3 (Reference LC-603)	97 (96, 99, 96)		0.49	0.14 (29)	0.35	0.38	19	<0.01	7.7	0.92	0.80	87
Reference mean (x):	97.3		0.447	0.106 (24)	0.340	0.340	33.0	<0.01	7.30	1.34	0.81	86.3
8 (HG-1)	95 (93, 94, 97)		0.56	0.12 (21)	0.44	0.50	37	0.01	8.3	1.3	1.2	89
9 (HG-2)	95 (91, 97, 97)		0.16	0.041 (26)	0.12	0.92	9.3	0.33	7.4	0.73	0.36	86
10 (HG-3)	97 (100, 94, 97)		0.21	0.092 (44)	0.12	1.3	7.2	0.04	7.4	0.23	0.23	82
11 (AC-1)	95 (97, 90, 97)		1.2	0.33 (28)	0.87	2.3	24	<0.01	9.0	1.0	1.1	91
12 (AC-2)	96 (99, 96, 93)		0.22	0.06 (27)	0.160	3.7	7.4	0.03	7.7	0.44	0.27	89
13 (AC-3)	96 (99, 93, 96)		32	0.88 (2.8)	31	13	130	0.86	9.9	1.7	1.9	100
14 (PB-1)	96 (94, 96, 97)		0.40	0.10 (25)	0.30	1.3	9.9	<0.01	7.6	0.43	0.56	80
15 (PB-2)	95 (91, 97, 96)		0.70	0.13 (19)	0.57	1.3	400	<0.01	6.0	0.71	0.88	94
16 (PB-3)	92(90, 96, 91)		0.29	0.10 (34)	0.19	0.34	14	<0.01	7.6	0.31	0.26	84
Potentially impacted area mean (x):	95.2		3.971	0.206 (5.2)	3.752	2.740	71.0	<0.15	7.88	0.76	0.8	88.3

[a] The information presented in this table is derived from 28-day tests primarily designed to evaluate bioaccumulation of chemicals in earthworms exposed to soil. However, in this case, toxicity of soil to earthworms was also assessed at the end of the 28-day exposure period.

[b] The highest concentrations of COPC in soil to which earthworms were exposed -- and experienced no apparent toxicity were -- total mercury: 12 mg/kg (dry wt); methylmercury: 0.0076 mg/kg; Aroclor 1268: 8.9 mg/kg; lead: 740 mg/kg; antimony: 9.9 mg/kg; copper: 8.8 mg/kg; nickel: 6.8 mg/kg; vanadium: 29 mg/kg; and zinc: 80 mg/kg (refer to Table 3).

[c] Mean survival of earthworms is presented first, with values for replicates indicated parenthetically.

[d] Values for inorganic mercury were derived as the difference between measured values for total mercury and methylmercury.

[e] Control soil consisted of a mixture of 70% silica sand, 20% kaolin clay, and 10% pre-sieved peat moss. Calcium carbonate was added to adjust pH to 7.0 ± 0.5.

Table 8.__ Exposure assumptions for primary chemicals of potential concern (COPC) evaluated in wildlife food-web exposure models for upland at LCP Site[a]

Assessment endpoints	Modeled wildlife (Measurement endpoints)	Exposure assumptions[a]				
		Diet[b]	Food ingestion rate (FIR) -- kg/day (dry wt)[c]	Soil/Sediment ingestion rate (SIR) -- kg/day (dry wt)[d]	Water ingestion rate (WIR) -- L/day[e]	Body weight (BW) -- kg (wet wt)[f]
Wildlife Feeding Exclusively on Terrestrial Food Items						
1) Grainivorous bird	Mourning dove (*Zenaida macroura*)	50% grass; 50% berries	0.015	0.0021 (13.9% of FIR)	0.014	0.12
2) Insectivorous bird	Carolina wren (*Thryothorus ludovicianus*)	100% insects	0.0046	0.00011 (2.4% of FIR)	0.0040	0.018
3) Carnivorous bird	Broad-winged hawk (*Buteo platypterus*)	100% small mammals	0.033	0.0019 (5.7% of FIR)	0.032	0.41
4) Grainivorous mammal	Meadow vole (*Microtus pennsylvanicus*)	50% grass; 50% berries	0.0068	0.00022 (3.2% of FIR)	0.0042	0.030
5) Insectivorous mammal	Short-tailed shrew (*Blarina carolinensis*)	60% insects; 40% earthworms	0.0022	0.000066 (3.0% of FIR)	0.0023	0.015
6) Carnivorous mammal	Long-tailed weasel (M*ustela frenata*)	100% small mammals	0.018	0.00077 (4.3% of FIR)	0.022	0.19
Wildlife Feeding at Least Partly on Estuarine Food Items						
7) Insectivorous bird	Common yellowthroat (*Geothlypis trichas*)	80% insects; 20% berries	0.0033	0.000079 (2.4% of FIR)	0.0030	0.012
8) Insectivorous/ crustaceovorous bird	Willet (*Catoptrophorus semipalmatus*)	80% insects; 20% fiddler crabs	0.022	0.0016 (7.3% of FIR)	0.021	0.22
9) Insectivorous/ piscivorous bird	Pied-billed grebe (*Podilymbus podiceps*)	80% spiders; 20% fish	0.034	0.0037 (11% of FIR)	0.034	0.44
10) Crustaceovorous bird	Clapper rail (*Rallus longirostris*)	90% fiddler crabs; 10% fish	0.025	0.0025 (10% of FIR)	0.025	0.28
11) Piscivorous bird	Belted kingfisher (*Ceryle alcyon*)	100% fish	0.017	0	0.027	0.15
12) Insectivorous mammal	Little brown bat (*Myotis lucifugus*)	100% insects	0.0012	0	0.0012	0.0075
13) Omnivorous mammal	Raccoon (*Procyon lotor*)	50% fiddler crabs; 50% fish	0.20	0.019 (9.4% of FIR)	0.32	3.7
14) Carnivorous mammal	Mink (*Neovison vison*)	50% small mammals; 50% fish	0.069	0.0065 (9.4% of FIR)	0.099	1.0

[a]Time-use factors (TUFs) and area-use factors (AUFs) for wildlife are assumed to be unity (1).

[b]Diet of wildlife reflects recommendations of Region 4, U. S. EPA (Thoms; 2007a) subject to availability of food items in the upland at the LCP Site . Although terrestrial insects were collected, aquatic insects could not be obtained. Consequently, terrestrial insects (which included some dragonflies) were modeled for the common yellowthroat, willet, and little brown bat; while spiders obtained along the bank of the freshwater pond were employed for the pied-billed grebe. The small percentage of insects (10%) initially identified for the diet of the clapper rail was eliminated and the percentages for the other food items (fiddler crabs and fish) were marginally increased.

[c]Food ingestion rates (FIRs) were derived from Nagy et al. (1987). Bird ingestion rates were based on "all-birds" equations except for the Carolina wren and common yellowthroat, for which "passerine" equations were employed. Mammalian ingestion rates were based on "eutherian" equations except for the meadow vole, for which the "herbivore" equation was employed.

[d]Soil/sediment ingestion rates (SIRs) were derived from U. S. EPA (2005a).

[e]Water ingestion rates (WIRs) were derived from U. S. EPA (1993).

[f]Body weights (BWs) of wildlife are values identified by Region 4, U. S. EPA (Thoms; 2007a, 2008).

Table 9.__ Toxicity reference values (TRVs) for primary chemicals of potential concern (COPC) evaluated in wildlife food-web exposure models for upland at LCP Site

Primary COPC	Wildlife guild	TRV (mg/kgBW/day) LOAEL[a]	NOAEL[b]	Literature reference	Rationale for selection[c]
Inorganic mercury	Birds	0.90	0.45	Hill and Schaffner, 1976	Chronic study of sexual maturity and reproduction of Japanese quail fed mecuric chloride
	Mammals	0.37	0.37	Heath et al., 2009	Chronic (two-generation) study of fertility and reproduction in rats fed mecuric chloride
Methylmercury	Birds	0.06	0.02	Spalding et al.; 2000a, 2000b	Study (14 weeks) of growth of juvenile great egrets fed methylmercury chloride
	Mammals	0.15	0.075	Dansereau et al., 1999	Chronic (two generation) study of mortality in mink (one of the mammals assessed in this BERA)
Aroclor 1268	Birds	3.9 (for Aroclor 1268)	1.3 (for Aroclor 1268)	Lillie et al., 1974	Only relevant toxicological information that addresses Aroclor 1268 (in chickens); LOAEL estimated by adjusting identified NOAEL by conservative factor of three
	Mammals	0.3 (for Aroclor 1254)	0.03 (for Aroclor 1254)	Aulerich and Ringer, 1977	Relevant toxicological information unavailable for Aroclor 1268; reported TRVs for Aroclor 1254 derived from chronic (9-month) study in which reproduction was evaluated in mink (one of the mammals assessed in this BERA)
Lead	Birds	11.3	3.85	Edens et al., 1976 (for LOAEL); Pattee, 1984 (for NOAEL)	Chronic studies of reproduction in Japanese quail (LOAEL) and American kestrels (NOAEL)
	Mammals	80	8	Azar et al., 1973	Chronic (2-year) study evaluating reproduction in rats

[a]LOAEL refers to lowest-observed-adverse-effect-level.

[b]NOAEL refers to no-observed-adverse-effect-level.

[c]TRVs reflect recommendations of Region 4, U. S. EPA (Thoms; 2007b, 2008; Region 4, 2010).

Table 10.__Hazard quotients (HQs) for primary chemicals of potential concern (COPC) evaluated in wildlife food-web exposure models for upland at LCP Site

Chemical of potential concern (COPC)	Location in study area	Estimated environmental exposure -- EEE (mg/kgBW/day)[a]	Toxicity reference value --TRV (mg/kgBW/day)[b]			Hazard quotient -- HQ (EEE / TRV)[c]		
			LOAEL	NOAEL	GMAEL	LOAEL	NOAEL	GMAEL
		Wildlife Feeding Exclusively on Terrestrial Food Items						
		1) Mourning Dove (*Zenaida macroura*)						
Inorganic	Reference	0.0063	0.90	0.45	0.64	0.01	0.01	0.01
mercury	Site mean	0.13	0.90	0.45	0.64	0.14	0.29	0.20
	Site maximum	0.96	0.90	0.45	0.64	**1.07**	**2.13**	**1.50**
Methylmercury	Reference	0.00025	0.06	0.02	0.035	0.004	0.01	0.01
	Site mean	0.00055	0.06	0.02	0.035	0.01	0.03	0.02
	Site maximum	0.0048	0.06	0.02	0.035	0.08	0.24	0.14
Aroclor 1268	Reference	0.0077	3.9	1.3	2.3	0.002	0.01	0.003
	Site mean	0.077	3.9	1.3	2.3	0.02	0.06	0.03
	Site maximum	0.60	3.9	1.3	2.3	0.15	0.46	0.26
Lead	Reference	0.63	11.3	3.85	6.6	0.06	0.16	0.10
	Site mean	3.1	11.3	3.85	6.6	0.27	0.81	0.47
	Site maximum	22	11.3	3.85	6.6	**1.95**	**5.71**	**3.33**
		2) Carolina Wren (*Thryothorus ludovicianus*)						
Inorganic	Reference	0.0033	0.90	0.45	0.64	0.004	0.007	0.01
mercury	Site mean	0.00019	0.90	0.45	0.64	0.0002	0.0004	0.0003
	Site maximum	0.13	0.90	0.45	0.64	0.14	0.29	0.20
Methylmercury	Reference	0.0038	0.06	0.02	0.035	0.06	0.19	0.11
	Site mean	0.0097	0.06	0.02	0.035	0.16	0.49	0.28
	Site maximum	0.025	0.06	0.02	0.035	0.42	**1.25**	0.71
Aroclor 1268	Reference	0.0035	3.9	1.3	2.3	0.001	0.003	0.002
	Site mean	0.0550	3.9	1.3	2.3	0.01	0.04	0.02
	Site maximum	0.22	3.9	1.3	2.3	0.06	0.17	0.10
Lead	Reference	0.18	11.3	3.85	6.6	0.02	0.05	0.03
	Site mean	0.66	11.3	3.85	6.6	0.06	0.17	0.10
	Site maximum	4.8	11.3	3.85	6.6	0.42	**1.25**	0.73
		3) Broad-Winged Hawk (*Buteo platypterus*)						
Inorganic	Reference	0.0022	0.90	0.45	0.64	0.002	0.005	0.003
mercury	Site mean							
(IHg in	90% IHg:	0.036	0.90	0.45	0.64	0.04	0.08	0.06
mammalian	50% IHg	0.024	0.90	0.45	0.64	0.03	0.05	0.04
diet)	0% IHg	0.011	0.90	0.45	0.64	0.012	0.024	0.017
	Site maximum							
	90% IHg:	0.18	0.90	0.45	0.64	0.20	0.40	0.28
	50% IHg	0.13	0.90	0.45	0.64	0.14	0.29	0.20
	0% IHg	0.056	0.90	0.45	0.64	0.06	0.12	0.09
Methylmercury	Reference	0.00017	0.06	0.02	0.035	0.003	0.01	0.005
(MeHg in	Site mean							
mammalian	10% MeHg	0.0027	0.06	0.02	0.035	0.05	0.14	0.08
diet)	50% MeHg	0.014	0.06	0.02	0.035	0.23	0.70	0.40
	100% MeHg	0.027	0.06	0.02	0.035	0.45	**1.35**	0.77
	Site maximum							
	10% MeHg	0.015	0.06	0.02	0.035	0.25	0.75	0.43
	50% MeHg	0.072	0.06	0.02	0.035	**1.20**	**3.60**	**2.06**
	100% MeHg	0.14	0.06	0.02	0.035	**2.33**	**7.00**	**4.00**
Aroclor 1268	Reference	0.0056	3.9	1.3	2.3	0.0014	0.004	0.0024
	Site mean	0.061	3.9	1.3	2.3	0.02	0.05	0.03
	Site maximum	0.48	3.9	1.3	2.3	0.12	0.37	0.21
Lead	Reference	0.53	11.3	3.85	6.6	0.05	0.14	0.08
	Site mean	1.1	11.3	3.85	6.6	0.10	0.29	0.17
	Site maximum	5.0	11.3	3.85	6.6	0.44	**1.30**	0.76

Table 10.__ Continued

Chemical of potential concern (COPC)	Location in study area	Estimated environmental exposure -- EEE (mg/kgBW/day)[a]	Toxicity reference value --TRV (mg/kgBW/day)[b] LOAEL	NOAEL	GMAEL	Hazard quotient -- HQ (EEE / TRV)[c] LOAEL	NOAEL	GMAEL
		4) Meadow Vole (*Microtus pennsylvanicus*)						
Inorganic	Reference	0.0079	0.37	0.37	0.37	0.02	0.02	0.02
mercury	Site mean	0.18	0.37	0.37	0.37	0.49	0.49	0.49
	Site maximum	1.5	0.37	0.37	0.37	**4.05**	**4.05**	**4.05**
Methylmercury	Reference	0.00045	0.15	0.075	0.11	0.003	0.01	0.004
	Site mean	0.00096	0.15	0.075	0.11	0.01	0.01	0.01
	Site maximum	0.0085	0.15	0.075	0.11	0.06	0.11	0.08
Aroclor 1268	Reference	0.0094	0.3	0.03	0.095	0.03	0.31	0.10
(TRVs for	Site mean	0.11	0.3	0.03	0.095	0.37	**3.67**	**1.16**
Aroclor 1254)	Site maximum	0.87	0.3	0.03	0.095	**2.90**	**29.00**	**9.16**
Lead	Reference	1.2	80	8	25	0.02	0.15	0.05
	Site mean	3.4	80	8	25	0.04	0.43	0.14
	Site maximum	21	80	8	25	0.26	**2.63**	0.84
		5) Short-Tailed Shrew (*Blarina carolinensis*)						
Inorganic	Reference	0.021	0.37	0.37	0.37	0.06	0.06	0.06
mercury	Site mean	0.24	0.37	0.37	0.37	0.65	0.65	0.65
	Site maximum	1.9	0.37	0.37	0.37	**5.14**	**5.14**	**5.14**
Methylmercury	Reference	0.0077	0.15	0.075	0.11	0.05	0.10	0.07
	Site mean	0.016	0.15	0.075	0.11	0.11	0.21	0.15
	Site maximum	0.060	0.15	0.075	0.11	0.40	0.80	0.55
Aroclor 1268	Reference	0.022	0.3	0.03	0.095	0.07	0.73	0.23
(TRVs for	Site mean	0.18	0.3	0.03	0.095	0.60	**6.00**	**1.89**
Aroclor 1254)	Site maximum	0.86	0.3	0.03	0.095	**2.87**	**28.67**	**9.05**
Lead	Reference	2.1	80	8	25	0.03	0.26	0.08
	Site mean	4.6	80	8	25	0.06	0.58	0.18
	Site maximum	27	80	8	25	0.34	**3.38**	**1.08**
		6) Long-Tailed Weasel (*Mustela frenata*)						
Inorganic	Reference	0.0025	0.37	0.37	0.37	0.01	0.01	0.01
mercury	Site mean							
(IHg in	90% IHg:	0.039	0.37	0.37	0.37	0.11	0.11	0.11
mammalian	50% IHg	0.026	0.37	0.37	0.37	0.07	0.07	0.07
diet)	0% IHg	0.0094	0.37	0.37	0.37	0.03	0.03	0.03
	Site maximum							
	90% IHg:	0.20	0.37	0.37	0.37	0.54	0.54	0.54
	50% IHg	0.13	0.37	0.37	0.37	0.35	0.35	0.35
	0% IHg	0.049	0.37	0.37	0.37	0.13	0.13	0.13
Methylmercury	Reference	0.0002	0.15	0.075	0.11	0.001	0.003	0.002
(MeHg in	Site mean							
mammalian	10% MeHg	0.0032	0.15	0.075	0.11	0.02	0.04	0.03
diet)	50% MeHg	0.016	0.15	0.075	0.11	0.11	0.21	0.15
	100% MeHg	0.032	0.15	0.075	0.11	0.21	0.43	0.29
	Site maximum							
	10% MeHg	0.017	0.15	0.075	0.11	0.11	0.23	0.15
	50% MeHg	0.084	0.15	0.075	0.11	0.56	**1.12**	0.76
	100% MeHg	0.17	0.15	0.075	0.11	**1.13**	**2.27**	**1.55**
Aroclor 1268	Reference	0.0063	0.3	0.03	0.095	0.021	0.21	0.07
(TRVs for	Site mean	0.070	0.3	0.03	0.095	0.23	**2.33**	0.74
Aroclor 1254)	Site maximum	0.56	0.3	0.03	0.095	**1.87**	**18.67**	**5.89**
Lead	Reference	0.59	80	8	25	0.01	0.07	0.02
	Site mean	0.75	80	8	25	0.01	0.09	0.03
	Site maximum	4.9	80	8	25	0.06	0.61	0.20

Table 10.__ Continued

Chemical of potential concern (COPC)	Location in study area	Estimated environmental exposure -- EEE (mg/kgBW/day)[a]	Toxicity reference value --TRV (mg/kgBW/day)[b]			Hazard quotient -- HQ (EEE / TRV)[c]		
			LOAEL	NOAEL	GMAEL	LOAEL	NOAEL	GMAEL
Wildlife Feeding at Least Partly on Estuarine Food Items								
7) Common Yellowthroat (*Geothlypis trichas*)								
Inorganic mercury	Reference	0.0037	0.90	0.45	0.64	0.004	0.01	0.01
	Site mean	0.033	0.90	0.45	0.64	0.04	0.07	0.05
	Site maximum	0.13	0.90	0.45	0.64	0.14	0.29	0.20
Methylmercury	Reference	0.0032	0.06	0.02	0.035	0.05	0.16	0.09
	Site mean	0.0085	0.06	0.02	0.035	0.14	0.43	0.24
	Site maximum	0.022	0.06	0.02	0.035	0.37	**1.10**	0.63
Aroclor 1268	Reference	0.0035	3.9	1.3	2.3	0.001	0.003	0.002
	Site mean	0.051	3.9	1.3	2.3	0.01	0.04	0.02
	Site maximum	0.20	3.9	1.3	2.3	0.05	0.15	0.09
Lead	Reference	0.25	11.3	3.85	6.6	0.02	0.06	0.04
	Site mean	0.7	11.3	3.85	6.6	0.06	0.18	0.11
	Site maximum	5.1	11.3	3.85	6.6	0.45	**1.32**	0.77
8) Willet (*Catoptrophorus semiplamatus*)								
Inorganic mercury	Reference	----------	0.90	0.45	0.64	----------	----------	----------
	Site mean	0.023	0.90	0.45	0.64	0.03	0.05	0.04
	Site maximum	0.094	0.90	0.45	0.64	0.10	0.21	0.15
Methylmercury	Reference	----------	0.06	0.02	0.035	----------	----------	----------
	Site mean	0.010	0.06	0.02	0.035	0.17	0.50	0.29
	Site maximum	0.024	0.06	0.02	0.035	0.40	**1.20**	0.69
Aroclor 1268	Reference	0.0020	3.9	1.3	2.3	0.0005	0.002	0.001
	Site mean	0.055	3.9	1.3	2.3	0.01	0.04	0.02
	Site maximum	0.21	3.9	1.3	2.3	0.05	0.16	0.09
Lead	Reference	0.23	11.3	3.85	6.6	0.02	0.06	0.03
	Site mean	1.1	11.3	3.85	6.6	0.10	0.29	0.17
	Site maximum	6.7	11.3	3.85	6.6	0.59	**1.74**	**1.02**
9) Pied-Billed Grebe (*Podilymbus podiceps*)								
Inorganic mercury	Reference	----------	0.90	0.45	0.64	----------	----------	----------
	Site mean	0.017	0.90	0.45	0.64	0.02	0.04	0.03
	Site maximum	0.033	0.90	0.45	0.64	0.04	0.07	0.05
Methylmercury	Reference	----------	0.06	0.02	0.035	----------	----------	----------
	Site mean	0.080	0.06	0.02	0.035	**1.33**	**4.00**	**2.29**
	Site maximum	0.085	0.06	0.02	0.035	**1.42**	**4.25**	**2.43**
Aroclor 1268	Reference	----------	3.9	1.3	2.3	----------	----------	----------
	Site mean	0.17	3.9	1.3	2.3	0.04	0.13	0.07
	Site maximum	0.27	3.9	1.3	2.3	0.07	0.21	0.12
Lead	Reference	----------	11.3	3.85	6.6	----------	----------	----------
	Site mean	2.5	11.3	3.85	6.6	0.22	0.65	0.38
	Site maximum	14	11.3	3.85	6.6	**1.24**	**3.64**	**2.12**

Table 10.__ Continued

Chemical of potential concern (COPC)	Location in study area	Estimated environmental exposure -- EEE (mg/kgBW/day)[a]	Toxicity reference value --TRV (mg/kgBW/day)[b]			Hazard quotient -- HQ (EEE / TRV)[c]		
			LOAEL	NOAEL	GMAEL	LOAEL	NOAEL	GMAEL
			10) Clapper Rail (*Rallus longirostris*)					
Inorganic	Reference	----------	0.90	0.45	0.64	----------	----------	----------
mercury	Site mean	0.015	0.90	0.45	0.64	0.02	0.03	0.02
	Site maximum	0.040	0.90	0.45	0.64	0.04	0.09	0.06
Methylmercury	Reference	----------	0.06	0.02	0.035	----------	----------	----------
	Site mean	0.033	0.06	0.02	0.035	0.55	**1.65**	0.94
	Site maximum	0.070	0.06	0.02	0.035	**1.17**	**3.50**	**2.00**
Aroclor 1268	Reference	0.0013	3.9	1.3	2.3	0.0003	0.001	0.001
	Site mean	0.17	3.9	1.3	2.3	0.04	0.13	0.07
	Site maximum	0.52	3.9	1.3	2.3	0.13	0.40	0.23
Lead	Reference	0.24	11.3	3.85	6.6	0.02	0.06	0.04
	Site mean	1.7	11.3	3.85	6.6	0.15	0.44	0.26
	Site maximum	14	11.3	3.85	6.6	**1.24**	**3.64**	**2.12**
			11) Belted Kingfisher (*Ceryle alcyon*)					
Inorganic	Reference	----------	0.90	0.45	0.64	----------	----------	----------
mercury	Site mean	0.019	0.90	0.45	0.64	0.02	0.04	0.03
	Site maximum	0.028	0.90	0.45	0.64	0.03	0.06	0.04
Methylmercury	Reference	----------	0.06	0.02	0.035	----------	----------	----------
	Site mean	0.045	0.06	0.02	0.035	0.75	**2.25**	**1.29**
	Site maximum	0.076	0.06	0.02	0.035	**1.27**	**3.80**	**2.17**
Aroclor 1268	Reference	0.0079	3.9	1.3	2.3	0.002	0.002	0.003
	Site mean	0.50	3.9	1.3	2.3	0.13	0.38	0.22
	Site maximum	0.73	3.9	1.3	2.3	0.19	0.56	0.32
Lead	Reference	0.020	11.3	3.85	6.6	0.002	0.01	0.003
	Site mean	0.054	11.3	3.85	6.6	0.005	0.01	0.01
	Site maximum	0.094	11.3	3.85	6.6	0.01	0.02	0.01
			12) Little Brown Bat (*Myotis lucifugus*)					
Inorganic	Reference	0.0016	0.37	0.37	0.37	0.004	0.004	0.004
mercury	Site mean	0.012	0.37	0.37	0.37	0.03	0.03	0.03
	Site maximum	0.036	0.37	0.37	0.37	0.10	0.10	0.10
Methylmercury	Reference	0.0022	0.15	0.075	0.11	0.01	0.03	0.02
	Site mean	0.0061	0.15	0.075	0.11	0.04	0.08	0.06
	Site maximum	0.016	0.15	0.075	0.11	0.11	0.21	0.15
Aroclor 1268	Reference	0.0015	0.3	0.03	0.095	0.01	0.05	0.02
(TRVs for	Site mean	0.030	0.3	0.03	0.095	0.10	1.00	0.32
Aroclor 1254)	Site maximum	0.10	0.3	0.03	0.095	0.33	**3.33**	**1.05**
Lead	Reference	0.030	80	8	25	0.0004	0.004	0.001
	Site mean	0.062	80	8	25	0.001	0.01	0.002
	Site maximum	0.15	80	8	25	0.002	0.02	0.01

Table 10.__ Continued

Chemical of potential concern (COPC)	Location in study area	Estimated environmental exposure -- EEE (mg/kgBW/day)[a]	Toxicity reference value --TRV (mg/kgBW/day)[b]			Hazard quotient -- HQ (EEE / TRV)[c]		
			LOAEL	NOAEL	GMAEL	LOAEL	NOAEL	GMAEL
			13) Raccoon (*Procyon lotor*)					
Inorganic	Reference	---------	0.37	0.37	0.37	---------	---------	---------
mercury	Site mean	0.012	0.37	0.37	0.37	0.03	0.03	0.03
	Site maximum	0.025	0.37	0.37	0.37	0.07	0.07	0.07
Methylmercury	Reference	---------	0.15	0.075	0.11	---------	---------	---------
	Site mean	0.021	0.15	0.075	0.11	0.14	0.28	0.19
	Site maximum	0.040	0.15	0.075	0.11	0.27	0.53	0.36
Aroclor 1268	Reference	0.0022	0.3	0.03	0.095	0.01	0.07	0.02
(TRVs for	Site mean	0.17	0.3	0.03	0.095	0.57	**5.67**	**1.79**
Aroclor 1254)	Site maximum	0.35	0.3	0.03	0.095	**1.17**	**11.67**	**3.68**
Lead	Reference	0.12	80	8	25	0.002	0.02	0.005
	Site mean	1.5	80	8	25	0.02	0.19	0.06
	Site maximum	8.3	80	8	25	0.104	**1.04**	0.33
			14) Mink (*Neovison vison*)					
Inorganic	Reference	0.0022	0.37	0.37	0.37	0.01	0.01	0.01
mercury	Site mean							
(IHg in	90% IHg:	0.028	0.37	0.37	0.37	0.08	0.08	0.08
mammalian	50% IHg	0.024	0.37	0.37	0.37	0.06	0.06	0.06
diet)	0% IHg	0.018	0.37	0.37	0.37	0.05	0.05	0.05
	Site maximum							
	90% IHg:	0.11	0.37	0.37	0.37	0.30	0.30	0.30
	50% IHg	0.087	0.37	0.37	0.37	0.24	0.24	0.24
	0% IHg	0.057	0.37	0.37	0.37	0.15	0.15	0.15
Methylmercury	Reference	0.00015	0.15	0.075	0.11	0.001	0.002	0.001
(MeHg in	Site mean							
mammalian	10% MeHg	0.015	0.15	0.075	0.11	0.10	0.20	0.14
diet)	50% MeHg	0.020	0.15	0.075	0.11	0.13	0.27	0.18
	100% MeHg	0.026	0.15	0.075	0.11	0.17	0.35	0.24
	Site maximum							
	10% MeHg	0.029	0.15	0.075	0.11	0.19	0.39	0.26
	50% MeHg	0.054	0.15	0.075	0.11	0.36	0.72	0.49
	100% MeHg	0.085	0.15	0.075	0.11	0.57	**1.13**	0.77
Aroclor 1268	Reference	0.0053	0.3	0.03	0.095	0.02	0.18	0.06
(TRVs for	Site mean	0.19	0.3	0.03	0.095	0.63	**6.33**	**2.00**
Aroclor 1254)	Site maximum	0.47	0.3	0.03	0.095	**1.57**	**15.67**	**4.95**
Lead	Reference	0.34	80	8	25	0.004	0.04	0.01
	Site mean	1.8	80	8	25	0.02	0.23	0.07
	Site maximum	8.5	80	8	25	0.11	**1.06**	0.34

Summary of Site HQs > 1.00 for 14 Wildlife Species

		LOAEL HQs (terrestrial vs. estuarine feeders)	NOAEL HQs (terrestrial vs. estuarine feeders)	GMAEL HQs (terrestrial vs. estuarine feeders)
Inorganic mercury	Site mean	0	0	0
	Site maximum	3 (3 + 0)	3 (3 + 0)	3 (3 + 0)
Methylmercury	Site mean	1 (0 + 1)	3 (0 + 3)	2 (0 + 2)
	Site maximum	4 (1 + 3)	8 (3 + 5)	4 (1 + 3)
Aroclor 1268	Site mean	0	5 (3 + 2)	4 (2 + 2)
	Site maximum	5 (3 + 2)	6 (3 + 3)	6 (3 + 3)
Lead	Site mean	0	0	0
	Site maximum	3 (1 + 2)	11 (5 + 6)	5 (2 + 3)

In this summary table, mercury exposure for the broad-winged hawk, long-tailed weasel, and mink is based on small-mammal prey items characterized by body burdens of 50% MeHg and 50% IHg. Other ratios (10% MeHg and 90% IHg; and 100% MeHg and 0% IHg) are also evaluated throughout this document.

[a] Assumptions pertaining to EEEs are presented in Table 8, and information and related data are detailed in Appendix C.

[b] LOAEL (lowest-observed-adverse-effect-level) and NOAEL (no-observed-adverse-effect-level) TRVs are detailed in Table 9. GMAEL TRVs are the geometric means of LOAEL and NOAEL TRVs. TRVs for mammals and Aroclor 1268 actually pertain to Aroclor 1254, a substantially more toxic PCB (Appendix A).

[c] HQs greater than 1 are identified in **bold print** in this table.

Table 11.__ Screening of wildlife for exposure to primary chemicals of potential concern (COPC) for upland at LCP Site[a]

Wildlife evaluated	COPC	Maximum estimated environmental exposure (EEE) of wildlife to COPC (mg/kgBW/day)[b]	GMAEL toxicity reference value (TRV) for wildlife and COPC (mg/kgBW/day)[c]	Hazard quotient (HQ) -- EEE/TRV
	Wildlife Feeding Exclusively on Terrestrial Food Items			
1) Grainivorous bird -- Mourning dove (*Zenaida macroura*)	Total mercury (MeHg exposure)	0.0048	0.035	0.14
	Total mercury (IHg exposure)	**0.96**	**0.64**	**1.50**
	Aroclor 1268	0.60	2.3	0.26
	Lead	**22**	**6.6**	**3.33**
2) Insectivorous bird --	Total mercury (MeHg exposure)	0.025	0.035	0.71
Carolina wren (*Thryothorus ludovicianus*)	Total mercury (IHg exposure)	0.13	0.64	0.20
	Aroclor 1268	0.22	2.3	0.10
	Lead	4.8	6.6	0.73
3) Carnivorous bird -- Broad-winged hawk (*Buteo platypterus*)	Total mercury			
	10% MeHg in mammalian diet	0.015	0.035	0.43
	50% MeHg in mammalian diet	**0.072**	**0.035**	**2.06**
	100% MeHg in mammalian diet	**0.14**	**0.035**	**4.00**
	Total mercury			
	90% IHg in mammalian diet	0.18	0.64	0.28
	50% IHg in mammalian diet	0.13	0.64	0.20
	0% IHg in mammalian diet	0.056	0.64	0.09
	Aroclor 1268	0.48	2.3	0.21
	Lead	5.0	6.6	0.76
4) Grainivorous mammal -- Meadow vole (Microtus *pennsylvanicus*)	Total mercury (MeHg exposure)	0.0085	0.11	0.08
	Total mercury (IHg exposure)	**1.5**	**0.37**	**4.05**
	Aroclor 1268	**0.87**	**0.095**	**9.16**
	Lead	21	25	0.84
5) Insectivorous mammal -- Short-tailed shrew (*Blarina carolinensis*)	Total mercury (MeHg exposure)	0.060	0.11	0.55
	Total mercury (IHg exposure)	**1.9**	**0.37**	**5.14**
	Aroclor 1268	**0.86**	**0.095**	**9.05**
	Lead	**27**	**25**	**1.08**
6) Carnivorous mammal -- Long-tailed weasel (*Mustela frenata*)	Total mercury			
	10% MeHg in mammalian diet	0.017	0.11	0.15
	50% MeHg in mammalian diet	0.084	0.11	0.76
	100% MeHg in mammalian diet	**0.17**	**0.11**	**1.55**
	Total mercury			
	90% IHg in mammalian diet	0.20	0.37	0.54
	50% IHg in mammalian diet	0.13	0.37	0.35
	0% IHg in mammalian diet	0.049	0.37	0.13
	Aroclor 1268	**0.56**	**0.095**	**5.89**
	Lead	4.9	25	0.20

Table 11.__ Continued

Wildlife evaluated	COPC	Maximum estimated environmental exposure (EEE) of wildlife to COPC (mg/kgBW/day)[b]	GMAEL toxicity reference value (TRV) for wildlife and COPC (mg/kgBW/day)[c]	Hazard quotient (HQ) -- EEE/TRV
Wildlife Feeding at Least Partly on Estuarine Food Items				
7) Insectivorous bird -- Common yellowthroat (*Geothlypis trichas*)	Total mercury (MeHg exposure)	0.022	0.035	0.63
	Total mercury (IHg exposure)	0.13	0.64	0.20
	Aroclor 1268	0.20	2.3	0.09
	Lead	5.1	6.6	0.77
8) Insectivorous/ crustaceovorous bird -- Willet (*Catoptrophorus semipalmatus*)	Total mercury (MeHg exposure)	0.024	0.035	0.69
	Total mercury (IHg exposure)	0.094	0.64	0.15
	Aroclor 1268	0.21	2.3	0.09
	Lead	**6.7**	**6.6**	**1.02**
9) Insectivorous/piscivorous bird -- Pied-billed grebe (*Podilymbus podiceps*)	**Total mercury (MeHg exposure)**	**0.085**	**0.035**	**2.43**
	Total mercury (IHg exposure)	0.033	0.64	0.05
	Aroclor 1268	0.27	2.25	0.12
	Lead	**14**	**6.6**	**2.12**
10) Crustaceovorous bird -- Clapper rail (*Rallus longirostris*)	**Total mercury (MeHg exposure)**	**0.070**	**0.035**	**2.00**
	Total mercury (IHg exposure)	0.040	0.64	0.06
	Aroclor 1268	0.52	2.3	0.23
	Lead	**14**	**6.6**	**2.12**
11) Piscivorous bird -- Belted kingfisher (*Ceryle alcyon*)	**Total mercury (MeHg exposure)**	**0.076**	**0.035**	**2.17**
	Total mercury (IHg exposure)	0.028	0.64	0.04
	Aroclor 1268	0.73	2.3	0.32
	Lead	0.094	6.6	0.01
12) Insectivorous mammal -- Little brown bat (Myotis lucifugus)	Total mercury (MeHg exposure)	0.016	0.11	0.15
	Total mercury (IHg exposure)	0.036	0.37	0.10
	Aroclor 1268	**0.10**	**0.095**	**1.05**
	Lead	0.15	25	0.01
13) Omnivorous mammal -- Raccoon (*Procyon lotor*)	Total mercury (MeHg exposure)	0.040	0.11	0.36
	Total mercury (IHg exposure)	0.025	0.37	0.07
	Aroclor 1268	**0.35**	**0.095**	**3.68**
	Lead	8.3	25	0.33

Table 11.__Continued

Wildlife evaluated	COPC	Maximum estimated environmental exposure (EEE) of wildlife to COPC (mg/kgBW/day)[b]	GMAEL toxicity reference value (TRV) for wildlife and COPC (mg/kgBW/day)[c]	Hazard quotient (HQ) -- EEE/TRV
Wildlife Feeding at Least Partly on Estuarine Food Items -- Continued				
14) Carnivorous mammal -- Mink (*Neovison vison*)	Total mercury			
	10% MeHg in mammalian diet	0.029	0.11	0.26
	50% MeHg in mammalian diet	0.054	0.11	0.49
	100% MeHg in mammalian diet	0.085	0.11	0.77
	Total mercury			
	90% IHg in mammalian diet	0.11	0.37	0.30
	50% IHg in mammalian diet	0.087	0.37	0.24
	0% IHg in mammalian diet	0.057	0.37	0.15
	Aroclor 1268	**0.47**	**0.095**	**4.95**
	Lead	8.5	25	0.34

[a]This table is abstracted from Table 10. HQs > 1 are identified by **bold print.**

[b]Maximum EEEs of wildlife to COPC are derived from Appendix Table C-1.

[c]The geometric TRV is derived as the geometric mean of the NOAEL and LOAEL TRVs.

