

# U.S. Environmental Protection Agency

## EPA Region 7

### RESPONSE ACTION CONTRACT

Contract No. 68-W5-0004

DRAFT  
ECOLOGICAL RISK ASSESSMENT  
REVISION 0

RIVERFRONT SUPERFUND SITE  
Operable Units 1 through 4  
New Haven, Missouri



BLACK & VEATCH Special Projects Corp.





**Ecological Risk Assessment  
Revision 0**

**Riverfront Superfund Site  
City of New Haven  
Franklin County, Missouri**

**Black & Veatch Project No. 046127.0107**

**Prepared under  
EPA Contract No. 68-W5-0004**

**July 12, 2002**

***Prepared by:***

**Black & Veatch Special Projects Corp.**

***Prepared for:***

**U.S. Environmental Protection Agency, Region 7  
Kansas City, Kansas**

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## 1.0 Introduction

The objective of this Ecological Risk Assessment (ERA) is to present an evaluation of the analytical data generated during investigations conducted during the Remedial Investigation (RI) as they relate to ecological risks at the Riverfront Superfund (Riverfront) Site. This ERA is intended to be evaluated in conjunction with the Riverfront Remedial Investigation/Feasibility Study (RI/FS) Report.

The methodology used in this ERA will be based on and complies with the latest guidance described in the Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (USEPA 1997). The guidance outlines eight steps to complete the ecological risk assessment process at Superfund sites. The ERA process is generally organized as follows:

- Screening Level Ecological Risk Assessment (Steps 1 through 2 of the Process Document)
- Baseline Ecological Risk Assessment (Steps 3 through 7 of the Process Document)

The screening-level ERA is initially performed to identify and discuss the potentially affected natural environment, distribution of contamination, fate and transport of contaminants, relevant exposure pathways, and to develop a list of preliminary contaminants of potential ecological concern (PCOPC), identifying those that present a potential ecological risk. Generally, the baseline ERA is conducted to provide additional detail to support development of more site-specific preliminary remedial goals (PRGs). In some cases, depending on the remedial options available, acceptable PRGs can be determined for media of concern after the completion of the screening-level ERA.

Based on the evaluation of the data presented in Steps 1 and 2 of this ERA by Black & Veatch (B&V) and the Region 7 EPA Biological Technical Assistance Group (BTAG), it was determined that adequate PRGs could be developed for the site based on the screening-level ERA. Therefore, Steps 3 through 6 of the ERA process will not be initiated and the screening-level ERA will essentially be a Baseline ERA.

## 2.0 Site Characterization

The objectives of this section are to compile and summarize the relevant environmental information from the site history and previous investigations conducted at the site. This section includes a brief discussion of the site and its history, environmental setting, ecological habitats observed at the site, identification of potentially complete exposure pathways, screening of contaminated media against ecological screening criteria, preliminary risk characterization, and a discussion of uncertainty.

### 2.1 Site Description and History

The New Haven Riverfront Site was placed on the National Priorities List (NPL) or "Superfund" on December 01, 2000. Since first proposed to the NPL, the extent of known tetrachloroethene (PCE) contamination in ground water has increased beyond the initial site in downtown New Haven. Concentrations of PCE have now been detected in the bedrock aquifer at a depth in excess of 400 ft (feet) along Orchard Street about 800 feet south of city well W2 and in shallow (less than 100 ft deep) bedrock monitoring wells in the south part of the city along Industrial Drive.

Although the term "Riverfront Site" has been used to refer to an investigation in downtown New Haven near the Missouri River, the Riverfront Superfund investigation includes four separate investigation areas or operable units within the city of New Haven, Missouri (Figure 2-1). Four OUs have been designated for the Riverfront RI Site:

- The Riverfront Site in downtown New Haven, OU-1. The Riverfront Site (OU-1) is located in the eastern part of downtown New Haven. The site is underlain by the Missouri River alluvial aquifer (about 30 feet thick at the site). The principle feature of the site is a one-story industrial building (Riverfront building). Interviews conducted by the Missouri Department of Natural Resources (MDNR) and the U.S. EPA indicate that industrial activities that occurred at the Riverfront site include metal fabrication, furniture assembly and painting, metal tempering, and automotive repair. During the 1950s, 1960s, and early 1970s, PCE was used at the facility and PCE-contaminated wastes were reportedly dumped on the land surface near the building. Given the types of industrial uses at the facility, the types of waste expected include scrap metal and metal shavings (aluminum and steel), chlorinated solvents (used to degrease metals), paints and paint solvents, and hydrocarbons (fuels and oils).

- The Kellwood Site on Industrial Drive in southern New Haven, OU-2. The U.S. EPA and MDNR have determined that PCE was used as a cleaning solvent for metal cutting and metal tubing fabrication processes and disposed on the ground north of the building and into the sanitary sewer system. The former building owner conducted a cleanup of PCE contaminated soils on the gravel lot north of the building in the 1990s.
- The old city dump in eastern New Haven, OU-3. OU-3 resides on a 1.5 acre lot in the southeast part of New Haven. The dump is situated in a ravine on the north side of Highway 100 and is approximately 320 ft. wide by 200 feet deep. The north face of the dump is more than 35 ft high and debris including rusted metal 55-gallon drums are exposed near the toe of the slope. The surface of the dump has been covered with more than 5 feet of yard wastes and demolition debris.
- The undeveloped area south and east of monitoring well BW-02 (hereinafter referred to as East New Haven), OU-4. The East New Haven site refers primarily to the area east of Miller Street, south of Orchard Street and north of State Highway 100. The site is located roughly between the old city dump (OU-3) and downtown New Haven. The detection of large PCE concentrations (more than 200 micrograms per liter) in monitoring well BW-02 during the ESI/RI indicated the possibility of an unknown PCE source south (upgradient) of BW-02.

## 2.2 Environmental Setting

New Haven, Missouri (population about 1,600), is located along the southern bank of the Missouri River in Franklin County, about 50 miles west of St. Louis, Missouri. The city is similar in character to other small towns and cities along the Missouri River with historic late-1800's era homes along the steep river valley slopes overlooking a downtown business district adjacent to the river. The principal road in the city is State Highway 100, which runs along part of an east-west trending ridge about 1 mile south of the Missouri River. The ridge forms a topographic divide between the Missouri River valley to the north and the Boeuf Creek valley to the south. The two major towns near New Haven are Washington (approximately 15 miles to the east) and Hermann (approximately 20 miles to the west).

The downtown business district is located within a narrow (less than 600-foot wide) strip of floodplain and consists of several small shops and restaurants, a few homes, and several

small old manufacturing facilities. This area of New Haven is surrounded by a flood protection levee that is maintained by the U.S. Army Corps of Engineers (USACE). Land use north of the State Highway 100, including the downtown area, is mostly residential, and land use outside the city is mostly pasture with some row crops. An industrial park (developed in the mid-1970s) containing several large manufacturing facilities is located south of this ridge and State Highway 100.

New Haven is located along the northern boundary of the Salem Plateau physiographic subprovince. The Salem Plateau is characterized by a moderate to rugged terrain of thin soils and narrow steep walled valleys. Topographic relief is the result of gradual uplift of the Ozark Dome in southern Missouri and erosion of the uplifted rocks by precipitation, runoff, and stream flow. The relief in the New Haven area is accentuated because of proximity to the Missouri River, which controls the base level for most streams in western and central Missouri. The land surface altitude ranges from a low of 470 feet above sea level at the Missouri River to about 920 feet on a ridge about 3 miles west of the city. In the upland areas of New Haven, loess deposits as much as 15 feet thick overlie the cherty, silty, clay residuum that is characteristic of surficial materials throughout most of the Salem Plateau. The average annual precipitation for this area is about 37 inches. There are two primary aquifers in the New Haven area:

- The Missouri River alluvial aquifer, and
- The Ozark aquifer (bedrock)

Downtown New Haven lies in the Missouri River Valley. Unconsolidated sediments beneath downtown are part of the Missouri River alluvial aquifer. Beneath downtown New Haven, the alluvial aquifer is about 30 to 40 feet thick with the thickness increasing toward the Missouri River. At normal stages of the Missouri River, the water table in the alluvial aquifer beneath downtown New Haven is about 20 feet below the land surface and slopes northeast toward the river channel. The upper 5 to 15 feet of aquifer consists of silt and clayey silt that grades into sand and gravel near the base of the alluvium. The Missouri River alluvial aquifer can be more than 100 feet thick and is used extensively for public, domestic, and industrial water supplies in Missouri. The alluvial aquifer is not used for water supply in the immediate vicinity of New Haven.

