ECOLOGICAL RISK ASSESSMENT

VERMILION PARISH SCHOOL BOARD PROPERTY, EAST WHITE LAKE OIL AND GAS FIELD, VERMILION PARISH, LA

Report by

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Executive Summary

This ecological risk assessment (ERA) prepared is prepared for the Vermilion Parish School Board (VPSB) property in accordance with Louisiana Department of Environmental Quality (LDEQ 2003) and U.S. Environmental Protection Agency (e.g. USEPA 1993, 1997, and 1998) guidance. It is being provided as a component of the site remediation plan that was developed pursuant to LSA-R.S. 30:29 to evaluate and/or remediate "environmental damage" related to oilfield operations on the East White Lake site. The ERA demonstrates that there are no unacceptable risks to ecological receptors on this property and that remedial action based on ecological risk is not warranted. This conclusion is supported by the following lines of evidence:

- Multiple site inspections and characterizations.
- Information from investigations conducted in 2010 - 2015 of the wildlife, vegetation as well as soils and sediments.
- Analysis of wetland functions and services provided by the site (Connelly and Rodgers 2014).
- A conservative Screening-Level Ecological Risk Assessment (SLERA).
- A conservative site-specific Baseline Ecological Risk Assessment (BERA).
- Evaluation of previous ERAs and associated data for the VPSB property.
- An intensive study of crabs (*Callinectes sapidus*) and forage fish to measure potential bioaccumulation of elements from the site.

The VPSB property is largely covered with emergent marsh as would be expected given the low elevation of the property. The vegetation on the VPSB property is growing vigorously and does not exhibit any diagnostic symptoms of exposure or adverse effects due to oil and gas exploration and production on the property. There is no evidence of stress or toxicity due to salt from exploration or production activities.

The VPSB property is providing significant wildlife habitat as would also be expected for wetlands in this area. The property is also providing habitat for species of special concern such as the osprey and brown pelican. There is clear evidence of healthy wildlife and game animals, and no evidence of adverse effects on wildlife from past or ongoing exploration and production activities. Based on observations and field sampling, ecological populations have not been adversely affected in the East White Lake Field. Further, the ecological populations in the East White Lake Field ecosystem represent an intact food web with diverse species, and provide services and functions to human and ecological communities residing in proximity to the site.

Wetlands in the East White Lake Oil and Gas Field of the VPSB property are providing valuable functions and services for both wildlife and people living in the area. The structural components of this ecosystem (e.g. plants and animals) are abundant, diverse and in obvious good health. Other services expected for these properties in this area such as water storage and soil stabilization are clearly being provided.

Based on the results from the SLERA and in order to be conservative, Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Zinc, were retained for more detailed

evaluation in a BERA. The BERA considered site and species specific data, including the biogeochemistry existing in these wetlands. The BERA quantitatively confirms that historical exploration and production activities on this site do not pose an unacceptable risk to wildlife.

The crabs were extensively sampled and analyzed at this site and those data further confirm the other lines of evidence. Moreover, my field investigations documented the health and abundance of crabs at the site.

The various lines of evidence each independently demonstrate that no unacceptable risk exists on the property and, when considered collectively, demonstrate that no remedial action is warranted from an ecological perspective.

List of Acronyms

AUF	Area Use Factor
AVS	Acid Volatile Sulfide
BAF	Bioaccumulation Factor
BCFs	Bioconcentration Factors
BERA	Baseline Ecological Risk Assessment
CAS	Columbia Analytical Services, Inc.
COPECs	Constituents of Potential Ecological Concern
CSM	Conceptual Site Model
DNR	Department of Natural Resources
DQOs	Data Quality Objectives
EEC	Estimated Environmental Concentration
ERAs	Ecological Risk Assessments
ERAGS	Risk Assessment Guidelines for Superfunds
ESV	Ecotoxicity Screening Value
EWL	East White Lake
HQ	Hazard Quotient
HRA	Human Risk Assessment
LDEQ	Louisiana Department of Environmental Quality
LDHH	Louisiana Department of Health & Hospitals
LDWF	Louisiana Department of Wildlife and Fisheries
LOAEL	Lowest Observed Adverse Effect Level
NOAEL	No Observed Adverse Effect Level
NRCS	Natural Resources Conservation Service
PPRTVs	Provisional Peer-Reviewed Toxicity Values
SAP	Sampling and Analysis Plan
SLERA	Screening-Level Ecological Risk Assessment
SMDP	Scientific Management Decision Point
TPH	Total Petroleum Hydrocarbon
TRVs	Toxicity Reference Values
UCL	Upper Confidence Limit
UNOCAL	Union Oil Company
USACE	United States Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VPSB	Vermilion Parish School Board
WOE	Weight of Evidence
WP	Work Plan

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1.0 INTRODUCTION

The property involved in this study is located in Section 16, Township 15 South, Range 1 East in Vermilion Parish, Louisiana. The property is managed by the Vermilion Parish School Board (VPSB) and is located approximately five miles southwest of Forked Island in an area of intermediate and fresh marshes. The specific area of the property known as the East White Lake Oil Field is primarily an intermediate marsh system that is protected by water control structures operated by the United States Army Corps of Engineers. The Louisiana Land and Exploration Company received a lease in 1935 for exploration and production on the property and the Union Oil Company (UNOCAL) received the lease in 1940. The VPSB filed suit against UNOCAL and others for alleged contamination of the property.

I prepared this ecological risk assessment (ERA) for the VPSB property in accordance with Louisiana Department of Environmental Quality (LDEQ 2003) and U.S. Environmental Protection Agency (e.g. USEPA 1993, 1997, and 1998) guidance. This ERA is being provided as a component of the site remediation plan that was developed pursuant to LSA-R.S. 30:29 to evaluate and/or remediate "environmental damage" related to oilfield operations on the East White Lake site. ERAs evaluate ecological effects caused by human activities or stressors. The term "stressor" is used here to describe any chemical, physical, or biological entity that can induce adverse effects on individuals, populations, communities, or ecosystems. Thus, the ERA process must be flexible while providing a logical and scientific structure to accommodate a broad array of stressors or potential stressors (USEPA, 1992).

USEPA guidance uses a tiered approach to determine whether site constituents of potential ecological concern (COPECs) particularly in soils or sediments present an unacceptable risk to ecological receptors. This ERA focuses on chemicals detected on the VPSB property in certain media (i.e., surface water, sediments and soils). An important fundamental principle of ERAs is embodied in USEPA (1998) policy: "It is USEPA policy that risk characterization should be consistent with the values of 'transparency, clarity, consistency, and reasonableness.'" Compliant with USEPA regulatory guidance framework, this ERA includes the following lines of evidence:

- A series of site inspections and characterizations conducted by various individuals that are included in Appendix F to the Most Feasible Plan for Evaluation/Remediation presented by Michael Pisani & Associates, Inc. and referenced throughout this ERA.
- Information from investigations conducted in 2010 - 2015 of the wildlife, vegetation as well as soils and sediments (e.g. LDHH 2015, MP&A, ICON, Connelly and Rodgers 2014, etc.).
- Analysis of wetland functions and services provided by the site (Connelly and Rodgers 2014).
- A Screening-Level Ecological Risk Assessment (SLERA) that was developed based on comparison of soil or sediment COPEC concentrations with appropriate soil or sediment

quality guidelines or ecological screening levels. Soil or sediment quality guidelines were developed for protection of ecological health and are not site-specific in the SLERA. The screening guidelines are intended to be conservative and, if exceeded, can serve as a point of departure for more detailed site-specific ecological risk analysis.

- Development of a site-specific Baseline Ecological Risk Assessment (BERA) for the VPSB property for those COPECs exceeding SLERA screening guidelines using updated analytical data for COPECs.
- Evaluation of previous ERAs and associated data for the VPSB property.
- An intensive study of crabs (*Callinectes sapidus*) and forage fish to measure potential bioaccumulation of elements from the site (Rogers 2010; LDHH 2015).

The purpose of this ERA is to conduct a SLERA as well as a more thorough, site-specific BERA for the VPSB property to determine if 1) there is a need for additional study, 2) whether mitigation action is needed, or 3) no further action is warranted. The SLERA includes Steps 1 and 2 from the USEPA (1997) guidance: 1) a screening-level problem formulation and ecological effects evaluation, and 2) preliminary exposure estimates and risk calculations. The site-specific BERA consists of Steps 3-8 of the USEPA (1997) guidance document as shown in Figure 1 below.

1.2 Site Inspections and Observations

I visited the site in 2010, 2011 and 2014 during which time I was able to observe and assess the condition of the site in both winter and late spring conditions and assess the property for any ecological changes over several years. The East White Lake ecosystem is a healthy and functioning ecosystem that provides services to wildlife populations, the human population, and to the watershed itself. The populations of vegetation, fish, crabs, birds, and other wildlife in the ecosystem are thriving, abundant, and diverse. As part of my assessment and subsequent evaluation of potential risk, I visited the property during different seasons, over a period of several years, thus providing the opportunity to observe the seasonal and temporal changes and trends at the site.

The ecosystem in the East White Lake area is dominated by perennial plant species, as would be expected. Perennials observed in the East White Lake area include: giant bulrush (*Schoenoplectus californicus*), common reed (*Phragmites australis*), giant cutgrass (*Cladium jamaicense*), narrow-leafed cattails (*Typha domengensis*), and bulltongue arrowhead (*Sagittaria lancifolia*). These and other perennials are continuously adding biomass (such as leaves) and contributing detritus in a regular cycle. The decaying plants, observed at locations throughout the site, return nutrients to the soil and allow the area to accrete, building soils and sediments. We observed more than 50 different plant species during the field study. Plants observed included a biodiverse assemblage of trees, grasses, rushes, vines, shrubs, and aquatic emergent plants. Based on my spatial and temporal observations, the vegetation observed at the site was appropriate and healthy for systems of this type and this geography.

Several species of fish were observed on the property including catfish, mosquitofish, bluegill,

gizzard shad and gar. Numerous bird species were also observed using habitat on the property including species of special concern such as osprey and brown pelicans. Mammals observed on the property included nutria and whitetail deer. And iconic species such as alligators were abundant. There were no missing components of the food web. Based on my observations, biota observed at the site was appropriate and healthy and indicative of highly functioning systems of this type and geography.

As a keystone species in coastal marshes, the blue crab (*Callinectes sapidus*) population in the East White Lake area, was assessed in 2010, 2011, and 2014, and is healthy and performing its role in the food web of this ecosystem. The aquatic habitat in the East White Lake ecosystem supports blue crabs in abundance, as well as the natural predators and prey of blue crabs (email communication between LDDH and LDWF, November 2010). Field observations of the crabs concurred with observations of healthy crabs by Louisiana Department of Wildlife and Fisheries during the sampling in 2010.

Based on my qualitative observations and field sampling, ecological populations have not been adversely affected in the East White Lake Field. I observed healthy ecological populations and no evidence of adverse effects. Further, the ecological populations in the East White Lake Field ecosystem represent an intact food web with diverse species, and provide services and functions to human and ecological communities residing in proximity to the site.

1.3 Wetland Function and Services Assessment for the East White Lake Field

To assess the environmental and ecological status of the VPSB property I conducted an analysis of wetland functions and services provided by the site (Connelly and Rodgers 2014; Appendix F). This analysis included development of a "report card" for critical ecosystem structure and function parameters pertinent to coastal Gulf of Mexico wetlands. This ecosystem "report card" was adapted from approaches recommended and used by professional organizations as well as regulatory scientists (USDA 2008, Novitski et al. 2009, Stein et al. 2009, USEPA 2014, Wisconsin Department of Natural Resources 2014). At least 13 individual locations throughout the property were formally evaluated for functions and services provided by the wetlands (Table 1).

Table 1. Wetland services and functions on the VPSB property.

Wetland Services	Wetland Functions Associated With Services
Flood Protection	Surface water detention/storage; Coastal storm surge detention
Recreation	Provision of habitat for fish and other aquatic animals Provision of waterfowl and habitat Provision of other wildlife habitat Diverse plant habitat Access for recreation
Maintain water quality	Nutrient transformation

Wetland Services	Wetland Functions Associated With Services
	Retention of sediments and other particulates Element transformation
Shoreline property	Shoreline stabilization
Protection/Erosion Control	Coastal storm surge detention/mitigation Subsidence/accretion
Maintain baseflow in streams or adjacent lotic systems	Streamflow maintenance Surge protection
Wildlife habitat and biodiversity	Provision of habitat for fish and other aquatic animals Provision of waterfowl and habitat Provision of other wildlife habitat Provision of habitat for unique, uncommon, or highly diverse Wetland plant communities Provision of habitat for federally or state protected species
Commercial products from wetlands (e.g. fish, shellfish, timber, etc.)	Provision of habitat for fish and other aquatic animals Provision of waterfowl and habitat Provision of other wildlife habitat Provision of habitat for unique, uncommon, or highly diverse Wetland plant communities
Reduce pollutants in streams and stormwater	Nutrient transformation Retention of sediments and other particulates

The analysis clearly indicated that the wetlands in the East White Lake Oil and Gas Field of the VPSB property are providing valuable functions and services for both wildlife and people living in the area. The structural components of this ecosystem (e.g. plants and animals) are abundant, diverse and in obvious good health.

2.0 USEPA (1997) Step 1 – Ecological Risk Assessment

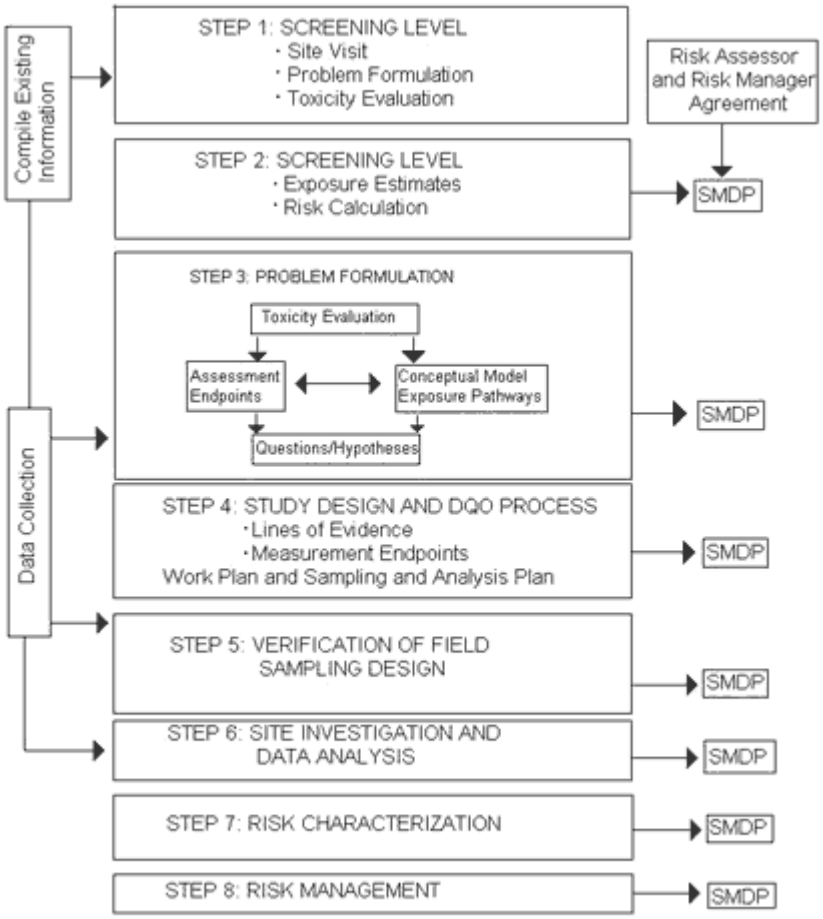

Figure 1: The eight steps recommended for Ecological Risk Assessment (USEPA 1997).

2.1 Screening Level Problem Formulation and Effects Evaluation

2.2 Screening Level Problem Formulation

Problem formulation is a formal process for developing and evaluating hypotheses about why adverse ecological effects may occur due to the presence of physical, chemical, or biological stressors on the property (USEPA 1998). This SLERA focuses on potential chemical stressors associated with media on the property (e.g. surface water, soil and sediment). Specific issues evaluated in problem formulation include the environmental setting, contaminant fate and transport, ecotoxicity and potential receptors, exposure pathway analysis, and endpoints to screen for potential ecological risks.

2.2.1 Environmental Setting

The VPSB property is comprised of approximately 1,197 acres in Vermilion Parish, Louisiana and includes Section 16 of Township 15 South Range 01 East (Figure 2). The property is located about 0.5 miles east of White Lake and to the south of Schooner Bayou. The property is part of the East White Lake Oil and Gas Field in Vermilion Parish. The Louisiana Land and Exploration Company received a lease for exploration and production in 1935. In 1940, UNOCAL began operations on the property and continued as the operator of record until 1995, when the company divested its operations to Resource Acquisitions Corporation. Resource Acquisitions Corporation, now known as Peak Operating Company, continues to conduct exploration and production activities on the VPSB property to this day.

The VPSB property is located in the White Lake drainage basin, which falls between the coastal Chenier Plain and the elevated Pleistocene prairie terrace area further north. The East White Lake Oil and Gas Field is an inundated fresh to intermediate marsh environment (Murphy and Libertset 1987, Vermillion Parish Soil Survey). The East White Lake Oil and Gas Field has been developed with canals for access and servicing of oil and gas production facilities. These canals drain to Schooner Bayou which in turn flows into White Lake. Access to the site is by boat; there are no access roads.

The State of Louisiana (Louisiana Department of Environmental Quality- Louisiana Administrative Code Title 33, Part IX) has designated waters in this area for use for primary contact recreation, secondary contact recreation, fish and wildlife propagation and agriculture. The specific site of interest for this study is a fresh to intermediate marsh, with low-lying uplands and elevated areas adjacent to oil production facilities. Notable wildlife that was readily observed during my site inspections included alligators, deer, raccoons, blue crabs, catfish, herons, and other shore birds. Evidence of trot line fishing in the onsite canals was observed as well as crab trap markers in Schooner Bayou.

The soil survey for Vermilion Parish produced by the Natural Resources Conservation Service (NRCS; Murphy and Libertset 1987) indicates this area has a humid subtropical climate typical of south Louisiana. The Gulf of Mexico is a major influence on the climate of Vermilion Parish for most of the year. In winter, the lowest average temperature of 52.0 degrees Fahrenheit (° F) occurs in January and the average daily minimum temperature is 42° F. The lowest temperature recorded was 12° F in January of 1962 at Vermilion Lock. In the summer, July is the hottest month on average, with a mean temperature of 81° F (an extreme high temperature of 101° F was recorded during July of 1971 at Vermilion Lock). The average daily maximum temperature is 89° F. The average annual precipitation in Vermilion Parish is about 59 inches; most of this occurs in April through September. The most intense daily rainfall (9.9 inches) was measured at Vermilion Lock on June 11, 1975. Thunderstorms occur about 74 days each year. The average relative humidity in midafternoon is about 60%. Humidity is higher at night, about 90% humidity at dawn. The sun shines about 80% of the time in the summer and 50% in the winter. The prevailing wind is from the south with an average windspeed of 11 mph in the spring. Vermilion Parish is periodically subjected to strong influence by hurricanes from the Gulf.

The marshes on the VPSB property are level with little elevation (1-2 feet). They are underlain

by very poorly drained, mucky and clayey soils (Murphy and Liberstat 1987). The soils are saturated most of the time and are frequently flooded. This acreage supports native vegetation and is used for habitat by wildlife as well as for recreation such as hunting. Development is limited by low soil strength and hazards of flooding during tropical storms and hurricanes. Soils on the property include mucks, clays, as well as other alluvial soils (Murphy and Liberset 1987; Soil Survey of Vermilion Parish). The dominant soil types in the area are Allemands - Larose, Clovely- Lafitte, and Banker-Creole Series which are generally formed from alluvium deposited in the area and are poorly drained. Clays are found in lenses in surface soils (0-3 feet) throughout the property. Most of the soil on the property retains water and is not well suited for agriculture. Importantly, soils are accreting in this marsh due to growth of vegetation.

Since the VPSB property has relatively little elevation and it is very poorly drained, water is present nearly year-round for most years. Due to hydrologic conditions in the area and hydric soils, the property is an inundated wetland that is used for hunting and other recreational activities. Of particular interest in this case is the portion of the property (the "Site") used for oil and gas exploration and production. These areas of the property are accessible only by boat or barge. Existing production facilities are currently located on the Site to support these activities (e.g. canals, well pads, flow lines, etc.) and this portion of the property has been altered to support the exploration and production activities and facilities. Based on aerial photographs, the property has changed somewhat over time due to altered hydrology and vegetation has responded accordingly. The predominant ecosystem observed at the site included emergent marshes containing broadleaf cattail (*Typha latifolia*), California bulrush (*Schoenoplectus californicus*), smooth cordgrass (*Spartina alterniflora*) and other iconic species. The property provides habitat which currently supports a variety of aquatic and terrestrial animals, plants, and native as well as migratory birds (Rodgers site inspection 2010; Connelly and Rodgers 2014).