Table 12.__ Nodal evaluation of preliminary remedial goals (PRGs) for primary chemicals of potential concern (COPC) in surface substrate of LCP Site based on back-calculated food-web exposure models for wildlife characterized by hazard quotients (HQs) > unity (1)[a]

Wildlife evaluated --substrate evaluated	Nodal number[b] 1 (NOAEL-based)	2	3	4 (GMAEL-based)	5	6	7 (LOAEL-based)
Total Mercury in Substrate (mg/kg, dw) -- Based on Methylmercury Exposure							
Broad-winged hawk (50% / 100% MeHg/tHg ratio in small-mammal food) -- soil	**3.5/1.7**	**4.2/2.0**	**5/2.4**	**5.9/2.9**	**7.1/3.5**	**8.5/4.2**	**10/5.0**
Long-tailed weasel (100% MeHg/tHg ratio in small-mammal food) -- soil	**5.3**	**6.0**	**6.8**	**7.6**	**8.6**	**9.8**	**11**
Pied-billed grebe -- sediment	1.1	1.3	1.6	1.9	2.2	2.7	3.2
Clapper rail -- sediment	0.47	0.57	0.69	0.84	1.0	1.2	1.5
Belted kingfisher -- sediment	0.75	0.90	1.1	1.3	1.5	1.8	2.2
Total Mercury in Substrate (mg/kg, dw) -- Based on Inorganic Mercury Exposure							
Mourning dove -- soil	**0.67**	**1.1**	**1.8**	**3.0**	**4.8**	**7.9**	**13**
Meadow vole -- soil	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**
Short-tailed shrew -- soil	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**
Aroclor 1268 in Substrate (mg/kg, dw) (Based on TRVs for Aroclor 1254)							
Meadow vole -- soil	**0.36**	**0.53**	**0.78**	**1.1**	**1.7**	**2.5**	**3.6**
Short-tailed shrew -- soil	**0.21**	**0.31**	**0.45**	**0.66**	**0.98**	**1.4**	**2.1**
Long-tailed weasel -- soil	**0.60**	**0.88**	**1.3**	**1.9**	**2.8**	**4.1**	**6.0**
Little brown bat -- sediment (soil surrogate employed)	2.3	3.4	5.0	7.3	11	16	23
Raccoon -- sediment	0.27	0.40	0.58	0.85	1.3	1.8	2.7
Mink -- soil/sediment	0.45	0.66	1.0	1.4	2.1	3.1	4.5
Lead in Substrate (mg/kg, dw)							
Mourning dove -- soil	**135**	**160**	**190**	**230**	**280**	**330**	**400**
Short-tailed shrew -- soil	**240**	**350**	**520**	**760**	**1,100**	**1,600**	**2,400**
Willet -- soil/sediment	500	600	720	870	1,000	1,200	1,500
Pied-billed grebe -- sediment	450	540	640	770	910	1,100	1,300
Clapper rail -- sediment	400	480	580	690	830	1,000	1,200

[a]These back-calculated PRGs pertain to the COPC/wildlife combinations identified in the screening process presented in Table 11. PRGs for soil are identified in **bold print**. Sediment-related PRGs, also presented in this table, are not considered to be representative of the overall estuary. Basic information employed to generate PRGs is presented in Appendix D.

[b]Series of nodal PRGs for each COPC and wildlife species reflects a geometric series generated by identifying the NOAEL-based and LOAEL-based PRG and adjusting the common geometric ratio (r) to interpolate other values.

Table 13.__ Hazard evaluations for selected terrestrial-feeding wildlife exposed to potentially problematic secondary chemicals of potential concern (COPC) in food-web exposure models for upland at LCP Site[a]

Modeled wildlife -- exposure assumptions	Evaluated Area	Concentrations of COPC (source of data in main body of BERA)	
		Meadow Vole (*Microtus pennsylvanicus*) Exposed to Antimony	
• Body weight (BW): 0.030 kg (wet wt)		**Grass (CF1) (mg/kg, dry wt)**	**Soil (CS) (mg/kg, dry wt)**
• Diet: 50% grass/50% berries (*but modeled as 100% grass in this evaluation because antimony was seldom detected in berries [Table 5], thereby preventing development of a relationship between soil and berries)*	Reference:	0.070 (Table 5; Stat. 2) (highest value)	0.060 (Table 3; Stat. 1) (highest value)
	Site mean:	<0.119 (Table 5; mean)	1.2 (Table 3; grand mean)
	Site maximum:	0.47 (Table 5; Stat. 13)	9.9 (Table 3; Stat. 13)
• Food ingestion rate (FIR): 0.0068 kg (dry wt)/day			
• Soil ingestion rate (SIR): 0.00022 kg (dry wt)/day			
•Toxicity reference value (TRV): 0.059 mg/kgBW/day (from U. S. EPA {2005] for mammals)			

Hazard Evaluation for Meadow Vole Exposed to Maximum Concentration of Antimony in Soil at Site and Feeding Exclusively on Grass

$$\text{Hazard Quotient (HQ)} = \frac{(CF1 \times FIR) + (CS \times SIR) / BW}{TRV}$$

$$HQ = \frac{(0.47 \times 0.0068) + (9.9 \times 0.00022) / 0.030}{0.059}$$

HQ = 3.04[b]

Modeled wildlife -- exposure assumptions	Evaluated Area	Concentrations of COPC	
		Carolina wren (*Thryothorus ludovicianus*) Exposed to Zinc	
• Body weight (BW): 0.018 kg (wet wt)		**Insects (CF1) (mg/kg, dry wt)**	**Soil (CS) (mg/kg, dry wt)**
• Diet: 100% insects	Reference:	200 (Table 5; Stat. C)	24 (Table 3; Stat. 1) (highest value)
• Food ingestion rate (FIR): 0.0046 kg (dry wt)/day	Site mean:	220 (Table 5; mean)	18 (Table 3; grand mean)
• Soil ingestion rate (SIR): 0.00011 kg (dry wt)/day	**Site maximum:**	320 (Table 5; Station 13)	80 (Table 3; Stat. 13)
• Toxicity reference value (TRV): 66.1 mg/kgBW/day (from U. S. EPA {2007] for birds)			

Hazard Evaluation for Carolina Wren Exposed to Maximum Concentration of Zinc in Soil at Site and Feeding on Insects

$$\text{Hazard Quotient (HQ)} = \frac{(CF1 \times FIR) + (CS \times SIR) / BW}{TRV}$$

$$HQ = \frac{(320 \times 0.0046) + (80 \times 0.00011) / 0.018}{66.1}$$

HQ = 1.24[c]

[a]The food-web exposure models presented in this table are based on simple models, addressing just food of wildlife and exposure to soil, as in the U. S. EPA documents on ecological soil screening levels (Eco-SSLs) for antimony and zinc.

[b]The concentration of antimony in soil associated with a HQ of unity (1.00) is 2.2 mg/kg. This determination is based on the relationship (mean bioaccumulation factor [BAF]) between concentrations of antimony in soil and grass as depicted in Figure 1.

[c]The concentration of zinc in soil associated with a HQ of unity (1.00) is 22 mg/kg. This determination is based on the relationship (mean BAF) between concentrations of zinc in soil and insects as depicted in Figure 2.

Appendix A

Toxicity Profiles of Chemicals of Potential Concern (COPC) Evaluated in Baseline Ecological Risk Assessment (BERA) for Upland at LCP Site

This appendix addresses primary chemicals of potential concern (COPC) followed by secondary COPC.

A.1 Primary Chemicals of Potential Concern

Primary COPC are mercury, Aroclor 1268, lead, and total polynuclear aromatic hydrocarbons (PAHs).

A.1.1 Mercury

The cycling of mercury in the natural environment is complex and influenced by numerous factors. The most important forms of mercury are elemental mercury (Hg^{o}), mercuric mercury (Hg^{2+}), and methylmercury (CH_3Hg^{+}). Hg^{o}, which readily vaporizes from its liquid state, is the most common form of mercury in the atmosphere. Hg^{2+} formed by oxidation of Hg^{o} or otherwise present in water or sediment can be converted to CH_3Hg^{+}. This is the most toxic form of mercury because of its high lipid solubility, which enhances bioaccumulation in biota. This conversion occurs more readily if Hg^{2+} is in a dissolved, rather than particulate, state (Davis et al., 2003). The methylation process is mediated primarily by sulfate-reducing bacteria that typically occur at zones of transition from oxic to anoxic conditions in the water column or sediment (Bloom et al., 1999).

Factors influencing the production and/or accumulation of CH_3Hg^{+} include total mercury concentration in water or sediment, redox potential, pH, temperature, concentrations of dissolved organic carbon (DOC), sulfate, sulfite, and salinity (Davis et al., 2003). However, some ecosystems with low concentrations of total mercury in water and sediment are characterized by high levels of CH_3Hg^{+} in biota because of high rates of bacteria-induced methylation in abiotic media. Conversely, ecosystems with high concentrations of total mercury in abiotic media may be characterized by low levels of CH_3Hg^{+} in biota. Redox potential (i. e., a reducing environment) is important because sulfate-reducing bacteria require anaerobic conditions. A low pH is often positively correlated with increased methylation by bacteria. High temperatures generally stimulate bacterial activity. High DOC in the water column may indicate high organic loading to an ecosystem, resulting in anoxic sediments and elevated bacterial activity.

The roles of the sulfur compounds and salinity in mediating the production and/or accumulation of CH_3Hg^{+} reflect the differences that can be expected in fresh water vs.

marine environments. In low sulfate waters, increased sulfate results in increased methylation (Davis et al., 2003; Chen et al., 1997); while in high sulfate waters, increased sulfate is associated with increased demethylation (Davis et al., 2003). In all waters, the sulfate-reduction process, and consequent build-up of sulfide, appears to limit production of CH_3Hg^+, perhaps by limiting the fraction of Hg^{2+} that is available for methylation (Benoit et al., 1998; Marvin-DiPasquale et al., 2005). In addition, complexation of mercury with chloride ions may inhibit uptake of mercury by sulfate-reducing bacteria in estuarine and marine environments (Barkay et al., 1997). Also, in a study of the effect of salinity on mercury-methylating activity of sulfate-reducing bacteria in estuarine sediments, methylation in high-salinity (up to 2.4%) sediments occurred at only 40% of the level observed in low-salinity (as low as 0.03%) sediments (Compeau and Bartha, 1987).

Several pathways exist for the removal (detoxification) of CH_3Hg^+ formed in water and sediment. Oxidative demethylation of CH_3Hg^+, involving bacterial liberation of carbon dioxide, can occur under both anaerobic and aerobic conditions (Hilner and Emons, 2004). Sunlight can also degrade CH_3Hg^+ via photolysis (Fink, 2002). In addition, bacteria may reduce Hg^{2+} to Hg^o, thereby eliminating the precursor of CH_3Hg^+, and generating a form of mercury (Hg^o) that rapidly passes to the atmosphere (Hilner and Emons, 2004). Rooted macrophytes may also pump Hg^o from their roots to leaves, and, thereafter, to the atmosphere (Fink, 2002).

Biota, particularly high-trophic-level fishes and wildlife, can accumulate CH_3Hg^+ from food and, also, directly from sediments and water. Aquatic invertebrates bioaccumulate mercury at a higher rate than fishes, and plants have variable rates of bioaccumulation that are species dependent (MDEP, 1996). The initial step for entry of CH_3Hg^+ into aquatic food webs is critical as evidenced by studies of a Wisconsin Lake, in which seston (plankton, etc.) exhibited a 30,000-fold increase in CH_3Hg^+ concentration as compared to concentration in water (25,000 vs. 0.9 parts per trillion), followed by a three-fold increase with each additional step up the food web (Watras et al., 1994). Terrestrial invertebrates also accumulate mercury, an observation that has suggested the possibility of employing earthworms to bioremediate soils contaminated with mercury (WHO, 1989).

The relatively high concentrations of mercury in some fish indicate that mercury is passed upward through the food chain and retained by the predator. Mercury is unusual among metals, most of which do not biomagnify, and methylmercury is the mercury species of importance for this process (Morel et al., 1998; Pickhardt et al., 2006). Many mercury species are non-reactive in organisms, allowing them to diffuse in and out. Hg^{2+} is reactive but is also not biomagnified. The difference between methylmercury and Hg^{2+} is apparently that methylmercury becomes associated with the soluble portion of cells of prey and can therefore be assimilated by the predator. In contrast, Hg^{2+} becomes bound to cell membranes of prey, which are generally excreted by the predator without digestion, thereby allowing theHg^{2+} to pass through the predator (Morel et al., 1998; Mason et al., 1996). In addition, these authors point out that the uptake of methylmercury is very efficient in the intestines of fish while inorganic mercury has a very low uptake rate.

As indicated by the numerous factors that control the production and retention of CH_3Hg^+ in the environment, the ecological consequences of mercury contamination in the environment are highly site-specific. Indeed, numerous laboratory-based studies have been conducted on the effects of mercury on aquatic biota, but the results of these studies frequently cannot be extrapolated to field conditions because of numerous sources of confounding variation. Whereas generic toxicological benchmarks for mercury in sediment are typically in the low parts-per-million range, site-specific criteria are often substantially higher. This discrepancy is usually related to limited bioavailability of mercury in sediment at a site, perhaps caused by the binding of Hg^{2+} to clay particles or organic matter, thereby reducing its availability for methylation (e. g., MDEP, 1996).

A goal for sites contaminated with mercury, as stated in the CALFED Bay-Delta Mercury Strategy Document (Weiner et al., 2003) is "to avoid increasing – and to eventually decrease – biotic exposure to methylmercury." In addition, the concentration of mercury in contaminated estuarine sediments of Bellington Bay, Washington, was found to decrease with a half-time of about 1.3 years after the primary anthropogenic source of mercury was removed (Bothner et al., 1980). Finally, the Mercury Experiment to Assess Atmospheric Loading in Canada and the United States (METAALICUS), as well as the mercury-spiking mesocosm experiments being conducted in the Everglades (as part of the Aquatic Cycling of Mercury [ACME] project), have indicated that recent mercury doses to an ecosystem are more likely to enter ecological food webs than older mercury doses (Krabbenhoft and Goodrich-Mahoney, Undated).

Implications of the above-described goal and studies suggest a management strategy for a mercury-contaminated site in which primary sources and hot spots of mercury are removed, followed by monitoring of aged mercury present at reduced concentrations in the remaining part of the site.

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A.1.2 Aroclor 1268

The dominant PCB at the LCP Site is Aroclor 1268, whose toxicological properties have not been as extensively investigated as other Aroclors (in particular, Aroclor 1254). Aroclor 1268 is a highly chlorinated (68% chlorine), superhydrophobic PCB that is extremely stable and slow to degrade. Aroclor 1268 is one of only two Aroclors (the other being Aroclor 1270) to exist in its unaltered form as a solid, as contrasted to a viscous liquid (Aroclor 1254), mobile oil (Aroclors 1221, 1232, 1242, and 1248), or sticky resin (Aroclors 1260 and 1262). A basic conclusion reached in the scientific literature is that ecological risk posed by mid-weight chlorinated Aroclors (1242, 1248, and 1254) is greater than the risk associated with extremely low- or high-weight chlorinated Aroclors (1221 and 1268).

The following embedded table (U. S. Environmental Protection Agency, Region 4; 2008) reviews dioxin-like toxicity of Aroclor 1268 as compared to Aroclor 1254, an Aroclor on which PCB toxicity reference values (TRVs) presented in this document for mammals are based:

Relative Potency (REP) of Aroclor 1268 vs. Aroclor 1254 for Fishes, Birds, and Mammals Based on Dioxin-Like Total Toxic Equivalents (TEQs) (U. S. Environmental Protection Agency – Region 4, 2008; from Burkhard and Lukasewycz, 2008)

Aroclor 1254			Aroclor 1268			Relative Potency (REP) of Aroclor 1268 vs. Aroclor 1254		
Fishes	Birds	Mammals	Fishes	Birds	Mammals	Fishes	Birds	Mammals
4.18E-07	2.00E-05	7.87E-06	3.14E-07	2.5E-06	4.89E-07	0.75	0.125	0.06

The following table (from Villeneuve *et al.*, 2001) presents results of *in vitro* bioassays conducted with Aroclors 1268 and 1254 in comparison to the dioxin 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD). Villeneuve *et al.* (2001) reported that the efficacy (magnitude of response) of the two Aroclors were insufficient to permit quantitative REP estimates. However, qualitative estimates of REP of the two Aroclors for mammals are similar to those generated by Burkhard and Lukasewycz (2008) – namely, Aroclor 1268 being about 15 – 30X less toxic than Aroclor 1254. For fishes, the REP suggested by Villeneuve *et al.* (2001) for Aroclor 1268 is considerably less than the value derived by Burkhard and Lukasewycz (2008).

Relative Potency (REP) of Aroclor 1268 vs. Aroclor 1254 for Fishes and Mammals Based on Comparison to 2,3,7,8-Tetrachlorodibenzo-*p*-Dioxin (TCDD) in *In Vitro* Bioassays (fromVilleneuve *et al.*, 2001)			
***In Vitro* Bioassay**	**Aroclor 1254**	**Aroclor 1268**	**Relative Potency (REP) of Aroclor 1268 vs. Aroclor 1254**
Fishes			
Desert topminnow PLHC-1 hematoma cells	$<1.8 \times 10^{-4}$	$<5.3 \times 10^{-6}$	~0.029
Mammals			
Rat H4IIE-EROD hematoma cells	$<2.8 \times 10^{-5}$	$<8.3 \times 10^{-7}$	~0.030
Rat H4IIE-luc hematoma cells	$<4.6 \times 10^{-5}$	$<1.4 \times 10^{-6}$	~0.030
Rat H4IIE-wt hematoma cells	$<3.8 \times 10^{-5}$	$<1.1 \times 10^{-6}$	~0.029

The REP factors referenced above indicate that Aroclor 1268 is substantially less toxic to biota than Aroclor 1254. However, dioxin-like toxicity is only a measure of the extent to which dioxin-like congeners (non-ortho and mono-ortho coplanar PCBs) bind with and disrupt the aryl hydrocarbon (Ah) receptor in cells of organisms, resulting in toxicological responses that include dermal toxicity, immunotoxicity, carcinogenicity, and adverse effects on endocrine, development, and reproduction functions.

Modes of toxicity other than that affecting the Ah receptor include effects on Ca^{2+} homeostasis and subsequent neurotoxic effects caused by congeners such as di-*ortho* non-coplanar PCBs), which have the potential to be evaluated by a Neurotoxic Equivalent (NEQ) scheme being developed by Simon *et al.* (2007). These authors noted that the congeners present in Aroclor 1268, in addition to possessing a low Ah receptor binding affinity, have a limited ability to interfere with Ca^{2+}– dependent intracellular signaling pathways. The authors also stated that reduced toxicity to fishes, birds, and mammals has been observed at the extremes of mean mixtures of chlorination (i. e., lowly and highly chlorinated Aroclors). They specifically concluded that Aroclor 1268 is approximately 22X less toxic than Aroclor 1254 in terms of NEQs.

In general, of the 10 homologues characteristic of all PCBs, the most toxic for all modes of action are the tetra-, penta-, and hexa-CBs. The makeup of Aroclor 1254 vs. Aroclor 1268 regarding these homologues is as follows:

PCB	Tetra-CD (%)	Penta-CB (%)	Hexa-CB (%)
Aroclor 1254	22	48	24
Aroclor 1268	0.5	3	2

Several uncertainties characterize the degree to which Aroclor 1268 is less toxic than Aroclor 1254 to biota. Chlorinated naphthalenes have been identified in PCBs (Ruzo *et al.*, 1976) and can affect the Ah receptor. However, the World Health Organization (WHO) has not established TEQ factors for these chemicals. Also, the relative potency of the two Aroclors after weathering in the environment is uncertain. In particular, the octa-, nona- and deca-PCB congeners in Aroclor 1268 are especially resistant to weathering. Some of these congeners, in particular di-*ortho* congeners, have relatively little affinity for the Ah receptor, but may have non-dioxin-like toxicity (Sajwan *et al.* 2008).

Aroclor 1268 References

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U. S. Environmental Protection Agency – Region 4. 2008. Baseline ecological risk assessment for the estuary at the LCP Chemical Site, Brunswick, Georgia. Document sent from S. Jones (Region 4) to M. Kamilow (Honeywell). 11 pp.

Villeneuve, D. L., J. S. Khim, K. Kannan, and J. P. Giesy. 2001. In vitro response of fish and mammalian cells to complex mixtures of polychlorinated naphthalenes, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons. Aquat. Toxicol. 54: 125-141.

A.1.3 Lead

Metallic lead is sparingly soluble in hard, basic waters up to 0.030 mg Pb/L (Eisler, 1988). In nature, lead occurs mainly as Pb^{2+}. In water, lead is most soluble and bioavailable under conditions of low pH, low organic content, and low concentrations of suspended particulate matter. Consequently, bioavailability of lead is low in estuaries. Most lead entering natural waters is precipitated to the sediment bed as carbonates or hydroxides. In sediment, lead is mobilized and released when pH or ionic composition changes. There is no convincing evidence that biomagnification of lead occurs in the ecological food web.

Lead acts in biological systems by modifying the structure and function of the central nervous system, bone, hematopoietic system, and kidneys (Eisler, 1988). These changes result in adverse biochemical, histopathological, neuropsychological, reproductive, fetotoxic, and teratogenic effects.

Lead poisoning in birds has been widely reported primarily in the context of ingestion of lead shotgun pellets by waterfowl. In addition, nestlings of American kestrels dosed orally with metallic lead for 10 days were characterized by high mortality (40% in 10 days) at 625 mg/kg, reduced growth at 125 mg/kg, and subtle chemical changes at 25 mg/kg (Eisler, 1988). Indeed, nestlings of altricial species (species such as the kestrel, that are confined to the nest for a prolonged period of time) may be more sensitive to lead exposure than adults or hatchlings of precocial species (species, including quail, mallards, and pheasants, which display a high degree of activity immediately after birth). Hatchlings of precocial species exhibited normal survival at up to 2,000 mg/kg and normal growth at up to 500 mg/kg (Eisler, 1988).

There are no reported studies of feral mammals exposed to lead (Eisler,1988). However, survival of domestic and laboratory mammals was reduced at 5 – 108 mg/kg in rats (acute oral exposure), 0.32 mg/kg/day in dogs (chronic oral exposure), and 1.7 mg/kg in horses (chronic oral exposure). Adverse sublethal effects of lead have been noted in monkeys given 0.1 mg/kg/day (impaired learning) and fed diets containing 0.5 mg/kg (abnormal social behavior). In general, mammals display a wide range of sensitivity to lead. Effects of lead are more pronounced with organolead than with inorganic lead compounds. Young developmental stages of mammals are more sensitive to lead than older animals.

Lead Reference

Eisler, R. 1988. Lead hazards to fish, wildlife, and invertebrates: a synoptic review. Report No. 14. U. S. Fish and Wildlife Service. Laurel, MD. 134 pp.

A.1.4 Polynuclear Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) are solely a toxicological concern in this BERA since they have limited potential to biomagnify in the ecological food web. PAHs consist of a large group of chemicals formed during the incomplete combustion of organic materials. There are over one hundred PAHs, and they are found throughout the environment. The fate and transport characteristics of the various PAHs vary substantially based on differing chemical/physical properties. Some fate characteristics are roughly correlated with molecular weight, which are grouped as follows (ATSDR, 1995):

- Low molecular weight PAHs: acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene,

- Medium molecular weight PAHs: fluoranthene and pyrene, and

- High molecular weight PAHs: benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

Potential mobility of organic compounds in the soil is related to the organic carbon partition coefficient (K_{oc}). The low molecular weight PAHs have K_{oc} values in the range of 10^3 to 10^4, which indicates a moderate potential to be adsorbed to organic material. Medium molecular weight compounds have values on the order of 10^4, while high molecular weight compounds have values in the 10^5 to 10^6 range. Thus, the high molecular weight PAHs have a much greater tendency to adsorb and resist movement through soil. With Henry's Law constants in the range of 10^{-3} to 10^{-5} atm-m^3/mole, volatilization of the lower molecular weight compounds from soil may be substantial. The higher molecular weight PAHs have low potential for volatilization. Under favorable environmental conditions, some portion of PAHs in soil may be transported to groundwater.

Some PAHs can bioaccumulate in plants and animals, but are subject to extensive metabolism by higher trophic-level consumers, indicating that the potential for biomagnification is not significant.

The limited studies of plants indicate that PAHs have relatively low phytotoxicity. However, many plants absorb PAHs from soils through their roots and translocate them to their leaves, fruits, and seeds (Eisler, 1987b). Thus, plants may serve as a pathway for exposure of organisms to PAHs.

The mallard has been evaluated in two studies for toxicological responses to PAHs (Eisler, 1987b). In one study, birds fed diets containing 4,000 mg PAHs/kg (mostly as naphthalenes, naphthenes, and phenanthrene) for 7 months exhibited no mortality or visible signs of stress. In another study, various PAHs were applied to the external surface of mallard eggs and resulting embryotoxicity was evaluated. Chrysene present at 0.015 μg (and greater)/egg caused substantial mortality of embryos and, among survivors, resulted in reduced embryonic growth and numerous physical anomalies. Benzo (a) pyrene present at 0.002 μg/egg did not affect survival of embryos, but did cause reduced embryonic growth and increased incidences of physical anomalies.

Numerous studies of laboratory mammals have documented the carcinogenic properties of a number of higher-molecular-weight PAHs. In the only reported study of mammalian wildlife (Eisler, 1987b), food consumption of deer mice exposed over a 5-day period to 2-methoxynaphthalene and 2-ethoxynaphthalene was reduced by 30% and 3%, respectively.

PAH References

ATSDR (Agency for Toxic Substances and Disease Registry. 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs) - Update. U.S. Department of Health and human Services.

Eisler, R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife, and invertebrates: a synoptic review. Report No. 11. U. S. Fish and Wildlife Service. Laurel, MD. 81 pp.

A.2 Secondary Chemicals of Potential Concern

Secondary COPC are antimony, copper, nickel, vanadium, and zinc. Toxic profiles for these chemicals are taken directly (verbatim) from Eco-SSL documents. The authors of this work plan have not reviewed the references that are the basis of the Eco-SSL documents.

A.2.1 Antimony

Antimony (Sb, stibium) is a semi-metallic element that belongs to group (VA) of the periodic table and shares some chemical properties with lead, arsenic, and bismuth (U S. EPA, 1992). In nature, antimony is associated with sulfur as stibnite. Antimony also occurs in ores with arsenic, and the two metals share similar chemical and physical properties. Antimony is a common component of lead and copper alloys and is used in the manufacturing of ceramics, textiles, paints, explosives, batteries, and semiconductors. Major sources of environmental contamination are smelters, coal combustion, and incineration of waste and sewage sludge. In the past, antimony compounds have been used therapeutically as an anti-helminthic and antiprotozoic treatment. This practice has been largely discontinued as a result of antimony toxicity.

Antimony exists in valences of 0, -3, +3, +5. The tri- and pentavalent forms are the most stable forms of antimony (U. S. EPA, 1992) and are of the most interest in biological systems. The toxicokinetics and toxicity of the tri- and pentavalent forms vary, with the trivalent form considered to be more toxic.

Ingested antimony is absorbed slowly, and many antimony compounds are reported to be gastrointestinal irritants. Trivalent antimony is absorbed more slowly than the pentavalent form. Approximately 15-39% of trivalent antimony is reported to be absorbed in the gastrointestinal tract of animals (Rossi et al., 1987). The toxic effects of antimony in mammals involve cardiovascular changes. Observed changes include degeneration of the myocardium, arterial hypotension, heart dysfunction, arrhythmia, and altered electrocardiogram patterns (Rossi et al. 1987). The mode of action for antimony-induced cardiotoxicity is unknown.

Antimony References

Rossi, F., R. Acampora, C. Vacca, S. Maione, M. G. Matera, R. Servodio, and E. Marmo. 1987. Prenatal and postnatal antimony exposure in rats: effect on vasomotor reactivity development of pups. Teratog. Carcinog. Mutagen. 7(5): 491-496.

U. S. Environmental Protection Agency (U. S. EPA). 1992. Drinking Water Criteria Document for Antimony. Final. Office of Science and Technology, Office of Water, Washingtone, D.C. EPA /920/5-00372

A.2.2 Copper

Copper is a naturally occurring element which can be found in all environmental media: air, soil, sediment, and water. In the metal state, copper is malleable, ductile, and a good conductor of heat and electricity (Alloway, 1990). Copper occurs in numerous minerals including cuprite, tenorite, malachite, azurite, and native copper (George, 1993). Copper forms sulphides, sulphates, sulphosalts, carbonates and other compounds and occurs in reducing environments as the native metal. Copper ranks 26th, behind zinc in abundance in the lithosphere (Alloway, 1990)

The principal uses of copper are in the production of wire, and of its alloys, brass and bronze (Alloway, 1990). Copper compounds may also be released to the environment through their use in dyes, catalysts, feed additives, pesticides, pigments, iron and steel production, coal and oil combustion, copper sulfate production, municipal incineration, and mining activities (Alloway, 1990; U. S. EPA 1987). Copper may also be released from natural sources, such as volcanoes, windblown dusts, the weathering of soil, decaying vegetation, and forest fires.

In soils, copper may be present as soluble compounds including nitrates, sulfates, and chlorides, and insoluble compounds such as oxides, hydroxides, carbonates, and sulfides (Bodek et al. 1988; Budavari 1996). Soluble copper compounds strongly sorb to particles of organic matter, clay, soil, or sand, and demonstrate low mobility in soils (Bodek et al. 1988). Insoluble copper compounds are solid salts and are effectively immobile in soils. Most copper compounds have a high melting point and low vapor pressure, and are not expected to volatilize from moist or dry soil surfaces (Bodek et al. 1988). Alloway (1990) describes six "pools" of copper in soils including soluble ions, inorganic and organic complexes in soil solution, exchangeable copper, stable organic complexes in humus, copper adsorbed by hydrous oxides of manganese, iron, and aluminum, copper adsorbed on the clay-humus colloidal comples and the crystal lattice-bound copper in soil minerals.

Copper is an essential element in both plants and animals. In animals, copper is essential for hemoglobin formation, carbohydrate metabolism, catecholamine biosynthesis, and cross-linking of collagen, elastin, and hair keratin (U. S. EPA 1987). The primary route of exposure for animals to copper is through ingestion. Generally, the normal intake by inhalation is a negligible fraction of the total (Friberg et al., 1986) and absorption through the skin is minimal (Venugopal and Luckey, 1978). In animal tissues, copper exists as complexes with proteins, peptides, and amino acids in tissues such as the liver, brain, and kidney, which retain more copper than do other soft tissues (Seiler et al., 1988). Muscle tissues contain about 35% of the total body copper. In tissues, copper cannot exist in the ionic form in appreciable amounts except in the acidic environment of the stomach (Seiler et al., 1988). Copper is excreted by the biliary system mainly through feces and bile, and to a smaller extent through urine and sweat (Venugopal and Luckey 1978). Absorption, distribution, metabolism, and utilization of copper can be affected by interaction with other metals such as iron, molybdenum, and zinc (U. S. EPA 1987).

In plants, copper is especially important in oxidation, photosynthesis, and protein and carbohydrate metabolism. Also, copper concentrations may affect nitrogen fixation, valence changes, and cell wall metabolism (Kabata-Pendias and Pendias, 1992). Since copper is unlikely to be transported across leaf cuticles, the primary route of uptake by plants is through soil as opposed to atmospheric deposition (Hutchinson, 1979). Copper tends to affect various plant species differently, and low growing grasses tend to accumulate copper at higher levels than tree foliage (U. S. EPA, 1987). In plants, copper deficiency is demonstrated by wilting leaves, melanism, white twisted tips, and reduction in panicle formation.

In mammals, the mechanism of copper toxicity is complex. Copper can increase cell permeability in erythrocytes leading to lysis and inhibition of intracellular enzymes. Thus, copper poisoning can lead to oxidative stress in erythrocytes and to accelerated loss of intracellular glutathione. In addition, copper ions can cause mitochondrial swelling and inhibit oxygen consumption, which leads to cell degeneration. In copper deficient animals, failure to form collagen in the walls of arterioles leads to subcutaneous bleeding and anemia. Other symptoms of acute copper toxicity in mammals include sporadic fever, tachycardia, hypotension, oliguria, uremia, coma, cardiovascular collapse, and death. Chronic copper poisoning in mammals may induce nausea, vomiting, epigastric pain, dizziness, jaundice, and general debility (Venugopal and Luckey, 1978).

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A.2.3 Nickel

Nickel is a naturally occurring element which can be found in all environmental media: air, soil, sediment, and water. In the metal state, nickel is silvery white, hard, malleable, and ductile. It is somewhat ferromagnetic, and a fair conductor of heat and electricity. Nickel occurs in numerous minerals as sulfides, arsenides, antimonides and oxides or silicates.

Primary sources include chalcopyrite, pyrrhotite, pentlandite, and garnierite (Budavari, 1996; HSDB).

Nickel is released to the environment through the extraction, processing and use of nickel compounds (HSDB). The single largest use of nickel is in the manufacture of stainless steels (Alloway, 1990). Nickel is also used in the production of alloys with other metals such as iron, copper, chromium, and zinc (ATSDR, 1988; HSDB). Other major uses are in electroplating alloys, nickel-cadmium batteries, electronic components, fuel cells, specialty ceramics, magnets, specialty chemicals, filters for gases, hydrogenation of fats, petroleum products, preparation of colored pigments and for color stabilization of color copy paper (ATSDR, 1988; Alloway, 1990). Nickel may also be released from natural sources, such as volcanoes, windblown dusts, the weathering of rocks, forest fires, and decaying vegetation (Davies, 1974; HSDB).

In the atmosphere, nickel is expected to exist in the particulate phase and is released to soils through wet and dry deposition. The species of nickel present in deposition include soil minerals, oxides and sulphates (Alloway, 1990). The largest anthropogenic sources of nickel to the atmosphere result from the burning of fuel and residual oils followed by diesel exhaust, the combustion of coal and nickel mining and smelting (Alloway, 1990).

In soils, nickel may be present as soluble compounds including chlorides and nitrates, and insoluble compounds such as oxides and sulfides. Soluble nickel compounds tend to exhibit greater mobility than insoluble nickel compounds (Dean, 1985; HSDB). The degree of mobility is influenced by the formation of complexes in the presence of organic substances and sulfates (Anderson and Christensen, 1988). The distribution of nickel between solid and solution phases is primarily controlled by pH with secondary factors being clay content, and the amount of hydrous iron and manganese oxides. Soluble nickel increases with decreases in pH. Increases in metal loading and cation exchange capacity (CEC) increase the amount of metal adsorbed by soil (Alloway, 1990). Due to low vapor pressures, most nickel compounds are not expected to volatilize from moist or dry soil surfaces, with one notable exception being nickel carbonyl (Ohe, 1976; HSDB). The concentration of nickel in plants generally reflects the concentration in soil although the relationship is more related to soluble and exchanged forms of nickel. Factors that increase solubility and exchangeability of nickel in soils also result in an increase of the element in plant tissue (Alloway, 1990).

In plants nickel is necessary for healthy growth and is essential for metabolic processes (Alloway, 1990; NRC, 2005). Nickel is generally not accepted as an essential trace element for mammals and birds as there is no clearly defined biochemical function. Under laboratory experimental conditions nickel deprivation can result in adverse effects including growth depression, impaired reproduction, and other biochemical changes (NRC, 2005).

<u>Nickel References</u>

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National Research Council (NRC). 2005. Mineral Tolerance of Animals. Second Edition. The National Academies Press. Washington, D. C. 496 pp.

Hazardous Substances Database (HSDB). National Library of Medicine.

A.2.4 <u>Vanadium</u>

Vanadium (V) occurs commonly but not uniformly in the earth's crust, ranking 22nd among the elements present (WHO, 1988). Elemental vanadium does not occur in nature but is contained in about 65 different minerals with patronite, roscoelite, carnotite, and vanadinite being the principal ore sources (CRC, 1994). Vanadium forms numerous and complicated compounds because of its many valence states which may range from +2 to +5, with +5 being the principle oxidation state (Lagerkvist et al., 1986). Vanadium can form both cationic and anionic salts (API, 1985).

Vanadium is mainly used in ferrous metallurgy where 75-85% of all vanadium produced is used as an alloy additive in making special steels. Alloys of vanadium with non-ferrous metals are widely used in the atomic industry, aircraft construction, and space technology. Vanadium is also used as a target material for x-rays and as a chemical catalyst (Alloway, 1990; WHO, 1988). Vanadium is present in coal, crude oil, naturally occurring petroleum hydrocarbons, and all fuel oils where it remains in the residue after the more volatile fractions have been distilled.

Major sources of environmental contamination of vanadium result from the combustion of fossil fuels, the burning of coal wastes, the disposal of coal waste and fly ash, and releases from metallurgical works and smelters (NRCC, 1980; WHO, 1988; Alloway, 1990). Vanadium also enters the environment from natural sources such as continental dust, marine aerosols, and volcanic emissions.

Vanadium is found in rocks and soil in the relatively insoluble trivalent form and can also be present in the pentavalent form as vanadates of Cu, Zn, Pb, U, ferric iron, Mn, Ca, or K (API, 1985). Weathering decomposes parent rock and increases vanadium availability in soils (CCME, 1996). Jacks (1976) found that the bulk of vanadium deposited in the environment is retained in the soil, mainly in association with organic matter. The mobility of vanadium in
soils is affected by pH. Vanadium is fairly mobile in neutral or alkaline soils relative to other metals, but its mobility decreases in acidic soils. In the presence of humic acids, mobile metavanadate anions can be converted to the immobile vanadyl cations resulting in local accumulation. Under oxidizing, unsaturated conditions some mobility is observed, but under reducing, saturated conditions vanadium is immobile. The pentavalent cation is considerably more soluble than the trivalent cation, is readily dissolved by groundwater, and can be transported over long distances.

If released into water, vanadium is expected to exist primarily in the tetravalent and pentavalent forms. Both species are known to bind strongly to mineral or biogenic surfaces by adsorption or complexing. The chemical formulas of the vanadyl species most commonly reported in water are VO(2+) and VO(OH)(I+), and the vanadate species are H2V04(1-) and HV04(2-). Soluble vanadium present in soil appears to be easily taken up by the roots of plants usually in the tetravalent or pentavalent form (NRCC, 1980). Evidence suggests a difference in absorption between these two forms with the tetravalent (vanadyl) form being more rapidly absorbed into the roots of plants (Hopkins et al. 1977).

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A.2.5 Zinc

Zinc is the 25th most abundant element that is used industrially in the production of galvanized materials, alloys and other products. Anthropogenic sources of zinc in the environment include electroplating, smelting and ore processing, domestic and industrial sewage, combustion of solid waste and fossil fuels, road surface runoff, corrosion of zinc alloy and galvanized surfaces, and erosion of agricultural soils (CCME, 1996).

Zinc occurs in soil solution under the single valence state zinc (+2). Zinc is highly reactive and is present as both soluble and insoluble compounds. Zinc also forms stable combination with organic substances. Metallic zinc is insoluble while the solubility of other zinc compounds range from insoluble (oxides, carbonates, phosphates, silicates) to extremely soluble (sulphates and chlorides) (CCME, 1996).

Zinc is an essential element for normal plant growth. Terrestrial plants primarily absorb zinc as zinc (2+) from soil solution and the uptake is dependant on the availability, solubility and movement of zinc to plant roots. Zinc availability to plants is a function of soil physico-chemical properties and plant biological characteristics. Uptake and distribution of zinc is influenced by the form of zinc, other metal ions present in the system, soil phosphorous level, cation exchange capacity, soil texture, pH and organic matter content (CCME, 1996).

Zinc is also an essential element for animal life and is necessary for a wide variety of physiologic functions (Thompson et al., 1991 and Ammerman et al., 1995). Zinc activates several enzymes and is a component of many important metalloenzymes. The element is critically involved in cell replication and in the development of cartilage and bone (Ammerman et al. 1995).

Zinc References

Ammerman, C. B., D. H. Baker, and A. J. Lewis (eds.) 1995. Bioavailability of Nutrients for Animals: Amino Acids, Minerals, and Vitamins. Academic Press. San Diego, CA.

Canadian Council of Ministers of the Environment (CCME). 1996. Recommended Canadian Soil Quality Guidelines for Zinc: Environmental Supporting Document – Final Draft. December 1996.

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Appendix B

Life Histories of Wildlife Evaluated in Food-Web Exposure Models for Chemicals of Potential Concern (COPC) in Upland at LCP Site

This appendix addresses life histories of upland wildlife that forage solely for terrestrial prey (or food), followed by life histories of wildlife that feed at least partly on prey from the estuary at the LCP Site. Life histories are based on numerous references that often contain similar or identical information. Consequently, references utilized in reviewing life histories of wildlife, which often refer to original sources of information, are presented at the end of each review.