The bedrock beneath New Haven is part of the Ozark aquifer. This aquifer is more than 1,000 feet thick beneath New Haven and consists mostly of limestone and dolostone with some cherty dolostone and sands. This aquifer is used extensively for public, industrial, and

domestic water supplies throughout southern Missouri. Domestic, industrial, and public supply wells in the New Haven area obtain their water from this aquifer.

## **2.3 Ecological Habitats**

Based on a review of previous site investigations and an ecological site reconnaissance performed by B&V in April 2002, several aquatic and terrestrial habitats were observed in the Riverfront study area. The study area was defined as all watersheds potentially affected by the Riverfront Site, based on a review of surficial topography (Figure 2-2).

Most terrestrial habitats within the study area are developed residentially or commercially; however, there are isolated areas of industrial development. Most of the undeveloped terrestrial habitat includes forest areas located adjacent to streams or floodplains. Additional undeveloped terrestrial habitats in the study area include agricultural lands located in the periphery of the study area and the city of New Haven.

Aquatic habitats in the study area include the Missouri River (which flows adjacent to OU1) and several small streams that originate within the study area. The small streams that flow within and from OU3 and OU4 flow directly into the Missouri River. A small stream that received runoff and groundwater associated with OU2 flows southward into Boeuf Creek. Boeuf Creek continues to flow for approximately 8 river miles where it discharges into the Missouri River. The general location of these habitats relative to the Riverfront Site OUs is presented in Figure 2-2.

### **2.3.1 Developed Terrestrial Habitats**

The developed habitats within the study area include residential, commercial, and industrial areas. The residential areas generally consist of  $\frac{1}{4}$  to  $\frac{1}{2}$  acre properties that include maintained lawns and both native and ornamental trees and shrubs. Commercial areas tend to be adjacent to the state highways traversing the study area and the downtown area of New Haven. Industrial areas are generally concentrated in specific areas within the study area. These commercial and industrial areas are largely completely paved and contain very little usable habitat; however, some birds and mammal species have adapted to these habitats.

The residential areas may provide habitat for seed-eating and insectivorous bird and mammal species (i.e. swallows, sparrows, squirrels, chipmunks), vermivorous mammals, birds, and reptiles (i.e. shrews, robins, garter snakes), herbivorous mammals and birds (i.e. meadow voles), carnivorous mammals, birds, and reptiles (i.e. red fox, kestrel, rat snakes).

Some of these species may occasionally be found in commercial and industrial areas. Developed terrestrial habitats are not critical habitat for these species; however, these species may be present in these habitats. Photographs 01 and 02 in Appendix A show the typical developed terrestrial habitats in the study area.

### **2.3.2 Cultivated/Agricultural Habitats**

The agricultural habitats include active cropping areas and abandoned agricultural fields in various stages of succession. In the study area, these areas range from small (less than 1 acre) portions of larger properties to large fields exceeding 50 acres. Windbreaks or hedgerows of deciduous trees that are useful to some species as edge habitat border most of the fields. Within the fields themselves, the dominant vegetative species include goldenrods (*Solidago spp.*), asters (*Aster spp.*), a variety of thistles. These areas provide habitat for most of the species also likely to be present in the developed areas; however, these areas are more likely to provide habitat for larger species such as deer, hawks, and larger snakes. Photograph 03 in Appendix A shows a typical agricultural habitat in the study area.

### **2.3.3 Forested Habitats**

The forested habitats are generally located in ravines associated with the streams that traverse the study area. The most extensive forested habitats are associated with the areas in the vicinity of OU3 and OU4. Another large forested area is located to the east of OU1 and is associated with the Missouri River floodplain. In the more upland areas, the dominant tree species include hickories (*Carya spp.*), oaks, (*Quercus spp.*), and American elm (*Ulmus americana*). In the lower areas, these trees mix with and transition to box elder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), and silver maple (*Acer saccharinum*). Most areas contain a moderately dense understory dominated by blackberries (*Rubus spp.*) and saplings of the overstory trees. These areas provide habitat for most of the species also likely to be present in the other habitats; however, these areas are more likely to provide habitat for larger species such as deer, hawks, and larger snakes. Photographs 04, 05, and 06 in Appendix A show several of the forested habitats located within the study area.

### **2.3.4 Streams**

There are several intermittent and first- and second-order perennial streams that traverse the study area. In general, the areas to the south of State Highway 100 flow southward through these first- and second-order streams into Boeuf Creek. Areas to the north of State Highway

100 generally flow northward through these first- and second-order streams into the Missouri River.

The first- and second-order streams in the study area are generally small streams between 6 and 10 feet in width with water depths ranging from a few inches to two feet. The substrate of these streams consists mostly of shaly cobbles with occasional boulders and silt deposits in low-energy areas. The banks of these streams are generally well defined and are two to three feet high. In the more heavily developed areas (generally those streams that flow northward directly into the Missouri River, the banks show some signs of erosion associated with high rates of runoff. These streams were observed to support a variety of benthic invertebrate species and some areas of deeper water contained small fish and amphibians. Photographs 07 and 08 in Appendix A show some of the first- and second order streams in the study area.

### **2.3.5 Rivers**

There are two rivers that receive drainage from smaller streams or OUs within the study area. These include the Missouri River and Boeuf Creek, a fourth-order river that flows directly in to the Missouri River approximately 4 miles downstream of the study area.

The Missouri River is a very large river that drains most of the mid-western United States. As such, it is highly susceptible to flooding and most of the river along the New Haven waterfront has been diked and engineers for flood protection purposes. At New Haven, the Missouri river is at its narrowest (less than 200 feet), resulting in very high flow rates and a deep bottom. Areas along the shoreline contained several jetties and these areas had accumulated flotsam. Between the jetties there appeared to be sediment deposition; however approximately 30 feet out into the river, the depth increase to over 30 feet and the flow rates probably preclude sediment deposition. In the sediments within the depositional areas between the jetties, there are likely to be Tubificerid worms. The Missouri River contains a wide variety of fish species. Crappie (*Pomoxis annularis*), bluegill (*Lepomis macrochirus*), sunfish (*Lepomis spp.*), and largemouth bass (*Micropterus salmoides*) are located primarily in off-channel waters. Species preferring swift water, such as freshwater drum (*Aplodinotus grunniens*), white bass (*Morone chrysops*), channel catfish (*Ictalurus punctatus*), walleye (*Stizostedion vitreum vitreum*) and sauger (*Stizostedion canadense*) are found in tailwater or main channel border habitats. Based on a visual reconnaissance of the Missouri River, birds and mammals would be expected to utilize the open water and

shoreline habitats for foraging. Photographs 09 and 10 in Appendix A show the Missouri River in the vicinity of the study area.

Boeuf Creek is third-order stream that drains the area south of New Haven in Franklin County. In the study area, Boeuf Creek is 15 and 25 feet in width with water depths ranging from a few inches to several feet and a variety of in-stream habitats including riffles, runs, and pools. The substrate of Boeuf Creek consists mostly of shaly cobbles with occasional boulders and silt deposits in low-energy areas. The banks of the Boeuf Creek are generally well defined and are several feet high. Boeuf Creek was observed to support a variety of benthic invertebrate species, small fish and amphibians. Based on a visual reconnaissance of the available habitat, birds, reptiles, and mammals would be expected to utilize the open water and shoreline habitats for foraging. Photographs 11 and 12 in Appendix A show the Boeuf Creek in the vicinity of the study area.