Most of the VPSB property is largely covered with emergent marsh as would be expected given the elevation of the property (Murphy and Liberstat 1987). The emergent marsh vegetation includes California bulrush (*Schoenoplectus californicus*), broadleaf cattail (*Typha latifolia*), southern cattail (*Typha domengensis*), and common reed (*Phragmites australis*). With relatively small changes in elevation (1-3 inches), other plant species that are found throughout the marsh on the VPSB property include giant cutgrass (*Cladium mariscus (jamaicense*), sesbania (*Sesbania* sp.), marshhay cordgrass (*Spartina patens*), swamp mallow (*Hibiscus moscheutos*), flatsedge (*Cyperus* sp.), and bulltongue arrowhead (*Sagittaria lancifolia*). The VPSB property also has some relatively higher elevations (~ 1-2 feet) along spoil banks along Schooner bayou and the canals to access exploration and production sites. Vegetation associated with these somewhat elevated areas includes broadleaf cattail (*Typha latifolia*), southern cattail (*Typha domengensis*), swamp cabbage (*Sabal palmetto*), and flatsedge (*Cyperus* sp.) as well as woody species such as red maple (*Acer rubrum*), bald cypress (*Taxodium distichum*) and black willow (*Salix nigra*). Higher elevations support live oak (*Quercus virginiana*), Chinese tallow (*Triadica sebifera*), and white oak (*Quercus alba*). Areas on the property contain both submersed aquatic vegetation (SAV) and floating aquatic vegetation (FAV) depending on the elevation and type of soil in the area. Some floating species on the property include coontail (*Ceratophyllum demersum*), giant salvinia (*Salvinia molesta*), duckweed (*Lemna minor*) and mosquito fern (*Azolla caroliniana*). SAV on the property were abundant and included water shield (*Brasenia* sp.), waternymph (*Najas guadalupensis*), water lily (*Nymphaea odorata*), milfoil (*Myriophyllum*

spicatum), water lily (*Nuphar odorata*), and widgeon grass (*Ruppia maritima*). Vegetation on the VPSB property is indicative of fresh to intermediate marsh.

The canals and adjacent areas are also habitat for vegetation on the VPSB property. Numerous herbaceous plant species such as grassy arrowhead (*Sagittaria graminea*), spikerush (*Eleocharis sp.*), frogsbit (*Limnobium spongia*), floating heart (*Nymphoides peltata*), alligatorweed (*Alternanthera philoxeroides*), pickerel weed (*Pontederia cordata*), torpedo grass (*Panicum repens*), maidencane (*Panicum hametomon*), bulltongue (*Sagittaria lancifolia*) and primrose-willow (*Ludwigia spp.*) as well as shrub species such as wax myrtle (*Morella cerifera*) and eastern baccharis (*Baccharis halmifolia*).

Wetlands and vegetation in southern Louisiana have changed with time and changes in hydrology (Keim et al. 2006). On the VPSB property, the wetlands are found where they would be expected based on water depth and elevation. As noted above and in the appended report by Connelly and Rodgers (2014), the property supports diverse and densely growing plants. These plants are growing vigorously and do not exhibit any diagnostic symptoms of exposure or adverse effects due to oil and gas exploration and production on the property (Pezeshki et al. 2000, National Acid Precipitation Assessment Program 1987).

At the present time, only a small portion of the VPSB property is being used or maintained for oil and gas production. Additionally, the property has been used for hunting. Alligators have historically been harvested from the property. Catfish, alligator gar, black crappie and mosquitofish were observed on the property. Fish and other animals such as crabs are also harvested from the property.

There was clear evidence of healthy wildlife and game animals, and no evidence of adverse effects on wildlife from past or ongoing exploration and production activities. Numerous animals were observed during the 2010, 2011 and 2014 site inspections. Wildlife observed directly or indirectly (i.e. by tracks, scat, calls, etc.) on this property included deer, alligators, birds, several species of frogs, fish, crabs, crayfish, and many other wetland species. The animal species observed during site inspections are listed in the attached report (Connolly and Rodgers 2014). Of the species observed on or near the property, many were birds. The birds observed on the property represent a significant portion of 342 species of birds reported for Vermilion Parish by the Louisiana Bird Records Committee of the Louisiana Ornithological Society (2013). Notable birds observed on the property included Mourning dove, Osprey, Herring gull, Common gallinule, Least tern, American crow, Marsh wren, Red-wing blackbird, Snowy egret, Mallard duck, Green-wing teal, Northern pintail, Brown pelican, Anhinga, Roseate spoonbill, Green heron, American woodcock, Cedar waxwing, Common grackle, Northern cardinal, Eastern meadowlark, Least sandpiper, Swamp sparrow, American robin, and American goldfinch. The VPSB property provides excellent ecological habitat for numerous animal species.

The property is providing significant wildlife habitat as expected for wetlands in this area. The property is also providing habitat for species of special concern such as the osprey and brown pelican. Other services expected for these properties in this area such as water storage and soil stabilization are clearly being provided.

The VPSB property is currently used for recreation and for exploration and production of oil. Exploration and production activities have also been conducted on the property in the past. It is alleged that these exploration and production activities conducted on the property have left residual chemicals on the property that have harmed plants or wildlife or have the potential to do so. The landowners have claimed that exploration and production activities deposited contaminants on the property including elements such as Arsenic, Barium (and true total Barium), Cadmium, Chromium, Lead, Mercury and Zinc, as well as salts (e.g. conductivity, chlorides and sodium) and oil and grease (e.g. TPH).

Habitats potentially affected by site-related contaminants include wetlands, associated canals, and elevated lands or pads that are used for industrial operations. Potential ecological receptors associated with these habitats include a variety of plants and animals: grasses and emergent wetland vegetation, insects (e.g. dragonflies, mosquitos, horseflies) and other invertebrates (e.g. crabs, crayfish), birds (e.g. spotted sandpiper, red-wing blackbirds), and mammals (Connelly and Rodgers 2014; site inspections and characterization conducted by Dr. John H. Rodgers, Jr.).

An Ecological Checklist (Form 18 of RECAP; LDEQ 2003) was prepared as part of the site inspection on May 13-14, 2014. The Ecological Checklist (attached to this report) contains information regarding additional site characterization and potentially sensitive areas. Based on the site inspections, there were no indications of any onsite or off-site adverse ecological effects due to historic or ongoing oil and gas operations on the property.

2.2.2 Contaminant Fate and Transport

Potential COPECs released from site-related exploration and production activities could be transported on the property by different means. The potential primary transport mechanisms are surface runoff and erosion. This area has been inundated over the years by storm surges from hurricanes and other major events (Vermilion Parish Soil Survey). Most COPECs on this site are also naturally occurring in surficial soils and sediments throughout this geographical area.

2.3 Ecotoxicity of COPECS

For purposes of this ERA, COPECs are conservatively assumed to originate from site-related exploration and production activities. However, most of the COPECs or conditions are also naturally occurring or present due to natural events such as storms and storm surges. To characterize the COPECs at the site, surface-water, soil or sediment samples were collected by ICON (2010; 2015) and MP&A (2015). The COPECs analyzed in these samples included inorganics/metals (e.g. arsenic, barium, cadmium, chromium, lead, mercury, selenium and zinc) as well as TPH. If they are present in toxic forms and amounts and exposure can occur, these COPECs have the potential to adversely affect survival, growth, or reproduction for some ecological receptors. For initial screening assessment of this ERA, conservative peer-reviewed screening thresholds for soils and sediments such as USEPA Soil Screening Levels (EPA EcoSSLs) for COPECs present in soil and sediments were used to assess the potential ecotoxicity of COPECs.

2.3.1 Potential Receptors and Routes of Exposure

This ERA focuses on the probability of adverse effects on ecological receptors that may be affected by COPECs found on the site, with an emphasis on selected phylogenetic groups, often referred to as populations or communities. The regulatory focus is usually on organisms that are generally recognized by the public to be of direct or indirect value to humans (i.e. larger and typically more mobile animals ["wildlife"]), as well as primary and secondary "producers" (plants and small animals that serve as cover or forage for wildlife). Another reason for this focus is that relevant toxicological and ecological information is more abundant and available for these groups of organisms. The major receptor groups of interest are described below.

2.4 Plants

Two basic plant communities (i.e. floating and rooted plants) are considered for habitats at the site. For wetlands, generally large, physiologically and structurally complex plants are rooted in soil or sediments or floating on the water surface. The plants rooted in sediment are generally confined to relatively shallow areas along some of the edges of the canals and water bodies which change periodically as the water level fluctuates.

2.4.1 Invertebrates

There are several groups of invertebrate animals associated with terrestrial and aquatic habitats at the site. Of particular interest are benthic invertebrates, which include a variety of crustaceans (e.g. amphipods, isopods, decapods, crabs, barnacles), mollusks (e.g. snails), and larval insects (especially dragonflies and flies such as "midges"). The benthic invertebrates spend most if not all of their time in direct contact with sediments, some of which are immersed in the matrix. The "benthos" community is generally regarded as a major source of secondary production in aquatic systems, providing important prey for many members of both of the last two major aquatic communities (nekton and wildlife). This ERA addresses potential adverse effects for benthic invertebrates by comparing sediment or soil concentrations of COPECs to published soil or sediment quality guidelines. The other major aquatic invertebrate group is referred to as "zooplankton". These microscopic animals are suspended in water columns, and include crustaceans (e.g. copepods and cladocerans), protozoans, rotifers, and numerous early-life stages of a wide variety of invertebrate species (e.g. larvae of many species of crustaceans, mollusks, insects, and other taxa). The terrestrial invertebrates include annelids, isopods, butterflies, and other insects. Other aquatic insects such as dragonflies have a terrestrial stage (and spend a portion of their life cycle in the water).

2.4.2 Nekton (Aquatic Animals)

Nektonic animals ("swimmers") are relatively large, physiologically and structurally complex animals such as fish that spend all (or virtually all) of their time in water. They generally respire by means of gills, although in some cases they are capable of obtaining oxygen via dermal or cloacal tissues from water or the atmosphere.

2.4.3 Wildlife (Vertebrates)

The final category of animals that occur in the study area are vertebrates. These animals are relatively large and mobile, characterized by relatively complex physiology and structure, and generally perceived by the public to be more charismatic or "important" from an anthropocentric perspective. For most people, to the extent that they are not domesticated, these vertebrates are considered "wildlife". They belong to four phylogenetic classes: amphibians, reptiles, birds, and mammals. In this and most other ERAs, wildlife is treated as individual species (in contrast to the above discussed "communities" of other animals and plants). By definition, a population is a group of organisms of a species and is the fundamental consideration for most ERAs.

Owing to their mobility and size, wildlife species are exposed indirectly to COPECs, primarily via ingestion of other organisms and physical media (soils and sediment). There are other potential pathways (e.g. dermal contact and inhalation), although the latter typically is irrelevant unless COPECs include highly volatile substances. Dermal contact is also ordinarily minimal because most "higher" vertebrates (birds and mammals) have feathers or fur to protect their skin.

2.5 Exposure Pathways and Conceptual Site Model

A Conceptual Site Model (CSM) was developed that depicts the potential ecological exposure pathways considered for the VPSB property (Figure 3). The CSM is a component of the USEPA's problem formulation phase that addresses: 1) sources of COPECs, 2) probable contaminant fate and transport mechanisms, 3) identification of potential complete exposure pathways, and 4) endpoints (receptors) to screen for ecological risk. For the VPSB property, the viable potential exposure pathway is through surficial soil/sediment with dermal contact and oral uptake as possible mechanisms depending upon the habits of the receptors of interest. For the ERA, the biologically active zone of soils/sediments was considered; therefore, subsurface soils (> 3 feet depth) are not potential pathways for ecological exposure. Similarly, there are no indications that the air pathway through dust and inhalation provide significant pathways based upon the site characteristics. Although surface water on site does not present any symptoms of exposure or adverse effects and there was no indication of exposure by this pathway, exposure to surface water is considered in this ERA. Groundwater was not considered a significant exposure pathway, therefore was ruled out of the ERA. Thus, potential risks to receptors are considered primarily through exposures to sediments and soils on the property.

2.6 Effects Evaluation

The next step in the SLERA is the preliminary ecological evaluation and establishment of COPEC exposure levels (i.e. concentrations) that represent conservative thresholds for adverse ecological effects (USEPA 1997). Those conservative thresholds for adverse effects are also referred to as ecotoxicity screening values (ESVs) or soil and sediment screening levels. ESVs are concentrations of COPECs that essentially represent general background levels of analytes or levels that pose no risks for adverse effects for exposed wildlife. Toxicity cannot necessarily be expected in soils or sediments for which only a single guideline or even multiple guidelines were exceeded because those screening guidelines were not intended as toxicity thresholds or absolute predictors of toxicity (e.g. Long and MacDonald 1998).

ESVs are typically derived from laboratory studies and endpoints such as lowest observed adverse effect level (LOAEL) and the no observed adverse effect level (NOAEL). The LOAEL is the lowest dose or exposure concentration that results in a statistically significant effect compared to a control. The NOAEL is the highest dose or exposure concentration at which there is no statistically significant difference from the untreated control response in a laboratory study. By definition, the NOAEL represents a dose or concentration at or below which a risk is not expected to occur. Practically, an NOAEL cannot be exceeded if concentrations of COPECs do not exceed background. Similarly, soil and sediment screening values are levels that are expected not to result in a significant exposure or consequent dose.

ESVs are also not site-specific. The published values are intended to be conservative, and when exceeded can serve as a point of departure for more detailed site-specific ecological risk analysis. Soil (or sediment) screening levels alone do not trigger the need for response actions or define "unacceptable" levels of contaminants in soils (USEPA 1996). In USEPA guidance, "screening" refers to the process of identifying and defining areas, contaminants, and conditions, at sites on a property that do not require further attention. Generally, at sites where contaminant concentrations fall below screening levels, no further action or study is warranted. Also, where contaminant concentrations exceed ESVs, further study or investigation, but not necessarily "cleanup", may be warranted.

Appropriate soil/sediment screening values for the VPSB property would include USEPA ecological soil and sediment screening levels (e.g. US EPA Eco-SSLs) that are applicable for assessing exposures to metals at the site. Eco-SSLs are based on primary ecotoxicity literature studies for the protection of plants, soil invertebrates, birds, and mammals. This ERA addresses potential adverse effects for sediment dwelling invertebrates by comparing sediment or soil concentrations of COPECs to multiple sediment quality guidelines. I have also included 29B values which are not designed for the purpose of assessing ecological risk. The screening values used in this SLERA are listed in Tables 2 and 3.

3.0 USEPA (1997) Step 2

3.1 Screening Level Estimates of Exposure and Risk Calculations

3.2 Screening Level Exposure Estimates

To estimate environmental exposure concentrations, very conservative assumptions are initially used to ensure protection of ecological receptors on the VPSB property. For this SLERA, receptors are assumed to be exposed to the maximum COPEC concentrations detected in the soil/sediment samples from the site collected by MP&A (2015) and ICON (2010, 2015). Other conservative assumptions include: 1) home range of ecological receptors is 100% on site; 2) COPECs are 100% bioavailable; 3) the most sensitive life stages of receptors are continually exposed to COPECs; and 4) receptor diets are composed 100% of the most contaminated food source (i.e. the soil or sediment). Thus, exposure estimates are inherently "worst case" initially for the SLERA. These types of conservative parameters are also typically inherent in the toxicity studies used to derive screening levels (as used in the SLERA) and result in very conservative

and even unrealistic estimates of risks for a property. Results from the SLERA are used to screen out areas from further investigation (at or below the screening values), or to include areas for further study (above screening values).

ICON (2010, 2015) and MP&A (2015) reported results for soil/sediment samples from multiple depth intervals. Per RECAP recommendations (LDEQ RECAP 7.0 - p.111 Data Requirements), analytical results for the shallowest depth intervals were used for the SLERA in order to best approximate the biologically active zone (i.e. 0 to 3 feet bgs). For example, the general pattern for distribution of infaunal benthic invertebrates is that the greatest numbers of organisms occur within 2 to 5 centimeters (1 to 2 inches) of the sediment surface, with very few numbers of organisms found deeper than 20 centimeters (8 inches) (Bosworth and Thibodeaux 1990). Surficial dwelling organisms generally contact the top 0 to 2 feet bgs of soil or less (Suter 2007). Maximum COPEC concentrations from the MP&A (2015) and ICON (2010, 2015) samples collected from the VPSB are summarized in Table 1 and Figure 2. The screening level approach is much more conservative than a site specific analysis, and offers the possibility of indicating potential risk where none exists ("repairing something that is not broken"). A sequential approach (SLERA followed by site-specific BERA) is scientifically defensible and needed for accurate assessment of this site. As usual, the risk assessor must make decisions and all decisions must be clearly presented and defended for each assessment (USEPA 1997).

3.3 Screening Level Risk Calculations

In accordance with USEPA (1997) guidance, the screening-level ecological risk can be estimated using the hazard quotient approach by comparing point estimates of ESVs and exposure values. For this SLERA, the hazard quotient (HQ) is defined by the estimated environmental concentration (EEC) divided by the ESV:

$$HQ = EEC / ESV$$

where the EEC is the maximum concentration detected in the medium (mg substance/kg medium) on the property and the ESV is a concentration representing an estimate of the threshold of a safe exposure. Thus, for each COPEC and environmental medium, the hazard quotient (HQ) is expressed as the ratio of a potential exposure level to an applicable toxicity-based threshold. For HQ values exceeding unity (1.0), the potential for adverse effects to the receptor is initially concluded to be possible (cannot be ruled out). In contrast, if the resulting HQ is equal to or less than unity, the potential for risks due to that COPEC can be considered negligible and therefore may be dropped from further consideration of risk for that exposure pathway. The logic is supported through the consistent application of conservative assumptions, biasing towards overestimating potential risks. If the information currently available is insufficient to determine potential risks of exposure to the COPECs (e.g. there are no reliable screening values) that COPEC is retained pending further review. It is important to remember that an HQ>1.0 does not mean that unacceptable ecological risks are extant on a property or that any risk mitigation activities are indicated, only that further analyses are required (e.g. a site-specific risk assessment or BERA).

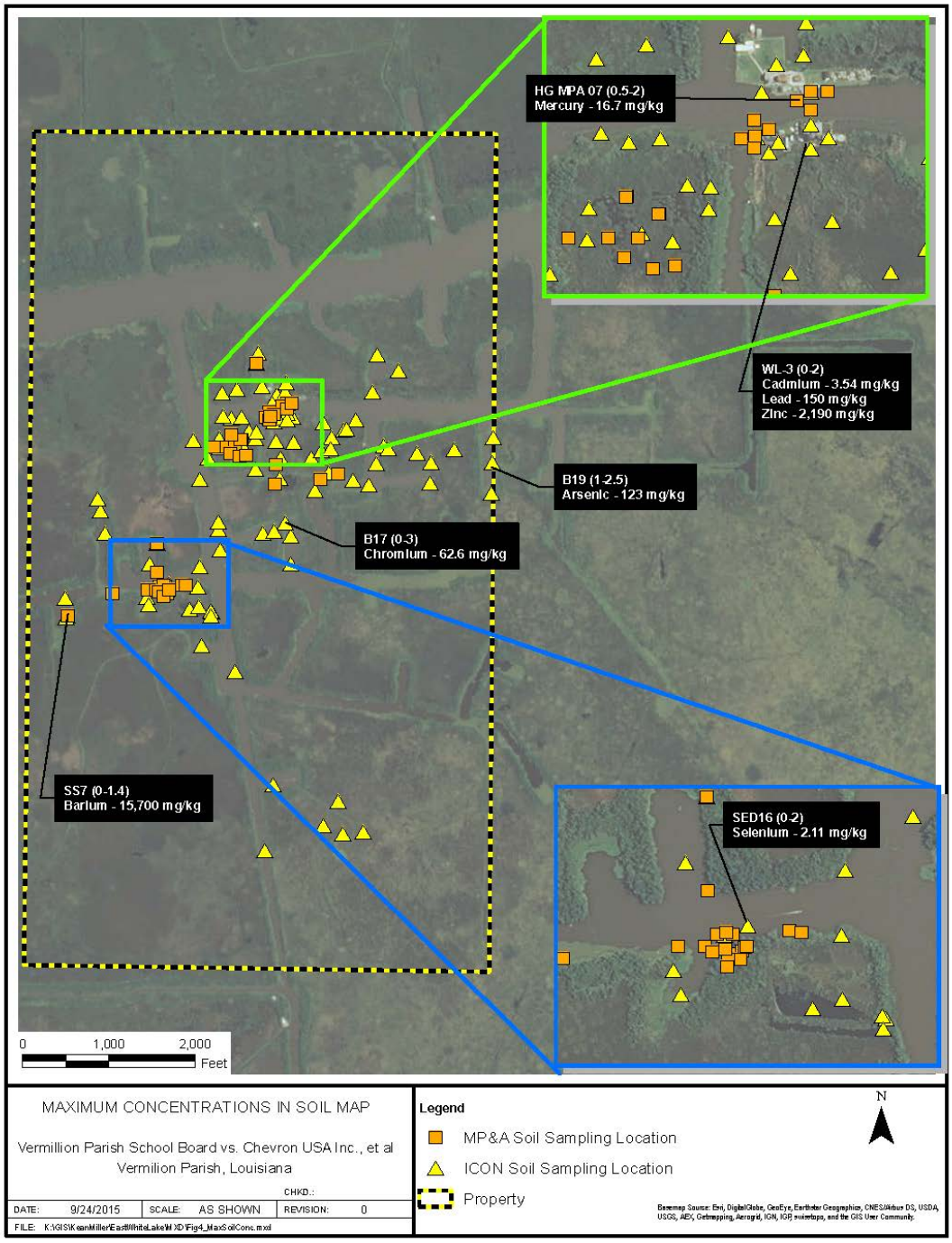

Figure 2: **Soil and Sediment Sampling Locations Evaluated in the Screening Level Ecological Risk Assessment (ICON 2010; MP&A 2010; 2015). All samples from surface soil or sediment with 0-3 feet depth.**

Table 2: Maximum soil and sediment concentrations reported at VPSB property (ICON 2010; ICON 2015; MP&A 2010; 2014)

Constituents	Maximum Reported Concentration	Location (depth feet bgs)	Sample Date
Metals (mg/kg-dry)			
Arsenic	123	B19 (1-2.5)	8/10/2006
Barium	15,700	SS7 (0- 1.4)	4/26/2006
Cadmium	3.54	WL-3 (0-2)	1/6/2015
Chromium	62.6	B17 (0-3)	8/10/2006
Lead	150	WL-3 (0-2)	1/6/2015
Mercury	16.7	HG MPA 07 (0.5-2)	10/15/2014
Selenium	2.11	SED16 (0-2)	2/26/2010
Zinc	2,190	WL-3 (0-2)	1/6/2015

Table 3: **Soil/Sediment Screening Values for Estimation of Potential Ecological Risks.** All concentrations are reported as mg/kg (dry wt.). NDt indicates that the USEPA determined that there are not enough data of sufficient quality to derive an Eco-SSL. NA indicates that an Eco-SSL or other reliable screening value is not currently available.