In all reviews, emphasis is placed on extracting information useful in wildlife food-web exposure modeling: body weight, home range, and diet.

B.1 Wildlife Feeding Exclusively on Terrestrial Food Items

Both birds and mammals that forage exclusively on terrestrial prey (food) were modeled.

B.1.1 Birds

Modeling addresses three species of birds that feed exclusively on terrestrial food.

.B.1.1.1 Mourning Dove (*Zenaida macroura*)

The morning dove is a year-round resident of Georgia, where, as elsewhere, it is an important game species. Flying speed of the birds has been reported as high as 55 miles per hour. Birds are quite mobile during the breeding season. Males often range from 0.8 to 7.7 km from the nest, and females as far as 5.3 km. Weight of mourning doves approximates 120 g.

The diet of mourning doves consists of more than 99% seeds or plant parts. However, they typically avoid rank, tall vegetation in which they are unable easily penetrate and remain vigilant for predators. In addition, they avoid feeding where ground litter makes finding seeds difficult.

Mourning doves breed throughout the year in the southernmost part of their range. They lay a small number of eggs – usually two per nest – and the parents share incubation duties. Parents first feed the rapidly growing young on a nutritious material known as "crop milk," which is later supplemented by seeds.

Longevity of mourning doves averages about 1.5 years, but life span of 19.3 years has been reported.

References

Baskett T. S., M. Sayre, R. Tomlinson, and R. Mirarchi. 1993. Ecology and management of the mourning dove. Stackpole Books. 608 pp.

Max Planak Institute for Demographic Research – online longevity data bases for birds and mammals. Rostock, Germany

B.1.1.2 Carolina Wren (*Thryothorus ludovicianus*)

The Carolina wren occurs in the eastern United States and Central America, and is a year-round resident of Georgia. Wrens inhabit a variety of habitats that includes brushy undergrowth and even suburban gardens. They are strongly philopatric and maintain territories and pair bonds year-round. Weight of Carolina wrens is about 18 to 22 g.

Carolina wrens feed primarily on insects and spiders. They typically feed on the ground, but sometimes forage on tree trunks and branches as do creepers and nuthatches.

Both sexes of Carolina wrens assist in building nests, which are usually domed and within 1 to 2 m of the ground. Multiple nestings of four or five eggs are common, and three broods are sometimes raised in a season. Males contribute substantially to the care of nestlings and fledglings.

Record life span of Carolina wrens is 6.1 years.

References

Max Planak Institute for Demographic Research – online longevity data bases for birds and mammals. Rostock, Germany

http://www.birds.cornell.edu/AllAboutBirds/BirdGuide.html

B.1.1.3 Broad-Winged Hawk (*Buteo platypterus*)

The broad-winged hawk is only a casual resident in Georgia during the winter, typically overwintering in Central America and northwestern South America. Much of the knowledge regarding this species is based on a monograph published in the early 1900s (Burns, 1911).

Food of these hawks is highly variable and can consist of rodents, shrews, rabbits, chipmunks, weasels, squirrels, snakes, toads, frogs, fishes, crayfishes, earthworms, insects, and spiders.

Broad-winged hawks are believed to mate for life. They build small and rather poorly constructed nests often made of twigs, dead leaves, lichens, and bark. They sometimes make use of an old nest of a squirrel or crow. The hawks most commonly produce two eggs, and the period of incubation is typically between 21 and 25 days.

Record longevity for broad-winged hawks has been reported to be 18.3 years.

References

Burns, F. L. 1911. A monograph of the broad-winged hawk. Wilson Bull. 23(3-4): 1-320.

B.1.2 Mammals

Modeling addresses three species of mammals that feed exclusively on terrestrial food.

B.1.2.1 Meadow Vole (*Microtus pennsylvanicus*)

The meadow vole is found in most of Canada southeast to Georgia. Meadow voles inhabit grassy fields, bogs, and marshes. Typical home range (in Virginia) averages from 0.00686 to 0.01923 ha, and population density (in Massachusetts) has been reported as from 28 to 85 individuals per hectare. Weight of meadow voles ranges from about 20 to 40 g.

Meadow voles typically feed on succulent vegetation, sedges, seeds, roots, bark, fungi, insects, and animal matter. They usually favor the most common plants in their habitat. They produce several litters throughout an extended breeding season. Gestation period is typically about 3 weeks. The number of young per litter averages about five, and young from spring and early summer litters reach adult weight in about 12 weeks.

Longevity of meadow voles has been reported as from 2 to 16 months.

Reference

U. S. Environmental Protection Agency. 1993. Wildlife exposure factors handbook. Vol. I and II. Washington, DC.

B.1.2.2 Short-Tailed Shrew (*Blarina carolinensis*)

The short-tailed shrew is found from the Maritime Provinces of Canada to southern Florida, west to the Prairie Provinces and south to eastern Texas. Typical home range varies from about 0.2 to 0.4 ha, and populations may reach as high as 62 shrews per hectare. Weight of shrews ranges from about 11 to 22 g.

Short-tailed shrews feed on insects, worms, snails, other invertebrates, and possibly on young mice. They generally breed between March – May and August – September. They have a gestation period 21+ days, and typically produce two to three liters per year of five to eight young per liter. The young are born naked and pink, with eyes and ears closed.

Life span of short-tailed shrews is typically about 1 year, with a record of 2.5 years.

References

Burt, W. B. 1952. A Field Guide to the Mammals. Houghton Mifflin Co. Boston. Pp. 15-16.

Max Planak Institute for Demographic Research – online longevity data bases for birds and mammals. Rostock, Germany

B.1.2.3 Long-Tailed Weasel (*Mustela frenata*)

This is the most widely distributed weasel occurring in all habitats near water from Artic Canada through Mexico. Home range is approximately 12 to 16 ha, with a population density reported of up to 15 to 20 individuals in a 259-ha area. Weight of males has been reported as from 198 to 340 g, with females considerably smaller (85 to 198 g).

The long-tailed weasel feeds mostly on small mammals up to rabbit size, but also consumes a few birds and other animals.

Males mate at 1 year of age, and females at from 3 to 4 months. The gestation period is from about 205 to 337 days, after which four to eight young are born. Eyes of the young open in 35 days.

References

Burt, W. B. 1952. A Field Guide to the Mammals. Houghton Mifflin Co. Boston. Pp. 58-59.

B.2 Wildlife Feeding at Least Partly on Estuarine Food Items

Birds and mammals that forage at least partly on estuarine food were modeled.

B.2.1 Birds

Modeling addresses five species of birds that feed at least pertly on estuarine food.

B.2.1.1 Common Yellowthroat (*Geothlypis trichas*)

The common yellowthroat is a wood-warbler, the only species in its genus that regularly occurs north of Mexico. Throughout its vast breeding range across most of North America south of the tundra, from southeast Alaska to Newfoundland and south into Mexico, it is one of the most abundant warblers. It is also one of the most geographically varied warbler species, with more than a dozen subspecies named.

Common yellowthroats are a year-round resident of coastal Georgia and typically inhabit marshes, streamside thickets, wet meadows and other wetlands. However, they are also found in drier upland habitats as long as there is abundant and dense undergrowth for foraging and nesting. Weight of birds varies from about 8.8 to 10.8 g.

Territory/home range of common yellowthroats is about 0.4-1.2 hectares. Within this area, the female constructs a nest usually on or very close to the ground at the base of a shrub or clump of grasses. Sometimes she suspends the nest over water, attaching the nest to the stems of grasses, reeds or cattails. The female incubates about three to six eggs for about 12 days. Young yellowthroats leave the nest just eight days after hatching. They fly a few days later. Both parents tend to the young for an extended period up to 20 days. When a pair attempts to raise a second brood, as is common, the male sometimes assumes care of the first brood. Common yellowthroats are frequent cowbird hosts. If a cowbird lays an egg in a yellowthroat's nest, the yellowthroat sometimes builds a second nest on top of the parasite's egg and lays a new clutch.

The diet of common yellowthroats is typically insects, gleaned from low vegetation on the ground, and lesser amounts of seeds.

Typical life span of common yellowthroats is probably less than 1 – 2 years, but banding programs have recorded a bird that was at least 10 years old.

References

Roberts, T.S. 1955. A manual for the identification of The Birds of Minnesota and Neighboring States. Univ. of Minnesota Press, Minneapolis. 738 pp.

http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/Common_Yellowthroat.html

http://www.prbo.org/calpif/htmldocs/species/riparian/common_yellowthroat.htm

http://www.mbr-pwrc.usgs.gov/id/framlst/i6810id.html

http://www.sfbbo.org/volunteer/summer02.php

B.2.1.2 Willet (*Catoptrophorus semipalmatus*)

The willet is a year-round resident along the coast of Georgia. Breeding willets inhabit "shortgrass" salt marshes and beaches where dunes rise above the high-tide line and are covered with clumps of beach grass (*Panicum amarum*) and sea oats (*Uniola paniculata*). Weight of birds varies from about 227 to 454 g, with females slightly larger than males.

The willet forages in mudflats, intertidal areas, and shallow marsh waters and snatches up food from the surface of the water or by probing in the mud with its long bill. It often wades up to its belly in the water searching for food. It eats aquatic insects, marine worms, small crabs, and small mollusks and fishes. Its diet also includes plant matter like grass and seeds. Fiddler crabs are the most common food item.

The willet sometimes nests on open beaches, but most often the nest, a depression in the ground or in a clump of grass that is lined with weeds or pieces of shell, is carefully hidden in marsh grasses. It is a semicolonial breeder, in that several pairs often nest closely together. The bird lays from three to five eggs, which exhibit an olive to sky-blue color spotted with brown. Incubation takes 22 to 29 days. The chicks are precocial and feed themselves shortly after birth. Both parents care for the chicks. The female will leave when the chicks are 2-3 weeks old. The male will stay with the chicks until they fledge at about 4 weeks old.

The maximum recorded life span for willets is 8.9 years.

References

Roberts, T.S. 1955. A manual for the identification of The Birds of Minnesota and Neighboring States. Univ. of Minnesota Press, Minneapolis. 738 pp.

Max Planak Institute for Demographic Research – online longevity data bases for birds and mammals. Rostock, Germany

http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/Willet.html

http://myfwc.com/bba/WILL.htm

http://www.nhptv.org/natureworks/willet.htm#4

B.2.1.3 Pied-Billed Grebe (*Podilymbus podiceps*)

The pied-billed grebe is a year-round resident in Georgia. The birds can be found in virtually all inland and coastal waters. During the breeding season, pied-billed grebes select freshwater habitats, such as marshes, ponds, lakes, canals, and slow-moving streams and rivers. Weight of birds may range from 253 to 568 g.

Pied-billed grebes feed on what is most readily available and is not too big for them to grip with their bill. Usually they eat small fish, crustaceans (in particular crayfish), and aquatic insects and their larvae. Like other grebes, they swallow hundreds of their own feathers, apparently to "cushion" their intestines against the sharp fish bones.

Pied-billed grebes first breed when they are 1 or 2 years old. Grebes breeding in the north raise one brood each summer. Some pairs breeding in the south may raise two broods in a summer. Pied-billed grebe nests float and are anchored to marsh vegetation in shallow waters. Both sexes gather soft, flexible, decomposed or fresh plants from the lake bottom to construct the nest. The nest itself resembles a bowl.

Grebe eggs are oval in shape and are bluish white to greenish white and occasionally turquoise. Within 2 days, the eggs become white and then take on the nest stains and turn brown. The typical clutch size is between 2 and 10, with incubation periods between 23 and 27 days. The chicks are able to leave the nest within an hour of hatching, usually by climbing onto a parent's back. They become independent from their parents within 25 to 62 days

There is little information available on the lifespan of pied-billed grebes. However, grebes are thought to be relatively long-lived birds.

References

http://animaldiversity.ummz.umich.edu/site/accounts/information/Podilymbus_podiceps.html

http://myfwc.com/bba/pbgr.htm

B.2.1.4 Clapper Rail (*Rallus longirostris*)

The clapper rail is a year-round resident in Georgia. It is abundant in saltwater marshes and mangrove swamps throughout its range from Massachusetts to South America. Breeding densities in prime habitat in Georgia have been reported to be from 2.2 to 8.4 birds per ha. Weight of birds may range from 160 to 400 g, with males averaging 20% larger than females.

Clapper rails forage on exposed mudflats mainly by shallow probing of sediment or surface gleaning. Main food consists of small crabs, other crustaceans, snails, and shellfish; but small fishes, clam worms, and aquatic insects are occasionally eaten. Seeds constitute only a small part of the diet. In some locations, up to 90% of the diet may consist of only one food, such as fiddler crabs (*Uca* spp.).

Clapper rails are solitary ground nesters, with nests consisting of basket-shaped aquatic vegetation or tidal wrack, hidden on a firm bank or under a small bush. Nesting activities begin in March and extend to July. Clutch size normally comprises 8 to 11 eggs that are creamy-white and lightly marked with dark brown. Incubation is performed by both sexes and lasts from 20 to 24 days. The precocial young are attended by both parents and usually leave the nest soon after hatching. They are capable of flight at 63 to 70 days. Two broods may be raised each season.

Life span of clapper rails may be as long as 7.5 years.

References

Max Planak Institute for Demographic Research – online longevity data bases for birds and mammals. Rostock, Germany

Oney, John. 1954. Final report, clapper rail survey and investigation study. Georgia Game and Fish Commission. 50 pp.

Sanderson, Glen C. 1977. ed. Management of Migratory Shore and Upland Game Birds in North America. International Association of Fish and Wildlife Agencies, Washington, D.C.

http://www.pwrc.usgs.gov/bioeco/clapper.htm

http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/Clapper_Rail.html#description

http://myfwc.com/bba/clra.htm

B.2.1.5 Belted Kingfisher (*Ceryle alcyon*)

The belted kingfisher is a year-round resident in Georgia. During breeding season, kingfisher pairs defend their territory against other kingfishers. A territory along a stream includes just the streambed and the vegetation along it, and averages 1 km long. The nest burrow or tunnel is usually in a dirt bank near water. The tunnel slopes upward from the entrance, perhaps to keep water from entering the nest. Tunnel length ranges from 30 to 250 cm. Weight of birds ranges from142 to 170 g.

Belted kingfishers typically prey on fishes that inhabit shallow water (no more than 60 cm in depth) or swim near the surface. The birds require clear water and unobstructed view of prey for foraging. Prey is detected from overhead from an unobstructed perch or by hovering over the water's surface. With eyes closed, the bird dives and grabs prey in its bill. Because prey is near the water's surface, the bird usually does not totally submerge. Captured fishes are generally less than 10.2 cm in size. After capturing a fish, the bird flies to a perch where it pounds the fish against the perch to stun it and turn it so the fish can be swallowed head first. In addition to fishes, belted kingfishers sometimes prey on crayfish and other crustaceans, frogs, salamanders, lizards, water-shrews, young sparrows, quail chicks, dragonfly nymphs, grasshoppers, moths, and butterflies, and, also, berries during the winter.

Belted kingfishers typically select clay or sand banks for breeding. Both adults dig the burrow, using their bills and feet. The nesting chamber is built at the end of the burrow and may be up to 5 m in length, but is usually from 1 to 2 m. In this protected chamber, four or five unmarked white eggs are laid from May through July. Both adults share in incubation, which takes 23 or 24 days. Young are fed regurgitant produced by their parents and fledge at about 23 days of age. One brood is raised per year.

A kingfisher maintained in captivity generated a longevity record of 30 years.

References

Fry, C. H., K. Fry, and A. Harris. 1992. Kingfishers Bee-Eaters and Rollers. Princeton University Press, Princeton, N.J. 324 pp.

Max Planak Institute for Demographic Research – online longevity data bases for birds and mammals. Rostock, Germany

http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/Belted_Kingfisher_dtl.html#range

http://www.pwrc.usgs.gov/bioeco/bkingfisher.htm

B.2.2 Mammals

Modeling addresses three species of mammals that feed exclusively on estuarine (or aquatic) prey.
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B.2.2.1 Little Brown Bat (*Myotis lucifugus*)

Little brown bats occur throughout southern Canada and the northern United States, extending to almost the Georgia-Florida line. They are nocturnal and typically weigh about 7 to 9 g.

They are nocturnal feeders from dusk to dawn, relying primarily on insects captured near forested areas or water.

Breeding occurs once or twice per year. Gestation period is about 80 days, after which a single (sometimes two) young is born. The young open their eyes in 2 or 3 days, and leave the nest at about 1 month of age.

Little brown bats maintained in captivity have survived for up to 30 years.

References

Burt, W. B. 1952. A Field Guide to the Mammals. Houghton Mifflin Co. Boston. Pp. 58-59.

Max Planak Institute for Demographic Research – online longevity data bases for birds and mammals. Rostock, Germany

B.2.2.2 Raccoon (*Procyon lotor*)

Raccoons are found throughout the southern Canada, the United States, and Mexico with the exception of portions of the Rocky Mountains and the southwest desert. Home range extends up to 3.2 km, but is normally less than 1.6 km. Young have been known to disperse up to 264 km from place of birth, but usually less than 50 km. Population density can vary from one animal per 0.4 to 6 ha. Raccoons typically weigh from about 5.4 to 15.8 kg.

The raccoon is an omnivore that typically eats anything available, including fruits, nuts, grains, insects, crayfish, frogs, bird eggs.

Raccoons produce one litter per year in the spring. Gestation period is about 63 days, after which from two to seven young are produced. Eyes of young open in about 3 weeks, and young leave mother in fall.

The longevity record for raccoons is 20 years.

References

Burt, W. B. 1952. A Field Guide to the Mammals. Houghton Mifflin Co. Boston. Pp. 50-51.

Max Planak Institute for Demographic Research – online longevity data bases for birds and mammals. Rostock, Germany

B.2.2.3 Mink (*Neovison vison*)

Mink occur throughout the United States except for the southwestern desert. Population densities typically range from 0.01 to 0.10 mink per hectare. Mink occur in wetland areas of all kinds including banks of rivers, streams, lakes, marshes, swamps, and ditches. Dens are located in tree roots and old beaver lodges. Home range of adult males is from 1.8 to 5 km. Mink typically weigh from about 0.7 to 1.1 kg.

Mink are opportunistic, primarily nocturnal hunters that feed on muskrats, shrews, insects, birds, bird eggs, fishes, crayfish, and snails. They are competent swimmers and often hunt prey in water. Females tend to have a harder time than males hunting larger prey such as muskrats and are more limited in their diets. Mink kill by biting prey on the neck.

Mink may breed in their 1st year of life and are characterized by a gestation period of from 39 to 76 days. Young usually range from 2 to 6, but occasionally are as many as 10. Eyes of young open in about 25 days.

Life span of mink may be as long as 10 years.

References

Max Planak Institute for Demographic Research – online longevity data bases for birds and mammals. Rostock, Germany
http://www.pwrc.usgs.gov/bioeco/mink.html

Appendix C

Assumptions and Data Employed in Wildlife Food-Web Exposure Models for Primary Chemicals of Potential Concern (COPC) In Upland at LCP Site

The assumptions and data utilized in wildlife food-web exposure modeling for primary COPC in upland at the LCP Site are detailed in Table C-1. Several general procedures were employed in the modeling exercise, while other procedures were applicable to just specific wildlife species.

General Procedures

1. Primary COPC for wildlife food-web modeling purposes were considered to be inorganic mercury, methylmercury, Aroclor 1268, and lead. (Polynuclear aromatic hydrocarbons [PAHs], another category of primary COPC, do not characteristically biomagnify in ecological food webs.)

2. Wildlife were modeled for mean and maximum exposure to COPC. Wildlife feeding exclusively on terrestrial food items were also evaluated at a reference area -- the old Drive-In Theater part of the site. Modeling of reference conditions was performed to determine the efficiency of wildlife models – i, e., whether the models were capable of discriminating between potentially impacted vs. reference conditions.

3. Modeling of incidental uptake of food-related substrate (soil or sediment) by wildlife addressed soil when only terrestrial food items were modeled, sediment in the case of exclusively estuarine food items, and appropriate combinations of soil and sediment when both types of food items were modeled.

4. Modeling of maximum exposure of wildlife to COPC via terrestrial food items (grass, berries from plants, insects, earthworms, and small mammals) and soil addressed the maximum concentration of COPC in those food items, together with the maximum concentration of COPC in soil regardless of whether that concentration of COPC was actually associated with the maximum concentration of COPC in food items. For estuarine food items (fiddler crabs and fish), maximum concentration of COPC in food was associated with maximum concentration of COPC in marsh and creek sediment.

5. Modeling of uptake of water was based on concentrations of COPC identified in the freshwater pond near the old Drive-In Theater (reference) part of the site. These concentrations of COPC were employed in modeling of both reference and site conditions since the pond was the only source of freshwater in the area.

6. Modeled concentrations of total lead in surface water of the freshwater pond excluded values obtained for Replicate 1. In this replicate, an atypically high value of the total

metal was observed, but the dissolved value was less than the applicable chronic ambient water quality criterion, thereby discounting a water-based hazard to biota.

7. Insects employed as food items in modeling exercises were typically terrestrial insects, although dragonflies were sometimes included in the collection of insects.

8. Area-use factors (AUFs) and time-use factors (TUFs) were assumed to be unity (1) in the case of all wildlife.

Specific Procedures

1. Mourning Dove Model.__ The diet of the mourning dove consisted of 50% grass and 50% plant berries. The mean concentration of a COPC in soil from the potentially impacted area of the site was based on the grand mean concentration of the COPC associated with both types of food items (refer to Table 3 in the main document). The maximum concentration of a COPC in potentially impacted soil was the maximum value associated with both of the food items.

2. Carolina Wren Model.__ The diet the Carolina wren consisted of 100% terrestrial insects. The mean concentration of a COPC in soil from the potentially impacted area of the site was based on the grand mean concentration of the COPC reported throughout the area (refer to Table 3 in the main document) since insects were assumed to have been exposed to the whole site, not just to the locations where they were collected. The maximum concentration of a COPC in soil was the maximum value reported for the whole site.

3. Broad-Winged Hawk Model.__ The model planned for the broad-winged hawk was to exclusively employ small mammals in the hawk's diet (100% of diet). Small mammals could not be collected at the site. Therefore, several sub-models were utilized to estimate body burdens of COPC in a hypothetical small mammal. Sub-model 1 was based on a scientific paper by Sample *et al.* (1998), who identified a 90^{th} percentile uptake factor (UF) of 0.1484 for small mammals (in general) exposed to total mercury in soil. This UF was applied to the estimated concentration of total mercury in soil, and the distinction between body burdens of inorganic mercury and methylmercury in the hypothetical small mammal was based on a reported 10% ratio of methylmercury to total mercury in small terrestrial mammals (Watras and Huckabee, 1994; Sigel and Sigel, 1997). However, for the purpose of conservatism, it was also assumed that the hypothetical small mammal was characterized by a body burden of 100% methylmercury. In addition, a 50% body burden of methylmercury in small mammals was modeled. Sub-model 2, which addressed lead, employed the following equation by Sample *et al.* (1998):

- $\text{Conc. lead}_{\text{mammal}} = e^{0.0761} \text{ x } (\text{conc. lead}_{\text{soil}})^{0.442}$

Sub-model 3, which was employed for Aroclor 1268, was predicated on the following equation suggested by Travis and Arms (1988):

- Conc. Aroclor 1268_{mammal} = conc. Aroclor 1268_{food} x $e^{(-7.6 + \log Kow)}$,

with food of mammal considered to be the meadow vole (also modeled as a major wildlife species in this assessment) and log Kow estimated as 8.04. Soil data employed in all models are presented in Table C-1, as is concentration of Aroclor 1268 in food (a two-component diet) of the meadow vole.

The mean concentration of a COPC in soil from the potentially impacted area of the site was based on the grand mean concentration of the COPC reported throughout the area (refer to Table 3 in the main document). The maximum concentration of a COPC in soil was the maximum value reported for the whole site.

4. Meadow Vole Model.__ The diet of the meadow vole consisted of 50% grass and 50% plant berries. The mean concentration of a COPC in soil from the potentially impacted area of the site was based on the grand mean concentration of the COPC associated with both types of food items (refer to Table 3 in the main document). The maximum concentration of a COPC in potentially impacted soil was the maximum value associated with both of the food items.

5. Short-tailed Shrew Model.__ The diet of the short-tailed shrew consisted of 60% of terrestrial insects and 40% earthworms. Earthworms could not be collected at the site. Therefore, a laboratory bioaccumulation/toxicity study with environmentally naïve earthworms was utilized to estimate body burdens of COPC in this potential food source.

The mean concentration of a COPC in soil from the potentially impacted area of the site was based on the grand mean concentration of the COPC associated with both types of food items (refer to Table 3 in the main document). The maximum concentration of a COPC in potentially impacted soil was the maximum value associated with both of the food items.

6. Long-Tailed Weasel Model.__ The model planned for the long-tailed weasel was to exclusively employ small mammals in the weasel's diet (100% of diet). Small mammals could not be collected at the site. Therefore, several sub-models were utilized to estimate body burdens of COPC in a hypothetical small mammal. Sub-model 1, which was employed for all forms of mercury, is based on a scientific paper by Sample et al. (1998), who identified a 90^{th} percentile uptake factor (UF) of 0.1484 for small mammals (in general) exposed to total mercury in soil. This UF was applied to the estimated concentration of total mercury in soil, and the distinction between body burdens of inorganic mercury and methylmercury in the hypothetical small mammal was based on a reported 10% ratio of methylmercury to total mercury in small terrestrial mammals (Watras and Huckabee, 1994; Sigel and Sigel, 1997). However, for the purpose of conservatism, it was also assumed that the hypothetical small mammal was characterized by a body burden of 100% methylmercury. In addition, a 50% body burden of methylmercury in small mammals was modeled. Sub-model 2, which addressed lead, employed the following equation by Sample *et al.* (1998):

- $\text{Conc. lead}_{mammal} = e^{0.0761} \times (\text{conc. lead}_{soil})^{0.442}$

Sub-model 3, which was employed for Aroclor 1268, was predicated on the following equation suggested by Travis and Arms (1988):

- $\text{Conc. Aroclor 1268}_{mammal} = \text{conc. Aroclor 1268}_{food} \times e^{(-7.6 + \log Kow)}$,

with food of mammal considered to be the meadow vole (also modeled as a major wildlife species in this assessment) and log Kow estimated as 8.04. Soil data employed in all models are presented in Table C-1, as is concentration of Aroclor 1268 in food (a two-component diet) of the meadow vole.

The mean concentration of a COPC in soil from the potentially impacted area of the site was based on the grand mean concentration of the COPC reported throughout the area (refer to Table 3 in the main document). The maximum concentration of a COPC in soil was the maximum value reported for the whole site.

7. Common Yellowthroat Model.__ The diet of the common yellowthroat consisted of 80% of terrestrial insects and 20% plant berries. It was initially planned to include aquatic insects in the diet of the common yellowthroat (80% of diet). Aquatic insects could not be collected in the freshwater pond. Consequently, the above-identified terrestrial insects (which contained some dragonflies) were substituted for aquatic insects.

The mean concentration of a COPC in soil (changed from sediment because of the substitution of terrestrial insects for aquatic insects) from the potentially impacted area of the site was based on the grand mean concentration of the COPC associated with both types of food items (refer to Table 3 in the main document). The maximum concentration of a COPC in potentially impacted soil was the maximum value reported in soil.

8. Willet Model.__ The diet of the willet consisted of 80% of terrestrial insects and 20% fiddler crabs. It was initially planned to include aquatic insects in the diet of the willet, but aquatic insects could not be collected in the freshwater pond. Consequently, the above-referenced terrestrial insects (which contained some dragonflies) were substituted for aquatic insects.

The mean concentration of a COPC in the two related substrates (soil for insects and sediment for fiddler crabs) from the potentially impacted area of the site was based on a prorated value derived from the grand mean concentration of the COPC in soil (refer to Table 3 in the main document) and highest mean concentration of the COPC in sediment (refer to Table 4 in the main document).

The maximum concentration of a COPC in potentially impacted substrate was derived from the prorated maximum values associated with soil and sediment.

9. Pied-Billed Grebe Model.__ The diet of the pied-billed grebe consisted of 80% spiders and 20% fish (mummichogs). It was initially planned to include aquatic insects in the diet of the pied-billed grebe, but aquatic insects could not be collected in the freshwater pond. Consequently, spiders, which were suggested as a substitute for aquatic insects by Region 4, U. S. Environmental Protection Agency (2008), were collected from the shoreline of the pond and employed as insect surrogates.

Sediment/soil was not collected over the large shoreline area where spiders (the dominant food item) were collected. The mean concentration of a COPC in sediment associated with mummichogs from the potentially impacted area of the site was the mean of the two mean values reported in Table 4, while the maximum concentration of a COPC was the highest value in that table.

10. Clapper Rail Model.__ The diet of the clapper rail consisted of 90% fiddler crabs and 10% fish (mummichogs). It was initially planned to include aquatic insects in the diet of the clapper rail (10% of diet), but aquatic insects could not be collected in the freshwater pond. Since the percentage of aquatic insects originally planned for inclusion in the diet was small, the other components of the diet were increased proportionately (90% fiddler crabs and 10% mummichogs).

The mean concentration of a COPC in sediment from the potentially impacted area of the site was based on the prorated mean values reported for the two food items of the clapper rail (refer to Table 4 in the main document). The maximum concentration of a COPC in potentially impacted sediment was the highest concentration reported in Table 4.

11. Belted Kingfisher Model.__ Sediment was not included in the model for the belted kingfisher, which was modeled to consume just fish (mummichogs).

12. Little Brown Bat Model.__ It was initially planned to employ aquatic insects as the diet of the little brown bat (100% of diet), but aquatic insects could not be collected in the freshwater pond. Consequently, the above-discussed terrestrial insects (which contained some dragonflies) were substituted for aquatic insects.

Sediment or soil was not included in the model for the little brown bat.

13. Raccoon Model.__ The diet of the raccoon consisted of 50% fiddler crabs and 50% fish (mummichogs). The mean concentration of a COPC in sediment from the potentially impacted area of the site was based on a prorated value derived from the mean concentrations of the COPC in sediment collected with fiddler crabs and mummichogs (refer to Table 4 in the main document). The maximum concentration of a COPC in potentially impacted sediment was the highest concentration reported in Table 4.

14. Mink Model.__ The model planned for the mink was to employ small mammals and fish (mummichogs) in its diet, each consisting of 50% of the diet. Small mammals could not be collected at the site. Therefore, several sub-models were utilized to estimate body burdens of COPC in a hypothetical small mammal. Sub-model 1, which was employed for all forms of mercury, is based on a scientific paper by Sample *et al.* (1998), who identified a 90th percentile uptake factor (UF) of 0.1484 for small mammals (in general) exposed to total mercury in soil. This UF was applied to the estimated concentration of total mercury in soil, and the distinction between body burdens of inorganic mercury and methylmercury in the hypothetical small mammal was based on a reported 10% ratio of methylmercury to total mercury in small terrestrial mammals (Watras and Huckabee, 1994; Sigel and Sigel, 1997). However, for the purpose of conservatism, it was also assumed that the hypothetical small mammal was characterized by a body burden of 100% methylmercury. In addition, a 50% body burden of methylmercury in small mammals was modeled. Sub-model 2, which addressed lead, employed the following equation by Sample *et al.* (1998):

- $\text{Conc. lead}_{mammal} = e^{0.0761} \text{ x } (\text{conc. lead}_{soil})^{0.442}$

Sub-model 3, which was employed for Aroclor 1268, was predicated on the following equation suggested by Travis and Arms (1988):

- $\text{Conc. Aroclor } 1268_{mammal} = \text{conc. Aroclor } 1268_{food} \text{ x } e^{(-7.6 + \log Kow)}$,

with food of mammal considered to be the meadow vole (also modeled as a major wildlife species in this assessment) and log Kow estimated as 8.04. Soil data employed in all models are presented in Table C-1, as is concentration of Aroclor 1268 in food (a two-component diet) of the meadow vole.

The mean concentration of a COPC in the two related substrates (soil for mammals and sediment for mummichogs) from the potentially impacted area of the site was based on a prorated value derived from the grand mean concentration of the COPC in soil (refer to Table 3 in the main document) and highest mean concentration of the COPC in sediment (refer to Table 4 in the main document).

The maximum concentration of a COPC in potentially impacted substrate was derived from the prorated maximum values associated with soil and sediment.

References

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Memorandum from S. Jones Region 4, EPA) to M. Kamilow (Honeywell). May 22, 2008. Atlanta, Ga. 6 pp.

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Table C-1.__ Assumptions and data employed in food-web exposure modeling of wildlife exposed to primary Chemicals of Potential Concern (COPC) in upland at LCP Site

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Concentrations of COPC (source of data in main body of BERA): Grass (CF1) (mg/kg, dry wt)	Plant berries (CF2) (mg/kg, dry wt)	Soil (CS) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
Wildlife Feeding Exclusively on Terrestrial Food Items							
1) Mourning dove	Inorganic mercury	Reference:	0.050 (Table 5; mean)	0.010 (Table 5; mean)	0.14 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.0063
• Body weight (BW): 0.12 kg (wet wt)	LOAEL: 0.90	Site mean:	1.4 (Table 5; mean)	0.011 (Table 5; mean)	2.3 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.13
• Diet: 50% grass/50% berries	NOAEL: 0.45	Site maximum:	12 (Table 5; Stat.13)	0.021 (Table 5; Stat. 19)	12 (Table 3; Stat. 13)	0.0026 Table 2; Rep. 1)	0.96
• Food ingestion rate (FIR):							
0.015 kg/day (dry wt)	Methylmercury	Reference:	0.0014 (Table 5; mean)	0.0025 (Table 5; all values)	0.00050 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.00025
• Soil ingestion rate (SIR):	LOAEL: 0.06	Site mean:	0.0058 (Table 5; mean)	0.0025 (Table 5; all values)	0.0020 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.00055
0.0021 kg/day (dry wt)	NOAEL: 0.02	Site maximum:	0.072 (Table 5; Stat. 13)	0.0025 (Table 5; all values)	0.010 (Table 3; Stat. 22)	0.0000078 Table 2; Rep. 1)	0.0048
• Water ingestion rate (WIR):							
0.014 L/day	Aroclor 1268	Reference:	0.070 (Table 5; mean)	0.0050 (Table 5; mean)	0.19 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.0077
	LOAEL: 3.9	Site mean:	0.88 (Table 5; mean)	0.039 (Table 5; mean)	1.1 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.077
	NOAEL: 1.3	Site maximum:	7.1 (Table 5; Stat.13)	0.0092 (Table 5; Stat.22)	8.9 (Table 3; Stat. 13)	0.00010 (Table 2; Rep. 1)	0.60
	Lead	Reference:	8.9 (Table 5; mean)	0.18 (Table 5; mean)	30 (Table 3; grand mean)	0.00051 (Table 2; mean)	0.63
	LOAEL: 11.3	Site mean:	24 (Table 5; mean)	0.26 (Table 5; mean)	91 (Table 3; grand mean)	0.00051 (Table 2; mean)	3.1
	NOAEL: 3.85	Site maximum:	140 (Table 5; Stat. 15)	0.84 (Table 5; Stat.24)	740 (Table 3; Stat. 13)	0.00089 (Table 2; Rep. 3)	22

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Insects (CF1) (mg/kg, dry wt)	Soil (CS) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
2) Carolina wren	Inorganic mercury	Reference:	0.0090 (Table 5; Footnote d; Stat. C)	0.14 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.0033
• Body weight (BW): 0.018 kg (wet wt)	LOAEL: 0.90	Site mean:	0.076 (Table 5; Footnote d; mean)	2.3 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.00019
• Diet: 100% insects	NOAEL: 0.45	Site maximum:	0.22 (Table 5; Footnote d; Stat.10)	12 (Table 3; Stat. 13)	0.0026 Table 2; Rep. 1)	0.13
• Food ingestion rate (FIR):						
0.0046 kg/day (dry wt)	Methylmercury	Reference:	0.014 (Table 5; Stat. C)	0.00050 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.0038
• Soil ingestion rate (SIR):	LOAEL: 0.06	Site mean:	0.038 (Table 5; mean)	0.0020 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.0097
0.00011 kg/day (dry wt)	NOAEL: 0.02	Site maximum:	0.097 (Table 5; Stat. 13)	0.010 (Table 3; Stat.22)	0.0000078 Table 2; Rep. 1)	0.025
• Water ingestion rate (WIR):						
0.0040 L/day	Aroclor 1268	Reference:	0.0091 (Table 5; Stat. C)	0.19 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.0035
	LOAEL: 3.9	Site mean:	0.19 (Table 5; mean)	1.1 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.0550
	NOAEL: 1.3	Site maximum:	0.63 (Table 5; Stat. 13)	8.9 (Table 3; Stat. 13)	0.00010 (Table 2; Rep. 1)	0.22
	Lead	Reference:	0.19 (Table 5; Stat. C)	30 (Table 3; grand mean)	0.00051 (Table 2; mean)	0.18
	LOAEL: 11.3	Site mean:	0.39 (Table 5; mean)	91 (Table 3; grand mean)	0.00051 (Table 2; mean)	0.66
	NOAEL: 3.85	Site maximum:	0.95 (Table 5; Stat.13)	740 (Table 3; Stat. 13)	0.00089 (Table 2; Rep. 3)	4.8

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Concentrations of COPC (source of data in main body of BERA): Mammals (CF1) (mg/kg, dry wt)	Soil (CS) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
3) Broad-winged hawk	Inorganic mercury	Reference:	0.019 (Sub-model 1) --90% IHg	0.14 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.0022
• Body weight (BW): 0.41 kg (wet wt)	LOAEL: 0.90	Site mean:	0.31 (Sub-model 1) -- 90% IHg	2.3 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.036
• Diet: 100% small mammals	NOAEL: 0.45		0.17 (Sub-model 1) -- 50% IHg			0.024
• Food ingestion rate (FIR): 0.033 kg/day (dry wt)			0 (Sub-model 1) -- 0% IHg			0.011
• Soil ingestion rate (SIR): 0.0019 kg/day (dry wt)		Site maximum:	1.6 (Sub-model 1) -- 90% IHg	12 (Table 3; Stat. 13)	0.0026 Table 2; Rep. 1)	0.18
• Water ingestion rate (WIR): 0.032 L/day			0.89 (Sub-model 1) -- 50% IHg			0.13
			0 (Sub-model 1) -- 0% IHg			0.056
	Methylmercury	Reference:	0.0021 (Sub-model 1) -- 10% MeHg	0.00050 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.00017
	LOAEL: 0.06	Site mean:	0.034 (Sub-model 1) -- 10% MeHg	0.0020 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.0027
	NOAEL: 0.02		0.17 (Sub-model 1) -- 50% MeHg			0.014
			0.34 (Sub-model 1) -- 100% MeHg			0.027
		Site maximum:	0.18 (Sub-model 1) -- 10% MeHg	0.010 (Table 3; Stat.22)	0.0000078 Table 2; Rep. 1)	0.015
			0.89 (Sub-model 1) -- 50% MeHg			0.072
			1.8 (Sub-model 1) -- 100% MeHg			0.14
	Aroclor 1268	Reference:	0.058 (Sub-model 3)	0.19 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.0056
	LOAEL: 3.9	Site mean:	0.69 (Sub-model 3)	1.1 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.061
	NOAEL: 1.3	Site maximum:	5.5 (Sub-model 3)	8.9 (Table 3; Stat. 13)	0.00010 (Table 2; Rep. 1)	0.48
	Lead	Reference:	4.9 (Sub-model 2)	30 (Table 3; grand mean)	0.00051 (Table 2; mean)	0.53
	LOAEL: 11.3	Site mean:	7.9 (Sub-model 2)	91 (Table 3; grand mean)	0.00051 (Table 2; mean)	1.1
	NOAEL: 3.85	Site maximum:	20 (Sub-model 2)	740 (Table 3; Stat. 13)	0.00089 (Table 2; Rep. 3)	5.0