### **2.3.6 Ponds**

Several small ponds are located throughout the study area. Most of these ponds are excavated farming ponds and contain shallow water with no discernable inflow or outflow. Based on these observations, these ponds are likely to be recharged by shallow groundwater. In general, most of the ponds are round, with shallow banks and fringe vegetation. These ponds are likely to provide habitat for small fish species and waterfowl.

### **2.3.7 Threatened and Endangered Species**

Documentation was requested from the Missouri Department of Conservation's Natural Heritage Program database (MDC 2002) and the U.S. Fish and Wildlife Service – Region 3 County List (USFWS 2001) concerning federal- and state-threatened and endangered species potentially present at the Riverfront Site.

The federal status is derived from the provisions of the Endangered Species Act of 1973, as amended, which is administered by the U.S. Fish and Wildlife Service. Passage of the Endangered Species Act of 1973 gave the United States one of the most far-reaching laws ever enacted by any country to prevent the extinction of imperiled animals and plants. Protecting endangered and threatened species and restoring them to the point where their existence is no longer jeopardized is the primary objective of the Fish and Wildlife Service's Endangered Species Program.

Rule 3CSR10-4.111 of the Wildlife Code of Missouri and certain state statutes apply to state Code listed species. The state status “endangered” is determined by the Department of Conservation under constitutional authority.

The following table provides a list of species in Franklin County, MO that are federal- and/or state-threatened and endangered species potentially present at the Riverfront Site.

### State and Federal Threatened and Endangered Species In Franklin County, Missouri

Common Name	Scientific Name	State Status	Federal Status	Habitat
Decurrent false aster	<i>Boltonia decurrens</i>	E	T	Disturbed alluvial soils
Grey bat	<i>Myotis grisiscens</i>	E	E	Caves
Indiana bat	<i>Myotis soldalis</i>	E	E	Hibernacula: Caves and mines. Maternity and foraging habitat: small stream corridors with well developed riparian woods; upland forests
Bald eagle	<i>Haliaeetus leucocephalus</i>	NL	T	Large river corridors
Pink mucket	<i>Lampsilis abrupta</i>	E	E	Usually found in streams with cobble-gravel bottom in water 1-10 feet deep. Has not been observed in streams within the study area.
Elephant-ear	<i>Elleptio crassidens</i>	E	NL	Large rivers in mud, sand, or fine gravel.
Pallid sturgeon	<i>Scaphirhynchus albus</i>	NL	E	Missouri River
Crystal darter	<i>Crystallaria asprella</i>	E	NL	Occur in streams and ditches with slow current, clear water, and sand or pebble bottom.
Sturgeon chub	<i>Macrhybopsis gelida</i>	NL	C	Inhabits streams with swift current and sand or gravel bottom. Missouri river.
Sicklefin chub	<i>Macrhybopsis meeki</i>	NL	C	Inhabits the main channels of large turbid rivers with sand or fine Gravel bottoms and strong current. Missouri River.
Sheepnose	<i>Plethobasus cyphus</i>	E	NL	Medium to large rivers in gravel or mixed sand and gravel.

## State and Federal Threatened and Endangered Species In Franklin County, Missouri

Common Name	Scientific Name	State Status	Federal Status	Habitat
T = Threatened species E = Endangered species C = Candidate for federal listing NL = Not Listed				

None of these species are known to occur within the study area; however, their presence within Franklin County, and the presence of suitable habitat within the study area, indicates that there is a potential for these species to be present.

### 2.4 Contaminants at the Site

Results of previous studies have detected PCE-contaminated soils and shallow ground water at two facilities in New Haven--the Riverfront site (OU-1) and the Kellwood site (OU-2). Trace concentrations of PCE were detected in soils at the old city dump (OU-3) and in a seep at the city dump sampled during a previous study called an Expanded Site Investigation-Remedial Investigation (ESI-RI). In addition, PCE has recently (2000) been detected in a bedrock monitoring well south of city well W2 (BW-02) and a small tributary (210 tributary) south of this monitoring well, indicating a potential source of PCE south of city well W2 in the area designated as OU-4.

Because the scope of the RI is based on the known discharges of PCE, the potential contaminants at the site are limited to PCE and related volatile organic compounds. RI activities began in June 2000. A field gas chromatograph (GC) was used to screen samples of soil, surface water, and groundwater to identify areas with contamination for further evaluation in the ERA. A selection of samples from key areas for use in the risk assessments were also analyzed under EPA's contract laboratory program using EPA Method 8260B (volatile organic compounds).

Based on the site history, previous investigations, and the results of the field GC, the following were identified as target contaminants at the Riverfront site:

- Tetrachloroethene (PCE)

- Trichloroethene (TCE)
- cis-Dichloroethene (cis-DCE)
- trans-Dichloroethene (t-DCE)
- Vinyl chloride (VC)
- Toluene
- Benzene

## 2.5 Potentially Complete Exposure Pathways

For an exposure pathway to be complete, a chemical must be able to travel from the source to ecological receptors (the migration pathway) and be taken up by the receptors via one or more exposure routes (EPA 1997). Incomplete exposure pathways are characterized by either a disruption in chemical transport to plants or animals or by the absence of chemicals in a medium to which an ecological receptor is exposed. Identifying complete migration pathways before the analysis step focuses the exposure and ecological effects analyses on only those chemicals that can reach ecological receptors. For the purposes of this ERA, exposure pathways to the potential receptors will not include inhalation or dermal absorption because of a general lack of quantifiable information. Therefore, this ERA focuses on the ingestion exposure pathway.

Based on the investigations conducted at the site, there are several known or suspected sources of contamination (Figure 2-3):

- The buildings in the southeast portion of OU1 (Source A).
- The Kellwood facility at OU2 (Source B).
- The residence of a former Kellwood employee suspected of dumping chlorinated solvents (Source C).
- A former dry cleaning facility located just south of OU1 (Source D).
- The city dump located at OU3 (Source E).
- Unidentified locations of isolated dumping throughout the study area.

Shallow and deep groundwater near the Riverfront OUs has been shown to contain chlorinated solvents and volatile organic compounds. While there may have been historical surficial contamination of soils at these sites, the target contaminants rapidly volatilize in the atmosphere. Based on these properties, recharge of groundwater into surface water bodies is the only significant migration pathway of concern for ecological receptors. There are two primary aquifers in the New Haven area:

- The Missouri River alluvial aquifer, and
- The Ozark aquifer (bedrock)

Downtown New Haven lies in the Missouri River Valley. Unconsolidated sediments beneath downtown are part of the Missouri River alluvial aquifer. Beneath downtown New Haven, the alluvial aquifer is about 30 to 40 ft (feet) thick with the thickness increasing toward the Missouri River. At normal stages of the Missouri River, the water table in the alluvial aquifer beneath downtown New Haven is about 20 ft below the land surface and slopes northeast toward the river channel. The upper 5 to 15 ft of aquifer consists of silt and clayey silt that grades into sand and gravel near the base of the alluvium. The Missouri River alluvial aquifer can be more than 100 ft thick and is used extensively for public, domestic, and industrial water supplies in Missouri. The alluvial aquifer is not used for water supply in the immediate vicinity of New Haven. The alluvial aquifer is a main source of water for surface water features in the study area and the flow directions are generally consistent with the surficial topography.

The bedrock beneath New Haven is part of the Ozark aquifer. This aquifer is more than 1,000 ft thick beneath New Haven and consists mostly of limestone and dolostone with some cherty dolostone and sands. This aquifer is used extensively for public, industrial, and domestic water supplies throughout southern Missouri. Domestic, industrial, and public supply wells in the New Haven area obtain their water from this aquifer. This aquifer does not charge local streams. The general flow direction for this aquifer is toward the north and the discharge point (if present) for this has not been identified.