Constituents	Screening Values					Maximum Reported Concentration	
	Eco-SSL[a]				29-B[b]	ICON (2010)[c]	MP&A (2010; 2014)[c]
	Soil		Wildlife				
	Plants	Invertebrates	Avian	Mammalian		Exceedance (Y/N)	Exceedance (Y/N)
Metals (mg/kg-dry)							
Arsenic	18	NDt	43	46	10	123, Y	10.5, Y
Barium	NDt	330	NDt	2000	NA	15700, Y	4887, Y
Cadmium	32	140	0.77	0.36	10	3.36, Y	3.54, Y
Chromium (III)	NDt	NDt	26	34	500	62.6, Y*	35.8, Y*
Chromium (VI)	NDt	NDt	NDt	130	-	62.6, Y*	35.8, Y*
Lead	120	1700	11	56	500	117, Y	150, Y
Mercury	NA	NA	NA	NA	10	16.7, Y	7.59, Y
Selenium	0.5	4.1	1.2	0.63	10	ND, N	2.11, Y
Zinc	160	120	46	79	500	1370, Y	2190, Y

NA Data Not Available; *NDt* Not Determined (data were insufficient to derive an Eco-SSL); *ND* Non-detect

(a) USEPA 2003

(b) Department of Natural Resources (DNR) regulations for onsite storage of nonhazardous oilfield waste generated by oilfield production

(c) Maximum concentration of reported in surface soil (0-3 feet below surface) map (ICON 2010; MP&A 2010; 2014)

*COPEC measured as total Chromium at VPSB site; for screening purposes both Chromium (III) and Chromium (VI) screening values were used

Table 4: **Sediment Screening Values for Estimation of Potential Ecological Risks.** All concentrations are reported as mg/kg (dry wt.). NA indicates that a reliable screening value was not available.

Constituent	Site Concentrations	Consensus Based PEC	Sediment Screening Values	Freshwater Sediment Guidance	Marine Sediment Guidance	Screening Level
	[Maximum]	(USEPA/ USGS Freshwater 2000)[a]	(USEPA Region 4)[b]	(NYDEC 2014)c	(NYDEC 2014)c	Exceedance (Y/N)
Metals (mg/kg-dry)						
Arsenic	123	33	7.24	10	8.2	Y
Barium	15,700	NA	NA	NA	NA	Y
Cadmium	3.54	4.98	1	1	1.2	Y
Chromium	62.6	111	52.3	43	81	Y
Lead	150	128	30.2	36	47	Y
Mercury	16.7	1.06	0.13	0.2	0.15	Y
Selenium	2.11	NDt	NDt	NDt	NDt	-
Zinc	2,190	459	124	120	150	Y

NA Data Not Available; *NDt* Not Determined

[a]Ingersoll et al. 2000. Prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines. USGS/USEPA/ Great Lakes national program office.

[b]Ecological Risk Assessment Bulletins - Supplement to RAGs (USEPA 2001)

[c]NYDEC 2014. Screening and Assessment of Contaminated Sediment. New York State Department of Environmental Conservation Division of Fish, Wildlife and Marine resources Bureau of Habitat. June 24, 2014.

Table 5: COPECs used for calculating Screening Level HQs for the VPSB property.

COPEC	[Maximum at Site][a] mg/kg-dry	Sample ID, Depth (ft)	Screening Value Lowest [ESV] mg/kg-dry	Screening Hazard Quotient (HQ) Based on Lowest [ESV]
Arsenic	123	B19 (1-2.5)	7.24	17.0
Barium	15,700	SS7 (0- 1.4)	330	47.6
Cadmium	3.54	WL-3 (0-2)	0.36	9.8
Chromium	62.6	B17 (0-3)	26	2.4
Lead	150	WL-3 (0-2)	11	13.6
Mercury	16.7	HG MPA 07 (0.5-2)	0.13	128.5
Selenium	2.11	SED16 (0-2)	0.5	4.2
Zinc	2,190	WL-3 (0-2)	46	47.6

[a]Maximum soil or sediment concentration observed on VPSB Property (ICON 2010; 2015; MP&A 2010; 2015)

Surface Water Screening Results

Surface water samples were collected in May 2010 by MP&A as part of the assessment of the East White Lake property. A total of 11 samples were collected from locations on the property and another 11 samples were collected off-site to represent area background samples. All samples were analyzed for dissolved Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Strontium and Zinc concentrations (Table 6). Surface water COPEC concentrations were compared to both Marine and Freshwater Chronic Aquatic Life Criteria. Maximum reported concentrations for Arsenic, Cadmium, Chromium, Mercury, Selenium, and Zinc did not exceed either freshwater or marine screening values (Table 6). Lead was detected above the method detection limit in 1 of the 11 surface water samples, and exceeded the screening values. While Lead was the only COPEC which exceeded the screening values, to be conservative, Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Zinc were included in the BERA.

Table 6: Screening Level HQs for water samples from the EWL property based on maximum reported values.

Location	unit	Dissolved Metals								
		Arsenic	**Barium**	**Cadmium**	**Chromium**	**Lead**	**Mercury**	**Selenium**	**Strontium**	**Zinc**
SW-01	mg/L	<0.00079	**0.28**	**0.00026**	**0.0017**	<0.0015	<0.000055	<0.0037	**0.69**	<0.004
SW-02	mg/L	<0.00079	**0.28**	**0.00027**	**0.0016**	<0.0015	**0.00009**	<0.0037	**0.74**	<0.004
SW-03	mg/L	<0.00079	**0.29**	<0.0001627	**0.0018**	<0.0015	**0.00009**	<0.0037	**0.71**	<0.004
SW-04	mg/L	<0.00079	**0.26**	**0.00035**	**0.0017**	<0.0015	**0.00006**	<0.0037	**0.73**	<0.004
SW-05	mg/L	<0.00079	**0.26**	<0.00016	**0.0018**	<0.0015	**0.00007**	<0.0037	**0.69**	<0.004
SW-06	mg/L	<0.00079	**0.37**	**0.0002**	**0.0021**	<0.0015	**0.0001**	<0.0037	**0.91**	<0.004
SW-07	mg/L	<0.00079	**0.42**	**0.00024**	**0.002**	<0.0015	**0.00009**	<0.0037	**0.93**	<0.004
SW-09	mg/L	<0.00079	**0.37**	<0.00016	**0.0024**	<0.0015	**0.0001**	<0.0037	**1**	**0.0095**
SW-10	mg/L	<0.00079	**0.35**	<0.00016	**0.0022**	<0.0015	**0.00012**	<0.0037	**0.88**	<0.004
SW-20	mg/L	**0.0075**	**1.1**	<0.00016	**0.0051**	**0.0088**	<0.000055	<0.0037	**1.66**	**0.023**
SW-109*	mg/L	<0.00079	**0.38**	**0.00027**	**0.0022**	<0.0015	**0.00006**	<0.0037	**1.03**	<0.004
SW BK-01	mg/L	<0.00079	**0.28**	<0.00016	**0.0032**	**0.0023**	**0.00006**	<0.0037	**1.05**	<0.004
SW BK-02	mg/L	<0.00079	**0.3**	<0.00016	**0.0033**	<0.0015	<0.000055	<0.0037	**1.12**	<0.004
SW BK-03	mg/L	<0.00079	**0.28**	<0.00016	**0.0025**	<0.0015	<0.000055	<0.0037	**0.84**	<0.004
SW BK-04	mg/L	<0.00079	**0.29**	<0.00016	**0.0038**	<0.0015	**0.00006**	<0.0037	**1.06**	<0.004
SW BK-05	mg/L	<0.00079	**0.3**	<0.00016	**0.003**	<0.0015	<0.000055	<0.0037	**1.04**	<0.004
SW BK-06	mg/L	**0.0047**	**0.39**	<0.00016	**0.0036**	**0.0021**	<0.000055	<0.0037	**1.56**	<0.004
SW BK-07	mg/L	**0.0033**	**0.4**	<0.00016	**0.0024**	<0.0015	<0.000055	<0.0037	**0.95**	<0.004
SW BK-08	mg/L	<0.00079	**0.31**	<0.00016	**0.0028**	<0.0015	<0.000055	<0.0037	**1.04**	<0.004
SW BK-09	mg/L	<0.00079	**0.33**	<0.00016	**0.003**	<0.0015	<0.000055	<0.0037	**1.06**	<0.004
SW BK-10	mg/L	**0.003**	**0.14**	**0.00086**	**0.00071**	<0.0015	<0.000055	<0.0037	**0.34**	<0.004
SW BK-11	mg/L	**0.0029**	**0.18**	**0.00078**	**0.0011**	<0.0015	<0.000055	<0.0037	**0.52**	<0.004
Number Detected	(n/of total)	1/11	11/11	6/11	11/11	1/11	9/11	0/11	11/11	2/11
Maximum Value at Site	mg/L	**0.0075**	**1.1**	**0.0004**	**0.0051**	**0.0088**	**0.00012**	**<0.0037**	**1.6600**	**0.0230**
Chronic Aquatic Life Criteria -Freshwater	mg/L	0.1500	NR	0.0028	0.0244	0.0056	0.0008	NR	NR	0.3383
Exceeds Freshwater	Y/N	NO	N/A	NO	NO	**Yes**	NO	N/A	N/A	NO
Chronic Aquatic Life Criteria -Marine	mg/L	0.0360	NR	0.0100	0.1030	0.0081	0.0009	0.0710	NR	0.0810
Exceeds Marine	Y/N	NO	N/A	NO	NO	**Yes**	NO	NO	N/A	NO

NR = none reported
N/A = not applicable
Hardness-dependent freshwater criteria are calculated with a maximum hardness value of 400 mg/L $CaCO_3$ as specified in 40 CFR 131.36.

3.4 Risk Characterization

Risk characterization, the final phase of the initial SLERA process, integrates data for exposures and effects into a statement about risk focused on the assessment endpoints established during problem formulation. The screening values used in the SLERA are not site-specific and are intended to be very conservative. If the screening values are not exceeded, there should be no risk due to exposures of COPECs at the site, and if the values are exceeded, this can serve as a point of departure for more detailed and focused site-specific ecological risk analysis prior to any risk mitigation planning. Based on the conservative nature of this SLERA (e.g. maximum detected concentrations for COPECs, etc.), HQs at or near unity are not considered significant (USEPA 1997). It is important to note that most of the samples from extensive sampling of targeted areas of the VPSB property did not indicate concentrations of constituents that would pose any ecological risks. To the extent where HQs were not at unity, COPECs were carried forward for a further site specific evaluation in the BERA.

Importantly, the few samples that exceeded the conservative ESVs were samples located in a relatively small area on the VPSB property (Figure 2). For most of the VPSB property, most COPECs in soil and sediment samples were at or near background levels indicating no ecological risks for species living on or occasionally using the property .

The VPSB property is dominated by wetland habitat, as indicated by the flora and fauna present at the site (Rodgers 2010, Connelly and Rodgers 2014). In the higher-tier risk evaluation (i.e. BERA), site specific conditions at the VPSB property which influence the exposure (e.g. bioavailability) of COPECs were considered. Factors controlling bioavailability of Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Zinc in soils and wetland sediments are outlined below as well as a summary of Total Petroleum Hydrocarbons (TPH).

Arsenic

Arsenic is present naturally in soils and sediments throughout Louisiana (LDEQ 2001). In wetlands, arsenic is typically associated with sulfide mineral deposits or bound to iron oxyhydroxides (Henke, 2009; Rahman et al., 2006). Wetlands facilitate arsenic sequestration by accommodating the necessary biogeochemical conditions, including sediment redox potential, dissolved oxygen (DO) concentration, and pH (Dorman et al., 2009; Eggert et al., 2008; Spacil et al., 2011). Wetlands promote co-precipitation and sorption of arsenic with iron oxyhydroxides under oxidizing conditions, and precipitation of arsenic with sulfide and co-precipitation of arsenic with iron sulfide under reducing conditions. At the VPSB site, acid volatile sulfide (AVS) was detected in sediment samples, with concentrations ranging from 0.11 to 60.9 µmol/g (Appendix B), indicating the biogeochemistry at the site supports the sequestration of arsenic into non-bioavailable forms.

Barium

Based on the conditions present at the VPSB property, barium in surficial soil and sediment is likely in the mineral form barite (barium sulfate; $BaSO_4$; LDHH, 2015). Barite has a

relatively low water solubility (i.e. <0.003 g/L) compared to other forms of barium (greater than 87 g/L; Menzie et al. 2008). Barium exposures in surficial soils on this property are not of concern because the barium at the site is mostly barite which would essentially not be bioavailable (Menzie et al. 2008, Alberta Environment 2009). The area on the VPSB property containing barium in sediments or soils measured above background is a relatively small area of legacy activities. There is no evidence of accumulation of barium by any species or harm due to barium on the VPSB property and accumulation would not be expected from exposure to barite, so no adverse effects due to barium on the property would be possible.

Cadmium

In naturally occurring surface waters, cadmium is present normally as Cd (II). In a wetland environment, this transitional metal can form strong covalent bonds with reduced forms of sulfur (pK CdS = 27.0; Brookings 1988) and partition to organic matter by weak non-specific sorption reactions. Sulfide bound species of cadmium are relatively insoluble (Ksp CdS = 1×10-27). In reducing conditions, CdS minerals are relatively stable, as indicated by the pK value of Cd, and require strongly acidic or oxidizing conditions to release Cd from these minerals (Kirk, 2004). At the VPSB site, acid volatile sulfide (AVS) concentrations support the sequestration of cadmium into non-bioavailable forms. Based on the properties of cadmium and the nature of the VPSB property, bioavailability of cadmium would be minimal.

Chromium

Under anoxic conditions in wetlands, Cr(VI) is readily reduced to Cr(III) by a number of chemical ligands (e.g. reduced sulfur, iron, and organic reductants) and microbial species found in wetland environments (Longmire et al. 2013). Cr(III) has very low solubility at mid-range pH values due to the formation of $Cr(OH)_3$. Because most sediments are anoxic, oxidation of Cr(III) to Cr(VI) does not readily occur, trivalent chromium is the dominant species in wetland areas. Consequently, chromium exists in wetland soils and sediments primarily as Cr(III), which is relatively insoluble and nontoxic. Chromium (VI) is thermodynamically unstable in wetland soils and anoxic sediments, and acid-volatile sulfides (AVS) are formed in those sediments to sequester hexavalent chromium (Berry et al. 2004). Therefore sediments with measurable AVS concentrations should not contain toxic Cr(VI) and AVS can form the basis for a theoretical guideline for Cr in sediments (Basser et al. 2004). In sediments where AVS exceeded analytical detection limits, Cr concentrations in interstitial water were very low (<100 µg/L) and no significant toxicity to *Ampelisca abdita* was observed (Berry et al. 2004). Titrations of sediments with Cr(VI) revealed complete Cr(VI) reduction when added Cr(VI) did not exceed sedimentary sulfide measured as acid volatile sulfide (AVS). Cr(VI) reduction rates were extremely rapid (half-life of minutes for 1.0 g/L sediment suspensions) and correlated with AVS concentrations of the sediment suspensions. At the VPSB site, acid volatile sulfide (AVS) concentrations support the sequestration of chromium into non-bioavailable forms. Essentially all of the chromium in wetland sediments and soils will exist as Cr(III) and no measurable toxicity due to this form of chromium will be observed (Masscheleyn et al. 1992).

Lead

Lead occurs typically in aqueous systems as Pb (II), but can exist as a fully oxidized species, Pb (IV). In aerobic soils, lead is attracted onto clay surfaces and oxide formations or it can complex with organic matter and reduced sulfur compounds. Lead can also form insoluble hydroxides, carbonates and phosphate complexes. In anaerobic wetland soils where sulfides are present, galena (PbS) forms as a highly insoluble precipitate (pK =27.5; Brookings 1988; Kirk, 2004). At the VPSB site, acid volatile sulfide (AVS) concentrations support the sequestration of lead into non-bioavailable forms. Given the propensity of lead to readily combine with sulfides, lead bioavailability would be minimal on the VPSB property.

Mercury

The biogeochemical cycling of mercury (Hg) is complex. Mercury has three oxidation states including elemental (Hg0), mercurous (Hg I), and mercuric (Hg II) with solubility generally increasing with oxidation (Kaplan et al. 2002). Due to physical and chemical characteristics, Hg has a tendency to be mobile through gas, liquid, and solid phases, but can also form relatively stable complexes such as cinnabar (HgS) (Kosolapov et al. 2004). Wetland environments that favor production of HgS contain soluble sulfides from microbial degradation of organic carbon (e.g. dissimilatory sulfate reduction) and permit complexation reactions between Hg and S2- to proceed before microbial reduction of Hg (II) can occur (Kadlec and Wallace 2009). Formation of mercuric polysulfides can also occur in low Eh environments (< -100 mV) and is a result of exceptional concentrations of reactive sulfide (Paquette and Helz 1995). Conditions on the VPSB property and the characteristics of mercury support the conclusion that bioavailability of mercury on the property is likely minimal.

Selenium

The chemistry of selenium in wetlands resembles that of sulfur (S) because of its proximity to it within group VI-A of the periodic table. Selenium, like S, can exist in four different oxidation states: selenide [Se(-II)], elemental selenium [Se(O)], selenite [Se(IV)], and selenate [Se(VI). Equilibrium speciation information for Se has been summarized and graphically displayed in redox-pH- (pe-pH-) related diagrams. At pH and redox (pe = Eh(mV)/59.2) conditions occurring in most aqueous and aerobic sedimentary environments, Se exists as oxyanion in the selenate (SeOi-), selenite (SeOZ-), or biselenite (HSeO,) form. At high redox values, selenate is predominant in a wide pH range. In the moderate redox range, biselenite and selenite are the major species at low and high pH, respectively. Elemental or native Se was thought to be rare in aqueous and aerobic sedimentary environments. However, elemental selenium has been reported to be present in reduced sediments and it is occasionally mixed with native S. As a result of biological conversions, however, thermodynamically predicted Se chemical species are often not present in the environment. They are frequently transformed to kinetically stabilized species. Thus, thermodynamic predictions are often misleading when applied to natural systems. Furthermore, details of constructed pe-pH diagrams depend on the assumptions made about ion activities and complexing agents.

Generally, Se species distribution and solubility are affected by wetland soil or sediment redox potentials. Selenium solubility is highest under oxidized conditions and decreases significantly upon reduction. In wetlands, at low redox potentials, elemental selenium or a metal selenide can limit Se solubility. Several investigators have found red amorphous and black crystalline Se(0) to be the end products of dissimilatory Se oxyanion reduction. Metal selenides of importance in wetland ecosystems are achavalite (FeSe) and ferroselite (FeSe). It has also been noted that selenium can ionically substitute for sulfur in metallic sulfide minerals. Especially important are chalcopyrite (CuFeS,) and pyrite (FeS,), although Se may also substitute in other sulfides such as galena (PbS) and pyrrhotite (FeS). In view of the above described geochemical considerations, it appears that the formation of nontoxic elemental Se or insoluble iron selenides in flooded soils and anoxic sediments could act as an environmentally important sink for selenium and an environmentally critical source if redox conditions change. For wetland sediments containing oxidizable organic matter, formation of elemental selenium by microbial dissimilatory selenium reduction would be expected to greatly decrease bioavailability of selenium in sediments. Based on the biogeochemical conditions present at the VPSB site, it is likely that the bioavailability of selenium would be decreased.

