SITE-SPECIFIC ECOLOGICAL RISK ASSESSMENT

BERNHART PARK

MUHLENBERG TOWNSHIP, PENNSYLVANIA

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Executive Summary

Bernhart Park is a 37.6 acre community park located in Muhlenburg Township, Berks County, Pennsylvania. The main feature of the park is an approximately 15 acre reservoir. Historic operations at the nearby Exide Technologies (Exide) manufacturing facility are alleged to have contributed to lead concentrations in soil, surface water, and sediment in the park. The park is currently closed pending completion of both human and ecological risk assessments and as appropriate, clean up activities.

Exide completed a Human Health Risk Assessment (HHRA) to evaluate potential risk posed by lead concentrations to humans. Exide has worked extensively with the United States Environmental Protection Agency (EPA) and Pennsylvania Department of Environmental Protection (PADEP) to develop soil clean up activities to address potential risk to humans which are acceptable to both the EPA and PADEP. However, neither the EPA nor PADEP have issued formal approval of the soil clean up activities developed. These clean up activities are subject to review by the City of Reading (Owner of the Park) before any formal approval is issued.

This Site-specific Ecological Risk Assessment (ERA) was performed to determine whether lead concentrations projected to remain after the clean up to address human exposure would pose a substantial risk to ecological receptors (e.g., plants, mammals, birds, fish, etc.). This ERA has been performed under the purview of both the EPA and the PADEP. Both agencies agree that the contaminant of concern that will drive clean up decisions at the park is lead. This evaluation follows PADEP guidance for Act 2 Site-Specific Ecological Risk Assessment, Initial Screen (PADEP 2002).

The ERA was performed using both direct observations (three visits to the park by an experienced ecological risk assessor) and indirect analysis (evaluation of existing data and available guidance applicable to such an ERA).

No terrestrial habitats or terrestrial or aquatic species of concern were identified in the park. No endangered or threatened species were observed at the park. No endangered, threatened or species of special concern were listed in the Pennsylvania Natural Diversity Inventory as being present in the park.

As part of the ERA, a model was developed as to where lead concentrations are located, how the lead might migrate, and the potential effects the lead may have on ecological receptors. This model is commonly referred to as the Preliminary Exposure Pathway Analysis or Conceptual Site Model.

The ERA evaluated all environmental sampling data available for the park including sampling performed in 2001 (soil, surface water, sediment), and 2009 (soil, fish).

For the ERA, the park was divided into five major land-use/habitat types: urban recreational (mowed-lawn), broad-leaved deciduous wetland - including islands (Forested Wetlands), deciduous forest (Upland Forest), scrub/shrub, and open water.

The ERA evaluates soil, surface water, sediments, and fish tissue separately. A summary of each medium evaluation is provided below.

Soil – Given the wide range of screening levels available and the uncertainty posed by the low bioavailability of lead to the receptors, a uniform value against which to compare soil lead values was sought. The EPA has not developed default soil lead standards for a park setting; however, the Canadian Council of Ministers of the Environment (CCME) has developed a peer reviewed guideline for parks. Therefore, soil lead concentrations were compared to the 300 mg/kg CCME ecological soil guideline. A summary of the comparisons of soil concentrations, by habitat, to the CCME guideline is as follows:

- Mowed Lawn Area – Soil lead concentrations in the 0-12 inch horizon will (after the proposed soil remediation) range from 42 ppm to 337 ppm with an average of 177 ppm. Two of 27 samples exceed 300 ppm and the average concentration for the area will be below 300 ppm.

- Scrub/Shrub Area – Soil lead concentrations in the 0-12 inch horizon range from 38 ppm to 266 ppm with an average of 129 ppm. None of the 10 samples exceed 300 ppm and the average concentration for the area will be below 300 ppm.

- Forested Wetland Area – Soil lead concentrations in the 0-12 inch horizon range from 140 ppm to 605 ppm with an average of 297 ppm. Four of 10 samples exceed 300 ppm and the average concentration for the area will be below 300 ppm.

- Forested Upland Area ("wooded hillside") – Soil lead concentrations in the 0-12 inch horizon range from 275 ppm to 569 ppm with an average of 385 ppm. Two of five samples exceed 300 ppm; however, the average concentration for the area will just exceeds 300 ppm.

A Hazard Quotient (HQ) analysis was performed using the soil sampling results and the CCME guideline to assess risk. For this ERA, the HQ is simply the soil lead concentration divided by the CCME guideline. The result of the HQ calculation relates the potential for ecological effects based on the concentrations of lead present within soil. In general, if the HQ exceeds 1, some potential for risk exists.

Based on the 0-12 inch soil lead concentrations determined for Bernhart Park, the calculated HQ values ranged from 0.13 to 2 with only seven locations out of 52 exceeding 1. The site wide average HQ was 0.7, and when evaluated on a habitat by habitat basis, the mean HQs were all below 1 except for the forested upland area which had an average HQ of 1.28. The significance of the calculated HQ value for each location was evaluated relative to a variety of exposure considerations, including site specific bioavailability testing which determined that typically only

1/3 of the observed lead is bioavailable. That evaluation concluded that no substantial ecological risk exists and no further evaluation is required.

Surface Water – Thirty-five (35) surface water samples from the reservoir were analyzed for total lead. Eighteen (18) samples were below the analytical detection limit of 1.5 parts per billion (ppb) and only two (2) of the 35 surface water concentrations exceeded the EPA/PADEP ambient water quality criteria of 2.5 ppb. The average observed value was less than 2 ppb. Based on these results lead in water does not represent a significant ecological risk.

Sediments – The EPA has developed freshwater sediment screening values that are intended to indicate at what concentration sediments pose a potential for risk to the benthic community. Although sediment benchmarks were exceeded, trophic-level effects are not expected as noted in the fish tissue discussion below.

Fish Tissue – No lead was detected in any of the fish tissue tested. The highest detection limit for any of the samples was 83 ppb. The lowest value of fillet fish tissue concentrations associated with adverse effects from lead exposure was 130 ppb – well above 83 ppb. Given that lead was not detected in fish, the IDLs were well below the food-based benchmark, and a diverse and substantial fish community was observed during the most recent sampling event; it is highly unlikely that there are aquatic food chain effects occurring due to lead exposure.

CONCLUSIONS

The Ecological Risk Assessment initially focuses on ecological exposure conditions for lead in soil, but also considers lead in sediment, surface water, and fish tissue. Following a step-wise evaluation that considers multiple lines of evidence, the Ecological Risk Assessment determined that following completion of the proposed soil remediation, no further evaluation is necessary. The key factors supporting this conclusion were:

- An average HQ for lead in soil less than 1 when screened against the CCME ecological screening level for lead in soil in a park setting.
- Habitat by habitat area average HQs all less than 1 except for forested upland areas which had an HQ of 1.28.
- Site-specific bioavailability of lead in soil, based on sequential extraction testing, generally less than 32%, while the screening values are based on research that utilizes a species of lead that is 100% available.
- Evaluation of the habitat- and location-specific HQs, in conjunction with the low bioavailability and site-specific ecological exposure conditions, indicates that no significant ecological risk occurs from observed soil lead concentrations at the site.
- Surface water sampling results that determined lead concentrations in greater than half the samples collected were below detection levels and that collectively the average

concentration was less than 2 ppb, or less than 80% of the EPA/PADEP ambient water quality standard of 2.5 ppb.

- Although sediment lead concentrations were greater than sediment screening levels, the results of fish tissue sampling were all below 83 ppb, while the lowest value of fish tissue concentrations associated with adverse effects from lead exposure is 130 ppb.

Considering all of these factors, it is concluded that surface water, sediment, and soil to remain after the proposed soil remediation to address human exposure would not result in a significant adverse ecological effect.

Section 1 Introduction

The purpose of this Site-specific Ecological Risk Assessment is to evaluate whether exposure to soils, sediment, surface water, and fish at Bernhart Park in Muhlenberg Township, Berks County, Pennsylvania, have the potential to pose substantial ecological risk as a result of lead contamination attributed to historic manufacturing activities at a nearby facility currently owned and operated by Exide Technologies. This evaluation follows Pennsylvania Department of Environmental Protection (PADEP) Act 2 Site-Specific Ecological Risk Assessment, Initial Screen (PADEP 2002) and was the approach agreed to by PADEP, United States Environmental Protection Agency (EPA) and Exide during a meeting on 10 December 2009. The initial screen is a two-step process. The goal of the initial screen is to determine if "No Substantial Ecological Risk" can be concluded or if a baseline phase (i.e., Steps 3-8) is warranted. Based on previous documentation provided by Exide to EPA and PADEP (Advanced GeoServices 2008, 2009) it was determined that Constituents of Potential Ecological Concern (CPECs) present at the site are limited to lead. The report that follows presents Step 1 and Step 2 of the Site-specific Ecological Risk Assessment procedure as identified in PADEP Act 2 Guidance. Exide investigated multiple metals during the initial phases of off-site soil sampling and determined that the other metals are at concentrations several orders of magnitude lower than lead. As a result, lead is the primary contaminant of concern associated with historic facility operations.

Section 2 Initial Screen (2 Steps)

The initial screening of a Site-specific Ecological Risk Assessment encompasses two steps: 1) Step 1 – Fundamental Components and Step 2 – Preliminary Exposure Estimate and Risk Assessment.

2.1 Step 1 – Fundamental Components

The fundamental components portion describes the site history, environmental setting, site visits, contaminant fate and transport, preliminary ecotoxicity evaluation, preliminary exposure pathways analysis, areas of concern, and assessment endpoints. These are described in the subsections below.

2.1.1 Site History

Bernhart Park (Park) is an approximately 40 acre recreational use park located in Muhlenberg Township, Berks County, Pennsylvania. The Park is owned by the City of Reading and includes a 15 +/- acre reservoir. The Park is situated within ¼ mile of a lead recycling facility (Facility), currently owned and operated by Exide Technologies. The Exide Facility has been in operation since the mid-1930s and historic aerial deposition of lead is believed to have contributed to soil lead levels currently present in Bernhart Park.

Pursuant to various requests from, and agreements with, the EPA and PADEP, Exide has sampled soil within a defined area in the vicinity of the Facility (Study Area) since 1992. As part of that soil sampling, the Park has been sampled on multiple occasions. The sampling performed in 1994 and 1996 was performed as part of regional investigation activities. In 1997 Exide conducted sampling at the specific request of PADEP and the City of Reading. The sampling performed in 2001 separated the Park into 20,000 sf exposure areas that were sampled individually to determine whether surficial soils presented a potentially unacceptable risk to human receptors frequenting the Park. To evaluate human risk, soil sampling performed at the Park as well as in the surrounding residential community consisted of collecting soil samples from the upper three inches of soil. Risk assessments conducted by Exide utilizing the soil sampling results concluded that the surface soils do not pose a potentially unacceptable risk to humans utilizing the Park.

In 1998, the PADEP required Exide to prepare a Remedial Investigation Report (RIR). A Draft RIR was submitted to the PADEP on December 14, 1998. The RIR included a summary of all sampling information obtained since 1992 for the Study Area (including the Park) as required by the Pennsylvania "Act 2" program. Act 2 also required, among other things, that an ecological evaluation be performed. The ecological evaluation followed a 9-step process that included an on-site evaluation, review of sampling results, and evaluation of ecological receptors. The conclusion of the ecological evaluation contained in the Draft RIR was that further evaluation of the Park (or any other parts of the Study Area) was not warranted.

A Human Health Risk Assessment was completed by Gradient Corporation for the recreational use of Bernhart Park (Gradient 2001). That Risk Assessment concluded that soil lead concentrations would not significantly elevate blood lead levels in recreational users of the Park even with no remedial activities. The EPA reviewed the Human Health Risk Assessment prepared by Gradient and asked that Exide consider remediating the grass areas of the Park. In response, Exide submitted a letter to the EPA on October 5, 2001 proposing to perform a variety of remedial activities in specific exposure areas within the mowed lawn areas of the Park. On August 2, 2007, the EPA issued a decision that a lead in soil cleanup criteria of 650 mg/kg be applied to the residential properties in the Study Area. The EPA requested that the same criteria be applied to the grass areas of the Park. Although Exide's evaluations conclude that a soil lead criteria this low is not warranted, Exide and EPA have agreed to apply the residential soil remediation criteria of 650 mg/kg to the 0-3 inch soil horizon in the lawn areas.

Remediation of those areas of >650 mg/kg lead-in-soil within the 0-3 inch soil horizon in the mowed lawn will address any reasonable concerns related to human exposure in the mowed lawn areas of the Park but are not intended to address ecological risk. This site-specific ecological risk assessment (initial screen) has been prepared to specifically evaluate potential ecological effects associated with lead levels in Park soils and aquatic media (including sediment). In addition to previously discussed soil sampling, sediment and surface water data collected from the lake in 2001 and fish tissue data collected in 2009 are included in this assessment.

2.1.2 Environmental Setting

The Park is a 37.6 acre recreational area located in the southeast corner of Muhlenberg Township, Pennsylvania. The majority of the land surrounding the Park is either residential or commercial, with a 20+ acre wooded area located off-site south of the Bernhart Reservoir dam. Using the USGS land use classification system (Anderson et al. 1976), the Park itself is comprised of 5 major land-use/habitat types (see Figure 1):