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Grass (CF1) (mg/kg, dry wt)	Plant berries (CF2) (mg/kg, dry wt)	Soil (CS) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
4) Meadow vole	Inorganic mercury	Reference:	0.050 (Table 5; mean)	0.010 (Table 5; mean)	0.14 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.0079
• Body weight (BW): 0.030 kg (wet wt)	LOAEL: 0.37	Site mean:	1.4 (Table 5; mean)	0.011 (Table 5; mean)	2.3 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.18
• Diet: 50% grass/50% berries	NOAEL: 0.37	Site maximum:	12 (Table 5; Stat.13)	0.021 (Table 5; Stat. 19)	12 (Table 3; Stat. 13)	0.0026 Table 2; Rep. 1)	1.5
• Food ingestion rate (FIR): 0.0068 kg/day (dry wt)	Methylmercury	Reference:	0.0014 (Table 5; mean)	0.0025 (Table 5; all values)	0.00050 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.00045
• Soil ingestion rate (SIR): 0.00022 kg/day (dry wt)	LOAEL: 0.15	Site mean:	0.0058 (Table 5; mean)	0.0025 (Table 5; all values)	0.0020 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.00096
• Water ingestion rate (WIR): 0.0042 L/day	NOAEL: 0.075	Site maximum:	0.072 (Table 5; Stat. 13)	0.0025 (Table 5; all values)	0.010 (Table 3; Stat. 22)	0.0000078 Table 2; Rep. 1)	0.0085
	Aroclor 1268	Reference:	0.070 (Table 5; mean)	0.0050 (Table 5; mean)	0.19 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.0094
	LOAEL: 0.3	Site mean:	0.88 (Table 5; mean)	0.039 (Table 5; mean)	1.1 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.11
	NOAEL: 0.03	Site maximum:	7.1 (Table 5; Stat.13)	0.0092 (Table 5; Stat.22)	8.9 (Table 3; Stat. 13)	0.00010 (Table 2; Rep. 1)	0.87
	Lead	Reference:	8.9 (Table 5; mean)	0.18 (Table 5; mean)	30 (Table 3; grand mean)	0.00051 (Table 2; mean)	1.2
	LOAEL: 80	Site mean:	24 (Table 5; mean)	0.26 (Table 5; mean)	91 (Table 3; grand mean)	0.00051 (Table 2; mean)	3.4
	NOAEL: 8	Site maximum:	140 (Table 5; Stat. 15)	0.84 (Table 5; Stat.24)	740 (Table 3; Stat. 13)	0.00089 (Table 2; Rep. 3)	21

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Concentrations of COPC (source of data in main body of BERA): Insects (CF1) (mg/kg, dry wt)	Earthworms (CF2) (mg/kg, dry wt)	Soil (CS) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
5) Short-tailed shrew	Inorganic mercury	Reference:	0.0090 (Table 5; Footnote d; Stat. C)	0.34 (Table 7; mean)	0.14 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.021
• Body weight (BW): 0.015 kg (wet wt)	LOAEL: 0.37	Site mean:	0.076 (Table 5; Footnote d; mean)	3.8 (Table 7; mean)	2.3 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.24
• Diet: 60% insects/40% earthworms	NOAEL: 0.37	Site maximum:	0.22 (Table 5; Footnote d; Stat.10)	31 (Table 7; Stat. 13)	12 (Table 3; Stat. 13)	0.0026 Table 2; Rep. 1)	1.9
• Food ingestion rate (FIR): 0.0022 kg/day (dry wt)	Methylmercury	Reference:	0.014 (Table 5; Stat. C)	0.11 (Table 7; mean)	0.00050 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.0077
• Soil ingestion rate (SIR):	LOAEL: 0.15	Site mean:	0.038 (Table 5; mean)	0.21 (Table 7; mean)	0.0020 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.016
0.000066 kg/day (dry wt)	NOAEL: 0.075	Site maximum:	0.097 (Table 5; Stat. 13)	0.88 (Table 7; Stat. 13)	0.010 (Table 3; Stat. 22)	0.0000078 Table 2; Rep. 1)	0.060
• Water ingestion rate (WIR): 0.0023 L/day	Aroclor 1268	Reference:	0.0091 (Table 5; Stat. C)	0.34 (Table 7; mean)	0.19 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.022
	LOAEL: 0.3	Site mean:	0.19 (Table 5; mean)	2.7 (Table 7; mean)	1.1 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.18
	NOAEL: 0.03	Site maximum:	0.63 (Table 5; Stat. 13)	13 (Table 7; Stat. 13)	8.9 (Table 3; Stat. 13)	0.00010 (Table 2; Rep. 1)	0.86
	Lead	Reference:	0.19 (Table 5; Stat. C)	33 (Table 7; mean)	30 (Table 3; grand mean)	0.00051 (Table 2; mean)	2.1
	LOAEL: 80	Site mean:	0.39 (Table 5; mean)	71 (Table 7; mean)	91 (Table 3; grand mean)	0.00051 (Table 2; mean)	4.6
	NOAEL: 8	Site maximum:	0.95 (Table 5; Stat.13)	400 (Table 7; Stat. 15)	740 (Table 3; Stat. 13)	0.00089 (Table 2; Rep. 3)	27

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Mammals (CF1) (mg/kg, dry wt)	Soil (CS) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
6) Long-tailed weasel	Inorganic mercury	Reference:	0.019 (Sub-model 1) --90% IHg	0.14 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.0025
• Body weight (BW): 0.19 kg (wet wt)	LOAEL: 0.37	Site mean	0.31 (Sub-model 1) -- 90% IHg	2.3 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.039
• Diet: 100% small mammals	NOAEL: 0.37		0.17 (Sub-model 1) -- 50% IHg			0.026
• Food ingestion rate (FIR):			0 (Sub-model 1) -- 0% IHg			0.0094
0.018 kg/day (dry wt)						
• Soil ingestion rate (SIR):		Site maximum	1.6 (Sub-model 1) -- 90% IHg	12 (Table 3; Stat. 13)	0.0026 Table 2; Rep. 1)	0.20
0.00077 kg/day (dry wt)			0.89 (Sub-model 1) -- 50% IHg			0.13
• Water ingestion rate (WIR):			0 (Sub-model 1) -- 0% IHg			0.049
0.022 L/day						
	Methylmercury	Reference:	0.0021 (Sub-model 1) -- 10% MeHg	0.00050 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.00020
	LOAEL: 0.15	Site mean	0.034 (Sub-model 1) -- 10% MeHg	0.0020 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.0032
	NOAEL: 0.075		0.17 (Sub-model 1) -- 50% MeHg			0.016
			0.34 (Sub-model 1) -- 100% MeHg			0.032
		Site maximum	0.18 (Sub-model 1) -- 10% MeHg	0.010 (Table 3; Stat.22)	0.0000078 Table 2; Rep. 1)	0.017
			0.89 (Sub-model 1) -- 50% MeHg			0.084
			1.8 (Sub-model 1) -- 100% MeHg			0.17
	Aroclor 1268	Reference:	0.058 (Sub-model 3)	0.19 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.0063
	LOAEL: 0.3	Site mean:	0.69 (Sub-model 3)	1.1 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.070
	NOAEL: 0.03	Site maximum:	5.5 (Sub-model 3)	8.9 (Table 3; Stat. 13)	0.00010 (Table 2; Rep. 1)	0.56
	Lead	Reference:	4.9 (Sub-model 2)	30 (Table 3; grand mean)	0.00051 (Table 2; mean)	0.59
	LOAEL: 80	Site mean:	7.9 (Sub-model 2)	91 (Table 3; grand mean)	0.00051 (Table 2; mean)	0.75
	NOAEL: 8	Site maximum:	20 (Sub-model 2)	740 (Table 3; Stat. 13)	0.00089 (Table 2; Rep. 3)	4.9

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Concentrations of COPC (source of data in main body of BERA): Insects (CF1) (mg/kg, dry wt)	Plant berries (CF2) (mg/kg, dry wt)	Soil (CS) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
			Wildlife Feeding at Least Partly on Estuarine Food Items		Changed from Sediment		
7) Common yellowthroat	Inorganic mercury	Reference:	0.0090 (Table 5; Footnote d; Stat. C)	0.010 (Table 5; mean)	0.14 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.0037
• Body weight (BW): 0.012 kg (wet wt)	LOAEL: 0.90	Site mean:	0.076 (Table 5; Footnote d; mean)	0.011 (Table 5; mean)	2.3 (Table 3; grand mean)	0.00087 (Table 2; mean)	0.033
• Diet: 80% insects/20% berries	NOAEL: 0.45	Site maximum:	0.22 (Table 5; Footnote d; Stat.10)	0.021 (Table 5; Stat. 19)	12 (Table 3; Stat. 13)	0.0026 Table 2; Rep. 1)	0.13
• Food ingestion rate (FIR): 0.0033 kg/day (dry wt)	Methylmercury	Reference:	0.014 (Table 5; Stat. C)	0.0025 (Table 5; all values)	0.00050 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.0032
• Soil ingestion rate (SIR): 0.000079 kg/day (dry wt)	LOAEL: 0.06	Site mean:	0.038 (Table 5; mean)	0.0025 (Table 5; all values)	0.0020 (Table 3; grand mean)	0.0000037 (Table 2; mean)	0.0085
• Water ingestion rate (WIR): 0.0030 L/day	NOAEL: 0.02	Site maximum:	0.097 (Table 5; Stat. 13)	0.0025 (Table 5; all values)	0.010 (Table 3; Stat. 22)	0.0000078 Table 2; Rep. 1)	0.022
	Aroclor 1268	Reference:	0.0091 (Table 5; Stat. C)	0.0050 (Table 5; mean)	0.19 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.0035
	LOAEL: 3.9	Site mean:	0.19 (Table 5; mean)	0.039 (Table 5; mean)	1.1 (Table 3; grand mean)	0.000022 (Table 2; mean)	0.051
	NOAEL: 1.3	Site maximum:	0.63 (Table 5; Stat. 13)	0.0092 (Table 5; Stat.22)	8.9 (Table 3; Stat. 13)	0.00010 (Table 2; Rep. 1)	0.20
	Lead	Reference:	0.19 (Table 5; Stat. C)	0.18 (Table 5; mean)	30 (Table 3; grand mean)	0.00051 (Table 2; mean)	0.249
	LOAEL: 11.3	Site mean:	0.39 (Table 5; mean)	0.26 (Table 5; mean)	91 (Table 3; grand mean)	0.00051 (Table 2; mean)	0.7
	NOAEL: 3.85	Site maximum:	0.95 (Table 5; Stat.13)	0.84 (Table 5; Stat.24)	740 (Table 3; Stat. 13)	0.00089 (Table 2; Rep. 3)	5.1
			Insects (CF1) (mg/kg, dry wt)	**Fiddler crabs (CF2) (mg/kg, dry wt)**	**Soil/Sediment (CS) (mg/kg, dry wt)**	**Water (CW) (mg/L)**	**Estimated environmental exposure -- EEE (mg/kg BW/day)**
8) Willet	Inorganic mercury	Reference:	0.0090 (Table 5; Footnote d; Stat. C)	----------	----------	0.00087 (Table 2; mean)	----------
• Body weight (BW): 0.22 kg (wet wt)	LOAEL: 0.90	Site mean:	0.076 (Table 5; Footnote d; mean)	0.087 (Table 6; mean)	2.1 (mean: 80% of 2.3 [Table 3] + 20% of 1.34 [Table 4])	0.00087 (Table 2; mean)	0.023
• Diet: 80% insects/20% fiddler crabs	NOAEL: 0.45	Site maximum:	0.22 (Table 5; Footnote d; Stat.10)	0.17 (Table 6; Stat. M-AB)	10 (mean: 80% of 12 [Table 3] + 20% of 2.7 [Table 4])	0.0026 Table 2; Rep. 1)	0.094
• Food ingestion rate (FIR): 0.022 kg/day (dry wt)	Methylmercury	Reference:	0.014 (Table 5; Stat. C)	----------	----------	0.0000037 (Table 2; mean)	----------
	LOAEL: 0.06	Site mean:	0.038 (Table 5; mean)	0.36 (Table 6; mean)	0.0024 (mean: 80% of 0.0020 [Table 3] + 20% of 0.0042 [Table 4])	0.0000037 (Table 2; mean)	0.010
• Soil/sedimemt ingestion rate (SIR): 0.0016 kg/day (dry wt)	NOAEL: 0.02	Site maximum:	0.097 (Table 5; Stat. 13)	0.79 (Table 6; Stat. M-AB)	0.010 (mean: 80% of 0.010 [Table 3] + 20% of 0.010 [Table 4])	0.0000078 Table 2; Rep. 1)	0.024
• Water ingestion rate (WIR): 0.021 L/day	Aroclor 1268	Reference:	0.0091 (Table 5; Stat. C)	0.0042 (Table 6; R)	0.16 (mean: 80% of 0.19 [Table 3] + 20% of 0.065 [Table 4])	0.000022 (Table 2; mean)	0.0020
	LOAEL: 3.9	Site mean:	0.19 (Table 5; mean)	1.5 (Table 6; mean)	1.4 (mean: 80% of 1.1 [Table 3] + 20% of 2.8 [Table 4])	0.000022 (Table 2; mean)	0.055
	NOAEL: 1.3	Site maximum:	0.63 (Table 5; Stat. 13)	4.6 (Table 6; Stat. M-AB)	9.1 (mean: 80% of 8.9 [Table 3] + 20% of 10 [Table 4])	0.00010 (Table 2; Rep. 1)	0.21
	Lead	Reference:	0.19 (Table 5; Stat. C)	0.77 (Table 6; R)	28 (mean: 80% of 30 [Table 3] + 20% of 20 [Table 4])	0.00051 (Table 2; mean)	0.23
	LOAEL: 11.3	Site mean:	0.39 (Table 5; mean)	1.0 (Table 6; mean)	150 (mean: 80% of 91 [Table 3] + 20% of 400 [Table 4])	0.00051 (Table 2; mean)	1.1
	NOAEL: 3.85	Site maximum:	0.95 (Table 5; Stat.13)	2.0 (Table 6; Stat. M-AB)	910 (mean: 80% of 740 [Table 3] + 20% of 1,600 [Table 4])	0.00089 (Table 2; Rep. 3)	6.7

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Concentrations of COPC (source of data in main body of BERA): Spiders (CF1) (mg/kg, dry wt)	Fish (mummichogs) -- (CF2) (mg/kg, dry wt)	Sediment (CS) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
9) Pied-billed grebe	<u>Inorganic mercury</u>	Reference:	----------	----------	----------	0.00087 (Table 2; mean)	----------
• Body weight (BW): 0.44 kg (wet wt)	LOAEL: 0.90	Site mean:	0.1 (Table 5; Footnote e)	0.17 (Table 6; mean)	0.97 (Table 4; mean: 0.60 & 1.34)	0.00087 (Table 2; mean)	0.017
• Diet: 80% spiders/20% fish	NOAEL: 0.45	Site maximum:		0.24 (Table 6; C-9)	2.7 (Table 4; Stat. C-5)	0.0026 Table 2; Rep. 1)	0.033
• Food ingestion rate (FIR): 0.034 kg/day (dry wt)	<u>Methylmercury</u>	Reference:	----------	----------	----------	0.0000037 (Table 2; mean)	----------
• Sediment ingestion rate (SIR):	LOAEL: 0.06	Site mean:	1.2 (Table 5)	0.40 (Table 6; mean)	0.0022 (Table 4; mean: 0.0042 & 0.00026)	0.0000037 (Table 2; mean)	0.080
0.0037 kg/day (dry wt)	NOAEL: 0.02	Site maximum:		0.67 (Table 6; Stat. C-9)	0.010 (Table 4; NOAA 8)	0.0000078 Table 2; Rep. 1)	0.085
• Water ingestion rate (WIR): 0.034 L/day	<u>Aroclor 1268</u>	Reference:	----------	0.070 (Table 6; Stat. R)	0.065 (Table 4; Stat. M-R)	0.000022 (Table 2; mean)	----------
	LOAEL: 3.9	Site mean:	1.4 (Table 5)	4.4 (Table 6; mean)	1.6 (Table 4; mean: 0.46 & 2.8)	0.000022 (Table 2; mean)	0.17
	NOAEL: 1.3	Site maximum:		6.4 (Table 6; C-9)	10 (Table 4; Stat. C-5)	0.00010 (Table 2; Rep. 1)	0.27
	<u>Lead</u>	Reference:	----------	0.18 (Table 6; Stat. R)	20 (Table 4; Stat. R)	0.00051 (Table 2; mean)	----------
	LOAEL: 11.3	Site mean:	2.4 (Table 5)	0.48 (Table 6; mean)	280 (Table 4; mean: 160 & 400)	0.00051 (Table 2; mean)	2.5
	NOAEL: 3.85	Site maximum:		0.83 (Table 6; Stat. C-33)	1,600 (Table 4; Stat. C-33)	0.00089 (Table 2; Rep. 3)	14
			Fiddler crabs (CF1) (mg/kg, dry wt)	**Fish (mummichogs) -- (CF2) (mg/kg, dry wt)**	**Sediment (CS) (mg/kg, dry wt)**	**Water (CW) (mg/L)**	**Estimated environmental exposure -- EEE (mg/kg BW/day)**
10) Clapper rail	<u>Inorganic mercury</u>	Reference:	----------	----------	----------	0.00087 (Table 2; mean)	----------
• Body weight (BW): 0.28 kg (wet wt)	LOAEL: 0.90	Site mean:	0.087 (Table 6; mean)	0.17 (Table 6; mean)	0.67 (Table 4; mean: 90% of 0.60 + 10% of 1.34)	0.00087 (Table 2; mean)	0.015
• Diet: 90% fiddler crabs/10% fish	NOAEL: 0.45	Site maximum:	0.17 (Table 6; Stat. M-AB)	0.24 (Table 6; C-9)	2.7 (Table 4; Stat.C-5)	0.0026 Table 2; Rep. 1)	0.040
• Food ingestion rate (FIR): 0.025 kg/day (dry wt)	<u>Methylmercury</u>	Reference:	----------	----------	----------	0.0000037 (Table 2; mean)	----------
• Sediment ingestion rate (SIR):	LOAEL: 0.06	Site mean:	0.36 (Table 6; mean)	0.40 (Table 6; mean)	0.0038 (Table 4; mean: 90% of 0.0042 + 10% of 0.00026)	0.0000037 (Table 2; mean)	0.033
0.0025 kg/day (dry wt)	NOAEL: 0.02	Site maximum:	0.79 (Table 6; Stat. M-AB)	0.67 (Table 6; Stat. C-9)	0.010 (Table 4; Stat. NOAA 8)	0.0000078 Table 2; Rep. 1)	0.070
• Water ingestion rate (WIR): 0.025 L/day	<u>Aroclor 1268</u>	Reference:	0.0042 (Table 6; R)	0.070 (Table 6; Stat. R)	0.033 (Table 4; mean: 90% of 0.029 + 10% of 0.065)	0.000022 (Table 2; mean)	0.0013
	LOAEL: 3.9	Site mean:	1.5 (Table 6; mean)	4.4 (Table 6; mean)	0.69 (Table 4; mean: 90% of 0.46 + 10% of 2.8)	0.000022 (Table 2; mean)	0.17
	NOAEL: 1.3	Site maximum:	4.6 (Table 6; Stat. M-AB)	6.4 (Table 6; C-9)	10 (Table 4; Stat. C-5)	0.00010 (Table 2; Rep. 1)	0.52
	<u>Lead</u>	Reference:	0.77 (Table 6; R)	0.18 (Table 6; Stat. R)	20 (Table 4; mean: 90% of 20 + 10% of 18)	0.00051 (Table 2; mean)	0.24
	LOAEL: 11.3	Site mean:	1.0 (Table 6; mean)	0.48 (Table 6; mean)	180 (Table 4; mean: 90% of 160 + 10% of 400)	0.00051 (Table 2; mean)	1.7
	NOAEL: 3.85	Site maximum:	2.0 (Table 6; Stat. M-AB)	0.83 (Table 6; Stat. C-33)	1,600 (Table 4; Stat. C-33)	0.00089 (Table 2; Rep. 3)	14

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Concentrations of COPC (source of data in main body of BERA): Fish (mummichogs) -- (CF1) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
11) Belted kingfisher	Inorganic mercury	Reference:	----------	0.00087 (Table 2; mean)	----------
• Body weight (BW): 0.15 kg (wet wt)	LOAEL: 0.90	Site mean:	0.17 (Table 6; mean)	0.00087 (Table 2; mean)	0.019
• Diet: 100% fish	NOAEL: 0.45	Site maximum:	0.24 (Table 6; C-9)	0.0026 Table 2; Rep. 1)	0.028
• Food ingestion rate (FIR): 0.017 kg/day (dry wt)	Methylmercury	Reference:	----------	0.0000037 (Table 2; mean)	----------
• Sediment ingestion rate (SIR): 0	LOAEL: 0.06	Site mean:	0.40 (Table 6; mean)	0.0000037 (Table 2; mean)	0.045
• Water ingestion rate (WIR): 0.027 L/day	NOAEL: 0.02	Site maximum:	0.67 (Table 6; Stat. C-9)	0.0000078 Table 2; Rep. 1)	0.076
	Aroclor 1268	Reference:	0.070 (Table 6; Stat. R)	0.000022 (Table 2; mean)	0.0079
	LOAEL: 3.9	Site mean:	4.4 (Table 6; mean)	0.000022 (Table 2; mean)	0.50
	NOAEL: 1.3	Site maximum:	6.4 (Table 6; C-9)	0.00010 (Table 2; Rep. 1)	0.73
	Lead	Reference:	0.18 (Table 6; Stat. R)	0.00051 (Table 2; mean)	0.020
	LOAEL: 11.3	Site mean:	0.48 (Table 6; mean)	0.00051 (Table 2; mean)	0.054
	NOAEL: 3.85	Site maximum:	0.83 (Table 6; Stat. C-33)	0.00089 (Table 2; Rep. 3)	0.094
			Insects (CF1) (mg/kg, dry wt)	**Water (CW) (mg/L)**	**Estimated environmental exposure -- EEE (mg/kg BW/day)**
12) Little brown bat	Inorganic mercury	Reference:	0.0090 (Table 5; Footnote d; Stat. C)	0.00087 (Table 2; mean)	0.0016
• Body weight (BW): 0.0075 kg (wet wt)	LOAEL: 0.37	Site mean:	0.076 (Table 5; Footnote d; mean)	0.00087 (Table 2; mean)	0.012
• Diet: 100% insects	NOAEL: 0.37	Site maximum:	0.22 (Table 5; Footnote d; Stat.10)	0.0026 Table 2; Rep. 1)	0.036
• Food ingestion rate (FIR): 0.0012 kg/day (dry wt)	Methylmercury	Reference:	0.014 (Table 5; Stat. C)	0.0000037 (Table 2; mean)	0.0022
• Soil ingestion rate (SIR): 0	LOAEL: 0.15	Site mean:	0.038 (Table 5; mean)	0.0000037 (Table 2; mean)	0.0061
• Water ingestion rate (WIR): 0.0012 L/day	NOAEL: 0.075	Site maximum:	0.097 (Table 5; Stat. 16)	0.0000078 Table 2; Rep. 1)	0.016
	Aroclor 1268	Reference:	0.0091 (Table 5; Stat. C)	0.000022 (Table 2; mean)	0.0015
	LOAEL: 0.3	Site mean:	0.19 (Table 5; mean)	0.000022 (Table 2; mean)	0.030
	NOAEL: 0.03	Site maximum:	0.63 (Table 5; Stat. 13)	0.00010 (Table 2; Rep. 1)	0.10
	Lead	Reference:	0.19 (Table 5; Stat. C)	0.00051 (Table 2; mean)	0.030
	LOAEL: 80	Site mean:	0.39 (Table 5; mean)	0.00051 (Table 2; mean)	0.062
	NOAEL: 8	Site maximum:	0.95 (Table 5; Stat.13)	0.00089 (Table 2; Rep. 3)	0.15

Modeled wildlife -- exposure assumptions	Evaluated COPC -- TRVs (mg/kgBW/day)	Evaluated Area	Concentrations of COPC (source of data in main body of BERA): Fiddler crabs (CF1) (mg/kg, dry wt)	Fish (mummichogs) -- (CF2) (mg/kg, dry wt)	Sediment (CS) (mg/kg, dry wt)	Water (CW) (mg/L)	Estimated environmental exposure -- EEE (mg/kg BW/day)
13) Raccoon	Inorganic mercury	Reference:	----------	----------	----------	0.00087 (Table 2; mean)	----------
• Body weight (BW): 3.7 kg (wet wt)	LOAEL: 0.37	Site mean:	0.087 (Table 6; mean)	0.17 (Table 6; mean)	0.97 (Table 4; mean: 0.60 & 1.34)	0.00087 (Table 2; mean)	0.012
• Diet: 50% fiddler crabs/50% fish	NOAEL: 0.37	Site maximum:	0.17 (Table 6; Stat. M-AB)	0.24 (Table 6; C-9)	2.7 (Table 4; Stat. C-5)	0.0026 Table 2; Rep. 1)	0.025
• Food ingestion rate (FIR): 0.20 kg/day (dry wt)	Methylmercury	Reference:	----------	----------	----------	0.0000037 (Table 2; mean)	----------
• Sediment ingestion rate (SIR): 0.019 kg/day (dry wt)	LOAEL: 0.15	Site mean:	0.36 (Table 6; mean)	0.40 (Table 6; mean)	0.0022 (Table 4; mean: 0.0042 & 0.00026)	0.0000037 (Table 2; mean)	0.021
• Water ingestion rate (WIR): 0.32 L/day	NOAEL: 0.075	Site maximum:	0.79 (Table 6; Stat. M-AB)	0.67 (Table 6; Stat. C-9)	0.010 (Table 4; Stat. NOAA 8)	0.0000078 Table 2; Rep. 1)	0.040
	Aroclor 1268	Reference:	0.0042 (Table 6; R)	0.070 (Table 6; Stat. R)	0.047 (Table 4; mean: 0.029 & 0.065)	0.000022 (Table 2; mean)	0.0022
	LOAEL: 0.3	Site mean:	1.5 (Table 6; mean)	4.4 (Table 6; mean)	1.6 (Table 4; mean: 0.46 & 2.8)	0.000022 (Table 2; mean)	0.17
	NOAEL: 0.03	Site maximum:	4.6 (Table 6; Stat. M-AB)	6.4 (Table 6; C-9)	10 (Table 4; Stat.C-5)	0.00010 (Table 2; Rep. 1)	0.35
	Lead	Reference:	0.77 (Table 6; R)	0.18 (Table 6; Stat. R)	19 (Table 4; mean: 20 & 18)	0.00051 (Table 2; mean)	0.12
	LOAEL: 80	Site mean:	1.0 (Table 6; mean)	0.48 (Table 6; mean)	280 (Table 4; mean; 160 & 400)	0.00051 (Table 2; mean)	1.5
	NOAEL: 8	Site maximum:	2.0 (Table 6; Stat. M-AB)	0.83 (Table 6; Stat. C-33)	1,600 (Table 4; Stat. C-33)	0.00089 (Table 2; Rep. 3)	8.3
			Mammals (CF1) (mg/kg, dry wt)	**Fish (mummichogs) -- (CF2) (mg/kg, dry wt)**	**Soil/Sediment (CS) (mg/kg, dry wt)**	**Water (CW) (mg/L)**	**Estimated environmental exposure -- EEE (mg/kg BW/day)**
14) Mink	Inorganic mercury	Reference:	0.019 (Sub-model 1) --90% IHg	----------	0.13 (mean: 50% of 0.14 [Table 3] + 50% of 0.12 [Table 4])	0.00087 (Table 2; mean)	0.0022
• Body weight (BW): 1.0 kg (wet wt) • Diet: 50% small mammals/50% fish • Food ingestion rate (FIR): 0.069 kg/day (dry wt)	LOAEL: 0.37 NOAEL: 0.37	Site mean:	0.31 (Sub-model 1) -- 90% IHg 0.17 (Sub-model 1) -- 50% IHg 0 (Sub-model 1) -- 0% IHg	0.17 (Table 6; mean)	1.8 (mean: 50% of 2.3 [Table 3] + 50% of 1.34 [Table 4])	0.00087 (Table 2; mean)	0.028 0.024 0.018
• Soil/sediment ingestion rate (SIR): 0.0065 kg/day (dry wt) • Water ingestion rate (WIR): 0.099 L/day		Site maximum:	1.6 (Sub-model 1) -- 90% IHg 0.89 (Sub-model 1) -- 50% IHg 0 (Sub-model 1) -- 0% IHg	0.24 (Table 6; C-9)	7.4 (mean: 50% of 12 [Table 3] + 50% of 2.7 [Table 4])	0.0026 Table 2; Rep. 1)	0.11 0.087 0.057
	Methylmercury	Reference:	0.0021 (Sub-model 1) -- 10% MeHg	----------	0.00050 (mean: 0.00050 [Table 3] + 0 [Table 4])	0.0000037 (Table 2; mean)	0.00015
	LOAEL: 0.15 NOAEL: 0.075	Site mean:	0.034 (Sub-model 1) -- 10% MeHg 0.17 (Sub-model 1) -- 50% MeHg 0.34 (Sub-model 1) -- 100% MeHg	0.40 (Table 6; mean)	0.0031 (mean: 50% of 0.0020 [Table 3] + 50% of 0.0042 [Table 4])	0.0000037 (Table 2; mean)	0.015 0.020 0.026
		Site maximum:	0.18 (Sub-model 1) -- 10% MeHg 0.89 (Sub-model 1) -- 50% MeHg 1.8 (Sub-model 1) -- 100% MeHg	0.67 (Table 6; Stat. C-9)	0.010 (mean: 50% of 0.010 [Table 3] + 50% of 0.010 [Table 4])	0.0000078 Table 2; Rep. 1)	0.029 0.054 0.085
	Aroclor 1268	Reference:	0.058 (Sub-model 3)	0.070 (Table 6; Stat. R)	0.13 (mean: 50% of 0.19 [Table 3] + 50% of 0.065 [Table 4])	0.000022 (Table 2; mean)	0.0053
	LOAEL: 0.3	Site mean:	0.69 (Sub-model 3)	4.4 (Table 6; mean)	2.0 (mean: 50% of 1.1 [Table 3] + 50% of 2.8 [Table 4])	0.000022 (Table 2; mean)	0.19
	NOAEL: 0.03	Site maximum:	5.5 (Sub-model 3)	6.4 (Table 6; C-9)	9.4 (mean: 50% of 8.9 [Table 3] + 50% of 10 [Table 4])	0.00010 (Table 2; Rep. 1)	0.47
	Lead	Reference:	4.9 (Sub-model 2)	0.18 (Table 6; Stat. R)	25 (mean: 50% of 30 [Table 3] + 50% of 20 [Table 4])	0.00051 (Table 2; mean)	0.34
	LOAEL: 80	Site mean:	7.9 (Sub-model 2)	0.48 (Table 6; mean)	240 (mean: 50% of 91 [Table 3] + 50% of 400 [Table 4])	0.00051 (Table 2; mean)	1.8
	NOAEL: 8	Site maximum:	20 (Sub-model 2)	0.83 (Table 6; Stat. C-33)	1,200 (mean: 50% of 740 [Table 3] + 50% of 1,600 [Table 4])	0.00089 (Table 2; Rep. 3)	8.5

Appendix D

Basic Information Employed for Back-Calculation of Preliminary Remedial Goals (PRGs) for Wildlife Potentially Exposed to Primary Chemicals of Potential Concern (COPC) in Upland at LCP Site

This appendix contains the information employed to derive back-calculated PRGs for wildlife potentially exposed to primary COPC. This information was developed for those wildlife/COPC combinations characterized by hazard quotients (HQs) > unity (1) – in Table 11 of the main body of this document. This information was then utilized to generate the node-based PRGs presented in Table 12 of the main body of the document.

D.1 Table

Table D-1 identifies Node 1 and Node 7 PRGs for wildlife/COPC combinations, which are associated with, respectively, no-observed-adverse-effect-level (NOAEL) and lowest-observed-adverse-effect-level (LOAEL) toxicity reference values (TRVs). Each of these PRGs was derived by employing the basic assumptions pertaining to each species of wildlife (e. g., ingestion rates and body weights), and then "back calculating" the relationship between concentration of COPC in substrate (soil and/or sediment) and body burden(s) of COPC in food item(s) of wildlife until the related HQ equaled or approximated unity (1).

The key element in the back-calculation procedure is the bioaccumulation factor (BAF), by which the relationship between concentration of COPC in substrate and body burden of COPC in food item of wildlife is estimated.

D.2 Figures

BAFs are estimated in Figures D.1 through D-18 according to the following organization:

- Soil-based BAFs: Figures D. 1 through D.12, with BAFs for mercury, Aroclor 1268, and lead sequentially presented according to food items of interest (grass, plant berries, insects, and earthworms)

- Sediment-based BAFs: Figures D. 13 through D.18, with BAFs for mercury, Aroclor 1268, and lead sequentially presented according to food items of interest (fiddler crabs and mummichogs)

In most cases, the relationships between concentrations of COPC in surface substrate and body burdens of food items of wildlife were modeled by logarithmic regression because the asymptotic character of this type of regression seemed theoretically appropriate. These curves sometimes underestimated data points for body burdens of COPC in food items. (Discrepancies between regression curves or lines vs. associated data are to be expected unless a perfect fit [R^2 = 1] occurs between independent and dependent variables.) However, the BAFs employed in deriving back-calculated RGOs for COPC in substrate are not based on these logarithmic relationships, but rather on modeled mean values for the actual data (Burkhard, 2006). These mean values can be interpreted by linear regression in which the regression line is not forced through the origin of the graph. The R^2 values for these linear regressions often indicated a better fit to data than the logarithmic R^2 values, but were statistically significant (a relatively robust criterion in evaluations of this type) in only some cases.

Statistically significant soil-based BAFs occurred for mercury in grass and earthworms; Aroclor 1268 in grass and plant berries; and lead in plant berries and earthworms. The absence of significant relationships between COPC in soil and insects is not surprising since mobile insects are likely to have been exposed to soil other than that directly associated with their capture.

There were no statistically significant BAFs for wildlife food items (fiddler crabs and mummichogs) exposed to sediment. This may be largely due to the limited sample size specified in the experimental design for the upland BERA, as contrasted to the Estuarine BERA. In the upland investigation, the estuarine sampling stations selected for collection of wildlife food items were just those reasonably close to the upland, where upland wildlife would theoretically be expected to frequent. The following BAFs were derived for these sampling stations: 1) fiddler crabs for mercury (0.49), Aroclor 1268 (2.7), and lead (0.0052); and 2) mummichogs for mercury (0.24), Aroclor 1268 (1.2), and lead (0.00096). These modeled BAFs, and associated RGOs, cannot be assumed to be representative of the entire estuary. For example, the BAFs for fiddler crabs exposed to mercury and Aroclor 1268 are expected to be atypically high because of the inclusion of the AB Seep Station in the experimental design for the upland. The BAFs for estuarine food items of wildlife – and related PRGs – can most reliably be based on the more voluminous data ultimately derived in the Estuarine BERA.

In this upland BERA, the reliability of the back-calculation procedure, which focuses on BAFs, can be roughly evaluated by comparing PRGs estimated by that procedure to those derived by a relatively simple procedure in which BAFs are only indirectly considered (not directly calculated). In this latter procedure, the mean concentration of a COPC in substrate is adjusted (divided by) the mean HQ associated with the substrate concentration.

The embedded table on the following page compares the back-calculation procedure with the simple procedure for estimating Node 1 (NOAEL-based) and Node 7 (LOAEL-based) PRGs for substrate (soil and/or sediment). In all cases, the two procedures generated similar (sometimes identical) RGOs.

Comparison of Back-Calculation and Simple Procedures for Estimating Preliminary Remedial Goals (PRGs) for Substrate

	Node 1 PRG (mg/kg, dry wt)		Node 7 PRG (mg/kg, dry wt)	
Wildlife -- Substrate Evaluated	**Back-Calculation Procedure**	**Simple Procedure**	**Back-Calculation Procedure**	**Simple Procedure**
Total Mercury (Based on Methylmercury Exposure)				
Broad-winged hawk (50% / 100% MeHg in small mammal food) -- soil	**3.5/1.7**	**3.3/1.7**	**10/5.0**	**10/5.1**
Long-tailed weasel (100% MeHg in small mammal food) -- soil	**5.3**	**5.3**	**11**	**11**
Pied-billed grebe -- sediment	1.1	0.24	3.2	0.73
Clapper rail -- Sediment	0.47	0.41	1.5	1.2
Belted kingfisher -- sediment	0.75	0.43	2.2	1.3
Total Mercury (Based on Inorganic Mercury Exposure)				
Mourning dove -- soil	**6.7**	**7.9**	**13**	**16**
Meadow vole -- soil	**3.8**	**4.7**	**3.8**	**4.7**
Short-tailed shrew -- soil	**2.8**	**3.5**	**2.8**	**3.5**
Aroclor 1268 (Based on Aroclor 1254 TRVs)				
Meadow vole -- soil	**0.36**	**0.30**	**3.6**	**3.0**
Short-tailed shrew -- soil	**0.21**	**0.18**	**2.1**	**1.8**
Long-tailed weasel -- soil	**0.60**	**0.47**	**6.0**	**4.8**
Little brown bat -- sediment (soil surrogate employed)	2.3	1.1	23	11
Raccoon -- sediment	0.27	0.28	2.7	2.8
Mink -- soil/sediment	0.45	0.32	4.5	3.2
Lead				
Mourning dove -- soil	**135**	**110**	**400**	**340**
Short-tailed shrew -- soil	**240**	**160**	**2,400**	**1,500**
Willet -- soil/sediment	500	520	1,500	1,500
Pied-billed grebe -- sediment	450	430	1,300	1,300
Clapper rail -- sediment	400	400	1,200	1,200

Note: PRGs estimated by the back-calculation procedure are derived from Table D-1 in this appendix. PRGs estimated by the simple method are typically derived as mean concentration of COPC in substrate (from Table C-1 in Appendix C) / mean hazard quotient (from Table 10 in main body of this document). However, for the belted kingfisher exposed to mercury (which was not modeled for intake of sediment), concentration of mercury in sediment was derived as the grand mean of the two mean values presented in Table 4 of the main body of the document. For the little brown bat exposed to Aroclor 1268 (also not modeled for uptake of substrate), concentration of Aroclor 1268 in soil was derived as the grand mean value presented in Table 3 of the main body of the document.

