CROW'S NEST MRS REMEDIAL INVESTIGATION
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT
WEST POINT MILITARY RESERVATION, WEST POINT, NY

Prepared for

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Am	amino
AUF	area use factor
AVS	acid volatile sulfide
BAF	bioaccumulation factor
BW	body weight
COC	contaminant of concern
COPC	constituent of potential concern
CSM	conceptual site model
DNT	dinitrotoluene
DU	decision unit
dw	dry weight
EEC	estimated environmental concentration
f_{oc}	fraction of organic carbon
g	gram
HQ	hazard quotient
INRMP	Integrated Natural Resources Management Plan
ISM	incremental sampling methodology
LANL	Los Alamos National Laboratory
LOAEL	Lowest Observed Adverse Effects Level
MC	munition constituent
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
MRS	munitions response site
NOAEL	No Observed Adverse Effects Level
NYNHP	New York Natural Heritage Program
NYSDEC	New York State Department of Environmental Conservation
RI	Remedial Investigation
SEM	simultaneously extracted metals
SLERA	Screening Level Ecological Risk Assessment
TNT	trinitrotoluene
TOC	total organic carbon
TRV	toxicity reference value
U.S.	United States
USEPA	U.S. Environmental Protection Agency

USFWS	U.S. Fish and Wildlife Services
µmol	micromoles

A Screening Level Ecological Risk Assessment (SLERA) was conducted using soil and sediment incremental sampling results collected in November 2015 at the Crow's Nest Munitions Response Site (MRS) to assess the potential for adverse effects to ecological receptors. Conservative ecological screening values were used to screen soil and sediment data. The SLERA identified lead as the primary soil and sediment constituent of potential concern at decision unit (DU)-01 and DU-02. Explosives were eliminated from further evaluation based on risk-based screening levels. An evaluation of background concentrations eliminated DU-03 from further evaluation.

Food-chain modeling was used to estimate risk from exposure to lead in soil at DU-01 and sediment at DU-02. For the screening level assessment, the maximum detected concentration of lead within each DU (DU-01: 2,220 milligrams per kilogram [mg/kg]; DU-02: 4,470 mg/kg) as well as highly conservative exposure parameters (i.e., minimum body weight, maximum food ingestion rate, and 100% dietary composition of the most contaminated food item) were used in the modeling. Following the screening level assessment, a refined assessment was conducted utilizing the mean concentration of lead within each DU (DU-01: 690.8 mg/kg; DU-02: 3,433 mg/kg) as well as less-conservative exposure parameters (i.e., average body weight, average food ingestion rate, and dietary fractions of individual food items).

The following assessment endpoints were evaluated for both the screening level and refined screening level assessment:

Assessment Endpoint No. 1: Terrestrial and/or Benthic Invertebrates

Assessment Endpoint No. 2: Small Insectivorous Mammal – Short tailed shrew

Assessment Endpoint No. 3: Insectivorous Birds – American Robin/ Marsh Wren

Assessment Endpoint No. 4: Omnivorous Mammals – Red Fox

Assessment Endpoint No. 5: Carnivorous Birds – Red-Tailed Hawk

At the screening level, the results indicate that lead levels in DU-01 surface soil and DU-02 sediment may result in potential adverse effects to all assessment endpoints evaluated except for the carnivorous bird in DU-01 and benthic invertebrates in DU-02.

For the refined screening level assessment, the results indicate that lead levels in DU-01 surface soil and DU-2 sediment may result in adverse effects to insectivorous mammals and birds. The relatively high concentration of total organic carbon found within DU-02 sediment has the ability to bind free metals and reduce their availability to benthic organisms.

The results of this SLERA indicate that, given the large size of DU-01 and colocation of DU-02, species that have a limited home range and could potentially spend all or most of their lives at the site, such as small insectivorous mammals and birds, have the greatest likelihood to be adversely affected by contaminants at the site.

SECTION ONE: INTRODUCTION

This document presents the Screening Level Ecological Risk Assessment (SLERA) for the Crow's Nest Munitions Response Site (MRS) located at the United States (U.S.) West Point Military Reservation (herein referred to as the Installation) in West Point, New York. This SLERA supports the Military Munitions Response Program for the Remedial Investigation (RI) conducted at the Crow's Nest MRS in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by Title 42 of the United States Code Sections 9601 through 9675.

This SLERA addresses potential exposure of ecological receptors to munitions constituents (MC) detected at the Crow's Nest MRS. Soil and sediment data used in this assessment were collected using incremental sampling methods.

This SLERA was performed in accordance with the methodology outlined in *Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (U.S. Environmental Protection Agency [USEPA], 1997). Specific methods used in the SLERA are described in the SLERA methodologies memorandum submitted as a Work Plan addendum which was accepted by the U.S. Army Corps of Engineers on January 19, 2016 (URS, 2016).

SECTION TWO: PROBLEM FORMULATION

The problem formulation process establishes the goals, complexity, and focus of the ecological risk assessment. The assessment is intended to evaluate potential threats resulting from historical use of the Former Crow's Nest Impact Area to the receptors from exposure to lead in soil and sediment and trinitrotoluene (TNT) and its breakdown products in soil. The problem formulation process includes identifying constituents of potential concern (COPCs), developing a conceptual model to identify exposure pathways and assessment endpoints, and identifying testable hypotheses and measurement endpoints. Elements of this process are presented in the following sections.

2.1 ENVIRONMENTAL SETTING

The Crow's Nest MRS is located at the U.S. West Point Military Reservation (herein referred to as the Installation) in West Point, New York. The MRS is approximately 615 acres with the majority of the area located on Crow's Nest Mountain. The MRS is comprised of four sub-areas: The Former Crow's Nest Impact Area; Training Area J1; Training Area G1; and Training Area G2. Decision units (DU) within the MRS were established following geostatistical analysis of analog geophysical data obtained during the intrusive investigation conducted as part of the RI. Three DUs were identified and defined as areas where an estimated density of 50 anomalies per acre was anticipated; DU-01 (147 acres), DU-02 (1.3 acres), and DU-03 (16 acres). **Figure 2-1** presents the location of the MRS, sub-areas, and the location of each DU.

2.1.1 The Crow's Nest MRS

The Crow's Nest MRS is bounded to the east by the Hudson River, to the west by Black Rock Forest Preserve, to the north by Storm King State Park, and to the south by the Main Post of the Installation and occupies approximately 615 acres (**Figure 2-1**). The majority of the MRS is located on Crow's Nest Mountain and its topography is characterized by a very steep rocky summit sloping toward the Hudson River to the east. The Crow's Nest Mountain has an approximate 1,400-foot elevation range from base to summit with the lowest elevation occurring at the Hudson River. The MRS contains exposed bedrock and shallow, well-drained soils consisting of glacial till and alluvium from glacially transported sediment.

The majority of the MRS is covered by mature hardwood forest with successional hardwoods surrounding the summit following previous fire disturbance. Highland areas of the MRS are comprised of the following communities: Oak Hickory, Chestnut Oak, Rich Rocky Woodland, and Pitch Pine-Oak-Heath Rocky Summit. Lower elevation area communities are predominantly comprised of Tulip Poplar and Maple-Beech. Dense underbrush exists over the majority of the MRS with vegetation consisting of small saplings, sweet-fern, mountain laurel, blueberry, briers, and vines (Tetra Tech, 2011).

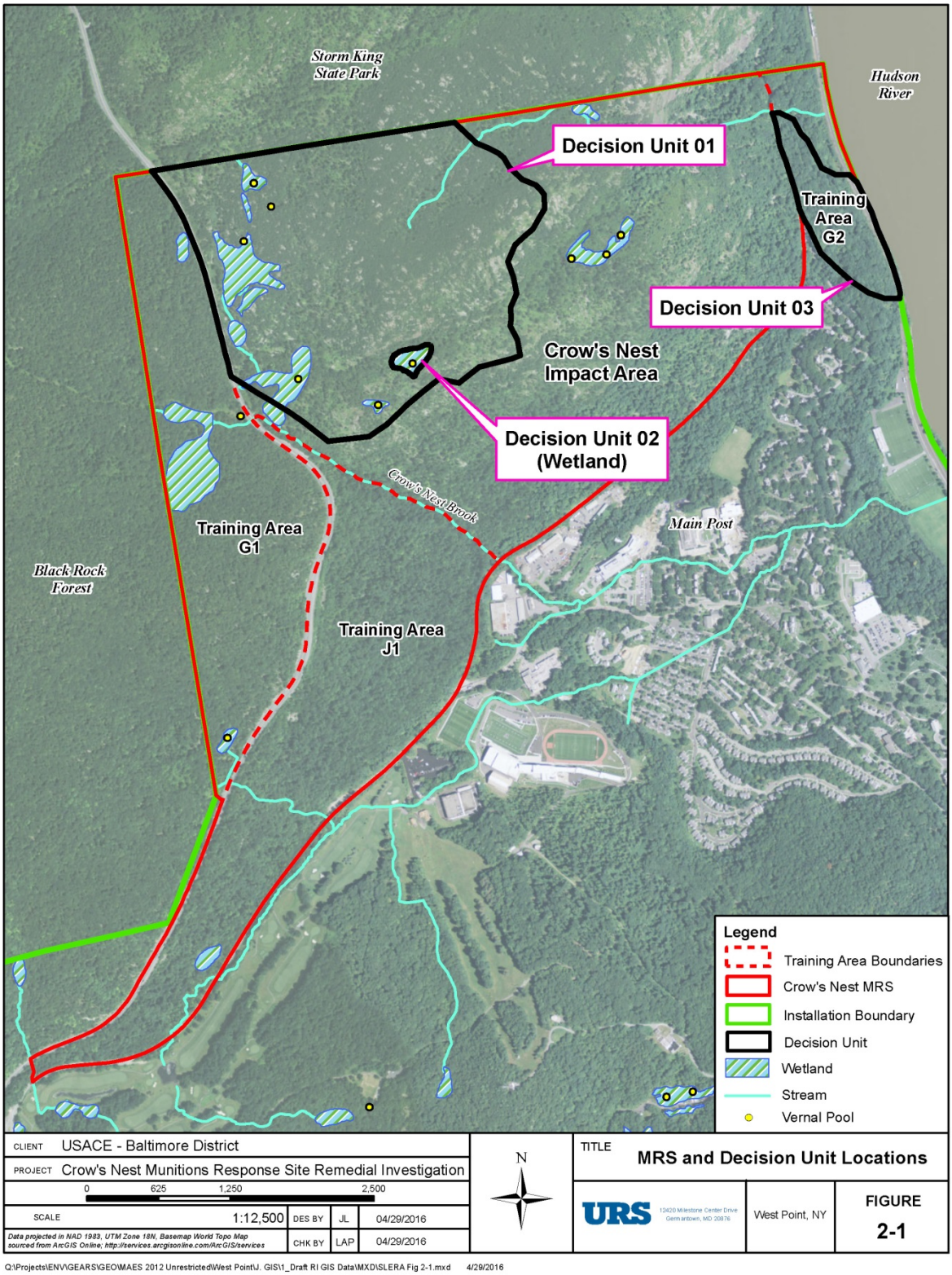

Figure 2-1: MRS and Decision Unit Locations

A variety of faunal species have been identified as occurring at the Installation. Forty-eight species of mammals have been observed on the Installation including the Red Fox (*Vulpes vulpes*) and Short-Tailed Shrew (*Blarina brevicauda*) among others. Two hundred and forty-nine species of birds have been observed on or near the Installation. Of these, 110 have been identified as breeding on the installation, with another 10 non-breeding winter residents. American Robins (*Turdus migratorius*), Marsh Wrens (*Cistothorus palustris*), and the Red-Tailed Hawk (*Buteo jamaicensis*) have all been positively identified. Twenty-two species of reptiles and 18 species of amphibians have been documented on the Installation, including the Timber Rattlesnake (*Crotalus horridus*), with five others believed present, but not confirmed. Numerous invertebrate species have also been identified including 67 species of butterflies, 101 species of the order Odonata (dragonflies and damselflies), and 294 species of moths (Tetra Tech, 2011).

Several species that are state or federally listed as threatened or endangered are known to, or have the potential to, inhabit the Installation. A discussion of the relevant federal and state-listed species is presented in **Attachment A**. The following listed species have been identified as having the potential to exist within the Crow's Nest MRS: Indiana Bat (*Myotis sodalist*), Northern Long-Eared Bat (*Myotis septentrionalis*), Bald Eagle (*Haliaeetus leucocephalus*), Timber Rattlesnake (*Crotalus horridus*), Small Whorled Pogonia (*Isotria medeoloides*), Gypsy-Wort (*Lycopus rubellus*), Weak Rush (*Juncus debilis*), Reflexed Sedge (*Carex retroflexa*), Black-Eyed Sedge (*Carex nigromarginata*), and Virginia Snakeroot (*Endodeca serpentaria*).