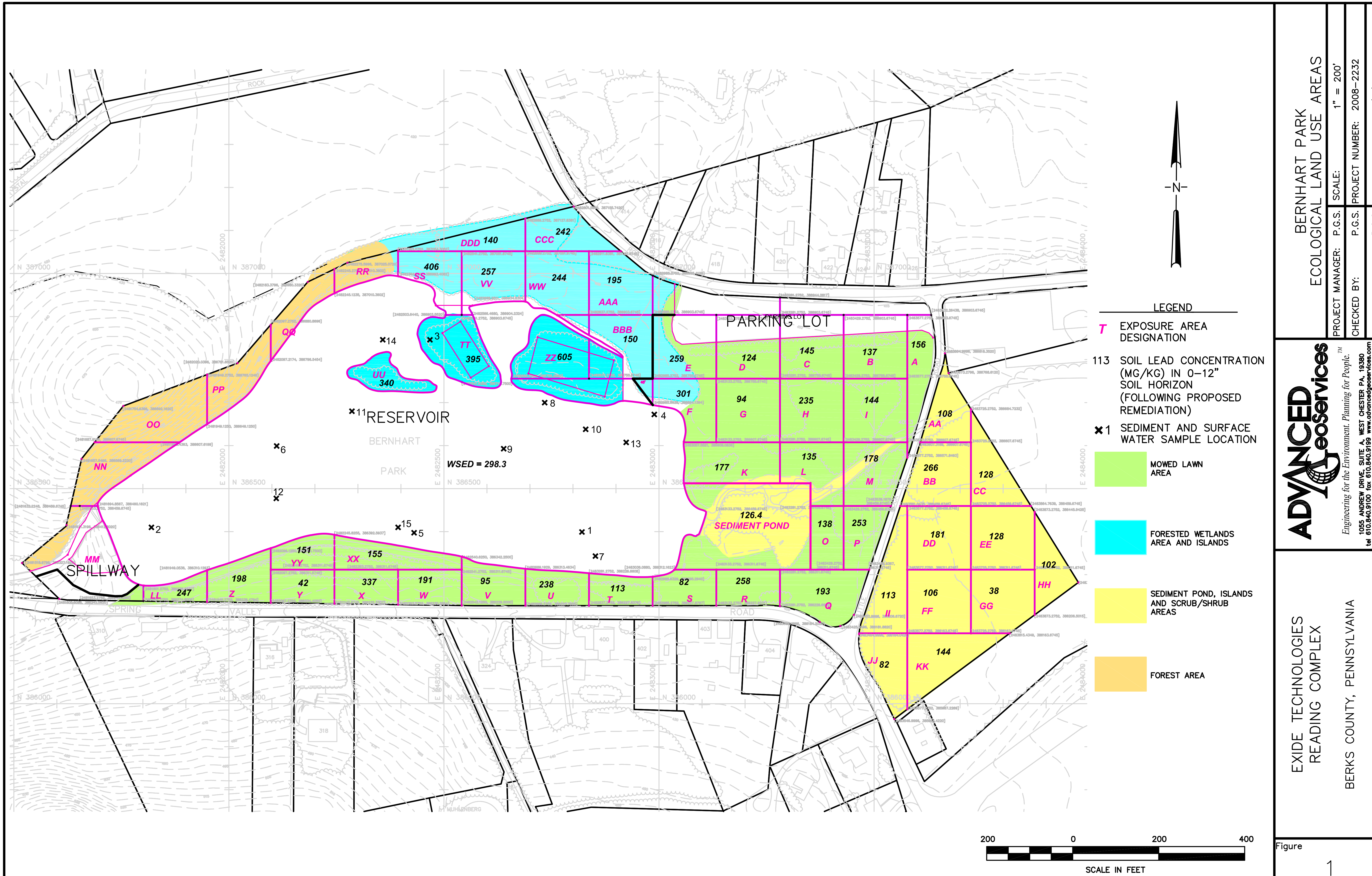
- **Urban recreational** (mowed-lawn) – approximately 9 acres along the south and east boundaries of the reservoir. This area includes: a walking path, a picnic area with barbecue pits, large shade trees bordering Spring Valley Road (mostly oaks – *Quercus sp.*, maples-*Acer sp.*, sycamore – *Plantanus occidentalis* and eastern hemlock – *Tsuga canadensis*), shoreline vegetation dominated by speckled alder (*Alnus rugosa*) and willow (*Salix sp*.) and open maintained lawn which is dominated by several grass species, mosses, asters (*Aster sp*.), Dame's violet (*Hesperis matronalis*), plantain (*Plantago sp*.), poison ivy (*Rhus radicans*), goldenrod (*Solidago sp*.) and numerous other early successional and invasive species.

- **Broad-leaved deciduous wetland - including islands** (Forested Wetlands) **–** a 4 acre area located on the north/northeastern shore of the reservoir and 3 vegetated islands. This habitat type is considered a habitat-of-concern under PADEP Act 2 regulations. The dominant overstory vegetation in this area includes: red maple, red oak (*Quercus rubra*), green ash (*Fraxinus pennsylvanica*), catalpa (*Catalpa bignonioides*) and black cherry (*Prunus serotina*). The understory is dense and dominated by blackberry (*Rubus allegheniensis*), tartarian honeysuckle (*Lonicera tatarica*), riverbank grape *(Vitis riparia*), jewelweed *(Impatiens sp*.), garlic mustard (*Alliaria officinalis*) and sensitive fern (*Onoclea sensibilis*).

- **Deciduous forest** (Upland Forest) – a 1.7 acre area located adjacent to the north/northwestern portion of the property, near the lake discharge (dam). This forested area is a mature forest stand dominated by black oak (*Quercus velutina*) and box elder (*Acer negundo*), with a sparse understory.

- **Scrub/shrub** – approximately 6.3 acres that includes a 4.8 acre area just east of Little Rock Road and a 1.5 acre area located west of Little Rock Road that is bisected by Bernhart Creek and is referred to as the sediment pond (see Figure 1). The dominate vegetation includes: honeysuckle, multiflora rose (*Rosa multiflora*), sumac (*Rhus sp*.), poison ivy, blackberry, willow species, alder species, red maple (*Acer rubrum*), greenbrier (*Smilax rotundifolia*), sassafras (*Sassafras albidum*), red raspberry (*Rubus strigosus*) and pin cherry (*Prunus pensylvanica*).

- Open water – Bernhart Reservoir is approximately 15.5 acres and is the dominant feature of the park.



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As defined in 25 PA Code, Chapter 250, Section 250.1, local parks are considered “habitats of concern;” therefore, the park as a whole must be evaluated. However, the only biologically defined “habitats of concern” at the site are the forested wetlands and open water (i.e., Bernhart Reservoir). From an ecological standpoint the wetland, forested, and open water areas are the habitats that support the most natural and diverse ecological communities in the Park and also provide the most essential habitat functions (cover and food sources) for both terrestrial and aquatic species.

While no quantitative inventory was conducted during site visits, the wildlife species observed directly or indirectly (scat, track, or vocalization) during three site visits are typical of urban park environments and include the species noted below:

Species	Habitat		
	Terrestrial	**Wetland**	**Open Water**
American robin (*Turdus migratorius*)	√	√	
Canada goose (*Branta canadensis*)	√	√	√
Mallard (*Anas platyrhynchos*)		√	√
Belted kingfisher (*Ceryle alcyon*)			√
Great blue heron (*Ardea herodias*)		√	√
Tree swallow (*Tachycineta bicolor*)			√
Gray catbird (*Dumetella carolinensis*)	√	√	
Northern mockingbird (*Mimus polyglottos*)	√	√	
House finch (*Caprodacus mexicanus*)	√	√	
American goldfinch (*Carduelis tristis*)	√	√	
Raccoon (*Procyon lotor*)	√	√	√
Opossum (*Didelphis virginiana*)	√	√	
White-footed mouse (*Peromyscus leucopus*)	√	√	
Meadow vole (*Microtus pennsylvanicus*)	√	√	
Short-tailed shrew (*Blarina brevicauda*)	√	√	
Gray squirrel (*Sciurus carolinensis*)	√	√	
Muskrat (*Ondontra zibethicus*)		√	√
White-tailed deer (*Odocoileus virginianus*)	√	√	

Note: Terrestrial habitats include urban/recreational, deciduous forest, and scrub/shrub.

An information request was submitted to the Pennsylvania Natural Diversity Inventory (PNDI) online database in July of 2009 in an effort to identify the presence of endangered, threatened or species of special concern within or adjacent to the Park. The results of the database review failed to find listed species within the Park (see Appendix A).

2.1.3 Site Visits

To provide some of the information necessary to understand the ecological issues at the site, an ecological risk assessor with 20 years of experience made three site visits in 2007 and 2008. The results of those visits and additional information collected are presented in the following subsections: Environmental Setting, Preliminary Exposure Pathway Analysis, Areas of Concern, and Assessment Endpoints.

2.1.4 Contaminant Fate and Transport

Lead can pose a threat to ecological receptors if it moves through the soil and is transferred to biota. Many factors influence the mobility and bioavailability of lead: pH, soil texture (especially clay content), and organic matter content. Since dissolved lead in soils is commonly in the form Pb^{2+}, the adsorption on cation exchange sites of clays or organic matter can decrease mobility and availability. In general, the following statements regarding lead fate and transport are true:

- Lead tends to be more bioavailable as acidity increases (pH decreases)
- The higher the organic carbon concentration, the more lead complexes and the less it is available.
- Increased carbonate, sulfate, sulfide and hydroxide concentrations increase lead complexation (although to a lesser degree than organic carbon)

A simple interpretation of these principles is that lead in soil or sediments tends to be immobile and not bioavailable when pH is greater than 6 (but below 12) and when there are high concentrations of available binding ligands (organic carbon, sulfides, sulfates, etc.).

The form of the lead when added to soil will also affect its solubility and initial mobility. For example, lead chlorides, lead acetates and lead nitrates (if not transformed) are soluble in the soil environment and more mobile. Lead oxides, although less soluble than salts, are more soluble than some of the lead compounds that form in soils. In aerobic soils, weathering of soluble lead compounds rapidly results in the formation of more stable compounds such as $Pb_3CO_3(OH)_2$. In anaerobic soils, the reduction of SO_4^{2-} to S^{2-} frequently leads to the formation of lead sulfide (PbS), a very insoluble, non-reactive species. The sulfides are commonly found in anaerobic, saturated wetland soils.

In soils, lead solubility seems to be limited by relatively insoluble compounds such as $PbCO_3$, $Pb(OH)_2$, $Pb_3(PO_4)_2$, or $Pb(PO_4)_3OH$, which have a pH-dependent solubility in contrast to the lead salts normally used in toxicity testing, whose solubilities are high and not dependent on pH.

The determination of the total concentration of lead in soils gives no information regarding the various forms of lead present and is often not informative regarding lead bioavailability (Eisler 1988, Pattee and Pain 2003, McGreer et al. 2004). Therefore, increasing effort and concern has been placed on the development of procedures that can help determine the form of lead in an environmental sample which can concurrently provide more insight into the bioavailable fraction. Numerous sequential extraction procedures have been developed to assist in the determination of the forms of lead present in environmental samples (Rauret et al. 2000, Tokalioglu et al. 2000, Marschner et al. 2006, Kashem et al. 2007, and Yusuf 2007). To aide in the evaluation of lead bioavailability in Park soils, 5 samples (2 forested wetland, 2 mowed-lawn/grassland, and 1 shrub-scrub) collected in February 2009 were submitted for sequential analysis using a four-part extraction method - see Appendix B.

The first extraction procedure (Exchangeable) measures lead concentrations associated with water and acid soluble carbonates. The second extraction procedure (Reducible) quantifies lead associated with iron and manganese. Several studies have shown that these forms of lead (i.e., Pb carbonates and Pb associated with Fe or Mn-oxides are more bioavailable than most other lead forms like PbS or lead phosphates (EPA 2005a, 2007). For the 5 samples evaluated, the mean percent of the total lead concentration associated with the first extraction procedures was less than 15% and the total lead concentration removed through the first two extraction procedures was 34% and the range of percent total lead in these two forms was 15 – 58%.

The third extraction procedure (Oxidizable) measures organic lead forms which are less bioavailable. The mean percent of the total lead concentration in these forms was 15% with a range of 1 – 22%. The fourth and final extraction (Residual non-silicate bound) represents the most strongly bound forms of lead (typically in a mineral structure) which are highly insoluble and relatively unavailable to potential biological receptors. The mean percent concentration of these forms was 56% with a range of 26 – 81%.

In summary, with the exception of BP-TT-0-12 which was very gravelly in composition, all samples had > 68% of the total lead in low or non-bioavailable forms (i.e., Oxidizable and Residual non-silicate bound). The importance of this fact, when evaluating potential ecological risk, becomes more evident when looking at the assumptions used to develop ecological soil screening values (see Section 2.2.1.5).

2.1.5 Preliminary Ecotoxicity Evaluation

Lead is not an essential element for plant growth and development, birds, or mammals. In plants, lead inhibits growth, reduces photosynthesis, interferes with cell division and respiration, accelerates abscission or defoliation and pigmentation, and reduces chlorophyll and ATP synthesis. In birds and mammals, toxicity is manifested differently for different species; but overall, signs are indicative of encephalopathy preceded and accompanied by gastrointestinal malfunction. Other signs of lead toxicity in domestic animals included anorexia, decreased milk production, fetal death, mortality and impaired postnatal growth, reduced pregnancy rate, and interference with resistance to infectious diseases (EPA 2005a).

In aquatic environments, biota exhibit lead toxicity as reduced survival, impaired reproduction, and reduced growth. Fish continuously exposed to toxic concentrations of waterborne lead show spinal curvature, anemia, darkening of the dorsal tail region, degeneration of the caudal fin, destruction of spinal neurons, ALAD inhibition in erythrocytes, spleen, liver, and renal tissues, reduced ability to swim against a current, destruction of the respiratory epithelium, basophilic stippling of erythrocytes, muscular atrophy, paralysis, renal pathology, growth inhibition, retardation of sexual maturity, altered blood chemistry, testicle and ovarian histopathology, and death (Eisler 1988).

2.1.6 Preliminary Exposure Pathway Analysis

Before assessing potential risks at a contaminated site, it is essential that an analysis of the potential for completed exposure pathways be performed. This is accomplished through the use of a conceptual model. The conceptual model consists of a written description and a visual representation of the fate, transport, and potential effects that chemical stressors may have on the ecology of the site. The conceptual model consists of a series of working hypotheses regarding how the contaminants might affect the ecological components of the natural environment. Conceptual models diagram the multiple relationships between the chemical stressors and receptors and the pathways of exposure at the site. Evaluation and inclusion of each relationship in the conceptual model are based on several criteria:

- Data availability.
- Strength of relationship between contaminants and effects.
- Endpoint significance.
- Relative importance or influence of the contaminants.
- Importance of effects to ecosystem function.

To assess the potential effects of contaminants released on the ecological resources of the Park, a conceptual model of the potential exposure to ecological receptors was developed. A conceptual model has been developed to describe the release and transport of CPECs in soils of the site (See Figure 2). The ecological exposure pathways at the Park are fairly consistent among habitat types, with the possible exception of exposure to amphibians being more likely in wetland habitats. The representative target species presented in Figure 2 are indicative of common receptors used to assess terrestrial risk as ecologically similar sites. A list of maximally exposed receptors could be developed to reflect subtle differences between terrestrial and wetland habitats; however, exposure parameters for habitat-specific receptors would not differ substantially between habitat types.

In addition, as requested by PADEP and EPA during a meeting on 10 December 2009, potential effects in Bernhart Park Lake resulting from lead in sediments, surface water, and fish tissues were included in this assessment. A conceptual model has been developed to describe the release and transport of CPECs in the lake (See Figure 3).