Figure D.1.__ Relationship between concentrations of total mercury in surface soil and inorganic mercury in grass in upland at LCP Site

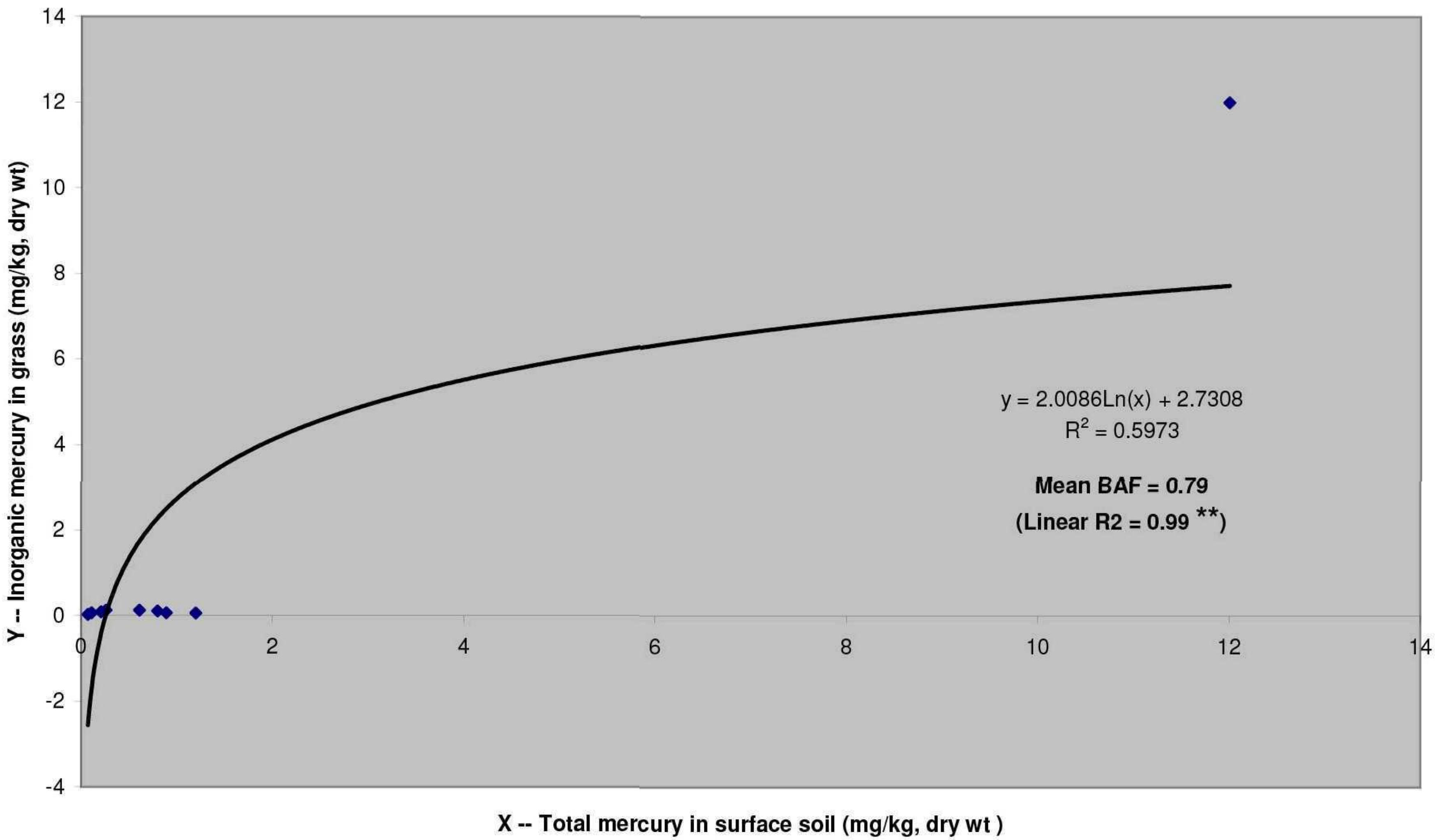

Table D.2.__ Relationship between concentrations of total mercury in surface soil and inorganic mercury in plants (berries) in upland at LCP Site

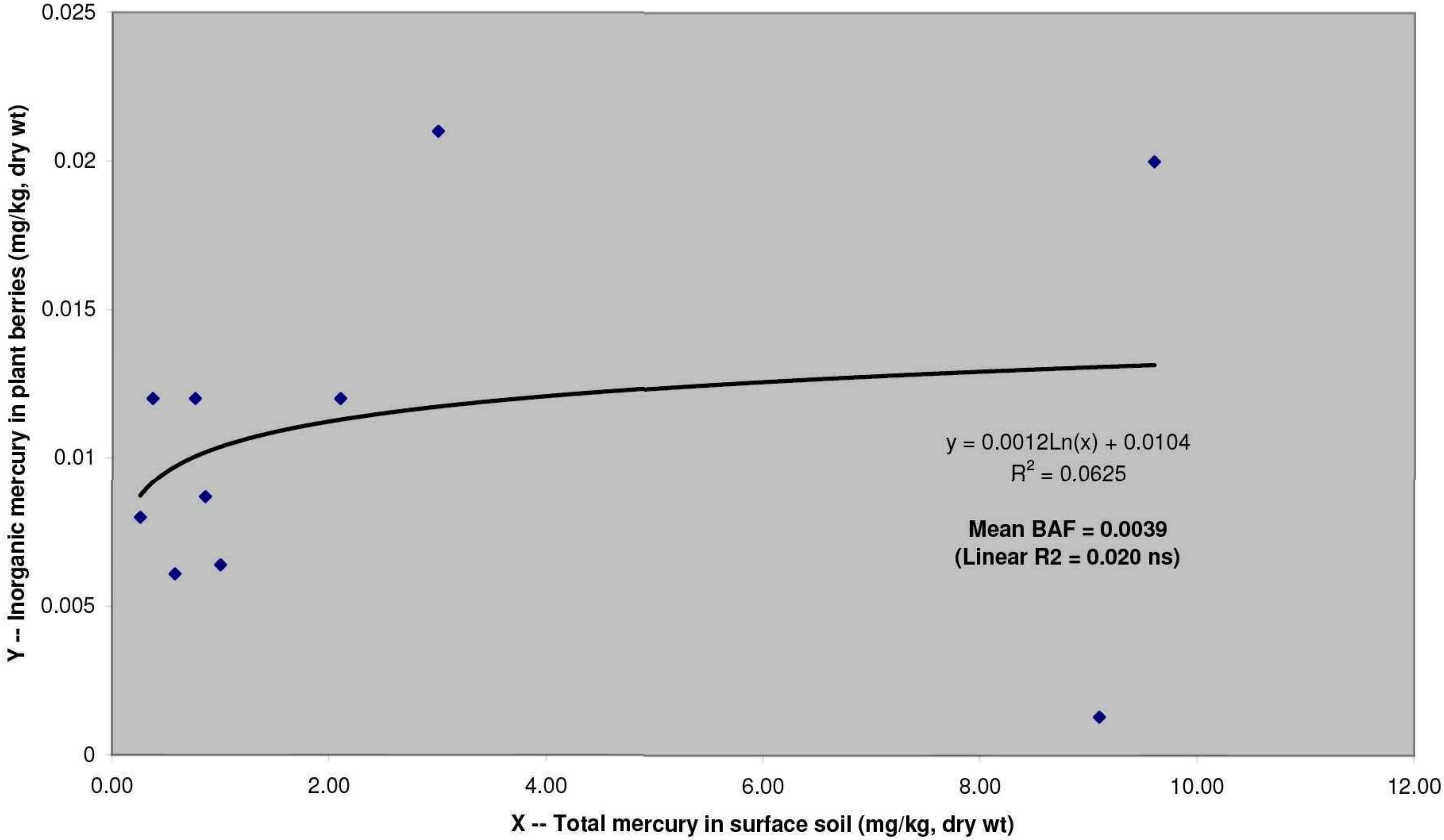

Figure D.3.__ Relationship between concentrations of total mercury in surface soil and inorganic mercury in insects in upland at LCP Site

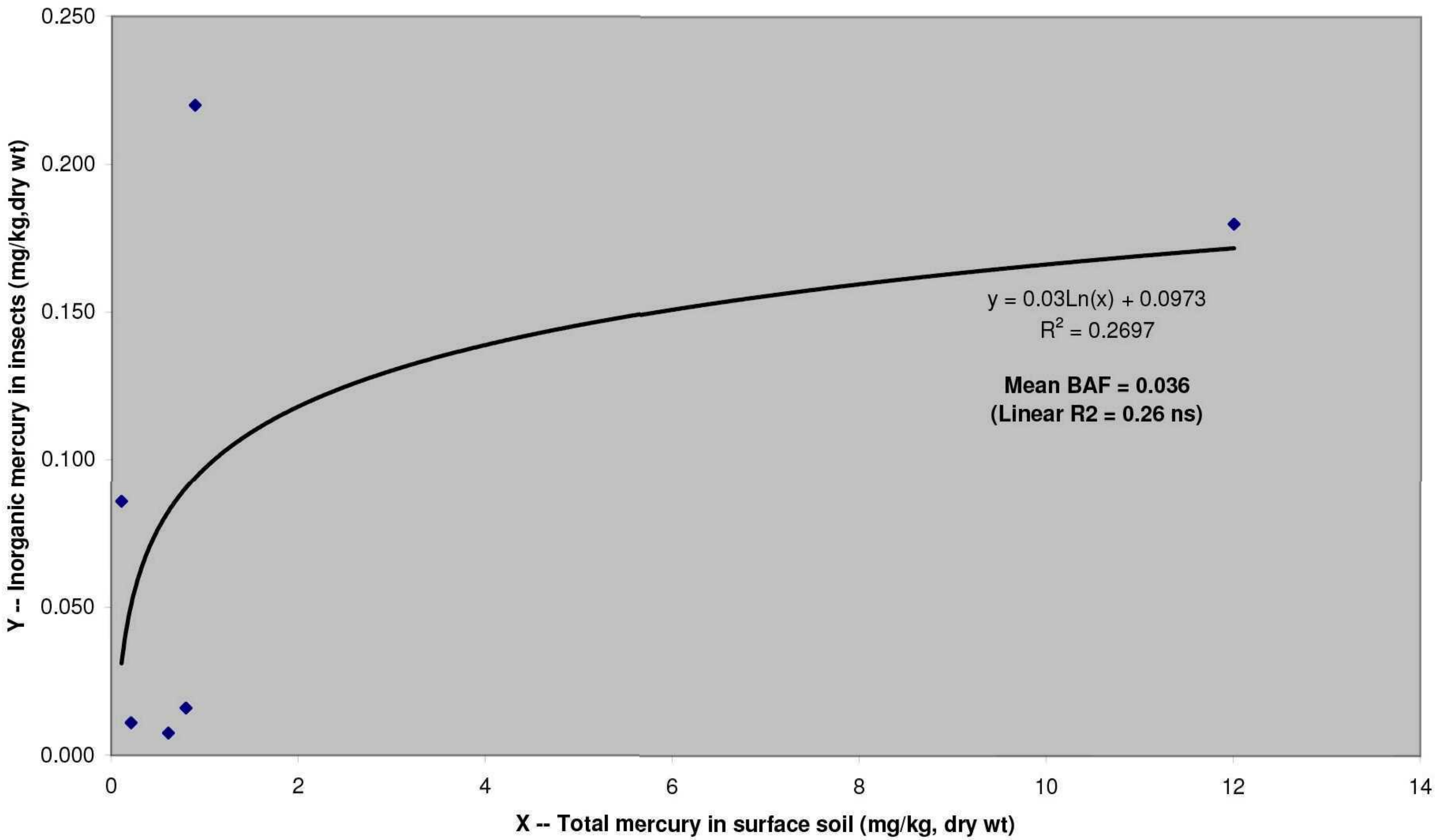

Figure D.4.__ Relationship between concentrations of total mercury in surface soil and inorganic mercury in laboratory earthworms for upland at LCP Site

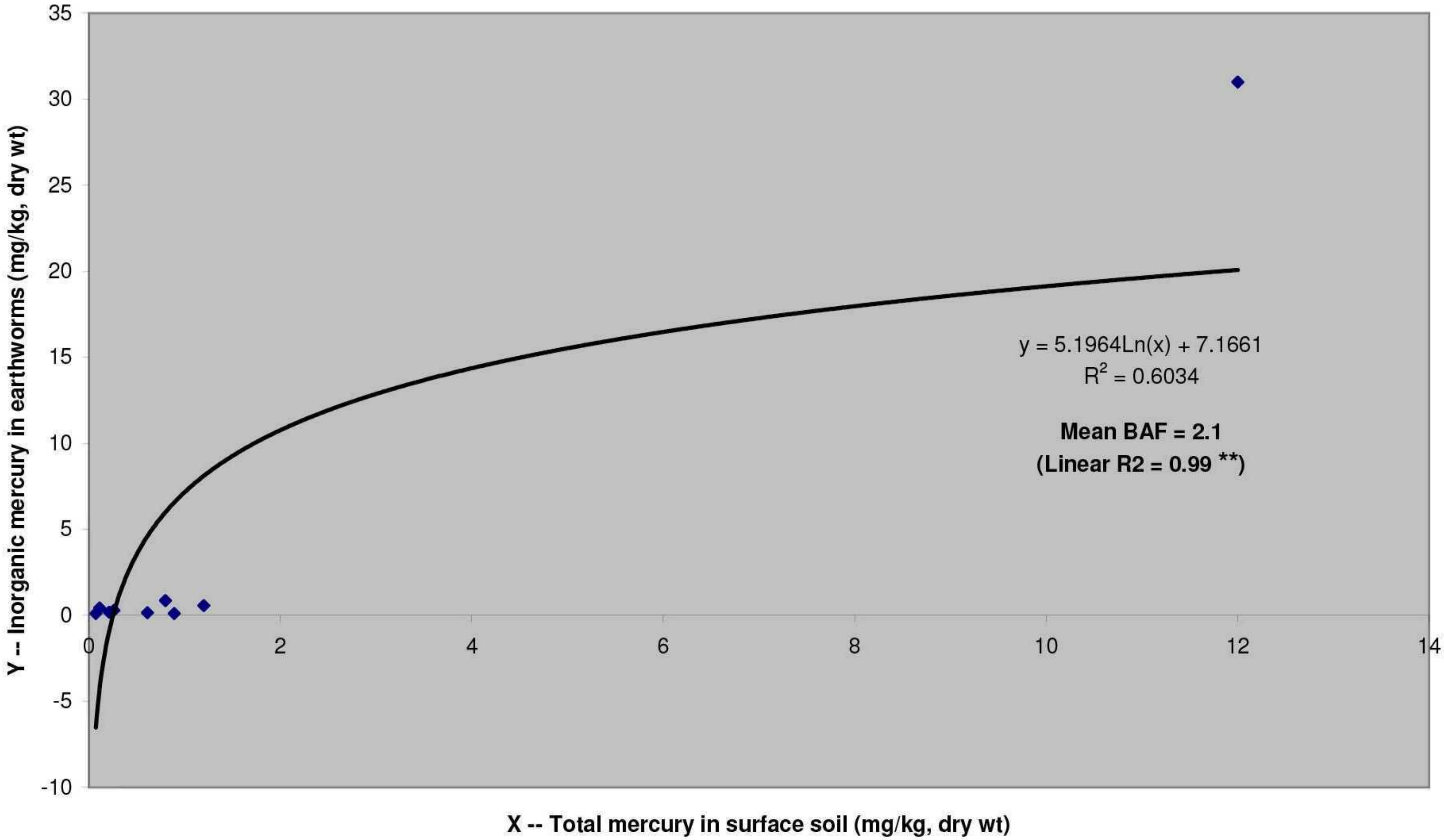

Figure D.5.__ Relationship between concentrations of Aroclor 1268 in surface soil and grass in upland at LCP Site

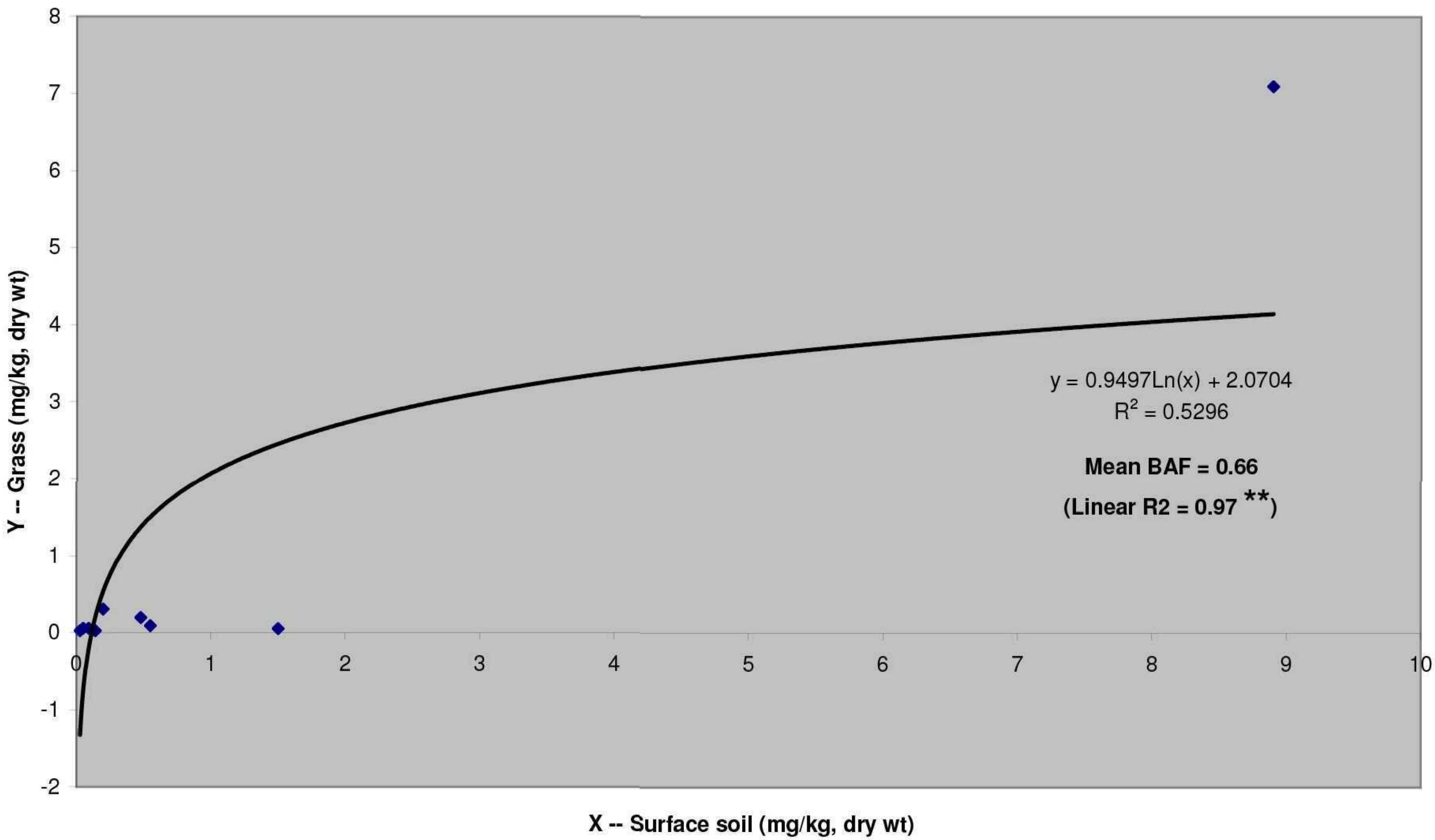

Figure D.6.__ Relationship between concentrations of Aroclor 1268 in surface soil and plants (berries) in upland at LCP Site (non-detected values for plants assigned 1/2 detection limit; 0.005 mg/kg)

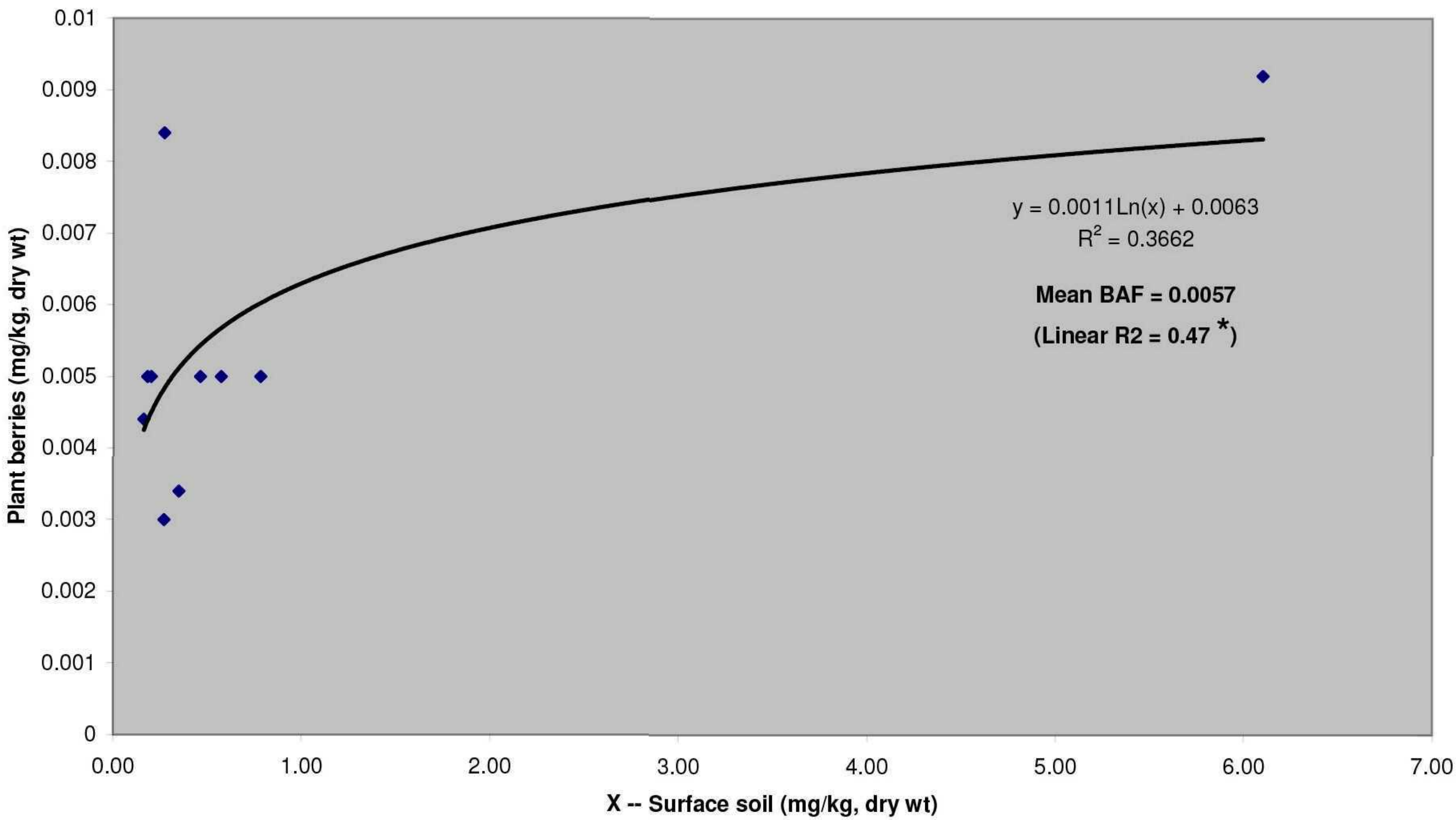

Figure D.7.__ Relationship between concentrations of Aroclor 1268 in surface soil and insects in upland at LCP Site

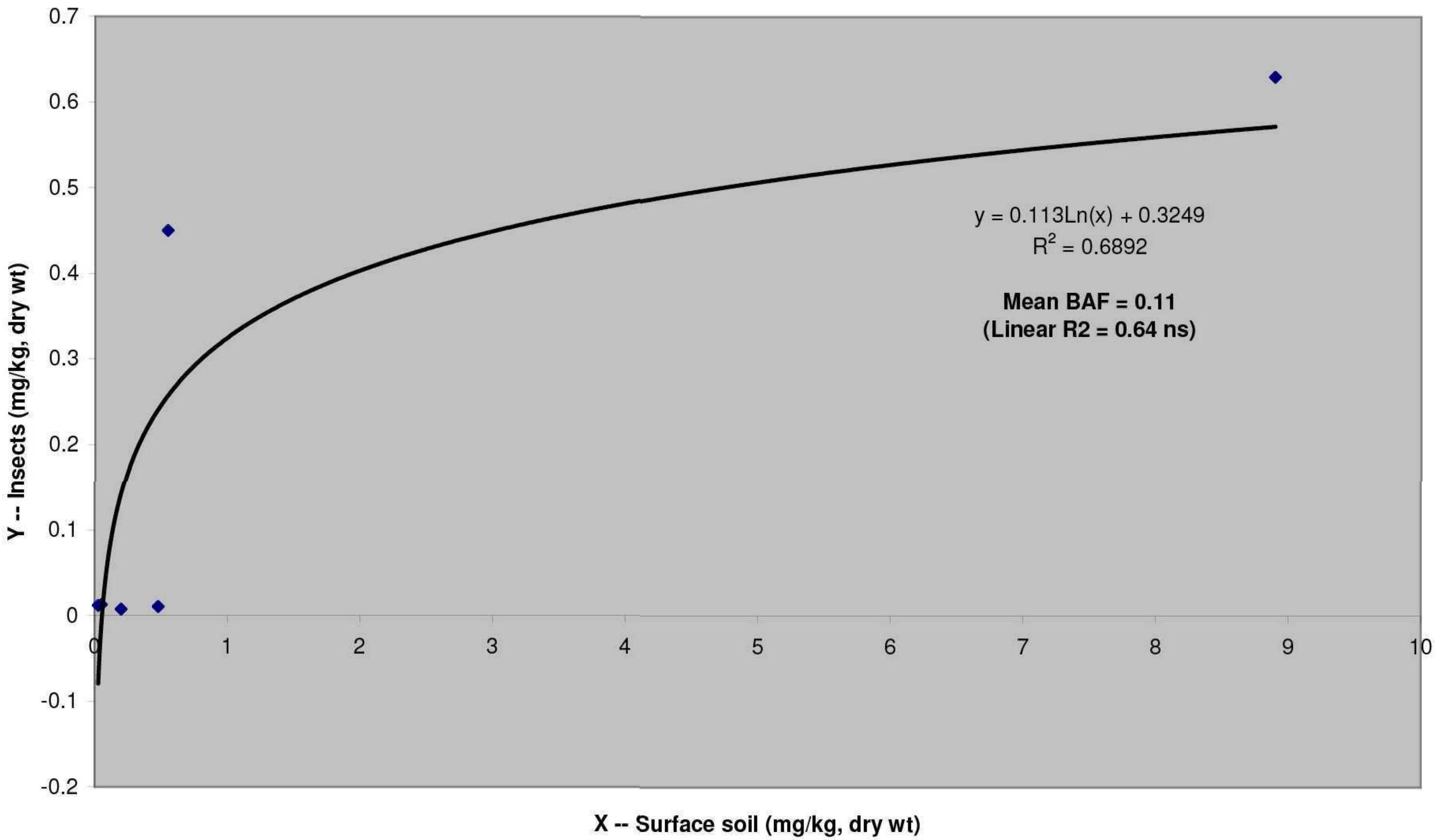

Figure D.8.__ Relationship between concentrations of Aroclor 1268 in surface soil and laboratory earthworms for upland at LCP Site

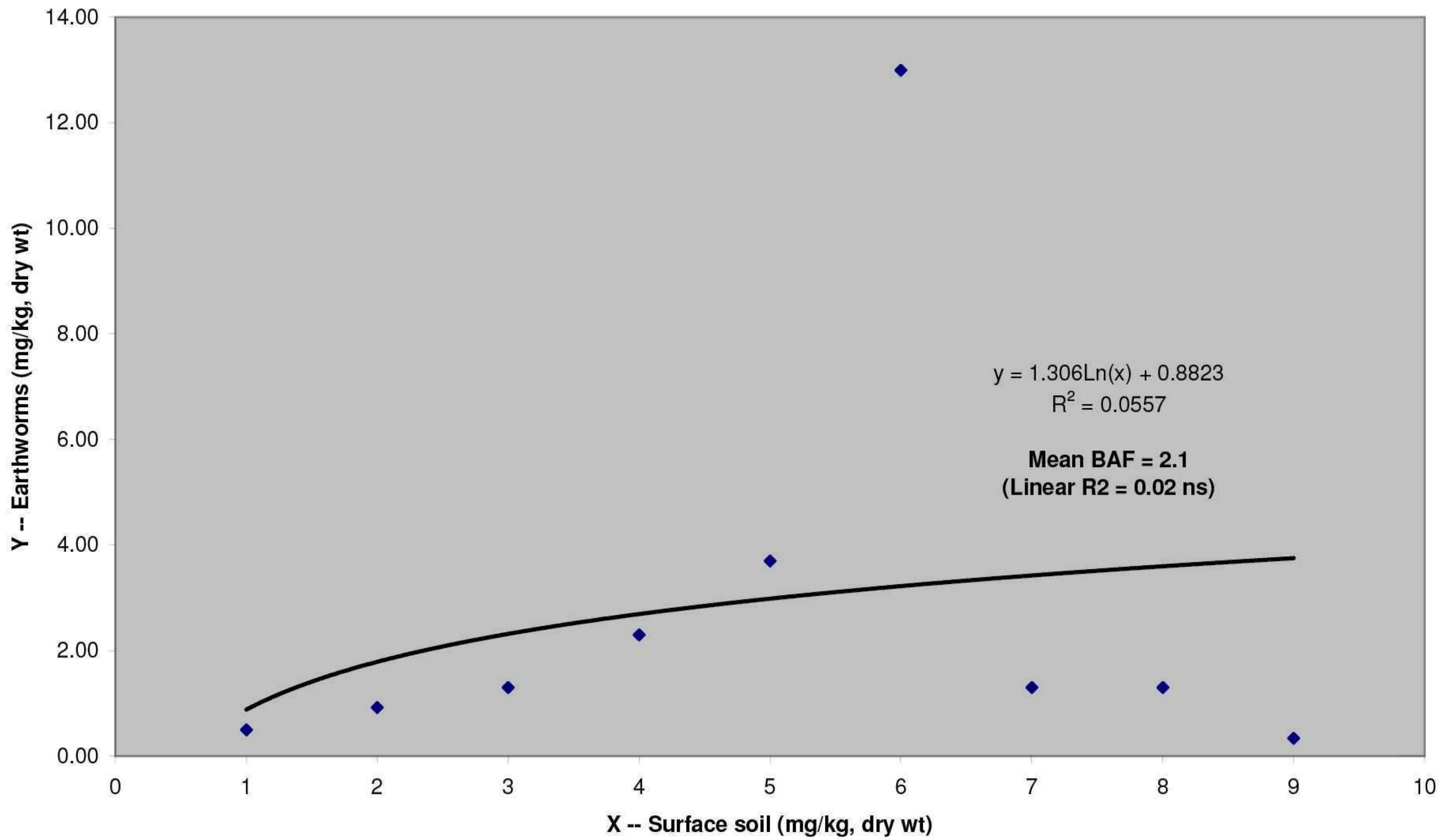

Figure D.9.__ Relationship between concentrations of lead in surface soil and grass in upland at LCP Site

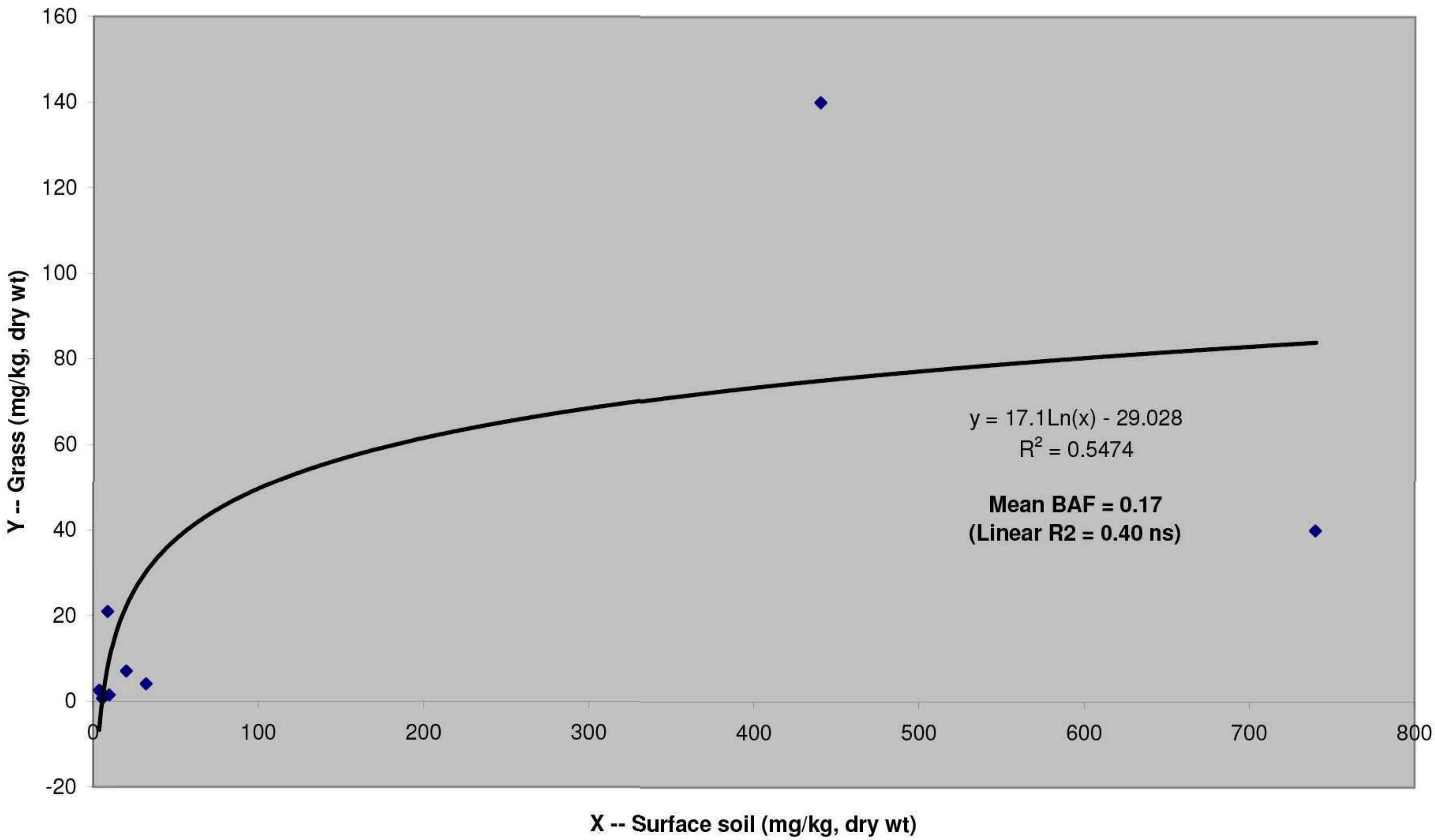

Figure D.10. Relationship between concentrations of lead in surface soil and plants (berries) in upland at LCP Site

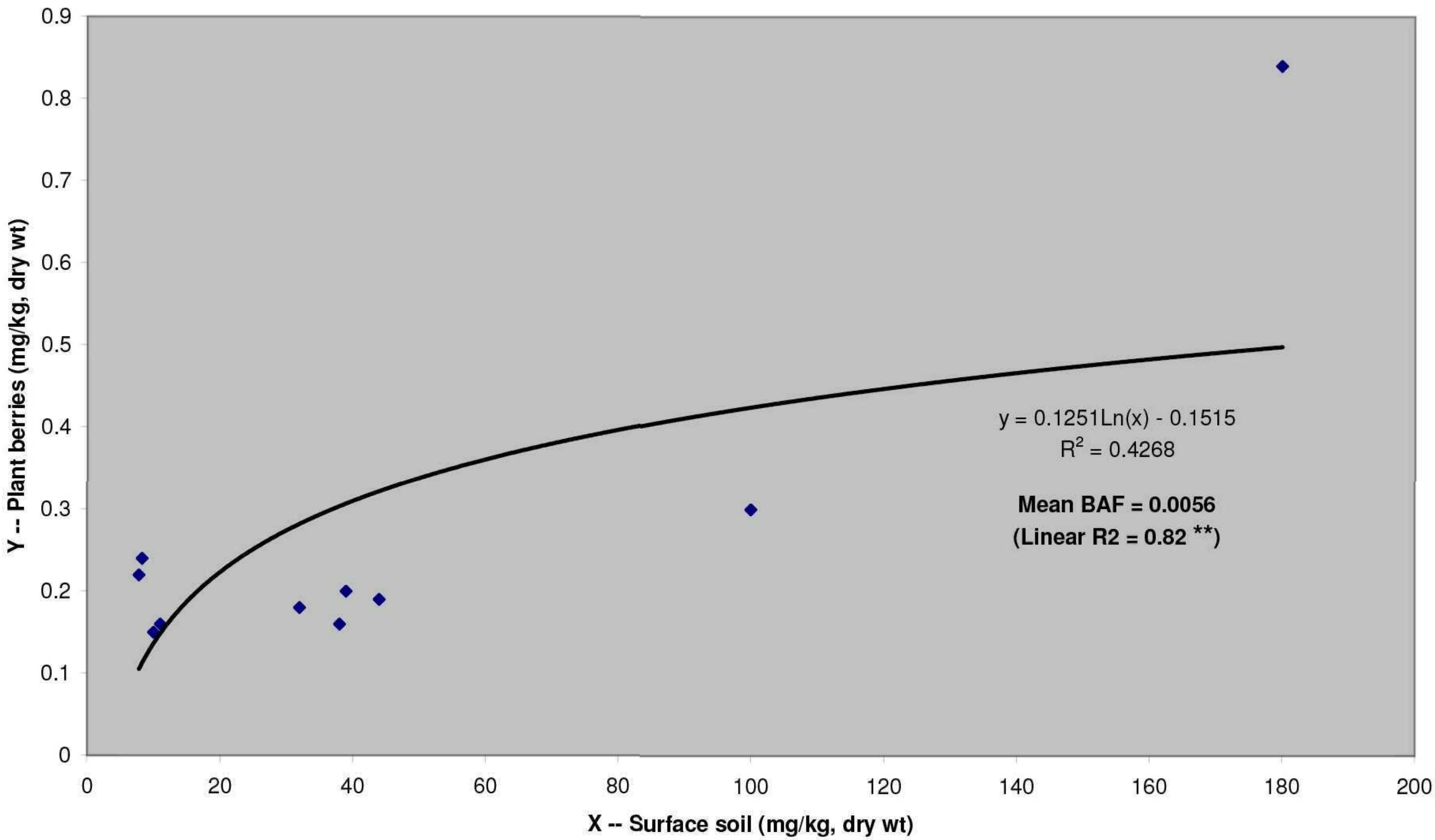

Figure D.11.__ Relationship between concentrations of lead in surface soil and insects in upland at LCP Site