2.1.2 Decision Unit 01

DU-01 (147 acres) is located within the northwest corner of the Former Crow's Nest Impact Area of the MRS and is situated on top of the Crow's Nest Mountain. It is predominately covered by mature hardwood forest with successional hardwoods surrounding the summit following previous fire disturbance and is comprised of the following communities: Oak Hickory, Chestnut Oak, Rich Rocky Woodland, and Pitch Pine-Oak-Heath Rocky Summit. Dense underbrush exists over the majority of the DU with vegetation consisting of small saplings, Sweet-Fern, Mountain Laurel, Blueberry, briers, and vines. Similar faunal species as identified for the MRS and Installation are expected within DU-01. Specifically, Black Bear, White-Tailed Deer, and Wild Turkeys were observed within the DU during RI investigation activities.

2.1.3 Decision Unit 02

DU-02 (1.3 acres) is a wetland located within the footprint of DU-01. It is classified as a freshwater seasonally-flooded/saturated palustrine forested wetland by the U.S. Fish and Wildlife Services (USFWS) National Wetlands Inventory Mapper (accessed February 2016). According to the Integrated Natural Resources Management Plan (INRMP), the wetland is also potentially cross identified as a vernal pool that experiences some level of drying during the year (Tetra Tech, 2011) and is thus unlikely to be viable habitat for fish species. The wetland is shallow with deeper areas not exceeding approximately 3 feet in depth and appears to be lined by bedrock. It contains organic-rich black sediment and is very densely vegetated by the reed *Phragmites australis*.

2.1.4 Decision Unit 03

DU-03 (16 acres) is located within southern half of Training Area G2. It is located directly adjacent to the railroad tracks that run the length of the western shore of the Hudson River and contains very steep rocky terrain. The area is predominantly covered by mature hardwoods consisting of Tulip Poplar and Maple-Beech. Little to no underbrush exists within DU-03 and terrain is comprised of steeply graded exposed medium to large-sized cobbles and boulders with little topsoil in many areas. Similar faunal species as identified for the MRS and Installation are expected within DU-03. Specifically, White-Tailed Deer and Wild Turkeys were observed during RI investigation activities within the DU-03 area.

2.2 CONTAMINANTS AT THE SITE

COPCs for the site were initially identified based on historical activities. These data were evaluated to determine which COPCs did not require further evaluation and could be eliminated based on comparison to established benchmarks and background data, as described in the following paragraphs, and which contaminants should be carried forward as contaminants of concern (COCs).

2.2.1 Benchmark Comparison

Since the site had not previously been investigated for MC, the initial list of potential contaminants (i.e., COPCs) for the site was identified based on the historical munitions used at the firing ranges which targeted the Former Crow's Nest Impact Area of the site. The inorganic COPC identified for the Crow's Nest MRS was lead. The organic COPCs identified were TNT and its breakdown products: 2,4- Dinitrotoluene (DNT), 2,6-DNT, 2-Amino (Am)-DNT, and 4-Am-DNT.

For lead, soil samples were collected using incremental sampling methodology (ISM) from two separate decision units, DU-01 (11 ISM samples collected in triplicate) and DU-03 (2 ISM samples collected in triplicate), and compared to an ecological benchmark for lead in soil. Sediment was collected from DU-02 by ISM (1 sample collected in triplicate) and compared to its respective ecological benchmark. Concentrations of lead in all DUs exceeded their respective screening values for lead in both soil and sediment.

Sediments within DU-02 were also analyzed for simultaneously extracted metals (SEM), acid volatile sulfide (AVS), and total organic carbon (TOC) to assess the bioavailability of metals in sediment.

For explosives COPCs, incremental soil samples were collected from DU-01 and DU-03 and compared to their respective ecological benchmarks. Explosives were not evaluated within DU-02 due to the unlikelihood of their persistence over time in saturated sediment. There were no exceedances of screening levels for TNT nor its breakdown products 2,4-DNT, 2,6-DNT, 2-Am-DNT, and 4-Am-DNT in DU-01 or DU-03. Based on these results, explosives MC are eliminated as COPCs for all DUs.

Following comparison to benchmarks, lead is the only COC for DU-01, DU-02 and DU-03 as shown in **Tables 2-1, 2-2** and **2-3**, respectively.

Table 2-1: Selection of Ecological COCs: DU-01 – Surface Soil

Surface Soil							
	Maximum	Invertebrate		Mammal		Avian	
Analyte	Concentration	Screening Level	COC?	Screening Level	COC?	Screening Level	COC?
2,4,6-Trinitrotoluene	0.03	32 [a]	No	96 [a]	No	7.6 [a]	No
2,4-Dinitrotoluene	0.041	18 [a]	No	13 [a]	No	13 [a,c]	No
2,6-Dinitrotoluene	ND	30 [a]	No	7.1 [a]	No	52 [a]	No
2-Amino-Dinitrotoluene	0.034	43 [a]	No	15 [a]	No	15 [a,c]	No
4-Amino-Dinitrotoluene	0.12	18 [a]	No	12 [a]	No	12 [a,c]	No
Lead	2,220	1700 [b]	Yes	56 [b]	Yes	11 [b]	Yes

Notes:
All concentrations are milligrams per kilogram (mg/kg)
ND: analyte not detected; NV: no value reported for receptor
a) Los Alamos National Laboratory Ecological Screening Levels (R3.3, October 2015)
b) USEPA Eco-SSL Soil Screening Benchmark
c) No value exists for avian receptors, therefore the lowest screening level presented will be utilized

Table 2-2: Selection of Ecological COCs: DU-02 – Sediment

Wetland Sediment							
	Maximum	Invertebrate		Mammal		Avian	
Analyte	Concentration	Screening Level	COC?	Screening Level	COC?	Screening Level	COC?
Lead	4,470	35.8 [a]	Yes	35.8[a]	Yes	35.8 [a]	Yes

Notes:
All concentrations are mg/kg
a) USEPA Region 3 Biological Technical Assistance Group Freshwater Sediment Screening Benchmarks

Table 2-3: Selection of Ecological COCs: DU-03 – Surface Soil

Surface Soil							
	Maximum	Invertebrate		Mammal		Avian	
Analyte	Concentration	Screening Level	COC?	Screening Level	COC?	Screening Level	COC?
2,4,6-Trinitrotoluene	ND	32 [a]	No	96 [a]	No	7.6 [a]	No
2,4-Dinitrotoluene	ND	18 [a]	No	13 [a]	No	13 [a,c]	No
2,6-Dinitrotoluene	ND	30 [a]	No	7.1 [a]	No	52 [a]	No
2-Amino-Dinitrotoluene	ND	43 [a]	No	15 [a]	No	15 [a,c]	No
4-Amino-Dinitrotoluene	ND	18 [a]	No	12 [a]	No	12 [a,c]	No
Lead	90.6	1700 [b]	No	56 [b]	No *	11 [b]	No *

Notes:
All concentrations are mg/kg
ND: analyte not detected
* Background lead concentrations range from 77.1 - 92.4 mg/kg; since the maximum concentration of lead in Decision Unit 3 is below background, it is not carried through as a COC.
a) Los Alamos National Laboratory Ecological Screening Levels (R3.3, October 2015)
b) USEPA Eco-SSL Soil Screening Benchmark
c) No value exists for avian receptors, therefore the lowest screening level presented will be utilized

2.2.2 Background Comparison

RI field activities included collection of incremental samples from two background locations: WPIS00SA01-03 (sediment) and WPIS00SB01-03 (soil). The background incremental sampling results are used to distinguish lead concentrations related to past munitions use at the MRS from those that are naturally occurring at the MRS. When the maximum detected concentration (MDC) and the calculated mean concentration are close values, it indicates that the high number of increments collected for each replicate produced a homogeneous aliquot and is a representative concentration. As shown below in **Table 2-4**, the background sample data has representative concentrations.

Table 2-4: Background Lead Results

Background Sample	Lead MDC (mg/kg)	Lead Mean (mg/kg)
WPIS00SA01 (Sediment)	78.6	74.5
WPIS00SB01 (Soil)	92.4	86.7

The soil MDC and mean concentrations of lead in DU-01 and DU-03 are compared with the corresponding lead concentrations in background soil to determine whether lead concentrations are likely associated with MC releases or attributed to background in **Table 2-5**.

Table 2-5: Site to Background Lead in Soil Comparison

Decision Unit	Lead MDC (mg/kg)	Lead Mean (mg/kg)	Background Soil Lead MDC (mg/kg)	Background Soil Lead Mean (mg/kg)
DU-01	2,220	690.8	92.4	86.7
DU-03	90.6	73.7		

The DU-01 concentrations of lead are higher than the background lead concentrations indicating that site-related activities have contributed to lead concentrations in surface soil. DU-03 lead concentrations are similar to the background concentrations indicating that the presence of lead at DU-03 surface soil may be attributed to background.

For DU-02, the sediment MDC and mean concentrations for lead are higher than the sediment MDC and mean concentrations for background sediment (**Table 2-6**). The lead concentrations at DU-02 are likely attributed to a MC release rather than background.

Table 2-6: Site to Background Lead in Sediment Comparison

Decision Unit	Lead MDC (mg/kg)	Lead Mean (mg/kg)	Background Sediment Lead MDC (mg/kg)	Background Sediment Lead Mean (mg/kg)
DU-02	4,470	3,433	78.6	74.5

Lead is carried forward as a COC at DU-01 and DU-02 following the background evaluation. No COCs have been identified for DU-03.

2.3 CONTAMINANT FATE AND TRANSPORT

Transport of COCs within, and potentially from, the Crow's Nest MRS could occur primarily through the following pathways:

- Movement of contaminants sorbed to suspended soil particles transported via stormwater/snow melt runoff and erosion to downgradient locations where invertebrates and higher trophic level receptors could be exposed.

This is a potentially complete pathway for soil and wetland sediment. Receptors may come into direct contact with contaminated soil and wetland sediment within the MRS.

- Movement of contaminants sorbed to soil particles and suspended as windblown dust.

This is a theoretically complete pathway, but is not likely to result in significant exposure. Saturated conditions over much of DU-02 make this pathway incomplete for this DU. Windblown dust, while a viable mode of transport, is not likely to be significant because of the presence of vegetation over much of the MRS. In addition, if particulate matter containing contaminants becomes airborne, it would be dispersed over a wide area and would not accumulate in significant concentrations at any single location.

- Movement of soluble contaminants with groundwater and discharge of groundwater into a surface water body.

This is an incomplete migration pathway.

Based on the exposed/shallow granitic bedrock at the MRS and low mobility of the potential MC, transport of MC to groundwater and subsequently surface water is highly unlikely.

2.4 ECOTOXICITY OF LEAD

Following comparison to conservative federal screening levels, the only COC selected for consideration in the SLERA is lead.

Lead is one of the most ubiquitous pollutants in the developed areas of the world. Lead is nonvolatile, with solubility depending on pH and other factors. It is strongly sorbed to sediments at a rate correlated to grain size and organic content, and tends to combine with a variety of complexing species. Lead uptake in wildlife depends on exposure time, aqueous concentration, pH, temperature, salinity, and diet. When released to soil, lead is normally converted from soluble lead compounds to relatively insoluble sulfate or phosphate derivatives (USEPA, 2005a).

In terrestrial wildlife, lead exposure may cause birth abnormalities and premature death. For aquatic organisms, all life stages are sensitive to the toxic effects of lead, particularly embryos. Gill, liver, kidney, and erythrocytes accumulate lead from aqueous sources in proportion to the time and concentration of exposure (Sample, et al., 1996).

2.4.1 NOAELs and LOAELs

A variety of No Observed Adverse Effects Level (NOAEL) and Lowest Observed Adverse Effects Level (LOAEL) values for lead for terrestrial and wetland receptors from different sources were evaluated for use in this SLERA. Values selected are reported by the Los Alamos National Laboratory (LANL) as described below.

The selected NOAEL and LOAEL for terrestrial invertebrates are 1,700 milligrams per kilogram (mg/kg) and 8,400 mg/kg, respectively. Both values were reported by the LANL, the NOAEL is the EcoSSL (USEPA, 2005a); the LOAEL was developed by LANL based on EcoSSL data.

The selected NOAEL and LOAEL for benthic invertebrates are 35.8 mg/kg and 128 mg/kg, respectively. The NOAEL is the consensus-based Threshold Effect Level based on studies by MacDonald et al, (2000) as reported by LANL. The LOAEL was the consensus-based Probable Effect Level based on the same source document.