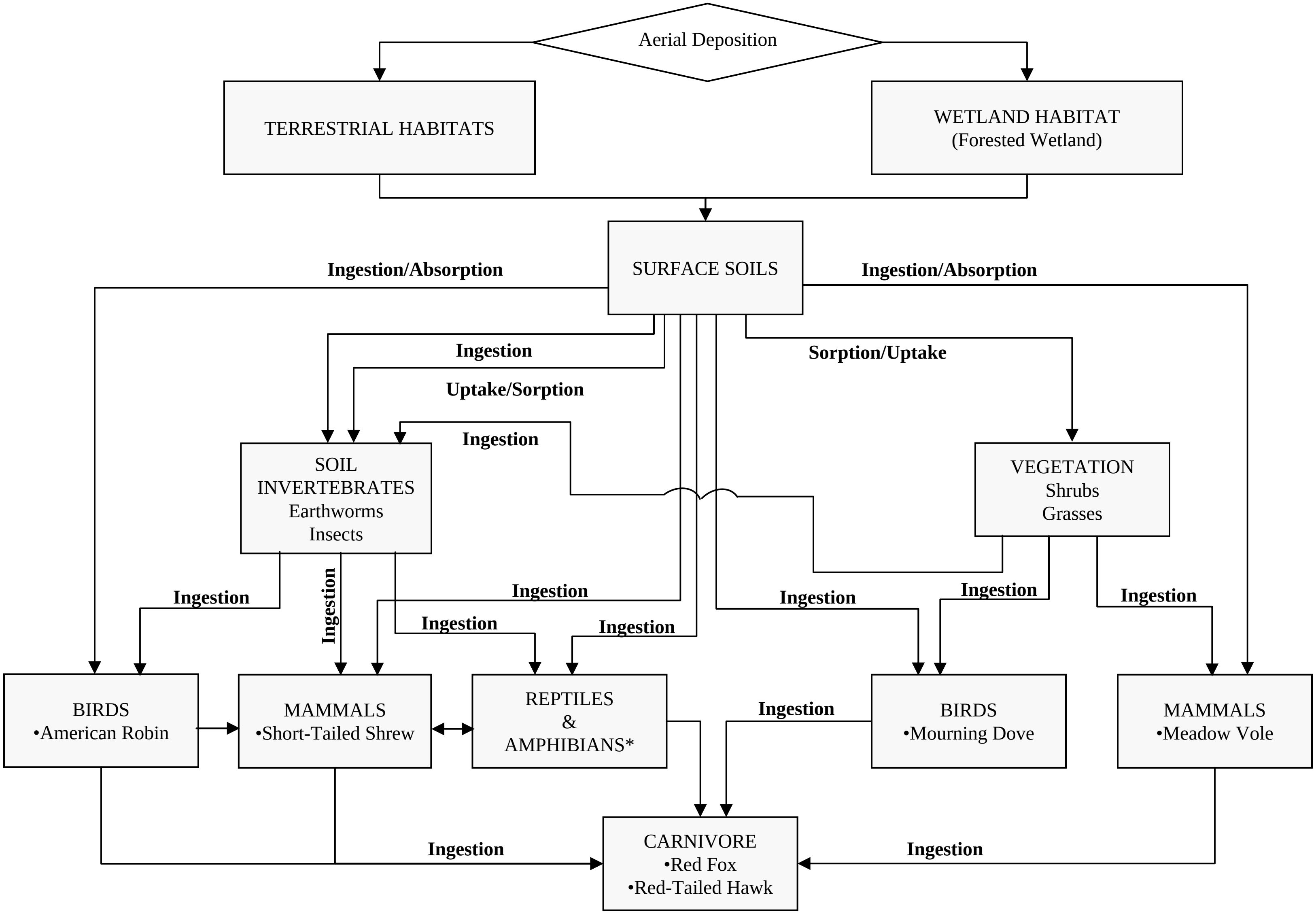
2.1.7 Areas of Concern

Given lead at the site is potentially the result of aerial deposition, the whole park is potentially contaminated. As previously mentioned (Section 2.1.2), PA Code considers local parks as "habitats of concern;" therefore, the park as a whole must be evaluated. However, the only biologically defined "habitats of concern" at the site are the forested wetlands and open water (i.e., Bernhart Reservoir).

No terrestrial habitats or terrestrial or aquatic species of concern exist at the site. Nonetheless, to address ecological concerns, all habitats, including terrestrial habitats (i.e., mowed lawn, scrub/shrub, and upland forest) within the park boundaries were evaluated.

2.1.8 Assessment Endpoints

Knowledge of the relationship of site-related contamination to ecological endpoints contributes significantly to the ecological risk assessment decision-making process (Suter 1989). An *endpoint* is defined as an ecological characteristic (e.g., small mammal survival) that may be



LEGEND

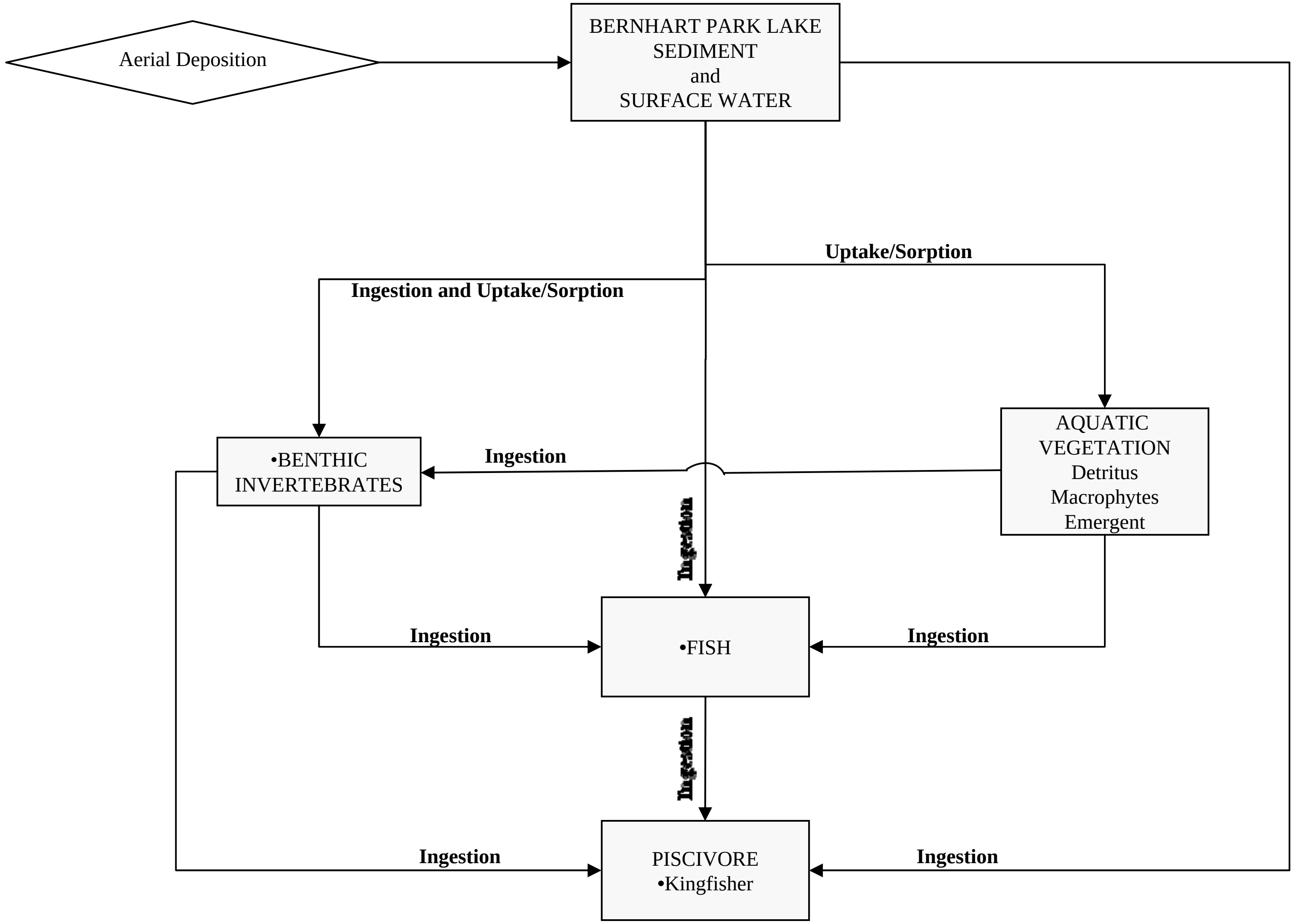
• Representative Species

→ Pathway Evaluated

*Reptiles and amphibians more likely associated with the wetland habitat than the terrestrial.

Bernhart Park
Muhlenberg Township, Pennsylvania

FIGURE 2
SITE CONCEPTUAL MODEL FOR THE TERRESTRIAL AND WETLAND ECOSYSTEMS



LEGEND

• Representative Species

→ Pathway Evaluated

Bernhart Park
Muhlenberg Township, Pennsylvania

FIGURE 3
SITE CONCEPTUAL MODEL FOR THE AQUATIC ECOSYSTEM

adversely affected by site contaminants (EPA 1992). In the ecological risk assessment process, two distinct types of endpoints are identified: assessment endpoints and measurement endpoints.

Assessment endpoints are explicit expressions of the actual environmental value that is to be protected (e.g., small mammal community maintenance). In general, an assessment endpoint is

linked to one or more measurement endpoints through the integration of modeled, literature, field, or laboratory data.

Measurement endpoints are measurable responses related to the valued characteristics chosen as the assessment endpoints. Measurement endpoints are selected when assessment endpoints cannot be directly measured. They are used to approximate, represent, or lead to the assessment endpoint (USACE 1996). The following two subsections provide definitions and criteria used to develop the endpoints evaluated to assess potential ecological risks associated with the Park.

Definition and Purpose of Assessment and Measurement Endpoints

Assessment endpoints are unambiguous statements or goals concerning an ecological characteristic (e.g., reproductive effects in terrestrial receptors) that are to be evaluated and protected (EPA 1997, 1998). They are critical to the risk assessment process because they link the risk assessment to management concerns; and they are central to conceptual model development.

Assessment endpoints establish the foundation for an ecological risk assessment for the following reasons:

- They provide guidance for evaluating the site and the extent of contamination.
- They establish a basis for assessing the potential risks to identified receptors.
- They assist in the identification of the ecological structure and function at the site.

The assessment endpoints have been selected to address both the potential direct and indirect risks resulting from exposure to lead (the CPEC for this site) in the terrestrial and wetland habitats associated with the Park.

Measurement endpoints link the conditions existing on-site to the goals established by the assessment endpoints (Maughan 1993). The evaluation of the assessment endpoints is determined through measurement endpoints (e.g., reproductive effects on small mammals can be evaluated by comparing exposure estimates to reproductive effects endpoints). For a screening-level ecological evaluation, literature-based reference toxicity values, such as ecological soil benchmarks, are used as toxicity endpoints (or surrogate measurement endpoints).

While assessment endpoints selected may reflect changes in populations, toxicity of contaminants to individual organisms is more easily discerned and likely to be selected as measurement endpoints in an ecological screening evaluation. Measurement endpoints reflecting changes in an individual is appropriate given that toxicity of contaminants to individual organisms can have consequences at the population, community, and ecosystem level.

Selected Assessment and Measurement Endpoints

Endpoints for this screening evaluation were selected to address the potential for both direct and indirect impacts to the environment resulting from lead contamination in the terrestrial and wetland soils. For example, organisms inhabiting the forested wetland habitats may be exposed through direct contact with surface soils, ingestion of contaminated soils, and indirectly by incorporation of contaminants into the aquatic food chain.

Although additional relevant endpoints could logically be used to evaluate potential risks from lead exposure at the site, endpoints were selected for evaluation that would, in a focused approach, best characterize the ecological risks to maximally exposed receptors using data and information currently available for this site. The assessment and measurement endpoints selected for terrestrial and wetland habitats the Park are presented below.

Ecological Endpoints

Assessment Endpoint	Measurement Endpoint
Growth, survival and fecundity of terrestrial fauna in wetland and upland habitats	Comparison of lead concentration in surficial soils to appropriate ecological benchmarks

As requested by the state, aquatic endpoints have been included:

Assessment Endpoint	Measurement Endpoint
Growth, survival, and fecundity of benthic organisms in wetland habitats (i.e., Bernhart Park Lake)	Comparison of lead concentrations in sediment and surface water to appropriate ecological benchmarks (e.g., sediment and surface water values)
Growth, survival and fecundity of fish in wetland habitats (i.e., Bernhart Park Lake)	Comparison of lead concentration in fish tissues to appropriate ecological benchmarks (e.g., surface water benchmarks, critical body residues, and food-chain modeling based tissue benchmarks)

2.2 Step 2 – Preliminary Exposure Estimate and Risk Assessment

Step 2 describes the option selected to evaluate the assessment endpoints selected in Step 1 and the uncertainty associated with the methodology and results of the evaluation method. For this site, the hazard quotient method was selected. Details of Step 2 are presented in the subsections below.

2.2.1 Hazard Quotient Method

The primary goal of using the hazard quotient (HQ) method to present risks is to present information on the potential magnitude of ecological effects expected based on the concentrations of CPECs present within soils at the site. The following subsections present available lead concentration data by habitats, ecological screening values available to evaluate potential ecological effects, and a characterization of potential ecological risks based on a comparison of appropriate screening values to site-specific data.

2.2.1.1 Soil Sampling Data

As indicated above, soil samples were collected from the 0-3 inch soil horizons in the Park in 1994 and 2001 for the purpose of evaluating risk to human receptors frequenting the Park. Unfortunately, the shallow soil samples do not accurately represent all ecological exposure conditions for the site. This issue was discussed during a site visit with EPA in November 2008. On December 8, 2008, Exide provided EPA a technical letter from Mr. Tod DeLong (Avatar Environmental) to Mr. Khai Dao (EPA) that provided justification for deeper sampling in the lawn, scrub-shrub and forested wetland areas to more accurately reflect potential ecological exposures. In the technical letter, Avatar proposed that the upper 12 inches of surface soil was more indicative of soils to which key ecological receptors would be exposed rather than the upper three inches previously sampled. The EPA agreed with Avatar's proposal on December 11, 2008 (email from Mr. Khai Dao to Mr. Tod DeLong).

Exide conducted additional sampling of the aforementioned habitats in January 2009, a summary of the sampling is provided in Appendix C. All 2009 samples were analyzed for total lead and five samples (see Appendix B) were also analyzed for lead using a sequential extraction method that identifies the general form of the lead present which can be related to the potential bioavailability of lead present in the Park soils.

Within the mowed-lawn areas, soil remediation is already proposed at the request of the EPA and the City of Reading. That remediation proposes the excavation and removal of the top 3 inches of soil from areas with total lead concentrations in the top 3-inches of soil >650 mg/kg. Because the top 3 inches will be removed in most of the lawn areas, the sampling conducted in January 2009 characterized the soil horizon from 3 to 12 inches below the surface, and the lead concentration for evaluating ecological exposure was calculated as a weighted average. The 12" Weighted Average shown on Table 1 was determined using the 2009 results for the 3 to 12 inch samples and an assumed lead concentration of 50 mg/kg for the topsoil used to replace the 3-inches of soil removed. A detailed discussion regarding the weighted average approach, including formulas, is provided in Appendix C. The 0-12 inch soil lead concentrations are shown on Figure 1.

Where no removal is proposed the weighted average was determined using the results from the 2001 sampling to represent the top 3-inches of soil. Soil lead concentrations for the 0-12 inch surface soil horizon (actual and estimated) are provided for the Forested Wetland, Scrub Shrub and Forested Upland Areas in Tables 2, 3 and 4 respectively. Soil lead concentrations have been provided by Advanced GeoServices Corporation and are provided as Appendix C to this report.

TABLE 1
BERNHART PARK SURFACE SOIL (0-12 INCH) LEAD CONCENTRATIONS
MOWED LAWN (GRASS)
ACTUAL AND ESTIMATED DATA

SAMPLE LOCATION	EXPOSURE AREA CONCENTRATION 12" WEIGHTED AVERAGE*
BP-Z	198
BP-YY	151
BP-XX	155
BP-W	191
BP-R	258
BP-Q	193
BP-O	138
BP-P	253
BP-L	135
BP-H	235
BP-A	156
BP-B	137
BP-C	145
BP-D	124
BP-E	259
BP-F	301
BP-G	94
BP-I	144
BP-K	177
BP-LL	247
BP-M	178
BP-S	82
BP-T	113
BP-U	238
BP-V	95
BP-X	337
BP-Y	42
Average of all Grass EAs 12" weighted average	177

* = shading indicates 3" clean-up and backfill with 50 ppm soil, no shading indicates no clean-up performed .