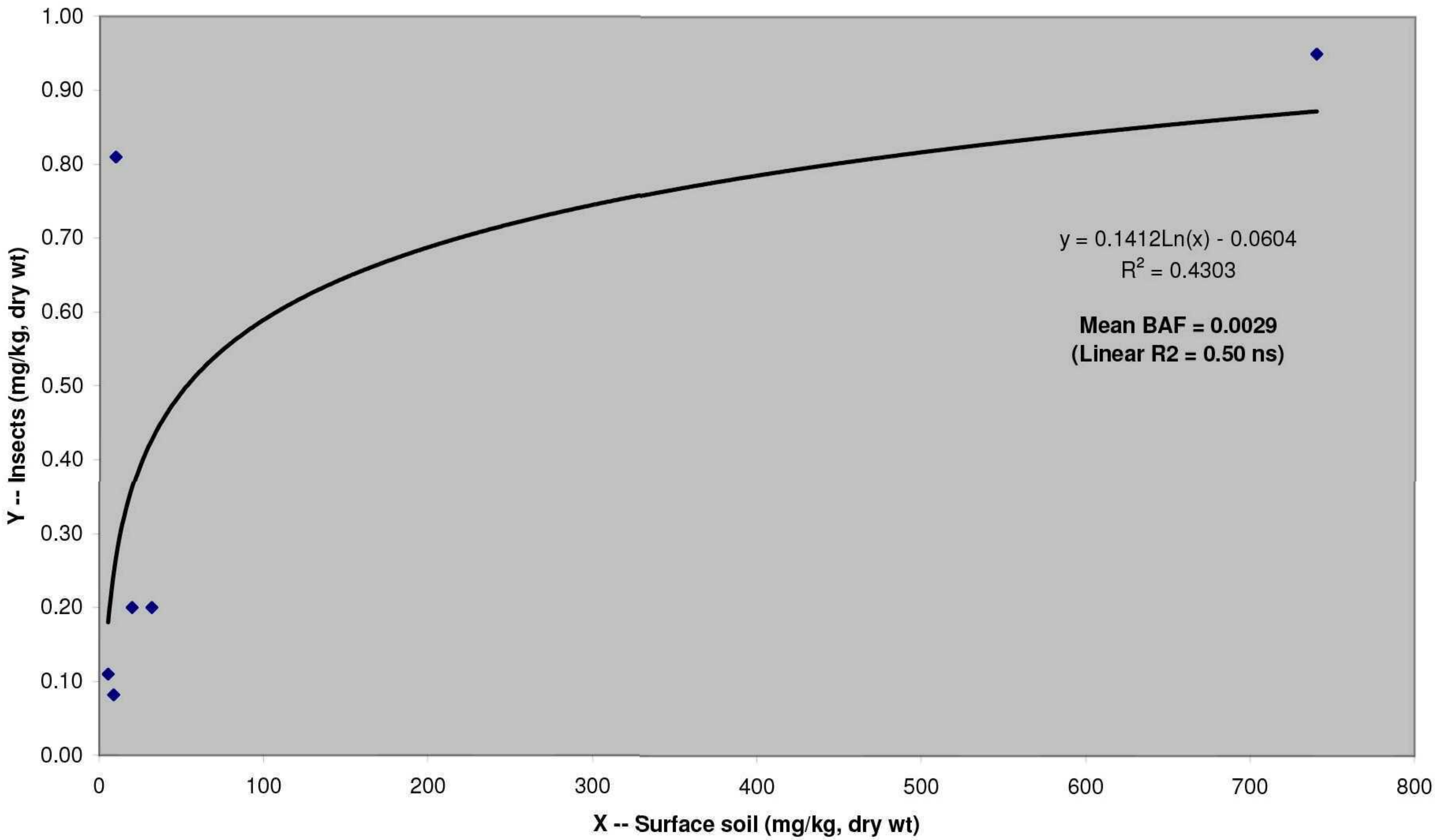

Figure D.12.__ Relationship between concentrations of lead in surface soil and laboratory earthworms for upland at LCP Site

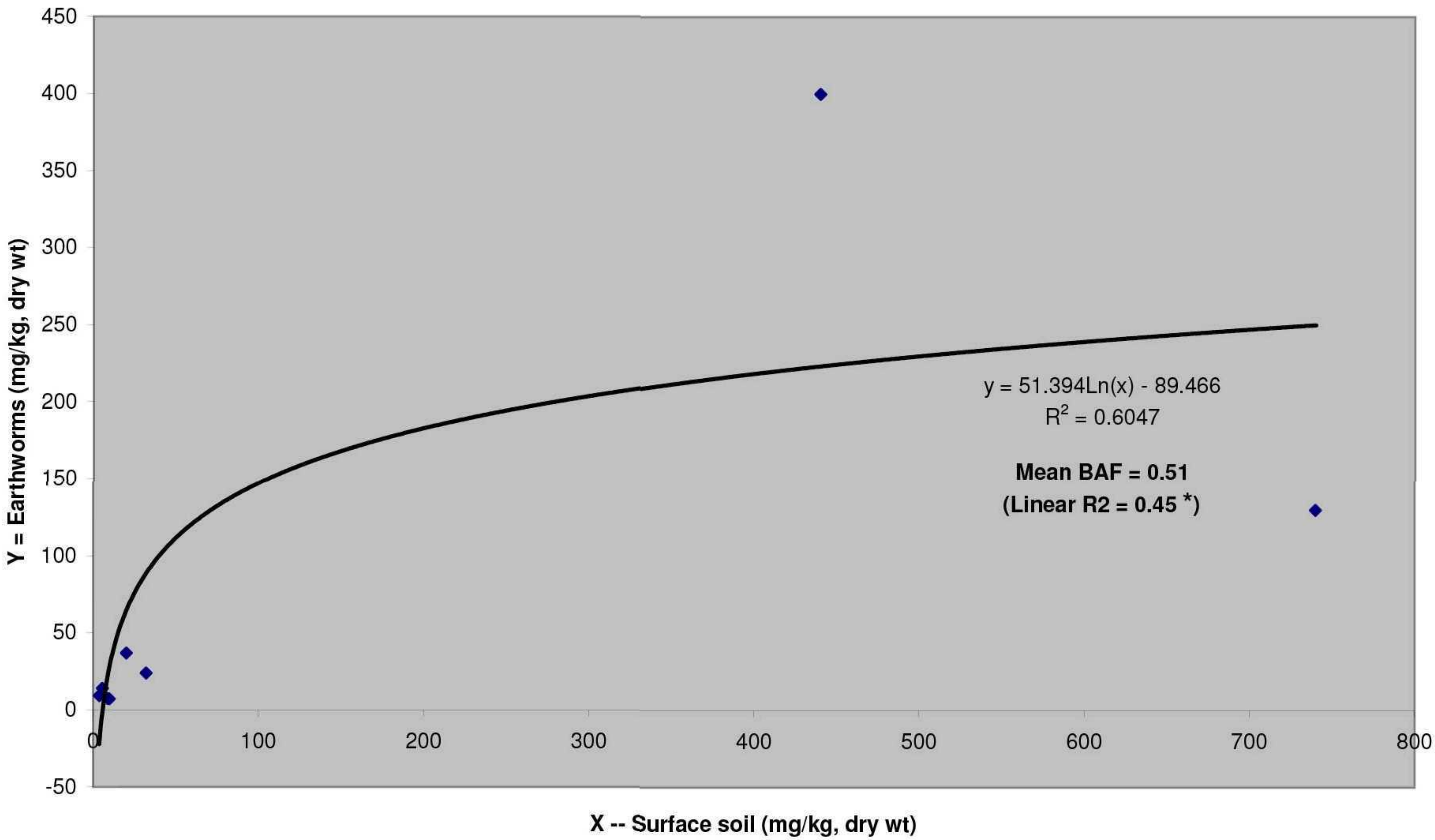

Figure D.13.__ Relationship between concentrations of total mercury in surface sediment and methylmercury in fiddler crabs (*Uca* spp.) in estuary at LCP Site

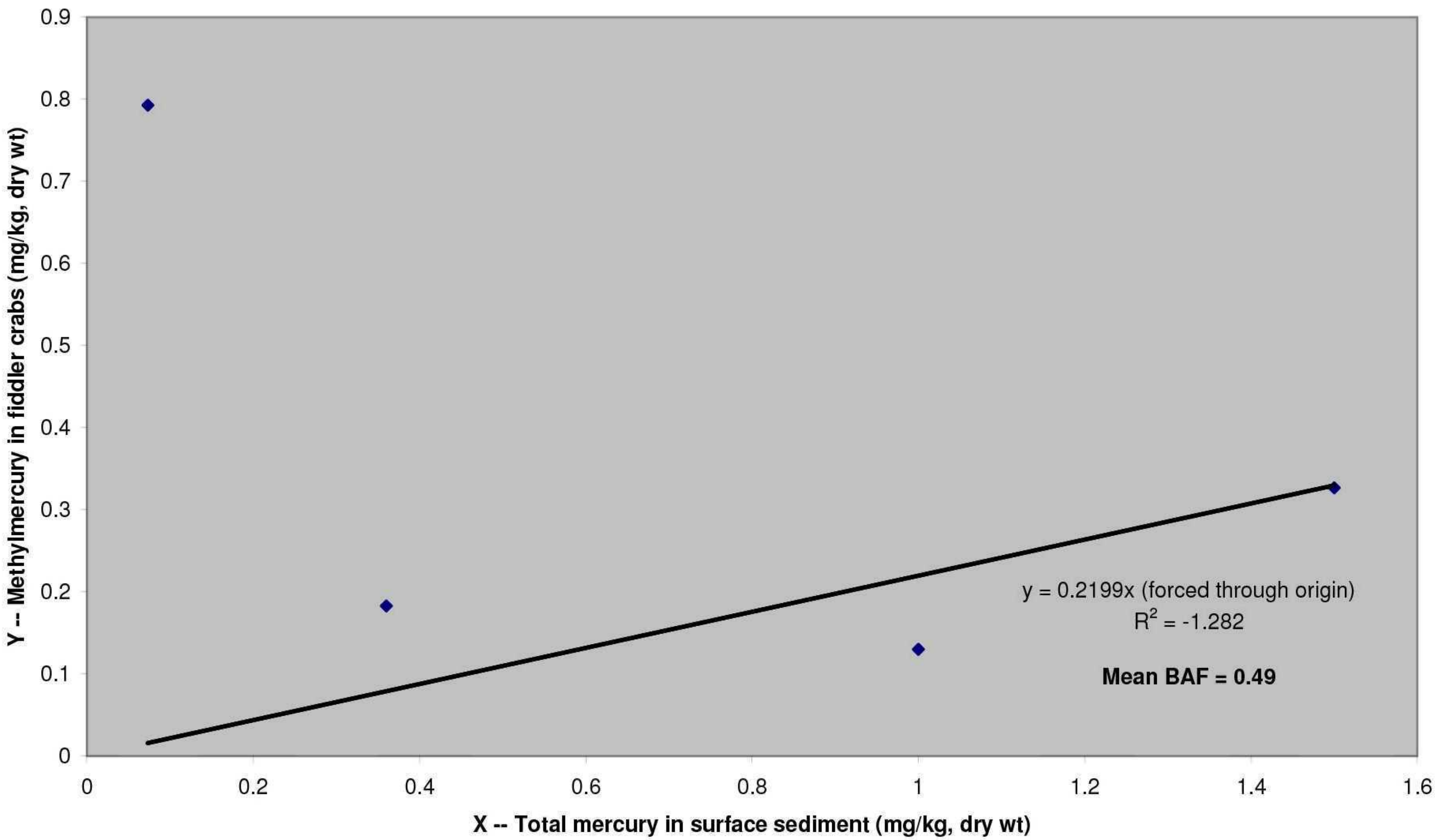

Figure D.14.__ Relationship between concentrations of total mercury in surface sediment and methylmercury in mummichogs (*Fundulus heteroclitus)* in estuary at LCP Site

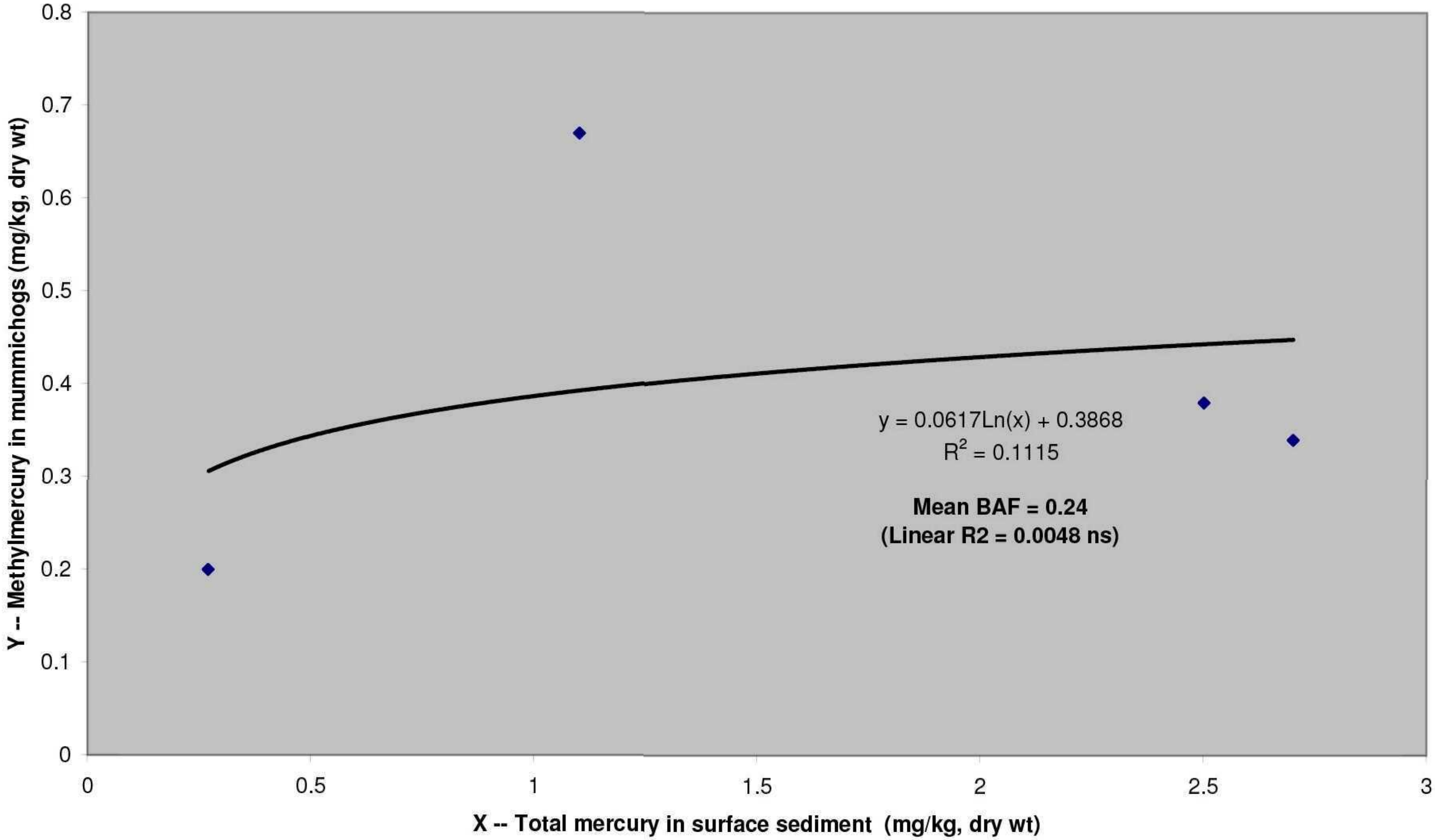

Figure D.15.__ Relationship between concentrations of Aroclor 1268 in surface sediment and fiddler crabs (*Uca* spp.) in estuary at LCP Site

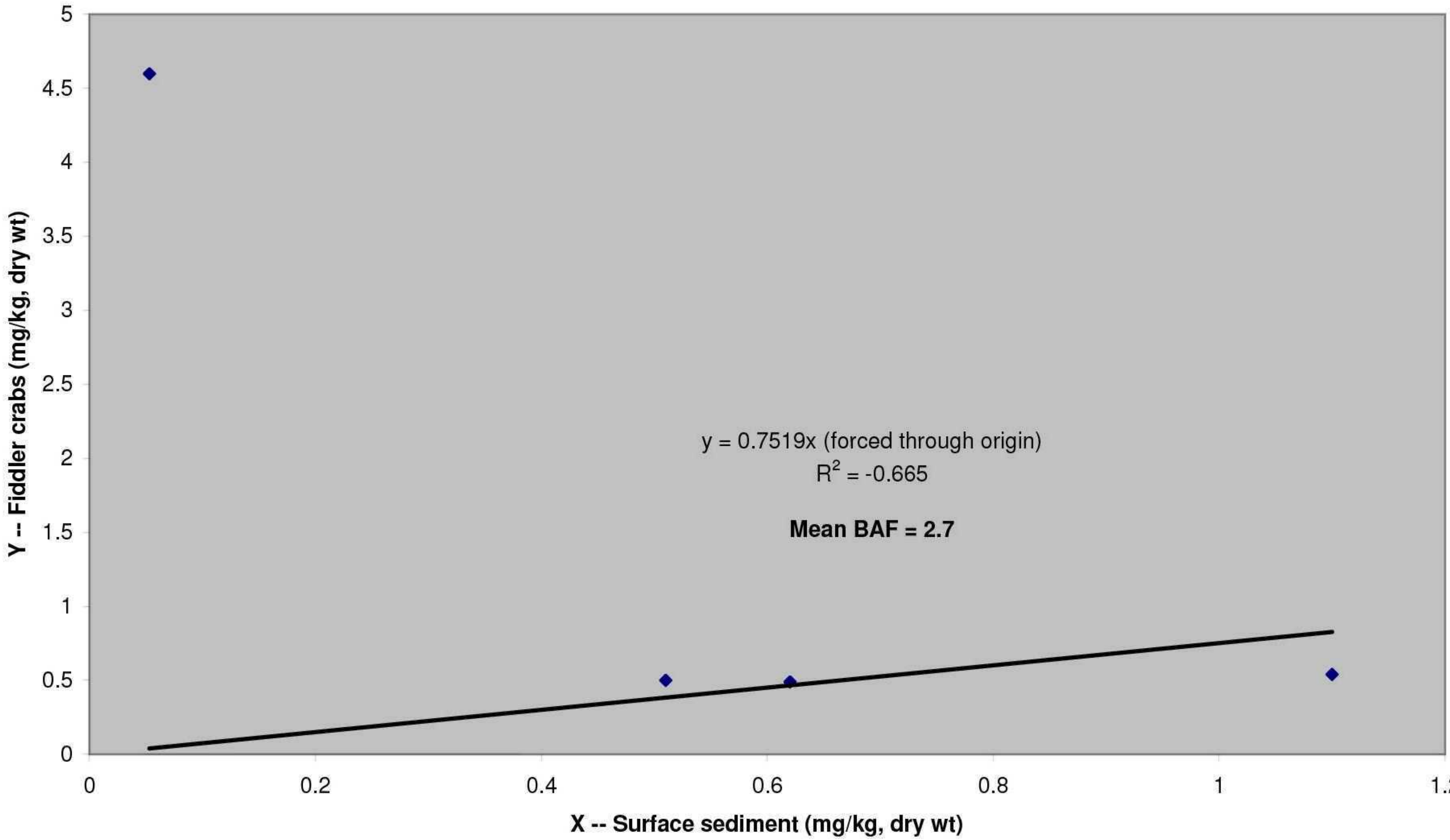

Figure D.16.__ Relationship between concentrations of Aroclor 1268 in surface sediment and mummichogs (*Fundulus heteroclitus*) in estuary at LCP Site

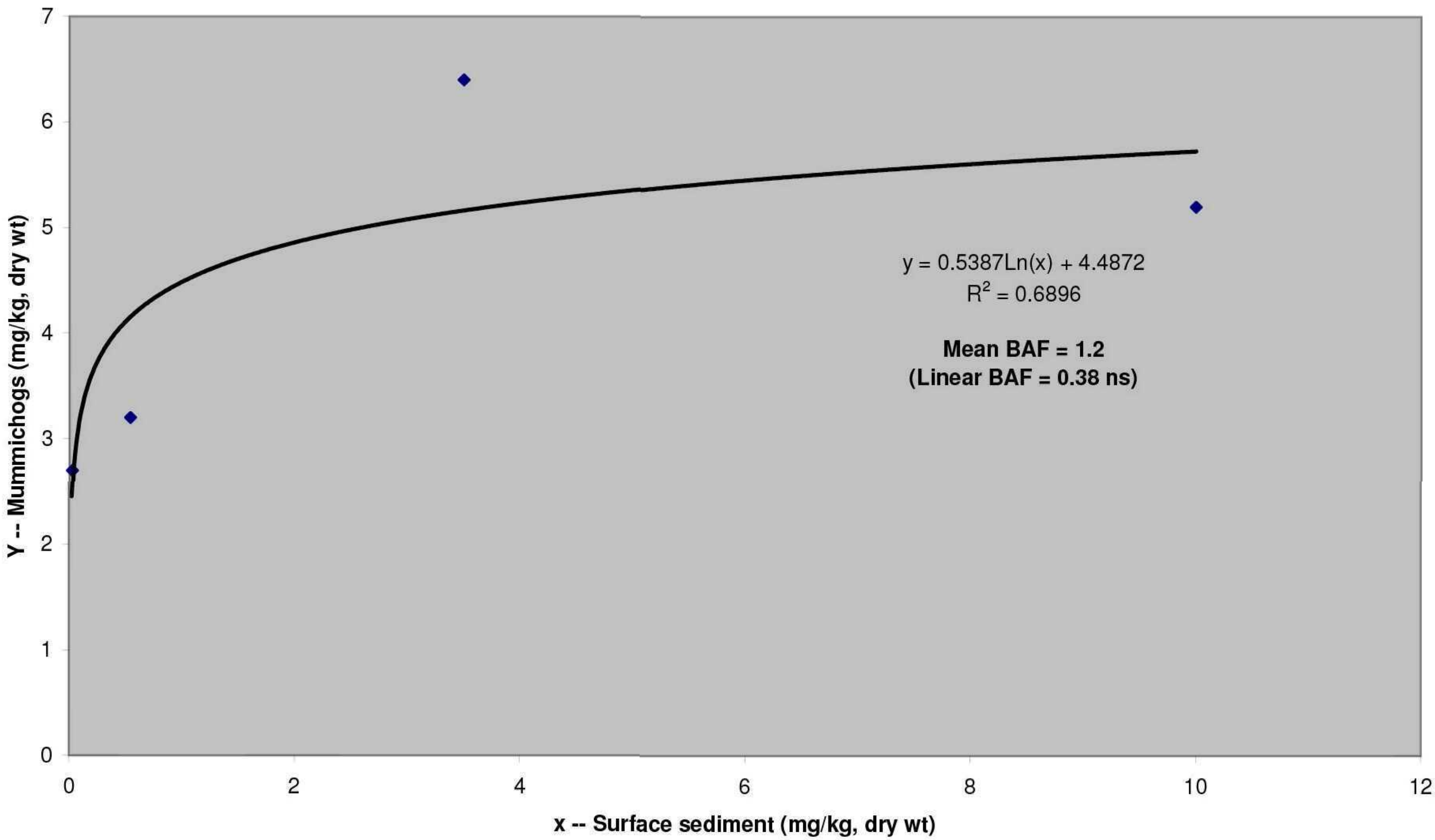

Figure D.17.__ Relationship between concentrations of lead in surface sediment and fiddler crabs (*Uca spp.*) in estuary at LCP Site

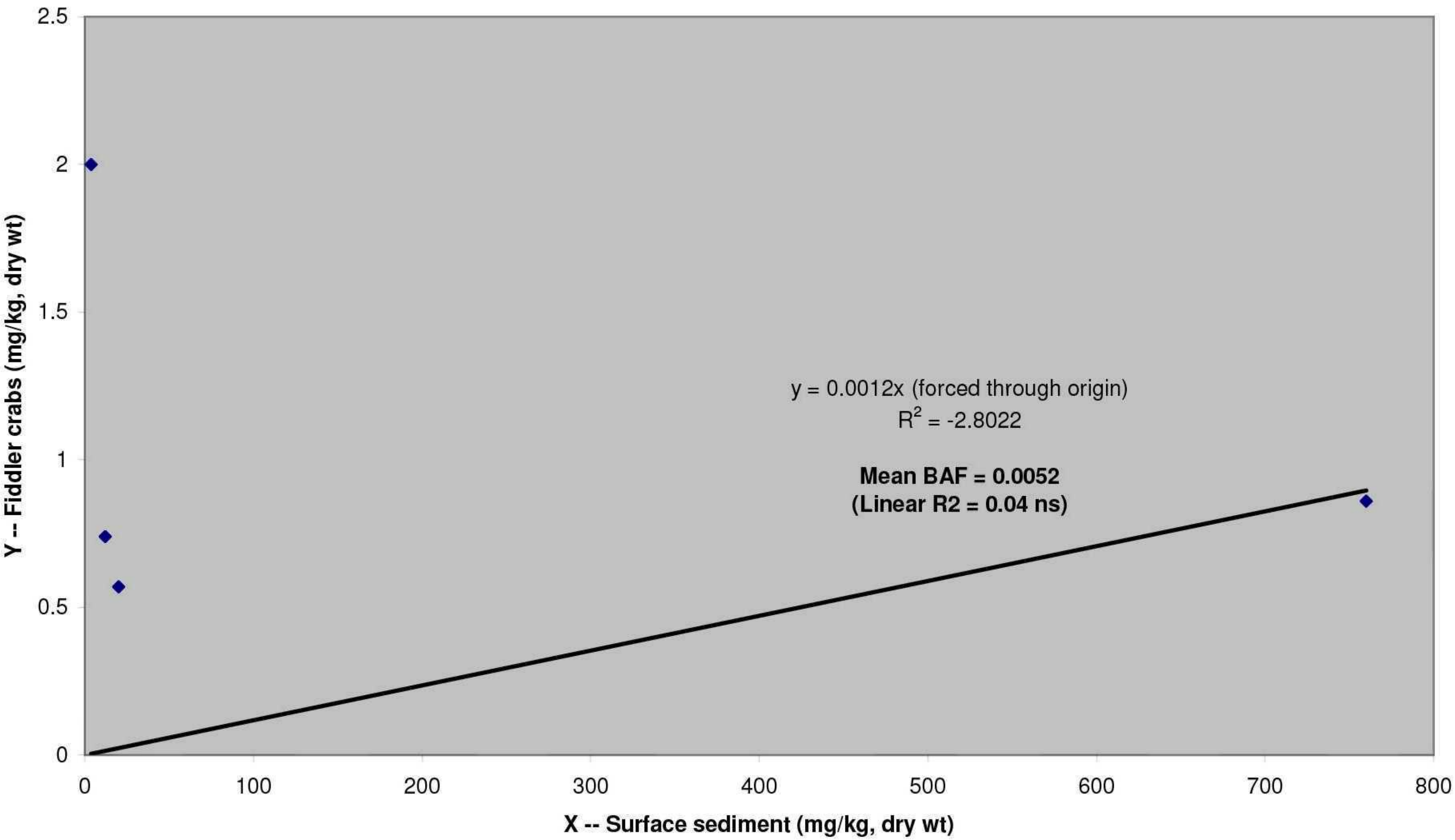

Figure D.18.__ Relationship between concentrations of lead in surface sediment and mummichogs (*Fundulus heteroclitus*) in estuary at LCP Site

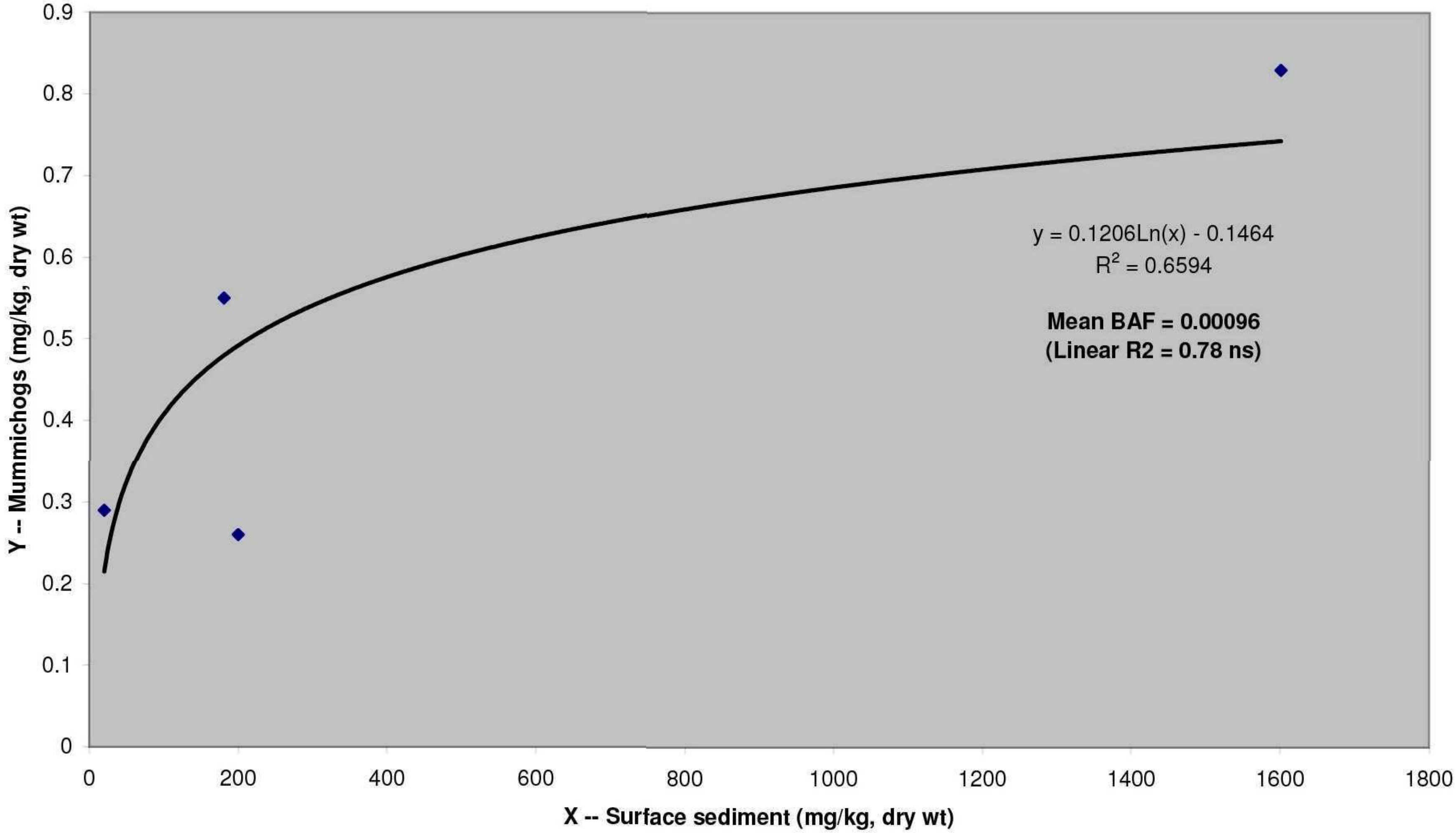

Table D-1. __ Basic information employed to back-calculated preliminary remedial goals (PRGs) for wildlife

Substrate concentration -- CS (mg/kg, dry wt)	Substrate ingestion rate -- SIR (kg/day, dry wt)	Diet concentration -- CF1 & CF2 (mg/kg, dry wt)		Food ingestion rate -- FIR (kg/day, dry wt)	Water concentration -- CW (mg/L)	Water ingestion rate -- WIR (L/day)	Body weight -- BW (kg, wet wt)	Estimated environmental exposure -- EEE (mg/kgBW/day)	Toxicity reference value --TRV (mg/kgBW/day)b	Hazard quotient (HQ)
		Total mercury in Soil for Broad-Winged Hawk Based on Methylmercury Exposure (50% MeHg in small mammal prey)								
Soil		Small Mammals (100%; 50% MeHg) -- BAF = 0.1484/2								
3.5 (0.0035 MeHg; 0.1%)	0.0019	0.26	----------	0.033	0.0000037	0.032	0.41	0.02	**0.02 (Node 1)**	**1.00**
10 (0.01 MeHg; 0.1%)	0.0019	0.74	----------	0.033	0.0000037	0.032	0.41	0.06	**0.06 (Node 7)**	**1.00**
		Total mercury in Soil for Broad-Winged Hawk Based on Methylmercury Exposure (100% MeHg in small mammal prey)								
Soil		Small Mammals (100%; 100% MeHg) -- BAF = 0.1484								
1.7 (0.0017 MeHg; 0.1%)	0.0019	0.25	----------	0.033	0.0000037	0.032	0.41	0.02	**0.02 (Node 1)**	**1.00**
5.0 (0.0050 MeHg; 0.1%)	0.0019	0.74	----------	0.033	0.0000037	0.032	0.41	0.06	**0.06 (Node 7)**	**1.00**
		Total mercury in Sediment for Pied-Billed Grebe Based on Methylmercury Exposure								
Sediment		Assume mummichogs (100%); no sediment data for spiders -- BAF = 0.24								
1.1 (0.0011 MeHg; 0.1%)	0.0037	0.26	----------	0.034	0.0000037	0.034	0.44	0.02	**0.02 (Node 1)**	**1.00**
3.2 (0.0032 MeHg; 0.1%)	0.0037	0.77	----------	0.034	0.0000037	0.034	0.44	0.06	**0.06 (Node 7)**	**1.00**
		Lead in Sediment for Pied-Billed Grebe								
Sediment		Assume mummichogs (100%); no sediment data for spiders -- BAF = 0.00096								
450	0.0037	0.43	----------	0.034	0.00051	0.034	0.44	3.82	**3.85 (Node 1)**	**~ 1.00 (0.99)**
1,300	0.0037	1.2	----------	0.034	0.00051	0.034	0.44	11.02	**11.3 (Node 7)**	**~ 1.00 (0.98)**

Table D-1. __ Continued

Substrate concentration -- CS (mg/kg, dry wt)	Substrate ingestion rate -- SIR	Diet concentration -- CF1 & CF2 (mg/kg, dry wt)		Food ingestion rate -- FIR (kg/day, dry wt)	Water concentration -- CW (mg/L)	Water ingestion rate -- WIR (L/day)	Body weight -- BW (kg, wet wt)	Estimated environmental exposure -- EEE (mg/kgBW/day)	Toxicity reference value --TRV (mg/kgBW/day)	Hazard quotient (HQ)
Total mercury in Sediment for Clapper Rail Based on Methylmercury Exposure										
Sediment		Fiddler crabs (90%) -- BAF = 0.49	Mummichogs (10%) -- BAF = 0.24							
0.47 (0.00047 MeHg; 0.1%)	0.0025	0.23	0.11	0.025	0.0000037	0.025	0.28	0.02	**0.02 (Node 1)**	**1.00**
1.5 (0.0015 MeHg; 0.1%)	0.0025	0.74	0.36	0.025	0.0000037	0.025	0.28	0.06	**0.06 (Node 7)**	**1.00**
Lead in Sediment for Clapper Rail										
Sediment		Fiddler crabs (90%) -- BAF = 0.0052	Mummichogs (10%) -- BAF = 0.00096							
400	0.0025	2.1	0.38	0.025	0.00051	0.025	0.28	3.74	**3.85 (Node 1)**	**~ 1.00 (0.97)**
1,200	0.0025	6.2	1.2	0.025	0.00051	0.025	0.28	11.22	**11.3 (Node 7)**	**~ 1.00 (0.99)**
Total mercury in Sediment for Belted Kingfisher Based on Methylmercury Exposure										
Sediment		Mummichogs (100%) -- BAF = 0.24								
0.75 (0.00075 MeHg; 0.1%)	0	0.18	----------	0.017	0.0000037	0.027	0.15	0.02	**0.02 (Node 1)**	**1.00**
2.2 (0.0022 MeHg; 0.1%)	0	0.53	----------	0.017	0.0000037	0.027	0.15	0.06	**0.06 (Node 7)**	**1.00**
Total mercury in Soil for Mourning Dove Based on Inorganic Mercury Exposure										
Soil		Grass (50%) -- BAF = 0.79	Berries (50%) -- BAF = 0.0039							
6.7	0.0021	5.3	0.026	0.015	0.00087	0.014	0.12	0.45	**0.45 (Node 1)**	**1.00**
13.2	0.0021	10	0.051	0.015	0.00087	0.014	0.12	0.86	**0.90 (Node 7)**	**~ 1.00 (0.96)**
Lead in Soil for Mourning Dove										
Soil		Grass (50%) -- BAF = 0.17	Berries (50%) -- BAF = 0.0056							
135	0.0021	23	0.76	0.015	0.00051	0.014	0.12	3.85	**3.85 (Node 1)**	**1.00**
400	0.0021	68	2.2	0.015	0.00051	0.014	0.12	11.4	**11.3 (Node 7)**	**~ 1.00 (1.01)**
Total mercury in Soil for Meadow Vole Based on Inorganic Mercury Exposure										
Soil		Grass (50%) -- BAF = 0.79	Berries (50%) -- BAF = 0.0039							
3.8	0.00022	3.0	0.015	0.0068	0.00087	0.0042	0.030	0.37	**0.37 (Node 1)**	**1.00**
3.8	0.00022	3.0	0.015	0.0068	0.00087	0.0042	0.030	0.37	**0.37 (Node 7)**	**1.00**

Table D-1. __ Continued

Substrate concentration -- CS (mg/kg, dry wt)	Substrate ingestion rate -- SIR (kg/day, dry wt)	Diet concentration -- CF1 & CF2 (mg/kg, dry wt)		Food ingestion rate -- FIR (kg/day, dry wt)	Water concentration -- CW (mg/L)	Water ingestion rate -- WIR (L/day)	Body weight -- BW (kg, wet wt)	Estimated environmental exposure -- EEE (mg/kgBW/day)	Toxicity reference value --TRV (mg/kgBW/day)	Hazard quotient (HQ)
Aroclor 1268 in Soil for Meadow Vole (based on TRVs for Aroclor 1254)										
Soil		Grass (50%) -- BAF = 0.66	Berries (50%) -- BAF = 0.0057							
0.36	0.00022	0.24	0.0021	0.0068	0.000022	0.0042	0.030	0.03	**0.03 (Node 1)**	**1.00**
3.6	0.00022	2.4	0.021	0.0068	0.000022	0.0042	0.030	0.30	**0.3 (Node 7)**	**1.00**
Total mercury in Soil for Short-Tailed Shrew Based on Inorganic Mercury Exposure										
Soil		Insects (60%) -- BAF = 0.036	Earthworms (40%) -- BAF = 2.1							
2.8	0.000066	0.11	5.9	0.0022	0.00087	0.0023	0.015	0.37	**0.37 (Node 1)**	**1.00**
2.8	0.000066	0.11	5.9	0.0022	0.00087	0.0023	0.015	0.37	**0.37 (Node 7)**	**1.00**
Aroclor 1268 in Soil for Short-Tailed Shrew (based on TRVs for Aroclor 1254)										
Soil		Insects (60%) -- BAF = 0.11	Earthworms (40%) -- BAF = 2.1							
0.21	0.000066	0.023	0.44	0.0022	0.000022	0.0023	0.015	0.03	**0.03 (Node 1)**	**1.00**
2.1	0.000066	0.23	4.4	0.0022	0.000022	0.0023	0.015	0.29	**0.3 (Node 7)**	**~1.00 (0.97)**
Lead in Soil for Short-Tailed Shrew										
Soil		Insects (60%) -- BAF = 0.0029	Earthworms (40%) -- BAF = 0.51							
240	0.000066	0.70	120	0.0022	0.00051	0.0023	0.015	8.16	**8 (Node 1)**	**~1.00 (1.02)**
2,400	0.000066	7.0	1,200	0.0022	0.00051	0.0023	0.015	81.58	**80 (Node 7)**	**~ 1.00 (1.02)**
Total mercury in Soil for Long-Tailed Weasel Based on Methylmercury Exposure (100% MeHg in small mammal prey)										
Soil		Small Mammals (100%; 100% MeHg) -- BAF = 0.1484								
5.3 (0.0053 MeHg; 0.1%)	0.00077	0.79	----------	0.018	0.0000037	0.022	0.19	0.075	**0.075 (Node 1)**	**1.00**
11 (0.011 MeHg; 0.1%)	0.00077	1.6	----------	0.018	0.0000037	0.022	0.19	0.15	**0.15 (Node 7)**	**1.00**
Aroclor 1268 in Soil for Long-Tailed Weasel (based on TRVs for Aroclor 1254)										
Soil		Small Mammals (100%) -- BAF = 0.50 (est.)								
0.60	0.00077	0.30	----------	0.018	0.000022	0.022	0.19	0.03	**0.03 (Node 1)**	**1.00**
6.0	0.00077	3.0	----------	0.018	0.000022	0.022	0.19	0.30	**0.3 (Node 7)**	**1.00**

Table D-1. __ Continued

Substrate concentration -- CS (mg/kg, dry wt)	Substrate ingestion rate -- SIR (kg/day, dry wt)	Diet concentration -- CF1 & CF2 (mg/kg, dry wt)		Food ingestion rate -- FIR (kg/day, dry wt)	Water concentration -- CW (mg/L)	Water ingestion rate -- WIR (L/day)	Body weight -- BW (kg, wet wt)	Estimated environmental exposure -- EEE (mg/kgBW/day)	Toxicity reference value --TRV (mg/kgBW/day)	Hazard quotient (HQ)
Aroclor 1268 for Little Brown Bat (based on TRVs for Aroclor 1254)										
Sediment (but Soil Surrogate employed)		Insects (100%) -- BAF = 0.11								
2.3	0	0.25	----------	0.0012	0.000022	0.001	0.01	0.03	**0.03 (Node 1)**	**1.00**
23	0	2.5	----------	0.0012	0.000022	0.001	0.01	0.30	**0.3 (Node 7)**	**1.00**
Aroclor 1268 in Sediment for Raccoon (based on TRVs for Aroclor 1254)										
Sediment		Fiddler crabs (50%) -- BAF = 2.7	Mummichogs (50%) -- BAF = 1.2							
0.27	0.019	0.73	0.32	0.20	0.000022	0.32	3.7	0.03	**0.03 (Node 1)**	**1.00**
2.7	0.019	7.3	3.2	0.20	0.000022	0.32	3.7	0.30	**0.3 (Node 7)**	**1.00**
Aroclor 1268 for Mink (based on TRVs for Aroclor 1254)										
Sediment/Soil		Small mammals (50%) -- BAF = = 0.50 (est.)	Mummichogs (50%) -- BAF = 1.2							
0.45	0.0065	0.22	0.54	0.069	0.000022	0.099	1.0	0.03	**0.03 (Node 1)**	**1.00**
4.5	0.0065	2.2	5.4	0.069	0.000022	0.099	1.0	0.3	**0.3 (Node 7)**	**1.00**
Lead for Willet										
Sediment/Soil		Fiddler crabs (20%) -- BAF = 0.0052	Insects (80%) -- BAF = 0.0029							
500	0.0016	2.6	1.4	0.022	0.00051	0.021	0.22	3.80	**3.85 (Node 1)**	**~ 1.00 (0.99)**
1,500	0.0016	7.8	4.4	0.022	0.00051	0.021	0.22	11.42	**11.3 (Node 7)**	**~ 1.00 (1.01)**

Appendix E

Graphical Analysis of Concentrations of Chemicals of Potential Concern (COPC) in Surface Soil of Upland at LCP Site and Preliminary Remedial Goals (PRGs)

This appendix present figures that identify sampling locations in upland at the LCP Site and compare concentrations of COPC in soil with preliminary remedial goals (PRGs) estimated for wildlife species that were modeled to feed exclusively on terrestrial food items.