The selected NOAEL and LOAEL toxicity reference values (TRVs) for mammalian receptors are 4.70 mg/kg of body weight per day (BW/day) and 8.90 mg/kg BW/day, respectively. The NOAEL is the TRV used for developing the Eco SSL for mammals (USEPA, 2005a), and is based on a study by Kimmel et. al. (1980) which involved exposing rats to lead acetate and monitoring changes to reproduction and growth (as reported by LANL). The LOAEL TRV was derived from the same study.

The selected NOAEL and LOAEL TRVs for avian receptors are 1.63 mg/kg BW/day and 3.26 mg/kg BW/day, respectively. The NOAEL is based on the TRV used to derive the EcoSSL for avian receptors (USEPA, 2005a) based on a study by Edens and Garlich (1983) which involved exposing chicken hens to lead acetate and monitoring changes to reproduction (as reported by LANL). The LOAEL TRV was derived from the same study.

Table 2-7 presents the selected values:

Table 2-7: NOAEL and LOAEL Values

Receptor	NOAEL/LOAEL	Value [a]
Terrestrial Invertebrate	NOAEL	1700 mg/kg [b]
	LOAEL	8400 mg/kg
Benthic Invertebrate	NOAEL	35.8 mg/kg [c]
	LOAEL	128 mg/kg [c]
Mammalian	NOAEL	4.70 mg/kg BW/day [d]
	LOAEL	8.90 mg/kg BW/day [d]
Avian	NOAEL	1.63 mg/kg BW/day [e]
	LOAEL	3.26 mg/kg BW/day [e]

Source: [a] All values developed and/or reported by the Los Alamos National Laboratory Ecological Screening Levels (R3.3; October 2015); source references include the following:
[b] USEPA Eco SSL for lead; [c] MacDonald et al, 2000; [d] Kimmel et al, 1980; [e] Edens and Garlich, 1983.

2.5 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) considers the attributes of the habitat in the MRS area along with the characteristics of the MRS to identify ecological receptors, exposure pathways, and assessment endpoints. **Figure 2-2** presents the graphical CSM for the MRS.

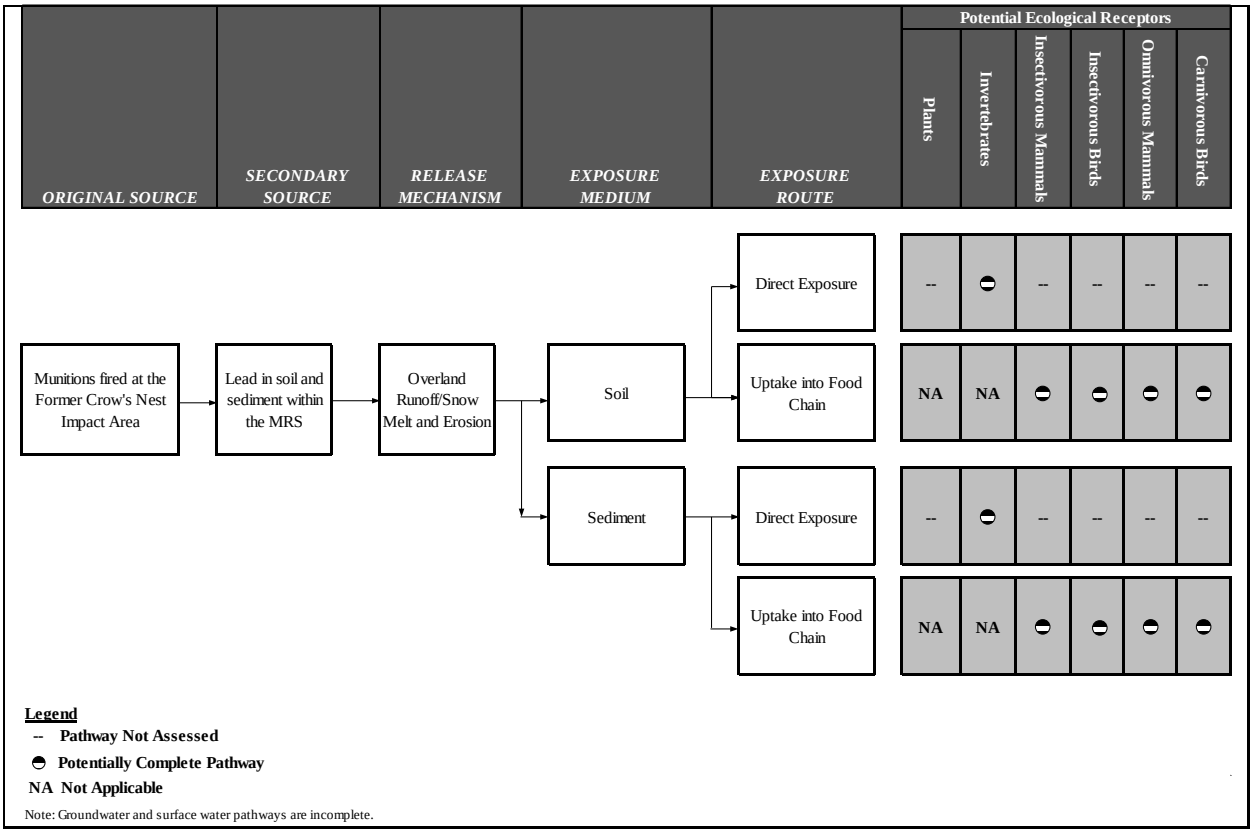

Figure 2-2: Crow's Nest MRS Remedial Investigation Preliminary Ecological CSM

2.5.1 Potential Receptors

The Crow's Nest MRS contains favorable habitat for a variety of terrestrial ecological receptors because of the variety of vegetative cover types and limited human activity. The quality of the habitat is enhanced because it is contiguous to other large tracts of undeveloped land, which allows the potential for wildlife migration over an extended area. Currently, the MRS is covered by mature hardwood forest with successional hardwoods surrounding the summit following previous fire disturbance.

A varied invertebrate community is present, which is important for nutrient cycling and as a source of food (and potentially contaminants) for upper trophic-level organisms. Mammals are also present across the less mountainous, forested habitat of the MRS. Small mammals that feed on plants and invertebrates are present, and larger omnivorous mammals, such as Red Fox and black bear, also inhabit this area. During field activities at the site, numerous mammals, including squirrels, deer, and black bear were observed. Bird species typical of the terrestrial habitat present in the area include insectivorous birds, which feed on invertebrates, as well as larger carnivorous birds, which feed on small mammals. Bird species most frequently observed at the site during field activities included turkeys and hawks.

Terrestrial plants are potential receptors exposed to COCs at the MRS, but it is unlikely that the adverse effects to plant communities would be significant. During RI field activities, no signs of contaminant-stressed vegetation were observed. Although the plant communities present at the site contribute to favorable habitat for animals, no unique or sensitive plant communities have

been identified within DU-01 or DU-02. Potential adverse effects to plants were not evaluated quantitatively in the SLERA.

The following indicator species were used in the SLERA:

- Terrestrial invertebrates – DU-01
- Benthic Invertebrates – DU-02
- Small insectivorous mammals – Short-Tailed Shrew (*Blarina brevicauda*) – DU-01 and DU-02
- Omnivorous mammals – Red Fox (*Vulpes vulpes*) – DU-01 and DU-02
- Insectivorous birds – American Robin (*Turdus migratorius*) – DU-01
- Insectivorous birds – Marsh Wren (*Cistothorus palustris*) – DU-2
- Carnivorous birds – Red-Tailed Hawk (*Buteo jamaicensis*) – DU-01 and DU-02

Benthic invertebrates were selected as the indicator species for invertebrates at DU-02 because this area is a wetland while terrestrial invertebrates were the selected invertebrate indicator species for DU-01. In addition, the Marsh Wren was selected as an indicator species for insectivorous birds at DU-02 as it may be more prevalent in the wetland environment. The American Robin was selected as an indicator species for insectivorous birds at DU-01. The Short-Tailed Shrew, Red Fox and Red-Tailed Hawk were considered to be appropriate indicator species for both DU-01 and DU-02.

The MRS contains confirmed habitat for the Timber Rattlesnake (*Crotalus horridus*), whose status is designated as threatened by the New York State Department of Environmental Conservation (NYDEC). Due to the infrequency of the rattlesnake's ingestion of prey, the resulting dose of lead is unlikely to be significant. Furthermore, exposure and toxicity data for reptiles is limited and does not currently exist for rattlesnakes based on a search of current literature. As such, risk was not calculated for this species.

2.5.2 Complete Exposure Pathways

Based on the physical characteristics of the DUs and surrounding areas, the COCs present at the site, and the ecological receptors likely to be present in habitats at and near the site, the following potential exposure pathways have been identified:

- Direct exposure to surface soil and/or sediment (invertebrate);
- Ingestion of soil (insectivorous mammal or bird, omnivorous mammal); and
- Ingestion of food items (insectivorous mammal or bird, omnivorous mammal, carnivorous bird)

Surface soil and sediment were used for the SLERA because most biological activity occurs within this shallow stratum.

2.6 ASSESSMENT AND MEASUREMENT ENDPOINTS

For the SLERA, assessment endpoints are any adverse effects to ecological receptors, where receptors are animal populations and communities, habitats, and sensitive environments. Adverse effects on populations can be inferred from measures related to impaired reproduction, growth, and survival. Adverse effects on communities can be inferred from changes in community structure or function. Adverse effects on habitats can be inferred from changes in composition and characteristics that reduce the habitats' ability to support animal populations and communities. The ecological assessment and measurement endpoints for the Crow's Nest MRS are provided in **Table 2-8**.

Table 2-8: Assessment and Measurement Endpoints

Assessment Goal	Assessment Endpoint	Testable Hypothesis (H_o)	Measurement Endpoint
Protection of terrestrial ecosystem structure and function.	**Assessment Endpoint No. 1:** Viability and function of soil invertebrate communities. Soil invertebrates are important for nutrient cycling and provide a food source for higher-level consumers.	Levels of site contaminants in soil are insufficiently available for biological uptake by terrestrial invertebrates or are available at levels which would not cause adverse effects on the long-term health of terrestrial invertebrates.	Concentrations in soil are compared to NOAELs and LOAELs through the calculation of a HQ.
Protection of wetland ecosystem structure and function.	**Assessment Endpoint No. 1:** Viability and function of sediment invertebrate communities. Sediment invertebrates are important for nutrient cycling and provide a food source for higher-level consumers.	Levels of site contaminants in sediment are insufficiently available for biological uptake by benthic invertebrates in wetland areas or are available at levels which would not cause adverse effects on the long-term health of benthic invertebrates.	Concentrations in sediment are compared to NOAELs and LOAELs through the calculation of a HQ. Bioavailability of contaminants in sediment is evaluated through AVS:SEM analysis.
Protection of terrestrial and wetland ecosystem structure and function.	**Assessment Endpoint No. 2:** Viability and function of small insectivorous mammal communities. Small insectivorous mammals feed on soil and sediment invertebrates and plant matter and provide a food source for higher-level consumers.	Levels of site contaminants in prey and forage are insufficient to cause adverse effects on the long-term health and reproductive capacity of small insectivorous mammals [Short-Tailed Shrew *(Blarina brevicauda)*] that utilize the site and surrounding areas	A food chain model is used to evaluate risk to small insectivorous mammals that utilize the site. The proposed endpoint receptor species is the Short-Tailed Shrew (*Blarina brevicauda*). The shrew has a high metabolic rate and a high food ingestion rate relative to body weight. Invertebrates and plant material were identified as the primary food source for the shrew. A dietary dose was calculated on the basis of ingestion of soil/sediment, invertebrates and forage. The concentration of COCs in food items was based on BAFs. The resulting total daily dose was compared to existing toxicity data (e.g., NOAELs and LOAELs) through the calculation of a HQ.