TABLE 2
BERNHART PARK SURFACE SOIL (0-12 INCH) LEAD CONCENTRATIONS
FORESTED WETLAND
ACTUAL AND ESTIMATED DATA

SAMPLE LOCATION	EXPOSURE AREA CONCENTRATION 0-12" RESULT (mg/kg)	
BP-AAA	195	
BP-BBB	150	
BP-DDD	140	
BP-SS	406	
BP-TT	395	
BP-UU	340	
BP-WW	244	
BP-ZZ	605	
BP-VV	257	*
BP-CCC	242	*
Average of all Forested Wetland EAs 0-12"	297	

*Value is an estimated concentration.

TABLE 3
BERNHART PARK SURFACE SOIL (0-12 INCH) LEAD CONCENTRATIONS
SCRUB/SHRUB
ACTUAL AND ESTIMATED DATA

SAMPLE LOCATION	EXPOSURE AREA CONCENTRATION 0-12" RESULT (mg/kg)
BP-BB	266
BP-DD	181
BP-EE	128
BP-GG	38
BP-II	113
BP-KK	144
BP-AA	108 *
BP-CC	128 *
BP-FF	106 *
BP-JJ	82 *
Average of all Scrub/Shrub EAs 0-12"	129

*Value is an estimated concentration.

TABLE 4
BERNHART PARK SURFACE SOIL (O-12 INCH) LEAD CONCENTRATIONS
FORESTED UPLAND
ESTIMATED DATA

SAMPLE LOCATION	EXPOSURE AREA CONCENTRATION 0-12" RESULT (mg/kg)
BP-AAA	569
BP-BBB	484
BP-DDD	305
BP-SS	294
BP-TT	275
Average of all Forested Upland EAs 0-12"	385

2.2.1.2 Surface Water Sampling Data

In 2001, surface water sampling was conducted at 18 different sampling locations within the reservoir from two different depths (3 feet below surface and 3 feet above the bottom). Total and dissolved lead concentrations were analyzed. Dissolved data is included in Appendix D (Table D-1) and used in this evaluation as the ecological surface water criterion is a dissolved lead concentration. Approximate locations of water samples are shown on Figure 1.

2.2.1.3 Sediment Sampling Data

In 2001, sediment sampling was conducted at 15 different sampling locations within the reservoir at depths of 0 to 3 inches. These data are presented in Appendix D (Table D-2). Approximate locations of sediment samples are shown on Figure 1.

2.2.1.4 Fish Tissue Sampling Data

At DEP's request, fish tissue sampling was conducted in May 2009. Fillet sample wet weight tissue concentrations from six composite samples (one sample representing one of six different species) were analyzed for lead. Fish lead residue concentrations are presented in Appendix D (Table D-3).

2.2.1.5 Ecological Screening Values

EPA Ecological Soil Screening Levels

The United States Environmental Protection Agency (EPA) has developed Ecological Soil Screening Levels (Eco-SSLs) in order to conserve resources by limiting the need for EPA and other risk assessors to perform repetitious toxicity data literature searches and data evaluations for the same contaminants at every site. Eco-SSLs are intended to be conservatively low concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with soil or ingest biota that live in or on soil. Eco-SSLs are derived separately for four groups of ecological receptors: plants, soil invertebrates, birds and mammals. As such, these values are presumed to provide adequate protection of terrestrial ecosystems. Eco-SSLs for wildlife are derived to be protective of the more sensitive receptors present in the terrestrial ecosystem, thereby ensuring protection of most local populations. A detailed description of the approach and criteria used to develop Eco-SSLs are presented in EPA's *Guidance for Developing Ecological Soil Screening Levels* (EPA 2005b).

The Eco-SSLs for lead (EPA 2005a) were derived for the inorganic forms of lead and are not derived for either organic lead compounds or metallic lead shot. Lead is not considered to be an essential element for plant growth and development, and has been shown to adversely affect plants in numerous ways: inhibit growth, reduce photosynthesis and water absorption, accelerate defoliation, and reduce chlorophyll and ATP synthesis. The Eco-SSL for plants is **120 mg/kg** and is the geometric mean of the maximum acceptable toxicant concentration (MATC) for four plant species (loblolly pine, red maple, clover and ryegrass) based potential impacts to plant growth.

Lead is also not considered an essential element to animals and is known at certain levels of exposure to impact red blood cell synthesis; cause adverse neurological effects; reduce fecundity etc. The Eco-SSL for soil invertebrates is **1,700 mg/kg** and is the geometric mean of the MATC for four studies that evaluated reproduction in a species of springtail (*Folsomia candida*). The Eco-SSLs for birds and mammals are **11 mg/kg** and **56 mg/kg**, respectively. Both the bird and mammal Eco-SSLs are based on modeled exposure to earthworm eating species (woodcock and shrew). The models used to estimate exposure and effects for these two species incorporate three very conservative assumptions:

1. 100% exposure occurs onsite.
2. There is a consistently positive linear relationship between soil concentrations and predicted earthworm concentrations.
3. The toxicity data used to assess impact for both birds and mammals is based on the highly soluble and bioavailable salt form of lead (lead acetate).

While 100% onsite exposure may be plausible for a shrew which has a limited home range, it is extremely doubtful that the Park provides sufficient quality habitat to support 100 % of a woodcock's food requirements. The ln-ln regression equation used to estimate earthworm lead concentration does not consider any site-specific conditions that would influence lead bioavailability (e.g., lead form, % TOC, pH etc.). This regression model, while statistically significant (R^2=0.58, p=0.0001), best fits lead concentrations in soil < 100 mg/kg and showed that accumulation rates greatly decrease as lead concentrations in soil increase (Sample et al. 1999).

The last and most significant assumption used in the development of the bird and mammal Eco-SSLs was the use of lead acetate toxicity information to represent the form of lead present at the site. As was previously discussed (see Section 2.1.4), lead salts (like lead acetate) are highly soluble and bioavailable; however, they are very unstable and are rarely encountered in natural environments. The site specific testing performed has demonstrated that the significant portion of the lead present in the Park soils are stable and remained in the sample even after the extractions for lead carbonates and lead - Fe and Mn oxides. A toxicity evaluation using the lead acetate is grossly over-conservative for the occurrence of lead in the Park, as demonstrated by the sequential extraction analysis which shows that on average only 34% of the lead present in the samples was extracted after the first two sequences. (Lead acetate would be removed almost entirely in the first extraction sequence).

It should be noted that during the derivation of the bird and mammal Eco-SSLs, EPA calculated conservative "potential" Eco-SSLs for two other bird and mammal species (**dove 46 mg/kg, hawk 510 mg/kg, weasel 460 mg/kg, and vole 1200 mg/kg**). As can be readily seen in these values, when EPA assessed risk to organisms that do not consume earthworms, screening levels increased substantially even when using lead acetate toxicity information.

Canadian Soil Quality Guidelines

Over the past 20 years the Canadian Council of Ministers of the Environment (CCME) have actively pursued and refined the development of Soil Quality Guidelines (SQGs) for the protection of ecological receptors in the environment (SQG_Es) and for the protection of human health (SQG_{HH}s) associated with four land uses: agricultural, residential/parkland, commercial and industrial. Canadian environmental soil quality guidelines are peer reviewed and are derived using toxicological data to determine threshold level effects for key ecological receptors.

In the case of SQG_Es, procedures for deriving soil guidelines were developed to maintain important ecological functions that support activities associated with the identified land uses.

The Threshold Effect Concentration (TEC) for soil-dependent biota or the Daily Threshold Effects Dose for terrestrial animals, were used to develop the SQG_E by providing the measurement endpoint, that if exceeded "may" result in adverse effects on populations in the field. Ideally, soil contaminants present at the guideline levels (or below) will provide a healthy functioning ecosystem capable of sustaining the current and likely future uses of the site by ecological receptors (CCME 2006). In most cases, data used to develop the SQG_E are biased towards conditions of relatively high bioavailability and therefore tend to be conservative in nature (CCME 2006).

The most appropriate land use category for the Park is the residential/parkland land use. The CCME protocol for the development of SQGs (CCME) was designed to ensure that the soil is capable of sustaining soil-dependent species such as: ornamental and native flora; terrestrial invertebrates; microorganisms; and residential and transitory wildlife. It is assumed that the level of protection offered to soil-dependent organisms from direct contact is adequate to protect wildlife from dermal and ingestion exposures. This assumption is based on the notion that soil-dependent organisms are directly in contact with the medium for a large portion of the life-cycle and will therefore be a more sensitive indicator of adverse effects than organisms at higher trophic levels. The SQG_E for lead in a residential/parkland land use scenario is **300 mg/kg** (CCME 1999)**.**

After reviewing both approaches for developing ecological soil screening values it was determined that the CCME lead ecological guideline for residential/parkland use was the more appropriate benchmark to use when performing an ecological screening evaluation for the Park surface soils.

EPA/PaDEP Ambient Water Quality Criteria

PaDEP has adopted EPA's ambient water quality criteria (AWQC) for lead. EPA's 1985 Guidelines (Stephan et al. 1985) describe an objective, internally consistent and appropriate way for deriving chemical-specific, numeric water quality criteria for the protection of the presence of, as well as the uses of, freshwater aquatic organisms. AWQC are derived to protect most of the aquatic communities and their uses most of the time (40 CFR 131). When sufficient data are available to support their derivation, EPA provides acute criteria or criterion maximum concentration (CMC) which correspond to concentrations that would cause less than 50% mortality in 5% of the exposed population in a brief exposure (Suter and Mabry 1994). Chronic criteria or criteria continuous concentration (CCC) are selected by choosing the most protective value after reviewing and analyzing acute and chronic toxicity information for aquatic organism, aquatic plants, and tissue residue level studies that demonstrate water tissue concentration relationship that is unacceptable for consumption by humans or wildlife. Chronic criteria are expected to protect aquatic life from lethal and sublethal effects over extended periods of exposure. The chronic lead exposure value of **2.5 µg/L** was used in this assessment (EPA 2006a; PA Code 2009).

EPA Region III Biological Technical Assistance Group Freshwater Sediment Screening Values

EPA Region III Biological Technical Assistance Group (BTAG) freshwater screening values (2006b)—These benchmarks represent screening values for flora and fauna that inhabit sediments. Preference was given to benchmarks based on chronic direct exposure, non-lethal endpoint studies designed to be protective of sensitive species. Values derived by statistical- or consensus-based evaluation of multiple studies were given first priority. For lead, the MacDonald et al. (2000) consensus-based threshold effect concentration threshold effect concentration (TEC) of **35.8 mg lead/kg** was adopted by BTAG.

MacDonald et al. evaluated the predictive ability of previously derived probable effect concentrations for major classes of compounds including metals, PAHs, pesticides and PCBs. A database was developed from 92 published reports that included a total of 1657 samples with high-quality matching sediment toxicity and chemistry data. The database was composed primarily of 10- to 14-day or 28- to 42-day toxicity tests with the amphipod *Hyalella azteca* (designated as the HA10 or HA28 tests) and 10- to 14-day toxicity tests with the midges *Chironomus tentans* or *C. riparius* (designated as the CS10 test). Endpoints reported in these tests were primarily survival or growth. From these data, both threshold effect concentrations (TECs) and probable effect concentrations (PECs) were developed.

TECs identify contaminant concentrations below which harmful effects on sediment-dwelling organisms are not expected. TECs include the following sediment quality guidelines (SQGs): threshold effect levels (TELs), effect range low values (ERLs), lowest effect levels (LELs), minimal effect threshold (METs), and sediment quality advisory levels (SQALs). TECs were calculated by determining the geometric mean of the SQGs. Consensus-based TECs were calculated only if three or more published SQGs were available for a chemical.

PECs identify contaminant concentrations above which harmful effects on sediment-dwelling organisms are expected to frequently occur. TECs include the following sediment quality guidelines (SQGs): probable effect levels (PELs), effect range median values (ERMs), severe effect levels (SELs), and toxic effect thresholds (TETs). PECs were calculated by determining the geometric mean of the SQGs. Consensus-based PECs were calculated only if three or more published SQGs were available for a chemical. The PEC for lead is **128 mg/kg**.

The evaluation of the predictive ability of probable effect concentrations (PECs) was conducted to determine the incidence of effects above and below various mean PEC quotients (mean quotients of 0.1, 0.5, 1.0, and 5.0). The PECs are SQGs that were established as concentrations of individual chemicals above which adverse effects in sediments are expected to frequently occur. A PEC quotient was calculated for each chemical in each sample in the database by dividing the concentration of a chemical by the PEC for that chemical. A mean quotient was calculated for each sample by summing the individual quotient for each chemical and then dividing this sum by the number of PECs evaluated, thereby deriving a mean PEC for those chemicals evaluated. The individual PEC for each substance was considered to be reliable if >75% of the sediment samples were correctly predicted to be toxic using the PEC.

For this assessment TECs and PECs were used to compare with site-specific sediment concentrations in an attempt to bracket potential risk to benthic organisms from contamination in the Bernhart Park Reservoir.

Fish Tissue Residue Concentrations

The U.S. Army Corps of Engineers and U.S. Environmental Protection Agency Environmental has compiled a database of biological effects associated with tissue contaminant concentrations within an organism. Residue-Effects Database (ERED; March 2010) was searched for fish tissue concentrations associated with adverse effects from lead exposure. The lowest applicable value was **130 ppb,** which was a carcass value associated with an ED11 (concentration that affected 11% of the population) for growth in rainbow trout associated with dietary ingestion of lead starting as a fry.

Wildlife NOAEL-based Food Concentrations

Food concentrations associated with adverse effects were calculated by Sample et al. (1996) for various ecological receptors. The lowest concentration for lead exposure in an aquatic receptor was a NOAEL-based benchmark of **2.23 mg/kg** in diet (e.g., fish) based on lead acetate exposure in the belted kingfisher.

2.2.1.6 Characterization of Potential Ecological Impacts

Hazard Quotients (HQs) were developed to determine potential effects to target receptors from exposure to lead in contaminated surface soils in the Park. The HQ approach used for this evaluation simplifies the comparison process and allows for a more standardized interpretation of the results (i.e., the HQ reflects the magnitude by which the sample concentration exceeds or is less than the guideline/benchmark). Although the HQ does not measure the probability for effects to an individual or specific population, when the HQ exceeds 1, there is some potential for risk (EPA 1993, 1994).

HQs were calculated as follows for each habitat type evaluated:

$$HQ = EL/MBB$$

Where:

HQ = hazard quotient (unitless)
EL = estimated exposure level (medium concentration in

mg Pb/kg or µg Pb/L)
MBB = medium-based benchmark (mg Pb/kg or µg Pb/L).

Table 5 presents the result of the HQ evaluation process for surface soils in the Park. The HQ calculation did not include a reduction to the exposure concentrations to compensate for the fact that the species of lead present in site soils have a bioavailability of less than 1/3 of the bioavailability utilized to develop the CCME screening value. As indicated by the shaded cells, even without this reduction, only 7 locations slightly exceed the SQGE for lead (4 forested wetland samples, 2 forested upland samples and 1 mowed lawn sample). With the exception of forested wetland sample BP-ZZ-03 (HQ=2), and forested upland samples BP-AAA-03 (HQ=1.9) and BP-BBB (HQ=1.6), the remaining sample locations had HQs very close to or below an HQ of 1.