Zinc

Under reducing wetland environments, zinc can be reduced to an insoluble sulfide form (ZnS, pK=24.7). Zinc is readily precipitated with sulfide, forming insoluble sulfide species that are relatively non-bioavailable (Brookings 1988; Gillespie et al., 1999; Gillespie et al., 2000). In aerobic conditions, zinc is mostly immobile, but under acidic oxidizing conditions, zinc can form soluble and mobile species of Zn. In higher pH ranges (pH 8-11), Zn (II) combines with calcium and magnesium carbonates to form co-precipitants (hydroxyl-carbonates; Stumm and Morgan 1996). In wetlands, Zn is primarily associated with insoluble sulfides, and minimally retained in plants (Gillespie et al., 1999; Gillespie et al., 2000). At the VPSB site, acid volatile sulfide (AVS) concentrations support the sequestration of zinc into non-bioavailable forms. Based on the conditions present at the VPSB property, the bioavailability of zinc is likely minimal.

Total Petroleum Hydrocarbons

Total Petroleum Hydrocarbon (TPH) measurements are not reliable for prediction of ecotoxicity. TPH is a term intended to refer to the total mass of hydrocarbons present without identifying individual compounds. In practice, TPH is defined by the analytical method that is used to measure the hydrocarbon content in contaminated media. To the extent that the hydrocarbon extraction efficiency is not identical for each method, the same soil or sediment sample analyzed by different TPH methods will produce different TPH concentrations. TPH measurements for soils and sediments are also subject to interferences that can contribute to “false positive” estimates of concentrations. TPH provides little basis for performing a risk assessment because it supplies limited information about the composition and, therefore, the properties that determine potential fate and toxicity of the material. However, it may be useful for determining the extent of contamination or the locations of the greatest contamination. Identification and quantification of specific fractions of TPH can shed more light on the potential for toxicity in a soil or sediment. The fractions can be used to indicate differences in oil composition and differential weathering patterns among chemical species within the crude. Definitive, scientific values for

higher tier ecological risk assessment have not been developed. For the VPSB property, forage fish and crab were collected from the East White Lake Oil Field canals and adjacent sites and processed and analyzed for TPH fractions. Based on analyses of tissue TPH residues in biota, there were no indications of ecological risks due to TPH on the VPSB property and therefore were not included in the BERA.

Based on the results from this SLERA and in order to be conservative, Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Zinc were retained for more detailed evaluation in a BERA. These COPECs are likely bound to soil particles with limited mobility and do not pose unacceptable risks from transport off site. Nor do they likely pose risks to biota on the property. The ecological screening values assume 100% utilization of the soil or sediment sample core by organisms (feeding, etc.) and maximum bioavailability. Much of the soils and sediments on this site have weathered for decades and there has been no evidence of adverse effects to biota. In a precautionary approach and to assuage residual concerns, the following site specific risk assessment is provided.

4.0 USEPA (1997) Step 3.

4.1 Problem Formulation

Based on the results from Step 2 of the US EPA (1997) ERA process, the following COPECs on the VPSB property exceeded the very conservative screening levels, so the potential for harmful effects to the ecological receptors cannot be ruled out using the initial screening process. COPECs retained for further investigation included:

- Arsenic
- Barium
- Cadmium
- Chromium
- Lead
- Mercury
- Selenium
- Zinc

Based on the screening results and the embodied data and assumptions, the Scientific Management Decision at the conclusion of Step 2 was to progress to a site-specific BERA. To ensure the integrity and transparency required in the BERA, the assessment proceeded through the following steps as recommended by the USEPA (1997).

BERA is a detailed site-specific ecological evaluation that accounts for the nature and extent of the COPECs retained, their ecotoxicity, and any complete exposure pathways. Except for protected species such as the bald eagle, the BERA differs from Human Risk Assessment (HRA) in that the BERA evaluates the potential toxicological impacts to populations of ecological receptors or their habitat rather than to individual receptors evaluated in the HRA. The ERA process includes identification of the potentially exposed habitats and indicator or surrogate species that may utilize those habitats.

Due to the number of potential species that can be found within a habitat, the ERA process includes guidance for selecting indicator species that are representative of the potentially impacted habitat and the potential toxicity of the COPECs. In the BERA, the risk assessor evaluates the potential bioavailability of the COPECs and their physical and biological fate and transport including potential for bioconcentration, bioaccumulation and biomagnification in the food chain. Selection of indicator species typically relies on guilds as presented in USEPA Risk Assessment Guidance (EPA 1989, 1997). In this process, the risk assessor evaluates the COPEC/trophic level/food chain relationships as well as physical aspects of the habitat to select appropriate species to act as indicators of the COPEC toxicity. Endpoints in the BERA are typically based on potential for mortality or impact on reproduction or growth within the indicator or surrogate species populations.

Species were selected for detailed evaluation based upon recommendations provided by USEPA (1997). In order to address a variety of exposures via ingestion, several species are required. Feeding or trophic guilds are useful concepts to categorize the components of the diets (food habits) and feeding mechanisms (behaviors) among wildlife species. Diverse diets and feeding methods are a major factor allowing variety among co-existing or sympatric species. Numerous birds and mammals that use the aquatic and semi-aquatic habitats in the East White Lake Oil Field were evaluated as potential candidate wildlife receptors based on this trophic-guild approach. The following factors were considered in the selection process:

- Ecological relevance to site
- Vulnerability to exposures
- Sensitivity to toxic effects of site COPECs
- Social and economic importance
- Protected status (e.g. endangered species, species of special concern)
- Availability of species-specific behavioral, physiological and toxicological information.

For this site-specific BERA for the VPSB property, several avian and mammal surrogate species were selected for evaluation: American Robin, Spotted Sandpiper, American Woodcock, Mallard Duck, Snowy Egret, Least Shrew, Swamp Rabbit, Red Fox, Great Blue Heron and American Mink. As presented below, these species represent a variety of feeding habits as well as behavior patterns and sensitivities. Species descriptions are outlined below:

American Robin *(Turdus migratorius)*

American Robins are common birds across the continent as well as in Louisiana. These robins are numerous and widespread, and their populations are stable or increasing throughout their range over the last few decades, according to the North American Breeding Bird Survey. Ruth et al. (2006) estimates the global breeding population at 310 million, with 79 percent spending some part of the year in the U.S., 45 percent in Canada, and 13 percent in Mexico. During winter many robins move to moist woods where berry-producing trees and shrubs are common. The American Robin forages largely on lawns and they eat a lot of fruit in fall and winter. American Robins eat large amounts of both invertebrates and fruit. Particularly in spring and summer, they eat mostly earthworms as well as insects and some snails. Robins eat a variety of fruits, including chokecherries, hawthorn, dogwood, and sumac fruits, and juniper berries. One study has suggested that robins may try to round out their diet by selectively eating fruits that have insects in them.

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American woodcock (*Scolopax minor*)

The American woodcock is the only species of woodcock inhabiting North America. Although classified with the sandpipers and shorebirds in Family Scolopacidae, the American woodcock lives mainly in upland settings. The American Woodcock is a small shorebird species found primarily in the eastern half of North America. Woodcocks spend most of their time on the ground in brushy, young-forest habitats, where the birds' brown, black, and gray plumage provides excellent camouflage. American woodcock live in wet thickets, moist woods, and brushy swamps. Ideal habitats feature young forest and abandoned farmland mixed with forest. In late summer, some woodcocks roost on the ground at night in large openings among sparse, patchy vegetation. The maximum lifespan of adult American woodcock in the wild is 8 years.

The American woodcock has a plump body, short legs, a large, rounded head, and a long, straight prehensile bill. The bill is 2.5 to 2.75 inches (6.4 to 7.0 cm) long. The woodcock uses its long prehensile bill to probe in the soil for food, mainly invertebrates and especially earthworms. Insects are also important in their diet, especially insect larvae that burrow in soil, such as those of many beetles, crane flies, and others. Also eaten are millipedes, spiders, snails, and other invertebrates. The woodcock consumes some plant material, including seeds of grasses, sedges, smartweeds. A unique bone-and-muscle arrangement lets the bird open and close the tip of its upper bill, or mandible, while it is in the ground. Both the underside of the upper mandible and the long tongue are rough-surfaced for grasping slippery prey. Woodcocks have large eyes located high in the head, and their visual field is probably the largest of any bird, 360° in the horizontal plane and 180° in the vertical plane.

As a migratory bird, the American woodcock lives in the North during spring and summer but spends the cold months in the South. The primary breeding range extends from Atlantic Canada (Nova Scotia, Prince Edward Island, and New Brunswick) west to southeastern Manitoba, and south to northern Virginia, western North Carolina, Kentucky, northern Tennessee, northern Illinois, Missouri, and eastern Kansas. A limited number of woodcock breed as far south as Florida and Texas. After migrating south in autumn, most woodcock spend the winter in the Gulf Coast and southeastern Atlantic Coast states. Some may remain as far north as southern Maryland, eastern Virginia, and southern New Jersey. The core of the wintering range centers on

Louisiana, Mississippi, Alabama, and Georgia.

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Great Blue Heron (*Ardea herodias*)

The great blue heron is one of the largest and most widespread wading birds in North America. It is one of two subspecies recognized on the continent, the second one being the great white heron (*Ardea occidentalis*) of Florida. The adult great blue heron is a large bird, standing 60 cm tall or more and measuring 97 to 137 cm long. The wings are long and broad, and the tail short. In flight, the long neck is doubled back in an S-shape and the head rests against the shoulders. The legs and bill are also long (Tufts 1986, Butler 1992).

The breeding range of the great blue heron is extensive, ranging from the southern Canadian provinces to southern Mexico. Wintering and permanent range includes southeastern Massachusetts south along the coastal states and west across the south half of the U.S. into Mexico and northern South America. Most great blue herons breeding in the northern regions of the range migrate southward in winter and northward in summer. Southward migration from northern portions of the breeding range begins in September and October, though some birds are recorded annually in Canada in December. Herons begin returning to the New England region in mid- March. Overall, migration chronology is not well understood, and little information is available on migration routes or migratory behavior. Banding studies suggest many may winter in the Caribbean. Great blue herons usually migrate alone or in small groups, but also occasionally in larger flocks of up to 100 birds (Palmer 1962, Butler 1992, DeGraaf and Yamasaki 2001).

In the breeding season, great blue herons inhabit many different wetland community types. They feed primarily in shoreline areas associated with lakes, ponds, beaver flowages, slow-moving freshwater streams, and estuaries, though they are occasionally found in shallow coastal marine habitats and fields. Great blue herons typically nest in tall trees near water, but may also build nests on the ground, on rock ledges and sea cliffs, or in shrubs when trees are not available. They are typically colonial nesters but may also be solitary. The nest sites are often located on islands or in swamps, presumably to avoid land predators. Some nest sites are located far from food sources. Habitat use by great blue herons during spring and fall migrations is probably similar to that of the breeding season (Butler 1992). Results of studies from the midwestern and western states show that mean distances from nesting colonies to principal foraging grounds ranged from 2.3 to 6.5 km. Most breeding colonies are located within 2 to 4 miles of feeding areas, often in isolated swamps or on islands, and near lakes and ponds bordered by forests. Great blue herons forage and roost alone or in loose flocks (Butler 1992).

Herons look for food anytime there is enough light. Studies suggest that cloudy weather is ideal for the birds to look for fish. Great Blue Herons can hunt day and night thanks to a high percentage of rod-type photoreceptors in their eyes that improve their night vision. Herons do not just eat fish, however. They eat a wide variety of prey, including frogs, salamanders, turtles, snakes, insects, rodents, and small birds. They can be seen patrolling along the shores of rivers, ponds, and lakes. Great Blue Herons live in both freshwater and saltwater habitats, and also forage in grasslands and agricultural fields, where they stalk frogs and mammals. These birds

will strike downward with quickness when attacking prey. Great Blue Herons eat nearly anything within striking distance, including fish, amphibians, reptiles, small mammals, insects, and other birds. They grab smaller prey in their strong mandibles or use their dagger-like bills to impale larger fish, often shaking them to break or relax the sharp spines before gulping them down.

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Least Shrew *(Cryptotis parva)*

The North American least shrew (*Cryptotis parva*) is one of the smallest mammals, growing to only 3 inches long. The North American least shrew has a long pointed snout and a tail never more than twice the length of its hind foot. It has a dense fur coat that is either grayish-brown or reddish-brown with a white belly. Its fur becomes lighter in the summer and darker in the winter. Although similar in appearance to several species of rodents, all shrews are members of the order Soricomorpha. The North American least shrew's eyes are small and its ears are completely concealed within its short fur, giving it very poor eyesight and hearing.

The least shrew is found from the grasslands of southern Canada through the eastern and central United States and Mexico. The North American least shrew mostly dwells in mesic grasslands, marshes, and meadows. Least shrews prefer somewhat wet habitats, but the least shrew will also inhabit dry upland regions. This species can be found in meadows, fields, and weedy areas, where the vegetation attracts its insect diet.

This tiny shrew is active at all hours of the day, but mostly at night. Hunting by smell and touch, the North American least shrew digs through loose soil and leaf litter for its prey along the surface of the ground. The behavior of captive individuals suggests it can also tunnel through moist soil in search of food. However, it mostly occupies burrows built by other mammals.

Its diet consists of mostly small insects, such as caterpillars, beetle larvae, earthworms, centipedes, slugs, and sow bugs. It will also eat from the corpses of dead animals, and small amounts of seeds or fruits. This shrew will eat its prey whole, but when eating crickets and grasshoppers, the North American least shrew will bite off the head of its prey and eat only the internal organs. When fighting a larger creature, it will aim for the legs and try to cripple its adversary, and will bite lizards, which are often too large for it to kill, on the tail, which then falls off and provides it with a meal while the lizard escapes. The North American least shrew will also sometimes live inside beehives and eat all the larvae. It will often share its food with other shrews.

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Mallard Duck (*Anas platyrhynchos*)

The mallard is the most abundant and commonly recognized species of duck in North America. The male's characteristic and conspicuous green head, grey flanks, and black tail-curl make it easily identified. The mallard has long been a game bird and source of meat. The mallard is a relatively large, dabbling duck with broad wings. The male's (drake) distinctive green head and brown chest are separated by a white neck-ring, contrasted by gray sides, a brown back, and a black rump. The female (hen) is marked in a mottled pattern of light and dark brown streaks, accented by a dark brown streak through the eye. Both male and female mallards have a violet-blue speculum on each wing. Mallards have excellent eyesight and hearing, giving the duck an advantage when a predator approaches. The mallard is more vocal than other ducks and uses a variety of quacks to communicate its actions and moods.

The majority of the mallard population is migratory. They leave their nesting sites in the North and fly as far south as northern Mexico, beginning in the fall. The home range for paired mallards often exceeds 700 acres. Factors that influence the mallard's range or alter its patterns include human interference, habitat and food abundance, and lack of a mate. Mallards are multivores and opportunistic feeders. They consume insects and aquatic invertebrates, acorns, seeds, tubers and vegetative parts of aquatic plants, and crops, such as corn, soybeans, rice, barley, and wheat.

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American Mink (*Neovison vison*)

The word "mink" is used for the two species of animals still residing on the earth. These semi-aquatic species are the American mink (*Neovison vison*) and the European mink (*Mustela lutreola*). American mink are usually deep brown or black in color, although they also feature white markings on their chests and on some other parts of their bodies. The smooth-furred animals have short limbs, lithe physiques, tiny ears and lengthy necks. American mink adult males range in total length from 19 to 29 inches (48–74 cm) and females grow to lengths of 18 to 28 inches.

American mink roam over both Canada and the United States, although they do not exist in a few states and regions like Arizona and Hawaii. These nocturnal mammals usually inhabit forested areas, especially those that are near water sources including ponds, rivers, marshes and swamps. American mink often use rocks and tree logs for denning purposes.

American mink are primarily carnivores. Mink will eat virtually anything they can catch and kill, including fish, birds, bird eggs, insects, crabs, clams, and small mammals. Some of their preferred prey animals are rabbits, chipmunks, ducks, birds, snakes, mice, shrews, frogs, muskrats and fish. There are both seasonal and annual differences in the diet depending on what is available. In cold weather, American mink are especially drawn to mammal consumption. An abundance of rabbits or mice may cause them to move inland. Adult mink have been known to kill and eat young mink.

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Red Fox (*Vulpes vulpes*)

The red fox is a wild canine that occurs in a variety of habitats throughout its range. Although its typical color is red, the red fox also occurs in a melanistic form called a "silver fox" and as a gray and yellow mixed color referred to as a "cross fox." Regardless of its color, the red fox can be identified by its characteristic bushy, white-tipped tail, pointed muzzle, and prominent ears.

The red fox is the most widely distributed carnivore in the world, occurring throughout most of Europe and Asia and in parts of Africa and the Middle East (Lariviere and Pasitschniak-Arts 1996). In North America the red fox is present throughout Canada and the United States, excluding the arctic, portions of the south Atlantic coastal region, the southwestern desert, the Pacific coastal region, and portions of the south-central Great Plains (Lariviere and Pasitschniak-Arts 1996, Whitaker and Hamilton 1998). The red fox is native to the North American continent, but prior to the 1600's it was either rare or not present along the eastern seaboard.

The red fox is a non-migratory species that maintains its territory throughout the year (Voigt 1987, as cited in Lariviere and Pasitschniak-Arts 1996). The red fox occupies a wide range of habitats including semi-arid deserts, tundra, farmland, boreal forests, and metropolitan areas (Lariviere and Pasitschniak-Arts 1996). The species appears to thrive in heterogeneous and fragmented landscapes as opposed to large unbroken tracts of land. Its preferred habitat is an interspersion of forest, cropland, and pastureland (Voigt 1987, Lariviere and Pasitschniak-Arts 1996). Red foxes may use a wide variety of forest cover types, but mostly prefer early successional stands (DeGraaf and Yamasaki 2001). Other habitats used by this species include upland fields, savannas, orchards, alpine zone, palustrine wetland systems (excluding ponds), riparian zones, coastal beaches, sand/gravel banks, and areas with exposed bedrock, cliffs, or talus (DeGraaf and Yamasaki 2001). Availabilities of prey and suitable den sites are key factors affecting habitat selection by red fox (Whitaker and Hamilton 1998, Lariviere and Pasitschniak-Arts 1996). They prefer to locate their dens in a forest, but close to an open area, or in areas that provide thick cover (Whitaker and Hamilton 1998; Voigt and Broadfoot 1983). Typically, a den will be located on a hillside underlain by sandy loam or other soft soil, usually within 100 meters (330 feet) of a source of water (Whitaker and Hamilton 1998).

The red fox does not hibernate, but remains active throughout the year (Ables 1969). An individual home range for the red fox is occupied by a single family unit composed of a male-female pair and their pups (DeGraaf and Yamasaki 2001). Home ranges of this species typically are well defined, non-overlapping and contiguous, and conform to natural physical boundaries (Sargeant 1972). In cases where home ranges do overlap, the family units may be genetically related (Voigt 1987). The red fox appears to display at least some site fidelity. According to Voigt (1987), home ranges in this species may be synonymous with territories because foxes actively defend their home ranges. The size of individual red fox home range varies. Ranges are largest during the winter. Available prey biomass and the patchiness of prey appear to affect territory size in this species (Voigt and Macdonald 1984).

Red foxes are omnivorous and feed on a variety of prey and plant material. Their diet includes insects, small mammals (e.g. rodents and lagamorphs), birds, turtles, frogs, snakes, fish, eggs, carrion, earthworms, berries, fruits, seeds, and garbage (DeGraaf and Yamasaki 2001).

Mustelids, raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*), muskrats (*Ondarta zibethicus*), deer fawns, and ringed seal (*Phoca hispida*) pups are also known to be taken by red fox (Lariviere and Pasitschniak-Arts 1996). Birds in the fox's diet include galliformes, passeriformes, columbiformes, anseriformes, and raptors (Lariviere and Pasitschniak-Arts 1996). Anseriformes consumed by red foxes include bluewinged teal (*Anas discors),* northern pintail *(Anas acuta),* mallard *(Anas platyrhynchos*), northern shoveler (*Anas clypeata),* gadwall (*Anas strepera),* American wigeon (*Anas americana*), and greenwinged teal, (*Anas crecca)* (Sargeant *et al.* 1984). In a Maine study, scat analysis (n = 500) showed that the diet of the Maine red foxes include a variety of prey and plant material. The red fox's diet varies throughout the year and changes with food availability. During the winter, their diet includes mice, rabbits, birds, carrion, apples, and dried berries. The spring and summer diet includes rabbits, rodents and other small mammals, woodchucks, poultry, birds, snakes, turtles and their eggs, deer fawns, raspberries, and blackberries. Wild cherries, grapes, grasshoppers, and mice are consumed during the fall (Whitaker and Hamilton 1998). In Maine, consumption of small mammals by red foxes increases from winter to summer and from summer to fall, which coincides with increases in small mammal production resulting in peak populations during September and October (DiBello *et al.* 1990). In the northern prairies states, nesting dabbling ducks form a major portion of the red fox diet during the denning season (Sargeant *et al.* 1984). Red foxes will cache surplus food under leaf litter or snow and mark the location with urine (Whitaker and Hamilton 1998, DeGraaf and Yamasaki 2001). Caches appear to be relocated by memory and scent, but these cashes may be raided by other animals.

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Snowy Egret (*Egretta thula*)

One of the most common wading birds in the United States, the Snowy Egret has a range that is more widespread than all but the Great Blue Heron and Blackcrowned Night-Heron and the Snowy Egret is certainly more numerous than both of those species combined.