Detailed information regarding groundwater migration pathways at the site can be obtained in the RI/FS report (BVSPC 2002).

### **3.0 Exposure Assessment**

Based on the evaluation of potential migration and exposure pathways at the Riverfront site, floodplains, surface waters, and sediments associated with several small streams, Boeuf Creek, and the Missouri River may contain concentrations of the target contaminants at levels that could present a risk to ecological receptors that use these habitats.

The most significant exposure pathway for exposure to the target contaminants is by direct exposure to contaminated media. The exposure routes would include ingestion of contaminated media, trans-dermal absorption of the contaminants, or inhalation/respiration of contaminants. The target chemicals, which are all volatile organic compounds, have very low bioconcentration factors and are not generally considered to be bioaccumulative.

Based on the site conditions and the physical properties of the target contaminants, this ERA will consider the direct exposure risks associated with floodplain soil, surface water, and sediment. Since information on plant tissue concentrations is readily available based on information gathered during the RI, a conservative ingestion model for a representative herbivore will also be included in this ERA. A schematic exposure model for the site is presented in Figure 3-1.

#### **3.1 Direct Exposure Concentrations**

In March 2002, additional samples of floodplain soil, sediment, and surface water were collected in areas of expected contamination to allow an estimation of risk in this ERA. This data was combined with previous data where appropriate to form the data set evaluated in this ERA. This ERA considers contamination in floodplain surface soil, sediment, surface water, and plant tissue.

##### **3.1.1 Floodplain Surface Soil**

Ten samples of floodplain surface soil were collected during the 2002 sampling event. There were no samples of floodplain surface soil collected during the previous investigations. Eight of the floodplain surface soils were co-located with surface water and sediment samples collected along streams within the study area. These samples were collected from adjacent overbank areas. The two remaining samples were collected from the broad forested floodplain habitat along the Missouri River located east of OU-1. A total

of 10 floodplain surface soils samples were evaluated in the ERA. The location of these samples is presented in Figure 3-2. The data for the samples is presented in Table 3-1.

### **3.1.2 Sediment**

Eight samples of sediment were analyzed from investigations during 2000 and 2001 along the Missouri River shoreline within the study area, adjacent to OU-1. An additional eight samples were collected along streams within the study area and were co-located with surface water and floodplain surface soil samples. A total of 16 sediment samples were evaluated in the ERA. The location of these samples is presented in Figure 3-2. The data for the samples is presented in Table 3-2.

### **3.1.3 Surface Water**

Surface water samples have been collected at various times from streams within the study during previous investigations and the RI. Surface water samples have been collected from 24 locations streams within the study area as part of the RI. Where multiple surface water samples have been collected at one location over a period of time, the data from the most recent sample was used in this ERA. The location of these samples is presented in Figure 3-2. The data for the samples is presented in Table 3-3.

### **3.1.4 Plant Tissue**

Cores and fruit samples from trees growing throughout the study area were collected to estimate the concentration of chemicals of concern absorbed by trees through either volatilization or uptake. During the previous investigations, 305 samples of tree core and fruit were collected. These samples were collected from trees suspected to be along contaminant migration pathways and include trees along sewer lines and drainageways. The location of these samples is presented in Figure 3-2. The data for the samples is presented in Table 3-4.

## **3.2 Food Chain Ingestion Model for Herbivores**

As stated previously, since there is a large data set to address concentrations of target compounds in plant tissue (specifically trees), that data will be used to assess the risks to herbivores that may be present in the study area.

Ingestion doses were based on both the average and maximum concentrations of each of these target compounds and were determined by the following equation derived from EPA's Wildlife Exposure Factors (EPA, 1993):

$$\text{ADD} = [C_{\text{PF}} * \text{FD}_{\text{PF}} * \text{AUF} * \text{NFIR}] \text{ (dose from prey)}$$

Where:

ADD	=	Average daily dose (mg/kgBW-day)
C <sub>PF</sub>	=	Estimated concentration of contaminant in prey (mg/kg)
NFIR	=	Normalized food ingestion rate (g/gBW-day)
FD <sub>PF</sub>	=	Dietary fraction comprised of item (assume 100%)
AUF	=	Area usage factor of receptor species (assume 100% usage)

The herbivore community was selected as an important community to evaluate using the food chain ingestion model based on the potential exposure pathway where target compounds are incorporated into the tissue of plants and the plant is ingested by an herbivore. An eastern cottontail rabbit was selected as a representative mammal for this pathway. A northern bobwhite was selected as a representative bird for this pathway.

The eastern cottontail (*Sylvilagus floridanus*) uses the habitat (woodlands, abandoned fields, residential landscaping) found in the study area, eats, leaves, shoots, seeds and fruit, and is likely to be present. Given these characteristics the meadow vole probably maximizes the exposure potential for a mammalian herbivore.

The northern bobwhite (*Colinus virginianus*) uses the habitat (woodlands, abandoned fields, residential landscaping) found in the study area, eats, leaves, shoots, seeds and fruit, and is likely to be present. Given these characteristics the northern bobwhite probably maximizes the exposure potential for an avian herbivore.

To determine the food chain exposure to typical herbivore, it is first necessary to determine the concentration of target compounds in the tissues of the herbivore prey species (e.g. plants). This information is presented in Table 3-4. The estimated average daily dose (ADD) to herbivores (using the representative surrogate species), based on the average and maximum soil concentrations, and the various exposure model variables used to estimate ADD, is presented in Table 3-5 (mammals) and 3-6 (birds).

## 4.0 Toxicological Assessment

Based on the evaluation of potential migration and exposure pathways at the Riverfront site, floodplains, surface waters, and sediments associated with several small streams, Boeuf Creek, and the Missouri River may contain concentrations of the target contaminants at levels that could present a risk to ecological receptors that use these habitats. Concentrations of target compounds in these media were compared to toxicological reference values (referred to as ecological screening values [ESVs]) to determine if these media presented a risk to ecological receptors.

ESVs for surface soil, sediment, surface water, and wildlife were developed from available literature sources. It is important to note that the database of ESVs for target compounds is very limited because volatile organic compounds are not generally considered to be significant in terms of ecological risk.

### 4.1 Surface Soil

Surface soil ESVs for the target compounds were found in several sources of ecological toxicity including:

1. EPA Region 4 screening values as published in EPA Region 4 Ecological Risk Assessment Bulletins -- Supplement to RAGS [1999].
2. EPA Region 5 RCRA Environmental Data Quality Levels (EDQLs; EPA 1999).
3. Efrogmson, R.A., M.E, Suter, G.W., and Wooten A.C. 1997a. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1997.
4. CCMOE, 1999. Canadian Council of Ministers of the Environment, Canadian Environmental Quality Guidelines, Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health – Summary Tables, 1999.

In selecting these soil ERVs, the screening values from EPA Region 4 and Region 5 were preferred since these are accepted and commonly used toxicity values in adjacent EPA regions. When considering between values from both regions, the most conservative (that is, protective) value was selected at the ESV. When neither Region 4 nor Region 5 data

were available, the data presented in Efroymson et al. (1997) was preferred because it summarized the data from a large variety of studies and recommended the most conservative value from those studies. In addition, this data evaluated the protection of the plants themselves, which is likely to be a key element in the ecosystem at the Riverfront Park Site. Finally, the data presented in Efroymson is largely accepted for screening ecological risks by other EPA regions and most other regulatory agencies. The last order of preference is the Canadian Soil Quality Guideline (SQG) for parklands (1999). The Canadian SQGs for parklands were developed to consider the ecological risks to organisms using these parklands; however, the data used in developing these SQGs is biased toward protection of human receptors.

ESVs for floodplain surface soils at the Riverfront site are presented in Table 4-1.