Given the inherent conservatism built into the development of the soil screening value and the lead bioavailability as documented by the sequential extraction testing, the HQ calculations are considered to be very conservative. Collectively, it can be concluded that soil lead levels that will remain after the proposed remediation for human exposure will not pose a significant ecological risk. (Note that this criterion is expected to be protective of the majority of species within a park habitat; therefore, individual indicator species within biologically defined habitats (e.g., mowed lawn versus forest) are not called-out.)

Tables D-1 and D-2 present the results of the surface water and sediment concentrations compared with benchmarks.

Table D-3 presents the fish tissue residue data. Lead was not detected in the fish tissue data. The highest IDL was 0.083 mg Pb/kg. Given that the maximum IDL was lower than the lowest fish tissue residue no-effect or effect residue identified in ERED (i.e., 0.278 mg/kg) and the lowest food-based NOAEL-based benchmark for aquatic receptors (i.e., 2.23 mg/kg based on lead acetate in the belted kingfisher; Sample et al. 1996), food chain effects from lead in the Bernhart Park Reservoir are not expected.

2.2.2 Uncertainty Analysis

The primary objective of the uncertainty analysis is to combine and summarize the uncertainty present throughout the risk assessment process so that this information can be integrated with other risk estimation information to more completely describe actual or potential risk and to assess the ecological significance of observed or predicted impacts.

As noted previously, the CCME SQG_E residential/parkland land use value was used to determine whether concentrations of lead in soil would be detrimental to terrestrial species inhabiting the park. It is assumed that the level of protection offered to soil-dependent organisms from direct contact is adequate to protect wildlife from dermal and ingestion exposures. This assumption is based on the notion that soil-dependent organisms are directly in contact with the medium for a large portion of the life-cycle and will therefore be a more sensitive indicator of adverse effects than organisms at higher trophic levels. In addition, data used to develop the SQG_E are biased

TABLE 5
COMPARISON RESULTS WITH CCME ECOLOGICAL SOIL QUALITY GUIDELINES (SQG_E)[a]
BERNHART PARK

Forested Wetland 2009 Known and Estimated Results		
SAMPLE LOCATION	EXPOSURE AREA CONCENTRATION 0-12" Result (mg/kg)	Result to CCME SQG_E HQ*
BP-AAA	195	0.65
BP-BBB	150	0.50
BP-DDD	140	0.47
BP-SS	406	1.4
BP-TT	395	1.3
BP-UU	340	1.1
BP-WW	244	0.81
BP-ZZ	605	2.0
BP-VV	257 [b]	0.9
BP-CCC	242 [b]	0.81

Scrub/Shrub 2009 Known and Estimated Results		
SAMPLE LOCATION	EXPOSURE AREA CONCENTRATION 0-12" Result (mg/kg)	Result to CCME SQG_E HQ*
BP-BB	266	0.89
BP-DD	181	0.60
BP-EE	128	0.43
BP-GG	37.9	0.13
BP-II	113	0.38
BP-KK	144	0.48
BP-AA	108 [b]	0.36
BP-CC	128 [b]	0.43
BP-FF	106 [b]	0.35
BP-JJ	82 [b]	0.27

Forested Upland Estimated Results		
SAMPLE LOCATION	EXPOSURE AREA CONCENTRATION 0-12" Result (mg/kg)	Result to CCME SQG_E HQ*
BP-AAA	569 [b]	1.9
BP-BBB	484 [b]	1.6
BP-DDD	305 [b]	1.0
BP-SS	294 [b]	0.98
BP-TT	275 [b]	0.92

Mowed Lawn (Grass) Known Results		
SAMPLE LOCATION	EXPOSURE AREA CONCENTRATION 12" Weighted Average	12" Weighted Average to CCME SQG_E HQ*
BP-F	301	1.0
BP-G	94	0.31
BP-I	144	0.48
BP-K	177	0.59
BP-LL	247	0.82
BP-M	178	0.59
BP-S	82	0.27
BP-T	113	0.38
BP-U	238	0.79
BP-V	95	0.32
BP-X	337	1.1
BP-Y	42	0.14

Mowed Lawn (Grass) Known and Estimated Results		
SAMPLE LOCATION	EXPOSURE AREA CONCENTRATION 12" Weighted Average	12" Weighted Average to CCME SQG_E HQ*
BP-Z	198	0.66
BP-YY	151	0.50
BP-XX	155	0.52
BP-W	191	0.64
BP-R	258	0.86
BP-Q	193	0.64
BP-O	138	0.46
BP-P	253	0.84
BP-L	135	0.45
BP-H	235	0.78
BP-A	156	0.52
BP-B	137	0.46
BP-C	145	0.48
BP-D	124	0.41
BP-E	259	0.86

* = shading indicates result concentration in exceedance of CCME SQG_E.

[a]CCME SQG_E lead value of 300 mg/kg used for comparison.

[b]Estimated concentration.

HQ = Hazard quotient (HQ = soil concentration/SQG_E).

towards conditions of relatively high bioavailability. Given these assumptions, it is likely that the soil evaluation is conservative; and therefore, may overestimate risk.

The lead BTAG value was adopted directly from MacDonald et al. (2000) sediment quality guidelines. Studies used to develop chemical-specific sediment guidelines involved a complex mixture of contaminants. These mixtures most likely do not match the conditions in the potentially contaminated areas of the reservoir. The TEC is fairly reliable and on the conservative side, having observed 124 samples to be toxic when 152 samples were predicted to be toxic. Likewise, the PEC is conservative, having observed 112 samples to be toxic when 125 samples were predicted to be toxic.

AWQC values for lead are hardness-dependent. Site-specific hardness values were not available; therefore a default hardness of 100 mg $CaCO_3$/L was assumed. Increasing hardness generally decreases toxicity, and vice versa. Therefore, depending upon the surface water characteristics at any given time, the evaluation of surface water concentrations of lead may under- or overestimate risk.

Potential aquatic food chain modeling effects were evaluated using a NOAEL-based food concentration derived by Sample et al. (1996). The value was based on lead acetate. In general, organic forms are more bioavailable than inorganic; therefore, the derivation of lead food value is likely conservative and overestimates potential risk. Given that lead was not detected in fish, the IDLs were well below the food-based benchmark, and a diverse and substantial fish community was observed during the most recent sampling event; it is highly unlikely that there are aquatic food chain effects occurring due to lead exposure.

2.3 Decision Point (Conclusion)

The Ecological Risk Assessment initially focuses on ecological exposure conditions for lead in soil, but also considers lead in sediment, surface water, and fish tissue. Following a step-wise evaluation that considers multiple lines of evidence, the Ecological Risk Assessment determined that following completion of the proposed soil remediation, no further evaluation is necessary. The key factors supporting this conclusion were:

- An average HQ for lead in soil less than 1 when screened against the CCME ecological screening level for lead in soil in a park setting.
- Habitat by habitat area average HQs all less than 1 except for forested upland areas which had an HQ of 1.28.
- Site-specific bioavailability of lead in soil, based on sequential extraction testing, generally less than 32%, while the screening values are based on research that utilizes a species of lead that is 100% available.
- Evaluation of the habitat- and location-specific HQs, in conjunction with the low bioavailability and site-specific ecological exposure conditions, indicates that no significant ecological risk occurs from observed soil lead concentrations at the site.

- Surface water sampling results that determined lead concentrations in greater than half the samples collected were below detection levels and that collectively the average concentration was less than 2 ppb, or less than 80% of the EPA/PADEP ambient water quality standard of 2.5 ppb.

- Although sediment lead concentrations were greater than sediment screening levels, the results of fish tissue sampling were all below 83 ppb, while the lowest value of fish tissue concentrations associated with adverse effects from lead exposure is 130 ppb.

Considering all of these factors, it is concluded that surface water, sediment, and soil to remain after the proposed soil remediation to address human exposure would not result in a significant adverse ecological effect.

Pursuant to the process defined in the PADEP Site-Specific Ecological Risk Assessment Guidance, at this Decision Point the investigator must make a determination using the site-specific information and sampling results gathered and evaluated under Steps 1 and 2. The options available to the investigator are: 1) proceed to the development of a site-specific cleanup goal; 2) determine that no substantial ecological risk exists and no further evaluation is required; or 3) determine that there is substantial impact and immediate remediation is required. Based on the information summarized above, including the absence of species of concern on or adjacent to the site, absence of lead in aquatic species sampled, and the lack of any visible sign of impact present during 3 site visits by an experienced ecological risk assessor; it is our professional opinion that "no substantial ecological risk" exists in the terrestrial and aquatic environments at the site. As a result of this determination under the PADEP Site-Specific Ecological Risk Assessment Guidance, Bernhart Park exits the assessment process and no further evaluation is required.

Section 3 References

Advanced GeoServices. 1998. Draft Remedial Investigation Report for the Act 2 Study Area in the Vicinity of the General Battery Corporation Facility Reading Pennsylvania Appendix I: Ecological Assessment Report.

Advanced GeoServices. 2008. Justification for No Further Ecological Risk Assessment (ERA) for the Mowed-lawn Portions of Bernhart Park. Tech. Memo. From T. DeLong (Avatar Environmental) to P. Stratman (Advanced GeoServices). June 30, 2008

Advanced GeoServices. 2009. Ecological Screening Evaluation of Surface Soils: Bernhart Park, Muhlenberg Township, PA. Tech. Memo. From T. DeLong (Avatar Environmental) to P. Stratman (Advanced GeoServices). April 8, 2008

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Lead. Canadian Environmental Quality Guidelines.

Canadian Council of Ministers of the Environment (CCME). 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines.

Eisler, R. 1988. Lead Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service. Contaminant Hazard Reviews: report No. 14. April 1988.

EPA (U.S. Environmental Protection Agency). 1992. Framework for Ecological Risk Assessment. Risk Assessment Forum. EPA/630/R-92/001.

EPA (U.S. Environmental Protection Agency). 1993. A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective. Washington, DC. EPA/630/R-92/005.

EPA (U.S. Environmental Protection Agency). 1994. Peer Review Workshop: Report on Ecological Risk Assessment Issue Papers. Risk Assessment Forum, Washington, DC.

EPA (U.S. Environmental Protection Agency). 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final. Prepared by U.S. EPA, Environmental Response Team, Edison, NJ. EPA 540-R-97-006. 5 June 1997.

EPA (U.S. Environmental Protection Agency). 1998. Guidelines for Ecological Risk Assessment. Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, DC. EPA/630/R-95/002F.

EPA (U.S. Environmental Protection Agency). 2005a. Ecological Soil Screening Levels for Lead. *OSWER Directive 9285.7-70.* Office of Solid Waste and Emergency Protection.

EPA (U.S. Environmental Protection Agency). 2005b. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). *OSWER Directive 9285.7-55*. Office of Solid Waste and Emergency Protection.

EPA (U.S. Environmental Protection Agency). 2006a. *National Recommended Water Quality Criteria – 2006*. EPA 822-R-02-047.

EPA (U.S. Environmental Protection Agency). 2006b. *Region III Biological Technical Assistance Group (BTAG) freshwater screening values*.

EPA (U.S. Environmental Protection Agency). 2007. Framework for Metals Risk Assessment. Office of the Science Advisor. Risk Assessment Forum. EPA 120/R-07/001.

ERED (Ecological Residue Effects Database), 2010. http://el.erdc.usace.army.mil/ered/

Gradient Corporation. 2001. *Risk Assessment for Lead Exposure from Recreational Use of Bernhart Park, Reading, PA.*

Kashem, M.A., B.R. Singh, T. Kondo, S.M. Imamul Huq, and S. Kawai. 2007. Comparison of Extractability of Cd, Cu, Pb, and Zn with Sequential Extraction in Contaminated and Non-contaminated Soils. *Int. J. Environ. Sci. Tech.* 4:169-176.

MacDonald, D.D., C.G. Ingersoll, T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Archives of Environmental Contamination and Toxicology*. 39: 20-31.

Marschner, B., P. Welge. A. Hack, J. Wittsiepe, and M. Wilhelm. 2006. Comparison of Soil Pb in Vitro Bioaccessibility and in Vivo Bioavailability with Pb Pools from Sequential Soil Extraction. *Environ. Sci. Technol.* 40: 2812-2818.

Maughan, J.T. 1993. Ecological Assessment of Hazardous Waste Sites. Van Nostrand Reinhold, New York, NY.

McGreer, J. et al. 2004. Issue Paper on the Bioavailability and Bioaccumulation of Metals. Submitted to: U.S. Environmental Protection Agency. Risk Assessment Forum. 19 August 2004.

Pennsylvania Code. Title 25 – Environmental Protection, Chapter 16 – Water Quality Toxics Management Strategy – Statement of Policy. Appendix A, Table 1 – Water Quality Criteria for Toxic Substances.

Pattee, O.H. and D.J. Pain. 2003. Lead In the Environment. *In* Hoffman, D.J., Rattner, B.A., Burton Jr., G.A. and J. Cairns Jr. eds. *Handbook of Ecotoxicology*. 2nd ed. Lewis Publishing.

Rauret, G., J. Lopez-Sanchez, A. Sahuquillo, E. Barahona, M. Lachica, A.M. Ure, C.M. Davidson, A. Gomez, D. Luck, J. Bacon, and P. Quevauller. 2000. Application of a Modified BCR Sequential Extraction (three-step) Procedure for their Determination of Extractable Trace

Metal Contents in Sewage Sludge Amended Soil Reference Material (CRM 483), Complemented by the Three-Year Stability Study for Acetic Acid and EDTA Extractable Metal Content. *J. Environ. Monitor.* 2: 228-233.

Sample, B.E., G.W. Suter II, J.J. Beauchamp, and R. A. Efroymson. 1991. Literature-Derived Bioaccumulation Models for Earthworms: Development and Validation. *Environ. Tox. and Chem.* 18(9):2110-2120.\

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Risk Assessment Program, Health Sciences Research Division, Oak Ridge, TN. ES/ER/TM-86/R3.

Stephan, C. E., D. I. Mount, D. J. Hansen, J. H. Gentile, G. A. Chapman, and W. A. Brungs. 1985. Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses. PB85-227049, National Technical Information Service, Springfield, Virginia.

Suter, G.W. II. 1989. "Ecological Endpoints." In: W. Warren-Hicks, B.R. Parkhurst, and S.S. Baker, Jr., (eds.). Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference Document. EPA 600/3-89-013.

Suter II, G.W. and J.B. Mabry. 1994. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota.* ES/ER/TM-96/R1. Oak Ridge National Laboratory, Oak Ridge, TN.

Tokalioglu, S., S. Kartal, and L. Elci. 2000. Determination of Heavy Metals and their Speciation in Lake Sediments by Flame Atomic Absorption Spectrometry after a Four-Stage Sequential Extraction Procedure. *Analytica Chimica Acta.* 413:33-40.

USACE (U.S. Army Corps of Engineers). 1996. RA Handbook, Volume II: Environmental Evaluation. EM 200-1-4. June 1996.