Assessment Goal	Assessment Endpoint	Testable Hypothesis (H_o)	Measurement Endpoint
Protection of terrestrial ecosystem structure and function	**Assessment Endpoint No. 3:** Viability and function of small insectivorous bird communities. Small insectivorous birds feed on soil invertebrates and plant matter.	Levels of site contaminants in prey and forage are insufficient to cause adverse effects on the long-term health and reproductive capacity of insectivorous birds [American Robin (Turdus migratorius)] that utilize the site and surrounding areas.	A food chain model is used to evaluate risk to insectivorous birds that utilize the site as a food source. The endpoint receptor species is the American Robin (Turdus migratorius). Invertebrates and terrestrial plants were identified as the primary food source for the robin. A dietary dose was calculated on the basis of ingestion of soil, invertebrates and plants. The concentration of COCs in food items was based on BAFs. The resulting total daily dose was compared to existing toxicity data (e.g., NOAEL and LOAELs) through the calculation of a HQ.
Protection of wetland ecosystem structure and function	**Assessment Endpoint No. 3:** Viability and function of small insectivorous bird communities. Small insectivorous birds feed on sediment invertebrates and plant matter.	Levels of site contaminants in prey and forage are insufficient to cause adverse effects on the long-term health and reproductive capacity of insectivorous birds [marsh wren (Cistothorus palustris)] that utilize the site and surrounding areas.	A food chain model is used to evaluate risk to insectivorous birds that utilize the site as a food source. The endpoint receptor species is the marsh wren (Cistothorus palustris). Invertebrates and terrestrial plants were identified as the primary food source for the marsh wren. A dietary dose was calculated on the basis of ingestion of sediment, invertebrates and plants. The concentration of COCs in food items was based on BAFs. The resulting total daily dose was compared to existing toxicity data (e.g., NOAEL and LOAELs) through the calculation of a HQ.
Protection of terrestrial and wetland ecosystem structure and function	**Assessment Endpoint No. 4:** Viability and function of omnivorous mammal communities. Omnivorous mammals feed on soil and sediment invertebrates, plant matter and small mammals.	Levels of site contaminants in prey and forage are insufficient to cause adverse effects on the long-term health and reproductive capacity of omnivorous mammals [Red Fox *(Vulpes vulpes)*] that utilize the site and surrounding areas.	A food chain model is used to evaluate risk to omnivorous mammals that utilize the site. The proposed endpoint receptor species is the Red Fox (Vulpes vulpes). Small mammals, plant material and invertebrates were identified as the primary food source for the fox. A dietary dose was calculated on the basis of ingestion of soil/sediment, mammals, invertebrates and forage. The concentration of COCs in food items was based on BAFs. The resulting total daily dose was compared to existing toxicity data (e.g., NOAELs and LOAELs) through the calculation of a HQ.

Assessment Goal	Assessment Endpoint	Testable Hypothesis (H_o)	Measurement Endpoint
Protection of terrestrial and wetland ecosystem structure and function. (continued)	**Assessment Endpoint No. 5:** Viability and function of carnivorous bird communities. Carnivorous birds feed on small mammals.	Levels of site contaminants in prey are insufficient to cause adverse effects on the long-term health and reproductive capacity of carnivorous birds [Red-Tailed Hawk *(Buteo jamaicensis)*] that utilize the site and surrounding areas.	A food chain model is used to evaluate risk to carnivorous birds that utilize the site. The proposed endpoint receptor species is the Red-Tailed Hawk (*Buteo jamaicensis*). Small mammals were identified as the primary food source for the hawk. A dietary dose was calculated on the basis of ingestion of mammals. The concentration of COCs in food items was based on BAFs. The resulting total daily dose was compared to existing toxicity data (e.g., NOAELs and LOAELs) through the calculation of a HQ.

SECTION THREE: EXPOSURE ESTIMATE AND RISK CALCULATION

This section describes estimation of exposure levels and quantification of ecological risks.

3.1 EXPOSURE ESTIMATES

To estimate exposures for the ecological risk calculation, complete exposure pathways were evaluated. For these, the MDC or calculated mean onsite contaminant concentration for each environmental medium was used to estimate exposures for both screening and refined screening level assessments. DU-01 is estimated to be approximately 147 acres and DU-02 estimated to be approximately 1.3 acres. Data from samples collected from the ground/sediment surface to a depth of 6 inches were used since the upper surface soil is the horizon with which foraging birds and mammals have the most contact and where the most invertebrate biotic activity occurs.

For benthic invertebrates in DU-02, the bioavailability of metals in sediment was also evaluated using SEM, AVS, and TOC analysis.

3.1.1 Risk Calculation: Invertebrate, Insectivorous Mammal, Insectivorous Birds, Omnivorous Mammals, and Carnivorous Birds

A quantitative risk was estimated using exposure estimates and ecotoxicity values. For the risk calculation, the hazard quotient approach, which compares point estimates of ecotoxicity values and exposure values, was used to estimate risk. The hazard quotient is expressed as the ratio of a potential exposure level to the NOAEL or LOAEL.

$$HQ = \frac{\text{Dose}}{\text{NOAEL or LOAEL}} \quad \text{or} \quad HQ = \frac{\text{EEC}}{\text{NOAEL or LOAEL}} \qquad (1)$$

Where:

HQ	=	Hazard Quotient
Dose	=	estimated contaminant intake at the site (e.g., mg contaminant/kg body weight per day)
EEC	=	estimated environmental concentration at the site (e.g., mg contaminant/kg soil or sediment)
NOAEL	=	No Observed Adverse Effects Level (in units that match the dose or EEC)
LOAEL	=	Lowest Observed Adverse Effects Level (in units that match the dose or EEC)

For invertebrates, the HQ is calculated as the EEC for soil or sediment (mg/kg) divided by the NOAEL or LOAEL, also in units of mg/kg.

For the shrew, robin, and marsh wren, a food chain model is used to calculate the dose of contaminant. This dose (mg contaminant/kg BW per day) is divided by a NOAEL or LOAEL, derived from laboratory studies and expressed in similar units, to obtain the HQ. The food chain model used in this SLERA to calculate the dose for the shrew, robin, and wren uses the formula below:

$$Dose = \frac{(((C_s \times FI \times F_s)+(C_{ti} \times FI \times F_{ti})+(C_p \times FI \times F_p)) \times GI_{abs}) \times AUF}{BW} \quad (2)$$

Where:

C_{ti}	=	concentration of COC in invertebrates (mg/kg dry weight [dw])
FI	=	food ingestion rate (kg/day) adjusted from wet weight basis to dry weight basis (**Attachment B, Table B-1**)
F_{ti}	=	dietary fraction of invertebrates (unitless)
C_p	=	concentration of COC in plant material (mg/kg dw)
F_p	=	dietary fraction of plant material (unitless)
C_s	=	concentration of COC in soil/sediment (mg/kg dw)
F_s	=	dietary fraction of soil/sediment (unitless)
GI	=	gastrointestinal absorption factor (unitless)
AUF	=	area use factor (unitless)
BW	=	body weight (kg)

And,

$$C_{ti/p} = C_{soil/sediment} \times BAF_{ti/p} \quad (3)$$

Where:

$BAF_{ti/p}$	=	bioaccumulation factor for invertebrates or plants (unitless). BAF calculation for each receptor shown in **Attachment B, Table B-2**.

The food chain model used to calculate the dose for both the Red Fox and Red-Tailed Hawk uses the following formula:

$$Dose = \frac{(((C_s \times FI \times F_s)+(C_{ti} \times FI \times F_{ti})+(C_p \times FI \times F_p)+(C_m \times FI \times F_m)) \times GI_{abs}) \times AUF}{BW} \quad (4)$$

Where (in addition to the above):

C_m	=	concentration of COC in mammals (mg/kg dw)
F_m	=	dietary fraction of mammals (unitless)

And,

$$C_m = C_{soil/sediment} \times BAF_m \quad (5)$$

Where:

BAF_m	=	bioaccumulation factor for mammals (unitless). BAF calculation for mammals shown in **Attachment B, Table B-2**.

An HQ less than 1 (unity) indicates that the contaminant alone is unlikely to cause adverse ecological effects. An HQ of greater than 1 indicates the potential for an adverse effect due to exposure to the contaminant in excess of the acceptable level. An HQ less than (or greater than) 1 does not indicate the absence (or presence) of ecological risk; rather, it should be interpreted based on the severity of the effect reported and the magnitude of the calculated quotient. As certainty in the exposure concentrations and the NOAEL or LOAEL increases, there is greater confidence in the predictive value of the HQ model.

The screening level risk calculation is a very conservative estimate to ensure that potential ecological threats are not overlooked. The calculation can be used to document a decision about whether or not there is a negligible potential for ecological impacts, based on the information available at this stage. If the potential for ecological impacts exists, this calculation can be used to eliminate the negligible-risk combinations of contaminants and exposure pathways from further consideration.

The refined screening is a less conservative estimate which provides insight regarding the likely results of a Baseline Ecological Risk Assessment. For this assessment, the refined screening provides HQ values using both the NOAEL and LOAEL values. Use of both of these criteria provides a range of HQ values for use by decision-makers.

3.1.2 Exposure Parameters: Food Chain Modeling

For parameters needed to estimate exposures for which detailed site-specific information is lacking, assumptions were made or values were developed using information obtained from the literature, general site characteristics, or similar sources.

Parameters used in the food chain model included in the SLERA are listed below:

- Area-use factor (AUF) – The entire home range of the receptor is assumed to be within each DU.
- Bioavailability – Assumed to be 100 percent
- Body weight – Minimum value from literature
- Food ingestion rate – Maximum value from literature
- Soil/sediment ingestion rate – Value from literature
- Bioaccumulation factor (BAF) for invertebrates – This was calculated for the maximum lead concentration in DU-01 using the uptake equation developed by Sample et al, 1999.
- BAF for benthic invertebrates – This was calculated for the maximum lead concentration in DU-02 using the uptake equation developed by Bechtel Jacobs Company LLC, 1998a.
- BAF for plants - This was calculated for the maximum lead concentration in each DU using the uptake equation developed by Bechtel Jacobs Company LLC, 1998b.
- BAF for mammals – This was calculated for the maximum lead concentration in each DU using the uptake equation developed by Sample et al, 1998.
- Dietary components – The diets for all receptors were conservatively assumed to be comprised of 100% of the food item with the highest concentration of contaminant.

The parameters used in the Refined SLERA food chain model were adjusted to provide a less-conservative estimate of potential hazard and are as follows:

- AUF– The entire home range of the receptor is assumed to be within each DU unless that home range is larger than the DU area. In such cases, the AUF is calculated as the DU area divided by the home range area.
- Bioavailability – Assumed to be 60 percent as reported in USEPA, 2009.
- Body weight – Average value from literature
- Food ingestion rate – Average value from literature
- Soil/sediment ingestion rate – Value from literature
- BAF for invertebrates – This was calculated for the arithmetic mean lead concentration in DU-01 using the uptake equation developed by Sample et al, 1999.
- BAF for benthic invertebrates – This was calculated for the arithmetic mean lead concentration in DU-02 using the uptake equation developed by Bechtel Jacobs Company LLC, 1998a.
- BAF for plants - This was calculated for the arithmetic mean lead concentration in each DU using the uptake equation developed by Bechtel Jacobs, 1998b.
- BAF for mammals – This was calculated for the arithmetic mean lead concentration in each DU using the uptake equation developed by Sample et al, 1998.
- Dietary components – The diet for each receptor were based on average values reported in literature.

Input parameters used for food chain modeling are provided in **Attachment B, Table B-3**.

3.1.3 Assessment of Metals Bioavailability in Sediment

The bioavailability of some cationic metals in most anoxic sediments can be predicted by measuring the 1:1 relationship (in micromoles [µmol]) between AVS and SEM (total SEM = sum of cadmium, copper, lead, nickel, mercury, and zinc). The resulting ratio of ∑SEM/AVS is useful for predicting metals bioavailability and toxicity (or lack thereof) to benthic organisms in sediments (Interstate Technology & Regulatory Council, 2011). Ratios less than 1 indicate low potential for metals bioavailability; while ratios above 1 indicate greater potential for metals bioavailability.

Furthermore, organic carbon in sediment can also bind free metals and reduce their availability to aquatic organisms. When ∑SEM-AVS is normalized to the fraction of organic carbon (f_{oc}) in sediment, the resulting ratio is an indication of the potential for metals in sediment to be toxic to benthic invertebrates. Sediment samples are predicted to be non-toxic with ratio values less than or equal to 130 µmol/g (gram) organic carbon. The prediction of toxicity is uncertain with ratio values between 130 and 3,000 µmol/g, and ratio values greater than 3,000 µmol/g are predicted to be toxic (USEPA, 2005b).

3.2 ECOLOGICAL RISK ASSESSMENT RESULTS

Both DU-01 and DU-02 are attractive habitat for insects, birds and mammals and are enhanced by the presence of large, contiguous areas of undeveloped land. The MRS does not contain any threatened or endangered receptor species or areas of sensitive or unique habitat. Results of the SLERA and refined SLERA are summarized in **Table 3-2** (located at the end of this section). Detailed tables for each assessment endpoint are provided in **Attachment B, Tables B-4 through B-23**.