Described as a “dashing hunter” by Texas ornithologist Harry Oberholser, the Snowy Egret typically employs a “quiver step” walking technique as it stalks small aquatic creatures within the shallow water habitats in which it forages. With its black legs and yellow feet, it is thought that the resulting color contrast aids the bird in its kinetic hunting style. Interestingly, Oberholser (Bird Life of Texas, 1974) also suggested that crawfish top the long list of Snowy Egret prey items. It is doubtful that this observation is supported by Louisiana observers, who would probably put “minnows” at the top of the list. Nevertheless, on breezy, heavily overcast spring mornings, Snowy Egrets have been routinely observed to hover tern-style, over the edges of commercial crawfish ponds, snatching up immature crawfish as they move out of the deoxygenating water and onto the surface of adjacent aquatic vegetation to “gulp” air. Year round, Snowy Egrets are also among the most commonly observed (along with Great Egret, Yellow-crowned Night-Heron, White Ibis, and White-faced Ibis) wading bird species within

rice-crawfish aquaculture units.

Snowy Egrets nest in colonies on thick vegetation in isolated places—such as barrier islands, dredge-spoil islands, salt marsh islands, swamps, and marshes. They often change location from year to year. During the breeding season Snowy Egrets feed in estuaries, saltmarshes, tidal channels, shallow bays, and mangroves. They winter in mangroves, saltwater lagoons, freshwater swamps, grassy ponds, and temporary pools, and forage on beaches, shallow reefs, and wet fields.

The Snowy Egret eats mostly aquatic animals, including fish, frogs, worms, crustaceans, and insects. It often uses its bright yellow feet to paddle in the water or probe in the mud, rounding up prey before striking with its bill. Snowy Egrets feed while standing, walking, running, or hopping, and they may vibrate their bills, sway their heads, or flick their wings as part of prey gathering. They even forage while hovering. Snowy Egrets forage in saltmarsh pools, tidal channels, tidal flats, freshwater marshes, swamps, ocean inlets, and lake edges, usually preferring brackish or marine habitats with shallow water. Other foraging water birds often assemble around them to form mixed-species foraging groups. Snowy Egrets eat fish, crustaceans, insects, small reptiles, snails, frogs, worms, mice, and crayfish. They stalk prey in shallow water, often running or shuffling their feet, flushing prey into view, as well "dip-fishing" by flying with their feet just over the water. Snowy egrets may also stand still and wait to ambush prey, or hunt for insects stirred up by domestic animals in open fields. Snowy Egrets wade in shallow water to spear fish and other small aquatic animals. While they may employ a sit-and-wait technique to capture their food, sometimes they are much more animated, running back and forth through the water with their wings spread, chasing their prey.

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Spotted Sandpiper (*Actitis macularius*)

The Spotted Sandpiper is the most widespread sandpiper in North America, and it has one of the most unusual breeding systems found in birds -- polyandry (one female mating with more than one male). Unlike most sandpipers, the Spotted Sandpiper has invaded temperate areas to breed. Apparently polyandry is a successful reproductive strategy for taking advantage of the relatively long breeding season (compared with the season in the arctic and subarctic breeding areas used by most members of this family). The Spotted Sandpiper can be characterized as a "pioneering species" that quickly and frequently colonizes new sites, emigrates in response to reproductive failure, breeds at an early age, lives a relatively short time (breeding females live an average of only 3.7 years), lays many eggs per female per year, and has relatively low nest success.

The Spotted Sandpiper feeds by probing, gleaning and stalking insects. They also capture some insects on the wing, and also wade in water to forage on bottom. Spotted Sandpipers mostly eat insects, including beetles, crickets, flies, grasshoppers, worms, and ants (Bent 1929). Aquatic fly larvae are especially important. They also take other aquatic invertebrates and catch small fish (Bent 1929).

The Spotted Sandpiper typically migrates for breeding season and migration usually occurs at night. Nesting density averaged 24/ha (10/ac) over a 9-yr period on a small island in Minnesota (Oring et al. 1983).

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Swamp Rabbit (*Sylvilagus aquaticus*)

Louisiana has two species of rabbits: eastern cottontails (*Sylvilagus floridanus*) and swamp rabbits (*Sylvilagus aquaticus*). Although the cottontail is considered more of an upland species and the swamp rabbit a forested wetland (wooded) species, both species occur within coastal areas. The swamp rabbit (*Sylvilagus aquaticus*) is a large cottontail rabbit found in the swamps and wetlands of the southern United States. Common names for the swamp rabbit include marsh rabbit and cane-cutter. The common name, along with the species name "aquaticus" (meaning found in water), are suitable names for a species with a strong preference for wet areas and that will enter the water and swim. Swamp rabbits mainly live close to lowland waters, often in cypress swamps, marshes, floodplains and river tributaries (bayous). Swamp rabbits spend much of their time in depressions that they dig in tall grass or leaves, providing cover while they wait until the nighttime to forage.

S. aquaticus is the largest of the cottontail species, although its ears are smaller than other cottontails. Males are somewhat larger than females. The head and back of swamp rabbits are typically dark or rusty brown or black, while the throat, ventral surface and tail are white, and there is a cinnamon-colored ring around the eye. Their sides, rump, tail and feet are much more brownish, along with a pinkish-cinnamon eye-ring as opposed to the whitish eye-ring in eastern cottontails. *S. aquaticus* ranges in length from 452 millimeters (17.8 in) to 552 millimeters (21.7 in), with an average length of 501 millimeters (19.7 in).

Swamp rabbits are herbivorous and they eat a variety of plants including grasses, sedges, shrubs, tree bark, twigs and seedlings. They consume aquatic vegetation and succulent herbaceous vegetation, such as grasses, sedges, and cane. They feed mainly at night but rain showers will often cause them to feed during daytime as well. A study has indicated that the preferred foods of *S. aquaticus* when available are savannah panic grass, false nettle, dewberry and greenbrier. Swamp rabbits are coprophagous; i.e. they eat feces. Swamp rabbits eat soft, green feces which still contain nutrients; they do not eat dark brown or black hard pellets, which do not. Home range is about 3.6 acres (USEPA 1993).

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5.0 USEPA (1997) Step 4

5.1 Study Design and Data Quality Objectives

5.2 Work Plan and Sampling Plan

Exposure Assessment. For this site-specific BERA, exposures were assessed on the basis of the CSM that was developed during the SLERA process. The CSM was updated to include information that was obtained during the field inspections and formed the basis for assessing exposures. All reasonable source areas, intermedia transport mechanisms, receptors, and exposure routes were evaluated in this activity.

For assessing exposures, available monitoring data (MP&A 2010, 2014, 2015; ICON 2010, 2015) for the VPSB property were used, potential chemical releases were analyzed, exposure point concentrations were estimated, the environmental fate and transport of chemicals released were evaluated qualitatively and quantitatively, and potential exposed populations were identified. As discussed above, the BERA considered ingestion, inhalation, and dermal contact exposure routes from the potentially affected environmental media at the site. For this BERA, conservative estimates of exposures were used (95% UCLs for arithmetic means of site concentrations; USEPA 1997).

5.3 Measurement Endpoints

Toxicity Reference Values (TRVs) that are conservative estimates of "safe" levels of exposures for the surrogate species were used for this BERA (USEPA 2005). TRVs were obtained from peer review literature as indicated in the problem formulation step (Table 14).

5.4 Study Design

The BERA is a detailed site-specific ecological evaluation that accounts for the nature and extent of the COPECs retained from the screening- level assessment, their ecotoxicity, and potential complete exposure pathways to surrogate receptors. Some of the conservative assumptions used for development of the SLERA are discussed below to contrast or compare with the site specific BERA:

Area-use factor: The SLERA assumes the home ranges of the animals are entirely within the contaminated area, and thus the animals are exposed 100 percent of the time to the contaminated soil or sediment core or sample. The BERA utilizes species- and site-specific home range information and potential use of the habitat, to estimate more accurately the percentage of time an animal would use a potentially contaminated area. This BERA also considers the possibility that some species might actually focus their activities in contaminated areas of the site (Table 13).

Bioavailability: The SLERA assumes that the bioavailability of contaminants at the site is 100 percent. The BERA provides an opportunity for bioavailability to be addressed specifically based on site conditions. The BERA considers the form of the COPEC and the environment to utilize a conservative but realistic estimate of bioavailability (Table 17).

Life stage: The SLERA assumes that the most sensitive life stages are present and exposed on the property. If an early life stage is the most sensitive, the population should be assumed to include or to be in that life stage. For vertebrate populations, it is likely that most of the population is not in the most sensitive life stage most of the time. However, for many invertebrate species, the entire population can be at an early stage of development during certain seasons but the duration of exposure is limited. The site-specific BERA employs a more realistic average or adult life stage.

Body weight and food ingestion rates: The BERA uses conservative estimates of body weight and food ingestion rates to maximize the dose (intake of contaminants) on a body-weight basis and to avoid underestimating risk (Table 12).

Bioaccumulation: Bioaccumulation factors obtained from scientific literature are used to estimate contaminant accumulation and food-chain transfer at a site at the screening stage. Because many environmental factors influence the degree of bioaccumulation, sometimes by several orders of magnitude, SLERA uses the most conservative (i.e. highest) bioaccumulation factor (BAF) reported in the literature. Bioaccumulation factors are refined in the BERA to more accurately represent exposures to COPECs at the site (Table 15 & 16).

Dietary composition: For species that feed on more than one type of food, the SLERA assumes their diet is composed entirely of the type of food that is most contaminated. For example, if some foods (e.g. earthworms) are likely to be more contaminated than other foods (e.g. seeds and fruits) typical in the diet of a receptor species, it was assumed that the receptor species feeds exclusively on the more contaminated type of food for the SLERA. This parameter was refined in the BERA to more accurately represent exposures to COPECs at the site (Table 12).

Exposures: To determine soil-based ecotoxicity screening levels for the SLERA, a receptor-based approach was chosen to evaluate the risk of each COPEC to different guilds of organisms (birds, mammals, plants, invertebrates, benthic invertebrates and other aquatic organisms). For each group of receptors, the appropriate US EPA Eco-Soil Screening Level was used.

For the Baseline Ecological Risk Assessment (BERA), the factors that were conservatively or even unrealistically estimated in the SLERA were selected to be site-specific and more reasonable (for the exposures and the receptors as well as habitats). The toxicity values (TRVs) remain conservative in the BERA. The 95% UCL for COPECs was used to capture more accurately the potential exposure at this site as compared to the maximum concentrations. The use of the 95% UCL, however, remains very conservative in assuming concentration levels across a broad area of interest that significantly exceed actual site conditions.

Following assessment and measurement endpoint selection and development of a testable hypothesis and site conceptual model, a study plan is designed to ensure that adequate data are collected to support the BERA. There are a number of fundamental approaches for conducting site specific investigations of COPECs.

5.5 Data Quality Objectives and Statistical Considerations

The updated sample locations, depths, and numbers used for the SLERA were adequate to initiate preparation of the BERA for this property. The sampling scheme is consistent with the CSM. Data Quality Objectives (DQOs) for all data collection activities are consistent with this work plan (WP)/Sampling and Analysis Plan (SAP), and contain the following information: sample location, sample depth, analytical method requirements, quantitation limit requirements, and identification of data use. The analytical quantitation capabilities were evaluated against protective levels and are adequate for the BERA. Before they were used in the BERA, all analytical data were reviewed by their analysts, and appropriate data qualifiers were applied, as required (see USEPA 1992). The data collected were of sufficient quantity and quality to meet their intended use. Data regarding potential exposures were refined by additional sampling and analyses conducted by MP&A (2015).

6.0 USEPA (1997) Step 5

6.1 Field Sampling Plan Verification

For assessing exposures, available monitoring data (MP&A 2010, 2014, 2015; ICON 2010, 2015) for the VPSB property were used. Based on the available site specific data, sufficient information for the VPSB site was available to accomplish the BERA and render my opinions.

6.2 Site Conditions after Initial Sampling

Field Verification of Sampling Design. Accompanied by some additional sampling to re-measure COPECs in surface soils and sediments, the field sampling effort was deemed practical and appropriate for this site-specific BERA.

7.0 USEPA (1997) Step 6

7.1 Site Investigation and Data Analysis

7.2 Site Investigation (sampling conducted)

The site investigation and sampling were accomplished. Samples were analyzed according to the sampling plan. The most current data available were used in this ERA.

7.3 Data Analysis – analyze data; evidence for effects or potential effects

Site Investigation and Analysis Phase. This step in the BERA process involved implementation of the field effort outlined in Step 5 (above) and analyzed the data produced, characterizing actual exposures and potential ecological effects, leading to the risk characterization in Step 7 (below).

Step 6 SMDP. This Scientific Management Decision Point (SMDP) is required only if it is necessary to alter the WP/SAP, as noted above. The risk assessor is responsible for the appropriateness of any changes, as well as how the information is used in the site-specific BERA.

Analysis of Ecological Exposures and Effects. In the analysis phase of the BERA, the data on existing and potential exposures and ecological effects at the site were technically evaluated (EPA/540/R-97/006). The procedures for characterizing exposures and ecological effects were documented in the WP/SAP (SMDP at the end of Step 4).

a) ***Characterizing Exposures***. The exposure analysis combines the spatial and temporal distributions of the selected endpoints with those of the COPECs to evaluate exposures. The result of the exposure analysis is an exposure profile. This profile quantifies the magnitude and spatial and temporal patterns of exposure as they relate to the assessment endpoints and risk hypotheses developed during problem formulation (EPA/540/R-97/006).

b) ***Characterizing Ecological Effects***. The ecological effects characterization includes a summary of the types of adverse effects on biota associated with exposure to COPECs and evaluates any relationship between magnitude of exposures and adverse effects.

c) ***Exposure-Response Analysis.*** Relationships between the magnitude, frequency, or duration of exposures to the COPECs and the magnitude of any responses were evaluated. The relationships between exposures and responses were described to the extent possible and the linkage between the measurement and assessment endpoints were explained if observed. Effects (i.e. potential or observed) or lack of potential effects were identified and a discussion of the confidence in these relationships, either qualitatively or quantitatively, as allowed by the data was presented.

The equation used for calculating potential risk (HQs) for COPECs in the site-specific BERA for the VPSB property is as follows (US EPA 2003 p. 4-2):

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ_a = Hazard Quotient for analyte $_a$ (COPEC $_a$) (unitless)
Soil $_a$ = Concentration of analyte $_a$ (COPEC $_a$) in soil (mg/kg dry weight; 95% UCLs)
N = Number of different biota types in diet (food types)
B_i = Analyte $_a$ (COPEC $_a$) in biota type (i) (mg/kg dry weight)
P_I = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF_{ai} = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF_{as} = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV_a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor (based on home range and time [temporal] factor)

The equation used for calculating potential risk (HQs) for COPECs in soil/sediment and surface water in the site-specific BERA for the VPSB property is as follows (modified from US EPA 2003 p. 4-2):

$$\frac{\{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] + [Water_a \; x \; WIR]\} \; x \; AUF}{TRV} = HQ$$

Where:

HQ_a = Hazard Quotient for analyte $_a$ (COEC $_a$) (unitless)
Soil $_a$ = Concentration of analyte $_a$ (COEC $_a$) in soil (mg/kg dry weight; 95% UCLs)
N = Number of different biota types in diet (food types)
B_i = Analyte $_a$ (COPEC $_a$) in biota type (i) (mg/kg dry weight)
P_I = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF_{ai} = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF_{as} = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV_a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
Water $_a$ = Concentration of Analyte$_a$ (COPEC) in surface water (mg/L) [1L = 1kg]
WIR = Water intake rate of receptor, kg [water]/kg BW/day
AUF = Area use factor (based on home range and time [temporal] factor)

Results from this analysis are summarized in Tables 7 & 8.

d) ***Evidence of Causality***. Importantly, the strength of the causal association between COPECs and effects on the selected endpoints was assessed. For example, demonstrating a correlation between a COPEC gradient and ecological impacts is a key component of establishing causality, but is not strictly required. The procedures and methods outlined in Ecological Risk Assessment Guidelines for Superfund (ERAGS) (EPA/540/R-97/006) and the Guidelines (EPA/540/R- 97/033) were used to assist in evaluating the cause and effect relationships or lack of relationships.

8.0 USEPA (1997) Step 7

8.1 Risk Characterization

8.2 Risk Estimation and Characterization

Risk Characterization. Risk Characterization includes two major steps: risk estimation and risk description.

1) ***Risk Estimation***. To estimate risk, the exposure profiles and the exposure-effects information gathered during the field effort were integrated, and the uncertainties associated with the process were assessed. All assumptions, defaults, uncertainties, use of professional judgment, and any other inputs to the risk estimate were clearly identified. The details of those calculations, analyses and inputs are presented in Tables 12 through 17.

2) ***Risk Description***. The risk description consisted of a summary of the results of the risk estimation and an assessment of confidence in the risk estimates through a discussion of the weight of evidence. An analysis and discussion of all identifiable uncertainties were also included below.

9.0 USEPA (1997) Step 8.

9.1 Risk Management Decision

Risk Management. At the conclusion of the BERA, information was provided in summary form for the current situation (Tables 7, 8, 9, 10) to accurately assess existing and potential ecological risks for the VPSB property. An accurate BERA is essential to support decisions regarding any need for risk mitigation for the property.

Table 7: Summary Results (HQs) from BERA for the EWL property based on 95% UCLs of COPECs in soil/sediments.

Surrogate Avian Species for BERA

COPEC	American Robin	Spotted Sandpiper	Snowy Egret	American Woodcock	Mallard Duck	Great Blue Heron
Arsenic	0.0193162	0.0046566	0.0008789	0.0218365	0.0046177	0.0006904
Barium	0.6361962	0.0174785	0.0274745	0.3687423	0.1923865	0.0216001
Cadmium	0.0996040	0.0035694	0.0045503	0.1190410	0.0053479	0.0035663
Chromium	0.0574181	0.0088872	0.0016258	0.0663081	0.0093174	0.0012797
Lead	0.2279359	0.0246710	0.0044784	0.2609784	0.0297252	0.0035268
Mercury	0.0237799	0.0056420	0.0018546	0.0236291	0.0069644	0.0014539
Selenium	0.1366783	0.0398018	0.0784845	0.1167250	0.0536415	0.0614973
Zinc	0.7230477	0.2301267	0.0633151	0.8444573	0.2047679	0.0496573

Surrogate Mammal Species for BERA

COPEC	Least Shrew	Swamp Rabbit	Red Fox	American Mink
Arsenic	0.0383079	0.0075638	0.0033652	0.0032640
Barium	0.1208011	0.2391613	0.1415018	0.0189888
Cadmium	0.1849120	0.0164544	0.0227870	0.0150543
Chromium	0.0598655	0.0095131	0.0287096	0.0030930
Lead	0.0737066	0.0127169	0.0486427	0.0026634
Mercury	0.0618868	0.0278223	0.0088338	0.0103364
Selenium	0.6249197	0.4972081	0.2350445	0.8953087
Zinc	0.6027657	0.0814596	0.2559910	0.0960473

Table 8: Summary Results (HQs) from BERA for the EWL property based on 95% UCLs of COPECs in soil/sediments and maximum surface water values.

Surrogate Avian Species for BERA

COPEC	American Robin	Spotted Sandpiper	Snowy Egret	American Woodcock	Mallard Duck	Great Blue Heron
Arsenic	0.0194542	0.0046638	0.0008998	0.0218545	0.0046822	0.0007513
Barium	0.6383750	0.0175913	0.0278048	0.3690268	0.1934049	0.0225626
Cadmium	0.0996138	0.0035699	0.0045518	0.1190423	0.0053525	0.0035706
Chromium	0.0574971	0.0088913	0.0016377	0.0663184	0.0093543	0.0013146
Lead	0.2281583	0.0246826	0.0045121	0.2610074	0.0298291	0.0036250
Mercury	0.0237814	0.0056421	0.0018548	0.0236293	0.0069651	0.0014545
Selenium	0.1366783	0.0398018	0.0784845	0.1167250	0.0536415	0.0614973
Zinc	0.7230620	0.2301275	0.0633172	0.8444592	0.2047746	0.0496636

Surrogate Mammal Species for BERA

COPEC	Least Shrew	Swamp Rabbit	Red Fox	American Mink
Arsenic	0.0383134	0.0089666	0.0041994	0.0034782
Barium	0.1208172	0.2432921	0.1439582	0.0196195
Cadmium	0.1849123	0.0165428	0.0228396	0.0150678
Chromium	0.0598671	0.0099265	0.0289555	0.0031561
Lead	0.0737080	0.0130811	0.0488593	0.0027190
Mercury	0.0618869	0.0278454	0.0088475	0.0103400
Selenium	0.6249197	0.4972081	0.2350445	0.8953087
Zinc	0.6027659	0.0815190	0.2560263	0.0960563

10.0 Uncertainty Evaluation

As required by the USEPA (1998), this uncertainty analysis is provided for this BERA for the VPSB property. There are basically four sources of uncertainty inherent in any BERA (USEPA 1997, 1998; Suter 2007): 1) stochasticity (natural variation); 2) lack of information (i.e. data gaps); 3) flawed model assumptions; and 4) human error. Natural variation (stochasticity) is an inherent characteristic of ecological systems and the factors that influence the systems (e.g. weather). Of all of the contributions to uncertainty, stochasticity is the only one that can be acknowledged but sometimes cannot be avoided (Suter 2007). For the VPSB property, extensive data were available, so lack of detailed information was not an issue. Sufficient soil samples were collected at the site to provide a good spatial coverage of all areas of potential concern. Analytical detection of COPECs was adequate relative to toxicity values. Accordingly, uncertainty in the concentration of COPECs in soil or sediment is judged to be low. Uncertainties associated with estimates of COPECs in food items and soil ingestion are likely moderate due to overestimates based on modeled concentrations. Selection of toxicity values (e.g. TRVs) is likely also conservative and contributes to overestimation of risks. The BERA necessarily relies on professional judgments (Suter 2007; USEPA 1997, 1998), however, such judgments are limited in this BERA. In addition, to the extent that assumptions may be erroneous, they can contribute to either under- or overestimation of risk. Human error (e.g. flawed assumptions or simple mathematical mistakes) is always a possibility, but with the degree of professional capability, integrity, and quality assurance measures involved, such problems are expected to be minimal or nil.