## **4.2 Sediment**

Sediment ESVs for the target compounds were found in two sources of ecological toxicity including:

1. EPA Region 5 RCRA Environmental Data Quality Levels (EDQLs; EPA 1999).
2. EPA 1996. Eco Update (Ecotox Thresholds). Interim Bulletin Volume 3, Number 2. EPA 540/f-95/038, January 1996 - Freshwater Sediment Values.

When considering between values from both sources of data, the most conservative (that is, protective) value was selected at the ESV.

ESVs for sediments at the Riverfront site are presented in Table 4-2.

## **4.3 Surface Water**

Surface water ESVs for the target compounds were found in two sources of ecological toxicity including:

1. EPA Region 5 RCRA Environmental Data Quality Levels (EDQLs; EPA 1999).
2. EPA 1996. Eco Update (Ecotox Thresholds). Interim Bulletin Volume 3, Number 2. EPA 540/f-95/038, January 1996 - Freshwater Sediment Values.

When considering between values from both sources of data, the most conservative (that is, protective) value was selected at the ESV.

ESVs for surface water at the Riverfront site are presented in Table 4-3.

#### **4.4 Wildlife**

Wildlife ESVs were developed to allow a comparison of the calculated doses of target compounds to which representative herbivores would be exposed. Unlike the ESVs presented for abiotic media, these ESVs are present as ingestion doses, not exposure concentrations. Two types of doses are considered in this ERA:

- The No-Observed-Adverse-Effect-Level (NOAEL), which is the highest tested dose of a compound that did not produce a discernable affect, and
- The Low-Observed-Adverse-Effect-Level (LOAEL), which is the lowest tested dose of a compound that did produce a discernable affect.

These NOAEL and LOAEL, were obtained from the U.S. Department of Energy's "*Toxicological Benchmarks for Wildlife*" (Sample et al. 1996). In selecting TRVs for contaminants with multiple studies in this reference, reproductive affects were the preferred endpoints, and dietary ingestion was the preferred exposure route. ESVs for wildlife at the Riverfront site are presented in Table 4-4.

## 5.0 Risk Characterization

In the risk characterization, risks to ecological receptors are evaluated by generating hazard quotients (HQs) for each target compound in each media. The HQ is the ratio that is expressed as an exposure concentration or dose (maximum detected concentration) divided by an effects concentration (ESV) as shown below.

$$\text{HQ} = \text{Maximum Compound Concentration or Dose} \div \text{Screening Value}$$

A HQ less than one indicates that the compound alone is unlikely to cause adverse ecological effects. This risk calculation is a conservative estimate to ensure that potential ecological threats are not overlooked (EPA 1997). The results of this risk calculation serve to determine whether a compound presents negligible risk or whether additional site-specific information needs to be further evaluated.

### 5.1 Floodplain Surface Soil Risk Characterization

Floodplain surface soil analytical results were compared to the selected ESVs for surface soil and are presented in Table 3-1. Target compounds were not detected in these surface soils samples; therefore, there are no significant risks presented by surface soils sampled in the study area. It is important to note that the reporting limits for TCE and VC are higher than the ESVs; therefore, there is a potential for the concentrations of these two compounds to be between the reporting limit and the ESV. This will be discussed in more detail in the Uncertainty (Section 6.0) of this ERA.

### 5.2 Sediment Risk Characterization

Sediment analytical data results were compared to the selected ESVs for sediment and are presented in Table 3-2. PCE and toluene were detected in two of these samples; however, the concentrations of these detections were all well below the ESVs for sediment. Based on this comparison, there are no significant risks presented by sediment sampled in the study area. It is important to note that the reporting limits for VC are higher than the ESVs; therefore, there is a potential for the concentrations VC to be between the reporting limit and the ESV. This will be discussed in more detail in the Uncertainty (Section 6.0) of this ERA.

### **5.3 Surface Water Risk Characterization**

Surface water analytical data results were compared to the selected ESVs for surface water and are presented in Table 3-3. PCE, cis-DCE, toluene, TCE, and VC were detected in several of these water samples; however, the concentrations of most detections were all well below the ESVs for surface water. Samples OUX-500TB-2 and OUX-500TB-3 contained PCE at concentrations 1.7 and 3.5 times greater than the ESVs, respectively. These two samples are located on a tributary of Boeuf Creek located downgradient of OU2. Based on known surface aquifer flow patterns and the location of these two locations in the landscape, it is likely that this tributary is charged by contaminated groundwater from OU2. It is important to note that laboratory data for the next downstream sample (OUX-500TB-4) did not detect PCE. Given the high volatility of PCE in surface water, it is likely to rapidly volatilize into the atmosphere from surface water, especially in a shallow, fast moving stream.

### **5.4 Risk Characterization for Herbivores**

Analytical results of tree and fruit samples were converted to exposure doses based on the equation and discussion presented in Section 3.4 and shown in Tables 3-5 and 3-6. All seven target compounds were detected in these samples of plant tissue. The estimated ADD for the representative mammal and bird species were compared to the wildlife ESVs presented in Table 4-3. Based on this comparison for the representative mammal and bird presented in Tables 5-1 and 5-2, respectively, none of the target compounds were present at levels that indicate a significant risk to herbivores.

## **6.0 Uncertainty**

ESVs and ingestions dose exposure parameters for the food chain exposure models were all based on approved guidance from EPA or other commonly accepted sources. Any uncertainties associated with these variables considered in this ERA are consistent with those normal scientific uncertainties commonly accepted in ecological risk assessment. However, the development and selection of these variables has been intentionally designed to minimize the potential for the under-estimation of ecological risk at the site.

### **6.1 Analytical Data Uncertainties**

The data for the target compounds have been provided by an EPA-approved analytical laboratory and have been validated in accordance with EPA standards. Several target compounds were reported as J-qualified data in the data set. J-qualified data indicate that the identification of the analyte is acceptable, but quality assurance criteria indicate that the quantitative values may be outside the normal range of precision, i.e., the quantitative value is considered estimated. J-qualified data is generally accepted for risk assessment purposes and it is unlikely that data quality adds significant uncertainty in the assessment of surface soils.

In the case of floodplain surface soil and sediment, the reporting values for TCE and VC were above the ESV for these respective media. Typically, analytical laboratories report detections below the reporting limit down to the method detection limit (MDL) with a J-qualifier. For soil and sediment, the MDL for TCE and VC are 1.2 and 1.6 ug/kg, respectively. The MDL for VC is below the ESVs for soil and sediment; therefore, it is unlikely that VC is present in these media at levels of concern. The MDL for TCE is only slightly above the ESVs for soil and sediment; therefore, even if it were present in these media, it would be at levels only slightly higher than the most conservative ecological criteria. Based on this information, the uncertainty associated with the reporting limits for TCE and VC is minor.

### **6.2 Food Chain Variables**

The exposure equation used in the food chain model relies on several variables that add uncertainty in the identification and assessment of target compounds. For the purposes of this ERA, these variables are biased toward conservatism to over-estimate the exposure dose

to avoid the elimination of risk-producing contaminants or exposure pathways. The FCM presented in the previous refinement makes the following conservative assumptions:

- The area usage factor (AUF) for receptor species is assumed to be 100 percent. This means that the receptor is assumed to spend all of its time in the contaminated area,
- The dietary fraction of the target food item (plant material) is assumed to be 100 percent for herbivores.

The selection of TRVs is based, when possible, on wildlife toxicity tests that were focused on the effects of a chronic oral ingestion of a contaminant on a reproductive endpoint. For several receptors, tests conducted under these conditions could not be obtained. In addition, the TRV species were never the same as the FCM species (which is not uncommon given the lack of ecological toxicity data available as a whole). This may result in over- or under-estimation of the food chain exposure risks.