3.2.1 Assessment Endpoint No. 1 (Terrestrial/Benthic Invertebrates)

Assessment endpoint Number 1 is stated as "Viability and function of soil and benthic invertebrate communities. Soil and benthic invertebrates are important for nutrient cycling and provide a food source for higher-level consumers."

DU-01

The SLERA HQ value for DU-01 is 1.3 (**Table B-4**). These SLERA results indicate the potential for adverse effects to terrestrial invertebrates, however, the magnitude indicates that these effects are may be of limited severity.

For the refined SLERA, the maximum detected concentration was replaced by the mean concentration and less conservative input parameters were used. This concentration was then divided by both the NOAEL and LOAEL. The refined SLERA NOAEL HQ is 0.41 and the refined LOAEL HQ is 0.082 for the invertebrate (**Table B-14**).

Consideration of mean concentration and NOAEL and LOAEL toxicity endpoints indicate that there is limited potential for adverse effects to terrestrial invertebrates in the DU-01.

DU-02

The SLERA HQ value for DU-02 is 124.9 (**Table B-9**). These SLERA results indicate the potential for adverse effects to benthic invertebrates.

The refined SLERA NOAEL HQ is 95.9 and the refined LOAEL HQ is 26.8 for the benthic invertebrate (**Table B-19**).

Consideration of mean concentration and NOAEL and LOAEL toxicity criteria indicate the potential for adverse effects to benthic invertebrates in DU-02.

However, sediment within DU-02 was also analyzed for SEM, AVS, and TOC to assess the bioavailability of metals in sediment. All of the ∑SEM/AVS ratios for DU-02 are above 1.0 (**Table 3-1**), indicating that the potential exists for metal toxicity, because sufficient AVS is not present to completely form insoluble metal sulfides.

When ∑SEM-AVS is normalized to the f_{oc} for DU-02, ratios are below 130 (**Table 3-1**). This indicates a low potential for metal toxicity to benthic invertebrates.

Table 3-1: DU-02 SEM, AVS, and TOC Analysis

Sample ID:	WPIS02SA01				WPIS02SA02				WPIS02SA03			
	Result	LQ	VQ	RC	Result	LQ	VQ	RC	Result	LQ	VQ	RC
SEM (umole/g)												
Cadmium	0.0128	J			0.0118	J			0.0116	J		
Copper	1.84	N*	J	m	0.83		J	m	0.647		J	M
Lead	3.66	N*E	J	q	3.79		J	s	5.04		J	S
Nickel	0.118	N	J	m	0.0918		J	m	0.113		J	M
Mercury	0.00008	UN	R	m	0.00007	U	R	m	0.00003	J	J	M
Zinc	2.84				2.71				2.52			
[1]Σ SEM	8.47				7.43				8.33			
AVS (umole/g)												
Acid Volatile Sulfide	1.7				0.42	J			0.65	J		
[1]Σ SEM / AVS	5.0				18				13			
TOC												
TOC (ug/g dry wt)	470000				580000				540000			
f_{OC} (g/g dry wt)	0.47				0.58				0.54			
([1]Σ SEM - AVS) / (f_{oc})	14				12				14			

Laboratory Qualifiers Used

J	Estimated Value
E	Concentration Exceeded the Linear Range
N	Tenatively Identified Compound; presumptive evidence of a compound based on mass spectral library search.
U	Analyte not detected
*	Relative percent difference was outside of quality control limits

Multiple flags of the same value indicates a repeat of the same anomaly

Data Validation Flags Used

J	Analyte present. Reported value may not be accurate or precise
R	The sample results are rejected and the data point is unusable

Reason Codes Used

m	MS/MSD Percent Recovery Anomaly
q	Concentration Exceeded the Linear Range
s	Surrogate Percent Recovery Anomaly

Notes:

1	When the laboratory reported a non-detect value for an SEM metal or AVS, the LOD concentration was used, including where rejected, as a conservative estimate
f_{OC}	Fraction of organic carbon

3.2.2 Assessment Endpoint No. 2 (Small Insectivorous Mammal – Short-Tailed Shrew)

Assessment endpoint Number 2 is stated as "Viability and function of small insectivorous mammal communities. Small insectivorous mammals feed on soil and sediment invertebrates and plant matter and provide a food source for higher-level consumers."

DU-01

The SLERA HQ value for the DU-01 is 29 (**Table B-5**). These SLERA results indicate the potential for adverse effects to small insectivorous mammals.

The refined SLERA NOAEL HQ is 4.8 and the refined LOAEL HQ is 2.5 for small insectivorous mammals (**Table B-15**).

Consideration of refined exposure parameters, mean concentration, and NOAEL and LOAEL toxicity criteria indicate the potential for adverse effects to small insectivorous mammals in DU-01 but the magnitude of the LOAEL HQ (2.5) indicates that these effects are may be of limited severity.

DU-02

The SLERA HQ value for DU-02 is 29.3 (**Table B-10**). These SLERA results indicate the potential for adverse effects to small insectivorous mammals.

The refined SLERA NOAEL HQ is 11.3 and the refined LOAEL HQ is 6.0 for small insectivorous mammals (**Table B-20**).

Consideration of refined exposure parameters, mean concentration, and LOAEL toxicity criteria indicate the potential for adverse effects to small insectivorous mammals in DU-02.

3.2.3 Assessment Endpoint No. 3 (Insectivorous Bird – American Robin)

Assessment endpoint Number 3 is stated as "Viability and function of small insectivorous bird communities. Small insectivorous birds feed on soil and sediment invertebrates and plant matter."

DU-01

The SLERA HQ value for DU-01 is 188.2 (**Table B-6**). These SLERA results indicate the potential for adverse effects to insectivorous birds.

The refined SLERA NOAEL HQ is 15.5 and the refined LOAEL HQ is 7.8 for insectivorous birds (**Table B-16**).

Consideration of refined exposure parameters, mean concentration, and LOAEL toxicity criteria indicate the potential for adverse effects to small insectivorous birds in DU-01.

3.2.4 Assessment Endpoint No. 3 (Insectivorous Bird – Marsh Wren)

Assessment endpoint Number 3 is stated as "Viability and function of small insectivorous bird communities. Small insectivorous birds feed on soil and sediment invertebrates and plant matter."

DU-02

The SLERA HQ value for DU-02 is 97.2 (**Table B-11**). These SLERA results indicate the potential for adverse effects to insectivorous birds.

The refined SLERA NOAEL HQ is 34.7 and the refined LOAEL HQ is 17.3 for insectivorous birds in DU-02 (**Table B-21**).

Consideration of refined exposure parameters, mean concentration, and NOAEL and LOAEL toxicity criteria indicate the potential for adverse effects to insectivorous birds in DU-02.

3.2.5 Assessment Endpoint No. 4 (Omnivorous Mammal – Red Fox)

Assessment endpoint Number 4 is stated as "Viability and function of omnivorous mammal communities. Omnivorous mammals feed on soil and sediment invertebrates, plant matter and small mammals."

DU-01

The SLERA HQ value for the DU-01 is 2.8 (**Table B-7**). These SLERA results indicate the potential for adverse effects to omnivorous mammals, however, the magnitude indicates that these effects are may be of limited severity.

The refined SLERA NOAEL HQ is 0.007 and the refined LOAEL HQ is 0.0037 for omnivorous mammals (**Table B-17**).

Consideration of mean concentration and NOAEL and LOAEL toxicity criteria indicate that there is low potential for lead in DU-01 soil to cause adverse effects to omnivorous mammals.

DU-02

The SLERA HQ value for DU-02 is 1.2 (**Table B-12**). These SLERA results indicate that lead levels in DU-02 sediment could cause adverse effects to omnivorous mammals but that such effects would be limited.

The refined SLERA NOAEL HQ is 0.00021 and the refined LOAEL HQ is 0.00011 for omnivorous mammals (**Table B-22**).

Consideration of mean concentration and NOAEL and LOAEL toxicity criteria confirm that lead levels in DU-02 sediment would not cause adverse effects to omnivorous mammals.

3.2.6 Assessment Endpoint No. 5 (Carnivorous Bird – Red-Tailed Hawk)

Assessment endpoint Number 5 is stated as "Viability and function of carnivorous bird communities. Carnivorous birds feed on small mammals."

DU-01

The SLERA HQ value for the DU-01 is 0.77 (**Table B-8**). These SLERA results indicate that lead concentrations in DU-01 soil would not cause adverse effects to carnivorous birds.

The refined SLERA NOAEL HQ is 0.014 and the refined LOAEL HQ is 0.007 for carnivorous birds (**Table B-18**).

Consideration of refined exposure parameters, mean concentration, and NOAEL and LOAEL toxicity criteria confirms that lead concentrations in DU-01 soil would not cause adverse effects to carnivorous birds.

DU-02

The SLERA HQ value for DU-02 is 1.0 (**Table B-13**). These SLERA results indicate the potential for adverse effects to carnivorous birds in DU-01 but the magnitude (1.0) indicates that these effects would be minimal.

The refined SLERA NOAEL HQ is 0.0003 and the refined LOAEL HQ is 0.0001 for carnivorous birds (**Table B-23**).

Consideration of refined exposure parameters, mean concentration, and NOAEL and LOAEL toxicity criteria confirms that lead concentrations in DU-02 sediment would not cause adverse effects to carnivorous birds.

Table 3-2: Ecological Risk Assessment Results

Assessment Endpoint	Receptor	Decision Unit	Screening Level HQ	Refined Screening Level HQ	
			NOAEL	NOAEL	LOAEL
1. Terrestrial and/or Benthic Invertebrates	Soil Invertebrates	DU-01 (surface soil)	**1.3**	0.41	0.082
	Benthic Invertebrates	DU-02 (sediment)	**124.9***	**95.9***	**26.8***
2. Small Insectivorous Mammal	Short-Tailed Shrew	DU-01 (surface soil)	**29**	**4.8**	**2.5**
		DU-02 (sediment)	**29.3**	**11.3**	**6.0**
3. Insectivorous Birds	American Robin	DU-01 (surface soil)	**188.2**	**15.5**	**7.8**
	Marsh Wren	DU-02 (sediment)	**97.2**	**34.7**	**17.3**
4. Omnivorous Mammals	Red Fox	DU-01 (surface soil)	**2.8**	0.007	0.0037
		DU-02 (sediment)	**1.2**	0.00021	0.00011
5. Carnivorous Bird	Red-Tailed Hawk	DU-01 (surface soil)	0.77	0.014	0.007
		DU-02 (sediment)	**1.0**	0.0003	0.0001

HQ = Hazard Quotient; NOAEL = No Observable Adverse Effect Level; DU = Decision Unit
BOLD values indicate a HQ above 1
* bioavailability evaluation (∑SEM-AVS normalized to the f_{oc}) indicates a low potential for metal toxicity to benthic invertebrates

3.3 UNCERTAINTY ANALYSIS

Results of the SLERA are influenced somewhat by variability and uncertainty, which need to be considered when interpreting results. Major sources of uncertainty include natural variability and incomplete knowledge of site-specific biological processes and fate and transport mechanisms. Uncertainties, which may affect the results of the SLERA, are briefly described below.

3.3.1 Complexity of Natural Systems

Natural systems, such as the various habitat types within the Crow's Nest MRS, are extremely complex and involve the interaction of myriad physical, chemical, and biological systems. Physical movement of soil and particulates within storm water and/or snow melt runoff within the study area is influenced by natural events such as weather. Chemical interactions may

include the partitioning of chemicals between soil, water, air, and biological components, and are driven by a variety of chemical processes, such as transformation, degradation, hydrolysis, and photolysis. Biological systems involve complex food webs, including many different species. The ecological risk assessment attempts to model these interactions to the extent possible and requires many significant simplifying assumptions. Direct measurements of chemical concentrations were used along with observations made at the site and information from current scientific literature to model the interactions occurring in natural systems. The assumptions made and models used, and how well or poorly these assumptions and models reproduce the interactions taking place in the natural system, introduce uncertainty in the SLERA.

3.3.2 Data Completeness

An important contributor to uncertainty is the completeness of the data or information upon which the risk assessment is based. Risk calculations were based on both maximum and mean COC levels in media. Although the site investigation included a relatively large number of ISM samples, using more sample points would lead to higher confidence in the development of a single point concentration to which receptors are likely to be exposed. The direction and magnitude of this uncertainty are not measurable.

3.3.3 Dermal Absorption and Inhalation

Contaminant uptakes via dermal absorption and inhalation were not considered when calculating the dose for the shrew, robin, wren, fox, and hawk. Although it is believed that the contribution of these exposure routes to the calculated dose would be negligible, not quantifying exposure via these routes could cause the calculated risk to be lower than the actual risk.