The soil data presented in this appendix represent soil samples collected between 1994 and 2009 down to a depth of about 0.6 m (2 ft). The data represent all of the soil samples collected during this time and at this depth (not just those obtained in the field study conducted for the BERA and evaluated in the body of this document) with the following exceptions: 1) "removal" samples (i. e., samples collected during the site-wide removal response action, after which clean back-fill was placed in the removal areas; 2) manhole, sump, and stockpile samples (because manholes and sumps were cleaned, and stockpiles removed); 3) duplicate samples (used only for QA/QC purposes); and 4) samples analyzed onsite by the first onsite laboratory, TEG (consistent with the OU3 HHBRA).

Soil concentrations of primary COPC were compared to PRGs generated for the 10 wildlife species characterized by food-web screening hazard quotients (HQs) > unity (1) in Table 12 of the main body of this document. The PRGs used in this graphical analysis for these wildlife species are the Node 1 (NOAEL), Node 4 (GMAEL), and Node 7 (LOAEL) values.

In addition, soil concentrations of lead and secondary COPC were compared to generic Eco-SSL values designed to protect plants, soil invertebrates, birds, and mammals. Soil concentrations of two of the secondary COPC (antimony and zinc) were also compared to site-specific PRGs derived using food-wed exposure models.

The following figures are presented in this appendix:

Figure	
E-1	**Surface Soil Sampling Locations**
PRG Comparisons for Primary COPC and Wildlife Species	
E-2	Mercury (methylmercury exposure) – Broad-winged hawk (50% MeHg in prey)
E-3	Mercury (methylmercury exposure) – Broad-winged hawk (100% MeHg in prey)
E-4	Mercury (inorganic mercury exposure) – Long-tailed weasel (100% MeHg in prey)

E-5	Mercury (inorganic mercury exposure) – Mourning dove
E-6	Mercury (inorganic mercury exposure) – Meadow vole
E-7	Mercury (inorganic mercury exposure) – Short-tailed shrew
E-8	Aroclor 1268 – Meadow vole (based on TRVs for Aroclor 1254)
E-9	Aroclor 1268 – Short-tailed shrew (based on TRVs for Aroclor 1254)
E-10	Aroclor 1268 – Long-tailed weasel (based on TRVs for Aroclor 1254)
E-11	Lead – Mourning dove
E-12	Lead – Short-tailed shrew
PRG/ECO-SSL Comparisons for Secondary COPC and Wildlife Species	
E-13	Lead – Generic Eco-SSL values
E-14	Antimony – Meadow vole (site-specific PRG; 2.3 mg/kg)
E-15	Antimony – Generic Eco-SSL values
E-16	Zinc – Carolina wren (site-specific PRG; 22 mg/kg)
E-17	Zinc – Generic Eco-SSL values
E-18	Copper – Generic Eco-SSL values
E-19	Nickel – Generic Eco-SSL values
E-20	Vanadium – Generic Eco-SSL values and background value (32 mg/kg)

The soil sampling locations (Figure E-1) are the same locations employed in the Human Health Baseline Risk Assessment for Upland Soils (Environmental Planning Specialists, 2010). Soil samples collected from these locations consisted of grab samples (i.e., samples taken from a specific horizontal position across a narrow vertical depth interval) and post-removal-action confirmation samples, both from the sidewalls and base of excavation zones that were subsequently filled with clean purchased backfill. There were 410 sampling locations spanning the upper 1 ft of soil at the site (note: this is defined by a database query where D1 (top of sample) is < 1ft and D2 (bottom of sample) is <= 2ft). Figure E-1 depicts these 410 sample locations, as well as the removal action excavation zones and depths of clean backfill. The reviewer will note the absence of soil sampling locations in the central part of the main site, where there is a soil cap overlying the footprint of the mercury cell buildings. This cap is comprised of clean backfill and has a Bermuda grass surface that is routinely mowed. The absence of soil samples in many of the excavation/backfill zones (depicted in Figure E-1 as the light yellow to deep brown color gradational polygons) indicates that the thickness of the clean backfill in these zones is greater than the biologically-active zone (upper 1 ft) and that the conformational sample data is from a deeper interval.

The figures for primary COPC (Figures E-2 through E-12) show that the majority of analytical measurements in soil across the site are either less than the method detection limit (i.e., "non-detect") or below the relevant food-web model-based NOAEL PRG. Most of the analytical measurements that exceed the LOAEL PRGs are located in the central portion of the site in former operational areas. However, it should be noted that, even in these areas, there are also a significant number of non-detects and measurements below the NOAEL PRGs.

The figures for secondary COPC (Figures E-13 through E-20) show that fewer soil samples have been analyzed than for primary COPC. However, as with the primary COPC, the majority of the analytical measurements are either below method detection limits or below the default Eco-SSL values and/or PRGs based on site-specific food-web exposure models.

When evaluating location-specific exceedences of PRG and/or Eco-SSL values, it is important to keep in mind the conservative character inherent in this presentation. Some examples of this conservative character are provided in the following bullets:

- The PRGs for mercury based on the broad-winged hawk and long-tailed weasel food-web exposure models (Figures E-2, E-3, and E-4) employed sub-models to estimate the uptake of methylmercury into the tissues of small mammals that comprise these receptors' diets.
- The PRGs for mercury based on the broad-winged hawk and long-tailed weasel food-web exposure models (Figures E-2, E-3, and E-4) assume that either 50% or 100% of the mercury present in the tissues of the small mammals is present as methylmercury. Older data from the estuary (Gardner *et al*. 1978) suggest that 50% may be reasonable even though other scientific literature suggests that 10% (methylmercury as a percent of total mercury) may be an alternative estimate (Watras and Huckabee, 1994; Sigel and Sigel, 1997).
- The PRGs for mercury based on the broad-winged hawk food-web exposure model (Figures E-2 and E-3) assume that 100% of the broad-winged hawk's prey is captured exclusively at the LCP site even though broad-winged hawks are known to migrate over long distances and forage over large areas.
- The PRGs for Aroclor 1268 based on the long-tailed weasel food-web exposure model (Figure E-10) employed a sub-model to estimate the uptake of Aroclor 1268 into the tissues of small mammals that comprise the weasel's diet.
- The PRGs for Aroclor 1268 based on the meadow vole, short-tailed shrew, and long-tailed weasel food-web exposure models (Figures E-8, E-9, and E-10) are based on TRVs for Aroclor 1254. As discussed in Appendix A.1.2 of this document, Aroclor 1254 is presumed to be more toxic to biota than Aroclor 1268.

OU3 Soil Sample Locations

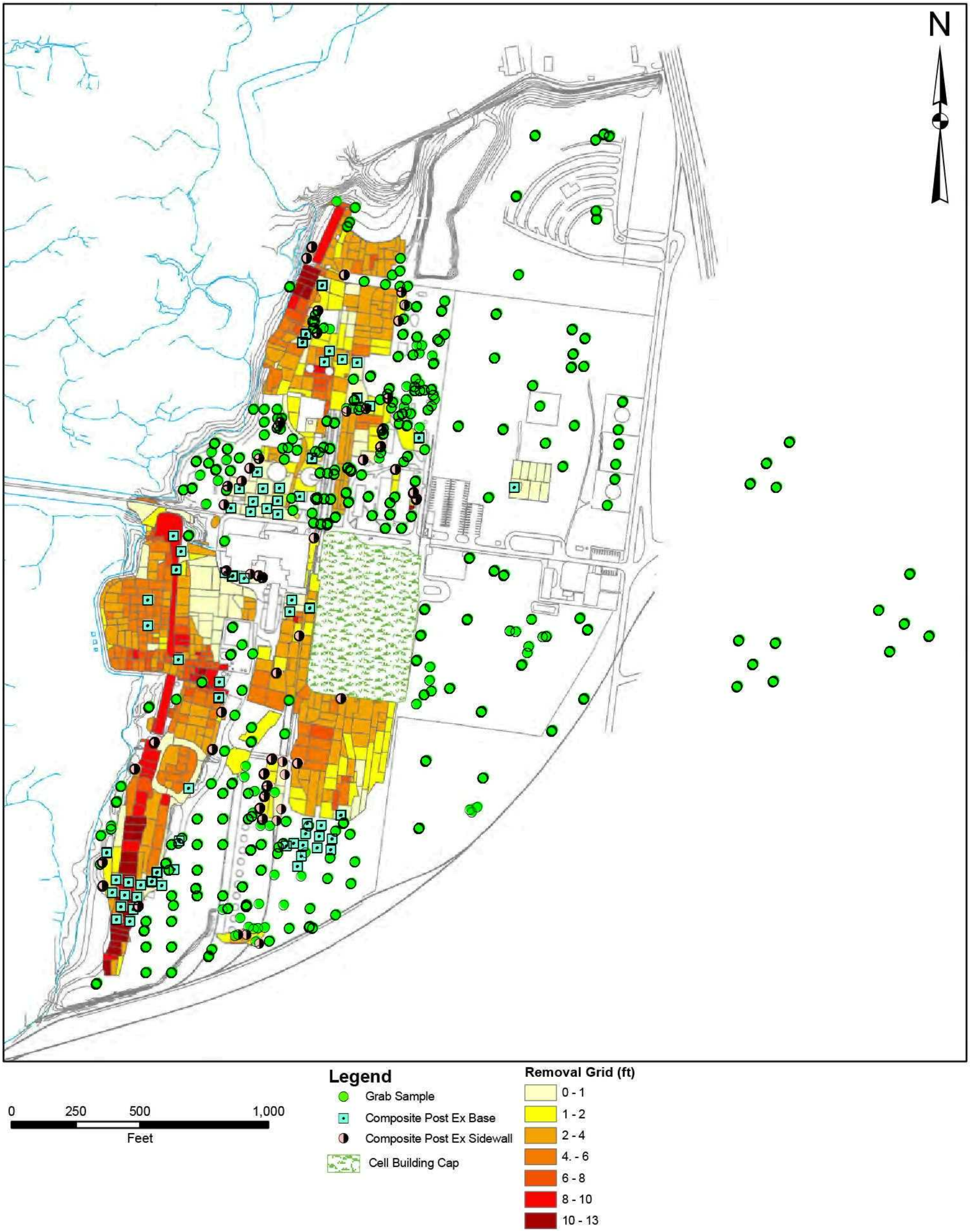

Figure No. E-1

Mercury (methylmercury exposure) - Broad-winged hawk (50% MeHg in prey)

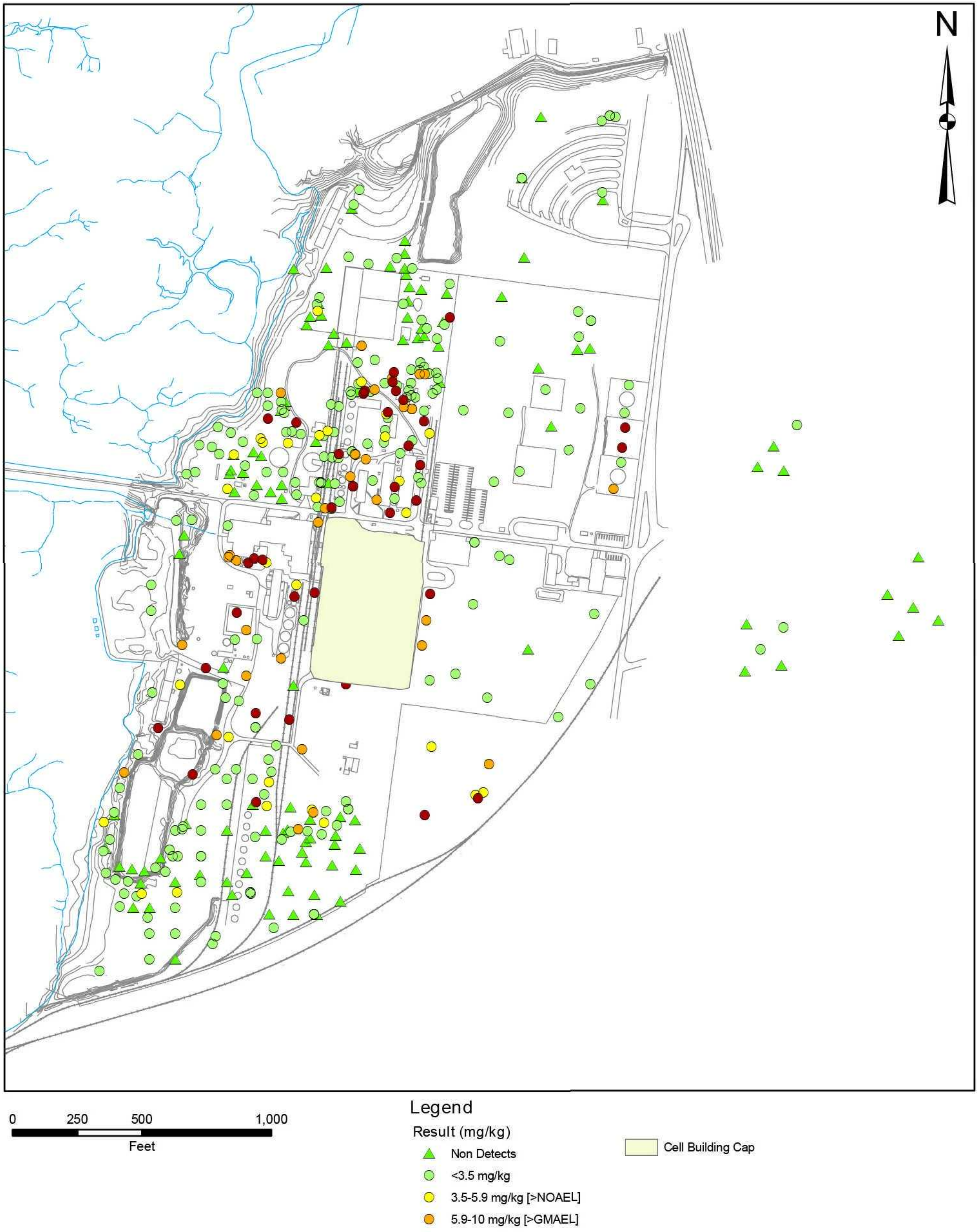

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Figure No. E-2

Mercury (methylmercury exposure) - Broad-winged hawk (100% MeHg in prey)

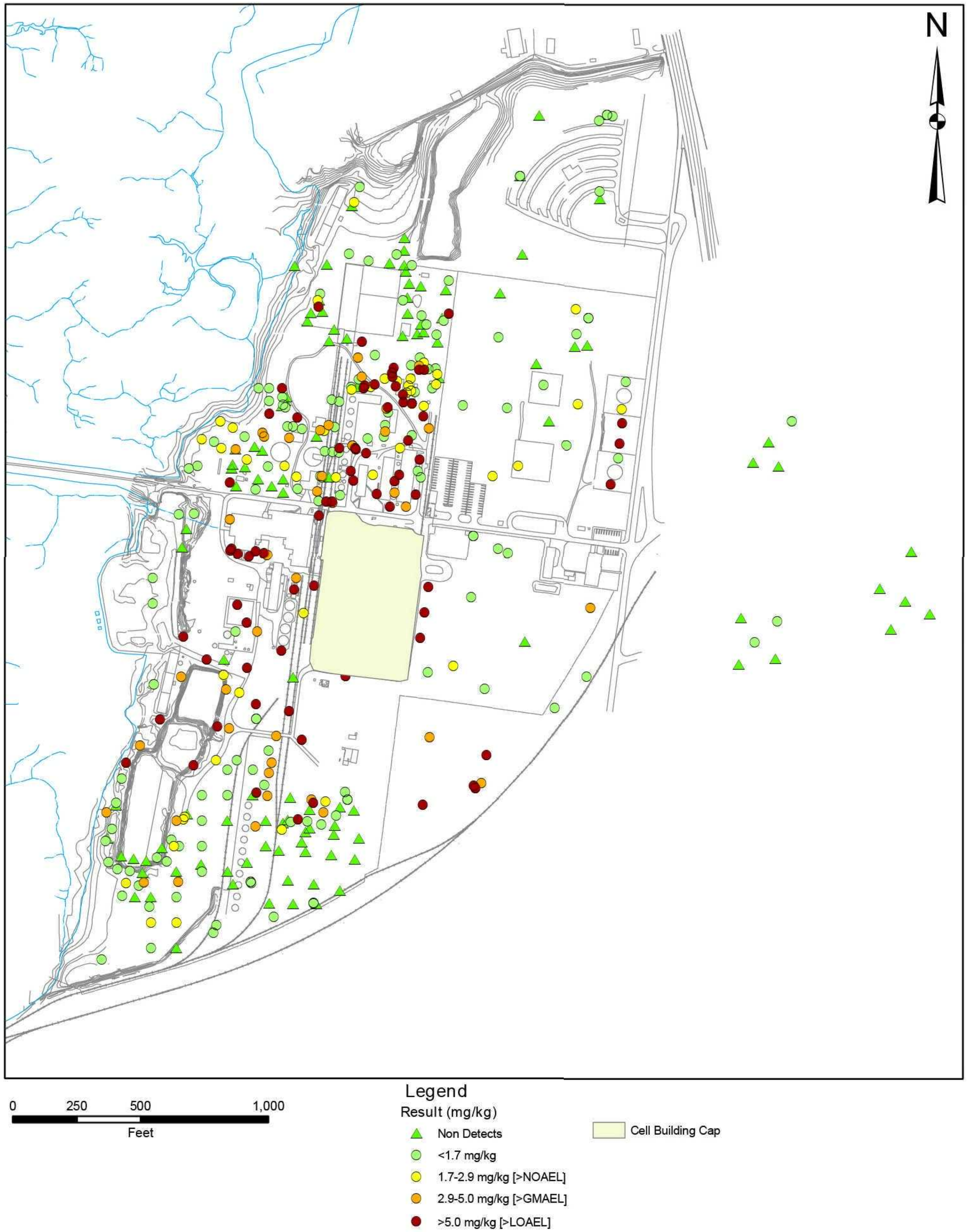

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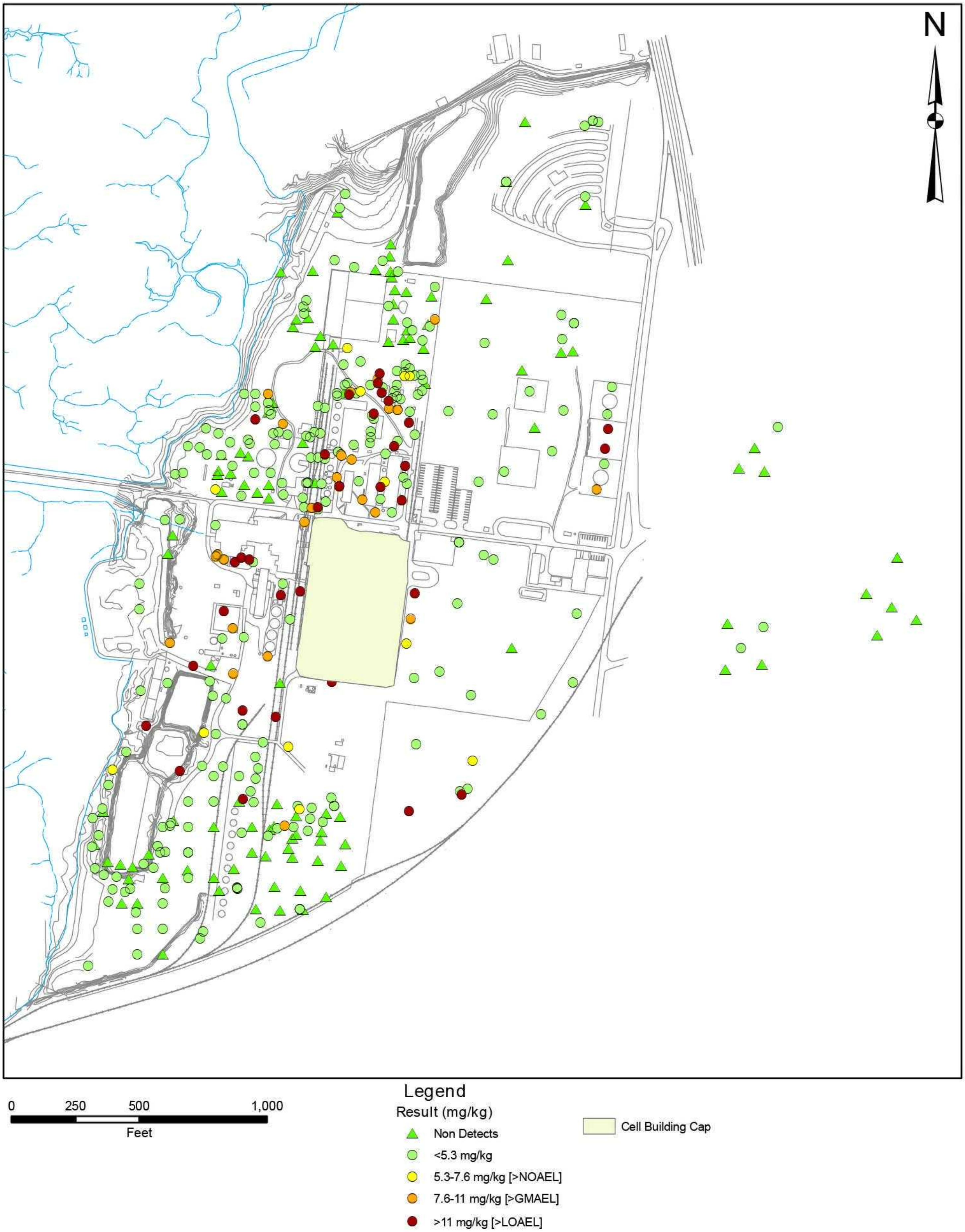
Figure No. E-3

Mercury (methylmercury exposure) - Long-tailed weasel (100% MeHg in prey)



Mercury (inorganic mercury exposure) - Mourning dove

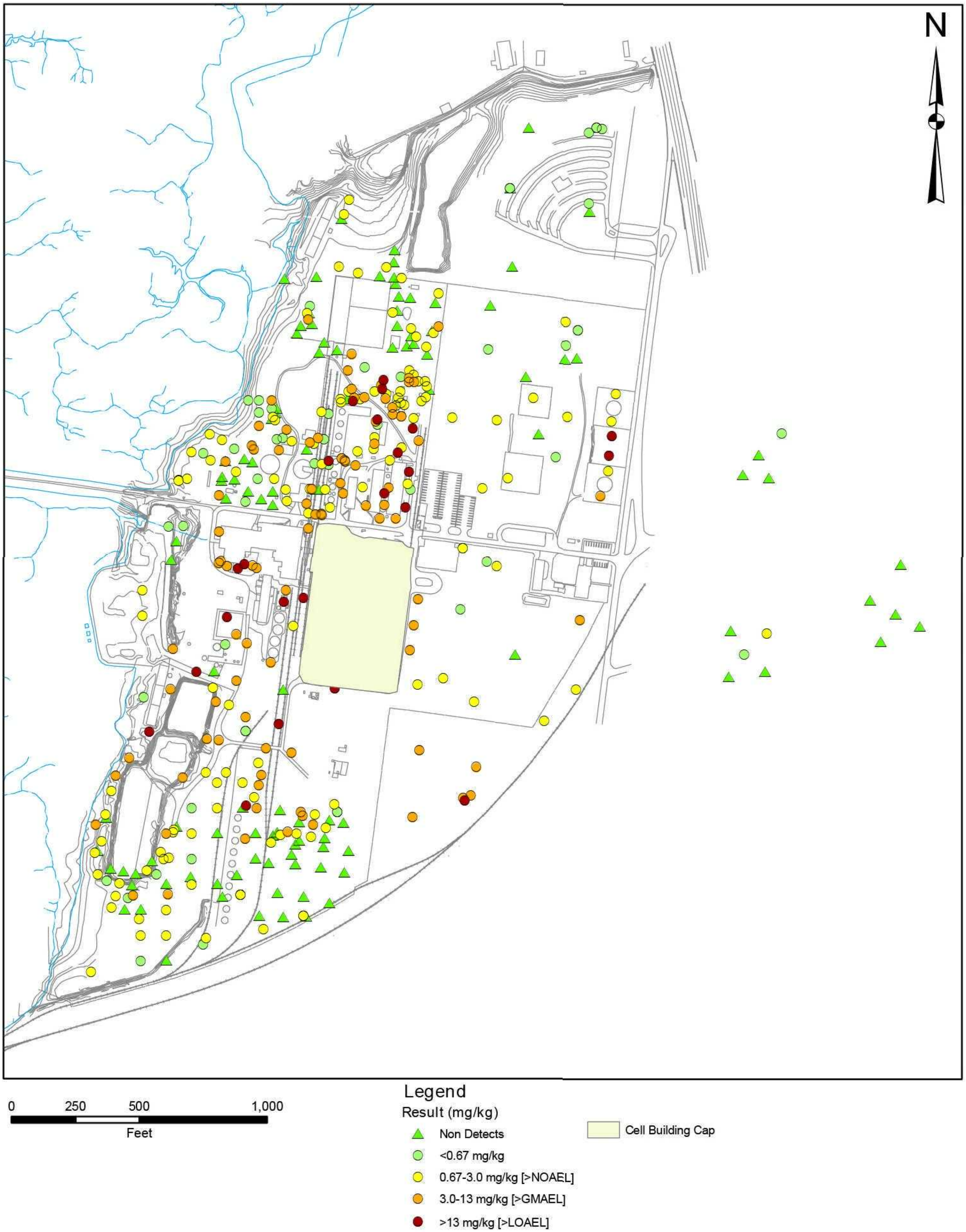


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Figure No. E-5

Mercury (inorganic mercury exposure) - Meadow vole

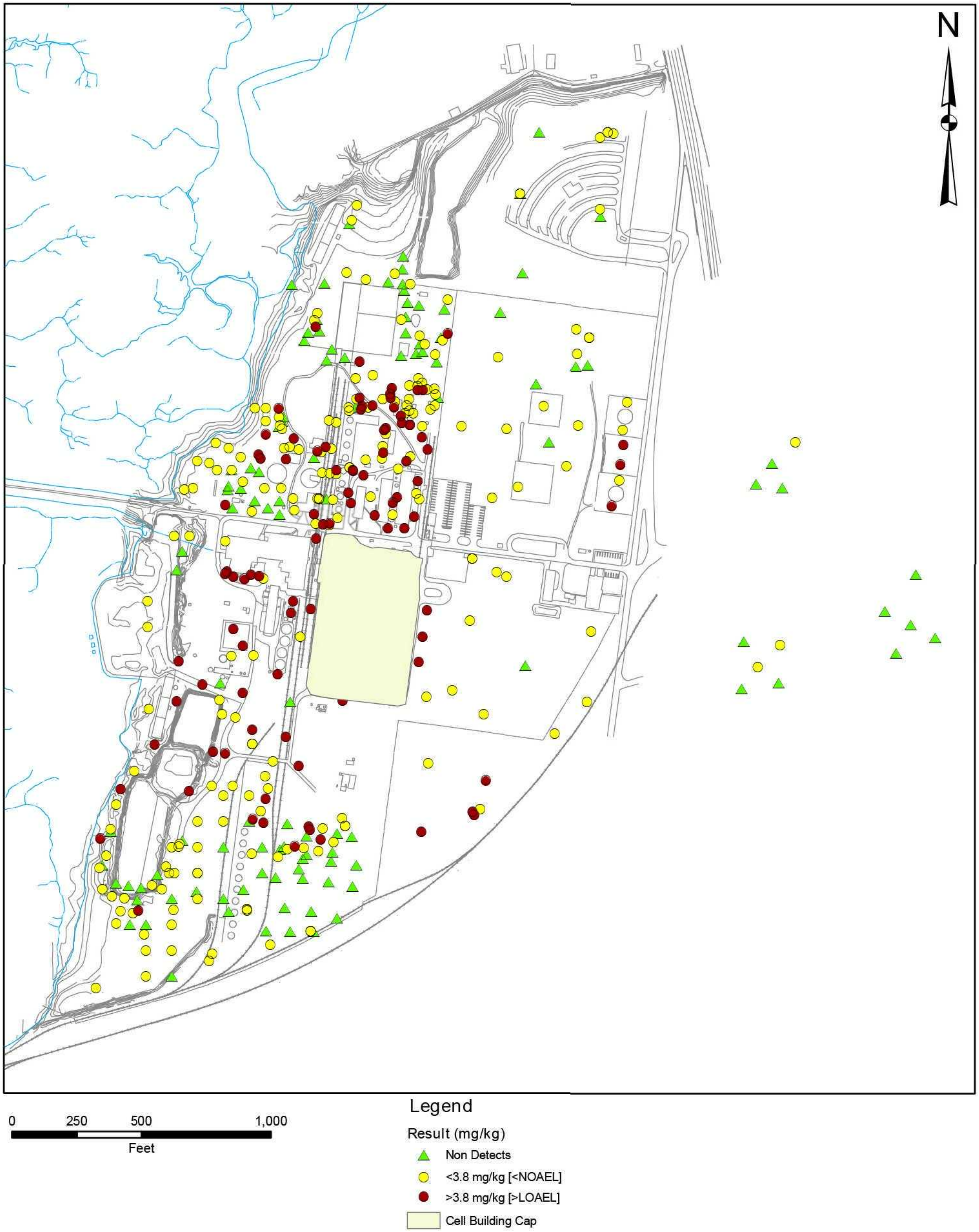

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Figure No. E-6

Mercury (inorganic mercury exposure) - Short-tailed shrew

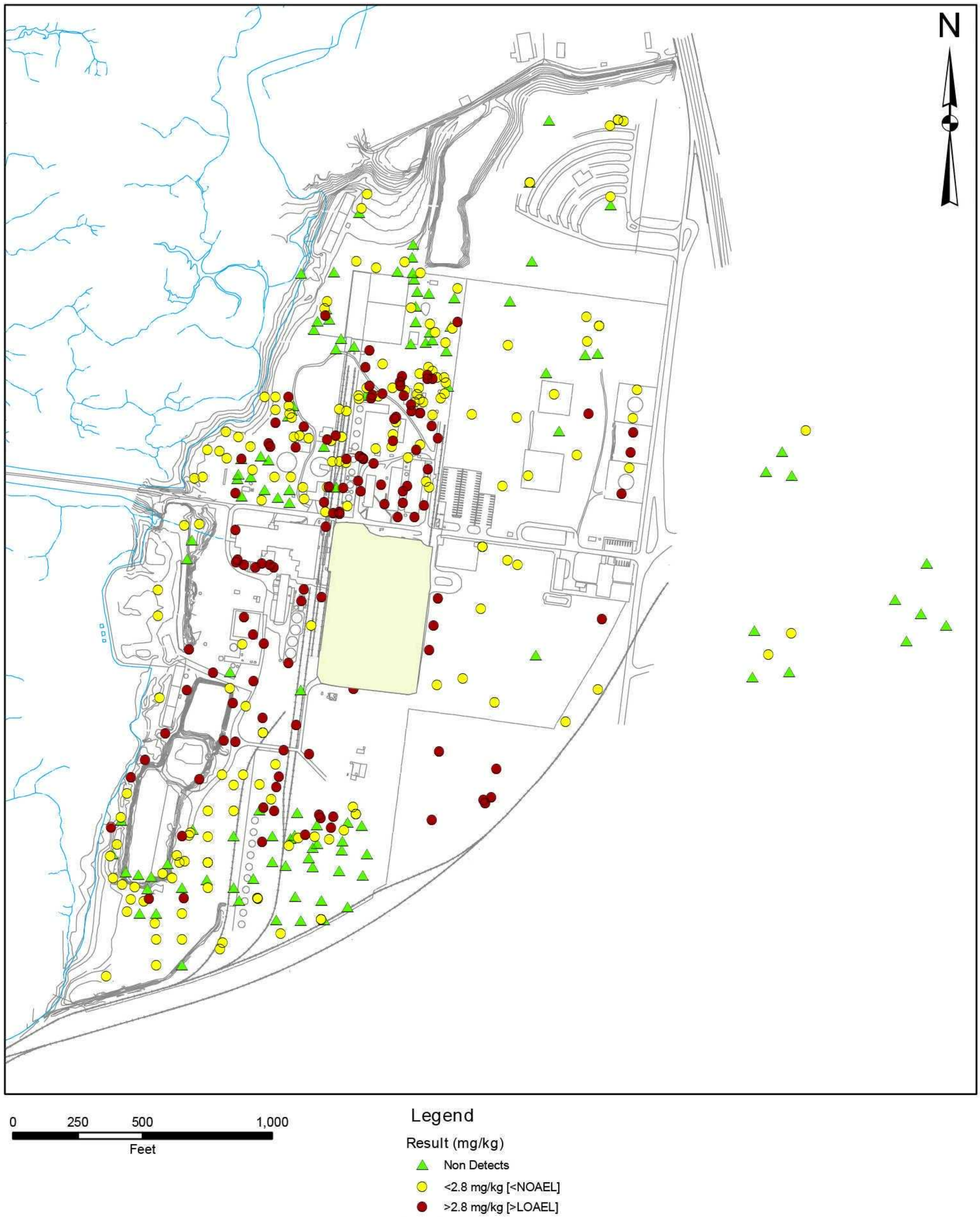

Figure No. E-7

Aroclor-1268 - Meadow vole (applying Aroclor-1254 toxicity)

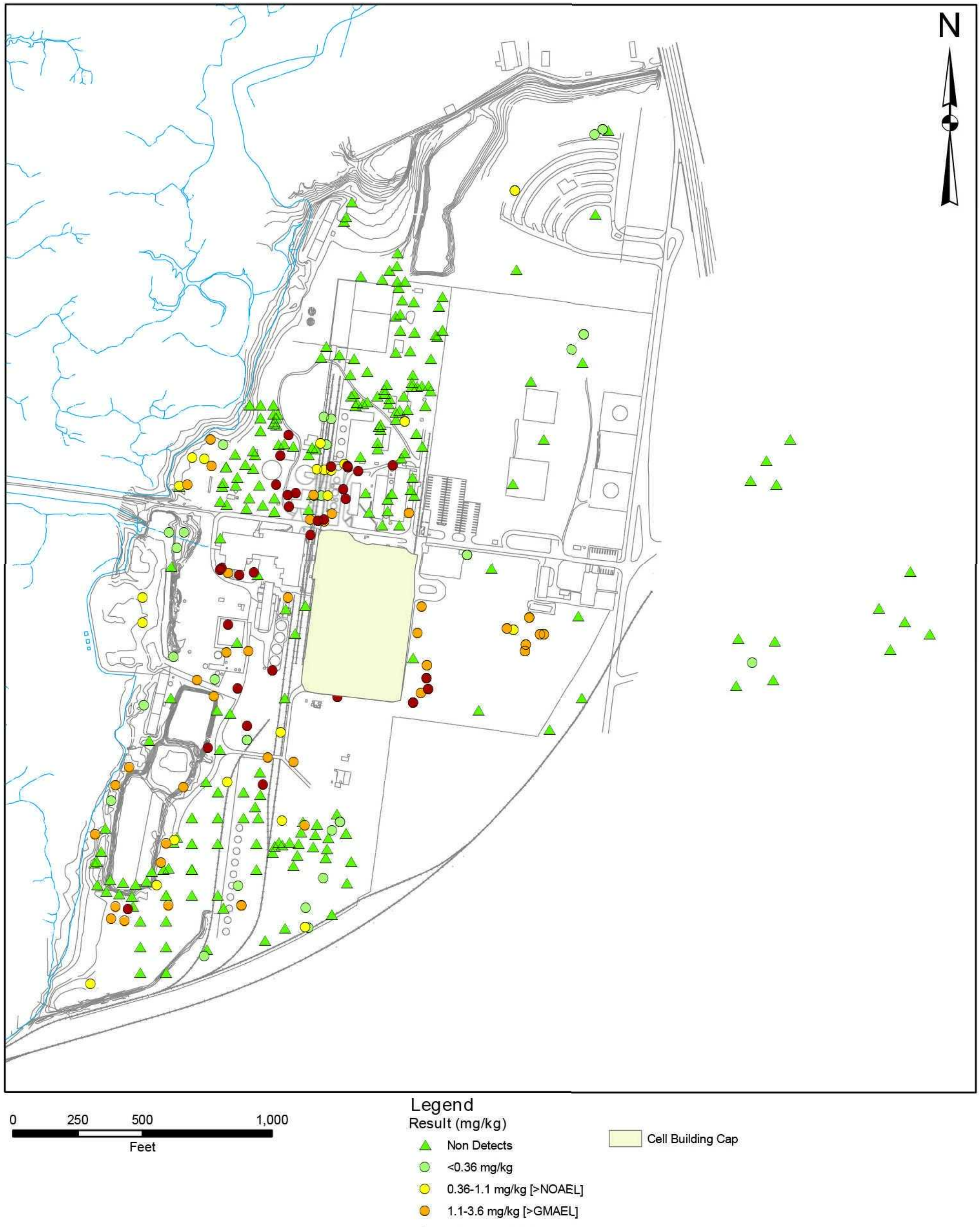

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Figure No. E-8

Aroclor-1268 - Short-tailed shrew (applying Aroclor-1254 toxicity)