On balance, most of the uncertainty in this ERA is associated with the degree to which estimates of exposures and toxicities are conservative. The weight of evidence (WOE) presented herein provides a reasonable level of confidence that the risks are not understated, especially for the more ubiquitous resident and transient receptors.

11.0 Summary and Conclusions

The BERA developed for the VPSB property was conducted in accordance with Louisiana Department of Environmental Quality (LDEQ 2003) guidance and USEPA (USEPA 1993, 1997, and 1998) advice. ERAs evaluate ecological effects caused by human activities or stressors. The term "stressor" is used here to describe any chemical, physical, or biological entity that can induce adverse effects on individuals, populations, communities, or ecosystems. Thus, the ERA process must be flexible while providing a logical and scientific structure to accommodate a broad array of stressors (USEPA, 1992).

USEPA guidance uses a tiered approach (Table 1) to determine if site constituents of potential ecological concern (COPECs) present an unacceptable risk to ecological receptors. The SLERA focused on potential chemical stressors associated with the VPSB property (i.e. surface water, surface soils and sediments). The SLERA for the VPSB property conservatively estimated potential risks by comparing maximum detected COPEC concentrations to conservatively-derived ecotoxicity screening values. The USEPA guidance provides an opportunity to develop or assemble more site-specific information for more accurate risk assessment. For the VPSB property, this was accomplished by proceeding with Steps 3-8 of the process and production of a BERA that is specific for this site.

Assumptions used in this site specific BERA were very conservative, assuming each indicator species or receptor spent 30% of its lifespan living on and feeding on the soils or sediments that represented the 95% Upper Confidence Limit on the average concentration of the COPEC or analyte measured on the property. For example, a robin generally has a six year life span. So the temporal factor would be an estimate of the time a robin would spend on the "spot or area" where the estimated 95% UCL of analyte was measured and the bird must be feeding on that spot (exposed). Based on a temporal factor of 0.3 and AUF of 1, the robin is feeding from the spot (soil or sediment core) approximately 110 days per year or more than 660 days over its life of 6 years. Based on feeding behavior of robins, this is a very conservative estimate of exposure and would be unlikely to actually occur (i.e. exposure would be much less, so the estimate is very protective of a robin population). As demonstrated by the data and analyses presented above, there are no extant or potential ecological risks indicated for the VPSB property.

11.1 Previous Ecological Risk Assessments for the East White Lake Field

Prior to and during 2010, sediments in canals, inundated areas, and surface waters in the East White Lake Oil and Gas Field were sampled and analyzed for constituents that may be associated with oil and gas production. The results from analyses of the sediments confirmed the presence of TPH and other potentially site-related constituents in canal sediments. Additional sampling was conducted and a SLERA was performed (Lingle 2010). The SLERA was performed using the guidance from Louisiana DEQ and USEPA and evaluated site exposures to COPECs in surface water, soil and sediments. Based on multiple lines of evidence, it was scientifically determined that there were no unacceptable risks to the site ecosystem and no further action for ecological receptors was appropriate for the site.

Rogers (2014) conducted an ecological risk assessment and toxicological evaluation for the East

White Lake Field. He concluded that "contamination of site media, particularly surface soil and shallow groundwater has resulted from oil and salt water handling operations. Residual contaminants from those operations, including metals, salts, and hydrocarbons pose an unacceptable health risk to human and ecological populations." Further, Rogers concluded that "the resistance to natural degradation processes of metals, hydrocarbons and salts allow these constituents to remain in the soil and groundwater posing a risk to human and ecological populations for a long period of time." And "contamination of surficial soils exceeded protective levels for waterfowl, small game and other wildlife, indicating a potential threat to these populations." As noted below, a careful analysis of Rogers (2014) report by Jenkins (2014) indicated that the report and these conclusions were unreliable.

Jenkins (2014) concluded that the Rogers (2014) BERA for the VPSB lacked transparency and identified a number of oversights, erroneous assumptions and quantitative errors. For example, 1) the Rogers (2014) BERA did not provide a basis for relating the COPECs to actual activities at the EWL Oil and Gas Field and 2) he assumed that all COPECs were 100% bioavailable. Because of these and other problems identified in Rogers' BERA, Jenkins systematically reviewed and revised Rogers' assumptions and calculations to correct errors and properly align the assessment with the purpose and objectives of a BERA, per EPA (1997, 1998) guidance, which is to provide upper-bound yet realistic best-estimates of ecological risk. As Jenkins noted, "these problems render Rogers' estimates of risk at EWL Field unreliable." Based upon Jenkins' analysis, his final HQ calculations demonstrated that "concentrations of arsenic, barium, cadmium, chromium, lead, mercury, selenium and zinc in sediments from the EWL Field do not pose a risk to representative receptor species utilizing the wetland habitat of EWL Field including snowy egrets, spotted sandpipers, mallards, mink, great blue herons, least shrews, woodcocks, robins, swamp rabbits and red fox." In addition, the AVS-SEM analysis demonstrated that, cadmium, copper, lead, nickel, and zinc pose no risk to benthic organisms dwelling in sediments from EWL Field. These results were consistent with his findings from his site inspection as well as my inspections (Connelly and Rodgers 2014) that there is no evidence of harmful impacts to ecological services provided by the aquatic and wetland habitat of the EWL Field.

11.2 Tissue Residue Study – Crabs and Forage Fish

For the VPSB property, a tissue residue study was conducted using blue crabs (*Callinectes sapidus*) and forage fish (*Dorosoma cepedianum*). For the field portion of the crab and forage fish study, the sampling and analysis plan was implemented December 13, 2010 through January 10, 2011 by a field sampling team including MP&A personnel and myself. The field sampling was guided by a thorough Quality Assurance Project Plan (Beck et al. 2010). A report of the field activities, prepared by the field team members, is appended to this report (Connelly and Rodgers 2014). The field sampling event resulted in collection of 307 crabs from thirteen site locations and ten reference locations in the waters adjacent to the site. Forage fish were collected from twelve site locations and nine reference locations. Crabs were collected using baited traps, and fish were collected with cast nets or trawl nets in accordance with a Scientific Collecting Permit issued by the Louisiana Department of Wildlife and Fisheries (LDWF). In addition, crabs

were purchased from commercial seafood markets to serve as additional reference samples, including markets in Baton Rouge, Lake Charles, New Orleans, Des Allemands, Biloxi, and Houston. The crabs and fish were delivered to Columbia Analytical Services, Inc. (CAS) for dissection and analysis of metals. Tissue samples were provided to Pace Laboratories for analysis of hydrocarbons for the human risk analysis. For this ecological analysis, the data for whole crabs from the site were used (Rogers 2010).

Forage fish were collected and analyzed using methods that support evaluation of ecological risks. Whole body samples of shad and blue gill were processed and analyzed according to scientifically valid, standardized procedures. Based upon third party data quality review, the fish and crab tissue data meet the requirements for definitive data as defined by LDEQ and are considered representative and usable for the purposes of quantitative site characterization and risk evaluation with limited qualification as noted in the attached report (two hydrocarbon fraction results were R-qualified in reference samples). Details of the data are presented in the attached report. The results from the whole crab and fish tissue analyses were analyzed for ecological risks based on trophic transfer to predators (great blue heron and mink) and comparison with measurements of analytes in healthy populations of crabs and fish. The data from whole crabs (Rogers 2010) and whole forage fish were used for this analysis (Appendix C). Based on the BERA results from “feeding” whole body fish and crab tissue to model or surrogate species, there was no potential for ecological risk (Tables 9 & 10).

Table 9: Summary Results (HQs) from BERA for the EWL property based on 95% UCLs of COPECs contained in whole body fish tissue. Species were fed 100% fish.

Surrogate Avian Species for BERA

COPEC	Snowy Egret	Great Blue Heron
Arsenic	0.0068511	0.0053583
Inorganic Arsenic	0.0010696	0.0008283
Barium	0.0210021	0.0160511
Mercury	0.0008527	0.0006639
Methyl Mercury	0.0000420	0.0000287

Surrogate Mammal Species for BERA

COPEC	American Mink
Arsenic	0.0255416
Inorganic Arsenic	0.0039482
Barium	0.0142642
Mercury	0.0047282
Methyl Mercury	0.0002044

Table 10: Summary Results (HQs) from BERA for the EWL property based on 95% UCLs of COPECs contained in whole body crab tissue. Species were fed 100% crabs.

Surrogate Avian Species for BERA

COPEC	Snowy Egret	Great Blue Heron
Arsenic	0.0078880	0.0061707
Barium	0.3210768	0.2511694
Cadmium	0.0035078	0.0027429
Chromium	0.1444000	0.1131095
Mercury	0.0005341	0.0004142

Surrogate Mammal Species for BERA

COPEC	American Mink
Arsenic	0.0294144
Barium	0.2232077
Cadmium	0.0115889
Chromium	0.2774458
Mercury	0.0029499

In addition to analysis of the crabs and forage fish collected from the site to serve as a source of COPECs to carnivores, the whole body tissue residue results were compared to measurements of analytes (Total Arsenic, Inorganic Arsenic, Total Barium, Total Mercury, Methyl Mercury, and TPH – fractions) in animals from other sites. Comparable data sets were limited.

Table 11: Average TPH and metal concentrations in forage fish and crabs (whole body; mg/kg-wet weight) from the VPSB property and environs.

Parameter	TPH (C8-C16)	TPH (C8-C40)	TPH (C16-C28)	Total Arsenic	Inorganic Arsenic	Total Barium	Total Mercury	Methyl Mercury
Forage Fish								
EWL site	ND		33	0.59	0.085	17	0.021	0.012
EWL Reference Site	ND		20	0.49	0.089	12	0.018	0.011
Crabs								
EWL site		62.15 (ND – 370)	NDt	0.676 (ND– 0.99)	NDt	236 (154 -452)	0.058 (0.03 – 0.182)	NDt

ND = non-detect

NDt = not measured

As noted above in Table 11, forage fish were collected from the East White Lake Oil Field canals and adjacent sites, and whole fish were analyzed using methods which support evaluation of ecological risks. Whole body samples of shad and blue gill were processed and analyzed for TPH, arsenic, inorganic arsenic, barium, mercury and methyl mercury according to scientifically valid, standardized procedures. As a general observation, tissue residues of these analytes in whole fish were unremarkable and consistent with that reported in studies on similar fish within the region. In a study of fish tissue residues in fish from Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Swarzenski et al. (2004) reported average concentrations of arsenic, barium and mercury in bluegill filets of <0.3 mg As/kg, 0.8 mg Ba/kg, and 0.2 mg Hg/kg (dry weight; to convert to wet weight, divide dry weight concentration by 5). In Caddo Lake, Texas, Chumchal et al. (2010) measured an average mercury concentration of 26.3 mg Hg/kg in gizzard shad (wet weight). They observed that trophic position of fish was related to the mercury concentration measured in forage fish.

I also considered sampling data collected as part of the Louisiana Mercury Program in the general area of this property (LDEQ 2015). The study involved higher trophic level fish such as bass and catfish. The samples were only evaluated for total mercury. The report suggests mercury concentrations in fish are consistent with bioaccumulation of mercury in higher trophic levels. The data do not suggest the occurrence of biomagnification in these higher trophic levels.

The EWL whole crab data were accessed from the Rogers (2010) report. Twenty-two crabs were

measured from nine locations. The data for the whole crabs had some important characteristics that should be considered when using them for risk assessment. TPHs are difficult to measure accurately in animal tissue. TPHs were non-detect for 9 of 22 analyses, and values for 12 of 22 analyses were estimated (J qualified). Only 1 crab had sufficient TPH to be detected and measured. Similarly, arsenic concentrations in whole crabs were estimated (J qualified) for 16 of 21 crabs. Analyses of mercury and barium were more reliable.

Hamilton et al. (2008) reported mercury concentrations in whole crabs from a "pristine" location in the Rockefeller Wildlife Refuge of 11.46 mg/kg (10.37-12.07). Jop et al. (1997) measured mercury and arsenic concentrations in crabs from the Quinnipiac River and Connecticut River estuaries. They found mean concentrations of 0.06 mg Hg/kg in muscle tissue and 0.04 mg Hg/kg in hepatopancreas of crabs from the Quinnipiac River and 0.11 mg Hg/kg in muscle tissue and 0.02 mg Hg/kg in hepatopancreas of crabs from the Connecticut River. The levels of mercury in these healthy populations are comparable to levels found in whole crabs from EWL (average of 0.058 mg Hg/kg). In a study of mercury loading to the Gulf of Mexico, Harris et al. (2012) reported the average concentration of mercury in blue crabs of 0.141 mg Hg/kg based on analysis of 239 crabs. Jop et al. (1997) reported mean concentrations of 0.76 mg As/kg in muscle tissue and 0.84 mg As/kg in hepatopancreas of crabs from the Quinnipiac River. In crabs from the Connecticut River, concentrations in muscle tissue and hepatopancreas of crabs were 0.62 mg As/kg and 0.60 mg As/kg, respectively. For EWL crabs, the average concentration of arsenic was 0.676 mg As/kg.

Based on results from the site-specific BERA, there are no extant risks to biota from COPECs from oil and gas activities in the East White Lake Field. This conclusion is supported by several lines of evidence including: the crab and fish residue analyses, the biota associated with the property as well as the functions and services assessment. Connelly and Rodgers (2014) reported numerous plants, animals, and signs of wildlife during site characterization, which indicates a healthy, fully-functioning ecosystem. For example, crabs were clearly abundant on the property and appeared thriving and healthy during my investigations. The LDWF reached similar conclusions when it collected crabs for its own study email communication between LDDH and LDWF, November 2010). The presence of active, healthy crabs provided strong evidence that the conditions on the property met their environmental requirements and tolerances. There is clear evidence of healthy wildlife, and there is no evidence of adverse effects on wildlife or causality from exploration and production activities.

On the VPSB property, there is no evidence of stress or toxicity due to salt from exploration or production activities. Due to periodic inundation of the VPSB property by water from the Gulf of Mexico, plants and animals are well adapted to salts that are present in this fresh to intermediate marsh. Diagnostic symptoms of salt stress are not present in the plant species. There is no pattern of salt exposure associated with exploration or production activities. Plants on the property are indicative of fresh to intermediate marsh.

Compliant with the regulatory guidance framework, this ERA includes the following lines of evidence:

- A series of site inspections and characterizations conducted by various individuals that re included in Appendix F to the Most Feasible Plan for Evaluation/Remediation presented

by Michael Pisani & Associates, Inc. and referenced throughout this ERA.

- Information from investigations conducted in 2010 - 2015 of the wildlife, vegetation as well as soils and sediments (e.g. LDHH 2015, MP&A, ICON, Connelly and Rodgers 2014, etc.).
- Analysis of wetland functions and services provided by the site (Connelly and Rodgers 2014).
- A Screening-Level Ecological Risk Assessment (SLERA) that was developed based on comparison of soil or sediment COPEC concentrations with appropriate soil or sediment quality guidelines or ecological screening levels. Soil or sediment quality guidelines were developed for protection of ecological health and are not site-specific in the SLERA. The screening guidelines are intended to be conservative and, if exceeded, can serve as a point of departure for more detailed site-specific ecological risk analysis.
- Development of a site-specific Baseline Ecological Risk Assessment (BERA) for the VPSB property for those COPECs exceeding SLERA screening guidelines using updated analytical data for COPECs.
- Evaluation of previous ERAs and associated data for the VPSB property.
- An intensive study of crabs (*Callinectes sapidus*) and forage fish to measure potential bioaccumulation of elements from the site (Rogers 2010; LDHH 2015).

The lines of evidence summarized above demonstrate that there are no unacceptable risks to the site ecosystem overall. Remedial action based on ecological risk is not warranted for the VPSB property.

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Table 12: Species factors for Ecological Risk Assessment.

Parameter	Description	Units	American Robin	Source	Spotted Sandpiper	Source	American Woodcock	Source
BW	Body weight of receptor	Kg	0.0773	USEPA 1993 (Section 2-197); [source: Clench and Leberman (1978)]; Sample and Suter 1994 (p. 21; Table 4.9 [source: Dunning 1984])	0.0425	USEPA 1993 (Section 2-149) [source: Maxson & Oring 1980][a]	0.169	USEPA 1993 (Section 2-140) [source: Nelson & Martin, 1953][b]
Food IR	Ingestion rate of food	Kg /KgBW/ d	0.129	Nagy 2001	0.044	Nagy 2001	0.118	Nagy 2001
Soil / Sediment Ingestion	Ingestion Proportion of soil or sediment	Fraction of Total Diet	0.02	Sample and Suter 1994 (p. 22; Table 4.9); Based on Beyer et al. 1994	0.17	Beyer et al. 1994	0.104	Beyer et al. 1994
Fd (plants)	Fraction of diet consisting of plants		0.41	USEPA 1993 (Section 2-198; based on Wheelwright 1986)	0		0	
Fd (inverts)	Fraction of diet consisting of soil invertebrates		0.59	USEPA 1993 (Section 2-198; based on Wheelwright 1986)	0		1	USEPA 1993 (Section 2-141) [source: Stribling & Doerr, 1985]
Fd (mammals)	Fraction of diet consisting of mammals		0		0		0	
Fd (benthic inverts)	Fraction of diet consisting of benthic invertebrates		0		1	USEPA 1993 (Section 2-152) [source: Maxson & Oring 1980]	0	
Fd (fish)	Fraction of diet consisting of fish		0		0		0	
Fd (birds)	Fraction of diet consisting of birds		0		0		0	

[a]Spotted Sandpiper body weight : Mean body weight of adult male (37.9 g) and female (47.1 g)

[b]Woodcock body weight: mean body weight of adult male (176 g) and adult female (218 g)

Table 12: Species factors for Ecological Risk Assessment.

Parameter	Description	Units	Mallard Duck	Source	Least Shrew	Source	Red Fox	Source
BW	Body weight of receptor	Kg	1.134	USEPA 1993 (Section 2-43) [source: Nelson & Martin, 1953][a]	0.017	USEPA 1993 (Section 2-213) [source: Guilday, 1957][b]	4.53	USEPA 1993 (Section 2-224) [source: Storm et al., 1976][c]
Food IR	Ingestion rate of food	Kg /KgBW/d	0.068	Nagy 2001	0.096	Nagy 2001	0.16	USEPA 1993 (Section 2-224) [source: Sargeant, 1978]
Soil / Sediment Ingestion	Ingestion Proportion of soil or sediment	Fraction of Total Diet	0.033	Beyer et al. 1994	0.13	Sample and Suter 1994 (Section 4.1; p. 11)	0.028	Beyer et al. 1994
Fd (plants)	Fraction of diet consisting of plants		0.5	USEPA 1993 (Section 2-45) [source: Dillon, 1959; Swanson et al., 1985][d]	0		0.07	USEPA 1993 (Section 2-225) [source: Knable, 1974; Hockman and Chapman, 1983]
Fd (inverts)	Fraction of diet consisting of soil invertebrates		0		1	USEPA 1993 (Section 2-214) [source: Whitaker & Ferraro, 1963]; (Whitaker & Ruckdeschel 2006)	0.03	USEPA 1993 (Section 2-225) [source: Knable, 1974; Hockman and Chapman, 1983]
Fd (mammals)	Fraction of diet consisting of mammals		0		0		0.9	USEPA 1993 (Section 2-225) [source: Knable, 1974; Hockman and Chapman, 1983]
Fd (benthic inverts)	Fraction of diet consisting of benthic invertebrates		0.5	USEPA 1993 (Section 2-45) [source: Dillon, 1959; Swanson et al., 1985]	0		0	
Fd (fish)	Fraction of diet consisting of fish		0		0		0	
Fd (birds)	Fraction of diet consisting of birds		0		0		0	

[a]Mallard body weight: mean body weight of adult male (1,225 g) and adult female (1,043 g)

[b]Least shrew body weight: arithmetic mean of average reported body weights of adult male and female during fall and summer

[c]Red fox body weight: arithmetic mean of adult male and female during spring and fall (Storm et al., 1976)

[d]Mallard diet: Dillon (1959) reports 93% of mallard diet consists of plants; Swanson et al. (1985) reports dietary consumption of invertebrates ranges from (67.8 % to 89.4% [wet volume % esophagus contents]); a conservative dietary estimate of 0.5 (50%) plants and 0.5 (50%) invertebrates was used.