3.3.4 Toxicity Data from Laboratory Studies Using Different Species

NOAELs and LOAELs used for the SLERA were calculated based on data obtained primarily from laboratory studies using test species different from the measurement endpoint species for the MRS. For the shrew and Red Fox, NOAELs and LOAELs were from laboratory studies using rats. For the robin and Red-Tailed Hawk, NOAELs and LOAELs were based on laboratory studies using chicken hens. The size and metabolism of the test species are different from those of the modeled species. This causes uncertainty for the resulting HQ values. It is not known whether use of these test species increased or decreased the estimated risk to ecological receptors.

3.3.5 Single Chemical Laboratory Studies

Uncertainty is introduced by the use of results from laboratory studies that use a single chemical under highly controlled conditions. These studies do not consider the potential synergistic or antagonistic effects of multiple chemicals or the effect of myriad other environmental factors.

3.3.6 Population Level Effects

Related to the use of single-species, single-contaminant laboratory studies is the issue of determining ecological effects at the population level. The risk assessment used toxicological data that were collected on an individual basis, not on a population level. Therefore, the HQs represent potential risk to a single individual organism, not to a population or community. This

potential risk is extrapolated to include the entire population as a whole. The direction and magnitude of this uncertainty are not measurable.

3.3.7 Use of Exposure Parameters from Literature

Values from published studies were used as input parameters for food chain modeling. Examples include values for food ingestion rate, dietary composition, soil ingestion rate, and home range. The studies from which these values were derived may have been conducted at a different time of year, at a different location, and under different conditions from those that exist at the Crow's Nest MRS. These values may not accurately reflect the species at the site, and may underestimate or overestimate the risk of adverse effects to ecological receptors.

SECTION FOUR: SUMMARY

Use of the Former Crow's Nest Impact Area as an historical impact area has resulted in the deposition of lead over the central area of the Crow's Nest MRS. The SLERA identified lead as the primary COC at DU-01 and DU-02. The background evaluation eliminated DU-03 from further evaluation.

At the screening level, the results indicate that lead levels in DU-01 surface soil and DU-02 sediment may result in potential adverse effects to all assessment endpoints evaluated except for carnivorous birds in DU-01 and benthic invertebrates in DU-02.

For the refined screening level assessment, the results indicate that lead levels in DU-01 surface soil and DU-2 sediment may result in adverse effects to insectivorous mammals and birds. The relatively high concentration of total organic carbon found within DU-02 sediment has the ability to bind free metals and reduce their availability to benthic organisms.

The results of this SLERA indicate that, given the large size of DU-01 and colocation of DU-02, species that have a limited home range and could potentially spend all or most of their lives at the site, such as small mammals and insectivorous birds, have the greatest likelihood to be adversely affected by contaminants at the site.

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Attachment A
Threatened and Endangered Species Assessment

Threatened and Endangered Species Assessment

Several species that are federally listed as threatened or endangered are known to or have the potential to inhabit the Installation. Relevant federally and state listed species are presented in **Table A-1**. This targeted list was identified in consultation with the NYSDEC Natural Heritage Division and the United States Fish and Wildlife Service's (USFWS's) Information, Planning, and Conservation decision support system.

Table A-1: Potential Federal and State-Listed Species

Scientific Name	Common Name	Taxonomy	State Status	Federal Status
Myotis sodalis	Indiana bat	Mammal	E	E
Myotis septentrionalis	Northern long-eared bat	Mammal	NL	T
Haliaeetus leucocephalus	Bald eagle	Bird	T	NL
Clemmys muhlenbergii	Bog turtle	Reptile	E	T
Crotalus horridus	Timber rattlesnake	Reptile	T	NL
Acipenser brevirostrum	Shortnose sturgeon	Fish	E	E
Acipenser oxyrinchus	Atlantic sturgeon	Fish	NOS	E; New York Bight DPS
Alasmidonta heterodon	Dwarf wedge mussel	Mussel	E	E
Isotria medeoloides	Small whorled pogonia	Plant	NL	T
Carex cumulata	Clustered sedge	Plant	T	NL
Lycopus rubellus	Gypsy-wort	Plant	E	NL
Juncus debilis	Weak rush	Plant	E	NL
Carex retroflexa	Reflexed sedge	Plant	T	NL
Carex nigromarginata	Black-edge sedge	Plant	T	NL
Endodeca serpentaria	Virginia snakeroot	Plant	T	NL
Sisyrinchium mucronatum	Michaux's blue-eyed-grass	Plant	E	NL

Status: E=Endangered; T=Threatened, PE=Proposed Endangered, NOS=No Open Season, NL=Not Listed, DPS=Distinct Population Segment

The Indiana bat tends to congregate in large groups and typically inhabits caves. Previous studies at the Installation indicated that habitat for the Indiana bat does exist. However, previous surveying efforts for the Indiana bat did not yield any positive captures, suggesting that this species may only be utilizing the property as a temporary stopover location during migration (Tetra Tech, 2011).

During its hibernation period, the northern long-eared bat frequents caves and mines. In summer, this species behaves similar to the Indiana bat, choosing to roost underneath the bark or in cavities and crevices of tree species that provide suitable conditions. Previous studies at the Installation yielded positive captures for the northern long-eared bat; a 2008 capture study

recorded the northern long-eared bat as the second most frequently captured species (Tetra Tech, 2011).

The bald eagle inhabits woodland habitat near or directly adjacent to estuaries, large open water bodies, rivers, and some coastal areas; it prefers areas with adequate perching and nesting locations (USFWS, 2007). Correspondence from the New York State Department of Environmental Conservation (NYSDEC) indicates the MRS may contain nonbreeding individuals. This does not negate the potential for nesting pairs to be present in areas of the MRS close to the Hudson River.

The bog turtle is the smallest turtle species in the United States and is very selective in its habitat preferences. This species is typically associated with fens, springs, bogs, marshes, wetlands, and very slow moving bodies of water where the depth of water is shallow and overhead canopy cover allows sunlight penetration. Several studies have been performed at the Installation to determine whether the bog turtle is present; to date, no individuals have been located, leading to the assumption that bog turtles do not occur on the Installation (Tetra Tech, 2011).

Habitat used by the timber rattlesnake is typically deciduous forests in rugged terrain (NYSDEC, 2015). Denning locations are typically located on rocky hillsides where there are underground crevices deep enough to allow them to escape the frost line. Denning locations also tend to have sparse to no canopy cover and are often located on south-facing slopes for maximum sun exposure. Previous studies and information provided by NYSDEC indicate that this species occurs at the MRS and that denning locations exist. Additionally, the current INRMP states that the timber rattlesnake is the only State-listed animal species known to be a permanent resident at the Crow's Nest MRS (Tetra Tech, 2011).

The shortnose and Atlantic sturgeon are known to utilize the Hudson River to the east of the MRS. Due to the inland stationing of the MRS no impacts to this species are anticipated.

According to the USFWS official species list for this project site, the dwarf wedge mussel has the potential to occur within the MRS. However, occurrence of the dwarf wedge mussel in New York has only been documented in the Neversink River, a tributary to the Delaware River, approximately 50 miles to the west of the Installation and is therefore highly unlikely to occur within the MRS.

According to the Installation's current INRMP and rare plant management plan, no federally listed plant species are found or likely to be found on the property (Tetra Tech, 2011). The only federally listed threatened or endangered plant species in the USFWS search results is the small whorled pogonia; all other plant species described below are State-listed.

The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed-deciduous/ coniferous forests that are in later stages of succession. No previous studies have found any individuals or colonies of this species within the MRS.

Clustered sedge tends to occur in dry habitats but can sometimes be found in drying peat bogs. This plant is more common in areas of acidic sandy, gravelly, or rocky soils of barrens, acidic woods, and thickets (United States Department of Agriculture, No Date). The current INRMP and rare plant management plan indicates this species is known to occur on the Installation, however, documented populations have not been reported within the MRS.

Gypsy-Wort is typically found in floodplain woodlands, swamps, soggy thickets and meadows, and wetlands. The current INRMP and rare plant management plan indicates this species is

known to occur on the Installation. NYSDEC correspondence indicates that this plant has a documented occurrence in the eastern section of the project site near the Hudson River.

Weak Rush has been found in a variety of habitats in New York, but is most commonly seen in swamps, mudflats, marshes, and coastal plain pond shores (NYSDEC, 2013). The current INRMP and rare plant management plan indicates this species is known to occur on the Installation, however, documented populations have not been reported within the MRS.

Reflexed Sedge occurs in openings and edges of dry-mesic to mesic deciduous forests. Occurrences have also been documented in open environments like rocky summits and ledges, and pathways or roadways that traverse through woodlands (New York Natural Heritage Program, NYNHP, 2013a). The current INRMP and rare plant management plan indicate this species is known to occur at the Installation. NYSDEC correspondence indicates that this plant has a documented occurrence in the southwestern section of the MRS, just off of Route 9W.

The black-eyed sedge occurs in rocky dry-mesic to mesic deciduous forests (NYNHP, 2013b) and can occur along clearing edges, open roadsides, and stream margins. The current INRMP and rare plant management plan indicates this species is known to occur on the Installation, however, documented populations have not been reported within the MRS.

Virginia Snakeroot typically inhabits dry-mesic oak-hickory forested slopes, often with abundant non-weedy herbaceous species, and can sometimes occur in seasonal drainages within this habitat (Weldy et al., 2014). The current INRMP and rare plant management plan indicates this species is known to occur on the Installation, however, documented populations have not been reported within the MRS.

According to the NYSDEC, habitat for Michaux's Blue-Eyed-Grass consists of "open, non-forested habitats that are usually herb-dominated or occasionally shrub and sapling-dominated" (NYNHP, 2013c). Correspondence from NYSDEC indicated this species has historic records of occurrence within the Black Rock Forest Preserve adjacent to the Crow's Nest MRS.

Of these species, the following have been identified as having the potential to exist within the Crow's Nest MRS: Indiana bat (*Myotis sodalist*), Northern long-eared bat (*Myotis septentrionalis*), Bald eagle (*Haliaeetus leucocephalus*), Timber rattlesnake (*Crotalus horridus*), Small whorled pogonia (*Isotria medeoloides*), Gypsy-wort (*Lycopus rubellus*), Weak rush (*Juncus debilis*), Reflexed sedge (*Carex retroflexa*), Black-eyed sedge (*Carex nigromarginata*), and Virginia Snakeroot (*Endodeca serpentaria*).

Attachment B
Screening Level Ecological Risk Assessment
Calculation Tables

Table B-1: Adjustment of Food Ingestion Rate from Wet Weight Basis to Dry Weight Basis

Dietary Component	Short-tailed Shrew		American Robin		Marsh Wren		Red Fox		Red-tailed Hawk	
	% of Diet	% Water	% of Diet	% Water	% of Diet	% Water	% of Diet	% Water	% of Diet	% Water
Invertebrate	86	71	37.5	71	100	71	2.8	71	0	71
Plant	14	51	62.5	51	0	51	7.2	51	0	51
Mammal	0	68	0	68	0	68	90	68	100	68
Weighted Average % Water in Diet	68.2		58.5		71.0		66.9		68.0	
Average Food Ingestion Rate - wet weight (kg/day)	0.0094		0.097		0.0087		0.33		0.099	
Maximum Food Ingestion Rate - wet weight (kg/day)	0.010		0.12		0.010		0.34		0.11	
Average Food Ingestion Rate - dry weight (kg/day)	0.0030		0.040		0.0025		0.11		0.032	
Maximum Food Ingestion Rate - dry weight (kg/day)	0.0032		0.050		0.0029		0.11		0.036	

Note: Wet weight food ingestion rates and % water for prey items were obtained from US EPA, 1993, Wildlife Exposure Factors Handbook, EPA/600/P.-93/187

Table B-2: Bioaccumulation Factor Calculation

Media	Lead Concentration (mg/kg)	C_p (mg/kg dw)	Plant BAF	C_i (mg/kg dw)	Invertebrate BAF	C_m (mg/kg dw)	Mammal BAF
Maximum Soil Lead Concentration	2220	20.0	0.0090	403.5	0.18	32.6	0.015
Maximum Sediment Lead Concentration	4470	29.6	0.0066	73.9	0.017	44.4	0.010
Average Soil Lead Concentration	691	10.4	0.015	157.3	0.23	19.4	0.028
Average Sediment Lead Concentration	3433	25.5	0.0074	62.2	0.018	39.5	0.012

Notes:

C_p = Concentration in plants

C_i = Concentration in invertebrates

C_m = Concentration in mammals

BAF = Bioaccumulation Factor

dw = dry weight

mg/kg = milligram per kilogram

Formula:

$C_p = e^{(0.561 \times LN(Pbconc) - 1.328)}$

$C_{i[SOIL]} = e^{(0.807 \times LN(Pbconc) - 0.218)}$

$C_{i[SED]} = 10^{(0.653 \times LOG(Pbconc) - 0.515)}$

$C_m = e^{(0.4422 \times LN(Pbconc) + 0.0761)}$

$BAF = C_{p/i/m} / Pb_{conc}$

Table B-3: Exposure Parameters

Exposure Parameter	Short-tailed Shrew		Marsh Wren		Robin		Red Fox		Red-tailed Hawk	
	Value	Comment	Value	Comment	Value	Comment	Value	Comment	Value	Comment
Minimum Body Weight (kg)	0.015	1	0.0094	1	0.077	1	3.9	1	0.96	1
Average Body Weight (kg)	0.017	2	0.011	2	0.081	2	4.5	2	1.1	2
Average Food Ingestion Rate (g/g*day)	0.56	3	0.82	3	1.2	3	0.072	3	0.099	3
Average Food Ingestion Rate (kg/day)	0.003	4	0.0025	4	0.04	4	0.11	4	0.032	4
Maximum Food Ingestion Rate (g/g*day)	0.62	5	0.99	5	1.5	5	0.075	5	0.11	5
Maximum Food Ingestion Rate (kg/day)	0.0032	6	0.0029	6	0.05	6	0.11	6	0.036	6
Invertebrate Diet Fraction (unitless)	0.76	7	0.9	9	0.331	7	0.018	7	0	9
Plant Diet Fraction (unitless)	0.11	7	0	9	0.631	7	0.072	7	0	9
Mammal Diet Fraction (unitless)	0	9	0	9	0	7	0.882	7	1	9
Soil Ingestion Fraction (unitless)	0.13	10	0.1	11	0.038	12	0.028	13	0	10
Home Range (acres)	0.96	9	0.2	7	1.19	8	2564	7	2081	7
Site Area, DU-01 (acres)	147	14	147	14	147	14	147	14	147	14
Site Area, DU-02 (acres)	1.3	14	1.3	14	1.3	14	1.3	14	1.3	14
Screening Area Use Factor, DU-01 (unitless)	1	15	1	15	1	15	1	15	1	15
Screening Area Use Factor, DU-02 (unitless)	1	15	1	15	1	15	1	15	1	15
Refined Screening Area Use Factor, DU-01 (unitless)	1	16	1	16	1	16	0.057	17	0.071	17
Refined Screening Area Use Factor, DU-02 (unitless)	1	16	1	16	1	16	0.00051	17	0.00062	17

Notes:

g = gram; kg = kilogram; DU = Decision Unit

Comment:

1) Body weight was minimum mean adult weight reported in US EPA, 1993, Wildlife Exposure Factors Handbook, EPA/600/P.-93/187a. No minimum value was reported.
2) Average of values for adults from US EPA, 1993, Wildlife Exposure Factors Handbook, EPA/600/P.-93/187a.
3) Average of wet weight values for adults from US EPA, 1993, Wildlife Exposure Factors Handbook, EPA/600/P.-93/187a.
4) Average food ingestion rate multiplied by average body weight and adjusted to dry weight basis.

5) Ingestion rate was maximum mean adult rate reported as wet weight in US EPA, 1993, Wildlife Exposure Factors Handbook, EPA/600/P.-93/187a. No maximum value was reported.
6) Maximum food ingestion rate multiplied by average body weight and adjusted to dry weight basis.
7) Average of values from US EPA, 1993, Wildlife Exposure Factors Handbook, EPA/600/P.-93/187a.
8) Average of values for Foraging Home Range from US EPA, 1993, Wildlife Exposure Factors Handbook, EPA/600/P.-93/187a.
9) US EPA, 1993, Wildlife Exposure Factors Handbook, EPA/600/P.-93/187a.
10) ORNL, Estimating Exposure of Terrestrial Wildlife to Contaminants ES/ER/TM-125
11) ORNL, Estimating Exposure of Terrestrial Wildlife to Contaminants ES/ER/TM-125 - assumed 10% of invertebrate diet fraction as per American Robin
12) ORNL, Estimating Exposure of Terrestrial Wildlife to Contaminants ES/ER/TM-125 - assumed 10% of invertebrate diet fraction
13) Beyer et al, 1994. Estimates of Soil Ingestion by Wildlife
14) Draft RI Report
15) Area Use Factor of 1 was assumed for screening
16) Home range < Site Area; Maximum Area Use Factor of 1 was used
17) AUF = Home Range/Site Area

Table B-4
SLERA Hazard Quotients for Terrestrial Invertebrates
Decision Unit 01

SLERA Results			
Constituent of Ecological Concern	**Maximum Surface Soil Concentration (mg/kg dry wt)**	**NOAEL Toxicity Reference Value (mg/kg)**	**Maximum/ NOAEL HQ**
Inorganic Analytes			
Lead	2220	1700	**1.3**

Notes:

SLERA = Screening Level Ecological Risk Assessment

HQ = Hazard Quotient

NOAEL = No Observable Adverse Effect Level

Table B-5
SLERA Hazard Quotients for the Short-tailed Shrew
Decision Unit 01

SLERA Results									
Constituent of Potential Ecological Concern	**Maximum Surface Soil Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Maximum Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Maximum Plant Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Maximum Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**Maximum NOAEL HQ (unitless)**
Inorganic Analytes									
Lead	2220	0.18	403.5	0.009	20.0	1	136.5	4.7	**29**

Shrew Constants:

Maximum Food Ingestion Rate (FI):	0.0032	kg/day
Dietary fraction of invertebrates (Fti):	0.87	unitless
Dietary fraction of plant material (Fp):	0	unitless
Dietary fraction of soil (Fs):	0.13	unitless
Minimum Body Weight (BW):	0.015	kg
Area Use Factor (AUF):	1	unitless

BAF = Bioaccumulation Factor
SLERA = Screening Level Ecological Risk Assessment
HQ = Hazard Quotient
NOAEL = No Observable Adverse Effect Level
GI = Gastrointestinal

Table B-6
SLERA Hazard Quotients for the American Robin
Decision Unit 01

SLERA Results									
Constituent of Potential Ecological Concern	**Maximum Surface Soil Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Maximum Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Maximum Plant Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Maximum Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**Maximum NOAEL HQ (unitless)**
Inorganic Analytes									
Lead	2220	0.18	403.5	0.0090	20.0	1	306.8	1.6	**188.2**

Robin Constants:

Maximum Food Ingestion Rate (FI):	0.050	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti):	0.962	unitless	SLERA = Screening Level Ecological Risk Assessment
Dietary fraction of plant material (Fp):	0	unitless	HQ = Hazard Quotient
Dietary fraction of soil (Fs):	0.038	unitless	NOAEL = No Observable Adverse Effect Level
Minimum Body Weight (BW):	0.077	kg	GI = Gastrointestinal
Area Use Factor (AUF):	1	unitless	

Table B-7
SLERA Hazard Quotients for the Red Fox
Decision Unit 01

SLERA Results											
Constituent of Potential Ecological Concern	Maximum Surface Soil Concentration (mg/kg dry wt)	Invertebrate BAF (unitless)	Maximum Invertebrate Concentration (mg/kg)	Plant BAF (unitless)	Maximum Plant Concentration (mg/kg)	Mammal BAF (unitless)	Maximum Mammal Concentration (mg/kg)	GI Absorption Factor (unitless)	Maximum Daily Dose Rate (mg/kgBW/day)	NOAEL Toxicity Reference Value (mg/kgBW/day)	Maximum NOAEL HQ (unitless)
Inorganic Analytes											
Lead	2220	0.18	403.5	0.0090	20.0	0.015	33.3	1	13.0	4.7	**2.8**

Red Fox Constants:

Maximum Food Ingestion Rate (FI):	0.11	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti):	0.972	unitless	SLERA = Screening Level Ecological Risk Assessment
Dietary fraction of plant material (Fp):	0	unitless	HQ = Hazard Quotient
Dietary fraction of mammals (Fm):	0	unitless	NOAEL = No Observable Adverse Effect Level
Dietary fraction of soil (Fs):	0.028	unitless	GI = Gastrointestinal
Minimum Body Weight (BW):	3.9	kg	
Area Use Factor (AUF):	1	unitless	

Table B-8
SLERA Hazard Quotients for the Red-Tailed Hawk
Decision Unit 01

SLERA Results											
Constituent of Potential Ecological Concern	**Maximum Surface Soil Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Maximum Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Maximum Plant Concentration (mg/kg)**	**Mammal BAF (unitless)**	**Maximum Mammal Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Maximum Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**Maximum NOAEL HQ (unitless)**
Inorganic Analytes											
Lead	2220	0.18	399.6	0.0090	20.0	0.015	33.3	1	1.3	1.6	**0.77**

Hawk Constants:

Maximum Food Ingestion Rate (FI):	0.036	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti):	0	unitless	SLERA = Ecological Risk Assessment
Dietary fraction of plant material (Fp):	0	unitless	HQ = Hazard Quotient
Dietary fraction of mammals (Fm):	1	unitless	NOAEL = No Observable Adverse Effect Level
Dietary fraction of soil (Fs):	0	unitless	GI = Gastrointestinal
Minimum Body Weight (BW):	0.96	kg	
Area Use Factor (AUF):	1	unitless	

Table B-9
SLERA Hazard Quotients for Benthic Invertebrates
Decision Unit 02

SLERA Results			
Constituent of Ecological Concern	**Maximum Sediment Concentration (mg/kg dry wt)**	**NOAEL Toxicity Reference Value (mg/kg)**	**Maximum/ NOAEL HQ**
Inorganic Analytes			
Lead	4470	35.8	**124.9**

Notes:

SLERA = Screening Level Ecological Risk Assessment

HQ = Hazard Quotient

NOAEL = No Observable Adverse Effect Level

Table B-10
SLERA Hazard Quotients for the Short-tailed Shrew
Decision Unit 02

SLERA Results									
Constituent of Potential Ecological Concern	**Maximum Sediment Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Maximum Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Maximum Plant Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Maximum Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**Maximum NOAEL HQ (unitless)**
Inorganic Analytes									
Lead	4470	0.017	73.8	0.0066	29.5	1	137.7	4.7	**29.3**

Shrew Constants:

Maximum Food Ingestion Rate (FI):	0.0032	kg/day
Dietary fraction of invertebrates (Fti):	0.87	unitless
Dietary fraction of plant material (Fp):	0.00	unitless
Dietary fraction of sediment (Fs):	0.13	unitless
Minimum Body Weight (BW):	0.015	kg
Area Use Factor (AUF):	1	unitless

BAF = Bioaccumulation Factor
SLERA = Ecological Risk Assessment
HQ = Hazard Quotient
NOAEL = No Observable Adverse Effect Level
GI = Gastrointestinal

Table B-11
SLERA Hazard Quotients for the Marsh Wren
Decision Unit 02

SLERA Results									
Constituent of Potential Ecological Concern	**Maximum Sediment Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Maximum Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Maximum Plant Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Maximum Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**Maximum NOAEL HQ (unitless)**
Inorganic Analytes									
Lead	4470	0.017	73.8	0.0066	29.5	1	158.4	1.6	**97.2**

Wren Constants:

Maximum Food Ingestion Rate (FI):	0.0029	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti):	0.9	unitless	SLERA = Ecological Risk Assessment
Dietary fraction of plants (Fp):	0	unitless	HQ = Hazard Quotient
Dietary fraction of sediment (Fs):	0.1	unitless	NOAEL = No Observable Adverse Effect Level
Minimum Body Weight (BW):	0.0094	kg	GI = Gastrointestinal
Area Use Factor (AUF):	1	unitless	

Table B-12
SLERA Hazard Quotients for the Red Fox
Decision Unit 02

SLERA Results											
Constituent of Potential Ecological Concern	**Maximum Sediment Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Maximum Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Maximum Plant Concentration (mg/kg)**	**Mammal BAF (unitless)**	**Maximum Mammal Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Maximum Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**Maximum NOAEL HQ (unitless)**
Inorganic Analytes											
Lead	4470	0.017	73.8	0.0066	29.5	0.010	44.7	1	5.6	4.7	**1.2**

Red Fox Constants:

Maximum Food Ingestion Rate (FI):	0.11	kg/day
Dietary fraction of invertebrates (Fti):	0.972	unitless
Dietary fraction of plant material (Fp):	0	unitless
Dietary fraction of mammals (Fm):	0	unitless
Dietary fraction of sediment (Fs):	0.028	unitless
Minimum Body Weight (BW):	3.9	kg
Area Use Factor (AUF):	1	unitless