It is important to note only two target compounds (cis- and trans-1,2-DCE) had toxicity information for birds; therefore, toxicity and risks from the other five target compounds could not be quantified. The ADD for the representative bird and mammal species are comparable and the toxicity of these target compounds is not expected to be significantly variable between birds and mammals (based on the comparison of data for cis-1,2-DCE). Based on this information, it is reasonable to assume that these compounds do not present a significant risk to herbivorous birds.

## 7.0 Conclusions

Based on the evaluation conducted in this ERA, surface waters in a portion of a tributary of Boeuf Creek, downstream of OU-2, may contain PCE at levels that could present a risk to ecological receptors. Floodplain surface soils, sediments, and plant tissue samples collected throughout the Riverfront Site's study are do not indicate a significant risk to the environment.

The risks presented by PCE in surface water collected at OUX-500TB-2 and OUX-500TB-3 are relatively minimal, having only produced HQs of 1.7 and 3.5, respectively. These two samples are located on a tributary of Boeuf Creek located downgradient of OU2. Based on known surface aquifer flow patterns and the location of these two locations in the landscape, it is likely that this tributary is charged by contaminated groundwater from OU2. It is important to note that laboratory data for the next downstream sample (OUX-500TB-4) did not detect PCE. Give the high volatility of PCE in surface water, it is likely to rapidly volatilize into the atmosphere from surface water, especially in a shallow, fast moving stream. This information suggests that PCE in groundwater being discharged at this location drives the ecological risk at this location.

There is sufficient information available to fully evaluate effect of the site on ecological receptors in the study area, and the risks are well defined given the data available. As a result, no further ecological investigation or analyses are recommended at the Riverfront Site. Section 8.0 of this ERA presents Preliminary Remedial Goals (PRGs) for PCE in surface water based on the information currently available. If lower remedial goals are required, additional ecological investigations will be required.

## **8.0 Preliminary Remedial Goals (PRGs)**

A PRG were developed for PCE in surface water at the Riverfront site. This PRG were based on the assumptions and limitations of this ERA for direct exposure. The PRGs present a concentration of PCE in surface water that is assumed to be protective of aquatic organisms in the habitats of the study area. A PRG for PCE of 8.9 ug/L was based on the EPA Region 5 environmental data quality limit.

## 9.0 References

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USFWS (U.S. Fish and Wildlife Service) 2001. County Distribution of Missouri's Federally-Listed Threatened, Endangered, Proposed, and Candidate Species. USFWS Region 3, Columbia, MO.

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## Tables

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Table 3-1  
 Analytical Results for Target Compounds Detected in Floodplain Surface Soils and Comparison to ESVs  
 Riverfront Site  
 New Haven, Missouri  
 Page 1 of 2

Target Compound	OUX-SO-EC01	OUX-SO-EC02	OUX-SO-EC03	OUX-SO-EC04	OUX-SO-EC05	OUX-SO-EC11	OUX-SO-EC08	OUX-SO-EC09	OUX-SO-EC06
Benzene	6.9 U	6.4 U	7.2 U	6.7 U	7 U	7 U	6.5 U	6.5 U	6.3 U
cis-Dichloroethene (cis-DCE)	3.4 U	3.2 U	3.6 U	3.3 U	3.6 U	3.5 U	3.2 U	3.2 U	3.2 U
Toluene	6.9 U	6.4 U	7.2 U	6.7 U	7 U	7 U	6.5 U	6.5 U	6.3 U
Tetrachloroethene (PCE)	6.9 U	6.4 U	7.2 U	6.7 U	7.1 U	7 U	6.4 U	6.5 U	6.3 U
trans-Dichloroethene (t-DCE)	3.4 U	3.2 U	3.6 U	3.3 U	3.6 U	3.5 U	3.2 U	3.2 U	3.2 U
Trichloroethene (TCE)	6.9 U	6.4 U	7.2 U	6.7 U	7.1 U	7 U	6.4 U	6.5 U	6.3 U
Vinyl chloride (VC)	14 U	13 U	14 U	13 U	14 U	14 U	13 U	13 U	13 U

Table 3-1  
**Analytical Results for Target Compounds Detected in Floodplain Surface Soils and Comparison to ESVs**  
 Riverfront Site  
 New Haven, Missouri  
 Page 2 of 2

Target Compound	OUX-SO-EC07	Total Samples	Total Detections	Minimum Detected	Maximum Detected	Ecological Screening Value	Total Detections > Screening Value	Screening HQ Based on Maximum	Selected as PCOPEC?
Benzene	6.2 U	10	0	na	na	50	0	0.00	YES
cis-Dichloroethene (cis-DCE)	3.1 U	10	0	na	na	400	0	0.00	NO
Toluene	6.2 U	10	0	na	na	10	0	0.00	NO
Tetrachloroethene (PCE)	6.2 U	10	0	na	na	50	0	0.00	NO
trans-Dichloroethene (t-DCE)	3.1 U	10	0	na	na	400	0	0.00	NO
Trichloroethene (TCE)	6.2 U	10	0	na	na	1	0	0.00	NO
Vinyl chloride (VC)	13 U	10	0	na	na	10	0	0.00	NO

Table 3-2  
**Analytical Results for Target Compounds Detected in Sediment and Comparison to ESVs**  
 Riverfront Site  
 New Haven, Missouri  
 Page 1 of 3

Target Compound	OUR-SD-MR01	OUR-SD-MR04	OUR-SD-MR05	OUR-SD-MR06	OUR-SD-MR07	OUR-SD-MR08	OUR-SD-MR09	OUR-SD-MR10
Benzene	4.25 U	3.05 U	3.05 U	4.7 U	3.35 U	4.45 U	3.75 U	3.95 U
cis-Dichloroethene (cis-DCE)	2.15 U	1.55 U	1.5 U	2.35 U	1.65 U	2.25 U	1.85 U	2 U
Tetrachloroethene (PCE)	4.25 U	3.05 U	3.05 U	4.7 U	3.35 U	4.45 U	3.75 U	3.95 U
Toluene	4.25 U	3.05 U	3.05 U	19	3.35 U	4.45 U	270	3.95 U
trans-Dichloroethene (t-DCE)	4.3 U	3.1 U	3 U	4.7 U	3.3 U	4.5 U	3.7 U	4 U
Trichloroethene (TCE)	4.25 U	3.05 U	3.05 U	4.7 U	3.35 U	4.45 U	3.75 U	3.95 U
Vinyl chloride (VC)	8.5 U	6 U	6 U	9.5 U	6.5 U	9 U	7.5 U	8 U

**Table 3-2**  
**Analytical Results for Target Compounds Detected in Sediment and Comparison to ESVs**  
**Riverfront Site**  
**New Haven, Missouri**  
**Page 2 of 3**

Target Compound	OUX-SD-EC03	OUX-SD-EC04	OUX-SD-EC05	OUX-SD-EC06	OUX-SD-EC07	OUX-SD-EC08	OUX-SD-EC09	OUX-SD-EC11
Benzene	4.1 U	2.95 U	3.65 U	3.15 U	3.05 U	3.55 U	3.6 U	3.15 U
cis-Dichloroethene (cis-DCE)	2.05 U	1.5 U	1.8 U	1.55 U	1.55 U	1.75 U	1.8 U	1.55 U
Tetrachloroethene (PCE)	4.1 U	2.95 U	2.8 J	1.8 J	3.05 U	3.55 U	3.6 U	3.15 U
Toluene	4.1 U	2.95 U	3.65 U	3.15 U	3.05 U	3.55 U	3.6 U	3.15 U
trans-Dichloroethene (t-DCE)	4.1 U	3 U	3.6 U	3.1 U	3.1 U	3.5 U	3.6 U	3.1 U
Trichloroethene (TCE)	4.1 U	2.95 U	3.65 U	3.15 U	3.05 U	3.55 U	3.6 U	3.15 U
Vinyl chloride (VC)	8 U	6 U	7.5 U	6.5 U	12 U	7 U	7 U	6.5 U