Table 12: Species factors for Ecological Risk Assessment.

Parameter	Description	Units	Swamp Rabbit	Source	Snowy Egret	Source
BW	Body weight of receptor	Kg	2.118	Bond et al., 2006[a]	0.37	Parsons et al., 2000
Food IR	Ingestion rate of food	Kg /KgBW/d	0.112	Sample and Suter 1994 (Section 4.5; page 16)	0.115	Nagy 2001
Soil / Sediment Ingestion	Ingestion Proportion of soil or sediment	Fraction of Total Diet	0.063	Sample and Suter 1994 (Section 4.5; p. 17)	0.005	Sample and Suter 1994 (Section 4.13; p. 27)
Fd (plants)	Fraction of diet consisting of plants		1	USEPA 1993 (Section 2-356) [source: Spencer & Chapman, 1986]	0	
Fd (inverts)	Fraction of diet consisting of soil invertebrates		0		0	
Fd (mammals)	Fraction of diet consisting of mammals		0		0	
Fd (benthic inverts)	Fraction of diet consisting of benthic invertebrates		0		0.1	Smith 1997
Fd (fish)	Fraction of diet consisting of fish		0		0.9	Smith 1997
Fd (birds)	Fraction of diet consisting of birds		0		0	

[a]Swamp rabbit body weight: arithmetic mean of adult male and female (Bond et al., 2006)

[b]Snowy egret diet (based on % biomass stomach contents): fish (91.4%), crayfish (6-7%); frogs (1%); invertebrates (1%; [insects, grass shrimp])

Table 12: Species factors for Ecological Risk Assessment.

Parameter	Description	Units	American Mink	Source	Great Blue Heron	Source
BW	Body weight of receptor	Kg	1.0	Sample and Suter 1994 (p. 18; Table 4.6 [source: Newell et al. 1987])	2.229	USEPA 1993 (Section 2-8) [source: Quinney 1982]
Food IR	Ingestion rate of food	Kg /KgBW/d	0.137	Sample and Suter 1994 (p. 18; Table 4.6 [source: Bleavins and Aulerich 1981])	0.103	Nagy 2001
Soil / Sediment Ingestion	Ingestion Proportion of soil or sediment	Fraction of Total Diet	0.005	Sample and Suter 1994 (p. 18; Table 4.6)	0.005	Sample and Suter 1994 (Section 4.13; p. 27)
Fd (plants)	Fraction of diet consisting of plants				0	
Fd (inverts)	Fraction of diet consisting of soil invertebrates				0	
Fd (mammals)	Fraction of diet consisting of mammals				0	
Fd (benthic inverts)	Fraction of diet consisting of benthic invertebrates		0.1	USEPA 1993 (Section 2-253) [source: Alexander 1977]	0.1	USEPA 1993 (Section 2-9) [source: Alexander 1977]
Fd (fish)	Fraction of diet consisting of fish		0.9	USEPA 1993 (Section 2-253) [source: Alexander 1977]	0.9	USEPA 1993 (Section 2-9) [source: Alexander 1977]
Fd (birds)	Fraction of diet consisting of birds				0	

Table 13: Exposure Modifying Factors (EMFs) for receptors in Ecological Risk Assessment.

Parameter	Description	American Robin	American Woodcock	Spotted Sandpiper	Mallard Duck	Snowy Egret	Great Blue Heron	Least Shrew	Red Fox	Swamp Rabbit	American Mink	Un its	Citations
Home Range	Home Range of receptor	1.04	11	8	405	490[a]	560	0.49	3030	3.6	2.2	acres	USEPA 1993; See species descriptions; [a]Custer and Osborn 1978
Home Range Factor (area use factor)	Fraction of home range that may be contaminated	1	1	1	0.832	0.687	0.601	1	0.1112	1	1		Calculated based on an estimated size of potentially affected site of 337 acres
Time (temporal) Factor	Fraction of time spent in presumed contaminated area	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3		

Table 14: Toxicity Reference Values (TRVs) for Baseline Ecological Risk Assessment.

Element or Constituent	TRV (mg/kg/d)			
	Avian (Robin, Woodcock, Mallard, Egret, Sandpiper)		Mammal (Shrew, Fox, and Rabbit)	
	Value	Source	Value	Source
Arsenic	2.24	US EPA 2005	1.04	US EPA 2005
Barium	20.8[a]	Sample et al., 1996	51.8	US EPA 2005
Cadmium	1.47	US EPA 2005	0.77	US EPA 2005
Chromium (Cr III)	2.66	US EPA 2008	2.4	US EPA 2008
Lead	1.63	US EPA 2005	4.7	US EPA 2005
Mercury	3.25[b]	US EPA 1999; Table E-8	1.01[c]	US EPA 1999; Table E-7
Selenium	0.5	US EPA 1999 Table E-8	0.076	US EPA 1999; Table E-7
Zinc	66.1	US EPA 2007	75.4	US EPA 2007

[a]Only a single paper (Johnson et al., 1960) with data on the toxicity of barium hydroxide to one avian species (chicken) was identified by USEPA (2005); therefore, an avian TRV could not be derived and an Eco-SSL could not be calculated for avian wildlife (calculation requires a minimum of three results for two test species). Johnson et al. (1960) reports a subchronic NOAEL of 208.26 mg/kg/d. The NOAEL was multiplied by an uncertainty factor of 0.1 to derive a very conservative TRV of 20.8 mg/kg/d.

[b]Mercuric chloride; Acute (5 day) LOAEL (mortality) for quail of 325 mg/kg/d; uncertainty factor of 0.01 applied to estimate from an acute to chronic endpoint (produces a very conservative TRV estimate).

[c]Mercuric chloride; Chronic (6 month) NOAEL (reproduction) for mink of 1.01 mg/kg/d

Table 15: Bioconcentration Factors (BCFs) for food items.

COPEC	Soil – Plant BCF	Citation	Soil-Earthworm BCF	Citation	Soil-Mammal BCF	Citation
Arsenic	0.0375	Bechtel-Jacobs 1998; Table 6	0.224	Sample et al. 1998a; Table 11	0.0025	Sample et al. 1998b; Table 7
Barium	0.156	Bechtel-Jacobs 1998; Table D-1	0.0910	Sample et al. 1998a; Table C.1	0.0566	Sample et al. 1998b; Table 7
Cadmium	0.586	Bechtel-Jacobs 1998; Table 6	7.708	Sample et al. 1998a; Table 11	0.333	Sample et al. 1998b; Table 7
Chromium	0.041	Bechtel-Jacobs 1998; Table D-1	0.306	Sample et al. 1998a; Table 11	0.0846	Sample et al. 1998b; Table 7
Lead	0.0389	Bechtel-Jacobs 1998; Table 6	0.266	Sample et al. 1998a; Table 11	0.1054	Sample et al. 1998b; Table 7
Mercury	0.652	Bechtel-Jacobs 1998; Table 6	1.693	Sample et al. 1998a; Table 11	0.0534	Sample et al. 1998b; Table 7
Selenium	0.672	Bechtel-Jacobs 1998; Table 6	0.985	Sample et al. 1998a; Table 11	0.1619	Sample et al. 1998b; Table 7
Zinc	0.366	Bechtel-Jacobs 1998; Table 6	3.201	Sample et al. 1998a; Table 11	0.7717	Sample et al. 1998b; Table 7

Table 16: Bioconcentration Factors (BCFs) for food items.

COPEC	Soil /Sediment – Benthic Invertebrate BCF	Citation	Sediment - Fish BCF	Citation
Arsenic	0.127	Bechtel Jacobs 1998b; Table 2	0.00065	Davis et al. 1996; p. 420
Barium	0.01	Menzie et al 2008; Zimmerman 2010	0.01	Menzie et al 2008; Zimmerman 2010
Cadmium	0.614	Bechtel Jacobs 1998b; Table 2	0.42	Chen and Chen 1992; Table 2
Chromium	0.108	Bechtel Jacobs 1998b; Table 2	<0.00011	Davis et al. 1996; p. 420
Lead	0.066	Bechtel Jacobs 1998b; Table 2	0.0000018	Davis et al. 1996; p. 420
Mercury	1.081	Bechtel Jacobs 1998b; Table 2	0.1	Zilloux et al. 1993; Knox et al. 2006; Gladden et al. 2008; Julian 2012
Selenium	0.9	USEPA 1999; Appendix C; Table C-6	1	Cleveland et al., 1993; Chapman et al., 2009
Zinc	2.33	Bechtel Jacobs 1998b; Table 2	0.138	Chen and Chen 1992; Table 2

Table 17: Soil Bioavailability Estimates for the EWL Property.

COPEC	Soil Bioavailability Factor	Citation
Arsenic	0.01	US EPA 2005; Watts et al. 2008
Barium	0.01	Menzie et al. 2008; Zimmerman 2010
Cadmium	0.036	Prokop et al. 2003
Chromium	0.015	Han et al. 2004; Whitmer et al. 1991; Fargasova 2012
Lead	0.01	Hettiarachchi and Pierzynski 2004; Luo et al. 2014
Mercury	0.01 - 0.03	Anjum et al., 2012
Selenium	0.01	Nakamora et al., 2014
Zinc	0.01 - 0.1	US EPA 2005; Wang et al. 2005

Table 18. Calculations used for calculating potential risk (HQs) for COPECs in the BERA for the EWL property based on soil/sediment 95% UCLs.

COPEC	95% UCL [COPEC]
As	6.14
Ba	2354
Cd	0.641
Cr	16.2
Pb	45
Hg	1.279
Se	1.672
Zn	491

American Robin

Assumptions	Parameter	Symbol
Body weight (kg)	0.081	BW
Soil ingestion proportion	0.02	P_s
Food ingestion Rate (kg/kgBW/d)	0.159	FIR
Proportion of diet, plants	0.41	Pp
Proportion of diet, inverts	0.59	Pi
Proportion of diet, fish	-	Pf
Proportion of diet, birds	-	Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	95% UCL [COPEC]	TRV	Soil bio-factor	BCF plants	BCF earthworm	BCF fish	BCF birds	HQ
As	6.14	2.24	0.01	0.0375	0.224			0.01932
Ba	2354	20.8	0.01	0.156	0.091			0.63620
Cd	0.641	1.47	0.036	0.586	7.708			0.09960
Cr	16.2	2.66	0.015	0.041	0.306			0.05742
Pb	45	1.63	0.01	0.0389	0.266			0.22794
Hg	1.279	3.25	0.03	0.652	1.693			0.02378
Se	1.672	0.5	0.01	0.672	0.985			0.13668
Zn	491	66.1	0.1	0.366	3.201			0.72305

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Spotted Sandpiper

Assumptions	Parameter	Symbol
Body weight (kg)	0.0425	BW
Soil ingestion proportion	0.17	P_s
Food ingestion Rate (kg/kgBW/d)	0.044	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts	1	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01		0.127			0.00466
Ba	2354	20.8	0.01		0.01			0.01748
Cd	0.641	1.47	0.036		0.614			0.00357
Cr	16.2	2.66	0.015		0.108			0.00889
Pb	45	1.63	0.01		0.066			0.02467
Hg	1.279	3.25	0.03		1.081			0.00564
Se	1.672	0.5	0.01		0.9			0.03980
Zn	491	66.1	0.1		2.33			0.23013

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Snowy Egret

Assumptions	Parameter	Symbol
Body weight (kg)	0.37	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.115	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts	0.1	Pi
Proportion of diet, fish	0.9	Pf
Proportion of diet, birds		Pb
Area use factor	0.687	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01		0.127	0.00065		0.00087885
Ba	2354	20.8	0.01		0.01	0.01		0.02747446
Cd	0.641	1.47	0.036		0.614	0.42		0.00455029
Cr	16.2	2.66	0.015		0.108	0.00011		0.00162577
Pb	45	1.63	0.01		0.066	0.0000018		0.00447842
Hg	1.279	3.25	0.03		1.081	0.1		0.00185456
Se	1.672	0.5	0.01		0.9	1		0.07848447
Zn	491	66.1	0.1		2.33	0.138		0.06331505

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

American Woodcock

Assumptions	Parameter	Symbol
Body weight (kg)	0.169	BW
Soil ingestion proportion	0.104	P_s
Food ingestion Rate (kg/kgBW/d)	0.118	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts	1	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	95% UCL [COPEC]	TRV	Soil bio-factor	BCF plants	BCF earthworm	BCF fish	BCF birds	HQ
As	6.14	2.24	0.01		0.224			0.021837
Ba	2354	20.8	0.01		0.091			0.368742
Cd	0.641	1.47	0.036		7.708			0.11904
Cr	16.2	2.66	0.015		0.306			0.066308
Pb	45	1.63	0.01		0.266			0.26098
Hg	1.279	3.25	0.03		1.693			0.02363
Se	1.672	0.5	0.01		0.985			0.11673
Zn	491	66.1	0.1		3.201			0.84446

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Mallard Duck

Assumptions	Parameter	Symbol
Body weight (kg)	1.134	BW
Soil ingestion proportion	0.033	P_s
Food ingestion Rate (kg/kgBW/d)	0.068	FIR
Proportion of diet, plants	0.5	Pp
Proportion of diet, inverts	0.5	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01	0.0375	0.127			0.00462
Ba	2354	20.8	0.01	0.156	0.01			0.19239
Cd	0.641	1.47	0.036	0.586	0.614			0.00535
Cr	16.2	2.66	0.015	0.041	0.108			0.00932
Pb	45	1.63	0.01	0.0389	0.066			0.02973
Hg	1.279	3.25	0.03	0.652	1.081			0.00696
Se	1.672	0.5	0.01	0.672	0.9			0.05364
Zn	491	66.1	0.1	0.366	2.33			0.20477

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Great Blue Heron

Assumptions	Parameter	Symbol
Body weight (kg)	2.229	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.103	FIR
Proportion of diet, plants		Pp
Proportion of diet, benthic inverts	0.1	Pi
Proportion of diet, fish	0.9	Pf
Proportion of diet, birds		Pb
Area use factor	0.601	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01		0.127	0.00065		0.00069038
Ba	2354	20.8	0.01		0.01	0.01		0.02160010
Cd	0.641	1.47	0.036		0.614	0.42		0.00356631
Cr	16.2	2.66	0.015		0.108	0.00011		0.00127973
Pb	45	1.63	0.01		0.066	0.0000018		0.00352679
Hg	1.279	3.25	0.03		1.081	0.1		0.00145387
Se	1.672	0.5	0.01		0.9	1		0.06149730
Zn	491	66.1	0.1		2.33	0.138		0.04965730

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Least Shrew

Assumptions	Parameter	Symbol
Body weight (kg)	0.017	BW
Soil ingestion proportion	0.13	P_s
Food ingestion Rate (kg/kgBW/d)	0.096	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts	1	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	95% UCL [COPEC]	TRV	Soil bio-factor	BCF earthworm	BCF mammals	BCF fish	BCF birds	HQ
As	6.14	1.04	0.01	0.224				0.03831
Ba	2354	51.8	0.01	0.091				0.12080
Cd	0.641	0.77	0.036	7.708				0.18491
Cr	16.2	2.4	0.015	0.306				0.05987
Pb	45	4.7	0.01	0.266				0.07371
Hg	1.279	1.01	0.03	1.693				0.06189
Se	1.672	0.076	0.01	0.985				0.62492
Zn	491	75.4	0.1	3.201				0.60277

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Swamp Rabbit

Assumptions	Parameter	Symbol
Body weight (kg)	2.118	BW
Soil ingestion proportion	0.063	P_s
Food ingestion Rate (kg/kgBW/d)	0.112	FIR
Proportion of diet, plants	1	Pp
Proportion of diet, inverts		Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF mammals**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	1.04	0.01	0.0375				0.00756
Ba	2354	51.8	0.01	0.156				0.23916
Cd	0.641	0.77	0.036	0.586				0.016454
Cr	16.2	2.4	0.015	0.041				0.009513
Pb	45	4.7	0.01	0.0389				0.01272
Hg	1.279	1.01	0.03	0.652				0.02782
Se	1.672	0.076	0.01	0.672				0.49721
Zn	491	75.4	0.1	0.366				0.08146

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Red Fox

Assumptions	Parameter	Symbol
Body weight (kg)	4.53	BW
Soil ingestion proportion	0.028	P_s
Food ingestion Rate (kg/kgBW/d)	0.16	FIR
Proportion of diet, plants	0.07	Pp
Proportion of diet, inverts	0.03	Pi
Proportion of diet, mammals	0.9	Pm
Proportion of diet, birds		Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	95% UCL [COPEC]	TRV	Soil bio-factor	BCF plants	BCF earthworm	BCF mammals	BCF birds	HQ
As	6.14	1.04	0.01	0.0375	0.224	0.0025		0.00336519
Ba	2354	51.8	0.01	0.156	0.091	0.0566		0.14150176
Cd	0.641	0.77	0.036	0.586	7.708	0.33		0.02278702
Cr	16.2	2.4	0.015	0.041	0.306	0.0846		0.02870964
Pb	45	4.7	0.01	0.0389	0.266	0.1054		0.04864274
Hg	1.279	1.01	0.03	0.652	1.693	0.0534		0.00883376
Se	1.672	0.076	0.01	0.672	0.985	0.1619		0.23504448
Zn	491	75.4	0.1	0.366	3.201	0.7717		0.25599099

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

American Mink

Assumptions	Parameter	Symbol
Body weight (kg)	1.0	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.137	FIR
Proportion of diet, plants		Pp
Proportion of diet, benthic inverts	0.1	Pi
Proportion of diet, fish	0.9	Pf
Proportion of diet, birds		Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	1.04	0.01		0.127	0.00065		0.00326402
Ba	2354	51.8	0.01		0.01	0.01		0.01898878
Cd	0.641	0.77	0.036		0.614	0.42		0.01505434
Cr	16.2	2.4	0.015		0.108	0.00011		0.00309301
Pb	45	4.7	0.01		0.066	0.0000018		0.00266339
Hg	1.279	1.01	0.03		1.081	0.1		0.01033642
Se	1.672	0.076	0.01		0.9	1		0.89530870
Zn	491	75.4	0.1		2.33	0.138		0.09604728

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Table 19. Calculations used for calculating potential risk (HQs) for COPECs in the BERA for the EWL property based on soil/sediment 95% UCLs and maximum surface water concentrations.