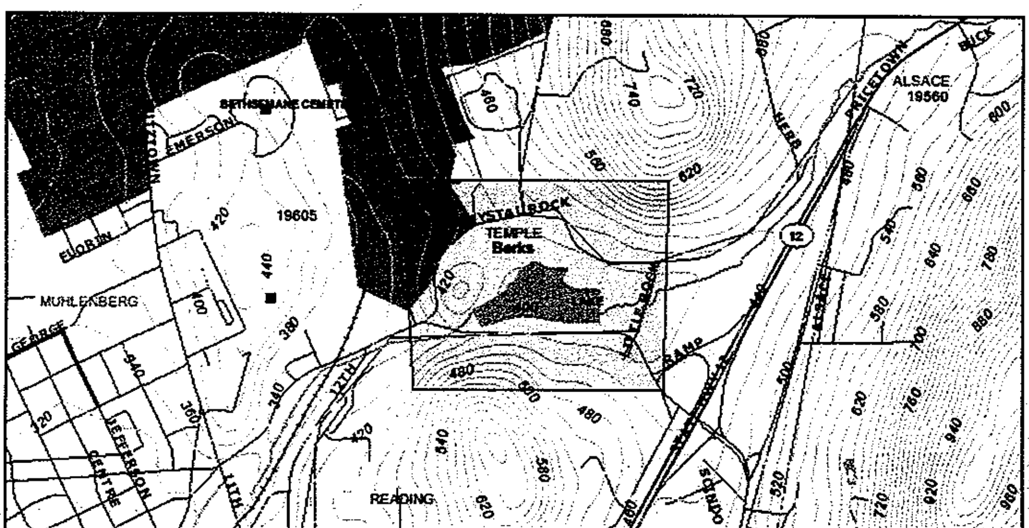
Yusuf, K.A. 2007. Sequential Extraction of Lead, Copper, Cadmium and Zinc In Soils near Ojota Waste Site. *J. Agronomy.* 6 (2):331-337.

APPENDIX A

PNDI DATABASE SEARCH

1. PROJECT INFORMATION

Project Name: **Bernhart Park 5**
Date of review: **7/17/2009 12:17:03 PM**
Project Category: **Hazardous Waste Clean-up, Site Remediation, and Reclamation,Other**
Project Area: **144.7** acres
County: **Berks** Township/Municipality: **Laureldale,Muhlenberg**
Quadrangle Name: **TEMPLE**
ZIP Code: **19560,19604,19605**
Decimal Degrees: **40.37719 N, --75.91011 W**
Degrees Minutes Seconds: **40° 22' 37.9" N, -75° 54' 36.4" W**



2. SEARCH RESULTS

Agency	Results	Response
PA Game Commission	No Known Impact	No Further Review Required
PA Department of Conservation and Natural Resources	No Known Impact	No Further Review Required
PA Fish and Boat Commission	No Known Impact	No Further Review Required
U.S. Fish and Wildlife Service	No Known Impact	No Further Review Required

As summarized above, Pennsylvania Natural Diversity Inventory (PNDI) records indicate no known impacts to threatened and endangered species and/or special concern species and resources within the project area. Therefore, based on the information you provided, no further coordination is required with the jurisdictional agencies. This response does not reflect potential agency concerns regarding impacts to other ecological resources, such as wetlands.

Note that regardless of PNDI search results, projects requiring a Chapter 105 DEP individual permit or GP 5, 6, 7, 8, 9 or 11 in certain counties (Adams, Berks, Bucks, Carbon, Chester, Cumberland, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Schuylkill and York) must comply with the bog turtle habitat screening requirements of the PASPGP.

3. AGENCY COMMENTS

Regardless of whether a DEP permit is necessary for this proposed project, any potential impacts to threatened and endangered species and/or special concern species and resources must be resolved with the appropriate jurisdictional agency. In some cases, a permit or authorization from the jurisdictional agency may be needed if adverse impacts to these species and habitats cannot be avoided.

These agency determinations and responses are **valid for one year** (from the date of the review), and are based on the project information that was provided, including the exact project location; the project type, description, and features; and any responses to questions that were generated during this search. If any of the following change: 1) project location, 2) project size or configuration, 3) project type, or 4) responses to the questions that were asked during the online review, the results of this review are not valid, and the review must be searched again via the PNDI Environmental Review Tool and resubmitted to the jurisdictional agencies. The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer impacts than what is listed on this PNDI receipt.

PA Game Commission

RESPONSE: No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

PA Department of Conservation and Natural Resources

RESPONSE: No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

PA Fish and Boat Commission

RESPONSE: No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

U.S. Fish and Wildlife Service

RESPONSE: No impacts to **federally** listed or proposed species are anticipated. Therefore, no further consultation/coordination under the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.* is required. Because no take of federally listed species is anticipated, none is authorized. This response does not reflect potential Fish and Wildlife Service concerns under the Fish and Wildlife Coordination Act or other authorities.

4. DEP INFORMATION

The Pa Department of Environmental Protection (DEP) requires that a signed copy of this receipt, along with any required documentation from jurisdictional agencies concerning resolution of potential impacts, be submitted with applications for permits requiring PNDI review. For cases where a "Potential Impact" to threatened and endangered species has been identified before the application has been submitted to DEP, the application should not be submitted until the impact has been resolved. For cases where "Potential Impact" to special concern species and resources has been identified before the application has been submitted, the application should be submitted to DEP along with the PNDI receipt, a completed PNDI form and a USGS 7.5 minute quadrangle map with the project boundaries delineated on the map. The PNDI Receipt should also be submitted to the appropriate agency according to directions on the PNDI Receipt. DEP and the jurisdictional agency will work together to resolve the potential impact(s). See the DEP PNDI policy at http://www.naturalheritage.state.pa.us.

5. ADDITIONAL INFORMATION

The PNDI environmental review website is a **preliminary** screening tool. There are often delays in updating species status classifications. Because the proposed status represents the best available information regarding the conservation status of the species, state jurisdictional agency staff give the proposed statuses at least the same consideration as the current legal status. If surveys or further information reveal that a threatened and endangered and/or special concern species and resources exist in your project area, contact the appropriate jurisdictional agency/agencies immediately to identify and resolve any impacts.

For a list of species known to occur in the county where your project is located, please see the species lists by county found on the PA Natural Heritage Program (PNHP) home page (www.naturalheritage.state.pa.us). Also note that the PNDI Environmental Review Tool only contains information about species occurrences that have actually been reported to the PNHP.

6. AGENCY CONTACT INFORMATION

PA Department of Conservation and Natural Resources
Bureau of Forestry, Ecological Services Section
400 Market Street, PO Box 8552, Harrisburg, PA. 17105-8552
Fax:(717) 772-0271

U.S. Fish and Wildlife Service
Endangered Species Section
315 South Allen Street, Suite 322, State College, PA. 16801-4851
NO Faxes Please.

PA Fish and Boat Commission
Division of Environmental Services
450 Robinson Lane, Bellefonte, PA. 16823-7437
NO Faxes Please

PA Game Commission
Bureau of Wildlife Habitat Management
Division of Environmental Planning and Habitat Protection
2001 Elmerton Avenue, Harrisburg, PA. 17110-9797
Fax:(717) 787-6957

7. PROJECT CONTACT INFORMATION

Name:____
Company/Business Name:______________________________
Address:____
City, State, Zip:______________________________________
Phone:(____)__________________Fax:(____)______________
Email:____

8. CERTIFICATION

I certify that ALL of the project information contained in this receipt (including project location, project size/configuration, project type, answers to questions) is true, accurate and complete. In addition, if the project type, location, size or configuration changes, or if the answers to any questions that were asked during this online review change, I agree to re-do the online environmental review.

______________________________ ______________
applicant/project proponent signature date

APPENDIX B

LEAD SPECIATION DATA REPORT

APPLIED SPECIATION AND CONSULTING, LLC

953 Industry Drive Tukwila, WA 98188
Tel: (206) 219-3779 Fax: (206) 388-3485
www.appliedspeciation.com

February 6, 2009

Jen Stanhope
Advanced Geoservices Corp
1055 Andrew Drive, Suite A
West Chester, PA 19380-4293
(610) 840-9100

Project Name: Exide-Reading Bernhart Park

Ms. Stanhope,

Attached is the report associated with eight (8) soil samples submitted for cationic metals sequential extraction on January 14, 2009. The samples were received on January 15, 2009 in a sealed container at -0.9°C. The sequential extraction procedure for cationic metals was performed using the method presented by the European Community Bureau of Reference (BCR). Any analytical issues associated with the analysis are addressed in the following report.

If you have any questions, please feel free to contact me at your convenience.

Sincerely,

Lydia Watts

Lydia Watts
Project Coordinator
Applied Speciation and Consulting, LLC

Applied Speciation and Consulting, LLC

Report Prepared for:

Jen Stanhope
Advanced Geoservices Corp
1055 Andrew Drive, Suite A
West Chester, PA 19380-4293

Project Name: Exide-Reading Bernhart Park

February 6, 2009

1. Sample Reception

Eight (8) soil samples were submitted for cationic metals sequential extractions on January 14, 2009. All samples were received in acceptable condition on January 15, 2009 in a sealed container at -0.9°C.

The samples were received in a laminar flow clean hood void of trace metals contamination and ultra-violet radiation. Immediately upon reception all samples were designated secrete sample identifiers and were stored in a refrigerator maintained at a temperature of 4°C until sequential extractions could be performed.

2. Sample Preparation

All sample preparation is performed in laminar flow clean hoods known to be free from trace metals contamination. All applied water for dilutions and sample preservatives are monitored for contamination to account for any biases associated with the sample results.

Prior to implementing any sequential extraction all samples were thoroughly homogenized and dried in an oven, maintained at a temperature of 50°C, until the mass of the residue remained constant. This measure was employed to increase the homogeneity of the sample matrix prior to subsampling and extraction.

Cationic Trace Metals Sequential Extraction by the European Community Bureau of Reference (BCR). A four stage sequential extraction method, presented by the European Community Bureau of Reference (BCR), was employed for correlation between Cr, Cu, Ni, Pb, Zn, and different substrate properties.

Approximately 1g of dried, homogenized soil was transferred to a 50mL polyethylene vial and 40mL of 0.11 M acetic acid (pH=2.85) was added to each vial. Each vial was capped and shaken on an inverted shaker for 16 hours at room temp at 30 RPM.

The samples were removed from the shaker and centrifuged for 20 minutes at 3000RPM. After the supernatant was decanted into a separate vial for trace metals analysis and labeled "Fraction 1" a total of 20mL of ultra pure deionized water was added to each vial. The vials were shaken vigorously and centrifuged for 20 minutes at 3000RPM. The supernatant was decanted and discarded.

Exactly 40mL of 0.1 M $NH_2OH.HCl$ (pH=2.0) was added to each vial. Each vial was capped and shaken on an inverted shaker for 16 hours at room temp at 30 RPM.

The samples were removed from the shaker and centrifuged for 20 minutes at 3000RPM. After the supernatant was decanted into a separate vial for trace metals analysis and labeled "Fraction 2" a total of 20mL of ultra pure deionized water was added to each vial. The vials were shaken vigorously and centrifuged for 20 minutes at 3000RPM. The supernatant was decanted and discarded.

Exactly 10mL of 30% (v/v) H_2O_2 was slowly added to each vial. Set tubes aside for one hour (swirl the tubes every 15 min). The vials were then refluxed in a Hotblock digestion apparatus for 60 min at 85°C. The reflux cones were then removed and the samples were heated until near dryness (~3mL of solution remaining).

After the addition of 10mL of H_2O_2 each vial was refluxed at 85°C for 60 minutes. The reflux cones were then removed and the samples were heated until near dryness (~3mL of solution remaining). The vials were then brought to volume (50mL) with 1.0 M ammonium acetate (pH=2). Each vial was capped and shaken on an inverted shaker for 16 hours at room temp at 30 RPM.

The samples were removed from the shaker and centrifuged for 20 minutes at 3000RPM. After the supernatant was decanted into a separate vial for trace metals analysis and labeled "Fraction 3" a total of 20mL of ultra pure deionized water was added to each vial. The vials were shaken vigorously and centrifuged for 20 minutes at 3000RPM. The supernatant was decanted and discarded.

Exactly 7mL concentrated HCl and 2.3mL concentrated HNO3 was added to each vial. The vials were then refluxed in a Hotblock digestion apparatus for 2 hours at 100°C. The samples were then allowed to cool to room temperature and were brought to volume (50mL) with ultra pure deionized water.

All extraction fractions were then analyzed for Cd, Cr, Cu, Ni, Pb, Zn, Fe, Mg, Ca, Mn, and Al by inductively coupled plasma dynamic reaction cell mass spectrometry (ICP-DRC-MS).

3. Sample Analysis

All sample analysis is precluded by a minimum of a five-point calibration curve spanning the entire concentration range of interest. Calibration curves are performed at the beginning of each analytical day. All calibration curves, associated with each species of interest, are standardized by linear regression resulting in a response factor. All sample results are **instrument blank corrected** to account for any operational biases associated with the analytical platform.

Prior to sample analysis, all calibration curves are verified using second source standards which are identified as initial calibration verification standards (ICV).

Ongoing instrument performance is identified by the analysis of continuing calibration verification standards (CCV) and continuing calibration blanks (CCB) at a minimal interval of every ten analytical runs.

Trace Metals Quantification by ICP-DRC-MS All samples for trace metals quantification were analyzed by inductively coupled plasma dynamic reaction cell mass spectrometry (ICP-DRC-MS) on January 28, 2009. Aliquots of each sample are introduced into a radio frequency (RF) plasma where energy-transfer processes cause desolvation, atomization, and ionization. The ions are extracted from the plasma through a differentially-pumped vacuum interface and travel through a pressurized chamber (DRC) containing a specific reactive gas which preferentially reacts with interfering ions of the same target mass to charge ratios (m/z). A solid-state detector detects ions transmitted through the mass analyzer, on the basis of their mass-to-charge ratio (m/z), and the resulting current is processed by a data handling system.

4. Analytical Issues

The overall analyses went very well and no significant analytical issues were encountered. All quality control parameters associated with these samples were within acceptance limits.

It should be noted that an identified limitation of the BCR sequential extraction method is not designed to include analytes encapsulate in silicate matrices. In order to represent such a fraction the residual fraction and the total metals digestions must facilitate a $HF/HNO_3/HCl$ digestion technique.

The fractions of the NIST 2711 were re-analyzed for Pb due to the sum of the fractions being much lower than the total result and the true value in the January 28, 2009 analysis. The fractions were re-analyzed on February 2, 2009, which confirmed fractions 1, 2, and 4, but fraction 3 was much higher. Some other analytes, such as Cr, Mn, Ni, and Ca, were also analyzed on February 2, 2009. The results from these analytes for fraction 3 were similar to the results from the January 28, 2009 analysis. Based on the result confirmation of the other fractions and of the other analytes, it was deemed appropriate to report the Pb result from February 2, 2009 for fraction 3 of NIST 2711.

If you have any questions or concerns regarding this report, please feel free to contact me at (206) 219-3779.