Table 3-2  
**Analytical Results for Target Compounds Detected in Sediment and Comparison to ESVs**  
**Riverfront Site**  
**New Haven, Missouri**  
**Page 3 of 3**

Target Compound	Total Samples	Total Detections	Minimum Detected	Maximum Concentration	Ecological Screening Value	Total Detections > Screening Value	Screening HQ Based on Maximum	Selected as PCOPEC?
Benzene	16	0	na	na	57	0	na	NO
cis-Dichloroethene (cis-DCE)	16	0	na	na	208.94	0	na	NO
Tetrachloroethene (PCE)	16	2	1.7	4.7	195.83	0	0.02	NO
Toluene	16	2	1.7	270	670	0	0.40	NO
trans-Dichloroethene (t-DCE)	16	0	na	na	208.94	0	na	NO
Trichloroethene (TCE)	16	0	na	na	179.56	0	na	NO
Vinyl chloride (VC)	16	0	na	na	2	0	na	NO

Table 3-3  
 Analytical Results for Target Compounds Detected in Surface Water and Comparison to ESVs  
 Riverfront Site  
 New Haven, Missouri  
 Page 1 of 4

Target Compound	OU4-210TB-C5	OU4-210TB-C6	OU4-210TB-C7	OUR-MR01	OUR-MR02	OUR-MR03	OUR-MR04	OUR-MR05	OUR-MR06
Benzene	1	1	1	U	1	U	1	U	U
cis-Dichloroethene (cis-DCE)	0.95	J 0.4	J 0.23	U	1	U	1	U	U
Tetrachloroethene (PCE)	7.4	5	0.36	U	1	U	1	U	U
Toluene	1	U	U	U 0.98	J 0.76	J 0.76	J 0.59	J 0.65	J 0.5
trans-Dichloroethene (t-DCE)	1	U 0.5	U	U	1	U	1	U	U
Trichloroethene (TCE)	0.57	J 0.36	U	U	1	U	1	U	U
Vinyl chloride (VC)	1	U 2	U	U	1	U	1	U	U





Table 3-3  
 Analytical Results for Target Compounds Detected in Surface Water and Comparison to ESVs  
 Riverfront Site  
 New Haven, Missouri  
 Page 4 of 4

Target Compound	Total Samples	Total Detections	Minimum Detected	Maximum Concentration	Ecological Screening Value	Total Detections > Screening Value	Screening HQ Based on Maximum	Selected as PCOPEC?
Benzene	24	0	na	na	46	0	na	NO
cis-Dichloroethene (cis-DCE)	24	7	0.23	1.7	310	0	0.005	NO
Tetrachloroethene (PCE)	24	8	0.33	31	8.9	2	3.48	YES
Toluene	24	11	0.48	1	130	0	0.01	NO
trans-Dichloroethene (t-DCE)	24	0	na	na	310	0	na	NO
Trichloroethene (TCE)	24	4	0.36	4.2	75	0	0.06	NO
Vinyl chloride (VC)	24	1	0.55	2	9.2	0	0.22	NO





**Table 3-5  
Food Chain Exposure Model for Mammalian Herbivores  
Riverfront Site  
New Haven, Missouri**

Target Compounds	Average Plant Tissue Concentration (mg/KG)	Maximum Plant Tissue Concentration (mg/KG)	Mammalian Herbivore	
			Average ADD (mg/kgBW-day)	Maximum ADD (mg/kgBW-day)
Data Source ---->	Table 3-4	Table 3-4	See Eq. 1	See Eq. 1
BENZENE	0.002	0.004	0.000	0.000
cis-1,2-DICHLOROETHYLENE	0.008	0.143	0.001	0.013
TETRACHLOROETHYLENE(PCE)	0.022	0.748	0.002	0.070
TOLUENE	0.002	0.090	0.000	0.008
trans-1,2-DICHLOROETHYLENE	0.001	0.005	0.000	0.000
TRICHLOROETHYLENE	0.006	0.065	0.001	0.006
VINYL CHLORIDE	0.002	0.004	0.000	0.000

**Ingestion Model:**

Eq. 1)  $ADD = [CPF * FDPF * AUF * NFIR]$

where:

CPF = Concentration of contaminant in food item (mg/KG)

FDPF = Fraction of diet comprised of item.

AUF = Area use factor (assume 1, most conservative)

NFIR = Normalized ingestion rate (g/gBW-day, from USEPA Wildlife Exposure Factors Handbook)

**Exposure Variables:**

Surrogate Receptor: Eastern Cottontail

<u>Variable</u>	<u>Value</u>	<u>Units</u>	<u>Reference</u>	<u>Notes</u>
AUF	1	unitless		Assumed for conservatism
NFIR	0.094	g/gBW-day	a	wet-weight basis
FDPF	1		a	100% of cottontail diet is plants

**References:**

a) EPA. 1993. U.S. Environmental Protection Agency, Office of Research and Development, Wildlife Exposure Factors Handbook, Vol. 1 of 2, EPA/600/R-93/187a, 1993.

**Table 3-6**  
**Food Chain Exposure Model for Avian Herbivores**  
**Riverfront Site**  
**New Haven, Missouri**

Target Compounds	Average Plant Tissue Concentration (mg/KG)	Maximum Plant Tissue Concentration (mg/KG)	Avian Herbivore	
			Average ADD (mg/kgBW-day)	Maximum ADD (mg/kgBW-day)
Data Source ---->	Table 3-4	Table 3-4	See Eq. 1	See Eq. 1
BENZENE	0.002	0.004	0.000	0.000
cis-1,2-DICHLOROETHYLENE	0.008	0.143	0.001	0.013
TETRACHLOROETHYLENE(PCE)	0.022	0.748	0.002	0.070
TOLUENE	0.002	0.090	0.000	0.008
trans-1,2-DICHLOROETHYLENE	0.001	0.005	0.000	0.000
TRICHLOROETHYLENE	0.006	0.065	0.001	0.006
VINYL CHLORIDE	0.002	0.004	0.000	0.000

**Ingestion Model:**

Eq. 1)  $ADD = [CPF * FDPF * AUF * NFIR]$

where:

CPF = Concentration of contaminant in food item (mg/KG)

FDPF = Fraction of diet comprised of item.

AUF = Area use factor (assume 1, most conservative)

NFIR = Normalized ingestion rate (g/gBW-day, from USEPA Wildlife Exposure Factors Handbook)

**Exposure Variables:**

Surrogate Receptor: Northern Bobwhite

Variable	Value	Units	Reference	Notes
AUF	1	unitless		Assumed for conservatism
NFIR	0.093	g/gBW-day	a	wet-weight basis
FDPF	1		a	100% of bobwhite diet is plants

**References:**

a) EPA. 1993. U.S. Environmental Protection Agency, Office of Research and Development, Wildlife Exposure Factors Handbook, Vol. 1 of 2, EPA/600/R-93/187a, 1993.