COPEC	95% UCL [COPEC]
As	6.14
Ba	2354
Cd	0.641
Cr	16.2
Pb	45
Hg	1.279
Se	1.672
Zn	491

COPEC	[Maximum Water; mg/L]
As	0.0075
Ba	1.1
Cd	0.00035
Cr	0.0051
Pb	0.0088
Hg	0.00012
Se	ND
Zn	0.023

ND = non-detect

American Robin

Assumptions	Parameter	Symbol
Body weight (kg)	0.081	BW
Soil ingestion proportion	0.02	P_s
Food ingestion Rate (kg/kgBW/d)	0.159	FIR
Proportion of diet, plants	0.41	Pp
Proportion of diet, inverts	0.59	Pi
Proportion of diet, fish	-	Pf
Proportion of diet, birds	-	Pb
Water Intake Rate	0.137	WIR
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF earthworm**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01	0.0375	0.224			0.01945
Ba	2354	20.8	0.01	0.156	0.091			0.63837
Cd	0.641	1.47	0.036	0.586	7.708			0.09961
Cr	16.2	2.66	0.015	0.041	0.306			0.05750
Pb	45	1.63	0.01	0.0389	0.266			0.22816
Hg	1.279	3.25	0.03	0.652	1.693			0.02378
Se	1.672	0.5	0.01	0.672	0.985			0.13668
Zn	491	66.1	0.1	0.366	3.201			0.72306

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Spotted Sandpiper

Assumptions	Parameter	Symbol
Body weight (kg)	0.0425	BW
Soil ingestion proportion	0.17	P_s
Food ingestion Rate (kg/kgBW/d)	0.044	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts	1	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Water Intake Rate	0.007	
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01		0.127			0.00466
Ba	2354	20.8	0.01		0.01			0.01759
Cd	0.641	1.47	0.036		0.614			0.00357
Cr	16.2	2.66	0.015		0.108			0.00889
Pb	45	1.63	0.01		0.066			0.02468
Hg	1.279	3.25	0.03		1.081			0.00564
Se	1.672	0.5	0.01		0.9			0.03980
Zn	491	66.1	0.1		2.33			0.23013

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Snowy Egret

Assumptions	Parameter	Symbol
Body weight (kg)	0.37	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.115	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts	0.1	Pi
Proportion of diet, fish	0.9	Pf
Proportion of diet, birds		Pb
Water Intake Rate	0.030	
Area use factor	0.687	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01		0.127	0.00065		0.00089977
Ba	2354	20.8	0.01		0.01	0.01		0.02780480
Cd	0.641	1.47	0.036		0.614	0.42		0.00455178
Cr	16.2	2.66	0.015		0.108	0.00011		0.00163775
Pb	45	1.63	0.01		0.066	0.0000018		0.00451214
Hg	1.279	3.25	0.03		1.081	0.1		0.00185479
Se	1.672	0.5	0.01		0.9	1		0.07848447
Zn	491	66.1	0.1		2.33	0.138		0.06331722

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

American Woodcock

Assumptions	Parameter	Symbol
Body weight (kg)	0.169	BW
Soil ingestion proportion	0.104	P_s
Food ingestion Rate (kg/kgBW/d)	0.118	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts	1	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Water Intake Rate	0.018	
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF earthworm**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01		0.224			0.021855
Ba	2354	20.8	0.01		0.091			0.369027
Cd	0.641	1.47	0.036		7.708			0.119042
Cr	16.2	2.66	0.015		0.306			0.066318
Pb	45	1.63	0.01		0.266			0.261007
Hg	1.279	3.25	0.03		1.693			0.023629
Se	1.672	0.5	0.01		0.985			0.116725
Zn	491	66.1	0.1		3.201			0.844459

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Mallard Duck

Assumptions	Parameter	Symbol
Body weight (kg)	1.134	BW
Soil ingestion proportion	0.033	P_s
Food ingestion Rate (kg/kgBW/d)	0.068	FIR
Proportion of diet, plants	0.5	Pp
Proportion of diet, inverts	0.5	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Water Intake Rate	0.064	
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01	0.0375	0.127			0.00468
Ba	2354	20.8	0.01	0.156	0.01			0.19340
Cd	0.641	1.47	0.036	0.586	0.614			0.00535
Cr	16.2	2.66	0.015	0.041	0.108			0.00935
Pb	45	1.63	0.01	0.0389	0.066			0.02983
Hg	1.279	3.25	0.03	0.652	1.081			0.00697
Se	1.672	0.5	0.01	0.672	0.9			0.05364
Zn	491	66.1	0.1	0.366	2.33			0.20477

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Great Blue Heron

Assumptions	Parameter	Symbol
Body weight (kg)	2.229	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.103	FIR
Proportion of diet, plants		Pp
Proportion of diet, benthic inverts	0.1	Pi
Proportion of diet, fish	0.9	Pf
Proportion of diet, birds		Pb
Water Intake Rate	0.101	
Area use factor	0.601	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01		0.127	0.00065		0.00075132
Ba	2354	20.8	0.01		0.01	0.01		0.02256262
Cd	0.641	1.47	0.036		0.614	0.42		0.00357065
Cr	16.2	2.66	0.015		0.108	0.00011		0.00131463
Pb	45	1.63	0.01		0.066	0.0000018		0.00362505
Hg	1.279	3.25	0.03		1.081	0.1		0.00145454
Se	1.672	0.5	0.01		0.9	1		0.06149730
Zn	491	66.1	0.1		2.33	0.138		0.04966363

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Least Shrew

Assumptions	Parameter	Symbol
Body weight (kg)	0.017	BW
Soil ingestion proportion	0.13	P_s
Food ingestion Rate (kg/kgBW/d)	0.096	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts	1	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Water Intake Rate	0.0025	
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF earthworm**	**BCF mammals**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	1.04	0.01	0.224				0.03831
Ba	2354	51.8	0.01	0.091				0.12082
Cd	0.641	0.77	0.036	7.708				0.18491
Cr	16.2	2.4	0.015	0.306				0.05987
Pb	45	4.7	0.01	0.266				0.07371
Hg	1.279	1.01	0.03	1.693				0.06189
Se	1.672	0.076	0.01	0.985				0.62492
Zn	491	75.4	0.1	3.201				0.60277

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Swamp Rabbit

Assumptions	Parameter	Symbol
Body weight (kg)	2.118	BW
Soil ingestion proportion	0.063	P_s
Food ingestion Rate (kg/kgBW/d)	0.112	FIR
Proportion of diet, plants	1	Pp
Proportion of diet, inverts		Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Water Intake Rate	0.195	
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF mammals**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	1.04	0.01	0.0375				0.00897
Ba	2354	51.8	0.01	0.156				0.24329
Cd	0.641	0.77	0.036	0.586				0.01654
Cr	16.2	2.4	0.015	0.041				0.00993
Pb	45	4.7	0.01	0.0389				0.01308
Hg	1.279	1.01	0.03	0.652				0.02785
Se	1.672	0.076	0.01	0.672				0.49721
Zn	491	75.4	0.1	0.366				0.08152

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Red Fox

Assumptions	Parameter	Symbol
Body weight (kg)	4.53	BW
Soil ingestion proportion	0.028	P_s
Food ingestion Rate (kg/kgBW/d)	0.16	FIR
Proportion of diet, plants	0.07	Pp
Proportion of diet, inverts	0.03	Pi
Proportion of diet, mammals	0.9	Pm
Proportion of diet, birds		Pb
Water Intake Rate	0.386	
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF earthworm**	**BCF mammals**	**BCF birds**	**HQ**
As	6.14	1.04	0.01	0.0375	0.224	0.0025		0.00419940
Ba	2354	51.8	0.01	0.156	0.091	0.0566		0.14395821
Cd	0.641	0.77	0.036	0.586	7.708	0.33		0.02283960
Cr	16.2	2.4	0.015	0.041	0.306	0.0846		0.02895545
Pb	45	4.7	0.01	0.0389	0.266	0.1054		0.04885933
Hg	1.279	1.01	0.03	0.652	1.693	0.0534		0.00884751
Se	1.672	0.076	0.01	0.672	0.985	0.1619		0.23504448
Zn	491	75.4	0.1	0.366	3.201	0.7717		0.25602628

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

American Mink

Assumptions	Parameter	Symbol
Body weight (kg)	1.0	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.137	FIR
Proportion of diet, plants		Pp
Proportion of diet, benthic inverts	0.1	Pi
Proportion of diet, fish	0.9	Pf
Proportion of diet, birds		Pb
Water Intake Rate	0.099	
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	[Maximum Water]
As	**0.0075**
Ba	**1.1**
Cd	**0.00035**
Cr	**0.0051**
Pb	**0.0088**
Hg	**0.00012**
Se	
Zn	**0.023**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	1.04	0.01		0.127	0.00065		0.00347820
Ba	2354	51.8	0.01		0.01	0.01		0.01961948
Cd	0.641	0.77	0.036		0.614	0.42		0.01506784
Cr	16.2	2.4	0.015		0.108	0.00011		0.00315612
Pb	45	4.7	0.01		0.066	0.0000018		0.00271900
Hg	1.279	1.01	0.03		1.081	0.1		0.01033995
Se	1.672	0.076	0.01		0.9	1		0.89530870
Zn	491	75.4	0.1		2.33	0.138		0.09605634

Notes:

$$\frac{\{[Soil_a \, x \, P_s \, x \, FIR \, x \, AF_{as}] + [\sum_i^N B_i \, x \, P_i \, x \, FIR \, x \, AF_{ai}] + [Water_a \, x \, WIR]\} \, x \, AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Water a	=	Concentration of analyte a (COPEC a) in surface water (mg/L); [1kg = 1L]
WIR	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Water intake rate of receptor, kg/kg BW/day
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Table 20. Calculations used for calculating potential risk (HQs) for COPECs in the BERA for the EWL property based on 95% UCLs soil/ sediment and fish whole body tissue.

COPEC	95% UCL [COPEC mg/kg] soil or sediment
As	6.14
Ba	2354
Hg	1.279

COPEC	95% UCL [COPEC mg/kg] Fish Whole Body Tissue
As	0.646
Inorganic As	0.0996
Ba	17.86
Hg	0.116
MeHg	0.00483

BERA using Fish Tissue Data

Snowy Egret

Assumptions	Parameter	Symbol
Body weight (kg)	0.37	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.115	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts		Pi
Proportion of diet, fish	1	Pf
Proportion of diet, birds		Pb
Area use factor	0.687	AUF
Time (temporal) factor	0.3	TF

COPEC	95% UCL [COPEC] Fish
As	**0.646**
Inorganic As	**0.0996**
Ba	**17.86**
Hg	**0.116**
MeHg	**0.00483**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01					0.00685110
As	6.14	2.24	0.01					0.00106963
Ba	2354	20.8	0.01					0.02100213
Hg	1.279	3.25	0.03					0.00085275
Hg	1.279	3.25	0.03					0.00004201

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

BERA using Fish Tissue Data

Great Blue Heron

Assumptions	Parameter	Symbol
Body weight (kg)	2.229	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.103	FIR
Proportion of diet, plants		Pp
Proportion of diet, benthic inverts		Pi
Proportion of diet, fish	1	Pf
Proportion of diet, birds		Pb
Area use factor	0.601	AUF
Time (temporal) factor	0.3	TF

COPEC	95% UCL [COPEC] Fish
As	**0.646**
Inorganic As	**0.0996**
Ba	**17.86**
Hg	**0.116**
MeHg	**0.00483**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01					0.00535826
As	6.14	2.24	0.01					0.00082829
Ba	2354	20.8	0.01					0.01605106
Hg	1.279	3.25	0.03					0.00066393
Hg	1.279	3.25	0.03					0.00002870

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

BERA using Fish Tissue Data

American Mink

Assumptions	Parameter	Symbol
Body weight (kg)	1.0	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.137	FIR
Proportion of diet, plants		Pp
Proportion of diet, benthic inverts		Pi
Proportion of diet, fish	1	Pf
Proportion of diet, birds		Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	95% UCL [COPEC] Fish
As	**0.646**
Inorganic As	**0.0996**
Ba	**17.86**
Hg	**0.116**
MeHg	**0.00483**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	1.04	0.01					0.02554156
As	6.14	1.04	0.01					0.00394825
Ba	2354	51.8	0.01					0.01426416
Hg	1.279	1.01	0.03					0.00472820
Hg	1.279	1.01	0.03					0.00020435

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

Table 21. Calculations used for calculating potential risk (HQs) for COPECs in the BERA for the EWL property based on 95% UCLs soil/ sediment and crab whole body tissue.

COPEC	95% UCL [COPEC] soil or sediment
As	6.14
Ba	2354
Cd	0.641
Cr	16.2
Hg	1.279

COPEC	95% UCL [COPEC] Crab Whole Body Tissue
As	0.744
Ba	281.2
Cd	0.217
Cr	16.2
Hg	0.0723

BERA using Crab Tissue Data

Snowy Egret

Assumptions	Parameter	Symbol
Body weight (kg)	0.37	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.115	FIR
Proportion of diet, plants		Pp
Proportion of diet, inverts	1	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Area use factor	0.687	AUF
Time (temporal) factor	0.3	TF

COPEC	95% UCL [COPEC] Crab
As	**0.744**
Ba	**281.2**
Cd	**0.217**
Cr	**16.2**
Hg	**0.0723**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01					0.00788805
Ba	2354	20.8	0.01					0.32107679
Cd	0.641	1.47	0.036					0.00350782
Cr	16.2	2.66	0.015					0.14440001
Hg	1.279	3.25	0.03					0.00053406

Notes:

$$\frac{[Soil_a \times P_s \times FIR \times AF_{as}] + [\sum_i^N B_i \times P_i \times FIR \times AF_{ai}] \times AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

BERA using Crab Tissue Data

Great Blue Heron

Assumptions	Parameter	Symbol
Body weight (kg)	2.229	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.103	FIR
Proportion of diet, plants		Pp
Proportion of diet, benthic inverts	1	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Area use factor	0.601	AUF
Time (temporal) factor	0.3	TF

COPEC	95% UCL [COPEC] Crab
As	**0.744**
Ba	**281.2**
Cd	**0.217**
Cr	**16.2**
Hg	**0.0723**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	2.24	0.01					0.00617074
Ba	2354	20.8	0.01					0.25116937
Cd	0.641	1.47	0.036					0.00274288
Cr	16.2	2.66	0.015					0.11310945
Hg	1.279	3.25	0.03					0.00041423

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

BERA using Crab Tissue Data

American Mink

Assumptions	Parameter	Symbol
Body weight (kg)	1.0	BW
Soil ingestion proportion	0.005	P_s
Food ingestion Rate (kg/kgBW/d)	0.137	FIR
Proportion of diet, plants		Pp
Proportion of diet, benthic inverts	1	Pi
Proportion of diet, fish		Pf
Proportion of diet, birds		Pb
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

COPEC	95% UCL [COPEC] Crab
As	**0.744**
Ba	**281.2**
Cd	**0.217**
Cr	**16.2**
Hg	**0.0723**

			Absorbed Fraction (AF)					
COPEC	**95% UCL [COPEC]**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**BCF fish**	**BCF birds**	**HQ**
As	6.14	1.04	0.01					0.02941444
Ba	2354	51.8	0.01					0.22320767
Cd	0.641	0.77	0.036					0.01158889
Cr	16.2	2.4	0.015					0.27744581
Hg	1.279	1.01	0.03					0.00294992

Notes:

$$\frac{[Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}] \; x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight; 95% UCL)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] x [temporal factor, TF])

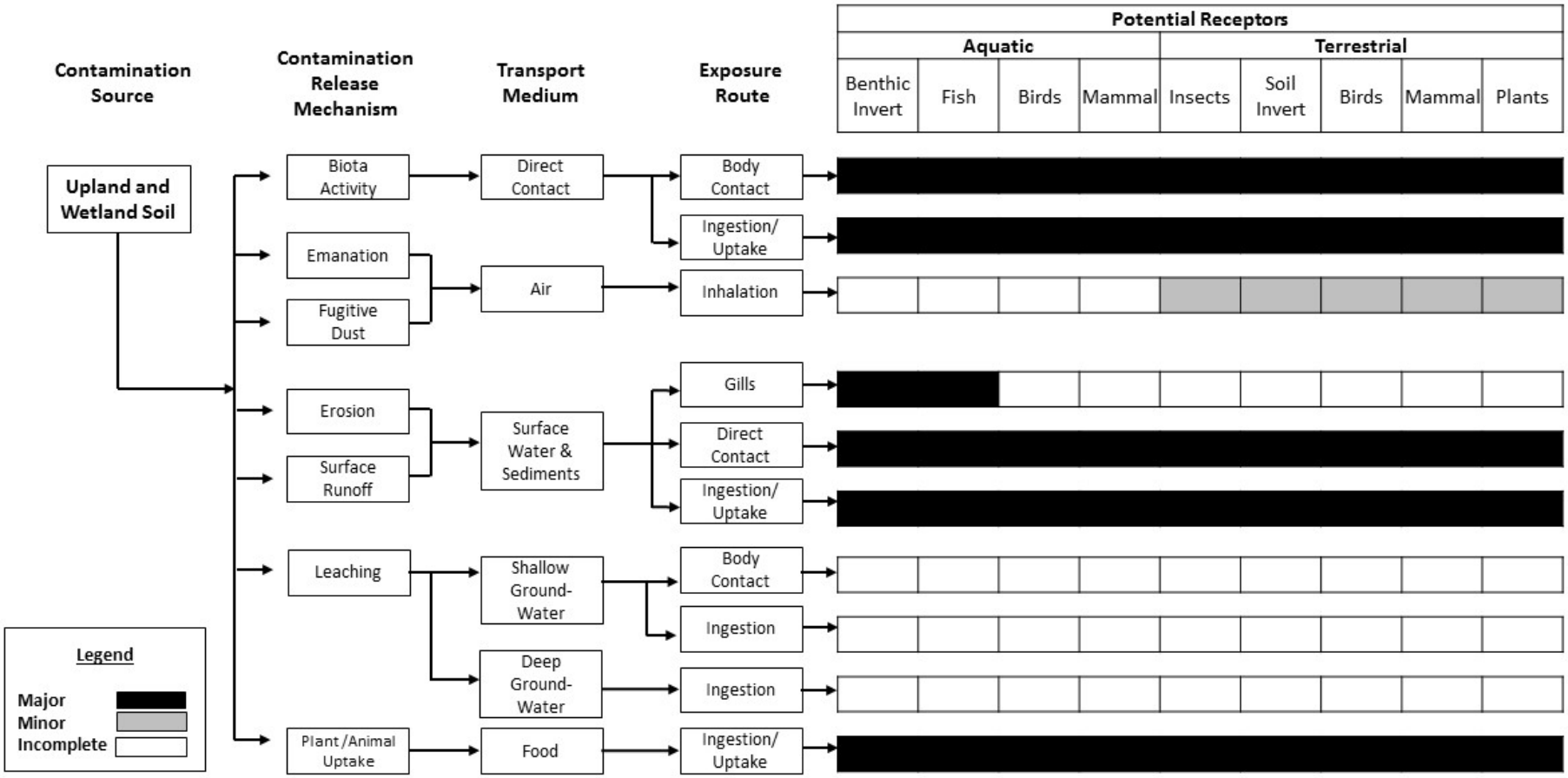

Figure 3. Conceptual Site Model for VPSB Property Ecological Risk Assessment.

Note: Adapted from USEPA 1989

Figure 4. Ecological Checklist (Form 18, RECAP, LDEQ 2003)

RECAP FORM 18
ECOLOGICAL CHECKLIST

Section 1 - Facility Information

1. Name of facility: Vermilion Parish School Board / EWL Field
2. Location of facility: EWL Oil and Gas Field / Section 16 of Township 15 South, Range 01 East (Vermilion Parish)
   Parish: Vermilion Parish
3. Mailing address: N/A
4. Type of facility and/or operations associated with AOC: oil and gas exploration and production, recreation
5. Name of AOC or AOI: VPSB / EWL Field
6. If available, attach a USGS topographic map of the facility and/or aerial or other photographs of the release site and surrounding areas. see reports

Section 2 - Land Use Information

1. Describe land use at and in the vicinity of the AOC/AOI: oil and gas exploration and production, recreation (hunting, fishing, etc.)
2. Describe land use adjacent to the facility: hunting, fishing, etc.
3. Provide the following information regarding the nearest surface water body which has been impacted or has the potential to be impacted by COC migrating from the AOC/AOC:

a) Name of the surface water body: Schooner Bayou, White Lake

b) Type of surface water body:

- [ ] freshwater river or stream
- [x] freshwater swamp/marsh/wetland intermediate marsh
- [ ] saltwater or brackish swamp/marsh/wetland
- [ ] lake or pond
- [x] bayou or estuary
- [x] drainage ditch/canals
- [ ] other: _____

c) Designated use of the segment/subsegment of the surface water body (LAC 33:IX): 050703
Primary contact rec., Secondary contact rec., Fish and wild life propagation, agriculture?

d) Distance from the AOC/AOI to nearest surface water body: < 0.5 mi.

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4. Do any potentially sensitive environmental areas exist adjacent to or in proximity to the site, e.g., federal and state parks, national and state monuments, wetlands, etc? [✓] Yes [ ] No

If yes, explain:
wetlands, intermediate marsh

Section 3 - Release Information

1. Nature of the release: oil and gas exploration and production
2. Location of the release (within the facility): see report
3. Location of the release with respect to the facility property boundaries: within boundaries
4. Constituents known or suspected have been released: oil and gas exploration and production
5. Indicate which media are known or suspected to be impacted and if sampling data are available:

[✓] soil 0 - 3 feet bgs	[✓] yes [ ] no	limited area
[✓] soil 0 - 15 feet bgs ?	[ ] yes [ ] no	
[✓] soil >15 feet bgs ?	[ ] yes [ ] no	
[✓] groundwater ?	[ ] yes [ ] no	
[✓] surface water/sediment	[✓] yes [ ] no	limited area

6. Has migration occurred outside the facility property boundaries? [ ] yes [✓] no no evidence

If yes, describe the designated use of the offsite land impacted:
no evidence of offsite impacts.

Section 4 - Criteria for Further Assessment

If the AOI meets **all** of the criteria presented below, then typically no further ecological evaluation shall be required. If the AOI **does not** meet **all** of the criteria, then a screening level ecological risk shall be conducted. The Submitter should make the initial decision regarding whether or not a screening level ecological risk assessment is warranted based on compliance of the AOI with criteria listed below. After review of the ecological checklist and other available site information, the Department will make a final determination on the need for a screening level ecological risk assessment. If site conditions at the AOI change such that one or more of the criteria are not met, then a screening level ecological risk assessment shall be conducted. Answers shall be based on current site conditions (i.e., shall not consider future remedial actions or institutional or engineering controls).

Indicate if the AOI meets the following criteria:

(1) The area of impacted soil is approximately 5 acres or less in size (based on the AOI identified for the human health assessment) and it is not expected that the COC will migrate such that the soil AOI becomes greater than 5 acres in size. [✓] yes [ ] no

(2) There is no current release or demonstrable long-term threat of release (via runoff or groundwater discharge) of COC from the AOI to a surface water body. [ ] yes [✓] no - perhaps

(3) Recreational species, commercial species, threatened or endangered species, and/or their habitats are not currently being exposed, or expected to be exposed, to COC present at or migrating from the AOI.
[✓] yes [ ] no confirmation needed

(4) There are no obvious impacts to ecological receptors or their habitats and none are expected in the future.
[✓] yes [ ] no confirmation needed

Is further ecological evaluation required at this AOI? [✓] yes [ ] no
This determination is subject to Department concurrence.

Section 5 - Site Summary

The ecological checklist submittal shall include a site summary that presents sufficient information to verify that the AOI meets or does not meet the criteria for further assessment.

Section 6 - Submitter Information

Date: May 13-14, 2014 site inspection

Name of person submitting this checklist: John H. Rodgers, Jr.

Affiliation: Clemson University

Signature: John H. Rodgers, Jr. Date: July 24, 2015 (Form 18 completed)

Additional Preparers: N/A