Sincerely,

Lydia Watts

Lydia Watts
Project Coordinator
Applied Speciation and Consulting, LLC

BCR Sequential Extraction Results forAdvanced Geoservices Corp.
Contact: Jen Stanhope
Project Name: Exide-Reading Bernhart Park

Date: February 6, 2009
Report Generated by: Lydia Watts
Applied Speciation and Consulting, LLC

Sample Results

Sample BP-TT-0-12

Fraction	Analyte (mg/kg)	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mg	Ca	Mn	Al
0.11M CH3COOH	Exchangeable; Water and Acid Soluble (Carbonates)	0.270	0.201	5.83	1.62	146	10.6	60.4	33.1	141	117	172
0.1M NH2OH HCl	Reducible (Fe and Mn)	0.0507	0.109	0.198	0.224	125	2.04	479	2.41	19.8	89.0	108
8.8M H2O2 + 1.0M CH3COONH4	Oxidizable (Organic)	0.0317	1.88	2.43	0.767	85.2	3.12	5.14	30.9	29.4	7.12	39.8
Aqua Regia	Residual non-silicate bound	0.0697	22.3	14.7	10.5	111	33.6	23900	645	228	72.4	5470
HNO3/H2O2	Total (Original sample)	0.376	22.4	36.6	12.6	472	53.9	25400	860	406	306	7720
SEP % Recovery		112%	109%	63%	104%	99%	92%	96%	83%	103%	93%	75%

Sample Results

Sample BP-TT-0-12D

Fraction	Analyte (mg/kg)	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mg	Ca	Mn	Al
0.11M CH3COOH	Exchangeable; Water and Acid Soluble (Carbonates)	0.294	0.207	6.30	1.84	157	11.2	55.8	33.9	149	144	181
0.1M NH2OH HCl	Reducible (Fe and Mn)	0.0634	0.119	0.193	0.451	130	2.87	499	2.86	25.6	194	112
8.8M H2O2 + 1.0M CH3COONH4	Oxidizable (Organic)	0.0531	2.24	2.63	1.14	86.7	3.42	4.31	27.7	27.7	17.0	36.0
Aqua Regia	Residual non-silicate bound	0.0802	31.0	16.0	15.3	136	45.3	25500	705	189	97.0	6000
HNO3/H2O2	Total (Original sample)	0.475	23.7	23.4	14.1	484	50.0	25500	803	405	328	7400
SEP % Recovery		103%	142%	108%	133%	105%	125%	102%	96%	97%	138%	86%

BCR Sequential Extraction Results forAdvanced Geoservices Corp.
Contact: Jen Stanhope
Project Name: Exide-Reading Bernhart Park

Date: February 6, 2009
Report Generated by: Lydia Watts
Applied Speciation and Consulting, LLC

Sample Results

Sample BP-ZZ-3-12

Fraction	Analyte (mg/kg)	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mg	Ca	Mn	Al
0.11M CH3COOH	Exchangeable; Water and Acid Soluble (Carbonates)	0.117	0.102	2.28	1.00	46.4	7.72	7.58	349	1720	79.3	63.7
0.1M NH2OH HCl	Reducible (Fe and Mn)	0.0671	0.125	0.517	0.867	114	5.32	804	111	698	237	186
8.8M H2O2 + 1.0M CH3COONH4	Oxidizable (Organic)	0.0400	4.20	2.22	1.33	96.2	5.30	10.6	177	236	36.0	192
Aqua Regia	Residual non-silicate bound	0.0965	83.5	82.8	38.3	232	200	46300	9340	1900	226	39700
HNO3/H2O2	Total (Original sample)	0.304	82.7	79.6	38.2	440	209	46700	9810	4300	539	42300
SEP % Recovery		105%	106%	110%	109%	111%	104%	101%	102%	106%	107%	95%

Sample Results

Sample BP-T-3-12

Fraction	Analyte (mg/kg)	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mg	Ca	Mn	Al
0.11M CH3COOH	Exchangeable; Water and Acid Soluble (Carbonates)	0.094	0.270	30.2	1.08	29.1	17.6	9.04	50.7	749	75.4	209
0.1M NH2OH HCl	Reducible (Fe and Mn)	0.0169	0.142	2.43	0.243	37.5	2.79	540	6.13	68.0	118	179
8.8M H2O2 + 1.0M CH3COONH4	Oxidizable (Organic)	0.0118	3.77	9.92	0.652	26.3	2.78	6.74	24.8	66.1	14.0	56.9
Aqua Regia	Residual non-silicate bound	0.0184	36.1	32.8	16.3	83.0	72.8	22300	2650	420	133	18600
HNO3/H2O2	Total (Original sample)	0.145	37.9	83.4	17.7	163	92.9	20800	2820	1840	300	20900
SEP % Recovery		97%	106%	90%	103%	108%	103%	110%	97%	71%	114%	91%

BCR Sequential Extraction Results forAdvanced Geoservices Corp.
Contact: Jen Stanhope
Project Name: Exide-Reading Bernhart Park

Date: February 6, 2009
Report Generated by: Lydia Watts
Applied Speciation and Consulting, LLC

Sample Results

Sample BP-DD-0-12

Fraction	Analyte (mg/kg)	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mg	Ca	Mn	Al
0.11M CH3COOH	Exchangeable; Water and Acid Soluble (Carbonates)	0.354	0.109	2.31	1.08	11.3	35.3	20.0	277	2300	126	94.4
0.1M NH2OH HCl	Reducible (Fe and Mn)	0.162	0.108	0.253	0.386	18.6	11.4	673	26.7	363	95.4	114
8.8M H2O2 + 1.0M CH3COONH4	Oxidizable (Organic)	0.0373	2.11	2.72	0.107	33.1	ND (<0.42)	3.41	27.2	92.1	5.15	3.87
Aqua Regia	Residual non-silicate bound	0.0816	10.1	29.7	6.70	138	67.6	9760	772	294	51.1	6830
HNO3/H2O2	Total (Original sample)	0.533	13.2	34.9	8.48	199	104	11100	1110	2710	235	7870
SEP % Recovery		119%	94%	100%	98%	101%	110%	94%	99%	113%	118%	89%

ND = Not detected at the applied dilution

Sample Results

Sample BP-DD-0-12 MS

Fraction	Analyte (mg/kg)	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mg	Ca	Mn	Al
0.11M CH3COOH	Exchangeable; Water and Acid Soluble (Carbonates)	0.331	0.0771	1.63	0.952	10.8	33.6	16.9	349	2900	114	77.0
0.1M NH2OH HCl	Reducible (Fe and Mn)	0.197	0.121	0.240	0.492	19.6	13.5	711	29.8	508	111	101
8.8M H2O2 + 1.0M CH3COONH4	Oxidizable (Organic)	0.0299	2.42	2.22	0.153	48.1	0.60	2.94	26.9	124	5.56	3.97
Aqua Regia	Residual non-silicate bound	0.0336	10.7	28.4	7.99	202	66.5	14400	802	261	67.8	7070
HNO3/H2O2	Total (Original sample)	0.590	13.9	34.6	9.38	214	116	11900	1240	3050	273	8020
SEP % Recovery		100%	96%	94%	102%	131%	98%	127%	97%	124%	109%	90%

BCR Sequential Extraction Results forAdvanced Geoservices Corp.
Contact: Jen Stanhope
Project Name: Exide-Reading Bernhart Park

Date: February 6, 2009
Report Generated by: Lydia Watts
Applied Speciation and Consulting, LLC

Sample Results

Sample BP-DD-0-12 MSD

Fraction	Analyte (mg/kg)	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mg	Ca	Mn	Al
0.11M CH3COOH	Exchangeable; Water and Acid Soluble (Carbonates)	0.365	0.108	1.95	1.07	11.1	36.4	23.3	374	2680	134	95.6
0.1M NH2OH HCl	Reducible (Fe and Mn)	0.189	0.125	0.265	0.433	19.5	12.6	722	31.1	475	102	114
8.8M H2O2 + 1.0M CH3COONH4	Oxidizable (Organic)	0.0372	2.54	2.66	0.138	35.9	0.44	3.77	29.5	117	5.75	4.02
Aqua Regia	Residual non-silicate bound	0.0904	10.8	30.4	7.75	152	65.1	10500	841	268	56.2	7180
HNO3/H2O2	Total (Original sample)	0.538	13.0	31.5	8.46	200	103	12300	1110	2780	244	7180
SEP % Recovery		127%	104%	112%	111%	109%	111%	91%	115%	127%	122%	103%

Sample Results

Sample BP-I-3-12

Fraction	Analyte (mg/kg)	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mg	Ca	Mn	Al
0.11M CH3COOH	Exchangeable; Water and Acid Soluble (Carbonates)	0.0316	0.128	1.35	0.957	4.87	5.41	18.0	180	1210	109	82.2
0.1M NH2OH HCl	Reducible (Fe and Mn)	0.0044	0.141	0.153	0.334	6.88	1.94	1230	17.9	166	130	105
8.8M H2O2 + 1.0M CH3COONH4	Oxidizable (Organic)	ND (<0.0084)	ND (<0.0049)	0.066	ND (<0.024)	0.045	ND (<0.42)	1.38	ND (<0.31)	ND (<6.1)	ND (<0.025)	0.57
Aqua Regia	Residual non-silicate bound	0.0248	18.9	14.0	9.70	56.6	53.2	19500	1460	355	181	17400
HNO3/H2O2	Total (Original sample)	0.0341	22.2	17.0	11.5	70.3	60.9	19800	1680	1690	406	18800
SEP % Recovery		178%	86%	92%	96%	97%	99%	105%	99%	102%	103%	94%

ND = Not detected at the applied dilution

BCR Sequential Extraction Results forAdvanced Geoservices Corp.
Contact: Jen Stanhope
Project Name: Exide-Reading Bernhart Park

Date: February 6, 2009
Report Generated by: Lydia Watts
Applied Speciation and Consulting, LLC

Sample Results

NIST 2711

Fraction	Analyte (mg/kg)	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mg	Ca	Mn	Al
0.11M CH3COOH	Exchangeable; Water and Acid Soluble (Carbonates)	34.3	0.234	5.52	3.21	318	49.2	22.2	1490	19500	343	141
0.1M NH2OH HCl	Reducible (Fe and Mn)	7.75	0.037	1.33	0.999	132	27.7	578	359	2360	78.1	62.1
8.8M H2O2 + 1.0M CH3COONH4	Oxidizable (Organic)	ND (<0.0084)	3.44	2.06	0.738	476	3.02	6.17	30.7	110	20.3	58.8
Aqua Regia	Residual non-silicate bound	1.83	21.7	85.9	11.2	241	225	22700	5600	1710	155	19600
HNO3/H2O2	Total (Original sample)	38.2	24.7	104	17.5	1160	319	24300	7950	20700	540	21800
SEP % Recovery		115%	103%	91%	92%	101%	95%	96%	94%	114%	110%	91%
True Value		41.7	47*	114	20.6	1162	350.4	28900	10500	28800	638	65300
SEP TV Recovery		105%	54%	83%	-78%	100%	87%	81%	71%	82%	93%	30%
HNO3/H202 TV Recovery		92%	53%	92%	85%	100%	91%	84%	76%	72%	85%	33%

ND = Not detected at the applied dilution
*Noncertified value

APPENDIX C

SUMMARY OF PARK ECOLOGICAL SAMPLING INFORMATION

SUMMARY OF PARK ECOLOGICAL SAMPLING INFORMATION

BACKGROUND

A site meeting was held at Bernhart Park (Park) with representatives of the United States Environmental Protection Agency (USEPA), Pennsylvania Department of Environmental Protection (PADEP) and Exide Technologies (Exide) in November, 2008 to review and discuss completion of a Screening Level Ecological Risk Evaluation for the Park. At that time EPA acknowledged receipt of a qualitative technical memorandum (dated June 2008) completed by Exide's Ecological Consultant, Avatar Environmental, but was requesting that Exide provide numerical values that would represent the soil lead concentrations remaining after completion of the remedial activities proposed to abate lead exposure to humans in the shallow surface soils within the mowed lawn areas of the Park so those remaining concentrations could be compared to screening levels for ecological exposure.

After discussions that included Exide's environmental and ecological consultants, Advanced GeoServices and Avatar respectively, it was concluded that to provide a representative comparison of lead exposure by ecological receptors at the park it was necessary to consider soil exposure over a wider range of depths and to consider bioavailability of the lead in the soil. Avatar issued a letter to EPA on December 11, 2008 proposing to characterize soil in the top 12-inches for evaluation of ecological exposure and to perform sequential extraction to determine the fraction of the lead that was most bioavailable. EPA approved the proposal in an e-mail from Khai Dao (EPA) to Tod DeLong (Avatar).

Presented herein is a summary of the sampling conducted by Advanced GeoServices in January 2009 and a description of how those results were utilized to develop representative concentrations for the 0"-12"- soil horizon remaining within each of the four ecological habitats after the proposed remediation of the mowed lawn areas to abate human exposure.

ECOLOGICAL SOIL SAMPLING (January 2009)

Soil sampling to characterize soils in the upper 12-inches of soil at the Park was performed by Advanced GeoServices in January 2009. For evaluation purposes, the sampling was conducted on an ecological area by ecological area basis. Those ecological areas are Mowed Lawn, Forested Wetlands, and Scrub-Shrub Areas.

Mowed Lawn Area

The mowed lawn areas are the grassy areas that comprise approximately 40% of the terrestrial area of the site and is the only area of the Park proposed for soil remediation for lead because of human exposure. During previous sampling of shallow surface soils performed in 2001, the mowed lawn area was separated into 27 “Exposure Areas” (EAs) each representing 20,000 sf or less. Seventeen (17) of the EAs are proposed to have approximately 3-inches of soil removed and replaced with clean soil as part of the proposed remediation.

To evaluate the average soil concentration that will be present within the mowed lawn areas of the Park following remediation, Advanced GeoServices collected soil samples from depths of 3-12-inches below the existing ground surface from 12 of the 27 mowed lawn EAs. The 12 EAs included 10 EAs proposed for remediation and two EAs below the proposed human exposure level of 650 mg/kg. To evaluate the “post remediation” average lead concentration for the top 12-inches of soil, Advanced GeoServices calculated a weighted concentration within a remediated EA using the sample result for the 3-12 inch horizon and an assumed concentration of 50 mg/kg total lead for the topsoil used to replace the remediated soil.

An example calculation is as follows:

> Exposure Area BP-G has a lead concentration in the 0-3 inch horizon of 1,141 mg/kg and concentration in the 3-12 inch horizon of 109 mg/kg.

Prior to remediation the average weighted concentration is:

{(3 x 1,141) + (9 x 109)}/12 = 367 mg/kg

After Remediation the average weighted concentration will be:

{(3 x 50*) + (9 x 109)}/12 = 94 mg/kg

* 50 mg/kg is the specified maximum lead concentration for replacement soil during remediation.

The above calculation was repeated for each EA that had a 3-12 inch soil result and was proposed for remediation. Within EAs where no remediation was performed the average concentration for before and after remediation would remain unchanged.

Because not all EAs were sampled from 3-12 inches, it was necessary to develop a correlation between the 0-3 inch and 3-12 inch soil horizons based on the 12 EAs where the deeper sampling was performed. As shown on the attached table (Table 1), on average the mean of the 3-12 inch depth concentration was 17.2% of the 0-3 inch depth concentration and based on a statistical analysis, the 95% UCL of the average mean was 22.3%. The average concentration of the 3-12 inch horizon was calculated by multiplying the known concentration for the 0-3 inch horizon by 0.223, and then the average concentrations remaining after proposed remediation were calculated following the procedures described above.