**Table 4-1  
Ecotoxicity Screening Values for Surface Soils  
Riverfront Site  
New Haven, Missouri  
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ParameterName	Ecotoxicity Values							Data Source
	EPA Region 4	EPA Region 5	Plant Toxicity	Canadian Soil Quality	Other Sources	Range of Toxicity Values	Screening Value Used in ERA	
	a	b	c	d				
<b>Volatile Organic Compounds (ug/KG)</b>								
BENZENE	50	255	-	500	-	50 - 500	50	a
cis-1,2-DICHLOROETHYLENE	400	784	-	-	-	400 - 783.73	400	a
TETRACHLOROETHYLENE (PCE)	10	9920	-	200	-	10 - 9920	10	a
TOLUENE	50	5450	200000	800	-	50 - 200000	50	a
trans-1,2-DICHLOROETHYLENE	400	784	-	-	-	400 - 783.73	400	a
TRICHLOROETHYLENE (TCE)	1	12400		3000		1 12400	1	a
VINYL CHLORIDE	10	646				10 646.14	10	a

**References:**

- a) EPA 1999. U.S. Environmental Protection Agency Region 4 Ecological Risk Assessment Bulletins – Supplemental to RAGS – Draft. August 11, 1999.
- b) EPA 1999. EPA Region 5 RCRA Ecological Data Quality Levels (EDQLs), Updated April 1999.
- c) Efrymson, R.A., M.E., Suter, G.W., and Wooten A.C. 1997a. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1997
- d) CCMOE. 1999. Canadian Council of Ministers of the Environment, Canadian Environmental Quality Guidelines. Canadian Soil Quality Guidelines for the Protection of

**Table 4-2**  
**Ecotoxicity Screening Values for Sediment**  
**Riverfront Site**  
**New Haven, Missouri**  
**Page 1 of 1**

ParameterName	Ecotoxicity Values					Data Source
	EPA Region 5	EPA Ecotox Fresh	Range of Toxicity Values	Screening Value Used in ERA		
Reference ---->	a	b				
<b>Volatile Organic Compounds (ug/KG)</b>						
BENZENE	142	57	57 - 141.57	57		b
cis-1,2-DICHLOROETHYLENE	209	-	208.94 - 208.94	209		a
trans-1,2-DICHLOROETHYLENE	209	-	208.94 - 208.94	209		a
TETRACHLOROETHYLENE(PCE)	196	530	195.83 - 530	196		a
TOLUENE	52500	670	670 - 52500	670		b
TRICHLOROETHYLENE	180	1600	179.56 - 1600	180		a
VINYL CHLORIDE	2	-	2 - 2	2		a

**References:**

- a) EPA 1999. EPA Region 5 RCRA Ecological Data Quality Levels (EDQLs), Updated April 1999.
- b) USEPA 1996. Eco Update (Ecotox Thresholds). Interim Bulletin Volume 3, Number 2. EPA 540/f-95/038, January 1996 - Freshwater

**Table 4-3**  
**Ecotoxicity Screening Values for Surface Water**  
**Riverfront Site**  
**New Haven, Missouri**  
**Page 1 of 1**

ParameterName	Screening Ecotoxicity Values					Data Source
	EPA Region 5	EPA Ecotox Fresh	Range of Toxicity Values	Screening Value Used in ERA		
Reference ---->	a	b				
BENZENE	114	46	46 - 114	46		b
cis-1,2-DICHLOROETHYLENE	310	-	310 - 310	310		a
TETRACHLOROETHYLENE(PCE)	8.9	120	8.9 - 120	8.9		a
TOLUENE	253	130	130 - 253	130		b
trans-1,2-DICHLOROETHYLENE	310	-	310 - 310	310		a
TRICHLOROETHYLENE (TCE)	75	350	75 - 350	75		a
VINYL CHLORIDE	9.2	-	9.2 - 9.2	9.2		a

**References:**

- a) EPA 1999. EPA Region 5 RCRA Ecological Data Quality Levels (EDQLs), Updated April 1999.
- b) USEPA 1996. Eco Update (Ecotox Thresholds). Interim Bulletin Volume 3, Number 2. EPA 540/f-95/038, January 1996 - Freshwater Surface Water

Table 4-4  
**Ecotoxicity Screening Values for Wildlife**  
 Riverfront Site  
 New Haven, Missouri  
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Target Compounds	Birds				Mammals					
	Toxicological Reference Doses		Test Species	Endpoint	Reference	Toxicological Reference Doses		Test Species	Endpoint	Reference
	NOAEL mg/kgBW-day	LOAEL mg/kgBW-day				NOAEL mg/kgBW-day	LOAEL mg/kgBW-day			
BENZENE	-	-	-	-	-	26.36	263.60	Mouse	Reproduction	a
dis-1,2-DICHLOROETHYLENE	17.20	34.40	Chicken <sup>1</sup>	Reproduction	a	45.20	-	Mouse	Hepatotoxicity	a
TETRACHLOROETHYLENE(PCE)	-	-	-	-	-	1.40	7.00	Mouse <sup>2</sup>	Hepatotoxicity	a
TOLUENE	-	-	-	-	-	26.00	260.00	Mouse	Reproduction	a
trans-1,2-DICHLOROETHYLENE	17.20	34.40	Chicken <sup>1</sup>	Reproduction	a	45.20	-	Mouse	Hepatotoxicity	a
TRICHLOROETHYLENE	-	-	-	-	-	0.70	7.00	Mouse	Hepatotoxicity	a
VINYL CHLORIDE	-	-	-	-	-	0.17	1.70	Rat	Mortality	a

**References:**

- (a) Toxicological Reference Values as cited in Appendix A of Sample, B.E., Opreko, D.M., and Suter, G.W. 1996. Toxicological Benchmarks for Wildlife. 1996 Revision. Lockheed Martin Energy Systems, Inc. for U.S. Department of Energy, June 1996. ES/ER/TM-86/R3.

**Notes:**

- (1) The value for 1,2-dichloroethane was used as a surrogate for this chemical, which had no available toxicological reference value.
- (2) The value for 1,1,2,2-tetrachloroethylene was used as a surrogate for this chemical, which had no available toxicological reference value.

**Table 5-1  
Risk Characterization for Food Chain Exposure to Mammalian Herbivores  
Riverfront Site  
New Haven, Missouri  
Page 1 of 1**

Target Compounds	Exposure		Toxicity		Risk Characterization			
	Average ADD (mg/kgBW-day)	Maximum ADD (mg/kgBW-day)	NOAEL mg/kgBW-day	LOAEL mg/kgBW-day	HQ = Exposure/Toxicity			
	Exposure		Toxicity		Average ADD	LOAEL	NOAEL	Maximum ADD
BENZENE	0.0023	0.0042	26.4	263.6	0.000087	0.000009	0.000159	0.000016
cis-1,2-DICHLOROETHYLENE	0.008	0.143	45.2	-	0.000175	-	0.003164	-
TETRACHLOROETHYLENE(PCE)	0.022	0.748	1.4	7.0	0.015714	0.003143	0.534286	0.106857
TOLUENE	0.002	0.090	26.0	260.0	0.000077	0.000008	0.003462	0.000346
trans-1,2-DICHLOROETHYLENE	0.0012	0.0045	45.2	-	0.000027	-	0.000100	-
TRICHLOROETHYLENE	0.006	0.065	0.7	7.0	0.008571	0.000857	0.092857	0.009286
VINYL CHLORIDE	0.0023	0.0040	0.2	1.7	0.013529	0.001353	0.023529	0.002353

**Table 5-2**  
**Risk Characterization for Food Chain Exposure to Avian Herbivores**  
**Riverfront Site**  
**New Haven, Missouri**  
**Page 1 of 1**

Target Compounds	Exposure		Toxicity		Risk Characterization			
	Average ADD (mg/kgBW-day)	Maximum ADD (mg/kgBW-day)	NOAEL mg/kgBW-day	LOAEL mg/kgBW-day	HQ = Exposure/Toxicity			
	Exposure		Toxicity		Average ADD	LOAEL	NOAEL	Maximum ADD
					NOAEL	LOAEL	NOAEL	LOAEL
BENZENE	0.0002	0.0004	-	-	-	-	-	-
cis-1,2-DICHLOROETHYLENE	0.001	0.013	17.2	34.4	0.000043	0.000021	0.000773	0.000387
TETRACHLOROETHYLENE(PCE)	0.002	0.070	-	-	-	-	-	-
TOLUENE	0.000	0.008	-	-	-	-	-	-
trans-1,2-DICHLOROETHYLENE	0.0001	0.0004	17.2	34.4	0.000006	0.000003	0.000024	0.000012
TRICHLOROETHYLENE	0.001	0.006	-	-	-	-	-	-
VINYL CHLORIDE	0.0002	0.0004	-	-	-	-	-	-

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## Figures