BAF = Bioaccumulation Factor
SLERA = Ecological Risk Assessment
HQ = Hazard Quotient
NOAEL = No Observable Adverse Effect Level
GI = Gastrointestinal

Table B-13
SLERA Hazard Quotients for the Red-Tailed Hawk
Decision Unit 02

SLERA Results											
Constituent of Potential Ecological Concern	**Maximum Sediment Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Maximum Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Maximum Plant Concentration (mg/kg)**	**Mammal BAF (unitless)**	**Maximum Mammal Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Maximum Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**Maximum NOAEL HQ (unitless)**
Inorganic Analytes											
Lead	4470	0.017	73.8	0.0066	29.5	0.010	44.7	1	1.7	1.6	**1.0**

Hawk Constants:

Maximum Food Ingestion Rate (FI):	0.036	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti):	0	unitless	SLERA = Ecological Risk Assessment
Dietary fraction of plant material (Fp):	0	unitless	HQ = Hazard Quotient
Dietary fraction of mammals (Fm):	1	unitless	NOAEL = No Observable Adverse Effect Level
Dietary fraction of sediment (Fs):	0	unitless	GI = Gastrointestinal
Minimum Body Weight (BW):	0.96	kg	
Area Use Factor (AUF):	1	unitless	

Table B-14
Refined SLERA Hazard Quotients for Terrestrial Invertebrates
Decision Unit 01

Refined SLERA Results					
Constituent of Ecological Concern	**Mean Surface Soil Concentration (mg/kg dry wt)**	**NOAEL Toxicity Reference Value (mg/kg)**	**LOAEL Toxicity Reference Value (mg/kg)**	**Mean/ NOAEL HQ**	**Mean/ LOAEL HQ**
Inorganic Analytes					
Lead	691	1700	8400	**0.41**	**0.082**

Notes:
SLERA = Screening Level Ecological Risk Assessment
HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observable Adverse Effect Level

Table B-15
Refined SLERA Hazard Quotients for the Short-tailed Shrew
Decision Unit 01

Refined SLERA Results											
Constituent of Potential Ecological Concern	**Mean Surface Soil Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Mean Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Mean Plant Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Mean Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**LOAEL Toxicity Reference Value (mg/kgBW/day)**	**Mean NOAEL HQ (unitless)**	**Mean LOAEL HQ (unitless)**
Inorganic Analytes											
Lead	691	0.23	158.9	0.015	10.4	0.60	23	4.7	8.9	**4.8**	**2.5**

Shrew Constants:

Average Food Ingestion Rate (FI):	0.0030	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti)	0.76	unitless	SLERA = Screening Level Ecological Risk Assessment
Dietary fraction of plant material (Fp)	0.11	unitless	HQ = Hazard Quotient
Dietary fraction of soil (Fs)	0.13	unitless	LOAEL = Lowest Observed Adverse Effect Level
Average Body Weight (BW):	0.017	kg	NOAEL = No Observable Adverse Effect Level
Area Use Factor (AUF):	1	unitless	GI = Gastrointestinal

Table B-16
Refined SLERA Hazard Quotients for the American Robin
Decision Unit 01

Refined SLERA Results												
Constituent of Potential Ecological Concern	**Mean Surface Soil Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Mean Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Maximum Plant Concentration (mg/kg)**	**Mean Plant Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Mean Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**LOAEL Toxicity Reference Value (mg/kgBW/day)**	**Mean NOAEL HQ (unitless)**	**Mean LOAEL HQ (unitless)**
Inorganic Analytes												
Lead	691	0.23	158.9	0.015	33.300	10.4	0.60	25.3	1.6	3.3	**15.5**	**7.8**

Robin Constants:

Average Food Ingestion Rate (FI):	0.040	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti)	0.331	unitless	SLERA = Screening Level Ecological Risk Assessment
Dietary fraction of plant material (Fp)	0.631	unitless	HQ = Hazard Quotient
Dietary fraction of soil (Fs)	0.038	unitless	LOAEL = Lowest Observed Adverse Effect Level
Average Body Weight (BW):	0.081	kg	NOAEL = No Observable Adverse Effect Level
Area Use Factor (AUF):	1	unitless	GI = Gastrointestinal

Table B-17
Refined SLERA Hazard Quotients for the Red Fox
Decision Unit 01

Refined SLERA Results													
Constituent of Potential Ecological Concern	**Mean Surface Soil Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Mean Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Mean Plant Concentration (mg/kg)**	**Mammal BAF (unitless)**	**Mean Mammal Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Mean Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**LOAEL Toxicity Reference Value (mg/kgBW/day)**	**Mean NOAEL HQ (unitless)**	**Mean LOAEL HQ (unitless)**
Inorganic Analytes													
Lead	691	0.23	158.9	0.015	10.4	0.028	19.3	0.60	0.033	4.7	8.9	**0.0070**	**0.0037**

Red Fox Constants:

Average Food Ingestion Rate (FI):	0.11	kg/day
Dietary fraction of invertebrates (Fti)	0.018	unitless
Dietary fraction of plant material (Fp)	0.072	unitless
Dietary fraction of mammals (Fm)	0.882	unitless
Dietary fraction of soil (Fs)	0.028	unitless
Average Body Weight (BW):	4.5	kg
Area Use Factor (AUF):	0.057	unitless

BAF = Bioaccumulation Factor
SLERA = Screening Level Ecological Risk Assessment
HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observable Adverse Effect Level
GI = Gastrointestinal

Table B-18
Refined SLERA Hazard Quotients for the Red-Tailed Hawk
Decision Unit 01

Refined SLERA Results														
Constituent of Potential Ecological Concern	**Mean Surface Soil Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Mean Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Mean Plant Concentration (mg/kg)**	**Mammal BAF (unitless)**	**Mean Mammal Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Maximum Daily Dose Rate (mg/kgBW/day)**	**Mean Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**LOAEL Toxicity Reference Value (mg/kgBW/day)**	**Mean NOAEL HQ (unitless)**	**Mean LOAEL HQ (unitless)**
Inorganic Analytes														
Lead	691	0.23	158.9	0.015	10.4	0.028	19.3	0.60	0.02	0.02	1.6	3.3	**0.014**	**0.007**

Hawk Constants:			
Average Food Ingestion Rate (FI):	0.032	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti)	0	unitless	SLERA = Screening Level Ecological Risk Assessment
Dietary fraction of plant material (Fp)	0	unitless	HQ = Hazard Quotient
Dietary fraction of mammals (Fm)	1	unitless	LOAEL = Lowest Observed Adverse Effect Level
Dietary fraction of soil (Fs)	0	unitless	NOAEL = No Observable Adverse Effect Level
Average Body Weight (BW):	1.1	kg	GI = Gastrointestinal
Area Use Factor (AUF):	0.071	unitless	

Table B-19
Refined SLERA Hazard Quotients for Benthic Invertebrates
Decision Unit 02

Refined SLERA Results					
Constituent of Ecological Concern	**Mean Sediment Concentration (mg/kg dry wt)**	**NOAEL Toxicity Reference Value (mg/kg)**	**LOAEL Toxicity Reference Value (mg/kg)**	**Mean/ NOAEL HQ**	**Mean/ LOAEL HQ**
Inorganic Analytes					
Lead	3,433	35.8	128	**95.9**	**26.8**

Notes:
SLERA = Screening Level Ecological Risk Assessment
HQ = Hazard Quotient
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observable Adverse Effect Level

Table B-20
Refined SLERA Hazard Quotients for the Short-tailed Shrew
Decision Unit 02

Refined SLERA Results											
Constituent of Potential Ecological Concern	**Mean Sediment Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Mean Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Mean Plant Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Mean Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**LOAEL Toxicity Reference Value (mg/kgBW/day)**	**Mean NOAEL HQ (unitless)**	**Mean LOAEL HQ (unitless)**
Inorganic Analytes											
Lead	3,433	0.018	62.1	0.0074	25.4	0.6	53	4.7	8.9	**11.3**	**5.98**

Shrew Constants:

Average Food Ingestion Rate (FI):	0.0030	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti)	0.76	unitless	SLERA = Screening Level Ecological Risk Assessment
Dietary fraction of plant material (Fp)	0.11	unitless	HQ = Hazard Quotient
Dietary fraction of sediment (Fs)	0.13	unitless	LOAEL = Lowest Observed Adverse Effect Level
Average Body Weight (BW):	0.017	kg	NOAEL = No Observable Adverse Effect Level
Area Use Factor (AUF):	1	unitless	GI = Gastrointestinal

Table B-21
Refined SLERA Hazard Quotients for the Marsh Wren
Decision Unit 02

Refined SLERA Results											
Constituent of Potential Ecological Concern	**Mean Sediment Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Mean Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Mean Plant Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Mean Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**LOAEL Toxicity Reference Value (mg/kgBW/day)**	**Mean NOAEL HQ (unitless)**	**Mean LOAEL HQ (unitless)**
Inorganic Analytes											
Lead	3,433	0.018	62.1	0.0074	25.4	0.60	56.5	1.6	3.3	**34.7**	**17.3**

Wren Constants:

Average Food Ingestion Rate (FI):	0.0025	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti)	0.9	unitless	SLERA = Screening Level Ecological Risk Assessment
Dietary fraction of plants (Fp)	0	unitless	HQ = Hazard Quotient
Dietary fraction of sediment (Fs)	0.1	unitless	LOAEL = Lowest Observed Adverse Effect Level
Average Body Weight (BW):	0.011	kg	NOAEL = No Observable Adverse Effect Level
Area Use Factor (AUF):	1	unitless	GI = Gastrointestinal

Table B-22
Refined SLERA Hazard Quotients for the Red Fox
Decision Unit 02

Refined SLERA Results													
Constituent of Potential Ecological Concern	**Mean Sediment Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Mean Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Mean Plant Concentration (mg/kg)**	**Mammal BAF (unitless)**	**Mean Mammal Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Mean Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**LOAEL Toxicity Reference Value (mg/kgBW/day)**	**Mean NOAEL HQ (unitless)**	**Mean LOAEL HQ (unitless)**
Inorganic Analytes													
Lead	3433	0.018	62.1	0.0074	25.4	0.012	41.2	0.60	0.001	4.7	8.9	**0.00021**	**0.00011**

Red Fox Constants:

Average Food Ingestion Rate (FI):	0.11	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti)	0.018	unitless	SLERA = Screening Level Ecological Risk Assessment
Dietary fraction of plant material (Fp)	0.072	unitless	HQ = Hazard Quotient
Dietary fraction of mammals (Fm)	0.88	unitless	LOAEL = Lowest Observed Adverse Effect Level
Dietary fraction of sediment (Fs)	0.028	unitless	NOAEL = No Observable Adverse Effect Level
Average Body Weight (BW):	4.5	kg	GI = Gastrointestinal
Area Use Factor (AUF):	0.00051	unitless	

Table B-23
Refined SLERA Hazard Quotients for the Red-Tailed Hawk
Decision Unit 02

Refined SLERA Results													
Constituent of Potential Ecological Concern	**Mean Sediment Concentration (mg/kg dry wt)**	**Invertebrate BAF (unitless)**	**Mean Invertebrate Concentration (mg/kg)**	**Plant BAF (unitless)**	**Mean Plant Concentration (mg/kg)**	**Mammal BAF (unitless)**	**Mean Mammal Concentration (mg/kg)**	**GI Absorption Factor (unitless)**	**Mean Daily Dose Rate (mg/kgBW/day)**	**NOAEL Toxicity Reference Value (mg/kgBW/day)**	**LOAEL Toxicity Reference Value (mg/kgBW/day)**	**Mean NOAEL HQ (unitless)**	**Mean LOAEL HQ (unitless)**
Inorganic Analytes													
Lead	3,433	0.018	62.1	0.0074	25.4	0.012	41.2	0.60	0.0004	1.6	3.3	**0.0003**	**0.0001**

Hawk Constants:

Average Food Ingestion Rate (FI):	0.032	kg/day	BAF = Bioaccumulation Factor
Dietary fraction of invertebrates (Fti)	0	unitless	ERA = Ecological Risk Assessment
Dietary fraction of plant material (Fp)	0	unitless	HQ = Hazard Quotient
Dietary fraction of mammals (Fm)	1	unitless	LOAEL = Lowest Observed Adverse Effect Level
Dietary fraction of sediment (Fs)	0	unitless	NOAEL = No Observable Adverse Effect Level
Average Body Weight (BW):	1.1	kg	GI = Gastrointestinal
Area Use Factor (AUF):	0.00062	unitless	