The "12" Weighted Average" values presented on Table 1 reflect the post remediation concentrations. Those with shading represent those EAs that will be remediated.

Forested Wetland and Scrub-Shrub Areas

The Forested Wetland and Scrub-Shrub Areas together comprise about 40% of the terrestrial areas of the Park. These include the islands. A total of 20 EAs represent these areas with 10 Forested Wetland and 10 Scrub-Shrub. Eight samples were collected from the Forested Wetland and 6 samples were collected from the Scrub Shrub. Because no remediation is proposed in these areas the samples were collected from 0-12 inches instead of from 3-12 inches as was done in the mowed lawn areas. The result from the 0-12 inch samples became the representative concentration for the EA from where it was collected. Similar to the mowed lawn areas we developed a statistical relationship between the 0-3 inch and 0-12 inch samples and utilized the 95% UCLs to calculate the concentration for those EAs where no 0-12 inch samples were collected. The correlation was 40.9% for the Forested Wetland and 24.3% for the Scrub Shrub Areas.

The representative values are presented on Table 2. The EAs where an actual sample was collected is identified on the table as "known" and where the value was calculated we have shown the word "calculated."

Wooded Hillside

The Wooded Hillside, also referred to as the Forested Upland was not originally included in the area proposed for further Ecological Screening in the November 2008 meeting with USEPA and PADEP and as a result deeper sampling was not performed in this area during January 2009. However; in the spring of 2009 USEPA asked that the Wooded Hillside be included in the Screening Level Ecological Risk Evaluation.

Because no direct statistical analysis was available to evaluate the wooded hillside, Advanced GeoServices utilized information from the Forested Wetland Area, (excluding sample BP-ZZ, which appears to be an outlier compared to other results) to develop a regression equation to calculate average concentrations in the top 12 inches based on the known concentration in the top 3 inches. The regression analysis is attached and the results of the calculations performed using the regression equation is provided as Table 3. The regression equation was utilized instead of the percentage relationship because of the wide range of concentrations observed in the wooded hillside.

This summarizes the data interpretation and evaluation performed on soil samples at Bernhart Park in relationship to development of representative concentrations for the top 12 inches of soil for use in the Screening Level Ecological Risk Evaluation.

TABLE 1
EXIDE - READING
BERNHART PARK SOIL SAMPLE RESULTS AND CALCULATIONS

	known	known		
GRASS SAMPLE ID	**O-3" RESULT (mg/kg)**	**3-12" RESULT (mg/kg)**	**3-12"/O-3" PERCENT**	**12" WEIGHTED AVERAGE***
BP-F	1147	384	0.335	301
BP-G	1141	109	0.096	94
BP-I	420	52	0.123	144
BP-K	472	78	0.165	177
BP-LL	1294	312	0.241	247
BP-M	860	220	0.256	178
BP-S	1129	93	0.082	82
BP-T	1921	134	0.070	113
BP-U-3	1177	301	0.256	238
BP-V	876	110	0.126	95
BP-X	1526	433	0.284	337
BP-Y	1522	40	0.026	42
Average			0.172	
Standard Deviation			0.0991	
95% UCL			0.2230	

	known	calculated		
GRASS SAMPLE ID	**O-3" RESULT (mg/kg)**	**3-12" RESULT (mg/kg)**	**3-12"/O-3" PERCENT**	**12" WEIGHTED AVERAGE***
BP-Z	1109	247	0.223	198
BP-YY	829	185	0.223	151
BP-XX	853	190	0.223	155
BP-W	1070	239	0.223	191
BP-R	618	138	0.223	258
BP-Q	462	103	0.223	193
BP-O	750	167	0.223	138
BP-P	607	135	0.223	253
BP-L	324	72	0.223	135
BP-H	564	126	0.223	235
BP-A	375	84	0.223	156
BP-B	329	73	0.223	137
BP-C	791	176	0.223	145
BP-D	667	149	0.223	124
BP-E	620	138	0.223	259
Average of all Grass EAs 12" weighted average				177

* = shading indicates 3" clean-up and backfill with 50 ppm soil, no shading indicates no clean-up performed

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TABLE 2
EXIDE - READING
BERNMART PARK SOIL SAMPLE RESULTS AND CALCULATIONS

	known	known	
FORESTED WETLAND SAMPLE ID	**0-3" RESULT (mg/kg)**	**0-12" RESULT (mg/kg)**	**0-12"/O-3" PERCENT**
BP-AAA-0-3	632	195	0.309
BP-BBB-0-3	361	150	0.416
BP-DDD-0-3	963	140	0.145
BP-SS-0-3	1016	406	0.400
BP-TT-0-3	1973	395	0.200
BP-UU-0-3	2713	340	0.125
BP-WW-0-3	1070	244	0.228
BP-ZZ-0-3	1022	605	0.592
Average			0.302
Standard Deviation			0.1595
95% UCL			0.4090

	known	calculated
FORESTED WETLAND SAMPLE ID	**0-3" RESULT (mg/kg)**	**0-12" RESULT (mg/kg)**
BP-VV-0-3	628	257
BP-CCC-0-3	591	242
Average of all Forested Wetland EAs 0-12"		297

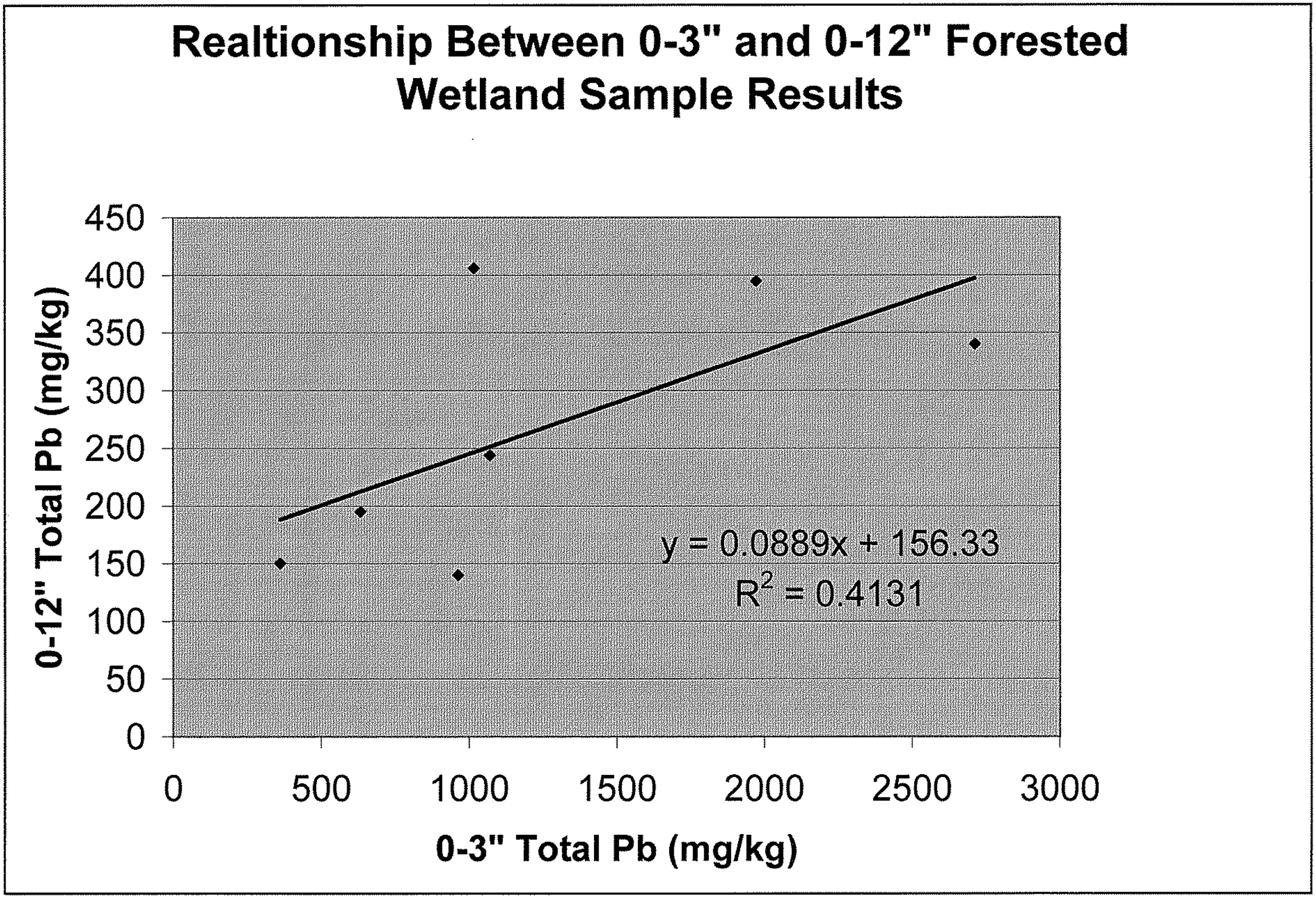
	known	known	
SCRUB/SHRUB SAMPLE ID	**0-3" RESULT (mg/kg)**	**0-12" RESULT (mg/kg)**	**0-12"/O-3" PERCENT**
BP-BB-0-3	1063	266	0.250
BP-DD-0-3	955	181	0.190
BP-EE-0-3	526	128	0.243
BP-GG-0-3	205	38	0.185
BP-II-0-3	472	113	0.239
BP-KK-0-3	693	144	0.208
Average			0.219
Standard Deviation			0.0288
95% UCL			0.2430

	known	calculated
SCRUB/SHRUB SAMPLE ID	**0-3" RESULT (mg/kg)**	**0-12" RESULT (mg/kg)**
BP-AA-0-3	444	108
BP-CC-0-3	526	128
BP-FF-0-3	438	106
BP-JJ-0-3	338	82
Average of all Scrub/Shrub EAs 0-12"		129

TABLE 3
BERNHART PARK ESTIMATED SURFACE (0-12INCH) SOIL CONCETRATIONS
FORESTED UPLAND

FORESTED UPLAND SAMPLE ID	0-3" RESULT (mg/kg)	0-12" RESULT (mg/kg)
BP-NN-0-3	4845.3	587
BP-OO-0-3	3654.6	481
BP-PP-0-3	1154.5	259
BP-QQ-0-3	1006.4	246
BP-RR-0-3	743	222
Average of all Forested Upland EAs 0-12"		359

Known values represent laboratory analytical results. Calculated values were developed using a regression equation based on the relationship of 0-3 inch and 0-12 inch samples collected from the nearby forested wetland ($y = 0.0889x + 156.33$)


Realtionship Between 0-3" and 0-12" Forested
Wetland Sample Results
450
400
350
300
250
200
150
100
50
0
0-12" Total Pb (mg/kg)
y = 0.0889x + 156.33
R2 = 0.4131
0
500
1000
1500
2000
2500
3000
0-3" Total Pb (mg/kg)

APPENDIX D

AQUATIC MEDIA CONCENTRATIONS

TABLE D-1

RESERVOIR SURFACE WATER SAMPLES - DISSOLVED LEAD CONCENTRATIONS VERSUS AQUATIC LIFE CRITERION BERNHART PARK - READING, PA

SAMPLE[a]	RESULT (µg/L)	HQ BASED ON CRITERION OF 2.5 µg/L[b]
1 WA	1.8	0.72
1 WA Duplicate	<1.5	<0.6
1 WB	<1.5	<0.6
10 WA	<1.5	<0.6
10 WB	<1.5	<0.6
11 WA	<1.5	<0.6
11 WB	2.6	1.0
12 WA	<1.5	<0.6
12 WB	2.1	0.84
13 WA	1.6	0.64
13 WB	2.8	1.1
14 WA	2.6	1.0
14 WB	6.7	2.7
15 WA	<1.5	<0.6
15 WB	<1.5	<0.6
2 WA	2.6	1.0
2 WB	2.3	0.92
3 WA	2	0.80
3 WB	<1.5	<0.6
4 WA	2.5	1.0
4 WB	<1.5	<0.6
5 WA	<1.5	<0.6
5 WB	<1.5	<0.6
6 WA	2.5	1.0
6 WA Duplicate	2.5	1.0
6 WB	<1.5	<0.6
7 WA	<1.5	<0.6
7 WB	<1.5	<0.6
8 WA	2.5	1.0
8 WB	2	0.80
9 WA	1.5	0.60
9 WB	<1.5	<0.6
Inlet	<1.5	<0.6
Outlet	1.7	0.68
SED Pond	<1.5	<0.6

Shading indicates ratio of sample to aquatic life criterion is greater than 1.0.

HQ = Hazard Quotient.

[a]WA samples taken at 3 feet below surface; WB samples taken at 3 feet from bottom. Concentrations are those obtained from the EPA laboratory from split samples.

[b]Chronic Aquatic Life Criterion for Lead based on hardness of 100 mg/L (25 PA Code CH 93; 39 Pa.B. 2523, 16 May 2009).

TABLE D-2

RESERVOIR SEDIMENT SAMPLES - LEAD CONCENTRATIONS VERSUS SEDIMENT BENCHMARK BERNHART PARK - READING, PA

SAMPLE	RESULT (mg/kg)	HQ BASED ON BENCHMARK OF 35.8 mg/kg[a]	HQ BASED ON BENCHMARK OF 128 mg/kg[b]
1W	246	6.9	1.9
2W	308	8.6	2.4
3W	212	5.9	1.7
4W	286	8.0	2.2
5W	417	12	3.3
6W	279	7.8	2.2
7W	326	9.1	2.5
8W	246	6.9	1.9
9W	221	6.2	1.7
10W	197	5.5	1.5
11W	267	7.5	2.1
12W	278	7.8	2.2
13W	203	5.7	1.6
14W	470	13	3.7
15W	345	9.6	2.7
16W (Duplicate of 14W)	471	13	3.7

[a]Region III BTAG Freshwater Sediment Value. Based on MacDonald et al., 2000 TEC.
[b]MacDonald et al., 2000 PEC.

Notes:
Concentrations in all samples exceed both the TEC and the PEC.
PEC = Probable Effects Concentration.
TEC = Threshold Effects Concentration.

TABLE D-3

RESERVOIR FISH FILLET SAMPLES - LEAD CONCENTRATIONS VERSUS SEDIMENT BENCHMARK BERNHART PARK - READING, PA

SAMPLE	RESULT (mg/kg)	IDL (mg/kg)
FISH-1	ND	0.083
FISH-2	ND	0.074
FISH-3	ND	0.077
FISH-4	ND	0.062
FISH-5	ND	0.068
FISH-6	ND	0.061

Notes:

All samples composites, except for FISH-5.

All IDLs lower than the most conservative applicable ERED toxicity value of 0.130 mg/kg (carcass concentrations; March 2010).

FISH-1: Pumpkinseed - 3 individuals, 6-6.5 inches long.

FISH-2: Bluegill - 6 individuals, 5-7 inches long.

FISH-3: Crappie - 2 individuals, 7.5-10 inches long.

FISH-4: Largemouth Bass - 5 individuals, 7.5-10 inches long.

FISH-5: Brown Trout - 1 individual, 7 inches long.

FISH-6: White Sucker - 7 individuals, 5-10 inches long.