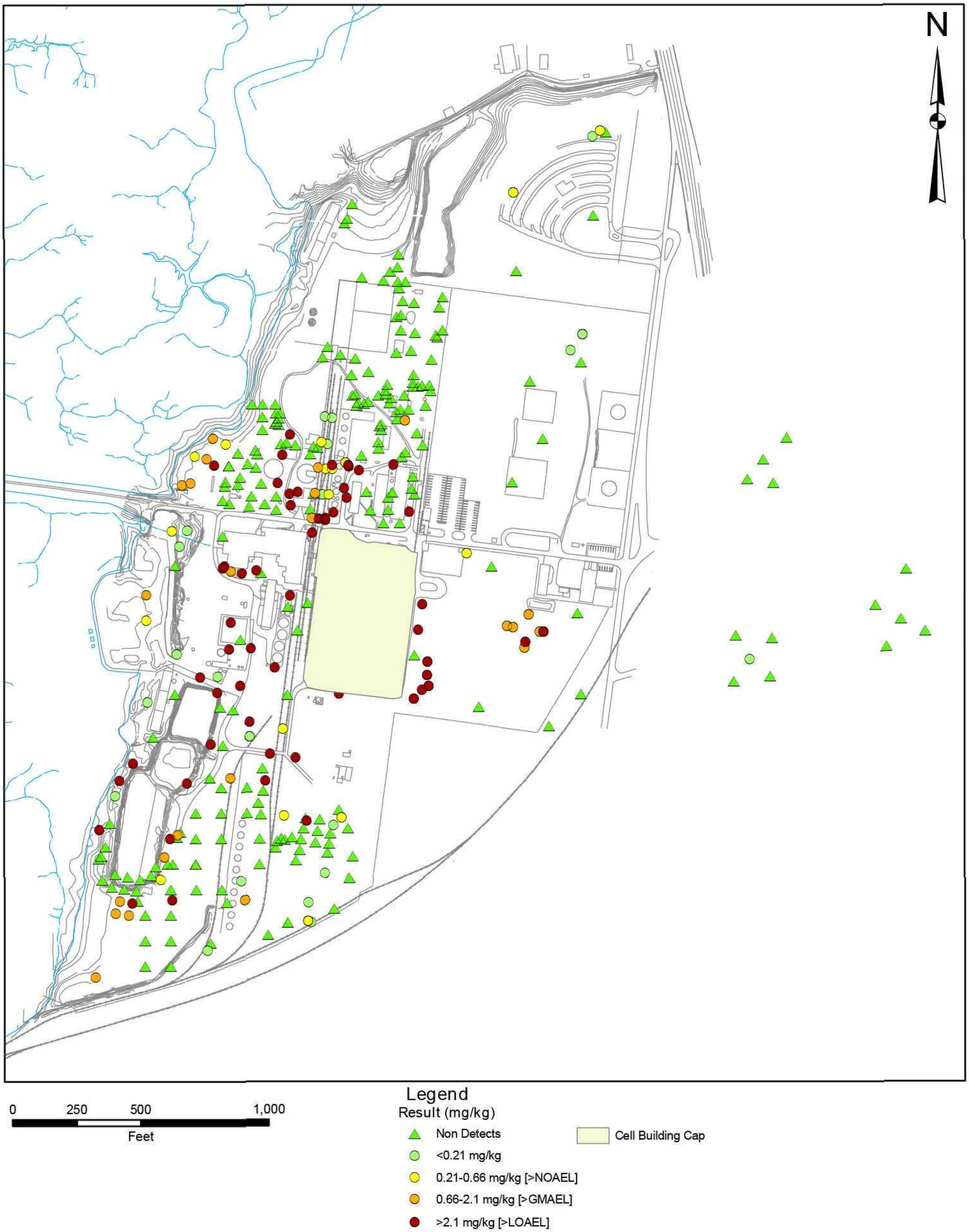

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Figure No. E-9

Aroclor-1268 - Long-tailed weasel (Applying Aroclor-1254 toxicity)

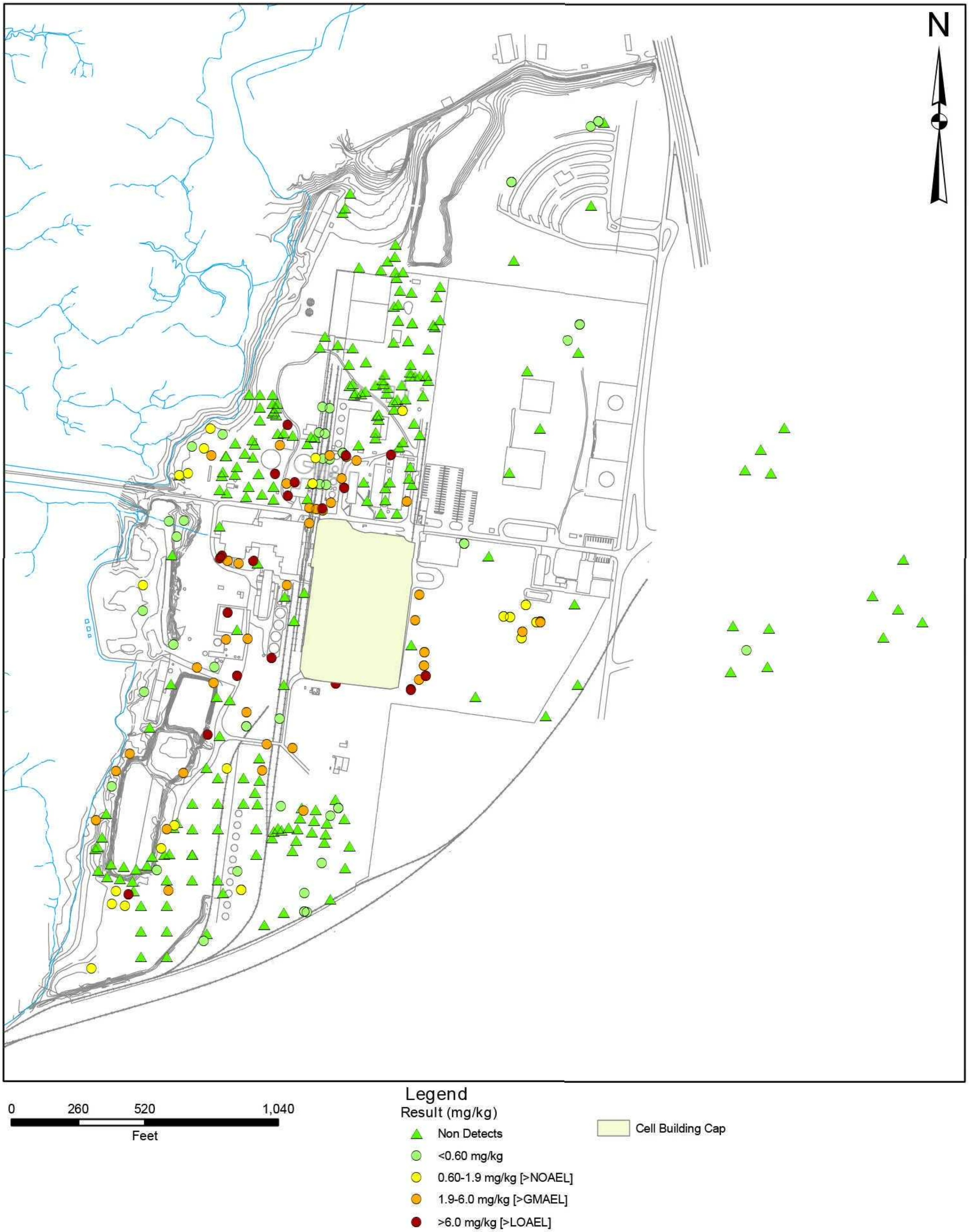

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Figure No. E-10

Lead - Mourning dove

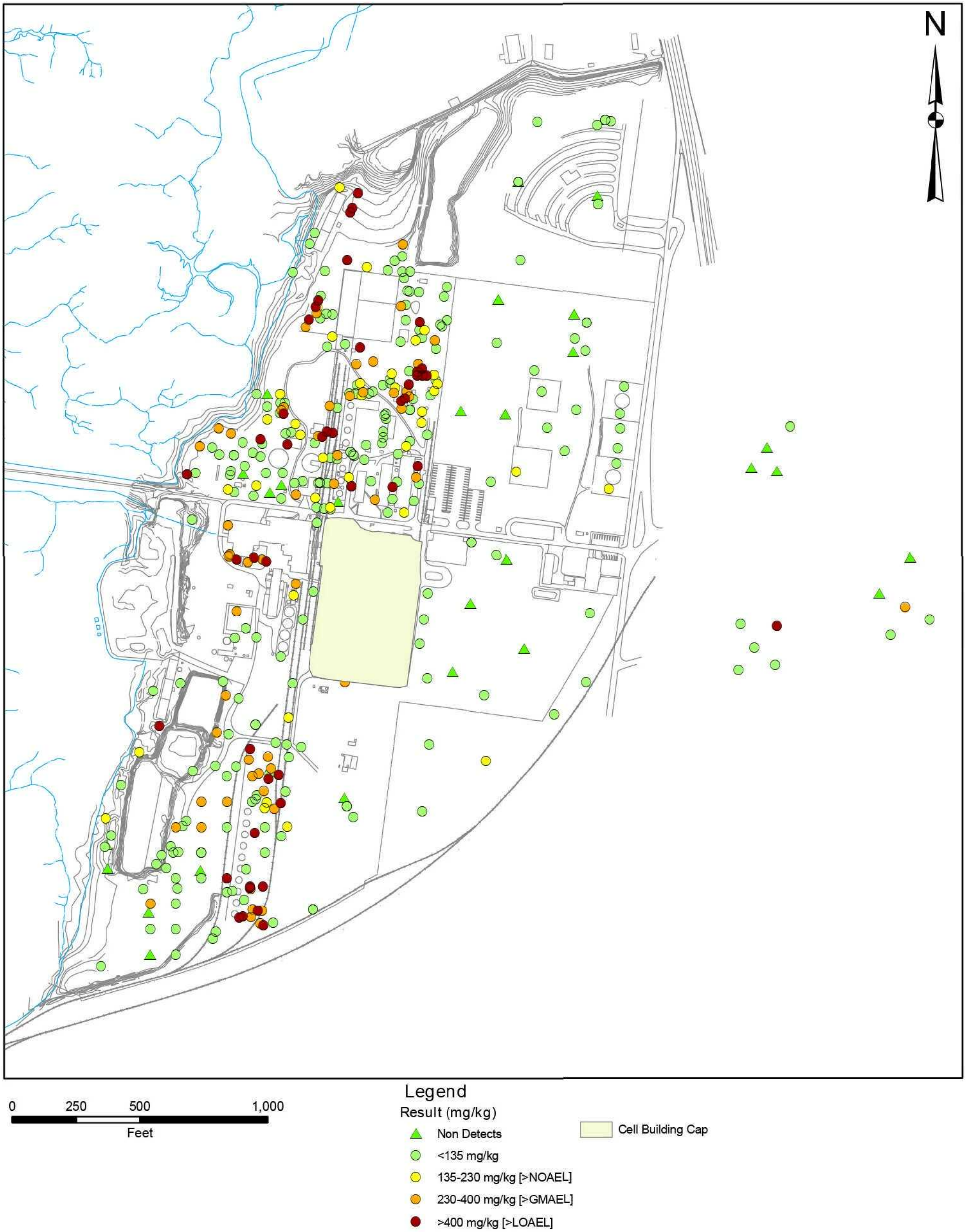

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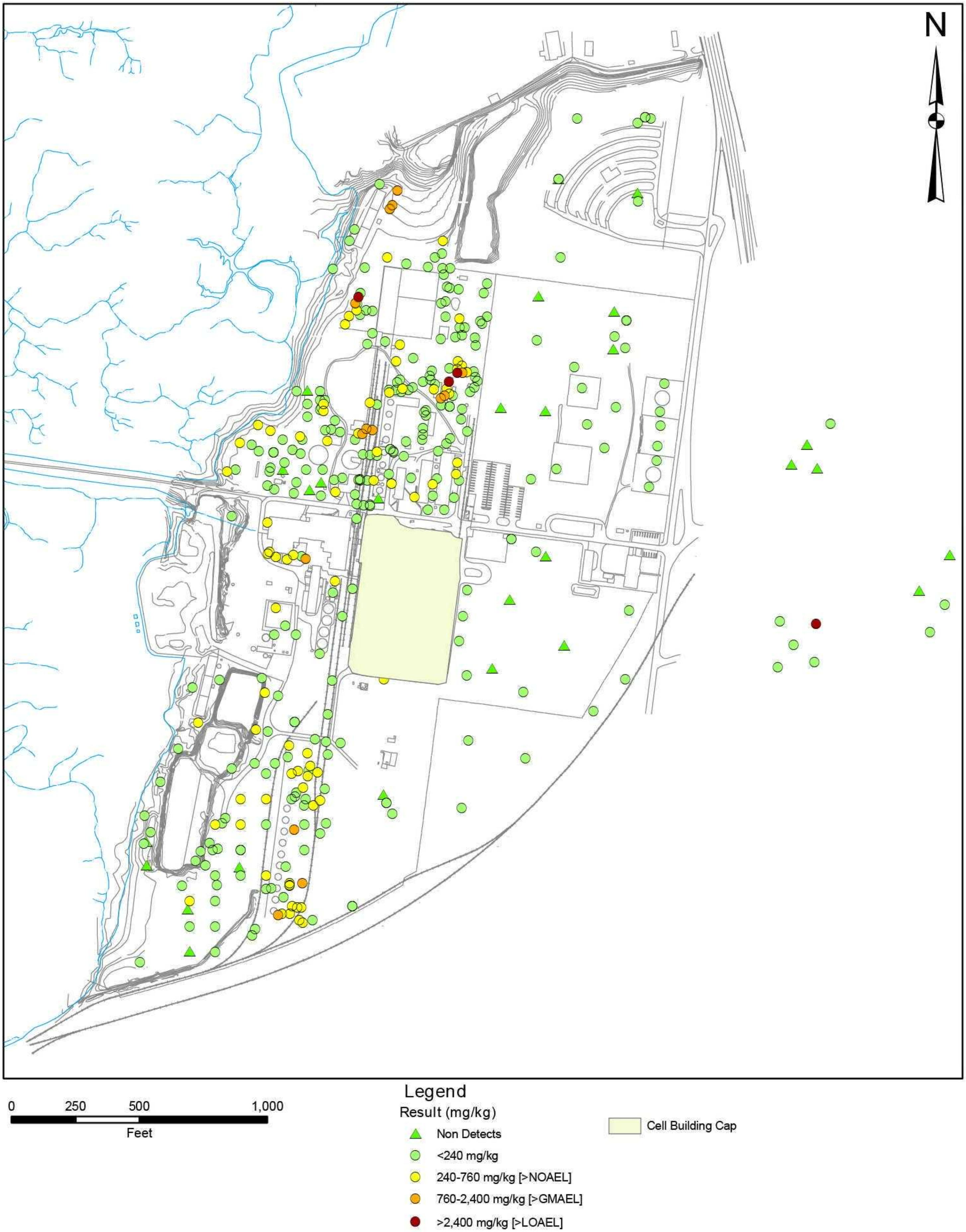
Figure No. E-11

Lead - Short-tailed shrew



Lead - Generic Eco-SSL values

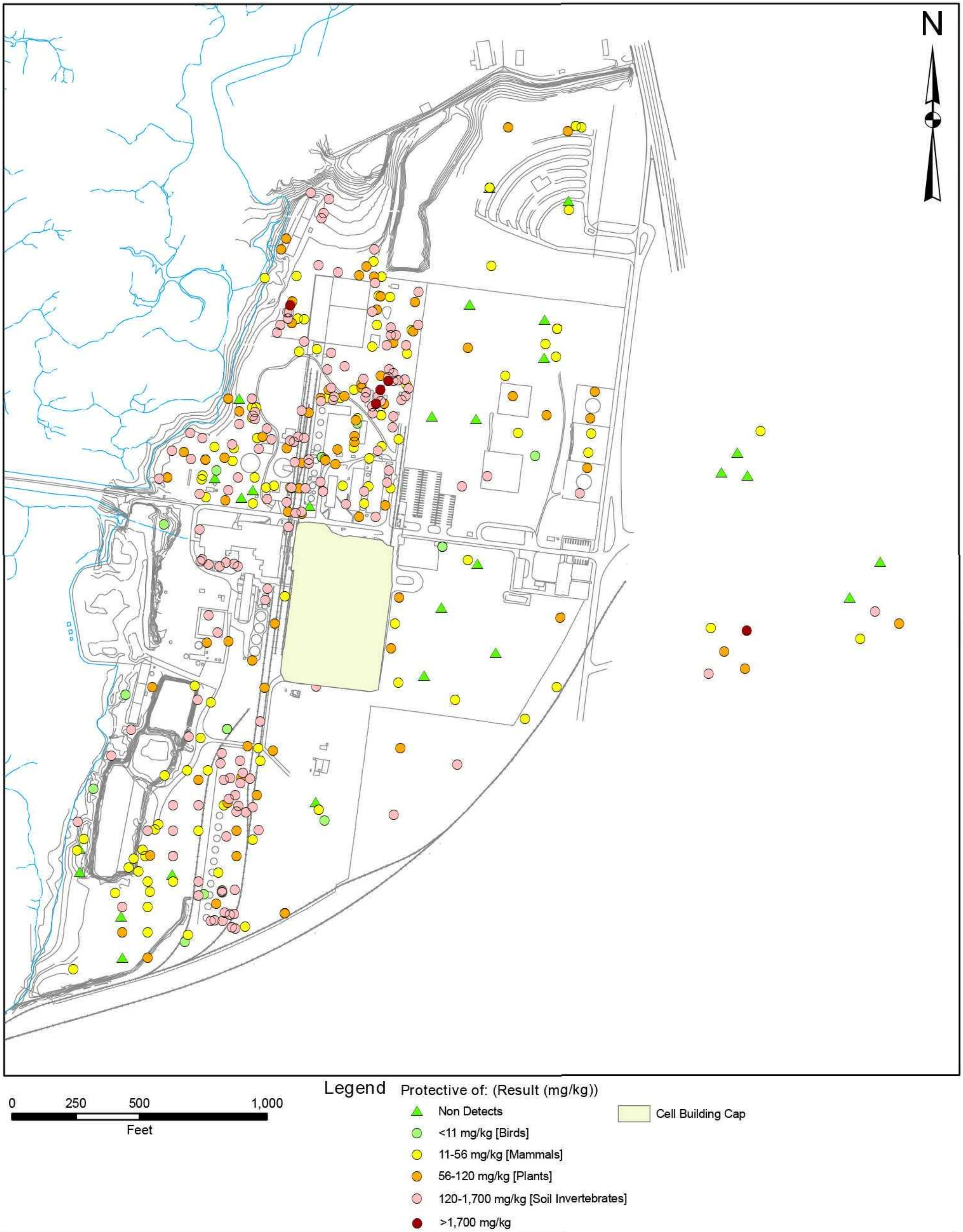


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Figure No. E-13

Antimony - Meadow vole (site-specific RGO; 2.3 mg/kg)

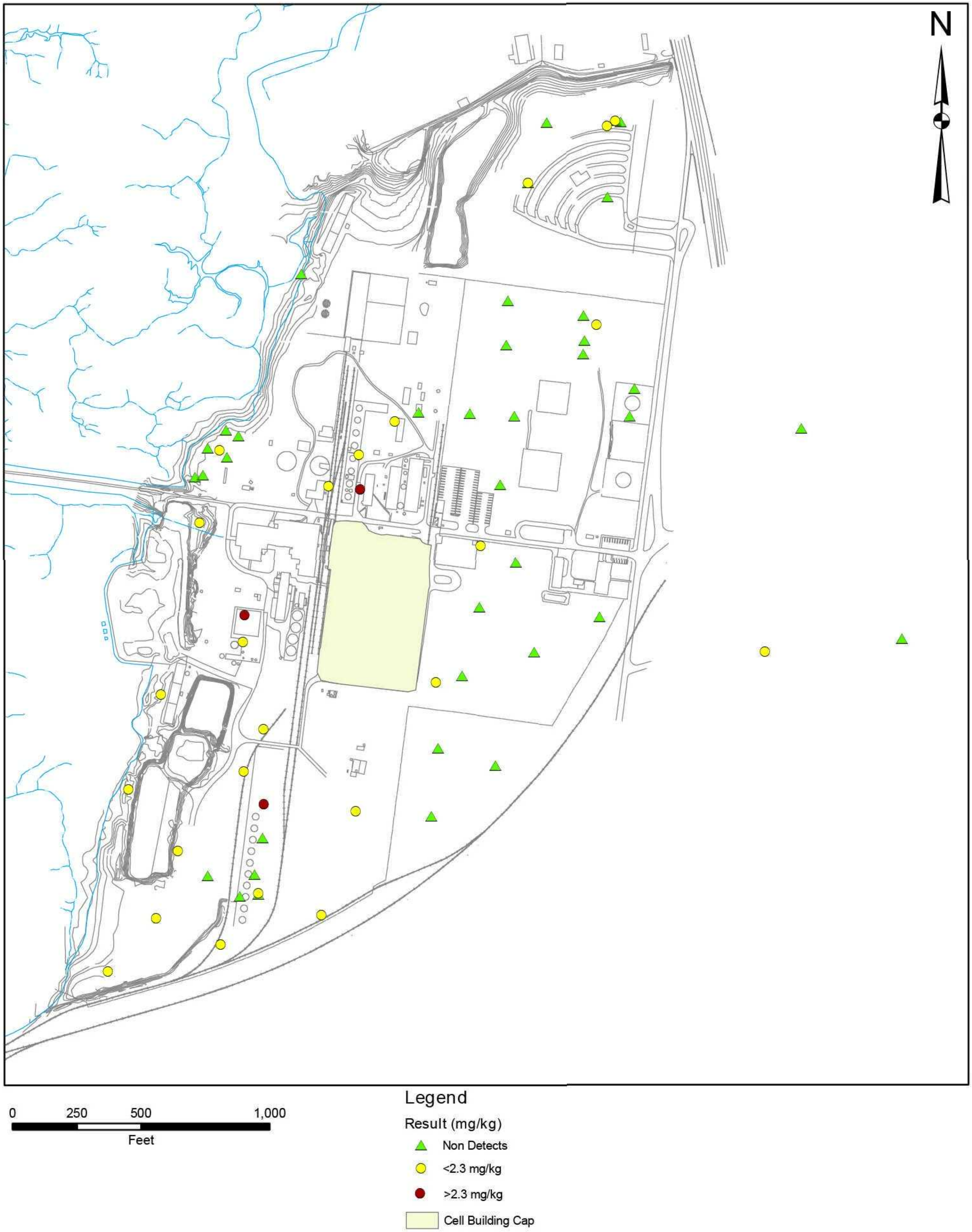

Figure No. E-14

Antimony - Generic Eco-SSL values

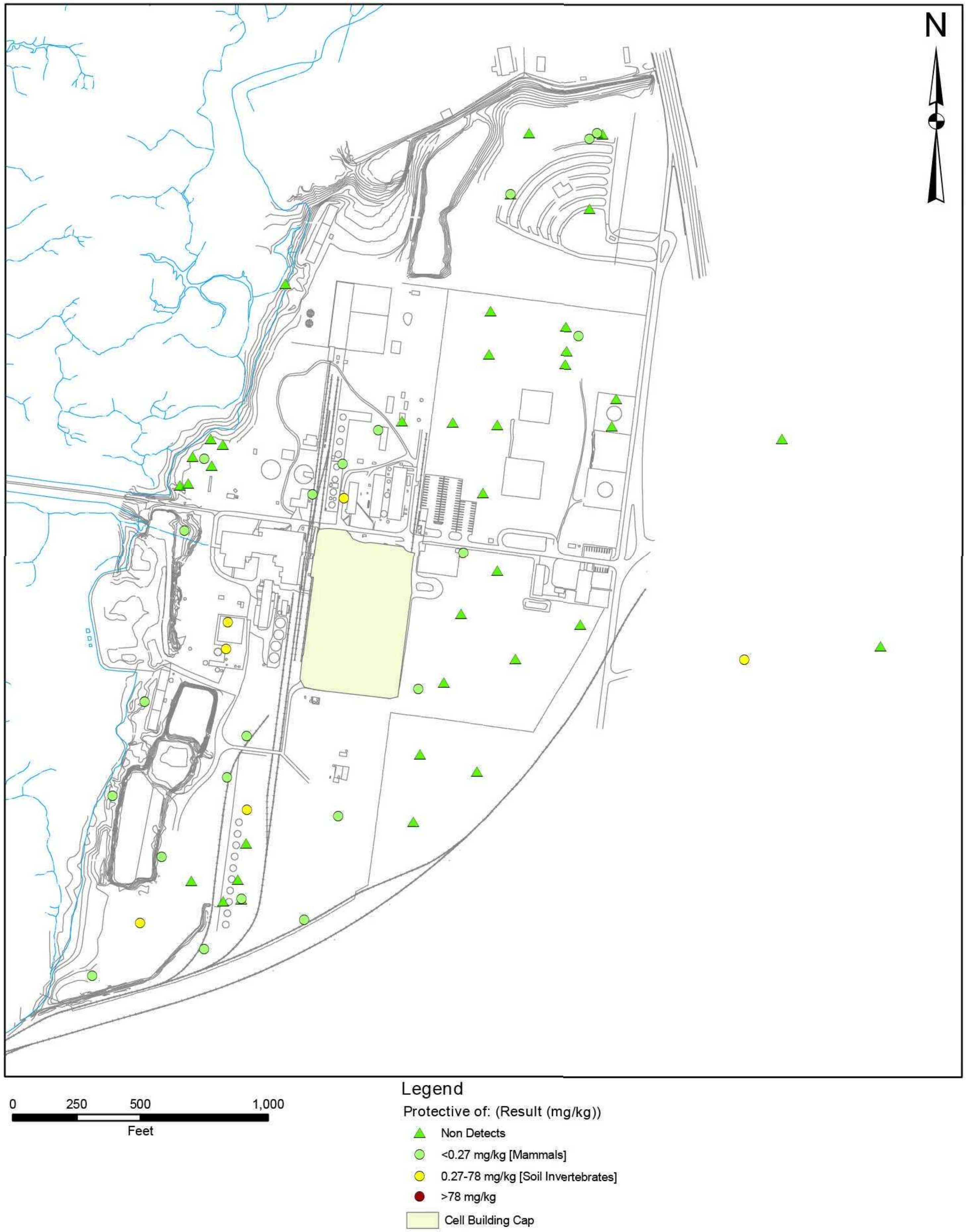

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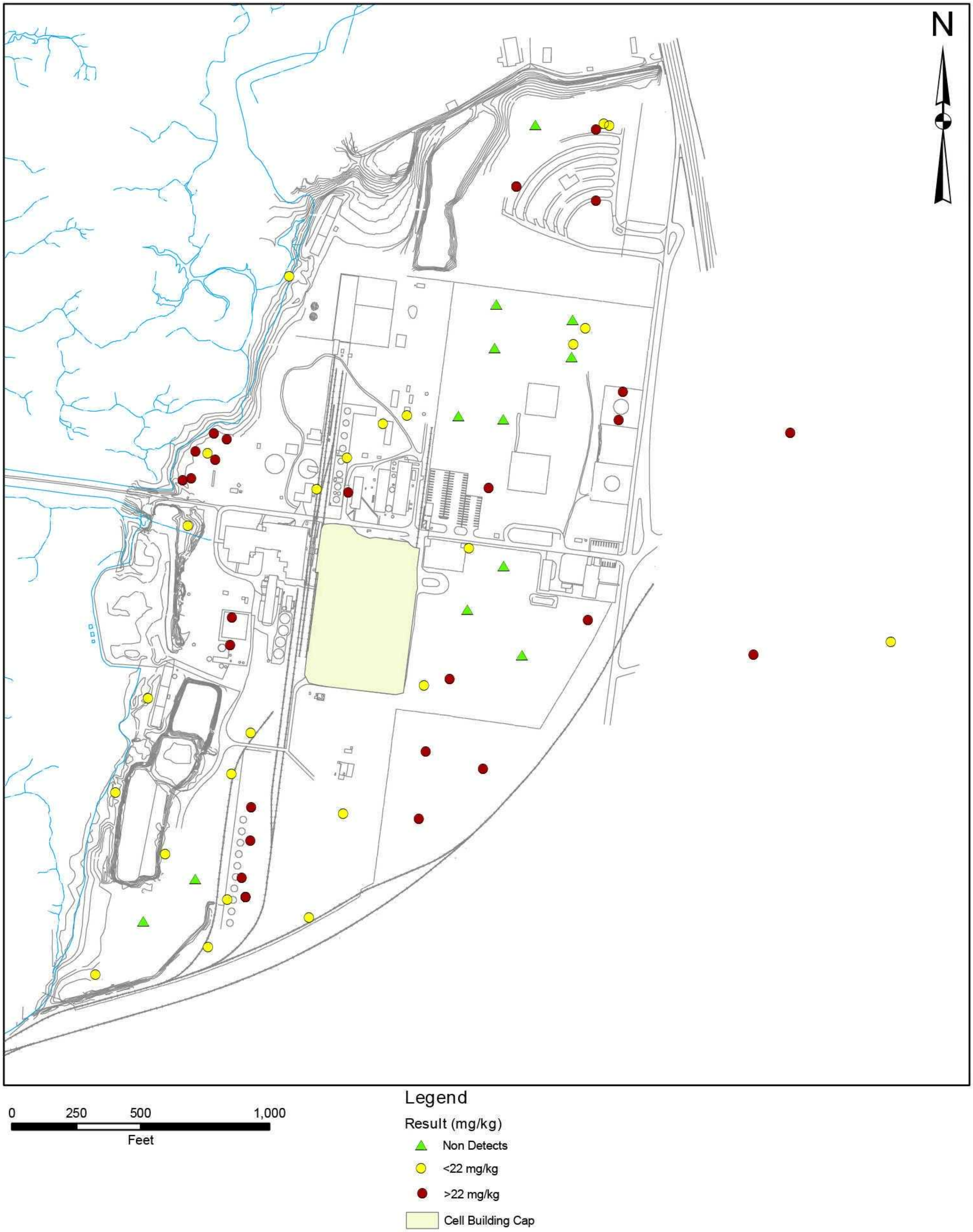
Figure No. E-15

Zinc - Carolina wren (site-specific RGO; 22 mg/kg)



Zinc - Generic Eco-SSL values

0 250 500 1,000
Feet

Legend

Protective of: (Result (mg/kg))

- Non Detects
- <46 mg/kg [Birds]
- 46-79 mg/kg [Mammals]
- 79-120 mg/kg [Soil Invertebrates]
- 120-160 mg/kg [Plants]
- >160 mg/kg

Cell Building Cap

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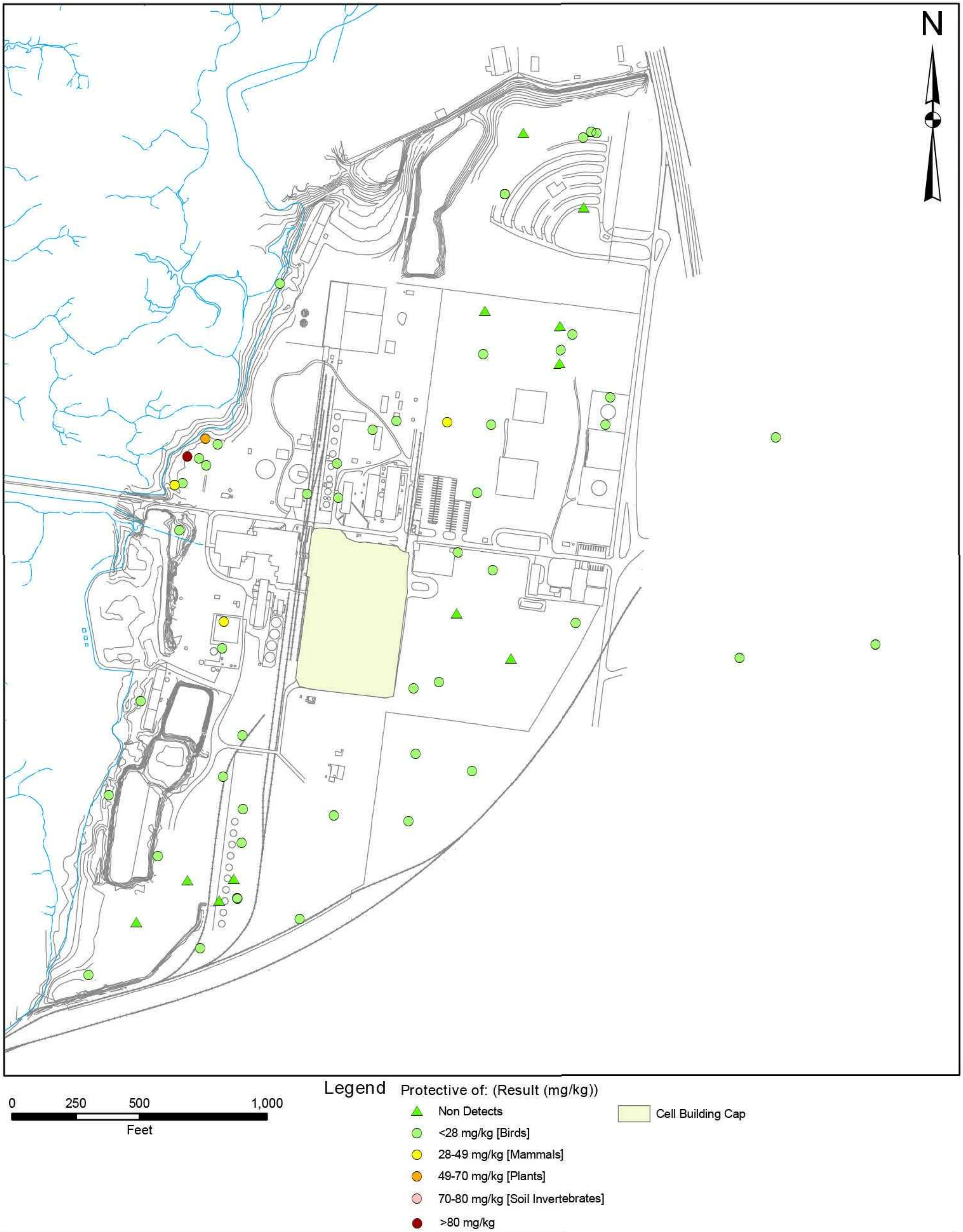
Figure No. E-17

Copper - Generic Eco-SSL values



Nickel - Generic Eco-SSL values

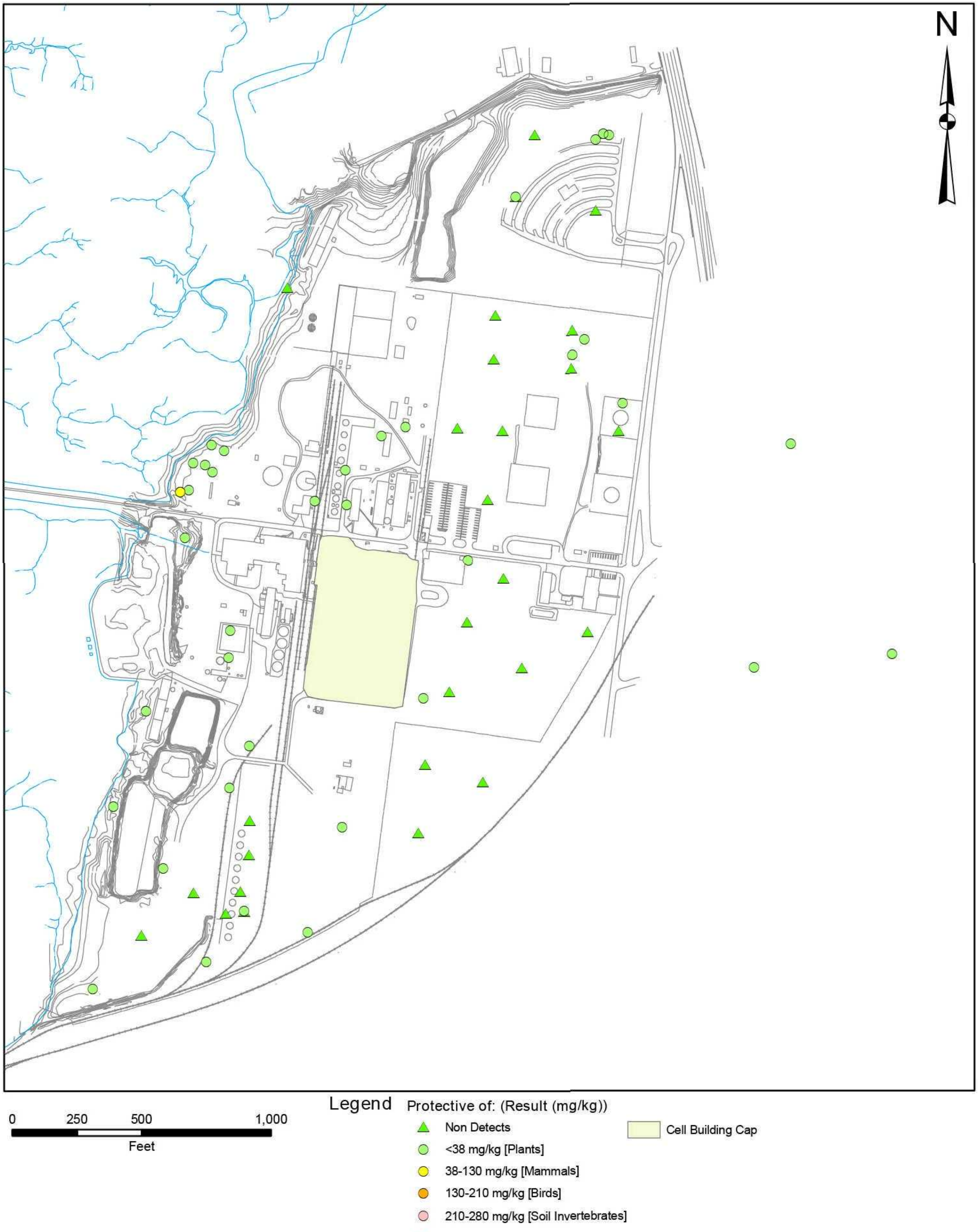


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Figure No. E-19

Vanadium - Generic Eco-SSL values and background value (32 mg/kg)